

ISO/IEC 14165-251:2008-01 (E)

Information technology - Fibre Channel - Part 251: Framing and Signaling (FC-FS)

Contents

FOREWORD	37
INTRODUCTION	40
1 Scope	41
2 Normative references	41
2.1 Approved references	41
2.2 References under development	41
2.3 Other references	41
3 Definitions, abbreviations, conventions and keywords	43
3.1 Definitions	43
3.2 Editorial conventions	50
3.3 Abbreviations, acronyms and symbols	51
3.3.1 Data rate abbreviations	51
3.3.2 Acronyms and other abbreviations	51
3.3.3 Symbols	55
3.4 Keywords	55
4 Structure and Concepts	57
4.1 Introduction	57
4.2 FC-1 general description	58
4.3 FC-2 general description	59
4.4 FC-FS physical model	60
4.5 Communication models	60
4.5.1 Introduction	60
4.5.2 Hunt Group	61
4.5.3 Fractional bandwidth	62
4.6 Bandwidth	62
4.7 Topology	62
4.7.1 Types	62
4.7.2 Point-to-point topology	62
4.7.3 Fabric topology	62
4.7.4 Arbitrated Loop topology	63
4.8 Classes of service	63
4.8.1 General	63
4.8.2 Class 1 service - dedicated connection	64
4.8.3 Class 2 service - multiplex	64
4.8.4 Class 3 service - datagram	64
4.8.5 Class 4 service – fractional bandwidth	65
4.8.6 Class 6 – multicast connection	65
4.9 Intermixing other classes with Class 1 or Class 6	65
4.10 General Fabric model	66
4.10.1 General	66
4.10.2 Fabric Ports (F_Ports)	66
4.10.3 Connection Service	68
4.10.4 Connectionless Service	68
4.11 Fibre Channel services	69
4.12 Building Blocks	69
4.12.1 Building block hierarchy	69
4.12.2 Frame	70
4.12.3 Sequence	70
4.12.3.1 Introduction	70
4.12.3.2 Sequence_Identifier (SEQ_ID)	70
4.12.3.3 Sequence Status Blocks	70
4.12.4 Exchange	71
4.12.4.1 Introduction	71

4.12.4.2	Exchange_Identifiers (OX_ID and RX_ID)	71
4.12.4.3	Association_Header	71
4.12.4.4	Exchange Status Blocks	71
4.12.5	Exchange of service parameters	71
4.13	Segmentation and reassembly	72
4.13.1	General	72
4.13.2	Application data mapping	72
4.13.3	Relative offset	72
4.13.4	Sending end mapping	72
4.13.5	Capability	72
4.13.6	FC-2 mapping	73
4.13.7	Segmentation	73
4.13.8	Reassembly	73
4.14	Error detection and recovery	73
5	FC-1 8B/10B transmission code	74
5.1	Introduction	74
5.2	Notation conventions	74
5.3	Character encoding and decoding	75
5.3.1	Introduction	75
5.3.2	Transmission order	75
5.3.3	Valid and invalid Transmission Characters	75
5.3.3.1	Definitions	75
5.3.3.2	Generating Transmission Characters	81
5.3.3.3	Validity of received Transmission Characters	81
5.4	Word encoding and decoding	82
5.5	Ordered Sets	82
5.5.1	General	82
5.5.2	Frame delimiters	83
5.5.3	Primitive Signals	83
5.5.3.1	Introduction	83
5.5.3.2	Idle	83
5.5.3.3	Receiver_Ready (R_RDY)	83
5.5.3.4	Virtual Circuit Ready (VC_RDY)	85
5.5.3.5	BB_SCs	85
5.5.3.6	BB_SCr	86
5.5.3.7	SYNx, SYNy, SYNz	86
5.5.3.8	ARByx, ARB(val)See [2]	86
5.5.3.9	CLS	86
5.5.3.10	DHD	86
5.5.3.11	MRKtx	86
5.5.3.12	OPNyx	86
5.5.3.13	OPNy	86
5.5.3.14	OPNyr	86
5.5.3.15	DHD	86
5.5.4	Primitive Sequences	86
5.5.4.1	Introduction	86
5.5.4.2	Not_Operational (NOS)	87
6	FC-1 Receiver and Transmitter State Diagrams	88
6.1	Receiver	88
6.1.1	Introduction	88
6.1.2	State Diagram Overview	88
6.1.3	Operational and Not Operational conditions	88
6.1.4	Word Synchronization Procedure	89
6.1.4.1	Bit Synchronization	89
6.1.4.2	Transmission Word synchronization	90
6.1.4.2.1	Introduction	90

6.1.4.2.2	Achieving Word Synchronization	90
6.1.4.2.3	Word alignment methods	90
6.1.4.2.3.1	Continuous-mode alignment	90
6.1.4.2.3.2	Explicit-mode alignment	90
6.1.5	Loss of Word Synchronization	90
6.1.5.1	Introduction	90
6.1.5.2	Detection of loss of Signal	91
6.1.5.3	Detection of an invalid Transmission Word	91
6.1.6	State transitions	91
6.1.6.1	Default State	91
6.1.6.2	State A (Loss of Synchronization)	91
6.1.6.3	State B (Word Synchronization Acquired)	91
6.1.6.3.1	State B.1 (No Invalid Transmission Word Detected State)	92
6.1.6.3.2	State B.2 (First Invalid Transmission Word Detected State)	92
6.1.6.3.3	State B.3 (Second Invalid Transmission Word Detected State)	92
6.1.6.3.4	State B.4 (Third Invalid Transmission Word Detection State)	92
6.1.6.4	State C (Reset)	92
6.2	Transmitter	93
6.2.1	State Diagram	93
6.2.2	Operational condition	93
6.2.3	State Transitions	93
6.2.3.1	Not Enabled State	93
6.2.3.2	Working State	94
6.2.3.3	Failure State	94
7	FC_Port state machine	95
7.1	State diagram	95
7.2	Active State (AC)	95
7.3	Link Recovery	95
7.3.1	Link recovery hierarchy	95
7.3.2	LR Transmit State (LR1)	95
7.3.2.1	General (while in the LR1 state)	95
7.3.2.2	Class 1 (while in the LR1 state)	95
7.3.2.3	Class 2 and Class 3 (while in the LR1 state)	96
7.3.2.4	Class 4 (while in the LR1 state)	97
7.3.2.5	Class 6 (while in the LR1 state)	97
7.3.3	LR Receive State (LR2)	97
7.3.3.1	General (while in the LR2 state)	97
7.3.3.2	Class 1 (while in the LR2 state)	97
7.3.3.3	Class 4 (while in the LR2 state)	97
7.3.3.4	Class 6 (while in the LR2 state)	98
7.3.4	LRR Receive State (LR3)	98
7.3.4.1	General (while in the LR3 state)	98
7.3.4.2	Class 1 and Class 6 behavior (while in the LR3 state)	98
7.3.4.3	Class 4 behavior (while in the LR2 state)	98
7.4	Link Failure	99
7.4.1	NOS Receive State (LF1)	99
7.4.1.1	General	99
7.4.1.2	Class 4 behavior	99
7.4.2	NOS Transmit State (LF2)	99
7.4.2.1	General	99
7.4.2.2	Class 4 behavior	99
7.5	Offline	99
7.5.1	General	99
7.5.2	OLS Transmit State (OL1)	100
7.5.2.1	Actions applicable to all classes	100
7.5.2.2	Class 4 behavior	100
7.5.3	OLS Receive State (OL2)	100

7.5.3.1	General	100
7.5.3.2	Class 4 behavior	100
7.5.4	Wait for OLS State (OL3)	100
7.5.4.1	Actions applicable to all classes	100
7.5.4.2	Class 4 behavior	101
7.6	Primitive Sequence protocols	101
7.6.1	Functions	101
7.6.2	Link Initialization protocol	101
7.6.3	Link Reset protocol	101
7.6.4	Link Failure protocol	101
7.6.5	Online-to-offline protocol	102
8	Frame formats	103
8.1	General frame format	103
8.2	Frame transmission	103
8.3	Start-of-Frame (SOF) delimiter	103
8.3.1	Introduction	103
8.3.2	SOF Connect Class 1 or 6 (SOF _{c1})	104
8.3.3	SOF Circuit Activate Class 4 (SOF _{c4})	104
8.3.4	SOF Initiate (SOF _{ix})	104
8.3.4.1	Applicability	104
8.3.4.2	SOF Initiate Class 1 or 6 (SOF _{i1})	104
8.3.4.3	SOF Initiate Class 2 (SOF _{i2})	104
8.3.4.4	SOF Initiate Class 3 (SOF _{i3})	104
8.3.4.5	SOF Initiate Class 4 (SOF _{i4})	104
8.3.5	SOF Normal (SOF _{nx})	104
8.3.5.1	Applicability	104
8.3.5.2	SOF Normal Class 1 or 6 (SOF _{n1})	104
8.3.5.3	SOF Normal Class 2 (SOF _{n2})	104
8.3.5.4	SOF Normal Class 3 (SOF _{n3})	104
8.3.5.5	SOF Normal Class 4 (SOF _{n4})	105
8.3.6	SOF Fabric (SOF _f)	105
8.4	Frame_Header	105
8.5	Data Field	105
8.6	CRC	105
8.7	End-of-Frame (EOF) delimiter	106
8.7.1	Introduction	106
8.7.2	Valid frame content	106
8.7.2.1	EOF Normal (EOF _n)	106
8.7.2.2	EOF Terminate (EOF _t)	106
8.7.2.3	EOF Disconnect Terminate (EOF _{dt}) (Class 1 or Class 6)	106
8.7.2.4	EOF Deactivate Terminate (EOF _{dt}) (Class 4)	107
8.7.2.5	EOF Remove Terminate (EOF _{rt})	107
8.7.3	Invalid frame content	107
8.7.3.1	General	107
8.7.3.2	End of Frame Abort (EOF _a)	107
8.7.3.3	EOF Disconnect Terminate Invalid (EOF _{dti}) (Class 1 and Class 6)	108
8.7.3.4	EOF Deactivate Terminate Invalid (EOF _{dti}) (Class 4)	108
8.7.3.5	EOF Remove Terminate Invalid (EOF _{rti})	108
8.7.3.6	EOF Invalid (EOF _{ni})	108
8.8	Frame field order	108
8.9	Frame reception	110
8.9.1	Rules	110
8.9.2	Frame validity	110
8.9.3	Invalid frame processing	110
9	Frame_Header	111
9.1	Introduction	111

9.2	Identification	111
9.2.1	Frame identification	111
9.2.2	Sequence identification	111
9.3	Routing Control (R_CTL)	112
9.3.1	Introduction	112
9.3.2	ROUTING Field	112
9.3.3	INFORMATION Field	112
9.4	Address identifiers (D_ID, S_ID)	114
9.4.1	General	114
9.4.2	Reserved address identifiers	114
9.4.3	Destination_ID (D_ID)	114
9.4.4	Source_ID (S_ID)	114
9.5	Class Specific Control (CS_CTL)/Priority	115
9.5.1	Introduction	115
9.5.2	CS_CTL	115
9.5.2.1	General	115
9.5.2.2	Class 1 and Class 6	115
9.5.2.3	Class 2	116
9.5.2.4	Class 3	116
9.5.2.5	Class 4	117
9.5.3	Priority	118
9.5.3.1	Introduction	118
9.5.3.2	Class 1 and Class 6	118
9.5.3.3	Class 2 and Class 3	119
9.5.3.4	Class 4	119
9.6	Data structure type (TYPE)	120
9.7	Frame Control (F_CTL)	122
9.7.1	Introduction	122
9.7.2	Exchange Context	122
9.7.3	Sequence Context	124
9.7.4	First_Sequence	125
9.7.5	Last_Sequence	125
9.7.6	End_Sequence	125
9.7.7	End_Connection (E_C) (Class 1 or 6) or Deactivate Class 4 circuit	125
9.7.8	CS_CTL/Priority Enable	125
9.7.9	Sequence Initiative	126
9.7.10	ACK_Form	126
9.7.11	Retransmitted Sequence	126
9.7.12	Unidirectional Transmit or Remove_Connection	126
9.7.13	Continue Sequence Condition	127
9.7.14	Abort Sequence Condition	127
9.7.15	Relative offset present	128
9.7.16	Exchange reassembly	129
9.7.17	Fill Data Bytes	129
9.7.18	F_CTL bits on Data frames	129
9.7.19	F_CTL bits on Link_Control frames	130
9.8	Sequence_ID (SEQ_ID)	132
9.9	Data Field Control (DF_CTL)	132
9.10	Sequence count (SEQ_CNT)	133
9.11	Originator Exchange_ID (OX_ID)	133
9.12	Responder Exchange_ID (RX_ID)	134
9.13	Parameter	134
10	Optional headers	135
10.1	Introduction	135
10.2	ESP_Header	136
10.3	Network_Header	138

10.4	Association_Header	139
10.4.1	Introduction	139
10.4.2	Process_Associators	140
10.4.2.1	Originator and Responder Process_Associators	140
10.4.2.2	Multicast Process_Associator	140
10.4.2.3	Operation_Associators	141
10.5	Device_Header	141
11	Data frames and responses	142
11.1	Data frames	142
11.1.1	Introduction	142
11.1.2	Frame Delimiters	142
11.1.3	Addressing	142
11.1.4	Data Field	143
11.1.5	Payload size	143
11.1.6	Responses	143
11.1.6.1	R_RDY response	143
11.1.6.2	Data frame responses	143
11.1.6.2.1	Introduction	143
11.1.6.2.2	ACK frames - successful Data frame delivery	143
11.1.6.3	Link_Response frames - Unsuccessful Data frame delivery	144
11.2	Link_Control Frames	144
11.2.1	Introduction	144
11.2.2	Link_Continue function	146
11.2.2.1	Introduction	146
11.2.2.2	Receiver Ready (R_RDY)	146
11.2.2.3	Acknowledge (ACK)	147
11.2.2.3.1	General	147
11.2.2.3.2	ACK_1	148
11.2.2.3.3	ACK_0	148
11.2.2.3.4	Header definition for all ACK forms	148
11.2.2.3.4.1	Addressing	148
11.2.2.3.4.2	F_CTL	148
11.2.2.3.4.3	SEQ_ID	148
11.2.2.3.4.4	SEQ_CNT	148
11.2.2.3.4.5	Parameter field	149
11.2.2.3.5	Responses	149
11.2.3	Link_Response	149
11.2.3.1	Introduction	149
11.2.3.2	Fabric Busy (F_BSY)	149
11.2.3.2.1	Description	149
11.2.3.2.2	Responses	150
11.2.3.3	N_Port Busy (P_BSY)	150
11.2.3.3.1	Description	150
11.2.3.3.2	Responses	152
11.2.3.4	Reject (P_RJT, F_RJT)	152
11.2.3.4.1	Introduction	152
11.2.3.4.2	Class 4	153
11.2.3.4.3	Parameter field	153
11.2.3.4.3.1	Reject Code format	153
11.2.3.4.3.2	Invalid D_ID	156
11.2.3.4.3.3	Invalid S_ID	156
11.2.3.4.3.4	Nx_Port not available, temporary	156
11.2.3.4.3.5	Nx_Port not available, permanent	156
11.2.3.4.3.6	Class not supported	156
11.2.3.4.3.7	Delimiter usage error	156
11.2.3.4.3.8	TYPE not supported	157

11.2.3.4.3.9	Invalid Link_Control	157
11.2.3.4.3.10	Invalid R_CTL field	157
11.2.3.4.3.11	Invalid F_CTL field	157
11.2.3.4.3.12	Invalid OX_ID	157
11.2.3.4.3.13	Invalid RX_ID	157
11.2.3.4.3.14	Invalid SEQ_ID	157
11.2.3.4.3.15	Invalid DF_CTL	157
11.2.3.4.3.16	Invalid SEQ_CNT	157
11.2.3.4.3.17	Invalid Parameter field	157
11.2.3.4.3.18	Exchange Error	157
11.2.3.4.3.19	Protocol Error	157
11.2.3.4.3.20	Incorrect length	157
11.2.3.4.3.21	Unexpected ACK	158
11.2.3.4.3.22	Class of service not supported by entity at hex 'FF FF FE'	158
11.2.3.4.3.23	Login Required	158
11.2.3.4.3.24	Excessive Sequences attempted	158
11.2.3.4.3.25	Unable to Establish Exchange	158
11.2.3.4.3.26	Fabric path not available	158
11.2.3.4.3.27	Invalid VC_ID (Class 4)	158
11.2.3.4.3.28	Invalid CS_CTL Field	158
11.2.3.4.3.29	Insufficient resources for VC (Class 4)	158
11.2.3.4.3.30	Invalid class of service	158
11.2.3.4.3.31	Preemption request rejected	158
11.2.3.4.3.32	Preemption not enabled	158
11.2.3.4.3.33	Multicast error	159
11.2.3.4.3.34	Multicast error terminate	159
11.2.3.4.3.35	Vendor Specific Reject	159
11.2.3.4.3.36	Responses	159
11.2.4	Link_Control commands	159
11.2.4.1	Introduction	159
11.2.4.2	Link Credit Reset (LCR)	159
11.2.4.2.1	Description	159
11.2.4.2.2	Protocol	160
11.2.4.2.3	Request Sequence	160
11.2.4.2.4	Responses	160
11.2.4.3	End (END)	160
11.2.4.3.1	Description	160
11.2.4.3.2	Protocol	161
11.2.4.3.3	Request Sequence	161
11.2.4.3.4	Reply Sequence	161
11.3	ACK generation assistance	161
11.3.1	Introduction	161
11.3.2	N_Port Login	161
11.3.2.1	Capability Indicator	161
11.3.3	Applicability	161
11.3.4	F_CTL bits	161
11.3.5	Login rules	161
11.3.6	ACK_Form errors	162
12	Link Services	163
12.1	Sequence and Exchange management	163
12.2	Basic Link Service commands	163
12.2.1	Introduction	163
12.2.2	Abort Sequence (ABTS)	164
12.2.2.1	Overview	164
12.2.2.2	Aborting Sequences using ABTS	165
12.2.2.2.1	Introduction	165

12.2.2.2.2	ABTS Initiator	165
12.2.2.2.3	ABTS Recipient	165
12.2.2.2.4	Recovery Qualifier	166
12.2.2.2.5	Protocol	166
12.2.2.2.6	Request Sequence	166
12.2.2.2.7	Reply Sequence	167
12.2.2.3	Aborting Exchanges using ABTS	167
12.2.2.3.1	Introduction	167
12.2.2.3.2	ABTS sent by the last Sequence Initiator in an open Sequence	168
12.2.2.3.3	ABTS sent by the last Sequence Initiator in a new Sequence	168
12.2.2.3.4	ABTS sent in an open or new Sequence	168
12.2.2.3.5	ABTS by the last Sequence Recipient	168
12.2.2.3.6	Request Sequence	168
12.2.2.3.7	Reply Sequence	169
12.2.3	Basic Accept (BA_ACC)	170
12.2.3.1	Description	170
12.2.3.2	Protocol	170
12.2.3.3	Request Sequence	170
12.2.3.4	Reply Sequence	170
12.2.4	Basic Reject (BA_RJT)	170
12.2.4.1	Description	170
12.2.4.2	Protocol	170
12.2.4.3	Request Sequence	170
12.2.4.4	Reply Sequence	171
12.2.5	No Operation (NOP)	172
12.2.5.1	Description	172
12.2.5.2	Protocol	172
12.2.5.3	Request Sequence	172
12.2.5.4	Reply Sequence	172
12.2.6	Remove Connection (RMC)	172
12.2.6.1	Description	172
12.2.6.2	Protocol:	173
12.2.6.3	Request Sequence	173
12.2.6.4	Reply Sequence	173
12.2.7	Dedicated connection preempted (PRMT)	173
12.2.7.1	Description	173
12.2.7.2	Protocol	173
12.2.7.3	Request Sequence	173
12.2.7.4	Reply Sequence	173
12.3	Extended Link Services	173
12.3.1	Introduction	173
12.3.2	Extended Link Service requests	174
12.3.2.1	Introduction	174
12.3.2.2	Abort Exchange (ABTX)	178
12.3.2.2.1	Description	178
12.3.2.2.2	Protocol	179
12.3.2.2.3	Request Sequence	179
12.3.2.2.4	Reply Sequence	180
12.3.2.3	Advise Credit (ADVC)	180
12.3.2.3.1	Description	180
12.3.2.3.2	Protocol	180
12.3.2.3.3	Request Sequence	180
12.3.2.3.4	Reply Sequence	181
12.3.2.4	Echo (ECHO)	182
12.3.2.4.1	Description	182
12.3.2.4.2	Protocol	182
12.3.2.4.3	Request Sequence	183

12.3.2.4.4	Reply Sequence	183
12.3.2.5	Estimate Credit (ESTC)	183
12.3.2.5.1	Description	183
12.3.2.5.2	Protocol	183
12.3.2.5.3	Request Sequence	184
12.3.2.5.4	Reply Sequence	184
12.3.2.6	Establish Streaming (ESTS)	184
12.3.2.6.1	Description	184
12.3.2.6.2	Protocol	184
12.3.2.6.3	Request Sequence	184
12.3.2.6.4	Reply Sequence	185
12.3.2.7	Login (FLOGI/PLOGI)	186
12.3.2.7.1	Description	186
12.3.2.7.2	Protocol	186
12.3.2.7.3	Request Sequence	186
12.3.2.7.4	Reply Sequence	186
12.3.2.8	Logout (LOGO)	186
12.3.2.8.1	Description	186
12.3.2.8.2	Protocol	187
12.3.2.8.3	Request Sequence	187
12.3.2.8.4	Reply Sequence	187
12.3.2.9	Read Connection Status (RCS)	187
12.3.2.9.1	Description	187
12.3.2.9.2	Protocol	187
12.3.2.9.3	Request Sequence	188
12.3.2.9.4	Reply Sequence	188
12.3.2.10	Read Exchange Status Block (RES)	189
12.3.2.10.1	Description	189
12.3.2.10.2	Protocol	190
12.3.2.10.3	Request Sequence	190
12.3.2.10.4	Reply Sequence	190
12.3.2.11	Read Link Error Status Block (RLS)	191
12.3.2.11.1	Description	191
12.3.2.11.2	Protocol	191
12.3.2.11.3	Request Sequence	191
12.3.2.11.4	Reply Sequence	191
12.3.2.12	Read Sequence Status Block (RSS)	191
12.3.2.12.1	Description	191
12.3.2.12.2	Protocol	192
12.3.2.12.3	Request Sequence	192
12.3.2.12.4	Reply Sequence	192
12.3.2.13	Read Timeout Value (RTV)	193
12.3.2.13.1	Description	193
12.3.2.13.2	Protocol	193
12.3.2.13.3	Request Sequence	193
12.3.2.13.4	Reply Sequence	193
12.3.2.14	Reinstate Recovery Qualifier (RRQ)	194
12.3.2.14.1	Description	194
12.3.2.14.2	Protocol	194
12.3.2.14.3	Request Sequence	194
12.3.2.14.4	Reply Sequence	195
12.3.2.15	Request Sequence Initiative (RSI)	195
12.3.2.15.1	Description	195
12.3.2.15.2	Protocol	196
12.3.2.15.3	Request Sequence	196
12.3.2.15.4	Reply Sequence	196
12.3.2.16	Test (TEST)	196

12.3.2.16.1	Description	196
12.3.2.16.2	Protocol	197
12.3.2.16.3	Request Sequence	197
12.3.2.16.4	Reply Sequence	197
12.3.2.17	Report node Capability Information (RNC)	197
12.3.2.18	Fabric Address Notification (FAN)	197
12.3.2.18.1	Description	197
12.3.2.18.2	Protocol	198
12.3.2.18.3	Request Sequence	198
12.3.2.18.4	Reply Sequence	198
12.3.2.19	Loop Initialize (LINIT)	198
12.3.2.19.1	Description	198
12.3.2.19.2	Protocol	198
12.3.2.19.3	Request Sequence	198
12.3.2.19.4	Reply Sequence	199
12.3.2.20	Loop Port Control (LPC) (Obsolete)	200
12.3.2.21	Loop Status (LSTS)	200
12.3.2.21.1	Description	200
12.3.2.21.2	Protocol	200
12.3.2.21.3	Request Sequence	200
12.3.2.21.4	Reply Sequence	200
12.3.2.22	Registered State Change Notification (RSCN)	202
12.3.2.22.1	Introduction	202
12.3.2.22.2	RSCNs issued by the Fabric Controller	203
12.3.2.22.3	RSCN issued by the affected Nx_Port	203
12.3.2.22.4	RSCN initiative	203
12.3.2.22.5	RSCN registration	203
12.3.2.22.6	Protocol	203
12.3.2.22.7	Request Sequence	204
12.3.2.22.8	Reply Sequence	205
12.3.2.23	State Change Registration (SCR)	206
12.3.2.23.1	Description	206
12.3.2.23.2	Protocol	206
12.3.2.23.3	Request Sequence	206
12.3.2.23.4	Reply Sequence	207
12.3.2.24	Process login (PRLI)	207
12.3.2.24.1	Introduction	207
12.3.2.24.2	Protocol	207
12.3.2.24.3	Request Sequence	207
12.3.2.24.4	Reply Sequence	209
12.3.2.25	Process logout (PRLO)	211
12.3.2.25.1	Description	211
12.3.2.25.2	Protocol	211
12.3.2.25.3	Request Sequence	212
12.3.2.25.4	Reply sequence	213
12.3.2.26	State change notification (SCN)	216
12.3.2.27	Test Process Login State (TPLS)	216
12.3.2.27.1	Description	216
12.3.2.27.2	Protocol	216
12.3.2.27.3	Request Sequence	216
12.3.2.27.4	Reply sequence	218
12.3.2.28	Fibre Channel Address Resolution Protocol Request (FARP_REQ)	220
12.3.2.28.1	Description	220
12.3.2.28.2	Protocol	220
12.3.2.28.3	Request Sequence	220
12.3.2.28.4	Reply Sequence	224
12.3.2.29	Fibre Channel Address Resolution Protocol Reply (FARP_REPLY)	224

12.3.2.29.1	Description	224
12.3.2.29.2	Protocol	225
12.3.2.29.3	Request Sequence	225
12.3.2.29.4	Reply Sequence	227
12.3.2.30	Request Node Identification Data (RNID)	227
12.3.2.30.1	Introduction	227
12.3.2.30.2	Protocol	228
12.3.2.30.3	Request Sequence	228
12.3.2.30.4	Reply Sequence:	229
12.3.2.31	Registered Link Incident Report (RLIR)	234
12.3.2.31.1	Description	234
12.3.2.31.2	Link Incident reporting procedure	234
12.3.2.31.3	Protocol	235
12.3.2.31.4	Request Sequence	235
12.3.2.31.5	Reply Sequence	241
12.3.2.32	Link Incident Record Registration (LIRR)	241
12.3.2.32.1	Description	241
12.3.2.32.2	Registration for Link Incident Records	241
12.3.2.32.3	Responsibilities of Valid-Registered Recipients	242
12.3.2.32.4	Protocol	242
12.3.2.32.5	Request Sequence	242
12.3.2.32.6	Reply Sequence	243
12.3.2.33	Get Alias_ID (GAID)	244
12.3.2.33.1	Description	244
12.3.2.33.2	Protocol	244
12.3.2.33.3	Request Sequence	244
12.3.2.33.4	Reply Sequence	245
12.3.2.34	Fabric Activate Alias_ID (FACT)	245
12.3.2.34.1	Description	245
12.3.2.34.2	Protocol	245
12.3.2.34.3	Request Sequence	245
12.3.2.34.4	Reply Sequence	246
12.3.2.35	Fabric Deactivate Alias_ID (FDACT)	246
12.3.2.35.1	Description	246
12.3.2.35.2	Protocol	246
12.3.2.35.3	Request Sequence	246
12.3.2.35.4	Reply Sequence	247
12.3.2.36	N_Port Activate Alias_ID (NACT)	247
12.3.2.36.1	Description	247
12.3.2.36.2	Protocol	247
12.3.2.36.3	Reply Sequence	248
12.3.2.36.4	Reply Sequence	248
12.3.2.37	N_Port Deactivate Alias_ID (NDACT)	249
12.3.2.37.1	Description	249
12.3.2.37.2	Protocol	249
12.3.2.37.3	Request Sequence	249
12.3.2.37.4	Reply Sequence	249
12.3.2.38	Quality of Service Request (QoSR)	250
12.3.2.38.1	Description	250
12.3.2.38.2	Protocol	250
12.3.2.38.3	Request Sequence	250
12.3.2.38.4	Reply Sequence	252
12.3.2.39	Read Virtual Circuit Status (RVCS)	254
12.3.2.39.1	Description	254
12.3.2.39.2	Protocol	254
12.3.2.39.3	Request Sequence	254
12.3.2.39.4	Reply Sequence	255

12.3.2.40	Discover N_Port/Service Parameters (PDISC)	255
12.3.2.40.1	Description	255
12.3.2.40.2	Protocol	255
12.3.2.40.3	Request Sequence	255
12.3.2.40.4	Reply Sequence	256
12.3.2.41	Discover F_Port Service Parameters (FDISC)	256
12.3.2.41.1	Description	256
12.3.2.41.2	Protocol	256
12.3.2.41.3	Request Sequence	256
12.3.2.41.4	Reply Sequence	256
12.3.2.42	Discover Address (ADISC)	256
12.3.2.42.1	Description	256
12.3.2.42.2	Protocol	256
12.3.2.42.3	Request Sequence	257
12.3.2.42.4	Reply Sequence	257
12.3.2.43	Third Party Process Logout (TPRLO)	258
12.3.2.43.1	Description	258
12.3.2.43.2	Protocol	258
12.3.2.43.3	Request Sequence	258
12.3.2.44	Clock Synchronization Request (CSR)	260
12.3.2.44.1	Description	260
12.3.2.44.2	Protocol	260
12.3.2.44.3	Request Sequence	260
12.3.2.44.4	Reply Sequence	260
12.3.2.45	Clock Synchronization Update (CSU)	260
12.3.2.45.1	Description	260
12.3.2.45.2	Protocol	261
12.3.2.45.3	Request Sequence	261
12.3.2.45.4	Reply Sequence	261
12.3.2.46	Login Control List Management (LCLM)	261
12.3.2.46.1	Description	261
12.3.2.46.2	Protocol	263
12.3.2.46.3	Request Sequence	263
12.3.2.46.4	Reply sequence	264
12.3.2.47	Read Port Status Block (RPS)	266
12.3.2.47.1	Description	266
12.3.2.47.2	Protocol	266
12.3.2.47.3	Request Sequence	266
12.3.2.47.4	Reply Sequence	267
12.3.2.48	Read Port List (RPL)	270
12.3.2.48.1	Description	270
12.3.2.48.2	Protocol	270
12.3.2.48.3	Request Sequence	270
12.3.2.48.4	Reply Sequence	271
12.3.2.49	Report Port Buffer Conditions (RPBC)	271
12.3.2.49.1	Description	271
12.3.2.49.2	Protocol	272
12.3.2.49.3	Request Sequence	272
12.3.2.49.4	Reply Sequence	272
12.3.2.50	Report node FC-4 Types (RNFT)	273
12.3.2.50.1	Description	273
12.3.2.50.2	Protocol	273
12.3.2.50.3	Request Sequence	273
12.3.2.50.4	Reply Sequence	274
12.3.2.51	Scan Remote Loop (SRL)	275
12.3.2.51.1	Description	275
12.3.2.51.2	Protocol	275

12.3.2.51.3	Request Sequence	275
12.3.2.51.4	Reply Sequence	276
12.3.2.52	Set Bit-error Reporting Parameters (SBRP)	276
12.3.2.52.1	Description	276
12.3.2.52.2	Protocol	277
12.3.2.52.3	Request Sequence	277
12.3.2.52.4	Reply Sequence	278
12.3.2.53	Report Port Speed Capabilities (RPSC)	279
12.3.2.53.1	Description	279
12.3.2.53.2	Protocol	279
12.3.2.53.3	Request Sequence	279
12.3.2.53.4	Reply Sequence	280
12.3.2.54	Read Exchange Concise (REC)	280
12.3.2.54.1	Description	280
12.3.2.54.2	Protocol	281
12.3.2.54.3	Request Sequence	281
12.3.2.54.4	Reply Sequence	281
12.3.3	Extended Link Service Reply Sequences	282
12.3.3.1	Overview	282
12.3.3.2	LS_ACC	282
12.3.3.3	Reply Sequence	283
12.3.3.4	Link Service Reject (LS_RJT)	283
12.3.3.4.1	Description	283
12.3.3.4.2	Payload	283
12.3.3.4.3	Reply Sequence	285
12.4	FC-4 Link Service	286
13	Classes of service-	288
13.1	Introduction	288
13.2	Class 1 - Dedicated connection	288
13.2.1	Function	288
13.2.2	Rules	289
13.2.3	Delimiters	290
13.2.4	Frame size	290
13.2.5	Flow control	290
13.2.6	Stacked connect-requests	290
13.3	Class 2 - Multiplex	290
13.3.1	Function	290
13.3.2	Rules	291
13.3.3	Delimiters	292
13.3.4	Frame size	292
13.3.5	Flow control	292
13.4	Class 3 - Datagram	292
13.4.1	Function	292
13.4.2	Rules	293
13.4.3	Delimiters	293
13.4.4	Frame size	294
13.4.5	Flow control	294
13.4.6	Sequence integrity	294
13.5	Intermix	294
13.5.1	Introduction	294
13.5.2	Rules	294
13.5.3	Frame size	295
13.5.4	Flow control	295
13.6	Class 4 - Fractional	295
13.6.1	Function	295
13.6.2	Procedures	296

13.6.3	Login	297
13.6.4	Circuit Setup	297
13.6.5	Circuit Activation	297
13.6.6	Circuit Deactivation	297
13.6.7	Circuit Removal	298
13.6.8	Rules	298
13.6.9	Interleaving other classes of service in Class 4	299
13.6.10	Class 4 delimiters	299
13.6.11	Frame size	300
13.6.12	End-to-end flow control	300
13.6.13	Buffer-to-buffer flow control	300
13.7	Class 6 - Connected Multicast	301
13.7.1	Function	301
13.7.2	Rules	301
13.7.3	Delimiters	303
13.7.4	Frame size	303
13.7.5	Flow control	303
13.7.6	Stacked Connect-requests	303
14	Name_Identifier Formats	304
14.1	Introduction	304
14.2	IEEE 48-bit address	304
14.3	IEEE extended	305
14.4	Locally assigned	305
14.5	32-bit IP address	306
14.6	IEEE registered	306
14.7	IEEE registered extended	307
14.8	Other uses of IEEE registered Company_ID	307
14.9	EUI-64 Mapped	307
14.9.1	General	307
14.9.2	EUI-64 to WWN Mapping Rules	308
14.9.3	Encapsulated MAC-48 and EUI-48 translation	308
15	Login and Service Parameters	309
15.1	Introduction	309
15.2	Default Login values	309
15.3	Fabric Login	310
15.3.1	Introduction	310
15.3.2	Explicit Fabric Login	310
15.3.2.1	Introduction	310
15.3.2.2	Explicit Fabric Login Request	310
15.3.2.3	Responses to Explicit Fabric Login	310
15.3.2.4	ReLogin with the Fabric	311
15.3.3	SOF delimiters	312
15.3.4	Frequency	312
15.3.5	Fabric Login completion - Originator	312
15.3.6	Fabric Login completion - Responder	312
15.4	N_Port Login	313
15.4.1	Introduction	313
15.4.2	Explicit N_Port Login	314
15.4.2.1	Introduction	314
15.4.2.2	N_Port Login - Fabric present	314
15.4.2.3	Responses to N_Port Login - Fabric present	314
15.4.2.4	N_Port Login - No Fabric present	315
15.4.2.5	Responses to N_Port Login - No Fabric present	315
15.4.3	SOF delimiters	316
15.4.4	Frequency	316
15.4.5	N_Port Login completion - Originator	316

15.4.6	N_Port Login completion - Responder	316
15.4.7	N_Port Login frame flow	316
15.5	Logout	317
15.5.1	Introduction	317
15.5.2	Explicit N_Port Logout	317
15.5.3	Implicit Logout	317
15.6	Service Parameters	317
15.6.1	ELS and LS_ACC Payload	317
15.6.2	Common Service Parameters	319
15.6.2.1	Applicability	319
15.6.2.2	Payload	320
15.6.2.3	Buffer-to-buffer Credit	321
15.6.2.4	Common Features	321
15.6.2.4.1	Continuously increasing relative offset	321
15.6.2.4.2	Clean Address	322
15.6.2.4.3	Random relative offset	322
15.6.2.4.4	Valid Vendor Version Level	322
15.6.2.4.5	Multiple N_Port_ID Assignment	322
15.6.2.4.6	N_Port/F_Port	322
15.6.2.4.7	BB_Credit Management	322
15.6.2.4.8	E_D_TOV Resolution	323
15.6.2.4.9	Multicast	323
15.6.2.4.10	Broadcast	323
15.6.2.4.11	Hunt Group	323
15.6.2.4.12	Query Buffer Conditions	323
15.6.2.4.13	Clock Synchronization Primitive Capable	323
15.6.2.4.14	R_T_TOV value	324
15.6.2.4.15	Dynamic Half Duplex Supported	324
15.6.2.4.16	SEQ_CNT	324
15.6.2.4.17	Payload Bit	324
15.6.2.5	BB_SC_N	325
15.6.2.6	Buffer-to-buffer Receive Data_Field size	325
15.6.2.7	Total Concurrent Sequences	325
15.6.2.8	Relative offset by category	325
15.6.2.9	R_A_TOV	325
15.6.2.10	E_D_TOV	325
15.6.3	N_Port_Name	326
15.6.4	Node_ or Fabric_Name	326
15.6.5	Class Service Parameters	326
15.6.5.1	Applicability	326
15.6.5.2	Payload	328
15.6.5.3	Class validity	329
15.6.5.4	Service options	329
15.6.5.4.1	Introduction	329
15.6.5.4.2	Intermix Mode	329
15.6.5.4.3	Stacked Connect-requests	330
15.6.5.4.4	Sequential delivery	330
15.6.5.4.5	Priority/Preemption	331
15.6.5.4.6	Preference	331
15.6.5.4.6.1	Nx_Port	331
15.6.5.4.6.2	Fx_Port	332
15.6.5.4.7	DiffServ QoS	333
15.6.5.4.7.1	N_Port Login	333
15.6.5.4.7.2	F_Port Login	333
15.6.5.5	Initiator control	334
15.6.5.5.1	Introduction	334
15.6.5.5.2	Initial Process_Associator	334

15.6.5.5.3	ACK_0 capability	334
15.6.5.5.4	ACK generation assistance	335
15.6.5.5.5	Clock synchronization ELS capable	335
15.6.5.6	Recipient control	336
15.6.5.6.1	Introduction	336
15.6.5.6.2	ACK_0 capability	336
15.6.5.6.3	X_ID interlock	337
15.6.5.6.4	Error policy supported	337
15.6.5.6.5	Categories per Sequence	338
15.6.5.6.6	Clock synchronization ELS capable	338
15.6.5.7	Receive Data_Field Size	338
15.6.5.8	Concurrent Sequences	338
15.6.5.9	End-to-end Credit	339
15.6.5.10	Open Sequences per Exchange	340
15.6.5.11	CR_TOV	340
15.6.6	Vendor Version Level	340
15.6.7	Services Availability	340
15.6.7.1	Introduction	340
15.6.7.2	Multicast Server	340
15.6.7.3	Clock Synchronization Server	340
15.6.7.4	Security Key Distribution Server	340
15.6.7.5	Alias Server	340
15.6.7.6	Quality of Service Facilitator	341
15.6.7.7	Management Server	341
15.6.7.8	Time Server	341
15.6.7.9	Directory Server	341
15.6.8	Login Extension	341
15.6.8.1	General	341
15.6.8.2	Login Extension Data Length	341
15.6.8.3	Login Extension format	341
15.6.9	Clock Synchronization Quality of Service	342
15.6.9.1	N_Port Login	342
15.6.9.1.1	Applicability	342
15.6.9.1.2	CS_QoS_Request	343
15.6.9.1.3	CS_Accuracy (Mantissa and Exponent)	343
15.6.9.1.4	Clock Synchronization Implemented MSB	344
15.6.9.1.5	Clock Synchronization Implemented LSB	344
15.6.9.1.6	Clock Synchronization Update Period	344
15.6.9.2	Fabric Login	344
15.6.9.2.1	Applicability	344
15.6.9.2.2	CS_Transfer_Accuracy	345
15.6.9.2.3	Clock Synchronization Implemented MSB	345
15.6.9.2.4	Word 0, Bits 7 to 0 Clock Synchronization Implemented LSB	346
16	Process Login/Logout	347
16.1	Process Login	347
16.1.1	Introduction	347
16.1.2	PRLI/PRLO Relationships	349
16.1.2.1	Introduction	349
16.1.2.2	PA not supported	349
16.1.2.3	PA required by originator, supported by responder	349
16.1.2.4	PA required by responder, supported by originator	349
16.1.2.5	PA required by originator and responder	350
16.1.3	Mode of operation	350
16.1.3.1	Informative mode	350
16.1.3.2	Binding mode	350
16.1.4	Protocol	350

16.1.4.1	PA required by originator and responder	350
16.1.4.2	PA required by originator, supported by responder	351
16.1.4.3	PA supported by originator, required by responder	351
16.2	Process Logout	351
17	Exchange, Sequence and sequence count management	353
17.1	Introduction	353
17.1.1	Data frame transfer	353
17.1.2	Sequence	353
17.1.3	Streamed Sequences	353
17.1.4	SEQ_CNT	353
17.1.5	Exchange	353
17.1.6	Sequence Initiative	355
17.2	Applicability	355
17.3	Exchange rules	356
17.3.1	Exchange management	356
17.3.2	Exchange origination	356
17.3.3	Sequence delimiters	357
17.3.4	Sequence initiation	357
17.3.5	Sequence management	357
17.3.6	SEQ_CNT	358
17.3.7	Normal ACK processing	358
17.3.8	Normal Sequence completion	359
17.3.9	Detection of missing frames	360
17.3.10	Sequence errors - Class 1, 2, 4 and 6	361
17.3.10.1	Rules common to all Discard policies	361
17.3.10.2	Discard multiple Sequences Error Policy	362
17.3.10.3	Discard a single Sequence Error Policy	363
17.3.10.4	Process with infinite buffers Error Policy	363
17.3.11	Sequence errors - Class 3	364
17.3.11.1	Rules common to all discard policies	364
17.3.11.2	Process with infinite buffers Error Policy	364
17.3.12	Sequence Status Rules	364
17.3.13	Exchange termination	365
17.3.14	Exchange Status Rules	365
17.4	Exchange management	365
17.5	Exchange origination	365
17.5.1	Introduction	365
17.5.2	Exchange Originator	366
17.5.3	Exchange Responder	366
17.5.4	X_ID assignment	367
17.5.5	X_ID interlock	367
17.6	Sequence management	367
17.6.1	Open and active Sequences	367
17.6.2	Sequence_Qualifier management	368
17.6.3	Sequence initiative and termination	368
17.6.4	Transfer of Sequence Initiative	368
17.6.5	Sequence Termination	368
17.6.5.1	Introduction	368
17.6.5.2	Class 1 and Class 6	369
17.6.5.3	Class 2	369
17.6.5.4	Class 3	369
17.6.5.5	Class 4	369
17.6.5.6	Continue Sequence Condition	369
17.6.5.7	End_Sequence	369
17.7	Exchange termination	369
17.7.1	Normal termination	369

17.7.2	Abnormal termination	370
17.8	Status blocks	370
17.8.1	Exchange Status Block	370
17.8.2	Sequence Status Block	371
18	Flow control management	374
18.1	Introduction	374
18.2	Physical flow control model for Classes 1, 2, 3 and 6	375
18.3	Credit and Credit_Count	376
18.3.1	Introduction	376
18.3.2	Credit_Count management	376
18.3.3	Management by increasing the Credit_Count	376
18.3.4	Management by decreasing the Credit_Count	376
18.3.5	Credit_Count types	376
18.3.6	Usage	376
18.4	End-to-end flow control	376
18.4.1	End-to-end management rules	376
18.4.2	Sequence Initiator	377
18.4.3	Sequence Recipient	378
18.4.3.1	General	378
18.4.3.2	ACK_0	378
18.4.3.3	ACK_1	378
18.4.3.4	Last ACK timeout	378
18.4.3.5	Streamed Sequences	379
18.4.4	EE_Credit	379
18.4.5	EE_Credit_CNT	379
18.4.6	EE_Credit management	379
18.4.7	End-to-end flow control model	380
18.4.8	End-to-end class dependency	380
18.4.8.1	End-to-end Credit allocation	380
18.4.8.2	EE_Credit_CNT management	380
18.4.9	EE_Credit recovery	381
18.4.10	Class 4	381
18.4.11	Procedure to estimate end-to-end Credit	382
18.4.11.1	Introduction	382
18.4.11.2	Procedure steps	382
18.4.11.2.1	General	382
18.4.11.2.2	Establish Streaming Sequence	383
18.4.11.2.3	Estimate Credit Sequence	384
18.4.11.2.4	Advise Credit Sequence	384
18.5	Buffer-to-buffer flow control	385
18.5.1	Introduction	385
18.5.2	Buffer-to-buffer management rules	385
18.5.3	BB_Credit	386
18.5.4	BB_Credit_Count	386
18.5.5	BB_Credit management	386
18.5.6	Buffer-to-buffer flow control model	386
18.5.7	Class dependent frame flow	386
18.5.8	R_RDY	386
18.5.9	BB_Credit_Count reset	387
18.5.10	Alternate buffer-to-buffer Credit management	391
18.5.11	BB_Credit Recovery	391
18.6	VC_RDY	392
18.7	BSY / RJT in flow control	393
18.8	LCR in flow control	393
18.9	Integrated Class 2 flow control	393
18.10	Intermix	393

18.11	Point-to-point topology	394
19	Segmentation and reassembly	398
19.1	Introduction	398
19.2	Sending end	398
19.2.1	Introduction	398
19.2.2	Relative offset space	398
19.2.3	Data block	398
19.2.4	Sequence	398
19.2.5	Relationship between Sequences	398
19.3	FC-2	399
19.3.1	Mechanisms	399
19.3.2	Relative offset	399
19.3.3	SEQ_CNT	399
19.4	Login	399
19.5	Segmentation rules	400
19.6	Reassembly rules	400
20	Connection management	402
20.1	Introduction	402
20.1.1	Establishing a Connection	402
20.1.2	Removing a Connection	402
20.1.3	Preempting a dedicated connection	402
20.1.4	Frame processing precedence	403
20.2	Applicability	403
20.3	Topology models	404
20.3.1	Introduction	404
20.3.2	Fabric model	404
20.3.3	Point-to-point model	404
20.4	Connect/disconnect rules	405
20.4.1	Connect-request rules	405
20.4.1.1	Source of connect-request	405
20.4.1.2	Destination of connect-request	406
20.4.2	Connection Rules	406
20.4.3	Remove Connection rules	407
20.5	Establishing a Connection	407
20.5.1	Introduction	407
20.5.2	Connection Initiator	407
20.5.3	Stacked connect-requests	409
20.5.4	Unidirectional dedicated connection	410
20.5.5	Destination of connect-request	410
20.6	Connected	411
20.7	Removing a Connection	411
20.7.1	Introduction	411
20.7.2	When to remove a Connection	411
20.7.3	End_Connection bit	411
20.7.4	EOF \mathbf{dt} transmission	412
20.8	Connection Recovery	412
20.8.1	Introduction	412
20.8.2	Link timeout	412
20.8.3	Corrupted connect-request	412
20.9	Connection Preemption	413
20.9.1	Applicability	413
20.9.2	Topology Model	413
20.9.3	Rules for Preemption	413
20.9.3.1	Preemptor	413
20.9.3.2	Preempted Source	413
20.9.3.3	Preempted Destination(s)	414

20.9.3.4	Preemption Destination(s)	414
20.10	Establishing a Connection Using Preemption	414
20.10.1	Introduction	414
20.10.2	Connection Initiator	414
20.10.3	Preemption Destination	416
21	Error detection/recovery	417
21.1	Introduction	417
21.2	Timeouts	417
21.2.1	Timeout periods	417
21.2.1.1	General	417
21.2.1.2	R_T_TOV	417
21.2.1.3	E_D_TOV	417
21.2.1.4	R_A_TOV	418
21.2.2	Link Failure timeouts	418
21.2.3	Link timeout	418
21.2.4	Sequence timeout	419
21.2.4.1	Introduction	419
21.2.4.2	Classes 1, 2 and 6	419
21.2.4.3	Class 3	419
21.2.4.4	End-to-end Class 2 Credit loss	420
21.2.5	OLS transmit timeout	420
21.2.6	Timer Enhancements for Classes 1 and 6	420
21.2.6.1	Introduction	420
21.2.6.2	Applicability	421
21.2.6.3	Login	421
21.2.6.4	Value	421
21.2.6.5	Stacked Connect-request	421
21.2.6.6	Rules	421
21.2.6.6.1	Connection Initiator	421
21.2.6.6.2	Connection Recipient	422
21.2.6.6.3	Fabric	422
21.2.7	Bit-Error-Rate Thresholding	422
21.2.7.1	Introduction	422
21.2.7.2	Types of Link Errors Caused by Bit Errors	422
21.2.7.3	Error Bursts	422
21.2.7.4	Bit-Error-Rate-Thresholding Measurement	422
21.3	Link error detection	423
21.3.1	Link Failure	423
21.3.2	Code violations	423
21.3.3	Primitive Sequence protocol error	423
21.4	Link error recovery	423
21.5	Link recovery - secondary effects	423
21.5.1	Class 1 and Class 6	423
21.5.2	Class 2	424
21.5.3	Class 3	425
21.5.4	Class 4	425
21.6	Exchange Integrity	425
21.6.1	Applicability	425
21.6.2	Exchange management	425
21.6.3	Exchange Error Policies	425
21.6.3.1	Introduction	425
21.6.3.2	Discard multiple Sequences	425
21.6.3.3	Discard a single Sequence	426
21.6.3.4	Process with infinite buffering	426
21.6.3.5	Discard multiple Sequences with retransmission	426
21.6.4	Sequence integrity	426

21.6.5	Sequence error detection	426
21.6.6	X_ID processing	427
21.7	Sequence recovery	427
21.7.1	Introduction	427
21.7.2	Abnormal Sequence termination	427
21.7.2.1	Introduction	427
21.7.2.2	Abort Sequence Protocol	427
21.7.2.2.1	General Case	427
21.7.2.2.2	Special case - new Exchange	428
21.7.2.3	Class 1 or 6 Sequence retransmission	428
21.7.2.4	Recipient abnormal termination	430
21.7.2.5	End_Sequence	430
21.7.3	Stop Sequence Protocol	430
21.7.4	End-to-end Credit loss	430
21.8	Link Error Status Block	431
21.9	Detailed Error Detection/Actions	431
21.9.1	Errors detected	431
21.9.2	Actions by Initiator or Recipient	432
22	Hunt Group	435
22.1	Introduction	435
22.2	Function	435
22.3	Communication Model	435
22.4	Applicability	435
22.4.1	Classes	435
22.4.2	Class 4 Addressing	435
22.5	Formation	436
22.5.1	General	436
22.5.2	Registration/deregistration	436
22.5.3	Inquiry	437
22.5.4	HG_ID Removal	437
22.6	N_Port Login	437
22.7	Addressing Protocol	437
22.7.1	address identifier Protocol	437
22.7.2	Originator	437
22.7.3	Responder	437
22.7.4	Address Resolution	438
22.7.5	Class	438
22.7.6	Class 4	438
22.8	Resource management	438
22.8.1	Introduction	438
22.8.2	HG_ID use	439
22.8.3	N_Port_ID use	439
22.9	Rotary Group	439
23	Multicast	441
23.1	Applicability	441
23.2	Class 3 Multicast	441
23.2.1	Introduction	441
23.2.2	Registration and De-registration	441
23.2.3	Multicast Routing	441
23.2.4	Class 3 Multicast Rules	442
23.3	Class 6 Multicast	442
23.3.1	Introduction	442
23.3.2	Class 6 Multicast Routing	443
23.3.3	Class 6 Multicast Rules	443
23.3.4	Class 6 Multicast Server	444
23.3.5	Class 6 Multicast Recovery	444

23.4	Broadcast	444
23.5	Other	445
24	Alias_IDs	446
24.1	Introduction	446
24.2	Alias Server	446
24.3	Alias Service protocol	446
24.4	Alias_ID Routing	446
24.5	Function Flow	447
24.6	PA Considerations	447
24.6.1	Hunt Groups	447
24.6.2	Multicast Groups	447
24.6.3	Broadcast	448
25	Class 4 – Fractional	449
25.1	Introduction	449
25.2	Default N_Port Login service parameters	450
25.3	Communication Model	450
25.3.1	Introduction	450
25.3.2	In-order delivery	451
25.3.3	Guaranteed delivery	451
25.3.4	Fractional bandwidth management	452
25.3.5	Class 4 circuit	452
25.3.5.1	Introduction	452
25.3.5.2	Setup	453
25.3.5.3	Activation	456
25.3.5.4	Deactivation	457
25.3.5.5	Removal	458
25.4	Deactivation, removal contention and error recovery	460
25.4.1	CTI has requested removal of Class 4 circuit	460
25.4.2	CTR has requested removal of a Class 4 circuit	460
25.4.3	CTI has requested deactivation of a Class 4 circuit	460
25.4.4	CTR has requested deactivation of a Class 4 circuit	461
25.4.5	CTI has no outstanding removal or deactivation request	461
25.4.6	CTR has no outstanding removal or deactivation request	461
25.5	Ordered Sets	461
25.6	Quality of Service	463
26	Stacked Connect-request	465
26.1	Introduction	465
26.2	FC-2 Mechanisms	465
26.3	Applicability	465
26.4	Communications Model	465
26.5	Requirements	465
26.5.1	Connection Initiator	465
26.5.2	Connection Recipient	465
26.5.3	Fabric	466
26.6	Login	466
26.7	Stacked Connect-request Invoked	466
26.8	Timer	466
26.8.1	General	466
26.8.2	CR_TOV	466
26.8.3	E_D_TOV	466
26.9	Rules	466
26.9.1	Connection Initiator	466
26.9.2	Connection Recipient	466
26.9.3	Fabric	467
27	Clock synchronization service	468

27.1	Introduction	468
27.1.1	References	468
27.1.2	Applicability	468
27.1.3	Function	468
27.1.4	Assumptions	468
27.1.5	Clock Synchronization Quality of Service	468
27.2	ELS Command Service	468
27.2.1	ELS Commands	468
27.2.2	Fabric Topology	469
27.2.2.1	Model	469
27.2.2.2	Clock Synchronization Server Rules	469
27.2.2.3	Fabric Rules	469
27.2.2.4	Fabric Options	470
27.2.2.5	Client Rules	470
27.2.2.6	Client Options	470
27.2.3	Loop Topology	470
27.2.3.1	Model	470
27.2.3.2	L_Port Server Rules	470
27.2.3.3	L_Port Server Options	471
27.2.3.4	L_Port Client Rules	471
27.2.3.5	Client Options	471
27.2.4	Use of FC-FS Constructs	471
27.2.4.1	Login/Logout	471
27.2.4.2	Clock Synchronization Request (CSR) ELS	472
27.2.4.2.1	Command Payload	472
27.2.4.2.2	LS_ACC Payload	473
27.2.4.3	Clock Synchronization Update (CSU) ELS Command	474
27.3	Primitive Signal Service	475
27.3.1	Topology compatibility	475
27.3.2	Communication Model	475
27.3.3	Requirements	476
27.3.3.1	Introduction	476
27.3.3.2	Clock Synchronization Server Rules	478
27.3.3.3	Fabric Rules	479
27.3.3.4	Client Rules	479
28	Link Speed Negotiation	480
28.1	Speed Negotiation overview	480
28.2	Link physical architecture and requirements	481
28.3	Speed Negotiation requirements on L_Ports	481
28.4	State machines	482
28.5	Primitives	482
28.6	Speed Negotiation algorithm	482
28.6.1	Algorithm overview	482
28.6.2	Stage 1 - Wait_for_signal	485
28.6.3	Stage 2 - Negotiate_master and Watchdog timer	486
28.6.4	Stage 3 - Negotiate_follow	488
28.6.5	Stage 4 - Normal operation	490
28.6.6	Optional Stage 5 - Slow_wait	490
28.6.7	Timing requirements	492
Annex A	(informative) CRC generation and checking	494
A.1	Extract from FDDI	494
A.2	Frame check sequence (FCS)	494
A.3	Definitions	494
A.3.1	FCS generation equations	495
A.3.2	FCS checking	495
A.4	CRC generation	495

A.5	Transmit order of a word	496
A.6	CRC generation example for ACK_1 frame	496
Annex B	(informative) Data transfer protocols and examples	500
B.1	General	500
B.2	Frame level protocol	500
B.2.1	Class 1 and 6 frame level protocol	500
B.2.2	Class 2 frame level protocol	501
B.2.3	Class 3 Frame Level Protocol	503
B.3	Sequence level protocol example	505
B.4	Class 1 and 6 frame level protocol example	507
B.5	Class 2 frame level protocol example	508
B.6	Class 3 frame level protocol example	509
Annex C	(informative) Connection management applications	511
C.1	Example cases	511
C.1.1	Introduction	511
C.1.2	Case 1	511
C.1.3	Case 2	511
C.1.4	Case 3	512
C.1.5	Case 4	512
C.2	Ending sequence and Connection	512
Annex D	(informative) Out of order characteristics	514
D.1	Introduction	514
D.2	Out of order Data frame delivery	514
D.3	Out of order ACK transmission	515
Annex E	(informative) Link Error Status Block	516
E.1	Introduction	516
E.2	Link failure counters	516
E.3	Invalid Transmission Word	516
E.4	Invalid CRC Count	516
Annex F	(informative) Class 4 Examples	518
F.1	Introduction	518
F.2	Setup, activate and deactivate	518
F.3	Activation collision and removal	519
Annex G	(informative) Priority and Preemption	524
G.1	Overview	524
G.2	Preemption Process	524
G.3	Link Reset Protocol	526
Annex H	(informative) Clock Synchronization	527
H.1	Introduction	527
H.2	Discussion	527
H.2.1	Introduction	527
H.2.2	A Model of an NL_Port	527
H.2.3	Hardware-Assisted Clock Synchronization	528
H.2.4	A Point-to-Point System	528
H.2.4.1	Introduction	528
H.2.4.2	Discussion of Errors	531
H.2.4.2.1	Introduction	531
H.2.4.2.2	Client Oscillator Frequency Error	531
H.2.4.2.3	Link Propagation Delay Error	532
H.2.4.2.4	Unload Error	533
H.2.4.2.5	Load Error	534
H.2.4.2.6	R/T Clock Domain Error	535
H.2.4.2.7	Server Oscillator Error	536

H.2.4.3	Techniques for Reducing Deterministic Errors	536
H.2.4.3.1	A Fix for Differences in Oscillator Frequencies	536
H.2.4.3.2	A Fix for Link Propagation Delay Error	537
H.2.4.3.3	A Fix for Load Error	537
H.2.4.3.4	A Fix for Unload Error	540
H.2.4.4	Dealing With Non-Deterministic Error	540
H.2.4.5	Dealing With Non-Monotonicity	540
H.2.5	Fabric Considerations	541
H.2.5.1	Introduction	541
H.2.5.2	Discussion of Errors	542
H.2.5.2.1	Client Oscillator Frequency Error	542
H.2.5.2.2	Link Propagation Delay Error	544
H.2.5.2.3	Unload Error	544
H.2.5.2.4	Load Error	544
H.2.5.2.5	R/T Clock Domain Error	544
H.2.5.2.6	Server Oscillator Error	545
H.2.5.3	Fixes for Fabric Errors	545
H.2.6	Loop Considerations	545
H.2.6.1	Introduction	545
H.2.6.2	Discussion of Errors	545
H.2.6.3	Introduction	545
H.2.6.3.1	Node Delay	546
H.2.6.3.2	Client Oscillator Frequency Error	547
H.2.6.3.3	Link Propagation Delay Error	547
H.2.6.3.4	Unload Error	547
H.2.6.3.5	Load Error	547
H.2.6.3.6	R/T Clock Domain Error	547
H.2.6.3.7	Server Oscillator Error	547
H.2.6.4	Fixes for Loop Errors	547
H.3	An Example	547
Annex I (informative)	Speed Negotiation details	550
I.1	Scope	550
I.2	Basic assumptions	550
I.3	Supported configuration	551
I.4	Derivation of timing requirements and characteristics	551
I.4.1	Introduction and diagram conventions	551
I.4.2	Receiver cycle time, t_{rxcycl}	552
I.4.3	Master transmitter cycle time, t_{txcycl}	552
I.4.4	Speed stability time, t_{stbl}	552
I.4.5	Watchdog timer threshold, t_{fail}	552
I.4.6	Watchdog Timer test delay, t_{wddly}	553
I.4.7	Speed recording time, t_{ncycl}	553
I.4.8	Speed recording time initial value, t_{ncinit}	554
I.4.9	Parameters relating to the optional <code>slow_wait</code> stage:	555
I.4.9.1	Low processing load sleep time, t_{sleep}	555
I.4.9.2	<code>slow_wait</code> cycle transmit cycle delay, t_{txdly}	555
I.4.9.3	Periodic sync search wake time, t_{wake}	555
I.4.10	Duration of disruption to single loops caused by connecting speed negotiating ports to hubs	556
I.4.10.1	Introduction	556
I.4.10.2	Maximum single disruption in <code>Wait_for_signal</code> stage	557
I.4.10.3	Maximum single disruption in <code>Slow_wait</code> stage	558
I.4.10.4	Maximum single disruption in <code>Negotiate_master</code> stage	558
I.4.10.5	Maximum single disruption in <code>Negotiate_follow</code> stage	559
I.4.10.6	Maximum disruption group - <code>Wait_for_signal</code>	559
I.4.10.7	Maximum disruption group - <code>Slow_wait</code>	560

I.4.10.8	Maximum disruption group - Negotiate_master	561
I.4.10.9	Maximum disruption group - Negotiate_follow	562
I.4.10.10	Maximum single disruption overall	562
I.4.10.11	Maximum disruption group overall	563
I.4.10.12	Summary of loop disruption	563
I.4.11	Algorithm convergence time:	564
I.5	Ports using separate PMD components	564
I.6	Implementation notes	566
Annex J (informative)	IEEE company_ID-	567
Annex K (informative)	WWN-to-EUI-64 Mapping	568
K.1	Background	568
K.2	Solution	568
K.3	Case Study	569
Bibliography		571

Figure 1 - Fibre Channel Structure	57
Figure 2 - Node functional configuration	59
Figure 3 - FC-FS physical model	61
Figure 4 - Point-to-point topology	62
Figure 5 - Fabric topology	63
Figure 6 - Examples of the Arbitrated Loop Topology	64
Figure 7 - Informative general Fabric model	67
Figure 8 - FC-2 building block hierarchy	69
Figure 9 - Receiver State Diagram	89
Figure 10 - Transmitter State Diagram	93
Figure 11 - FC-2 frame format	103
Figure 12 - CIVC_ID and CRVC_ID management	118
Figure 13 - Frame structure when ESP_Header is not used	135
Figure 14 - Frame structure with ESP_Header and ESP_Trailer	136
Figure 15 - QoS SR Sequence flow	250
Figure 16 - Illustration of parameters	277
Figure 17 - LS_RJT format	283
Figure 18 - Class 4 circuit – Management	296
Figure 19 - Image/Group of Related Processes	347
Figure 20 - Image pairs	348
Figure 21 - Exchange - Sequence relationship	354
Figure 22 - Exchange origination	366
Figure 23 - Physical flow control model for Classes 1, 2, 3 and 6	375
Figure 24 - End-to-end flow control model	381
Figure 25 - Procedure to estimate end-to-end Credit	383
Figure 26 - Buffer-to-buffer flow control model	387
Figure 27 - Class 1 or 6/SOFc1 frame flow with delivery or non-delivery to the fabric	388
Figure 28 - Class 1 or 6/SOFc1 frame flow with delivery or non-delivery to an Nx_Port	388
Figure 29 - Buffer-to-buffer - Class 2 frame flow with delivery or non-delivery to a Fabric	389
Figure 30 - Buffer-to-buffer - Class 2 frame flow with delivery or non-delivery to an Nx_Port	390
Figure 31 - Buffer-to-buffer - Class 3 frame flow	391
Figure 32 - LCR frame flow and possible responses	394
Figure 33 - LCR flow control model	395
Figure 34 - Integrated Class 2 flow control	397
Figure 35 - Frame Flow Timers	421
Figure 36 - Link recovery hierarchy	424
Figure 37 - Relationship of a Non-Participating to a Participating Nx_Port and switch	440
Figure 38 - Class 3 Multicast Routing	442
Figure 39 - Class 6 Multicast Routing	443
Figure 40 - Function Flow	447
Figure 41 - Class 4 Circuit hierarchy	449
Figure 42 - Basic Class 4 circuit	451
Figure 43 - Class 4 circuits – Example	451
Figure 44 - Class 4 circuit - Port level state diagram	453
Figure 45 - Class 4 circuit – Setup	455
Figure 46 - Class 4 circuit – Activation	457
Figure 47 - Class 4 - Example of frame flow	457
Figure 48 - Class 4 circuit - CTI or CTR initiated	458
Figure 49 - Class 4 circuit - Fabric initiated deactivation	458
Figure 50 - Class 4 circuit - CTI or CTR initiated removal	459
Figure 51 - Class 4 circuit - Fabric initiated removal	459
Figure 52 - Class 4 circuit - Data frame responses	463
Figure 53 - ELS Clock Sync Model – Fabric	469
Figure 54 - ELS Clock Sync Model – Loop	471

Figure 55 - Clock Synchronization Data Distribution	476
Figure 56 - Synchronization Primitive Substitution for IDLE Primitives in Inter-frame Interval	476
Figure 57 - Clock Synchronization Primitive Ordered Sets	477
Figure 58 - Physical architecture of the Speed Negotiating Link	481
Figure 59 - Delay / Test operations	483
Figure 60 - Overview of the Speed Negotiation algorithm	484
Figure 61 - Wait_for_signal flowchart	485
Figure 62 - Negotiate_master and Watchdog timer flowchart	487
Figure 63 - Negotiate_follow flowchart	489
Figure 64 - Normal operation flowchart	490
Figure 65 - Slow_wait flowchart	491
Figure A.1 - CRC coverage and bit ordering.....	496
Figure A.2 - Word transmit order	496
Figure B.1 - Class 1 and 6 frame level protocol.....	501
Figure B.2 - Class 2 frame level protocol.....	503
Figure B.3 - Class 3 frame level protocol.....	504
Figure B.4 - Sequence level protocol example	506
Figure B.5 - Class 1 and 6 frame level protocol - Login example	508
Figure B.6 - Class 2 frame level protocol - Login example	509
Figure B.7 - Class 3 frame level protocol - Login example	510
Figure F.1 - Class 4 setup, activation and deactivation	521
Figure F.2 - Class 4 activation collision and circuit removal	523
Figure G.1 - Preemption Request	524
Figure G.2 - Connection Rejection	525
Figure G.3 - Preemption Accepted	525
Figure G.4 - Connection Established	525
Figure G.5 - Link Reset Diagram.....	526
Figure H.1 - Generic NL_Port	528
Figure H.2 - Server NL_Port Clock Sync Context.....	529
Figure H.3 - Client NL_Port Clock Sync Context.....	529
Figure H.4 - Server Clock Sync Implementation (Basic Approach).....	530
Figure H.5 - Client Clock Sync Implementation (Basic Approach).....	530
Figure H.6 - ELS Clock Sync Model - Point-to-Point.....	530
Figure H.7 - Client Clock Drift	531
Figure H.8 - Client Clock Sync Logic Model (Rate Adjusted).....	538
Figure H.9 - Rate Adjustment Hardware Assists for Client Clock Sync	539
Figure H.10 - Client Clock Sync Implementation (Link Delay Fix).....	539
Figure H.11 - Server Clock Sync Implementation (Unload Error Fix).....	540
Figure H.12 - Client Clock Drift (Monotonic).....	541
Figure H.13 - ELS Clock Sync Model – Fabric.....	542
Figure H.14 - ELS Clock Sync Model – Loop.....	545
Figure H.15 - Application of Clock Synchronization to Tactical Avionics	548
Figure I.1 - Three configurations supported by the speed negotiation requirements	551
Figure I.2 - Example worst case timing for t_fail.....	553
Figure I.3 - Example worst case timing for t_ncycl using Rx_LOS.....	554
Figure I.4 - Example worst case timing for t_ncinit using Pass_sync_test	555
Figure I.5 - Example worst case timing for t_wake	556
Figure I.6 - Example of maximum single disruption, Wait_for_signal	557
Figure I.7 - Example of maximum single disruption, Slow_wait.....	558
Figure I.8 - Example of maximum single disruption, Negotiate_master	559
Figure I.9 - Example where hub is at maximum port speed	559
Figure I.10 - Example of maximum disruption group - Wait_for_signal.....	560
Figure I.11 - Example of maximum disruption group - Slow_wait.....	561
Figure I.12 - Example of maximum disruption group - Negotiate_master	562
Figure I.13 - Example of maximum single disruption overall	563
Figure I.14 - Physical architecture of a port with a separate transceiver component	565
Figure K.1 - Case Study.....	570

Table 1 -	Comparison of ISO and American numbering conventions	51
Table 2 -	Data rate abbreviations	51
Table 3 -	Symbols	55
Table 4 -	Bit designations	74
Table 5 -	Conversion Example	75
Table 6 -	Valid Data Characters	77
Table 7 -	Valid Special Characters	81
Table 8 -	Delayed Code Violation example	82
Table 9 -	Frame Delimiters	84
Table 10 -	Primitive Signals	85
Table 11 -	Primitive Sequences	87
Table 12 -	FC_Port states	96
Table 13 -	Frame byte order	109
Table 14 -	Frame_Header	111
Table 15 -	R_CTL - Type Code Summary	112
Table 16 -	Device_Data Information Categories	113
Table 17 -	Data Descriptor Payload	113
Table 18 -	FC-4 Link_Data Information Categories	113
Table 19 -	Video_Data Information Categories	114
Table 20 -	Extended Routing Information Categories	114
Table 21 -	Domain Controller and Well-known address identifiers	115
Table 22 -	CS_CTL field - Class 1	116
Table 23 -	CS_CTL field - Class 2	116
Table 24 -	CS_CTL field - Class 3	116
Table 25 -	CS_CTL field - Class 4	117
Table 26 -	Priority Field - Class 1 and Class 6	118
Table 27 -	Priority Field	119
Table 28 -	TYPE codes - Link Service	120
Table 29 -	TYPE codes - Video_Data	120
Table 30 -	TYPE codes - FC-4 (Device_Data and Link_Data)	121
Table 31 -	Exchange/Sequence Control (F_CTL)	123
Table 32 -	Continue Sequence Condition Bits Definition	127
Table 33 -	Abort Sequence Condition Bits Definition by Sequence Initiator	128
Table 34 -	Abort Sequence Condition Bits Definition by Sequence Recipient	129
Table 35 -	F_CTL bit interactions on Data frames	130
Table 36 -	F_CTL bit interactions on ACK, BSY or RJT	131
Table 37 -	DF_CTL bit definition	132
Table 38 -	ESP_Header and ESP_Trailer in a frame	138
Table 39 -	Network_Header	138
Table 40 -	Association_Header	139
Table 41 -	Association_Header Validity bits (Word 0, Bits 31 to 24)	140
Table 42 -	Allowable Data frame delimiters	142
Table 43 -	ACK Frames by Class	144
Table 44 -	Link_Response Frames by Class	144
Table 45 -	Link_Control Information Categories	145
Table 46 -	Link_Control frame delimiters	146
Table 47 -	ACK precedence	147
Table 48 -	F_BSY Reason Codes	150
Table 49 -	P_BSY code format	151
Table 50 -	P_BSY action codes	151
Table 51 -	P_BSY Reason Codes	152
Table 52 -	Reject Code format	153
Table 53 -	Reject Action Codes	154
Table 54 -	Reject Reason Codes	154

Table 55 - Basic Link Service Information Categories	164
Table 56 - ABTS Parameter Field Definitions	164
Table 57 - BA_ACC Payload	169
Table 58 - BA_RJT Payload Format	171
Table 59 - BA_RJT reason codes	171
Table 60 - BA_RJT Reason Code Explanation	172
Table 61 - Extended Link Routing Bits and Information Categories	174
Table 62 - ELS_Command codes	175
Table 63 - Responses to Received ELSs	177
Table 64 - ABTX Payload	179
Table 65 - Recovery Qualifier Values	180
Table 66 - ABTX LS_ACC Payload	180
Table 67 - ADVC Payload	181
Table 68 - ADVC LS_ACC Payload	182
Table 69 - ECHO Payload	183
Table 70 - ECHO LS_ACC Payload	183
Table 71 - ESTC Payload	184
Table 72 - ESTS Payload	185
Table 73 - ESTS LS_ACC Payload	185
Table 74 - LOGO Payload	187
Table 75 - LOGO LS_ACC Payload	187
Table 76 - RCS Payload	188
Table 77 - RCS LS_ACC Payload	188
Table 78 - Connection Status Codes	189
Table 79 - RES Payload	190
Table 80 - RES LS_ACC Payload	190
Table 81 - RLS Payload	191
Table 82 - RLS LS_ACC Payload	191
Table 83 - RSS Payload	192
Table 84 - RSS LS_ACC Payload	192
Table 85 - RTV Payload	193
Table 86 - RTV LS_ACC Payload	193
Table 87 - RRQ Payload	195
Table 88 - RRQ LS_ACC Payload	195
Table 89 - RSI Payload	196
Table 90 - RSI LS_ACC Payload	196
Table 91 - TEST Payload	197
Table 92 - FAN Payload	198
Table 93 - LINIT Payload	199
Table 94 - Initialization Function	199
Table 95 - LINIT LS_ACC Payload	199
Table 96 - LINIT Status	199
Table 97 - LSTS Payload	200
Table 98 - LSTS LS_ACC Payload	200
Table 99 - FC-FLA Compliance Level	201
Table 100 - Loop State	202
Table 101 - RSCN Payload	204
Table 102 - Generic affected Port_ID page	204
Table 103 - RSCN Event Qualifier values	205
Table 104 - Address Format	205
Table 105 - RSCN LS_ACC Payload	206
Table 106 - SCR Payload	206
Table 107 - Registration Function	207
Table 108 - SCR LS_ACC Payload	207
Table 109 - PRLI Payload	208
Table 110 - PRLI service parameter page format	208
Table 111 - PRLI LS_ACC Payload	209

Table 112 - PRLI LS_ACC service parameter response page format	210
Table 113 - PRLI accept response code	211
Table 114 - PRLO Payload	212
Table 115 - PRLO logout parameter page format	213
Table 116 - PRLO LS_ACC Payload	214
Table 117 - PRLO LS_ACC logout parameter response page format	215
Table 118 - PRLO accept response code	216
Table 119 - TPLS Payload	217
Table 120 - TPLS image pair ID page format	217
Table 121 - TPLS LS_ACC Payload	218
Table 122 - TPLS response page format	219
Table 123 - TPLS accept response code	220
Table 124 - FARP_REQ Request Payload Item	221
Table 125 - FARP_REQ Match Address Code Points	223
Table 126 - FARP_REQ Address Fields	224
Table 127 - Responder Action	224
Table 128 - FARP_REPLY Request Payload	225
Table 129 - FARP_REPLY Address Fields	227
Table 130 - FARP_REPLY LS_ACC Payload	227
Table 131 - RNID Payload	228
Table 132 - Node Identification Data Format	228
Table 133 - RNID Accept Payload	229
Table 134 - Node Identification Data Format	229
Table 135 - Common Identification Data	230
Table 136 - General Topology Specific Identification Data	231
Table 137 - Associated Type	232
Table 138 - Multi-function device bit definitions	233
Table 139 - Node Management	233
Table 140 - IP Version	234
Table 141 - RLIR Payload	236
Table 142 - Link Incident Record Format	236
Table 143 - Common Link Incident Record Data	237
Table 144 - Time Stamp Format values	238
Table 145 - Incident Qualifier	239
Table 146 - Incident Code values	240
Table 147 - RLIR LS_ACC Payload	241
Table 148 - LIRR Payload	242
Table 149 - Registration Function	243
Table 150 - Link Incident Record-Registration Format	243
Table 151 - LIRR LS_ACC Payload	243
Table 152 - Get Alias_ID Payload	244
Table 153 - Get Alias_ID LS_ACC Payload	245
Table 154 - Fabric Activate Alias_ID Payload	246
Table 155 - Fabric Activate Alias_ID LS_ACC Payload	246
Table 156 - Fabric Deactivate Alias_ID Payload	247
Table 157 - Fabric Deactivate Alias_ID LS_ACC Payload	247
Table 158 - N_Port Activate Alias_ID Payload	248
Table 159 - N_Port Activate Alias_ID LS_ACC Payload	249
Table 160 - N_Port Deactivate Alias_ID Payload	249
Table 161 - N_Port Deactivate Alias_ID LS_ACC Payload	250
Table 162 - QoSR Payload	251
Table 163 - QoSR LS_ACC Payload	253
Table 164 - RVCS Payload	255
Table 165 - RVCS LS_ACC Payload	255
Table 166 - Class 4 VC Status Block entry	255
Table 167 - ADISC Payload	257
Table 168 - ADISC LS_ACC Payload	257

Table 169 - Response summary to FDISC/PDISC	258
Table 170 - TPRLO Payload	259
Table 171 - TPRLO logout parameter page format	259
Table 172 - TPRLO LS_ACC Payload	259
Table 173 - LCLM Payload	263
Table 174 - LCLM Commands	264
Table 175 - Global capabilities	264
Table 176 - N_Port and node Name Field Values	264
Table 177 - LCLM LS_ACC Payload	265
Table 178 - Global capabilities	265
Table 179 - RPS Payload	266
Table 180 - Flag field bit definitions	267
Table 181 - RPS LS_ACC Payload	267
Table 182 - Flag field bit definitions	267
Table 183 - Port Status	268
Table 184 - L_Port_Extension	268
Table 185 - L_Port Status	269
Table 186 - RPL Payload	270
Table 187 - Maximum Size values	270
Table 188 - RPL LS_ACC Payload	271
Table 189 - Port Number Block	271
Table 190 - RPBC Payload	272
Table 191 - ELS Buffer Parameters Field	272
Table 192 - RPL LS_ACC Payload	273
Table 193 - RNFT Payload	273
Table 194 - RNFT LS_ACC Payload	274
Table 195 - RNFT FC-4 Entry	274
Table 196 - SRL Payload	275
Table 197 - Flag field definitions	276
Table 198 - SRL LS_ACC Payload	276
Table 199 - SBRP Payload	277
Table 200 - SBRP LS_ACC Payload	279
Table 201 - RPSC Payload	280
Table 202 - RPSC LS_ACC Payload	280
Table 203 - REC Payload	281
Table 204 - REC LS_ACC Payload	282
Table 205 - LS_RJT Reason Codes	284
Table 206 - LS_RJT Reason Code Explanation	285
Table 207 - NAA identifiers	304
Table 208 - IEEE 48-bit address format	304
Table 209 - IEEE extended format	305
Table 210 - Locally assigned format	306
Table 211 - 32-bit IP address format	306
Table 212 - IEEE Registered	306
Table 213 - IEEE Registered Extended	307
Table 214 - EUI-64 Mapped Name_Identifier Format	308
Table 215 - Bit Position Map	308
Table 216 - FLOGI, PLOGI or LS_ACC Payload	318
Table 217 - Common Service Parameter applicability	319
Table 218 - Common Service Parameters - FLOGI	320
Table 219 - Common Service Parameters - PLOGI and PLOGI LS_ACC	321
Table 220 - Common Service Parameters - FLOGI LS_ACC	321
Table 221 - Clock Synchronization Applicability	324
Table 222 - Class Service Parameters Applicability	326
Table 223 - Class Service Parameters - FLOGI	328
Table 224 - Class Service Parameters - PLOGI and PLOGI LS_ACC	329
Table 225 - Class Service Parameters - FLOGI LS_ACC	329

Table 226 - Intermix Mode Support	330
Table 227 - Stacked Connect-request support Login Bits	330
Table 228 - Sequential delivery support	331
Table 229 - Fabric Login Priority and Preemption Support	331
Table 230 - Class 2 and 3 Preference Bit Function	332
Table 231 - Relationship between Preferred delivery and sequential delivery	333
Table 232 - DiffServ QoS bit definition	334
Table 233 - Initial Process_Associator Bits Definition	334
Table 234 - ACK_0 Support Conditions (Initiator Control)	335
Table 235 - ACK_0 Support Conditions (Recipient Control)	336
Table 236 - Error Policy Bits Definition	337
Table 237 - Categories per Sequence Bits Definition	338
Table 238 - Concurrent Sequences field meaning	339
Table 239 - End-to-end Credit Field Meaning	339
Table 240 - Login Extension Page format	342
Table 241 - Page Code Definitions	342
Table 242 - Vendor Specific Page format	342
Table 243 - N_Port Clock Synchronization QoS	343
Table 244 - FLOGI/PLOGI CS_QoS_Request	343
Table 245 - Fx_Port Clock Synchronization QoS	345
Table 246 - Exchange Status Block	370
Table 247 - Sequence Status Block	372
Table 248 - Flow control applicability	374
Table 249 - Buffer participation	375
Table 250 - End-to-end flow control management	377
Table 251 - Buffer-to-buffer flow control management	385
Table 252 - Integrated Class 2 flow control management	396
Table 253 - Segmentation and reassembly rules summary	401
Table 254 - Responses to connect-request (SOFc1)	408
Table 255 - Responses to Preemption Requests	415
Table 256 - Link Error Status Block format for RLS command	431
Table 257 - Detailed errors and actions	432
Table 258 - Address Resolution	438
Table 259 - Bandwidth Allocation Example	453
Table 260 - Frame delimiter usage	461
Table 261 - CSR Payload	472
Table 262 - CSR Clock Sync Mode Meaning	472
Table 263 - CSR LS_ACC Payload	473
Table 264 - CSU Clock Sync Mode Meaning	473
Table 265 - CSU Payload	474
Table 266 - Clock Count Field Meaning	475
Table 267 - Neutral Disparity Character Values	477
Table 268 - Timing parameters with a range	493
Table 269 - Constant timing parameters	493
Table A.1 - Sample FC-2 frame	497
Table A.2 - Sample ACK_1 without CRC	497
Table A.3 - F(x)	497
Table A.4 - $X^{*32} F(x) + X^{*k} L(x)$	498
Table A.5 - R(x)	498
Table A.6 - $L(x) + R(x) = R(x)$	498
Table A.7 - M(x)	498
Table A.8 - M(x) - (10B)	499
Table B.1 - F_CTL for Class 1, Class 2, and Class 6 frame level protocols	505
Table B.2 - F_CTL for Class 3 frame level protocol	505
Table B.3 - Sequence level protocol example	507
Table C.1 - Case 1	511
Table C.2 - Case 2	511

Table C.3 - Case 3	512
Table C.4 - Case 4	512
Table C.5 - F_CTL for example Exchange	513
Table E.1 - Link Failure Counters and management	517
Table H.1 - Parameters used in analysis	532
Table H.2 - Example of analysis results	532
Table H.3 - Parameters used in analysis	533
Table H.4 - Parameters used in analysis	534
Table H.5 - Parameters used in analysis	535
Table H.6 - Parameters used in analysis	536
Table H.7 - Parameters used in analysis	543
Table H.8 - Example of analysis results	543
Table H.9 - Parameters used in analysis	546
Table K.1 - IEEE 48 bit address WWN format	568
Table K.2 - Mapped EUI-64 address	568
Table K.3 - IEEE Extended WWN format	569
Table K.4 - Mapped EUI-64 address	569
Table K.5 - IEEE Registered WWN format	569
Table K.6 - Mapped EUI-64 address	569