

STANDARD

9316

Second edition
1995-11-01

Information technology — Small Computer System Interface-2

Technologies de l'information — Interface «Small Computer System-2»



Reference number
ISO/IEC 9316:1995(E)

ISO/IEC 9316:1995(E)

Contents

	Page
1 Scope	1
2 Normative references	2
3 Definitions, symbols and abbreviations	3
3.1 Definitions	3
3.2 Symbols and abbreviations	5
4 General	6
4.1 Overview	6
4.2 Conventions	7
5 Physical characteristics	8
5.1 Physical description	8
5.2 Cable requirements	8
5.2.1 Single-ended cable	8
5.2.2 Differential cable	9
5.2.3 Cable requirements for fast synchronous data transfer	9
5.3 Connector requirements	9
5.3.1 Non-shielded connector requirements	9
5.3.1.1 Non-shielded connector alternative 1 - A cable	9
5.3.1.2 Non-shielded connector alternative 2 - A cable	10
5.3.1.3 Non-shielded connector - B cable	10
5.3.2 Shielded connector requirements	15
5.3.2.1 Shielded connector alternative 1 - A cable	15
5.3.2.2 Shielded connector alternative 2 - A cable	15
5.3.2.3 Shielded connector - B cable	15
5.3.3 Connector contact assignments	20

© ISO/IEC 1995

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

ISO/IEC Copyright Office • Case postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

5.4 Electrical description	25
5.4.1 Single-ended alternative	25
5.4.1.1 Output characteristics	25
5.4.1.2 Input characteristics	25
5.4.2 Differential alternative	26
5.4.2.1 Output characteristics	26
5.4.2.2 Input characteristics	26
5.4.3 Terminator power	26
5.4.4 RESERVED lines	29
5.5 SCSI bus	30
5.6 SCSI bus signals	32
5.6.1 Signal values	33
5.6.2 OR-tied signals	33
5.6.3 Signal sources	33
5.7 SCSI bus timing	34
5.7.1 Arbitration delay	35
5.7.2 Assertion period	35
5.7.3 Bus clear delay	35
5.7.4 Bus free delay	35
5.7.5 Bus set delay	36
5.7.6 Bus settle delay	36
5.7.7 Cable skew delay	36
5.7.8 Data release delay	36
5.7.9 Deskew delay	36
5.7.10 Disconnection delay	36
5.7.11 Hold time	36
5.7.12 Negation period	36
5.7.13 Power-on to selection time	36
5.7.14 Reset to selection time	36
5.7.15 Reset hold time	37
5.7.16 Selection abort time	37
5.7.17 Selection time-out delay	37
5.7.18 Transfer period	37
5.8 Fast synchronous transfer option	37
5.8.1 Fast assertion period	37
5.8.2 Fast cable skew delay	37
5.8.3 Fast deskew delay	37
5.8.4 Fast hold time	37
5.8.5 Fast negation period	38
6 Logical characteristics	39
6.1 SCSI bus phases	39
6.1.1 BUS FREE phase	39
6.1.2 ARBITRATION phase	40
6.1.3 SELECTION phase	40
6.1.3.1 SELECTION time-out procedure	41
6.1.4 RESELECTION phase	41
6.1.4.1 RESELECTION	41
6.1.4.2 RESELECTION time-out procedure	42
6.1.5 Information transfer phases	42
6.1.5.1 Asynchronous information transfer	43
6.1.5.2 Synchronous data transfer	43
6.1.5.3 Wide data transfer	44

ISO/IEC 9316:1995(E)	©ISO/IEC
6.1.6 COMMAND phase	46
6.1.7 Data phase	46
6.1.7.1 DATA IN phase	46
6.1.7.2 DATA OUT phase	46
6.1.8 STATUS phase	46
6.1.9 Message phase	46
6.1.9.1 MESSAGE IN phase	46
6.1.9.2 MESSAGE OUT phase	46
6.1.10 Signal restrictions between phases	47
6.2 SCSI bus conditions	47
6.2.1 Attention condition	47
6.2.2 Reset condition	48
6.2.2.1 Hard reset alternative	49
6.2.2.2 Soft reset alternative	49
6.3 SCSI bus phase sequences	50
6.4 SCSI pointers	51
6.5 Message system description	52
6.6 Messages	55
6.6.1 ABORT	55
6.6.2 ABORT TAG	55
6.6.3 BUS DEVICE RESET	56
6.6.4 CLEAR QUEUE	56
6.6.5 COMMAND COMPLETE	56
6.6.6 DISCONNECT	56
6.6.7 IDENTIFY	57
6.6.8 IGNORE WIDE RESIDUE	58
6.6.9 INITIATE RECOVERY	58
6.6.10 INITIATOR DETECTED ERROR	59
6.6.11 LINKED COMMAND COMPLETE	59
6.6.12 LINKED COMMAND COMPLETE (WITH FLAG)	59
6.6.13 MESSAGE PARITY ERROR	59
6.6.14 MESSAGE REJECT	59
6.6.15 MODIFY DATA POINTER Message	60
6.6.16 NO OPERATION	60
6.6.17 Queue tag messages	60
6.6.17.1 HEAD OF QUEUE TAG	61
6.6.17.2 ORDERED QUEUE TAG	61
6.6.17.3 SIMPLE QUEUE TAG	61
6.6.18 RELEASE RECOVERY	61
6.6.19 RESTORE POINTERS	61
6.6.20 SAVE DATA POINTER	62
6.6.21 SYNCHRONOUS DATA TRANSFER REQUEST	62
6.6.22 TERMINATE I/O PROCESS	64
6.6.23 WIDE DATA TRANSFER REQUEST	64
7 SCSI commands and status	67
7.1 Command implementation requirements	67
7.1.1 Reserved	67
7.1.2 Operation code types	67
7.2 Command descriptor block	68
7.2.1 Operation code	69
7.2.2 Logical unit number	70
7.2.3 Logical block address	70

7.2.4 Transfer length	70
7.2.5 Parameter list length	70
7.2.6 Allocation length	70
7.2.7 Control field	71
7.3 Status	71
7.4 Command examples	73
7.4.1 Single command example	73
7.4.2 Disconnect example	73
7.4.3 Linked command example	74
7.5 Command processing considerations and exception conditions	74
7.5.1 Programmable operating definition	74
7.5.2 Incorrect initiator connection	75
7.5.3 Selection of an invalid logical unit	75
7.5.4 Parameter rounding	76
7.5.5 Asynchronous event notification	76
7.5.6 Unexpected reselection	77
7.6 Contingent allegiance condition	78
7.7 Extended contingent allegiance condition	78
7.8 Queued I/O processes	79
7.8.1 Untagged queuing	79
7.8.2 Tagged queuing	79
7.8.3 Example of queued I/O process	80
7.8.3.1 Typical sequences for tagged queuing	81
7.8.3.2 Example of tagged queuing	81
7.9 Unit attention condition	83
8 All device types	84
8.1 Model for all device types	84
8.1.1 SCSI addresses	84
8.1.1.1 SCSI device address	84
8.1.1.2 Logical units	84
8.1.1.3 Target routines	84
8.1.2 Commands implemented by all SCSI devices	84
8.1.2.1 Using the INQUIRY command	85
8.1.2.2 Using the REQUEST SENSE command	85
8.1.2.3 Using the SEND DIAGNOSTIC command	85
8.1.2.4 Using the TEST UNIT READY command	85
8.2 Commands for all device types	85
8.2.1 CHANGE DEFINITION command	86
8.2.2 COMPARE command	88
8.2.3 COPY command	89
8.2.3.1 Errors detected by the managing SCSI device	90
8.2.3.2 Errors detected by a target	91
8.2.3.3 COPY function code 00h and 01h	91
8.2.3.4 COPY function code 02h	92
8.2.3.5 COPY function code 03h	93
8.2.3.6 COPY function code 04h	94
8.2.3.7 Copies with unequal block lengths	94
8.2.4 COPY AND VERIFY command	95
8.2.5 INQUIRY command	96
8.2.5.1 Standard INQUIRY data	97
8.2.5.2 Vital product data	100
8.2.6 LOG SELECT command	101

8.2.7 LOG SENSE command	103
8.2.8 MODE SELECT(6) command	104
8.2.9 MODE SELECT(10) command	106
8.2.10 MODE SENSE(6) command	106
8.2.10.1 Current values	107
8.2.10.2 Changeable values	108
8.2.10.3 Default values	108
8.2.10.4 Saved values	108
8.2.10.5 Initial responses	108
8.2.11 MODE SENSE(10) command	109
8.2.12 READ BUFFER command	109
8.2.12.1 Combined header and data mode (000b)	110
8.2.12.2 Vendor-specific mode (001b)	110
8.2.12.3 Data mode (010b)	110
8.2.12.4 Descriptor mode (011b)	111
8.2.13 RECEIVE DIAGNOSTIC RESULTS command	112
8.2.14 REQUEST SENSE command	112
8.2.14.1 Sense-key specific	116
8.2.14.2 Deferred errors	117
8.2.14.3 Sense key and sense code definitions	119
8.2.15 SEND DIAGNOSTIC command	125
8.2.16 TEST UNIT READY command	126
8.2.17 WRITE BUFFER command	127
8.2.17.1 Combined header and data mode (000b)	128
8.2.17.2 Vendor-specific mode (001b)	128
8.2.17.3 Data mode (010b)	128
8.2.17.4 Download microcode mode (100b)	129
8.2.17.5 Download microcode and save mode (101b)	129
8.3 Parameters for all device types	129
8.3.1 Diagnostic parameters	129
8.3.1.1 Supported diagnostic pages	130
8.3.2 Log parameters	131
8.3.2.1 Buffer over-run/under-run page	134
8.3.2.2 Error counter pages	135
8.3.2.3 Last <i>n</i> error events page	136
8.3.2.4 Non-medium error page	136
8.3.2.5 Supported log pages	136
8.3.3 Mode parameters	137
8.3.3.1 Control mode page	140
8.3.3.2 Disconnect-reconnect page	142
8.3.3.3 Peripheral device page	144
8.3.4 Vital product data parameters	144
8.3.4.1 ISO/IEC 646 implemented operating definition page	145
8.3.4.2 ISO/IEC 646 information page	146
8.3.4.3 Implemented operating definition page	146
8.3.4.4 Supported vital product data pages	148
8.3.4.5 Unit serial number page	149
9 Direct-access devices	150
9.1 Direct-access device model	150
9.1.1 Removable medium	150
9.1.2 Logical blocks	150
9.1.3 Ready state	151

9.1.4 Initialization	151
9.1.5 Medium defects	151
9.1.6 Data cache	152
9.1.7 Reservations	153
9.1.8 Seek and rezero	154
9.1.9 Notched drives	154
9.1.10 Rotational position locking	154
9.1.11 Relative addressing	154
9.1.12 Error reporting	154
9.1.13 Examples	155
9.1.13.1 Rotating media	155
9.1.13.2 Sequential media	156
9.1.13.3 Memory media	156
9.2 Commands for direct-access devices	157
9.2.1 FORMAT UNIT command	158
9.2.1.1 Defect list formats	162
9.2.1.2 Initialization pattern option	163
9.2.2 LOCK UNLOCK CACHE command	165
9.2.3 PRE-FETCH command	166
9.2.4 PREVENT ALLOW MEDIUM REMOVAL command	167
9.2.5 READ(06) command	168
9.2.6 READ(10) command	168
9.2.7 READ CAPACITY command	169
9.2.8 READ DEFECT DATA command	171
9.2.9 READ LONG command	173
9.2.10 REASSIGN BLOCKS command	174
9.2.11 RELEASE command	175
9.2.11.1 Logical unit release	176
9.2.11.2 Extent release	176
9.2.11.3 Third-party release	176
9.2.12 RESERVE command	177
9.2.12.1 Logical unit reservation	177
9.2.12.2 Extent reservation	177
9.2.12.3 Third-party reservation	179
9.2.12.4 Superseding reservations	180
9.2.13 REZERO UNIT command	180
9.2.14 SEARCH DATA commands	181
9.2.14.1 SEARCH DATA EQUAL command	183
9.2.14.2 SEARCH DATA HIGH command	183
9.2.14.3 SEARCH DATA LOW command	183
9.2.15 SEEK(06) and SEEK(10) commands	183
9.2.16 SET LIMITS command	184
9.2.17 START STOP UNIT command	185
9.2.18 SYNCHRONIZE CACHE command	186
9.2.19 VERIFY command	187
9.2.20 WRITE(06) command	188
9.2.21 WRITE(10) command	188
9.2.22 WRITE AND VERIFY command	189
9.2.23 WRITE LONG command	190
9.2.24 WRITE SAME command	191
9.3 Parameters for direct-access devices	192
9.3.1 Diagnostic parameters	192
9.3.1.1 Translate address page - SEND DIAGNOSTIC	192

9.3.1.2 Translate address page - RECEIVE DIAGNOSTIC	193
9.3.2 Log parameters	194
9.3.3 Mode parameters	194
9.3.3.1 Caching page	196
9.3.3.2 Flexible disk page	199
9.3.3.3 Format device page	202
9.3.3.4 Medium types supported page	205
9.3.3.5 Notch and partition page	206
9.3.3.6 Read-write error recovery page	207
9.3.3.7 Rigid disk drive geometry page	214
9.3.3.8 Verify error recovery page	215
9.4 Definitions specific to direct-access devices	217
10 Sequential-access devices	218
10.1 Sequential-access device model	218
10.1.1 Physical elements	218
10.1.2 Data storage characteristics	219
10.1.3 Partitions within a volume	221
10.1.4 Logical elements within a partition	222
10.1.5 Data buffering	223
10.1.6 Recorded object descriptors (block identifiers)	224
10.1.7 Direction and position definitions	224
10.1.8 Error reporting	225
10.2 Command descriptions for sequential-access devices	226
10.2.1 ERASE command	227
10.2.2 LOAD UNLOAD command	228
10.2.3 LOCATE command	229
10.2.4 READ command	230
10.2.5 READ BLOCK LIMITS command	232
10.2.6 READ POSITION command	233
10.2.7 READ REVERSE command	235
10.2.8 RECOVER BUFFERED DATA command	236
10.2.9 RELEASE UNIT command	237
10.2.9.1 Third-party release	237
10.2.10 RESERVE UNIT command	238
10.2.10.1 Third-party reservation	238
10.2.10.2 Superseding reservations	239
10.2.11 REWIND command	239
10.2.12 SPACE command	240
10.2.13 VERIFY command	242
10.2.14 WRITE command	243
10.2.15 WRITE FILEMARKS command	244
10.3 Parameters for sequential-access devices	246
10.3.1 Diagnostic parameters	246
10.3.2 Log parameters	246
10.3.3 Mode parameters	246
10.3.3.1 Device configuration page	250
10.3.3.2 Medium partition page(1)	253
10.3.3.3 Medium partition page(2-4)	254
10.3.3.4 Read-write error recovery page	254
10.4 Definitions specific to sequential access devices	256
11 Commands for printer devices	257

11.1 Model for printer devices	257
11.2 Commands for printer devices	258
11.2.1 FORMAT command	259
11.2.2 PRINT command	260
11.2.3 RECOVER BUFFERED DATA command	260
11.2.4 SLEW AND PRINT command	261
11.2.5 STOP PRINT command	262
11.2.6 SYNCHRONIZE BUFFER command	262
11.3 Parameters for printer devices	263
11.3.1 Diagnostic parameters	263
11.3.2 Log parameters	263
11.3.3 Mode parameters	263
11.3.3.1 Parallel printer interface page	264
11.3.3.2 Printer options page	266
11.3.3.3 Serial printer interface page	269
12 Processor devices	271
12.1 Model for processor devices	271
12.1.1 Host-to-host communication, SEND only	272
12.1.2 Host-to-host communication, SEND and RECEIVE	272
12.1.3 Host-to-special-output peripheral	272
12.1.4 Host-to-special-input peripheral	272
12.2 Commands for processor devices	273
12.2.1 RECEIVE command	273
12.2.2 SEND command	274
12.3 Parameters for processor devices	275
12.3.1 Diagnostic parameters	275
12.3.2 Log parameters	275
12.4 Definitions specific to processor devices	275
13 Write-once devices	276
13.1 Model for write-once devices	276
13.1.1 Logical blocks	276
13.1.2 Initialization	276
13.1.3 Physical medium defects	276
13.1.4 Error reporting	276
13.2 Commands for write-once devices	277
13.3 Parameters for write-once devices	279
13.4 Definitions specific to write-once devices	279
14 CD-ROM devices	280
14.1 Model for CD-ROM devices	280
14.1.1 CD-ROM media organization	280
14.1.2 CD-ROM physical data format	283
14.1.2.1 Frame format for audio	283
14.1.2.2 Sector format for data	283
14.1.2.3 Sub-channel information formats	284
14.1.3 CD Audio error reporting	285
14.1.4 CD-ROM ready condition/not ready condition	285
14.1.5 CD-ROM address reporting formats (MSF bit)	285
14.1.6 Sensing support for CD-audio commands	286
14.1.7 Error reporting	286
14.2 Commands for CD-ROM devices	287

14.2.1 PAUSE RESUME command	288
14.2.2 PLAY AUDIO(10) command	289
14.2.3 PLAY AUDIO(12) command	290
14.2.4 PLAY AUDIO MSF command	290
14.2.5 PLAY AUDIO TRACK INDEX command	292
14.2.6 PLAY AUDIO TRACK RELATIVE(10) command	293
14.2.7 PLAY AUDIO TRACK RELATIVE(12) command	294
14.2.8 READ CD-ROM CAPACITY command	294
14.2.9 READ HEADER command	296
14.2.10 READ SUB-CHANNEL command	297
14.2.10.1 Sub-Q channel data format	298
14.2.10.2 CD-ROM current position data format	302
14.2.10.3 Media catalogue number data format	302
14.2.10.4 Track international standard recording code data format	303
14.2.11 READ TOC command	305
14.3 Parameters for CD-ROM devices	307
14.3.1 Diagnostic parameters	307
14.3.2 Log parameters	307
14.3.3 Mode parameters	307
14.3.3.1 CD-ROM audio control parameters	309
14.3.3.2 CD-ROM device parameters	311
14.3.3.3 Read error recovery parameters	312
14.3.3.4 Verify error recovery parameters	318
14.4 Definitions specific to CD-ROM devices	318
15 Scanner devices	321
15.1 Model for scanner devices	321
15.2 Commands for scanner devices	322
15.2.1 GET DATA BUFFER STATUS command	323
15.2.2 GET WINDOW command	325
15.2.3 OBJECT POSITION command	329
15.2.4 READ command	331
15.2.5 SCAN command	332
15.2.6 SEND command	332
15.2.7 SET WINDOW command	333
15.3 Parameters for scanner devices	334
15.3.1 Diagnostic parameters	334
15.3.2 Log parameters	334
15.3.3 Mode parameters	335
15.3.3.1 Measurement units page	335
15.4 Definitions specific to scanner devices	337
16 Optical memory devices	338
16.1 Model for optical memory devices	338
16.1.1 Defect management	339
16.1.2 Error reporting	339
16.2 Commands for optical memory devices	340
16.2.1 ERASE(10) command	341
16.2.2 ERASE(12) command	342
16.2.3 MEDIUM SCAN command	342
16.2.4 READ(12) command	344
16.2.5 READ DEFECT DATA(12) command	345
16.2.6 READ GENERATION command	346

16.2.7 READ UPDATED BLOCK(10) command	347
16.2.8 SEARCH DATA(12) commands	348
16.2.9 SET LIMITS(12) command	348
16.2.10 UPDATE BLOCK command	349
16.2.11 VERIFY(10) command	350
16.2.12 VERIFY(12) command	351
16.2.13 WRITE(10) command	352
16.2.14 WRITE(12) command	353
16.2.15 WRITE AND VERIFY(10) command	353
16.2.16 WRITE AND VERIFY(12) command	354
16.3 Parameters for optical memory devices	355
16.3.1 Diagnostic parameters	355
16.3.2 Log parameters	355
16.3.3 Mode parameters	355
16.3.3.1 Optical memory page	357
16.4 Definitions specific to write-once and optical memory devices	358
17 Medium-changer devices	359
17.1 Medium-changer device model	359
17.1.1 Medium-changer elements	359
17.1.1.1 Medium transport elements	359
17.1.1.2 Storage elements	360
17.1.1.3 Import export elements	360
17.1.1.4 Data transfer element	360
17.1.2 SCSI addressing of medium changer devices	360
17.1.3 Data access operations using a medium changer device	361
17.1.4 Element status maintenance requirements	361
17.1.5 Volume tags	361
17.1.5.1 Volume tag format	362
17.1.5.2 Primary and alternate volume tag information	362
17.2 Commands for medium changer devices	363
17.2.1 EXCHANGE MEDIUM command	364
17.2.2 INITIALIZE ELEMENT STATUS command	365
17.2.3 MOVE MEDIUM command	366
17.2.4 POSITION TO ELEMENT command	367
17.2.5 READ ELEMENT STATUS command	368
17.2.5.1 Element status data	369
17.2.5.2 Element status page	371
17.2.5.3 Medium transport element descriptor	372
17.2.5.4 Storage element descriptor	373
17.2.5.5 Import export element descriptor	374
17.2.5.6 Data transfer element descriptor	375
17.2.6 REQUEST VOLUME ELEMENT ADDRESS command	376
17.2.7 RELEASE command	378
17.2.7.1 Logical unit release	378
17.2.7.2 Element release (optional)	378
17.2.7.3 Third party release	378
17.2.8 RESERVE command	379
17.2.8.1 Logical unit reservation	379
17.2.8.2 Element reservation (optional)	379
17.2.8.3 Third party reservation	380
17.2.8.4 Superseding reservations	381
17.2.9 SEND VOLUME TAG command	381

17.3 Parameters for medium changer devices	383
17.3.1 Diagnostic parameters	383
17.3.2 Log parameters	384
17.3.3 Mode parameters	384
17.3.3.1 Device capabilities page	385
17.3.3.2 Element address assignment page	386
17.3.3.3 Transport geometry parameters page	388
17.4 Definitions specific to medium changer devices	389
18 Communications devices	390
18.1 Communications device model	390
18.1.1 Implementation examples	391
18.1.1.1 Host-to-host communications	391
18.1.1.2 Host-to-device communications	391
18.1.1.3 Multiple role communications	391
18.2 Command descriptions for communications devices	392
18.2.1 GET MESSAGE(06) command	393
18.2.2 GET MESSAGE(10) command	393
18.2.3 GET MESSAGE(12) command	394
18.2.4 SEND MESSAGE(06) command	394
18.2.5 SEND MESSAGE(10) command	395
18.2.6 SEND MESSAGE(12) command	395
18.3 Parameters for communication devices	396
18.3.1 Diagnostic parameters	396
18.3.2 Log parameters	396
18.3.3 Mode parameters	397
18.4 Definitions specific to communications devices	398
Index	420
Annexes	
A SCSI signal sequence example	399
B SCSI skew time	403
C Other SCSI standardization activities	405
D Numeric order codes	406
E Vendor identification	416

Tables	
1 - Cross-reference to connector contact assignments	20
2 - Single-ended contact assignments - A cable	20
3 - Single-ended contact assignments - B cable	21
4 - Differential contact assignments - A cable	22
5 - Differential contact assignments - B cable	23
6 - Signal sources	33
7 - SCSI bus timing values	34
8 - Information transfer phases	42
9 - Message format	52
10 - Message codes	52
11 - Extended message format	53
12 - Extended message codes	54
13 - IDENTIFY message format	57
14 - IGNORE WIDE RESIDUE message format	58
15 - Ignore field definition	58
16 - MODIFY DATA POINTER	60
17 - Queue tag message format	60
18 - SYNCHRONOUS DATA TRANSFER REQUEST	62
19 - WIDE DATA TRANSFER REQUEST	64
20 - Operation code type	67
21 - Typical command descriptor block for six-byte commands	68
22 - Typical command descriptor block for ten-byte commands	68
23 - Typical command descriptor block for twelve-byte commands	68
24 - Operation code	70
25 - Control field	71
26 - Status byte	71
27 - Status byte code	72
28 - Commands in order received by target	81
29 - Commands in order of execution	81
30 - Modified by HEAD OF QUEUE TAG message	82
31 - Commands for all device types	85
32 - CHANGE DEFINITION command	86
33 - Definition parameter field	86
34 - COMPARE command	88
35 - COPY command	89
36 - COPY parameter list	89
37 - COPY function codes	90
38 - Segment descriptor for COPY function codes 00h and 01h	91
39 - Segment descriptor for COPY function code 02h	92
40 - Segment descriptor for COPY function code 03h	93
41 - Segment descriptor for COPY function code 04h	94
42 - Pad and Cat bit definition	94
43 - COPY AND VERIFY command	95
44 - INQUIRY command	96
45 - Standard INQUIRY data format	97
46 - Peripheral qualifier	97
47 - Peripheral device type	98
48 - ISO-approved version	98
49 - LOG SELECT command	101
50 - Page control field	101
51 - LOG SENSE command	103
52 - MODE SELECT(6) command	104

53 - MODE SELECT(10) command	106
54 - MODE SENSE(6) command	106
55 - Page control field	107
56 - Mode page code usage for all devices	107
57 - MODE SENSE(10) command	109
58 - READ BUFFER command	109
59 - READ BUFFER mode field	110
60 - READ BUFFER header	110
61 - READ BUFFER descriptor	111
62 - Buffer offset boundary	111
63 - RECEIVE DIAGNOSTIC RESULTS command	112
64 - REQUEST SENSE command	112
65 - Error codes 70h and 71h sense data format	113
66 - Field pointer bytes	116
67 - Actual retry count bytes	116
68 - Format progress indication bytes	117
69 - Sense key (0h-7h) descriptions	119
70 - Sense key (8h-Fh) descriptions	120
71 - ASC and ASCQ assignments	121
72 - SEND DIAGNOSTIC command	125
73 - TEST UNIT READY command	126
74 - Preferred TEST UNIT READY responses	126
75 - WRITE BUFFER command	127
76 - WRITE BUFFER mode field	128
77 - Diagnostic page format	129
78 - Diagnostic page codes	130
79 - Supported diagnostic pages	130
80 - Log page format	131
81 - Log parameter	131
82 - Threshold met criteria	133
83 - Log page codes	134
84 - Parameter code field for buffer over-run/under-run counters	134
85 - Count basis definition	135
86 - Cause field definition	135
87 - Parameter codes for error counter pages	135
88 - Non-medium error event parameter codes	136
89 - Supported log pages	136
90 - Mode parameter list	137
91 - Mode parameter header(06)	137
92 - Mode parameter header(10)	137
93 - Mode parameter block descriptor	138
94 - Mode page format	139
95 - Mode page codes	140
96 - Control mode page	140
97 - Queue algorithm modifier	140
98 - Disconnect-reconnect page	142
99 - Data transfer disconnect control	143
100 - Peripheral device page	144
101 - Interface identifier codes	144
102 - Vital product data page codes	144
103 - ISO/IEC 646 implemented operating definition	145
104 - ISO/IEC 646 information page	146
105 - Implemented operating definition page	147

106 - Supported vital product data pages	148
107 - Unit serial number page	149
108 - Commands for direct-access devices	157
109 - FORMAT UNIT command	158
110 - FORMAT UNIT parameter list	159
111 - Defect list header	159
112 - FORMAT UNIT defect descriptor format and requirements	160
113 - Defect descriptor - Block format	162
114 - Defect descriptor - Bytes from index format	162
115 - Defect descriptor - Physical sector format	163
116 - Initialization pattern descriptor	163
117 - Initialization pattern modifier	164
118 - Initialization pattern type	164
119 - LOCK UNLOCK CACHE command	165
120 - PRE-FETCH command	166
121 - PREVENT ALLOW MEDIUM REMOVAL command	167
122 - READ(06) command	168
123 - READ(10) command	168
124 - READ CAPACITY command	169
125 - READ CAPACITY data	170
126 - READ DEFECT DATA command	171
127 - READ DEFECT DATA defect list	172
128 - READ LONG command	173
129 - REASSIGN BLOCKS command	174
130 - REASSIGN BLOCKS defect list	174
131 - RELEASE command	175
132 - RESERVE command	177
133 - Data format of extent descriptors	178
134 - Reservation types	178
135 - REZERO UNIT command	180
136 - SEARCH DATA commands	181
137 - SEARCH DATA parameter list	182
138 - SEEK(06) command	183
139 - SEEK(10) command	183
140 - SET LIMITS command	184
141 - START STOP UNIT command	185
142 - SYNCHRONIZE CACHE command	186
143 - VERIFY command	187
144 - WRITE(06) command	188
145 - WRITE(10) command	188
146 - WRITE AND VERIFY command	189
147 - WRITE LONG command	190
148 - WRITE SAME command	191
149 - Diagnostic page codes	192
150 - Translate address page - SEND DIAGNOSTIC	192
151 - Translate address page - RECEIVE DIAGNOSTIC	193
152 - Log page codes	194
153 - Direct-access medium-type codes	194
154 - Device specific parameter	195
155 - Mode page codes	196
156 - Caching page	196
157 - Demand read and write retention priority	197
158 - Flexible disk page	199

159 - Examples of transfer rates	200
160 - Pin 34 field	201
161 - Pin 4 field	201
162 - Pin 2 field	202
163 - Format device page	202
164 - Reporting of default sector formatting support	204
165 - Reporting of changeable sector formatting support	205
166 - Medium types supported page	205
167 - Notch page	206
168 - Read-write error recovery page	207
169 - Error recovery bit definitions	208
170 - Combined error recovery parameter descriptions	209
171 - Rigid disk drive geometry page	214
172 - Rotational position locking	215
173 - Verify error recovery page	216
174 - Commands for sequential-access devices	226
175 - ERASE command	227
176 - LOAD UNLOAD command	228
177 - LOCATE command	229
178 - READ command	230
179 - READ BLOCK LIMITS command	232
180 - READ BLOCK LIMITS data	232
181 - READ POSITION command	233
182 - READ POSITION data format	233
183 - READ REVERSE command	235
184 - RECOVER BUFFERED DATA command	236
185 - RELEASE UNIT command	237
186 - RESERVE UNIT command	238
187 - REWIND command	239
188 - SPACE command	240
189 - Code field definition	240
190 - VERIFY command	242
191 - WRITE command	243
192 - WRITE FILEMARKS command	244
193 - Diagnostic page codes	246
194 - Log page codes	246
195 - Device-specific parameter	246
196 - Buffered modes	247
197 - Speed field definition	247
198 - Sequential-access density codes	249
199 - Mode page codes	249
200 - Device configuration page	250
201 - EOD formats	252
202 - Medium partition page(1)	253
203 - Medium partition page(2-4)	254
204 - Read-write error recovery page	254
205 - Commands for printer devices	258
206 - FORMAT command	259
207 - Format type	259
208 - PRINT command	260
209 - RECOVER BUFFERED DATA command	260
210 - SLEW AND PRINT command	261
211 - STOP PRINT command	262

212 - SYNCHRONIZE BUFFER command	262
213 - Diagnostic page codes	263
214 - Log page codes	263
215 - Printer device-specific parameter	263
216 - Mode page codes	264
217 - Parallel printer interface	264
218 - Parity select	264
219 - VFU control byte	265
220 - Printer options	266
221 - Font identification	266
222 - Slew mode	266
223 - Line slew	267
224 - Form slew	268
225 - Data termination option	268
226 - Serial printer interface	269
227 - Parity selection	270
228 - Pacing protocol	270
229 - Commands for processor devices	273
230 - RECEIVE command	273
231 - SEND command	274
232 - SEND command - AEN data format	274
233 - Diagnostic page codes	275
234 - Log page codes	275
235 - Commands for write-once devices	277
236 - Example mixed mode CD-ROM disc layout	281
237 - MSF address format	285
238 - Commands for CD-ROM device	287
239 - PAUSE RESUME command	288
240 - PLAY AUDIO(10) command	289
241 - PLAY AUDIO(12) command	290
242 - PLAY AUDIO MSF command	290
243 - PLAY AUDIO TRACK INDEX command	292
244 - PLAY AUDIO TRACK RELATIVE(10) command	293
245 - PLAY AUDIO TRACK RELATIVE(12) command	294
246 - READ CD-ROM CAPACITY command	294
247 - READ CAPACITY data format	295
248 - READ HEADER command	296
249 - READ HEADER data format	296
250 - CD-ROM data mode codes	297
251 - READ SUB-CHANNEL command	297
252 - Sub-channel data format codes	298
253 - Sub-Q channel data format	298
254 - Audio status codes	299
255 - ADR sub-channel Q field	300
256 - Sub-channel Q control bits	300
257 - CD-ROM current position data format	302
258 - Media catalogue number data format	302
259 - Track international standard recording code data format	303
260 - READ TOC command	305
261 - READ TOC data format	305
262 - Diagnostic page codes	307
263 - Log page codes	307
264 - CD-ROM medium type codes	307

265 - CD-ROM device-specific parameter	308
266 - CD-ROM density codes	308
267 - Mode page codes	309
268 - CD-ROM audio control parameters page	309
269 - Multiplier for LBAs	310
270 - Output port channel selection	310
271 - CD-ROM parameters page	311
272 - Inactivity timer multiplier values	311
273 - Read error recovery parameters page	312
274 - Error recovery bit settings	312
275 - CD-ROM error recovery descriptions	313
276 - Verify error recovery parameters page	318
277 - Commands for scanner devices	322
278 - GET DATA BUFFER STATUS command	323
279 - Data buffer status format	323
280 - GET WINDOW command	325
281 - Get window data header	325
282 - Window descriptor bytes	326
283 - Image composition codes	327
284 - Padding types	328
285 - Compression types and arguments	328
286 - OBJECT POSITION command	329
287 - Position function	329
288 - READ command	331
289 - Data type codes	331
290 - SCAN command	332
291 - SEND command	332
292 - SET WINDOW command	333
293 - Set window data header	333
294 - Diagnostic page codes	334
295 - Log page codes	334
296 - Mode page codes	335
297 - Measurement units page	335
298 - Basic measurement units	336
299 - Commands for optical memory devices	340
300 - ERASE(10) command	341
301 - ERASE(12) command	342
302 - MEDIUM SCAN command	342
303 - MEDIUM SCAN parameter list	343
304 - READ(12) command	344
305 - READ DEFECT DATA(12) command	345
306 - READ DEFECT DATA(12) list header	345
307 - READ GENERATION command	346
308 - Maximum generation data block	346
309 - READ UPDATED BLOCK(10) command	347
310 - SEARCH DATA(12) commands	348
311 - SET LIMITS(12) command	348
312 - UPDATE BLOCK command	349
313 - VERIFY command	350
314 - VERIFY(12) command	351
315 - WRITE(10) command	352
316 - WRITE(12) command	353
317 - WRITE AND VERIFY(10) command	353

318 - WRITE AND VERIFY(12) command	354
319 - Diagnostic page codes	355
320 - Log page codes	355
321 - Optical memory medium-type codes	355
322 - Optical memory device specific parameter	356
323 - Optical memory density codes	356
324 - Mode page codes	357
325 - Optical memory page	358
326 - Volume tag information format	362
327 - Commands for medium changer devices	363
328 - EXCHANGE MEDIUM command	364
329 - INITIALIZE ELEMENT STATUS command	365
330 - MOVE MEDIUM command	366
331 - POSITION TO ELEMENT command	367
332 - READ ELEMENT STATUS command	368
333 - Element type code	368
334 - Element status data	369
335 - Element status page	371
336 - Medium transport element descriptor	372
337 - Storage element descriptor	373
338 - Import export element descriptor	374
339 - Data transfer element descriptor	375
340 - REQUEST VOLUME ELEMENT ADDRESS command	376
341 - Volume element address header format	377
342 - RELEASE command	378
343 - RESERVE command	379
344 - Data format of element list descriptors	380
345 - SEND VOLUME TAG command	381
346 - Send volume tag action codes	381
347 - Send volume tag parameters format	382
348 - Diagnostic page codes	383
349 - Log page codes	384
350 - Mode page codes	384
351 - Device capabilities page	385
352 - Element address assignment page	386
353 - Transport geometry parameters page	388
354 - Commands for communications devices	392
355 - GET MESSAGE(06) command	393
356 - GET MESSAGE(10) command	393
357 - GET MESSAGE(12) command	394
358 - SEND MESSAGE(06) command	394
359 - SEND MESSAGE(10) command	395
360 - SEND MESSAGE(12) command	395
361 - Diagnostic page codes	396
362 - Log page codes	396
363 - Mode page codes	397
B.1 - Fast SCSI jitter budget	403
B.2 - Mapping of jitter to SCSI	403
D.1 - ASC and ASCQ assignments	406
D.2 - SCSI-2 Operation Codes	412
E.1 - Vendor identification list	416

Figures

1 - 50/68-contact non-shielded high-density SCSI device connector	11
2 - 50/68-contact non-shielded high-density cable connector	12
3 - 50-contact non-shielded low-density SCSI device connector	13
4 - 50-contact non-shielded low-density cable connector	14
5 - 50/68-contact shielded high-density SCSI device connector	16
6 - 50/68-contact shielded high-density cable connector	17
7 - 50-contact shielded low-density SCSI device connector	18
8 - 50-contact shielded low-density cable connector	19
9 - Alternative 1 termination	28
10 - Alternative 2 termination for single-ended devices	28
11 - Termination for differential devices	29
12 - Differential driver protection circuit	29
13 - SCSI ID bits	30
14 - Sample SCSI configurations	31
15 - Wide SCSI byte ordering	45
16 - Phase sequences	50
17 - Simplified SCSI system	51
18 - Typical volume layout	219
19 - Typical medium track layout	219
20 - Serpentine recording example	219
21 - Parallel recording example	220
22 - Helical scan recording example	220
23 - Early-warning example	220
24 - Partitioning example - one partition per track group	221
25 - Partitioning example - one partition per two track groups	221
26 - Partitioning example - two partitions per track group	222
27 - SCSI printer model	257
28 - Illustration of element status data structure	370
A.1 - SCSI signal sequence example	402
C.1 - SCSI-3 standards structure	405

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

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

International Standard ISO/IEC 9316 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Subcommittee SC 25, Interconnection of information technology equipment*.

This second edition cancels and replaces the first edition (ISO 9316:1989), which has been technically revised.

Annexes A to E of this International Standard are for information only.

Introduction

This International Standard constitutes a revision of and therefore replaces ISO 9316:1989, *Information processing systems – Small Computer System Interface (SCSI)*.

This International Standard encompasses the following:

- Clause 1 describes the scope.
- Clause 2 lists the normative references.
- Clause 3 provides a glossary common to the whole document.
- Clause 4 provides descriptions and conventions.
- Clause 5 describes the physical characteristics.
- Clause 6 describes the logical characteristics of the interface.
- Clause 7 describes the SCSI command and status structure.
- Clause 8 specifies those commands that have a consistent meaning for all device types.
- Clause 9 specifies commands for direct-access devices.
- Clause 10 specifies commands for sequential-access devices.
- Clause 11 specifies commands for printer devices.
- Clause 12 specifies commands for processor devices.
- Clause 13 specifies commands for write-once devices.
- Clause 14 specifies commands for CD-ROM devices.
- Clause 15 specifies commands for scanner devices.
- Clause 16 specifies commands for optical memory devices.
- Clause 17 specifies commands for medium changer devices.
- Clause 18 specifies commands for communications devices.
- Annex A illustrates SCSI signal sequence.
- Annex B illustrates fast SCSI skew time.
- Annex C describes other SCSI standardization activities.
- Annex D contains SCSI-2 additional sense codes and operation codes in numeric order.
- Annex E contains the list of SCSI-2 vendor identifications.

The SCSI protocol is designed to provide an efficient peer-to-peer I/O bus with up to 16 devices, including one or more hosts. Data may be transferred asynchronously at rates that only depend on device implementation and cable length. Synchronous data transfers are supported at rates up to 10 mega-transfers per second. With the 32-bit wide data transfer option, data rates of up to 40 megabytes per second are possible.

SCSI-2 includes command sets for magnetic and optical disks, tapes, printers, processors, CD-ROMs, scanners, medium changers, and communications devices.

In 1985, when the first SCSI standard was being finalized several manufacturers wanted to increase the mandatory requirements of SCSI and to define further features for direct-access devices. Rather than delay the SCSI standard, an ad hoc group was formed to develop a working paper that was eventually called the Common Command Set (CCS). Many disk products were designed using this working paper.

In parallel with the development of the CCS working paper, work began on an enhanced SCSI standard which was named SCSI-2. SCSI-2 included the results of the CCS working paper and extended them to all device types. It also added caching commands, performance enhancement features, and other worthwhile functions. While SCSI-2 has gone well beyond the original SCSI standard (now referred to as SCSI-1), it retains a high degree of compatibility with SCSI-1 devices.

SCSI-2 has evolved significantly from SCSI-1 with the new document nearly three times larger. Most of the changes are additions, but several obsolete options were removed:

- a) Single initiator option
- b) Non-arbitrating systems option

- c) The SCSI-1 alternative 1 shielded connector
- d) Non-extended sense data option
- e) Reservation queuing option
- f) The read-only device command set.

There are several new low-level requirements:

- a) Parity is now required
- b) Initiators are required to provide terminator power
- c) The arbitration delay was increased from 2,2 to 2,4 μ s
- d) Message support is now required.

Several low-level options were added:

- a) Wide SCSI (up to 32 bits wide using a second cable)
- b) Fast SCSI (synchronous data transfers of up to 10 mega-transfers per second)
- c) Command queuing (up to 256 commands per initiator per logical unit)
- d) High-density connector alternatives were added
- e) Asynchronous event notification
- f) Extended contingent allegiance.

New command sets were added including:

- a) CD-ROM (replaces read-only device)
- b) Scanner device
- c) Optical memory device (provides for write-once, read-only, and erasable media)
- d) Medium changer device
- e) Communications device

All command sets were enhanced:

- a) Device models were added
- b) Extended sense was expanded
- c) The INQUIRY data was expanded
- d) The MODE SELECT and MODE SENSE commands were paged for all device types
- e) The CHANGE DEFINITION, LOG SELECT, LOG SENSE, READ BUFFER, and WRITE BUFFER commands were added for all device types
- f) The COPY command definition was expanded to include inexact block size handling and an image copy option
- g) The direct-access device command set was enhanced to add cache management, several new commands and to provide more initiator control over defect management
- h) The sequential-access device command set was enhanced to add a partitioned media concept
- i) The printer device command set was enhanced by adding several mode pages
- j) The write-once (optical) device command set was enhanced by adding several new commands plus extending several command descriptor blocks to twelve bytes to accommodate larger transfer lengths.

This is a preview of ISO/IEC 9316:1995. [Click here to purchase the full version from the ANSI store.](#)

Information technology - Small Computer System Interface-2

1 Scope

This International Standard defines an input/output bus for interconnecting computers and peripheral devices. It defines extensions to the Small Computer System Interface (ISO 9316:1989), referred to herein as SCSI-1. It also provides more complete standardization of the previously defined command sets. It includes the necessary specification of the mechanical, electrical, and functional characteristics of the interface to allow inter-operability of conforming devices. This International Standard is referred to herein as SCSI-2. The term SCSI is used wherever it is not necessary to distinguish between the two versions.