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ISO/IEC 14776-362

First edition
2006-04

Information technology –
Small computer system interface (SCSI) –

Part 362:
Multimedia commands-2 (MMC-2)



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CONTENTS

FOREWORD 18
INTRODUCTION 20
1 Scope 21
2 References 21
2.1 Normative references 21
2.1.1 Approved references 21
2.1.2 References under development 22
2.2 Other references 22
3 Definitions, abbreviations and acronyms 22
3.1 Definitions of terms 22
3.2 Conventions 31
3.3 Keywords 31
4 C/DVD models 32
4.1 General 32
4.1.1 CD address reporting formats (MSF bit) 32
4.1.2 Logical blocks 33
4.1.3 Data cache 33
4.1.4 RESETS 34
4.1.5 Error reporting 35
4.1.6 Deferred errors 35
4.1.7 Removable medium 36
4.2 CD device model 37
4.2.1 Recorded CD media structure 37
4.2.2 Physical track topology – Multi-session disc 40
4.2.3 CD Audio error reporting 55
4.2.4 CD ready condition/not ready condition 55
4.2.5 Sensing support for CD-audio commands 57
4.3 DVD Model 57
4.3.1 DVD media functionality 57
4.3.2 Track structure 58
4.3.3 Recording for DVD-R 65
4.3.4 ECC Block 66
4.3.5 Sector configuration 66
4.3.6 DVD ready condition/Not ready condition 71
4.3.7 DVD copy protection 72
4.4 Changer model 76
4.4.1 Side definition 77
4.4.2 Changer addressing 79
4.4.3 Automatic load and unload operations 79
4.4.4 Delayed disc load operation 79
4.4.5 Prevent/Allow processing 81
4.4.6 Error reporting for Changers 81
5 Features and profiles 81
5.1 Introduction 81
5.2 Features 82
5.2.1 Version field 83
5.2.2 Persistent bit 83

--`,,```,,,,````-`-`,,`,,`,`,,`---
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5.2.3 Current bit 83
5.2.4 Additional length field 83
5.2.5 Feature codes 83
5.3 Feature definitions 85
5.3.1 Profile list feature (0000h) 85
5.3.2 Core feature (0001h) 86
5.3.3 Morphing feature (0002h) 88
5.3.4 Removable medium feature (0003h) 89
5.3.5 Random readable feature (0010h) 90
5.3.6 Multi-Read feature (001Dh) 92
5.3.7 CD read feature (001Eh) 92
5.3.8 DVD read feature (001Fh) 93
5.3.9 Random writable feature (0020h) 94
5.3.10 Incremental streaming writable (0021h) 95
5.3.11 Sector erasable feature (0022h) 97
5.3.12 Formattable feature (0023h) 97
5.3.13 Defect management feature (0024h) 98
5.3.14 Write once feature (0025h) 99
5.3.15 Restricted overwrite feature (0026h) 100
5.3.16 CD Track at once feature (002Dh) 101
5.3.17 CD mastering (session at once) feature (002Eh) 102
5.3.18 DVD-R write feature (002Fh) 104
5.3.19 Power management feature (0100h) 105
5.3.20 Embedded changer feature (0102h) 105
5.3.21 CD audio external play feature (0103h) 106
5.3.22 Microcode upgrade feature (0104h) 108
5.3.23 Time-out feature (0105h) 108
5.3.24 DVD-CSS Feature (0106h) 109
5.3.25 Real-time streaming feature (0107h) 110
5.3.26 Feature 0108h – Logical unit serial number 110
5.3.27 Feature 010Ah - Disc control blocks 111
5.4 Profile definitions 112
5.4.1 Profile 2 - Removable disk 113
5.4.2 Profile 3 - Magneto-optical 113
5.4.3 Profile 4 - Magneto-optical write once 114
5.4.4 Profile 5h - AS-MO 114
5.4.5 Profile 8 - CD-ROM 115
5.4.6 Profile 9 - CD-R 115
5.4.7 Profile Ah - CD-RW 116
5.4.8 Profile 10h - DVD-ROM 116
5.4.9 Profile 11h - DVD-R 117
5.4.10 Profile 12h - DVD re-writable 117
5.4.11 Profile FFFFh - Logical units not conforming to a standard profile 118
5.5 Parameters for all logical unit types 118
5.5.1 Mode pages 118
5.5.2 Mode select/sense parameters 119
5.5.3 Read/write error recovery parameters page (page code 01h) 121
5.5.4 Write parameters mode page (page code 05h) 126
5.5.5 CD device parameters (page code 0Dh) 130
5.5.6 CD audio control parameters page (page code 0Eh) 131
5.5.7 Power condition page (page code 1Ah) 133
5.5.8 Fault/failure reporting control page 134

--`,,```,,,,````-`-`,,`,,`,`,,`---

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5.5.9 Time-out and protect page 136
5.5.10 Capabilities and mechanical status page 137
6 Command descriptions for all logical units 141
6.1 C/DVD commands 142
6.1.1 BLANK command 143
6.1.2 CLOSE TRACK/SESSION command 145
6.1.3 FORMAT UNIT command 147
6.1.4 GET CONFIGURATION command 154
6.1.5 GET EVENT/STATUS NOTIFICATION 158
6.1.6 GET PERFORMANCE 167
6.1.7 LOAD/UNLOAD MEDIUM command 171
6.1.8 MECHANISM STATUS command 173
6.1.9 PAUSE/RESUME command 176
6.1.10 PLAY AUDIO (10) Command 177
6.1.11 PLAY AUDIO (12) command 178
6.1.12 PLAY AUDIO MSF command 179
6.1.13 Play CD command (obsolete) 180
6.1.14 READ BUFFER CAPACITY command (obsolete) 182
6.1.15 READ CD command 183
6.1.16 READ CD MSF command 191
6.1.17 READ CAPACITY command 193
6.1.18 READ DISC INFORMATION command 194
6.1.19 READ DVD STRUCTURE command 198
6.1.20 READ FORMAT CAPACITIES 215
6.1.21 READ HEADER command (obsolete) 219
6.1.22 READ MASTER CUE command (obsolete) 221
6.1.23 READ SUB-CHANNEL command 222
6.1.24 READ TOC/PMA/ATIP command 229
6.1.25 TOC/PMA/ATIP response data format 0100b 237
6.1.26 READ TRACK INFORMATION command 239
6.1.27 REPAIR TRACK command (obsolete) 247
6.1.28 REPORT KEY command 247
6.1.29 RESERVE TRACK command 253
6.1.30 SCAN command 255
6.1.31 SEND CUE SHEET command 258
6.1.32 SEND DVD STRUCTURE command 266
6.1.33 SEND EVENT Command 271
6.1.34 SEND KEY command 273
6.1.35 SEND OPC INFORMATION Command 275
6.1.36 SET CD SPEED command (obsolete) 277
6.1.37 SET READ AHEAD command 278
6.1.38 SET STREAMING command 279
6.1.39 STOP PLAY/SCAN command 282
6.1.40 SYNCHRONIZE CACHE command 283
6.1.41 WRITE (10) command 284
6.1.42 WRITE AND VERIFY (10) command 287
Annex A (normative) Additional Sense Codes for CD 289
A.1 Error reporting 289
Annex B (normative) ATAPI Compliance 299
B.1 Introduction 299

--`,,```,,,,````-`-`,,`,,`,`,,`---
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B.2 General 299
B.2.1 Terms 299
B.2.2 Supported Block Sizes 299
B.2.3 CD Audio error reporting 299
B.2.4 Multi-Initiator Environment 299
B.2.5 Command Packet Padding 300
B.2.6 Mapping of reset functions 300
B.3 ATAPI commands requirements 300
Annex C (normative) Requirements for SBP-2 compliance 303
C.1 SBP-2 definitions 303
C.2 SBP-2 Storage Model 304
C.2.1 Model configuration 304
C.2.2 Model operation 305
C.2.3 Reconnect/Power reset support (normative) 306
C.3 Configuration ROM support 306
C.3.1 Unit Directory – Command_Set_Spec_ID 306
C.3.2 Unit Directory – Command_Set 306
C.3.3 Unit Directory – Command_Set_Revision 307
C.3.4 Unit Directory – Logical_Unit_Number 307
C.4 Login support 307
C.5 Security support 308
C.6 Status block support 308
C.7 Unsolicited Status support 308
C.8 Unit attention condition 309
Annex D (normative) Requirements for Fibre Channel Protocol for SCSI Compliance 310
D.1 Introduction 310
D.2 General 310
D.2.1 Terms 310
D.2.2 Information units 310
D.2.3 Process login/logout 310
D.2.4 Sense information 310
D.2.5 Reset mapping 311
Annex E (normative) SCSI Implementation notes 312
E.1 Introduction 312
E.2 SCSI signal utilization 312
E.3 SCSI compatibility 312
E.3.1 Additions to the SCSI Standards (ISO/IEC 14776-xxx) 312
E.4 Reset Functionality 312
E.4.1 Power On Reset 312
E.4.2 Hard Reset 312
E.4.3 TARGET RESET task management function 313
E.4.4 Device Reset 313
E.4.5 Power Management and Device Reset in SCSI 313
E.4.6 Mapping of reset functions 314
Annex F (normative) Power management functions 315
F.1 Power management states 315
F.2 Power state transitions 316

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F.2.1 Active State (D0) 316
F.2.2 Idle State (D1) 316
F.2.3 Standby State (D2) 316
F.2.4 Sleep State (D3) 317
F.3 Power management state diagram 317
F.4 Power Management Timers 318
F.5 Standby timer 319
F.6 Power Management Status Reporting 321
Annex G (informative) SCSI command listings 322
G.1 List of SCSI commands 322
Annex H (informative) Implementation of features 323
H.1 What's a Feature? 323
H.2 History 323
H.3 Implementation of Features 324
H.4 Compatibility 325
H.5 Summary 325
Annex I (informative) MMC command listings 326
Annex J (informative) CD -TEXT Format in the Lead-in Area 329
Bibliography 332

Figure 1 – Single Session Disc 40
Figure 2 – Multi-Session Recorded Disc 40
Figure 3 – Q Sub-channel Mode-1 Format recorded in Program Area 42
Figure 4 – Q Sub-channel Mode-2 Format 42
Figure 5 – Q Sub-channel, Mode-3 Format 43
Figure 6 – Q Sub-channel Mode-1 Format recorded in Lead-in 44
Figure 7 – Q Sub-channel Mode-5 Format recorded in Lead-in 45
Figure 8 – Synchronization Field pattern 46
Figure 9 – CD-R and CD-RW medium 50
Figure 10 – PMA, Q Sub-channel 51
Figure 11 – Packet Format 52
Figure 12 – Physical and Logical Layout of Single Layer DVD-ROM Media 59
Figure 13 – Physical and Logical Layout of Parallel Track Path DVD-ROM Media 60
Figure 14 – Physical and Logical Layout of Opposite Track Path DVD-ROM Media 61
Figure 15 – Physical and Logical Layout of DVD-R Media 62
Figure 16 – Physical and Logical Layout of Single Layer DVD + RW Media 63
Figure 17 – Physical and Logical Layout of DVD-RAM Media 64
Figure 18 – Data Organization within an ECC Block 66
Figure 19 – Formation of Data Unit 3 66
Figure 20 – Data Unit 1 67
Figure 21 – Data ID Field definition 67
Figure 22 – Data Structure of Disc Lead-in Area 68
Figure 23 – Device key exchange and authentication state diagram 73

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Figure 24 – Authentication flag sequence 73
Figure 25 – Region State Diagram 76
Figure 26 – Media Changer Mechanism Model 77
Figure 27 – Changer State Diagram 79
Figure 28 – Read CD Sub-channel, R-W (100b) 190
Figure 29 – CD (CD-DA) 262
Figure 30 – CD-ROM mode 1 263
Figure 31 – CD-ROM XA, CD-I 263
Figure 32 – CD-ROM Mode 2 264
Figure 33 – Location of Sub-channel Data 265
Figure 34 – Stop Play/Play Audio/Audio Scan/Pause/Resume Sequencing 283
Figure C.1 – Mass storage interface block diagram 304
Figure C.2 – Command_Set_Spec_ID 306
Figure C.3 – Command_Set 307
Figure C.4 – Command_Set_Revision 307
Figure C.5 – Logical_Unit_Number 307
Figure C.6 – Status block for MMC-2 308
Figure F.1 – Power Management STATE diagram 318
Figure J.1 – Block number character position 330

Table 1 – MSF address format 33
Table 2 – Sense key responses for error reporting 35
Table 3 – Small Frame layout and definition 37
Table 4 – CD Frame Structure from Small Frames 38
Table 5 – Sub-Channel byte layout 38
Table 6 – P-Sub-Channel Layout 39
Table 7 – Q Sub-channel record format 41
Table 8 – ISRC 6 bit character codes (in hexadecimal) 43
Table 9 – Sync pattern block header 46
Table 10 – Mode zero data format 47
Table 11 – Mode 1 data format 47
Table 12 – Mode 2 formless block format 48
Table 13 – Mode 2 form 1 data format 48
Table 14 – Mode 2 form 1 sub-header format 49
Table 15 – Mode 2 form 2 data format 49
Table 16 – ATIP format 50
Table 17 – Block Identifier bits 53
Table 18 – Track Descriptor Block (TDB) header 54
Table 19 – Track Descriptor Unit (TDU) Format 54
Table 20 – Not Ready Error Reporting (by command) 56
Table 21 – Data field number for DVD media 68
Table 22 – Control structure of control data block 69

--`,,```,,,,````-`-`,,`,,`,`,,`---

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Table 23 – Common part of physical format information 69
Table 24 – Book type field 69
Table 25 – DVD-ROM unique part of physical format information 70
Table 26 – DVD-R unique part of physical format information 70
Table 27 – DVD-RAM unique part of physical format information 70
Table 28 – DVD + RW unique part of physical format 70
Table 29 – Data area allocation definition 71
Table 30 – Commands that may cause delayed loads to occur 80
Table 31 – Commands that will cause delayed loads to occur 80
Table 32 – Commands that should not cause delayed loads to occur 80
Table 33 – Error conditions and Sense Keys for Changer mechanisms 81
Table 34 – GET CONFIGURATION response data format 82
Table 35 – Feature header 82
Table 36 – Feature descriptor generic format 83
Table 37 – Feature codes 84
Table 38 – Profile list descriptor format 85
Table 39 – Profile descriptor 85
Table 40 – Profile list 86
Table 41 – Core commands 87
Table 42 – Core feature descriptor format 87
Table 43 – Physical interface standard 88
Table 44 – Morphing feature commands 88
Table 45 – Morphing descriptor format 88
Table 46 – Removable medium commands 89
Table 47 – Removable medium descriptor format 89
Table 48 – Loading mechanism type 90
Table 49 – Random readable feature 90
Table 50 – Random Readable Descriptor format 91
Table 51 – Multi-Read feature commands 92
Table 52 – Multi-Read descriptor format 92
Table 53 – CD READ commands 92
Table 54 – CD Read descriptor format 93
Table 55 – DVD READ feature commands 93
Table 56 – DVD read descriptor format 93
Table 57 – Random writable block device commands 94
Table 58 – Random writable descriptor format 94
Table 59 – Incremental streaming commands 95
Table 60 – Incremental streaming parameters 96
Table 61 – Incremental streaming writable descriptor format 96
Table 62 – Sector erasable feature commands 97
Table 63 – Sector erasable 97
Table 64 – Formattable feature commands 97

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Table 65 – Formattable descriptor format 98
Table 66 – Defect management feature parameters 98
Table 67 – Defect management descriptor format 98
Table 68 – Write once feature commands 99
Table 69 – Write once feature parameters 99
Table 70 – Write once descriptor format 99
Table 71 – Restricted overwrite commands 100
Table 72 – Restricted Overwrite parameter 100
Table 73 – Restricted overwrite descriptor format 100
Table 74 – CD track at once feature commands 101
Table 75 – CD track at once feature parameters 101
Table 76 – CD Track at once descriptor format 101
Table 77 – CD mastering (session at once) feature commands 102
Table 78 – CD mastering (session at once) parameter 102
Table 79 – CD mastering (RAW) feature commands 102
Table 80 – CD mastering (RAW) parameters 102
Table 81 – CD mastering feature descriptor 103
Table 82 – DVD-R write commands 104
Table 83 – DVD-R write feature parameters 104
Table 84 – DVD-R write feature descriptor format 104
Table 85 – Power management commands 105
Table 86 – Power management mode parameters 105
Table 87 – Power management descriptor format 105
Table 88 – Embedded changer command 106
Table 89 – Embedded changer descriptor format 106
Table 90 – CD-audio external play feature commands 107
Table 91 – CD-Audio External Output Parameters 107
Table 92 – CD audio external play descriptor format 107
Table 93 – Microcode upgrade command 108
Table 94 – Microcode upgrade descriptor format 108
Table 95 – Time-out feature parameter 108
Table 96 – Time-Out Descriptor Format 109
Table 97 – DVD-CSS feature commands 109
Table 98 – DVD-CSS feature descriptor format 109
Table 99 – Real-time streaming feature commands 110
Table 100 – Real-time streaming feature descriptor format 110
Table 101 – Logical unit serial number feature descriptor 111
Table 102 – Disc control blocks feature commands 111
Table 103 – Disc control blocks feature descriptor 112
Table 104 – Mandatory features for removable disks 113
Table 105 – Mandatory features for magneto-optical erasable 113
Table 106 – Mandatory features for magneto-optical write once 114

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Table 107 – Mandatory features for AS-MO 114
Table 108 – Mandatory features for CD-ROM 115
Table 109 – Mandatory features for CD-R 115
Table 110 – Mandatory features for CD-RW 116
Table 111 – Mandatory Features for DVD-ROM 116
Table 112 – Mandatory features for DVD-R 117
Table 113 – Mandatory features for DVD re-writable 117
Table 114 – Mandatory features for logical units not conforming to a standard profile 118
Table 115 – Mode page codes for C/DVD 118
Table 116 – Mode parameter list 119
Table 117 – Mode page format 119
Table 118 – Mode parameter header 120
Table 119 – Block Descriptor Block Sizes for Read 120
Table 120 – Read/Write Error Recovery Parameters Page Format 121
Table 121 – CD-ROM Devices, error recovery description 123
Table 122 – DVD Devices, Error Recovery Description 125
Table 123 – Write Parameters Mode Page 126
Table 124 – Write Type Field 127
Table 125 – Multi-session Field Definition 128
Table 126 – Data Block Type Codes 129
Table 127 – Session Format Codes 130
Table 128 – CD Parameters page 130
Table 129 – Inactivity timer multiplier values 131
Table 130 – CD Audio Control Mode Page Format 131
Table 131 – CDDA Output Port Channel Selection Codes 132
Table 132 – Attenuation Levels for Audio 133
Table 133 – Power Condition Mode Page Format 133
Table 134 – Fault/Failure Reporting Control Page 134
Table 135 – Method of Reporting Fault/Failure Reporting Field 135
Table 136 – Time-out & Protect Page 136
Table 137 – CD Capabilities and Mechanical Status Page 137
Table 138 – Loading Mechanism Type 139
Table 139 – Commands Specific to C/DVD Devices 142
Table 140 – BLANK Command Descriptor Block 143
Table 141 – Blanking types 144
Table 142 – Recommended errors for BLANK Command 145
Table 143 – CLOSE TRACK/SESSION Command Descriptor Block 145
Table 144 – Session and Track bits Definitions 146
Table 145 – Recommended errors for CLOSE TRACK/SESSION Command 147
Table 146 – Format Unit Command 147
Table 147 – DVD-RAM Defect List Handling 148
Table 148 – Format Unit Parameter List 149

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Table 149 – Format List Header 149
Table 150 – Initialization Pattern Descriptor 150
Table 151 – IP Modifier Field 151
Table 152 – Initialization Pattern Type 151
Table 153 – CD-RW Format Descriptor 152
Table 154 – Format Code 001b Format Descriptor 153
Table 155 – Recommended errors for FORMAT UNIT Command 154
Table 156 – GET CONFIGURATION Command Descriptor Block 155
Table 157 – RT Field definition 155
Table 158 – GET CONFIGURATION response data format 156
Table 159 – Feature Header 156
Table 160 – Feature Descriptor generic format 156
Table 161 – Recommended Errors for GET CONFIGURATION Command 158
Table 162 – GET EVENT/STATUS NOTIFICATION Command 158
Table 163 – Notification Class Request 159
Table 164 – Event Status Notification Response 159
Table 165 – Event Header Return Data 159
Table 166 – Notification Class Field 160
Table 167 – Operational Change/Notification Returned Data 160
Table 168 – Operational Status Response 160
Table 169 – Operational Status Format 161
Table 170 – Operational Request/Report Format 161
Table 171 – Power Management Status Returned Data 161
Table 172 – Power Event Field 162
Table 173 – Power Status Field 162
Table 174 – External Request Descriptor 162
Table 175 – External Request Event Format 163
Table 176 – External Request Status Codes 163
Table 177 – External Request Codes 163
Table 178 – Media Event Descriptor 164
Table 179 – Media Event Format 164
Table 180 – Media Status Byte Definition 164
Table 181 – Multiple Initiator Descriptor 165
Table 182 – Multiple Initiator Event Format 165
Table 183 – Multiple Initiator Status Codes 165
Table 184 – Multiple Initiator Codes 166
Table 185 – Device Busy Event Descriptor 166
Table 186 – Device Busy Event Format 166
Table 187 – Device Busy Status Format 166
Table 188 – Recommended Errors for GET EVENT/STATUS NOTIFICATION command 167
Table 189 – GET PERFORMANCE command Descriptor Block 168
Table 190 – Performance response format 168

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Table 191 – Performance Header 169
Table 192 – Performance Descriptor – Nominal Performance 170
Table 193 – Performance Descriptor – Exceptions 170
Table 194 – Recommended errors for GET PERFORMANCE command 171
Table 195 – LOAD/UNLOAD MEDIUM command 171
Table 196 – Load/Unload Operations 172
Table 197 – Recommended errors for LOAD/UNLOAD MEDIUM operation 172
Table 198 – MECHANISM STATUS Command Descriptor Block 173
Table 199 – Mechanism Status Parameter List 173
Table 200 – Mechanism Status Header 174
Table 201 – Changer State Field 174
Table 202 – Mechanism State Field 175
Table 203 – Slot Table Response Format 175
Table 204 – Recommended errors for Mechanism Status command 176
Table 205 – PAUSE/RESUME Command Descriptor Block 176
Table 206 – Recommended errors for PAUSE/RESUME command 176
Table 207 – PLAY AUDIO(10) Command Descriptor Block 177
Table 208 – Recommended errors for PLAY AUDIO (10) command 178
Table 209 – PLAY AUDIO (12) Command Descriptor Block 178
Table 210 – Recommended errors for PLAY AUDIO(12) Command 179
Table 211 – PLAY AUDIO MSF Command Descriptor Block 179
Table 212 – Recommended errors for PLAY AUDIO MSF Command 180
Table 213 – PLAY CD Command Descriptor Block 180
Table 214 – PLAY CD Field definition 181
Table 215 – Recommended errors PLAY CD command 181
Table 216 – READ BUFFER CAPACITY Command Descriptor Block 182
Table 217 – READ BUFFER CAPACITY data 182
Table 218 – Recommended errors for READ BUFFER CAPACITY command 183
Table 219 – READ CD Command Descriptor Block 183
Table 220 – Expected Sector type field bit definitions 184
Table 221 – Header Code field definition 184
Table 222 – READ CD, Error field definition 185
Table 223 – READ CD, Sub-channel Data Selection Field definition 185
Table 224 – Formatted Q Sub-channel response data 186
Table 225 – Number of Bytes Returned Based on Data Selection Field 187
Table 226 – CD-DA (Digital Audio) Data Block Format 188
Table 227 – P-W RAW data format 188
Table 228 – P-W Data de-interleaved and error corrected 189
Table 229 – Sub-channel R-W: Allowed mode/item combinations 191
Table 230 – Recommended errors for READ CD command 191
Table 231 – READ CD MSF Command Descriptor Block 192
Table 232 – Recommended errors for READ CD MSF command 192

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Table 233 – READ CAPACITY Command Descriptor Block 193
Table 234 – READ CAPACITY Response Data format 193
Table 235 – Recommended errors for READ CAPACITY command 194
Table 236 – READ DISC INFORMATION Command Descriptor Block 194
Table 237 – Disc Information Block 195
Table 238 – Disc Status 196
Table 239 – State of Last Session 196
Table 240 – Disc Type Field – PMA 197
Table 241 – OPC Table Entry 198
Table 242 – Recommended errors for READ DISC INFORMATION Command 198
Table 243 – READ DVD STRUCTURE command 199
Table 244 – Format Code definitions for READ DVD STRUCTURE command 200
Table 245 – READ DVD STRUCTURE Data Format (Format field = 00h) 201
Table 246 – Layer Descriptor(s) 201
Table 247 – Book Type Field 202
Table 248 – Minimum Rate Field 202
Table 249 – Layer Type Field 203
Table 250 – Linear Density Field 203
Table 251 – Track Density Field 203
Table 252 – Starting Physical Sector Number of Main Data Field 203
Table 253 – READ DVD STRUCTURE Data Format (Format field = 01h) 204
Table 254 – READ DVD STRUCTURE Data Format (Format field = 02h) 205
Table 255 – READ DVD STRUCTURE Data Format (Format field = 03h) 205
Table 256 – READ DVD STRUCTURE Data Format (Format field = 04h) 206
Table 257 – READ DVD STRUCTURE Data Format (Format field = 05h) 206
Table 258 – READ DVD STRUCTURE Data Format (Format field = 08h) 207
Table 259 – READ DVD STRUCTURE Data Format (Format field = 0Ch) 208
Table 260 – READ DVD STRUCTURE Data Format (Format field = 0Dh) 208
Table 261 – READ DVD STRUCTURE Data Format (Format field = 0Eh) 209
Table 262 – READ DVD STRUCTURE Data Format (Format field = 0Fh) 211
Table 263 – Content Descriptor 211
Table 264 – READ DVD STRUCTURE Data Format (Format field = 30h) 212
Table 265 – Generic Disc Control Block 212
Table 266 – Unknown Content Descriptor Actions 212
Table 267 – Disc Control Block (FFFFFFFFh) 213
Table 268 – READ DVD STRUCTURE Data Format (Format field = FFh) 214
Table 269 – Structure List Entry 214
Table 270 – Recommended errors for READ DVD STRUCTURE command 215
Table 271 – READ FORMAT CAPACITIES Command Descriptor Block 215
Table 272 – READ FORMAT CAPACITIES Data Format 216
Table 273 – Capacity List Header 216
Table 274 – Current/Maximum Capacity Descriptor 216

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Table 275 – Descriptor Types 217
Table 276 – Formattable Capacity Descriptor(s) 217
Table 277 – Format Type 218
Table 278 – Returned Current/Maximum Descriptor for Combination of Logical Unit and Media 219
Table 279 – Recommended errors for READ FORMAT CAPACITIES command 219
Table 280 – READ HEADER Command Descriptor Block 219
Table 281 – READ HEADER LBA data format 220
Table 282 – CD Data Mode field 220
Table 283 – READ HEADER MSF data format 221
Table 284 – Recommended errors for READ HEADER command 221
Table 285 – READ MASTER CUE Command Descriptor Block 221
Table 286 – Sheet Number Values 222
Table 287 – Master CD response data format 222
Table 288 – Recommended errors for READ MASTER CUE command 222
Table 289 – READ SUB-CHANNEL Command Descriptor Block 223
Table 290 – Sub-channel parameter list codes 223
Table 291 – Sub-Q Channel Data Header Format 224
Table 292 – Audio status codes 224
Table 293 – CD current position data format 225
Table 294 – ADR Q Sub-channel field 225
Table 295 – Q Sub-channel control field 226
Table 296 – Media Catalog Number data format 227
Table 297 – MCN Format of Data Returned 227
Table 298 – Track International Standard Recording Code data format 228
Table 299 – ISRC Format of Data Returned 228
Table 300 – ISRC Translation 229
Table 301 – Recommended errors for READ SUB-CHANNEL command 229
Table 302 – READ TOC/PMA/ATIP Command Descriptor Block 230
Table 303 – Format Field 230
Table 304 – READ TOC/PMA/ATIP parameter list, general definition 231
Table 305 – READ TOC/PMA/ATIP response data (Format = 0000b) 232
Table 306 – READ TOC/PMA/ATIP response data (Format = 0001b) 233
Table 307 – READ TOC/PMA/ATIP response data (Format = 0010b) 234
Table 308 – TOC Track Descriptor Format, Q Sub-channel 235
Table 309 – POINT Field 235
Table 310 – Disc Type Byte Format 236
Table 311 – READ TOC/PMA/ATIP response data (Format = 0011b) 236
Table 312 – READ TOC/PMA/ATIP response data (Format = 0100b) 237
Table 313 – Lowest CLV Recording Speeds 238
Table 314 – Highest CLV Recording Speeds 238
Table 315 – READ TOC/PMA/ATIP response data (With Format Field = 0101b) 239
Table 316 – Recommended errors for READ TOC/PMA/ATIP command 239

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Table 317 – READ TRACK INFORMATION Command Descriptor Block 240
Table 318 – LBA/Track/Session Number Field definition 240
Table 319 – Track Information Block 241
Table 320 – Write Parameter Restrictions due to Track State 243
Table 321 – Track Status Indications 244
Table 322 – Data Mode 244
Table 323 – Next Writable Address Definition 245
Table 324 – Recommended errors for READ TRACK INFORMATION command 246
Table 325 – REPAIR TRACK Command Descriptor Block 247
Table 326 – Recommended errors for REPAIR TRACK command 247
Table 327 – REPORT KEY Command Descriptor Block 248
Table 328 – Key Format Code definitions for REPORT KEY Command 248
Table 329 – REPORT KEY Data Format (With KEY Format = 000000b) 249
Table 330 – REPORT KEY Data Format (With KEY Format = 000001b) 249
Table 331 – REPORT KEY Data Format (With KEY Format = 000010b) 250
Table 332 – REPORT KEY Data Format (With KEY Format = 000100b) 250
Table 333 – REPORT KEY Data Format (with KEY Format = 000101b) 251
Table 334 – REPORT KEY Data Format (with KEY Format = 001000b) 252
Table 335 – Type Code Field Definitions 252
Table 336 – RPC Scheme field Definition 253
Table 337 – Recommended errors for REPORT KEY command 253
Table 338 – RESERVE TRACK Command Descriptor Block 253
Table 339 – Track reservation sizing (CD) 254
Table 340 – TRACK reservation sizing (DVD) 254
Table 341 – Recommended errors for RESERVE TRACK command 255
Table 342 – SCAN Command Descriptor Block 256
Table 343 – Type field bit definitions 256
Table 344 – Scan starting address field format-logical blocks 256
Table 345 – Scan Starting Address format – MIN, SEC, FRAME format 257
Table 346 – Scan Starting Address Format-Track Number (TNO) 257
Table 347 – Recommended errors for SCAN operation 257
Table 348 – SEND CUE SHEET Command Descriptor Block 258
Table 349 – Cue Sheet format 258
Table 350 – Sample CUE SHEET 259
Table 351 – Cue Sheet Data 260
Table 352 – CTL/ADR byte 260
Table 353 – Control Field 260
Table 354 – ADR Field 261
Table 355 – Data Form Byte 261
Table 356 – SCMS Byte 261
Table 357 – CD-DA Data format (1 Sample) 262
Table 358 – Data Form of Sub-channel 264

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Table 359 – Media Catalog Number (N1..N13) 266
Table 360 – ISRC (I1..I12) 266
Table 361 – Recommended Sense Key, ASC and ASCQ SEND CUE SHEET command 266
Table 362 – SEND DVD STRUCTURE Command Descriptor Block 267
Table 363 – Format Field Definition 267
Table 364 – SEND DVD STRUCTURE Data Format (Format Code = 04h) 268
Table 365 – SEND DVD STRUCTURE Data Format (Format Code = 05h) 268
Table 366 – SEND DVD STRUCTURE Data Format (Format Code = 0Fh) 269
Table 367 – SEND DVD STRUCTURE Data Format (Format Code = 30h) 270
Table 368 – Recommended errors for SEND DVD STRUCTURE Command 271
Table 369 – SEND EVENT Command Descriptor Block 271
Table 370 – Event Parameter Header 272
Table 371 – Operational Change/Notification Parameter Data 272
Table 372 – Operational Event Field 272
Table 373 – Recommended errors for SEND EVENT Command 273
Table 374 – SEND KEY Command Descriptor Block 273
Table 375 – Key Format Code definitions for SEND KEY command 274
Table 376 – SEND KEY Parameter List (KEY Format field =000001b) 274
Table 377 – SEND KEY Parameter List (KEY Format field =000011b) 274
Table 378 – SEND KEY Parameter List (KEY Format field =000110b) 275
Table 379 – Recommended errors for SEND KEY Command 275
Table 380 – SEND OPC INFORMATION Command Descriptor Block 276
Table 381 – SEND OPC INFORMATION Parameter List 276
Table 382 – Recommended errors for SEND OPC INFORMATION command 277
Table 383 – SET CD SPEED Command Descriptor Block 277
Table 384 – Recommended errors for SET CD SPEED command 277
Table 385 – SET READ AHEAD Command Descriptor Block 278
Table 386 – Recommended errors for SET READ AHEAD command 278
Table 387 – SET STREAMING Command Descriptor Block 279
Table 388 – Performance Descriptor 280
Table 389 – Recommended errors for SET STREAMING command 281
Table 390 – STOP PLAY/SCAN Command Descriptor Block 282
Table 391 – Recommended errors for STOP PLAY/SCAN command 282
Table 392 – SYNCHRONIZE CACHE command 284
Table 393 – Recommended errors for SYNCHRONIZE CACHE command 284
Table 394 – WRITE (10) command 285
Table 395 – LBA to MSF translation 286
Table 396 – Recommended errors for WRITE Command 287
Table 397 – WRITE AND VERIFY (10) command 288
Table 398 – Recommended errors for WRITE AND VERIFY (10) command 288
Table A.1 – Logical Unit Sense Key, ASC and ASCQ Assignments 289
Table A.2 – Logical Unit General Errors 294

--`,,```,,,,````-`-`,,`,,`,`,,`---

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Table A.3 – Media Access Errors 296
Table A.4 – Logical Unit Write Errors 298
Table A.5 – Logical Unit Fixation Errors 298
Table B.1 – Example Reset Function Mapping in ATAPI 300
Table B.2 – ATAPI Commands Requirements 301
Table E.1 – Example Reset Function Mapping in SCSI 314
Table F.1 – Power Management Model States 315
Table F.2 – State Transition, Events and Status 319
Table F.3 – Effects of Initiator commands on Timers 320
Table G.1 – Commands common to all SCSI devices 322
Table I.1 – Multimedia commands – Alphabetically 326
Table I.2 – Multimedia commands – By OpCode 327
Table I.3 – Commands common to all SCSI devices 328
Table J.1 – CD-TEXT Pack Data format for the Lead-in area 329
Table J.2 – Pack type indicator definitions 330

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INFORMATION TECHNOLOGY – SMALL COMPUTER SYSTEM INTERFACE (SCSI) –

Part 362: Mutimedia commands-2 (MMC-2)

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

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

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ISO/IEC 14776 consists of the following parts, under the general title *Information technology – Small computer system interface (SCSI):*

Part 112: Parallel interface-2 (SPI-2)

Part 113: Parallel interface-3 (SPI-3)

Part 115: Parallel interface-5 (SPI-5)

Part 150: Serial attached SCSI (SAS)

Part 222: Fibre channel protocol for SCSI, second version (FCP-2)

Part 232: Serial bus protocol-2 (SBP-2)

Part 321: Block commands (SBC)

Part 322: Block commands-2 (SBC-2)

Part 326: Stream commands (SSC)

Part 341: Controller commands (SCC)

Part 342: Controller commands-2 (SCC-2)

Part 351: Medium changer commands (SMC)

Part 362: Multimedia commands-2 (MMC-2)

Part 381: Optical memory card device commands (OMC)

Part 411: Architecture model commands (SAM)

Part 412: Architecture model-2 (SAM-2)

Part 452: Primary commands-2 (SPC-2)

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INTRODUCTION

Requests for interpretation, suggestions for improvement and addenda or defect reports are welcome. They should be sent to IEC Central Office, see address on the title page.

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INFORMATION TECHNOLOGY – SMALL COMPUTER SYSTEM INTERFACE (SCSI) –

Part 362: Mutimedia commands-2 (MMC-2)

1 Scope

This part of ISO/IEC 14776 defines the SCSI command set extensions to access multimedia features for all classes of SCSI devices.

The commands specified within this standard define standard access and control of those features of the device that are used in multimedia applications.

The SPC command set and its extensions are transport independent and may be implemented across a wide variety of environments for which a SCSI command mapping and delivery vehicle has been defined. To date, these include Fibre Channel, SCSI Parallel Interface, High Performance Serial Bus, Serial Storage Architecture and ATA/ATAPI.

This command set gives and/or enables the following.

a) A definition of the command formats and functions independently of delivery, protocol/signalling or transport mechanism. Architectural constraints regarding command functions, over the various transports are addressed in the document specific to the physical transport.

b) Standardized access to common Features of SCSI devices employed in multimedia applications.

c) System software/firmware independence across device classes. Thus, different tape drives, optical media drives and other devices can be added to the system without requiring modifications to generic system hardware and software. Provision is made for the addition of special Features and functions through the use of vendor-specific options. Reserved Opcodes are provided for future standardization.

d) Provides compatibility such a way that properly conforming ISO/IEC 9316 devices may inter-operate with subsequent devices provided that the system engineering is correctly done. SCSI protocol extensions are designed to be permissive of rejections by conforming ISO/IEC 9316 devices and thus allow the ISO/IEC 9316 device to continue operation without requiring the use of the extension.

2 References

2.1 Normative references

2.1.0 General

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

2.1.1 Approved references

The following approved international and regional standards (ISO, IEC, CEN/CENELEC and ITU-T) may be obtained from the international and regional organizations that control them.

IEC 60908, *Audio recording – Compact disc digital audio system*

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ISO/IEC 646:1991, *Information technology – ISO 7-bit coded character set for information interchange*

ISO/IEC 14776-232, *Information technology – Small Computer System Interface (SCSI) – Part 232: Serial Bus Protocol-2 (SBP-2)* [NCITS.325:1998]

ISO/IEC 14776-321, *Information technology – Small Computer System Interface-3 (SCSI-3) – Part 321: Block commands (SBC)* [NCITS.306:1998]

ISO/IEC 10149, *Information technology – Data interchange on read-only 120 mm optical data discs (CD-ROM)*

ISO 3901, *Information and documentation – International Standard Recording Code (ISRC)*

2.1.2 References under development

At the time of publication, the following referenced standards were still under development. For information on the current status of the document, or regarding availability, contact the relevant standards body or other organization as indicated.

ISO/IEC 14776-351, *Information technology – Small Computer System Interface (SCSI) – Part 351: SCSI-3 Medium Changer Commands (SMC)* [X3T10/0999-D]

2.2 Other references

The following standards and specifications were also consulted.

ANSI INCITS 269-1996, *Information technology – SCSI-3 Fibre Channel protocol (FCP), (R2001)*

ANSI INCITS 301-1997, *Information technology – SCSI-3 Primary Commands (SPC), (R2002)*

ANSI INCITS 317-1998, *Information Technology – AT Attachment with Packet Interface Extension (ATA/ATAPI-4), (R2003)*

3 Definitions, abbreviations and acronyms

3.0 General

Certain words and terms used in this standard have a specific meaning beyond the normal English meaning and are indicated in upper case. These words and terms are defined either in the glossary or in the text where they first appear. Lower case is used for words having the normal English meaning.

3.1 Definitions of terms

3.1.1
absolute MSF field
See 3.1.65.

3.1.2
algorithm type
refers to various copy protection techniques

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3.1.3
appendable disc
if the last non-empty session contains a pointer to the next possible session, then the disc is appendable

3.1.4
ATA (AT attachment)
ATA defines the physical, electrical, transport and command protocols for the internal attachment of block storage devices [NCITS 317:1998]

3.1.5
ATAPI (AT attachment packet interface)
An extension of the ATA interface that permits the use of command descriptor blocks. [NCITS 317:1998]

3.1.6
ATIP
absolute time in pre-groove

3.1.7
AGID (authentication grant ID)
value used for resource control during key management

Individual key management threads are identified through the use of AGID.

3.1.8
bcd
binary coded decimal

number system used on the physical CD media

Numbers using this notation have the 'bcd' suffix attached. A byte has two four-bit values each with a value from 0 to 9. The maximum value is 99bcd (99 decimal).

3.1.9
bootable CD
CD capable of providing boot records

3.1.10
bordered area
recorded area of DVD-R media

See 4.3.3.2.

3.1.11
BCA (burst cutting area)
provides a unique physical identification mark for individual DVD medium

This area is not directly addressable by the user.

3.1.12
C/DVD media
media that conform to the CD or DVD specifications

3.1.13
challenge key
data used during an authentication key exchange process

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3.1.14
CDB (command descriptor block)
structure used to communicate commands from an Initiator to C/DVD Logical Units

3.1.15
command packet
structure used to communicate commands from an Initiator to a C/DVD device

See 3.1.14.

3.1.16
complete session
session that contains a completed (written) Lead-in and Lead-out area

In DVD-R a complete session contains a completed Border-in and a Border-out.

3.1.17
CD-DA (compact disc digital audio system)
[see IEC 60908]

3.1.18
CD (compact disc)
family of related optical storage media

3.1.19
CD-ROM (compact disc read only memory)
a CD-ROM stores digitized audio and digital data

CD-ROM is used to describe media with digital data rather than discs that encode audio only. [ISO/IEC 10149]

3.1.20
CD control field
4-bit field in the Q Sub-channel data indicating the type of information encoded on the current track

Indicates audio versus data and the type of audio encoding, etc. The control field is also found in the table of contents entries.

3.1.21
CD data mode
byte in the header of CD data sectors

CD data mode indicates if data is present and if layered error correction information is present

3.1.22
CD-RW (CD rewritable)
a CD that can be re-written

3.1.23
CD-R (CD recordable)
a CD that can be written only once

3.1.24
CD R/RW
a CD-R or a CD-RW or both

3.1.25
CD-text
method for storing text information on CD-DA disc

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3.1.26
CIRC (cross interleaved reed-solomon code)
error detection and correction technique used on a CD

The CIRC bytes are present in all CD modes. The error correction procedure that uses the CIRC bytes is referred to as the CIRC based algorithm

3.1.27
defect management
method for providing apparent error free media

3.1.28
direct-overwrite
process or capability of writing over previously written data without an erase cycle

3.1.29
disc key
value used during the scrambling process of the title key data on DVD media

3.1.30
double sided
medium with two independently addressed sides

3.1.31
dual layer
two surfaces that can be accessed from the same side

On dual layer Discs the data is recorded using either OTP or PTP.

3.1.32
DVD
family of related optical storage media and Logical Units

3.1.33
DVD control area
the DVD Control area is comprised of 192 ECC blocks in the Lead-in Area of a DVD medium. The content of 16 sectors in each block is repeated 192 times. This area contains information concerning the disc

3.1.34
DVD disc manufacturing information
the DVD Disc Manufacturing Information is recorded in the DVD Control Area and contains information supplied by the disc manufacturer

3.1.35
DVD ECC-block
self-contained block of data and error correction codes that are grouped into a sequential series of 16 DVD sectors

3.1.36
DVD-R (DVD recordable)
DVD medium that can be written once [DVD-R]

3.1.37
DVD-RAM (DVD-random access memory)
DVD that can be re-written

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3.1.38
DVD-ROM (DVD-read only memory)
standardized medium defined by the DVD specification for recording digital data, including digital video movie data

3.1.39
DVD+RW (DVD rewritable)
DVD that can be re-written

3.1.40
EAN (European article number)
controlled by the EAN Council located at Rue des Colonies, 54-BTE8, 1000 Brussels, Belgium

3.1.41
ECC (error correction code)
code for detecting and correcting errors

3.1.42
EDC (error detection code)
code for detecting an error

3.1.43
EFM
8 bit to 14 bit modulation

3.1.44
field
group of two or more contiguous bits

Fields containing only one bit are referred to as the “named” bit instead of the “named” field.

3.1.45
fixed packet track
track that contains a TDB indicating that the track is a fixed track and has user packets of a fixed size specified in the TDB

3.1.46
format
arrangement or layout of information on a medium

3.1.47
frame
sector on CD media. Also the F field unit of a MSF CD address. The smallest addressable unit

3.1.48
hex
indicates a binary value represented in base 16

This value may extend across multiple bytes.

3.1.49
hold track state
when a C/DVD device enters the hold track state the optical pick-up is maintained at an approximately constant radial position on the media

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3.1.50
ID
4-byte field in the header of DVD sectors that contains sector information and a physical sector number

3.1.51
IED (ID error detection)
code for detecting errors in an ID field

3.1.52
incomplete session
session without Lead-in and Lead-out written

3.1.53
index
subdivision of a track

3.1.54
layer
recorded information is in layers as seen from one side of a DVD disc. There are single and dual layer discs

3.1.55
lead-in
on CD media, the area that contains the TOC data and precedes each program area

The main channel in the Lead-in area contains audio or data null information. This area is coded as track zero. The Q Sub-channel in this area is coded with the Table of Contents information.
The DVD Lead-in area is the area comprising physical sectors 1,2 mm wide or more adjacent to the inside of the Data area. The area contains the Control data and precedes the Data area.

3.1.56
lead-out
on CD media, the area that follows each program area

The main channel in the Lead-out area contains audio or data null information. This area is coded as track AAh.
The DVD Lead-out area is the area comprising physical sectors 1,0 mm wide or more adjacent to the outside of the data area in single layered disc for PTP (Parallel Track Path) disc. Or, it is the area comprising physical sectors 1,2 mm wide or more adjacent to the inside of the data area in layer 1 of OTP (Opposite Track Path) disc.

3.1.57
L-EC (layered error correction)
second level of error correction used on CD data

3.1.58
logical block
an initiator addressable unit of data

3.1.59
LBA (logical block address)
defines a mapping mode to a linear address space

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3.1.60
logical unit
physical or virtual peripheral device addressable through a target

3.1.61
LUN (logical unit number)
address of a Logical Unit

3.1.62
magazine
multiple disc changer unit

3.1.63
medium
a single disc

3.1.64
middle area
area comprising physical sectors 1,0 mm wide or more adjacent to the outside of the Data Area in OTP (Opposite Track Path) disc on both layers of DVD media

3.1.65
MSF address (minute/second/frame)
the physical address, expressed as a sector count relative to either the beginning of the medium (absolute) or to the beginning of the current track (relative)

As defined by the CD standards, each F field unit is one sector; each S field unit is 75 F field units; each M field unit is 60 S field units. Valid contents of F fields are binary values from 0 through 74. Valid contents of S fields are binary values from 0 through 59. Valid contents of M fields are binary values from 0 through 74.

3.1.66
OPC (optimum power calibration)
procedure performed by the device to calibrate laser power

Values from this calibration are used for subsequent write operation.

3.1.67
OTP (opposite track path)
dual layer disc that has a Lead-in, two separated user areas, Lead-out and a Middle area

The physical sector number (PSN) of layer 0 increases to the Lead-out and the one of layer 1 that is complement of layer 0 address increases from the Lead-out to Lead-in.

3.1.68
output port
means for connecting to data ports other than the initiator interface

3.1.69
PTP (parallel track path)
a dual layer disc that has a Lead-in, user area and Lead-out in each layer respectively

The ID sector number of both layers increases to the Lead-out in parallel.

3.1.70
packet
set of recorded link, run-in, data and run-out blocks

A typical packet is shown in Figure 11.

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3.1.71
packet size
the number of Data Blocks in a packet

3.1.72
packet track
track written as a concatenation of a pre-gap, written as one or two packets and some non-zero number of user packets

3.1.73
physical sector number
unique address assigned to a physical location; it is not modifiable

3.1.74
post-gap
transition area located at the end of a data track

3.1.75
pre-gap
transition area located at the beginning of a data track

3.1.76
program area(s)
a logical address space

3.1.77
PMA (program memory area)
contains information about the recordings on a recordable disc

3.1.78
regional code
value used to identify one or more regions of the world

Currently there are six regions defined.

3.1.79
region playback control (RPC)
limits the playback of DVD-ROM content to specific regions of the world

3.1.80
relative MSF field
See 3.1.65.

3.1.81
RZone
logical subdivision of a DVD-R, similar to a Track on CD

See 4.3.3.1.

3.1.82
scramble flag
indication that there is scrambled data on the media

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3.1.83
sector
in the case of CD media, Sector refers to the data contained in one frame

in the case of DVD media, Sector is the smallest user addressable part of the media. The user data contained within a sector is 2 048 bytes

NOTE In IEC/ISO 10149 the term block is used for this unit.

3.1.84
session
a contiguous area of the disc that contains a Lead-in, a Program Area and a Lead-out

3.1.85
single sided
a single sided DVD disc has exactly one recorded or recordable side

3.1.86
small frame
1/98 of a frame

3.1.87
sub-channel
CD media have a main channel and a Sub-channel

The Sub-channel area has eight parts called P, Q, R, S, T, U, V and W. The Q Sub-channel contains information useful to the controller and device, such as the control field and MSF addresses. The data rate of each Sub-channel (P, Q, etc.) is 1/192nd of that of the main channel.

3.1.88
TOC (table of contents)
has information on the type of session and the starting address of the tracks

This information is encoded in the Q Sub-channel in the Lead-in area.

3.1.89
title key
value used during the scrambling process of movie data on DVD media

3.1.90
track descriptor block (TDB)
contains information on the attributes of the current track

3.1.91
track
a logical sub-division of the media

3.1.92
track at once
when a track, including its pre-gap, is written as a single packet

3.1.93
track relative logical address
value used to address logical blocks relative to the beginning of a track

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3.1.94
transition area
sectors at the beginning or end of tracks

For example: Pause Area, Pre-Gap, Lead-out, Post-Gap.

3.1.95
UPC (uniform product code)
barcode, controlled by the UPC Council (see bibliography)

3.1.96
user packet
packet that contains only user data blocks as the data blocks

User data blocks consist of data transferred to the device during a write command.

3.1.97
writable disc
disc that is blank, appendable, or contains an incomplete session

3.1.98
yellow book
[see ISO/IEC 10149]

3.2 Conventions

Various conventions are used throughout this standard and are identified in this subclause.

3.2.1
Error codes

Recommended error code tables defined within each command subclause use the following:

- errors shown in mixed case indicate that all errors, in that class, are valid;
- errors shown in uppercase refer to the identified specific error condition.

3.2.2
Decimal values

Numbers that are not immediately followed by lowercase “b”, “h” or “bcd” are decimal values.

Numbers immediately followed by lowercase “b” (xxb) are binary values.

Numbers immediately followed by lowercase “h” (xxh) are hexadecimal values.

Numbers immediately followed by lowercase “bcd” (xxbcd) are binary coded decimal values.

3.3 Keywords

Several keywords are used to differentiate between levels of requirements and options, as listed below.

3.3.1
expected
A keyword used to describe the behaviour of the hardware or software in the design models assumed by this standard. Other hardware and software design models may also be implemented.

3.3.2
may
A keyword that indicates flexibility of choice with no implied preference.

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3.3.3
shall
A keyword indicating a mandatory requirement. Designers are required to implement all such mandatory requirements to ensure interoperability with other standard conforming products.

3.3.4
should
A keyword indicating flexibility of choice with a strongly preferred alternative. Equivalent to the phrase, “it is recommended.”

3.3.5
obsolete
A keyword indicating items that were defined in prior versions of this standard and that are intended to be removed from future versions of this standard.

3.3.6
mandatory
A keyword indicating items required to be implemented as defined by this standard.

3.3.7
optional
A keyword that describes features that are not required for compliance to this standard. However, if any optional feature defined is implemented, it shall be implemented as defined by this standard.

3.3.8
reserved
A keyword referring to bits, bytes, words, fields and code values that are set-aside for future standardization. Their use and interpretation may be specified by future extensions to this or other standards. A reserved bit , byte, word or field shall be set to zero or in accordance with any future extension to this standard. The recipient shall not check reserved bits, bytes, words or fields. Receipt of reserved code values in defined fields shall be treated as an error.

4 C/DVD models

4.1 General

The following subclauses provide an overview of the operations and functionality of all CD and DVD types.

4.1.1 CD address reporting formats (MSF bit)

Several CD commands can report addresses either in logical block address or in MSF format (see Table 1). The READ HEADER, READ SUB-CHANNEL and READ TOC/PMA/ATIP commands have this Feature.

An MSF bit of zero, in the above listed commands, requests that the logical block address format be used for the CD absolute address field or for the offset from the beginning of the current track expressed as a number of logical blocks in a CD-ROM track relative address field. This track relative logical block address (TRLBA) value is reported as a negative value in twos-complement notation for transition areas that have decreasing MSF encoded relative addresses.

An MSF bit of one, in the above listed commands, requests that the MSF format be used for these fields. In certain transition areas, the relative MSF addresses are decreasing positive values. The absolute MSF addresses are always increasing positive values.

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Table 1 – MSF address format

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	M field							
2	S field							
3	F field							

The M, S and F fields are expressed as binary numbers. The values match those on the media, except for the encoding.

NOTE For a logical block size of 512 bytes, the MSF address returned is that for the physical block containing the specified logical blocks.

4.1.2 Logical blocks

Blocks of data are stored on the medium along with additional information that the Logical Unit uses to manage the storage and retrieval. The format of the additional information is unique and is hidden from the Initiator during normal read or write operations. This additional information is often used to identify the physical location of the blocks of data and the address of the logical block and to provide protection against the loss of user data.

The address of the first logical block is zero. The address of the last logical block is [*n*-1], where [*n*] is the number of logical blocks available on the medium. A READ CAPACITY command may be issued to determine the value of [*n*-1]. If a command is issued that requests access to a logical block not within the capacity of the medium, the command shall be terminated with CHECK CONDITION status and the sense key set to ILLEGAL REQUEST and additional sense code set to LOGICAL BLOCK ADDRESS OUT OF RANGE.

The number of bytes of data contained in a logical block is known as the block length. Each logical block has a block length associated with it. The block descriptor in the MODE SENSE data describes the block length that is used on the medium. Note that the block descriptor shall not be present for an ATAPI C/DVD Logical Unit. In addition the Block Descriptor for SCSI Logical Units has been made Obsolete in this standard.

The location of a logical block on the medium is not required to have a specific relationship to the location of any other logical block. However, in a typical Logical Unit the logical blocks are located in an ascending order. The time to access the logical block at address [x] and then the logical block at address [x+1] need not be less than time to access [x] and then [x+100].

4.1.3 Data cache

Some Logical Units implement cache memory. A cache memory is usually an area of temporary storage in the Logical Unit with a fast access time that is used to enhance performance. It exists separately from the blocks of data stored and is normally not directly addressable by the Initiator. Use of cache memory for write or read operations typically reduces the access time to a logical block and can increase the overall data throughput.

During read operations, the Logical Unit uses the cache memory to store blocks of data that the Initiator may request at some future time. The algorithm used to manage the cache memory is not part of this specification. However, parameters are provided to advise the Logical Unit about future requests or to restrict the use of cache memory for a particular request.

Sometimes the Initiator may request that the blocks of data read from the medium instead of from the cache memory. The force unit access (FUA) bit is used to indicate that the Logical Unit shall access the physical medium. For a write operation, setting FUA to one causes the

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Logical Unit to complete the data write to the physical medium before completing the command. For a read operation, setting FUA to one causes the logical blocks to be retrieved from the physical medium.

Commands may be implemented by the Logical Unit that allow the Initiator to control other behaviour of the cache memory:

- The MODE SENSE (10) Command defines a page for the control of cache behaviour and handles certain basic elements of cache replacement algorithms.
- The SYNCHRONIZE CACHE Command is used by the Initiator to guarantee that data in the cache has been moved to the media.

4.1.4 RESETS

4.1.4.1 General

Within this standard there are three resets identified. These resets are named:

- Power-On Reset
- Hard Reset
- Device Reset

These resets are defined differently in different parts of ISO/IEC 14776. For this part of ISO/IEC 14776 the following definitions apply

4.1.4.2 Power-on reset

When power is applied, the device executes a series of electrical circuitry diagnostics, resets Logical Unit specific parameters (mode pages) to default values and if media are present, may spin up and make the Logical Unit ready for use. In addition, power management and key management are reset to their default states.

4.1.4.3 Hard reset

For each physical interface the detection of Hard Reset is different. The device executes a series of electrical circuitry diagnostics, resets Logical Unit specific parameters (mode pages) to default values, and if media are present, may spin up and make the Logical Unit ready for use. In addition power management and key management are reset to their default states. The behaviour of the Logical Unit when Hard Reset is received is the same as for Power-On Reset.

Hard Reset is used to reset devices or even a whole interface bus, not individual Logical Units.

4.1.4.4 Device reset

For each physical interface the detection of Device Reset is different. The Device Reset is used to bring a non-responding Logical Unit into an operable state. Device Reset is different from Power-On or Hard Reset. With the Device Reset the parameters being used by the Logical Unit are not set to the defaults. In some cases this may not be possible and the Logical Unit may need to reset to the default conditions. If a reset to default conditions occurs as a result of a Device Reset, a Unit Attention and Power Management Event Notification shall be generated. Logical Unit should:

- reset Initiator interface circuitry;
- perform hardware initialization and device-internal diagnostics, only if necessary;
- not revert to the default conditions, Logical Unit Number or TOC information;

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- stay in the current Power State;
- make sure that persistent Prevent state remains unchanged;
- make sure that the key management is reset to the default state.

4.1.5 Error reporting

If any of the conditions in Table 2 occur during the execution of a command, the target shall return CHECK CONDITION status. The appropriate sense key and additional sense code should be set. The following list illustrates some error conditions and the applicable sense keys. The list does not provide an exhaustive enumeration of all conditions that may cause the CHECK CONDITION status.

Table 2 – Sense key responses for error reporting

Condition	Sense Key
Invalid Logical Block Address	ILLEGAL REQUEST
Unsupported option requested	ILLEGAL REQUEST
Attempt to read a blank block	ILLEGAL REQUEST
Attempt to play a data block as audio	ILLEGAL REQUEST
Target reset or medium change since last command	UNIT ATTENTION
Self-diagnostic failed	HARDWARE ERROR
Un-recovered read error	MEDIUM ERROR/HARDWARE ERROR
Recovered read error	RECOVERED ERROR
Overrun or other error that might be resolved by repeating the command	ABORTED COMMAND

In the case of an invalid logical block address, the sense data information field shall be set to the logical block address of the first invalid address.

In the case of an attempt to read a blank or previously unwritten block, the sense data information field shall be set to the logical block address of the first blank block encountered. The data read up to that block shall be transferred.

There are other special error situations for CD devices. In the following cases the sense key shall be set to ILLEGAL REQUEST and the additional sense code set to END OF USER AREA ENCOUNTERED ON THIS TRACK:

a) a pre-gap area is encountered (i.e. a block with index equal to 0);

b) a post-gap area is encountered;

c) the information type (data versus audio) changes.

When the command is other than an audio playback operation, the command shall be terminated with CHECK CONDITION status if the Logical Block Address requested is not within a data track. The sense key shall be set to ILLEGAL REQUEST and the additional sense code set to ILLEGAL MODE FOR THIS TRACK. This applies to audio and audio-combined media.

4.1.6 Deferred errors

Error code 71h (deferred error) indicates that the CHECK CONDITION status returned is the result of an error or exception condition that occurred during execution of a previous command for which GOOD status has already been returned. Such commands are associated

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with use of the immediate bit , with some forms of caching. C/DVD Logical Units that implement these Features shall implement deferred error reporting.

A deferred error may be indicated by returning CHECK CONDITION status to the Initiator as described below. The subsequent execution of a REQUEST SENSE command shall return the deferred error sense information.

If an I/O Command terminates with CHECK CONDITION status and the subsequent sense data returns a deferred error, that I/O command shall not have been executed. After the C/DVD Logical Unit detects a deferred error condition on a Logical Unit, it shall return a deferred error according to the rules described below:

a) if a deferred error can be recovered with no external system intervention, a deferred error indication shall not be posted unless required by the error handling parameters of the MODE SELECT command. The occurrence of the error may be logged if statistical or error logging is supported;
b) if a deferred error can be associated with a particular function or a particular subset of data and the error is either un-recovered or required to be reported by the mode parameters, a deferred error indication shall be returned to the Initiator.

Deferred errors may indicate that an operation was unsuccessful long after the command performing the data transfer returned GOOD status. If data that cannot be replicated or recovered from other sources is being stored using buffered write operations, synchronization commands should be performed before the critical data is destroyed in the Initiator. This is necessary to be sure that recovery actions can be taken if deferred errors do occur in the storing of the data.

4.1.7 Removable medium

A disc has an attribute of being mounted or de-mounted on a suitable transport mechanism. A disc is mounted when the Logical Unit is capable of performing read operations to the medium. A mounted disc may not be accessible by an Initiator, if it has been reserved by another Initiator. A disc is de-mounted at any other time (e.g. during loading, unloading or storage).

An Initiator may check whether a disc is mounted by issuing a TEST UNIT READY command. In addition, there now exists a MEDIA STATUS NOTIFICATION Feature. This allows the Initiator to prevent the removal of any media, as well as sensing requests from the user to remove media.

The PREVENT ALLOW MEDIUM REMOVAL command allows an Initiator to restrict the de-mounting of the disc. This is useful in maintaining system integrity. If the Logical Unit implements cache memory, it shall ensure that all logical blocks of the medium contain the most recent data prior to permitting de-mounting of the disc. If the Initiator issues a START STOP UNIT command to eject the disc and is prevented from de-mounting by the PREVENT ALLOW MEDIUM REMOVAL command, the START STOP unit command is rejected by the Logical Unit.

When the Persistent Prevent state is entered, the media shall remain locked in the Logical Unit, until the Initiator issues an eject request, or a power on or hard reset condition occurs. The Persistent Prevent state shall be maintained after the eject request. New media that is inserted into the Logical Unit shall be locked in the Logical Unit after the Logical Unit reports the NEW MEDIA event. Prior to reporting the NEW MEDIA event, the Logical Unit may eject media without an explicit eject command from the Initiator. This allows the user to remove incorrectly inserted media without having to wait for Initiator intervention.

While in the Persistent prevent state, the Logical Unit shall generate Events upon receipt of a User Eject request. The Logical Unit shall not eject the media on receipt of these requests, if the Logical Unit has already reported a NEW MEDIA event for this media. When the Initiator receives the Eject Request and determines that it is safe to eject the medium, an eject command will be issued, at that time the Logical Unit shall eject the medium.

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The Logical Unit shall only generate GET EVENT/STATUS NOTIFICATION (EJECT REQUEST) events after reporting a GET EVENT/STATUS NOTIFICATION (NEW MEDIA) event and prior to reporting a GET EVENT/STATUS NOTIFICATION (MEDIA REMOVAL) event for the given media.

To maintain compatibility with existing BIOS implementations and operating systems, the Logical Unit shall default to Persistent Prevent disabled. When the Initiator enables the support using the PREVENT ALLOW command, the Logical Unit shall respond as described in this specification. When the Initiator disables this Feature, the Logical Unit shall default to normal operating modes. A power on or hard reset shall cause the Logical Unit to the default Persistent Prevent state.

If the Logical Unit is unable to maintain media status information across a reset or power cycle, the Logical Unit shall generate a NEW MEDIA event.

Commands shall be processed exactly the same as they would be if Persistent Prevent was not enabled. For compatibility reasons, UNIT ATTENTION status conditions shall still be returned. However, the Logical Unit shall not return the UNIT ATTENTION status on a GET EVENT/STATUS NOTIFICATION command. For example, if the user inserts a new medium and the Logical Unit is accessed with a command, the CHECK CONDITION with UNIT ATTENTION shall be reported, but the Logical Unit shall also report the NEW MEDIA Event with the next available GET EVENT/STATUS NOTIFICATION (Media Status) command.

4.2 CD device model

4.2.0 General

The CD device model is driven by the CD media organization and data formats.

4.2.1 Recorded CD media structure

4.2.1.0 General

A CD medium is an 80 mm or 120 mm disc with a continuously recorded physical track beginning near a diameter of 50 mm and spiraling outward to a diameter near 78 mm or 118 mm.

4.2.1.1 CD Frame structure

Data is recorded in a continuous stream of Small Frames. Each byte of a Small Frame is encoded with an 8 bit to 14 bit modulation (EFM) code. Three merging bits are appended. The merging bits are chosen to provide minimum low-frequency signal content and optimize phase lock loop performance. Each Small Frame consists of 588 EFM bits (see Table 3). A Small Frame is defined in Table 3.

Table 3 – Small Frame layout and definition

1 synchronization pattern (24 + 3 bits)	1 byte of Sub-channel data (14 + 3 bits)	12 bytes of main channel data (12 × (14 + 3) bits	4 bytes of CIRC code (4 × (14 + 3) bits)	12 bytes of main channel data (12 × (14 + 3) bits	4 bytes of CIRC code (4 × (14 + 3) bits)
588 bits					

A CD frame consists of 98 contiguous Small Frames. This yields 24 × 98 = 2 352 bytes of main channel data per frame and 98 bytes of Sub-channel data per CD frame. A recorded CD is a succession of CD frames. For audio, the bounds of a CD frame are defined by the Sub-channel bytes and for data, they are determined by the sync bytes in the main channel data.

The 98 Sub-channel bytes are separated into 2 bytes of synchronization and 96 bytes of data. Each CD frame begins with the first Sub-channel sync byte and ends with the 96th Sub-channel data byte. A CD frame is constructed from Small Frames as shown in Table 4. This is

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a logical representation since Small Frames are physically interleaved. This means that precise CD frame boundaries do not exist.

Table 4 – CD Frame Structure from Small Frames

F	.	.	.
R	.	.	.
A	Small Frame 94	Sub-channel data byte 92	24 bytes main channel data
M	Small Frame 95	Sub-channel data byte 93	24 bytes main channel data
E	Small Frame 96	Sub-channel data byte 94	24 bytes main channel data
	Small Frame 97	Sub-channel data byte 95	24 bytes main channel data
N	Small Frame 98	Sub-channel data byte 96	24 bytes main channel data
F	Small Frame 1	Sub-channel sync byte 1	24 bytes main channel data
R	Small Frame 2	Sub-channel sync byte 2	24 bytes main channel data
A	Small Frame 3	Sub-channel data byte 1	24 bytes main channel data
M	Small Frame 4	Sub-channel data byte 2	24 bytes main channel data
E	.	.	.
	.	.	.
N+1	Small Frame 97	Sub-channel data byte 95	24 bytes main channel data
	Small Frame 98	Sub-channel data byte 96	24 bytes main channel data
F	Small Frame 1	Sub-channel sync byte 1	24 bytes main channel data
R	Small Frame 2	Sub-channel sync byte 2	24 bytes main channel data
A	Small Frame 3	Sub-channel data byte 1	24 bytes main channel data
M	Small Frame 4	Sub-channel data byte 2	24 bytes main channel data
E	Small Frame 5	Sub-channel data byte 3	24 bytes main channel data
	.	.	.
N+2	.	.	.

4.2.1.2 Sub-channel

Each non-sync byte of Sub-channel is labeled according to bit position, as shown in Table 5.

Table 5 – Sub-Channel byte layout

Small Frame Sub-channel Byte							
P	Q	R	S	T	U	V	W
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Over the 98 Small Frames, the Sub-channel is separated into bytes associated with the Sub-channel letter. The Sub-channel sync bytes are not a part of Sub-channel data, so there are 96 bytes of Sub-channel. For example, the P Sub-channel is separated into bytes as shown in Table 6.

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Table 6 – P-Sub-Channel Layout

Small Frame	P bit	P BYTE
1	SYNC 0	–
2	SYNC 1	–
3	7	0
4	6	
5	5	
6	4	
7	3	
8	2	
9	1	
10	0	
11	7	1
12	6	
13	5	
14	4	
15	3	
16	2	
17	1	
18	0	
.	.	.
.	.	.
.	.	.
91	7	11
92	6	
93	5	
94	4	
95	3	
96	2	
97	1	
98	0	

The byte construction for Q Sub-channels is identical.

P and Q Sub-channels provide information about the recording.

R-W Sub-channel is defined only for audio tracks. It is most often unused and is set to zeros. When used, it carries line graphics, MIDI Control or text. See 6.1.23, READ SUB-CHANNEL Command.

4.2.1.3 Physical track topology – Single session disc

CD players and readers follow the physical track by following the path of recorded EFM data. When there is no EFM data, the player/reader is unable to follow the physical track.

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The physical track is divided into 3 logical entities from the inner radius:

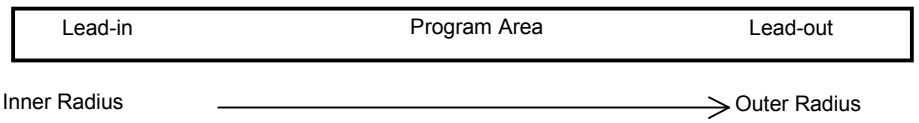

Figure 1 – Single session disc

LEAD-IN – The Lead-in is a zone of protection from unrecorded areas near the disc center. The Lead-in also contains the table of contents (TOC) for the disc's Program Area.

PROGRAM AREA – This is also known as the user area of the disc. For example, on an audio CD, this is where the music is recorded.

LEAD-OUT – The Lead-out is a zone of protection from unrecorded areas toward the disc's outer edge.

4.2.2 Physical track topology – Multi-session disc

4.2.2.0 General

A Session is the recorded sequence: Lead-in, program area, Lead-out. The multi-session allows a single disc to have several concatenated sessions.

CD-ROM devices are not typically capable of reading through unrecorded areas on the medium. The CD-ROM device needs EFM data in order to find and stay in the physical track. This means that to ensure that a CD-ROM Logical Unit is capable of accessing all areas of a Program Area, the Program Area needs the protection zones of Lead-in and Lead-out.

On a recorded disc, sessions may appear as shown in Figure 2.

Session 1 Lead-in	Session 1 Program Area	Session 1 Lead-out	Session 2 Lead-in	Session 2 Program Area	Session 2 Lead-out	.....	
				.....	Last Session Lead-in	Last Session Program Area	Last Session Lead-out

Figure 2 – Multi-session Recorded Disc

In order to assure readability by CD-ROM Logical Units, the recording system should always close the session with the most recently added program area before attempting interchange.

Additional information is needed in order to locate all of the program areas. This is accomplished by using Mode-5 Q in the Lead-in areas.

4.2.2.1 Tracks

The Program Area of the disc is divided into logically separated areas called tracks. There shall be at least one track in the Program Area. There may be gaps between tracks, primarily to provide a zone of digital silence between audio program selections. P Sub-channel is reserved for identifying these transition areas between tracks. The normal value for P is 0. During a transition area, the value for P is 1.

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4.2.2.2 Frame addressing

CD was originally developed for playing digital audio that has two channels of 16-bit samples at 44,1 kHz. The number of frames per second of play is 75:

4 bytes/sample×44 100 Samples/s = 176 400 bytes/s

176 400 bytes/s/2 352 bytes/frame = 75 frames/s

Given this, CD frames are addressed in terms of audio play time, i.e. Minute, Second and Frame (MSF). The traditional value of 60 s per minute is followed.

In all cases, when an address appears as part of the CD format, it is in MSF format using 2 bcd digits per time unit. This limits the time addressing on the disc to 99bcd minutes. The representation for a time based address is MM:SS:FF, where MM = minutes, SS = seconds, and FF = frames.

Addressing in the program area begins with 00:00:00. This advances up through the Lead-out.

The last frame in the Lead-in is 99:59:74 and decreases as the physical track is followed toward the center of the disc. The Lead-in is typically 3 min to 4 min in length.

4.2.2.3 Q Sub-channel

Since an audio CD frame has no address field built into the main channel, the address is carried in the Q Sub-channel. Q Sub-channel may also carry information about the logical structure of the disc, disc identification and music track identification. The general format of a Q Sub-channel record is shown in Table 7.

Table 7 – Q Sub-channel record format

Field name	Definitions
S0, S1	Sub-channel synchronization
CONTROL	The Control Field has 4 bits that define the type of information in the frame: 00x0b = 2 audio channels without pre-emphasis 00x1b = 2 audio channels with pre-emphasis of 50/15 µs 10x0b = 4 audio channels without pre-emphasis 10x1b = 4 audio channels with pre-emphasis of 50/15 µs 01x0b = Data track, recorded uninterrupted 01x1b = Data track, recorded increment 11xxb = reserved xx0xb = digital copy prohibited xx1xb = digital copy permitted The bits of the control field (except for the copy bit) may change during a pause (X=00) of at least 2 s and during the Lead-in area only.
ADR	4 bits of identification for DATA-Q. This is also known as the Mode (ADR) Q.
DATA Q	72 bits of data
CRC	A 16 bit CRC for the Control, ADR, and DATA-Q Fields. On the disc the CRC bits are inverted. The remainder has to be checked at zero. Polynomial = P(X)=X16+X12+X5+1

Because the sync bits and the two bytes of CRC are overhead, the valid Q information length is actually 10 bytes.

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4.2.2.4 Q Sub-channel in the Program Area

4.2.2.4.0 General

During the program area 3 types of Q Sub-channel may be encountered, Mode-1 Q, Mode-2 Q or Mode-3 Q.

ADR=1 (0001b) – Mode-1 Q

Mode-1 Q occupies at least 9 out of 10 successive CD frames. Mode-1 Q in the program area is also referred to as current position Q. The Mode-1 Q format during data and audio tracks is shown in Figure 3.

ADR	DATA-Q								
0001	TNO	INDEX	MIN	SEC	FRAME	ZERO	AMIN	ASEC	AFRAME

Figure 3 – Q Sub-channel Mode-1 Format recorded in Program Area

TNO = 01 to 99bcd is the track number

INDEX = 00 to 99bcd is the Index to TNO. An audio track may be divided into up to 99 sections, identified by a non-zero index. The first indexed area in a track shall be 01. Most audio discs have only one indexed area per track. The pre-gap is the part of a track-to-track gap that belongs to the following track. In a track's pre-gap, the track number is that of the following track and the INDEX is 00.

MIN, SEC, FRAME = Is the relative time within the track encoded as 6 bcd digits. This is 00:00:00 at track start and advances through the track. During the pre-gap the time decreases.

ZERO = 8 bits of zero (00000000b)

AMIN, ASEC, AFRAME = Is the program area absolute time address expressed in 6 bcd digits.

ADR=2 (0010b) – Mode-2 Q

Mode-2 Q is optional. If Mode-2 Q is present, it shall occupy 1 out of each 100 successive frames. The Mode-2 Q data format is shown in Figure 4.

ADR	DATA-Q														
0010	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12	N13	ZERO	AFRAME

Figure 4 – Q Sub-channel Mode-2 Format

The DATA-Q field is 52 bits long, organized as 13 nibbles (N1 – N13), each carrying a single bcd digit. The resulting bcd string is the Media Catalog Number (MCN). The catalog number does not change on a disc. In case no catalog number is encoded according to the UPC/EAN code, N1 – N13 are all zero, or Mode-2 can be deleted from the disc.

The ZERO field contains 12 bits of zero (000000000000b).

AFRAME is as defined in Q Sub-channel Mode-1 (two bcd digits running from 00 to 74). During the Lead-in (TNO = 00), these 8 bits are zero.

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4.2.2.4.1 ADR=3 (0011b) – Mode-3 Q

Mode-3 Q is optional. If Mode-3 is present, it occupies at least 1 out of 100 successive sub-coding blocks. Mode-3 is used to give a unique number to an audio track. This is done by means of the International Standard Recording Code (ISRC). The ISRC, as recorded on the media, is defined in Figure 5. If no ISRC is used, Mode-3 shall be deleted. During the Lead-in and Lead-out, Mode-3 is not present on the disc. The ISRC may only change immediately after the Track Number (TNO) has been changed. The Mode-3 data format is shown in Figure 5.

ADR	DATA-Q															
0011	I1	I2	I3	I4	I5	0	0	I6	I7	I8	I9	I10	I11	I12	ZERO	AFRAME

Figure 5 – Q Sub-channel, Mode-3 Format

The Country-Code is given in fields I1 through I2, the owner-code in fields I3 to I5. The year of recording in fields I6 to I7 and the I8 through I12 contain the serial number of the recording. The characters I1 to I5 are 6-bit cells, coded as shown in Table 8. The characters I6 to I12 are coded in 4 bit bcd numbers.

I1 to I12 define the ISRC.

The ZERO Field contains 4 bits of zero (0000b).

A FRAME is defined in Q Sub-channel Mode-1 Q (two bcd digits running from 00 to 74). During the Lead-in area (TNO = 00), these 8 bits are zero.

Table 8 – ISRC 6 bit character codes (in hexadecimal)

CHAR	CODE		CHAR	CODE
0	00		I	19
1	01		J	1A
2	02		K	1B
3	03		L	1C
4	04		M	1D
5	05		N	1E
6	06		O	1F
7	07		P	20
8	08		Q	21
9	09		R	22
A	11		S	23
B	12		T	24
C	13		U	25
D	14		V	26
E	15		W	27
F	16		X	28
G	17		Y	29
H	18		Z	2A

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4.2.2.5 Q Sub-channel in the Lead-out Area

Q Sub-channel in the Lead-out area is similar to Q Sub-channel in the program area. The differences are:

- Mode-1 Q Sub-channel: TNO = AAh, INDEX = 01bcd
- Mode-2 Q Sub-channel: No differences.

No other Q Sub-channel modes are allowed in the Lead-out area.

4.2.2.6 Q Sub-channel in the Lead-in Area

4.2.2.6.0 General

Q Sub-channel in the Lead-in area is referred to as the Table of Contents (TOC).

Three modes of Q are allowed in the Lead-in area: Mode-1 Q, Mode-2 Q and Mode-5 Q.

4.2.2.6.1 Mode-1 Q

The Mode-1 Q format during the Lead-in is shown in Figure 6. TNO is always 00 during the Lead-in and ZERO is always 00 during the Lead-in. Variations of Mode-1 Q are defined by the value of POINT.

ADR	DATA-Q								
0001	TNO=00	POINT	MIN	SEC	FRAME	ZERO=00	PMIN	PSEC	PFRAME

Figure 6 – Q Sub-channel Mode-1 Format recorded in Lead-in

POINT = 01bcd – 99bcd is the track number of the track being defined

MIN, SEC, FRAME = Running time in the Lead-in, encoded as bcd

PMIN, PSEC, PFRAME = Track start time, encoded as bcd

POINT=A0h

MIN, SEC, FRAME = Running time in the Lead-in, encoded as bcd

PMIN = the track number of the first track in the program area, encoded as bcd

PSEC = the program area format:

00h – CD-DA or CD-ROM

10h – CD-I

20h – CD-ROM-XA

PFRAME = 00

POINT=A1h

MIN, SEC, FRAME = Running time in the Lead-in, encoded as bcd

PMIN = the track number of the last track in the program area, encoded as bcd

PSEC = 00

PFRAME = 00

POINT=A2h

MIN, SEC, FRAME = Running time in the Lead-in, encoded as bcd

PMIN, PSEC, PFRAME = the start time, encoded as bcd, of the Lead-out area

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4.2.2.6.2 Mode-2 Q

Mode-2 Q Sub-channel is defined the same in the Lead-in, program area and Lead-out.

4.2.2.6.3 Mode-5 Q

Mode-5 Q Sub-channel provides additional information about CD-R and CD-RW recordings. The format of a Mode-5 Q Sub-channel is shown in Figure 7. TNO is always 00 during the Lead-in. Variations of Mode-5 Q are defined by POINT.

ADR	DATA-Q								
0101	TNO	POINT	MIN	SEC	FRAME	ZERO	PMIN	PSEC	PFRAME

Figure 7 – Q Sub-channel Mode-5 Format recorded in Lead-in

POINT= B0h (This identifies a multi-session disc.)

MIN, SEC, FRAME = the start time for the next possible session's program area. A final session is indicated when either the Mode-5 point B0 is absent or when MSF = FF:FF:FF.

ZERO = the number of different Mode-5 pointers present.

PMIN, PSEC, PFRAME = the maximum possible start time of the outermost Lead-out.

POINT=B1h (Audio only: This identifies the presence of skip intervals.)

MIN = 00

SEC = 00

FRAME = 00

ZERO = 00

PMIN = the number of skip interval pointers

PSEC = the number of skip track assignments in POINT=B2, B3, and B4

PFRAME = 0

POINT=B2h, B3h, B4h (Audio only: This identifies tracks that should be skipped during playback.)

ZERO = 00..09bcd is a label of the frame number in the PMA unity

MIN = 01..99bcd track number to skip upon playback

SEC = 00..99bcd track number to skip upon playback, 00 if no skip track is specified

FRAME = 00..99bcd track number to skip upon playback, 00 if no skip track is specified

PMIN = 00..99bcd track number to skip upon playback, 00 if no skip track is specified

PSEC = 00..99bcd track number to skip upon playback, 00 if no skip track is specified

PFRAME = 00..99bcd track number to skip upon playback, 00 if no skip track is specified

NOTE Skip intervals are seldom written by recorders and typically ignored by readers.

POINT=01…40 (Audio only: This identifies a specific playback skip interval.)

ZERO = 00

MIN, SEC, FRAME = Skip interval stop time in 6 bcd digits

PMIN, PSEC, PFRAME = Skip interval start time in 6 bcd digits

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POINT=C0h (Together with POINT=B0h, this is used to identify a multi-session disc)

ZERO = 00

MIN, SEC, FRAME = ATIP values from Special Information 1, ID=101 (See 4.2.3.)

PMIN, PSEC, PFRAME =Start time of the first Lead-in area of the disc.

4.2.2.7 CD Main channel block formats

4.2.2.7.1 General

Although some are rarely used, there are 6 main channel frame formats defined. Audio blocks are recorded unmodified.

Data blocks are given a synchronization field at the beginning of the block. The pattern is shown in Figure 8.

00h	FFh	FFh	FFh	FFh	FFh	FFh	FFh	FFh	FFh	FFh	00h

Figure 8 – Synchronization Field pattern

The synchronization field is followed by a 4 byte header defined in Table 9. After the sync pattern the remaining bytes of the data block are scrambled with a feedback mechanism. This is done with a 15-bit shift register fed back according to the polynomial X15+X+1.

Table 9 – Sync pattern block header

Header offset	Header byte	Content
0	Minute	Program area time of block, minute component (00.-.79 bcd)
1	Second	Program area time of block, second component (00.-.59 bcd)
2	Frame	Program area time of block, frame component (00.-.74 bcd)
3	Mode	Bits 1, 0 = Data Mode, bits 7 – 5 = block indicator field, bits 4 to 2 = Reserved. When bits 7 – 5 = 000 indicates user data.

Mode byte Format is shown below:

Bits 7,6,5

=000 – User Data block

=001 – Fourth Run-in block

=010 – Third Run-in block

=011 – Second Run-in block

=100 – First Run-in block

=101 – Link block. Physical linking of EFM data

=110 – Second Run-out block

=111 – First Run-out block

Bits 4,3,2 =000 – Reserved

Bits 1,0

=00 – Mode 0 Data

=01 – Mode 1 Data

=10 – Mode 2 Data

=11 – Reserved

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4.2.2.7.2 Block format for audio

Audio is streamed, so only user data resides within the frame. See the READ CD command description for byte ordering.

4.2.2.7.3 Block format for mode 0 data

Mode 0 is a rarely used format as it is zero filled in the entire user data area. Mode zero data (Table 10) has the following format.

Table 10 – Mode zero data format

Byte offset	Field length	Content
0	12	Data Block Sync pattern
12	3	Block MSF address (bcd)
15	1	Data mode = 0
16	2 336	User data (each byte is zero)

4.2.2.7.4 Block format for mode 1 data

Mode 1 data (Table 11) is most prevalent in CD-ROM applications. The sync pattern, header and user data are protected by a 32-bit CRC. The header and user data are covered by two additional layers of error correction, P and Q, collectively called Level 3 correction. This is also referred to as Layered error correction (L-EC or C3) .

Table 11 – Mode 1 data format

Byte offset	Field length	Content
0	12	Data Block Sync pattern
12	3	Block MSF address (bcd)
15	1	Data mode = 01
16	2 048	User data
2 064	4	CRC (P = (X16+X15+X2+X1)*(X16+X2+X+1)) Bytes 0 to 2 063
2 068	8	Zero fill
2 076	172	P parity symbols
2 248	104	Q parity symbols

The coverage of the CRC is the sync pattern, Header and the User Data.

The coverage of Level 3 P is Header, User Data, CRC and the zero fill.

The coverage of Level 3 Q is Header, User Data, CRC, the zero fill and the P parity.

4.2.2.7.5 Block format for mode 2 formless data

The Mode 2 formless block format (see Table 12) is rarely used. There is no defined CRC or additional correction.

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Table 12 – Mode 2 formless block format

Byte offset	Field length	Content
0	12	Data Block Sync pattern
12	3	Block MSF address (bcd)
15	1	Data mode = 2
16	2 336	User data

4.2.2.7.6 Block format for mode 2 form 1 data

Mode 2 form 1 data is regularly used in recorder applications and Video CD movies. The Mode 2 form 1 format is very similar to Mode 1 format. The differences are:

- the 8 zero fill bytes have been moved to between the header and user data as two copies of a 4 byte sub-header;
- the CRC, P-parity and Q-parity do NOT cover the block header. This assures the ability of relocating data, including all parity symbols.

Table 13 – Mode 2 form 1 data format

Byte offset	Field length	Content
0	12	Data Block Sync pattern
12	3	Block MSF address (bcd)
15	1	Data mode = 2
16	4	Sub-header, first copy
20	4	Sub-header, second copy
24	2 048	User data
2 072	4	CRC (P = (X16+X15+X2+X1)*(X16+X2+X+1)) Bytes 16 – 2 071
2 076	172	P parity symbols
2 248	104	Q parity symbols

The format of the sub-header is shown in Table 14.

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Table 14 – Mode 2 form 1 sub-header format

Sub-header Byte	Byte name	Definition
0	File number	Identifies the file to that the block belongs
1	Channel number	Playback channel selection
2	Sub-mode	
	Bit 7	End-of-File
	Bit 6	Real-time block
	Bit 5	Form (0 = Form 1, 1 = Form 2)
	Bit 4	Trigger Block
	Bit 3	Data Block
	Bit 2	Audio Block (not traditional CD-DA audio)
	Bit 1	Video Block
	Bit 0	End-of-Record
3	Coding information	

4.2.2.7.7 Block format for mode 2 form 2 data

Mode 2 form 2 data (Table 15) is regularly used in Video CD movies. The data is optionally covered by CRC within the last 4 bytes of the block.

Table 15 – Mode 2 form 2 data format

Byte offset	Field length	Content
0	12	Data Block Sync pattern
12	3	Block MSF address (bcd)
15	1	Data mode = 2
16	4	Sub-header, first copy
20	4	Sub-header, second copy
24	2 324	User data
2 348	4	Optional CRC Bytes 16 to 2 347

4.2.2.8 CD Recordable and CD ReWritable media structure

4.2.2.8.0 General

An unrecorded CD-R or CD-RW disc does not have any EFM present to find the physical track in the traditional way of CD-ROM Logical Units. A blank CD-R or CD-RW is not smooth, it is pre-grooved and the groove has a built-in wobble for the purpose of defining and finding the physical track.

The wobble is a 22,05 kHz signal (at 1X) modulated with digital information. The time position within the pre-groove is contained in each pre-groove frame of 42 bits. This is known as Absolute Time In Pre-groove (ATIP) (Table 16).

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Table 16 – ATIP format

ATIP Frame Item	Content
Sync (4 bit s)	Synchronization nibble
Minute (8 bit s)	Absolute disc time: Minute (bcd)
Second (8 bit s)	Absolute disc time: Seconds (bcd)
Frame (8 bit s)	Absolute disc time: Frame (bcd)
CRC (14 bit s)	CRC protection

In the area that is expected to be the disc's Lead-in, additional information is interleaved between positional ATIP frames. The additional information provided is:

- first possible start time for disc Lead-in (TOC);
- last possible start time for disc Lead-out;
- special information about recording permissions;
- power and speed requirements for recording the medium
- CD-R versus CD-RW medium

4.2.2.8.1 CD-R/RW Disc Management

CD-R/RW discs have two additional areas prior to the first Lead-in, the Power Calibration Area (PCA), and the Program Memory Area (PMA).

PCA – The Power Calibration Area (PCA) is present only for CD-R and CD-RW media for the purpose of write power calibration. The PCA is divided into two areas: the test area and the count area. The test area is divided into 100 calibration partitions. The count area is an accounting area for recording usage of the test area.

PMA – The Program Memory Area is present only for CD-R and CD-RW media for the purpose of accounting for the usage of user data areas on the medium. This information is contained only within the Sub-channel of the PMA frames. The main channel content is not defined within the PMA.

Update the PMA means to update the PMA on the disc or to update the PMA Cache that shall be written to the PMA on the disc prior to the removing of the disc from the Logical Unit. PMA Caching is vendor-specific.

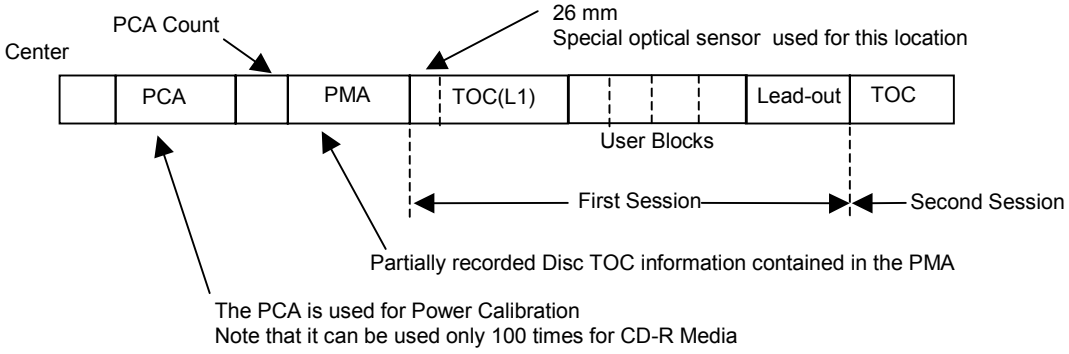

Figure 9 – CD-R and CD-RW medium

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4.2.2.8.2 PMA Q Sub-channel

The PMA is a temporary TOC to be used as a disc is being recorded in increments. The format of the Q Sub-channel for PMA entries is similar to those in the Lead-in.

The PMA is recorded in groups of 10 frames called a PMA unity. If any of the frames in a unity is recorded, then all frames in the unity shall be recorded. A given PMA entry shall appear either 5 times or 10 times within a unity.

Q Sub-channel in the PMA has the general form shown in Figure 10.

ADR	DATA-Q								
0001-0110	TNO	POINT	MIN	SEC	FRAME	ZERO	PMIN	PSEC	PFRAME

Figure 10 – PMA, Q Sub-channel

Mode-1 Q Sub-channel in the PMA is a TOC item:

TNO = 00

POINT =Track number encoded as two bcd digits.

ZERO = 00-09bcd is a label of the frame number in the PMA unity

MIN, SEC, FRAME = Track stop time in 6 bcd digits.

PMIN, PSEC, PFRAME = Track start time in 6 bcd digits.

Mode-2 Q Sub-channel in the PMA is a Disc Identification item (optional):

TNO = 00

POINT = 00

ZERO = 00-09bcd is a label of the frame number in the PMA unity

MIN, SEC, FRAME = Disc identification as a 6 bcd digit number.

PMIN = 00

PSEC = Sessions format: 00 – CD-DA or CD-ROM, 10 – CD-I, 20 – CD-ROM-XA

PFRAME = 00

Mode-3 Q Sub-channel in the PMA is a Skip track item (optional, audio only):

TNO = 00

POINT = 01-21bcd is the mode-3 index of this item

ZERO = 00-09bcd is a label of the frame number in the PMA unity

MIN = 01-99bcd track number to skip upon playback

SEC = 00-99bcd track number to skip upon playback, 00 if no skip track is specified

FRAME = 00-99bcd track number to skip upon playback, 00 if no skip track is specified

PMIN = 00-99bcd track number to skip upon playback, 00 if no skip track is specified

PSEC = 00-99bcd track number to skip upon playback, 00 if no skip track is specified

PFRAME = 00-99bcd track number to skip upon playback, 00 if no skip track is specified

Mode-4 Q Sub-channel in the PMA is an unskip track item (optional, audio only):

TNO = 00

POINT = 01-21bcd is the mode-4 index of this item

ZERO = 00-09bcd is a label of the frame number in the PMA unity

MIN = 01-99bcd track number to unskip upon playback

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SEC = 00-99bcd track number to unskip upon playback, 00 if no unskip track is specified

FRAME = 00-99bcd track number to unskip upon playback, 00 if no unskip track is specified

PMIN = 00-99bcd track number to unskip upon playback, 00 if no unskip track is specified

PSEC = 00-99bcd track number to unskip upon playback, 00 if no unskip track is specified

PFRAME = 00-99bcd track number to unskip upon playback, 00 if no unskip track is specified

Mode-5 Q Sub-channel in the PMA is a skip interval item:

TNO = 00

POINT = 01-40bcd is the mode-5 index of this item

ZERO = 00-09bcd is a label of the frame number in the PMA unity

MIN, SEC, FRAME = Skip interval stop time in 6 bcd digits

PMIN, PSEC, PFRAME = Skip interval start time in 6 bcd digits

Mode-6 Q Sub-channel in the PMA is an “unskip interval” item:

TNO = 00

POINT = 01-40bcd is the mode-6 index of this item

ZERO = 00-09bcd is a label of the frame number in the PMA unity

MIN, SEC, FRAME = Unskip interval stop time in 6 bcd digits

PMIN, PSEC, PFRAME = Unskip interval start time in 6 bcd digits

4.2.2.9 Recording

Blank CD-R is not randomly writable. CD-RW is limited in its random write capability. Due to the interleaved nature of CD frames, blank media shall be recorded in groups of frames with linkage for appending new recording.

There are two methods for linking separate writes on CD-R or CD-RW:

Audio – Linkage occurs within a single frame time. This assures that locating the linkage frame by its Q at a later time is nearly impossible.

Data – Since it is necessary to locate exact boundaries of user blocks, additional padding is inserted around the linkage frame. The collection of the link block, the pad blocks, and the user blocks is called a Packet. The format of the packet is shown as follows:

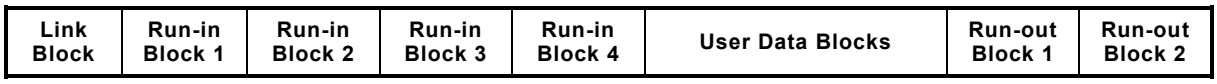

Figure 11 – Packet Format

Blocks are uniquely identified by bits 5, 6, and 7 of the block’s mode byte (see Table 17).

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Table 17 – Block Identifier bits

Mode Byte bits 7, 6, 5	Block
000	User Data
001	Run-in block 4
010	Run-in block 3
011	Run-in block 2
100	Run-in block 1
101	Link block
110	Run-out block 2
111	Run-out block 1

See 4.2.2.7 for a detailed definition of the Mode Byte. Main channel user data should be all zeros.

Only entire packets may be rewritten on CD-RW media.

There are 2 types of recording on CD-R: Uninterrupted and Incremental. Incremental recording requires linking, whereas uninterrupted does not.

Disc At Once is the only type of uninterrupted recording and is a special case of Session At Once. The recording begins at the start of the Lead-in and stops only when the last block of the Lead-out is written. The PMA is not written. No linking is required.

There are 5 types of incremental recording:

- Session At Once – The recording begins at the start of the Lead-in of the next session and stops only when the last block of that session's Lead-out is written. The PMA is constructed and written as a separate write action. Linking between sessions is required.
- Reserve Track – User data is not necessarily written. The PMA is written for the purpose of defining a new track.
- Track At Once – A single packet that includes the pre-gap of the track and all of the track's user data.
- Variable Packet – A variable number of user blocks is written between data linkage blocks. A variable packet shall be a part of the user data area of a track.
- Fixed Packet – A fixed number of user blocks is written between the user blocks. A fixed packet shall be a part of the user data area of a track.

4.2.2.10 Track Descriptor Block

The Track Descriptor Block (TDB) is required for Track at Once or Packet recording. When the TDB is present, each block of the pre-gap of a track is a TDB. When a track is only reserved for Track At Once recording, recording of the TDB is deferred until the track data is written. When a track is reserved for either sort of packet recording, the TDB shall be written as a single packet upon reservation.

The TDB contains main channel information about the track recording and optionally contains a history of tracks that preceded the TDB. (See Table 18.)

The TDB begins with an 8 byte header. The TDB header is followed by one or more Track Descriptor Units (TDU). (See Table 19.)

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Table 18 – Track Descriptor Block (TDB) header

Bit/ Byte	7	6	5	4	3	2	1	0
0	54h (“T” according to ISO/IEC 646:1991)							
1	44h (“D” according to ISO/IEC 646:1991)							
2	49h (“I” according to ISO/IEC 646:1991)							
3	Pre-gap Length encoded bcd							
4								
5	Reserved							Current
6	Lowest Track Number Listed (bcd)							
7	Highest Track Number Listed (bcd)							
8 :	One or more Track Descriptor Unit (TDU)							
n								

Pre-gap length is given in number of blocks.

The Current bit, when set to 1, indicates that only the TDU for the current track is present. When cleared to 0, indicates that a TDU for tracks with numbers smaller than or equal to the current track, are present.

Table 19 – Track Descriptor Unit (TDU) Format

Bit/ Byte	7	6	5	4	3	2	1	0
0	Track Number (bcd)							
1	Recording method							
2	(MSB) Fixed Packet Size in blocks (bcd)							
3								
4								(LSB)
5	Reserved (00)							
…	Reserved (00)							
15	Reserved (00)							

Recording method is coded as follows:

00h Audio track written TAO

80h Data track written TAO

90h Incrementally written data track, variable packets

91h Incrementally written data track, fixed packets

Fixed Packet size is filled with FFFFFFh whenever the recording method is not fixed packet.

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4.2.3 CD Audio error reporting

PLAY commands with the immediate bitset in the audio control mode return status as soon as the command has been validated (that may involve a seek to the starting address). The playback operation continues and may complete without notification to the Initiator. Error termination of audio operations shall be reported to the Initiator by returning CHECK CONDITION STATUS to the next command (except for REQUEST SENSE, INQUIRY, GET CONFIGURATION, and GET EVENT/STATUS NOTIFICATION). The deferred error sense data is used to indicate that the error is not due to the current command.

The status of the play operation may be determined by issuing a REQUEST SENSE command. The sense key is set to NO SENSE, the ASC is set to NO ADDITIONAL SENSE DATA and the audio status (see Table 292) is reported in the additional sense code qualifier field.

4.2.4 CD ready condition/not ready condition

The ready condition occurs after a disc is inserted and the Logical Unit has performed its initialization tasks. These tasks may include reading the Table of Contents from the media. Table 20 defines the Not Ready Error reporting for each command. A not ready condition shall occur only for the following reasons.

a) There is no medium mounted.

b) The Logical Unit is unable to load or unload the medium.

c) The Logical Unit is unable to recover the Table of Contents.

d) The controller cannot select the Logical Unit.

e) As otherwise described in the command operation.

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Table 20 – Not Ready Error Reporting (by command)

Command Name	Operation Code	Return Ready Status	Returns Not Ready Status
BLANK	A1h	Yes	Group 2 NOTE
CLOSE TRACK/SESSION	5Eh	Yes	Group 2 NOTE
COMPARE	39h	Yes	Group 1
COPY	18h	Yes	Group 2
COPY AND VERIFY	3Ah	Yes	Group 2
SYNCHRONIZE CACHE	36h	Yes	Group 2
FORMAT UNIT	04h	Yes	Group 2 NOTE
GET EVENT/STATUS NOTIFICATION	4Ah	No	Not Allowed
INQUIRY	12h	No	Not Allowed
LOAD/UNLOAD CD	A6h	Yes	Group 1 NOTE
LOCK/UNLOCK CACHE	38h	No	Group 2
LOG SELECT/SENSE	4Ch,4Dh	No	Group 1
MECHANISM STATUS	BDh	No	Group 1
MODE SELECT	55h, 15h	No	Group 1
MODE SENSE	5Ah, 1Ah	No	Group 1
PAUSE/RESUME	4Bh	Yes	Group 1
PLAY AUDIO (10)	45h	Yes	Group 1
PLAY AUDIO (12)	A5h	Yes	Group 1
PLAY AUDIO MSF	47h	Yes	Group 1
PLAY CD	BCh	Yes	Group 1
PREFETCH	34h	Yes	Group 1
PREVENT/ALLOW MEDIUM REMOVAL	1Eh	No	Group 1
READ (10)	28h	Yes	Group 1
READ (12)	A8h	Yes	Group 1
READ BUFFER	3Ch	No	Group 1
READ CAPACITY	25h	Yes	Group 1
READ CD	BEh	Yes	Group 1
READ CD MSF	B9h	Yes	Group 1
READ DISC INFORMATION	51h	Yes	Group 1
READ DVD STRUCTURE	A0h	Yes	Group 1
READ FORMAT CAPACITIES	23h	No	Group 1
READ HEADER	44h	Yes	Group 1
READ LONG	3Eh	Yes	Group 1
READ SUB-CHANNEL	42h	Yes	Group 1
READ TOC/PMA/ATIP	43h	Yes	Group 1
READ TRACK INFORMATION	52h	Yes	Group 1
RECEIVE DIAGNOSTIC RESULTS	1Ch	No	Not Allowed
RELEASE	17h, 57h	No	Not Allowed
REPAIR TRACK	58h	Yes	Group 1
REPORT KEY	AAh	Yes	Group 1
REPORT LUNS	A0h	No	Group 1
REQUEST SENSE	03h	No	Not Allowed
RESERVE	16h, 56h	No	Not Allowed
RESERVE TRACK	53h	Yes	Group 2
REZERO	01h	Yes	Group 1
SCAN	BAh	Yes	Group 1

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Command Name	Operation Code	Return Ready Status	Returns Not Ready Status
SEEK	2Bh	Yes	Group 1
SEND DIAGNOSTICS	1Dh	No	Not Allowed
SEND KEY	A3h	Yes	Group 1
SEND OPC INFORMATION	54h	No	Group 1
SET CD SPEED	BBh	No	Group 1
SET READ AHEAD	A7h	Yes	Group 1
START/STOP UNIT	1Bh	Yes	Group 1
STOP PLAY/SCAN	4Eh	Yes	Group 1
TEST UNIT READY	00h	Yes	Group 1
VERIFY (10)	02F	Yes	Group 2
VERIFY (12)	A2h	Yes	Group 1
WRITE (10)	2Ah	Yes	Group 1
WRITE AND VERIFY (10)	AEh	Yes	Group 1
NOTE With the IMMED bit set, Time Out is not allowed and shall be completed within the Group 1 time.			

4.2.5 Sensing support for CD-audio commands

The preferred method of sensing support for CD audio is the implementation of the GET CONFIGURATION command, see 6.1.4. For legacy implementations, if any commands related to audio operations are implemented, then the PLAY AUDIO(10) command shall be implemented to allow a method for the Initiator to determine if audio operations are supported. A target responding to a PLAY AUDIO(10) command that has a transfer length of zero, with CHECK CONDITION STATUS, and setting the sense key to ILLEGAL REQUEST does not support audio play operations.

4.3 DVD Model

4.3.0 General

Like CD Logical Units/Media there are multiple types of DVD Logical Units/Media:

- Read Only (DVD-ROM)
- Recordable (DVD-R)
- Re-Writable (DVD-RAM, DVD+RW)

The capacities of these different media vary. In addition, each item of these media also has the possibility of one or two sides, and DVD-ROM may have one or two layers per side. A DVD Logical Unit may be capable of reading CD-ROM.

4.3.1 DVD media functionality

The DVD media are currently specified by the Physical sections of the DVD Consortium Specifications or Books.

- DVD Media can contain information on one side (Single Sided) or on both sides (Double Sided).
- DVD-ROM disc has two types of layer structure: single layer and double layer.
- Each Layer on either side contains a spiral track. This track contains a Lead-in, Data Area, and a Middle Area or a Lead-out.
- Dual Layer discs have two types of track path: Parallel Track Path and Opposite Track Path.

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- One ECC BLOCK consisting of 16 sectors, and having 37 856 bytes.
- There is no Sub-channel, only a main channel.
- Addressing from the Initiator is LBA (Logical Block Address) only.
- Information concerning error correction that has been performed is not usually returned to the Initiator.
- Some data on DVD Media are used only inside of the DVD Logical Unit and is not transferred to the Initiator.
- The Initiator Read & Write unit (User Data) is 2 kB (2 048 bytes).

4.3.2 Track structure

There are two types of track path for double layer discs, either parallel or opposite. When the path is parallel each track has its own Lead-in and Lead-out.

There are two addresses used in the DVD system, the Block address contained in the sector headers (Physical Sector Number) and the address used to reference the blocks from the Initiator system (LBA). The address used from the Initiator starts at 0 and progresses up through the end of the recorded information on the disc. LBA 0 shall correspond with the sector address of 030000h on DVD-ROM media. Only the Data Area is generally addressable using an LBA.

Figure 12 through Figure 17 show examples of LBA to Physical Sector Number translations for DVD media.

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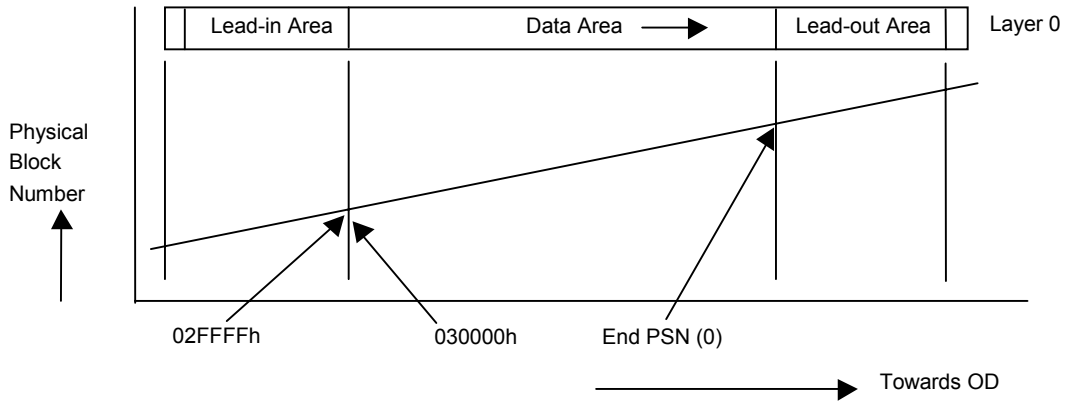

End PSN (0): The end Physical Block number of Data Area of Layer 0

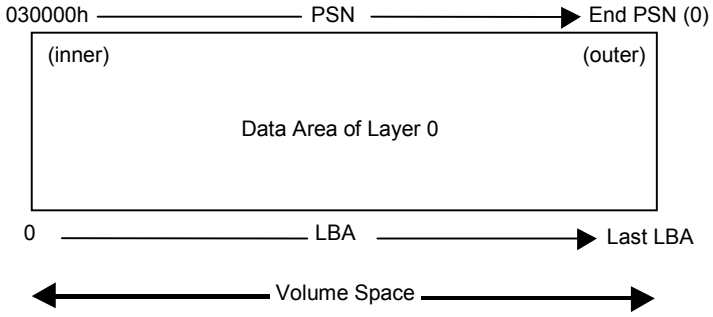

Figure 12 – Physical and logical layout of single layer DVD-ROM media

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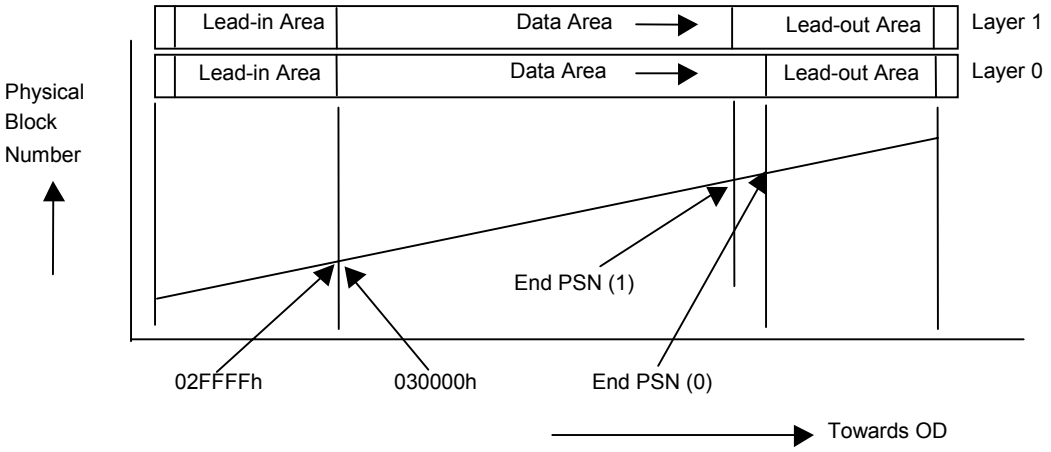

End PSN (0): The end Physical Block number of Data Area of Layer 0

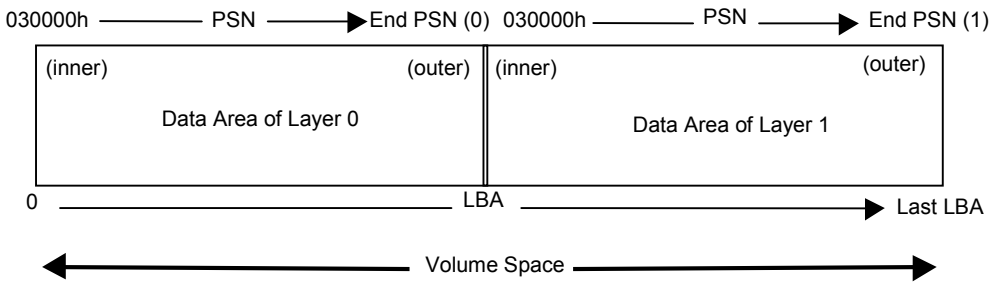

Figure 13 – Physical and logical layout of parallel track path DVD-ROM media

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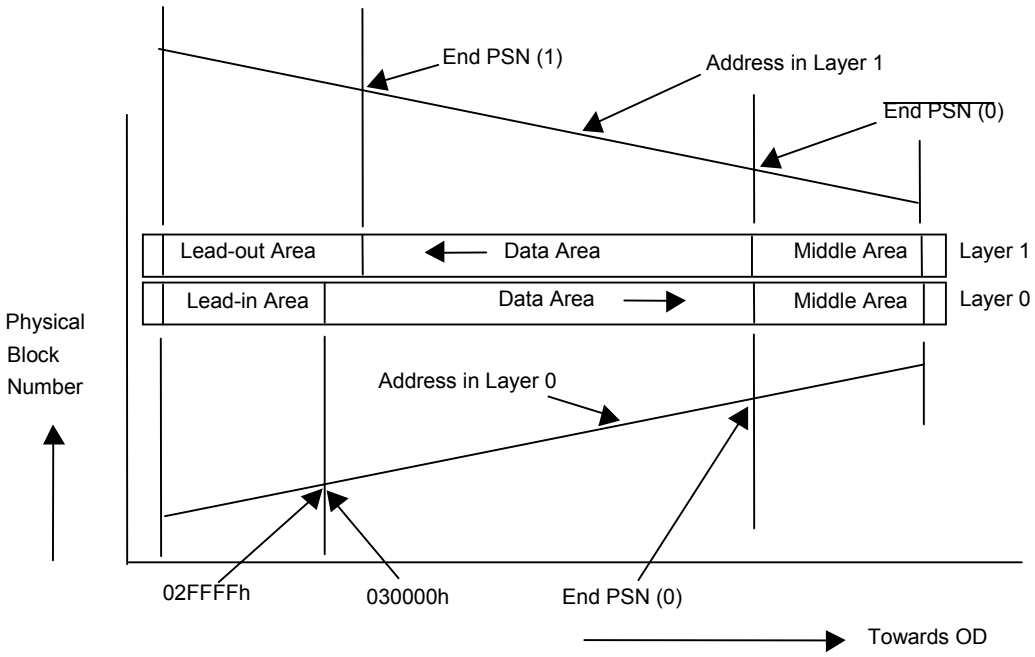

End PSN (0): end Physical Block number of Data Area of Layer 0

$\overline{\text{End PSN (0)}}$: number calculated so that each bit of the End PSN (0) is inverted

End PSN (1): end Physical sector number of Data Area of Layer 1

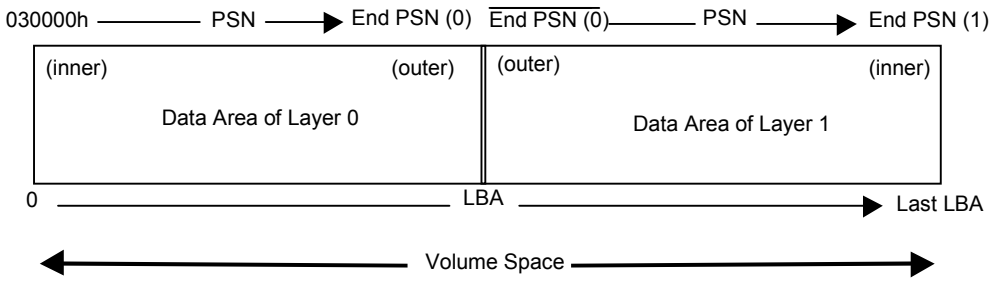

Figure 14 – Physical and logical layout of opposite track path DVD-ROM media

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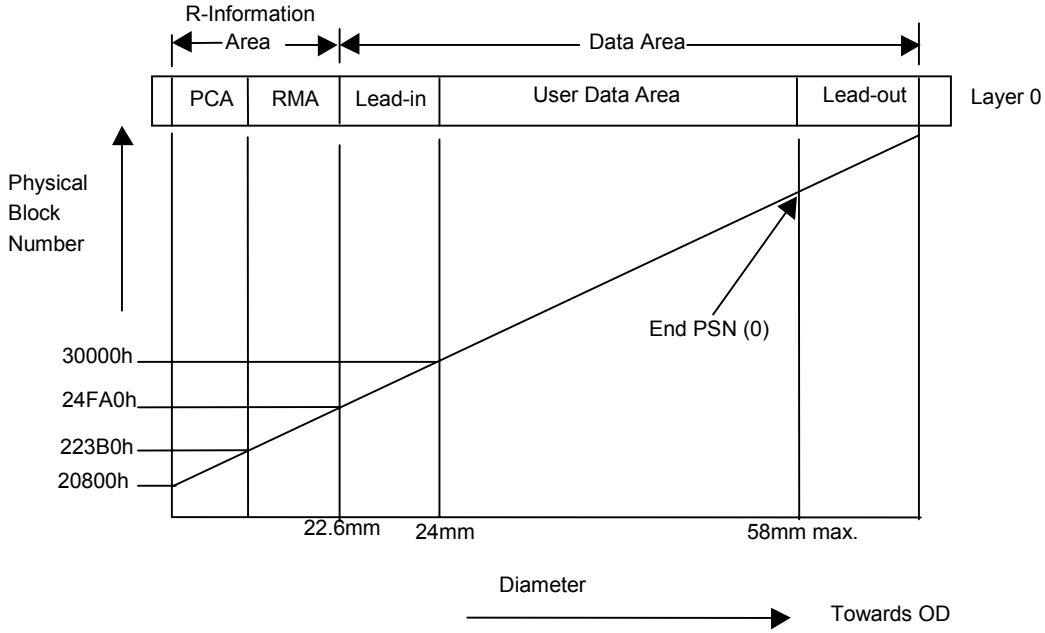

End PSN (0): The end Physical sector number of Data

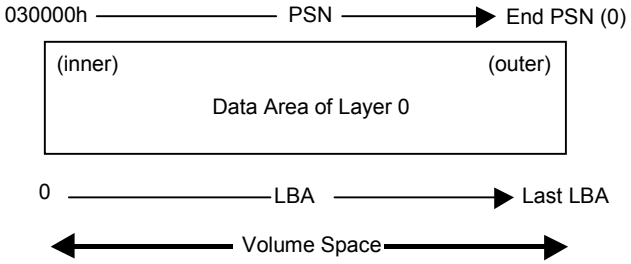

Figure 15 – Physical and logical layout of DVD-R media

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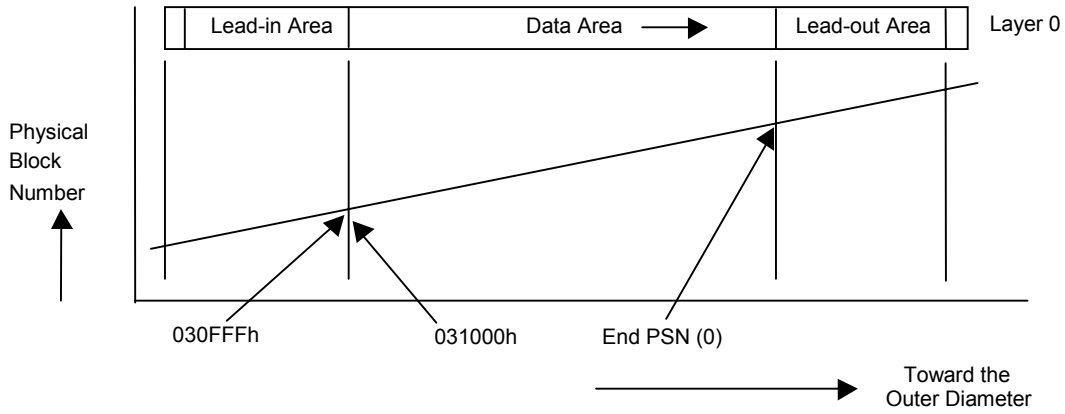

End PSN (0): The end Physical Block number of Data Area of Layer 0

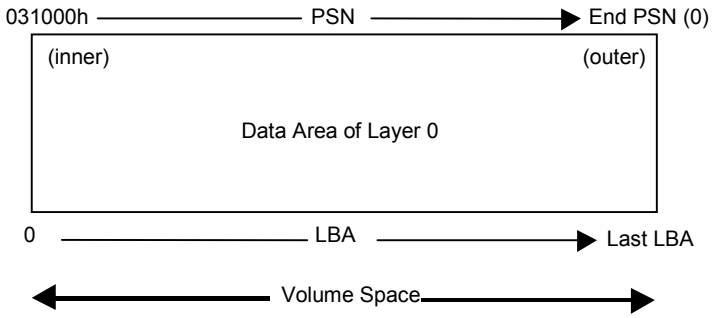

Figure 16 – Physical and logical layout of single layer DVD + RW media

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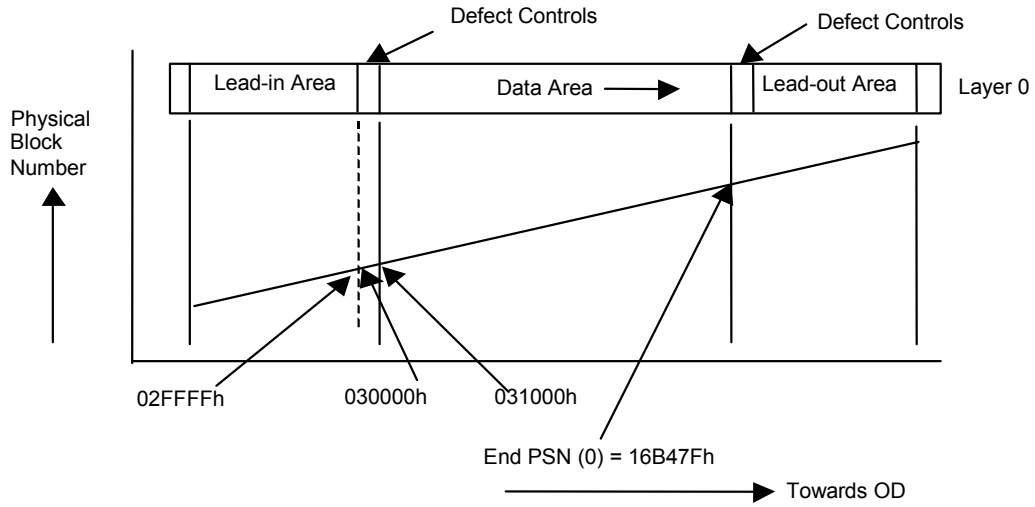
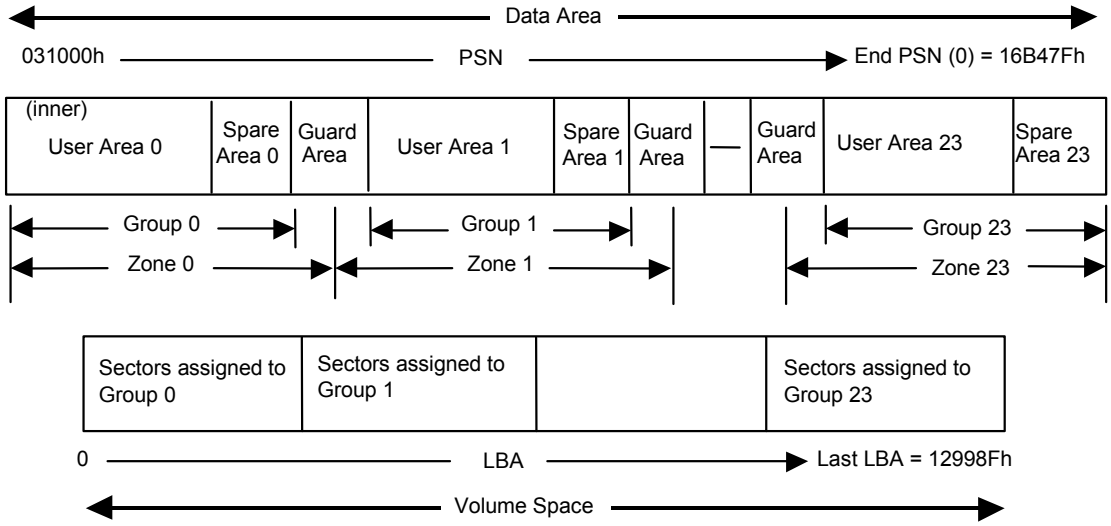


End PSN (0): end Physical sector number of Data Area of Layer 0

Defect Controls are non user addressable blocks, used for drive controlled defect management. These blocks contain Defect management Areas (DMAs). Defect controls begins 030000h, this is the data area for DVD-ROM and for DVD-R. The data area begins 031000h for DVD-RAM.



- DVD-RAM media contains 24 zones.
- Each of these zones has equal radial size, therefore number of ECC blocks per zone increase from 1662 at Inter Diameter to 4 475 at Outer Diameter.
- The number of sectors in each Spare Area allocated per zone is proportional to the number of sectors in each User Area, approximately 5 %.
- The User Area may contain defective sectors which are replaced by sectors in the Spare Area; therefore, the number of user accessible sectors in each zone is predetermined.

Figure 17 – Physical and logical layout of DVD-RAM media

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4.3.3 Recording for DVD-R

4.3.3.1 RZone description

The DVD-R specification describes a logical entity called an RZone. This standard describes Tracks as they are implemented on CD. An RZone shall be treated as a Track, with the following differences from a CD Track.

a) An RZone may only contain data (no CD Audio Tracks).

b) An RZone has a pre-gap of 0 or 16 sectors instead of 150.

c) An RZone post-gap size is determined by rounding to the ECC block size and is 0 to 15 sectors in length.

NOTE Pre-gap, post-gap are not defined in the DVD-R specification. In this standard, pre-gap is Linking Loss Area at the beginning of an RZone, post-gap is Linking Loss Area at the end of an RZone. Linking Loss Areas are possible in the middle of an RZone.

d) CD track parameters such as Copy, Control, Data Mode, Packet, FP and Packet Size either do not apply or have constant values. For purposes of reporting, Copy = 0, Control = 5, Data Mode = 1, FP = 0, Packet Size = 16.

e) The link size is variable due to both user selection of 2k or 32k linking and Logical Unit padding of the last write to an ECC boundary. As in CD, the Next Writable Address can always be obtained via the READ TRACK INFORMATION command.

f) The maximum number of RZones is 2 302.

g) RZones do not contain sub-channel information.

Whenever this standard references a Track, and the medium is DVD-R, the translation above should be applied.

4.3.3.2 Border-in/Border-out

The DVD-R specification describes entities called Lead-in, Lead-out, Border-in and Border-out. DVD-R always has zero or one Lead-in and zero or one Lead-out. The Lead-in, if recorded, is always at the beginning of the disc and the Lead-out, if recorded, is always at the end of the disc. No data can be recorded beyond the Lead-out. The information recording area is a collection of Lead-in/Border-in, Bordered Areas and Border-out. This area, when written, is called a complete session.

If intermediate interchangeability is desired before recording the Lead-out, a Border-out is written in its place. When additional recording is to be done, a Border-in is recorded between the last Border-out and the new data.

If only a Border-in and Border-out are to be written (after incrementally recording data), the Initiator shall set the Multi-session field of the Write Parameters page to 11b. If set to 11b, and insufficient space exists on the medium for another Border, the Logical Unit shall permanently close the medium by recording a Lead-out. If it is desired to permanently close a disc, the Multi-session field shall be set to 00b or 01b. The Multi-session field is ignored on DVD-R when the Write Type is set to Session at Once and no next Border is possible. Within this standard Multi-session is used instead of Multi-Border, incomplete session is used instead of incomplete Border, complete session is used instead of complete Border for DVD-R Logical Units.

4.3.3.3 RMA caching

RMA area is the Recording Management Area for DVD-R media. To Update the RMA means to update the RMA on the disc or to update the RMA Cache, that shall be written to the RMA on the disc prior to the removing of the disc from the Logical Unit. RMA Caching is vendor-specific.

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4.3.4 ECC Block

The user data is contained in ECC Blocks. The ECC Blocks are made up of 16 sectors and are used to provide error correction. To read any data, the whole ECC Block shall be read and error correction applied. When the ECC Block is written during formatting or normal write operation, the user data and the ECC information is encoded and written to sectors as a whole ECC Block.

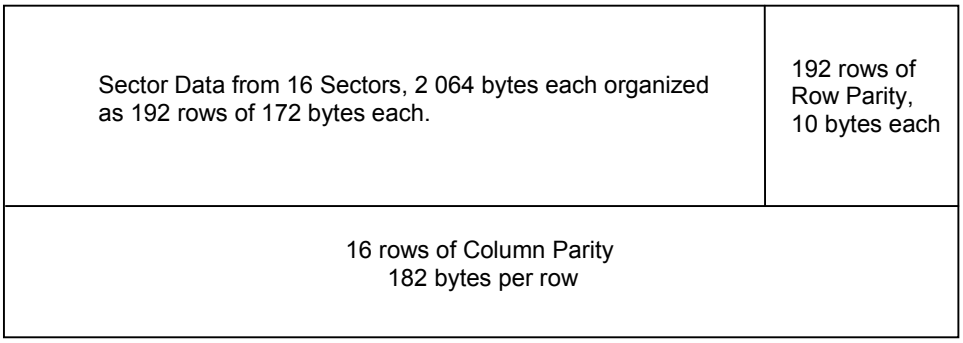

Figure 18 – Data organization within an ECC Block

4.3.5 Sector configuration

4.3.5.1 Physical sector

The data recorded to the DVD media are in a format called Data Unit 3, which consists of 2 048 bytes of User Data, 12 bytes of Data ID and others, 4 bytes of error detection code (EDC), 302 bytes of ECC and 52 bytes of SYNC. During the formation of the Data Unit 3, there are intermediate products which are called Data Unit 1 and Data Unit 2 according to the stage of signal processing, as shown in Figure 19. The Data Unit 3 is identical among DVD-ROM, DVD-R, DVD-RAM and DVD + RW. In the case of DVD-ROM, DVD-R and DVD + RW, only the Data Unit 3 is recorded. DVD-RAM media have other fields in between the Data Unit 3, as shown in Figure 19.

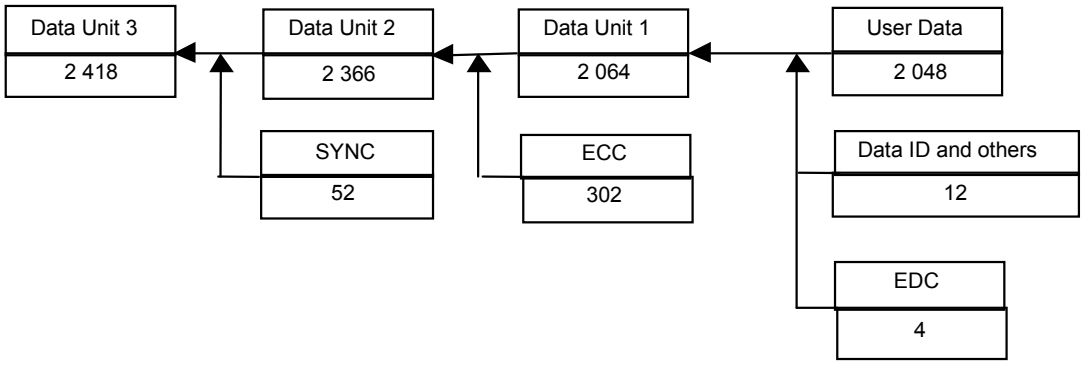

Figure 19 – Formation of Data Unit 3

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The physical sector of DVD-RAM consists of Data Unit 3, preceding fields and succeeding fields to it and embossed fields. The Data Unit 3 is identical with that for DVD-ROM. The Header field contains four physical IDs. In the case of DVD-RAM, there are two sets of IDs; one that is contained in the Data Unit 1 and another that is pre-recorded. Addressing of sectors for DVD-RAM will only use the physical (pre-recorded) ID. After formatting, it is possible for the ID in Data Unit 1 to contain an invalid address.

4.3.5.2 Data Unit 1

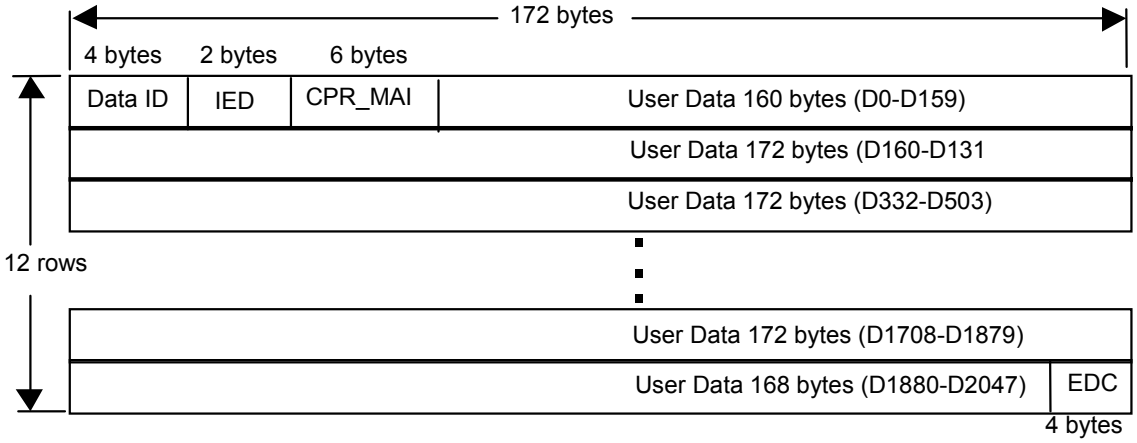

Figure 20 – Data Unit 1

4.3.5.3 Data configuration of data ID field

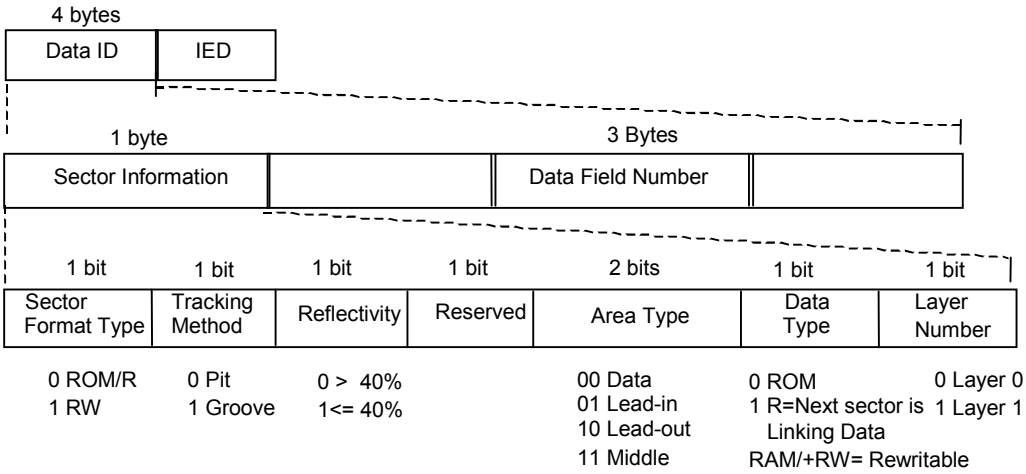

Figure 21 – Data ID field definition

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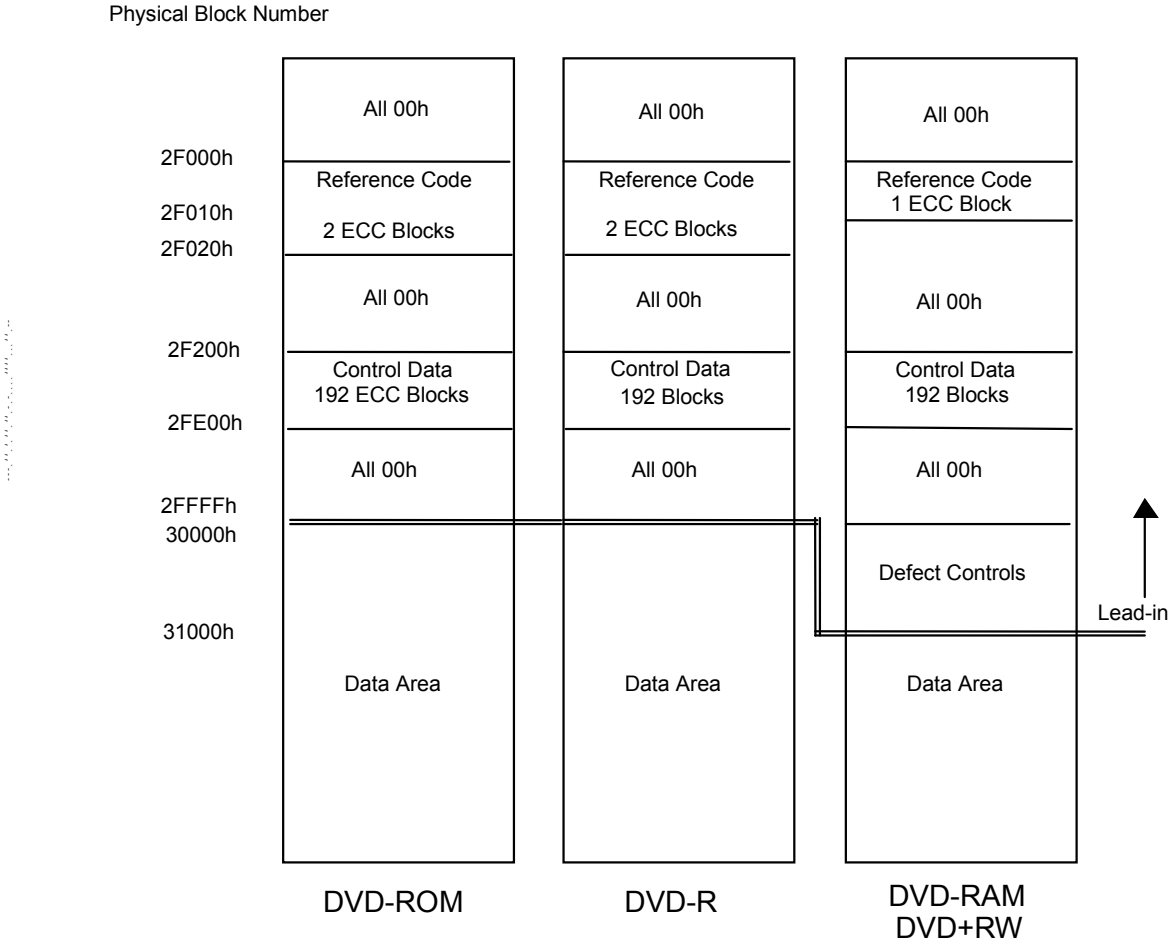
The Data Field Number consists of the PSN and other data. See Table 21.

Table 21 – Data field number for DVD media

Area	Media type	Description	Data field number
Lead-in and Lead-out	ROM, R, RAM, +RW	Pre-recorded information	PSN
Data Area	ROM, R	Pre-recorded information or written for DVD-R Media	PSN = (LBA + 30000h)
	RAM	ECC Block written by the Initiator	LBA + 31000h
		ECC Block not written by the Initiator after formatting	Any of the following three cases (1) Initialization pattern (2) Unrecorded (3) Old value of LBA + 31000h assigned before previous re-formatting
	+RW	Written data	PSN (first one in data area is 31000h, sequential thereafter)
		Unwritten	Unrecorded

4.3.5.4 Data structure of disc lead-in area



Reference Code contains repetition of the Data Symbol “172” with added scrambled data.

Control Data comprises repetition of a content of 16 sectors (one ECC Block).

Figure 22 – Data structure of disc Lead-in area

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4.3.5.5 Control data area

The Control data area contains 192 ECC Blocks. Each of the ECC Blocks (16) Sectors contains one of four distinct types of data. See Table 22 for a generic descriptor.

Table 22 – Control structure of control data block

Sector number	Description
0	Physical Format Information
1	Disc Manufacturing Information
2	Reserved
… . …	
14	
15	

4.3.5.6 Control area sector descriptions

Table 23 shows the format of the Physical Format descriptor.

Table 23 – Common part of physical format information

Byte \ Bit	7	6	5	4	3	2	1	0
0	Book Type				Book Version			
1	Disc Size				Minimum Rate			
2	Reserved	Number of Layers		Track Path	Layer Type			
3	Linear Density				Track Density			
4	Data Area Allocation							
5								
… … …								
15								
16	BCA Flag	Reserved						
17 to 2 047	Medium Unique Data							

The Book Type field is described in Table 24.

Table 24 – Book type field

Book type value	Definition
0	DVD-ROM
1	DVD-RAM
2	DVD-R
9	DVD+RW
Others	Reserved

Table 25, Table 26, Table 27 and Table 28 define the format unique descriptors for each media type.

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Table 25 – DVD-ROM unique part of physical format information

Bit / Byte	7	6	5	4	3	2	1	0
32 to 2 047	Reserved							

Table 26 – DVD-R unique part of physical format information

Bit / Byte	7	6	5	4	3	2	1	0
32~35	Start PSN of the R-Information Area							
36~39	Start PSN of the next Lead-in							
40 to 2 047	Reserved							

Table 27 – DVD-RAM unique part of physical format information

Bit / Byte	7	6	5	4	3	2	1	0
32	Disc Type Identification							
33 to 47	Reserved							
48	Velocity 1							
49 to 65	Write conditions at Velocity 1							
66 to 479	Reserved for write conditions at velocity of Velocity 2 to Velocity 24							
480 to 2 047	Reserved							

Table 28 – DVD + RW unique part of physical format

Bit / Byte	7	6	5	4	3	2	1	0
32	Recording Velocity							
33	Maximum read power at maximum velocity							
34	P_{IND} at maximum velocity							
35	ρ at maximum velocity							
36	ε_1 at maximum velocity							
37	ε_2 at maximum velocity							
38	γ_{target} at maximum velocity							
39	Maximum read power at reference velocity							
40	P_{IND} at reference velocity							
41	ρ at reference velocity							
42	ε_1 at reference velocity							
43	ε_2 at reference velocity							
44	γ_{target} at reference velocity							
45	Maximum read power at minimum velocity							
46	P_{IND} at minimum velocity							
47	ρ at minimum velocity							
48	ε_1 at minimum velocity							
49	ε_2 at minimum velocity							
50	γ_{target} at minimum velocity							
51 to 2 047	Reserved							

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Table 29 describes the contents of the Data Area Allocation field.

Table 29 – Data area allocation definition

Byte	Single Layer DVD-ROM	Parallel Track Path DVD-ROM	Opposite Track Path DVD-ROM	DVD-R disc at once	DVD-R incremental	DVD-RAM	DVD + RW
4	00h	00h	00h	00h	00h	00h	00
5	Starting PSN of Data Area (030000h)	Starting PSN of Data Area (030000h)	Starting PSN of Data Area (030000h)	Starting PSN of Data Area (030000h)	Starting PSN of Data Area (030000h)	Starting PSN of Data Area (031000h)	Starting PSN of Data Area (031000h)
6							
7							
8	00h	00h	00h	00h	00h	00h	00h
9	End PSN of Data Area	End PSN of Data Area	End PSN of Data Area	End PSN of Data Area	Last Recorded Sector Number of the last Track in the Session	End PSN of Data Area (16B47Fh)	End PSN of Data Area (198FFFh)
10							
11							
12	00h	00h	00h	00h	00h	00h	00h
13	000000h	000000h	End PSN in Layer 0	000000h	000000h	000000h	000000h
14							
15							

For DVD-RAM, the end PSN is the PSN for the last spare sector of the last zone. It should not be used for counting user capacity.

For DVD + RW, the end PSN should not be used for counting user capacity. Blocks in the Data Area may be spared or set aside for replacement.

4.3.6 DVD ready condition/Not ready condition

The Ready Condition occurs after a disc is inserted and the Logical Unit has performed its initialization tasks. These may include reading the Lead-in information from the media. This Ready is different from and should not be confused with the ATA Ready Status. A CHECK CONDITION Status shall be returned for the Not Ready Condition only for commands that require or imply a disc access.

A Not Ready Condition may occur for the following reasons.

a) There is no disc mounted.

b) The Logical Unit is unable to load or unload the disc.

c) The Logical Unit is performing an extended operation as a result of an Immediate Mode command such as FORMAT UNIT or BLANK.

The Logical Unit shall spin up and make the disc ready for media accesses when a new disc is detected.

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Any media access that occurs when the Logical Unit is not spinning shall spin the media up and not generate an error. Any media access that is requested while a deferred operation is in progress (i.e. writing from a write cache) shall not generate an error. Any media access that is requested while the Logical Unit is processing an Immediate command, e.g. BLANK or FORMAT UNIT with the Immediate bit set, may result in a Not Ready Condition.

NOTE Accesses to the media can be satisfied from the Logical Unit's cache and may not require the media to be spinning.

4.3.7 DVD copy protection

4.3.7.0 General

The DVD Copy Management is made up of two basic concepts. The first is to scramble the content of the data in such a way that if it is available for copy operations, it would still be unusable. The data shall be unscrambled before it can be used. The protection comes from an Authentication process that shall exchange protected information (Keys) before the unscramble operation is possible. The second is to limit the playback of content to specific regions of the world. Both the scrambled content and regionalization are used only for discs that make use of the Content Scrambling System (CSS) which is used only on DVD with video content.

4.3.7.1 Management of protected data

4.3.7.1.0 General

Any read by the Initiator to a disc that contains scrambled content and a sector with a Title Key present, when the Authentication Success Flag (ASF) is set to zero shall be terminated. The command shall be terminated with a CHECK CONDITION status, sense key set to ILLEGAL REQUEST and ASC is set to READ OF SCRAMBLED SECTOR WITHOUT AUTHENTICATION. For more information on the authentication process, see Figure 23. For more information on the Authentication Success Flag, see Figure 24.

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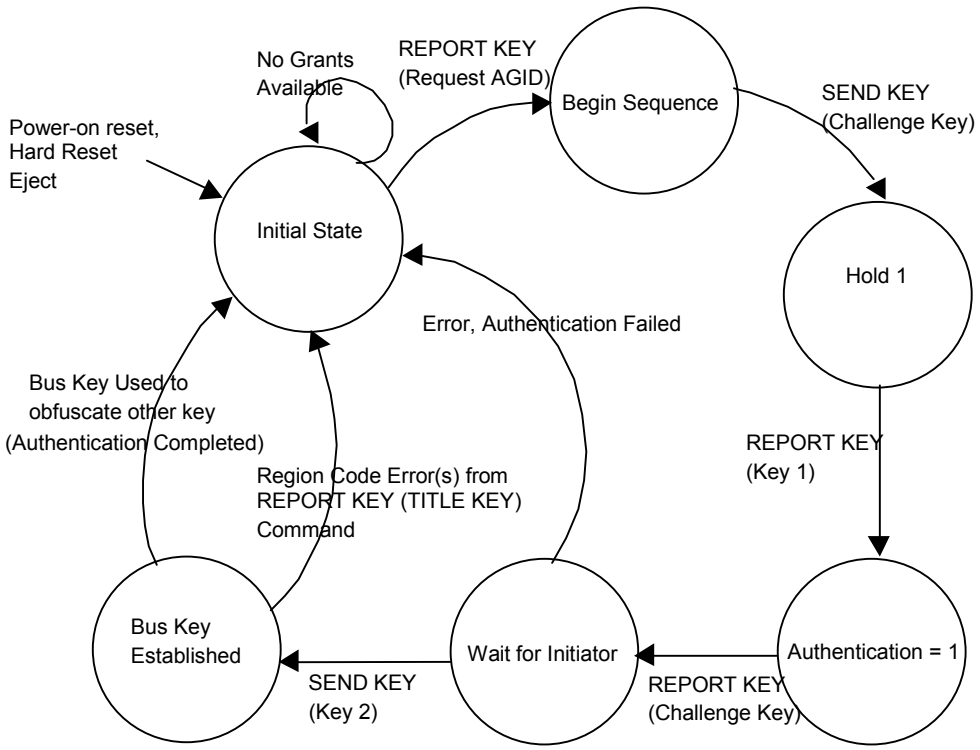
4.3.7.1.1 Authentication process



Note: Initiator must reset a non-responding authentication process in the Logical Unit by invalidating the corresponding AGID. The Initiator may detect lost grants by refusal of the Start Authentication Process operation.

Figure 23 – Device key exchange and authentication state diagram

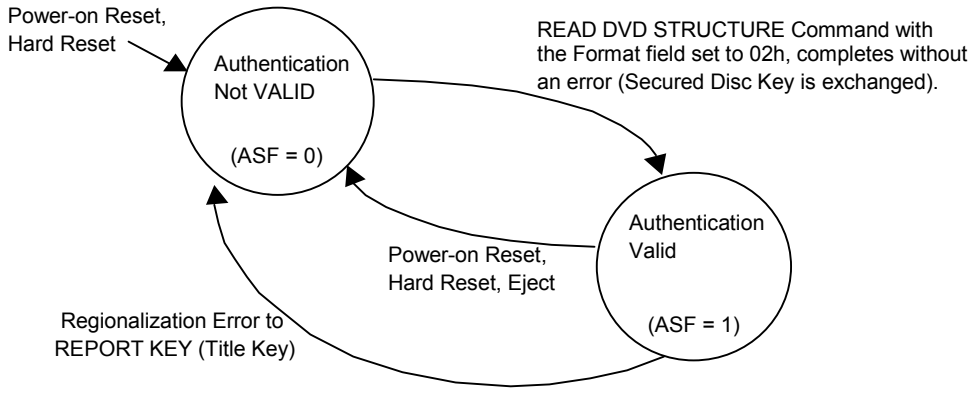


Figure 24 – Authentication flag sequence

4.3.7.2 Region playback control (RPC)

The copy management capability used for Copy Protected DVD-ROM Media limits the play-back of content to specific regions of the world. This capability is called Region Playback Control (RPC) or Regionalization.

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4.3.7.3 Playback limitations by World Region

The use of Regionalization is limited to Discs that employ CSS. There are two places that contain region information, one in the Logical Unit and another for each media that contains CSS Scrambled Title(s). When the region in the Logical Unit and that of the CSS Title are different, the system shall prevent the playback of that title (movie).

When a REPORT KEY Command is received by a Logical Unit, in the Bus Key Established state (see Figure 23 with a Format Code of 04h (Title Key) and the region code of the current media are not playable in the current region set in the Logical Unit, the command shall be terminated with CHECK CONDITION status, sense key set to ILLEGAL REQUEST and additional sense code set to MEDIA REGION CODE IS MISMATCHED TO LOGICAL UNIT REGION. A regionalized CSS media shall be deemed not playable if the region of the Logical Unit is not set.

The Logical Unit will report the current RPC State using the REPORT KEY Command with Format Code 08h.

4.3.7.4 Region Code Setting

Two methods have been defined for setting the region code in the DVD Logical Unit. Each method has the same end result, specifying which region shall be used to determine if it is allowable to play a disc that has a region code included within the information on the disc in this Logical Unit.

The Logical Unit has the following four Region States according to the Logical UnitRegion setting (see Figure 25).

a) NONE state – The Logical UnitRegion has not been set. The Initiator shall set the initial Logical UnitRegion value in the Logical Unit. The region setting counter shall be set to 5. The Logical Unit shall respond to the REPORT KEY Command, Key Format 01000b, with successful command completion and a Region Mask value of FFh.

b) SET state – The Logical UnitRegion has been set and the change of the Region is acceptable. The region setting counter shall initially be 4, decrementing to 2.

c) LAST CHANCE state – The Logical UnitRegion has been set and the change of the Region is acceptable. In order to change the Logical Unit Region using a command method, an inserted disc shall have the same single region with the requested Region. The region setting counter shall be 1.

d) PERMANENT state – The Logical UnitRegion has been set and the change of the Region is not acceptable. The region setting counter shall be 0. However, the Logical UnitRegion can be re-initialized by the vendor to become the NONE state.

4.3.7.5 Initial setting

In the NONE state, the Logical UnitRegion has not been set and the Initiator shall set the initial Logical UnitRegion value in the Logical Unit. The region setting counter shall be set to 5. The Logical Unit shall respond to the REPORT KEY Command, Key Format 01000b, with successful command completion and a Region Mask value of FFh.

The Initiator shall set a preferable region, the value of which is specified in the Preferred Logical UnitRegion Code field of the SEND KEY Command with Key Format = 000110b. On execution of this command, the Logical Unit ignores the region code of the inserted medium.

After the successful execution of setting the Logical UnitRegion, the Logical Unit shall enter the SET state. The region setting counter shall be decremented to 4.

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4.3.7.6 Changing of the logical UnitRegion

4.2.7.6.0 General

In the SET state, the Logical UnitRegion has been already set and may be changed by one of the two methods specified. After the successful execution of changing the Logical UnitRegion, the region setting counter shall be decremented. When the region setting counter is 2 and a successful execution of changing of the Logical UnitRegion, the Logical Unit shall enter into the LAST CHANCE state.

In the LAST CHANCE state, the Logical UnitRegion may be changed by one of the two methods specified, see 4.3.7.6.1, and 4.3.7.6.2. When using the command method with a disc, the inserted disc shall have the same single Region Code value as the Preferred Logical UnitRegion Code specified in the SEND KEY Command. After the successful execution of the Logical UnitRegion change, the region setting counter shall be zero and the Logical Unit shall enter into the PERMANENT state.

In the PERMANENT state, the user cannot change the Logical UnitRegion.

4.3.7.6.1 Command method for changing the Logical UnitRegion with a CSS enabled Disc

To set the Logical UnitRegion, the procedure shall be executed as follows:

a) insert a disc having the requested Region;

b) issue a SEND KEY Command with the Key Format = 000110b. The requested Region Code value shall be specified in the Preferred Logical UnitRegion Code field.

When the Logical Unit receives the SEND KEY Command correctly, the Logical UnitRegion is changed to the requested region. If the disc does not have the same region code value as the Preferred Logical UnitRegion Code specified in the SEND KEY Command, then the command shall be terminated with CHECK CONDITION Status, sense code ILLEGAL REQUEST and an additional sense code of MEDIA REGION CODE IS MISMATCHED TO LOGICAL UNIT REGION.

4.3.7.6.2 Setting Disc method for changing the Logical UnitRegion

The Logical UnitRegion, may be set by inserting a special disc that contains a specific region code. This special disc does not require any command intervention.

4.3.7.7 Limits on Logical UnitRegion Changes

Any of the methods defined in this specification may be used up to five times to change a Logical Unit's region. If the new region is the same as the old region, the region setting process shall be treated as if it had not occurred.

If an attempt by the user is made to change the Logical UnitRegion more than five times, the SEND KEY Command shall terminate with CHECK CONDITION Status, sense key set to ILLEGAL REQUEST and additional sense code set to LOGICAL UNITREGION MUST BE PERMANENT/REGION RESET COUNT ERROR.

For more information on the region code setting process, see Figure 25.

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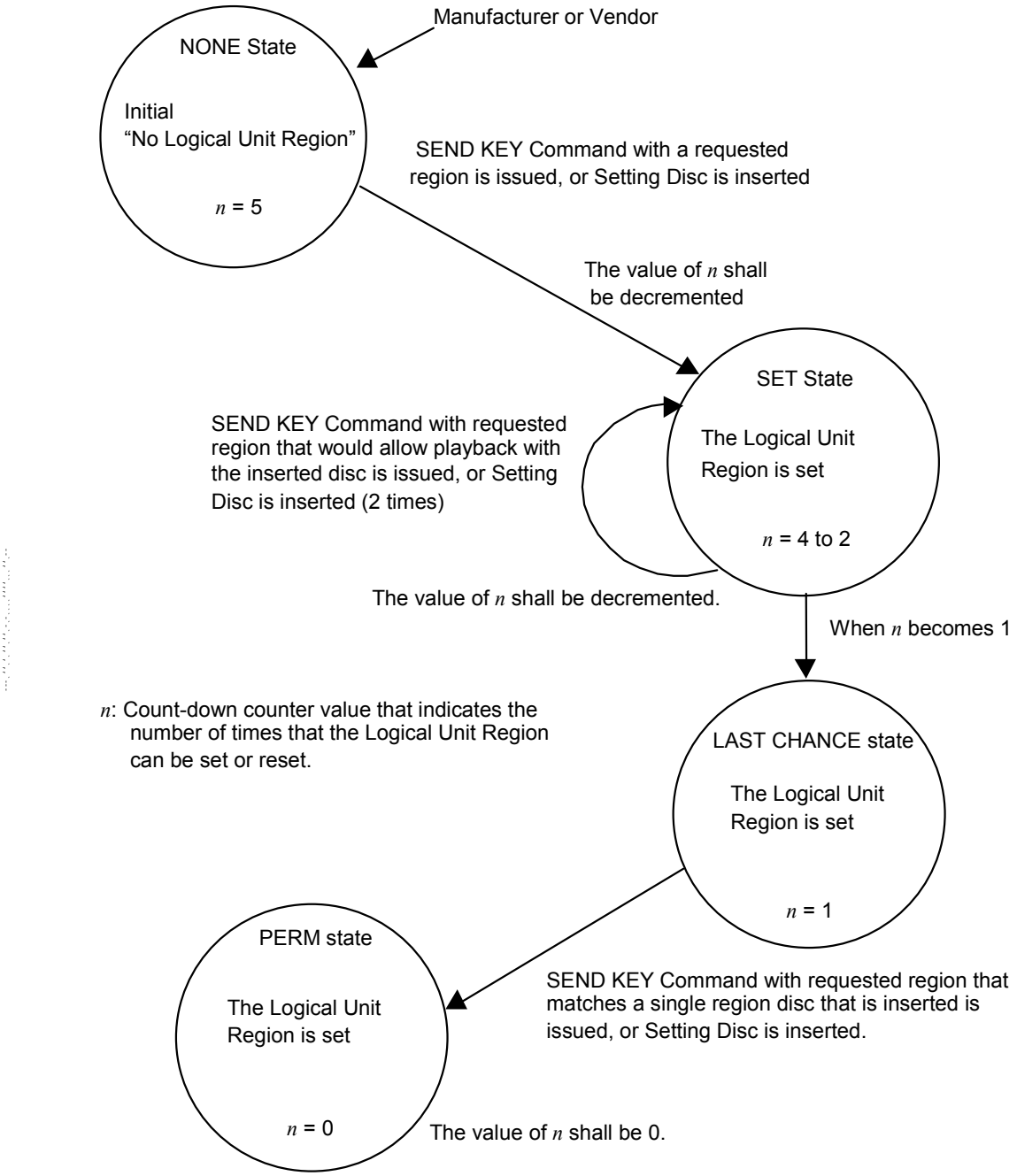

Figure 25 – Region state diagram

4.4 Changer model

4.4.0 General

The changer is a Feature of a C/DVD device. It shall support two (2) additional commands, MECHANISM STATUS (6.1.8) and LOAD/UNLOAD CD (6.1.7).

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A changer device provides a storage area for more than one CD disc. This storage area contains multiple areas called slots. Each slot can contain just one disc. Once a disc has been placed into a given slot, it becomes locked in that position. This standard provides no capability to move a disc from one slot to another. Thus, when a Disc has been moved from a given slot into the playing position, it can only be moved back into the slot it came from. This procedure shall be followed even if power is lost while a Disc is in the playing position or while it was being moved.

There are two basic types of changer mechanisms, one with individually addressable eject and load capability and another which uses a magazine to hold the discs. In the former, individual discs can be changed, while in the latter all the stored discs shall be changed at the same time.

Any time a disc or magazine is removed or installed from the changer, the device shall generate a Unit Attention Condition. After the Initiator detects the unit attention on a known changer device, the Initiator may issue a MECHANISM STATUS Command. This informs the Initiator which disc is present or was changed.

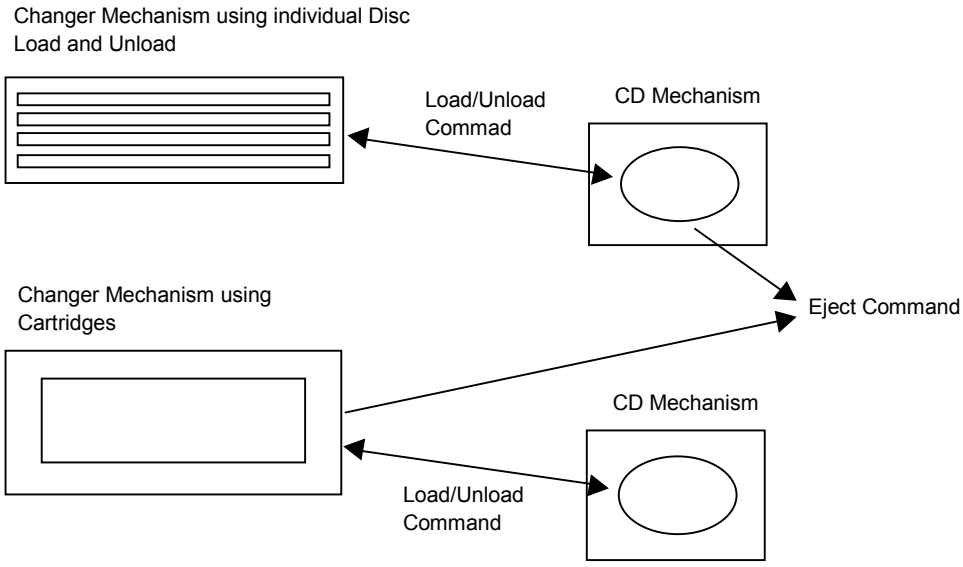

Figure 26 – Media changer mechanism model

4.4.1 Side definition

4.4.1.0 General

As part of the DVD specifications, there is a type of media supported that includes data on more than one side of the Disc. This will allow devices that can automatically change sides. For C/DVD Devices, there is an optional capability to select each side of the Disc. Although this would not normally be thought of as a changer type of operation, the two sides to the Disc are independent and changer like functions are a good match for selecting sides. When the Logical Unit supports this functionality, each physical slot will have two logical slots. For example, referencing slot 0 would be one side of the Disc and slot 1 would then be the other side.

There are two fundamental techniques used to select each side of DVD media. The first is the most space efficient. It simply moves the Pick up (laser unit used to read the disc) to the other side. This adds complexity to the laser mechanism but allows it to be positioned on either the bottom or top of the media. The second approach is to flip the media over.

For a Logical Unit that supports changing sides (see Table 137), the number of Slots reported shall be even, and every other slot shall be an alternating side.

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4.4.1.1 Side changing only Logical Unit

A Logical Unit that is capable of changing the side of the Disc, but does not have separate slots from the playing position, reports that it has a Mechanism type that is not a changer, but also reports Side Change Capable. This style of Logical Unit will still make use of the LOAD/UNLOAD command to change the currently selected side. The Logical Unit shall report two slots available.

When the Logical Unit can only change sides, and not discs, it does not perform any action. This will appear to the Initiator as a Logical Unit with a Delayed Load type of operation.

A DVD Logical Unit that supports changing sides will not be able to report if there is actually data on both sides until each side has been read.

4.4.1.2 Attention conditions for Sided Discs

Devices that support changing sides shall only report UNIT ATTENTION with sense code NOT READY TO READY, MEDIUM MAY HAVE CHANGED for changes that involve movement of a Disc in/out of the Logical Unit. Changes of side shall not generate UNIT ATTENTION Conditions.

4.4.1.3 Error conditions for Sided Discs

Devices that support changing sides of a Disc shall use the Sense Key NOT READY, Additional Sense code NO REFERENCE POSITION FOUND, to report when the currently selected side does not contain valid data.

4.4.1.4 Initialization

The Changer shall perform its initialization routine at power on or receipt of a hardware reset from the Initiator.

Initializing Changer is a process that refers to gathering the information that is necessary to respond to the MECHANISM STATUS Command. If a changer is in the process of initializing when it receives a MECHANISM STATUS Command, it will respond immediately and provide no slot table information (only the header).

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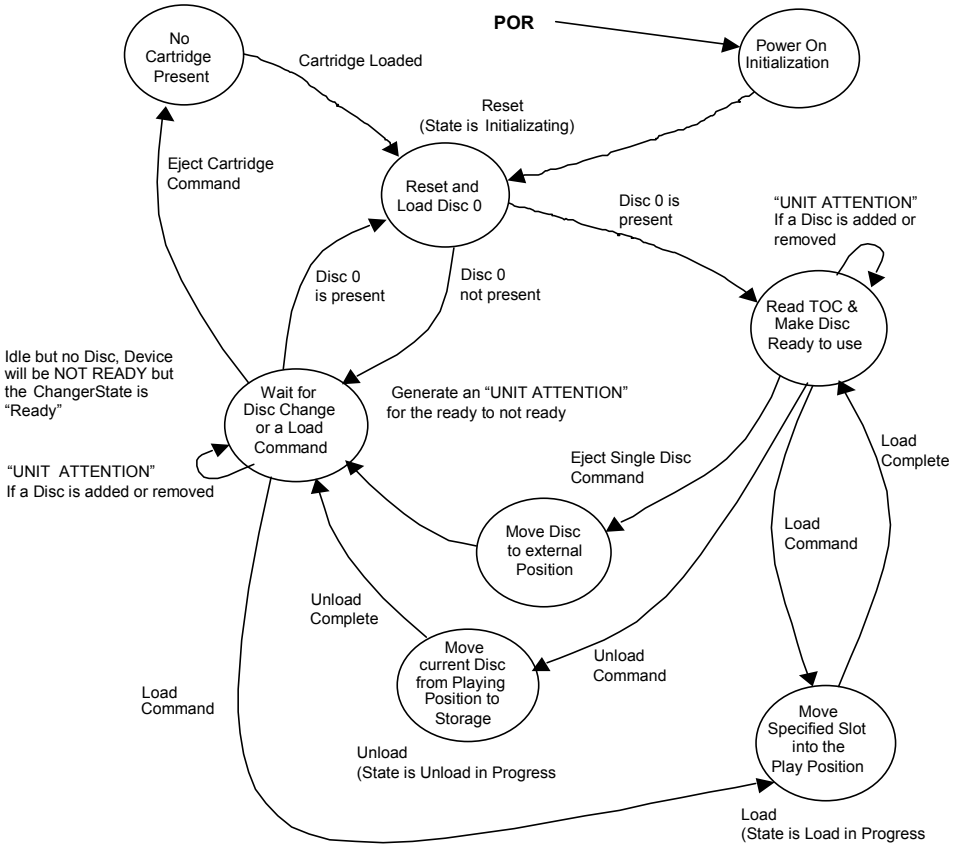

Figure 27 – Changer state diagram

4.4.2 Changer addressing

Several Changer specific commands use addresses called Slots.

If any commands related to Changer operations are implemented, then all the Changer commands shall be implemented. To determine if a Logical Unit is a changer type device, the Loading Mechanism Type field in the Capabilities page will contain one of the two changer type codes (see Table 137) for individual disc or magazine implementations.

4.4.3 Automatic load and unload operations

After initialization is complete the changer shall have Disc 0 loaded into the play position. This enables drivers that are not changer aware to work with a changer device as if it were a normal single CD device. This also ensures compatibility with a Bootable CD. In support of this goal the changer shall also load and unload (Eject) default Disc 0 if the changer supports loading and unloading (Ejecting) individual Discs unless otherwise commanded by the use of one of the changer specific Load/Unload commands.

When a LOAD Command is received and a Disc is present in the Playing position, it shall be unloaded automatically before the specified Load operation is performed.

4.4.4 Delayed disc load operation

CD Changer Devices may either move a disc into the playing position immediately upon receipt of a LOAD command, or delay the loading of the disc until a media access command is received. It is recommended that the device not load discs into the playing position until data from a disc that is not cached is requested from the Initiator.

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Initiator drivers should expect to encounter load mechanism delays on media accesses in addition to the spin up and seek delays normally introduced with these commands.

If the device supports delayed loading and the selected disc is not in the play position, then the commands listed in Table 30 shall move the selected disc into the play position when data that has not been cached has been requested by the Initiator.

Table 30 – Commands that may cause delayed loads to occur

Command
Play Audio (10)
Play Audio MSF
Play CD
Read (10)
Read (12)
Read CD
Read CD MSF
Read CD-ROM Capacity
Read Header
Read Sub-channel
Read TOC
Scan

If the device supports delayed loading and the selected disc is not in the play position, then the following commands shall load the selected disc into the play position before execution of the command. (See Table 31.)

Table 31 – Commands that will cause delayed loads to occur

Command
Seek
Start/Stop Unit (LoEj=1)

If the device supports delayed loading and the selected disc is not in the play position, then the following commands shall not move the selected disc into the play position. (See Table 32.)

Table 32 – Commands that should not cause delayed loads to occur

Command
Stop Play/Scan
Start/Stop Unit (LoEj=0)
Test Unit Ready
Inquiry
Mechanism Status
Mode Select
Mode Sense
Prevent/Allow Medium Removal
Request Sense
Set CD Speed

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4.4.5 Prevent/Allow processing

There are two techniques for Prevent/Allow. Either all the discs shall be prevented from being ejected by the user or each disc individually shall be prevented. If the device reports support for Software Slot Selection, then each slot shall be individually controlled by the Prevent/Allow command. Changer devices that use a Magazine and not individually controlled slots should not report the Software Slot Selection capability.

4.4.6 Error reporting for Changers

If any of the following conditions occur during the execution of a command, the Changer shall return CHECK CONDITION status. The appropriate sense key and additional sense code shall be set. Table 33 below lists some error conditions and the applicable sense keys. The list does not provide an exhaustive enumeration of all conditions that may cause the CHECK CONDITION status.

Table 33 – Error conditions and Sense Keys for Changer mechanisms

Condition	Sense Key
Invalid Slot Number	ILLEGAL REQUEST
Unsupported option requested	ILLEGAL REQUEST
Load or Unload to invalid slot or no Disc in source location	ILLEGAL REQUEST
CD-ROM Device Reset or medium change since last command	UNIT ATTENTION
Self diagnostic failed	HARDWARE ERROR

In the case of an invalid Slot number, the sense data information field shall be set to the Slot number of the first invalid address.

Attempts to eject a Disc if the changer type is magazine and there is a Disc in the playing position shall be rejected with a CHECK CONDITION status and sense key set to ILLEGAL REQUEST, and additional sense code set to MECHANICAL POSITIONING OR CHANGER ERROR.

5 Features and profiles

5.1 Introduction

A DVD Logical Unit will look different to Initiators depending on the type of media that is currently installed. The Initiator system will now need to deal with a Logical Unit, that supports various commands, based on the type of media that is currently in the Logical Unit. This type of operation will be handled via the use of Features, Profiles and Events. This concept, further described in Annex H, will allow the Logical Unit to implement various capabilities. The Initiator will detect and configure the Logical Unit given the various capabilities and functions that are available.

A Feature is a set of Commands, Mode Parameters and behaviours that specify the capabilities of a Logical Unit and its associated medium. One or more Features may be supported by a particular Logical Unit. In general, Features associated with device capabilities are static while Features associated with medium capabilities are dynamic. While Features are optional, the commands and mode parameters specified by a Feature are mandatory. If a particular Feature is reported, the Logical Unit or its transport shall implement all of the commands and mode parameters of that Feature.

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Classification by Features allows Logical Units to report and provide layers of functionality; it also allows applications to use Logical Units in a precise and consistent manner. For example, to illustrate the layered aspect, consider two CD-ROM Logical Units where one particular CD-ROM Logical Unit may be used as both a read only block device and as a CD-Audio player. These two capabilities are reported as two separate Features. Another CD-ROM Logical Unit may only be capable of being used as a read only block device, and it would not report the Feature that specifies CD-Audio support.

Another important characteristic of classification by Features is its dynamic nature. A device capable of reading both DVD-ROM and CD-ROM medium report's different Features according to whether a DVD-ROM or CD-ROM medium is loaded.

Profiles define a base set of functions for Logical Units. Logical Units that list a Profile as current shall support all Features required by that Profile, but not all Features may be current. Logical Units may support Features in addition to those required by the Profile. A single device may implement more than one Profile, and more than one Profile may be active at any given time. All required Features may not be current, depending on the medium installed. If a Not Ready response would be given to a TEST UNIT READY command, no Profile shall be current.

In addition, a Profile enables an application to load and initialize the appropriate modules that support the Logical Unit, to provide an iconic representation of the Logical Unit and to determine the default file system of the Logical Unit and its medium.

5.2 Features

5.2.0 General

To determine the Features supported by the Logical Unit, the Initiator shall issue a GET CONFIGURATION command (see 6.1.4). In response to this GET CONFIGURATION command the Logical Unit shall respond with data as defined in Table 34. Response data consists of a header field and zero or more variable length Feature descriptors.

Table 34 – GET CONFIGURATION response data format

Bit / Byte	7	6	5	4	3	2	1	0
0 to 7	Feature Header							
8 to *n*	Feature Descriptor(s)							

The Feature Header field to be returned is shown in Table 35.

Table 35 – Feature header

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	Data Length							
2								
3								(LSB)
4	Reserved							
5	Reserved							
6	(MSB)	Current Profile						
7								(LSB)

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The Data Length field indicates the amount of data available given a sufficient allocation length following this field. This length shall not be truncated due to an insufficient Allocation Length. If the Data Length is greater than 65 530 bytes, multiple GET CONFIGURATION commands with different Starting Feature Numbers will be required for the Initiator to read all configuration data. This field is adjusted as appropriate for the given Starting Feature Number.

The Current Profile field shall indicate the Logical Unit's current Profile. The Logical Unit shall choose the most appropriate current Profile from the list of Profiles (see Table 40) with their Current bit set. If there are no Profiles currently active, this field shall contain zero.

Each Feature supported by a Logical Unit shall be described by a Feature Descriptor. All Feature descriptors shall be a multiple of 4 bytes. The Feature Descriptor(s) generic format returned is defined in Table 36. Each individual Feature description is defined in the appropriate subclause.

Table 36 – Feature descriptor generic format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Feature Code							
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length							
4 to *n*	Feature Dependent Data							

The Feature Code field shall identify a Feature supported by the Logical Unit.

5.2.1 Version field

The Version field is reserved and shall be set to zero unless otherwise specified within the Feature Description. Future versions of a Feature will be backward compatible; incompatible changes will be included in a different Feature.

5.2.2 Persistent bit

The Persistent bit, when set to zero, shall indicate that this Feature may change its current status. When set to one, shall indicate that this Feature is always active. The Logical Unit shall not set this bit to one if the Current bit is, or may become, zero.

5.2.3 Current bit

The Current bit, when set to zero, indicates that this Feature is not currently active and that the Feature Dependent Data may not be valid. When set to one, this Feature is currently active and the Feature Dependent Data is valid.

5.2.4 Additional length field

The Additional Length field indicates the number of Feature specific bytes that follow this header. This field shall be an integral multiple of 4.

5.2.5 Feature codes

Features are the smallest set of commands, pages and behaviour that may be implemented. Each Feature is assigned a unique code or number to identify the Feature. Feature codes are shown in Table 37. The maximum number of Feature sets is 65 536 and the Feature code value of 0000h is reserved for the list of Profiles supported by the Logical Unit.

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Table 37 – Feature codes

Feature code	Feature name	Description
0000h	Profile List	A list of all Profiles supported by the Logical Unit
0001h	Core	Mandatory behaviour for all devices
0002h	Morphing	Ability to notify Initiator about operational changes and accept Initiator requests to prevent operational changes.
0003h	Removable Medium	The medium may be removed from the device
0004h to 000Fh	Reserved	
0010h	Random Readable	Readability for storage devices with random addressing
0011h to 001Ch	Reserved	
001Dh	MultiRead	The Logical Unit can read all CD media types; based on OSTA MultiRead
001Eh	CD Read	The ability to read CD specific structures
001Fh	DVD Read	The ability to read DVD specific structures
0020h	Random Writable	Write support for randomly addressed writes
0021h	Incremental Streaming Writable	Write support for sequential recording
0022h	Sector erasable	Write support for erasable media and media that require an erase pass before overwrite.
0023h	Formattable	Support for formatting of media.
0024h	Defect Management	Ability of the drive/media system to provide an apparently defect-free space.
0025h	Write Once	Write support for write once media that can be written in random order.
0026h	Restricted Overwrite	Write support for media that shall be written in multiples of logical blocks.
0027h to 002Ch	Reserved	
002Dh	CD Track at Once	Ability to write CD with Track at Once recording
002Eh	CD Mastering	The ability to write CD with Session at Once or Raw write methods.
002Fh	DVD-R Write	The ability to write DVD specific structures
0030h to 00FFh	Reserved	
0100h	Power Management	Initiator and device directed power management
0101h	Reserved	
0102h	Embedded Changer	Single mechanism multiple disc changer
0103h	CD Audio analog play	Ability to play audio CDs via the drive's own analog output
0104h	Microcode Upgrade	Ability for the device to accept new microcode via the interface
0105h	Time-out	Ability to respond to all commands within a specific time
0106h	DVD-CSS	Ability to perform data authentication
0107h	Real-time Streaming	Ability to read and write using Initiator requested performance parameters
108h	Logical Unit serial number	The Logical Unit has a unique identifier.
109h	Reserved	
10Ah	Disc Control Blocks	The ability to read and/or write Disc Control Blocks
010Bh – FEFFh	Reserved	
FF00h – FFFFh	Vendor-specific	

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5.3 Feature definitions

5.3.0 General

The following subclauses define the Feature sets and the commands supported by each Feature.

5.3.1 Profile list feature (0000h)

This Feature identifies Profiles supported by the Logical Unit. The Profile List descriptor returned is defined in Table 38. Profiles are defined as collections of Features and provide a method to quickly determine the Logical Unit's type. This Feature is always current, even if none of the Profiles listed are current.

Table 38 – Profile list descriptor format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0000h				
1								(LSB)
2	Reserved			Version			Persistent	Current
3	Additional Length							
4 to n	Profile Descriptor(s)							

The Feature Code field shall be set to 0000h.

The Version field is reserved and shall be set to zero. Future versions of a Feature will be backward compatible; incompatible changes will be included in a different Feature.

The Persistent bit shall be set to one to indicate that the reporting of the Profile list is always supported.

The Current bit shall be set to one.

The Additional Length field shall be set to ((number of Profile Descriptors) × 4).

The Profile Descriptors are shown in Table 39. All Profiles supported by the Logical Unit shall always be reported. Profile descriptors are returned in the order of preferred operation – most desirable to least desirable. For example a DVD-ROM that could also read CD-ROM would list the DVD-ROM Profile first and the CD-ROM Profile second.

Table 39 – Profile descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Profile Number				
1								(LSB)
2	Reserved							CurrentP
3	Reserved							

The Profile Number identifies a Profile the Logical Unit conforms to, see Table 40.

The CurrentP bit, when set to one, shall indicate that this Profile is currently active. If no medium is present, no Profile should be active. Multifunction devices shall select the most appropriate Profile(s), if any, to set as current. The most appropriate current Profile is also reported in the Feature Header (see Table 35).

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Table 40 – Profile list

Profile number	Profile name	Description	Subclause
0000h	Reserved		
0001h	Non-removable disk	Re-writable disk, capable of changing behaviour	
0002h	Removable disk	Re-writable; with removable media	5.4.1
0003h	MO Erasable	Magneto-Optical disk with sector erase capability	5.4.2
0004h	MO Write Once	Magneto-Optical write once	5.4.3
0005h	AS-MO	Advance Storage – Magneto-Optical	5.4.4
0006h to 0007h	Reserved		
0008h	CD-ROM	Read only Compact Disc capable	5.4.5
0009h	CD-R	Write once Compact Disc capable	5.4.6
000Ah	CD-RW	Re-writable Compact Disc capable	5.4.7
000Bh to 000Fh	Reserved		
0010h	DVD-ROM	Read only DVD	5.4.8
0011h	DVD-R	Write once DVD	5.4.9
0012h	DVD-RAM or DVD+RW	Re-writable DVD	5.4.10
0013h to FFFEh	Reserved		
FFFFh	Logical Units Not Conforming to a Standard Profile	The Logical Unit does not conform to any Profile.	5.4.11

5.3.2 Core feature (0001h)

This Feature identifies a Logical Unit that supports functionality common to all devices. All Logical Units that conform to this standard shall implement the Core Feature set of commands specified in Table 41.

In the Polling Mode of Event Notification, an Initiator shall repeatedly issue GET EVENT/STATUS NOTIFICATION commands with an immediate bit of 1. The Logical Unit shall complete these commands upon receipt, supplying the Initiator with information on the most recent event occurrences, as described in the GET EVENT/STATUS NOTIFICATION command. If an event occurrence of the class(es) requested is not in the Logical Unit event queue, the Logical Unit shall complete the GET EVENT/STATUS NOTIFICATION command, and shall set the NEA bit to 1. This shall not be deemed an error.

The Logical Unit shall maintain a separate queue for each class of Event Notification(s) supported. This queue is the Event Queue and events generated shall be placed at the tail of the queue of the appropriate class. The depth of the Event Queue(s) is vendor-specific, although it shall be at least one. If an overflow occurs, the Logical Unit shall maintain the most recent Events in the queue.

If command queuing is supported, the Initiator may issue a GET EVENT/STATUS NOTIFICATION command with an immediate bit of 0. The command shall not complete until an event of the class(es) requested is either in the Event Queue, or has occurred.

Each command shall report only one event. If multiple Event Classes are requested and multiple events are available, the Logical Unit shall report the Event in the Event Class with the lowest Notification Class ordinal.

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Table 41 – Core commands

Op code	Command description	Clause
12h	INQUIRY	ANSI INCITS 301
46h	GET CONFIGURATION	6.1.4
4Ah	GET EVENT/STATUS NOTIFICATION	6.1.5
55h	MODE SELECT (10)	ANSI INCITS 301
5Ah	MODE SENSE (10)	ANSI INCITS 301
03h	REQUEST SENSE (NOTE)	ANSI INCITS 301
00h	TEST UNIT READY	ANSI INCITS 301
NOTE Logical Units shall be able to report sense to the Initiator. For transports that implement automatic delivery of Logical Unit Sense Information to the Initiator, it shall use the transport's mechanism. For other transports, the REQUEST SENSE command shall be supported.		

The Feature descriptor response data to be returned to the Initiator is defined in Table 42.

Table 42 – Core feature descriptor format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 0001h							
1								(LSB)
2	Reserved			Version			Persistent	Current
3	Additional Length							
4	(MSB)							
5	Physical Interface Standard							
6								
7								(LSB)

The Feature Code field shall be set to 0001h.

The Version Field is defined in 5.2.1.

The Persistent bit shall be set to one.

The Current bit shall be set to one.

The Additional Length field shall be set to 4.

The Physical Interface Standard field shall be set to the current Initiator to Logical Unit communication path as defined in Table 43.

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Table 43 – Physical interface standard

Physical interface standard	Description	Application
00000000h	Unspecified	
00000001h	SCSI Family	See SCSI implementation
00000002h	ATAPI	See ATAPI implementation
00000003h	IEEE 1394 to 1995	See IEEE 1394 implementation
00000004h	IEEE 1394A	See IEEE 1394 implementation
00000005h	Fibre Channel	See Fibre Channel (FCP) implementation
00000006h to 0000FFFEh	Reserved	
0000FFFFh	Vendor Unique	
00010000h to 0001FFFFh	Defined by NCITS	
00020000h to 0002FFFFh	Defined by SFF	
00030000h to 0003FFFFh	Defined by IEEE	
00040000h to FFFFFFFFh	Reserved	

5.3.3 Morphing feature (0002h)

This Feature identifies the ability of the Logical Unit to notify an Initiator about operational changes and accept Initiator requests to prevent operational changes. Logical Units that support this Feature shall implement the commands specified in Table 44.

Table 44 – Morphing feature commands

Op code	Command description	Clause
46h	GET CONFIGURATION	6.1.4
4Ah	GET EVENT/STATUS NOTIFICATION	6.1.5
1Eh	PREVENT/ALLOW MEDIUM REMOVAL with Persistent bit set to one.	ANSI INCITS 301
A2h	SEND EVENT when Class 3 Event (External Request) is implemented.	6.1.33

Support, for this Feature, is enabled using the PREVENT/ALLOW command (Persistent bit), and the media status is retrieved using the GET EVENT/STATUS NOTIFICATION command.

The Feature descriptor response data to be returned to the Initiator is defined in Table 45.

Table 45 – Morphing descriptor format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 00002h				
1								(LSB)
2	Reserved			Version			Persistent	Current
3	Additional Length = 04h							
4	Reserved							Async
5	Reserved							
6	Reserved							
7	Reserved							

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The Feature Code field shall be set to 0002h.

The Version Field is defined in 5.2.1.

The Persistent bit shall be set to one.

The Current bit shall be set to one.

The Additional Length field shall be set to 4.

The Async bit, when set to zero, indicates that the Logical Unit supports only the polling implementation of GET EVENT/STATUS NOTIFICATION. When set to one, indicates that the Logical Unit supports both polling and asynchronous GET EVENT/STATUS NOTIFICATION.

5.3.4 Removable medium feature (0003h)

Implementing this Feature, Logical Units shall have a means of communicating to the Initiator that the user wants to eject the medium or has inserted a new medium. Logical Units that support the Removable Medium Feature shall implement the commands specified in Table 46.

Table 46 – Removable medium commands

Op code	Command description	Clause
BDh	MECHANISM STATUS	6.1.8
1Eh	PREVENT/ALLOW MEDIUM REMOVAL with the Persistent Prevent bit set to zero	ANSI INCITS 301
1Bh	START/STOP UNIT and load eject (LOEJ) bit	ANSI INCITS 301

If a changer type Logical Unit uses media status operation, it shall use the following variations. If the changer Logical Unit supports individual slot load and unload capability, the slot number(s) exhibiting the media status change shall be reported in the slot fields of the Media Status Event Data. If the changer Logical Unit uses a magazine load mechanism, the slot fields shall be set to the start and end slot numbers present in the magazine.

For non-immediate GET EVENT/STATUS NOTIFICATION commands, the Initiator shall use exactly one GET EVENT/STATUS NOTIFICATION request for the entire changer Logical Unit. The Logical Unit shall respond as indicated in the Asynchronous Operation section above, indicating the slot information in the Request Sense Data as described above.

This Feature identifies a Logical Unit that has a medium that is removable. The Feature descriptor response data to be returned is defined in Table 47.

Table 47 – Removable medium descriptor format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0003h				
1								(LSB)
2	Reserved			Version			Persistent	Current
3	Additional Length = 04h							
4	Loading Mechanism Type		Reserved		Eject	Pvnt Jmpr	Reserved	Lock
5	Reserved							
6	Reserved							
7	Reserved							

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The Feature Code field shall be set to 0003h.

The Version Field is defined in 5.2.1.

The Persistent bit shall be set to one.

The Current bit shall be set to one.

Event Class 4 shall be supported.

The Additional Length field shall be set to 4.

The Loading Mechanism Type field (Table 48) shall be set according to the Eject bit. The Eject bit, when set to zero, indicates that the device cannot eject the medium or magazine via the normal START/STOP command with the LoEj bitset. When set to one, indicates that the device can eject the medium or magazine.

The Pvnt Jmpr bit, when set to zero, shall indicate that the Prevent Jumper is present. The Logical Unit shall power up to the allow state and locking the Logical Unit with the Prevent/Allow command shall not prevent insertion of the media. When set to one, the Prevent Jumper is not present. The Logical Unit shall power up to the prevent state (locked) and shall not accept new media or allow the ejection of media already loaded until a PREVENT/ALLOW MEDIUM REMOVAL (allow) command is issued. The Pvnt Jmpr bit shall not change state, even if the physical jumper is added or removed during operation. Logical Units that do not have a Prevent Jumper available should set this bit to 0 to indicate that the Logical Unit behaves as described for a jumper being present.

The Lock bit, when set to zero, shall indicate that the medium cannot be locked into the Logical Unit. When set to one, shall indicate that the PREVENT/ALLOW MEDIUM REMOVAL command is capable of actually locking the media into the Logical Unit.

Table 48 – Loading mechanism type

Loading mechanism type	Description
000b	Caddy/Slot type loading mechanism
001b	Tray type loading mechanism
010b	Pop-up type loading mechanism
011b	Reserved
100b	Embedded changer with individually changeable discs
101b	Embedded changer using a magazine mechanism
110b to 111b	Reserved

5.3.5 Random readable feature (0010h)

This Feature identifies a Logical Unit that can read data from logical blocks specified in a READ command. Logical Units that may be used as Random Readable block devices shall implement the commands specified in Table 49.

Table 49 – Random readable feature

Op code	Command description	Clause
25h	READ CAPACITY	6.1.17
28h	READ(10)	ANSI INCITS 301

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The Feature descriptor response data to be returned to the Initiator is defined in Table 50.

Table 50 – Random Readable Descriptor format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 0010h							
1								(LSB)
2	Reserved			Version			Persistent	Current
3	Additional Length = 08h							
4	(MSB) Logical Block Size							
5								
6								
7								(LSB)
8	(MSB) Blocking							
9								(LSB)
10	Reserved							PP
11	Reserved							

There is no requirement that the addresses, in sequences of reads, occur in any particular order.

The Feature Code field shall be set to 0010h.

The Version Field is defined in 5.2.1.

The Persistent bit shall be defined as in 5.2.2. This bit shall be set to zero if the medium is removable.

The Current bit shall be defined as in 5.2.3. This bit shall be set to zero if random readable media are not present.

The Additional Length field shall be set to 8.

The Logical Block Size shall be set to the number of bytes per logical block.

The Blocking field shall indicate the number of logical blocks per device readable unit. For most hard disks, this value is 1. For DVD devices, this number is 10h.

If there is more than one Blocking on the medium possible, the Blocking field shall be set to zero. See the READ TRACK INFORMATION Command for more information.

The PP (Page Present) bit, when set to zero, shall indicate that the Read/Write Error Recovery page may not be present. When set to one, shall indicate that the Read/Write Error Recovery page is present.

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5.3.6 Multi-Read feature (001Dh)

This Feature identifies a Logical Unit that can read all CD media types. The Logical Unit shall conform to the OSTA Multi-Read specification 1.00, with the exception of CD Play capability (the CD Audio Feature is not required). Reading of CD Audio data via the READ CD command shall be supported. Logical Units that support the Multi-Read Feature shall implement the commands specified in Table 51.

Table 51 – Multi-Read feature commands

Op code	Command description	Clause
28h	READ (10)	ANSI INCITS 301
BEh	READ CD	6.1.15
51h	READ DISC INFORMATION	6.1.18
52h	READ TRACK INFORMATION	6.1.26

The Feature descriptor response data to be returned to the Initiator is defined in Table 52.

Table 52 – Multi-Read descriptor format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 001Dh							
1								(LSB)
2	Reserved			Version			Persistent	Current
3	Additional Length = 00h							

The Feature Code field shall be set to 001Dh.

The Version Field is defined in 5.2.1.

The Persistent bit shall be defined as in 5.2.2.

The Current bit shall be defined as in 5.2.3.

The Additional Length field shall be set to 00h.

5.3.7 CD read feature (001Eh)

This Feature identifies a Logical Unit that can read CD specific information from the media and can read user data from all types of CD blocks. Logical Units that read CD-ROM media shall support the commands specified in Table 53.

Table 53 – CD READ commands

Op code	Command description	Clause
BEh	READ CD	6.1.15
B9h	READ CD MSF	6.1.16
43h	READ TOC/PMA/ATIP Supports Format codes 0h, 1h, 2h and 5h if the CD-TEXT bit is set to one	6.1.24

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The Feature descriptor response data to be returned to the Initiator is defined in Table 54.

Table 54 – CD Read descriptor format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 001Eh							
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 04h							
–4							C2 Flag	CD-Text
5	Reserved							
6	Reserved							
7	Reserved							

The Feature Code field shall be set to 001Eh.

The Version Field is set to one.

The Persistent bit shall be defined as in 5.2.2. This bit shall be set to zero if the medium is removable.

The Current bit shall be defined as in 5.2.3. This bit shall be set to zero if CD media are not present.

The Additional Length field shall be set to 04h.

The C2 Flag, when set to one, indicates the Logical Unit supports the C2 Error Pointers. When set to zero the Logical Unit does not support C2 Error Pointers.

The CD-Text bit, when set to one, indicates the Logical Unit supports Format Code 5h of the READ TOC/PMA/ATIP command. When set to zero, CD-Text is not supported.

5.3.8 DVD read feature (001Fh)

This Feature identifies a Logical Unit that can read DVD specific information from the media. Logical Units that read DVD-ROM media shall support the commands specified in Table 55.

Table 55 – DVD READ feature commands

Op code	Command description	Clause
51h	READ(10)	ANSI INCITS 301
A8h	READ(12)	ANSI INCITS 301
ADh	READ DVD STRUCTURE	6.1.19
43h	READ TOC/PMA/ATIP	6.1.24

The Feature descriptor response data to be returned to the Initiator is defined in Table 56.

Table 56 – DVD read descriptor format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 001Fh							
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 00h							

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The Feature Code field shall be set to 001Fh.

The Version Field is defined in 5.2.1.

The Persistent bit shall be defined as in 5.2.2. This bit shall be set to zero if the medium is removable.

The Current bit shall be defined as in 5.2.3. This bit shall be set to zero if DVD media are not present.

The Additional Length field shall be set to 0.

5.3.9 Random writable feature (0020h)

This Feature identifies a Logical Unit that can write data to logical blocks specified by a Write command. There is no requirement that the addresses in sequences of writes occur in any particular order. Logical Units that may be used as a random writable block device shall implement the commands as specified in Table 57.

Table 57 – Random writable block device commands

Op code	Command description	Clause
25h	READ CAPACITY	6.1.17
2Ah	WRITE(10)	6.1.41
2Eh	WRITE AND VERIFY (10)	6.1.42
35h	SYNCHRONIZE CACHE The Immediate bit shall be supported.	6.1.40

The Feature descriptor response data to be returned to the Initiator is defined in Table 58

Table 58 – Random writable descriptor format

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0020h				
1								(LSB)
2	Reserved			Version			Persistent	Current
3	Additional Length = 0Ch							
4	(MSB)							
5				Last Logical Block Address				
6								
7								(LSB)
8	(MSB)							
9				Logical Block Size				
10								
11								(LSB)
12	(MSB)			Blocking				
13								(LSB)
14	Reserved							PP
15	Reserved							

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The Feature Code field shall be set to 0020h.

The Version field shall be set to 1h.

The Persistent bit shall be defined as in 5.2.2. This bit shall be set to zero if the medium is removable.

The Current bit shall be defined as in 5.2.3. This bit shall be set to zero if randomly writable media are not present.

The Additional Length field shall be set to 0Ch.

The Last Logical Block Address is the logical block address of the last addressable block on the medium.

The Logical Block Size field specifies the number of bytes per logical block. This value shall be the same as reported by the Random Readable Feature and the READ CAPACITY Command.

The Blocking field shall indicate the number of logical blocks per readable Logical Unit. For most hard disks, this value is 1. For DVD devices, this number is 10h.

If there is more than one Blocking on the medium possible, the Blocking field shall be set to zero. See the READ TRACK INFORMATION Command for more information.

The PP (Page Present) bit, when set to zero, shall indicate that the Read/Write Error Recovery page may not be present. When set to one, shall indicate that the Read/Write Error Recovery page is present.

5.3.10 Incremental streaming writable (0021h)

This Feature identifies a Logical Unit that can write data to a contiguous region and can append data to a limited number of locations on the media. On CD media, this is known as packet recording and on DVD media it is known as Incremental Recording. Logical Units that support this Feature shall implement the commands shown in Table 59.

Table 59 – Incremental streaming commands

Op code	Command description	Clause
A1h	BLANK (Note 1)	6.1.1
5Bh	CLOSE TRACK/SESSION	6.1.2
51h	READ DISC INFORMATION	6.1.18
52h	READ TRACK INFORMATION	6.1.26
53h	RESERVE TRACK	6.1.29
54h	SEND OPC INFORMATION (Note 2)	6.1.35
2Ah	WRITE(10)	6.1.41
35h	SYNCHRONIZE CACHE	6.1.40

NOTE 1 Shall be supported if the Erasable bit in READ DISC INFORMATION, returned data, is set to one. If supported, Blanking Types 000b, 001b and 100b shall be supported.

NOTE 2 Shall be supported if the OPC information is ever returned in the READ DISC INFORMATION return data.

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Table 60 – Incremental streaming parameters

Page code	Mode page	Clause
05h	Write Parameters	5.5.4

The Feature descriptor response data to be returned to the Initiator is defined in Table 61.

Table 61 – Incremental streaming writable descriptor format

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 0021h							
1								(LSB)
2	Reserved			Version			Persistent	Current
3	Additional Length							
4	(MSB) Data Type Supported							
5								(LSB)
6	Reserved							
7	Number of Link Sizes							
8 to *n*	Link Size							
n to ?	Pad							

The Feature Code field shall be set to 0021h.

The Version field is set to 1h.

The Persistent bit shall be defined as in 5.2.2. This bit shall be set to zero if the medium is removable.

The Current bit shall be defined as in 5.2.3. This bit shall be set to zero if sequential write media are not present.

The Additional Length field shall be set to 4 + (Number of Link Sizes) + (Number of Pad bytes).

The Data Type Supported field is a bit field that identifies the supported Data Type. A bit set to zero indicates the Data Type is not supported. A bit set to one indicates the Data Type is supported. Bit 0 equates to Data Type 0 and bit 15 equates to Data Type 15, etc.

The Number of Link Sizes shall specify the number of link sizes available for the current media. For CD media, this field should be 1. For DVD-R, this field should be 2.

Each Link Size field shall indicate the number of logical blocks per link. Links occur on sequentially written media between independent write operations. The link size does not include any logical blocks written by the Logical Unit to satisfy the writable unit specified by the Blocking field in the Random Readable Feature. This field is 7 for CD-R media, and may be 0, 1 or 16 for DVD media. Link Size fields are reported by the Logical Unit in the Logical Unit's preferred order, most desirable first.

The Pad field shall contain zeros. The number of Pad bytes shall be 4 × IP((Number of Link Sizes + 3)/4) – (Number of Link Sizes), where IP() is the integer part of the number. The Pad field is present to make the length of the Feature Descriptor a multiple of 4 bytes.

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5.3.11 Sector erasable feature (0022h)

This Feature identifies a Logical Unit that supports erasable media and media that require an erase pass before overwrite, such as some magneto-optical technologies. Logical Units that support this Feature shall implement the commands listed in Table 62.

NOTE This Feature does not apply to DVD-RAM, that is a direct overwrite technology.

Table 62 – Sector erasable feature commands

Op code	Command description	Clause
2Ch	ERASE(10)	ANSI INCITS 301
2Fh	VERIFY(10) (Note 1)	ANSI INCITS 301
2Ah	WRITE(10) (Note 2)	6.1.41
NOTE 1 The BLKVFY bit shall be supported. NOTE 2 The EBP bit shall be supported.		

The Feature descriptor response data to be returned to the Initiator is defined in Table 63.

Table 63 – Sector erasable

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 0022h							
1								(LSB)
2	Reserved			Version			Persistent	Current
3	Additional Length							

The Feature Code field shall be set to 0022h.

The Version Field is defined in 5.2.1.

The Persistent bit shall be defined as in 5.2.2.

The Current bit shall be defined as in 5.2.3.

The Additional Length field shall be set to 00h.

5.3.12 Formattable feature (0023h)

This Feature identifies a Logical Unit that can format media into logical blocks. Logical Units that use media that may be formatted shall implement the commands specified in Table 64.

Table 64 – Formattable feature commands

Op code	Command description	Clause
04h	FORMAT UNIT with a Format Code of 001b, Format Type 0h	6.1.3
23h	READ FORMAT CAPACITIES	6.1.20
03h	REQUEST SENSE	ANSI INCITS 301
2Fh	VERIFY(10)	ANSI INCITS 301

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The Feature descriptor response data to be returned to the Initiator is defined in Table 65.

Table 65 – Formattable descriptor format

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0023h				
1								(LSB)
2	Reserved			Version			Persistent	Current
3	Additional Length = 00h							

The Feature Code field shall be set to 0023h.

The Version Field is defined in 5.2.1.

The Persistent bit shall be defined as in 5.2.2. This bit shall be set to zero if the medium is removable.

The Current bit shall be defined as in 5.2.3. This bit shall be set to zero if non-formattable media are present.

The Additional Length field shall be set to 0.

5.3.13 Defect management feature (0024h)

This Feature identifies a Logical Unit that shall have defect management available to provide a defect-free contiguous address space. Logical Units that support this Feature shall implement the parameter listed in Table 66.

Table 66 – Defect management feature parameters

Page code	Parameter	Clause
01h	C/DVD Read/Write Error Recovery Page	5.5.3

NOTE The AWRE and ARRE shall be supported if medium is Writable.

The Feature descriptor response data to be returned to the Initiator is defined in Table 67.

Table 67 – Defect management descriptor format

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0024h				
1								(LSB)
2	Reserved			Version			Persistent	Current
3	Additional Length = 00h							

The Feature Code field shall be set to 0024h.

The Version Field is defined in 5.2.1.

The Persistent bit shall be defined as in 5.2.2. This bit shall be set to zero if the medium is removable.

The Current bit shall be defined as in 5.2.3. This bit shall be set to zero if non-managed media are not present. If the media are Defect Managed, it may have no defects.

The Additional Length field shall be set to 0.

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5.3.14 Write once feature (0025h)

This Feature identifies a Logical Unit that shall have the ability to record to any previously unrecorded logical block. The recording of logical blocks may occur in any order. Previously recorded blocks shall not be overwritten. Logical Units that support this Feature shall implement the commands listed in Table 68.

Table 68 – Write once feature commands

Op code	Command description	Clause
25h	READ CAPACITY	6.1.17
35h	SYNCHRONIZE CACHE	6.1.40
2Ah	WRITE(10)	6.1.41
2Eh	WRITE AND VERIFY (10)	6.1.42

Table 69 – Write once feature parameters

Page code	Parameter	Clause
01h	C/DVD Read/Write Error Recovery Page	5.5.3

The Feature descriptor response data to be returned to the Initiator is defined in Table 70.

Table 70 – Write once descriptor format

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 00025h				
1								(LSB)
2	Reserved			Version			Persistent	Current
3	Additional Length = 08h							
4	(MSB)							
5				Last Logical Block				
6								
7								(LSB)
8	(MSB)			Blocking				
9								(LSB)
10	Reserved							PP
11	Reserved							

The Feature Code field shall be set to 25h.

The Version Field is defined in 5.2.1.

The Persistent bit shall be defined as in 5.2.2. This bit shall be set to zero if the medium is removable.

The Current bit shall be defined as in 5.2.3. This bit shall be set to zero if write once media are not present.

The Additional Length field shall be set to 08h.

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The Last Logical Block is the logical block address of the last addressable block on the medium.

The Blocking field shall indicate the number of logical blocks per readable Logical Unit. For most hard disks, this value is 1. For DVD devices, this number is 10h.

If there is more than one Blocking on the medium possible, the Blocking field shall be set to zero. See the READ TRACK INFORMATION Command for more information.

The PP (Page Present) bit, when set to zero, shall indicate that the Read/Write Error Recovery page may not be present. When set to one, it shall indicate that the Read/Write Error Recovery page is present.

5.3.15 Restricted overwrite feature (0026h)

This Feature identifies a Logical Unit that shall have the ability to overwrite logical blocks only in fixed sets at a time. Logical Units that write and read CD-RW media shall support the commands specified in Table 71.

Table 71 – Restricted overwrite commands

Op code	Command description	Clause
A1h	BLANK	6.1.1
25h	READ CAPACITY	6.1.17
51h	READ DISC INFORMATION	6.1.18
52h	READ TRACK INFORMATION	6.1.26
35h	SYNCHRONIZE CACHE	6.1.40
2Ah	WRITE(10)	6.1.41

Table 72 – Restricted Overwrite parameter

Page code	Parameter	Clause
05h	Write Parameter Page	5.5.4

The Feature descriptor response data to be returned to the Initiator is defined in Table 73.

Table 73 – Restricted overwrite descriptor format

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0026h				
1								(LSB)
2	Reserved			Version			Persistent	Current
3	Additional Length = 00h							

The Feature Code field shall be set to 0025h.

The Version Field is defined in 5.2.1.

The Persistent bit shall be defined as in 5.2.2. This bit shall be set to zero if the medium is removable.

The Current bit shall be defined as in 5.2.3. This bit shall be set to zero if write once media arenot present.

The Additional Length field shall be set to 0.

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5.3.16 CD Track at once feature (002Dh)

This Feature identifies a Logical Unit that can write data to a CD track. Logical Units that support this Feature shall implement the commands and Features identified in Table 74.

Table 74 – CD track at once feature commands

Op code	Command description	Subclause
A1h	BLANK (Note 1)	6.1.1
5Bh	CLOSE TRACK/SESSION	6.1.2
51h	READ DISC INFORMATION	6.1.18
52h	READ TRACK INFORMATION	6.1.26
53h	RESERVE TRACK	6.1.29
54h	SEND OPC INFORMATION (Note 2)	6.1.35
35h	SYNCHRONIZE CACHE	6.1.40
2Ah	WRITE (10)	6.1.41

NOTE 1 Shall be implemented if the Erasable bit, in the READ DISC INFORMATION returned data, is set to one. If supported, Blanking Type 000b, 001b and 100b shall be supported.

NOTE 2 Shall be implemented if OPC Information is returned in the READ DISC INFORMATION returned data.

Table 75 – CD track at once feature parameters

Pagecode	Parameter	Subclause
05h	Write Parameters	5.5.4

The Feature descriptor response data to be returned to the Initiator is defined in Table 76.

Table 76 – CD Track at once descriptor format

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 002Dh				
1								(LSB)
2	Reserved			Version			Persistent	Current
3	Additional Length = 04h							
4	Reserved					Test Write	CD-RW	R-W Sub-code
5	Reserved							
6	(MSB)			Data Type Supported				
7								(LSB)

The Feature Code field shall be set to 002Dh.

The Version Field is defined in 5.2.1.

The Persistent bit shall be defined as in 5.2.2. This bit shall be set to zero if the medium is removable.

The Current bit shall be defined as in 5.2.3. This bit shall be set to zero if CD-R or CD-RW media are not present.

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The Additional Length field shall be set to 04h.

The following bits indicate Feature support. If set to zero, the Feature is not supported. If set to one, the Feature is supported.

The Test Write bit indicates that the Logical Unit can perform test writes. See 5.5.4.

The CD-RW bit indicates support for overwriting a Track at Once track with another.

The R-W Sub-code bit indicates that the Logical Unit can record the R-W Sub-channels with user supplied data.

The Data Type Supported field is defined in 5.3.10.

5.3.17 CD mastering (session at once) feature (002Eh)

This Feature identifies a Logical Unit that can write a CD in Session at Once or Raw mode. Logical Units that support Session at Once mastering shall implement the commands listed in Table 77, and parameters listed in Table 78. Logical Units that support mastering in RAW mode shall implement the commands listed in Table 79 and parameters listed in Table 80.

Table 77 – CD mastering (session at once) feature commands

Op code	Command description	Subclause
51h	READ DISC INFORMATION	6.1.18
52h	READ TRACK INFORMATION	6.1.26
5Dh	SEND CUE SHEET	6.1.31
2Ah	WRITE (10)	6.1.41

Table 78 – CD mastering (session at once) parameter

Page code	Parameter	Subclause
05h	Write Parameters – Session at once write type shall be supported.	5.5.4

Table 79 – CD mastering (RAW) feature commands

Op code	Command	Subclause
51h	READ DISC INFORMATION	6.1.18
52h	READ TRACK INFORMATION	6.1.26
35h	SYNCHRONIZE CACHE	6.1.40
2Ah	WRITE (10)	6.1.41

Table 80 – CD mastering (RAW) parameters

Page code	Parameter	Subclause
05h	Write Parameters Page – RAW Write Type shall be supported	5.5.4

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The Feature descriptor response data to be returned to the Initiator is defined in Table 81.

Table 81 – CD mastering feature descriptor

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 002Eh				
1								(LSB)
2	Reserved			Version			Persistent	Current
3	Additional Length = 04h							
4	Reserved		SAO	RAW MS	RAW	TEST WRITE	CD_RW	R-W
5	(MSB)							
6	Maximum Cue Sheet Length							
7								(LSB)

The Feature Code field shall be set to 002Eh.

The Version Field is defined in 5.2.1.

The Persistent bit shall be defined as in 5.2.2.This bit shall be set to zero if the medium is removable.

The Current bit shall be defined as in 5.2.3.This bit shall be set to zero if CD-R or CD-RW media are not present.

The Additional Length field shall be set to 04h.

The following bits indicate Feature support. If set to zero, the Feature is not supported. If set to one, the Feature is supported.

The SAO bit shall indicate that the Logical Unit can record using the Session at Once write type.

The Raw MS bit shall indicate that the Logical Unit can record multi-session in raw mode.

The Raw bit shall indicate that the Logical Unit can record using the raw write type.

The Test Write bit shall indicate that the Logical Unit can perform test writes.

The CD-RW bit shall indicate that the Logical Unit can overwrite previously recorded data.

The R-W bit shall indicate that the Logical Unit can record the R-W Sub-channels with user supplied information.

The Maximum Cue Sheet Length field indicates the maximum length of a Cue Sheet that can be accepted by the Logical Unit for Session at Once recording. If the SAO bit is zero, this field shall be set to zero.

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5.3.18 DVD-R write feature (002Fh)

This Feature identifies a Logical Unit that can write data to DVD-R in Disc at Once mode. Logical Units that write and read DVD-R media shall support the commands specified in Table 82 and the parameters identified in Table 83.

Table 82 – DVD-R write commands

Op code	Command description	Clause
51h	READ DISC INFORMATION	6.1.18
52h	READ TRACK INFORMATION	6.1.26
53h	RESERVE TRACK	6.1.29
ADh	SEND DVD STRUCTURE	6.1.32
2Ah	WRITE (10)	6.1.41

Table 83 – DVD-R write feature parameters

Page code	Parameter	Subclause
05h	Write Parameter – Session at Once shall be supported	5.5.4

The DVD-R write feature descriptor response data to be returned to the Initiator is defined in Table 84.

Table 84 – DVD-R write feature descriptor format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)				Feature Code = 002Fh			
1								(LSB)
2	Reserved			Version			Persistent	Current
3	Additional Length = 04h							
4	Reserved	BUF		Reserved		Test Write	Reserved	
5	Reserved							
6	Reserved							
7	Reserved							

The Feature Code field shall be set to 002Fh.

The Version Field is defined in 5.2.1.

The Persistent bit shall be defined as in 5.2.2. This bit shall be set to zero if the medium is removable.

The Current bit shall be defined as in 5.2.3. This bit shall be set to zero if DVD-R media are not present.

The Additional Length field shall be set to 04h.

The BUF bit, when set to one, indicates the Logical Unit can perform Buffer Under-run Free recording.

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The Test Write bit, when set to zero, shall indicate that the Logical Unit is not capable of performing test writes. When set to one, the Logical Unit shall not be capable of performing test writes.

5.3.19 Power management feature (0100h)

This Feature identifies a Logical Unit that can perform Initiator and Logical Unit directed power management. Logical Units that support this Feature shall implement the commands specified in Table 85 and the mode parameters specified in Table 86.

Table 85 – Power management commands

Op code	Command description	Clause
4Ah	GET EVENT/STATUS NOTIFICATION (Note 1)	6.1.5
1Bh	START/STOP UNIT (NOTE 2)	ANSI INCITS 301
NOTE 1 Power Class events shall be supported. NOTE 2 Power Condition field shall be supported.		

Table 86 – Power management mode parameters

Page code	Page description	Clause
1Ah	Power Condition	5.5.7

The Feature descriptor response data to be returned to the Initiator is defined in Table 87.

Table 87 – Power management descriptor format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 0100h							
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 00h							

The Feature Code field shall be set to 0100h.

The Version Field is defined in 5.2.1.

The Persistent bit shall be set to one.

The Current bit shall be set to one.

The Additional Length field shall be set to 0.

5.3.20 Embedded changer feature (0102h)

This Feature identifies a Logical Unit that can move media from a storage area to a mechanism and back. Logical Units that support an embedded changer shall implement the commands specified in Table 88.

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Table 88 – Embedded changer command

Op code	Command description	Clause
A6h	LOAD/UNLOAD MEDIUM	6.1.7
BDh	MECHANISM STATUS	6.1.8

The Feature descriptor response data to be returned to the Initiator is defined in Table 89.

Table 89 – Embedded changer descriptor format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 0102h							
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 04h							
4	Reserved			SCC	Reserved	SDP	Reserved	
5	Reserved							
6	Reserved							
7	Reserved			Highest Slot Number				

The Feature Code field shall be set to 0102h.

The Version Field is defined in 5.2.1.

The Persistent bit shall be defined as in 5.2.2.

The Current bit shall be defined as in 5.2.3.

The Additional Length field shall be set to 4.

The SCC (Side Change Capable) bit, when set to zero, shall indicate that the Logical Unit is not capable of selecting both sides of the media. When set to one, shall indicate that the Logical Unit is capable of selecting both sides of the media.

The SDP (Supports Disc Present) bit, when set to zero, shall indicate that the Logical Unit cannot report the contents of the slots after a reset or magazine change. When set to one, shall indicate that the Logical Unit can report the contents of the slots after a reset or magazine change and that the response to the Mechanism Status command will contain valid Disc is Present status information for all slots.

Highest Slot Number shall be set to the number of slots minus one.

5.3.21 CD audio external play feature (0103h)

This Feature identifies a Logical Unit that can play CD Audio data directly to an external output. Logical Units that have a CD-Audio external output shall support the commands specified in Table 90 and the mode pages specified in Table 91.

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A Logical Unit without a CD-Audio output shall respond to a PLAY AUDIO command, that has a transfer length of zero, with CHECK CONDITION status, and set the sense key to ILLEGAL REQUEST. This behaviour allows an Initiator to determine if a CD-Audio analog output is supported.

Table 90 – CD-audio external play feature commands

Op code	Command description	Clause
BDh	MECHANISM STATUS	6.1.8
4Bh	PAUSE/RESUME	6.1.9
45h	PLAY AUDIO (10)	6.1.10
47h	PLAY AUDIO MSF	6.1.12
43h	READ TOC/PMA/ATIP	6.1.24
42h	READ SUBCHANNEL	6.1.23
2Bh	SEEK	ANSI INCITS 301
4Eh	STOP PLAY/SCAN	6.1.39

Table 91 – CD-Audio External Output Parameters

Page code	Page description	Clause
0Eh	CD Audio Control Mode Page	5.5.6

The Feature descriptor response data to be returned to the Initiator is defined in Table 92.

Table 92 – CD audio external play descriptor format

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 0103h							
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 04h							
4	Reserved					Scan	SCM	SV
5	Reserved							
6	(MSB) Number of Volume Levels							
7 to *n*								(LSB)

The Feature Code field shall be set to 0103h.

The Version Field is defined in 5.2.1.

The Persistent bit shall be defined as in 5.2.2.

The Current bit shall be defined as in 5.2.3.

The Additional Length field shall be set to 4.

The Scan bit, when set to one, indicates the SCAN command is supported.

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The SCM (Separate Channel Mute) bit, when set to zero, shall indicate that all audio channels are muted simultaneously.

When set to one, shall indicate that each audio channel can be independently muted.

The SV (Separate Volume) bit, when set to zero, shall indicate that all audio channels will have the same volume level. When set to one, shall indicate that audio channel volume may be set independently.

The Number of Volume Levels shall indicate the number of discrete volume levels supported by the Logical Unit. If the Logical Unit supports only turning audio on and off, the Number of Volume Levels field shall be set to 2.

5.3.22 Microcode upgrade feature (0104h)

This Feature identifies a Logical Unit that can upgrade its internal microcode via the interface. Logical Units that support microcode upgrades shall implement the commands specified in Table 93.

Table 93 – Microcode upgrade command

Op code	Command description	Clause
3Ch	READ BUFFER with Mode 011b set	ANSI INCITS 301
3Bh	WRITE BUFFER with Mode 111b (Download microcode with offset and save)	ANSI INCITS 301

The Feature descriptor response data to be returned to the Initiator is defined in Table 94.

Table 94 – Microcode upgrade descriptor format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 0104h							
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 00h							

The Feature Code field shall be set to 0104h.

The Version Field is defined in 5.2.1.

The Persistent bit shall be defined as in 5.2.2.

The Current bit shall be defined as in 5.2.3.

The Additional Length field shall be set to 0.

5.3.23 Time-out feature (0105h)

This Feature identifies a Logical Unit that can always respond to commands within a set time period. If a command cannot complete normally within the allotted time, it completes with an error. Logical Units that support this Feature shall support the parameter listed in Table 95.

Table 95 – Time-out feature parameter

Page code	Parameter	Subclause
1Dh	Time-out and Protect Page	5.5.9

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Logical Units that support queuing shall support Event Notification Class 6. If queuing is not supported, a CHECK CONDITION status with a sense code of ILLEGAL REQUEST and an ASC of INSUFFICIENT TIME FOR OPERATION" shall be supported.

Event Notification Class 6 shall be supported if queuing is supported.

The Feature descriptor response data to be returned to the Initiator is defined in Table 96.

Table 96 – Time-Out Descriptor Format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 0105h							
1								(LSB)
2	Reserved			Version			Persistent	Current
3	Additional Length = 00h							

The Feature Code field shall be set to 0105h.

The Version Field is defined in 5.2.1.

The Persistent bit shall be defined as in 5.2.2.

The Current bit shall be defined as in 5.2.3.

The Additional Length field shall be set to 00h.

5.3.24 DVD-CSS Feature (0106h)

This Feature identifies a Logical Unit that can perform DVD-CSS authentication and key management. Logical Units that support DVD-Video CSS (Content Scramble System) shall implement the commands specified by Table 97.

Table 97 – DVD-CSS feature commands

Op code	Command description	Clause
A2h	REPORT KEY	6.1.28
A3h	SEND KEY	6.1.34
ADh	READ DVD STRUCTURE	6.1.19

The Feature descriptor response data to be returned to the Initiator is defined in Table 98.

Table 98 – DVD-CSS feature descriptor format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Feature Code 0106h							
1								(LSB)
2	Reserved			Version			Persistent	Current
3	Additional Length = 04h							
4	Reserved							
5	Reserved							
6	Reserved							
7	CSS Version							

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The Feature Code field shall be set to 0106h.

The Version Field is defined in 5.2.1.

The Persistent bit shall be defined as in 5.2.2.

The Current bit shall be defined as in 5.2.3. This bit shall be set to zero if DVD-CSS media are not present.

The Additional Length field shall be set to 4.

The CSS version shall be set to 01h.

5.3.25 Real-time streaming feature (0107h)

This Feature identifies a Logical Unit that can perform reading and writing within Initiator specified (and Logical Unit verified) performance ranges. Logical Units that support this Feature shall implement the commands listed in Table 99.

Table 99 – Real-time streaming feature commands

Op code	Command description	Clause
Ach	GET PERFORMANCE	6.1.6
B6h	SET STREAMING	6.1.38
A7h	SET READ AHEAD	6.1.37

The Feature descriptor response data to be returned to the Initiator is defined in Table 100.

Table 100 – Real-time streaming feature descriptor format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 0107h							
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length =00h							

The Feature Code field shall be set to 0107h.

The Version Field is defined in 5.2.1.

The Persistent bit shall be defined as in 5.2.2.

The Current bit shall be defined as in 5.2.3.

The Additional Length field shall be set to 0.

5.3.26 Feature 0108h – Logical unit serial number

This Feature identifies a Logical Unit that has a unique serial number. A Logical Unit can be uniquely identified by checking its vendor ID, model ID and serial number.

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Table 101 – Logical unit serial number feature descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 0108h							
1								(LSB)
2	Reserved			Version			Persistent	Current
3	Additional Length							
4 to *n*	Serial Number							

The Feature Code field shall be set to 0108h.

The Persistent bit shall be set to one.

The Current bit shall be set to one.

The Additional Length field shall be set to a multiple of 4.

The coding of the Serial Number shall meet ISO/IEC 646:1991 (i.e. codes 20h to 7Eh). Any unused bytes in the Serial Number shall be padded with spaces (20h). There should not be more than three pad bytes.

5.3.27 Feature 010Ah - Disc control blocks

This Feature identifies a Logical Unit that can read and/or write Disc Control Blocks from or to the media. Logical Units that support this command shall implement the commands listed in Table 102.

Table 102 – Disc control blocks feature commands

Op code	Command description	Clause
ADh	READ DVD STRUCTURE Format Code 30h shall be supported.	6.1.19
BFh	SEND DVD STRUCTURE If any DCB's are identified as writable, this command shall be supported	6.1.32

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Table 103 – Disc control blocks feature descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)				Feature Code = 0108h			
1								(LSB)
2	Reserved			Version			Persistent	Current
3	Additional Length							
4	(MSB)							
5	Supported DCB entry 0							
6								
7								(LSB)

$n \times 4 + 4$	(MSB)
$n \times 4 + 5$	Supported DCB entry n
$n \times 4 + 6$	
$n \times 4 + 7$	(LSB)

The Feature Code field shall be set to 010Ah.

The Version Field is defined in 5.2.1.

The Persistent bit shall be defined as in 5.2.2. This bit shall be set to zero if the medium is removable.

The Current bit shall be defined as in 5.2.3. This bit shall be set to zero if no DCBs can be read or written.

The Additional Length field shall be set to $n \times 4$, where n is the number of Supported DCB entries. The Supported DCB entry n fields shall each contain the Content Descriptor of a supported DCB. Entries shall be sorted in ascending order.

5.4 Profile definitions

5.4.0 General

Profiles define a base set of functions for Logical Units. Logical Units that list a Profile as current shall support all Features required by that Profile, but not all Features may be current. Logical Units may support Features in addition to those required by the Profile. A single device may implement more than one Profile, and more than one Profile may be active at any given time. All required Features may not be current, depending on the medium installed. If a Not Ready response would be given to a TEST UNIT READY command, no Profile shall be current.

For example, a Logical Unit, with unformatted media, may not be able to read or write and the corresponding Features would not be current. But the Profile corresponding to the Logical Unit/media system may be current, i.e., a DVD-RAM Logical Unit with unformatted media loaded may claim compliance to the DVD-RAM Profile; a DVD-RAM Logical Unit with no media loaded shall claim no Profile as current.

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5.4.1 Profile 2 - Removable disk

Logical Units identifying Profile 2 as current shall support the Features listed in Table 104.

Table 104 – Mandatory features for removable disks

Feature number	Feature name	Description	Sub-clause
0000h	Profile List	A list of all Profiles supported by the device	5.3.1
0001h	Core	Basic Functionality	5.3.2
0002h	Morphing	Ability to notify Initiator about operational changes and accept Initiator requests to prevent operational changes.	5.3.3
0003h	Removable Medium	The medium may be removed from the device	5.3.4
0010h	Random Readable, PP=1	Read ability for storage devices with random addressing.	5.3.5
0020h	Random Writable	Write support for randomly addressed writes	5.3.9
0023h	Formattable	Support for formatting of media	5.3.12
0024h	Defect Management	Ability of the drive/media system to provide an apparently defect-free space	5.3.13
0100h	Power Management	Initiator and device directed power management	5.3.19
0105h	Time-out	Ability to respond to all commands within a specific time	5.3.23

5.4.2 Profile 3 - Magneto-optical

Logical Units identifying profile 3 as current shall support the Features listed in Table 105.

Table 105 – Mandatory features for magneto-optical erasable

Feature number	Feature name	Description	Sub-clause
0000h	Profile List	A list of all profiles supported by the device	5.3.1
0001h	Core	Basic Functionality	5.3.2
0002h	Morphing	Ability to notify initiator about operational changes and accept initiator requests to prevent operational changes	5.3.3
0003h	Removable Medium	The medium may be removed from the device	5.3.4
0010h	Random Readable, PP = 1	Readability for storage with random addressing	5.3.5
0020h	Random Writable	Write support for randomly addressed writes	5.3.9
0022h	Sector Erasable	Write support for erasable media and media that require an erase pass before overwrite.	5.3.11
0023h	Formattable	Support for formatting of media	5.3.12
0024h	Defect Management	Ability of the drive/media system to provide an apparently defect free space	5.3.13
0100h	Power Management	Initiator and Logical Unit power management	5.3.19
0105h	Time-out	Ability to response to all commands within a specific time	5.3.23

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5.4.3 Profile 4 - Magneto-optical write once

Logical Units identifying profile 4 as current shall support the Features listed in Table 106.

Table 106 – Mandatory features for magneto-optical write once

Feature number	Feature name	Description	Sub-clause
0000h	Profile List	A list of all profiles supported by the device	5.3.1
0001h	Core	Basic Functionality	5.3.2
0002h	Morphing	Ability to notify initiator about operational changes and accept initiator requests to prevent operational changes	5.3.3
0003h	Removable Medium	The medium may be removed from the device	5.3.4
0010h	Random Readable, PP = 1	Readability for storage with random addressing	5.3.5
0024h	Defect Management	Ability of the drive/media system to provide an apparently defect free space	5.3.13
0025h	Write Once	Write support for write once media that can be written in random order	5.3.14
0100h	Power Management	Initiator and Logical Unit power management	5.3.19
0105h	Time-out	Ability to response to all commands within a specific time	5.3.23

5.4.4 Profile 5h - AS-MO

Logical Units identifying Profile 5 shall support the Features listed in Table 107.

Table 107 – Mandatory features for AS-MO

Feature number	Feature name	Description	Sub-clause
0000h	Profile List	A list of all Profiles supported by the device	5.3.1
0001h	Core	Basic Functionality	5.3.2
0002h	Morphing	Ability to notify Initiator about operational changes and accept Initiator requests to prevent operational changes	5.3.3
0003h	Removable Medium	The medium may be removed from the device	5.3.4
0010h	Random Readable, PP = 1	Readability for storage devices with random addressing	5.3.5
0020h	Random Writable	Write support for randomly addressed writes	5.3.9
0023h	Formattable	Support for formatting of media	5.3.12
0024h	Defect Management	Ability of the drive/media system to provide an apparently defect-free space	5.3.13
0100h	Power Management	Initiator and device directed power management	5.3.19
0105h	Time-out	Ability to respond to all commands within a specific time	5.3.23
0107h	Real-Time Streaming	Ability to read and write using Initiator requested performance parameters	5.3.25

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5.4.5 Profile 8 - CD-ROM

Logical Units identifying Profile 8 as current shall support the Features listed in Table 108.

Table 108 – Mandatory features for CD-ROM

Feature number	Feature name	Description	Sub-clause
0000h	Profile List	A list of all Profiles supported by the device	5.3.1
0001h	Core	Basic Functionality	5.3.2
0002h	Morphing	Ability to notify Initiator about operational changes and accept Initiator requests to prevent operational changes	5.3.3
0003h	Removable Medium	The medium may be removed from the device	5.3.4
0010h	Random Readable, PP = 1	Readability for storage devices with random addressing	5.3.5
001Eh	CD Read	The ability to read CD specific structures	5.3.7
0100h	Power Management	Initiator and device directed power management	5.3.19
0105h	Time-out	Ability to respond to all commands within a specific time	5.3.23

5.4.6 Profile 9 - CD-R

Logical Units identifying profile 9 as current shall support the Features listed in Table 109:

Table 109 – Mandatory features for CD-R

Feature Number	Feature Name	Description	Sub-clause
0000h	Profile List	A list of all profiles supported by the device	5.3.1
0001h	Core	Basic Functionality	5.3.2
0002h	Morphing	Ability to notify initiator about operational changes and accept initiator requests to prevent operational changes	5.3.3
0003h	Removable Medium	The medium may be removed from the device	5.3.4
0010h	Random Readable, PP = 1	Readability for storage with random addressing	5.3.5
001Eh	CD Read	The ability to read CD specific structures	5.3.7
0021h	Incremental Streaming Writable	Write support of sequential recording	5.3.10
002Dh	CD Track at Once	Ability to write CD with Track at Once recording	5.3.16
0100h	Power Management	Initiator and Logical Unit power management	5.3.19
0105h	Time-out	Ability to response to all commands within a specific time	5.3.23
0107h	Real-Time Streaming	Ability to read and write using Initiator requested performance parameters	5.3.25

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5.4.7 Profile Ah - CD-RW

Logical Units identifying profile Ah as current shall support the Features listed in Table 110.

Table 110 – Mandatory features for CD-RW

Feature number	Feature name	Description	Sub-clause
0000h	Profile List	A list of all profiles supported by the device	5.3.1
0001h	Core	Basic Functionality	5.3.2
0002h	Morphing	Ability to notify initiator about operational changes and accept initiator requests to prevent operational changes	5.3.3
0003h	Removable Medium	The medium may be removed from the device	5.3.4
0010h	Random Readable, PP = 1	Readability for storage with random addressing	5.3.5
001Dh	Multi-Read	The Logical Unit complies with OSTA Multi-Read	5.3.6
001Eh	CD Read	The ability to read CD specific structure	5.3.7
0021h	Incremental Streaming Writable	Write support of sequential recording	5.3.10
0023h	Formattable	Support for formatting of media	5.3.12
0026h	Restricted Overwrite	Write support for media that shall be written in multiples of logical blocks	5.3.15
002Dh	CD Track at Once	Ability to write CD with Track at Once recording	5.3.16
0100h	Power Management	Initiator and Logical Unit power management	5.3.19
0105h	Time-out	Ability to response to all commands within a specific time	5.3.23
0107h	Real-Time Streaming	Ability to read and write using Initiator requested performance parameters	5.3.25

5.4.8 Profile 10h - DVD-ROM

Logical Units identifying Profile 10h as current shall support the Features listed in Table 111.

Table 111 – Mandatory Features for DVD-ROM

Feature number	Feature name	Description	Sub-clause
0000h	Profile List	A list of all Profiles supported by the device	5.3.1
0001h	Core	Basic Functionality	5.3.2
0002h	Morphing	Ability to notify Initiator about operational changes and accept Initiator requests to prevent operational changes	5.3.3
0003h	Removable Medium	The medium may be removed from the device	5.3.4
0010h	Random Readable, PP = 1	Readability for storage devices with random addressing	5.3.5
001Fh	DVD Read	The ability to read DVD specific structures	5.3.8
0100h	Power Management	Initiator and device directed power management	5.3.19
0105h	Time-out	Ability to respond to all commands within a specific time	5.3.23
0107h	Real-Time Streaming	Ability to read using Initiator requested performance parameters	5.3.25

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5.4.9 Profile 11h - DVD-R

Logical Units identifying profile 11h as current shall support the Features listed in Table 112.

Table 112 – Mandatory features for DVD-R

Feature number	Feature name	Description	Sub-clause
0000h	Profile List	A list of all profiles supported by the device	5.3.1
0001h	Core	Basic Functionality	5.3.2
0002h	Morphing	Ability to notify initiator about operational changes and accept initiator requests to prevent operational changes	5.3.3
0003h	Removable Medium	The medium may be removed from the device	5.3.4
0010h	Random Readable, PP = 1	Readability for storage with random addressing	5.3.5
001Fh	DVD Read	The ability to respond to all commands within a specific time	5.3.8
0021h	Incremental Streaming Writable	Write support for sequential recording	5.3.10
002Fh	DVD-R Write	Ability to write data in Disc at Once mode	5.3.18
0100h	Power Management	Initiator and Logical Unit power management	5.3.19
0105h	Time-out	Ability to response to all commands within a specific time	5.3.23
0107h	Real-Time Streaming	Ability to read and write using initiator requested performance parameters	5.3.25
0108h	Logical Unit Serial Number	Ability to provide Logical Unit serial number	5.3.26

5.4.10 Profile 12h - DVD re-writable

Logical Units identifying Profile 12h as current shall support the Features listed in Table 113.

Table 113 – Mandatory features for DVD re-writable

Feature number	Feature name	Description	Sub-clause
0000h	Profile List	A list of all Profiles supported by the device	5.3.1
0001h	Core	Basic Functionality	5.3.2
0002h	Morphing	Ability to notify Initiator about operational changes and accept Initiator requests to prevent operational changes	5.3.3
0003h	Removable Medium	The medium may be removed from the device	5.3.4
0010h	Random Readable, PP = 1	Readability for storage devices with random addressing	5.3.5
001Fh	DVD Read	The ability to read DVD specific structures	5.3.8
0020h	Random Writable	Write support for randomly addressed writes	5.3.9
0023h	Formattable	Support for formatting of media	5.3.12
0024h	Defect Management	Ability of the drive/media system to provide an apparently defect-free space	5.3.13
0100h	Power Management	Initiator and device directed power management	5.3.19
0105h	Time-out	Ability to respond to all commands within a specific time	5.3.23
0107h	Real-Time Streaming	Ability to read and write using Initiator requested performance parameters	5.3.25

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5.4.11 Profile FFFFh - Logical units not conforming to a standard profile

Logical Units identifying Profile FFFFh as current shall support the Features listed in Table 114.

Table 114 – Mandatory features for logical units not conforming to a standard profile

Feature number	Feature name	Description	Subclause
0000h	Profile List	A list of all Profiles supported by the device	5.3.1
0001h	Core	Basic Functionality	5.3.2

5.5 Parameters for all logical unit types

This clause defines and lists the specified parameters that an Initiator system or Logical Unit would require performing at a desired level.

Parameters uniquely required to implement a specific Feature set are defined within the sub-clause defining that Feature set. Other parameters that are unique to a specific command are listed in the specific subclause defining that command.

5.5.1 Mode pages

Mode Pages are used to provide information to or from the Logical Unit. MODE SELECT (used to set parameters) and MODE SENSE (used to interrogate capabilities) commands move the pages (as shown in Table 115) to/from the Logical Units. The page definitions are provided in the following subclauses.

Each mode page (see Table 115) contains a page code, a page length and a set of mode parameters.

Table 115 – Mode page codes for C/DVD

Page code	Description	Subclause
00h	Vendor-specific (does not require page format)	
01h	Read/Write error recovery page	5.5.3
02h to 04h	Reserved	
05h	Write Parameter page	5.5.4
06h	Reserved	
07h	Verify error recovery page	Shall not be used
08h to 0Ah	Reserved	
0Bh	Medium types supported page	Shall not be used
0Ch	Reserved	
0Dh	CD Device Parameters Page	5.5.5
0Eh	CD Audio Control Page	5.5.6
0Fh to 19h	Reserved	
1Ah	Power Condition Page	5.5.7
1Bh	Reserved	
1Ch	Fault/Failure Reporting Page	5.5.8
1Dh	Time-out & Protect Page	5.5.9
1Eh to 1Fh	Reserved	
20h to 29h	Vendor-specific	
2Ah	C/DVD Capabilities & Mechanical Status Page	5.5.10
2Bh – 3Eh	Vendor-specific	
3Fh	Return all pages (valid only for the Mode Sense command)	

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5.5.2 Mode select/sense parameters

This subclause describes the pages used with MODE SELECT and MODE SENSE commands.

The Mode Parameter List (given in Table 116) contains a header, followed by zero or more variable length mode pages defined in Table 117.

Table 116 – Mode parameter list

Bit / Byte	7	6	5	4	3	2	1	0
0 to 7	Mode Parameter Header							
8 to *n*	Page(s)							

Table 117 – Mode page format

Bit / Byte	7	6	5	4	3	2	1	0
0	PS/ Reserved	Reserved	Page Code					
1	Page Length (*n* to 1)							
2	Mode Parameter							
n								

5.5.2.1 Parameters savable bit (PS)

When using the MODE SENSE command, a Parameters Savable (PS) bit of one indicates that the mode page can be saved by the Logical Unit in a non-volatile, vendor-specific location. A PS bit of zero indicates that the supported parameters cannot be saved. When using the MODE SELECT command, the PS bit is reserved.

5.5.2.2 Page code

The Page Code field identifies the format and parameters defined for that mode page.

When using the MODE SENSE command, if Page Code 00h (vendor-specific page) is implemented, the Logical Unit shall return that page last, in response to a request to return all pages (page code 3Fh). When using the MODE SELECT command, this page shall be sent last.

5.5.2.3 Page length

The Page Length field specifies the length in bytes of the mode parameters that follow. If the Initiator does not set this value to the value that is returned for the page by the MODE SENSE command, the Logical Unit shall terminate the command with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST with the additional sense code set to INVALID FIELD IN PARAMETER LIST. The Logical Unit is permitted to implement a mode page that is less than the full page length defined in this Specification, provided no field is truncated and the Page Length field correctly specifies the actual length implemented.

The mode parameters header (see Table 118) for each page are defined here. Mode parameters not implemented by the Logical Unit shall be set to zero.

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Table 118 – Mode parameter header

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Mode Data Length							
1								(LSB)
2	Obsolete (Medium Type Code)							
3	Reserved							
4	Reserved							
5	Reserved							
6	Block Descriptor Length 0 (8 for legacy SCSI Logical Units)							
7								

When using the MODE SENSE command, the mode data length field specifies the length in bytes of the following data that is available to be transferred. The mode data length is the total byte count of all data following the mode data length field. When using the MODE SELECT command, this field is reserved.

The block descriptor associated with the Mode Select and Mode Sense commands is used for legacy system support for SCSI systems. If supported, block sizes (see Table 119) shall include 2 048 and may include 512, 2 056, 2 324, 2 332, 2 336, 2 340, 2 352, 2 368 and 2 448 bytes. Table 119 shows the implementation of the various block sizes. These definitions apply for reading with the READ (XX) commands. Other block sizes are allowed and the contents of the blocks are not specified by this specification.

Table 119 – Block descriptor block sizes for read

Size	Readable block types
512	Mode 1 or Mode 2 Form 1 sectors divided into four blocks each
2 048	Mode 1, Mode 2 Form1 or DVD
2 056	Mode 2 Form 1 with subheader. Equivalent to READ CD, Flag = 50h.
2 324	Mode 2 Form 2 with no sub-header. [1)]
2 332	Mode 2, Form 1 or 2 data. The Logical Unit shall operate as specified for 2 048 byte blocks except that both forms send 2 332 blocks. Form 1 blocks return the third layer ECC with the user data. There is no mapping to READ CD, as the 4 spare bytes are not returned.
2 336	Mode 2 data. The Logical Unit shall operate as specified for 2 048 byte block lengths. This mode will include all data including ISO/IEC 10149 Mode 2 sectors and Form 1 & 3. Equivalent to READ CD, Flag = 58h.
2 340	All bytes except the synchronization field. Equivalent to READ CD, Flag = 78h.
2 352	Audio or raw blocks. The Logical Unit shall operate as specified for 2 048 byte block lengths. Reads of data mode sectors shall return descrambled data. Equivalent to READ CD, Flag = F8h.
2 448 or 2 368	Audio or raw blocks with raw Sub-channel. The Logical Unit shall not perform the data descrambling operation. Equivalent to READ CD, Flag = F8. Sub-channel data selection = 010b (2 448) or Sub-channel data selection = 001b (2 368).
[1)] There is no mapping to READ CD, as the 4 spare bytes are not returned.	

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5.5.3 Read/write error recovery parameters page (page code 01h)

The Read/Write Error Recovery Parameters Page (see Table 120) specifies the error recovery parameters the Logical Unit shall use during any command that performs a data read or write operation from the media (for example READ, READ TOC/PMA/ATIP, WRITE, etc.).

Table 120 – Read/write error recovery parameters page format

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Reserved	Page Code (01h)					
1	Page Length (0Ah)							
2	Error Recovery Parameter							
	AWRE	ARRE	TB	RC	Reserved	PER	DTE	DCR
3	Read Retry Count							
4	Reserved (Correction Span in ANSI INCITS 301-1997)							
5	Reserved (Head Offset Count in ANSI INCITS 301-1997)							
6	Reserved (Data Strobe Offset Count inANSI INCITS 301-1997)							
7	Reserved							
8	Write Retry Count							
9	Reserved							
10	(MSB) Recovery Time Limit (0)							
11	(LSB)							

The Parameters Savable (PS) bit is defined in 5.5.2.1.

NOTE The implementation of error recovery procedures for Logical Units is markedly different from those used for magnetic medium disk drives. At least one level of error correction is required to transfer the data stream. Therefore, the performance of the Logical Unit may differ substantially from what would be expected by sending the same error recovery parameters to a magnetic medium Logical Unit.

An Automatic Write Reallocation Enabled (AWRE) bit of one indicates that the Logical Unit shall enable automatic reallocation to be performed during write operations. An AWRE bit of zero indicates that the Logical Unit shall not perform automatic reallocation of defective data blocks during write operations.

An Automatic Read Reallocation Enabled (ARRE) bit of one indicates that the Logical Unit shall enable automatic reallocation of defective data blocks during read operation. An ARRE bit of zero indicates that the Logical Unit shall not perform automatic reallocation of defective data blocks during read operation. When ARRE is enabled other error recovery modes shall not be used. The Disable Correction and Read Continuous shall not be enabled while ARRE is enabled.

A Transfer Block (TB) bit of one indicates that a data block that is not recovered within the recovery limits specified, shall be transferred to the Initiator before CHECK CONDITION status is returned. A TB bit of zero indicates that such a data block shall not be transferred to the Initiator. The TB bit does not affect the action taken for recovered data.

A Read Continuous (RC) bit of one indicates that the Logical Unit shall transfer the entire requested length of data without adding delays to perform error recovery procedures. This implies that the Logical Unit may send data that is erroneous or fabricated in order to maintain a continuous flow of data. A RC bit of zero indicates that error recovery operations that cause delays are acceptable during the data transfer.

A Post Error (PER) bit of one indicates that the Logical Unit shall report recovered errors. A PER bit of zero indicates that the Logical Unit shall not report recovered errors. Error recovery procedures shall be performed within the limits established by the error recovery parameters. This capability is very different for DVD media. To be able to recover the data from DVD media, error correction shall be used. Thus, it is not reasonable to report when ECC is used

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to recover the data. This bit for DVD media shall only be used to report when auto reallocation of a logical block has been performed. For CD media this capability is used to report when the Layered Error correction has been used to recover the data. Again, as the CIRC is mandatory for recovery of data, it shall not cause recovered errors to be reported.

A Disable Transfer on Error (DTE) bit of one indicates that the Logical Unit shall terminate the data transfer to the Initiator upon detection of a recovered error. A DTE bit of zero indicates that the Logical Unit shall not terminate the data transfer upon detection of a recovered error.

A Disable Correction (DCR) bit of one indicates that error correction codes shall not be used for data error recovery. A DCR bit of zero allows the use of error correction codes for data error recovery.

As an example, an interpretation of bits 5-0 in the Error Recovery Parameter byte for CD-ROM Logical Units is given in Table 121.

The Read Retry Count field specifies the number of times that the controller shall attempt its read recovery algorithm.

The Write Retry Count field specifies the number of times that the controller shall attempt its write recovery algorithm. This may not have any effect if the Logical Unit does not support read after write operations.

A CIRC Recovered Data Error is defined as a block that the CIRC based error correction algorithm was unsuccessful for a read attempt, but on a subsequent read operation no error was reported. The number of subsequent read operations is limited to the read retry count. Layered error correction was not used.

A CIRC Un-recovered Data Error is defined as a block that the CIRC based error correction algorithm was unsuccessful on all read attempts up to the read retry count. Layered error correction was not used.

An L-EC Recovered Data Error is defined as a block that the CIRC based error correction algorithm was unsuccessful, but the layered error correction was able to correct the block within the read retry count.

An L-EC Un-correctable Data Error is defined as a block that could not be corrected by layered error correction within the read retry count.

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Table 121 – CD-ROM devices, error recovery description

Error code	Description
00h	The maximum error recovery procedures available are used. If an error occurs that is uncorrectable with the error correction codes (ECC) on the media, data transfer is terminated with CHECK CONDITION status. The block with the error is not transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected. Recovered errors are not reported.
01h	Only retries of the read operation and CIRC are used (layered error correction is not used). Only CIRC unrecovered data errors are reported. If an CIRC unrecovered data error occurs, data transfer is terminated with CHECK CONDITION status. The block with the error is not transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected. Recovered errors are not reported.
04h	The maximum error recovery procedures available are used. Recovered data errors are reported. If a recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR. The information bytes give the address of the last block where a recovered data error was detected. If a data error occurs that is uncorrectable with the ECC information available on the media, data transfer is terminated and CHECK CONDITION status is reported. The block with the error is not transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the uncorrectable error was detected.
05h	Only retries of the read operation and CIRC are used (layered error correction is not used). Recovered data errors are reported. If a recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR. The information bytes give the address of the last block where a CIRC recovered data error was detected. If an unrecovered data error occurs, data transfer is terminated and CHECK CONDITION status is reported. The block with the error is not transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected.
06h	The maximum error recovery procedures are used. Recovered data errors are reported. If a recovered data error occurs data transfer is terminated and CHECK CONDITION status is reported. The block with the recovered error is not transferred. The sense key is set to RECOVERED ERROR. The information bytes give the address of the block where the recovered data error was detected. If a data error occurs that is uncorrectable with the ECC information on the medium, data transfer is terminated with CHECK CONDITION status. The block with the error is not transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the uncorrectable error was detected.
07h	Only retries of the read operation are used (layered error correction is not used). CIRC recovered data errors are reported. If a CIRC recovered data error occurs, data transfer is terminated with CHECK CONDITION status. The block with the recovered error is not transferred. The sense key is set to RECOVERED ERROR. The information bytes give the address of the block where the recovered data error was detected. If an CIRC unrecovered data error occurs, data transfer is terminated with CHECK CONDITION status. The block with the error is not transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the uncorrectable error was detected.
10h	If data transfer can be maintained, the maximum error recovery procedures available are used (RC=1). If an error occurs that is uncorrectable with the error codes (ECC) on the media, or is uncorrectable in time to maintain data transfer, the data transfer is not terminated. However, when the data transfer has completed, CHECK CONDITION status is reported. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the first unrecovered error was detected. Recovered errors are not reported.
11h	If data transfer can be maintained, retries of the read operation and CIRC are used (layered error correction is not used). (RC=1.) Only CIRC unrecovered data errors are reported. If a CIRC unrecovered data error occurs, data transfer is not terminated. However, when data transfer has completed, CHECK CONDITION status is reported. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the first unrecovered error was detected. Recovered errors are not reported. If a data error occurs that is uncorrectable with the ECC information available on the media, data transfer is terminated and CHECK CONDITION status is reported. The block with the error is not transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the uncorrectable error was detected.

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Table 21 (*continued*)

Error code	Description
14h	If data transfer can be maintained, the maximum error recovery procedures available are used (RC=1). Recovered data errors are reported. If a recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed, CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR. The information bytes give the address of the block where a recovered data error was detected. If a data error occurs that is uncorrectable with the ECC information available on the media, or is uncorrectable in time to maintain data transfer, the data transfer is not terminated. However, when the data transfer has completed, CHECK CONDITION status is reported. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the first unrecovered error was detected. Reporting unrecovered errors takes precedence over reporting recovered errors.
15h	If data transfer can be maintained, retries of the read operation and CIRC are used (layered error correction is not used) (RC=1). Recovered data errors are reported. If a recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR. The information bytes give the address of the block where a CIRC recovered data error was detected. If an unrecovered data error occurs, data transfer is not terminated. However, when the data transfer has completed CHECK CONDITION status is reported. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected. Recovered errors are not reported.
20h	The maximum error recovery procedures available are used. If an error occurs that is uncorrectable with the error correction codes (ECC) on the media, data transfer is terminated with CHECK CONDITION status. The block with the error is transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected. Recovered errors are not reported.
21h	Only retries of the read operation and CIRC are used (layered error correction is not used). Only CIRC unrecovered data errors are reported. If an CIRC unrecovered data error occurs, data transfer is terminated with CHECK CONDITION status. The block with the error is transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected. Recovered errors are not reported.
24h	The maximum error recovery procedures available are used. Recovered data errors are reported. If a recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed, CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR. The information bytes give the address of the last block where a recovered data error was detected. If a data error occurs that is uncorrectable with the ECC information available on the media, data transfer is terminated and CHECK CONDITION status is reported. The block with the error is transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the uncorrectable error was detected.
5h	Only retries of the read operation and CIRC are used (layered error correction is not used). Recovered data errors are reported. If a recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR. The information bytes give the address of the last block where a CIRC recovered data error was detected. If an unrecovered data error occurs, data transfer is terminated and CHECK CONDITION status is reported. The block with the error is transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected.
26h	The maximum error recovery procedures are used. Recovered data errors are reported. If a recovered data error occurs data transfer is terminated and CHECK CONDITION status is reported. The block with the recovered error is transferred. The sense key is set to RECOVERED ERROR. The information bytes give the address of the block where the recovered data error was detected. If a data error occurs that is uncorrectable with the ECC information on the medium, data transfer is terminated with CHECK CONDITION status. The block with the error is transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the uncorrectable error was detected.
27h	Only retries of the read operation are used (layer error correction is not used). CIRC recovered data errors are reported. If a CIRC recovered data error occurs, data transfer is terminated with CHECK CONDITION status. The block with the recovered error is transferred. The sense key is set to RECOVERED ERROR. The information bytes give the address of the block where the recovered data error was detected. If a CIRC unrecovered data error occurs, data transfer is terminated with CHECK CONDITION status. The block with the error is transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected.
30h	Same as code 10h
31h	Same as code 11h
34h	Same as code 14h
35h	Same as code 15h

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As an example, an interpretation of bits 5-0 in the Error Recovery Parameter byte for DVD Logical Units is given in Table 122.

Table 122 – DVD devices, error recovery description

Code	Error recovery description
00h	The maximum error recovery procedures available are used. If an error occurs which is uncorrectable with the error correction codes (ECC) on the media, data transfer is terminated with CHECK CONDITION status. The block with the error is not transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected. Recovered errors are not reported.
04h	The maximum error recovery procedures available are used. Recovered data errors are reported. If a recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR. The information bytes give the address of the last block where a recovered data error was detected. If a data error occurs that is uncorrectable with the ECC information available on the media, data transfer is terminated and CHECK CONDITION status is reported. The block with the error is not transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the uncorrectable error was detected. The only possible recovered errors are when a block is automatically reassigned using ARRE.
10h	If data transfer can be maintained, the maximum error recovery procedures available are used. (RC = 1.) If an error occurs which is uncorrectable with the error correction codes (ECC) on the media, or is uncorrectable in time to maintain data transfer, the data transfer is not terminated. However, when the data transfer has completed, CHECK CONDITION status is reported. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the first unrecovered error was detected. Recovered errors are not reported.
20h	The maximum error recovery procedures available are used. If an error occurs that is uncorrectable with the error correction codes (ECC) on the media, data transfer is terminated with CHECK CONDITION status. The block with the error is transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected. Recovered errors are not reported.
24h	The maximum error recovery procedures available are used. Recovered data errors are reported. If a recovered data error occurs data transfer is not terminated. However, when the data transfer has completed, CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR. The information bytes give the address of the last block where a recovered data error was detected. If a data error occurs that is uncorrectable with the ECC information available on the media data transfer is terminated and CHECK CONDITION status is reported. The block with the error is transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the uncorrectable error was detected. The only possible recovered errors are when a block is automatically reassigned using ARRE.

The Read Retry Count field specifies the number of times that the Logical Unit shall attempt its read recovery algorithm.

The Correction Span field should be set to zero.

The Head Offset Count field should be set to zero.

The Data Strobe Offset Count field should be set to zero.

The Write Retry Count field specifies the number of times that the Logical Unit shall attempt its write recovery algorithm. This may not have any effect if the Logical Unit does not support read after write operations.

The Recovery Time Limit field should be set to zero.

A CIRC Recovered Data Error is defined as a block for which the CIRC based error correction algorithm was unsuccessful for a read attempt, but on a subsequent read operation no error was reported. The number of subsequent read operations is limited to the read retry count. Layered error correction was not used.

A CIRC Unrecovered Data Error is defined as a block for which the CIRC based error correction algorithm was unsuccessful on all read attempts up to the read retry count. Layered error correction was not used.

An L-EC Recovered Data Error is defined as a block for which the CIRC based error correction algorithm was unsuccessful, but the layered error correction was able to correct the block within the read retry count.

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5.5.4 Write parameters mode page (page code 05h)

The Write Parameters Mode Page (see Table 123) contains parameters needed for the correct execution of WRITE(XX) commands when writing, using certain writing models.

The values in this page do not necessarily reflect the status on a given medium. They will be used as applicable when a write operation occurs. If any parameters have values incompatible with the current medium, the Logical Unit shall generate a CHECK CONDITION status, a sense code of ILLEGAL REQUEST and an ASC of ILLEGAL MODE FOR THIS TRACK shall occur when a write is attempted. Fields that are ignored for the current medium may contain 0 for the default mode parameter value.

Fields and bits within the Write Parameters Mode Page not utilized by the installed medium may be ignored.

Table 123 – Write parameters mode page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Reserved	Page Code (05h)					
1	Page Length (32h)							
2	Reserved	BUFE	LS_V	Test Write	Write Type			
3	Multi-session		FP	Copy	Track Mode			
4	Reserved				Data Block Type			
5	Link Size							
6	Reserved							
7	Reserved		Host Application Code					
8	Session Format							
9	Reserved							
10	(MSB)							
11	Packet Size							
12								
13								(LSB)
14	(MSB)	Audio Pause Length						
15								(LSB)
16	(MSB)							
17	…							
…	Media Catalog Number							
30	…							
31								(LSB)
32	(MSB)							
33	…							
…	International Standard Recording Code							
46	…							
47								(LSB)
48	Sub-header Byte 0							
49	Sub-header Byte 1							
50	Sub-header Byte 2							
51	Sub-header Byte 3							
52 to 55	Vendor-specific							

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The Parameter Savable bit is defined in 5.5.2.1.

The BUFE bit, when set to one, indicates that Buffer Under-run Free recording is enabled for sequential recording. The Logical Unit shall perform silent linking and continue the writing when the buffer becomes empty. When set to zero, it shall indicate that Logical Unit shall terminate writing and perform linking. The following WRITE (10) Command is terminated with CHECK CONDITION Status, ILLEGAL REQUEST, INVALID ADDRESS FOR WRITE. This bit is valid when the DVD-R Write Feature is current.

The LS_V (Link Size Valid) bit, when set to one indicates that the value in the Link Size field is valid. When set to zero, indicates compatibility with legacy Logical Units that did not implement the Link Size field; such Logical Units assume a Link Size of 7.

The Link Size field specifies the Linking Loss area size in sectors. The Link Size field is valid only for Write Type “Packet/Incremental.” When another Write Type is specified, device shall ignore LS_V bit and Link Size field. The Logical Unit shall accept values that are valid for the Logical Unit but not valid for the current medium. If writing is attempted when an invalid Link Size is set, the Logical Unit shall generate CHECK CONDITION status, ILLEGAL REQUEST, ILLEGAL MODE FOR THIS TRACK/RZONE.

On CD-R/RW media the Test Write bit is valid only for Write Type 1 or 2 (Track at Once or Session at Once). On DVD-R media, the Test Write bit is valid only for Write Type 0 or 2 (Incremental or Disc-at-once). When the Test Write bit is set to one, it indicates that the device performs the write process, but does not write data to the media. When the Test Write bit is set to zero the Write laser power is set in such a way that user data is transferred to the media. In addition, all track and disc information collected, during test write mode, shall be cleared. It should be noted that the number of tracks reserved or written may be limited in test write mode.

Write Type Field (Table 124) specifies the stream type to be used during writing. Write Type values are shown in Table 124.

Table 124 – Write type field

Value	Definition
00h	Packet/Incremental
01h	Track-at-once
02h	Session-at-once
03h	Raw
04h to 0Fh	Reserved

Packet/Incremental – the device shall perform packet/Incremental writing when WRITE commands are issued.

Track At Once – the device shall perform Track At Once recording when write commands are issued.

Session At Once – the device shall perform Session At Once recording. For CD, this mode requires that a cue sheet be sent prior to sending write commands.

Raw – the device shall write data as received from the Initiator. In this mode, the Initiator sends the Lead-in. The Initiator shall provide Q Sub-channel in this mode, the only valid Data Block Types are 1, 2 and 3. The Next Writable Address starts at the beginning of the Lead-in (this shall be a negative LBA on a blank disc).

NOTE In RAW record mode the Logical Unit shall not generate run-in and run-out blocks (main and Sub-channel 1 data) but shall generate and record the link block. Write Type of Track-at-once and Raw are invalid when DVD-R media are present.

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The Multi-session field defines how session closure affects the opening of the next session. See Table 125.

Table 125 – Multi-session field definition

Multi-session Field	Action Upon Session Closure
00b	No B0 pointer. Next Session not allowed
01b	B0 pointer = FF:FF:FF. Next session not allowed. Field reserved for non-CD media
10b	Reserved
11b	Next session allowed. B0 pointer = next possible program area.

The FP bit, when set to one indicates that the packet type is fixed. Otherwise, the packet type is variable. This bit is ignored unless the write type is set to 0 (Packet). For DVD-R, this bit shall default to one.

A Copy bit with value one indicates that this is the first or higher generation copy of a copyright protected track. When set to one, the copyright bit in the control nibble of each mode 1 Q Sub-channel shall alternate between 1 and 0 at 9,375 Hz. The duty cycle is 50 %, changing every 4 blocks. The initial value on the medium is zero.

Track Mode is the Control nibble in all Mode 1 Q Sub-channel in the track. The default value of this field for DVD-R Logical Units shall be 5.

Data Block Type defines both the specific data fields in a user data block and its size. The Data Block Type is defined in Table 126. This size is used for writing instead of the block size set in the mode select header. The default value of this field for DVD-R Logical Units shall be 8.

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Table 126 – Data block type codes

Value	Block Size	Definition	Requirement
0	2 352	Raw data 2 352 bytes of raw data (not valid for write type = packet)	Optional
1	2 368	Raw data with P and Q Sub-channel 2 352 bytes of raw data. 16 bytes for P & Q Sub-channel (see Table 224): Bytes 0..9 are Q Sub-channel data Bytes 10..11 are Q Sub-channel EDC Bytes 12..14 are zero Byte 15, most significant bit has state of P Sub-channel bit (not valid for write type = packet)	Optional
2	2 448	Raw data with P-W Sub-channel appended: 2 352 bytes of raw data. 96 bytes of pack form R-W Sub-channel in the low order 6 bits of each byte. Bit 7 of each byte contains the P Sub-channel state and bit 6 of each byte contains the Q Sub-channel bit (not valid for write type = packet).	Optional
3	2 448	Raw data with raw P-W Sub-channel appended: 2 352 bytes of raw data. 96 bytes of raw P-W Sub-channel (not valid for write type = packet).	Optional
4 to 6		Reserved values	
7	NA	Vendor-specific	Optional
8	2 048	Mode 1 (ISO/IEC 10149): 2 048 bytes of user data	Mandatory
9	2 336	Mode 2 (ISO/IEC 10149): 2 336 bytes of user data	Optional
10	2 048	Mode 2 (CD-ROM XA, form 1): 2 048 bytes of user data, sub-header from write parameters	Mandatory
11	2 056	Mode 2 (CD-ROM XA, form 1): 8 bytes of sub-header, 2 048 bytes of user data	Optional
12	2 324	Mode 2 (CD-ROM XA, form 2): 2 324 bytes of user data, sub-header from write parameters	Optional
13	2 332	Mode 2 (CD-ROM XA, form 1, form 2, or mixed form): 8 bytes of sub-header 2 324 bytes of user data	Mandatory
14	–	Reserved values	
15	NA	Vendor-specific	Optional

NOTE 1 When a track has been designated for packet writing, the device shall ensure that the TDB is written upon receipt of the write command.

NOTE 2 With the exceptions of data block types 1, 2 and 3, the device shall generate all P Sub-channel and all mode 1, mode 2 and mode 3 Q Sub-channel.

NOTE 3 For data block types 8 through 13, the device shall generate all sync fields and all headers.

NOTE 4 For data blocks of mode 1 or of mode 2, form 1, the device shall generate EDC and L-EC parity.

NOTE 5 For data block types 0, 1, 2 and 3, the device shall perform no data scrambling per ISO/IEC 10149.

NOTE 6 For data block types 8 through 13, the device shall perform data scrambling per ISO/IEC 10149.

The Host Application Code field is typically zero. When the unrestricted Use Disc bit in Disc Information Block (see Table 237) is one, the Host Application Code field shall be ignored by the device. If the Unrestricted Use Disc bit is zero, then the Host Application Code shall be set to the appropriate value for the medium in order that writing be allowed. A Host Application Code of zero is used for a Restricted Use – General Purpose Disc.

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The Session Format code is to be written in the TOC of the session containing this track. The Session Format code is the PSEC byte of the mode 1, point A0 TOC entry. See Table 305.

Table 127 – Session format codes

Session Format Codes	Session Format
00h	CD-DA, or CD-ROM or other data discs
10h	CD-I Disc
20h	CD-ROM XA Disc
All Other Values	Reserved

The Packet Size field, if FP bit is set to one, specifies the number of User Data Blocks per fixed packet. The Packet Size field, if FP bit is set to 0, shall be ignored. For DVD-R media, the default Packet Size shall be 16. Audio Pause Length is the number of blocks from the beginning of the track that the mode 1 Q Sub-channel INDEX shall be zero. If this number is zero, then there is no period where the Mode 1 Q Sub-channel INDEX shall be zero. The default value shall be 150. This field is valid only for audio tracks, otherwise it is ignored.

The Media Catalog Number (MCN) will be written in the mode 2 Q Sub-channel in at least one out of every 100 blocks in the program area. The Initiator may include bytes 14 & 15, However, the Logical Unit will ignore these bytes and insert the appropriate Zero and AFRAME values. When the MCN is returned to the Initiator the Media Catalog Number (MCN) is formatted as in Table 297.

The International Standard Recording Code (ISRC) is formatted as in Table 299.

5.5.5 CD device parameters (page code 0Dh)

The CD Parameters page (see Table 128) specifies parameters that affect all CD-ROM data types.

Table 128 – CD parameters page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Reserved	Page Code (0Dh)					
1	Parameter Length (06h)							
2	Reserved							
3	Reserved				Inactivity Timer Multiplier			
4	(MSB) Number Of MSF – S Units Per MSF – M Unit							
5	(LSB)							
6	(MSB) Number Of MSF – F Units Per MSF – S Unit							
7	(LSB)							

The Parameter Savable bit is defined in 5.5.2.1. The inactivity timer multiplier value specifies the length of time that the Logical Unit shall remain in the hold track state after completion of a seek or read operation (see Table 129).

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Table 129 – Inactivity timer multiplier values

Inactivity timer multiplier value	Minimum time in hold track state	Inactivity timer multiplier value	Minimum time in hold track state
0	Vendor-specific	8	16 s
1	125 ms	9	32 s
2	250 ms	Ah	1 min
3	500 ms	Bh	2 min
4	1 s	Ch	4 min
5	2 s	Dh	8 min
6	4 s	Eh	16 min
7	8 s	Fh	32 min

The number of S units per M unit field gives the ratio of these MSF address values. For media conforming to the CD data and CD-DA standard, this value is 60.

The number of F units per S unit field gives the ratio of these MSF address values. For media conforming to the CD data and CD-DA standard, this value is 75.

5.5.6 CD audio control parameters page (page code 0Eh)

The CD Audio Control Parameters Page (see Table 130) sets the playback modes and output controls for subsequent PLAY AUDIO commands and any current audio playback operation.

Table 130 – CD audio control mode page format

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Reserved	Page Code (0Eh)					
1	Page Length (0Eh)							
2	Reserved					IMMED Default = 1	SOTC Default = 0	Reserved
3	Reserved							
4	Reserved							
5	Reserved							
6	Obsolete (75)							
7	Obsolete (75)							
8	Reserved				CDDA Output Port 0 Channel Selection			
9	Output Port 0 Volume Default FFh							
10	Reserved				CDDA Output Port 1 Channel Selection			
11	Output Port 1 Volume Default FFh							
12	Reserved				CDDA Output Port 2 Channel Selection			
13	Output Port 2 Volume Default 00h							
14	Reserved				CDDA Output Port 3 Channel Selection			
15	Output Port 3 Volume Default 00h							

The Parameter Savable bit is defined in 5.5.2.1.

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The Immediate bit (IMMED) is used for information purposes only; the audio commands will always send completion status as soon as the playback operation has been started. This bit shall always be set to 1.

A Stop On Track Crossing (SOTC) bit of zero indicates the Logical Unit shall terminate the audio playback operation when the transfer length is satisfied. Multiple tracks shall be played as necessary. Periods of time encoded as audio pause/silence at the beginning of tracks, (index 0) shall also be played. A SOTC bit of one indicates the Logical Unit shall terminate the audio playback operation when the beginning of a following track is encountered. The SOTC bit is mandatory.

The CDDA Output Port Channel Selection field (see Table 131) specifies the IEC 60908 audio channels that a specific output port shall be connected. More than one output port may be connected to an audio channel. More than one audio channel may be connected to an output port.

Table 131 – CDDA output port channel selection codes

Code	Description
0000b	Output port muted
0001	Connect audio channel 0 to this output port
0010b	Connect audio channel 1 to this output port
0011b	Connect audio channel 0 and audio channel 1 to this output port
0100b	Connect audio channel 2 to this output port
1000b	Connect audio channel 3 to this output port

The Output Port Volume Control indicates the relative volume level for this audio output port. The value used is specified as an attenuation of the normal volume level. A value of zero indicates the minimum volume level (Mute), and a value of FFh indicates maximum volume (No attenuation) level. It is recommended that the MUTE and volume functions should be supported on a per channel basis. The attenuation used shall be as specified in Table 132. All values not shown in the table shall be valid, with the attenuation selected by interpolating using the known table values.

It is recommended that the Logical Unit support at least 16 volume levels. The actual attenuation levels for any given Binary attenuation value shall be given by the following equation:

20 log (Binary Level/256).

NOTE Channel volume control regarding channel selection of MUTE versus Volume Level setting of 0. It is recommend that Logical Units allow the setting of the Channel Selection fields to MUTE and also allow the setting of the Volume Level field to 0. It is up to the Logical Unit to determine how to shut off the volume, either via muting circuitry or via the volume control.

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Table 132 – Attenuation levels for audio

Binary Level	Attenuation
FFh	0db (0n)
F0h	–0,52
E0h	–1,12
C0h	–2,45
80h	–5,95
40h	–11,9
20h	–17,8
10h	–23,6
0Fh	–24,1
0Eh	–24,6
0Ch	–25,9
08h	–29,1
04h	–34,2
02h	–38,6
01h	–42,1
00h	Mute (Off)

5.5.7 Power condition page (page code 1Ah)

The power condition page (see Table 133) provides the application client with the means to control the length of time a Logical Unit will delay before changing its power requirements. There are notification events to the Initiator that a Logical Unit has entered into one of the power conditions.

On receipt of a command the Logical Unit shall adjust itself to the power condition that allows the command to execute. The timer that maps to this power condition and any lower power condition timers shall be reset on receipt of the command. On completion of the command the timer associated with this power condition shall be restarted.

Table 133 – Power condition mode page format

Bit / Byte	7	6	5	4	3	2	1	0
0	PS (Optional)	Reserved	Page Code (1Ah)					
1	Page Length (0Ah)							
2	Reserved							
3	Reserved						Idle	Standby
4	(MSB)							
5	Idle Timer							
6								
7								(LSB)
8	(MSB)							
9	Standby Timer							
10								
11								(LSB)

The Parameter Savable bit is defined in 5.5.2.1.

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An Idle bit of one indicates a Logical Unit shall use the Idle Timer to determine the length of inactivity time to wait before entering the Idle Condition. If the Idle bit is zero, or the Idle Timer has a value of zero, the Logical Unit shall disable the Idle Timer.

A Standby bit of one indicates a Logical Unit shall use the Standby Timer to determine the length of inactivity time to wait before entering the Standby condition. If the Standby bit is zero or the Standby Timer has a value of zero, the Logical Unit shall disable the Standby Timer.

The Idle Timer field indicates the inactivity time in 100 ms increments that the Logical Unit shall wait before entering the Idle condition.

The Standby Timer field indicates the inactivity time in 100 ms increments that the Logical Unit shall wait before entering the Standby condition.

5.5.8 Fault/failure reporting control page

The Fault/Failure Reporting Control page (see Table 134) defines the methods used by the target to control the reporting and the operations of specific informational exception conditions. This page shall only apply to informational exception conditions that report an additional sense code of FAILURE PREDICTION THRESHOLD EXCEEDED to the application client.

Informational exception conditions occur as a result of vendor-specific events within a target. An informational exception condition may occur asynchronous to any commands issued by an application client.

Table 134 – Fault/failure reporting control page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Reserved	Page Code (1Ch)					
1	Page Length (0Ah)							
2	Perf	Reserved			DExcept	Test	Reserved	LogErr (0)
3	Reserved				MRIE			
4	(MSB)							
5	Interval Timer							
6								
7								(LSB)
8	(MSB)							
9	Report Count							
10								
11								(LSB)

The Parameter Savable bit is defined in 5.5.2.1.

A Performance bit (Perf) of zero indicates that informational exception operations that are the cause of delays are acceptable. A Perf bit of one indicates the Logical Unit shall not cause delays while doing informational exception operations. A Perf bit set to one may cause the Logical Unit to disable some or all of the informational exception operations, thereby limiting the reporting of informational exception conditions.

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A disable exception control (DExcpt) bit of zero indicates information exception operations shall be enabled. The reporting of informational exception conditions when the DExcpt bit is set to zero is determined from the MRIE field. A DExcpt bit of one indicates the Logical Unit shall disable all information exception operations. The MRIE field is ignored when DExcpt is set to one.

A Test bit of one shall create a false Logical Unit failure at the next interval time (as specified by the Interval timer field), if the DExcpt bit is not set. When the Test bit is one, the MRIE and Report count fields shall apply as if the Test bit were zero. The false Logical Unit failure shall be reported with an additional sense code of FAILURE PREDICTION THRESHOLD EXCEEDED (FALSE). If both the Test and the DExcpt bits are one, the Logical Unit shall terminate the MODE SELECT command with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST with the additional sense code set to INVALID FIELD IN PARAMETER LIST. A Test bit of zero shall instruct the Logical Unit not to generate any false Logical Unit failure notifications.

The log errors bit (LogErr) of zero indicates that the logging of informational exception conditions within a Logical Unit is vendor-specific.

The Method of Reporting Fault/Failure Reporting field (MRIE) (see Table 135) indicates the methods that shall be used by the Logical Unit to report informational exception conditions. The priority of reporting multiple information exceptions is vendor-specific.

Table 135 – Method of reporting fault/failure reporting field

MRIE	Description
0h	No reporting of informational exception condition: This method instructs the target to not report information exception conditions.
1h to 3h	Reserved
4h	Unconditionally generate recovered error: This method instructs the target to report informational exception conditions, regardless of the value of the Perf bit of the error recovery parameters mode page, by returning a CHECK CONDITION status on any command. The sense key shall be set to RECOVERED ERROR and the additional sense code shall be set to FAILURE PREDICTION THRESHOLD – Predicted Logical Unit Failure or FAILURE PREDICTION THRESHOLD EXCEEDED – Predicted Media Failure. The command that has the CHECK CONDITION shall complete without error before any informational exception condition may be reported.
5h to Bh	Reserved
Ch to Fh	Vendor-specific

The Interval Timer field indicates the period in 100 ms increments that a informational exception condition has occurred. The Logical Unit shall not report informational exception conditions more frequently than the time specified by the Interval Timer field and as soon as possible after the timer interval has elapsed. After the informational exception condition has been reported, the interval timer shall be restarted. A value of zero in the Interval Timer field indicates that the Logical Unit shall only report the informational exception condition one time.

The Report Count field indicates the number of times to report an informational exception condition to the application client. A value of zero in the Report Count field indicates that there is no limit to the number of times the Logical Unit shall report an informational exception condition.

The maintaining of the Interval Timer and the Report Count field across power cycles and/or resets by the Logical Unit shall be vendor-specific.

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5.5.9 Time-out and protect page

The Time-out and Protect page (see Table 136) specifies parameters that affect Logical Unit operation.

Table 136 – Time-out & protect page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Reserved	Page Code (1Dh)					
1	Page Length (08h)							
2	Reserved							
3	Reserved							
4	Reserved					TMOE Default 0	DISP Default 0	SW PPDefault 0
5	Reserved							
6	(MSB) Group 1 Minimum Time-out (Seconds)							
7								(LSB)
8	(MSB) Group 2 Minimum Time-out (Seconds)							
9								(LSB)

The Parameter Savable bit is defined in 5.5.2.1.

The Time Out Enable bit (TMOE), when set to one, indicates the time out parameters are in effect. When set to zero, indicates the command shall not time out.

The DISP bit when set to 1 shall make the Logical Unit unavailable until power has been removed and then reapplied. The Logical Unit shall report not ready for all media access after this bit has been set to 1.

The SWPP bit provides a Software Write Protect until power has been removed and then reapplied. When this bit is set to 1 the Logical Unit shall prevent writes to the media. When the bit is set to 1, the Logical Unit shall flush any data in the Cache to the media before preventing any further writes.

See the Time-out model for more information on the Group 1 & 2 Minimum Time-out fields.

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5.5.10 Capabilities and mechanical status page

The Capabilities and Mechanical Status Page (see Table 137) is read only and may not be set with Mode Select.

Table 137 – CD capabilities and mechanical status page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Reserved	Page Code (2Ah)					
1	Page Length (18h)							
2	Reserved		DVD-RAM Read	DVD-R Read	DVD-ROM Read	Method 2	CD-R/RW Read	CD-R Read
3	Reserved		DVD-RAM Write	DVD-R Write	Reserved	Test Write	CD-R/RW Write	CD-R Write
4	Reserved	Multi Session	Mode 2 Form 2	Mode 2 Form 1	Digital Port (2)	Digital Port (1)	Composite	Audio Play
5	Read Bar Code	UPC	ISRC	C2 Pointers supported	R-W De-interleaved & corrected	R-W Supported	CD-DA Stream is Accurate	CD-DA Commands Supported
6	Loading Mechanism Type			Reserved	Eject (Individual or Magazine)	Prevent Jumper	Lock State	Lock
7	Reserved		P through W in Lead-in	Side Change Capable	S/W Slot Selection (SSS)	Changer Supports Disc Present	Separate Channel Mute	Separate volume levels
8	(MSB) Obsolete – Reserved							
9	(LSB)							
10	(MSB) Number of Volume Levels Supported							
11	(LSB)							
12	(MSB) Buffer Size Supported							
13	(LSB)							
14	(MSB) Obsolete – Reserved							
15	(LSB)							
16	Reserved							
17	Reserved		Length		LSBF	RCK	BCKF	Reserved
18	Obsolete							
19								
20	Obsolete							
21								
22	(MSB) Copy Management Revision Supported							
23	(LSB)							
24	Reserved							
25	Reserved							

The Parameter Savable bit is defined in 5.5.2.1.

The Page Length field shall be set to 18h.

If DVD-RAM Read bit is set to one, the Logical Unit shall support the read function of DVD-RAM disc.

If DVD-R Read bit is set to one, the Logical Unit shall support the read function of DVD-R disc.

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If DVD-ROM Read bit is set to one, the Logical Unit shall support the read function of DVD-ROM disc.

If Method 2 is set to one, the Logical Unit shall support the read function of CD-R media written using fixed packet tracks using Addressing Method 2.

If CD-R/RW Read Field is set to one, the Logical Unit shall support the read function of CD-R/RW disc (Orange Book Part III).

If CD-R Read Field is set to one, the Logical Unit shall support the read function of CD-R disc (Orange Book Part II).

If DVD-RAM Write bit is set to one, the Logical Unit shall support the write function of DVD-RAM disc.

If DVD-R Write bit (read only field) is set to one, the Logical Unit shall support the write function of DVD-R disc.

If the Test Write bit is set to one, the Logical Unit shall only accept data from the Initiator and not write to the media.

If CD-R/RW Write Field is set to one, the Logical Unit shall support the write function of CD-R/RW disc (Orange Book Part III).

If CD-R Write Field is set to one, the Logical Unit shall support the write function of CD-R disc (Orange Book Part II).

The individual capabilities of the Logical Unit are specified by bytes 4 through 7. Each of the bits indicate if that specific capability is supported. A value of zero indicates that the capability is NOT supported; a value of one indicates the capability is supported.

Bit 0 – Audio Play – The Logical Unit is capable of Audio Play operation. This also indicates that the Logical Unit is capable of overlapping Play and other commands such as reading of the Sub-channel information.

Bit 1 – Composite – The Logical Unit is capable of delivering a composite Audio and Video data stream.

Bit 2 – Digital Port(1) – The Logical Unit supports digital output (IEC 60958) on port 1.

Bit 3 – Digital Port(2) – The Logical Unit supports digital output (IEC 60958) on port 2.

Bit 4 – Mode 2 Form 1 – The Logical Unit is capable of reading sectors in Mode 2 Form 1 (XA) format.

Bit 5 – Mode 2 Form 2 – The Logical Unit is capable of reading sectors in Mode 2 Form 2 format.

Bit 6 – MultiSession – The Logical Unit is capable of reading multiple session or Photo CD discs.

Bit 7 – Reserved

Bit 8 – CD-DA Commands Supported – IEC 60908 audio can be read using the READ-CD command.

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Bit 9 – CD-DA Stream is Accurate – This bit indicates that the Logical Unit supports an advanced Feature that allows it to return to an audio location without losing place to continue the READ CD-DA command. 0 The Logical Unit is incapable of accurately restarting the CD-DA read operation, and a BUFFER OVERFLOW error shall be reported whenever a loss of streaming occurs. This error will be fatal and the command will have to be repeated from the beginning. The Logical Unit can continue from a loss of streaming condition and no error will be generated.

Bit 10 – R-W Supported – The commands that return Sub-channel data can return the combined R-W information.

Bit 11 – R-W De-interleaved & Corrected – This indicates that the R-W Sub-channel data will be returned de-interleaved and error corrected.

Bit 12 – C2 Pointers Supported – This indicates that the Logical Unit supports the C2 Error Pointers. This also indicates that the Logical Unit is capable of returning the C2 Error Pointers and C2 Block Error flags in the READ CD command.

Bit 13 – ISRC – The Logical Unit can return the International Standard Recording Code Information.

Bit 14 – UPC – The Logical Unit can return the Media Catalog Number (UPC).

Bit 15 – Read Bar Code – The Logical Unit is capable of reading the disc bar code.

Bit 16 – Lock – The PREVENT/ALLOW command is capable of actually locking the media into the Logical Unit.

Bit 17 – Lock State – This indicates the current state of the Logical Unit. If 0, the Logical Unit is currently in the allow (Unlocked) state. Media may be inserted or ejected. If 1, the Logical Unit is currently in the prevent (Locked) state. Media loaded in the Logical Unit may not be removed via a soft or hard eject. If the Logical Unit is empty, media may not be inserted if the Prevent Jumper is not present. If the jumper is present, then media may be inserted.

Bit 18 – Prevent Jumper – This indicates the state of the (Optional) Prevent/Allow Jumper. If 0, Jumper is present. Logical Unit will power up to the allow state. Locking the Logical Unit with the Prevent/Allow Command shall NOT prevent the insertion of media. If 1, Jumper is not present. Logical Unit will power up to the Prevent State (Locked). The Logical Unit will not accept new media or allow the ejection of media already loaded until an allow command is issued.

Bit 19 – Eject Command – The Logical Unit can eject the disc via the normal START/STOP command with the LoEj bit set. If the mechanism is a Changer that uses a Magazine, then this bit indicates that the Magazine can be ejected.

Bit 20 – Reserved

Bit 21 to 23 – Loading Mechanism Type – This field specifies the type of disc loading the Logical Unit supports.

Table 138 – Loading mechanism type

Bits 21, 22, 24	Loading mechanism type
0 0 0	Caddy type loading mechanism
0 0 1	Tray type loading mechanism
0 1 0	Popup type loading mechanism
0 1 1	Reserved
1 0 0	Changer with individually changeable discs
1 0 1	Changer using a Magazine mechanism
1 1 0	Reserved
1 1 1	Reserved

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Bit 24 – Separate Volume Levels – The audio level for each channel can be controlled independently.

Bit 25 – Separate Channel Mute – The mute capability for each channel can be controlled independently.

Bit 26 – Supports Disc Present (SDP) – This bit indicates that the Logical Unit contains an embedded changer and that after a reset condition or if a magazine is changed, it can report the exact contents of the slots. The response to the MECHANISM STATUS command will contain valid Disc is Present status information for all slots.

Bit 27 – Software Slot Selection (SSS) – This bit controls the behaviour of the LOAD/UNLOAD command when trying to load a Slot with no Disc present.

Bit 28 – Side Change Capable – This bit indicates that the Logical Unit is capable of selecting both sides of the Discs. This capability can be reported for Logical Units that have changer functions.

Bit 29 – P through W in Lead-in – This bit indicates that the Logical Units are capable of reading the raw R-W Sub-channel information from the Lead-in.

Bit 30 – 31 – Reserved

Bytes 8, 9, 14 & 15 are identified as obsolete in this standard. They should not be used in future developments.

The Number of Volume Levels Supported field returns the number of discrete levels. If the Logical Unit only supports turning audio on and off, the Number of Volume Levels field shall be set to 2.

The Buffer Size Supported field returns the number of bytes of buffer dedicated to the data stream returned to the Initiator. This value is returned in kB (Size/1 024). If the Logical Unit does not have a buffer cache, the value returned shall be zero.

Byte 17 is used to describe the format of the Logical Units digital output. Valid only if Digital Port(1) or Digital Port(2) are set (see IEC 60958).

Bit 1 – BCKF Set if data valid on the falling edge of the BCK signal. Clear if data valid on the rising edge of the BCK signal.

Bit 2 – RCK Set if HIGH on LRCK indicates left channel. Clear if HIGH on LRCK indicates right channel.

Bit 3 – LSBF Set if LSB first. Clear if MSB first.

Bit 4-5	–	Length	BCKs
	00		32
	01		16
	10		24
	11		24 (I2S)

Bytes 18 – 21 are identified as obsolete in this standard. They should not be used in future developments.

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Bytes 22 & 23 – The Copy Management Revision Supported Field indicates the version of the DVD Copy Protection scheme that is supported by the Logical Unit. For DVD this field shall be set to 0001h, if Copy Protection is implemented. All other Logical Units shall set this field to 0000h.

6 Command descriptions for all logical units

6.0 General

Commands that may be implemented common to some or all Logical Unit types are listed in other SCSI standards. For a complete description of these commands reference SCSI Primary Commands, SCSI Block Commands, SCSI MultiMedia Commands and others.

The commands listed in this subclause follow a packetized command layout. Some implementations may desire to have a common CDB length that will require the Initiator to provide a padding of a number of bytes to fill the byte length requirements of the Logical Unit.

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6.1 C/DVD commands

6.1.0 General

Commands referenced for Logical Units are listed in Table 139. These commands are described in the following subclauses.

Table 139 – Commands specific to C/DVD devices

Command name	Op code	Subclause
BLANK	A1h	6.1.1
CLOSE TRACK/SESSION	5Bh	6.1.2
ERASE (10)	2Ch	ANSI INCITS 301
FORMAT UNIT	04h	6.1.3
GET CONFIGURATION	46h	6.1.4
GET EVENT/STATUS NOTIFICATION	4Ah	6.1.5
GET PERFORMANCE	ACh	6.1.6
INQUIRY	12h	ANSI INCITS 301
LOAD/UNLOAD MEDIUM	A6h	6.1.7
MECHANISM STATUS	BDh	6.1.8
MODE SELECT (10)	55h	ANSI INCITS 301
MODE SENSE (10)	5Ah	ANSI INCITS 301
PAUSE/RESUME	4Bh	6.1.9
PLAY AUDIO (10)	45h	6.1.10
PLAY AUDIO (12)	A5h	6.1.11
PLAY AUDIO MSF	47h	6.1.12
PLAY CD	BCh	6.1.13
PREVENT/ALLOW MEDIUM REMOVAL	1Eh	ANSI INCITS 301
READ (10)	28h	ANSI INCITS 301
READ (12)	A8h	ANSI INCITS 301
READ BUFFER	3Ch	ANSI INCITS 301
READ BUFFER CAPACITY	5Ch	6.1.14
READ CD	BEh	6.1.15
READ CD MSF	B9h	6.1.16
READ CAPACITY	25h	6.1.17
READ DISC INFORMATION	51h	6.1.18
READ DVD STRUCTURE	ADh	6.1.19
READ FORMAT CAPACITIES	23h	6.1.20
READ HEADER	44h	6.1.21
READ MASTER CUE	59h	6.1.22
READ SUB-CHANNEL	42h	6.1.23
READ TOC/PMA/ATIP	43h	6.1.24
READ TRACK INFORMATION	52h	6.1.26
REPAIR TRACK	58h	6.1.27
REPORT KEY	A4h	6.1.28
REQUEST SENSE	03h	ANSI INCITS 301
RESERVE TRACK	53h	6.1.29

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Command name	Op code	Subclause
SCAN	BAh	6.1.30
SEEK (10)	2Bh	ANSI INCITS 301
SEND CUE SHEET	5Dh	6.1.31
SEND DVD STRUCTURE	ADh	6.1.32
SEND EVENT	A2h	6.1.33
SEND KEY	A3h	6.1.34
SEND OPC INFORMATION	54h	6.1.35
SET CD SPEED	BBh	6.1.36
SET READ AHEAD	A7h	6.1.37
SET STREAMING	B6h	6.1.38
START/STOP UNIT	1Bh	ANSI INCITS 301
STOP PLAY/SCAN	4Eh	6.1.39
SYNCHRONIZE CACHE	35h	6.1.40
TEST UNIT READY	00h	ANSI INCITS 301
VERIFY (10)	2Fh	ANSI INCITS 301
WRITE (10)	2Ah	6.1.41
WRITE AND VERIFY (10)	2Eh	6.1.42
WRITE BUFFER	3Bh	ANSI INCITS 301

6.1.1 BLANK command

CD-RW discs have two properties not available with CD-R: direct-overwrite and the ability to erase. The BLANK command (see Table 140) provides the ability to erase any part of a CD-RW disc.

Table 140 – BLANK command descriptor block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (A1h)							
1	Reserved			IMMED	Reserved	Blanking Type		
2	(MSB)							
3	Start Address/Track Number							
4								
5								(LSB)
6	Reserved							
7	Reserved							
8	Reserved							
9	Reserved							
10	Reserved							
11	Control Byte							

NOTE The erasing action performed in this command is a Logical Erase, in that the data is overwritten with Mode 0 data on CD media.

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The IMMED bit allows execution of the Blank command as an immediate operation. If IMMED is zero, then the requested operation is executed to completion prior to returning status. If IMMED is one, then status is returned once the operation has begun.

Blanking Type identifies the method and coverage of blanking. The codes for Blanking Type are defined in Table 141.

Start Address/Track Number is the LBA that a range, for erasure, begins.

a) When Blanking Type is Blank a Track Tail, this field indicates the start LBA.

b) When Blanking Type is Blank a Track, this field indicates the track. When the Logical Unit changes status (NOT READY, READY) a Class 1 Event shall be generated.

Table 141 – Blanking types

Value	Name	Description
000b	Blank the disc	The entire disc is to be erased. The Start Address parameter is ignored. This is used for clearing a complete disc. The PCA may be excluded. At completion of the operation, the area from the start time of Lead-in through the last possible start time of Lead-out plus 6,750 blocks and the entire PMA shall be blank.
001b	Minimally blank the disc	Erases only the PMA, first session TOC and the pre-gap of the first track. The Start Address parameter is ignored. This is used for blanking a disc quickly. After completion of this command the disc is treated as a blank disc. Caution shall be exercised when using this command as the program area still contains user data.
010b	Blank a Track	Erases the track specified in the Start Address/Track Number field. This command erases the track only, it does not erase the TOC or the PMA. The track to be erased shall be in the incomplete session.
011b	Un-reserve a Track	This is valid only when the last recorded track is incomplete, reserved or is complete and in an incomplete session. If the last track is incomplete the track and PMA entry for incomplete track is erased. If the track is reserved or complete, the track and PMA entry of the track is erased. The Start Address/Track Number parameter is ignored.
100b	Blank a Track Tail	Erase the area between the LBA specified Start Address/Track Number field and the end of the track that includes the LBA specified. The LBA specified shall be the first user data block within a packet. This blank type is valid for only a Packet track. This may be used to prepare for writing a packet track to a CD-RW disc with the same write process as a CD-R. The track to be erased shall be in an incomplete session.
101b	Unclose the last session	Erases the Lead-in and Lead-out of the last session. The last session shall be complete when this command is issued.
110b	Erase Session	If the last session is complete, its Lead-in, program area and Lead-out shall be erased. If the last session is incomplete, its program area shall be erased. If the last session is empty, the complete session immediately preceding the empty session shall be erased. If the empty session is the only session on the disc, erasing shall not be considered an error.
111b	Reserved	

During the Blanking operation, the Logical Unit shall respond to commands as follows:

a) In response to all commands except REQUEST SENSE and INQUIRY, the Logical Unit shall return CHECK CONDITION status, sense code of LOGICAL UNIT NOT READY and an asc of OPERATION IN PROGRESS unless a reservation conflict exists, in that case RESERVATION CONFLICT status shall be returned. INQUIRY` GET CONFIGURATION, GET EVENT/STATUS NOTIFICATION and REQUEST SENSE are among the commands that shall not return a NOT READY error (Sense Key 2).

b) In response to the INQUIRY, GET CONFIGURATION, GET EVENT/STATUS NOTIFICATION commands, the Logical Unit shall respond as commanded.

c) In response to the REQUEST SENSE command, unless an error has occurred, the Logical Unit shall return a sense key of NOT READY and an additional sense code of LOGICAL

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UNIT NOT READY, OPERATION IN PROGRESS, with the sense key specific bytes set for progress indication (see ANSI INCITS 301-1997). Refer to 4.1.6, description of deferred error handling for errors that may occur during the CLOSE TRACK/SESSION operation.

Recommended error reporting is defined in Table 142.

Table 142 – Recommended errors for BLANK command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3
Write Errors	Table A.4
ERASE FAILURE	Table A.1

6.1.2 CLOSE TRACK/SESSION command

The CLOSE TRACK/SESSION Command, Table 143, allows closure of either a track or a session. If the MultiSession field in the Write Parameters Mode Page (05h) is set to 11b and there is not sufficient space for the next Session, the Session to be closed shall be closed and next Session shall not be allowed. For CD, the Session is closed without the B0 pointer. For DVD, the Session is closed with Lead-out and the Start PSN of the next Border-in field of Lead-in/Border-in set to 0. In the case of insufficient space for the next Session, legacy CD-R/RW Logical Units may generate an error in the above case. In this case, the Initiator shall change the MultiSession field in the Write Parameters Mode Page (05h) and retry the Command.

Table 143 – CLOSE TRACK/SESSION command descriptor block

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (5Bh)							
1	Reserved							IMMED
2	Reserved						Session	Track
3	Reserved							
4	(MSB) Track Number							
5								(LSB)
6	Reserved							
7	Reserved							
8	Reserved							
9	Control Byte							

The IMMED bit allows execution of the close function as an immediate operation. If IMMED is zero, then the requested close operation is executed to completion prior to returning status. If IMMED is one, then status is returned once the close operation has begun.

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The Session and Track bits (see Table 144) have the following meanings:

Table 144 – Session and track bits definitions

Session	Track	Close actions
0	0	Reserved, not valid
0	1	Close the track associated with the track number in the CDB. For CD, if this is the incomplete track, the Logical Unit shall pad with all zero main data to the minimum length of 4 s. No other padding is to be done. If this is the partially recorded or empty reserved track, the Logical Unit shall pad the track. In the case of an empty track, the Logical Unit shall write the track according to the write parameter page. If the write parameter page is inconsistent with the PMA, CHECK CONDITION status shall be returned and the additional sens code shall be set to ILLEGAL MODE FOR THIS TRACK. For a partially recorded reserved track, the Logical Unit shall continue writing in the same mode as the data already recorded. For DVD, if this is the Partially Recorded Reserved Track or the Empty Reserved Track, the Logical Unit shall pad the Track with 00h bytes. If the Track status is Invisible, no close operation is to be done. In the case of an Incomplete Track, no padding is to be done and cached RMD shall be written into the RMA.
1	0	Close Session. If all Tracks in the last Session are not complete, generate a CHECK CONDITION Status, sense code of SESSION FIXATION ERROR – INCOMPLETE TRACK IN SESSION. Or if an empty or partially recorded, reserved Tracks exist in the incomplete Session, generate CHECK CONDITION Status, sense code EMPTY OR PARTIALLY WRITTEN RESERVED TRACK. Behaviour of the closing operation is dependent on the MultiSession field in the Write Parameters Mode Page (05h). Closing an empty Session not produce an error and a write to the media shall not occur.
1	1	Reserved, not valid

If a Session or Track is to be closed that is already closed, no error shall be reported.

If Session bit is set to zero and Track bit is set to one, the Track Number field indicates the number of tracks to close. Byte 4 and Byte 5 of the CDB shall be ignored if the Session bit is set to one.

For a CD to close the incomplete track, the following steps are required.

a) If necessary, the track is padded with all zero main data to the minimum length of 4 s.

b) The PMA is consulted in order to locate the largest track number recorded, ‘N’.

c) The boundaries of the track are determined and a PMA entry is written for track N+1. Closing a Track shall cause cached information for the specified Track to be committed to the medium prior to closing.

For CD Closing a Session shall cause the Lead-in and Lead-out to be written for the incomplete Session. Closing a Session when the last session is closed shall not be considered an error. Closing a session when the last session is empty shall cause no actions to be performed and shall not be considered an error. For DVD, closing an incomplete Session shall cause the Lead-in or Border-in and Border-out to be written for the incomplete Session. If the MultiSession field in the Write Parameters Mode Page (05h) is set to 00b, a Lead-out shall be appended to last Border-out. Once the Lead-out has been written for DVD media, data can not be further appended to the medium.

During the Close Track operation, the Logical Unit shall respond to commands as follows.

a) The Logical Unit may respond to commands that can return NOT READY status with CHECK CONDITION Status, sense code of LOGICAL UNIT NOT READY, OPERATION IN PROGRESS unless a reservation conflict exists, in that case RESERVATION CONFLICT status shall be returned.

b) In response to the INQUIRY, GET CONFIGURATION and GET EVENT/STATUS NOTIFICATION commands, the Logical Unit shall respond as commanded.

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c) In response to the REQUEST SENSE command, unless an error within the command has occurred, the Logical Unit shall return NOT READY status with CHECK CONDITION Status, an additional sense code of LOGICAL UNIT NOT READY, OPERATION IN PROGRESS, or an additional sense code LOGICAL UNIT NOT READY, LONG WRITE IN PROGRESS indicated in the result data and the sense key specific bytes set for progress indication with the sense key specific bytes set for progress indication (see ANSI INCITS 301-1997). Refer to 4.1.6., description of deferred error handling for errors that may occur during the CLOSE TRACK/SESSION operation.

d) Closing a Track or Session shall cause a Class 1 Event when the command is issued if the Logical Unit becomes NOT READY. A Class 1 Event shall occur if the medium returns to READY or if the medium becomes unwritable. Other Class 1 Events may occur due to closing a Track or Session.

Recommended error reporting is defined in Table 145.

Table 145 – Recommended errors for CLOSE TRACK/SESSION command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3
Write Errors	Table A.4
SESSION FIXATION ERROR	Table A.1
SESSION FIXATION ERROR WRITING LEAD-IN	Table A.1
SESSION FIXATION ERROR WRITING LEAD-OUT	Table A.1
SESSION FIXATION ERROR – INCOMPLETE TRACK IN SESSION	Table A.1
EMPTY OR PARTIALLY WRITTEN RESERVED TRACK	Table A.1

6.1.3 FORMAT UNIT command

6.1.3.0 General

The FORMAT UNIT Command (see Table 146) formats a medium into Initiator addressable logical blocks per the Initiator defined options.

The medium may be certified and control structures created for the management of the medium and defects. There is no guarantee that the medium has not been altered.

Table 146 – Format unit command

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (04h)							
1	Reserved			FmtData	CmpList	Format Code		
2	Reserved							
3	(MSB) Interleave Value							
4	(LSB)							
5	Control Byte							

A FmtData bit of zero indicates that there is no parameter list. A FmtData bit of one indicates that a parameter list is available from the Initiator. For CD-RW, DVD-RAM, and DVD-R FmtData shall be set to one.

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The CmpList bit is used in conjunction with the DCRT (see Table 149) bit to determine usage of the existing G1-list, G2-list and SDL to construct new G1-list and G2-list (see Table 147) on DVD-RAM media. A CmpList bit of zero indicates that the parameter list provided is in addition to those already available to the Logical Unit. A CmpList bit of one indicates that the parameter list is complete and the Logical Unit is to ignore any existing parameters.

Table 147 – DVD-RAM defect list handling

Cmp List	DCRT	Certification	PDL			SDL	Remarks
			P-list	G1-list	G2-list		
0	0	Yes	Preserved	New from Certification	Disposed	Disposed	Slow initialization
0	1	No	Preserved	Preserved	Old + New from SDL	Disposed	Change linear replacement to slipping, quickly
1	0	Yes (Partial)	Preserved	Old plus New from Certification	Disposed	Disposed	Create new defect list by disposing all except P-list and G1 – list
1	1	No	Preserved	Preserved	Disposed	Disposed	Return to original slipping at the latest certification, quickly

A formatted CD-RW session shall consist of a single, fixed packet track. The packet size specified in the WRITE PARAMETERS mode page defines the packet size for the format operation.

If the WRITE TYPE field in the WRITE PARAMETERS mode page is not packet (00b), the FORMAT UNIT command shall terminate with a CHECK CONDITION and set sense to ILLEGAL REQUEST, COMMAND SEQUENCE ERROR. If the FP bit in the WRITE PARAMETERS mode page is not set to one (Fixed Packet), the FORMAT UNIT command shall terminate with a CHECK CONDITION and set sense to ILLEGAL REQUEST, COMMAND SEQUENCE ERROR.

The Format Code identifies the parameter list format. For CD-RW, the Format Code shall be set to seven (111b), for DVD-RAM the Format Code shall be set to one (001b).

The Interleave Value field identifies the value to be used when formatting. The values are specified below:

- For CD-RW, Interleave Value shall be zero.
- For DVD-RAM, the value shall be set to zero

During the operation of the FORMAT command, the Logical Unit shall respond to other commands as follows.

a) In response to all commands except GET CONFIGURATION, GET EVENT/STATUS NOTIFICATION, REQUEST SENSE and INQUIRY, the Logical Unit shall return CHECK CONDITION status.

b) In response to the GET CONFIGURATION, GET EVENT/STATUS NOTIFICATION and INQUIRY command, the Logical Unit shall respond as commanded.

c) In response to the REQUEST SENSE command, unless an error has occurred, the Logical Unit shall return a sense key of NOT READY and an additional sense code of LOGICAL UNIT NOT READY, FORMAT IN PROGRESS, with the sense key specific bytes set for progress indication. See the REQUEST SENSE Command description in ANSI INCITS 301-1997. Refer to 4.1.6. for the description of handling deferred errors that may occur during the format operation.

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During the execution of the FORMAT UNIT command, the Logical Unit shall perform a medium defect management algorithm if the Defect Management Feature is current. The FORMAT UNIT command for DVD-RAM media may not provide a method to receive defect location information from the Initiator.

A format data (FmtData) bit of one indicates that the FORMAT UNIT parameter list (see Table 148) shall be transferred to the Logical Unit. The data sent to the Logical Unit consists of a Format List Header, followed by an initialization pattern descriptor (that may have zero length), followed by zero or one Format descriptors. The Format descriptor shall be one of Formattable Capacity Descriptors returned by the READ FORMAT CAPACITIES command.

The FORMAT UNIT Command parameter list (see Table 148) consists of three descriptors: the Format List Header, the Initialization Pattern Descriptor and the Format Descriptor.

Table 148 – Format unit parameter list

Bit / Byte	7	6	5	4	3	2	1	0
0 – 3	Format List Header							
4 – *n*	Initialization Pattern Descriptor (present if IP = 1)							
N + 1 to *n* + 8	Format Descriptor							

The Format List Header (see Table 149) provides several format control bits. Logical Units that implement these bits give Initiators additional control over the formatting operation. If the Initiator attempts to select any function not implemented by the Logical Unit, the Logical Unit shall terminate the command with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to INVALID FIELD IN PARAMETER LIST.

If the Initialization Pattern Descriptor is to be included in parameter data sent to the Initiator, the IP bit shall be set to one and the data shall begin at a byte offset of 4. If the IP bit is set to zero, the Initialization Pattern Descriptor shall not be included in the Format Unit Parameter data sent to the Logical Unit and the Format Descriptor shall begin at byte offset 4.

Table 149 – Format list header

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	FOV	DPRY	DCRT	STPF	IP	Try-out	IMMED	VS
2	(MSB) Format Descriptor Length							
3	(LSB)							

A Format Options Valid (FOV) bit of zero indicates that the Logical Unit shall use its default settings for the DCRT, STPF, Try-out and IMMED bits (see below). The Initiator shall set these bits to zero. If any of these bits are not zero, the Logical Unit shall terminate the command with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to INVALID FIELD IN PARAMETER LIST.

A FOV bit of one indicates that the Logical Unit shall examine the setting of the DCRT, STPF, Try-out and IMMED bits. When the FOV bit is one, the DCRT, STPF, Try-out and IMMED bits are defined as follows.

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A Disable Primary (DPRY) bit, when set to zero, indicates that the Logical Unit shall not use portions of the medium identified as defective in the primary defect Plist for Initiator addressed logical blocks. Logical Units that support DVD-RAM media do not permit the Initiator to set this bit to one. If set to one, a CHECK CONDITION status with additional sense code set to INVALID FIELD IN PARAMETER LIST is generated.

A Disable Certification (DCRT) bit, when set to zero, indicates that the Logical Unit shall perform a vendor-specific medium certification operation to generate a G 1-list (C-list). A DCRT bit of one indicates that the Logical Unit shall not perform any vendor-specific medium certification process or format verification operation while executing the FORMAT UNIT command.

The STPF bit shall be reserved.

An Initialization Pattern (IP) bit of zero indicates that an initialization pattern descriptor is not included and that the Logical Unit shall use its default initialization pattern. An IP bit of one indicates that an initialization pattern descriptor is sent to the Logical Unit as part of the FORMAT UNIT parameter list (see 6.1.3.1).

A Try-out bit of one indicates that the Logical Unit shall not alter the media format, but shall examine whether the specified FORMAT command can be performed without error, based on available information before starting the formatting.

An immediate (IMMED) bit of zero indicates that status shall be returned after the format operation has completed. An IMMED bit value of one indicates that the Logical Unit shall return status as soon as the command descriptor block has been validated and the entire Format Descriptor has been transferred.

If the IMMED bit is set to one, and a REQUEST SENSE command is issued during the formatting operation, the Logical Unit shall return a sense key of NOT READY and an additional sense code of LOGICAL UNIT NOT READY, OPERATION IN PROGRESS, unless an error has occurred. The sense key specific bytes shall be set to the percentage of the operation that has completed. The sense key specific field contains a value from 0 to FFFFh, where FFFFh indicates the formatting is completed.

The Format Descriptor Length field in the Format list header specifies the total length in bytes of the Format descriptors that follow and does not include the initialization pattern descriptor or initialization pattern, if any.

The Format Descriptor Length shall be set to 8. Any other value in this field shall return CHECK CONDITION with the Sense Key set to ILLEGAL REQUEST and the Sense Code set to INVALID FIELD IN PARAMETER LIST.

6.1.3.1 Initialization pattern

The initialization pattern option specifies that the logical blocks contain the specified initialization pattern. The initialization pattern descriptor (see Table 150) is sent to the Logical Unit as part of the FORMAT UNIT parameter list.

Table 150 – Initialization pattern descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	IP Modifier		SI	Reserved				
1	Pattern Type							
2	(MSB) Initialization Pattern Length							
3								(LSB)
4	Initialization Pattern							
:								
n								

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The IP Modifier field specifies the type and location of a header that modifies the initialization pattern (see Table 151).

Table 151 – IP modifier field

IP modifier	Descriptor
00b	No header. The device server shall not modify the initialization pattern.
01b	The device server shall overwrite the initialization pattern to write the logical block address in the first four bytes of the logical block. The LBA shall be written with the most significant byte first.
10b	The device server shall overwrite the initialization pattern to write the logical block address in the first four bytes of each physical block contained within the logical block. The lowest numbered logical block or part thereof that occurs within the physical block is used. The LBA shall be written with the most significant byte first.
11b	Reserved

The Initialization Pattern Type field (see Table 152) indicates the type of pattern the device server shall use to initialize each logical block within the application client accessible portion of the medium. All bytes within a logical block shall be written with the initialization pattern. The Initialization Pattern is modified by the IP Modifier field.

Table 152 – Initialization pattern type

Initialization pattern type	Description
00h	Use default pattern1
01h	Repeat the initialization pattern as required to fill the logical block.2
02h to 7Fh	Reserved
80h to FFh	Vendor-specific
NOTE 1 If the initialization pattern length is not zero the device server shall terminate the command with CHECK CONDITION status and the sense key shall be set to ILLEGAL REQUEST with the additional sense code set to INVALID FIELD IN PARAMETER LIST. NOTE 2 If the initialization pattern length is zero the device server shall terminate the command with CHECK CONDITION status and the sense key shall be set to ILLEGAL REQUEST with the additional sense code set to INVALID FIELD IN PARAMETER LIST.	

A Security Initialize (SI) bit of one indicates that the device server shall attempt to write the initialization pattern to all areas of the media including those that may have been reassigned. An SI bit of one shall take precedence over any other FORMAT UNIT field. The initialization pattern shall be written using a security erasure write technique. Application clients may choose to use this command multiple times to fully erase the previous data. Such security erasure write technique procedures are outside the scope of this standard. The exact requirements placed on the security erasure write techniques are vendor-specific. The intent of the security erasure write is to render any previous user data unrecoverable by any analog or digital technique.

An SI bit of zero indicates that the device server shall initialize the application client accessible area of the media. The device server is not required to initialize other areas of the media. However, the device server shall format the medium as defined in the FORMAT UNIT command.

When the SI bit is one, the device server need not rewrite (format) header and other information not previously accessible to the application client. If any area of the medium that previously was accessible to the application client cannot be written, the device server shall terminate the command with CHECK CONDITION status and the sense key shall be set to MEDIUM ERROR with the appropriate additional sense code for the condition.

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The Initialization Pattern Length field indicates the number of bytes contained in the initialization pattern.

If the length exceeds the current logical block size the device server shall terminate the command with CHECK CONDITION status and the sense key shall be set to ILLEGAL REQUEST with the additional sense code set to INVALID FIELD IN PARAMETER LIST. The pattern is modified by the IP Modifier field.

The Format descriptor specifies an eight-byte entry.

6.1.3.2 CD-RW format descriptor, format code 111b

If the Format Code, in the CDB, is 111b the CD-RW Format Descriptor defined in Table 153 shall be sent.

Table 153 – CD-RW format descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	SESS	Grow	Reserved					
1	Reserved							
2	Reserved							
3	Reserved							
4	(MSB)							
5	Format Size							
6								
7								(LSB)

If both the Grow and Session bits are set to zero the format operation shall format (Format Size) user data blocks. Format Size shall be integrally divisible by the Packet Size field in the WRITE PARAMETERS mode page. The first formatted user data block shall be LBA 0. Existing information on the disc may be overwritten. After the format, a single session containing a single fixed packet track will exist on the medium.

If the Grow bit is set to zero and the Session bit is set to 1 the format operation shall create a new session that contains (Format Size) user data blocks. Format Size shall be integrally divisible by the Packet Size field in the WRITE PARAMETERS mode page. If the last session on the disc is not complete when this command is issued, a CHECK CONDITION status shall be generated.

A Grow bit of 1 indicates that the final session shall be "grown" to (Format Size) from its original size. This is accomplished by appending packets to the existing session, writing a new Lead-out and updating the PMA and Lead-in to change the track size to reflect the new size. Data in existing packets shall not be affected. If the Format Size is smaller than the existing size, a CHECK CONDITION status shall be returned. The order of updating the PMA, Lead-in, Lead-out and data area is not specified.

The session bit shall be ignored when the Grow bit is set.

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6.1.3.3 Format code 001b

If the Format Code, in the CDB, is 001b the Format Code 1 Format Descriptor defined in Table 154 shall be sent.

Table 154 – Format code 001b format descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	Number of Blocks							
2								
3								(LSB)
4	Format Type						Reserved	
5	(MSB)							
6	Type Dependent Parameter							
7								(LSB)

The Format descriptor specifies an eight-byte entry.

The Format Type field specifies the type of formatting. Contents of the Number of Blocks field and the Type Dependent Parameter field depend on the type of formatting.

6.1.3.4 Formatting on format type = 00h (full format)

Formatting for the whole media are specified. The defect list handling is specified by the combination of the CmpList bit and the DCRT bit as shown in Table 147. The Number of Blocks field specifies the number of addressable blocks for the whole disc and the Type Dependent Parameter field specifies the Block Length. Neither field is changeable from the values reported by the READ CAPACITY Command in 6.1.17.

6.1.3.5 Formatting on format type = 04h (zone reformat)

The Zoned formatting for a zone of the media are specified, where the size of zone is not constant across zones. The defect list handling is specified by the combination of the CmpList bit and the DCRT bit as shown Table 147 – DVD-RAM Defect List Handling. The Number of Blocks field specifies the number of addressable blocks for the zone and the Type Dependent Parameter field specifies the Zone number of the zone to be formatted. If a spare sector is used as a replacement for another zone so that the zoned formatting cannot be preformed, the command shall be terminated with an CHECK CONDITION status. The sense key shall be set to MEDIUM ERROR and the additional sense code & qualifier set to ZONED FORMATTING FAILED DUE TO SPARE LINKING, with the sense key specific bytes set to zone number of the first zone that has a spare linking into the designated zone.

The discarding of G 1-list, G 2-list and SDL is only applicable to defects within the zone being reformatted.

6.1.3.6 Formatting on format type = 05h (zone format)

The Zoned formatting for a zone of the media are specified, where the size of zone is constant for each zone, e.g. floppy media where each track is labeled a zone. The Number of Blocks field specifies the number of addressable blocks for the zone and the Type Dependent Parameter field specifies the Zone number of the zone to be formatted. The zone number shall be in the range of 0 to the Type Dependent Parameter reported in READ CAPACITY Command in 6.1.17.

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6.1.3.7 Formatting on format type = 10h (CD-RW full format)

Formatting to create a session on CD-RW media is specified. The created session shall become the only session on the medium. The Number of Blocks field specifies the number of addressable blocks for the new session and the Type Dependent Parameter field specifies the Fixed Packet Size. Both parameters may be adjusted to values less than or equal to the values reported by the READ FORMAT CAPACITIES Command, see 6.1.20. The Logical Unit shall round the Number of Blocks up to be an integral multiple of the packet size.

6.1.3.8 Formatting on format type = 11h (CD-RW grow session)

Formatting to expand the last session of a CD-RW media is specified. The Number of Blocks field specifies the number of addressable blocks to be enlarged and the Type Dependent Parameter field specifies the Block Length.

6.1.3.9 Formatting on format type = 12h (CD-RW add session)

Formatting to add a new session to a CD-RW media is specified. The Number of Blocks field specifies the number of addressable blocks for the new session and the Type Dependent Parameter field specifies the Fixed Packet Size. Both parameters may be adjusted to values less than or equal to the values reported, see 6.1.17.

6.1.3.10 Formatting on format type = 20h (full format, DVD + RW)

Formatting for the whole media is specified. The Number of Blocks field specifies the maximum number of addressable blocks for the whole disc and the Type Dependent Parameter field specifies the sparing parameters SL and SI. The Logical Unit shall verify that SL and SI are usable values (will not cause overflow of the SDL).

If the MultiSession Field (see Table 123) in the Write Parameter Page is 11b, the Logical Unit shall erase the remaining area of the disc.

Recommended error reporting is defined in Table 155.

Table 155 – Recommended errors for FORMAT UNIT command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3
Write Errors	Table A.4
FORMAT COMMAND FAILED	Table A.1
CANNOT FORMAT MEDIUM – INCOMPATIBLE MEDIUM	Table A.1

6.1.4 GET CONFIGURATION command

6.1.4.0 General

This command is intended to provide information to the initiator about the overall capabilities of the device and the current capabilities of the device. For example, configurations reported by devices are used by the Initiator for Driver Identification/loading and other user presentation processes.

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The GET CONFIGURATION command, see Table 156, requests that the device respond with the configuration of the device and medium.

The configuration of the device, is described by the Logical Unit supported features. The currently defined features are listed in Table 37. The maximum number of features is 65 536; and the maximum number of bytes that a device may return to describe its set of supported features is 65 534. Feature lists longer than 65 534 bytes require multiple commands.

Persistent Prevent may be used to control when changes occur. If a persistent prevent is in place, the configuration should not change except under initiator control.

Table 156 – GET CONFIGURATION command descriptor block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (46h)							
1	Reserved				Reserved		RT	
2	(MSB) Starting Feature Number							
3								(LSB)
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB) Allocation Length							
8								(LSB)
9	Control							

The RT (Requested Type) (see Table 157) field indicates the set of Feature Descriptors desired from the Logical Unit.

Table 157 – RT field definition

RT field	Description	Starting feature number (SFN) usage
00b	Indicates that the Logical Unit shall return the Feature Header and all Feature Descriptors supported by the Logical Unit whether or not they are currently active.	The first Feature Descriptor returned shall have a feature number greater than or equal to the SFN.
01b	Indicates that the Feature Header and only those Feature Descriptors that have their Current bit set shall be returned.	
10b	Indicates that exactly one Feature Header and zero or one Feature Descriptors be returned. If the Logical Unit does not support the indicated feature, no Feature Descriptor is returned.[1)]	The SFN specifies the Feature Descriptor that shall be returned.
11b	Reserved	

1) This may be used to request Feature 0, which is a list of Profiles.

The Starting Feature Number field indicates the first feature number to be returned. All supported feature numbers higher than the Starting Feature Number will be returned.

The Allocation Length field specifies the maximum length in bytes of the Get Configuration response data. An Allocation Length field of zero indicates that no data shall be transferred. This condition shall not be considered an error.

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6.1.4.1 GET CONFIGURATION response data

The GET CONFIGURATION response Data (see Table 158) consists of a header field and zero or more variable length feature descriptors.

Table 158 – GET CONFIGURATION response data format

Bit / Byte	7	6	5	4	3	2	1	0
0 to 7	Feature Header							
8 to n	Feature Descriptor(s)							

The Feature Header field to be returned is shown in Table 159.

Table 159 – Feature header

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	Data Length							
2								
3								(LSB)
4	Reserved							
5	Reserved							
6	(MSB)	Current Profile						
7								(LSB)

The Data Length field indicates the amount of data available given a sufficient allocation length following this field. This length shall not be truncated due to an insufficient Allocation Length. If the Data Length is greater than 65 530 bytes, multiple GET CONFIGURATION commands with different Starting Feature Numbers will be required for the initiator to read all configuration data. This field is adjusted as appropriate for the given Starting Feature Number.

The Current Profile field shall indicate the Logical Unit's current profile. The Logical Unit shall choose the most appropriate current profile from the list of profiles (see Table 39) with their CurrentP bit set. If there are no profiles currently active, this field shall contain zero.

The Feature Descriptor(s) generic format returned is defined in Table 160. Each individual feature description is defined in the appropriate subclause.

Table 160 – Feature descriptor generic format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)	Feature Code						
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length							
4 to *n*	Feature Dependent Data							

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The Feature Code field contains the code number assigned to the feature.

Version field, see 5.2.1.

Persistent bit, see 5.2.2.

Current bit, see 5.2.3.

6.1.4.2 Features

Features are the smallest set of commands, pages and behaviour that may be implemented. A list of features are shown in Table 37.

Each Feature supported by a Logical Unit shall be described by a Feature Descriptor. All feature descriptors shall be a multiple of four bytes long. The format of a Feature Descriptor is shown in Table 36.

The Feature Code field shall identify a feature supported by the Logical Unit.

The Version field is reserved and shall be set to zero. Future versions of a feature will be backward compatible; incompatible changes will be included in a different feature.

The Persistent bit, when set to zero, shall indicate that this feature may change its current status. The Persistent bit, when set to one, shall indicate that this feature is always active. The Logical Unit shall not set this bit to one if the Current bit is, or may become, zero.

The Current bit, when set to zero, indicates that this feature is not currently active and that the Feature Dependent Data may not be valid. The Current bit, when set to one, is currently active and the Feature Dependent Data is valid.

The Additional Length field indicates the number of Feature specific bytes that follow this header. This field shall be an integral multiple of 4.

6.1.4.3 Profile list

This feature identifies profiles supported by the Logical Unit. Profiles are defined as collections of features and provide a method to quickly determine the Logical Unit's type. This feature is always current, even if none of the profiles listed is current. See Table 38, Table 39 and Table 40 for definitions and description of the Profile List.

The Profile Descriptors are shown in Table 39. All profiles supported by the Logical Unit shall always be reported. Profile descriptors are returned in the order of preferred operation most desirable to least desirable. For example, a DVD-ROM that could also read CD-ROM would list the DVD-ROM profile first and the CD-ROM profile second.

The Profile Number identifies a profile to which the Logical Unit conforms, see Table 40.

The Current bit, when set to one, shall indicate that this profile is currently active. If no medium is present, no profile should be active. Multifunction devices shall select the most appropriate profile(s), if any, to set as current. The most appropriate current profile is also reported in the Feature Header, see Table 35.

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Recommended error reporting is defined in Table 161.

Table 161 – Recommended errors for GET CONFIGURATION command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3

6.1.5 GET EVENT/STATUS NOTIFICATION

The GET EVENT/STATUS NOTIFICATION Command, see Table 162, requests the Logical Unit to report events and statuses as specified in the Notification Class field and provides asynchronous notification. Two modes of operation are defined here. They are polling and asynchronous modes.

In polling mode, the Initiator will issue GET EVENT/STATUS NOTIFICATION commands at periodic intervals with an IMMED (Immediate) bit set to one. The target shall complete this command with the most recently available event status requested. The Logical Unit shall support polling mode.

In asynchronous mode, the Initiator will issue a single GET EVENT/STATUS NOTIFICATION command with an IMMED (immediate) bit of 0 requested. If the Logical Unit does not support Asynchronous Mode, the command shall fail as an illegal request. If the Initiator requests Asynchronous Mode using a request that is not queued or overlapped, the command shall fail as an illegal request.

When Asynchronous Event Status reporting is supported, the target shall not complete a GET EVENT/STATUS NOTIFICATION command with an IMMED bit of 0 until a change in event status of the requested class occurs. The target shall complete the GET EVENT/STATUS NOTIFICATION Command as soon as possible after the event occurs. It will report the event as outlined below.

Only one class of event per GET EVENT/STATUS NOTIFICATION Command shall be reported. The priority of event reporting shall be by Event Class number. The lower the Class number the higher the priority.

This command shall not return CHECK CONDITION status to report a unit attention condition.

Table 162 – GET EVENT/STATUS NOTIFICATION command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (4Ah)							
1	Reserved				Reserved			IMMED
2	Reserved							
3	Reserved							
4	Notification Class Request							
5	Reserved							
6	Reserved							
7	(MSB) Allocation Length							
8								(LSB)
9	Control							

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The Allocation Length field specifies the maximum Event Notification Response length, in bytes, that shall be transferred from the Logical Unit to the Initiator. An Allocation Length field of zero indicates that no data shall be transferred. This condition shall not be considered an error.

Notification Class Request field specifies that the Logical Unit report event(s) from the event classes requested in this field. Table 163 defines the codes listed in this field.

Table 163 – Notification class request

Bit	Definition
0	Reserved
1	Operational Change Request/Notification
2	Power Management Class Events
3	External Request
4	Media Status Class Events
5	Multi-Initiator
6	Device Busy Class Events
7	Reserved

If a Logical Unit does not support any of the requested event classes, the Logical Unit shall terminate the command successfully, returning only the Event Status Notification Response (see Table 164) and indicating a returned Class of 0.

Initiators that manage media event status may or may not be linked to other entities that manage power states. This notification field provides a way that power and media event status notifications can be independently managed by the responsible entities. If a driver manages media, power management and Busy Device events, the driver can issue this command with notification field set to 01010100b to request the Logical Unit to report power, media and busy events.

Table 164 – Event status notification response

Bit / Byte	7	6	5	4	3	2	1	0
0 to 3	Event Header							
4 to *n*	Event Data							

The Event Header returns the data defined in Table 165.

Table 165 – Event header return data

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Event Data Length							
1								(LSB)
2	NEA	Reserved				Notification Class		
3	Supported Event Classes							

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The Event Data Length field specifies the amount of data that follows the Event Status Notification Header. The amount of data reported shall be the number of bytes following the data length field.

The No Event Available (NEA) bit, when set to one, shall indicate none of the requested notification classes are supported. When set to zero, it shall indicate that at least one of the requested notification classes is supported.

The Notification Class field specifies the class of notification by number. See Table 166.

Supported Event Classes field specifies the event classes that the Logical Unit supports as per the Notification Class Field. If a Feature is supported, the corresponding bit shall be set to one.

Table 166 – Notification class field

Field	Description
000b	Reserved
001b	Operational Change Request/Notification
010b	Returns Power Management class events
011b	External Request
100b	Returns Media Class events
101b	Multiple Initiators
110b	Device Busy Class event
111b	Reserved

The data returned, with a class code 001b, is defined in Table 167.

Table 167 – Operational change/notification returned data

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved				Operational Event			
1	Persistent Prevented	Reserved			Operational Status			
2	(MSB) Operation Request/Report							
3	(LSB)							

Persistent Prevented bit reports the current state of the persistent prevent for the Logical Unit. See 5.3.4.

Operational Status (Table 169) field reports the device's ability to respond to the Initiator.

Table 168 – Operational status response

Code	Status	Description
0h	NoChg	No changes in the Logical Unit Operational state performed or requested
1h	Operational Change Request	The Logical Unit The unit requests to change operational state (morph request)
2h	Logical Unit has changed Operational state	The Logical Unit has changed Operational state
3h to Fh	Reserved	Reserved

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Table 169 – Operational status format

Code	Status	Description
0h	Available	The Logical Unit is ready for operation
1h	Temporarily busy	The Logical Unit is performing a task that will self-terminate
2h	Busy/Reserved	The Logical Unit is performing operations that will take an indefinite amount of time to terminate or is reserved by another Initiator.
3h to Fh	Reserved	Reserved

Operational Event field reports Logical Unit requests to change state and notifications of changes in device state. If a persistent prevent is in place, any action request that can be reported before performing the action shall not be performed by the Logical Unit and the device shall notify the Initiator of the requested action. In all other cases, the Logical Unit shall notify the Initiator of actions that change Device State. An example of an action that shall be reported after the action is taken is termination of a format operation due to completion of formatting. Upon reporting operational change notification to the Initiator, this field is reported as 0h on subsequent GET EVENT/STATUS NOTIFICATION commands until a new change in operational state occurs.

Operation Request/Report field (see Table 170) reports the operation requested or operation that has been performed. The request usually originates from another Initiator.

Table 170 – Operational request/report format

Code	Event	Description
0h	NoChg	No changes in operational state performed or requested
1h	Change	An unspecified event has changed the Feature list
2h	Add Change	The Feature list may have added Current Features (No Features became non-Current)
3h	Reset	The Logical Unit has been reset
4h	Firmware Changed	The Logical Unit's Microcode may have changed
5h	Inquiry change	The Logical Unit's identification information may have changed
6h to FFFFh	Reserved	

Event 0h requires no Initiator action. The Initiator should respond to Events 1h through 5h with a GET CONFIGURATION Command to determine the Logical Unit configuration.

The data returned, with a class code 010b, is defined in Table 171.

Table 171 – Power management status returned data

Byte \ Bit	7	6	5	4	3	2	1	0
0	Reserved				Power Event			
1	Power Status							
2	Reserved							
3	Reserved							

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Power Event field (see Table 172) reports the current change in the power status. This field is set to a new power event if a change in the power state occurs. Upon reporting the current power status change to the Initiator, this field is reported as 0h on subsequent GET EVENT/STATUS NOTIFICATION commands until a new change in the power state occurs.

If the Logical Unit is commanded to go the same state as the Logical Unit is currently in, the next GET EVENT/STATUS NOTIFICATION (Power Class) command shall report a Power Change Successful event.

Table 172 – Power event field

Code	Event	Description
0h	NoChg	No changes in power state or in power state transition
1h	PwrChg-Successful	The Logical Unit successfully changed to the specified power state
2h	PwrChg-Fail	The Logical Unit failed to enter the last requested state and is still operating at the power state specified in the Power State field.
3h to Fh	Reserved	

The Power Status field (see Table 173) indicates the state of the Logical Unit. The Logical Unit shall be set to Standby (3h) by a hard reset, a power-on reset or a Device reset (issued from a Sleep state).

Table 173 – Power status field

Code	Status	Description
0h	Reserved	
1h	Active	The Logical Unit is in Active state
2h	Idle	The Logical Unit is in Idle state
3h	Standby	The Logical Unit is in Standby state
4h	Sleep	The Logical Unit is about to enter Sleep state
5h to Fh	Reserved	

Table 174 – External request descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved				External Request Event			
1	Persistent Prevented	Reserved			External Request Status			
2	(MSB) External Request							
3								(LSB)

The External Request Event field reports external requests to change state and notifications of changes in Logical Unit state. If a Persistent Prevent is in place for the Initiator, the action shall not be performed by the Logical Unit. If a Persistent Prevent is not in place for the Initiator, the drive shall notify the Initiator of actions that change drive state. Upon reporting operational change notification to the Initiator, this field is reported as 0h on subsequent GET EVENT/STATUS NOTIFICATION Commands until a new External Request occurs. The External Request Events are listed in Table 175.

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Table 175 – External request event format

Code	Event	Description
0h	NoChg	No changes in the Logical Unit Operational state performed or requested
1h	Logical Unit Key Down	A front, back or remote button has been depressed
2h	Logical Unit Key Up	A front, back or remote button has been released
3h	External Request Notification	The Logical Unit has received a command from another Initiator that would require an action that may interfere with the Persistent Prevent owner's operation.
4h – Fh	Reserved	

The Initiator may respond to Events 1-3 with no action, an appropriate action or with a SEND EVENT Command. The Initiator may respond to Event 4 with a GET CONFIGURATION Command. Events 1 and 2 should occur in pairs.

The Persistent Prevent bit reports the current state of the persistent prevent for the Logical Unit. This bit shall be set to 1 if any Initiator has performed a persistent reservation.

The External Request Status field reports the Logical Unit's ability to respond to the Initiator.

Table 176 – External request status codes

Code	Status	Description
0h	Available	The Logical Unit is ready for operation
1h	Other Prevent	Indicates that another Initiator has an active Persistent Prevent. The Persistent Prevent bit shall be set to one.
2h to Fh	Reserved	Reserved

The External Request field reports the operation requested or operation that has been performed. The request usually originates from the unit's own user interface (i.e. front panel buttons) or from another initiator.

Table 177 – External request codes

Code	Status	Description
0h	No Request	No requests are pending
1h	Overrun	The Request Queue has overflowed, External Request Events may be lost.
2h to FFh	Reserved	
100h to 1FFh	Programmed Button	A front panel button was pressed or equivalent action requested by another Initiator. The button has an associated 8-bit value. The 8-bit value shall be the least significant 8 bits of Code.
101h	Play	The play button was pressed or another initiator requested a play operation.
102h	Rewind/back	The rewind/back button was pressed or another initiator requested a rewind/back operation.
103h	Fast Forward	The fast/forward button was pressed or another initiator requested a fast/forward operation.
104h	Pause	The pause button was pressed or another initiator requested a pause.
105h	Reserved	
106h	Stop	The stop button was pressed or another initiator requested a stop.
107h to EFFFh	Reserved	
F000h to FFFFh	Vendor Unique	

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The data returned, with a class code 100b, is defined in Table 178.

Table 178 – Media event descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved				Media Event			
1	Media Status							
2	Start Slot							
3	End Slot							

The Media Event field is defined in Table 179.

Table 179 – Media event format

Code	Event	Description
0h	NoEvent	Media status is unchanged
1h	EjectRequest	The Logical Unit has received a request from the user (usually through a mechanical switch on the Logical Unit) to eject the specified slot or media.
2h	NewMedia	The specified slot (or the Logical Unit) has received new media and is ready to access it.
3h	MediaRemoval	The media have been removed from the specified slot, and the Logical Unit is unable to access the media without user intervention.
4h	MediaChanged	The user has requested that the media in the specified slot be loaded.
5h to Fh	Reserved	

The Media Status byte is defined in Table 180.

Table 180 – Media status byte definition

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved						Media Present	Door or Tray open

The Media Present status bit indicates if there are media present in the Logical Unit. A bit of 1 indicates that there are media present in the Logical Unit. This bit is reported independently from the Door or Tray Open bit. If the Logical Unit does not support the capability of reporting the media state while the door or tray is open, it shall set this bit to zero when the door or tray is open.

Door or Tray Open Status bit indicates if the Tray or Door mechanism is in the open state. A bit of 1 indicates the door/tray is open.

Start Slot field defines the first slot of a multiple slot Logical Unit the media status notification applies to. For Logical Units that do not support multiple slots, this field shall be reserved.

End Slot field defines the last slot of a multiple slot Logical Unit the media status notification applies to. For Logical Units that do not support multiple slots, this field shall be reserved.

The slot numbers are defined in the GET MECHANISM STATUS Command, see 6.1.8.

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The data returned, with a class code 110b, is defined in Table 185.

Multi-Initiator Class Events notify the Initiator of requests for control by other Initiators.

Table 181 – Multiple initiator descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved				Multiple Initiator Event			
1	Persistent Prevented	Reserved			Multiple Initiator Status			
2	(MSB) Multiple Initiator							
3	(LSB)							

The Multi-Initator Event field reports requests for control of and reporting of changes in Logical Unit state. If a Persistent Prevent is in place for that Initiator, the Logical Unit shall not perform the action requested. If a Persistent Prevent is not in place for that Initiator, the drive shall notify the Initiator of actions that change the Logical Unit state. Upon reporting Multi-Initiator Events to the Initator, this field is reported as 0h on subsequent GET EVENT/STATUS NOTIFICATION Commands until a new Multi-Initator Event occurs. The Multi-Initiator Events are listed in Table 184.

Table 182 – Multiple initiator event format

Code	Event	Description
0h	NoChg	No changes in the Logical Unit Operational state performed or requested
1h	Control Request	Another Initiator as requested Logical Unit control.
2h	Control Grant	Another Initiator as received Logical Unit control.
3h	Control Release	Another Initiator as released Logical Unit control.
4h to Fh	Reserved	

The Initator may respond to Events 1-3 with no action or an appropriate Persistent Prevent or Persistent Release.

The Persistent Prevent bit reports the current state of the Persistent Prevent for the Logical Unit.

Table 183 – Multiple initiator status codes

Code	Status	Description
0h	Available	The Logical Unit is ready for operation
1h	Other Prevent	Indicates that another Initiator has an active Persistent Prevent. The Persistent Prevent bit shall be set to one.
2h to Fh	Reserved	Reserved

The Multiple Intiator Request field reports the operation requested or the operation that has been performed. The request originates from the Logical Unit's own user interface (i.e. front panel buttons) or from another Initiator.

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Table 184 – Multiple initiator codes

Code	Status	Description
0h	No Request	No requests are pending
1h	Low	There are no tasks pending on the Initiator for this Logical Unit.
2h	Medium	There are no critical tasks pending on the Initiator for this Logical Unit.
3h	High	There are critical tasks pending on the Initiator for this Logical Unit.
4h to FFFFh	Reserved	

Device Busy Events are used to notify the Initiator of commands that are executing but that require an abnormally long time to complete. Response data is defined in Table 185.

Table 185 – Device busy event descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved				Device Busy Event			
1	Device Busy Status							
2	(MSB) Time							
3	(LSB)							

The Device Busy Event field code is defined in Table 186.

Table 186 – Device busy event format

Code	Event	Description
0h	NoEvent	No event is available
1h	Busy Event	A time-out has occurred
2h to Fh	Reserved	

The Device Busy Status byte is defined in Table 187.

Table 187 – Device busy status format

Code	Status	Description
0h	NoEvent	The Logical Unit is ready to accept any command.
1h	Power	The Logical Unit is in the process of waking up from a low-power state.
2h	Immediate	The Logical Unit is in the process of completing an earlier command.
3h	Deferred	The Logical Unit is in the process of completing a deferred operation.
4h to Fh	Reserved	

The Time field is the predicted amount of time remaining for the Logical Unit to become not busy, in units of 100 ms.

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This type of event is usable in two environments. The first is in a queued environment. The GET EVENT/STATUS NOTIFICATION command may be issued in a non-immediate mode prior to executing commands or in the immediate mode while commands are being executed. The second environment is where immediate commands and deferred writing are performed. This command may be issued in the immediate mode to obtain status. If a normal command is issued while the device is busy, this command cannot be issued until the normal command completes. Therefore, if queuing is not used, the GET EVENT/STATUS NOTIFICATION command should precede any command that may time out.

If a GET EVENT/STATUS NOTIFICATION command with the Device Busy class bit set is queued, the Logical Unit shall complete the command after a time-out as defined in the time-out section has occurred. However, instead of generating a UNIT ATTENTION condition, the only action is to complete this command. If this event is to be used via polling in the immediate mode, the Initiator should disable the Logical Unit time-outs.

If Report Status Notification is not supported or not enabled, the Logical Unit shall return CHECK CONDITION, sense key set to ILLGAL REQUEST, additional sense key set to INVALID FIELD IN CDB.

If the IMMED bit is set to one and there is no Event to report, the command shall return good status.

If the IMMED bit is set to zero (and the Logical Unit supports tagged command queuing) and there is NO event to report, the GET EVENT/STATUS NOTIFICATION command shall be queued by the target until there is an Event to report.

If the IMMED bit is set to zero and the target DOES NOT support tagged command queuing, the target shall return CHECK CONDITION, sense key to ILLEGAL REQUEST, additional sense code to INVALID FIELD IN CDB.

Recommended error reporting is defined in Table 188.

Table 188 – Recommended errors for GET EVENT/STATUS NOTIFICATION command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3

6.1.6 GET PERFORMANCE

The GET PERFORMANCE command, see Table 189, provides a method for the Initiator to Profile the performance of the drive. The command can report two forms: the nominal performance and exception locations that may cause seek delays to occur. These performance parameters are reported separately for read and write.

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Table 189 – GET PERFORMANCE command descriptor block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (ACh)							
1	Reserved			Tolerance		Write	Except	
2	(MSB)							
3	Starting LBA							
4								
5								(LSB)
6	Reserved							
7	Reserved							
8	(MSB)			Maximum Number of Descriptors				
9								(LSB)
10	Reserved							
11	Control							

The Tolerance field, when set to 10b, shall indicate that the descriptors returned shall have a 10 % tolerance for the nominal performance and 20 % for the exception list. All other values are reserved for future standardization.

The Write bit, when set to zero, shall indicate that the performance parameters for reading shall be returned. When set to one, the performance parameters for writing shall be returned.

The Except field, when set to 00b, shall indicate that the nominal performance parameters be returned. When set to 01b, the entire performance exception list, qualified by the Starting LBA, shall be returned. When set to 10b, only performance exceptions that cause the performance to fall outside the nominal shall be reported. For example, slipped sectors may not be included in the 10b list, but would be included in the 01b list. An Except field of 11b is reserved.

The Starting LBA field is valid only when Except = 01b. If Except = 01b, the Starting LBA field shall indicate the starting point for returning performance data. All performance data shall be for logical block addresses equal to this field or greater.

The Maximum Number of Descriptors shall indicate the maximum number of descriptors that the Logical Unit returns.

The performance response (see Table 190) shall contain a Performance header and Performance descriptors.

Table 190 – Performance response format

Bit / Byte	7	6	5	4	3	2	1	0
0 – 7	Performance Header							
8 to *n*	Performance Descriptor(s)							

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The Performance Header is defined in Table 191.

Table 191 – Performance header

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	Performance Data Length							
2								
3								(LSB)
4	Reserved						Write	Except
5	Reserved							
6	Reserved							
7	Reserved							

The Performance Data Length field shall specify the amount of result data that follows the Performance Data Length field.

The Write bit, when set to zero, shall indicate that the result data is for read performance using the nominal command for the data type. The Write bit, when set to one, shall indicate that the result data is for write performance.

The Except bit, when set to zero, shall indicate that the result data is for nominal performance (see Table 192). The Except bit, when set to one, shall indicate that the result data is for exception conditions (see Table 193).

The Performance Descriptors (see Table 192) for nominal performance are intended to give the Initiator an approximation of Logical Unit performance. All numbers are nominal. On CD media, all sectors shall be reported as 2 352 byte sectors. The descriptor includes a Start LBA value, a Start Performance value in kilobytes per second, an End LBA value and an End Performance value in kilobytes per second.

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Table 192 – Performance descriptor – Nominal performance

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1				Start LBA				
2								
3								(LSB)
4	(MSB)							
5				Start Performance				
6								
7								(LSB)
8	(MSB)							
9				End LBA				
10								
11								(LSB)
12	(MSB)							
13				End Performance				
14								
15								(LSB)

The Start LBA field contains the first logical block address of the extent described by this descriptor.

The Start Performance field contains the nominal Logical Unit performance at the Start LBA in kB/s.

The End LBA field contains the last logical block address of the extent described by this descriptor.

The End Performance field contains the nominal Logical Unit performance at the End LBA in kB/s.

Table 193 – Performance descriptor – Exceptions

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1				LBA				
2								
3								(LSB)
4	(MSB)				Time			
5								(LSB)

The LBA field shall indicate that there is a seek delay between (LBA – 1) and LBA.

The Time field shall indicate the expected additional delay between (LBA – 1) and LBA from nominal, in units of tenths of milliseconds (100 µs). This seek delay may be due to linear replacement, zone boundaries or other media dependent Features. The expected additional delay should represent the typical time expected for the type of exception described.

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NOTE A block replaced by linear replacement may cause two exceptions to appear in the Exception Descriptor list – one between the non-replaced area and the beginning of the replaced block and one from the end of the replaced block back to the non-replaced area.

Recommended error reporting is defined in Table 194.

Table 194 – Recommended errors for GET PERFORMANCE command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3

6.1.7 LOAD/UNLOAD MEDIUM command

The LOAD/UNLOAD MEDIUM command (see Table 195) requests the Logical Unit Changer to load or unload a Disc. New LOAD/UNLOAD MEDIUM commands issued before the changer enters the READY STATE (00b), see Table 201, shall cause the changer to stop any LOAD/UNLOAD MEDIUM command in progress and begin processing the new LOAD/UNLOAD MEDIUM command.

Table 195 – LOAD/UNLOAD MEDIUM command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (A6h)							
1	Reserved			Reserved				IMMED
2	Reserved							
3	Reserved							
4	Reserved						LoUnlo	Start
5	Reserved							
6	Reserved							
7	Reserved							
8	SLOT							
9	Reserved							
10	Reserved							
11	Control							

An Immediate (IMMED) bit of one indicates that the Logical Unit shall return status as soon as the command descriptor block has been validated. An IMMED bit of zero indicates that the status shall not be returned until the operation has been completed.

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The Load/Unload (LoUnlo) bit and the Start bit encoding is shown in Table 196

Table 196 – Load/unload operations

LoUnlo	Start	Operation to be performed
0	0	Abort any prior Changer command (Stop)
0	1	Reserved
1	0	Unload media. The Slot Parameter is ignored for this operation.
1	1	Load the Media from specified Slot and initialize or select the Slot specified for use with future Media Access Commands

The SLOT field indicated the Slot to be loaded or unloaded. Changer should always initialize (Load) Slot 0 on Power On or Bus Device Reset.

Any attempt to Load or Unload a Disc when the Device does not support that capability shall result in a CHECK CONDITION being reported to the Initiator with Sense key ILLEGAL REQUEST, Sense Code INVALID FIELD IN CDB.

Loading when the slot does not contain a Disc or the Play Position does not contain a Disc will be rejected with Sense Key ILLEGAL REQUEST, Sense Code INVALID FIELD IN CDB for the Slot Bytes. Unloading when the Play Position does not contain a Disc will be rejected with a Sense Key ILLEGAL REQUEST, Sense Code INVALID FIELD IN CDB for the Slot Bytes.

Loading when the slot does not contain a Disc will be rejected with a Sense Key NOT READY and Sense Code 3Ah MEDIUM NOT PRESENT. When this error is returned there are two possible actions by the CD Changer Device. If the Logical Unit reports Software Slot Selection (SSS) = 1 (see Table 137) then the slot specified shall be selected for use. If the Logical Unit reports SSS = 0 then the previously used slot shall continue to be selected for use.

If the Logical Unit is capable of caching data then a delayed load of a disc into the playing position can be supported. If delayed loading of a disc into the playing position is supported, the Logical Unit shall have previously cached the Lead-in data from that disc. If the medium is DVD then the caching of the Lead-in information shall be performed. If the medium is CD then the caching of the TOC shall be performed. If the Logical Unit has not read the Lead-in for a disc that is being loaded into the playing position then delayed loading shall not be performed and the disc shall be loaded into the playing position immediately. If the loading of the Disc into the playing position is delayed then the Logical Unit shall report that the Disc is ready, even though the Disc is not spinning and installed in the playing position. In all cases the behaviour seen by the Initiator (other than a longer subsequent media access latency) shall not be different between delayed and immediate loading of a disc.

A UNIT ATTENTION Condition shall not be generated when discs are loaded or unloaded from the playing position.

Recommended error reporting is defined in Table 197.

Table 197 – Recommended errors for LOAD/UNLOAD MEDIUM operation

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
MECHANICAL POSITIONING ERROR	Table A.1
INVALID ELEMENT ADDRESS	Table A.1
MEDIA LOAD OR EJECT FAILED	Table A.1

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6.1.8 MECHANISM STATUS command

The Mechanism Status command (see Table 198) requests that the Logical Unit respond with the current status of the device, including any Changer Mechanism that adheres to this standard. This command is intended to provide information to the Initiator about the current operational state of the Logical Unit. The Logical Unit takes operational direction from both the Initiator and the user. Movement of media in/out of the Logical Unit as well as Play operation may be due to external controls or Initiator commands. This command provides a method that allows the Initiator to know what has transpired with the changer mechanism.

Table 198 – MECHANISM STATUS command descriptor block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (BDh)							
1	Reserved			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	(MSB) Allocation Length							
9								(LSB)
10	Reserved							
11	Control							

The Allocation Length field specifies the maximum length, in bytes, of the Mechanical Status Parameter list, see Table 199, that shall be transferred from the Logical Unit to the Initiator. An Allocation Length field of zero indicates that no data shall be transferred. This condition shall not be considered an error.

The Mechanism Status Parameter list returned contains a header (see Table 200) followed by zero or more fixed-length Slot Tables (see Table 203). If the Logical Unit does not support the changer commands, then the number of slot tables returned to the Initiator shall be zero.

Table 199 – Mechanism status parameter list

Bit / Byte	7	6	5	4	3	2	1	0
0-7	Mechanism Status Header							
8-*n*	Slot Table(s)							

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Table 200 – Mechanism status header

Bit / Byte	7	6	5	4	3	2	1	0
0	Fault	Changer State		Current Slot Low(LSB)				
1	Mechanism State			Door open	Reserved	Current Slot High (MSB)		
2	(MSB) Current LBA							
3								
4								(LSB)
5	Number of Slots Available							
6	(MSB) Length of Slot Table(s)							
7								(LSB)

The Fault bit, bit 7, indicates that the changer failed to complete the operation reported in the Changer State field.

The Changer State field (see Table 201) indicates the current state of the changer.

Table 201 – Changer state field

Changer state	Definition
0h	Ready
1h	Load in Progress
2h	Unload in Progress
3h	Initializing

The Current Slot field indicates the Current Slot selected. Changers compatible with a bootable device specification should always initialize (Load) Slot zero on Power On or Bus Device Reset. This value shall only be changed when a Load Command is processed. Operations initiated by a user shall not cause this value to change. If the Logical Unit is not a changer, then this field is reserved.

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The Mechanism State field (see Table 202) encodes the current operation of mechanism.

Table 202 – Mechanism state field

Mechanism state	Definition
0h	Idle
1h	Playing (Audio or Data)
2h	Scanning
3h	Active with Initiator, Composite or Other Ports in use (i.e. READ, PLAY CD, SCAN during PLAY CD)
4h to 6h	Reserved
7h	No State Information Available

The Slot Table response data format is defined in Table 203. Each slot shall respond with the status defined.

The Door open bit, when set to one, indicates that the Door(s) or Tray(s) is/are open or the magazine is not present.

The Current LBA value returns the location that was last used while reading or playing. Once a Read or Play operation has been completed the value of this field may be undefined. While a Read or Play is in progress this field will contain the LBA of the current block being processed.

The Number of Slots Available field indicates the number of slots available. The maximum number of slots is 256.

The Length of Slot Tables field specifies the length in bytes of all the slot information that follows (e.g. for a 2 slot Logical Unit this value would be 8).

Table 203 – Slot table response format

Bit Byte	7	6	5	4	3	2	1	0
0	Disc Present (Optional)	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Change - Mandatory
1	Reserved							
2	Reserved							
3	Reserved							

The Disc Present bit, bit 7, indicates that there is a Disc in this slot. The reporting of this information is optional after a reset or Disc change. If this Feature is not supported, this bit shall be set to one after a reset condition or when a medium has been changed. When the Logical Unit is given a load command for a slot that contains no Disc, the bit corresponding to that slot shall then contain a 0 for any following response. If this bit is valid after a reset or medium change, then this capability shall be reported in the CD Capabilities and Mechanical Status Page (see Table 137).

The Change bit, bit 0, indicates that the Disc in that slot has been changed since the last time the disc was loaded.

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Recommended error reporting is defined in Table 204.

Table 204 – Recommended errors for mechanism status command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2

6.1.9 PAUSE/RESUME command

The PAUSE/RESUME command (see Table 205) requests that the Logical Unit stop or start a playback operation. This command is used with PLAY AUDIO and Play CD commands that are executing in immediate mode.

Table 205 – PAUSE/RESUME command descriptor block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (4Bh)							
1	Reserved			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							Resume
9	Control							

A Resume bit of zero causes the Logical Unit to enter the hold track state with the audio output muted after the current block is played. A Resume bit of one causes the Logical Unit to release the pause/scan and begin play at the block following the last block played/scanned.

If an audio play operation cannot be resumed and the Resume bit is one, the command is terminated with CHECK CONDITION status, COMMAND SEQUENCE ERROR. If the Resume bit is zero and an audio play operation cannot be paused, (no audio play operation has been requested, or the requested audio play operation has been completed), the command is terminated with CHECK CONDITION status, COMMAND SEQUENCE ERROR.

It shall not be considered an error to request a Pause when a pause is already in effect, or to request a Resume when a play operation is in progress.

Table 206 – Recommended errors for PAUSE/RESUME command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
COMMAND SEQUENCE ERROR	Table A.1

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6.1.10 PLAY AUDIO (10) Command

6.1.10.0 General

The PLAY AUDIO command (see Table 207) requests that the Logical Unit begin an audio playback operation. The command function and the output of audio signals shall be as specified by the settings of the mode parameters, including the SOTC bit.

If any commands related to audio operations are implemented then the PLAY AUDIO (10) command shall be implemented to allow a method for the Initiator to determine if audio operations are supported. A Logical Unit responding to a PLAY AUDIO (10) command that has a transfer length of zero with CHECK CONDITION status and setting the sense key to ILLEGAL REQUEST does not support audio play operations.

Table 207 – PLAY AUDIO(10) command descriptor block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (45h)							
1	Reserved			Reserved				RELADR
2	(MSB)							
3	Starting Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	(MSB)			Play Length				
8								(LSB)
9	Control							

The RELADR bit shall be set to zero.

The Starting Logical Block Address field specifies the logical block that the audio playback operation shall begin. PLAY AUDIO commands with a starting logical block address of FFFF FFFFh shall implement audio play from the current location of the optics. PLAY AUDIO commands with a starting LBA address of 0000 0000h shall begin the audio play operation at 00/02/00 MSF.

The Play Length field specifies the number of contiguous logical blocks that shall be played. A Play Length field of zero indicates that no audio operation shall occur. This condition shall not be considered an error.

If the starting address is not found, the command shall be terminated with CHECK CONDITION status, LOGICAL BLOCK ADDRESS OUT OF RANGE. If the address is not within an audio track, the command shall be terminated with CHECK CONDITION status, ILLEGAL MODE FOR THIS TRACK.

If the logical block address requested is not within an audio track and the Play Length is non-zero, the command shall be terminated with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code set to ILLEGAL MODE FOR THIS TRACK.

If the CD Sub-channel mode type (data versus audio) is other than audio or changes within the transfer length the command shall be terminated with a CHECK CONDITION. The Sense Key shall be set to ILLEGAL REQUEST and additional sense code set to END OF USER AREA ENCOUNTERED ON THIS TRACK.

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6.1.10.1 Play audio immediate

The PLAY AUDIO and SCAN commands will continue to play, while other commands may be processed, by the Logical Unit. Some commands can be accepted without disrupting the audio operations, while others will cause the Play operation to stop.

The Logical Unit shall accept and perform the commands as specified. If a PLAY or SCAN operation is executing such a way that the IMMED bit in the Audio Control Page was set to one when the command started, execution of a new command takes precedence. When the new command can be executed to completion without disturbing execution of the PLAY or SCAN, it shall be done. Otherwise, the PLAY or SCAN shall be terminated in order that the new command can be executed. The following commands shall be executed without disturbing the PLAY or SCAN command:

– REQUEST SENSE
– READ SUB-CHANNEL, current position
– PAUSE/RESUME
– INQUIRY
– READ CAPACITY

All other commands that may effect the termination of PLAY or SCAN are implementation specific.

Table 208 – Recommended errors for PLAY AUDIO (10) command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3

6.1.11 PLAY AUDIO (12) command

The PLAY AUDIO command (see Table 209) requests that the Logical Unit begin an audio playback operation. The command function and the output of audio signals shall be as specified by the settings of the mode parameters, including the SOTC bit.

Table 209 – PLAY AUDIO (12) command descriptor block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (A5h)							
1	Reserved			Reserved				RELADR
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	(MSB)							
7	Play Length							
8								
9								(LSB)
10	Reserved							
11	Control							

See PLAY AUDIO (10) Command for bit and field description in the CDB.

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Recommended error reporting is defined in Table 210.

Table 210 – Recommended errors for PLAY AUDIO(12) command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3

6.1.12 PLAY AUDIO MSF command

The PLAY AUDIO MSF command (see Table 211) requests that the Logical Unit begin an audio playback operation. The command function and the output of audio signals shall be as specified by the settings of the mode parameters including the SOTC bit described in 5.5.6.

Table 211 – PLAY AUDIO MSF command descriptor block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (47h)							
1	Reserved			Reserved				
2	Reserved							
3	Starting M Field							
4	Starting S Field							
5	Starting F Field							
6	Ending M Field							
7	Ending S Field							
8	Ending F Field							
9	Control							

The Starting M Field, the Starting S Field and the Starting F Field specify the absolute MSF address that the audio play operation shall begin. The Ending M Field, the Ending S Field, and the Ending F Field specify the absolute MSF address where the audio play operation shall end. All contiguous audio sectors between the starting and the ending MSF address shall be played.

If the Starting Minutes, Seconds and Frame Fields are set to FFh, the Starting address is taken from the Current Optical Head location. This allows the Audio Ending address to be changed without interrupting the current playback operation.

A starting MSF address equal to an ending MSF address causes no audio play operation to occur. This shall not be considered an error. If the starting MSF address is greater than the ending MSF address, the command shall be terminated with CHECK CONDITION status, INVALID FIELD IN CDB.

If the starting address is not found the command shall be terminated with CHECK CONDITION status, LOGICAL BLOCK ADDRESS OUT OF RANGE. If the address is not within an audio track the command shall be terminated with CHECK CONDITION status, ILLEGAL MODE FOR THIS TRACK or INCOMPATIBLE MEDIUM INSTALLED. If a not ready condition exists, the command shall be terminated with CHECK CONDITION status.

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Recommended error reporting is defined in Table 212.

Table 212 – Recommended errors for PLAY AUDIO MSF command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3

6.1.13 Play CD command (obsolete)

The Play CD Command (see Table 213) provides one standard, universal way of sending digital CD data to an external port.

Table 213 – PLAY CD command descriptor block

Byte \ Bit	7	6	5	4	3	2	1	0
0	OPERATION CODE (BCh)							
1	Reserved			Expected Sector Type			CMSF	Reserved
2	(MSB)							
3	Starting Logical Block Address							
4								
5								(LSB)
6	(MSB)							
7	Play Length in Blocks							
8								
9								(LSB)
10	Speed	Reserved			Port 2	Port 1	Composite	Audio
11	Control							

The Expected Sector Type field (see Table 220) is used to check the sector type only. If the Requested Sector(s) do not match the specified type, the command will be terminated with a CHECK CONDITION, ILLEGAL MODE FOR THIS TRACK. The sector that does not match will not be transferred.

If the CMSF bit is set to zero, the Starting Logical Block Address field specifies the logical block that the playback operation shall begin. If the CMSF bit is set to one, bytes 3 through 5 specify the MSF starting address and bytes 6 through 8 indicate the ending MSF address. Bytes 2 and 9 are reserved if CMSF is set to one.

PLAY CD commands with a starting LBA address of 0000 0000h shall begin the play operation at 00/02/00 MSF.

The Starting Logical Block Address field specifies the logical block that the audio playback operation shall begin. PLAY AUDIO commands with a starting logical block address of FFFF FFFFh shall implement audio play from the current location of the optics. PLAY AUDIO commands with a starting LBA address of 0000 0000h shall begin the audio play operation at 00/02/00 MSF.

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If the Starting Logical Block Address is set to ‘FF FF FF FFh’ (or ‘00 FF FF FFh’, when CMSF is set to one) and the playback operation is in progress, or the Logical Unit is in the hold track state, the Logical Unit shall change the Transfer Length (or Ending Address when CMSF is one) without interrupting current playback operation. If there is no playback operation in progress the Logical Unit shall implement the playback operation from the current location of the optics.

The Play Length field specifies the number of contiguous logical blocks that shall be played. A Play Length field of zero indicates that no play operation shall occur. This condition shall not be considered an error.

If the starting address is not found, the command shall be terminated with CHECK CONDITION status, LOGICAL BLOCK ADDRESS OUT OF RANGE.

Byte 10, the Play CD field, of the command descriptor block, defines a group of bits that define the play operations for this command. Table 214 provides the definitions for PLAY CD field.

Table 214 – PLAY CD field definition

Byte 10 bit	Value	Description
Audio	0	Analog Audio Channel is Disabled
	1	Analog Audio Channel is Enabled
Composite	0	Composite Video port is Disabled
	1	Composite Video port is Enabled
Port 1	0	Digital Port 1 is Disabled
	1	Digital Port 1 is Enabled
Port 2	0	Digital Port 2 is Disabled
	1	Digital Port 2 is Enabled
Speed	0	Speed will be set to X1 for the operation
	1	The speed used will be the best possible

Recommended error reporting is defined in Table 215.

Table 215 – Recommended errors PLAY CD command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3

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6.1.14 READ BUFFER CAPACITY command (obsolete)

The READ BUFFER CAPACITY command (see Table 216) checks the total length of buffer and the length of blank area.

Table 216 – READ BUFFER CAPACITY command descriptor block

Bit / Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (5Ch)							
1	Reserved			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB) Allocation Length							
8	(LSB)							
9	Control							

The Logical Unit reports the length of the buffer during Session at Once Recording or Track at Once Recording. If the READ BUFFER CAPACITY command is issued in a condition except Session at Once Recording or Track at Once Recording, the Blank Length of Buffer field may be invalid.

An Allocation Length of zero is not an error.

The READ BUFFER CAPACITY data (see Table 217) is sent in response to this command.

Table 217 – READ BUFFER CAPACITY data

Bit / Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	(MSB) Data Length							
1								(LSB)
2	Reserved							
3	Reserved							
4	(MSB)							
5	The Length of Buffer							
6								
7								(LSB)
8	(MSB)							
9	Blank Length of Buffer							
10								
11								(LSB)

The Data Length field defines the number data bytes to be transferred by the Logical Unit.

The Length of Buffer indicates the whole capacity of the buffer in bytes.

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The Blank Length of Buffer indicates the length of unused area of the buffer in bytes.

Table 218 – Recommended errors for READ BUFFER CAPACITY command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2

6.1.15 READ CD command

6.1.15.0 General

The READ CD Command described in Table 219 provides a single standard, universal way of accessing CD data. This command is generic to all types of CD data formats.

This command returns any of the defined CD data streams, including the headers, EDC, ECC, user data and CD-DA data. Each type of data is enabled via the fields in the READ CD command descriptor block. These fields, (byte 9) indicate the information from the CD is to be returned in the data stream. If a bit is cleared, then that particular information is not returned. If all the fields contain zero then no information is returned. This condition shall not be considered an error.

Table 219 – READ CD command descriptor block

Byte \ Bit	7	6	5	4	3	2	1	0
0	OPERATION CODE (BEh)							
1	RESERVED			Expected Sector Type			Reserved	RELADR
2	(MSB) Starting Logical Block Address							
3								
4								
5	(LSB)							
6	(MSB) Transfer Length							
7								
8	(LSB)							
9	SYNC	Header Codes		User Data	EDC & ECC	Error Field		Reserved
10	Reserved					Sub-channel Selection Bits		
11	Control							

The Expected Sector Type field (see Table 220) is used as a filter or mask to select the types of data format information returned to the Initiator. A transfer operation is terminated as soon as data is encountered that do not match one of those specified in the sector type field of the command. If the requested data are not of the type/types requested, the command will be terminated with a CHECK CONDITION status, ILLEGAL MODE FOR THIS TRACK. The sector/sectors that does/do not match will not be transferred to the Initiator.

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Table 220 – Expected sector type field bit definitions

Sector type	Definition	Description
000b	All types (mandatory)	No checking of the data type is performed. The Logical Unit shall always terminate a command at the sector where a transition between CD-ROM and CD-DA data occurs.
001b	CD-DA (optional)	Only IEC 60908 (CD-DA) (see 4.2.2) sectors shall be returned. All other data formats encountered return an error.
010b	Mode 1 (mandatory)	Only ISO/IEC 10149 (see Table 126) sectors with a user data field of 2 048 bytes shall be returned. All other data formats encountered return an error.
011b	Mode 2 formless (mandatory)	Only ISO/IEC 10149 (see Table 126) sectors with the expanded user data field (2 336 bytes) shall be returned. All other formats encountered will terminate the command and return CHECK CONDITION.
100b	Mode 2 form 1 (mandatory)	Only sectors (see Table 126) that have a user data field of 2 048 bytes will be returned. All other formats encountered will terminate the command and return CHECK CONDITION.
101b	Mode 2 form 2 (mandatory)	Only sectors (see Table 126) that have a user data field of 2 324 shall be returned. All other formats encountered will terminate the command and return CHECK CONDITION. 1)
110b to 111b	Reserved	

1) 4 spare bytes are included making the total data length returned 2 328 bytes/sector.

The RELADR bit shall be set to zero.

The Starting Logical Block Address field specifies the logical block that the read operation shall begin.

The Transfer Length field specifies the number of contiguous logical blocks of data that shall be transferred. A Transfer Length field of zero indicates that no transfer of data shall occur. This condition shall not be considered an error.

The Sync bit, set to one, indicates that the Sync field from the sector shall be included in the data stream. The Sync bit, set to zero indicates the Sync field shall not be included in the data stream.

The Header Code field (see Table 221) is encoded to select Header/Sub-header information that should be included in the returned data stream.

Table 221 – Header code field definition

Header code	Definition	Description
00b	None	No header information shall be returned.
01b	Header only	Only the four byte header will be returned in the data stream.
10b	Sub-header only	Only the mode 2 form 1 or form 2 sub-header will be returned.
11b	All headers	Return both header and sub-header information.

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The User data bit, when set to one, indicates that the user data part of a CD sector shall be returned in the data stream. When set to zero, user data shall not be returned to the Initiator. The setting of the Mode Select Block Size does not apply to this command. If the current track is an audio track, then audio data shall be returned. Otherwise, the normal user data shall be returned.

The EDC and ECC bit, when set to one, indicates that the EDC and ECC (L-EC) field shall be included in the data stream. For Mode 1 CD format, this will include the 8 bytes of pad data.

The Error field (see Table 222) is an encoded field that indicates that if any of the C2 and/or Block error data will be included in the data stream.

If the Logical Unit does not support the C2 pointers, and the Error field is not zero, the C2 data field shall be zero filled

Table 222 – READ CD, error field definition

Error field	Definition	Description
00b	None	No error information is returned.
01b	C2 error block data	The C2 error, Pointer bits (2 352 bits or 294 bytes) will be included in the data stream. There will be one bit for each byte in error in the sector (2 352 total). The bit ordering is from the most significant bit to the least significant bit in each byte. The first bytes in the sector will be the first bit s/bytes in the data stream.
10b	C2 and Block Error bit s	Both the C2 error bits (2 352 bits/294 bytes) and the Block Error byte will be included in the data stream. The Block Error byte is the logical or of all the C2 Error bit bytes. The Error byte will be padded with a byte (undefined) to ensure an even number of bytes in the data stream. The Block error byte will be first in the data stream followed by the pad byte.
11b	Reserved	Reserved for future enhancement.

The Sub-channel data selection field (see Table 223) indicates that CD Sub-channel information is to be included in the data stream. This may be the Q information and/or the “Raw” Sub-channel information. If the field is set to a nonzero value, then that Sub-channel data will be included in the data stream to the Initiator.

Table 223 – READ CD, Sub-channel Data Selection Field definition

Sub-channel data selection value	Definition	Description	Type
000b	No Sub-channel data	No Sub-channel data will be returned	Mandatory
001b	RAW	RAW P-W Sub-channel data will be transferred	Optional
010b	Q	Q data is transferred (see Table 224)	Optional
011b	Reserved		
100b	P-W	R-W data is transferred	Optional
101b-111b	Reserved		

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In the case of R-W the Logical Unit may return the data de-interleaved and error corrected, RAW or padded with zeroes depending on the R-W supported and R-W de-interleaved and error corrected bits in the CD capabilities and Mechanism status page. In the case of RAW the Logical Unit will return the P-W Sub-channel data that is not de-interleaved. See Table 227 and for P-W data formats.

If the Starting Logical Block Address is set to FFFF FFFFh and the only information requested is the Sub-channel data, and there is currently a PLAY AUDIO command in process, the actual address used will be from the current location (of the audio play).

If the Logical Unit is not playing audio, it shall respond with a CHECK CONDITION Status and a sense code of COMMAND SEQUENCE ERROR.

Table 224 – Formatted Q sub-channel response data

Byte	Description
0	Control (4 ms bit s), ADR (4 Ls bit s)
1	Track number
2	Index number
3	Min
4	Sec
5	Frame
6	ZERO
7	AMIN
8	ASEC
9	AFRAME
10	CRC[1)] or 00h
11	CRC[1)] or 00h
12	00h (pad)
13	00h (pad)
14	00h (pad)
15	MSB is P-Sub-code(optional), all others are 0h
1) CRC is optional.	

The lengths of the data returned from a READ CD command will vary based on the type of sector that is being read and the requested fields to be returned to the Initiator. Many combinations are possible, but most are not very useful. Table 225 specifies how the Logical Unit responds to many of the requests. Requests for transfers not specified in the Table 225 shall not be supported and treated as illegal. Illegal values will cause the command to be aborted with a CHECK CONDITION status, INVALID FIELD IN CDB. See Table 220 for definition of sector formats.

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Table 225 – Number of bytes returned based on data selection field

Data to be transferred	Byte[2] 9	CD-DA	Mode 1	Mode 2	Mode 2 Form 1	Mode 2 Form 2
User Data	10h	2 352	2 048 [1]	2 336 [1]	2 048	2 328 [1]
User Data + EDC/ECC	18h	(10h) [1]	2 336	(10h) [1]	2 328	(10h) [1]
Header	20h	(10h) [1]	4	4	4	4
Header Only + EDC/ECC	28h	(10h) [1]	Illegal	Illegal	Illegal	Illegal
Header & user data	30h	(10h) [1]	2 052 [1]	2 340 [1]	Illegal	Illegal
Header & User Data + EDC/ECC	38h	(10h) [1]	2 340	(30h) [1]	Illegal	Illegal
Sub Header Only	40h	(10h) [1]	0	0	8	8
Sub Header Only + EDC/ECC	48h	(10h) [1]	Illegal	Illegal	Illegal	Illegal
Sub Header & user data	50h	(10h) [1]	(10h) [1]	(10h) [1]	2 056 [1]	2 336 [1]
Sub Header & user data + EDC/ECC	58h	(10h) [1]	(18h) [1]	(10h) [1]	2 336	(50h) [1]
All Headers Only	60h	(10h) [1]	4	4	12	12
All Headers Only + EDC/ECC	68h	(10h) [1]	Illegal	Illegal	Illegal	Illegal
All Headers & user data	70h	(10h) [1]	(30h) [1]	(30h) [1]	2 060 [1]	2 340 [1]
All Headers & user data + EDC/ECC	78h	(10h) [1]	(38h) [1]	(30h) [1]	2 340	2 340
Sync & User Data	90h	(10h) [1]	Illegal	Illegal	Illegal	Illegal
Sync & User Data + EDC/ECC	98h	(10h) [1]	Illegal	Illegal	Illegal	Illegal
Sync & Header Only	A0h	(10h) [1]	16	16	16	16
Sync & Header Only + EDC/ECC	A8h	(10h) [1]	Illegal	Illegal	Illegal	Illegal
Sync & Header User Data	B0h	(10h) [1]	2 064	2 352	Illegal	Illegal
Sync & Header User Data + EDC/ECC	B8h	(10h) [1]	2 352	(B0h)	Illegal	Illegal
Sync & Sub Header Only	C0h	(10h) [1]	Illegal	Illegal	Illegal	Illegal
Sync & Sub Header Only + EDC/ECC	C8h	(10h) [1]	Illegal	Illegal	Illegal	Illegal
Sync & Sub Header & User Data	D0h	(10h) [1]	Illegal	Illegal	Illegal	Illegal
Sync & Sub Header & User Data + EDC/ECC	D8h	(10h) [1]	Illegal	Illegal	Illegal	Illegal
Sync & All Headers Only	E0h	(10h) [1]	16	16	24	24
Sync & All Headers Only + EDC/ECC	E8h	(10h) [1]	Illegal	Illegal	Illegal	Illegal
Sync & All Headers & user data	F0h	(10h) [1]	2 064	2 352 [1]	2 072	2 352 [1]
Sync & All Headers & user data + EDC/ECC	F8h	(10h) [1]	2 352 [1]	(F0h) [1]	2 352 [1]	(F0h) [1]
Repeat 10h to F8h and Add Error bit s	02h	+2 94 [3]	+294	+294	+294	+294
Repeat 10h to F8h and Add Block & Error bit s	04h	+296	+296	+296	+296	+296

1) Data should be returned as if Byte 9 contained this value.

2) Value of Byte 9 in the READ CD Command Descriptor Block, in hexadecimal.

3) "+" indicates the addition of the specified number of bytes to the stream of the data.

For definitions of the headers of Table 225 refer to 6.1.15.

Values enclosed in brackets "()" indicate that the amount of data is the same as the Flag byte setting specified by the contents of the parenthesis.

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The CD-DA audio data includes 16 bits of information for each channel and will be formatted as follows when an audio track is read. See Table 226.

Table 226 – CD-DA (digital audio) data block format

Bit / Byte	7	6	5	4	3	2	1	0
0	Left Channel (Lower Byte)							(LSB)
1	(MSB)	Left Channel (Upper Byte)						
2	Right Channel (Lower Byte)							(LSB)
3	(MSB)	Right Channel (Upper Byte)						
…	…							
…	…							
2 348	Left Channel (Lower Byte)							(LSB)
2 349	(MSB)	Left Channel (Upper Byte)						
2 350	Right Channel (Lower Byte)							(LSB)
2 351	(MSB)	Right Channel (Upper Byte)						

If the CD Logical Unit does not support the CD-DA Stream-Is-Accurate capability, see Table 137, then the digital audio data shall be read as a continuous stream. If, while streaming, the Logical Unit shall stop, there will be a non-recoverable error generated READ ERROR – LOSS OF STREAMING. This is due to the 1 s uncertainty of the address (i.e. there is no header in CD-DA data). Re-issuing the command may not return exactly the same data as the previous try. When the Logical Unit supports the stream accurate capability, there will be no error, only some time delay for rotational latency.

The format for P-W raw data is described in Table 227.

Table 227 – P-W RAW data format

Bit / Byte	7	6	5	4	3	2	1	0
0	P-W (0)							
1	P-W (1)							
…	…							
95	P-W (95)							

R-W raw data (bits 0-5, see Table 228) is returned in the format and order found on the media. It is the responsibility of the Logical Unit driver to de-interleave and perform error detection and correction on the RAW data to make it usable to higher level applications.

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Table 228 – P-W Data de-interleaved and error corrected

Bit / Byte	7	6	5	4	3	2	1	0
0	P	Q	PACK (0)					
1	P	Q	PACK (1)					
…	…							
23	P	Q	PACK (23)					
24	P	Q	PACK (0)					
25	P	Q	PACK (1)					
…	…							
47	P	Q	PACK (23)					
48	P	Q	PACK (0)					
49	P	Q	PACK (1)					
…	…							
71	P	Q	PACK (23)					
72	P	Q	PACK (0)					
73	P	Q	PACK (1)					
…	…							
93	P	Q	PACK (23)					

Drives that cannot return P or Q code with PACK data will return undefined data in the unsupported P or Q bits. Each PACK is generated after 2 contiguous Sub-channel data frames consisting of 24 bytes with 6 bits of PACK data per byte. Each 96 byte Packet consists of 4 Packs of 24 bytes each.

The basic RAW format is shown in Figure 28. The data is synchronized with the Sub-channel sync patterns S0 and S1. Each group of 6 bits (R-W) is called a symbol. The symbol following the Sub-channel patterns S0 and S1 is the first symbol of the first pack in a packet.

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6.1.15.1 Description of sub-channels R-W

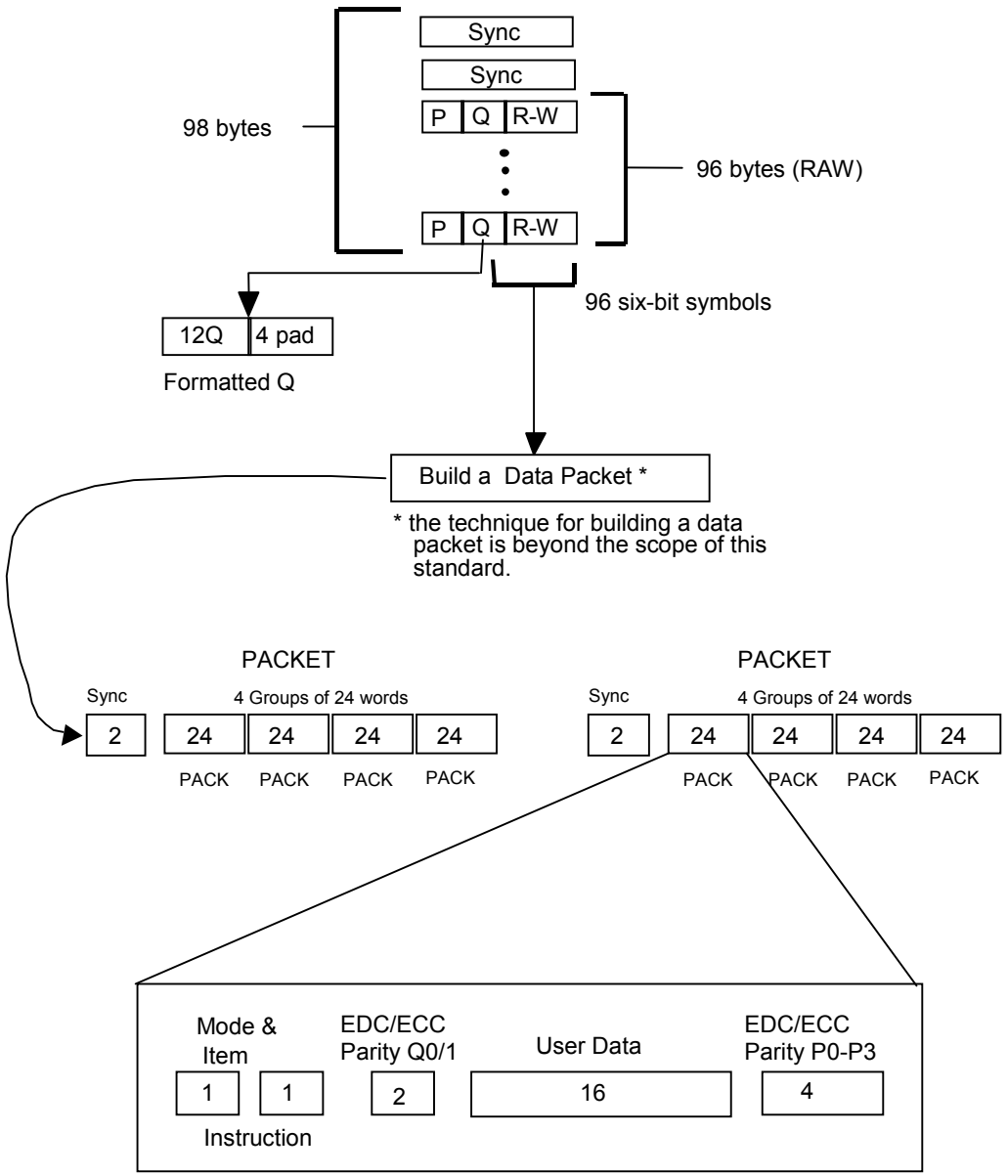

Figure 28 – Read CD sub-channel, R-W (100b)

To guard the data in the sub-coding channels R-W, a (24,20) Reed-Solomon Error Correction Code is used. To improve the burst error correction capability, eight way interleaving is added to this error correction system.

The first two symbols in a pack have additional protection with a (4,2) Reed Solomon Error Correction Code. The first symbol of a pack contains a mode-switch of 3 bits and a 3 bit sub-division of mode, called “item”. The defined mode-item combinations are listed in Table 229.

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Table 229 – Sub-channel R-W – Allowed mode/item combinations

Mode	Item	Description
000b	000b	The Zero mode
001b	000b	The LINE GRAPHICS mode
	001b	The TV GRAPHICS mode
111b	000b	The USER mode
All others		Reserved for future use

The R-W information is returned as part of the “raw” Sub-channel data. The lower 6 bits of each of the bytes contain the R-W data. This data follows the format shown in Figure 28. If the Q information needs to be taken from the raw data then it shall not be interleaved.

6.1.15.2 CD-TEXT

When the Starting Logical Block Address is set to F000 0000h and P-W raw data is selected, the Logical Unit returns P-W raw data from the Lead-in area. If there is no data recorded in the Lead-in area, the command shall be terminated with CHECK CONDITION status, ILLEGAL MODE FOR THIS TRACK or INCOMPATIBLE MEDIUM INSTALLED.

If the Starting Logical Block Address is set to FFFF FFFFh after the above command, the Sub-channel data will be returned from the current location within the Lead-in area. It is the responsibility of the device driver to convert this data to CD-TEXT format without losing streaming.

Recommended error reporting is defined in Table 230.

Table 230 – Recommended errors for READ CD command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3
READ ERROR – LOSS OF STREAMING	Table A.1

6.1.16 READ CD MSF command

The READ CD MSF Command described in Table 231 provides a single standard command format for accessing CD data via MSF addressing. This command is generic to all types of CD data formats.

This command returns any of the defined CD data streams, including the headers, EDC, ECC, user data and CD-DA data. Each type of data is enabled via the fields in the READ CD MSF command descriptor block. These fields indicate the information from the CD is to be returned in the data stream. If the bit is cleared, then that particular information is not returned. If all the fields contain zero then no information is returned. This condition shall not be considered an error.

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Table 231 – READ CD MSF command descriptor block

Byte \ Bit	7	6	5	4	3	2	1	0
0	OPERATION CODE (B9h)							
1	Reserved			Sector Type			Reserved	
2	Reserved							
3	Starting M Field							
4	Starting S Field							
5	Starting F Field							
6	Ending M Field							
7	Ending S Field							
8	Ending F Field							
9	SYNC	Header Codes		User Data	EDC & ECC	Error Fields		Reserved
10	Reserved					Sub-channel Selection bit s		
11	Control							

The Starting M field, the Starting S field and the Starting F field specify the absolute MSF address where the Read operation shall begin. The Ending M field, the Ending S field and the Ending F field specify the absolute MSF address where the Read operation shall end. All contiguous sectors between the starting and ending MSF addresses shall be read.

A starting MSF address equal to an ending MSF address prevents a read operation. This shall not be considered an error. If the starting MSF address is greater than the ending MSF address, the command shall be terminated with CHECK CONDITION status, ILLEGAL REQUEST.

If the starting address is not found, or if a not ready condition exists, the command shall be terminated with CHECK CONDITION status.

For descriptions of Sector Type field, see Table 220.

For a description of all fields in byte 9, and Sub-channel Selection bits (byte 10), see 6.1.15 Read CD Command.

Recommended error reporting is defined in Table 232.

Table 232 – Recommended errors for READ CD MSF command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3
READ ERROR – LOSS OF STREAMING	Table A.1

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6.1.17 READ CAPACITY command

The READ CAPACITY command (see Table 233) provides a means for the Initiator to request information regarding the capacity of the Logical Unit. This command may not report the correct capacity of the recorded data for CD-R, CD-RW and DVD-R media that do not have a Lead-out in the last Session or last Border-out. For CD-ROM, the returned logical block address is modified to allow returning a possibly inexact value (but one with a known error bound) based on the Table of Contents data.

Table 233 – READ CAPACITY command descriptor block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (25h)							
1	RESERVED				Reserved			RELADR
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	Reserved							
8	Reserved							PMI
9	Control							

The RELADR, PMI bit s, and Logical Block Address field shall be set to zero for Logical Units.

Eight bytes of READ CAPACITY response data (see Table 234) shall be returned in response to the command.

Table 234 – READ CAPACITY response data format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
…	Logical Block Address							
3								(LSB)
4	(MSB)							
…	Block Length in Bytes (Length reported shall be 2 048d)							
7								(LSB)

The returned Logical Block Address shall be the last sector in the last complete session.

The Block Length shall be reported, in bytes, as 2 048d. A block length of 512 is obsolete.

For CD media, the last logical block shall be determined by converting the last recorded Lead-out to an LBA and subtracting one. If the resulting address points to a run out block (because the session was recorded with packets or track at once in data mode), the Logical Unit shall subtract 2 from the LBA to point to the actual last user data block. If no complete session exists on the medium, this field shall be set to zero.

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Recommended error reporting is defined in Table 235.

Table 235 – Recommended errors for READ CAPACITY command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3

6.1.18 READ DISC INFORMATION command

The READ DISC INFORMATION command (see Table 236) provides information about all discs. The parameters returned by the Logical Unit are specific to the media that are currently installed in the Logical Unit. In the case of a DVD-ROM Logical Unit, the disc information returned may be for the last closed Session. In the case of media that do not have logical Tracks, the number of Tracks and Sessions is considered one. If this command is required by an implemented Feature, the command shall always function, even if that Feature's Current bit becomes zero. If a Logical Unit does not implement this command, it shall respond with a CHECK CONDITION status.

Table 236 – READ DISC INFORMATION command descriptor block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (51h)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB) Allocation Length							
8								(LSB)
9	Control Byte							

The Disc Information Block has two parts; a static disc information area, as shown in Table 237, and an OPC response shown in Table 241.

The number of Disc Information bytes returned (see Table 237) is limited by the Allocation Length parameter of the command packet. An Allocation Length of zero shall not be considered an error. If the Allocation Length is greater than the amount of available Disc Information Data, only the available data will be transferred.

If a field or bit is not applicable to the installed medium, the default parameters in the Write Parameters Mode Page shall be returned in the corresponding field.

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Table 237 – Disc information block

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			Disc Information Length				
1								(LSB)
2	Reserved			Erasable	State of last Session		Disc Status	
3	Number of First Track on Disc							
4	Number of Sessions(LSB)							
5	First Track Number in Last Session(LSB)							
6	Last Track Number in Last Session(LSB)							
7	DID_V	DBC_V	URU	Reserved				
8	Disc Type							
9	Number of Sessions (MSB)							
10	First Track Number in Last Session (MSB)							
11	Last Track Number in Last Session (MSB)							
12	(MSB)							
13	Disc							
14	Identification							
15								(LSB)
16	(MSB)							
17	Last Session Lead-in Start Time							
18	MSF							
19								(LSB)
20	(MSB)							
21	Last Possible Start Time for Start of Lead-out							
22	MSF							
23								(LSB)
24	(MSB)							
…	Disc Bar Code							
31								(LSB)
32	Reserved							
33	Number of OPC Table Entries							
34 to *n*	OPC Table Entries							

The Disc Information Length is the number of bytes available in both the recording information area and the appended OPC table. Disc Information Length excludes itself.

Disc Status field indicates the status of the disc and is shown in Table 238. A device that does not have the ability to write the inserted medium (for example C/DVD-ROM) will return COMPLETE (10b) status.

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Table 238 – Disc status

Status	Definition
00b	Empty disc
01b	Incomplete disc (Appendable)
10b	Complete Disc (for example: Not Appendable. C/DVD-ROM, complete CD-R, CD-RW, DVD-R, or write protected Random Writable media)
11b	Others (non-write protected Random Writable media)

The State of Last Session field is defined in Table 239. For media that do not use Sessions this field shall be 11h.

Table 239 – State of last session

Session state	Definition
00b	Empty Session
01b	Incomplete Session
10b	Reserved
11b	Complete Session (only possible when Disc Status is Complete)

The Erasable bit, when set to one, indicates that CD-RW medium is present. Otherwise, CD-RW medium is not present.

The Number of First Track identifies the first track number.

For non-CD media, this field shall be set to 1. For CD media,

a) if Disc Status is set to 00 (Empty Disc), the Number of First Track field shall be 1;

b) if there are no entries in the PMA and the first track is an Incomplete Track, the Number of First Track field shall be equal to 1;

c) if the only session on the disc is an Incomplete Session, the Number of First Track field is from the PMA;

d) otherwise, the Number of First Track field contains the track number for the first TOC entry in the first Session.The Number of Sessions (bytes 4 & 9) on the disc refers to all complete sessions plus any incomplete or empty sessions. A Blank Disc will always have a session count equal to one.

First Track Number in Last Session (bytes 5 & 10) is the track number of the first track in the last session. For Tracks in the last Session, that may be open, in order to be scanned by the READ TRACK INFORMATION Command, the First Track Number in Last Session is identified. This is inclusive of the invisible track.

Last Track Number in Last Session (bytes 6 & 11) is the track number of the last track in the last session. For Tracks in the last Session, that may be open, in order to be scanned by READ TRACK INFORMATION Command, the Last Track Number in Last Session is identified.This is inclusive of the invisible track.

The DID_V (Disc ID Valid) bit, when set to one, indicates that the Disc Identification field is valid.

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The DBC_V (Disc Bar Code Valid bit, when set to one, indicates that the Disc Bar Code field (bytes 24 through 31) is valid.

The URU (Unrestricted Use Disc) bit, when set to one, indicates that the mounted DVD-R, CD-R/RW disc is defined for unrestricted use. When the Unrestricted Use Disc bit is set to zero, the mounted DVD-R, CD-R/RW disc is defined for restricted use. To record data to the mounted disc the appropriate Initiator Application code shall be set through the Write Parameters Page. An Initiator Application Code of zero may be used to indicate a restricted use disc – general purpose. Logical Units that do not read a URU bit from the medium shall set this bit to one.

For CD, the Disc Type field specifies the type of data on the whole disc. A disc has only one disc type. The Disc Type shall be obtained from the PMA or from the A0/PSEC field in the TOC of the first session in that there is at least one data track, or it is recorded together with disc ID in PMA.

In the case of a session that contains no data track (only audio), A0/PSEC field in the TOC of the session is always 00h regardless of actual Disc Type. For CD discs, the Disc Type shall be determined from the following sequences:

a) Disc ID (Disc Type) as written in PMA;
b) from the first Complete Session that includes at least one data track;
c) from the first Session of a Complete Disc;
d) the Disc type is NOT decided, the Disc Type field of Disc Information shall contain FF (undefined).

Table 240 – Disc type field – PMA

Disc type code	Disc type
00h	CD-DA or CD-ROM Disc
10h	CD-I Disc
20h	CD-ROM XA Disc
FFh	Undefined
All Other Values	Reserved

For CD, the Disc Identification number recorded in the PMA is returned. The Disc Identification Number is recorded in the PMA as a six-digit bcd number. It is returned in the Disc Information Block as a 32 bit binary integer.

The Last Session Lead-in Start Time field is valid only for CD medium. Otherwise, this field shall be set to 0. This field is an address given in MSF format as defined in 4.1.1.This field shall specify the location of the next Lead-in to be recorded. If the disc is Empty as specified in the Disc Status field or has no Complete Session, then the Lead-in Start Time is returned as specified by ATIP. If the last Session, is second or greater, Empty or Incomplete, this field shall specify the Lead-in Start Time of the Last Session. If the Disc Status is Complete, the Lead-in Start Time shall be FF/FF/FF MSF.

The Last Possible Start Time for Start of Lead-out field is valid only for CD media. Otherwise this field shall be set to 0. This field is returned as the address, encoded in the ATIP and is returned in MSF format, as specified in 4.1.1. If the disc is a Complete Disc, the Last Possible Start Time of Lead-out shall be FF/FF/FF MSF.

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The Disc Bar Code field contains the hexadecimal value of the bar code if the Logical Unit has the ability to read the Disc Bar Code and a bar code is present. See Table 137.

An OPC (Optimum Power Calibration) Table is attached only if the values are known for the disc. Since OPC values are likely to be different for different recording speeds, each table entry is associated with a recording speed. The Number of OPC Table Entries indicates that [8 x (Number of OPC Table Entries)] bytes follow the first part of the Disc Information. This number shall be the same for all values of Allocation Length. The Number of OPC Table Entries shall always be zero for discs that OPC has not yet been determined. For DVD-R, the use of OPC table entries is vendor-specific.

Table 241 – OPC table entry

Bit / Byte	7	6	5	4	3	2	1	0
0	Speed (kBytes per second)							
1								
2	OPC Values							
3								
4								
5								
6								
7								

Speed is in kilobytes per second. See SEND OPC command 6.1.35.

The OPC Value field is associated with the speed specified in the speed field and its content is vendor-specific.

Recommended error reporting is defined in Table 242.

Table 242 – Recommended errors for READ DISC INFORMATION command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3

6.1.19 READ DVD STRUCTURE command

6.1.19.0 General

The READ DVD STRUCTURE command, see Table 243, requests that the DVD Logical Unit transfer data from areas on the DVD Media to the Initiator. There are several control structures on the DVD media, including the Lead-in and Burst Cutting Area (BCA). The Lead-in area for DVD media contain information about the media as well as information used by the Logical Unit to allow it to recover information from the media. The BCA for DVD media are optional, contents are specified by the media manufacture.

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Table 243 – READ DVD STRUCTURE command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (ADh)							
1	Reserved			Reserved				
2	(MSB)							
3	Address							
4								
5								(LSB)
6	Layer Number							
7	Format							
8	(MSB)			Allocation Length				
9								(LSB)
10	AGID		Reserved					
11	Control							

The Address field contains values that depend on the value in Format field.

- Format field = 05h (CGMS, CPM) – Address field contains LBA (Logical Block Address).
- Format field = 0Ch (RMD in last Border-out) – Address field contains the Field number of RMD block that is recorded in the last Border-out. Field numbers of RMD block are integers assigned in ascending order in the range of 0 to 14.
- Format field = 0Dh (RMD in RMA) – Address field contains sector number of RMA where the RMA read operation shall begin. The RMA sector size is 2 kB. The RMA sector number is assigned to each sector of RMA. The RMA sector numbers are integers assigned in ascending order starting with zero. Each successive sector of RMA has a number increased by 1.
- Format field = 30h (Disc Control Blocks) – the Address field contains the Content Descriptor desired.

For other Format field values the Address field shall be reserved.

When the Address field specifies an unrecorded RMA sector, this command shall be terminated with CHECK CONDITION status.

NOTE Cached RMD information shall be returned by this command as if it had been committed to the medium.

The Format field, see Table 244, indicates the type of information that is requested by the Initiator.

The Layer Number field specifies the layer number for the response data returned by the READ DVD STRUCTURE command.

The number of data bytes returned in response to a READ DVD STRUCTURE command is limited by the Allocation Length field of the CDB. An Allocation Length field of zero shall not be considered an error.

The AGID field is described in the REPORT KEY command. This field is used only when the Format field contains 2h, for all other values it is reserved.

Requests for Format FFh shall always be fulfilled, even if there is no medium or an incompatible medium installed.

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When a READ DVD STRUCTURE Command is issued for CD media, with format codes 00h to FEh, the command shall be terminated with CHECK CONDITION status, sense key set to ILLEGAL REQUEST and the additional sense code set to CANNOT READ MEDIUM-INCOMPATIBLE FORMAT. When the Logical Unit/media combination does not support the specified Format code, the command shall be terminated with CHECK CONDITION status, INVALID FIELD IN CDB.

Table 244 – Format code definitions for READ DVD STRUCTURE command

Format code	Returned data	Layer byte usage	Address field explanation	Description
00h	Physical	Layer Number	Reserved	Returns information in the DVD Lead-in area. DVD-R returns the last Lead-in.
01h	Copyright	Layer Number	Reserved	Returns the Copyright information from the DVD Lead-in area.
02h	Disc Key	Reserved	Reserved	Returns the Disc Key obfuscated by using a Bus Key.
03h	BCA	Layer Number	Reserved	Returns the BCA information on DVD media.
04h	Manufacturer	Layer Number	Reserved	Returns the Disc Manufacturing information from the DVD Lead-in area.
05h	CGMS, CPM	Layer Number	LBA	Returns CGMS, CPM information from specified sector.
06h to 07h	Reserved			
08h	DDS	Reserved	Reserved	Returns the DDS information on DVD-RAM media.
09h to 0Bh	Reserved			
0Ch	RMD in last Border-out	Reserved	Start Field number of RMD Blocks	Returns the Field of RMD in the last Border-out.
0Dh	RMD	Reserved	Start RMA Sector Number	Returns RMD sectors that are recorded in RMA.
0Eh	Pre-recorded information in Lead-in	Reserved	Reserved	Returns pre-recorded information in the Lead-in area.
0Fh	Unique Disc Identifier	Reserved	Reserved	Returns Unique Disc Identifier of the disc.
10h to 2Fh	Reserved			
30h	Disc Control Blocks	Reserved	Content Descriptor	Returns Disc Control Block identified by the Content Descriptor.
31h to FEh	Reserved			
FFh	Structure List	Layer Number	Reserved	Returns a list of DVD Structures present in the specified Layer.

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6.1.19.1 Physical format information

Physical Format Information is shown in Table 245.

Table 245 – READ DVD STRUCTURE data format (format field = 00h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
DVD Lead-in Structure								
0 to 2 047	Layer Descriptor							

The DVD STRUCTURE Data Length specifies the length in bytes of the following DVD STRUCTURE data that is available to be transferred to the Initiator. The DVD STRUCTURE Data Length value does not include the DVD STRUCTURE Data Length field itself.

Layer Descriptor is defined in Table 246.

Table 246 – Layer descriptor(s)

Bit / Byte	7	6	5	4	3	2	1	0
0	Book Type				Book Version			
1	Disc Size				Minimum Rate			
2	Reserved	Number of Layers		Track Path	Layer Type			
3	Linear Density				Track Density			
4	00h							
5	(MSB)							
6	Starting Sector Number of Main Data							
7								(LSB)
8	00h							
9	(MSB)							
10	End Sector of Main Data							
11								(LSB)
12	00h							
13	(MSB)							
14	End Sector Number in Layer 0							
15								(LSB)
16	BCA	Reserved						
17 to 2 047	Media Specific							

This information is returned for DVD media only. The information for the layer specified by the Layer Number field in the Command Packet is returned. If there is only one layer then the only valid layer is layer 0. If a nonexistent layer is requested then the command shall be aborted with an INVALID FIELD IN THE COMMAND PACKET error. If the media have more than one

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layer, but are recorded using the Opposite Track Path method, then the same information shall be returned for all layers.

The Book Type field (see Table 247) specifies the DVD Book these media comply with.

Table 247 – Book type field

Book type	Book name
0000b	DVD-ROM
0001b	DVD-RAM
0010b	DVD-R
1001b	DVD+RW
Others	Reserved

The Book Version specifies the version of the specified book that these media comply with.

The Disc Size specifies the physical size of the Media. A value of 0000b specifies 120 mm, a value of 0001b specifies a size of 80 mm.

The Minimum Rate field (see Table 248) is used to specify to the Logical Unit the read rate to use for these media.

Table 248 – Minimum Rate Field

Minimum rate	Read rate
0000b	2,52 Mbit/s
0001b	5,04 Mbit/s
0010b	10,08 Mbit/s
1111b	Not Specified
Others	Reserved

The Number of Layers field specifies the number of layers for this side of the media. A value of 00b indicates that the media have only one layer. A value of 01b specifies that this side of the media has two layers. Currently only one and two layer discs are specified.

The Track Path bit specifies the direction of the layers when more than one layer is used. If the bit is cleared to 0 then these media use Parallel Track Path (PTP). When PTP is used each layer is independent and has its own Lead-in and Lead-out areas on the media. If the bit is set to 1 then the media use Opposite Track Path (OTP). With opposite track path both layers are tied together. There is only one Lead-in and Lead-out. In the middle of the media there is an area called the middle area. The addresses of blocks in one layer are mirrored in the other layer.

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The Layer Type field (see Table 249) indicates the read/write ability of the layer.

Table 249 – Layer type field

Layer type code	Layer type
0001b	Read-only layer
0010b	Recordable layer
0100b	ReWritable layer
Others	Reserved

The Linear Density field (see Table 250) indicates the minimum/maximum pit length used for this layer.

Table 250 – Linear density field

Linear density code	Linear density
0000b	0,267 μm/bit
0001b	0,293 μm/bit
0010b	0,409 to 0,435 μm/bit
1000b	0,176 μm/bit
Others	Reserved

The Track Density field (see Table 251) indicates the track width used for these media. Currently = 0000b 0,74 μm/track.

Table 251 – Track density field

Track density code	Track density
0000b	0,74 μm/track
0001b	0,80 μm/track
Others	Reserved

The Starting Sector Number of Main Data field (see Table 252) specifies the first block that contains user data.

Table 252 – Starting physical sector number of main data field

Starting sector number	Media type
30000h	DVD-ROM & DVD-R
31000h	DVD-RAM & DVD + RW
Others	Reserved

The End Sector of Main Data field specifies the last sector of the user data in the last layer of the media. For DVD-RAM, the End Sector of Main Data, is the PSN for the last spare sector of the last zone.

The End Sector Number in Layer 0 field specifies the last sector of the user data in layer 0. If these media do not use Opposite Track Paths and contain Multiple Layers, this value is set to 000000h.

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The Burst Cutting Area (BCA) flag indicates the presence of data in the Burst Cutting Area. If set to zero, it indicates BCA data do not exist. If set to one, it indicates BCA data exist.

In case of DVD-R, the Logical Unit may have cache memory for the Lead-in Control Area data. If the disc has no Lead-in, and there is no DVD Control Data in the cache, the Logical Unit shall generate a CHECK CONDITION status, sense code INVALID FIELD IN CDB. If the Lead-in is already written or there are DVD structures in the cache, the Logical Unit shall return the requested structures.

The Media Specific field may be filled with all zero data or information as specified in the associated DVD specification.

6.1.19.2 DVD copyright information

The Read DVD Structure data format 01h (see Table 253) includes the DVD Copyright information response.

Table 253 – READ DVD STRUCTURE data format (format field = 01h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) DVD STRUCTURE Data Length							
1								(LSB)
2	Reserved							
3	Reserved							
DVD Copyright Information								
0	Copyright Protection System Type							
1	Region Management Information							
2	Reserved							
3	Reserved							

The DVD STRUCTURE Data Length specifies the length in bytes of the following DVD STRUCTURE data that is available to be transferred to the Initiator. The DVD STRUCTURE Data Length value does not include the DVD STRUCTURE Data Length field itself.

The Copyright Protection System Type field indicates the presence of data structures specific to a copyright protection system. Only two values are defined, 00h indicates there is no such data and 01h indicates a specific data structure exists. All other values are reserved.

The Region Management Information field describes the regions in that the disc can be played. Each bit represents one of eight regions. If a bit is not set in this field, the disc can be played in the corresponding region. If a bit is set in this field the disc can not be played in the corresponding region.

6.1.19.3 Disc key

The Disc Key data recorded on the media are identified with a data format defined in Table 254.

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Table 254 – READ DVD STRUCTURE data format (format field = 02h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
Disc Key Structures								
0	DISC KEY Data							
…								
2 047								

The DVD STRUCTURE Data Length specifies the length in bytes of the following DVD STRUCTURE data that is available to be transferred to the Initiator. The DVD STRUCTURE Data Length value does not include the DVD STRUCTURE Data Length field itself.

DISC KEY Data field returns the DISC KEY that is obfuscated by a Bus Key. The length of DISC KEY Data field is currently 2 048 bytes.

When the DISC KEY does not exist on DVD media, this command with Format = 02h shall be terminated with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code set to COPY PROTECTION KEY EXCHANGE FAILURE – KEY NOT PRESENT.

When the DVD Logical Unit is not in the Bus Key state, this command with Format = 02h shall be terminated with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code set to COPY PROTECTION KEY EXCHANGE FAILURE – KEY NOT ESTABLISHED.

6.1.19.4 BCA information

The BCA information is defined in data format 03h shown in Table 255.

Table 255 – READ DVD STRUCTURE data format (format field = 03h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
DVD BCA Structure								
0	BCA Information							
…								
…								
…								
n								

This Information is returned from BCA recorded DVD media only. The Length of BCA Information is in the range of 12 bytes to 188 bytes.

When a READ DVD STRUCTURE Command with a format field value of 03h is presented for a DVD media without BCA, the command shall be terminated with CHECK CONDITION

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status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.

6.1.19.5 DVD disc manufacturing information

Table 256 defines the data format for the Disc Manufacturing information.

Table 256 – READ DVD STRUCTURE data format (format field = 04h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) DVD STRUCTURE Data Length							
1								(LSB)
2	Reserved							
3	Reserved							
DVD Manufacturing Structures								
0	Disc Manufacturing Information							
…								
…								
…								
2 047								

The DVD STRUCTURE Data Length specifies the length in bytes of the following DVD STRUCTURE data that is available to be transferred to the Initiator. The DVD STRUCTURE Data Length value does not include the DVD STRUCTURE Data Length field itself.

The Disc Manufacturing Information is taken from the DVD media Lead-in. In the case of DVD-R multi-session disc, this information is taken from the last Border-in.

6.1.19.6 Copyright management information

The Copyright Management Information returned is shown in Table 257.

Table 257 – READ DVD STRUCTURE data format (format field = 05h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) DVD STRUCTURE Data Length							
1								(LSB)
2	Reserved							
3	Reserved							
Copyright Management Information								
0	CPM	Reserved	CGMS		Reserved			
1	Reserved							
2	Reserved							
3	Reserved							

The DVD STRUCTURE Data Length specifies the length in bytes of the following DVD STRUCTURE data that is available to be transferred to the Initiator. The DVD STRUCTURE Data Length value does not include the DVD STRUCTURE Data Length field itself.

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The CPM bit, if set to 0, indicates that this sector contains no copyright material. The CPM bit, if set to 1, indicates that this sector contains copyright material.

When the CPM bit is set to 0, the CGMS field is set to 00b. When the CPM bit is set to 1, and if the CGMS field is set to 00b, it indicates that copying is permitted without restriction. If the CGMS field is set to 01b, it indicates that the CGMS field is reserved, and if the CGMS field is set to 10b, indicates that one generation of copies may be made, and if the CGMS field is set to 11b, indicates that no copying is permitted.

6.1.19.7 DVD-RAM disc definition structure (DDS)

The DVD-RAM Disc definition is identified with the data format defined in Table 258.

Table 258 – READ DVD STRUCTURE data format (format field = 08h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
	DVD-RAM Disc Definition Structure (DDS)							
0	DDS Information							
…								
2 047								

The DVD STRUCTURE Data Length specifies the length in bytes of the following DVD STRUCTURE data that is available to be transferred to the Initiator. The DVD STRUCTURE Data Length value does not include the DVD STRUCTURE Data Length field itself.

The DDS Information is taken from the Defect Controls of the DVD-RAM media Lead-in. The length of the DDS Information is currently 2 048 bytes only.

When a READ DVD STRUCTURE Command with a format field value of 08h is presented for a DVD media without the DDS Information, the command shall be terminated with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code set to CAN NOT READ MEDIUM – INCOMPATIBLE FORMAT 30h/02h.

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6.1.19.8 RMD in the last border-out

The RMD field recorded in the Border-out is defined in Table 259.

Table 259 – READ DVD STRUCTURE data format (format field = 0Ch)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) DVD STRUCTURE Data Length							
1								(LSB)
2	Reserved							
3	Reserved							

RMD in last Border-out

0	RMD
…	
n	

The DVD STRUCTURE Data Length specifies the length in bytes of the following DVD STRUCTURE data that is available to be transferred to the Initiator. The DVD STRUCTURE Data Length value does not include the DVD STRUCTURE Data Length field itself.

The RMD Bytes field returns the RMD that is written in the last recorded Border-out.

The Address field in the Command specifies the starting RMD Field number where the read operation shall begin. The Allocation Length field in the command specifies the maximum number of RMD bytes that shall be returned. The largest RMD available is 30 720 bytes (15 sectors).

6.1.19.9 Recording management area data

The DVD-R Recording Management Data Structure sectors recorded in the RMA, on the media, is identified with the data format defined in Table 260.

Table 260 – READ DVD STRUCTURE data format (format field = 0Dh)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) DVD STRUCTURE Data Length							
1								(LSB)
2	Reserved							
3	Reserved							

DVD-R Recording Management Data Structure

0	(MSB) Last Recorded RMA Sector Number
1	
2	
3	(LSB)
4	RMD bytes
…	
n	

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The DVD STRUCTURE Data Length specifies the length in bytes of the following DVD STRUCTURE data that is available to be transferred to the Initiator. The DVD STRUCTURE Data Length value does not include the DVD STRUCTURE Data Length field itself.

Last Recorded RMA Sector Number field indicates the RMA sector number where the last RMD is recorded.

The RMD bytes field returns RMD that is written in RMA. The Address field in the command specifies the starting address of the RMA sector where the read operation shall begin. The Allocation Length field in the command specifies the maximum length of the descriptor returned to the Initiator. The returned RMD data shall end at the next ECC boundary.

The maximum number of RMD bytes that can be returned is 32 768.

6.1.19.10 Pre-recorded information in lead-in

The Pre-recorded Information in Lead-in area recorded on the media are identified with a data format defined in Table 261. This format is available only for DVD-R media. For other media, this format is reserved.

Table 261 – READ DVD STRUCTURE data format (format field = 0Eh)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) DVD STRUCTURE Data Length							
1								(LSB)
2	Reserved							
3	Reserved							
	DVD-R Pre-recorded Information Structure							
0	Field ID (= 1)							
1	Application code							
2	Disc Physical data							
3	(MSB) Last address of Data Recordable Area							
4								
5								(LSB)
6	Reserved							
7	Reserved							
8	Field ID (= 2)							
9	Recommended Write power							
10	Specified Wavelength for RWP							
11	Optimum Write Strategy							
12	Reserved							
13	Reserved							
14	Reserved							
15	Reserved							
16	Field ID (= 3)							
17	Manufacturer ID (17)							
18	Manufacturer ID (16)							
19	Manufacturer ID (15)							
20	Manufacturer ID (14)							

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Bit / Byte	7	6	5	4	3	2	1	0
21	Manufacturer ID (13)							
22	Manufacturer ID (12)							
23	Reserved							
24	Field ID (= 4)							
25	Manufacturer ID (11)							
26	Manufacturer ID (10)							
27	Manufacturer ID (9)							
28	Manufacturer ID (8)							
29	Manufacturer ID (7)							
30	Manufacturer ID (6)							
31	Reserved							
32	Field ID (= 5)							
33	Manufacturer ID (5)							
34	Manufacturer ID (4)							
35	Manufacturer ID (3)							
36	Manufacturer ID (2)							
37	Manufacturer ID (1)							
38	Manufacturer ID (0)							
39	Reserved							
40 to 63	Reserved							

The DVD STRUCTURE Data Length specifies the length in bytes of the following DVD STRUCTURE data that is available to be transferred to the Initiator. The DVD STRUCTURE Data Length value does not include the DVD STRUCTURE Data Length field itself.

The contents of Pre-recorded information are specified by DVD2.

6.1.19.11 Unique disc identifier

The Unique Disc Identifier data recorded on the media are identified with a data format defined in Table 262. This format is available only for DVD-R media. For other media, this format is invalid and reserved.

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Table 262 – READ DVD STRUCTURE data format (format field = 0Fh)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
	DVD-R Unique Disc Identifier							
0	Reserved							
1	Reserved							
2	(MSB)			Random Number				
3								(LSB)
4	(MSB)							
5								
6				YEAR				
7								(LSB)
8	(MSB)			Month				
9								(LSB)
10	(MSB)			Day				
11								(LSB)
12	(MSB			Hour				
13								(LSB)
14	(MSB)			Minute				
15								(LSB)
16	(MSB)			Second				
17								(LSB)

The DVD STRUCTURE Data Length specifies the length in bytes of the following DVD STRUCTURE data that is available to be transferred to the Initiator. The DVD STRUCTURE Data Length value does not include the DVD STRUCTURE Data Length field itself.

This format returns the Unique Disc Identifier that is recorded in RMD Field 0.

6.1.19.12 Disc control blocks

The Address field of the READ DVD STRUCTURE command shall contain a Content Descriptor to identify the Disc Control Blocks (DCB) requested. Valid values are as shown in Table 263.

Table 263 – Content descriptor

Content descriptor	Definition
00000000h	Reserved
00000000h to FFFFFFFDh	The DCB with a matching Content Descriptor is returned
FFFFFFFEh	Reserved
FFFFFFFFh	Return a list of readable and writable DCB Content Descriptors

Disc Control Block data returned is formatted as shown in Table 264.

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Table 264 – READ DVD STRUCTURE data format (format field = 30h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) DVD STRUCTURE Data Length							
1								(LSB)
2	Reserved							
3	Reserved							
0 to 32 767	Disc Control Block							

Each Disc Control Block is up to 16 sectors in length. The first 40 bytes of the block have a common definition and the remaining bytes depend on the value of the Content Descriptor field, see Table 265.

Table 265 – Generic disc control block

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Content Descriptor							
1								
2								
3								(LSB)
4	(MSB) Unknown Content Descriptor Actions							
5								
6								
7								(LSB)
8 to 39	Vendor ID							
40 to 32 767	Disc Control Block Data							

The DVD STRUCTURE Data Length specifies the length in bytes of the following DVD STRUCTURE data that is available to be transferred to the Initiator. The DVD STRUCTURE Data Length value does not include the DVD STRUCTURE Data Length field itself.

The Content Descriptor field identifies the contents of bytes 40 to 32 767.

The Unknown Content Descriptor Actions contains a bit mask. This mask shall describe actions the Logical Unit is allowed to perform if the Content Descriptor is not known by the drive. Each bit, when set to one, shall prohibit the corresponding action. When set to zero, the corresponding action is allowed, see Table 266.

Table 266 – Unknown content descriptor actions

Bit	Actions
0	Recording within the user data area
1	Reading within the user data area
2	Formatting of the medium
3	Modification of this DCB
4 to 31	Reserved

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The Vendor ID field contains 24 arbitrary bytes.

When Content Descriptor FFFFFFFFh, see Table 267, is requested, the Logical Unit shall generate a list of DCBs that may be read from and/or recorded on the current medium by the Initiator. If the Logical Unit records DCBs that are generated internally, and those DCBs cannot be sent from the Initiator, the Logical Unit shall not report those DCBs as recordable.

Table 267 – Disc control block (FFFFFFFFh)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	Content Descriptor = FFFFFFFFh							
2								
3								(LSB)
4	(MSB)							
5	Reserved							
6								
7								(LSB)
8 to 39	Vendor ID							
40	Reserved							
41	Number of Readable DCBs (= M)							
42	Reserved							
43	Number of Recordable DCBs (= N)							
44	(MSB)							
45	Recordable DCB 0							
46								
47								(LSB)
M * 4 + 40	(MSB)							
M * 4 + 41	Recordable DCB N-1							
M * 4 + 42								
M * 4 + 43								(LSB)
M * 4 + 44	(MSB)							
M * 4 + 45	Readable DCB M – 1							
M * 4 + 46								
M * 4 + 47								(LSB)
(M + N) * 4 + 40	(MSB)							
	Readable DCB N – 1							
(M + N) * 4 + 43								(LSB)

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The Content Descriptor field shall contain FFFFFFFFh.

The Unknown Content Descriptor Actions field shall be set to 0.

The Vendor ID field shall be set to the value the Logical Unit uses for its own DCBs.

The Number of Readable DCBs field shall identify the number of entries in the Readable DCB list.

The Number of Recordable DCBs field shall identify the number of entries in the Recordable DCB list.

Each Readable DCB field shall contain a Content Descriptor of a DCB that may be read from the medium.

Each Recordable DCB field shall contain a Content Descriptor of a DCB that may be sent from the Initiator. If a DCB is both readable and recordable, the DCB shall appear in both lists. The Logical Unit shall not record any DCB that it does not recognize.

6.1.19.13 DVD structure list

The DVD Structure List is returned in the format as shown in Table 268.

Table 268 – READ DVD STRUCTURE data format (format field = FFh)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
DVD Structure List								
0 to *n*	Structure List							

The DVD STRUCTURE Data Length specifies the length in bytes of the following DVD STRUCTURE data that is available to be transferred to the Initiator. The DVD STRUCTURE Data Length value does not include the DVD STRUCTURE Data Length field itself.

The Structure List is returned as a sequence of Structure List Entries, as shown in Table 269.

NOTE This DVD Structure is generated by the Logical Unit rather than read from the medium.

Table 269 – Structure list entry

Bit / Byte	7	6	5	4	3	2	1	0
0	Format Code							
1	SDS	RDS	Reserved					
2	(MSB)			Structure Length				
3								(LSB)

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The Format Code field shall identify a DVD Structure that is readable via the READ DVD STRUCTURE Command.

The SDS bit, when set to zero, shall indicate that the DVD structure is not writable via the SEND DVD STRUCTURE Command. The SDS bit, when set to one, shall indicate that the DVD structure is writable via the SEND DVD STRUCTURE Command.

The RDS bit, when set to zero, shall indicate that the DVD structure is not readable via the READ DVD STRUCTURE Command. The RDS bit, when set to one, shall indicate that the DVD structure is readable via the READ DVD STRUCTURE Command.

The Structure Length field shall specify the length of the DVD Structure that is identified by the Format Code.

Table 270 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 270 – Recommended errors for READ DVD STRUCTURE command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3

6.1.20 READ FORMAT CAPACITIES

The READ FORMAT CAPACITIES command (see Table 271) allows the Initiator to request a list of the possible format capacities for an installed random-Writable media. This command also has the capability to report the capacity for a media when it is installed. If the command is required, by an implemented Feature, it shall function independently of the state of that Feature's Current bit.

The Allocation Length field specifies the maximum number of bytes that an Initiator has allocated for returned data. An Allocation Length of zero indicates that no data shall be transferred. This condition shall not be considered an error. The Logical Unit shall terminate the data transfer when Allocation Length bytes have been transferred or when all available data have been transferred to the Initiator, whatever is less.

Table 271 – READ FORMAT CAPACITIES command descriptor block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (23h)							
1	Reserved			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB) Allocation Length							
8								(LSB)
9	Control							

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Table 272 – READ FORMAT CAPACITIES data format

Bit / Byte	7	6	5	4	3	2	1	0
0 to 3	Capacity List Header							
4 to 11	Current/Maximum Capacity Descriptor							
	Formattable Capacity Descriptor(s)							
0	Formattable Capacity Descriptor 0							
..								
7								
....								
0	Formattable Capacity Descriptor *n*							
..								
7								

Table 273 – Capacity list header

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved							
2	Reserved							
3	Capacity List Length							

The Capacity List Length specifies the length in bytes of the Capacity Descriptors that follow. Each Capacity Descriptor is eight bytes in length, making the Capacity List Length equal to eight times the number of descriptors. Values of $n \times 8$ are valid, where $0 < n < 32$.

Table 274 – Current/maximum capacity descriptor

Bit / Byte	7	6	5	4	3	2	1	0
4	(MSB)							
5	Number of Blocks							
6								
7								(LSB)
8	Reserved						Descriptor Type	
9	(MSB)							
10	Block Length							
11								(LSB)

The Number of Blocks indicates the number of addressable blocks for the capacity defined by each Descriptor Type.

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The Descriptor Type field (see Table 275) indicates the type of information the descriptor contains.

Table 275 – Descriptor types

Descriptor type	Description
00b	Reserved
01b	Unformatted Media. The reported value is for the maximum formatted capacity for this media.
10b	Formatted Media. The reported value is the current media's capacity. In the case of sequential writable media, the number of blocks field indicates the number of blocks between the first Lead-in and the Lead-out or Border-out. When the media do not have a complete session it shall be reported as "No Media Present" with Descriptor Type = 11b.
11b	No Media Present. The reported value is for the maximum capacity of media that the Logical Unit is capable of reading.

The Block Length specifies the length in bytes of each logical block.

Table 276 – Formattable capacity descriptor(s)

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)							
1	Number of Blocks							
2								
3								(LSB)
4	Format Type						Reserved	
5	(MSB)							
6	Type Dependent Parameter							
7								(LSB)

The Format Type field (see Table 277) indicates the type of information required for formatting.

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Table 277 – Format type

Format type	Description	Type rependent parameter
00h	The descriptor shall contain the number of addressable blocks and the block size used for formatting the whole media. If multiple formatting for the whole media is possible, each capacity/block size combination shall be reported as a separate descriptor.	Block length in bytes
01h – 03h	Reserved	
04h	The descriptor shall contain the number of addressable blocks in the zone and zone number used by zoned formatting for a zone of the media where the size of zone is not constant for each zone. The information for each zone shall be reported as a separate descriptor.	Zone number of the description
05h	The descriptor shall contain the number of addressable blocks per zone and zone number of the highest numbered zone. This descriptor is used for zoned formatting of the media, where the size of zone is constant for each zone.	Zone Number of the last zone
06h-0Fh	Reserved	
10h	The descriptor shall contain the maximum number of addressable blocks and maximum packet size that can be used to fully format CD-RW media. The packet size and number of addressable blocks may be adjusted downward by the Initiator before sending this descriptor back via the FORMAT UNIT command.	Fixed Packet Size in sectors
11h	The descriptor shall contain the maximum number of addressable blocks and the packet size that can be used to expand (grow) the last complete session of CD-RW media. The number of addressable blocks may be adjusted downward by the Initiator before sending this descriptor back via the FORMAT UNIT command.	Fixed Packet Size in sectors
12h	The descriptor shall contain the maximum number of addressable blocks and the maximum packet size that can be used to add a new session to a CD-RW media. The packet size and number of addressable blocks may be adjusted downward by the Initiator before sending this descriptor back via the FORMAT UNIT command.	Fixed Packet Size in sectors
13h – 1Fh	Reserved	
20h	The descriptor shall contain the maximum number of addressable blocks and the sparing parameters to be used.	M and N (sparing parameters)
21h – 3Fh	Reserved	

The Number of Blocks field indicates the number of addressable blocks for the capacity defined by each Format Type.

The Type Dependent Parameter contents are as specified for each Format Type in Table 277. In the case of Format Type 20h, M specifies SL where SL = 2^M, 4 ≤ M ≤ 15 or SL = 0, if M = 0 and N identifies SI where SI = 2^N , 4 ≤ N ≤ 24.

The Type Dependent Parameter shall be set to M × 10 000h + N, effectively placing M in byte offset 5 and N in byte offset 7, and making byte 8 reserved. The device shall supply its default values for M and N.

The Logical Unit shall only return Formattable Capacity Descriptors that apply to the installed media. If there is no medium installed, the Logical Unit shall return only the Current/Maximum Capacity Descriptor, with the maximum capacity of a medium that the Logical Unit is capable of reading.

A Formattable Capacity Descriptor of Format Type 00h shall be reported if any other Formattable Capacity Descriptor is reported.

The descriptors shall be returned in ascending order of Format Type. For Format Types other than 04h and 05h, if multiple format descriptors exist, they shall be returned in Logical Unit preferred order. For Format Types 04h and 05h, the format descriptors shall be returned in ascending order of Zone number.

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Formattable Capacity Descriptors for formats that can be read, but not formatted, shall not be reported.

Table 278 indicates the values returned if the Logical Unit implements the command.

Table 278 – Returned current/maximum descriptor for combination of logical unit and media

Logical unit type	No media	ROM media	Sequential writable media	Random writable media
ROM	Descriptor Type = 11b	Descriptor Type = 10b	Descriptor Type = 10b or 11b	Descriptor Type = 10b
Sequential Writable			Descriptor Type = 10b	Descriptor Type = 10b
Random Writable			Descriptor Type = 10b or 11b	Descriptor Type = 01b or 10b plus Formattable Capacity Descriptor(s)

This command is not mandatory for all Logical Unit types shown in Table 278; the table indicates the values returned if the command is implemented.

Table 279 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 279 – Recommended errors for READ FORMAT CAPACITIES command

Error	Reference
Deferred Errors	A.1.
General Errors	Table A.2
Media Access Errors	Table A.3

6.1.21 READ HEADER command (obsolete)

The READ HEADER Command (see Table 280) requests that the Logical Unit return the CD data block address header of the requested logical block.

Table 280 – READ HEADER command descriptor block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (44h)							
1	RESERVED			Reserved			MSF	Reserved
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	(MSB)			Allocation Length				
8								(LSB)
9	Control							

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If the MSF bit is zero, the read header LBA parameter list, see Table 281, defines the CD data block address header of the requested logical block. If the MSF bit is one, the read header MSF parameter list (see Table 283) defines the CD data absolute address of the requested logical block.

The logical block address field specifies the logical block where the read header operation shall begin. If the logical block size is other than the physical block size, it shall be mapped into the appropriate physical block from that the data would have been read.

The READ HEADER data format (see Table 281) defines the CD data block address header of the requested logical block.

Table 281 – READ HEADER LBA data format

Bit / Byte	7	6	5	4	3	2	1	0
0	CD Data Mode							
1	Reserved							
2	Reserved							
3	Reserved							
4	(MSB)							
5	Logical Block Address							
6								
7								(LSB)

The CD data mode field specifies the CD-ROM data mode of the logical blocks in this sector of data. The values in this field are defined in Table 282.

Table 282 – CD data mode field

CD data mode	CD sector formats
00h	Mode 0 or Audio
01h	Mode 1
02h	Mode 2
03h to FFh	Reserved

See Table 220 for the CD sector format definition.

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Table 283 – READ HEADER MSF data format

Byte \ Bit	7	6	5	4	3	2	1	0
0	CD Data Mode							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	M							
6	S							
7	F							

Table 284 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 284 – Recommended errors for READ HEADER command

Error	Reference
Deferred Errors	A.1.
General Errors	Table A.2
Media Access Errors	Table A.3

6.1.22 READ MASTER CUE command (obsolete)

The READ MASTER CUE command reads the Mastering Information from a Master CD. Refer to RIS 105-1994 (see bibliography).

NOTE This standard does not define any relationship between the master cue data and data sent with the Send Cue Sheet command.

Table 285 – READ MASTER CUE command descriptor block

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (59h)							
1	Reserved			Reserved				
2	Reserved							
3	Reserved							
4	Sheet Number							
5	Reserved							
6	(MSB)							
7	Allocation Length							
8								(LSB)
9	Control							

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The Sheet Number values are shown in Table 286 below.

Table 286 – Sheet number values

Sheet number	Content
00h	Disc Information
01h	Master Cue Sheet
02 ... FFh	Reserved

Allocation Length specifies the maximum number of returned bytes. Response data is terminated when allocation length bytes have been transferred or when all data have been transferred to the Initiator, whatever is less. An Allocation Length of zero is not an error. If Allocation Length is zero, no data shall be transferred. The data read from the Master CD is transferred in the format shown in Table 287.

If the master cue sheet does not exist on the media, the Logical Unit shall return a CHECK CONDITION status, INCOMPATIBLE MEDIUM INSTALLED.

Table 287 – Master CD response data format

Byte number	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0	00h	Ooh	00h	00h	Sheet Length (bytes)			
8	Contents of the Sheet							
.....	.....							

Table 288 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 288 – Recommended errors for READ MASTER CUE command

Error	Reference
Deferred Errors	A.1.
General Errors	Table A.2
Media Access Errors	Table A.3

6.1.23 READ SUB-CHANNEL command

6.1.23.0 General

The READ SUB-CHANNEL command (see Table 289) requests that the Logical Unit return the requested Sub-channel data plus the state of audio play operations.

NOTE Sub-channel data, returned by this command, may be from the last appropriate sector encountered by a current or previous media accessing operation. When there is no current audio play operation, the Logical Unit may access the media to read the Sub-channel data. The Logical Unit is responsible for ensuring that the data returned is current and consistent.

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Table 289 – READ SUB-CHANNEL command descriptor block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (42h)							
1	RESERVED			Reserved			MSF	Reserved
2	Reserved	SUBQ	Reserved					
3	Sub-channel Parameter List							
4	Reserved							
5	Reserved							
6	Track Number (Hex)							
7	(MSB) Allocation Length							
8	(LSB)							
9	Control							

If the MSF bit is zero, the read header LBA parameter list, see Table 281, defines the CD data block address header of the requested logical block. If the MSF bit is one, the read header MSF parameter list (see Table 283) defines the CD data absolute address of the requested logical block.

The sub-Q bit set to one requests that the Logical Unit return the Q Sub-channel data. The sub-Q bit set to zero requests that no Sub-channel data be returned, see 6.1.23.1. This shall not be considered an error.

The Sub-channel parameter list (see Table 290) field specifies the returned sub-channel data.

Table 290 – Sub-channel parameter list codes

Format code	Returned data
00h	Reserved
01h	CD current position
02h	Media Catalog number (UPC/bar code)
03h	Track International standard recording code (ISRC)
04h to EFh	Reserved
F0h to FFh	Vendor-specific

The Track Number field specifies the track number from that ISRC data is read. This field shall have a value between 01h and 63h (99bcd) and is valid only when the Sub-channel parameter list field is 03h. In this case, the Logical Unit returns ISRC data for this track. This field may contain 00h when the Format code is not 03h.

6.1.23.1 Sub-channel data header

The Sub-channel data header format (see Table 291) is four bytes. If the Sub-Q bit is zero, in the command, the Logical Unit shall return only the Sub-channel data header. In this case, the Sub-channel data length is 0.

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Table 291 – Sub-Q channel data header format

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Audio Status							
2	(MSB) Sub-channel							
3	Data Length (LSB)							

The audio status field indicates the status of audio play operations. The audio status values are defined in Table 292. Logical Units that do not support audio play operations shall always report 00h.

For Logical Units that support audio operations: The initial value for audio status is 15h. Audio status values 13h and 14h return information on previous audio operations. When audio play stops due to an error and the IMMED bit in the CD Audio Control Page (see 5.5.6.) is set to one, the Logical Unit shall report 14h in this audio status byte and shall report no deferred error.

Table 292 – Audio status codes

Status	Description
00h	Audio status byte not supported or not valid
01h to 10h	Reserved
11h	Audio play operation in progress
12h	Audio play operation paused
13h	Audio play operation successfully completed
14h	Audio play operation stopped due to error
15h	No current audio status to return
16h to FFh	Reserved

The Sub-channel data length field specifies the length in bytes of the following Sub-channel data block. A Sub-channel data length of zero indicates that no Sub-channel data block is included in the returned data. Sub-channel data length does not include the sub-channel header.

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6.1.23.2 Sub-channel data format (01h), CD current position

Table 293 defines the response data format for the CD current position data format.

Table 293 – CD current position data format

Byte \ Bit	7	6	5	4	3	2	1	0
0	Sub-channel Data Format Code (01h)							
1	ADR				CONTROL			
2	TRACK NUMBER							
3	INDEX NUMBER							
4	(MSB)							
	Absolute CD Address							
7								(LSB)
8	(MSB)							
	Track Relative CD Address							
11								(LSB)

The ADR field gives the type of information encoded in the Q Sub-channel of this block, as shown in Table 294.

Table 294 – ADR Q sub-channel field

ADR code	Description
0h	Q Sub-channel mode information not supplied
1h	Q Sub-channel encodes current position data (i.e., track, index, absolute address, relative address)
2h	Q Sub-channel encodes media catalog number
3h	Q Sub-channel encodes ISRC
4h to Fh	Reserved

The control field is defined in Table 295.

The bits of the control field (except for the copy bit) can change during an actual pause (X=00) of at least 2 s and during the Lead-in area only.

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Table 295 – Q sub-channel control field

Field	Definitions
00x0b	2 audio channels without pre-emphasis
00x1b	2 audio channels with pre-emphasis of 50/15 µs
10x0b	audio channels without pre-emphasis (reserved in CD-R/RW)
10x1b	audio channels with pre-emphasis of 50/15 µs (reserved in CD-R/RW)
01x0b	Data track, recorded uninterrupted
01x1b	Data track, recorded incremental
11xxb	Reserved
xx0xb	Digital copy prohibited
xx1xb	Digital copy permitted

The Track Number field contains the current track number.

The Index Number field contains the current index number.

The Absolute CD Address field gives the current location relative to the logical beginning of the media. If the MSF bit (see Table 289) is zero, this field is an LBA. If the MSF bit is one, the address is MSF. See 4.1.1 for a definition of the MSF field.

The Track Relative CD Address field gives the current location relative to the logical beginning of the current track. If the MSF bit is zero, this field is a track relative LBA. (If the current block is in the pre-gap area of a track, this will be a negative value, expressed as a two's-complement number.) If the MSF bit in the CDB is set to one, this field is the relative MSF address from the Q Sub-channel.

The control data and current position data are obtained from the Q Sub-channel information of the current block. Identification data may be reported that was obtained from a previous block. If identification data is reported, the data shall be valid for the sector addressed by the current position data.

a) If an audio play operation is proceeding in the background, position data for the last sector played shall be reported.

b) In other cases, for instance after a READ command, the Logical Unit may either report position data for the last sector processed for that operation or may report position data from the sector at the current read head position.

NOTE When the type of information encoded in the Q Sub-channel of the current sector is the media catalog number or ISRC, the track, index and address fields should be extrapolated from the previous sector.

6.1.23.3 Sub-channel data format (02h), media catalog number

With a Sub-channel format code of 02h the data returned is the Media Catalog Number. The Media Catalog field contains the identifying number of these media shall be graphic characters according to ISO/IEC 646:1991. A value in this field of all graphic character zero indicates that the media catalog number is not supplied. Table 296 defines the media catalog number data format.

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Table 296 – Media catalog number data format

Bit / Byte	7	6	5	4	3	2	1	0
0	Sub-channel Data Format Code (02h)							
1	Reserved							
2	Reserved							
3	Reserved							
4 … … 19	Media Catalog Number (MCN)							

If media catalog number data is found, the MCVAL bit is set to one. If MCN data is not detected, the MCVAL bit is set to zero to indicate the media catalog number field is invalid.

Media Catalog Number (see Table 297) data returned in bytes 4 through 19 by this command with Sub-channel data format field code 02h may be from any block that has MCN Q Sub-channel data, see 4.2.2.4.

Table 297 – MCN Format of Data Returned

Byte	Char	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0		MCVAL	Reserved						
1	N1	N1 (Most significant)							
2	N2	N2							
3	N3	N3							
…	…	…							
12	N12	N12							
13	N13	N13 (Least significant)							
14		Zero							
15		AFRAME							

The Media Catalog Number, N1 through N13, when sent to the Initiator, is formatted as graphic characters according to ISO/IEC 646:1991 characters.

The MCVAL bit when set to one, indicates the Media Catalog Number field is valid.

Zero field shall return 00h.

AFRAME may return the frame number where the MCN was found. This shall be a value from 00h to 4Ah. All other values are reserved.

6.1.23.4 Sub-channel data format (03h), track international standard recording code

The track ISRC field contains the identifying number of these media according to the ISRC standards (ISO 3901) formatted as graphic characters according to ISO/IEC 646:1991). Table 298 defines the Track International Standard Recording Code data format. A unique ISRC may exist for each track.

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Table 298 – Track international standard recording code data format

Byte \ Bit	7	6	5	4	3	2	1	0
0	Sub-channel Data Format Code (03h)							
1	ADR				CONTROL			
2	Track Number							
3	Reserved							
4	(MSB)							
…	Track International Standard Recording Code (ISRC)							
19	(LSB)							

If ISRC data are detected, the TCVAL bit (see Table 299) is set to one. If ISRC data are not detected, the TCVAL bit is set to zero to indicate the ISRC field is invalid.

The ADR (see Table 294) and Control fields (see Table 295) shall be returned from the ADR and Control fields on the media.

The Track Number shall indicate the track for which the ISRC was requested.

Track ISRC data (see Table 299) may be from any block in the specified track that has ISRC data. When ADR field is 3 (0011), it is used to assign a unique number to an audio track. This is done by means of the ISRC that is 12 characters long (represented by I1 to I12, see Table 299.) The ISRC shall only change immediately after the TNO has been changed.

The format of the data is defined in Table 299.

Table 299 – ISRC format of data returned

Byte	Char	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0		TCVAL	Reserved						
1	I1	I1 (Country Code)							
2	I2	I2							
3	I3	I3 (Owner Code)							
4	I4	I4							
5	I5	I5							
6	I6	I6 (Year of Recording)							
7	I7	I7							
8	I8	I8 (Serial Number)							
9	I9	I9							
10	I10	I10							
11	I11	I11							
12	I12	I12							
13		Zero							
14		AFRAME							
15		Reserved							

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The following translation (see Table 300) is specified for Logical Units:

Table 300 – ISRC translation

ISO/IEC 646:1991	Hex	MEDIA
'0' to '9'	30h to 39h	00 to 09h
'@' to 'o'	40h to 6Fh	10h to 3Fh

The following codes shall be valid for the above fields (see Table 299):

a) Country Code: 'A' to 'Z' (41h to 5Ah)

b) Owner Code: '0' to '9' and 'A' to 'Z' (30h to 39h, 41h to 5Ah)

c) Year of Recording: '0' to '9' (30h to 39h)

d) Serial Number: '0' to '9' (30h to 39h)

The Zero field shall return 00h.

AFRAME may return the frame number in that the MCN was found. This shall be a value from 00h to 4Ah. All other values are reserved.

Table 301 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 301 – Recommended errors for READ SUB-CHANNEL command

Error	Reference
Deferred Errors	A.1.
General Errors	Table A.2
Media Access Errors	Table A.3
AUDIO PLAY OPERATION IN PROGRESS	Table A.1
AUDIO PLAY OPERATION PAUSED	Table A.1
AUDIO PLAY OPERATION SUCCESSFULLY COMPLETED	Table A.1
AUDIO PLAY OPERATION STOPPED DUE TO ERROR	Table A.1
NO CURRENT AUDIO STATUS TO RETURN	Table A.1

6.1.24 READ TOC/PMA/ATIP command

6.1.24.0 General

The READ TOC/PMA/ATIP Command (see Table 302) requests that the Logical Unit transfer data from the Table of Contents, the Program Memory Area (PMA) and the Absolute Time in Pre-Grove (ATIP) from CD media. For media that do not support a TOC, this command will return fabricated information that is similar to that of CD media for some formats. This fabrication is required for some legacy Initiator environments.

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Table 302 – READ TOC/PMA/ATIP command descriptor block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (43h)							
1	Reserved			Reserved			MSF	Reserved
2	Reserved				Format			
3	Reserved							
4	Reserved							
5	Reserved							
6	Track/Session Number							
7	(MSB) Allocation Length							
8	(LSB)							
9	Control							

See 4.1.1 for a description of the MSF bit.

The Format field is defined in Table 303.

Table 303 – Format field

Format field	Return data	Optional/ mandatory	Description	Track/ session field usage
0001b	Session Info	M	This format returns the first complete session number, last complete session number and last complete session starting address. In this format, the Track/Session Number field is reserved and should be set to 00h.[a]	Reserved
0010b	Full TOC	M	This format returns all Q sub-code data in the Lead-in (TOC) areas starting from a session number as specified in the Track/Session Number field. In this mode, the Logical Unit will support Q Sub-channel POINT field value of A0h, A1h, A2h, Track numbers, B0h, B1h, B2h, B3h, B4h, C0h and C1h, see Table 307. There is no defined LBA addressing and MSF bit shall be set to one.	Session Number
0011b	PMA	O	This format returns all Q sub-code data in the PMA area. In this format, the Track/Session Number field is reserved and shall be set to 00h, see Table 311. There is no defined LBA addressing and MSF bit shall be set to one.	Reserved
0100b	ATIP	O	This format returns ATIP data. In this format, the Track/ Session Number field is reserved and shall be set to 00h, see Table 312. There is no defined LBA addressing and MSF bit shall be set to one.	Reserved
0101b	CD-TEXT	O	This format returns CD-TEXT information that is recorded in the Lead-in area as R-W Sub-channel Data.	Reserved
All Other Format Codes			Reserved	Reserved

[a] This format provides the Initiator access to the last finalized session starting address quickly. See Table 306.

The Track/Session Number field specifies the starting track number for that the data shall be returned. The data is returned in contiguous ascending track number order. A value of AAh requests that the starting address of the Lead-out area be returned. If this value is zero, the Table of Contents data shall begin with the first track or session on the medium.

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If the Track/Session Number field is not valid for the currently installed medium, the command shall be terminated with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.

When a Read TOC/PMA/ATIP command is presented for a CD-R/RW media, where the first TOC has not been recorded (no complete session) and the Format codes 0000b, 0001b, or 0010b are specified, this command shall be rejected with an INVALID FIELD IN CDB. Devices that are not capable of reading an incomplete session on CD-R/RW media shall report CANNOT READ MEDIUM – INCOMPATIBLE FORMAT.

6.1.24.1 READ TOC response parameter list, general definition

The response parameter list (see Table 304) indicates the general description of the response data to the Read TOC/PMA/ATIP command. Each descriptor field is format specific and is defined in the appropriate format subclause.

Table 304 – READ TOC/PMA/ATIP parameter list, general definition

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Data Length				
1								(LSB)
2	First Track/Session/Reserved Field(Hex)							
3	Last Track/Session/Reserved Field(Hex)							
Parameter List Descriptor(s)								
0 : : n	Descriptor data, format specific							

The Data Length indicates the length, in bytes, of the parameter list descriptor data.

The Track/Session/Reserved Field is format specific and indicates the location, if any, of the information in the parameter list descriptors.

Descriptor data fields are format specific. The definitions of the bytes are described in each format subclause.

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6.1.24.2 TOC/PMA/ATIP response data format 0000b

The response data consist of four header bytes and zero or more track descriptors. The response data is dependent upon the format specified in the format field of the CDB. The response data returned for Format 0000b is specified in Table 305.

Table 305 – READ TOC/PMA/ATIP response data (format = 0000b)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			TOC Data Length				
1								(LSB)
2	First Track Number(Hex)							
3	Last Track Number(Hex)							
	TOC Track Descriptor(s)							
0	Reserved							
1	ADR				CONTROL			
2	Track Number(Hex)							
3	Reserved							
4	(MSB)							
…	Logical Block Address							
7								(LSB)

The TOC data length indicates the length in bytes of the following TOC data. The TOC data length value does not include the TOC data length field itself. This value is not modified when the allocation length is insufficient to return all of the TOC data available.

The First Track Number field indicates the first track number in the first complete session Table of Contents.

The Last Track Number field indicates the last track number in the last complete session Table of Contents before the Lead-out.

The ADR field gives the type of information encoded in the Q Sub-channel of the block where this TOC entry was found. The possible ADR values are defined in Table 294.

The Control Field indicates the attributes of the track, see Table 295.

The Track Number field indicates the track number for that the data in the TOC track descriptor is valid. A track number of AAh indicates that the track descriptor is for the start of the Lead-out area.

The Logical Block Address contains the address of the first block with user information for that track number as read from the Table of Contents. An MSF bit of zero indicates that the Logical Block Address field contains a logical block address. An MSF bit of one indicates the Logical Block Address field contains an MSF address (see 4.1.6).

6.1.24.3 TOC/PMA/ATIP response data format 0001b

The response data returned for Format 0001b is specified in Table 306.

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Table 306 – READ TOC/PMA/ATIP response data (format = 0001b)

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			TOC Data Length				
1								(LSB)
2	First Complete Session Number (Hex)							
3	Last Complete Session Number (Hex)							
	TOC Track Descriptor							
0	Reserved							
1	ADR				CONTROL			
2	First Track Number In Last Complete Session (Hex)							
3	Reserved							
4	(MSB)							
…	Logical Block Address of First Track in Last Session							
7								(LSB)

The TOC Data Length specifies the length in bytes of the available session data. The TOC Data Length value does not include the TOC Data Length field itself. This value is not modified when the allocation length is insufficient to return all of the session data available.

The First Complete Session Number is set to one.

The Last Complete Session Number indicates the number of the last complete session on the disc. The Last Complete Session Number shall be set to one for a single session disc or if the Logical Unit does not support multi-session discs.

The ADR field gives the type of information encoded in the Q Sub-channel of the block where this TOC entry was found. The possible ADR values are defined in Table 294.

The Control Field indicates the attributes of the track. The possible control field values are defined in Table 295.

First Track Number In Last Complete Session returns the first track number in the last complete session.

The Logical Block Address contains the address of the first block with user information for the first track of the last session, as read from the Table of Contents. An MSF bit of zero indicates that the Logical Block Address field contains a logical block address. An MSF bit of one indicates the Logical Block Address field contains an MSF address (see 4.1.5).

6.1.24.4 TOC/PMA/ATIP response data format 0010b

None of the fields in the response data of Format 0010b are affected by the MSF bit in the CDB. The response data returned for Format 0010b is specified in Table 307.

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Table 307 – READ TOC/PMA/ATIP response data (format = 0010b)

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			TOC Data Length				
1								(LSB)
2	First Complete Session Number (Hex)							
3	Last Complete Session Number (Hex)							
	TOC Track Descriptor(s)							
0	Session Number (Hex)							
1	ADR				CONTROL			
2	TNO							
3	POINT							
4	Min							
5	Sec							
6	Frame							
7	Zero							
8	PMIN							
9	PSEC							
10	PFRAME							

Multiple TOC Track Descriptors may be returned, but only one of each entry is reported.

For Format field of 0010b, the Logical Unit shall return TOC data for Q Sub-channel modes 1 and 5 (except mode 5, point 1 through 40) in the Lead-in area.

The TOC Data Length specifies the length in bytes of the available TOC data. The TOC Data Length value does not include the TOC Data Length field itself. This value is not modified when the allocation length is insufficient to return all TOC data available.

The First Complete Session Number shall be set to one.

The Last Complete Session Number indicates the number of the last complete session on the disc. The Last Complete Session Number is set to one for a single session disc or if the Logical Unit does not support multi-session discs.

The ADR field gives the type of information encoded in the Q Sub-channel of the block where this TOC entry was found. The possible ADR values are defined in Table 294.

The Control Field indicates the attributes of the track. The possible control field values are defined in Table 295.

Entries in bytes 2 through 10 of the descriptors (TNO, POINT, MIN, SEC, FRAME, PMIN, PSEC, PFRAME, Zero) shall be converted to hex by the Logical Unit if the media contain a value between 0 and 99bcd. (See 4.2.2.6.)

The returned TOC data of a multi-session disc is arranged in ascending order of the session number with duplicates removed. The TOC data within a session is arranged in the order of Q Sub-channel POINT field value of A0h – AFh, Track Numbers, B0h, BFh. Only recorded Points shall be returned.

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The TOC Track Descriptor format in the Lead-in area of the TOC is described in Table 308.

Table 308 – TOC track descriptor format, Q sub-channel

CTRL	ADR	TNO	POINT	MIN	SEC	FRAME	ZERO	PMIN	PSEC	PFRAME
4 or 6	1	00h	01h-63h	ATIME (Absolute time)			00h	Start position of track		
4 or 6	1	00h	A0h	ATIME (Absolute time)			00h	First Track Number	Disc Type	00h
4 or 6	1	00h	A1h	ATIME (Absolute time)			00h	Last Track Number	00h	00h
4 or 6	1	00h	A2h	ATIME (Absolute time)			00h	Start position of Lead-out		
4 or 6	5	00h	B0h	Start time of next possible program in the Recordable Area of the disc			# of pointers in Mode 5	Maximum start time of outer-most Lead-out area in the Recordable Area of the disc		
4 or 6	5	00h	B1h	00h	00h	00h	00h	# of skip interval Pointers (N<=40)	# of skip Track Pointers (N<=21)	00h
4 or 6	5	00h	B2h-B4h	Skip #	Skip #	Skip #	Skip #	Skip #	Skip #	Skip #
4 or 6	5	00h	01h-40h	Ending time for the interval that should be skipped			Reserved	Start time for interval that should be skipped on playback		
4 or 6	5	00h	C0h	Optimum recording power	Reserved	Reserved	Reserved	Start time of the first Lead-in Area of the disc		
4 or 6	5	00h	C1h	Copy of information from A1 point in ATIP.						

The POINT Field (see Table 309) defines various types of information within the TOC Lead-in area.

Table 309 – POINT field

ADR	POINT field	Description
1	01 - 63h	Track number references
1	A0h	First Track number in the program area
1	A1h	Last Track number in the program area
1	A2h	Start location of the Lead-out area
5	01 to 40h	Skip Interval Pointers
5	B0h	Used to Identify a Multi-session Disc (Photo CD) Contains start time of next possible program area
5	B1h	Number of skip interval pointers & Skip track assignments
5	01 to 40h	Skip Interval Pointers
5	B2 to B4h	Skip Track Assignment Pointers
5	C0h	Start time of first Lead-in area of disc (This only exists in the first Lead-in area)
5	C1h	Copy of information from additional area 1 in ATIP.

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The Disc Type field (see Table 310) indicates the type of disc inserted.

Table 310 – Disc type byte format

Value	Description
00h	CD-DA or CD Data with first track in Mode 1
10h	CD-I disc
20h	CD data XA disc with first track in Mode 2

The definition for the Control Field in the Q Sub-channel is in Table 295.

6.1.24.5 TOC/PMA/ATIP response data format 0011b

None of the fields in the response data of Format 0011b are affected by the MSF bit in the CDB.The response data returned for Format 0011b is specified in Table 311.

Table 311 – READ TOC/PMA/ATIP response data (format = 0011b)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) PMA Data Length							
1								(LSB)
2	Reserved							
3	Reserved							
	PMA Descriptor(s)							
0	Reserved							
1	ADR				CONTROL			
2	TNO							
3	POINT							
4	Min							
5	Sec							
6	Frame							
7	Zero							
8	PMIN							
9	PSEC							
10	PFRAME							

Multiple PMA Descriptors may be returned.

The returned PMA descriptors are arranged in the order found in the PMA, with duplicates removed.

The PMA Data Length indicates the length in bytes of the available PMA data. The PMA Data Length value does not include the PMA Data Length field itself. This value is not modified when the allocation length is insufficient to return all PMA data available. This value is set to 2 plus eleven times the number of descriptors read.

Entries in bytes 2 through 10 of the descriptors (TNO, POINT, MIN, SEC, FRAME, Zero) shall be converted to binary by the Logical Unit if the media contain a value between 0 and 99bcd. (See 4.2.2.8.2.)

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6.1.25 TOC/PMA/ATIP response data format 0100b

6.1.25.0 General

None of the fields in the response data of Format 0100b are affected by the MSF bit in the CDB. The response data returned for Format 0100b is specified in Table 312.

Table 312 – READ TOC/PMA/ATIP response data (format = 0100b)

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			ATIP Data Length				
1								(LSB)
2	Reserved							
3	Reserved							

ATIP Descriptor

0	1	Indicative Target Writing Power		Reserved	Reference Speed		
1	0	URU	Reserved				
2	1	Disc Type	Disc Sub-Type		A1	A2	A3
3	Reserved						
4	ATIP Start Time of Lead-in (Min)						
5	ATIP Start Time of Lead-in (Sec)						
6	ATIP Start Time of Lead-in (Frame)						
7	Reserved						
8	ATIP Last Possible Start Time of Lead-out (Min)						
9	ATIP Last Possible Start Time of Lead-out (Sec)						
10	ATIP Last Possible Start Time of Lead-out (Frame)						
11	Reserved						
12	0	Lowest Usable CLV Recording Speed		Highest Usable CLV Recording Speed			
13	0	Power Multiplication Factor p		Target y value of the Modulation/Power function			Reserved
14	1	Recommended Erase/Write Power Ratio (Peo/Weo)		Reserved			
15	Reserved						
16 to 18	A2 Values						
19	Reserved						
20 to 22	A3 Values						
23	Reserved						

ATIP Data Length specifies the number of bytes to be transferred in response to the command. The ATIP Data Length value does not include the data length field itself. This value is not modified when the allocation length is insufficient to return all of the ATIP data available.

Indicative Target Writing Power Field – encoded information indicating the media's recommended initial laser power setting. The meaning of these bits varies between CD-R and CD-RW media.

Reference Speed Field – encoded information indicating the recommended write speed for the media. 00h = reserved. 01h to 2X recording, 02h-07h are reserved. Only valid for CD-RW media.

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The URU (Unrestricted Use Disc) bit, when set to one, indicates that the mounted CD-R/RW disc is defined for unrestricted use. When the Unrestricted Use Disc bit is set to zero, the mounted CD-R/RW disc is defined for restricted use. To record data to the mounted disc the appropriate Initiator Application code shall be set through the Write Parameters Page. An Initiator Application Code of zero may be used to indicate a restricted use disc – general purpose.

Disc Type – zero indicates CD-R media; one indicates CD-RW media.

Disc Sub-Type – shall be set to zero.

A1 – when set to one, indicates that bytes 16-18 are valid.

A2 – when set to one, indicates that bytes 20-22 are valid.

A3 – when set to one, indicates that bytes 24-26 are valid.

ATIP Start Time of Lead-in (min, sec, frame) – the start time of the Lead-in. The value is read from ATIP and returned in hex format. Legal values for the M field are 50h through 63h.

ATIP Last Possible Start Time of Lead-out (min, sec, frame) – the last possible start time of Lead-out. The value is read from ATIP and returned in hex format. Valid values for the M field is 0 through 4Fh.

Lowest Usable CLV Recording Speed (see Table 313) – valid only when A1 = 1.

Table 313 – Lowest CLV recording speeds

Value	Recording speed
000b	Reserved
001b	2X
010b to 111b	Reserved

Highest Usable CLV Recording Speed (see Table 314) - valid only when A1 = 1.

Table 314 – Highest CLV recording speeds

Value	Recording speed
000b	Reserved
001b	2X
010b	4X
011b	6X
100b	8X
101b to 111b	Reserved

The following fields reported as recorded in ATIP, contain information that is beyond the scope of this standard.

Power Multiplication Factor p field.

Target value of the Modulation/Power function field.

Recommended Erase/Write Power Ratio (Peo/Weo) field.

A2 Values – Reserved

A3 Values – Reserved

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6.1.25.1 TOC/PMA/ATIP response data format 0101b

None of the fields in the response data of Format 0101b are affected by the MSF bit in the CDB. The response data returned for Format 0101b is specified in Table 315.

Table 315 – READ TOC/PMA/ATIP response data (with format field = 0101b)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			CD-TEXT Data Length				
1								(LSB)
2	First Track/Session/Reserved Field(Hex)							
3	Last Track/Session/Reserved Field(Hex)							
	CD-TEXT Descriptor(s)							
0 : : *n*	Descriptor data, format specific							

CD-TEXT Data Length specifies the number of bytes to be transferred in response to the command. The ATIP Data Length value does not include the data length field itself. This value is not modified when the allocation length is insufficient to return all of the CD-TEXT data available. This length is variable and depends on the number of recording Pack Data.

CD-TEXT Information Descriptor(s) provides Pack Data available in the Lead-in area of the disc. Each Pack Data consists of 18 bytes of CD-TEXT information. If a Pack Data is recorded repeatedly on the disc, the device should return it only once.

The detail of Pack Data and CD-TEXT information is described in Annex J.

Table 316 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 316 – Recommended errors for READ TOC/PMA/ATIP command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3
AUDIO PLAY OPERATION IN PROGRESS	Table A.1

6.1.26 READ TRACK INFORMATION command

The READ TRACK INFORMATION Command (see Table 317) provides information about a track, regardless of its status. In case of media that do not support logical tracks, the number of tracks and sessions is considered one. If this command is required, by an implemented Feature, the command shall function if any media are present.

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For CD, if the PMA/TOC is unreadable, the command shall be terminated with CHECK CONDITION Status, sense code of UNABLE TO RECOVER TABLE-OF-CONTENTS. For DVD, if the RMA/RMD in Border-out is unreadable, the command shall be terminated with CHECK CONDITION Status, sense code L-EC UNCORRECTABLE ERROR.

Table 317 – READ TRACK INFORMATION command descriptor block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (52h)							
1	Reserved							Address/Number Type
2	(MSB)							
3	Logical Block Address/							
4	Track/Session Number							
5								(LSB)
6	Reserved							
7	(MSB)			Allocation Length				
8								(LSB)
9	Control byte							

The Address/Number Type field in byte 1 is used to specify the contents of bytes 2 through 5 of the CDB.

The Logical Block Address/Track/Session Number field, Bytes 2 through 5 are defined in Table 318.

Table 318 – LBA/track/session number field definition

Address/ number type field	Logical block address/track/ session number	Description
00b	Logical Block Address	TLBA, where TLBA is the number of the track that contains the block associated with Logical Block Address.
01b	00h	Ttoc, where Ttoc is the Lead-in area of the disc
01b	TCDB, a valid track number	TCDB
01b	FFh	TINV, where TINV is the Track number of the invisible or incomplete Track
10b	Session Number	Tsession, where Tsession is the number of the first Track that is in the Session Number.
11b	Reserved	

The number of Track Information Block bytes returned is limited by the Allocation Length parameter of the CDB. An Allocation Length of zero is not an error. Fields not used with the installed media shall return 0.

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The format and content of the Track Information Block is shown in Table 319.

Table 319 – Track information block

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB) Data Length							
1								(LSB)
2	Track Number(LSB)							
3	Session Number(LSB)							
4	Reserved							
5	Reserved		Damage	Copy	Track Mode			
6	RT	Blank	Packet/Inc	FP	Data Mode			
7	Reserved						LRA_V	NWA_V
8	(MSB) Track Start Address							
9								
10								
11								(LSB)
12	(MSB) Next Writable Address							
13								
14								
15								(LSB)
16	(MSB) Free Blocks							
17								
18								
19								(LSB)
20	(MSB) Fixed Packet Size/ Blocking Factor							
21								
22								
23								(LSB)
24	(MSB) Track Size							
25								
26								
27								(LSB)
28	(MSB) Last Recorded Address							
29								
30								
31								(LSB)
32	Track Number (MSB)							
33	Session Number (MSB)							
34	Reserved							
35	Reserved							

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Data length field specifies the length, in bytes, of the requested data to be transferred in response to the command. The data length value does not include the data length field itself. If the Allocation length specified is less than the data length, the response shall be truncated at the allocation length specified. This truncation shall not cause a CHECK CONDITION status to be presented. The Data Length is not modified when the allocation length is insufficient to return all of the response data available.

Track Number is the track number for all of the information in this structure or a value of 1 for media not containing logical tracks. If the Track number is set to zero, and the P through W bit is set (see Table 126), the contents of Track Information Block shall be returned for the Lead-in area. In this case, the Track Start Address field is the start address of the Lead-in area.

Session Number is the number of the session containing this track, or a value of 1 for media not containing sessions that contain this track.

The Copy bit indicates that this track is a second or higher generation copy. For media that do not support CGMS, this bit shall beset to zero.

The Damage bit, when set to one, and the NWA_V is set to zero, the track shall be considered "not closed due to an incomplete write”. An automatic repair may be attempted by the Logical Unit when the CLOSE TRACK/SESSION command is issued. Further incremental writing in this track is not possible. The Damage bit, when set to one, with the NWA_V set to one, indicates a Track that may be recorded further in an incremental manner. An automatic repair shall be attempted by the Logical Unit when the next command that requires writing to the Track is issued. If the repair is successful, the Damage bit shall be set to zero. Prior to the start of the repair, the NWA field shall contain the address of the Next Writable Sector assuming a successful repair.

Track Mode is the control nibble as defined for mode 1 Q Sub-channel for this track. For non-CD media, this field shall be set to 4. See Tables 123 and 295.

For CD, if the RT bit is zero then the track is not reserved, otherwise the track is reserved. The RT bit indicates that a PMA entry indicating the track’s start and end addresses exists. For DVD, an RT bit of zero indicates that the Track is at Complete, Invisible or Incomplete status. An RT bit of one indicates that the Track is at Empty Reserved or Partially Recorded Reserved status.

If the Logical Unit is not capable of reading the PMA or RMA, this field shall be set to zero.

The Blank bit, when set to one, indicates that the track contains no written data and Last Recorded Address field is invalid. For CD, Tracks with the Track Descriptor Block recorded shall not be considered blank. For other media, this bit shall be set to zero.

For CD, the Packet/Inc bit is valid only when the RT bit is set to one or the track indicated is the incomplete track. The Packet/Inc bit, when set to one, indicates that this track is to be written only with packets (CD) or incremental recording (DVD).

For CD media, the FP (Fixed Packet) bit is valid only when the Packet/Inc bit is set to one. When the Packet/Inc bit is set to one and the FP bit is also set to one, then the track is to be written only with fixed packets. When the Packet/Inc bit is set to one and the FP bit is set to zero, then the track is to be written only with variable packets. Except for C/DVD-R/RW, this field should be set to zero

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When writing, certain parameters may be set via the Write Parameters Page. The state of the track determines what parameters shall be set and that parameters in the mode page shall match. Required Write Parameters are defined in Table 320.

Table 320 – Write Parameter Restrictions due to Track State

RT	Blank	Packet	CD Write Parameter Restrictions	DVD Write Parameter Restrictions
0	0	0	Can't write to stamped disc, or during track at once on invisible track, or writing session at once mode.	Can't write to stamped disc, or writing disc-at-once, cannot write to complete disc.
0	0	1	Write type is set to packet; all parameters common to READ TRACK INFOMATION and the Write Parameters mode page shall match.	Write type is set to incremental; all parameters common to READ TRACK INFOMATION and the Write Parameters mode page shall match
0	1	0	Write type may be set to packet or TAO. All other parameters shall be changeable. If this track is the first track of a Session, then Session at Once is allowed.	Write type is set to disc-at-once: Invisible Track of disc-at-once, empty. Can't start disc-at-once recording in this state. A Track shall be reserved prior to start of disc-at-once recording. All parameters common to READ TRACK INFOMATION and the Write Parameters mode page shall match
0	1	1	Invalid State	Write type is set to incremental; Invisible track for incremental recording, the Track is writable. All parameters common to READ TRACK INFOMATION and the Write Parameters mode page shall match.
1	0	0	Can't write to recorded track or during track at once on reserved Track.	Can't write to disc during disc at once on reserved Track.
1	0	1	Write type is set to packet; all parameters common to READ TRACK INFO and the write parameters mode page shall match.	Write type is set to incremental; partially recorded reserved Track, the Track is writable. All parameters common to READ TRACK INFOMATION and the Write Parameters mode page shall match.
1	1	0	Write type is set to TAO. Track mode set to same as READ TRACK INFO. Copy bit may be set only if copyright bit in track mode is clear. All other common parameters shall match.	Write type is set to disc-at-once; empty reserved Track for disc-at-once. All parameters common to READ TRACK INFOMATION and the Write Parameters mode page shall match.
1	1	1	Write type is set to Packet. Track mode set to same as READ TRACK INFO. Copy bit may be set only if copyright bit in track mode is clear. FP and packet size are changeable. All other common parameters shall match.	Write type is set to incremental; empty reserved Track, the Track is writable. All parameters common to READ TRACK INFOMATION and the Write Parameters mode page shall match

For CD, when the RT, Blank and Packet bits are set to one, FP bit of the READ TRACK INFORMATION response data is set to zero.

Data Mode field defines the track content. Data Mode is defined in Table 322.

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Table 321 – Track Status Indications

RT	Blank	Packet	FP	DVD		CD	
				Write Method	Track Status	Write Method	Track Status
0	0	0	–	–	(invalid)	Uninterrupted/ TAO/SAO	Complete/During TAO/SAO
0	0	1	0	Incremental	Incomplete	Variable	Incomplete
0	0	1	1	–	(invalid)	Fixed	Incomplete
0	1	0	–	DAO/ Incremental	Invisible	TAO/Variable/ Fixed(*)	Invisible
0	1	1	0	Incremental	Invisible	–	(invalid)
0	1	1	1	–	(invalid)	–	(invalid)
1	0	0	–	DAO	Complete/ During DAO	TAO	Complete/During TAO
1	0	1	0	Incremental	Complete/ Partially Recorded Reserved	Variable	Complete/ Partially Recorded Reserved
1	0	1	1	–	(invalid)	Fixed	Complete/ Partially Recorded Reserved
1	1	0	–	DAO	Before starting writing	TAO	Empty Reserved
1	1	1	0	Incremental	Empty Reserved	Variable/Fixed	Empty Reserved
1	1	1	1	–	(invalid)	–	(invalid)

* In case last session is empty, SAO is also valid.

Table 322 – Data mode

Value	Definition
1	Mode 1 (ISO/IEC 10149)
2	Mode 2 (ISO/IEC 10149 or CD-ROM XA)
Fh	Data Block Type unknown (no track descriptor block)
0, 3 to Eh	Reserved

If NWA_V is zero, then the next writable address field is not valid. Otherwise the next writable address field is valid. NWA_V shall be set to zero if the Track is not writable for any reason.

If LRA_V is zero, then the Last Recorded Address field is not valid. Otherwise, the Last Recorded Address field is valid. The LRA_V bit shall be set to zero if the Track has damage for any reason and is repaired automatically.

The Track Start Address is the starting address for the specified Track.

The Next Writable Address, if valid, is the LBA of the next writable user block in the Track specified by the LBA/Track Number field in the CDB. For CD media, Next Writable Address shall be associated with the RT, Blank, Packet and FP bits as defined in Table 323. If the write type is Raw, the Next Writable Address may be a negative number as required to point to the start of the first Lead-in. When streaming in any write type, the Next Writable Address shall be the next user data block the Logical Unit expects to receive if no under-run occurs.

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Table 323 – Next writable address definition

RT	Blank	Packet	FP	NWA_V	Definition
0	0	0	–	04	LBA that shall be specified by next write command *2
0	0	1	0	11	LBA that shall be specified by next write command *2
0	0	1	1	11	LBA that shall be specified by next write command *2, *3
0	1	0	0	1	LBA of the first data block after pre-gap *5
0	1	1	0	–	–
0	1	1	1	–	–
1	0	0	–	04	LBA that shall be specified by next write command *2
1	0	1	0	11	LBA that shall be specified by next write command *2
1	0	1	1	11	LBA that shall be specified by next write command *2, *3
1	1	0	–	1	LBA of the first data block after pre-gap
1	1	1	0	1	LBA of the first data block after pre-gap
1	1	1	1	–	–

NOTE 1 When "Free Blocks" is 0 (data full), NWA_V is 0.

NOTE 2 NWA shall be taken account of data blocks in buffer that has not yet been written to media. If the Logical Unit can write the data of next write command without interrupting of current data streaming (no underrun condition), NWA shall be contiguous to last address data in buffer. If WCE in Mode Cache Page is zero, NWA shall be taken account of Link Blocks (2 Run-out blocks, 1 Link block and 4 Run-out blocks) in case of Addressing Method-1.

NOTE 3 NWA shall follow the Addressing Method-2 if Method-2 bit in Mode CD Capabilities and Mechanical Status Page is set to one.

NOTE 4 During TAO (SAO), NWA_V is 1.

NOTE 5 In the case of SAO NWA shall be the first block after Lead-in for the first track of session.

The Free Blocks field represents the maximum number of user data blocks available for recording in the track. For CD media, this field shall be computed as follows: First, the Available Track Space (ATS) shall be computed.

For the invisible track; *ATS = (StartTimeofLastPossibleLead-out) – NWA* + 5.

For a reserved track; *ATS = (PMAStopTime) – NWA* + 5.

If the track is reserved for, or written with fixed packets, or is the invisible track and the Write Parameters Mode Page specifies fixed packets, otherwise,

FreeBlocks = ATS –7.

$$FreeBlocks = \left[\frac{ATS}{PacketSize + 7} \right] \times PacketSize.$$

NOTE The StartTimeofLastPossibleLead-out is the last possible location of the link block at the start of the Lead-out. If a disc is fully recorded, the PMA entry for the last track will be equal to the StartTimeofLastPossibleLead-out.

Addressing within fixed packet written tracks is translated by the Logical Unit for reading and writing. The NWA shall also reflect this translation:

$$NWA_{\text{Method2}} = NWA_{\text{Method1}} - 7 \times IP \left[\frac{NWA_{\text{Method1}} - TrackStartAddress}{PacketSize + 7} \right]$$

Method 1 is the physical address.

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Method 2 is used on fixed packet written tracks to hide the link areas from the Initiator. The TrackStartAddress is always a physical address, even if prior tracks are recorded with Method 2. IP() is the integer part of the value.

For CD, the Fixed Packet Size is valid only when the Packet and the FP bits are both set to one. For DVD-R, if the FP bit is set to zero, the Fixed Packet Size field specifies the number of sectors that are actual disc access units. In the case of DVD, this field has a value of 16. FP bit set to one is undefined.

If the disc is stamped, then DAMAGE = 0, BLANK = 0, RT = 0, and NWA_V = 0.

Track Size is the number of user data blocks in the track. For CD, the track size shall be computed as follows.

First, compute the Complete Track Size (CTS).

For an incomplete track: *CTS = (StartTimeofLastPossibleLead-out) – PMATrackStart* + 5.

For a reserved track: *CTS = (PMAStopTime) – PMAStartTime* + 5.

If the track is reserved for, or written with, fixed packets:

$$TrackSize = IP\left[\frac{CTS}{PacketSize + 7}\right] \times PacketSize.$$

otherwise, *TrackSize = CTS – 7*.

READ TRACK INFORMATION shall provide certain valid fields for a disc with the Un-recordable status: Track Number, Session Number, Track Mode, Data Mode, Track Start Address.

For CD media, the Track Size number may not be exact for the tracks that do not have a PMA entry. The track size of tracks that do not have PMA entries, is calculated as follows:

TrackSize of track n = (*start of track* n + 1) – (*start of track* n), n + 1 is the Lead Out if n is the last track recorded in the TOC.

The Track Size from this calculation may include blocks from the following track and these blocks may not be readable.

Table 324 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 324 – Recommended errors for READ TRACK INFORMATION command

Error	Reference
Deferred Errors	A.1.
General Errors	Table A.2
Media Access Errors	Table A.3

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6.1.27 REPAIR TRACK command (obsolete)

A track that has been defined for packet writing may be damaged due to an incomplete packet at the end of written data. This may be caused by a RESET, or a power-fail condition during a packet write. The REPAIR TRACK (see Table 325) command will fill a fixed length packet to its correct user data length and add run-outs. Variable length packets will simply be completed with run-outs. The user data in the repaired packet shall be rewritten as the repaired packet is not readable. The recovery indicated here only allows the track to become writable again.

Table 325 – REPAIR TRACK command descriptor block

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (58h)							
1	Reserved							
2	Reserved							
3	Reserved							
4	(MSB) Track Number							
5								(LSB)
6	Reserved							
7	Reserved							
8	Reserved							
9	Control							

The Track Number field specifies the track that requires repair.

Behaviour of this command with non-packet written tracks is vendor-specific.

Table 326 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 326 – Recommended errors for REPAIR TRACK command

Error	Reference
Deferred Errors	A.1.
General Errors	Table A.2
Media Access Errors	Table A.3
Write Errors	Table A.4

6.1.28 REPORT KEY command

The REPORT KEY command (see Table 327) requests the start of the authentication process and provides data necessary for authentication and for generating a Bus Key for the DVD Logical Unit. This command, in conjunction with the SEND KEY command, is intended to perform authentication for Logical Units that conform to DVD Copy Protection schemes, and generates a Bus Key as the result of that authentication.

The REPORT KEY command also requests the DVD Logical Unit to transfer TITLE KEY data, obfuscated by a Bus Key, to the Initiator.

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Table 327 – REPORT KEY command descriptor block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (A4h)							
1	Reserved			Reserved				
2	(MSB)							
3	Reserved or Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	Reserved							
8	(MSB)			Allocation Length				
9								(LSB)
10	AGID		KEY Format					
11	Control							

The KEY Format field (see Table 328) indicates the types of information that is to be sent to the Initiator.

The REPORT KEY command with KEY Format field of 000000b begins the authentication process. The Logical Unit, when ready to begin the authentication process, shall grant the request by returning an Authentication Grant ID (AGID). If there is no available Authentication Grant ID, the command shall be terminated with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code set to SYSTEM RESOURCE FAILURE.

The AGID field is used to control simultaneous key exchange sequences. The AGID specified in subsequent Key Exchange commands shall match a currently active AGID. The AGID field shall be reserved when the KEY Format Field contains either 0h or 5h.

In case of KEY Format = 000100b, the Reserved/Logical Block Address field specifies the logical block address that contains the TITLE KEY to be sent to the Initiator obfuscated by a Bus Key. In all other cases, this field shall be reserved.

Table 328 – Key format code definitions for REPORT KEY command

Key format	Returned data	Description	AGID use
000000b	AGID	Returns an AUTHENTICATION GRANT ID	Reserved & N/A
000001b	Challenge Key	Returns a Challenge KEY	Valid AGID Required
000010b	KEY1	Returns a KEY1	
000100b	TITLE KEY	Returns a TITLE KEY obfuscated by a Bus Key	
000101b	ASF	Returns the current state of the Authentication Success Flag	Reserved & Ignored
001000b	RPC	Report Logical Unit region settings	
111111b	None	Invalidate Specified AGID. Invalidating an invalid AGID shall not be considered an error. An AGID that has not been granted shall be considered invalid.	Valid AGID required
All other values	Reserved		

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The data returned to the Initiator for this command is shown in the following tables. The response for each format is defined. It should be noted that with a Key Format Code of 3Fh, no data shall be returned to the Initiator. Table 329 defines the response data for Key Format 000000b.

Table 329 – REPORT KEY data format (with KEY format = 000000b)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			REPORT KEY Data Length				
1								(LSB)
2	Reserved							
3	Reserved							

AUTHENTICATION GRANT ID

0	Reserved	
1	Reserved	
2	Reserved	
3	AGID	Reserved

Table 330 defines the response data for Key Format 000001b

Table 330 – REPORT KEY data format (with KEY format = 000001b)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			REPORT KEY Data Length (0Eh)				
1								(LSB)
2	Reserved							
3	Reserved							

Challenge Key

0	(MSB)
:	Challenge Key Value
9	(LSB)
10	Reserved
11	Reserved

Challenge Key Value field returns a value to be used to interrogate an external device to determine conformance with the DVD Copy Protection scheme. The external device then generates the corresponding KEY2.

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Table 331 defines the response data for Key Format 000010b

Table 331 – REPORT KEY Data Format (With KEY Format = 000010b)

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			REPORT KEY Data Length (0Ah)				
1								(LSB)
2	Reserved							
3	Reserved							

KEY1

0	(MSB)
:	KEY1 Value
4	(LSB)
5	Reserved
6	Reserved
7	Reserved

KEY1 Value field returns a value used to determine the Logical Unit's conformity with DVD Copy Protection scheme by an external device. The KEY1 value will also be used as a parameter to generate a Bus Key in the Logical Unit.

When the Logical Unit is unable to produce a KEY1 value, this command with KEY Format = 000010b shall be terminated with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code & qualifier set to COPY PROTECTION KEY EXCHANGE FAILURE – KEY NOT PRESENT.

Table 332 defines the response data for Key Format 000100b

Table 332 – REPORT KEY data format (with KEY format = 000100b)

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			REPORT KEY Data Length (0Ah)				
1								(LSB)
2	Reserved							
3	Reserved							

COPYRIGHT MANAGEMENT/TITLE KEY Information

0	CPM	CP_SEC	CGMS	Reserved
1	(MSB)			
2				
3	TITLE KEY Value			
4				
5				(LSB)
6	Reserved			
7	Reserved			

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The CPM field identifies the presence of copyright material in this sector. If set to zero, the material is not copyright; if set to one, the material is copyright.

The CP_SEC field indicates that the specified sector has a specific data structure for a copyright protection system. If set to zero, no such data structure exists in this sector. If set to one, a specific data structure exists in this sector.

The CGMS field indicates the restrictions on copying, as follows:

- 00b Copying is permitted without restriction;
- 01b Reserved;
- 10b One generation of copies may be made;
- 11b No copying is allowed.

TITLE KEY Value field returns the TITLE KEY that is obfuscated by a Bus Key.

When the TITLE KEY does not exist on DVD media, this command with KEY Format = 000100b shall be terminated with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code set to COPY PROTECTION KEY EXCHANGE FAILURE and the additional sense code qualifier shall be set to KEY NOT PRESENT.

When the Logical Unit is not in the Bus Key Established state, this command with KEY Format = 000100b shall be terminated with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code & qualifier set to COPY PROTECTION KEY EXCHANGE FAILURE – KEY NOT ESTABLISHED.

Table 333 defines the response data for Key Format 000101b.

Table 333 – REPORT KEY data format (with KEY format = 000101b)

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			REPORT KEY Data Length (06h)				
1								(LSB)
2	Reserved							
3	Reserved							

AUTHENTICATION SUCCESS FLAG

0	Reserved							
1	Reserved							
2	Reserved							
3	Reserved							Success Flag

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Table 334 defines the response data for Key Format 001000b.

Table 334 – REPORT KEY data format (with KEY format = 001000b)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) REPORT KEY Data Length (06h)							
1								(LSB)
2	RPC Scheme							
3	Reserved							

RPC State

0	Type Code	# of Vendor Resets Available	# of User Controlled Resets Available
1	Region Mask		
2	RPC Scheme		
3	Reserved		

RPC Scheme specifies the type of Region Playback Controls being used by the Logical Unit.

Type Code field (see Table 335) specifies the current state of the Regionalization Process.

Table 335 – Type code field definitions

Type code	Name	Definition
00	NONE	No Logical Unit region.
01	SET	Logical Unit region is set.
10	LAST CHANCE	Logical UnitRegion is set. Additional restrictions required to make a change.
11	PERM	Logical UnitRegion has been set permanently, but may be reset by the vendor if necessary.

# of Vendor Resets Available is a count down counter that indicates the number of times that the vendor can reset the region. The manufacturer of the Logical Unit sets this value to 4 and the value is decremented each time the vendor clears the Logical Unit's region. When this value is zero, the vendor can no longer clear the drive's region.

# of User Controlled Changes Available is a count down counter that indicates the number of times that the user can set the region. This value is initially 5.

The Region Mask returns a value that specifies the Logical Unit Region in which the Logical Unit is located. Once the Logical Unit Region has been set, the Logical Unit shall be located in only one region. Each bit represents one of eight regions. If a bit is cleared in this field, the disc can be played in the corresponding region. If a bit is set in this field, the disc cannot be played in the corresponding region.

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RPC Scheme specifies the type of Region Playback Controls being used by the Logical Unit, see Table 336.

Table 336 – RPC scheme field definition

RPC scheme	RPC name	Definition
00h	Unknown	Logical Unit does not enforce Region Playback Controls (RPC).
01h	RPC Phase II	Logical Unit region shall adhere to this standard and all requirements of the CSS license agreement concerning RPC.
02h to FFh	Reserved	

Table 337 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 337 – Recommended errors for REPORT KEY command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3

6.1.29 RESERVE TRACK command

The RESERVE TRACK Command (see Table 338) allows reservation of disc space for a track. A PMA entry for the track shall be either written or cached for writing prior to disc removal.

Table 338 – RESERVE TRACK command descriptor block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (53h)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	(MSB)							
6	Reservation							
7	Size							
8	(LSB)							
9	Control byte							

The Reservation Size field contains the number of user blocks desired for the track reservation. The actual number of blocks allocated shall be according to the Write Parameters Mode Page. For DVD, track reservation size shall be determined by the settings of the Write Parameters mode page, see Table 339. For CD, the PMA start time shall reflect the appropriate pre-gap, as determined by the previous track's mode and the settings of the Write Parameters mode page. Table 339 specifies the PMA stop time and specifies the Track sizing.

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Table 339 – Track reservation sizing (CD)

Write parameters Mode page Write type value	PMA stop time
Session-at-once	CHECK CONDITION status is returned and sense is set to ILLEGAL REQUEST, COMMAND SEQUENCE ERROR.
Track-at-once	Reserves the number of user blocks specified. The PMA stop time shall be *PMAStart* + *ReservationSize* + 2.
Variable Packet	Reserve behaves as in track-at-once.
Fixed Packet	Set $p = \frac{ReservationSize}{PacketSize}$ packets, where packet size is taken from the Write Parameters Mode Page. If p is an integer, then the reservation is performed and the PMA stop time shall be PMAStart + (*PacketSize* + 7) × p – 5. Otherwise, the reservation is not performed, CHECK CONDITION status is returned, and sense is set to ILLEGAL REQUEST, INVALID FIELD IN CDB. Enough space for reservation size user data packets shall be reserved.

Table 340 – TRACK reservation sizing (DVD)

Write parameters Mode page Write type value	Reserved track size
Disc-at-once	Reserves the number of user blocks specified. The Reserved Track shall be ReservedTrackSize = ReservationSize where ReservationSize is a value that is specified in the CDB
Incremental	Reserves the number of user blocks specified. The Reserved Track Size shall be $ReservedTrack = 16 \times Ceil\left[\frac{ReservationSize + (NWA \hat{} 0Fh)}{PacketSize}\right] - (NWA \hat{} 0Fh) + 16$ where ReservationSize is a value that is specified in the CDB. NWA is a Next Writable Address of invisible Track. ^ means mathematical AND. +16 means BSGLL.
NOTE Ceil (x) returns the least integral value greater than, or equal to, x.	

If the last track, defined in the PMA/RMA, is N, then the invisible track is assigned track number N 1. A track shall only be reserved from the beginning of the invisible track. After the reservation is done, the track number given to the new track is the current track number of the invisible track. The number of the invisible track is increased by one following a reservation.

For CD, if the Reservation Size is smaller than four seconds, excluding pre-gap length, the Logical Unit shall return CHECK CONDITION status.

For DVD, the actual reserved size shall be raised to ECC block unit by the device. If Reservation Size field is set to 0, no reservation is done by device and shall not be considered an error.

Reserving shall be allowed when the last track is invisible. When the last track is not invisible, Reserving shall generate a CHECK CONDITION status, ILLEGAL REQUEST, COMMAND SEQUENCE ERROR.

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For DVD, maximum reserved Tracks that can be reserved are limited to two at the same time. Attempting to reserve Track when two Empty/Partially recorded reserved tracks are already reserved, the command shall be terminated with CHECK CONDITION status, the sense key set to ILLEGAL REQUEST and the additional sense code set to NO MORE RESERVATION IS ALLOWED.

Attempting to reserve Track when the remaining ECC blocks in the RMA are less than three, the command shall be terminated with CHECK CONDITION status, the sense key set to MEDIUM ERROR and the additional sense code set to RMA/PMA IS FULL. Three RMD blocks are required for reservation, Track closure and Session closure.

For CD, Reserving a track when the Write Type is set to packet (see Table 124) shall cause the TDB (Track Descriptor Block) to be written.

Table 341 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 341 – Recommended errors for RESERVE TRACK command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3
Write Errors	Table A.4

6.1.30 SCAN command

The scan command requests a fast-forward or fast-reverse scan operation starting from the Scan Starting Address. The Logical Unit shall respond to this command by scanning all the way to the end of the last audio track on the media.

Like the PLAY AUDIO command, the SCAN command shall terminate the scan at the last audio track or upon receipt of a STOP PLAY/SCAN command. Upon receipt of the STOP PLAY/SCAN command the Logical Unit shall set the current address to the last address of data read from the media by the scan operation. Subsequent Audio Play commands shall cause the Logical Unit to begin playing at the location's last output by the SCAN command. If the Logical Unit receives a PAUSE/RESUME Command with the resume bit clear, the Logical Unit shall pause. After that, if the Logical Unit receives a PAUSE/RESUME Command with the resume bit set, the Logical Unit shall resume audio play, not scan, from the address where the audio pause occurred.

If the Logical Unit receives a SCAN command during play or pause, the Logical Unit shall stop play or pause and perform Scan.

If the Logical Unit encounters a data track, it shall terminate the scan.

Upon receipt of a READ SUB-CHANNEL Command during scan, the Logical Unit shall return an Audio Status of 11h (Audio Play operation in Progress).

The Initiator is required to issue PLAY AUDIO command immediately following a STOP PLAY/SCAN command to resume the play audio operation at normal speed.

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Table 342 – SCAN command descriptor block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (BAh)							
1	Reserved			Direct	Reserved			RELADR
2	(MSB)							
3	Scan Starting Address Field							
4								
5								(LSB)
6	Reserved							
7	Reserved							
8	Reserved							
9	Type		Reserved					
10	Reserved							
11	Control							

If the DIRECT bit is set to zero, the Logical Unit shall perform a fast-forward scan operation. A DIRECT bit of one causes a fast-reversed scan operation.

The RELADR bit shall be set to zero.

The Scan Starting Address specifies the address at that the audio fast scan operation shall begin. The Type field Table 343 specifies the format of the address contained in the Scan Starting Address Field. Table 343 defines the type field bits.

Table 343 – Type field bit definitions

Bits 7 to 6	Address type
0 0	Logical block address format
0 1	MIN, SEC, and FRAME format (MSF)
1 0	Track Number (TNO) format
1 1	Reserved

With a Type field of 00h the Scan Starting address field specified in command bytes 2 – 5 are defined in Table 344.

Table 344 – Scan starting address field format-logical blocks

Bit / Byte	7	6	5	4	3	2	1	0
2	(MSB)							
3	Scan Starting Logical Block Address Field							
4								
5								(LSB)

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With a Type field of 01h, bytes 2 to 5 specify the MSF address of the starting sector. See Table 345.

Table 345 – Scan starting address format – MIN, SEC, FRAME format

Bit / Byte	7	6	5	4	3	2	1	0
2	Reserved							
3	CD-Absolute Time (MIN)							
4	CD-Absolute Time (SEC)							
5	CD-Absolute Time (FRAME)							

The MIN, SEC and FRAME fields specify the relative running time from the beginning of the disc. The MIN field has a range of 00d to 99d (00h to 63h). The SEC field ranges from 00d to 59d (00h to 3Bh). The FRAME field has a range of 00h to 74d (00h to 4Ah). All MSF fields shall be binary.

With a Type field of 10h, bytes 2 to 5 specify a starting address of a specific Track Number (TNO). See Table 346.

Table 346 – Scan starting address format-track number (TNO)

Bit / Byte	7	6	5	4	3	2	1	0
2	Reserved							
3	Reserved							
4	Reserved							
5	Track Number							

The track number field specifies the track number in binary at which the scan operation will begin. This field has a range of 01h to 63h.

Scanning is a repeated play and jump operation. An example is the following implementation of forward and reverse scan that will provide good quality sound: Forward scan – Play six CD-DA blocks and then jump 190 CD-DA blocks in the forward direction. Reverse Scan – play six CD-DA blocks and then jump 150 CD-DA blocks (from the last block of the six) in the reverse direction.

Table 347 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 347 – Recommended errors for SCAN operation

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3

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6.1.31 SEND CUE SHEET command

6.1.31.0 General

A Session-at-once recording is written beginning with the Lead-in and continuing through the Lead-out. Only user data will be sent with the write commands, so a guide structure is required by the Logical Unit in order to control the recording process. This guide structure is called the cue sheet. The cue sheet is constructed in the Initiator and sent to the Logical Unit.

Table 348 – SEND CUE SHEET command descriptor block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (5Dh)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	(MSB)							
7	Cue Sheet Size							
8								(LSB)
9	Control byte							

The Cue Sheet Size parameter is the number of bytes in the cue sheet to be sent to the Logical Unit. The entire Cue Sheet shall be received by the Logical Unit prior to beginning the write process. If the Logical Unit cannot accept and buffer the entire cue sheet, then CHECK CONDITION is returned and sense is set to ILLEGAL REQUEST, INVALID FIELD IN CDB.

If the Write Parameters Mode Page does not have Write Type set to Session-at-once , then CHECK CONDITION status is returned and sense key is set to ILLEGAL REQUEST, COMMAND SEQUENCE ERROR.

If the Write Mode in the Write Parameter Mode Page, is changed from session at once, the Q sheet may not be available.

6.1.31.1 CUE SHEET FORMAT

The Cue Sheet contains information required to specify the layout of a disc to be written and shall be sent to the Logical Unit via the SEND CUE SHEET command before writing data to the disc.

The Cue Sheet format is shown in Table 349.

Table 349 – Cue Sheet format

Byte number	Cue sheet data
0	Mixture of Information of absolute disc location, catalog Code and ISRC (total m lines)
…	
(m – 1) × 8	

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If the Catalog Code is to be recorded, it shall be described at the beginning of the Cue sheet.

If the ISRC is to be recorded, it shall be described immediately preceding each Track's information in the Cue Sheet.

For the Cue sheet, the Lead-out start time shall be the last entry.

6.1.31.2 Information of the absolute disc location

6.1.31.2.0 General

The Logical Unit writes a disc according to this information. This information defines the following parameters.

a) Generation of Sub-channel P and Q channel.

b) Format and block size of the data transferred by the WRITE command.

Table 350 – Sample CUE SHEET

Byte number	CTL/ADR	TNO	INDEX	DATA FORM	SCMS	ABSOLUTE TIME		
						MIN	SEC	FRAME
00 (Lead-in)	01h [e]	00h	00h [a]	01h [e]	00h	00hm [a]	00h [a]	00h [a]
08 (TNO:01)	01h	01h	00h	01h	00h	00h	00h	00h
10 (TNO:01) [b]	01h	01h	01h	00h	00h	00h	02h	00h
18 (TNO:02)	01h	02h	00h	C0h	00h	07h	29h	71h
20 (TNO:02)	01h	02h	01h	C0h	00h	07h	31h	71h
28 (TNO:03)	01h	03h	01h	C0h	00h	14h	18h	03h
30 (TNO:04) [d]	41h	04h	00h	10h	00h	19h	06h	62h
38 (TNO:04)	41h	04h	01h	10h	00h	19h	09h	62h
40 (TNO:05) [d]	41h	05h	00h	11h	00h	27h	37h	10h
48 (TNO:05)	41h	05h	01h	10h	00h	27h	40h	10h
50 (TNO:06)	01h	06h	00h	01h	80h [f]	38h	53h	23h
58 (TNO:06)	01h	06h	01h	00h	80h [f]	38h	55h	23h
60 (Lead-out)	01h[e]	AAh	01h [c]	01h [e]	00h	56h	37h	46h

[a] Always zero for Lead-in except when DATA FORM is set to 41h.

[b] The first information track on a disc is preceded by a pause encoding of 2 s to 3 s. (If the first track is a Data track, this track does not contain pause encoding, but always contains a "pause" of 2 s of pre-gap).

[c] Always 01h for Lead-out.

[d] Pre-gap.

[e] For the Lead-out area the DATA FORM shall be one. For Lead-in, DATA FORM shall be either 01h or 41h. The control mode of the first track is specified. All data for both Lead-in and Lead-out shall be generated by the Logical Unit except if DATA FORM 41h is selected for the Lead-in.

[f] Copy.

This information is composed of data units of 8 bytes (1 line). The information consists of three parts, as follows:

a) the Lead-in area containing only one data unit;

b) the Program area containing data units;

c) the Lead-out area containing one or more data units.

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The data units in Program Area and Lead-out area are in Absolute Time order from the start time of index = 0 of the first track of the session.

Each data unit of Program area and Lead-out area indicates that the value of each field (CONTROL, TNO, X, DATA FORM or ZERO) changes at the time shown in ABSOLUTE TIME field.

Table 351 – Cue sheet data

CTL/ADR	TNO	INDEX	DATA FORM	SCMS	ABSOLUTE TIME		
					Min	Sec	Frame
01h	02h	01h	C0h	00h	07h	31h	71h
01h	03h	01h	C0h	00h	14h	18h	03h

The above data unit indicates that the value of TNO changes from 02 to 03 when ABSOLUTE TIME is 14/18/03 MSF.

6.1.31.2.1 Control/address field

The CTL/ADR byte contains the Control field in the upper 4 bits and the ADR in the lower 4 bits. Refer to Table 352.

Table 352 – CTL/ADR byte

7	6	5	4	3	2	1	0
CTL Field				ADR Field			

6.1.31.2.2 CTL field (upper 4 bits)

The CTL (Control) field contains 4 bits that define the kind of information in a track. The definition is shown in Table 353.

Table 353 – Control field

Bit 7	Bit 6	Bit 5	Bit 4	Definition
0	0	x	0	2 audio channels without pre-emphasis
1	0	x	0	4 audio channels without pre-emphasis
0	0	x	1	2 audio channels with pre-emphasis of 50/15 μs.
1	0	x	1	4 audio channels with pre-emphasis of 50/15 μs.
0	1	x	0	Data track
x	x	0	x	Digital copy prohibited
x	x	1	x	Digital copy permitted

The bits of the Control field (except for the copy bit) shall only be changed during an actual pause (Index = 00) of at least 2 s and during Lead-in area.

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6.1.31.2.3 ADR field (lower 4 bits)

Table 354 defines the codes found in the ADR Field

Table 354 – ADR field

Bit 3	Bit 2	Bit 1	Bit 0	Definition
0	0	0	1	Start time at TNO/IDX
0	0	1	0	CATALOG CODE
0	0	1	1	ISRC CODE

All other codes are reserved for future use.

Control shall be the same for each entry associated with a particular track except for first part of pre-gap.

6.1.31.2.4 TNO

The TNO field indicates track number expressed in hexadecimal. Each track has a minimum length of 4 s, not including the pause length preceding the track.

6.1.31.2.5 INDEX field

The index number expressed in hexadecimal. The Logical Unit supports only 00h to 63h.

6.1.31.2.6 DATA FORM

Table 355 defines the data form byte.

Table 355 – Data form byte

7	6	5	4	3	2	1	0
Data Form of Sub-channel		Data Form of Main Data					

6.1.31.2.7 SCMS (serial copy management system)

Bit 7 of data form of 1 indicates that Copy bit of CONTROL field alternates for Serial Copy Management System (see Table 356). The other 7 bits (Reserved) are zero. This bit is effective if Copy bit of the Control Code is zero.

Table 356 – SCMS byte

7	6	5	4	3	2	1	0
Alternate Copy bit	Reserved						

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6.1.31.2.8 DATA FORM OF MAIN DATA

The DATA FORM OF MAIN DATA field specifies the format of the main data to be sent by a WRITE command to write on the disc. Currently available data formats are

a) CD-DA,

b) CD-ROM mode 1,

c) CD-ROM XA and CD-I.

For Lead-in and Lead-out area data are generated automatically except if DATA FORM is set to 41h.

6.1.31.2.9 CD-DA data form

Figure 29 – CD (CD-DA) defines a CD-DA Data Form for one frame.

Data form	Data of one frame	Data size
00h	2 352	2 352
01h	2 352	0

Figure 29 – CD (CD-DA)

The CD-DA data format, given in Table 357, is as follows:

Table 357 – CD-DA data format (1 sample)

Bit / Byte	7	6	5	4	3	2	1	0
*n**4 + 0 (LCh)	L7	L6	L5	L4	L3	L2	L1	L0
*n**4 + 1 (LCh)	L15	L14	L13	L12	L11	L10	L9	L8
*n**4 + 2 (RCh)	R7	R6	R5	R4	R3	R2	R1	R0
*n**4 + 3 (RCh)	R15	R14	R13	R12	R11	R10	R9	R8
n = 0, 1, to 587 1 Second = 75 Frames 1 Frame = 588 Samples 1 Sample = 4 bytes (16 bits L, RCh)								

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6.1.31.2.10 CD-ROM mode 1 form

Figure 30 – CD-ROM mode 1 defines the form for CD-ROM mode 1.

Data form	Sync/ header	Data of one frame	EDC/ECC area	Data size
10h	16[b]	2 048[a]	288[b]	2 048
11h	16[c]	2 048[a]	288[c]	2 352
12h	16[b]	2 048[c]	288[b]	2 048
13h	16[c]	2 048[c]	288[c]	2 352
14h	16[b]	2 048[b]	288[b]	0

[a] Read Buffer: The data is sent by the Initiator.

[b] Generate Data: The Logical Unit generates the data in this area. The Initiator shall not send the data for this area. All sectors in the program area shall have an associated write, even if all data for the sector is to be generated by the drive. Zero bytes shall be transferred for such sectors.

[c] Ignore Buffer: The Logical Unit receives the data for this area from the Initiator with Write command. However, the Logical Unit ignores the data and generates data for this area.

Figure 30 – CD-ROM mode 1

6.1.31.2.11 CD-ROM XA, CD-I form

Figure 31 – CD-ROM XA, CD-I defines the form for CD-ROM XA, CD-I.

Data form		Sync/ header	Sub header	Data of one frame	EDC/ECC area	Data size
20h	Form 1	16[b]	8[a]	2 048[a]	280[c]	2 336
	Form 2	16[b]	8[a]	2 324[a]	4[c]	2 336
21h	Form 1	16[c]	8[a]	2 048[a]	280[c]	2 352
	Form 2	16[c]	8[a]	2 324[a]	4[c]	2 352
22h	Form 1	16[b]	8[a]	2 048[c]	280 [c]	2 336
	Form 2	16[b]	8[a]	2 324[c]	4[c]	2 336
23h	Form 1	16[c]	8[a]	2 048[c]	280[c]	2 352
	Form 2	16[c]	8[a]	2 324[c]	4[c]	2 352
24h	Form 1	NA	NA	NA	NA	NA
	Form 2	16[b]	8[b]	2 324[b]	4[b]	0

[a] Read Buffer: The data is sent by the Initiator.

[b] Generate Data: The Logical Unit generates the data in this area. The Initiator shall not send the data for this area. All sectors in the program area shall have an associated write, even if all data for the sector is to be generated by the drive. Zero bytes shall be transferred for such sectors.

[c] Ignore Buffer: The Logical Unit receives the data for this area from the Initiator with Write command. However, the Logical Unit ignores the data and generates data for this area.

Figure 31 – CD-ROM XA, CD-I

Reserved Area: The Reserved Area contains 4 bytes that are reserved for quality control during the disc production process. In case of Generate Zero, the Logical Unit generates zero data of 4 bytes for this area.

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6.1.31.2.12 CD-ROM mode 2

Figure 32 defines the form for CD-ROM mode 2.

Data form	Sync/ header	Data of one frame	Data size
30h	16[b]	2 336[a]	2 336
31h	16[c]	2 336[a]	2 352
32h	16[b]	2 336[c]	2 336
33h	16[c]	2 336[c]	2 352
34h	16[b]	2 336[b]	0

[a] Read Buffer: The data is sent by the Initiator.

[b] Generate Data: The Logical Unit generates the data in this area. The Initiator shall not send the data for this area. All sectors in the program area shall have an associated write, even if all data for the sector is to be generated by the drive. Zero bytes shall be transferred for such sectors.

[c] Ignore Buffer: The Logical Unit receives the data for this area from the Initiator with Write command. However, the Logical Unit ignores the data and generates data for this area.

Figure 32 – CD-ROM Mode 2

6.1.31.3 Data form of sub-channel

The DATA FORM OF SUB-CHANNEL (see Table 358) field specifies the format of the Sub-channel data stored in the inner buffer by WRITE command to write on the disc.

Table 358 – Data form of sub-channel

Data form		Data of one frame				Data size
Bit 7	Bit 6					
0	0	96 * (see NOTE 1)				0
0	1	96 * (see NOTE 2				96
1	0	Reserved				
1	1	24 Pack[a]	24 Pack[a]	24 Pack[a]	24 Pack[a]	96

NOTE 1 Generate zero data

NOTE 2 RAW Data

[a] PACK DATA, Initiator sends packed data. The Logical Unit writes R-W. The Logical Unit calculates and overwrites ECC and performs Interleaving for each PACK.

NOTE When this Data Form of Sub-channel is selected, along with 01h Data Form of Main Data, this indicates that there will be an attempt to write Raw P-W Sub-channel data in the Lead-in. Absolute Time field should be set with the start address of the Lead-in, that can be read via a READ TRACK command for track 0. In this case, the Data Block Type of the Write Parameters Mode Page should be set to 2, 3 or 4.

The Sub-channel data is placed at the end of each Frame of main data. Figure 33 shows the relationship of Main Data and Sub-channel data.

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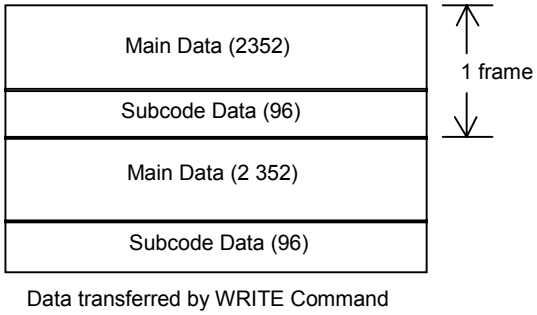

Figure 33 – Location of Sub-channel Data

The P and Q Sub-channel information contained within the Sub-code Data shall be ignored. The P and Q Sub-channel information is generated by the Logical Unit and based on the content of the cue sheet.

6.1.31.4 Absolute time

The time shown at Min, Sec and Frame gives the changing point of the CONTROL, TNO, X, DATA FORM or SCMS field. These values are given in absolute time scale.

6.1.31.5 Session format

The Session Format is used for the identification of the type of disc. Refer to Table 319.

6.1.31.6 Pre-gap

If a Data track is preceded by a different mode of track (such as an audio track) or if the mode number of CD-ROM changes, this Data track starts with an extended pre-gap. A pre-gap is placed at the head of a Data track and also belongs to the Data track. A pre-gap does not contain actual user data. The pre-gap is encoded as “pause.”

An extended pre-gap is divided into two parts. The first part of the extended pre-gap has a minimum of 1 s of data and is encoded according to the data structure of the previous track. The second part has a minimum of 2 s data and this data track is encoded according to the same data structure as the other parts.

6.1.31.7 Post-gap

If a Data track is followed by another kind of track (such as an audio track), this Data track ends with a post-gap. A post-gap is placed at the end of a Data track and is part of the Data Track. A post-gap does not contain actual user data. The minimum length of post-gap is 2 s. The Logical Unit does not perform any action for a Post-gap.

6.1.31.8 Media catalog number

Table 359, Catalog Number, indicates the catalog number of a disc. The number uses UPC/EAN-code (BAR coding). If no catalog number is used, it shall be omitted. The format is as follows:

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Table 359 – Media catalog number (N1..N13)

CTL/ ADR	Catalog number						
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
02h	N1	N2	N3	N4	N5	N6	N7
02h	N8	N9	N10	N11	N12	N13	00h
NOTE The format of the data recorded in the Sub-channel area is not identical to that specified in the Write Parameter Mode Page. N1-N13 Catalog Number CTL: 4 bits are zero. ADR: 0010b Catalog Number: 13 BYTES							

6.1.31.9 ISRC

Table 360, ISRC (International Standard Recording Code), is a code that is given to CD-DA tracks. If no ISRC is used, it shall be omitted. If a track has no ISRC, it is not written in the Cue Sheet.

Table 360 – ISRC (I1..I12)

CTL/ ADR	ISRC (International Standard Recording Code)						
byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7
x3h	TNO	I1	I2	I3	I4	I5	I6
x3h	TNO	I7	I8	I9	I10	I11	I12
NOTE The format of the data recorded in the Sub-channel area is not identical to that specified in the Write Parameter Mode Page. CTL: 4 bits of Control code are the same as that of disc location of the specified track ADR: 0011b TNO: Track number in HEX. 12 letters ISRC (On the Cue Sheet, I1-I12 shall be described by valid graphic characters according to ISO/IEC 646:1991. See this table for valid codes. I1-I2: Country Code I3-I5: Owner Code I6-I7: Year of recording I8-I12: Serial Number							

Table 361 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 361 – Recommended sense key, ASC and ASCQ SEND CUE SHEET command

Error	Reference
Deferred Errors	Table A.1
General Errors	Table A.2

6.1.32 SEND DVD STRUCTURE command

6.1.32.0 General

The SEND DVD STRUCTURE command (see Table 362) provides a means for the Initiator to transfer DVD STRUCTURE data to the Logical Unit.

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Table 362 – SEND DVD STRUCTURE command descriptor block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (BFh)							
1	Reserved			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Format							
8	(MSB) Structure Data Length							
9	(LSB)							
10	Reserved							
11	Control							

The Format field (see Table 363) indicates the type of information to be sent to the device. When the device/media does/do not support the specified format code, the command shall be terminated with a CHECK CONDITION. The sense key shall be set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.

Table 363 – Format field definition

Format code	Data	Description
00h to 03h	Reserved	
04h	User Specific Data	Send User Specific Data to the RMD cache
05h	CGMS, CPM	Send data to CPR_MAI in data area cache (CPM, CGMS)
06h to 0Eh	Reserved	
0Fh	Timestamp	Send Timestamp data to the RMD cache
10h to 2Fh	Reserved	
30h	Disc Control Block	Send a Disc Control Block
31h to FFh	Reserved	

The DVD-R device shall implement the cache memory for DVD STRUCTURE data.

The cached RMD can be read by using the READ DVD STRUCTURE command.

The Structure Data Length field specifies the length in bytes of the DVD STRUCTURE data to be transferred from the Initiator to the Logical Unit after the CDB is transferred. A Structure Data Length field of zero indicates that no data shall be transferred. This condition shall not be considered an error.

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6.1.32.1 User specific data

Table 364 defines the response data format for User Specific Data, Format code 04h

Table 364 – SEND DVD STRUCTURE data format (format code = 04h)

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2	Reserved							
3	Reserved							

DVD-R User Specific Data

0	(MSB)
…	User Specific Data
2 047	(LSB)

The DVD STRUCTURE Data Length field specifies the length in bytes of the User Specific Data to follow. A DVD Structure Data Length field of zero indicates that no User Specific Data shall be transferred. This condition shall not be considered an error.

The User Specific Data field contains user specific data. This data shall be used to specify the RMD Field 2, and when writing Lead-in the contents of this field shall also be written in Disc manufacturing information field of Lead-in or Border-in.

6.1.32.2 Copyright management information

Table 365 describes the response data format for Copyright Management Information, format code 05h.

Table 365 – SEND DVD STRUCTURE data format (format code = 05h)

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2	Reserved							
3	Reserved							

Copyright Management Information in data area

0	CPM	Reserved	CGMS	Reserved
1	Reserved			
2	Reserved			
3	Reserved			

The DVD STRUCTURE Data Length field specifies the length in bytes of the Copyright Management data to follow. A DVD Structure Data Length field of zero indicates that no Copyright Management data shall be transferred. This condition shall not be considered an error.

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The CPM bit set to zero indicates that this sector contains no copyright material. The CPM bit set to one indicates that this sector contains copyright material. If this structure is not sent, then the default value of the CPM bit shall be set to zero.

When the CPM bit is set to 0, the CGMS field shall be set to 00b. When the CPM bit is set to 1, and the CGMS field is set to 00b, this indicates that copying is permitted without restriction. If the CGMS field is set to 01b and CPM = 1, this indicates that the CGMS field is reserved. If the CGMS field is set to 10b and CPM =1, this indicates that one generation of copies may be made. If the CGMS field is set to 11b and CPM =1, this indicates that copying is not permitted.

The identical CGMS value of CPR_MAI in data area shall match this format following a write operation.

6.1.32.3 Timestamp

The format of Timestamp field is structured as shown in Table 345. This format code is used to set Unique Disc Identifier field of RMD (Recording Management Data) for DVD-R. This time stamp data may also be used in OPC related field in RMD Field 1 and may help the judgement to do OPC.

The time should be current UTC (Universal Coordinated Time) 24 hour clock.

Table 366 – SEND DVD STRUCTURE data format (format code = 0Fh)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) DVD STRUCTURE Data Length							
1								(LSB)
2	Reserved							
3	Reserved							
	DVD Timestamp Data							
0	Reserved							
1	Reserved							
2	Reserved							
3	Reserved							
4	(MSB) Year							
5								
6								
7								(LSB)
8	(MSB) Month							
9								(LSB)
10	(MSB) Day							
11								(LSB)
12	(MSB) Hour							
13								(LSB)
14	(MSB) Minute							
15								(LSB)
16	(MSB) Second							
17								(LSB)

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The DVD STRUCTURE Data Length field specifies the length in bytes of the DVD Timestamp Data to follow. A DVD Structure Data Length field of zero indicates that no DVD Timestamp Data shall be transferred. This condition shall not be considered an error.

The Year field shall specify the year coded as graphic characters according to ISO/IEC 646:1991 in the range “0 001” to “9 999”.

The Month field shall specify the month of the year coded as graphic characters according to ISO/IEC 646:1991 in the range “01” to “12”.

The Day field shall specify the day of the month coded as graphic characters according to ISO/IEC 646:1991 in the range “01” to “31”.

The Hour field shall specify the hour of the day coded as graphic characters according to ISO/IEC 646:1991 in the range “00” to “23”.

The Minute field shall specify the minute of the hour coded as graphic characters according to ISO/IEC 646:1991 in the range “00” to “59”.

The Second field shall specify the second of the minute coded as graphic characters according to ISO/IEC 646:1991 in the range “00” to “59”.

6.1.32.4 Disc control block

Table 367 defines data format code 30h.

Table 367 – SEND DVD STRUCTURE data format (format code = 30h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2	Reserved							Erase
3	Reserved							
	Disc Control Block							
0	Disc Control Block							
…								
n								

The Structure Data Length field shall indicate the number of bytes following this field.

The Erase bit, when set to zero, shall indicate that the Disc Control Block be written to the media. When set to one, it shall indicate that the Disc Control Block on the medium, with a Content Descriptor matching the one sent, shall be erased. When erasing a DCB, at least the first four bytes shall be sent. The Logical Unit shall not record any DCB unknown to the Logical Unit.

The Disc Control Block field is defined in Table 265. If a Disc Control Block, with fewer than 32 768 bytes, is sent the Logical Unit shall pad the Disc Control Block with 00h bytes.

Table 368 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

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Table 368 – Recommended errors for SEND DVD STRUCTURE command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3

6.1.33 SEND EVENT command

The SEND EVENT command requests the Logical Unit to process an event for the Initiator. The event should be one that the Initiator had received from an earlier GET EVENT/STATUS NOTIFICATION command but not handled by the Initiator. If a Logical Unit has received a persistent prevent, it will report events via the GET EVENT/STATUS NOTIFICATION command instead of processing them directly. For example, if a user pushes an independent play button on the front panel while the Logical Unit is in a persistent prevent state, the play would not be performed and instead the request shall be reported to the Initiator by a GET EVENT/STATUS NOTIFICATION command. Such events may include front panel button presses, etc. When such a request is received by the Initiator, it should complete any operations in progress and process the event by emulating the button's functionality via commands or sending the event back to the Logical Unit using the SEND EVENT command.

The Media Status Class Events reported to the Initiator shall not be sent back to the Logical Unit using the SEND EVENT command. Only events of Class External Request (Class 3) shall be sent via the SEND EVENT command.

Table 369 – SEND EVENT command descriptor block

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (5Dh)							
1	Reserved				Reserved			IMMED
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	(MSB) Parameter List Length							
9								(LSB)
10	Reserved							
119	Control byte							

An immediate (IMMED) bit of one indicates that status shall be returned as soon as the Command Packet has been validated. The actual operation specified by the Event Parameter shall be processed after the status has been reported to the Initiator. The IMMED bit shall be set to 1h.

The Parameter List Length field specifies the length in bytes of the Event parameter list that shall be transferred from the Initiator to the Logical Unit after the Command Packet is transferred. A parameter list length of zero indicates that no data shall be transferred. This condition shall not be considered an error.

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The Logical Unit shall terminate the command with CHECK CONDITION status if the Event parameter list length results in the truncation of Event parameter data. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to PARAMETER LIST LENGTH ERROR.

The Logical Unit shall terminate the command with CHECK CONDITION status, set the sense key to ILLEGAL REQUEST, set the additional sense code to INVALID FIELD IN PARAMETER LIST and shall not take any action directed by the event specified for the following conditions.

a) If the Initiator sets any unreserved field in the Event parameter header to an unsupported value.

b) If an Initiator sends an Event parameter list with an Event Data Length not equal to the length returned by the GET EVENT/STATUS NOTIFICATION command for the specified event class.

c) If the Initiator sends an invalid value for any Event parameter.

Table 370 – Event parameter header

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Event Parameter Length				
1								(LSB)
2	Reserved	Reserved				Notification Class (1h)		
3	Reserved							

The Event Parameter Length field specifies the number of bytes that follow the Event Parameter Length field. Notification Class field specifies the class of Event being sent to the Logical Unit. This field shall contain a 1h.

Table 371 – Operational change/notification parameter data

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved				Operational Event			
1	Persistent Prevented	Reserved			Operational Status			
2	(MSB)			Operational Request Code				
3								(LSB)

The Operational Event field indicates the type of operation to be performed.

Table 372 – Operational event field

Code	Event	Description
0h	No Change (NoCHge)	No request shall be processed by the Logical Unit
1h	Operational Change Request	Initiator requests Logical Unit to process the Operational Request
2h to Fh	Reserved	

The Persistent Prevent bit is reserved and shall be ignored.

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The Operational Status field is reserved and shall be ignored. This field may contain the non zero value reported to the Initiator.

Operational Request Code field contains the actual requested operation. See Table 170 for code descriptions.

Table 373 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 373 – Recommended errors for SEND EVENT command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3

6.1.34 SEND KEY command

The SEND KEY command, see Table 374, provides data necessary for authentication and for generating a Bus Key for the DVD Logical Unit.

This command, in conjunction with REPORT KEY command, is intended to perform authentication for Logical Units that conform to a DVD Copy Protection scheme and generate a Bus Key as the result of authentication.

Table 374 – SEND KEY command descriptor block

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (A3h)							
1	Reserved			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	(MSB) Parameter List Length							
9	(LSB)							
10	AGID			Key Format				
11	Control							

The KEY Format field (see Table 375) indicates the type of information that is to be sent to the Initiator.

The AGID field is described in the REPORT KEY command.

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Table 375 – Key format code definitions for SEND KEY command

Key format	Sent data	Description	AGID use
000001b	Challenge Key	Accepts a Challenge Key	Valid AGID required
000011b	KEY2	Accepts a KEY2	
000110b	RPC Structure	Set Region	Reserved & Ignored
111111b	None	Invalidate Specified AGID. Invalidating an invalid AGID shall not be considered an error. An AGID that has not been granted shall be considered invalid.	Valid AGID required
All other values	Reserved		

The Key Formats are defined in Table 376, Table 377 and Table 380.

Table 376 – SEND KEY parameter list (KEY format field =000001b)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			SEND KEY Parameter List Length (0Eh)				
1				(LSB)				
2	Reserved							
3	Reserved							
Challenge Key Value								
0	(MSB)							
:	Challenge Key Value							
9	(LSB)							
10	Reserved							
11	Reserved							

Challenge Key is sent to the DVD Logical Unit to get corresponding KEY1 from the DVD Logical Unit to interrogate conformity with DVD Copy Protection scheme.

Table 377 – SEND KEY parameter list (KEY format field =000011b)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			SEND KEY Parameter List Length (0Ah)				
1								(LSB)
2	Reserved							
3	Reserved							
KEY2								
0	(MSB)							
:	Challenge Key Value							
4								(LSB)
5	Reserved							
6	Reserved							
7	Reserved							

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The KEY2, generated external to the DVD Logical Unit, is sent to the DVD Logical Unit to determine its conformity with DVD Copy Protection scheme. The KEY2 value will be used for the second input to generate a Bus Key in the DVD Logical Unit.

When the KEY2 value sent does not conform to the DVD Copy Protection scheme, this command shall be terminated with an CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code & qualifier set to COPY PROTECTION KEY EXCHANGE FAILURE – AUTHENTICATION FAILURE.

When the SEND KEY command with KEY Format = 000011b terminates with CHECK CONDITION status, the retry of authentication shall be performed from the beginning.

Table 378 – SEND KEY parameter list (KEY format field =000110b)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) SEND KEY Parameter List Length (06h)							
1								(LSB)
2	Reserved							
3	Reserved							

RPC Structure

0	Preferred Logical Unit Region Code
1	Reserved
2	Reserved
3	Reserved

Preferred Logical Unit Regional Code is sent to the DVD Logical Unit to make the Logical Unit regionalized. The Preferred Logical Unit Region Code specifies a single region in which the disc can be played. Each bit represents one of eight regions. If a bit is cleared in this field, the disc can be played in the corresponding region. If a bit is set in this field, the disc cannot be played in the corresponding region. Exactly one bit of the Preferred Logical Unit Region Code shall contain a zero.

If the Logical Unit does not support setting of the Region, or the Region is no longer changeable, then this command shall be terminated with CHECK CONDITION Status, 5/6F/05 LOGICAL UNITREGION MUST BE PERMANENT/REGION RESET COUNT ERROR.

Table 379 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 379 – Recommended errors for SEND KEY command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3

6.1.35 SEND OPC INFORMATION command

This command is used to restore the Optimum Power Calibration (OPC) (see Table 380) values to the Logical Unit for a specific disc. It is used in combination with the READ DISC INFORMATION command (6.1.18).

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Table 380 – SEND OPC INFORMATION command descriptor block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (54h)							
1	Reserved				Reserved			DoOpc
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB) Parameter List Length							
8								(LSB)
9	Control							

The Parameter List Length shall be set to reflect the number of the parameter bytes to be transferred. The Parameter List Length shall be an integral number of eight, (2 byte OPC Speed and 6 bytes of OPC value). This can be extended with a second OPC Speed and Value. In this case the length is 16. See 6.1.18 for more information.

The DoOpc bit, when set to one, indicates the Logical Unit shall perform an OPC operation to set the OPC values for the current speed. These OPC values shall become current. Parameter List length should be set to zero. When the bit is set to zero, the Logical Unit sets OPC values to those sent in the Parameter List.

A Parameter List Length field of zero shall not be considered an error condition.

The Initiator shall transfer zero or more OPC tables (see Table 241). The transfer length shall be 8 × (the number of OPC table entries).

The format of the OPC Response Data to be transferred is shown in Table 381.

Table 381 – SEND OPC INFORMATION parameter list

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) OPC Speed in Kbytes per Second							
1								(LSB)
2	(MSB)							
3								
4				OPC Value				
5								
6								
7								(LSB)

Table 382 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

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Table 382 – Recommended errors for SEND OPC INFORMATION command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3
Write Errors	Table A.4

6.1.36 SET CD SPEED command (obsolete)

The SET CD SPEED (see Table 383) command provides a means for the Initiator to set the spindle speed to be used while reading CD data. Note that PLAY commands will not use the speed set by this command.

Table 383 – SET CD SPEED command descriptor block

Byte \ Bit	7	6	5	4	3	2	1	0
0	OPERATION CODE (BBh)							
1	Reserved			Reserved				
2	(MSB) Logical Unit Read Speed (Kbytes/sec)							
3	(LSB)							
4	(MSB) Logical Unit Write Speed (Kbytes/sec) (CD-R/RW only)							
5	(Reserved for CD-ROM) (LSB)							
6	Reserved							
7	Reserved							
8	Reserved							
9	Reserved							
10	Reserved							
11	Control							

The Logical Unit Read Speed and Write Speed parameters contain the requested Data rates the Logical Unit should use. The Logical Unit may choose to select the speed specified or any slower rate. A value of FFFFh will set the Logical Unit Read Speed or the Logical Unit Write Speed to the maximum supported. Requesting a speed faster than the Logical Unit supports shall not generate an error. The actual speed set is returned in the CD Capabilities Mechanical Status Mode page, see 5.5.10. Table 384 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 384 – Recommended errors for SET CD SPEED command

Error	Reference
Deferred Errors	A 1
General Errors	Table A.2
Media Access Errors	Table A.3

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6.1.37 SET READ AHEAD command

The SET READ AHEAD command (see Table 385) requests that the Logical Unit perform Read Ahead Caching operations from the Read-Ahead Logical Block Address when the Logical Unit encounters the Trigger Logical Block Address during its internal Read Ahead Caching operation.

If this command is received by the DVD Logical Unit when data after the Trigger Logical Block Address and before the Read Ahead Logical Block Address is contained in its cache, that data should be discarded and Read Ahead Caching restarted from the specified Read Ahead Logical Block Address.

Sectors after the Trigger LBA (Not including the Trigger LBA) should be skipped. The Initiator will normally read the data for both the Trigger and Read Ahead LBAs. The sectors between these addresses (exclusive) are normally not read by the Initiator.

The Read-Ahead operation shall be performed in background, i.e. the Logical Unit shall accept a command during the Read-Ahead operation.

Table 385 – SET READ AHEAD command descriptor block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (A7h)							
1	Reserved				Reserved			
2	(MSB)							
3	Trigger Logical Block Address							
4								
5								(LSB)
6	(MSB)							
7	Read Ahead Logical Block Address							
8								
9								(LSB)
10	Reserved							
11	Control							

Table 386 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 386 – Recommended errors for SET READ AHEAD command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3

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6.1.38 SET STREAMING command

The SET STREAMING command (see Table 387) provides a way for the Initiator to indicate to the Logical Unit that the application has specific requests or requirements for Logical Unit performance. The Logical Unit may utilize the Initiator supplied information to change mechanical or logical operation. For example, the spindle motor speed may be adjusted downward for lower data rates to help avoid buffer overrun (during reading) or buffer underrun (during writing) followed by a consequent rotational delay. The performance setting is persistent and remains until a new descriptor is sent. The setting only applies to the extent identified by the Start and End LBA field. Only zero or one performance extents shall be valid at any time.

The SET STREAMING command affects the READ and Write command operation and may affect other commands, for example BLANK and FORMAT UNIT.

If the SET STREAMING command is used to set a performance, the Logical Unit may disable read and write reallocation in the specified region in order to meet the performance criteria.

Table 387 – SET STREAMING command descriptor block

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (B6h)							
1	Reserved			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	(MSB) Parameter List Length							
10								(LSB)
11	Control							

The Initiator shall send a performance descriptor during the data phase of this command. The Performance Descriptor shall be sent in the format shown in Table 388.

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Table 388 – Performance descriptor

Byte \ Bit	7	6	5	4	3	2	1	0
0	Reserved					RDD	Exact	RA
1	Reserved							
2	Reserved							
3	Reserved							
4	(MSB)							
5	Start LBA							
6								
7								(LSB)
8	(MSB)							
9	End LBA							
10								
11								(LSB)
12	(MSB)							
13	Read Size							
14								
15								(LSB)
16	(MSB)							
17	Read Time							
18								
19								(LSB)
20	(MSB)							
21	Write Size							
22								
23								(LSB)
24	(MSB)							
25	Write Time							
26								
27								(LSB)

The RDD (Restore Logical Unit Defaults) bit, when set to zero, indicates the remaining fields are valid. When set to one, it shall indicate that the Logical Unit is to return to its default performance settings and the remaining fields in this descriptor shall be ignored. Read and Write reallocation ability shall be restored to the operation specified by the Read/Write Error Recovery page.

The Exact bit, when set to zero, shall indicate that the Logical Unit shall set its internal configuration to match the parameters as best as possible. No errors shall occur. When set to one, the Logical Unit shall set its internal configuration to support the requested parameters. If the Logical Unit cannot perform as requested, it shall generate CHECK CONDITION status, sense key set to ILLEGAL REQUEST and additional sense code set to INVALID FIELD IN PARAMETER LIST.

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The RA (Random Access) bit, when set to zero, allows the Logical Unit to independently set the read and write speeds. When set to one, directs the Logical Unit to set its performance settings for the optimized settings for random changes between reading and writing by the Initiator. For example, a CD recorder that can record at 2X and read at 6X may choose to limit reading to 2X if the RA bit was set to one.

The Start LBA field is the first logical block for which the performance request is being made.

The End LBA field is the last logical block for which the performance request is being made.

The data rate to be delivered for reading is (Read Size)/(Read Time).

The Read Size field shall indicate the number of kilobytes the Initiator expects to be delivered per period of Read Time when the Initiator's requests for data occur sufficiently fast.

The Read Time field shall indicate the amount of time, in milliseconds, over that the Read Size is expected to be read. The Initiator may set these two fields by setting Read Size to the size of its application's buffer and the Read Time to the amount of time it takes to empty that buffer.

The Write Size field shall be set to the number of kilobytes to be written per Write Time.

The Write Time field shall indicate the amount of time, in milliseconds, over which the Write Size is expected to be written.

In many cases, the Write Size and Write Time fields should be set to match the corresponding Read fields. If not, the Initiator may set the Write Size to the size of its application buffer and the Write Time to the time it takes to fill that buffer.

Table 389 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 389 – Recommended errors for SET STREAMING command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3
Write Errors	Table A.4

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6.1.39 STOP PLAY/SCAN command

The STOP PLAY/SCAN (see Table 390) command stops playback of CD audio commands.

Table 390 – STOP PLAY/SCAN command descriptor block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (4Eh)							
1	Reserved			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	Control							

Issuing a Stop Play/Scan command while the Logical Unit is scanning shall result in continuation of the play command. Issuing a Stop Play/Scan command while the Logical Unit is paused shall stop the play command.

Issuing a Stop Play/Scan command when no play operation is in progress shall not be considered an error.

Figure 34 provides an overview of the terminate sequences performed by the Stop Play commands.

Table 391 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 391 – Recommended errors for STOP PLAY/SCAN command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3

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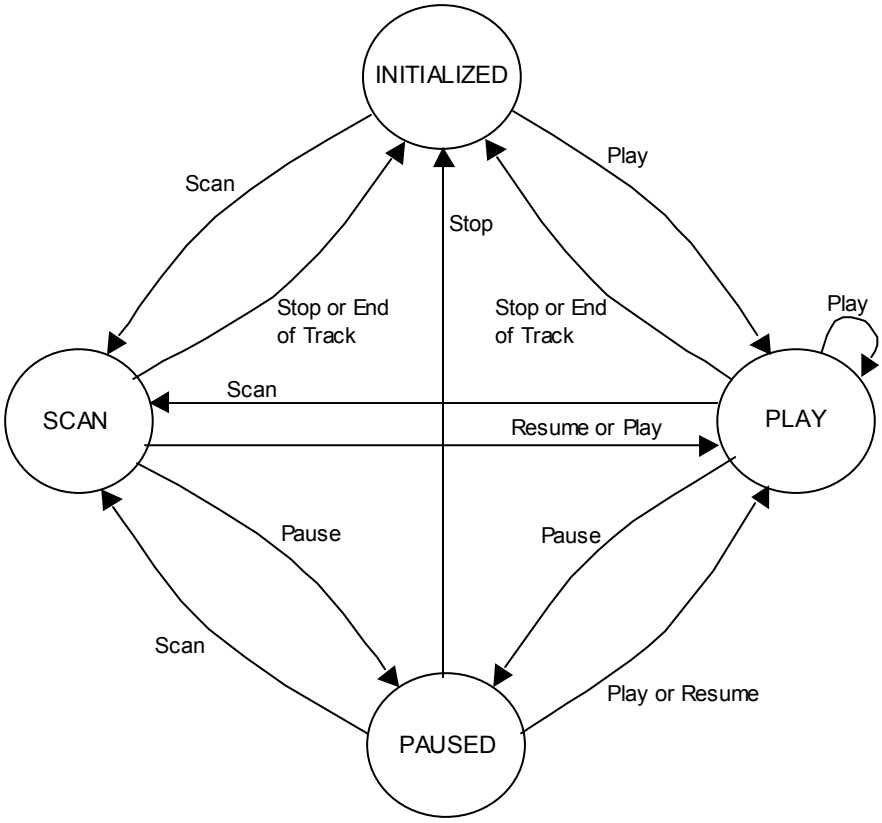

Figure 34 – Stop Play/Play Audio/Audio Scan/Pause/Resume sequencing

6.1.40 SYNCHRONIZE CACHE command

The SYNCHRONIZE CACHE command is shown in Table 392.

This command assures that all remaining data in the data buffer has been written to the media. Logical blocks are not necessarily removed from the cache memory as a result of the cache flush operation.

If the data buffer is empty, issuing this command will result in no data being written to the physical media. This action will not be considered an error. Normal status shall be presented at the completion of the action.

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Table 392 – SYNCHRONIZE CACHE command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (35h)							
1	Reserved			Reserved			IMMED	RELADR
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	(MSB)			Number of Blocks				
8								(LSB)
9	Control							

An IMMED (Immediate) bit of one indicates that the Logical Unit shall return status when the command descriptor block has been validated. An Immediate bit of zero indicates that the status shall not be returned until the operation has been completed. If the Immediate bit is one and the Logical Unit does not support immediate operation, then the command shall terminate with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to INVALID FIELD IN CDB.

The RELADR bit shall be set to zero.

The Logical Block Address field may be ignored by the Logical Unit.

The Number of Blocks field specifies the total number of contiguous logical blocks within the range. A Number of Blocks field, equal to 0, indicates that all remaining logical blocks on the Logical Unit shall be within the range. This field may be ignored by the drive.

A logical block within the specified range that is not in cache memory is not considered an error.

Table 393 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 393 – Recommended errors for SYNCHRONIZE CACHE command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3
Write Errors	Table A.4

6.1.41 WRITE (10) command

The Write (10) command (see Table 394) shall use the WRITE Parameters mode page to determine its operating behaviour. The description of the behaviour, described in the Write (10) command, applies only to CD-R/RW and DVD-R Logical Units or Logical Units implementing incremental streaming write operations. For the write behaviour of other Logical Units refer to the WRITE (10) Command defined in the ISO/IEC 14776-321.

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Table 394 – WRITE (10) command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (2Ah)							
1	Reserved			DPO	FUA	Reserved		RELADR
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	(MSB)			Transfer Length				
8								(LSB)
9	Control							

A DPO (Disable Page Out) bit, set to one, indicates that the Logical Unit shall assign the logical blocks accessed by this command the lowest priority for being fetched into or retained by the cache. A DPO bit of one, overrides any retention priority specified in the cache page. A DPO bit, of zero, indicates the priority shall be determined by the retention priority fields in the cache page, if supported. All other aspects of the algorithm implementing the cache replacement strategy are not defined by this International Standard. The Logical Unit may ignore this bit.

NOTE The DPO bit is used to control replacement of logical blocks in the cache memory when the Initiator has information on the future usage of the logical blocks. If the DPO bit is set to one, the Initiator knows the logical blocks accessed by the command are not likely to be accessed again in the near future and should not be put in the cache memory nor retained by the cache memory. If the DPO bit is zero, the Initiator expects that logical blocks accessed by this command are likely to be accessed again in the near future.

The Disable Page Out (DPO) bit is not used by C/DVD Logical Units and shall be set to zero for this device type.

A FUA (force unit access) bit, set to one, indicates that the Logical Unit shall access the media in performing the command prior to returning GOOD status. In the case where the cache contains a more recent version of a logical block than the media, the logical block shall first be written to the media. WRITE commands shall not return GOOD status until the logical blocks have actually been written on the media and the Write process is complete. This mode may not work with a sequence of writes intended to produce a continuos stream unless command queuing is implemented

An FUA bit of zero indicates that the Logical Unit may satisfy the command by accessing the cache memory. For WRITE operations, logical blocks may be transferred directly to the cache memory. GOOD status may be returned to the Initiator prior to writing the logical blocks to the medium. Any error that occurs after the GOOD status is returned is a deferred error. Information regarding the error is not reported until the following command.

The Logical Block Address field specifies the logical block where the write operation shall begin. In case of WCE = 1 (see Write Cache page in SCSI Block Commands) and FUA = 0 with variable packet writing, and if the LBA is equal to the Next Writable Address in the same track as a previous Write, then writing should continue without interruption of streaming. For CD-R/RW media, if, during streaming, a WRITE command is issued for packet writing with an LBA = NWA+7 the Logical Unit shall begin a new packet. If the LBA is equal to the NWA in another track, a SYNCHRONIZE CACHE may be performed before executing the write command. If the LBA is not any next writable address or a writable CD address, the status shall be set to CHECK CONDITION, ILLEGAL REQUEST, INVALID ADDRESS FOR WRITE.

--`,,```,,,,````-`-`,,`,,`,`,,`---

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LBA in the range of –45 150 (FFFF4FA2h) to –1 (FFFFFFFFh) shall be encoded as a two's complement negative number. Values in the range 0 through FFFF4FA1h shall be considered positive values. Values –45 150 through 404 849 are valid for CD media. Table 395 shows the MSF to LBA mapping.

The RELADR bit shall be set to zero.

The transfer length field specifies the number of contiguous logical blocks of data that shall be transferred. A transfer length of zero indicates that no logical blocks shall be transferred. This condition shall not be considered an error. Any other value indicates the number of logical blocks that shall be transferred. For CD-R/RW media, the block size shall be determined by the write parameters mode page (if in track at once, packet or raw mode) or by the cue sheet (session at once mode).

Table 395 – LBA to MSF translation

Condition	Formulae
$-150 \le \text{LBA} \le 404849$	$M = IP\left(\frac{LBA + 150}{60 \cdot 75}\right)$ $S = IP\left(\frac{LBA + 150 - M \cdot 60 \cdot 75}{75}\right)$ $F = IP(LBA + 150 - M\ \ 60\ \ 75 - S\ \ 75)$
$-45150 \le \text{LBA} \le -151$	$M = IP\left(\frac{LBA + 450150}{60 \cdot 75}\right)$ $S = IP\left(\frac{LBA + 450150 - M \cdot 60 \cdot 75}{75}\right)$ $F = IP(LBA + 450150 - M \cdot 60 \cdot 75 - S \cdot 75)$
$00/00/00 \le \text{MSF} \le 89/59/74$	$LBA = (M \cdot 60 + S) \cdot 75 + F - 150$
$90/00/00 \le \text{MSF} \le 99/59/74$	$LBA = (M\ \ 60 + S)\ \ 75 + F - 450150$

For CD-R and DVD-R, once actual writing to the media has started, the data stream shall be uninterrupted until the recording is done. Interruptions of data are called "under-run." The under-run condition may also be forced with the SYNCHRONIZE CACHE command. The Logical Unit shall behave as follows in an under-run condition.

a) Session at Once mode: The Logical Unit shall generate and write a Lead-out (the Lead-in was generated and written before any data). The Logical Unit shall update the PMA (CD) or RMA (DVD).

b) Track at Once mode: The Logical Unit shall pad the track (if reserved or not minimum length) and update the PMA (CD).

c) Variable Packet: For CD, if insufficient space exists for another variable packet within a reserved track, the Logical Unit shall pad the packet in such way that it fills the track. Otherwise, the Logical Unit shall write run-out and link blocks. For DVD the Logical Unit shall perform linking.

d) Fixed Packet: The Logical Unit shall pad the packet.

e) Raw mode: The Logical Unit shall write run-out and link blocks. The Logical Unit shall read the TOC and track information from the session just written and update the PMA. It is assumed that the Initiator has written the Lead-out.

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If the block number specified by the LBA field is already written on CD-R media, the Logical Unit shall return a CHECK CONDITION status, ILLEGAL REQUEST, INVALID ADDRESS FOR WRITE. This error will indicate that an under-run may have occurred, as the run-out and link blocks occupy logical addresses. On CD-RW media, the LBA shall specify an address that is an appendable point (according to CD-R rules) or is the first user data block of an existing packet or track.

While writing is occurring, the Logical Unit may not be able to process all SCSI commands. The following is a list of commands that shall function during writing without causing a SYNCHRONIZE CACHE.

a) TEST UNIT READY

b) REQUEST SENSE

c) INQUIRY

d) READ TRACK INFO (for current track). If the LBA or track number specified is not within the current track, the Logical Unit may return CHECK CONDITION status, ILLEGAL COMMAND, INVALID FIELD IN CDB.

e) READ BUFFER CAPACITY

f) WRITE with the NWA in the current track.

g) GET CONFIGURATION

h) GET EVENT/STATUS NOTIFICATION

All other commands shall execute normally, but may force a SYNCHRONIZE CACHE before executing. The process of writing from the Logical Unit's cache to the medium shall not cause a NOT READY condition for any command. CHECK CONDITION Status, LOGICAL UNIT NOT READY, LONG WRITE IN PROGRESS may exist when the Logical Unit is padding a reserved track or writing Lead-in and Lead-out.

Table 396 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 396 – Recommended errors for WRITE command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3
Write Errors	Table A.4

6.1.42 WRITE AND VERIFY (10) command

The WRITE AND VERIFY (10) command (see Table 397) requests that the Logical Unit write the data transferred from the Initiator to the medium and then verify that the data is correctly written.

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Table 397 – WRITE AND VERIFY (10) command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (2Eh)							
1	Reserved			DPO (0)	Reserved		BytChk (0)	RELADR
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	(MSB)			Transfer Length				
7								
8								
9								(LSB)
10	Reserved							
11	Control							

The VERIFY operation of this command shall use stricter criteria for data recoverability than READ commands. The criteria are derived from the DVD-RAM Book, with additional vendor-specific criteria allowed. Automatic Reallocation shall be controlled, by the ARRE bit, in the READ/WRITE ERROR RECOVERY PAGE. The VERIFY(10) command may return an error for a sector that a READ command may not.

VERIFY ERROR RECOVERY PAGE parameters are not supported.

The RELADR bit shall be set to zero.

For C/DVD Logical Units the Byte Check (BytChk) bit is not used and shall be set to zero.

For C/DVD Logical Units the Disable Page Out (DPO) bit is not used and shall be set to zero.

The transfer length specifies the number of contiguous logical blocks of data or blanks that shall be written and verified. A transfer length of zero indicates that no logical blocks shall be verified. This condition shall not be considered an error. Any other value indicates the number of logical blocks that shall be verified.

Table 398 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 398 – Recommended errors for WRITE AND VERIFY (10) command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3
Write Errors	Table A.4

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Annex A
(normative)

Additional sense codes for CD

A.0 General

This annex lists error codes that may be generated by CD devices. Specific commands specify that certain errors occur in response to certain conditions, but each command does not contain a comprehensive list of possible error conditions.

A.1 Error reporting

Any error may be reported in response to any command due to the occurrence of a deferred error. For example, a write error may occur due to a cached write command and that error shall be reported in response to the next command. Errors listed in Table A.2 are not caused by any specific commands but by actions outside the control of the Initiator. Table A.1 lists all errors that may be generated by Logical Units. Not all errors are applicable to all devices.

Table A.1 – Logical unit sense key, ASC and ASCQ assignments

Sense key	ASC	ASCQ	Type	Description
0	00	00	R	NO ADDITIONAL SENSE INFORMATION
b	00	06	R	I/O PROCESS TERMINATED
5	00	11	R	AUDIO PLAY OPERATION IN PROGRESS
5	00	12	R	AUDIO PLAY OPERATION PAUSED
5	00	13	R	AUDIO PLAY OPERATION SUCCESSFULLY COMPLETED
5	00	14	R	AUDIO PLAY OPERATION STOPPED DUE TO ERROR
5	00	15	R	NO CURRENT AUDIO STATUS TO RETURN
4	00	17	R	CLEANING REQUESTED
3	02	00	R	NO SEEK COMPLETE
2	04	00	R	LOGICAL UNIT NOT READY, CAUSE NOT REPORTABLE
2	04	01	R	LOGICAL UNIT IS IN PROCESS OF BECOMING READY
2	04	02	R	LOGICAL UNIT NOT READY, INITIALIZING COMMAND REQUIRED
2	04	03	R	LOGICAL UNIT NOT READY, MANUAL INTERVENTION REQUIRED
2	04	04	R	LOGICAL UNIT NOT READY, FORMAT IN PROGRESS
2	04	07	R	LOGICAL UNIT NOT READY, OPERATION IN PROGRESS
2	04	08	R	LOGICAL UNIT NOT READY, LONG WRITE IN PROGRESS
4	05	00	R	LOGICAL UNIT DOES NOT RESPOND TO SELECTION
3	06	00	R	NO REFERENCE POSITION FOUND
5	07	00	R	MULTIPLE PERIPHERAL DEVICES SELECTED
4	08	00	R	LOGICAL UNIT COMMUNICATION FAILURE
4	08	01	R	LOGICAL UNIT COMMUNICATION TIME-OUT
4	08	02	R	LOGICAL UNIT COMMUNICATION PARITY ERROR
4	09	00	R	TRACK FOLLOWING ERROR
4	09	01	R	TRACKING SERVO FAILURE
4	09	02	R	FOCUS SERVO FAILURE
4	09	03	R	SPINDLE SERVO FAILURE
4	09	04	R	HEAD SELECT FAULT
6	0A	00	R	ERROR LOG OVERFLOW
1	0B	00	R	WARNING
1	0B	01	R	WARNING – SPECIFIED TEMPERATURE EXCEEDED

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Sense key	ASC	ASCQ	Type	Description
1	0B	02	R	WARNING – ENCLOSURE DEGRADED
3	0C	00	R	WRITE ERROR
3	0C	07	R	WRITE ERROR – RECOVERY NEEDED
3	0C	08	R	WRITE ERROR – RECOVERY FAILED
3	0C	09	R	WRITE ERROR – LOSS OF STREAMING
3	0C	0A	R	WRITE ERROR – PADDING BLOCKS ADDED
3	11	00	R	UNRECOVERED READ ERROR
3	11	01	R	READ RETRIES EXHAUSTED
3	11	02	R	ERROR TOO LONG TO CORRECT
3	11	05	R	L-EC UNCORRECTABLE ERROR
3	11	06	R	CIRC UNRECOVERED ERROR
3	11	0F	R	ERROR READING UPC/EAN NUMBER
3	11	10	R	ERROR READING ISRC NUMBER
b	11	11	R	READ ERROR – LOSS OF STREAMING
3	15	00	R	RANDOM POSITIONING ERROR
3	15	01	R	MECHANICAL POSITIONING ERROR
3	15	02	R	POSITIONING ERROR DETECTED BY READ OF MEDIUM
1	17	00	R	RECOVERED DATA WITH NO ERROR CORRECTION APPLIED
1	17	01	R	RECOVERED DATA WITH RETRIES
1	17	02	R	RECOVERED DATA WITH POSITIVE HEAD OFFSET
1	17	03	R	RECOVERED DATA WITH NEGATIVE HEAD OFFSET
1	17	04	R	RECOVERED DATA WITH RETRIES AND/OR CIRC APPLIED
1	17	05	R	RECOVERED DATA USING PREVIOUS SECTOR ID
1	17	07	R	RECOVERED DATA WITHOUT ECC – RECOMMEND REASSIGNMENT
1	17	08	R	RECOVERED DATA WITHOUT ECC – RECOMMEND REWRITE
1	17	09	R	RECOVERED DATA WITHOUT ECC – DATA REWRITTEN
1	18	00	R	RECOVERED DATA WITH ERROR CORRECTION APPLIED
1	18	01	R	RECOVERED DATA WITH ERROR CORRECTION & RETRIES APPLIED
1	18	02	R	RECOVERED DATA – DATA AUTO-REALLOCATED
1	18	03	R	RECOVERED DATA WITH CIRC
1	18	04	R	RECOVERED DATA WITH L-EC
1	18	05	R	RECOVERED DATA – RECOMMEND REASSIGNMENT
1	18	06	R	RECOVERED DATA – RECOMMEND REWRITE
5	1A	00	R	PARAMETER LIST LENGTH ERROR
4	1B	00	R	SYNCHRONOUS DATA TRANSFER ERROR
a	1D	00	R	MISCOMPARE DURING VERIFY OPERATION
5	20	00	R	INVALID COMMAND OPERATION CODE
5	21	00	R	LOGICAL BLOCK ADDRESS OUT OF RANGE
5	21	01	R	INVALID ELEMENT ADDRESS
5	24	00	R	INVALID FIELD IN CDB
5	25	00	R	LOGICAL UNIT NOT SUPPORTED
5	26	00	R	INVALID FIELD IN PARAMETER LIST
5	26	01	R	PARAMETER NOT SUPPORTED
5	26	02	R	PARAMETER VALUE INVALID
5	26	03	R	THRESHOLD PARAMETERS NOT SUPPORTED
5	26	04	R	INVALID RELEASE OF ACTIVE PERSISTENT RESERVATION
5	27	00	R	WRITE PROTECTED
5	27	01	R	HARDWARE WRITE PROTECTED
5	27	02	R	LOGICAL UNIT SOFTWARE WRITE PROTECTED

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Sense key	ASC	ASCQ	Type	Description
5	27	03	R	ASSOCIATED WRITE PROTECT
5	27	04	R	PERSISTENT WRITE PROTECT
5	27	05	R	PERMANENT WRITE PROTECT
6	28	00	R	NOT READY TO READY CHANGE, MEDIUM MAY HAVE CHANGED
6	28	01	R	IMPORT OR EXPORT ELEMENT ACCESSED
6	29	00	R	POWER ON, RESET OR BUS DEVICE RESET OCCURRED
6	29	01	R	POWER ON OCCURRED
6	29	02	R	SCSI BUS RESET OCCURRED
6	29	03	R	BUS DEVICE RESET FUNCTION OCCURRED
6	29	04	R	DEVICE INTERNAL RESET
6	2A	00	R	PARAMETERS CHANGED
6	2A	01	R	MODE PARAMETERS CHANGED
6	2A	02	R	LOG PARAMETERS CHANGED
6	2A	03	R	RESERVATIONS PREEMPTED
5	2B	00	R	COPY CANNOT EXECUTE SINCE INITIATOR CANNOT DISCONNECT
5	2C	00	R	COMMAND SEQUENCE ERROR
5	2C	03	R	CURRENT PROGRAM AREA IS NOT EMPTY
5	2C	04	R	CURRENT PROGRAM AREA IS EMPTY
6	2F	00	R	COMMANDS CLEARED BY ANOTHER INITIATOR
2	30	00	R	INCOMPATIBLE MEDIUM INSTALLED
2	30	01	R	CANNOT READ MEDIUM – UNKNOWN FORMAT
2	30	02	R	CANNOT READ MEDIUM – INCOMPATIBLE FORMAT
2	30	03	R	CLEANING CARTRIDGE INSTALLED
2	30	04	R	CANNOT WRITE MEDIUM – UNKNOWN FORMAT
2	30	05	R	CANNOT WRITE MEDIUM – INCOMPATIBLE FORMAT
2	30	06	R	CANNOT FORMAT MEDIUM – INCOMPATIBLE MEDIUM
2	30	07	R	CLEANING FAILURE
5	30	08	R	CANNOT WRITE – APPLICATION CODE MISMATCH
5	30	09	R	CURRENT SESSION NOT FIXATED FOR APPEND
3	31	00	R	MEDIUM FORMAT CORRUPTED
3	31	01	R	FORMAT COMMAND FAILED
3	31	02	R	ZONED FORMATTING FAILED DUE TO SPARE LINKING
	34	00	R	ENCLOSURE FAILURE
	35	00	R	ENCLOSURE SERVICES FAILURE
	35	01	R	UNSUPPORTED ENCLOSURE FUNCTION
	35	02	R	ENCLOSURE SERVICES UNAVAILABLE
	35	03	R	ENCLOSURE SERVICES TRANSFER FAILURE
	35	04	R	ENCLOSURE SERVICES TRANSFER REFUSED
1	37	00	R	ROUNDED PARAMETER
5	39	00	R	SAVING PARAMETERS NOT SUPPORTED
2	3A	00	R	MEDIUM NOT PRESENT
2	3A	01	R	MEDIUM NOT PRESENT – TRAY CLOSED

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Sense key	ASC	ASCQ	Type	Description
2	3A	02	R	MEDIUM NOT PRESENT – TRAY OPEN
6	3B	0D	R	MEDIUM DESTINATION ELEMENT FULL
6	3B	0E	R	MEDIUM SOURCE ELEMENT EMPTY
6	3B	0F	R	END OF MEDIUM REACHED
6	3B	11	R	MEDIUM MAGAZINE NOT ACCESSIBLE
6	3B	12	R	MEDIUM MAGAZINE REMOVED
6	3B	13	R	MEDIUM MAGAZINE INSERTED
6	3B	14	R	MEDIUM MAGAZINE LOCKED
6	3B	15	R	MEDIUM MAGAZINE UNLOCKED
4	3B	16	R	MECHANICAL POSITIONING OR CHANGER ERROR
5	3D	00	R	INVALID bits IN IDENTIFY MESSAGE
2	3E	00	R	LOGICAL UNIT HAS NOT SELF-CONFIGURED YET
4	3E	01	R	LOGICAL UNIT FAILURE
4	3E	02	R	TIMEOUT ON LOGICAL UNIT
6	3F	00	R	TARGET OPERATING CONDITIONS HAVE CHANGED
6	3F	01	R	MICROCODE HAS BEEN CHANGED
6	3F	02	R	CHANGED OPERATING DEFINITION
6	3F	03	R	INQUIRY DATA HAS CHANGED
4	40	NN	R	DIAGNOSTIC FAILURE ON COMPONENT NN (80H-FFH)
5	43	00	R	MESSAGE ERROR
4	44	00	R	INTERNAL TARGET FAILURE
b	45	00	R	SELECT OR RESELECT FAILURE
4	46	00	R	UNSUCCESSFUL SOFT RESET
4	47	00	R	SCSI PARITY ERROR
b	48	00	R	INITIATOR DETECTED ERROR MESSAGE RECEIVED
b	49	00	R	INVALID MESSAGE ERROR
4	4A	00	R	COMMAND PHASE ERROR
4	4B	00	R	DATA PHASE ERROR
4	4C	00	R	LOGICAL UNIT FAILED SELF-CONFIGURATION
b	4D	NN	R	TAGGED OVERLAPPED COMMANDS (NN = QUEUE TAG)
b	4E	00	R	OVERLAPPED COMMANDS ATTEMPTED
3	51	00	R	ERASE FAILURE
4	53	00	R	MEDIA LOAD OR EJECT FAILED
5	53	02	R	MEDIUM REMOVAL PREVENTED
5	55	00	R	SYSTEM RESOURCE FAILURE
3	57	00	R	UNABLE TO RECOVER TABLE-OF-CONTENTS
6	5A	00	R	OPERATOR REQUEST OR STATE CHANGE INPUT
6	5A	01	R	OPERATOR MEDIUM REMOVAL REQUEST
6	5A	02	R	OPERATOR SELECTED WRITE PROTECT
6	5A	03	R	OPERATOR SELECTED WRITE PERMIT
6	5B	00	R	LOG EXCEPTION

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Sense key	ASC	ASCQ	Type	Description
6	5B	01	R	THRESHOLD CONDITION MET
6	5B	02	R	LOG COUNTER AT MAXIMUM
6	5B	03	R	LOG LIST CODES EXHAUSTED
1	5D	01	R	FAILURE PREDICTION THRESHOLD EXCEEDED – Predicted Media failure
1	5D	02	R	LOGICAL UNIT FAILURE PREDICTION THRESHOLD EXCEEDED
1	5D	FF	R	FAILURE PREDICTION THRESHOLD EXCEEDED (FALSE)
6	5E	00	R	LOW POWER CONDITION ON
6	5E	01	R	IDLE CONDITION ACTIVATED BY TIMER
6	5E	02	R	STANDBY CONDITION ACTIVATED BY TIMER
6	5E	03	R	IDLE CONDITION ACTIVATED BY COMMAND
6	5E	04	R	STANDBY CONDITION ACTIVATED BY COMMAND
5	63	00	R	END OF USER AREA ENCOUNTERED ON THIS TRACK
5	63	01	R	PACKET DOES NOT FIT IN AVAILABLE SPACE
5	64	00	R	ILLEGAL MODE FOR THIS TRACK
5	64	01	R	INVALID PACKET SIZE
4	65	00	R	VOLTAGE FAULT
5	6F	00		COPY PROTECTION KEY EXCHANGE FAILURE – AUTHENTICATION FAILURE
5	6F	01		COPY PROTECTION KEY EXCHANGE FAILURE – KEY NOT PRESENT
5	6F	02		COPY PROTECTION KEY EXCHANGE FAILURE –KEY NOT ESTABLISHED
5	6F	03		READ OF SCRAMBLED SECTOR WITHOUT AUTHENTICATION
5	6F	04		MEDIA REGION CODE IS MISMATCHED TO LOGICAL UNIT REGION
5	6F	05		LOGICAL UNITREGION MUST BE PERMANENT/REGION RESET COUNT ERROR
3	72	00	R	SESSION FIXATION ERROR
3	72	01	R	SESSION FIXATION ERROR WRITING LEAD-IN
3	72	02	R	SESSION FIXATION ERROR WRITING LEAD-OUT
5	72	03	R	SESSION FIXATION ERROR – INCOMPLETE TRACK IN SESSION
5	72	04	R	EMPTY OR PARTIALLY WRITTEN RESERVED TRACK
5	72	05	R	NO MORE TRACK RESERVATIONS ALLOWED
3	73	00	R	CD CONTROL ERROR
1	73	01	R	POWER CALIBRATION AREA ALMOST FULL
3	73	02	R	POWER CALIBRATION AREA IS FULL
3	73	03	R	POWER CALIBRATION AREA ERROR
3	73	04	R	PROGRAM MEMORY AREA UPDATE FAILURE
3	73	05	R	PROGRAM MEMORY AREA IS FULL
3	73	06	R	RMA/PMA IS FULL
All values are in hexadecimal.				

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Table A.2 lists errors that may occur at any time, typically in response to a protocol or hardware error or user intervention.

Table A.2 – Logical unit general errors

Sense key	ASC	ASCQ	Type	Description
0	00	00	R	NO ADDITIONAL SENSE INFORMATION
b	00	06	R	I/O PROCESS TERMINATED
2	04	00	R	LOGICAL UNIT NOT READY, CAUSE NOT REPORTABLE
2	04	01	R	LOGICAL UNIT IS IN PROCESS OF BECOMING READY
2	04	02	R	LOGICAL UNIT NOT READY, INITIALIZING CMD. REQUIRED
2	04	03	R	LOGICAL UNIT NOT READY, MANUAL INTERVENTION REQUIRED
2	04	04	R	LOGICAL UNIT NOT READY, FORMAT IN PROGRESS
2	04	07	R	LOGICAL UNIT NOT READY, OPERATION IN PROGRESS
2	04	08	R	LOGICAL UNIT NOT READY, LONG WRITE IN PROGRESS
4	05	00	R	LOGICAL UNIT DOES NOT RESPOND TO SELECTION
5	07	00	R	MULTIPLE PERIPHERAL DEVICES SELECTED
4	08	00	R	LOGICAL UNIT COMMUNICATION FAILURE
4	08	01	R	LOGICAL UNIT COMMUNICATION TIME-OUT
4	08	02	R	LOGICAL UNIT COMMUNICATION PARITY ERROR
6	0A	00	R	ERROR LOG OVERFLOW
1	0B	00	R	WARNING
1	0B	01	R	WARNING – SPECIFIED TEMPERATURE EXCEEDED
1	0B	02	R	WARNING – ENCLOSURE DEGRADED
5	1A	00	R	PARAMETER LIST LENGTH ERROR
4	1B	00	R	SYNCHRONOUS DATA TRANSFER ERROR
5	20	00	R	INVALID COMMAND OPERATION CODE
5	24	00	R	INVALID FIELD IN CDB
5	25	00	R	LOGICAL UNIT NOT SUPPORTED
5	26	00	R	INVALID FIELD IN PARAMETER LIST
5	26	01	R	PARAMETER NOT SUPPORTED
5	26	02	R	PARAMETER VALUE INVALID
6	28	00	R	NOT READY TO READY CHANGE, MEDIUM MAY HAVE CHANGED
6	29	00	R	POWER ON, RESET OR BUS DEVICE RESET OCCURRED
6	29	01	R	POWER ON OCCURRED
6	29	02	R	SCSI BUS RESET OCCURRED
6	29	03	R	BUS DEVICE RESET FUNCTION OCCURRED
6	29	04	R	DEVICE INTERNAL RESET
6	2A	00	R	PARAMETERS CHANGED
6	2A	01	R	MODE PARAMETERS CHANGED
6	2A	02	R	LOG PARAMETERS CHANGED
6	2F	00	R	COMMANDS CLEARED BY ANOTHER INITIATOR
	34	00	R	ENCLOSURE FAILURE
	35	00	R	ENCLOSURE SERVICES FAILURE

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Sense key	ASC	ASCQ	Type	Description
	35	01	R	UNSUPPORTED ENCLOSURE FUNCTION
	35	02	R	ENCLOSURE SERVICES UNAVAILABLE
	35	03	R	ENCLOSURE SERVICES TRANSFER FAILURE
	35	04	R	ENCLOSURE SERVICES TRANSFER REFUSED
5	3D	00	R	INVALID bits IN IDENTIFY MESSAGE
2	3E	00	R	LOGICAL UNIT HAS NOT SELF-CONFIGURED YET
4	3E	01	R	LOGICAL UNIT FAILURE
4	3E	02	R	TIMEOUT ON LOGICAL UNIT
6	3F	00	R	TARGET OPERATING CONDITIONS HAVE CHANGED
6	3F	01	R	MICROCODE HAS BEEN CHANGED
6	3F	02	R	CHANGED OPERATING DEFINITION
6	3F	03	R	INQUIRY DATA HAS CHANGED
4	40	NN	R	DIAGNOSTIC FAILURE ON COMPONENT NN (80H-FFH)
5	43	00	R	MESSAGE ERROR
4	44	00	R	INTERNAL TARGET FAILURE
b	45	00	R	SELECT OR RESELECT FAILURE
4	46	00	R	UNSUCCESSFUL SOFT RESET
4	47	00	R	SCSI PARITY ERROR
b	48	00	R	INITIATOR DETECTED ERROR MESSAGE RECEIVED
b	49	00	R	INVALID MESSAGE ERROR
4	4A	00	R	COMMAND PHASE ERROR
4	4B	00	R	DATA PHASE ERROR
4	4C	00	R	LOGICAL UNIT FAILED SELF-CONFIGURATION
b	4D	NN	R	TAGGED OVERLAPPED COMMANDS (NN = QUEUE TAG)
b	4E	00	R	OVERLAPPED COMMANDS ATTEMPTED
6	5A	00	R	OPERATOR REQUEST OR STATE CHANGE INPUT
6	5A	01	R	OPERATOR MEDIUM REMOVAL REQUEST
6	5B	00	R	LOG EXCEPTION
6	5B	01	R	THRESHOLD CONDITION MET
6	5B	02	R	LOG COUNTER AT MAXIMUM
6	5B	03	R	LOG LIST CODES EXHAUSTED
6	5D	00	R	FAILURE PREDICTION THRESHOLD EXCEEDED
6	5D	FF	R	FAILURE PREDICTION THRESHOLD EXCEEDED (FALSE)
4	65	00	R	VOLTAGE FAULT

NOTE All values are in hexadecimal.

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Table A.3 lists errors that may be generated by media access commands of any type (read of control or user data or writing of control or data area).

Table A.3 – Media access errors

Sense key	ASC	ASCQ	Type	Description
4	00	17	R	CLEANING REQUESTED
3	02	00	R	NO SEEK COMPLETE
3	06	00	R	NO REFERENCE POSITION FOUND
4	09	00	R	TRACK FOLLOWING ERROR
4	09	01	R	TRACKING SERVO FAILURE
4	09	02	R	FOCUS SERVO FAILURE
4	09	03	R	SPINDLE SERVO FAILURE
4	09	04	R	HEAD SELECT FAULT
3	11	00	R	UNRECOVERED READ ERROR
3	11	01	R	READ RETRIES EXHAUSTED
3	11	02	R	ERROR TOO LONG TO CORRECT
3	11	05	R	L-EC UNCORRECTABLE ERROR
3	11	06	R	CIRC UNRECOVERED ERROR
3	11	0F	R	ERROR READING UPC/EAN NUMBER
3	11	10	R	ERROR READING ISRC NUMBER
3	15	00	R	RANDOM POSITIONING ERROR
3	15	01	R	MECHANICAL POSITIONING ERROR
3	15	02	R	POSITIONING ERROR DETECTED BY READ OF MEDIUM
1	17	00	R	RECOVERED DATA WITH NO ERROR CORRECTION APPLIED
1	17	01	R	RECOVERED DATA WITH RETRIES
1	17	02	R	RECOVERED DATA WITH POSITIVE HEAD OFFSET
1	17	03	R	RECOVERED DATA WITH NEGATIVE HEAD OFFSET
1	17	04	R	RECOVERED DATA WITH RETRIES AND/OR CIRC APPLIED
1	17	05	R	RECOVERED DATA USING PREVIOUS SECTOR ID
1	17	07	R	RECOVERED DATA WITHOUT ECC – RECOMMEND REASSIGNMENT
1	17	08	R	RECOVERED DATA WITHOUT ECC – RECOMMEND REWRITE
1	17	09	R	RECOVERED DATA WITHOUT ECC – DATA REWRITTEN
1	18	00	R	RECOVERED DATA WITH ERROR CORRECTION APPLIED
1	18	01	R	RECOVERED DATA WITH ERROR CORRECTION & RETRIES APPLIED
1	18	02	R	RECOVERED DATA – DATA AUTO-REALLOCATED
1	18	03	R	RECOVERED DATA WITH CIRC
1	18	04	R	RECOVERED DATA WITH L-EC
1	18	05	R	RECOVERED DATA – RECOMMEND REASSIGNMENT
1	18	06	R	RECOVERED DATA – RECOMMEND REWRITE
5	21	00	R	LOGICAL BLOCK ADDRESS OUT OF RANGE
2	30	00	R	INCOMPATIBLE MEDIUM INSTALLED

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Sense key	ASC	ASCQ	Type	Description
2	30	01	R	CANNOT READ MEDIUM – UNKNOWN FORMAT
2	30	03	R	CLEANING CARTRIDGE INSTALLED
2	30	07	R	CLEANING FAILURE
3	31	00	R	MEDIUM FORMAT CORRUPTED
2	3A	00	R	MEDIUM NOT PRESENT
2	3A	01	R	MEDIUM NOT PRESENT – TRAY CLOSED
2	3A	02	R	MEDIUM NOT PRESENT – TRAY OPEN
3	57	00	R	UNABLE TO RECOVER TABLE-OF-CONTENTS
6	5E	00	R	LOW POWER CONDITION ON
6	5E	01	R	IDLE CONDITION ACTIVATED BY TIMER
6	5E	02	R	STANDBY CONDITION ACTIVATED BY TIMER
6	5E	03	R	IDLE CONDITION ACTIVATED BY COMMAND
6	5E	04	R	STANDBY CONDITION ACTIVATED BY COMMAND
5	63	00	R	END OF USER AREA ENCOUNTERED ON THIS TRACK
5	64	00	R	ILLEGAL MODE FOR THIS TRACK
3	73	00	R	CD CONTROL ERROR
NOTE All values are in hexadecimal.				

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Table A.4 describes errors that may be generated by commands that cause user or control data to be written to the medium.

Table A.4 – Logical unit write errors

Sense key	ASC	ASCQ	Type	Description
3	0C	00	R	WRITE ERROR
3	0C	07	R	WRITE ERROR – RECOVERY NEEDED
3	0C	08	R	WRITE ERROR – RECOVERY FAILED
3	0C	09	R	WRITE ERROR – LOSS OF STREAMING
3	0C	0A	R	WRITE ERROR – PADDING BLOCKS ADDED
5	27	00	R	WRITE PROTECTED
5	27	01	R	HARDWARE WRITE PROTECTED
5	27	02	R	LOGICAL UNIT SOFTWARE WRITE PROTECTED
5	27	03	R	ASSOCIATED WRITE PROTECT
5	27	04	R	PERSISTENT WRITE PROTECT
5	27	05	R	PERMANENT WRITE PROTECT
2	30	04	R	CANNOT WRITE MEDIUM – UNKNOWN FORMAT
2	30	05	R	CANNOT WRITE MEDIUM – INCOMPATIBLE FORMAT
5	30	08	R	CANNOT WRITE – APPLICATION CODE MISMATCH
5	30	09	R	CURRENT SESSION NOT FIXATED FOR APPEND
6	5A	02	R	OPERATOR SELECTED WRITE PROTECT
6	5A	03	R	OPERATOR SELECTED WRITE PERMIT
1	73	01	R	POWER CALIBRATION AREA ALMOST FULL
3	73	02	R	POWER CALIBRATION AREA IS FULL
3	73	03	R	POWER CALIBRATION AREA ERROR
3	73	04	R	PROGRAM MEMORY AREA UPDATE FAILURE
3	73	05	R	PROGRAM MEMORY AREA IS FULL
NOTE All values are in hexadecimal.				

Table A.5 describes errors that may be generated by commands that cause the Logical Unit session to be closed.

Table A.5 – Logical unit fixation errors

Sense key	ASC	ASCQ	Type	Description
5	2C	03	R	CURRENT PROGRAM AREA IS NOT EMPTY
5	2C	04	R	CURRENT PROGRAM AREA IS EMPTY
3	72	00	R	SESSION FIXATION ERROR
3	72	01	R	SESSION FIXATION ERROR WRITING LEAD-IN
3	72	02	R	SESSION FIXATION ERROR WRITING LEAD-OUT
5	72	03	R	SESSION FIXATION ERROR – INCOMPLETE TRACK IN SESSION
5	72	04	R	EMPTY OR PARTIALLY WRITTEN RESERVED TRACK
NOTE All values are in hexadecimal.				

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Annex B
(normative)

ATAPI compliance

B.1 Introduction

This annex describes the implementation of the MultiMedia Commands in ATAPI devices. The intent is to make the command sets highly compatible. It is desired that a common driver may be written to control both SCSI and ATAPI devices.

B.2 General

ATAPI devices implement a subset of SCSI behaviour. Certain errors and conditions that exist in SCSI do not exist in ATAPI. In addition, certain terms are used in ATAPI instead of related SCSI terms. The mechanisms for transporting the commands, data and status are unique to each transport. Addressing of units is also unique to each transport. MMC-2 does not directly specify any of these mechanisms; the command and data layer definition may be layered on either transport.

B.2.1 Terms

B.2.1.1
initiator
ATAPI equivalent for the SCSI term “Initiator”

B.2.1.2
device
ATAPI equivalent for the SCSI term “Target” or “Logical Unit”

B.2.1.3
command packet
ATAPI equivalent for the SCSI term “Command Descriptor Block”

B.2.2 Supported block sizes

ATAPI does not use the block size in the mode select block descriptor. Instead, the block size shall be determined by the command. The READ command shall return 2 048 bytes per block. The WRITE command shall send the number of bytes per block as determined by the WRITE PARAMETERS mode page. The READ CD and READ CD MSF commands shall return the number of bytes per block as specified by the command.

B.2.3 CD audio error reporting

PLAY commands with the immediate bit set in the audio control mode return status as soon as the command has been validated (that may involve a seek to the starting address). The playback operation continues and may complete without notification to the Initiator. Error termination of audio operations shall not be reported to the Initiator by returning immediate CHECK CONDITION status to the next command. The status may be obtained with READ SUB-CHANNEL or any command that returns the audio status.

B.2.4 Multi-Initiator environment

A multi-Initiator environment cannot exist in ATAPI. Therefore, conditions which occur only in multi-Initiator environments cannot occur. For example, there is no way in ATAPI to produce a reservation conflict, or, for another Initiator to change common mode parameters. The descriptions of these conditions in SCSI shall be ignored in ATAPI implementations.

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B.2.5 Command packet padding

All ATAPI commands are twelve bytes long. SCSI commands are six, ten, or twelve bytes long. To build the appropriate ATAPI Command Packet, padding bytes shall be added to the six and ten byte SCSI Command Descriptor Blocks. Six byte commands shall have six padding bytes added. Ten byte commands shall have two padding bytes added. These pad bytes shall have a value of zero.

The Control byte shall be reserved and set to zero.

B.2.6 Mapping of reset functions

Table B.1 shows how the different reset functions specified in the SCSI standards are used in this standard. Note that this table is not intended to show all possible resets or their mapping.

Table B.1 – Example reset function mapping in ATAPI

Reset type	ATAPI
Power-On Reset	Same as Power-On Reset
Hard Reset	Hard Reset
	ATA SRST. This is a channel reset and, as such, is treated as a Hard Reset. However, the SRST shall not reset any mode parameters to the default state.
Device Reset	Device Reset in ATA/ATAPI-4
	ATAPI Soft Reset in ATA/ATAPI-4

B.3 ATAPI commands requirements

Commands required for ATAPI devices are listed in Table B.2. Commands that have no differences other than those mentioned in B.2.1 through B.2.5 are defined only in the main body of this document.

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Table B.2 – ATAPI command requirements

Command name	Operation code	Type	Subclause
BLANK	A1h	E	6.1.1
CLOSE TRACK/SESSION	5Bh	E, K, R	6.1.2
ERASE (10)	2Ch		ANSI INCITS 301
FORMAT UNIT	04h	E, W	6.1.3
GET CONFIGURATION	46h	M	6.1.4
GET EVENT/STATUS NOTIFICATION	4Ah	M	6.1.5
GET PERFORMANCE	ACh	D, R	6.1.6
INQUIRY	12h	M	ANSI INCITS 301
LOAD/UNLOAD MEDIUM	A6h	C	6.1.7
MECHANISM STATUS	BDh	M	6.1.8
MODE SELECT (10)	55h	M	ANSI INCITS 301
MODE SENSE (10)	5Ah	M	ANSI INCITS 301
PAUSE/RESUME	4Bh	A	6.1.9
PLAY AUDIO (10)	45h	A	6.1.10
PLAY AUDIO (12)	A5h	D	6.1.11
PLAY AUDIO MSF	47h	A	6.1.12
PLAY CD	BCh	O	6.1.13
PREVENT/ALLOW MEDIUM REMOVAL	1Eh	M	ANSI INCITS 301
READ (10)	28h	M	ANSI INCITS 301
READ (12)	A8h	D	ANSI INCITS 301
READ BUFFER	3Ch	O	ANSI INCITS 301
READ BUFFER CAPACITY	5Ch	Obsolete	6.1.14
READ CD	BEh	B	6.1.15
READ CD MSF	B9h	B	6.1.16
READ CAPACITY	25h	M	6.1.17
READ DISC INFORMATION	51h	E, R, K	6.1.18
READ DVD STRUCTURE	ADh	D	6.1.19
READ FORMAT CAPACITIES	23h	E, W	6.1.20
READ HEADER	44h	Obsolete	6.1.21
READ MASTER CUE	59h	Obsolete	6.1.22
READ SUB-CHANNEL	42h	B	6.1.23
READ TOC/PMA/ATIP	43h	B	6.1.24
READ TRACK INFORMATION	52h	E, R, K	6.1.26
REPAIR TRACK	58h	Obsolete	6.1.27
REPORT KEY	A4h	O	6.1.28
REQUEST SENSE	03h	M	ANSI INCITS 301
RESERVE TRACK	53h	K, R	6.1.29
SCAN	BAh	O	6.1.30
SEEK	2Bh	M	ANSI INCITS 301
SEND CUE SHEET	5Dh	O	6.1.31

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Command name	Operation code	Type	Subclause
SEND DVD STRUCTURE	BFh	K	6.1.32
SEND EVENT	A2h	M	6.1.33
SEND KEY	A3h	O	6.1.34
SEND OPC INFORMATION	54h	O	6.1.35
SET CD SPEED	BBh	Obsolete	6.1.36
SET READ AHEAD	A7h	O	6.1.37
SET STREAMING	B6h	R, K	6.1.38
START/STOP UNIT	1Bh	M	ANSI INCITS 301
STOP PLAY/SCAN	4Eh	A	6.1.39
SYNCHRONIZE CACHE	35h	K, R, W	6.1.40
TEST UNIT READY	00h	M	ANSI INCITS 301
VERIFY	2Fh	W	ANSI INCITS 301
WRITE (10)	2Ah	K, R, W	6.1.41
WRITE (12)	AAh	K, R, W	ANSI INCITS 301
WRITE AND VERIFY (10)	2Eh	W	6.1.42
WRITE BUFFER	3Bh	O	ANSI INCITS 301

Key

M = command implementation is mandatory for all Logical Units

O = command implementation is optional.

A = mandatory command when implementing Audio

B = mandatory command for all CD Logical Units

R = mandatory command for CD-R/RW devices

E = mandatory command for CD-RW devices

C = mandatory for embedded changer

D = mandatory for DVD Logical Units

W = mandatory for DVD RE-WRITABLE Logical Units

K = mandatory for DVD-R Logical Units

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Annex C
(normative)

Requirements for SBP-2 compliance

C.1 SBP-2 definitions

C.1.1
command block
space reserved within an ORB to describe a command intended for a Logical Unit that controls device functions or the transfer of data to or from device medium

C.1.2
login
process by which an Initiator obtains access to a set of device fetch agents

The device fetch agents and their control and status registers provide a mechanism for an Initiator to signal ORB's to the device.

C.1.3
quadlet
four bytes, or 32 bits, of data

C.1.4
register
describes quadlet aligned addresses that may be read or written by Serial Bus transactions

In this standard, the use of the term register does not imply a specific hardware implementation. For example, the behaviour of registers may be emulated by a processor.

C.1.5
status block
data structure written to system memory by a device after an operation request block has been completed

C.1.6
system memory
the portions of any node's memory that are directly addressable by a Serial Bus address and which accepts, at a minimum, quadlet read and write access

Computers are the most common example of nodes that make system memory addressable from Serial Bus, but any node, including those usually thought of as peripheral devices, may have system memory.

C.1.7
transaction
exchange between a requester and a responder that consists of a request and a response sub-action

The request sub-action transmits a Serial Bus transaction such as quadlet read, block write or lock, from the requesting node to the node intended to respond. Some Serial Bus commands include data as well as transaction codes. The response sub-action returns completion status and sometimes data from the responding node to the requesting node.

C.1.8
unit
component of a Serial Bus node that provides processing, memory, I/O or some other functionality

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Once the node is initialized, the unit provides a CSR interface that is typically accessed by device driver software at an Initiator. A node may have multiple units which normally operate independently of each other. For the purposes of this standard, a unit is equivalent to a device.

C.1.9
unit architecture
the specification of the interface to and the services provided by a unit implemented within a Serial Bus node

C.1.10
unit attention
state that a Logical Unit maintains while it has unsolicited status information to report to one or more logged-in Initiators

A unit attention condition shall be created as described elsewhere in this standard or in the applicable command set- and device-dependent documents.

C.2 SBP-2 storage model

The SBP-2 Storage Model describes general characteristics and functions of MMC-2 Logical Units when implemented using SBP-2. It is intended to provide design information and lead to a better understanding of MMC-2 Logical Unit functionality.

C.2.1 Model configuration

C.2.1.0 General

This configuration is used only as an example of a common implementation. The following is assumed for the configuration of this model.

- The device supports a single Logical Unit.
- The device does not support multiple Initiators.
- The device does not support isochronous data transfers.

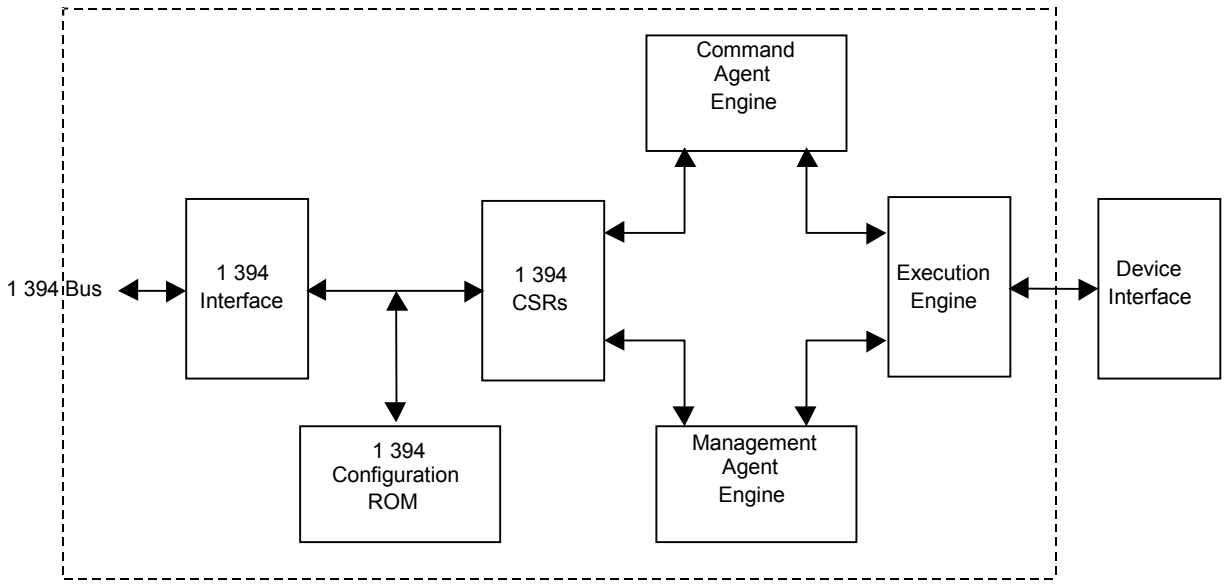

Figure C.1 – Mass storage interface block diagram

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C.2.2 Model operation

The block diagram in Figure C.1 indicates the functional blocks contained in an MMC-2 device that supports SBP-2. This annex describes the function of those blocks when processing a list of ORBs. The ORBs contain READ commands in this example.

After power-on or bus reset, the Command_Agent and Management_Agent engines are in the Reset state.

The Initiator reads the MMC-2 device's Configuration ROM data in order to determine its 1 394 capabilities, SBP-2 capabilities, EUI-64 value, command set identifiers, software versions and Management_Agent CSR address.

The Initiator performs a Login operation prior to any request to the MMC-2 device. To perform a Login, the Initiator writes its Login ORB address to the Management_Agent register. The Login ORB should contain either the current or master password for the Login to be successful. The MMC-2 device returns the Login response to the bus address specified in the Login ORB. One field of the Login response contains the Command_Agent's CSR base address.

Prior to initiating command transfers, the Initiator builds a list of Command_Block ORBs in system memory. The list may be as short as one ORB, but this example assumes a list length of more than one. The last ORB in the list contains a NULL Next_ORB pointer which indicates the end of the list to the MMC-2 device's Command_Agent fetch engine.

To transition the Command_Agent state from Reset to Active the Initiator writes the offset of the first ORB in the ORB list to the MMC-2 device's ORB_Pointer CSR address. This allows the Command_Agent fetch engine to begin fetching ORBs from Initiator memory. If the Initiator writes to the Doorbell CSR, the MMC-2 device will ignore the Doorbell at this time.

The MMC-2 device fetches ORBs until its ORB space is full or until an ORB containing a NULL Next_ORB pointer is fetched. Fetched ORBs are routed to the Execution engine. The Execution engine may reorder the commands contained in the ORBs for best performance.

As each READ command is executed the MMC-2 device transfers READ data to the Initiator's memory space via block write requests.

Following the data transfer portion of each command the MMC-2 device writes a Status_Block to the Initiator's Status_FIFO address. The Status_FIFO address for Command Block ORBs is contained in the Login ORB. The status block contains SBP-2 specific command information, such as the ORB_offset of the Command_Block ORB associated with this status, as well as general sense information.

ORBs contain a notify bit that is to be set if a Status_Block is to be written to Initiator memory after every ORB is executed or cleared if a Status_Block is to be written only after ORB execution encounters an error. This bit is advisory only. MMC-2 Logical Units shall return a Status_Block for all ORBs executed.

If an ORB containing a Null Next_ORB pointer is fetched the Execution engine completes all fetched commands, including the one in the just fetched ORB, before the Command_Agent transitions to the Suspended state.

If additional commands are to be executed, the Initiator creates a new list of Command_Block ORBs; changes the Next_ORB pointer in the last ORB of the old list from NULL to the offset of the first ORB in the new list; then writes to the MMC-2 device's Doorbell CSR address. This transitions the Command_Agent to the Active state.

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The MMC-2 device fetches the new Next_ORB pointer value from the last ORB of the old list and begins fetching ORBs from the new list at that offset.

If the Command_Agent fetch engine has not reached the ORB containing a Null Next_ORB pointer (and is still in the Active state), the MMC-2 device ignores any writes to the Doorbell CSR address.

This sequence may continue until the MMC-2 device is reset, power is removed, or an error occurs.

C.2.3 Reconnect/power reset support (normative)

MMC-2 Logical Units shall support the Reconnect management function following a bus reset, as described in SBP-2. However, in the case that a Reconnect request occurs following a power reset, MMC-2 Logical Units shall perform as follows.

a) Following a power reset, any previous login information shall be discarded and the device shall transition to the Reset state.

b) If an Initiator sends a Reconnect ORB to the device, the device shall return status with resp set to 0, REQUEST COMPLETE and sbp_status set to A16, Login ID not recognized.

C.3 Configuration ROM support

C.3.0 General

Although most Configuration ROM entries are generic, several contain information specific to each device type. Hard disk Logical Unit specific Configuration ROM information is defined in this annex.

C.3.1 Unit directory – Command_Set_Spec_ID

The command_set_spec_id entry (key – 3 816) is an immediate entry that specifies the organization responsible for the command set definition for the device. SCSI targets shall have a command_set_spec_ID of 00 609Eh, which indicates that NCITS is responsible for the command set definition.

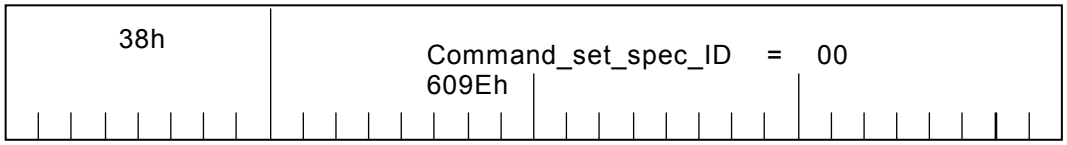

Figure C.2 – Command_Set_Spec_ID

C.3.2 Unit directory – Command_Set

The command_set entry (key – 39h) is an immediate entry that, in combination with the command_set_spec_id entry specifies the command set supported by the unit. SCSI targets shall have a command_set value of 01 04D8h, which indicates that the target's command set is specified by ANSI INCITS 301-1997 and related command set standard(s), as determined by the targets peripheral device type(s).

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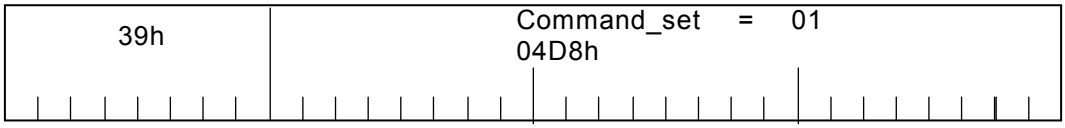

Figure C.3 – Command_Set

C.3.3 Unit directory – Command_Set_Revision

The command_set_revision entry (key – 3Bh) is an immediate entry that specifies the current revision level of the command set implemented by the unit.

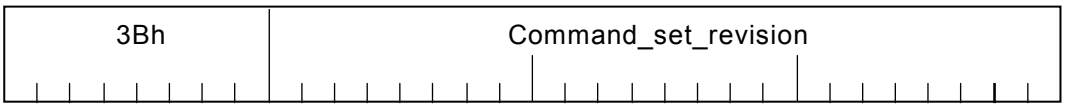

Figure C.4 – Command_Set_Revision

C.3.4 Unit directory – Logical_Unit_Number

The logical_unit_number entry (key – 14h) is an immediate entry that specifies the device type and the Logical Unit number of a Logical Unit supported by the device. The format of this entry is defined in SBP-2 and duplicated here with additional field information for hard disk drives.



Figure C.5 – Logical_Unit_Number

R in Figure C.5 indicates reserved bits.

The ordered bit (abbreviated as O in Figure C.5) specifies the manner in which the Logical Unit executes tasks signaled to the command block agent. If the Logical Unit executes and reports completion status without any ordering constraints, the ordered bit shall be zero. Otherwise, if the Logical Unit both executes all tasks in order and reports their completion status in the same order, the ordered bit shall be one.

The Device_Type field indicates the peripheral device type implemented by the Logical Unit. The value defined for MMC-2 Logical Units is 05h.

Logical_Unit_Number field shall identify the Logical Unit to which the information in the LOGICAL_UNIT_NUMBER entry applies.

C.4 Login support

MMC-2 Logical Units shall implement the Login support as defined in SBP-2.

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C.5 Security support

MMC-2 Logical Units shall implement security against unauthorized media access as defined in the security annex of ISO/IEC 14776-232.

The master password, referenced in SBP-2, is contained in the INQUIRY command, Vital Product Data, page 80h. Following a successful Login operation, the Initiator shall request that the Logical Unit perform the INQUIRY command, in order to obtain the Logical Unit's serial number.

C.6 Status block support

The status block for MMC-2 Logical Units shall be implemented as described in the following text and Figure C.6. Refer to SBP-2, Annex B, for a complete description of all bits and fields.

If no exception status is generated, only the first two quadlets (len = 1) shall be written to the Initiator's status_fifo address.

If exception status is generated, the device shall write, at a minimum, the four quadlets (len = 2) shown below. This format is required for unsolicited status as well as command status.

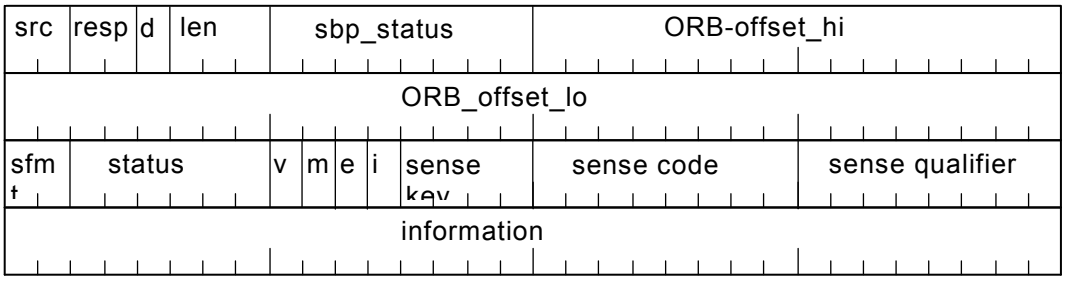

Figure C.6 – Status block for MMC-2

C.7 Unsolicited status support

MMC-2 Logical Units that support the SBP-2 transport protocol shall implement the generation of unsolicited status. Devices shall notify Initiators of unsolicited status support by setting the asynchronous event reporting capability (aerc) bit to one in the standard data format of the INQUIRY command (see ANSI INCITS 301-1997).

As stated in SBP-2, unsolicited status is enabled when the Initiator writes to the Unsolicited_Status_Enable CSR. Devices default to unsolicited status disabled and only send unsolicited status following a write to the Unsolicited_Status_Enable CSR. The Unsolicited_Status_Enable CSR is a handshake mechanism and must be written after every unsolicited status event in order to enable another such event.

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C.8 Unit attention condition

A unit attention condition shall persist for a logged-in Initiator until

– unsolicited status, that reports the unit attention condition, is successfully written to the Initiator's status FIFO address, or

– the Initiator's login becomes invalid or is released. Logical Units may queue unit attention conditions; more than one unit attention condition may exist at the same time.

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Annex D
(normative)

Requirements for fibre channel protocol for SCSI compliance

D.1 Introduction

This Annex describes the implementation of the MultiMedia Commands in Fibre Channel devices. The intent is to highlight the concerns of implementation of the command set using the Fibre Channel Protocol (FCP). The Fibre Channel Protocol for SCSI (ANSI INCITS 269-1996) was referred to in this Annex.

D.2 General

Certain terms are used in FCP in addition to the related SCSI terms. The mechanisms for transporting the commands, data and status are unique to each transport. FCP differs from other transports such as SBP-2, SCSI, etc. Addressing of units is also unique to each transport. MMC does not directly specify any of these mechanisms; the command and data layer definition may be layered on either transport.

D.2.1 Terms

D.2.1.1
originator
FCP equivalent for the SCSI term “Initiator”

D.2.10.2
responder
FCP equivalent for the SCSI term “Target” or “Logical Unit”

D.2.10.3
information unit (IU)
similar to the SCSI phases. Carried in FCP frames.

D.2.2 Information units

CDBs are transferred from the intiator to target using FCP_CMND IUs. Responses to these commands are returned in the FCP_RSP IUs. For write operations, a CDB and associated data may be transferred in a single IU possibly followed by subsequent FCP_DATA IUs. For read operations, the final IU may contain both the FCP_DATA and FCP_RSP.

D.2.3 Process login/logout

Before any commands can be issued, the FCP link-level protocol of Process login (PRLI) shall be completed between the initiator and target. This can be accomplished either implicitly via external conventions or explicitly using IUs. The first command that completes after a PRLI will generate a Unit Attention condition with an additional Sense Code of Reset Occurred (ASC=29h, ASCQ=00h).

D.2.4 Sense information

FCP devices always use auto-sense to report information appropriate for the REQUEST SENSE command in the FCP_RSP IU.

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D.2.5 Reset mapping

FCP initiators use the FCP_CNTL field contained within the FCP_CMND IU to reset the FCP targets. Byte 2, bit 5 of the FCP_CNTL field represents a TARGET RESET that shall be mapped to a Hard Reset for MMC-2 targets. Byte 2, bit 2 of the FCP_CNTL field represents a CLEAR TASK SET that shall be mapped to a Device Reset for MMC-2 targets. Byte 2, bit 1 of the FCP_CNTL field represents an ABORT TASK SET that shall be mapped to a Device Reset for MMC-2 targets.

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Annex E
(normative)

SCSI implementation notes

E.1 Introduction

This annex is intended to be used in conjunction with ANSI INCITS 301-1997, ISO/IEC 14776-321 and ISO/IEC 14776-411.

E.2 SCSI signal utilization

Logical Unit will utilize the same signals and timing from the SCSI Standard and Extensions.

E.3 SCSI compatibility

E.3.1 Additions to the SCSI Standards (ISO/IEC 14776-xxx)

New requirements:

- GET EVENT/STATUS NOTIFICATION command in addition to the AEN capability in SCSI;
- features are introduced and added;
- CHANGE DEFINITION is not required;
- the Mechanism State in this standard uses a value of 3h for the data port in use and not 1h as is specified in the SCSI standard;
- the power model for this specification is different from that described for SCSI;
- the Information Exceptions Mode Page is called the Fault/Failure Reporting page in this standard.

E.4 Reset functionality

This subclause describes the functionality of the various resets implemented in SCSI.

E.4.1 Power-on reset

The Power-On Reset is an event that causes the Power On condition in SCSI. See “Task and Command Lifetimes” in ISO/IEC 14776-411 (under development).

E.4.2 Hard reset

Hard Reset is described in the SCSI Architecture Model. See “Hard Reset” in ISO/IEC 14776-411 (under development).

A Hard Reset for a SCSI Device will

- abort all tasks in all task sets;
- clear all auto contingent allegiance conditions;
- release all SCSI device reservations;

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- return any device operating modes to their appropriate initial conditions, similar to those conditions that would be found following device power-on. The MODE SELECT conditions shall be restored to their last saved values if saved values have been established. MODE SELECT conditions for which no saved values have been established, shall be returned to their default values;
- Unit Attention condition shall be set.

E.4.3 TARGET RESET task management function

The TARGET RESET function may reset a Logical Unit individually. When an Initiator requires a reset of all Logical Units connected to the bus, the initiator shall issue the TARGET RESET task management request to every Logical Unit.

NOTE The TARGET RESET task management function was called a “Bus Device Reset” in ISO/IEC 9316.

If the Initiator issues the LOGICAL UNIT RESET function to a Logical Unit, the response of the Logical Unit shall be the same as the response to a TARGET RESET task management function.

E.4.4 Device reset

There are two possible Device Reset alternatives, ABORT TASK SET and CLEAR TASK SET. The ABORT TASK SET is mandatory for all SCSI Logical Units. SCSI Logical Units that do not support tagged tasks may support CLEAR TASK SET.

CLEAR TASK SET is different from ABORT TASK SET in that CLEAR TASK SET clears all of the queued tasks for all Initiators. If the Logical Unit is in a single Initiator environment, ABORT and CLEAR TASK SET functions in the same manner.

The ABORT/CLEAR TASK SET

- does not immediately reset SCSI bus protocol,
- does not reset parameters in mode page to default values,
- always keep the disc information such as disc TOC information,
- does not change the Persistent Prevent state.

E.4.5 Power management and device reset in SCSI

When a SCSI Device is in the Power Managed Sleep state, the TARGET RESET shall be used to wake the device.

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E.4.6 Mapping of reset functions

Table E.1 shows how the different reset functions specified in the various ATAPI specifications are used in this standard. Note that this table is not intended to show all possible resets or their mapping.

Table E.1 – Example reset function mapping in SCSI

Reset type	SCSI
Power-On Reset	Same as Power-On Reset
Hard Reset	TARGET RESET task management function
	ISO/IEC 14776-411 defined Reset events.[a]
	SPI Reset Signal
Device Reset	ABORT TASK SET task management function
	CLEAR TASK SET task management function
[a] This is SCSI protocol dependent.	

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Annex F
(normative)

Power management functions

F.1 Power management states

Four power states are defined. These are named Active, Idle, Standby and Sleep, with Active being the “Full-On” state, Sleep the “Off” state, and “Idle, Standby and Sleep” progressively more aggressive power managed states. This model differs significantly from previous ATA and SCSI power management definitions. This new model defines power states in terms of the perceived impact on the end user, instead of absolute power levels. The Idle state is optimized for minimal end user performance impact. The Standby state is optimized for power savings.

To provide consistent behaviour across Logical Units, standard definitions are used for the power states of Logical Units. These states are defined in terms of the following criteria:

- power consumption, i.e. power consumption of theLogical Unit;
- Logical Unit Context,. i.e. how much of the internal state of the Logical Unit is retained by hardware and what shall be restored by the responsible software;
- Restore time, i.e. the time necessary to raise the power level to the active power state and to put the Logical Unit into operational condition (including mechanical operation such as spin up) required before entering into the Active power state. Restoring is vendor-specific and any mechanism can be employed here to raise the power consumption and to put the Logical Unit in operation condition required in a higher power state. For example, “turning on or raising internal Vcc for power hungry circuits such as motors, laser sensors”, “raising internal Vcc or the clock frequency for the digital circuits”, etc. A critical factor is the quick restoration of the Logical Unit to operation condition required in a higher power state (for example spin up);
- De-power time, i.e. the time necessary to reduce the power to the desired level in lower power state after entering the lower power state from higher power state. De-powering is vendor-specific and any mechanism can be employed here to reduce the power consumption. For example, “turning off or lowering internal Vcc for power hungry circuits such as motors, laser sensors”, “lowering internal Vcc or reducing the clock frequency for the digital circuits”, “dynamic clock gating”, “cutting off the DC paths for unused circuits”, “turning off PLLs”, etc.

Table F.1 – Power Management Model States

Logical Unit State	Power Consumption	Logical Unit Context Retained	Restore Time
Active (D0)	As needed for operation	All	None
Idle (D1)	Less than Active	All	The Logical Unit shall be restored to active state within 1 s on any request to enter active state, independent of the de-powering process.
Standby (D2)	Less than idle	All buffers are empty before entering Standby state.	Vendor-specific: Greater than, or equal to Idle to Active.
Sleep (D3)	Less than Standby	None, Buffer & All of Command queues are empty before entering Sleep state.	Greater than or equal to Standby to Active. Vendor-specific. May Need full initialization. The Initiator may remove Vcc.

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Transitions between these power states may occur at the request of the Initiator or the Logical Unit. Transitions to a higher power state from a lower power state shall occur after restoring the Logical Unit to the operating conditions (including mechanical operation if applicable, such as spin up) required in the higher power state. When the Logical Unit transitions from a higher power state to a lower power state, the Logical Unit shall be considered to be in the lower power state when the Logical Unit is assured of reaching the lower power condition. Actual de-powering occurs after the Logical Unit enters the lower power state. The Logical Unit shall generate a power event when the Logical Unit is considered to have entered a power state.

In order to create a robust power management environment, Logical Units shall support the following.

- Four power states: Active(D0), Idle(D1), Standby(D2) and Sleep(D3).
- Idle Timer: Provides a method for the Logical Unit to enter Idle state from Active state, following a programmed period of inactivity.
- Standby Timer: Provides a method for the Logical Unit to enter Standby state from either Active or Idle state, following a programmed period of inactivity.
- START/STOP UNIT Command and the Power Condition Field: Provides a method for the Initiator to request the Logical Unit to enter a power state.
- GET EVENT/STATUS NOTIFICATION Command: Notifies the Initiator of power state changes and current power status.
- Power Condition Mode page: Enables or disables timers and specifies the reload value of the Idle and Standby timers.

F.2 Power state transitions

F.2.1 Active State (D0)

The Logical Unit is completely active and responsive. The Logical Unit is consuming its highest level of power. During the execution of a media access command (commands that reload both timers) the Logical Unit shall be in active state.

The Logical Unit should minimize power consumption at all times, even when in the active state. Any mechanism can be employed, as long as it is transparent to software and does not prevent the Logical Unit from performing expected functions.

For example, the Logical Unit may dynamically gate on/off internal clocks by monitoring bus activities and internal activities.

F.2.2 Idle State (D1)

In Idle state, the Logical Unit is capable of responding to commands but may take up to 1 s longer to complete commands than the Active state. The Logical Unit is consuming less power than the Active state. Any mechanism can be employed as long as the restoring time is less than 1 s. The Logical Unit may, for example

- reduce internal clock frequency,
- lower the internal Vcc for digital circuits,
- dynamically gate internal clocks by monitoring bus/internal activities.

F.2.3 Standby State (D2)

In Standby state the Logical Unit shall only be required to accept commands from the Initiator. All other mechanisms are in the power save condition. In Standby state, the Logical Unit is capable of responding to commands but the Logical Unit takes longer to complete commands than when in Idle state. Buffers shall be emptied before entering into Standby state. The Logical Unit context shall be preserved. The Logical Unit is consuming less power than when in Idle state.

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F.2.4 Sleep State (D3)

Maximum power saving state: Buffers and all command queues, including GET EVENT/STATUS NOTIFICATION commands, shall be emptied before entering into the Sleep state. When the Logical Unit enters the sleep state, any GET EVENT/STATUS NOTIFICATION commands present in the command queue, shall be removed from the command queue, without command completion. In this Sleep state, all functions are stopped and no commands, except for reset can be received. The unit is consuming less power than when in Standby state. The Logical Unit context is invalid in Sleep state.

The Initiator software shall fully initialize the Logical Unit after exiting Sleep state, as all context may be lost in Sleep state. Therefore, disc(s)/cassette may be manually ejected or inserted while in Sleep state, independent of any lock/unlock mechanism employed. For the Initiator to consistently rely on the Logical Unit Media Status Notifications, when the Logical Unit is unable to determine if media have been changed while the Logical Unit was in Sleep state, the Logical Unit shall report NEW MEDIA on the next GET EVENT/STATUS NOTIFICATION (Media Status) command.

In Sleep state, the Initiator may completely remove power from the device by turning off Vcc.

F.3 Power management state diagram

The state diagram, see Figure F.1, defines state transitions for the power management model.

A power-on or hard reset always returns the Power State to the Standby State. A Device Reset does not alter the current power state, unless the current power state is Sleep. A Device Reset received while in sleep state returns the power state to Standby.

The Sleep state is entered when the Logical Unit has been commanded to go to Sleep but Vcc is still applied to the device. Removing Vcc always takes the device to the Power Off State. Removing Vcc is recommended only when all Logical Units on a given bus are in Sleep State.

Table F.2 shows transition conditions for this model, and shows the Initial state, the Resultant state, Notification class, and Event class (Media or Power). Notification class and Event class fields specify the events that shall be generated during the transitions as outlined in the GET EVENT/STATUS NOTIFICATION command.

In Idle or Standby states, the Logical Unit should attempt to maintain the minimal power level for that state at all times. However, the Logical Unit may create transitory, higher power level conditions as needed. The transitory power conditions shall not affect the reported power state, or generate power state events. Examples of transitory conditions are

flushing the buffers,

emptying command queues,

media insertion spin up, or

auto off-line, etc.

On insertion of new media, the Logical Unit may enter a transitory, higher power condition and stay in this condition for vendor-specific time period. If the Logical Unit has not received a media access command (commands that reload both timers) during this period, the Logical Unit shall return to the normal power level for the current power state. This prevents excessive power consumption while the Initiator is off-line.

It is permissible to enter intermediate states while in transition between states, however, the Logical Unit shall not report power change events for the intermediate states. If the Logical Unit fails to enter the target power state, the Logical Unit shall return to the original power

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state. Simultaneous expiration of multiple timers, shall cause the Logical Unit to enter the lower power state, and shall only report the result of the transition to that state.

When the Logical Unit is reporting NOT READY, the Logical Unit shall enter the Standby State.

If a power change event has not been reported to the Initiator, when a new event is generated, the Logical Unit may choose only to report the most recent power event.

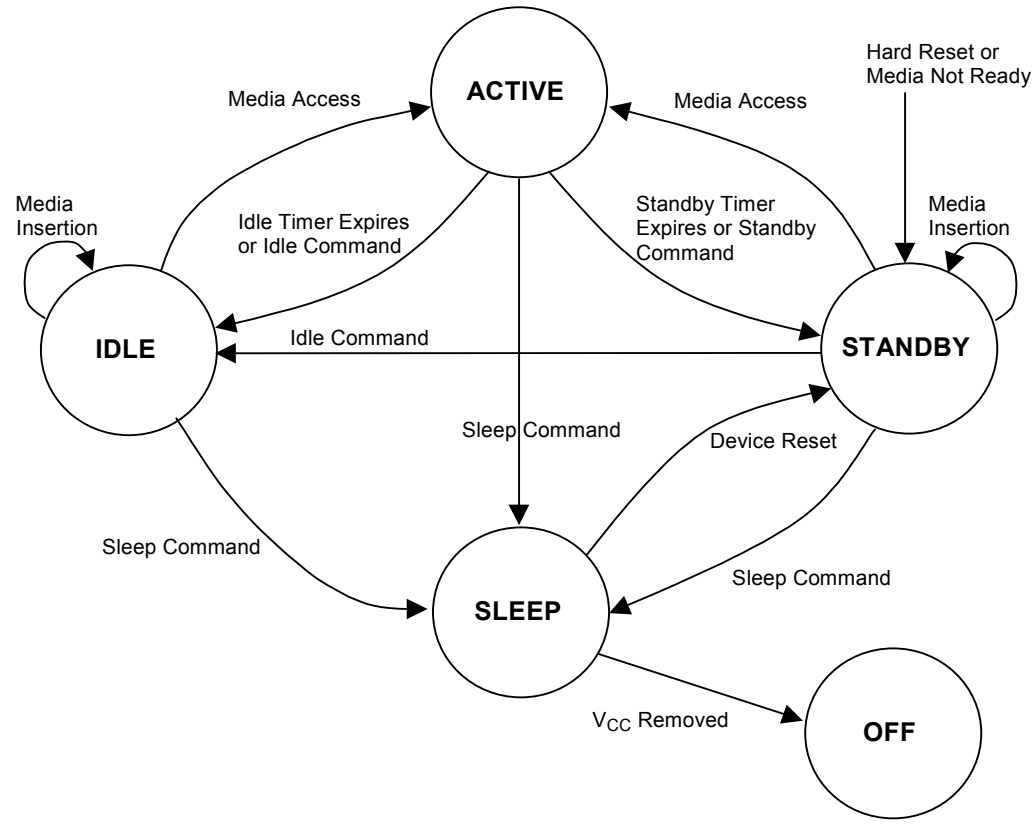

Figure F.1 – Power Management STATE diagram

F.4 Power Management Timers

The Idle and Standby timers provide a method for the Logical Unit to enter lower power states after an Initiator programmable period of inactivity, without direct Initiator command.

A timer is deactivated (no longer used by the Logical Unit, regardless of Enable/Disable setting provided from the Initiator) when the Logical Unit is in the associated power state or a lower power state.

A timer is both reactivated (the Logical Unit shall use the timer if enabled) and reloaded when a Logical Unit transitions to power state higher than the associated timer.

Timers shall be reloaded, as specified in Table F.3, using the current timer value from the POWER CONDITION mode page.

Timers shall be disabled/enabled as specified in the POWER CONDITION mode page.

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Timers shall be set to default conditions upon receiving a power-on, or hard reset. The default condition for the Timers shall be enabled with the vendor-specific values of the timers.

F.5 Standby timer

If the Standby Timer expires the Logical Unit shall attempt to flush all buffers.

If this operation fails, the Logical Unit shall remain in the current power state, and the Standby timer is reloaded. If the flush succeeds, the Logical Unit shall enter the Standby State.

Table F.2 – State Transition, Events and Status

Initial State	Resultant State	Cause of Transition	Notification Class	Event
Active	Active	Unsuccessful Idle, Standby or Sleep command	Power	PwrChg-Fail
	Idle	Successful completion of Idle command	Power	PwrChg-Succ
	Idle	Expiration of Idle timer	Power	PwrChg-Succ
	Standby	Successful completion of Standby command	Power	PwrChg-Succ
	Standby	Expiration of Standby timer, all Buffers are empty	Power	PwrChg-Succ
	Sleep	Successful completion of Sleep Command	Power	PwrChg-Succ
Idle	Idle	Successful completion of Idle command	Power	PwrChg-Succ
	Idle	Unsuccessful Idle, Standby, or Sleep command	Power	PwrChg-Fail
	Idle	Insertion of media and ready to use	Media	New Media
	Standby	Expiration of Standby timer, all buffers are empty	Power	PwrChg-Succ
	Standby	Successful completion of Standby command	Power	PwrChg-Succ
	Sleep	Successful completion of Sleep command	Power	PwrChg-Succ
	Active	Receptions of a command that reloads both timers	Power	PwrChg-Succ
Standby	Standby	Successful completion of Standby command	Power	PwrChg-Succ
	Standby	Unsuccessful Idle, Standby or Sleep command	Power	PwrChg-Fail
	Standby	Insertion of media and ready to use	Media	NewMedia
	Idle	Successful completion of Idle command	Power	PwrChg-Succ
	Sleep	Successful completion of Sleep command	Power	PwrChg-Succ
	Active	Receptions of a command that reloads both timers	Power	PwrChg-Succ
Any	Standby	A power-on or hard reset occurred, or the Logical Unit becomes NOT READY	Power	PwrChg-Succ
Sleep	Standby	Device Reset	Power	PwrChg-Succ

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Table F.3 – Effects of Initiator commands on Timers

Initiator Command Issued	Timer Effects	Comments
BLANK	Reload Both	Recordable only
CHANGE DEFINITION	None	
CLOSE TRACK	Reload Both	Recordable only
COMPARE	Reload Both	SCSI only
EXCUTE LOGICAL UNITDIAGNOSTIC	Reload Both	ATA command
SYNCHRONIZE CACHE	Reload Both	
FORMAT UNIT	Reload Both	Recordable only
GET CONFIGURATION	None	
GET EVENT/STATUS NOTIFICATION	None	
INQUIRY	None	
LOAD/UNLOAD C/DVD	Reload Both	
LOCK/UNLOCK CHACHE	None	SCSI only A Lock Cache command shall prevent the Logical Unit from entering Standby or Sleep states.
LOG SELECT/SENSE	None	SCSI only
MECHANISM STATUS	None	
MODE SELECT	May Reload Timers	A MODE SELECT command that changes the Standby or Idle timers shall reload the timer.
MODE SENSE	None	
PLAY AUDIO/MSF	Reload Both	
PLAY CD	Reload Both	
PREFETCH	Reload Both	SCSI only
PREVENT/ALLOW MEDIUM REMOVAL	Reload Standby	
READ (12)	Reload Both	
READ BUFFER	Reload Standby	
READ C/DVD CAPACITY	Reload Both	
READ CD	Reload Both	
READ CD MSF	Reload Both	
READ DISC INFORMATION	Reload Both	
READ DVD STRUCTURE	Reload Both	
READ FORMATABLE CAPACITIES	Reload Standby	
READ HEADER	Reload Both	
READ LONG	Reload Both	SCSI only
READ TRACK INFORMATION	Reload Both	
READ SUB-CHANNEL	Reload Both	
READ TOC/PMA/ATIP	Reload Both	
REALEASE	None	SCSI only
REPAIR TRACK	Reload Both	Sequential CD/DVD Recordable
REPORT KEY	Reload Both	
REPORT PERFORMANCE	Reload Both	May need to access media

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Initiator Command Issued	Timer Effects	Comments
REQUEST SENSE	None	
RESERVE	None	SCSI only
RESERVE TRACK	Reload Both	Recordable only
REZERO	Reload Both	SCSI only
SCAN	Reload Both	
SEEK	Reload Both	
SEND EVENT	Reload Both	May effect media access
SEND KEY	Reload Both	
SEND DVD STRUCTURE	Reload Both	Sequential DVD Recordable
SEND OPC INFORMATION	Reload Both	Recordable only
SET CD SPEED	Reload Both	Obsolete
SET READ AHEAD	Reload Both	
SET STREAMING	Reload Both	
START/STOP UNIT	See Start Stop Unit Command	
TEST UNIT READY	Reload Both	
VERIFY	Reload Both	
WRITE	Reload Both	Recordable only
WRITE AND VERIFY (10)	Reload Both	Recordable only
WRITE DVD STRUCTURE	Reload Both	Recordable only
Device Reset	Reload Both	Reset operation, the Logical Unit shall not return to default timer conditions.
Other Commands	Vendor-specific	

F.6 Power Management Status Reporting

The POWER STATUS field of the GET EVENT/STATUS NOTIFICATION (Power Management Class) event data shall always report the current Logical Unit power state. This provides a mechanism for the Initiator to query the current power state, irrespective of state transitions.

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Annex G
(informative)

SCSI command listings

G.1 List of SCSI commands

Table G.1 lists the commands that may be implemented when claiming compliance with SCSI interface. The listed commands are common to all SCSI devices.

Table G.1 – Commands common to all SCSI devices

Command Name	Operation Code	SCSI	
		Type	Ref Std
CHANGE DEFINITION	40h	O	
COMPARE	39h	O	
COPY	18h	O	
COPY AND VERIFY	3Ah	O	
INQUIRY	12h	M	
LOCK/UNLOCK CACHE	36h	O	
LOG SELECT	4Ch	O	
LOG SENSE	4Dh	O	
MODE SELECT (10)	55h	O	
MODE SELECT (6)	15h	M	
MODE SENSE (10)	5Ah	M	
MODE SENSE (6)	1Ah	M	
PREFETCH	34h	O	
PREVENT/ALLOW MEDIUM REMOVAL	1Eh	M	
READ (10)	28h	M	
READ (12)	A8h	O	
READ (6)	08h	O	
READ BUFFER	3Ch	O	
READ LONG	3Eh	O	
RECEIVE DIAGNOSTIC RESULTS	1Ch	O	
RELEASE (10)	57h	M	
RELEASE (6)	17h	O	
REQUEST SENSE	03h	M	
RESERVE (10)	56h	M	
RESERVE (6)	16h	O	
SEEK (10)	2Bh	M	
SEEK (6)	0Bh	M	
SEND DIAGNOSTIC	1Dh	M	
SET LIMITS (10)	33h	O	
SET LIMITS (12)	B3h	O	
START/STOP UNIT	1Bh	M	
TEST UNIT READY	00h	M	
VERIFY (10)	2Fh	O	
VERIFY (12)	AFh	O	
WRITE BUFFER	3Bh	O	

Key
- M = command implementation is mandatory
- O = command implementation is optional
- The following command codes are vendor-specific: 02h, 05h, 06h, 09h, 0Ch, 0Dh, 0Eh, 0Fh, 10h, 11h, 13h, 14h, 19h, 20h, 21h, 22h, 23h, 24h, 26h, 27h, 29h and C0h through FFh.

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Annex H
(informative)

Implementation of features

H.1 What's a Feature?

T10/99-121R0 (MtFuji) introduces Features. Features were designed to be atomic units of functionality. On the first level, Features are only a description in a document. Traditional drivers work without modification with Logical Units that implement Features. Features were a part of the documentation in SFF-8020, SFF-8090, and MMC; however they were not comprehensive, typically documenting only optional behaviour. Mt. Fuji 2 (SFF-8090 r2) associates all normal functionality with Features. Detection of a whole group of functions (a "Feature") was typically accomplished by the Initiator by issuing a command unique to that Feature and examining the completion status of that command.

The Mt. Fuji and T10 (MMC) groups have been consciously trying to avoid using errors as a method for status detection. Error handling code is typically one of the more complex parts of implementing drivers; reducing the number of cases that need to be handled, helps implementations by reserving error status for only true errors. Status information is reported via explicit status reporting commands such as GET EVENT/STATUS NOTIFICATION and GET CONFIGURATION.

The descriptions of Features in Mt. Fuji 2 appear complex, and they are. However, these descriptions describe almost nothing new; they are simply the descriptions of existing legacy behaviour. The only new parts are the descriptors themselves, that are either static identification blocks or groups of information that the Logical Unit shall already have to operate, even in a legacy behaviour. For example, a Logical Unit shall internally identify whether or not a PLAY AUDIO command may succeed. Features are simply a way to let the Initiator in on the secret.

Previously, new devices had to make a choice, either they had to look completely like an old device with added functionality or as a new device not compatible with old drivers. With Features and Profiles, an Initiator can first determine if the "right" driver is available by examining the Profiles. If the right driver isn't available, the Initiator can identify operable subsets when multiple Profiles are reported. Finally, the Initiator can identify basic functions to use the device via the Feature reporting.

H.2 History

The separation of status and error reporting is very important in multitasking environments. Typically, the operating system needs to constantly be aware of the status of the drive. Various applications, operating through a variety of OS interfaces, may also need to be aware of Logical Unit status. Reporting of status via errors breaks down in this environment; only one process is made aware of state changes via the error, while other processes cannot obtain the same state information because the error (status change) has already been reported to the Initiator (according to the drive).

Features do not replace legacy behaviour. In most cases, Features define a subset of legacy behaviour. Several Features, taken together, are generally equivalent to legacy devices of the same type. Error and status reporting in legacy Initiator environments is the same as legacy devices without any special mode setting.

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The Features described in Mt. Fuji 2 add something new: reporting. Legacy devices, while implementing the content of the Features, did not have any mechanism to report specifically the drive's capabilities. The closest mechanism that has existed is a command that reported implemented commands. Implemented mode pages are also reportable via standard mechanisms. However, a command is more than an operation code (OpCode). A whole set of commands, mode pages and behaviour needs to be grouped together to be useful. For example, write once MO, hard disk drives and CD-R all use the WRITE command, but it is impossible to use the same strategies for writing these three media. Typically, different drivers or fragments or drivers are used for each kind of media. The previous mechanism would only identify that the WRITE command was implemented, but could not identify how to use it.

The capabilities of a particular Logical Unit may change at arbitrary times. The most common example of this is seen in a removable medium device. Even a basic removable magnetic medium device changes: from a random read/write device to a virtually less functional device when the medium is removed. Multi-function devices can change their behaviour even more radically when they accept a variety of physical and logical formats.

Before Features, Initiators had to use a trial and error method for determining what would or would not function. Medium codes became outdated even before publication of the relevant standard and still were not adequate to describe all media. The Profiles, also introduced in Mt. Fuji 2, provide an equivalent to the medium type. However, the Profile does not indicate exact capabilities for the drive/medium system, only a generic identification of core capabilities.

Feature reporting is not completely new. Operating systems first identify a driver via the device type. The device type implied a core set of functions, for example, a CD-ROM Logical Unit would support READ, READ TOC, etc. However, even these commands would not work if no medium were loaded. A driver would determine media status by trying a few commands and examining the error codes. After determining that media were present, a driver would have to probe to find out about additional Features such as audio or medium changers. Features were "reportable", but each Feature had a different mechanism, and many of the mechanisms relied on the success or failure of special "key" commands.

H.3 Implementation of Features

There are only two requirements to fully implement Features. The first is the GET CONFIGURATION command. This command is a very basic reporting command that reports some very static information; only a few Features have any dynamic fields; most Features have only one bit that changes. The command is a form of Inquiry: a technique for the Initiator to identify the device on the bus. The GET CONFIGURATION command simply provides more detail and the information reported is expected to be dynamic.

Implementation of Feature reporting via the GET CONFIGURATION command is simple: the image of the result data can be copied from device ROM to its buffer, a few fields set with information already known to the Logical Unit (such as the block size) and a few bits set according to already existing flags in the firmware (i.e. DVD versus CD, audio tracks present, etc.). Devices with non-removable media may have a completely static image that is reported. If a starting point other than the beginning is requested, the Logical Unit walks the table to find the first requested Feature, subtracts the offset from the data length, and transfers data starting at the same offset.aa

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The second part of Features is reporting when the Features change. As it is important for the Initiator to know what operations will function with the Logical Unit at any given moment, preemptive reporting of Feature changes greatly eases Initiator implementations by reducing the number of error conditions that shall be handled. The GET EVENT/STATUS NOTIFICATION command is used for status change reporting (an “Event.”) In many drives, implementation simply requires recording an event whenever a UNIT ATTENTION is generated, and having the GET EVENT/STATUS NOTIFICATION command clear the UNIT ATTENTION when the command completes.

As mentioned earlier, Features are not new; their reporting is. This reporting has become very important in modern environments. Multiple drivers are talking to the same device, doing different tasks. For example, a DVD-ROM Logical Unit may use the basic CD-ROM driver when a CD is installed, and another driver when a DVD is installed, and both a basic DVD driver and a separate copy protection process when copy protected media are mounted. All of these processes shall interact well to provide seamless and solid support. Feature reporting provides a method for clean interaction.

H.4 Compatibility

Drives implementing Feature reporting are fully compatible with legacy systems.

The GET CONFIGURATION changes no behaviour of the drive; it simply reports existing state information. Repeated GET CONFIGURATION commands will report the same information (unless the user inserts or removes the medium, etc.). GET CONFIGURATION never changes any state information in the drive, including UNIT ATTENTION conditions.

The GET EVENT/STATUS NOTIFICATION command changes legacy behaviour only slightly, and not at all in a legacy environment. In a legacy environment, UNIT ATTENTION conditions are reported as done in the past. In a new environment, completion of the GET EVENT/STATUS NOTIFICATION command clears the UNIT ATTENTION. In a legacy environment, it would be cleared anyway; there are two differences:

a) the error is reported as an event, rather than as an error, and
b) in a queued environment, the GET EVENT/STATUS NOTIFICATION command will complete before anything else, because it was idle in the drive, awaiting completion. In this environment, UNIT ATTENTION reporting will be very rare or non-existent.

H.5 Summary

Features do not radically modify any legacy behaviour or functionality. The only new parts involve reporting of behaviour, and typically reflect state information already required of any firmware implementation, via two new commands. One command reports status, and the other notifies the Initiator that the status may have changed.

The benefits include easier coding of highly robust drivers, fewer error conditions, and forward and backward compatibility with operating system drivers.

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Annex I
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MMC command listings

Table I.1 – Multimedia commands – Alphabetically

Command Name	OpCode	Feature	Sub-clause
BLANK	A1h		6.1.1
CLOSE TRACK/SESSION	5Bh		6.1.2
FORMAT UNIT	04h	Formattable	6.1.3
GET CONFIGURATION	46h	Core	6.1.4
GET EVENT/STATUS NOTIFICATION	4Ah	Core	6.1.5
GET PERFORMANCE	ACh	Real-time Streaming	6.1.6
INQUIRY	12h	Core	ANSI INCITS 301
LOAD/UNLOAD C/DVD	A6h	Embedded Changer	6.1.7
MECANISM STATUS	BDh	Embedded Changer	6.1.8
MODE SELECT (10)	55h	Core	ANSI INCITS 301
MODE SENSE (10)	5Ah	Core	ANSI INCITS 301
PAUSE/RESUME	4Bh	CD Audio	6.1.9
PLAY AUDIO (10)	45h	CD Audio	6.1.10
PLAY AUDIO (12)	A5h	CD Audio	6.1.11
PLAY AUDIO MSF	47h	CD Audio	6.1.12
PLAY CD	BCh	Digital Output	6.1.13
PREVENT/ALLOW MEDIUM REMOVAL	1Eh	Core	ANSI INCITS 301
READ (10)	28h	Random Readable	ANSI INCITS 301
READ (12)	A8h	DVD Read	
READ BUFFER CAPACITY	5Ch		6.1.14
READ C/DVD RECORDED CAPACITY	25h	Random Readable	6.1.17
READ CD	BEh	CD Read	6.1.15
READ CD MSF	B9h	CD Read	6.1.16
READ DISC INFORMATION	51h		6.1.18
READ DVD STRUCTURE	ADh	DVD Read	6.1.19
READ FORMAT CAPACITIES	23h	Formattable	6.1.20
READ HEADER	44h		6.1.21
READ MASTER CUE	59h		6.1.22
READ SUB-CHANNEL	42h	CD Audio	6.1.23
READ TOC/PMA/ATIP	43h	CD Read	6.1.24
READ TRACK/TRACK INFORMATION	52h		6.1.26
REPAIR TRACK	58h		6.1.27
REPORT KEY	A4h	DVD CSS	6.1.28
REQUEST SENSE	03h		ANSI INCITS 301
RESERVE TRACK	53h		6.1.29
SCAN	BAh		6.1.30
SEEK (10)	2Bh		ANSI INCITS 301
SEND CUE SHEET	5Dh		6.1.31
SEND DVD STRUCTURE	ADh		6.1.32
SEND EVENT	A2h		6.1.33
SEND KEY	A3h	DVD CSS	6.1.34
SEND OPC INFORMATION	54h		6.1.35
SET C/D SPEED	BBh	R	6.1.36
SET READ AHEAD	A7h	Real-time Streaming	6.1.37
SET STREAMING	B6h	Real-time Streaming	6.1.38
START/STOP UNIT	1Bh	Random Readable	ANSI INCITS 301
STOP/PLAY/SCAN	4Eh	CD Audio	6.1.39
SYNCHRONIZE CACHE	35h	Random Writable, Incremental Streaming Write	6.1.40
TEST UNIT READY	00h	Core	ANSI INCITS 301
VERIFY	2Fh	Formattable	ANSI INCITS 301
WRITE (10)	2Ah	Random Writable, Incremental Streaming Write	6.1.41
WRITE AND VERIFY (10)	2Eh	Random Recordable	6.1.42

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Table I.2 – Multimedia commands – By OpCode

Command Name	OpCode	Feature	Sub-clause
TEST UNIT READY	00h	Core	ANSI INCITS 301
REQUEST SENSE	03h		ANSI INCITS 301
FORMAT UNIT	04h	Formattable	6.1.3
INQUIRY	12h	Core	ANSI INCITS 301
START/STOP UNIT	1Bh	Random Readable	ANSI INCITS 301
PREVENT/ALLOW MEDIUM REMOVAL	1Eh	Core	ANSI INCITS 301
READ FORMAT CAPACITIES	23h	Formattable	6.1.20
READ C/DVD RECORDED CAPACITY	25h	Random Readable	6.1.17
READ (10)	28h	Random Readable	ANSI INCITS 301
WRITE (10)	2Ah	Random Writable, Incremental Streaming Write	6.1.41
SEEK (10)	2Bh		ANSI INCITS 301
WRITE AND VERIFY (10)	2Eh	Random Recordable	6.1.42
VERIFY	2Fh	Formattable	ANSI INCITS 301
SYNCHRONIZE CACHE	35h	Random Writable, Incremental Streaming Write	6.1.40
READ SUB-CHANNEL	42h	CD Audio	6.1.23
READ TOC/PMA/ATIP	43h	CD Read	6.1.24
READ HEADER	44h	M	6.1.21
PLAY AUDIO (10)	45h	CD Audio	6.1.10
GET CONFIGURATION	46h	Core	ANSI INCITS 301
PLAY AUDIO MSF	47h	CD Audio	6.1.12
GET EVENT/STATUS NOTIFICATION	4Ah	Core	6.1.5
PAUSE/RESUME	4Bh	CD Audio	6.1.9
STOP/SCAN	4Eh	CD Audio	6.1.39
READ DISC INFORMATION	51h		6.1.18
READ TRACK INFORMATION	52h		6.1.26
RESERVE TRACK	53h		6.1.29
SEND OPC INFORMATION	54h		6.1.35
MODE SELECT (10)	55h	Core	ANSI INCITS 301
REPAIR TRACK	58h		6.1.27
READ MASTER CUE	59h		6.1.22
MODE SENSE (10)	5Ah	Core	ANSI INCITS 301
CLOSE TRACK/SESSION	5Bh		6.1.2
READ BUFFER CAPACITY	5Ch		6.1.14
SEND CUE SHEET	5Dh		6.1.31
BLANK	A1h		6.1.1
SEND EVENT	A2h		6.1.33
SEND KEY	A3h	DVD CSS	6.1.34
REPORT KEY	A4h	DVD CSS	6.1.28
PLAY AUDIO (12)	A5h	CD Audio	6.1.11
LOAD/UNLOAD C/DVD	A6h	Embedded Changer	6.1.7
SET READ AHEAD	A7h	Real-time Streaming	6.1.37
READ (12)	A8h	DVD Read	ANSI INCITS 301
GET PERFORMANCE	ACh	Real-time Streaming	6.1.6
READ DVD STRUCTURE	ADh	DVD Read	6.1.19
SEND DVD STRUCTURE	ADh		6.1.32
SET STREAMING	B6h	Real-time Streaming	6.1.38
READ CD MSF	B9h	CD Read	6.1.16
SCAN	BAh		6.1.30
SET C/D SPEED	BBh	R	6.1.36
PLAY CD	BCh	Digital Output	6.1.13
MECANISM STATUS	BDh	Embedded Changer	6.1.8
READ CD	BEh	CD Read	6.1.15

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Table I.3 – Commands common to all SCSI devices

Command Name	Operation Code	SCSI	
		Type	Ref Std
CHANGE DEFINITION	40h	O	
COMPARE	39h	O	
COPY	18h	O	
COPY AND VERIFY	3Ah	O	
INQUIRY	12h	M	
LOCK/UNLOCK CACHE	36h	O	
LOG SELECT	4Ch	O	
LOG SENSE	4Dh	O	
MODE SELECT (10)	55h	O	
MODE SELECT (6)	15h	O	
MODE SENSE (10)	5Ah	M	
MODE SENSE (6)	1Ah	O	
PREFETCH	34h	O	
PREVENT/ALLOW MEDIUM REMOVAL	1Eh	M	
READ (10)	28h	M	
READ (12)	A8h	O	
READ (6)	08h	O	
READ BUFFER	3Ch	O	
READ LONG	3Eh	O	
RECEIVE DIAGNOSTIC RESULTS	1Ch	O	
RELEASE (10)	57h	M	
RELEASE (6)	17h	O	
REQUEST SENSE	03h	M	
RESERVE (10)	56h	M	
RESERVE (6)	16h	O	
SEEK (10)	2Bh	M	
SEEK (6)	0Bh	M	
SEND DIAGNOSTIC	1Dh	M	
SET LIMITS (10)	33h	O	
SET LIMITS (12)	B3h	O	
START/STOP UNIT	1Bh	M	
TEST UNIT READY	00h	M	ANSI INCITS 301
VERIFY (10)	2Fh	O	ANSI INCITS 301
VERIFY (12)	AFh	O	ANSI INCITS 301
WRITE BUFFER	3Bh	O	ANSI INCITS 301

Key

M = command implementation is mandatory

O = command implementation is optional

The following command codes are vendor-specific: 02h, 05h, 06h, 09h, 0Ch, 0Dh, 0Eh, 0Fh, 10h, 11h, 13h, 14h, 19h, 20h, 21h, 22h, 23h, 24h, 26h, 27h, 29h and C0h through FFh.

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Annex J
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CD -TEXT Format in the Lead-in Area

This annex explains the CD-TEXT information that is stored in the Lead-in Area as raw R-W Sub-channel data. The information here is stored in a memory and can be retrieved to the Initiator immediately.

The CD-TEXT information in the Lead-in area is retrieved from raw R-W Sub-channel data. The data format of RAW Sub-channel is explained in 6.1.15. READ CD Command. 6 bits of each byte are R-W Raw data and it is converted from 6 bits to 8 bits from the 1st bytes, it makes 4 chunk of 18 bytes data. Each 18 bytes of data is called CD-TEXT Pack Data as shown in Table J.1. CD-TEXT information is recorded repeatedly in the Lead-in area and this one repeated data is called Text Group. Text Group consists of up to 8 types of language Blocks. Each Block represents one language and consists of maximum 255 Pack Data. Table J.1 defines the contents of one Pack Data.

Table J.1 – CD-TEXT Pack Data format for the Lead-in area

BYTE	CD-TEXT Pack Data Format
0	Header Field ID1: Pack Type Indicator
1	Header Field ID2: Pack Type Indicator
2	Header Field ID3: Pack Type Indicator
3	Header Field ID4: Block Number and Character Position Indicator
4	Text Data Field byte 0
5	Text Data Field byte 1
6	Text Data Field byte 2
7	Text Data Field byte 3
8	Text Data Field byte 4
9	Text Data Field byte 5
10	Text Data Field byte 6
11	Text Data Field byte 7
12	Text Data Field byte 8
13	Text Data Field byte 9
14	Text Data Field byte 10
15	Text Data Field byte 11
16	CRC Field byte 0 or Reserved
17	CRC Field byte 1 or Reserved

Pack is used to indicate the chunk of data in 18 bytes as shown in Table J.1. Each Pack consists of a Header Field, Text Data Field and CRC Field.

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Pack Type Indicator has the value and descriptions defined in Table J.2. Packs shall be encoded in the order of the items listed in the Table.

Table J.2 – Pack type indicator definitions

Value	Descriptions
80h	Title of Album name(ID2=00h) or Track Titles (ID2=01h...63h)
81h	Name(s) of the performer(s) (encoded according to ISO/IEC 646:1991)
82h	Name(s) of the songwriter(s) encoded according to ISO/IEC 646:1991)
83h	Name(s) of the composer(s) encoded according to ISO/IEC 646:1991)
84h	Name(s) of the arranger(s) (encoded according to ISO/IEC 646:1991)
85h	Message(s) from content provider and/or artist (encoded according to ISO/IEC 646:1991)
86h	Disc Identification information
87h	Genre Identification and Genre information
88h	Table of Content information
89h	Second Table of Content information
8Ah	Reserved
8Bh	Reserved
8Ch	Reserved
8Dh	Reserved for content provider only
8Eh	UPC/EAN code of the album and ISRC code of each track
8Fh	Size information of the Block

Track Number Indicator consists of 2 fields of information. MSB of this byte in the Extension Flag is normally set to 0b. If it is set to 1b, the Pack is used for an extended application (TBD). The rest of the byte is used for Track Number or Pack Element Number. Track Number is used when the Text Data field belongs to the track. If the Pack is independent of the Track, this field indicates Pack Element Number that depends on the type of the Pack.

Sequence Number Indicator is the number incrementally increased from the first Pack to the end in each Block. It starts from 00h to FFh.

Block Number and Character Position Indicator contains 3 fields of information defined in the following figure.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
DBCC	Block Number			Character Position			

Figure J.1 – Block number character position

Bit 7 (MSB) is the Double Byte Character Code indication, that indicates if the Text Data Field contains the Double Byte Character Code or not. If it is set to 0b, the Single Byte Character Code is used.

Bit 4 to 6, 3 bit s, indicate the Block Number of the Block to which the Pack belongs. A Block is used to indicate a set of text information representing one particular language. It can be used up to 8 at the same time.

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Bit 0 to bit 3, indicate the Character Position. It is the number of character in the strings that belongs to the Text Data Field in the previous Pack. The Character Position starts from 0 to 15 and 15 indicates that the first character belongs to the one before the previous Pack. When the character code is double byte code, a set of 2 bytes in the Text Data Field is counted at one.

A null code is also counted as a character, that indicates termination of each strings.

Character Position is not used in Packs with ID1=88h, 89h and 8Fh. 00h shall be used in all these Packs.

A Text Data Field consists of 12 bytes. It contains either character strings or binary information depending on the type of Pack. All data in this field shall be transferred as recorded on the disc.

Packs except ID1=88h, 89h and 8Fh shall contain character strings in the Text Data Field. If Packs with ID1=80h to 85h and 8Eh are used, a character string for each track shall be provided.

A character string consists of a series of characters and a terminator (one null code for single byte, two null code for double byte)`.

The size of a character string is recommended to be less than 160 bytes. If a character string does not fit in a Text Data Field of a Pack, it is continued onto the succeeding Packs. The succeeding character string will be encoded starting at the next byte in the Text Data Field after the terminator of the current string. Unused bytes in the Text Data Field shall be filled with null codes.

In case, the same character string is used for consecutive tracks, the Tab Indicator may be used to indicate the same as previous track. It is a single tab code (09h) for single byte codes, and two tab codes for double bytes character codes. It shall not used for the first track.

Packs with ID1=86h, 87h, 88h, 89h and 8Fh contain binary information in the Text Data Field.

CRC Field consists of 2 bytes. Initiator system may use these bytes to check errors in the Pack. The Pack polynomial is $X^{16} + X^{12} + X^5 + 1$. All bits shall be inverted. This field is not mandatory for supporting CD-TEXT data.

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CD-ROM XA: Compact Disc Read Only Memory extended Architecture (CD-ROM XA), specified in the System Description CD-ROM XA, NV Philips and Sony Corporation.

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Orange Book – part II: Compact Disc Write Once (CD-WO), specified in the System Description Recordable Compact Disc Systems, part II: CD-WO (Orange Book part II), NV Philips and Sony Corporation

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Multi-session CD: Multi-session Compact Disc, specified in the Multi-session Compact Disc Specification, NV Philips and Sony Corporation.

RIS 105-1994 RIAJ Standard, , Operational Rule of CD-R Master for CD

The following are published by the DVD Forum (for availability, consult www.dvdforum.org):

DVD1: DVD Specification for Read only Disc part one Physical Specifications

DVD2 DVD Specification for Recordable Disc part one Physical Specifications

DVD3: DVD Specifications for Recordable Disc for Authoring Part one Physical Specifications

DVD4: DVD Specifications for Recordable Disc for General Part one Physical Specifications

DVD5: DVD Specification for Rewritable Disc part one Physical Specifications

DVD6: DVD Specification for Re-recordable Disc (DVD-RW) part one Physical specifications

SFF-8020 *ATA Packet Interface for CD-ROMs*

SFF-8090 *ATAPI for Multimedia Devices (Mt Fuji5)*

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