

Accessory Design Guidelines for Apple Devices

Release R24

Contents

Overview 21

1. Introduction 22

2. Requirements 23

3. Terminology 24

- 3.1 Device 24
- 3.2 Accessory 24
- 3.3 Component 24
- 3.4 Control Surface 25
- 3.5 Direct User Action 25
- 3.6 Built-In Cable 25
- 3.7 Apple MFi Program 26
- 3.8 Accessory Interface Specification 26

Accessories 27

4. All Accessories 28

- 4.1 Scratches and Damage 28
- 4.2 Compliance Testing 28
- 4.3 USB-B Receptacles 28
- 4.4 User Supplied Cables and AC Power Adapters 28
- 4.5 TDMA Noise 29
- 4.6 Attachments 29
- 4.7 Magnetic Interference 29
- 4.8 Radio Frequency (RF) Performance 31
 - 4.8.1 Materials and Coatings 31
 - 4.8.2 Antenna Keep-Out 31
 - 4.8.3 Over The Air (OTA) Transmission/Reception 31
 - 4.8.4 Specific Absorption Rate (SAR) 32
 - 4.8.5 Near Field Communication (NFC) 32
- 4.9 Thermal Management 33

- 4.10 Tripod Connections 33
- 4.11 Anthropometric Considerations 34

5. Cases 35

- 5.1 Product Design 35
 - 5.1.1 Device Protection 35
 - 5.1.2 Access to Inputs and Interconnects 36
 - 5.1.3 Dock Compatibility 41
 - 5.1.4 Wireless Power 41
- 5.2 Acoustics 41
 - 5.2.1 Call Quality 42
 - 5.2.2 Speaker to Microphone Coupling 42
 - 5.2.3 Speaker/Microphone Openings 42
- 5.3 Ambient Light Sensor and Proximity Sensor 45
- 5.4 Haptics 45
- 5.5 Magnetic Interference 45
- 5.6 Touch ID 45
- 5.7 Camera 45
 - 5.7.1 Geometry 46
 - 5.7.2 Color 46
 - 5.7.3 Surface Finish 46
 - 5.7.4 Image Degradation Examples 47
- 5.8 Reliability 48
 - 5.8.1 Device Insertion and Removal 48
 - 5.8.2 Colorfastness 48
- 5.9 Environmental 48
- 5.10 Verification 49
 - 5.10.1 Device Models 49
 - 5.10.2 Product Design 67
 - 5.10.3 Camera Control 69
 - 5.10.4 Haptics 69
 - 5.10.5 Touch ID Sensor Overlays 70
 - 5.10.6 Camera 71
 - 5.10.7 Near-Field Communication (NFC) 72
 - 5.10.8 Compass 73
 - 5.10.9 Acoustics 74

6. Covers 76

- 6.1 Device Protection 76
- 6.2 Magnetic Interference 76

- 6.3 Smart Covers 76
- 7. Screen Overlays 78**
 - 7.1 Product Design 78
 - 7.1.1 Optical Transmission 78
 - 7.1.2 Infrared Transmission 79
 - 7.1.3 Transmission Haze 79
 - 7.1.4 Dynamic Island 80
 - 7.2 Edge Swipe Gestures 80
- 8. Camera Attachments 81**
 - 8.1 Magnetic Interference 81
- 9. Adapters 82**
 - 9.1 Headset Adapters (Lightning to 3.5 mm) 82
 - 9.2 USB-A/USB-C to Lightning Headset Adapters 82
 - 9.3 Lightning to USB Micro-B Adapters 82
- 10. AC Power Adapters 84**
 - 10.1 Converter Switching Frequencies 84
 - 10.2 YCAP AC Capacitor 84
 - 10.3 Impedance Stability 84
 - 10.4 Fuse Protection 85
 - 10.5 Short Circuit Response 86
- 11. Battery Packs 87**
- 12. Headsets 88**
 - 12.1 Product Design 88
 - 12.2 Audio Interface 88
 - 12.3 Remote Controls 88
 - 12.4 USB-C Headset Identification 89
- 13. Strobes 90**
- 14. Keyboards 92**
 - 14.1 Requirements 92
 - 14.2 Examples 97
 - 14.2.1 Example HID Report Descriptor 97

15. Trackpads	98
15.1 Requirements	98
15.1.1 Integration with Keyboards	98
15.1.2 HID Report Descriptor	98
15.1.3 Coexistence	99
15.1.4 Performance	99
15.1.5 Input Confidence	100
15.1.6 Click to Wake	100
15.2 Examples	101
15.2.1 Example HID Report Descriptor	101
15.2.2 Example Trackpad	104
16. External Storage	107
16.1 Overview	107
16.2 Apple ProRes 4K	107
16.3 Verification	108
16.3.1 Apple ProRes 4K	108
17. AirPods Accessories	109
17.1 Charging Case Covers	109
17.2 Chargers	110
17.3 AirPods Max Accessories	110
17.3.1 Sleep Mode	110
17.4 Magnetic Flux Probe	111
17.5 Verification	112
17.5.1 MagSafe Charging with Case Cover	112
18. Apple Vision Pro Accessories	113
18.1 Apple Vision Pro Storage Cases	113
18.2 Apple Vision Pro Battery Holders	113
18.3 Apple Vision Pro Bands	114
18.4 Verification	114
18.4.1 Equipment	114
18.4.2 Peel Force Test	114
19. Watch Bands	116
19.1 Requirements	116
19.2 Apple Watch Band Interface	118
19.3 Example Apple Watch Lug Assembly	119
19.4 Example Apple Watch Lug	121

20. Apple MagSafe Charger Mounts 122

20.1 Mechanical 122

21. StandBy Mounts 123

21.1 Product Design 124

21.2 Verification 125

21.2.1 Equipment 125

21.2.2 Enable StandBy 125

21.2.3 Product Design 125

22. Continuity Camera Mounts 126

22.1 Product Design 127

22.2 Apple TV Mount 128

22.3 MacBook Mount 129

22.4 iMac or Display Mount 130

22.5 Verification 131

22.5.1 Equipment 131

22.5.2 Setup 131

22.5.3 Product Design 132

22.5.4 Center Stage 132

22.5.5 Desk View 133

Features 135

23. Accessory Power (USB-C) 136

23.1 Available Current 136

23.2 Fast Role Swap (FRS) 137

23.3 Verification 137

23.3.1 Maximum Accessory Power 137

24. Accessory Power (Lightning) 140

25. App Discovery 141

26. App Launch 142

27. App Match 143

28. Bluetooth Accessory Identification 144

- 28.1 HFP Command AT+XAPL 144
- 29. Bluetooth Headset Battery Level Indication 146**
 - 29.1 HFP Command AT+IPHONEACCEV 146
- 30. Device Power (USB-C) 147**
 - 30.1 External Power Source 147
 - 30.2 Power State Changes 148
- 31. Device Power (Lightning) 149**
 - 31.1 Direct Power Source 149
 - 31.2 External Power Source 149
 - 31.3 Declaring Capability 150
 - 31.4 Providing Power using USB Connectors 150
 - 31.5 Labeling Multiple Connectors 150
 - 31.6 Fast Charge for iPhone (20 W) 151
 - 31.7 Overcurrent and Short Circuit Protection 152
 - 31.8 Overcurrent and Short Circuit Protection Resets 153
 - 31.9 Power State Changes 153
- 32. Device Power (Inductive) 154**
 - 32.1 Qi Wireless Power 154
 - 32.2 MagSafe 155
 - 32.3 Electromagnetic Compatibility (EMC) 156
- 33. Ethernet over USB 158**
- 34. External Accessory Protocol 159**
- 35. HID Headset Remote 160**
 - 35.1 Requirements 160
 - 35.2 Examples 161
 - 35.2.1 Headset Remote Example HID Report Descriptor (Telephony) 161
 - 35.2.2 Headset Remote Example HID Report Descriptor (Media Playback) 161
 - 35.2.3 Headset Remote Example HID Report Descriptor (Telephony and Media Playback) 162
- 36. Location Information 164**
- 37. MagSafe Attach 165**

37.1 MagSafe Case Magnet Array	166
37.1.1 Product Design	166
37.1.2 Mechanical	166
37.1.3 Magnetic Interference	172
37.2 MagSafe Accessory Magnet Array	173
37.2.1 Product Design	173
37.2.2 Mechanical	173
37.3 MagSafe Accessory Enclosure Geometry	180
37.4 Verification	181
37.4.1 MagSafe Case Magnet Array	181
37.4.2 MagSafe Accessory Magnet Array	184
38. Media Library Access	186
39. Musical Instrument Digital Interface (MIDI)	187
39.1 Requirements	187
39.2 Verification	187
40. Now Playing Updates	188
41. Out-of-Band Bluetooth Pairing	189
42. Siri	190
42.1 Enabling Custom Siri Commands	190
42.2 Obtaining Siri Availability Information	190
42.2.1 Obtaining Status Information at Connection	190
42.2.2 Receiving Siri Availability Updates from the Device	191
42.3 Initiating a Siri Session	192
42.3.1 Initiating a Session from the Accessory	192
42.3.2 Initiating a Session from the Device	193
42.3.3 Ending a Session from the Accessory	194
42.4 Siri Eyes Free Mode	194
42.4.1 HFP Command AT+APLEFM	195
42.5 Improving Voice Recognition	195
42.5.1 Wide Band Speech Support	196
42.6 Optimizing the Siri Experience	196
42.7 Common Siri Applications	197
42.7.1 Initialization Procedure After Connection is Established	197
42.7.2 Phone Dialing Using Siri	198
42.7.3 Audio Routing and Media Playback Using Siri	198

- 42.7.4 Turn-By-Turn Directions Using Siri 199
- 42.8 User Interaction with Siri Eyes Free in a Vehicle 199
- 42.9 Enabling/Disabling Siri from the Device 201
- 42.10 Verification 202
 - 42.10.1 Siri Eyes Free 202

43. Wi-Fi Information Sharing 207

Protocols 208

44. USB Power Capability Vendor Request 209

45. USB D+/D- Resistor Networks 210

- 45.1 Declaring Power Source Capability 210
- 45.2 Identifying Power Source Current Limit 211

46. USB Power Delivery (PD) 213

47. USB Type-C Current 214

48. Advanced Audio Distribution Profile (A2DP) 215

- 48.1 Bluetooth A2DP Specification 215
 - 48.1.1 AVDTP Transactions 215
- 48.2 SubBand Codec (SBC) 215
- 48.3 MPEG 2/4 AAC Codecs 216
- 48.4 Verification 217
 - 48.4.1 Audio Quality 217
 - 48.4.2 Audio Switching 217
 - 48.4.3 HFP Interaction 218
 - 48.4.4 Siri 218
 - 48.4.5 Video Playback 218

49. iAP2 219

50. Human Interface Device (HID) 220

- 50.1 Requirements 220
 - 50.1.1 Report Descriptor 221
 - 50.1.2 USB 221
- 50.2 Verification 221

50.2.1 General 221

Transports 223

51. Bluetooth 224

- 51.1 Enhanced Data Rate 224
- 51.2 Adaptive Frequency Hopping 224
- 51.3 Sniff Mode for Low Power Consumption 224
- 51.4 Role and Topology Management 225
- 51.5 Extended Inquiry Response 226
- 51.6 Secure Simple Pairing 226
- 51.7 Pairing Button 226
- 51.8 Class of Device (CoD) 227
- 51.9 Link Supervision Timeout 227
- 51.10 Delay Reporting 227
- 51.11 Profiles 227
 - 51.11.1 Device ID Profile (DID) 227
 - 51.11.2 Service Discovery Protocol (SDP) 228
 - 51.11.3 Hands-Free Profile (HFP) 228
 - 51.11.4 Message Access Profile (MAP) 230
 - 51.11.5 Audio/Video Remote Control Profile (AVRCP) 231
 - 51.11.6 Advanced Audio Distribution Profile (A2DP) 233
- 51.12 Audio Routing 233
 - 51.12.1 Audio Data Received using HFP Profile 233
 - 51.12.2 Audio Data Received using A2DP Profile 233
- 51.13 HID 235

52. Bluetooth Low Energy (BLE) 236

- 52.1 Role 236
- 52.2 Advertising Channels 236
- 52.3 Advertising PDU 236
- 52.4 Advertising Data 236
- 52.5 Advertising Interval 237
- 52.6 Connection Parameters 238
- 52.7 Data Packet Length Extension 238
- 52.8 Privacy 239
- 52.9 Permissions 239
- 52.10 Pairing 239
- 52.11 MTU Size 240

- 52.12 Services 240
 - 52.12.1 Generic Access Profile Service 240
 - 52.12.2 Generic Attribute Profile Service 240
 - 52.12.3 Device Information Service 241
 - 52.12.4 Available Services 241
- 52.13 GATT Server 241

Modules 243

- 53. Apple USB-C Analog Headset Module 244**
 - 53.1 Overview 244
 - 53.1.1 Additional Specifications & Support 245
 - 53.1.2 Procurement 245
 - 53.2 Mechanical 245
 - 53.2.1 Shielding 245
 - 53.3 Pad Assignments 246
 - 53.4 Electrical 247
 - 53.4.1 DAC Characteristics 247
 - 53.5 C125 Dimensions 249
 - 53.6 C125 Recommended Clamshell Shields 250
 - 53.7 C125 Recommended Rear Shield 251

Components 252

- 54. Headset Remote and Microphone Transmitter 253**
 - 54.1 Overview 253
 - 54.2 Requirements 253
 - 54.3 Usage 257
 - 54.3.1 Pin Assignments 258
 - 54.3.2 Maximum Voltage and Current Ratings 258
 - 54.3.3 Electrical Characteristics 259
 - 54.3.4 Theory of Operation 260
 - 54.3.5 Button Mode 261
 - 54.3.6 Tone Mode 262
 - 54.4 Button Detection Circuitry Usage 265
 - 54.4.1 Button Detection Circuitry Adjustments 268

Connectors 269

55. USB-A Receptacle 270

55.1 Mechanical 270

55.2 Electrical 270

56. USB-C Plug 271

56.1 Overview 271

56.2 Mechanical 271

56.3 Electrical 272

56.3.1 Drawing Power 272

56.3.2 Providing Power 273

56.4 Verification 273

56.4.1 Mechanical 273

56.4.2 Connector Test ID 273

56.4.3 Drawing Power 273

57. USB-C Receptacle 275

57.1 Overview 275

57.2 Mechanical 275

57.3 Electrical 275

57.3.1 Drawing Power 275

57.3.2 Providing Power 276

57.4 USB-C receptacle accessory keep-out 277

57.5 Verification 278

57.5.1 Connector Test ID 278

57.5.2 Drawing Power 278

57.5.3 Providing Power 279

Tools 280

58. Accessory Developer Assistant (ADA) 281

58.1 Autofocus & Optical Image Stabilization Test Profile 282

References 283

59. Device Dimensional Drawings 284

59.1 iPhone 16 Pro Max, 1 of 4 292

59.2 iPhone 16 Pro Max, 2 of 4	293
59.3 iPhone 16 Pro Max, 3 of 4	294
59.4 iPhone 16 Pro Max, 4 of 4	295
59.5 iPhone 16 Pro, 1 of 4	296
59.6 iPhone 16 Pro, 2 of 4	297
59.7 iPhone 16 Pro, 3 of 4	298
59.8 iPhone 16 Pro, 4 of 4	299
59.9 iPhone 16 Plus, 1 of 4	300
59.10 iPhone 16 Plus, 2 of 4	301
59.11 iPhone 16 Plus, 3 of 4	302
59.12 iPhone 16 Plus, 4 of 4	303
59.13 iPhone 16, 1 of 4	304
59.14 iPhone 16, 2 of 4	305
59.15 iPhone 16, 3 of 4	306
59.16 iPhone 16, 4 of 4	307
59.17 iPhone 15 Pro Max, 1 of 3	308
59.18 iPhone 15 Pro Max, 2 of 3	309
59.19 iPhone 15 Pro Max, 3 of 3	310
59.20 iPhone 15 Pro, 1 of 3	311
59.21 iPhone 15 Pro, 2 of 3	312
59.22 iPhone 15 Pro, 3 of 3	313
59.23 iPhone 15 Plus, 1 of 3	314
59.24 iPhone 15 Plus, 2 of 3	315
59.25 iPhone 15 Plus, 3 of 3	316
59.26 iPhone 15, 1 of 3	317
59.27 iPhone 15, 2 of 3	318
59.28 iPhone 15, 3 of 3	319
59.29 iPhone 14 Pro Max, 1 of 3	320
59.30 iPhone 14 Pro Max, 2 of 3	321
59.31 iPhone 14 Pro Max, 3 of 3	322
59.32 iPhone 14 Pro, 1 of 3	323
59.33 iPhone 14 Pro, 2 of 3	324
59.34 iPhone 14 Pro, 3 of 3	325
59.35 iPhone 14 Plus, 1 of 3	326
59.36 iPhone 14 Plus, 2 of 3	327
59.37 iPhone 14 Plus, 3 of 3	328
59.38 iPhone 14, 1 of 3	329
59.39 iPhone 14, 2 of 3	330
59.40 iPhone 14, 3 of 3	331

59.41 iPhone 13 Pro Max, 1 of 2	332
59.42 iPhone 13 Pro Max, 2 of 2	333
59.43 iPhone 13 Pro, 1 of 2	334
59.44 iPhone 13 Pro, 2 of 2	335
59.45 iPhone 13, 1 of 2	336
59.46 iPhone 13, 2 of 2	337
59.47 iPhone 13 mini, 1 of 2	338
59.48 iPhone 13 mini, 2 of 2	339
59.49 iPhone 12 Pro Max, 1 of 2	340
59.50 iPhone 12 Pro Max, 2 of 2	341
59.51 iPhone 12 Pro, 1 of 2	342
59.52 iPhone 12 Pro, 2 of 2	343
59.53 iPhone 12, 1 of 2	344
59.54 iPhone 12, 2 of 2	345
59.55 iPhone 12 mini, 1 of 2	346
59.56 iPhone 12 mini, 2 of 2	347
59.57 iPhone SE (3rd generation) and iPhone SE (2nd generation)	348
59.58 iPhone 11 Pro Max	349
59.59 iPhone 11 Pro	350
59.60 iPhone 11	351
59.61 iPhone XS Max	352
59.62 iPhone XS	353
59.63 iPhone XR	354
59.64 iPhone X	355
59.65 iPhone 8 Plus	356
59.66 iPhone 8	357
59.67 iPhone 7 Plus	358
59.68 iPhone 7	359
59.69 iPhone 6s Plus	360
59.70 iPhone 6s	361
59.71 iPhone 6 Plus	362
59.72 iPhone 6	363
59.73 iPhone 5s and iPhone SE	364
59.74 iPhone 5c	365
59.75 iPhone 5	366
59.76 iPad mini (A17 Pro), 1 of 6	367
59.77 iPad mini (A17 Pro), 2 of 6	368
59.78 iPad mini (A17 Pro), 3 of 6	369
59.79 iPad mini (A17 Pro), 4 of 6	370

59.80 iPad mini (A17 Pro), 5 of 6	371
59.81 iPad mini (A17 Pro), 6 of 6	372
59.82 iPad Pro 13-inch (M4), 1 of 5	373
59.83 iPad Pro 13-inch (M4), 2 of 5	374
59.84 iPad Pro 13-inch (M4), 3 of 5	375
59.85 iPad Pro 13-inch (M4), 4 of 5	376
59.86 iPad Pro 13-inch (M4), 5 of 5	377
59.87 iPad Pro 11-inch (M4), 1 of 5	378
59.88 iPad Pro 11-inch (M4), 2 of 5	379
59.89 iPad Pro 11-inch (M4), 3 of 5	380
59.90 iPad Pro 11-inch (M4), 4 of 5	381
59.91 iPad Pro 11-inch (M4), 5 of 5	382
59.92 iPad Air 13-inch (M2), 1 of 5	383
59.93 iPad Air 13-inch (M2), 2 of 5	384
59.94 iPad Air 13-inch (M2), 3 of 5	385
59.95 iPad Air 13-inch (M2), 4 of 5	386
59.96 iPad Air 13-inch (M2), 5 of 5	387
59.97 iPad Air 11-inch (M2), 1 of 5	388
59.98 iPad Air 11-inch (M2), 2 of 5	389
59.99 iPad Air 11-inch (M2), 3 of 5	390
59.100 iPad Air 11-inch (M2), 4 of 5	391
59.101 iPad Air 11-inch (M2), 5 of 5	392
59.102 iPad Pro 12.9-inch (6th generation), 1 of 5	393
59.103 iPad Pro 12.9-inch (6th generation), 2 of 5	394
59.104 iPad Pro 12.9-inch (6th generation), 3 of 5	395
59.105 iPad Pro 12.9-inch (6th generation), 4 of 5	396
59.106 iPad Pro 12.9-inch (6th generation), 5 of 5	397
59.107 iPad Pro 11-inch (4th generation), 1 of 5	398
59.108 iPad Pro 11-inch (4th generation), 2 of 5	399
59.109 iPad Pro 11-inch (4th generation), 3 of 5	400
59.110 iPad Pro 11-inch (4th generation), 4 of 5	401
59.111 iPad Pro 11-inch (4th generation), 5 of 5	402
59.112 iPad (10th generation), 1 of 6	403
59.113 iPad (10th generation), 2 of 6	404
59.114 iPad (10th generation), 3 of 6	405
59.115 iPad (10th generation), 4 of 6	406
59.116 iPad (10th generation), 5 of 6	407
59.117 iPad (10th generation), 6 of 6	408
59.118 iPad Air (5th generation) and iPad Air (4th generation), 1 of 5	409

59.119 iPad Air (5th generation) and iPad Air (4th generation), 2 of 5	410
59.120 iPad Air (5th generation) and iPad Air (4th generation), 3 of 5	411
59.121 iPad Air (5th generation) and iPad Air (4th generation), 4 of 5	412
59.122 iPad Air (5th generation) and iPad Air (4th generation), 5 of 5	413
59.123 iPad mini (6th generation), 1 of 6	414
59.124 iPad mini (6th generation), 2 of 6	415
59.125 iPad mini (6th generation), 3 of 6	416
59.126 iPad mini (6th generation), 4 of 6	417
59.127 iPad mini (6th generation), 5 of 6	418
59.128 iPad mini (6th generation), 6 of 6	419
59.129 iPad (9th generation), iPad (8th generation) and iPad (7th generation), 1 of 4	420
59.130 iPad (9th generation), iPad (8th generation) and iPad (7th generation), 2 of 4	421
59.131 iPad (9th generation), iPad (8th generation) and iPad (7th generation), 3 of 4	422
59.132 iPad (9th generation), iPad (8th generation) and iPad (7th generation), 4 of 4	423
59.133 iPad Pro 12.9-inch (5th generation), 1 of 5	424
59.134 iPad Pro 12.9-inch (5th generation), 2 of 5	425
59.135 iPad Pro 12.9-inch (5th generation), 3 of 5	426
59.136 iPad Pro 12.9-inch (5th generation), 4 of 5	427
59.137 iPad Pro 12.9-inch (5th generation), 5 of 5	428
59.138 iPad Pro 11-inch (3rd generation), 1 of 5	429
59.139 iPad Pro 11-inch (3rd generation), 2 of 5	430
59.140 iPad Pro 11-inch (3rd generation), 3 of 5	431
59.141 iPad Pro 11-inch (3rd generation), 4 of 5	432
59.142 iPad Pro 11-inch (3rd generation), 5 of 5	433
59.143 iPad Pro 12.9-inch (4th generation), 1 of 5	434
59.144 iPad Pro 12.9-inch (4th generation), 2 of 5	435
59.145 iPad Pro 12.9-inch (4th generation), 3 of 5	436
59.146 iPad Pro 12.9-inch (4th generation), 4 of 5	437
59.147 iPad Pro 12.9-inch (4th generation), 5 of 5	438
59.148 iPad Pro 11-inch (2nd generation), 1 of 5	439
59.149 iPad Pro 11-inch (2nd generation), 2 of 5	440
59.150 iPad Pro 11-inch (2nd generation), 3 of 5	441
59.151 iPad Pro 11-inch (2nd generation), 4 of 5	442
59.152 iPad Pro 11-inch (2nd generation), 5 of 5	443
59.153 iPad Air (3rd generation), 1 of 3	444
59.154 iPad Air (3rd generation), 2 of 3	445
59.155 iPad Air (3rd generation), 3 of 3	446
59.156 iPad Air (3rd generation) with Cellular, 1 of 3	447
59.157 iPad Air (3rd generation) with Cellular, 2 of 3	448

59.158 iPad Air (3rd generation) with Cellular, 3 of 3	449
59.159 iPad mini (5th generation), 1 of 3	450
59.160 iPad mini (5th generation), 2 of 3	451
59.161 iPad mini (5th generation), 3 of 3	452
59.162 iPad mini (5th generation) with Cellular, 1 of 3	453
59.163 iPad mini (5th generation) with Cellular, 2 of 3	454
59.164 iPad mini (5th generation) with Cellular, 3 of 3	455
59.165 iPad Pro 12.9-inch (3rd generation), 1 of 3	456
59.166 iPad Pro 12.9-inch (3rd generation), 2 of 3	457
59.167 iPad Pro 12.9-inch (3rd generation), 3 of 3	458
59.168 iPad Pro 11-inch (1st generation), 1 of 3	459
59.169 iPad Pro 11-inch (1st generation), 2 of 3	460
59.170 iPad Pro 11-inch (1st generation), 3 of 3	461
59.171 iPad Pro 12.9-inch (2nd generation)	462
59.172 iPad Pro 12.9-inch (2nd generation) with Cellular	463
59.173 iPad Pro 12.9-inch (2nd generation) Magnet/Hall Effect Sensors, 1 of 2	464
59.174 iPad Pro 12.9-inch (2nd generation) Magnet/Hall Effect Sensors, 2 of 2	465
59.175 iPad Pro 10.5-inch	466
59.176 iPad Pro 10.5-inch with Cellular	467
59.177 iPad Pro 10.5-inch Magnet/Hall Effect Sensors, 1 of 2	468
59.178 iPad Pro 10.5-inch Magnet/Hall Effect Sensors, 2 of 2	469
59.179 iPad (5th and 6th generation) with Cellular	470
59.180 iPad (5th and 6th generation) Magnet/Hall Effect Sensors, 1 of 2	471
59.181 iPad (5th and 6th generation) Magnet/Hall Effect Sensors, 2 of 2	472
59.182 iPad Pro 9.7-inch	473
59.183 iPad Pro 9.7-inch with Cellular	474
59.184 iPad Pro 9.7-inch Magnet/Hall Effect Sensors, 1 of 2	475
59.185 iPad Pro 9.7-inch Magnet/Hall Effect Sensors, 2 of 2	476
59.186 iPad Pro 12.9-inch (1st generation)	477
59.187 iPad Pro 12.9-inch (1st generation) with Cellular	478
59.188 iPad Pro 12.9-inch (1st generation) Magnet/Hall Effect Sensors, 1 of 2	479
59.189 iPad Pro 12.9-inch (1st generation) Magnet/Hall Effect Sensors, 2 of 2	480
59.190 iPad mini 4	481
59.191 iPad mini 4 with Cellular	482
59.192 iPad mini 4 Magnet/Hall Effect Sensors	483
59.193 iPad Air 2	484
59.194 iPad Air 2 with Cellular	485
59.195 iPad mini 2 and iPad mini 3	486
59.196 iPad mini 2 and iPad mini 3 with Cellular	487

59.197 iPad Air	488
59.198 iPad Air with Cellular	489
59.199 iPad mini	490
59.200 iPad mini with Cellular	491
59.201 iPad (4th generation)	492
59.202 iPad (4th generation) with Cellular	493
59.203 iPod touch (6th generation) and iPod touch (7th generation)	494
59.204 iPod touch (5th generation)	495
59.205 Apple Watch Series 10, 46 mm	496
59.206 Apple Watch Series 10, 42 mm	497
59.207 Apple Watch Ultra 2, 1 of 3	498
59.208 Apple Watch Ultra 2, 2 of 3	499
59.209 Apple Watch Ultra 2, 3 of 3	500
59.210 Apple Watch Series 9, 45 mm	501
59.211 Apple Watch Series 9, 41 mm	502
59.212 Apple Watch Ultra, 1 of 3	503
59.213 Apple Watch Ultra, 2 of 3	504
59.214 Apple Watch Ultra, 3 of 3	505
59.215 Apple Watch Series 8, 45 mm	506
59.216 Apple Watch Series 8, 41 mm	507
59.217 Apple Watch SE, 44 mm	508
59.218 Apple Watch SE, 40 mm	509
59.219 Apple Watch Series 7, 45 mm	510
59.220 Apple Watch Series 7, 41 mm	511
59.221 Apple Watch Series 6, 44 mm	512
59.222 Apple Watch Series 6, 40 mm	513
59.223 Apple Watch SE (1st generation), 44 mm	514
59.224 Apple Watch SE (1st generation), 40 mm	515
59.225 Apple Watch Series 5, 44 mm	516
59.226 Apple Watch Series 5, 40 mm	517
59.227 Apple Watch Series 5 Ceramic, 44 mm	518
59.228 Apple Watch Series 5 Ceramic, 40 mm	519
59.229 Apple Watch Series 4, 44 mm	520
59.230 Apple Watch Series 4, 40 mm	521
59.231 Apple Watch Series 3 Ceramic, 42 mm	522
59.232 Apple Watch Series 3 Ceramic, 38 mm	523
59.233 Apple Watch Series 3 Metal, 42 mm	524
59.234 Apple Watch Series 3 Metal, 38 mm	525
59.235 Apple Watch Series 2 Ceramic, 42 mm	526

59.236 Apple Watch Series 2 Ceramic, 38 mm	527	
59.237 Apple Watch Series 2 Metal, 42 mm	528	
59.238 Apple Watch Series 2 Metal, 38 mm	529	
59.239 Apple Watch (1st generation) and Apple Watch Series 1, 42 mm	530	
59.240 Apple Watch (1st generation) and Apple Watch Series 1, 38 mm	531	
59.241 Apple Vision Pro, 1 of 6	532	
59.242 Apple Vision Pro, 2 of 6	533	
59.243 Apple Vision Pro, 3 of 6	534	
59.244 Apple Vision Pro, 4 of 6	535	
59.245 Apple Vision Pro, 5 of 6	536	
59.246 Apple Vision Pro, 6 of 6	537	
59.247 Apple Vision Pro Battery	538	
59.248 Apple Vision Pro Audio Strap	539	
59.249 ZEISS Optical Inserts, 1 of 4	540	
59.250 ZEISS Optical Inserts, 2 of 4	541	
59.251 ZEISS Optical Inserts, 3 of 4	542	
59.252 ZEISS Optical Inserts, 4 of 4	543	
59.253 Wireless Charging Case (USB-C) for AirPods 4, 1 of 3	544	
59.254 Wireless Charging Case (USB-C) for AirPods 4, 2 of 3	545	
59.255 Wireless Charging Case (USB-C) for AirPods 4, 3 of 3	546	
59.256 AirPods 4	547	
59.257 MagSafe Charging Case (USB-C) for AirPods Pro (2nd generation), 1 of 3	548	
59.258 MagSafe Charging Case (USB-C) for AirPods Pro (2nd generation), 2 of 3	549	
59.259 MagSafe Charging Case (USB-C) for AirPods Pro (2nd generation), 3 of 3	550	
59.260 MagSafe Charging Case for AirPods Pro (2nd generation), 1 of 3	551	
59.261 MagSafe Charging Case for AirPods Pro (2nd generation), 2 of 3	552	
59.262 MagSafe Charging Case for AirPods Pro (2nd generation), 3 of 3	553	
59.263 AirPods Pro (2nd generation)	554	
59.264 MagSafe Charging Case for AirPods (3rd generation)	555	
59.265 AirPods (3rd generation)	556	
59.266 AirPods Max, 1 of 6	557	
59.267 AirPods Max, 2 of 6	558	
59.268 AirPods Max, 3 of 6	559	
59.269 AirPods Max, 4 of 6	560	
59.270 AirPods Max, 5 of 6	561	
59.271 AirPods Max, 6 of 6	562	
59.272 Wireless Charging Case for AirPods Pro (1st generation)	563	
59.273 AirPods Pro (1st generation)	564	
59.274 Wireless Charging Case for AirPods	565	

59.275 AirPods (1st generation) and AirPods (2nd generation)	566
59.276 Apple MagSafe Charger (1 m) and Apple MagSafe Charger (2 m)	567
59.277 Apple MagSafe Charger	568
59.278 AirTag	569
59.279 Apple TV 4K (3rd generation)	570
59.280 Siri Remote (3rd generation)	571
Revision History	572
Added Content	572
Updated Content	572

Overview

1. Introduction

Note:

These Accessory Design Guidelines for Apple Devices ('Guidelines') are subject to the terms and conditions set forth on the final page of this document. By downloading, accessing, or otherwise utilizing these Guidelines, you agree to be bound by, and only utilize the Guidelines in accordance with, such terms and conditions.

These guidelines address:

- Physical compatibility with iPhone, iPad, Apple Watch, AirPods, Apple TV, and Apple Vision Pro.
- Using USB-C to connect to iPhone, iPad, and AirPods.
- Using Bluetooth to connect to iPhone, iPad, Apple Watch, Apple TV, Apple Vision Pro, and Mac computers.
- AC power adapters and battery packs compatible with iPhone, iPad, and AirPods.
- Qi wireless transmitters compatible with iPhone and AirPods.

Some aspects of accessory interaction are not addressed in this document and may require access to the [Apple MFi Program](#) (page 26) and the [Accessory Interface Specification](#) (page 26).

2. Requirements

The use of the words *shall*, *shall not*, *required*, *prohibited*, *should*, *should not*, *recommended*, *not recommended*, *may*, *optional*, and *deprecated* in a statement have the following meanings:

- *shall*, or *required* means the statement is an absolute requirement.
- *shall not* or *prohibited* means the statement is an absolute prohibition.
- *should* or *recommended* means the full implications shall be understood before choosing a different course.
- *should not* or *not recommended* means the full implications shall be understood before choosing this course.
- *may* or *optional* means the statement is truly optional, and its presence or absence cannot be assumed.
- *deprecated* means the statement is provided for historical purposes only and is equivalent to 'shall not'.

3. Terminology

3.1 Device

Device refers to an iPhone, iPad, or iPod.

iOS device refers to an iPhone or iPod running iOS.

iPadOS device refers to an iPad running iPadOS.

watchOS device refers to an Apple Watch running watchOS.

tvOS device refers to an Apple TV running tvOS.

Where appropriate, specific Apple product and operating system references will also be used.

3.2 Accessory

Accessory refers to any product connecting to a *device* using the interfaces described in this specification.

3.3 Component

A *component* is a functional unit or a constituent part of an accessory. Components inter-connect and function as a part of a greater system. Examples include:

- Integrated circuits, micro-processors, flash memory, microphones, and speakers.
- Data transport interface, such as a Lightning connector, USB connector, or Bluetooth radio.
- Power sources, such as a battery or power supply.
- Human Interface Device (HID) [Control Surface](#) (page 25), such as a play/pause button.

A *component* may also refer to a group or collection, such as the keyboard portion of a keyboard/trackpad accessory.

3.4 Control Surface

A *control surface* is a human interface device (HID) component enabling user interaction with an accessory. Examples include:

- Connectors
- Buttons
- Switches
- Rotary knobs
- Joysticks
- Touchscreens or touch-sensitive surfaces
- Microphones
- Motion/presence sensors

References to specific types of control surfaces such as buttons or switches are only applicable to those control surface types. If a requirement calls for a physical button to be implemented, a physical button shall be present.

3.5 Direct User Action

A *direct user action* is defined as user interaction with an accessory using a [Control Surface](#) (page 25).

Examples include:

- Physical gestures, such as:
 - Attaching an accessory to a device.
 - Pressing a button.
 - Actuating a switch.
 - Turning a knob.
 - Interacting with a touchscreen.
 - Waving a hand.
 - Moving in/out of range (for wireless accessories).
- Voice input.

Accessories shall not autonomously perform user inputs unless explicitly authorized by the user.

3.6 Built-In Cable

A *built-in cable* is a cable with one end permanently attached to the accessory enclosure.

3.7 Apple MFi Program

The Apple MFi Program provides access to specifications, components, connectors, and other resources to create accessories capable of communicating with devices.

See <https://mfi.apple.com> for more information.

3.8 Accessory Interface Specification

The *Accessory Interface Specification* is available through the [Apple MFi Program](#) (page 26).

Use of some features requires accessory developers to be a member of the program and to integrate specific MFi hardware into the accessory.

Accessories

4. All Accessories

Requirements in this section apply to all accessories regardless of their supported features.

4.1 Scratches and Damage

Accessories shall not scratch or damage any device.

Accessories with abrasive surfaces and sharp edges (such as hard plastic, metal, or glass) shall not contact the active area of the device display.

4.2 Compliance Testing

Accessories shall not assume evidence of functionality when attached to a device means the accessory is specification compliant. Such an approach does not account for future devices or software releases, and runs a high risk of dependence on un-documented device behavior which is subject to change at any time.

If available, accessories should validate their design and implementation using the recommended test procedures for all supported features.

4.3 USB-B Receptacles

Accessories integrating USB-B receptacles shall comply with *USB Battery Charging Specification –Release 1.2*.

4.4 User Supplied Cables and AC Power Adapters

Accessories intended for use with user-supplied cables and/or AC power adapters shall be designed to work with any cables, [AC Power Adapters](#) (page 84), or [Battery Packs](#) (page 87) compliant with this specification, including Apple branded cables and AC power adapters. Such accessories shall not declare compatibility with only Apple branded USB cables or AC power adapters.

4. All Accessories

4.5 TDMA Noise

This compatibility requirement applies to all aspects of user-supplied cables and power adapters. For example:

- Connector receptacles on accessories shall accommodate all specification-compliant connector overmolds, and any accessory opening surrounding the device receptacle shall provide sufficient clearance for specification-compliant connector overmolds.
- Accessories shall work with all specification-compliant cables in regards to electrical DCR and SI.

Such accessories shall be tested with a wide variety of specification-compliant cables (including various lengths of the same cable if applicable) and AC power adapters during accessory development, in addition to Apple branded cables and AC power adapters.

4.5 TDMA Noise

GSM phones emit radiated and conducted RF noise, which can produce time division multiple access (TDMA) sounds from audio outputs. Accessories shall minimize coupling of audible interference from the device (commonly known as *TDMA noise* or *chopper noise*) into an accessory's electronics.

4.6 Attachments

Accessories shall remain compliant with the specification when connected to any attachments designed for the accessory.

Examples of accessory attachments include, but are not limited to:

- Car or desk mounts for a case.
- Wireless charging mats for a dongle or case.
- Detachable barcode scanners/credit card readers for a dock.

4.7 Magnetic Interference

Unless otherwise specified, Apple recommends avoiding the use of magnets and metal components in accessories.

Accessories claiming compatibility with a device with a digital compass (magnetometer) shall minimize interference with the digital compass and shall not repeatedly trigger compass recalibration.

Accessories claiming compatibility with a device with autofocus (AF) and/or optical image stabilization (OIS) shall not affect the operation of those features.

Devices featuring optical image stabilization:

4. All Accessories

4.7 Magnetic Interference

- iPhone 16 Pro Max
- iPhone 16 Pro
- iPhone 16 Plus
- iPhone 16
- iPhone 15 Pro Max
- iPhone 15 Pro
- iPhone 15 Plus
- iPhone 15
- iPhone 14 Pro Max
- iPhone 14 Pro
- iPhone 14 Plus
- iPhone 14
- iPhone SE (3rd generation)
- iPhone 13 Pro Max
- iPhone 13 Pro
- iPhone 13
- iPhone 13 mini
- iPhone 12 Pro Max
- iPhone 12 Pro
- iPhone 12
- iPhone 12 mini
- iPhone SE (2nd generation)
- iPhone 11 Pro Max
- iPhone 11 Pro
- iPhone 11
- iPhone XS Max
- iPhone XS
- iPhone XR
- iPhone X
- iPhone 8 Plus
- iPhone 8
- iPhone 7 Plus
- iPhone 7
- iPhone 6s Plus
- iPhone 6 Plus
- iPad Pro 12.9-inch (2nd generation)
- iPad Pro 10.5-inch

4.8 Radio Frequency (RF) Performance

This section contains RF performance requirements and recommendations for accessories.

4.8.1 Materials and Coatings

Accessories should avoid use of:

- Metals
- Conductive materials or coatings
- Materials with high dielectric (permittivity >5 F/m)

Such materials absorb radio frequency energy and may impair or degrade the performance of antennas for cellular communication, GPS, Wi-Fi, Bluetooth, and NFC.

Examples include, but are not limited to:

- Steel, aluminum, magnesium, titanium, etc.
- Plastics with any carbon content, glass content, or metallic plating
- Metallic paints
- Black paints with high carbon loading
- White paints with high titanium dioxide loading
- Metallic Physical Vapor Deposition (PVD) coatings

4.8.2 Antenna Keep-Out

Antenna keep-out regions can be found in [Device Dimensional Drawings](#) (page 284).

Accessory [Materials and Coatings](#) (page 31) which absorb radio frequency energy located in the antenna keep-out region have a higher risk of degrading device's wireless performance.

4.8.3 Over The Air (OTA) Transmission/Reception

Accessories shall not excessively degrade device's RF transmission efficiency. This can be quantified by measuring Total Radiated Power (TRP) across all of the device's operating bands.

Accessories shall not excessively degrade device's RF reception sensitivity. This can be quantified by measuring Effective Isotropic Sensitivity (EIS) across all of the device's operating bands.

Accessories may have a higher risk of excessively degrading device's RF performance if they:

- Contain magnets.
- Intrude on device [Antenna Keep-Out](#) (page 31) zones.
- Contain active electronic circuitry, such as:
 - Bluetooth radios.
 - Switched-mode power supplies.

4. All Accessories

4.8 Radio Frequency (RF) Performance

- High speed data interfaces.

Accessory configurations shall be taken into account when designing for maximum RF compatibility.

Examples include, but are not limited to:

- Accessory on/off.
- Accessory open/closed.
- [Attachments](#) (page 29) present/not present.

Good design practices shall be followed to minimize emissions and maximize RF compatibility. These include, but are not limited to:

- Shielding digital circuitry and clock signals.
- Minimizing radiation from digital interfaces.
- Decoupling high frequency signals and power supplies.
- Filtering off-board signals.
- Maintaining ground plane circuit board integrity.
- Minimizing current loop areas.
- Ensuring proper cable shielding terminations.

4.8.4 Specific Absorption Rate (SAR)

A list of labs performing SAR testing with devices is available through the [Apple MFi Program](#) (page 26).

4.8.5 Near Field Communication (NFC)

Accessories shall not degrade device's NFC transaction performance.

Accessories may have a higher risk of degrading device's NFC transaction performance if they intrude on device [Antenna Keep-Out](#) (page 31) zones.

Devices featuring NFC:

- iPhone 16 Pro Max
- iPhone 16 Pro
- iPhone 16 Plus
- iPhone 16
- iPhone 15 Pro Max
- iPhone 15 Pro
- iPhone 15 Plus
- iPhone 15
- iPhone 14 Pro Max
- iPhone 14 Pro
- iPhone 14 Plus

4. All Accessories

4.9 Thermal Management

- iPhone 14
- iPhone SE (3rd generation)
- iPhone 13 Pro Max
- iPhone 13 Pro
- iPhone 13
- iPhone 13 mini
- iPhone 12 Pro Max
- iPhone 12 Pro
- iPhone 12
- iPhone 12 mini
- iPhone SE (2nd generation)
- iPhone 11 Pro Max
- iPhone 11 Pro
- iPhone 11
- iPhone XS Max
- iPhone XS
- iPhone XR
- iPhone X
- iPhone 8 Plus
- iPhone 8
- iPhone 7 Plus
- iPhone 7
- iPhone SE
- iPhone 6s Plus
- iPhone 6s
- iPhone 6 Plus
- iPhone 6

4.9 Thermal Management

The accessory's supported temperature range shall be greater than or equal to the published temperature ranges of every device the accessory claims compatibility with.

4.10 Tripod Connections

Tripod connections shall comply with *ISO 1222:2010, Photography — Tripod connections*, see <https://www.iso.org/standard/55918.html>.

4.11 Anthropometric Considerations

Children and people with smaller hands (5th percentile), as well as people with larger hands (95th percentile) should all be considered during the accessory design process.

Apple recommends using design resources such as:

- AnthroKids (<https://math.nist.gov/~Sressler/anthrokids/>).
- U.S. Army Anthropometry Survey (<http://mreed.umtri.umich.edu/mreed/downloads.html#ansur2>).
- Civilian American and European Surface Anthropometry Resource (CAESAR).

5. Cases

Cases are accessories substantially enclosing devices.

Accessories substantially enclosing devices shall comply with the requirements stated in this chapter unless the accessory supports other features in this specification whose requirements conflict with the requirements in this chapter.

The requirements shall be applied to each component separately for cases with multiple user-detachable components substantially enclosing the device.

5.1 Product Design

A well-designed case will securely house a device without interfering with the device's operation. Significant factors in mechanical design include access to the device's sensors, controls, and connectors. See [Device Dimensional Drawings](#) (page 284).

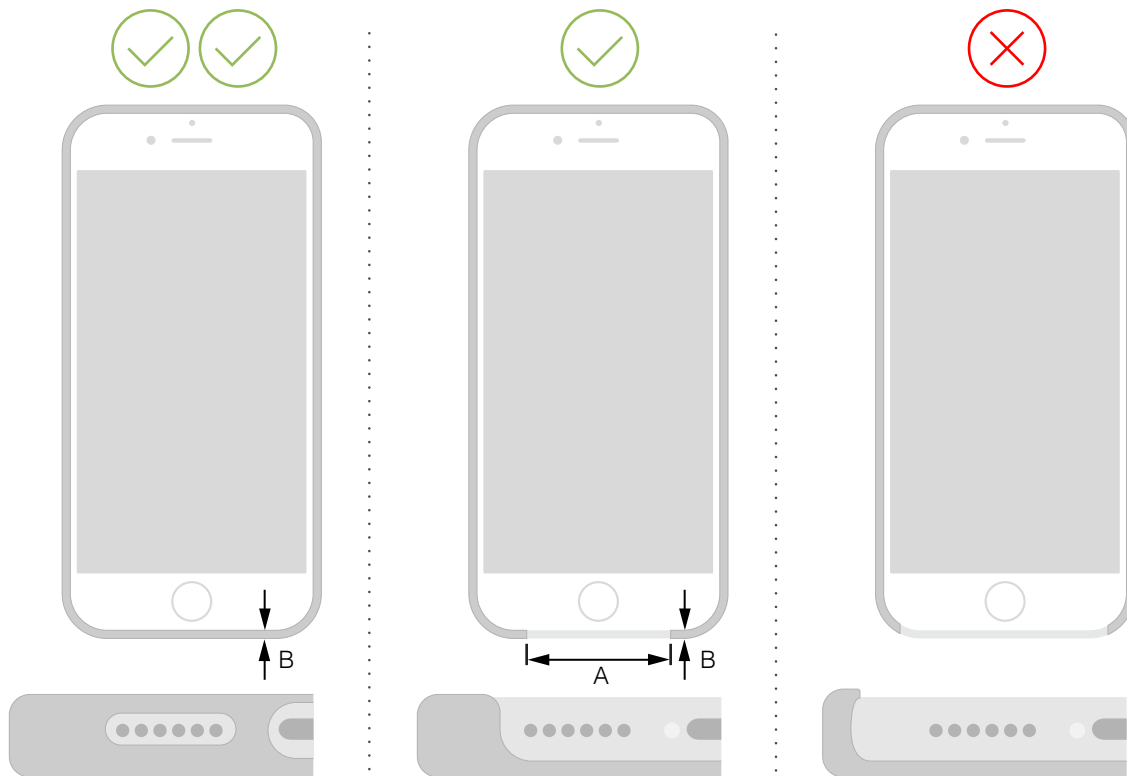
5.1.1 Device Protection

Cases shall protect the device from a 1 m drop onto a hard paved surface in any orientation.

Exposed glass on the device shall not come within 0.85 mm of a flat surface, such as a table or floor, in any orientation when the case is attached. Ideally the glass should not come within 1.00 mm. Device protection should be achieved by creating features around the exposed glass to keep it away from the flat surface.

Care should be given to the design of the bottom of the case to achieve both device protection and provide access to device speakers, microphones, and connectors. For example, the bottom of iPhone X cases should:

- Not have an opening wider than 50 mm, see dimension 'A' in [Figure 5-1](#) (page 36).
- Be made of polycarbonate (PC) at least 1.15 mm thick, see dimension 'B' in [Figure 5-1](#) (page 36).

Figure 5-1 Device protection

5.1.2 Access to Inputs and Interconnects

Cases shall readily permit user access to inputs and interconnects.

5.1.2.1 Access to Controls

Cases shall readily permit user access and operation of the device's mechanical controls, such as:

- Volume buttons.
- Camera Control.
- Side/Top button.
- Action button.
- Ring/Silent switch.
- Home button.
- Touch ID sensor.

5.1.2.2 Access to the Camera Control

This section applies to cases for devices with a Camera Control.

The case shall accommodate the following gestures across the entire surface of the Camera Control:

5. Cases

5.1 Product Design

- Click.
- Light press.
- Slide.
- Swipe.

The case shall either:

- Have a keep-out defined in the [Device Dimensional Drawings](#) (page 284).
- Integrate a [Camera Control Case Interface](#) (page 37).

The keep-out shall be designed to accommodate various:

- Grip styles, including:
 - Portrait mode, when held with either the right hand or left hand.
 - Landscape mode, with the Camera Control at the top, when held with either one hand or two hands.
- Hand sizes, see [Anthropometric Considerations](#) (page 34).
- Finger nail lengths, including nails extending beyond the tip of the finger.

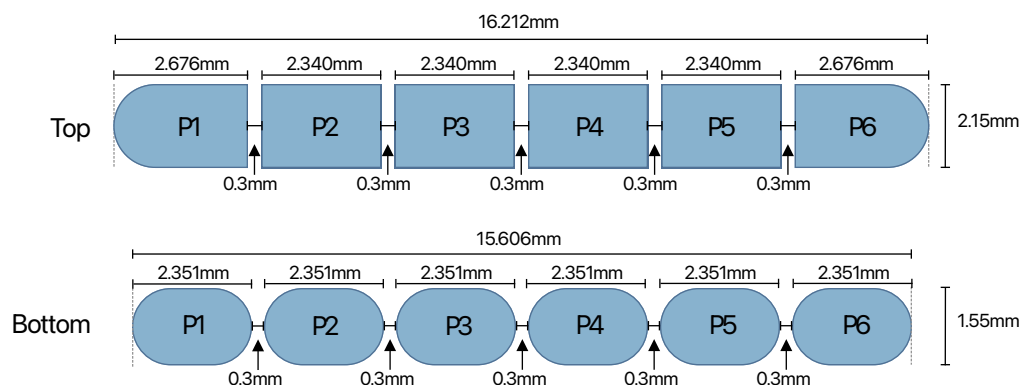
5.1.2.2.1 Camera Control Case Interface

Cases may integrate their own Camera Control case interface.

A Camera Control case interface shall have a:

- Bottom layer consisting of 6 copper pads connecting to the Camera Control, see [Figure 5-2](#) (page 37).
- Top layer consisting of 6 copper pads, see [Figure 5-2](#) (page 37).
- PCB-like material to connect the bottom and top layers and to achieve proper thickness for the case design.

Figure 5-2 Camera Control case interface top and bottom layers



Camera Control case interface shall:

- Have a top cap, such as a sapphire crystal.
- Have a flatness of less than 25 μm where it makes contact with the Camera Control.
- Have a tilt of less than 160 μm in all directions.
- Have a static (no user contact) misalignment center to center along:
 - The width of the Camera Control of less than 160 μm .
 - The length of the Camera Control of less than 190 μm .
- Have a dynamic (user contact) misalignment center to center in all directions of less than 130 μm .
- Have a maximum stiffness of 180 gf/mm.
 - Target stiffness should be 90 gf/mm throughout its range of travel.
- Be designed to maintain contact with the Camera Control across all copper pads and shall:
 - Have a case applied force (preload) of 45 gf or less at maximum button offset.
 - Not trigger a light press when the area around the Camera Control is squeezed up to 1050 gf.
 - Not have an air gap greater than 50 μm to the Camera Control. Apple recommends no air gap.
- Have a capacitance greater than 0.362 pF for pads P1 and P6.
- Have a capacitance greater than 0.432 pF for pads P2, P3, P4, and P5.
- Have a sheet resistance for inks and coatings greater than 50 G- Ω /sq.

5.1.2.2.2 User Study

A user study evaluating the usability of the Camera Control by end users shall be completed. The study population shall include:

- Various hand sizes as defined in [Anthropometric Considerations](#) (page 34).
- Various finger shapes, taking into account:
 - Taper.
 - Flatness.
- Various finger nail lengths:
 - Shorter than the fingertip.
 - At the fingertip.
 - Slightly longer than the fingertip.
 - Much longer than the fingertip.

The user study shall be performed using the [Gestures](#) (page 69) portion of the [Camera Control](#) (page 69) test.

5.1.2.3 Access to the USB-C Connector

Cases shall provide easy access to a device's USB-C connector, if present.

The USB-C receptacle keep-out:

- Shall be at least 12.35 mm by 6.50 mm.

5. Cases

5.1 Product Design

- Should be at least 12.45 mm by 6.60 mm with full radii rounded edges for the greatest compatibility with the widest variety of cables and docks, see [USB-C receptacle accessory keep-out](#) (page 277).

USB-C connector openings shall be designed with enough margin to compensate for shifting or dimensional changes of the case material.

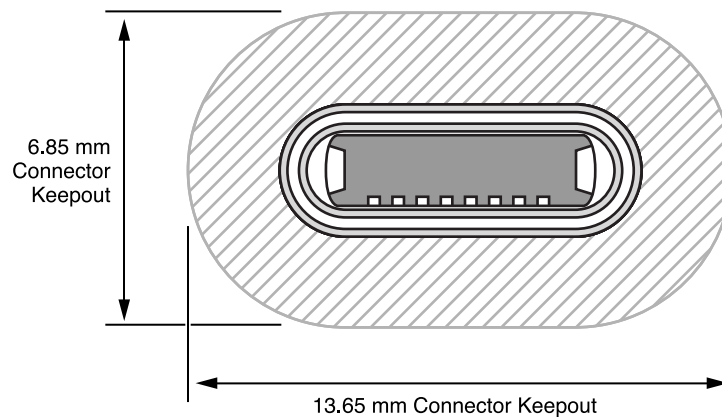
5.1.2.4 Access to the Lightning Connector

Cases shall provide easy access to a device's Lightning connector, if present.

The Lightning receptacle keep-out:

- Shall be at least 12.05 mm by 6.30 mm with full radii rounded edges.
- Should be at least 13.65 mm by 6.85 mm for the greatest compatibility with the widest variety of cables and docks, see [Figure 5-3](#) (page 39).

Figure 5-3 Lightning Receptacle (C37) keep-out



Lightning connector openings shall be designed with enough margin to compensate for shifting or dimensional changes of the case material.

5.1.2.5 Access to the Headset Jack

Cases shall provide easy access to a device's headset jack, if present.

The headset jack keep-out:

- Shall be at least 6.0 mm in diameter and at most 14.0 mm deep.
- Should be at least 6.5 mm in diameter and at most 10.0 mm deep for the best compatibility with a range of headsets.

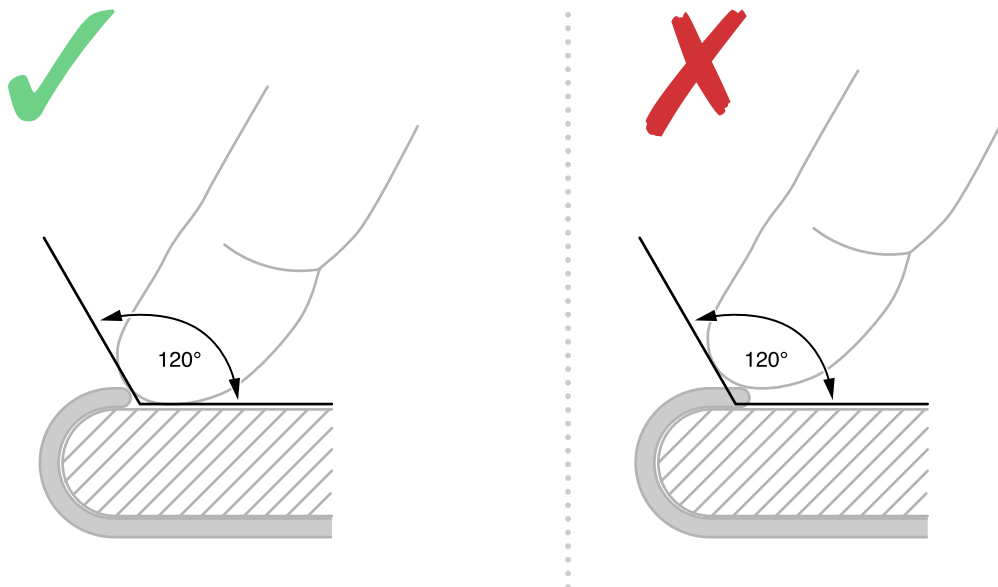
Headset jack openings shall be designed with enough margin to compensate for shifting or dimensional changes of the case material.

5.1.2.6 Touchscreen

Cases should not have any edges trapping water on the touchscreen when the device is held at a 30° angle relative to the horizon.

Cases shall allow a 120° opening, see [Figure 5-4](#) (page 40), along the edges of a touchscreen's active area to ensure compatibility with touchscreen features. See [Device Dimensional Drawings](#) (page 284) for active areas.

Figure 5-4 Touchscreen keep-out angle



5.1.2.7 Edge Swipe Gestures

Users shall be able to easily use edge swipe gestures.

Examples of such gestures include, but are not limited to:

- Swipe in from the top edge for Control Center or Notification Center.
- Swipe in from the bottom edge for Home, App Switcher, or Reachability.
- Swipe in from the left edge in Messages or Mail to go back from a conversation.

5.1.2.8 Cover Glass Contact

Cases should not contact the cover glass of:

5. Cases

5.2 Acoustics

- iPhone SE (3rd generation)
- iPhone SE (2nd generation)
- iPhone 11 Pro Max
- iPhone 11 Pro
- iPhone 11
- iPhone XS Max
- iPhone XS
- iPhone XR
- iPhone X
- iPhone 8 Plus
- iPhone 8
- iPhone 7 Plus
- iPhone 7
- iPhone 6s Plus
- iPhone 6s
- iPhone 6 Plus
- iPhone 6

5.1.3 Dock Compatibility

The distance from bottom of the device to the outside of a case should not exceed 1.8 mm for compatibility with docks.

5.1.4 Wireless Power

Cases claiming compatibility with MagSafe or Qi wireless power 2.0 or later, see [Device Power \(Inductive\)](#) (page 154), shall:

- Integrate a [MagSafe Case Magnet Array](#) (page 166).
- Not have rear pockets or holders for credit cards, RFID cards, or other similar items. Cards may be damaged and/or impact wireless charging performance.

5.2 Acoustics

Cases shall not impair or degrade the acoustic performance of a device.

5.2.1 Call Quality

Cases shall not impair or degrade the user experience making and receiving audio calls over a cellular network or audio/video calls using FaceTime in both handset and speakerphone modes. Cases should not change the frequency response of the speakers or microphones. In addition, the user should not hear any distortion or echo resulting from using the case.

Cases shall not obstruct any microphones during a phone call. Occluding microphones can result in call quality degradation.

5.2.2 Speaker to Microphone Coupling

Cases shall not facilitate the conduction of sound from any speaker to any microphone. Such sound conduction may cause echoing in phone calls.

5.2.3 Speaker/Microphone Openings

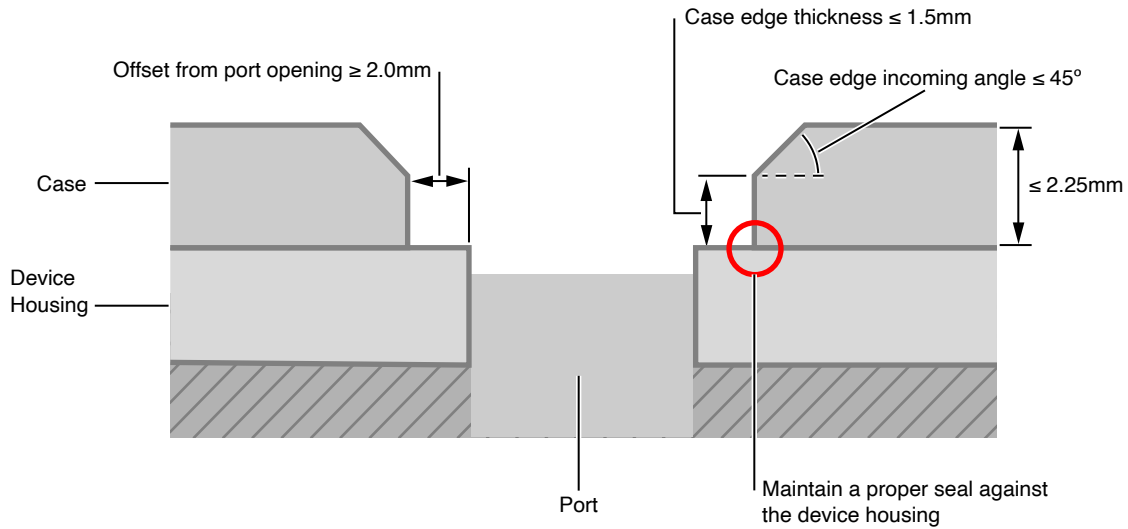
Device speaker/microphone port locations vary from model to model, see [Device Dimensional Drawings](#) (page 284).

5.2.3.1 Thin Cases (≤ 2.25 mm)

Microphone/speaker openings in thin cases should:

- Be offset at least 2.0 mm from the edge of any device speaker/microphone port.
- Be at most 1.5 mm thick along their inner diameter.
- Have a maximum 45° incoming angle to their inner diameter.
- Maintain a proper seal against the device between speaker/microphone ports.

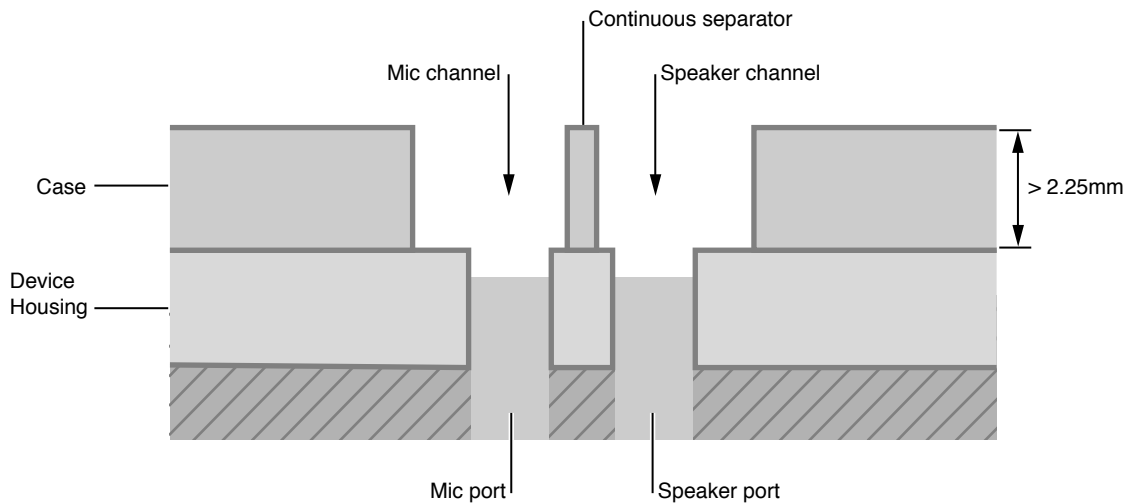
Figure 5-5 Microphone/speaker opening recommendations for thin cases



5.2.3.2 Thick Cases (>2.25 mm)

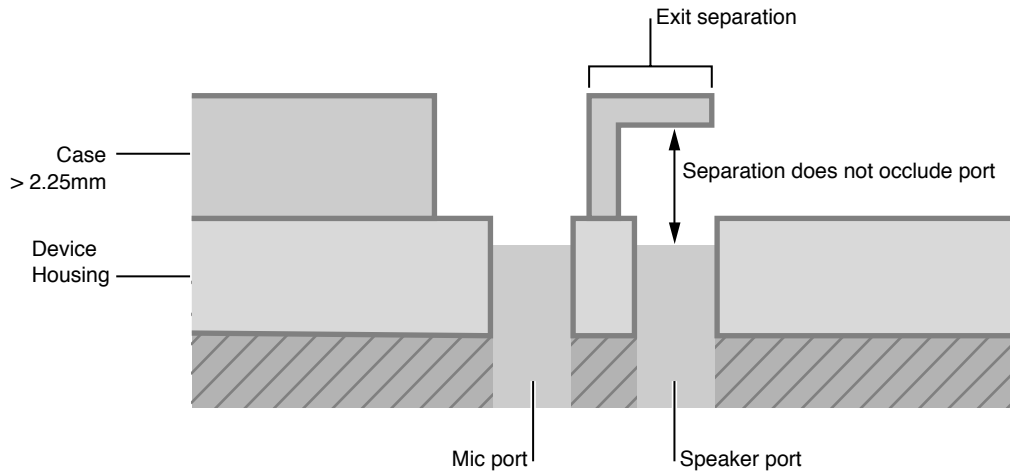
Speaker and microphone openings should be channeled independently and without interruption to/from the outside surface of a thick case.

Figure 5-6 Thick case acoustic channels



Thick cases should maximize exit separation between speaker and microphone channels.

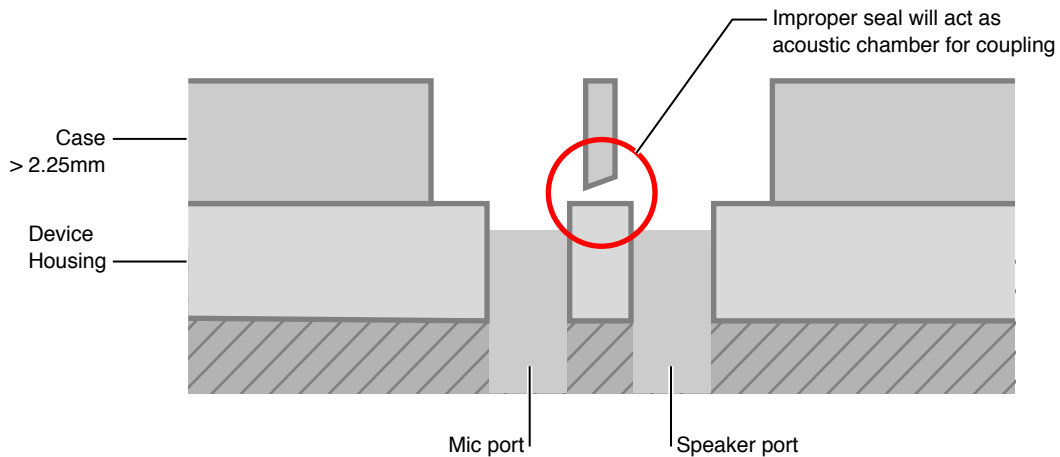
Figure 5-7 Thick case microphone and speaker exit separation



Thick case channels may act as a resonance chamber and detune microphone/speaker frequency response. The resulting frequency response may vary according to channel size/shape.

If a thick case does not maintain a proper seal against the device between microphone/speaker channels, the case itself may become an acoustic chamber.

Figure 5-8 Improper thick case seal



5.3 Ambient Light Sensor and Proximity Sensor

Ambient light sensor and proximity sensor locations for various devices are illustrated in the [Device Dimensional Drawings](#) (page 284). Some drawings indicate sensor keep-out areas.

5.4 Haptics

Cases should not cause a substantial change in the feel of the device's haptic feedback.

5.5 Magnetic Interference

Cases shall not interfere with the device's:

- Magnetic compass.
- Rear camera autofocus (AF).
- Rear camera optical image stabilization (OIS), if present.
- Front camera autofocus, if present.

See [Magnetic Interference](#) (page 29) for additional details.

5.6 Touch ID

Cases shall not inhibit use of the device's Touch ID sensor. Touch ID sensor keep-outs are indicated in the [Device Dimensional Drawings](#) (page 284).

Cases overlaying the sensor may cause users to have difficulty using Touch ID.

5.7 Camera

The camera field of view (FOV) and the illumination provided by the flash are designed for each device's camera. It is exceptionally important manufacturers consult [Device Dimensional Drawings](#) (page 284) for each device, and shall not assume any parameters are shared between devices.

Images from the camera may be affected by the geometry, color, and surface finish of the case, particularly when using a flash. Camera opening trim should be designed to avoid reflecting light into the camera.

5.7.1 Geometry

The camera lens FOV shall not be blocked. Making opening dimensions too small around the camera and flash may block the lens FOV and the illumination from the flash. Blocking the FOV may cause vignetting in the image, where one or more corners of the image are darker than the center. Blocking marginal rays just outside the lens FOV may also reduce the sharpness and contrast of the image. Blocking flash illumination may cause haze in the image, resulting in reduced contrast. See [Device Dimensional Drawings](#) (page 284) for camera keep-outs.

Case openings shall not be designed in a manner directing stray light into the camera lens. If the opening is too narrow or too steep, it may reflect light into the camera lens washing out the image or adding unwanted color casting. Adding a chamfer to the opening trim near the camera may help direct stray light away from the camera lens. When the device includes a flash, a narrow or steep opening may reflect light from the camera and flash opening back into the camera lens. This may cause images to appear washed out or cause unwanted artifacts. Designers should also ensure mechanical keep-outs as outlined in the [Device Dimensional Drawings](#) (page 284) are maintained with worst-case X-Y placement tolerances to minimize the risk of image haze.

5.7.2 Color

Light reflected from a case may carry the color of the case. Black material or black coatings may help avoid color bleeding into the camera lens from an external light source or the flash. The darker the color the less likely light from a flash or external source may be reflected off the case and into the camera lens. Apple recommends a semi-gloss black material or coating around the camera and flash openings.

5.7.3 Surface Finish

Matte or diffuse materials scatter light in all directions increasing the likelihood light from the flash or other strong light sources may be reflected into camera lenses. Semi-gloss materials may direct light away from the camera lens.

5.7.4 Image Degradation Examples

Figure 5-9 Sample image degradation by image blocking in an ambient condition

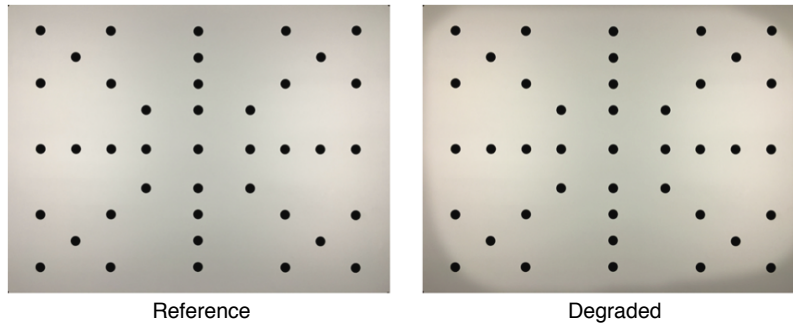


Figure 5-10 Sample image degradation by color shift through accessory with strong color

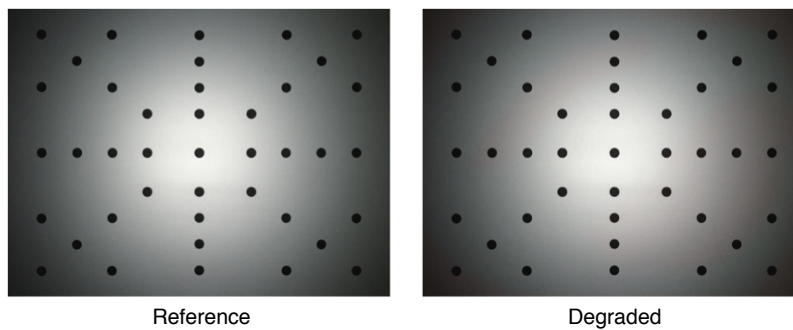
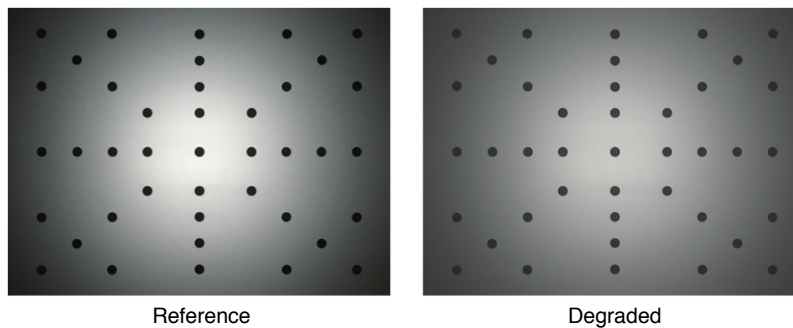


Figure 5-11 Sample image degradation by flash interference



5.8 Reliability

Cases shall be tested to verify they will withstand long-term use under typical use conditions, and will not impair, functionally degrade a device, cause [Scratches and Damage](#) (page 28) to the device or its immediate surroundings, or adversely affect the user.

5.8.1 Device Insertion and Removal

Cases shall hold the device securely while permitting easy insertion and removal. A case shall not cause [Scratches and Damage](#) (page 28) to the device by the repeated insertion and removal of the device from the case under conditions representative of long-term use in a variety of environments.

5.8.2 Colorfastness

Dyes, inks, or coatings in or on the case shall not transfer or bleed color onto either the device or user, particularly while the case is in contact with common substances such as water, hand sanitizer, sunscreen or lotions.

5.9 Environmental

Cases shall comply with applicable environmental regulations for the regions in which such accessories are to be sold, as well as applicable substance or material restrictions including:

- Organic tin compounds, PFOS, PFOA, phthalates, azo dyes, polybrominated biphenyls (PBBs) and PAHs, per requirements of the EU REACH regulation EC 1907/2006.
- Nickel leach rate on surfaces in prolonged skin contact, per requirements of the EU REACH regulation EC 1907/2006.
- Cadmium, lead, hexavalent chromium, and nickel, per requirements of EU Directive 2009/48/EC.
- Natural rubber latex, per requirements of EU Directive EC 93/42/EEC.
- Dimethylfumarate (DMFu), per requirements of EU Regulation 412/2012.
- pH and Formaldehyde, per requirements of China GB 18401 for textiles and China GB 20400 for leather.
- Endangered species of flora and fauna in products or packaging (US Lacey Act).
- Polybrominated diphenyl ethers (PBDE).
- Compliance with California proposition 65, as applicable.

5.10 Verification

5.10.1 Device Models

Case testing procedures vary depending on the device they enclose.

5.10.1.1 iPhone 16 Pro Max

Table 5-1 iPhone 16 Pro Max case testing matrix

Test	Using	Notes
Product Design (page 67)	iPhone 16 Pro Max	
Camera Control (page 69)	iPhone 16 Pro Max	
Haptics (page 69)	iPhone 16 Pro Max	
Autofocus & Optical Image Stabilization (page 71)	iPhone 16 Pro Max	
Near-Field Communication (NFC) (page 72)	iPhone 16 Pro Max	
Acoustics (page 74)	iPhone 16 Pro Max	
MagSafe Case Magnet Array (page 181)	iPhone 16 Pro Max	Cases supporting MagSafe only.

5.10.1.2 iPhone 16 Pro

Table 5-2 iPhone 16 Pro case testing matrix

Test	Using	Notes
Product Design (page 67)	iPhone 16 Pro	
Camera Control (page 69)	iPhone 16 Pro	
Haptics (page 69)	iPhone 16 Pro	
Autofocus & Optical Image Stabilization (page 71)	iPhone 16 Pro	
Near-Field Communication (NFC) (page 72)	iPhone 16 Pro	
Acoustics (page 74)	iPhone 16 Pro	
MagSafe Case Magnet Array (page 181)	iPhone 16 Pro	Cases supporting MagSafe only.

5.10.1.3 iPhone 16 Plus

Table 5-3 iPhone 16 Plus case testing matrix

Test	Using	Notes
Product Design (page 67)	iPhone 16 Plus	
Camera Control (page 69)	iPhone 16 Plus	

5. Cases

5.10 Verification

Test	Using	Notes
Haptics (page 69)	iPhone 16 Plus	
Autofocus & Optical Image Stabilization (page 71)	iPhone 16 Plus	
Near-Field Communication (NFC) (page 72)	iPhone 16 Plus	
Acoustics (page 74)	iPhone 16 Plus	
MagSafe Case Magnet Array (page 181)	iPhone 16 Plus	Cases supporting MagSafe only.

5.10.1.4 iPhone 16

Table 5-4 iPhone 16 case testing matrix

Test	Using	Notes
Product Design (page 67)	iPhone 16	
Camera Control (page 69)	iPhone 16	
Haptics (page 69)	iPhone 16	
Autofocus & Optical Image Stabilization (page 71)	iPhone 16	
Near-Field Communication (NFC) (page 72)	iPhone 16	
Acoustics (page 74)	iPhone 16	
MagSafe Case Magnet Array (page 181)	iPhone 16	Cases supporting MagSafe only.

5.10.1.5 iPhone 15 Pro Max

Table 5-5 iPhone 15 Pro Max case testing matrix

Test	Using	Notes
Product Design (page 67)	iPhone 15 Pro Max	
Haptics (page 69)	iPhone 15 Pro Max	
Autofocus & Optical Image Stabilization (page 71)	iPhone 15 Pro Max	
Near-Field Communication (NFC) (page 72)	iPhone 15 Pro Max	
Acoustics (page 74)	iPhone 15 Pro Max	
MagSafe Case Magnet Array (page 181)	iPhone 15 Pro Max	Cases supporting MagSafe only.

5.10.1.6 iPhone 15 Pro

Table 5-6 iPhone 15 Pro case testing matrix

Test	Using	Notes
Product Design (page 67)	iPhone 15 Pro	
Haptics (page 69)	iPhone 15 Pro	

5. Cases

5.10 Verification

Test	Using	Notes
Autofocus & Optical Image Stabilization (page 71)	iPhone 15 Pro	
Near-Field Communication (NFC) (page 72)	iPhone 15 Pro	
Acoustics (page 74)	iPhone 15 Pro	
MagSafe Case Magnet Array (page 181)	iPhone 15 Pro	Cases supporting MagSafe only.

5.10.1.7 iPhone 15 Plus

Table 5-7 iPhone 15 Plus case testing matrix

Test	Using	Notes
Product Design (page 67)	iPhone 15 Plus	
Haptics (page 69)	iPhone 15 Plus	
Autofocus & Optical Image Stabilization (page 71)	iPhone 15 Plus	
Near-Field Communication (NFC) (page 72)	iPhone 15 Plus	
Acoustics (page 74)	iPhone 15 Plus	
MagSafe Case Magnet Array (page 181)	iPhone 15 Plus	Cases supporting MagSafe only.

5.10.1.8 iPhone 15

Table 5-8 iPhone 15 case testing matrix

Test	Using	Notes
Product Design (page 67)	iPhone 15	
Haptics (page 69)	iPhone 15	
Autofocus & Optical Image Stabilization (page 71)	iPhone 15	
Near-Field Communication (NFC) (page 72)	iPhone 15	
Acoustics (page 74)	iPhone 15	
MagSafe Case Magnet Array (page 181)	iPhone 15	Cases supporting MagSafe only.

5.10.1.9 iPhone 14 Pro Max

Table 5-9 iPhone 14 Pro Max case testing matrix

Test	Using	Notes
Product Design (page 67)	iPhone 14 Pro Max	
Haptics (page 69)	iPhone 14 Pro Max	
Autofocus & Optical Image Stabilization (page 71)	iPhone 14 Pro Max	
Near-Field Communication (NFC) (page 72)	iPhone 14 Pro Max	

5. Cases

5.10 Verification

Test	Using	Notes
Acoustics (page 74)	iPhone 14 Pro Max	
MagSafe Case Magnet Array (page 181)	iPhone 14 Pro Max	Cases supporting MagSafe only.

5.10.1.10 iPhone 14 Pro

Table iPhone 14 Pro case testing matrix
5-10

Test	Using	Notes
Product Design (page 67)	iPhone 14 Pro	
Haptics (page 69)	iPhone 14 Pro	
Autofocus & Optical Image Stabilization (page 71)	iPhone 14 Pro	
Near-Field Communication (NFC) (page 72)	iPhone 14 Pro	
Acoustics (page 74)	iPhone 14 Pro	
MagSafe Case Magnet Array (page 181)	iPhone 14 Pro	Cases supporting MagSafe only.

5.10.1.11 iPhone 14 Plus

Table iPhone 14 Plus case testing matrix
5-11

Test	Using	Notes
Product Design (page 67)	iPhone 14 Plus	
Haptics (page 69)	iPhone 14 Plus	
Autofocus & Optical Image Stabilization (page 71)	iPhone 14 Plus	
Near-Field Communication (NFC) (page 72)	iPhone 14 Plus	
Acoustics (page 74)	iPhone 14 Plus	
MagSafe Case Magnet Array (page 181)	iPhone 14 Plus	Cases supporting MagSafe only.

5.10.1.12 iPhone 14

Table iPhone 14 case testing matrix
5-12

Test	Using	Notes
Product Design (page 67)	iPhone 14	
Haptics (page 69)	iPhone 14	
Autofocus & Optical Image Stabilization (page 71)	iPhone 14	
Near-Field Communication (NFC) (page 72)	iPhone 14	

5. Cases

5.10 Verification

Test	Using	Notes
Acoustics (page 74)	iPhone 14	
MagSafe Case Magnet Array (page 181)	iPhone 14	Cases supporting MagSafe only.

5.10.1.13 iPhone 13 Pro Max

Table iPhone 13 Pro Max case testing matrix
5-13

Test	Using	Notes
Product Design (page 67)	iPhone 13 Pro Max	
Haptics (page 69)	iPhone 13 Pro Max	
Autofocus & Optical Image Stabilization (page 71)	iPhone 13 Pro Max	
Near-Field Communication (NFC) (page 72)	iPhone 13 Pro Max	
Acoustics (page 74)	iPhone 13 Pro Max	
MagSafe Case Magnet Array (page 181)	iPhone 13 Pro Max	Cases supporting MagSafe only.

5.10.1.14 iPhone 13 Pro

Table iPhone 13 Pro case testing matrix
5-14

Test	Using	Notes
Product Design (page 67)	iPhone 13 Pro	
Haptics (page 69)	iPhone 13 Pro	
Autofocus & Optical Image Stabilization (page 71)	iPhone 13 Pro	
Near-Field Communication (NFC) (page 72)	iPhone 13 Pro	
Acoustics (page 74)	iPhone 13 Pro	
MagSafe Case Magnet Array (page 181)	iPhone 13 Pro	Cases supporting MagSafe only.

5.10.1.15 iPhone 13

Table iPhone 13 case testing matrix
5-15

Test	Using	Notes
Product Design (page 67)	iPhone 13	
Haptics (page 69)	iPhone 13	
Autofocus & Optical Image Stabilization (page 71)	iPhone 13	
Near-Field Communication (NFC) (page 72)	iPhone 13	

5. Cases

5.10 Verification

Test	Using	Notes
Acoustics (page 74)	iPhone 13	
MagSafe Case Magnet Array (page 181)	iPhone 13	Cases supporting MagSafe only.

5.10.1.16 iPhone 13 mini

Table iPhone 13 mini case testing matrix
5-16

Test	Using	Notes
Product Design (page 67)	iPhone 13 mini	
Haptics (page 69)	iPhone 13 mini	
Autofocus & Optical Image Stabilization (page 71)	iPhone 13 mini	
Near-Field Communication (NFC) (page 72)	iPhone 13 mini	
Acoustics (page 74)	iPhone 13 mini	
MagSafe Case Magnet Array (page 181)	iPhone 13 mini	Cases supporting MagSafe only.

5.10.1.17 iPhone 12 Pro Max

Table iPhone 12 Pro Max case testing matrix
5-17

Test	Using	Notes
Product Design (page 67)	iPhone 12 Pro Max	
Haptics (page 69)	iPhone 12 Pro Max	
Autofocus & Optical Image Stabilization (page 71)	iPhone 12 Pro Max	
Near-Field Communication (NFC) (page 72)	iPhone 12 Pro Max	
Acoustics (page 74)	iPhone 12 Pro Max	
MagSafe Case Magnet Array (page 181)	iPhone 12 Pro Max	Cases supporting MagSafe only.

5.10.1.18 iPhone 12 Pro

Table iPhone 12 Pro case testing matrix
5-18

Test	Using	Notes
Product Design (page 67)	iPhone 12 Pro	
Haptics (page 69)	iPhone 12 Pro	
Autofocus & Optical Image Stabilization (page 71)	iPhone 12 Pro	
Near-Field Communication (NFC) (page 72)	iPhone 12 Pro	

5. Cases

5.10 Verification

Test	Using	Notes
Acoustics (page 74)	iPhone 12 Pro	
MagSafe Case Magnet Array (page 181)	iPhone 12 Pro	Cases supporting MagSafe only.

5.10.1.19 iPhone 12

Table iPhone 12 case testing matrix
5-19

Test	Using	Notes
Product Design (page 67)	iPhone 12	
Haptics (page 69)	iPhone 12	
Autofocus & Optical Image Stabilization (page 71)	iPhone 12	
Near-Field Communication (NFC) (page 72)	iPhone 12	
Acoustics (page 74)	iPhone 12	
MagSafe Case Magnet Array (page 181)	iPhone 12	Cases supporting MagSafe only.

5.10.1.20 iPhone 12 mini

Table iPhone 12 mini case testing matrix
5-20

Test	Using	Notes
Product Design (page 67)	iPhone 12 mini	
Haptics (page 69)	iPhone 12 mini	
Autofocus & Optical Image Stabilization (page 71)	iPhone 12 mini	
Near-Field Communication (NFC) (page 72)	iPhone 12 mini	
Acoustics (page 74)	iPhone 12 mini	
MagSafe Case Magnet Array (page 181)	iPhone 12 mini	Cases supporting MagSafe only.

5.10.1.21 iPhone 11 Pro Max

Table iPhone 11 Pro Max case testing matrix
5-21

Test	Using	Notes
Product Design (page 67)	iPhone 11 Pro Max	
Haptics (page 69)	iPhone 11 Pro Max	
Autofocus & Optical Image Stabilization (page 71)	iPhone 11 Pro Max	
Near-Field Communication (NFC) (page 72)	iPhone 11 Pro Max	

5. Cases

5.10 Verification

Test	Using	Notes
Acoustics (page 74)	iPhone 11 Pro Max	

5.10.1.22 iPhone 11 Pro

Table iPhone 11 Pro case testing matrix
5-22

Test	Using	Notes
Product Design (page 67)	iPhone 11 Pro	
Haptics (page 69)	iPhone 11 Pro	
Autofocus & Optical Image Stabilization (page 71)	iPhone 11 Pro	
Near-Field Communication (NFC) (page 72)	iPhone 11 Pro	
Acoustics (page 74)	iPhone 11 Pro	

5.10.1.23 iPhone 11

Table iPhone 11 case testing matrix
5-23

Test	Using	Notes
Product Design (page 67)	iPhone 11	
Haptics (page 69)	iPhone 11	
Autofocus & Optical Image Stabilization (page 71)	iPhone 11	
Near-Field Communication (NFC) (page 72)	iPhone 11	
Acoustics (page 74)	iPhone 11	

5.10.1.24 iPhone XS Max

Table iPhone XS Max case testing matrix
5-24

Test	Using	Notes
Product Design (page 67)	iPhone XS Max	
Haptics (page 69)	iPhone XS Max	
Autofocus & Optical Image Stabilization (page 71)	iPhone XS Max	
Near-Field Communication (NFC) (page 72)	iPhone XS Max	
Acoustics (page 74)	iPhone XS Max	

5. Cases

5.10 Verification

5.10.1.25 iPhone XS

Table iPhone XS case testing matrix
5-25

Test	Using	Notes
Product Design (page 67)	iPhone XS	
Haptics (page 69)	iPhone XS	
Autofocus & Optical Image Stabilization (page 71)	iPhone XS	
Near-Field Communication (NFC) (page 72)	iPhone XS	
Acoustics (page 74)	iPhone XS	

5.10.1.26 iPhone XR

Table iPhone XR case testing matrix
5-26

Test	Using	Notes
Product Design (page 67)	iPhone XR	
Haptics (page 69)	iPhone XR	
Autofocus & Optical Image Stabilization (page 71)	iPhone XR	
Near-Field Communication (NFC) (page 72)	iPhone XR	
Acoustics (page 74)	iPhone XR	

5.10.1.27 iPhone X

Table iPhone X case testing matrix
5-27

Test	Using	Notes
Product Design (page 67)	iPhone X	
Haptics (page 69)	iPhone X	
Autofocus & Optical Image Stabilization (page 71)	iPhone X	
Near-Field Communication (NFC) (page 72)	iPhone X	
Acoustics (page 74)	iPhone X	

5.10.1.28 iPhone 8 Plus/iPhone 7 Plus

Table 5-28 iPhone 8 Plus/iPhone 7 Plus case testing matrix

Test	Using	Notes
Product Design (page 67)	iPhone 8 Plus and iPhone 7 Plus	
Haptics (page 69)	iPhone 8 Plus and iPhone 7 Plus	
Touch ID Sensor Overlays (page 70)	iPhone 8 Plus and iPhone 7 Plus	
Autofocus & Optical Image Stabilization (page 71)	iPhone 8 Plus	
Near-Field Communication (NFC) (page 72)	iPhone 8 Plus and iPhone 7 Plus	
Acoustics (page 74)	iPhone 8 Plus and iPhone 7 Plus	

It is not possible for a case to claim compatibility with only iPhone 8 Plus or only iPhone 7 Plus.

5.10.1.29 iPhone SE (3rd generation)/iPhone SE (2nd generation)/iPhone 8/iPhone 7

Table 5-29 iPhone SE (3rd generation)/iPhone SE (2nd generation)/iPhone 8/iPhone 7 case testing matrix

Test	Using	Notes
Product Design (page 67)	iPhone SE (3rd generation), iPhone SE (2nd generation), iPhone 8, and iPhone 7	
Haptics (page 69)	iPhone SE (3rd generation), iPhone SE (2nd generation), iPhone 8, and iPhone 7	
Touch ID Sensor Overlays (page 70)	iPhone SE (3rd generation), iPhone SE (2nd generation), iPhone 8, and iPhone 7	
Autofocus & Optical Image Stabilization (page 71)	iPhone SE (3rd generation) and iPhone SE (2nd generation)	
Near-Field Communication (NFC) (page 72)	iPhone SE (3rd generation) and iPhone SE (2nd generation)	
Acoustics (page 74)	iPhone SE (3rd generation), iPhone SE (2nd generation), iPhone 8, and iPhone 7	

It is not possible for a case to claim compatibility with only iPhone SE (3rd generation), only iPhone SE (2nd generation), only iPhone 8, or only iPhone 7.

5. Cases

5.10 Verification

5.10.1.30 iPhone 6s Plus/iPhone 6 Plus

Table iPhone 6s Plus/iPhone 6 Plus case testing matrix
5-30

Test	Using	Notes
Product Design (page 67)	iPhone 6s Plus and iPhone 6 Plus	
Autofocus & Optical Image Stabilization (page 71)	iPhone 6s Plus	
Near-Field Communication (NFC) (page 72)	iPhone 6s Plus and iPhone 6 Plus	
Haptics (page 69)	iPhone 6s Plus	

It is not possible for a case to claim compatibility with only iPhone 6s Plus or only iPhone 6 Plus.

5.10.1.31 iPhone 6s/iPhone 6

Table iPhone 6s/iPhone 6 case testing matrix
5-31

Test	Using	Notes
Product Design (page 67)	iPhone 6s and iPhone 6	
Near-Field Communication (NFC) (page 72)	iPhone 6s and iPhone 6	
Haptics (page 69)	iPhone 6s	

It is not possible for a case to claim compatibility with only iPhone 6s or only iPhone 6.

5.10.1.32 iPhone 5/iPhone 5s/iPhone SE

Table iPhone 5/iPhone 5s/iPhone SE case testing matrix
5-32

Test	Using	Notes
Product Design (page 67)	iPhone SE	

It is not possible for a case to claim compatibility with only iPhone 5 or only iPhone 5s or only iPhone SE.

5.10.1.33 iPhone 5c

Table iPhone 5c case testing matrix
5-33

Test	Using	Notes
Product Design (page 67)	iPhone 5c	
Compass (page 73)	iPhone 5c	

5.10.1.34 iPad Pro 13-inch (M4)

Table iPad Pro 13-inch (M4) case testing matrix
5-34

Test	Using	Notes
Product Design (page 67)	iPad Pro 13-inch (M4)	
Compass (page 73)	iPad Pro 13-inch (M4)	

5.10.1.35 iPad Pro 11-inch (M4)

Table iPad Pro 11-inch (M4) case testing matrix
5-35

Test	Using	Notes
Product Design (page 67)	iPad Pro 11-inch (M4)	
Compass (page 73)	iPad Pro 11-inch (M4)	

5.10.1.36 iPad Air 13-inch (M2)

Table iPad Air 13-inch (M2) case testing matrix
5-36

Test	Using	Notes
Product Design (page 67)	iPad Air 13-inch (M2)	
Compass (page 73)	iPad Air 13-inch (M2)	

5.10.1.37 iPad Air 11-inch (M2)

Table 5-37 iPad Air 11-inch (M2) case testing matrix

Test	Using	Notes
Product Design (page 67)	iPad Air 11-inch (M2)	
Compass (page 73)	iPad Air 11-inch (M2)	

5.10.1.38 iPad Pro 12.9-inch (6th generation) and iPad Pro 12.9-inch (5th generation)

Table 5-38 iPad Pro 12.9-inch (6th generation) and iPad Pro 12.9-inch (5th generation) case testing matrix

Test	Using	Notes
Product Design (page 67)	iPad Pro 12.9-inch (6th generation)	
Compass (page 73)	iPad Pro 12.9-inch (6th generation)	

It is not possible for a case to claim compatibility with only iPad Pro 12.9-inch (6th generation) or only iPad Pro 12.9-inch (5th generation).

5.10.1.39 iPad Pro 11-inch (4th generation) and iPad Pro 11-inch (3rd generation)

Table 5-39 iPad Pro 11-inch (4th generation) and iPad Pro 11-inch (3rd generation) case testing matrix

Test	Using	Notes
Product Design (page 67)	iPad Pro 11-inch (4th generation)	
Compass (page 73)	iPad Pro 11-inch (4th generation)	

It is not possible for a case to claim compatibility with only iPad Pro 11-inch (4th generation) or only iPad Pro 11-inch (3rd generation).

5.10.1.40 iPad (10th generation)

Table 5-40 iPad (10th generation) case testing matrix

Test	Using	Notes
Product Design (page 67)	iPad (10th generation)	
Compass (page 73)	iPad (10th generation)	

5.10.1.41 iPad mini (A17 Pro) and iPad mini (6th generation)

Table 5-41 iPad mini (A17 Pro) and iPad mini (6th generation) case testing matrix

Test	Using	Notes
Product Design (page 67)	iPad mini (A17 Pro)	
Compass (page 73)	iPad mini (A17 Pro)	

It is not possible for a case to claim compatibility with only iPad mini (A17 Pro) or only iPad mini (6th generation).

5.10.1.42 iPad (7th generation)/iPad (8th generation)/iPad (9th generation)

Table 5-42 iPad (7th generation)/iPad (8th generation)/iPad (9th generation) case testing matrix

Test	Using	Notes
Product Design (page 67)	iPad (7th generation), iPad (8th generation), and iPad (9th generation)	
Compass (page 73)	iPad (7th generation), iPad (8th generation), and iPad (9th generation)	

It is not possible for a case to claim compatibility with only iPad (7th generation) or only iPad (8th generation) or only iPad (9th generation).

5.10.1.43 iPad Air (5th generation)/iPad Air (4th generation)

Table 5-43 iPad Air (5th generation)/iPad Air (4th generation) case testing matrix

Test	Using	Notes
Product Design (page 67)	iPad Air (5th generation)	
Compass (page 73)	iPad Air (5th generation)	

5.10.1.44 iPad Pro 12.9-inch (4th generation)

Table 5-44 iPad Pro 12.9-inch (4th generation) case testing matrix

Test	Using	Notes
Product Design (page 67)	iPad Pro 12.9-inch (4th generation)	
Compass (page 73)	iPad Pro 12.9-inch (4th generation)	

5.10.1.45 iPad Pro 11-inch (2nd generation)

Table iPad Pro 11-inch (2nd generation) case testing matrix
5-45

Test	Using	Notes
Product Design (page 67)	iPad Pro 11-inch (2nd generation)	
Compass (page 73)	iPad Pro 11-inch (2nd generation)	

5.10.1.46 iPad Air (3rd generation)

Table iPad Air (3rd generation) case testing matrix
5-46

Test	Using	Notes
Product Design (page 67)	iPad Air (3rd generation)	
Autofocus & Optical Image Stabilization (page 71)	iPad Air (3rd generation)	
Compass (page 73)	iPad Air (3rd generation)	

5.10.1.47 iPad mini (5th generation)

Table iPad mini (5th generation) case testing matrix
5-47

Test	Using	Notes
Product Design (page 67)	iPad mini (5th generation)	
Compass (page 73)	iPad mini (5th generation)	

5.10.1.48 iPad Pro 12.9-inch (3rd generation)

Table iPad Pro 12.9-inch (3rd generation) case testing matrix
5-48

Test	Using	Notes
Product Design (page 67)	iPad Pro 12.9-inch (3rd generation)	
Compass (page 73)	iPad Pro 12.9-inch (3rd generation)	

5.10.1.49 iPad Pro 11-inch (1st generation)

Table iPad Pro 11-inch (1st generation) case testing matrix
5-49

Test	Using	Notes
Product Design (page 67)	iPad Pro 11-inch (1st generation)	
Compass (page 73)	iPad Pro 11-inch (1st generation)	

5.10.1.50 iPad Pro 10.5-inch

Table iPad Pro 10.5-inch case testing matrix
5-50

Test	Using	Notes
Product Design (page 67)	iPad Pro 10.5-inch	
Autofocus & Optical Image Stabilization (page 71)	iPad Pro 10.5-inch	
Compass (page 73)	iPad Pro 10.5-inch	

5.10.1.51 iPad Pro 12.9-inch (2nd generation)

Table iPad Pro 12.9-inch (2nd generation) case testing matrix
5-51

Test	Using	Notes
Product Design (page 67)	iPad Pro 12.9-inch (2nd generation)	
Autofocus & Optical Image Stabilization (page 71)	iPad Pro 12.9-inch (2nd generation)	
Compass (page 73)	iPad Pro 12.9-inch (2nd generation)	

5.10.1.52 iPad (5th and 6th generation)

Table iPad (5th and 6th generation) case testing matrix
5-52

Test	Using	Notes
Product Design (page 67)	iPad (5th generation) or iPad (6th generation)	
Compass (page 73)	iPad (5th generation) or iPad (6th generation)	

5.10.1.53 iPad Pro 9.7-inch

Table 5-53 iPad Pro 9.7-inch case testing matrix

Test	Using	Notes
Product Design (page 67)	iPad Pro 9.7-inch	
Compass (page 73)	iPad Pro 9.7-inch	

5.10.1.54 iPad Pro 12.9-inch (1st generation)

Table 5-54 iPad Pro 12.9-inch (1st generation) case testing matrix

Test	Using	Notes
Product Design (page 67)	iPad Pro 12.9-inch (1st generation)	
Compass (page 73)	iPad Pro 12.9-inch (1st generation)	

5.10.1.55 iPad mini 4

Table 5-55 iPad mini 4 case testing matrix

Test	Using	Notes
Product Design (page 67)	iPad mini 4	
Compass (page 73)	iPad mini 4	

5.10.1.56 iPad mini/iPad mini 2/iPad mini 3

Table 5-56 iPad mini/iPad mini 2/iPad mini 3 case testing matrix

Test	Using	Notes
Product Design (page 67)	iPad mini 3	
Compass (page 73)	iPad mini 2 and iPad mini 3	

It is not possible for a case to claim compatibility with only iPad mini or only iPad mini 2 or only iPad mini 3.

5.10.1.57 iPad Air 2

Table 5-57 iPad Air 2 case testing matrix

Test	Using	Notes
Product Design (page 67)	iPad Air 2	
Compass (page 73)	iPad Air 2	

5.10.1.58 iPad Air

Table 5-58 iPad Air case testing matrix

Test	Using	Notes
Product Design (page 67)	iPad Air	
Compass (page 73)	iPad Air	

5.10.1.59 iPad (4th generation)

Table 5-59 iPad (4th generation) case testing matrix

Test	Using	Notes
Product Design (page 67)	iPad (4th generation)	
Compass (page 73)	iPad (4th generation)	

5.10.1.60 iPod touch (5th generation)/iPod touch (6th generation)/iPod touch (7th generation)

Table 5-60 iPod touch (5th generation)/iPod touch (6th generation)/iPod touch (7th generation) Case Testing Matrix

Test	Using	Notes
Product Design (page 67)	iPod touch (7th generation)	

It is not possible for a case to claim compatibility with only iPod touch (5th generation), iPod touch (6th generation) or iPod touch (7th generation).

5.10.2 Product Design

5.10.2.1 Equipment

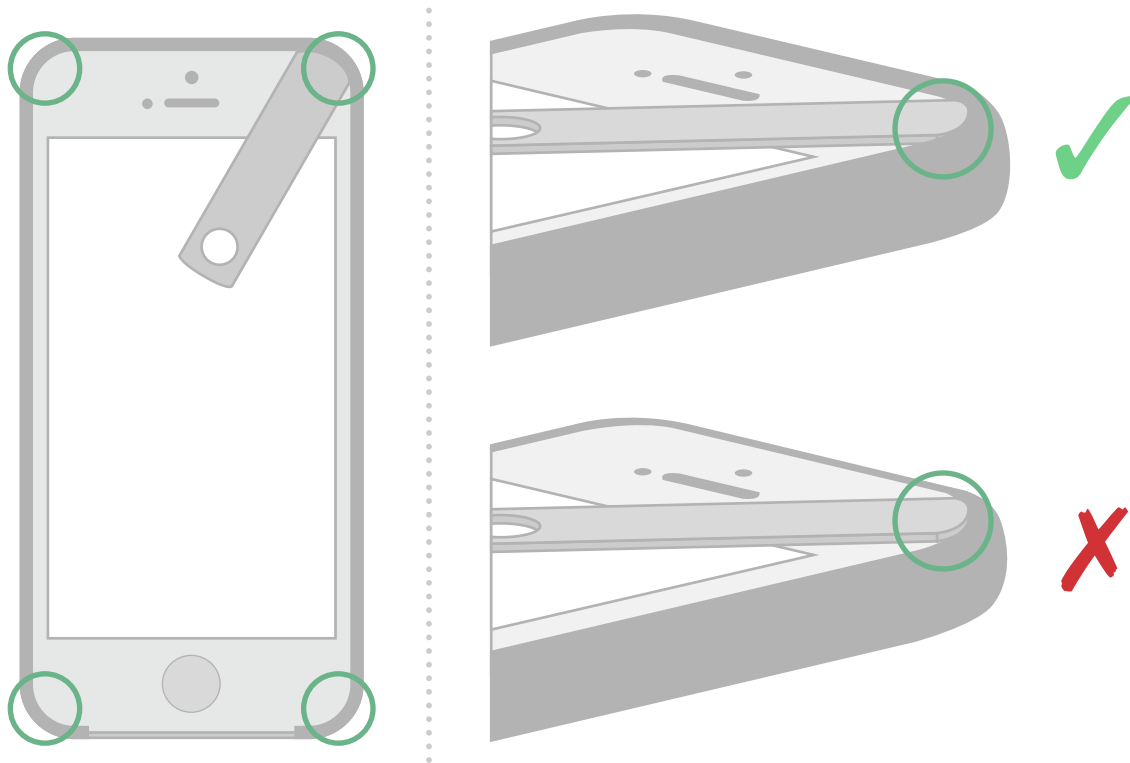
- Device
- Apple Lightning Digital AV Adapter for devices with a Lightning receptacle.
- Apple USB-C Digital AV Multiport Adapter for devices with a USB-C receptacle.
- EarPods with 3.5 mm Headphone Plug for devices with a 3.5 mm headset jack.
- Vernier calipers
- 0.85 mm plastic feeler gauge

5.10.2.2 Procedure

1. Insert the device into the case.
2. Verify the device completely fits inside the case.
3. Verify the device is not loose.
4. Verify all buttons are accessible.
5. Inspect for button feel. Verify all buttons are not too hard to press or take a lot of effort to press.
6. Verify speaker/microphone ports are not occluded.
7. If the device has an Apple Lightning receptacle:
 - a. Insert the Apple Lightning Digital AV Adapter into the receptacle and verify it fits.
 - b. Using vernier calipers, measure the Lightning connector opening on the case. Verify the opening is measured to be at least 12.05 mm by 6.30 mm.
8. If the device has a USB-C receptacle:
 - a. Insert the Apple USB-C Digital AV Multiport Adapter into the receptacle and verify it fits.
 - b. Using vernier calipers, measure the USB-C connector opening on the case. Verify the opening is measured to be at least 12.35 mm by 6.50 mm.
9. If the device has a 3.5 mm headset jack:
 - a. Insert EarPods with 3.5 mm Headphone Plug into the headset jack and verify it fits.
 - b. Using vernier calipers, measure the headset jack opening on the case. Verify the opening is measured to be at least 6 mm in diameter and no more than 14 mm deep.
10. If the device has a Touch ID sensor integrated with the Home button, use vernier calipers to verify the case is at least 2 mm away from the Touch ID sensor.
11. If the device has a Touch ID sensor integrated with the Top button, use vernier calipers to verify the case meets the keep-out defined for each device the accessory claims compatibility with. See [Device Dimensional Drawings](#) (page 284).

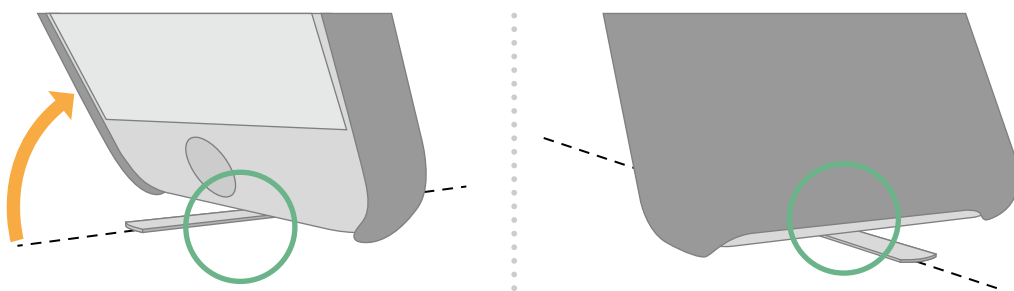
12. Verify the case is always proud of the feeler gauge when the gauge is placed at each corner of the device. See [Figure 5-12](#) (page 68).

Figure 5-12 Device proudness test



13. Set the device flat on its face (screen facing down).
14. Roll the device towards any side not enclosed by the case until the gap between the device's exposed glass and flat surface is smallest.
15. Verify the feeler gauge fits into the gap between the device's exposed glass and flat surface.

Figure 5-13 Device gap test



16. If the case has an overlay, verify there are no air gaps introduced between it and the touchscreen.

5.10.3 Camera Control

This test applies to devices equipped with a Camera Control.

5.10.3.1 Equipment

The following equipment is necessary:

- Device running iOS 18.0.1 or later.
- [Accessory Developer Assistant \(ADA\)](#) (page 281) installed on the device.

5.10.3.2 Setup

1. Attach the case to the device.
2. Launch the Accessory Developer Assistant app and sign in.
3. Select Case, Camera Control.

5.10.3.3 Preload

1. Select Preload, and follow the on-screen instructions.
2. Verify the test passes.
3. Perform the Preload test again, firmly squeezing the device just above or below the Camera Control.
4. Verify the test passes.

5.10.3.4 Gestures

1. Perform the 'Light press', 'Click', and 'Slide' tests under Landscape, following the on-screen instructions for each.
2. Verify the tests pass.
3. Using only the left hand, perform the 'Light press', 'Click', and 'Slide' tests under Portrait, following the on-screen instructions for each.
4. Verify the tests pass.
5. Using only the right hand, perform the 'Light press', 'Click', and 'Slide' tests under Portrait, following the on-screen instructions for each.
6. Verify the tests pass.

5.10.4 Haptics

5.10.4.1 Equipment

- Two devices of the same model.

5.10.4.2 Setup

Repeat the following for each device:

1. Open Settings > Sound & Haptics > Haptics, select Always Play.

5.10.4.3 Procedure

1. Attach the case to one device.
2. Verify the case does not cause substantial changes in the feel of the device's haptic feedback by comparing the haptic feedback between the devices for each of the following tasks:
 - a. Toggle the Ring/Silent switch or use the Action button.
 - b. Connect a charger, wait a few seconds, then disconnect the charger.
 - c. Open Settings > Notifications > Phone > Sounds, select Reflection (Default).
 - d. Open Settings > Notifications > Messages > Sounds, select Note (Default).
 - e. Go to the Home Screen.
 - f. Long press the Settings app to show the Quick Actions menu, then slide a finger across the menu and release to select Wi-Fi.
 - g. Go to the Home Screen.
 - h. Long press the Home app to show the Quick Actions menu. Release, then tap away from the menu to return to the Home Screen.
 - i. Open the Clock app, select Timers, then scroll through the hours, minutes, and seconds.
 - j. If the device has a Home button:
 - a. Open Settings > General > Home Button, select option 2.
 - b. Press the Home button.
 - c. Place the device on a flat surface, like a table.
 - d. Press the Home button.

5.10.5 Touch ID Sensor Overlays

This test procedure applies to accessories overlaying the Touch ID sensor.

5.10.5.1 Equipment

- Nitrile gloves (for example, Ansell TNT Blue)
- Ethyl alcohol hand sanitizer (for example, Purell)
- Scissors

5.10.5.2 Procedure

1. Cut off a square of material from the nitrile glove's wrist portion.
2. Install the accessory onto the device.
3. Press the Side/Top button to place the device into a sleep state (display off).

5. Cases

5.10 Verification

4. Place the square of nitrile glove material over the Touch ID sensor with the glove's outer side facing away from the device.
5. Apply a small amount of hand sanitizer (approximately 2 cm in diameter) to the glove over the Touch ID sensor.
6. Repeat the following steps 10 times:
 - a. Press the Touch ID sensor with a thumb.
 - b. Verify the device wakes (display on).
 - c. Place the device into a sleep state (display off).
7. Repeat the following steps 10 times:
 - a. Press the Touch ID sensor with an index finger.
 - b. Verify the device wakes (display on).
 - c. Place the device into a sleep state (display off).

5.10.5.3 Pass/Fail Criteria

Verify the device wakes every time the Touch ID sensor is pressed.

5.10.6 Camera

5.10.6.1 Autofocus & Optical Image Stabilization

This test applies to devices equipped with Autofocus (AF) and/or Optical Image Stabilization (OIS).

5.10.6.1.1 Equipment

- Device running iOS 18.0.1 or later or iPadOS 18.0.1 or later. See [Device Models](#) (page 49).
- A flat level non-ferrous test surface away from magnetic fields.
- [Accessory Developer Assistant \(ADA\)](#) (page 281) installed on the device.
- [Autofocus & Optical Image Stabilization Test Profile](#) (page 282) installed on the device.

5.10.6.1.2 Procedure

1. Launch the Accessory Developer Assistant app and sign in.
2. Select Case, Autofocus and Optical Image Stabilization.
3. Allow ADA to access the device camera, if prompted.
4. Set the device on the test surface.
5. Follow the on-screen instructions.
6. Select Measure Baseline and wait for the measurement to complete.
7. Attach the case being tested on the device.
8. Set the device back on the test surface.
9. Select Measure Attached and wait for the measurement to complete.

10. Verify all tests pass and note the results.

5.10.7 Near-Field Communication (NFC)

This test applies to devices equipped with NFC.

5.10.7.1 Equipment

The following equipment is necessary:

- Device running iOS 18.0.1 or later.
- [Accessory Developer Assistant \(ADA\)](#) (page 281) installed on the device.
- An NFC tag.
- An NFC transmitter.
 - A separate device with the ADA app may be used as an NFC transmitter.
- A flat level non-ferrous test surface away from magnetic fields.
- A straight edge non-metallic ruler.

5.10.7.2 Setup

1. Place the NFC tag or transmitter on the flat level non-ferrous test surface.
2. Position the ruler to measure the vertical distance from the NFC tag or transmitter to the device.

5.10.7.3 Procedure

This procedure establishes a detection baseline without a case attached and then tests are rerun with the case attached. The procedure is repeated for both NFC tag & transmitter modes.

1. Launch the Accessory Developer Assistant app and sign in.
2. Select Near Field Communication.
3. Select 'Test with NFC tag', and follow the on-screen instructions.
 - a. Measure baseline average distance with no case attached.
 - b. Attach case.
 - c. Repeat measurements with case attached.
 - d. Verify test passes.
4. Select 'Test with an NFC transmitter', and follow the on-screen instructions.
 - a. If using a second device as an NFC transmitter:
 - a. Open ADA app on the second device.
 - b. Select Apple Pay Detector.
 - c. Select Start Detector.
 - b. Measure baseline average distance with no case attached.
 - c. Attach case.
 - d. Repeat measurements with case attached.

- e. Verify test passes.
5. Perform multi-angle detection.
6. Verify multi-angle detection test passes.

5.10.8 Compass

5.10.8.1 Equipment

The following equipment is necessary:

- Device running iPadOS 18.0.1 or later.
- [Accessory Developer Assistant \(ADA\)](#) (page 281) installed on the device.
- A flat level non-ferrous test surface away from magnetic fields.
- Magnetometer, such as the Meda FVM400.

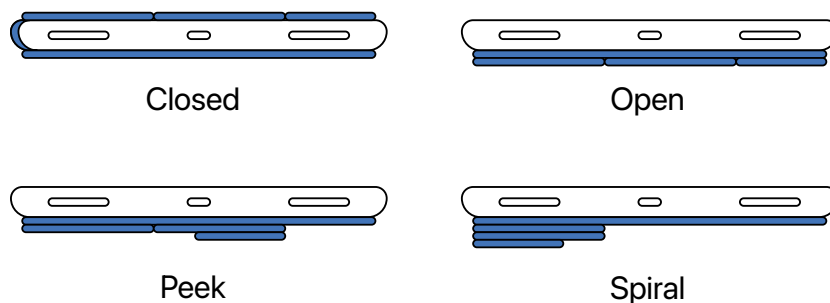
5.10.8.2 Setup

1. Place a mark on the test surface with a 90° angle to use for repeated device alignment. For example, use two pieces of tape perpendicular to each other.
2. Use the magnetometer to verify the test surface has a consistent magnetic field, not affected by nearby electronics or magnets.

5.10.8.3 Procedure

1. Launch the Accessory Developer Assistant app and sign in.
2. Select Compass and the case type, such as: Folio, Keyboard Folio, or Shell.
3. Scroll down and select all supported case configurations, see [Figure 5-14](#) (page 73).

Figure 5-14 Case configurations



4. Scroll down and select all included case materials.
5. Select Start Test.
6. If a closed case configuration is selected, connect an external display and mouse when prompted.

7. Place the device with no case attached on the test surface, aligned to the mark.
8. Select Measure Baseline to collect an initial measurement.
9. Once the measurement is complete, follow the on-screen instructions to attach the case and collect a measurement for each supported case configuration.
10. Verify all tests pass and note the results.

5.10.9 Acoustics

The following test procedures apply to devices with a built in speaker and/or microphone.

5.10.9.1 Speakerphone Call

This procedure evaluates the impact of a case on the speakerphone performance of a device.

5.10.9.1.1 Equipment and Test Setup

This procedure needs two operators in separate quiet rooms.

Room A:

- Operator A.
- The device used to evaluate the case with cellular service and at least two out of five bars of cellular reception within the room.

Room B:

- Operator B.
- Landline speakerphone.
- Digital audio recorder (for example, a device with the Voice Memo app).

5.10.9.1.2 Pass/Fail Criteria

There are two categories of failure for this procedure:

- Echo: If Operator B hears their own voice from the landline.
- Double talk: If Operator B hears Operator A inconsistently.

Establish the pass/fail threshold for these two categories by performing the test procedure using the device (without the case) as a reference. If there is no perceivable difference between the reference and the same procedure conducted with the case on the device, the test passes.

5.10.9.1.3 Procedure

1. Operator A: Use the device (without a case) in Room A to call the landline phone in Room B.
2. Operator A: Place the device in speakerphone mode.
3. Operator B: Answer the call with the landline phone in Room B.

5. Cases

5.10 Verification

4. Operator B: Place the landline phone in speakerphone mode.
5. Operator A and B: Simultaneously recite the following phrases to evaluate the call quality:
 - a. The birch canoe slid on the smooth planks.
 - b. Glue the sheet to the dark blue background.
 - c. It's easy to tell the depth of a well.
 - d. These days a chicken leg is a rare dish.
 - e. Rice is often served in round bowls.
 - f. The juice of lemons makes fine punch.
 - g. The box was thrown beside the parked truck.
 - h. The hogs were fed chopped corn and garbage.
 - i. Four hours of steady work faced us.
 - j. Large size in stockings is hard to sell.
6. Operator B: Evaluate the call. Ensure the call is audible and clear when there is no case on the device.
7. Operator A: Place the case on the device.
8. Operator B: Start audio recording using a digital audio recorder.
9. Operator A: State the test date and identify the manufacturer name, product name, and a unique identifier (UID) for case (production run name, design version, etc.).
10. Operator A and B: Simultaneously recite the same phrases as above.
11. Operator B: Stop audio recording.
12. Operator B: Evaluate the recording against the [Pass/Fail Criteria](#) (page 74).

The phrases used for this test procedure are from "IEEE Recommended Practice for Speech Quality Measurements," in *IEEE Transactions on Audio and Electroacoustics*, vol. 17, no. 3, pp. 225-246, September 1969.

6. Covers

This chapter is applicable to accessories covering device displays.

6.1 Device Protection

Covers shall not damage coatings on the display in any operating condition (for example, when closed, carrying in a backpack, or storing).

6.2 Magnetic Interference

Accessory covers shall not interfere with the device's:

- Magnetic compass.
- Rear camera autofocus (AF).
- Rear camera optical image stabilization (OIS), if present.
- Front camera autofocus, if present.

See [Magnetic Interference](#) (page 29) for additional details.

6.3 Smart Covers

Dimensional drawings indicating magnet and Hall effect sensor locations are available for:

- [iPad mini \(A17 Pro\), 3 of 6](#) (page 369)
- [iPad mini \(A17 Pro\), 4 of 6](#) (page 370)
- [iPad Pro 13-inch \(M4\), 3 of 5](#) (page 375)
- [iPad Pro 11-inch \(M4\), 3 of 5](#) (page 380)
- [iPad Air 13-inch \(M2\), 3 of 5](#) (page 385)
- [iPad Air 11-inch \(M2\), 3 of 5](#) (page 390)
- [iPad Pro 12.9-inch \(6th generation\), 3 of 5](#) (page 395)
- [iPad Pro 11-inch \(4th generation\), 3 of 5](#) (page 400)
- [iPad \(10th generation\), 4 of 6](#) (page 406)
- [iPad Air \(5th generation\) and iPad Air \(4th generation\), 3 of 5](#) (page 411)
- [iPad mini \(6th generation\), 3 of 6](#) (page 416)

6. Covers

6.3 Smart Covers

- iPad mini (6th generation), 4 of 6 (page 417)
- iPad (9th generation), iPad (8th generation) and iPad (7th generation), 2 of 4 (page 421)
- iPad Pro 12.9-inch (5th generation), 3 of 5 (page 426)
- iPad Pro 11-inch (3rd generation), 3 of 5 (page 431)
- iPad Pro 12.9-inch (4th generation), 3 of 5 (page 436)
- iPad Pro 11-inch (2nd generation), 3 of 5 (page 441)
- iPad Air (3rd generation), 2 of 3 (page 445)
- iPad Air (3rd generation) with Cellular, 2 of 3 (page 448)
- iPad mini (5th generation), 2 of 3 (page 451)
- iPad mini (5th generation) with Cellular, 2 of 3 (page 454)
- iPad Pro 12.9-inch (3rd generation), 2 of 3 (page 457)
- iPad Pro 11-inch (1st generation), 2 of 3 (page 460)
- iPad Pro 12.9-inch (2nd generation) Magnet/Hall Effect Sensors, 1 of 2 (page 464)
- iPad Pro 12.9-inch (2nd generation) Magnet/Hall Effect Sensors, 2 of 2 (page 465)
- iPad Pro 10.5-inch Magnet/Hall Effect Sensors, 1 of 2 (page 468)
- iPad Pro 10.5-inch Magnet/Hall Effect Sensors, 2 of 2 (page 469)
- iPad (5th and 6th generation) Magnet/Hall Effect Sensors, 1 of 2 (page 471)
- iPad (5th and 6th generation) Magnet/Hall Effect Sensors, 2 of 2 (page 472)
- iPad Pro 9.7-inch Magnet/Hall Effect Sensors, 1 of 2 (page 475)
- iPad Pro 9.7-inch Magnet/Hall Effect Sensors, 2 of 2 (page 476)
- iPad Pro 12.9-inch (1st generation) Magnet/Hall Effect Sensors, 1 of 2 (page 479)
- iPad Pro 12.9-inch (1st generation) Magnet/Hall Effect Sensors, 2 of 2 (page 480)
- iPad mini 4 Magnet/Hall Effect Sensors (page 483)

7. Screen Overlays

The displays on Apple products have been carefully engineered and tested to deliver exacting visual performance. Many products also feature Multi-Touch technology to support user interactions. Any material overlaying the screen or between the surface and users' fingers (or writing instruments on iPad) may impact the visual, touch, or sensor performance.

7.1 Product Design

A screen overlay shall not:

- Degrade the performance of Multi-Touch, Apple Pencil, or sensors.
- Introduce air gaps between the touchscreen and overlay.
- Be electrically conductive.
- Cause any color tinge to cool white light sources.

A screen overlay should have a relative permittivity (dielectric) of 3.1 to 3.2.

A screen overlay should not:

- Exceed 0.3 mm in thickness.
- Exceed 0.095 mm in thickness to support Apple Pencil.
- Have a water contact angle $<110^\circ$.

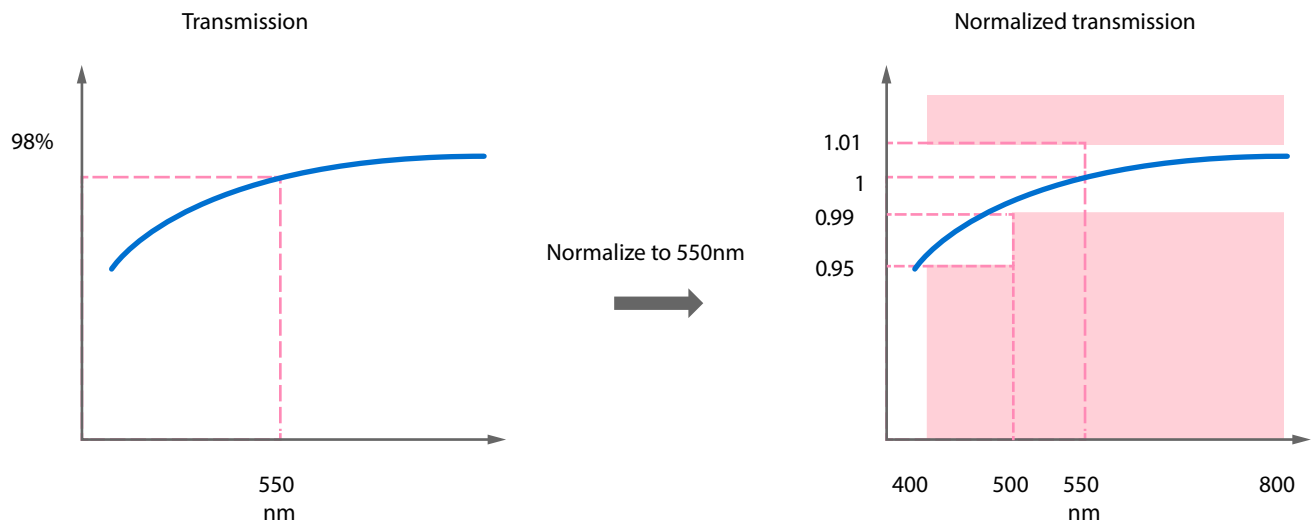
Note:

Non-glossy surfaces may accelerate Apple Pencil tip wear.

7.1.1 Optical Transmission

Optical transmission of screen overlays should:

- Be greater than 90% relative to clear glass for any viewing angle across the active display area, see [Device Dimensional Drawings](#) (page 284).
- Remain flat as defined in [Figure 7-1](#) (page 79). Upon normalizing the transmission spectrum to the value at 550 nm, the normalized spectrum should fall in the range of [0.99, 1.01] from 500-800 nm and [0.95, 1.01] from 400-500 nm.

Figure 7-1 Transmission spectrum

7.1.2 Infrared Transmission

Infrared transmission variance shall not exceed 1.5%. The infrared transmission in the 1200 nm - 1500 nm range relative to light source should be greater than:

- 90% for an angle of incidence between 0° and 45°.
- 84% for an angle of incidence between 45° and 60°.

7.1.3 Transmission Haze

Transmission haze is the percentage of visible and infrared light scattered at more than 2.5° from the normal transmission. Screen overlay transmission haze should:

- Not exceed 0.3% for:
 - iPhone 16 Pro Max
 - iPhone 16 Pro
 - iPhone 16 Plus
 - iPhone 16
 - iPhone 15 Pro Max
 - iPhone 15 Pro
 - iPhone 15 Plus
 - iPhone 15
 - iPhone 14 Pro Max
 - iPhone 14 Pro
- Not exceed 13% for all other devices.
- Be measured with a haze meter, per *ASTM D1003*.

7. Screen Overlays

7.2 Edge Swipe Gestures

7.1.4 Dynamic Island

Screen overlays shall not have a punch-out for the Dynamic Island.

7.2 Edge Swipe Gestures

See [Edge Swipe Gestures](#) (page 40).

8. Camera Attachments

This chapter is applicable to accessories intentionally altering images captured by device cameras.

8.1 Magnetic Interference

Accessory camera attachments shall not interfere with the device's:

- Magnetic compass.
- Rear camera autofocus (AF).
- Rear camera optical image stabilization (OIS), if present.
- Front camera autofocus, if present.

See [Magnetic Interference](#) (page 29) for additional details.

9. Adapters

An adapter accessory is a dongle or a [Built-In Cable](#) (page 25) enabling connections between physically incompatible devices and accessories.

Unless otherwise specified, accessories may integrate one or more adapter components as well as other accessory features to create more advanced multi-port adapters. For example, a Lightning or USB-C adapter may support audio, power, external storage, media controls, app communication, and more.

See the [Accessory Interface Specification](#) (page 26) for more information.

9.1 Headset Adapters (Lightning to 3.5 mm)

Lightning to 3.5 mm headset adapters are accessories enabling 3.5 mm audio connections.

See the [Accessory Interface Specification](#) (page 26) for more information.

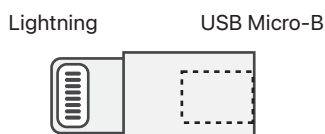
9.2 USB-A/USB-C to Lightning Headset Adapters

USB-A to Lightning or USB-C to Lightning headset adapters are accessories integrating a Lightning Receptacle (C37) to support Lightning headsets, speakers, and microphones.

See the [Accessory Interface Specification](#) (page 26) for more information.

9.3 Lightning to USB Micro-B Adapters

Figure9-1 Lightning to USB Micro-B adapter



9. Adapters

9.3 Lightning to USB Micro-B Adapters

Lightning to USB Micro-B adapters are Lightning dongle accessories functioning exactly like the Apple Lightning to USB Micro-B Adapter and shall consist of:

- Lightning connector.
- USB Micro-B receptacle.

See the [Accessory Interface Specification](#) (page 26) for more information.

10. AC Power Adapters

AC power adapters convert AC "mains" power to DC to provide power to a device and may provide power using:

- [Device Power \(Inductive\)](#) (page 154).
- [Device Power \(USB-C\)](#) (page 147).
- [Device Power \(Lightning\)](#) (page 149).

10.1 Converter Switching Frequencies

Device touchscreen or audio functionality may be degraded by converter switching frequencies.

Converter switching frequencies shall:

- Be above 22 kHz under loads greater than 5 mA.
- Be above 60 kHz and should be above 450 kHz under loads greater than 20 mA.

10.2 YCAP AC Capacitor

AC power adapters should include a YCAP AC capacitor (up to 1000 pF) between the primary and secondary sections of the adapter's transformer to reduce common-mode noise at switching frequencies. These frequencies or their harmonics can interfere with device touchscreen sensors.

10.3 Impedance Stability

AC power adapter series impedance should not change abruptly. Sudden changes in impedance may cause touchscreen sensor output oscillations.

Bridge diodes used in full-wave bridge rectifiers can be a major source of abrupt changes in the series impedance. If the bridge diodes have large inherent reverse capacitance (greater than 100 pF), then the net impedance change due to diode switching may be acceptably small. However, diode reverse capacitance may decrease in more compact IC designs due to decreased chip area.

Impedance of bridge diodes with unacceptably low reverse capacitance can be stabilized using the example circuit shown in Figure 10-1 (page 85) and Table 10-1 (page 85). In this example, capacitors C1, C2, C3, and C4 have been placed in parallel with diodes D1, D2, D3, and D4 to stabilize the bridge impedance. Their values are larger than the inherent reverse capacitances of the diodes.

Resistors R1, R2, R3, and R4 are optional; if included, they can block noise at very high frequencies, which can help with EMI compatibility. The recommended values of R1, R2, R3, and R4 in Table 10-1 (page 85) were chosen to have trivial levels of impedance relative to the impedances of C1, C2, C3, and C4 at power line frequencies.

Figure 10-1 Typical AC power adapter diode bridge circuit

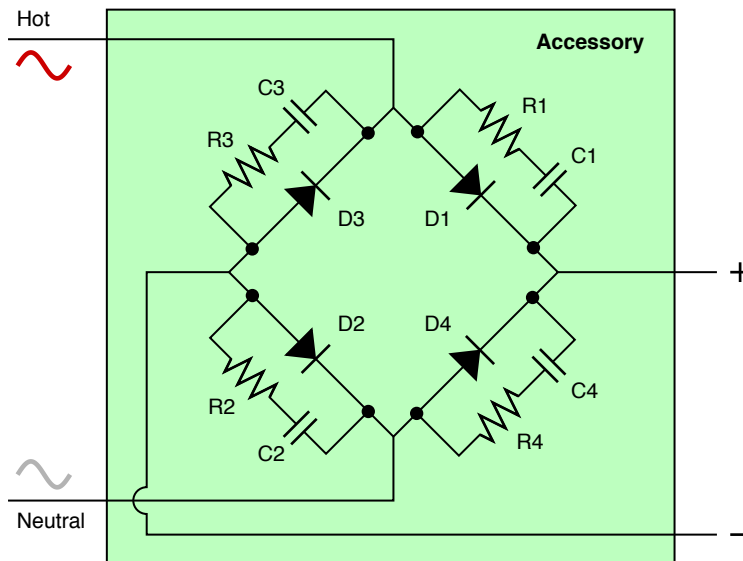


Table 10-1 Typical component values for an AC power adapter diode bridge circuit

Component	Value
C1, C2, C3, C4	47 pF
R1, R2, R3, R4	2 kΩ

10.4 Fuse Protection

A fuse should be present at the input of the AC power adapter to protect it under any fault condition.

10.5 Short Circuit Response

The output of the AC power adapter should drop or fold back without any resulting damage if its output is shorted to the secondary common (less than 10 mΩ).

11. Battery Packs

A battery pack is an accessory designed to provide power to the device.

The battery pack may provide power using:

- [Device Power \(Inductive\)](#) (page 154).
- [Device Power \(USB-C\)](#) (page 147).
- [Device Power \(Lightning\)](#) (page 149).

12. Headsets

Headsets provide users with personal audio experiences. Devices treat headsets differently from accessories with speakers.

Headsets shall comply with:

- [TDMA Noise](#) (page 29) requirements.
- Applicable volume limit regulations in the regions in which they are sold.

Wired headsets should support Apple Music Lossless or Hi-Res Lossless. See <https://support.apple.com/en-us/118295>.

12.1 Product Design

Headsets shall have:

- Drivers positioned at user's ears.
- Microphone(s) positioned to record user's voice.

12.2 Audio Interface

Headsets shall establish audio connections to devices using one of the following interfaces:

- [USB-C Plug](#) (page 271), including the [Apple USB-C Analog Headset Module](#) (page 244).
- [Bluetooth](#) (page 224):
 - [Hands-Free Profile \(HFP\)](#) (page 228)
 - [Advanced Audio Distribution Profile \(A2DP\)](#) (page 233)

If connected using the [USB-C Plug](#) (page 271), headsets shall integrate one of the following:

- [Apple USB-C Analog Headset Module](#) (page 244) (recommended for standard headsets).
- USB Audio Device Class 2.0 or 4.0 compliant codec.

12.3 Remote Controls

Controls shall be implemented using one of the following:

12. Headsets

12.4 USB-C Headset Identification

- Direct electrical connections to the [Headset Remote and Microphone Transmitter](#) (page 253) when integrating an [Apple USB-C Analog Headset Module](#) (page 244).
- [HID Headset Remote](#) (page 160) when using one of the following:
 - [USB-C Plug](#) (page 271) with a USB Audio Device Class 2.0 or 4.0 compliant codec.
 - [Bluetooth](#) (page 224).
- Bluetooth [Audio/Video Remote Control Profile \(AVRCP\)](#) (page 231).

Bluetooth headsets should implement controls identical to an Apple wired headset.

12.4 USB-C Headset Identification

This section applies to headsets integrating a USB-C connector.

Headsets shall:

- Set the `idVendor`, `idProduct`, `iManufacturer`, `iProduct`, and `iSerialNumber` in the Standard Device Descriptor to reflect the accessory markings and packaging.
- Set the Output Terminal Type to `0x0302` (Headphones) if the headset does not integrate a microphone.
- Set the Output Terminal Type and Input Terminal Type to `0x0402` (Headset) if the headset integrates a microphone.
- Set the Audio Function Category to `0x04` (Headset).

Headsets should:

- Set the `ilInterface Playback` and `ilInterface Record` strings to reflect the accessory markings and packaging.
- Set a unique `iSerialNumber` in the Standard Device Descriptor.

Note:

C125 has its Output Terminal Type and Input Terminal Type set to `0x0402` (Headset) and Audio Function Category set to `0x04` (Headset). These configurations cannot be overwritten.

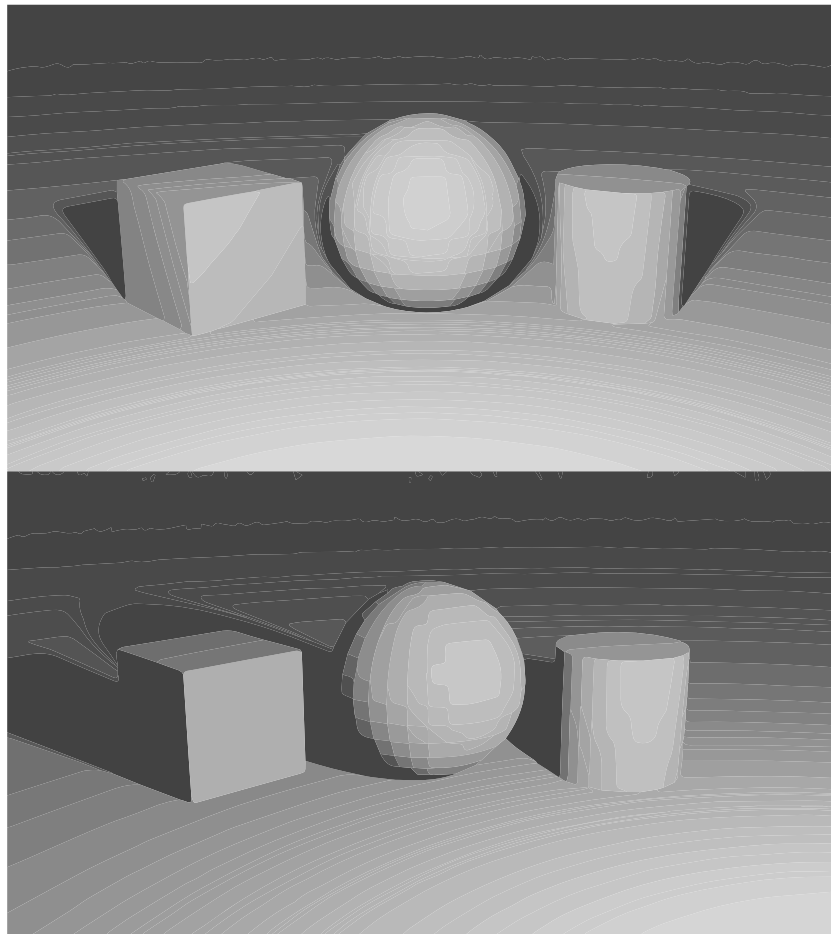
13. Strobes

Strobe accessories replace a device's integrated flash when capturing a still image from either the front or rear-facing cameras. Photographers can use such accessories to control scene lighting for creative purposes.

Strobes are:

- Compatible with all iOS camera applications.
- Synchronized with iPhone camera using the Lightning connector.

Figure 13-1 Example of integrated flash (top) vs. external strobe (bottom)



Devices supporting strobe accessories:

- iPhone 14 Pro Max
- iPhone 14 Pro
- iPhone 14 Plus
- iPhone 14
- iPhone SE (3rd generation)
- iPhone 13 Pro Max
- iPhone 13 Pro
- iPhone 13
- iPhone 13 mini
- iPhone 12 Pro Max
- iPhone 12 Pro
- iPhone 12
- iPhone 12 mini
- iPhone SE (2nd generation)
- iPhone 11 Pro Max
- iPhone 11 Pro
- iPhone 11

This feature is supported on iOS 14.0 or later.

See the [Accessory Interface Specification](#) (page 26) for more information.

14. Keyboards

Devices may accept user input from accessory keyboards in place of the onscreen keyboard.

14.1 Requirements

Accessory keyboards shall:

- Support the [Human Interface Device \(HID\)](#) (page 220) protocol.
- Not identify themselves as Apple-branded accessories, for example, using the Apple Vendor ID and/or Product IDs.

Keyboard keys exhibiting any of the following behaviors are explicitly prohibited:

- Send anything other than 'key pressed' or 'key released' for key(s) physically pressed/released.
- Emulate combinations or sequences of keys (for example, a Copy button sending ⌘-C or macros generating a timed sequence of events).
- Emulate timed user actions, such as 'press-and-hold'.
- Send different HID usages depending on the state of another control surface.

HID reports sent from the keyboard shall only occur in response to a [Direct User Action](#) (page 25).

Keyboards may integrate LEDs to indicate the:

- Caps Lock status of the device.
- Connection status, such as Bluetooth state.
- Battery status of the accessory, if applicable.

Keyboards shall not incorporate any other status LEDs not supported by devices.

Keyboards should be integrated with [Trackpads](#) (page 98) when possible to provide an enhanced user experience.

Mechanical key layout shall be based on the *ISO/IEC 9995-2*, *ANSI-INCITS 154-1988*, or *JIS X 6002-1980* standards. Keyboard HID descriptors shall set the Keyboard Physical Layout usage to the appropriate layout code as defined in [Table 14-5](#) (page 96).

Keyboard HID descriptors shall set the bCountryCode field to the appropriate country code as defined in *Device Class Definition for Human Interface Devices (HID) – Version 1.11, Section 6.2.1 HID Descriptor*.

14. Keyboards

14.1 Requirements

Keyboard HID descriptors shall declare support for the HID Keyboard/Keypad Page. HID report descriptors may declare a input usage minimum of 0 and maximum of 255 as shown in [Example HID Report Descriptor](#) (page 97) for efficiency. Otherwise, the descriptor shall individually enumerate each HID Keyboard/Keypad page usage the keyboard is capable of sending.

Keyboards shall implement individual keys emitting the following HID Keyboard/Keypad page usages:

Table 14-1 Required HID Keyboard/Keypad Page (0x07) controls for use by keyboards

Usage ID	Usage Name	Apple Function
0x0004	a and A	a and A
0x0005	b and B	b and B
0x0006	c and C	c and C
0x0007	d and D	d and D
0x0008	e and E	e and E
0x0009	f and F	f and F
0x000A	g and G	g and G
0x000B	h and H	h and H
0x000C	i and I	i and I
0x000D	j and J	j and J
0x000E	k and K	k and K
0x000F	l and L	l and L
0x0010	m and M	m and M
0x0011	n and N	n and N
0x0012	o and O	o and O
0x0013	p and P	p and P
0x0014	q and Q	q and Q
0x0015	r and R	r and R
0x0016	s and S	s and S
0x0017	t and T	t and T
0x0018	u and U	u and U
0x0019	v and V	v and V
0x001A	w and W	w and W
0x001B	x and X	x and X
0x001C	y and Y	y and Y
0x001D	z and Z	z and Z
0x001E	1 and !	1 and !
0x001F	2 and @	2 and @
0x0020	3 and #	3 and #

14. Keyboards

14.1 Requirements

Usage ID	Usage Name	Apple Function
0x0021	4 and \$	4 and \$
0x0022	5 and %	5 and %
0x0023	6 and ^	6 and ^
0x0024	7 and &	7 and &
0x0025	8 and *	8 and *
0x0026	9 and (9 and (
0x0027	0 and)	0 and)
0x0028	Return/Enter	Return
0x002A	Delete/Backspace	Delete
0x002B	Tab	Tab
0x002C	Spacebar	Spacebar
0x002D	- and _	- and _
0x002E	= and +	= and +
0x002F	[and {	[and {
0x0030] and }] and }
0x0031	\ and	\ and
0x0033	; and :	; and :
0x0034	' and "	' and "
0x0035	Grave Accent and Tilde	` and ~
0x0036	, and <	, and <
0x0037	. and >	. and >
0x0038	/ and ?	/ and ?
0x0039	CapsLock	Caps Lock
0x004F	RightArrow	Right Arrow
0x0050	LeftArrow	Left Arrow
0x0051	DownArrow	Down Arrow
0x0052	UpArrow	Up Arrow
0x00E1	LeftShift	Left Shift
0x00E2	LeftAlt	Left Option / Alt
0x00E3	LeftGUI	Left Command / ⌘
0x00E5	RightShift	Right Shift
0x00E6	RightAlt	Right Option / Alt
0x00E7	RightGUI	Right Command / ⌘

Keyboards may implement individual keys emitting the following HID Keyboard/Keypad page usages:

14. Keyboards

14.1 Requirements

Table 14-2 Optional HID Keyboard/Keypad Page (0x07) controls for use by keyboards

Usage ID	Usage Name	Apple Function
0x0029	Escape	Escape
0x00E0	LeftControl	Left Control
0x00E4	RightControl	Right Control
0x004A	Home	Home
0x004D	End	End
0x0054	Keypad /	Keypad /
0x0055	Keypad *	Keypad *
0x0056	Keypad -	Keypad -
0x0057	Keypad +	Keypad +
0x0058	Keypad Enter	Keypad Enter
0x0059	Keypad 1 and End	Keypad 1
0x005A	Keypad 2 and Down Arrow	Keypad 2
0x005B	Keypad 3 and PageDn	Keypad 3
0x005C	Keypad 4 and Left Arrow	Keypad 4
0x005D	Keypad 5	Keypad 5
0x005E	Keypad 6 and Right Arrow	Keypad 6
0x005F	Keypad 7 and Home	Keypad 7
0x0060	Keypad 8 and Up Arrow	Keypad 8
0x0061	Keypad 9 and PageUp	Keypad 9
0x0062	Keypad 0 and Insert	Keypad 0
0x0063	Keypad . and Delete	Keypad .
0x0067	Keypad =	Keypad =

Keyboards may implement individual keys emitting the following HID Consumer page usages:

Table 14-3 HID Consumer Page (0x0C) controls for use by keyboards

Usage ID	Usage Name	Apple Function
0x0030	Power	Lock
0x0040	Menu	Home Button
0x006F	Display Brightness Increment	Brighter
0x0070	Display Brightness Decrement	Dimmer
0x00B5	Scan Next Track	Transport Right
0x00B6	Scan Previous Track	Transport Left
0x00CD	Play/Pause	Play/Pause

14. Keyboards

14.1 Requirements

Usage ID	Usage Name	Apple Function
0x00E2	Mute	Mute
0x00E9	Volume Increment	Louder
0x00EA	Volume Decrement	Softer
0x01AE	AL Keyboard Layout	Toggle Onscreen Keyboard
0x029D	AC Keyboard Layout Select	Globe Key
0x0221	AC Search	Spotlight
0x025B	Promote	Play More Like This
0x025C	Demote	Play Less Like This
0x0262	Add to Cart	Add to Wish List
0x02C3	Keyboard Physical Layout	Keyboard Physical Layout, see Table 14-5 (page 96).

Keyboards may implement individual keys emitting the following HID Generic Desktop page usages:

Table 14-4 HID Generic Desktop Page (0x01) controls for use by keyboards

Usage ID	Usage Name	Apple Function
0x009B	System Do Not Disturb	Toggle Focus Mode

Table 14-5 Keyboard Physical Layout codes

Value	Description
1	101 (for example, US) - ANSI
3	102 (for example, German) - ISO
5	106 (DOS/V Japan) - JIS

JIS keyboards shall also implement additional keys found on the Japanese Apple Magic Keyboard. Non-JIS keyboards shall not implement the Japanese keys.

Table 14-6 Required HID Keyboard/Keypad Page (0x07) controls for use by JIS keyboards

Usage ID	Usage Name	Apple Function
0x0087	Keyboard International1	_
0x0089	Keyboard International3	¥
0x0090	LANG1	Switch to Previous Language
0x0091	LANG2	Switch to Next Language

14.2 Examples

14.2.1 Example HID Report Descriptor

```

USAGE PAGE (Generic Desktop)          05 01
USAGE (Keyboard)                      09 06
COLLECTION (Application)              A1 01
  USAGE PAGE (LEDs)                   05 08
  LOGICAL MINIMUM (0)                 15 00
  LOGICAL MAXIMUM (1)                25 01
  USAGE (Caps Lock)                   09 02
  REPORT SIZE (1)                     75 01
  REPORT COUNT (1)                    95 01
  OUTPUT (Data,Var,Abs)               91 02
  REPORT SIZE (7)                     75 07
  REPORT COUNT (1)                    95 01
  OUTPUT (Cnst,Var,Abs)               91 03
  USAGE PAGE (Keyboard)               05 07
  USAGE MINIMUM (Keyboard Left Control) 19 E0
  USAGE MAXIMUM (Keyboard Right GUI)  29 E7
  REPORT SIZE (1)                     75 01
  REPORT COUNT (8)                    95 08
  INPUT (Data,Var,Abs)                81 02
  LOGICAL MINIMUM (0)                 15 00
  LOGICAL MAXIMUM (255)               26 FF 00
  USAGE MINIMUM (0)                   19 00
  USAGE MAXIMUM (255)                 2A FF 00
  REPORT SIZE (8)                     75 08
  REPORT COUNT (5)                    95 05
  INPUT (Data,Ary,Abs)                81 00
  USAGE PAGE (Consumer Devices)       05 0C
  LOGICAL MINIMUM (0)                 15 00
  LOGICAL MAXIMUM (1)                25 01
  USAGE (Menu)                        09 40
  USAGE (AC Search)                   0A 21 02
  USAGE (AL Keyboard Layout)          0A AE 01
  USAGE (Scan Previous Track)         09 B6
  USAGE (Play/Pause)                  09 CD
  USAGE (Scan Next Track)             09 B5
  USAGE (Mute)                        09 E2
  USAGE (Volume Down)                 09 EA
  USAGE (Volume Up)                   09 E9
  USAGE (Power)                       09 30
  REPORT SIZE (1)                     75 01
  REPORT COUNT (10)                   95 0A
  INPUT (Data,Var,Abs)                81 02
  REPORT SIZE (6)                     75 06
  REPORT COUNT (1)                    95 01
  INPUT (Cnst,Var,Abs)                81 03
END COLLECTION                        C0

```

15. Trackpads

Devices may accept user input from accessory trackpads.

This feature is supported on iPadOS 14.5 or later.

15.1 Requirements

Accessory trackpads shall:

- Support the [Human Interface Device \(HID\)](#) (page 220) protocol.
- Not identify themselves as Apple-branded accessories, for example, using the Apple Vendor ID (VID).

Accessory trackpads exhibiting any of the following behaviors are explicitly prohibited:

- Emulate combinations of touch gestures.
- Emulate timed user actions, such as 'click and hold', drag, and zoom gestures.
- Send different HID usages depending on the state of another control surface.

HID reports sent from the accessory trackpad shall only occur in response to a [Direct User Action](#) (page 25).

Trackpads shall support 2-5 simultaneous contacts on the digitizer surface.

15.1.1 Integration with Keyboards

Accessory trackpads shall be integrated with [Keyboards](#) (page 92) and simultaneously support both input methods. The following are examples of interactions involving both keyboard and trackpad input:

- Rapidly transitioning between cursor movement and keyboard entry.
- Pressing and holding modifier keys while performing a drag.
- Pressing \mathbb{A} -Tab to see the app switcher, then using the cursor to switch apps.
- Dragging an item using the trackpad, followed by pressing \mathbb{A} -Tab to switch apps.

15.1.2 HID Report Descriptor

HID report descriptors for an accessory trackpad shall declare support for the HID Digitizer Page.

Accessory trackpads shall implement the following HID Digitizer page usages:

15. Trackpads

15.1 Requirements

Table 15-1 Required HID Digitizer Page (0x0D) controls for use by accessory trackpads

Usage ID	Usage Name	Apple Function
0x01	Button 1	Primary button state
0x05	Report ID	Feature Report ID
0x22	Finger	Number of contact collection points
0x30	X	X coordinate of contact position
0x31	Y	Y coordinate of contact position
0x38 or 0x51	Transducer Index or Contact ID	Index (from 0-4) uniquely identifying the finger/contact
0x42	Tip Switch	Contact is on the surface of the digitizer
0x47	Confidence	Touch is an intended, valid contact
0x57	Surface Switch	Digitizer surface on/off

Accessory trackpads may implement the following HID Digitizer page usages. These HID usages are recommended:

Table 15-2 Recommended HID Digitizer Page (0x0D) controls for use by accessory trackpads

Usage ID	Usage Name	Apple Function
0x02	Button 2	Secondary button state
0x56	Scan Time	Relative scan time
0xA1	Report Rate	Report rate (Hz)

15.1.3 Coexistence

Accessory trackpads shall:

- Not degrade the performance of Multi-Touch or Apple Pencil.
- Not support a drive voltage greater than $6 V_{pp}$.
- Not support drive frequencies less than 500 kHz.
- Support 3 or more drive frequencies, separated by at least 50 kHz each.
- Dynamically switch between drive frequencies whenever effective resolution drops below 120 DPI. For example, effective resolution may drop in the presence of 50 mV RMS noise from external power sources.

Accessory trackpads should support a sine wave narrow band drive frequency.

15.1.4 Performance

Accessory trackpads shall:

15. Trackpads

15.1 Requirements

- Behave uniformly across the digitizer surface.
- Uniquely detect contact points as close as 8 mm center to center.
- Detect contact sizes of at least 5 mm.
- Differentiate between multi-finger taps and single-finger drags.
- Maintain an effective input resolution less than 20 μm and immediately report positional updates greater than or equal to the effective input resolution.
- Maintain an effective resolution more than 600 DPI.
- Maintain the highest possible report rate to the device. Apple recommends 60 Hz or higher.
- Maintain a panning latency less than or equal to 23 ms.
- Maintain a touch down latency less than or equal to 35 ms.
- Maintain a positional accuracy less than or equal to 500 μm .
- Maintain a stationary contact jitter less than or equal to 210 μm .
- Not deviate more than 250 μm from an ideal line.

15.1.5 Input Confidence

Accessory trackpads shall:

- Set the Confidence usage when an input transitions from valid to invalid. Contact transitions should be quick, accurate, and stable to achieve the best user experience. Incorrect or fluctuating classification of contacts may result in recognition of unintended gestures, interruption, or cancelation of intended gestures.
- Detect and reject unintended/invalid inputs, such as palms, while continuing to report valid inputs to the device, such as multiple contacts.
- Distinguish between a valid large thumb and an invalid lightly resting palm.
- Reject inputs ≥ 1 mm from the tracking surface.

15.1.6 Click to Wake

Devices use Report ID usage to indicate to the trackpad whether surface contacts shall be reported or not. Devices will use the Surface Switch usage to tell the accessory to go into Click to Wake mode where only button clicks are accepted. Trackpads may use this opportunity to go into a low power mode where the digitizer surface does not have to be constantly scanned.

This feature report also doubles as an informational report. Devices may query the accessory trackpad at any time after enumeration to obtain the current state of the Surface Switch, and also to get the accessory's Report Rate.

15.2 Examples

15.2.1 Example HID Report Descriptor

The following descriptor is for a 92.10 mm x 50.60 mm trackpad with two buttons supporting up to five simultaneous contacts.

Additional modifications may be necessary in order to implement this HID report descriptor in the accessory trackpad firmware, specifically:

- Modify physical maximum values for X (0x30) and Y (0x31) positions of each finger to match the physical size of the accessory trackpad. Units are in tenths of a mm (0.1 mm). In the example, X goes from 0x0 to 0x0399 (92.10 mm) and Y goes from 0x0 to 0x01FA (50.60 mm).
- Modify logical maximum values for the X (0x30) and Y (0x31) of each finger positions to match the resolution of the accessory trackpad. In the example, X (0x30) goes from 0 to 0x0451 (for a resolution of $92.10/1105 = \sim 0.083$ mm) and Y (0x31) goes from 0 to 0x025F (for the same resolution of $50.60/607 = \sim 0.083$ mm).

```

USAGE PAGE (Digitizer Device Page)          05 0D
USAGE (Touch Pad)                           09 05
COLLECTION (Application)                    A1 01
  REPORT_ID (3)                              85 03
  LOGICAL MAXIMUM (65535)                    27 FF FF 00 00
  USAGE (Relative Scan Time (DV=Dynamic Value)) 09 56
  REPORT SIZE (16)                          75 10
  REPORT COUNT (1)                          95 01
  INPUT (Data,Var,Abs)                      81 02
  LOGICAL MAXIMUM (1)                       25 01
  REPORT SIZE (1)                           75 01
  USAGE (Surface Switch)                    09 57
  FEATURE (Data,Var,Abs)                    B1 02
  LOGICAL MAXIMUM (32767)                   26 FF 7F
  REPORT SIZE (15)                         75 0F
  USAGE (Report Rate)                       09 A1
  FEATURE (Data,Var,Abs)                    B1 02
  USAGE PAGE (Button Page)                  05 09
  LOGICAL MAXIMUM (1)                       25 01
  USAGE MINIMUM (Button 1)                  19 01
  USAGE MAXIMUM (Button 2)                  29 02
  REPORT COUNT (2)                          95 02
  REPORT SIZE (1)                           75 01
  INPUT (Data,Var,Abs)                      81 02
  REPORT COUNT (6)                          95 06
  INPUT (Cost, Ary, Abs)                    81 01
  USAGE PAGE (Digitizer Device Page)        05 0D
  USAGE (Finger)                            09 22
  COLLECTION (Physical)                     A1 00
  USAGE (Tip Switch)                        09 42
  USAGE (Confidence)                        09 47

```

15. Trackpads

15.2 Examples

REPORT COUNT (2)	95 02
INPUT (Data,Var,Abs)	81 02
LOGICAL MAXIMUM (5)	25 05
USAGE (Transducer Index)	09 38
REPORT SIZE (6)	75 06
REPORT COUNT (1)	95 01
INPUT (Data,Var,Abs)	81 02
USAGE PAGE (Generic Desktop Page)	05 01
PHYSICAL MAXIMUM (921)	46 99 03
PHYSICAL MINIMUM (0)	35 00
LOGICAL MAXIMUM (1105)	26 51 04
REPORT SIZE (12)	75 0C
UNIT EXPONENT (Unit Value x .01)	55 0E
GLOBAL UNIT (Distance in centimeters)	65 11
USAGE (X)	09 30
INPUT (Data,Var,Abs)	81 02
PHYSICAL MAXIMUM (506)	46 FA 01
LOGICAL MAXIMUM (607)	26 5F 02
USAGE (Y)	09 31
INPUT (Data,Var,Abs)	81 02
END COLLECTION (Physical)	C0
USAGE PAGE (Digitizer Device Page)	05 0D
USAGE (Finger)	09 22
COLLECTION (PHYSICAL)	A1 00
LOGICAL MAXIMUM (1)	25 01
USAGE (Tip Switch)	09 42
USAGE (Confidence)	09 47
REPORT SIZE (1)	75 01
REPORT COUNT (2)	95 02
INPUT (Data,Var,Abs)	81 02
USAGE (Transducer Index)	09 38
LOGICAL MAXIMUM (5)	25 05
REPORT SIZE (6)	75 06
REPORT COUNT (1)	95 01
INPUT (Data,Var,Abs)	81 02
USAGE PAGE (Generic Desktop Page)	05 01
PHYSICAL MAXIMUM (921)	46 99 03
LOGICAL MAXIMUM (1105)	26 51 04
REPORT SIZE (12)	75 0C
USAGE (X)	09 30
INPUT (Data,Var,Abs)	81 02
PHYSICAL MAXIMUM (506)	46 FA 01
LOGICAL MAXIMUM (607)	26 5F 02
USAGE (Y)	09 31
INPUT (Data,Var,Abs)	81 02
END COLLECTION (Physical)	C0
USAGE PAGE (Digitizer Device Page)	05 0D
USAGE (Finger)	09 22
COLLECTION (Physical)	A1 00
LOGICAL MAXIMUM (1)	25 01
USAGE (Tip Switch)	09 42
USAGE (Confidence)	09 47
REPORT SIZE (1)	75 01

15. Trackpads

15.2 Examples

REPORT COUNT (2)	95 02
INPUT (Data,Var,Abs)	81 02
USAGE (Transducer Index)	09 38
LOGICAL MAXIMUM (5)	25 05
REPORT SIZE (6)	75 06
REPORT COUNT (1)	95 01
INPUT (Data,Var,Abs)	81 02
USAGE PAGE (Generic Desktop Page)	05 01
PHYSICAL MAXIMUM (921)	46 99 03
LOGICAL MAXIMUM (1105)	26 51 04
REPORT SIZE (12)	75 0C
USAGE (X)	09 30
INPUT (Data,Var,Abs)	81 02
PHYSICAL MAXIMUM (506)	46 FA 01
LOGICAL MAXIMUM (607)	26 5F 02
USAGE (Y)	09 31
INPUT (Data,Var,Abs)	81 02
END COLLECTION (PHYSICAL)	C0
USAGE PAGE (Digitizer Device Page)	05 0D
USAGE (Finger)	09 22
COLLECTION (PHYSICAL)	A1 00
LOGICAL MAXIMUM (1)	25 01
USAGE (Tip Switch)	09 42
USAGE (Confidence)	09 47
REPORT SIZE (1)	75 01
REPORT COUNT (2)	95 02
INPUT (Data,Var,Abs)	81 02
USAGE (Transducer Index)	09 38
LOGICAL MAXIMUM (5)	25 05
REPORT SIZE (6)	75 06
REPORT COUNT (1)	95 01
INPUT (Data,Var,Abs)	81 02
USAGE PAGE (Generic Desktop Page)	05 01
PHYSICAL MAXIMUM (921)	46 99 03
LOGICAL MAXIMUM (1105)	26 51 04
REPORT SIZE (12)	75 0C
USAGE (X)	09 30
INPUT (Data,Var,Abs)	81 02
PHYSICAL MAXIMUM (506)	46 FA 01
LOGICAL MAXIMUM (607)	26 5F 02
USAGE (Y)	09 31
INPUT (Data,Var,Abs)	81 02
END COLLECTION (Physical)	C0
USAGE PAGE (Digitizer Device Page)	05 0D
USAGE (Finger)	09 22
COLLECTION (PHYSICAL)	A1 00
LOGICAL MAXIMUM (1)	25 01
USAGE (Tip Switch)	09 42
USAGE (Confidence)	09 47
REPORT SIZE (1)	75 01
REPORT COUNT (2)	95 02
INPUT (Data,Var,Abs)	81 02
USAGE (Transducer Index)	09 38

15. Trackpads

15.2 Examples

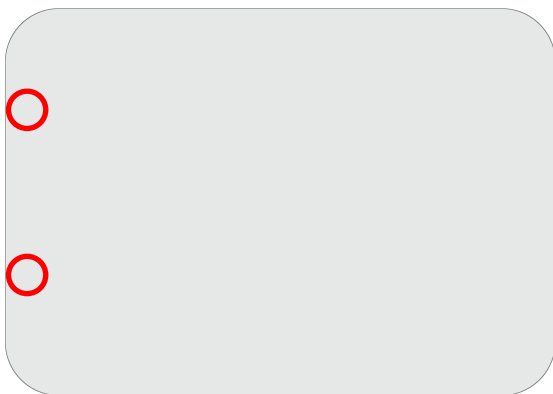
LOGICAL MAXIMUM (5)	25 05
REPORT SIZE (6)	75 06
REPORT COUNT (1)	95 01
INPUT (Data,Var,Abs)	81 02
USAGE PAGE (Generic Desktop Page)	05 01
PHYSICAL MAXIMUM (921)	46 99 03
LOGICAL MAXIMUM (1105)	26 51 04
REPORT SIZE (12)	75 0C
USAGE (X)	09 30
INPUT (Data,Var,Abs)	81 02
PHYSICAL MAXIMUM (506)	46 FA 01
LOGICAL MAXIMUM (607)	26 5F 02
USAGE (Y)	09 31
INPUT (Data,Var,Abs)	81 02
END COLLECTION (Physical)	C0
END COLLECTION (Application)	C0

15.2.2 Example Trackpad

The following HID reports are for a 60 Hz accessory trackpad using the [Example HID Report Descriptor](#) (page 101):

1. Two contacts are made on the surface of the accessory trackpad.

```
03000000 0300100F 0700C016 00000000 00000000 00000000
```

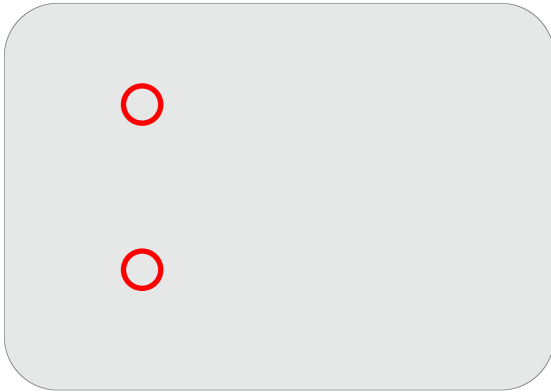


2. Two contacts move simultaneously along the X axis.

```
03A70000 0314110F 0714C116 00000000 00000000 00000000
```

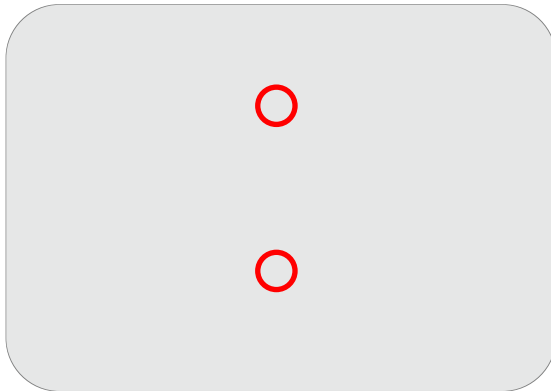

15. Trackpads

15.2 Examples



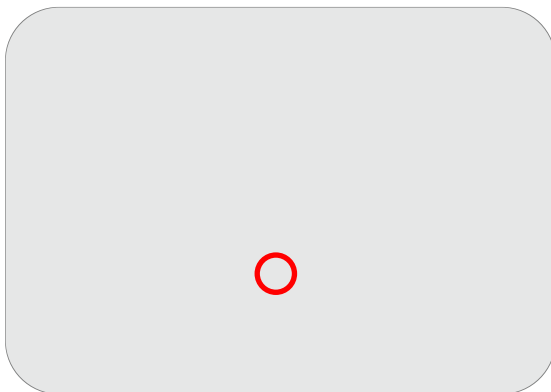
3. Two contacts continue moving until they reach the center of the digitizer surface.

```
034E0100 0328120F 0728C216 00000000 00000000 00000000
```



4. One contact is removed. Confidence for removed contact is still 1 and its coordinates are unchanged.

```
03F50100 0328120F 0628C216 00000000 00000000 00000000
```

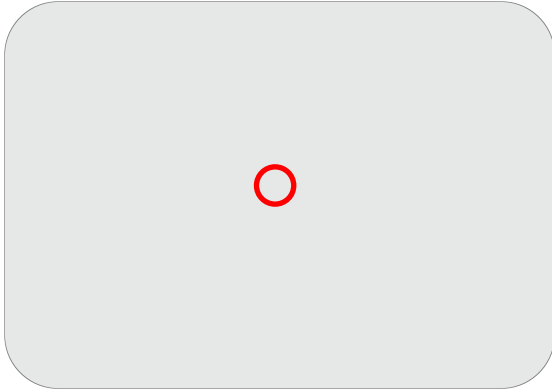


5. Remaining contact moves to the exact center of the digitizer surface. Confidence and coordinates of the removed contact are now 0.

```
039C0200 0328F212 00000000 00000000 00000000 00000000
```

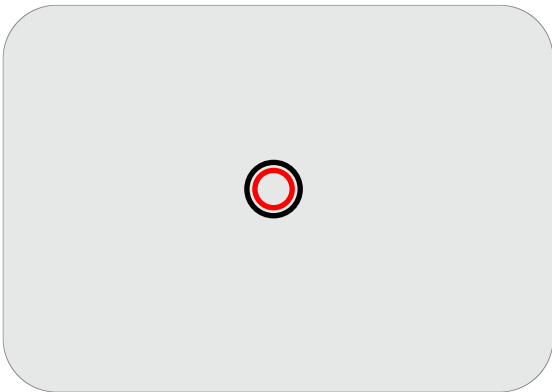
15. Trackpads

15.2 Examples



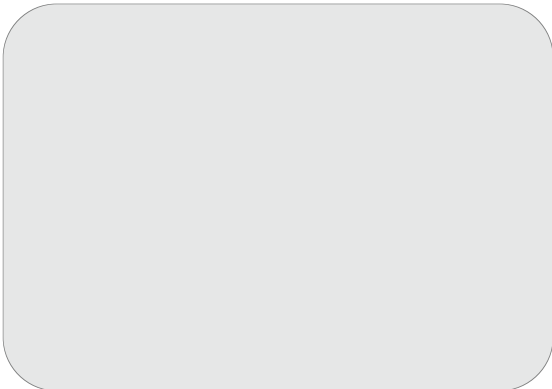
6. Button 1 is clicked.

03430301 0328F212 00000000 00000000 00000000 00000000



7. Button 1 is un-clicked and contact is removed. Confidence for removed contact is still 1 and its coordinates are unchanged.

03EA0300 0228F212 00000000 00000000 00000000 00000000



16. External Storage

Devices support external storage, such as USB drives and SD card readers, to:

- Store and access files.
- Import and export photos.
- Record video.

16.1 Overview

Accessories may support moving data to or from a device using:

- *USB Mass Storage Class Specification Overview—Version 1.4*, see <https://www.usb.org/document-library/mass-storage-class-specification-overview-14>.
- [External Accessory Protocol](#) (page 159).

16.2 Apple ProRes 4K

To support Apple ProRes capture at 4K, external storage shall:

- Be ExFAT formatted.
- Sustain a write speed of incompressible data, sampled every second, across the entire storage capacity, of at least:
 - 440 MiB/s for 4K at 120 fps.
 - 220 MiB/s for 4K at 60 fps.
- Not exceed 900 mA of current draw at any point in time. See [Accessory Power \(USB-C\)](#) (page 136).

For more information on Apple ProRes, including specific device support, see <https://support.apple.com/en-us/109041>.

16.3 Verification

16.3.1 Apple ProRes 4K

16.3.1.1 Equipment

The following equipment is necessary:

- Device supporting external Apple ProRes 4K capture running iOS 18.0 or later, see <https://support.apple.com/en-us/109041>.

16.3.1.2 Setup

1. Fully charge the device.
2. Attach the external storage.
3. Erase and format the external storage as ExFAT:
 - a. Open Files and browse to the top level.
 - b. Long press the external storage entry and select Erase.
 - c. Verify the external storage is empty.
4. Open Settings > Camera > Formats and enable Apple ProRes under Video Capture.
5. Verify ProRes encoding is set to HDR.

16.3.1.3 Procedure

1. Attach the external storage to the device.
2. Open Camera, select Video and enable ProRes HDR from the Camera header.
3. Select the resolution indicator until it displays 4K.
4. Select the fps indicator until it displays:
 - 120 for devices and accessories supporting 4K at 120 fps.
 - 60 for devices and accessories supporting 4K at 60 fps.
5. Verify the Max Time indicator is displayed.
6. Verify the 'USB-C' indicator is displayed near the USB-C port.
7. Record video including motion (camera pan/tilt, people, vehicles) for at least 10 minutes.
8. Stop recording and wait for all data to be written to external storage.
9. Verify no error messages are displayed.
10. Attach the external storage to a Mac and play the video.
11. Verify the video playback is smooth, with no choppiness or missing frames.
12. Repeat the procedure, recording video until the drive is full, and verify all video is smooth, with no choppiness or missing frames.

17. AirPods Accessories

Accessories shall not interfere with AirPods operation. Keep-out regions may be found in the device dimensional drawings, see:

- [AirPods 4](#) (page 547).
- [AirPods Pro \(2nd generation\)](#) (page 554).
- [AirPods \(3rd generation\)](#) (page 556).
- [AirPods Max, 1 of 6](#) (page 557).
- [AirPods Pro \(1st generation\)](#) (page 564).
- [AirPods \(1st generation\) and AirPods \(2nd generation\)](#) (page 566).

17.1 Charging Case Covers

Charging case covers shall:

- Not interfere with AirPods charging case operation.
- Have a uniform thickness across the metal keep-out region.
- Not exceed 2.5 mm in thickness. Apple recommends 1.0 mm for maximum compatibility with inductive transmitters.

Keep-out regions may be found in the device dimensional drawings, see:

- [Wireless Charging Case \(USB-C\) for AirPods 4, 1 of 3](#) (page 544).
- [MagSafe Charging Case \(USB-C\) for AirPods Pro \(2nd generation\), 1 of 3](#) (page 548).
- [MagSafe Charging Case for AirPods Pro \(2nd generation\), 1 of 3](#) (page 551).
- [MagSafe Charging Case for AirPods \(3rd generation\)](#) (page 555).
- [Wireless Charging Case for AirPods Pro \(1st generation\)](#) (page 563).
- [Wireless Charging Case for AirPods](#) (page 565).

Case covers claiming compatibility with Apple Watch chargers shall not obstruct the Apple Watch charger keep-out region, see:

- [Wireless Charging Case \(USB-C\) for AirPods 4, 2 of 3](#) (page 545).
- [MagSafe Charging Case \(USB-C\) for AirPods Pro \(2nd generation\), 2 of 3](#) (page 549).
- [MagSafe Charging Case for AirPods Pro \(2nd generation\), 2 of 3](#) (page 552).

17.2 Chargers

Wired charging accessories shall:

- Provide 5 W (1.0 A at 5 V) at all times using:
 - [USB Battery Charging Specification –Release 1.2](#).
 - USB enumeration.
 - [USB Power Delivery \(PD\)](#) (page 213).
 - [USB Type-C Current](#) (page 214).

Wireless charging accessories shall meet the requirements in [Device Power \(Inductive\)](#) (page 154).

17.3 AirPods Max Accessories

Accessories shall not stretch the headband or canopy. Accessories should use soft, compliant materials such as microfiber or silicone.

If the accessory is a case for AirPods Max (USB-C), the keep-out for the USB-C connector:

- Shall be at least 12.35 mm by 6.50 mm.
- Should be at least 12.45 mm by 6.60 mm with full radii rounded edges for the greatest compatibility with the widest variety of cables and docks, see [USB-C receptacle accessory keep-out](#) (page 277).

17.3.1 Sleep Mode

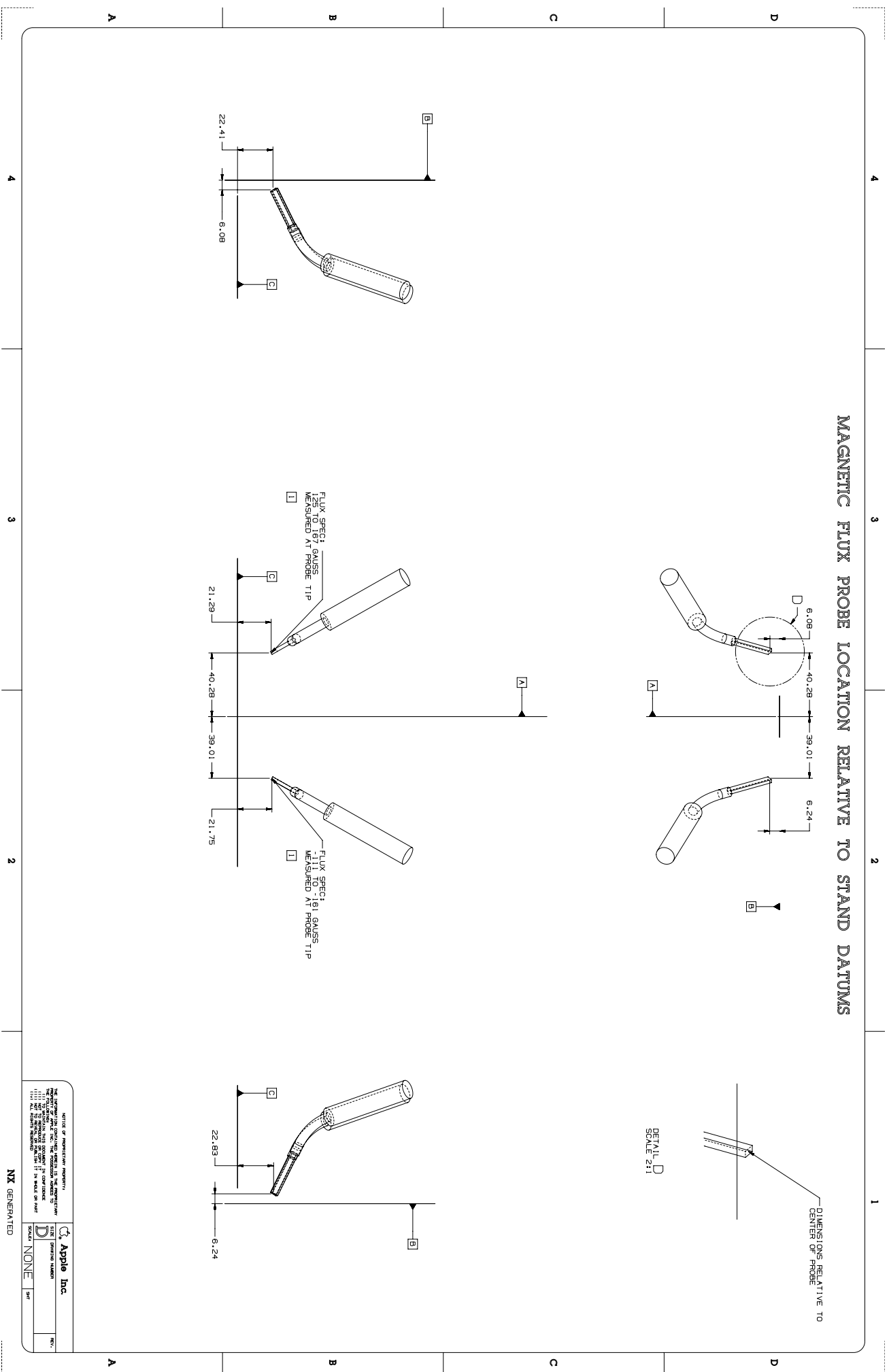
Accessories may enable sleep mode to help maintain the battery charge. Sleep mode is activated when AirPods Max:

- Is not charging.
- Magnetic flux at the:
 - Right earcup is 125 to 167 gauss.
 - Left earcup is -111 to -161 gauss.

See [Magnetic Flux Probe](#) (page 111) for the precise measuring point, and [AirPods Max, 2 of 6](#) (page 558) for datums.

17.4 Magnetic Flux Probe

MAGNETIC FLUX PROBE LOCATION RELATIVE TO STAND DATUMS



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 APPLE INC. 1000 AVENUE OF LEAVES, CUPERTINO, CA 95014
 11/11 2024 10:21 AM

Apple Inc.
 PART NUMBER: NONE
 REVISION: NONE
 DATE: 11/11/24

MX GENERATED

17.5 Verification

Test procedures for AirPods accessories.

17.5.1 MagSafe Charging with Case Cover

Power test procedures for AirPods charging case covers.

17.5.1.1 Equipment

Equipment necessary for MagSafe charger testing:

- AirPods.
- AirPods charging case.
- Apple MagSafe Charger.
- Device running iOS 18.0.1 or later.

17.5.1.2 Setup

1. Insert AirPods into charging case.
2. Unlock the device and open the charging case lid.
3. Pair AirPods with the device, if necessary.
4. Using the device, verify the state of charge for:
 - a. Charging case is less than 80%.
 - b. AirPods is less than 50%.
5. Close the charging case lid.
6. Verify the MagSafe charger is plugged into a functional power source.
7. Place the charging case onto the MagSafe charger on a flat surface.
8. Verify the charging case LED turns on momentarily.
9. Monitor the charging case LED for 30 seconds and verify the LED turns off.
10. Tap the charging case and verify the LED turns on momentarily.

17.5.1.3 Procedure

1. Attach the cover to the AirPods charging case.
2. Place the charging case and attached cover onto a MagSafe charger on a flat surface.
3. Verify the charging case LED turns on momentarily.
4. Monitor the charging case LED for 30 seconds and verify the LED turns off.
5. Tap the charging case and verify the LED turns on momentarily.

18. Apple Vision Pro Accessories

Accessories shall not interfere with Apple Vision Pro operation. Keep-out regions may be found in the device dimensional drawings, see:

- [Apple Vision Pro, 1 of 6](#) (page 532)
- [Apple Vision Pro, 2 of 6](#) (page 533)
- [Apple Vision Pro, 3 of 6](#) (page 534)
- [Apple Vision Pro, 4 of 6](#) (page 535)
- [Apple Vision Pro, 5 of 6](#) (page 536)
- [Apple Vision Pro, 6 of 6](#) (page 537)
- [Apple Vision Pro Battery](#) (page 538)
- [Apple Vision Pro Audio Strap](#) (page 539)
- [ZEISS Optical Inserts, 1 of 4](#) (page 540)
- [ZEISS Optical Inserts, 2 of 4](#) (page 541)
- [ZEISS Optical Inserts, 3 of 4](#) (page 542)
- [ZEISS Optical Inserts, 4 of 4](#) (page 543)

18.1 Apple Vision Pro Storage Cases

Storage cases shall:

- Not interfere with the click or rotation function of the top button, digital crown, and fit dial.
- Not apply force on the top button, digital crown, and fit dial.
- Minimize contact with all glass surfaces, including the display and optics. When necessary, use a soft non-abrasive material.
- Maintain a power cable bend radius of at least 13 mm at the Apple Vision Pro Battery.

18.2 Apple Vision Pro Battery Holders

Battery holders should maintain at least 25% surface exposure for heat dissipation, see [Apple Vision Pro Battery](#) (page 538).

18.3 Apple Vision Pro Bands

Bands attaching to the Apple Vision Pro Audio Strap connector shall:

- Be designed to prevent hair snag between the connector and mating parts, particularly in small spaces and between hard materials.
- Not detach with a peel force less than 100 N at 12 mm from the connector.
- Have a maximum insertion force of 18.3 N.
- Not have metal contact with the elastomer portion of Apple Vision Pro Audio Strap.
- Not have a material hardness exceeding 320 HV for portions contacting the Apple Vision Pro Audio Strap connector.
- Have a maximum normal pull force of 300 N on the Apple Vision Pro Audio Strap connector.

18.4 Verification

Test procedures for Apple Vision Pro accessories.

18.4.1 Equipment

The following equipment is necessary to perform the tests in this procedure:

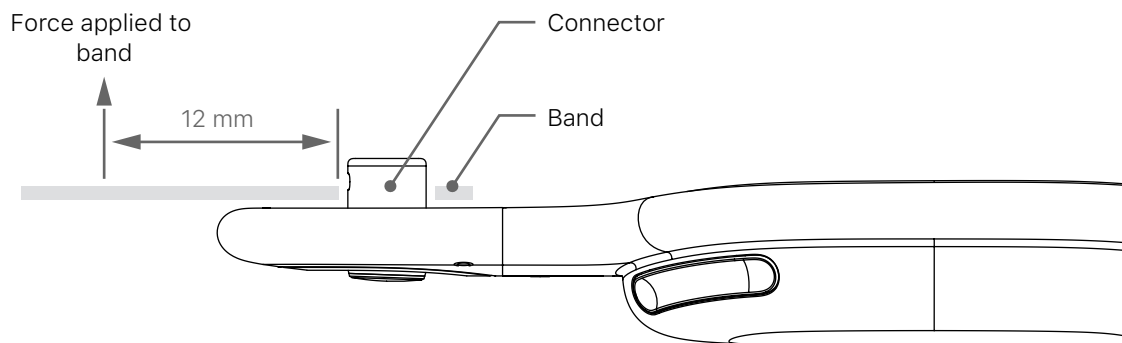
- Apple Vision Pro Audio Strap.
- Digital force gauge, such as the Chatillon DFX II.
- Hook attachment for digital force gauge.
- Clamps, or a vice, to securely hold the Apple Vision Pro Audio Strap on a flat level surface.

18.4.2 Peel Force Test

Peel force test procedure for Apple Vision Pro Bands.

1. Clamp the Apple Vision Pro Audio Strap as close to the connector as possible.
2. Apply ramping force to the band at 12 mm from the connector until 100 N of force is reached, see [Figure 18-1](#) (page 115).
3. Verify the band is still attached to the Apple Vision Pro Audio Strap. Material failure on the band is allowed.

Figure 18-1 Peel force test setup



19. Watch Bands

A well-designed watch band will securely attach to Apple Watch without interfering with Apple Watch operation. See [Device Dimensional Drawings](#) (page 284) for Apple Watch keep-out zones.

19.1 Requirements

Watch bands for Apple Watch shall integrate two lugs to mate with the [Apple Watch Band Interface](#) (page 118). Apple Watch uses a high precision interface profile, see <https://developer.apple.com/accessories/apple-watch-lug-profile.zip> for a sample 2D lug profile. Lugs should lock into the watch band mating slot with a 'lug latch' feature to prevent accidental removal of the watch band.

Exposed edges of watch bands and lugs shall pass *UL 1439, Tests for Sharpness of Edges on Equipment* and *BS EN 71-1:2014, Safety of toys - Part 1: Mechanical and physical properties*.

The lug latch shall never become jammed in the extended position.

Watch bands shall not integrate magnetic chargers.

Watch bands and lugs should:

- Pass a 72 hour salt mist test as specified in *ASTM B117* with no visible corrosion.
- Resist a 5-20 kgf lateral slide-out force when installed in Apple Watch.
- Resist a 20 kgf or greater pull force as specified in *ISO-6245:1996, Specifications for Diver's Watches – Section 7.3*.
- Detach easily from Apple Watch when the watch band release buttons are pressed.
- Take into account the weight of Apple Watch.

Watch bands shall enable the user to maintain direct skin contact with Apple Watch heart sensors and the back of Apple Watch, and shall incorporate sufficient margin to compensate for shifting or dimensional changes of the watch band material. Failure to do so may interfere with Apple Watch wrist detect and Apple Pay features. Watch bands should:

- Have length sizing adjustment pitch of less than 7 mm (center to center).
- Provide sufficient adjustability for the user to achieve a snug, yet comfortable fit preventing movement of Apple Watch relative to the wearer's skin.

Watch bands intended for use during exercise should maintain a snug fit through a full range of motion to maintain compatibility with Apple Watch heart sensors.

19. Watch Bands

19.1 Requirements

Apple recommends the following materials for lug bodies:

- 75 Shore A silicone.
- 50-55% glass-filled nylon.
- 240-270HV 316L / EN 1.4435 stainless steel.

Apple recommends the following materials for lug latches:

- 50-55% glass-filled nylon.
- 240-270HV 316L / EN 1.4435 stainless steel.

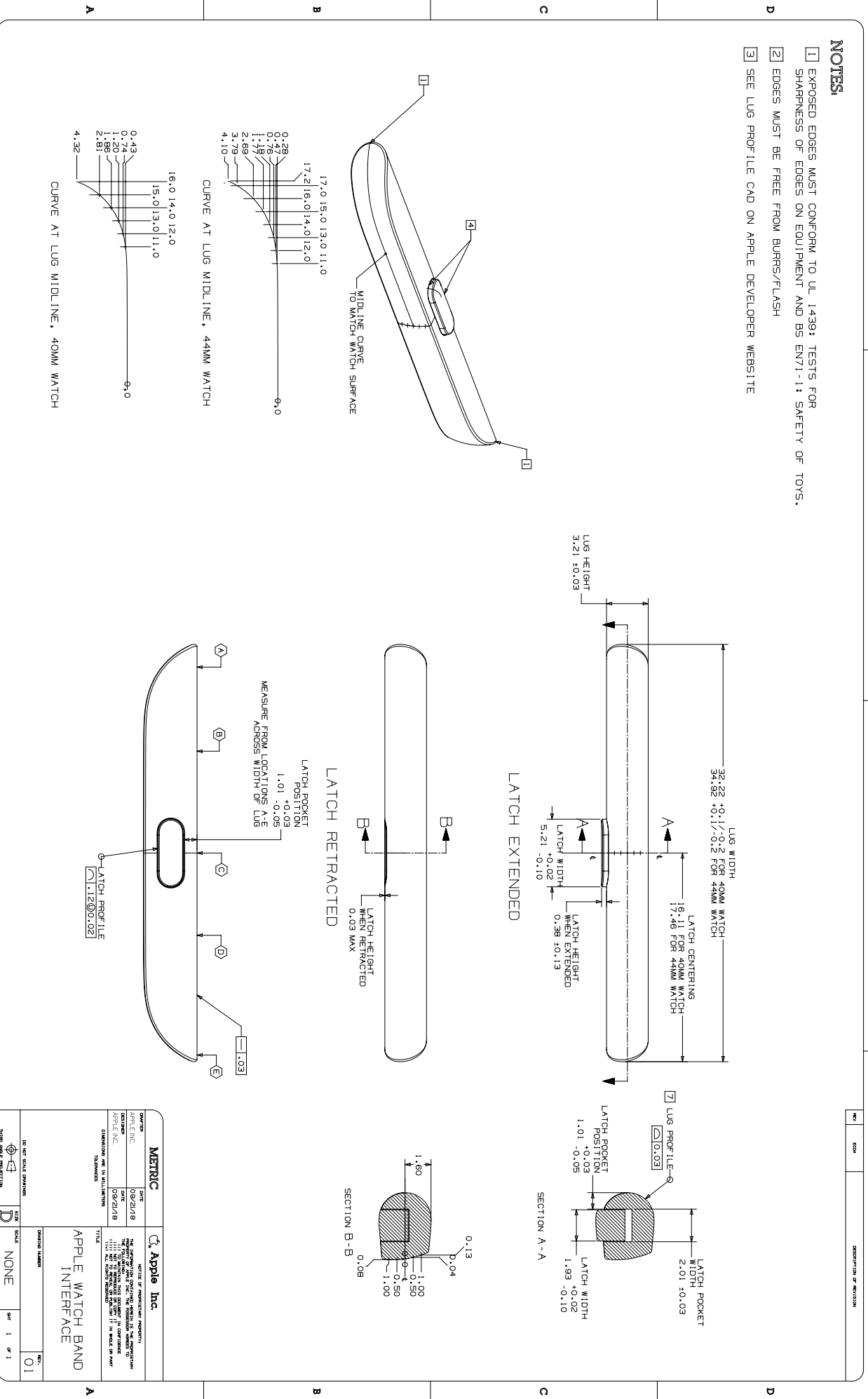
Watch bands for Apple Watch shall comply with applicable environmental regulations for the regions in which the watch bands are to be sold, and any applicable substance or material restrictions, including applicable restrictions on:

- Organic tin compounds, PFOS, PFOA, phthalates, azo dyes, polybrominated biphenyls (PBBs) and PAHs, per requirements of the EU REACH regulation EC 1907/2006.
- Nickel leach rate on surfaces in prolonged skin contact, per requirements of the EU REACH regulation EC 1907/2006.
- Cadmium, lead, hexavalent chromium, and nickel, per requirements of EU Directive 2009/48/EC.
- Natural rubber latex, per requirements of EU Directive EC 93/42/EEC.
- Dimethylfumarate (DMFu), per requirements of EU Regulation 412/2012.
- pH and Formaldehyde, per requirements of China GB 18401 for textiles and China GB 20400 for leather.
- Endangered species of flora and fauna in products or packaging (US Lacey Act).
- Polybrominated diphenyl ethers (PBDE).

19.2 Apple Watch Band Interface

NOTES:

- 1 EXPOSED EDGES MUST CONFORM TO UL 1439: TESTS FOR SHARPNESS OF EDGES ON EQUIPMENT AND BS EN71-1: SAFETY OF TOYS.
- 2 EDGES MUST BE FREE FROM BURRS/FLASH
- 3 SEE LUG PROFILE CAD ON APPLE DEVELOPER WEBSITE



4 3 2 1

METRIC		Apple Inc.	
DATE	09/21/18	DATE	09/21/18
DESIGNED BY	Apple Inc.	DESIGNED BY	Apple Inc.
DATE	09/21/18	DATE	09/21/18
DESIGNED IN	USA	DESIGNED IN	USA
TOLERANCES		TOLERANCES	
TITLE		TITLE	
APPLE WATCH BAND INTERFACE		APPLE WATCH BAND INTERFACE	
DO NOT SCALE DIMENSIONS	THE	DATE	REV
NO DIMENSIONAL RESTRICTIONS	D	NONE	1 OF 1
			01

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19.3 Example Apple Watch Lug Assembly

Assembly instructions are based on [Example Apple Watch Lug](#) (page 121) and an assembly fixture with a clamping mechanism.

Proper assembly of the lug is critical to ensure the watch band securely attaches to Apple Watch. Improper assembly may result in damage to Apple Watch and/or the watch band.

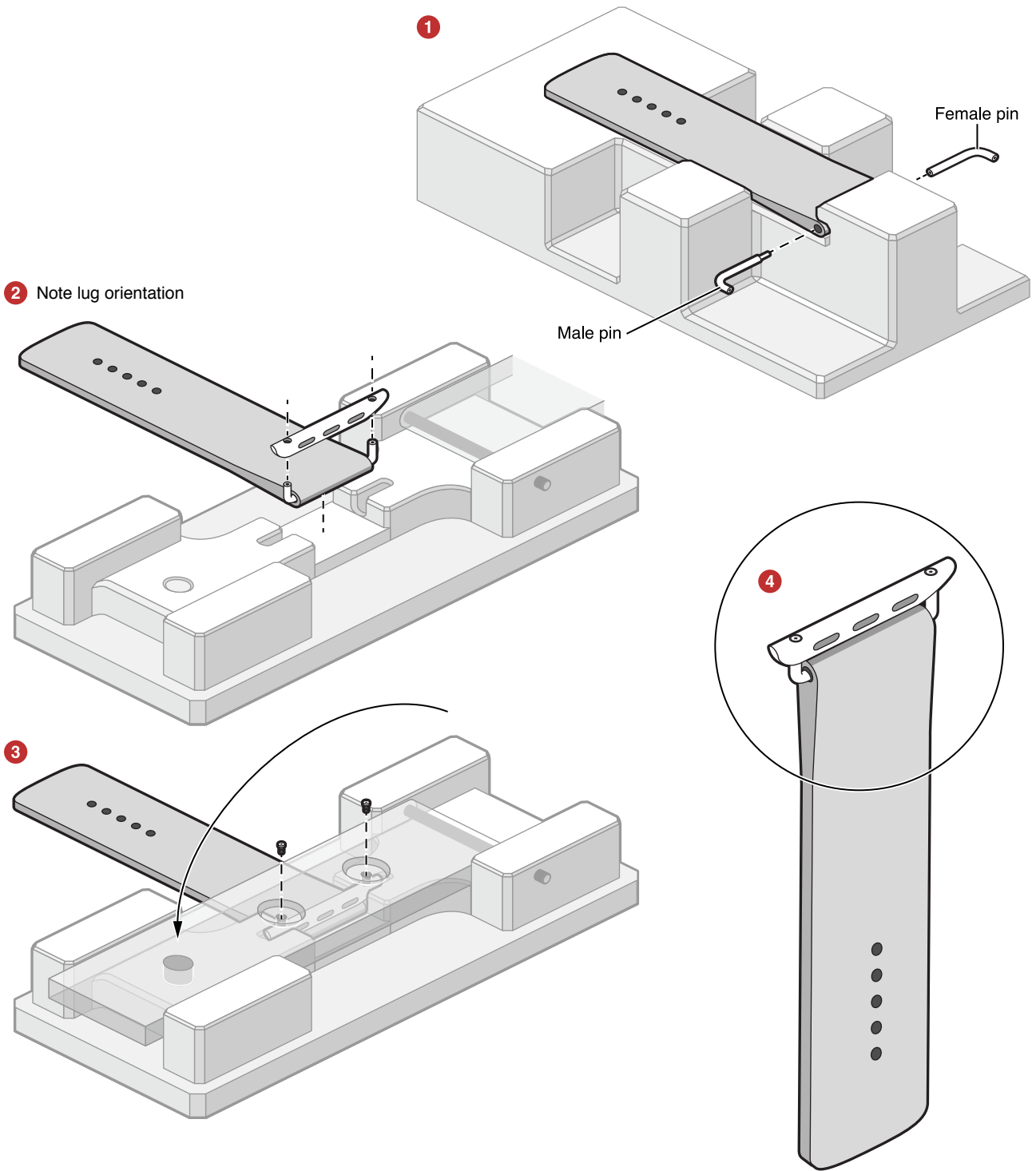
Screw threads should be secured with Loctite 435. Previously installed/used screws should not be reused.

The assembly fixture should hold the lug assembly in place and a clamping mechanism should compress the lug during screw insertion.

Assemble the watch band and lug as follows, see [Figure 19-1](#) (page 120).

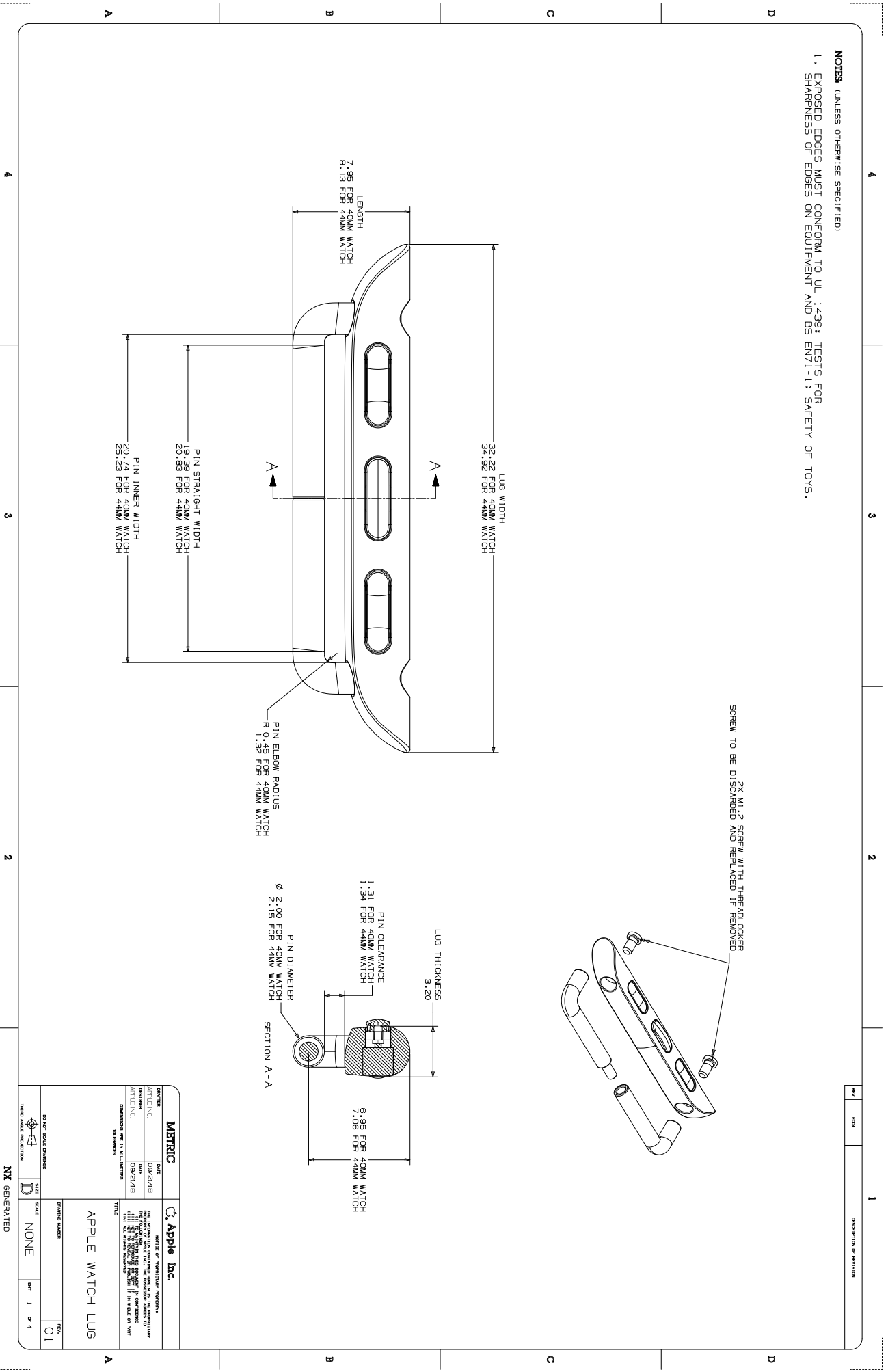
1. Lightly insert the long end of the female pin in the watch band until hard stop. Ensure there is no warping or damage in the watch band.
2. Lightly insert the long end of the male pin in the other side of the band until it interlocks with the female pin and both pins are seated together. Ensure there is no warping or damage in the watch band.
3. Align the holes on the bottom of the lug with the exposed ends of the female and male pins. Note lug latch top/bottom orientation relative to the watch band. Latch shall be on the side of the watch band against the wrist.
4. Apply Loctite 435 to screw threads.
5. Install both screws using the following specification:
 - Torque: 1.1 kgf-cm \pm 10%
 - RPM: 120 \pm 10%
6. Visually inspect at 1200-1400 lux for screw proudness and cross-threading.
7. Ensure screws are just sub-flush to the lowest part of the counterbore and appear parallel to the long axis of the lug.
8. Ensure screws are undamaged, flat, and concentric with the counterbore.

Figure 19-1 Apple Watch lug assembly fixture



19.4 Example Apple Watch Lug

NOTES: (UNLESS OTHERWISE SPECIFIED)
 1. EXPOSED EDGES MUST CONFORM TO UL 1439: TESTS FOR SHARPNESS OF EDGES ON EQUIPMENT AND BS EN71-1: SAFETY OF TOYS.



METRIC		Apple Inc.	
DATE	09/21/18	DATE	09/21/18
DESIGNED BY	APPLE INC.	DESIGNED BY	APPLE INC.
DATE	09/21/18	DATE	09/21/18
DIMENSIONS ARE IN MILLIMETERS			
TOLERANCES			
NONE			
DRAWING NUMBER			
APPLE WATCH LUG			
DO NOT SCALE DIMENSIONS		SCALE	
NONE		NONE	
HARD COPY INDENTATION		SHEET 1 OF 4	
MX GENERATED		REV. 01	

20. Apple MagSafe Charger Mounts

Apple MagSafe Charger mounts (stands, docks, and other holders) provide a means to hold and position the charger and may support StandBy, see [StandBy Mounts](#) (page 123).

20.1 Mechanical

Mounts shall be compatible with:

- [Apple MagSafe Charger \(1 m\) and Apple MagSafe Charger \(2 m\)](#) (page 567)
- [Apple MagSafe Charger](#) (page 568)

Mounts should keep the Apple MagSafe Charger secure when attaching, detaching, or rotating a device.

Mounts shall not interfere with or cause [Scratches and Damage](#) (page 28) to the device.

To avoid interference with devices, mounts shall:

- Not exceed 30 mm from the center of the Apple MagSafe Charger surface towards the top edge of the device for all supported device orientations. If the device can be attached in any orientation, the accessory shall not exceed 30 mm in radius around the center of the Apple MagSafe Charger surface.
- Maintain a clearance of 5 mm from the back of the device (mating surface) for any part of the accessory past the 30 mm keep-in constraint.
- Stay within the [MagSafe Accessory Enclosure Geometry](#) (page 180).

21. StandBy Mounts

StandBy provides iPhone users a full-screen experience with glanceable information designed to be viewed from a distance when iPhone is in landscape orientation, locked, and charging. StandBy can be personalized to display a range of widgets and supports Live Activities, Siri, incoming calls, and notifications. StandBy remembers user's preferred views when using MagSafe.

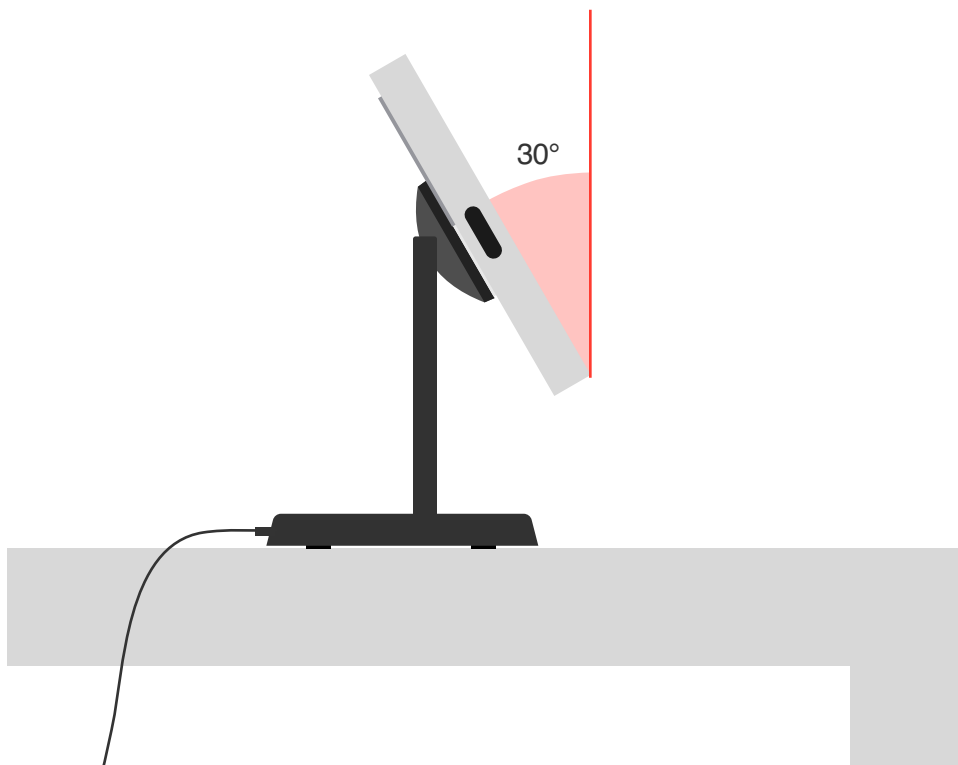
Figure MagSafe example
21-1



This feature is supported on iOS 17.0 or later.

21.1 Product Design

Figure 21-2 StandBy mount example



Mounts supporting StandBy shall:

- Support landscape orientation.
- Support inductive or wired device charging.
- Not obstruct or touch the device cover glass or any device sensors.
- Not cause [Scratches and Damage](#) (page 28).

Mounts may be [Apple MagSafe Charger Mounts](#) (page 122).

The mounts should:

- Prevent free rotation of the device.
- Enable an adjustable backward tilt of at least 30° for optimal visibility.

- Be stable to prevent unintentionally exiting StandBy.
- Not obstruct [Access to Controls](#) (page 36).
- Implement the [MagSafe Accessory Magnet Array](#) (page 173).

21.2 Verification

21.2.1 Equipment

The following equipment is necessary:

- Supported device running iOS 17.0 or later.
- A charger, if not integrated in accessory.

21.2.2 Enable StandBy

1. Attach locked device in landscape orientation to the accessory.
2. Attach a charger if the accessory does not integrate inductive or wired charging.
3. Verify device enters StandBy within a few seconds.

21.2.3 Product Design

Verify the StandBy Mount:

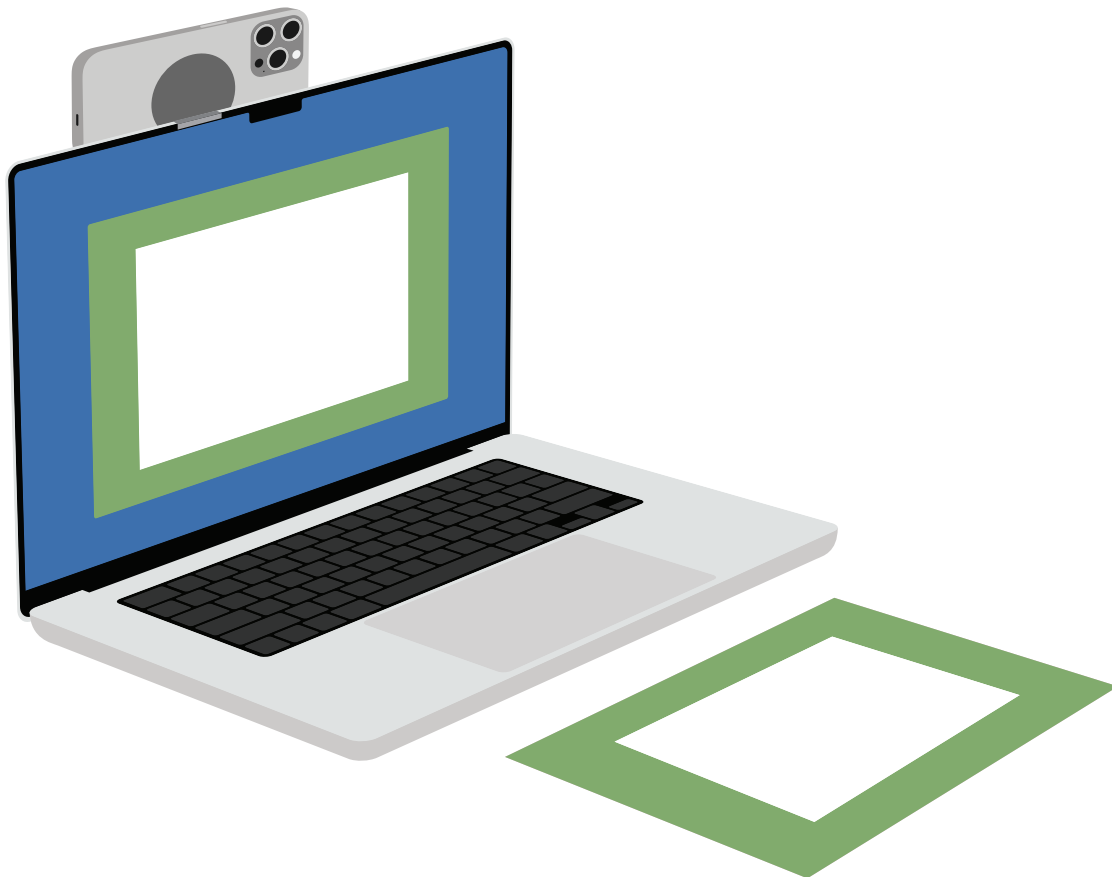
1. Supports landscape orientation.
2. Does not obstruct or touch the device cover glass or any device sensors.
3. Does not scratch or damage device.

22. Continuity Camera Mounts

Continuity Camera enables device cameras to be used with Apple TV or Mac and supports Portrait, Studio Light, Center Stage, Reactions, and Desk View video effects. System requirements for Continuity Camera are available at <https://support.apple.com/en-us/108046#camera>.

Mounts supporting Continuity Camera securely hold a device at the optimal height and angle to use with FaceTime and other apps.

Figure 22-1 MacBook Desk View example



22.1 Product Design

Mounts supporting Continuity Camera shall:

- Support devices in portrait and landscape orientations.
- Enable use of a USB-C cable or USB to Lightning charge cable.
- Not touch the device cover glass, block any device camera field of view, or obstruct any ambient light sensors, see [Device Dimensional Drawings](#) (page 284).
- Not cause [Scratches and Damage](#) (page 28).

The mounts should:

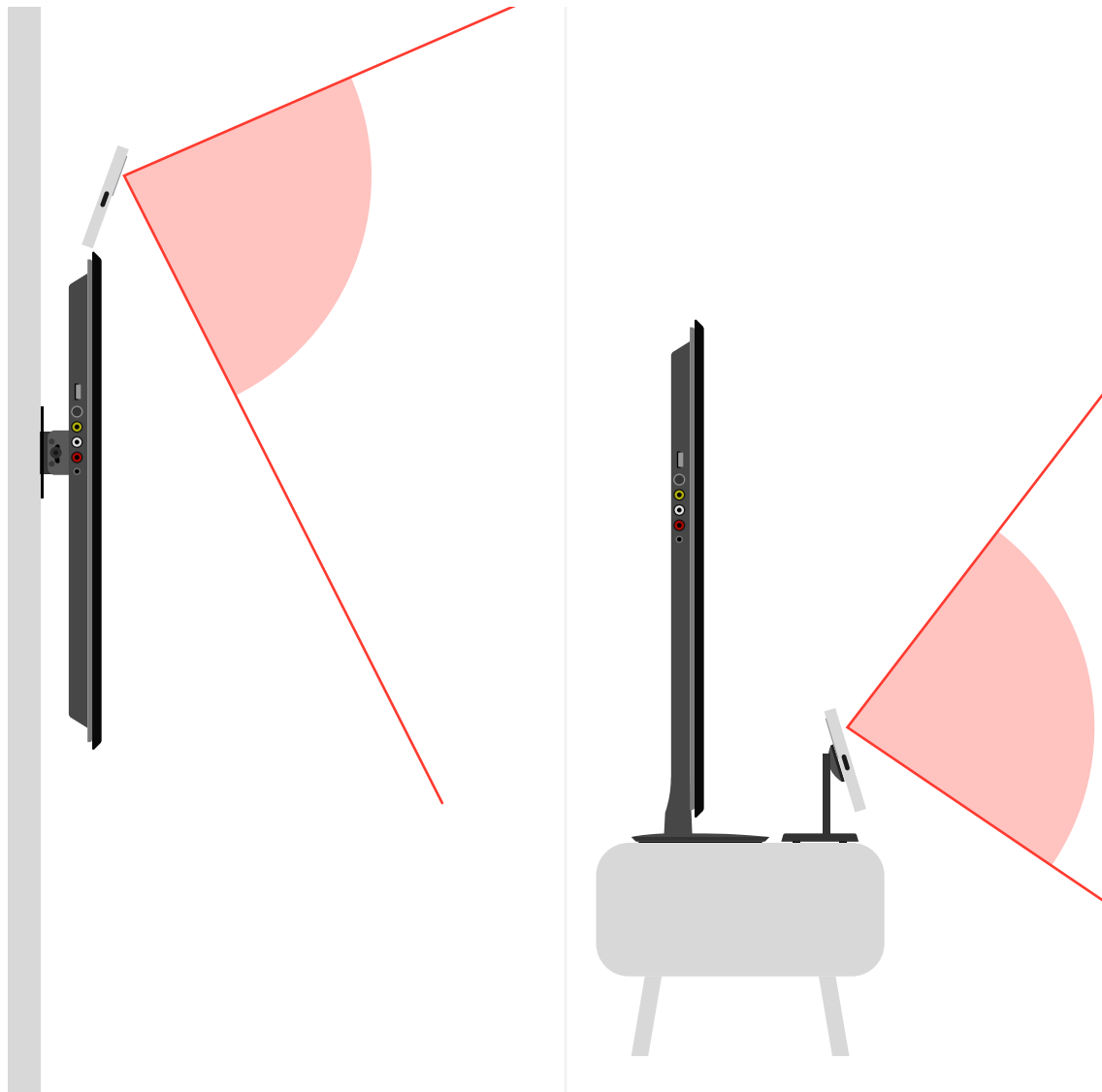
- Prevent free rotation of the device.
- Enable a device camera lens height of at least 228 mm to support Desk View.
- Not obstruct [Access to Controls](#) (page 36).
- Implement the [MagSafe Accessory Magnet Array](#) (page 173).
- Support [Tripod Connections](#) (page 33).

Additional requirements apply to mounts used in the following scenerios:

- [Apple TV Mount](#) (page 128)
- [MacBook Mount](#) (page 129)
- [iMac or Display Mount](#) (page 130)

22.2 Apple TV Mount

Figure 22-2 Apple TV mount example



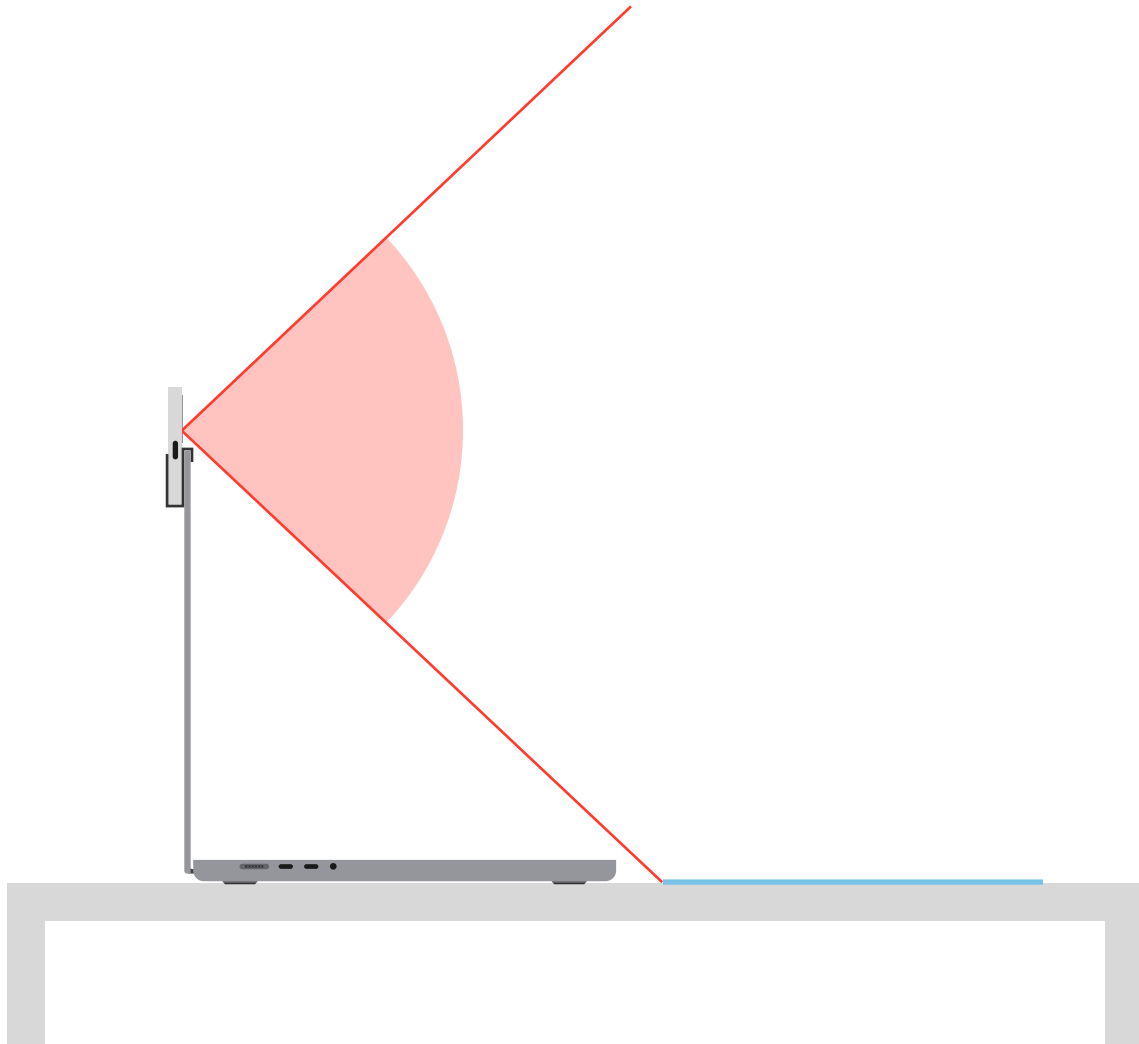
A mount designed for Apple TV shall:

- Be stable when placed on top, or in front of a TV.
- Not touch the display glass (active and non-active areas).
- Not sandwich or squeeze the TV and device together.

The mount should enable upward and downward tilt.

22.3 MacBook Mount

Figure 22-3 MacBook mount example



A mount designed for MacBook, MacBook Air, and MacBook Pro shall:

- Not scratch or damage the MacBook.
- Not touch the MacBook display glass (active and non-active areas).
- Not interfere with or prevent fully closing the MacBook.
- Not sandwich or squeeze the MacBook and device together.

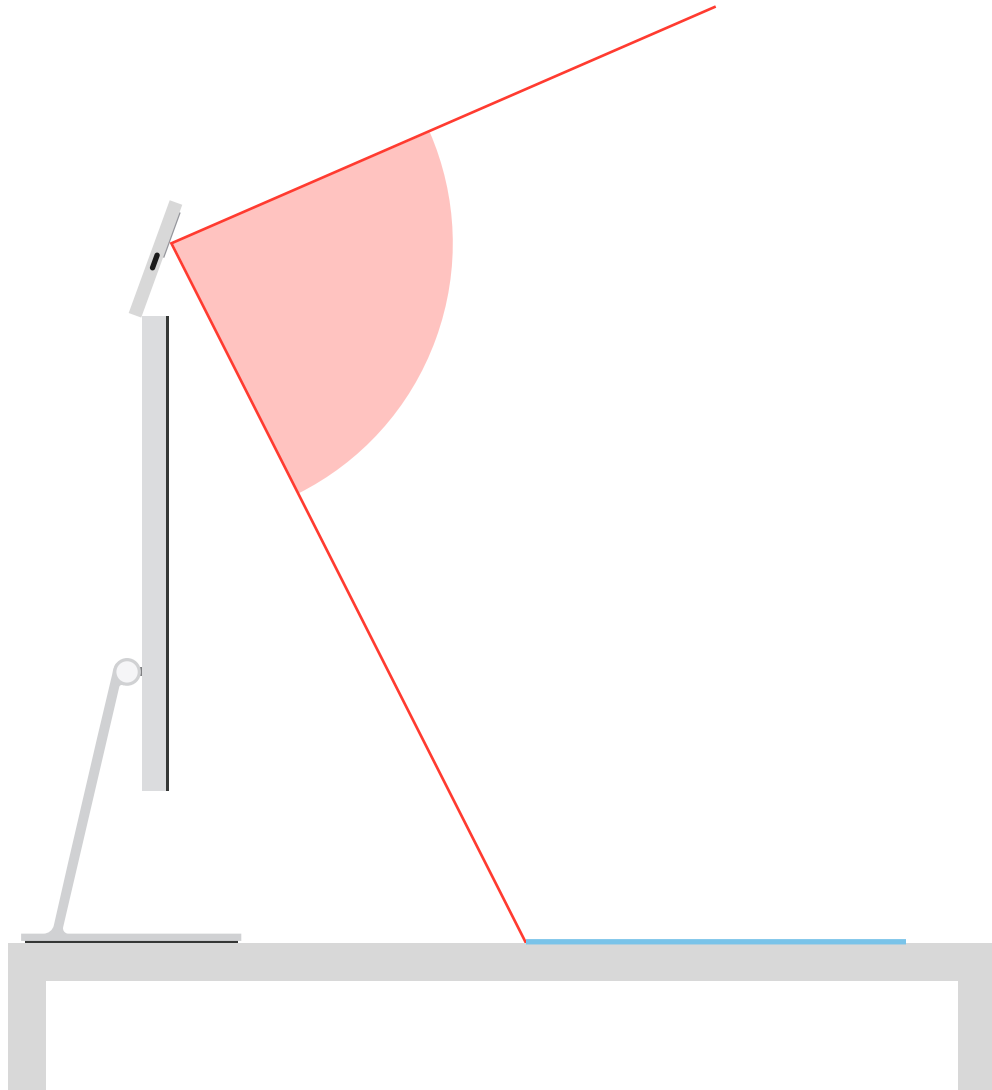
The mount should:

- Not cover or touch any portion of the MacBook display glass, camera, or other sensors.
- Enable a downward tilt in portrait orientation from 0° to 12° to support Desk View.

- Minimize the mass to maintain stability of the display.

22.4 iMac or Display Mount

Figure Display mount example
22-4



A mount designed for iMac or displays shall:

- Not scratch or damage the iMac or display.
- Not touch the display glass (active and non-active areas).
- Not sandwich or squeeze the iMac or display and device together.

The mount should:

- Not cover or touch any portion of the display glass, camera, microphones, or other sensors.
- Enable a downward tilt from 0° to 30° to support Desk View.

22.5 Verification

22.5.1 Equipment

The following equipment is necessary to perform the tests in this procedure:

- If the mount is designed for Apple TV:
 - Supported devices running iOS 17.0 or later.
 - An Apple TV 4K (2nd generation) or later running tvOS 17.0 or later, connected to a TV.
- If the mount is designed for Mac:
 - Supported devices running iOS 16.0 or later.
 - A Mac computer running macOS 13.0 Ventura or later.
 - A MacBook, MacBook Air, and MacBook Pro if the mount is designed for MacBook.
 - An iMac if the mount is designed for iMac.
 - A variety of displays if the mount is designed for external displays.
 - A USB-C cable.
 - A USB to Lightning charge cable.
- An Apple Account with two-factor authentication enabled and used on devices, Apple TV, and all Mac computers.
- A tripod, if the mount is designed for tripod connections.

22.5.2 Setup

22.5.2.1 Enable Continuity Camera on Apple TV

Configure an Apple TV and a device to enable Continuity Camera:

1. Open FaceTime on the Apple TV.
2. Select the user matching the device Apple Account.
3. Using the device, select the Continuity Camera notification and select Accept.
4. Attach the device to mount and orient it as prompted.
5. Verify Continuity Camera view displays full screen in FaceTime.

22.5.2.2 Enable Continuity Camera on Mac

Configure a Mac and a device to enable Continuity Camera:

1. Connect the device to the Mac using a cable.

2. If the Mac is not a trusted computer, select Trust on the Trust This Computer alert on the device.
3. To use Continuity Camera wirelessly, disconnect the cable.
4. Attach the device to mount.
5. Open FaceTime on the Mac.
6. If the 'Use your iPhone as a Camera for your Mac' alert appears, select Continue.
7. Select the Continuity Camera option from the Video menu.
8. Verify Continuity Camera view displays in FaceTime.

Reconnect after the Mac and/or device are in sleep mode:

1. Wake the device and the Mac.
2. Connect the device to the Mac using a cable for a wired connection or disconnect the cable for a wireless connection.
3. Attach the device to the mount.
4. Open FaceTime on the Mac and select Continuity Camera from the Video menu.
5. Verify Continuity Camera view displays in FaceTime.

22.5.3 Product Design

Verify the mount:

1. Supports portrait and landscape orientations.
2. Does not touch the device cover glass or block any device camera field of view.
3. Does not scratch or damage the device.
4. When designed for tripods, complies with ISO 1222:2010.

If the mount is designed for Apple TV, verify the mount:

1. Is stable when placed on top, or in front of a TV.
2. Does not touch the display glass.
3. Does not sandwich or squeeze the TV and device together.

If the mount is designed for MacBook, iMac, or displays, verify the mount:

1. Does not touch the display glass.
2. Does not block any MacBook, iMac, or display camera field of view.
3. Does not sandwich or squeeze the device, MacBook, iMac, or display together.
4. Does not scratch or damage the device, MacBook, iMac, or display.
5. Enables use of USB-C cables or USB to Lightning charge cables.

22.5.4 Center Stage

Center Stage is a video effect available on Apple TV and in the Mac Control Center. Enabling Center Stage on Apple TV, or selecting it in the Control Center Video Effects causes the video to follow people's faces as they move within the Continuity Camera field of view. The video will zoom (in and out) and pan (left to right, right to left, up and down), to keep people's faces in the video frame.

22.5.4.1 Center Stage on Apple TV

Perform mount testing using the FaceTime app on Apple TV to ensure the mount is not visible in the field of view:

1. Observe the Continuity Camera video from different positions using Center Stage face tracking, from the most extreme visible positions (left, right, top, bottom, and all four corners).
2. Verify there are no visual anomalies caused by the mount in any position.

22.5.4.2 Center Stage on Mac

Perform mount testing using the Photo Booth app on the Mac, with and without Center Stage enabled, to ensure the mount is not visible in the field of view:

1. Open the Photo Booth app on the Mac:
 - a. Use the Camera menu to select Continuity Camera.
 - b. Use the still photo mode.
2. Use the Mac Control Center menu to select Video Effects, and enable Center Stage.
3. Capture photos from different positions using Center Stage face tracking, in portrait and landscape orientation from the most extreme visible positions (left, right, top, bottom, and all four corners), waiting 5 seconds between each photo.
4. Use the Mac Control Center menu to select Video Effects, and disable Center Stage.
5. Capture photos in portrait and landscape orientation, waiting 5 seconds between each photo.
6. Using the Photo Booth film strip feature, verify all photos taken during the test:
 - a. Are saved to the computer.
 - b. Are clearly displayed when viewed.
 - c. Have no visual anomalies caused by the mount in either portrait and landscape orientation.

22.5.5 Desk View

Desk View is a video effect available in the Mac Control Center. Selecting Video Effects and enabling Desk View causes a confirmation dialog box to appear, then a separate Desk View window opens. The tilt angle of the mount and its position determines the Desk View field of view. Adjust the tilt angle as necessary to display the desktop subject matter. Remote viewers will see the subject matter from the presenters perspective. Closing the Desk View window disables Desk View.

1. Ensure the device is logged into the same Apple Account used on the Mac.
2. Place the device in the mount and on the MacBook, iMac, display, tripod or free-standing support.
3. Perform mount testing using the FaceTime app with the Desk View video effect enabled.
 - a. Open the FaceTime app on the Mac, and use the Video menu to select the Continuity Camera.
 - b. Use the Mac Control Center menu to select Video Effects, and enable Desk View.
 - c. Verify the Desk View window is displayed.
4. In both landscape and portrait orientation:
 - a. Adjust the tilt angle of the mount to display the desktop subject matter in the Desk View window.

22. Continuity Camera Mounts

22.5 Verification

- b.** Verify the desktop subject matter is visible in the Desk View window, and clearly displayed.
- c.** Verify there are no visible anomalies caused by the mount in the Desk View window.
- d.** Verify the user's face is still visible in FaceTime while Desk View is showing the desktop subject matter.

Features

23. Accessory Power (USB-C)

This chapter applies to devices integrating a USB-C connector.

Accessory power enables accessories to draw a limited amount of power from a device, thereby avoiding the need to integrate a battery or connect to an external power source. This eliminates the need for users to monitor and charge the accessory and enables the accessory to function as long as the device has power. Accessories designed to temporarily connect to the device are good candidates for using accessory power.

Accessories drawing power from the device shall comply with *USB Type-C Cable and Connector Specification –Release 2.3*. Accessories should also support [USB Power Delivery \(PD\)](#) (page 213).

Accessories benefitting from accessory power include:

- [Headsets](#) (page 88).
- [Adapters](#) (page 82).
- [Keyboards](#) (page 92).
- [External Storage](#) (page 107).

23.1 Available Current

The following table lists the current available to an accessory.

Table 23-1 Available current

Device	Default	USB Type-C Current (page 214)	USB Power Delivery (PD) (page 213)
iPhone 16 Pro Max	900 mA	900 mA	900 mA (4.5 W)
iPhone 16 Pro	900 mA	900 mA	900 mA (4.5 W)
iPhone 16 Plus	500 mA	500 mA	900 mA (4.5 W)
iPhone 16	500 mA	500 mA	900 mA (4.5 W)
iPhone 15 Pro Max	900 mA	900 mA	900 mA (4.5 W)
iPhone 15 Pro	900 mA	900 mA	900 mA (4.5 W)
iPhone 15 Plus	500 mA	500 mA	900 mA (4.5 W)
iPhone 15	500 mA	500 mA	900 mA (4.5 W)

23. Accessory Power (USB-C)

23.2 Fast Role Swap (FRS)

Device	Default	USB Type-C Current (page 214)	USB Power Delivery (PD) (page 213)
iPad mini (A17 Pro)	900 mA	1.5 A	1.5 A (7.5 W)
iPad Pro 13-inch (M4)	900 mA	3.0 A	3.0 A (15 W)
iPad Pro 11-inch (M4)	900 mA	3.0 A	3.0 A (15 W)
iPad Air 13-inch (M2)	900 mA	1.5 A	1.5 A (7.5 W)
iPad Air 11-inch (M2)	900 mA	1.5 A	1.5 A (7.5 W)
iPad Pro 12.9-inch (6th generation)	900 mA	3.0 A	3.0 A (15 W)
iPad Pro 12.9-inch (5th generation)	900 mA	3.0 A	3.0 A (15 W)
iPad Pro 12.9-inch (4th generation)	900 mA	1.5 A	1.5 A (7.5 W)
iPad Pro 12.9-inch (3rd generation)	900 mA	1.5 A	1.5 A (7.5 W)
iPad Pro 11-inch (4th generation)	900 mA	3.0 A	3.0 A (15 W)
iPad Pro 11-inch (3rd generation)	900 mA	3.0 A	3.0 A (15 W)
iPad Pro 11-inch (2nd generation)	900 mA	1.5 A	1.5 A (7.5 W)
iPad Pro 11-inch (1st generation)	900 mA	1.5 A	1.5 A (7.5 W)
iPad Air (5th generation)	900 mA	1.5 A	1.5 A (7.5 W)
iPad Air (4th generation)	900 mA	1.5 A	1.5 A (7.5 W)
iPad mini (6th generation)	900 mA	1.5 A	1.5 A (7.5 W)
iPad (10th generation)	500 mA	1.5 A	1.5 A (7.5 W)

23.2 Fast Role Swap (FRS)

iPads with a USB-C connector support [USB Power Delivery \(PD\)](#) (page 213) Fast Role Swap (FRS).

23.3 Verification

23.3.1 Maximum Accessory Power

This test procedure applies to accessories drawing power from the device. The accessory needs to be exercised to its full capability.

The example accessory in this test procedure is an external USB 3 drive claiming to draw up to 900 mA from the USB 3 host. The accessory is exercised by reading and writing a large file. Adapt this procedure as needed for different accessory types.

23.3.1.1 Equipment

The following equipment is necessary:


- An external USB drive in APFS format (the example accessory).
- A Mac with USB-C.
- A USB-IF certified USB-C to USB-C Full-Featured cable.
- A USB-C breakout board or USB-IF approved test fixture, such as:
 - FS-HUCP available at <https://fixturesolution.com/product/usb2-0-type-c-signal-quality-test-fixture/>.
 - FS-HUCR available at <https://fixturesolution.com/product/usb-type-c-high-speed-signal-quality-test-fixture/>.
- An oscilloscope with a current probe.

23.3.1.2 Setup

1. Using the current probe attach the oscilloscope to the current loop circuit of the accessory, or the USB-C breakout board.
2. Verify the oscilloscope configuration settings match the following:
 - a. Acquisition: >5 M samples/s.
 - b. Current Channel: 200 mA/div.
 - c. Horizontal Channel: 100 μ s/div.
 - d. Voltage Channel: 1 V/div, bandwidth limited.
 - e. Infinite persistence (reset before each test case).
 - f. Adjust offset down, to be able see 7 divisions.
 - g. Adjust offset towards the left, to maximize the window.
 - h. Trigger: Current Channel, Positive Threshold, 900 mA, Normal Mode.
3. Connect the Mac to the external USB drive using the USB-C cable.
4. Launch Terminal on the Mac, and enter the following command:
 - `dd if=/dev/random of=~ /Desktop/testfile.dat count=1024 bs=78643200`
5. The new file `~/Desktop/testfile.dat` is the file to use for testing.

23.3.1.3 Procedure

23.3.1.3.1 Enumeration

1. Verify the external USB drive fully enumerates in the Mac System Report:
 - a. Select Apple Menu  > 'About this Mac'.
 - b. Select 'More Info...'
 - c. Select 'System Report...'
 - d. Select USB from the sidebar.
2. Verify the accessory is displayed in the USB Device Tree.
3. Verify the speed displayed is one of the following:
 - a. Up to 5 Gb/s.

23. Accessory Power (USB-C)

23.3 Verification

- b. Up to 10 Gb/s.

23.3.1.3.2 Idle

1. Record the maximum current while idle.
2. Verify the maximum current does not exceed 900 mA.

23.3.1.3.3 Write to USB Drive

1. Use Finder to copy the `testfile.dat` from the Mac to the USB drive.
2. Record the maximum current.
3. Verify the maximum current does not exceed 900 mA.

23.3.1.3.4 Read from USB Drive

1. Use Finder to copy the `testfile.dat` from the USB drive to the Mac.
2. Record the maximum current.
3. Verify the maximum current does not exceed 900 mA.

24. Accessory Power (Lightning)

Accessory power enables accessories to draw a limited amount of power from a device, thereby avoiding the need to integrate a battery or connect to an external power source. This eliminates the need for users to monitor and charge the accessory and enables the accessory to function as long as the device has power. Accessories designed to temporarily connect to the device are good candidates for using accessory power.

See the [Accessory Interface Specification](#) (page 26) for more information.

25. App Discovery

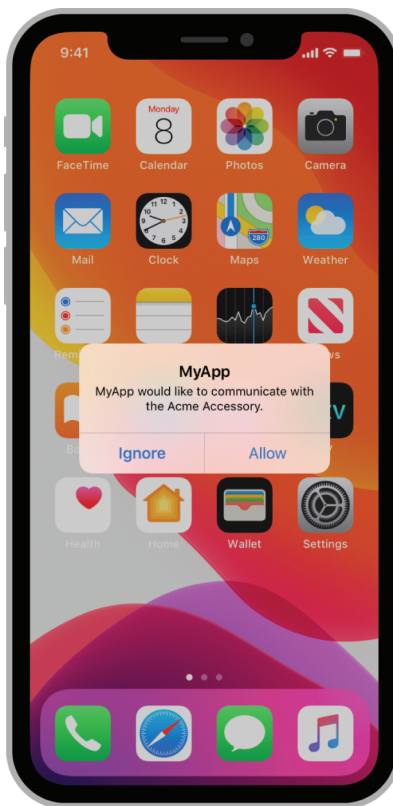
The App Discovery feature enables accessories to retrieve a list of installed apps on the device capable of communicating with the accessory. See [App Launch](#) (page 142) to use the list.

See the [Accessory Interface Specification](#) (page 26) for more information.

26. App Launch

Accessories supporting the App Launch feature can request a device launch an app on its behalf.

Figure 26-1 App Launch alert



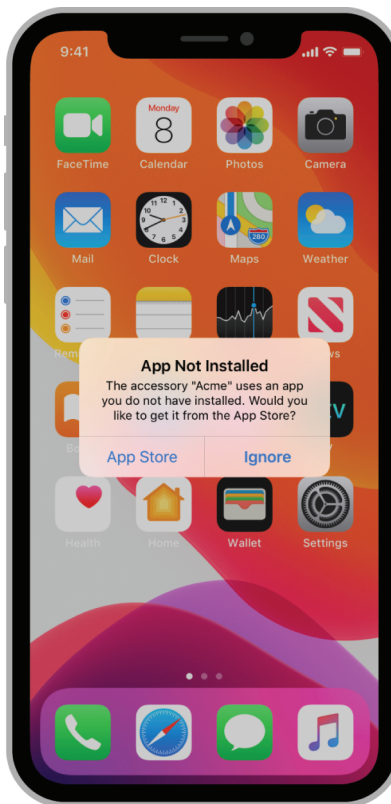
See the [Accessory Interface Specification](#) (page 26) for more information.

27. App Match

The App Match feature enables accessories supporting an External Accessory Protocol to match with compatible apps on the App Store.

When connected for the first time, the device asks the user if they would like to visit the App Store and view compatible apps. Subsequently, this action may be repeated using Settings > General > About > '[Accessory name]' > 'Find App for Accessory'.

Figure 27-1 App Match alert



See the [Accessory Interface Specification](#) (page 26) for more information.

28. Bluetooth Accessory Identification

This chapter describes Apple-specific Bluetooth commands extending accessory capabilities beyond those supported by standard Bluetooth profiles.

To enable Apple-specific features, the accessory shall support [HFP Command AT+XAPL](#) (page 144), which provides accurate information about the accessory's supported features. The device will use the information sent by this command to enable and disable custom commands.

The accessory shall send the following AT+XAPL command after making a successful HFP Service Level Connection (SLC) to the device. The accessory should send an AT+XAPL command first, before sending any additional Apple-specific commands. See [Siri](#) (page 190) and [Bluetooth Headset Battery Level Indication](#) (page 146).

28.1 HFP Command AT+XAPL

Description: Enables custom AT commands from an accessory.

Initiator: Bluetooth accessory

Format: AT+XAPL=*vendorID-productID-version,features*

Parameters:

- *vendorID*: A string representation of the hex value of the vendor ID from the manufacturer, without the 0x prefix.
- *productID*: A string representation of the hex value of the product ID from the manufacturer, without the 0x prefix.
- *version*: The software version.
- *features*: A base-10 representation of a bit field. Available features are:
 - Bit 0 = reserved
 - Bit 1 = The accessory supports battery reporting (reserved only for battery operated accessories).
 - Bit 2 = The accessory is docked or powered (reserved only for battery operated accessories).
 - Bit 3 = The accessory supports Siri status reporting.
 - Bit 4 = the accessory supports noise reduction (NR) status reporting.
 - All other values are reserved.

Example: AT+XAPL=ABCD-1234-0100,10 (Supports battery reporting and Siri status)

28. Bluetooth Accessory Identification

28.1 HFP Command AT+XAPL

Response: +XAPL=iPhone,*features*

29. Bluetooth Headset Battery Level Indication

Any Hands-Free Bluetooth headset accessory may display its battery level to the user as an indicator icon in the device status bar. This feature is supported on all devices supporting the Hands-Free Profile, including iPhone, iPod touch, and iPad.

Headset battery indication is implemented by two Apple-specific Bluetooth HFP AT commands, [HFP Command AT+XAPL](#) (page 144) and [HFP Command AT+IPHONEACCEV](#) (page 146)

29.1 HFP Command AT+IPHONEACCEV

Description: Reports a headset state change.

Initiator: Headset accessory

Format: AT+IPHONEACCEV=*Number of key/value pairs, key1, val1, key2, val2, . . .*

Parameters:

- *Number of key/value pairs:* The number of parameters coming next.
- *key:* the type of change being reported:
 - 1 = Battery Level
 - 2 = Dock State
- *val:* the value of the change:
 - Battery Level: string value between '0' and '9'
 - Dock State: 0 = undocked, 1 = docked

Example: AT+IPHONEACCEV=1,1,3

30. Device Power (USB-C)

Accessories may provide power to devices using USB-C.

Apple recommends providing power to the device whenever possible for the best user experience.

Accessories providing power to a device shall:

- Connect to the device either through an integrated [USB-C Plug](#) (page 271) or a USB-C cable.
- Use [USB Type-C Current](#) (page 214) to identify their power capability and should use [USB Power Delivery \(PD\)](#) (page 213) to provide higher power, see <https://support.apple.com/en-us/102574>.
- Provide power at all times unless a direct user action is taken turning the accessory 'off'. Failure to provide power at all times may result in the accessory being unable to charge a device whose battery level is too low to boot.

Accessories may use the [iAP2](#) (page 219) protocol in conjunction with [USB Type-C Current](#) (page 214) to allow for more granular control of the available current after the initial connection. Accessories shall not use [iAP2](#) (page 219) to adjust available current in conjunction with [USB Power Delivery \(PD\)](#) (page 213).

Accessories providing power from a USB-C receptacle, see [Providing Power](#) (page 276).

30.1 External Power Source

Accessories drawing power from external power sources and providing all or a portion of their power to the device shall:

- Identify the power source's capability and report accordingly to the device.
- Not manipulate a device into drawing more power from the external power source than the device would normally draw when directly connected to the external power source.
- Derate the available power by the amount of power consumed by the accessory, if applicable.

Accessories drawing power from external power sources may inform the device when power is not available or only available at a reduced level (for example, from an internal battery) or when the user unplugs the accessory from the external power source (for example, an AC power adapter or AC "mains" power outlet). Power to the device shall be restored and the updated power providing capability change shall be communicated to the device when the user re-connects the external power source.

See [AC Power Adapters](#) (page 84), [Providing Power](#) (page 276), and [User Supplied Cables and AC Power Adapters](#) (page 28) for additional requirements specific to external USB power supplies/cables.

30.2 Power State Changes

Accessories shall not change the amount of power provided to a device unless:

- Direct user action is taken to turn the accessory on or off.
- An external power source (for example, mains electricity or battery) is connected to or disconnected from the accessory.
- The accessory's internal power source (for example, a battery) is depleted or loaded to the point where it is no longer capable of supplying its declared power providing capability or is now capable of supplying more power than previously declared.

31. Device Power (Lightning)

Accessories may provide power to devices using Lightning.

Apple recommends providing power to the device whenever possible for the best user experience.

Accessories providing power to a device shall connect to the device either through an integrated Lightning connector or a USB to Lightning cable. To incorporate an integrated Lightning connector, the accessory developer shall be a member of the [Apple MFi Program](#) (page 26).

Accessories providing power to a device shall either:

- Provide direct power, see [Direct Power Source](#) (page 149).
- Manage power from external sources, see [External Power Source](#) (page 149).

Accessories without the potential for data communication with the device shall provide direct power to the device, see [Direct Power Source](#) (page 149).

31.1 Direct Power Source

Accessories providing power directly shall provide power at all times unless disabled by a direct user action. Failure to provide power at all times may result in the accessory being unable to charge a device whose battery level is too low to boot.

Accessory power source testing shall be performed with programmable loads, not devices. Device power draw varies with environmental factors.

31.2 External Power Source

Accessories drawing power from external power sources and providing all or a portion of their power to the device:

- Shall identify the power source's capability and report accordingly to the device.
- Shall not manipulate a device into drawing more power from the external power source than the device would normally draw when directly connected to the external power source.
- Shall not manipulate a device into drawing less than the minimum power required by the accessory compatibility claims if it is available from the external source, see [Providing Power using USB Connectors](#) (page 150).

Accessories drawing power from external power sources may inform the device when power is not available or only available at a reduced level (for example, from an internal battery) or when the user unplugs the accessory from the external power source (for example, an AC power adapter or AC "mains" power outlet). Power to the device shall be restored and the updated power providing capability change shall be communicated to the device when the user re-connects the external power source.

See [AC Power Adapters](#) (page 84), [Electrical](#) (page 270), and [User Supplied Cables and AC Power Adapters](#) (page 28) for additional requirements specific to external USB power supplies/cables.

31.3 Declaring Capability

If the accessory provides power using a:

- USB-A receptacle, it shall use one of the following to declare its power providing capability:
 - [USB Power Capability Vendor Request](#) (page 209).
 - [USB D+/D- Resistor Networks](#) (page 210).
- USB-C receptacle, then:
 - It shall use one of the following to declare its power providing capability:
 - [USB Type-C Current](#) (page 214).
 - [USB Power Delivery \(PD\)](#) (page 213).
 - If the accessory does not have the potential for data communication with the device, it shall also support the *USB Battery Charging Specification –Release 1.2*.

31.4 Providing Power using USB Connectors

Accessories providing power from:

- A USB-C receptacle, see [USB-C Receptacle](#) (page 275).
- A USB-A receptacle, see [USB-A Receptacle](#) (page 270).

31.5 Labeling Multiple Connectors

If the accessory has multiple connectors with different device compatibilities, iPad-compatible connectors shall be labeled with the text 'iPad' unless it is physically impossible to connect an iPad to iPhone/iPod compatible connectors.

31.6 Fast Charge for iPhone (20 W)

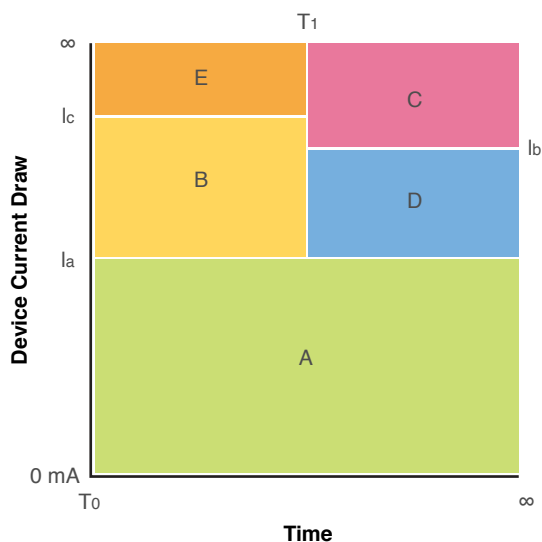
Accessories advertising "fast charge" for iPhone (<https://support.apple.com/en-us/102574>) shall:

- Support [USB Power Delivery \(PD\)](#) (page 213).
- Supply at least 20 W (2.22 A at 9 V) using USB PD.
- Claim compatibility with at least one of the following iPhone models:
 - iPhone 14 Pro Max
 - iPhone 14 Pro
 - iPhone 14 Plus
 - iPhone 14
 - iPhone SE (3rd generation)
 - iPhone 13 Pro Max
 - iPhone 13 Pro
 - iPhone 13
 - iPhone 13 mini
 - iPhone 12 Pro Max
 - iPhone 12 Pro
 - iPhone 12
 - iPhone 12 mini
 - iPhone SE (2nd generation)
 - iPhone 11 Pro Max
 - iPhone 11 Pro
 - iPhone 11
 - iPhone XS Max
 - iPhone XS
 - iPhone XR
 - iPhone X
 - iPhone 8 Plus
 - iPhone 8

Accessories such as charging cables should be capable of supporting up to 60 W (3 A at 20 V) to provide compatibility with a variety of sources and devices.

31.7 Overcurrent and Short Circuit Protection

Figure 31-1 Overcurrent and short circuit protection



Power-providing accessories shall implement overcurrent and short circuit protection for each region in [Figure 31-1](#) (page 152) according to [Table 31-1](#) (page 152), [Table 31-2](#) (page 152), and [Table 31-3](#) (page 153).

Table 31-1 Overcurrent / short circuit protection current thresholds

Threshold	Definition
I_a	Nominal accessory output current (for example, 1000 mA, 2100 mA, 2400 mA, 3000 mA).
I_b	$I_a + 60\%$.
I_c	Lowest device current draw causing accessory output voltage (measured at Lightning Device Power) to drop below 2 V.

Table 31-2 Overcurrent / short circuit protection time thresholds

Threshold	Definition
T_0	Start of any device current draw transient.
T_1	Accessory overcurrent/short circuit deglitch/debounce time, shall $\geq T_0 + 1$ ms.

31. Device Power (Lightning)

31.8 Overcurrent and Short Circuit Protection Resets

Table 31-3 Overcurrent / short circuit protection behaviors

Region	Name	Accessory Behavior
A	Normal Operation	Accessory shall not limit or shutdown output current.
B	Overcurrent Transient	Accessory shall not shutdown output current. Accessory may limit output current to I_a or higher.
C	Overcurrent	Accessory shall shutdown output current.
D	Potential Overcurrent	Accessory may shutdown output current.
E	Potential Short Circuit	If Lightning Device Power voltage drops below 2 V, the accessory may trigger short circuit protection. Accessories shall not trigger short circuit protection on device current draw.

31.8 Overcurrent and Short Circuit Protection Resets

Accessory overcurrent and short circuit protection shall reset without mechanical intervention.

31.9 Power State Changes

Accessories shall not change the amount of power provided to a device unless:

- Direct user action is taken to turn the accessory on or off.
- An external power source (for example, mains electricity or battery) is connected to or disconnected from the accessory.
- The accessory's internal power source (for example, a battery) is depleted or loaded to the point where it is no longer capable of supplying its declared power providing capability or is now capable of supplying more power than previously declared.

32. Device Power (Inductive)

Accessories may provide power to devices using inductive power transmitters, specifically:

- [Qi Wireless Power](#) (page 154)
- [MagSafe](#) (page 155)

32.1 Qi Wireless Power

Devices supporting [Qi Wireless Power](#) (page 154):

- iPhone 16 Pro Max
- iPhone 16 Pro
- iPhone 16 Plus
- iPhone 16
- iPhone 15 Pro Max
- iPhone 15 Pro
- iPhone 15 Plus
- iPhone 15
- iPhone 14 Pro Max
- iPhone 14 Pro
- iPhone 14 Plus
- iPhone 14
- iPhone SE (3rd generation)
- iPhone 13 Pro Max
- iPhone 13 Pro
- iPhone 13
- iPhone 13 mini
- iPhone 12 Pro Max
- iPhone 12 Pro
- iPhone 12
- iPhone 12 mini
- iPhone SE (2nd generation)
- iPhone 11 Pro Max
- iPhone 11 Pro
- iPhone 11
- iPhone XS Max

32. Device Power (Inductive)

32.2 MagSafe

- iPhone XS
- iPhone XR
- iPhone X
- iPhone 8 Plus
- iPhone 8
- Wireless Charging Case (USB-C) for AirPods 4
- MagSafe Charging Case (USB-C) for AirPods Pro (2nd generation)
- MagSafe Charging Case for AirPods Pro (2nd generation)
- MagSafe Charging Case for AirPods (3rd generation)
- Wireless Charging Case for AirPods

Accessories incorporating a Qi transmitter shall use an embedded Qi Certified subsystem or shall be Qi Certified according to *The Qi Wireless Power Transfer System, Power Class 0 Specification – Version 2.0 or later*, see <https://www.wirelesspowerconsortium.com>.

32.2 MagSafe

Devices supporting MagSafe:

- iPhone 16 Pro Max
- iPhone 16 Pro
- iPhone 16 Plus
- iPhone 16
- iPhone 15 Pro Max
- iPhone 15 Pro
- iPhone 15 Plus
- iPhone 15
- iPhone 14 Pro Max
- iPhone 14 Pro
- iPhone 14 Plus
- iPhone 14
- iPhone 13 Pro Max
- iPhone 13 Pro
- iPhone 13
- iPhone 13 mini
- iPhone 12 Pro Max
- iPhone 12 Pro
- iPhone 12
- iPhone 12 mini
- MagSafe Charging Case (USB-C) for AirPods Pro (2nd generation)

32. Device Power (Inductive)

32.3 Electromagnetic Compatibility (EMC)

- MagSafe Charging Case for AirPods Pro (2nd generation)
- MagSafe Charging Case for AirPods (3rd generation)

See the [Accessory Interface Specification](#) (page 26) for information on MagSafe.

32.3 Electromagnetic Compatibility (EMC)

Accessories providing inductive device power should be designed for electromagnetic compatibility.

Apple recommends shielding the magnetic field from the charging coil and maintaining a low impedance shield termination for cables to comply with regulatory EMC requirements for the completed product. Implementation, final compliance testing, report preparation, and labeling are the responsibilities of the company marketing and producing the product.

Cable termination is critical for reduced emissions. Cable termination and connectors should be kept away from the charging coil and cables should be routed away from the charging surface.

If emissions are present, adding clamp-on ferrites/absorbers to the cable can help reduce emissions. Selected ferrite/absorber materials should be rated for the failing frequencies.

Depending on the accessory's supported use cases, testing should be performed with the following power supplies:

- Apple USB-C Power Adapters:
 - Apple 140W USB-C Power Adapter
 - Apple 96W USB-C Power Adapter
 - Apple 70W USB-C Power Adapter
 - Apple 67W USB-C Power Adapter
 - Apple 30W USB-C Power Adapter
 - Apple 20W USB-C Power Adapter
 - Apple 35W Dual USB-C Port Compact Power Adapter
 - Apple 35W Dual USB-C Port Power Adapter
- Apple USB-A Power Adapters:
 - Apple 12W USB Power Adapter
 - Apple 5W USB Power Adapter
 - Model A1385 (US)
 - Model A1400 (Int.)
 - Model A1552 (UK)
 - Model A1443 (China)
 - Model A1444 (Australia)
 - Model A1486 (Brazil)
 - Model A1487 (Korea)

32. Device Power (Inductive)

32.3 Electromagnetic Compatibility (EMC)

- Model A1501 (Argentina)
- Apple Mac computers:
 - Apple MacBook Pro
 - Apple MacBook Air

If power sources are used differing from those listed above, emission testing should be performed while the power sources are on.

In addition to the use cases above, charging devices should be tested in idle mode for emissions.

Emissions tests should be conducted in accordance with standards referenced in the following:

- FCC CFR 47, Part 15
- ICES-003, Issue 5, CAN/CSA-CEI/IEC CISPR 22-10
- CISPR 22: 2008
- EN 55022: 2010
- AS/NZS CISPR 22:2009, TCVN 7189:2009
- VCCI V-3/2013.04
- GB 9254-2008, GB 17625.1-2012, GB 17625.2-2007, CNS 13438-2006
- CISPR 24: 2010
- EN 55024: 2010

Once the highest emitting combination is identified, complete testing should be performed on the configuration. Some regulatory domains may require EMC certification.

33. Ethernet over USB

Accessories may support Ethernet over USB using the Network Control Model (NCM) protocol to enable a device to access a wired network.

Accessories shall comply with the *Network Control Model Devices Specification – Revision 1.0*, see <https://www.usb.org/document-library/network-control-model-devices-specification-v10-and-errata-and-adopters-agreement>.

34. External Accessory Protocol

The External Accessory (EA) framework provides accessories the means to communicate with one or more apps using EA sessions, providing a read/write bytestream interface. Accessory developers specify a custom protocol between the application and the accessory. The design and maintenance of communication protocols between accessories and applications are entirely the responsibility of the accessory and app developers. External Accessory framework documentation can be found at <https://developer.apple.com/documentation/externalaccessory>.

See the [Accessory Interface Specification](#) (page 26) for more information.

35. HID Headset Remote

Devices may accept user input from headsets to control audio volume and media playback.

35.1 Requirements

Accessories implementing HID headset remote controls shall:

- Connect to the device using one of the following:
 - [USB-C Plug](#) (page 271).
 - [Bluetooth](#) (page 224).

HID headset remotes shall support the [Human Interface Device \(HID\)](#) (page 220) protocol.

The HID report descriptor for a headset remote shall declare support for the HID Consumer and/or Telephony pages and only send usages from [Table 35-1](#) (page 160) and [Table 35-2](#) (page 160).

Table 35-1 HID Consumer Page (0x0C) controls for use by headset remotes

Usage ID	Usage Name	Apple Function
0x00B5	Scan Next Track	Transport Right
0x00B6	Scan Previous Track	Transport Left
0x00B9	Random Play	Shuffle
0x00BC	Repeat	Repeat
0x00E2	Mute	Mute
0x00E9	Volume Increment	Volume Up
0x00EA	Volume Decrement	Volume Down
0x025B	Promote	Play More Like This
0x025C	Demote	Play Less Like This

Table 35-2 HID Telephony Page (0x0B) controls for use by headset remotes

Usage ID	Usage Name	Apple Function
0x0021	Flash	Center

If a user presses and holds the accessory control surface corresponding to the 'Transport Right' or 'Transport Left' function, devices may scrub forwards or backwards within the current playing media item. Accessories shall not present a separate 'Fast-Forward' or 'Reverse' control surface to the user for the same feature.

35.2 Examples

35.2.1 Headset Remote Example HID Report Descriptor (Telephony)

The following sample HID descriptor demonstrates how to implement telephony and volume controls.

```

USAGE_PAGE (Consumer Devices) 05 0C
USAGE (Consumer Control)      09 01
COLLECTION (Application)      A1 01
  LOGICAL_MINIMUM (0)         15 00
  LOGICAL_MAXIMUM (1)         25 01
  REPORT_SIZE (1)             75 01
  REPORT_COUNT (2)            95 02
  USAGE (Volume Increment)    09 E9 // Volume Up
  USAGE (Volume Decrement)    09 EA // Volume Down
  INPUT (Data,Var,Abs)        81 02
  USAGE_PAGE (Telephony)      05 0B
  REPORT_COUNT (1)            95 01
  USAGE (Flash)                09 21 // Center
  INPUT (Data,Var,Abs)        81 02
  REPORT_SIZE (5)              75 05
  REPORT_COUNT (1)            95 01
  INPUT (Cnst, Var, Abs)       81 03
END_COLLECTION                  C0

```

Each report is one byte, and each bit corresponds to one of the functions. For example, the following sample reports communicate the referenced button having been pressed:

- Volume Up is 0x01
- Volume Down is 0x02
- Center is 0x04

35.2.2 Headset Remote Example HID Report Descriptor (Media Playback)

The following sample HID descriptor demonstrates how to implement media playback controls.

```

USAGE PAGE (Consumer Devices) 05 0C
USAGE (Consumer Control)      09 01
COLLECTION (Application)      A1 01
  LOGICAL_MINIMUM (0)         15 00

```

35. HID Headset Remote

35.2 Examples

```
LOGICAL_MAXIMUM (1)      25 01
REPORT_SIZE (1)          75 01
REPORT_COUNT (7)         95 07
USAGE (Scan Next Track)  09 B5 // Transport Right
USAGE (Scan Previous Track) 09 B6 // Transport Left
USAGE (Mute)              09 E2 // Mute
USAGE (Shuffle)           09 B9 // Shuffle
USAGE (Repeat)            09 BC // Repeat
USAGE (Promote)           0A 5B 02 // Play More Like This
USAGE (Demote)            0A 5C 02 // Play Less Like This
INPUT (Data,Var,Abs)      81 02
END_COLLECTION            C0
```

Each report is one byte, and each bit corresponds to one of the functions. For example, the following sample reports communicate the referenced button having been pressed:

- Transport Right is 0x01
- Transport Left is 0x02
- Mute is 0x04

35.2.3 Headset Remote Example HID Report Descriptor (Telephony and Media Playback)

The following sample HID descriptor demonstrates how to implement all possible media playback controls along with the same controls found on the Apple headset remote.

```
USAGE_PAGE (Consumer Devices) 05 0C
USAGE (Consumer Control)      09 01
COLLECTION (Application)      A1 01
  LOGICAL_MINIMUM (0)         15 00
  LOGICAL_MAXIMUM (1)         25 01
  REPORT_SIZE (1)             75 01
  REPORT_COUNT (9)            95 09
  USAGE (Scan Next Track)     09 B5 // Transport Right
  USAGE (Scan Previous Track) 09 B6 // Transport Left
  USAGE (Mute)                 09 E2 // Mute
  USAGE (Shuffle)              09 B9 // Shuffle
  USAGE (Repeat)               09 BC // Repeat
  USAGE (Promote)              0A 5B 02 // Play More Like This
  USAGE (Demote)               0A 5C 02 // Play Less Like This
  USAGE (Volume Increment)     09 E9 // Volume Up
  USAGE (Volume Decrement)     09 EA // Volume Down
  INPUT (Data,Var,Abs)         81 02
  USAGE_PAGE (Telephony)       05 0B
  REPORT_COUNT (1)             95 01
  USAGE (Flash)                09 21 // Center
  INPUT (Data,Var,Abs)         81 02
  REPORT_SIZE (5)              75 05
  REPORT_COUNT (1)            95 01
  INPUT (Cnst, Var, Abs)       81 03
```

35. HID Headset Remote

35.2 Examples

END COLLECTION

C0

Each report is two bytes. The bits are assigned top-to-bottom (from 'Transport Right' to 'Center'). For example, the following sample reports communicate the referenced button having been pressed:

- Transport Right is 0x0100
- Transport Left is 0x0200
- Mute is 0x0400
- Volume Up is 0x8000
- Volume Down is 0x0001
- Center is 0x0002

36. Location Information

Location features enable accessories to provide Global Navigation Satellite System (GNSS) and sensor data (for example, speed) to devices in the form of National Marine Electronics Association (NMEA) sentences. Devices can use the additional information to augment built-in location services. For example, some external accessories provide more accurate or more frequent position updates. Additionally, devices can conserve power by using location information from a self-powered external accessory.

See the [Accessory Interface Specification](#) (page 26) for more information.

37. MagSafe Attach

Devices supporting MagSafe Attach:

- iPhone 16 Pro Max
- iPhone 16 Pro
- iPhone 16 Plus
- iPhone 16
- iPhone 15 Pro Max
- iPhone 15 Pro
- iPhone 15 Plus
- iPhone 15
- iPhone 14 Pro Max
- iPhone 14 Pro
- iPhone 14 Plus
- iPhone 14
- iPhone 13 Pro Max
- iPhone 13 Pro
- iPhone 13
- iPhone 13 mini
- iPhone 12 Pro Max
- iPhone 12 Pro
- iPhone 12
- iPhone 12 mini

MagSafe [Cases](#) (page 35) shall:

- Claim compatibility with a MagSafe-capable device.
- Integrate a [MagSafe Case Magnet Array](#) (page 166).

Other MagSafe accessories shall:

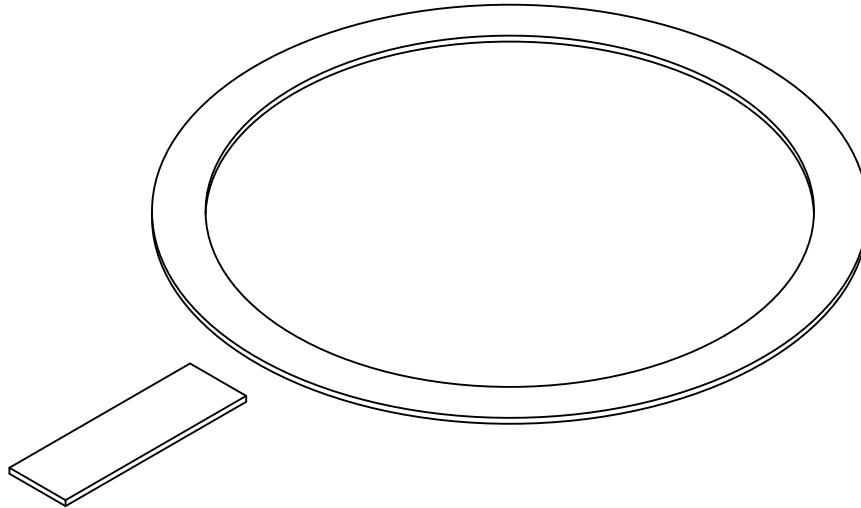
- Claim compatibility with a MagSafe-capable device.
- Integrate a [MagSafe Accessory Magnet Array](#) (page 173).

Apple recommends the following magnet array vendors:

- Baotou INST Magnetic New Materials Co., Ltd. (<https://www.instmagnets.com>)
- Ningbo Sanhuan Magsound Industry & Trade Co., Ltd. (<https://www.magsound.com>)
- Quadrant Solutions, Inc. (<https://www.quadrant.us>)

37.1 MagSafe Case Magnet Array

Figure 37-1 MagSafe case magnet array



37.1.1 Product Design

Cases integrating a MagSafe case magnet array shall:

- Enclose the device.
- Have a uniform thickness no greater than 2.1 mm; Apple recommends 2.0 mm.
- Firmly attach to the device without relying on the magnets.
- Not integrate magnets on the back of the case other than the MagSafe magnets.
- Comply with requirements for [Cases](#) (page 35).
- Work with:
 - Apple MagSafe Charger.
 - Apple MagSafe Battery Pack.
 - iPhone Leather Wallet with MagSafe.

37.1.2 Mechanical

Magnets in the MagSafe case magnet array shall be positioned in the same plane.

The case and MagSafe case magnet array shall enable MagSafe accessories to magnetically self align within a 1.55 mm radial maximum.

37. MagSafe Attach

37.1 MagSafe Case Magnet Array

37.1.2.1 Magnets

MagSafe case magnets shall be N45SH NdFeB with a 7 μm - 13 μm NiCuNi plating finish (or similar) and shall meet the requirements in [Table 37-1](#) (page 167).

Table 37-1 Magnet properties

Property	Minimum	Maximum
Br	13.2 kGs	13.6 kGs
Hcb	12.75 kOe	
Hcj	20.50 kOe	
BHmax	43 MGOe	46 MGOe

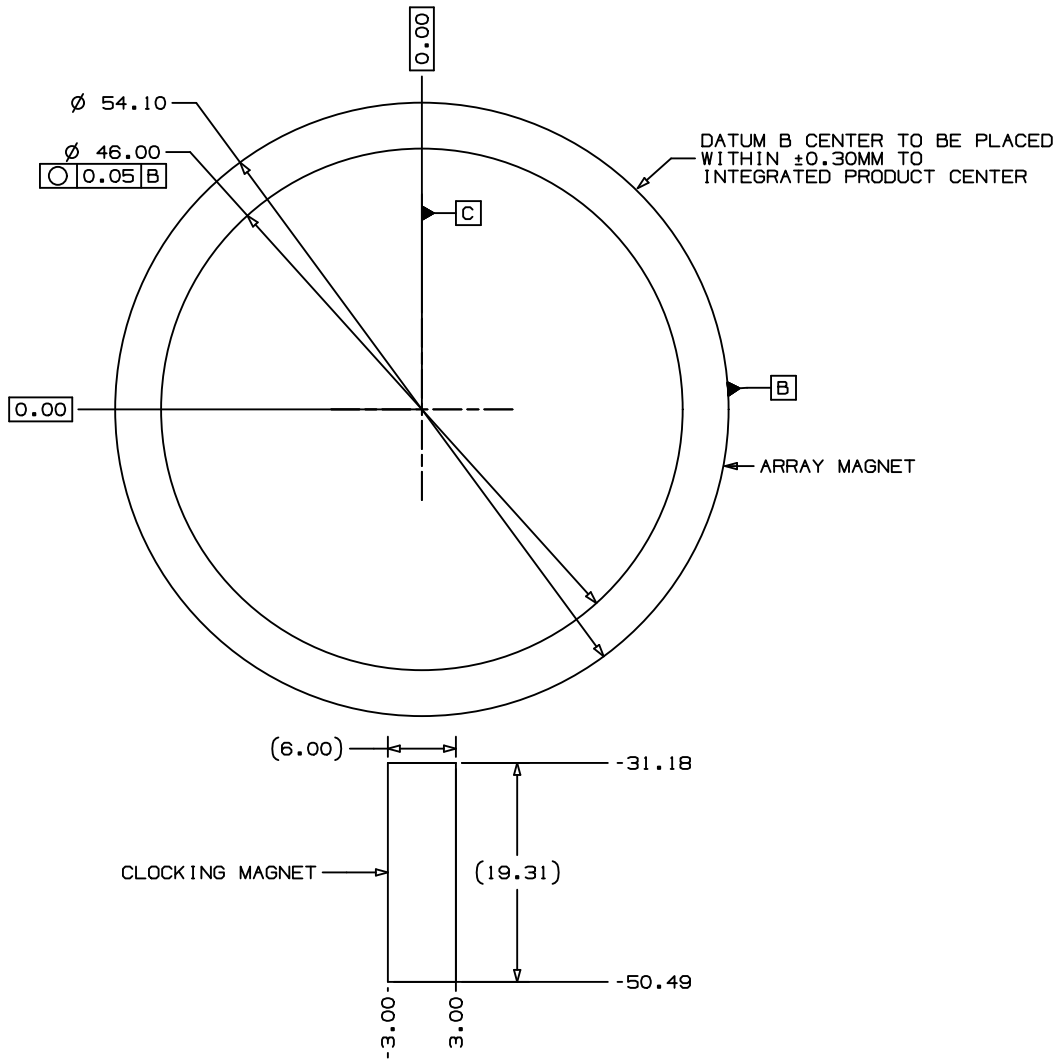
37.1.2.2 Magnet Array

The magnets shall be positioned in the case following the dimensions and polarity shown in [Figure 37-2](#) (page 168), [Figure 37-3](#) (page 169) and [Figure 37-4](#) (page 169).

37. MagSafe Attach

37.1 MagSafe Case Magnet Array

Figure 37-2 MagSafe magnet array dimensions



37. MagSafe Attach

37.1 MagSafe Case Magnet Array

Figure 37-3 MagSafe magnet ring dimensions and polarity

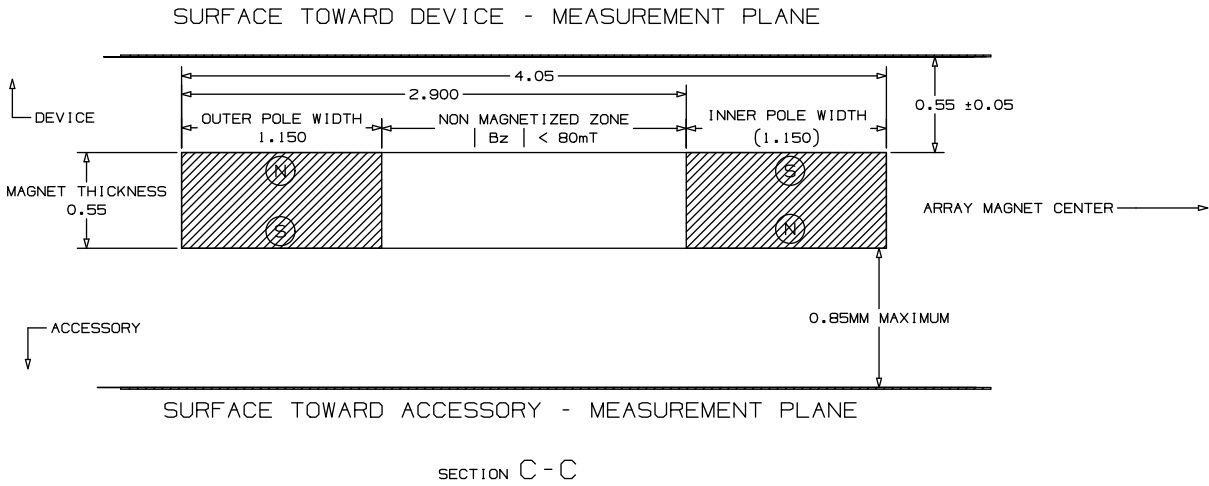
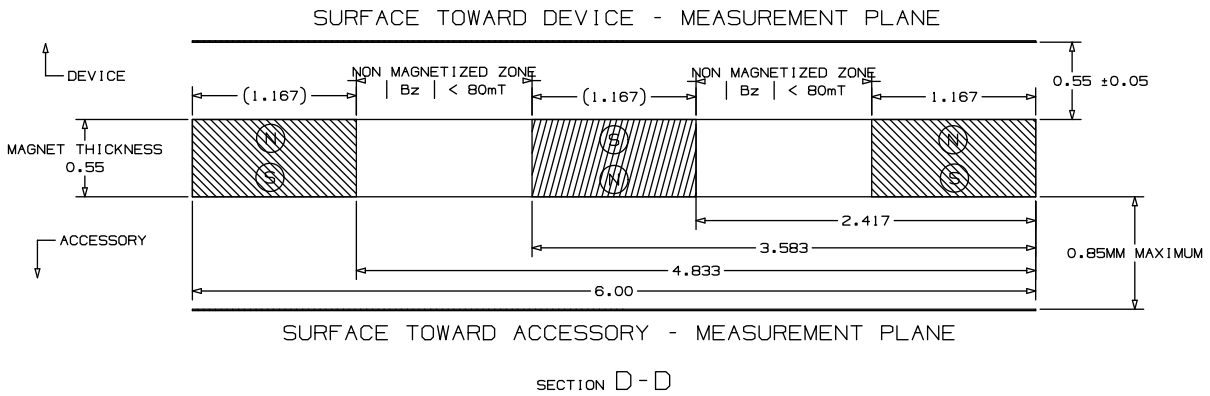


Figure 37-4 MagSafe orientation magnet dimensions and polarity



The flux density of a MagSafe case magnet ring shall comply with [Table 37-2](#) (page 170) and [Table 37-3](#) (page 171) across the 8 lines (S1 - S8) in [Figure 37-5](#) (page 170).

Figure 37-5 MagSafe flux density measurement plane

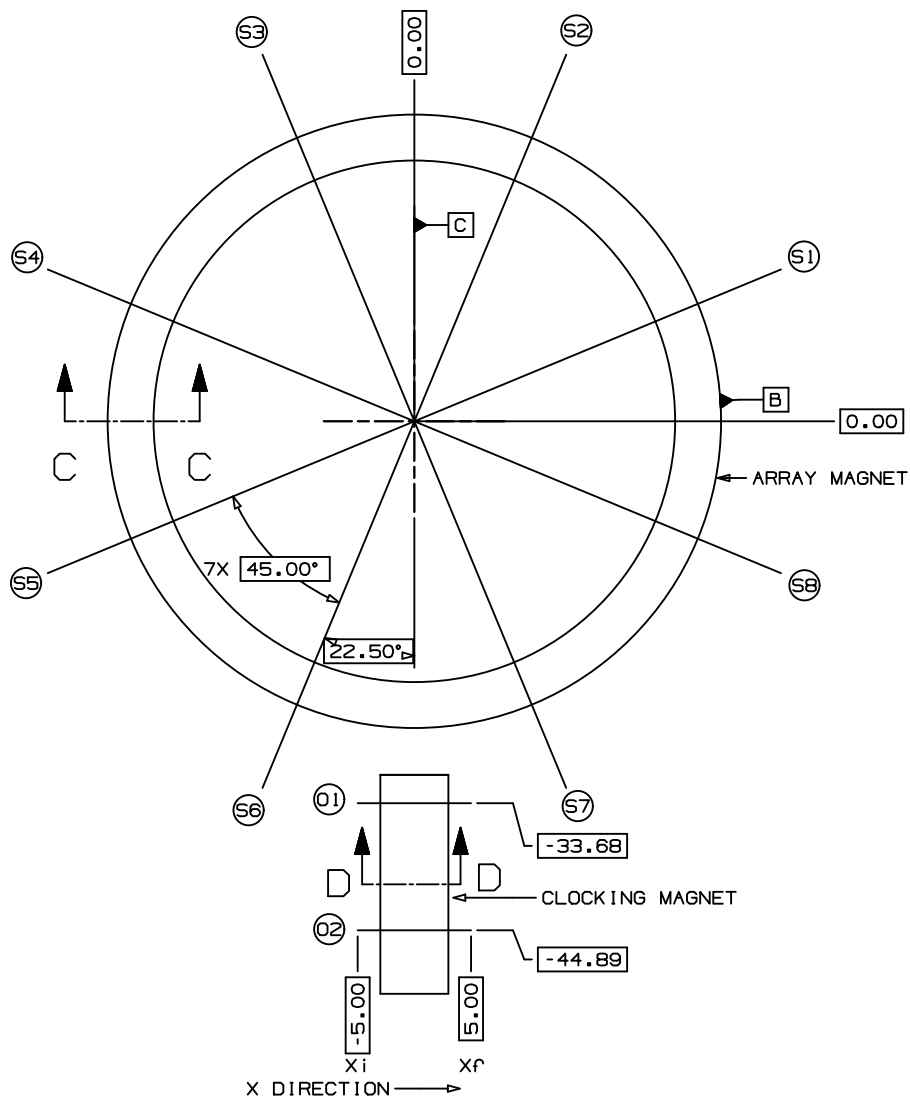


Table 37-2 Device side flux density at 0.55 mm from magnet ring surface

Minimum r	Maximum r	Minimum Bz	Maximum Bz	Minimum Bxy	Maximum Bxy
	19.5 mm	-0.020 T	0.020 T		0.025 T
19.5 mm	23 mm				0.075 T
23 mm	24 mm	-0.170 T	-0.125 T		
24 mm	26 mm			0.095 T	0.1325 T

37. MagSafe Attach

37.1 MagSafe Case Magnet Array

Minimum r	Maximum r	Minimum Bz	Maximum Bz	Minimum Bxy	Maximum Bxy
26 mm	27 mm	0.125 T	0.170 T		
27 mm	30 mm				0.075 T
30 mm		-0.020 T	0.000 T		0.025 T

Table 37-3 Accessory side flux density at 0.80 mm from magnet ring surface

Minimum r	Maximum r	Minimum Bz	Maximum Bz	Minimum Bxy	Maximum Bxy
	19.5 mm	-0.020 T	0.020 T		0.025 T
19.5 mm	23 mm				0.065 T
23 mm	24 mm	-0.120 T	-0.085 T		
24 mm	26 mm			0.070 T	0.100 T
26 mm	27 mm	0.85 T	0.120 T		
27 mm	30 mm				0.065 T
30 mm		-0.020 T	0.000 T		0.025 T

The flux density of a MagSafe case orientation magnet shall comply with [Table 37-4](#) (page 171) and [Table 37-5](#) (page 172) across the 2 lines (O1 and O2) in [Figure 37-5](#) (page 170).

Table 37-4 Device side flux density at 0.55 mm from orientation magnet surface

Minimum x	Maximum x	Minimum Bz	Maximum Bz	Minimum Bxy	Maximum Bxy
	-5.0 mm	-0.020 T	0.020 T		0.025 T
-5.0 mm	-4.5 mm	-0.020 T	0.020 T		
-4.5 mm	-2.75 mm			0.080 T	0.110 T
-2.75 mm	-2.0 mm	0.125 T	0.175 T		
-2.0 mm	-0.5 mm			0.110 T	0.155 T
-0.5 mm	0.5 mm	-0.1925 T	-0.140 T		
0.5 mm	2.0 mm			0.110 T	0.155 T
2.0 mm	2.75 mm	0.125 T	0.175 T		
2.75 mm	4.0 mm			0.080 T	0.110 T
4.0 mm	5.0 mm	-0.020 T	0.020 T		
5.0 mm		-0.020 T	0.020 T		0.025 T

37. MagSafe Attach

37.1 MagSafe Case Magnet Array

Table 37-5 Accessory side flux density at 0.80 mm from orientation magnet surface

Minimum x	Maximum x	Minimum Bz	Maximum Bz	Minimum Bxy	Maximum Bxy
	-5.0 mm	-0.020 T	0.020 T		0.025 T
-5.0 mm	-4.5 mm	-0.020 T	0.020 T		
-4.5 mm	-2.75 mm			0.050 T	0.070 T
-2.75 mm	-2.0 mm	0.085 T	0.120 T		
-2.0 mm	-0.5 mm			0.0825 T	0.115 T
-0.5 mm	0.5 mm	-0.140 T	-0.0975 T		
0.5 mm	2.0 mm			0.0825 T	0.115 T
2.0 mm	2.75 mm	0.085 T	0.120 T		
2.75 mm	4.0 mm			0.050 T	0.070 T
4.0 mm	5.0 mm	-0.020 T	0.020 T		
5.0 mm		-0.020 T	0.020 T		0.025 T

37.1.2.3 Magnetic Force

The force normal to the back of the case needed to dislodge a MagSafe accessory, such as the Apple MagSafe Charger, shall meet the requirements in [Table 37-6](#) (page 172).

Table 37-6 Magnetic force

Scenario	Minimum	Maximum
Case attached to device	800 gf	1100 gf
Case only	600 gf	900 gf

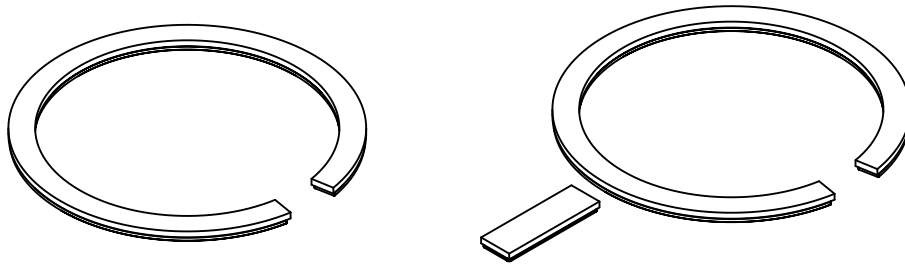
37.1.3 Magnetic Interference

Cases with an integrated MagSafe magnet array shall not interfere with:

- Inductive charging.
- Magnetic stripe cards in an attached iPhone Leather Wallet with MagSafe.

37.2 MagSafe Accessory Magnet Array

Figure 37-6 MagSafe accessory magnet array options



The MagSafe accessory magnet array shall be implemented as a [Magnet Ring](#) (page 175). The magnet ring enables the device and accessory to be attached in any orientation. To support a specific orientation, the accessory may include an [Orientation Magnet](#) (page 176) as part of the array.

37.2.1 Product Design

Accessories integrating the MagSafe accessory magnet array shall not enclose the device.

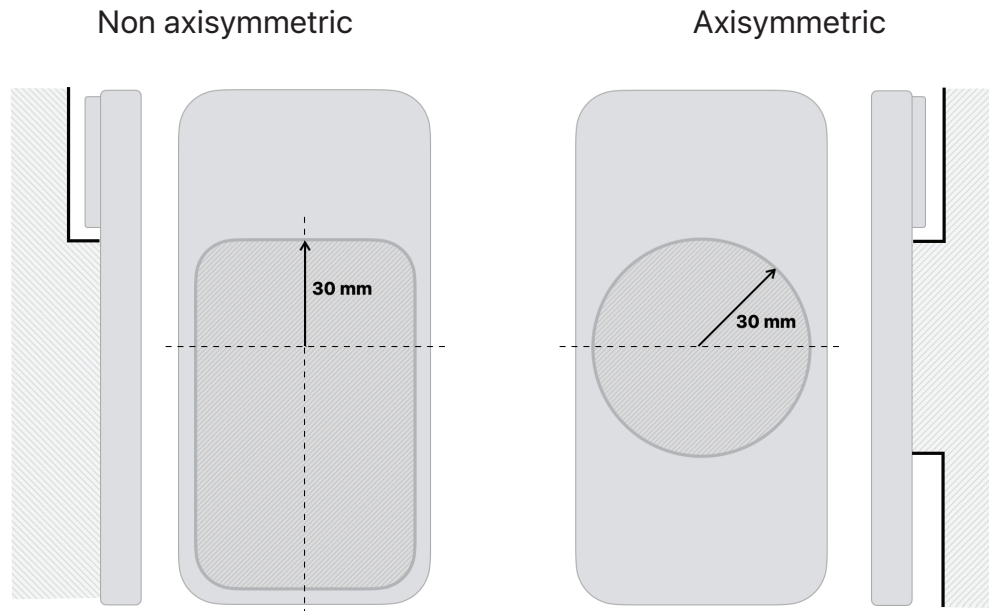
37.2.2 Mechanical

The accessory shall not interfere with or cause [Scratches and Damage](#) (page 28) to the device.

To avoid interference with devices, accessories shall:

- Not exceed 30 mm from the center of the magnet ring surface towards the top edge of the device for all supported device orientations. If the device can be attached in any orientation, the accessory shall not exceed 30 mm in radius around the center of the magnet ring surface.
- Maintain a clearance of 5 mm from the back of the device (mating surface) for any part of the accessory past the 30 mm keep-in constraint.
- Stay within the [MagSafe Accessory Enclosure Geometry](#) (page 180).

Figure 37-7 MagSafe accessory clearance



Magnets in the MagSafe accessory magnet array shall be positioned in the same plane.

The MagSafe accessory's [Magnet Ring](#) (page 175) shall magnetically self align to the device's magnet ring within a 1.55 mm radial maximum.

37.2.2.1 Magnets

MagSafe accessory magnets shall be N48H NdFeB with a 7 μm - 13 μm NiCuNi plating finish (or similar) and shall meet the requirements in [Table 37-7](#) (page 174).

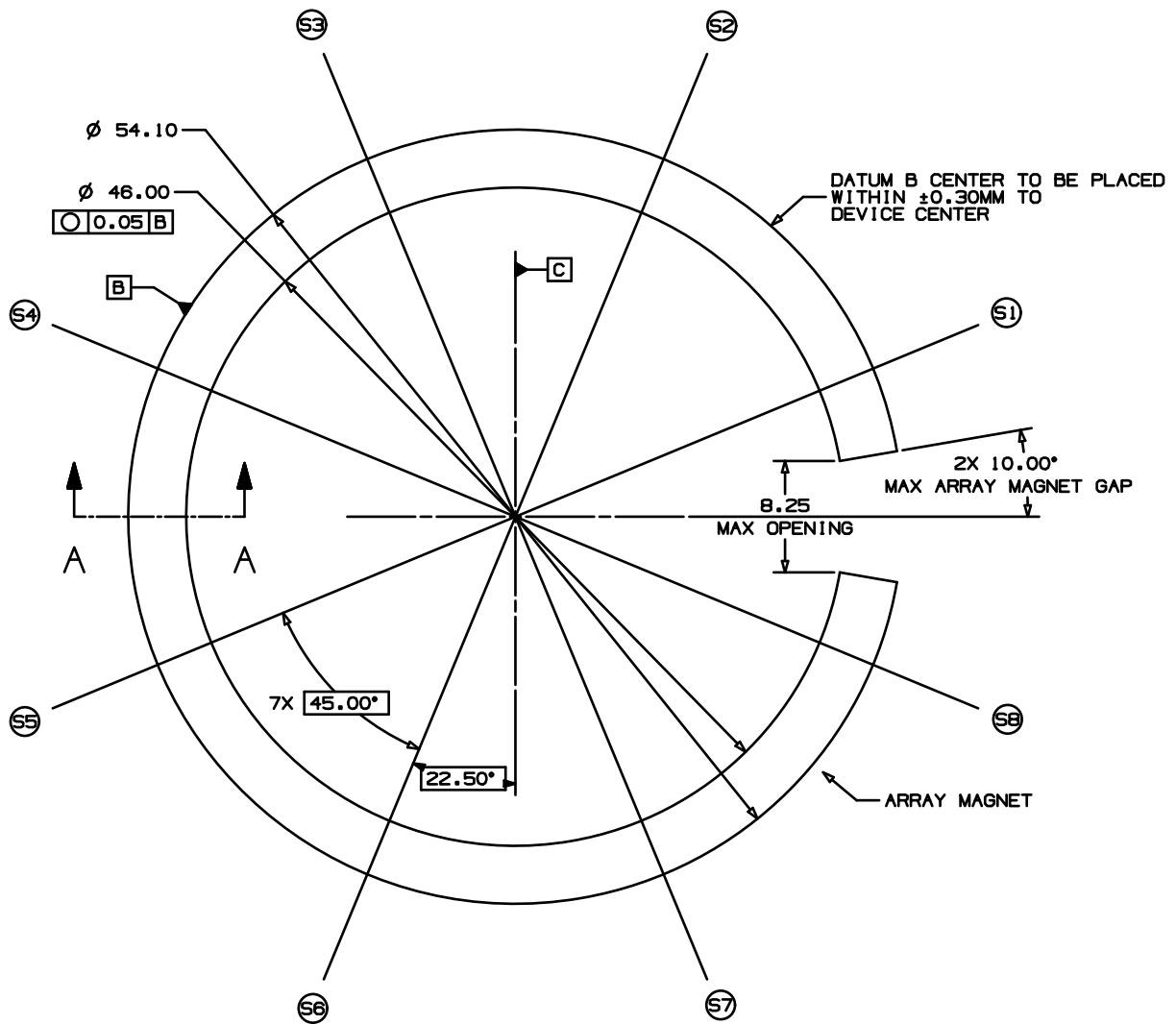
Table 37-7 Magnet properties

Property	Minimum	Maximum
Br	13.7 kGs	14.1 kGs
Hcb	13.25 kOe	
Hcj	17 kOe	
BHmax	45 MGOe	48 MGOe

37.2.2.2 Magnet Ring

The magnet ring shall be positioned in the accessory in compliance with the dimensions and polarity requirements in [Figure 37-8](#) (page 175) and [Figure 37-9](#) (page 176).

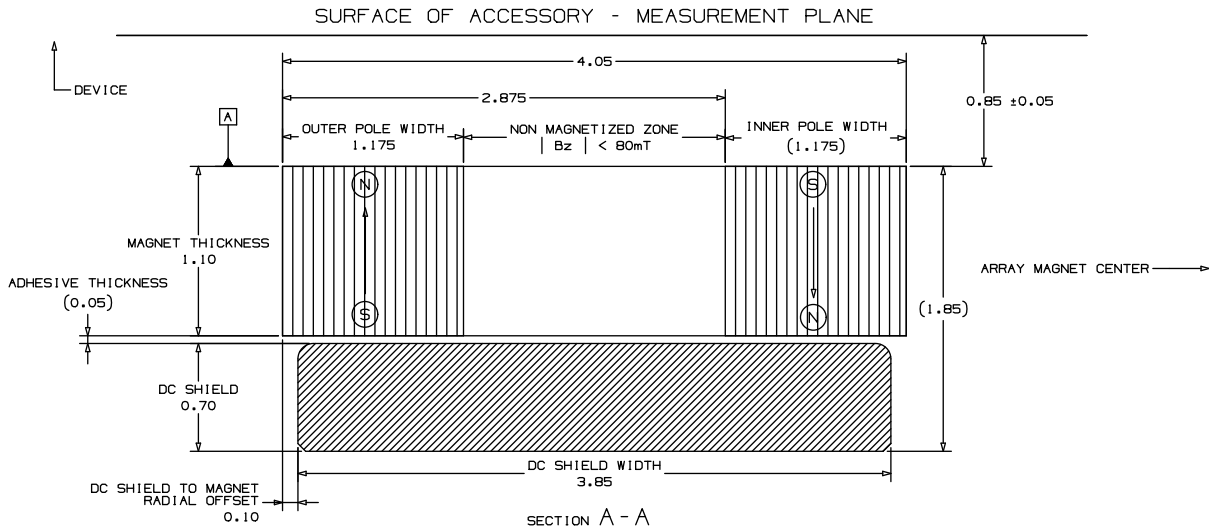
Figure 37-8 MagSafe magnet ring dimensions



37. MagSafe Attach

37.2 MagSafe Accessory Magnet Array

Figure 37-9 MagSafe magnet ring dimensions and polarity



See [DC Shield](#) (page 179) for additional requirements of the DC shield specified in [Figure 37-9](#) (page 176).

The flux density of a MagSafe accessory magnet ring shall comply with [Table 37-8](#) (page 176) across the 8 lines (S1 - S8) in [Figure 37-8](#) (page 175).

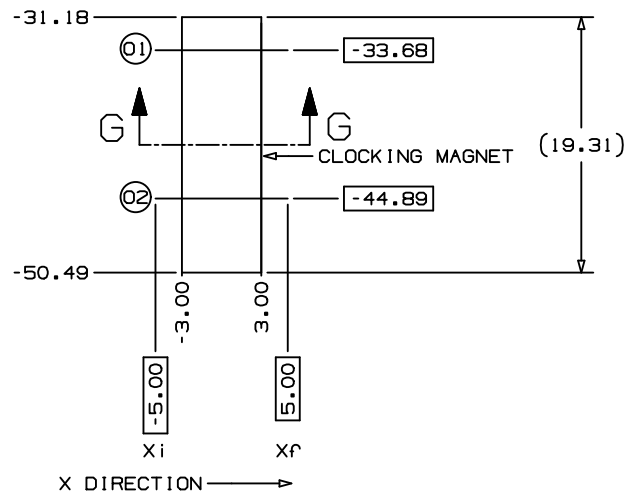
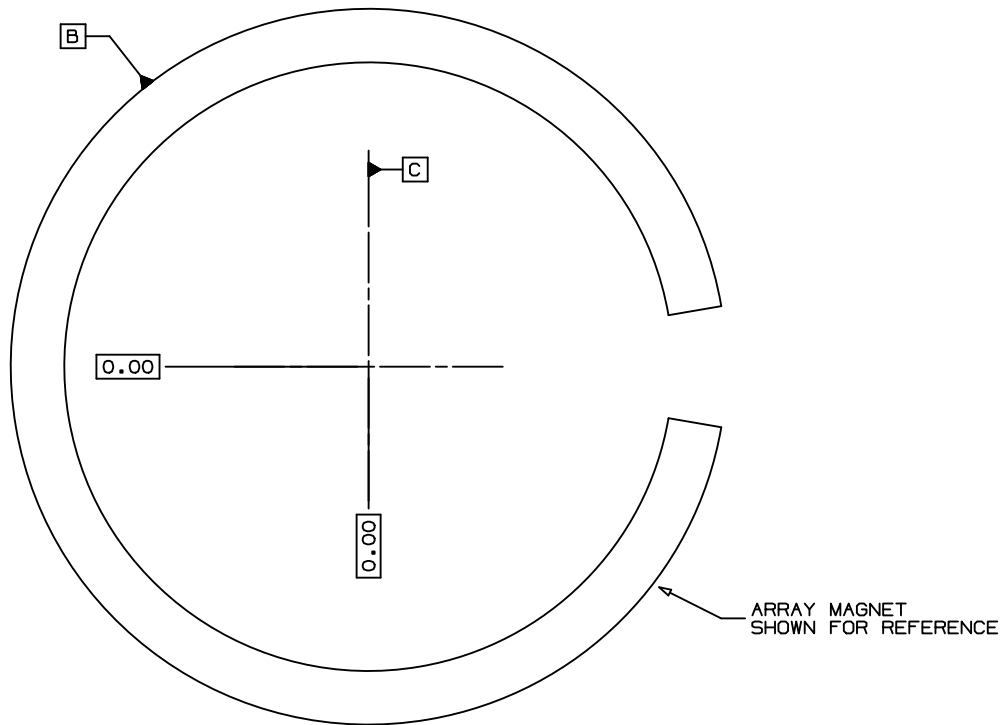
Table 37-8 Flux density at 0.85 mm from magnet ring surface

Minimum r	Maximum r	Minimum Bz	Maximum Bz	Minimum Bxy	Maximum Bxy
0 mm	19.5 mm	-0.025 T	0.025 T		0.025 T
19.5 mm	23 mm				0.075 T
23 mm	24.5 mm	-0.215 T	-0.155 T		
24.5 mm	25.5 mm			0.170 T	0.215 T
25.5 mm	27 mm	0.155 T	0.215 T		
27 mm	30 mm				0.075 T
30 mm		-0.025 T	0.025 T		0.025 T

37.2.2.3 Orientation Magnet

If orientation magnets are included, the magnets shall be positioned according to [Figure 37-10](#) (page 177) and [Figure 37-11](#) (page 178).

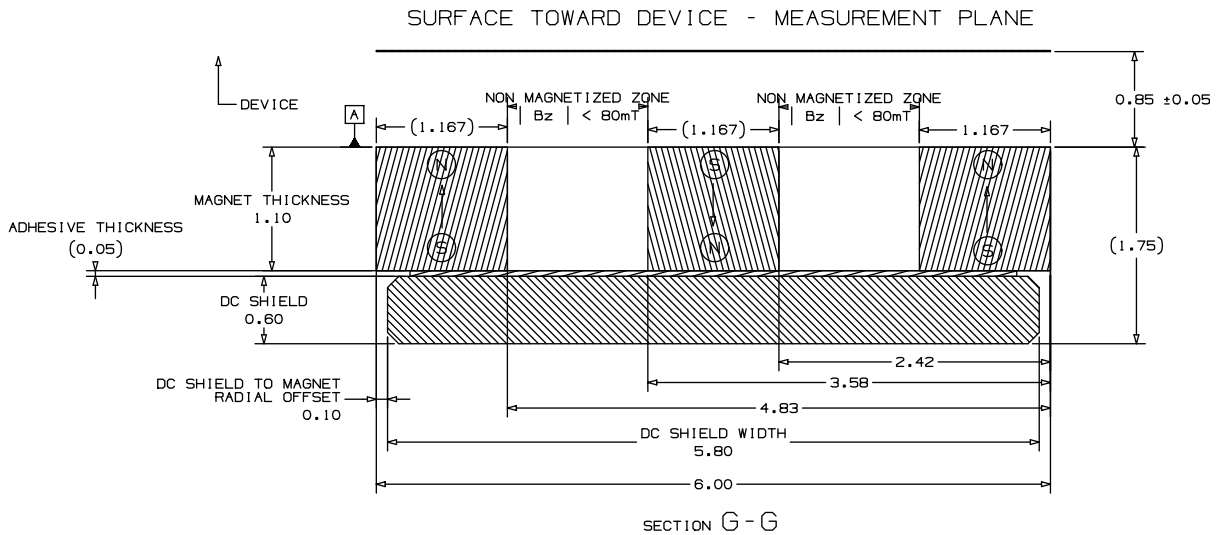
Figure 37-10 MagSafe orientation magnet dimensions



37. MagSafe Attach

37.2 MagSafe Accessory Magnet Array

Figure 37-11 MagSafe orientation magnet dimensions and polarity



See [DC Shield](#) (page 179) for additional requirements of the DC shield specified in [Figure 37-11](#) (page 178).

The flux density of a MagSafe accessory orientation magnet shall comply with [Table 37-9](#) (page 178) across the 2 lines (O1 and O2) in [Figure 37-10](#) (page 177).

Table 37-9 Flux density at 0.85 mm from orientation magnet surface

Minimum x	Maximum x	Minimum Bz	Maximum Bz	Minimum Bxy	Maximum Bxy
	-5.0 mm	-0.025 T	0.025 T		0.025 T
-5.0 mm	-4.5 mm	-0.025 T	0.025 T		
-4.5 mm	-3.0 mm			0.0625 T	0.0875 T
-3.0 mm	-2.0 mm	0.145 T	0.195 T		
-2.0 mm	-0.5 mm			0.165 T	0.215 T
-0.5 mm	0.5 mm	-0.250 T	-0.185 T		
0.5 mm	2.0 mm			0.165 T	0.215 T
2.0 mm	3.0 mm	0.145 T	0.195 T		
3.0 mm	4.0 mm			0.0625 T	0.0875 T
4.0 mm	5.0 mm	-0.025 T	0.025 T		
5.0 mm		-0.025 T	0.025 T		0.025 T

37.2.2.4 Magnetic Force

The force normal to the back of the device needed to dislodge the MagSafe accessory shall meet the requirements in [Table 37-10](#) (page 179).

Table 37-10 Magnetic force

Scenario	Minimum	Maximum
Accessory attached to device	650 gf	900 gf

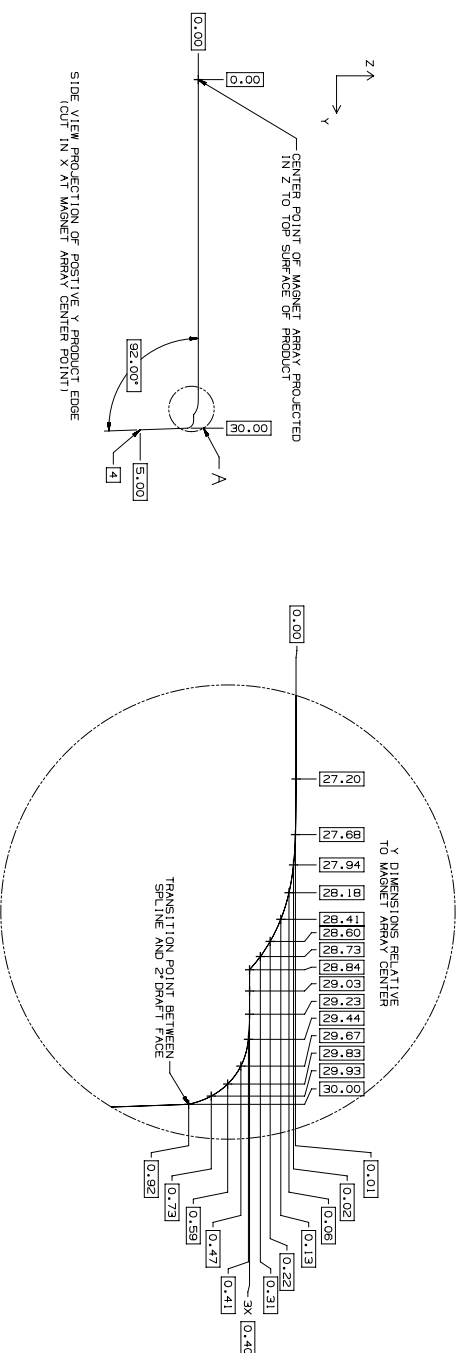
37.2.2.5 DC Shield

The DC shield shall be low carbon steel (1010, DT4 or similar), per ASTM848, with a 5 μm - 10 μm Ni plating finish or similar.

The DC shield shall have a saturation flux density (B_{sat}) of at least 2.0 T.

37.3 MagSafe Accessory Enclosure Geometry

- NOTES** (UNLESS OTHERWISE SPECIFIED):
- SPLINE REPRESENTS MAX MATERIAL CONDITION FOR AN EXTERIOR PRODUCT SURFACE. MAGSAFE COMPATIBLE ACCESSORIES SHALL STAY WITHIN THE PROVIDED SPLINE.
 - FOR NON AXISYMMETRIC APPLICATIONS, SPLINE REPRESENTS MAX MATERIAL CONDITION WHEN VIEWED ALONG X AXIS
 - FOR AXISYMMETRIC APPLICATIONS, A REVOLUTION OF THE SPLINE AROUND THE Z AXIS THROUGH THE CENTER POINT OF THE MAGNET ARRAY REPRESENTS THE MAX MATERIAL CONDITION
- [4] ANY CURVATURE DEVIATING BEYOND SPLINE TO EXIST BEYOND 5MM Z CLEARANCE FROM TOP OF PRODUCT



DETAIL A
SCALE 50:1

METRIC		Apple Inc.	
DATE	DATE	VERSION	REV
APRIL 11 2024	APRIL 11 2024	1	01
APRIL 11 2024	APRIL 11 2024		
DIMENSIONS ARE IN MILLIMETERS		TITLE	
TOLERANCES		MAGSAFE COMPATIBLE ENCLOSURE GEOMETRY	
UNLESS OTHERWISE SPECIFIED		DRAWING NUMBER	
NONE		01	
DO NOT SCALE DRAWING		SCALE	
HIDDEN AREA PROJECTION		NONE	
NX GENERATED		SHEET 1 OF 1	

37.4 Verification

37.4.1 MagSafe Case Magnet Array

37.4.1.1 Case Thickness

37.4.1.1.1 Equipment

- Digital thickness gauge, such as the Mitutoyo 547-520S.

37.4.1.1.2 Procedure

1. Using the digital thickness gauge, verify the thickness is less than or equal to 2.1 mm at:
 - Four points along the magnet ring.
 - Two points along the orientation magnet.

37.4.1.2 Accessory Clearance

37.4.1.2.1 Equipment

- MagSafe-capable device.
- Apple MagSafe Battery Pack.

37.4.1.2.2 Procedure

1. Attach the case to the device.
2. Attach the Apple MagSafe Battery Pack to the back of the case.
3. Verify the case does not interfere with the Apple MagSafe Battery Pack and only the mating surface is in contact.

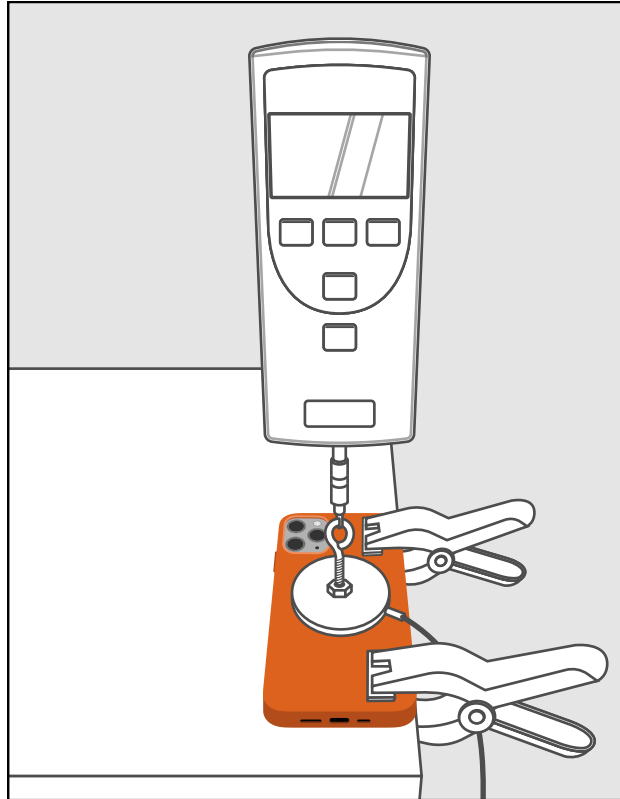
37.4.1.3 Magnetic Force

37.4.1.3.1 Equipment

- MagSafe-capable device.
- Apple MagSafe Charger.
- Non-magnetic eyelet screw.
- Digital force gauge capable of capturing peak values, such as the Chatillon DFX II.
- Hook attachment for digital force gauge.
- Clamps to securely hold the device on a flat level surface.

37.4.1.3.2 Setup

Figure 37-12 Magnetic force test setup



1. Attach the case to the device.
2. Place the device on a flat level surface with the display facing down and clamp it firmly in place.
3. Glue the non-magnetic eyelet to the center of the back of the Apple MagSafe Charger so pulling on the eyelet exerts a force on the center of the charger.

37.4.1.3.3 Procedure

1. Repeat the following steps 5 times:
 - a. Attach the Apple MagSafe Charger and eyelet assembly to the back of the case, allowing them to magnetically align.
 - b. Connect the force gauge hook to the eyelet.
 - c. Reset the force gauge's peak force value.
 - d. Pull the force gauge vertically until the Apple MagSafe Charger and eyelet assembly dislodge from the case.
 - e. Note the peak value from the force gauge.

2. Calculate the average of the 5 peak force measurements.
3. Verify the average force is within the range of 800 gf to 1100 gf when removing the mass of the Apple MagSafe Charger and eyelet assembly.

37.4.1.4 iPhone Leather Wallet with MagSafe Detection

37.4.1.4.1 Equipment

- MagSafe-capable device.
- iPhone Leather Wallet with MagSafe.

37.4.1.4.2 Procedure

1. Attach the case to the device.
2. Attach the wallet to the back of the case.
3. Verify the device displays the wallet animation.

37.4.1.5 Magnetic Stripe Cards in iPhone Leather Wallet with MagSafe

37.4.1.5.1 Equipment

- MagSafe-capable device.
- iPhone Leather Wallet with MagSafe.
- Low Coercivity Magnetic stripe (LoCo) cards, such as cards from the following vendors:
 - American Card Service.
 - Allsafe.
 - CI Solutions.
 - PSA.
- LoCo card reader/writer, such as:
 - Q-card Mag3x.
 - Magtek InSpec 9000.
 - Misiri X6BT.
 - Deftun MSR605X.

37.4.1.5.2 Procedure

1. Attach the accessory to the device.
2. Repeat this procedure for three different brands of LoCo cards:
 - a. Write to the LoCo card.
 - b. Read from the LoCo card and verify it was written successfully.
 - c. Insert the LoCo card into the wallet with the magnetic stripe facing the magnets.

- d. Place additional cards into the wallet to ensure a LoCo card is in contact with the magnetic side of the wallet.
- e. Attach the wallet to the accessory (attached to the device).
- f. Wait 10 seconds.
- g. Remove the wallet from the accessory.
- h. Remove the LoCo card from the wallet.
- i. Verify the LoCo card is readable and its contents have not changed.

37.4.2 MagSafe Accessory Magnet Array

37.4.2.1 Orientation Magnet

If the accessory includes an orientation magnet:

1. Use a straight edge to verify the device contact surfaces of the magnet ring and orientation magnet are coplanar (aligned in the same plane).
2. Attach a MagSafe-capable device to the accessory and align it with the orientation magnet. Verify there are no gaps between the:
 - MagSafe magnet ring and device.
 - MagSafe orientation magnet and device.

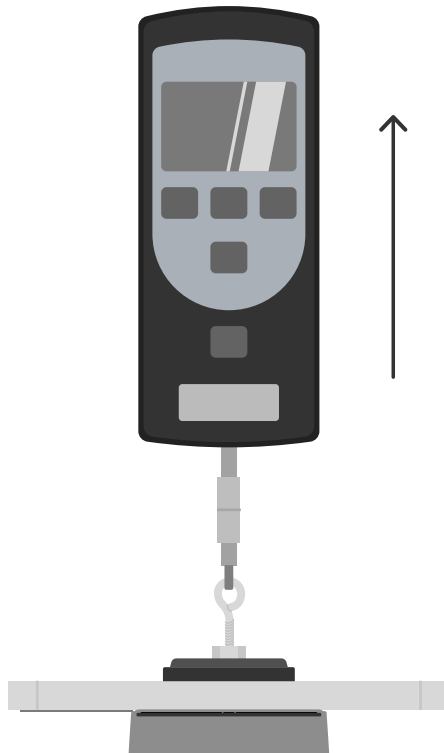
37.4.2.2 Magnetic Force

37.4.2.2.1 Equipment

- MagSafe-capable device.
- Non-magnetic eyelet to attach to the device.
- Digital force gauge capable of capturing peak values, such as the Chatillon DFX II.
- Hook attachment for digital force gauge.
- Clamps, or a vice, to securely hold the accessory on a flat level surface.

37.4.2.2.2 Setup

Figure 37-13 Magnetic force test setup



1. Clamp the accessory in place so the MagSafe surface is level.
2. Attach the non-magnetic eyelet to the MagSafe-capable device so pulling on the eyelet exerts a force on the center of the back of the device. A bracket, strong suction cup, or glue may be used.

37.4.2.2.3 Procedure

1. Repeat the following steps 5 times:
 - a. Attach the device and eyelet assembly to the accessory, allowing them to magnetically align.
 - b. Connect the force gauge hook to the eyelet.
 - c. Reset the force gauge's peak force value.
 - d. Pull the force gauge vertically until the device and eyelet assembly dislodge from the accessory.
 - e. Note the peak value from the force gauge.
2. Calculate the average of the 5 peak force measurements.
3. Verify the average force is within the range of 650 gf to 900 gf when removing the mass of the device and eyelet assembly.

38. Media Library Access

The Media Library feature allows accessories to download the metadata contents of a device's media libraries (not the media items themselves) and request playback of media items. The feature is divided into the following sub-features:

- Media Library Information informs the accessory about media libraries available on the device.
- Media Library Updates provide an accessory with an updated view of the contents of a particular media library.
- Media Library Playback allows the accessory to request playback of one or more items from a media library.

See the [Accessory Interface Specification](#) (page 26) for more information.

39. Musical Instrument Digital Interface (MIDI)

Compatible USB and Bluetooth Low Energy MIDI accessories can interface directly with iOS 17.0, iPadOS 17.0, and macOS 14.0 Sonoma apps using the Core MIDI framework, see <https://developer.apple.com/documentation/coremidi>.

39.1 Requirements

Accessories supporting MIDI as a USB device shall implement a MIDI Streaming IN endpoint and shall support either:

- *USB Device Class Definition for MIDI Devices –Version 2.0*, see <https://www.usb.org/document-library/usb-class-definition-midi-devices-v20>.
- *USB Device Class Definition for MIDI Devices –Release 1.0*, see <https://www.usb.org/document-library/usb-midi-devices-10>.

Accessories supporting MIDI over Bluetooth Low Energy shall support:

- *MIDI Association MIDI over Bluetooth Low Energy (BLE-MIDI) –Version 1.0a*, see <https://midi.org/midi-over-bluetooth-low-energy-ble-midi>.

39.2 Verification

Developers should test accessory designs against macOS 15.0.1 Sequoia using the Audio MIDI Setup app and its MIDI Studio and Test MIDI Setup features. See the user guide at <https://support.apple.com/guide/audio-midi-setup/welcome/mac>.

40. Now Playing Updates

The Now Playing feature enables an accessory to display information about the current "Now Playing" media source and media item on a device. Media sources include both the built-in Apple Music and Apple Video apps on devices and certain third-party iOS apps supporting the generation of Now Playing metadata, see *MPNowPlayingInfoCenter* in the iOS SDK documentation. Accessories shall be prepared for the Now Playing media source and media item to change at any time, whether the accessory requested the change or not.

See the [Accessory Interface Specification](#) (page 26) for more information.

41. Out-of-Band Bluetooth Pairing

Accessories with the ability to connect to a device using Bluetooth and a wired transport should use the Out-of-Band Bluetooth Pairing feature to simplify Bluetooth connection setup.

For example, USB to Lightning charge cables or Lightning to USB accessory cables can be used to exchange Bluetooth pairing information upon initial connection. This may reduce or eliminate the need for instruction manuals to describe how to:

- Put the accessory into a discoverable and pairable mode.
- Initiate Bluetooth pairing on the device using the Settings app.
- Download the accessory's companion app and initiate pairing from the app.

See the [Accessory Interface Specification](#) (page 26) for more information.

42. Siri

Siri enables a user to have rich interactions with a device by primarily using their voice.

Accessories supporting Siri shall not use an icon resembling the Siri microphone icon.

The rest of this chapter is applicable to accessories supporting Siri over Bluetooth using HFP commands.

To support Siri using other transports and protocols, the accessory developer shall be a member of the [Apple MFi Program](#) (page 26).

42.1 Enabling Custom Siri Commands

Accessories supporting Siri over Bluetooth using HFP commands shall support [HFP Command AT+XAPL](#) (page 144). The device will use the information sent by this command to enable and disable custom commands related to Siri.

To receive Siri status events, the accessory shall send the AT+XAPL command after making a successful HFP Service Level Connection (SLC) to the device. The accessory should send an AT+XAPL command first, before sending any of the additional Siri-specific commands described below.

42.2 Obtaining Siri Availability Information

After establishing an HFP profile connection, an accessory can determine if Siri is available and enabled on a device. It can also receive notifications of changes in Siri status. If Siri is disabled, Voice Control will be activated instead.

42.2.1 Obtaining Status Information at Connection

The accessory should send the following command after making a successful HFP profile (SLC) connection and sending an AT+XAPL command.

42.2.1.1 HFP Command AT+APLSIRI?

Description: AT command to retrieve Siri status information.

42. Siri

42.2 Obtaining Siri Availability Information

Initiator: Accessory

Format: AT+APLSIRI?

Response: +APLSIRI : *value*

Defined Values:

- 0 = Siri is not available on this platform.
- 1 = Siri is available and enabled.
- 2 = Siri is available but not enabled.

Example: +APLSIRI : 1 (Siri is available and enabled)

42.2.2 Receiving Siri Availability Updates from the Device

After initialization has been completed, the device will send the accessory the following notification if there is a change in Siri status. This notification will be provided only if the accessory has requested Siri status (by sending AT+APLSIRI?) at least once after connection and if the device has reported Siri is available and enabled.

42.2.2.1 HFP Command +APLSIRI

Description: Unsolicited event indicating a change in Siri status.

Initiator: Device

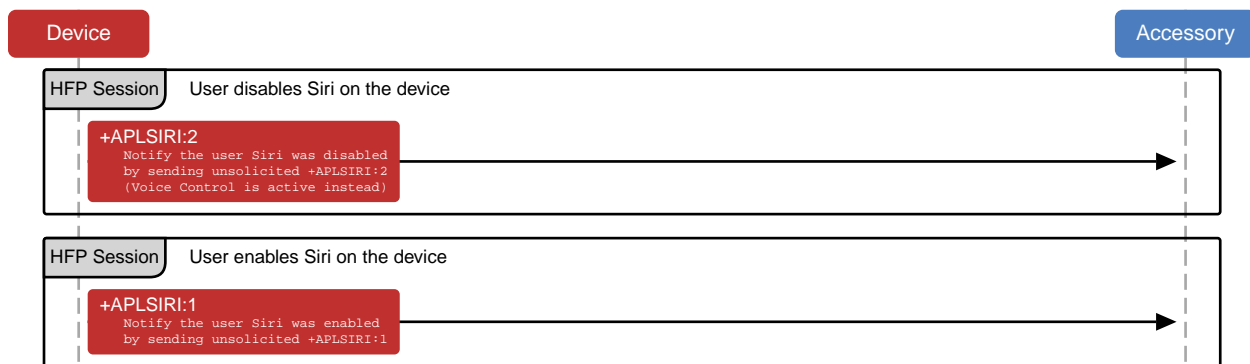
Format: +APLSIRI : *value*

Defined Values:

- 1 = Siri is available and enabled.
- 2 = Siri is available but not enabled.

Example: +APLSIRI : 2 (Siri is available but not enabled)

Figure 42-1 Siri is Disabled/Enabled from the Device's Settings



42.3 Initiating a Siri Session

Once support for Siri is established on both the accessory and the device, a Siri session can be started from either one.

42.3.1 Initiating a Session from the Accessory

The accessory should only initiate a Siri session as a result of a direct user action.

The accessory shall use the voice recognition command `AT+BVRA` defined in the *Bluetooth Hands-Free Profile Specification – Version 1.6, Section 4.25* to initiate a Siri session.

The HFP profile shall be connected and SLC shall exist.

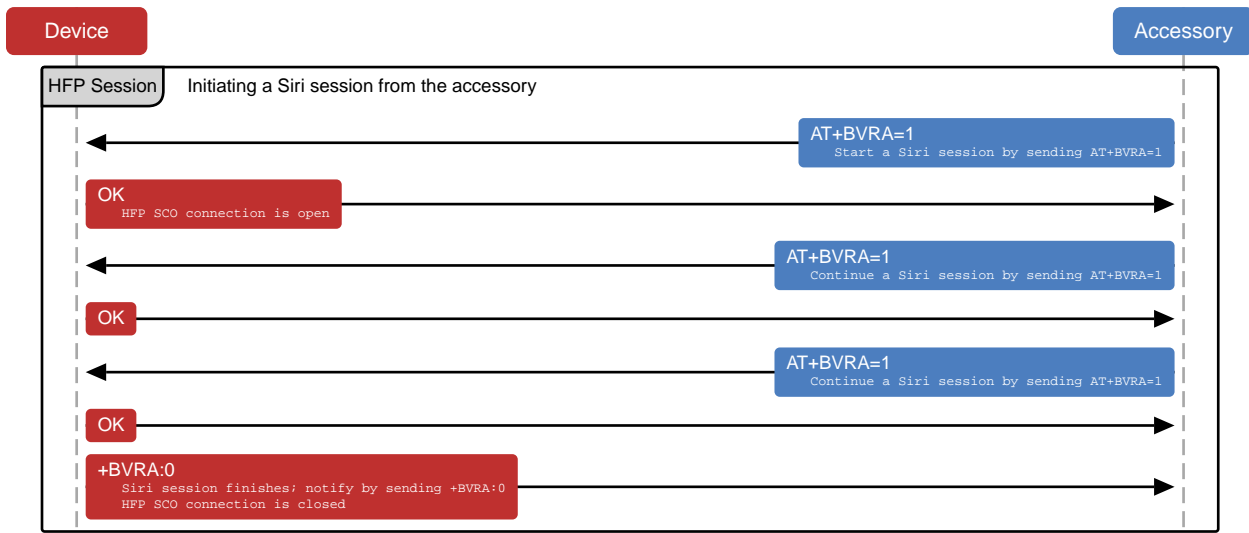
The accessory should use the following command sequence:

- The accessory sends an `AT+BVRA=1` command to the device.
- The device sends an OK response.
- The device activates a Siri session and creates a Synchronous Connection (SCO) for the audio.
- If the Siri session is not finished, the accessory shall send `AT+BVRA=1` to continue the conversation. This may need to happen multiple times.
- When the Siri session is finished, the device sends a `+BVRA:0` result code to the accessory.
- The device disconnects the SCO connection.

While a Siri session is active, the accessory shall let the user continue the conversation and ask follow up questions within the current context. In order to do so, the accessory shall be able to send an `AT+BVRA=1` command to the device even after Siri has been already activated and before `+BVRA:0`

is received. Figure 42-2 (page 193) shows an overview of the interaction when Siri is triggered from the accessory, the running session was continued twice and once Siri was finished, the device dismissed the session.

Figure 42-2 Initiating a Siri Session from the Accessory



42.3.2 Initiating a Session from the Device

If the accessory supports voice recognition commands, the device sends a +BVRA event to indicate the start of a Siri session. The accessory shall enable support for voice recognition and indicate it in its feature response as described in the *Bluetooth Hands-Free Profile Specification – Version 1.6, Section 4.34.1*. Specifically, the HFP profile shall be connected, SLC shall exist, and voice recognition activation (bit 3) shall be enabled in the AT+BRSF command. The device will not use virtual call functionality for the Siri session if voice recognition activation is supported by the accessory.

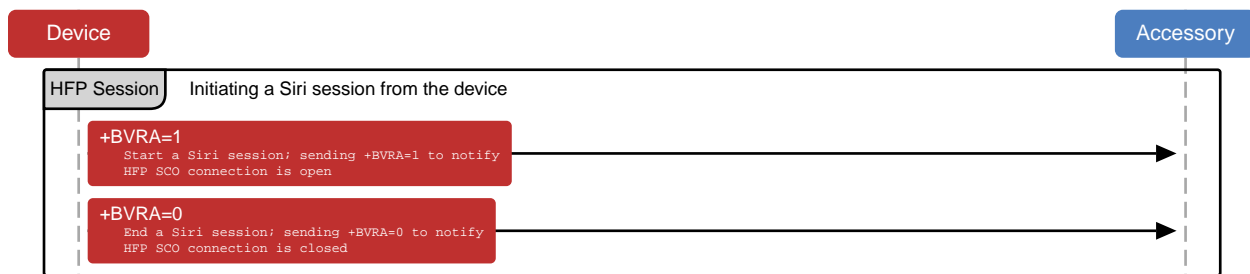
The accessory should expect the following command sequence:

- The device sends a +BVRA:1 event to the accessory.
- The device activates a Siri session and creates a SCO connection for the audio.
- When the Siri session is finished, the device sends a +BVRA:0 result code to the accessory.
- The device disconnects the SCO connection.

42. Siri

42.4 Siri Eyes Free Mode

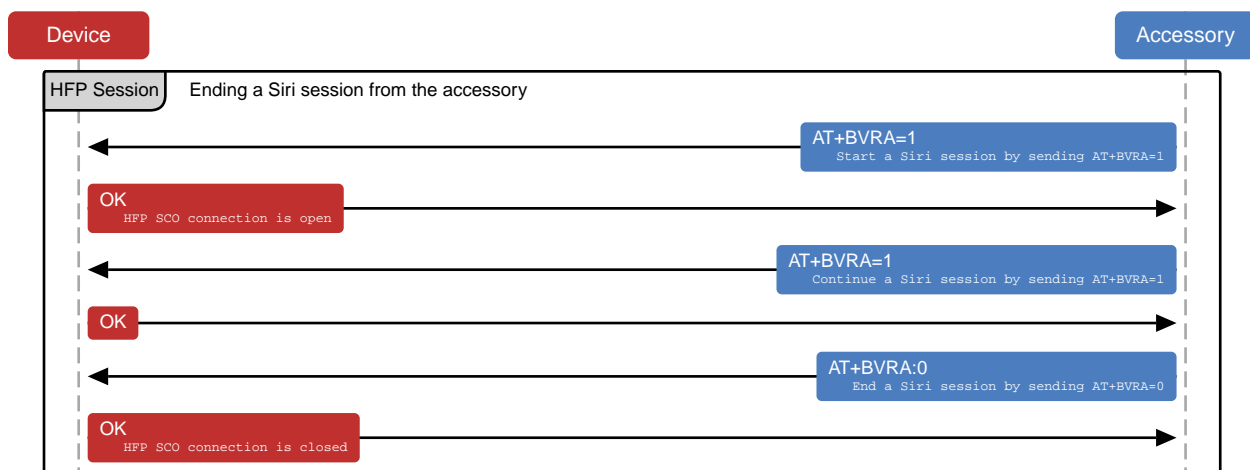
Figure 42-3 Initiating a Siri Session from the Device



42.3.3 Ending a Session from the Accessory

Once a Siri session is running the accessory shall be capable of ending the session by sending an `AT+BVRA=0` command to the device. [Figure 42-4](#) (page 194) shows an example of ending a running Siri session from the accessory. The accessory should only end an active session as a result of a direct user action.

Figure 42-4 Ending a Siri Session from the Accessory



42.4 Siri Eyes Free Mode

Siri Eyes Free mode is a feature to control Siri responses including display information and can be enabled or disabled as needed. In Siri Eyes Free mode, the user experience is tailored towards a driving scenario and interactions with Siri are done primarily using voice to minimize the need for the user to

look at a screen. Siri Eyes Free mode is supported only for Bluetooth-enabled vehicle entertainment systems and should not be used by any other accessories. Siri Eyes Free should not be triggered using a voice command.

The device will listen for the HFP AT command AT+APLEFM to enable or disable Siri Eyes Free mode.

This command is used by the device to modify Siri responses containing visual information or requiring user interaction. Suitable audio feedback and voice commands will be available to the user based on the initiated Siri use case.

Siri Eyes Free mode is disabled by default. Once the accessory has enabled Siri Eyes Free mode, it remains enabled for all subsequent Siri sessions initiated from the accessory until the accessory disables it or the Bluetooth connection is disconnected.

42.4.1 HFP Command AT+APLEFM

Description: An accessory sends this command to notify a device of the preferred state of Siri Eyes Free mode.

Initiator: Accessory

Format: AT+APLEFM=*value*

Response: OK

Defined Values:

- 0x00 = Disable Siri Eyes Free mode.
- 0x01 = Enable Siri Eyes Free mode.
- 0x02-0xFF = reserved

Example: AT+APLEFM=1

42.5 Improving Voice Recognition

The microphone audio an accessory sends to the device during a Siri session should be suitable for voice recognition. Audio requirements for optimal voice recognition may differ from requirements for optimal human perception (for example, during a cellular phone call).

Filtering of the audio signal to remove echoes or feedback noise is acceptable.

To provide the best possible audio quality as Siri input, the accessory shall observe the following recommendations:

- **Echo cancellation and noise suppression (EC/NR):** Directional microphones and linear beamforming with microphone arrays giving improved SNR are recommended. Linear echo cancellation for reducing unwanted audio sources (such as audio output from the system) without having any other effect on the speech signal are also recommended. However, single channel noise reduction methods (such as spectrum subtraction) shall not be applied, as they will be detrimental to the speech recognition accuracy. Similarly, automatic gain control, residual echo suppression and attempts to blank out non-speech periods in the waveform shall not be applied.
- **Signal gain:** When adjusting signal levels, the accessory shall avoid artifacts, dropouts, and clipping in all circumstances. Automatic Gain Control is not recommended. If the accessory adjusts signal gain, the gain should be held constant across each spoken utterance. The nominal level measured at the uplink output of the accessory should be A-weighted $-30\text{ dB} \pm 2\text{ dB}$ root-mean-square (RMS), expressed in units relative to full-scale (dBFS(A)). Alternatively, the nominal level may be $13\text{ dB} \pm 2\text{ dB}$ SLR if using the ITU measurement procedure.
- **Signal-to-noise ratio (SNR):** The average SNR should be greater than 20 dB. Below 20 dB, recognition rates will be impacted.
- **Reverberation:** An RT60 time less than 200 ms should be maintained.

42.5.1 Wide Band Speech Support

An accessory using Siri should support 16 kHz wide band speech audio for better audio quality and voice recognition performance. See the *Bluetooth Hands-Free Profile Specification – Version 1.6* for details about wide band speech audio. Narrow band audio signal (8 kHz) is supported but not recommended.

42.6 Optimizing the Siri Experience

The start of a Siri session should not be accompanied by local beeps or verbal indications (such as an announcement of "...voice dialing...") from the accessory. When a Siri session becomes active, the device sends two beeps indicating Siri is ready to receive instructions. Adding extra audible notifications only inserts delays in the system.

The accessory should wait for the device to end each Siri session.

The accessory should not send an `AT+BVRA=0` command unless it is prompted to do so by user interaction.

The accessory should be capable of rendering audio within 200 ms of SCO connection activation to ensure the user always hears the Siri introductory beeps.

42.7 Common Siri Applications

Siri can send messages, find points of interests, place phone calls, and much more. As Siri capabilities are constantly growing, additional use cases may become available after the initial integration. In Siri Eyes Free mode, some of these use cases may not be accessible as the user experience is tailored towards a driving scenario.

42.7.1 Initialization Procedure After Connection is Established

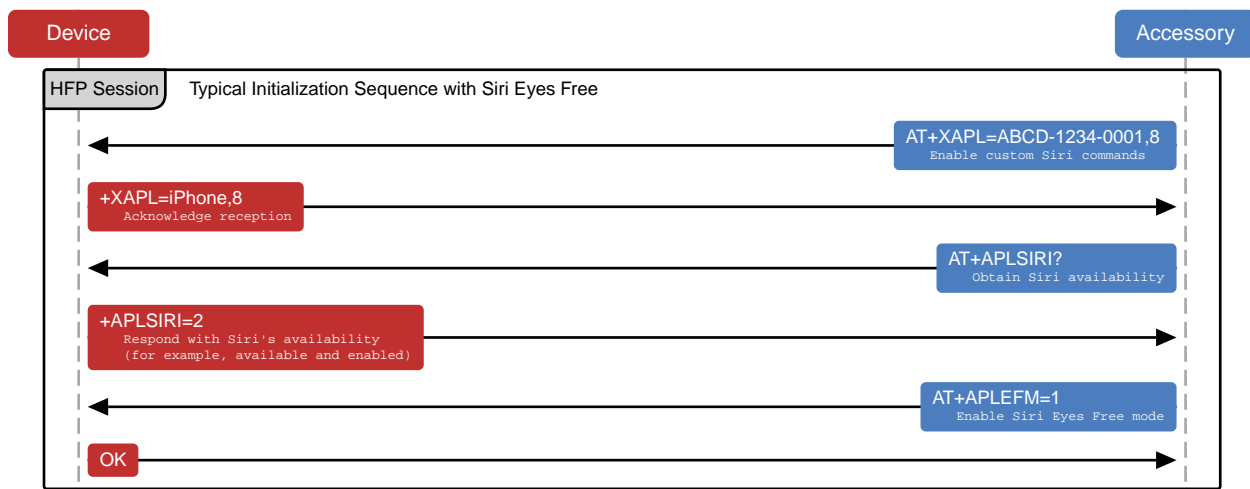
Figure 42-5 (page 197) outlines the sequence the accessory has to trigger to be able to use Siri on a device. After establishing an HFP profile connection, the accessory shall first enable the custom Siri commands by sending AT+XAPL and provide the features it supports. After a confirmation is received from the device, the accessory should determine Siri's availability with AT+APLSIRI?.

Vehicles with Bluetooth-enabled infotainment systems can also enable Siri Eyes Free Mode during initialization. This is detailed in Figure 42-6 (page 198).

Figure 42-5 Siri Initialization Procedure



Figure 42-6 Siri Initialization Procedure with Siri Eyes Free



42.7.2 Phone Dialing Using Siri

Upon user request, Siri can initiate an outgoing phone call. The device will initiate HFP call signaling to establish a phone call as described in [Bluetooth](#) (page 224). The accessory shall be able to transition to Hands-Free dialing at any time during or after a Siri session when signaled by the device.

42.7.3 Audio Routing and Media Playback Using Siri

Siri can control the media playback on a device, and if Siri determines the user wants to play or pause music, Siri will either start, pause or resume media playback. The device will send a notification to the accessory indicating a change in playback state and any associated track information. The accessory shall respond to the notifications, start or stop the music playback as requested, as well as update the correct playback state (for example, shuffle, repeat).

The accessory shall not force a change in the playback state after a Siri session is ended. If music was playing before Siri was started, it shall continue playing, if it was paused, it shall remain paused.

After Siri starts music playback the accessory shall set its current audio route to match the audio source, depending on how audio is being received from the device (using Bluetooth or by a wired connection).

The available media playback notifications depend on the audio route being used:

- Bluetooth audio routes shall use the approach described in [Notifications](#) (page 231) and [Audio Data Received using A2DP Profile](#) (page 233).
- Wired audio routes shall use iAP2.

42.7.4 Turn-By-Turn Directions Using Siri

Siri can initiate active route guidance to provide turn-by-turn directions. In case the device is the active source and is already playing music, turn-by-turn directions will be mixed in as part of the audio stream. In case the device is not playing music, the accessory should be able to mix in turn-by-turn directions with the active audio source.

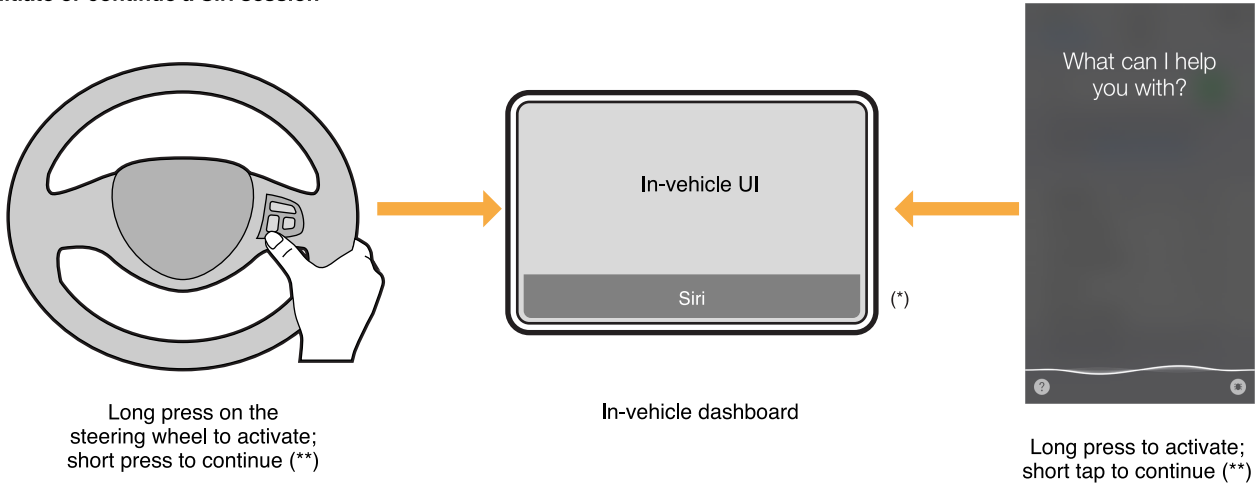
The device will notify the accessory to play turn-by-turn directions only over Bluetooth. Detailed information on how to distinguish between music playback and turn-by-turn notifications is available in [Notifications](#) (page 231).

42.8 User Interaction with Siri Eyes Free in a Vehicle

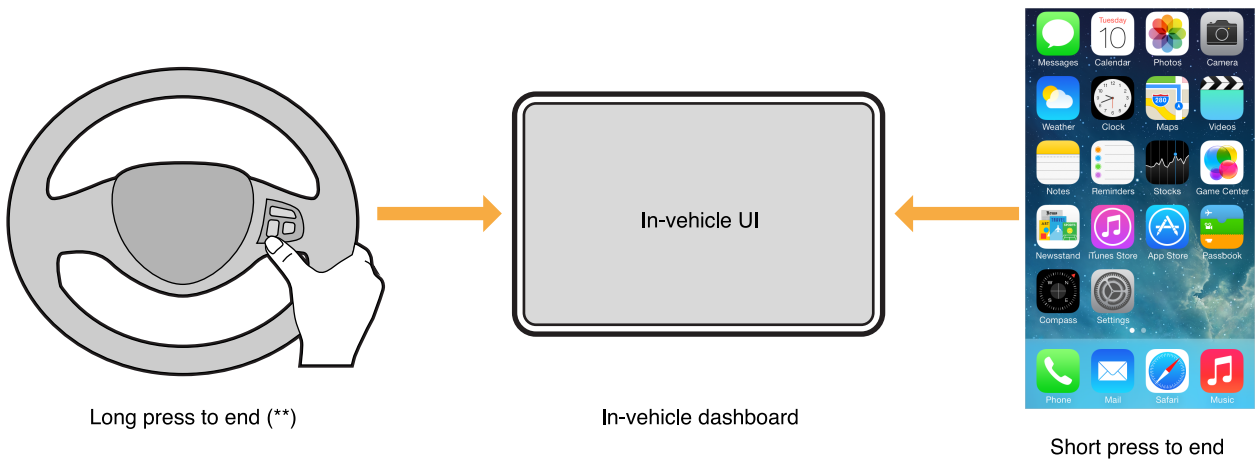
A vehicle using Siri Eyes Free mode shall integrate the Siri experience with the existing in-vehicle entertainment system and controls. The vehicle should provide a convenient interface to initiate, continue, and end a Siri session. Once a Siri session is running, the vehicle shall display a visual cue indicating voice recognition is in use. [Figure 42-7](#) (page 200) outlines how a Siri interaction should be designed.

Figure 42-7 Siri Eyes Free user interaction

Initiate or continue a Siri session



End a Siri session



As shown in [Figure 42-7](#) (page 200):

- (*) If the accessory wishes to indicate Siri is active, it shall either:
 - Display the word 'Siri' (as capitalized) with no additional text or icon.
 - Use generic text or icon not resembling the Siri microphone icon.
- (**) If the vehicle is equipped with steering wheel controls, the steering wheel shall have a dedicated button or a long-press action on a button to start, continue and end a Siri session. The button long-press shall be 600 ms or less. If no steering wheel controls are available, a soft button shall be available within the in-vehicle user interface to start, continue or end a Siri session.

When a vehicle enables Siri Eyes Free mode, the device will not display any onscreen Siri content. If the device was locked at the time the Siri session was activated from the vehicle, it will remain locked and the screen will not wake. If the user unlocks or manually activates the device while in an Eyes Free Session there will be a notification the device is in an active Siri session but there will be no visual Siri content displayed.

42.9 Enabling/Disabling Siri from the Device

The user has the ability to disable or enable Siri from the Settings menu on the device. When Siri is disabled, Voice Control becomes the recognition engine on the device and will be triggered by default. The accessory may choose to either:

- Activate Voice Control (in the same way Siri is activated) as in [Figure 42-8](#) (page 201).
- Display a warning message and not send an activation command to the device as in [Figure 42-9](#) (page 202).

Figure 42-8 Siri is disabled - activating Voice Control

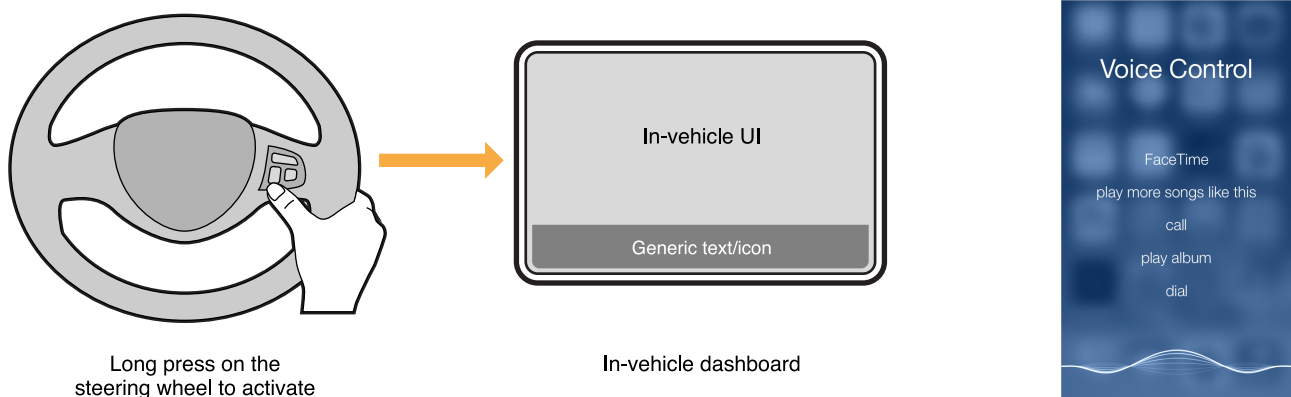
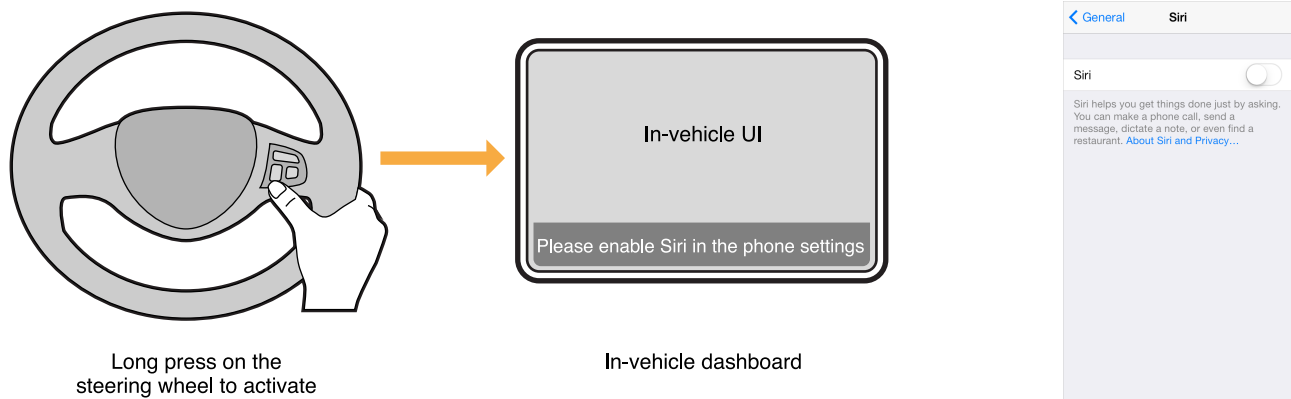


Figure 42-9 Siri is disabled - displaying a warning message



42.10 Verification

42.10.1 Siri Eyes Free

The following test procedures are applicable to accessories interacting with Siri Eyes Free.

The ideal test operator is a native speaker of North American English. If the operator's native language is not North American English, set Siri to the operator's native language and translate the provided phrases into their native language.

42.10.1.1 General

1. Pair and establish a Bluetooth Hands-Free Profile (HFP) connection between the device and the head unit. Activate Siri from the vehicle steering wheel button (for example, by pressing and holding):
 - a. Observe the device screen remains inactive after a Siri session has started (a visual indicator will be visible on the device if the screen is activated manually).
 - b. Ensure Siri's opening chime is heard completely through the vehicle speakers.
 - c. Observe a visual notification in the in-car User Interface (UI) indicating a Siri session is active (for example, text notification, on-screen UI).
2. Activate Siri from the vehicle steering wheel button and say "Send a message to Peter. How are you?". While still saying the message, press the vehicle steering wheel button to cancel Siri:
 - a. Ensure the device screen remains inactive (if manually activated, the visual indicator on the phone will disappear).
 - b. Verify the in-car Siri UI interaction is dismissed and the head unit returns to its prior state before the Siri interaction.

3. Activate Siri from the vehicle steering wheel button and say "How is the weather in San Francisco?". Wait for Siri to respond with the weather forecast. Once the weather forecast is complete, resume Siri from the vehicle steering wheel button and say "What about New York?":
 - a. Confirm the visual indicator is still active on the phone.
 - b. Listen for the Siri opening chime.
 - c. Verify the vehicle UI indicates a Siri session is active.
 - d. Verify Siri responds with the weather forecast for New York.
4. In case the vehicle UI offers on-screen controls to activate/cancel/resume Siri, repeat steps (1) to (3) for all on-screen controls.
5. Activate Siri from the steering wheel button and say "What's the time?". Listen to the current time and do not interact with Siri or the device. After 5 seconds have expired:
 - a. Observe the visual Siri session indicator on the phone is no longer visible.
 - b. Verify the in-car UI for Siri interaction was dismissed.
 - c. Verify the head unit returned to its prior state before the Siri interaction.
6. Listen to FM radio from the car speakers (for example, no A2DP streaming active). Press and hold the device Side/Top/Home button to activate Siri:
 - a. Observe a visual notification in the in-car UI indicating a Siri session is active (textual notification, on-screen UI, etc.).
 - b. Observe Siri's interaction on the device screen and ask "What's the time?".
 - c. After Siri has responded, lock the device again to dismiss the Siri session by pressing the device Side/Top/Home button.
7. Open Settings and turn Siri off. Activate Siri from the head unit. Observe one of the following depending on the actual implementation (a) Voice Control starts instead of Siri (b) The head unit displays a warning indicating Siri Eyes Free is not available.
8. Open Settings and turn Siri back on. Verify Siri can be activated/cancelled from the head unit and from the device Side/Top/Home button.
9. Open Settings and turn Bluetooth off. Verify Siri cannot be started.
10. Open Settings and turn Bluetooth back on. Verify Bluetooth HFP profile reconnects and Siri can be activated/cancelled from the head unit and from the device Side/Top/Home button.
11. Confirm there is no accessory battery status level indicator icon displayed on the device status bar.

42.10.1.2 Siri Dialog

1. Activate Siri from the vehicle's steering wheel button and say "Send a text message to *insert contact name*". When Siri prompts "What would you like it to say?", dictate a short message. After Siri has read back the dictated message, say "Review it". After Siri has read back the message again, say "Review it" again. Repeat this cycle ~5 times to ensure the head unit is able to handle a long interaction with Siri. At the end say "Send it" and verify the message is sent. Verify the opening

chime is audible and the message is sent. After the Siri session is closed, verify the audio playback went back to the audio state it was in before Siri was activated (that is, if audio was paused it remains paused, if it was playing it resumes playing).

2. Start Siri from the vehicle's steering wheel button and ask for directions. Follow up through the dialog until the navigation is started. Verify the Siri session is closed and the audio playback returns to the audio state it was in before Siri was activated (that is, if audio was paused it remains paused, if it was playing it resumes playing).
3. Start Siri from the vehicle's steering wheel button and say "Search the web for polar bears". Verify Siri Eyes Free mode is on and this use case is blocked by Siri. In some implementations the vehicle has to be in motion before Siri Eyes Free is activated by the car kit.
4. Start Siri from the vehicle's steering wheel button and say "What is the current time in Munich?". After Siri answers but before ~5 seconds have elapsed, resume Siri (for example, using a short press on the steering wheel button) and verify Siri is activated again. Say "What about San Francisco?". Repeat (with a different city) and verify this can continue indefinitely as long as there is a short press on the steering wheel button within 5 seconds of the last response.

42.10.1.3 Bluetooth HFP A2DP Music

1. Establish a Bluetooth A2DP connection and switch to Bluetooth audio source on the head unit. Activate Siri and say "Next track". Verify the track advances and audio is played through the vehicle speakers. Verify the Siri in-car UI is dismissed and the head unit returns to its initial audio state.
2. Activate Siri and say "Pause the music". Verify audio remains paused after Siri has been dismissed. Verify the Siri in-car UI is dismissed and the head unit returns to its initial audio state.
3. Pause music playback on the head unit (using AVRCP command). Activate Siri and ask "What time is it?". Verify the music playback remains paused after the Siri session has been dismissed. Verify the Siri in-car UI is dismissed and the head unit returns to its initial audio state.
4. Switch to FM radio on the head unit. Activate Siri and say "Play me a song". Verify the head unit is able to automatically switch to Bluetooth audio and music starts playing. Verify the beginning of the selected track is heard (for example, there is no skipping of audio packets). Verify the Siri in-car UI is dismissed and the head unit returns to its initial audio state.
5. Activate Siri and say "Shuffle all songs". Verify the head unit correctly updates the NowPlaying track information. Verify the Siri in-car UI is dismissed and the head unit returns to its initial audio state.
6. Activate Siri and ask to play a specific artist or title. Verify the Siri session is dismissed after the music starts. Confirm the correct metadata is displayed on the screen. Verify the Siri in-car UI is dismissed and the head unit returns to its initial audio state.

42.10.1.4 Call

1. Activate Siri and call a contact with more than one phone number (for example, home and mobile). Wait for Siri's response asking which phone number to call. Answer with "home". Verify call transition is handled correctly by the head unit and any Siri UI displayed on the vehicle screen is dismissed.
2. While device music is playing, activate Siri and say "Call (*insert contact to call*)". Verify call transition is handled correctly by the head unit. Verify device music playback resumes after the call has been answered and terminated on the far end. Verify the Siri in-car UI is dismissed and the head unit returns to its initial audio state.
3. While device music is playing, start Siri and say "Call (*insert contact to call*)". Verify call transition is handled correctly by the head unit. Verify device music playback resumes after the call has been answered and terminated on the near end (that is, on the head unit). Verify the Siri in-car UI is dismissed and the head unit returns to its initial audio state.
4. While in a Siri session, receive an incoming call on the head unit. Verify the head unit handles call-signaling correctly and transitions to the phone UI once the call has been accepted. Verify the Siri in-car UI is dismissed and the head unit returns to its initial audio state.

42.10.1.5 Bluetooth + Wired iAP2

1. Connect the device to the head unit. Switch to device audio and verify audio is playing. Activate Siri and say "Next track". Verify the track advances and the head unit displays the track metadata correctly. Verify the Siri in-car UI is dismissed and the head unit returns to its initial audio state.
2. From the head unit UI, select a playlist with a single song and start playing it. Start Siri from the vehicle steering wheel and say "Play *make sure to select a song to play (a) not in the same album as the single-track playlist and (b) not song track index 0 of its album*". Verify the new song starts playing and the head unit correctly displays the track metadata for the new song. Verify the Siri in-car UI is dismissed and the head unit returns to its initial audio state.
3. Turn Shuffle off on the head unit UI. Then start Siri and say "Shuffle all songs". Verify the shuffle indicator on the head unit UI is updated and the correct track metadata for the new now playing song is displayed correctly. Verify the Siri in-car UI is dismissed and the head unit returns to its initial audio state.
4. Switch to FM radio on the head unit. Activate Siri and say "Play me a song". Verify the head unit is able to automatically switch to device audio source and music starts playing through the speakers. Verify there is no skipping of audio at the beginning of the selected track. Verify the Siri in-car UI is dismissed and the head unit returns to its initial audio state.
5. Pause music playback on the head unit (using iAP2 commands). Activate Siri and ask "What time is it?". Verify music playback remains paused after the Siri session has been dismissed. Verify the Siri in-car UI is dismissed and the head unit returns to its initial audio state.

6. While device music is playing, start Siri and say "Call (*insert contact to call*)". Verify call transition is handled correctly by the head unit. Verify device music playback resumes after the call has been answered and terminated on the far end. Verify the Siri in-car UI is dismissed and the head unit returns to its initial audio state.
7. While device music is playing, start Siri and say "Call (*insert contact to call*)". Verify call transition is handled correctly by the head unit. Verify device music playback resumes after the call has been answered and terminated on the near end (for example, on the head unit). Verify the Siri in-car UI is dismissed and the head unit returns to its initial audio state.
8. Pause music playback on the head unit (using iAP2 commands). Start Siri and say "Call *insert contact name to call*". Verify call transition is handled correctly by the head unit. Verify device music playback remains paused after the call has been answered and terminated on the far end. Verify the Siri in-car UI is dismissed and the head unit returns to its initial audio state.

43. Wi-Fi Information Sharing

Wi-Fi configuration information can be exchanged between devices and accessories.

Devices can share Wi-Fi configuration information with an accessory. The accessory can initiate this process, but the user shall grant permission for the device to share this information. The device can only share information about the currently connected Wi-Fi network, and this feature will not account for other router-configured access control mechanisms, such as RADIUS or MAC address filtering.

Figure 43-1 Wi-Fi information sharing alert



See the [Accessory Interface Specification](#) (page 26) for more information.

Protocols

44. USB Power Capability Vendor Request

If the accessory is a USB host, and it does not implement [iAP2](#) (page 219), then it may send an Apple-specific USB vendor request communicating how much power is available to the device. In this case, the accessory shall enumerate and identify the presence of a device, then send the vendor request. The vendor request shall be sent every time the device is enumerated by the accessory.

Table 44-1 USB Vendor Request for non-iAP2 accessory USB Embedded Host

Field	Value	Comments
bmRequestType	0x40	Device-to-host request, vendor-defined type, device is recipient.
bRequest	0x40	Vendor-defined USB get enabled capabilities request.
wValue	See comments.	Charging current available, expressed as an offset from 500 mA. Shall be 500 (1000 mA charging current available), 1000 (1500 mA charging current available), 1600 (2100 mA charging current available), 1900 (2400 mA charging current available), or 2500 (3000 mA charging current available).
wIndex	See comments.	Shall be the same as wValue.
wLength	0	0 bytes expected.

45. USB D+/D- Resistor Networks

Accessories not implementing any of the following may use USB resistor networks to identify their current capability:

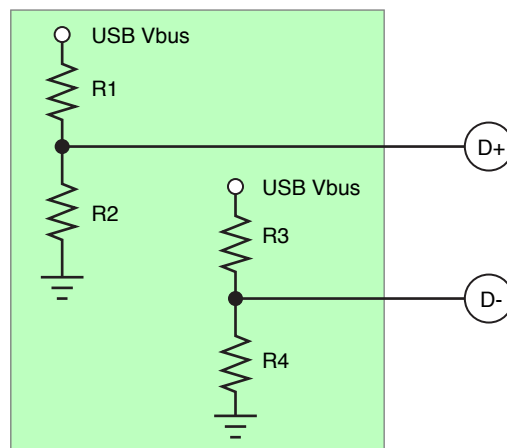
- [iAP2](#) (page 219).
- [USB Power Capability Vendor Request](#) (page 209).
- [USB Type-C Current](#) (page 214).
- [USB Power Delivery \(PD\)](#) (page 213).

Device power draw varies with environmental factors. Accessory power source testing shall be performed with programmable loads, not devices.

45.1 Declaring Power Source Capability

Accessories shall connect the USB D+ and USB D- pins to resistor networks as shown in [Figure 45-1](#) (page 210).

Figure 45-1 USB D+/D- resistor networks



Every iOS device-compatible connector on an accessory using a USB resistor network shall have its own set of resistors. The accessory shall be capable of supplying the total current required when all connectors are in use, regardless of whether the connectors are compatible with devices or not.

The resistor network shall be connected at all times unless the accessory uses one of the following methods to enable charging or detect the presence of a device. In these cases, it shall immediately present the resistor network. The accessory:

- Uses a direct user action to enable charging.
- Senses the attachment of the device using electromechanical means such as a contact switch.

The accessory shall not monitor the USB D+ and USB D- pins to detect the presence of a device.

Resistors used to implement the networks specified in [Figure 45-1](#) (page 210) shall have a tolerance of 1% or better. The resistor network shall not be emulated by driving the voltage of the USB D+/D- pins using some other means.

Table 45-1 USB D+/D- resistor values

Max Current	R1	R2	R3	R4
3000 mA	43.2 k Ω	49.9 k Ω	24.9 k Ω	49.9 k Ω
2400 mA	43.2 k Ω	49.9 k Ω	43.2 k Ω	49.9 k Ω
2100 mA	43.2 k Ω	49.9 k Ω	75.0 k Ω	49.9 k Ω
1000 mA	75.0 k Ω	49.9 k Ω	43.2 k Ω	49.9 k Ω

45.2 Identifying Power Source Current Limit

Accessories shall take into account the variation of USB VBUS voltage and resistor tolerances.

The resistor network values and corresponding current source limits should be identified using the following procedures:

1. Read the VBUS voltage using an ADC. If value is less than 4.5 V, return no resistors detected.
2. Pull-down the D+ and D- lines and read the voltage using an ADC. If either voltage value is less than 1 V, return no resistors detected.
3. Disable the D+ and D- pull-downs and allow the voltage to return to normal.
4. Read the D+ and D- voltages using an ADC (to determine the value for R1 and R3 respectively):
 - If voltage is >2.995 V (based on 1 M Ω load impedance), assume a resistor value of 24.9 k Ω .
 - If voltage is between 2.320 V and 2.995 V (based on 1 M Ω load impedance), assume a resistor value of 43.2 k Ω .
 - If voltage is < 2.320 V (based on 1 M Ω load impedance), assume a resistor value of 75.0 k Ω .
5. Determine the max current based on [Table 45-2](#) (page 212).
6. If resistor values could not be identified, proceed to identify the power available based on the *USB Battery Charging Specification –Release 1.2*.

45. USB D+/D- Resistor Networks

45.2 Identifying Power Source Current Limit

Table USB D+/D- resistor values
45-2

Max Current	R1	R2	R3	R4
1000 mA	24.9 k Ω	49.9 k Ω	24.9 k Ω	49.9 k Ω
1000 mA	24.9 k Ω	49.9 k Ω	43.2 k Ω	49.9 k Ω
1000 mA	24.9 k Ω	49.9 k Ω	75.0 k Ω	49.9 k Ω
3000 mA	43.2 k Ω	49.9 k Ω	24.9 k Ω	49.9 k Ω
2400 mA	43.2 k Ω	49.9 k Ω	43.2 k Ω	49.9 k Ω
2100 mA	43.2 k Ω	49.9 k Ω	75.0 k Ω	49.9 k Ω
1000 mA	75.0 k Ω	49.9 k Ω	24.9 k Ω	49.9 k Ω
1000 mA	75.0 k Ω	49.9 k Ω	43.2 k Ω	49.9 k Ω
500 mA	75.0 k Ω	49.9 k Ω	75.0 k Ω	49.9 k Ω

46. USB Power Delivery (PD)

Accessories providing direct power using USB Power Delivery (PD) or drawing power from USB PD sources shall comply with the *USB Power Delivery Specification – Revision 3.1, Version 1.3*, see <https://www.usb.org/document-library/usb-power-delivery>.

Accessories implementing USB PD shall incorporate a USB-IF certified PD controller with a *Silicon Test ID* from the USB-IF, see <https://www.usb.org/products>.

Apple recommends the GRL-USB-PD-C2 (see <https://www.graniteriverlabs.com/en-us/test-solutions/protocol-power-test-solutions/usb-pd-c2>) for USB PD testing and compliance verification.

47. USB Type-C Current

Accessories providing direct power using USB Type-C Current or drawing power from USB Type-C Current sources shall comply with the *USB Type-C Cable and Connector Specification –Release 2.3, Section 4.6.2*.

Apple recommends the GRL-USB-PD-C2 (see <https://www.graniteriverlabs.com/en-us/test-solutions/protocol-power-test-solutions/usb-pd-c2>) for USB Type-C Current testing and compliance verification.

48. Advanced Audio Distribution Profile (A2DP)

Accessories may implement the Advanced Audio Distribution Profile (A2DP) over [Bluetooth](#) (page 224) to receive audio from iPhone, iPad, Apple Watch, Apple TV, Mac, and Apple Vision Pro.

The audio content from the device can be broadly classified into two categories:

- Audio content from music, video, or gaming applications.
- System-generated sounds for alerts and notifications.

A2DP is often implemented in speakers and headsets.

Accessories implementing A2DP shall satisfy all requirements stated in [Bluetooth](#) (page 224).

48.1 Bluetooth A2DP Specification

Accessories implementing the Advanced Audio Distribution Profile (A2DP) shall meet the requirements of the Bluetooth *Advanced Audio Distribution Profile Specification –Version 1.2*.

48.1.1 AVDTP Transactions

Accessories shall respond to Audio/Video Distribution Transport Protocol (AVDTP) signaling transactions before the device's five second RTX_SIG_TIMER expires or the device will terminate the signaling channel. See Bluetooth *Audio/Video Distribution Transport Protocol –Version 1.3, Section 6.2 Transaction Model and Section 6.4 Signal Command Set*.

48.2 SubBand Codec (SBC)

The SBC Codec Specific Information Elements, defined in *Advanced Audio Distribution Profile Specification –Version 1.2, Section 4.3.2*, applicable to iOS devices and Mac computers are listed in [Table 48-1](#) (page 216).

Table 48-1 SubBand Codec Information Elements for iOS devices and Mac computers

Element	Value
Sampling Frequency	44,100 Hz
Channel Mode	Stereo
Block Length	16
Subbands	8
Allocation Method	Loudness
Bitpool range	2 to 53. Accessories for iOS devices and Mac computers should support 53.

48.3 MPEG 2/4 AAC Codecs

Devices support the non-mandatory codec MPEG-2/4 AAC, as defined in *Advanced Audio Distribution Profile Specification – Version 1.2, Section 4.5*. Accessories should use the AAC codec in addition to SBC, because AAC provides higher audio quality for a given bit rate.

Note:

The following specifications provide details of Apple's implementation of the MPEG-2/4 AAC codec. In case of conflicts, the A2DP specification governs.

The MPEG 2/4 AAC Codec Specific Information Elements, defined in *Advanced Audio Distribution Profile Specification – Version 1.2, Section 4.5*, applicable to devices are listed in [Table 48-2](#) (page 216).

Table 48-2 MPEG-2/4 AAC Codec Information Elements for devices

Element	Value
Object Type	MPEG-2 AAC LC
Sampling Frequency	44,100 Hz
Channels	2
Bit rate	264,630 bps
VBR	0

AAC audio stream packets in devices have the structure shown in [Table 48-3](#) (page 217).

Table 48-3 AAC audio packet for devices

L2CAP	AVDTP	MPEG-4 LATM	MPEG-4 AAC
Header	Header	AudioMuxElement	Audio Payload

The AAC Media Payload Format, as defined in *Advanced Audio Distribution Profile Specification–Version 1.2, Section 4.5.4*, is formatted using LATM as defined in *IETF RFC 3016–Section 4*. The following notes apply to the packet fields shown in [Table 48-3](#) (page 217).

- The recommended L2CAP MTU value for each device's AAC streaming channel is 885 bytes.
- The AVDTP Header is shown as the RTP header in *RFC 3016–Figure 4*, defined in *Bluetooth Audio/Video Distribution Transport Protocol–Version 1.2, Section 7.2.1*.
- The AudioMuxElement is the same as the *RFC 3016–RTP payload*, defined in *ISO/IEC 14496-3:2009–Subpart 1, Section 1.7.3, Table 1.41*. The muxConfigPresent argument to the AudioMuxElement is set to 1 (in-band mode), as recommended in *RFC 3016–Section 4.1*. As recommended in *RFC 3016–Section 4.3*, only one AudioMuxElement is put into each AVDTP packet.
- The audio payload is encoded using MPEG-4, as recommended in *Advanced Audio Distribution Profile Specification–Version 1.2, Section 4.5.4*.
- The accessory should support AAC-LC VBR and handle bit rate changes without audio gaps. Devices will vary AAC bit rate depending on the content.

48.4 Verification

48.4.1 Audio Quality

Verify there are no audio quality issues in each of the following scenarios:

1. Stream music from the Apple Music app.
2. Stream music from a radio station within the Apple Music app.
3. Stream audio using the Apple Podcasts app.

48.4.2 Audio Switching

1. During A2DP streaming, switch audio back to device and switch back to accessory.
2. Verify audio was routed to the intended source, and audio quality was good switching back to Bluetooth.

48.4.3 HFP Interaction

1. Make incoming/outgoing call during A2DP.
2. Verify audio was suspended during the call and resumed after the call.

48.4.4 Siri

1. Trigger Siri during A2DP.
2. Verify audio resumed after the Siri session.

48.4.5 Video Playback

1. Stream A2DP while watching a video.
2. Verify audio/video synchronization and quality is good.

49. iAP2

Accessories may use the iAP2 protocol to access advanced device features, such as:

- Communicating securely with third-party iOS/iPadOS apps using the [External Accessory Protocol](#) (page 159).
- Accessing the media library and retrieving album artwork using [Media Library Access](#) (page 186) and [Now Playing Updates](#) (page 188).
- Launching apps using [App Launch](#) (page 142).
- Discovering compatible apps using [App Discovery](#) (page 141).
- Helping users find compatible apps in the App Store using [App Match](#) (page 143).
- Providing GNSS location data using [Location Information](#) (page 164).
- Supporting connectivity with [Out-of-Band Bluetooth Pairing](#) (page 189) and [Wi-Fi Information Sharing](#) (page 207).

See the [Accessory Interface Specification](#) (page 26) for more information.

50. Human Interface Device (HID)

Devices can accept input from and send output to Human Interface Device (HID) accessories, such as external keyboards, trackpads, mice, and game controllers. This capability is made available system-wide for all apps on the device as well as to support features built into iOS, iPadOS, and tvOS. If an accessory is designed to provide human input events to a specific third-party app, the accessory should use the External Accessory Protocol feature instead; see the [Accessory Interface Specification](#) (page 26) for more information.

The HID protocol can be implemented over:

- USB
- Bluetooth

50.1 Requirements

Accessories shall only send HID reports for changes in physical or virtual control surfaces declared in the corresponding HID descriptor.

Accessories shall not send a HID report if there has not been any change in the state of the corresponding physical or virtual control surface. For example, the accessory shall never generate a "Play/Pause" event without the user pressing a dedicated "Play/Pause" button.

Each HID report shall contain the correct number of bytes as described in its corresponding HID descriptor.

The accessory shall not anticipate or assume corresponding state changes in the device after sending HID reports.

Unless otherwise specified:

- The accessory shall be capable of generating and receiving all HID usages declared in its HID descriptor.
- The accessory's declared HID usages shall map directly to physical or virtual control surfaces on a 1:1 basis. For example, a button labeled "Play/Pause" shall send a Play/Pause HID usage and not "Play" or "Pause" usages. Compound controls such as knobs, joysticks, and directional pads may be considered multiple control surfaces. For example, clockwise and counterclockwise rotation may map to separate HID usages.

- Physical or virtual control surfaces generating HID reports shall be labeled with appropriate iconography or text corresponding to the resulting device behavior. For example, a Play/Pause button shall be labeled with the text 'Play/Pause' or a Play/Pause icon.
- The accessory shall send one HID report in response to each direct user action on the corresponding physical or virtual control surface. For example:
 - When the user presses a button, one 'button pressed' HID report shall be sent to the device.
 - When the user releases the button, one 'button released' HID report shall be sent to the device.

50.1.1 Report Descriptor

When padding packets to align within a byte boundary, each Main item tag (Input, Output, or Feature) shall be marked constant. Padding bits should be set to 0.

When defining Variable type Input/Output fields, either:

- Report Count number shall correspond to the number of Usages specified.
- Report Size shall be 8 and the Report Count shall correspond to the size of a multi-byte blob.

50.1.2 USB

If implementing HID over USB, the accessory shall comply with the *Device Class Definition for Human Interface Devices (HID) – Version 1.11*, see <https://www.usb.org/hid>.

50.2 Verification

50.2.1 General

1. Verify the accessory generates and receives all HID usages declared in the component's HID descriptor.
2. Verify the accessory does not send a HID report if there has not been any change in the state of the control surfaces (that is, no polling of HID reports).
3. Verify if any accessory has physical or virtual control surfaces generating accessory HID usages, the controls are labeled with appropriate iconography or text corresponding to the resulting device behavior (for example, a Play/Pause button is labeled with the text "Play/Pause" or a Play/Pause icon).
4. Verify HID usages map to physical or virtual controls on a 1:1 basis (for example, Play button only sends Play usages, not Play/Pause).

50. Human Interface Device (HID)

50.2 Verification

5. Verify one accessory HID report is sent in response to each direct user action on the corresponding physical or virtual control surface. For example, when the user presses a button, one 'button pressed' usage report is sent, and a separate 'button released' usage report is sent when the user releases the button.

Transports

51. Bluetooth

Accessories integrating Bluetooth technology shall comply with the requirements stated in this chapter.

Accessories shall support the *Bluetooth Core Specification – Version 2.1+EDR or later*.

51.1 Enhanced Data Rate

The Enhanced Data Rate (EDR) feature introduced in the *Bluetooth 2.0 Specification* enables accessories to communicate more efficiently. Accessories shall use EDR for the following reasons:

- EDR provides higher data rates compared to Basic Data Rate (BDR).
- EDR communicates more efficiently, transferring more data bits in less time.
- EDR reduces power consumption per bit transferred.
- EDR improves coexistence with Wi-Fi and other Bluetooth accessories by using less airtime.
- EDR improves performance in multipoint configurations.

51.2 Adaptive Frequency Hopping

Adaptive Frequency Hopping (AFH) introduced in the *Bluetooth 1.2 Specification* improves coexistence with Wi-Fi and other connected Bluetooth accessories. Accessories shall use AFH.

51.3 Sniff Mode for Low Power Consumption

Minimizing power consumption is critical for all mobile devices, therefore accessories shall:

- Support and should request Bluetooth sniff mode.
- Accept sniff mode requests and support valid parameters from the Bluetooth specification.
- Support a sniff interval of 15 ms.
- Support sniff subrating.
- Not renegotiate sniff mode after it is established.

Accessories should use sniff mode values of:

- Max Interval: 15 ms
- Min Interval: 15 ms

- Sniff Attempt: 1
- Sniff Timeout: 0

Accessories compatible with iOS devices and Mac computers should use sniff mode as often as possible, especially when there is little or no data being transmitted over the Bluetooth link. Sniff mode enables better antenna sharing with Wi-Fi, in addition to the power consumption advantages.

Sniff mode parameters are specific to the usage model and Bluetooth profile. Accessories should request sniff mode with appropriate parameters for specific usage models. If the accessory does not send a sniff mode request, the device may send a sniff mode request. When the device sends a sniff mode request, the accessory shall accept the request and parameters without negotiation.

If the accessory requests sniff mode, the accessory shall set the sniff interval to less than a third of the Bluetooth baseband [Link Supervision Timeout](#) (page 227), to make the Bluetooth link less susceptible to interference. To improve link robustness, the accessory should use a shorter sniff interval instead of multiple sniff attempts.

Links with a sniff interval of 1 second or more require a large correlation window, which has to be taken into account when calculating the number of sniff attempts. With sniff intervals shorter than 1 second, multiple sniff attempts can improve link robustness, but will increase power consumption.

51.4 Role and Topology Management

Accessories shall:

- Accept device Role Switch requests.
- Continue with the connection when the device rejects a request for Role Switch.

In a Bluetooth connection, there are two entities:

- The Central entity establishes a common clock and frequency hopping synchronization reference.
- The Peripheral entity synchronizes with the Central entity.

The Central entity can be synchronized with multiple Peripheral entities, thus forming a piconet. The Central entity can also be a Peripheral entity to another Central entity, creating a scatternet.

Accessories simultaneously connecting to multiple iOS devices or Mac computers shall support creating a scatternet.

Scatternets create complications since the device has to alternate between piconets, wasting valuable bandwidth. Efficiently managing network topology is important to maximize performance. The device may request a Role Switch, depending on its current topology, and the accessory shall accept the request. The device may also reject a Role Switch request due to topology concerns, as suboptimal topologies may degrade audio quality and the user experience.

Accessories should avoid requesting to be the Central entity, as in more frequently occurring scenarios the device needs to be the Central entity. Accessories insisting on being the Central entity may negatively impact the overall user experience.

51.5 Extended Inquiry Response

Accessories shall provide the following information in their Extended Inquiry Response packet:

- Local Name of the accessory (Complete or Shortened).
- TX Power Level.

During Bluetooth discovery, devices display accessories Friendly Names when available. Extended Inquiry Response enables accessories to proactively send their Local Name, and other information, as part of an Inquiry Response to increase the speed and efficiency of the discovery process.

Accessory Local Name should match the accessory's labeling and packaging without colons ':' or semi-colons ';'. Accessories may append up to six differentiating characters to their Local Name, such as the last few digits of a serial number or MAC address, if users are likely to encounter multiple accessories at the same time using the same name. If the accessory allows a user to customize the Local Name parameter, the accessory should provide a means to restore the factory default name.

51.6 Secure Simple Pairing

Accessories shall:

- Use Secure Simple Pairing.
- Use the Numerical Comparison method, if it has a display and input device supporting it.

Secure Simple Pairing greatly increases security, and is a mandatory security feature in the *Bluetooth 2.1 Specification*. To protect against a 'man-in-the-middle' attack, the Numerical Comparison association model should be used whenever feasible. See *Bluetooth 2.1+EDR Specification – Volume 1, Section 5.4*.

51.7 Pairing Button

If the accessory has a labeled dedicated pairing control, it should use official Bluetooth branding. See <https://www.bluetooth.com/develop-with-bluetooth/marketing-branding/>.

51.8 Class of Device (CoD)

iOS devices and Mac computers use the accessory's Class of Device for UI purposes or to configure specific features. Accessories shall accurately set their Class of Device using the Bluetooth SIG defined Major Device Class and Minor Device Class. See *Bluetooth 5.0 Specification – Volume 3, Part C, Section 3.2.4*. For example, an audio/video accessory intended to operate in a vehicle should set Major Device Class to 'audio/video' and Minor Device Class to 'car-audio'.

51.9 Link Supervision Timeout

Link supervision timeout is used to detect link loss between an accessory and a device. An accessory shall set the link supervision timeout to 2 seconds or greater when it is the Central entity, to account for the unpredictable nature of RF signals, as well as the device's need to service other concurrent wireless systems.

51.10 Delay Reporting

As of iOS 8.2, devices support Delay Reporting commands as specified in the Bluetooth *Audio/Video Distribution Transport Protocol – Version 1.3*. Accessories should provide this information to improve audio/video synchronization for video playback. Accessories should not report a delay of more than 1000 ms, and should not update the delay more than 1 time per second.

51.11 Profiles

The Apple Bluetooth profiles knowledge base article <https://support.apple.com/kb/ht3647> provides a complete list of the profiles supported by devices. Bluetooth specifications are the starting point for designing accessories compatible with these devices. The following sections provide additional information and requirements for common profiles to help accessory developers achieve superior results.

51.11.1 Device ID Profile (DID)

Accessories shall:

- Support Bluetooth Device ID Profile, Version 1.3 or later.

- Use their Company Identifier from the Assigned Numbers specification assigned by the Bluetooth SIG as the Vendor ID value (VID), see <https://www.bluetooth.com/specifications/assigned-numbers/>. Bluetooth HID Profile accessories may use a VID assigned by the USB Implementers Forum (USB-IF), see <https://www.usb.org/getting-vendor-id>, if the manufacturer does not have a Bluetooth SIG Company Identifier.
- Use its VID value for the end product manufacturer.
- Not use the Company ID assigned to Apple by the Bluetooth SIG, or the Vendor ID assigned to Apple by the USB Implementers Forum.
- Use the Vendor ID Source field to identify which organization assigned the value used in the Vendor ID field. See *Bluetooth Device ID Profile Specification – Section 5.6*.
- Use a ProductID value uniquely identifying the product.
- Use a Version value uniquely identifying the software version.

The Device ID record enables devices to identify the implementation of the remote accessory, which is used to bridge alternate interpretations of the Bluetooth specification when communicating with a remote accessory. It is important the information in the Device ID record uniquely identify the implementation in use.

In the case of Bluetooth car kit devices, the same car kit may be present in different car models. Ideally, the two car kits should have different ProductIDs. However, it is acceptable for them to have the same ProductID as long as they have identical hardware, software, and features. If the implementations differ at all, they should have different ProductIDs. The accessory can also use a secondary Device ID record to uniquely identify the product ID, or model number.

51.11.2 Service Discovery Protocol (SDP)

To facilitate caching Service Discovery Protocol service records, accessories shall:

- Support the ServiceDiscoveryServer Service Class.
- Support the ServiceDatabaseState attribute.
 - Attribute's value shall change whenever any SDP service record or attributes within a record are added, removed, or modified.
 - Attribute's value shall not change based on RFCOMM channel protocol parameters. Devices query these values separately at connection time.

51.11.3 Hands-Free Profile (HFP)

Accessories supporting Hands-Free Profile should meet the requirements of the *Bluetooth Hands-Free Profile Specification – Version 1.5 or later*. Additional Apple requirements are specified in this section.

Remote accessories can use the Bluetooth Hands-Free Profile for phone communications. To achieve the best user experience, the remote accessory should support the following features, which are optional in the Bluetooth specification.

51.11.3.1 Remote Audio Volume Control

Accessories supporting HFP should:

- Support Remote Audio Volume Control, so speaker volume on the hands-free accessory can be controlled from the device as described in *Bluetooth Hands-Free Profile Specification – Version 1.5, Section 4.28*.
- Set the Remote volume control bit in the Supported Features bitmap sent with the AT+BRSF= command.

In some situations it is easier for the user to control the output volume through the device, instead of directly on the remote accessory. For example, a car passenger (or if the car is parked, the driver) could use the volume slider on the phone to control audio volume. Volume control synchronization is outlined in *Bluetooth Hands-Free Profile Specification – Version 1.5, Section 4.48.2*.

51.11.3.2 Indicator Event Reporting

Accessories supporting HFP should use Indicator Event Reporting, and not perform repetitive status polling.

iOS devices and Mac computers support all mandatory and optional indicators specified in HFP version 1.5 (service, call, callsetup, callheld, signal, roam, battchg). To minimize unnecessary status polling using the AT+CIND? command, the remote accessory should enable Indicator Event Reporting by sending an AT+CMER command. The device will then send a +CIEV event when there is a status change. The remote accessory should request initial status using the AT+CIND=? and AT+CIND? commands, according to the HFP specification.

51.11.3.3 Voice Recognition Activation

Accessories supporting HFP shall:

- Support Voice Recognition Activation, both AG and HF, initiated as described in *Bluetooth Hands-Free Profile Specification – Version 1.5, Section 4.25*.
- Set the Voice Recognition Activation bit in the "SupportedFeatures" bitmap sent with the AT+BRSF= command.

iOS devices and Mac computers support voice recognition initiated by remote (Hands-Free) accessories, and iOS (Audio Gateway) accessories.

51.11.3.4 Echo Cancellation and Noise Reduction

When echo cancellation and noise reduction are performed locally on a hands-free accessory, the accessory should disable echo cancellation and noise reduction on the device by sending an AT+NREC command, as described in *Bluetooth Hands-Free Profile Specification – Version 1.5, Section 4.24*.

iOS devices and Mac computers support echo cancellation and noise reduction by default. If a hands-free accessory performs echo cancellation and noise reduction, the accessory needs to turn these features off on the device (the Audio Gateway), to avoid unnecessary audio quality degradation due to duplicate audio processing.

51.11.3.5 In-Band Ringing

Accessories supporting HFP should also support In-Band Ringing as specified in *Bluetooth Hands-Free Profile Specification – Version 1.5, Section 4.13.1*. If the user sets a ring tone on the device, the same ring tone should sound on the hands-free accessory.

51.11.3.6 Synchronous Connection

Accessories supporting HFP shall:

- Support eSCO parameter set S2 and S3 and accept requests for these settings. See *Bluetooth Hands-Free Profile Specification – Version 1.5, Section 5.6*.
- Request eSCO parameter set S2 or S3 when setting up a Synchronous Connection. eSCO parameter set S1 should not be requested.
- Render audio within 40 ms after the SCO/eSCO connection has been set up.

eSCO packet types offer packet retransmission, whereas traditional SCO packets are not retransmitted. This improves audio quality and the user experience. eSCO packet types 2-EV3 and 3-EV3 offer a greater time interval between packets, which can improve Wi-Fi performance and allow time for other concurrent Bluetooth connections to send data.

Apple strongly recommends the use of 2-EV3 and 3-EV3 packets for SCO connections. Using HV3 packets is highly discouraged. HV3 packets require more link time and do not allow audio packet retransmission, which impacts audio performance in the presence of RF interference.

51.11.3.7 Wide Band Speech

Accessories supporting HFP should support Wide Band Speech as described in the *Bluetooth Hands-Free Profile Specification – Version 1.6, Section 5.7.4*. If Wide Band Speech is supported, the accessory should support the T2 link parameter settings.

Devices running iOS 5 or later support Wide Band Speech. If both the device and the accessory support Wide Band Speech, the device will use it for eSCO connection scenarios such as cellular calls, FaceTime, and Siri.

51.11.4 Message Access Profile (MAP)

Accessories supporting Message Access Profile shall:

- Support Message Notification, as described in *Bluetooth Message Access Profile Specification –Version 1.1, Section 4.1*
- Register for notifications immediately after the connection is established, as described in *Message Access Profile Specification –Version 1.1, Section 4.5*.

Devices running iOS 13.0 or later support MAP 1.1.

51.11.5 Audio/Video Remote Control Profile (AVRCP)

Accessories supporting Audio/Video Remote Control Profile should meet the requirements of the *Bluetooth Audio/Video Remote Control Profile Specification –Version 1.4*. Additional Apple requirements are specified in this section.

51.11.5.1 Supported Operations

iOS devices and Mac computers support the following operation_IDs in passthrough commands:

- Play
- Stop
- Pause
- Fast Forward
- Rewind
- Forward
- Backward

51.11.5.2 Repeat and Shuffle Modes

Every device in the role of an AVRCP target supports Repeat and Shuffle modes. An AVRCP controller may use `SetPlayerApplicationSettingValue` to set a value on the device and `GetPlayerApplicationSettingValue` to read a value, as described in *Bluetooth Audio/Video Remote Control Profile Specification –Version 1.4, Sections 6.5.4 and 6.4.3*.

51.11.5.3 Notifications

Accessories supporting AVRCP shall:

- Register for notifications.
- Not perform repetitive device status polling.

Every device in the role of an AVRCP Target supports registering for notifications, as described in *Bluetooth Audio/Video Remote Control Profile Specification –Version 1.4, Section 6.7*. The commands `RegisterNotification` and `GetPlayStatus` are supported for these notifications:

- `EVENT_PLAYBACK_STATUS_CHANGED`
- `EVENT_TRACK_CHANGED`

- EVENT_NOW_PLAYING_CONTENT_CHANGED
- EVENT_AVAILABLE_PLAYERS_CHANGED
- EVENT_ADDRESSED_PLAYER_CHANGED
- EVENT_VOLUME_CHANGED

51.11.5.4 Play/Pause Button

Accessories supporting AVRCP implementing a Play/Pause control surface shall confirm the playback status of the device using AVRCP [Notifications](#) (page 231), before sending a Play or Pause command. See [Supported Operations](#) (page 231). Specifically:

- If a device notifies the accessory it is paused, pressing the accessory's Play/Pause control surface should send a Play command.
- If a device notifies the accessory it is playing, pressing the accessory's Play/Pause control surface should send a Pause command.
- The accessory should not infer device playback status based on the number of times the Play/Pause control surface has been pressed.

51.11.5.5 Volume Handling

Accessories supporting AVRCP should support Absolute Volume, as described in *Bluetooth Audio/Video Remote Control Profile Specification – Version 1.4, Section 6.13*.

Every device in the role of AVRCP Controller supports volume handling.

51.11.5.6 Browsing

Accessories supporting Browsing (in controller role) as part of AVRCP shall:

- Not try to index or cache the entire library upon connection. The device may contain tens of thousands of media items, and each may be present multiple times in the hierarchy.
- Not fetch all items when browsing a folder; only fetch items displayed to the user. The accessory may prefetch a few items to improve the responsiveness of the user interface.
- Not reorder items (for example, alphabetically).
- Not assume UIDs to be statically defined, especially in the root folder. The ordering and UIDs of folders and items may change at any point in future releases.
- Send the `SetBrowsedPlayer` command after receiving an `EVENT_UIDS_CHANGED` notification.
- Not assume the UID passed to the `PlayItem` command will result in the media player playing the UID.

Currently only the built-in Music app supports browsing. When switching between players, an `EVENT_AVAILABLE_PLAYERS_CHANGED` notification, and an `EVENT_ADDRESSED_PLAYER_CHANGED` notification will be generated. The UI needs to look at the feature bit mask of the listed player to determine whether browsing is currently available.

Devices running iOS 6.0 or later support AVRCP Browsing.

51.11.5.7 iOS App-Provided Metadata

An audio app running on a device may use the iOS Media Player Framework to provide metadata about the current audio stream to the accessory using AVRCP. Requirements and usage for these messages may be found in the `MPNowPlayingInfoCenter` class in Apple Media Player Framework documentation.

51.11.6 Advanced Audio Distribution Profile (A2DP)

See [Advanced Audio Distribution Profile \(A2DP\)](#) (page 215).

51.12 Audio Routing

Accessories can differentiate between various audio content provided by a device, and determine playback behavior.

An accessory can receive audio data from the device using either of two Bluetooth profiles:

- HFP using eSCO channel.
- A2DP using ACL channel.

The device determines which channel to use, depending on how the audio content is used. An audio path created for two-way communication (for example, phone calls or FaceTime) always uses the HFP (eSCO) route for sending audio data. Music and similar content uses the A2DP channel route. In the absence of a defined route, audio playback defaults to the device.

51.12.1 Audio Data Received using HFP Profile

Most of the audio content sent using HFP (eSCO) route requires two-way communication. Scenarios where HFP (eSCO) is used include, but are not limited to: cellular calls, FaceTime, and voice mail.

The accessory speaker and microphone should be dedicated to the HFP (eSCO) route, and not mixed/muxed with any other audio sources.

51.12.2 Audio Data Received using A2DP Profile

Audio content transferred using A2DP profiles can be broadly classified into two categories:

- Audio content from music, video, or game-like applications.
- System-generated sounds used for alerts and notifications.

51.12.2.1 Differentiating Audio Content from System Sounds

Music-like content can be differentiated from system sounds by adding support for Audio/Video Remote Control Profile (AVRCP) version 1.3 or later. The AVRCP profile allows an accessory to be aware of the audio playback device state, using notifications. See [Audio/Video Remote Control Profile \(AVRCP\)](#) (page 231).

When a device initiates audio playback over an A2DP channel for playing music content, an AVRCP notification `EVENT_PLAYBACK_STATUS_CHANGED` is sent to indicate playback status has changed to the play state. See *Bluetooth Audio/Video Remote Control Profile Specification – Version 1.4, Section 6.7.2*. This indicates audio data using the A2DP profile contains music. When a device initiates audio playback over an A2DP channel for playing system sounds, no AVRCP notifications are sent.

[Figure 51-1](#) (page 234) and [Figure 51-2](#) (page 235) show the difference between notifications for music playback, and system sounds.

Figure 51-1 Initiate Audio Playback (for example, music)

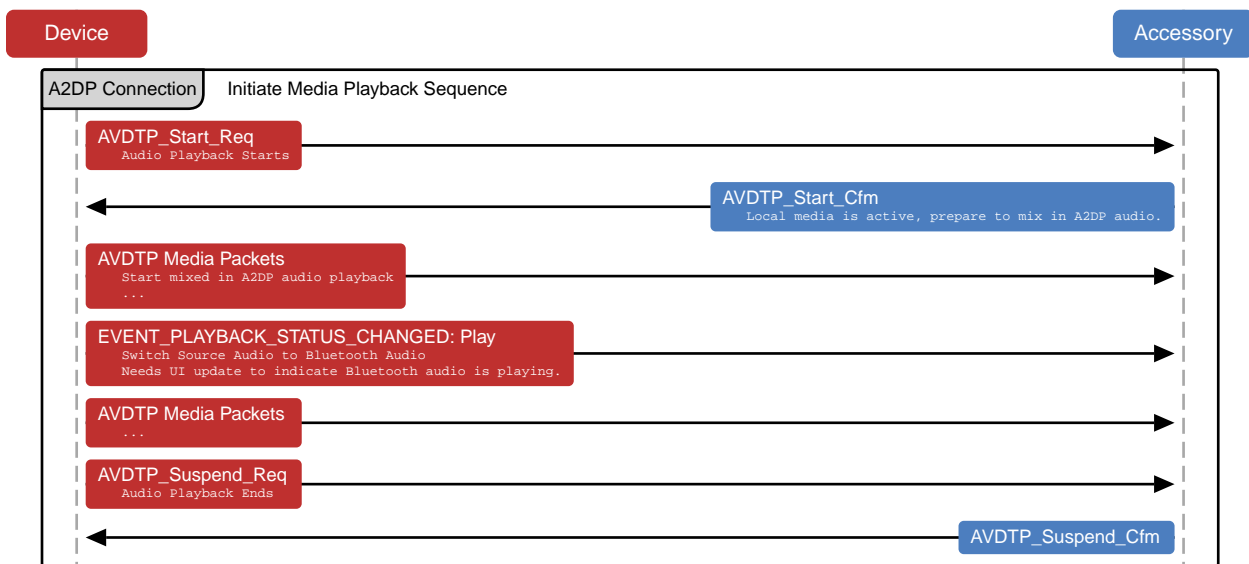
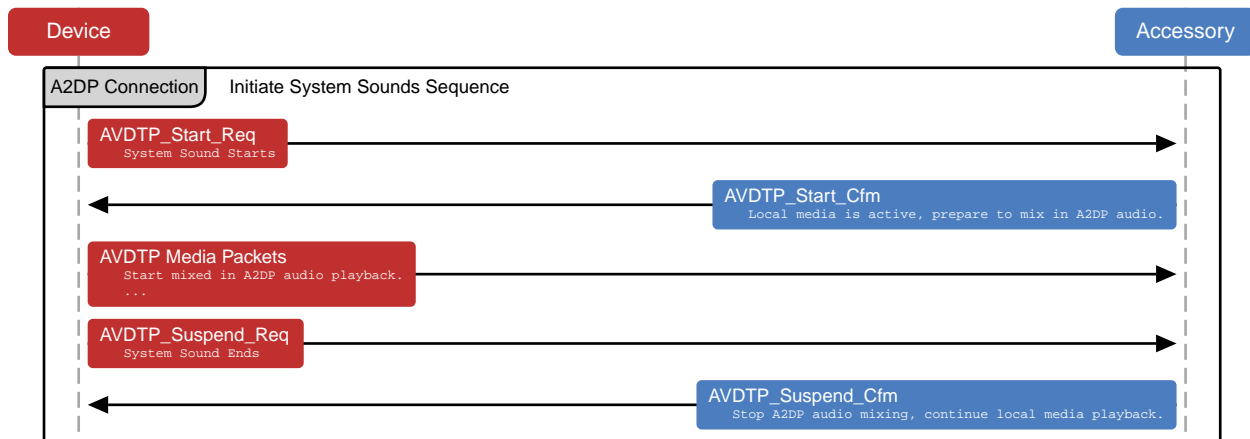


Figure 51-2 Initiate System Sound (such as turn-by-turn directions)



51.12.2.2 Expected Audio Routing Behavior for A2DP

The accessory should tune its audio routing behavior based on audio content over the A2DP channel.

If audio data contains music, accessory speakers are expected to be dedicated to audio data using the Bluetooth link, and any other audio playback is paused. If audio data contains system sounds, it is expected the accessory can render audio as desired. If the accessory is playing audio from a different source, it is not necessary to pause existing audio playback on the device, and system sound data can be mixed with the existing track for playback.

51.13 HID

When implementing HID over Bluetooth, the accessory should:

- Support Bluetooth HID Profile 1.1.
- Support [Sniff Mode for Low Power Consumption](#) (page 224).

The accessory should:

- Use the following parameters in SDP for sniff subrating:
 - HIDSSRHostMaxLatency - 450 ms (720 slots)
 - HIDSSRHostMinTimeout - 45 ms (72 slots)
- Use a typical report packet of 22 bytes or less. This is small enough to fit into a DH1 packet with L2CAP and HID header.

52. Bluetooth Low Energy (BLE)

The *Bluetooth 4.0 Specification* introduces Bluetooth Low Energy (BLE), a wireless technology targeted for accessories with limited battery resources. If Bluetooth Low Energy is supported, the accessory should follow the guidelines in this section.

52.1 Role

The accessory should implement either the Peripheral role or the Broadcaster role as defined in the *Bluetooth 4.0 Specification – Volume 3, Part C, Section 2.2.2.3 and Section 2.2.2.1*.

52.2 Advertising Channels

The accessory should advertise on all three advertising channels (37, 38, and 39) at each advertising event. See the *Bluetooth 4.0 Specification – Volume 6, Part B, Section 4.4.2.1*.

52.3 Advertising PDU

The accessory should use one of the following advertising PDUs:

- ADV_IND
- ADV_NOCONN_IND
- ADV_SCAN_IND

ADV_DIRECT_IND should not be used. See the *Bluetooth 4.0 Specification – Volume 6, Part B, Section 2.3.1*.

52.4 Advertising Data

The advertising data sent by the accessory should contain at least the following information as described in the *Bluetooth Core Specification Supplement – Part A*:

- Flags
- TX Power Level

- Local Name
- Services

The Local Name should match the accessory's markings and packaging and not contain a colon ':' or semi-colon ';'.

The accessory may put the Local Name and the TX Power Level data in the SCAN_RSP PDU if, for example, it needs to reduce power consumption or not all of the advertising data fit into the advertising PDU. Depending on its state, the device may not always perform active scanning.

The primary services should always be advertised in the advertising PDU. Secondary services should not be advertised. Services not significant to the primary use case of the accessory may be omitted if space is limited in the Advertising PDU.

The advertising data and the scan response data in the SCAN_RSP PDU should comply with the formatting guidelines in the *Bluetooth 4.0 Specification – Volume 3, Part C, Section 18*: it starts with a length field, followed by AD Type and AD Data.

52.5 Advertising Interval

The accessory should first use the recommended advertising interval of 20 ms for at least 30 seconds.

If it is not discovered within the initial 30 seconds, Apple recommends using one of the following longer intervals to increase chances of discovery by the device:

- 152.5 ms
- 211.25 ms
- 318.75 ms
- 417.5 ms
- 546.25 ms
- 760 ms
- 852.5 ms
- 1022.5 ms
- 1285 ms

Note:

Longer advertising intervals usually result in longer discovery and connect times, but may lower accessory power consumption.

52.6 Connection Parameters

If both the Central and Peripheral support the Connection Parameters Request procedure, then either shall use the procedure. The device will not read or use the parameters in the Peripheral Preferred Connection Parameters characteristic. See *Bluetooth 5.3 Specification – Volume 6, Part B, Section 5.1.1 Connection Update*.

Connection parameter requests may be rejected if they do not meet the guidelines in this section.

General connection parameter request guidelines:

- Peripheral Latency ≤ 30 connection intervals.
- Supervision Timeout from 6 seconds to 18 seconds.
- Interval Min ≥ 15 ms.
- Interval Min ≤ 2 seconds.
- Interval Min is a multiple of 15 ms.
- One of the following:
 - Interval Max at least 15 ms greater than Interval Min.
 - Interval Max and Interval Min are both 15 ms.
- Interval Max * (Peripheral Latency + 1) of 6 seconds or less.
- Supervision Timeout greater than Interval Max * (Peripheral Latency + 1) * 3.

If Bluetooth Low Energy HID is one of the connected services of an accessory, a connection interval down to 11.25 ms may be accepted by some devices.

Note:

When Interval Max and Interval Min are both 15 ms, some devices (such as Apple Watch) will offer a 30 ms interval to better balance power and performance constraints.

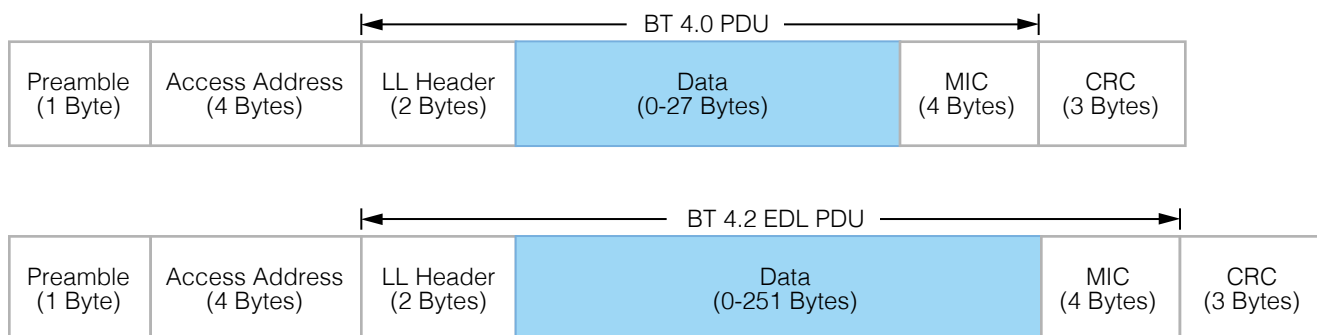
Apple Watch connection parameter request guidelines:

- Interval Min ≥ 30 ms.
- Interval Min is a multiple of 30 ms.
- One of the following:
 - Interval Max at least 30 ms greater than Interval Min.
 - Interval Max and Interval Min are both 30 ms.

52.7 Data Packet Length Extension

Data Packet Length Extension increases the maximum data length from 27 to 251. Using larger per-packet data lengths improves radio efficiency, greatly increasing application data rates and boosting battery life. See *Bluetooth 5.0 Specification – Volume 6, Part B, Section 4.6.6*.

Figure 52-1 Data Packet Length Extension



Accessories should support Data Packet Length Extension for best performance with devices.

iOS devices and Mac computers operating as the Central will negotiate optimal data packet lengths based on various factors, such as connection event length, system topology, and protocol.

52.8 Privacy

The accessory should be able to resolve a Resolvable Private Address in all situations. Due to privacy concerns, the device will use a Random Device Address as defined in the *Bluetooth 4.0 Specification – Volume 3, Part C, Section 10.8*.

52.9 Permissions

The accessory should not require special permissions, such as pairing, authentication, or encryption to discover services and characteristics. It may require special permissions only for access to a characteristic value or a descriptor value. See the *Bluetooth 4.0 Specification – Volume 3, Part G, Section 8.1*, fifth paragraph.

52.10 Pairing

The accessory should not request pairing until an ATT request is rejected using the Insufficient Authentication error code. See *Bluetooth 4.0 Specification – Volume 3, Part F, Section 4*.

If, for security reasons, the accessory requires a bonded relationship with the Central, the Peripheral should reject the ATT request using the Insufficient Authentication error code, as appropriate. As a result, the device may proceed with the necessary security procedures.

Similarly, if the device acts as a Central and a GATT server, it may reject an ATT request using the Insufficient Authentication error code. The accessory should initiate the security procedure for pairing in response.

Pairing may require user authorization depending on device. Once an accessory is paired with a device, the accessory shall retain the distributed keys of both central and peripheral for future use. If the pairing is no longer required, the accessory shall delete both sets of keys.

52.11 MTU Size

An accessory supporting packet length extension shall perform the packet length update procedure before performing the Exchange MTU Request handshake, see [Data Packet Length Extension](#) (page 238).

Devices will support and request an MTU size larger than the default during the Exchange MTU Request handshake. See the *Bluetooth 4.0 Specification – Volume 3, Part F, Section 3.2.8*.

When operating as ATT client, the device will request the optimal MTU size based on factors such as the Bluetooth topology, connection event length, maximum data length, and protocol (GATT or connection-oriented L2CAP).

An accessory operating as ATT server should select an MTU equal to or greater than the device's MTU request.

52.12 Services

52.12.1 Generic Access Profile Service

The accessory should implement the Device Name characteristic per the *Bluetooth 4.0 Specification – Volume 3, Part C, Section 12.1*. The Device Name characteristic should be writeable.

52.12.2 Generic Attribute Profile Service

The accessory shall implement the Service Changed characteristic only if the accessory has the ability to change its services during its lifetime.

The device may use the Service Changed characteristic to determine if it can rely on previously read (cached) information from the device. See the *Bluetooth 4.0 Specification – Volume 3, Part G, Section 7.1*.

52.12.3 Device Information Service

The accessory shall implement the Device Information Service. The service UUID for this service should not be advertised in the Advertising Data. The following characteristics should be supported:

- Manufacturer Name String (26 characters maximum).
- Model Number String (26 characters maximum).
- Firmware Revision String
- Software Revision String

52.12.4 Available Services

With iOS 7.0, any device makes Battery Service, Current Time Service and Apple Notification Center Service (ANCS) available to an accessory. The Current Time Service supports the current time and local time information characteristics. The service does not provide an "Adjust Reason" when the current time changes. ANCS uses 7905F431-B5CE-4E99-A40F-4B1E122D00D0 as its UUID.

These services are not guaranteed to be available immediately after connection and the accessory shall support Characteristic Value Indication of the Service Changed characteristic (see *Bluetooth 4.0 Specification – Volume 3, Part G, Section 7.1*) to be notified when the services become available. The device will maintain a connection to an accessory as long as it is paired and uses one of the available services.

52.13 GATT Server

With iOS 6.0, applications may contribute services and characteristics to the GATT server the device makes available to the accessory. The recommendations in this section apply to the accessory in this case.

The following services are implemented internally by iOS and shall not be published by third-party iOS applications:

- Generic Attribute Profile Service
- Generic Access Profile Service
- Bluetooth Low Energy HID Service
- Battery Service
- Current Time Service
- Apple Notification Center Service

The device implements the GAP Service Changed characteristic, because the database contents can change at any time. The accessory should therefore support the Characteristic Value Indication of this characteristic and, upon receiving indications, invalidate its database cache accordingly. See the *Bluetooth 4.0 Specification – Volume 3, Part G, Section 7.1*.

The accessory should minimize the use of ATT/GATT requests and commands and only send what is necessary. For example, do not use GATT Discover All Services when the accessory is looking for specific services. Use Discover Primary Service By Service UUID instead. Less airtime equals less power consumption and better performance for both the accessory and the device.

When third-party iOS applications discover services on the accessory, the following services are used internally by iOS and are filtered out from the list of discovered services:

- Generic Attribute Profile Service
- Generic Access Profile Service
- Bluetooth Low Energy HID Service
- Apple Notification Center Service

The accessory should be robust enough to handle any error gracefully. Pairing and Characteristic Value reads/writes may fail if the application owning the service is not in the foreground and is not entitled to run in the background.

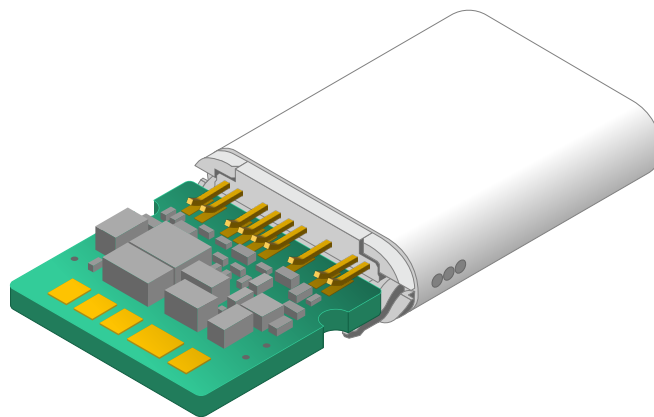
If an ATT Prepare Write Request is used, all queued attributes are contained within the same GATT Service.

Modules

53. Apple USB-C Analog Headset Module

The Apple USB-C Analog Headset Module (C125) may be used to create USB-IF compliant [Headsets](#) (page 88) supporting up to 24-bit/384 kHz stereo and up to 24-bit/48 kHz mono (microphone) audio. C125 supports Apple Music Lossless and Hi-Res Lossless.

Figure 53-1 USB-C Analog Headset Module (C125)



53.1 Overview

C125 is a USB-IF compliant USB Audio Device Class 2.0 and 3.0 codec with an integrated USB-IF certified USB-C plug (Test ID: 11559).

C125 supports:

- 16-bit and 24-bit samples.
- 44.1 kHz, 48 kHz, 88.2 kHz, 96 kHz stereo headphone-level output.
- Optional:
 - 176.4 kHz, 192 kHz, 384 kHz stereo headphone-level output.
 - 7-band output EQ.
- 44.1 kHz, 48 kHz mono microphone input.
- Optional:
 - 7-band microphone input EQ.
 - 3-band sidetone EQ.

- Volume Up, Volume Down, and Center buttons.

C125 does not support USB-C to 3.5 mm headset jack adapters.

53.1.1 Additional Specifications & Support

Additional software and support for C125 is available from Cirrus Logic, Inc.

Get started at <https://www.cirrus.com/support/c125/>.

53.1.2 Procurement

The C125 is available at <https://c125.proscalnext.com/>:

Variant	Part Number
C125	AB23169-1A033-AH

53.2 Mechanical

C125 has the following mechanical characteristics:

- Integrated USB-C connector.
- Not encapsulated.
- -20 °C to 65 °C working temperature range.

See [C125 Dimensions](#) (page 249) for dimensional drawing.

C125 headsets shall:

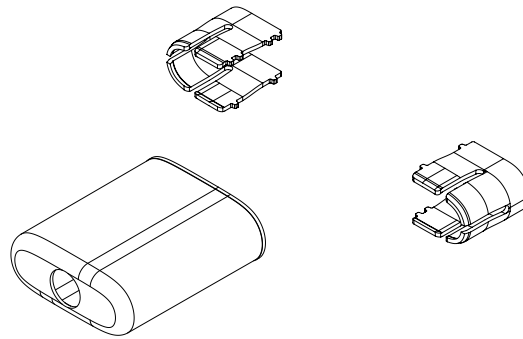
- Meet the requirements for USB-C connector integration, see [Mechanical](#) (page 271).
- Encapsulate both sides of C125.

53.2.1 Shielding

C125 headsets shall:

- Protect the C125 electronic components with a SUS shield.
- Laser weld the SUS shield to the C125 ground ring.

Figure 53-2 C125 recommended three-part shield design



Apple recommends the following three-part shield design as shown in [Figure 53-2](#) (page 246) for C125:

- [C125 Recommended Clamshell Shields](#) (page 250)
- [C125 Recommended Rear Shield](#) (page 251)

53.3 Pad Assignments

[Figure 53-3](#) (page 246) and [Table 53-1](#) (page 247) detail the layout, names, description, and assignments of the C125 pads.

Figure 53-3 C125 pads

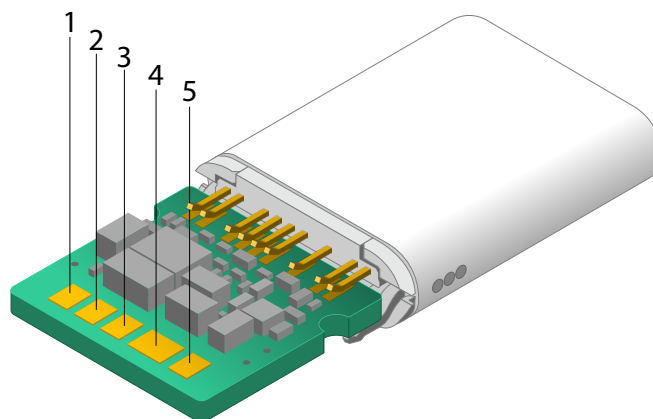


Table 53-1 C125 pad assignments

Pad	Name	Assignments
1	Left Driver	Left Driver
2	Microphone Bias	Microphone Bias
3	Reserved	NC
4	Ground	Right Return, Left Return, Microphone Return
5	Right Driver	Right Driver

53.4 Electrical

C125 headsets shall incorporate the [Headset Remote and Microphone Transmitter](#) (page 253) using [Tone Mode](#) (page 262).

The C125 shield may be treated as an electrical ground.

53.4.1 DAC Characteristics

The C125 DAC receives lossless 24-bit stereo audio from the device.

Table 53-2 C125 DAC characteristics, 24-bit/96 kHz mode

Driver	Parameter	Typical
32 Ω , 1 nF	Dynamic range (A-weighted)	117 dB
	THD+N (FS = 48 kHz, BW = 20 kHz)	-91 dB
	Full-scale output voltage	2.4 V _{PP}
	Output power	22.6 mW
16 Ω , 1 nF	Dynamic range (A-weighted)	112 dB
	THD+N (FS = 48 kHz, BW = 20 kHz)	-83 dB
	Full-scale output voltage	1.3 V _{PP}
	Output power	14.2 mW

Table 53-3 C125 DAC characteristics, 24-bit/384 kHz mode

Driver	Parameter	Typical
32 Ω , 500 pF	Dynamic range (A-weighted)	117 dB

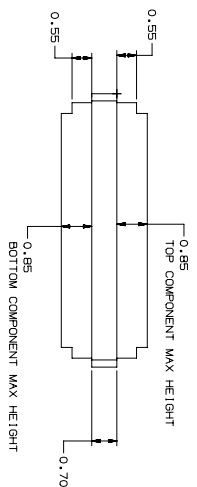
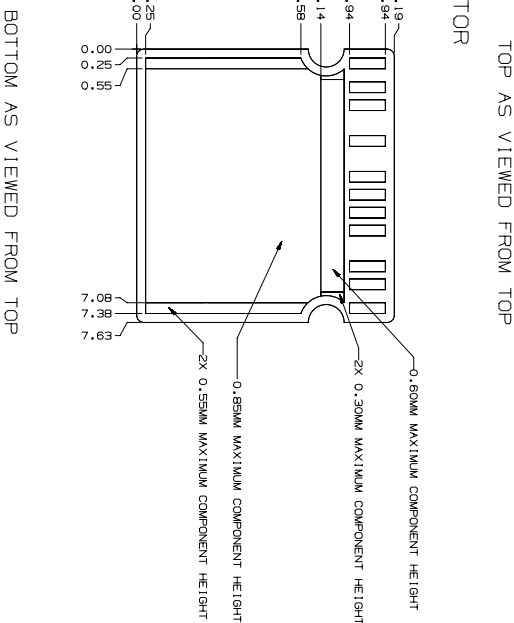
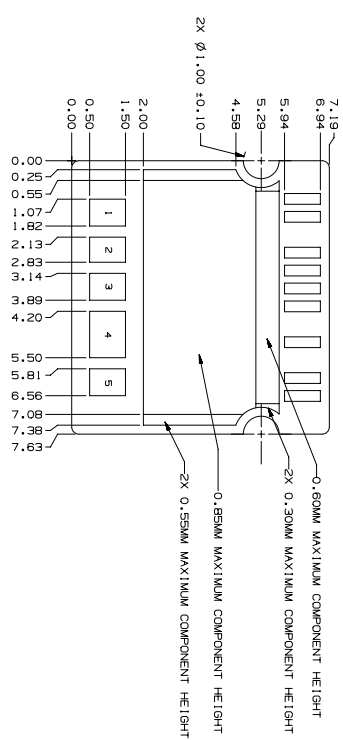
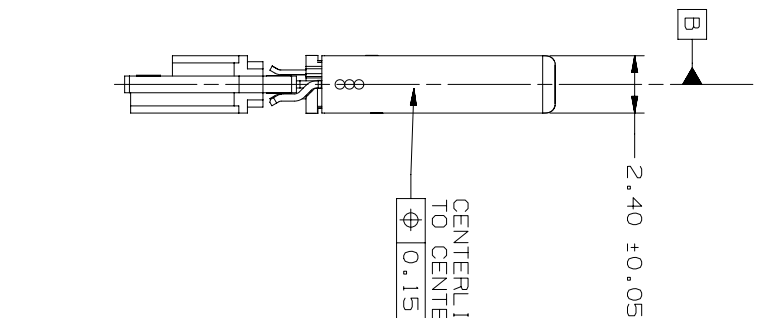
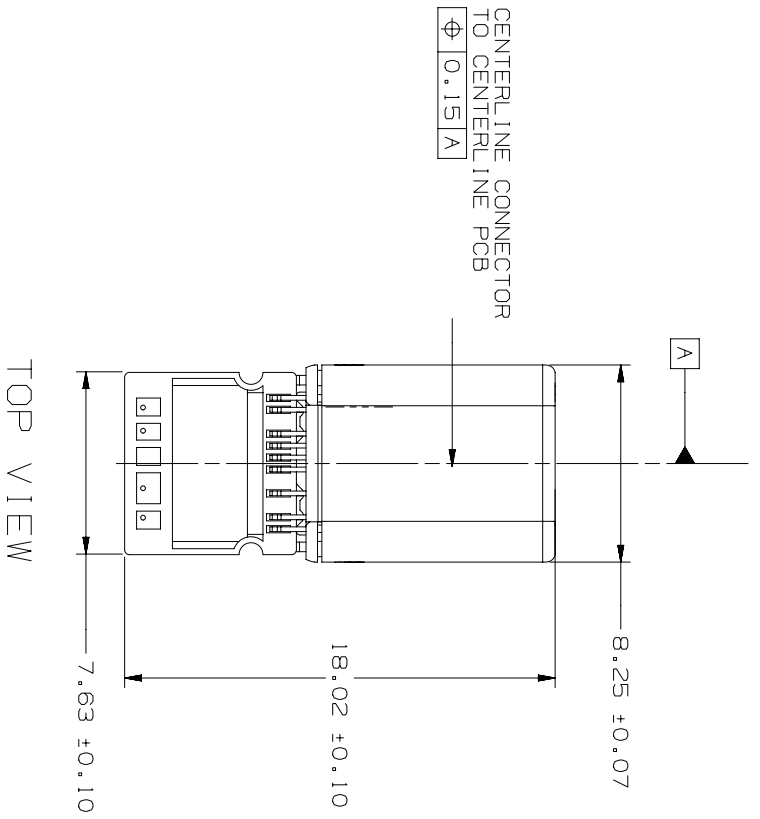
Driver	Parameter	Typical
	THD+N (FS = 48 kHz, BW = 20 kHz)	-91 dB
	THD+N (FS = 192 kHz, BW = 80 kHz)	-90 dB
	Full-scale output voltage	2.4 V _{PP}
	Output power	22.6 mW
16 Ω, 500 pF	Dynamic range (A-weighted)	112 dB
	THD+N (FS = 48 kHz, BW = 20 kHz)	-84 dB
	THD+N (FS = 192 kHz, BW = 80 kHz)	-83 dB
	Full-scale output voltage	1.3 V _{PP}
	Output power	14.2 mW

The characteristics in [Table 53-2](#) (page 247) and [Table 53-3](#) (page 247) were measured under the following conditions:

- Left Driver, Right Driver, and Ground pads on C125 connected to a load and an audio analyzer, such as the Audio Precision APx series.
- Microphone Bias pad connected to the Ground pad.
- Full-scale 1 kHz sine wave input test signal.

53.5 C125 Dimensions

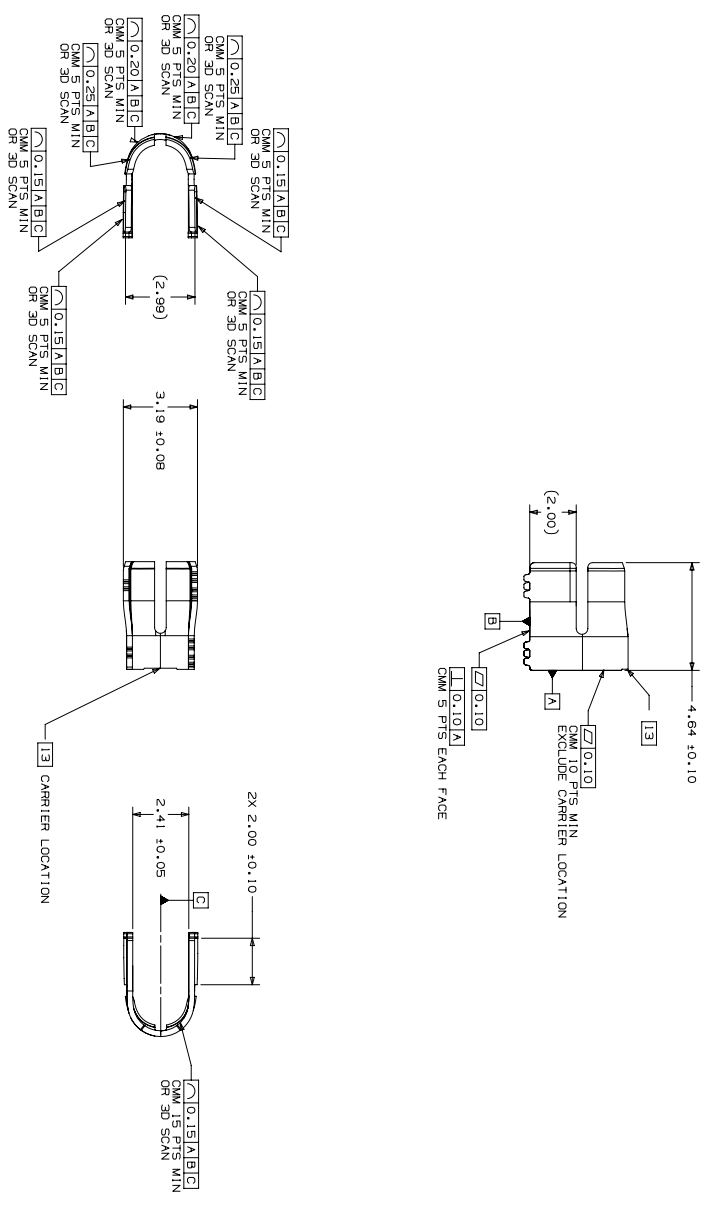
NOTES: (UNLESS OTHERWISE SPECIFIED)



METRIC		Apple Inc.	
SYMBOL	DATE	NOTE OR REVISIONS	REV.
DESCRIPTION	DATE	THIS DRAWING IS THE PROPERTY OF APPLE INC. IT IS TO BE USED ONLY FOR THE PROJECT AND IN ACCORDANCE WITH THE TERMS AND CONDITIONS OF THE APPLE INC. SUPPLIER AGREEMENT.	A
CONNECTIONS AND INSTRUCTIONS			
X.X	+0.2	DRAWING NUMBER	
X.XX	+0.10	ANGLES ± 0.5°	
X.XXX	+0.050	DO NOT SCALE DRAWING	
HARD MATE PROJECTION		SCALE	NONE
		SHEET	1 OF 1

53.6 C125 Recommended Clamshell Shields

- NOTES** (UNLESS OTHERWISE SPECIFIED)
- ALL DIMENSIONS AND TOLERANCES APPLY PER ASME Y14.5M, 1994. IT IS EXPECTED THAT THE SUPPLIER UNDERSTAND AND COMPLY WITH ALL TOLERANCES AS DESCRIBED IN THIS STANDARD AND APPLIED TO THIS DRAWING.
 - DIMENSIONS ARE MEASURED AFTER PLATING.
 - ALL DIMENSIONS THAT LOCATE GEOMETRICAL TOLERANCE FEATURES (PROFILE AND POSITION CHARACTERISTICS) ARE CONSIDERED BASIC AS DEFINED IN THE ASME Y14.5M, 1994 STANDARD.
 - WHEN DATUMS ARE SPECIFIED ON A DRAWING, DIMENSIONS ARE RELATED TO DATUM A (AS THE PRIMARY DATUM), DATUM B (SECONDARY), AND DATUM C (TERTIARY). PERFECT ORIENTATION AND/OR PERFECT LOCATION AT MMC REQUIRED FOR THE INTERPRETATION OF ALL DATUM FEATURES OF SIZE, UNLESS OTHERWISE SPECIFIED ON DRAWING.
 - UNLESS OTHERWISE SPECIFIED, ALL SURFACES TO BE WITHIN A SURFACE PROFILE TOLERANCE OF $\sqrt{0.1|A|B|C}$.
 - ALL BURRETS TO BE LESS THAN 0.02 mm.
 - BREAK ALL EDGES 0.05 mm R UNLESS SPECIFIED.
 - PART NEEDS TO SURVIVE BHR SALT SPRAY TEST.
 - MATERIAL: SUS304-1/2H, 0.25mm THK
 - FINISH: 2-5 μ m NICKEL PLATING PER AMS QQ-N-290
 - ALL PLATING TO OCCUR AFTER PART STAMPING AND FORMING
 - BURRS SHALL BE SUBFLUSH TO DATUM A

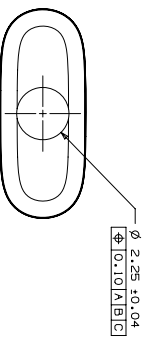
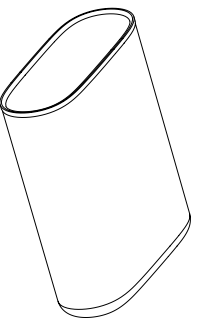
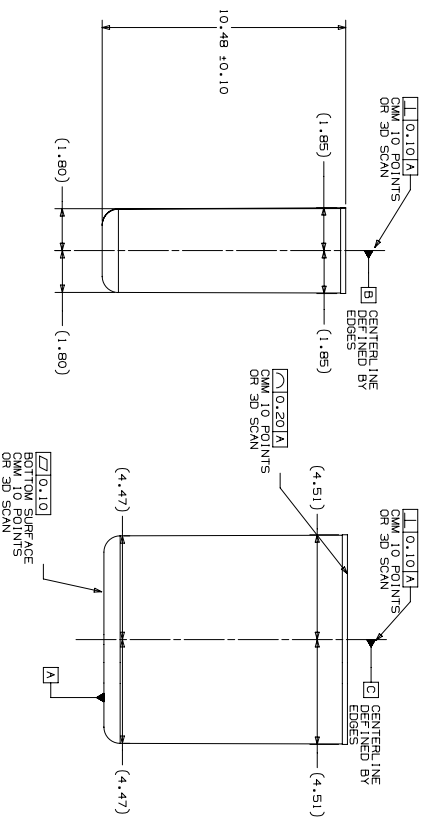
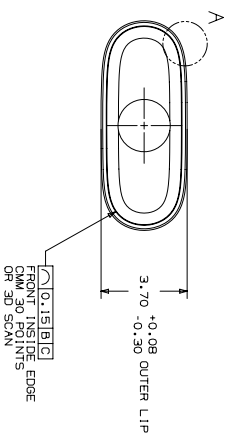
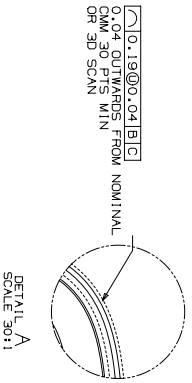


<p>METRIC</p> <p>DATE: _____</p> <p>DESIGNED BY: _____</p> <p>DRAWN BY: _____</p> <p>CHECKED BY: _____</p> <p>DATE: _____</p> <p>SCALE: NONE</p> <p>UNIT: 1 OF 1</p> <p>DO NOT SCALE DRAWING</p> <p>THIS DRAWING IS THE PROPERTY OF APPLE INC. IT IS TO BE USED ONLY FOR THE PURPOSES SPECIFIED HEREIN. IT IS TO BE KEPT IN CONFIDENTIALITY AND NOT TO BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC OR MECHANICAL, INCLUDING PHOTOCOPYING, RECORDING, OR BY ANY INFORMATION STORAGE AND RETRIEVAL SYSTEM.</p> <p>APPLE INC. 1000 AVENUE AVENUE</p> <p>CUPERTINO, CA 95014</p> <p>© 2024 APPLE INC. ALL RIGHTS RESERVED.</p>		<p>Apple Inc.</p> <p>DATE: _____</p> <p>DESIGNED BY: _____</p> <p>DRAWN BY: _____</p> <p>CHECKED BY: _____</p> <p>DATE: _____</p> <p>SCALE: NONE</p> <p>UNIT: 1 OF 1</p> <p>DO NOT SCALE DRAWING</p> <p>THIS DRAWING IS THE PROPERTY OF APPLE INC. IT IS TO BE USED ONLY FOR THE PURPOSES SPECIFIED HEREIN. IT IS TO BE KEPT IN CONFIDENTIALITY AND NOT TO BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC OR MECHANICAL, INCLUDING PHOTOCOPYING, RECORDING, OR BY ANY INFORMATION STORAGE AND RETRIEVAL SYSTEM.</p> <p>APPLE INC. 1000 AVENUE AVENUE</p> <p>CUPERTINO, CA 95014</p> <p>© 2024 APPLE INC. ALL RIGHTS RESERVED.</p>	
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53.7 C125 Recommended Rear Shield

NOTES (UNLESS OTHERWISE SPECIFIED)

1. ALL DIMENSIONS AND TOLERANCES APPLY PER ASME Y14.5M-1994. IT IS EXPECTED THAT THE SUPPLIER UNDERSTAND AND COMPLY WITH ALL TOLERANCES AS DESCRIBED IN THIS STANDARD AND APPLIED TO THIS DRAWING.
2. DIMENSIONS ARE MEASURED AFTER PLATING
3. UNLESS OTHERWISE SPECIFIED, ALL SURFACES TO BE WITHIN A SURFACE PROFILE TOLERANCE OF $\boxed{0.20|A|B|C}$.
4. MAXIMUM BURR ALLOWANCE IS 0.05 mm.
5. PART TO BE FREE FROM MANUFACTURING LUBRICANTS.
6. ALL UNSPECIFIED INSIDE BEND RADIUS TO BE 0.4 mm OR LESS.
7. MATERIAL: SUS 316L-0 PLATING: 2-5% NICKEL PLATING PER AMS QQ-N-290
8. PART NEEDS TO SURVIVE BHR SALT SPRAY TEST.



METRIC		Apple Inc.	
DATE	SCALE	REV.	REV.
DESIGNED BY	SCALE	NONE	1 OF 1
DRAWN BY	SCALE	NONE	1 OF 1
DIMENSIONS IN MILLIMETERS			
TOLERANCES			
TITLE			
DRAWING NUMBER			
DO NOT SCALE DRAWINGS			
HARD MAKE REJECTION			
NX GENERATED			

Components

54. Headset Remote and Microphone Transmitter

Devices can receive button press information from [Headsets](#) (page 88) incorporating a Headset Remote and Microphone Transmitter using the [Apple USB-C Analog Headset Module](#) (page 244).

54.1 Overview

A Headset Remote and Microphone Transmitter is a component transmitting Volume Up, Volume Down, and Center button controls over the microphone bias to a C125. This chapter defines how the component shall behave.

Subjective listening tests with the latest devices are recommended to determine which part produces the best user experience.

54.2 Requirements

Headsets and headset cables implementing the Headset Remote and Microphone Transmitter shall:

- Locate the microphone 120-160 mm from the center of a headset driver when worn by the user.
- Have three physical remote buttons for Volume Up, Volume Down, and Center button functions.
- Use six wires from the plug corresponding to the following signals:
 - Right Driver
 - Right Return
 - Left Driver
 - Left Return
 - Microphone Bias
 - Microphone Return
- Run signals separately to their respective components.

Headsets and headset cables integrating the Headset Remote and Microphone Transmitter shall integrate a MEMS analog microphone.

Headset drivers shall have:

- A minimum load impedance of 16 Ω .
- A maximum load capacitance of 150 pF.

54. Headset Remote and Microphone Transmitter

54.2 Requirements

Headsets and headset cables shall implement one of the following configurations. The microphone and remote buttons may be located on either the left or right side of the headset.

Figure 54-1 USB-C Analog Headset Module (C125), single detachable cable

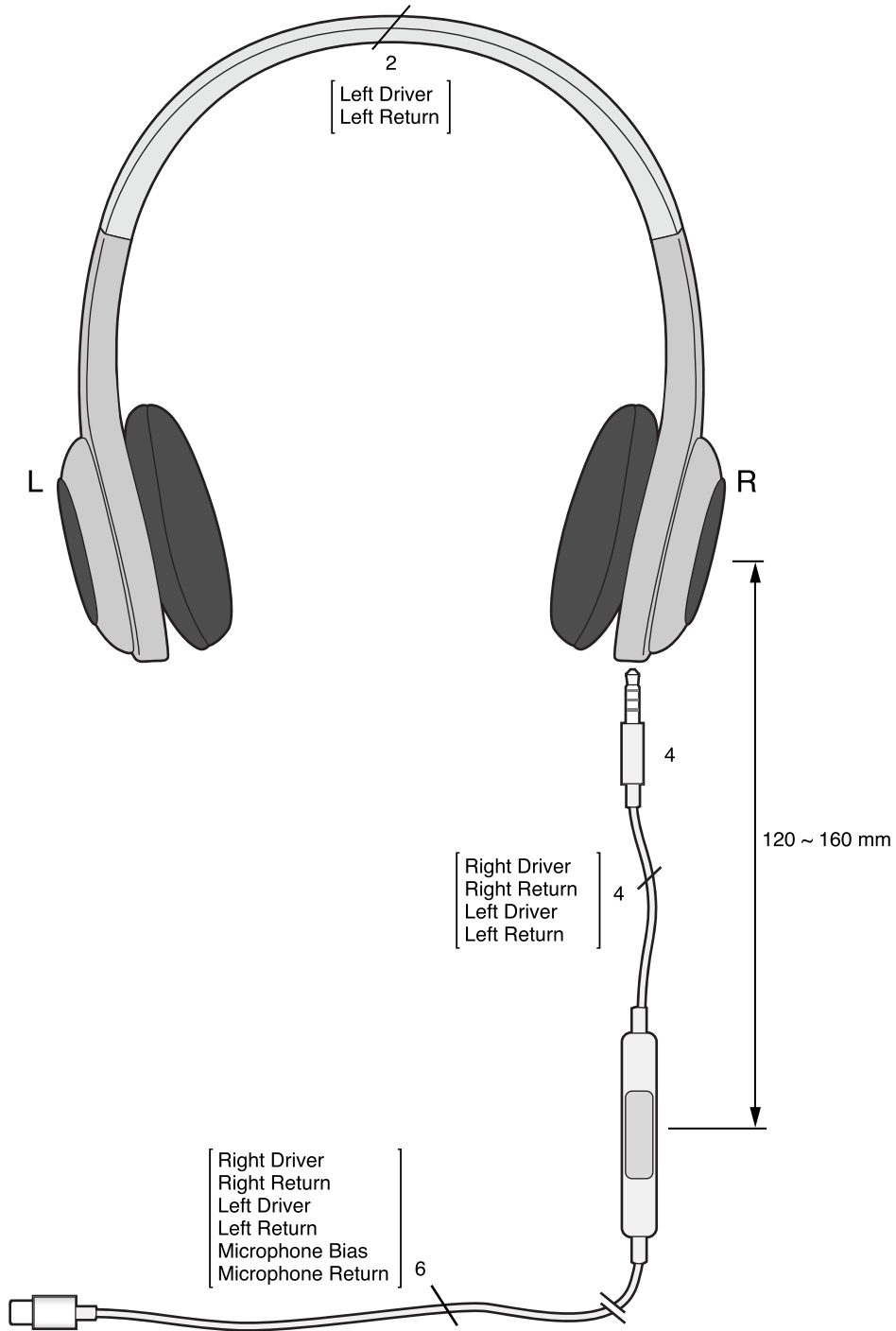
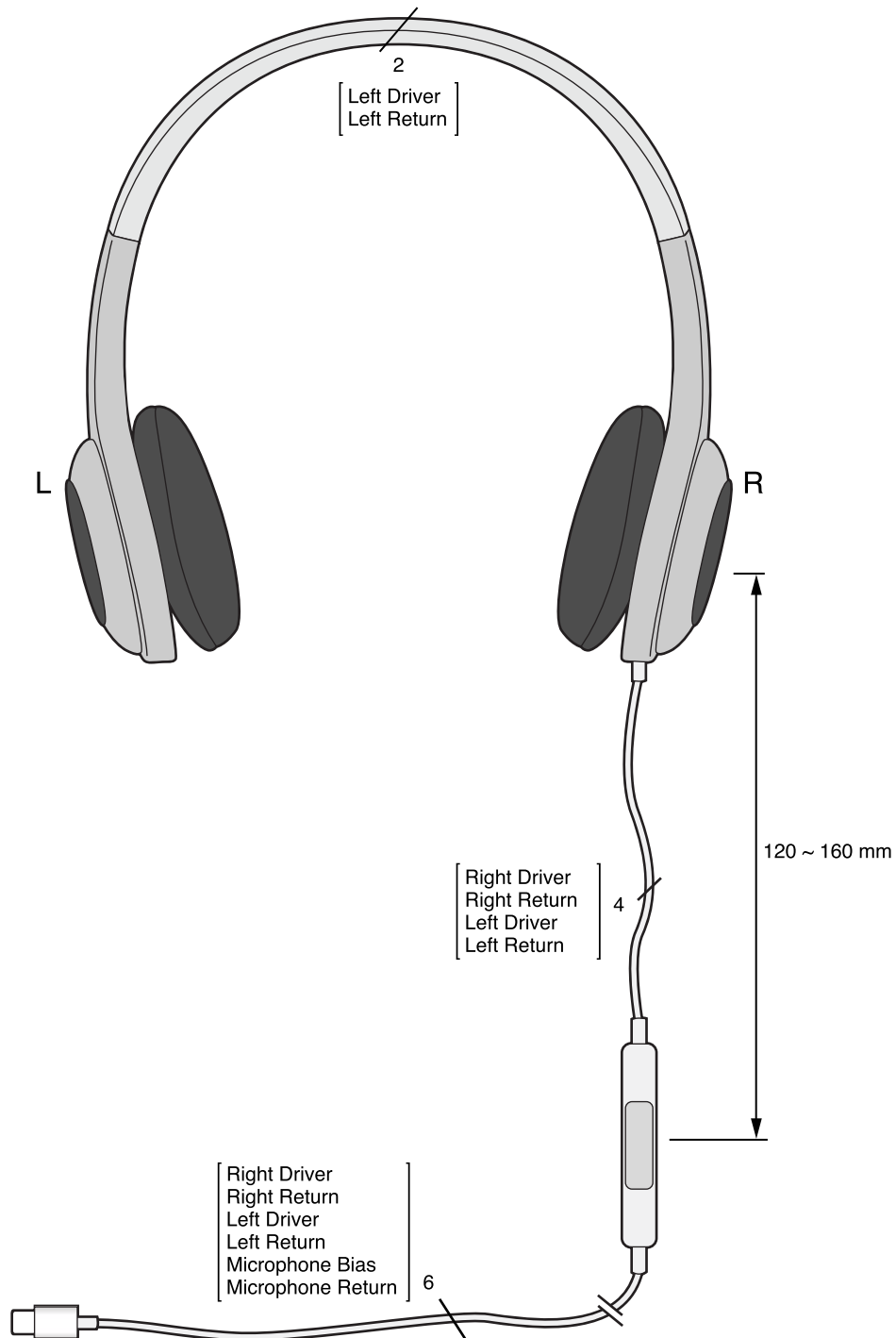


Figure 54-2 USB-C Analog Headset Module (C125), single built-in cable



54. Headset Remote and Microphone Transmitter

54.2 Requirements

Figure 54-3 USB-C Analog Headset Module (C125), split detachable cable

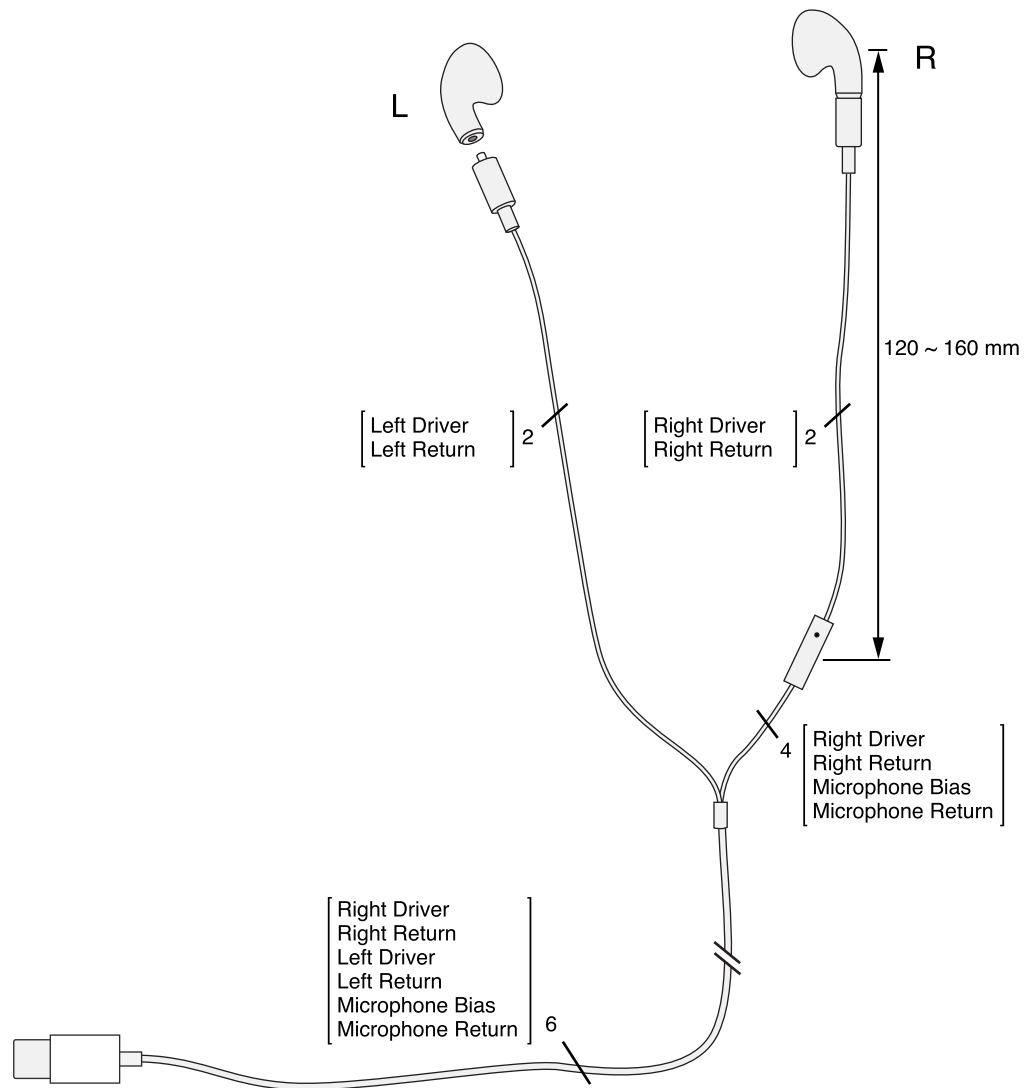
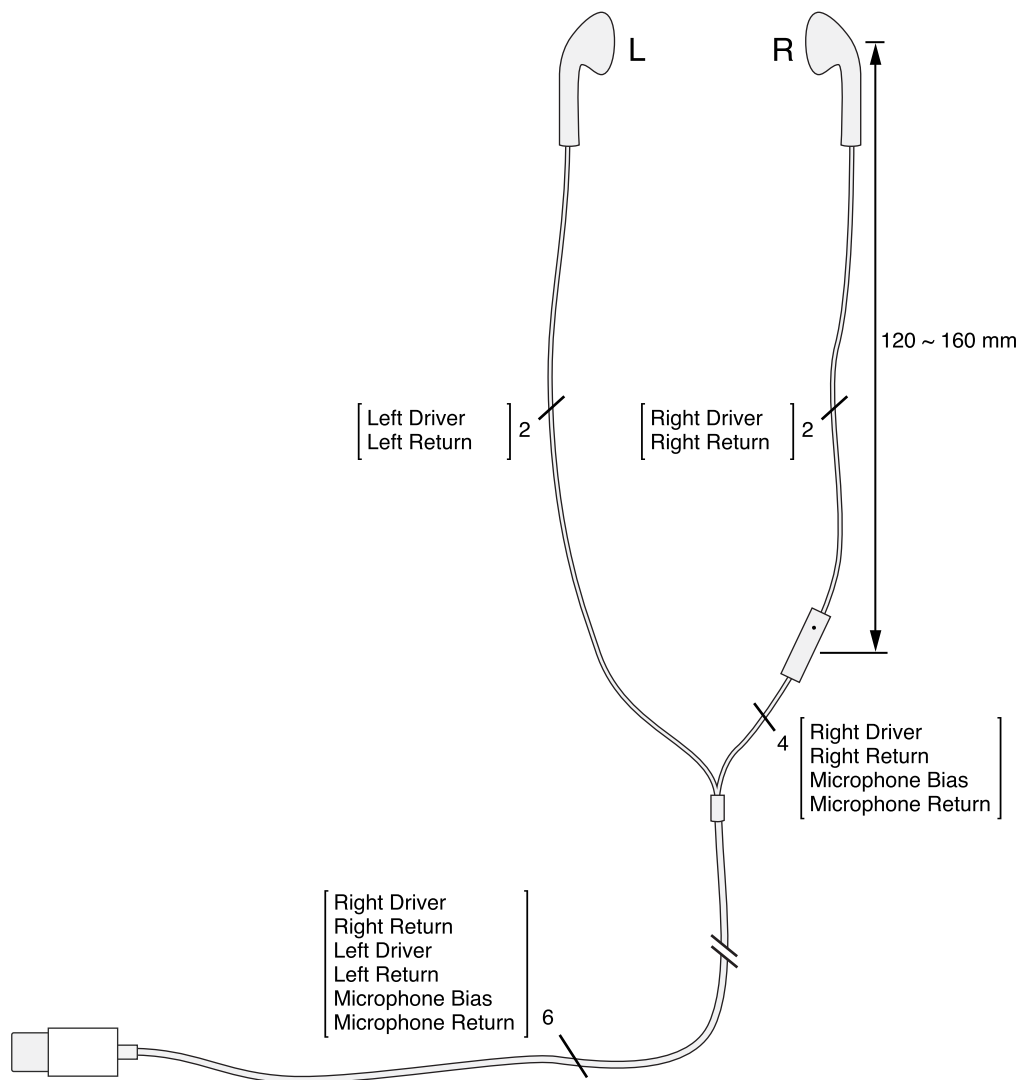


Figure 54-4 USB-C Analog Headset Module (C125), split built-in cable



54.3 Usage

The transmitter operates with a receiver in C125 to enable remote button press detection using the microphone bias line. The C125 provides regulated downstream power (nominally 2.7 V or 2.0 V) to the transmitter and MEMS microphone through the microphone bias line, and the C125 decodes the button information from the transmitter.

The transmitter sends button press state over the microphone bias line in either:

- Button mode.
- Tone mode.

54. Headset Remote and Microphone Transmitter

54.3 Usage

If the voltage on the microphone bias line is less than 2.35 V, the microphone is not in use. The transmitter enters button mode and sends button-press information as discrete voltage levels.

If the voltage on the microphone bias line greater than 2.35 V, the microphone is in use. The transmitter enters tone mode and sends button-press information as ultrasonic tone sequences in the range of 99 kHz to 300 kHz.

54.3.1 Pin Assignments

Table 54-1 Headset Remote and Microphone Transmitter pin assignments

Name	I/O	Description
TONE	Output	Tone generator output
GND	Power	Audio return
MIC	Input	Microphone bias
REM	Input/output	Remote switch network
VSHUNT	Input	Shunt regulator supply
MICPWR	Output	Microphone power

54.3.2 Maximum Voltage and Current Ratings

Table 54-2 (page 258) lists the transmitter's maximum voltage and current ratings while operating over a free-air temperature range (T_A) of -40 °C to +85 °C.

Voltages are measured with respect to ground. Input and output clamp-current ratings shall be observed.

Table 54-2 Maximum voltage and current ratings

Symbol	Description	Minimum	Maximum
V_{SUPPLY}	Supply voltage, VSHUNT, MIC	-0.5 V	4.6 V
V_I	Input voltage, REM	-0.5 V	4.6 V
V_O	Output voltage, MICPWR, TONE	-0.5 V	4.6 V
I_{IK}	Input clamp current, REM ($V_I < 0$)	-20 mA	
I_{OK}	Output clamp current, MICPWR, TONE ($V_O < 0$)	-20 mA	
$I_{\text{SUPPLY}}, I_{\text{GND}}$	Continuous current through VSHUNT, MIC, or GND	-50 mA	50 mA

54.3.3 Electrical Characteristics

Table 54-3 (page 259), Table 54-4 (page 260), and Table 54-5 (page 260) list the transmitter's electrical and timing characteristics under the following conditions:

- Operating temperature = -40 °C to +85 °C.
- MIC is connected to $V_{MICBIAS}$ through a 2.21 k Ω \pm 1% resistor.
- Button mode, $V_{MICBIAS} = 1.8$ to 2.1 V.
- Tone mode, $V_{MICBIAS} = 2.56$ to 2.84 V.

The values in the Typical column of the tables are measured at 25 °C.

Table 54-3 Electrical characteristics (general)

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum
$I_{MICBIAS-B}$	Quiescent current into MIC+VSHUNT	Button mode, $V_{MICBIAS} = 2.1$ V		3 μ A	6 μ A
$I_{MICBIAS-B}$	Quiescent current into MIC+VSHUNT	Button mode, $V_{MICBIAS} = 1.5$ V		3 μ A	6 μ A
I_{MIC-T}	Quiescent current into MIC	Tone mode		34 μ A	46 μ A
$I_{VSHUNT-T}$	Quiescent current into VSHUNT	Tone mode (see note below)		60 μ A	70 μ A
I_{MIC-TA}	Active current into MIC	Tone mode		35 μ A	45 μ A
$I_{VSHUNT-TA}$	Active current into VSHUNT	(see note below)		104 μ A	118 μ A
V_{TR}	Tone mode threshold voltage	MIC rising (Microphone enable), $V_{MICPWR} = 1.0$ V	2.20 V	2.35 V	2.50 V
V_{TF}	Tone mode threshold voltage	MIC falling (Microphone disable), $V_{MICPWR} = 400$ mV	0.55 V	0.8 V	1 V
V_{MICPWR}	MICPWR output voltage	$I_{MICPWR} = 120 - 150$ μ A	1.51 V	1.56 V	1.61 V
R_{SO}	Shunt regulator output impedance	Freq = 100 Hz	5 Ω	18 Ω	25 Ω
R_{SO}	Shunt regulator output impedance	Freq = 20 Hz	12 Ω	21 Ω	35 Ω
R_{ONA}	Switch A, R_{DSON}	Tone mode, $I_{MICPWR} = 1$ mA, $V_{MICBIAS} = 2.56$ V		40 Ω	55 Ω
R_{ONB}	Switch B, R_{DSON}	$V_{MIC} = 1.2$ V, $I_{REM} = 1$ mA		22 Ω	30.5 Ω

Note:

This current is pulled through R_{VSHUNT} between MIC and VSHUNT and is the minimum current to keep VSHUNT regulated at 1.56 V. Excess current through R_{VSHUNT} is available to the load at MICPWR. Excess current not used by the load at MICPWR is internally shunted to GND.

Table 54-4 Electrical characteristics (tone mode)

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum
$e_{n-mic100}$	MIC integrated noise	100 Hz to 20 kHz		1.5 μ Vrms	2 μ Vrms
f_{TONE1}	Button 1 frequency	$R_{REM} = 6.81 \text{ k}\Omega$	109 kHz	130 kHz	159 kHz
f_{TONE2}	Button 2 frequency	$R_{REM} = 9.42 \text{ k}\Omega$	138 kHz	165 kHz	200 kHz
f_{REL}	Button released frequency		81 kHz	97 kHz	117 kHz
R_{BT1}	Button 1 boundary		6.61 k Ω	6.81 k Ω	7.01 k Ω
R_{BT2}	Button 2 boundary		9.33 k Ω	9.42 k Ω	9.51 k Ω
V_{TA}	Tone amplitude	$R_{TONE} = 1 \text{ M}\Omega$	350 mV	550 mV	720 mV
V_{TA}	Tone amplitude	$R_{TONE} = 100 \text{ k}\Omega$	300 mV	515 mV	710 mV

Table 54-5 Electrical characteristics (button mode)

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum
t_{ONA}	Switch A enable time		0.8 ms	1.2 ms	2 ms
t_{OFFB}	Switch B disable time		0.7 ms	1 ms	2 ms
t_{REG}	Shunt regulator enable time	Time from MIC = 2.3 V to MICPWR = 1.56 V	1 ms	2.5 ms	3.5 ms

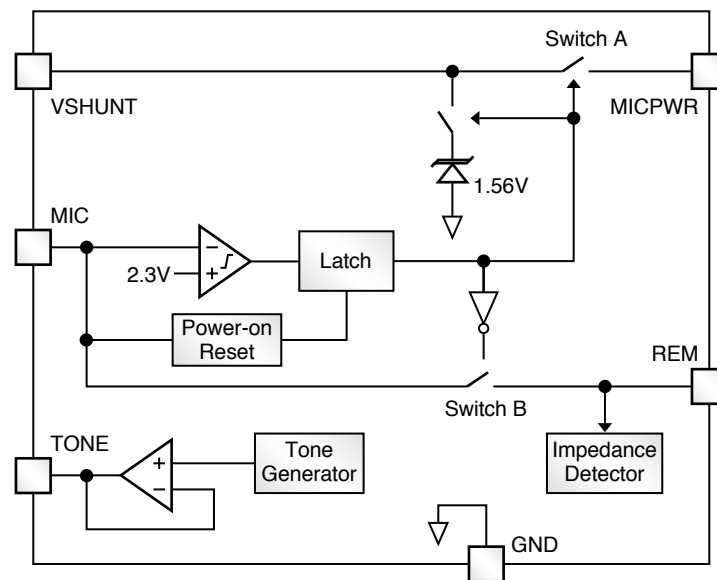
54.3.4 Theory of Operation

The transmitter provides:

- An interface to a button switch-resistor network.
- Power for a colocated microphone.
- A tone generator for sending discrete frequency tones on the microphone bias line corresponding to button events.

The receiver provides regulated downstream power (nominally 2.7 or 2.0 V) to the transmitter and microphone through the microphone bias line. [Figure 54-5](#) (page 261) illustrates the functional components of the transmitter. In this diagram, a latch drives the configuration of switches A and B. The power-on reset monitors voltage on the MIC pin to ensure there is a enough power before initiating the power-on sequence; it shuts the transmitter down if there is insufficient voltage.

Figure 54-5 Block diagram



Button events are sent from the transmitter to the receiver in one of two modes, button mode or tone mode. When a microphone is not present or is not in use, the transmitter is put in button mode by the receiver, and button events are detected using discrete voltage levels. These discrete voltage levels are a percentage of a regulated output voltage on the microphone bias line. When a microphone is in use, the receiver puts the transmitter into tone mode by placing more than 2.35 V on the microphone bias line, and the transmitter then sends button events using tone sequences of discrete frequencies in the range 99 kHz to 300 kHz.

54.3.5 Button Mode

In button mode, the transmitter operates as a passthrough element switching a button switch-resistor network onto the bias line. Each switch represents a unique button. When a button is pressed, the DC level on the bias line is changed and detected by the receiver. [Table 54-6](#) (page 262) shows the DETECT pin voltages with $V_{MICBIAS} = 2.0\text{ V}$.

Table 54-6 DETECT pin voltages

Switch Closed	Voltage
S0	0.000 V \pm 1%
S1	1.510 V \pm 1%
S2	1.603 V \pm 1%

When the transmitter is in button mode (V_{MIC} has never reached 2.35 V), it shorts the MIC and REM pins together and disables all other inputs and outputs. When a button event occurs, the DC voltage on the microphone bias line changes. [Table 54-6](#) (page 262) shows the DC voltage corresponding to a given button press when using the R1 and R4 resistor values listed in [Table 54-7](#) (page 267). This DC level is then detected by the receiver. Switch S0 is a unique switch shorting the V_{MIC} line to ground.

When the V_{MIC} line is shorted to ground, power is removed from the transmitter. When power recovers, the transmitter enters button mode or tone mode, depending on the voltage detected at the MIC pin.

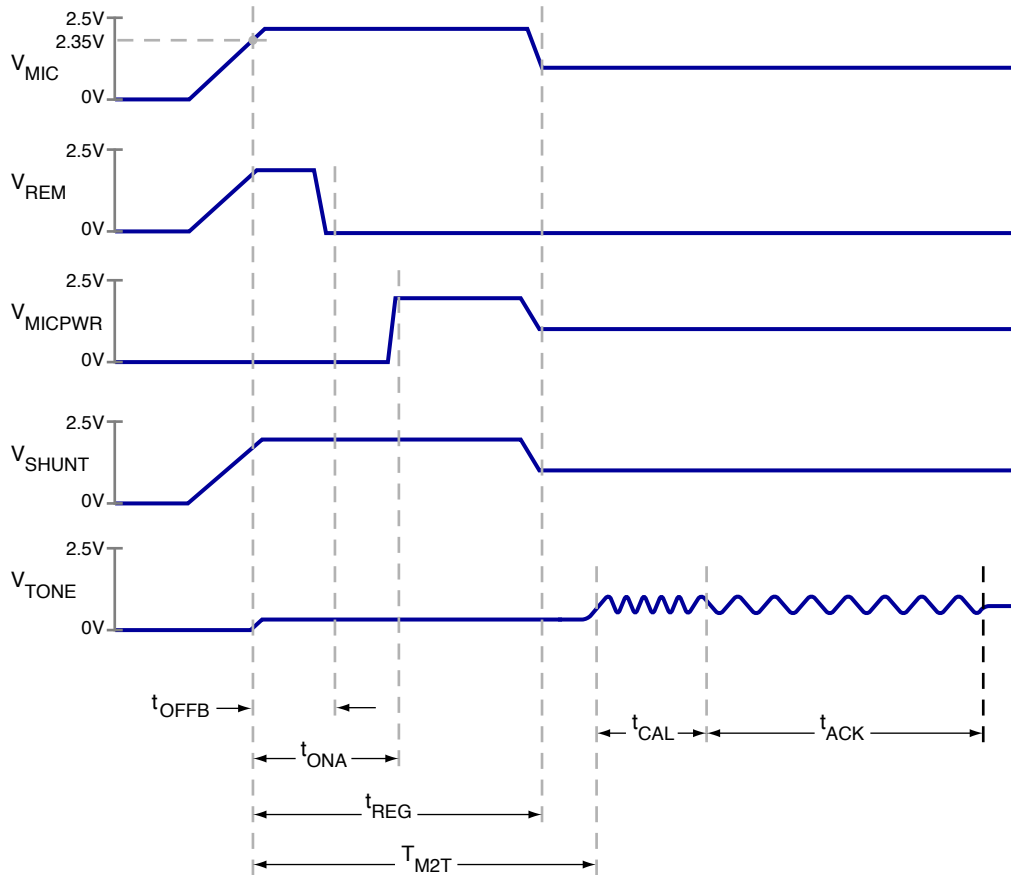
54.3.6 Tone Mode

When the transmitter detects a voltage greater than 2.35 V at the MIC pin, it enters tone mode. With a microphone biased and in use, the switch-resistor network used for button mode would cause large DC level shifts in the bias voltage. Such shifts would result in unwanted audible clicks or pops or would cause de-biasing of the microphone. To prevent this problem, when the transmitter enters tone mode it disconnects the switch-resistor network from the microphone bias line, enables the microphone using the FET switch, and engages the tone generation circuit shown in [Figure 54-5](#) (page 261).

In tone mode the transmitter has two functions. First, it powers on the MEMS microphone by forcing a FET switch to ground. Second, it detects button events and places a discrete tone sequence onto the microphone bias line. The tone frequencies in each sequence are unique to each button press. The receiver detects the tones on the bias line and determines the corresponding button event.

The transmitter's startup timing when it enters tone mode is shown in [Figure 54-6](#) (page 263). Values for the timing parameters are given in [Table 54-4](#) (page 260).

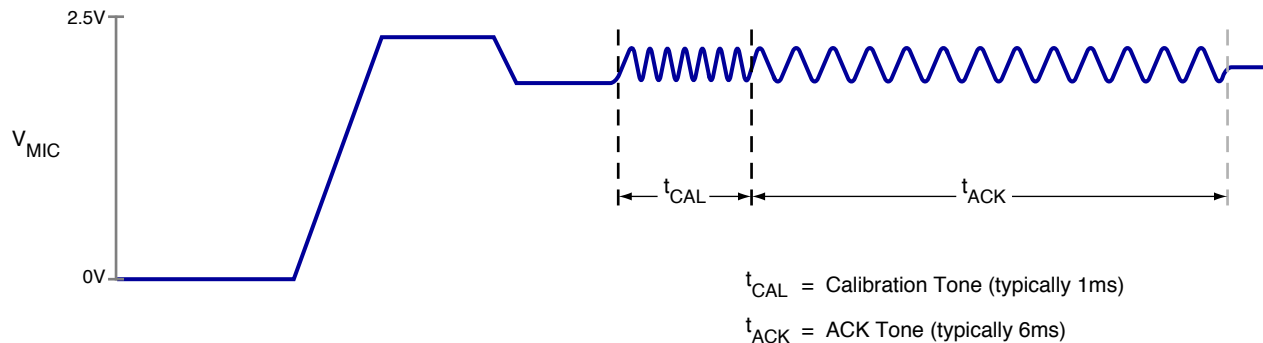
Figure 54-6 Startup timing



The tone mode startup sequence is as follows:

1. Upon detecting $V_{MIC} > 2.35$ V, the switch connecting the MIC and REM pins together is opened after time t_{OFFB} , see [Figure 54-6](#) (page 263) and [Table 54-4](#) (page 260).
2. After a delay of t_{REG} after $V_{MIC} > 2.35$ V, the SHUNT pin and the MICPWR pins are shorted. The microphone is enabled using the FET switch through the MICPWR pin.
3. Once the noise prevention process has settled, the transmitter sends a preset acknowledge (ACK) tone sequence.
4. The receiver detects the ACK sequence, see [Figure 54-7](#) (page 264), and authenticates the presence of the transmitter.

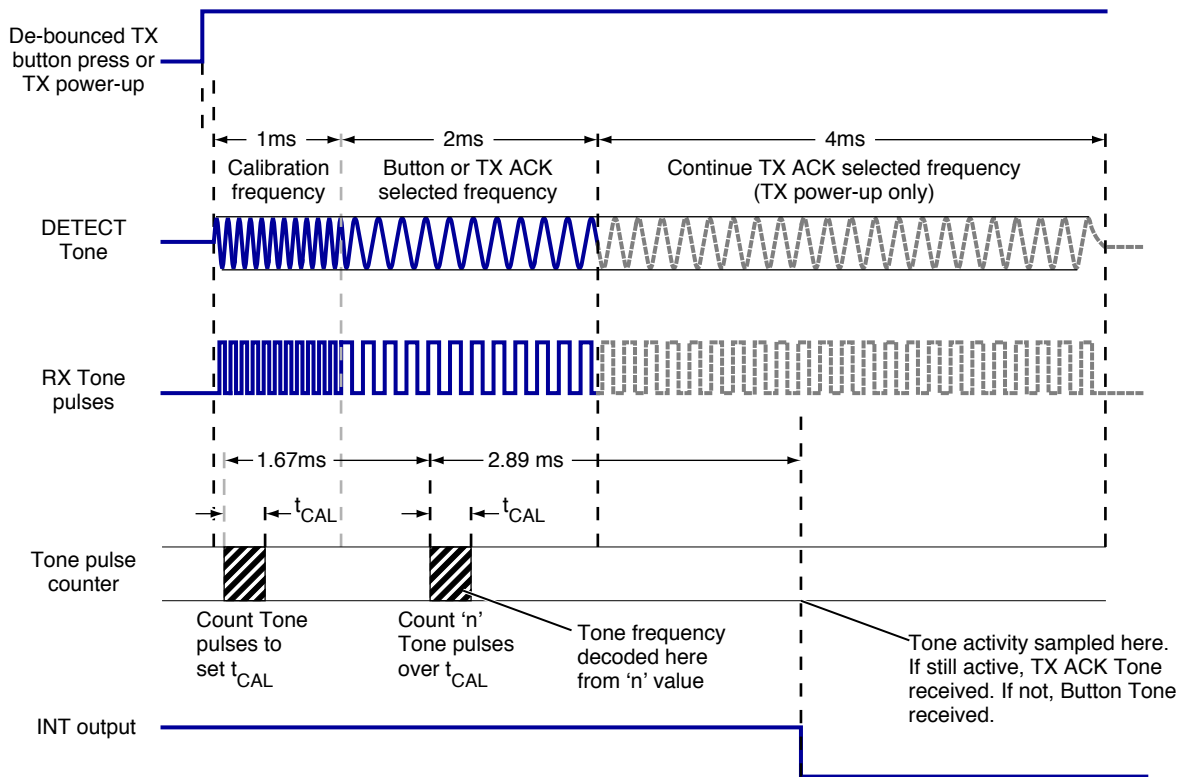
Figure 54-7 Tone mode ACK sequence



The tone generation circuit of the transmitter internally detects each button press and sends a high frequency tone sequence between 99 kHz and 300 kHz. The high frequency tone sequence is unique to each button. The receiver detects the frequency of each tone and translates it into a predetermined button event. A button release has a different frequency than a button press.

The transmitter sends two tones for each button press as shown in [Figure 54-8](#) (page 265) to improve accuracy. The first tone, lasting 1 ms, is a calibration frequency and the second, lasting 2 ms, is the unique frequency for the selected button. The ratio of these two frequencies is calculated and translated into button press information. This provides a very accurate result independent of clock frequency variation.

Figure 54-8 Tone transmit/decode method



The transmitter remains in tone mode until the MIC pin is pulled below 0.8 V. When power recovers, the transmitter enters button mode or tone mode depending on the voltage detected at the MIC pin.

54.4 Button Detection Circuitry Usage

The circuits in the accessory supporting these components shall be those shown in [Figure 54-9](#) (page 266) and [Figure 54-10](#) (page 267). The nominal values of the components shown in these schematics are given in [Table 54-7](#) (page 267).

These circuits are designed to produce a tone amplitude between the microphone bias line and the microphone return, at the end of a cable 1 meter long, of at least 30 mV peak-to-peak into a 2 kΩ load. If necessary, the value of R3 shall be adjusted to achieve this result. [Figure 54-10](#) (page 267) shows how a voltage on the Microphone Power line from the transmitter enables the MEMS microphone chip through Q1. It also shows components R7, C4, and R8, which control the microphone frequency response. The equation determines the values of these components is given in [Button Detection Circuitry Adjustments](#) (page 268).

54. Headset Remote and Microphone Transmitter

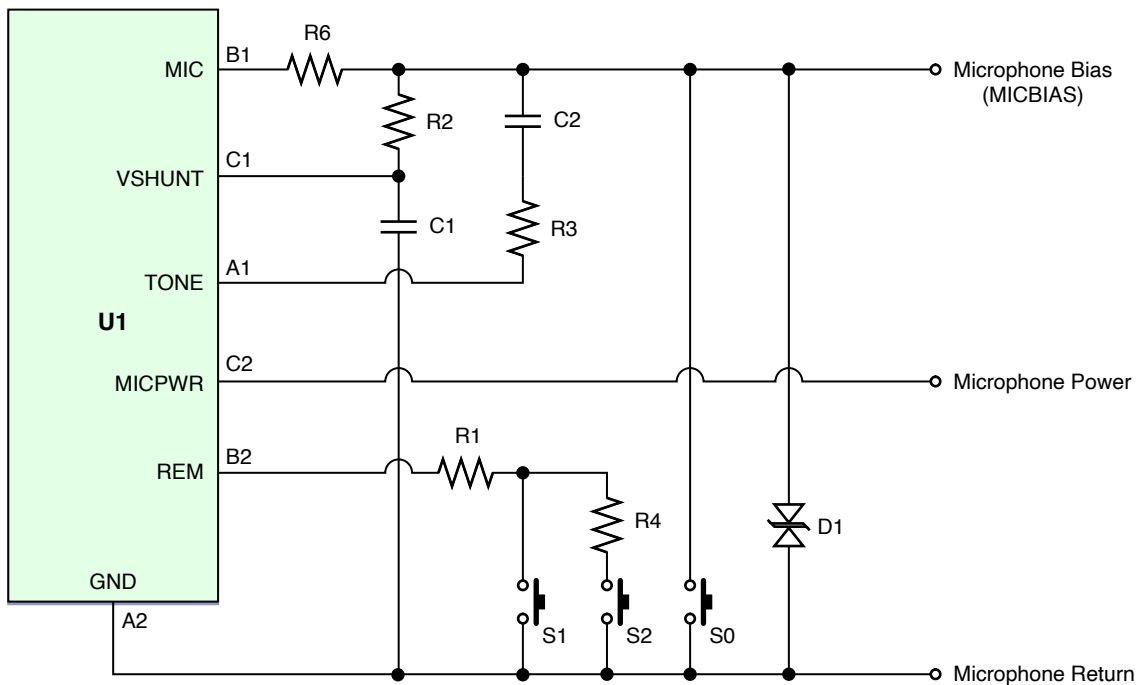
54.4 Button Detection Circuitry Usage

Figure 54-9 (page 266) and Figure 54-10 (page 267) are two parts of one circuit:

- The two microphone return lines shown in these sub-circuits shall be connected at the component locations.
- Their common return line and the return lines for each of the two drivers shall then be routed separately through the cable going to the device. The return lines shall be tied together only at the headset connector.

The above configuration minimizes crosstalk between the separate driver channels and the microphone.

Figure 54-9 Transmitter circuit



54. Headset Remote and Microphone Transmitter

54.4 Button Detection Circuitry Usage

Figure 54-10 Microphone circuit

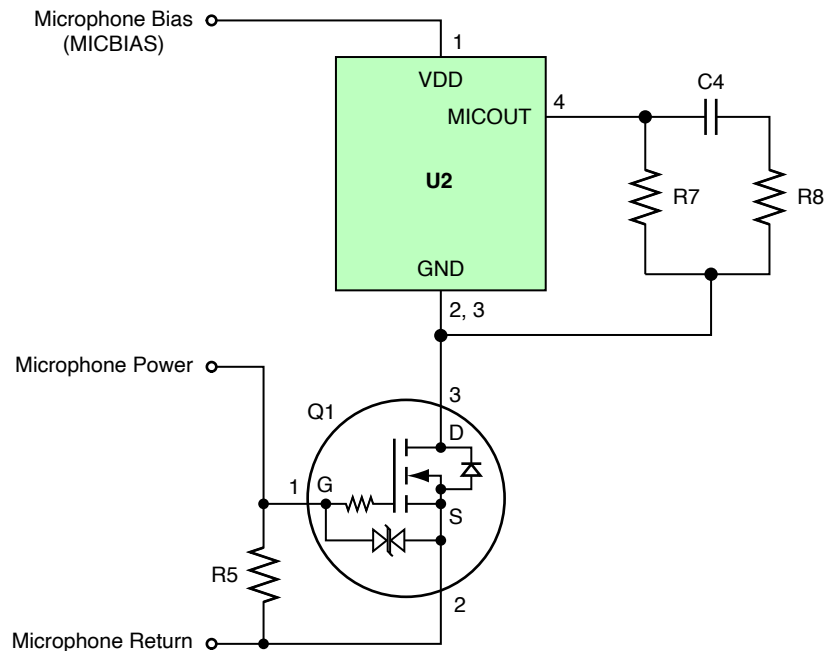


Table 54-7 Transmitter circuit components

Symbol	Description	Notes
C1	Capacitor, 0.1 μF $\pm 10\%$, 6.3 V	
C2	Capacitor, 220 pF $\pm 5\%$, 25 V	Ceramic
C4	Capacitor, 2.2 μF $\pm 10\%$, 6.3 V	
D1	ESD protection diode, 5 pF, 6.1 V	ST Micro ESDALC6V1-1BU2; install as close to transmitter pin B1 as possible.
Q1	MOS field-effect transistor	CEDM 7001
R1	Resistor, 6.81 k Ω $\pm 0.5\%$, 1/20 W	
R2	Resistor, 2 k Ω $\pm 1\%$, 1/20 W	
R3	Resistor, 1.2 k Ω $\pm 0.5\%$, 1/20 W	
R4	Resistor, 2.61 k Ω $\pm 0.5\%$, 1/20 W	
R5	Resistor, 887 k Ω $\pm 1\%$, 1/20 W	
R6	Resistor, 49.9 Ω $+0.2\%/-1\%$, 1/20 W	Shall not exceed 50 Ω .
R7	Resistor, 17.4 k Ω $\pm 1\%$, 1/20 W	
R8	Resistor, value depends on U2.	See Additional Specifications & Support (page 245).
S0	Dome switch	Center button; shall not exceed 20 Ω when closed.
S1	Dome switch	Volume down; shall not exceed 20 Ω when closed.

54. Headset Remote and Microphone Transmitter

54.4 Button Detection Circuitry Usage

Symbol	Description	Notes
S2	Dome switch	Volume up; shall not exceed 20 Ω when closed.
U1	Headset interface transmitter	Headset Remote and Microphone Transmitter
U2	MEMS analog microphone	See Additional Specifications & Support (page 245).

54.4.1 Button Detection Circuitry Adjustments

The values of some of the components listed in [Table 54-7](#) (page 267) may be adjusted to optimize the performance of the headset accessory, using these formulas:

- **High-pass filter corner frequency in Hertz** $\approx 1/(2\pi \cdot R_8 \cdot C_4)$, where R_8 is the value of resistor R8 in ohms and C_4 is the value of capacitor C4 in Farads. This formula assumes the value of R7 is greater than the value of R8.
- **System sensitivity at 1 Pascal in Volts** = $(M_0/R_8) \cdot R_2$, where M_0 is the microphone sensitivity in Volts per Pascal, R_8 is the value of resistor R8 in ohms, and R_2 is the value of resistor R2 in ohms in parallel with 1.05 k Ω .
- **Maximum excursion of the microphone in Volts** = $(1/R_7) \cdot R_2$, where R_7 is the value of resistor R7 in ohms, and R_2 is the value of resistor R2 in ohms in parallel with 1.05 k Ω .

Note:

If the microphone bias voltage drops below 1.6 V, the transmitter will begin to fail and the microphone chip may produce indeterminate outputs.

Connectors

55. USB-A Receptacle

Accessories may incorporate a USB-A receptacle to:

- Provide power to a device.

55.1 Mechanical

The USB-A receptacle shall meet or exceed all applicable USB-IF mechanical specifications.

55.2 Electrical

The USB-A receptacle shall meet or exceed all applicable USB-IF electrical specifications.

56. USB-C Plug

Accessories incorporating a USB-C plug shall comply with the *USB Type-C Cable and Connector Specification –Release 2.3*.

Accessories may incorporate a USB-C plug to:

- Provide power to device.
- Draw power from USB Type-C Current sources.
- Draw power from USB Power Delivery sources.
- Draw power from USB Dedicated Charging Ports and USB hosts.

Accessories benefiting from integrating a USB-C plug include cables, headsets, battery packs, and adapters.

56.1 Overview

The USB-C plug shall have an assigned *Connector* Test ID from the USB-IF, see <https://www.usb.org/products>.

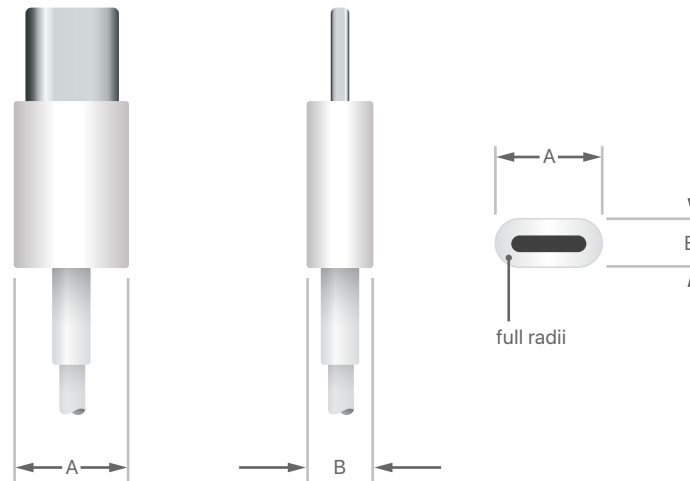
56.2 Mechanical

Accessories incorporating a USB-C plug shall comply with USB-C plug interface dimensions as specified in *USB Type-C Cable and Connector Specification –Release 2.3*.

USB-C plug enclosures shall not exceed the following dimensions as shown in [Figure 56-1](#) (page 272):

- 'A' \leq 12.35 mm.
- 'B' \leq 6.50 mm.

Figure 56-1 USB-C plug example



USB-C plug enclosures should have full radii rounded edges for the greatest compatibility with the widest variety of cases, see [USB-C receptacle accessory keep-out](#) (page 277).

56.3 Electrical

56.3.1 Drawing Power

Accessories drawing power from the USB-C plug shall:

- Correctly identify all [USB Type-C Current](#) (page 214) sources.
- Correctly identify all USB Dedicated Charging Ports (DCP) as defined in the *USB Battery Charging Specification –Release 1.2*.
- Enumerate as a USB device when connected to a USB host and:
 - Not draw more than 100 mA of current until they have been successfully enumerated.
 - Request no more than 500 mA of charging current in their USB device descriptor.
- Not draw more power than the USB power source claims it is capable of providing using one of the above methods.

Accessories may also correctly identify all [USB Power Delivery \(PD\)](#) (page 213) sources.

Accessories drawing power from a device may do so using one of the following protocols:

- [USB Type-C Current](#) (page 214)
- [USB Power Delivery \(PD\)](#) (page 213)

56.3.2 Providing Power

Accessories providing power to a device using a USB-C plug shall:

- Provide at least 15 W (3 A at 5.0 V) of power.
- Support [USB Type-C Current](#) (page 214).

The accessories should:

- Support [USB Power Delivery \(PD\)](#) (page 213).
- Label the receptacle indicating how much power is supplied in watts.

56.4 Verification

USB-C plug test procedures are outlined in this section.

56.4.1 Mechanical

Verify the dimensions of the USB-C plug comply with interface dimensions.

56.4.2 Connector Test ID

Verify the accessory's USB-C plug has an assigned *Connector* Test ID from the USB-IF, see <https://www.usb.org/products>.

56.4.3 Drawing Power

This procedure applies to accessories drawing power using the USB-C plug.

56.4.3.1 Equipment

The following equipment is necessary:

- Apple 140W USB-C Power Adapter
- Apple 96W USB-C Power Adapter
- Apple 70W USB-C Power Adapter
- Apple 67W USB-C Power Adapter
- Apple 30W USB-C Power Adapter
- Apple 20W USB-C Power Adapter
- Apple 35W Dual USB-C Port Compact Power Adapter
- Apple 35W Dual USB-C Port Power Adapter
- Bundled USB-C power adapter (if applicable)

56.4.3.2 Procedure

1. Verify the accessory correctly identifies all Apple branded or bundled power sources:
 - a. Verify each USB-C power adapter is correctly identified and provides power.
2. Verify the accessory correctly identifies a Mac and iPad:
 - a. Verify the Mac is correctly identified and provides power.
 - b. Verify the iPad is correctly identified and provides power.

57. USB-C Receptacle

Accessories incorporating a USB-C receptacle shall comply with the *USB Type-C Cable and Connector Specification –Release 2.3*.

Accessories may incorporate a USB-C receptacle to:

- Provide power to device.
- Draw power from Apple branded power sources.
- Draw power from USB Type-C Current sources.
- Draw power from USB Power Delivery sources.
- Draw power from USB Dedicated Charging Ports and USB hosts.

Accessories benefiting from incorporating a USB-C receptacle include [AC Power Adapters](#) (page 84), [Battery Packs](#) (page 87), and speakers.

57.1 Overview

The USB-C receptacle shall be USB-IF certified and have a *Connector* Test ID from the USB-IF, see <https://www.usb.org/products>.

57.2 Mechanical

Accessories incorporating a USB-C receptacle shall comply with USB-C receptacle interface dimensions as specified in *USB Type-C Cable and Connector Specification –Release 2.3*.

See the recommended minimum [USB-C receptacle accessory keep-out](#) (page 277).

57.3 Electrical

57.3.1 Drawing Power

Accessories drawing power from the USB-C receptacle shall:

- Correctly identify all Apple branded power sources.

- Correctly identify all [USB Type-C Current](#) (page 214) sources.
- Enumerate as a USB device when connected to a USB host and:
 - Not draw more than 100 mA of current until they have been successfully enumerated.
 - Request no more than 500 mA of charging current in their USB device descriptor.
- Correctly identify all USB Dedicated Charging Ports (DCP) as defined in the *USB Battery Charging Specification –Release 1.2*.
- Not draw more power than the USB power source claims it is capable of providing using one of the above methods.

Accessories may also correctly identify all [USB Power Delivery \(PD\)](#) (page 213) sources.

57.3.2 Providing Power

Accessories providing power to a device using a USB-C receptacle shall:

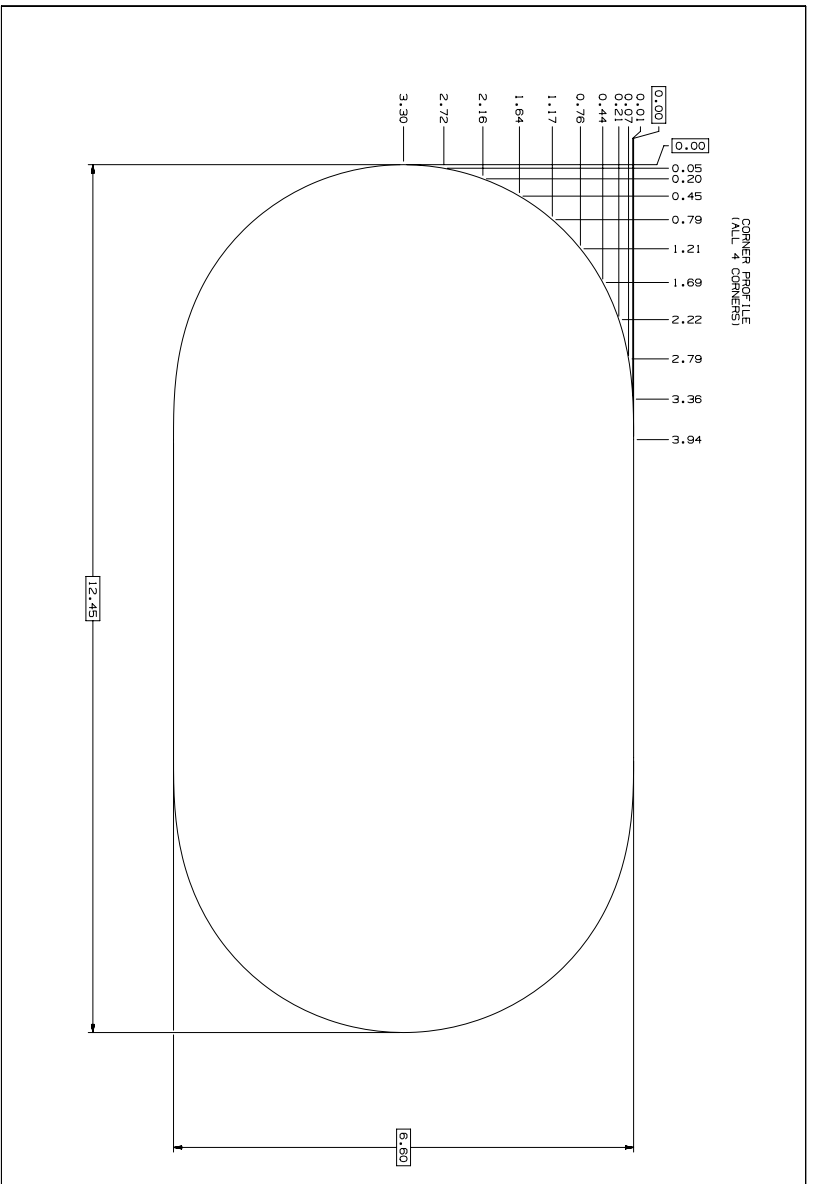
- Provide at least 15 W (3 A at 5.0 V) of power.
- Support [USB Type-C Current](#) (page 214).

The accessories should:

- Support [USB Power Delivery \(PD\)](#) (page 213).
- Label the receptacle indicating how much power is supplied in watts.

57.4 USB-C receptacle accessory keep-out

NOTES (UNLESS OTHERWISE SPECIFIED)



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	PROFILE, USB-C		
DO NOT SCALE DRAWINGS		SCALE	1" = 1" 1
THIRD ANGLE PROJECTION		NX GENERATED	

57.5 Verification

USB-C receptacle test procedures are outlined in this section.

57.5.1 Connector Test ID

Verify the accessory's USB-C receptacle has an assigned *Connector* Test ID from the USB-IF, see <https://www.usb.org/products>.

57.5.2 Drawing Power

This procedure applies to accessories drawing power using the USB-C receptacle.

57.5.2.1 Equipment

The following equipment is necessary:

- Apple USB-C Charge Cable (1 m)
- Apple USB-C Charge Cable (2 m)
- Bundled USB-C to USB-C cable (if applicable)
- Bundled USB-A to USB-C cable (if applicable)
- 3rd-party USB-A to USB-C cable
- Apple 140W USB-C Power Adapter
- Apple 96W USB-C Power Adapter
- Apple 70W USB-C Power Adapter
- Apple 67W USB-C Power Adapter
- Apple 30W USB-C Power Adapter
- Apple 20W USB-C Power Adapter
- Apple 35W Dual USB-C Port Compact Power Adapter
- Apple 35W Dual USB-C Port Power Adapter
- Apple 12W USB Power Adapter
- Apple 5W USB Power Adapter
- Bundled USB-C power adapter (if applicable)
- Bundled USB-A power adapter (if applicable)

57.5.2.2 Procedure

1. Verify the accessory correctly identifies all Apple branded or bundled power adapters:
 - a. Using each USB-A to USB-C cable, verify each USB-A power adapter is correctly identified and provides power.
 - b. Using each USB-C to USB-C cable, verify each USB-C power adapter is correctly identified and provides power.

- 2.** Verify the accessory correctly identifies a Mac and iPad:
 - a.** Using each USB-A to USB-C cable and USB-C to USB-C cable, verify the Mac is correctly identified and provides power.
 - b.** Using each USB-A to USB-C cable and USB-C to USB-C cable, verify the iPad is correctly identified and provides power.

57.5.3 Providing Power

This procedure applies to accessories providing power using the USB-C receptacle.

57.5.3.1 Equipment

The following equipment is necessary:

- Apple USB-C to Lightning Cable (1 m)
- Apple USB-C to Lightning Cable (2 m)
- Apple USB-C Charge Cable (1 m)
- Apple USB-C Charge Cable (2 m)
- Bundled USB-C to USB-C cable (if applicable)

57.5.3.2 Procedure

- 1.** Verify the accessory correctly provides power to devices:
 - a.** Using each USB-C to Lightning cable, verify the accessory uses USB Type-C Current or USB PD to identify at least 15 W of power providing capability.
 - b.** Using each USB-C to Lightning cable, verify the accessory provides power to the device.
- 2.** Verify the accessory correctly identifies a Mac and iPad:
 - a.** Using each USB-C to USB-C cable, verify the accessory is correctly identified and provides power to the Mac.
 - b.** Using each USB-C to USB-C cable, verify the accessory is correctly identified and provides power to the iPad.

Tools

58. Accessory Developer Assistant (ADA)



Some test procedures in this specification require use of the Accessory Developer Assistant app, available from the App Store at <https://apps.apple.com/us/app/accessory-developer-assistant/id1635862694>.

The Accessory Developer Assistant app is a set of utilities designed to help accessory makers test new accessories. Use the Accessory Developer Assistant app to ensure iPhone and iPad performance for features such as:

- [Camera Control](#) (page 69)
- [Autofocus & Optical Image Stabilization](#) (page 71)
- Image Quality
- [Near-Field Communication \(NFC\)](#) (page 72)
- [Compass](#) (page 73)

58.1 Autofocus & Optical Image Stabilization Test Profile

The [Autofocus & Optical Image Stabilization](#) (page 71) test procedure requires an additional profile to be installed:

1. Use the device to access the ADA Camera Test profile at https://download.developer.apple.com/Developer_Tools/Accessory_Developer_Assistant_Camera_Test_Profile/ADACamera.mobileconfig.
2. Install the profile to the device.
3. Open Settings > Profile Downloaded and complete the installation.
4. Reboot the device.

References

59. Device Dimensional Drawings

This chapter contains the following iPhone dimensional drawings:

- [iPhone 16 Pro Max, 1 of 4](#) (page 292)
- [iPhone 16 Pro Max, 2 of 4](#) (page 293)
- [iPhone 16 Pro Max, 3 of 4](#) (page 294)
- [iPhone 16 Pro Max, 4 of 4](#) (page 295)
- [iPhone 16 Pro, 1 of 4](#) (page 296)
- [iPhone 16 Pro, 2 of 4](#) (page 297)
- [iPhone 16 Pro, 3 of 4](#) (page 298)
- [iPhone 16 Pro, 4 of 4](#) (page 299)
- [iPhone 16 Plus, 1 of 4](#) (page 300)
- [iPhone 16 Plus, 2 of 4](#) (page 301)
- [iPhone 16 Plus, 3 of 4](#) (page 302)
- [iPhone 16 Plus, 4 of 4](#) (page 303)
- [iPhone 16, 1 of 4](#) (page 304)
- [iPhone 16, 2 of 4](#) (page 305)
- [iPhone 16, 3 of 4](#) (page 306)
- [iPhone 16, 4 of 4](#) (page 307)
- [iPhone 15 Pro Max, 1 of 3](#) (page 308)
- [iPhone 15 Pro Max, 2 of 3](#) (page 309)
- [iPhone 15 Pro Max, 3 of 3](#) (page 310)
- [iPhone 15 Pro, 1 of 3](#) (page 311)
- [iPhone 15 Pro, 2 of 3](#) (page 312)
- [iPhone 15 Pro, 3 of 3](#) (page 313)
- [iPhone 15 Plus, 1 of 3](#) (page 314)
- [iPhone 15 Plus, 2 of 3](#) (page 315)
- [iPhone 15 Plus, 3 of 3](#) (page 316)
- [iPhone 15, 1 of 3](#) (page 317)
- [iPhone 15, 2 of 3](#) (page 318)
- [iPhone 15, 3 of 3](#) (page 319)
- [iPhone 14 Pro Max, 1 of 3](#) (page 320)
- [iPhone 14 Pro Max, 2 of 3](#) (page 321)
- [iPhone 14 Pro Max, 3 of 3](#) (page 322)
- [iPhone 14 Pro, 1 of 3](#) (page 323)
- [iPhone 14 Pro, 2 of 3](#) (page 324)

- [iPhone 14 Pro, 3 of 3](#) (page 325)
- [iPhone 14 Plus, 1 of 3](#) (page 326)
- [iPhone 14 Plus, 2 of 3](#) (page 327)
- [iPhone 14 Plus, 3 of 3](#) (page 328)
- [iPhone 14, 1 of 3](#) (page 329)
- [iPhone 14, 2 of 3](#) (page 330)
- [iPhone 14, 3 of 3](#) (page 331)
- [iPhone SE \(3rd generation\) and iPhone SE \(2nd generation\)](#) (page 348)
- [iPhone 13 Pro Max, 1 of 2](#) (page 332)
- [iPhone 13 Pro Max, 2 of 2](#) (page 333)
- [iPhone 13 Pro, 1 of 2](#) (page 334)
- [iPhone 13 Pro, 2 of 2](#) (page 335)
- [iPhone 13, 1 of 2](#) (page 336)
- [iPhone 13, 2 of 2](#) (page 337)
- [iPhone 13 mini, 1 of 2](#) (page 338)
- [iPhone 13 mini, 2 of 2](#) (page 339)
- [iPhone 12 Pro Max, 1 of 2](#) (page 340)
- [iPhone 12 Pro Max, 2 of 2](#) (page 341)
- [iPhone 12 Pro, 1 of 2](#) (page 342)
- [iPhone 12 Pro, 2 of 2](#) (page 343)
- [iPhone 12, 1 of 2](#) (page 344)
- [iPhone 12, 2 of 2](#) (page 345)
- [iPhone 12 mini, 1 of 2](#) (page 346)
- [iPhone 12 mini, 2 of 2](#) (page 347)
- [iPhone 11 Pro Max](#) (page 349)
- [iPhone 11 Pro](#) (page 350)
- [iPhone 11](#) (page 351)
- [iPhone XS Max](#) (page 352)
- [iPhone XS](#) (page 353)
- [iPhone XR](#) (page 354)
- [iPhone X](#) (page 355)
- [iPhone 8 Plus](#) (page 356)
- [iPhone 8](#) (page 357)
- [iPhone 7 Plus](#) (page 358)
- [iPhone 7](#) (page 359)
- [iPhone 6s Plus](#) (page 360)
- [iPhone 6s](#) (page 361)
- [iPhone 6 Plus](#) (page 362)
- [iPhone 6](#) (page 363)
- [iPhone 5s and iPhone SE](#) (page 364)

- [iPhone 5c](#) (page 365)
- [iPhone 5](#) (page 366)

This chapter contains the following iPad dimensional drawings:

- [iPad mini \(A17 Pro\), 1 of 6](#) (page 367)
- [iPad mini \(A17 Pro\), 2 of 6](#) (page 368)
- [iPad mini \(A17 Pro\), 3 of 6](#) (page 369)
- [iPad mini \(A17 Pro\), 4 of 6](#) (page 370)
- [iPad mini \(A17 Pro\), 5 of 6](#) (page 371)
- [iPad mini \(A17 Pro\), 6 of 6](#) (page 372)
- [iPad Pro 13-inch \(M4\), 1 of 5](#) (page 373)
- [iPad Pro 13-inch \(M4\), 2 of 5](#) (page 374)
- [iPad Pro 13-inch \(M4\), 3 of 5](#) (page 375)
- [iPad Pro 13-inch \(M4\), 4 of 5](#) (page 376)
- [iPad Pro 13-inch \(M4\), 5 of 5](#) (page 377)
- [iPad Pro 11-inch \(M4\), 1 of 5](#) (page 378)
- [iPad Pro 11-inch \(M4\), 2 of 5](#) (page 379)
- [iPad Pro 11-inch \(M4\), 3 of 5](#) (page 380)
- [iPad Pro 11-inch \(M4\), 4 of 5](#) (page 381)
- [iPad Pro 11-inch \(M4\), 5 of 5](#) (page 382)
- [iPad Air 13-inch \(M2\), 1 of 5](#) (page 383)
- [iPad Air 13-inch \(M2\), 2 of 5](#) (page 384)
- [iPad Air 13-inch \(M2\), 3 of 5](#) (page 385)
- [iPad Air 13-inch \(M2\), 4 of 5](#) (page 386)
- [iPad Air 13-inch \(M2\), 5 of 5](#) (page 387)
- [iPad Air 11-inch \(M2\), 1 of 5](#) (page 388)
- [iPad Air 11-inch \(M2\), 2 of 5](#) (page 389)
- [iPad Air 11-inch \(M2\), 3 of 5](#) (page 390)
- [iPad Air 11-inch \(M2\), 4 of 5](#) (page 391)
- [iPad Air 11-inch \(M2\), 5 of 5](#) (page 392)
- [iPad Pro 12.9-inch \(6th generation\), 1 of 5](#) (page 393)
- [iPad Pro 12.9-inch \(6th generation\), 2 of 5](#) (page 394)
- [iPad Pro 12.9-inch \(6th generation\), 3 of 5](#) (page 395)
- [iPad Pro 12.9-inch \(6th generation\), 4 of 5](#) (page 396)
- [iPad Pro 12.9-inch \(6th generation\), 5 of 5](#) (page 397)
- [iPad Pro 11-inch \(4th generation\), 1 of 5](#) (page 398)
- [iPad Pro 11-inch \(4th generation\), 2 of 5](#) (page 399)
- [iPad Pro 11-inch \(4th generation\), 3 of 5](#) (page 400)
- [iPad Pro 11-inch \(4th generation\), 4 of 5](#) (page 401)
- [iPad Pro 11-inch \(4th generation\), 5 of 5](#) (page 402)

- iPad (10th generation), 1 of 6 (page 403)
- iPad (10th generation), 2 of 6 (page 404)
- iPad (10th generation), 3 of 6 (page 405)
- iPad (10th generation), 4 of 6 (page 406)
- iPad (10th generation), 5 of 6 (page 407)
- iPad (10th generation), 6 of 6 (page 408)
- iPad Air (5th generation) and iPad Air (4th generation), 1 of 5 (page 409)
- iPad Air (5th generation) and iPad Air (4th generation), 2 of 5 (page 410)
- iPad Air (5th generation) and iPad Air (4th generation), 3 of 5 (page 411)
- iPad Air (5th generation) and iPad Air (4th generation), 4 of 5 (page 412)
- iPad Air (5th generation) and iPad Air (4th generation), 5 of 5 (page 413)
- iPad mini (6th generation), 1 of 6 (page 414)
- iPad mini (6th generation), 2 of 6 (page 415)
- iPad mini (6th generation), 3 of 6 (page 416)
- iPad mini (6th generation), 4 of 6 (page 417)
- iPad mini (6th generation), 5 of 6 (page 418)
- iPad mini (6th generation), 6 of 6 (page 419)
- iPad (9th generation), iPad (8th generation) and iPad (7th generation), 1 of 4 (page 420)
- iPad (9th generation), iPad (8th generation) and iPad (7th generation), 2 of 4 (page 421)
- iPad (9th generation), iPad (8th generation) and iPad (7th generation), 3 of 4 (page 422)
- iPad (9th generation), iPad (8th generation) and iPad (7th generation), 4 of 4 (page 423)
- iPad Pro 12.9-inch (5th generation), 1 of 5 (page 424)
- iPad Pro 12.9-inch (5th generation), 2 of 5 (page 425)
- iPad Pro 12.9-inch (5th generation), 3 of 5 (page 426)
- iPad Pro 12.9-inch (5th generation), 4 of 5 (page 427)
- iPad Pro 12.9-inch (5th generation), 5 of 5 (page 428)
- iPad Pro 11-inch (3rd generation), 1 of 5 (page 429)
- iPad Pro 11-inch (3rd generation), 2 of 5 (page 430)
- iPad Pro 11-inch (3rd generation), 3 of 5 (page 431)
- iPad Pro 11-inch (3rd generation), 4 of 5 (page 432)
- iPad Pro 11-inch (3rd generation), 5 of 5 (page 433)
- iPad Pro 12.9-inch (4th generation), 1 of 5 (page 434)
- iPad Pro 12.9-inch (4th generation), 2 of 5 (page 435)
- iPad Pro 12.9-inch (4th generation), 3 of 5 (page 436)
- iPad Pro 12.9-inch (4th generation), 4 of 5 (page 437)
- iPad Pro 12.9-inch (4th generation), 5 of 5 (page 438)
- iPad Pro 11-inch (2nd generation), 1 of 5 (page 439)
- iPad Pro 11-inch (2nd generation), 2 of 5 (page 440)
- iPad Pro 11-inch (2nd generation), 3 of 5 (page 441)
- iPad Pro 11-inch (2nd generation), 4 of 5 (page 442)

- [iPad Pro 11-inch \(2nd generation\), 5 of 5 \(page 443\)](#)
- [iPad Air \(3rd generation\), 1 of 3 \(page 444\)](#)
- [iPad Air \(3rd generation\), 2 of 3 \(page 445\)](#)
- [iPad Air \(3rd generation\), 3 of 3 \(page 446\)](#)
- [iPad Air \(3rd generation\) with Cellular, 1 of 3 \(page 447\)](#)
- [iPad Air \(3rd generation\) with Cellular, 2 of 3 \(page 448\)](#)
- [iPad Air \(3rd generation\) with Cellular, 3 of 3 \(page 449\)](#)
- [iPad mini \(5th generation\), 1 of 3 \(page 450\)](#)
- [iPad mini \(5th generation\), 2 of 3 \(page 451\)](#)
- [iPad mini \(5th generation\), 3 of 3 \(page 452\)](#)
- [iPad mini \(5th generation\) with Cellular, 1 of 3 \(page 453\)](#)
- [iPad mini \(5th generation\) with Cellular, 2 of 3 \(page 454\)](#)
- [iPad mini \(5th generation\) with Cellular, 3 of 3 \(page 455\)](#)
- [iPad Pro 12.9-inch \(3rd generation\), 1 of 3 \(page 456\)](#)
- [iPad Pro 12.9-inch \(3rd generation\), 2 of 3 \(page 457\)](#)
- [iPad Pro 12.9-inch \(3rd generation\), 3 of 3 \(page 458\)](#)
- [iPad Pro 11-inch \(1st generation\), 1 of 3 \(page 459\)](#)
- [iPad Pro 11-inch \(1st generation\), 2 of 3 \(page 460\)](#)
- [iPad Pro 11-inch \(1st generation\), 3 of 3 \(page 461\)](#)
- [iPad Pro 12.9-inch \(2nd generation\) \(page 462\)](#)
- [iPad Pro 12.9-inch \(2nd generation\) with Cellular \(page 463\)](#)
- [iPad Pro 12.9-inch \(2nd generation\) Magnet/Hall Effect Sensors, 1 of 2 \(page 464\)](#)
- [iPad Pro 12.9-inch \(2nd generation\) Magnet/Hall Effect Sensors, 2 of 2 \(page 465\)](#)
- [iPad Pro 10.5-inch \(page 466\)](#)
- [iPad Pro 10.5-inch with Cellular \(page 467\)](#)
- [iPad Pro 10.5-inch Magnet/Hall Effect Sensors, 1 of 2 \(page 468\)](#)
- [iPad Pro 10.5-inch Magnet/Hall Effect Sensors, 2 of 2 \(page 469\)](#)
- [iPad \(5th and 6th generation\) with Cellular \(page 470\)](#)
- [iPad \(5th and 6th generation\) Magnet/Hall Effect Sensors, 1 of 2 \(page 471\)](#)
- [iPad \(5th and 6th generation\) Magnet/Hall Effect Sensors, 2 of 2 \(page 472\)](#)
- [iPad Pro 9.7-inch \(page 473\)](#)
- [iPad Pro 9.7-inch with Cellular \(page 474\)](#)
- [iPad Pro 9.7-inch Magnet/Hall Effect Sensors, 1 of 2 \(page 475\)](#)
- [iPad Pro 9.7-inch Magnet/Hall Effect Sensors, 2 of 2 \(page 476\)](#)
- [iPad Pro 12.9-inch \(1st generation\) \(page 477\)](#)
- [iPad Pro 12.9-inch \(1st generation\) with Cellular \(page 478\)](#)
- [iPad Pro 12.9-inch \(1st generation\) Magnet/Hall Effect Sensors, 1 of 2 \(page 479\)](#)
- [iPad Pro 12.9-inch \(1st generation\) Magnet/Hall Effect Sensors, 2 of 2 \(page 480\)](#)
- [iPad mini 4 \(page 481\)](#)
- [iPad mini 4 with Cellular \(page 482\)](#)

- [iPad mini 4 Magnet/Hall Effect Sensors](#) (page 483)
- [iPad Air 2](#) (page 484)
- [iPad Air 2 with Cellular](#) (page 485)
- [iPad mini 2 and iPad mini 3](#) (page 486)
- [iPad mini 2 and iPad mini 3 with Cellular](#) (page 487)
- [iPad Air](#) (page 488)
- [iPad Air with Cellular](#) (page 489)
- [iPad mini](#) (page 490)
- [iPad mini with Cellular](#) (page 491)
- [iPad \(4th generation\)](#) (page 492)
- [iPad \(4th generation\) with Cellular](#) (page 493)

This chapter contains the following iPod dimensional drawings:

- [iPod touch \(6th generation\) and iPod touch \(7th generation\)](#) (page 494)
- [iPod touch \(5th generation\)](#) (page 495)

This chapter contains the following Apple Watch dimensional drawings:

- [Apple Watch Series 10, 46 mm](#) (page 496)
- [Apple Watch Series 10, 42 mm](#) (page 497)
- [Apple Watch Ultra 2, 1 of 3](#) (page 498)
- [Apple Watch Ultra 2, 2 of 3](#) (page 499)
- [Apple Watch Ultra 2, 3 of 3](#) (page 500)
- [Apple Watch Series 9, 45 mm](#) (page 501)
- [Apple Watch Series 9, 41 mm](#) (page 502)
- [Apple Watch Ultra, 1 of 3](#) (page 503)
- [Apple Watch Ultra, 2 of 3](#) (page 504)
- [Apple Watch Ultra, 3 of 3](#) (page 505)
- [Apple Watch Series 8, 45 mm](#) (page 506)
- [Apple Watch Series 8, 41 mm](#) (page 507)
- [Apple Watch SE, 44 mm](#) (page 508)
- [Apple Watch SE, 40 mm](#) (page 509)
- [Apple Watch Series 7, 45 mm](#) (page 510)
- [Apple Watch Series 7, 41 mm](#) (page 511)
- [Apple Watch Series 6, 44 mm](#) (page 512)
- [Apple Watch Series 6, 40 mm](#) (page 513)
- [Apple Watch SE \(1st generation\), 44 mm](#) (page 514)
- [Apple Watch SE \(1st generation\), 40 mm](#) (page 515)
- [Apple Watch Series 5, 44 mm](#) (page 516)
- [Apple Watch Series 5, 40 mm](#) (page 517)
- [Apple Watch Series 5 Ceramic, 44 mm](#) (page 518)
- [Apple Watch Series 5 Ceramic, 40 mm](#) (page 519)

- [Apple Watch Series 4, 44 mm \(page 520\)](#)
- [Apple Watch Series 4, 40 mm \(page 521\)](#)
- [Apple Watch Series 3 Ceramic, 42 mm \(page 522\)](#)
- [Apple Watch Series 3 Ceramic, 38 mm \(page 523\)](#)
- [Apple Watch Series 3 Metal, 42 mm \(page 524\)](#)
- [Apple Watch Series 3 Metal, 38 mm \(page 525\)](#)
- [Apple Watch Series 2 Ceramic, 42 mm \(page 526\)](#)
- [Apple Watch Series 2 Ceramic, 38 mm \(page 527\)](#)
- [Apple Watch Series 2 Metal, 42 mm \(page 528\)](#)
- [Apple Watch Series 2 Metal, 38 mm \(page 529\)](#)
- [Apple Watch \(1st generation\) and Apple Watch Series 1, 42 mm \(page 530\)](#)
- [Apple Watch \(1st generation\) and Apple Watch Series 1, 38 mm \(page 531\)](#)

This chapter contains the following Apple Vision Pro dimensional drawings:

- [Apple Vision Pro, 1 of 6 \(page 532\)](#)
- [Apple Vision Pro, 2 of 6 \(page 533\)](#)
- [Apple Vision Pro, 3 of 6 \(page 534\)](#)
- [Apple Vision Pro, 4 of 6 \(page 535\)](#)
- [Apple Vision Pro, 5 of 6 \(page 536\)](#)
- [Apple Vision Pro, 6 of 6 \(page 537\)](#)
- [Apple Vision Pro Battery \(page 538\)](#)
- [Apple Vision Pro Audio Strap \(page 539\)](#)
- [ZEISS Optical Inserts, 1 of 4 \(page 540\)](#)
- [ZEISS Optical Inserts, 2 of 4 \(page 541\)](#)
- [ZEISS Optical Inserts, 3 of 4 \(page 542\)](#)
- [ZEISS Optical Inserts, 4 of 4 \(page 543\)](#)

This chapter contains the following AirPods dimensional drawings:

- [Wireless Charging Case \(USB-C\) for AirPods 4, 1 of 3 \(page 544\)](#)
- [Wireless Charging Case \(USB-C\) for AirPods 4, 2 of 3 \(page 545\)](#)
- [Wireless Charging Case \(USB-C\) for AirPods 4, 3 of 3 \(page 546\)](#)
- [AirPods 4 \(page 547\)](#)
- [MagSafe Charging Case \(USB-C\) for AirPods Pro \(2nd generation\), 1 of 3 \(page 548\)](#)
- [MagSafe Charging Case \(USB-C\) for AirPods Pro \(2nd generation\), 2 of 3 \(page 549\)](#)
- [MagSafe Charging Case \(USB-C\) for AirPods Pro \(2nd generation\), 3 of 3 \(page 550\)](#)
- [MagSafe Charging Case for AirPods Pro \(2nd generation\), 1 of 3 \(page 551\)](#)
- [MagSafe Charging Case for AirPods Pro \(2nd generation\), 2 of 3 \(page 552\)](#)
- [MagSafe Charging Case for AirPods Pro \(2nd generation\), 3 of 3 \(page 553\)](#)
- [AirPods Pro \(2nd generation\) \(page 554\)](#)
- [MagSafe Charging Case for AirPods \(3rd generation\) \(page 555\)](#)
- [AirPods \(3rd generation\) \(page 556\)](#)

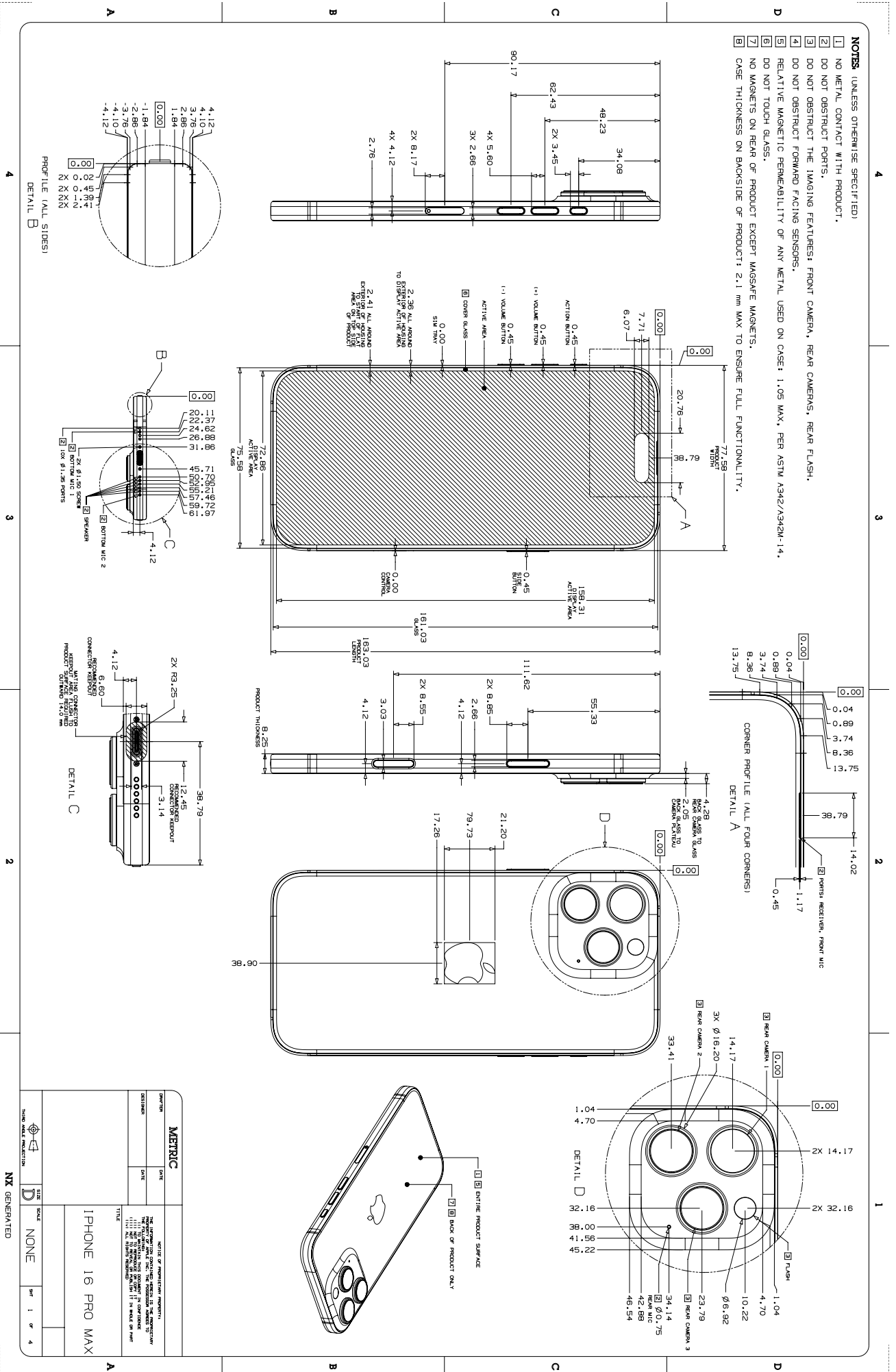
- [AirPods Max, 1 of 6 \(page 557\)](#)
- [AirPods Max, 2 of 6 \(page 558\)](#)
- [AirPods Max, 3 of 6 \(page 559\)](#)
- [AirPods Max, 4 of 6 \(page 560\)](#)
- [AirPods Max, 5 of 6 \(page 561\)](#)
- [AirPods Max, 6 of 6 \(page 562\)](#)
- [Wireless Charging Case for AirPods Pro \(1st generation\) \(page 563\)](#)
- [AirPods Pro \(1st generation\) \(page 564\)](#)
- [Wireless Charging Case for AirPods \(page 565\)](#)
- [AirPods \(1st generation\) and AirPods \(2nd generation\) \(page 566\)](#)

This chapter contains the following dimensional drawings:

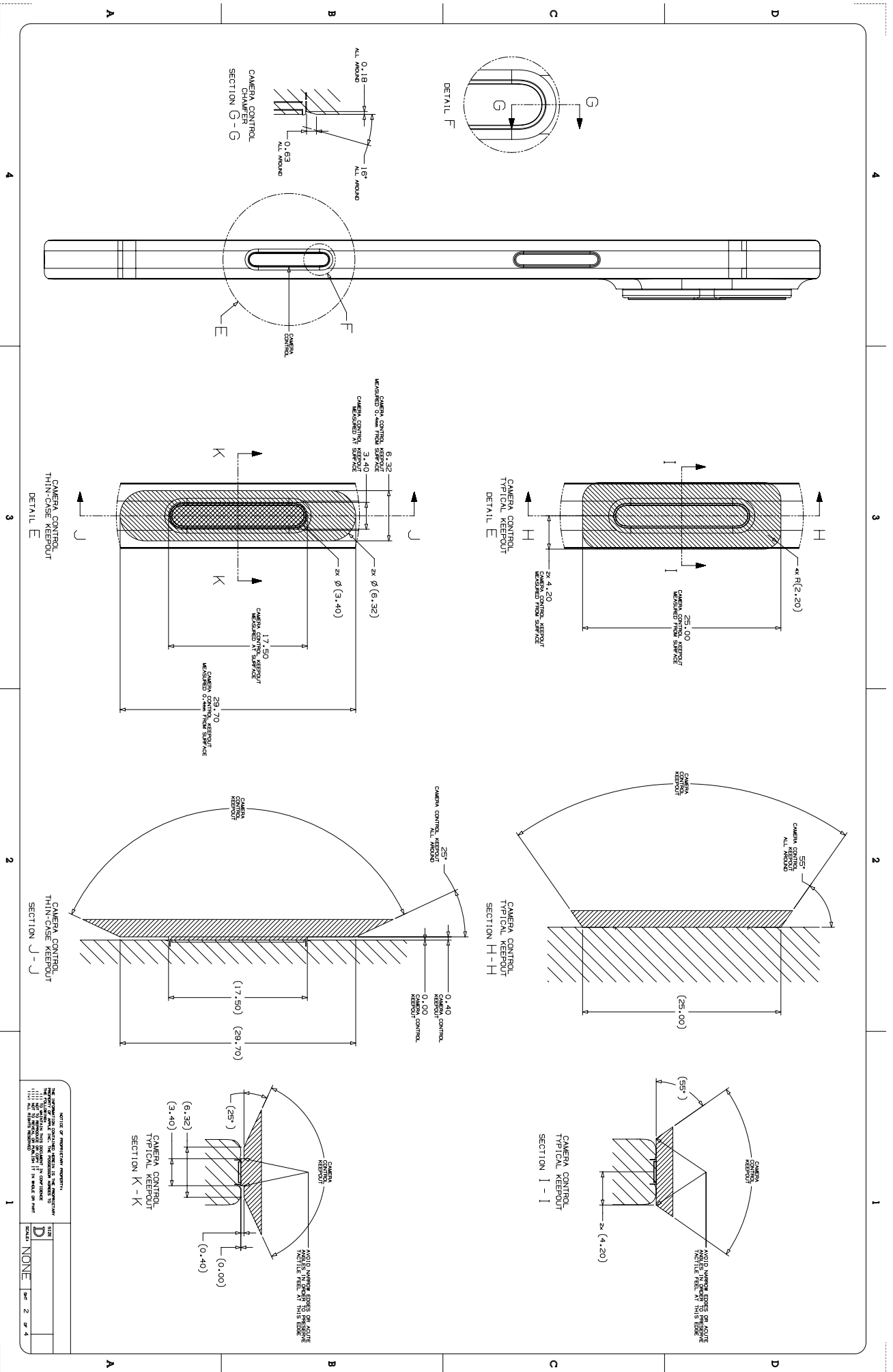
- [Apple MagSafe Charger \(1 m\) and Apple MagSafe Charger \(2 m\) \(page 567\)](#)
- [Apple MagSafe Charger \(page 568\)](#)
- [AirTag \(page 569\)](#)
- [Apple TV 4K \(3rd generation\) \(page 570\)](#)
- [Siri Remote \(3rd generation\) \(page 571\)](#)

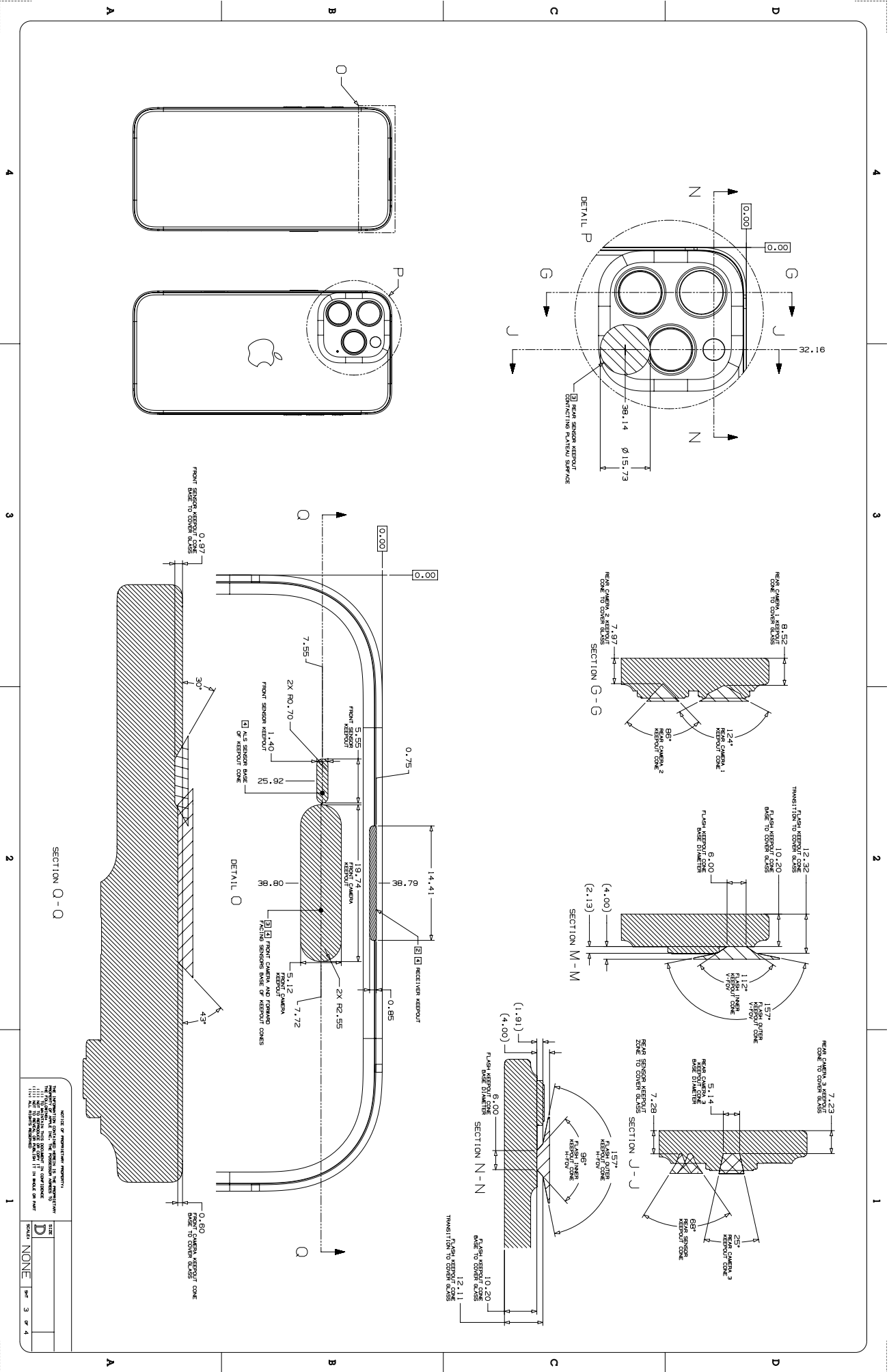
NOTES (UNLESS OTHERWISE SPECIFIED)

- 1 NO METAL CONTACT WITH PRODUCT.
- 2 DO NOT OBSTRUCT PORTS.
- 3 DO NOT OBSTRUCT THE IMAGING FEATURES: FRONT CAMERA, REAR CAMERAS, REAR FLASH.
- 4 DO NOT OBSTRUCT FORWARD FACING SENSORS.
- 5 RELATIVE MAGNETIC PERMEABILITY OF ANY METAL USED ON CASE: 1.05 MAX. PER ASTM A342/A342M-14.
- 6 DO NOT TOUCH GLASS.
- 7 NO MAGNETS ON REAR OF PRODUCT EXCEPT MASSAFE MAGNETS.
- 8 CASE THICKNESS ON BACKSIDE OF PRODUCT: 2.1 mm MAX TO ENSURE FULL FUNCTIONALITY.

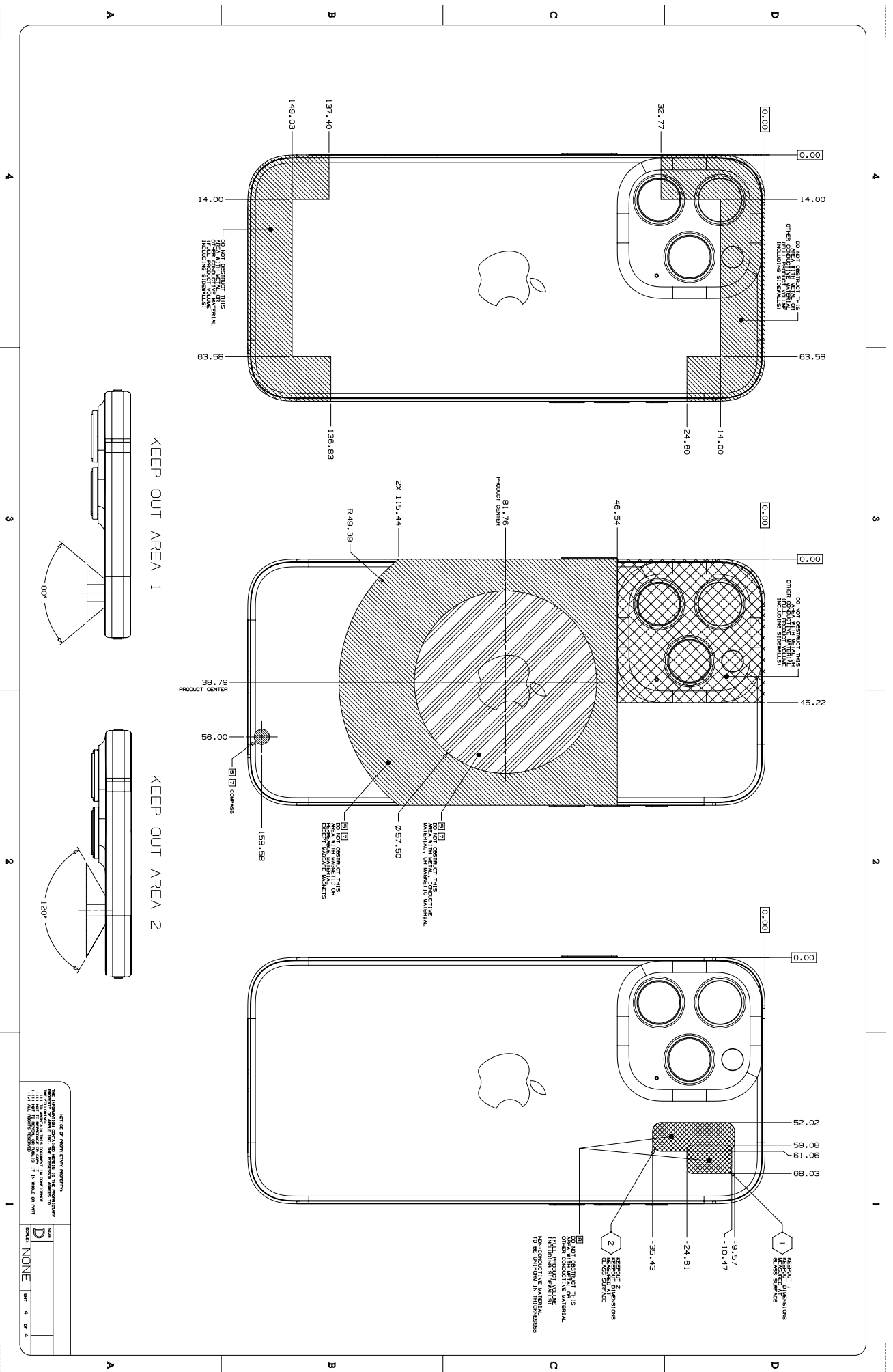


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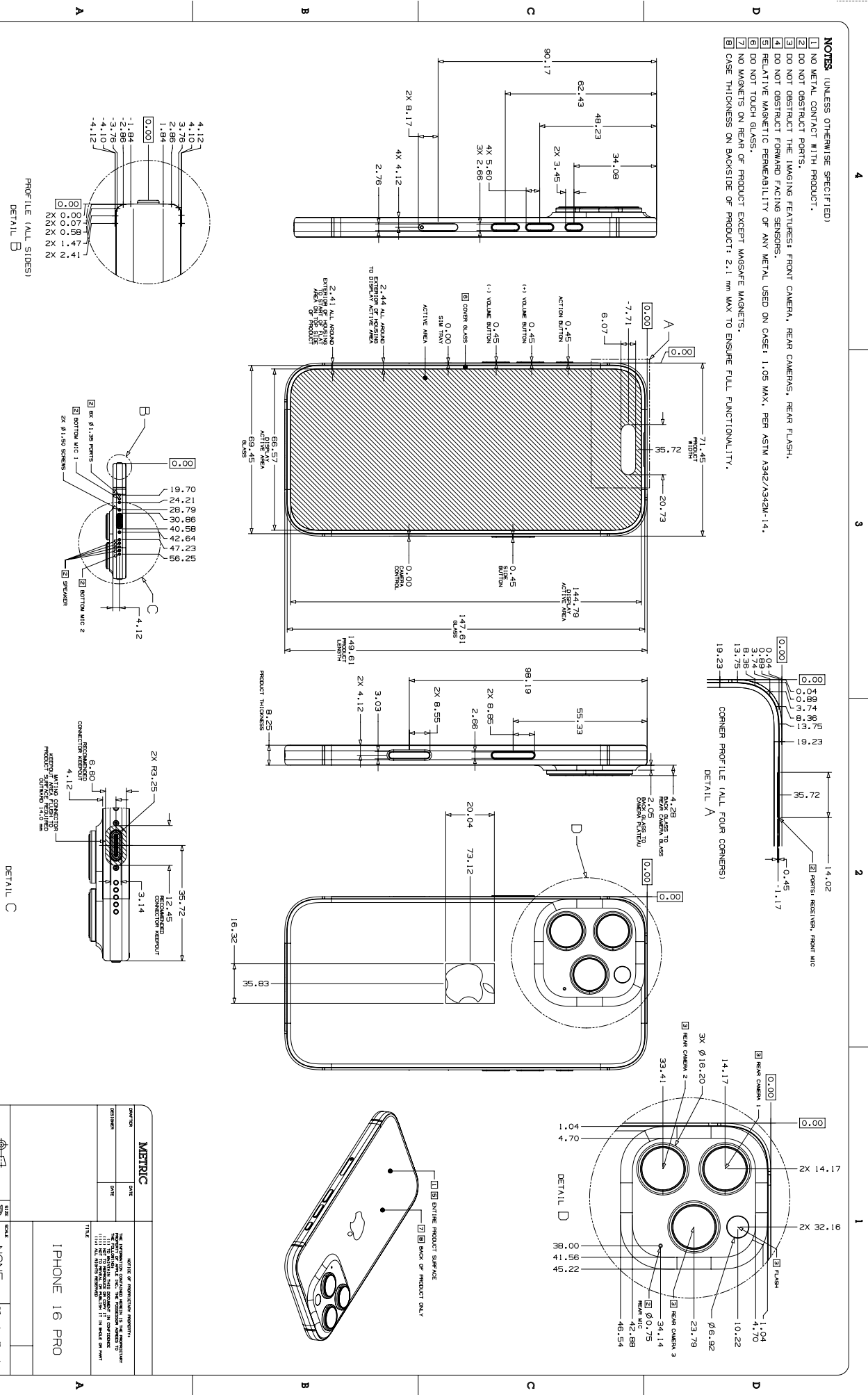
59.4 iPhone 16 Pro Max, 4 of 4



59.5 iPhone 16 Pro, 1 of 4

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- 3 DO NOT OBSTRUCT THE IMAGING FEATURES: FRONT CAMERA, REAR CAMERAS, REAR FLASH.
- 4 DO NOT OBSTRUCT FORWARD FACING SENSORS.
- 5 RELATIVE MAGNETIC PERMEABILITY OF ANY METAL USED ON CASE: 1.05 MAX, PER ASTM A362/A362M-14.
- 6 DO NOT TOUCH GLASS.
- 7 NO MAGNETS ON REAR OF PRODUCT EXCEPT MAGSAFE MAGNETS.
- 8 CASE THICKNESS ON BACKSIDE OF PRODUCT: 2.1 mm MAX TO ENSURE FULL FUNCTIONALITY.

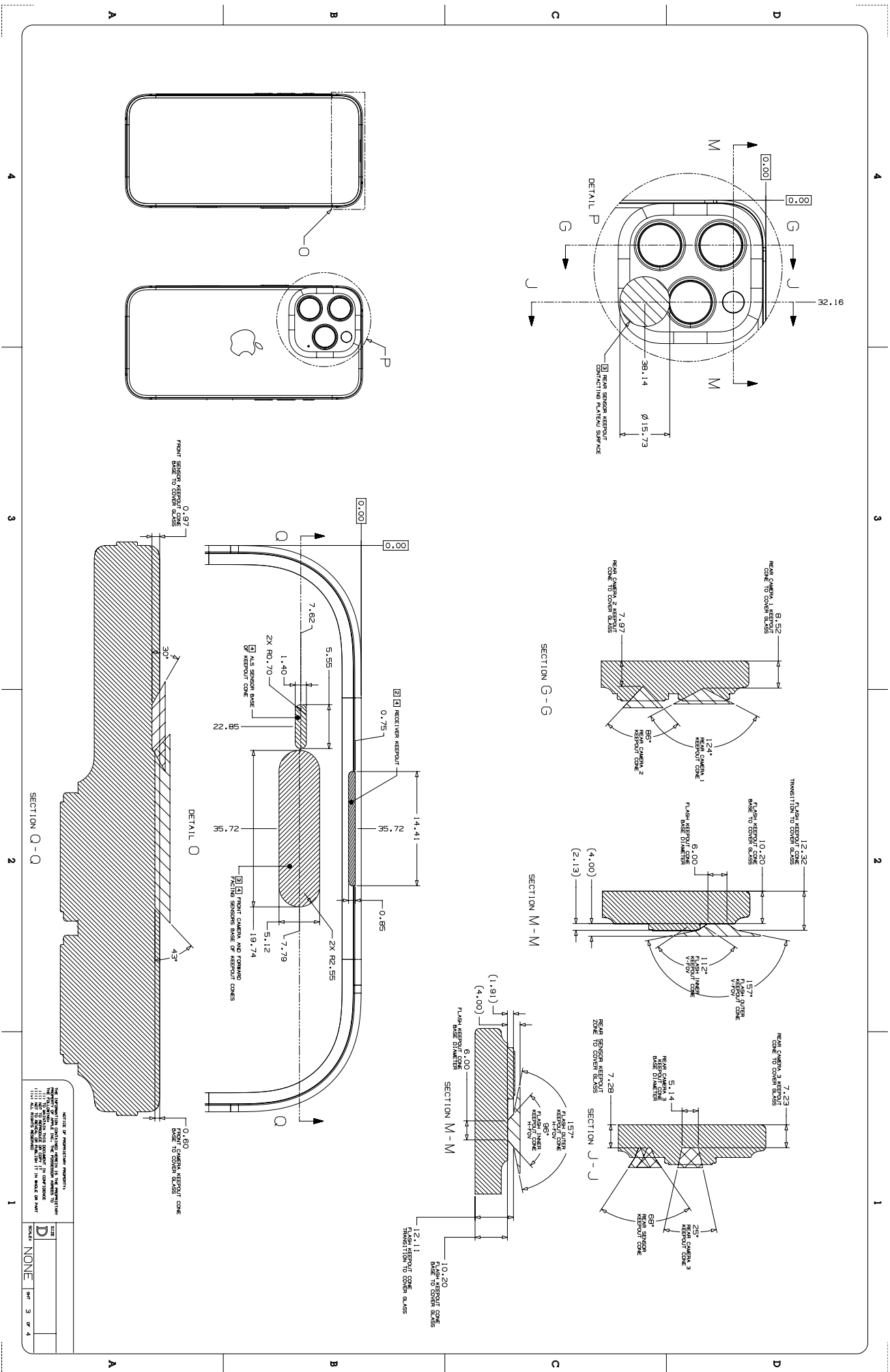


PROFILE (ALL SIDES)
DETAIL B

PROFILE (ALL SIDES)
DETAIL C

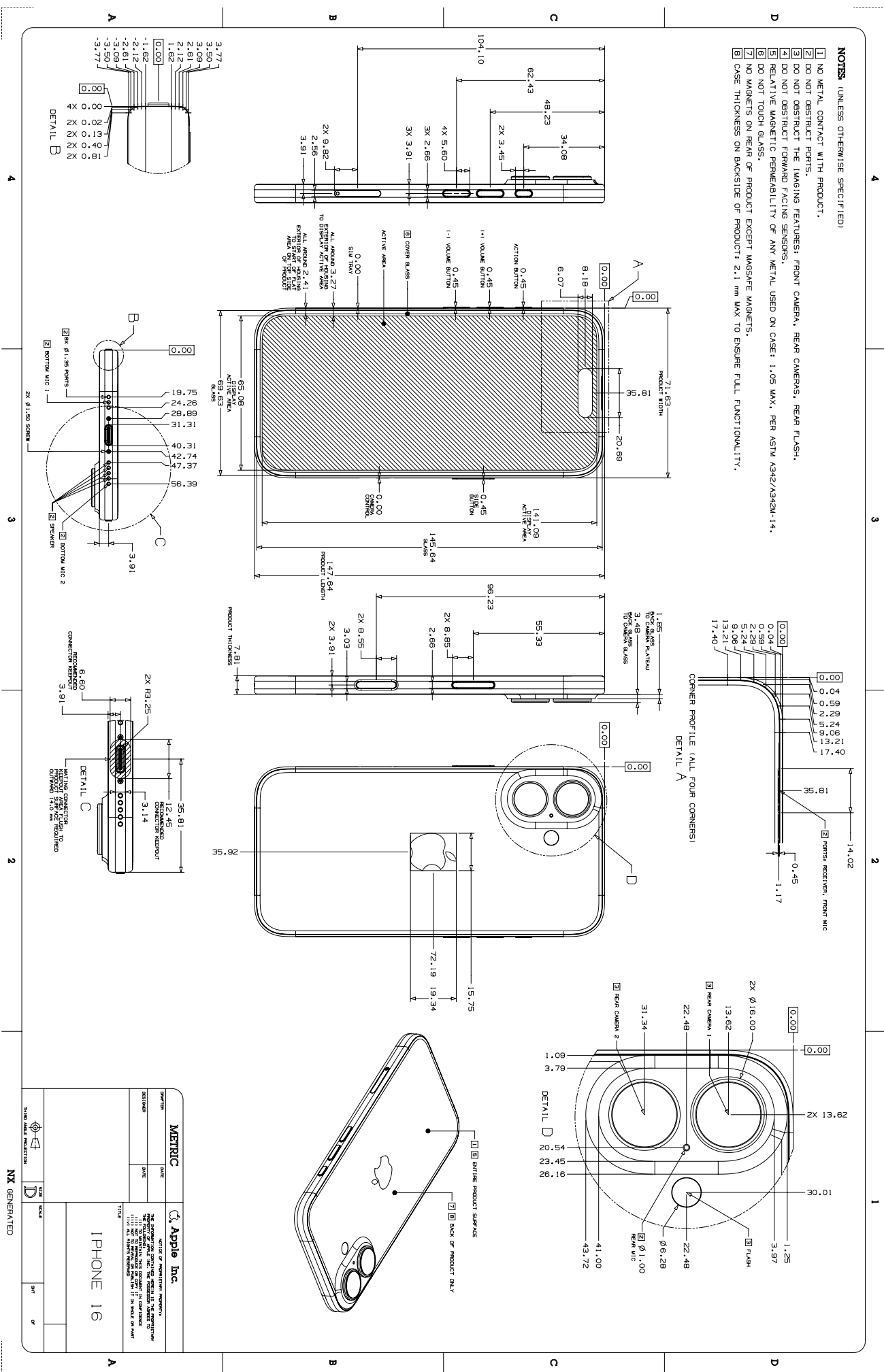
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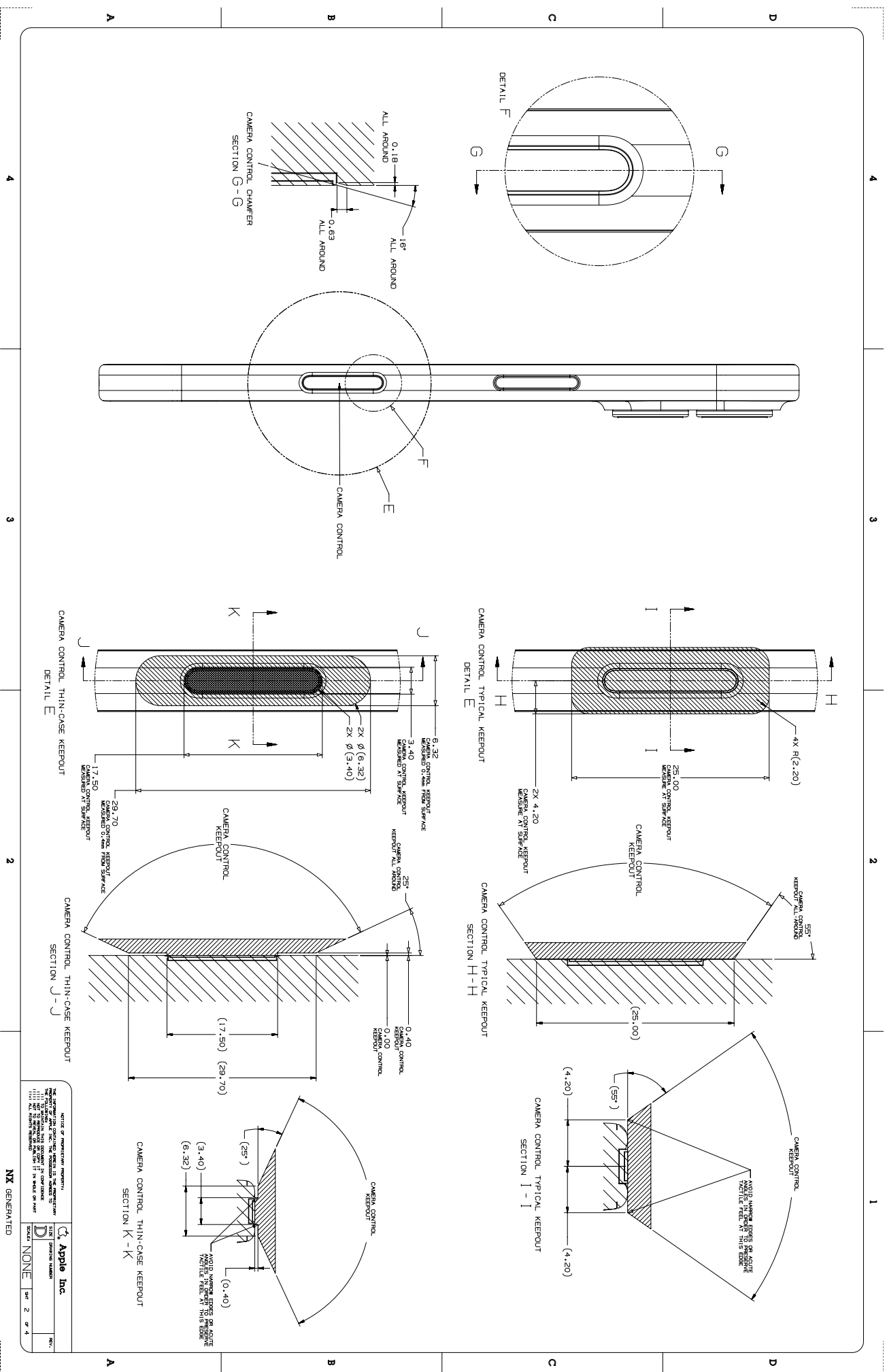


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59.13 iPhone 16, 1 of 4



59.14 iPhone 16, 2 of 4



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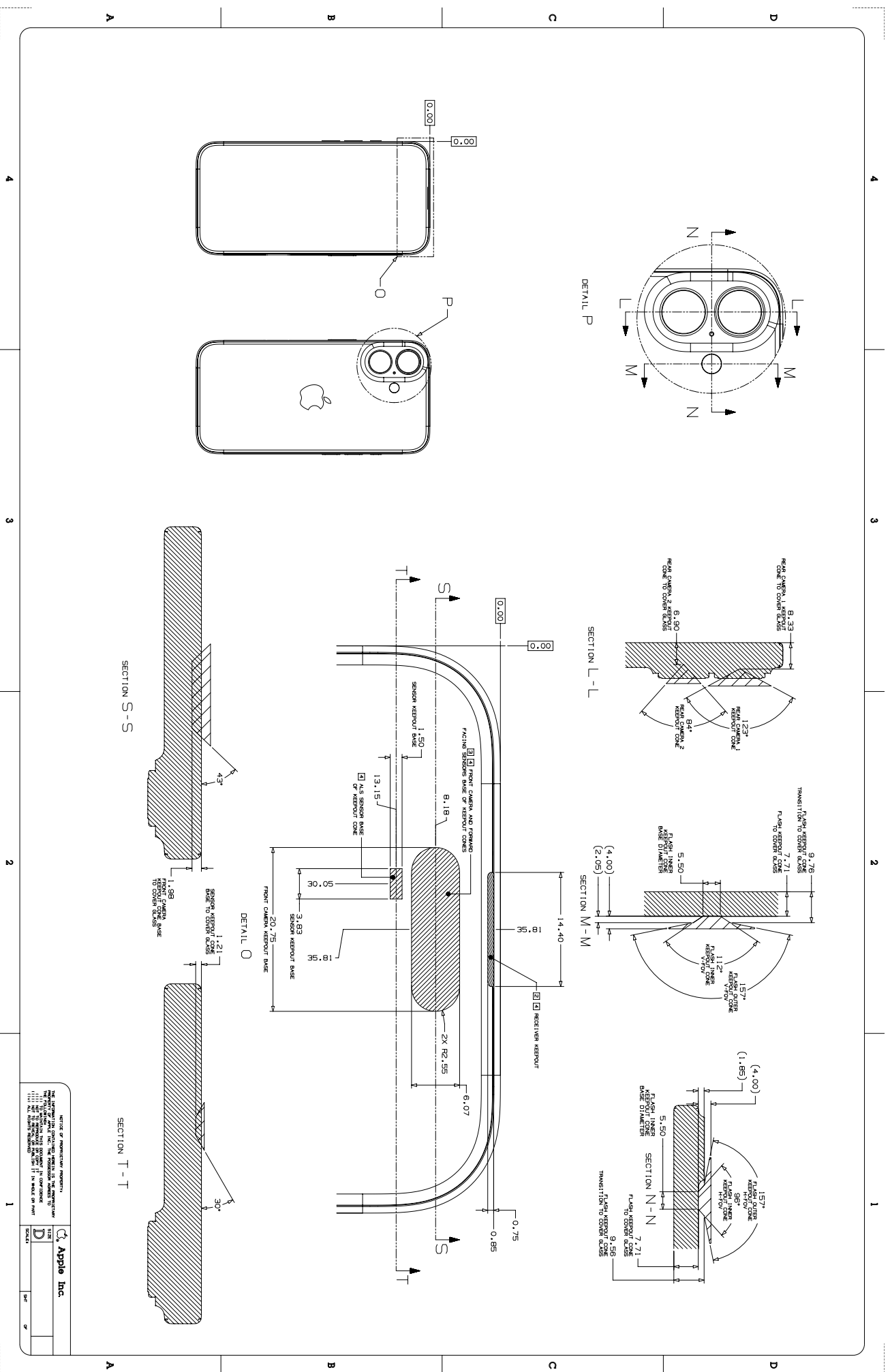
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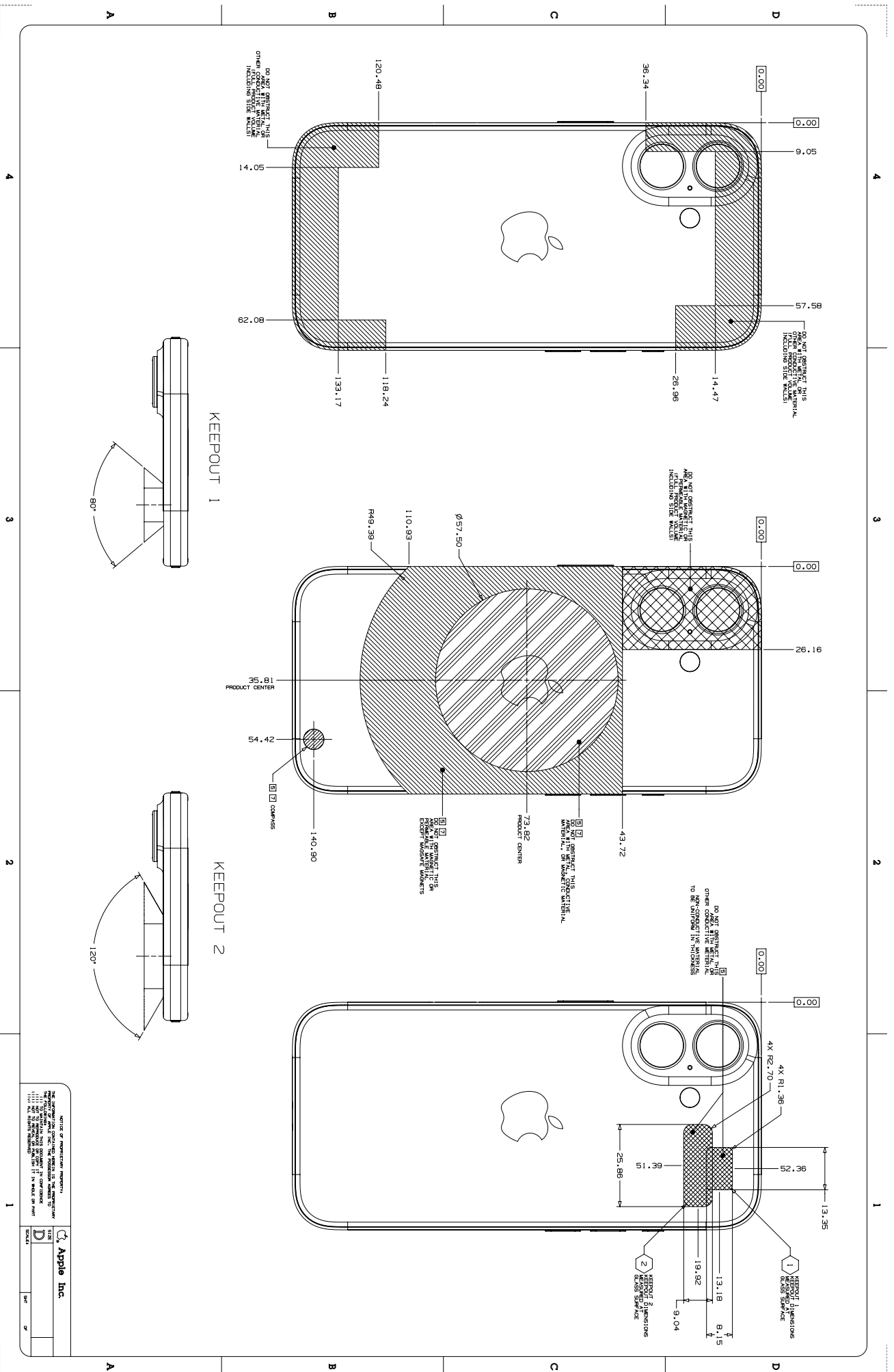
FIG. 59.14

NO. 157899 (REV. 11/14)

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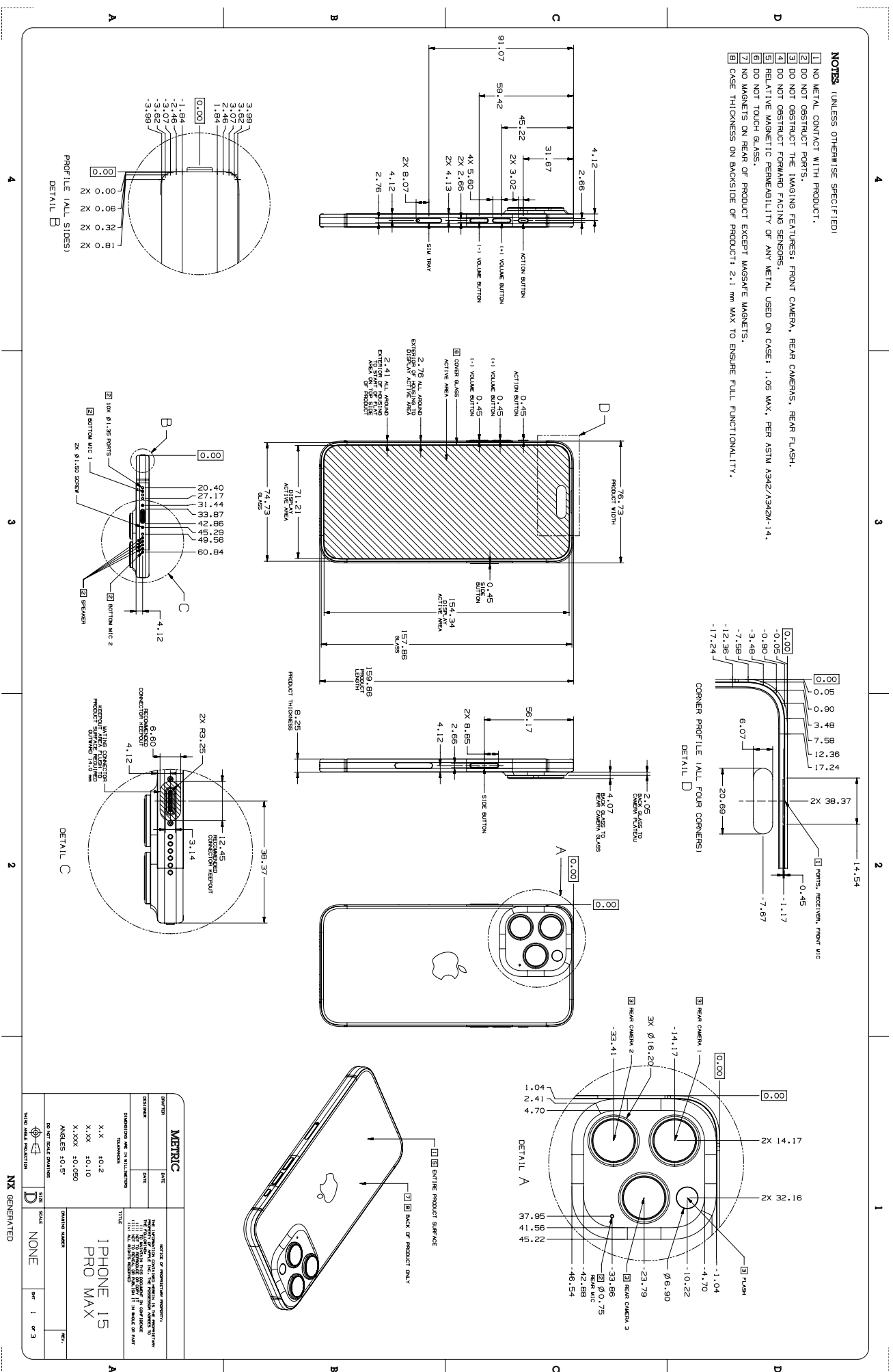
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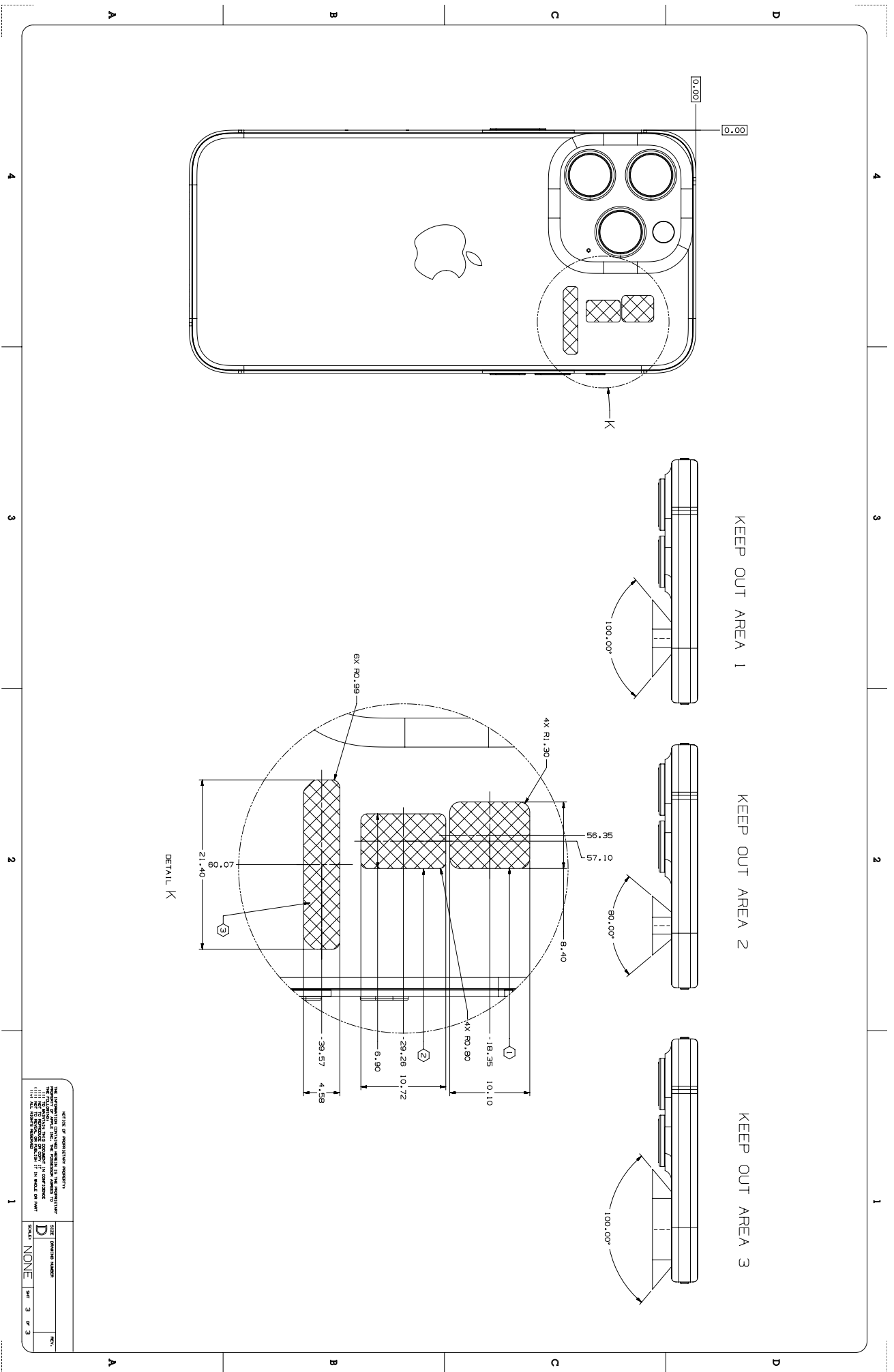
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59.17 iPhone 15 Pro Max, 1 of 3



METRIC		UNITS	
SYMBOL	UNIT	SYMBOL	UNIT
DIMENSIONS ARE TO UNLESS NOTED OTHERWISE			
TOLERANCES			
X.XX ±0.2			
X.XXX ±0.10			
X.XXX ±0.050			
ANGLES 10-5°			
DO NOT SCALE DIMENSIONS			
HIDDEN SHAPE PROJECTION			
FIRST ANGLE PROJECTION		NONE	
SCALE		NONE	
SHEET		1 OF 3	
iPhone 15 Pro Max			
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59.19 iPhone 15 Pro Max, 3 of 3



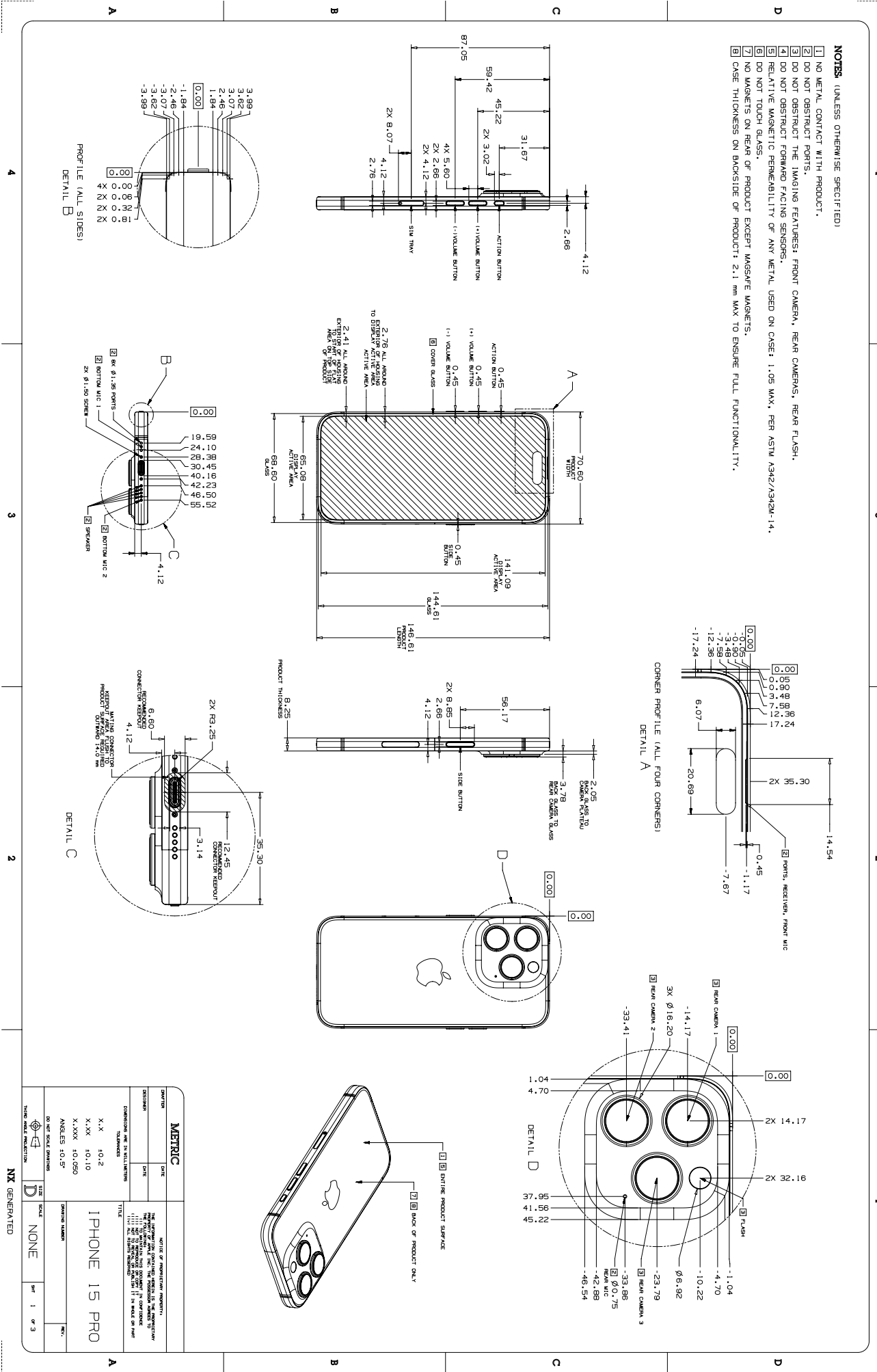
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REV. 1
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 3 OF 3

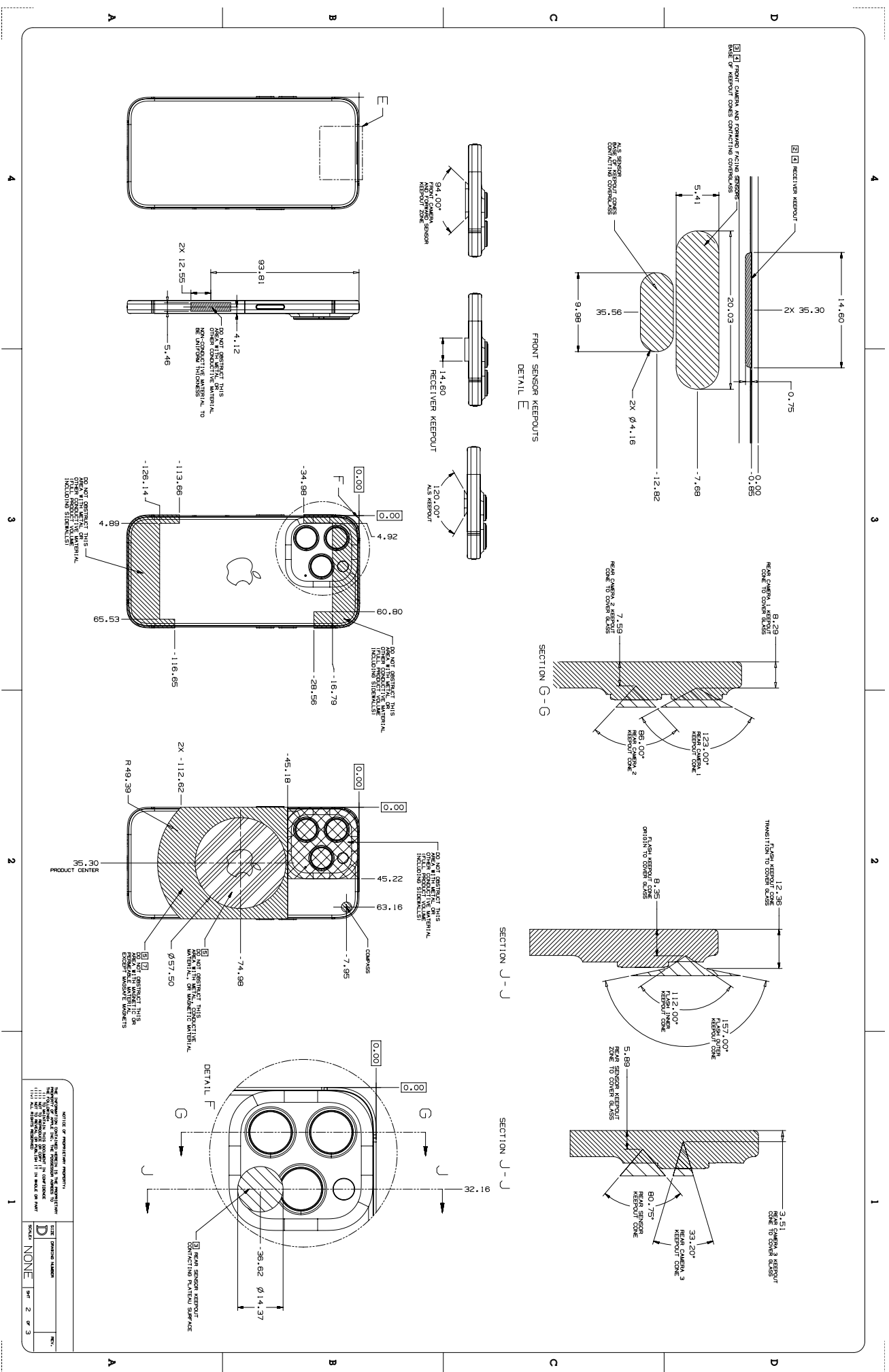
59.20 iPhone 15 Pro, 1 of 3

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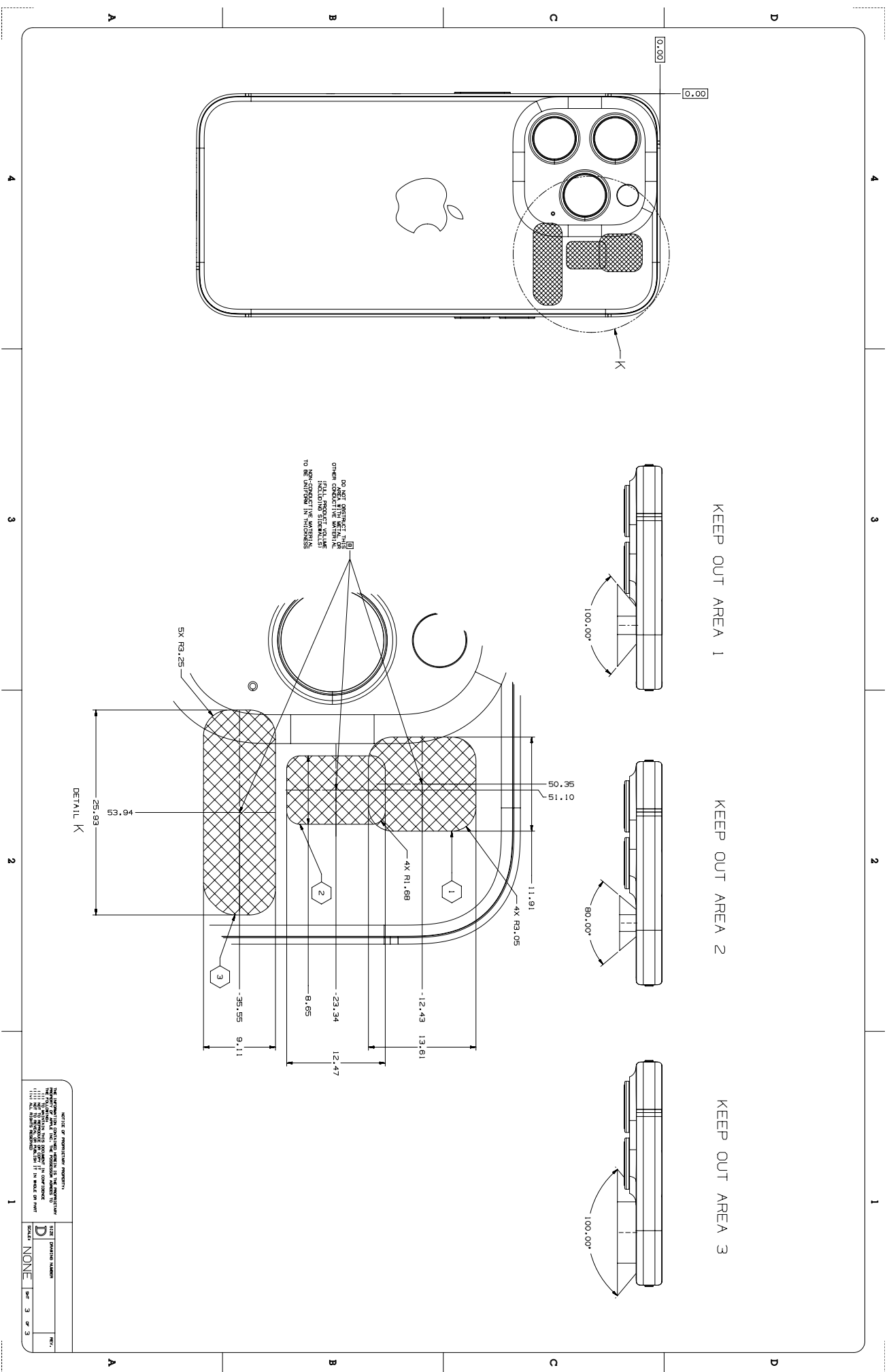
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- 6 DO NOT TOUCH GLASS.
- 7 NO MAGNETS ON REAR OF PRODUCT EXCEPT MAGSAFE MAGNETS.
- 8 CASE THICKNESS ON BACKSIDE OF PRODUCT: 2.1 mm MAX TO ENSURE FULL FUNCTIONALITY.



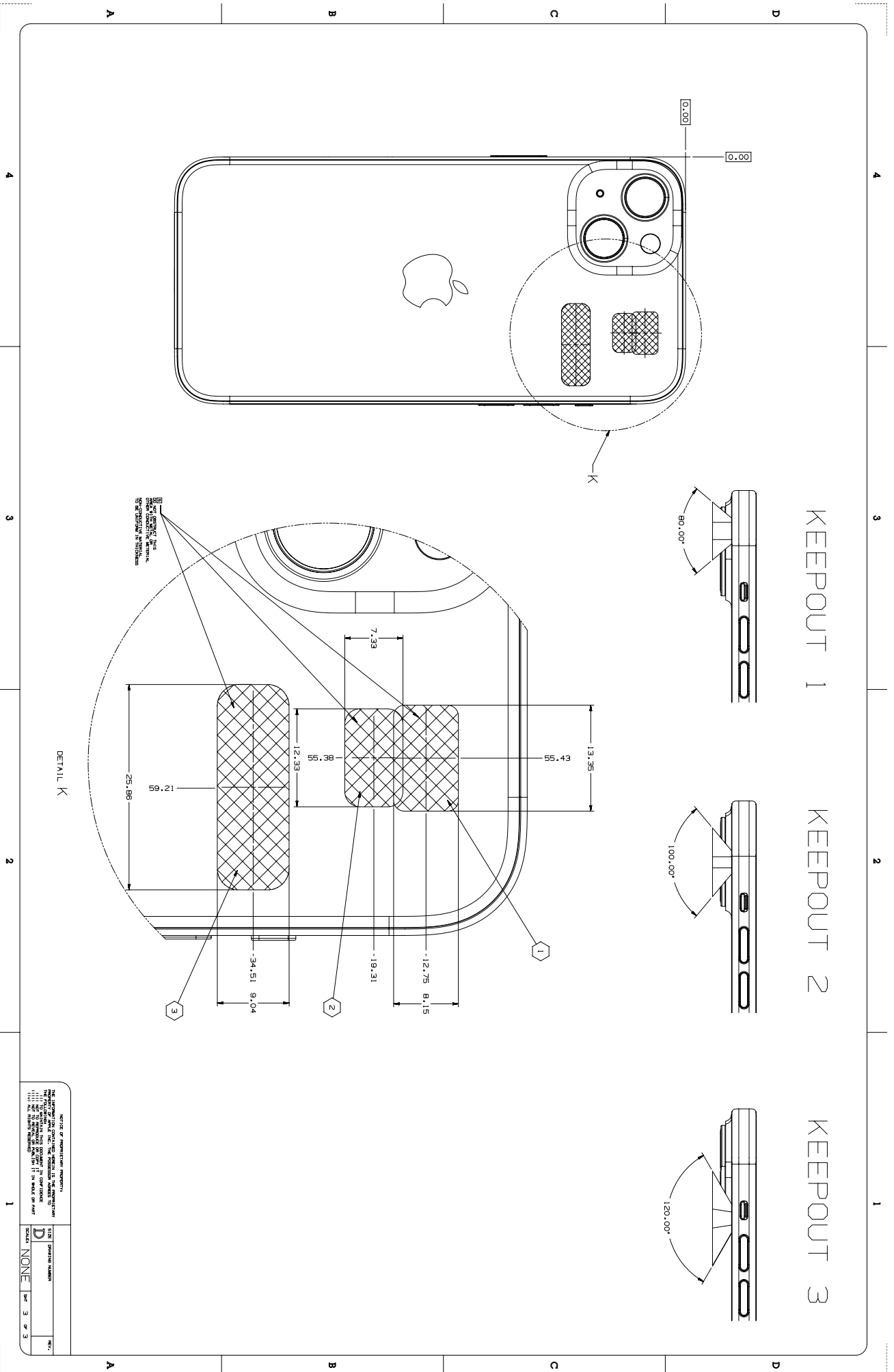
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DESIGNED	DATE	DATE	DATE
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X.XX	+0.10		
X.XXX	+0.050		
ANGLES: 10, 5°			
DO NOT SCALE DRAWINGS			
HIDE HOLE PROJECTION		SCALE	SHEET 1 OF 3
NX GENERATED		NONE	
TITLE: IPHONE 15 PRO			
DRAWING NUMBER: NONE			
DATE: NONE			



59.22 iPhone 15 Pro, 3 of 3



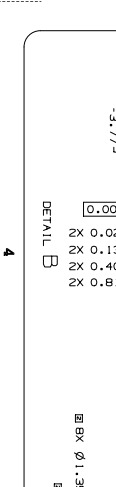
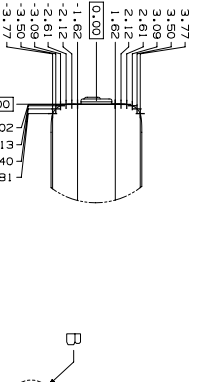
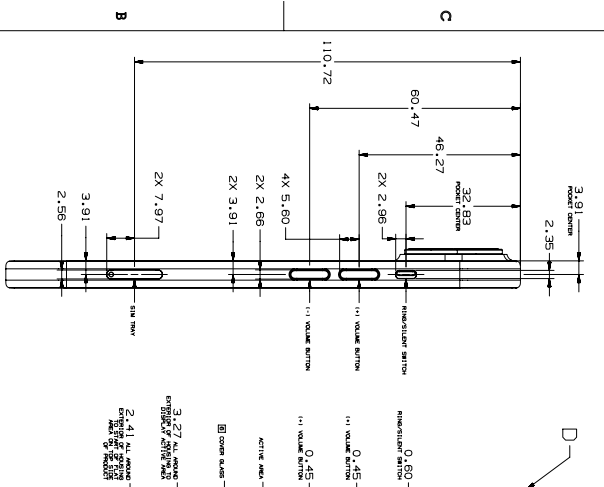
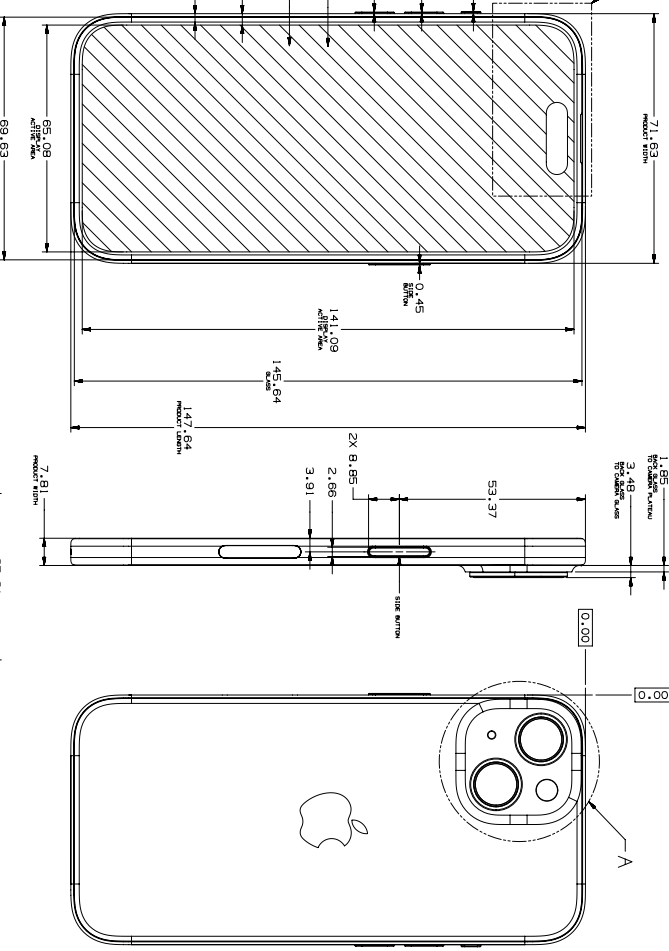
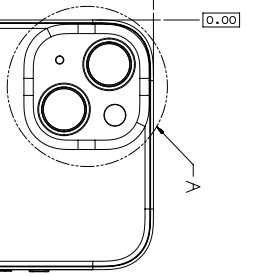
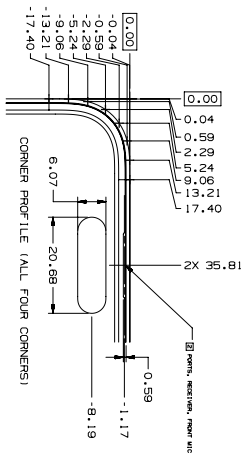
59.25 iPhone 15 Plus, 3 of 3



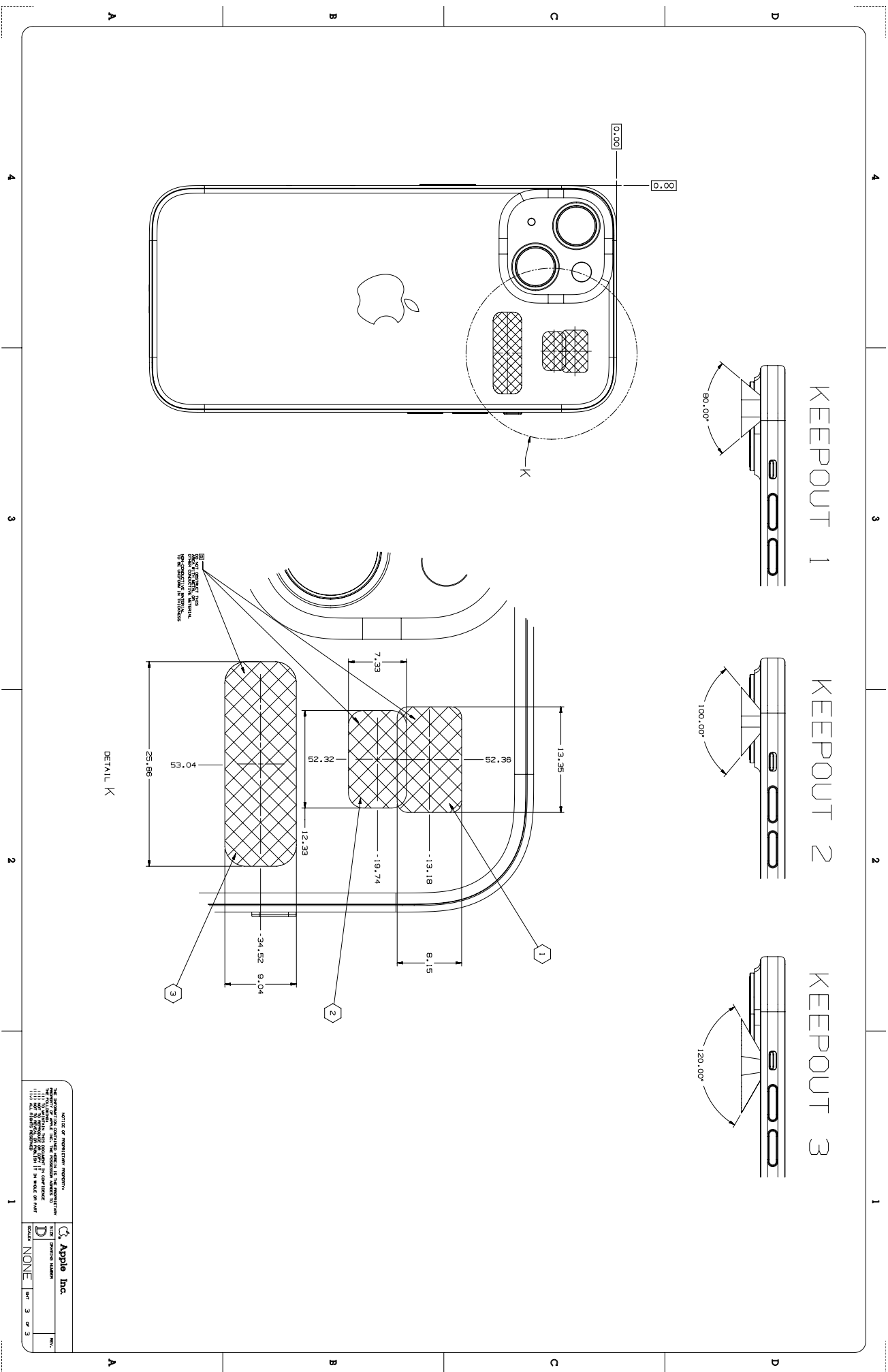
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 - 4 DO NOT OBSTRUCT FORWARD FACING SENSORS.
 - 5 RELATIVE MAGNETIC PERMEABILITY OF ANY METAL USED ON CASE: 1.05 MAX. PER ASTM A342/A342M-14.
 - 6 DO NOT TOUCH GLASS.
 - 7 NO MARKETS ON REAR OF PRODUCT EXCEPT MASSAFE MARKETS.
 - 8 CASE THICKNESS ON BACKSIDE OF PRODUCT: 2.1 MM MAX TO ENSURE FULL FUNCTIONALITY.



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DESIGNED				
DRAWN				
CHECKED				
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TOLERANCES				
FRACTIONS DECIMALS ANGLES				
X.X .012 X.XX .010 X.XXX .0050				
ANGLES 10.5°				
DO NOT SCALE DRAWINGS				
HIDDEN LINE REJECTION				
SCALE NONE				
SHEET 1 OF 3				

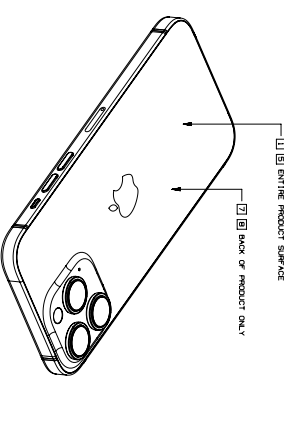
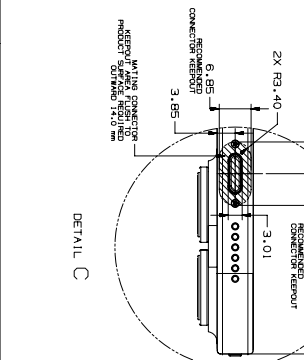
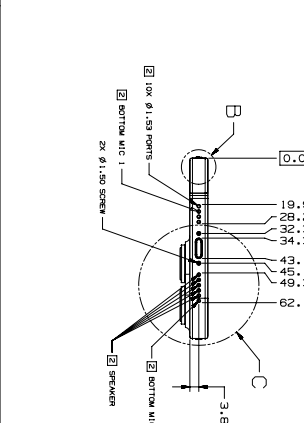
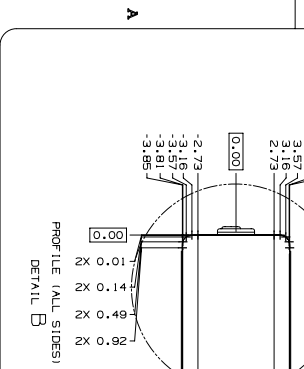
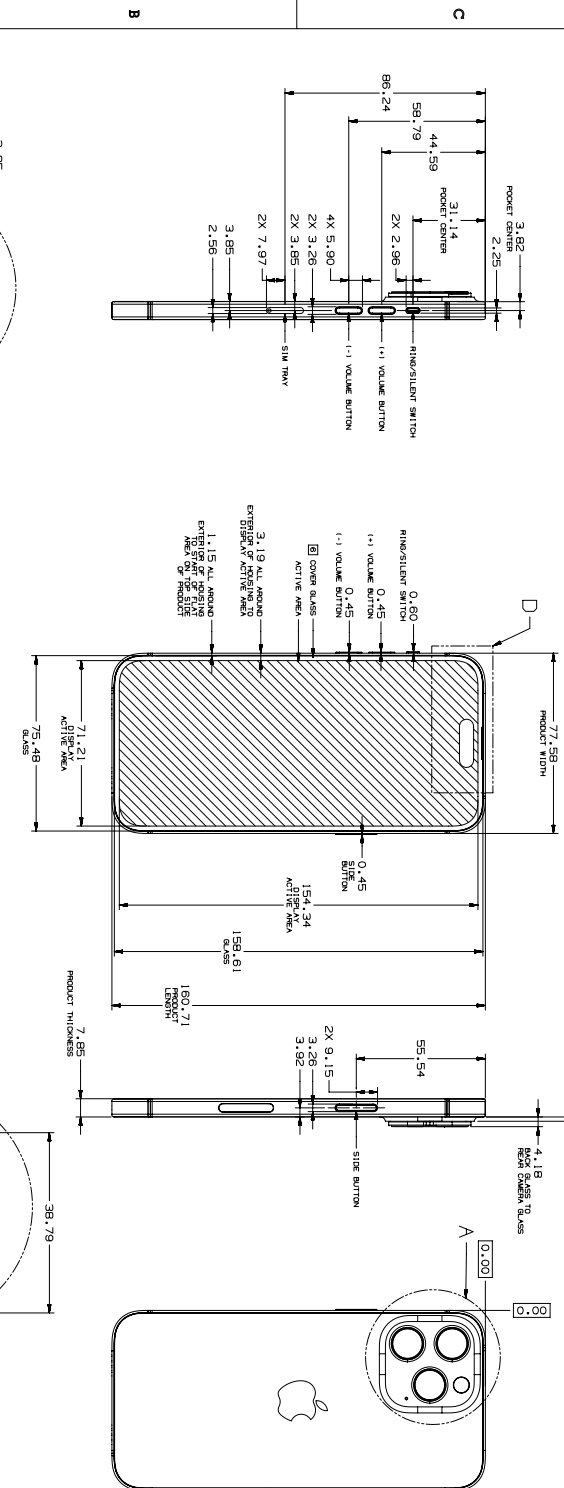
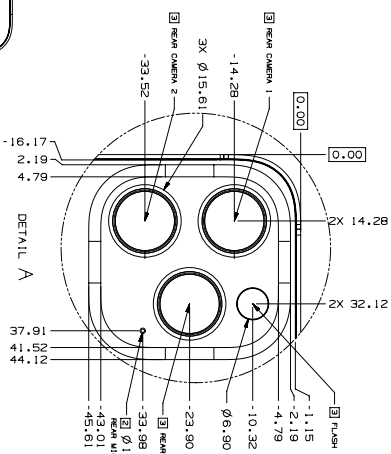
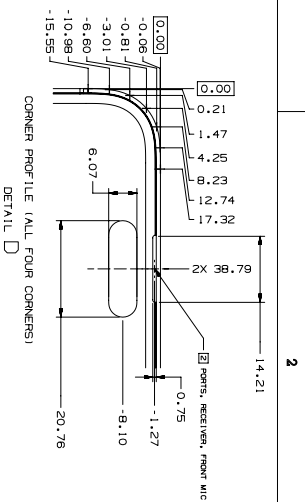


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 Version: 1.0
 Revision: 3 of 3

59.29 iPhone 14 Pro Max, 1 of 3

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 - 7 NO MAGNETS ON REAR OF PRODUCT EXCEPT MAGSAFE MAGNETS.
 - 8 CASE THICKNESS ON BACKSIDE OF PRODUCT: 2.1 mm MAX TO ENSURE FULL FUNCTIONALITY.

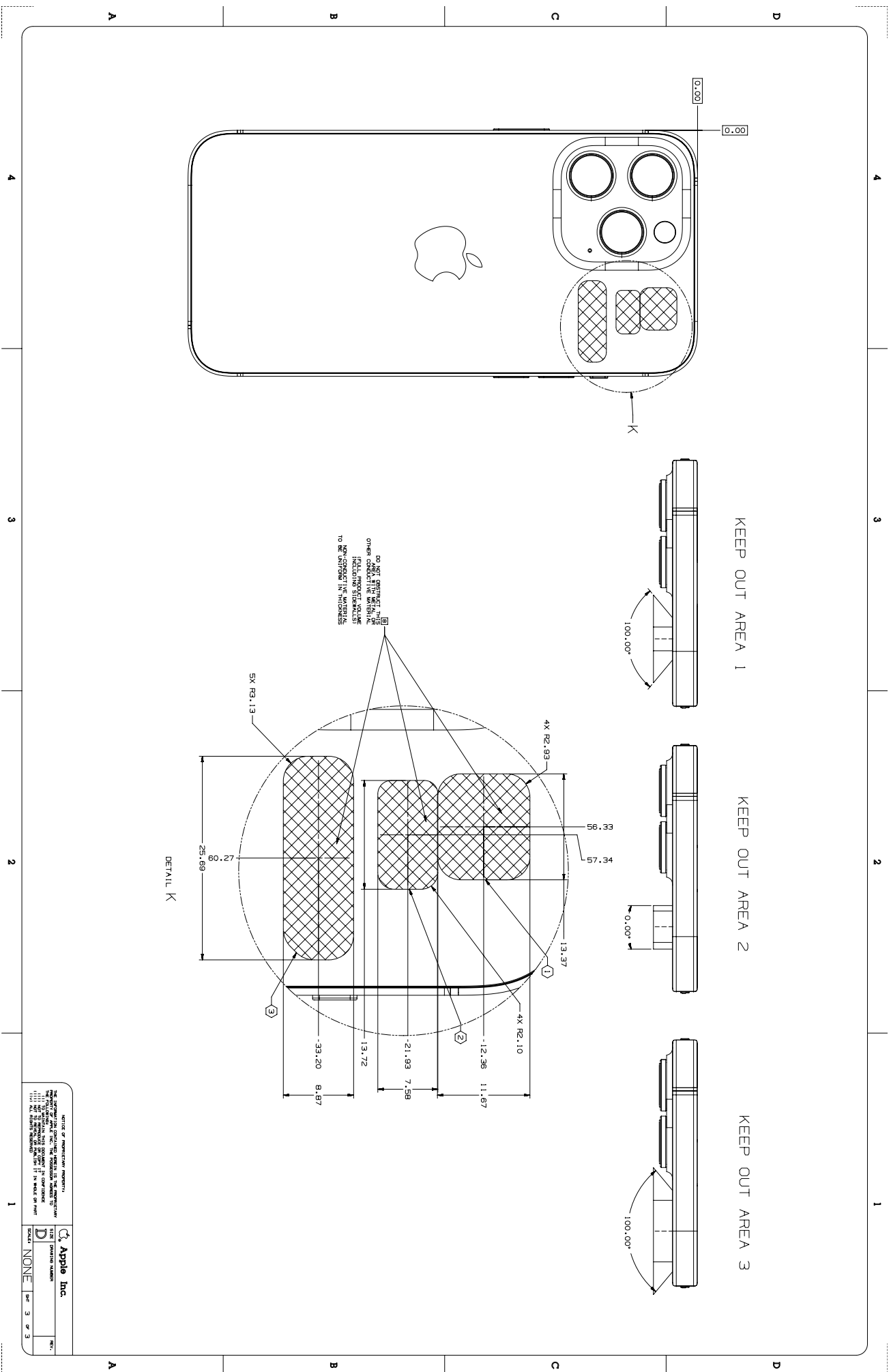


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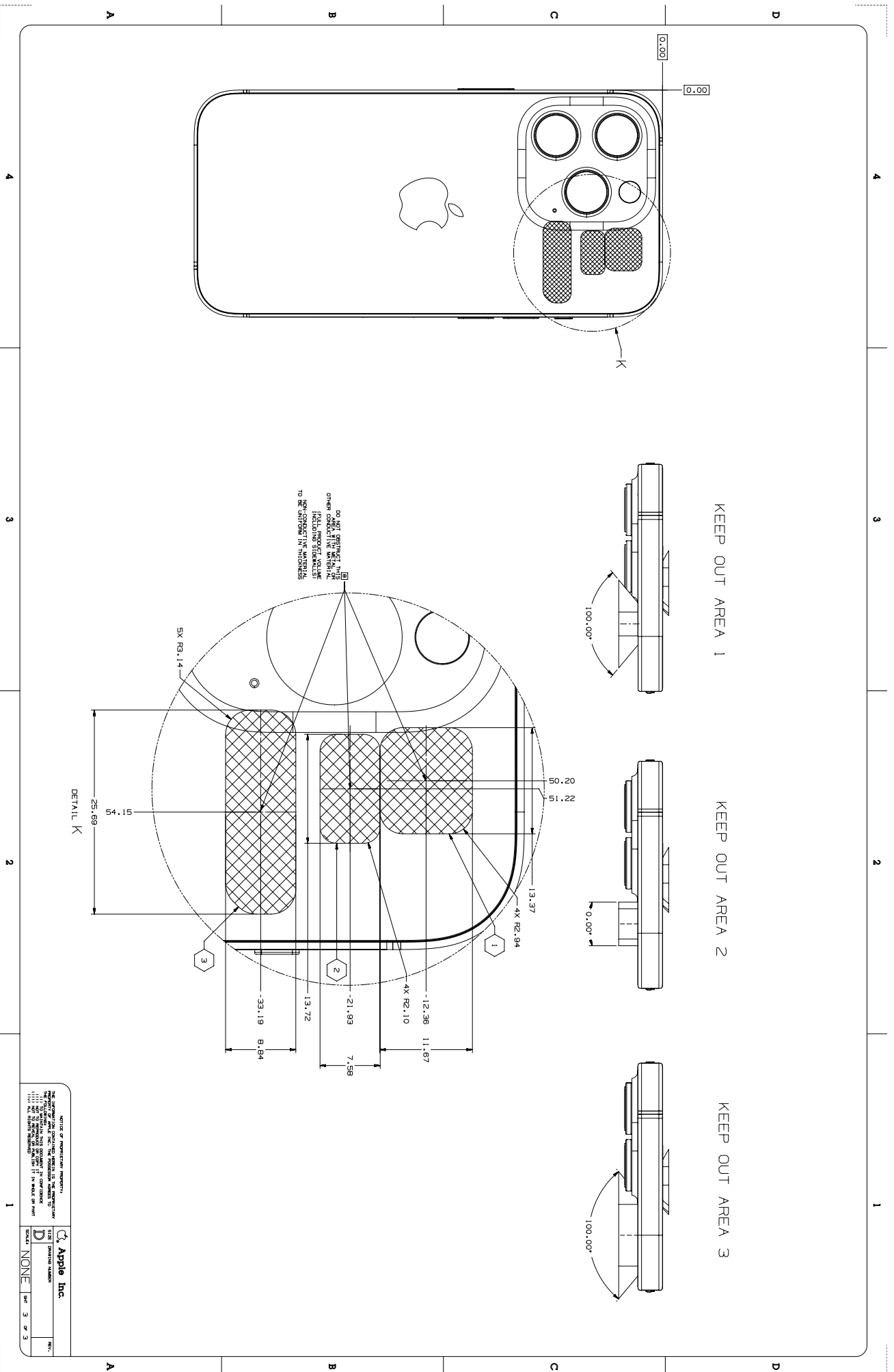
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59.31 iPhone 14 Pro Max, 3 of 3



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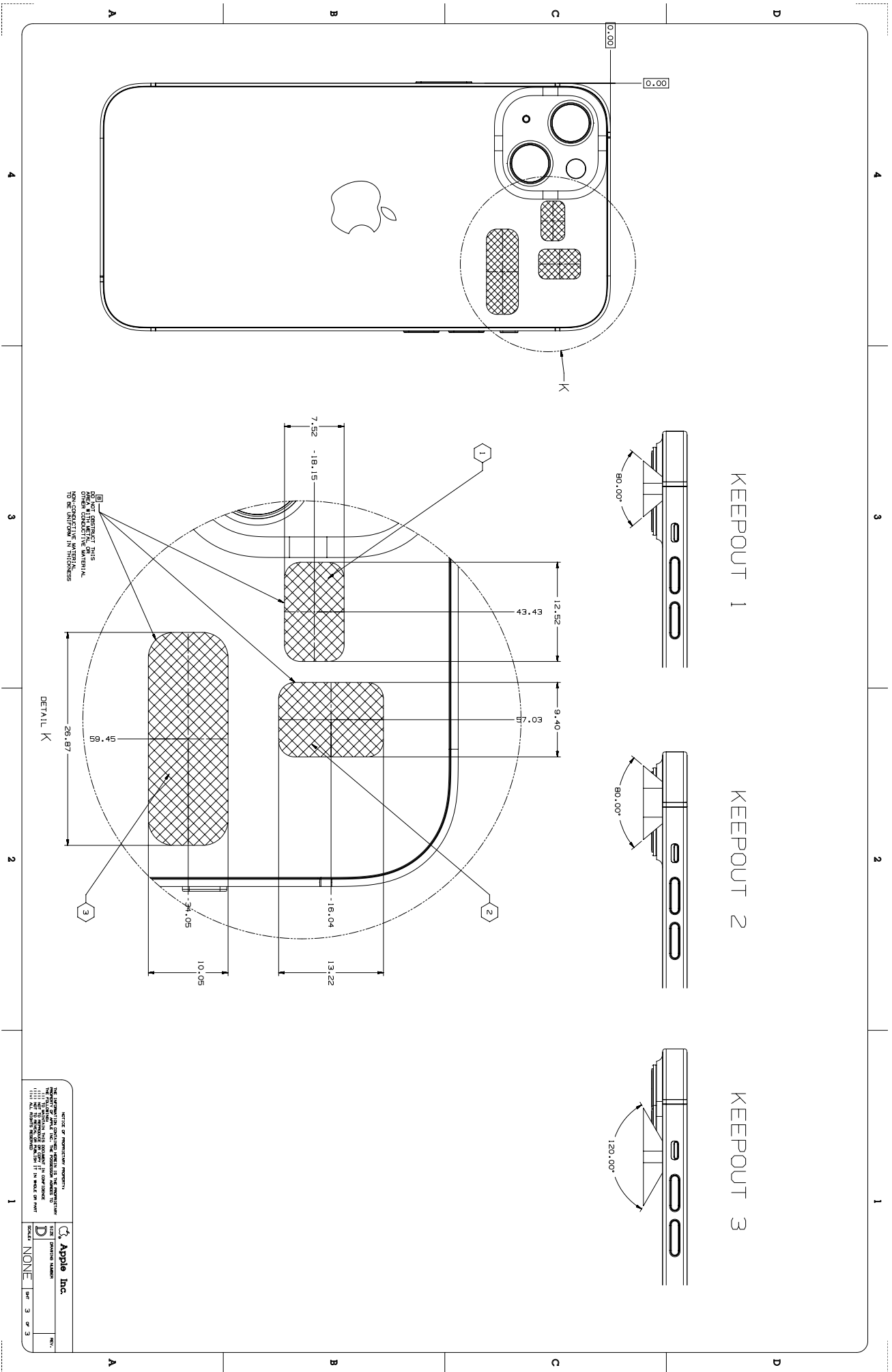
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59.37 iPhone 14 Plus, 3 of 3



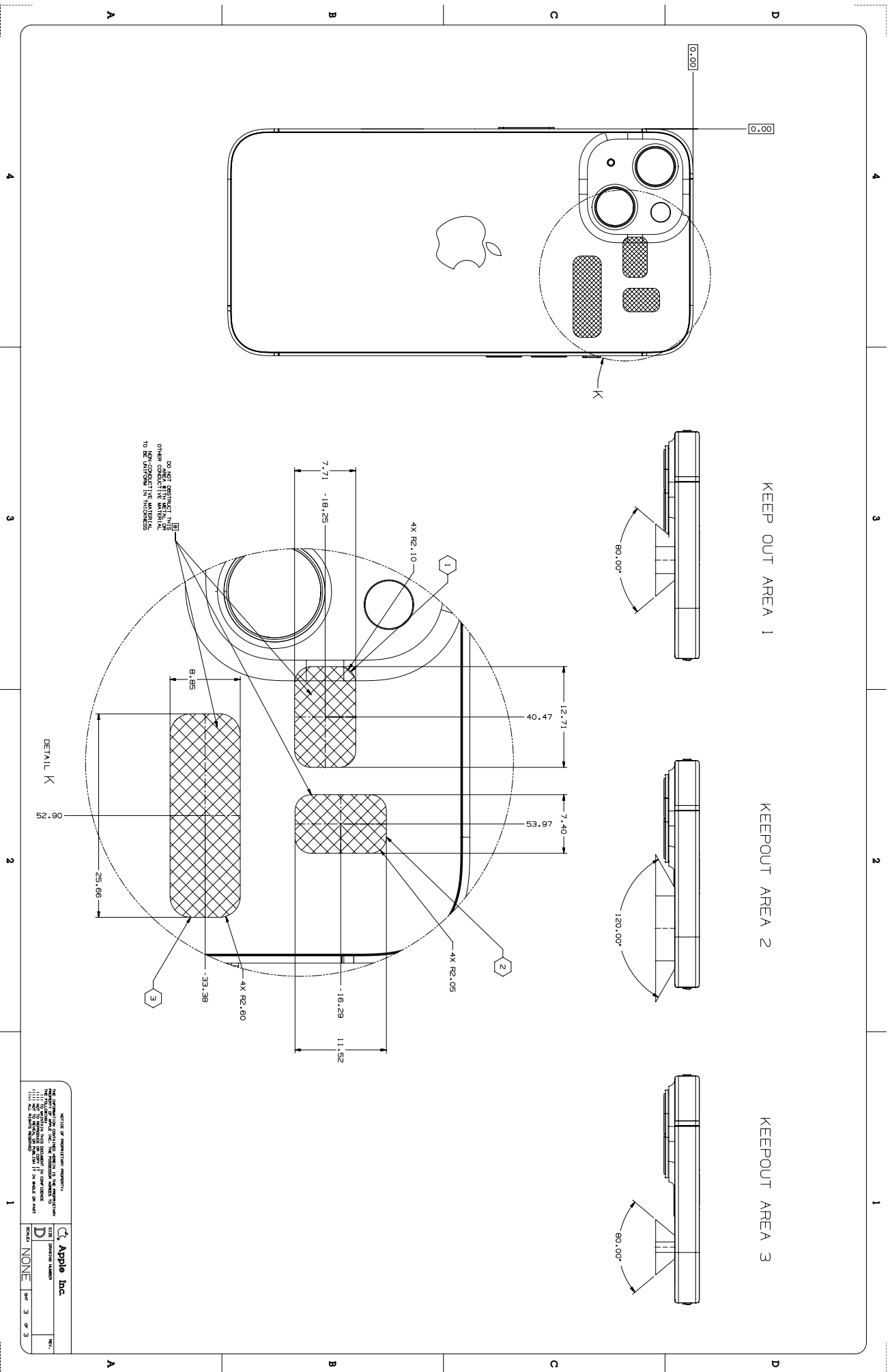
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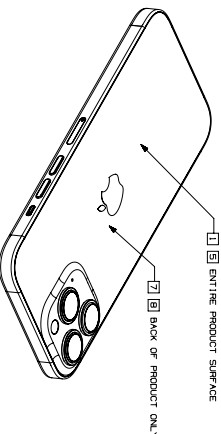
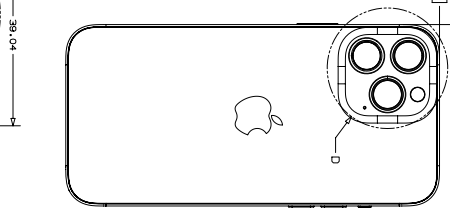
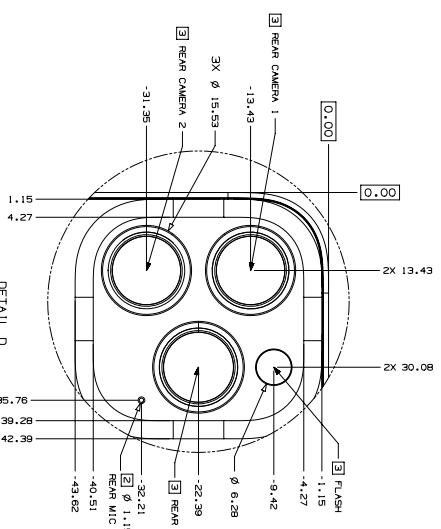
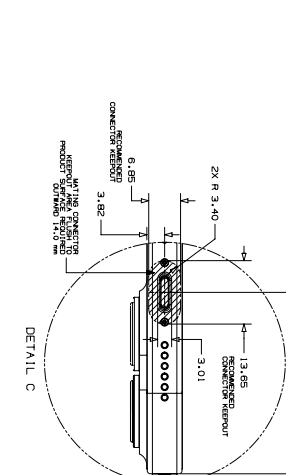
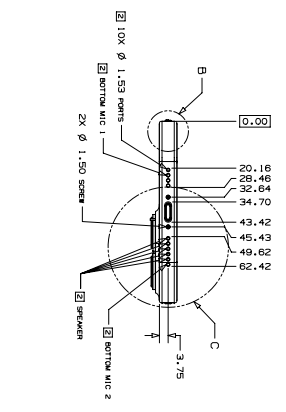
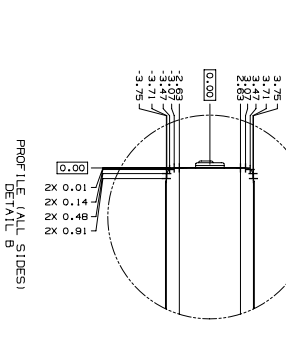
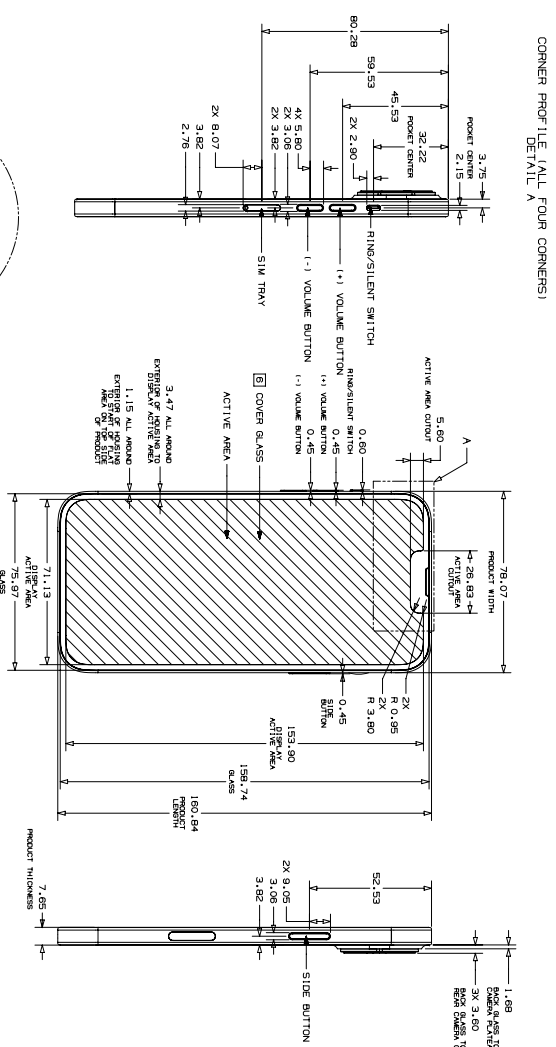
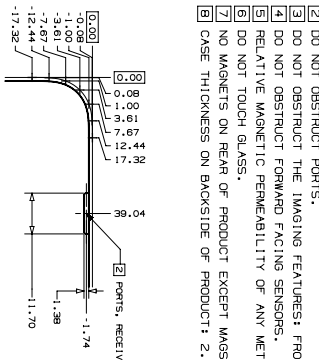
59.40 iPhone 14, 3 of 3



59.41 iPhone 13 Pro Max, 1 of 2

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SECTION	MATERIAL	SECTION	MATERIAL
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REAR	GLASS	REAR	GLASS
SIDE	ALUMINUM	SIDE	ALUMINUM
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MIC	MEMBRANE	MIC	MEMBRANE
SWITCH	PLASTIC	SWITCH	PLASTIC
CONNECTOR	PLASTIC	CONNECTOR	PLASTIC

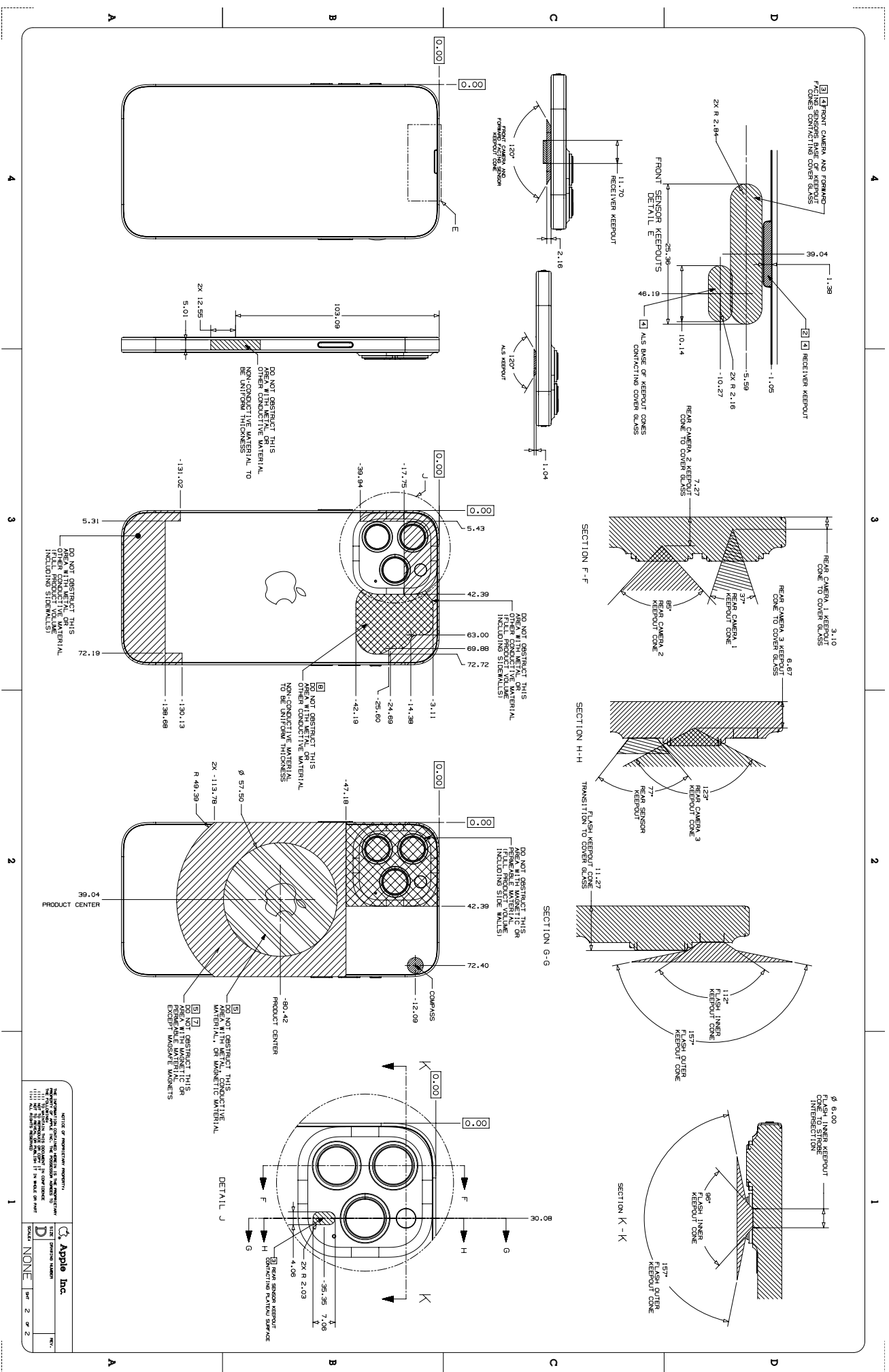
iPhone 13 Pro Max

DATE: 10/21/24

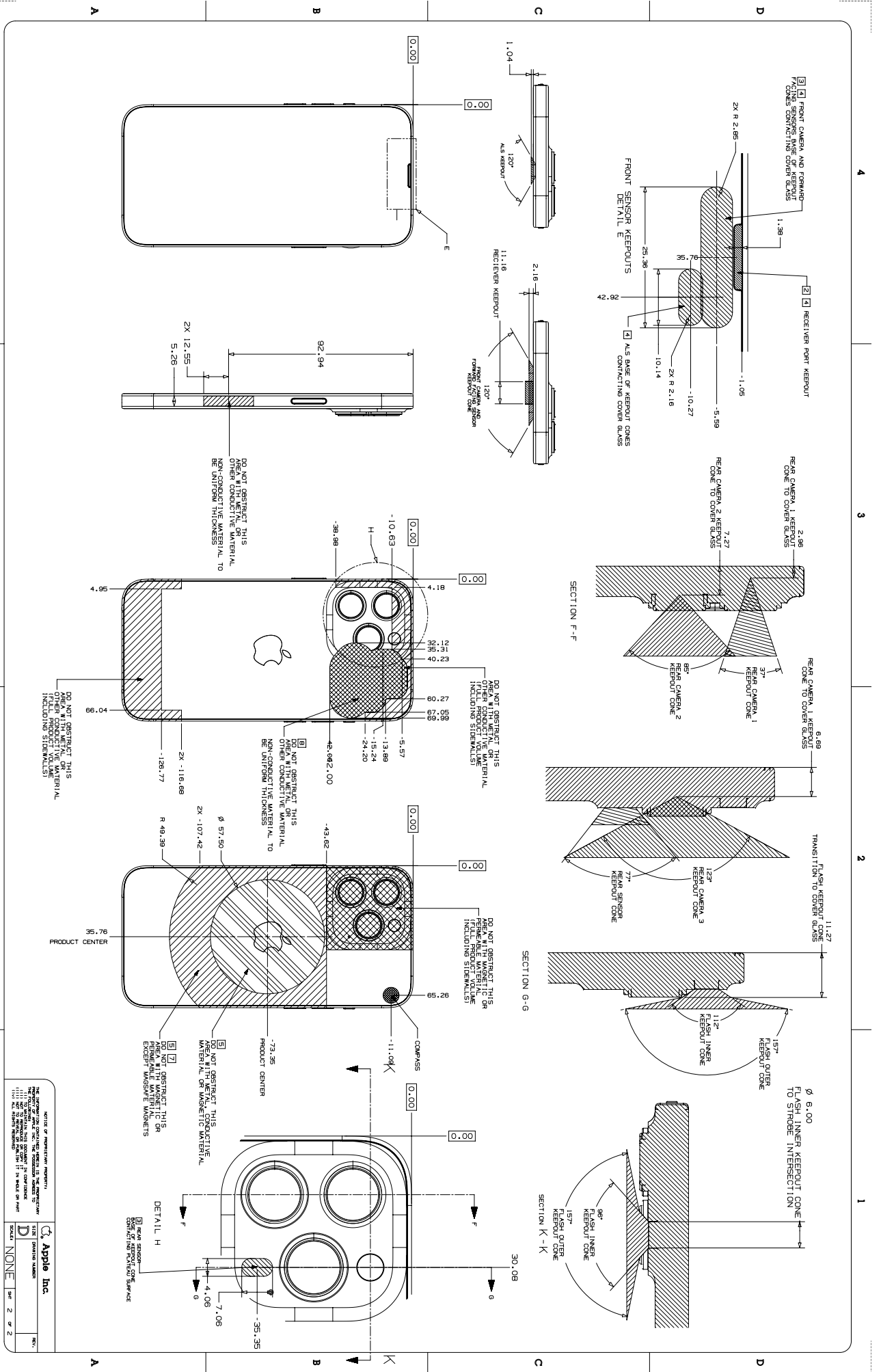
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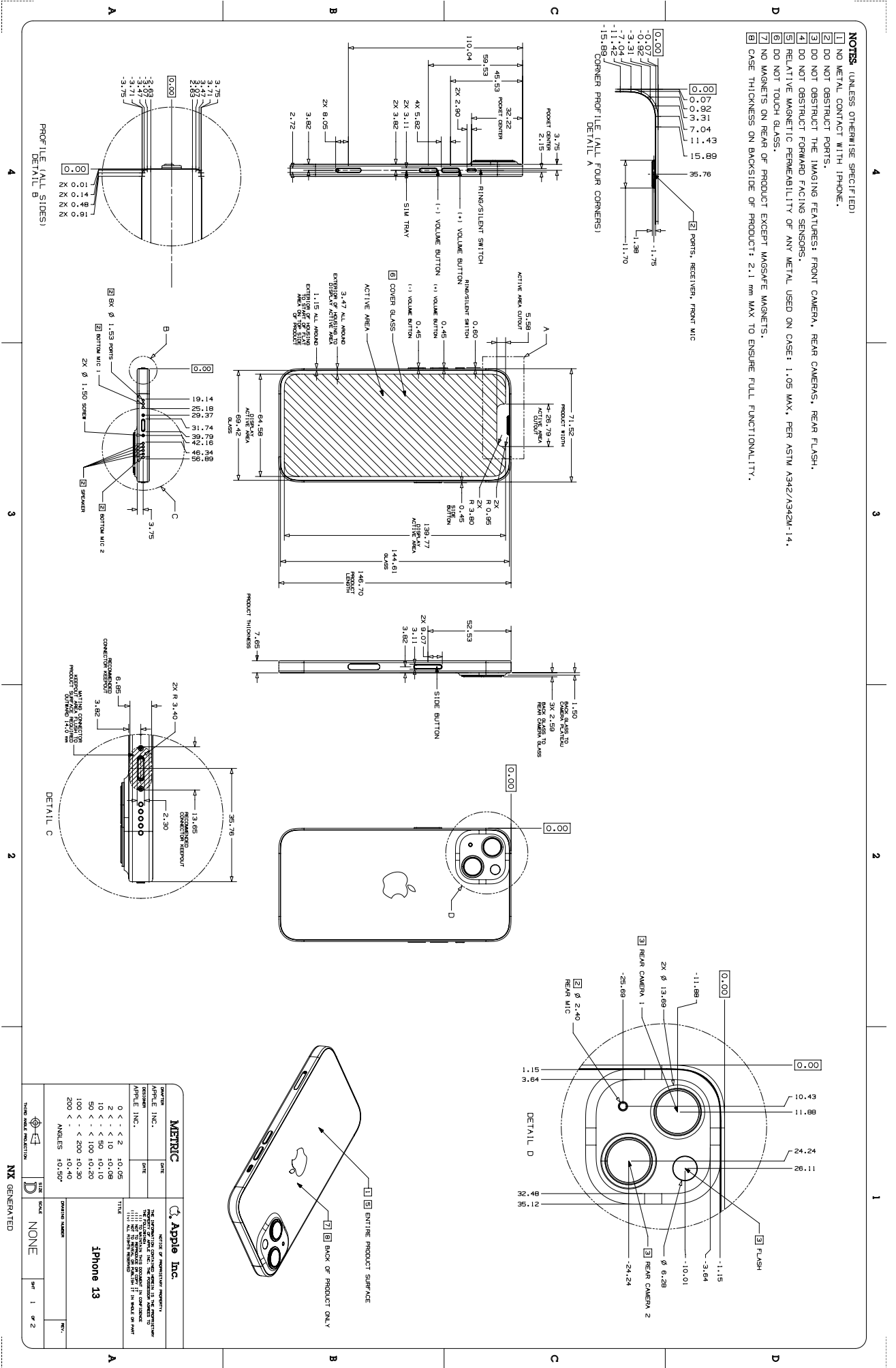


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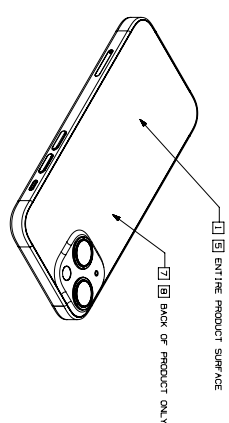
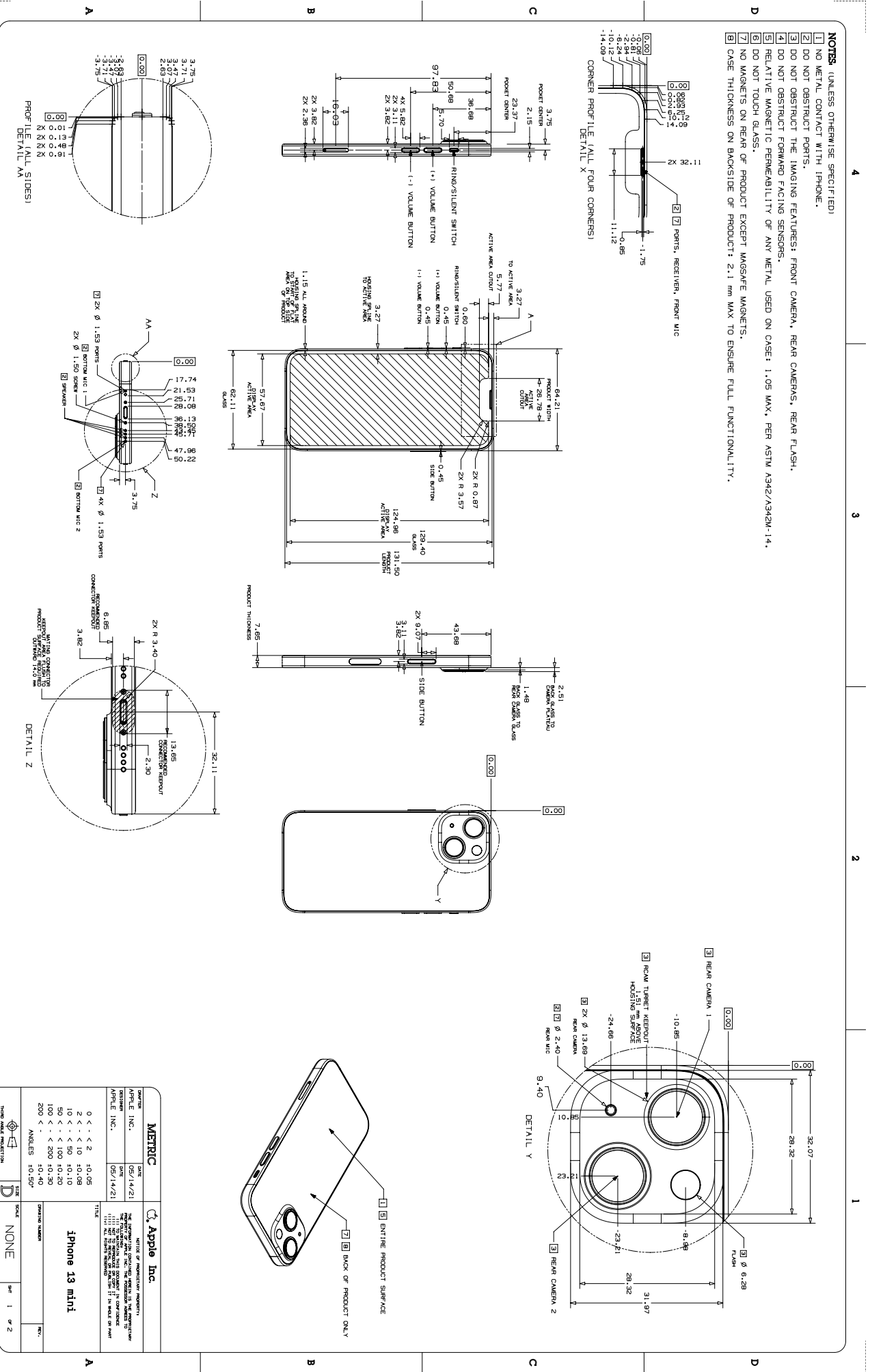
59.45 iPhone 13, 1 of 2



59.47 iPhone 13 mini, 1 of 2

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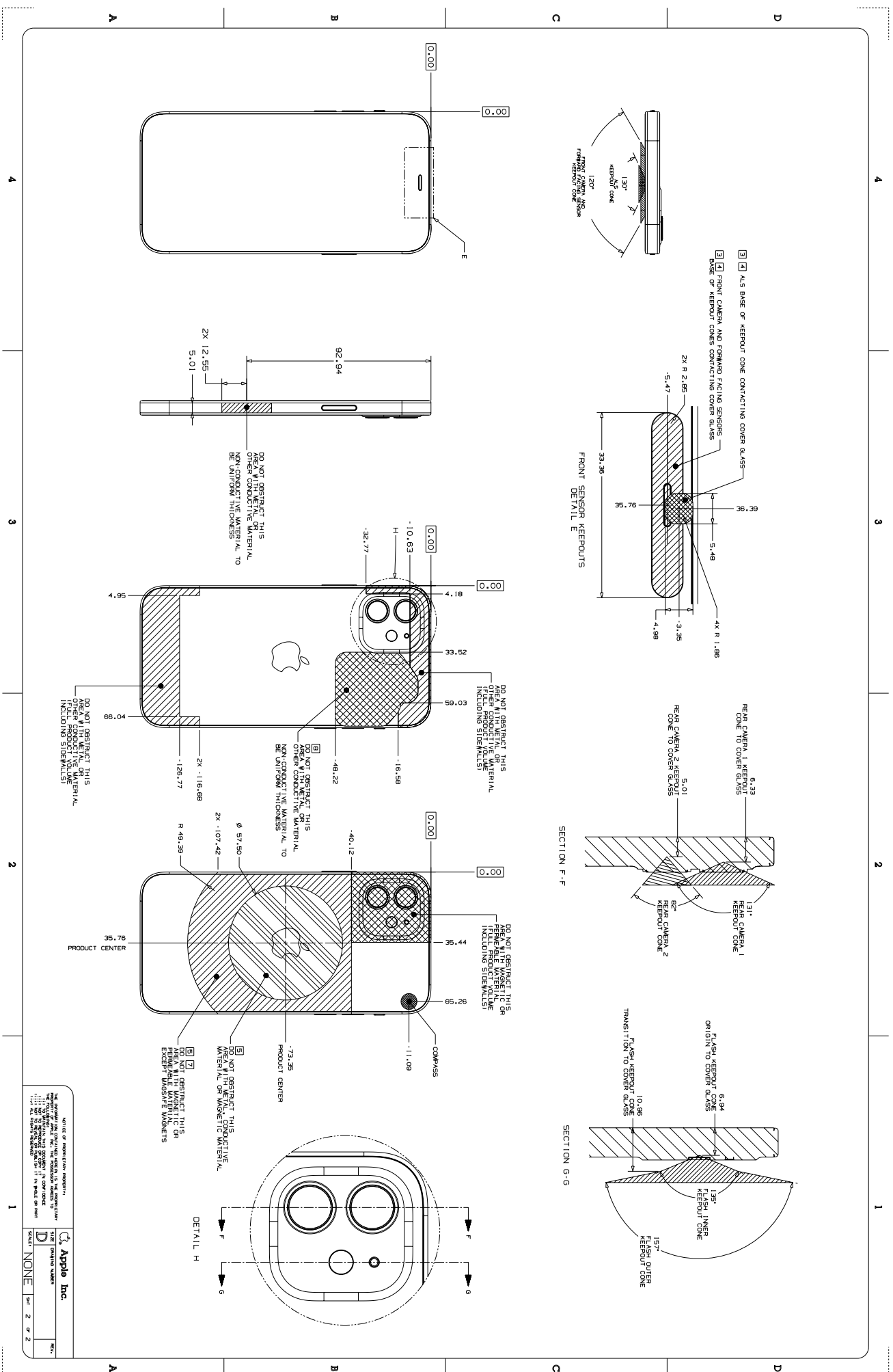


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SCALE	TITLE	DATE	BY	CHK
NONE	iPhone 13 mini	05/14/21		

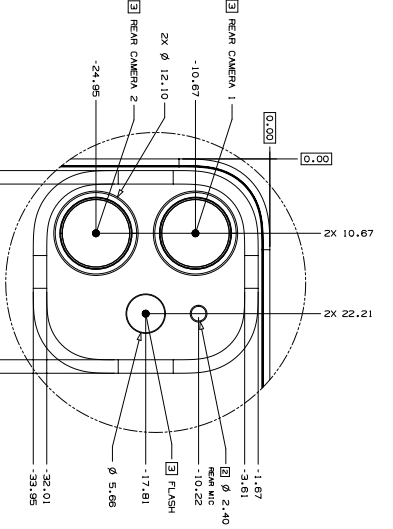
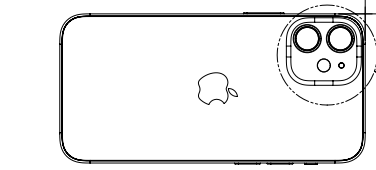
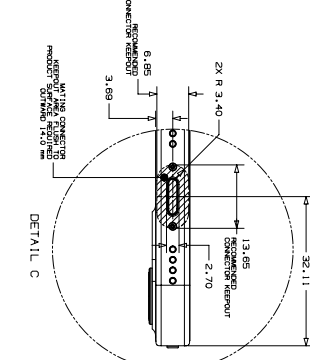
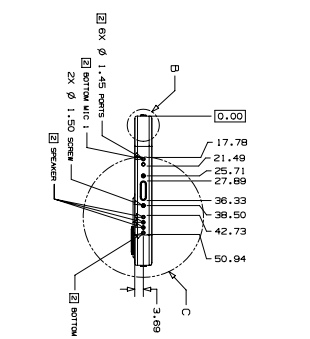
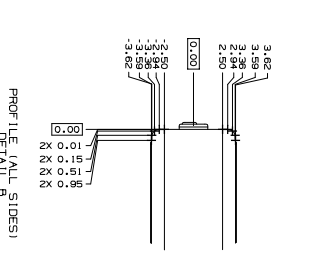
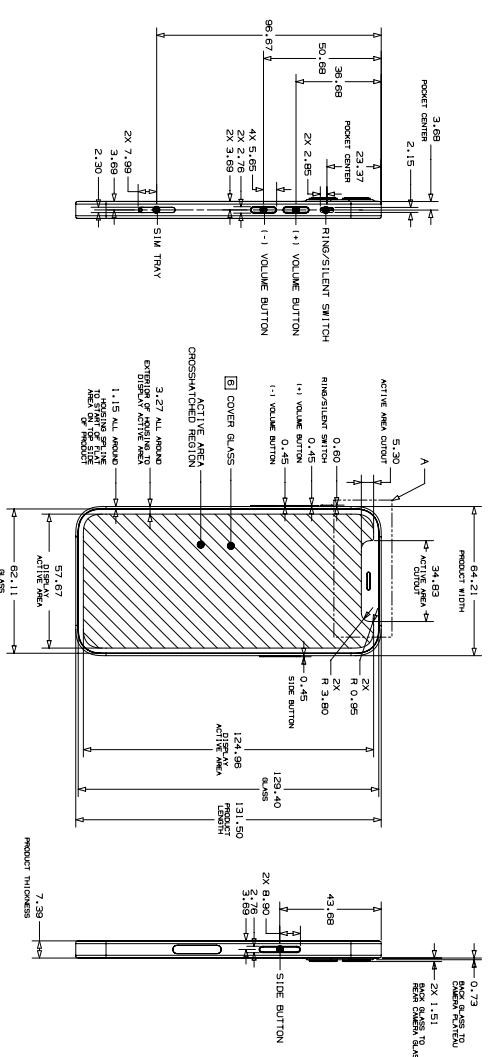
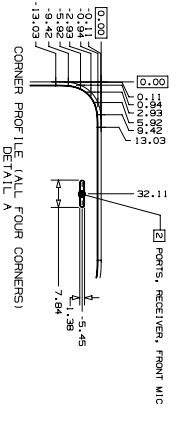
SCALE	TITLE	DATE	BY	CHK
NONE	iPhone 13 mini	05/14/21		

MX GENERATED



59.55 iPhone 12 mini, 1 of 2

- NOTES** (UNLESS OTHERWISE SPECIFIED)
- 1 NO METAL CONTACT WITH IPHONE.
 - 2 DO NOT OBSTRUCT PORTS.
 - 3 DO NOT OBSTRUCT THE IMAGING FEATURES: FRONT CAMERA, REAR CAMERAS, REAR FLASH.
 - 4 DO NOT OBSTRUCT FORWARD FACING SENSORS.
 - 5 RELATIVE MAGNETIC PERMEABILITY OF ANY METAL USED ON CASE: 1.05 MAX, PER ASTM A342/342M-14.
 - 6 DO NOT TOUCH GLASS.
 - 7 NO MAGNETS ON REAR OF PRODUCT EXCEPT MAGSAFE MAGNETS.
 - 8 CASE THICKNESS ON BACKSIDE OF PRODUCT: 2.1 mm MAX TO ENSURE FULL FUNCTIONALITY.

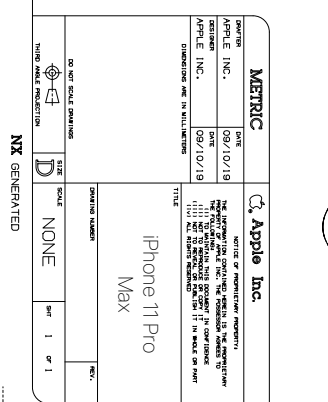
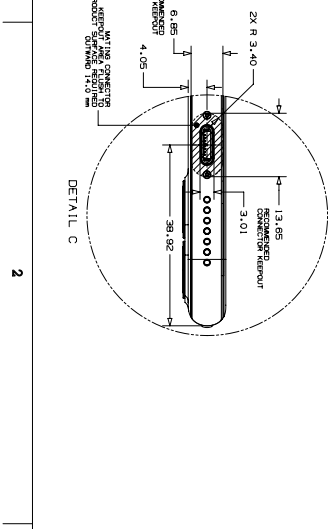
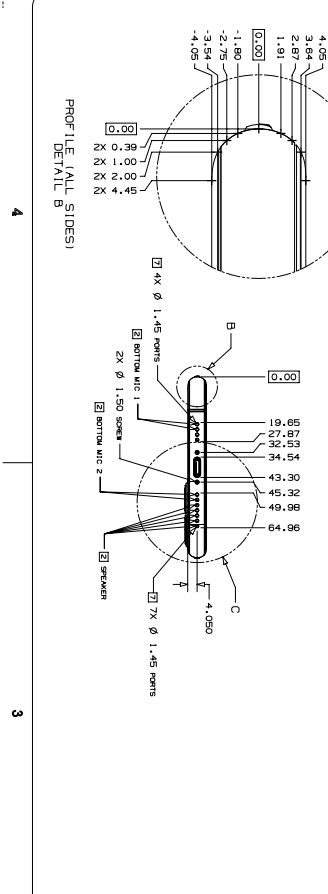
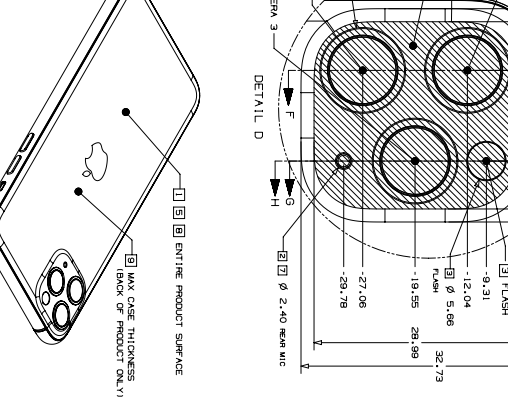
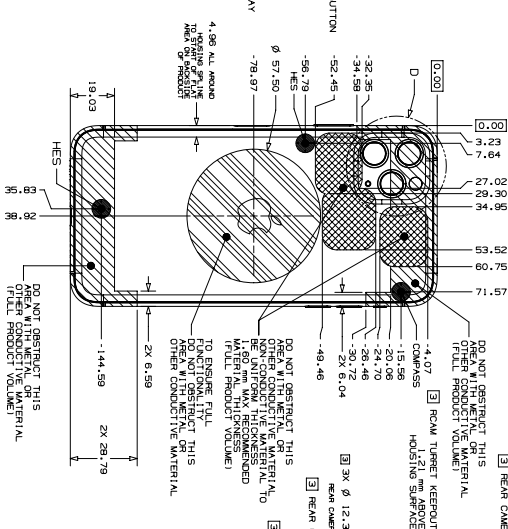
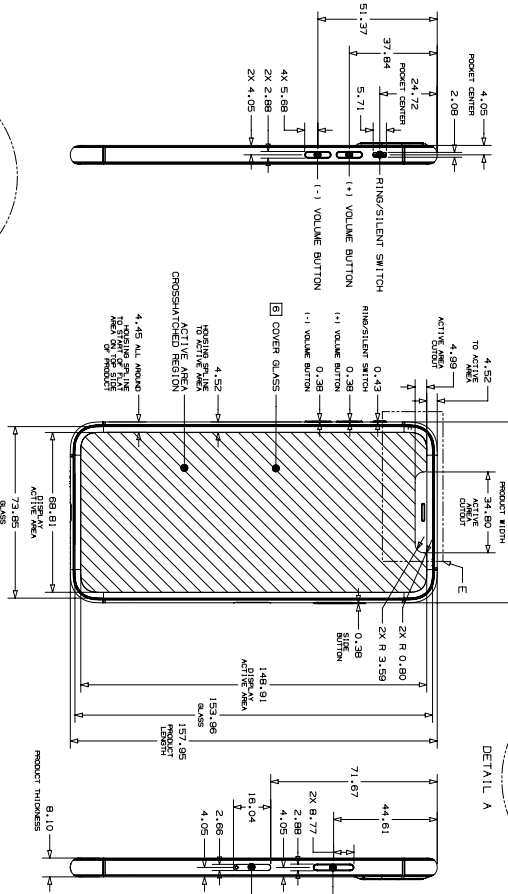
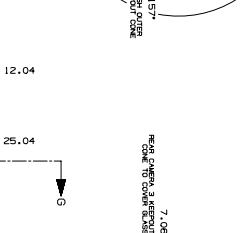
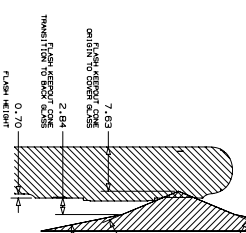
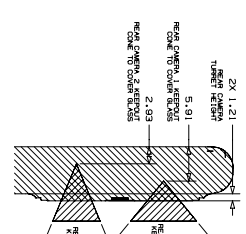
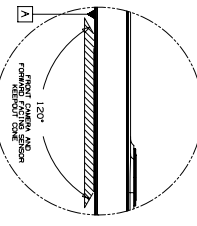
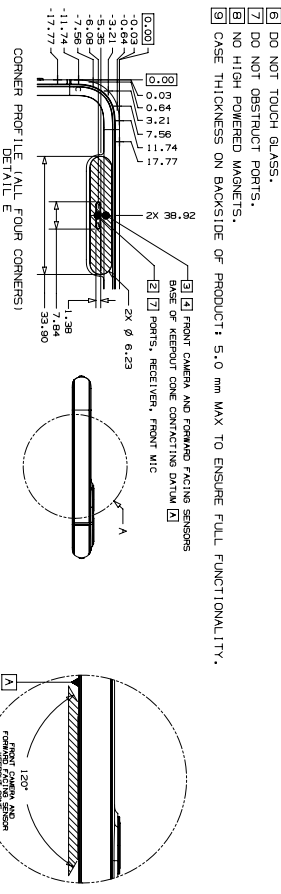


MTRRC		Apple Inc.	
DATE	10/19/20	DATE	10/19/20
APPROVED BY	[Signature]	DATE	10/19/20
DESIGNED BY	[Signature]	TITLE	iPhone 12 mini
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ORIGINATOR	Apple Inc.	SCALE	NONE
DATE GENERATED	10/19/20	SHR	1 of 2

59.58 iPhone 11 Pro Max

NOTES (UNLESS OTHERWISE SPECIFIED)

- 1 NO METAL CONTACT WITH IPHONE.
- 2 DO NOT OBSTRUCT THE ACOUSTIC OPENINGS: FRONT MIC, REAR MIC, BOTTOM MIC1, BOTTOM MIC2, RECEIVER AND SPEAKER.
- 3 DO NOT OBSTRUCT THE IMAGING FEATURES: FRONT CAMERA, REAR CAMERAS, REAR FLASH.
- 4 DO NOT OBSTRUCT FORWARD FACING SENSORS.
- 5 RELATIVE MAGNETIC PERMEABILITY OF ANY METAL USED ON CASE: 1.05 MAX, PER ASTM A342/A342M-14.
- 6 DO NOT TOUCH GLASS.
- 7 DO NOT OBSTRUCT PORTS.
- 8 NO HIGH POWERED MAGNETS.
- 9 CASE THICKNESS ON BACKSIDE OF PRODUCT: 5.0 mm MAX TO ENSURE FULL FUNCTIONALITY.

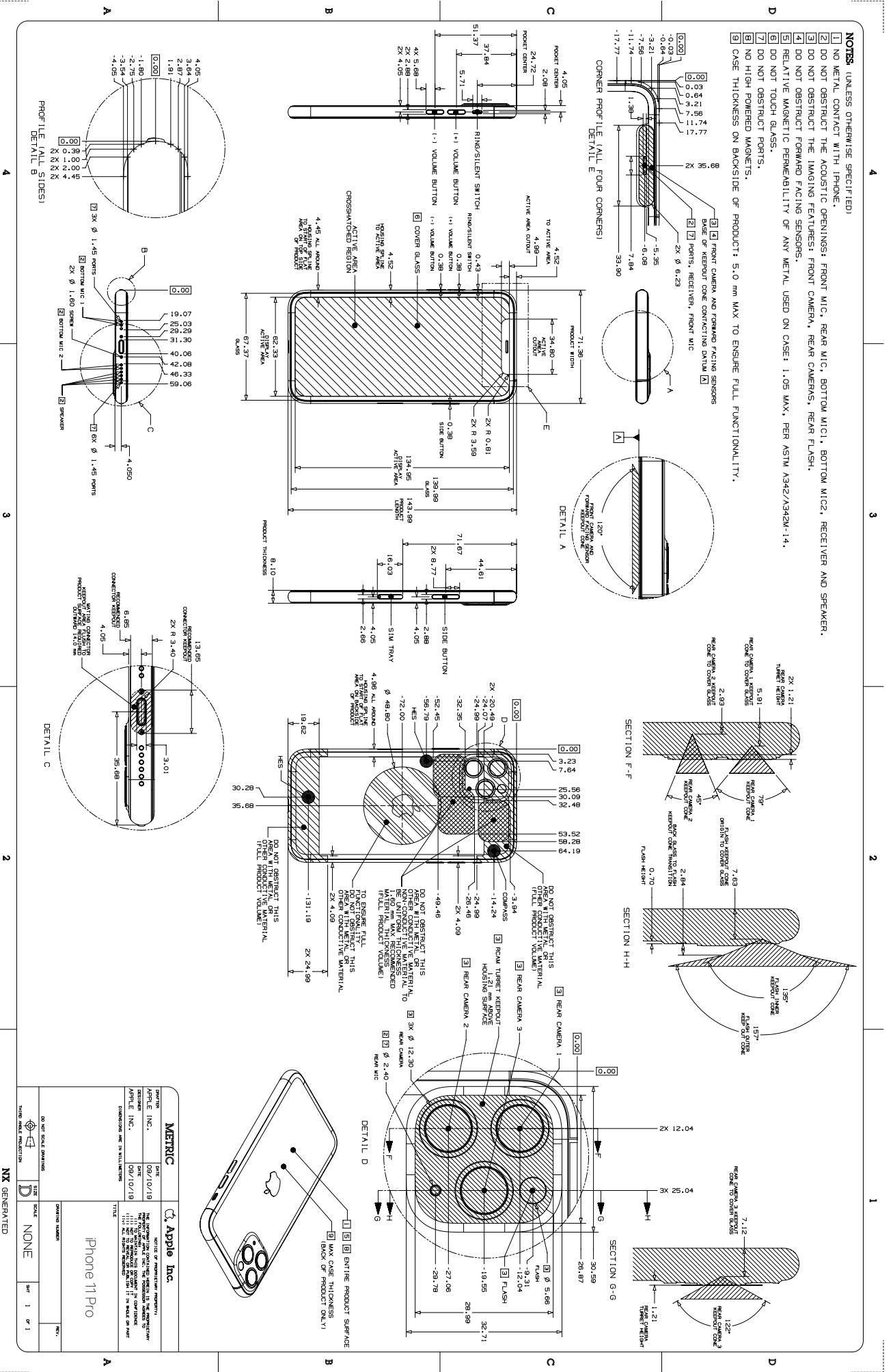


METRIC	DATE	SCALE	REV.
Apple Inc.	09/10/18	NONE	1 of 1
Apple Inc.	09/10/18	NONE	1 of 1
Apple Inc.	09/10/18	NONE	1 of 1

iPhone 11 Pro Max

NOTES (UNLESS OTHERWISE SPECIFIED)

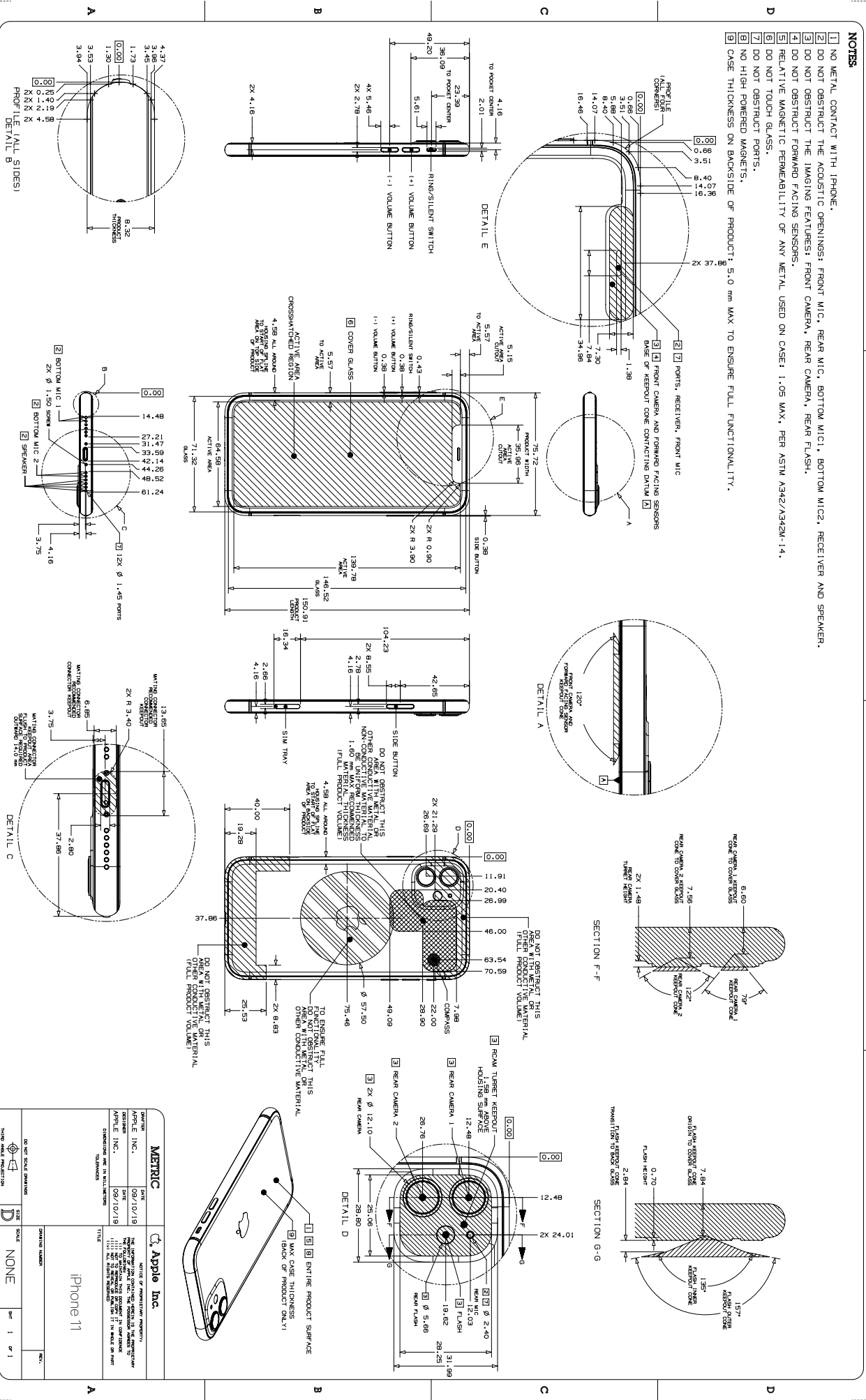
- 1 NO METAL CONTACT WITH IPHONE.
- 2 DO NOT OBSTRUCT THE ACOUSTIC OPENINGS: FRONT MIC, REAR MIC, BOTTOM MIC1, BOTTOM MIC2, RECEIVER AND SPEAKER.
- 3 DO NOT OBSTRUCT THE IMAGING FEATURES: FRONT CAMERA, REAR CAMERA, REAR FLASH.
- 4 DO NOT OBSTRUCT FORWARD FACING SENSORS.
- 5 RELATIVE MAGNETIC PERMEABILITY OF ANY METAL USED ON CASE: 1.05 MAX, PER ASTM A342/A342M-14.
- 6 DO NOT TOUCH GLASS.
- 7 DO NOT OBSTRUCT PORTS.
- 8 NO HIGH POWERED MAGNETS.
- 9 CASE THICKNESS ON BACKSIDE OF PRODUCT: 5.0 mm MAX TO ENSURE FULL FUNCTIONALITY.



METRIC		Apple Inc.	
DATE	SCALE	DATE	SCALE
09/10/19	D	09/10/19	NONE
09/10/19		09/10/19	

DO NOT SCALE DIMENSIONS
 DIMENSIONS ARE IN MILLIMETERS
 DRAWING NUMBER: iPhone 11 Pro
 SHEET: 1 OF 1
 NX GENERATED

- NOTES:**
- NO METAL CONTACT WITH IPHONE.
 - DO NOT OBSTRUCT THE ACOUSTIC OPENINGS: FRONT MIC, REAR MIC, BOTTOM MIC1, BOTTOM MIC2, RECEIVER AND SPEAKER.
 - DO NOT OBSTRUCT THE IMAGING FEATURES: FRONT CAMERA, REAR CAMERA, REAR FLASH.
 - DO NOT OBSTRUCT FORWARD FACING SENSORS.
 - RELATIVE MAGNETIC PERMEABILITY OF ANY METAL USED ON CASE: 1.05 MAX, PER ASTM A342/A342M-14.
 - DO NOT TOUGH GLASS.
 - DO NOT OBSTRUCT PORTS.
 - NO HIGH POWERED MAGNETS.
 - CASE THICKNESS ON BACKSIDE OF PRODUCT: 5.0 mm MAX TO ENSURE FULL FUNCTIONALITY.



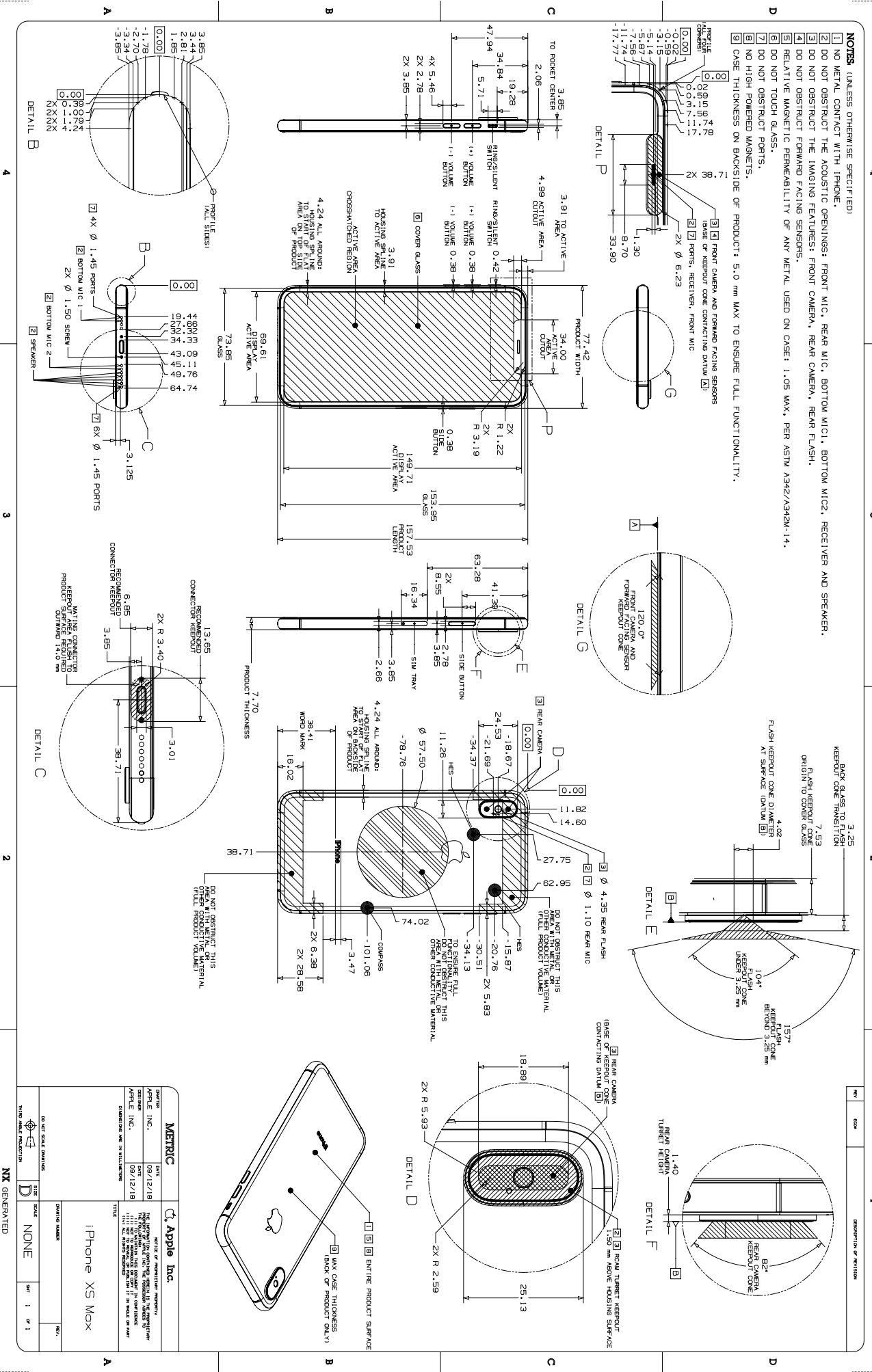
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DATE	VERSION	DATE	VERSION
09/10/18	1	09/10/18	1
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DRAWING NUMBER		TITLE	
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SCALE		REV.	
NONE		1 of 1	

MX GENERATED

59.61 iPhone XS Max

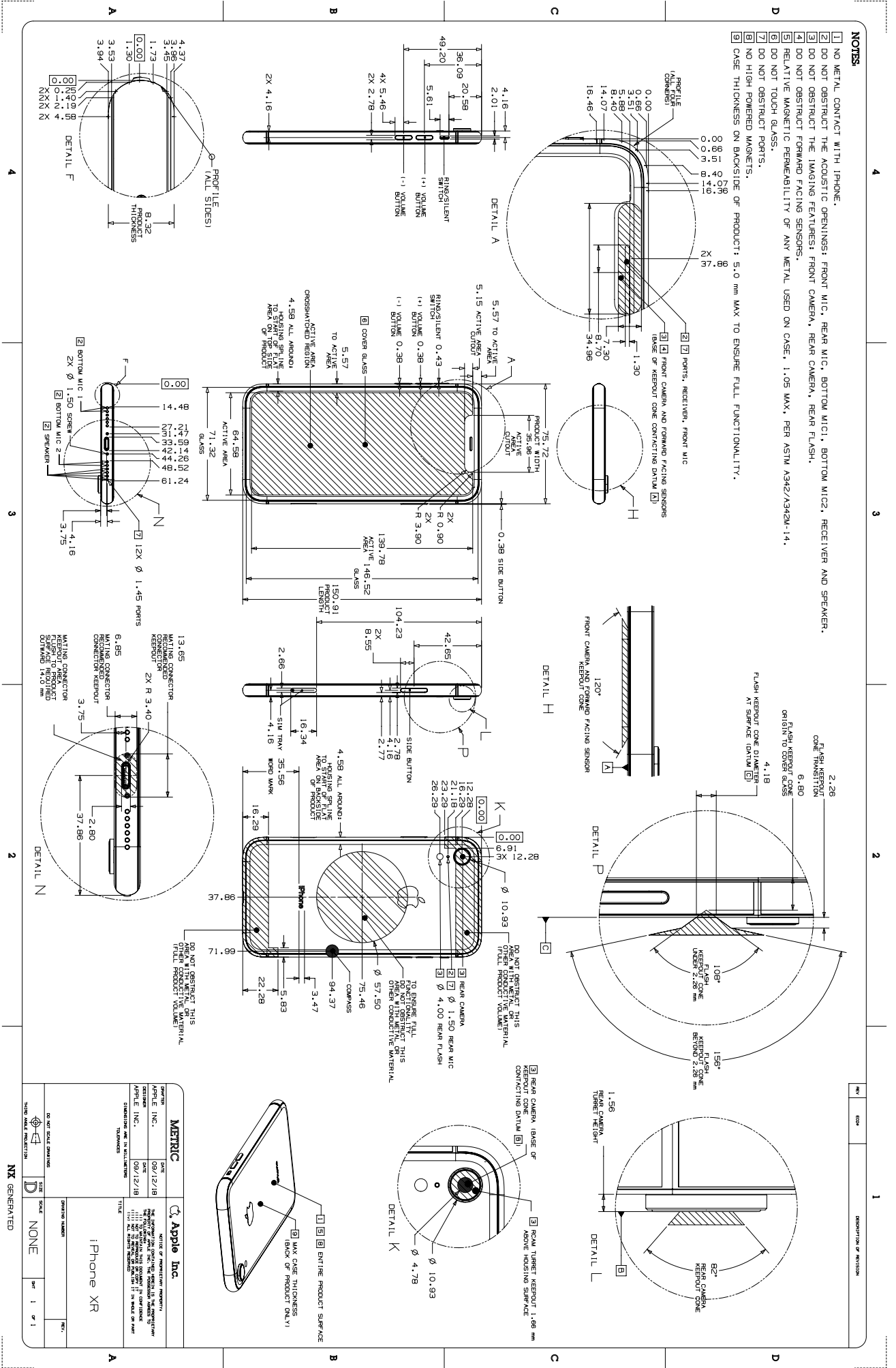
NOTES (UNLESS OTHERWISE SPECIFIED)

- 1 NO METAL CONTACT WITH IPHONE.
- 2 DO NOT OBSTRUCT THE ACOUSTIC OPENINGS: FRONT MIC, REAR MIC, BOTTOM MIC1, BOTTOM MIC2, RECEIVER AND SPEAKER.
- 3 DO NOT OBSTRUCT THE IMAGING FEATURES: FRONT CAMERA, REAR CAMERA, REAR FLASH.
- 4 DO NOT OBSTRUCT FORWARD FACING SENSORS.
- 5 RELATIVE MAGNETIC PERMEABILITY OF ANY METAL USED ON CASE: 1.05 MAX, PER ASTM A342/A342M-14.
- 6 DO NOT TOUCH GLASS.
- 7 DO NOT OBSTRUCT PORTS.
- 8 NO HIGH POWERED MAGNETS.
- 9 CASE THICKNESS ON BACKSIDE OF PRODUCT: 5.0 mm MAX TO ENSURE FULL FUNCTIONALITY.



59.63 iPhone XR

- NOTES:
- 1 NO METAL CONTACT WITH IPHONE.
 - 2 DO NOT OBSTRUCT THE ACOUSTIC OPENINGS: FRONT MIC, REAR MIC, BOTTOM MIC1, BOTTOM MIC2, RECEIVER AND SPEAKER.
 - 3 DO NOT OBSTRUCT THE IMAGING FEATURES: FRONT CAMERA, REAR CAMERA, REAR FLASH.
 - 4 DO NOT OBSTRUCT FORWARD FACING SENSORS.
 - 5 RELATIVE MAGNETIC PERMEABILITY OF ANY METAL USED ON CASE, 1.05 MAX, PER ASTM A342/A342M-14.
 - 6 DO NOT TOUCH GLASS.
 - 7 DO NOT OBSTRUCT PORTS.
 - 8 NO HIGH POWERED MAGNETS.
 - 9 CASE THICKNESS ON BACKSIDE OF PRODUCT: 5.0 mm MAX TO ENSURE FULL FUNCTIONALITY.



NO.	ECO	DESCRIPTION OF REVISION
1		

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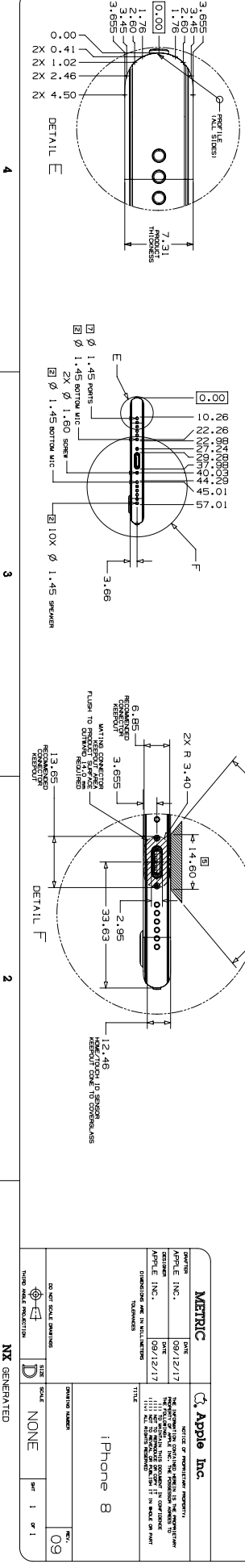
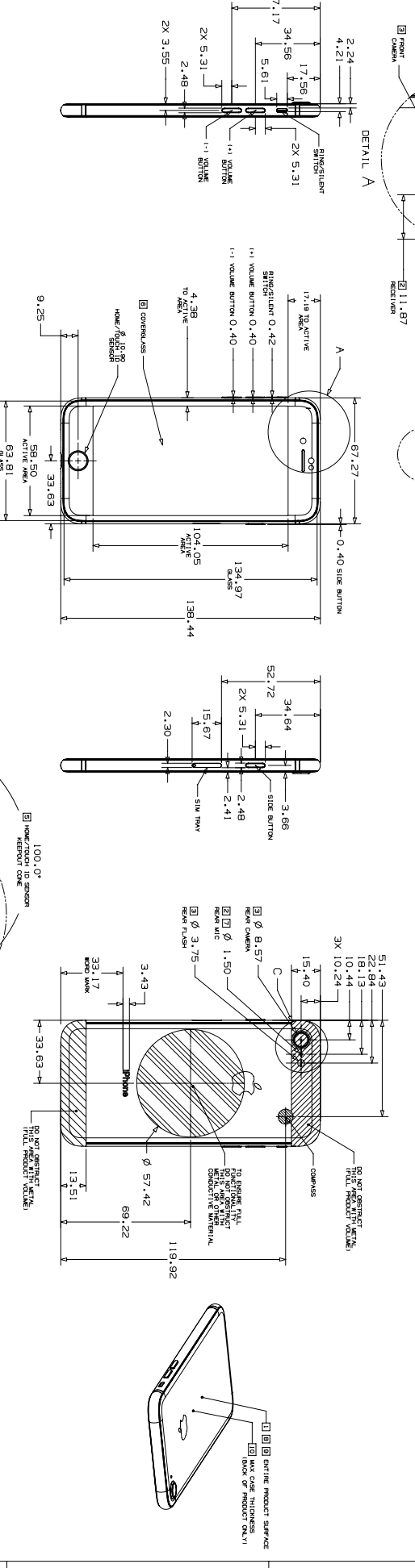
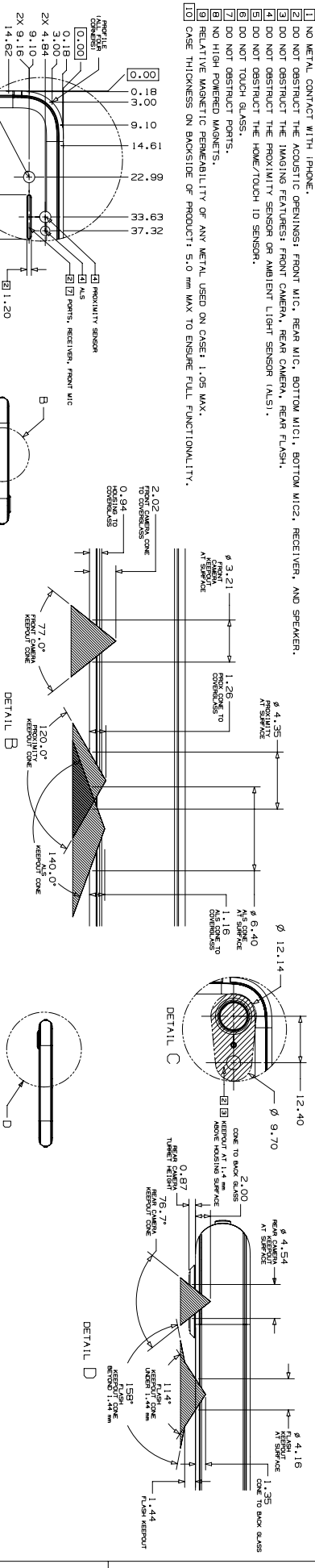
DO NOT SCALE DRAWING	DATE	DRAWING NUMBER
HIDE AND PROJECT	09/12/18	

Apple Inc. iPhone XR

NX GENERATED SHEET 1 OF 1

59.66 iPhone 8

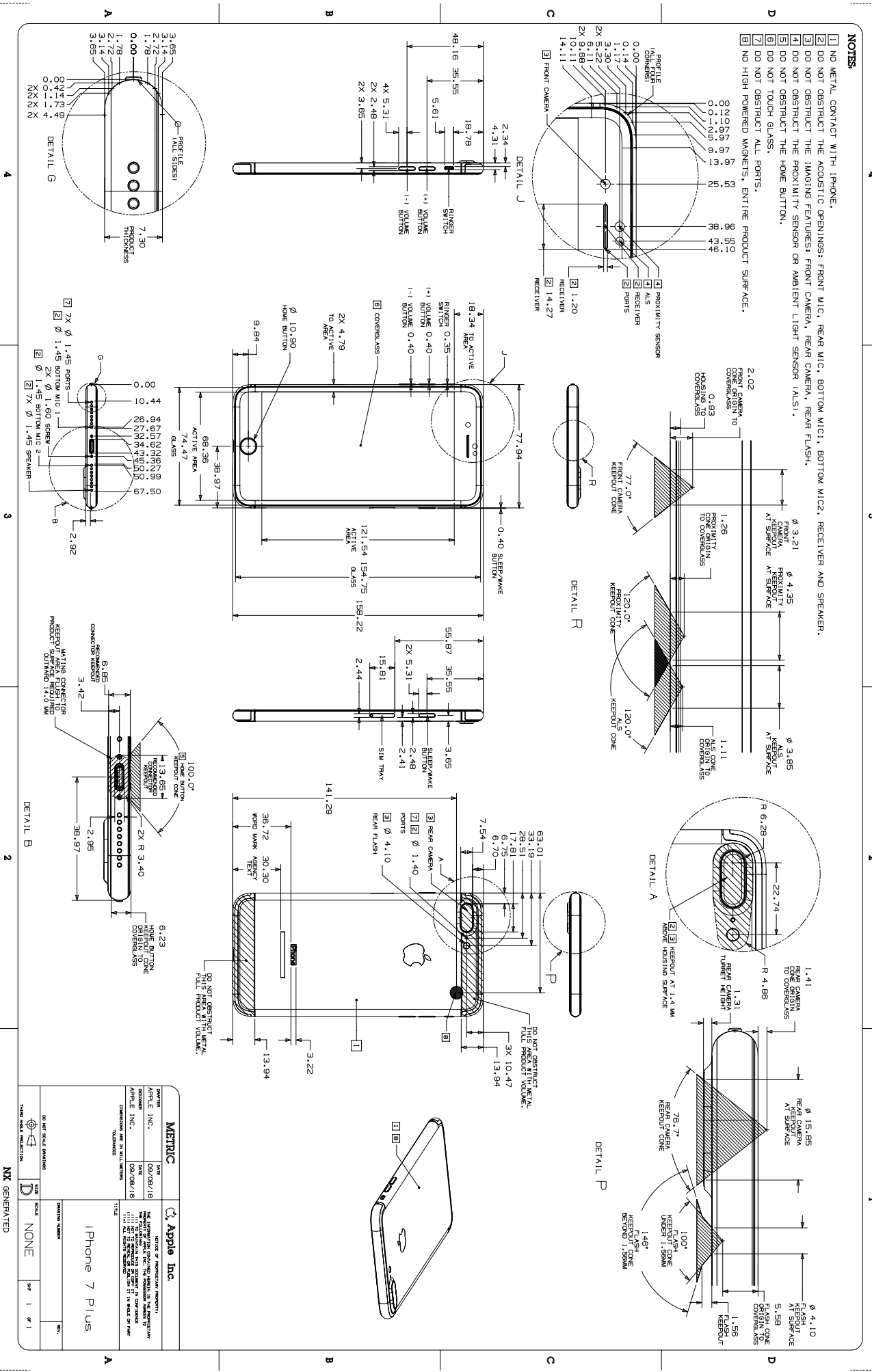
- NOTES:**
- 1 NO METAL CONTACT WITH IPHONE.
 - 2 DO NOT OBSTRUCT THE ACOUSTIC OPENINGS; FRONT MIC, REAR MIC, BOTTOM MIC2, RECEIVER, AND SPEAKER.
 - 3 DO NOT OBSTRUCT THE IMAGING FEATURES: FRONT CAMERA, REAR CAMERA, REAR FLASH.
 - 4 DO NOT OBSTRUCT THE PROXIMITY SENSOR OR AMBIENT LIGHT SENSOR (ALS).
 - 5 DO NOT OBSTRUCT THE HOME/TOUCH ID SENSOR.
 - 6 DO NOT TOUCH GLASS.
 - 7 DO NOT OBSTRUCT PORTS.
 - 8 NO HIGH POWERED MAGNETS.
 - 9 RELATIVE MAGNETIC PERMEABILITY OF ANY METAL USED ON CASE: 1.05 MAX.
 - 10 CASE THICKNESS ON BACKSIDE OF PRODUCT: 5.0 mm MAX TO ENSURE FULL FUNCTIONALITY.



METRIC		Apple Inc.	
DATE	09/12/17	DATE	09/12/17
DESIGNED BY	Apple Inc.	DESIGNED BY	Apple Inc.
CHECKED BY	Apple Inc.	CHECKED BY	Apple Inc.
DATE	09/12/17	DATE	09/12/17
TITLE	iPhone 8	TITLE	iPhone 8
DO NOT SCALE DIMENSIONS	DRG	SCALE	NONE
HIDE HIDDEN DIMENSIONS	DRG	SCALE	NONE
DATE	09/12/17	REV	1 OF 1

NOTES

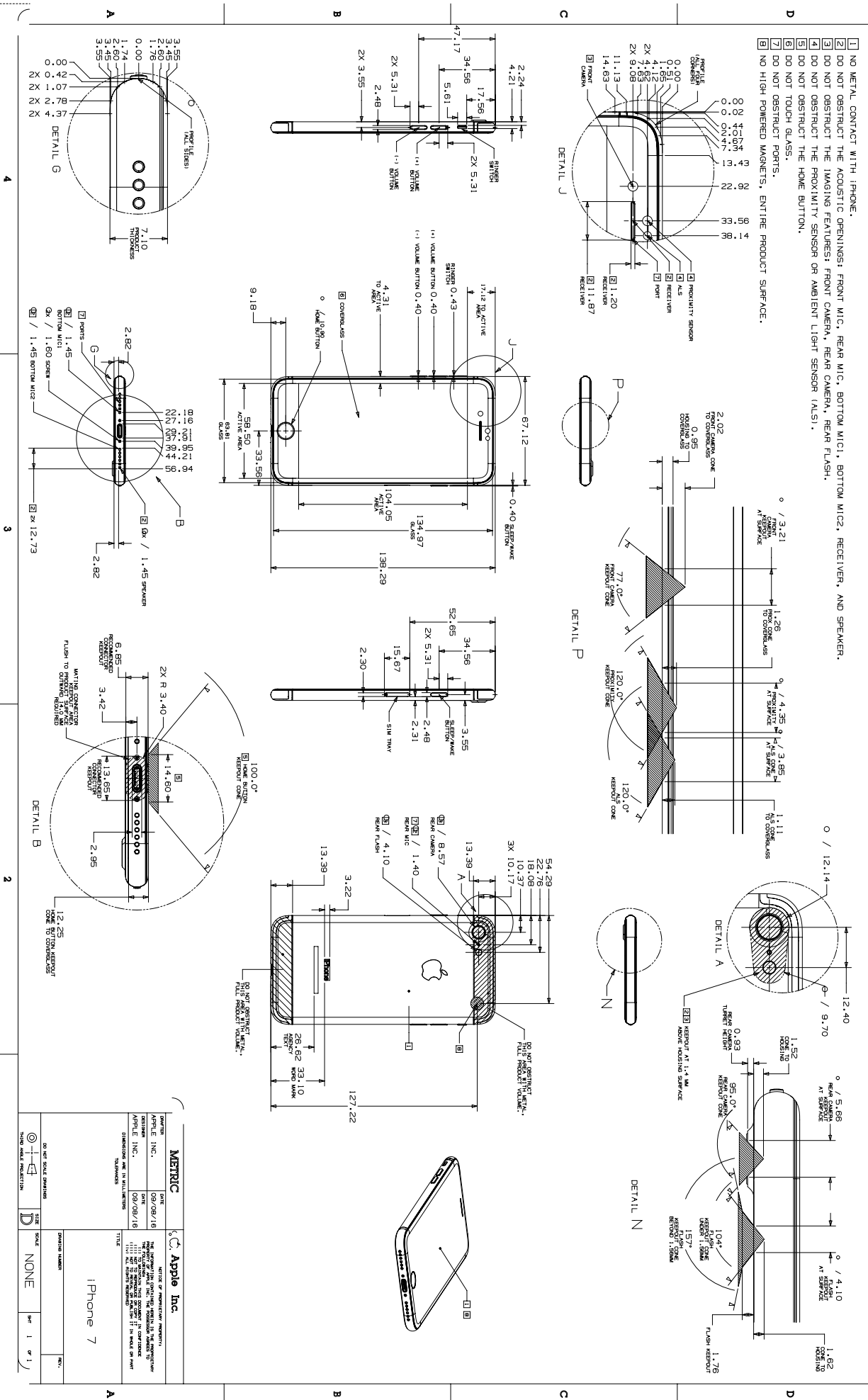
- 1 NO METAL CONTACT WITH IPHONE.
- 2 DO NOT OBSTRUCT THE ACOUSTIC OPENINGS; FRONT MIC, REAR MIC, BOTTOM MIC1, BOTTOM MIC2, RECEIVER AND SPEAKER.
- 3 DO NOT OBSTRUCT THE IMAGING FEATURES: FRONT CAMERA, REAR CAMERA, REAR FLASH.
- 4 DO NOT OBSTRUCT THE PROXIMITY SENSOR OR AMBIENT LIGHT SENSOR (ALS).
- 5 DO NOT OBSTRUCT THE HOME BUTTON.
- 6 DO NOT TOUCH GLASS.
- 7 DO NOT OBSTRUCT ALL PORTS.
- 8 NO HIGH POWERED MAGNETS, ENTIRE PRODUCT SURFACE.



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APPROVED BY	[Signature]	DATE	09/08/18
DESIGNED BY	[Signature]	DATE	09/08/18
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NO. OF CHANGES	1	DATE	09/08/18
NO. OF REVISIONS	1	DATE	09/08/18
NO. OF APPROVALS	1	DATE	09/08/18
NO. OF CHECKS	1	DATE	09/08/18
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NO. OF CALIBRATIONS	1	DATE	09/08/18
NO. OF VERIFICATIONS	1	DATE	09/08/18
NO. OF VALIDATIONS	1	DATE	09/08/18
iPhone 7 Plus			

NOTES

- 1 NO METAL CONTACT WITH IPHONE.
- 2 DO NOT OBSTRUCT THE ACOUSTIC OPENINGS: FRONT MIC, REAR MIC, BOTTOM MIC1, BOTTOM MIC2, RECEIVER, AND SPEAKER.
- 3 DO NOT OBSTRUCT THE IMAGING FEATURES: FRONT CAMERA, REAR CAMERA, REAR FLASH.
- 4 DO NOT OBSTRUCT THE PROXIMITY SENSOR OR AMBIENT LIGHT SENSOR (ALS).
- 5 DO NOT TOUCH GLASS.
- 6 DO NOT OBSTRUCT THE HOME BUTTON.
- 7 DO NOT OBSTRUCT PORTS.
- 8 NO HIGH POWERED MAGNETS, ENTIRE PRODUCT SURFACE.

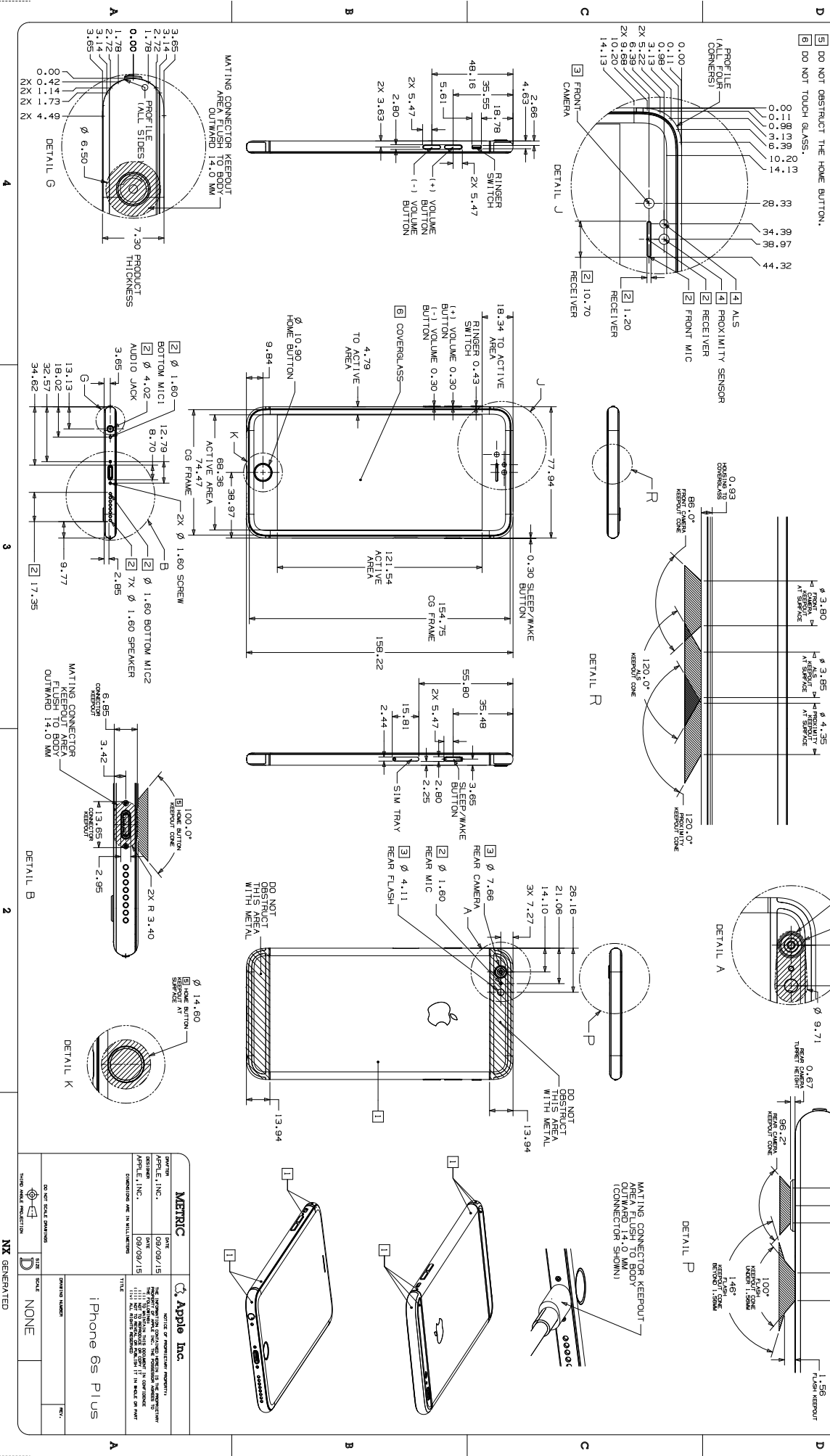


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DRAWN		TITLE	
NONE		iPhone 7	
<p>DO NOT SCALE DRAWINGS</p>			
SCALE	NONE	SHEET	1 OF 1

59.69 iPhone 6s Plus

NOTES

- 1 NO METAL CONTACT WITH ANY IPHONE METAL.
- 2 DO NOT OBSTRUCT THE ACOUSTIC OPENINGS: FRONT MIC, REAR MIC, BOTTOM MIC1, BOTTOM MIC2, RECEIVER AND SPEAKER.
- 3 DO NOT OBSTRUCT THE IMAGING FEATURES: FRONT CAMERA, REAR CAMERA, REAR FLASH.
- 4 DO NOT OBSTRUCT THE PROXIMITY SENSOR OR AMBIENT LIGHT SENSOR (ALS).
- 5 DO NOT OBSTRUCT THE HOME BUTTON.
- 6 DO NOT TOUCH GLASS.

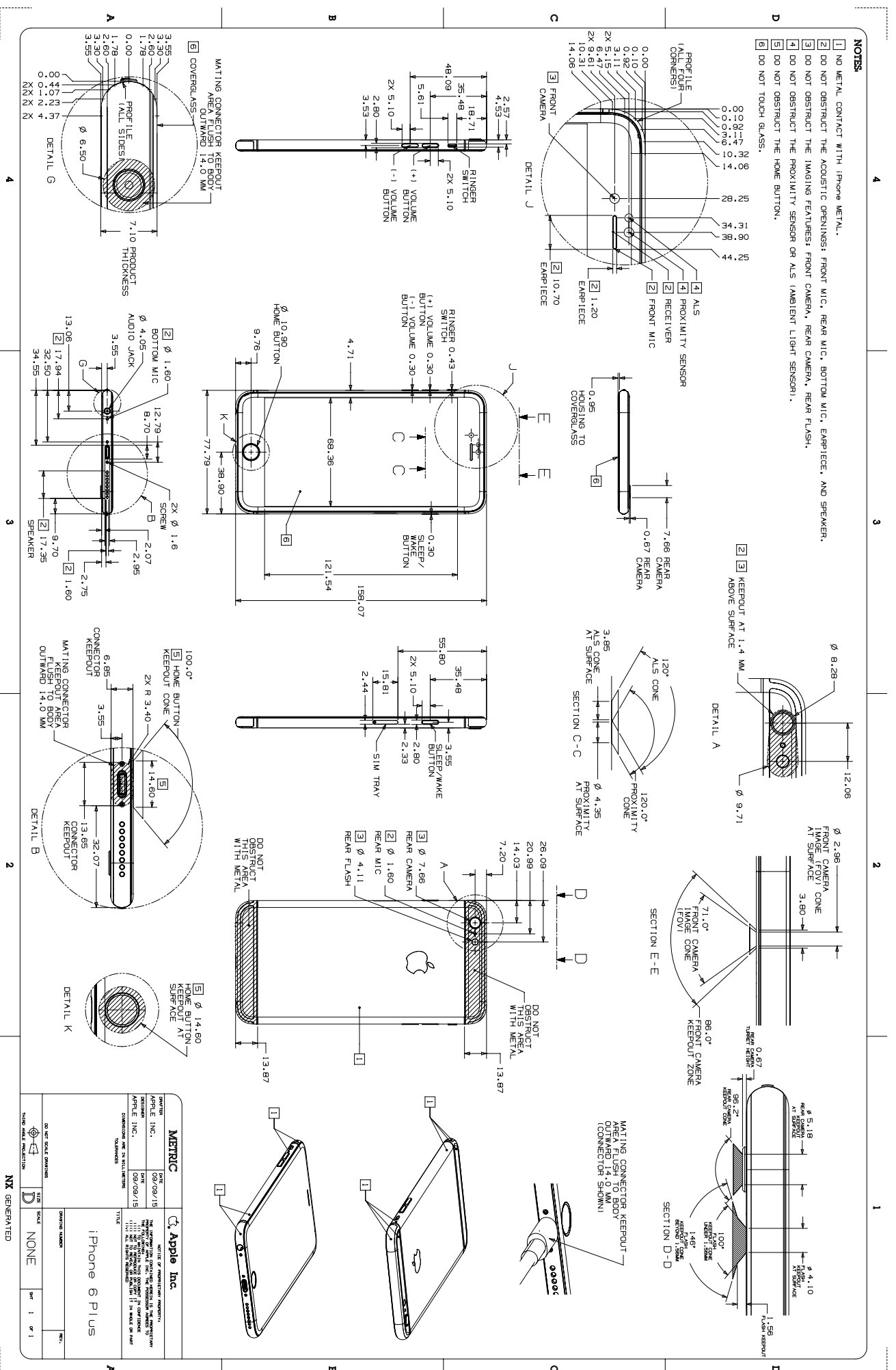


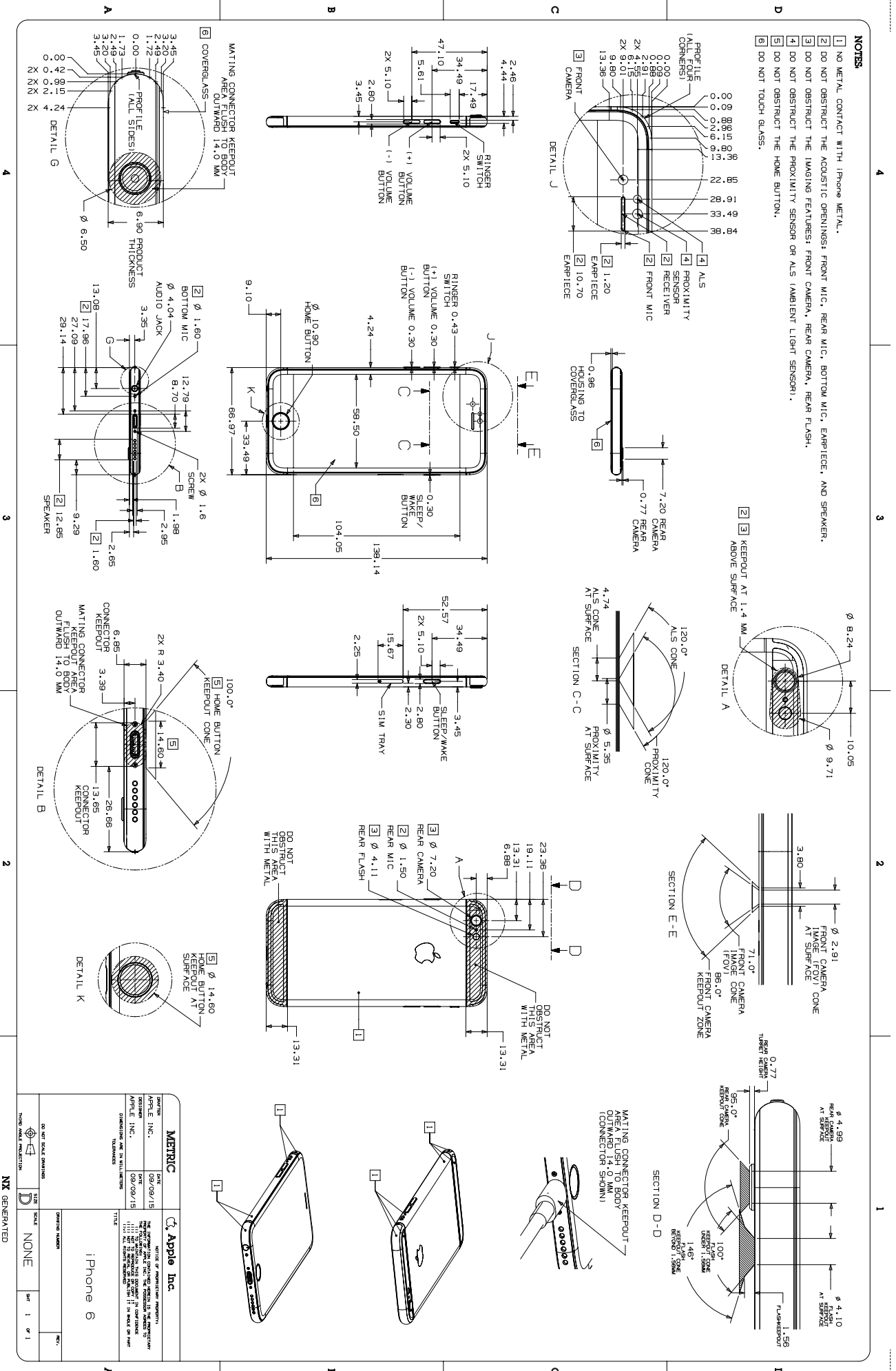
METRIC		Apple Inc.	
DATE	REV	DATE	REV
09/08/15		09/08/15	
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SCALE		REV.	
NONE			

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NOTES:

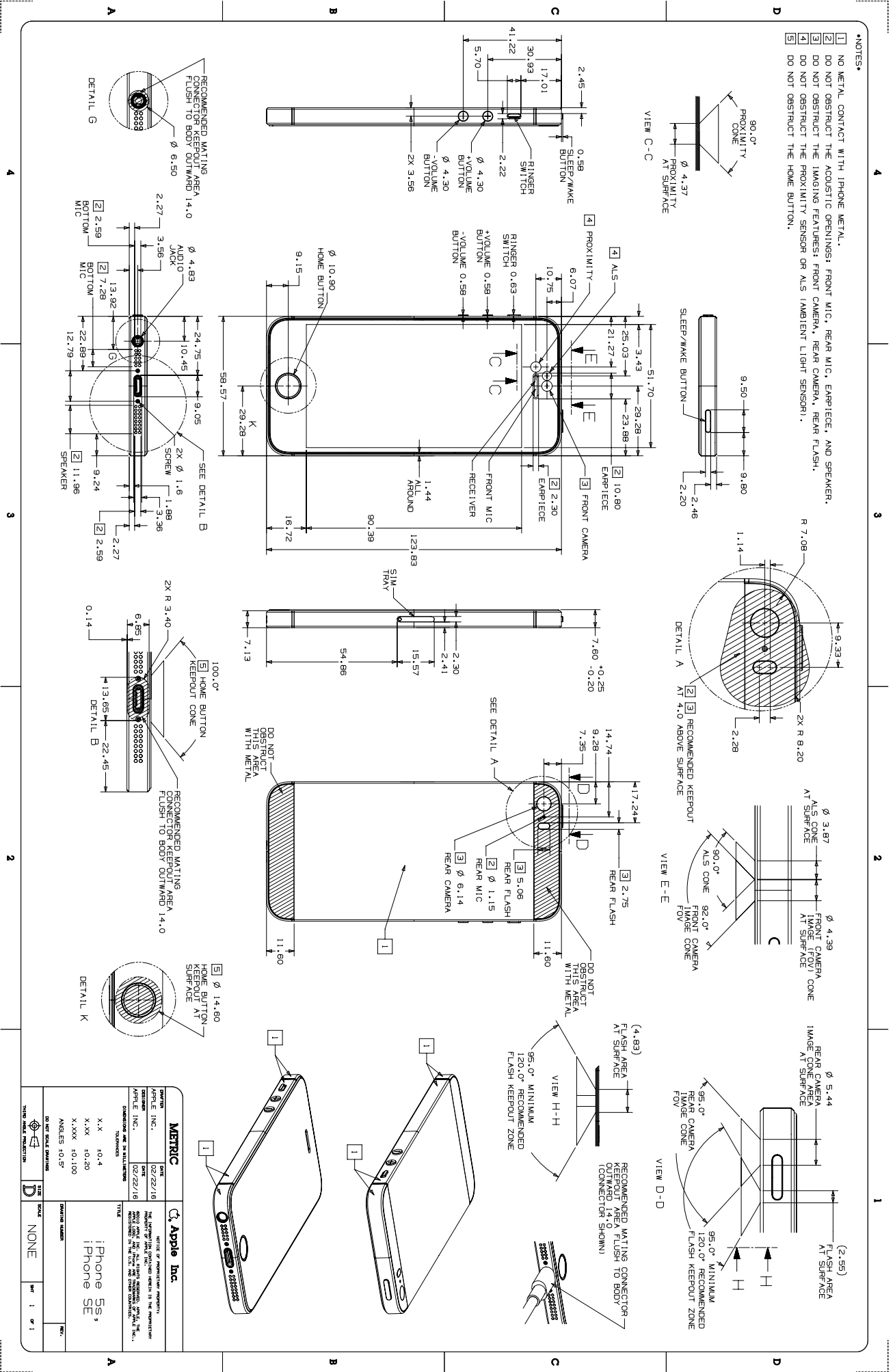
- 1 NO METAL CONTACT WITH iPhone METAL.
- 2 DO NOT OBSTRUCT THE ACOUSTIC OPENINGS: FRONT MIC, REAR MIC, BOTTOM MIC, EARRPIECE, AND SPEAKER.
- 3 DO NOT OBSTRUCT THE IMAGING FEATURES: FRONT CAMERA, REAR CAMERA, REAR FLASH.
- 4 DO NOT OBSTRUCT THE PROXIMITY SENSOR OR ALS (AMBIENT LIGHT SENSOR).
- 5 DO NOT OBSTRUCT THE HOME BUTTON.
- 6 DO NOT TOUCH GLASS.



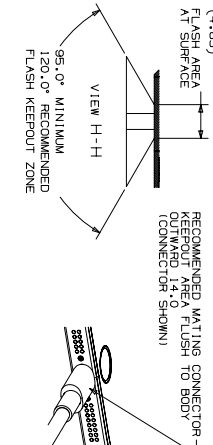
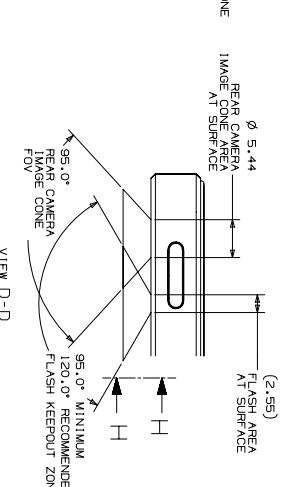
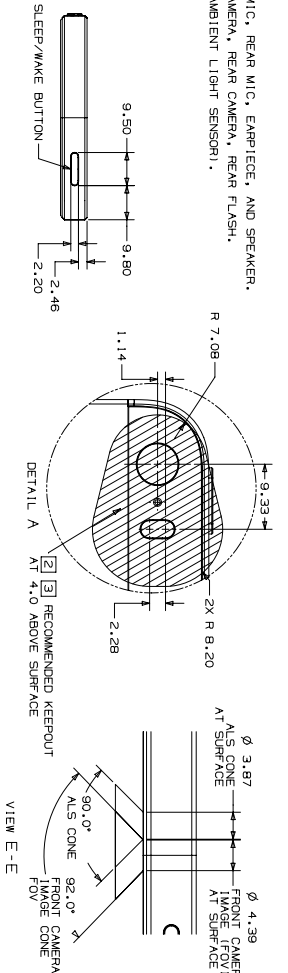


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DESIGNED BY	Apple Inc.	DATE	09/09/15
DESIGNED BY	Apple Inc.	DATE	09/09/15
DESIGNED BY	Apple Inc.	DATE	09/09/15
TITLE: iPhone 6			
DRAWING NUMBER: 59.72			
SCALE: NONE			
SHEET: 1 of 1			

59.73 iPhone 5s and iPhone SE



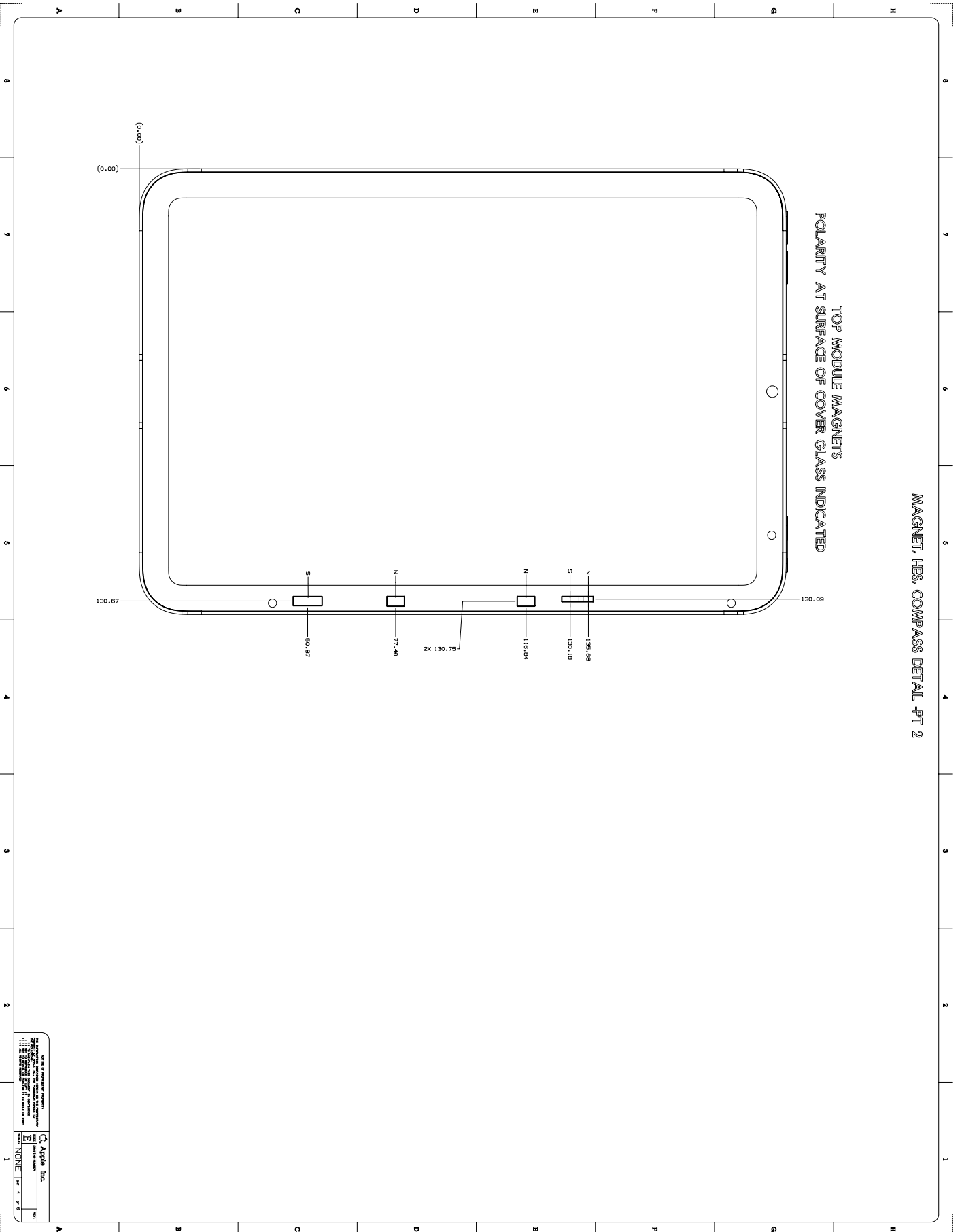
- 1 NO METAL CONTACT WITH IPHONE METAL.
- 2 DO NOT OBSTRUCT THE ACOUSTIC OPENINGS, FRONT MIC, REAR MIC, EARPIECE, AND SPEAKER.
- 3 DO NOT OBSTRUCT THE IMAGING FEATURES: FRONT CAMERA, REAR CAMERA, REAR FLASH.
- 4 DO NOT OBSTRUCT THE PROXIMITY SENSOR OR ALS (AMBIENT LIGHT SENSOR).
- 5 DO NOT OBSTRUCT THE HOME BUTTON.



METRIC	DATE	DESCRIPTION
APPLE INC.	02/22/16	DATE
APPLE INC.	02/22/16	DATE
APPLE INC.	02/22/16	DATE
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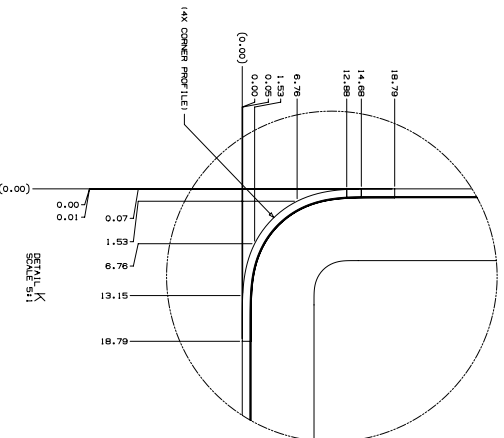
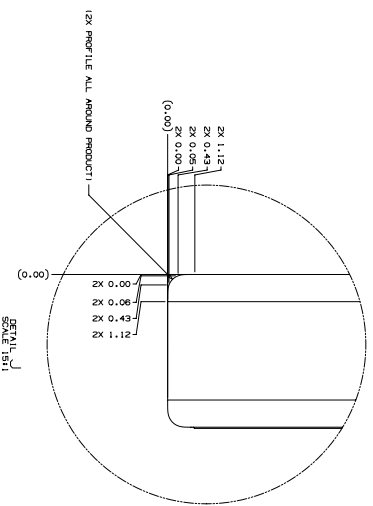
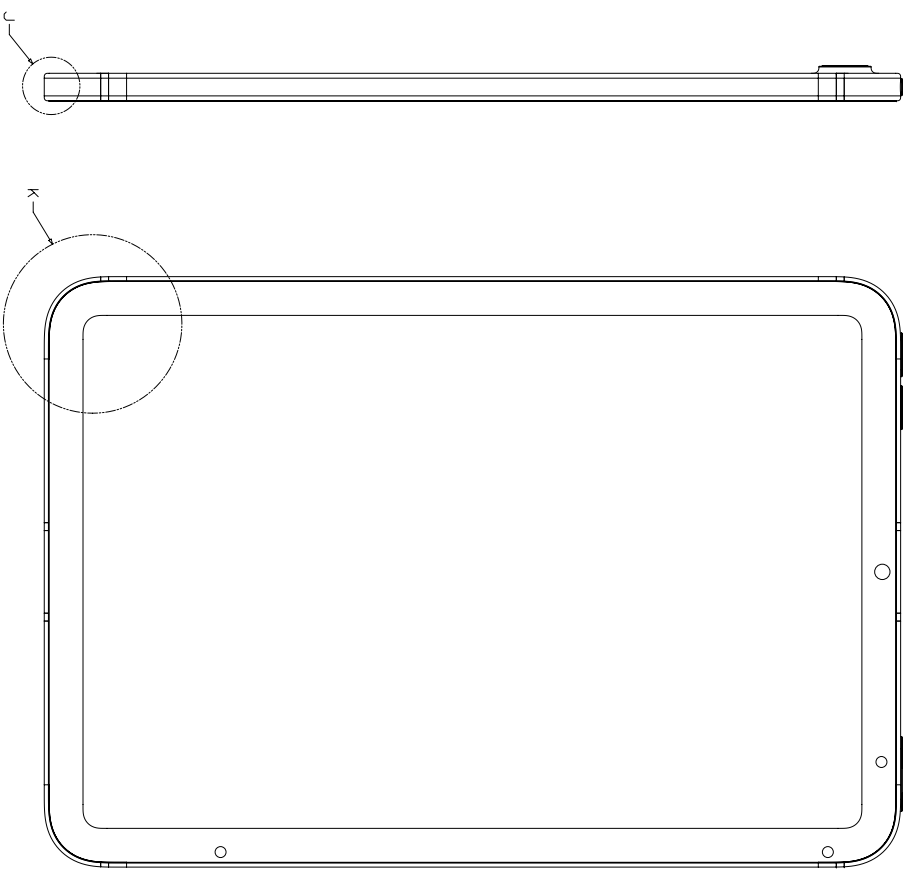
59.79 iPad mini (A17 Pro), 4 of 6

MAGNET, HES, COMPASS DETAIL -PT 2



59.80 iPad mini (A17 Pro), 5 of 6

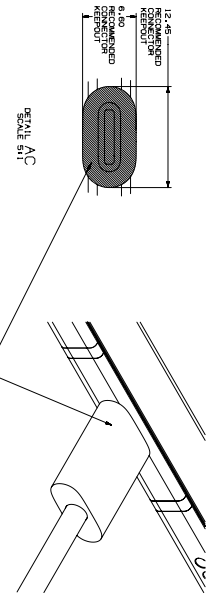
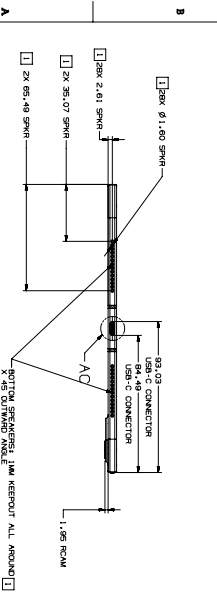
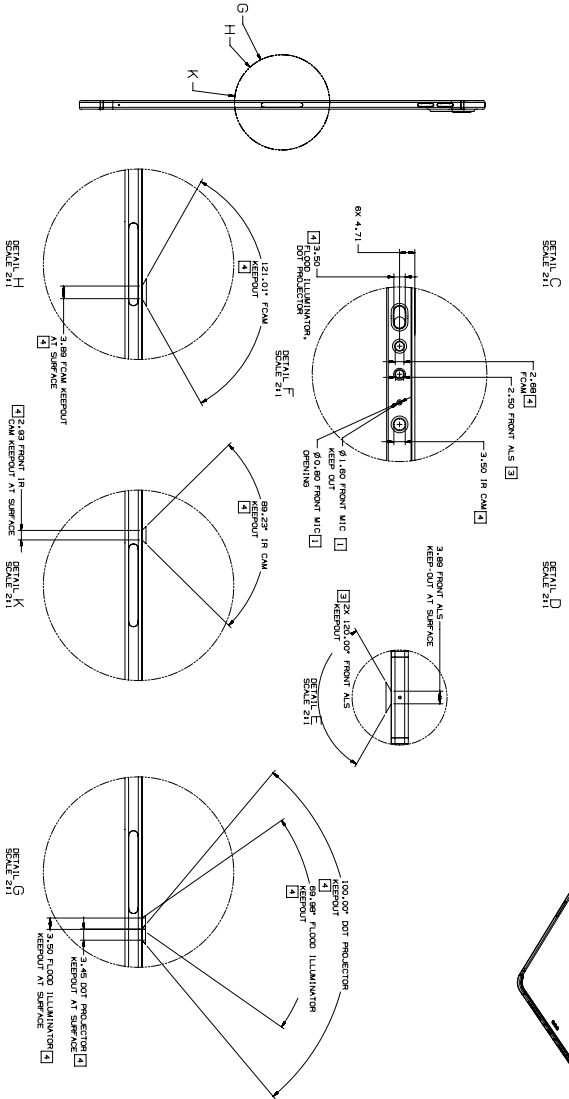
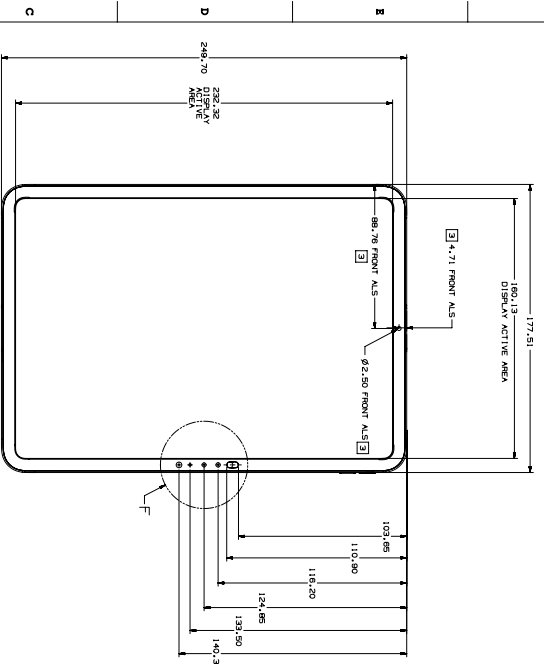
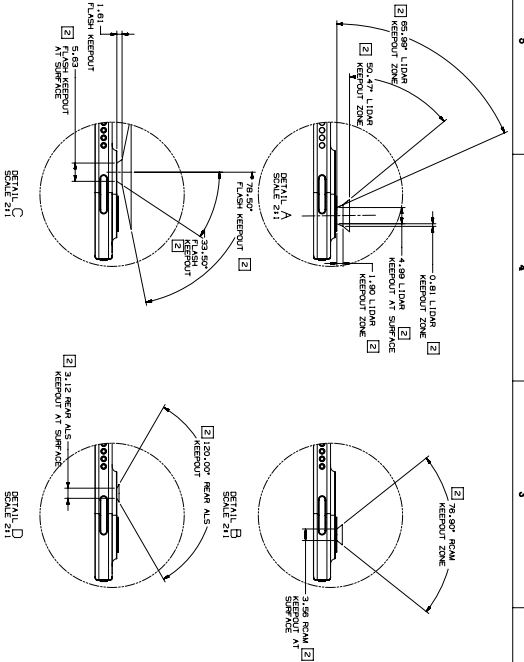
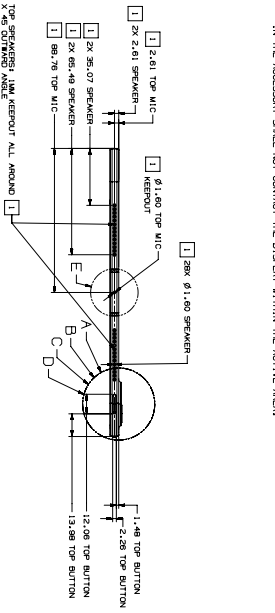
PROFILE DETAIL



Apple Inc.	
Model	A17 Pro
Part Number	59.80
Revision	1
Material	Aluminum
Color	Space Gray
Finish	Brushed
Weight	158.5g
Dimensions	119.5 x 84.8 x 6.4mm
Notes	See drawing for dimensions and tolerances.

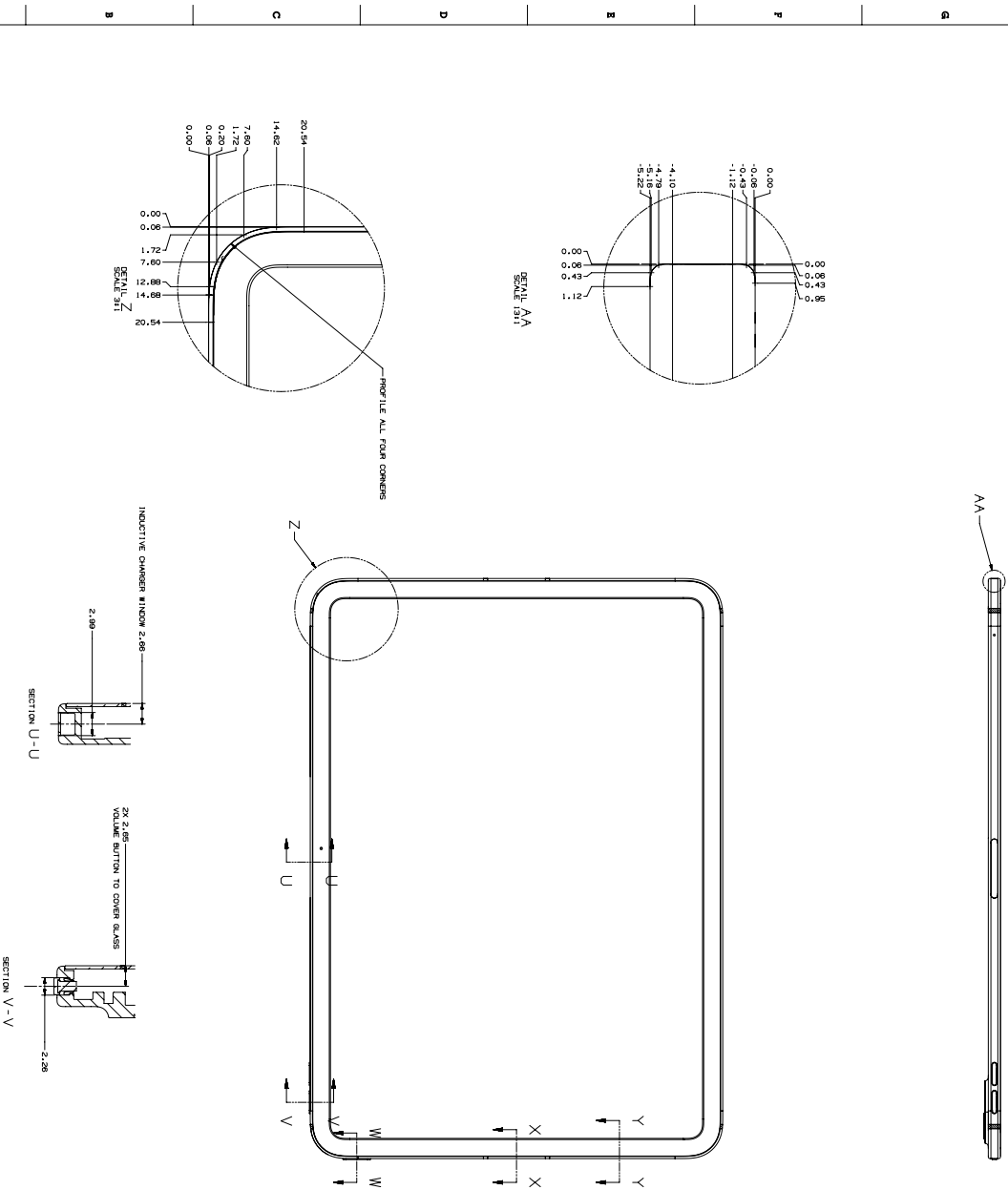
NOTES UNLESS OTHERWISE SPECIFIED:

- 1 DO NOT OBSTRUCT ACOUSTIC OPENINGS TOP MIC, SIDE MIC, FRONT MIC, REAR MIC, SPEAKERS (SPKR), MICROPHONE ARRAY (MIC ARR), IR CAM, FLUO ILLUMINATOR, & DOT PROJECTOR
- 2 DO NOT OBSTRUCT AMBIENT LIGHT SENSOR (ALS)
- 3 DO NOT OBSTRUCT FRONT CAMERA (FCAM), REAR LIDAR, & REAR AMBIENT LIGHT SENSOR (ALS)
- 4 ACCESSORY SHALL NOT DAMAGE COATINGS ON DISPLAY IN ANY OPERATING CONDITION.
- 5 ACCESSORY SHALL NOT DAMAGE COATINGS ON DISPLAY IN ANY OPERATING CONDITION.
- 6 REACTIVE SPEAKERS AND SENSORS CANNOT BE PLACED IN CONTACT WITH THE ACTIVE AREA OF THE ACCESSORY SHALL NOT CONTACT THE DISPLAY WITHIN THE ACTIVE AREA.



METRIC		Apple Inc.	
DATE	2024 10 21	REV	0
DESCRIPTION	iPad Pro 11-inch (M4)		
DESIGNED BY	Apple Inc.	CHECKED BY	Apple Inc.
ENGINEERED BY	Apple Inc.	APPROVED BY	Apple Inc.
THE INFORMATION CONTAINED HEREIN IS UNCLASSIFIED EXCEPT WHERE SHOWN OTHERWISE. UNCLASSIFIED//FOR OFFICIAL USE ONLY			
THIS DRAWING IS THE PROPERTY OF APPLE INC. IT IS TO BE USED ONLY FOR THE PROJECT AND FOR THE PURPOSE SPECIFIED. IT IS NOT TO BE REPRODUCED, COPIED, OR DISTRIBUTED IN ANY MANNER WITHOUT THE WRITTEN PERMISSION OF APPLE INC.			
SCALE: 1:1			

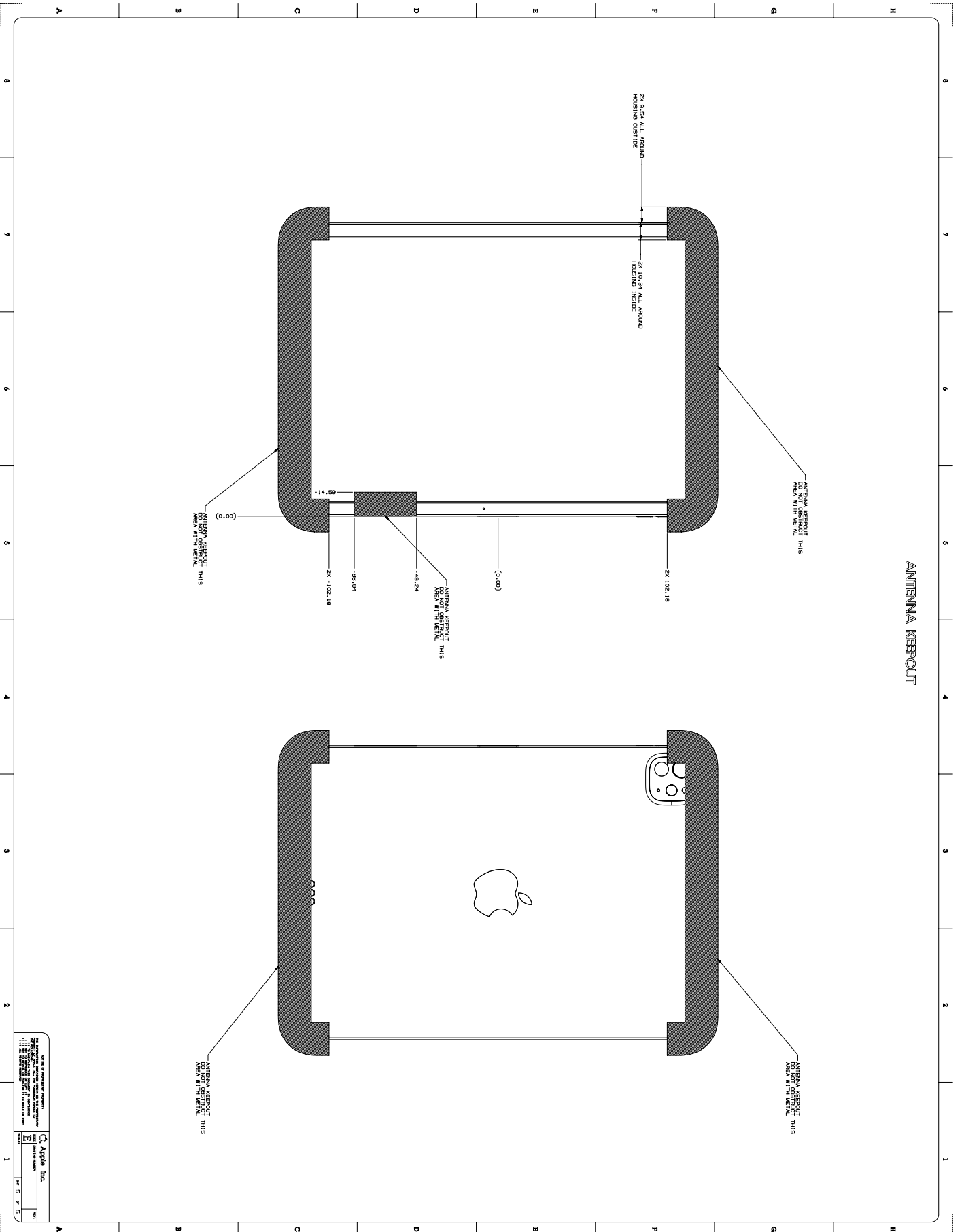
SECTION AND DETAIL INFORMATION



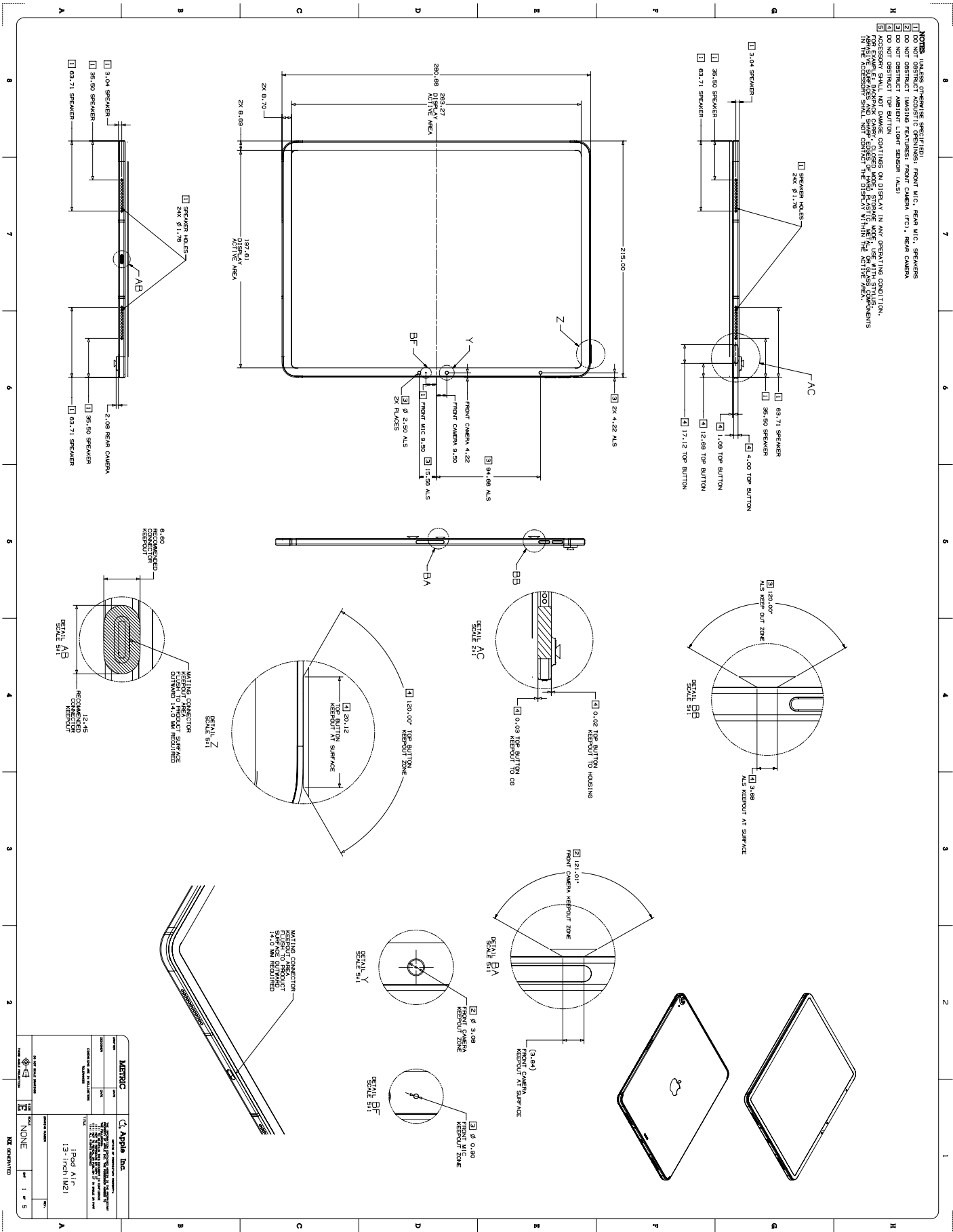
A 8 7 6 5 4 3 2 1

SECTION OR MODIFICATION NUMBER: 59.90 iPad Pro 11-inch (M4) 4 of 5 DATE: 11/14/24 DRAWN BY: [Redacted] CHECKED BY: [Redacted]	DATE: 11/14/24 DRAWN BY: [Redacted] CHECKED BY: [Redacted]
---	--

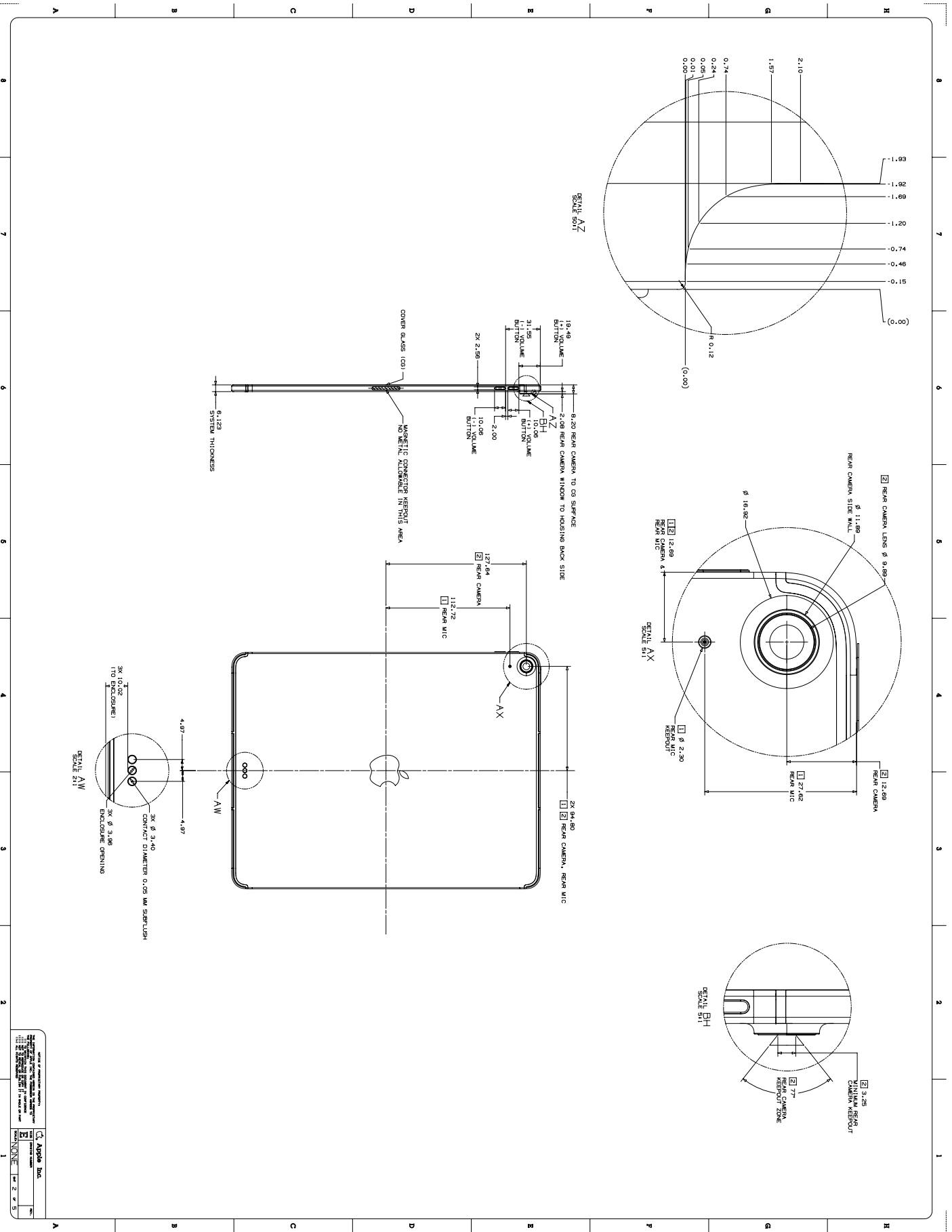
59.91 iPad Pro 11-inch (M4), 5 of 5



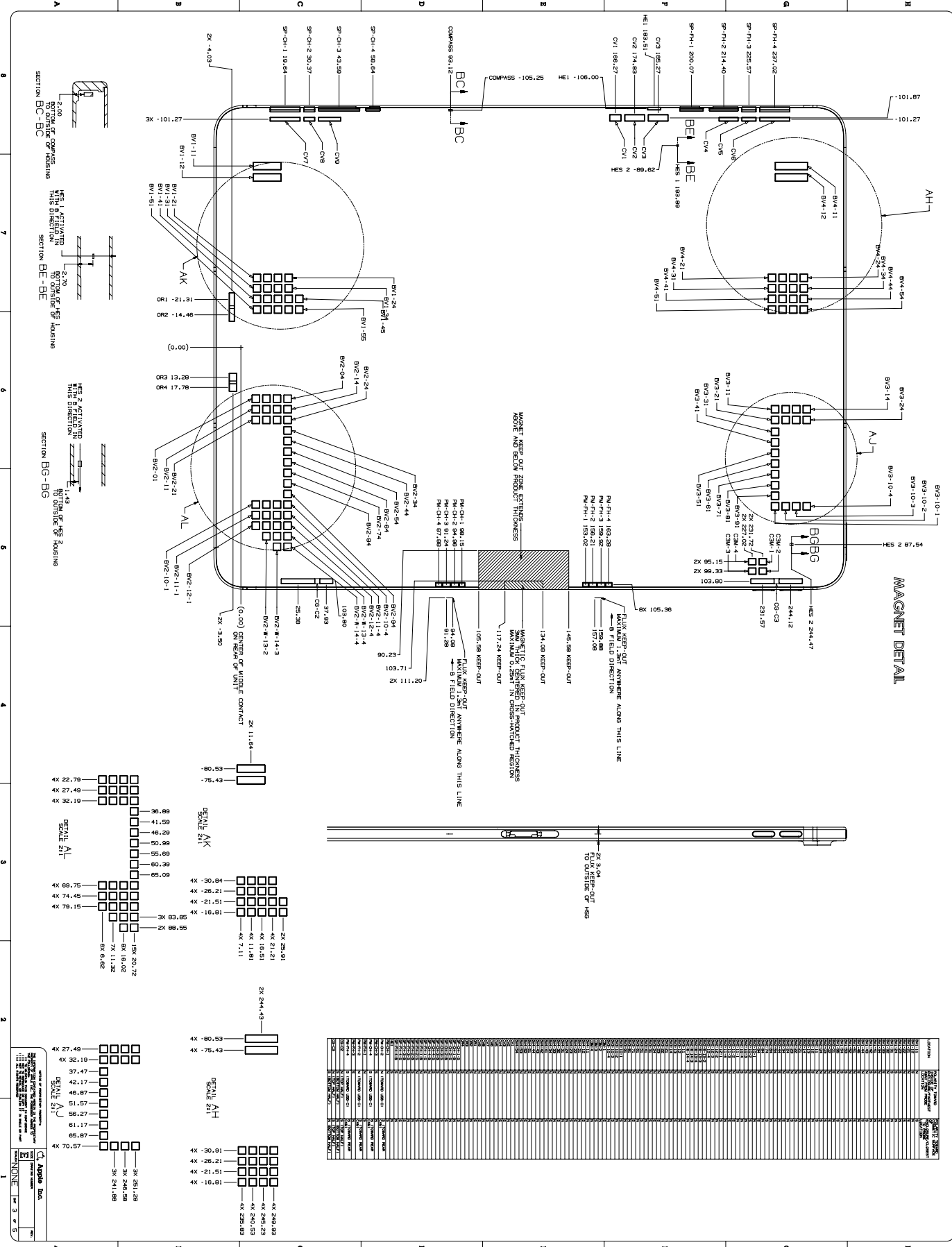
59.92 iPad Air 13-inch (M2), 1 of 5



59.93 iPad Air 13-inch (M2), 2 of 5

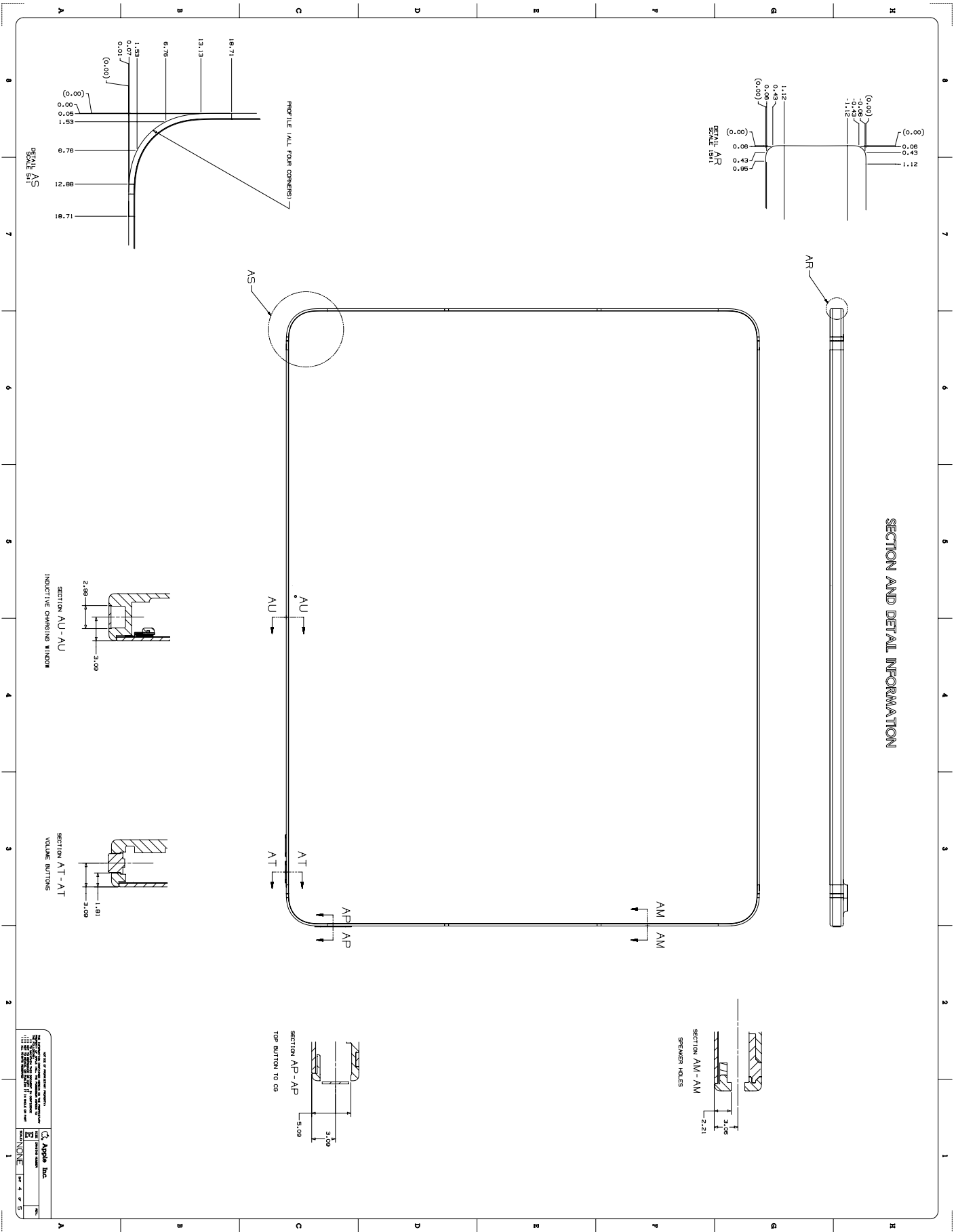


Apple Inc.	
Model	59.93
Material	Aluminum
Color	Space Gray
Finish	Matte
Weight	1.45 kg
Dimensions	284.0 mm x 220.8 mm x 6.4 mm
Part Number	59.93.001
Revision	1

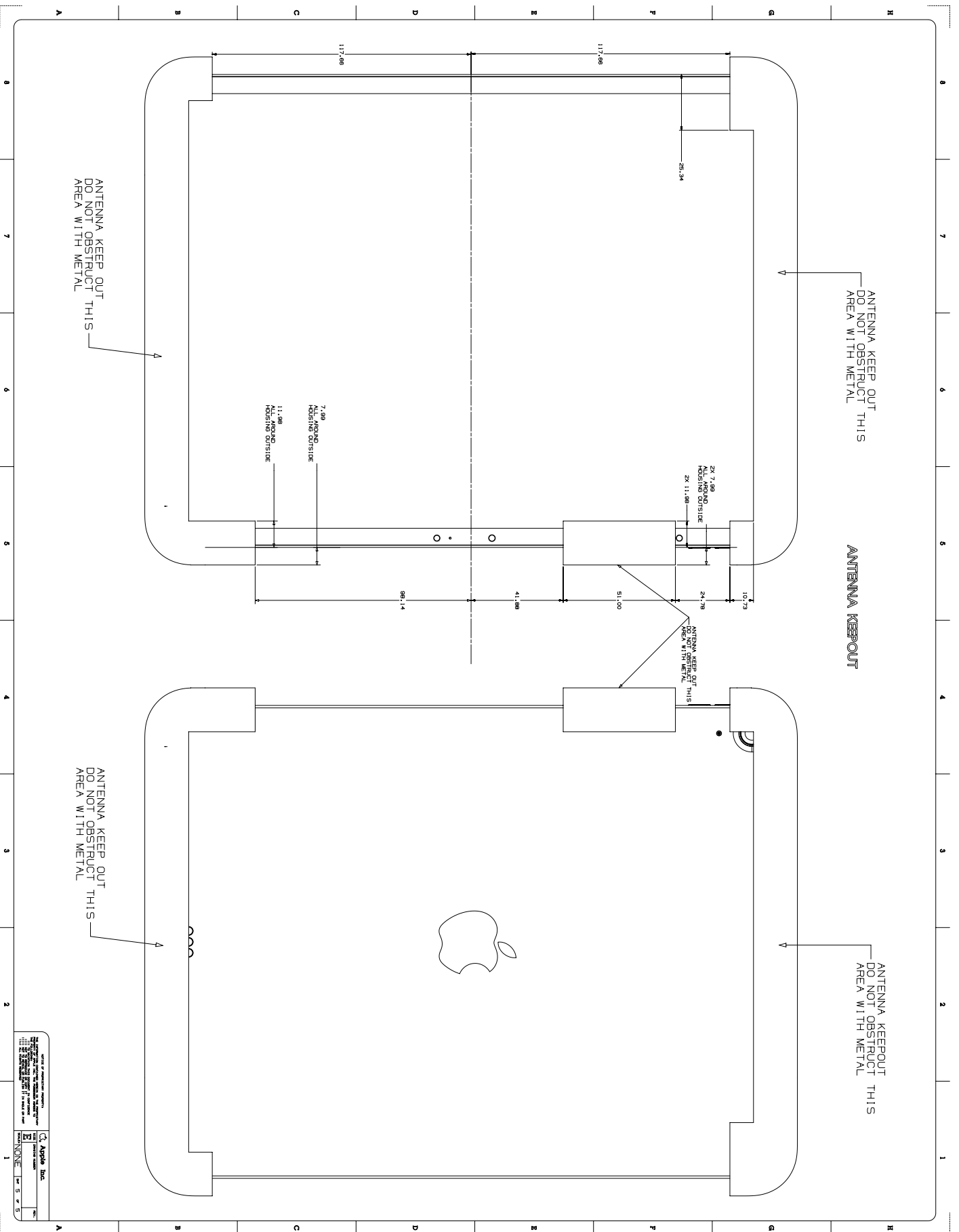


LOCATION	DESCRIPTION	SCALE	DATE	BY	CHKD
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2	13.00	1:2	10/15/23	JL	JL
3	13.00	1:2	10/15/23	JL	JL
4	13.00	1:2	10/15/23	JL	JL
5	13.00	1:2	10/15/23	JL	JL
6	13.00	1:2	10/15/23	JL	JL
7	13.00	1:2	10/15/23	JL	JL
8	13.00	1:2	10/15/23	JL	JL
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SECTION AND DETAIL INFORMATION

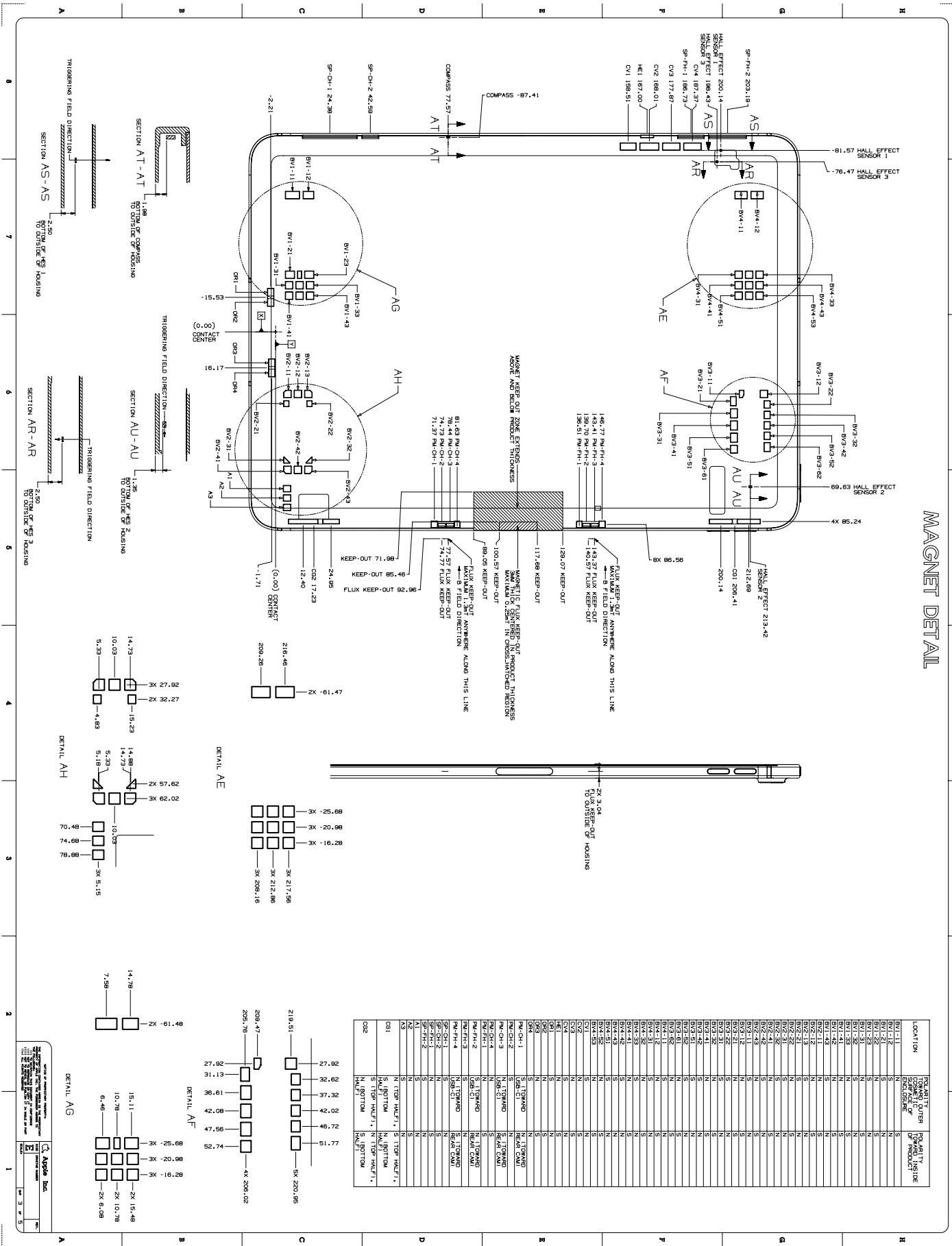


59.96 iPad Air 13-inch (M2), 5 of 5



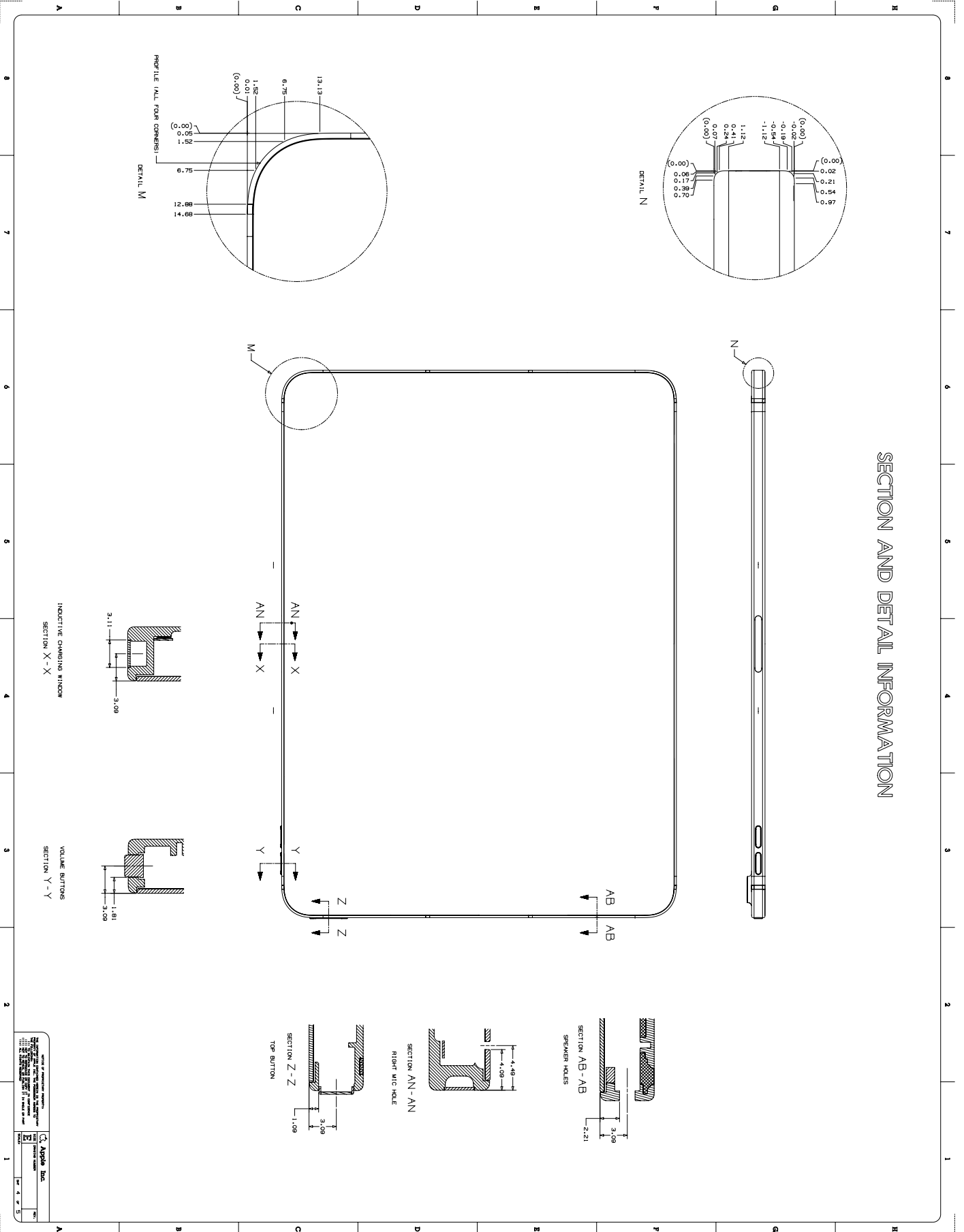
Model of antenna assembly	Apple Inc.
Part Name	Antenna Assembly
Part Number	11111111
Revision	1
Material	None
Color	None
Finish	None
Notes	None

MAGNET DETAIL

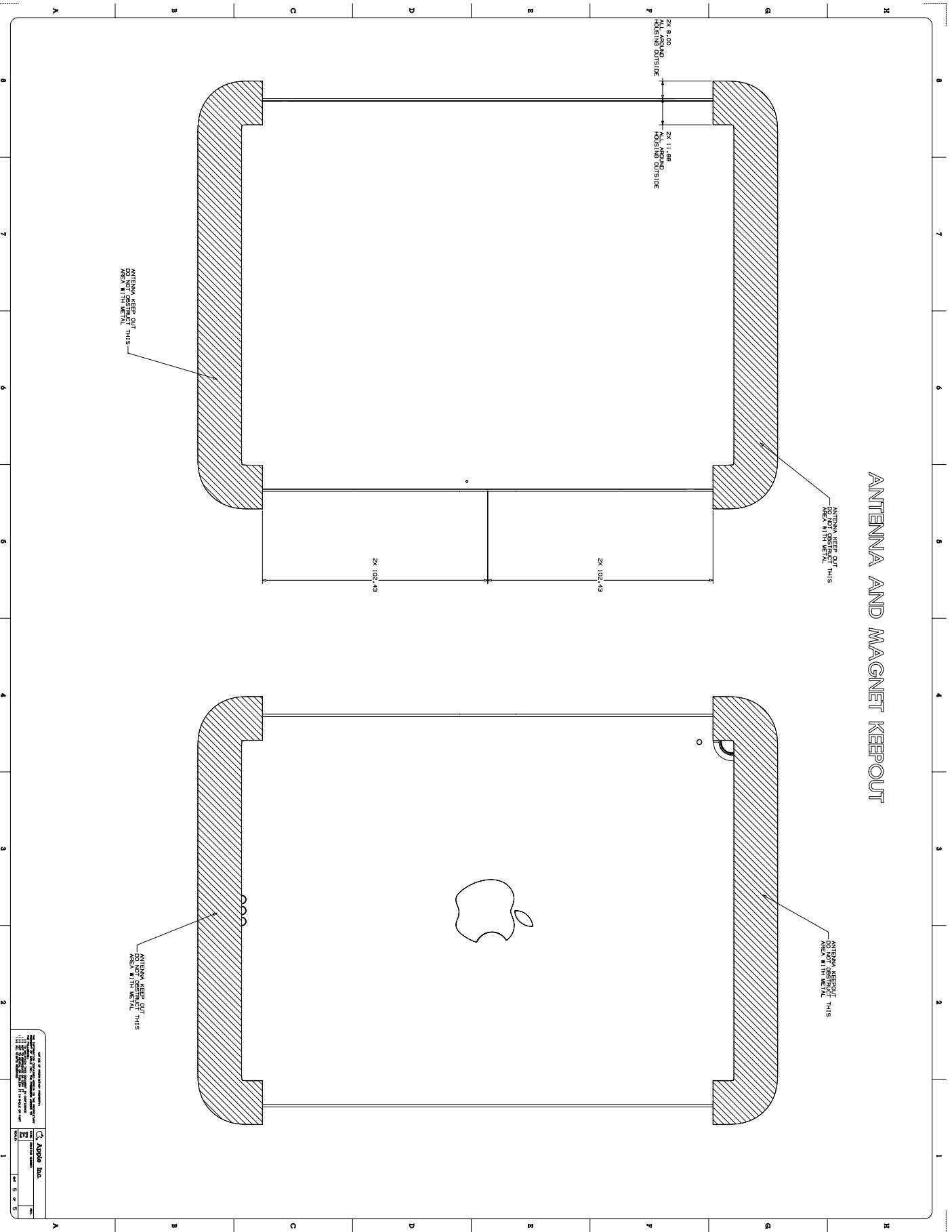


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BW1-12	2x 21.50	2	2009.02
BW1-21	2x 21.50	2	2009.02
BW1-22	2x 21.50	2	2009.02
BW1-31	2x 21.50	2	2009.02
BW1-32	2x 21.50	2	2009.02
BW1-41	2x 21.50	2	2009.02
BW1-42	2x 21.50	2	2009.02
BW1-51	2x 21.50	2	2009.02
BW1-52	2x 21.50	2	2009.02
BW2-11	2x 21.50	2	2009.02
BW2-12	2x 21.50	2	2009.02
BW2-21	2x 21.50	2	2009.02
BW2-22	2x 21.50	2	2009.02
BW2-31	2x 21.50	2	2009.02
BW2-32	2x 21.50	2	2009.02
BW2-41	2x 21.50	2	2009.02
BW2-42	2x 21.50	2	2009.02
BW2-51	2x 21.50	2	2009.02
BW2-52	2x 21.50	2	2009.02
BW3-11	2x 21.50	2	2009.02
BW3-12	2x 21.50	2	2009.02
BW3-21	2x 21.50	2	2009.02
BW3-22	2x 21.50	2	2009.02
BW3-31	2x 21.50	2	2009.02
BW3-32	2x 21.50	2	2009.02
BW3-41	2x 21.50	2	2009.02
BW3-42	2x 21.50	2	2009.02
BW3-51	2x 21.50	2	2009.02
BW3-52	2x 21.50	2	2009.02
BW4-11	2x 21.50	2	2009.02
BW4-12	2x 21.50	2	2009.02
BW4-21	2x 21.50	2	2009.02
BW4-22	2x 21.50	2	2009.02
BW4-31	2x 21.50	2	2009.02
BW4-32	2x 21.50	2	2009.02
BW4-41	2x 21.50	2	2009.02
BW4-42	2x 21.50	2	2009.02
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BW4-82	2x 21.50	2	2009.02
BW4-91	2x 21.50	2	2009.02
BW4-92	2x 21.50	2	2009.02
BW4-101	2x 21.50	2	2009.02
BW4-102	2x 21.50	2	2009.02
BW4-111	2x 21.50	2	2009.02
BW4-112	2x 21.50	2	2009.02
BW4-121	2x 21.50	2	2009.02
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BW4-152	2x 21.50	2	2009.02
BW4-161	2x 21.50	2	2009.02
BW4-162	2x 21.50	2	2009.02
BW4-171	2x 21.50	2	2009.02
BW4-172	2x 21.50	2	2009.02
BW4-181	2x 21.50	2	2009.02
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BW4-191	2x 21.50	2	2009.02
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BW4-322	2x 21.50	2	2009.02
BW4-331	2x 21.50	2	2009.02
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BW4-342	2x 21.50	2	2009.02
BW4-351	2x 21.50	2	2009.02
BW4-352	2x 21.50	2	2009.02
BW4-361	2x 21.50	2	2009.02
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BW4-371	2x 21.50	2	2009.02
BW4-372	2x 21.50	2	2009.02
BW4-381	2x 21.50	2	2009.02
BW4-382	2x 21.50	2	2009.02
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BW4-392	2x 21.50	2	2009.02
BW4-401	2x 21.50	2	2009.02
BW4-402	2x 21.50	2	2009.02
BW4-411	2x 21.50	2	2009.02
BW4-412	2x 21.50	2	2009.02
BW4-421	2x 21.50	2	2009.02
BW4-422	2x 21.50	2	2009.02
BW4-431	2x 21.50	2	2009.02
BW4-432	2x 21.50	2	2009.02
BW4-441	2x 21.50	2	2009.02
BW4-442	2x 21.50	2	2009.02
BW4-451	2x 21.50	2	2009.02
BW4-452	2x 21.50	2	2009.02
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BW4-462	2x 21.50	2	2009.02
BW4-471	2x 21.50	2	2009.02
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BW4-482	2x 21.50	2	2009.02
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SECTION AND DETAIL INFORMATION



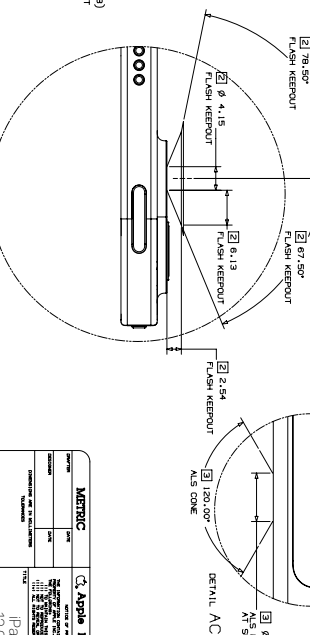
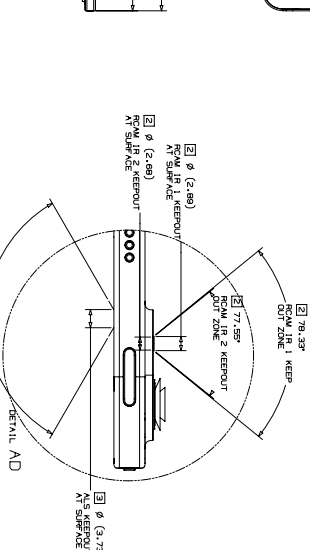
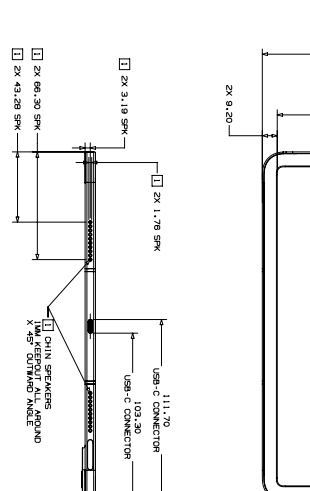
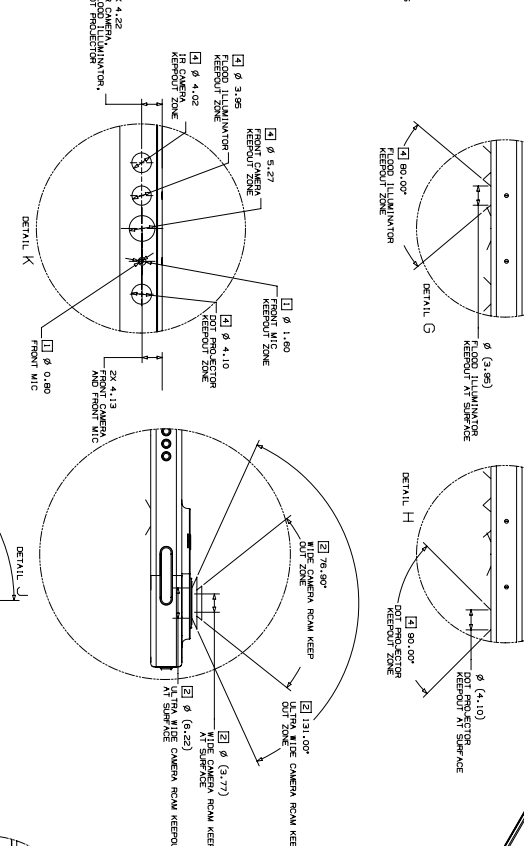
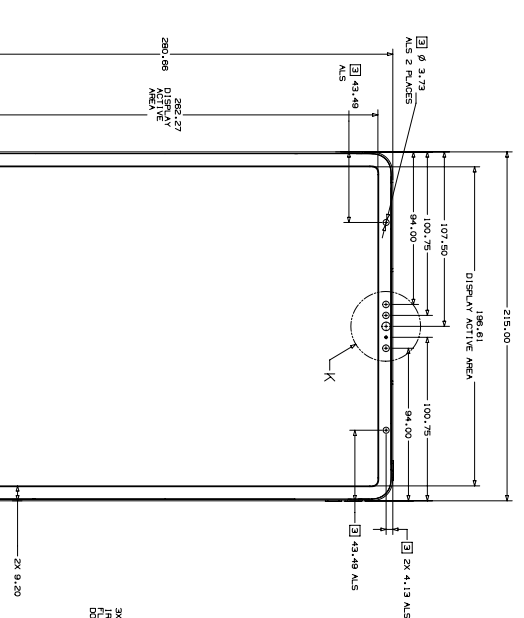
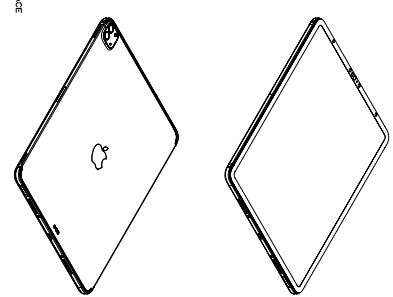
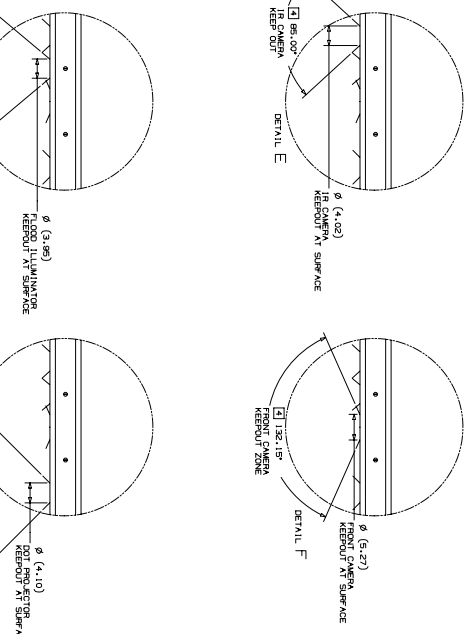
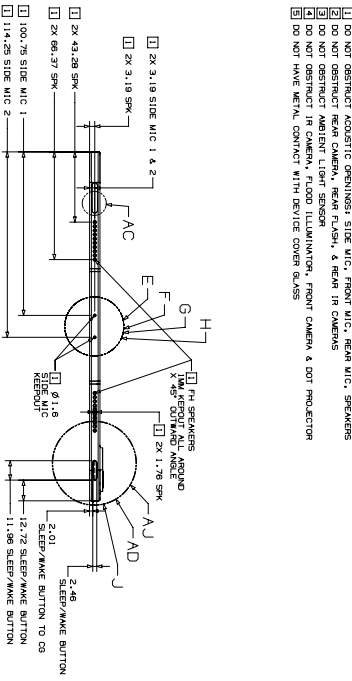
ANTENNA AND MAGNET KEEP-OUT



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<small>Model: A2709</small> <small>Part Number: 59.101</small> <small>Copyright © 2024 Apple Inc. All Rights Reserved.</small>	Apple Inc. <small>Apple logo</small>

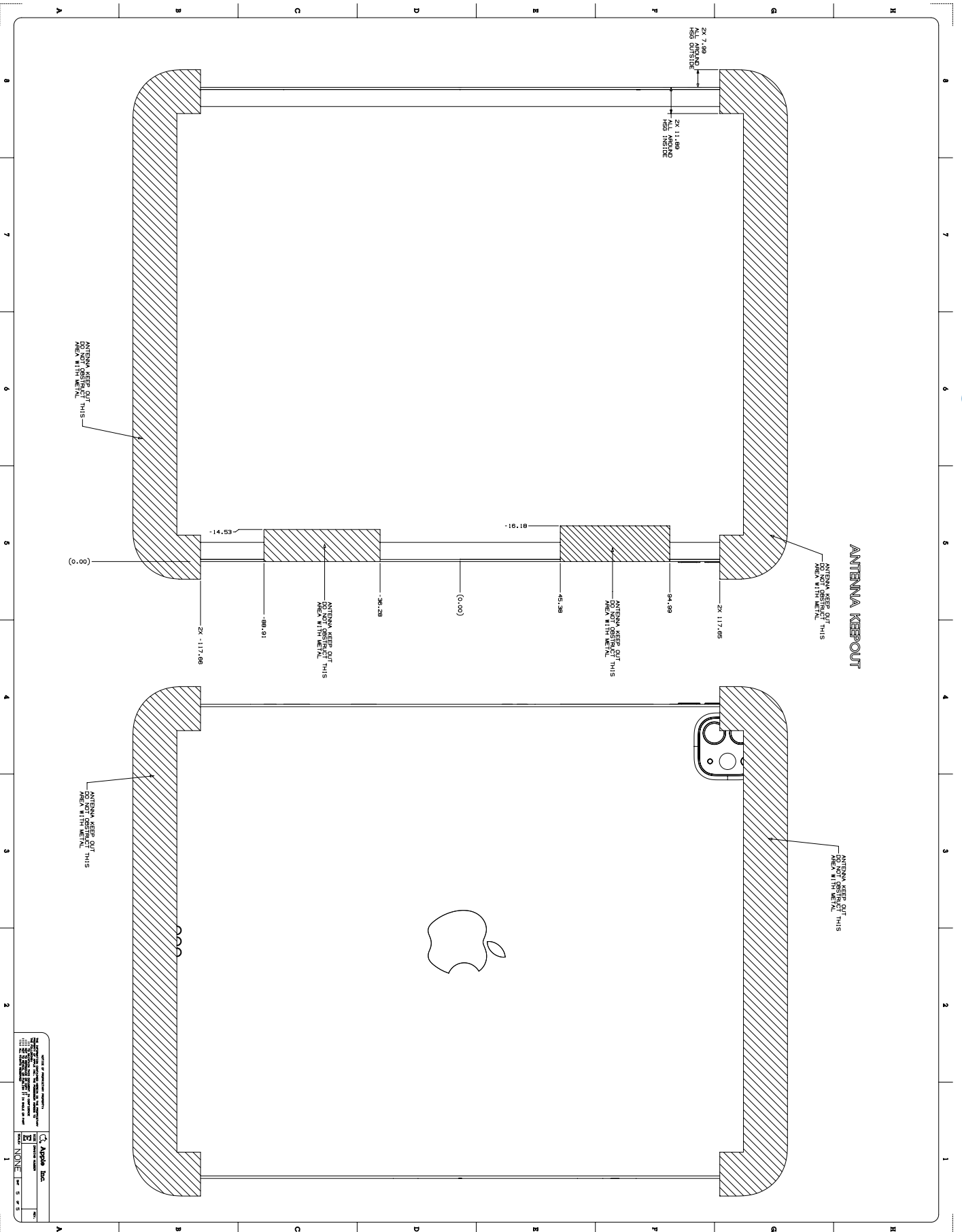
59.102 iPad Pro 12.9-inch (6th generation), 1 of 5

- NOTES** (UNLESS OTHERWISE SPECIFIED)
- 1 DO NOT OBSTRUCT ACOUSTIC OPENINGS: SIDE MIC, FRONT MIC, REAR MIC, SPEAKERS
 - 2 DO NOT OBSTRUCT REAR CAMERA, REAR FLASH, & REAR IR CAMERAS
 - 3 DO NOT OBSTRUCT IR CAMERA, FLOOD ILLUMINATOR, FRONT CAMERA & DOT PROJECTOR
 - 4 DO NOT HAVE METAL CONTACT WITH DEVICE COVER GLASS



METRIC		Apple Inc.	
DATE	10/20/2021	DESIGN	59.102
REVISION		DESCRIPTION	IPAD PRO 12.9-INCH (6TH GENERATION)
APPROVED BY		DESIGNED BY	
CHECKED BY		MANUFACTURED BY	
DATE	10/20/2021	SCALE	1:1
PART NUMBER		59.102	
DESCRIPTION		IPAD PRO 12.9-INCH (6TH GENERATION)	
MATERIAL		NONE	
FINISH		NONE	
TOLERANCES		NONE	
DIMENSIONS		NONE	
ASSEMBLY		NONE	
DRAWING		NONE	
REVISIONS		NONE	
APPROVED BY		NONE	
DATE		NONE	
SCALE		NONE	
SHEET		1 OF 5	

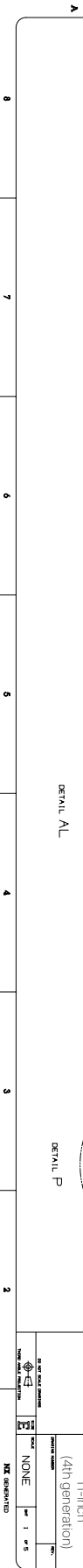
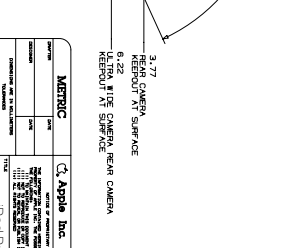
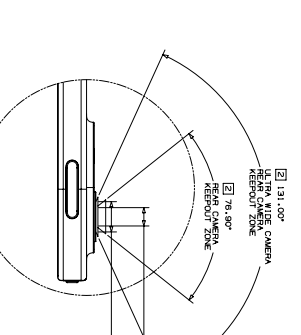
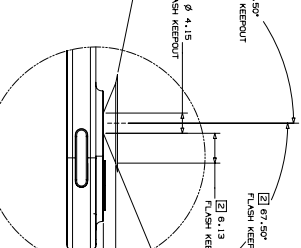
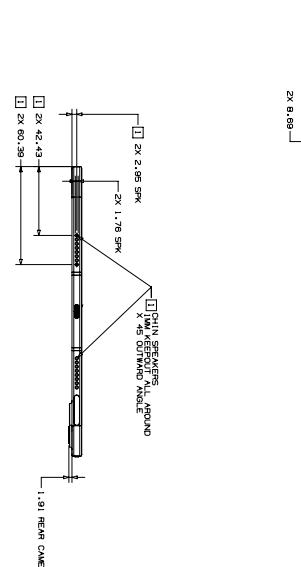
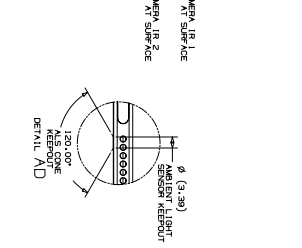
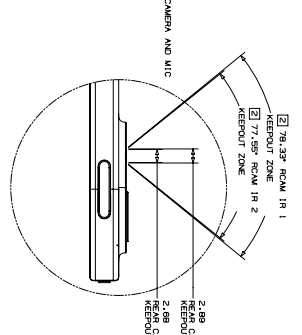
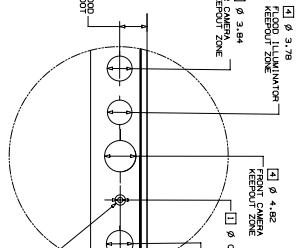
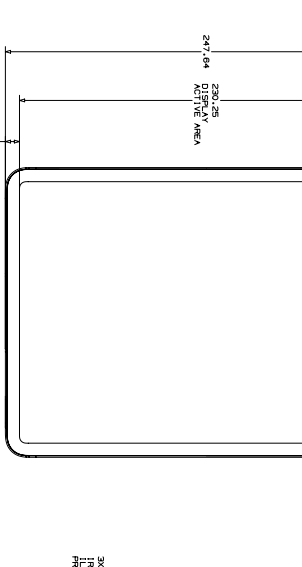
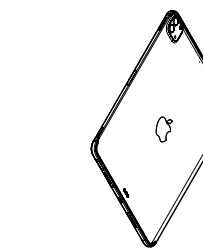
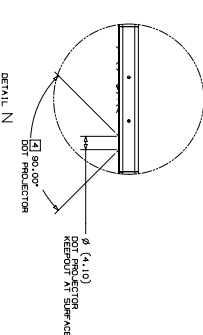
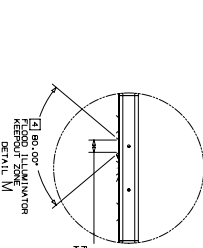
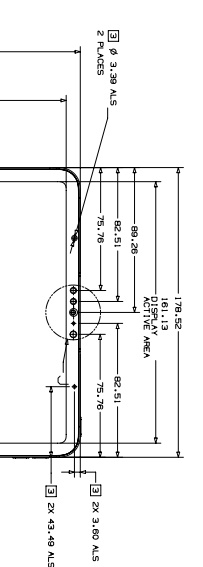
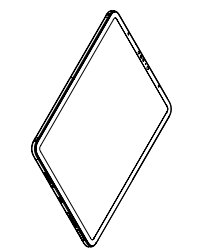
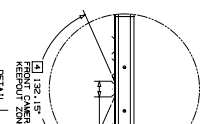
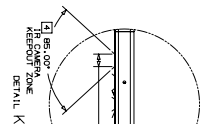
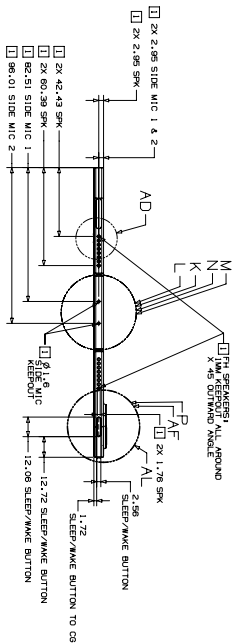
59.106 iPad Pro 12.9-inch (6th generation), 5 of 5



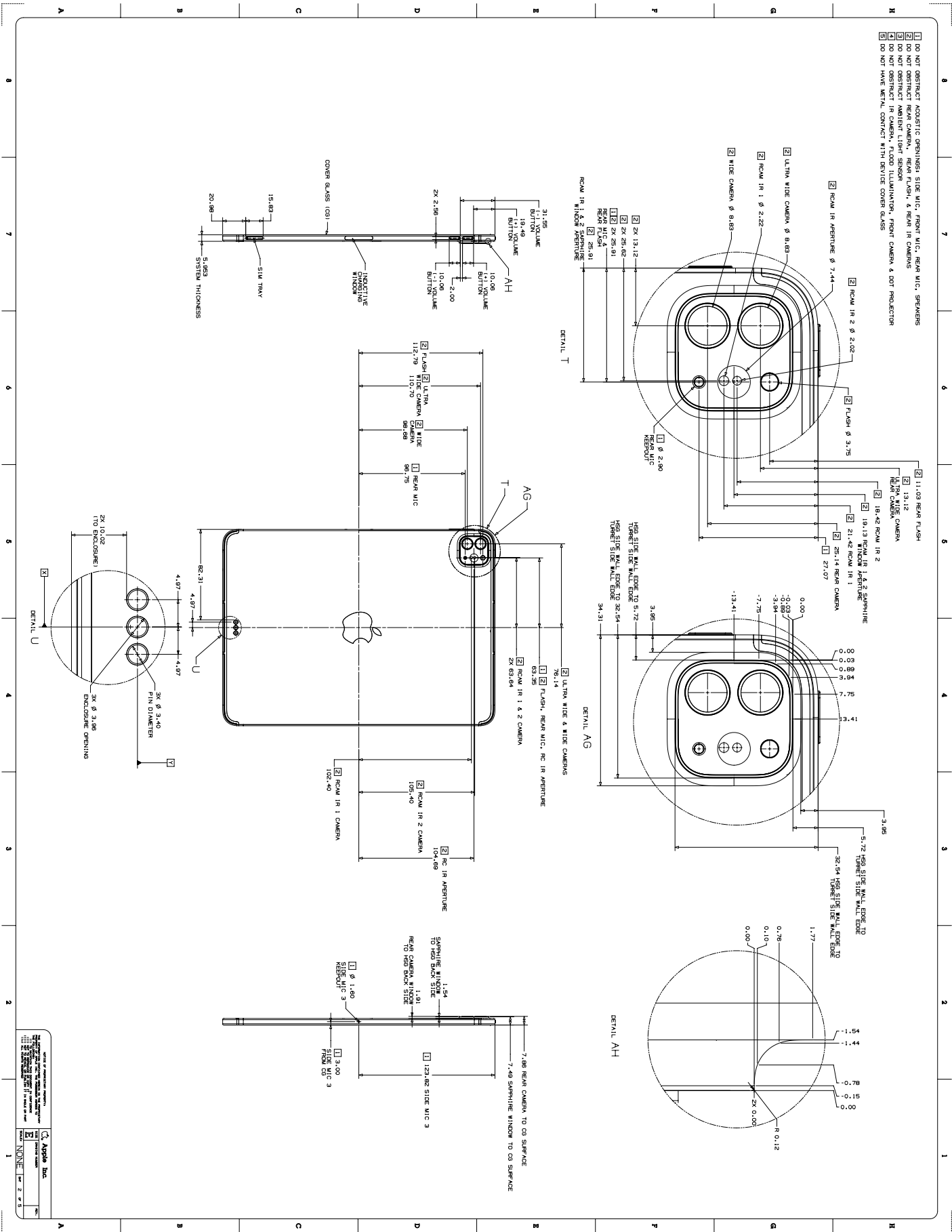
Apple Inc.	
Model	None
Part Number	None
Revision	1
Date	11/11/2021
Author	Apple Inc.
Checked	Apple Inc.
Approved	Apple Inc.

59.107 iPad Pro 11-inch (4th generation), 1 of 5

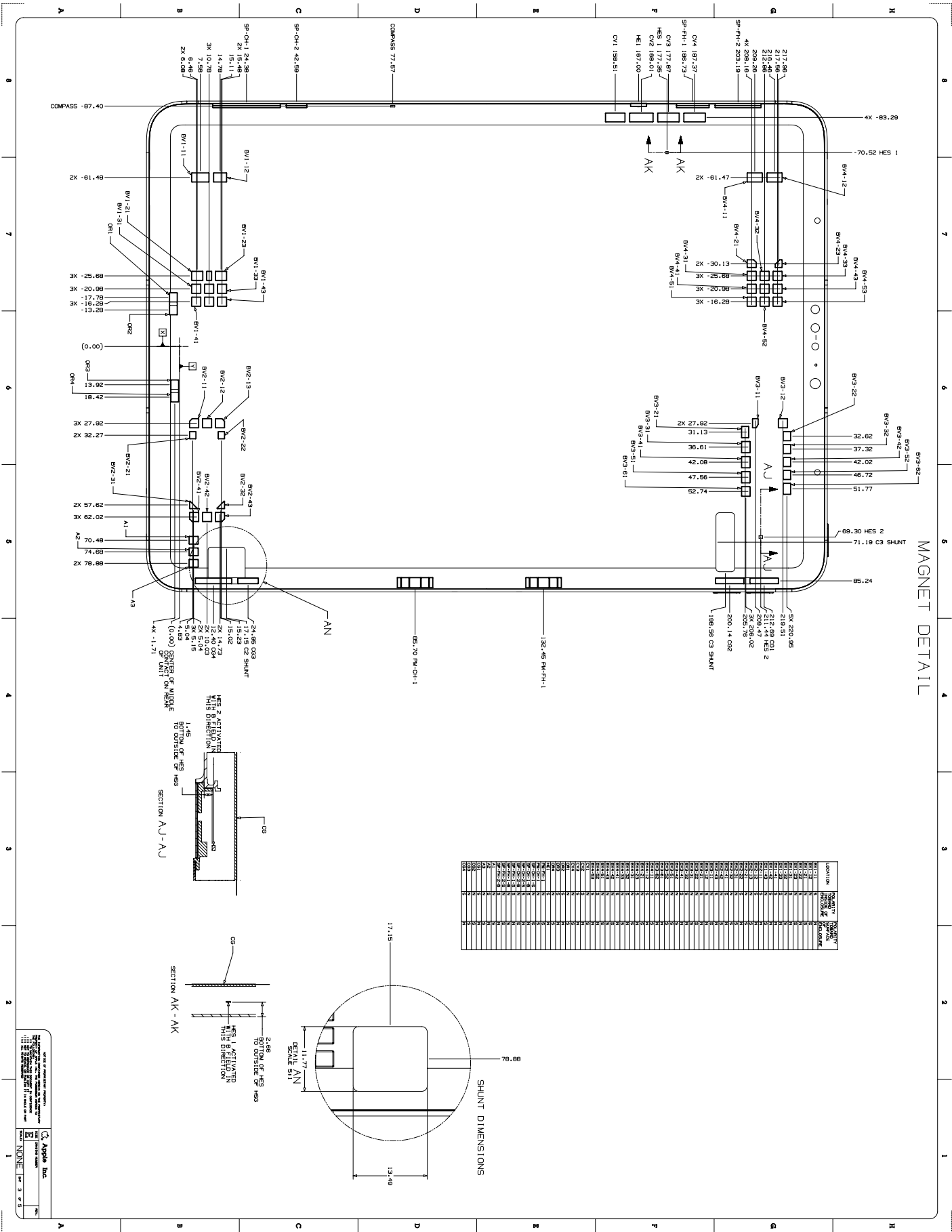
- NOTES** (UNLESS OTHERWISE SPECIFIED):
- 1 DO NOT OBSTRUCT ACOUSTIC OPENINGS: SIDE MIC, FRONT MIC, REAR MIC, SPEAKERS
 - 2 DO NOT OBSTRUCT CAMERA LENS, FLOOD ILLUMINATOR, & REAR IR CAMERA
 - 3 DO NOT OBSTRUCT AMBIENT LIGHT SENSOR
 - 4 DO NOT OBSTRUCT IR CAMERA, FLOOD ILLUMINATOR, FRONT CAMERA, & DOT PROJECTOR
 - 5 DO NOT HAVE METAL CONTACT WITH DEVICE COVER GLASS



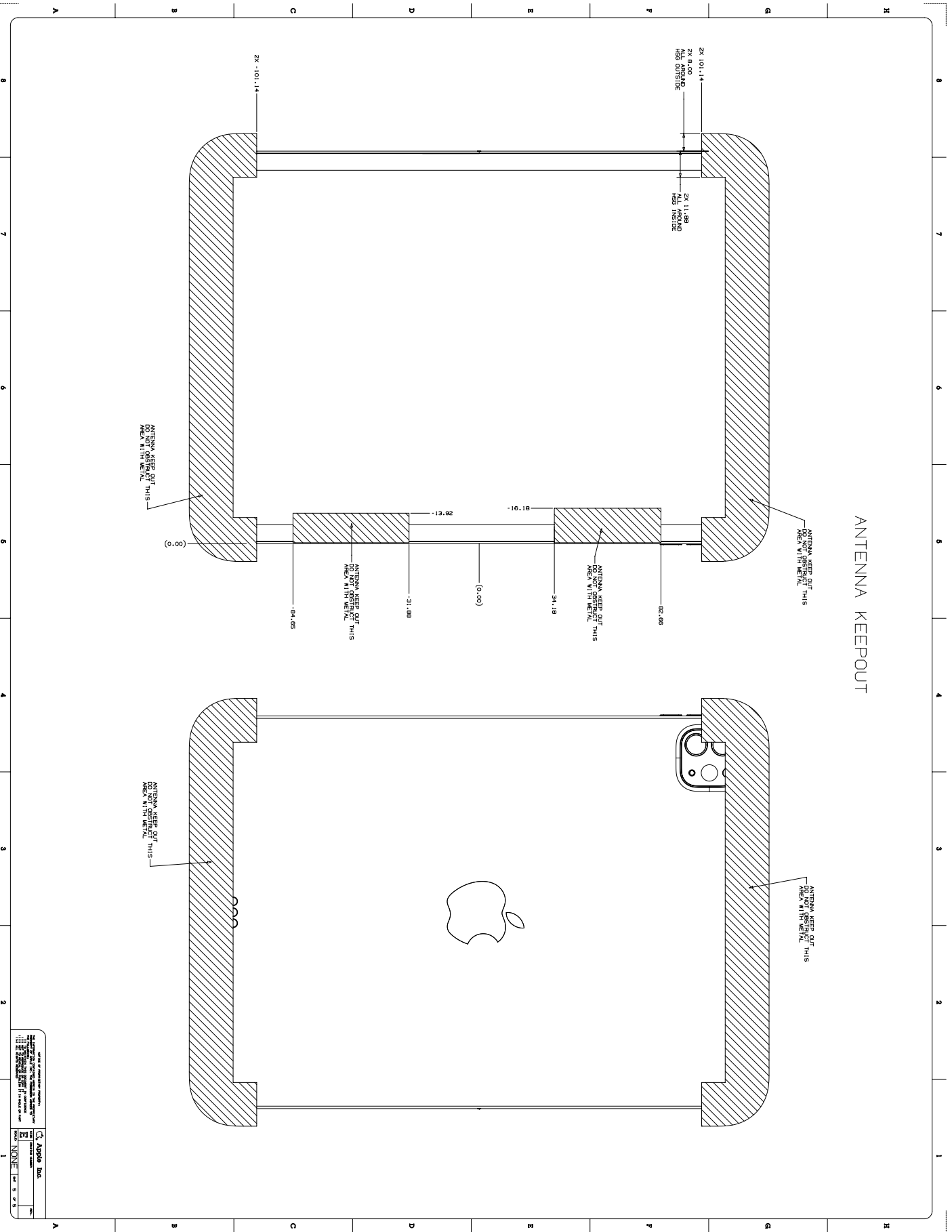
METRIC DIMENSIONS IN MILLIMETERS DIMENSIONS IN INCHES CONVERSION: 1 INCH = 25.4 MILLIMETERS ROUNDING: MILLIMETERS TO NEAREST 0.1; INCHES TO NEAREST 0.005 TOLERANCES: DIMENSIONS IN MILLIMETERS: 0.25 (0.010) UNLESS OTHERWISE SPECIFIED; DIMENSIONS IN INCHES: 0.005 (0.0002) UNLESS OTHERWISE SPECIFIED FINISHES: UNLESS OTHERWISE SPECIFIED, ALL SURFACES SHALL BE FINISHED TO A MATTE, NON-REFLECTIVE, ANTI-FINGERPRINT FINISH MATERIALS: UNLESS OTHERWISE SPECIFIED, ALL MATERIALS SHALL BE OF THE HIGHEST QUALITY AVAILABLE FINISHES: UNLESS OTHERWISE SPECIFIED, ALL SURFACES SHALL BE FINISHED TO A MATTE, NON-REFLECTIVE, ANTI-FINGERPRINT FINISH MATERIALS: UNLESS OTHERWISE SPECIFIED, ALL MATERIALS SHALL BE OF THE HIGHEST QUALITY AVAILABLE		Apple Inc. iPad Pro 11-inch (4th generation)
PART NUMBER: 59.107 DATE: 2024-10-21 DRAWN BY: [REDACTED] CHECKED BY: [REDACTED]	NONE	1 of 5 NOT QUANTIFIED



MAGNET DETAIL

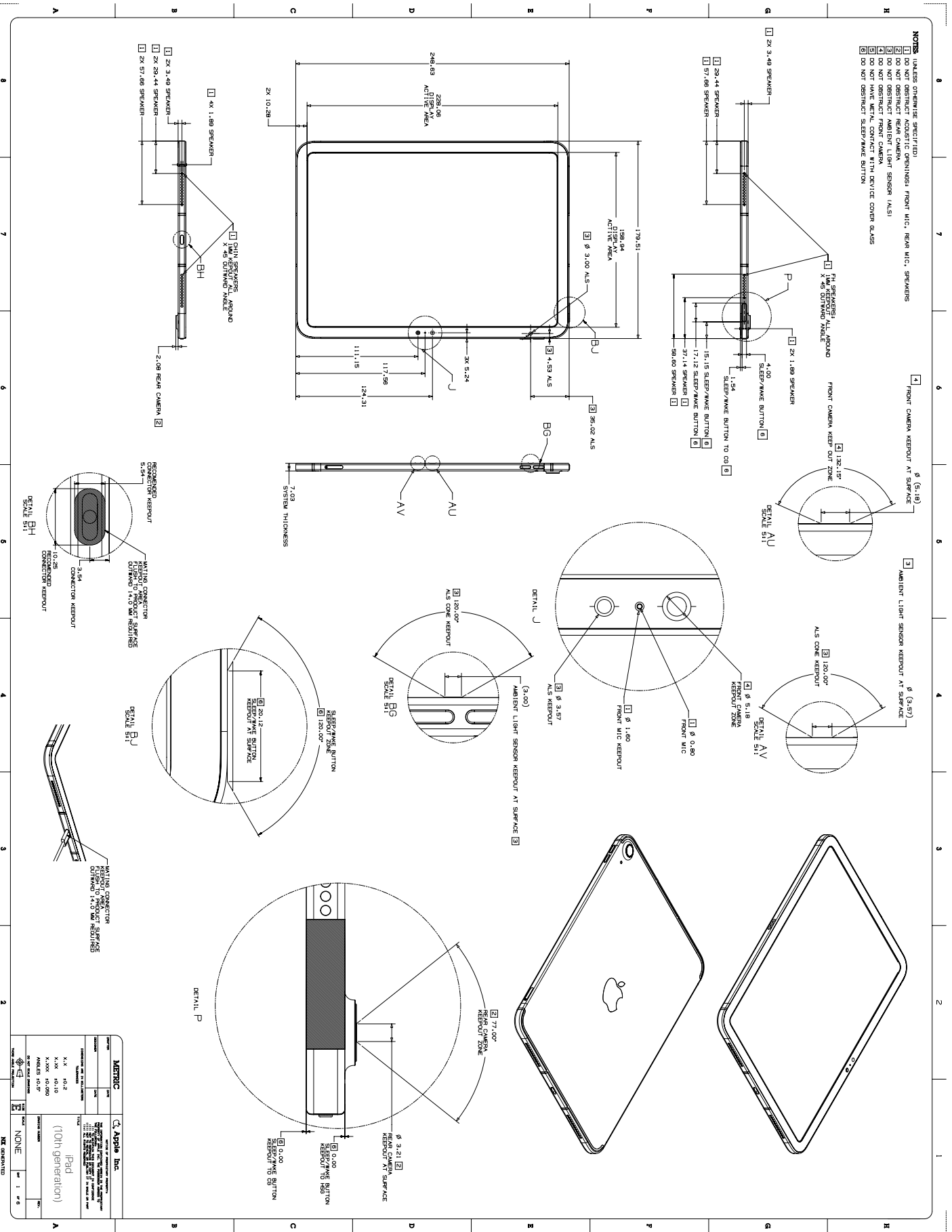


ANTENNA KEEPOUT

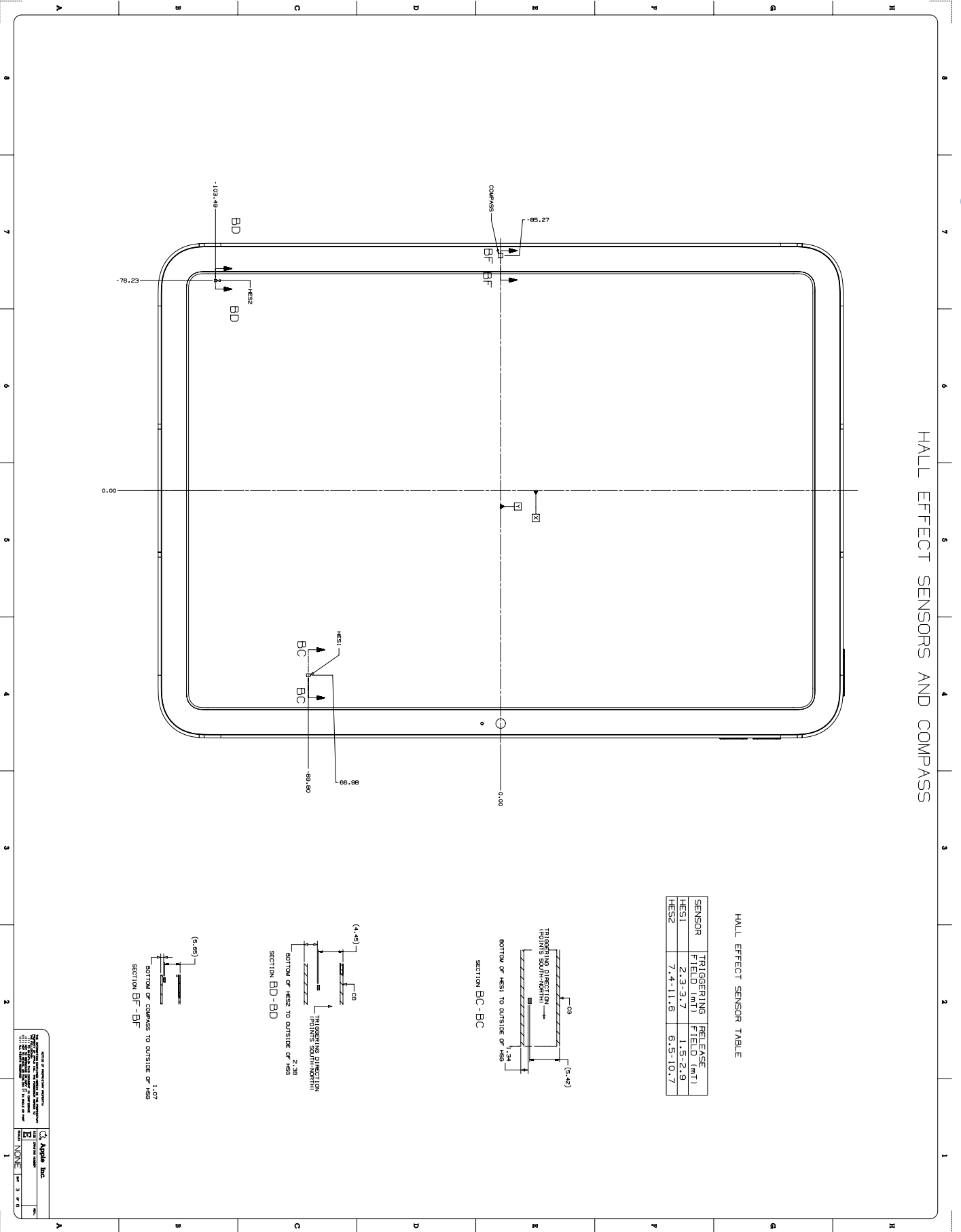


Apple Inc. 100 Apple Park Blvd Cupertino, CA 95014 © 2024 Apple Inc. All rights reserved.	
DATE: 2024-10-21 TIME: 10:00 AM USER: [Name]	APPROVED: [Signature] TITLE: [Title]

59.112 iPad (10th generation), 1 of 6

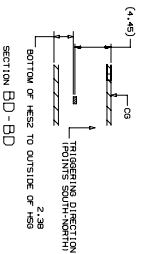
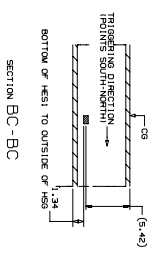


HALL EFFECT SENSORS AND COMPASS



HALL EFFECT SENSOR TABLE

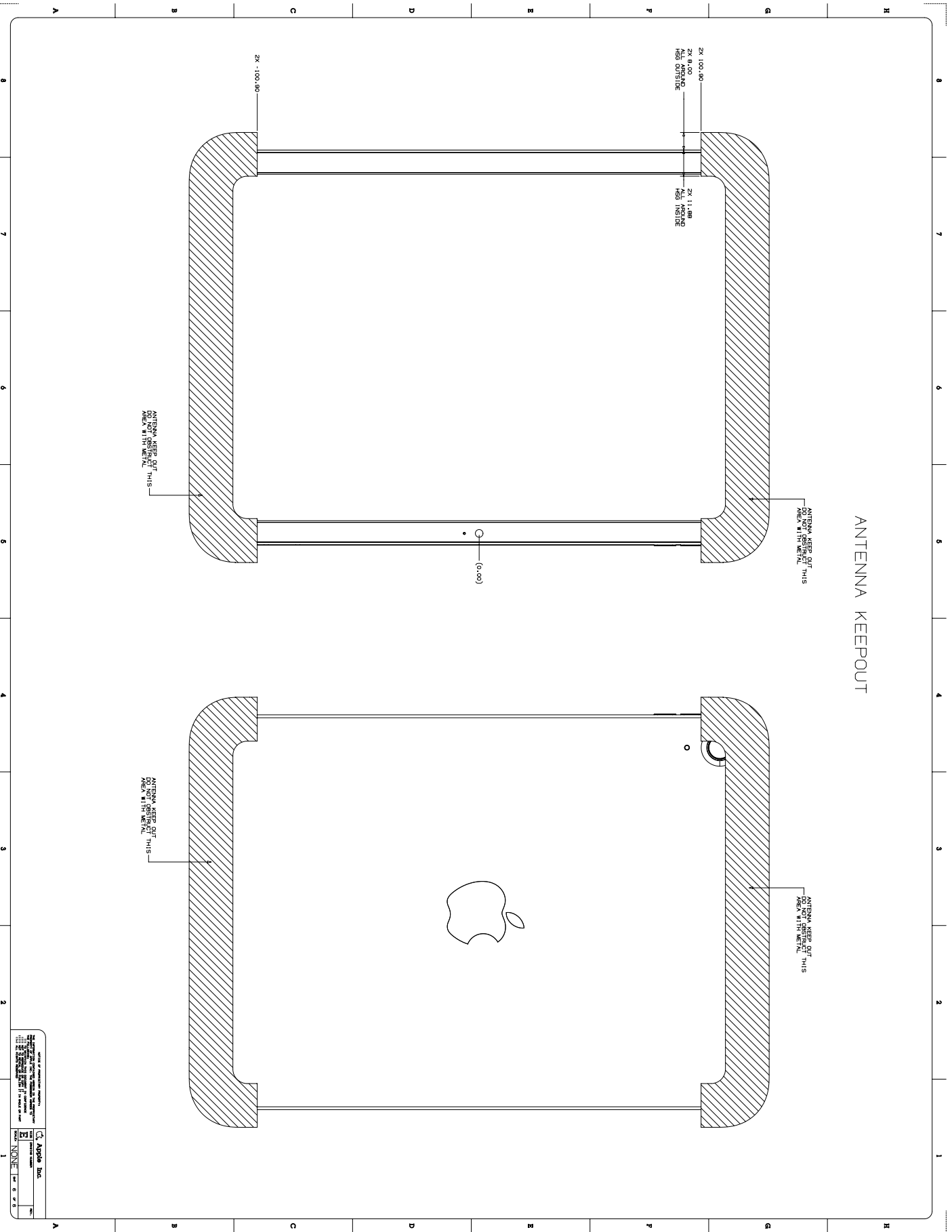
SENSOR	TRIGGERING FIELD (mT)	RELEASE FIELD (mT)
HES1	2.3-3.7	1.5-2.9
HES2	7.4-11.6	6.5-10.7



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 NONE 3 of 6

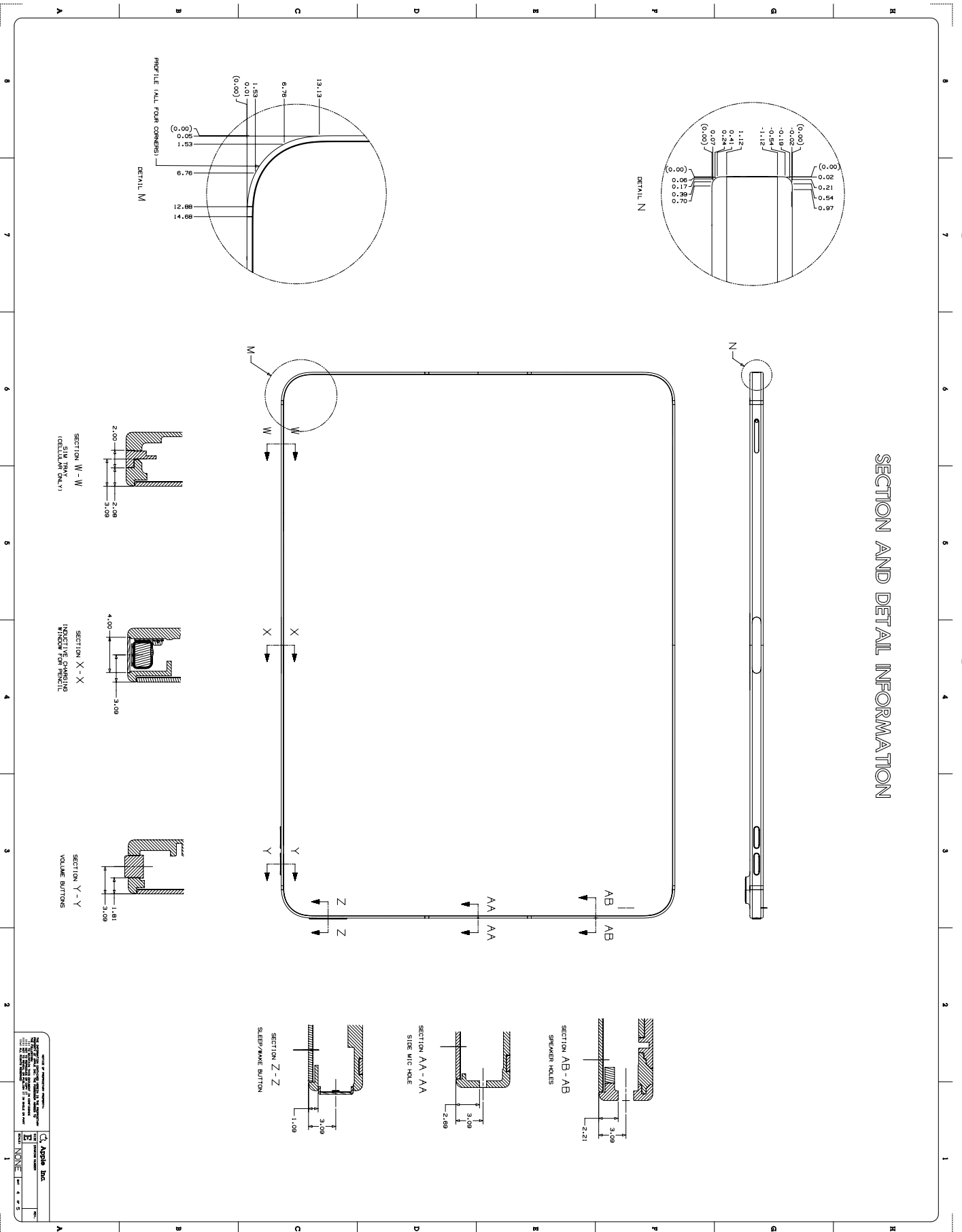
59.117 iPad (10th generation), 6 of 6

ANTENNA KEEPOUT



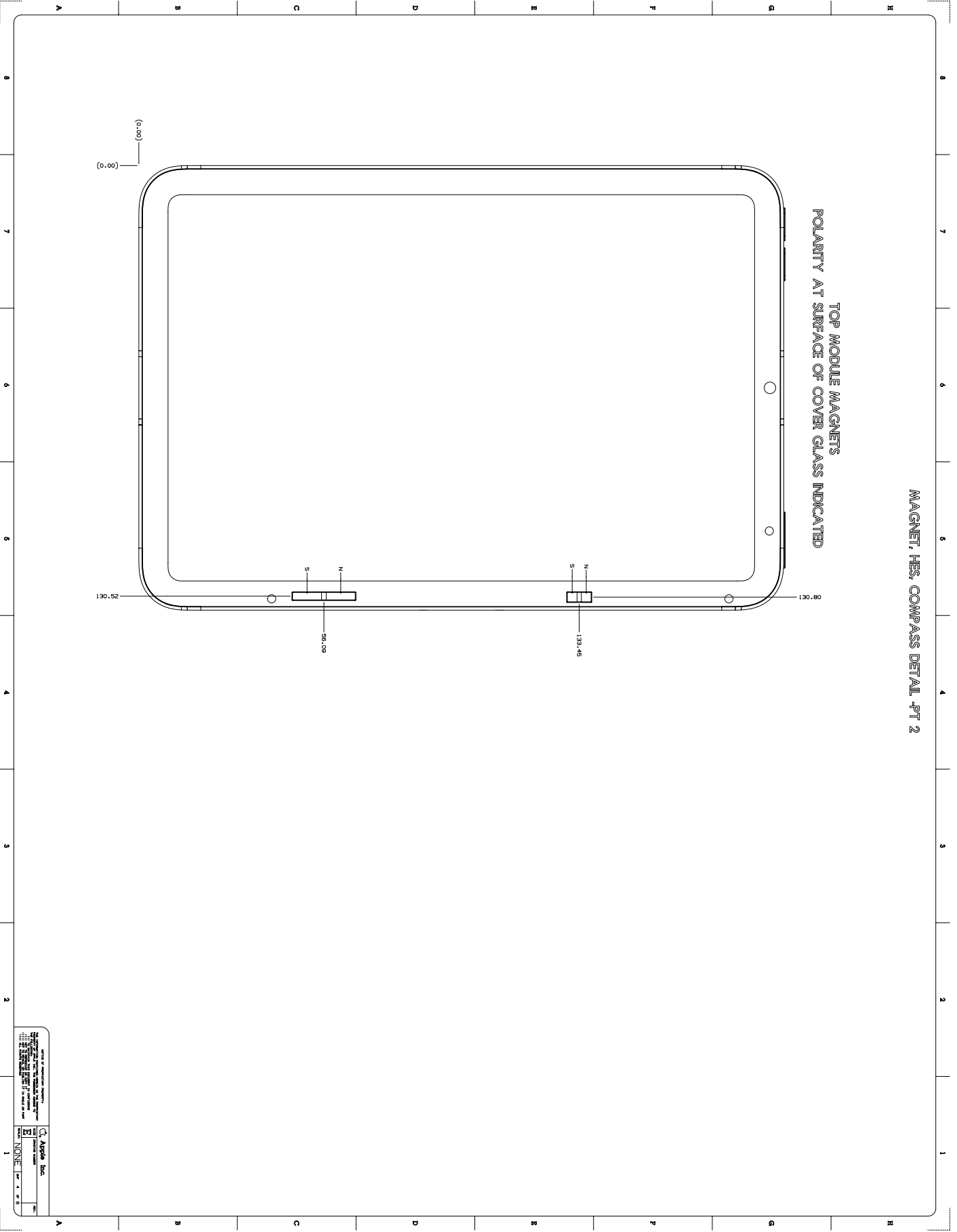
Apple Inc.	
Model	None
Version	1.0
Created	2024-10-21
Author	Apple Inc.
Part Name	Antenna Keepout
Material	None
Color	None
Finish	None
Notes	None

SECTION AND DETAIL INFORMATION

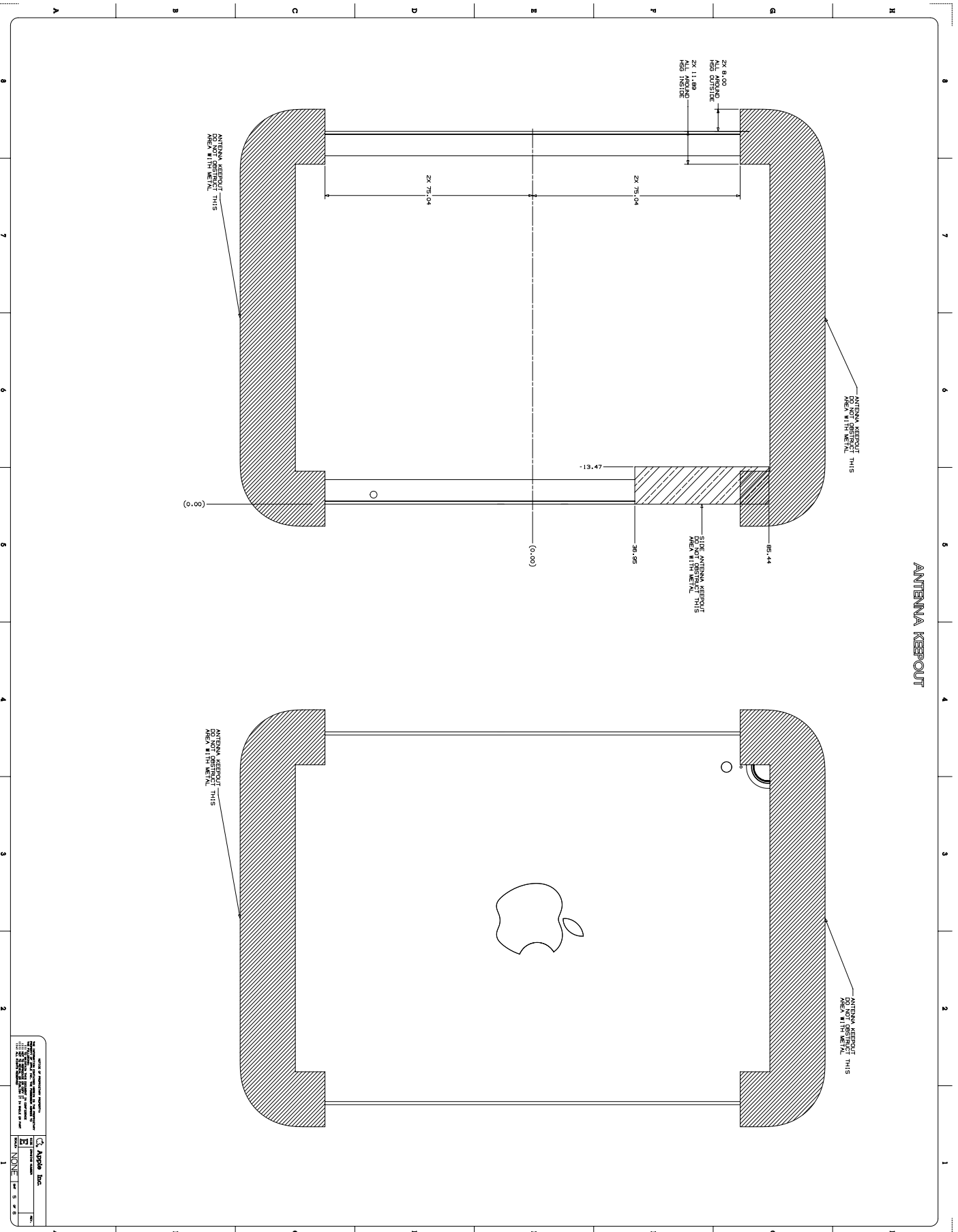


59.126 iPad mini (6th generation), 4 of 6

MAGNET, HES. COMPASS DETAIL -PT 2



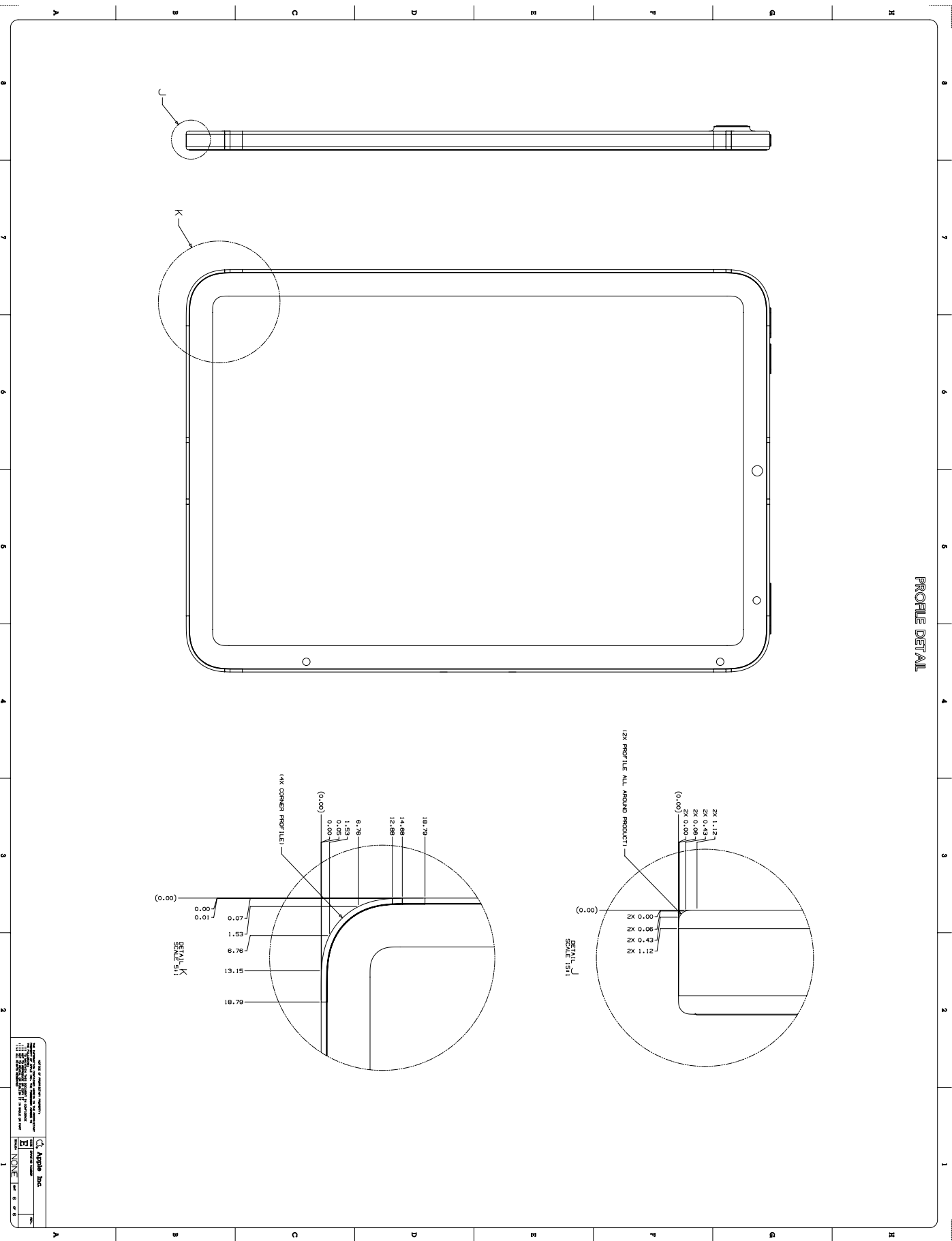
59.127 iPad mini (6th generation), 5 of 6



Notes	
1	ANTENNA KEEPOUT THIS AREA WITH METAL
2	ANTENNA KEEPOUT THIS AREA WITH METAL
3	ANTENNA KEEPOUT THIS AREA WITH METAL
4	ANTENNA KEEPOUT THIS AREA WITH METAL
5	ANTENNA KEEPOUT THIS AREA WITH METAL
6	ANTENNA KEEPOUT THIS AREA WITH METAL
7	ANTENNA KEEPOUT THIS AREA WITH METAL
8	ANTENNA KEEPOUT THIS AREA WITH METAL
9	ANTENNA KEEPOUT THIS AREA WITH METAL
10	ANTENNA KEEPOUT THIS AREA WITH METAL

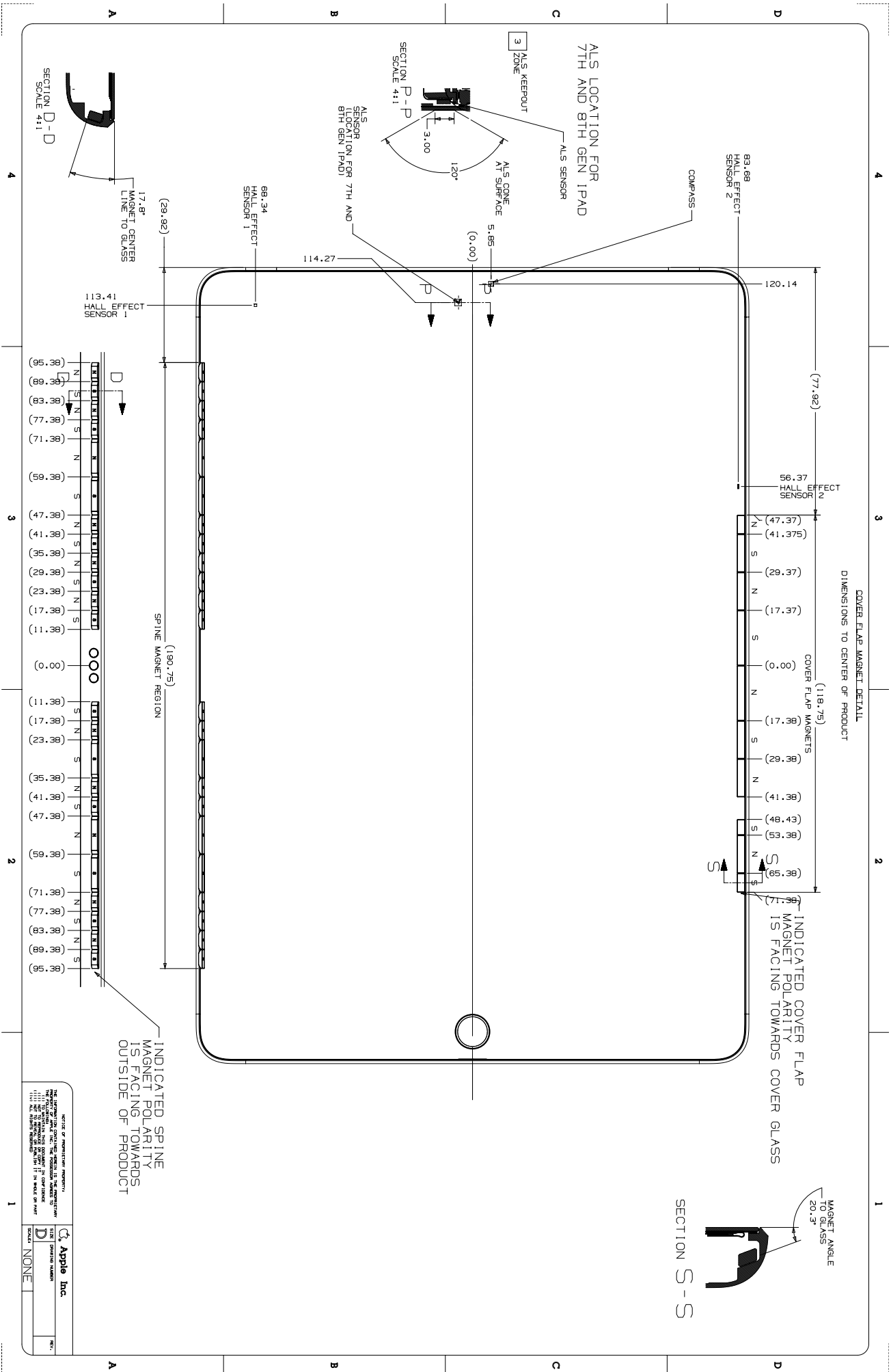
59.128 iPad mini (6th generation), 6 of 6

PROFILE DETAIL

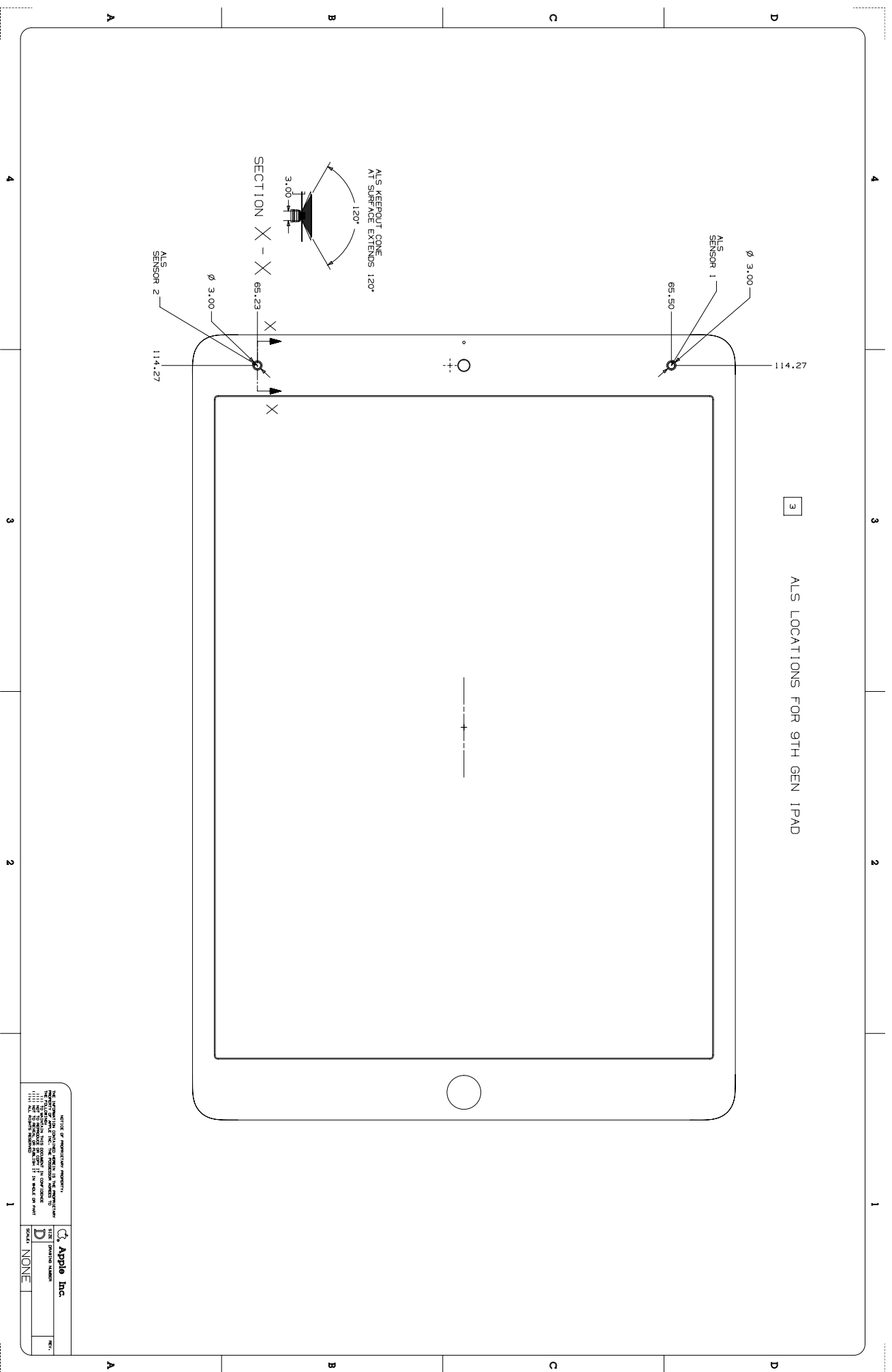


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59.130 iPad (9th generation), iPad (8th generation) and iPad (7th generation), 2 of 4



59.131 iPad (9th generation), iPad (8th generation) and iPad (7th generation), 3 of 4



SECTION OF INDUSTRIAL DRAWING

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DATE: 11/11/2023

DESIGNED BY: [REDACTED]

CHECKED BY: [REDACTED]

DATE: 11/11/2023

SCALE: NONE

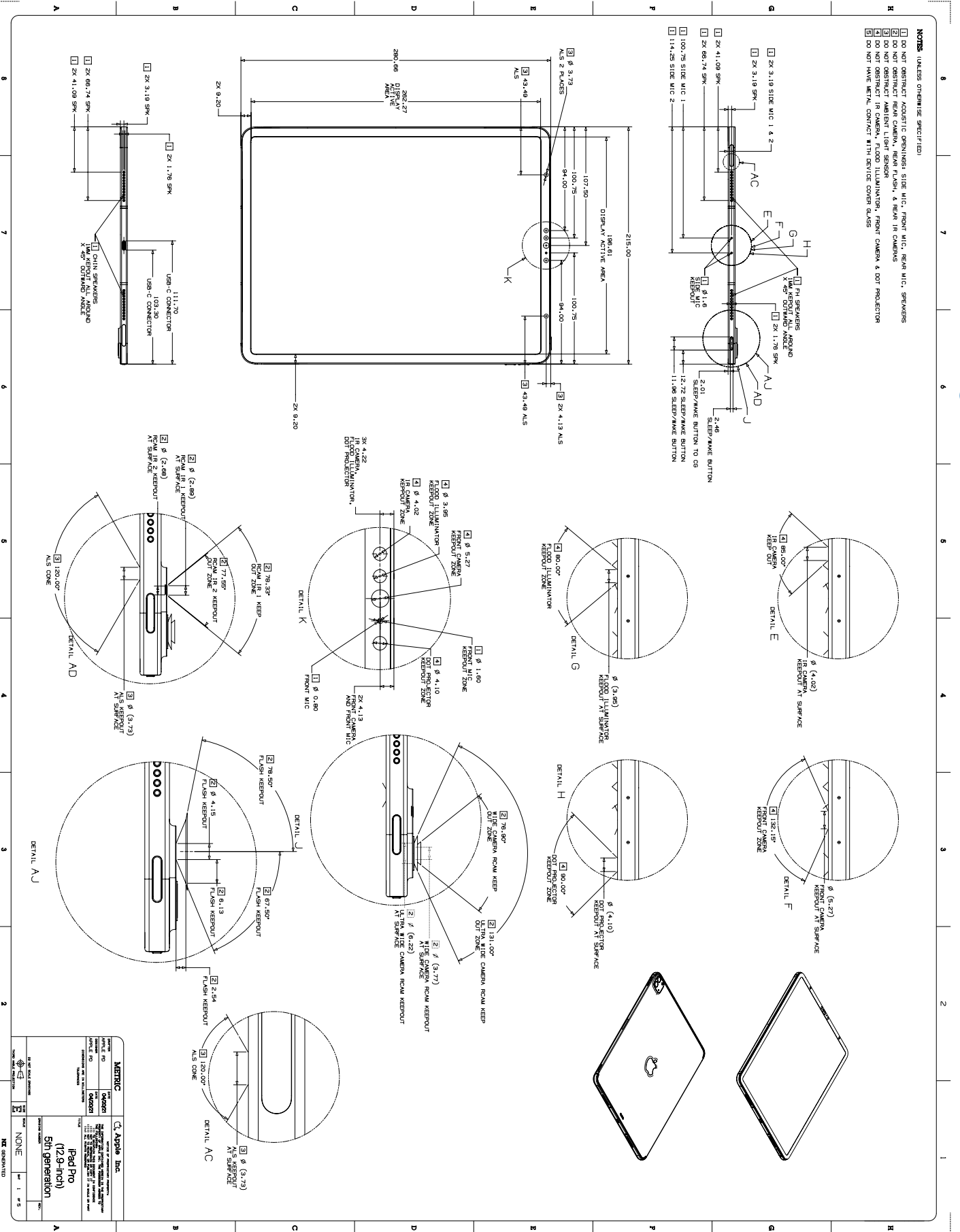
Apple Inc.

TYPE: DRAWING

SIZE: NONE

REV:

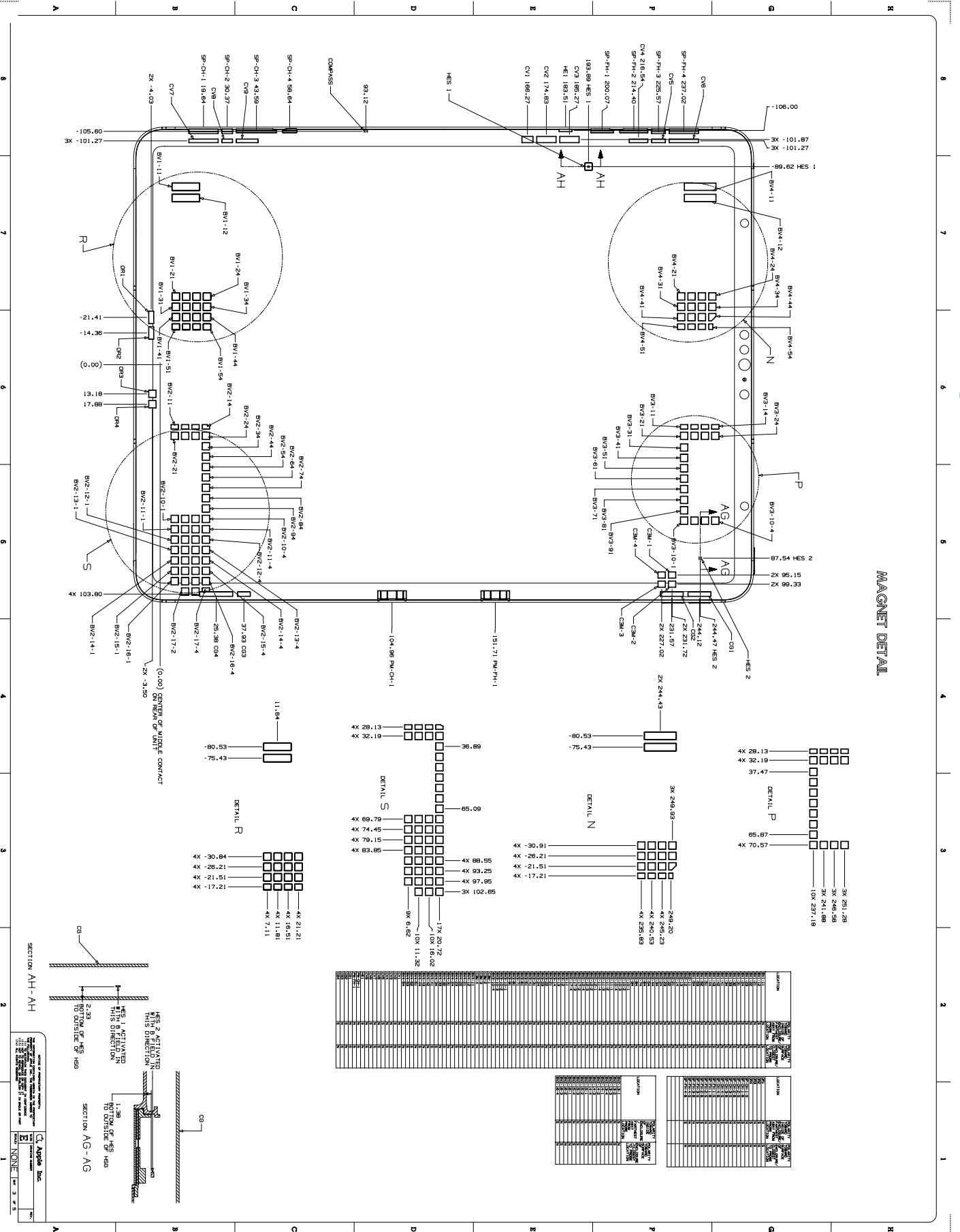
59.133 iPad Pro 12.9-inch (5th generation), 1 of 5



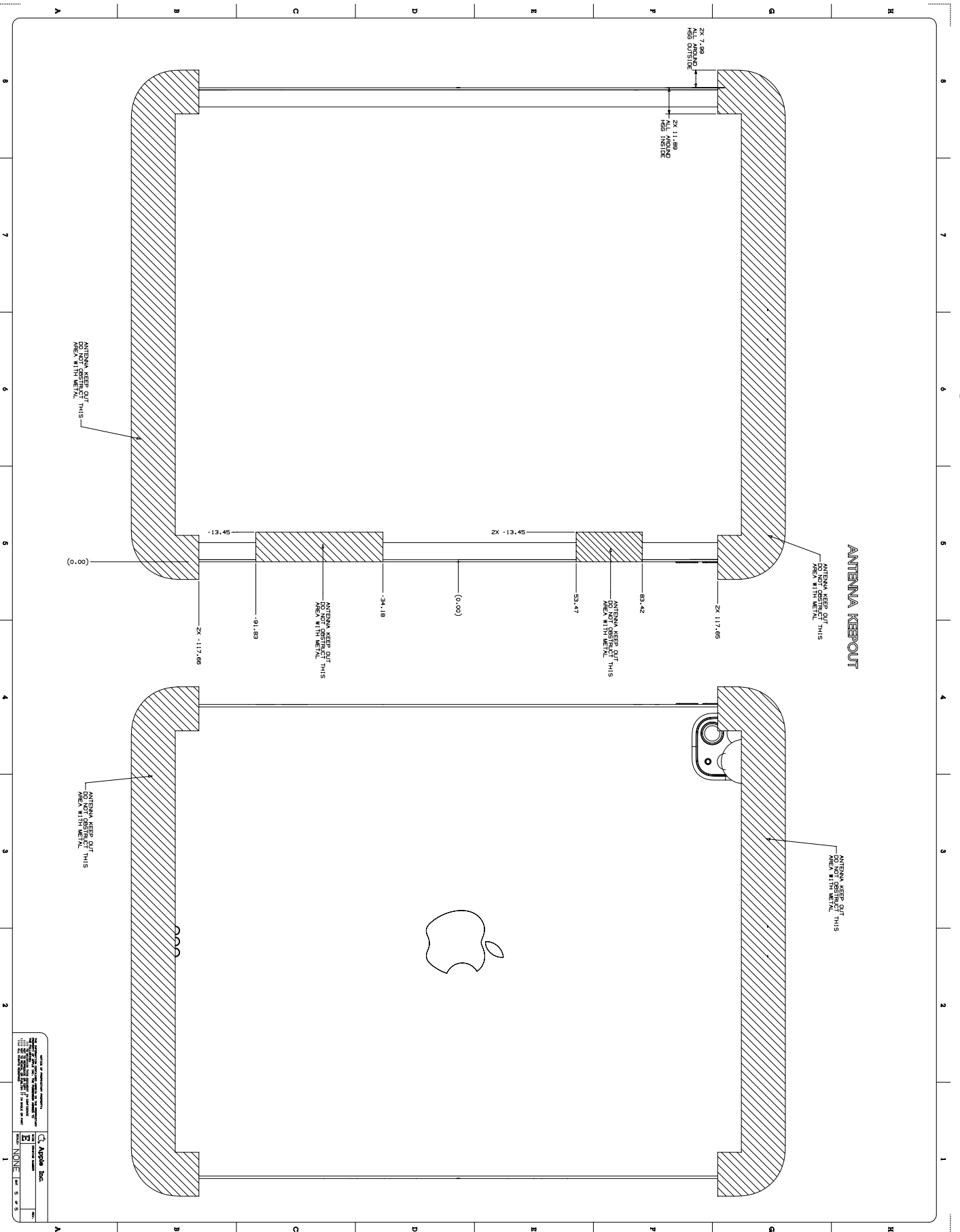
- NOTES:** UNLESS OTHERWISE SPECIFIED:
- DO NOT OBSTRUCT ACOUSTIC PENINGS; SIDE MIC, FRONT MIC, REAR MIC, SPEAKERS
 - DO NOT OBSTRUCT REAR CAMERA, REAR FLASH, & REAR IR CAMERAS
 - DO NOT OBSTRUCT REAR CAMERA LENS, SENSOR, TRANSMITTER, FRONT CAMERA & DOT PROJECTOR
 - DO NOT OBSTRUCT MICROPHONE, TRANSMITTER, FRONT CAMERA & DOT PROJECTOR
 - DO NOT HAVE METAL CONTACT WITH DEVICE COVER GLASS

METRIC		Apple Inc.	
PART NO.	59.133	DATE	11/17/2017
REV.	1	DESCRIPTION	iPad Pro (12.9-inch) 5th generation
ASSEMBLY	1	ISSUED BY	Apple Inc.
CHECKED BY	Apple Inc.	APPROVED BY	Apple Inc.
DRAWN BY	Apple Inc.	SCALE	NONE
ISSUED BY	Apple Inc.	COPY NO.	1 of 5
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MAGNET DETAIL

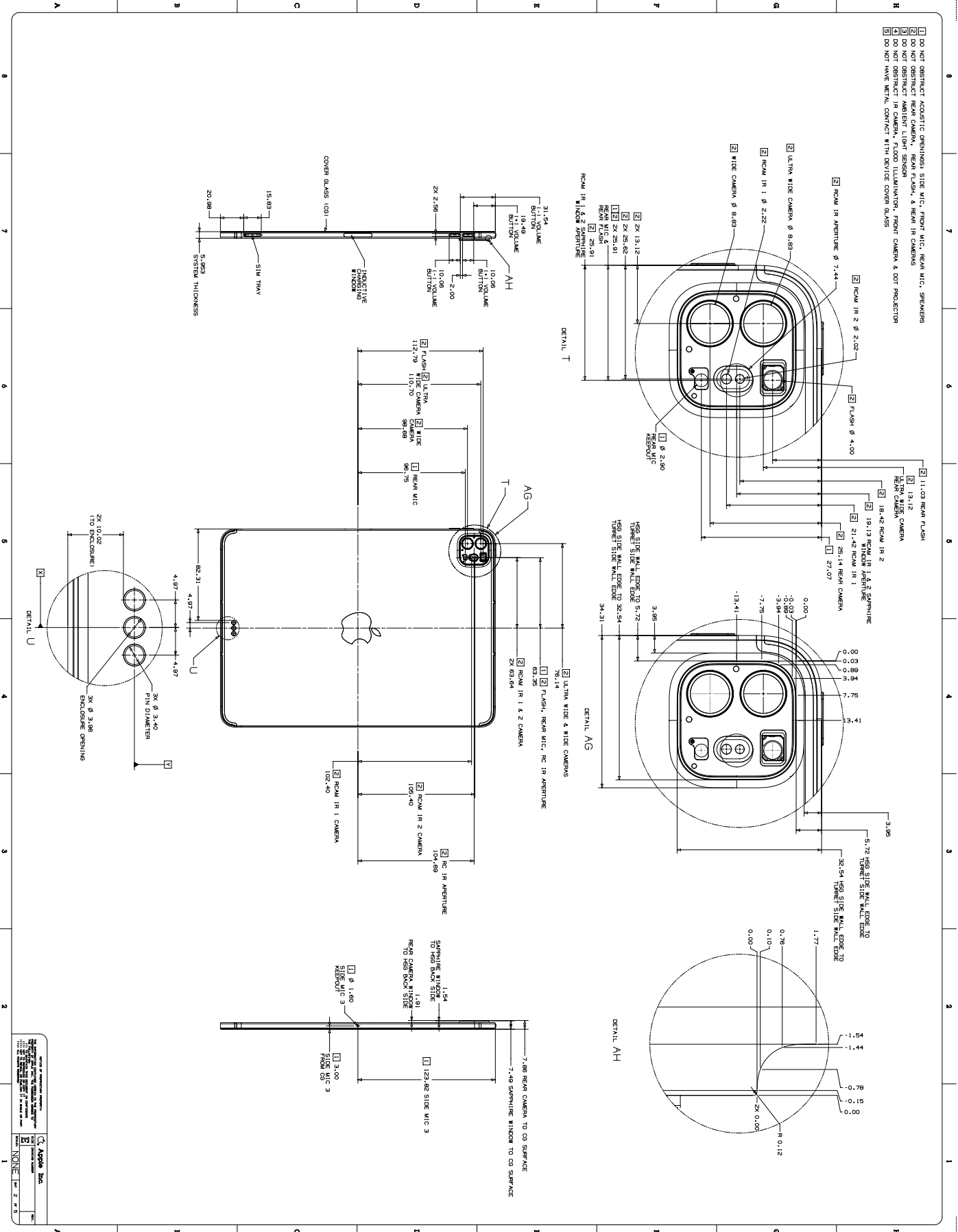


59.137 iPad Pro 12.9-inch (5th generation), 5 of 5

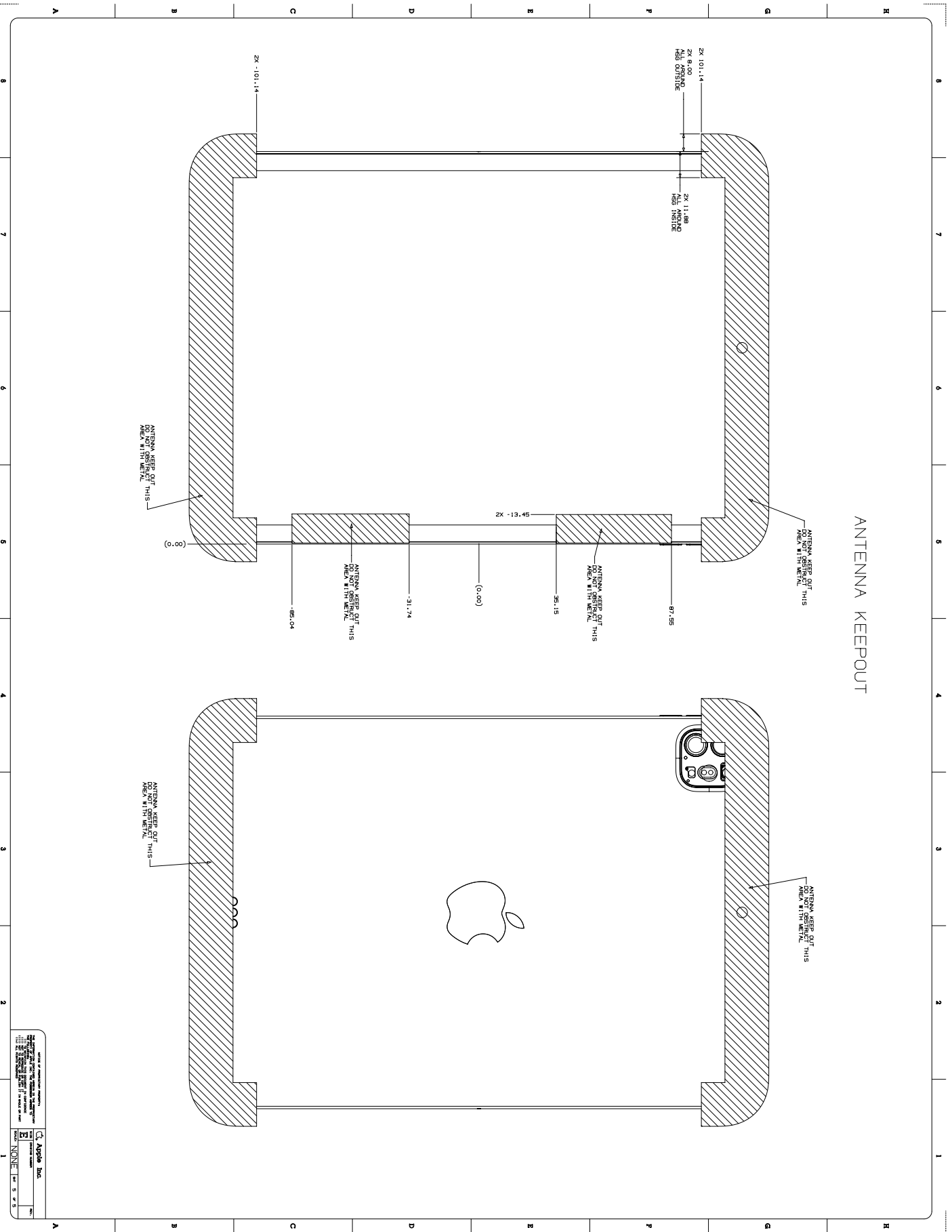


Apple Inc.	
Model	59.137
Version	1.0
Created	2024-10-21
Author	Apple Inc.
Part Name	Antenna Keepout
Material	None
Notes	Antenna Keepout Area with Metal

59.139 iPad Pro 11-inch (3rd generation), 2 of 5

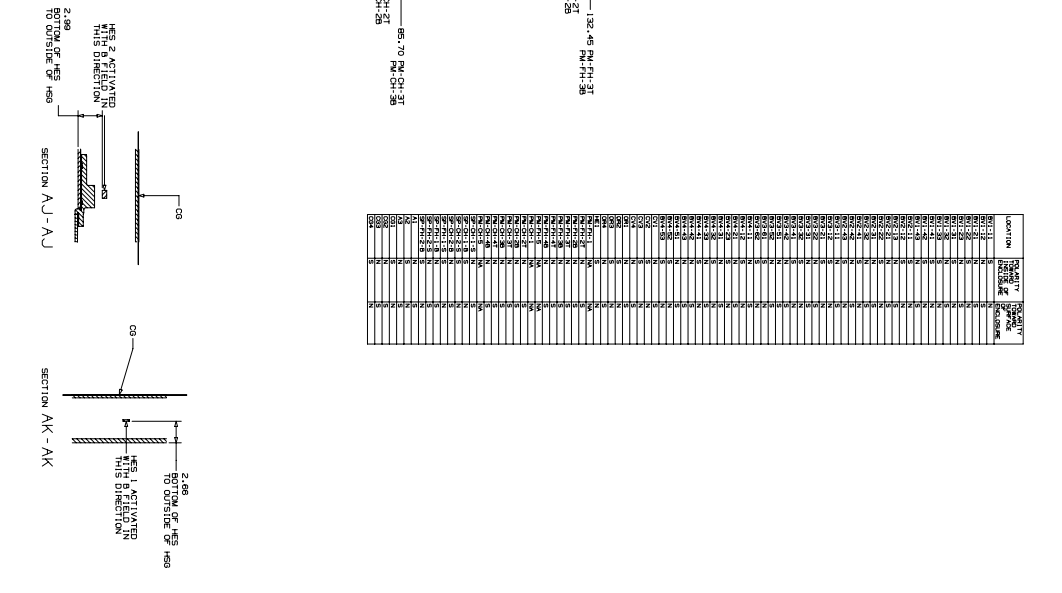
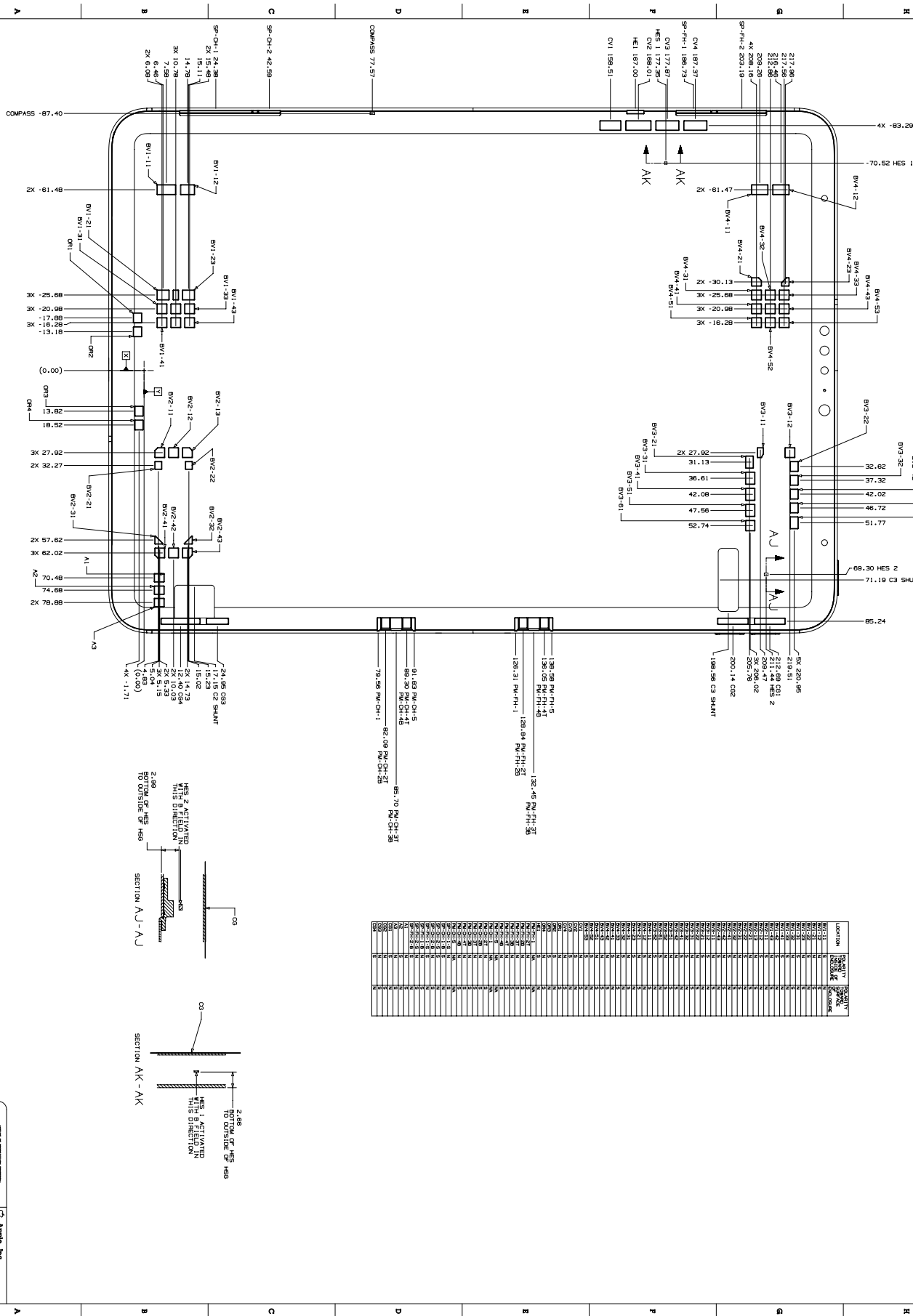


ANTENNA KEEPOUT



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Part Name: ANTENNA KEEPOUT	Revision: 1
Date: 10/21/2024	Author: [Redacted]
Drawing Scale: 1:1	Sheet: 1 of 1

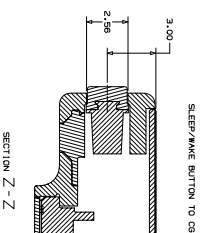
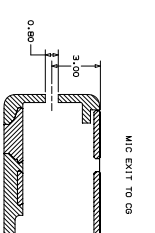
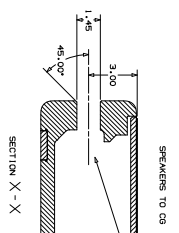
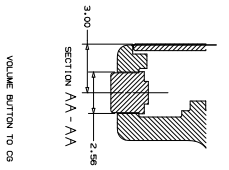
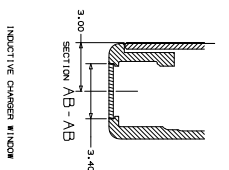
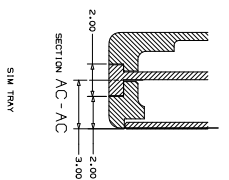
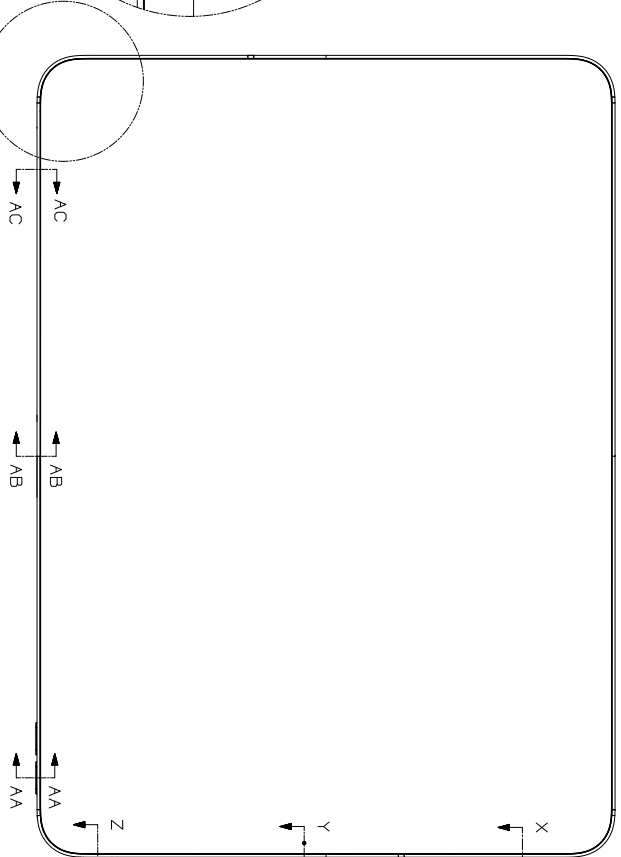
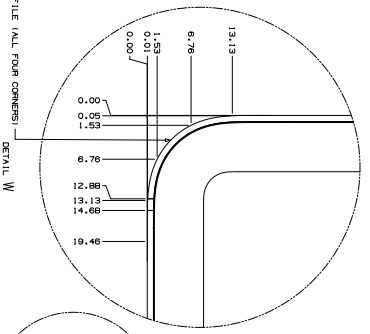
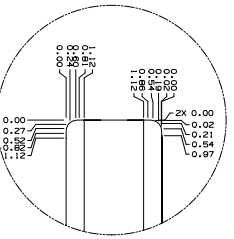
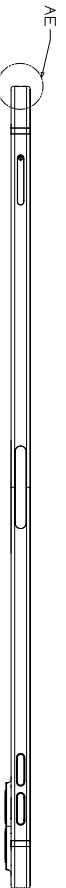
MAGNET DETAIL



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 441

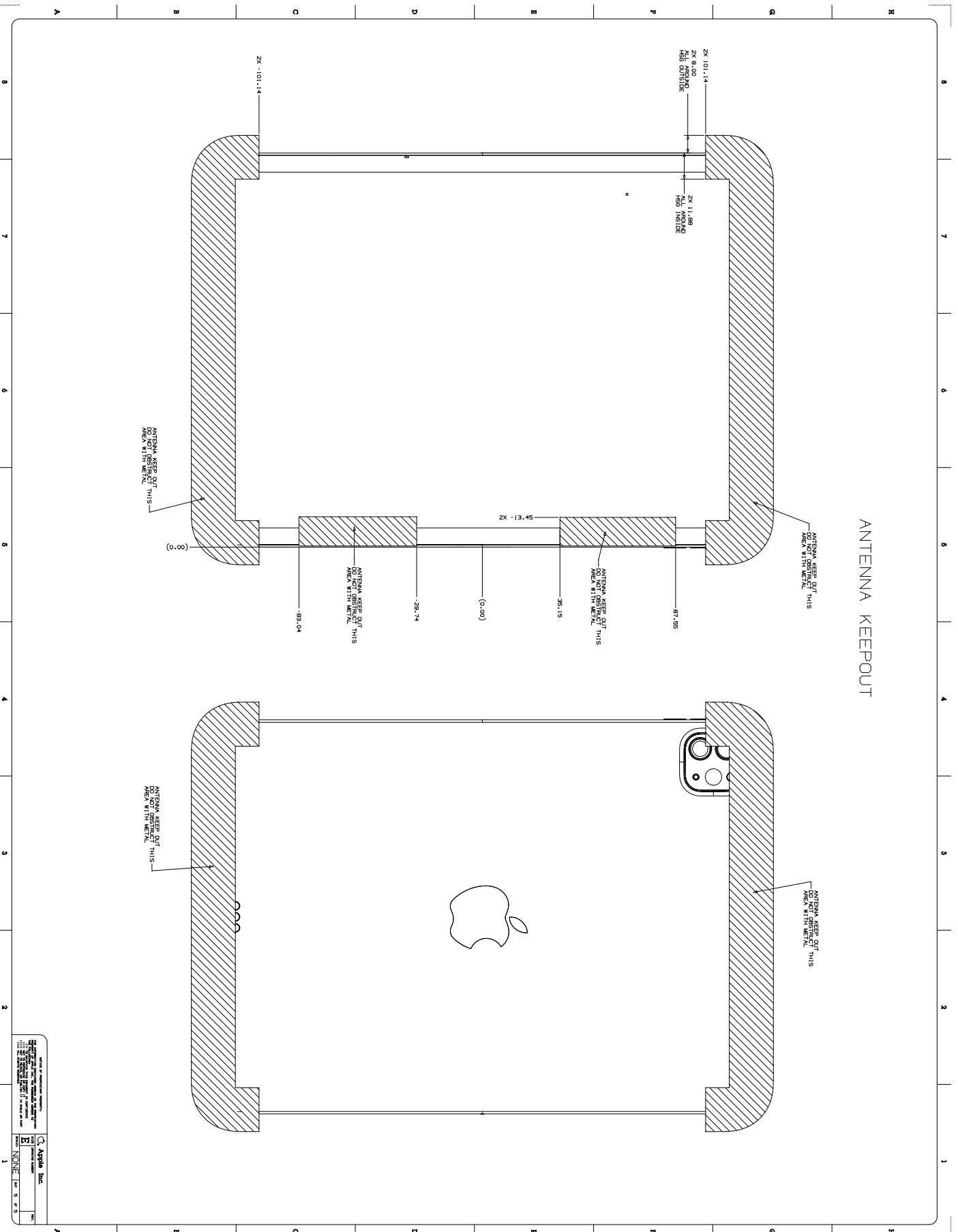
59.151 iPad Pro 11-inch (2nd generation), 4 of 5

SECTION AND DETAIL INFORMATION



Model Number	Capacity	Color	Material	Weight	Dimensions
MLY2LL/A	64 GB	Space Gray	Aluminum	1.35 lb (0.61 kg)	9.76 in (248 mm) H x 7.19 in (183 mm) W x 0.37 in (9.5 mm) D
MLY2LL/A	128 GB	Space Gray	Aluminum	1.35 lb (0.61 kg)	9.76 in (248 mm) H x 7.19 in (183 mm) W x 0.37 in (9.5 mm) D
MLY2LL/A	256 GB	Space Gray	Aluminum	1.35 lb (0.61 kg)	9.76 in (248 mm) H x 7.19 in (183 mm) W x 0.37 in (9.5 mm) D
MLY2LL/A	512 GB	Space Gray	Aluminum	1.35 lb (0.61 kg)	9.76 in (248 mm) H x 7.19 in (183 mm) W x 0.37 in (9.5 mm) D
MLY2LL/A	1 TB	Space Gray	Aluminum	1.35 lb (0.61 kg)	9.76 in (248 mm) H x 7.19 in (183 mm) W x 0.37 in (9.5 mm) D
MLY2LL/A	2 TB	Space Gray	Aluminum	1.35 lb (0.61 kg)	9.76 in (248 mm) H x 7.19 in (183 mm) W x 0.37 in (9.5 mm) D
MLY2LL/A	64 GB	Gold	Aluminum	1.35 lb (0.61 kg)	9.76 in (248 mm) H x 7.19 in (183 mm) W x 0.37 in (9.5 mm) D
MLY2LL/A	128 GB	Gold	Aluminum	1.35 lb (0.61 kg)	9.76 in (248 mm) H x 7.19 in (183 mm) W x 0.37 in (9.5 mm) D
MLY2LL/A	256 GB	Gold	Aluminum	1.35 lb (0.61 kg)	9.76 in (248 mm) H x 7.19 in (183 mm) W x 0.37 in (9.5 mm) D
MLY2LL/A	512 GB	Gold	Aluminum	1.35 lb (0.61 kg)	9.76 in (248 mm) H x 7.19 in (183 mm) W x 0.37 in (9.5 mm) D
MLY2LL/A	1 TB	Gold	Aluminum	1.35 lb (0.61 kg)	9.76 in (248 mm) H x 7.19 in (183 mm) W x 0.37 in (9.5 mm) D
MLY2LL/A	2 TB	Gold	Aluminum	1.35 lb (0.61 kg)	9.76 in (248 mm) H x 7.19 in (183 mm) W x 0.37 in (9.5 mm) D
MLY2LL/A	64 GB	Silver	Aluminum	1.35 lb (0.61 kg)	9.76 in (248 mm) H x 7.19 in (183 mm) W x 0.37 in (9.5 mm) D
MLY2LL/A	128 GB	Silver	Aluminum	1.35 lb (0.61 kg)	9.76 in (248 mm) H x 7.19 in (183 mm) W x 0.37 in (9.5 mm) D
MLY2LL/A	256 GB	Silver	Aluminum	1.35 lb (0.61 kg)	9.76 in (248 mm) H x 7.19 in (183 mm) W x 0.37 in (9.5 mm) D
MLY2LL/A	512 GB	Silver	Aluminum	1.35 lb (0.61 kg)	9.76 in (248 mm) H x 7.19 in (183 mm) W x 0.37 in (9.5 mm) D
MLY2LL/A	1 TB	Silver	Aluminum	1.35 lb (0.61 kg)	9.76 in (248 mm) H x 7.19 in (183 mm) W x 0.37 in (9.5 mm) D
MLY2LL/A	2 TB	Silver	Aluminum	1.35 lb (0.61 kg)	9.76 in (248 mm) H x 7.19 in (183 mm) W x 0.37 in (9.5 mm) D

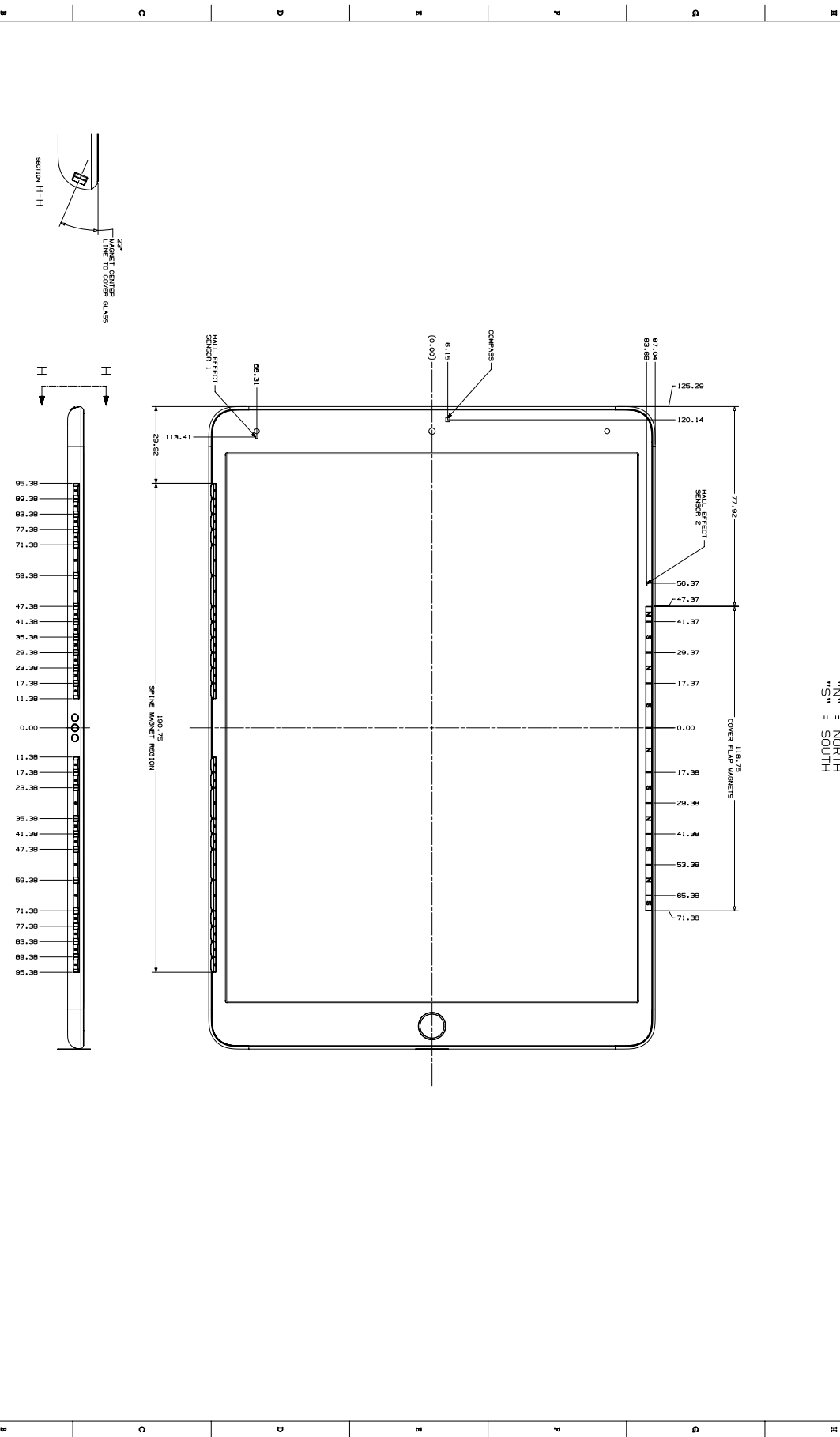
ANTENNA KEEPOUT



Model or specification identifier 59.152 iPad Pro 11-inch (2nd generation)		Apple Inc. 1 Apple Park Way Cupertino, CA 95014 USA Model: 59.152
Part number NONE	Date 1	

59.154 iPad Air (3rd generation), 2 of 3

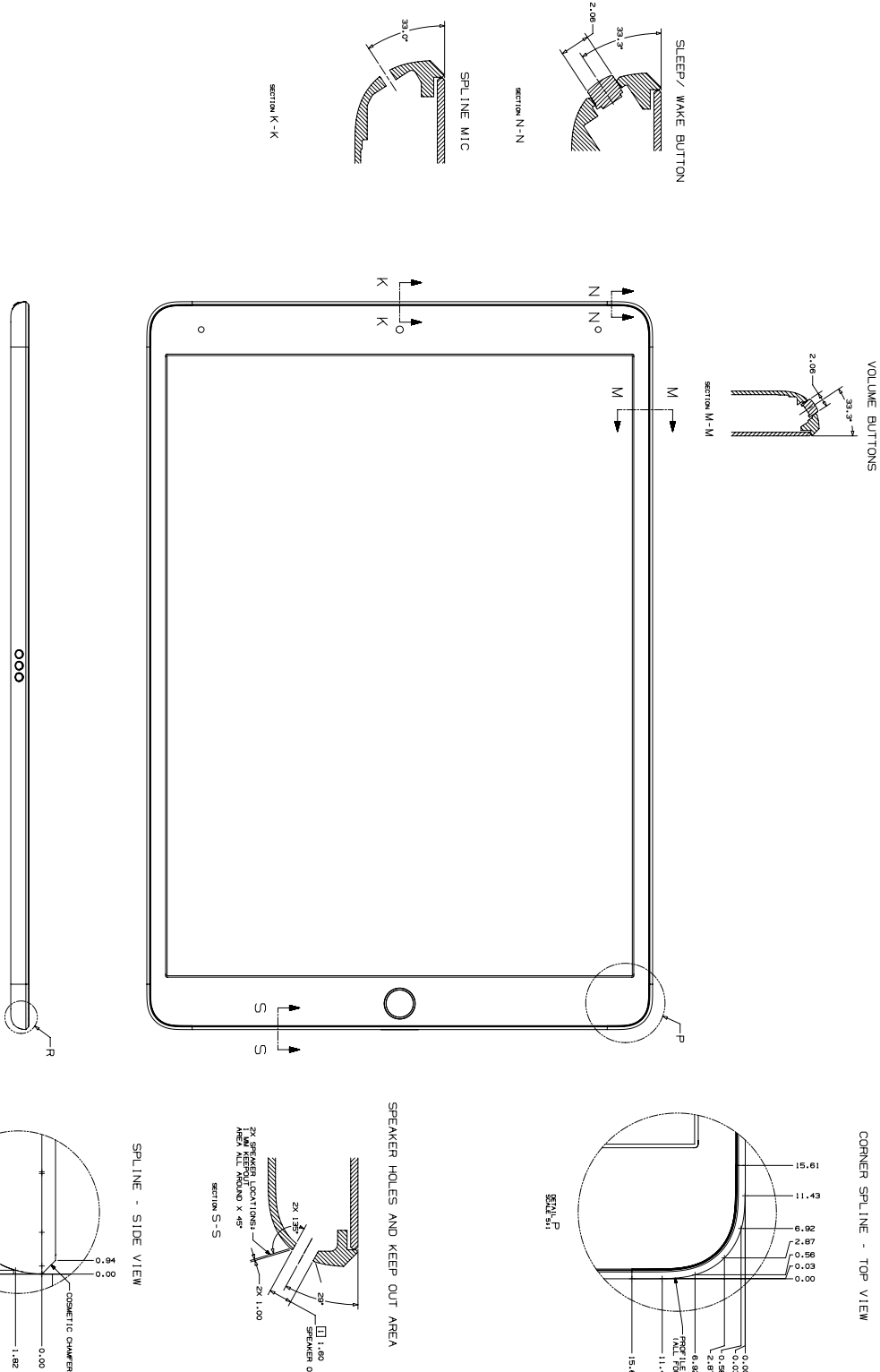
COVER FLAP MAGNET DETAIL
 POLARITY SHOWN NORMAL TO GLASS
 DIMENSIONS TO CENTER OF PRODUCT
 N = NORTH
 S = SOUTH



Apple Inc. 1 Apple Park Way Cupertino, CA 95014 © 2024 Apple Inc. All rights reserved.	
Part Name: 59.154 iPad Air (3rd generation) Part Number: 59.154 Revision: 01	Date: 2024-10-21 Author: [Name] Engineer: [Name]

59.155 iPad Air (3rd generation), 3 of 3

SECTION AND DETAIL INFORMATION

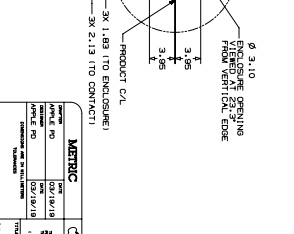
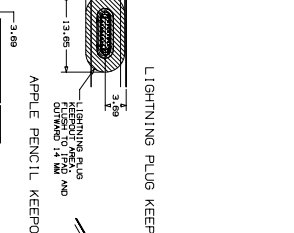
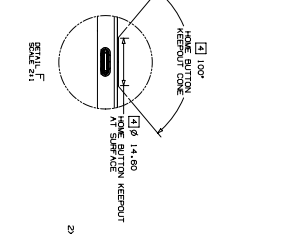
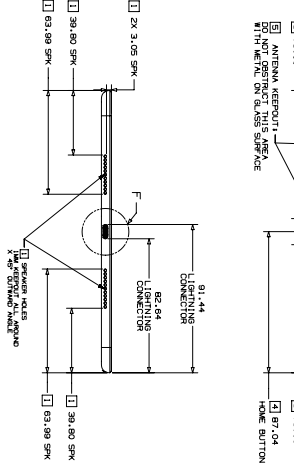
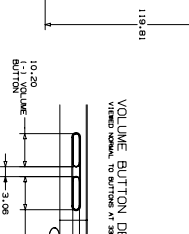
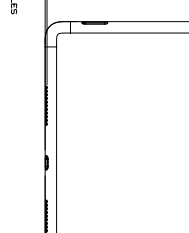
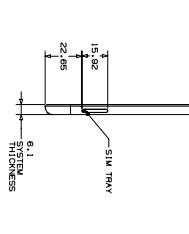
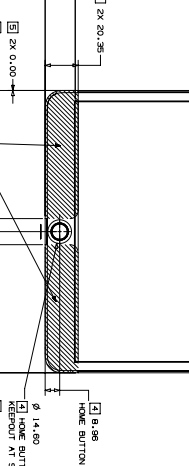
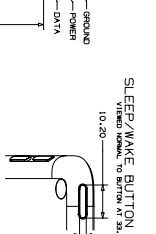
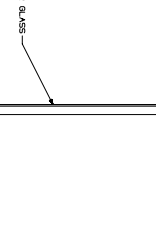
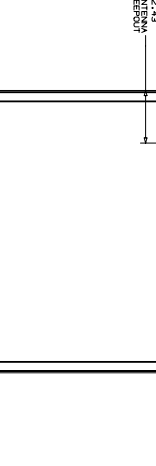
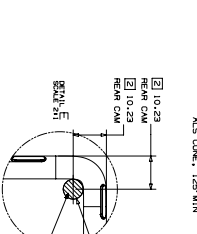
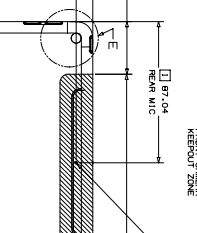
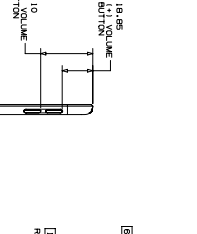
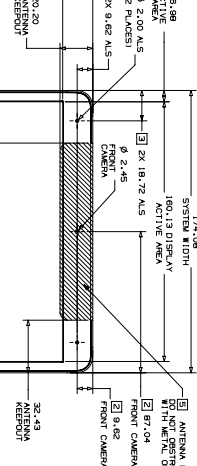
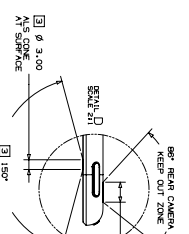
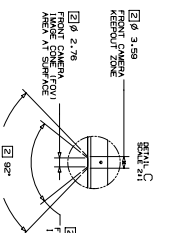
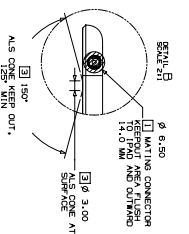
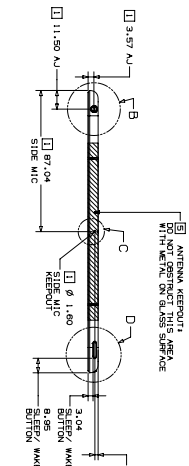
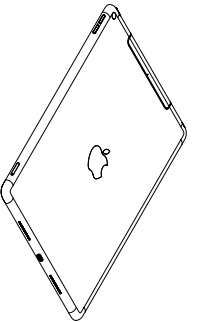
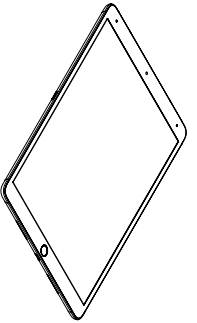


A 8 7 6 5 4 3 2 1

<small>SECTION OF REGISTERED INFORMATION</small> <small>DATE: 02/25/2023 10:10:35 AM</small> <small>DESIGNED BY: [REDACTED]</small> <small>CHECKED BY: [REDACTED]</small> <small>DRAWN BY: [REDACTED]</small> <small>SCALE: 1.00</small>		<small>Apple Inc.</small> <small>01</small>
<small>NON-CONFIDENTIAL</small>		<small>01</small>

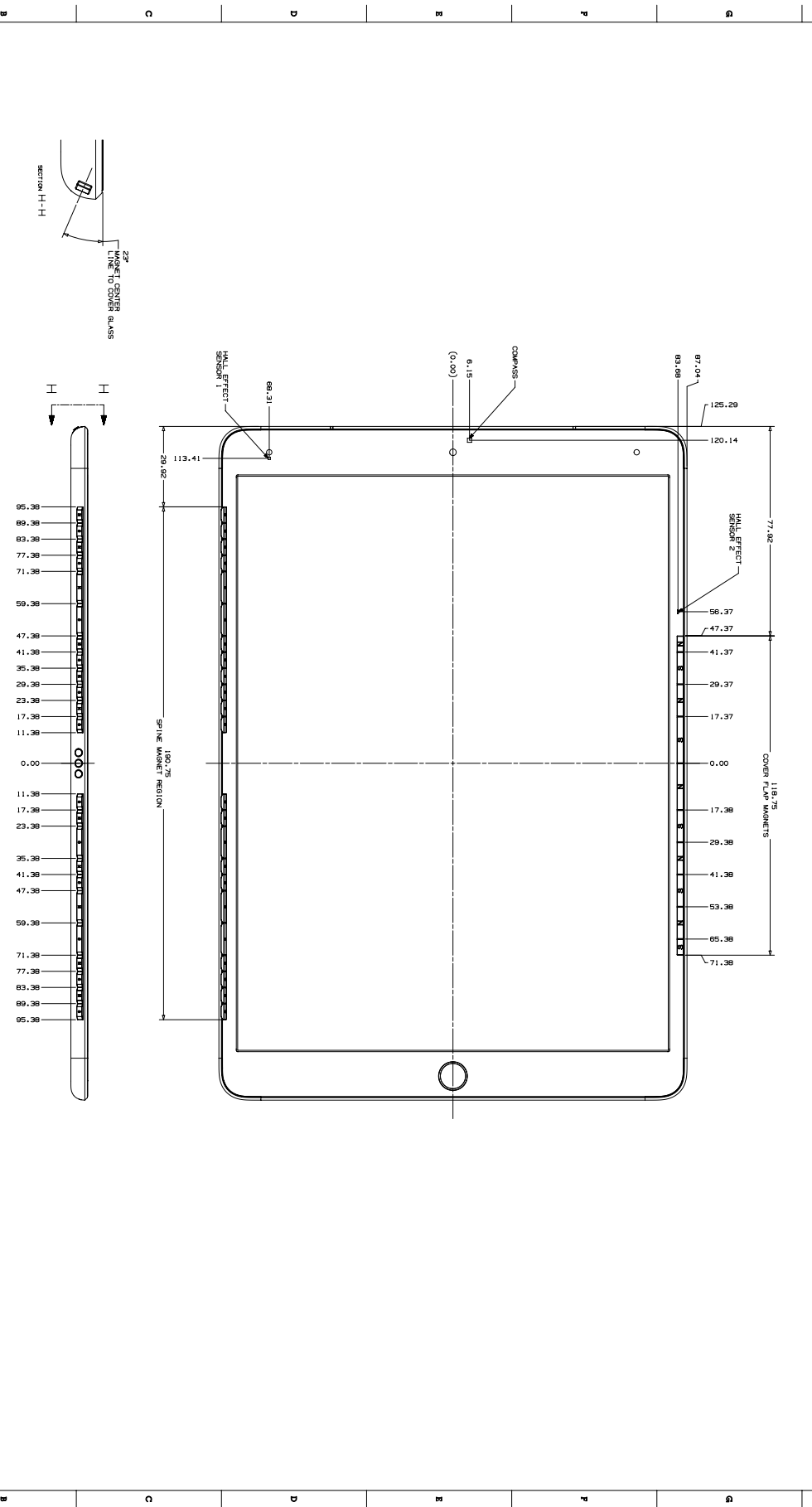
59.156 iPad Air (3rd generation) with Cellular, 1 of 3

- NOTES**
- 1 DO NOT OBSTRUCT ACOUSTIC GROUNDS, SIDE MIC, REAR MIC, AUDIO JACK, SPEAKERS
 - 2 DO NOT OBSTRUCT THE IMAGING FEATURES FROM CAMERA, REAR CAMERA, REAR FLASH
 - 3 DO NOT OBSTRUCT THE AMBIENT LIGHT SENSOR (ALS)
 - 4 DO NOT OBSTRUCT THE HOME BUTTON
 - 5 DO NOT HAVE METAL CONTACT WITH DEVICE COVER GLASS
 - 6 DO NOT HAVE METAL CONTACT WITH DEVICE ENCLOSURE



59.157 iPad Air (3rd generation) with Cellular, 2 of 3

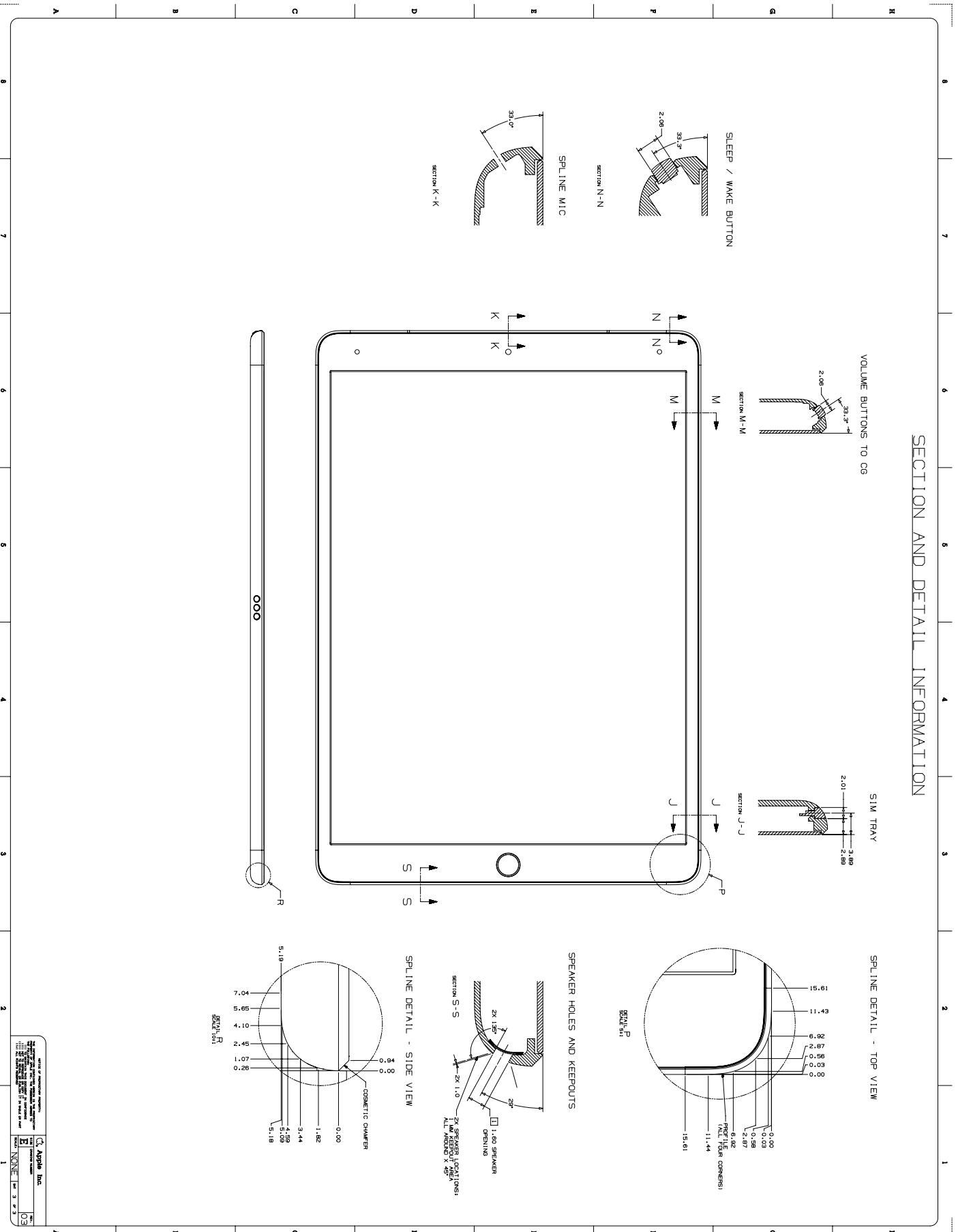
COVER FLAP MAGNET DETAIL
 POLARITY SHOWN NORMAL TO GLASS
 DIMENSIONS TO CENTER OF PRODUCT
 N = NORTH
 S = SOUTH



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 03

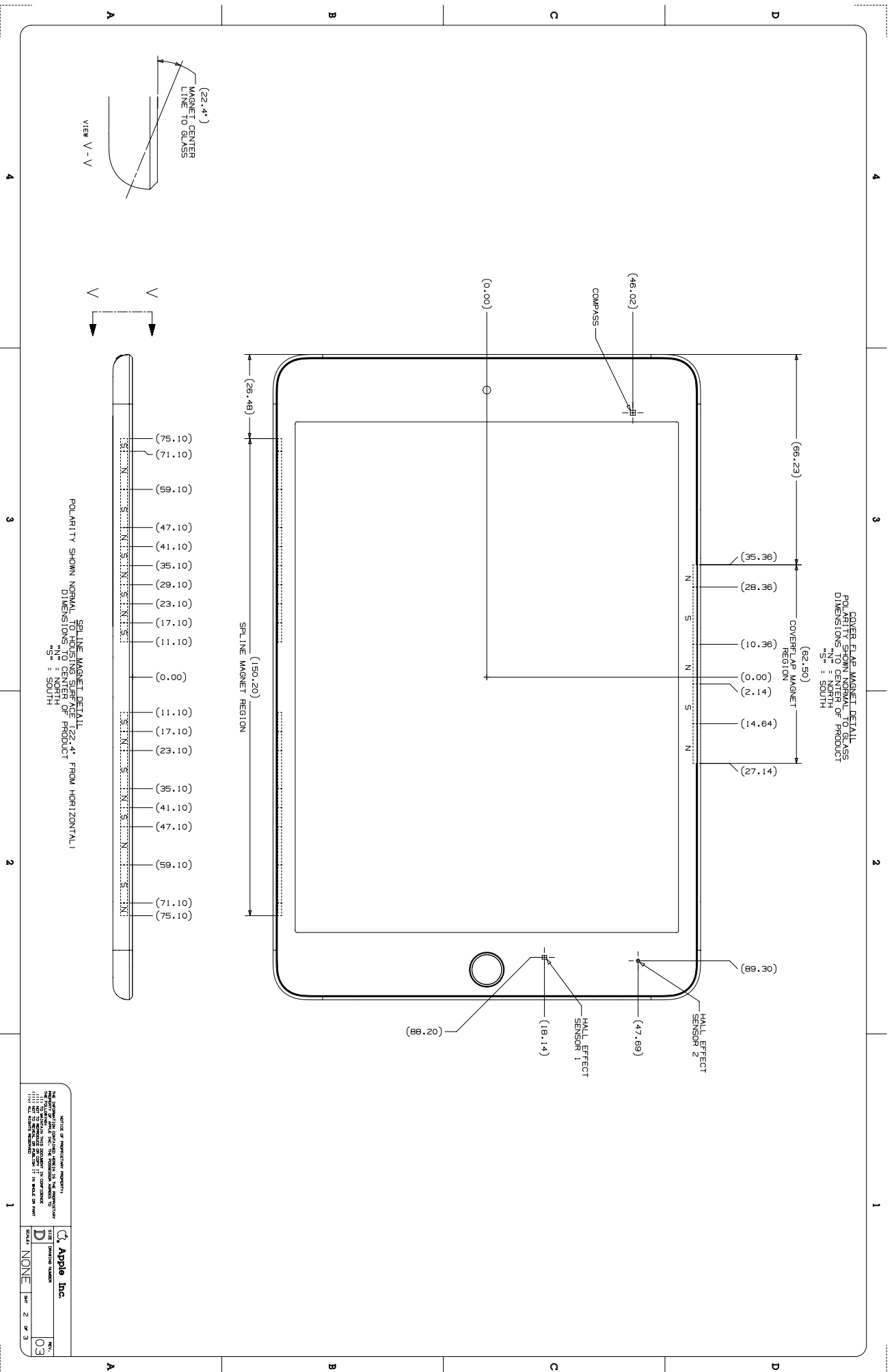
59.158 iPad Air (3rd generation) with Cellular, 3 of 3

SECTION AND DETAIL INFORMATION



Apple Inc.	
Model	03
Material	NONE
Color	3
Finish	3
Part Name	NONE
Part Number	03

59.160 iPad mini (5th generation), 2 of 3

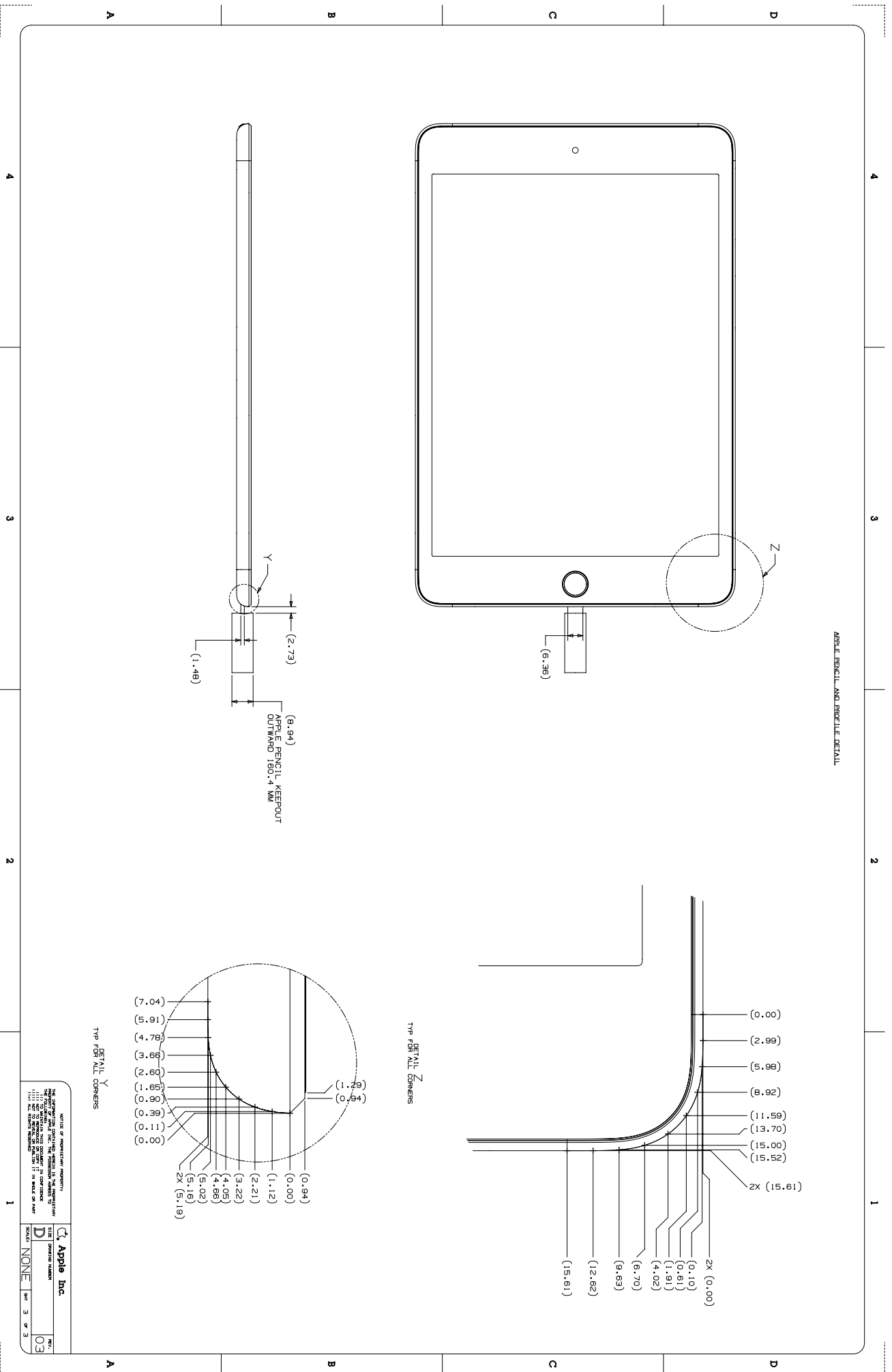


Apple Inc.
 Apple logo
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03

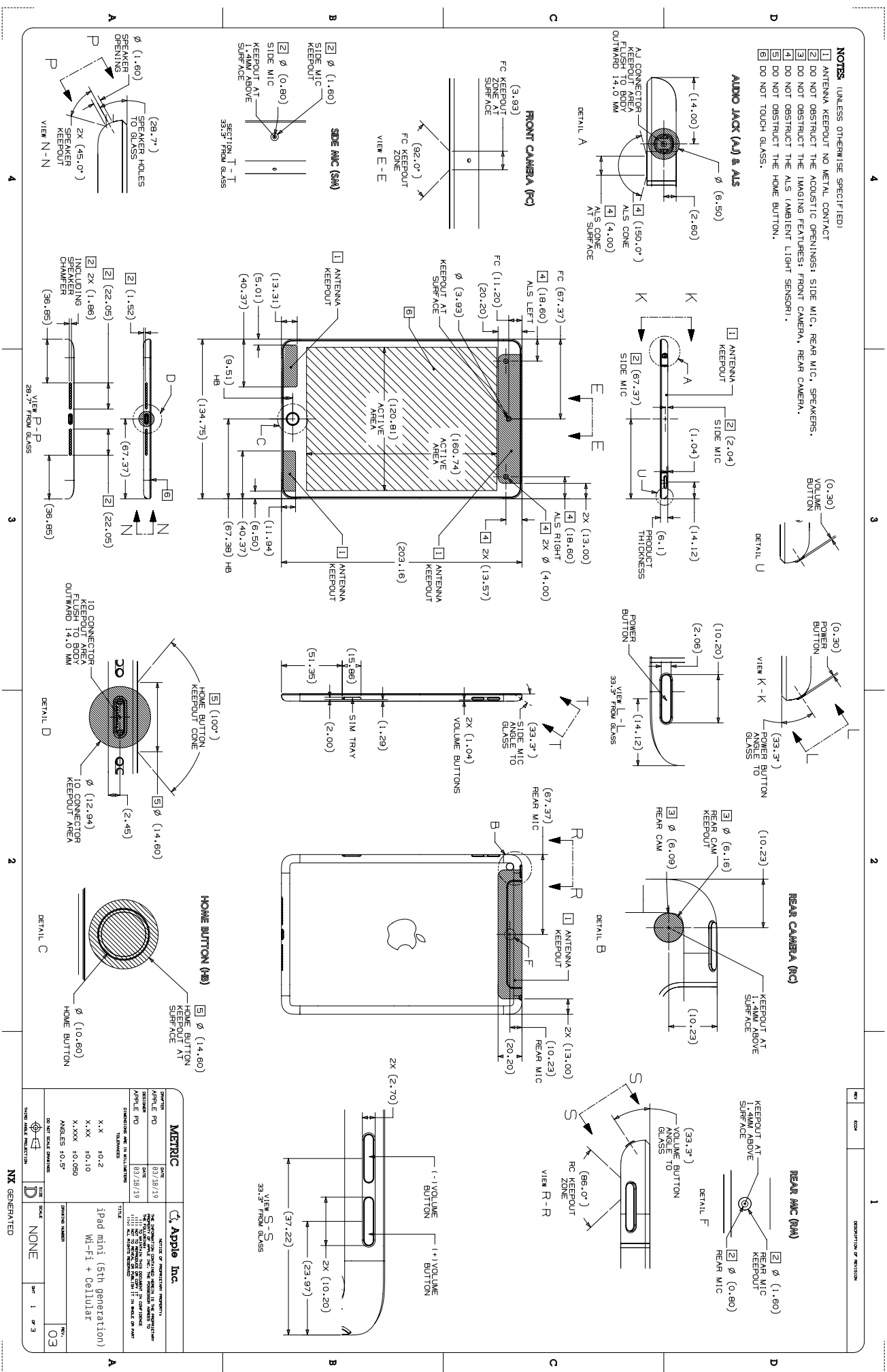
59.161 iPad mini (5th generation), 3 of 3

APPLE PENCIL AND PROFILE DETAIL

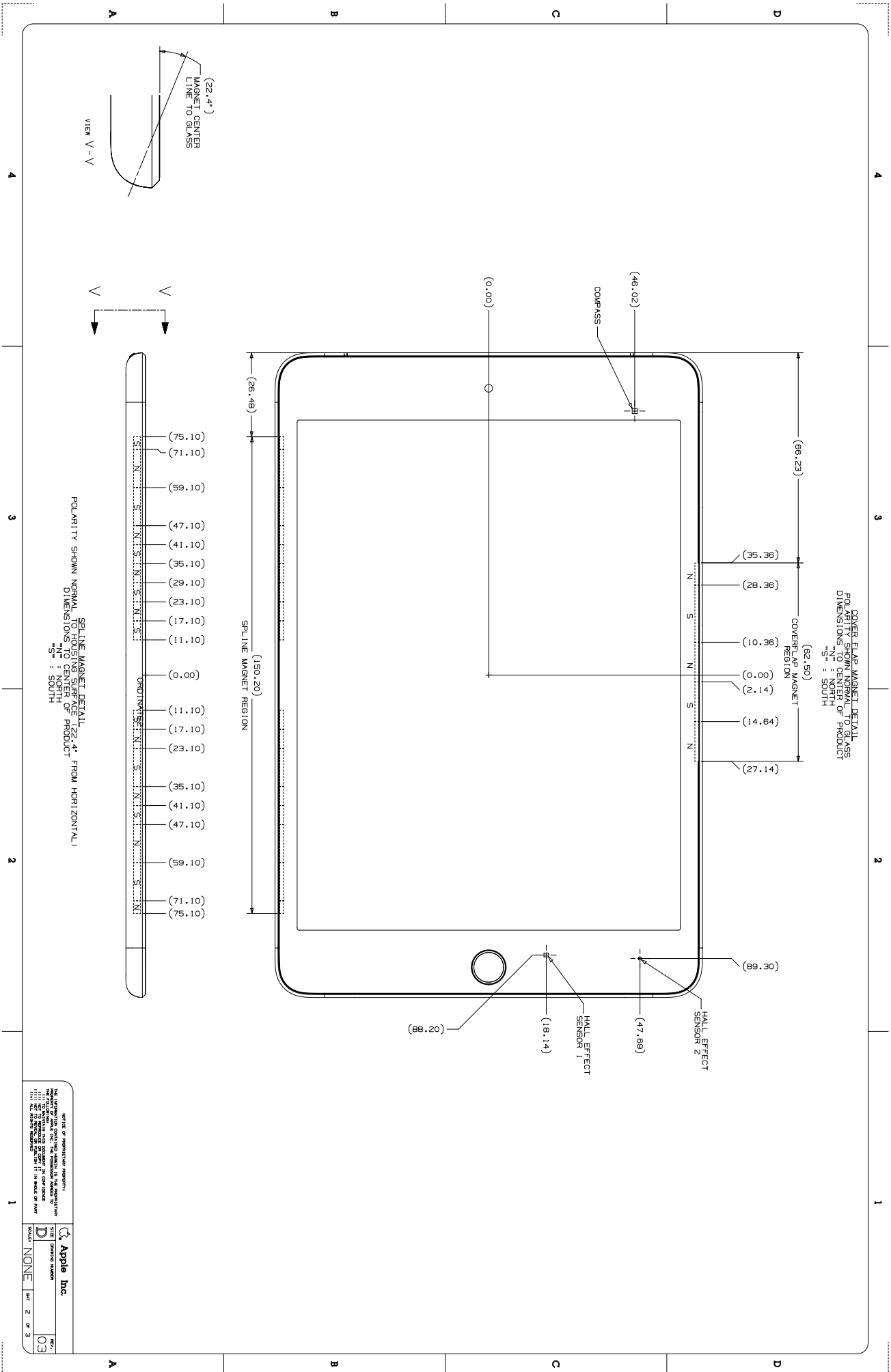


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Model: A2709
 Part Number: 59.161.03
 Revision: 3 of 3



59.163 iPad mini (5th generation) with Cellular, 2 of 3

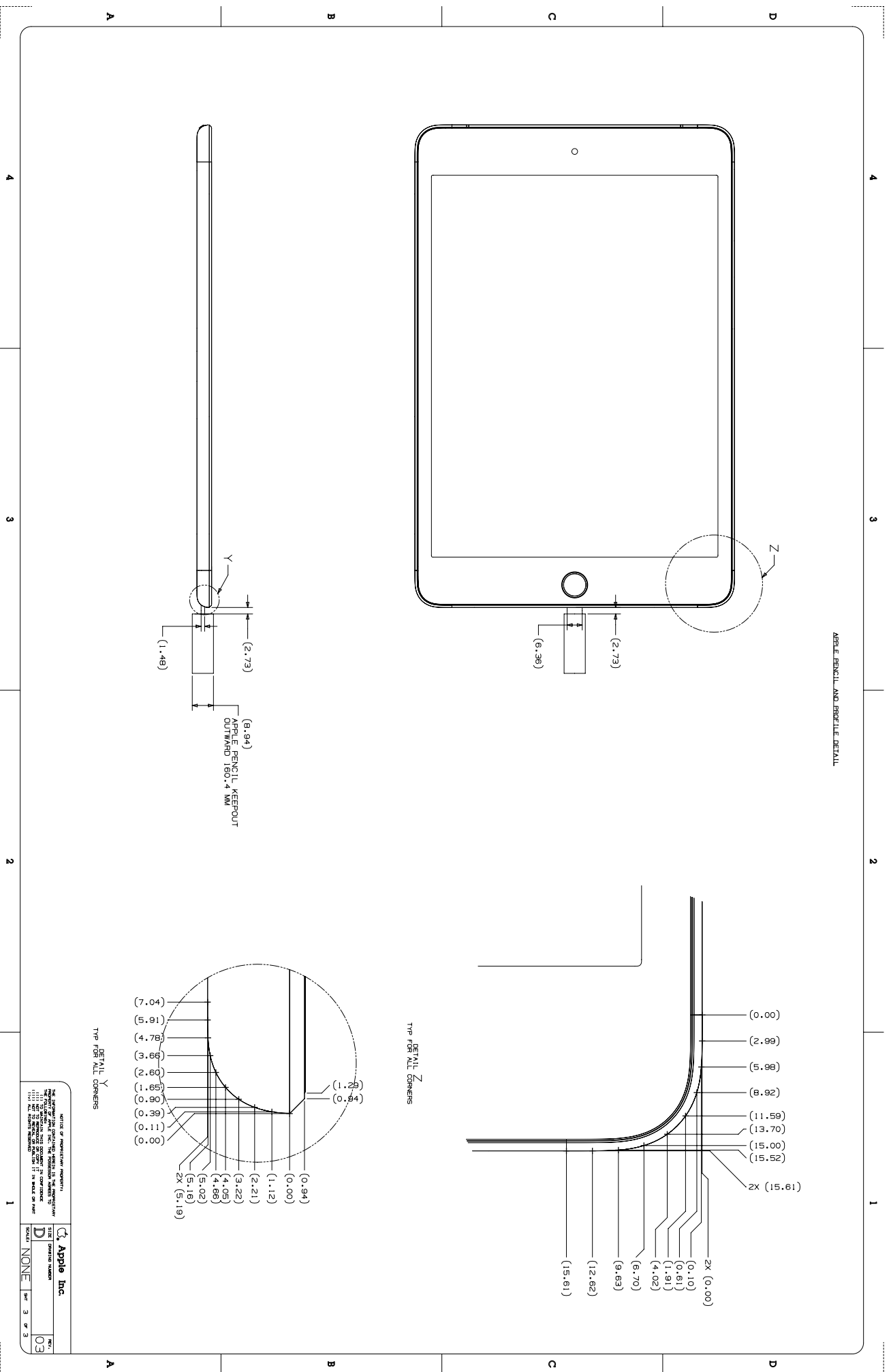


Apple Inc.
Apple logo
Model: NONE
Rev: 03

Apple Inc.
Apple logo
Model: NONE
Rev: 03

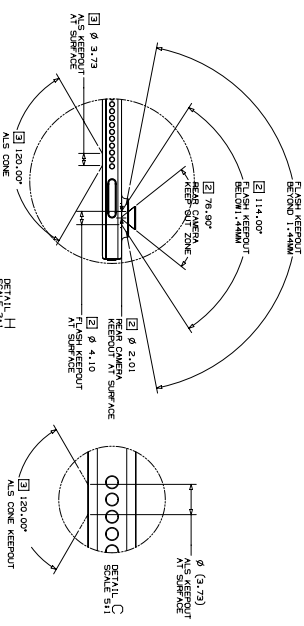
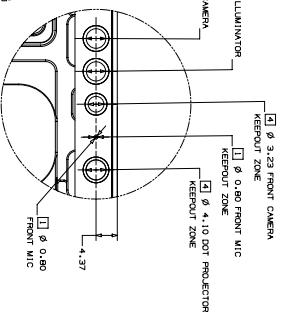
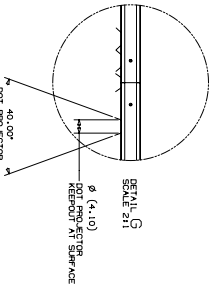
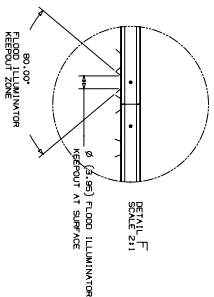
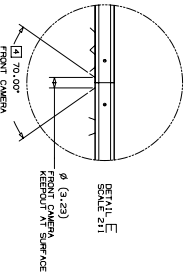
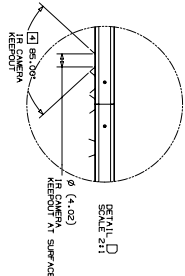
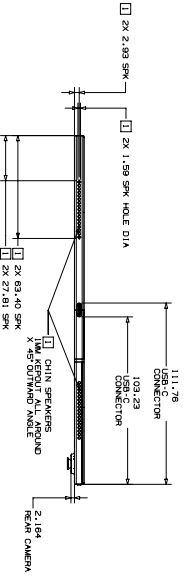
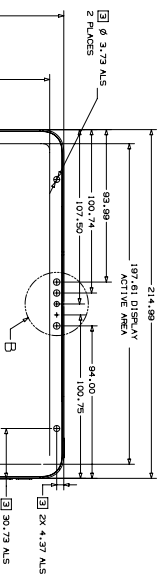
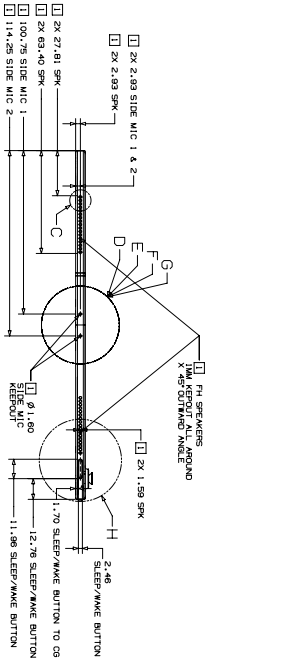
59.164 iPad mini (5th generation) with Cellular, 3 of 3

APPLE PENCIL AND PROFILE DETAIL



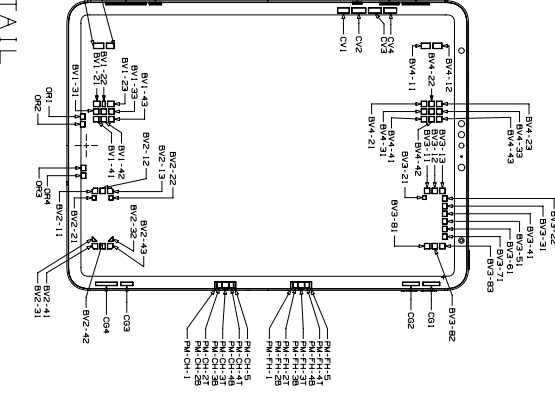
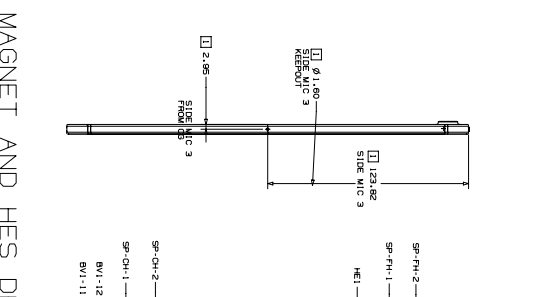
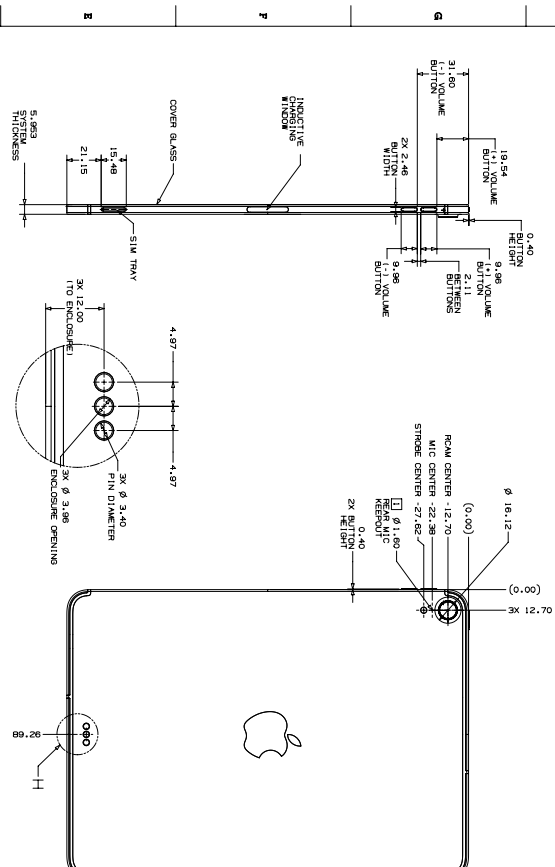
Apple Inc.
 Apple Pencil (5th generation) with Cellular
 Model: A2709
 Part Number: 59.164
 Revision: 3 of 3

- NOTES:** (UNLESS OTHERWISE SPECIFIED)
- 1 DO NOT OBSTRUCT ACOUSTIC OPENINGS: REAR MIC, SIDE MICS, FRONT MIC, SPEAKERS
 - 2 DO NOT OBSTRUCT REAR CAMERA & REAR FLASH
 - 3 DO NOT OBSTRUCT AMBIENT LIGHT SENSOR
 - 4 DO NOT OBSTRUCT IR CAMERA, FLOOD ILLUMINATOR, FRONT CAMERA & DOT PROJECTOR
 - 5 DO NOT HAVE METAL CONTACT WITH DEVICE COVER GLASS

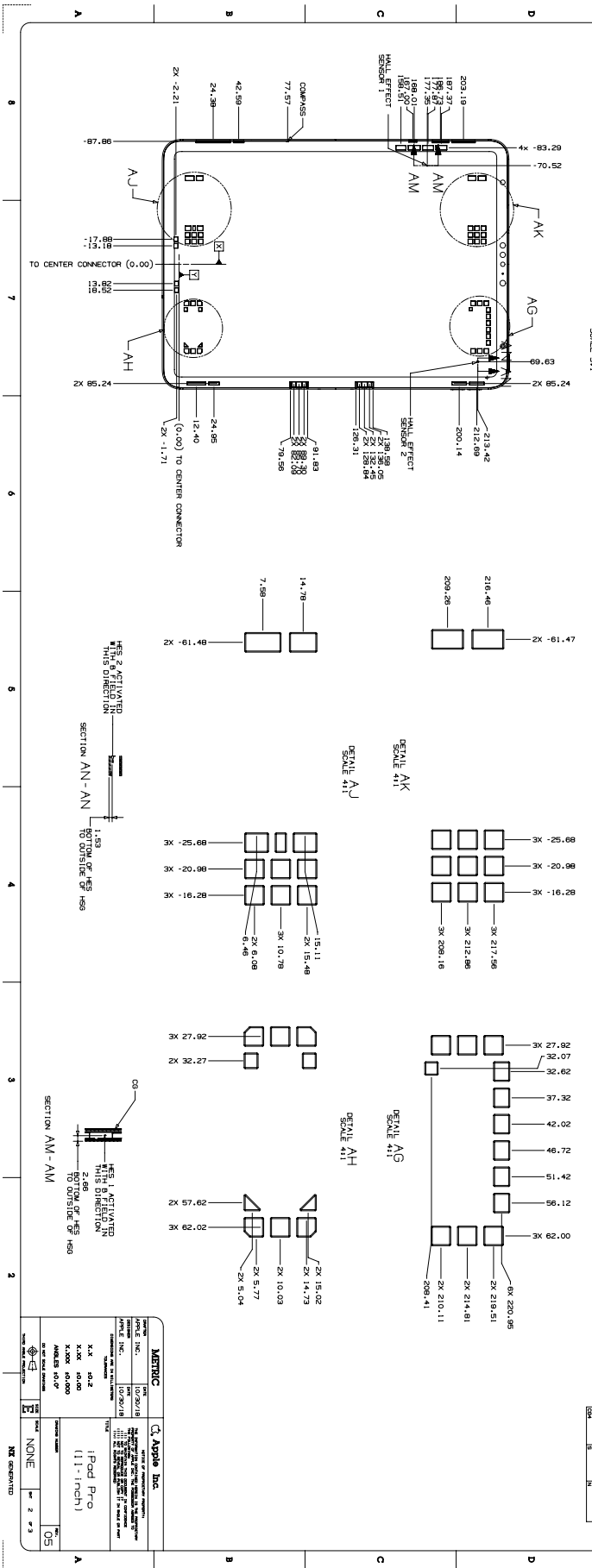


METRIC		Apple Inc.	
DATE:	10/27/21	REV:	04
DESIGNER:	Apple Inc.	ENGINEER:	Apple Inc.
CHECKED:	Apple Inc.	APPROVED:	Apple Inc.
PART NAME:	IPAD PRO (12.9-INCH) 3RD GENERATION	QUANTITY:	1
DESCRIPTION:	IPAD PRO (12.9-INCH) 3RD GENERATION	ASSEMBLY:	NONE
SCALE:	1:1	UNIT:	MM
DATE:	10/27/21	TIME:	1:30
BY:	Apple Inc.	CHKD:	Apple Inc.
APP'D:	Apple Inc.	DATE:	10/27/21

- NOTES:** (UNLESS OTHERWISE SPECIFIED)
- 1 DO NOT OBSTRUCT ACOUSTIC OPENINGS: REAR MIC, SIDE MICS, FRONT MIC, SPEAKERS
 - 2 DO NOT OBSTRUCT REAR CAMERA & REAR FLASH
 - 3 DO NOT OBSTRUCT AMBIENT LIGHT SENSOR
 - 4 DO NOT OBSTRUCT IR CAMERA, FLUOR ILLUMINATION, FRONT CAMERA & DOT PROJECTOR
 - 5 DO NOT HAVE METAL CONTACT WITH DEVICE COVER GLASS

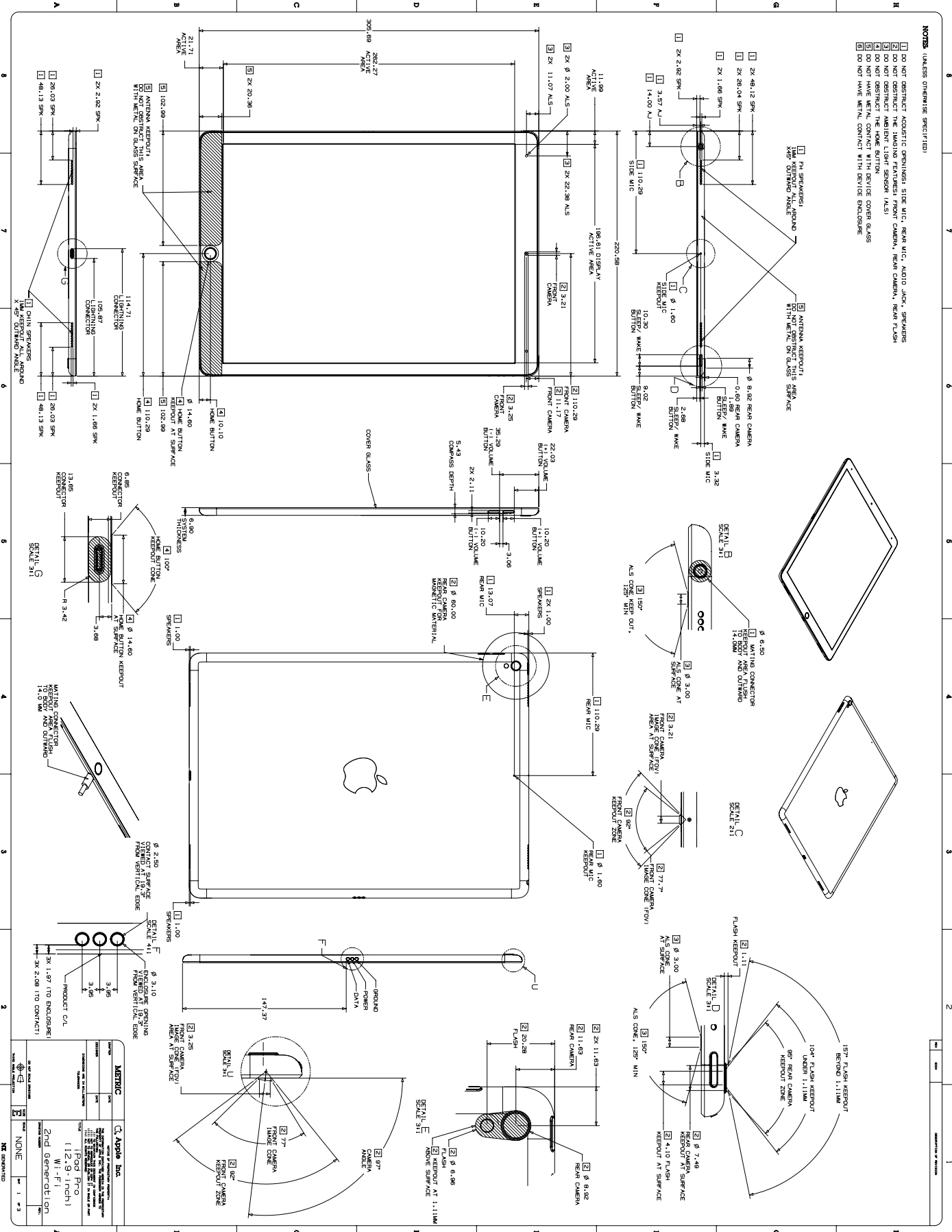


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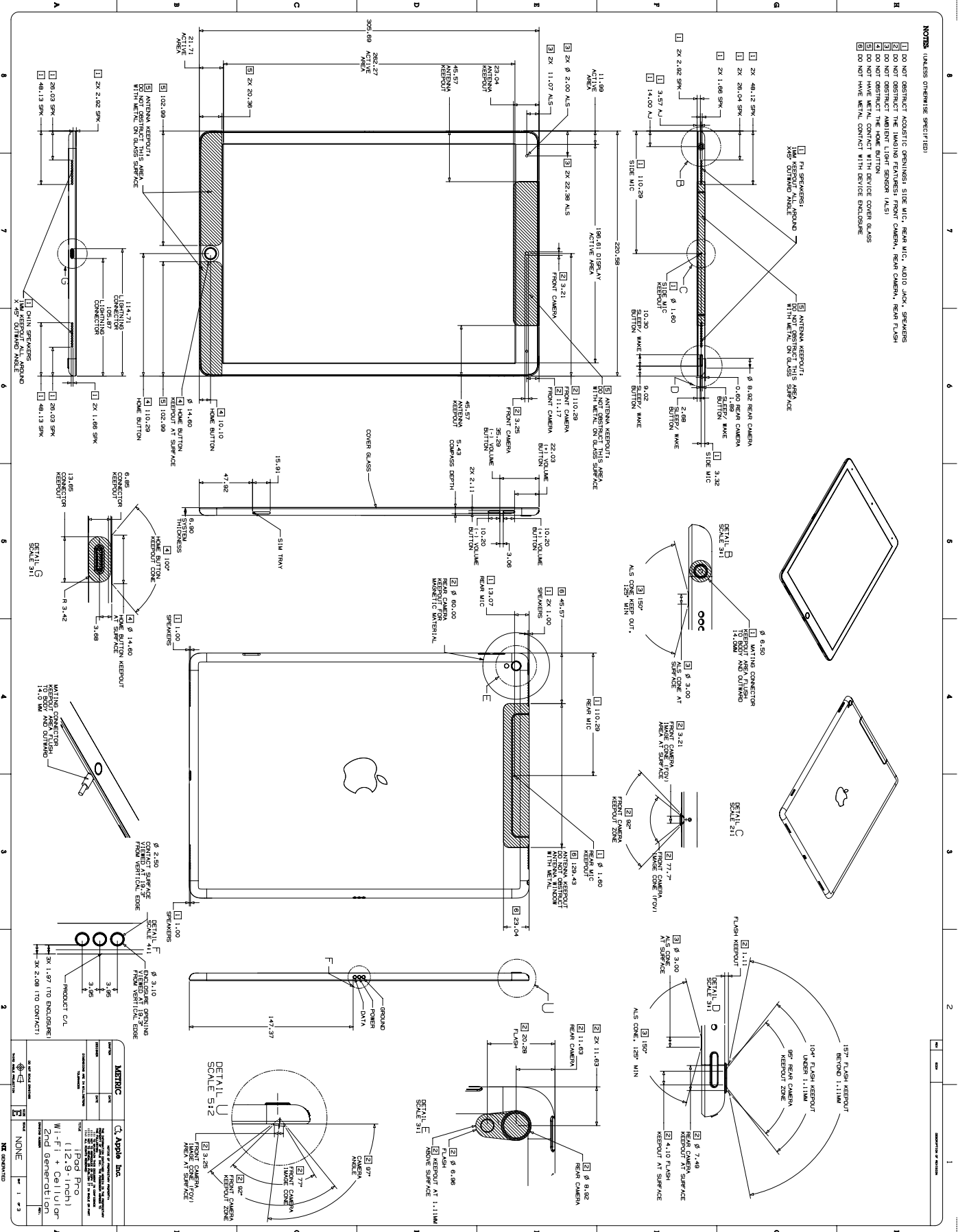


METRIC		Apple Inc.	
DATE:	10/20/18	REV:	05
SCALE:	1:1	DESCRIPTION:	IPad Pro (11-inch)
DESIGNED BY:		APPROVED BY:	
CHECKED BY:		DATE:	10/20/18
STATUS:	FOR PRODUCTION	REVISIONS:	
NO. OF SHEETS:	2	OF:	2
NONE			
NOT QUOTED			

59.171 iPad Pro 12.9-inch (2nd generation)

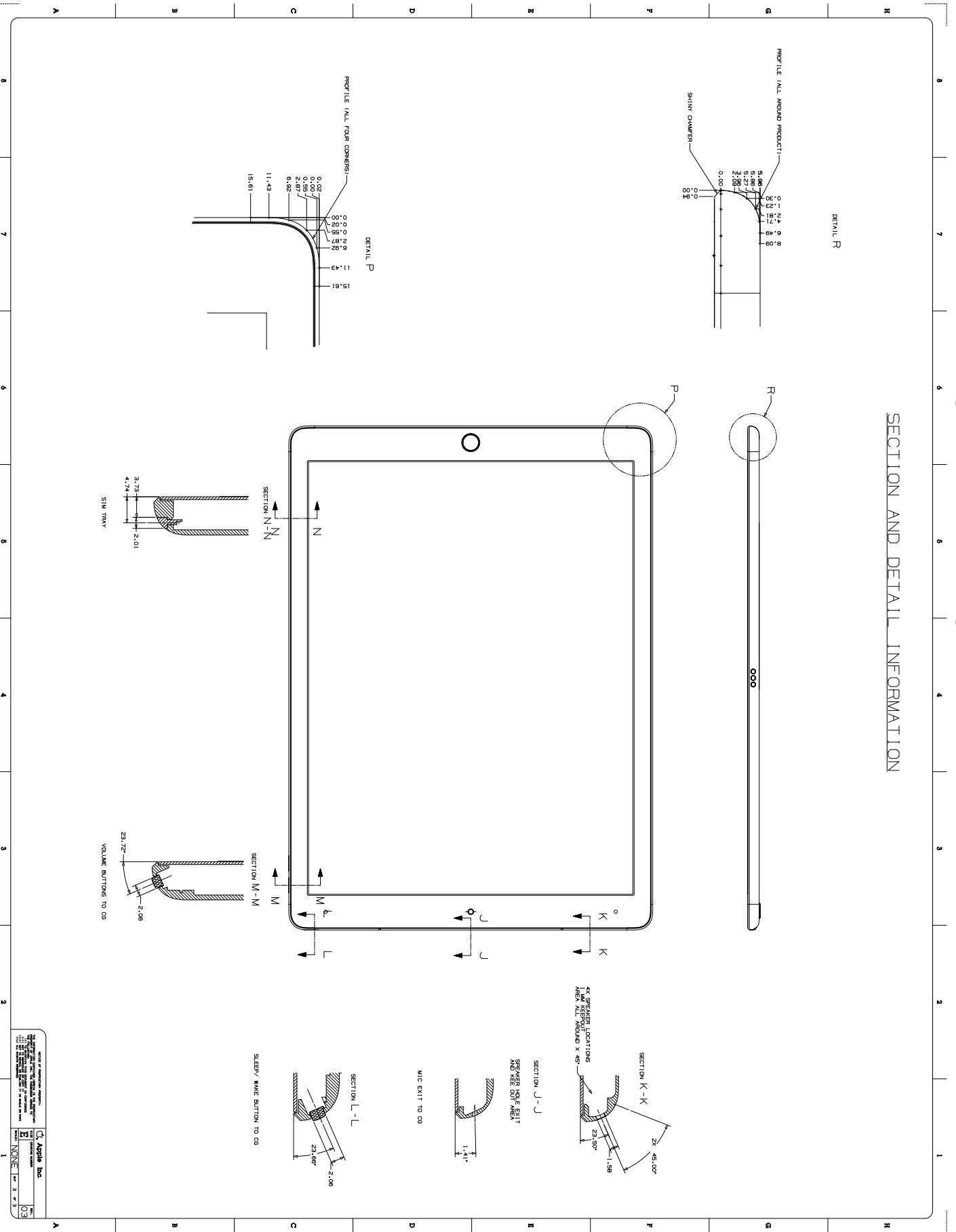


59.172 iPad Pro 12.9-inch (2nd generation) with Cellular



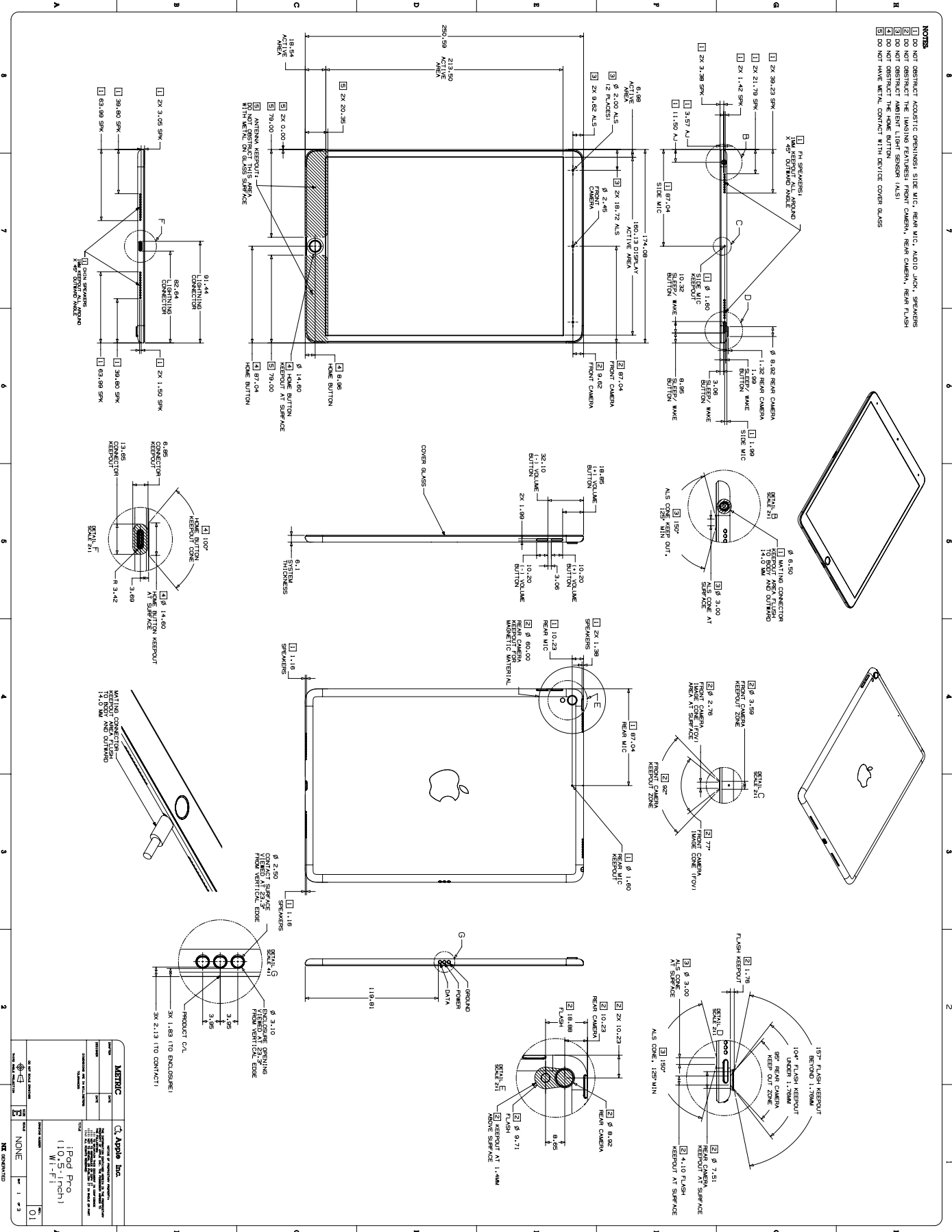
59.174 iPad Pro 12.9-inch (2nd generation) Magnet/Hall Effect Sensors, 2 of 2

SECTION AND DETAIL INFORMATION

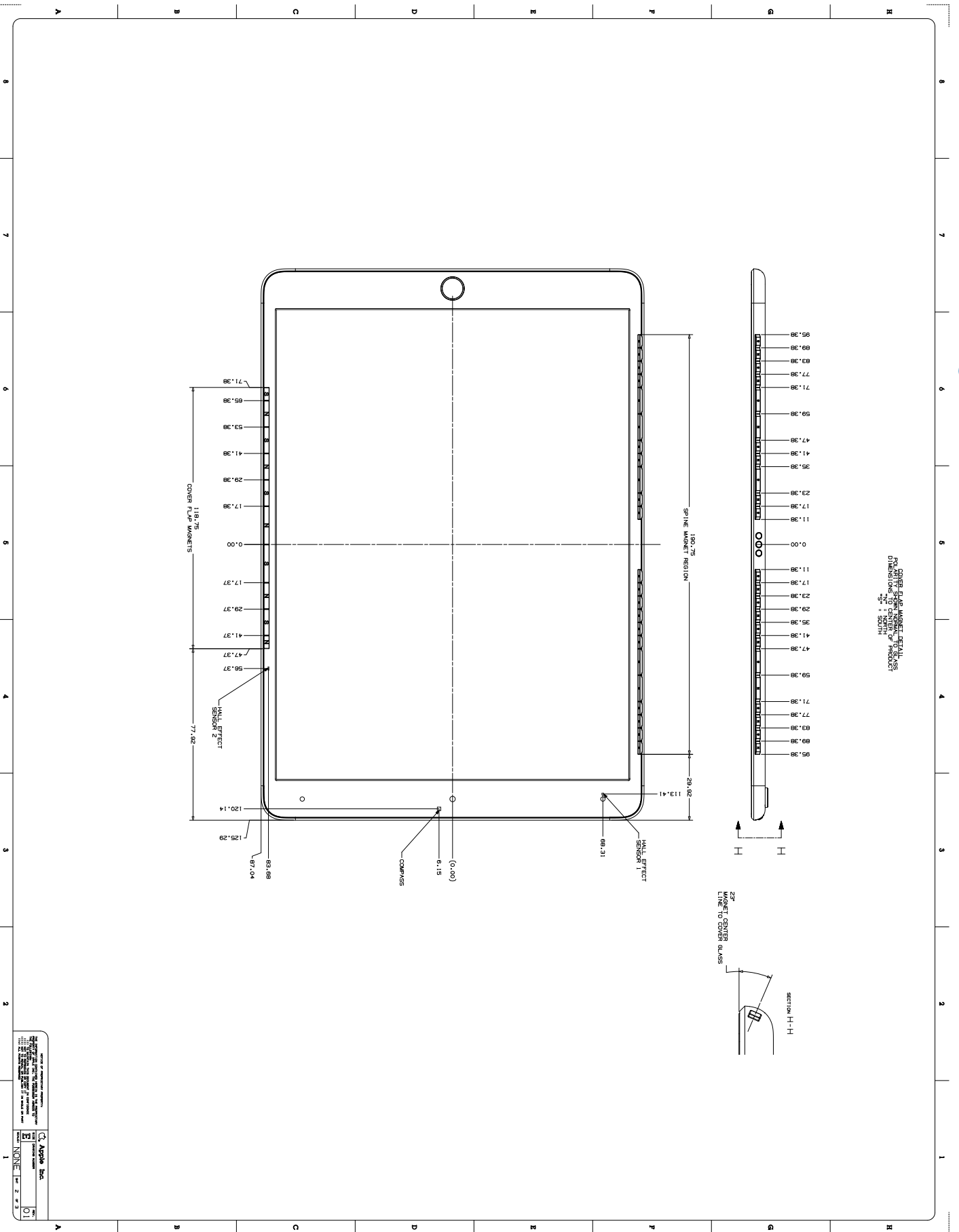


59.175 iPad Pro 10.5-inch

- NOTES**
- 1) DO NOT OBSTRUCT ACOUSTIC GRILLINGS, SLIDE MIC, REAR MIC, AUDIO JACK, SPEAKERS
 - 2) DO NOT OBSTRUCT THE IMAGING FEATURES FRONT CAMERA, REAR CAMERA, REAR FLASH
 - 3) DO NOT OBSTRUCT THE AMBIENT LIGHT SENSOR (ALS)
 - 4) DO NOT OBSTRUCT THE HOME BUTTON
 - 5) DO NOT HAVE METAL CONTACT WITH DEVICE COVER GLASS



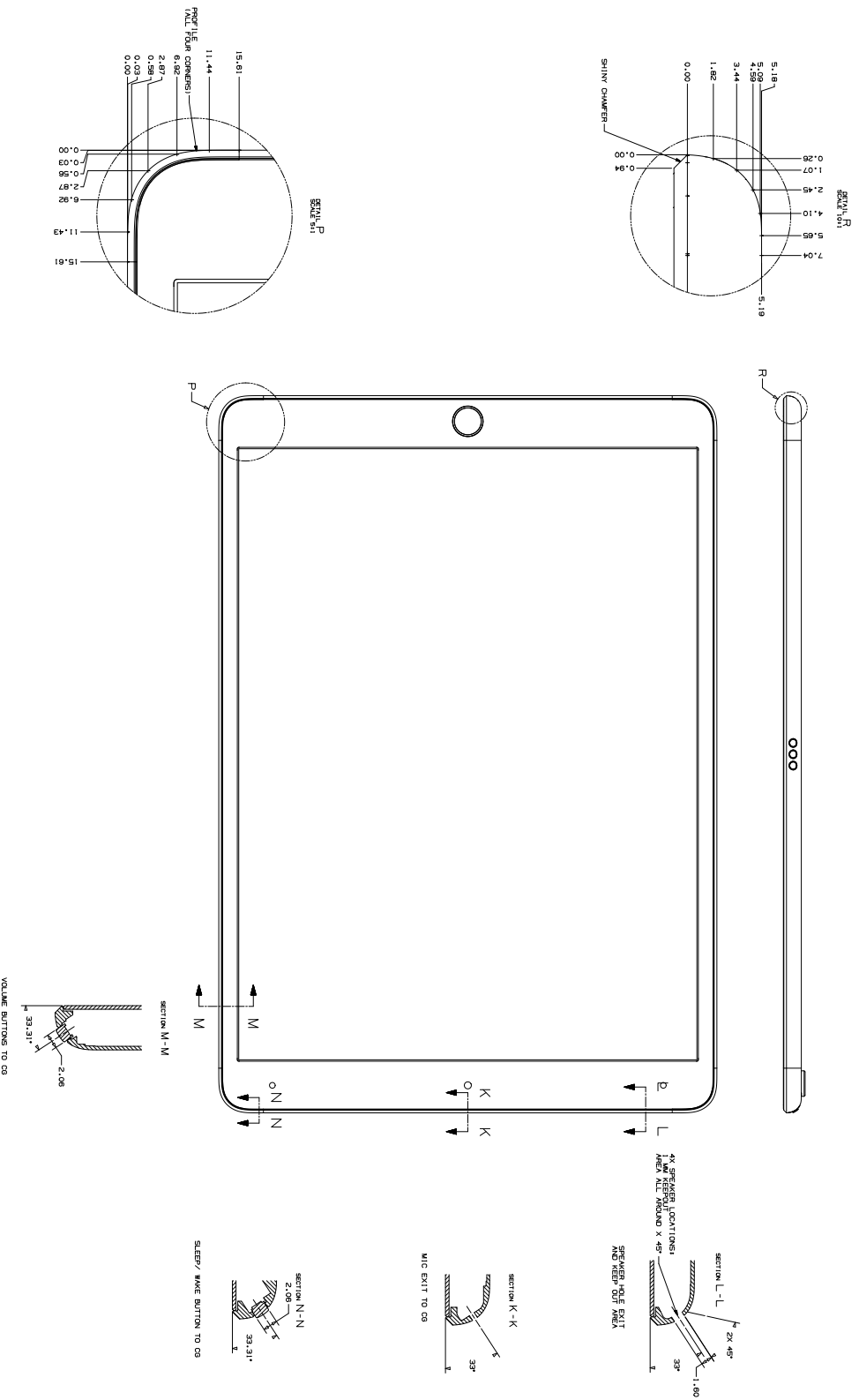
59.177 iPad Pro 10.5-inch Magnet/Hall Effect Sensors, 1 of 2



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59.178 iPad Pro 10.5-inch Magnet/Hall Effect Sensors, 2 of 2

SECTION AND DETAIL INFORMATION

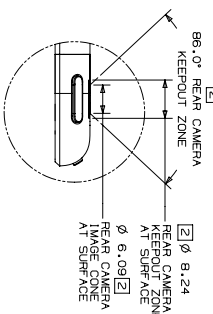
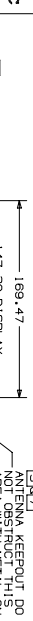
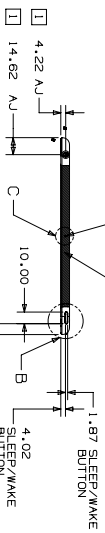
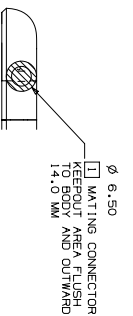
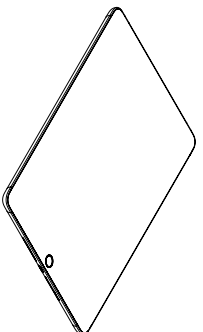
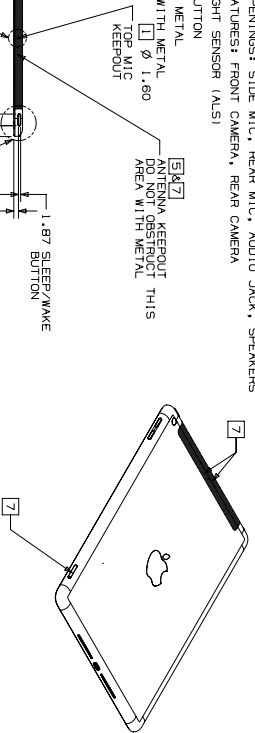


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SCALE: NONE		SHEET: 3 OF 2	

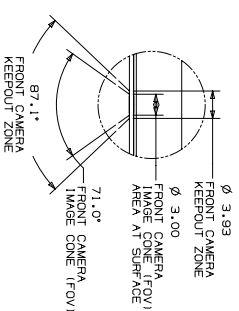
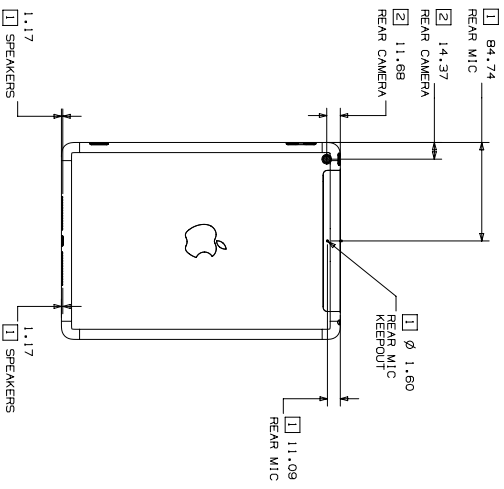
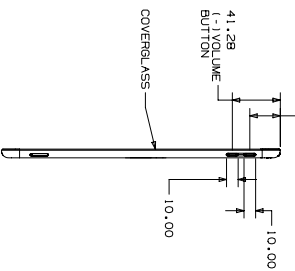
59.179 iPad (5th and 6th generation) with Cellular

NOTES (UNLESS OTHERWISE SPECIFIED):

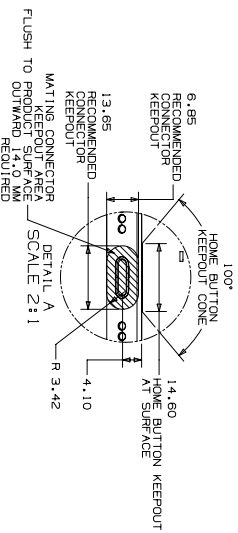
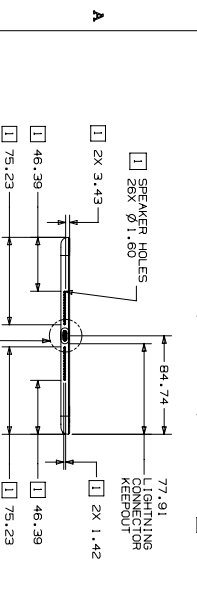
- DO NOT OBSTRUCT ACOUSTIC OPENINGS: SIDE MIC, REAR MIC, AUDIO JACK, SPEAKERS
- DO NOT OBSTRUCT IMAGING FEATURES: FRONT CAMERA, REAR CAMERA
- DO NOT OBSTRUCT AMBIENT LIGHT SENSOR (ALS)
- DO NOT OBSTRUCT THE HOME BUTTON
- DO NOT OBSTRUCT GLASS WITH METAL
- DO NOT OBSTRUCT ENCLOSURE WITH METAL
- CELLULAR SYSTEM ONLY



DETAIL B
SCALE 2:1



DETAIL C
SCALE 3:1

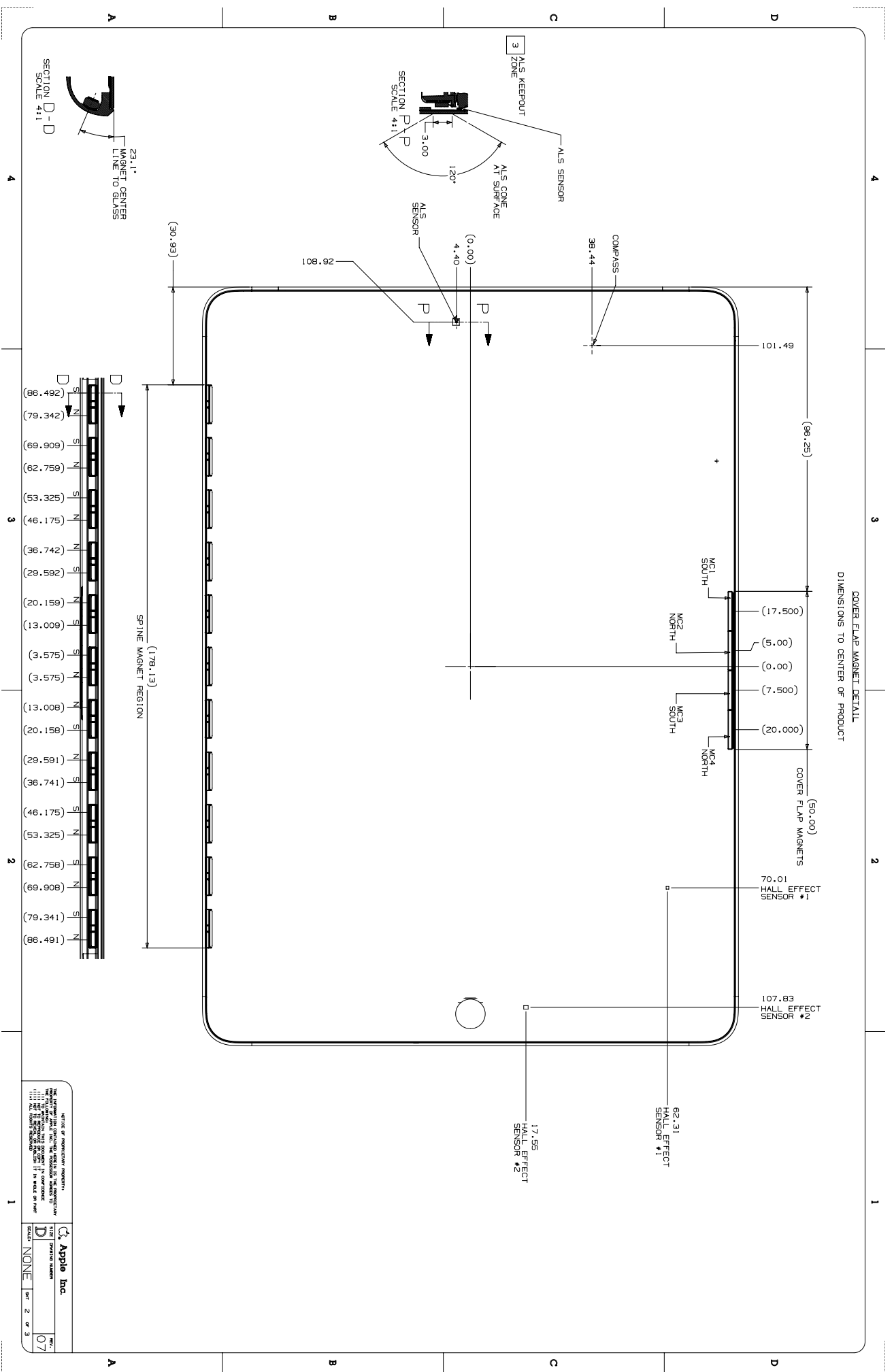


DETAIL A
SCALE 2:1

DESCRIPTION OF REVISION	
REV	DESCRIPTION OF REVISION
1	MATING CONNECTOR KEEPOUT AREA FLUSH KEEPOUT AREA OUTWARD 14.0 MM

METRIC		Apple Inc.	
DATE	03/24/17	APPROVED BY	[Signature]
APPROVED BY	[Signature]	DATE	03/24/17
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DIMENSIONS ARE IN MILLIMETERS		TITLE	
TOLERANCES		iPad Wi-Fi + Cellular (5th & 6th generation)	
X.X	+0.2	DRAWING NUMBER	07
X.XX	+0.10	SCALE	NONE
X.XXX	+0.050		
ANGLES 10.5°		DATE	07/18/17
DO NOT SCALE DRAWINGS		DRAWN BY	
HIDDEN LINE REJECTION		CHECKED BY	
NX GENERATED		REV	1 OF 3

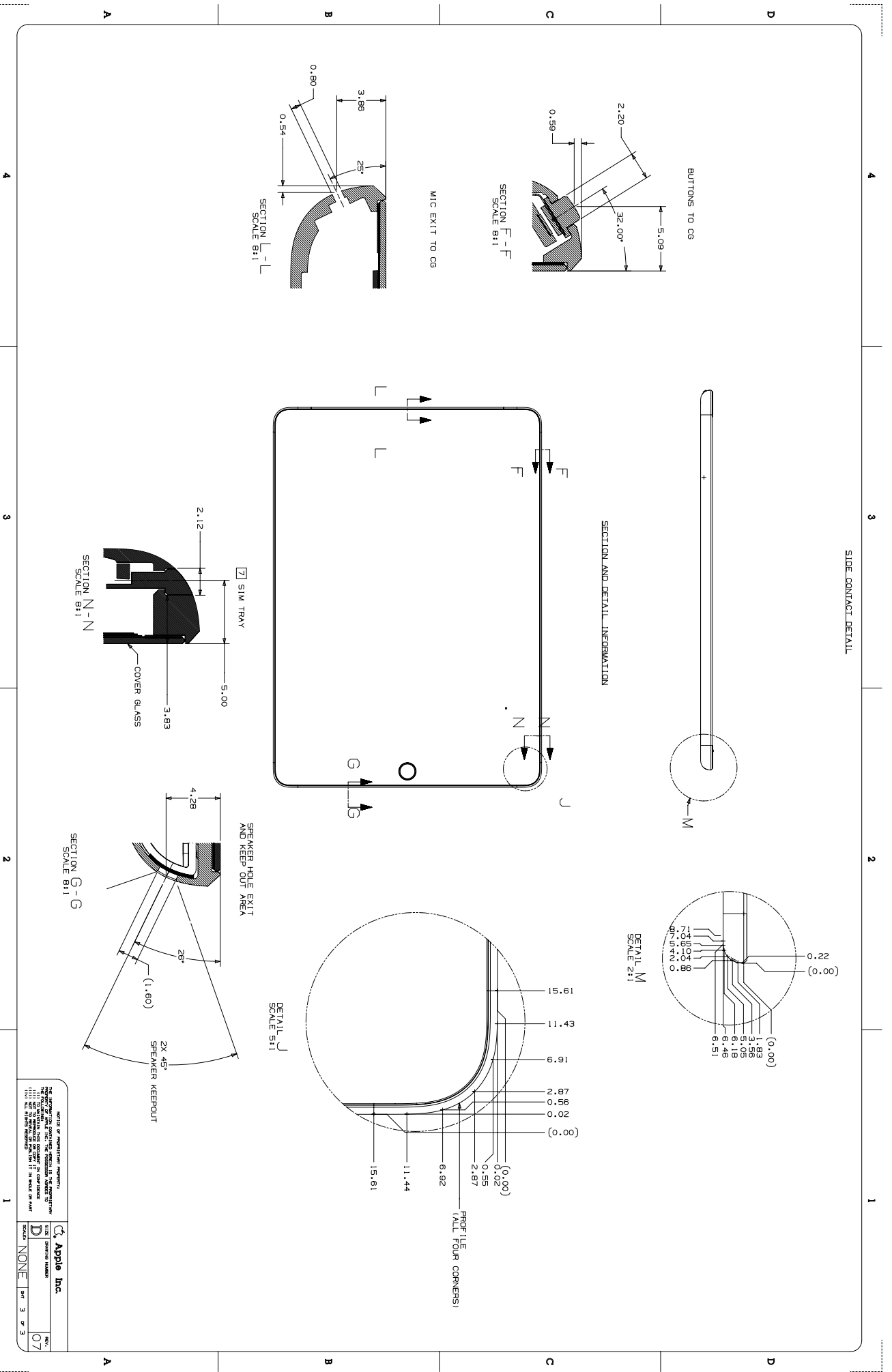
59.180 iPad (5th and 6th generation) Magnet/Hall Effect Sensors, 1 of 2



DATE OF ORIGINAL AMENDMENT
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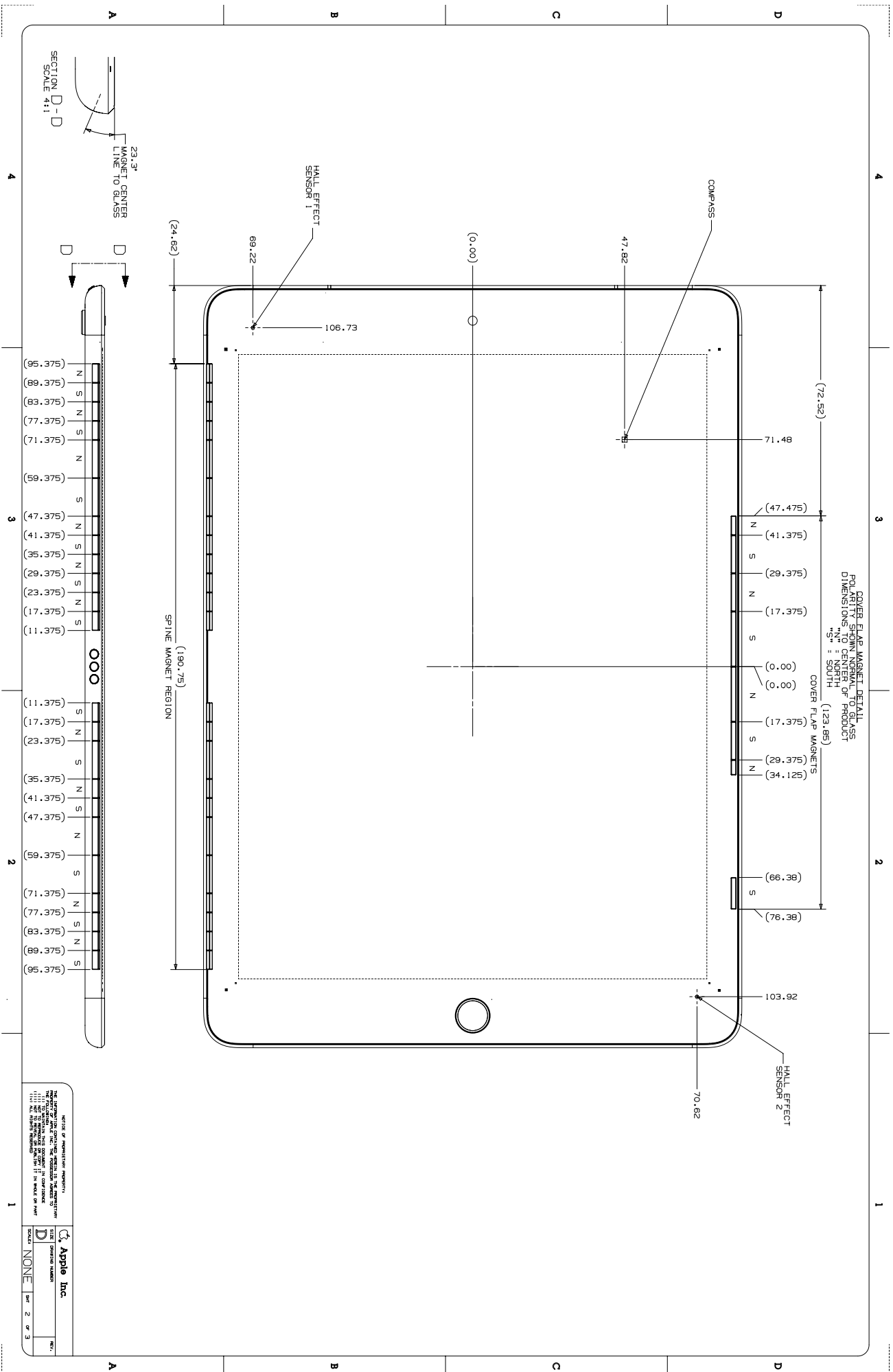
Apple Inc.	REV:
TYPE: [REDACTED]	DATE: [REDACTED]
ISSUES: NONE	SHEET: 2 OF 3

59.181 iPad (5th and 6th generation) Magnet/Hall Effect Sensors, 2 of 2

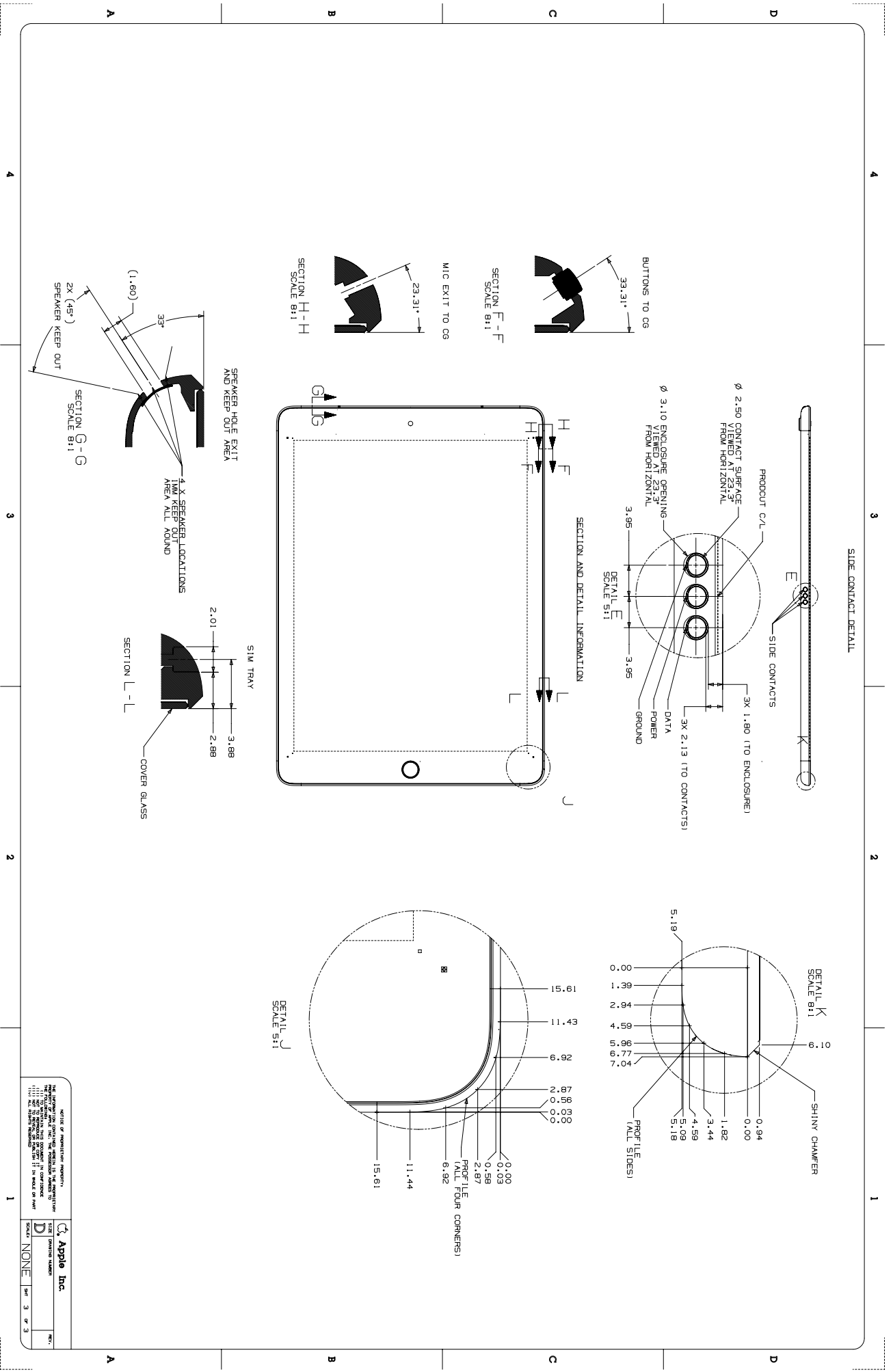


Apple Inc.
 Apple logo
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59.184 iPad Pro 9.7-inch Magnet/Hall Effect Sensors, 1 of 2



59.185 iPad Pro 9.7-inch Magnet/Hall Effect Sensors, 2 of 2

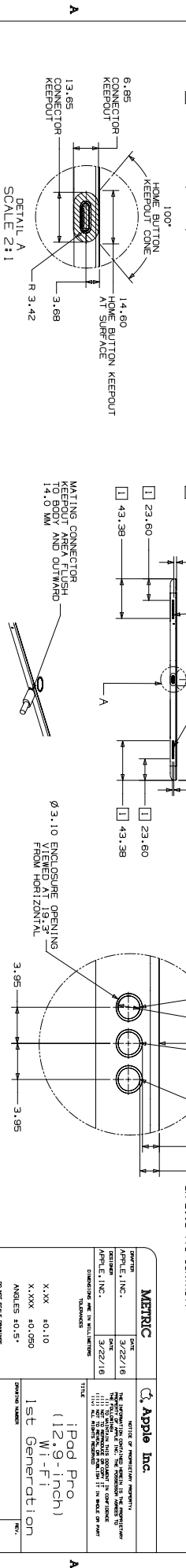
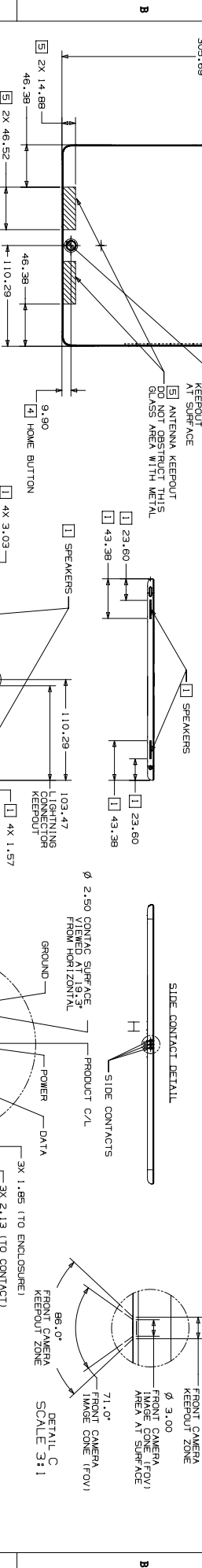
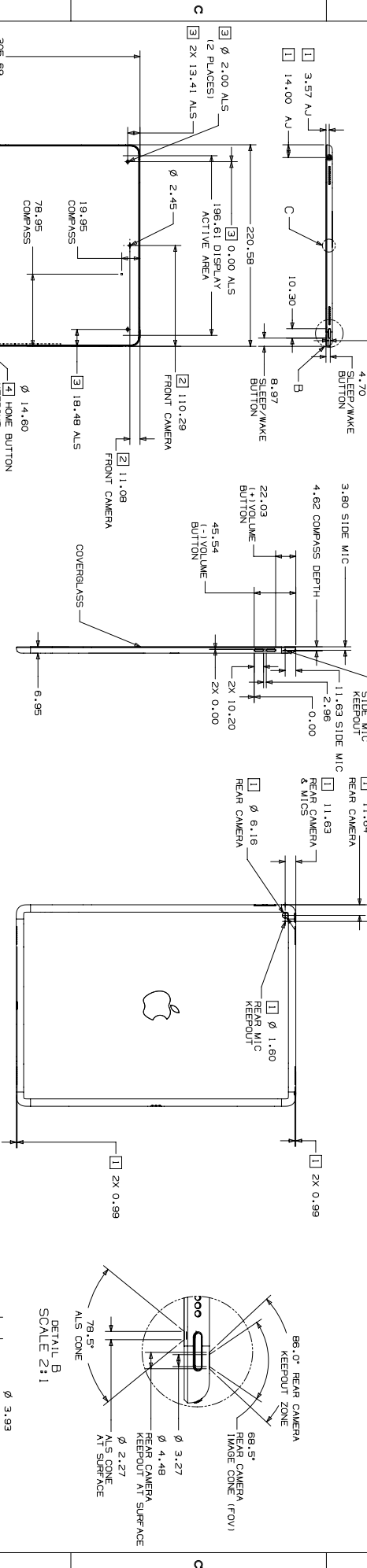
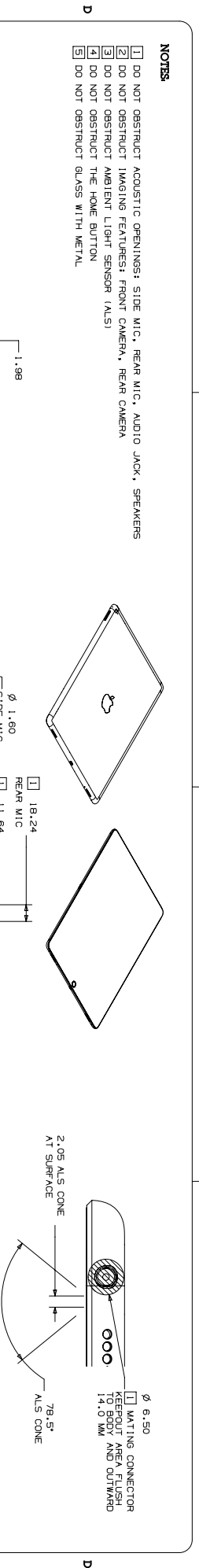


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59.186 iPad Pro 12.9-inch (1st generation)

NOTES

- 1 DO NOT OBSTRUCT ACOUSTIC OPENINGS: SIDE MIC, REAR MIC, AUDIO JACK, SPEAKERS
- 2 DO NOT OBSTRUCT IMAGING FEATURES: FRONT CAMERA, REAR CAMERA
- 3 DO NOT OBSTRUCT AMBIENT LIGHT SENSOR (ALS)
- 4 DO NOT OBSTRUCT THE HOME BUTTON
- 5 DO NOT OBSTRUCT GLASS WITH METAL



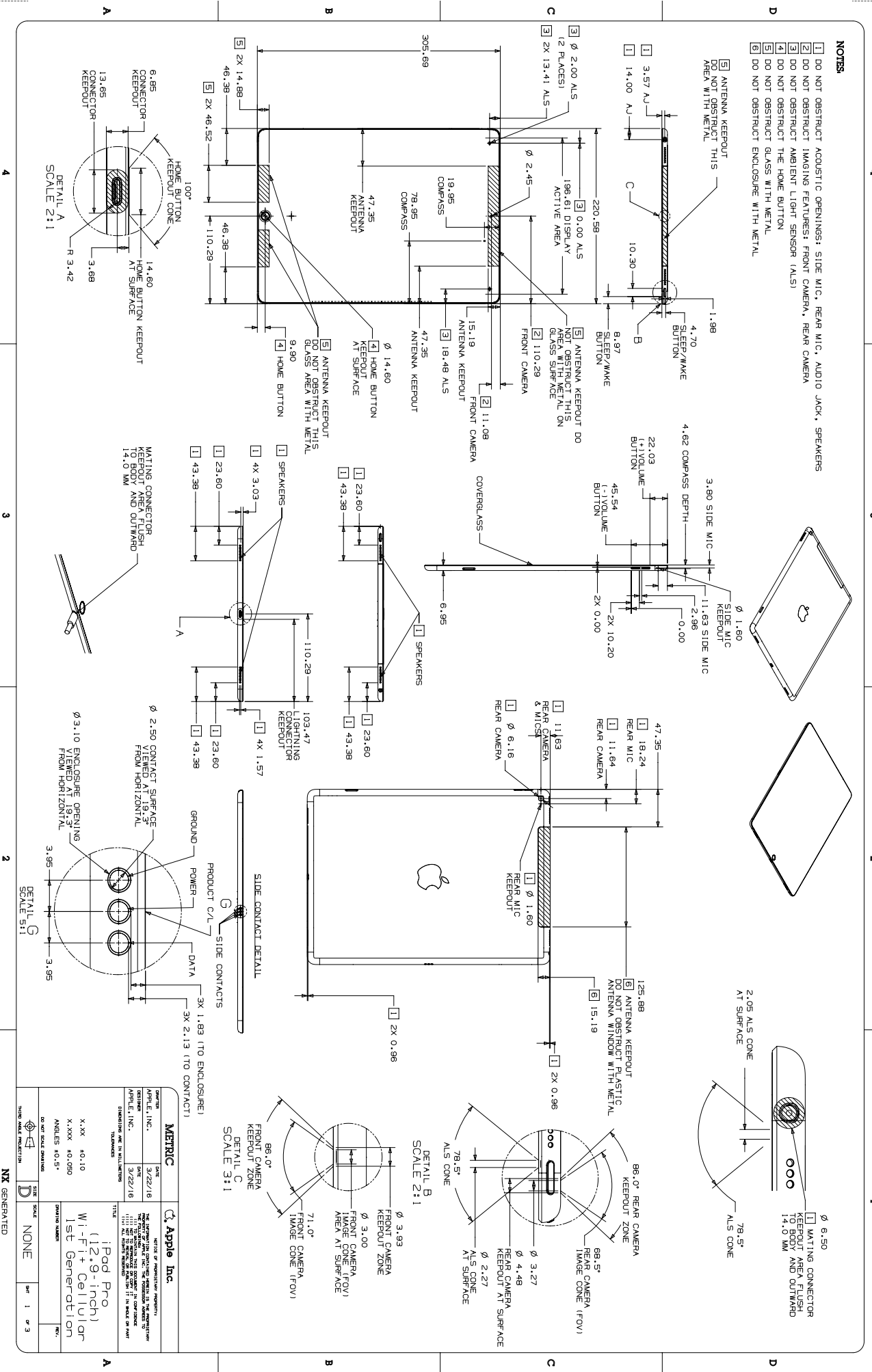
METRIC	UNIT	DATE	VERSION
APPLE, INC.	3/22/16		
APPLE, INC.	3/22/16		
APPLE, INC.	3/22/16		
APPLE, INC.	3/22/16		
APPLE, INC.	3/22/16		

TITLE !Pod Pro (12.9-inch) Wi-Fi 1st Generation		DRAWING NUMBER 59.186
DO NOT SCALE DIMENSIONS ANGLES 10.0°		SCALE 1 OF 3

59.187 iPad Pro 12.9-inch (1st generation) with Cellular

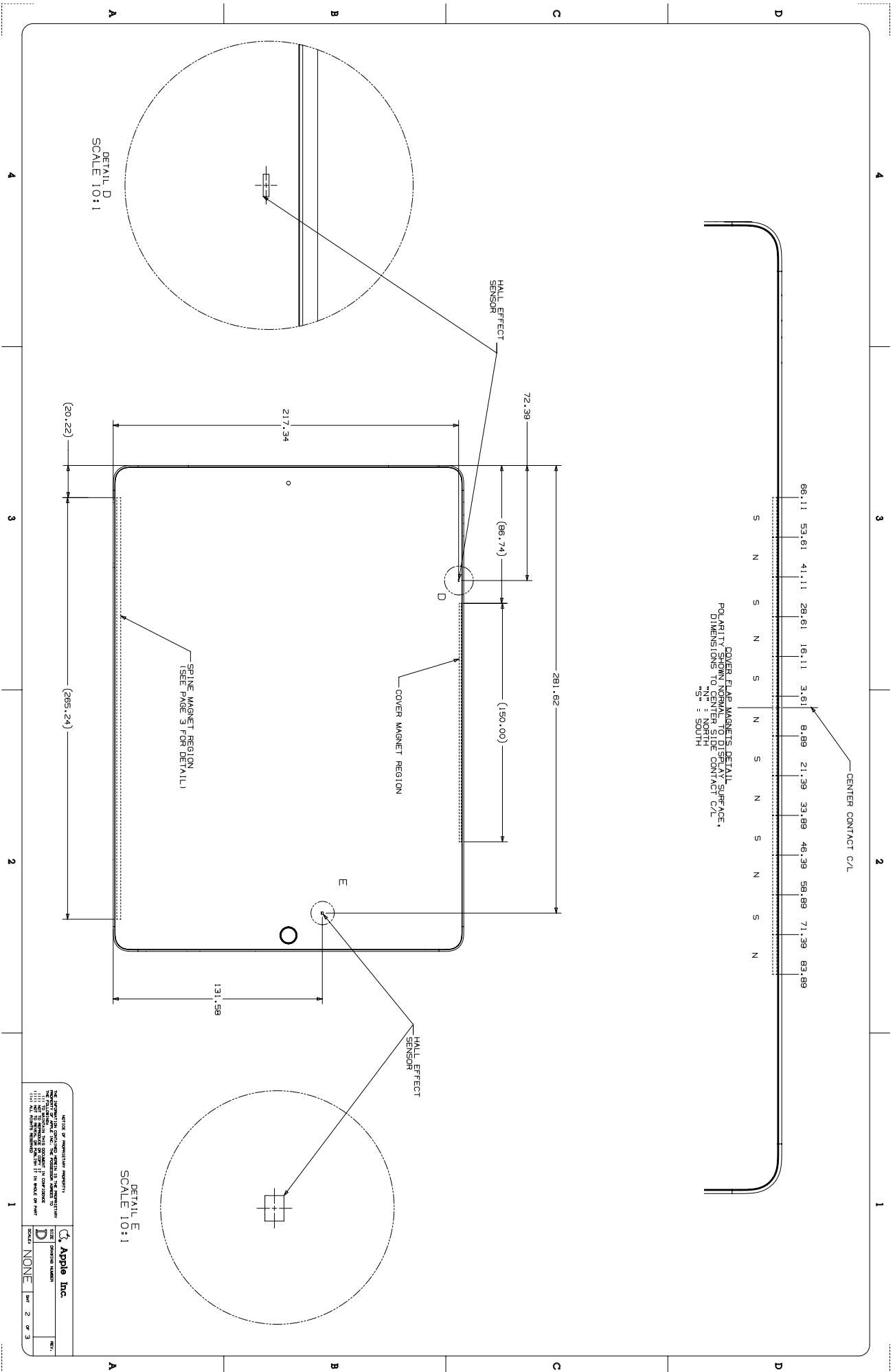
NOTES

- 1 DO NOT OBSTRUCT ACOUSTIC OPENINGS: SIDE MIC, REAR MIC, AUDIO JACK, SPEAKERS
- 2 DO NOT OBSTRUCT IMAGING FEATURES: FRONT CAMERA, REAR CAMERA
- 3 DO NOT OBSTRUCT AMBIENT LIGHT SENSOR (ALS)
- 4 DO NOT OBSTRUCT THE HOME BUTTON
- 5 DO NOT OBSTRUCT GLASS WITH METAL
- 6 DO NOT OBSTRUCT ENCLOSURE WITH METAL



METRIC		Apple Inc.	
DATE	3/22/16	VERSION	1.0
APPROVED BY	[Signature]	DESIGNED BY	[Signature]
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<p>Apple Inc. 12.9-inch (12.9-inch) Wi-Fi + Cellular 1st Generation</p>			
<p>SCALE: NONE</p>		<p>DATE: 1 of 3</p>	

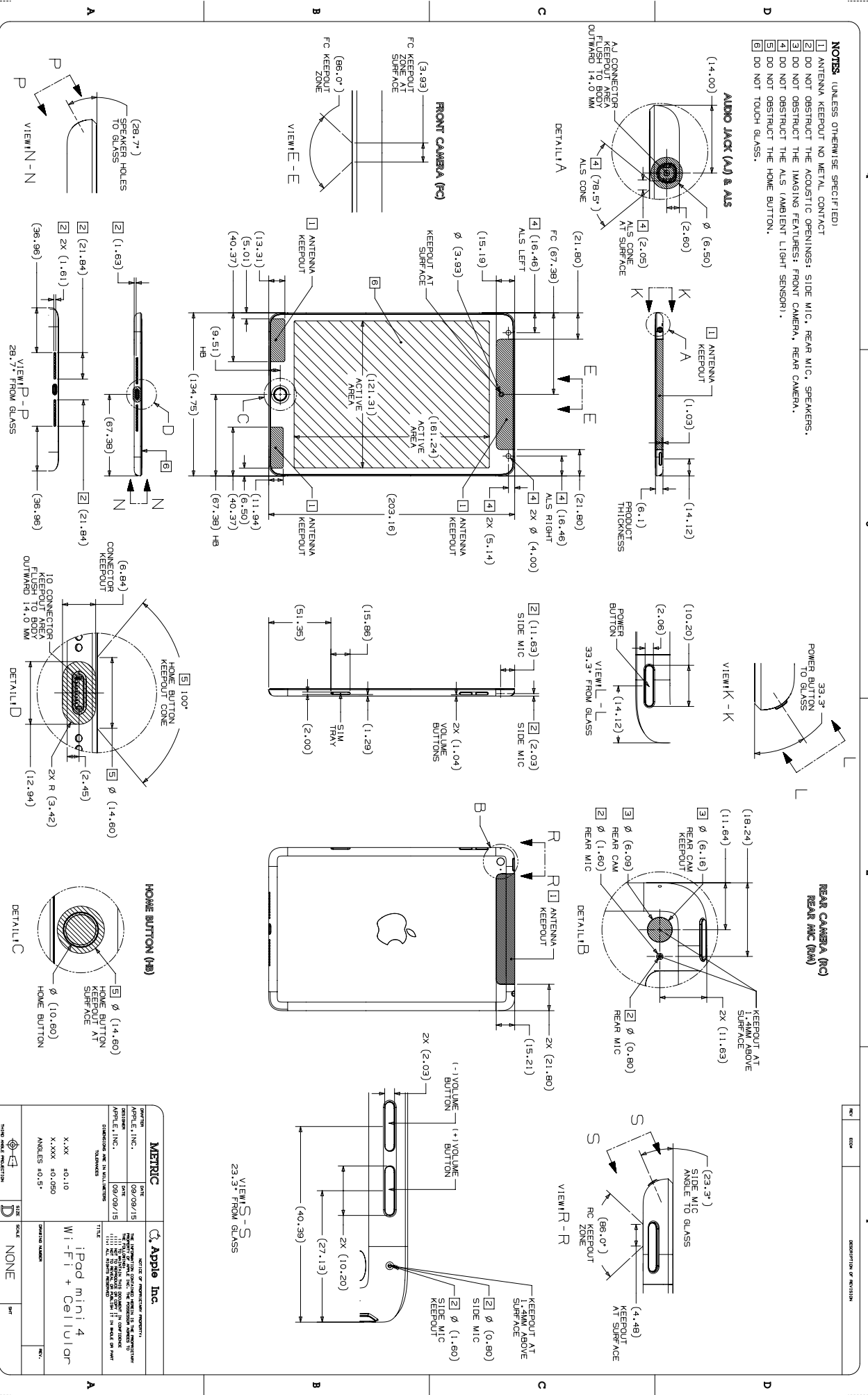
59.188 iPad Pro 12.9-inch (1st generation) Magnet/Hall Effect Sensors, 1 of 2



Apple Inc.
 Model: B
 Revision: NONE
 Sheet: 2 of 3

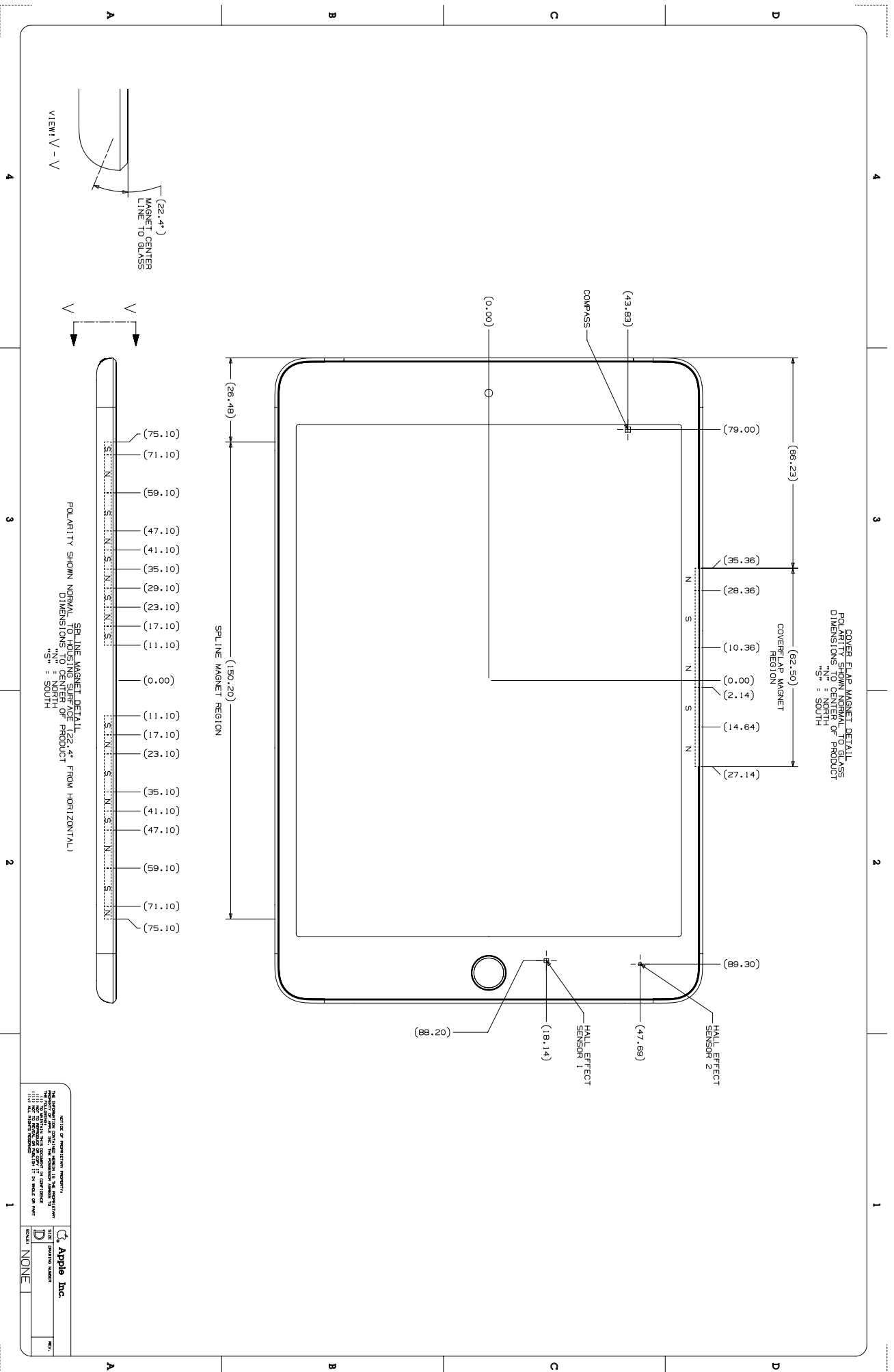
59.191 iPad mini 4 with Cellular

- NOTES** (UNLESS OTHERWISE SPECIFIED):
- 1 ANTENNA KEEP-OUT NO METAL CONTACT
 - 2 DO NOT OBSTRUCT THE ACOUSTIC OPENINGS: SIDE MIC, REAR MIC, SPEAKERS.
 - 3 DO NOT OBSTRUCT THE IMAGING FEATURES: FRONT CAMERA, REAR CAMERA.
 - 4 DO NOT OBSTRUCT THE ALS (AMBIENT LIGHT SENSOR).
 - 5 DO NOT OBSTRUCT THE HOME BUTTON.
 - 6 DO NOT TOUCH GLASS.



METRIC		Apple Inc.	
DATE	DESCRIPTION	DATE	DESCRIPTION
09/08/15	APPL E, INC.	09/08/15	APPL E, INC.
09/09/15	APPL E, INC.	09/09/15	APPL E, INC.
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<small> DIMENSIONS ARE IN MILLIMETERS (PARENTS) </small>			
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<small> DRIVING VALUES NONE </small>			
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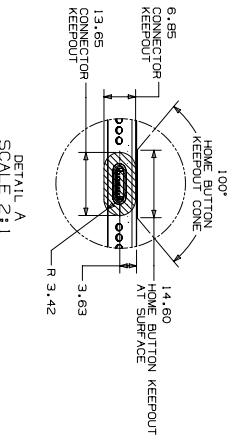
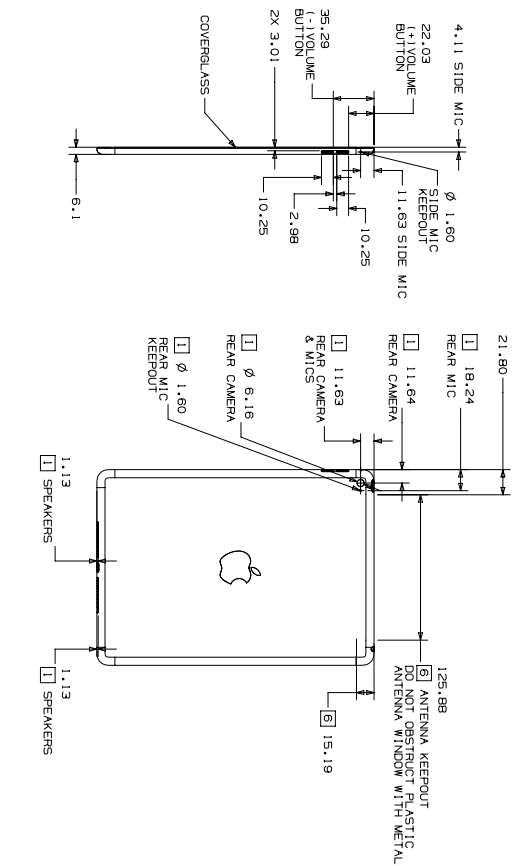
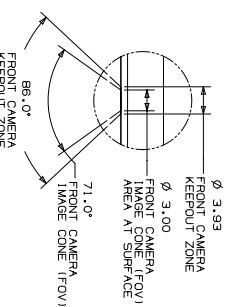
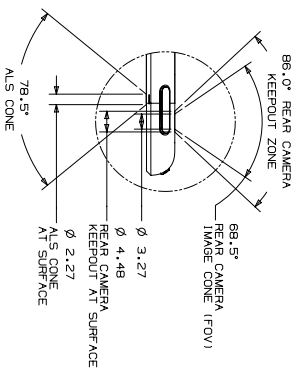
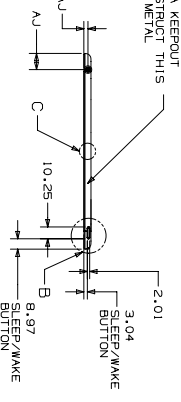
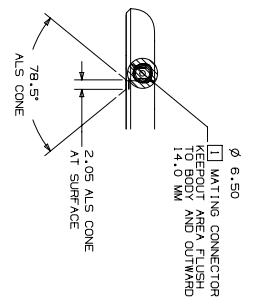
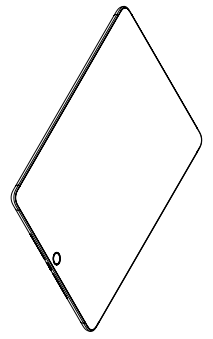
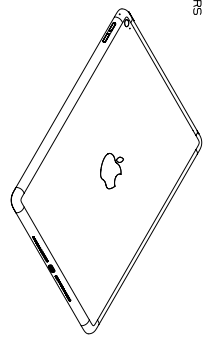
59.192 iPad mini 4 Magnet/Hall Effect Sensors



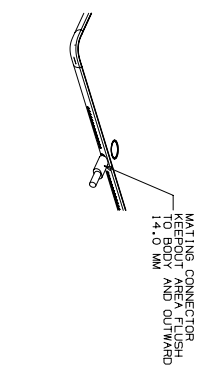
Apple Inc.
 Apple logo
 Apple Inc.
 Apple logo
 Apple Inc.

NOTES:

- 1 DO NOT OBSTRUCT ACOUSTIC OPENINGS, SIDE MIC, REAR MIC, AUDIO JACK, SPEAKERS
- 2 DO NOT OBSTRUCT IMAGING FEATURES: FRONT CAMERA, REAR CAMERA
- 3 DO NOT OBSTRUCT AMBIENT LIGHT SENSOR (ALS)
- 4 DO NOT OBSTRUCT THE HOME BUTTON
- 5 DO NOT OBSTRUCT GLASS WITH METAL
- 6 DO NOT OBSTRUCT ENCLOSURE WITH METAL



DETAIL A
SCALE 2:1



DETAIL B
SCALE 3:1

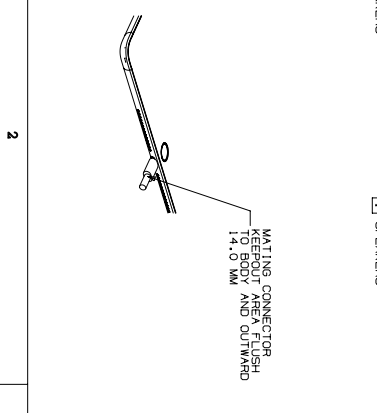
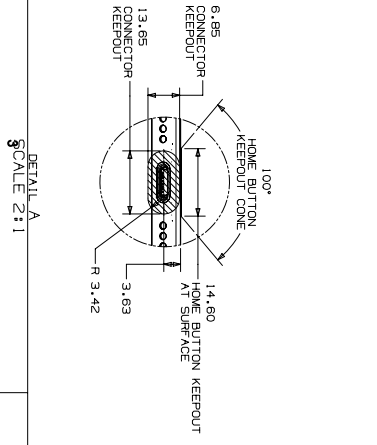
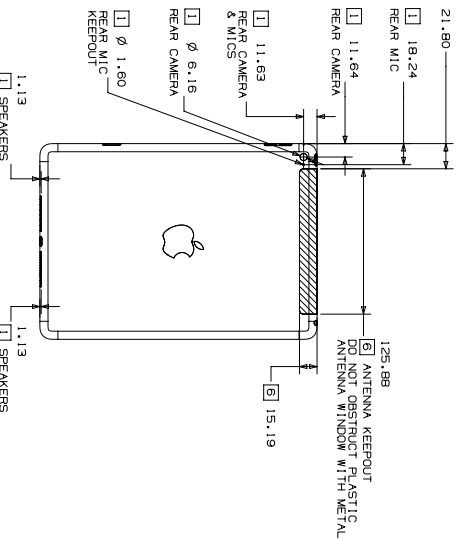
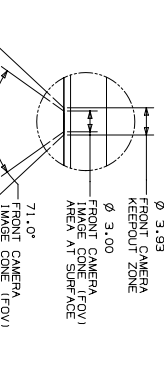
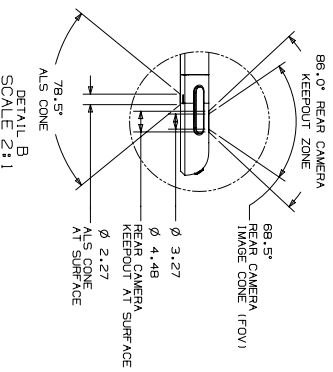
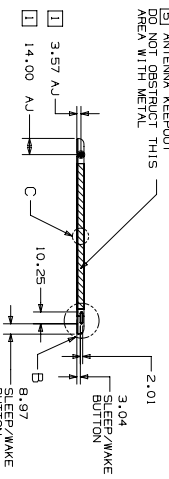
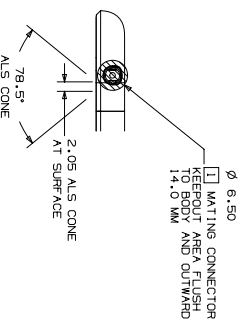
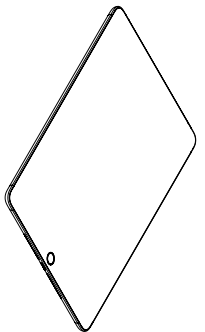
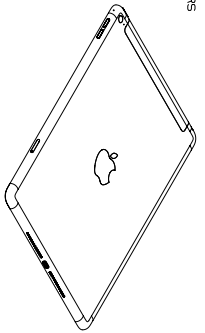
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DATE: _____	DATE: _____
DESIGNED BY: _____	DESIGNED BY: _____
APPROVED BY: _____	APPROVED BY: _____
CONSTRUCTION: _____	CONSTRUCTION: _____
TITLE: iPod Air 2 Wi-Fi	TITLE: _____
DRAWING NUMBER: _____	DRAWING NUMBER: _____
SIZE: D	SCALE: NONE
DATE: _____	REV: 1
BY: _____	OF: 1

NX GENERATED

59.194 iPad Air 2 with Cellular

NOTES:

- 1 DO NOT OBSTRUCT ACOUSTIC OPENINGS, SIDE MIC, REAR MIC, AUDIO JACK, SPEAKERS
- 2 DO NOT OBSTRUCT IMAGING FEATURES: FRONT CAMERA, REAR CAMERA
- 3 DO NOT OBSTRUCT AMBIENT LIGHT SENSOR (ALS)
- 4 DO NOT OBSTRUCT THE HOME BUTTON
- 5 DO NOT OBSTRUCT GLASS WITH METAL
- 6 DO NOT OBSTRUCT ENCLOSURE WITH METAL



METRIC		INCH	
DATE	VERSION	DATE	VERSION
08/11/14	1	08/11/14	1
DESIGNER: APPLE, INC. CHECKER: APPLE, INC. DRAWING NO: 59.194.001.001		TITLE: iPad Air 2 Wi-Fi + Cellular	
0.00" SCALE DIMENSIONS THIS DRAWING IS UNLIMBATED UNLESS OTHERWISE SPECIFIED		NONE NONE	

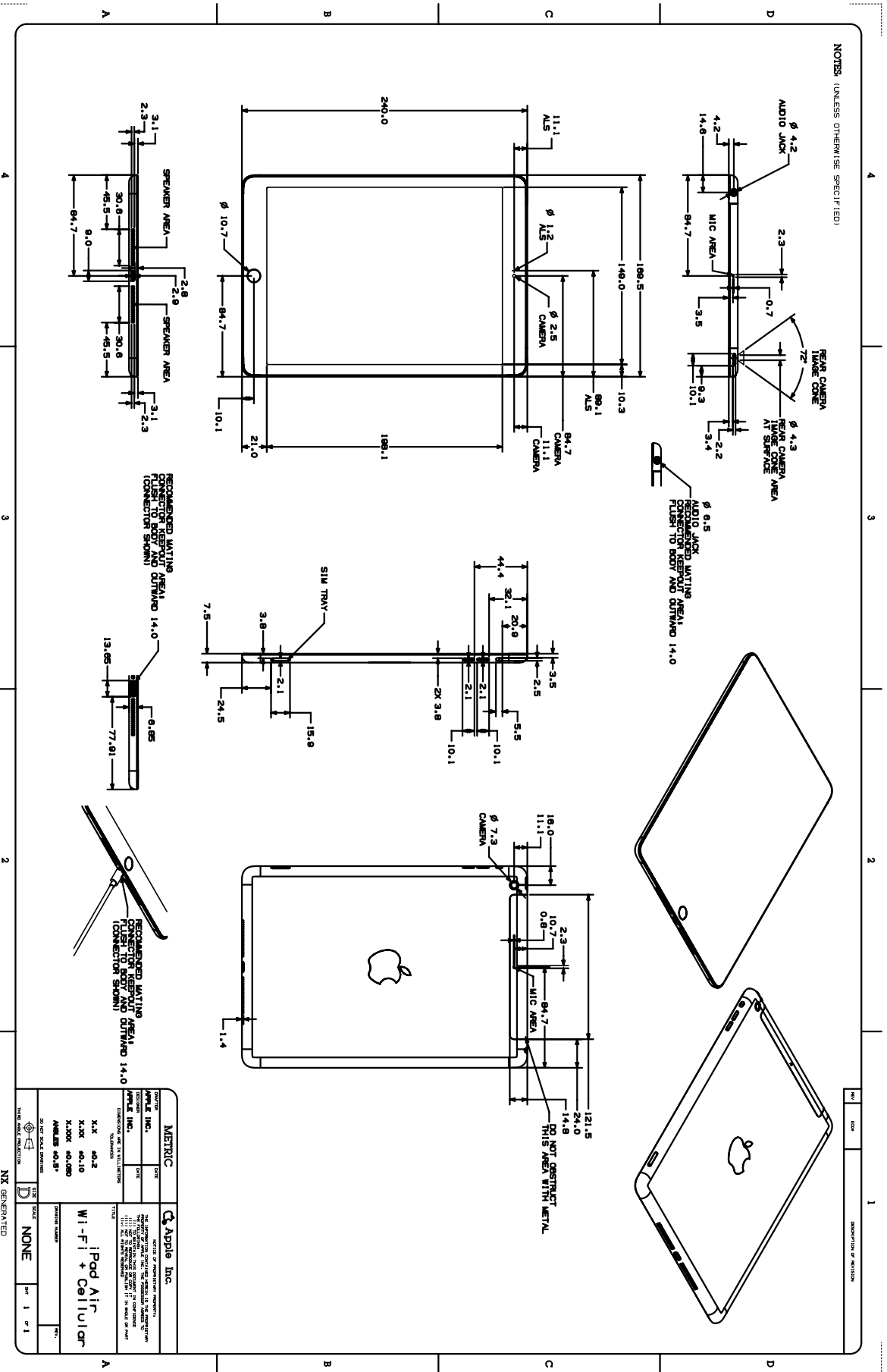
SCALE 2:1

SCALE 3:1

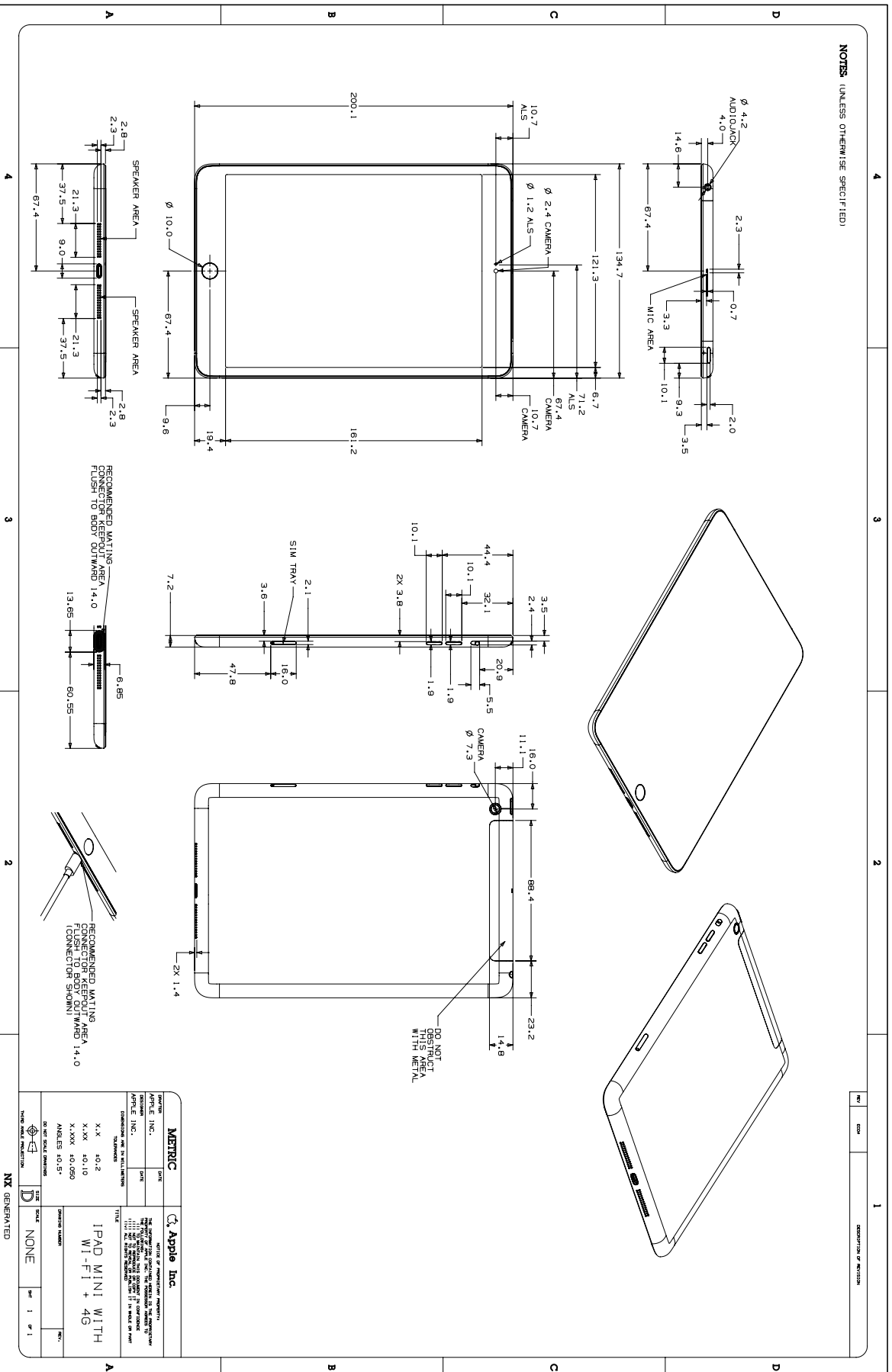
SCALE 2:1

SCALE 3:1

59.198 iPad Air with Cellular

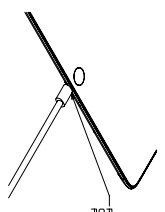
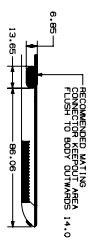
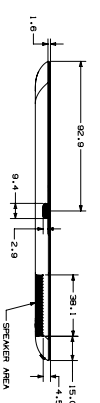
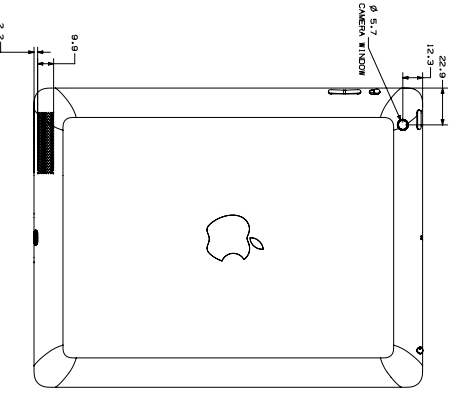
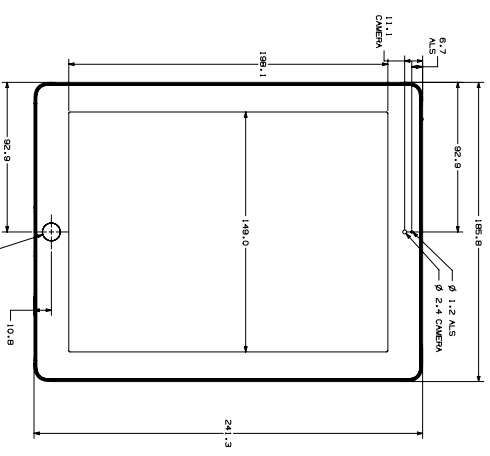
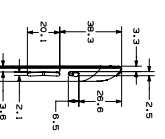
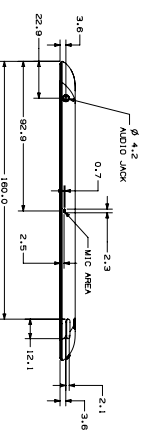
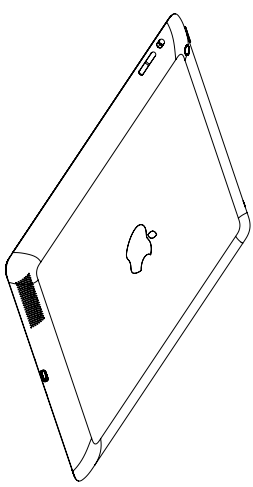
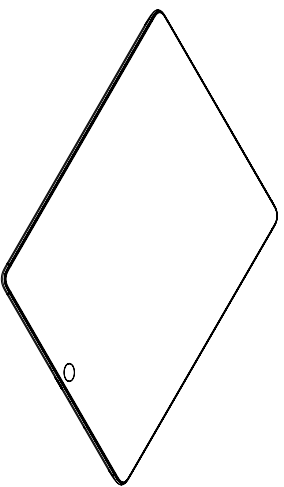


59.200 iPad mini with Cellular



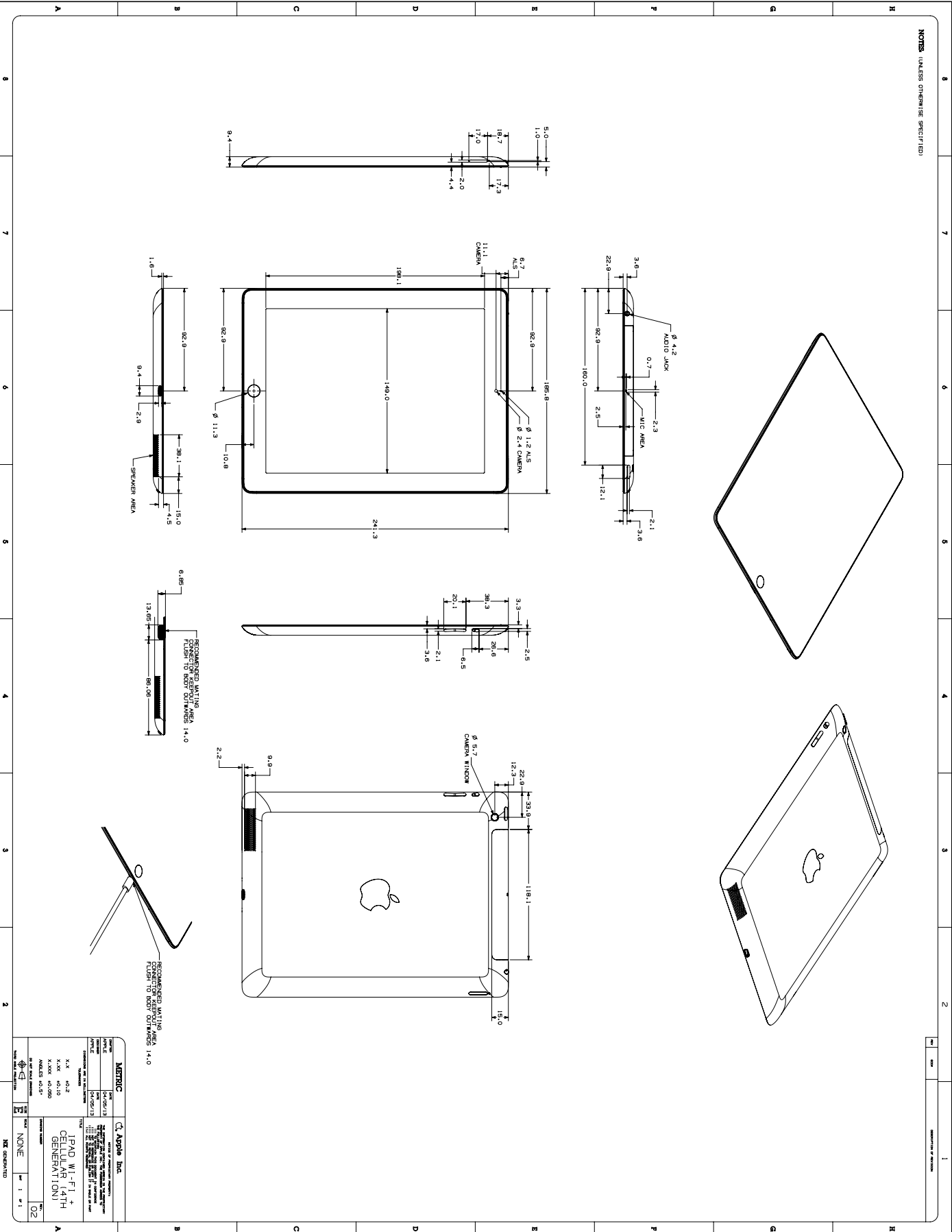
59.201 iPad (4th generation)

NOTES: UNLESS OTHERWISE SPECIFIED



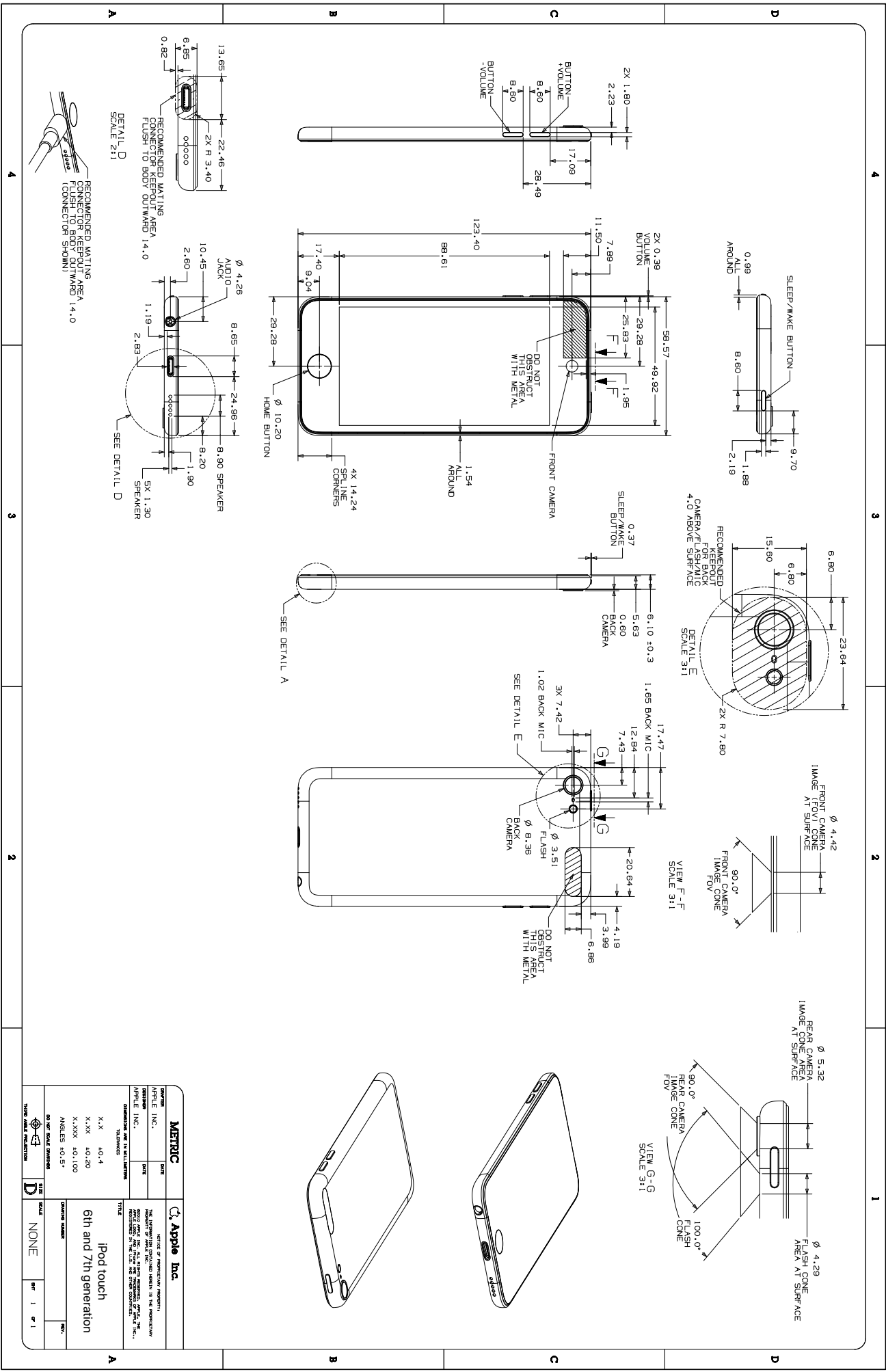
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TYPE: 1 MATERIAL: 14.0 FINISH: 02	TYPE: 1 MATERIAL: 14.0 FINISH: 02	TYPE: 1 MATERIAL: 14.0 FINISH: 02	TYPE: 1 MATERIAL: 14.0 FINISH: 02

59.202 iPad (4th generation) with Cellular



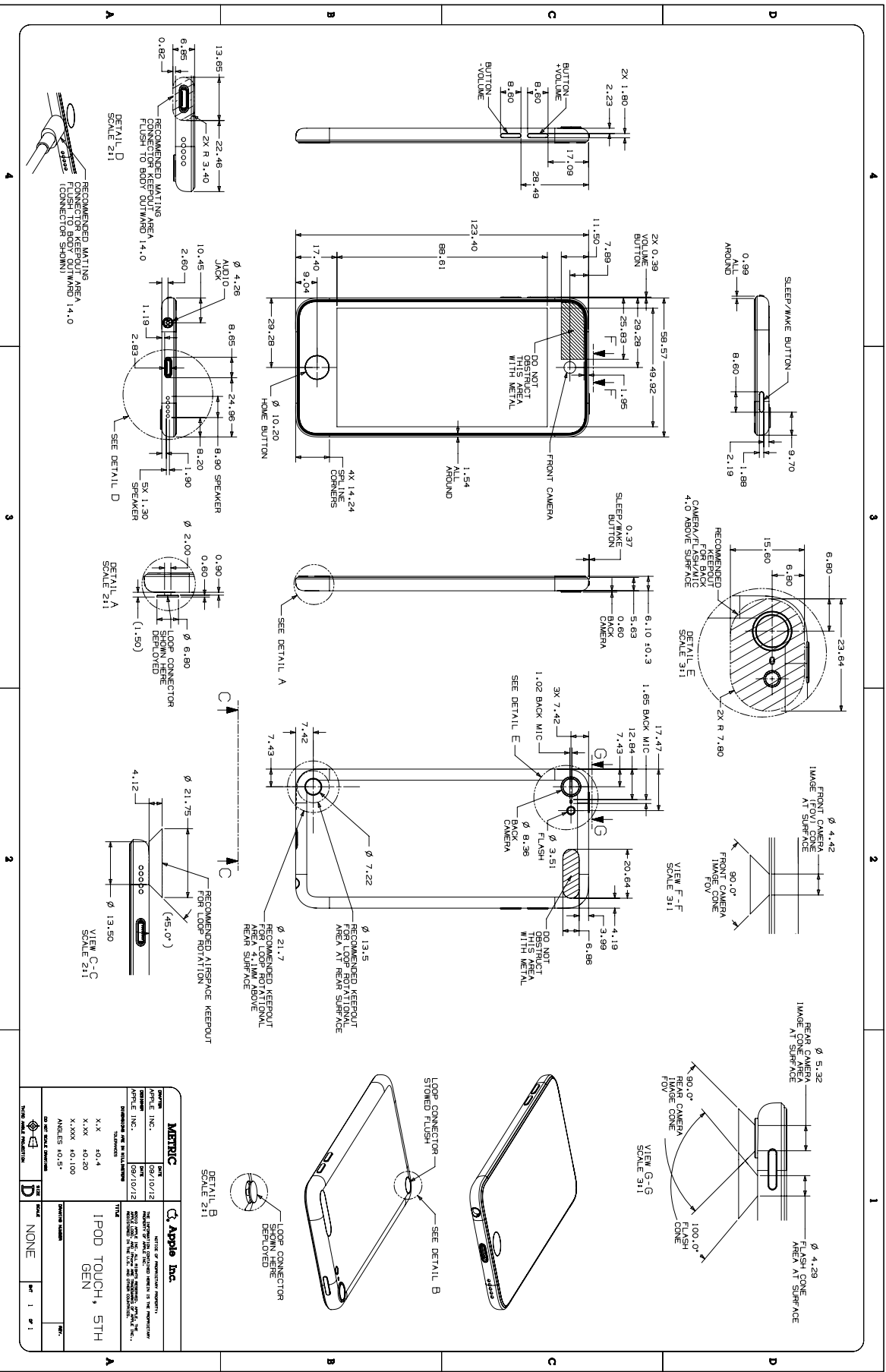
METRIC		Apple Inc.	
DATE	REV	DESCRIPTION	BY
09/28/15	1	59.202 iPad (4th generation) with Cellular	
REVISIONS AND REVISIONS			
NO	DATE	DESCRIPTION	BY
1	09/28/15	INITIAL RELEASE	
2	02/25/16	RELEASE 4025	
APPROVALS			
DESIGN	DATE	BY	CHK
PART INFORMATION			
PART NUMBER	DESCRIPTION	QTY	UNIT
59.202	IPAD Wi-Fi + Cellular (4th Generation)	1	EA
OTHER INFORMATION			
NONE			
PAGE 1 OF 1			
NOT DRAWING			

59.203 iPod touch (6th generation) and iPod touch (7th generation)



METRIC		Apple Inc.	
OWNER	DATE	DATE OF REVISION	REVISION
APPLE INC.			
DESIGNER	DATE	PROJECT OR PRODUCT	DESCRIPTION
APPLE INC.		IPD TOUCH 6TH AND 7TH GENERATION	
DIMENSIONS ARE IN MILLIMETERS			
X.X	10.4		
X.XX	10.20		
X.XXX	10.100		
ANGLES	10.5°		
DO NOT SCALE DIMENSIONS			
TYPICAL DIMENSIONS			
TOLERANCES			
NONE			
SCALE			
NONE			
SHEET			
1 OF 1			
TITLE: iPod touch 6th and 7th generation DRAWING NUMBER:			

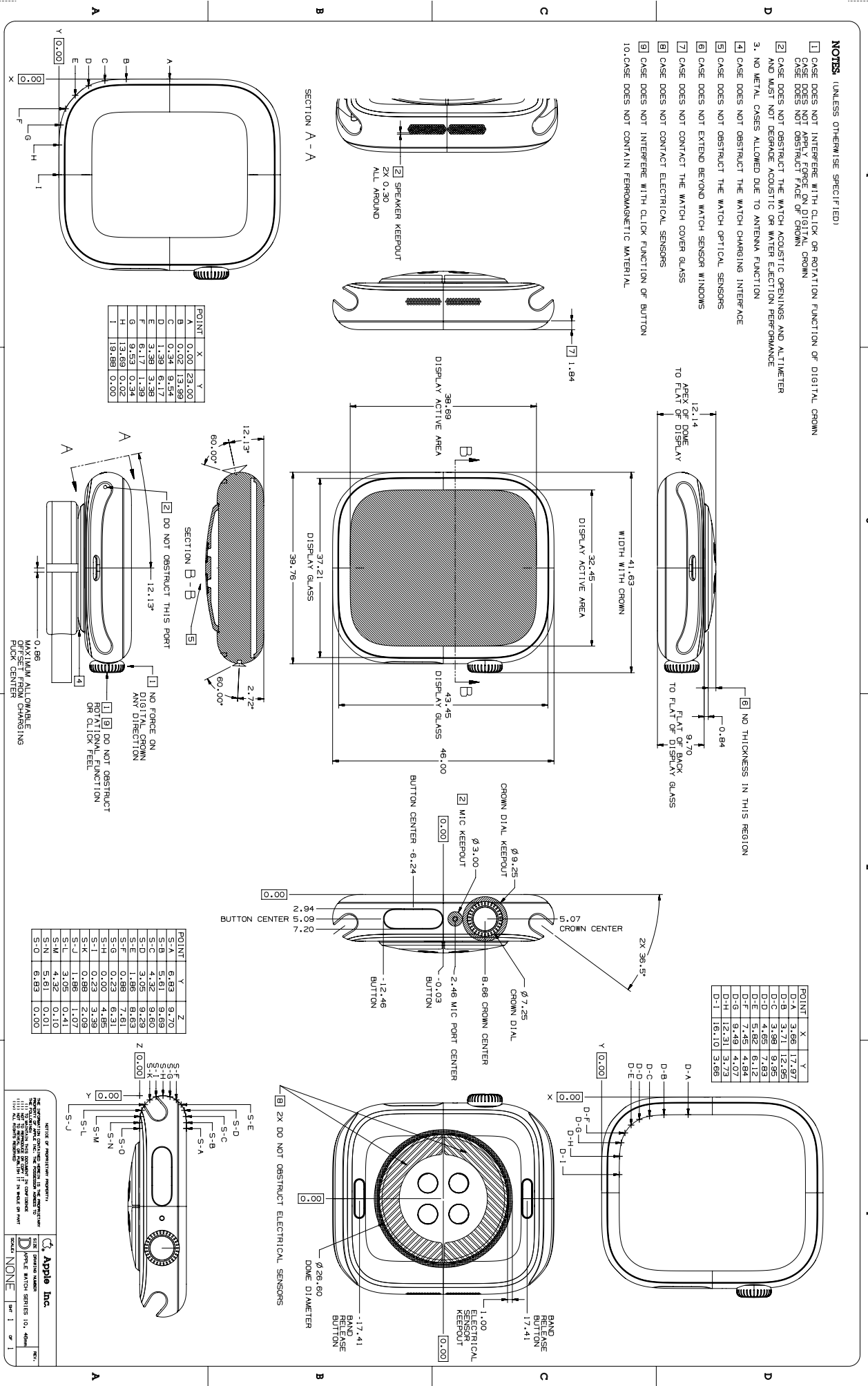
59.204 iPod touch (5th generation)



59.205 Apple Watch Series 10, 46 mm

NOTES (UNLESS OTHERWISE SPECIFIED)

- 1 CASE DOES NOT INTERFERE WITH CLICK OR ROTATION FUNCTION OF DIGITAL CROWN
CASE DOES NOT APPLY FORCE ON DIGITAL CROWN
CASE DOES NOT OBSTRUCT FACE OF CROWN
- 2 CASE DOES NOT OBSTRUCT THE WATCH ACOUSTIC OPENINGS AND ALTIMETER
AND MUST NOT DEGRADE ACOUSTIC OR WATER EJECTION PERFORMANCE
3. NO METAL CASES ALLOWED DUE TO ANTENNA FUNCTION
- 4 CASE DOES NOT OBSTRUCT THE WATCH CHARGING INTERFACE
- 5 CASE DOES NOT OBSTRUCT THE WATCH OPTICAL SENSORS
- 6 CASE DOES NOT EXTEND BEYOND WATCH SENSOR WINDOWS
- 7 CASE DOES NOT CONTACT THE WATCH COVER GLASS
- 8 CASE DOES NOT CONTACT ELECTRICAL SENSORS
- 9 CASE DOES NOT INTERFERE WITH CLICK FUNCTION OF BUTTON
10. CASE DOES NOT CONTAIN FERROMAGNETIC MATERIAL



POINT	X	Y	Z
D-A	3.66	17.97	
D-B	3.71	12.95	
D-C	3.98	9.95	
D-D	4.63	6.95	
D-E	5.49	4.84	
D-F	7.45	4.84	
D-G	9.49	4.07	
D-H	12.31	3.73	
D-I	16.10	3.66	

POINT	X	Y	Z
A	0.00	13.00	
B	0.00	11.00	
C	0.34	9.54	
D	1.39	6.17	
E	3.38	3.38	
F	6.17	1.39	
G	9.53	0.34	
H	13.88	0.00	
I	18.88	0.00	

POINT	X	Y	Z
S-A	6.83	9.70	
S-B	5.61	9.69	
S-C	4.32	9.69	
S-D	3.05	9.29	
S-E	1.88	8.63	
S-F	0.99	7.61	
S-G	0.40	6.48	
S-H	0.00	4.88	
S-I	0.23	3.39	
S-J	0.88	2.09	
S-K	1.86	1.07	
S-L	3.05	0.41	
S-M	4.32	0.00	
S-N	5.61	0.00	
S-O	6.83	0.00	

Apple Inc.
Apple Watch Series 10, 46mm
NX GENERATED

59.206 Apple Watch Series 10, 42 mm

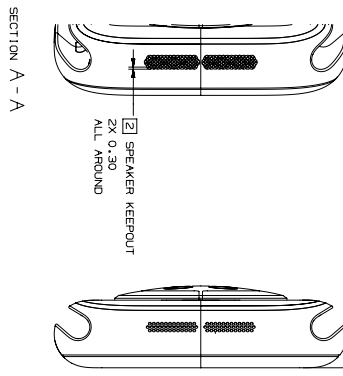
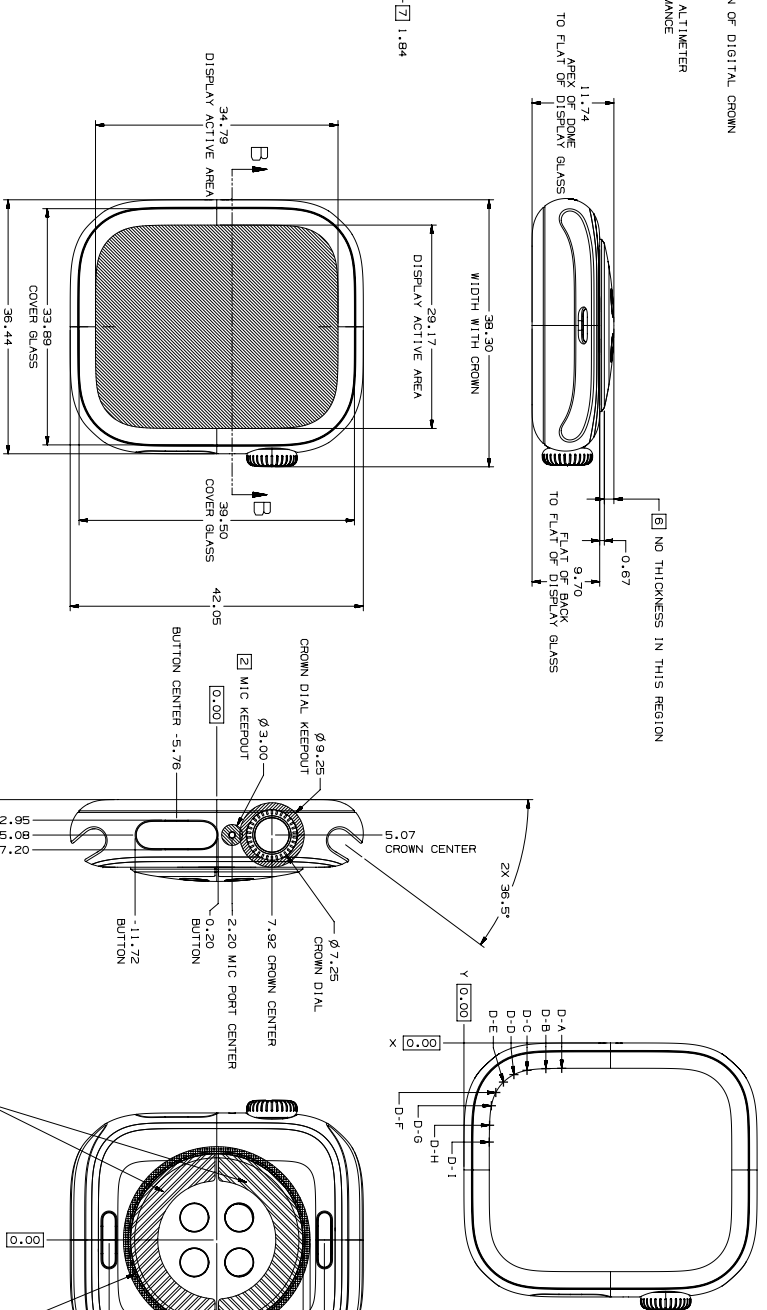
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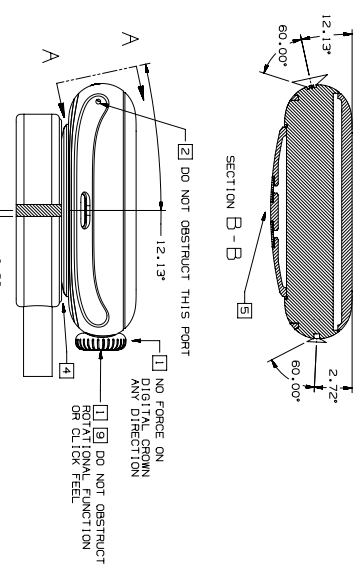
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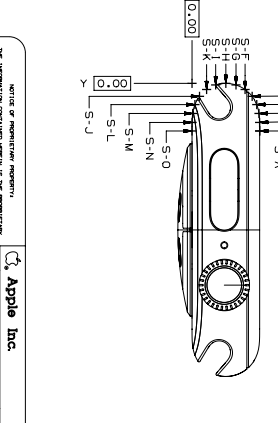
- NOTES** (UNLESS OTHERWISE SPECIFIED)
- 1 CASE DOES NOT INTERFERE WITH CLICK OR ROTATION FUNCTION OF DIGITAL CROWN. CASE DOES NOT APPLY FORCE ON DIGITAL CROWN.
 - 2 CASE DOES NOT OBSTRUCT THE WATCH ACOUSTIC OPENINGS AND ALTIMETER AND MUST NOT DEGRADE ACOUSTIC OR WATER EJECTION PERFORMANCE.
 3. NO METAL CASES ALLOWED DUE TO ANTENNA FUNCTION.
 - 4 CASE DOES NOT OBSTRUCT THE WATCH CHARGING INTERFACE.
 - 5 CASE DOES NOT OBSTRUCT THE WATCH OPTICAL SENSORS.
 - 6 CASE DOES NOT EXTEND BEYOND WATCH SENSOR WINDOWS.
 - 7 CASE DOES NOT CONTACT THE WATCH COVER GLASS.
 - 8 CASE DOES NOT CONTACT ELECTRICAL SENSORS.
 - 9 CASE DOES NOT INTERFERE WITH CLICK FUNCTION OF BUTTON.
 10. CASE DOES NOT CONTAIN FERROMAGNETIC MATERIAL.



POINT	X	Y
A	0.00	21.03
B	0.32	13.03
C	0.35	8.42
D	1.57	5.03
E	3.19	2.95
F	5.39	1.40
G	6.78	0.25
H	16.25	0.00
I	18.25	0.00



POINT	Y	Z
S-A	6.83	9.70
S-B	5.61	9.69
S-C	4.26	9.59
S-D	3.06	9.58
S-E	1.86	8.63
S-F	0.89	7.61
S-G	0.23	6.31
S-H	0.00	4.85
S-I	0.23	3.39
S-K	0.89	2.09
S-L	3.06	0.47
S-M	4.32	0.10
S-N	5.61	0.01
S-O	6.83	0.00



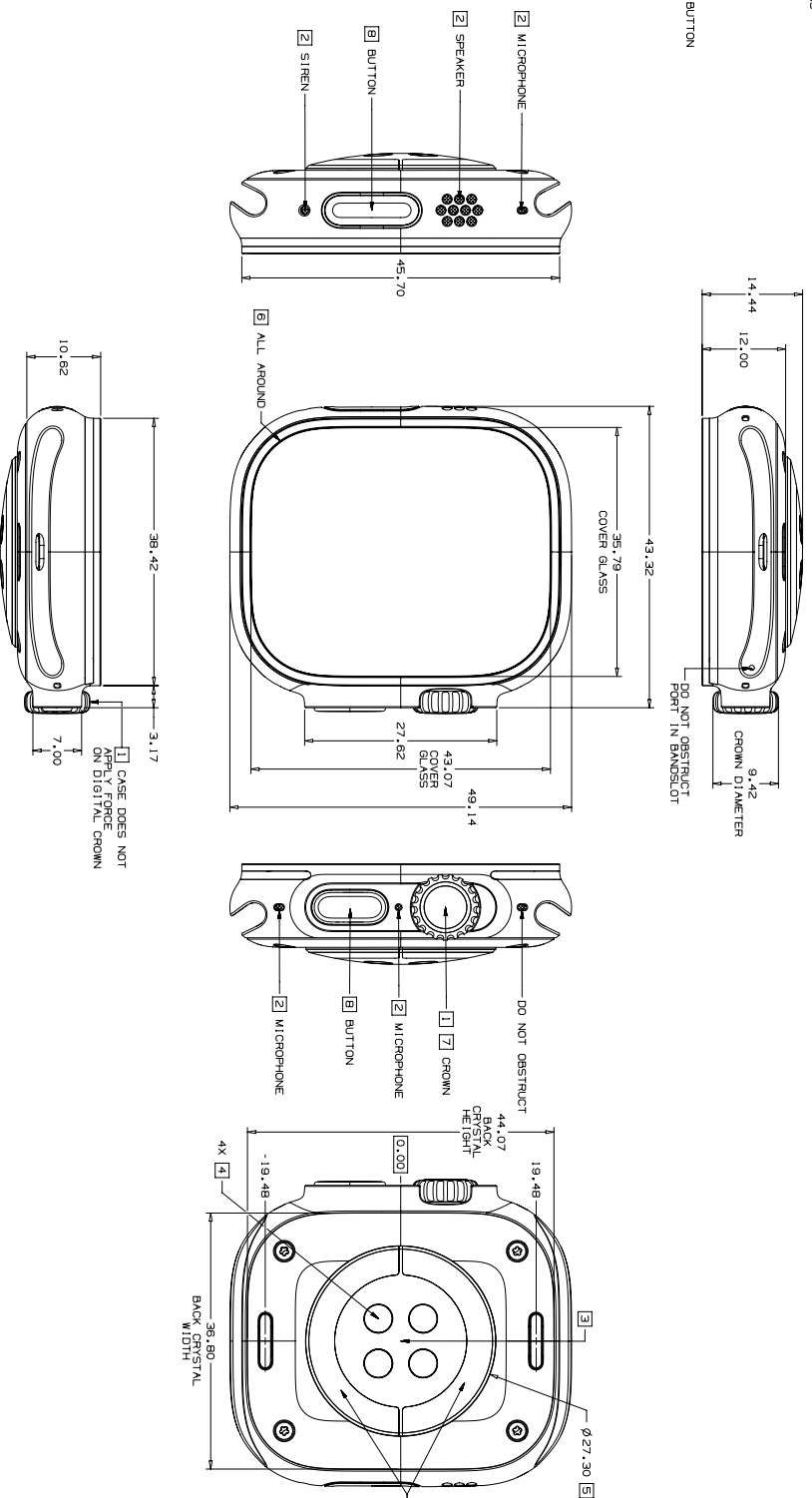
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 Model: N14221
 NONE
 1

59.207 Apple Watch Ultra 2, 1 of 3

OVERALL DIMENSIONS AND CALLOUTS

- NOTES**
- 1 CASE DOES NOT INTERFERE WITH CLICK OR ROTATION FUNCTION OF DIGITAL CROWN
 - 2 CASE DOES NOT APPLY FORCE ON DIGITAL CROWN
 - 3 CASE DOES NOT OBSTRUCT FACE OF CROWN
 - 4 CASE DOES NOT OBSTRUCT THE WATCH ACOUSTIC OPENINGS AND ALTIMETER AND MUST NOT DEGRADE ACOUSTIC OR WATER EJECTION PERFORMANCE
 - 5 CASE DOES NOT OBSTRUCT THE WATCH OPTICAL SENSORS
 - 6 CASE DOES NOT EXTEND INTO WATCH SENSOR WINDOWS
 - 7 CASE DOES NOT CONTACT THE WATCH COVER GLASS
 - 8 CASE DOES NOT CONTACT ELECTRICAL SENSORS
 - 9 CASE DOES NOT INTERFERE WITH CLICK FUNCTION OF BUTTON
 10. NO METAL CASES ALLOWED DUE TO ANTENNA FUNCTION
 10. CASE DOES NOT CONTAIN FERROMAGNETIC MATERIAL



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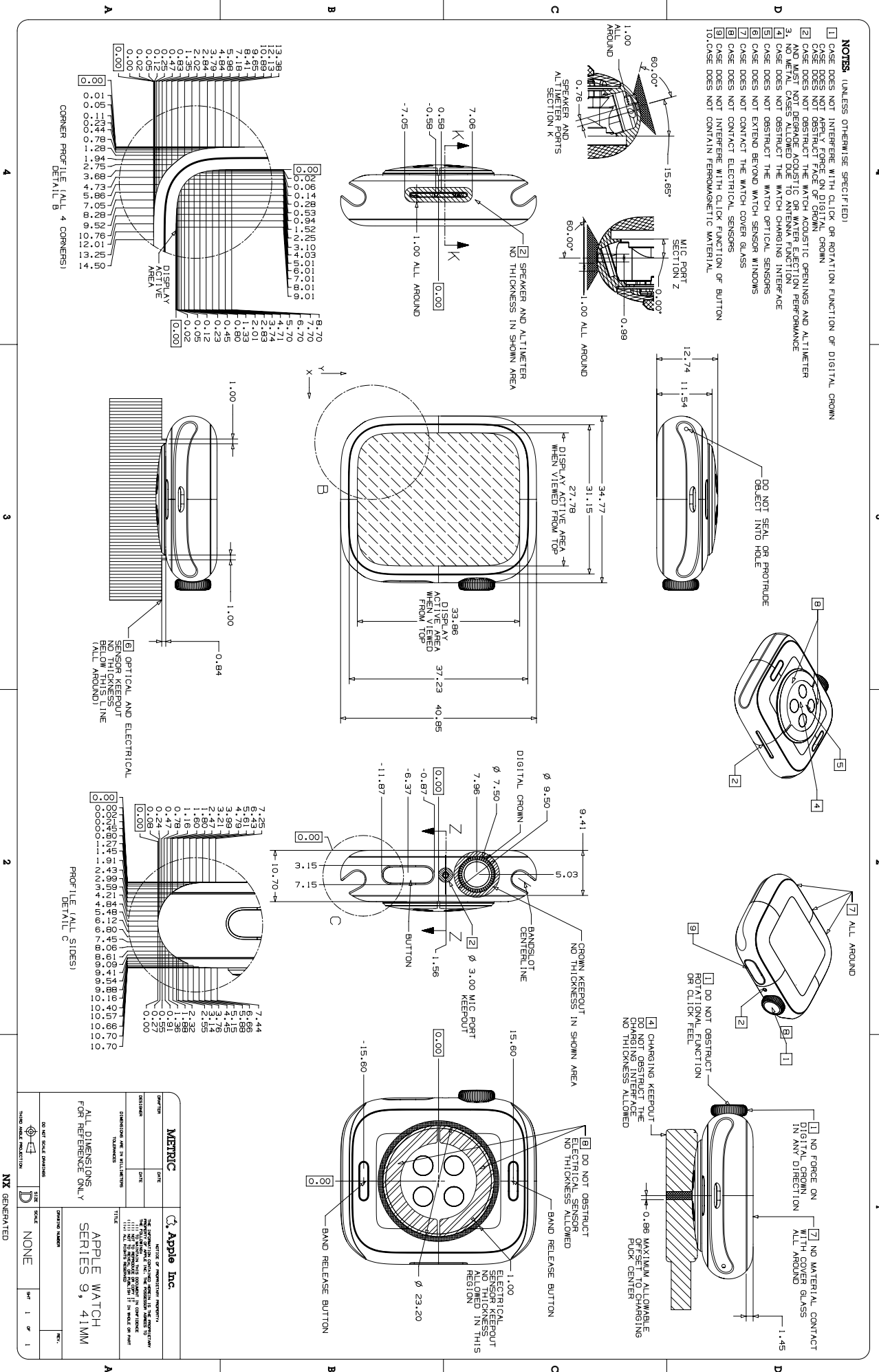
APPLE WATCH ULTRA 2 01

Apple Inc. 1 of 3

59.211 Apple Watch Series 9, 41 mm

NOTES (UNLESS OTHERWISE SPECIFIED):

- 1 CASE DOES NOT INTERFERE WITH CLICK OR ROTATION FUNCTION OF DIGITAL CROWN
- 2 CASE DOES NOT APPLY FORCE ON DIGITAL CROWN
- 3 CASE DOES NOT OBSTRUCT FACE OF CROWN
- 4 CASE DOES NOT OBSTRUCT THE WATCH ACOUSTIC OPENINGS AND ALTIMETER AND ALL OTHER CASE-TO-CASE INTERFERENCE PERFORMANCE
- 5 AND ALL CASE SENSORS MUST BE IN AN INTERFERECTION PERFORMANCE REGION
- 6 CASE DOES NOT OBSTRUCT THE WATCH CHARGING INTERFACE
- 7 CASE DOES NOT EXTEND BEYOND WATCH SENSORS WINDOWS
- 8 CASE DOES NOT CONTACT THE WATCH COVER GLASS
- 9 CASE DOES NOT CONTACT ELECTRICAL SENSORS
- 10 CASE DOES NOT INTERFERE WITH CLICK FUNCTION OF BUTTON
- 11 CASE DOES NOT CONTAIN FERROMAGNETIC MATERIAL

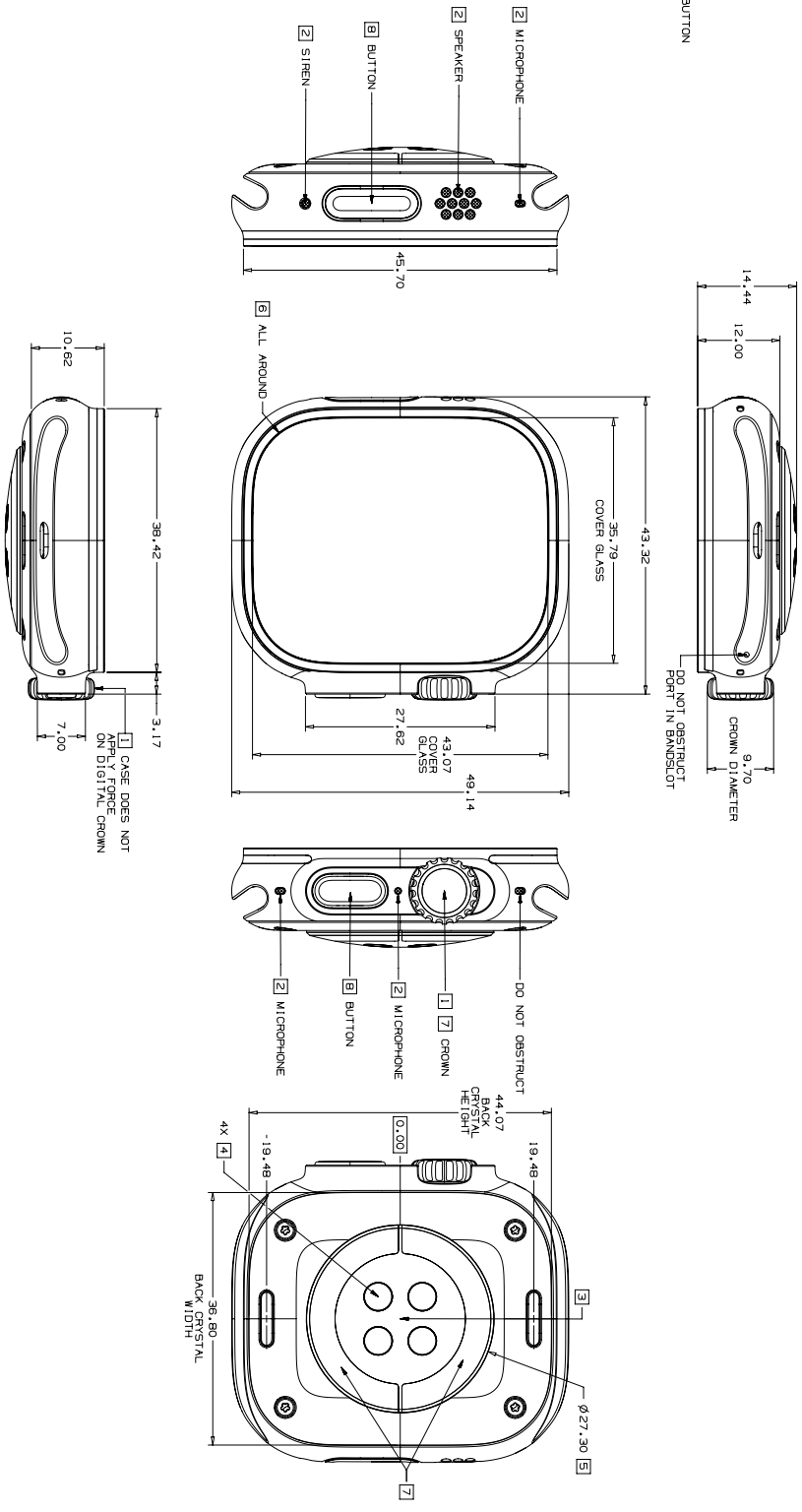


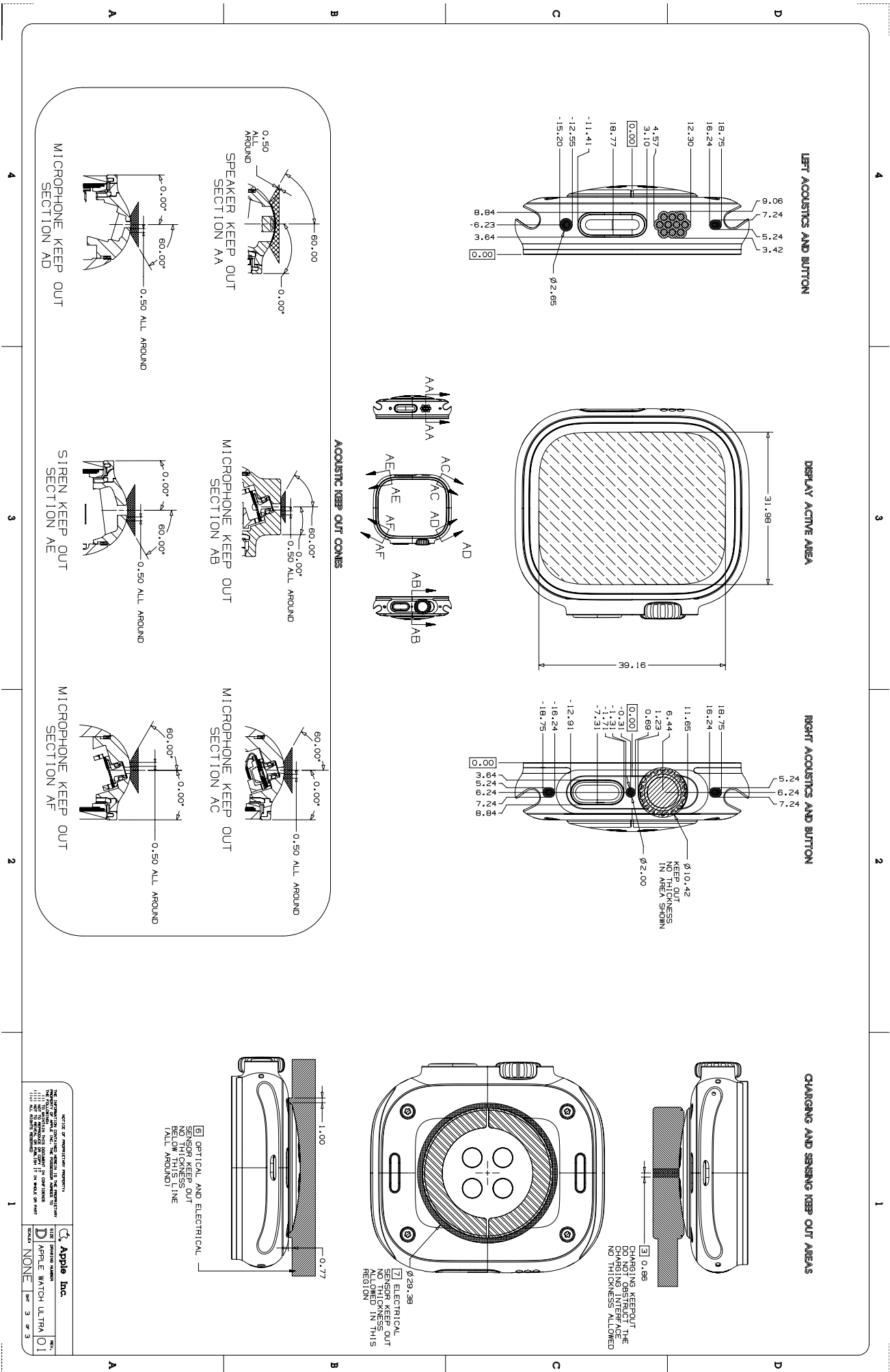
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Apple Inc. 1101 MITCHELL AVENUE, CUPERTINO, CA 95014 TEL: (408) 996-1010 FAX: (408) 996-1011 WWW.APPLE.COM					
Apple Watch Series 9, 41mm			Apple Watch Series 9, 41mm		
ALL DIMENSIONS FOR REFERENCE ONLY			ALL DIMENSIONS FOR REFERENCE ONLY		
DIMENSIONS IN MILLIMETERS			DIMENSIONS IN MILLIMETERS		
TOLERANCES			TOLERANCES		
FINISHES			FINISHES		
DRAWING NUMBER			DRAWING NUMBER		
CHECKED BY: MX			CHECKED BY: MX		
DATE:			DATE:		
DRAWN BY:			DRAWN BY:		

59.212 Apple Watch Ultra, 1 of 3

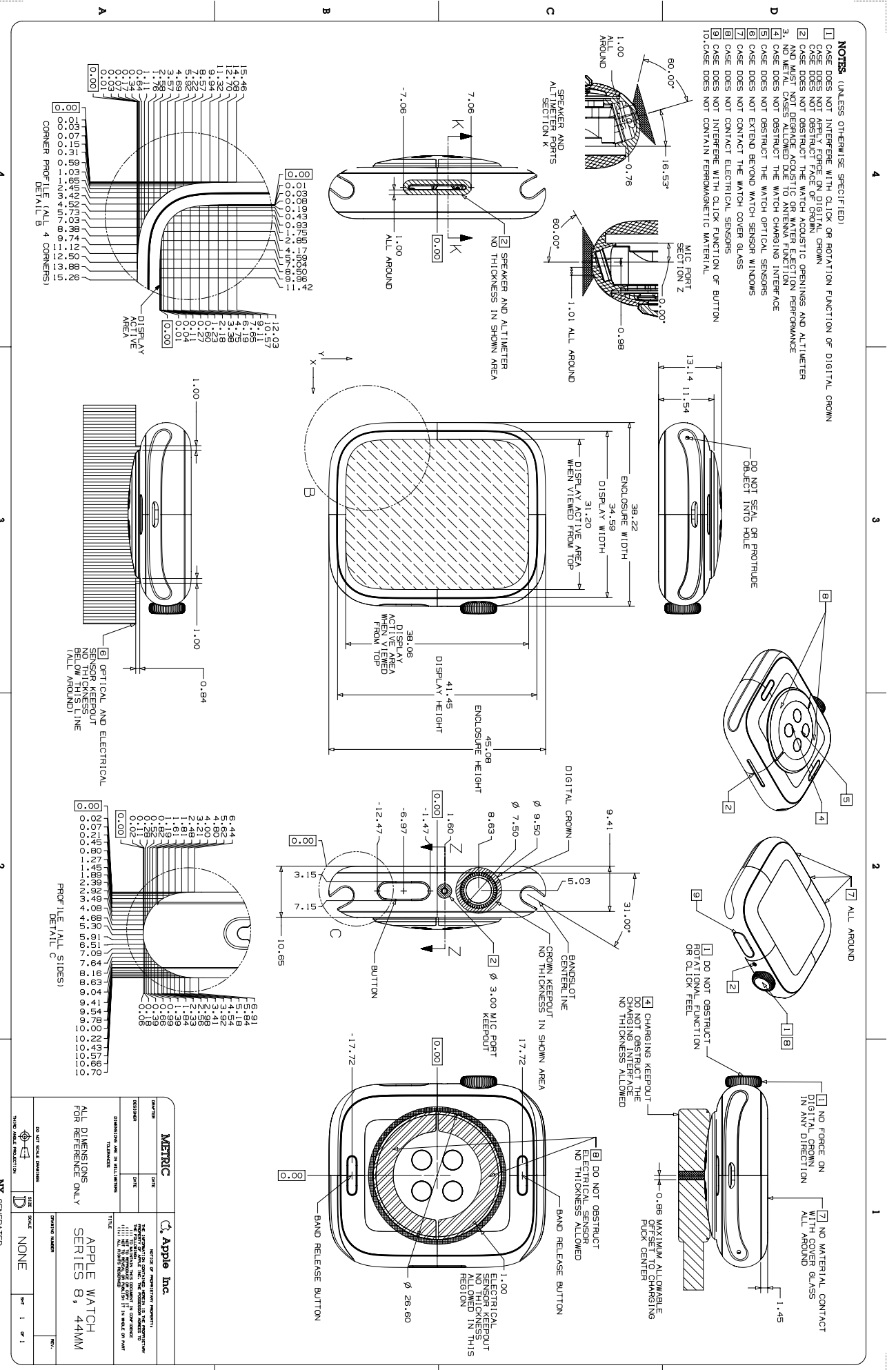
OVERALL DIMENSIONS AND CALLOUTS

- NOTES**
- CASE DOES NOT INTERFERE WITH CLICK OR ROTATION FUNCTION OF DIGITAL CROWN
 - CASE DOES NOT APPLY FORCE ON DIGITAL CROWN
 - CASE DOES NOT OBSTRUCT FACE OF CROWN
 - CASE DOES NOT OBSTRUCT THE WATCH ACOUSTIC OPENINGS AND ALTITUDE AND MUST NOT DEGRADE ACOUSTIC OR WATER EJECTION PERFORMANCE
 - CASE DOES NOT OBSTRUCT THE WATCH CHARGING INTERFACE
 - CASE DOES NOT OBSTRUCT THE WATCH OPTICAL SENSORS
 - CASE DOES NOT EXTEND INTO WATCH SENSOR WINDOWS
 - CASE DOES NOT CONTACT THE WATCH COVER GLASS
 - CASE DOES NOT CONTACT ELECTRICAL SENSORS
 - CASE DOES NOT INTERFERE WITH CLICK FUNCTION OF BUTTON
 - NO METAL CASES ALLOWED DUE TO ANTENNA FUNCTION
 - CASE DOES NOT CONTAIN FERROMAGNETIC MATERIAL

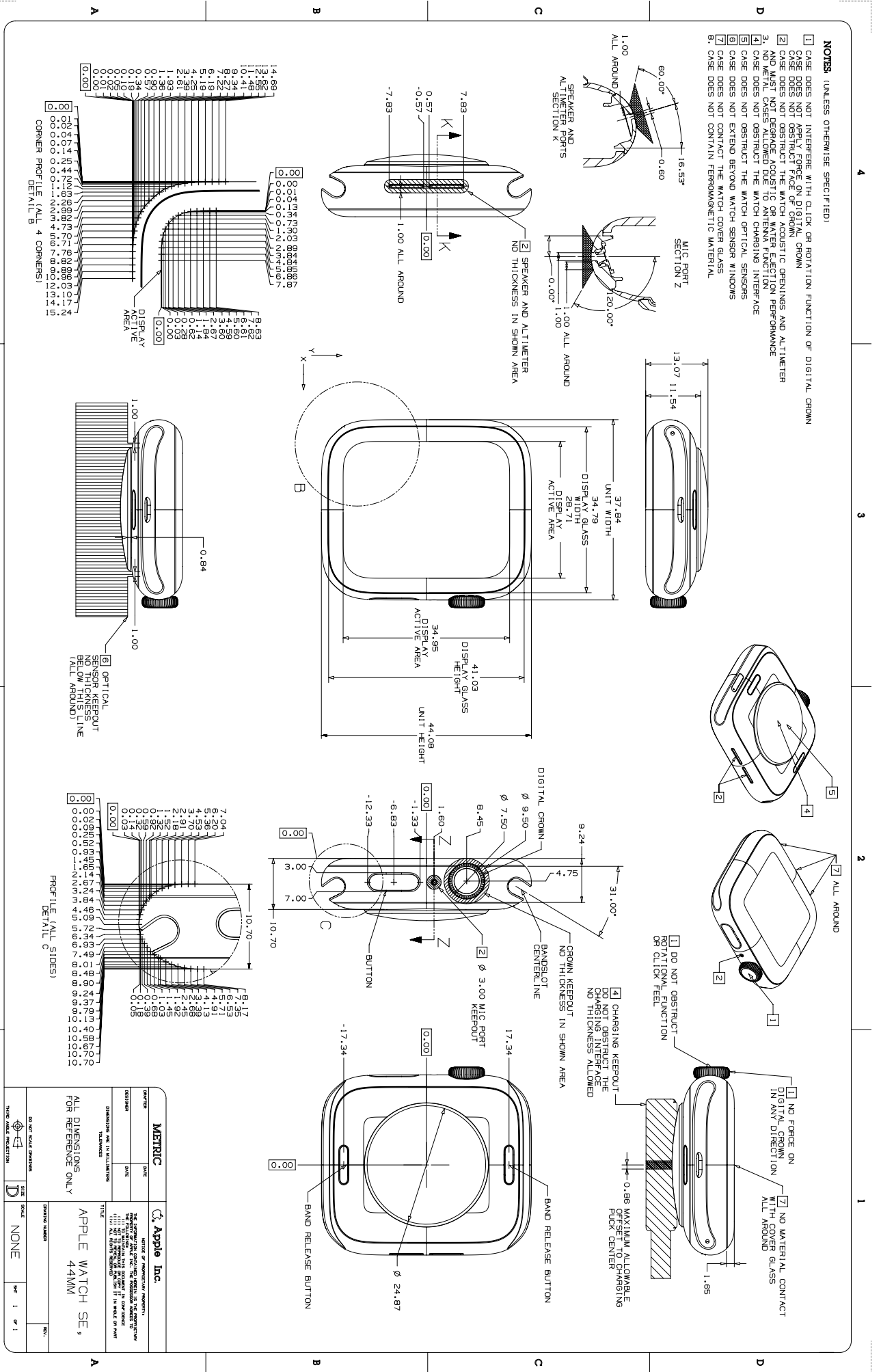




DATE OF REVISION: 01/11/2024
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 Apple Inc.
 1 Apple Park Drive
 Cupertino, CA 95014
 Apple Watch Ultra 3 of 3



59.217 Apple Watch SE, 44 mm



DATE	
DESIGNED BY	
DRAWN BY	
CHECKED BY	
APPROVED BY	
DATE	
SCALE	NONE
UNIT	MM
PROJ. NO.	
REV.	
DATE	

METRIC

Apple Inc.

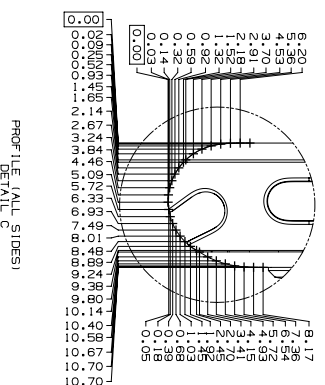
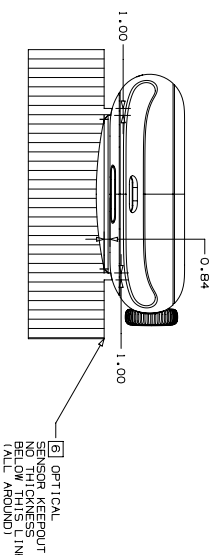
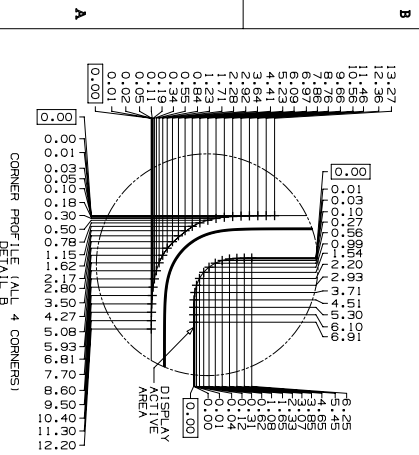
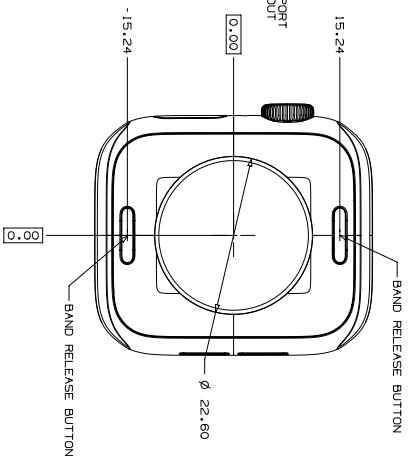
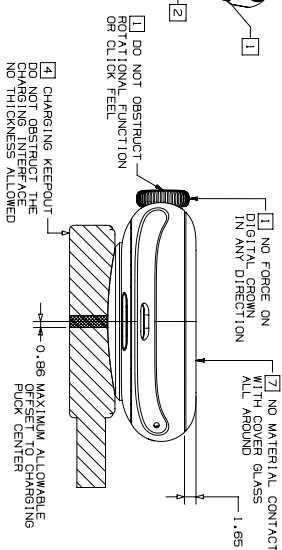
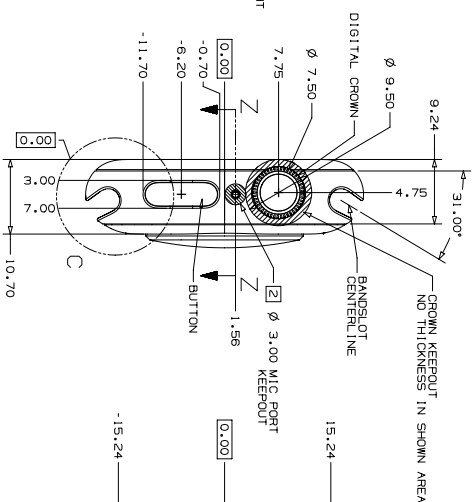
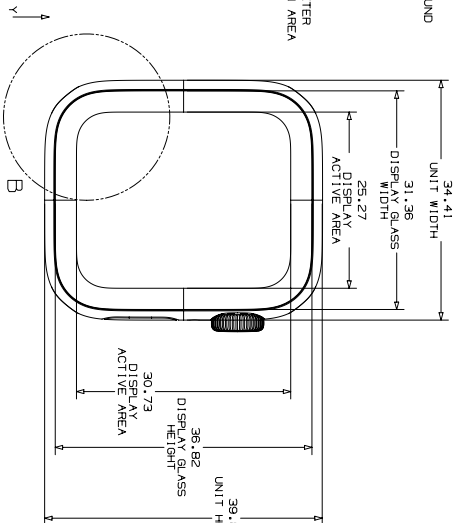
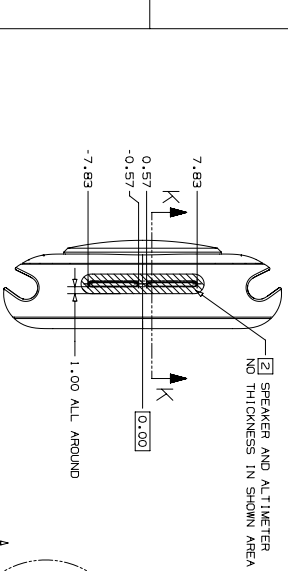
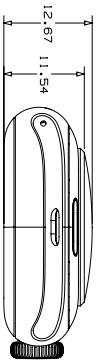
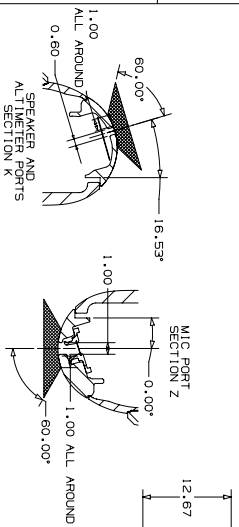
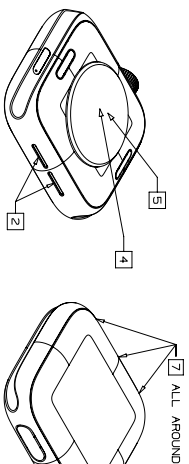
ALL DIMENSIONS FOR REFERENCE ONLY

APPLE WATCH SE, 44MM

MX GENERATED

59.218 Apple Watch SE, 40 mm

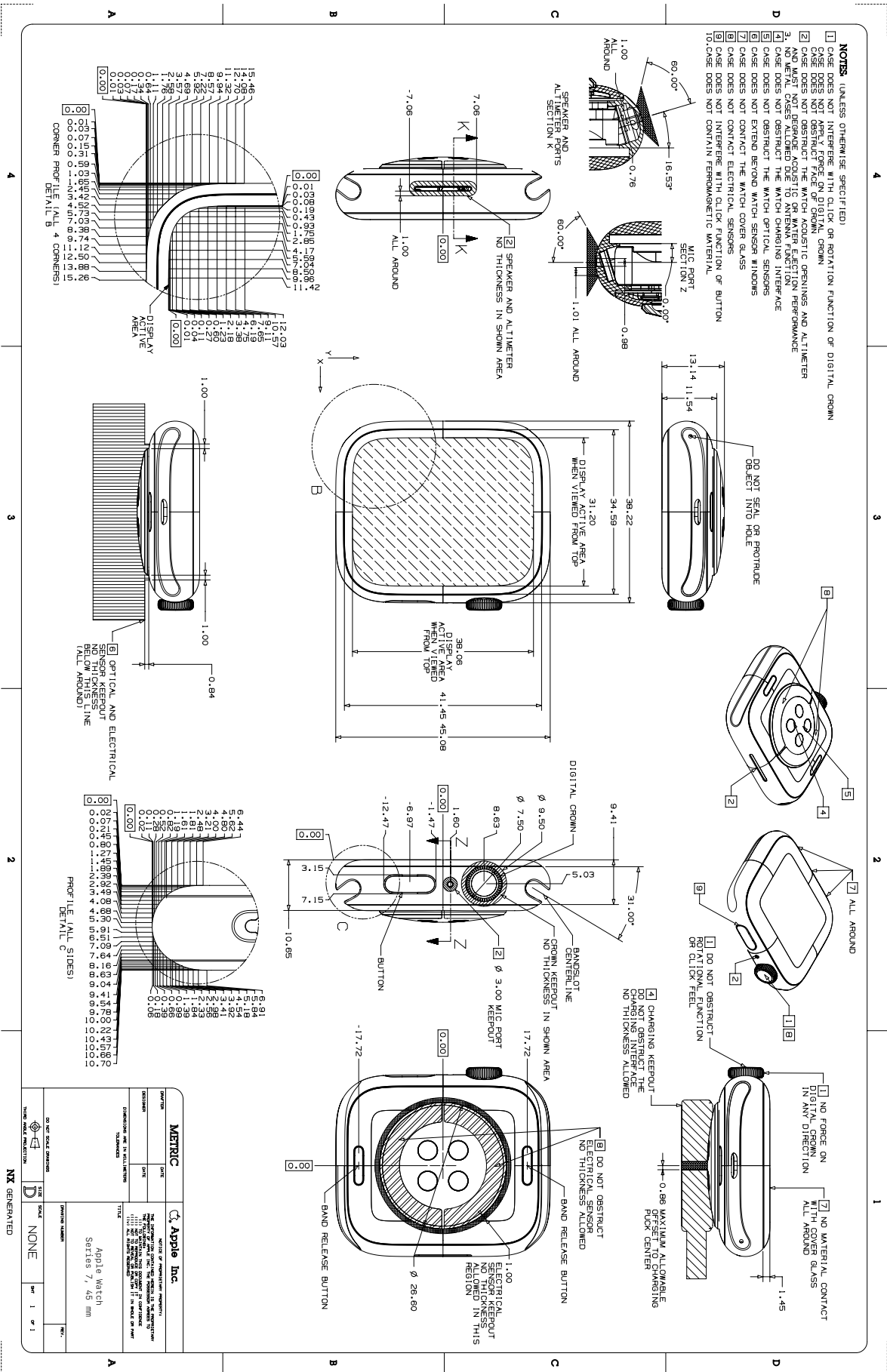
- NOTES** (UNLESS OTHERWISE SPECIFIED):
- CASE DOES NOT INTERFERE WITH CLICK OR ROTATION FUNCTION OF DIGITAL CROWN
 - CASE DOES NOT APPLY FORCE ON DIGITAL CROWN
 - CASE DOES NOT OBSTRUCT FACE OF CROWN
 - CASE DOES NOT OBSTRUCT THE WATCH ACOUSTIC OPENINGS AND ALTIMETER
 - CASE DOES NOT OBSTRUCT THE WATCH CHARGING INTERFACE
 - CASE DOES NOT OBSTRUCT THE WATCH CHARGING INTERFACE AND MUST NOT OBSTRUCT THE WATCH CHARGING INTERFACE
 - CASE DOES NOT OBSTRUCT THE WATCH CHARGING INTERFACE
 - CASE DOES NOT OBSTRUCT THE WATCH OPTICAL SENSORS
 - CASE DOES NOT OBSTRUCT THE WATCH SENSOR WINDOWS
 - CASE DOES NOT CONTACT THE WATCH COVER GLASS
 - CASE DOES NOT CONTAIN FERROMAGNETIC MATERIAL



METRIC		Apple Inc.	
DATE	SCALE	DATE	SCALE
DESIGNED BY	DATE	DESIGNED BY	DATE
CHECKED BY	DATE	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY	DATE
DIMENSIONS ARE IN MILLIMETERS			
TOLERANCES			
TITLE: APPLE WATCH SE, 40MM			
DRAWING NUMBER			
DO NOT SCALE DRAWINGS			
HIDDEN LINE REJECTION			
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SCALE: NONE			
SHEET: 1 OF 1			

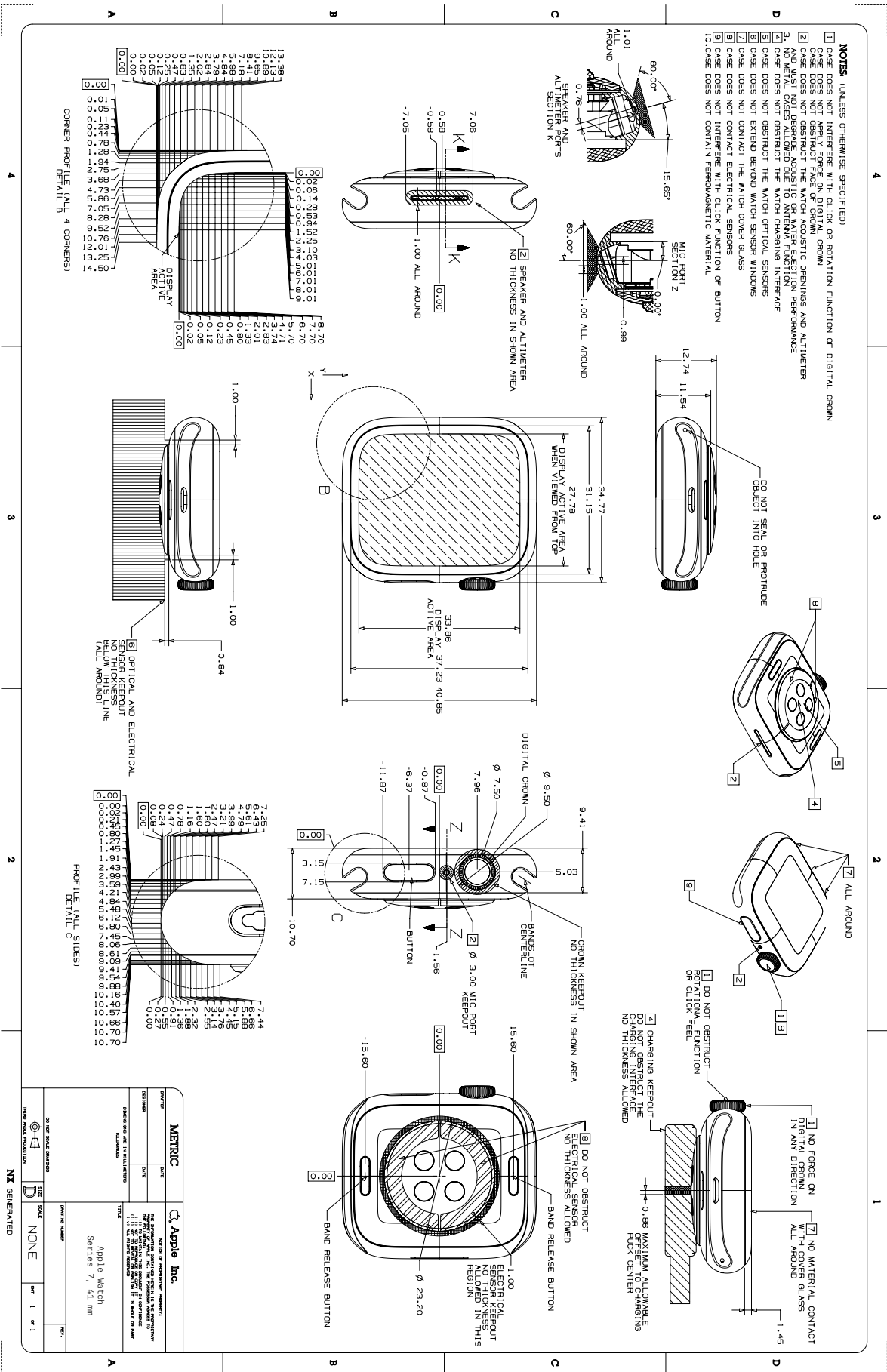
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59.219 Apple Watch Series 7, 45 mm



METRIC		NONE	
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DESIGNER		DESIGNER	
CHECKER		CHECKER	
DATE		DATE	
DESCRIPTION	NEW IN DEVELOPMENT	DESCRIPTION	NEW IN DEVELOPMENT
CONFORMANCE		CONFORMANCE	
TITLE		TITLE	
Apple Inc.		Apple Inc.	
Apple Watch Series 7, 45 mm		Apple Watch Series 7, 45 mm	
Apple Inc. 1 Infinite Loop Cupertino, CA 95014		Apple Inc. 1 Infinite Loop Cupertino, CA 95014	
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DO NOT SCALE DIMENSIONS	SIZE	SCALE	NONE
THIS FILE REFLECTS	REV	DATE	1 2021
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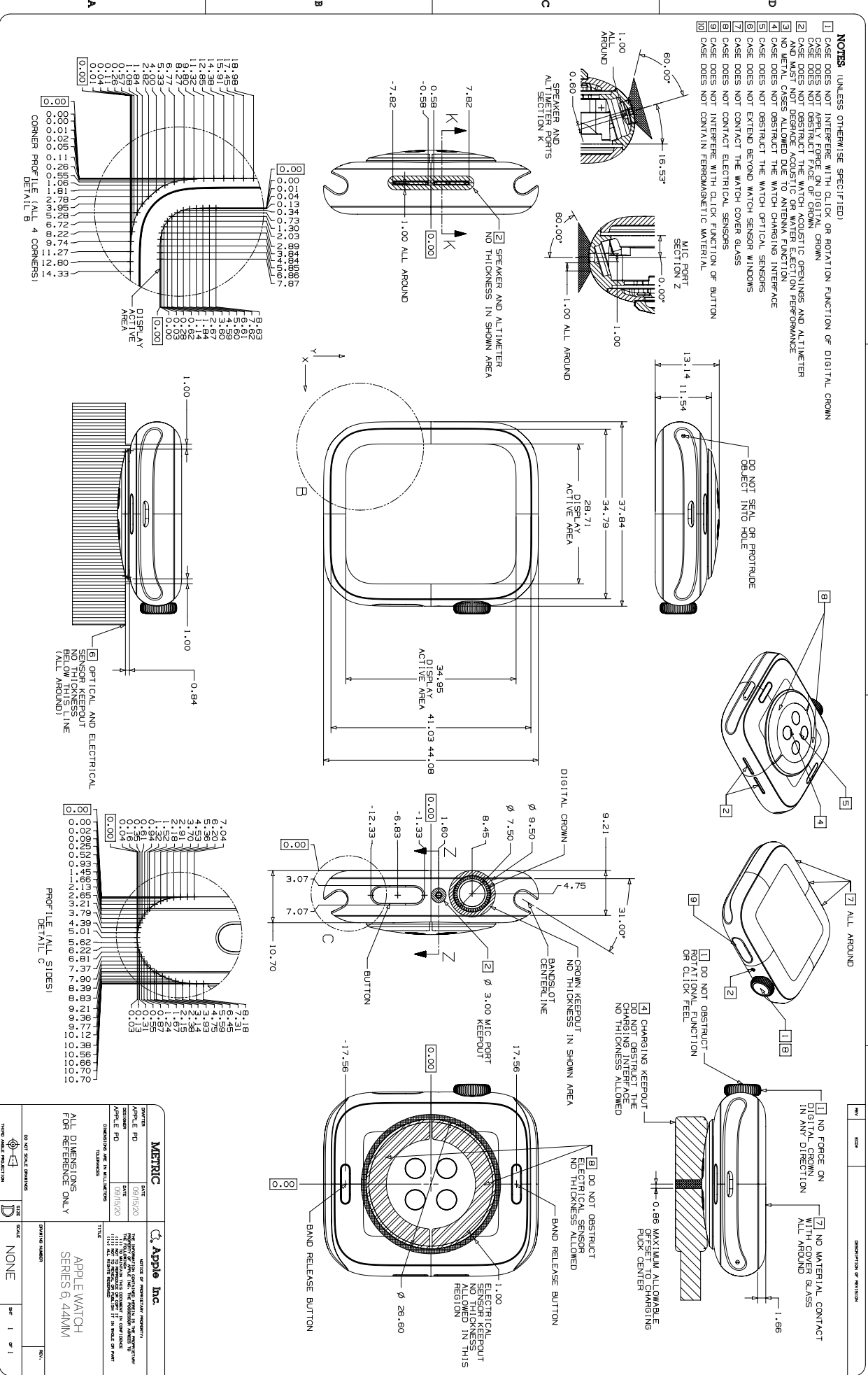
59.220 Apple Watch Series 7, 41 mm



59.221 Apple Watch Series 6, 44 mm

NOTES (UNLESS OTHERWISE SPECIFIED):

- 1 CASE DOES NOT INTERFERE WITH CLICK OR ROTATION FUNCTION OF DIGITAL CROWN
- 2 CASE DOES NOT APPLY FORCE ON DIGITAL CROWN
- 3 CASE DOES NOT OBSTRUCT THE WATCH ADJUSTIVE OPENINGS AND ALTIMETER
- 4 CASE DOES NOT OBSTRUCT THE WATCH CHARGING PORT
- 5 NO METAL CASES ALLOWED DUE TO ANTENNA FUNCTION
- 6 CASE DOES NOT OBSTRUCT THE WATCH CHARGING INTERFACE
- 7 CASE DOES NOT EXTEND BEYOND THE WATCH OPTICAL WINDOWS
- 8 CASE DOES NOT CONTACT THE WATCH SENSOR WINDOWS
- 9 CASE DOES NOT CONTACT ELECTRICAL SENSORS
- 10 CASE DOES NOT INTERFERE WITH CLICK FUNCTION OF BUTTON



METRIC		DATE	DESCRIPTION
APPLY TO	DATE	08/15/20	REVISION 1
APPLY TO	DATE	08/15/20	REVISION 2
APPLY TO	DATE	08/15/20	REVISION 3

ALL DIMENSIONS FOR REFERENCE ONLY

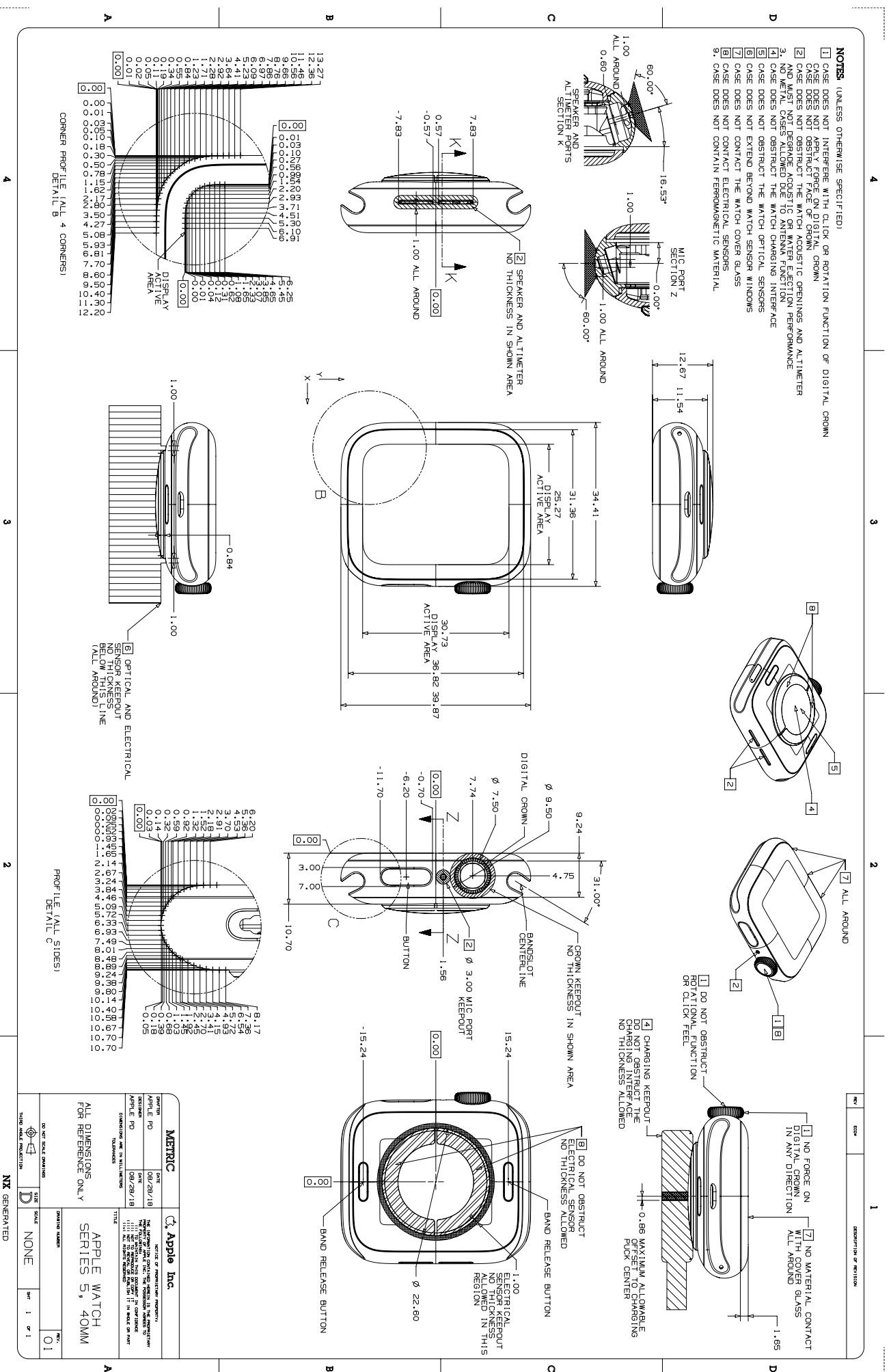
Apple Inc.

Apple Watch Series 6, 44mm

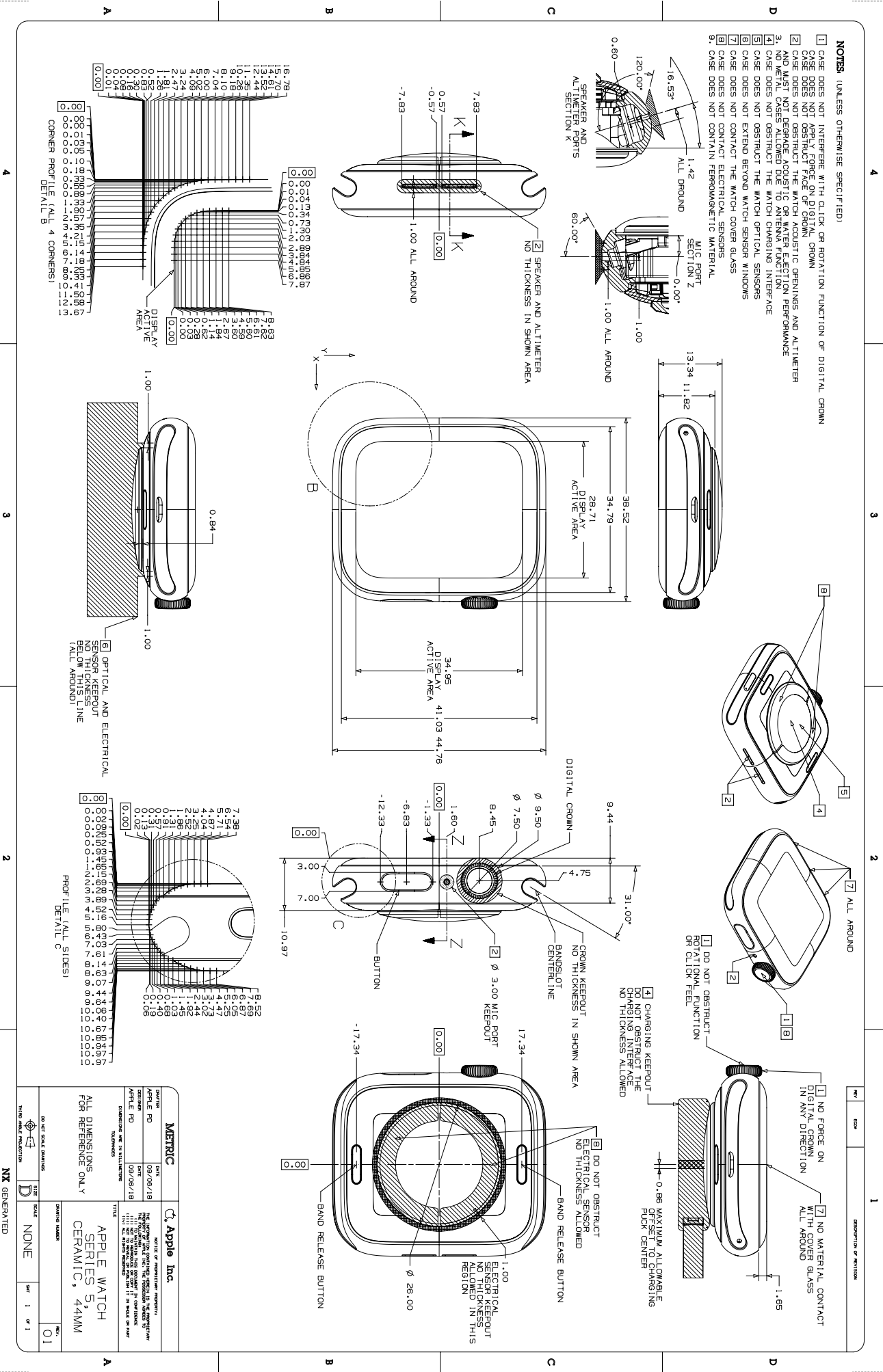
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Sheet: 1 of 1

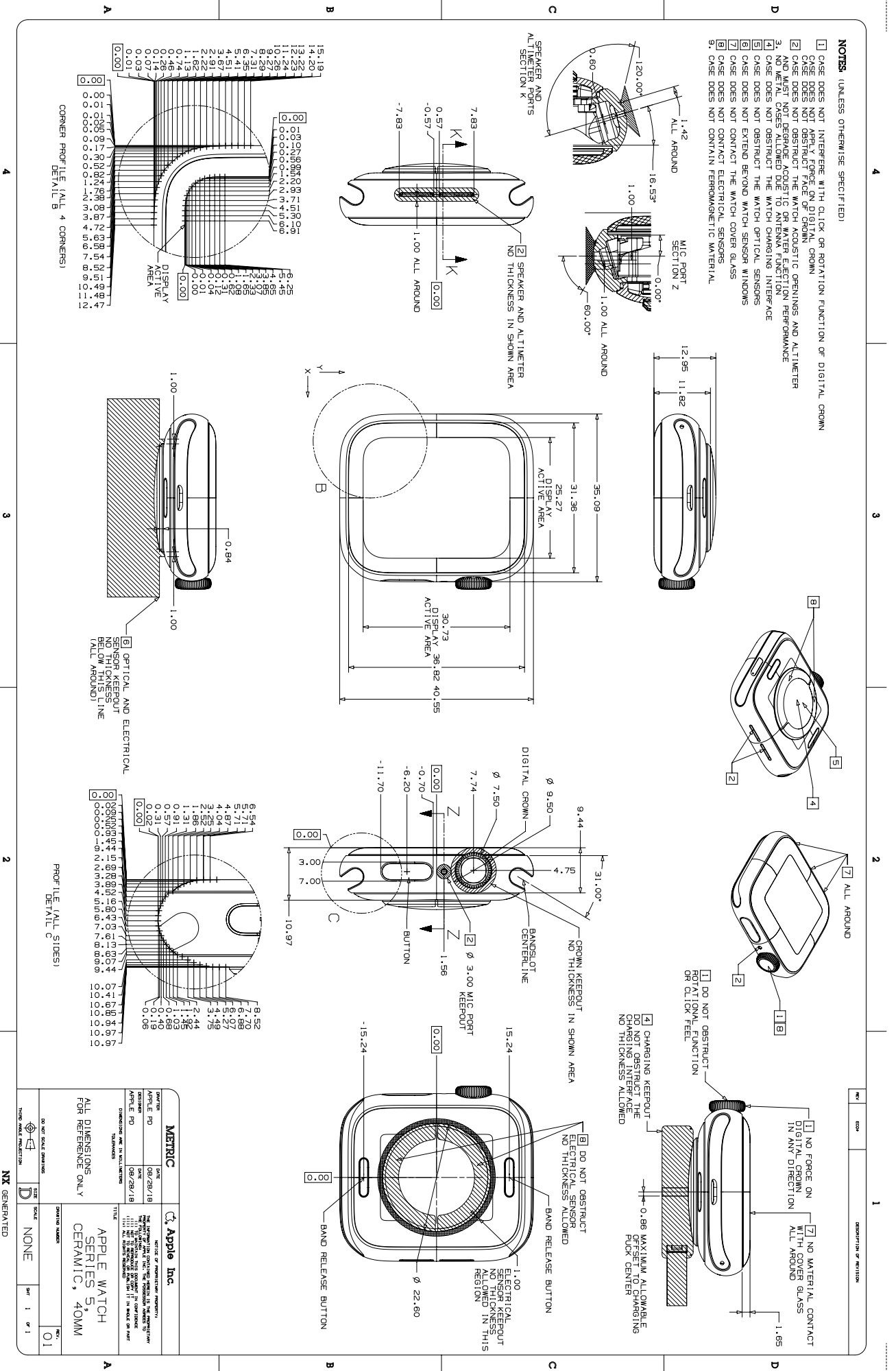
59.226 Apple Watch Series 5, 40 mm



59.227 Apple Watch Series 5 Ceramic, 44 mm



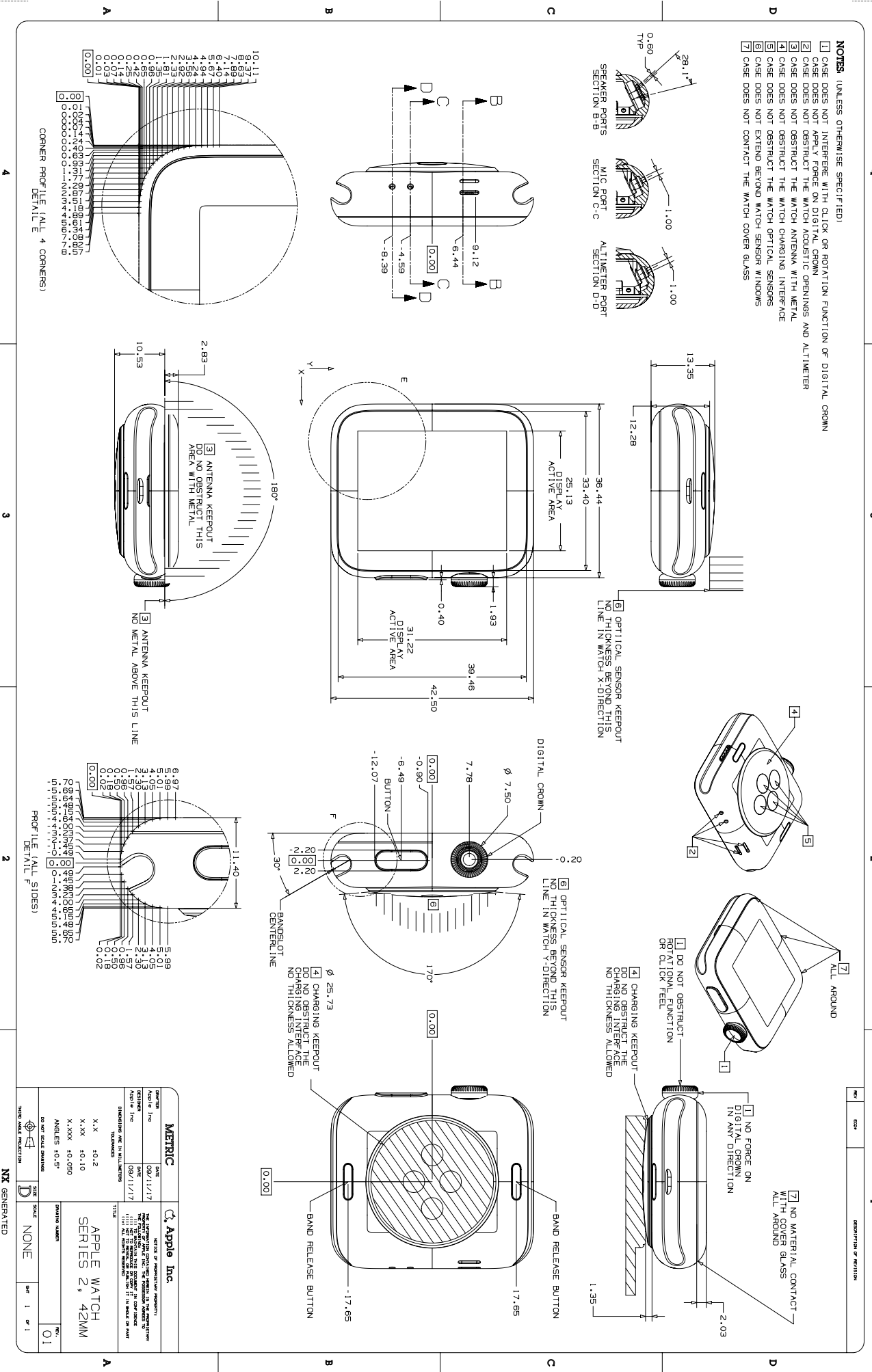
59.228 Apple Watch Series 5 Ceramic, 40 mm



59.237 Apple Watch Series 2 Metal, 42 mm

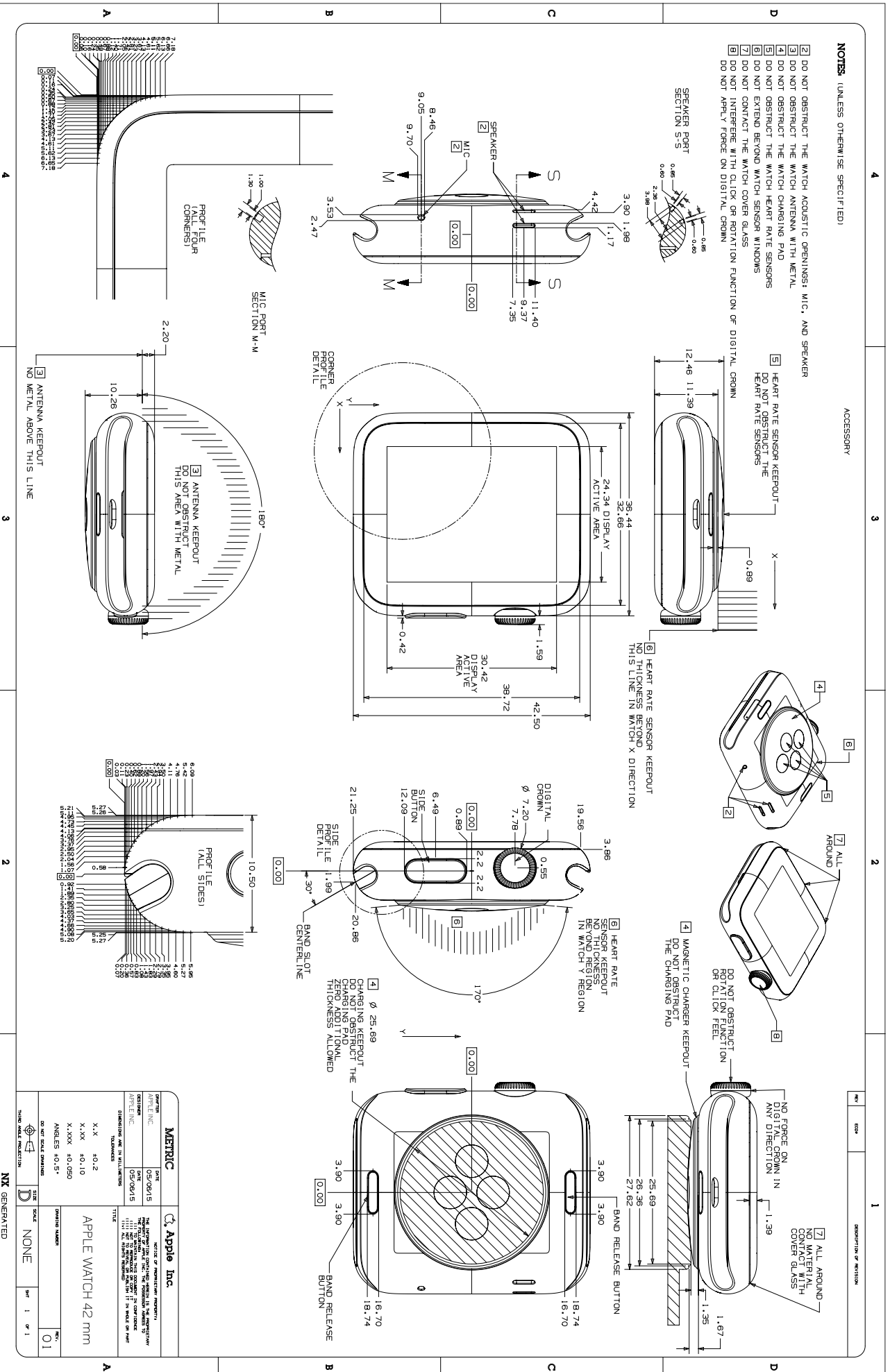
NOTES (UNLESS OTHERWISE SPECIFIED):

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- 2 CASE DOES NOT APPLY FORCE ON DIGITAL CROWN
- 3 CASE DOES NOT OBSTRUCT THE WATCH ACOUSTIC OPENINGS AND ALTIMETER
- 4 CASE DOES NOT OBSTRUCT THE WATCH ANTENNA WITH METAL
- 5 CASE DOES NOT OBSTRUCT THE WATCH CHARGING INTERFACE
- 6 CASE DOES NOT OBSTRUCT THE WATCH OPTICAL SENSORS
- 7 CASE DOES NOT EXTEND BEYOND WATCH SENSOR WINDOWS
- 8 CASE DOES NOT CONTACT THE WATCH COVER GLASS

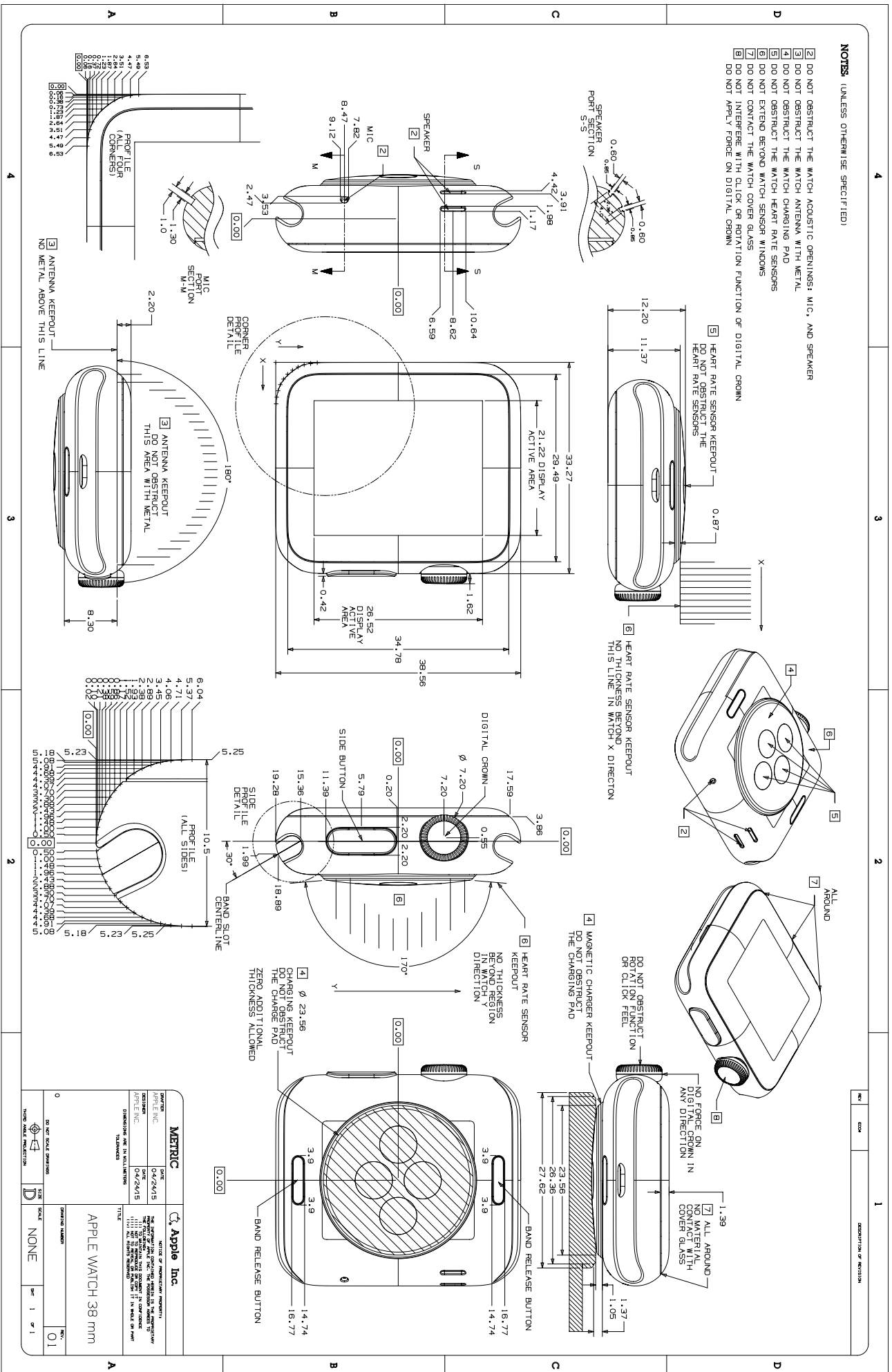


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DESIGNED BY	X.XX	DESIGNED BY	X.XX
CHECKED BY	X.XX	CHECKED BY	X.XX
APPROVED BY	X.XX	APPROVED BY	X.XX
DATE	09/11/17	DATE	09/11/17
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<p>CHANGING KEYPOT IN MILLIMETERS</p>			
SCALE	1:1	TITLE	APPLE WATCH SERIES 2, 42MM
DATE	09/11/17	SCALE	NONE
NO. OF SHEETS	1	NO. OF SHEETS	1
TOTAL SHEETS	1	TOTAL SHEETS	1

59.239 Apple Watch (1st generation) and Apple Watch Series 1, 42 mm



59.240 Apple Watch (1st generation) and Apple Watch Series 1, 38 mm



59.241 Apple Vision Pro, 1 of 6

4 3 2 1

NOTES (UNLESS OTHERWISE SPECIFIED)

- 1 NO METAL CONTACT WITH PRODUCT.
- 2 DO NOT OBSTRUCT PORTS.
- 3 CASE DOES NOT INTERFERE WITH CLICK OR ROTATION FUNCTION OF BUTTON, DIGITAL CROWN, OR FIT DIAL. CASE DOES NOT APPLY FORCE ON BUTTON, DIGITAL CROWN, OR FIT DIAL.
- 4 2N MAX ALLOWABLE FORCE APPLIED TO OUTER TEXTILE/FACETRACK PERIMETER.
- 5 RELATIVE MAGNETIC PERMEABILITY OF ANY METAL USED ON CASE: 1.05 MAX, PER ASTM A342/A342M-14.
- 6 MINIMIZE CONTACT WITH GLASS ON DISPLAY, OPTICAL MODULES, AND CLIP-ON LENSES. IF CONTACT IS REQUIRED, USE SOFT NON-ABRASIVE MATERIALS TO AVOID SCRATCHING.
- 7 DO NOT TOUCH LIGHTPIPE.
- 8 4N MAX ALLOWABLE FORCE APPLIED TO CUSHION FROM USER SIDE. UNIT SHALL NOT BE POWERED ON OR UNDER OPERATING CONDITIONS WHILE STORED INSIDE THE CASE.

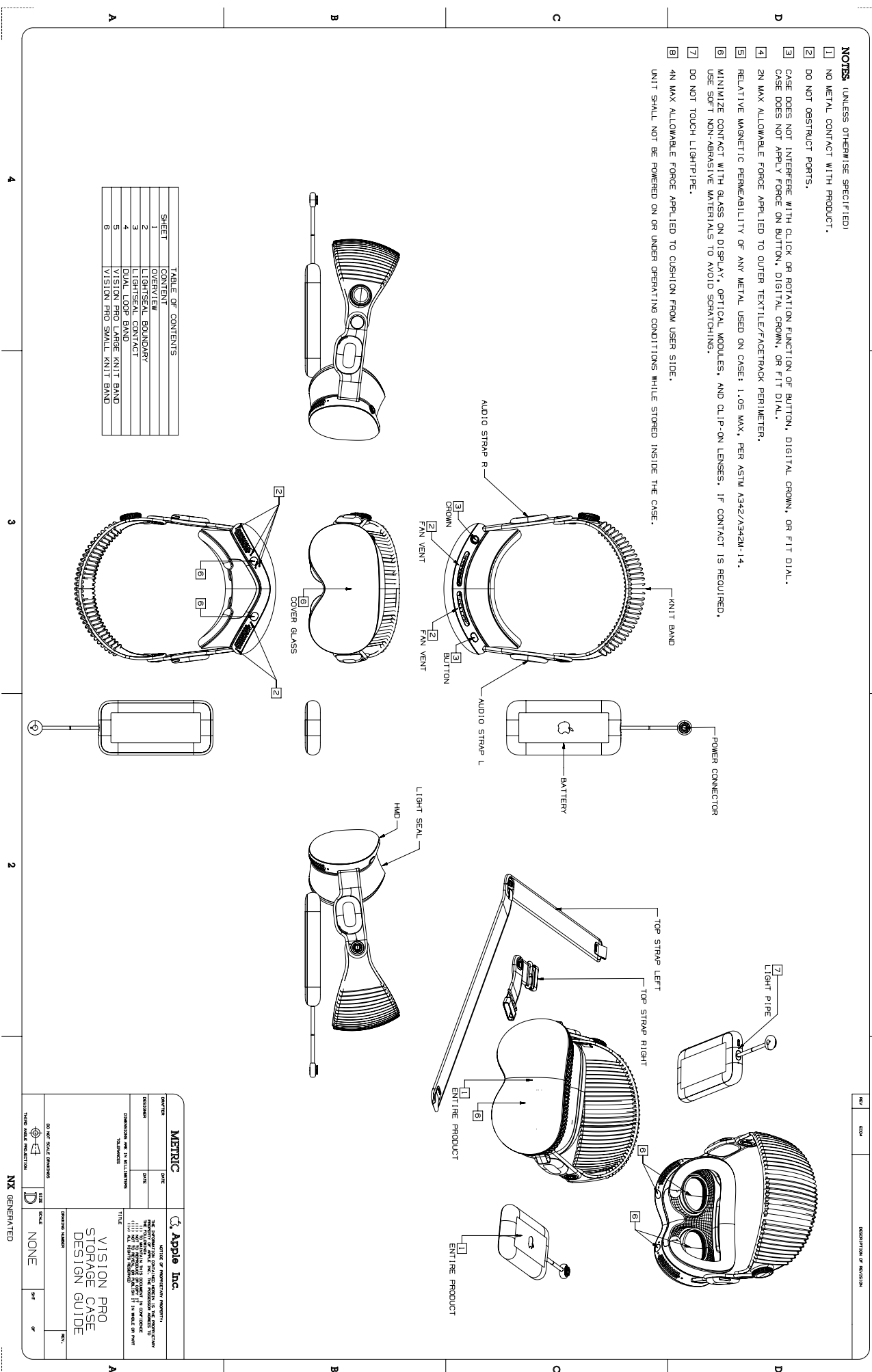


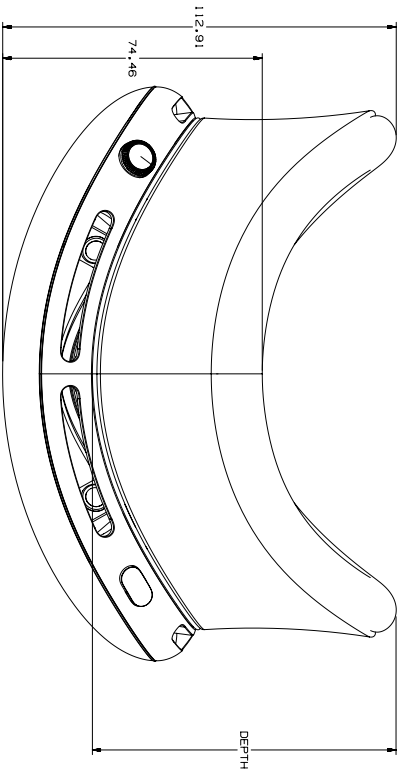
TABLE OF CONTENTS

SHEET	CONTENT
1	OVERVIEW
2	LIGHTSEAL BOUNDARY
3	LIGHTSEAL CONTACT
4	DUAL LOOP BAND
5	VISION PRO LARGE KNIT BAND
6	VISION PRO SMALL KNIT BAND

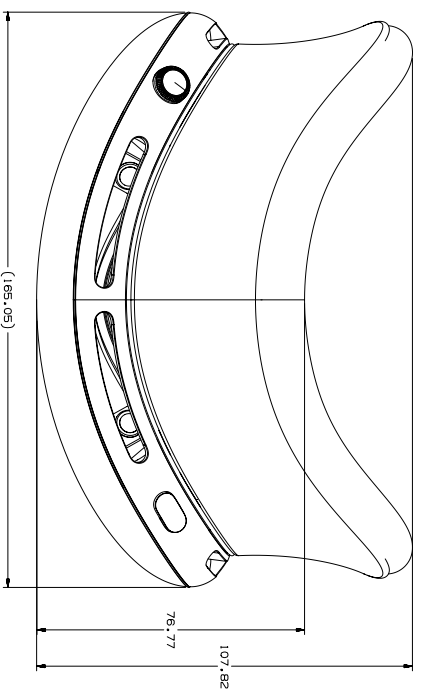
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DESIGNER	SCALE	DATE	SCALE
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INDICATED	SCALE	DATE	SCALE
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HARD MAKE REFLECTION		HARD MAKE REFLECTION	
NX GENERATED		NX GENERATED	
VISION PRO STORAGE CASE DESIGN GUIDE		VISION PRO STORAGE CASE DESIGN GUIDE	

LIGHT SEAL BOUNDARY REQUIREMENTS

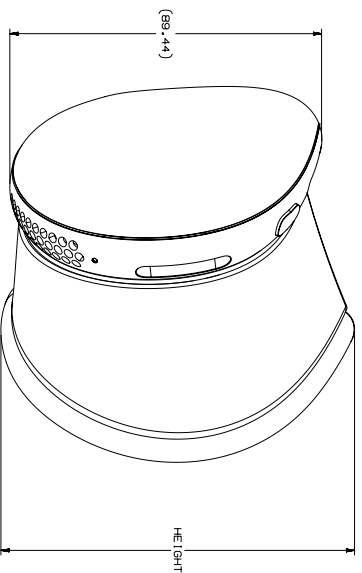
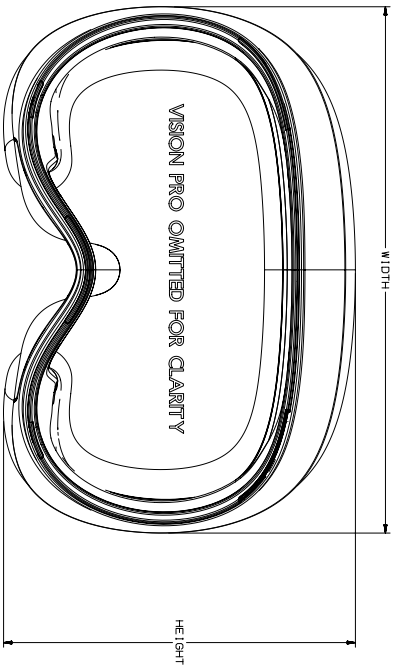


DEEPEST LIGHT SEAL



WIDEST • TALLEST LIGHT SEAL

DESCRIPTION	LIGHTSEAL + FACE CUSHION (mm)		
	WIDTH	DEPTH	HEIGHT
LARGEST IN ALL DIMENSIONS	161.95 MMC	98.4 MMC	104.28 MMC
SMALLEST IN ALL DIMENSIONS	147.57 LMC	72.98 MMC	94.07 LMC



4 3 2 1

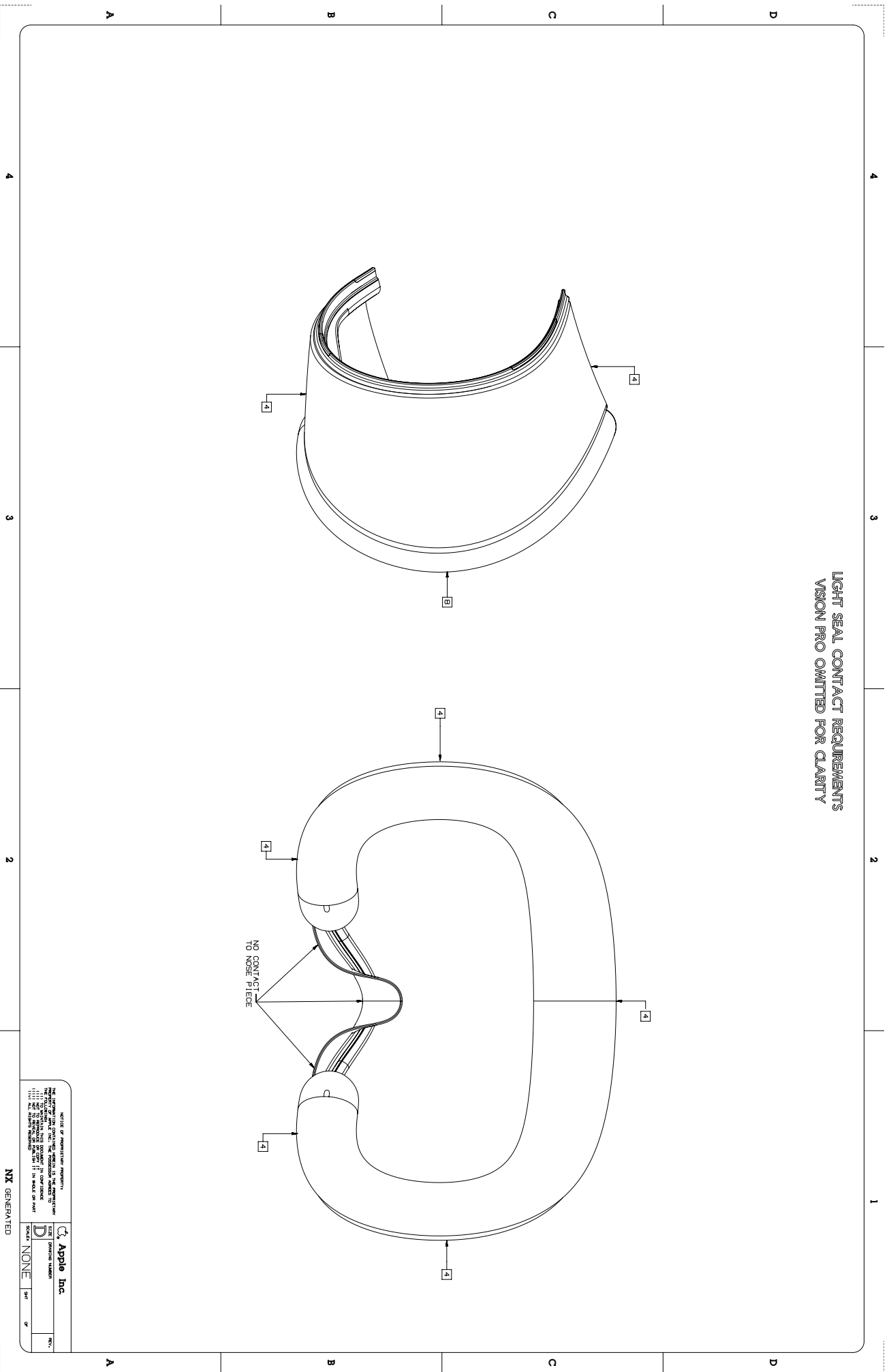
2

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 Model: NONE

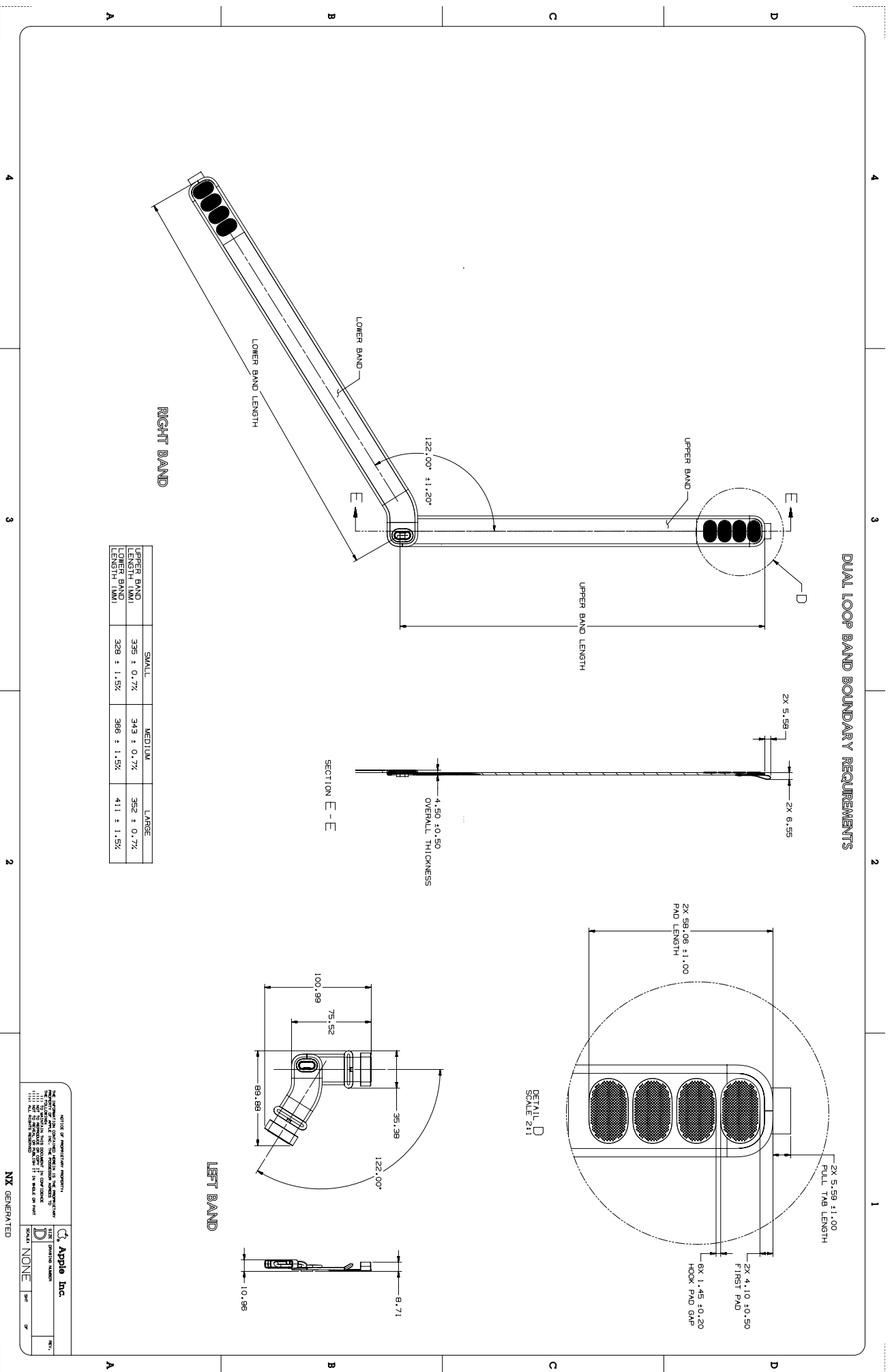
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LIGHT SEAL CONTACT REQUIREMENTS
VISION PRO OMITTED FOR CLARITY

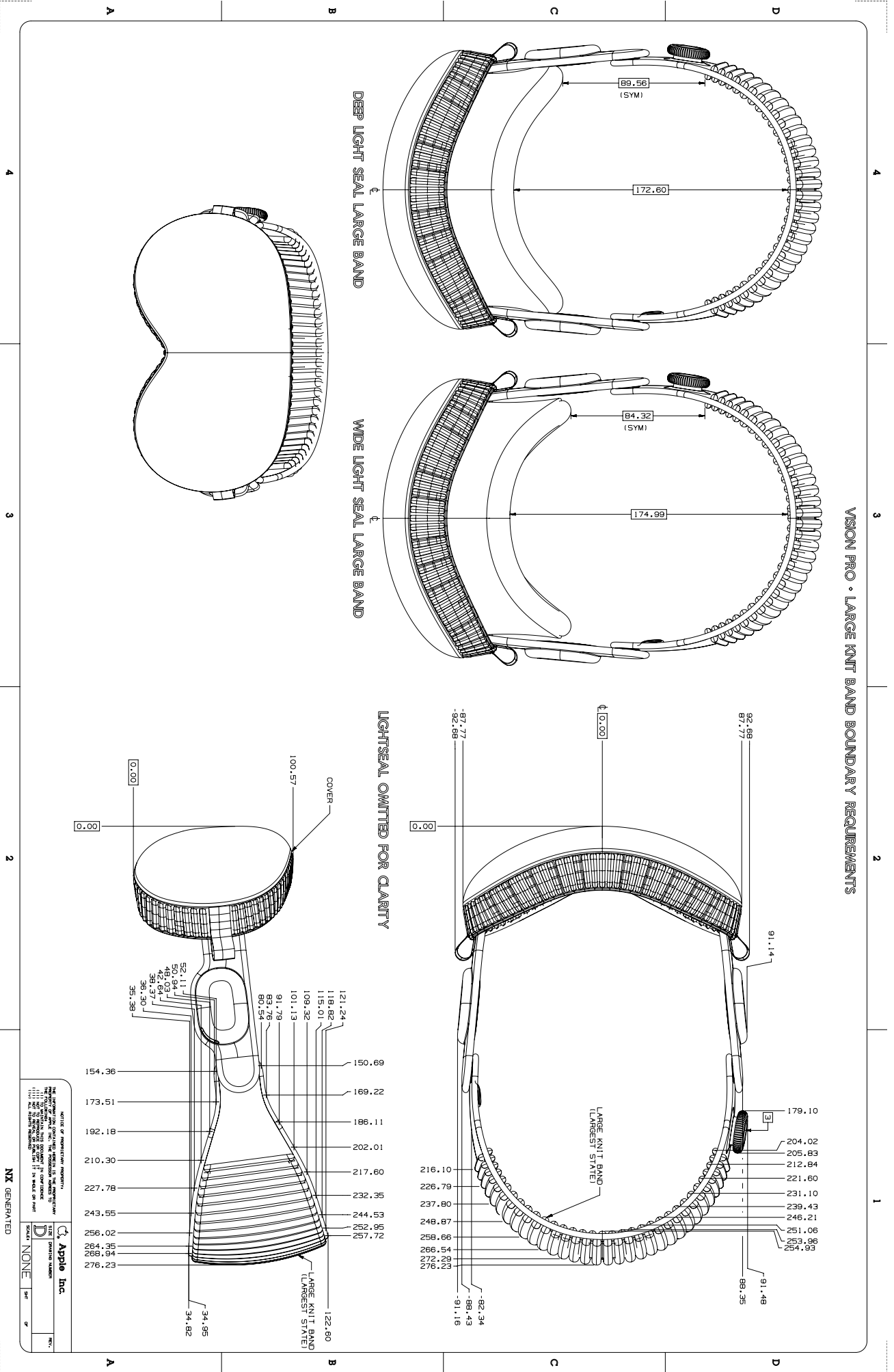


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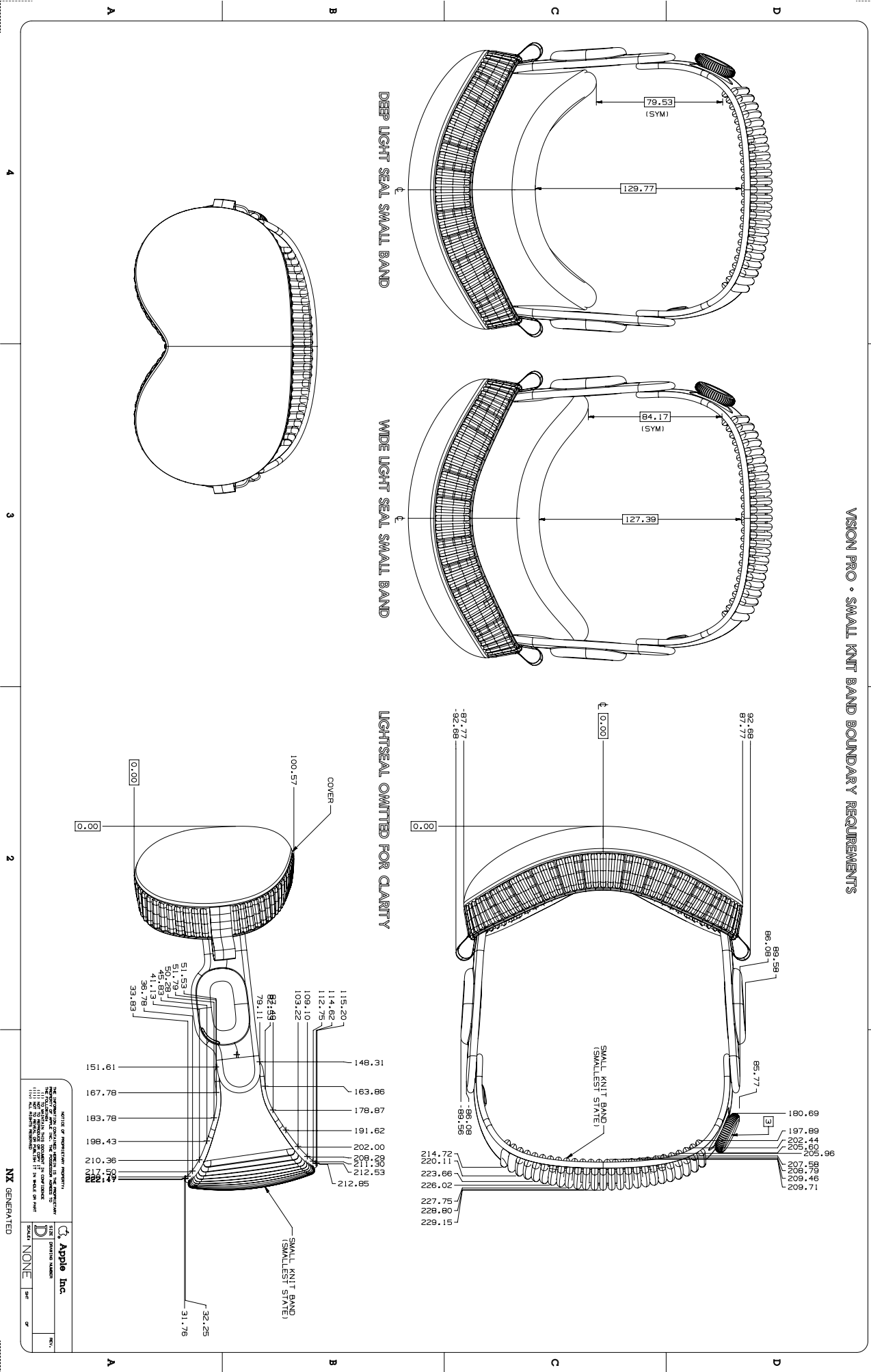
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VISION PRO • LARGE KNI T BAND BOUNDARY REQUIREMENTS



VISION PRO • SMALL KNIT BAND BOUNDARY REQUIREMENTS



VIEW OF PRODUCTION DRAWING

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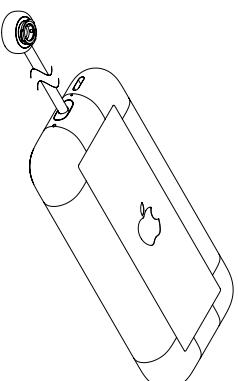
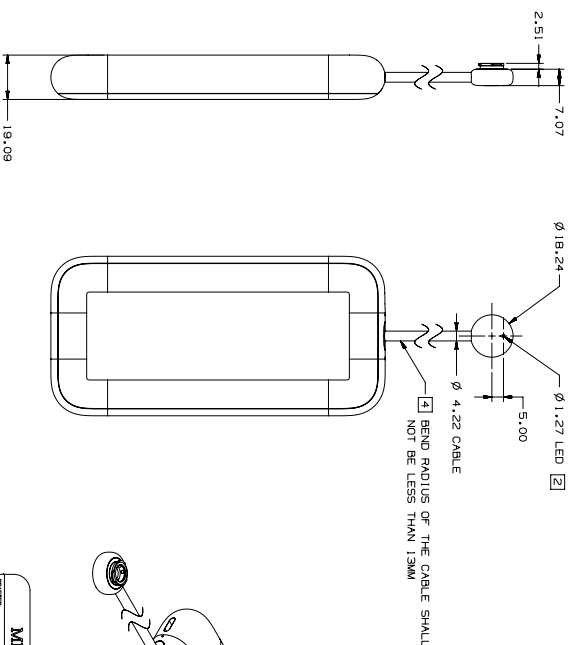
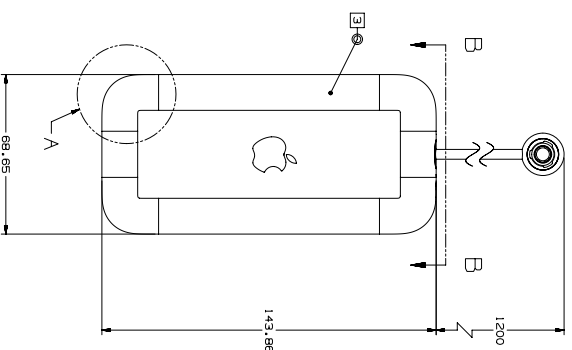
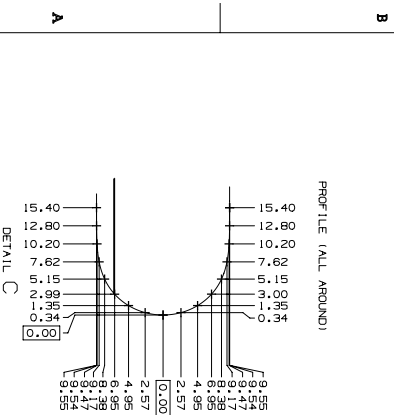
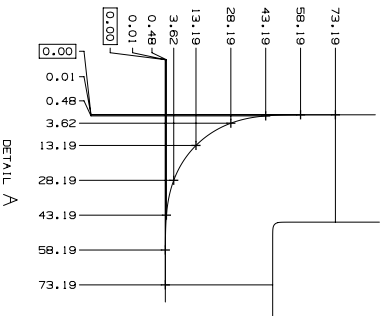
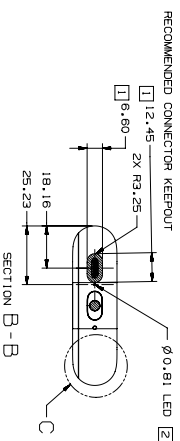
Apple Inc.	REV.
PROJECT NUMBER	
POOR NONE	SR

DATE GENERATED

59.247 Apple Vision Pro Battery

NOTES (UNLESS OTHERWISE SPECIFIED)

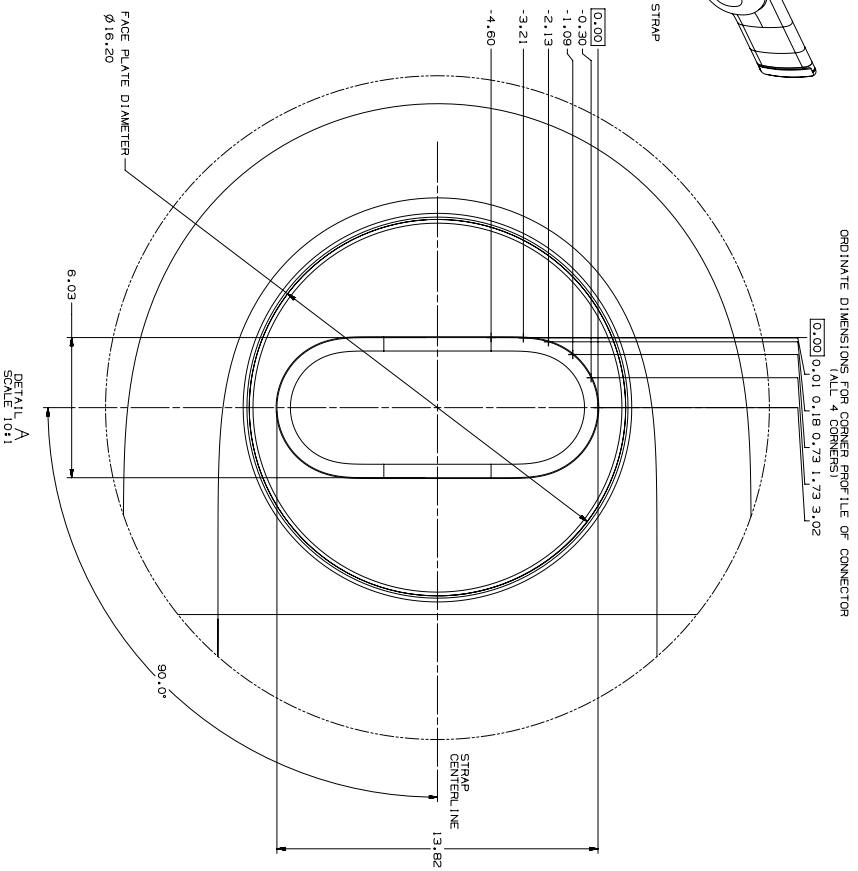
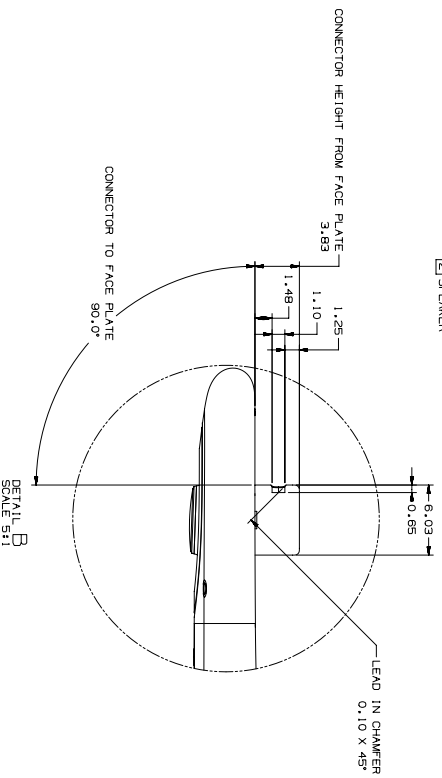
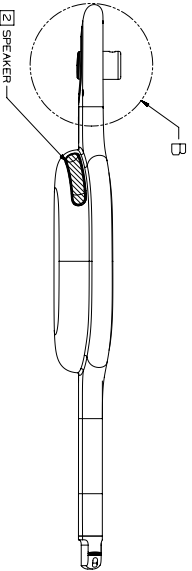
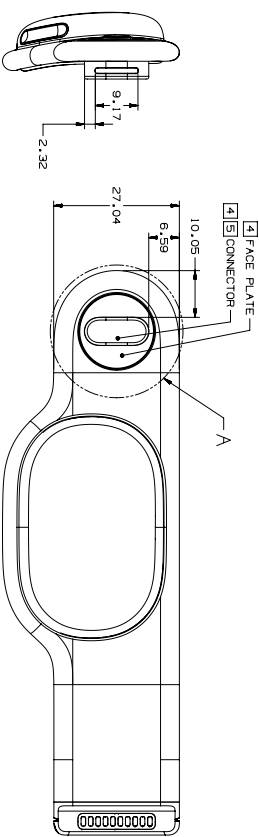
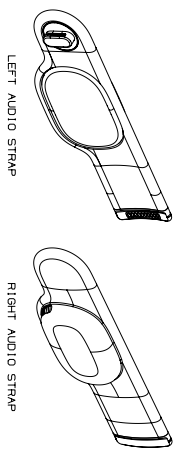
- 1 DO NOT OBSTRUCT PORT.
- 2 DO NOT OBSTRUCT LED.
- 3 NO METAL CONTACT.
- 4 BEND RADIUS REQUIREMENT.
- 5 RECOMMEND TO MAINTAIN AT LEAST 25% SURFACE EXPOSURE FOR HEAT DISSIPATION.



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DRAWING NUMBER		VISION PRO BATTERY	
TITLE		VISION PRO BATTERY	
DIMENSIONS (IN MILLIMETERS)		DIMENSIONS (IN MILLIMETERS)	
TOLERANCES		TOLERANCES	
DO NOT SCALE DRAWINGS		DO NOT SCALE DRAWINGS	
HIDDEN AREA PROJECTION		HIDDEN AREA PROJECTION	
NX GENERATED		NX GENERATED	

59.248 Apple Vision Pro Audio Strap

- NOTES** (UNLESS OTHERWISE SPECIFIED)
1. DIMENSIONS REFER TO LEFT AUDIO STRAP. RIGHT AUDIO STRAP IS MIRRORED UNLESS OTHERWISE SPECIFIED.
 2. DO NOT OBSTRUCT PORTS.
 3. NO METAL CONTACT WITH ELASTOMER PORTION OF AUDIO STRAP.
 4. MATERIAL CONTACT WITH CONNECTOR AND FACE PLATE MAX HARDNESS: 320 HV.
 5. MAXIMUM NORMAL PULL FORCE ON CONNECTOR: 350 N.



METRIC		Apple Inc.	
SECTION	DATE	DESIGNER	DATE
REVISIONS	DATE	BY	REASON
DIMENSIONS IN IN MILLIMETERS			
TOLERANCES			
TITLE			
DRAWING NUMBER			
SCALE			
SHEET 1 OF 1			
REV.			

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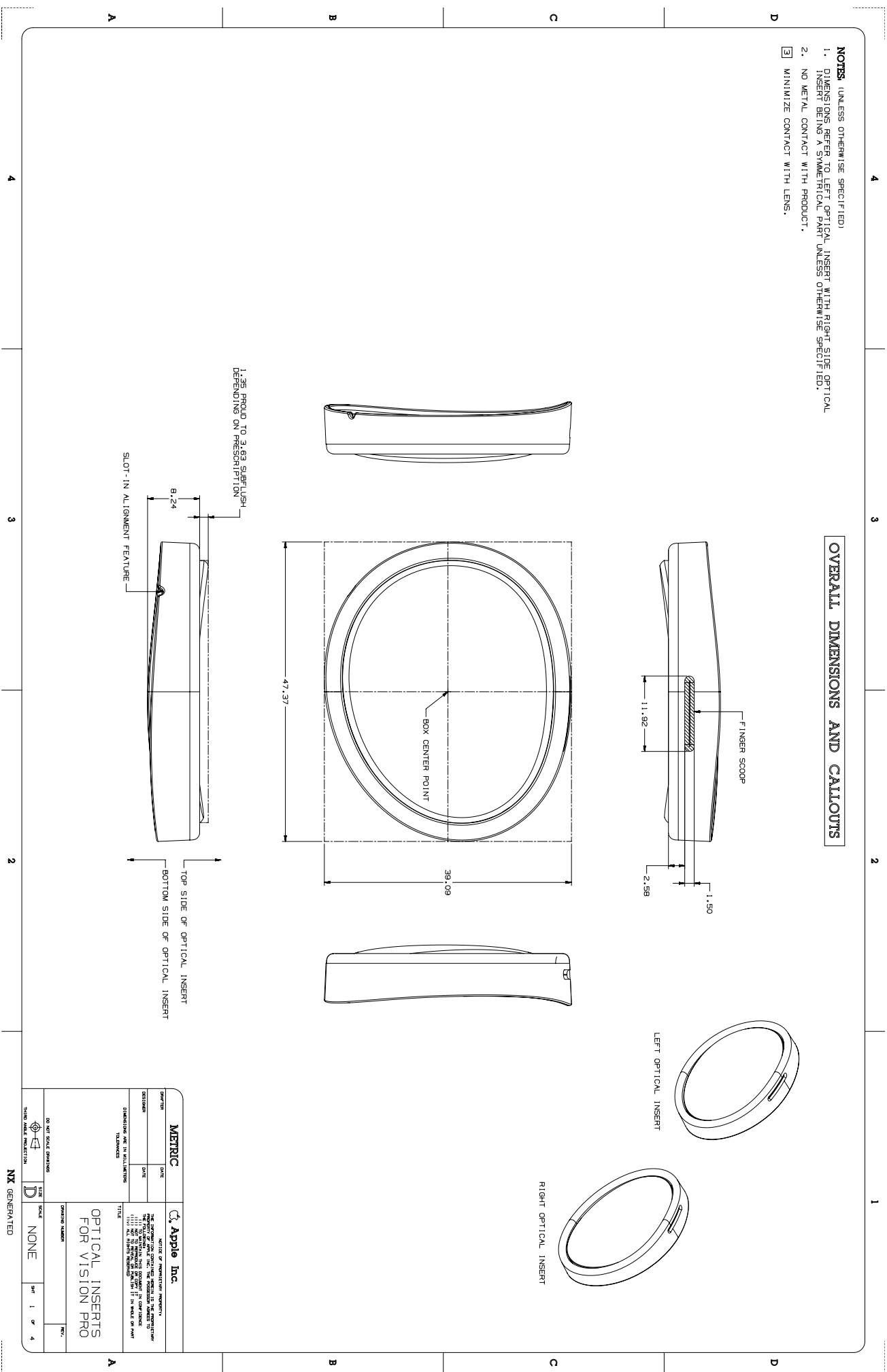
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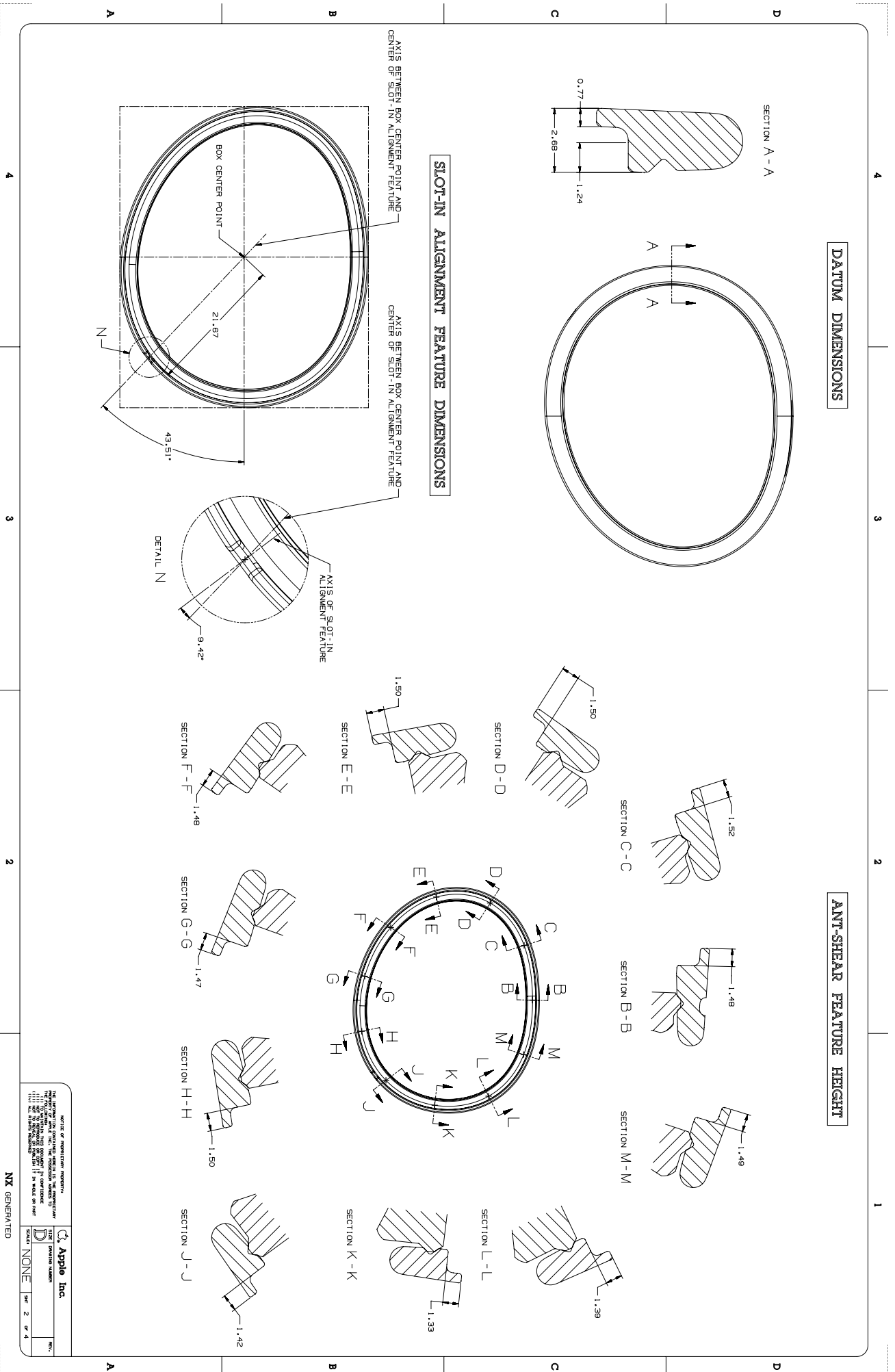
59.249 ZEISS Optical Inserts, 1 of 4

NOTES (UNLESS OTHERWISE SPECIFIED)

1. DIMENSIONS REFER TO LEFT OPTICAL INSERT WITH RIGHT SIDE OPTICAL INSERT BEING A SYMMETRICAL PART UNLESS OTHERWISE SPECIFIED.
2. NO METAL CONTACT WITH PRODUCT.
3. MINIMIZE CONTACT WITH LENS.

OVERALL DIMENSIONS AND CALLOUTS





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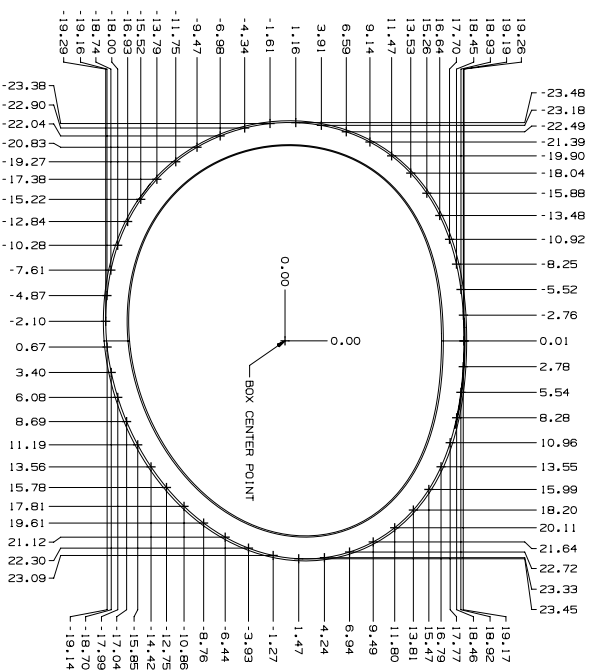
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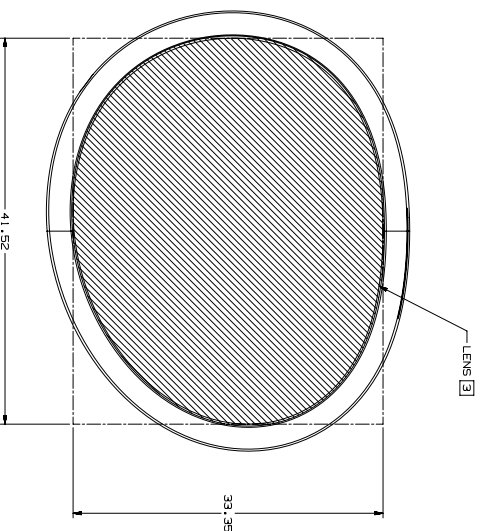
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59.251 ZEISS Optical Inserts, 3 of 4

FRAME PROFILE



LENS DIMENSIONS

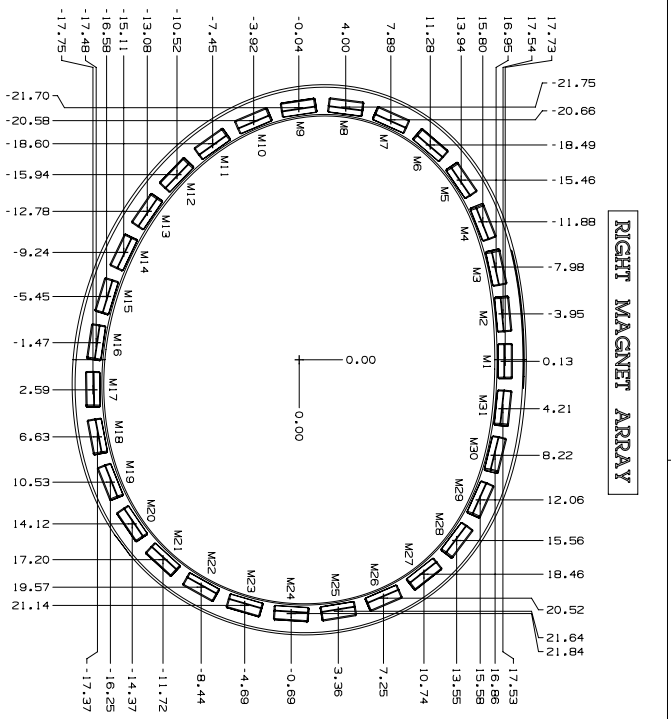
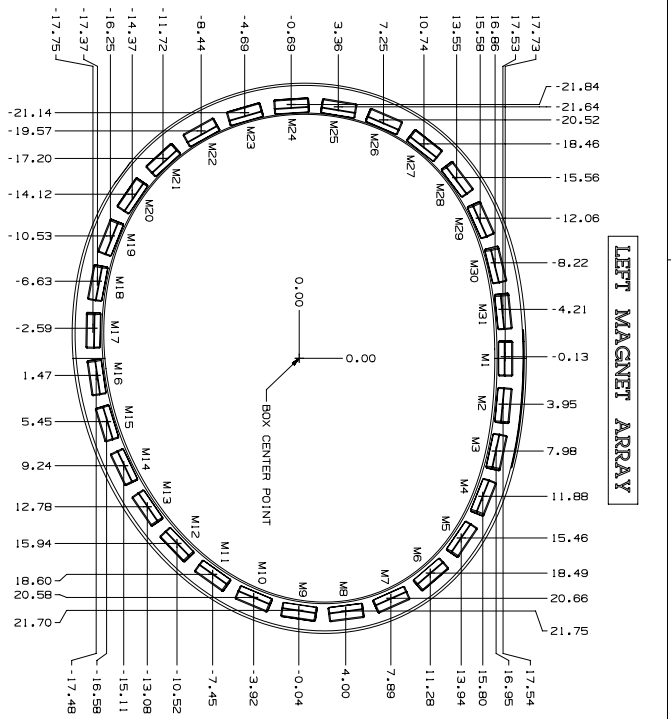


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Apple Inc.
 PART NUMBER: NONE
 REVISION: NONE
 DATE: 2024-10-21

MX GENERATED

59.252 ZEISS Optical Inserts, 4 of 4



MAGNET	POLARITY TOWARD TOP SIDE	POLARITY TOWARD BOTTOM SIDE
M1		
M2		
M3	N	S
M4		
M5		
M6		
M7		
M8		
M9		
M10		
M11		
M12	S	N
M13		
M14		
M15		
M16		
M17		
M18		
M19	N	S
M20		
M21		
M22		
M23		
M24		
M25	S	N
M26		
M27		
M28		
M29		
M30	N	S
M31		

MAGNET	POLARITY TOWARD TOP SIDE	POLARITY TOWARD BOTTOM SIDE
M1		
M2		
M3		
M4	S	N
M5		
M6		
M7		
M8		
M9		
M10		
M11		
M12		
M13		
M14		
M15	N	S
M16		
M17		
M18		
M19	S	N
M20		
M21		
M22		
M23		
M24		
M25		
M26	N	S
M27		
M28		
M29		
M30	S	N
M31		

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 PART NUMBER: NONE
 REV: 1
 DATE: 2024-10-21
 DRAWN BY: NONE
 CHECKED BY: NONE
 APPROVED BY: NONE
 DATE: 2024-10-21

NX GENERATED
 SHEET 4 OF 4

59.253 Wireless Charging Case (USB-C) for AirPods 4, 1 of 3

4

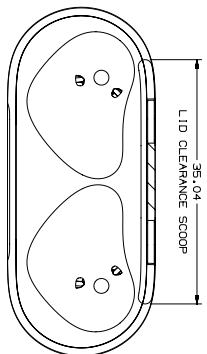
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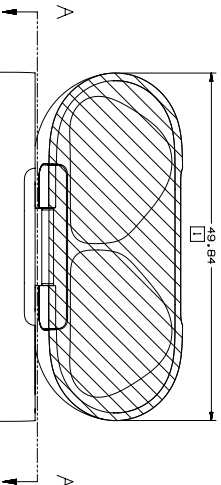
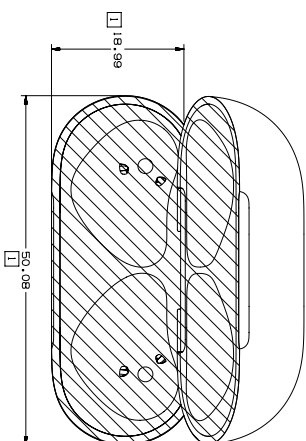
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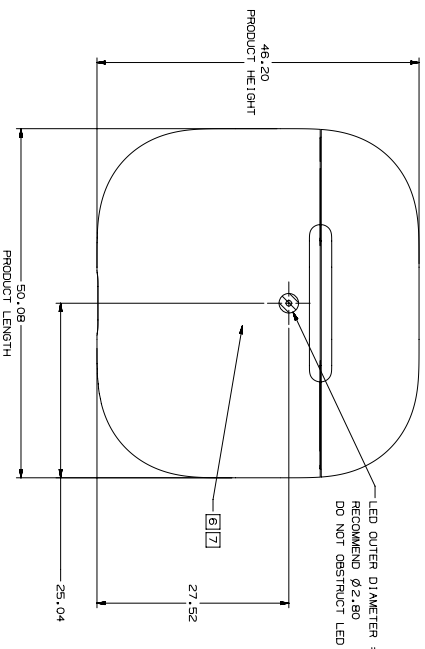
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- [2] TO ENSURE FULL FUNCTIONALITY, DO NOT OBSTRUCT THIS AREA WITH METAL OR OTHER CONDUCTIVE MATERIAL.
- [3] TO ENSURE FULL FUNCTIONALITY WITH MINIMAL IMPACT TO Qi CHARGING PERFORMANCE, MINIMIZE ANY MATERIAL THICKNESS.
- [4] TO ENABLE CHARGING VIA APPLE WATCH CHARGER, IT IS RECOMMENDED THERE BE NO MATERIAL BETWEEN BACK OF DEVICE AND WATCH CHARGER.
- [5] PROTECTIVE CASES OR COVERS MAY DETUNE OR IMPACT RF & WIRELESS CHARGING PERFORMANCE.
- [6] IMPACT IS HIGHLY DEPENDENT ON MATERIAL AND MATERIAL THICKNESS. HIGHLY RECOMMEND AVOIDING METAL MATERIAL AND FOLLOWING GUIDELINES IN THIS DOCUMENT TO MINIMIZE IMPACT.
- [7] PROTECTIVE CASES OR COVERS MAY IMPACT PAIRING, FACTORY RESET, AND SERIAL NUMBER LOOKUP FUNCTIONS ON CHARGING CASE FOR AIRPODS 4.
- [8] ONLY APPLICABLE TO WIRELESS CHARGING CASE FOR AIRPODS 4 (ANC).



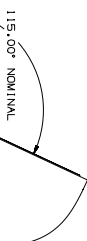
SECTION A - A



PRODUCT HEIGHT

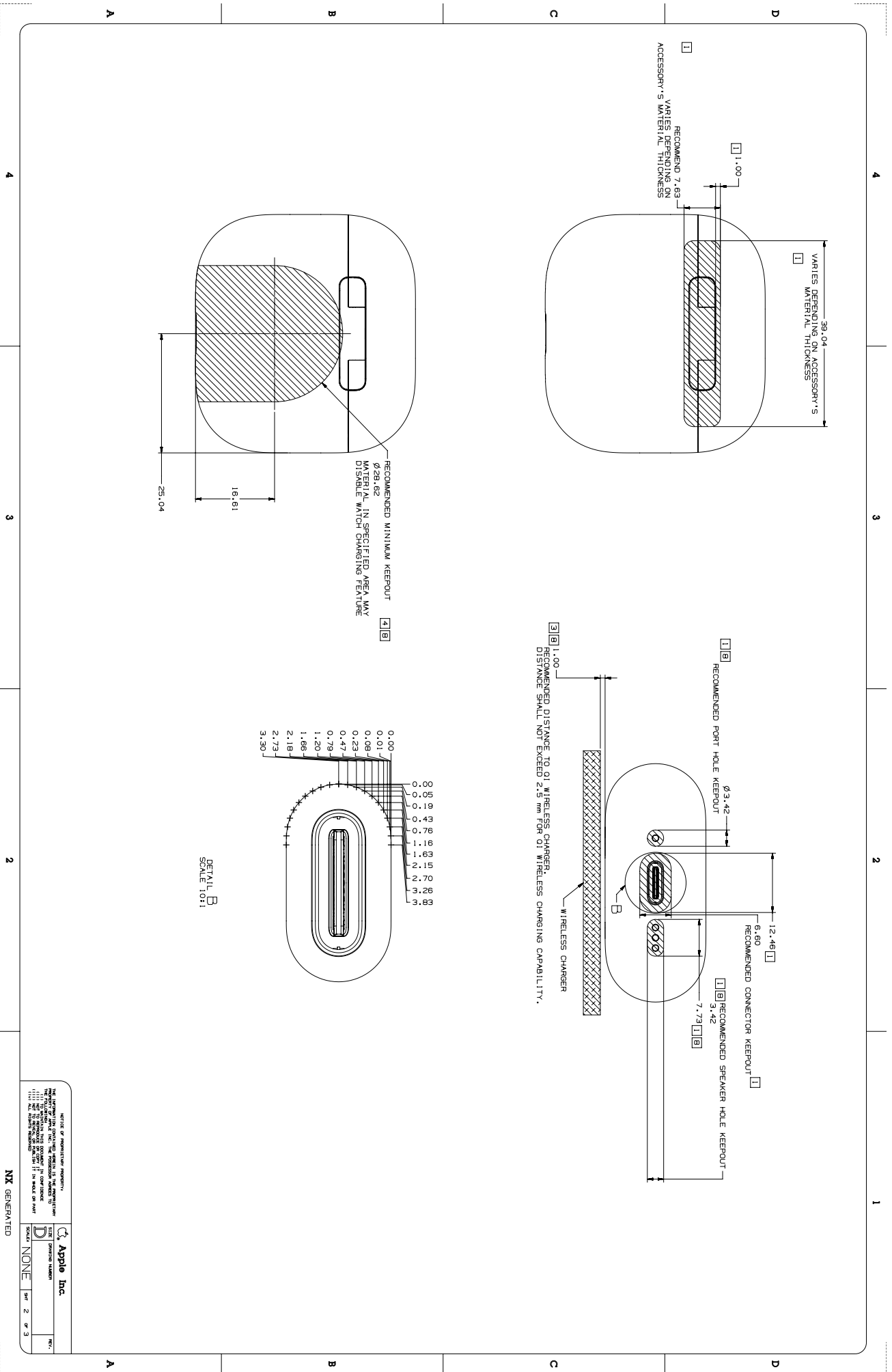


LED OUTER DIAMETER = $\phi 0.80$
RECOMMEND $\phi 2.90$
DO NOT OBSTRUCT LED



METRIC		Apple Inc.	
DATE	VERSION	REVISION	DESCRIPTION
			CHARGING CASE FOR AIRPODS 4 AND WIRELESS CHARGING CASE FOR AIRPODS 4 (ANC)
DRAWING NUMBER		SCALE	
NONE		1 OF 3	
DO NOT SCALE DRAWING		HAND MADE REJECTION	
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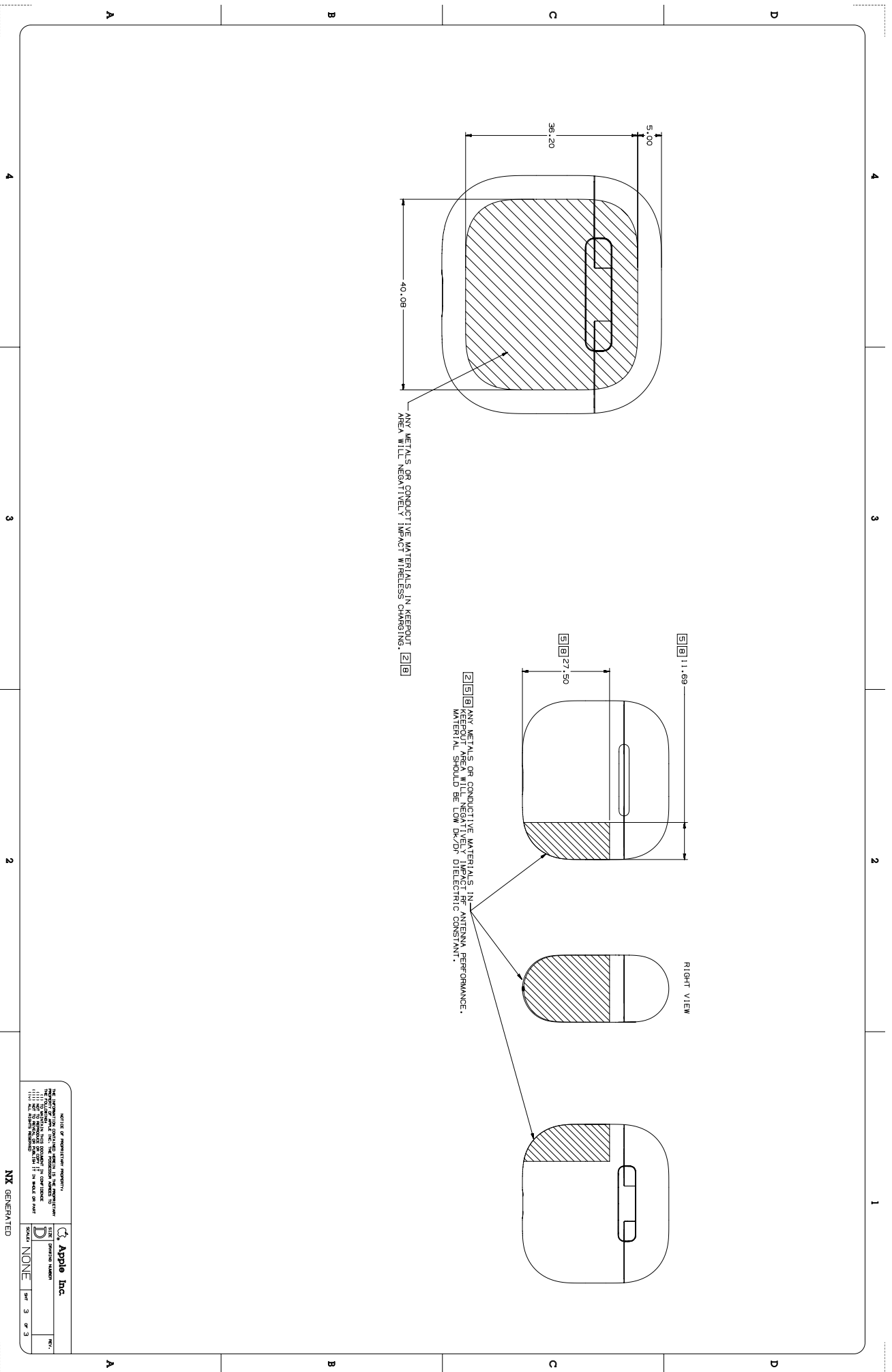
59.254 Wireless Charging Case (USB-C) for AirPods 4, 2 of 3



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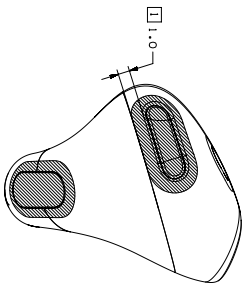
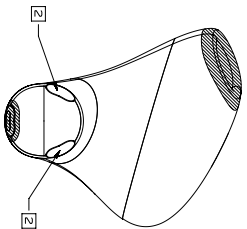
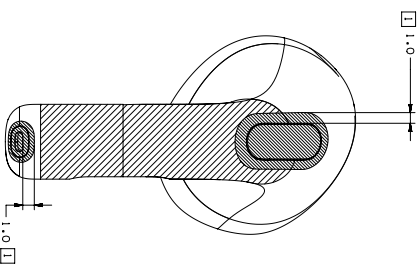
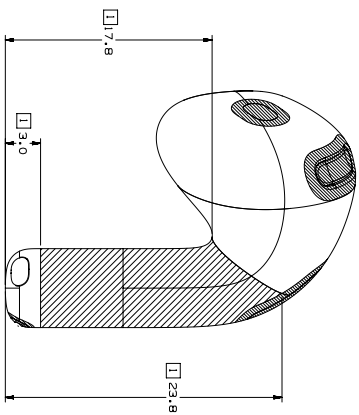
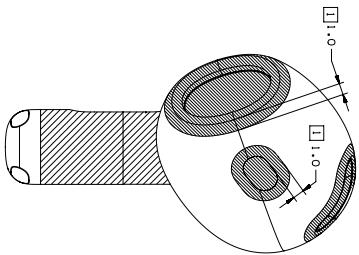
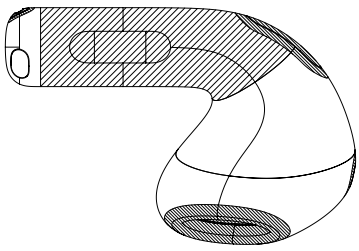
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59.255 Wireless Charging Case (USB-C) for AirPods 4, 3 of 3



59.256 AirPods 4

- NOTES** (UNLESS OTHERWISE SPECIFIED)
- [1] ACCESSORIES INTRUDING INTO SHADED REGIONS WILL NEGATIVELY AFFECT PRODUCT PERFORMANCE
 - [2] ACCESSORIES MAY NOT COVER THESE METAL SURFACES

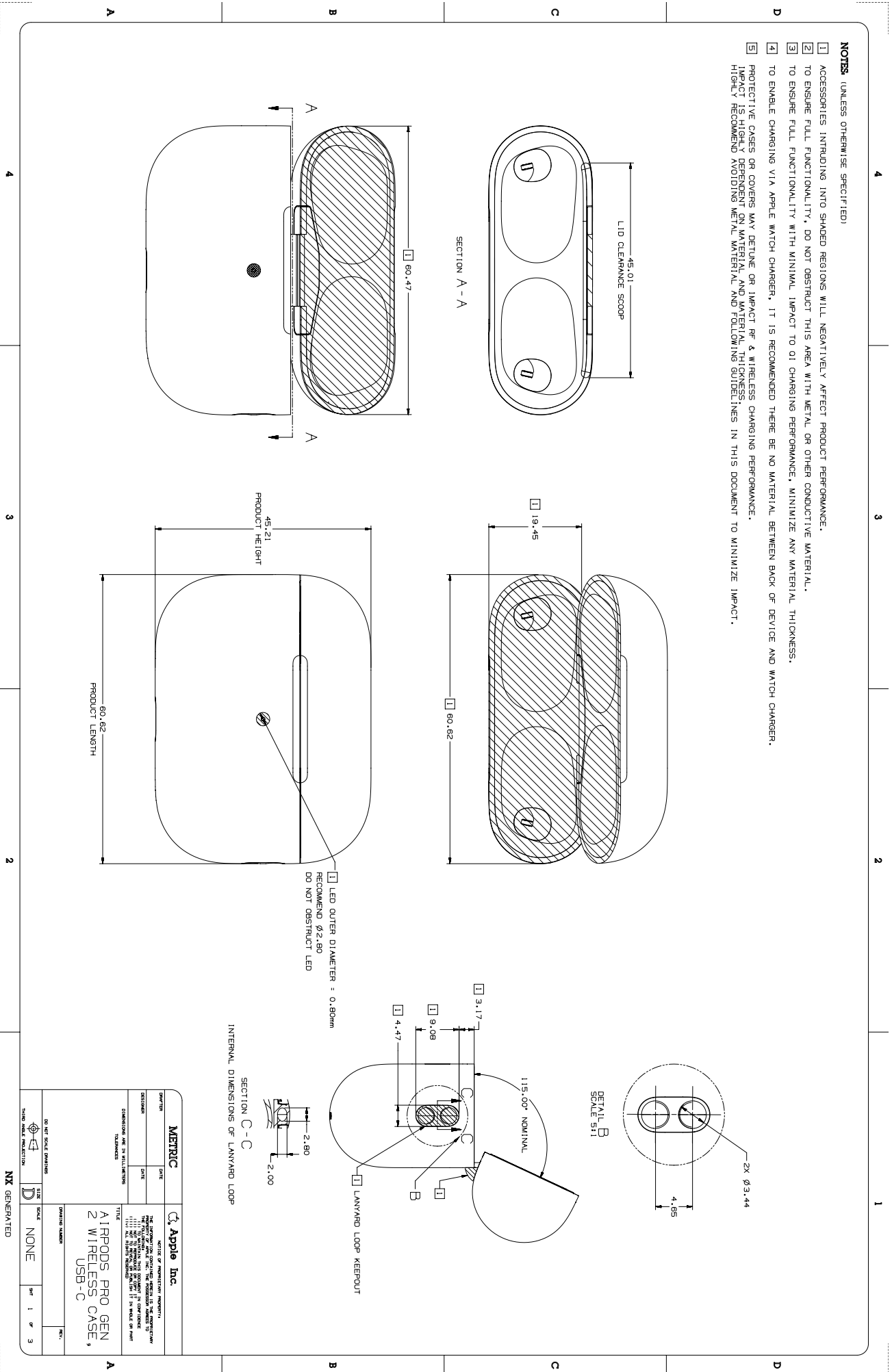


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TOLERANCES		AIRPODS 4	
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HIDDEN AREA INDICATION		SCALE	
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NX GENERATED		SHEET 1 OF 1	

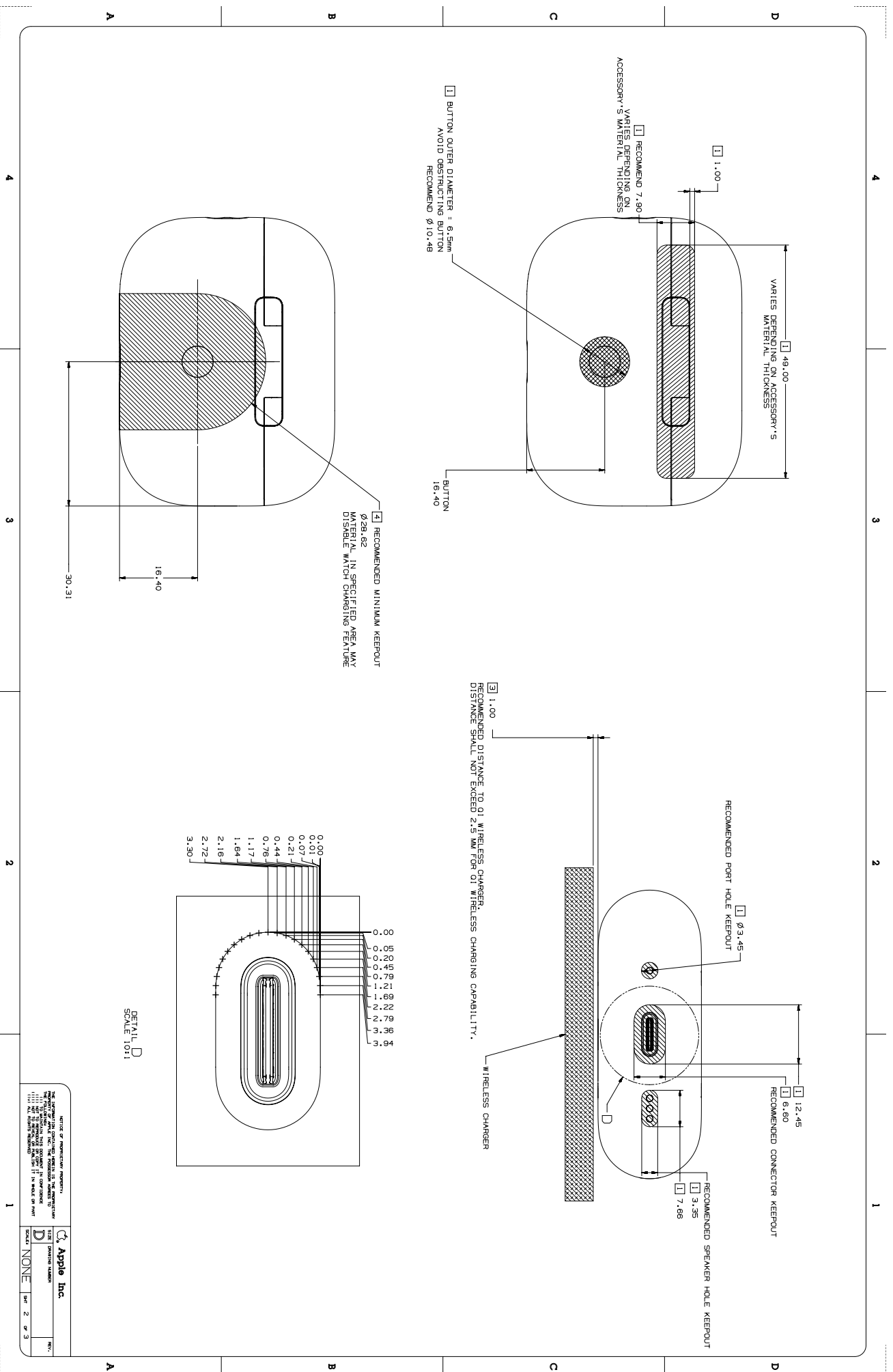
59.257 MagSafe Charging Case (USB-C) for AirPods Pro (2nd generation), 1 of 3

NOTES (UNLESS OTHERWISE SPECIFIED)

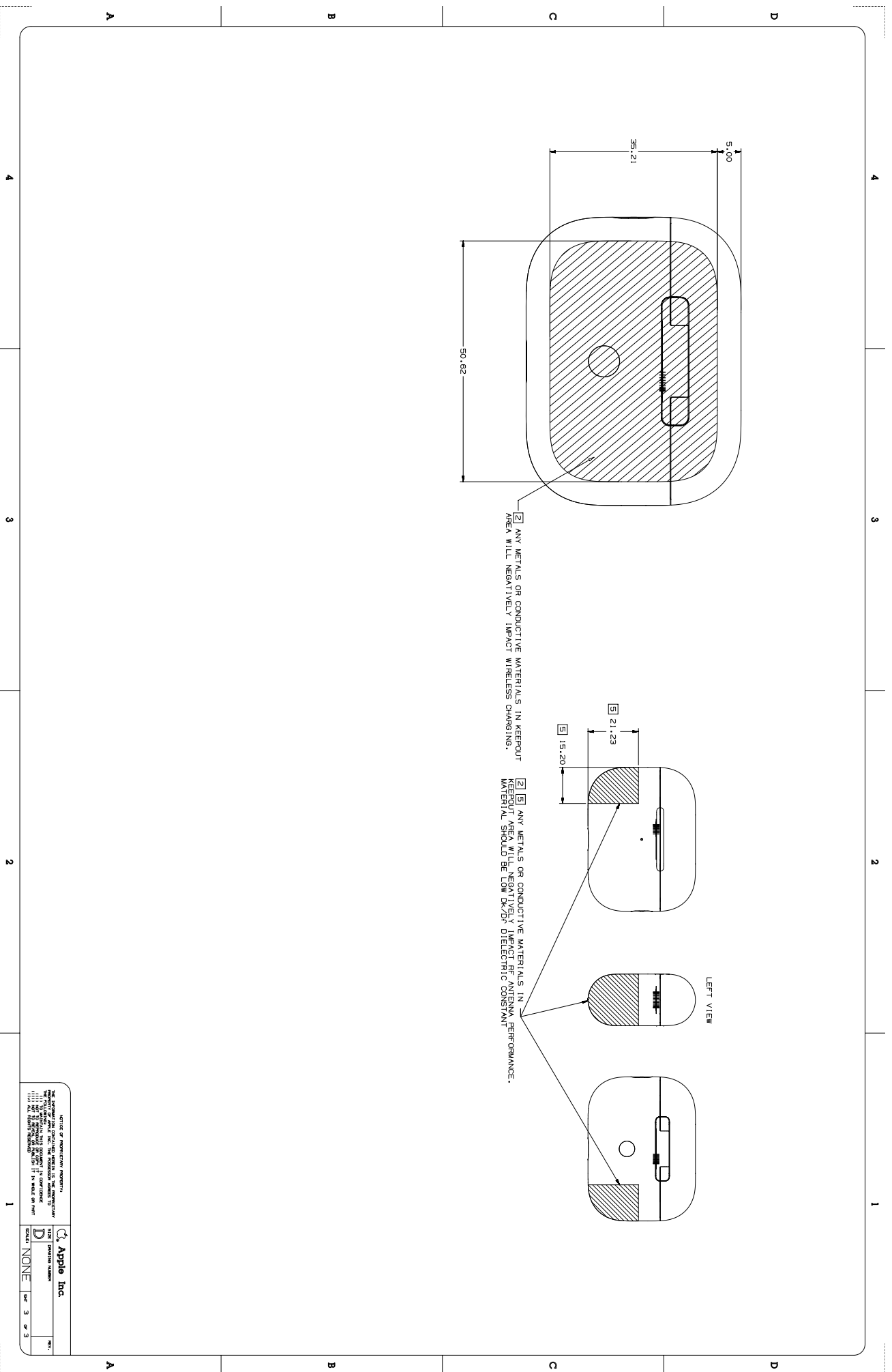
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 - 3 TO ENSURE FULL FUNCTIONALITY WITH MINIMAL IMPACT TO Qi CHARGING PERFORMANCE, MINIMIZE ANY MATERIAL THICKNESS.
 - 4 TO ENABLE CHARGING VIA APPLE WATCH CHARGER, IT IS RECOMMENDED THERE BE NO MATERIAL BETWEEN BACK OF DEVICE AND WATCH CHARGER.
- PROTECTIVE CASES OR COVERS MAY DETUNE OR IMPACT Qi & WIRELESS CHARGING PERFORMANCE. PROTECTIVE CASES OR COVERS DEPENDENT ON MATERIAL AND MATERIAL THICKNESS. HIGHLY RECOMMEND AVOIDING METAL MATERIAL AND FOLLOWING GUIDELINES IN THIS DOCUMENT TO MINIMIZE IMPACT.



59.258 MagSafe Charging Case (USB-C) for AirPods Pro (2nd generation), 2 of 3



59.259 MagSafe Charging Case (USB-C) for AirPods Pro (2nd generation), 3 of 3



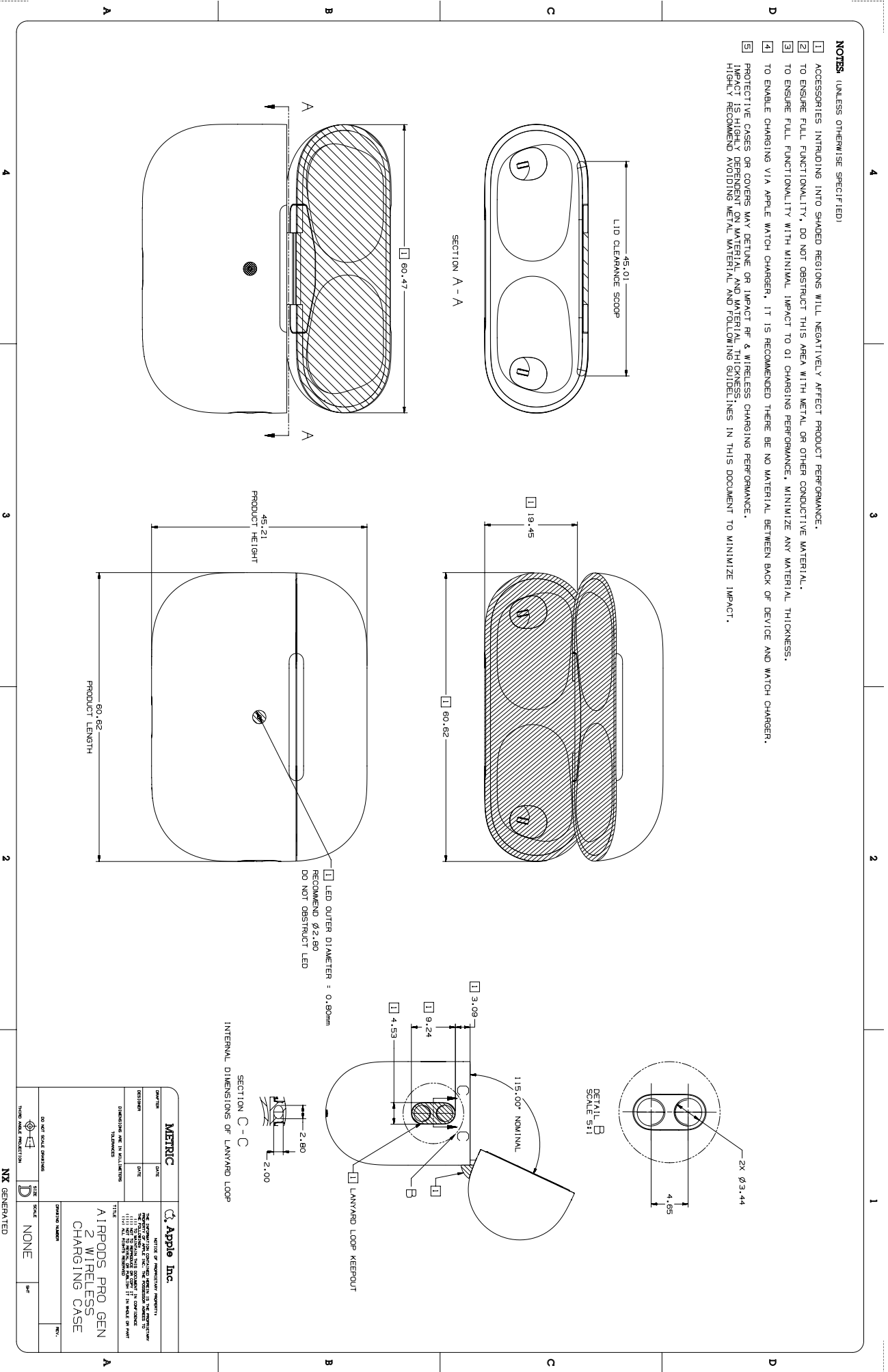
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 SOCKET: NONE
 REV: 3 OF 3

59.260 MagSafe Charging Case for AirPods Pro (2nd generation), 1 of 3

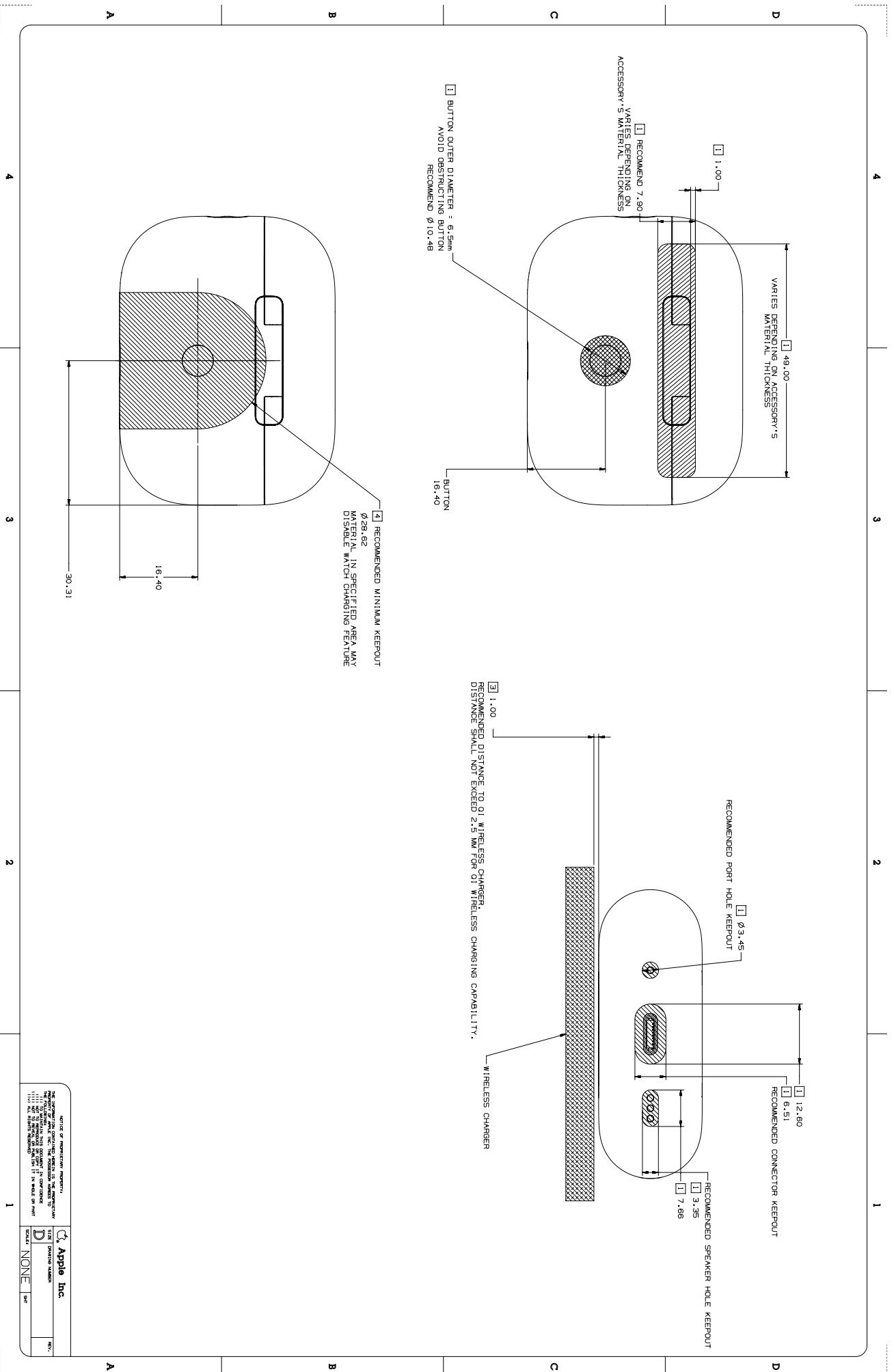
NOTES (UNLESS OTHERWISE SPECIFIED)

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 - 2 TO ENSURE FULL FUNCTIONALITY, DO NOT OBSTRUCT THIS AREA WITH METAL OR OTHER CONDUCTIVE MATERIAL.
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DIMENSIONS IN MILLIMETERS		AIRPODS PRO GEN 2 WIRELESS CHARGING CASE	
DRAWING NUMBER		SCALE	
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DO NOT SCALE DRAWINGS		SHEET	
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NX GENERATED			

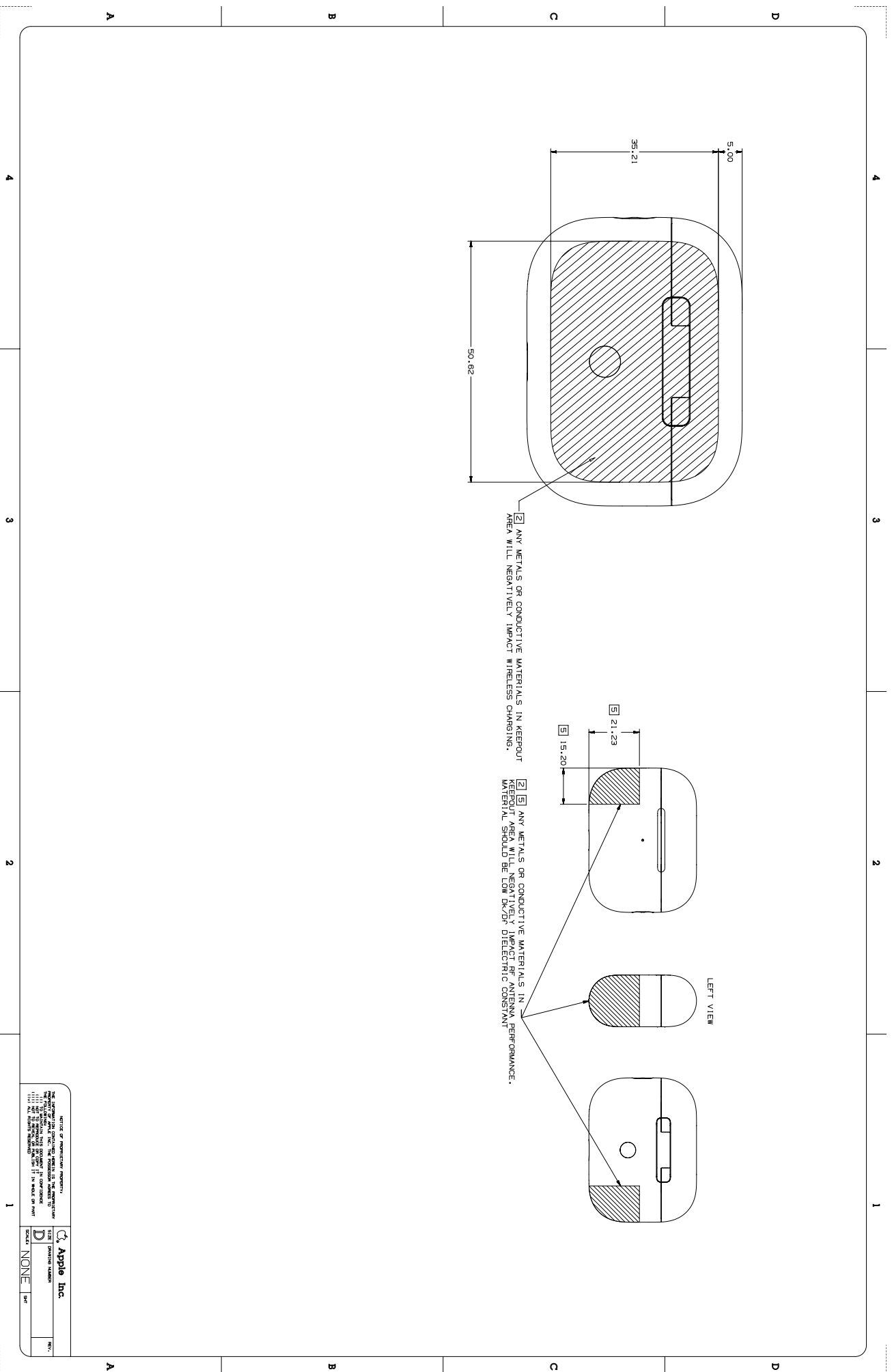
59.261 MagSafe Charging Case for AirPods Pro (2nd generation), 2 of 3



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 SOCKET: NONE SHIP

59.262 MagSafe Charging Case for AirPods Pro (2nd generation), 3 of 3



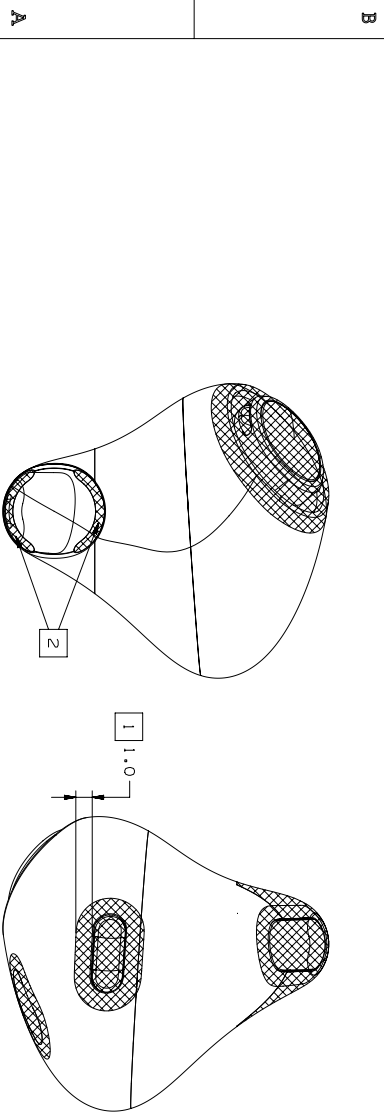
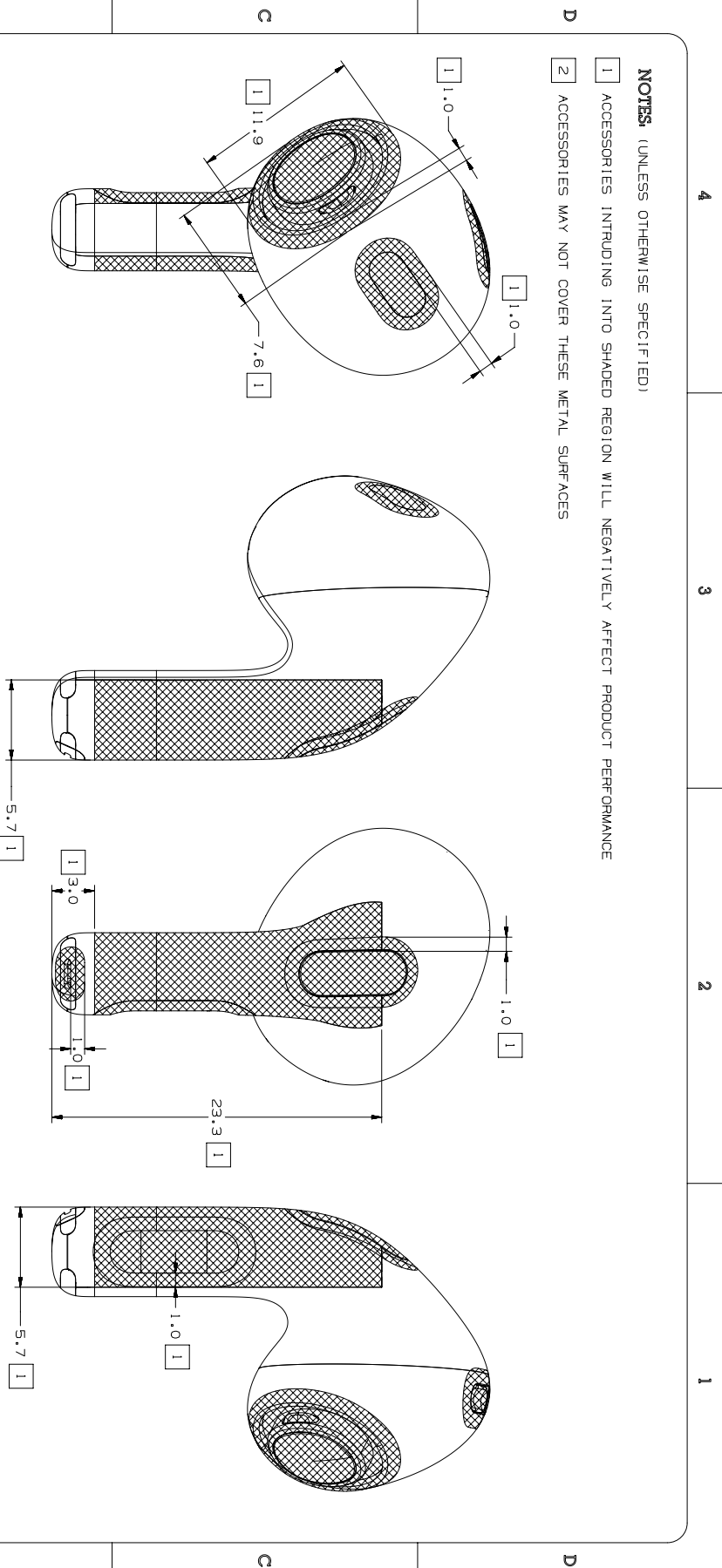
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1000 APPLE BLVD.
CUPERTINO, CA 95014
TEL: 415 924 6200
WWW.APPLE.COM

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REVISION: 1
REV. NO.: 1
REV. DATE: 08/2023
REV. BY: [REDACTED]

Apple Inc.
PART NAME: NONE
REV. NO.: NONE
REV. DATE: NONE
REV. BY: NONE

59.263 AirPods Pro (2nd generation)

- NOTES:** (UNLESS OTHERWISE SPECIFIED)
- 1 ACCESSORIES INTRODUCING INTO SHADED REGION WILL NEGATIVELY AFFECT PRODUCT PERFORMANCE
 - 2 ACCESSORIES MAY NOT COVER THESE METAL SURFACES



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DESIGNER		DATE	
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TOLERANCES			
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AIRPODS PRO GEN2			
DRAWING NUMBER		REV.	
DO NOT SCALE DRAWINGS			
THIRD ANGLE PROJECTION		SIZE	SCALE
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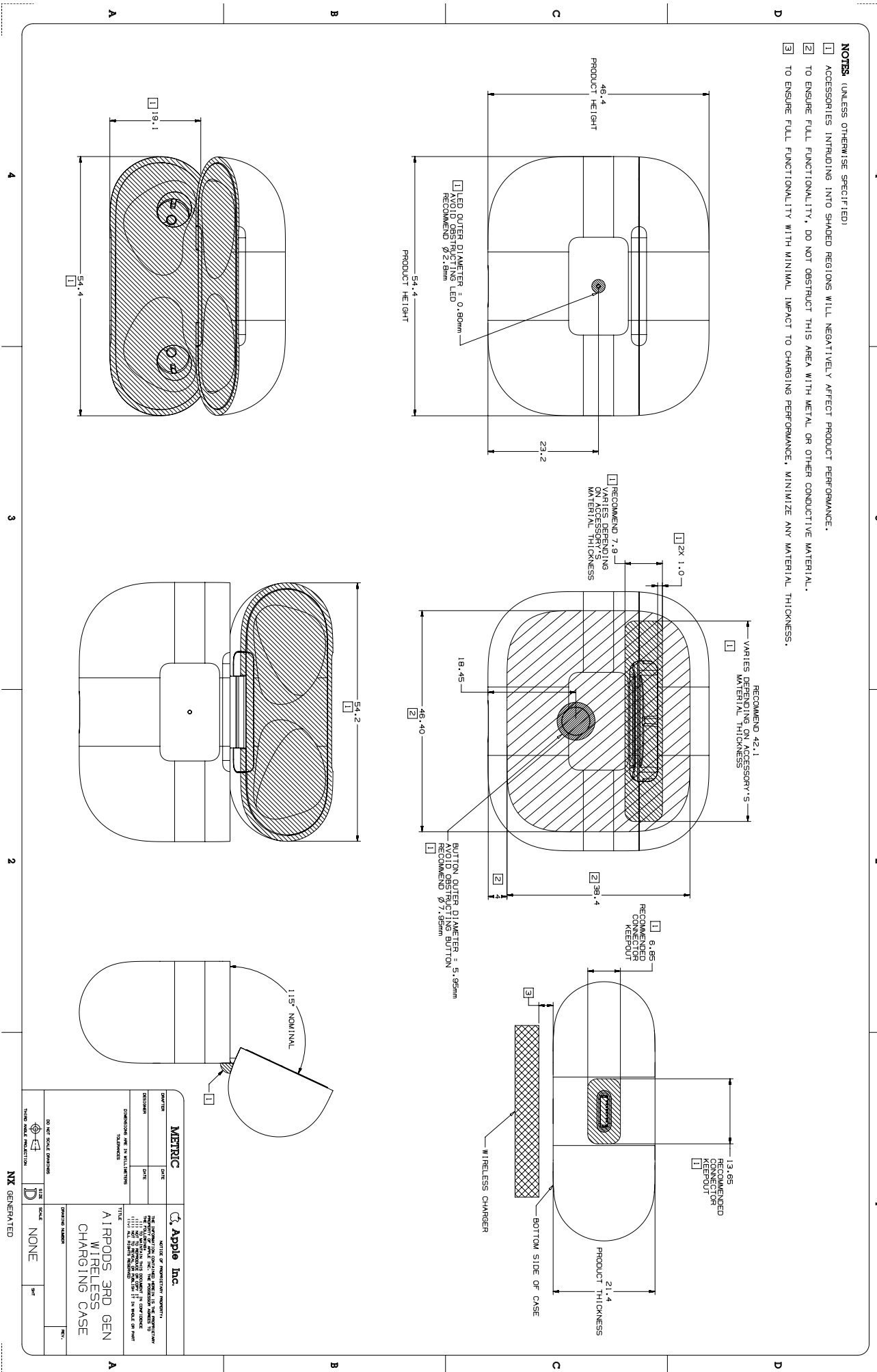
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59.264 MagSafe Charging Case for AirPods (3rd generation)

NOTES (UNLESS OTHERWISE SPECIFIED)

- [1] ACCESSORIES INTRODUCING INTO SHADED REGIONS WILL NEGATIVELY AFFECT PRODUCT PERFORMANCE.
- [2] TO ENSURE FULL FUNCTIONALITY, DO NOT OBSTRUCT THIS AREA WITH METAL OR OTHER CONDUCTIVE MATERIAL.
- [3] TO ENSURE FULL FUNCTIONALITY WITH MINIMAL IMPACT TO CHARGING PERFORMANCE, MINIMIZE ANY MATERIAL THICKNESS.



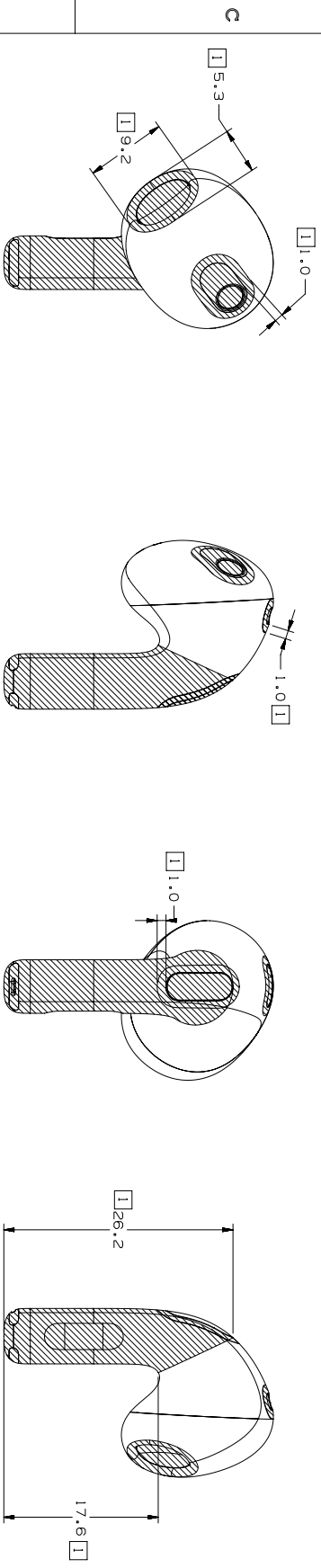
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AIRPODS 3RD GEN WIRELESS CHARGING CASE		NONE	
SCALE:		SHEET:	
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NX GENERATED

59.265 AirPods (3rd generation)

REV.	EQD#	DESCRIPTION OF REVISION
1		

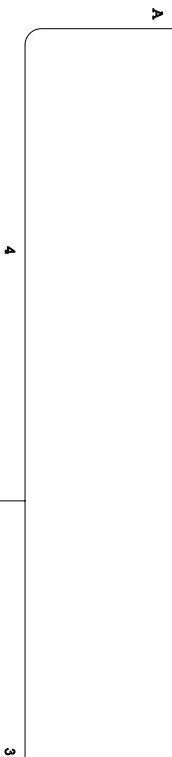
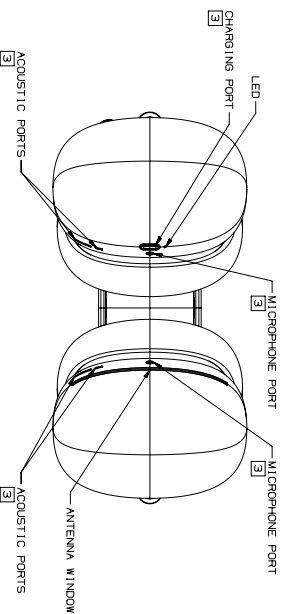
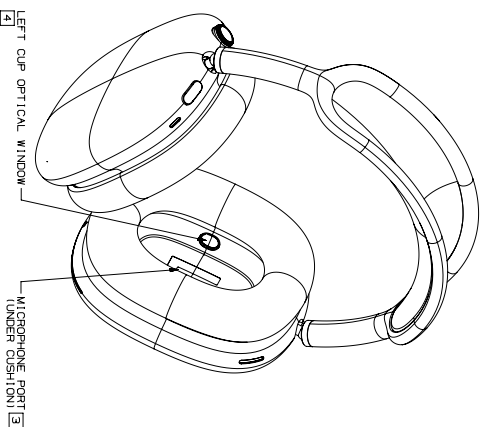
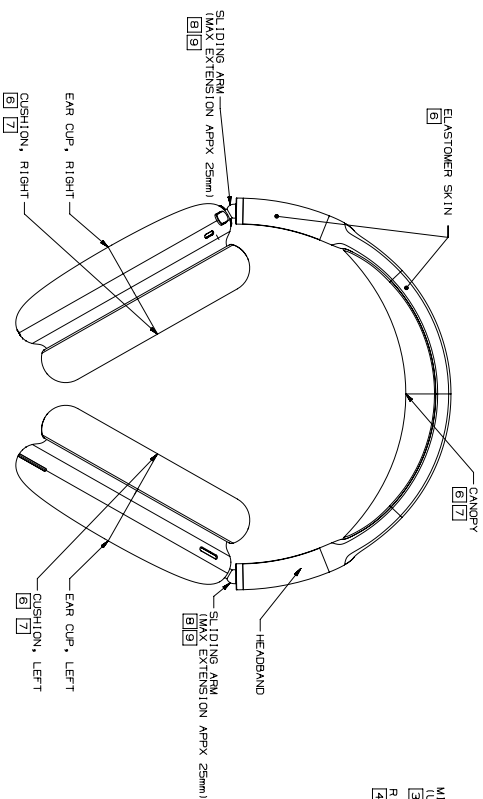
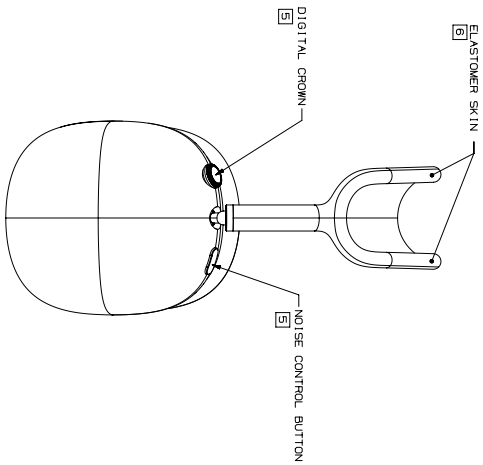
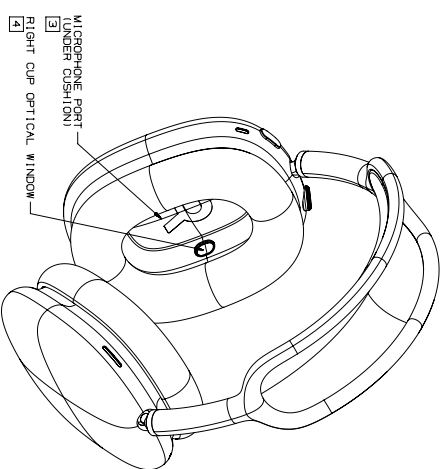
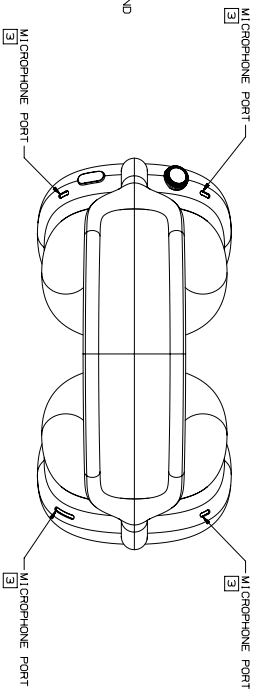
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- [1] ACCESSORIES INTRUDING INTO SHADED REGION WILL NEGATIVELY AFFECT PRODUCT PERFORMANCE
 - [2] ACCESSORIES MUST NOT COVER THESE METAL SURFACES



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DESIGNED	APPLE				
CHECKED					
DATE					
DIMENSIONS ARE IN MILLIMETERS					
TOLERANCES					
X.X	±0.2	<p>AirPods (3rd generation)</p> <p>DRAWING NUMBER: _____ REV: 01</p>			
X.XX	±0.10				
X.XXX	±0.050				
ANGLES ±0.5°					
DO NOT SCALE DRAWINGS					
THIRD ANGLE PROJECTION					
SCALE	NONE	9H	1	0"	1
NX GENERATED					

COMPONENT DEFINITION

- NOTES** (UNLESS OTHERWISE SPECIFIED):
- 1 MEASURE MAGNETIC FLUX USING FLUX PROBE WITH CUPS ROTATED TO 'ON-HEAD' POSITION (AS SHOWN)
 2. NO METAL CONTACT WITH PRODUCT
 - 3 DO NOT OBSTRUCT PORTS
 - 4 DO NOT OBSTRUCT OPTICAL WINDOWS
 - 5 DO NOT APPLY PERSISTENT FORCE TO NOISE CONTROL BUTTON OR DIGITAL CROWN
 - 6 DO NOT APPLY PERSISTENT FORCE TO CANOPY, CUSHION, OR ELASTOMER SKIN ON HEADBAND
 - 7 DO NOT APPLY POINT LOADS TO CANOPY, CUSHION, OR ELASTOMER SKIN ON HEADBAND
 - 8 DO NOT RESTRICT MOTION OF EAR CUP WITH RESPECT TO HEADBAND
 - 9 DO NOT RESTRICT MOTION OF SLIDING ARMS ON HEADBAND



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MX GENERATED

SCALE NONE SH 1 of 7

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METRIC DATE: _____ DESIGNED BY: _____ DRAWN BY: _____ DIMENSIONS: (IN) MILLIMETERS (TOLERANCES) TITLE: AIRPODS MAX		Apple Inc. NOTICE OF PROPRIETARY RIGHTS: THE INFORMATION CONTAINED HEREIN IS PROPRIETARY AND CONFIDENTIAL TO APPLE INC. ("APPLE"). IT IS TO BE USED ONLY FOR THE PURPOSES SPECIFIED IN THIS DOCUMENT AND IS NOT TO BE DISCLOSED TO ANY THIRD PARTY WITHOUT THE WRITTEN PERMISSION OF APPLE INC.	
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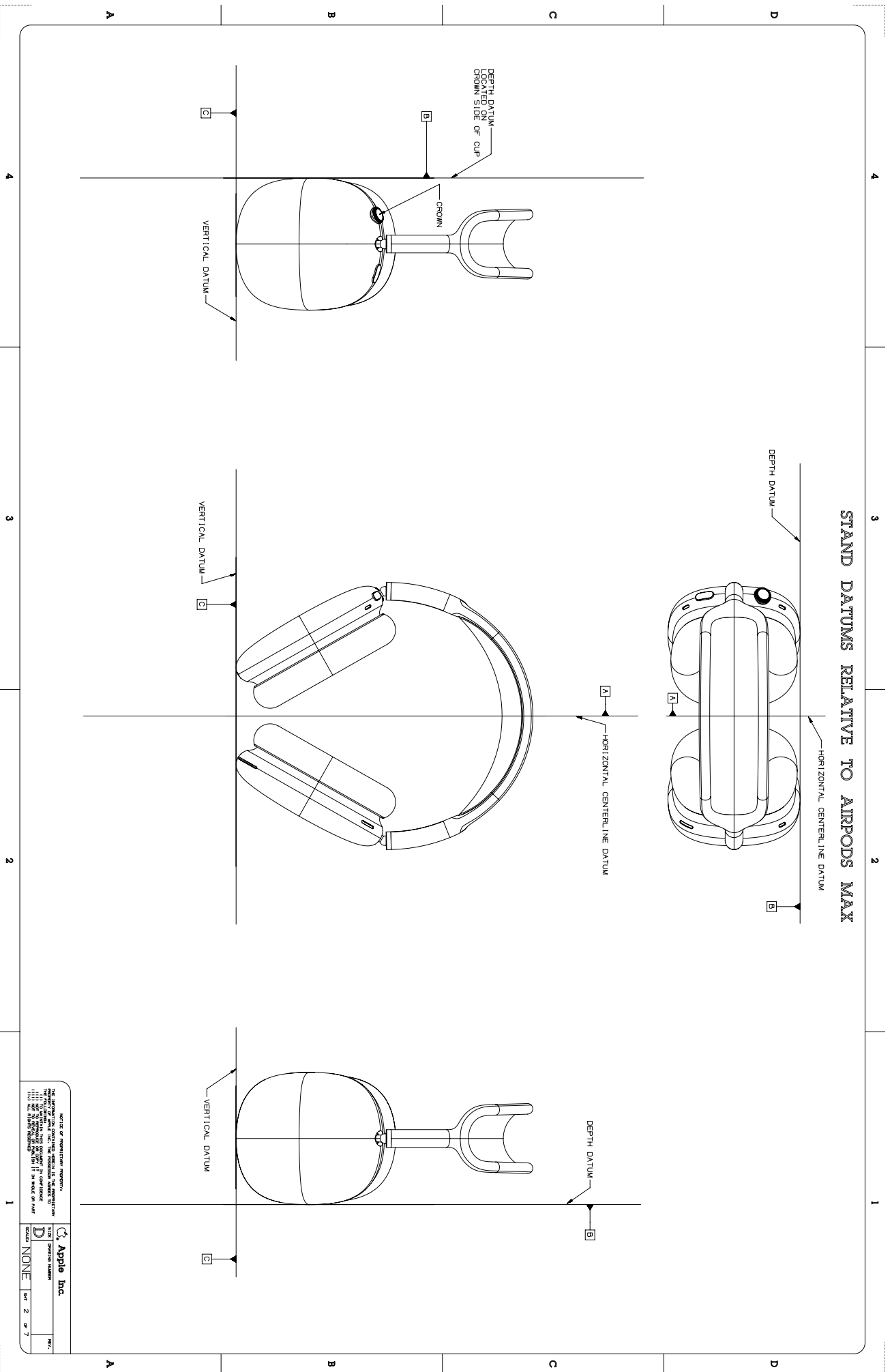
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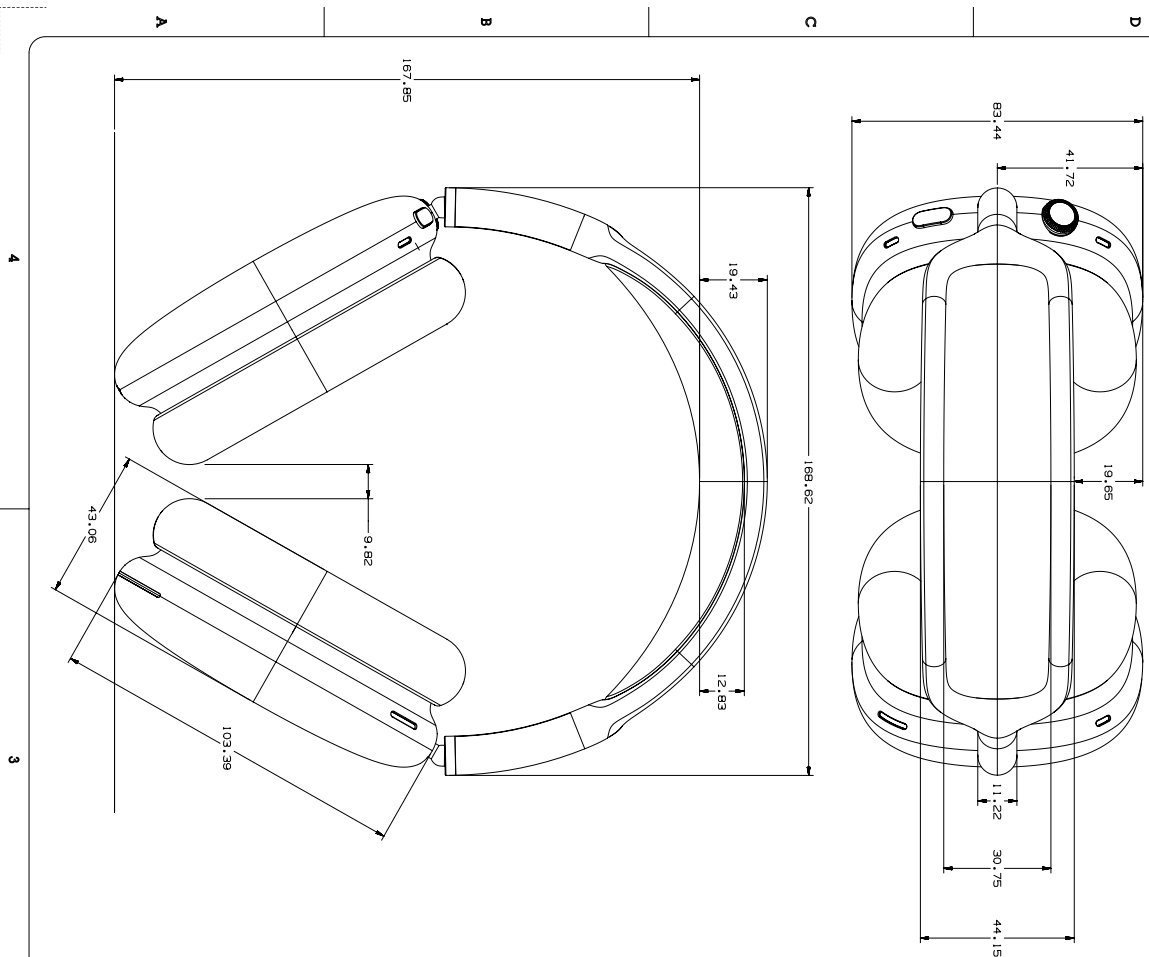


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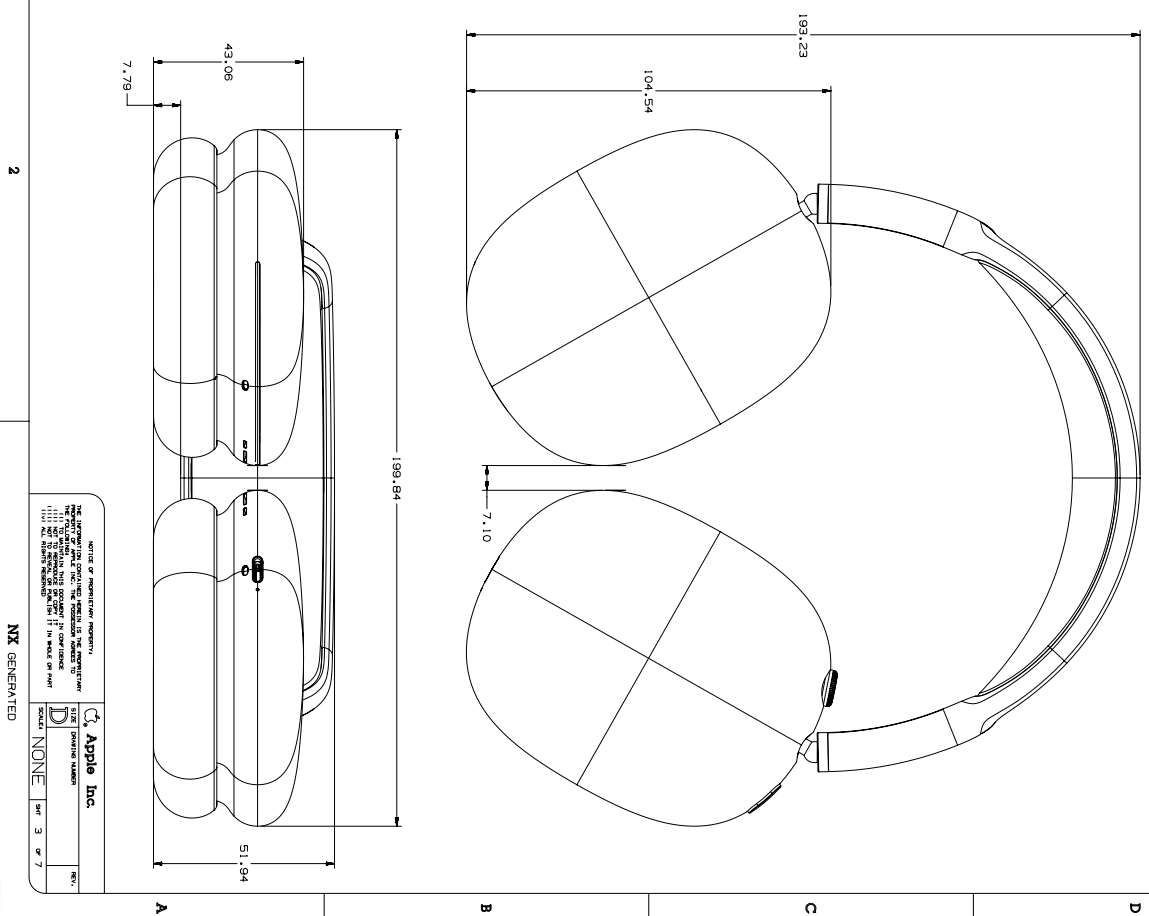
Apple Inc.
 TRADE DRESS NUMBER: NONE
 DRAWING NUMBER: 59.267
 SHEET: 2 OF 7

59.268 AirPods Max, 3 of 6

PRODUCT OVERALL DIMENSIONS, AS WORN



PRODUCT OVERALL DIMENSIONS, AS STOWED

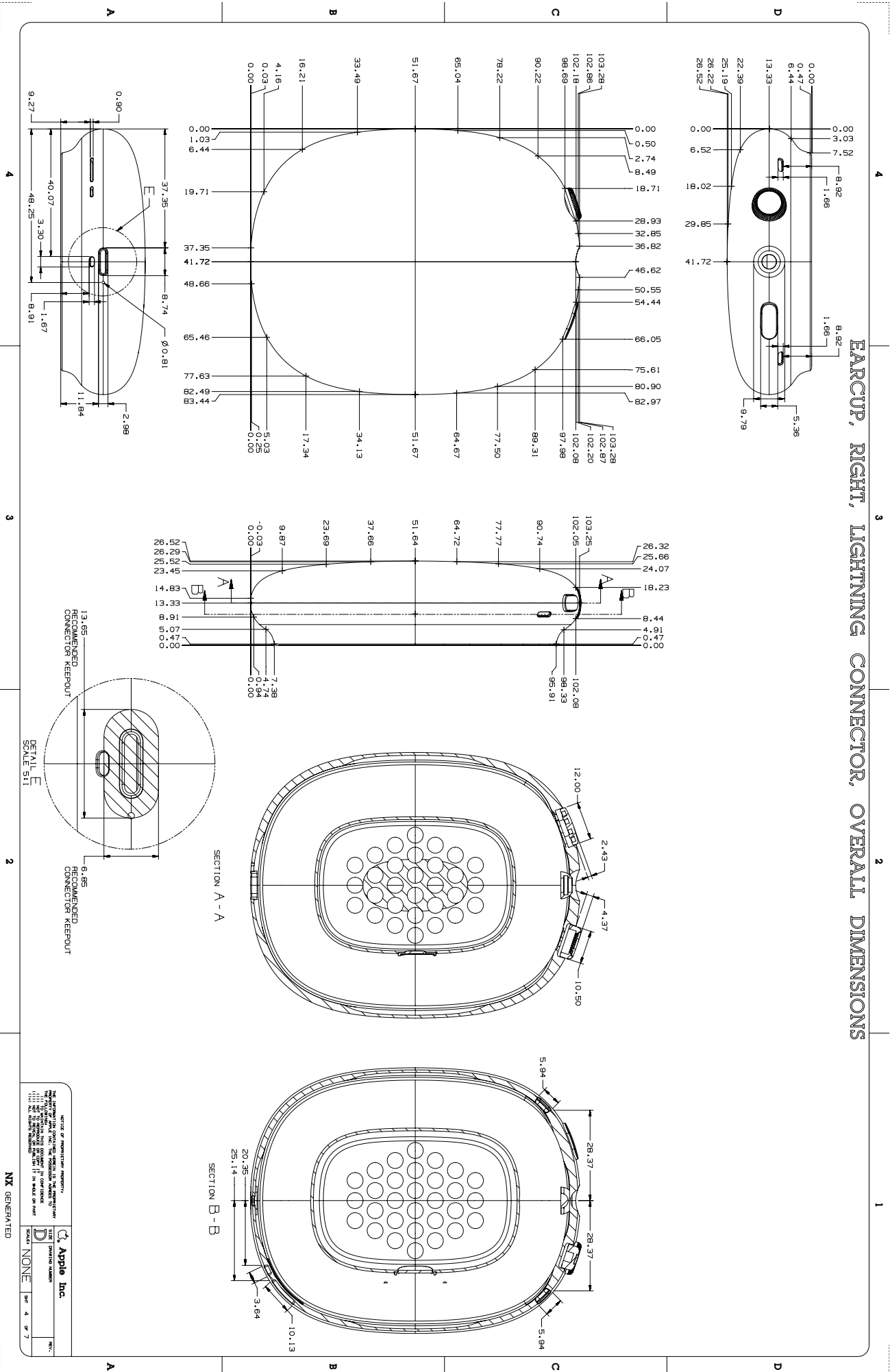


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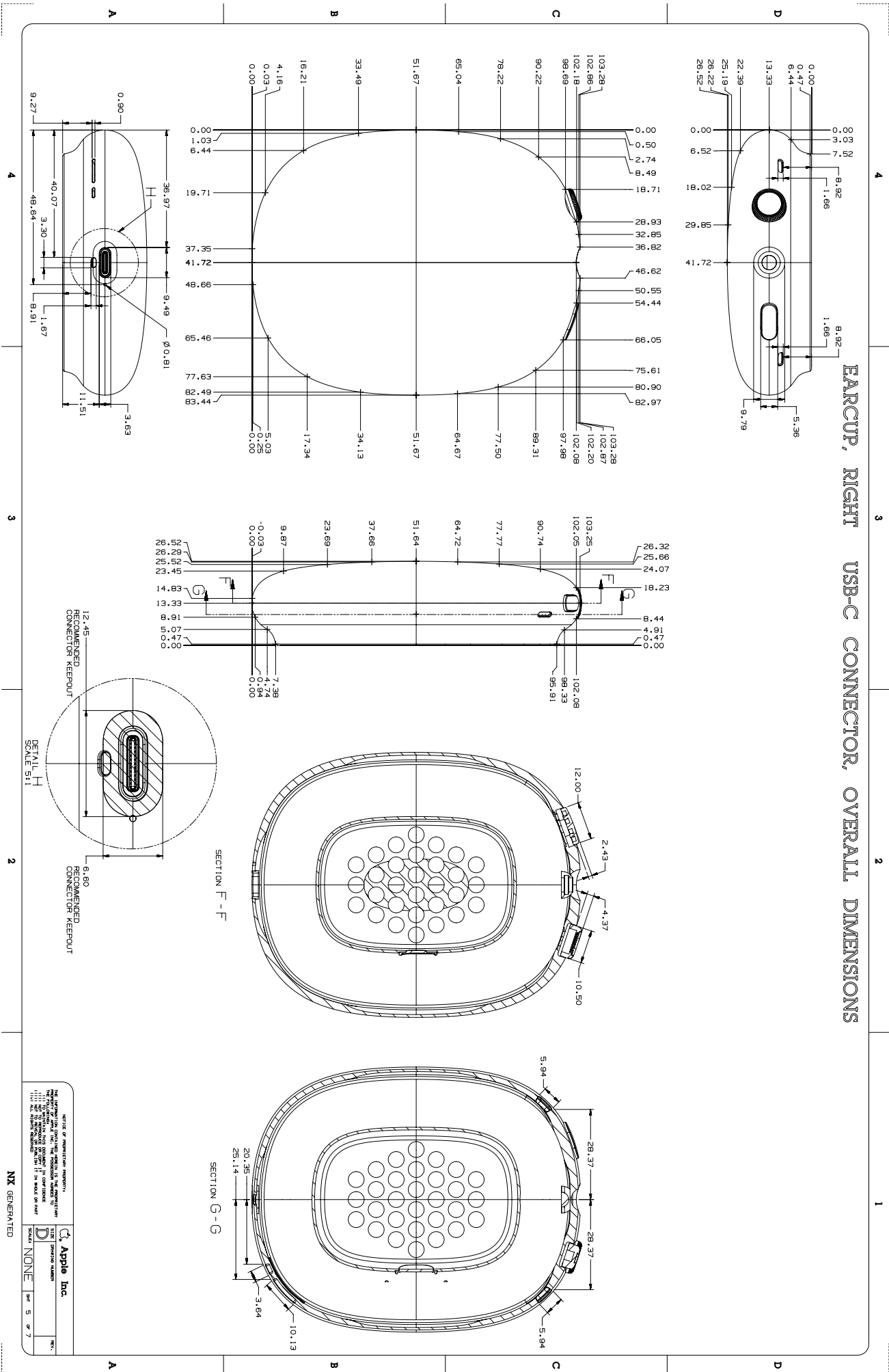
Apple Inc.
 Part Number: N11111
 Revision: 3 of 7

EARCUP, RIGHT, LIGHTNING CONNECTOR, OVERALL DIMENSIONS



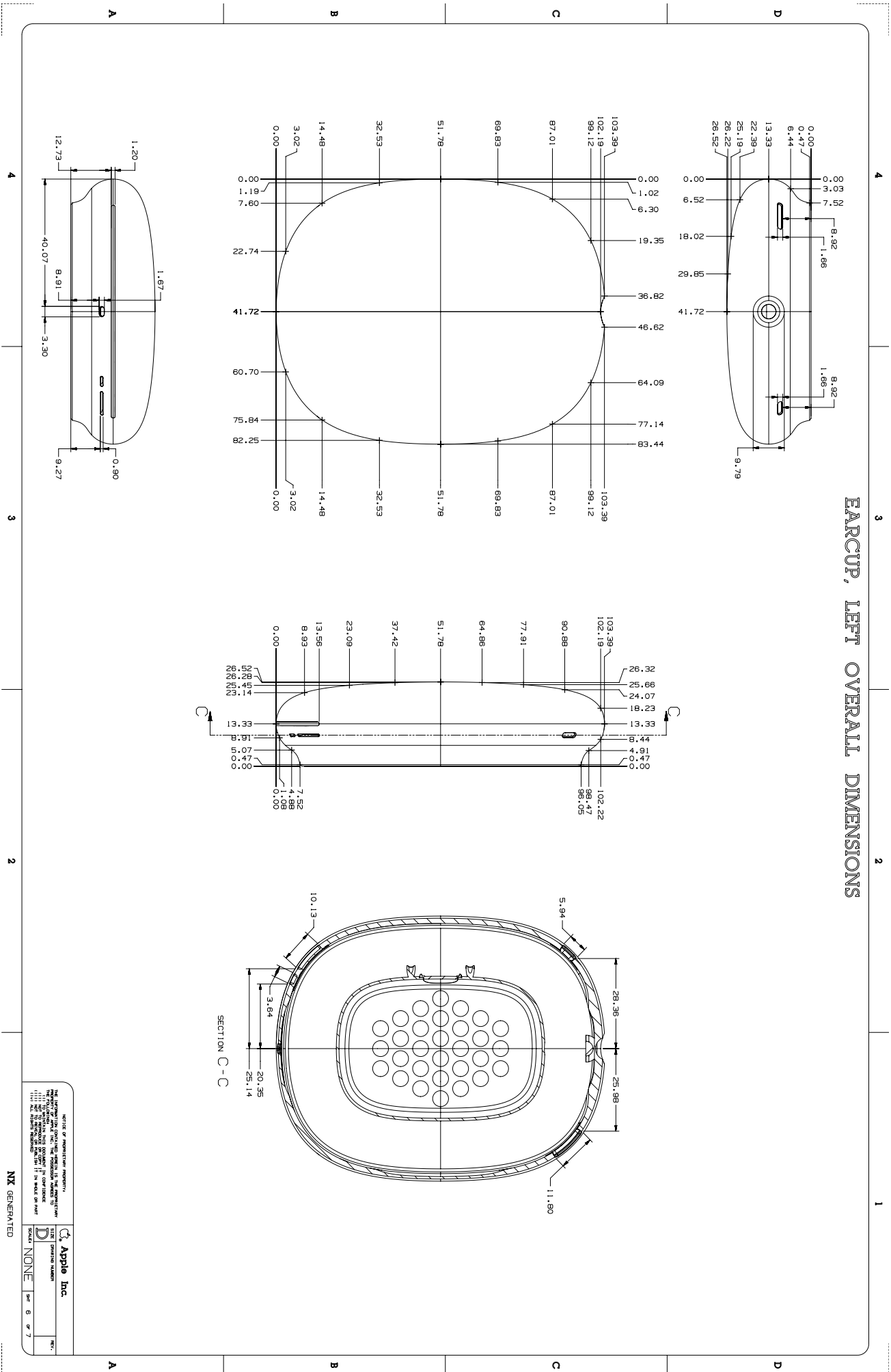
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59.269	4	7
NX GENERATED	NONE	NONE

EARCUP, RIGHT USB-C CONNECTOR, OVERALL DIMENSIONS



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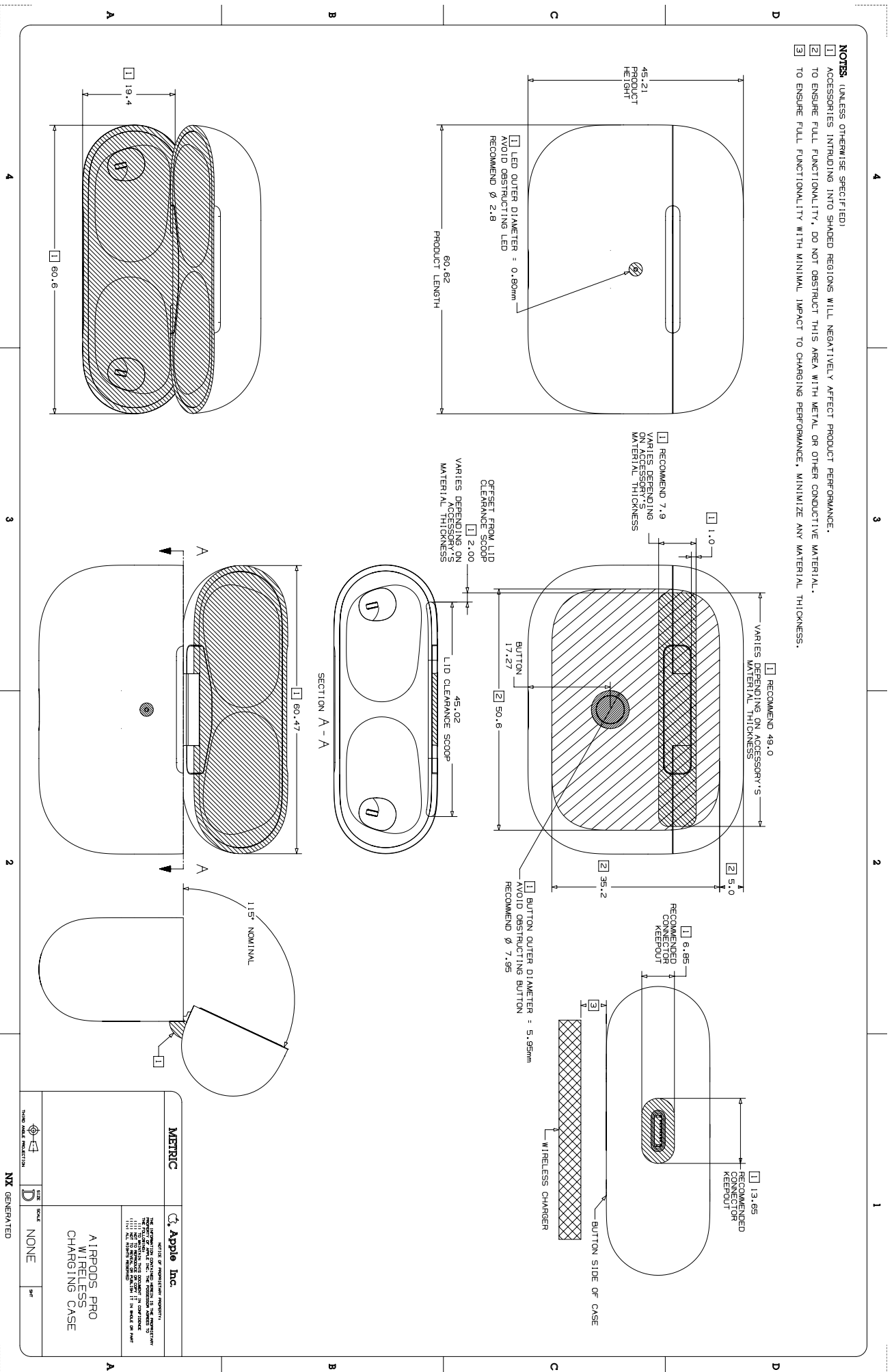
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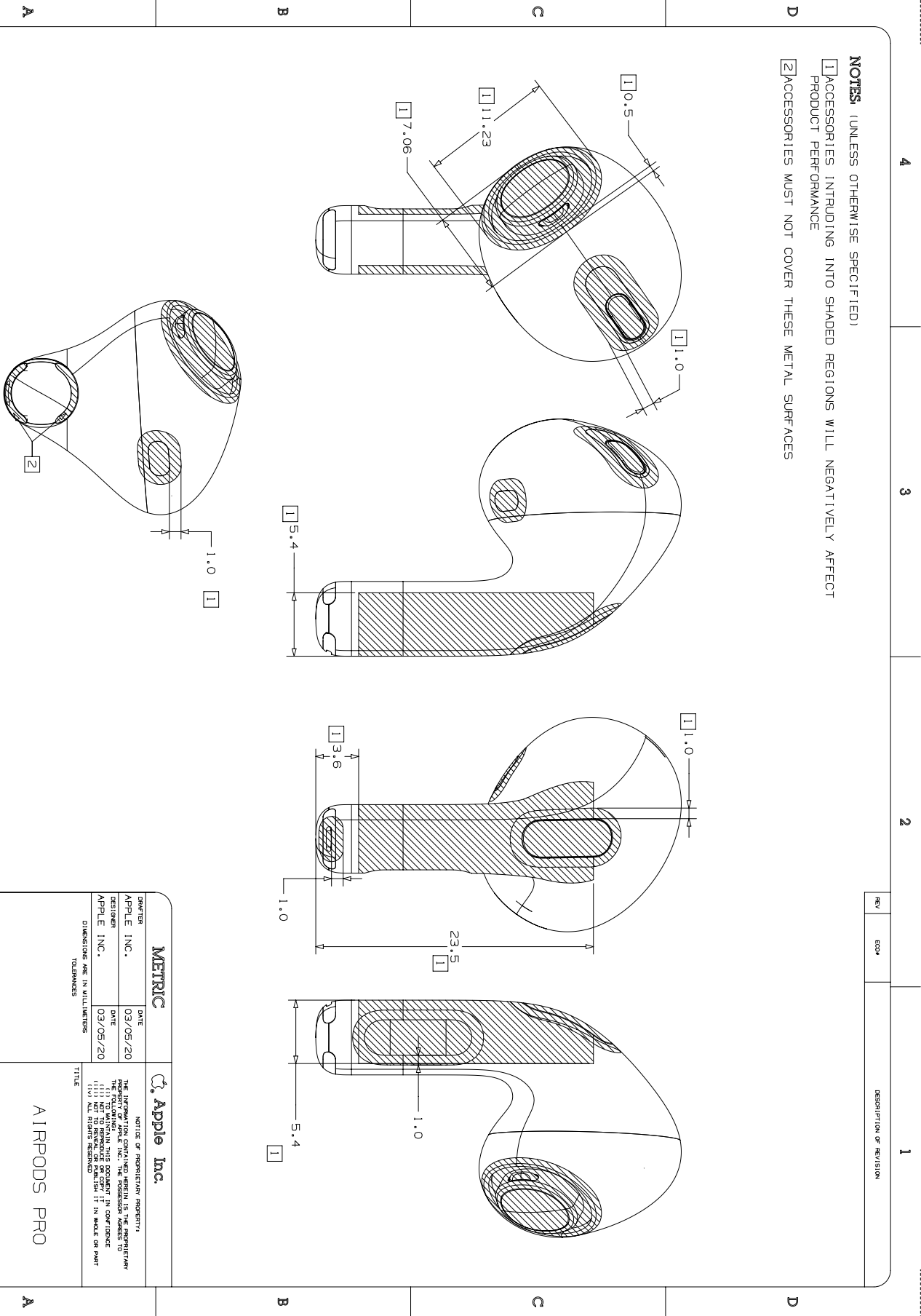
59.272 Wireless Charging Case for AirPods Pro (1st generation)



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<p>AIRPODS PRO WIRELESS CHARGING CASE</p>		<p>DATE: 2024-10-21</p> <p>SCALE: NONE</p> <p>9411</p>

59.273 AirPods Pro (1st generation)

- NOTES:** (UNLESS OTHERWISE SPECIFIED)
- [1] ACCESSORIES INTRUDING INTO SHADED REGIONS WILL NEGATIVELY AFFECT PRODUCT PERFORMANCE
 - [2] ACCESSORIES MUST NOT COVER THESE METAL SURFACES



REV.	ESQA	DESCRIPTION OF REVISION
1		

DATE	DATE	DATE	DATE
03/05/20	03/05/20	03/05/20	03/05/20

METRIC

APPLE INC.

DESIGNER: APPLE INC.

DATE: 03/05/20

DIVISIONS ARE IN MILLIMETERS

TOLERANCES

TITLE: AIRPODS PRO

DRAWING NUMBER: 01

REV: 01

DO NOT SCALE DRAWINGS		THIRD ANGLE PROJECTION	
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A B C D

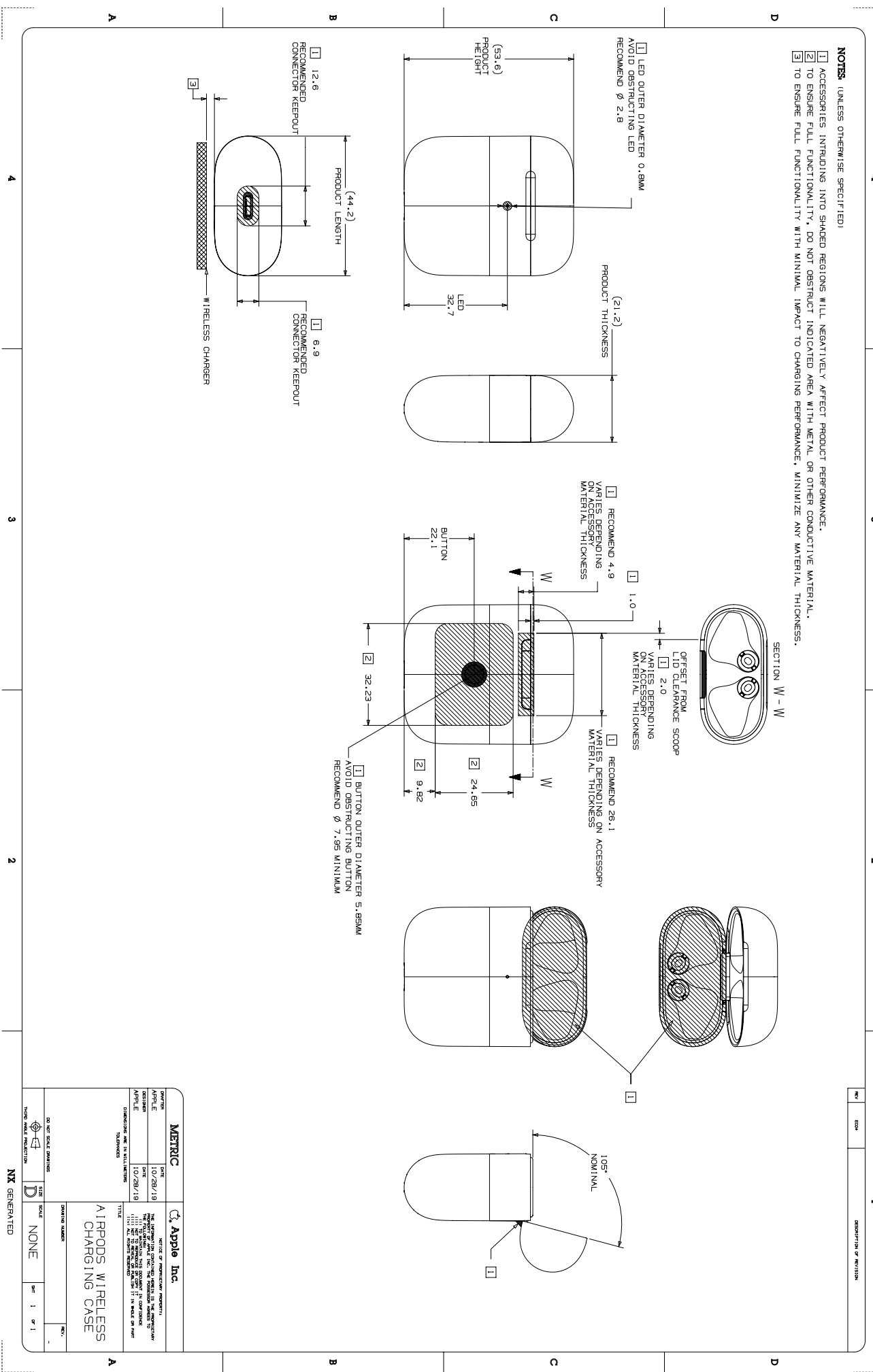
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A B C D

59.274 Wireless Charging Case for AirPods

NOTES (UNLESS OTHERWISE SPECIFIED)

- 1 ACCESSORIES INTRUDING INTO SHADED REGIONS WILL NEGATIVELY AFFECT PRODUCT PERFORMANCE.
- 2 TO ENSURE FULL FUNCTIONALITY, DO NOT OBSTRUCT INDICATED AREA WITH METAL OR OTHER CONDUCTIVE MATERIAL.
- 3 TO ENSURE FULL FUNCTIONALITY WITH MINIMAL IMPACT TO CHARGING PERFORMANCE, MINIMIZE ANY MATERIAL THICKNESS.



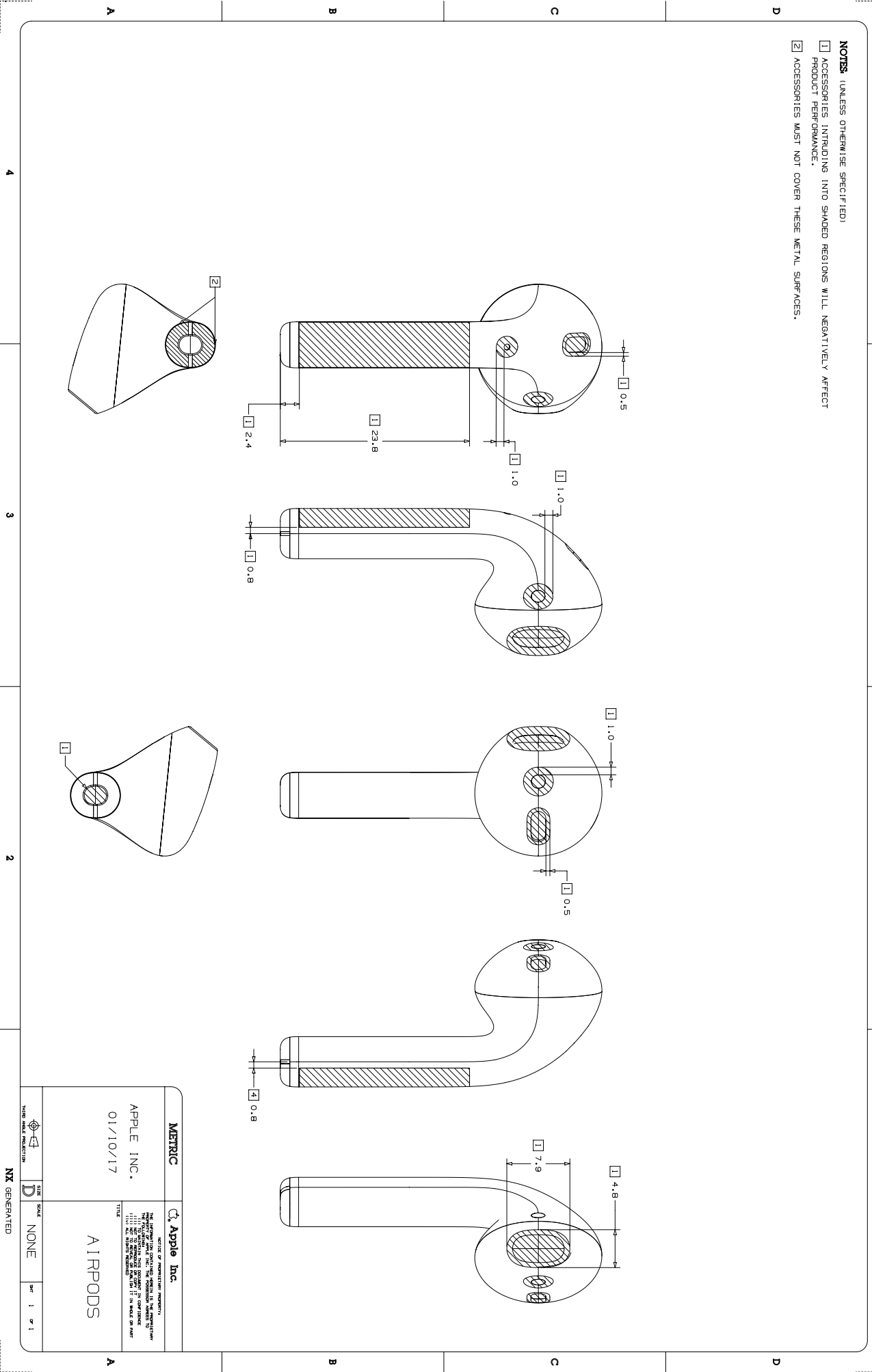
METRIC		Apple Inc.	
DATE	10/28/18	DATE	10/28/18
DESIGNED BY	APPLE	DESIGNED BY	APPLE
CHANGING NAME TO BULK PARTS		CHANGING NAME TO BULK PARTS	
TITLE	AIRPODS WIRELESS CHARGING CASE	TITLE	AIRPODS WIRELESS CHARGING CASE
SCALE	NONE	SCALE	NONE
DO NOT SCALE DIMENSIONS		DO NOT SCALE DIMENSIONS	
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DATE GENERATED	10/28/18	DATE GENERATED	10/28/18
REV.	1	REV.	1

59.275 AirPods (1st generation) and AirPods (2nd generation)

NOTES (UNLESS OTHERWISE SPECIFIED)

[1] ACCESSORIES INTRUDING INTO SHADED REGIONS WILL NEGATIVELY AFFECT PRODUCT PERFORMANCE.

[2] ACCESSORIES MUST NOT COVER THESE METAL SURFACES.



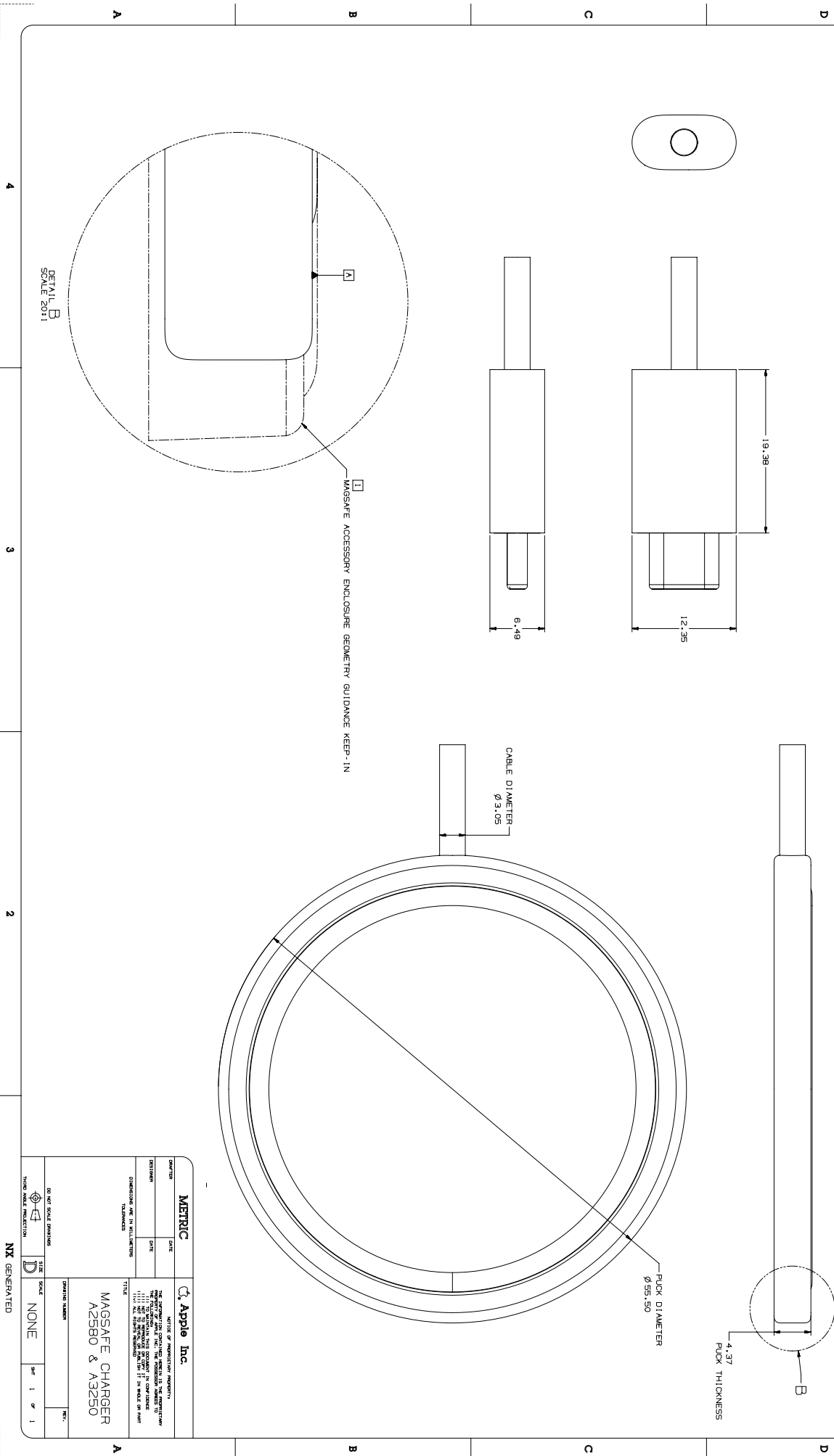
<p>METRIC</p>	<p>Apple Inc.</p>	
<p>APPLE INC. 01/10/17</p>	<p><small>NOTICE OF REVISIONS AND OTHER INFORMATION: The information on this drawing is the property of Apple Inc. The customer agrees to hold Apple Inc. responsible for any errors or omissions on this drawing. All dimensions are in millimeters unless otherwise specified. All rights reserved.</small></p>	
<p>TITLE</p>	<p>AIRPODS</p>	
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NX GENERATED

59.276 Apple MagSafe Charger (1 m) and Apple MagSafe Charger (2 m)

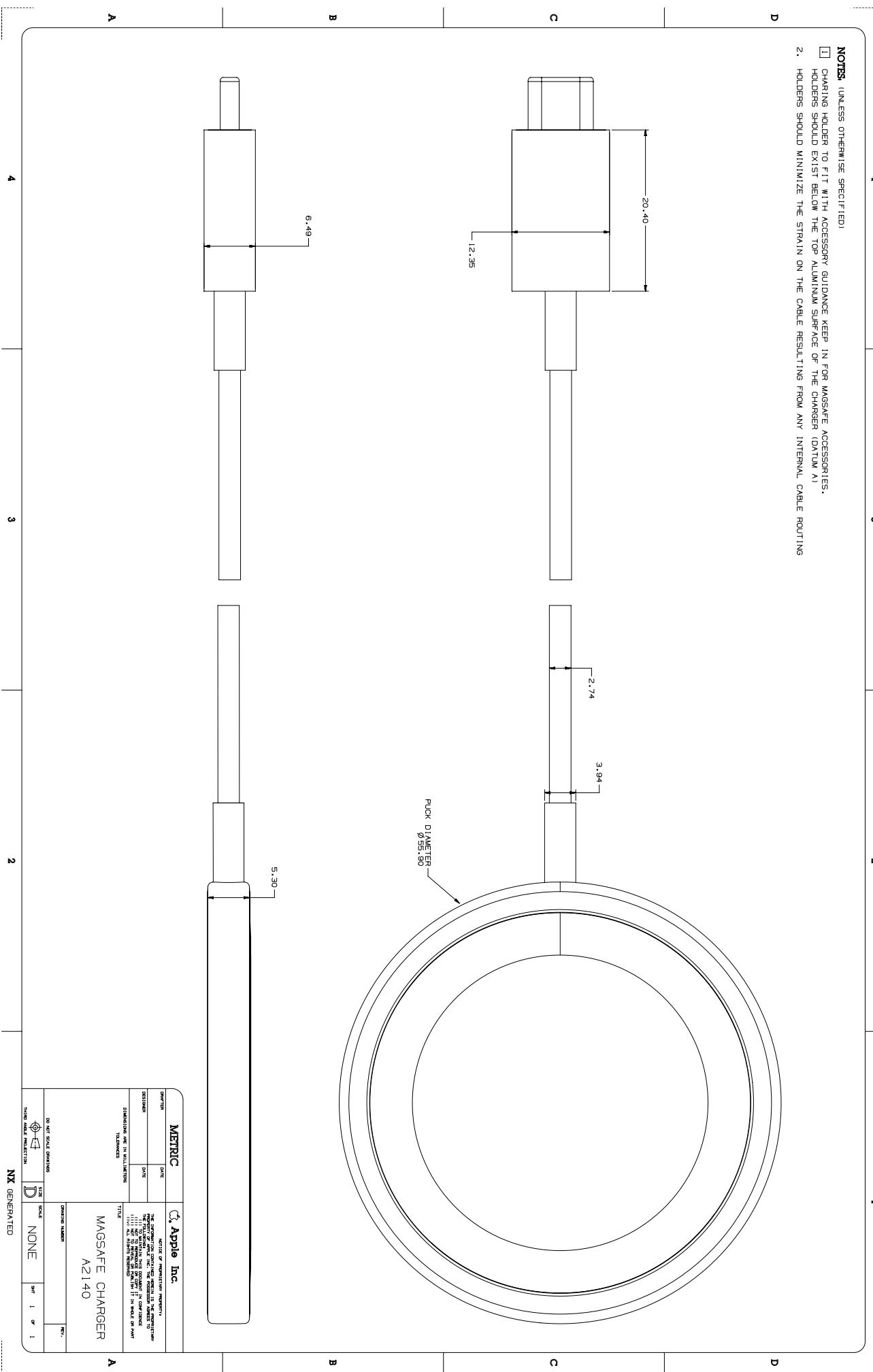
- NOTES** (UNLESS OTHERWISE SPECIFIED)
- CHARGING HOLDER TO FIT WITH ACCESSORY GUIDANCE KEEP -IN FOR MAGSAFE ACCESSORIES. HOLDERS SHOULD EXIST BELOW THE TOP ALUMINUM SURFACE OF THE CHARGER (DONTUM A)
 - HOLDERS SHOULD MINIMIZE THE STRAIN ON THE CABLE RESULTING FROM ANY INTERNAL CABLE ROUTING



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DIMENSIONS ARE IN MILLIMETERS TOLERANCES		DRAWING NUMBER NX GENERATED	
DO NOT SCALE DRAWINGS THIRD ANGLE PROJECTION		THE SCALE NONE	SHEET 1 OF 1

59.277 Apple MagSafe Charger

- NOTES** (UNLESS OTHERWISE SPECIFIED)
- CHARGING HOLDER TO FIT WITH ACCESSORY GUIDANCE KEEP IN FOR MAGSAFE ACCESSORIES.
 - HOLDERS SHOULD EXIST BELOW THE TOP ALUMINUM SURFACE OF THE CHARGER (D/TUM A)
 - HOLDERS SHOULD MINIMIZE THE STRAIN ON THE CABLE RESULTING FROM ANY INTERNAL CABLE ROUTING



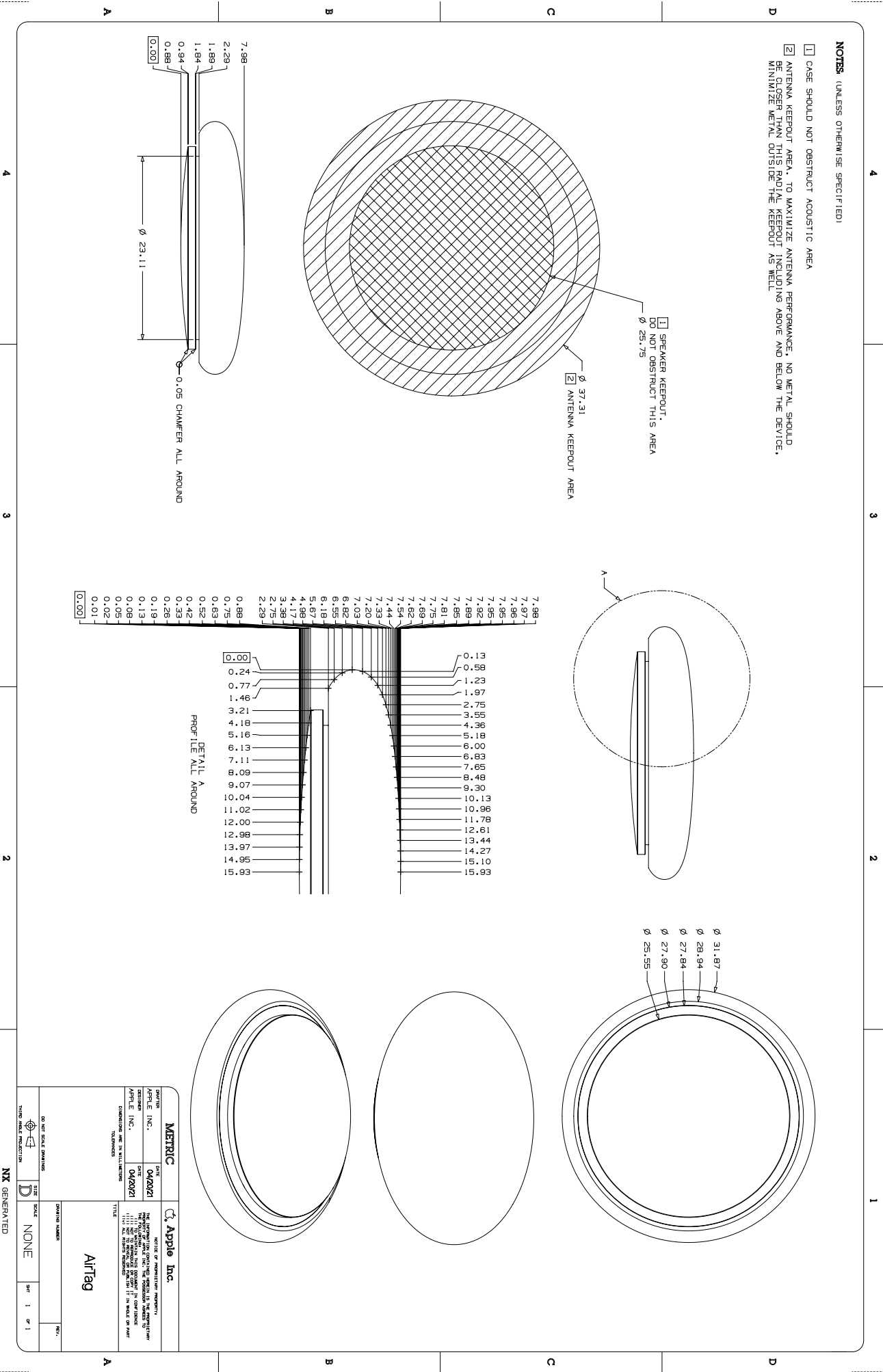
METRIC		Apple Inc.	
DATE	REV	DESCRIPTION	REV
DESIGNED BY	DATE	THE INFORMATION CONTAINED HEREIN IS PROPRIETARY AND CONFIDENTIAL TO APPLE INC. AND IS TO BE USED ONLY FOR THE PURPOSES SPECIFIED IN THIS DOCUMENT. ALL RIGHTS RESERVED.	
DIMENSIONS ARE IN MILLIMETERS (UNLESS NOTED OTHERWISE)		TITLE	
		MAGSAFE CHARGER	
		A2140	
DO NOT SCALE DIMENSIONS		DRAWING NUMBER	
THIRD ANGLE PROJECTION		SCALE	NONE
		SHR	1 OF 1
		REV.	

NX GENERATED

59.278 AirTag

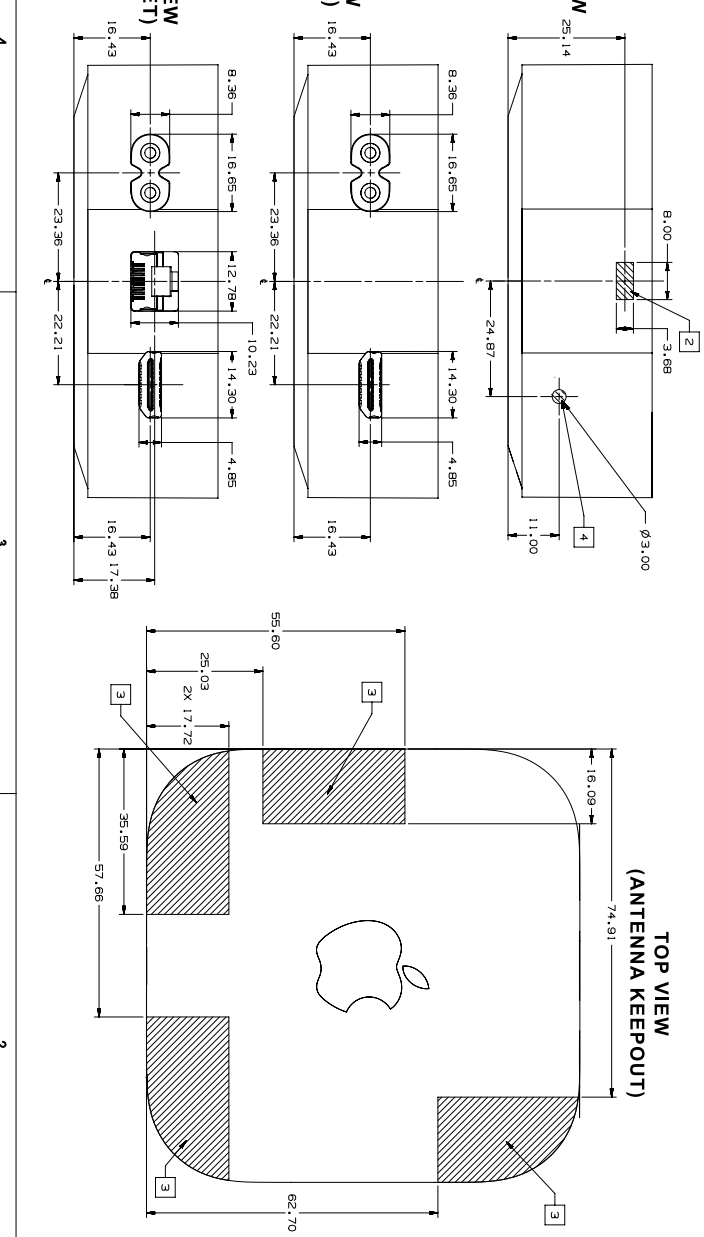
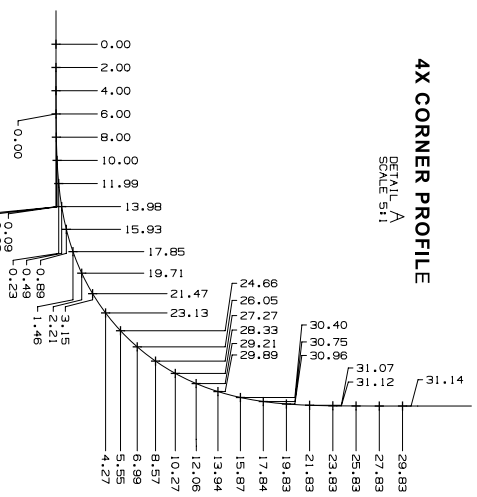
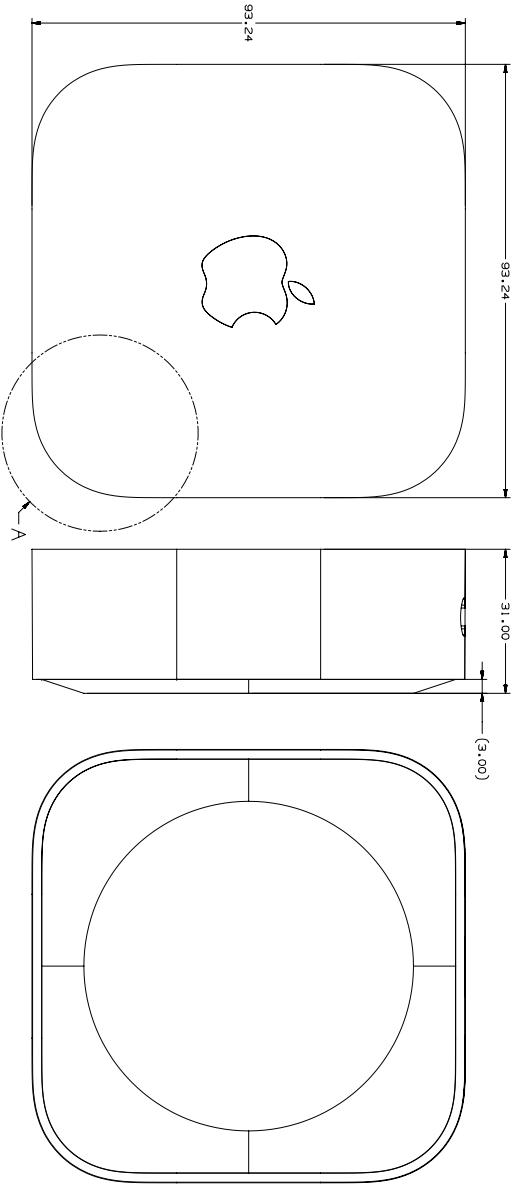
NOTES (UNLESS OTHERWISE SPECIFIED)

- 1 CASE SHOULD NOT OBSTRUCT ACOUSTIC AREA
- 2 ANTENNA KEEP-OUT AREA. TO MAXIMIZE ANTENNA PERFORMANCE, NO METAL SHOULD BE CLOSER THAN THIS RADIAL KEEP-OUT INCLUDING ABOVE AND BELOW THE DEVICE, MINIMIZE METAL OUTSIDE THE KEEP-OUT AS WELL
- 3 SPEAKER KEEP-OUT. DO NOT OBSTRUCT THIS AREA. $\varnothing 25.75$
- 4 ANTENNA KEEP-OUT AREA. $\varnothing 37.31$



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59.279 Apple TV 4K (3rd generation)



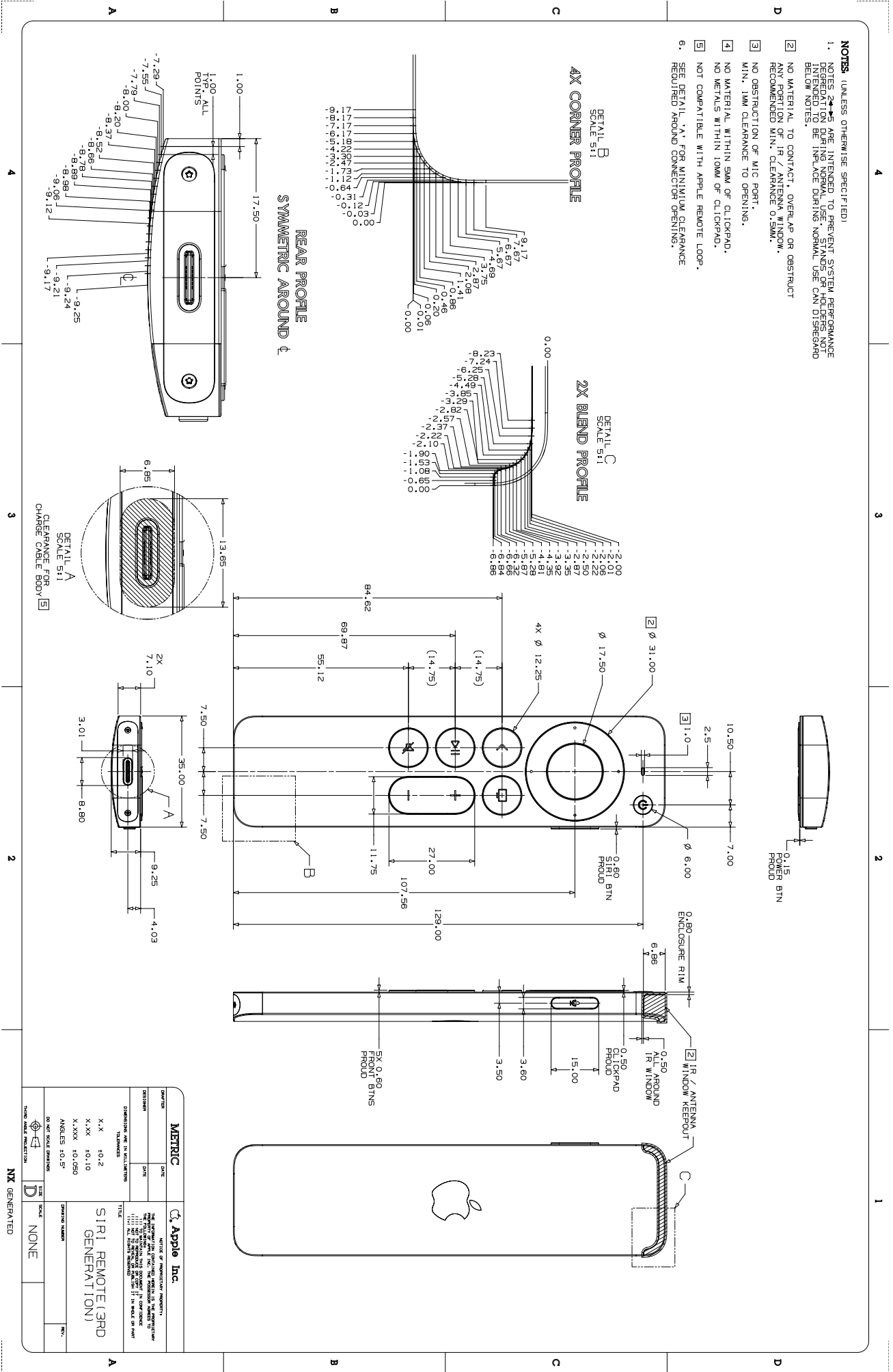
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- NOTES 2 & 4 ARE INTENDED TO PREVENT SYSTEM PERFORMANCE DEGRADATION DURING NORMAL USE. INTENDED TO BE IN PLACE DURING NORMAL USE CAN BE DISCARDED BELOW NOTES.
 - NO MATERIAL TO CONTACT, OVERLAP OR OBSTRUCT ANY PORTION OF IR WINDOW. RECOMMENDED MIN. CLEARANCE 0.5MM.
 - NO METALLIC MATERIAL TO OVERLAP OR OBSTRUCT ANY PORTION OF ANTENNA KEEP-OUT AREA. RECOMMENDED MIN. CLEARANCE 0.5MM.
 - NO MATERIAL TO CONTACT, OVERLAP OR OBSTRUCT ANY PORTION OF SYSTEM INDICATOR LIGHT AREA. RECOMMENDED MIN. CLEARANCE 0.5MM.

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DESIGNED BY:	DRAWN BY:	TITLE: APPLE TV 4K (3RD GENERATION)	
APPROVED BY:	CHECKED BY:	DRAWING NUMBER:	
DIMENSIONS ARE IN MILLIMETERS (UNLESS OTHERWISE SPECIFIED)		DRAWING SCALE: NONE	
DO NOT SCALE DRAWINGS		SHEET: 1 OF 1	
HIDDEN LINE REJECTION		NX GENERATED	

59.280 Siri Remote (3rd generation)

NOTES (UNLESS OTHERWISE SPECIFIED):

- NOTES 2-4 ARE INTENDED TO PREVENT SYSTEM PERFORMANCE DEGRADATION DURING NORMAL USE. STANDS OR HOLDERS NOT INTENDED TO BE IN PLACE DURING NORMAL USE CAN DISREGARD BELOW NOTES.
- NO MATERIAL TO CONTACT, OVERLAP OR OBSTRUCT ANY PORTION OF IR / ANTENNA WINDOW. RECOMMENDED MIN. CLEARANCE 0.5MM.
- NO OBSTRUCTION OF MIC PORT. MIN. 1MM CLEARANCE TO OPENING.
- NO MATERIAL WITHIN 5MM OF CLICKPAD.
- NO MATERIAL WITHIN 10MM OF CLICKPAD.
- NOT COMPATIBLE WITH APPLE REMOTE LOOP.
- SEE DETAIL 'A' FOR MINIMUM CLEARANCE REQUIRED AROUND CONNECTOR OPENING.



METRIC		Apple Inc.	
DATE		DATE	
DESIGNER		DESIGNER	
DRAWN		DRAWN	
CHECKED		CHECKED	
APPROVED		APPROVED	
DIMENSIONS ARE IN MILLIMETERS			
TOLERANCES			
X.X	+0.2		
X.XX	+0.10		
X.XXX	+0.050		
ANGLES 10.5°			
DO NOT SCALE DIMENSIONS			
HIDDEN LINE PRACTICE			
SCALE		NONE	
DRAWING NUMBER		NX GENERATED	
TITLE			
SIRI REMOTE (3RD GENERATION)			
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Revision History

This chapter describes changes to the Accessory Design Guidelines for Apple Devices from the previous revision, excluding stylistic and editorial changes.

Added Content

- [Access to the Camera Control](#) (page 36):
 - [User Study](#) (page 38)
- [Verification](#) (page 49)
 - [Camera Control](#) (page 69)
- [iPad mini \(A17 Pro\), 1 of 6](#) (page 367)
- [iPad mini \(A17 Pro\), 2 of 6](#) (page 368)
- [iPad mini \(A17 Pro\), 3 of 6](#) (page 369)
- [iPad mini \(A17 Pro\), 4 of 6](#) (page 370)
- [iPad mini \(A17 Pro\), 5 of 6](#) (page 371)
- [iPad mini \(A17 Pro\), 6 of 6](#) (page 372)
- [AirPods Max, 5 of 6](#) (page 561)

Updated Content

- [Product Design](#) (page 35)
 - [Wireless Power](#) (page 41)
- [Verification](#) (page 49)
 - [iPad mini \(A17 Pro\) and iPad mini \(6th generation\)](#) (page 62)
- [Smart Covers](#) (page 76)
- [Accessory Power \(USB-C\)](#) (page 136)
 - [Available Current](#) (page 136)
- [Accessory Developer Assistant \(ADA\)](#) (page 281)



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