39. 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 179).

Other MagSafe accessories shall:

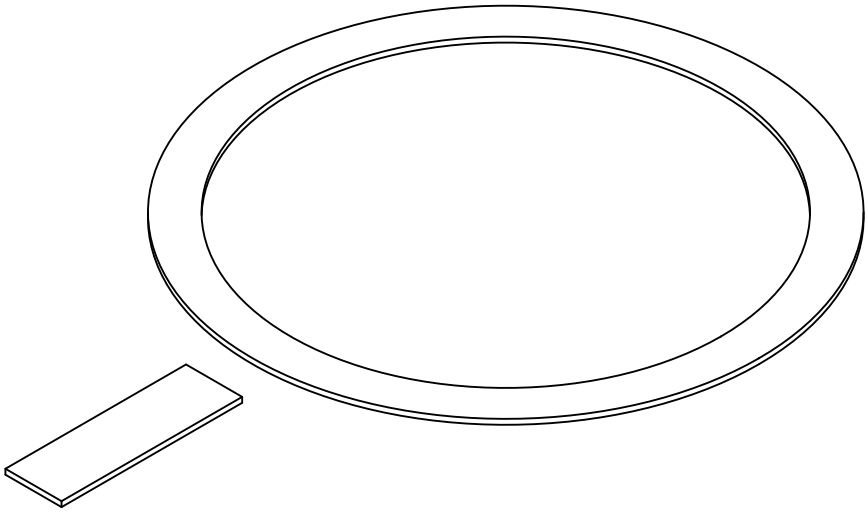
- Claim compatibility with a MagSafe-capable device.
- Integrate a MagSafe Accessory Magnet Array (page 186).

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)

39.1 MagSafe Case Magnet Array

Figure 39-1 MagSafe case magnet array



39.1.1 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.

39.1.2 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.

39.1.2.1 Magnets

MagSafe case magnets shall be N45SH NdFeB with a 8 µm - 16 µm epoxy coating (or similar non-metallic coating) and shall meet the requirements in Table 39-1 (page 180).

Table 39-1 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

39.1.2.2 Magnet Array

The magnets shall be positioned in the case following the dimensions and polarity shown in Figure 39-2 (page 181), Figure 39-3 (page 182) and Figure 39-4 (page 182).

Figure 39-2 MagSafe magnet array dimensions

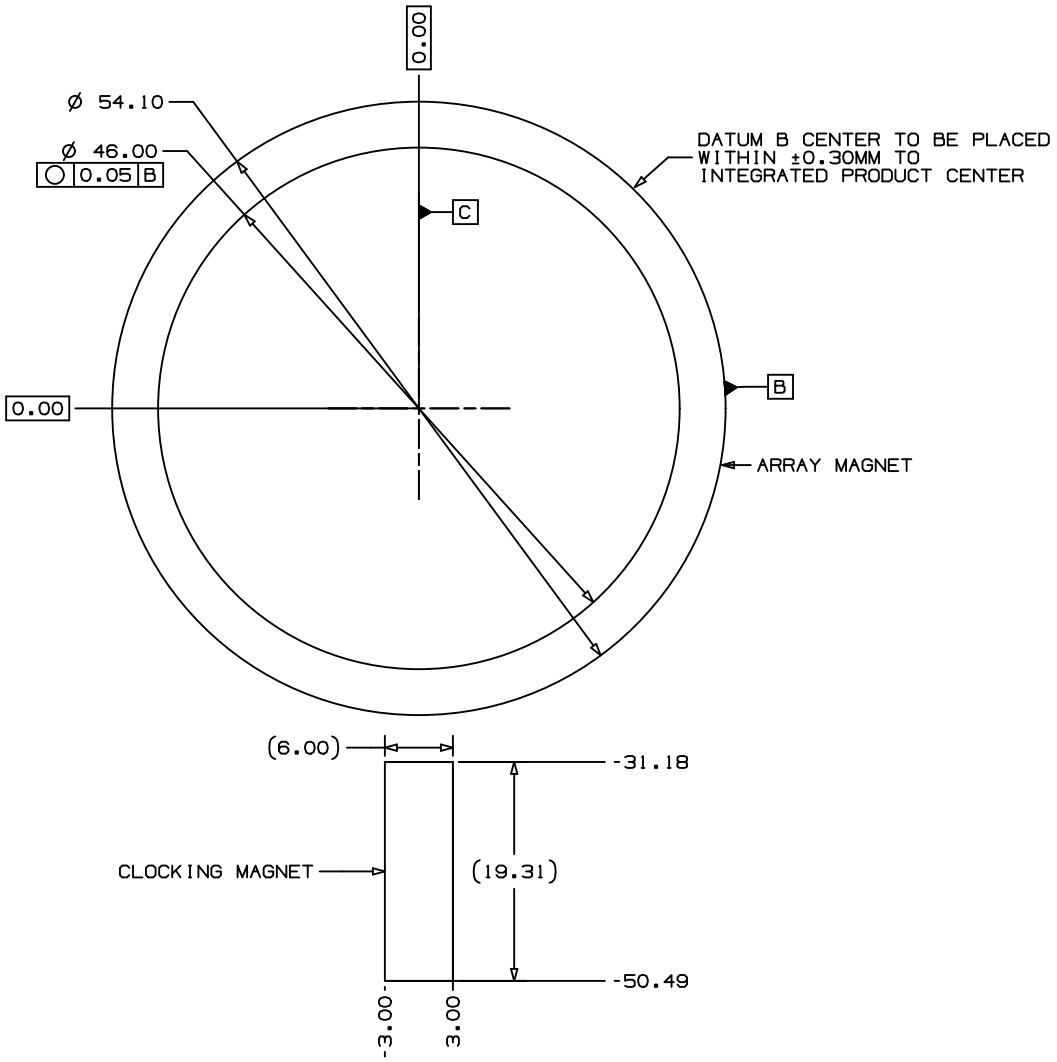


Figure 39-3 MagSafe magnet ring dimensions and polarity

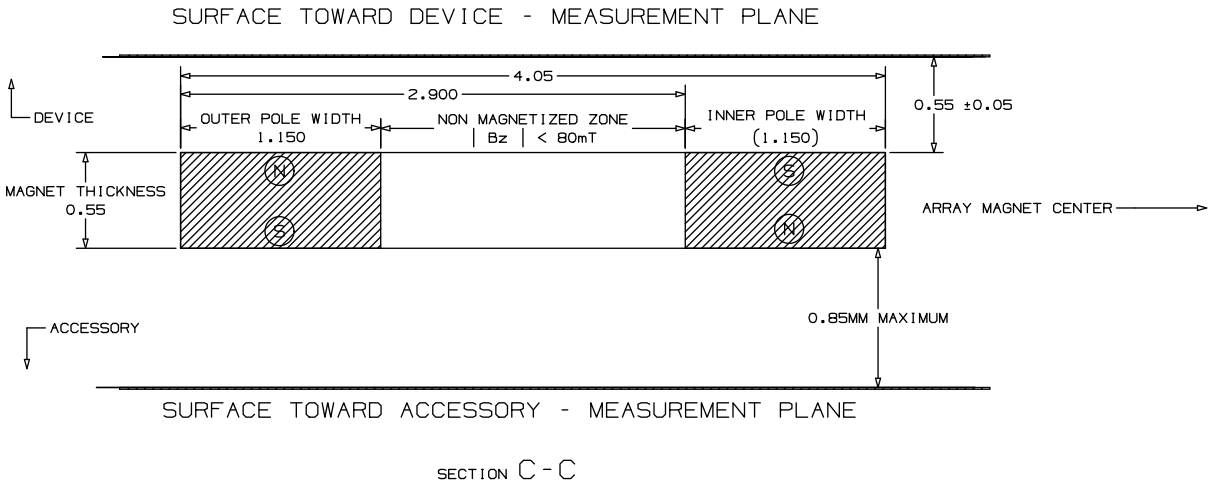
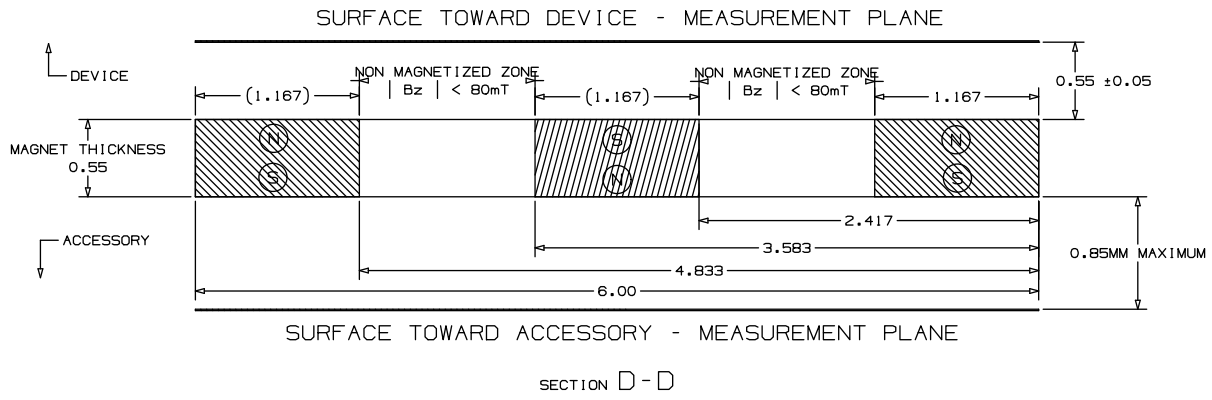


Figure 39-4 MagSafe orientation magnet dimensions and polarity



The flux density of a MagSafe case magnet ring shall comply with Table 39-2 (page 183) and Table 39-3 (page 184) across the 8 lines (S1 - S8) in Figure 39-5 (page 183).

Figure 39-5 MagSafe flux density measurement plane

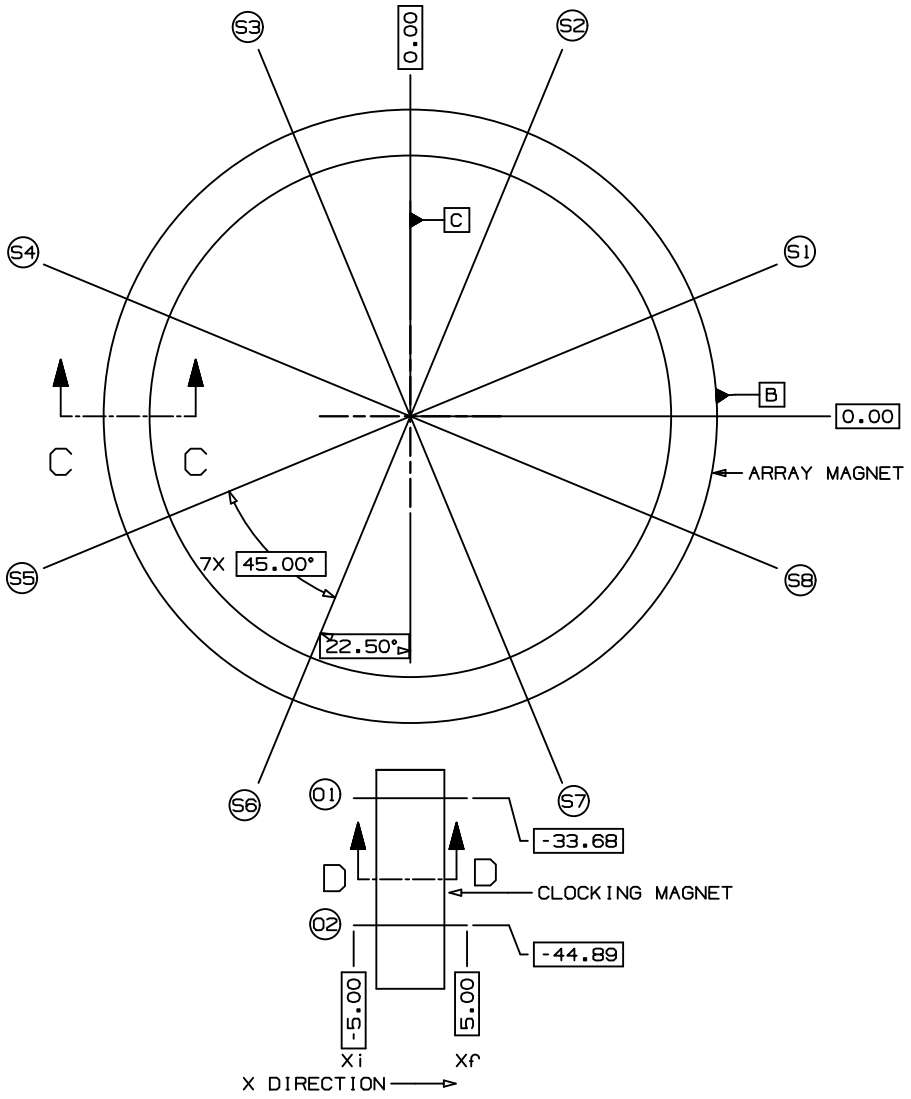


Table 39-2 Device side flux density at 0.55 mm from magnet ring surface

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

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 39-3 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 39-4 (page 184) and Table 39-5 (page 185) across the 2 lines (O1 and O2) in Figure 39-5 (page 183).

Table 39-4 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

Table 39-5 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

39.1.2.3 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 39-6 (page 185).

Table 39-6 Magnetic force

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

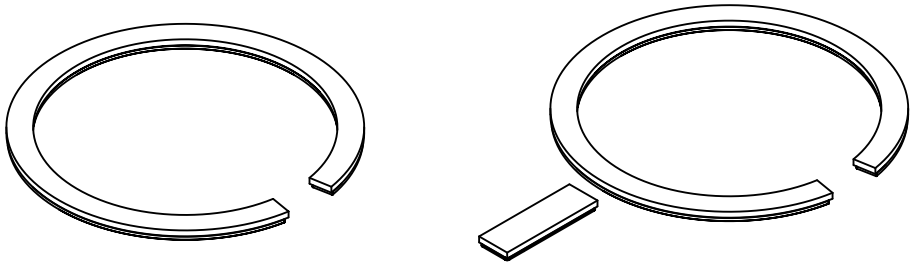
39.1.3 Magnetic Interference

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

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

39.2 MagSafe Accessory Magnet Array

Figure 39-6 MagSafe accessory magnet array options



The MagSafe accessory magnet array shall be implemented as a Magnet Ring (page 188). 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 189) as part of the array.

39.2.1 Product Design

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

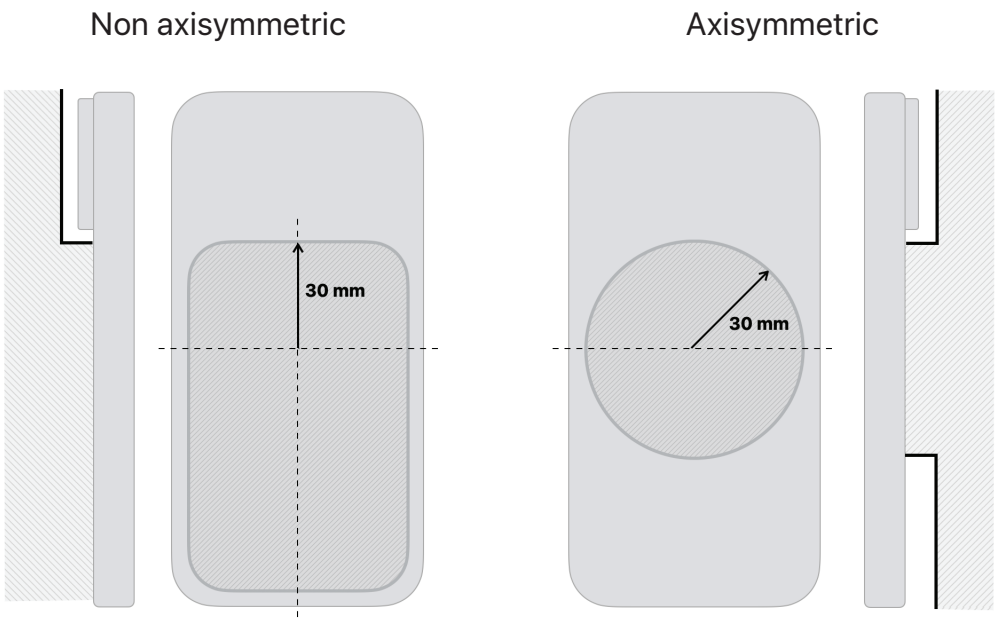
39.2.2 Mechanical

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 193).

Figure 39-7 MagSafe accessory clearance



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

The MagSafe accessory's Magnet Ring (page 188) shall magnetically self align to the device's magnet ring within a 1.55 mm radial maximum.

39.2.2.1 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 39-7 (page 187).

Table 39-7 Magnet properties

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

39.2.2.2 Magnet Ring

The magnet ring shall be positioned in the accessory in compliance with the dimensions and polarity requirements in Figure 39-8 (page 188) and Figure 39-9 (page 189).

Figure 39-8 MagSafe magnet ring dimensions

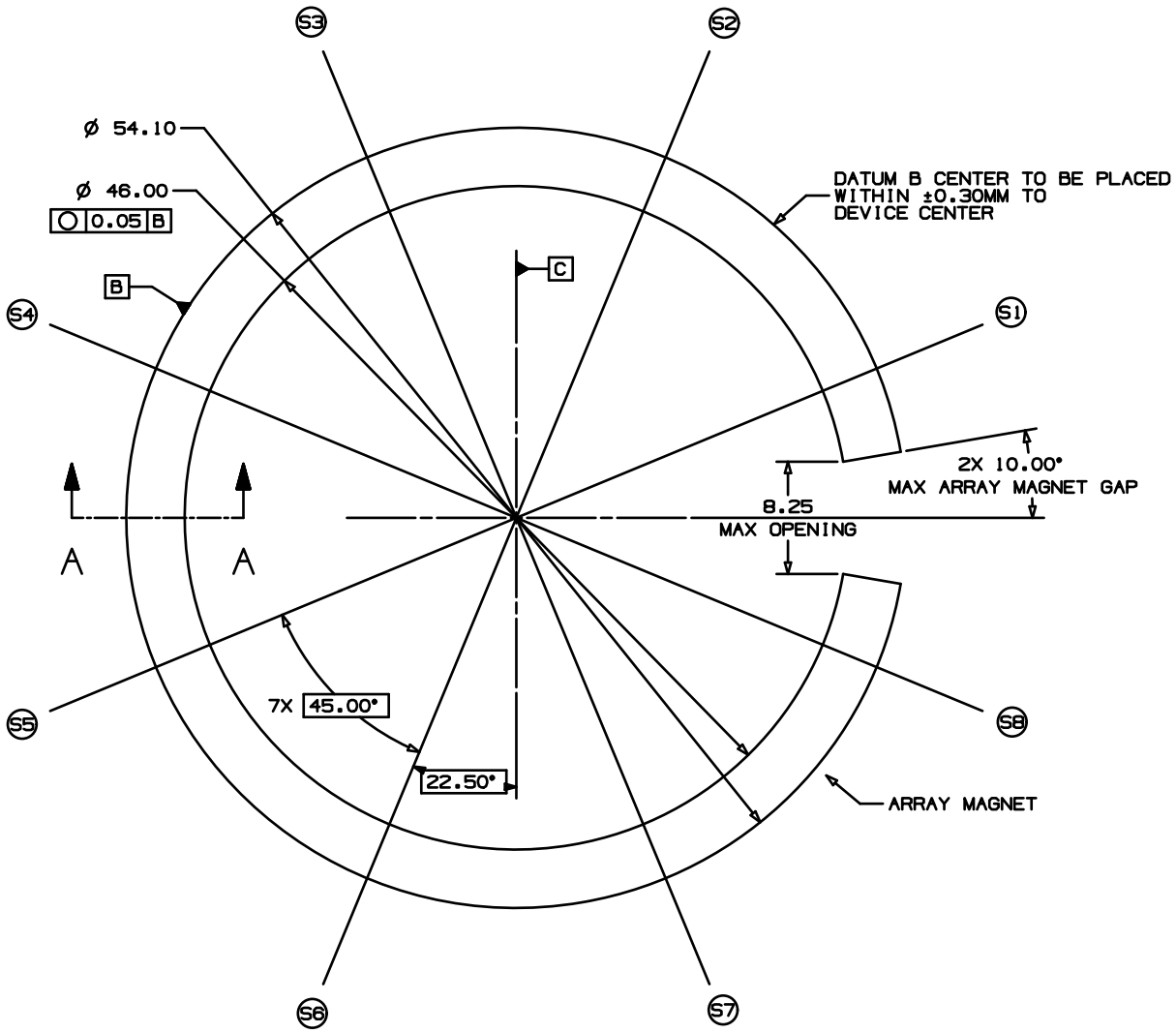
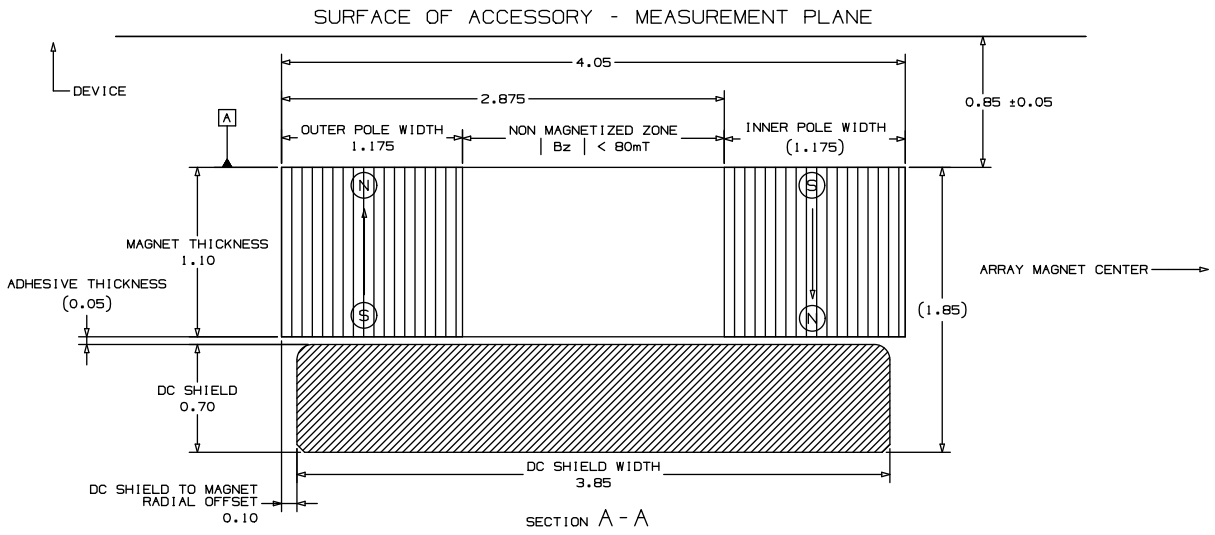


Figure 39-9 MagSafe magnet ring dimensions and polarity



See DC Shield (page 192) for additional requirements of the DC shield specified in Figure 39-9 (page 189).

The flux density of a MagSafe accessory magnet ring shall comply with Table 39-8 (page 189) across the 8 lines (S1 - S8) in Figure 39-8 (page 188).

Table 39-8 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

39.2.2.3 Orientation Magnet

If orientation magnets are included, the magnets shall be positioned according to Figure 39-10 (page 190) and Figure 39-11 (page 191).

Figure 39-10 MagSafe orientation magnet dimensions

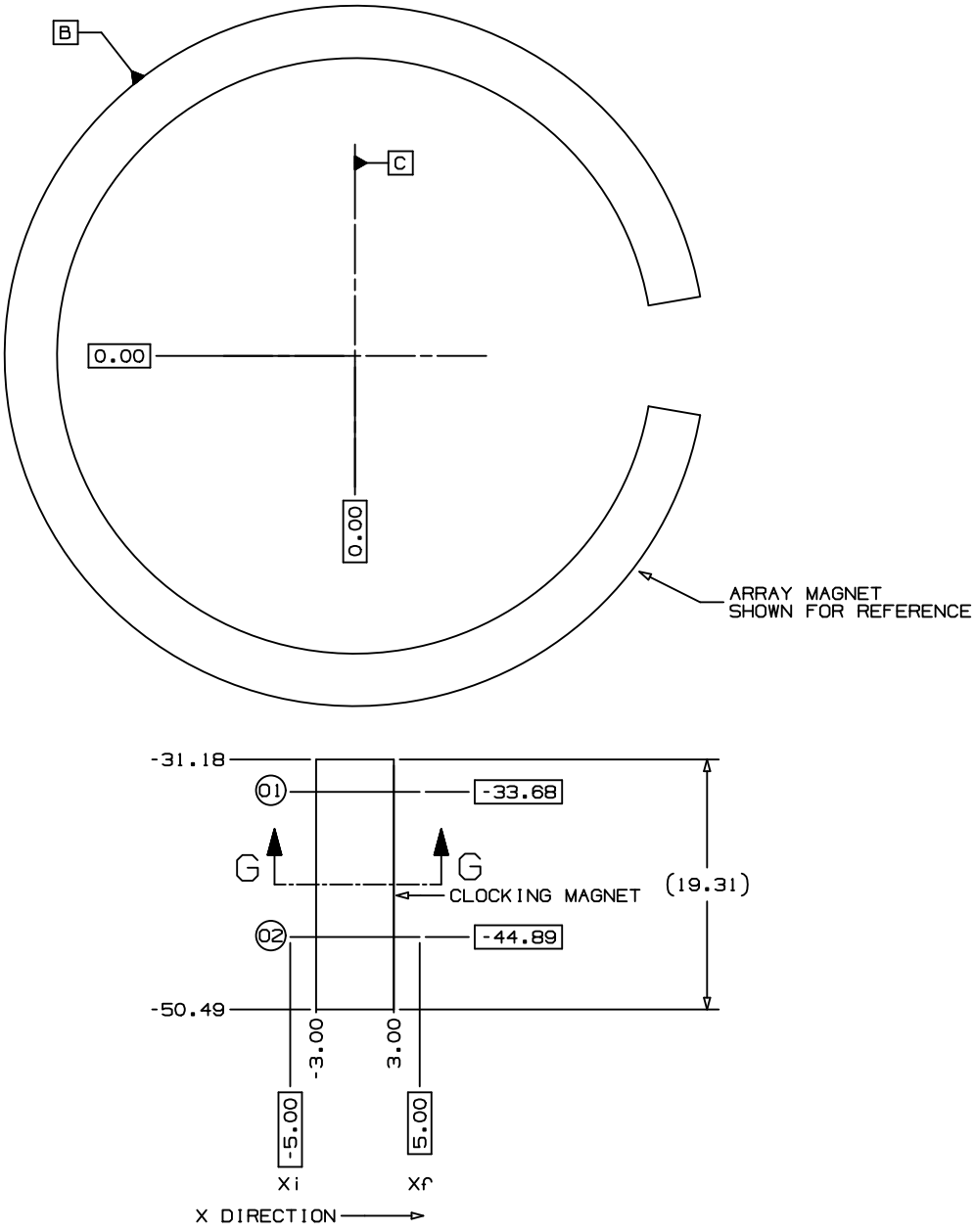
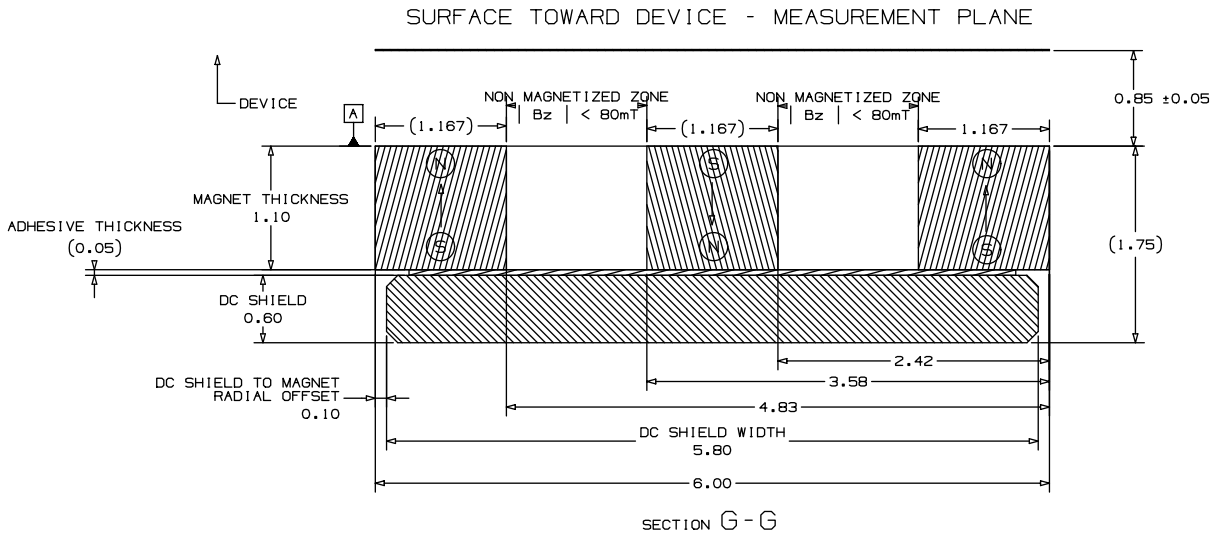


Figure 39-11 MagSafe orientation magnet dimensions and polarity



See DC Shield (page 192) for additional requirements of the DC shield specified in Figure 39-11 (page 191).

The flux density of a MagSafe accessory orientation magnet shall comply with Table 39-9 (page 191) across the 2 lines (O1 and O2) in Figure 39-10 (page 190).

Table 39-9 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

39.2.2.4 Magnetic Force

The force normal to the back of the device needed to dislodge the MagSafe accessory shall meet the requirements in Table 39-10 (page 192).

Table 39-10 Magnetic force

Scenario	Minimum	Maximum
Accessory attached to device	650 gf	900 gf

39.2.2.5 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.

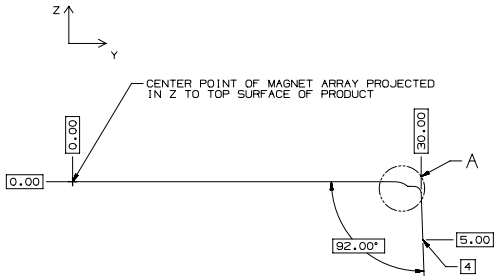
39.3 MagSafe Accessory Enclosure Geometry

REV	ECO#	DESCRIPTION OF REVISION

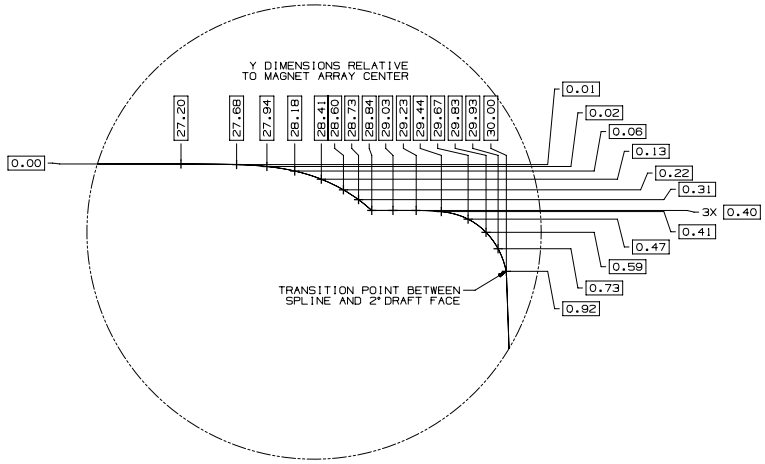
NOTES: (UNLESS OTHERWISE SPECIFIED)

1. SPLINE REPRESENTS MAX MATERIAL CONDITION FOR AN EXTERIOR PRODUCT SURFACE. MAGSAFE COMPATIBLE ACCESSORIES SHALL STAY WITHIN THE PROVIDED SPLINE.
2. FOR NON AXISYMMETRIC APPLICATIONS, SPLINE REPRESENTS MAX MATERIAL CONDITION WHEN VIEWED ALONG X AXIS
3. 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



SIDE VIEW PROJECTION OF POSTIVE Y PRODUCT EDGE
(CUT IN X AT MAGNET ARRAY CENTER POINT)



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