



Standard Specification for Sintered Ceramic Ferrite Permanent Magnets¹

This standard is issued under the fixed designation A1054; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers technically important, commercially available, magnetically hard sintered ceramic ferrite permanent magnets.

1.2 Ceramic ferrite magnets have residual magnetic induction B_r from 2000 G (0.2 T) up to about 5000 G (0.5 T) and intrinsic coercive field strength H_{ci} (H_{cJ}) from 2000 Oe (160 kA/m) up to about 5000 Oe (400 kA/m). Their specific magnetic hysteresis behavior (demagnetization curve) can be characterized using Test Method [A977/A977M](#).

1.3 The values stated in customary (cgs-emu and inch-pound) units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units which are provided for information only and are not considered standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

[A340 Terminology of Symbols and Definitions Relating to Magnetic Testing](#)

[A977/A977M Test Method for Magnetic Properties of High-Coercivity Permanent Magnet Materials Using Hysteresisgraphs](#)

2.2 Other Standards:

[MMPA Standard No. 0100-00 Standard Specifications for Permanent Magnet Materials](#)³

¹ This specification is under the jurisdiction of ASTM Committee A06 on Magnetic Properties and is the direct responsibility of Subcommittee A06.02 on Material Specifications.

Current edition approved May 15, 2014. Published June 2014. Originally approved in 2007. Last previous addition approved in 2007 as A1054-07. DOI: 10.1520/A1054-07.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from The International Magnetics Association (IMA), 8 South Michigan Avenue, Suite 1000, Chicago, IL 60603.

[IEC 60404-8-1, Magnetic Materials Part 8: Specifications for individual materials Section 1 – Standard specifications for magnetically hard materials](#)⁴

[International Air Transport Association \(IATA\) Dangerous Goods Regulations, Packing Instruction 902](#)⁵

3. Terminology

3.1 The terms and symbols used in this specification are defined in Terminology [A340](#).

4. Classification

4.1 The classification of ceramic ferrite permanent magnets is given in [Tables 1 and 2](#), with cross-reference to MMPA Standard No. 0100-00 and IEC 60404-8-1 standards.

5. Ordering Information

5.1 Orders for parts conforming to this specification shall include the following information:

5.1.1 Reference to this standard and year of issue/revision.

5.1.2 Reference to an applicable part drawing.

5.1.3 Magnetic property requirements if they are more stringent than the minimum values listed in the tables.

5.1.4 Quantity required.

5.1.5 The required magnetization state of the provided material (unmagnetized, fully magnetized, magnetized and thermally stabilized, magnetized and partially demagnetized or “calibrated”). This information should appear on the part drawing whenever possible.

5.1.6 Certification of magnetic property evaluation.

5.1.7 Marking and packaging requirements.

5.1.8 Exceptions to this specification or special requirements such as plating, coating, or functional testing as mutually agreed upon by the producer and user.

6. Chemical Composition

6.1 The general chemical composition of ceramic ferrite magnets is $MO \cdot 6Fe_2O_3$ with M being barium, strontium, or some combination of the two. New ferrite grades may also

⁴ Available from IEC (International Electrotechnical Commission) Central Office 3, rue de Varembe, P.O. Box 131, CH - 1211, GENEVA 20 Switzerland.

⁵ Available from IATA, 800 Place Victoria, PO Box 113, Montréal, Québec, H4Z 1M1.

TABLE 1 Classification and Minimum Magnetic Property Requirements for Isotropic Sintered Ceramic Ferrite Magnets

ASTM Designation ^A	MMPA Brief Designation	Material			Maximum Energy Product, MGOe (kJ/m ³)	Remanent Induction Br, gauss (mT)	Magnetic Properties		
		Original MMPA Class	IEC Brief Designation	IEC Code Reference			Normal Coercive Field Strength, Hc (HcB) oersted (kA/m)	Intrinsic Coercive Field Strength, H _{ci} (H _{cj}) oersted (kA/m)	Relative Recoil Permeability, μ_{rec} G/Oe
CE-I-01	1.03/3	Ceramic 1	...	S1-0-1	1.05 (8.4)	2300 (230)	1860 (148)	3250 (259)	1.2

^A Designations are XX-Y-ZZZ where:

- XX = material type (CE = ceramic ferrite),
 Y = processing and orientation (I = isotropic (non-oriented), A = anisotropic (oriented)), and
 ZZZ = numeric grade designation.

TABLE 2 Classification and Minimum Magnetic Property Requirements for Anisotropic Sintered Ceramic Ferrite Magnets

ASTM Designation ^A	MMPA Brief Designation	Material			Maximum Energy Product, MGOe (kJ/m ³)	Remanent Induction Br, gauss (mT)	Magnetic Properties		
		Original MMPA Class	IEC Brief Designation	IEC Code Reference			Normal Coercive Field Strength, Hc (HcB) oersted (kA/m)	Intrinsic Coercive Field Strength, H _{ci} (H _{cj}) oersted (kA/m)	Relative Recoil Permeability μ_{rec} G/Oe
CE-A-02	...	Ceramic 2	...	...	1.8 (14.3)	2900 (290)	2400 (191)	3000 (239)	1.1
CE-A-05	3.4/2.5	Ceramic 5	Hard ferrite 26/18	S1-1-6	3.40 (27.1)	3800 (380)	2400 (191)	2500 (199)	1.1
CE-A-06	...	Ceramic 6	...	...	2.45 (19.5)	3200 (320)	2820 (225)	3300 (263)	1.1
CE-A-07	2.7/4.0	Ceramic 7	Hard ferrite 20/28	S1-1-2	2.75 (21.9)	3400 (340)	3250 (259)	4000 (318)	1.1
CE-A-08A	3.5/3.1	Ceramic 8A	Hard ferrite 25/12	S1-1-5	3.50 (27.9)	3850 (385)	2950 (235)	3050 (243)	1.1
CE-A-08B	...	Ceramic 8B	...	...	4.12 (32.8)	4200 (420)	2913 (232)	2960 (236)	1.1
CE-A-10	...	Ceramic 10	...	...	3.82 (30.4)	4000 (400)	3510 (280)	3617 (288)	1.1
CE-A-11	...	Ceramic 11	...	...	4.32 (34.4)	4300 (430)	2512 (200)	2560 (204)	1.1
CE-A-21	3.4/3.9	...	...	...	3.40 (27.1)	3800 (380)	3400 (271)	3900 (310)	1.1
CE-A-22	4.0/2.9	...	...	...	4.00 (31.8)	4100 (410)	2800 (223)	2900 (231)	1.1
CE-A-23	3.2/4.8	...	...	...	3.20 (25.5)	3700 (370)	3500 (279)	4800 (382)	1.1
CE-A-24	3.8/4.0	...	...	...	3.80 (30.3)	4000 (400)	3560 (290)	4000 (318)	1.1

^A Designations are XX-Y-ZZZ where:

- XX = material type (CE = ceramic ferrite),
 Y = processing and orientation (I = isotropic (non-oriented), A = anisotropic (oriented)), and
 ZZZ = numeric grade designation.

include some rare earth elements. Chemical compositions listed in the tables are typical and are not guaranteed.

7. Physical and Mechanical Properties

7.1 Typical thermal properties are listed in [Appendix X1](#).

7.2 Typical physical properties are listed in [Appendix X2](#).

7.3 Physical density values are given for information purposes only and are not guaranteed.

7.4 Ceramic magnets are used for their magnetic characteristics. The end-use application should not rely on them for structural purposes due to low tensile and flexural strength. These materials are very brittle, and they chip and break easily.

8. Magnetic Property Requirements

8.1 Magnetic properties are listed in [Tables 1 and 2](#).

8.2 The values of essential magnetic properties listed in the table are specified minimum values at +68F (+20C), determined after magnetizing to full saturation.

8.3 The specified values of magnetic properties are valid only for magnet test specimens with a uniform cross-section along the axis of magnetization. Properties for anisotropic (magnetically oriented) magnets are measured along the axis of preferred orientation.

8.4 Because of the nature of permanent magnet production, magnetic testing of each lot is strongly recommended, especially for applications where the magnet performance is closely specified. Such magnetic property evaluations shall be conducted in the manner described below. Where the magnet shape is not suitable for magnetic testing, a sample shall be cut from the magnet using appropriate slicing and grinding techniques, paying attention to any magnetic orientation within the magnet.

8.4.1 The magnetic properties shall be determined in accordance with Test Method [A977/A977M](#), or by using a suitable, mutually agreed upon magnetometer.

8.4.2 When magnets are being purchased in the fully magnetized condition, the testing shall determine the magnetic properties from the as-received magnetization state, followed

by magnetization to full saturation and testing of the magnetic properties from the fully magnetized condition.

8.4.3 When magnets are being purchased in the unmagnetized condition or in an unknown state of magnetization, the test laboratory shall magnetize the test sample(s) to full saturation and measure the magnetic properties from the fully magnetized condition.

8.4.4 When the magnets are being purchased in a calibrated, stabilized, or “knocked-down” condition, testing should be performed by a method other than Test Method **A977/A977M** to avoid changing the magnetization state of the material. A Helmholtz coil set and fluxmeter are often used to check the open-circuit magnetization of magnets without changing the magnetization state; this is a one-point test which does not fully characterize the magnetic properties but may be a suitable screening tool in production.

9. Workmanship, Finish, and Appearance

9.1 Dimensions and tolerances shall be as specified on the magnet drawing and must be agreed upon between the user and the producer.

9.2 Cracks, porosity, and voids are common in sintered ferrite magnets and shall not in themselves constitute reason for rejection unless agreed upon between user and producer. Allowable defects shall be documented in writing as part of the ordering or contracting process.

9.3 Magnets shall be free of loose chips and surface residue which may interfere with assembly or proper device function.

9.4 Chips shall be acceptable if no more than 5 % of any surface identified as a magnetic pole surface is removed.

9.5 Cracks shall be acceptable provided they do not extend across more than 50 % of any surface identified as a magnetic pole surface.

10. Sampling

10.1 A lot shall consist of parts of the same form and dimensions, produced from a single mixed powder batch or sintering run, or both, from an unchanged process, without discontinuity in production, and submitted for inspection at one time.

10.2 The user and producer shall agree upon a representative number of specimens for testing. Typically, a suitable number of parts, as mutually agreed upon between producer and user, shall be randomly selected from each lot. It is advisable to test a minimum of two parts from each lot, and

more if there is reason to suspect that the magnetic properties are not uniform throughout the lot.

11. Rejection and Rehearing

11.1 Parts that fail to conform to the requirements of this specification shall be rejected. Rejection should be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of the test, the producer may make claim for a rehearing.

11.2 The disposition of rejected parts shall be subject to agreement between the user and the producer.

12. Certification

12.1 When specified in the purchase order or contract, the user shall be furnished certification that samples representing each lot have been either tested or inspected as directed in this specification and that the requirements have been met.

12.2 When specified in the purchase order or contract, a report of the test results shall include:

12.2.1 Grade of material.

12.2.2 Magnetic test results.

12.2.3 The results of any other tests stipulated in the purchase order or contract.

13. Packaging and Package Marking

13.1 Packaging shall be subject to agreement between the user and the producer.

13.2 Parts furnished under this specification shall be in a container identified by the name or symbol of the parts producer.

13.3 Magnetized parts shall be properly labeled as such for safe handling and shipping purposes.

13.3.1 Unless declared as “Dangerous Goods,” magnetized parts to be shipped via aircraft must be packaged in an appropriate manner so the closed shipping container meets the IATA magnetic requirements for air shipment. This may require (1) rearranging the parts within the shipping container, or (2) adding sheets of steel or other magnetically soft shielding material, or both, to reduce the magnetic field external to the shipping container below the required levels.

14. Keywords

14.1 ceramic ferrite; ceramic magnet; coercive field strength; ferrite magnet; hard ferrite; magnetic induction; magnetic properties; permanent magnet; sintered ceramic ferrite; sintered ferrite magnet

APPENDIXES

(Nonmandatory Information)

X1. TYPICAL THERMAL PROPERTIES OF CERAMIC MAGNETS

Reversible temperature coefficient of residual induction	-0.2 %/°C
Reversible temperature coefficient of intrinsic coercive field strength	+0.2 to +0.5 %/°C
Curie temperature	450°C
Maximum exposure temperature without structural change	800°C

X2. TYPICAL PHYSICAL PROPERTIES OF CERAMIC MAGNETS

Density	4.9 to 5.1 g/cm ³ (4.9 to 5.1 × 10 ³ kg/m ³)
Coefficient of thermal expansion	
Perpendicular to magnetic orientation	10 ppm/°C
Parallel to magnetic orientation	14 ppm/°C
Thermal conductivity	0.007 cal/cm-sec°C (2.93 J/m-sec°C)
Electrical resistivity	10 ⁶ ohm-cm (10 ⁴ ohm-m)
Porosity	5 %
Modulus of elasticity	2.5 × 10 ⁷ psi (170 × 10 ⁹ Pa)
Poisson ratio	0.28
Compressive strength	130 000 psi (900 × 10 ⁶ Pa)
Tensile strength	5000 psi (35 × 10 ⁶ Pa)
Flexural strength	9000 psi (62 × 10 ⁶ Pa)
Hardness	7 Mohs

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