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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Classification of magnetic powder cores

Classification des noyaux en poudre magnétique

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CLASSIFICATION OF MAGNETIC POWDER CORES

FOREWORD

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The text of this International Standard is based on the following documents:

Draft	Report on voting
51/1403/CDV	51/1413/RVC

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

CLASSIFICATION OF MAGNETIC POWDER CORES

1 Scope

This document specifies classification rules for metallic magnetic powder cores used in inductive components fulfilling the requirements of the electronics industries.

This document addresses the following objectives for magnetic powder cores suppliers and users:

– cross-reference between core materials from multiple suppliers;
– assistance to users in understanding the published technical data in catalogues when comparing multiple suppliers;
– guidance to users in selecting the most applicable core for each application;
– establishing uniform benchmarks for suppliers for performance in the new development of core material.

The numerical values given in this document are typical values of parameters of the related material. Direct translation from the material specification into the core specification is not always easy or possible.

Every detailed material and core specification will be agreed upon between the user and the supplier.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-221, *International Electrotechnical Vocabulary (IEV) – Part 221: Magnetic materials and components*

IEC 60404-1, *Magnetic materials – Part 1: Classification*

IEC 63300[1], *Test methods for electrical and magnetic properties of magnetic powder cores*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-221, IEC 60404-1 and IEC 63300 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

[1] Under preparation. Stage at the time of publication: IEC CDV 63300:2022.

4 Classification

4.1 General

Magnetic powder cores consist of a basic metallic soft magnetic powder and inorganic or organic electrically insulating additives and binders. The magnetic powder core materials can be divided into some main classes according to the composition and crystal structure of metallic magnetic powder. The relevant main classes are pure iron (Fe) powder, iron-silicon (Fe-Si) powder, iron-silicon-aluminium (Fe-Si-Al) powder, iron-nickel (Fe-Ni) powder, iron-nickel-molybdenum (Fe-Ni-Mo) powder, iron-based amorphous powder (typically Fe-Si-B), and iron-based nanocrystalline (typically Fe-Si-B-Cu-Nb) powder.

The subclassification of powder cores of each material is based on their (effective) initial permeability.

A 060

- 060: Permeability code, e.g. 060 for permeability μ = 60
- A: Powder composition code, I, K, S, H, M, A and N
  - I: Fe
  - K: Fe-Si
  - S: Fe-Si-Al
  - H: Fe-Ni
  - M: Fe-Ni-Mo
  - A: Iron-based amorphous material
  - N: Iron-based nanocrystalline material

Magnetic powder core materials are mainly used for inductive components. The shapes produced include rings, blocks, cylinders, ellipses, E types, EQ types, EER types, U types and pot types. The shape and dimension of the cores shall be determined in the detailed specification.

4.2 Iron powder core materials

4.2.1 Chemical composition

Iron powder cores consist of basic pure iron powder and inorganic or organic electrically insulating additives and binders.

4.2.2 Characteristics

A more complete definition of this material can be based on the following characteristics:

– magnetic: initial permeability, saturation magnetic flux density, DC-bias characteristic, power loss density, temperature coefficient of permeability;

– other: density, mechanical strength, thermal conductivity.

The typical magnetic properties of iron powder core materials are given in Table 1.

Table 1 – Typical magnetic properties of iron powder core materials

Subclasses	Initial permeability	Magnetic flux density at f = 50 Hz, H = 20 kA/m T	DC-bias characteristic [a] at f = 10 kHz, B ≤ 0,5 mT %		Power loss density at f = 50 kHz, B = 25 mT kW/m^3
			H = 8 kA/m	H = 16 kA/m	
I 010	10 × (1 ± 10 %)	≥ 0,26	-	≥ 85	≤ 40
I 035	35 × (1 ± 10 %)	≥ 0,78	-	≥ 50	≤ 70
I 055	55 × (1 ± 10 %)	≥ 1,03	≥ 43	-	≤ 100
I 060	60 × (1 ± 10 %)	≥ 1,30	≥ 40	-	≤ 150
I 075	75 × (1 ± 10 %)	≥ 1,30	≥ 25	-	≤ 150
NOTE The measuring methods for the main magnetic properties are in accordance with IEC 63300.The specimens are ring-cores whose dimensions are Ø 26,9 mm × Ø 14,5 mm × 11,1 mm.					
[a] DC bias characteristic is defined as the ratio of the initial permeability of a magnetic powder core with DC bias magnetic field to that without DC bias magnetic field.					

4.3 Iron-silicon powder core materials

4.3.1 Chemical composition

Iron-silicon powder cores consist of basic iron-silicon powder and inorganic or organic electrically insulating additives and binders.

4.3.2 Characteristics

A more complete definition of this material can be based on the following characteristics:

– magnetic: initial permeability, saturation magnetic flux density, DC-bias characteristic, power loss density, temperature coefficient of permeability;

– other: density, mechanical strength, thermal conductivity.

The typical magnetic properties of iron-silicon powder core materials are given in Table 2.

Table 2 – Typical magnetic properties of iron-silicon powder core materials

Subclasses	Initial permeability	Magnetic flux density at f = 50 Hz, H = 20 kA/m T	DC-bias characteristic [a] at f = 10 kHz, B ≤ 0,5 mT %		Power loss density kW/m^3	
			H = 8 kA/m	H = 16 kA/m	f = 100 kHz, B = 100 mT	f = 500 kHz, B = 20 mT
K 026	26 × (1 ± 8 %)	≥ 0,62	-	≥ 75	≤ 2200	≤ 420
K 040	40 × (1 ± 8 %)	≥ 0,80	-	≥ 63	≤ 1900	≤ 400
K 060	60 × (1 ± 8 %)	≥ 1,03	≥ 67	-	≤ 1700	≤ 400
K 075	75 × (1 ± 8 %)	≥ 1,10	≥ 54	-	≤ 1700	≤ 420
K 090	90 × (1 ± 8 %)	≥ 1,16	≥ 44	-	≤ 1900	≤ 450
NOTE The measuring methods for the main magnetic properties are in accordance with IEC 63300.The specimens are ring-cores whose dimensions are Ø 26,9 mm × Ø 14,7 mm × 11,2 mm.						
[a] DC bias characteristic is defined as the ratio of the initial permeability of a magnetic powder core with DC bias magnetic field to that without DC bias magnetic field.						

4.4 Iron-silicon-aluminum powder core materials

4.4.1 Chemical composition

Iron-silicon-aluminum powder cores consist of basic iron-silicon-aluminum powder and inorganic or organic electrically insulating additives and binders.

4.4.2 Characteristics

A more complete definition of this material can be based on the following characteristics:

– magnetic: initial permeability, saturation magnetic flux density, DC-bias characteristic, power loss density, temperature coefficient of permeability;

– other: density, mechanical strength, thermal conductivity.

The typical magnetic properties of iron-silicon-aluminum powder core materials are given in Table 3.

Table 3 – Typical magnetic properties of iron-silicon-aluminum powder core materials

Subclasses	Initial permeability	Magnetic flux density at f = 50 Hz, H = 20 kA/m T	DC-bias characteristic [a] at f = 10 kHz, B ≤ 0,5 mT %			Power loss density kW/m^3	
			H = 4 kA/m	H = 8 kA/m	H = 16 kA/m	f = 100 kHz, B = 100 mT	f = 500 kHz, B = 20 mT
S 026	26 × (1 ± 8 %)	≥ 0,43	-	-	≥ 48	≤ 1000	≤ 230
S 060	60 × (1 ± 8 %)	≥ 0,71	-	≥ 43	-	≤ 750	≤ 230
S 075	75 × (1 ± 8 %)	≥ 0,77	≥ 58	-	-	≤ 750	≤ 230
S 090	90 × (1 ± 8 %)	≥ 0,79	≥ 51	-	-	≤ 800	≤ 260
S 125	125 × (1 ± 8 %)	≥ 0,85	≥ 38	-	-	≤ 800	≤ 260
NOTE The measuring methods for the main magnetic properties are in accordance with IEC 63300. The specimens are ring-cores whose dimensions are Ø 26,9 mm × Ø 14,7 mm × 11,2 mm.							
[a] DC bias characteristic is defined as the ratio of the initial permeability of a magnetic powder core with DC bias magnetic field to that without DC bias magnetic field.							

4.5 Iron-nickel powder core materials

4.5.1 Chemical composition

Iron-nickel powder cores consist of basic nickel-iron powder and inorganic or organic electrically insulating additives and binders.

NOTE These materials are known in the industry as "high flux".

4.5.2 Characteristics

A more complete definition of this material can be based on the following characteristics:

– magnetic: initial permeability, saturation magnetic flux density, DC-bias characteristic, power loss density, temperature coefficient of permeability;

– other: density, mechanical strength, thermal conductivity.

The typical magnetic properties of iron-nickel powder core materials are given in Table 4.

Table 4 – Typical magnetic properties of iron-nickel powder core materials

Subclasses	Initial permeability	Magnetic flux density at f = 50 Hz, H = 20 kA/m T	DC-bias characteristic [a] at f = 10 kHz, B ≤ 0,5 mT %			Power loss density kW/m^3	
			H = 5 kA/m	H = 8 kA/m	H = 16 kA/m	f = 100 kHz, B = 100 mT	f = 500 kHz, B = 20 mT
H 026	26 × (1 ± 8 %)	≥ 0,55	-	-	≥ 75	≤ 1100	≤ 300
H 060	60 × (1 ± 8 %)	≥ 0,87	-	≥ 70	-	≤ 800	≤ 300
H 125	125 × (1 ± 8 %)	≥ 1,19	≥ 47	-	-	≤ 850	≤ 320
H 147	147 × (1 ± 8 %)	≥ 1,19	≥ 50	-	-	≤ 900	≤ 350
H 160	160 × (1 ± 8 %)	≥ 1,19	≥ 43	-	-	≤ 1100	≤ 380

NOTE The measuring methods for the main magnetic properties are in accordance with IEC 63300. The specimens are ring-cores whose dimensions are Ø 26,9 mm × Ø 14,7 mm × 11,2 mm.

[a] DC bias characteristic is defined as the ratio of the initial permeability of a magnetic powder core with DC bias magnetic field to that without DC bias magnetic field.

4.6 Iron-nickel-molybdenum powder core materials

4.6.1 Chemical composition

Iron-nickel-molybdenum powder cores consist of basic iron-nickel-molybdenum powder and inorganic or organic electrically insulating additives and binders.

NOTE These materials are known in the industry as "MPP" (molypermalloy powder).

4.6.2 Characteristics

A more complete definition of this material can be based on the following characteristics:

– magnetic: initial permeability, saturation magnetic flux density, DC-bias characteristic, power loss density, temperature coefficient of permeability;

– other: density, mechanical strength, thermal conductivity.

The typical magnetic properties of iron-nickel-molybdenum powder core materials are given in Table 5.