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REDLINE VERSION

INTERNATIONAL STANDARD

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Terms and nomenclature for cores made of magnetically soft ferrites – Part 1: Terms used for physical irregularities and reference of dimensions

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INTERNATIONAL
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TERMS AND NOMENCLATURE FOR CORES MADE OF MAGNETICALLY SOFT FERRITES –

Part 1: Terms used for physical irregularities and reference of dimensions

FOREWORD

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International Standard IEC 60401-1 has been prepared by IEC technical committee 51: Magnetic components, ferrite and magnetic powder materials.

This second edition cancels and replaces the first edition of IEC 60401-1 published in 2002 and the second edition of IEC 60401-2 published in 2009. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous editions of IEC 60401-1 and IEC 60401-2:

a) added the surface irregularity term “pores” in 4.3.1.6;
b) added the surface irregularity term “scratch” in 4.3.6.3;
c) removed the surface irregularity term “crater” in 4.1.5 of IEC 60401-1: 2002;
d) removed the bulk irregularity terms “superpores” in 5.1, “inclusions” in 5.2, “internal stratification” in 5.3 and “internal crack” in 5.4 of IEC 60401-1: 2002;
e) removed the contents related to “yoke ring cores” in 7.1.3 and 7.4 of IEC 60401-1:2002;
f) replaced the surface irregularity term “stratification” with “lamination” in 4.3.4.7;
g) replaced the location related terms “upper surface of back” with “bottom surface” and “lower surface of back” with “back surface” in Figure A.1;
h) changed Clause 7 of IEC 60401-1:2002 into Annex A.

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

CDV	Report on voting
51/1313/CDV	51/1332/RVC

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

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

A list of all parts in the IEC 60401 series, published under the general title *Terms and nomenclature for cores made of magnetically soft ferrites* can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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

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TERMS AND NOMENCLATURE FOR CORES MADE OF MAGNETICALLY SOFT FERRITES –

Part 1: Terms used for physical irregularities and reference of dimensions

1 Scope

This part of IEC 60401 provides a nomenclature of the most frequent surface, bulk and shape irregularities relevant to cores made of soft ferrites (magnetic oxides). Most irregularities are graphically exemplified as visual aids. A general recommendation is also given in Annex A for a consistent scheme for specifying the exact location of the irregularity, combining a general name for the location with more detailed qualifiers of the specified location. This document can also be useful as a terminology reference when preparing technical documentation, irregularity inspection specifications, etc.

This document also presents a method for defining the designation nomenclature for the major physical attributes of soft ferrite core shapes. The purpose of this document is to facilitate uniform usage of dimensional characters by manufacturers, specifiers, and users when describing core dimensions on drawings, in tables, and on catalogue specification sheets.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in 4.2, 4.3, 4.5 and Annex A apply.

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

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

4 Physical irregularities

4.1 General overview

Physical irregularities mean here the surface irregularities, bulk irregularities and shape irregularities. The irregularity here stands for inconsistency of the state or quality of the part's surface, bulk or shape with its intended regularity. These irregularities are considered here in the macroscopic scale, i.e. within the range of linear dimensions of irregularities from one micrometre to tens of millimetres.

There is a great variety of surface, bulk and shape irregularities degrading the quality of parts made of ferrites. Different types of these irregularities ~~may~~ can often occur together and overlap one another.

Each type of irregularity is, in general, produced by one or more of the following: ~~an incorrectly or inaccurately performed~~ process variability in a manufacturing step, ~~or improper~~ handling, grinding, packing or transportation.

The extent of the quality degradation is dependent on the type, scale, and combination of irregularities being present as well as on their locations on the part. There are locations particularly sensitive to the degrading effect of the specific types of irregularities.

The irregularities ~~may~~ can in extreme cases ~~give~~ have a detrimental or critical effect ~~to~~ on magnetic, electric and mechanical performances of the part. Operations performed on the part, such as marking, winding, assembling and mounting, can also be adversely affected by the irregularities.

An ongoing tendency to upgrade the overall quality of the parts results in more stringent restrictions being imposed on the quantity of irregularities in these parts.

This brings about a need for a set of definitions, or nomenclature, which would be a primary basis for approaches to irregularities and their location issues.

Therefore, this nomenclature is intended to be used as a uniform reference when formulating more detailed descriptions of irregularities at specified locations, requirements and procedures related to the inspection and assessment of irregularities. This nomenclature can also be useful with regard to methods and tools used for detection, recognition and classification of irregularities.

4.2 General terms for physical irregularities

4.2.1
surface irregularity
unintentional state or appearance of the surfaces, edges and corners of the part

Note 1 to entry: Some surface irregularities, if excessive, can so deform contours and surfaces of the part, that they may also be classified as shape irregularities.

4.2.2
interior irregularity
unintentional inhomogeneity inside the part

4.2.3
shape irregularity
unintentional deformation of the contour lines or surfaces delimiting the shape of the part

Note 1 to entry: In some cases, shape irregularities smaller than quoted tolerances ~~may~~ can still disqualify the part.

~~**3.3**~~
~~**bulk irregularity**~~
~~unintentional inhomogeneity inside the part~~

4.2.4
tolerance
<dimensional> allowable difference between the nominal and permissible limit dimensions of the contour lines defining the part's shape

4.2.5
location
<of the irregularity> position on or within the part where the irregularity is present

4.3 Surface irregularities

4.3.1 Chip irregularities

4.3.1.1
chip
lack of surface material generally caused by mechanical impact during handling or ~~grinding~~ transportation

Note 1 to entry: In almost all cases, chips are located on the edges of surfaces.

~~According to specific locations, the chips are sub-classified:~~

4.3.1.2
surface chip
chip located only on the core surface

SEE: Figure 1.

Figure 1 – Surface chip

4.3.1.3
edge chip
chip located only on the core edge

SEE: Figure 2.

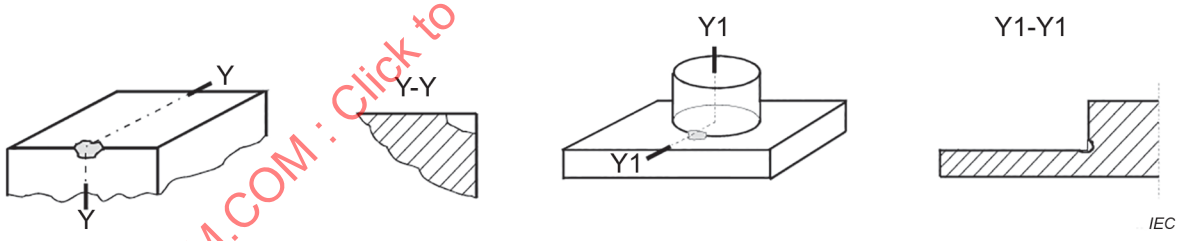


Figure 2 – Edge chip

4.3.1.4
corner chip
chip located only in a corner

SEE: Figure 3.

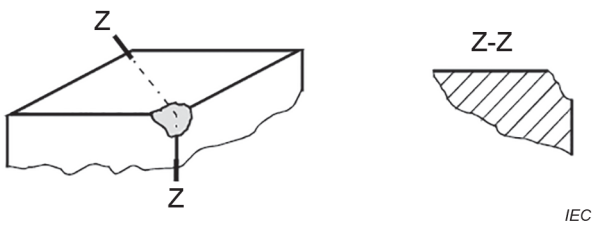


Figure 3 – Corner chip

4.3.1.5
pull-out
consequence of the removal of the surface layer of the core due to die “sticking”, which occurs on surfaces perpendicular to the direction of the pressing action

Note 1 to entry: A pull-out with a depth greater than 1 mm should be considered as a chip.

SEE: Figure 4.

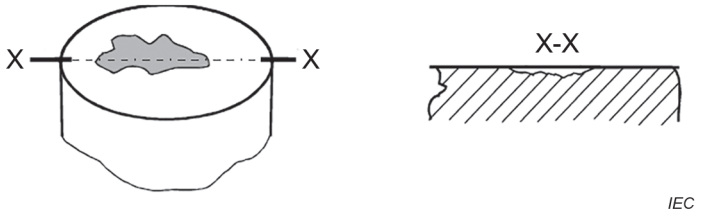
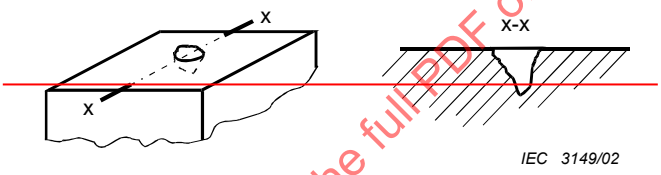


Figure 4 – Pull-out

~~**4.1.5**~~
~~**crater**~~
~~blind hole with depth comparable to or greater than its diameter~~



4.3.1.6
pore
hole left on the surface of cores after sintering and surface finishing

SEE: Figure 5.

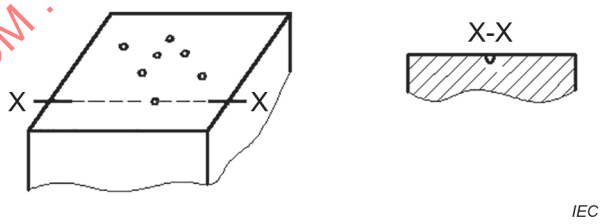


Figure 5 – Pores

4.3.2 Protruding (convex) irregularities

4.3.2.1
hump
elevation of a rounded contour on the relevant surface

SEE: Figure 6.

Figure 6 – Hump

4.3.2.2
attached particle
any particle on the surface which cannot be removed by compressed-air, cleaning, washing or wiping

SEE: Figure 7.

Figure 7 – Attached particle

4.3.2.3
inclusion
millimetre or sub-millimetre-sized foreign body located in the surface of the part ~~(refer to 5.2)~~

4.3.3 Edge irregularities

4.3.3.1
ragged edge
edge affected by a series of small chips

SEE: Figure 8.

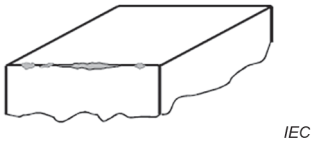


Figure 8 – Ragged edge

4.3.3.2
flash
sharp feather-edge wall extending beyond the intended contour surface of the core

SEE: Figure 9.

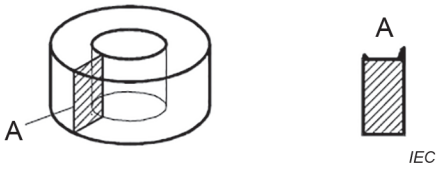


Figure 9 – Flash

4.3.4 Crack irregularities

4.3.4.1
crack
surface irregularity which has a width much smaller than its length and penetrates into the core

~~Specific types of 'cracks' can be sub-classified:~~

4.3.4.2
single-surface narrow crack
crack located on a single surface, not going beyond its edges, and with a width not exceeding a specified limit (e.g. 0,1 mm) anywhere along the crack path on the surface

SEE. Figure 10.

Figure 10 – Single-surface narrow crack

4.3.4.3
single-surface broad crack
crack located on a single surface, not going beyond its edges, and with a width equal to or exceeding the limit specified for the narrow crack anywhere along the crack path on the surface

SEE. Figure 11.

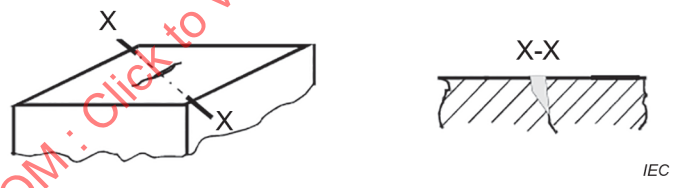


Figure 11 – Single-surface broad crack

4.3.4.4
edge narrow crack
crack located on two adjacent surfaces and crossing their common edge, with a width not exceeding a specified limit (e.g. 0,1 mm) anywhere along the crack path on these surfaces

SEE: Figure 12.

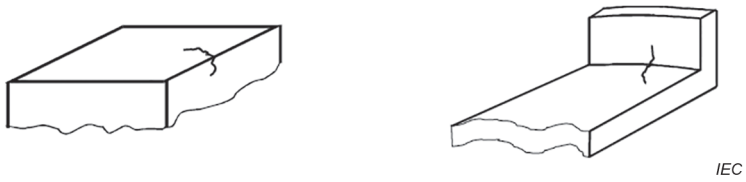


Figure 12 – Edge narrow crack

4.3.4.5
edge broad crack
crack located on two adjacent surfaces and crossing their common edge, with a width equal to or exceeding the limit specified for the narrow crack anywhere along the crack path on these surfaces

SEE: Figure 13.

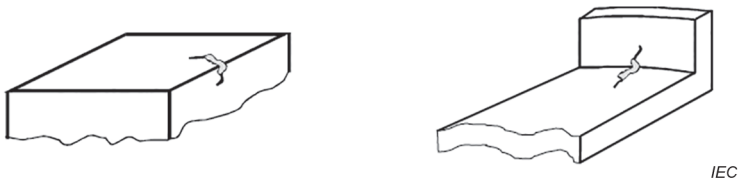


Figure 13 – Edge broad crack

4.3.4.6
inner channel crack
narrow or broad crack along an inner edge of the core

SEE. Figure 14.

Figure 14 – Inner channel crack

4.3.4.7
~~stratification~~ lamination
series of cracks located side by side which are more or less parallel, or single crack, which runs along a significant portion (e.g. 20 %) of the periphery of the part

Note 1 to entry: ~~Stratification~~ Lamination is usually positioned transversely to the direction of the pressing of the core.

SEE: Figure 15.

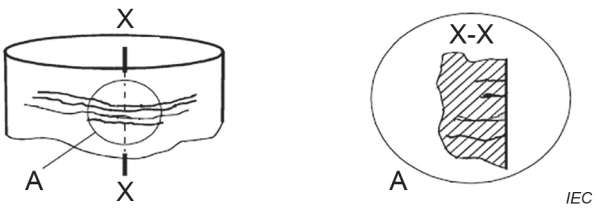


Figure 15 – Lamination

4.3.4.8
crazing
grid-like pattern of superficial cracks of a depth not exceeding a specified limit (e.g. 0,3 mm)

SEE: Figure 16.

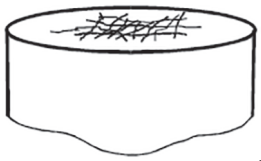


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Figure 16 – Crazing

4.3.5 Colour irregularities

4.3.5.1
difference in colour tone
slight but visible local change(s) in the tint of the natural colour or shading of an area of a surface from the surrounding background

SEE: Figure 17.

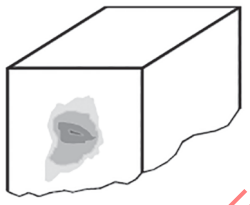

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Figure 17 – Difference in colour tones

4.3.5.2
discoloration
visible difference in the colours of an area of a surface from the normal uniform colour background

SEE: Figure 18.

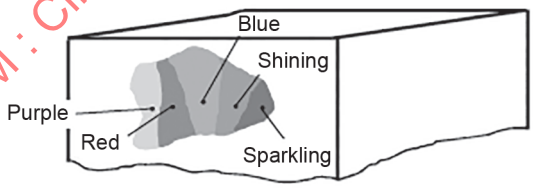

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Figure 18 – Discoloration

4.3.5.3
stain
smear of oil, grease, or other substance ~~etc.~~ or deposit (e.g. whitish or water marks) on the surface

SEE: Figure 19.

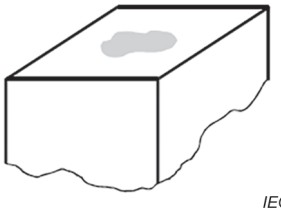


Figure 19 – Stain

4.3.5.4
crystallite
grain of abnormal size distinguishable on the surface, often with sparkling facets

SEE: Figure 20.

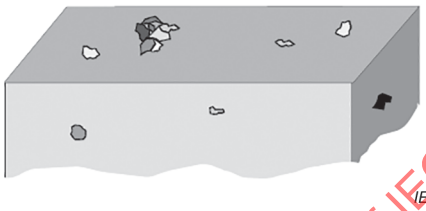
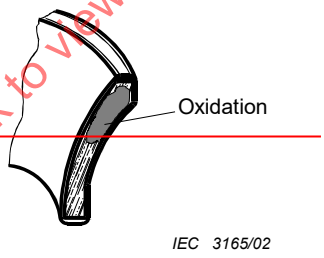


Figure 20 – Crystallite

~~**4.5.5**~~
~~**oxidation of split surfaces**~~
~~part of split (detached, crashed, etc.) surface which is oxidized~~



4.3.6 Machining-related irregularities

4.3.6.1
roughness
uneven~~, not smooth~~ rough surface ~~including~~ which includes traces from grinding, abrasives, etc.

SEE: Figure 21.

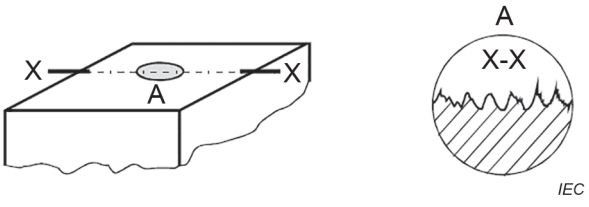


Figure 21 – Roughness

4.3.6.2
short-ground surface
part of surface which unintentionally remains un-ground after grinding, with no steplike surface irregularities

Note 1 to entry: See 4.5.3.1.

SEE: Figure 22.

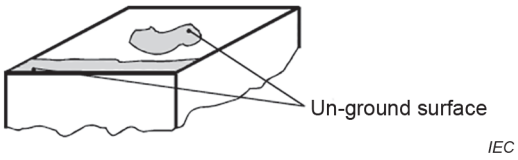


Figure 22 – Short-ground surface

4.3.6.3
scratch
one or more scrapes caused by the handling process

SEE: Figure 23.

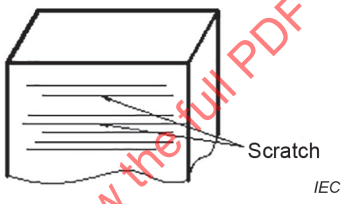


Figure 23 – Scratch

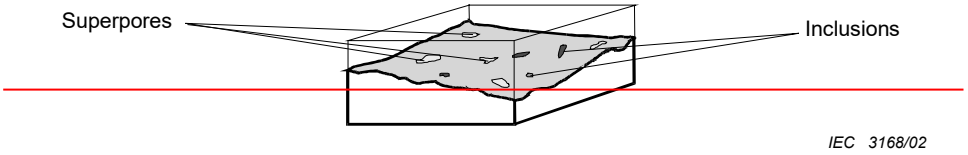
4.4 Interior irregularities

Since inclusions, cracks or lamination that is confined to the inside of a part cannot be detected by direct inspection except with destructive or expensive procedures, control of bulk irregularities is maintained through break strength testing. Small sample sizes from production batches are destructively broken with M testing, W testing, or tensile pull testing. The yield strength is recorded and compared with specification limits or control limits. Further, internal irregularities that cause electrical performance to be impaired are detected by means of testing against the electrical specifications.

~~5 Bulk irregularities~~

~~**5.1**~~
~~**superpores**~~
~~pores being millimetre-sized voids~~

~~**5.2**~~
~~**inclusions**~~
~~millimetre or sub-millimetre-sized foreign bodies located inside cores~~

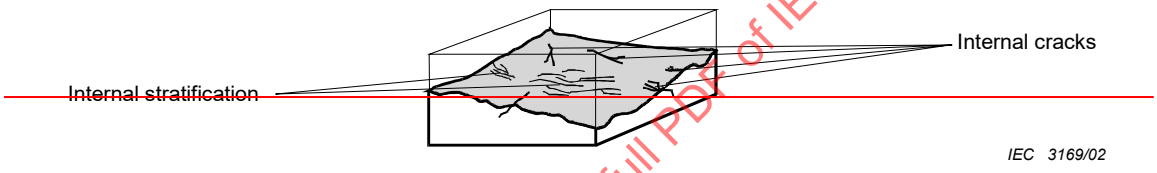


~~NOTE An inclusion, if it appears on the surface of the part, is also considered as the surface irregularity (see 4.2.3).~~

~~**5.3**~~
~~**internal stratification**~~
~~stratum shaped material discontinuity located inside the core and not always extending to the surface; usually narrow but sometimes of an extensive area~~

~~NOTE The internal stratification caused by the improper press of the material is usually positioned transversely to the direction of pressing.~~

~~**5.4**~~
~~**internal crack**~~
~~crack shaped material discontinuity inside the core not always extending to the surface; usually narrow but sometimes of an extensive length~~



4.5 Shape irregularities (deformations)

4.5.1 Non-flat irregularities

4.5.1.1
convexity
~~outwards~~ outwardly curved outline or surface

SEE: Figure 24.

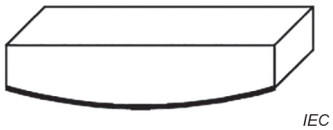


Figure 24 – Convexity

4.5.1.2
concavity
~~inwards~~ inwardly curved outline or surface

SEE: Figure 25.

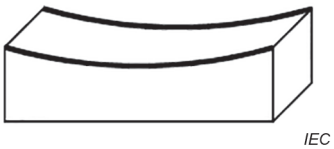


Figure 25 – Concavity

4.5.1.3
warping
state of a shape with twisted surface(s)

SEE: Figure 26.

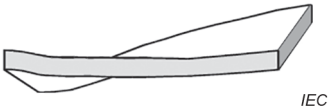


Figure 26 – Warping

4.5.1.4
bending
deflection, curved or angular, from any direction that is regarded as the intended ~~one~~ deflection

~~Three different kind of deflections as follows:~~

4.5.1.4.1
deflection-out
state of being more or less inclined to the outside from the perpendicular or from another intended inclination

Note 1 to entry: This is also called "toe-out".

SEE: Figure 27.

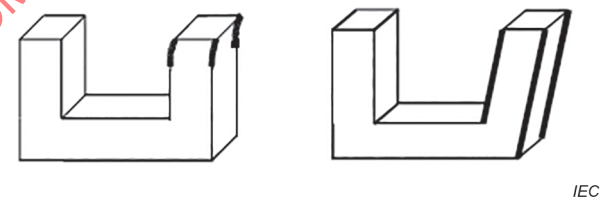


Figure 27 – Deflection-out

4.5.1.4.2
deflection-in
state of being more or less inclined to the inside from the perpendicular or from another intended inclination

Note 1 to entry: This is also called "toe-in".

SEE: Figure 28.

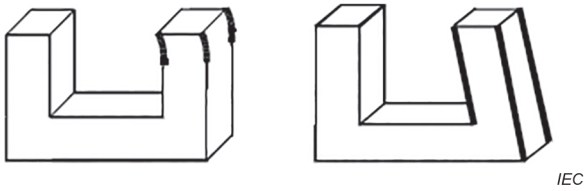


Figure 28 – Deflection-in

4.5.1.4.3
transverse deflection
state of being more or less inclined or twisted transversely to the reference surface

SEE: Figure 29.

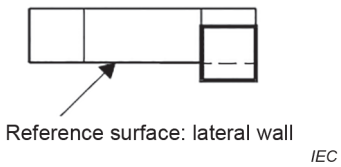


Figure 29 – Transverse deflection

4.5.1.5
undulation
upwards and downwards bending of the outline or surface

SEE: Figure 30.

Figure 30 – Undulation

4.5.2 Simple geometry irregularities

4.5.2.1
non-parallelism
deviation from being parallel of two or more lines, planes or surfaces including the deviation from their intended equidistance

SEE: Figure 31.

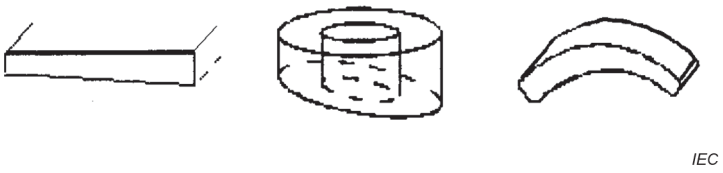


Figure 31 – Non-parallelism

4.5.2.2
non-perpendicularity
deviation from the right angle

SEE: Figure 32.

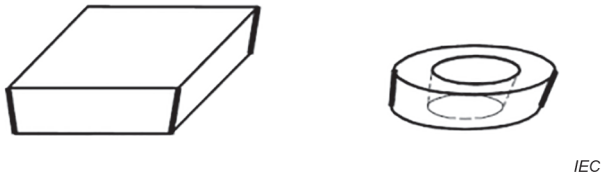


Figure 32 – Non-perpendicularity

4.5.2.3
non-coplanarity
deviation from belonging to the same plane

SEE: Figure 33.

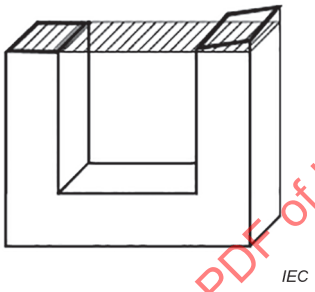


Figure 33 – Non-coplanarity

4.5.2.4
non-circularity
deviation from the shape of a circle

SEE: Figure 34.

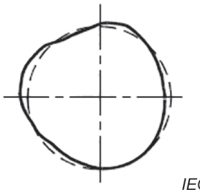


Figure 34 – Non-circularity

4.5.2.5
ovality
deviation from the shape of a circle to an oval or egg-shape

SEE: Figure 35.

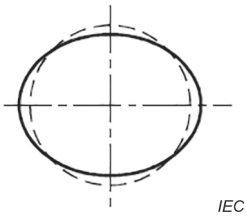


Figure 35 – Ovality

4.5.2.6
non-concentricity
shift between the centres of circles, arcs, or sectors~~, etc. intended~~ which are supposed to have a common centre

~~One distinguishes the following:~~

4.5.2.6.1
non-concentricity of co-planar circles
non-concentricity of circles lying on the same plane

Note 1 to entry: In such a case, the axes of circles are parallel.

SEE: Figure 36.

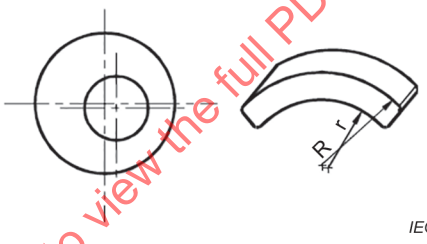
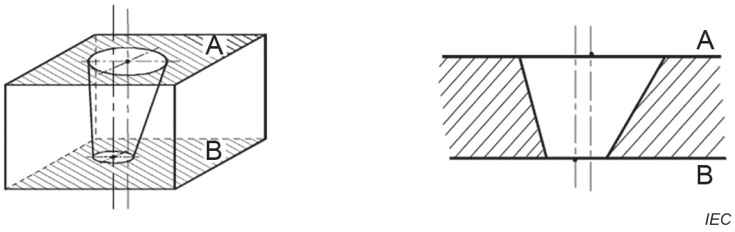


Figure 36 – Non-concentricity of co-planar circles

4.5.2.6.2
non-concentricity of circles lying on two planes
non-concentricity of circles lying on two planes situated one above the other

SEE: Figure 37.



NOTE Planes A and B ~~may~~ can be non-parallel (see 4.5.2.1). In such a case, the axes of the circles are mutually twisted.

Figure 37 – Non-concentricity of circles lying on two planes

4.5.3 Grinding related irregularities

4.5.3.1
steplike ground surface
step caused by a partial grinding of the surface intended to be ground with no step remainder

SEE: Figure 38.

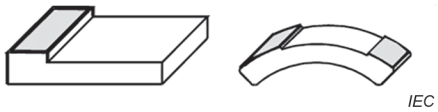


Figure 38 – Steplike ground surface

4.5.3.2
uneven grinding slant
non-coplanar ground surface

SEE: Figure 39.

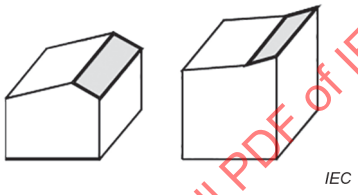


Figure 39 – Uneven grinding slant

4.5.4 Other shape irregularities

4.5.4.1
un-matching
incomplete overlap or misalignment of mating parts, surfaces, dimensions, etc., in parts which have to be joined or paired

SEE: Figure 40.

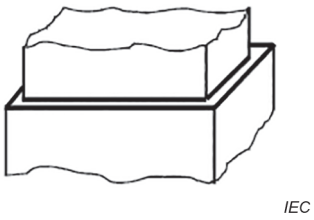


Figure 40 – Un-matching

4.5.4.2
profile deformation
deformation from the intended profile outline

SEE: Figure 41.

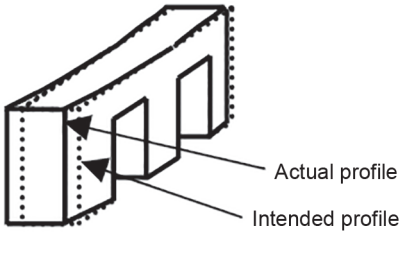


Figure 41 – Profile deformation

5 Reference of dimensions

5.1 General specifications

Only upper case alphabetic character assignments shall be used.

Only one character per dimension and per ferrite piece shall be used.

Characters 2B and 2D shall be used for core sets such as EP, PQ, pot and RM.

Subscripts (e.g. F_1 and F_2 for planar EL- and EFD-cores) may be used.

5.2 Dimension descriptions

Table 1 and Table 2 describe the alphabetic character assignments for the major dimensions of ring-cores and other ferrite shapes, respectively. All other minor core dimensions designations are left to the discretion of the specifier.

Table 1 – Ring-core dimension designations

Letter	Dimension description
A	Ring outside diameter
B	Ring inside diameter
C	Ring height

Table 2 – Other ferrite shape dimension designations

Letter	Dimension description
A	Overall length of the core back or diameter
B	Outside leg length or height of core
C	Core width or floor width at wire aperture
D	Inside leg length or available bobbin depth
E	Window width or available bobbin width
F	Centre post thickness or diameter
G	Wire aperture or slot width
H	Centre post hole diameter
J	RM-core side-to-side parallel width or PQ floor angle opening
K	Centre post offset dimension
L	PQ floor angle separation
S	Slot width in outside legs
T	Distance between slot depths in outside legs

5.3 Core illustrations

Figure 42 through Figure 60 represent typical core geometries with the standard dimension nomenclature applied.

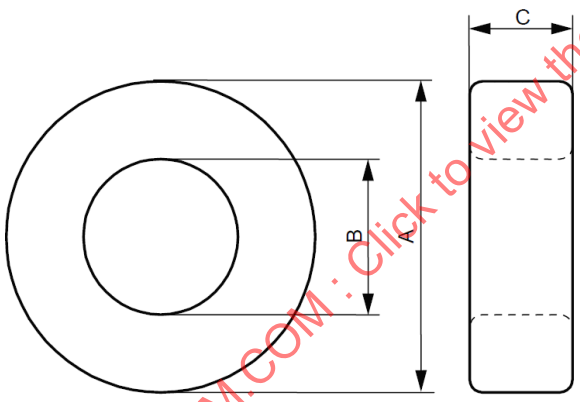


Figure 42 – Ring-core

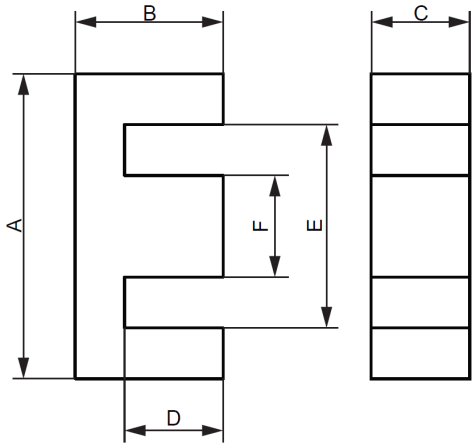


Figure 43 – E-core

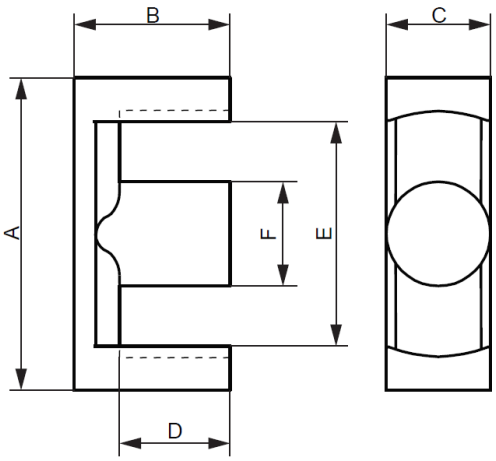


Figure 44 – ETD- or EER-core

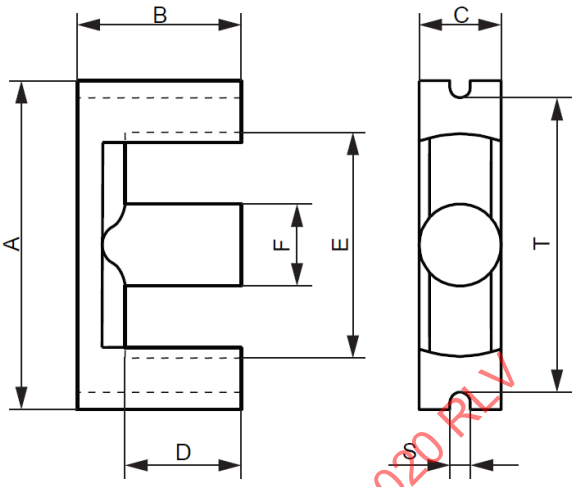


Figure 45 – EC-core

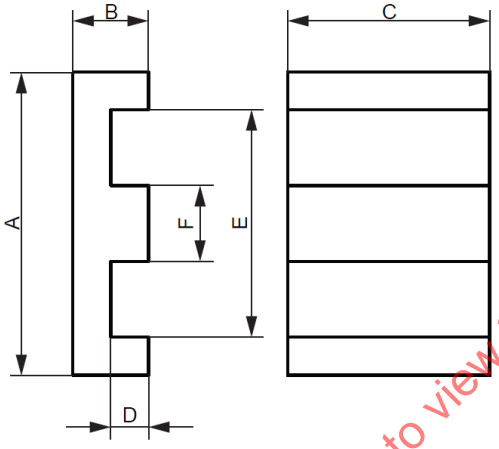


Figure 46 – Planar E-core

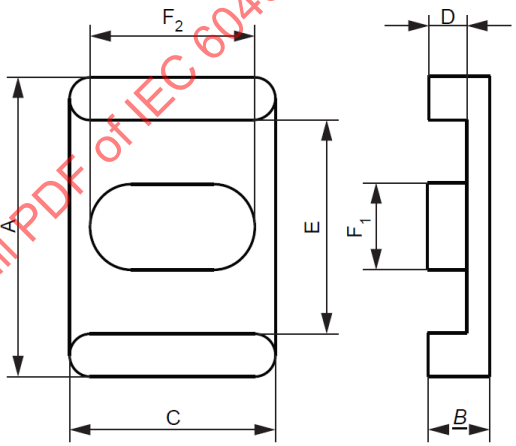


Figure 47 – Planar EL-core

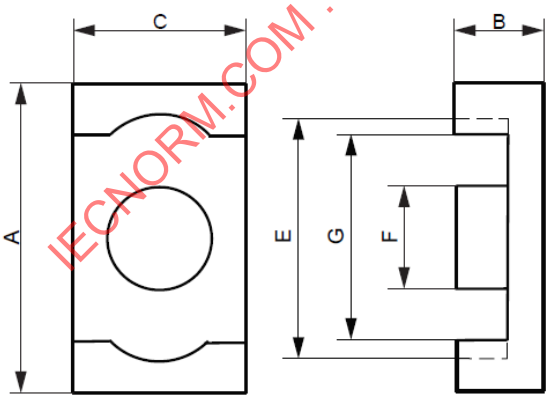


Figure 48 – Planar ER-core

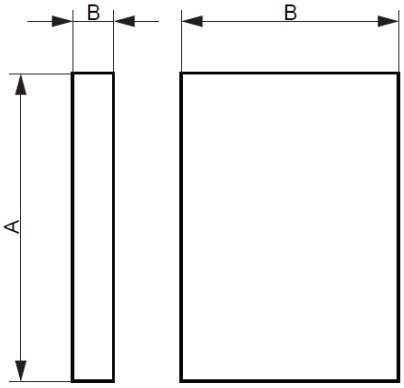


Figure 49 – Plate-core mating planar cores

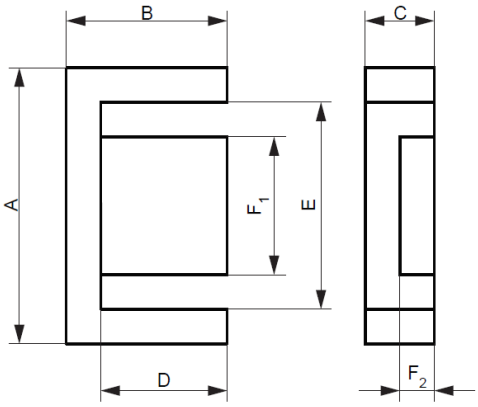


Figure 50 – EFD-core

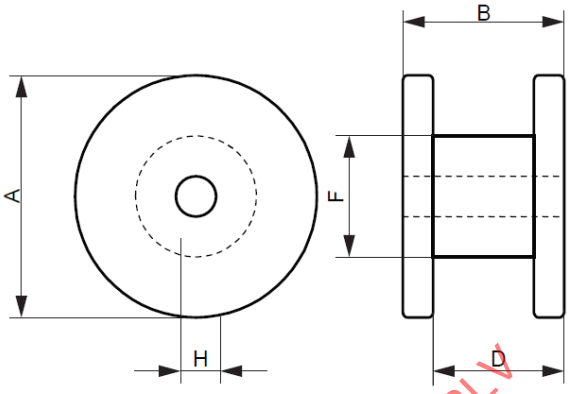


Figure 51 – Drum-core

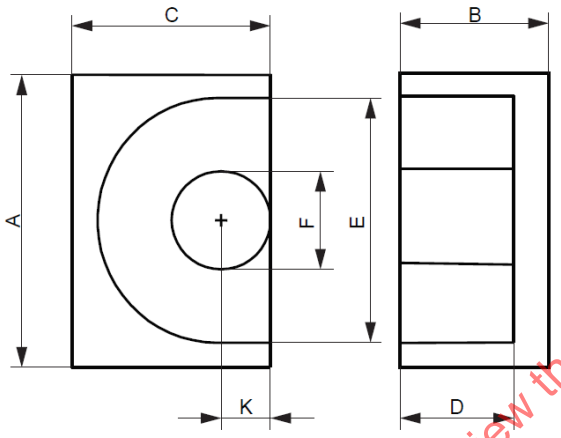


Figure 52 – EP-core

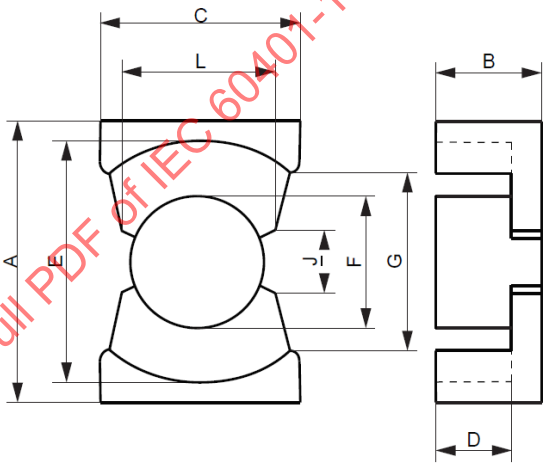


Figure 53 – PQ-core

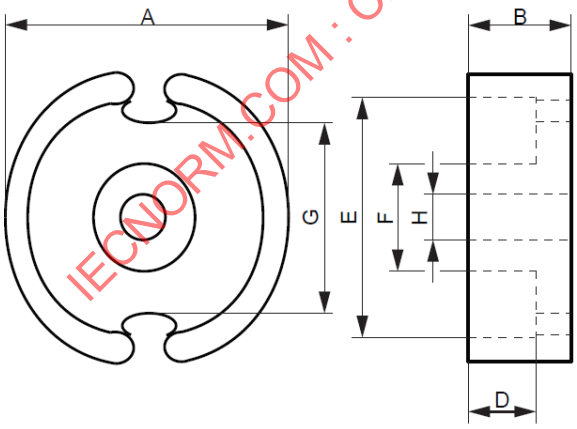


Figure 54 – Pot-core and half pot-core for inductive proximity switches

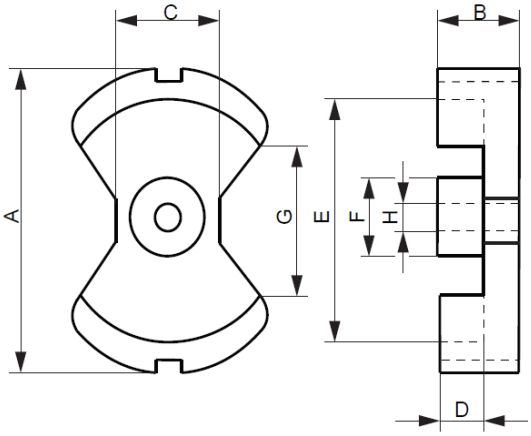


Figure 55 – PM-core

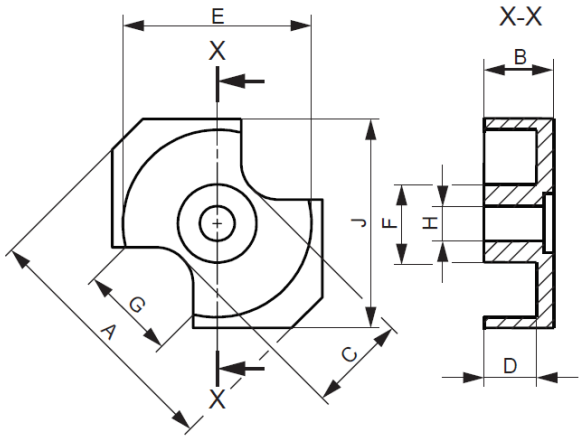


Figure 56 – RM-core

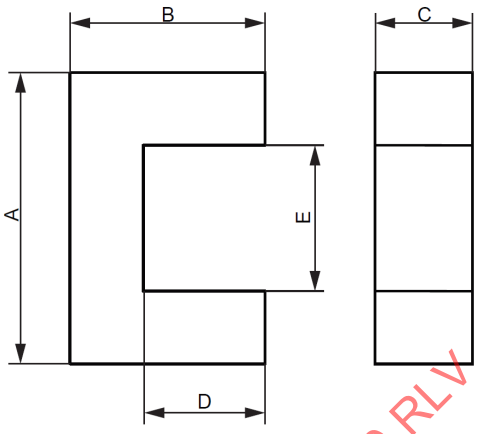


Figure 57 – U-core

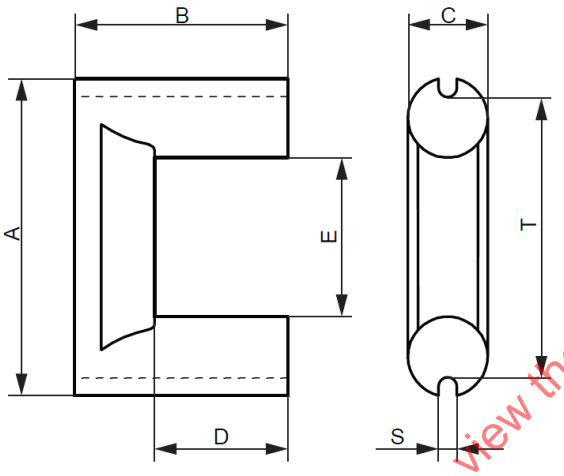


Figure 58 – UR-core

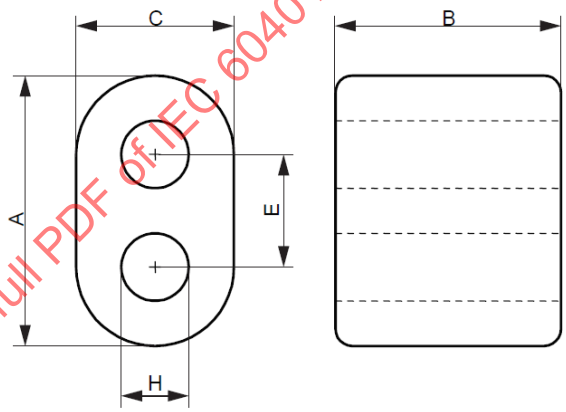


Figure 59 – Balun-core

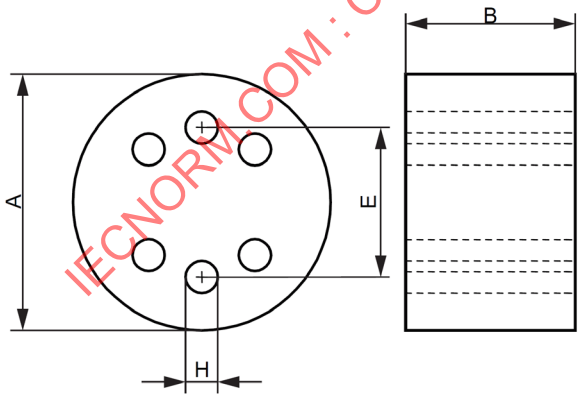


Figure 60 – Multi hole bead

Annex A
(informative)

Location related terms

A.1 General

Location is directly related to the shape geometry of the part by such shape determiners as surfaces, contours, edges, etc. However, a specific state or function (additional attributes) of some locations means that their names, in practical use, are not only related to the shape geometry but also to the additional attribute such as, for example, ground or un-ground (surface).

A.2 Surfaces

A.2.1
ground surface
surface which has been made smoother by grinding, polishing or lapping

A.2.2
un-ground surface
surface not subjected to any smoothing process(es)

A.2.3
mating surface
~~surface intended to be crossed by the main magnetic flux (leakage flux excluded) guided by the magnetic core~~

location where part halves meet (or nearly meet except for an intentional air gap) to form a part set (e.g. EI-core, E-core, U-core, pot-core), and where the main magnetic flux (leakage flux excluded) is guided by the magnetic core to cross the surfaces that so meet

Note 1 to entry: The mating surface is the magnetically active surface.

Note 2 to entry: The quality of the magnetically active surface is one of the crucial factors affecting locally the direction and value of the magnetic flux crossing that surface.

Note ~~2~~3 to entry: Mating surfaces are usually ground, especially in cases where it is essential that the magnetic flux crossing these surfaces runs as intended.

Note ~~3~~4 to entry: Magnetic cores forming a closed magnetic circuit with no air-gap (i.e. non-cut cores such as ring cores, non-cut E- or U-cores), being magnetized along that circuit, have no magnetically active surfaces. Nevertheless, irregularities ~~may~~ can also affect the performance of such cores (e.g. cracks ~~may~~ can extend the main magnetic flux beyond the core surface, contributing to flux leakage).

~~NOTE 4 Mating surfaces are adjacent parts or halves of a part which meet to form a part set (e.g. EI-core, pot-core, E-core, U-core, split halves of a yoke ring core, surfaces of air-gap).~~

A.2.4
magnetically passive surfaces
other surfaces than active surfaces

~~Within the passive surfaces one distinguishes the following ones:~~

A.2.4.1
wall
more or less vertical inner or outer surface, with sides from the top and bottom, back and front, between two ends

~~**7.1.4.2**~~
~~**upper and lower, back and front surfaces**~~
~~usually horizontal surfaces of a part~~

A.2.4.2
bottom surface
interior plane of the back wall, facing the coil

A.2.4.3
back surface
lower base surface which serves as a reference plane for grinding the mating surface

Note 1 to entry: Irregularities on magnetically passive surfaces can also affect performance of the magnetic cores.

A.3 Shape

A.3.1
profile
line or surface outlining the shape, usually projected on a plane, if not specified otherwise

A.3.2
edge
line between two adjacent surfaces (outer or inner) where a sudden change of slope occurs

A.3.3
corner
point at which three or more surfaces (outer or inner) meet

A.3.4
ridge
elevation on a surface of a recess groove (used to fix a clip) ~~etc.~~

~~**7.3 Inside**~~

~~**7.3.1**~~
~~**inside**~~
~~the bulk within the interior of the part~~

~~NOTE Term related only to the bulk irregularities.~~

A.4 Specific parts location qualifiers

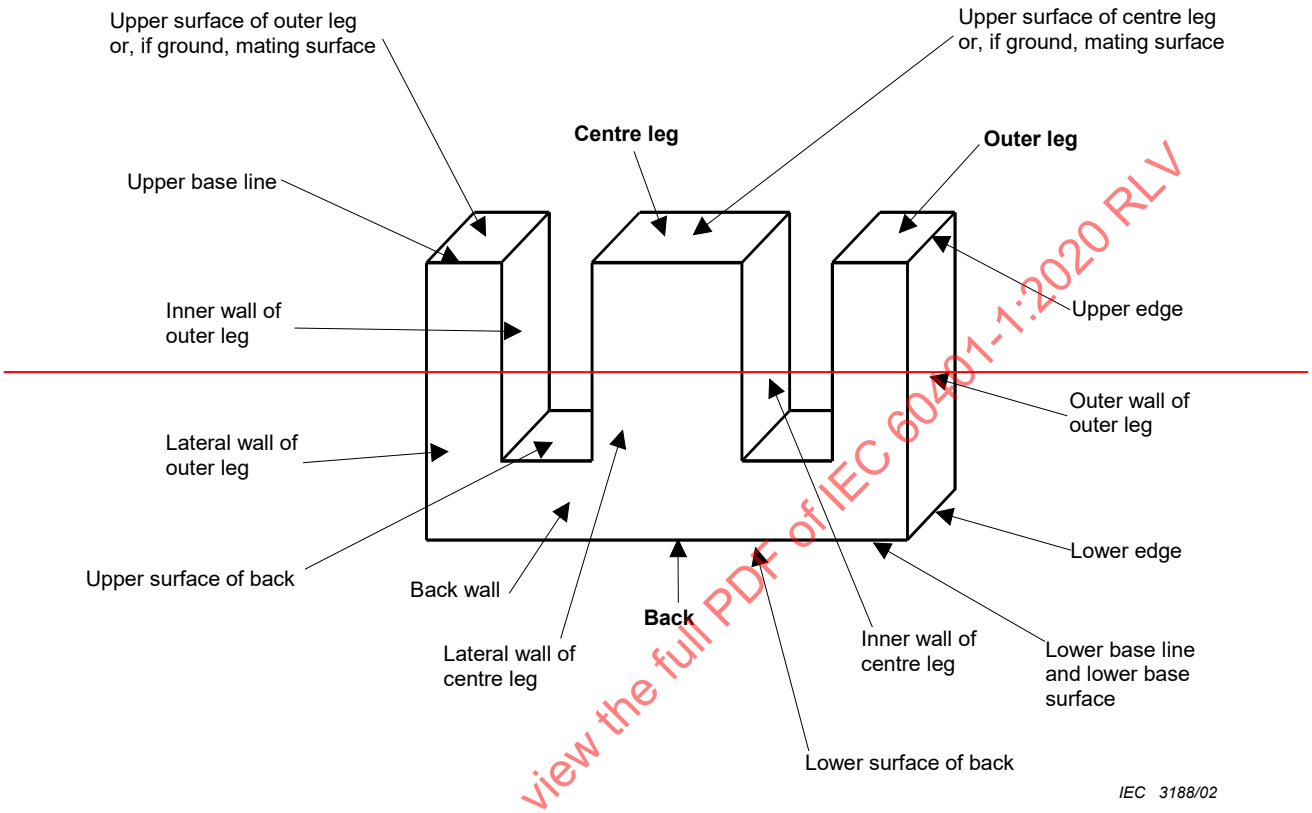
As a rule, the shape determiners such as the surfaces, contours, edges, etc., are further qualified by adding more precise qualifying words, usually related to a specific geometry (shape) of the part and/or with the location where the specified irregularity has to be examined. Often these surfaces, walls and their qualifiers are termed according to custom. Nevertheless, it is recommended to follow, as far as possible, the terminology proposed here which is aimed at a more precise and unified classification linking the irregularities with their locations in specific types of parts. Moreover, to avoid any ambiguity, the given locations should be distinctly indicated on a relevant drawing of the concerned part.

~~Examples of such more precise terminology are:~~

~~upper surface of back (of U-core); lateral wall of outer leg (of E-core); outer circular wall (of pot-core…); back flange wall (of yoke ring core), foot, bevelled wall, end wall (in segment) etc.~~

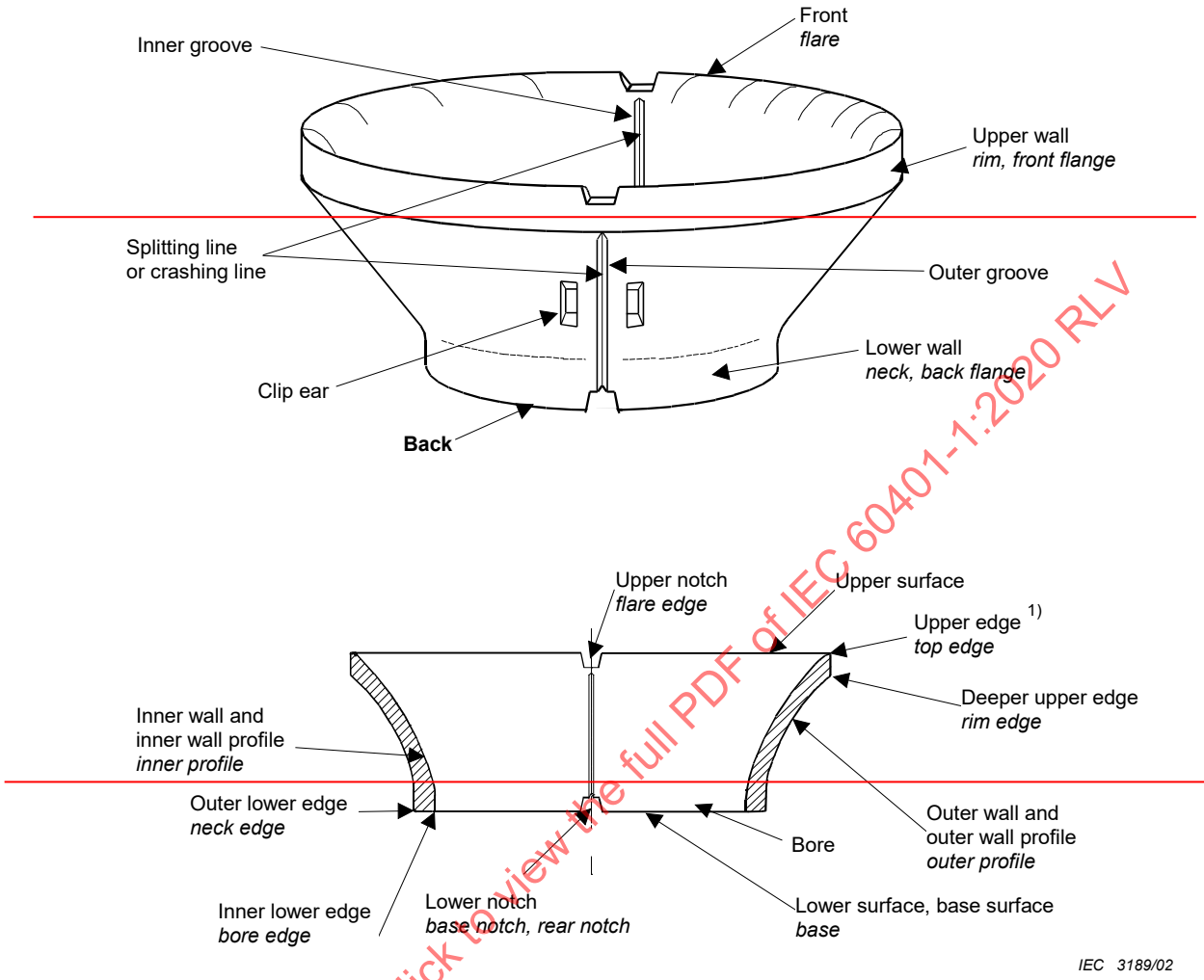
~~Examples of the use of location qualifiers for the case of E-core, yoke ring core and RM-core are given below.~~

~~EXAMPLE 1 – E-core~~



~~NOTE The term "centre pole" shall be used when the cross-section of the centre leg is round.~~

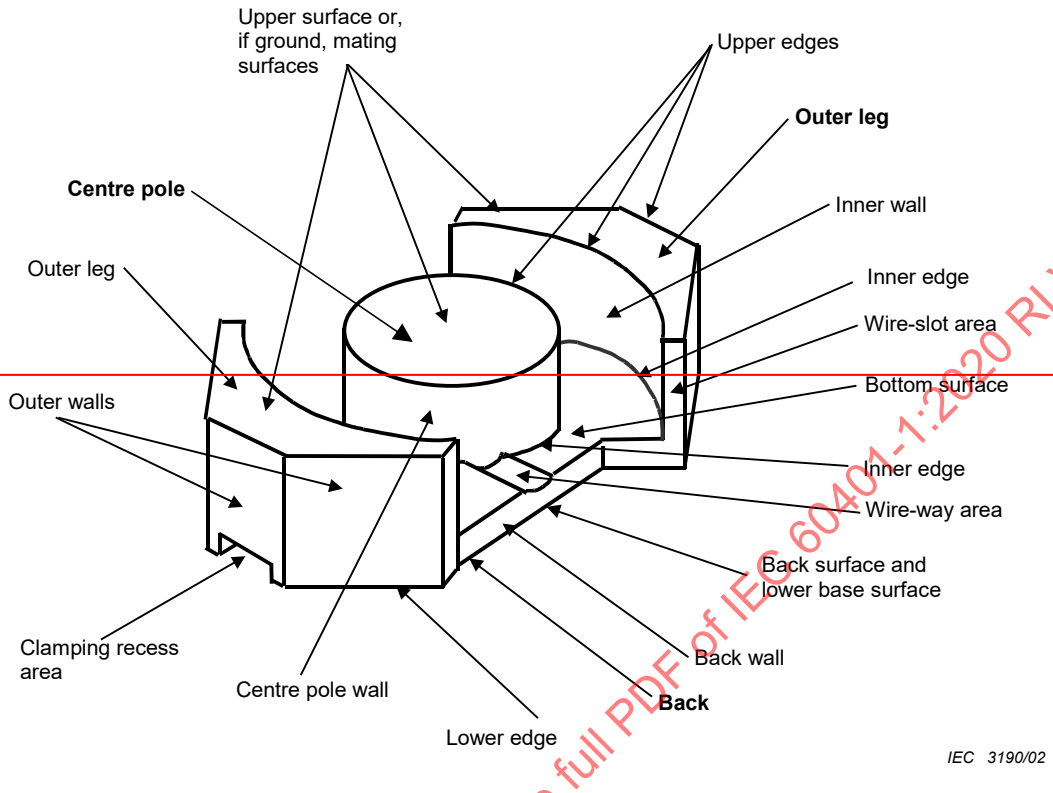
~~EXAMPLE 2 – Yoke ring core~~



~~NOTE This example illustrates the case of a complicated shape (yoke ring core) when the recommended (in 7.1 and 7.2) and accustomed (in italics) location qualifiers are both in alternative use.~~

~~1)~~ ~~Upper edge can be rounded, bevelled or softly pointed.~~

~~Example 3 – RM-core~~

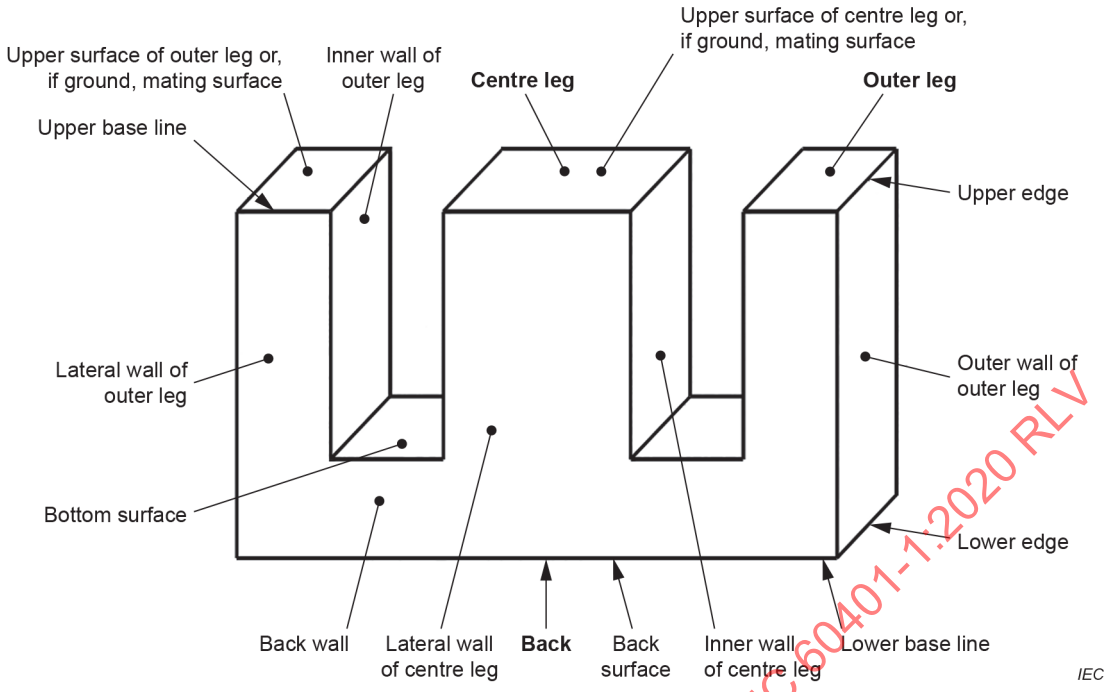


~~NOTE The term "centre leg" shall be used when cross-section of centre leg is square.~~

Examples of such more precise terminology are:

- bottom surface (of U-core);
- lateral wall of outer leg (of E-core);
- outer circular wall (of pot-core), etc.

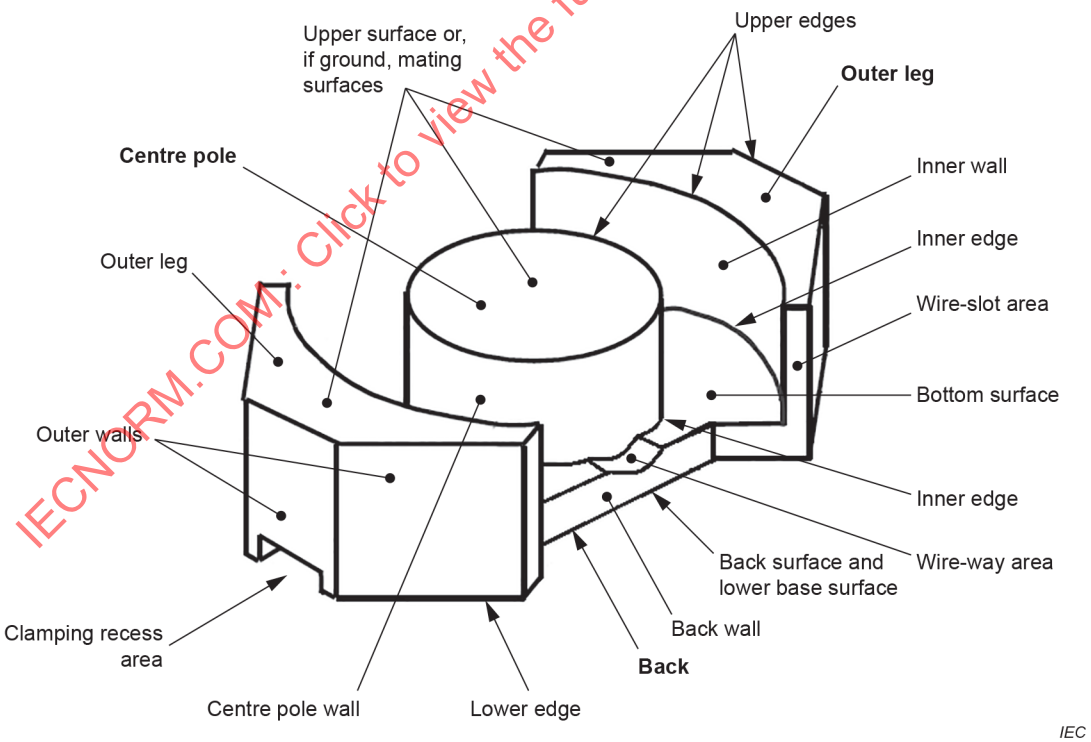
Examples of the use of location qualifiers for the cases of an E-core and an RM-core are given in Figure A.1 and Figure A.2.



The term “centre pole” shall be used when the cross-section of the centre post is round.

The term “back” means the three-dimensional area enclosed with the bottom surface, back surface and two back walls.

Figure A.1 – E-core



The term “centre leg” shall be used when cross-section of centre post is square.

The term “back” means the three-dimensional area enclosed with the bottom surface, back surface and two back walls.

Figure A.2 – RM-core

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Edition 2.0 2020-04

INTERNATIONAL STANDARD

Terms and nomenclature for cores made of magnetically soft ferrites – Part 1: Terms used for physical irregularities and reference of dimensions

IEC 60401-1:2020-04(en)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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TERMS AND NOMENCLATURE FOR CORES MADE OF MAGNETICALLY SOFT FERRITES –

Part 1: Terms used for physical irregularities and reference of dimensions

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International Standard IEC 60401-1 has been prepared by IEC technical committee 51: Magnetic components, ferrite and magnetic powder materials.

This second edition cancels and replaces the first edition of IEC 60401-1 published in 2002 and the second edition of IEC 60401-2 published in 2009. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous editions of IEC 60401-1 and IEC 60401-2:

a) added the surface irregularity term "pores" in 4.3.1.6;
b) added the surface irregularity term "scratch" in 4.3.6.3;
c) removed the surface irregularity term "crater" in 4.1.5 of IEC 60401-1: 2002;

d) removed the bulk irregularity terms “superpores” in 5.1, “inclusions” in 5.2, “internal stratification” in 5.3 and “internal crack” in 5.4 of IEC 60401-1: 2002;

e) removed the contents related to “yoke ring cores” in 7.1.3 and 7.4 of IEC 60401-1:2002;

f) replaced the surface irregularity term “stratification” with “lamination” in 4.3.4.7;

g) replaced the location related terms “upper surface of back” with “bottom surface” and “lower surface of back” with “back surface” in Figure A.1;

h) changed Clause 7 of IEC 60401-1:2002 into Annex A.

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

CDV	Report on voting
51/1313/CDV	51/1332/RVC

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

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

A list of all parts in the IEC 60401 series, published under the general title *Terms and nomenclature for cores made of magnetically soft ferrites* can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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

TERMS AND NOMENCLATURE FOR CORES MADE OF MAGNETICALLY SOFT FERRITES –

Part 1: Terms used for physical irregularities and reference of dimensions

1 Scope

This part of IEC 60401 provides a nomenclature of the most frequent surface, bulk and shape irregularities relevant to cores made of soft ferrites (magnetic oxides). Most irregularities are graphically exemplified as visual aids. A general recommendation is also given in Annex A for a consistent scheme for specifying the exact location of the irregularity, combining a general name for the location with more detailed qualifiers of the specified location. This document can also be useful as a terminology reference when preparing technical documentation, irregularity inspection specifications, etc.

This document also presents a method for defining the designation nomenclature for the major physical attributes of soft ferrite core shapes. The purpose of this document is to facilitate uniform usage of dimensional characters by manufacturers, specifiers, and users when describing core dimensions on drawings, in tables, and on catalogue specification sheets.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in 4.2, 4.3, 4.5 and Annex A apply.

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

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

4 Physical irregularities

4.1 General overview

Physical irregularities mean here the surface irregularities, bulk irregularities and shape irregularities. The irregularity here stands for inconsistency of the state or quality of the part's surface, bulk or shape with its intended regularity. These irregularities are considered here in the macroscopic scale, i.e. within the range of linear dimensions of irregularities from one micrometre to tens of millimetres.

There is a great variety of surface, bulk and shape irregularities degrading the quality of parts made of ferrites. Different types of these irregularities can often occur together and overlap one another.

Each type of irregularity is, in general, produced by one or more of the following: process variability in a manufacturing step, handling, grinding, packing or transportation.

The extent of the quality degradation is dependent on the type, scale, and combination of irregularities being present as well as on their locations on the part. There are locations particularly sensitive to the degrading effect of the specific types of irregularities.

The irregularities can in extreme cases have a detrimental or critical effect on magnetic, electric and mechanical performances of the part. Operations performed on the part, such as marking, winding, assembling and mounting, can also be adversely affected by the irregularities.

An ongoing tendency to upgrade the overall quality of the parts results in more stringent restrictions being imposed on the quantity of irregularities in these parts.

This brings about a need for a set of definitions, or nomenclature, which would be a primary basis for approaches to irregularities and their location issues.

Therefore, this nomenclature is intended to be used as a uniform reference when formulating more detailed descriptions of irregularities at specified locations, requirements and procedures related to the inspection and assessment of irregularities. This nomenclature can also be useful with regard to methods and tools used for detection, recognition and classification of irregularities.

4.2 General terms for physical irregularities

4.2.1
surface irregularity
unintentional state or appearance of the surfaces, edges and corners of the part

Note 1 to entry: Some surface irregularities, if excessive, can so deform contours and surfaces of the part, that they may also be classified as shape irregularities.

4.2.2
interior irregularity
unintentional inhomogeneity inside the part

4.2.3
shape irregularity
unintentional deformation of the contour lines or surfaces delimiting the shape of the part

Note 1 to entry: In some cases, shape irregularities smaller than quoted tolerances can still disqualify the part.

4.2.4
tolerance
<dimensional> allowable difference between the nominal and permissible limit dimensions of the contour lines defining the part's shape

4.2.5
location
<of the irregularity> position on or within the part where the irregularity is present

4.3 Surface irregularities

4.3.1 Chip irregularities

4.3.1.1
chip
lack of surface material generally caused by mechanical impact during handling or transportation

Note 1 to entry: In almost all cases, chips are located on the edges of surfaces.

4.3.1.2
surface chip
chip located only on the core surface

SEE: Figure 1.

Figure 1 – Surface chip

4.3.1.3
edge chip
chip located only on the core edge

SEE: Figure 2.

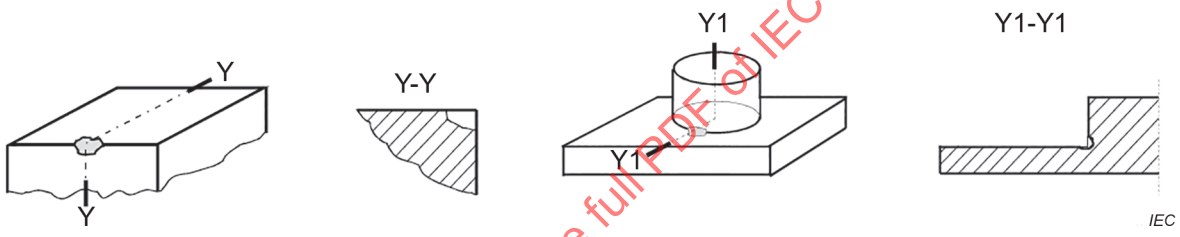

Figure 2 – Edge chip

4.3.1.4
corner chip
chip located only in a corner

SEE: Figure 3.

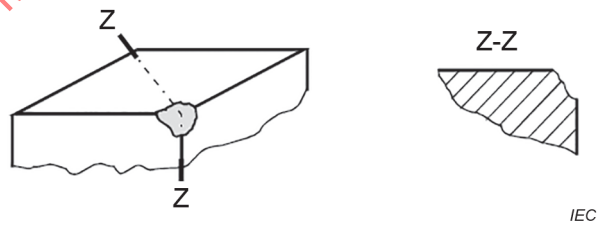

Figure 3 – Corner chip

4.3.1.5
pull-out
consequence of the removal of the surface layer of the core due to die “sticking”, which occurs on surfaces perpendicular to the direction of the pressing action

Note 1 to entry: A pull-out with a depth greater than 1 mm should be considered as a chip.

SEE: Figure 4.

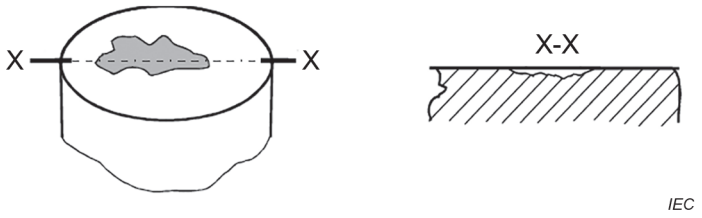

Figure 4 – Pull-out

4.3.1.6
pore
hole left on the surface of cores after sintering and surface finishing

SEE: Figure 5.

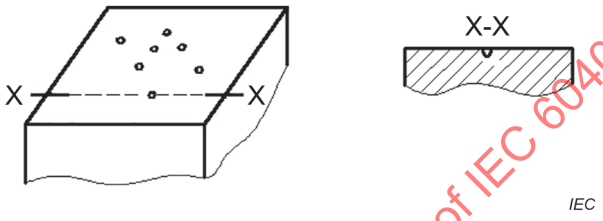

Figure 5 – Pores

4.3.2 Protruding (convex) irregularities

4.3.2.1
hump
elevation of a rounded contour on the relevant surface

SEE: Figure 6.

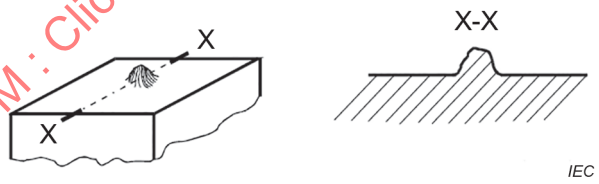

Figure 6 – Hump

4.3.2.2
attached particle
any particle on the surface which cannot be removed by compressed-air, cleaning, washing or wiping

SEE: Figure 7.

Figure 7 – Attached particle

4.3.2.3
inclusion
millimetre or sub-millimetre-sized foreign body located in the surface of the part

4.3.3 Edge irregularities

4.3.3.1
ragged edge
edge affected by a series of small chips

SEE: Figure 8.

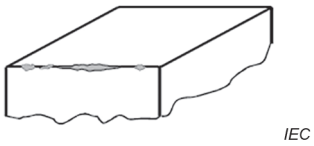

Figure 8 – Ragged edge

4.3.3.2
flash
sharp feather-edge wall extending beyond the intended contour surface of the core

SEE: Figure 9.

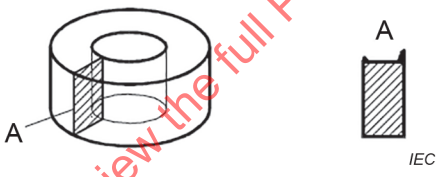

Figure 9 – Flash

4.3.4 Crack irregularities

4.3.4.1
crack
surface irregularity which has a width much smaller than its length and penetrates into the core

4.3.4.2
single-surface narrow crack
crack located on a single surface, not going beyond its edges, and with a width not exceeding a specified limit (e.g. 0,1 mm) anywhere along the crack path on the surface

SEE. Figure 10.

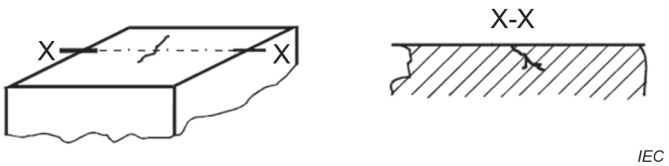

Figure 10 – Single-surface narrow crack

4.3.4.3
single-surface broad crack
crack located on a single surface, not going beyond its edges, and with a width equal to or exceeding the limit specified for the narrow crack anywhere along the crack path on the surface

SEE. Figure 11.

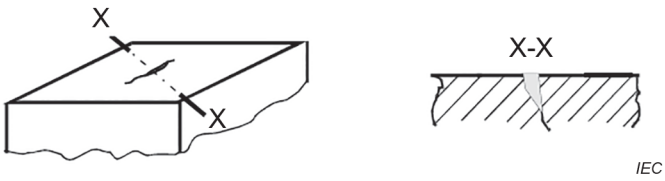

Figure 11 – Single-surface broad crack

4.3.4.4
edge narrow crack
crack located on two adjacent surfaces and crossing their common edge, with a width not exceeding a specified limit (e.g. 0,1 mm) anywhere along the crack path on these surfaces

SEE: Figure 12.

Figure 12 – Edge narrow crack

4.3.4.5
edge broad crack
crack located on two adjacent surfaces and crossing their common edge, with a width equal to or exceeding the limit specified for the narrow crack anywhere along the crack path on these surfaces

SEE: Figure 13.

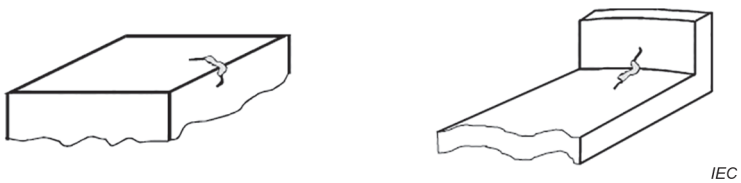

Figure 13 – Edge broad crack

4.3.4.6
inner channel crack
narrow or broad crack along an inner edge of the core

SEE. Figure 14.

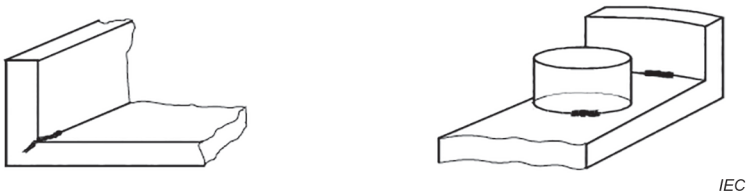

Figure 14 – Inner channel crack

4.3.4.7
lamination
series of cracks located side by side which are more or less parallel, or single crack, which runs along a significant portion (e.g. 20 %) of the periphery of the part

Note 1 to entry: Lamination is usually positioned transversely to the direction of the pressing of the core.

SEE: Figure 15.

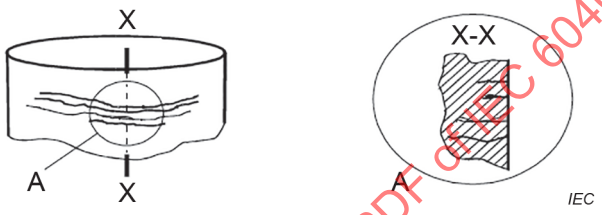

Figure 15 – Lamination

4.3.4.8
crazing
grid-like pattern of superficial cracks of a depth not exceeding a specified limit (e.g. 0,3 mm)

SEE: Figure 16.

Figure 16 – Crazing

4.3.5 Colour irregularities

4.3.5.1
difference in colour tone
slight but visible local change(s) in the tint of the natural colour or shading of an area of a surface from the surrounding background

SEE: Figure 17.

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Figure 17 – Difference in colour tones

4.3.5.2
discoloration
visible difference in the colours of an area of a surface from the normal uniform colour background

SEE: Figure 18.

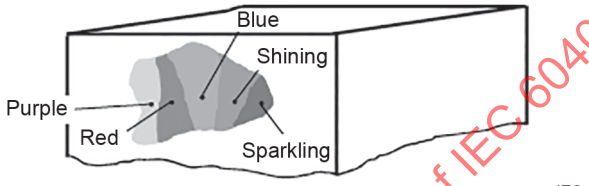

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Figure 18 – Discoloration

4.3.5.3
stain
smear of oil, grease, or other substance, or deposit (e.g. whitish or water marks) on the surface

SEE: Figure 19.

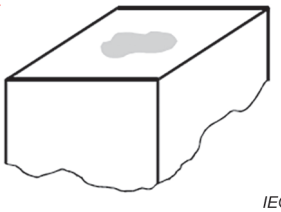

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Figure 19 – Stain

4.3.5.4
crystallite
grain of abnormal size distinguishable on the surface, often with sparkling facets

SEE: Figure 20.

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Figure 20 – Crystallite

4.3.6 Machining-related irregularities

4.3.6.1
roughness
uneven, rough surface which includes traces from grinding, abrasives, etc.

SEE: Figure 21.

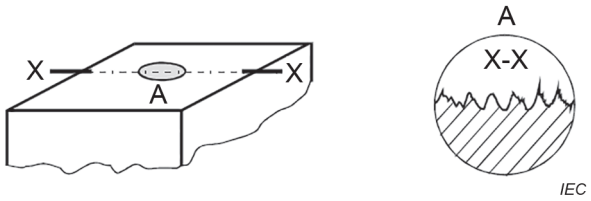

Figure 21 – Roughness

4.3.6.2
short-ground surface
part of surface which unintentionally remains un-ground after grinding, with no steplike surface irregularities

Note 1 to entry: See 4.5.3.1.

SEE: Figure 22.

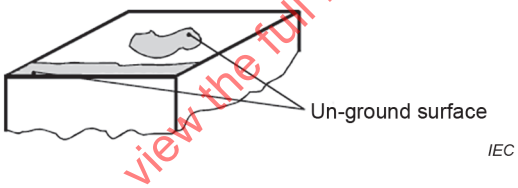

Figure 22 – Short-ground surface

4.3.6.3
scratch
one or more scrapes caused by the handling process

SEE: Figure 23.

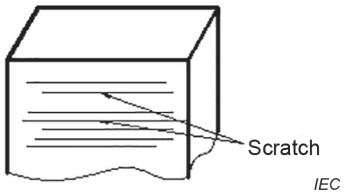

Figure 23 – Scratch

4.4 Interior irregularities

Since inclusions, cracks or lamination that is confined to the inside of a part cannot be detected by direct inspection except with destructive or expensive procedures, control of bulk irregularities is maintained through break strength testing. Small sample sizes from production batches are destructively broken with M testing, W testing, or tensile pull testing. The yield strength is recorded and compared with specification limits or control limits. Further, internal irregularities that cause electrical performance to be impaired are detected by means of testing against the electrical specifications.

4.5 Shape irregularities (deformations)

4.5.1 Non-flat irregularities

4.5.1.1
convexity
outwardly curved outline or surface

SEE: Figure 24.

Figure 24 – Convexity

4.5.1.2
concavity
inwardly curved outline or surface

SEE: Figure 25.

Figure 25 – Concavity

4.5.1.3
warping
state of a shape with twisted surface(s)

SEE: Figure 26.

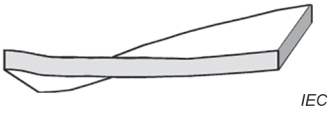

Figure 26 – Warping

4.5.1.4
bending
deflection, curved or angular, from any direction that is regarded as the intended deflection