

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Ferrite cores – Guidelines on dimensions and the limits of
surface irregularities –
Part 9: Planar-cores**

**Noyaux ferrites – Lignes directrices relatives aux dimensions
et aux limites des irrégularités de surface –
Partie 9: Noyaux plans**



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Part 9: Planar-cores**

**Noyaux ferrites – Lignes directrices relatives aux dimensions
et aux limites des irrégularités de surface –
Partie 9: Noyaux planaires**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**FERRITE CORES – GUIDELINES ON DIMENSIONS AND
THE LIMITS OF SURFACE IRREGULARITIES –****Part 9: Planar-cores****FOREWORD**

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International Standard IEC 63093-9 has been prepared by IEC technical committee 51: Magnetic components, ferrite and magnetic powder materials.

This first edition cancels and replaces the first edition of IEC 60424-5 published in 2009 and first edition of IEC 62317-9 published in 2006 and its Amendment 1:2007. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous editions of IEC 60424-5 and IEC 62317-9:

- a) IEC 63093-9 integrates IEC 60424-5 and IEC 62317-9;
- b) Table 1, Table 2 and Table 3 in IEC 60424-5:2009 have been moved to Annex B;
- c) some numbers are corrected in Table 4;
- d) Table 6 is amended following IEC 60205.

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

CDV	Report on voting
51/1308/CDV	51/1326/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 63093 series, published under the general title *Ferrite cores – Guidelines on dimensions and the limits of surface irregularities*, 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- withdrawn,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.

INTRODUCTION

Today, DC-to-DC converter power supplies increasingly employ transformers and chokes, the windings of which are made of multi-layer printed circuit boards or are constructed in the motherboard, rather than the transformers wound by conventional copper wires. This document specifies the optimum shapes and dimensions of cores for surface mounted devices (SMDs) and of cores for which the windings are constructed in the motherboard. The motherboard has slots cut out to accept the ferrite cores. This is called the total integration in a multi-layer motherboard. The core shape specified in this document satisfies the demand for lower profile as well as for smaller floor space.

The relations between the main dimensions of planar E-, ER- and EL-cores differ from those of standard cores. For example, the width of planar-cores is larger while the total height is much smaller. Also the thickness of the legs is in most cases smaller than compared to standard cores. Therefore the concept of fixed reference dimensions to determine the length of crack limits yields crack lengths which are not acceptable for this type of core. This document follows another concept which relates the crack length to dimensions of the surface on which the crack occurs.

Also the concept to determine the maximum area of chips based on the total mating surface fails in the case of planar-cores. The outer legs of planar-cores are much thinner than those of standard cores which makes overlapping and gluing much more difficult. A single chip of maximum size on the outer leg can affect the functionality of the core set. Therefore this document uses as a reference the mating surface on which the chip occurs.

Windings of planar-cores are often PCBs which are glued to the inner surfaces of the planar-core. For this reason the inner surfaces of the planar-cores should have a better quality than the inner surfaces of standard cores. This was taken into account by reducing the maximum allowable area of pull-outs in the inner surfaces.

FERRITE CORES – GUIDELINES ON DIMENSIONS AND THE LIMITS OF SURFACE IRREGULARITIES –

Part 9: Planar-cores

1 Scope

This part of IEC 63093 specifies the shapes and dimensions of ferrite cores for inductive components (transformers and chokes), whose the coil is typically made of multi-layer boards (or the coil is part of the motherboard), and the effective parameter values used in calculations. This document gives guidelines on allowable limits of surface irregularities applicable to planar-cores as well.

This document is considered as a sectional specification useful in the negotiation between ferrite core suppliers and users about surface irregularities.

The general consideration upon which the design of this range of cores is based is given in Annex A.

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 60205:2016, *Calculation of the effective parameters of magnetic piece parts*

IEC 60401-1, *Terms and nomenclature for cores made of magnetically soft ferrites – Part 1: Terms used for physical irregularities*

IEC 60424-1, *Ferrite cores – Guidelines on the limits of surface irregularities – Part 1: General specification*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in IEC 60401-1 and IEC 60424-1 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 Primary dimensions

4.1 Planar shapes and dimensions

The main shapes and dimensions shall be as given in the following figures and tables.

The main shapes, dimensions, and parameters for EL-cores are given in:

- Figure 1 – Planar EL-core- and mating PLT-core;
- Table 1 – Dimensions of planar EL-core and mating PLT-core;
- Table 2 – Effective parameter values and $A_{\min}$ values.

The main shape, dimensions, and parameters for low-profile E-cores are given in:

- Figure 2 – Low-profile E-core and mating PLT-core;
- Table 3 – Dimensions of low-profile E-core and mating PLT-core;
- Table 4 – Effective parameter values and $A_{\min}$ values.

The main shape, dimensions, and parameters for ER-cores are given in:

- Figure 3 – Low-profile ER-core and mating PLT-core;
- Table 5 – Dimensions of low-profile ER-core and mating PLT-core;
- Table 6 – Effective parameter values and $A_{\min}$ values.

A uniform dimensional nomenclature has been chosen in order to facilitate a comparison of major physical attributes among the different core shapes.

4.2 Dimensions and effective parameters of planar EL-core and mating PLT-core

For the definitions of effective parameters and their calculations, reference shall be made to IEC 60205.

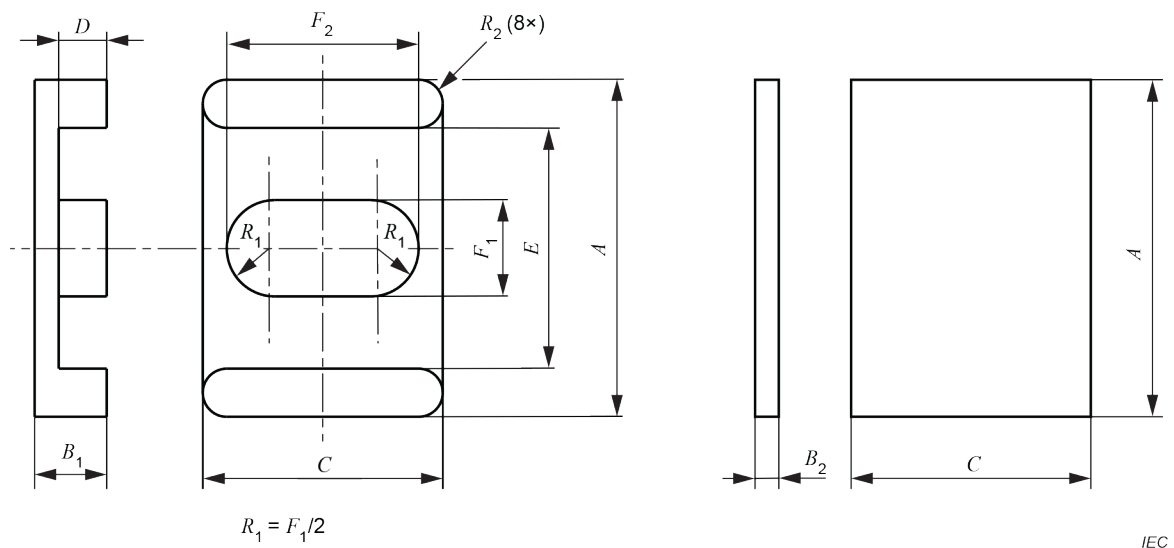


Figure 1 – Planar EL-core and mating PLT-core

Table 1 – Dimensions of planar EL-core EL and mating PLT-core*Dimensions in millimetres*

Size		<i>A</i>	<i>B</i> ₁	<i>B</i> ₂	<i>C</i>	<i>D</i>	<i>E</i>	<i>F</i> ₁	<i>F</i> ₂	<i>R</i> ₂
EL11 × 2,0	min.	10,80	1,91		8,60	0,90	8,97	2,68	6,25	0,3
	max.	11,20	2,11		9,00	1,10	9,37	2,88	6,55	
EL11 × 3,0	min.	10,80	2,91		8,60	1,90	8,97	2,68	6,25	0,3
	max.	11,20	3,11		9,00	2,10	9,37	2,88	6,55	
PLT11 × 1,0	min.	10,80		0,96	8,60					
	max.	11,20		1,06	9,00					
EL13 × 2,2	min.	12,75	2,09		10,20	0,90	10,63	3,19	7,41	0,3
	max.	13,25	2,29		10,60	1,10	11,03	3,39	7,71	
EL13 × 3,2	min.	12,75	3,09		10,20	1,90	10,63	3,19	7,41	0,3
	max.	13,25	3,29		10,60	2,10	11,03	3,39	7,71	
PLT13 × 1,2	min.	12,75		1,14	10,20					
	max.	13,25		1,24	10,60					
EL15,5 × 2,9	min.	15,20	2,82		12,15	1,40	12,67	3,82	8,81	0,3
	max.	15,80	3,02		12,65	1,60	13,17	4,02	9,21	
EL15,5 × 4,4	min.	15,20	4,32		12,15	2,90	12,67	3,82	8,81	0,3
	max.	15,80	4,52		12,65	3,10	13,17	4,02	9,21	
PLT15,5 × 1,4	min.	15,20		1,32	12,15					
	max.	15,80		1,52	12,65					
EL18 × 3,7	min.	17,70	3,55		14,15	1,90	14,70	4,45	10,27	0,3
	max.	18,30	3,75		14,65	2,10	15,30	4,65	10,67	
EL18 × 5,7	min.	17,70	5,55		14,15	3,85	14,70	4,45	10,27	0,3
	max.	18,30	5,75		14,65	4,15	15,30	4,65	10,67	
PLT18 × 1,7	min.	17,70		1,55	14,15					
	max.	18,30		1,75	14,65					
EL20 × 3,8	min.	19,65	3,73		15,70	1,90	16,37	4,91	11,43	0,5
	max.	20,35	3,93		16,30	2,10	16,97	5,21	11,83	
EL20 × 5,8	min.	19,65	5,68		15,70	3,85	16,37	4,91	11,43	0,5
	max.	20,35	5,98		16,30	4,15	16,97	5,21	11,83	
PLT20 × 1,8	min.	19,65		1,73	15,70					
	max.	20,35		1,93	16,30					
EL22 × 4,0	min.	21,60	3,92		17,30	1,90	17,98	5,41	12,54	0,5
	max.	22,40	4,12		17,90	2,10	18,68	5,71	13,04	
EL22 × 6,0	min.	21,60	5,87		17,30	3,85	17,98	5,41	12,54	0,5
	max.	22,40	6,17		17,90	4,15	18,68	5,71	13,04	
PLT22 × 2,0	min.	21,60		1,92	17,30					
	max.	22,40		2,12	17,90					
EL25 × 4,3	min.	24,55	4,19		19,65	1,90	20,48	6,17	14,29	0,5
	max.	25,45	4,39		20,35	2,10	21,18	6,47	14,79	
EL25 × 6,3	min.	24,55	6,14		19,65	3,85	20,48	6,17	14,29	0,5
	max.	25,45	6,44		20,35	4,15	21,18	6,47	14,79	
PLT25 × 2,3	min.	24,55		2,19	19,65					
	max.	25,45		2,39	20,35					

Table 2 – Effective parameter values and $A_{\min}$ values

Size	C_1 mm ⁻¹	C_2 mm ⁻³	l_e mm	A_e mm ²	V_e mm ³	$A_{\min}^a$ mm ²	Remarks
EL-EL11 × 4,0	0,826 45	$49,923 \times 10^{-3}$	13,7	16,5	226	15,9	The combination EL-EL refers to two shorter height EL-cores for size-designation.
EL-EL13 × 4,4	0,666 66	$28,815 \times 10^{-3}$	15,4	23,1	357	22,4	
EL-EL15,5 × 5,8	0,596 74	$18,143 \times 10^{-3}$	19,6	32,9	646	31,9	
EL-EL18 × 7,3	0,538 30	$12,162 \times 10^{-3}$	23,8	44,3	1 050	43,0	
EL-EL20 × 7,7	0,468 64	$8,586 6 \times 10^{-3}$	25,6	54,6	1 400	52,9	
EL-EL22 × 8,0	0,412 80	$6,231 4 \times 10^{-3}$	27,3	66,2	1 810	64,2	The combination EL-PLT refers to one taller height EL core paired with one PLT-core for each size-designation.
EL-EL25 × 8,6	0,350 34	$4,094 2 \times 10^{-3}$	30,0	85,6	2 570	83,0	
EL-PLT11 × 4,0	0,826 45	$49,943 \times 10^{-3}$	13,7	16,5	226	15,9	
EL-PLT13 × 4,4	0,666 66	$28,815 \times 10^{-3}$	15,4	23,1	357	22,4	
EL-PLT15,5 × 5,8	0,569 74	$18,143 \times 10^{-3}$	19,6	32,9	646	31,9	
EL-PLT18 × 7,3	0,538 30	$12,162 \times 10^{-3}$	23,8	44,3	1 050	43,0	
EL-PLT20 × 7,7	0,468 64	$8,586 6 \times 10^{-3}$	25,6	54,6	1 400	52,9	
EL-PLT22 × 8,0	0,412 80	$6,231 4 \times 10^{-3}$	27,3	66,2	1 810	64,2	
EL-PLT25 × 8,6	0,350 34	$4,094 2 \times 10^{-3}$	30,0	85,6	2 570	83,0	
EL-PLT11 × 3,0	0,701 76	$42,170 \times 10^{-3}$	11,7	16,6	194	15,9	
EL-PLT13 × 3,4	0,577 71	$24,857 \times 10^{-3}$	13,4	23,2	312	22,4	
EL-PLT15,5 × 4,3	0,502 96	$15,212 \times 10^{-3}$	16,6	33,1	550	31,9	
EL-PLT18 × 5,3	0,445 54	$10,011 \times 10^{-3}$	19,8	44,5	882	43,0	
EL-PLT20 × 5,7	0,392 32	$7,167 9 \times 10^{-3}$	21,6	54,9	1 180	52,9	
EL-PLT22 × 6,0	0,350 61	$5,264 5 \times 10^{-3}$	23,4	66,6	1 560	64,2	
EL-PLT25 × 6,6	0,302 22	$3,515 6 \times 10^{-3}$	26,0	86,0	2 230	83,0	

^a See 4.2 of IEC 60205:2016 for the definition of $A_{\min}$.

4.3 Dimensions and effective parameters of low-profile E-core and mating PLT-core

For the definitions of effective parameters and their calculations, reference shall be made to IEC 60205.

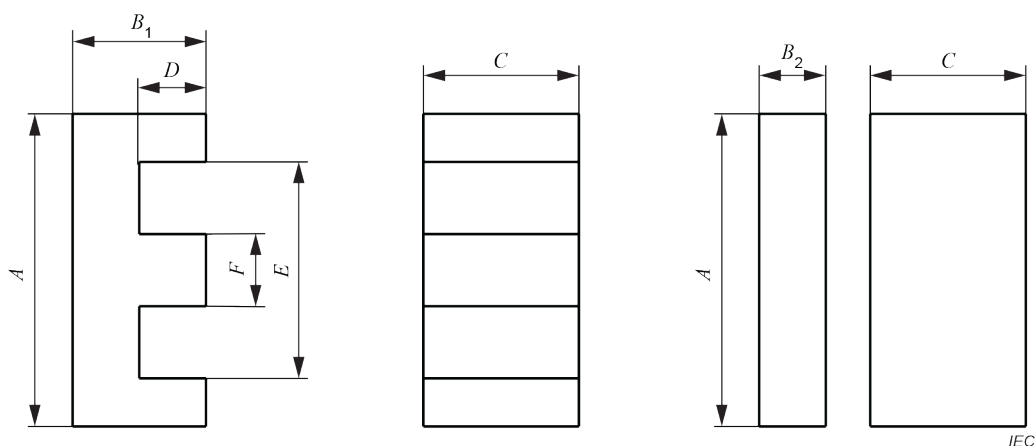
**Figure 2 – Low-profile E-core and mating PLT-core**

Table 3 – Dimensions of low-profile E-core and mating PLT-core*Dimensions in millimetres*

Size		<i>A</i>	<i>B</i> ₁	<i>B</i> ₂	<i>C</i>	<i>D</i>	<i>E</i>	<i>F</i>
E14 × 3,5 × 5	min.	13,70	3,40		4,90	1,90	10,75	2,95
	max.	14,30	3,60		5,10	2,10	11,25	3,05
PLT14 × 1,5 × 5	min.	13,70		1,40	4,90			
	max.	14,30		1,60	5,10			
E18 × 4 × 10	min.	17,65	3,90		9,80	1,90	13,70	3,90
	max.	18,35	4,10		10,20	2,10	14,30	4,10
PLT18 × 2 × 10	min.	17,65		1,90	9,80			
	max.	18,35		2,10	10,20			
E22 × 6 × 16	min.	21,40	5,60		15,50	3,10	16,40	4,90
	max.	22,20	5,80		16,10	3,30	17,20	5,10
PLT22 × 2,5 × 16	min.	21,40		2,40	15,50			
	max.	22,20		2,60	16,10			
E32 × 6 × 20	min.	31,10	6,20		19,90	2,95	24,90	6,20
	max.	32,40	6,50		20,75	3,40	26,10	6,50
PLT32 × 3 × 20	min.	31,10		3,00	19,90			
	max.	32,40		3,35	20,75			
E38 × 8 × 25	min.	37,30	8,10		24,85	4,30	30,20	7,40
	max.	38,90	8,40		25,95	4,60	31,40	7,80
PLT38 × 4 × 25	min.	37,30		3,65	24,85			
	max.	38,90		3,95	25,95			
E43 × 10 × 28	min.	42,30	9,35		27,30	5,25	34,70	7,90
	max.	44,10	9,65		28,50	5,55	36,30	8,30
PLT43 × 4 × 28	min.	42,30		3,95	27,30			
	max.	44,10		4,25	28,50			
E58 × 11 × 38	min.	57,20	10,35		37,30	6,35	50,00	7,90
	max.	59,60	10,75		38,90	6,65	52,20	8,30
PLT58 × 4 × 38	min.	57,20		3,85	37,30			
	max.	59,60		4,25	38,90			
E64 × 10 × 50	min.	62,70	10,05		49,70	4,95	52,50	10,00
	max.	65,30	10,35		51,90	5,25	54,70	10,40
PLT64 × 5 × 50	min.	62,70		4,95	49,70			
	max.	65,30		5,25	51,90			
E102 × 20 × 38	min.	100,0	20,10		36,50	12,90	85,00	13,70
	max.	104,0	20,50		38,50	13,40	88,60	14,30
PLT102 × 7 × 38	min.	100,0		6,95	36,50			
	max.	104,0		7,35	38,50			

Table 4 – Effective parameter values and $A_{\min}$ values

Size	C_1 mm ⁻¹	C_2 mm ⁻³	l_e mm	A_e mm ²	V_e mm ³	$A_{\min}^a$ mm ²	Remarks
E-E14	1,380 8	$92,055 \times 10^{-3}$	20,7	15,0	311	15,0	Combination E-E
E-E18	0,607 08	$15,177 \times 10^{-3}$	24,3	40,0	971	40,0	
E-E22	0,410 81	$5,200\ 1 \times 10^{-3}$	32,5	79,0	2 560	79,0	
E-E32	0,324 85	$2,525\ 5 \times 10^{-3}$	41,8	129	5 370	127	
E-E38	0,276 13	$1,443\ 9 \times 10^{-3}$	52,8	191	10 100	185	
E-E43	0,274 13	$1,219\ 7 \times 10^{-3}$	61,6	225	13 800	215	
E-E58	0,269 43	$0,893\ 10 \times 10^{-3}$	81,3	302	24 500	278	
E-E64	0,153 67	$0,295\ 56 \times 10^{-3}$	79,9	520	41 500	518	
E-E102	0,273 88	$0,506\ 86 \times 10^{-3}$	148	540	80 000	525	
E-PLT14	1,114 2	$74,277 \times 10^{-3}$	16,7	15,0	251	15,0	Combination E-PLT
E-PLT18	0,507 08	$12,677 \times 10^{-3}$	20,3	40,0	811	40,0	
E-PLT22	0,329 80	$4,174\ 6 \times 10^{-3}$	26,1	79,0	2 060	79,0	
E-PLT32	0,275 28	$2,138\ 6 \times 10^{-3}$	35,4	129	4 560	127	
E-PLT38	0,229 08	$1,195\ 0 \times 10^{-3}$	43,9	192	8 420	185	
E-PLT43	0,225 10	$0,996\ 95 \times 10^{-3}$	50,8	226	11 500	214	
E-PLT58	0,225 00	$0,740\ 83 \times 10^{-3}$	68,3	304	20 800	278	
E-PLT64	0,134 18	$0,258\ 30 \times 10^{-3}$	70,0	519	36 200	518	
E-PLT102	0,225 76	$0,418\ 68 \times 10^{-3}$	122	539	65 600	525	
NOTE Values ignore the effect of radii. These can have some influence on the outcome of the calculation. They can be incorporated in the formulae as shown in IEC 60205.							
a See 4.2 of IEC 60205:2016 for the definition of $A_{\min}$.							

4.4 Dimensions and effective parameters of low-profile ER-core and mating PLT-core

For the definitions of effective parameters and their calculations, reference shall be made to IEC 60205.

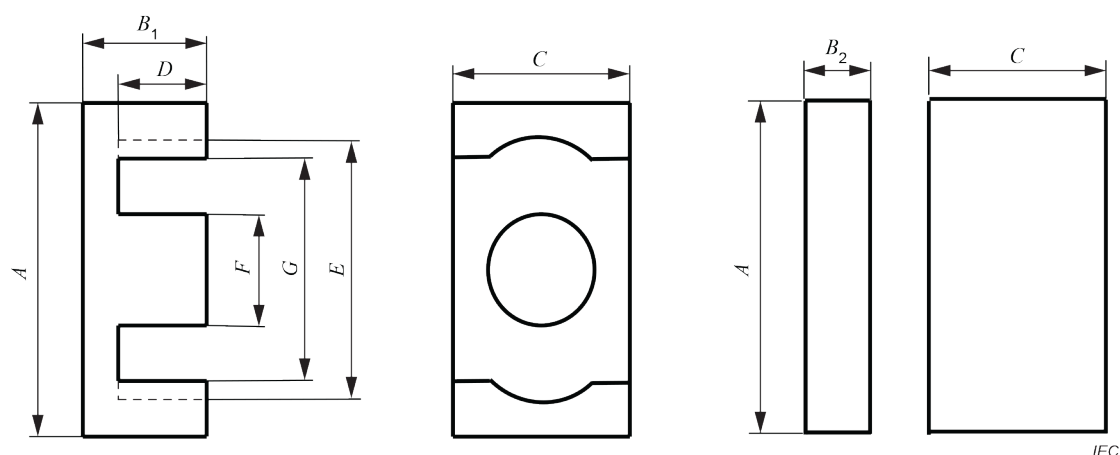
**Figure 3 – Low-profile ER-core and mating PLT-core**

Table 5 – Dimensions of low-profile ER-core and mating PLT-core*Dimensions in millimetres*

Size		A	B₁	B₂	C	D	E	F	G
ER9,5 × 2,5 × 5	min.	9,15	2,375		4,80	1,60	7,50	3,25	7,00
	max.	9,55	2,525		5,00	1,75	7,75	3,55	7,40
PLT9,5 × 1 × 5	min.	9,15		0,70	4,80				
	max.	9,55		0,85	5,00				
ER11 × 2,5 × 6	min.	10,65	2,375		5,80	1,50	8,70	4,00	7,90
	max.	11,00	2,525		6,00	1,65	9,00	4,25	8,30
PLT11 × 1 × 6	min.	10,65		0,80	5,80				
	max.	11,00		0,95	6,00				
ER13 × 3 × 9	min.	12,5	2,775		8,45	1,625	10,9	4,85	8,75
	max.	13,1	2,925		8,95	1,875	11,5	5,15	9,35
PLT13 × 1 × 9	min.	12,5		1,00	8,45				
	max.	13,1		1,20	8,95				
ER14,5 × 3 × 7	min.	14,30	2,90		6,60	1,55	11,6	4,60	11,6
	max.	14,70	3,00		6,80	1,75	12,0	4,80	12,0
PLT14,5 × 1 × 7	min.	14,30		1,20	6,60				
	max.	14,70		1,40	6,80				
ER18 × 3 × 10	min.	17,65	3,05		9,5	1,50	15,3	6,05	13,5
	max.	18,35	3,25		9,9	1,70	15,9	6,35	14,1
PLT18 × 1,5 × 10	min.	17,65		1,45	9,5				
	max.	18,35		1,65	9,9				
ER20 × 6 × 14	min.	19,65	6,20		13,7	3,95	17,65	8,65	12,51
	max.	20,35	6,40		14,3	4,25	18,35	8,95	13,21
PLT20 × 2 × 14	min.	19,65		2,25	13,7				
	max.	20,35		2,35	14,3				
ER23 × 3,6 × 13	min.	22,75	3,50		12,25	1,50	19,8	7,8	17,5
	max.	23,65	3,70		12,75	1,70	20,6	8,2	18,2
ER23 × 5 × 13	min.	22,75	5,00		12,25	3,00	19,8	7,8	17,5
	max.	23,65	5,20		12,75	3,20	20,6	8,2	18,2
PLT23 × 2 × 13	min.	22,75		1,90	12,25				
	max.	23,65		2,10	12,75				
ER25 × 8 × 18	min.	24,6	7,90		17,7	5,00	21,6	10,8	14,5
	max.	25,4	8,10		18,3	5,30	22,4	11,2	14,9
PLT25 × 3 × 18	min.	24,6		2,75	17,7				
	max.	25,4		2,95	18,3				
ER25 × 6 × 15	min.	24,5	5,40		14,5	3,00	21,3	9,20	18,3
	max.	25,5	5,60		15,1	3,20	22,1	9,60	18,7
PLT25 × 2,4 × 15	min.	24,5		2,30	14,5				
	max.	25,5		2,50	15,1				
ER25 × 6 × 18	min.	24,6	5,55		17,7	3,05	21,6	10,8	14,5
	max.	25,4	5,65		18,3	3,35	22,4	11,2	14,9
PLT25 × 2 × 18	min.	24,6		2,35	17,7				
	max.	25,4		2,45	18,3				

Size		<i>A</i>	<i>B</i> ₁	<i>B</i> ₂	<i>C</i>	<i>D</i>	<i>E</i>	<i>F</i>	<i>G</i>
ER30 × 8 × 20	min.	29,6	7,85		19,7	5,10	25,6	10,8	19,05
	max.	30,4	8,15		20,3	5,50	26,4	11,2	19,85
PLT30 × 3 × 20	min.	29,6		2,60	19,7				
	max.	30,4		2,80	20,3				
ER32 × 5 × 21	min.	31,4	5,00		20,6	2,6	29,2	11,0	23,0
	max.	32,6	5,20		21,4	2,8	30,2	11,4	24,2
PLT32 × 2 × 21	min.	31,4		2,3	20,6				
	max.	32,6		2,5	21,4				
ER32 × 6 × 25	min.	31,65	5,84		25,0	2,65	26,8	12,15	26,8
	max.	32,75	6,13		25,8	2,91	27,6	12,55	27,6
PLT32 × 3 × 25	min.	31,65		3,14	25,0				
	max.	32,75		3,34	25,8				
ER35 × 10 × 26	min.	34,6	9,90		25,6	5,00	29,6	14,1	26,4
	max.	35,4	10,1		26,4	5,30	30,4	14,7	27,5
PLT35 × 5 × 26	min.	34,6		4,75	25,6				
	max.	35,4		4,95	26,4				
ER40 × 10 × 28	min.	39,6	9,90		27,6	5,00	34,6	14,6	31,5
	max.	40,4	10,1		28,4	5,30	35,4	15,2	32,5
PLT40 × 5 × 28	min.	39,6		4,75	27,6				
	max.	40,4		4,95	28,4				

Table 6 – Effective parameter values and *A*_{min} values

Size	<i>C</i> ₁ mm ⁻¹	<i>C</i> ₂ mm ⁻³	<i>l</i> _e mm	<i>A</i> _e mm ²	<i>V</i> _e mm ³	<i>A</i> _{min} ^a mm ²	Remarks
ER9,5 × 2,5 × 5	1,749 4	206,64 × 10 ⁻³	14,8	8,47	125	7,60	Combination ER-ER
ER11 × 2,5 × 6	1,310 6	111,23 × 10 ⁻³	15,4	11,8	182	10,3	
ER13 × 3 × 9	0,926 09	46,376 × 10 ⁻³	18,5	20,0	369	19,1	
ER14,5 × 3 × 7	1,133 5	64,620 × 10 ⁻³	19,9	17,5	349	17,3	
ER18 × 3 × 10	0,746 41	24,539 × 10 ⁻³	22,7	30,4	691	30,1	
ER20 × 6 × 14	0,578 88	9,741 4 × 10 ⁻³	34,4	59,4	2 040	55,4	
ER23 × 3,6 × 13	0,545 25	10,828 × 10 ⁻³	27,5	50,4	1 380	50,0	
ER23 × 5 × 13	0,660 31	13,059 × 10 ⁻³	33,4	50,6	1 690	50,0	
ER25 × 6 × 15	0,497 16	7,030 4 × 10 ⁻³	35,2	70,7	2 490	69,4	
ER25 × 6 × 18	0,374 11	4,070 1 × 10 ⁻³	34,4	91,9	3 160	86,4	
ER30 × 8 × 20	0,440 78	4,094 1 × 10 ⁻³	47,5	108	5 110	95,0	
ER32 × 5 × 21	0,400 06	3,985 5 × 10 ⁻³	40,2	100	4 030	98,5	
ER32 × 6 × 25	0,300 89	2,099 3 × 10 ⁻³	43,1	143	6 180	121	
ER35 × 10 × 27	0,274 12	1,372 5 × 10 ⁻³	54,7	200	10 900	163	
ER40 × 10 × 28	0,272 71	1,254 8 × 10 ⁻³	59,3	217	12 900	174	

Size	C_1 mm ⁻¹	C_2 mm ⁻³	l_e mm	A_e mm ²	V_e mm ³	A_{min}^a mm ²	Remarks
ER9,5 × 2,5 × 5 / PLT9,5 × 1 × 5	1,394 3	168,95 × 10 ⁻³	11,5	8,25	95,0	7,60	Combination ER-PLT
ER11 × 2,5 × 6 / PLT11 × 1 × 6	1,082 4	94,686 × 10 ⁻³	12,4	11,4	141	10,3	
ER13 × 3 × 9 / PLT13 × 1 × 9	0,760 78	38,520 × 10 ⁻³	15,0	19,8	297	19,1	
ER14,5 × 3 × 7/ PLT14,5 × 1 × 7	0,947 19	54,097 × 10 ⁻³	16,6	17,5	290	17,3	
ER18 × 3 × 10 / PLT18 × 1,5 × 10	0,643 27	21,212 × 10 ⁻³	19,5	30,3	592	30,1	
ER20 × 6 × 14 / PLT20 × 2 × 14	0,433 67	7,153 7 × 10 ⁻³	26,3	60,6	1 590	55,4	
ER23 × 3,6 × 13 / PLT23 × 2 × 13	0,480 86	9,557 1 × 10 ⁻³	24,2	50,3	1 220	50,0	
ER23 × 5 × 13 / PLT23 × 2 × 13	0,539 38	10,699 × 10 ⁻³	27,2	50,4	1 370	50,0	
ER25 × 6 × 15 / PLT25 × 2,4 × 15	0,413 16	5,888 5 × 10 ⁻³	29,0	70,2	2 030	69,4	
ER25 × 6 × 18 / PLT25 × 2 × 18	0,309 27	3,412 1 × 10 ⁻³	28,0	90,6	2 540	86,4	
ER30 × 8 × 20 / PLT30 × 3 × 20	0,345 32	3,210 0 × 10 ⁻³	37,1	108	4 000	95,0	
ER32 × 5 × 21 / PLT32 × 2 × 21	0,346 04	3,444 8 × 10 ⁻³	34,8	100	3 490	98,5	
ER32 × 6 × 25 / PLT32 × 3 × 25	0,255 65	1,731 3 × 10 ⁻³	37,7	148	5 570	121	
ER35 × 10 × 26 / PLT35 × 5 × 26	0,214 13	1,022 2 × 10 ⁻³	44,9	209	9 400	163	
ER40 × 10 × 28 / PLT40 × 5 × 28	0,216 83	0,950 50 × 10 ⁻³	49,5	228	11 300	174	
NOTE Values ignore the effect of radii. These can have some influence on the outcome of the calculation. They can be incorporated in the formulae as shown in IEC 60205.							
^a See 4.2 of IEC 60205:2016 for the definition of A_{min} .							

5 Limits of surface irregularities

5.1 General

Surface irregularities are defined in IEC 60424-1.

5.2 Examples of surface irregularities

Figure 4 shows different examples of surface irregularities for a planar EL-core.

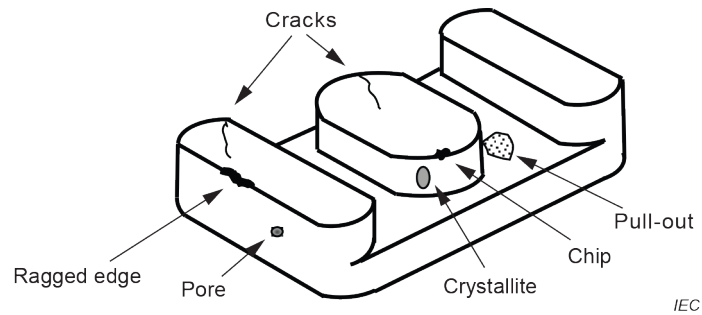


Figure 4 – Examples of surface irregularities for planar EL-core

Figure 5 shows different examples of surface irregularities for a low-profile E-core.

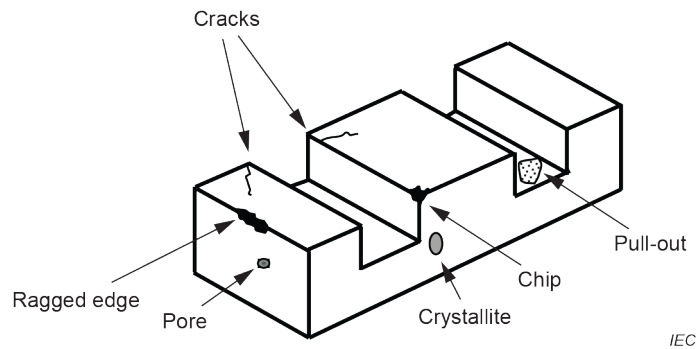


Figure 5 – Examples of surface irregularities for low-profile E-core

Figure 6 shows different examples of surface irregularities for a low-profile ER-core.

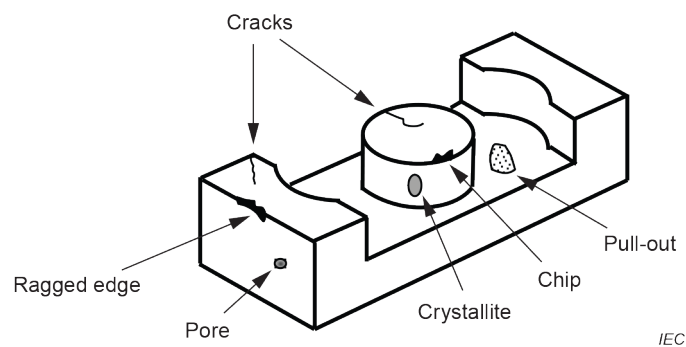


Figure 6 – Examples of surface irregularities for low-profile ER-core

5.3 Chips and ragged edges

5.3.1 General

Chips and ragged edges are shown in Figure 7, Figure 8 and Figure 9.

5.3.2 Chips and ragged edges on the mating surfaces

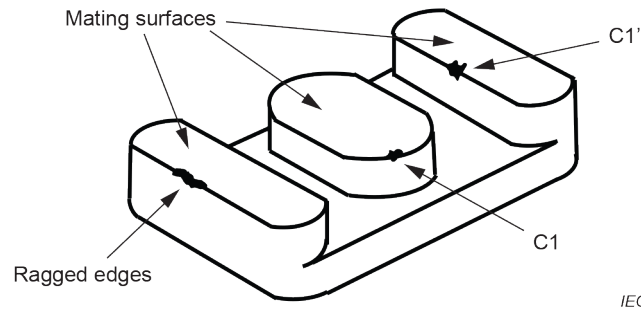


Figure 7 – Chip location for planar EL-core

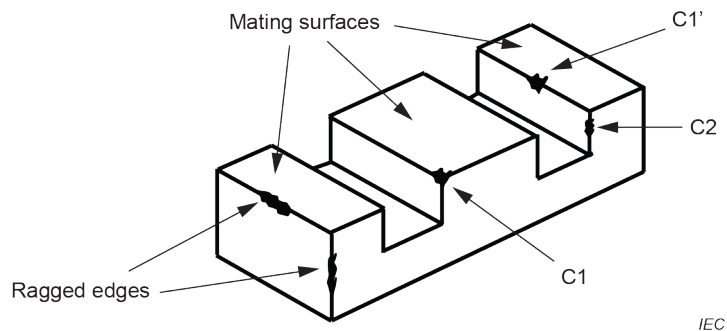


Figure 8 – Chip location for low-profile E-core

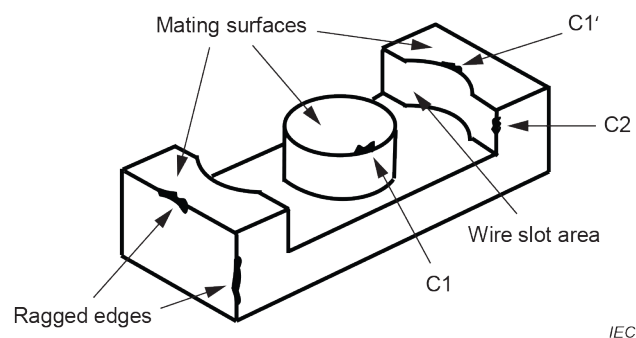


Figure 9 – Chip location for low-profile ER-core

The areas of the chips located on the mating surfaces (C1 and C1' irregularities in Figure 7, Figure 8 and Figure 9) shall not exceed the following limits:

- the cumulative area of the chips shall be less than 4 % of the relevant mating surface. The mating surface of each outer leg and centre post is considered separately. The minimum area is taken as 0,5 mm² to be distinguishable to the naked eye;
- the total length of the ragged edges shall be less than 25 % of the perimeter of the relevant mating surface.

5.3.3 Chips and ragged edges on other surfaces

For chips and ragged edges located on the surfaces:

- the allowable chipping areas are doubled as compared to the limits for the whole mating surfaces;
- the total length of the ragged edges shall be less than 25 % of the perimeter of the smaller adjoining surface;
- chips and ragged edges are not acceptable on the inner edges of the wire slot area (C2 irregularity in Figure 8 and Figure 9).

Area and length reference for visual inspection are given in Table 7. Reference values of allowable areas of chips are given in Annex B.