Ferrites and accessories

E cores
General information

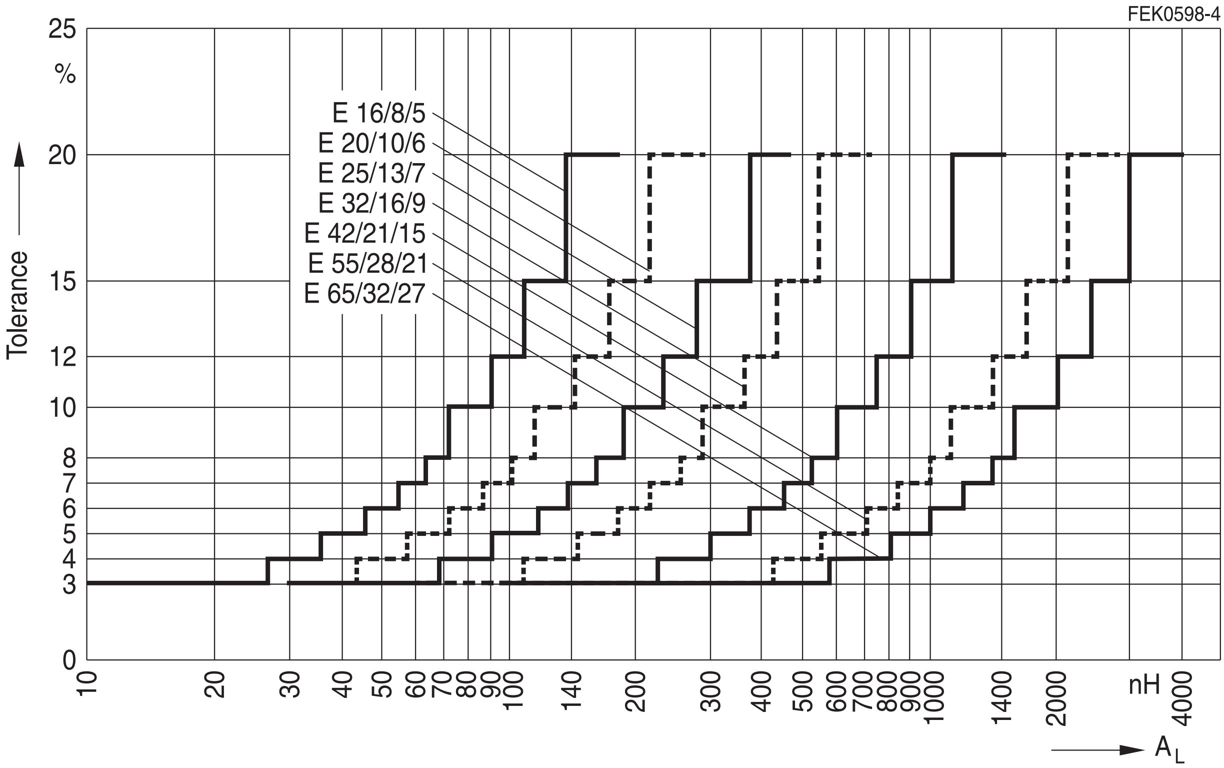
Date: October 2022

1 Tolerances for E cores

The A_L value tolerances for E cores have consequently been defined with consideration of optimized process parameters for all materials with an initial permeability μ_i in the region of 2200 to 10000 as a step function (see figure below).

The quantized A_L step values should preferably be used. They are still available in their respective lower tolerance ranges. Thus a tolerance of ±15% can be determined for an E 42/21/15 made of N87 material for an A_L value of 1190 nH.

With this type of tolerance definition, TDK Electronics has defined standard A_L values and the associated tolerance for the first time. Based on the initial permeability the tolerance can be slightly lower or higher.



2 Core shapes and materials

The preferred materials for manufacture of E cores are the SIFERRIT materials N27, N87, N97, N88, N95, N96, N92, T46 and N30. N27 is recommended for power applications in the frequency range up to about 100 kHz and N87, N97, N88, N95, N96 and N92 for the frequency range up to 500 kHz; EFD cores made of N49 are particularly suitable for frequencies up to 1 MHz (PC200 up to 4 MHz). These materials feature a high saturation flux density and low power loss.

Material N30 is particularly suitable for broadband small-signal applications and also for interference suppression chokes.

The E core spectrum contained in this data book comprises five basic core shapes, which can be used not only for transformers but also for chokes with a power capacity of up to 10 kW.

a) Types with round center leg

We offer the following types:

- ER cores
- EQ cores
- ETD cores to IEC 63093-6 (Economic Transformer Design)

E cores with round center leg offer the advantage of easy winding, particularly when thick winding wires are used, compact mounting dimensions and wide openings on each side. ETD cores have the additional benefit of an almost constant cross section along the magnetic path. A wide variety of optimized accessories is available. ER cores in sizes 9.5 and 11/5 are particularly suitable for designing transformers with low overall height and high inductance. They come in material T38 for broadband applications plus in N87, N97, N88, N95, N96, N92 and N49 for power transformers for frequencies up to and over 500 kHz (PC200 up to 4 MHz).

b) Types with rectangular center leg

- E cores
- EFD cores (Economic Flat Transformer Design); EV cores

The conventional E cores with rectangular center leg are available in a wide variety of sizes.

EFD cores have an optimized cross section and enable the design of very flat and compacts transformers, even for high-frequency applications.

c) ELP cores (E Low Profile)

ELP cores enable the design of very flat transformers and feature excellent thermal performance due to the large core surface. ELP cores are now specified in IEC 63093-9.

3 Ordering, marking, delivery

E cores are supplied as single units (except ER 9.5, ER 11 and ER 14.5/6: in sets), with each packing unit (PU) exclusively containing cores with or without shortened center leg (air gap dimension „g“).

Gapped EFD cores are supplied with toleranced A_L value as specified in the data sheets. All other E cores are availble with toleranced A_L value on request.

There are two possibilites of air gap distribution, either symmetrical (each core of a set has the same air gap size) or unsymmetrical (a gapped core is combined with an ungapped core).

E and U cores are marked using the same system. Hence, the following description applies to both core shapes.

- **E 5**, **E 6.3, E 8.8, EFD 10** and **I cores** are not marked.
- **E cores** are marked by an ink-jet printer on the outside of the legs (figure 1).

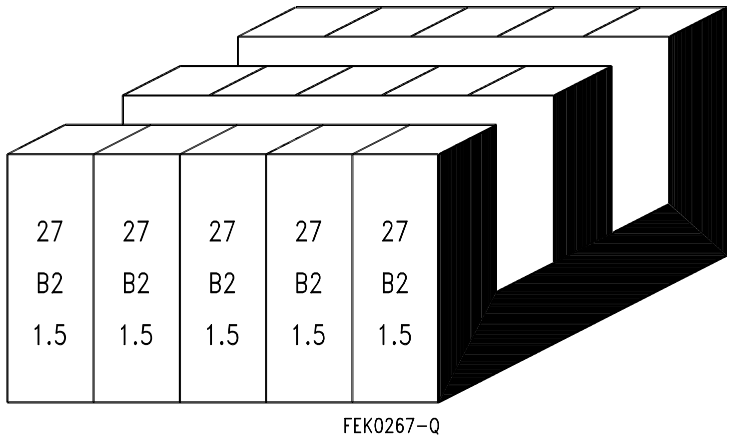


Fig. 1 Marking by ink-jet printer

Gapped cores:

with toleranced air gap: material, date code and size of air gap,
e.g.: 27 B2 1.5
with toleranced A_L value:
symmetrical version: material, date code, A_L value and code for A_L value tolerance, e.g.: 27 B230A
unsymmetrical version: material, date code and size of air gap,
e.g.: 27 B2 1.5

Ungapped cores are marked with material and date code, e.g.: 27 B2.

E cores

General information

Depending on their height and width, there is not enough space on all cores for complete marking, meaning that simplification is necessary. So only the material and the date code will be stated. This ensures that there is space for at least one complete marking (two characters per line) on the core. To avoid confusion of names like N27 and N72, the beginning of the material designation coincides with the position of the letter in the date code.

Example: ↓

727272

2B2B2B

means N27 (not N72)

Remark: in some exception cases parts are stamped with rolls on the back (gapped EFD 15 for example).

Date code:

Date coding is based on a two-week period (see tables, counting by calendar weeks CW).

In the following year lines 1 and 2 will we swapped (material and date code). The position of letters and digits will not be swapped. Counting started in 1996.

Coding of two-week production periods

CW	Code	CW	Code	CW	Code
1 and 2	A	19 and 20	J	37 and 38	S
3 and 4	B	21 and 22	K	39 and 40	T
5 and 6	C	23 and 24	L	41 and 42	U
7 and 8	D	25 and 26	M	43 and 44	V
9 and 10	E	27 and 28	N	45 and 46	W
11 and 12	F	29 and 30	O	47 and 48	X
13 and 14	G	31 and 32	P	49 and 50	Y
15 and 16	H	33 and 34	Q	51 and 52	Z
17 and 18	I	35 and 36	R	53	AA

Coding of week day

	Day	Code		Day	Code
CW_n	Monday	1	CW_{n+1}	Monday	6
	Tuesday	2		Tuesday	7
	Wednesday	3		Wednesday	8
	Thursday	4		Thursday	9
	Friday	5		Friday	0
	Saturday	5		Saturday	0
	Sunday	+		Sunday	—

The black ink is insoluble in water, but it will dissolve in fluids based on ketones. It will also dissolve if left for a long time in an ultrasonic bath. Different colored markings are not feasible.

4 Cores with toleranced air gap

The following tolerances for dimension „g“ apply to all E cores:

Dimension g mm	Tolerance mm
g < 0.10	±0.01
0.10 ≤ g < 0.5	±0.02
g ≥ 0.5	±0.05

As is the case with ungapped cores, a certain degree of roughness cannot be avoided on the ground surfaces of the outer legs.

5 Cores with toleranced A_L value

The tolerance of the A_L value depends on the magnitude of the A_L value and the core shape. Tolerance figures are therefore given only on a core-type-specific basis.

6 Calculation formulae

Calculation formulae a) and b) apply to the A_L value under the following measuring conditions:

Measuring flux density $\hat{B} \leq 0.25$ mT, measuring frequency f = 10 kHz,
measuring temperature T = 25 ±3 °C, measuring coil: N = 100 turns, fully wound

a) Air gap and A_L *value*

The typical A_L value tabulated in the individual data sheets refers to a core set comprising a gapped core with dimension „g“ and an ungapped core with „g“ approx. 0.

By inserting the core-specific constants K1 and K2, a nominal A_L value can be calculated for the materials N27 and N87 within the relevant quoted air-gap validity range:

$$s = \left(\frac{A_L}{K1}\right)^{\frac{1}{K2}} \qquad s = [\text{mm}] \quad A_L = [\text{nH}]$$

Production variations with regard to μ_i and grinding quality should be taken into account additionally.

b) DC magnetic bias I_{DC}

By using the core-shape-related factors K3 and K4, nominal values can be determined for the DC magnetic biasing characteristic of E, ETD and EFD cores made of N27 and N87 and ELP cores made of N87 at temperature 25 °C and 100 °C.

The direct current I_{DC} at which the A_L value drops by 10% compared to the A_L value without magnetic biasing (I_{DC} = 0 A) is determined for a coil with 100 turns.

Calculation of I_{DC} at T = 25 °C:
The factors K3 and K4 for T = 25 °C and the A_L value without magnetic biasing are inserted into the equation for the calculation.

Calculation of I_{DC} at T = 100 °C:

The factors K3 and K4 for T = 100 °C are inserted into the equation for the calculation. The value for T = 25 °C without magnetic biasing should be used here as the A_L value.

$$I_{DC} = \left(\frac{0.9 \cdot A_L}{K3}\right)^{\frac{1}{K4}}$$

$I_{DC} = [A]$

$A_L = [nH]$ (without magnetic biasing)

7 Magnetic characteristics

The set characteristics $\Sigma l/A$, l_e, A_e, A_{min} and V_e required for the calculation of field strength, flux density and hysteresis losses have been determined to IEC 60205 (A_{min} = minimum cross section relative to the nominal dimensions).

8 Core losses

The maximum power loss for each core type is specified in W/set together with the measurement parameters. The flux density has been calculated on the basis of a sinusoidal voltage and is referred to the minimum cross-sectional area A_{min}.

9 Accessories

The coil formers for all ETD, EFD and ER cores and most of the E cores are designed so that they can be wound fully automatically.

With the ETD cores and most E cores, each core half and its mounting assembly can be fitted to the coil former from the same side, thus permitting simple fully automatic assembly.

If coil formers are used for cores with a rectangular cross section (E cores), the indication of the winding height represents only a theoretical value. The use of thicker wires or litz wires results in a gradual rounding of the winding from layer to layer. In such cases the planned winding design should be verified by means of a winding test.

SMD coil formers are available as accessory.

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The following applies to all products named in this publication:

1. Some parts of this publication contain **statements about the suitability of our products for certain areas of application**. These statements are based on our knowledge of typical requirements that are often placed on our products in the areas of application concerned. We nevertheless expressly point out **that such statements cannot be regarded as binding statements about the suitability of our products for a particular customer application.** As a rule, we are either unfamiliar with individual customer applications or less familiar with them than the customers themselves. For these reasons, it is always ultimately incumbent on the customer to check and decide whether a product with the properties described in the product specification is suitable for use in a particular customer application.

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