



Ferrites and accessories

E 13/7/4 (EF 12.6)
Cores and accessories

Series/Type: **B66305, B66202, B66306, B66414**

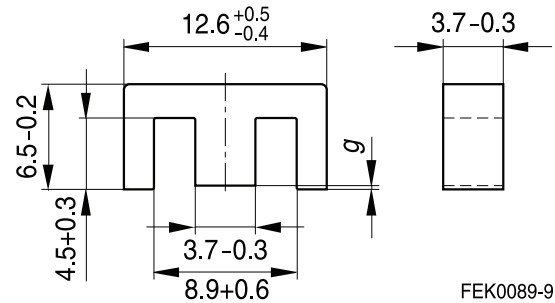
Date: **May 2017**

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E 13/7/4 (EF 12.6)
Core
B66305

- To IEC 62317-8
- For miniature transformers
- Available with SMD coil former
- E cores with high permeability for common-mode chokes and broadband applications
- Delivery mode: single units



FEK0089-9

Magnetic characteristics (per set)

$$\Sigma l/A = 2.39 \text{ mm}^{-1}$$

$$l_e = 29.6 \text{ mm}$$

$$A_e = 12.4 \text{ mm}^2$$

$$A_{\min} = 12.2 \text{ mm}^2$$

$$V_e = 367 \text{ mm}^3$$

Approx. weight 2 g/set
Ungapped

| Material | A_L value nH | μ_e | P_V W/set | Ordering code |
|----------|-------------------|---------|----------------------------------|-----------------|
| N30 | 1000 +30/-20% | 1900 | | B66305G0000X130 |
| T65 | 1300 ±30% | 2470 | | B66305G0000X165 |
| T65 | 1900 ±30% | 3610 | | B66305F0000X165 |
| T46 | 3600 ±30% | 6839 | | B66305F0000X146 |
| N27 | 800 +30/-20% | 1510 | < 0.40 (200 mT, 100 kHz, 100 °C) | B66305G0000X127 |
| N87 | 850 +30/-20% | 1620 | < 0.20 (200 mT, 100 kHz, 100 °C) | B66305G0000X187 |

Gapped (A_L values/air gaps examples)

| Material | g mm | A_L value approx. nH | μ_e | Ordering code |
|----------|------------|---------------------------|---------|-----------------|
| N27 | 0.04 ±0.01 | 250 | 454 | B66305G0040X127 |
| | 0.5 ±0.05 | 45 | 85 | B66305G0500X127 |
| N87 | 0.04 ±0.01 | 280 | 530 | B66305G0040X187 |
| | 0.13 ±0.02 | 112 | 215 | B66305G0130X187 |
| | 0.30 ±0.02 | 64 | 122 | B66305G0300X187 |

The A_L value in the table applies to a core set comprising one ungapped core (dimension $g = 0$ mm) and one gapped core (dimension $g > 0$ mm).

Other A_L values/air gaps and materials available on request – see Processing remarks on page 8.

Calculation factors (for formulas, see “*E cores: general information*”)

| Material | Relationship between air gap – A_L value | | Calculation of saturation current | | | |
|----------|--|------------|-----------------------------------|------------|-------------|-------------|
| | K1 (25 °C) | K2 (25 °C) | K3 (25 °C) | K4 (25 °C) | K3 (100 °C) | K4 (100 °C) |
| N27 | 28.4 | -0.676 | 36.5 | -0.847 | 33.2 | -0.865 |
| N87 | 28.4 | -0.676 | 37.5 | -0.796 | 32.1 | -0.873 |

Validity range: K1, K2: 0.03 mm < s < 1.00 mm
 K3, K4: 30 nH < A_L < 260 nH

Coil former (magnetic axis horizontal or vertical)

Material: GFR polyterephthalate (UL 94 V-0, insulation class to IEC 60085:

F \triangleq max. operating temperature 155 °C), color code black

Valox 420-SE0® [E207780 (M)], SABIC JAPAN L L C

Solderability: to IEC 60068-2-20, test Ta, method 1 (aging 3): 235 °C, 2 s

Resistance to soldering heat: to IEC 60068-2-20, test Tb, method 1B: 350 °C, 3.5 s

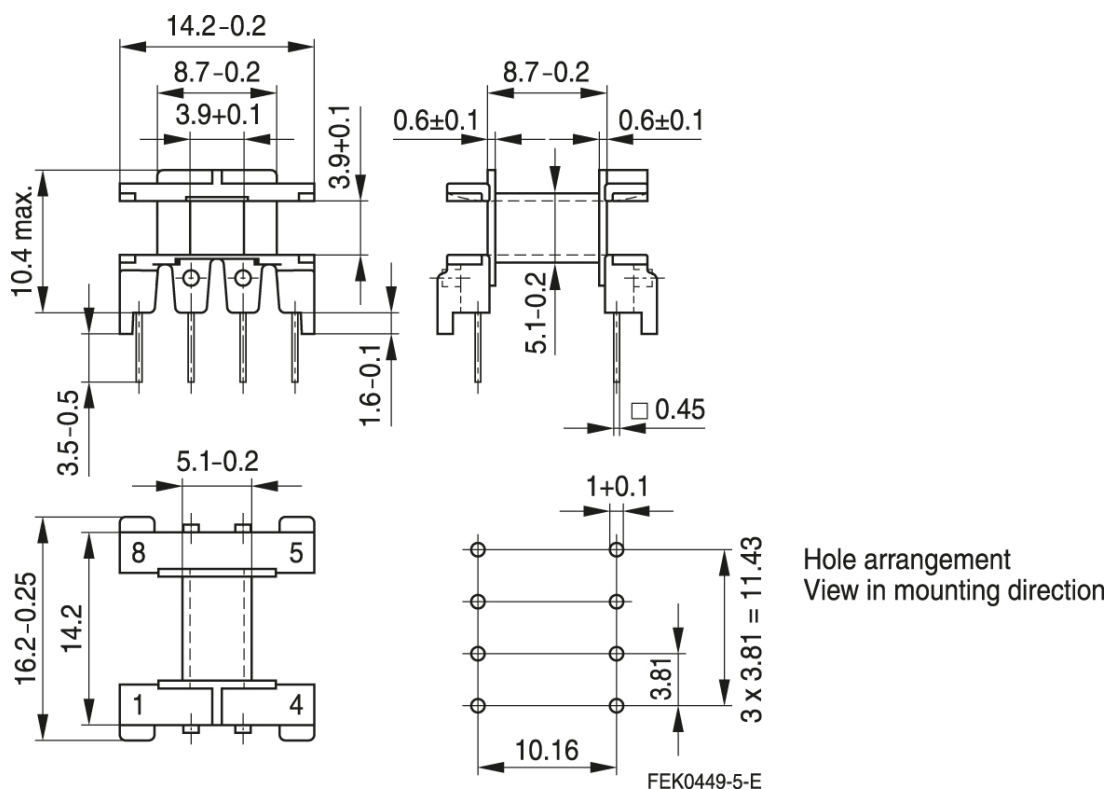
Winding: see Processing notes, 2.1

Pins: Squared pins

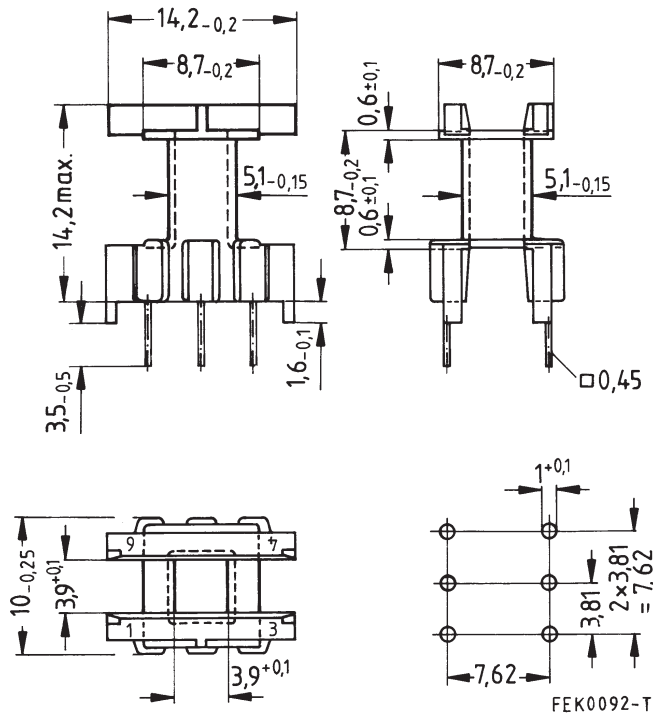
Yoke

Material: Stainless spring steel (0.2 mm)

| Coil former | | | | | | Ordering code |
|--|----------|--------------------------|-------------|----------------------------|------|-----------------|
| Version | Sections | A_N mm ² | l_N mm | A_R value $\mu\Omega$ | Pins | |
| Horizontal | 1 | 11.6 | 27.2 | 80.6 | 8 | B66202B1108T001 |
| Vertical | 1 | 11.6 | 27.2 | 80.6 | 6 | B66202B1106T001 |
| Yoke (ordering code per piece, 2 are required) | | | | | | B66202A2010X000 |

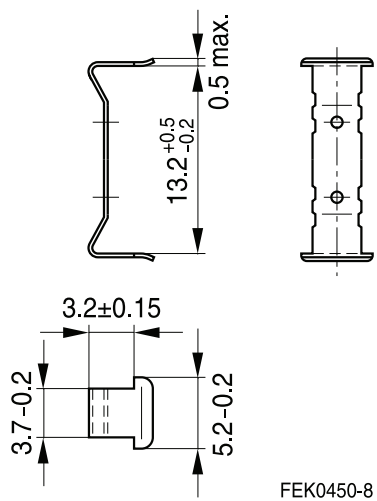
Horizontal version


Vertical version



Hole arrangement
View in mounting direction

Yoke



SMD

SMD coil former with gullwing terminals

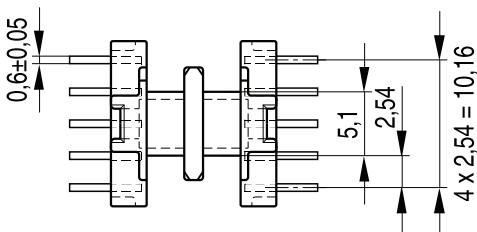
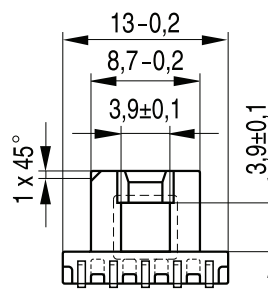
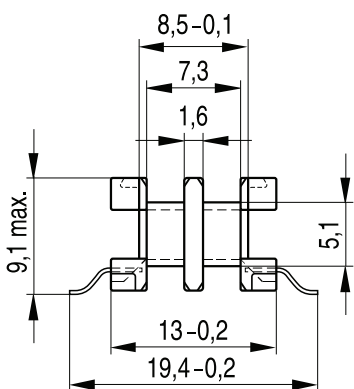
Material: GFR liquid crystal polymer (UL 94 V-0, insulation class to IEC 60085:
 $F \triangleq$ max. operating temperature 155 °C), color code black
 Vectra E 130i [E106764 (M)], POLYPLASTICS CO LTD
 Vectra E 130i [E83005 (M)], CELANESE INTERNATIONAL CORP.

Solderability: to IEC 60068-2-58, test Td, method 6 (Group 3): 245 °C, 3 s

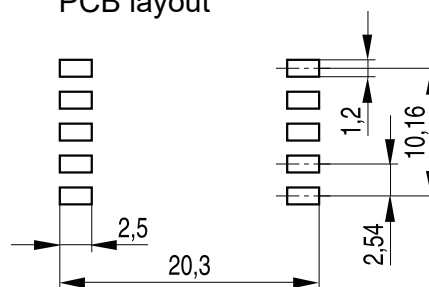
Resistance to soldering heat: to IEC 60068-2-58, test Td, method 6 (Group 3): 255 °C, 10 s
 permissible soldering temperature for wire-wrap connection on coil former: 400 °C, 1 s

Winding: see Processing notes, 2.1

| Sections | A_N mm ² | l_N mm | A_R value $\mu\Omega$ | Terminals | Ordering code |
|----------|--------------------------|-------------|----------------------------|-----------|-----------------|
| 1 | 13.0 | 27 | 71 | 10 | B66306C1010T001 |
| 2 | 10.2 | 27 | 91 | 10 | B66306C1010T002 |



Recommended PCB layout



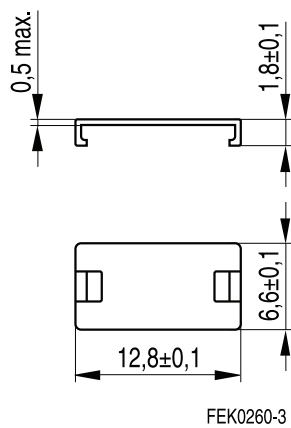
FEK0291-X

Cover plate

Material: GFR liquid crystal polymer (UL 94 V-0, insulation class to IEC 60085:
 F \triangleq max. operating temperature 155 °C), color code black
 Sumika Super E4008® [E54705 (M)], SUMITOMO CHEMICAL CO LTD

- For stamping and for improved processing on assembly machines
- See under SMD coil former for material and resistance to soldering heat

| | |
|-------------|-----------------|
| | Ordering code |
| Cover plate | B66414A7000X000 |



Ferrites and accessories

Cautions and warnings

Mechanical stress and mounting

Ferrite cores have to meet mechanical requirements during assembling and for a growing number of applications. Since ferrites are ceramic materials one has to be aware of the special behavior under mechanical load.

As valid for any ceramic material, ferrite cores are brittle and sensitive to any shock, fast temperature changing or tensile load. Especially high cooling rates under ultrasonic cleaning and high static or cyclic loads can cause cracks or failure of the ferrite cores.

For detailed information see data book, chapter “*General - Definitions, 8.1*”.

Effects of core combination on A_L value

Stresses in the core affect not only the mechanical but also the magnetic properties. It is apparent that the initial permeability is dependent on the stress state of the core. The higher the stresses are in the core, the lower is the value for the initial permeability. Thus the embedding medium should have the greatest possible elasticity.

For detailed information see data book, chapter “*General - Definitions, 8.1*”.

Heating up

Ferrites can run hot during operation at higher flux densities and higher frequencies.

NiZn-materials

The magnetic properties of NiZn-materials can change irreversible in high magnetic fields.

Ferrite Accessories

EPCOS ferrite accessories have been designed and evaluated only in combination with EPCOS ferrite cores. EPCOS explicitly points out that EPCOS ferrite accessories or EPCOS ferrite cores may not be compatible with those of other manufacturers. Any such combination requires prior testing by the customer and will be at the customer's own risk.

EPCOS assumes no warranty or reliability for the combination of EPCOS ferrite accessories with cores and other accessories from any other manufacturer.

Processing remarks

The start of the winding process should be soft. Else the flanges may be destroyed.

- Too strong winding forces may blast the flanges or squeeze the tube that the cores can not be mounted any more.
- Too long soldering time at high temperature (>300 °C) may effect coplanarity or pin arrangement.
- Not following the processing notes for soldering of the J-leg terminals may cause solderability problems at the transformer because of pollution with Sn oxyde of the tin bath or burned insulation of the wire. For detailed information see chapter “*Processing notes*”, section 2.2.
- The dimensions of the hole arrangement have fixed values and should be understood as a recommendation for drilling the printed circuit board. For dimensioning the pins, the group of holes can only be seen under certain conditions, as they fit into the given hole arrangement. To avoid problems when mounting the transformer, the manufacturing tolerances for positioning the customers' drilling process must be considered by increasing the hole diameter.

Display of ordering codes for EPCOS products

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Ferrites and accessories

Symbols and terms

| Symbol | Meaning | Unit |
|---------------------|---|------------------------------|
| A | Cross section of coil | mm ² |
| A _e | Effective magnetic cross section | mm ² |
| A _L | Inductance factor; $A_L = L/N^2$ | nH |
| A _{L1} | Minimum inductance at defined high saturation ($\hat{=} \mu_a$) | nH |
| A _{min} | Minimum core cross section | mm ² |
| A _N | Winding cross section | mm ² |
| A _R | Resistance factor; $A_R = R_{Cu}/N^2$ | $\mu\Omega = 10^{-6} \Omega$ |
| B | RMS value of magnetic flux density | Vs/m ² , mT |
| ΔB | Flux density deviation | Vs/m ² , mT |
| \hat{B} | Peak value of magnetic flux density | Vs/m ² , mT |
| $\Delta \hat{B}$ | Peak value of flux density deviation | Vs/m ² , mT |
| B _{DC} | DC magnetic flux density | Vs/m ² , mT |
| B _R | Remanent flux density | Vs/m ² , mT |
| B _S | Saturation magnetization | Vs/m ² , mT |
| C ₀ | Winding capacitance | F = As/V |
| CDF | Core distortion factor | mm ^{-4.5} |
| DF | Relative disaccommodation coefficient $DF = d/\mu_i$ | |
| d | Disaccommodation coefficient | |
| E _a | Activation energy | J |
| f | Frequency | s ⁻¹ , Hz |
| f _{cutoff} | Cut-off frequency | s ⁻¹ , Hz |
| f _{max} | Upper frequency limit | s ⁻¹ , Hz |
| f _{min} | Lower frequency limit | s ⁻¹ , Hz |
| f _r | Resonance frequency | s ⁻¹ , Hz |
| f _{Cu} | Copper filling factor | |
| g | Air gap | mm |
| H | RMS value of magnetic field strength | A/m |
| \hat{H} | Peak value of magnetic field strength | A/m |
| H _{DC} | DC field strength | A/m |
| H _c | Coercive field strength | A/m |
| h | Hysteresis coefficient of material | 10 ⁻⁶ cm/A |
| h/μ_i^2 | Relative hysteresis coefficient | 10 ⁻⁶ cm/A |
| I | RMS value of current | A |
| I _{DC} | Direct current | A |
| \hat{I} | Peak value of current | A |
| J | Polarization | Vs/m ² |
| k | Boltzmann constant | J/K |
| k ₃ | Third harmonic distortion | |
| k _{3c} | Circuit third harmonic distortion | |
| L | Inductance | H = Vs/A |

Ferrites and accessories
Symbols and terms

| Symbol | Meaning | Unit |
|---------------------|--|--------------------|
| $\Delta L/L$ | Relative inductance change | H |
| L_0 | Inductance of coil without core | H |
| L_H | Main inductance | H |
| L_p | Parallel inductance | H |
| L_{rev} | Reversible inductance | H |
| L_s | Series inductance | H |
| l_e | Effective magnetic path length | mm |
| l_N | Average length of turn | mm |
| N | Number of turns | |
| P_{Cu} | Copper (winding) losses | W |
| P_{trans} | Transferrable power | W |
| P_V | Relative core losses | mW/g |
| PF | Performance factor | |
| Q | Quality factor ($Q = \omega L/R_s = 1/\tan \delta_L$) | |
| R | Resistance | Ω |
| R_{Cu} | Copper (winding) resistance ($f = 0$) | Ω |
| R_h | Hysteresis loss resistance of a core | Ω |
| ΔR_h | R_h change | Ω |
| R_i | Internal resistance | Ω |
| R_p | Parallel loss resistance of a core | Ω |
| R_s | Series loss resistance of a core | Ω |
| R_{th} | Thermal resistance | K/W |
| R_V | Effective loss resistance of a core | Ω |
| s | Total air gap | mm |
| T | Temperature | $^{\circ}\text{C}$ |
| ΔT | Temperature difference | K |
| T_C | Curie temperature | $^{\circ}\text{C}$ |
| t | Time | s |
| t_v | Pulse duty factor | |
| $\tan \delta$ | Loss factor | |
| $\tan \delta_L$ | Loss factor of coil | |
| $\tan \delta_r$ | (Residual) loss factor at $H \rightarrow 0$ | |
| $\tan \delta_e$ | Relative loss factor | |
| $\tan \delta_h$ | Hysteresis loss factor | |
| $\tan \delta/\mu_i$ | Relative loss factor of material at $H \rightarrow 0$ | |
| U | RMS value of voltage | V |
| \hat{U} | Peak value of voltage | V |
| V_e | Effective magnetic volume | mm^3 |
| Z | Complex impedance | Ω |
| Z_n | Normalized impedance $ Z _n = Z /N^2 \times \epsilon (l_e/A_e)$ | Ω/mm |

Ferrites and accessories

Symbols and terms

| Symbol | Meaning | Unit |
|--------------|--|-----------------------------------|
| α | Temperature coefficient (TK) | 1/K |
| α_F | Relative temperature coefficient of material | 1/K |
| α_e | Temperature coefficient of effective permeability | 1/K |
| ϵ_r | Relative permittivity | |
| Φ | Magnetic flux | Vs |
| η | Efficiency of a transformer | |
| η_B | Hysteresis material constant | mT ⁻¹ |
| η_i | Hysteresis core constant | A ⁻¹ H ^{-1/2} |
| λ_s | Magnetostriction at saturation magnetization | |
| μ | Relative complex permeability | |
| μ_0 | Magnetic field constant | Vs/Am |
| μ_a | Relative amplitude permeability | |
| μ_{app} | Relative apparent permeability | |
| μ_e | Relative effective permeability | |
| μ_i | Relative initial permeability | |
| μ_p' | Relative real (inductive) component of $\bar{\mu}$ (for parallel components) | |
| μ_p'' | Relative imaginary (loss) component of $\bar{\mu}$ (for parallel components) | |
| μ_r | Relative permeability | |
| μ_{rev} | Relative reversible permeability | |
| μ_s' | Relative real (inductive) component of $\bar{\mu}$ (for series components) | |
| μ_s'' | Relative imaginary (loss) component of $\bar{\mu}$ (for series components) | |
| μ_{tot} | Relative total permeability derived from the static magnetization curve | |
| ρ | Resistivity | Ωm^{-1} |
| $\Sigma l/A$ | Magnetic form factor | mm^{-1} |
| τ_{Cu} | DC time constant $\tau_{Cu} = L/R_{Cu} = A_L/A_R$ | s |
| ω | Angular frequency; $\omega = 2 \Pi f$ | s ⁻¹ |

All dimensions are given in mm.

SMD Surface-mount device

Important notes

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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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Release 2018-10

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