# Ferrites and accessories

## EELP 64, EILP 64
## Core set (without clamp recess)

**Series/Type:** **B66295G, B66295K**
Date: June 2013

**Core set EELP 64**
**Combination: ELP 64/10/50 with ELP 64/10/50**

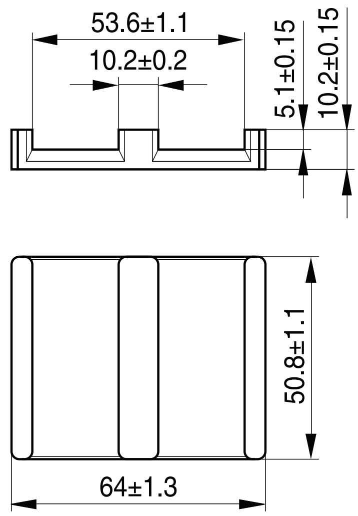
- To IEC 62317-9
- Delivery mode: single units

**Magnetic characteristics** (per set)

$\Sigma l/A$ = 0.15 $mm^{-1}$
$l_e$ = 79.9 mm
$A_e$ = 519 $mm^2$
$A_{min}$ = 518 $mm^2$
$V_e$ = 41500 $mm^3$

**Approx. weight** 210 g/set

**ELP 64/10/50**




**Ungapped**

| Material | $A_L$ value nH | $\mu_e$ | $B_S$* mT | $P_V$ W/set | Ordering code (per piece) |
|---|---|---|---|---|---|
| N49 | 8000 ±30% | 980 | 250 | < 10.7 ( 50 mT, 500 kHz, 100 °C) | B66295G0000X149 |
| N87 | 12500 ±25% | 1490 | 300 | < 26.0 (200 mT, 100 kHz, 100 °C) | B66295G0000X187 |
| N97 | 12500 ±25% | 1531 | 310 | < 19.0 (200 mT, 100 kHz, 100 °C) | B66295G0000X197 |

* H = 250 A/m; f = 10 kHz; T = 100 °C

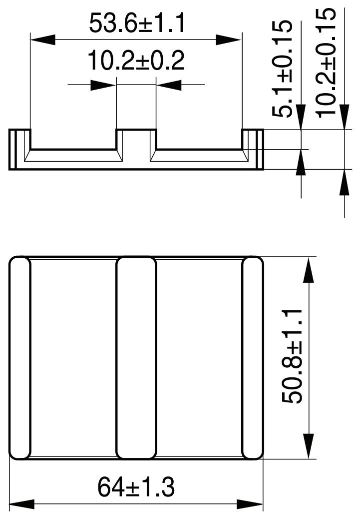
**Calculation factors** (for formulas, see *"E cores: general information"*)
**EELP 64:**

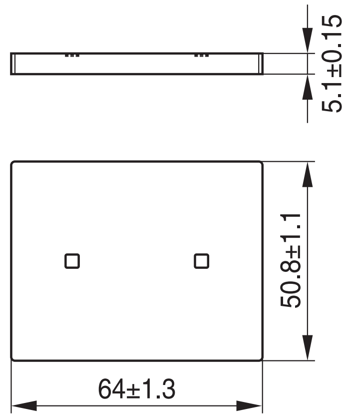
| Material | Relationship between air gap – $A_L$ value | | Calculation of saturation current | | | |
|---|---|---|---|---|---|---|
| | K1 (25 °C) | K2 (25 °C) | K3 (25 °C) | K4 (25 °C) | K3 (100 °C) | K4 (100 °C) |
| N87 | 820 | –0.767 | 1280 | –0.796 | 1182 | –0.873 |

Validity range: K1, K2: 0.10 mm < s < 2.00 mm
K3, K4: 480 nH < $A_L$ < 4800 nH

**Core set EILP 64**
**Combination:**
**ELP 64/10/50 with I 64/5/50**

- To IEC 62317-9
- Delivery mode: single units




**Magnetic characteristics** (per set)

$\Sigma l/A$ = 0.13 $mm^{-1}$
$l_e$ = 69.7 mm
$A_e$ = 519 $mm^2$
$A_{min}$ = 518 $mm^2$
$V_e$ = 36200 $mm^3$

**Approx. weight** 185 g/set

**Ungapped**

| Material | $A_L$ value nH | $\mu_e$ | $B_S$* mT | $P_V$ W/set | Ordering code (per piece) |
|---|---|---|---|---|---|
| N49 | 8900 ±30% | 950 | 250 | < 9.3 ( 50 mT, 500 kHz, 100 °C) | B66295G0000X149 (ELP core)<br>B66295K0000X149 (I core)** |
| N87 | 14000 ±25% | 1450 | 300 | < 23.0 (200 mT, 100 kHz, 100 °C) | B66295G0000X187 (ELP core)<br>B66295K0000X187 (I core)** |

* H = 250 A/m; f = 10 kHz; T = 100 °C
** Plate-type tool type

**Calculation factors** (for formulas, see *"E cores: general information"*)
**EILP 64:**

| 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) |
| N87 | 835 | –0.790 | 1316 | –0.796 | 1203 | –0.873 |

Validity range: K1, K2: 0.10 mm < s < 2.00 mm
K3, K4: 480 nH < $A_L$ < 4800 nH

### 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 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 chapter *"Definitions"*, section 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 chapter *"Definitions"*, section 8.2.

### 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.

### Processing notes

- The start of the winding process should be soft. Else the flanges may be destroid.
- To strong winding forces may blast the flanges or squeeze the tube that the cores can no more be mount.
- To 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 oxyd of the tin bath or burned insulation of the wire. For detailed information see chapter *"Processing notes"*, section 8.2.
- 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.

## 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 ($\triangleq \mu_a$) | 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 |
| $\Delta B$ | 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 |
| $h/\mu_i^2$ | 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 |

## 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 |
| $\Delta R_h$ | $R_h$ 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 | °C |
| $\Delta T$ | Temperature difference | K |
| $T_C$ | Curie temperature | °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 $\lvert Z\rvert_n = \lvert Z\rvert / N^2 \times \varepsilon\ (l_e/A_e)$ | Ω/mm |

## Symbols and terms

| Symbol | Meaning | Unit |
|---|---|---|
| $\alpha$ | Temperature coefficient (TK) | 1/K |
| $\alpha_F$ | Relative temperature coefficient of material | 1/K |
| $\alpha_e$ | Temperature coefficient of effective permeability | 1/K |
| $\varepsilon_r$ | Relative permittivity | |
| $\Phi$ | Magnetic flux | Vs |
| $\eta$ | Efficiency of a transformer | |
| $\eta_B$ | Hysteresis material constant | $mT^{-1}$ |
| $\eta_i$ | Hysteresis core constant | $A^{-1}H^{-1/2}$ |
| $\lambda_s$ | Magnetostriction at saturation magnetization | |
| $\mu$ | Relative complex permeability | |
| $\mu_0$ | Magnetic field constant | Vs/Am |
| $\mu_a$ | Relative amplitude permeability | |
| $\mu_{app}$ | Relative apparent permeability | |
| $\mu_e$ | Relative effective permeability | |
| $\mu_i$ | Relative initial permeability | |
| $\mu_p'$ | Relative real (inductive) component of $\bar{\mu}$ (for parallel components) | |
| $\mu_p''$ | Relative imaginary (loss) component of $\bar{\mu}$ (for parallel components) | |
| $\mu_r$ | Relative permeability | |
| $\mu_{rev}$ | Relative reversible permeability | |
| $\mu_s'$ | Relative real (inductive) component of $\bar{\mu}$ (for series components) | |
| $\mu_s''$ | Relative imaginary (loss) component of $\bar{\mu}$ (for series components) | |
| $\mu_{tot}$ | Relative total permeability derived from the static magnetization curve | |
| $\rho$ | Resistivity | $\Omega m^{-1}$ |
| $\Sigma l/A$ | Magnetic form factor | $mm^{-1}$ |
| $\tau_{Cu}$ | DC time constant $\tau_{Cu} = L/R_{Cu} = A_L/A_R$ | s |
| $\omega$ | Angular frequency; $\omega = 2\,\Pi f$ | $s^{-1}$ |

All dimensions are given in mm.

SMD Surface-mount device

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