



Ferrites and accessories

FPC film
C350, C351

Series/Type: **B68450, B68451**

Date: **May 2018**

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Basic features

- FPC is a composite material of polymer and ferrite
- FPC film is a thin, mechanically flexible film

Technical benefits

- Stable magnetic characteristics
- Low weight: FPC film is 40% lower in density than ferrite
- High mechanical strength
- Shaping as required: customer-specific solutions possible
- Economy: easy transport and storage, simple, rationalized processing, low mounting volume
- C351 film suitable for high-temperature applications (up to 200 °C)
- Material C351 approved to UL 94-V0 (E 140 693)
- Various film thickness (from 0.2 to 0.4 mm), thickness tolerance $\pm 15\%$
- Self-adhesive versions (limited shelf life)

Applications

- Implementation of low-profile coils, e.g. for
 - identification systems
 - security tags for electronic article surveillance
 - sensors
 - inductive reading of smart cards
- Electromagnetic shielding of coils from metals to prevent interference
- EMC: absorption of radiated emissions at frequencies ≥ 500 MHz
- Compensation of deflection yokes to correct distortion at the corners of TV screens and monitors
- Spacing between ferrite cores (as a substitute for air gaps or non-magnetic films) for
 - suppression of the leakage field
 - adjustment of the biasing curve

| | |
|-------------------|-----------------------|
| FPC film | |
| C350, C351 | B68450, B68451 |

Ordering details

The ordering codes are structured as follows:

| 1st group Design | 2nd group Film thickness/width | | 3rd group Material | |
|-----------------------------------------|-----------------------------------|--------------|-----------------------|------------|
| B68450 = Film on reel | A = 0.2 mm | 0080 = 80 mm | X = Default letter | 350 = C350 |
| | B = 0.3 mm | | | 351 = C351 |
| B68451 = Film on reel, self-adhesive | | | | |

| Material | Thickness (mm) | Extra features | Ordering code |
|----------|----------------|----------------|-------------------------------|
| C350 | 0.2 | | B68450A0080X350 |
| C351 | 0.2 | | B68450A0080X351 |
| C350 | 0.2 | self-adhesive | B68451A0080X350 ¹⁾ |
| C351 | 0.3 | self-adhesive | B68451B0080X351 ¹⁾ |

FPC film is supplied in units of 50 m length.

¹⁾ On request

FPC film
C350, C351
B68450, B68451
Physical properties (material values defined on 0.2 mm thick film)

| Material | Symbol | Unit | C350 | C351 ³⁾ |
|---------------------------------------------------------------------------|----------------------------------|----------------------|-----------------------|-----------------------|
| Initial permeability ¹⁾ f = 1 MHz | μ_i | | 9 ±30% | 9 ±30% |
| Flux density (near saturation) ¹⁾ H = 25 kA/m f = 10 kHz | B_S | mT | 255 | 255 |
| Remanent flux density ¹⁾ H = 25 kA/m f = 10 kHz | B_r | mT | 9 | 9 |
| Coercive field strength ¹⁾ H = 25 kA/m f = 10 kHz | H_C | A/m | 600 | 600 |
| Relative loss factor ¹⁾ f = 10 MHz f = 1 GHz | $\tan\delta/\mu_i$ | | <0.005 <0.400 | <0.005 <0.400 |
| Hysteresis material constant | η_B | 10 ⁻³ /mT | <2 | <2 |
| Temperature coefficient ¹⁾ | $\alpha = \Delta\mu/\mu\Delta T$ | 1/K | <5 · 10 ⁻⁵ | <5 · 10 ⁻⁵ |
| Density | | kg/m ³ | 2930 | 2930 |
| Resistivity ¹⁾ f = 1 kHz f = 10 MHz | ρ | Ωm | 500 100 | 500 100 |
| Dielectric constant ¹⁾ f = 1 kHz f = 10 MHz | ϵ_r | | 700 21 | 700 21 |
| Dielectric strength | | kV/mm | 1 | 0.8 |
| Max. operating temperature | T_{max} | °C | 120 | 200 |
| Tensile strength ²⁾ | σ_Z | N/mm ² | 1.5 | 2.5 |

1) T = 25 °C to IEC 51 (CO) 282

2) T = 23 °C and 50% r.h.

3) UL 94, flame class V0 (listed E 140 693)

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

The ordering code for one and the same product can be represented differently in data sheets, data books, other publications and the website of EPCOS, or in order-related documents such as shipping notes, order confirmations and product labels. **The varying representations of the ordering codes are due to different processes employed and do not affect the specifications of the respective products.** Detailed information can be found on the Internet under www.epcos.com/orderingcodes.

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

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Release 2018-10

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