

Miniature drum cores for power inductors



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Introduction

Today's miniaturization trends are leading to smaller, light, hand held devices. Both the size and the need for micro power are driving the necessity for very small power inductors.

FERROXCUBE new series of mini drum cores for power inductors has been developed in the most advanced materials to meet the demand for smaller, thinner and advanced-featured products.

With a maximum height which can go down to 0.8 mm the new series of small drum cores will help designers to succeed in selecting magnetic cores.

Main applications of the end power inductors are telecom, lap tops, set-top boxes, hand held equipment....

Features

- Very low profile (max. height down to 0.8 mm).
- Advanced power and high resistivity materials.
- Very high saturation.
- Broad bandwidth.
- Micro-precision in mechanical dimensions.
- Controlled ferrite process.
- Superior physical properties.
- Custom designs.

Material selection

MnZn material is preferred when high B_{sat} and high T_c are important. 3C92 is a new power material, optimized with respect to these parameters. Application frequencies are up to 400 kHz, depending on ripple current.

NiZn material is preferred when high resistivity and low losses at high frequencies are required. Our materials 4A11 and 4B1 have the right characteristics for this application. 4A11 provides medium inductance, low saturation, high resistivity and low T_c . It operates up to 1 MHz. 4B1 provides lower inductance, medium saturation, high resistivity and high T_c and is recommended for operating frequencies between 1 and 3 MHz.

Technical capabilities

FERROXCUBE's manufacturing expertise and technology allow a very robust and precise product.

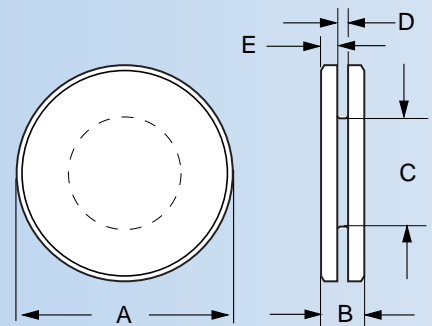
Custom designs can be made within the following dimensions:

- A - Min/max disc diameter: 3.5 mm to 8 mm, tolerance ± 0.1
- B - Min/max height: 0.8 mm to 3 mm, tolerance ± 0.1 for lowest profiles, ± 0.15 for larger ones
- C - Minimum pin diameter: 1.5 mm, tolerance ± 0.1
- D - Minimum slot height: 0.25 mm
- E - Minimum disc thickness: 0.25 mm

Presently available standard sizes are:

D: Drum Core
C(optional): parylene
dimensions ACBD

DC42182009
DC41151409
DC41150803
DC41151405
DC41180803



Electrical characteristics

Miniature drum cores are specified in the following way:

- Inductance without DC current (L_1), tolerance $\pm 10\%$
- DC current is rated so L drops $\approx 15\%$.
- Inductance with DC current minimum: $L_2 > 80\%$ of L_1

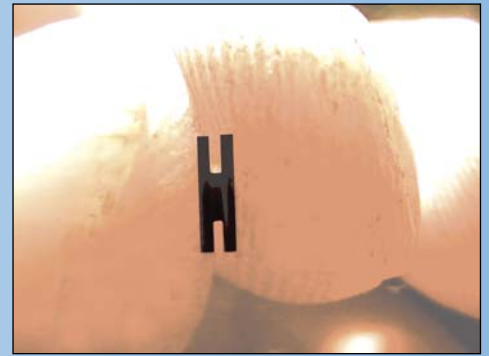
Measuring conditions are:

- Winding is chosen to ensure accuracy and reliability of measurement:
- Wire gauge: smaller than half the slot height (D dimension). Maximum diameter: 0.5 mm.
- Number of turns is defined so L_1 and L_2 tested values are higher than $1 \mu\text{H}$ to have enough accuracy and reliability. Turns should fill homogeneously the winding window,

keeping a free distance from the top of the winding to the edge of the disc of 0.5 mm.

- Winding window (W_w) is defined: $B + 2 \times W_w + 2 \times 0.5 = C$
- Winding distribution is uniform to make the fringing flux constant from product to product.

Equipment to measure inductance with and without DC bias is LCR HP4284A and power supply HP42841A.



How small they are

Advantages of the new high B_{sat} material 3C92 for power inductors

3C92 - Material Characteristics

A low frequency, high B_{sat} power material for use in power inductors at frequencies up to 0.4 MHz.

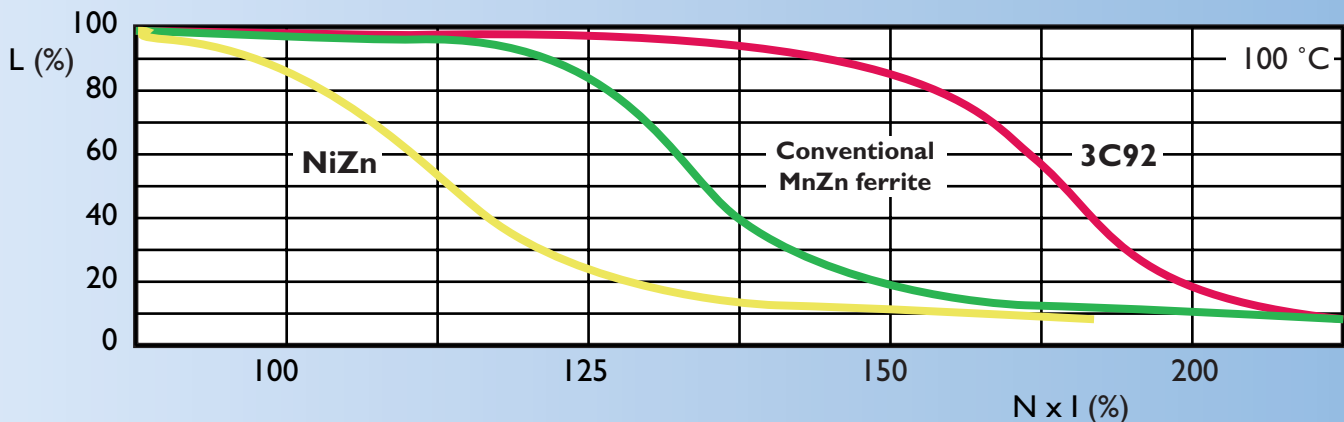
SYMBOL	CONDITIONS	VALUE	UNIT
μ_i	25 °C; ≤ 10 kHz; 0.1 mT	$1500 \pm 20\%$	
μ_a	100 °C; 25 kHz; 200 mT	≈ 5000	
B	25 °C; 10 kHz; 250 A/m 100 °C; 10 kHz; 250 A/m	≈ 470 ≈ 410	mT
P_v	100 °C; 25 kHz; 200 mT 100 °C; 100 kHz; 200 mT	≈ 50 ≈ 350	kW/m^3
ρ	DC; 25 °C	≈ 5	Ωm
T_c		≈ 280	°C
density		≈ 4800	kg/m^3

During operation, power inductors made from miniature drum cores can become very hot, depending on the application.

In some applications the wire carries high currents and the ferrite will heat up as a result of alternating flux densities in the core. The latter will especially be the case in buck- or boost converters.

For these reasons operating temperatures of 100 °C or higher are more rule than exception. Therefore a high saturation level of the ferrite at

high temperatures is a key issue for the maximum load current of a power inductor. This is exactly the strong point of the new FERROXCUBE ferrite material 3C92. From the graph below it is clear that a drum core from this ferrite, instead of a NiZn ferrite, will boost the saturation current of an inductor with approximately 50%. Since energy storage is increasing with I^2 , this means a gain of even more than 100% with respect to NiZn drum cores and 50% compared to conventional MnZn ferrites.



Effect of material choice on saturation currents

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