

# Miniature drum cores for power inductors



# Mini drum cores for power inductors

## 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 Bsat and high Tc 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 Tc. It operates up to 1 MHz. 4B1 provides lower inductance, medium saturation, high resistivity and high Tc 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.

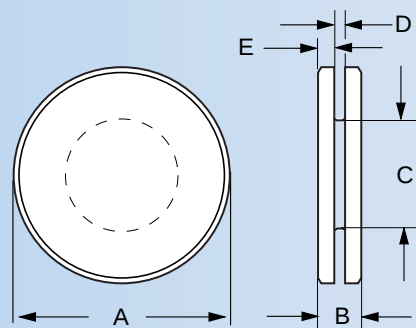
Custom designs can be made within the following dimensions:

- A - Min/max disc diameter: 3.5 mm to 8 mm, tolerance  $\pm 0.1$
- B - Min/max height: 0.8 mm to 3 mm, tolerance  $\pm 0.1$  for lowest profiles,  $\pm 0.15$  for larger ones
- C - Minimum pin diameter: 1.5 mm, tolerance  $\pm 0.1$
- 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  $L_1$

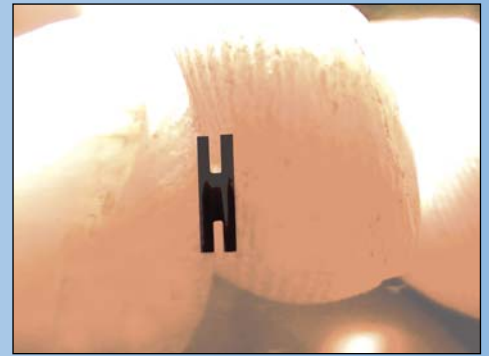
Measuring conditions are:

- 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 (Ww) is defined:  $B + 2 \times Ww + 2 \times 0.5 = C$
- 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 Bsat material 3C92 for power inductors

### 3C92 - Material Characteristics

A low frequency, high Bsat power material for use in power inductors at frequencies up to 0.4 MHz.

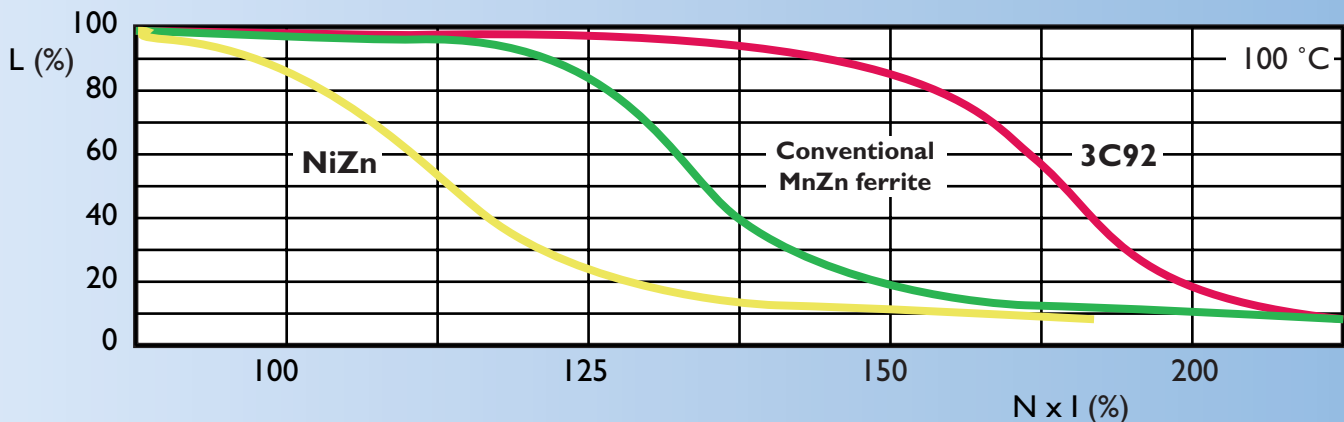
| SYMBOL  | CONDITIONS                   | VALUE           | UNIT              |
|---------|------------------------------|-----------------|-------------------|
| $\mu_i$ | 25 °C; $\leq 10$ kHz; 0.1 mT | $1500 \pm 20\%$ |                   |
| $\mu_a$ | 100 °C; 25 kHz; 200 mT       | $\approx 5000$  |                   |
| B       | 25 °C; 10 kHz; 250 A/m       | $\approx 470$   | mT                |
|         | 100 °C; 10 kHz; 250 A/m      | $\approx 410$   |                   |
| $P_v$   | 100 °C; 25 kHz; 200 mT       | $\approx 50$    | kW/m <sup>3</sup> |
|         | 100 °C; 100 kHz; 200 mT      | $\approx 350$   |                   |
| $\rho$  | DC; 25 °C                    | $\approx 5$     | $\Omega\text{m}$  |
| $T_c$   |                              | $\approx 280$   | °C                |
| density |                              | $\approx 4800$  | kg/m <sup>3</sup> |

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

# FERROXCUBE - your global partner

**Australia:** Contact Ferroxcube Taiwan

Tel. +886 2 86650099, Fax: +886 2 86650145

**Austria:** Contact Ferroxcube Germany

Tel: +49 (040) 527 28 305, Fax: +49 (040) 527 28 306

**Benelux:** Ferroxcube Netherlands, EINDHOVEN

Tel: +31 (0)40 27 24 216, Fax: +31 (0)40 27 24 411

**Canada:** Contact Ferroxcube USA

Tel: +1 915 8603289, Fax: +1 915 8603270

**China:** Ferroxcube Hong Kong, SHANGHAI

Tel. +86 21 6380 0607 / 3121, Fax. +86 21 6380 0910

**Czech Republic:** Contact Ferroxcube Poland

Tel: +48 46 834 00 07, Fax: +48 46 834 00 35

**Denmark:** Contact Ferroxcube Sweden

Tel: +46 8 580 119 76, Fax: +46 8 580 121 60

**Finland:** Contact Ferroxcube Sweden

Tel: +46 8 580 119 76, Fax: +46 8 580 121 60

**France:** Ferroxcube France, NANTERRE

Tel: +33 (01) 5551 8422, Fax: +33 (01) 5551 8423

**Germany:** Ferroxcube Germany, HAMBURG

Tel: +49 (040) 527 28 302, Fax: +49 (040) 527 28 306

**Greece:** Contact Ferroxcube Italy

Tel: +39 02 241131 1, Fax: +39 02 241131 11

**Hungary:** Contact Ferroxcube Poland

Tel: +48 46 834 00 07, Fax: +48 46 834 00 35

**Hong Kong:** Ferroxcube Hong Kong, HONG KONG

Tel: +852 2319 2740, Fax: +852 2319 2757

**Indonesia:** Contact Ferroxcube Singapore

Tel: +65 6244 7815, Fax: +65 6449 0446

**Ireland:** Contact Ferroxcube UK

Tel: +44 1306 646200, Fax: +44 1306 646222

**Israel:** Arrow/Rapac Ltd., PETACH TIKVA

Tel: +972 3 9203480, Fax: +972 3 9203443

**Italy:** Ferroxcube Italy, SESTO S. GIOVANNI (MI)

Tel: +39 02 241131 1, Fax: +39 02 241131 11

**Malaysia:** Contact Ferroxcube Singapore

Tel: +65 6244 7815, Fax: +65 6449 0446

**Mexico:** Contact Ferroxcube USA

Tel: +1 915 8603289, Fax: +1 915 8603270

**New Zealand:** Contact Ferroxcube Taiwan

Tel. +886 2 86650099, Fax: +886 2 86650145

**Norway:** Contact Ferroxcube Sweden

Tel: +46 8 580 119 76, Fax: +46 8 580 121 60

**Philippines:** Contact Ferroxcube Singapore

Tel: +65 6244 7815, Fax: +65 6449 0446

**Poland:** Ferroxcube Polska, SKIERNIEWICE

Tel: +48 46 834 00 07, Fax: +48 46 834 00 35

**Portugal:** Contact Hispano Ferritas, Spain

Tel: +34 (93) 317 2518, Fax: +34 (93) 302 3387

**Singapore:** Ferroxcube Singapore, SINGAPORE

Tel: +65 6244 7815, Fax: +65 6449 0446

**Slovak Republic:** Contact Ferroxcube Poland

Tel: +48 46 834 00 07, Fax: +48 46 834 00 35

**Spain:** Hispano Ferritas, BARCELONA

Tel: +34 (93) 317 2518, Fax: +34 (93) 302 3387

**Sweden:** Ferroxcube Sweden, JÄRFÄLLA

Tel: +46 8 580 119 76, Fax: +46 8 580 121 60

**Switzerland:** Contact Ferroxcube Germany

Tel: +49 (040) 527 28 305, Fax: +49 (040) 527 28 306

**Taiwan:** Ferroxcube Taiwan, TAIPEI

Tel. +886 2 86650099, Fax: +886 2 86650145

**Turkey:** Contact Ferroxcube Italy

Tel: +39 02 241131 1, Fax: +39 02 241131 11

**United Kingdom:** Ferroxcube UK, DORKING

Tel: +44 1306 646200, Fax: +44 1306 646222

**United States:** Ferroxcube USA, EL PASO (TX)

Tel: +1 915 8603289, Fax: +1 915 8603270

**For all other countries apply to closest regional sales office:**

■ HAMBURG, Germany

Tel: +49 (040) 527 28 302, Fax: +49 (040) 527 28 306

e-mail: [saleseurope@ferroxcube.com](mailto:saleseurope@ferroxcube.com)

■ EL PASO (TX), USA

Tel: +1 915 8603289, Fax: +1 915 8603270

e-mail: [salesusa@ferroxcube.com](mailto:salesusa@ferroxcube.com)

■ TAIPEI, Taiwan

Tel. +886 2 86650099, Fax: +886 2 86650145

e-mail: [salesasia@ferroxcube.com](mailto:salesasia@ferroxcube.com)

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