

NANOPERM® - Advanced softmagnetic material for EMI filter chokes



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Content of presentation

- Nanocrystalline material NANOPERM®
- Current compensated chokes
- Comparison Nanocrystalline and Ferrite core chokes

Advanced softmagnetic material for EMI filter chokes

Material properties of NANOPERM®

Alloy composition	Fe _{73,5} Cu ₁ Nb ₃ Si _{15,5} B ₇
Saturation flux density B _{sat}	1,2 T
Permeability levels μ	20.000 - 200.000
Saturation magnetostriction λ_s	< 0,5 ppm
Specific electrical resistivity σ	115 $\mu\Omega\text{cm}$
Density γ	7,35 g/cm ³
Curie temperature T _c	~ 600 °C
Max. operational temperature T _{max}	~ 120 °C (180°C)
Core losses (0,3T, 100kHz, sine) P _v	< 110 W/kg
Tape thickness d	17 / 23 μm

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Choice of softmagnetic material

Main requirement on a EMC filter choke:

High impedance $Z(f)$, $f = 150\text{kHz}$ to 30MHz

$$Z(f) = \omega * L(f) = 2\pi * f * L(f)$$

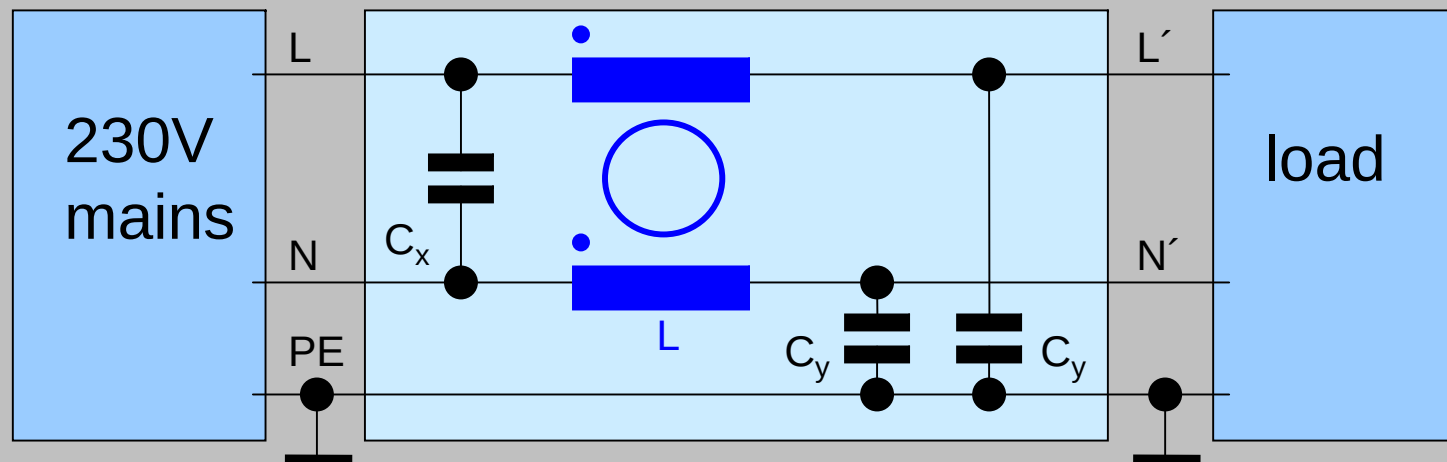
$$L(f) = A_L * n^2 \text{ with } A_L = \mu_0 * \mu_r(f) * A_{fe} / l_f$$

$$Z(f) = 2\pi * f * n^2 * \mu_0 * \mu_r(f) * A_{fe} / l_{fe}$$

n : number of turns μ_r : permeability A_{fe} : Iron cross section

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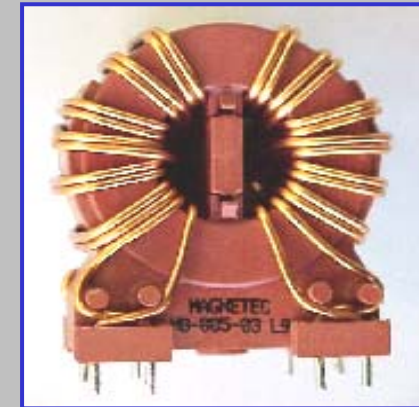
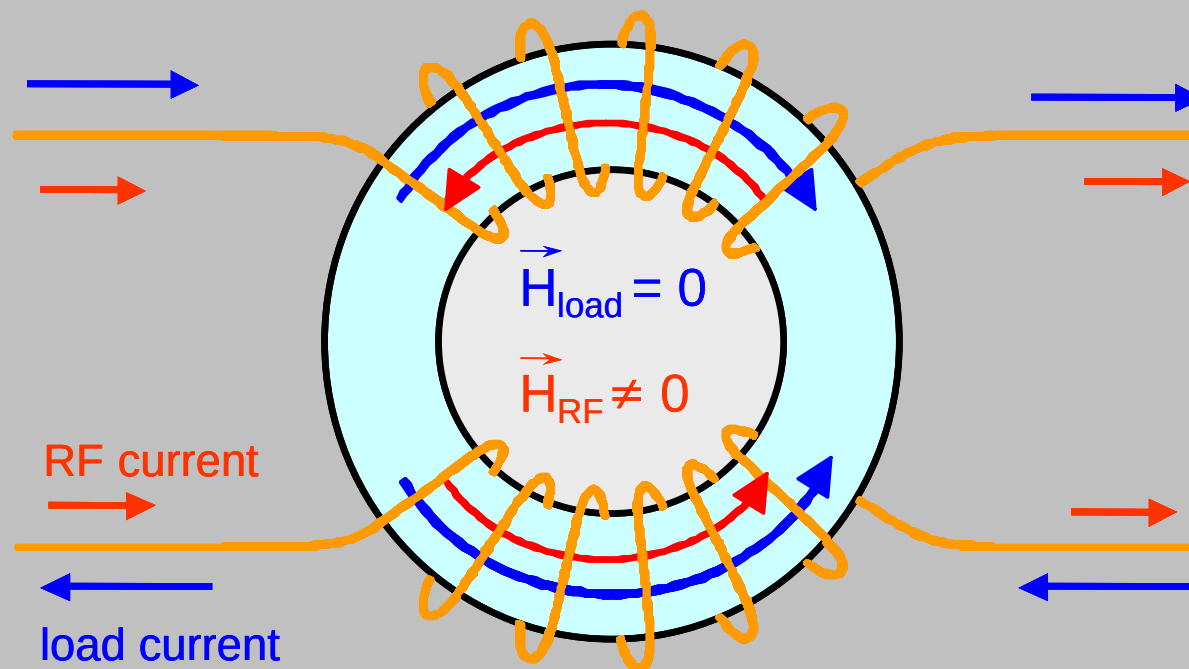
Basic circuitry of a EMI mains filter



C_x : X-capacitor, L : Current compensated choke, C_y : Y-capacitor

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Principle of a CM choke



1-phase version



3-phase version

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Benefits of NANOPERM products



- **High insertion losses**
- **Small build volume**
- **Low earth leakage currents**
- **High working temperature**
- **Best value for the money**

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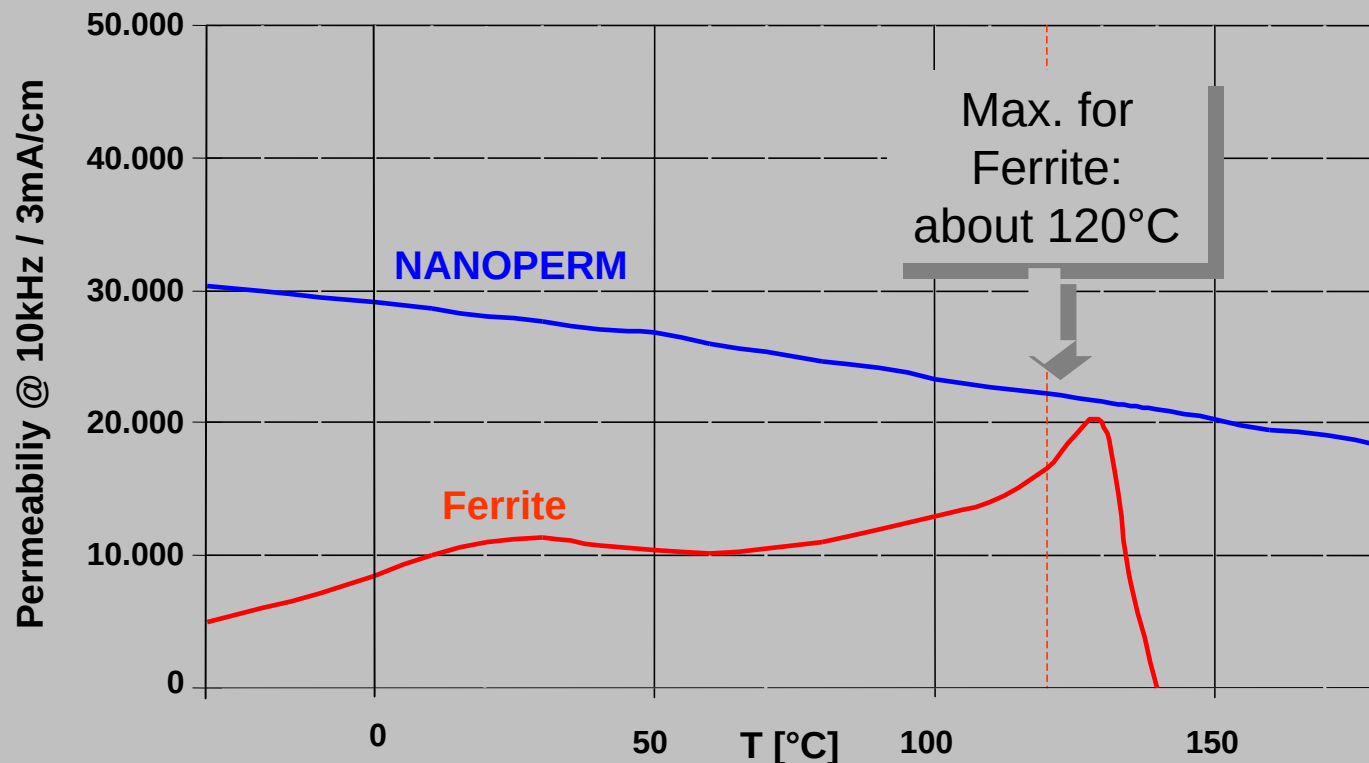
Comparison Ferrite - NANOPERM[®]

	Ferrite	NANOPERM [®]
Permeability (@ <u>100kHz</u>)	10.000 – 12.000	20.000 – 30.000
Saturation flux density B _{sat}	230 mT	1180 mT
Curie temperature T _c	~ 130 °C	~ 600 °C
Max. working temperature	95 °C	120 °C (180 °C)
Relative cost	1	< 2

NANOPERM: ⇒ Advanced, smaller and lighter components!

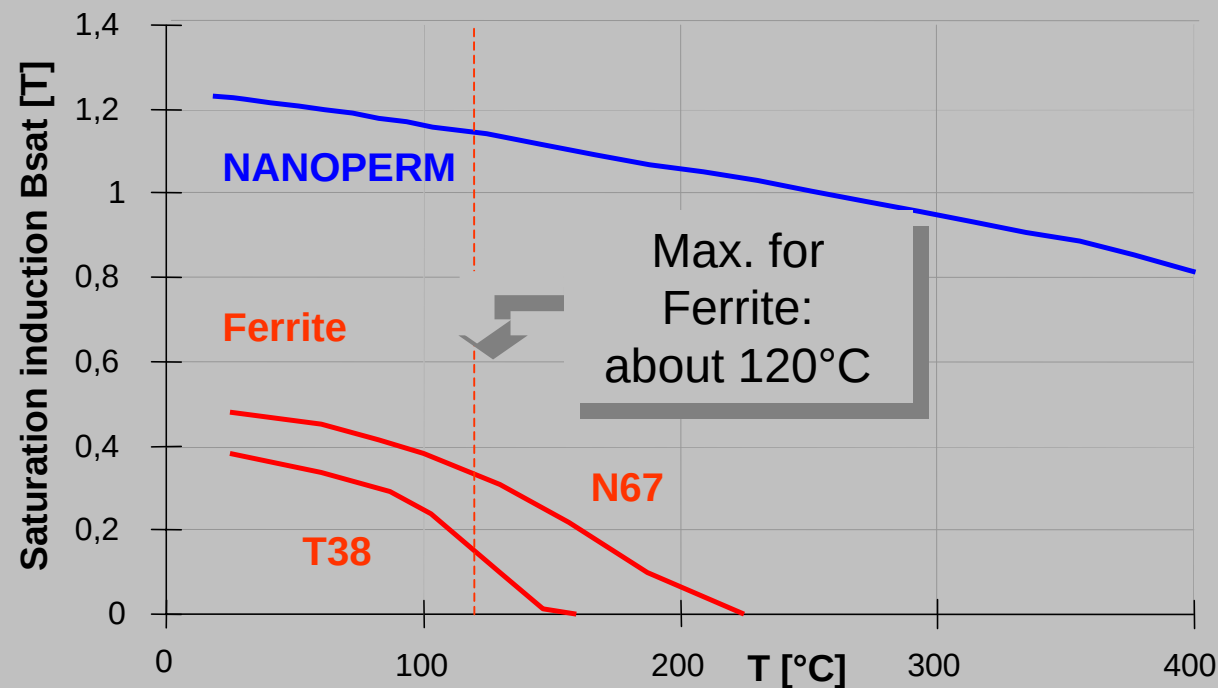
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Permeability as a function of temperature



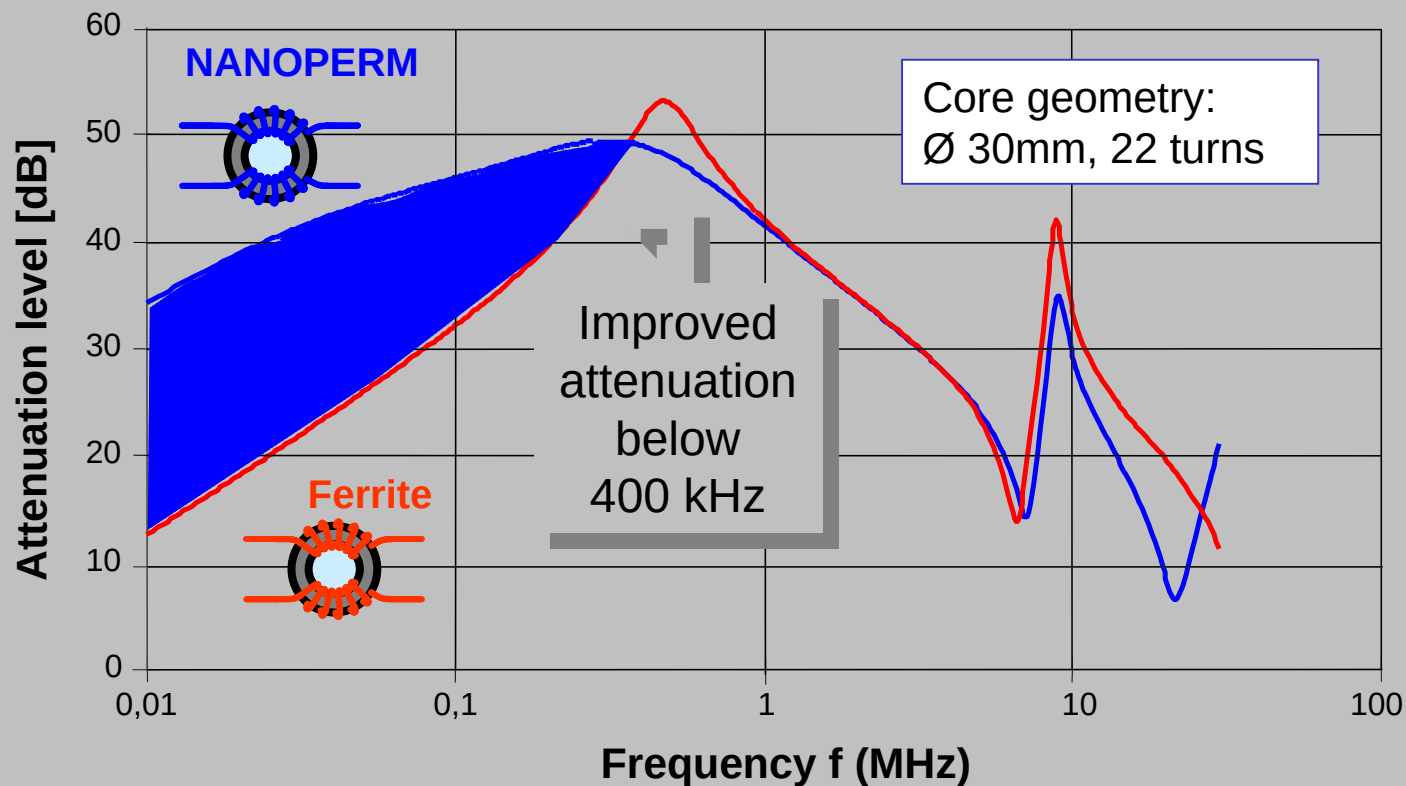
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Saturation flux density as a function of temperature



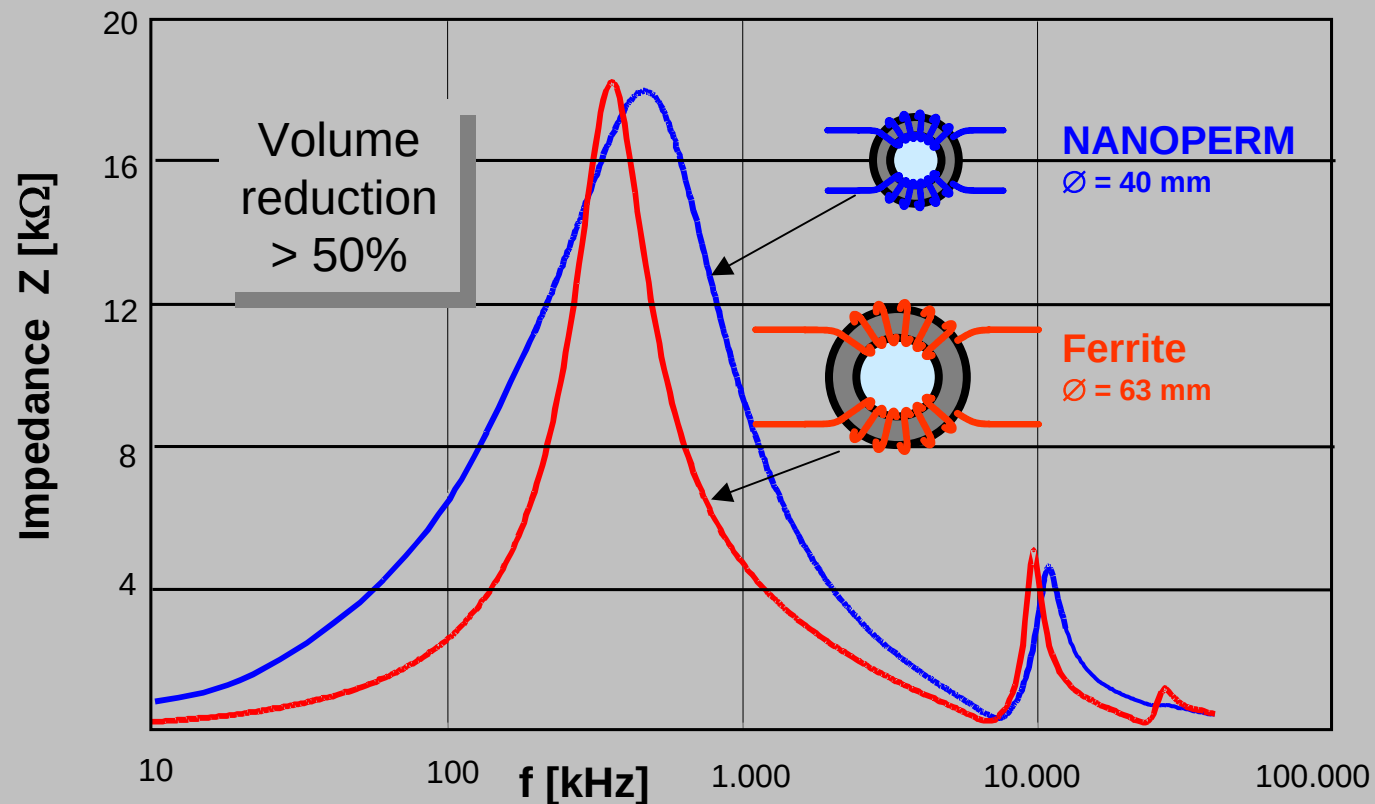
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Better impedance with same core geometries



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Same impedance at smaller volume



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Build volume - real example

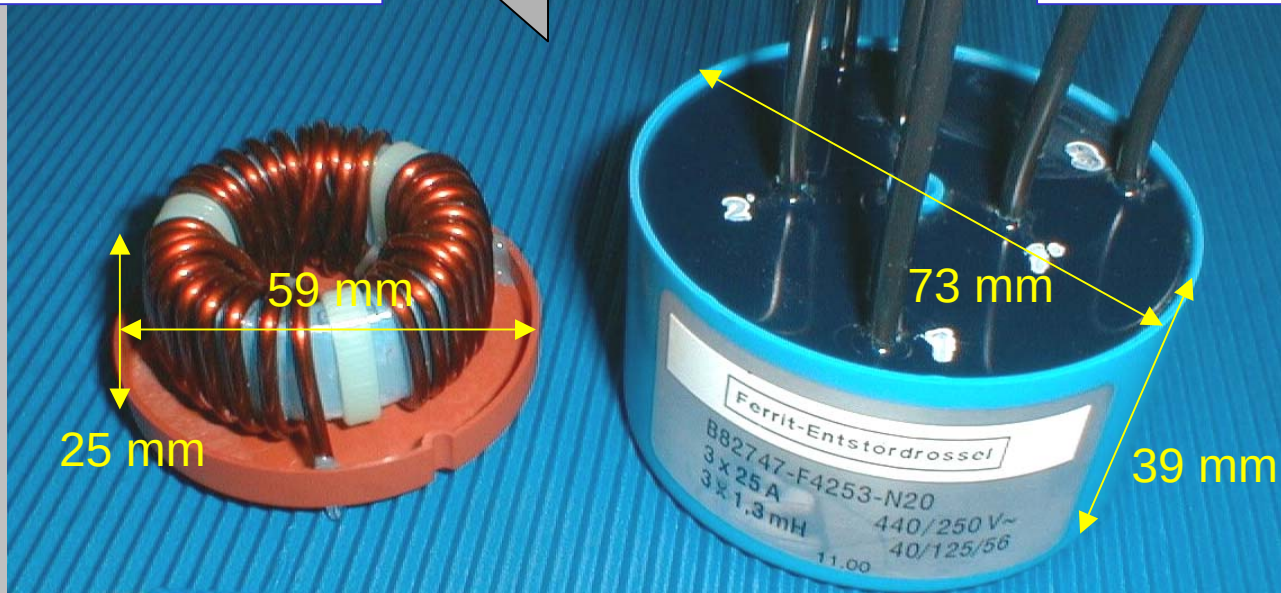
NANOPERM® choke

$I_N = 3 \times 25\text{A} @ 60^\circ\text{C}$
 $L_N = 3 \times 1,6\text{mH} @ 10\text{kHz}$
 $m = 120\text{g}$

Volume reduction 60%
Weight reduction 65%

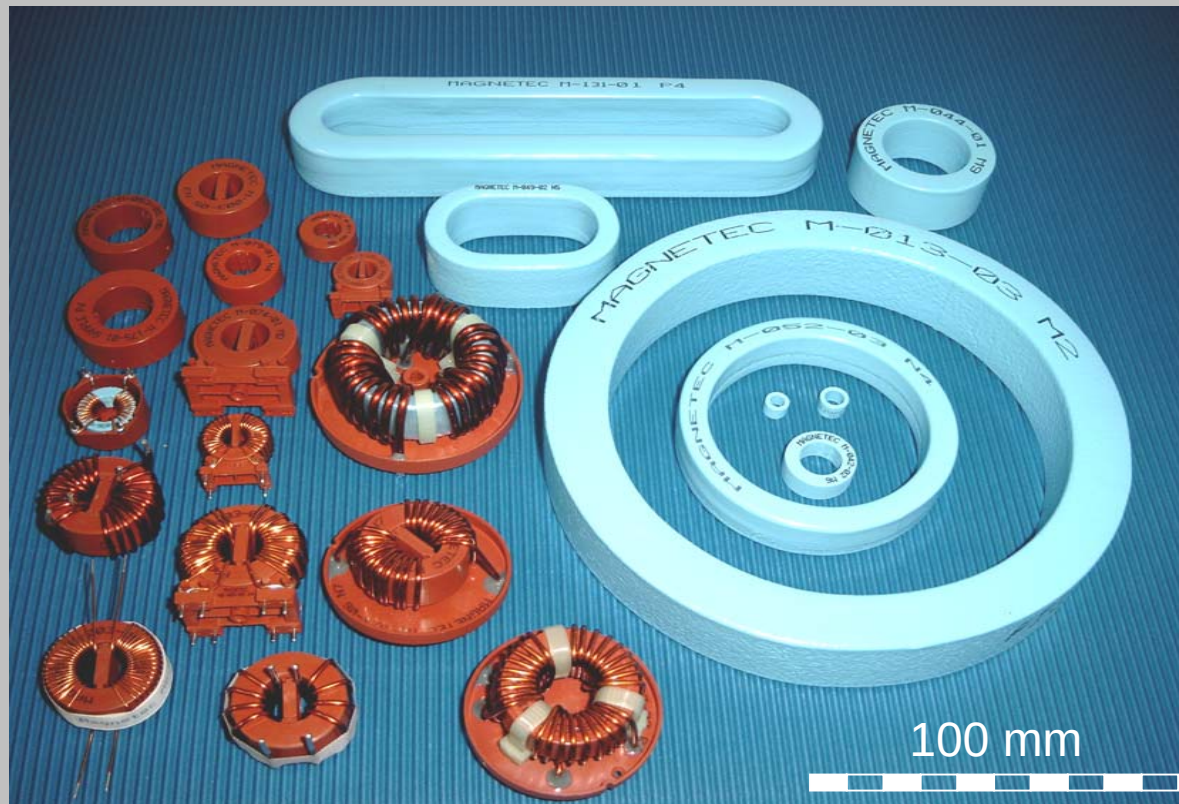
Ferrite choke

$I_N = 3 \times 25\text{A} @ 40^\circ\text{C}$
 $L_N = 3 \times 1,3\text{mH} @ 10\text{kHz}$
 $m = 350\text{g}$



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Available products - cores & chokes



Tape wound
cores from $\varnothing$
12 ... 300mm

1-phase EMC
chokes up to
 $I = 2 \times 60A$

3-phase EMC
chokes up to
 $I = 3 \times 200A$

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Thank you for your attention!

Come and visit us at booth 525!

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