3E65

FERROXCUBE

High temperature Common Mode EMI suppression

Medium permeability
High Curie Temperature
High Saturation Flux
Superior EMI ferrite material

Formerly, a Philips Components company we now belong to the Yageo Group, one of the world's strongest suppliers of passive components. As a leading supplier of ferrite components, FERROXCUBE has manufacturing operations, sales offices, and customer service centers all over the world.

We supply one of the broadest ranges of high-quality, innovative products and place strong emphasis on miniaturization of magnetic functions. Ferrite components and accessories from FERROXCUBE are used in a wide range of applications, from telecommunications and computing electronics through consumer electronic products to automotive.

FERROXCUBE offers a wide range of materials for different frequency bands, thermal conditions and type of noise to be suppressed, with complete data and characterization to ease the design process. Materials can be found in most appropriate shapes for its use: toroids for common mode chokes, cable shields, beads, rods and several ready to mount solutions like SMD beads, through hole wideband chokes and encapsulated cable shields.

3E65

Ferroxcube 3E65 is a medium permeability ferrite material optimized for Common Mode Electro Magnetic Interference (EMI) suppression. Its frequency stability allows the designer to attenuate noise over the complete conducted EMI frequency band up to 30 MHz.

Increased Curie Temperature (Tc, highest temperature at which the material shows its magnetic properties) is well suited for high temperature application segments, such as automotive, industrial and renewable energies.

Maximum magnetic flux density (Bsat) is also higher than in standard medium permeability ferrite materials, improving the EMI suppression capability under inrush currents or non-compensated currents.

3E65 Specifications

A medium permeability material with low losses and high Tc, optimized for use in wideband transformers as well as EMI-suppression filters.

Symbol	Conditions	Value	Unit
μ_i	25 °C; ≤10 kHz, 0.25 mT	5200±20%	
Bsat	25 °C; 10 kHz, 1200 A/m	≈ 480	mT
	100 °C; 10 kHz, 1200 A/m	≈ 320	
$\tan\delta/\mu_i$	25 °C; 100 kHz; 0.25 mT	$\leq 10 \times 10^{-6}$	
	25 °C; 200 kHz; 0.25 mT	$\leq 25 \times 10^{-6}$	
η_B	25 °C; 10 kHz; 1.5 to 3 mT	$\leq 0.5 \times 10^{-3}$	T^{-1}
ρ	DC; 25 °C	≈ 0.5	Ωm
T_C		≥165	°C
Density		≈ 4900	kg/m^3

Material Specifications

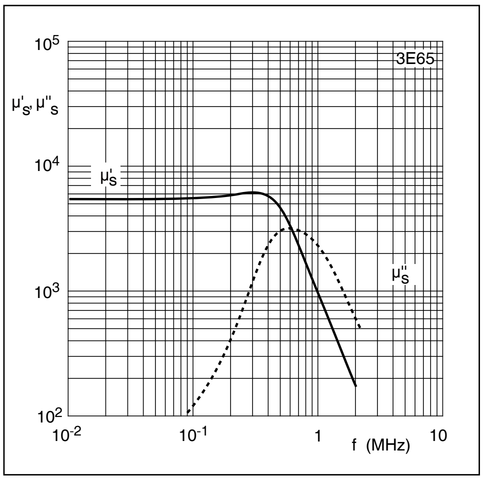


Fig. 1 Complex permeability as a function of frequency

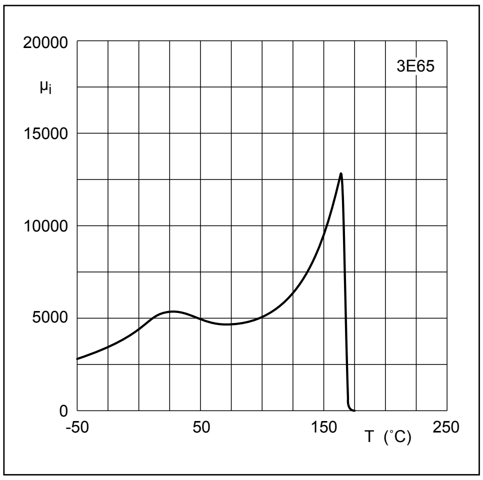


Fig. 2 Initial permeability as a function of temperature

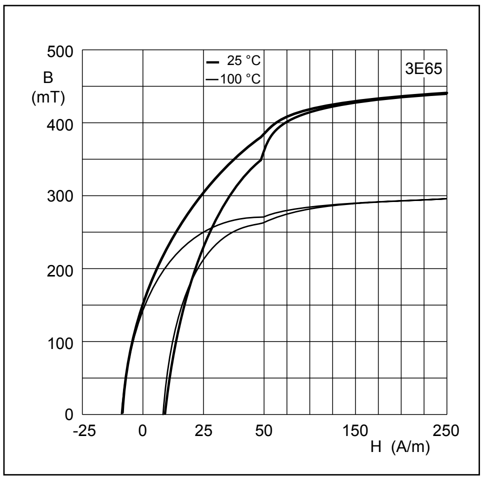


Fig. 3 Typical B-H loops

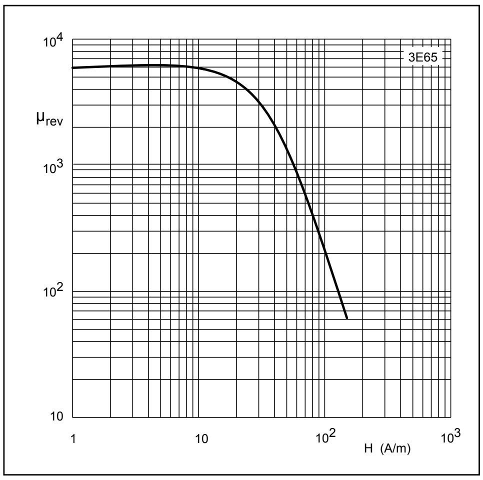


Fig. 4 Reversible permeability as a function of magnetic field strength

These properties are measured on stress free toroid cores 25mm/15mm/10mm (outer diameter/ inner diameter/height). Deviations may occur due to product design (large cross section increases eddy currents thus decreasing the frequency stability) as well as process coating and tumbling. Winding with thick wire and potting influences the performance as well.

3E65

Extended bandwidth and High Curie Temperature

Standard Product Range

Ferroxcube 3E65 is available in a wide variety of toroid sizes.

Description	Ae (mm2)	le (mm)	μ_{eff}	Mass (g)	AL (nH/T2)
TC3.4/1.8/1.3-3E65	1.01	7.63	5200	0.035	870
TC5.8/3.1/3.2-3E65	4.28	13	5200	0.31	2150
TC6.3/3.8/2.5-3E65	3.06	15.2	5200	0.23	1300
TC9.5/4.8/3.2-3E65	7.26	20.7	5200	0.7	2300
TX14/8/7-3E65	20.5	32.8	5200	3.3	4100
TX16/12/8-3E65	15.9	43.4	5200	3.5	2400
TX18/10/10-3E65	38.9	41.5	5200	8.1	6100
TX20/10/7-3E65	33.6	43.6	5200	7.7	5000
TX22/14/6.4-3E65	25.9	54.1	5200	6.5	3100
TX25/15/10-3E65	48.9	60.2	5200	15	5300
TX29/19/7.6-3E65	37.4	73.2	5200	13	3300
TX31/19/13-3E65	75	75.4	5200	28	6500
TX36/23/15-3E65	93.3	89.6	5200	40	6800
TX42/26/18-3E65	134	103	5200	55	8500
TX50/30/19-3E65	186	120	5200	100	10000
TX63/38/25-3E65	297	152	5200	220	13000
TX80/40/15-3E65	288	174	5200	240	11000
TX102/66/15-3E65	265	255	5200	325	6800
TX107/65/18-3E65	370	259	5200	456	9300
TX140/106/25-3E65	419	381	5200	800	7200

TC stands for Parylene coating and TX for Epoxy coating. Bare cores are available as well, then referenced as T. Product dimensions are shown as TX [Outer Diameter / Inner / Height]-3E65.

Standard AL tolerance is ±20% for TX (Epoxy) and ±25% for TC (Parylene).

It is also possible to produce 3E65 in planar cores to be wound with PCB windings or clamped on bus bars.

Coating Properties

Toroidal cores are coated to prevent isolation failures due to the high voltages present on common mode chokes. The coating material applied depends on the core size: small cores (less than 10 mm outer diameter) are coated with Parylene, while the rest are coated with Epoxy.

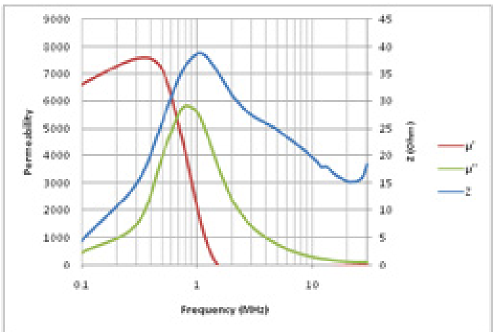
Parylene is a conformal coating, vapor deposited polymer which provides 1000 Volts DC isolation voltage. The coating thickness is 10 to 15 µm. Parylene meets RoHS directives, and is flame retardant according to UL94 V-2. Maximum operating temperature in air is 120 deg C, but in oxygen free environments up to 260 deg C.

Epoxy is a spray coating material which provides 2000 Volts DC isolation voltage with a 0.10 to 0.15 mm layer. Epoxy meets RoHS directives and is flame retardant according to UL94 V-0 class. The maximum operating temperature is 200 deg C. This material is very well suited for winding with thick copper wire due to its hardness.

Impedance Performance

Inductive components and in particular ferrites exhibit ideal properties to attenuate EMI: their impedance increases with frequency and becomes resistive when μ'', the complex component of ferrite magnetic permeability, is predominant over μ'.

The common mode choke impedance per line can be estimated by the following formula:

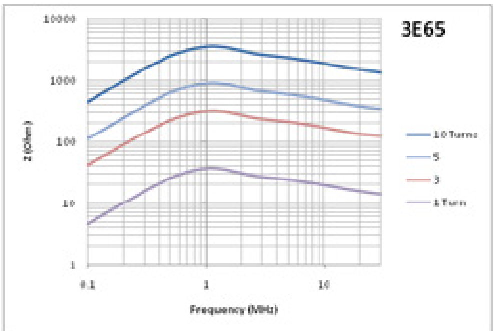


$$\vec{Z} = 2\pi f \times \frac{A_e}{l_e} \times N^2 \times \mu_0 \times (\mu'' + j\mu')$$

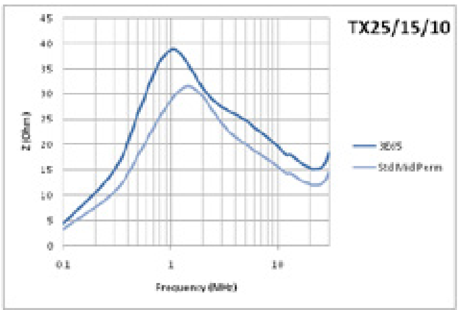
Ae: core effective area, le: core effective length, f: frequency, N: number of turns per line, μ0: vacuum permeability, μ' and μ'': real and complex material permeability.

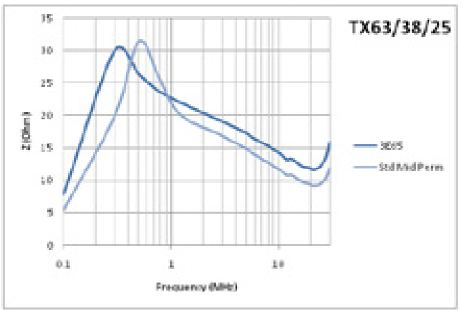
This formula gives a rough estimation because the parasitic capacitance between windings has strong impact on the high frequency performance.

The plot on the right shows typical performance curves for TX25/15/10-3E65 (25 mm outer diameter, 15 inner, 10 height) wound with different number of turns.



The following plots compare the performance of 3E65 on different sizes with a market standard medium permeability material:





3E65

Optimized for use in wideband transformers as well as EMI-suppression filters

Ferroxcube 3E65 outperforms other ferrite materials when it comes to tough conditions: high Tc 165 deg C makes this ferrite material suitable to operate at extreme temperatures up to 150 deg C, as requested on automotive grade 0 components.

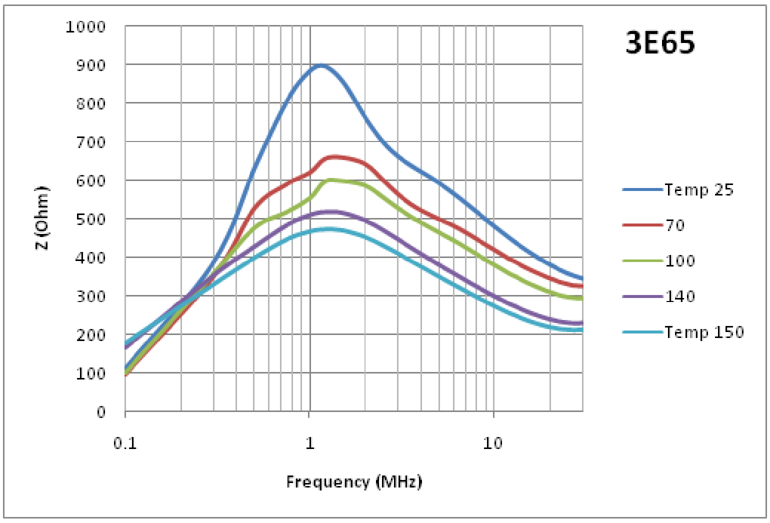


Fig. 5 impedance vs frequency

Inrush currents and non-compensated phases are critical for standard common mode chokes, as they can be driven into saturation by these flux peaks. 3E65 handles up to 480 mT when standard mid-perm ferrite materials saturate at 400 – 430 mT. The plots below show how this property turns into higher current handling capability:

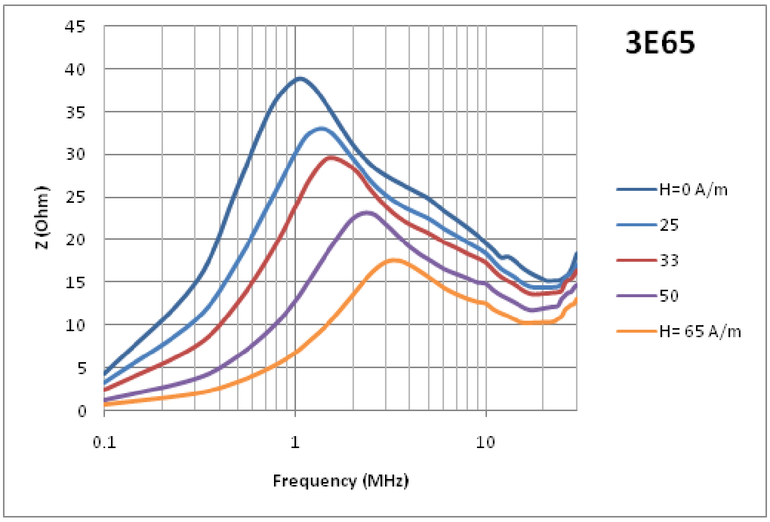


Fig. 6 plot with impedance over freq under different H levels

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