

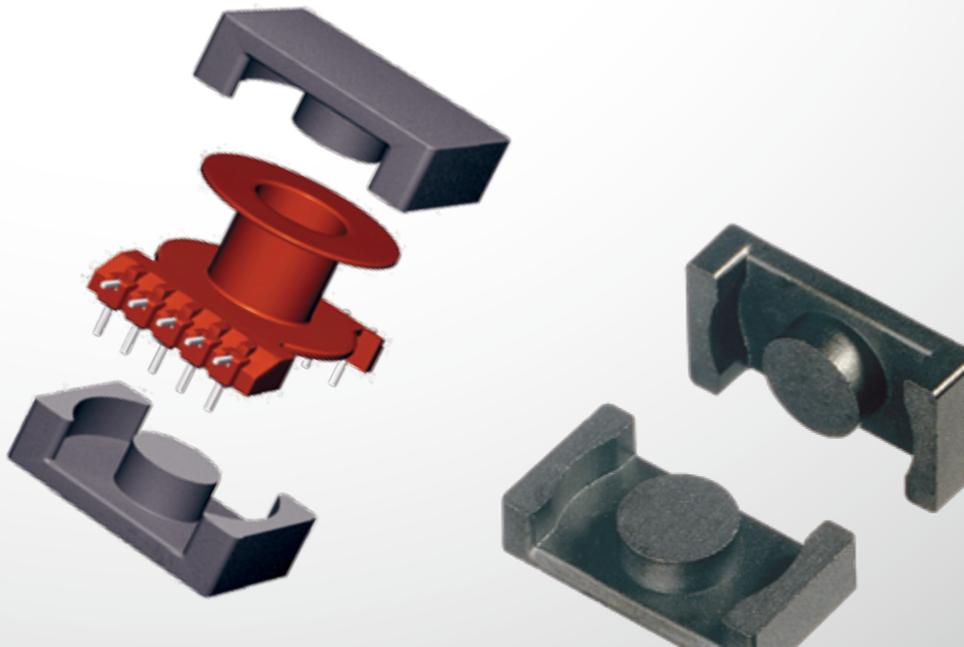
3F36

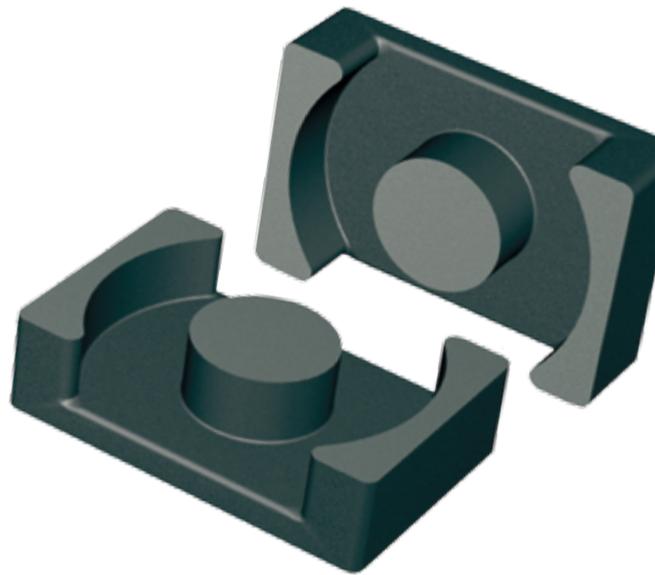
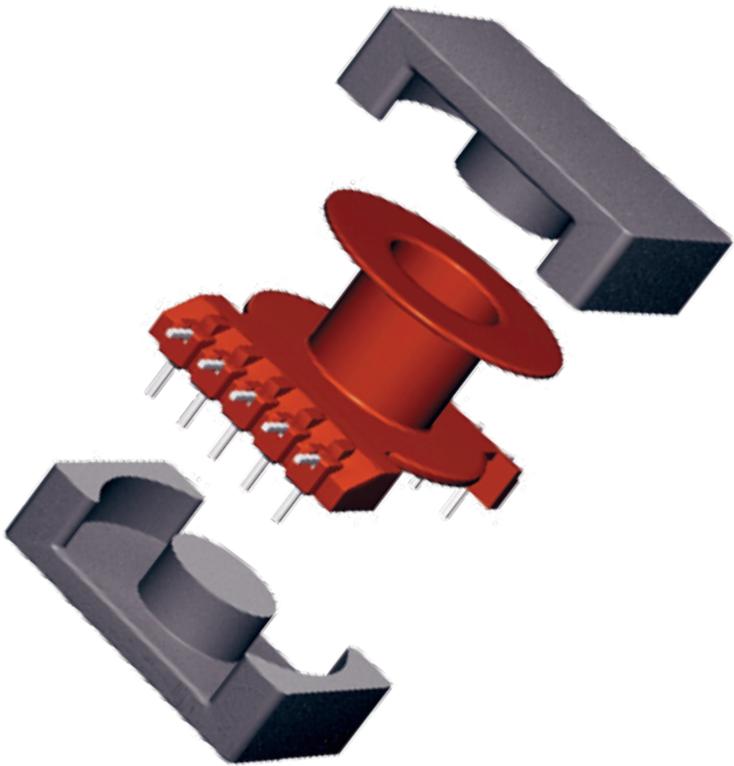
 **FERROXCUBE**  
A YAGEO COMPANY



Improved performance  
at low temperature

Flat loss, medium  
to high frequency  
power material for  
broad temperature  
range applications.

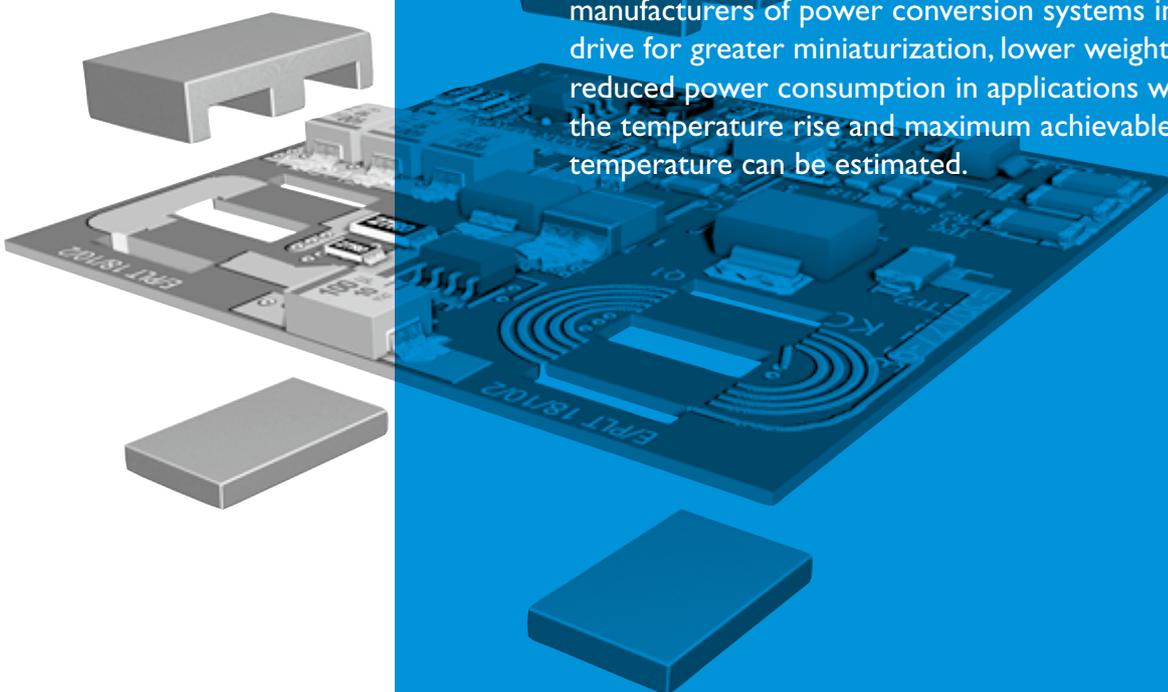




**F**ERROXCUBE is a member of the Yageo Group, which is among the world's strongest suppliers of high quality passive components. As a leading supplier of ferrite components, FERROXCUBE has manufacturing operations, sales offices, and customer service centers all over the world.

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 as the leading manufacturer in the ferrite industry, has been providing to the power conversion industry ferrite cores with low power losses and high saturation magnetic flux density over a wide range of operating frequencies (20kHz to 10MHz). This has allowed us to support today's manufacturers of power conversion systems in their drive for greater miniaturization, lower weight and reduced power consumption in applications where the temperature rise and maximum achievable temperature can be estimated.

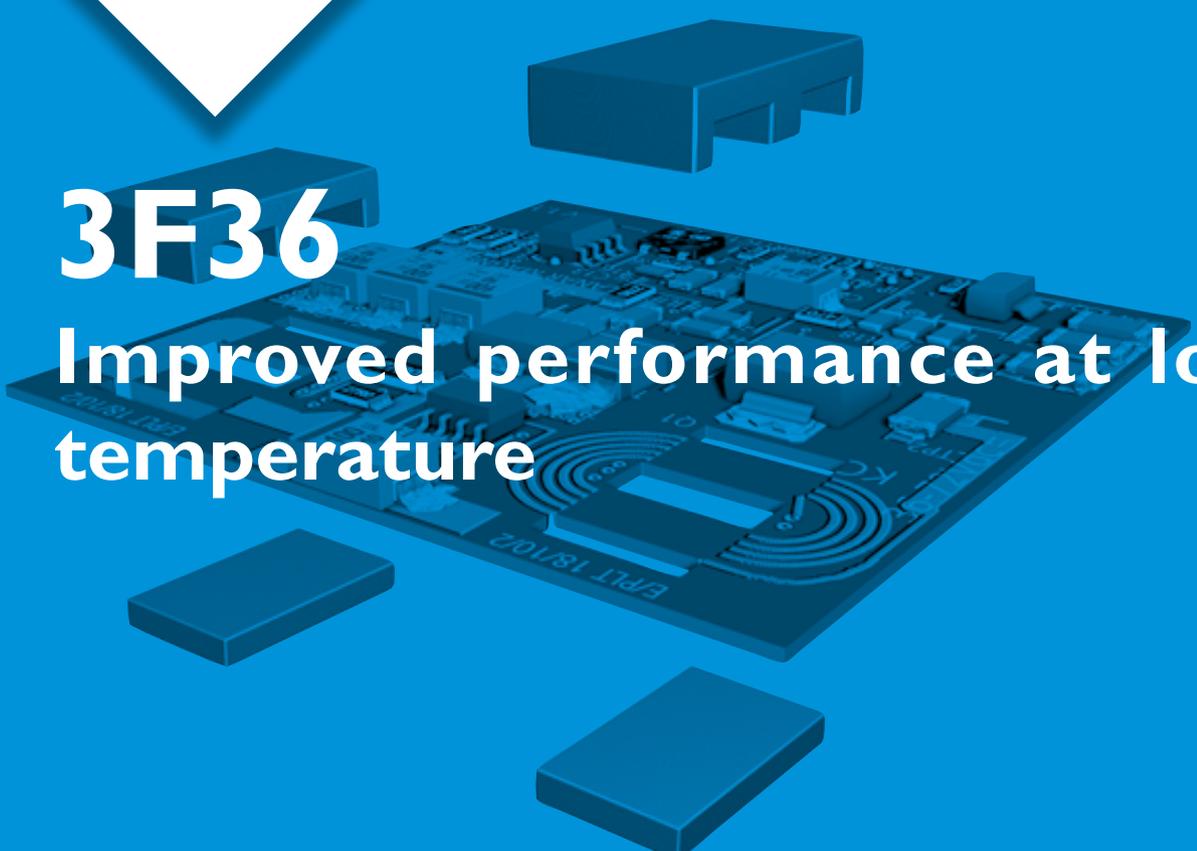


The switching frequency of power conversion equipment is continuously growing, searching for both efficiency and miniaturization. These working conditions require specific properties from the transformers and inductors in order to minimize magnetic power loss in the system: These properties include extended frequency bandwidth, high resistivity to prevent eddy currents and a flat response over a temperature range for reliable behavior in outdoor applications.

Temperature stability is also a key design parameter in reaching the highest efficiency awards when tested under light load conditions when the system is not heating itself.

Ferroxcube 3F36 has been developed to work in this field with a flat response over a temperature range and optimal operating frequency spanning from 250 kHz to 1 MHz keeping a maximum magnetic flux density as high as 420 mT (at 100 deg C, 1200 A/m).

Target applications are many: automotive DC/DC converters in hybrid and electric vehicles, photovoltaic micro-inverters, DC/DC converters in telecommunication and computing equipment or high power LED drivers for public lighting are among some of the potential applications.



**3F36**

**Improved performance at low temperature**

## Material Specifications

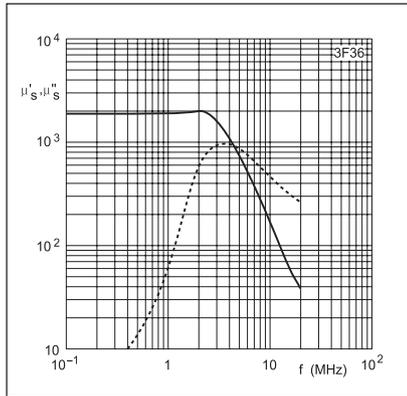


Fig. 1 Complex permeability as a function of frequency

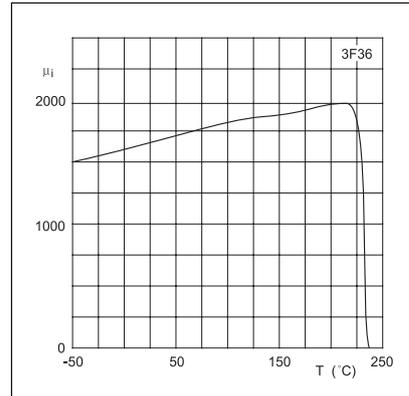


Fig. 2 Initial permeability as a function of temperature

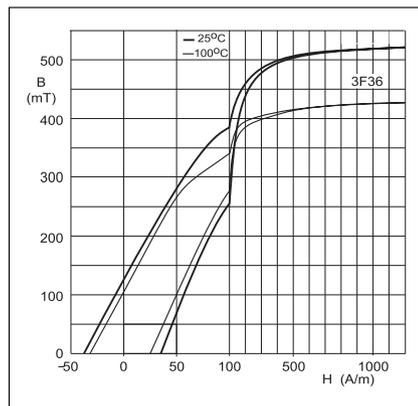


Fig. 3 Typical B-H loops

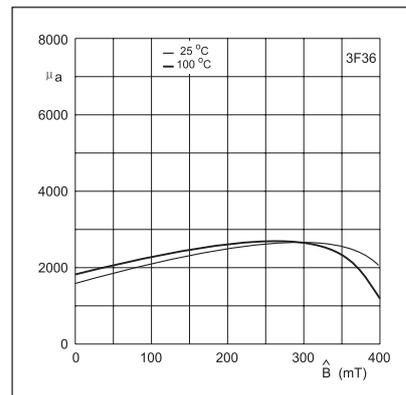


Fig. 4 Amplitude permeability as function of peak flux density

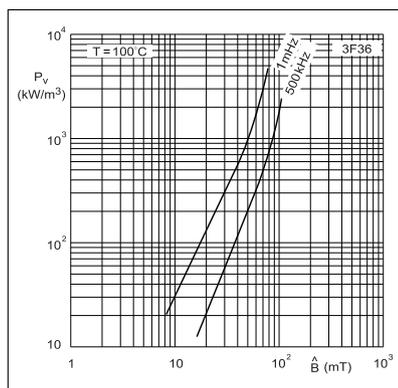


Fig. 5 Specific power loss as a function of peak flux density with frequency as a parameter

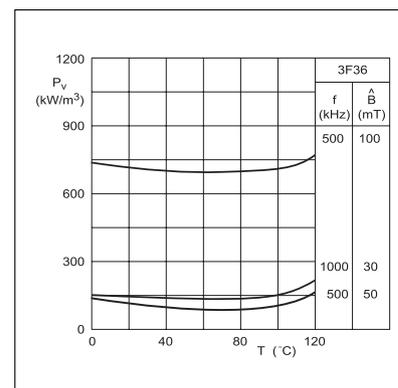
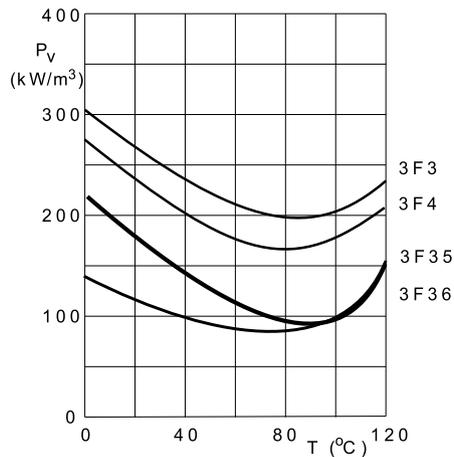


Fig. 6 Specific power loss for several frequency/flux density combinations as a function of temperature

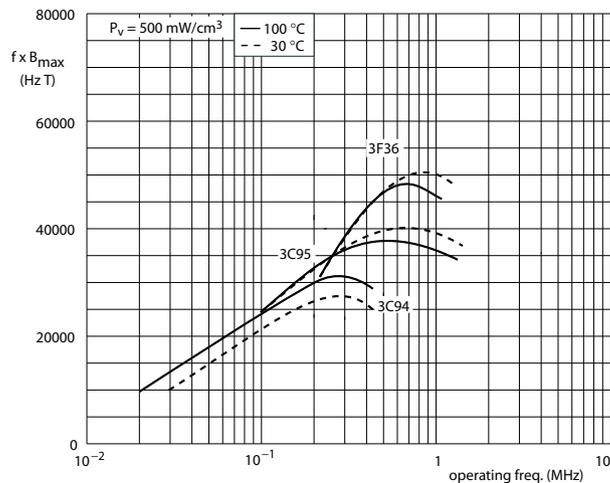
## 3F36 vs 3F35

Symbol	Conditions	Value		Unit
		3F36	3F35	
$\mu_i$	25 °C; $\leq 10$ kHz, 0.25 mT	1600 $\pm$ 25%	1400 $\pm$ 25%	
$\mu_a$	100 °C; 25 kHz, 200 mT	$\approx 2400$	$\approx 2400$	
Bsat	25 °C; 10 kHz, 1200 A/m	$\approx 520$	$\approx 500$	mT
	100 °C; 10 kHz, 1200 A/m	$\approx 420$	$\approx 420$	
P <sub>v</sub>	25 °C; 400 kHz; 50 mT	$\approx 70$	$\approx 120$	kW/m <sup>3</sup>
	100 °C; 400 kHz; 50 mT	$\approx 60$	$\approx 60$	
	25 °C; 500 kHz; 50 mT	$\approx 110$	$\approx 170$	
	100 °C; 500 kHz; 50 mT	$\approx 90$	$\approx 90$	
	25 °C; 500 kHz; 100 mT	$\approx 700$	$\approx 900$	
	100 °C; 500 kHz; 100 mT	$\approx 700$	$\approx 700$	
$\rho$	DC; 25 °C	$\approx 12$	$\approx 10$	$\Omega$ m
T <sub>c</sub>		$\geq 230$	$\geq 240$	°C
Density		$\approx 4750$	$\approx 4750$	kg/m <sup>3</sup>

## Power Loss Comparison



Ferroxcube provides also 3C95, a flat loss material optimized for frequencies up to 400 kHz. Graph below shows 3C95 performance factor data to help select the optimum material when the frequency is in the overlapping area.



The performance factor ( $f \times B_{max}$ ) is a measure of the throughput power that a ferrite core can handle at a certain loss level.

Each material has its optimum operating frequency range. Above 300kHz 3F36 will benefit in higher throughput power than Ferroxcube well known 3C95 material.

In typical ferrite materials like 3C94 performance factor at room temperatures drops down due to the saddle shape of the losses versus temperature curve.

3F36 and 3C95 exhibits no drop at room temperatures, and this is what makes of them best materials for broad temperature applications.

## Design remarks: Power loss curve fit parameters

It maybe necessary to calculate the core loss density in different conditions when designing a transformer or inductor. An approximation of the core loss density for any combination of operating temperature (T) in [° C], frequency (f) in [Hz] and flux density (B) in [T] can be obtained from the following empirical fit formula :

Material	Freq min	Freq max	Cm	x	y	Ct <sub>2</sub>	Ct <sub>1</sub>	Ct
3F35	100000	499999	6.83E-03	1.4390	3.2672	1.614E-04	3.352E-02	2.759E+00
3F35	500000	799999	1.12E-07	2.1952	2.7199	1.284E-04	2.105E-02	1.801E+00
3F35	800000	1200000	2.24E-10	2.6105	2.4977	8.170E-05	1.011E-02	1.152E+00
3F36	100000	499999	6.83E-03	1.4390	3.2672	8.395E-05	1.078E-02	1.233E+00
3F36	500000	799999	1.12E-07	2.1952	2.7199	8.926E-05	1.172E-02	1.282E+00
3F36	800000	1200000	2.24E-10	2.6105	2.4977	6.119E-05	6.142E-03	1.011E+00

$$P_v = C_m \cdot f^x \cdot B^y \cdot (C_{t_2} \cdot T^2 - C_{t_1} \cdot T + C_t) \left[ \frac{\text{mW}}{\text{Cm}^3} \right]$$

Results obtained with this formula are an estimation of typical material performance. Product specs will show higher power loss density.

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