3C92 and 3C93
The high saturation & high temperature low loss power ferrites

FERROXCUBE
A YAGEO COMPANY

3C92 - The new standard for high flux density applications

FERROXCUBE has made a big move forward in high flux density applications with the new material 3C92. This material is primarily intended for output chokes in power supplies. These carry mainly dc current with a small ac ripple, so core losses are generally not the first worry. Required is a high saturation level to accomodate a high dc current without too much inductance loss. The energy storage value of a choke is proportional to the square of peak flux density and determines the core volume required. Whenever space is limited, this is an important consideration.

FERROXCUBE's new power material 3C92 for high flux density applications has an increased Curie temperature compared to the general purpose power material 3C94. Because of this, 3C92 has a higher saturation flux density than 3C94 and the difference increases with temperature. Losses are the same as for 3C94 which makes 3C92 also suitable for high flux density transformers.

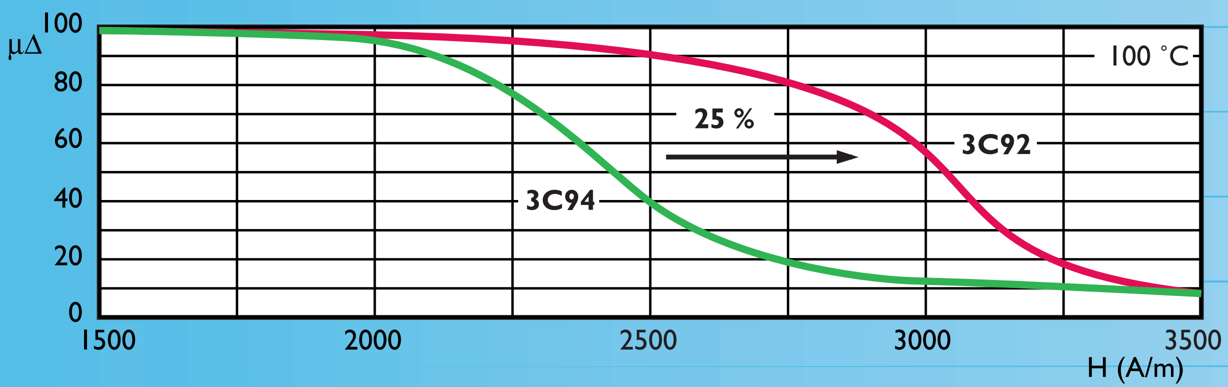
High flux density performance
In the graph below the current carrying capabilities of 3C92 and 3C94 are compared. The magnetic field strength H is proportional to the current I and the effective permeability μ_e is proportional to the inductance. All curves have been measured on gapped toroids with the same μ_e value to make them directly comparable. In the fall-off region 3C92 gains about 25 % on 3C94.

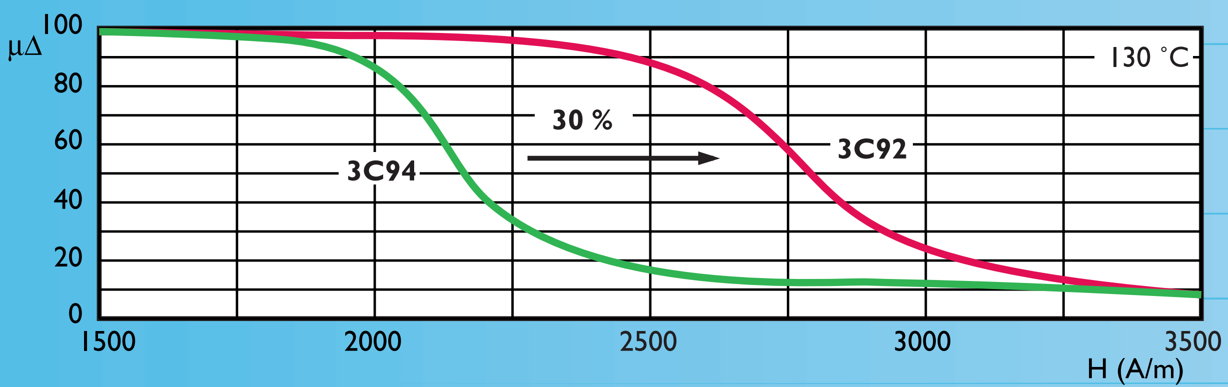
Preferred applications are:

• High current output chokes
Wherever space is at a premium like in low profile converter modules, core volume can be reduced. The advantage increases with temperature.

• High voltage ignition transformers
For example in electronic lighting ballast where high flux density occurs during ignition, but losses have to be low during steady state operation.

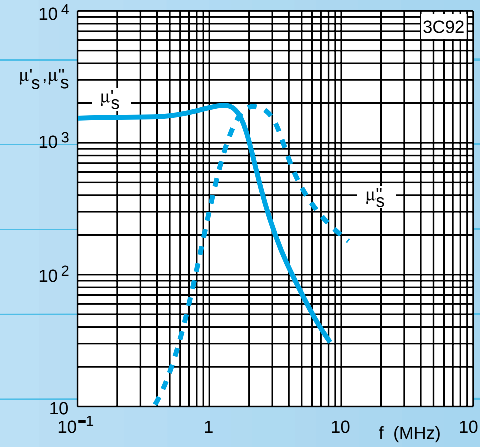
Incremental permeability as a function of magnetic field strength compared



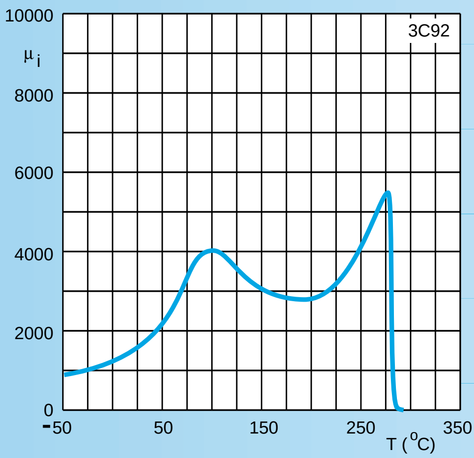


3C92 - Material Characteristics

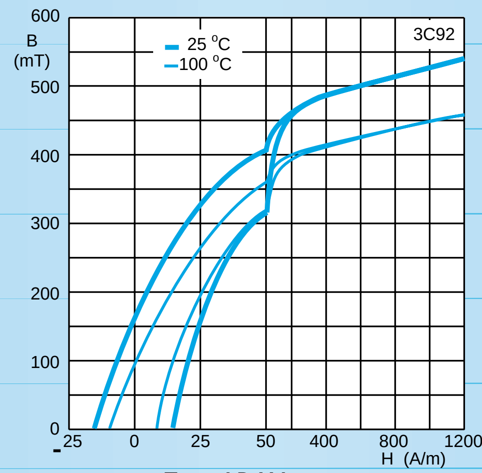
	CONDITIONS	VALUE	UNIT
μ_i	25 °C, ≤ 10 kHz, 0.1 mT	1500 ± 20 %	
μ_a	100 °C, 25 kHz, 200 mT	≈ 5000	
B	25 °C, 10 kHz, 1200 A/m 100 °C, 10 kHz, 1200 A/m 140 °C, 10 kHz, 1200 A/m	≈ 540 ≈ 460 ≈ 400	mT
P_V	100 °C, 25 kHz, 200 mT 100 °C, 100 kHz, 200 mT	≈ 50 ≈ 350	kW/m^3
ρ	DC, 25 °C	≈ 5	Ωm
T_C		≥ 280	°C
density		≈ 4800	kg/m^3



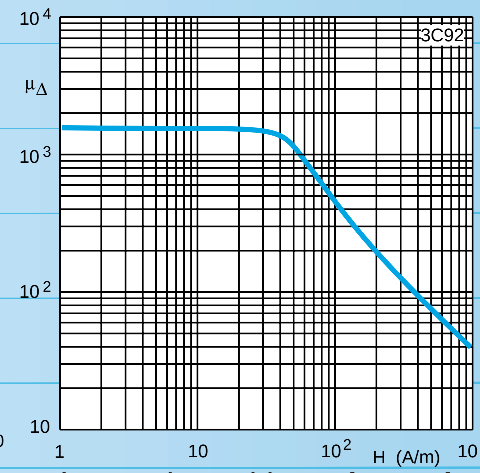
Complex permeability as a function of frequency



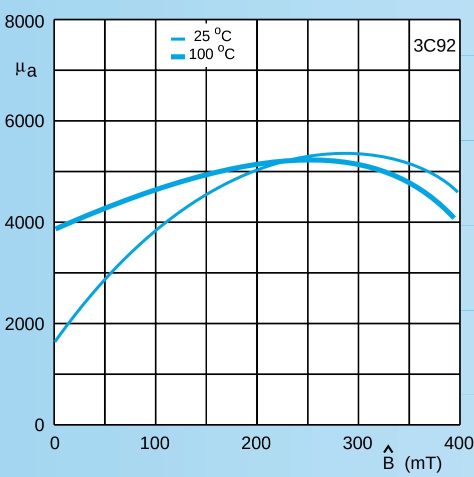
Initial permeability as a function of temperature



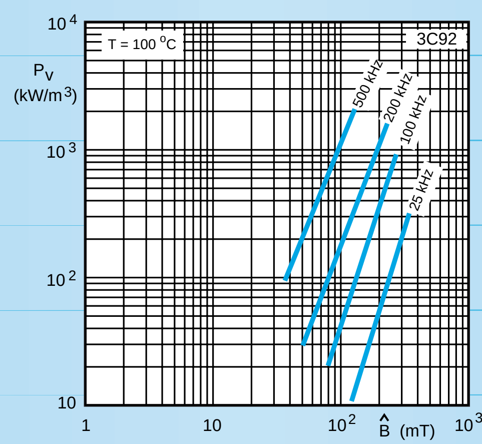
Typical B-H loops.



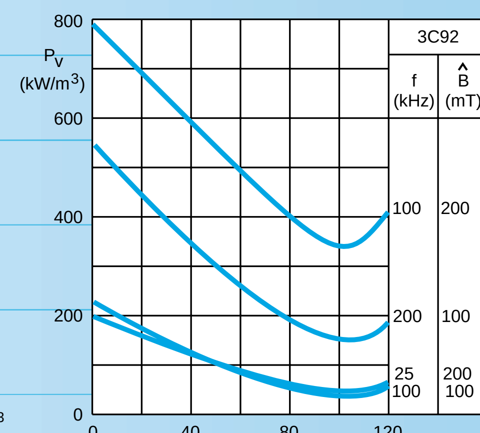
Incremental permeability as a function of magnetic field strength



Amplitude permeability as a function of peak flux density



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



Specific power losses for several frequency/ flux density combinations as a function of temperature

3C93 - The new standard for high temperature applications

FERROXCUBE proudly presents its high temperature power material : 3C93. Most soft Ferrites for power applications have a loss minimum between 80 and 100 °C. They have been designed for operation in normal PCB circuits. For safety reasons the maximum working temperature is not far above 100 °C. At higher temperatures the commonly used PCB materials degrade or can even give rise to fire hazard. Certain power applications however require or can benefit from working temperatures clearly exceeding 100 °C. Typical examples are electronic lighting ballasts and automotive electronics mounted in the neighbourhood of the engine.

FERROXCUBE has available the power material 3C93 aiming at these high temperature applications. The loss level is comparable to that of the general purpose power material 3C94, but the loss minimum has shifted from 100 to 140 °C. The temperature shift is largely independent of the flux density and frequency condition. The result is a considerable gain in performance at temperatures above 120 °C. Lowering the overall loss level would not have eliminated the risk of instable temperature behaviour due to the positive temperature coefficient of losses in this region. Also saturation flux density at higher temperatures has been improved in comparison with 3C94, which makes 3C93 suitable for chokes as well as transformers.

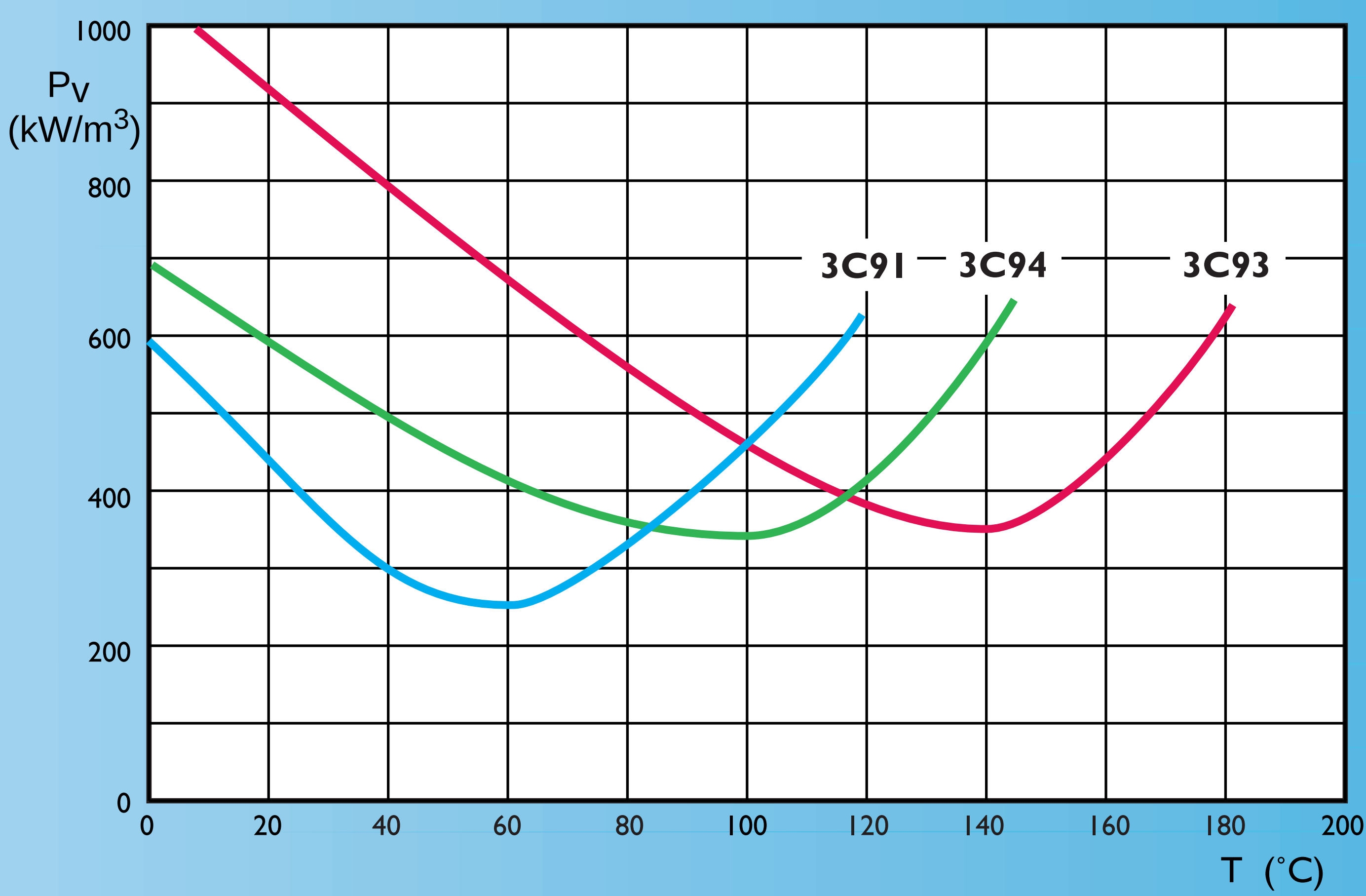
High temperature performance

The graph below shows the loss versus temperature curves of 3C93 and the standard power materials 3C91 and 3C94. Clearly, 3C93 achieves a lower loss level with stable temperature behaviour at elevated temperatures favouring applications like :

- Automotive electronics near the engine. Ambient temperature rises to very high values here. Components mounted near the engine are usually specified for working temperatures up to 150 °C.

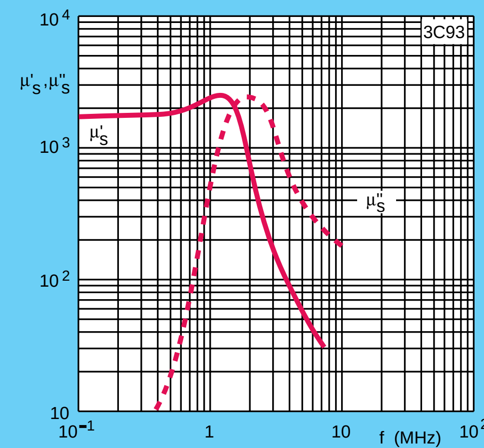
- Electronic lighting ballasts
Due to tight mounting in the lamp armature, there is already a considerable temperature rise from outer to inner ambient. Upward shift of the loss minimum allows for compacter or less critical designs.

Power losses at 100 kHz and 200mT as a function of temperature compared

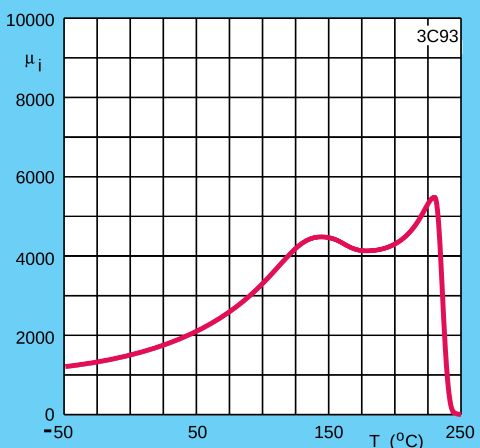


3C93 - Material Characteristics

	CONDITIONS	VALUE	UNIT
μ_i	25 °C, ≤ 10 kHz, 0.1 mT	1800 ± 20 %	
μ_a	100 °C, 25 kHz, 200 mT	≈ 5000	
B	25 °C, 10 kHz, 1200 A/m 100 °C, 10 kHz, 1200 A/m 140 °C, 10 kHz, 1200 A/m	≈ 520 ≈ 430 ≈ 360	mT
P_V	140 °C, 100 kHz, 100 mT 140 °C, 100 kHz, 200 mT 140 °C, 500 kHz, 50 mT	≈ 50 ≈ 350 ≈ 300	kW/m^3
ρ	DC, 25 °C	≈ 5	Ωm
T_C		≥ 240	°C
density		≈ 4800	kg/m^3



Complex permeability as a function of frequency



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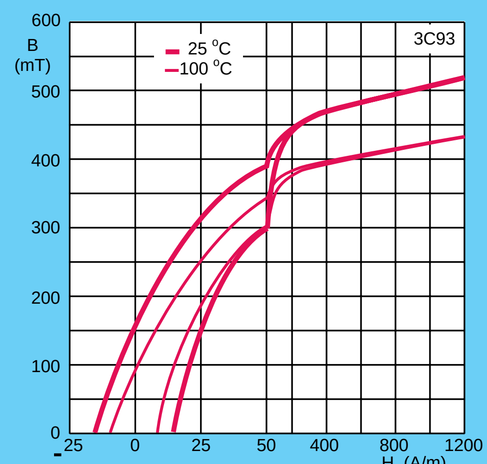

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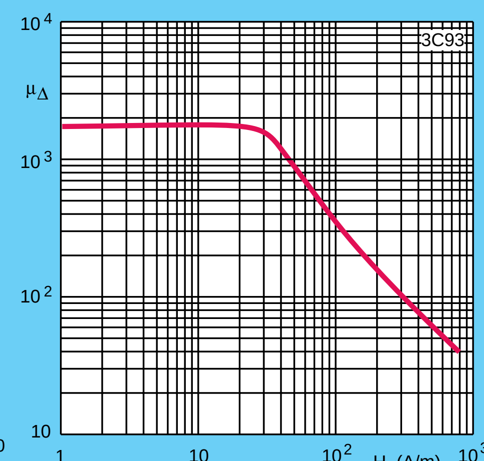

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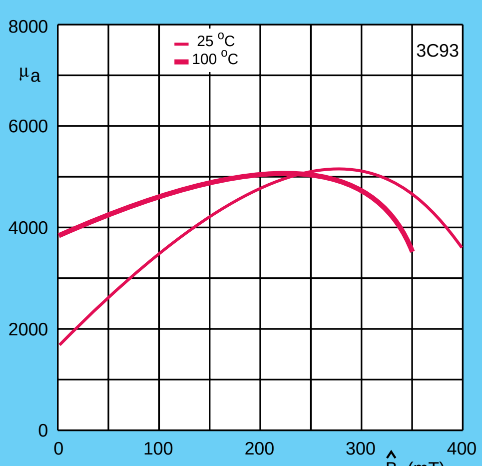
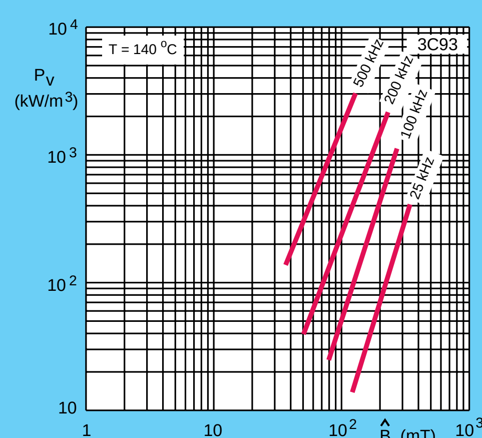


Amplitude permeability as a function of peak flux density



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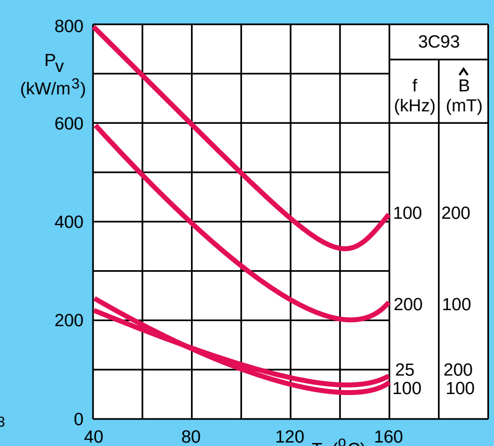

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