Ferrite Material and Cores in LED Lighting

- LED Lighting circuits use different converter topologies—buck, boost, buck-boost.
- The conversion frequency generally varies from 50 kHz to 200 kHz
- Line Switches are frequently used as power semiconductor—typically at 66 / 132 kHz
- The operating temperature is quite high, typically close to 100°C
- The converter circuits need be compact with large area of heat dissipation
- LED lighting is widely used in automotive sector where the converters are exposed to varying ambient conditions
- The choice of power ferrite material and core shapes for LED Lighting is governed by the features above.
- The ferrite material must have low core loss at the typical frequencies of application and operating temperatures.
- The ferrite material must have high saturation flux density at the operating temperature to cater for high input voltages.
- The ferrite material must have sufficiently high Curie Temperature to cover all operating condition.
- The ferrite material should have a flat loss-temperature curve to have the similar core lossand hence efficiency for shifting ambient and load resulting in varying operating temperatures.
- The ferrite core should have the best dissipation area and **EFD, PQ,RM** cores are preferred for this reason.
- **PQ cores** also have the best area product for the same footprint and have a near-closed magnetic circuit to contain leakage flux.

Cosmo Power Ferrite Material CF295

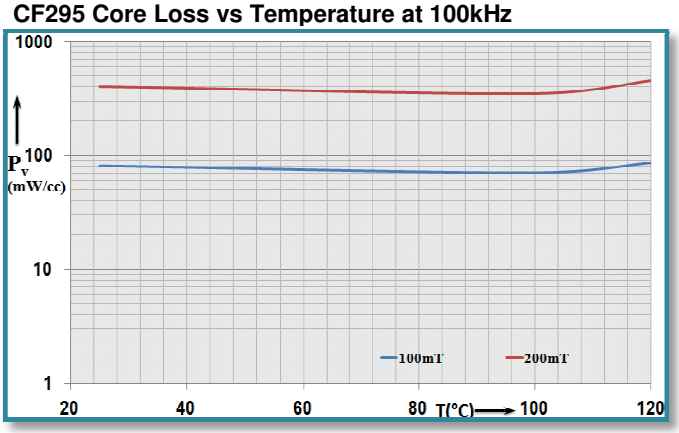
With the above points in view, Cosmo Ferrites Limited has developed the Power FerriteMaterial CF295 having the desired features for application in LED Lighting.The datasheet of the Material CF295 is presented below with the curves of :-

a) Loss versus temperature,
b) Saturation flux density versus temperature and
c) Permeability versus temperature.

Material Properties:-

Property	Symbol	Unit	Value
Initial Permeability(T = 25°C)	μ_i		3000±20%
Flux density (H = 1000 A/m,f = 10 kHz)	Bs (25°C) Bs (100°C)	mT	525 410
Residual Flux Density	Br (25°C)	mT	80
Power loss density 100 kHz, 100 mT, 25°C 100°C 100 kHz, 200 mT,25°C 100°C	P_v	kW/m³	≤100 ≤90 ≤400 ≤350
Curie Temperature	T_c	°C	>220°C
Resistivity	ρ	Ωm	
Density	d	kg/m³	4800

CF295 Core Loss vs Temperature at 100kHz

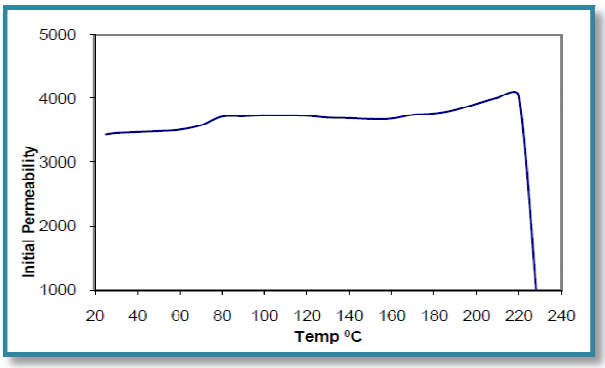


Power Loss: The figures for CF295 as indicated in the datasheet show the power loss at the typical application frequency for LED Lighting converters (100 kHz) is 350 kW/m³ for an operating flux density of 200 mT at 100˚C. This is an improvement over the loss power figures of 400 to 450 kW/m³ achieved at the same operating condition for most other commercially available power ferrite materials.

Power Loss versus Temperature curve: The curves for CF295 are flat over a temperature range from 25˚C to 120˚C, the typical operating temperature range for ferrite cores. The frequency is 100 kHz for both the curves. For a flux density of 100 mT the maximum variation in power loss over the entire temperature range is 10 kW/m³ and for a flux density of 200 mT the variation is limited to 70 kW/m³. For other typical power ferrite materials this variation is 80 kW/m³ at 100 mT and 300 kW/m³ at 200 mT. Generally, the converter circuit is designed for best efficiency at the maximum operating temperature and for typical power ferrite materials this is the lowest power loss. With a change in operating condition, the core loss thus increases substantially, affecting the efficiency in these conditions. The use of a material as CF295 on the other hand ensures the core loss and hence efficiency remains independent of operating condition.

Initial Permeability vs temperature

Permeability versus Temperature curve: The curve for CF295 remains quite unchanged (within 10%) over the temperature range as for power loss as compared to a variation of 30% for typical power ferrite materials over the same range. The variation in permeability affects the magnetizing current of the transformer which also accounts for the efficiency of the system. Hence CF295 by its temperature invariant characteristic becomes a better choice.



Curie Temperature: A ferrite material loses its magnetic characteristics above the Curie temperature and for power ferrites it is important that the Curie point should be above 200˚C to cater for all Classes of Insulating materials used for the winding. CF295 has a Curie point 220°C as indicated in datasheet and is safe to be used with any known Class of Insulating material

Saturation Flux Density vs Temperature

Saturation Flux Density: A high value of saturation flux density assures a better dc bias capability of the core when used as choke inductors or fly-back transformers or single quadrant converters. As indicated in the datasheet CF295 has a saturation flux density of 525 mT at 25°C dropping to 410 mT at 100˚C. These are well above typical values of 490 mT at 25˚C and 380 mT at 100˚C for other power ferrite materials.