

FERROXCUBE FERRITES

Power conversion in hybrid and electric vehicles has led to new technical challenges in the automotive field. Currently, high voltage batteries supply the power to the motor as well as to other electronic devices. Several stages and types of

EVS and HE

energy transformation are required.

When it comes to power conversion systems, magnetic design has a great impact not only on efficiency, but also on weight and cost. Applications of ferrites in hybrid and electric cars are countless. This application note shows the variety of Ferroxcube's shapes, sizes and materials that can be combined to achieve the highest efficiency in a power conversion system design for hybrid and electric vehicles.

Ferroxcube offers a wide variety of cores for transformers and inductors in these applications, optimized for different conditions of frequency and temperature. Recommended shapes, sizes and grades are intended to support the main design considerations:

- Low core losses at working frequency and temperature are necessary to achieve high efficiency. Considering these factors you can choose among our 3Cxx material grades, which are optimized to perform on each condition.
- Switching at higher frequencies allows size and cost reduction of the magnetic component. Our 3Fxx material grades have outstanding performance from several hundreds kHz up to several MHz.
- Low profile shapes are recommended in order to build compact and modular designs



Ferrites in power conversion

On board power systems in electric vehicles have constraints of weight and size. High power density is required. Our cores cover a wide range of design types, not only for the on board charger, but also for other ways of charging, and power system systems that are being developed together with the hybrid and electric vehicles . A summary of recommended cores for the different applications is shown below.





High power DC-DC converters

New concept in converters appears in EV and HEV such as those transferring energy from the high voltage battery (hundred of Volts) to the auxiliary battery (12-15V or 42V) or other low voltage systems such as electric power steering. Magnetic shapes performing at high currents with the smallest size possible are required. The trend is using planar and distributed magnetic technology because it provides lower leakage inductance, eases cooling and has better shock and vibration features.

Shapes ⁽¹⁾			Grades ⁽¹⁾
EQ13	EQ20	EQ25	3C92
EQ30	PQ26/20	PQ32/20	3 C 94
PQ35/35	RM10/I	RM12/I	3C95
RM14/I	E22/x/16 ⁽²⁾	E32/x/20 ⁽²⁾	3C96
E38/x/25 ⁽²⁾	E43/x/28 ⁽²⁾	ER41/x/32(2)	3C97
E58/x/38 ⁽²⁾	E64/x/50 ⁽²⁾	ER23/x/13(2)	3F3
ER32/x/25 ⁽²⁾	ER51/x/38 ⁽²⁾	ER64/x/51 ⁽²⁾	3F35

(1) This is a summary of the recommended shapes and materials, but many other are available. See details in Ferroxcube data handbook(2) x means variable height of the core



On board charger

E58/x/38⁽²⁾

E64/x/50⁽²⁾

AC-DC conversion from the mains to the car battery includes EMI filters, transformers, and inductors. High effi-

Ferrites in on-board charger



ER64/x/5⁽²⁾

ER23/x/13⁽²⁾ ER32/x/25⁽²⁾ ER41/x/32⁽²⁾ ER51/x/38⁽²⁾



Wireless charger

Although the standard for wireless charging, SAE J2954, is still under development, many prototypes are already being designed and tested. Part of the charger components are placed out of the vehicle. The secondary of the transformer (the energy receiver) is placed in the car, and the power is transferred by resonant magnetic coupling from the primary, which is placed in the charging station. Larger ferrite cores than in the on board charger must be used in order to compensate the inefficiency produced by the gap between the primary and the secondary of the transformer. Split ferrite shapes are used to avoid core breakage due to mechanical vibrations in the vehicle.

The basic shapes for this application are plates or sectors, but any other custom shape can be made upon request.

Shapes		Grades
PLT109/30/x ⁽¹⁾	PLT126/28/x ⁽¹⁾	2004
PLT100/25/x ⁽¹⁾	PLT132/25/x ⁽¹⁾	3C94

Current sensors

As electronic control systems become more sophisticated, controlling the current flow through the various power systems is a must. Ferroxcube ferrites are recommended not only for current transformers, but also for current sensing circuits as magnetic concentrators for Hall effect sensors. Monitoring the traction battery or the motor inverter-driving currents requires high accuracy and bandwidth. As a result, current sensors have an important impact in the hybrid and electric vehicle world.

Please contact your Ferroxcube's representative for your Hall effect sensor needs.





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