MICROMETALS
IRON POWDER CORES

Design Guidelines for Iron Powder Cores

* Maximum Ambient Temperature
* Loss Distribution between Core & Copper
* Temperature Rise of Magnetic Device
* Thermal Conductivity of Core Material
* Availability of Air Flow, Static or Forced
* Thermal Aging Considerations
* Mechanical Mounting Precautions
* Micrometals Design Software Disc

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Maximum Ambient Temperature Limits

* Most applications for Iron Powder cores have a maximum ambient temperature of +55°C or less

* Some designs are safe in a +70°C ambient provided Thermal Aging is considered and the life expectancy meets end of life goal for the product

* The higher the ripple current in a specific design the lower the energy storage capability is for a given size core

* As the % of Ripple Current increases, the greater the core loss will become. A larger core, lower permeability or a completely different core material may be necessary to assure longevity

* Temperature Rise of the Magnetic component will set the maximum safe ambient temperature

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Loss Distribution between Core & Copper

* A design dominated by core loss is not a prudent thing to do regardless of core material

* As a starting point, consider a 50-50 split between core and copper loss

* A better design is on the order of 20-80 split between core and copper loss

* Core loss is expressed in mW/cm^3 of volume

* Copper loss is expressed as I^2 x Resistance

* It is much easier to remove heat from the copper winding than from the core material

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Temperature Rise of the Magnetic Device

* Assuming a +55°C ambient, a good design practice to follow is +40°C temperature rise or less

* This rule will keep UL and Product Safety people very happy

* The design will have a built in safety margin which will tolerate abnormal overloads

* Again, reduce the core loss at the expense of the copper loss

* A 25°C reduction in temperature will improve the life expectancy of the core by one order of magnitude

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Thermal Conductivity of Various Materials

Material Mix No.	Permeability μi	Thermal Conductivity mW/cm°C
-2	10	10.8
-8	35	29.9
-10	6.0	10.3
-17	4.0	13.3
-18	55	21.2
-26	75	42.6
-28	22	16.3
-33	33	20.2
-40	60	34.0
-52	75	34.0
-0	1.0	5.6

Approximate Values of Other Materials for Reference

Material Description	Thermal Conductivity mW/cm°C
Aluminum	450
Solid Iron	120
Ferrite	10

Availability of air Flow, Static or Forced

* Good thermal data is not always easy to obtain

* The placement of thermocouples and connections is critical for reliable and repeatable data

* Static Air means just that, no air flow at all. A closed box may take 3 - 5 hours in order to reach temperature equilibrium

* Do not be fooled by adding Forced Air to solve an overheated Magnetic Component problem

* Variable speed fans can be **Deadly** for a design that is dominated by core loss. Even at reduced power, a PFC choke still has constant core loss and heat

* Thermal Conductivity of a given core material may mask an internal core temperature that is +5°C to +30°C hotter on the inside Vs measured on the outside surface

* Iron Powder Cores allow for easy placement of a thermocouple inside the core. A small diameter hole is drilled into the core. The thermocouple is installed into the hole and glued in position

* Improperly designed and not adequately tested Magnetics can lead to Thermal Runaway of the core material

Thermal Aging Considerations

* The Micrometals Web Page will have the latest Thermal Aging information.
Our address is http://www.micrometals.com

* Thermal Aging is generally not a problem at frequencies below 10 KHz

* Eddy current losses become increasingly significant at higher frequencies. Thermal Aging increases the eddy current loss of the core

* Hysteresis loss is the major loss at low frequencies but is not effected by Thermal Aging

* The Volume of the core is directly related to how quickly a material will age. Larger cores age at a faster rate than smaller cores

* Micrometals has developed an expression for increasing Core loss Vs Time and Temperature that takes into account Peak AC Flux, Frequency and Core Volume

* Micrometals can provide Design evaluation free for the asking

* The next version of our Design Software will have the evaluation feature included in it

Mechanical Mounting Precautions

* Iron Powder cores have a distributed air gap structure

* The placement of ferrous materials around or under E-cores, U-cores and HS-cores will short the gap structure and dramatically increase the core loss

* Cores can be secured by the following

* Phosphor bronze or nonmagnetic stainless steel banding material

* Brass hardware

* Various electrical tapes

* Cable tie wraps

* Filled epoxy or filled super glue. Pay close attention to the upper thermal limits of these materials

Micrometals Design Software Disk

* Is available from our Web page or free by requesting it

* The Design Software presently contains four inductor design aids

* Design of DC output inductors and Differential mode inductors

* Design of controlled inductance swing or limited inductance value change Vs current

* Design of 10:1 or 20:1 swinging inductors using a Composit core of Ferrite and Iron Powder

* Design of PFC Boost or Buck inductors

* This is a fast and accurate software program that allows for rapid design. The default is set for +40°C temperature rise that results in conservative designs

* Revised Design Software will be released in Q1 of ‘98

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