Inductor Design

Ferrite E cores and pot cores offer the advantages of decreased cost and low core losses at high frequencies. For switching regulators, power materials are recommended because of their temperature and DC bias characteristics. By adding air gaps to these ferrite shapes, the cores can be used efficiently while avoiding saturation.

These core selection procedures simplify the design of inductors for switching regulator applications. One can determine the smallest core size, assuming a winding factor of 50% and wire current carrying capacity of 500 circular mils per ampere.

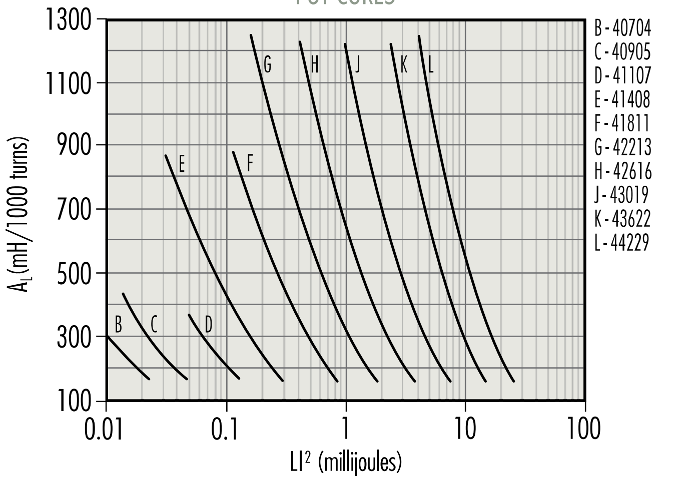
Only two parameters of the design applications must be known:
(a) Inductance required with DC bias
(b) DC current

1. Compute the product of LI^2 where:
   L = inductance required with DC bias (millihenries)
   I = maximum DC output current + 1/2 AC Ripple
2. Locate the LI^2 value on the Ferrite Core Selector charts on the following page. Follow this coordinate up to the intersection with the first core size curve. Read the maximum nominal inductance, A_L, on the Y-axis. This represents the smallest core size and maximum A_L at which saturation will be avoided.
3. Any core size line that intersects the LI^2 coordinate represents a workable core for the inductor if the core's A_L value is less than the maximum value obtained on the chart.
4. Required inductance L, core size, and core nominal inductance (A_L) are known. Calculate the number of turns using

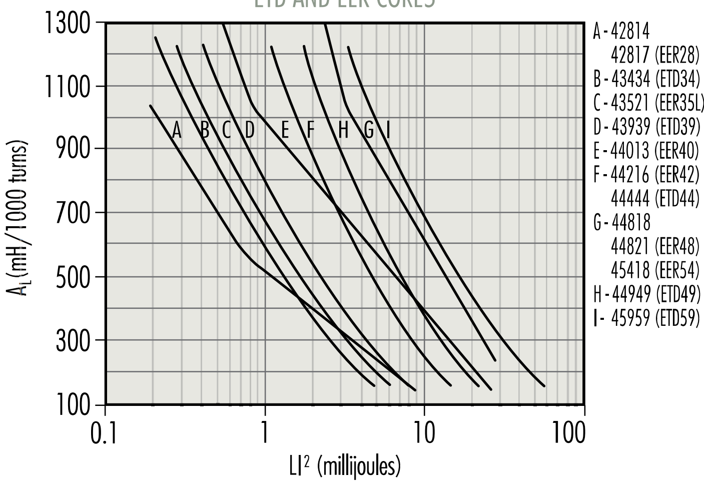
$$N = 10^3 \sqrt{\frac{L}{A_L}}$$

   where L is in millihenries.
5. Example: If I_{MAX} = 8 Amps; L, inductance required = 100 µHenries
   LI^2 = (0.100 mH) X (8^2 Amps) = 6.4 millijoules
6. There are many ferrite cores available that will support the energy required. Any core size that the LI^2 coordinate intersects can be used at the A_L value shown on the chart.
7. Some choices based upon an LI^2 value of 6.4 millijoules are:
   Pot core 43622 A_L = 400 Double Slab 43622 A_L = 250
   PQ core 43220 A_L = 300 E core 44317 A_L = 250
8. For the following A_L values the number of turns required is:
   A_L = 400, N = 16 A_L = 300, N = 19 A_L = 250, N = 20
   Make sure the wire size chosen will support the current and fit into the core set.

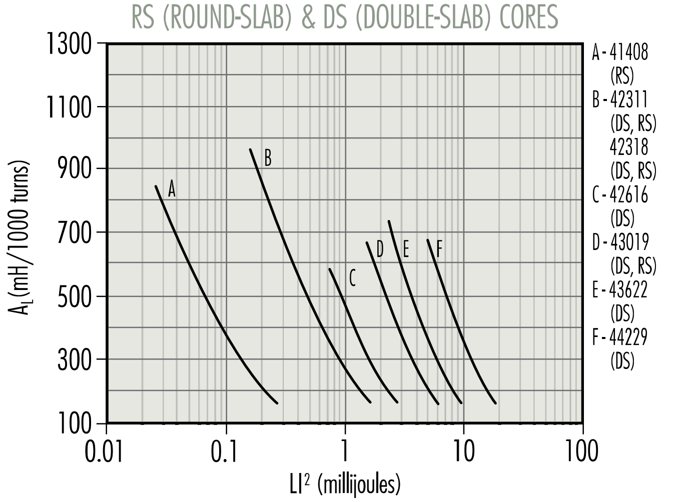
POT CORES



ETD AND EER CORES

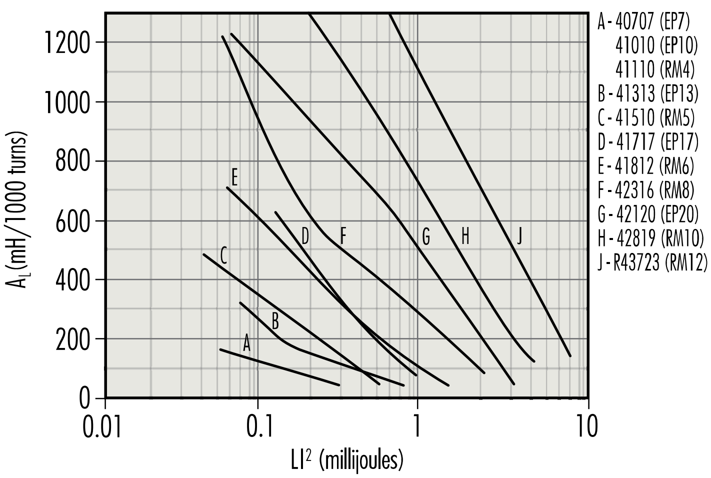


RS (ROUND-SLAB) & DS (DOUBLE-SLAB) CORES

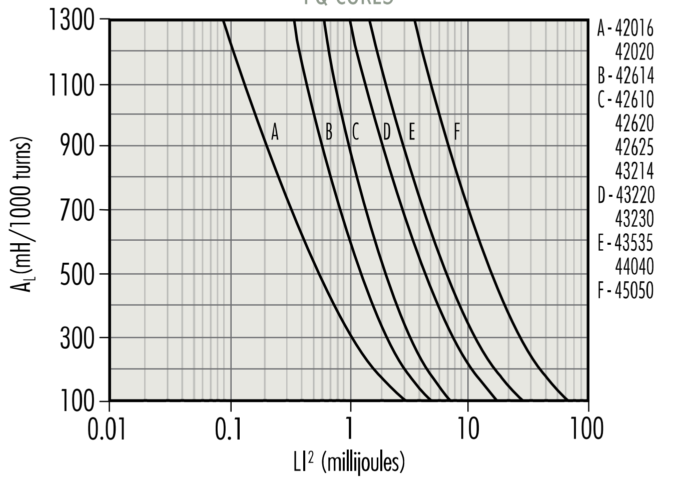


Inductor Design

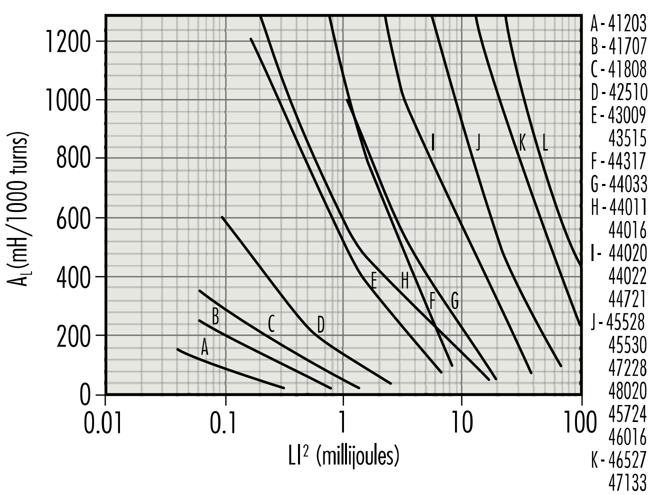
RM AND EP CORES



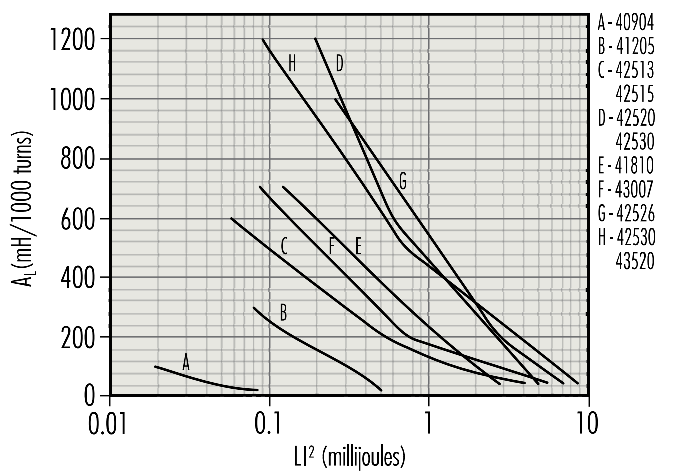
PQ CORES



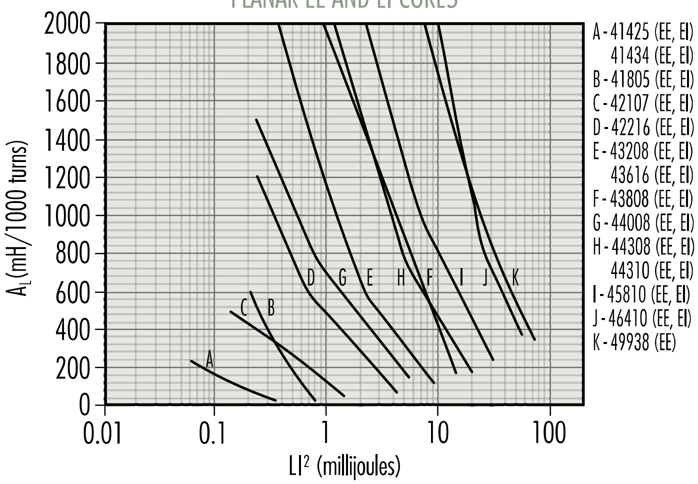
LAMINATION SIZE E CORES



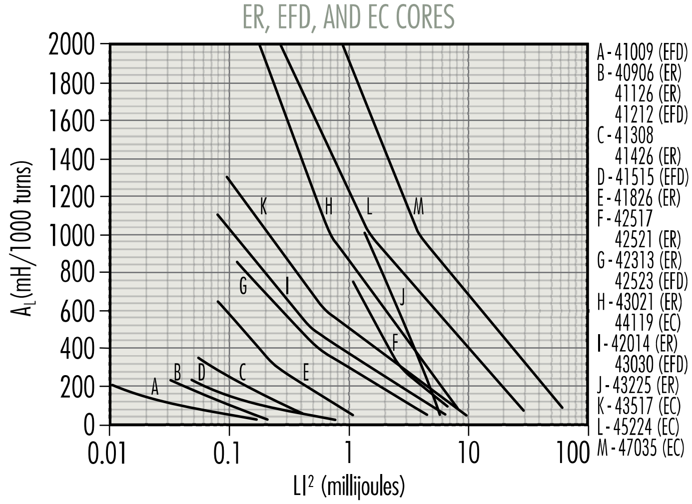
E CORES



PLANAR EE AND EI CORES

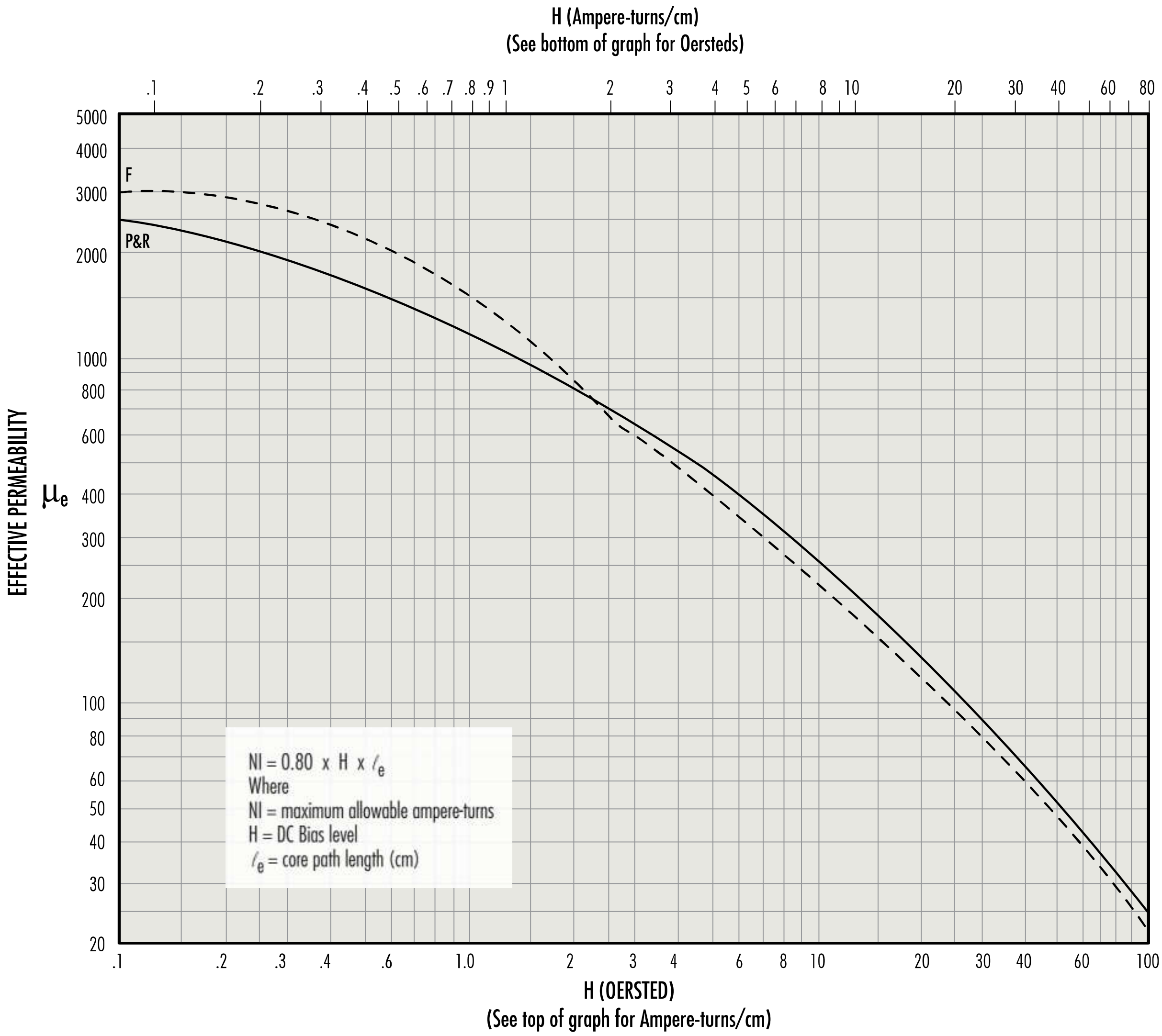


ER, EFD, AND EC CORES



Inductor Design

DC BIAS DATA — FOR GAPPED APPLICATIONS



The above curves are limit curves, up to which *effective permeability* remains constant. They show the maximum allowable DC bias, in ampere-turns, without a reduction in inductance. Beyond this level (see insert), inductance drops rapidly.

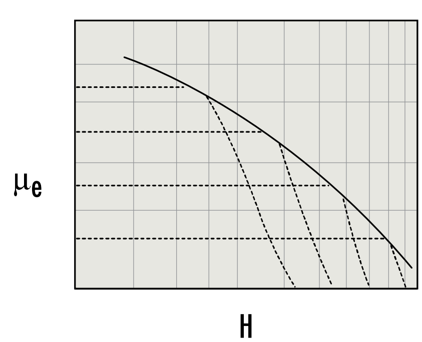
Example: How many ampere-turns can be supported by an R42213A315 pot core without a reduction in inductance value?
$\ell_e = 3.12$ cm $\mu_e = 125$

Maximum allowable H = 25 Oersted (from the graph above)
NI (maximum) = 0.80 x H x ℓ_e = 62.4 ampere-turns
or (Using top scale, maximum allowable H = 20 A•T/cm.)
NI (maximum) = A•T/cm x ℓ_e
= 20 x 3.12
= 62.4 A•T

$$\mu_e = \frac{A_L \cdot \ell_e}{4\pi A_e}$$

$$\frac{1}{\mu_e} = \frac{1}{\mu_i} + \frac{\ell_g}{\ell_e}$$

A_e = effective cross sectional area (cm^2)
A_L = inductance/1,000 turns (mH)
μ_i = initial permeability
ℓ_g = gap length (cm)



Inductance falls off rapidly above the limit curve. The dashed lines illustrate the μ_e curve for individual gapped core sets.