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DC Inductor Design Examples

EXAMPLE 1

Requirements:
45 μH at 7.5 amps DC
(< 1% ripple current)

EXAMPLE 2

Requirements:
45 μH at 7.5 amps DC
60μH max at 0 amps DC
(25% saturation max)
(<1 % ripple current)

Determine importance of the following design considerations: component size, temperature rise and cost.

Example #1: Design Priorities
cost
temperature rise
component size

Example #2: Design Priorities
component size
temperature rise
cost

Select appropriate materials to be considered.

-26, -52 and -40 Materials should be considered since the inductor requirements do not limit swing and these materials are the most cost effective.

-8, -18, -28 and -33 Materials should be considered because of the limited swing requirements.

Calculate the required Energy Storage (1/2 LI2)

Example 1: $1/2\ LI^2 = (1/2)\ (45)\ (7.5)^2 = 1266$ μJ

Example 2: $1/2\ LI^2 = (1/2)\ (45)\ (7.5)^2 = 1266$ μJ

Select core size and shape

-26 Material will be used in this example. Refer to the Energy Storage Table in Core Loss Increase Due to Thermal Aging, (Figure 4). The T106 size toroid will be selected in order to keep the winding “simple” and the temperature rise around 25C°. The E137 is an attractive choice if bobbin winding is preferred.

The -8 Material is the best choice since component size is the primary concern. The Energy Storage Table Core Loss Increase Due to Thermal Aging, (Figure 1), indicates that the T94 size toroid is the smallest core able to meet the energy storage requirements at < 40C° temperature rise. We must also check the % saturation curves found in theCore Loss Increase Due to Thermal Aging text to verify that this core will be operating at less than 25% saturation.

Determine number of turns

The curve at the top of page 40 indicates the T106 will require 217 ampere-turns to produce 1266 μJ.

Therefore,
NI = 162 / 7.5 = 29 turns

In the case of the E137 core, the curves indicate that 162 ampere-turns will be required to provide 1266 μJ.

Therefore,
NI = 162 / 7.5 = 22 turns

The curves in theCore Loss Increase Due to Thermal Aging text indicate that the T94 will be operating at 84.5% of initial permeability (15.5% saturation) to produce 1266 μJ. Use the following formula to calculate turns:

In the case of the T106 toroidal core, the "simple" winding limits are close estimates of typical single layer windings, refer to the Single Layer Winding Table. This table shows that #7 wire will fit in a single layer and result in a 25C° temperature rise from the wire. In the case of the E137, referring to the "Full Winding" Table indicates that up to #13 wire can be used.

$$N = \left[\frac{\text{desired L (nH)}}{(A_L)\ (\%\mu_o)}\right]^{1/2}$$

$$N = \left[\frac{45{,}000}{(25.0)\ (.85)}\right]^{1/2} = 46 \text{ turns}$$

Since a "full" winding was required to keep the temperature rise of the T94 below 40C°, refer to the "Full Winding" Table. This table indicates that #16 wire should be used. This table also contains the information necessary to calculate the DC resistance of a winding.

Determine wire size

Solution:
T106-26 with 29 turns #17
or E137-26 with 22 turns #14

Solution:
Part number T94-8/90
with 46 turns #16
