IHLP Selection Example

INPUT

L_{REQ}	I_{DC}	ΔI	Freq.	T_{AMB}	V-µs	δ
0.54 µH	20 A	7.39 A	300 kHz	50 °C	4.14	0.46

IHLP SELECTED

Step 1.

IHLP-4040DZ-01 0.56 µH								
L	DCR	I_{HEAT}	I_{SAT}	R_{TH}	P_{HEAT}	ET_{100}	K_0	K_1
0.56 µH	0.0018 Ω	30 A	49 A	26.96 °C/W	1.48 W	0.88	18.31	0.00340

VERIFICATION

Step 2.

$$B_{PK_{OPER}} = \frac{4.14}{0.88} \times 100 = 470.5\ \text{G}$$

Step 3.

$$f_e = \frac{300\ 000}{2\pi\ (0.46 - 0.46^2)} = 192\ 216.1\ \text{Hz}$$

Step 4.

$$P_{CORE} = 18.31 \times 192\ 216^{0.188} \times 470.5^{2.118} \times 300\ 000 \times 10^{-14} = 0.248\ \text{W}$$

Step 5.

The core losses are 0.248 W which is less then $^1/_3$ of P_{HEAT} (0.493 W)

Step 6.

$$P_{CUallowed} = 1.48 - 0.248 = 1.32\ \text{W}$$

Step 7.

$$R_{OPER} = 0.0018 \times \left[\frac{274.5 + 50}{259.5}\right] = 0.00225\ \Omega$$

$$P_{DC} = 20^2 \times 0.00225 = 0.900\ \text{W}$$

$$P_{AC} = 0.00340 \times 7.39^2 \times \sqrt{300\ 000} \times 0.00225 = 0.229\ \text{W}$$

Step 8.

$$P_{TOTAL} = 0.248 + 0.900 + 0.229 = 1.377\ \text{W}$$

Step 9.

$$\Delta T = 1.377 \times 26.96 = 37.12\ °\text{C}$$

$$T_{OPER} = 50 + 37.12 = 87.12\ °\text{C}$$

Step 10.

$$I_{PEAK} = 20 + \frac{7.39}{2} = 23.7\ \text{A}$$

I_{SAT} = 49 A which is greater then the required 23.7 A

IHLP Selection Example

SELECTION CRITERIA

1. Limit core losses (P_{CORE}) to ≤ $^1/_3$ of total losses for 40 °C temperature rise (P_{HEAT}).
2. Total copper losses allowed will be equal to P_{HEAT} - P_{CORE}.
3. Maximum component temperature should be kept ≤ 125 °C.
4. Maximum ΔT should be ≤ 40 °C (this can be exceeded provided caution is taken to insure max. temperature ≤ 125 °C).
5. $I_{PEAK} \le I_{SAT}$ (recommended, I_{PEAK} can exceed I_{SAT} with caution due to soft saturation of IHLP product).

GOVERNING EQUATIONS

1. $B_{PK_{OPER}} = \frac{ET_{ckt}}{ET_{100}} \times 100$ [G]
2. $f_e = \frac{f_0}{2\pi\ (\delta - \delta^2)}$ [Hz]
3. $P_{CORE} = K_0 f_e^{K_f - 1} B_{pk}^{Kb} \times f_0 \times 10^{-14}$ [W]
4. $P_{AC} = K_1 \times \Delta I^2 \times \sqrt{f_0} \times R_{OPER}$ [W]
5. $R_{OPER} = R_{MAX.} \times \left[\frac{274.5 + T_{AMB}}{259.5}\right]$ [A]
6. $P_{DC} = I^2_{DC} \times R_{OPER}$ [W]
7. $P_{TOTAL} = P_{CORE} + P_{DC} + P_{AC}$ [W]
8. $\Delta T = P_{TOTAL} \times R_{TH}$ [°C]
9. $T_{OPER} = T_{AMB} + \Delta T$ [°C]
10. $I_{PEAK} = I_{DC} + \frac{\Delta I}{2}$ [A]

Notes

(1) Use equation #3 for -01 and -11 components
(2) Equation #7 assumes a 40 °C temperature rise and will have the same units as $R_{MAX.}$
(3) For equations #3 f in Hz and B_{PK} in G
(4) R_{OPER} is based on a 40 °C temperature rise
(5) K_f is 1.188 for -01 material and 1.173 for -11 material
(6) K_b is 2.118 for -01 material and 2.213 for -11 material

SELECTION PROCESS

Note

- This process assumes that the following is known: Required inductance, frequency, I_{DC}, ΔI, T_{AMB}, and V-µs (ET) required

Step 1. Select inductor value based on controller data sheet recommendation and current (I_{DC}) rating.
Step 2. Determine peak operational flux density in Gauss using equation #1.
Step 3. Calculate effective frequency using equation #2.
Step 4. Determine core loss using equation #3 (see notes #1 and #2) and compare to selection criteria #1.
Step 5. If core losses are > $^1/_3$ P_{HEAT} select a larger inductor.
Step 6. Use selection criteria #2 to determine allowable copper losses.
Step 7. Determine actual copper losses using equations #4, #5 and #6.
Step 8. Use equation #7 for total losses.
Step 9. Determine ΔT using equation #8 and insure $T_{OPER} \le 125$ °C using equation #9.
Step 10. Verify I_{PEAK} is less then I_{SAT} using equation #10 for the selected part (see selection criteria #5).

DEFINITIONS

ET_{ckt}	V-µs product of the circuit
ET_{100}	V-µs product at 100 Gauss from table #1
P_{CORE}	Core losses in W
P_{DC}	Losses due to the D_{CR} of the inductor copper winding in W
K_0	IHLP core constant from table #1
f_0	Switching frequency in Hz
R_{TH}	Thermal gradient of IHLP from Table #1
f_e	Effective frequency in Hz
δ	Duty cycle
P_{AC}-	Losses in the coil due to AC effects
K_1-	AC loss constant from Table #1