



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	0.0017 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 than $\frac{1}{3}$ of P_{HEAT} (0.493 W)

Step 6.

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

Step 7.

$$R_{OPER} = 0.0017 \times \left[\frac{274.5 + 50}{259.5} \right] = 0.00213 \Omega$$

$$P_{DC} = 20^2 \times 0.00213 = 0.852 \text{ W}$$

$$P_{AC} = 0.00340 \times 7.39^2 \times \sqrt{300\,000} \times 0.00213 = 0.217 \text{ W}$$

Step 8.

$$P_{TOTAL} = 0.248 + 0.852 + 0.217 = 1.317 \text{ W}$$

Step 9.

$$\Delta T = 1.317 \times 26.96 = 35.51 \text{ °C}$$

$$T_{OPER} = 50 + 35.51 = 85.51 \text{ °C}$$

Step 10.

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

$I_{SAT} = 49 \text{ A}$ which is greater than the required 23.7 A



IHLP Selection Example

SELECTION CRITERIA

1. Limit core losses (P_{CORE}) to $\leq 1/3$ 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. $I_{PEAK} \leq I_{SAT}$ (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. $P_{CORE} = K_0 f_e^{K_f - 1} B_{pk}^{K_b} \times f_0 \times 10^{-14}$ [W]
4. $P_{AC} = K_1 \times \Delta I^2 \times \sqrt{f_0} \times R_{OPER}$ [W]
5. $R_{OPER} = R_{TYP.} \times \left[\frac{274.5 + T_{AMB}}{259.5} \right]$ [A]
6. $P_{DC} = I_{DC}^2 \times R_{OPER}$ [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
- (7) For IHLP-2525EZ-01 - $K_f = 1.181$ and $K_b = 2.166$

SELECTION PROCESS

Note

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

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

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