

Switched Mode Power Conversion

Semester II Academic Year 2025-26

Lecture 33

15th April 2026

Inductor Design

- Specification of a power converter $\Rightarrow$ Value of L at a rated current.

$$E_L = \frac{1}{2} L i^2$$

Inductor Design

- Specification of a power converter $\Rightarrow$ Value of L at a rated current.

$$B = \frac{\mu N i}{l_m}$$

$$\phi = \frac{\mu N A_c i}{l_m}$$

$$e = -N \frac{d\phi}{dt}$$

$$= - \frac{\mu N^2 A_c}{l_m} \frac{di}{dt}$$

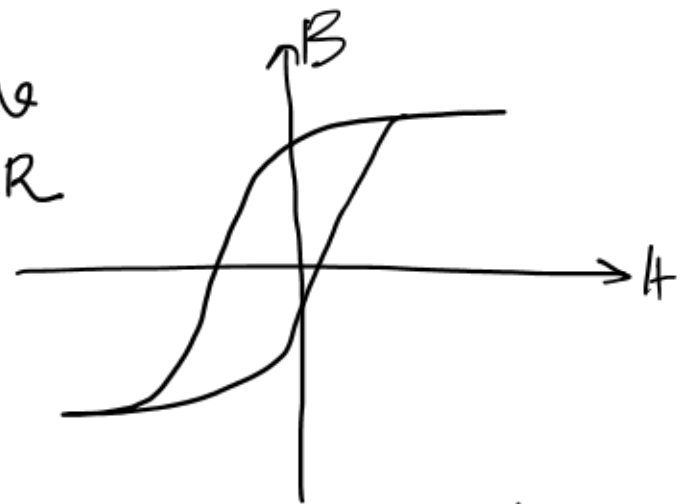
$$E_L = \frac{1}{2} L i^2$$

$$L = \frac{N^2}{(l_m / \mu A_c)}$$

$$\frac{l_m}{\mu A_c} = \text{Reluctance (turn}^2/\text{H)}$$

$$= \mathcal{R}$$

$$\Lambda = \frac{1}{\mathcal{R}} [\text{Permeance}]$$



Near saturation

$$\frac{d\phi}{dt} \approx 0$$

$L \downarrow$ [Current rises]

Inductor Design

- Specification of a power converter $\Rightarrow$ Value of L at a rated current.

$$E_L = \frac{1}{2} L i^2$$

$$K_w A_w = N \frac{i}{J}$$

$$\Rightarrow K_w A_w J = N i$$

$$K_c K_w A_w J = N i_{pk}$$

$$K_c = \frac{i_{pk}}{i_{rms}} = \text{Crest factor}$$

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$$E_{L_{pk}} = \frac{1}{2} (L i_{pk}) i_{pk}$$

$$= \frac{1}{2} N A_c B_{pk} \frac{K_c K_w A_w J}{N}$$

$$A_w A_c = \frac{2 E_{L_{pk}}}{K_c K_w J B_{pk}}$$

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$$L = 0.216 \text{ mH} \quad I_L = 20.83 \text{ A} \\ f_{\text{sw}} = 10 \text{ kHz} \quad (20\% \text{ ripple})$$

$$I_{Lpk} \approx 23 \text{ A}$$

$$E_L = \frac{1}{2} L i_{pk}^2 = 0.057 \text{ J}$$

$$J = 5 \text{ A/mm}^2$$

$$\therefore A_p = \frac{2 \times 0.057}{\frac{5}{10^{-6}} \times 0.3 \times 0.3}$$

$$= 2.533 \times 10^{-7} \text{ m}^4$$

$$= 25.3 \text{ cm}^4$$

Inductor Design

		MAGNETIC DATA						HARDWARE
SIZE (mm)	ORDERING CODE	l_e (mm)	A_e (mm ²)	V_e (mm ³)	Window Area (cm ²)	WaAc (cm ⁴)	Weight (grams per piece)	Headers & Mounts
49.1 x 33.8 x 15.9	0_44916TC	127	120	15,298	8.99	10.6	75.3	TVH49164A
49.1 x 31.8 x 15.9	0_44920TC	123.2	135.4	16,676	7.94	9.45	83	TVH49164A
49.1 x 31.8 x 19.05	0_44925TC	123	162	20,000	7.94	12.8	98	TVH49164A
49.1 x 33.8 x 31.3	0_44932TC	127	237	30,100	8.99	21.2	150.6	TVH49164A
60.96 x 41.78 x 12.7	0_46013TC	157.6	120.4	18,968	13.68	16.48	94	
60.96 x 41.78 x 19.05	0_46019TC	157.6	180.5	28,453	13.68	24.7	141	
61 x 35.6 x 12.7	0_46113TC	144.6	157.4	22,774	9.93	15.5	113	TVH49164A
63 x 38 x 24.5	0_46325TC	152	300	45,598	11.1	33.2	225	TVH49164A
63 x 38 x 24.5	0_46326TC	152	300	45,600	11.3	33.9	225	TVH49164A
73.7 x 38.9 x 12.5	0_47313TC	165	210	34,771	11.9	25	172	
73.7 x 38.9 x 25.2	0_47325TC	165	423	70,099	11.9	50.3	347	
73.7 x 38.9 x 25.4	0_47326TC	165	427	70,595	11.9	50.8	350	
85.7 x 55.5 x 12.7	0_48613TC	214.9	188.8	40,582	24.2	45.7	201	
85.7 x 55.5 x 25.4	0_48625TC	215	375	80,700	24.2	90.8	399	
85.7 x 55.5 x 25.4	0_48626TC	215	377	81,165	24.2	91.2	402	
102 x 65.8 x 15	0_49715TC	255.3	267.2	68,821	34	90.8	341	
107 x 65 x 18	0_49718TC	259.31	370.27	96,013	28.6	106	475	
107 x 65 x 25	0_49725TC	259.31	514.3	133,351	33.2	171	660	
140 x 106 x 25	0_49740TC	381.5	422.3	161,086	88.2	372	797	

Inductor Design

		COATING			NOMINAL A _L (mH/1000T)				
SIZE (mm)	ORDERING CODE	V	Y	Z	R ± 25%	P ± 25%	F ± 20%	J ± 20%	W ± 30%
49.1 x 33.8 x 15.9	0_44916TC			✓	2,710	2,950	3,540	5,900	11,800
49.1 x 31.8 x 15.9	0_44920TC			✓	2,790	3,032	3,640	6,065	12,130
49.1 x 31.8 x 19.05	0_44925TC			✓	3,420	3,718	4,460	7,435	14,870
49.1 x 33.8 x 31.3	0_44932TC			✓	5,430	5,900	7,080	11,800	23,600
60.96 x 41.78 x 12.7	0_46013TC			✓				4,800	9,483
60.96 x 41.78 x 19.05	0_46019TC			✓				7,100	
61 x 35.6 x 12.7	0_46113TC			✓	3,140	3,491	4,107	6,845	13,690
63 x 38 x 24.5	0_46325TC			✓					21,056
63 x 38 x 24.5	0_46326TC			✓	5,770	6,270	7,530	12,500	
73.7 x 38.9 x 12.5	0_47313TC			✓	3,700	4,024	4,880	8,140	16,280
73.7 x 38.9 x 25.2	0_47325TC			✓	7,400	8,050	9,760	16,280	
73.7 x 38.9 x 25.4	0_47326TC			✓					27,610
85.7 x 55.5 x 12.7	0_48613TC			✓	2,510	2,726	3,310	5,520	11,040
85.7 x 55.5 x 25.4	0_48625TC			✓	5,040	5,480	6,570	10,960	
85.7 x 55.5 x 25.4	0_48626TC			✓					18,760
102 x 65.8 x 15	0_49715TC			✓	3,025	3,464	3,945	6,575	11,178
107 x 65 x 18	0_49718TC			✓	4,127	4,486	5,383	8,972	15,252
107 x 65 x 25	0_49725TC			✓	5,732	6,230	7,477	12,461	21,184
140 x 106 x 25	0_49740TC			✓	3,200	3,477	4,173	6,955	11,823

$$\mu_r = 10,000 \quad l_m = 152 \text{ mm} \quad A_c = 300 \text{ mm}^2$$

$$L = \frac{N^2}{l_m / \mu A_c}$$

$$\lambda = \frac{\mu A_c}{l_m} = 25 \mu\text{H} / \text{turn}^2$$

$$\therefore N = \sqrt{\frac{0.216 \times 10^{-3}}{25 \times 10^{-6}}} \approx 3 \text{ turns}$$

$$A_c = \frac{20.83}{5} = 4.16 \text{ mm}^2 \quad \left[\begin{array}{l} 11.1 \text{ AWG} \\ 4.17 \text{ mm}^2 \end{array} \right]$$

$$N A_c = 3 \times 4.16 \text{ mm}^2$$

$$K_w = \frac{12.48}{11.1 \times 10^2} = 0.011$$

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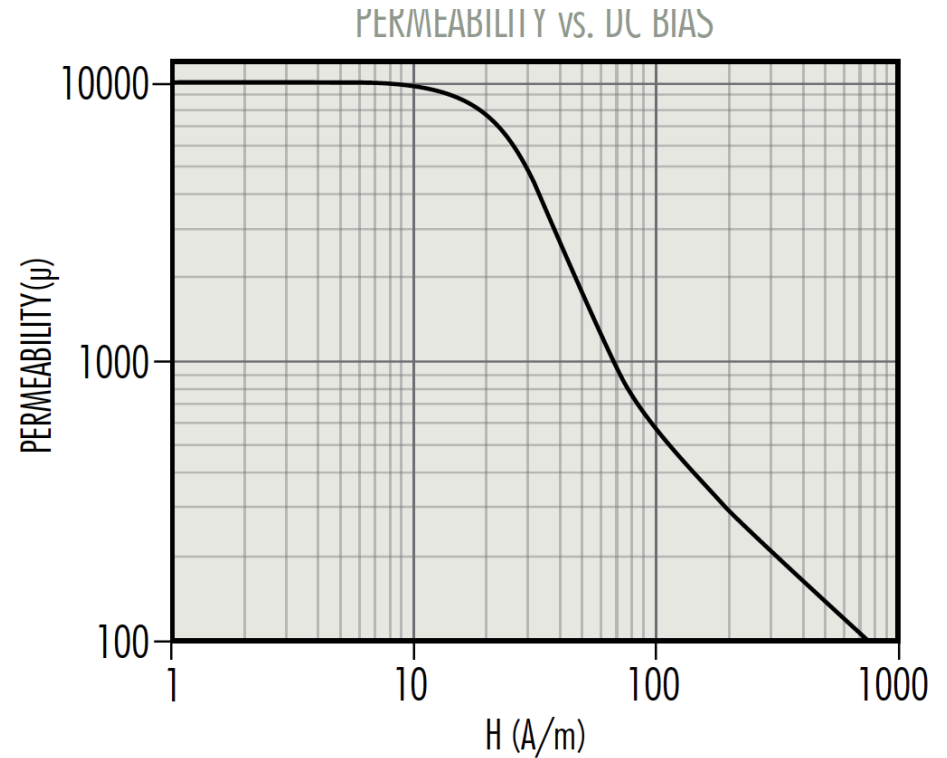
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$$H = \frac{Ni}{l_m} = 453 \text{ A/m}$$

$$\lambda = 0.4 \mu\text{H/turn}^2$$

$$L = 3.6 \mu\text{H}$$



Air gap in core to avoid saturation

$$R = \frac{l_m \overset{\text{core}}{\uparrow}}{\mu A_c} + \frac{l_g \overset{\text{Air gap}}{\uparrow}}{\mu_0 A_c}$$

$$\because \mu \gg \mu_0$$

$$R \approx \frac{l_g}{\mu_0 A_c}$$

