

Appendix 2

Magnetics Design Tables

Geometrical data for several standard ferrite core shapes are listed here. The geometrical constant K_g is a measure of core size, useful for designing inductors and transformers which attain a given copper loss [1]. The K_g method for inductor design is described in Chapter 13. K_g is defined as

$$K_g = \frac{A_c^2 W_A}{MLT} \quad (\text{A2.1})$$

where A_c is the core cross-sectional area, W_A is the window area, and MLT is the winding mean-length-per-turn. The geometrical constant K_{gfe} is a similar measure of core size, which is useful for designing ac inductors and transformers when the total copper plus core loss is constrained. The K_{gfe} method for magnetics design is described in Chapter 14. K_{gfe} is defined as

$$K_{gfe} = \frac{W_A A_c^{2(1-1/\beta)}}{MLT l_e^{2/\beta}} u(\beta) \quad (\text{A2.2})$$

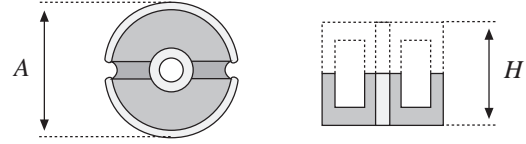
where l_e is the core mean magnetic path length, and β is the core loss exponent:

$$P_{fe} = K_{fe} B_{\max}^\beta \quad (\text{A2.3})$$

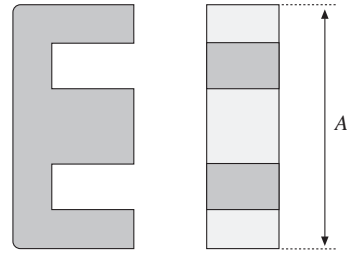
For modern ferrite materials, β typically lies in the range 2.6 to 2.8. The quantity $u(\beta)$ is defined as

$$u(\beta) = \left[\left(\frac{\beta}{2} \right)^{-\left(\frac{\beta}{\beta+2} \right)} + \left(\frac{\beta}{2} \right)^{\left(\frac{2}{\beta+2} \right)} \right]^{-\left(\frac{\beta+2}{\beta} \right)} \quad (\text{A2.4})$$

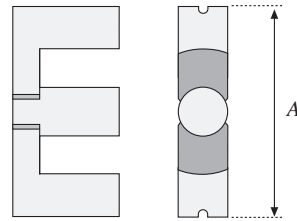
$u(\beta)$ is equal to 0.305 for $\beta = 2.7$. This quantity varies by roughly 5% over the range $2.6 \leq \beta \leq 2.8$. Values of K_{gfe} are tabulated for $\beta = 2.7$; variation of K_{gfe} over the range $2.6 \leq \beta \leq 2.8$ is typically quite small.

A2.1 Pot core data

Core type	Geometrical constant	Geometrical constant	Cross-sectional area	Bobbin winding area	Mean length per turn	Magnetic path length	Thermal resistance	Core weight
(AH) (mm)	K_{g_s} cm^5	$K_{g_{fe}}$ cm^x	A_c (cm^2)	W_A (cm^2)	MLT (cm)	l_m (cm)	R_{th} ($^{\circ}\text{C}/\text{W}$)	(g)
704	$0.738 \cdot 10^{-6}$	$1.61 \cdot 10^{-6}$	0.070	$0.22 \cdot 10^{-3}$	1.46	1.0		0.5
905	$0.183 \cdot 10^{-3}$	$256 \cdot 10^{-6}$	0.101	0.034	1.90	1.26		1.0
1107	$0.667 \cdot 10^{-3}$	$554 \cdot 10^{-6}$	0.167	0.055	2.30	1.55		1.8
1408	$2.107 \cdot 10^{-3}$	$1.1 \cdot 10^{-3}$	0.251	0.097	2.90	2.00	100	3.2
1811	$9.45 \cdot 10^{-3}$	$2.6 \cdot 10^{-3}$	0.433	0.187	3.71	2.60	60	7.3
2213	$27.1 \cdot 10^{-3}$	$4.9 \cdot 10^{-3}$	0.635	0.297	4.42	3.15	38	13
2616	$69.1 \cdot 10^{-3}$	$8.2 \cdot 10^{-3}$	0.948	0.406	5.28	3.75	30	20
3019	0.180	$14.2 \cdot 10^{-3}$	1.38	0.587	6.20	4.50	23	34
3622	0.411	$21.7 \cdot 10^{-3}$	2.02	0.748	7.42	5.30	19	57
4229	1.15	$41.1 \cdot 10^{-3}$	2.66	1.40	8.60	6.81	13.5	104

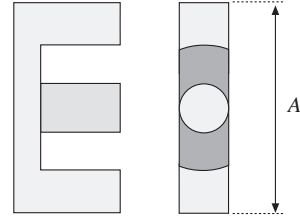
A2.2 EE core data

Core type	Geometrical constant	Geometrical constant	Cross-sectional area	Bobbin winding area	Mean length per turn	Magnetic path length	Core weight
(A) (mm)	K_{g_5} cm^5	K_{gfe} cm^x	A_c (cm^2)	W_A (cm^2)	MLT (cm)	l_m (cm)	(g)
EE12	$0.731 \cdot 10^{-3}$	$0.458 \cdot 10^{-3}$	0.14	0.085	2.28	2.7	2.34
EE16	$2.02 \cdot 10^{-3}$	$0.842 \cdot 10^{-3}$	0.19	0.190	3.40	3.45	3.29
EE19	$4.07 \cdot 10^{-3}$	$1.3 \cdot 10^{-3}$	0.23	0.284	3.69	3.94	4.83
EE22	$8.26 \cdot 10^{-3}$	$1.8 \cdot 10^{-3}$	0.41	0.196	3.99	3.96	8.81
EE30	$85.7 \cdot 10^{-3}$	$6.7 \cdot 10^{-3}$	1.09	0.476	6.60	5.77	32.4
EE40	0.209	$11.8 \cdot 10^{-3}$	1.27	1.10	8.50	7.70	50.3
EE50	0.909	$28.4 \cdot 10^{-3}$	2.26	1.78	10.0	9.58	116
EE60	1.38	$36.4 \cdot 10^{-3}$	2.47	2.89	12.8	11.0	135
EE70/68/19	5.06	$127 \cdot 10^{-3}$	3.24	6.75	14.0	9.0	280

A2.3 EC core data

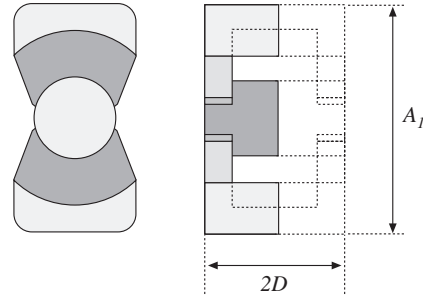
Core type	Geometrical constant	Geometrical constant	Cross-sectional area	Bobbin winding area	Mean length per turn	Magnetic path length	Thermal resistance	Core weight
(A) (mm)	K_{g_5} cm^5	K_{gfe} cm^x	A_c (cm^2)	W_A (cm^2)	MLT (cm)	l_m (cm)	R_{ih} $(^\circ\text{C}/\text{W})$	(g)
EC35	0.131	$9.9 \cdot 10^{-3}$	0.843	0.975	5.30	7.74	18.5	35.5
EC41	0.374	$19.5 \cdot 10^{-3}$	1.21	1.35	5.30	8.93	16.5	57.0
EC52	0.914	$31.7 \cdot 10^{-3}$	1.80	2.12	7.50	10.5	11.0	111
EC70	2.84	$56.2 \cdot 10^{-3}$	2.79	4.71	12.9	14.4	7.5	256

A2.4 ETD core data



Core type	Geometrical constant	Geometrical constant	Cross-sectional area	Bobbin winding area	Mean length per turn	Magnetic path length	Thermal resistance	Core weight
(A) (mm)	K_{g5} cm^5	K_{gfe} cm^x	A_c (cm^2)	W_{A^2} (cm^2)	MLT (cm)	l_m (cm)	R_{th} ($^{\circ}\text{C}/\text{W}$)	(g)
ETD29	0.0978	$8.5 \cdot 10^{-3}$	0.76	0.903	5.33	7.20		30
ETD34	0.193	$13.1 \cdot 10^{-3}$	0.97	1.23	6.00	7.86	19	40
ETD39	0.397	$19.8 \cdot 10^{-3}$	1.25	1.74	6.86	9.21	15	60
ETD44	0.846	$30.4 \cdot 10^{-3}$	1.74	2.13	7.62	10.3	12	94
ETD49	1.42	$41.0 \cdot 10^{-3}$	2.11	2.71	8.51	11.4	11	124

A2.5 PQ core data



Core type	Geometrical constant	Geometrical constant	Cross-sectional area	Bobbin winding area	Mean length per turn	Magnetic path length	Core weight
$(A_1/2D)$ (mm)	K_{g5} cm^5	K_{gfe} cm^x	A_c (cm^2)	W_{A^2} (cm^2)	MLT (cm)	l_m (cm)	(g)
PQ 20/16	$22.4 \cdot 10^{-3}$	$3.7 \cdot 10^{-3}$	0.62	0.256	4.4	3.74	13
PQ 20/20	$33.6 \cdot 10^{-3}$	$4.8 \cdot 10^{-3}$	0.62	0.384	4.4	4.54	15
PQ 26/20	$83.9 \cdot 10^{-3}$	$7.2 \cdot 10^{-3}$	1.19	0.333	5.62	4.63	31
PQ 26/25	0.125	$9.4 \cdot 10^{-3}$	1.18	0.503	5.62	5.55	36
PQ 32/20	0.203	$11.7 \cdot 10^{-3}$	1.70	0.471	6.71	5.55	42
PQ 32/30	0.384	$18.6 \cdot 10^{-3}$	1.61	0.995	6.71	7.46	55
PQ 35/35	0.820	$30.4 \cdot 10^{-3}$	1.96	1.61	7.52	8.79	73
PQ 40/40	1.20	$39.1 \cdot 10^{-3}$	2.01	2.50	8.39	10.2	95

A2.6 American wire gauge data

AWG#	Bare area, 10^{-3} cm^2	Resistance, $10^{-6} \Omega/\text{cm}$	Diameter, cm
0000	1072.3	1.608	1.168
000	850.3	2.027	1.040
00	674.2	2.557	0.927
0	534.8	3.224	0.825
1	424.1	4.065	0.735
2	336.3	5.128	0.654
3	266.7	6.463	0.583
4	211.5	8.153	0.519
5	167.7	10.28	0.462
6	133.0	13.0	0.411
7	105.5	16.3	0.366
8	83.67	20.6	0.326
9	66.32	26.0	0.291
10	52.41	32.9	0.267
11	41.60	41.37	0.238
12	33.08	52.09	0.213
13	26.26	69.64	0.190
14	20.02	82.80	0.171
15	16.51	104.3	0.153
16	13.07	131.8	0.137
17	10.39	165.8	0.122
18	8.228	209.5	0.109
19	6.531	263.9	0.0948
20	5.188	332.3	0.0874
21	4.116	418.9	0.0785
22	3.243	531.4	0.0701
23	2.508	666.0	0.0632
24	2.047	842.1	0.0566
25	1.623	1062.0	0.0505
26	1.280	1345.0	0.0452
27	1.021	1687.6	0.0409
28	0.8046	2142.7	0.0366
29	0.6470	2664.3	0.0330
30	0.5067	3402.2	0.0294
31	0.4013	4294.6	0.0267
32	0.3242	5314.9	0.0241
33	0.2554	6748.6	0.0236
34	0.2011	8572.8	0.0191
35	0.1589	10849	0.0170
36	0.1266	13608	0.0152
37	0.1026	16801	0.0140
38	0.08107	21266	0.0124
39	0.06207	27775	0.0109
40	0.04869	35400	0.0096
41	0.03972	43405	0.00863
42	0.03166	54429	0.00762
43	0.02452	70308	0.00685

