EPCOS Product Brief 2019

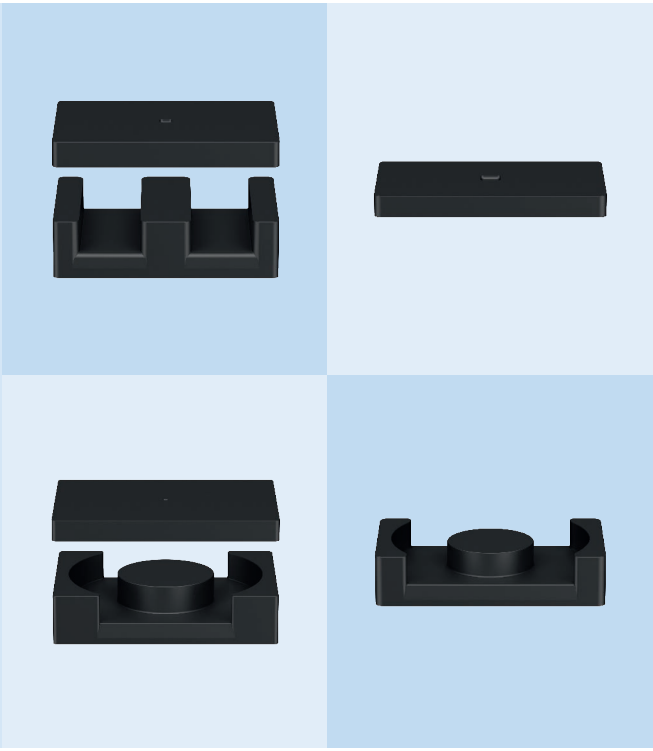
Planar Cores for Power Applications

New Power Material PC200 for Switching Frequencies up to 4 MHz

With rapidly increased frequencies, magnetics become a very important component to achieve high-efficiency and high-power-density converter. Combined with low profile cores the trend of downsizing and miniaturization is realized. Such planar designs offer advantages that include:

- Low leakage inductance
- Excellent repeatability of the performance
- Economical assembly
- Mechanical integrity
- Superior thermal characteristics

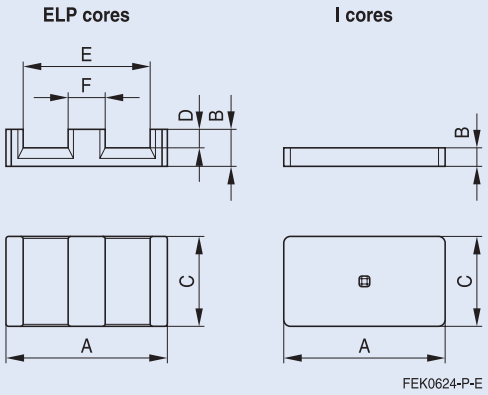
Besides the ELP core series that range from ELP 14 to ELP 102, TDK offers extended series of EPCOS planar cores with round center posts as well – ER 9.5 to ER 32 and EQ 13 to EQ 30. This wide range of shapes improves the design capabilities for individual power converter solutions. Customer specific heights can be supplied as well as different air gap or A_L value requirements for all series. EPCOS planar cores are ob-tainable as EELP, EEQ and EER sets as well as EILP, EIQ and EIR sets.



www.tdk-electronics.tdk.com

ELP Cores

Dimensional drawings



Dimensions

Cores	Dimensions					
	A mm	B mm	C mm	D mm	E mm	F mm
ELP/I						
ELP 14/3.5/5	14.00±0.30	3.50±0.10	5.00±0.10	2.00±0.10	11.00±0.25	3.00±0.05
I 14/1.5/5	14.00±0.30	1.50±0.10	5.00±0.10			
ELP 18/4/10	18.00±0.35	4.00±0.10	10.00±0.20	2.00±0.10	14.00±0.30	4.00±0.10
I 18/2/10	18.00±0.35	2.00±0.10	10.00±0.20			
ELP 22/6/16	21.80±0.40	5.70±0.10	15.80±0.30	3.20±0.10	16.80±0.40	5.00±0.10
I 22/2.5/16	21.80±0.40	2.50±0.10	15.80±0.30			
ELP 32/6/20	31.75±0.65	6.35±0.15	20.35±0.40	3.20±0.15	25.40±0.50	6.35±0.15
I 32/3/20	31.75±0.65	3.15±0.15	20.35±0.40			
ELP/I						
ELP 38/8/25	38.10±0.80	8.25±0.15	25.40±0.55	4.45±0.15	30.80±0.60	7.60±0.20
I 38/4/25	38.10±0.80	3.80±0.15	25.40±0.55			
ELP 43/10/28	43.20±0.90	9.50±0.15	27.90±0.60	5.40±0.15	35.40±0.70	8.10±0.20
I 43/4/28	43.20±0.90	4.10±0.15	27.90±0.60			
ELP 58/11/38	58.40±1.20	10.55±0.10	38.10±0.80	6.50±0.15	51.10±1.10	8.10±0.20
I 58/4/38	58.40±1.20	4.05±0.20	38.10±0.80			
ELP 64/10/50	64.00±1.30	10.20±0.15	50.80±1.10	5.10±0.15	53.60±1.10	10.20±0.20
I 64/5/50	64.00±1.30	5.10±0.15	50.80±1.10			
ELP 102/20/38	102.00±1.50	20.30±0.20	37.50±0.60	13.30±0.30	86.00±1.20	14.00±0.35
I 102/7/38	102.00±1.50	7.00±0.10	37.50±0.60			

ELP Cores

Magnetic characteristics

Planar core sets		Magnetic characteristics (sets)				
Piece 1	Piece 2	l_e/A_e mm^{-1}	l_e mm	A_e mm^2	A_{min} mm^2	V_e mm^3
ELP	**ELP/I**					
ELP 14/3.5/5	I 14/1.5/5	1.15	16.7	14.5	13.9	242
	ELP 14/3.5/5	1.45	20.7	14.3	13.9	296
ELP 18/4/10	I 18/2/10	0.51	20.3	39.5	38.9	802
	ELP 18/4/10	0.62	24.3	39.3	38.9	955
ELP 22/6/16	I 22/2.5/16	0.33	26.1	78.5	77.9	2050
	ELP 22/6/16	0.41	32.5	78.3	77.9	2540
ELP 32/6/20	I 32/3/20	0.27	35.1	130.0	128.0	4560
	ELP 32/6/20	0.32	41.4	130.0	128.0	5390

A_L values and ordering codes

Combination		A_L values [nH] Material (code number)			Ordering code
		N49 (*** = 149)	N87 (*** = 187)	N92 (*** = 192)	Single core
Set	**ELP/I**				**ELP/I**
EELP	ELP 14/3.5/5	800±25%	1100±25%	850±25%	B66281G0000X***
	ELP 14/3.5/5				B66281G0000X***
EILP	ELP 14/3.5/5	850±25%	1250±25%	900±25%	B66281G0000X***
	I 14/1.5/5				B66281K0000X***
EELP	ELP 18/4/10	1900±25%	2600±25%	2050±25%	B66453G0000X***
	ELP 18/4/10				B66453G0000X***
EILP	ELP 18/4/10	2100±25%	2900±25%	2300±25%	B66453G0000X***
	I 18/2/10				B66453K0000X***
EELP	ELP 22/6/16	3100±25%	4500±25%	3400±25%	B66455G0000X***
	ELP 22/6/16				B66455G0000X***
EILP	ELP 22/6/16	3700±25%	5200±25%	4000±25%	B66455G0000X***
	I 22/2.5/16				B66455K0000X***
EELP	ELP 32/6/20	3900±25%	5700±25%	4300±25%	B66457G0000X***
	ELP 32/6/20				B66457G0000X***
EILP	ELP 32/6/20	4400±25%	6300±25%	4800±25%	B66457G0000X***
	I 32/3/20				B66457K0000X***
Set	**ELP/I**				**ELP/I**
EELP	ELP 38/8/25	4850±25%	7200±25%	5400±25%	B66459G0000X***
	ELP 38/8/25				B66459G0000X***
EILP	ELP 38/8/25	5700±25%	8300±25%	6200±25%	B66459G0000X***
	I 38/4/25				B66459K0000X***
EELP	ELP 43/10/28	5000±25%	7300±25%	5500±25%	B66461G0000X***
	ELP 43/10/28				B66461G0000X***
EILP	ELP 43/10/28	5900±25%	8500±25%	6400±25%	B66461G0000X***
	I 43/4/28				B66461K0000X***
EELP	ELP 58/11/38	5600±25%	7400±25%	5600±25%	B66293G0000X***
	ELP 58/11/38				B66293G0000X***
EILP	ELP 58/11/38	6400±25%	8400±25%	6400±25%	B66293G0000X***
	I 58/4/38				B66293K0000X***
EELP	ELP 64/10/50	8000±30%	12500±25%	on request	B66295G0000X***
	ELP 64/10/50				B66295G0000X***
EILP	ELP 64/10/50	8900±30%	14000±25%	on request	B66295G0000X***
	I 64/5/50				B66295K0000X***
EELP	ELP 102/20/38	5900±25%	8200±25%	on request	B66297G0000X***
	ELP 102/20/38				B66297G0000X***
EILP	ELP 102/20/38	6800±25%	9300±25%	on request	B66297G0000X***
	I 102/7/38				B66297K0000X***

ELP Cores

Magnetic characteristics

Planar core sets		Magnetic characteristics (sets)				
Piece 1	Piece 2	l_e/A_e mm^{-1}	l_e mm	A_e mm^2	A_{min} mm^2	V_e mm^3
ELP	**ELP/I**					
ELP 38/8/25	I 38/4/25	0.220	43.6	194.0	192.0	8440
	ELP 38/8/25	0.270	52.4	194.0	192.0	10200
ELP 43/10/28	I 43/4/28	0.225	50.8	225.0	217.0	11430
	ELP 43/10/28	0.274	61.6	225.0	217.0	13748
ELP 58/11/38	I 58/4/38	0.220	67.7	310.0	308.0	21000
	ELP 58/11/38	0.260	80.7	310.0	308.0	25000
ELP 64/10/50	I 64/5/50	0.130	69.7	519.0	518.0	36200
	ELP 64/10/50	0.150	79.9	519.0	518.0	41500
ELP 102/20/38	I 102/7/38	0.227	121.2	534.2	524.5	67745
	ELP 102/20/38	0.274	147.6	538.0	524.5	79410

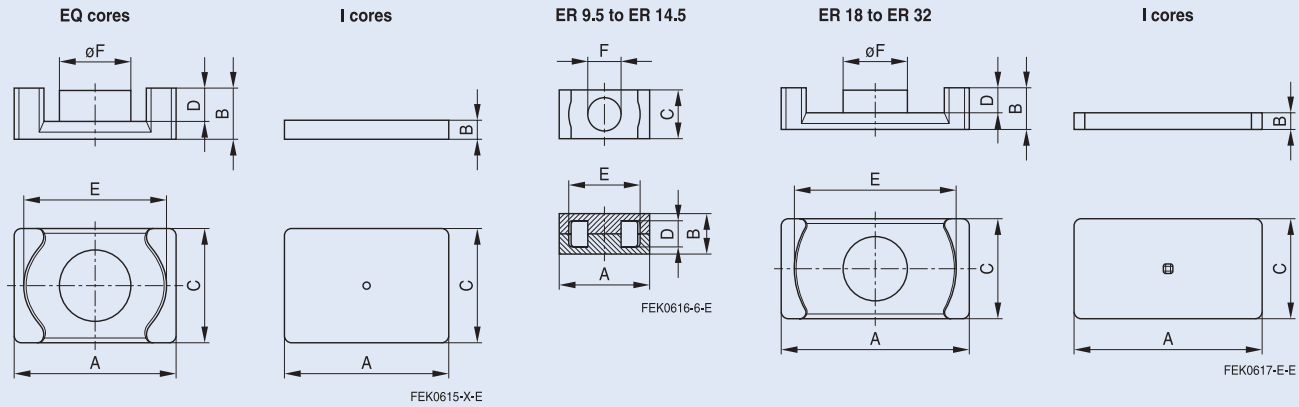
A_L values and ordering codes

Combination		A_L values [nH] Material (code number)				Ordering code
		N95[1] (***= 195)	PC95[2] (*** = 606)	N97 (*** = 197)	PC200 (*** = 608)	Single core
Set	**ELP/I**					**ELP/I**
EELP	ELP 14/3.5/5	1300±25%	1350±25%	1150±25%	600±25%	B66281G0000X***
	ELP 14/3.5/5					B66281G0000X***
EILP	ELP 14/3.5/5	1450±25%	1500±25%	1300±25%	660±25%[3]	B66281G0000X***
	I 14/1.5/5					B66281K0000X***
EELP	ELP 18/4/10	3000±25%	3200±25%	2670±25%	1300±25%	B66453G0000X***
	ELP 18/4/10					B66453G0000X***
EILP	ELP 18/4/10	3400±25%	3500±25%	3000±25%	1500±25%	B66453G0000X***
	I 18/2/10					B66453K0000X***
EELP	ELP 22/6/16	5300±25%	5800±25%	4600±25%	2100±25%	B66455G0000X***
	ELP 22/6/16					B66455G0000X***
EILP	ELP 22/6/16	6100±25%	6500±25%	5250±25%	2500±25%[3]	B66455G0000X***
	I 22/2.5/16					B66455K0000X***
EELP	ELP 32/6/20	6900±25%	7300±25%	5700±25%	2700±25%	B66457G0000X***
	ELP 32/6/20					B66457G0000X***
EILP	ELP 32/6/20	7550±25%	7900±25%	6300±25%	2850±25%[3]	B66457G0000X***
	I 32/3/20					B66457K0000X***
Set	**ELP/I**					**ELP/I**
EELP	ELP 38/8/25	8800±25%	9400±25%	7400±25%	2900±25%	B66459G0000X***
	ELP 38/8/25					B66459G0000X***
EILP	ELP 38/8/25	10100±25%	10700±25%	8400±25%	3600±25%[3]	B66459G0000X***
	I 38/4/25					B66459K0000X***
EELP	ELP 43/10/28	9000±25%	9600±25%	7500±25%	3000±25%	B66461G0000X***
	ELP 43/10/28					B66461G0000X***
EILP	ELP 43/10/28	10400±25%	11000±25%	8700±25%	3600±25%[3]	B66461G0000X***
	I 43/4/28					B66461K0000X***
EELP	ELP 58/11/38	9000±25%	9600±25%	7400±25%	3000±25%	B66293G0000X***
	ELP 58/11/38					B66293G0000X***
EILP	ELP 58/11/38	10200±25%	10700±25%	8600±25%	3900±25%[3]	B66293G0000X***
	I 58/4/38					B66293K0000X***
EELP	ELP 64/10/50	15500±25%	16300±25%	12500±25%	5600±25%	B66295G0000X***
	ELP 64/10/50					B66295G0000X***
EILP	ELP 64/10/50	17100±25%	18100±25%	14400±25%	6400±25%[3]	B66295G0000X***
	I 64/5/50					B66295K0000X***
EELP	ELP 102/20/38	10500±25%	11200±25%	8500±25%	on request	B66297G0000X***
	ELP 102/20/38					B66297G0000X***
EILP	ELP 102/20/38	11700±25%	12500±25%	9600±25%	on request	B66297G0000X***
	I 102/7/38					B66297K0000X***

[1] Not for new designs [2] For new designs [3] Preliminary data

EQ/ER Cores

Dimensional drawings



EPCOS

Dimensions

Cores	Dimensions					
	A mm	B mm	C mm	D mm	E mm	F mm
EQ/I						
EQ 13/2.85/8.7	12.80±0.30	2.85±0.075	8.70±0.25	1.75±0.125	Ø11.20±0.30	Ø5.00±0.15
I 13/1/8.7	12.80±0.30	1.10±0.100	8.70±0.25			
EQ 20/6.3/14	20.00±0.35	6.30±0.100	14.00±0.30	4.10±0.150	Ø18.00±0.35	Ø8.80±0.15
I 20/2.3/14	20.35±0.35	2.30±0.050	14.00±0.30			
EQ 25/5.6/18	25.00±0.40	5.60±0.050	18.00±0.30	3.20±0.150	Ø22.00±0.40	Ø11.00±0.20
I 25/2.3/18	25.00±0.40	2.30±0.050	18.00±0.30			
EQ 30/8/20	30.00±0.40	8.00±0.150	20.00±0.30	5.30±0.200	Ø26.00±0.40	Ø11.00±0.20
I 30/2.7/20	30.00±0.40	2.70±0.100	20.00±0.30			
ER/I						
EER 9.5/5/5	9.50–0.30	5.00–0.20[1)]	5.00–0.20	3.20+0.30[1)]	Ø7.50+0.25	Ø3.50–0.20
EER 11/5/6	11.00–0.35	5.00–0.20[1)]	6.00–0.20	3.00+0.30[1)]	Ø8.70+0.30	Ø4.25–0.20
EER 14.5/6/6.7	14.50±0.20	5.90±0.10[1)]	6.70±0.10	3.30±0.20[1)]	Ø11.80±0.20	Ø4.70±0.10
ER 18/3/10	18.00±0.35	3.15±0.10	9.70±0.20	1.55±0.10	Ø15.60±0.30	Ø6.20±0.15
ER 23/5/13	23.20±0.45	5.10±0.10	12.50±0.25	3.10±0.10	Ø20.20±0.40	Ø8.00±0.20
I 23/2/13	23.20±0.45	2.10±0.10	12.50±0.25			
ER 25/6/15	25.00±0.50	5.50±0.10	14.80±0.30	3.10±0.10	Ø21.70±0.40	Ø9.40±0.20
I 25/3/15	25.00±0.50	2.50±0.10	14.80±0.30			
ER 32/5/21	32.00±0.60	5.10±0.10	21.00±0.40	2.70±0.10	Ø29.70±0.50	Ø11.20±0.20

[1)] Dimensions for set

EQ/ER Cores

Magnetic characteristics

Planar core sets		Magnetic characteristics (sets)				
Piece 1	Piece 2	l_e/A_e mm^{-1}	l_e mm	A_e mm^2	A_{min} mm^2	V_e mm^3
EQ	**EQ/I**					
EQ 13/2.85/8.7	I 13/1/8.7	0.803	15.90	19.80	19.2	315
	EQ 13/2.85/8.7	0.900	17.50	19.80	19.2	347
EQ 20/6.3/14	I 20/2.3/14	0.420	25.10	59.80	55.0	1500
	EQ 20/6.3/14	0.560	33.20	59.00	55.0	1960
EQ 25/5.6/18	I 25/2.3/18	0.294	26.40	89.70	82.8	2370
	EQ 25/5.6/18	0.352	32.95	93.51	86.4	3082
EQ 30/8/20	I 30/2.7/20	0.290	31.50	108.00	95.0	3400
	EQ 30/8/20	0.426	46.00	108.00	95.0	4970

A_L values and ordering codes

Combination		A_L values [nH] Material (code number)			Ordering code
		N49 (*** = 149)	N87 (*** = 187)	N92 (*** = 192)	Single core
Set	**EQ/I**				**EQ/I**
EEQ	EQ 13/2.85/8.7	1360±25%	1640±25%	1320±25%	B66479G0000X***
	EQ 13/2.85/8.7				B66479G0000X***
EIQ	EQ 13/2.85/8.7	1600±25%	1700±25%	1550±25%	B66479G0000X***
	I 13/1/8.7				B66479K0000X***
EEQ	EQ 20/6.3/14	2400±25%	3100±25%	2450±25%	B66483G0000X***
	EQ 20/6.3/14				B66483G0000X***
EIQ	EQ 20/6.3/14	3000±25%	3680±25%	2950±25%	B66483G0000X***
	I 20/2.3/14				B66483K0000X***
EEQ	EQ 25/5.6/18	3600±25%	4700±25%	3650±25%	B66481G0000X***
	EQ 25/5.6/18				B66481G0000X***
EIQ	EQ 25/5.6/18	4200±25%	5100±25%	4150±25%	B66481G0000X***
	I 25/2.3/18				B66481K0000X***
EEQ	EQ 30/8/20	3330±25%	4300±25%	3270±25%	B66506G0000X***
	EQ 30/8/20				B66506G0000X***
EIQ	EQ 30/8/20	4350±25%	5600±25%	4450±25%	B66506G0000X***
	I 30/2.7/20				B66506K0000X***
Set	**ER/I**				**ER/I**
EER	ER 9.5/2.5/5	660+30/–20%	800+30/–20%	660+30/–20%	B65523J0000R***[1)]
	ER 9.5/2.5/5				
EER	ER 11/2.5/6	800+30/–20%	1200+30/–20%	900+30/–20%	B65525J0000R***[1)]
	ER 11/2.5/6				
EER	ER 14.5/3/6.7	1100+30/–20%	1500+30/–20%	1100+30/–20%	B65513J0000R***[1)]
	ER 14.5/3/6.7				
EER	ER 18/3/10	1800±25%	2300±25%	1800±25%	B66480G0000X***
	ER 18/3/10				B66480G0000X***
EER	ER 23/5/13	2200±25%	3000±25%	2200±25%	B66482G0000X***
	ER 23/5/13				B66482G0000X***
EIR	ER 23/5/13	2600±25%	3400±25%	2600±25%	B66482G0000X***
	I 23/2/13				B66482K0000X***
EER	ER 25/6/15	3000±25%	4100±25%	3000±25%	B66484G0000X***
	ER 25/6/15				B66484G0000X***
EIR	ER 25/6/15	3400±25%	4600±25%	3400±25%	B66484G0000X***
	I 25/3/15				B66484K0000X***
EER	ER 32/5/21	3800±25%	4900±25%	3800±25%	B66501G0000X***
	ER 32/5/21				B66501G0000X***

[1)] Delivery mode set

EQ/ER Cores

Magnetic characteristics

Planar core sets		Magnetic characteristics (sets)				
Piece 1	Piece 2	l_e/A_e mm^{-1}	l_e mm	A_e mm^2	A_{min} mm^2	V_e mm^3
ER	**ER/I**					
ER 9.5/2.5/5	ER 9.5/2.5/5	1.540	13.6	8.81	7.60	120
ER 11/2.5/6	ER 11/2.5/6	1.100	14.1	12.40	10.30	174
ER 14.5/3/6.7	ER 14.5/3/6.7	1.100	19.0	17.60	17.30	334
ER 18/3/10	ER 18/3/10	0.732	22.1	30.20	30.10	667
ER 23/5/13	I 23/2/13	0.530	26.6	50.30	50.00	1335
	ER 23/5/13	0.648	32.6	50.30	50.00	1640
ER 25/6/15	I 25/3/15	0.399	28.1	70.40	69.40	1978
	ER 25/6/15	0.482	34.1	70.80	69.40	2414
ER 32/5/21	ER 32/5/21	0.381	38.3	100.50	98.50	3847

A_L values and ordering codes

Combination		A_L values [nH] Material (code number)				Ordering code
		N95[1] (***= 195)	PC95[2] (*** = 606)	N97 (*** = 197)	PC200 (*** = 608)	Single core
Set	**EQ/I**					**EQ/I**
EEQ	EQ 13/2.85/8.7	2250±25%	on request	1700±25%	1000±25%[4]	B66479G0000X***
	EQ 13/2.85/8.7					B66479G0000X***
EIQ	EQ 13/2.85/8.7	on request	on request	1800±25%	1200±25%[4]	B66479G0000X***
	I 13/1/8.7					B66479K0000X***
EEQ	EQ 20/6.3/14	3700±25%	3700±25%	3200±25%	1400±25%[4]	B66483G0000X***
	EQ 20/6.3/14					B66483G0000X***
EIQ	EQ 20/6.3/14	4600±25%	4600±25%	3770±25%	1900±25%[4]	B66483G0000X***
	I 20/2.3/14					B66483K0000X***
EEQ	EQ 25/5.6/18	on request	on request	4800±25%	2400±25%	B66481G0000X***
	EQ 25/5.6/18					B66481G0000X***
EIQ	EQ 25/5.6/18	on request	on request	5300±25%	2900±25%[4]	B66481G0000X***
	I 25/2.3/18					B66481K0000X***
EEQ	EQ 30/8/20	5300±25%	5300±25%	4500±25%	2000±25%[4]	B66506G0000X***
	EQ 30/8/20					B66506G0000X***
EIQ	EQ 30/8/20	6500±25%	6500±25%	5750±25%	2700±25%[4]	B66506G0000X***
	I 30/2.7/20					B66506K0000X***
Set	**ER/I**					**ER/I**
EER	ER 9.5/2.5/5	on request	on request	840+30/–20%	480+30/–20%	B65523J0000R***[3]
	ER 9.5/2.5/5					
EER	ER 11/2.5/6	on request	on request	1200+30/–20%	640+30/–20%	B65525J0000R***[3]
	ER 11/2.5/6					
EER	ER 14.5/3/6.7	on request	on request	1500+30/–20%	750+30/–20%	B65513J0000R***[3]
	ER 14.5/3/6.7					
EER	ER 18/3/10	2750±25%	2890±25%	2300±25%	1200±25%	B66480G0000X***
	ER 18/3/10					B66480G0000X***
EER	ER 23/5/13	3700±25%	3900±25%	3000±25%	1400±25%	B66482G0000X***
	ER 23/5/13					B66482G0000X***
EIR	ER 23/5/13	4200±25%	4400±25%	3400±25%	1600±25%[4]	B66482G0000X***
	I 23/2/13					B66482K0000X***
EER	ER 25/6/15	5000±25%	5300±25%	4100±25%	1800±25%[4]	B66484G0000X***
	ER 25/6/15					B66484G0000X***
EIR	ER 25/6/15	5700±25%	6000±25%	4600±25%	2100±25%[4]	B66484G0000X***
	I 25/3/15					B66484K0000X***
EER	ER 32/5/21	6900±25%	7300±25%	5000±25%	2300±25%[4]	B66501G0000X***
	ER 32/5/21					B66501G0000X***

[1] Not for new designs [2] For new designs [3] Delivery mode set [4] Preliminary data

Advantages of Planar Cores

Materials and benefits

Available EPCOS power materials

- **N92** is optimized for high saturation currents in the output chokes
- **N95 (not for new designs)** has flat dependence of power loss versus temperature
- **PC95 (for new designs)** has flat dependence of power loss versus temperature
- **N97** is optimized for low losses at 100 °C
- **N87** is suitable for standard requirements
- **N49** we recommend for frequencies higher than 0.4 MHz and up to 1 MHz
- **PC200** is designed for frequencies higher than 1 MHz up to 4 MHz

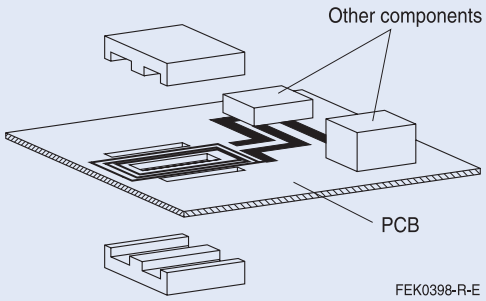
In general

- Windings manufactured by PCB machines for planar cores are more precise and consistent, resulting in magnetic design with highly controllable and predictable parasitic parameters
- Winding processes used in planar cores are based on advanced computer aided manufacturing techniques (SMT)
- Great modularity so no extra connections are required
- Ease of implementation on interleaved windings (multilayer PCBs allow for an interconnection between arbitrary layers)
- Superior thermal characteristics due to a bigger surface-to-volume ratio than conventional ferrite cores

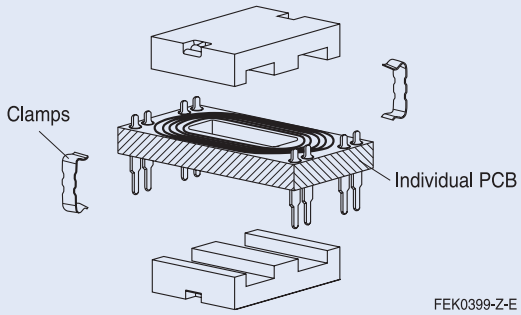
Mounting and layout

ELP cores

With ELP cores **without clamp recess** a total integration of the ferrite cores into the PCB is possible. The assembling progress works with gluing technology.



ELP cores **with clamp recess** realize an individual integration of the device. An individual PCB is made for the ferrite set and is assembled by clamping technology.



EQ cores

- Optimized winding area
- Small overall footprint (core and winding)
- Less EMI
- Minimized winding length

ER cores

- Optimized winding area
- Small overall footprint (core and winding)
- Less EMI
- Minimized winding length

For detailed information please refer to the appropriate data sheets.

Edition 06/2019