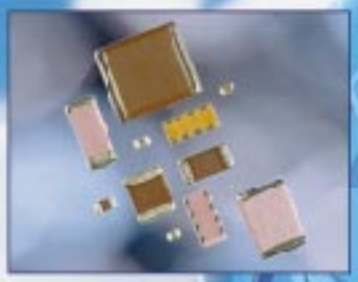
Ceramic and Thin-film Components for Signal Processing

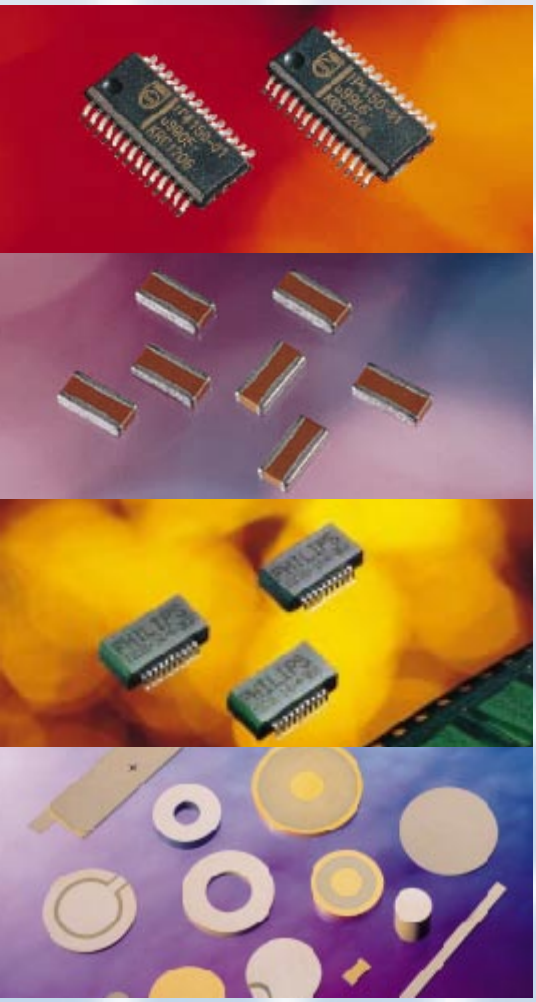
PRODUCT SELECTION GUIDE
1999 - 2000



Philips Components
Advanced Ceramics & Modules

PHILIPS

Let's make things better.



Ceramic and Thin-film Components for Signal Processing

Innovative solutions in ceramic and integrated components

Philips Components is a leading innovator in dielectric, ferrite and piezo ceramic technologies. Our Ceramic Innovation Centers, strategically located worldwide, develop integrated ceramic-based and thin-film solutions to support today's equipment manufacturers, especially in the EDP and telecommunications industries, in their drive for ever higher functionality, greater portability and lower power consumption.

Specific technologies we offer include:

- Integrated ceramic-based passive functions to provide ever higher levels of miniaturization
- Thin-film integrated components offering high levels of integration, precision and good high-frequency performance

Supporting your new designs

Our broad range of surface-mount discrete ceramic and integrated components supports our customers' innovative designs with functions such as RF filtering and tuning, impedance matching, line termination, signal delay, coupling and safety isolation. We also assist our customers with extensive application information and we constantly strive to work closely with them to provide the support they need to remain competitive in their markets.

Application-specific solutions

With our extensive know-how in ceramic and thin-film technology, we're uniquely qualified to support equipment manufacturers with innovative solutions dedicated to easing design, improving performance and cutting assembly costs.

Miniaturization, integration, application-specific performance and superior high-frequency behaviour are just some of the benefits offered by our new generation of products for signal processing. Products designed to support our customers in today's highly competitive markets and assure their future success.

Aiding your design-in decisions

This catalogue is dedicated to our broad range of ceramic and thin-film products for signal processing and is intended as a first selection guide to aid your design-in decision. As well as established products, you will also find useful information on our very latest developments including: integrated resistor/capacitor networks, Integrated *Passive Components (IPCs), high-stability, high-precision thin-film resistors, thin-film inductors and Integrated Inductive Components (IICs).*

Besides signal processing, we also support designers in other key functional areas, notably:

- ***Power conversion*** with low-loss ferrite cores plus bobbins and accessories allowing exceptional levels of transformer miniaturization and energy saving. We also supply planar E-cores for low-profile transformers in which the windings are completed by the PC-board tracks.

- ***EMI suppression*** with thin-film integrated solutions including multilayer suppressors and integrated inductive products, plus ferrite beads, cable shields, RC networks etc.

Product Selection Guides for these areas will be available later this year!

Need more information? Visit our web site on www.acm.components.philips.com

www.acm.components.philips.com

Our new site reflects our new focus on supporting the fast growing digital-electronics markets with a truly global range of ceramic and integrated products. Here you will find extensive data on our full product range, plus application information to support your design-in decisions.

The site has also been extensively revised, making navigation easier and faster than ever to be able to provide you with up-to-the-minute information on our latest developments.

For answers to specific questions there's also a 'talk' button that enables you to email us directly. In addition, our worldwide sales offices and distributors are happy to answer any questions you may have.

Preferred types

In this catalogue you will find a broad range of ceramic components meeting the many and varied requirements of today's equipment manufacturers.

For some product sections we clearly indicate the preferred types.
"Preferred" means types which are generally easily available from our factories and through franchised distributors. These products are recommended for design-in.
In the sections Ferrite Ceramics and Piezoelectric Ceramics a more detailed classification is used.

Product status definition for Ferrite Ceramics and Piezoelectric Ceramics

STATUS	INDICATION	DEFINITION
Prototype	prot	These are products that have been made as development samples for the purposes of technical evaluation only. The data for these types is provisional and is subject to change.
Design-in	des	These products are recommended for new design.
Preferred		These products are recommended for use in current designs and are available via our sales channels.
Support	sup	These products are **not** recommended for new designs and may not be available through all of our sales channels. Customers are advised to check for availability.

Besides the products listed in this catalogue, we can also offer application specific components and a custom-design service for customers with special requirements.

How to order

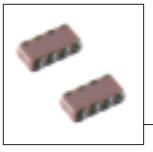
For most of the products you will be able to obtain the catalogue/type number in clear text code or the Philips unique 12-digit ordering code from this catalogue.

For ordering information of all other types consult our Data Handbooks or visit our internet site: **www.acm.components.philips.com**

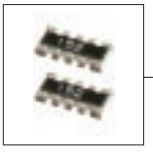
Minimum shipment quantities, price and delivery details can be obtained from the Philips Components sales contacts in your country or from one of our franchised distributors.

New products & highlights

Ceramic Multilayer Capacitors, SMD



Fixed Resistors, SMD

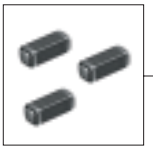


High-frequency Inductors

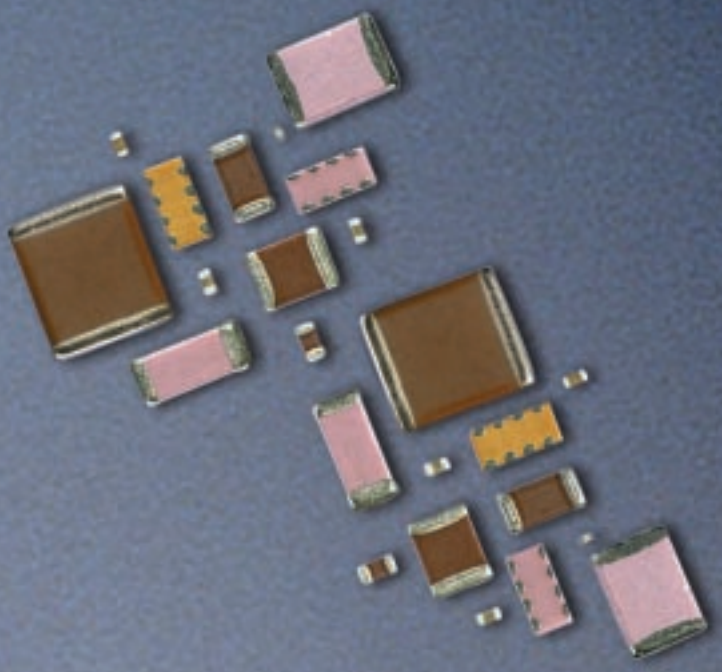
RC networks

Application Specific Integrated Products (ASIPs)

Ferrite Ceramics



Ceramic Multilayer Capacitors, SMD



Part numbering system and ordering

You can order components from this catalogue in two ways.
Both ways give logistic and packaging information.

Clear text ordering code (preferred)

This unique number is an easy-readable 15-digit code.

12-digit ordering code

This unique 12 NC number forms the basis for the Philips logistic system.

You will find details for ordering in the *Ordering* section next to each selection chart.

Minimum shipment quantities, prices and delivery details can be obtained from the Philips Components sales organization in your country or from one of our franchised distributors.

Custom-design service

Besides the products listed in this catalogue, we also offer application-specific components and a custom-design service for customers with special requirements. Please consult our local representative if you require these services.

Ni-barrier versus AgPd terminations

Almost all our CMCs are supplied with Ni-barrier terminations but AgPd terminations can be supplied on special request (see note). A small number of products, however, mostly the larger sizes, are available only with AgPd terminations. This is clearly indicated in the ordering information of each series.

Electrode technology

Two electrode technologies are currently used in Philips CMCs:
Noble metal electrodes (NME) based on palladium with conventional ceramic materials
Base metal electrodes (BME), a newer technology based on nickel. We plan to extend our **BME** product ranges.

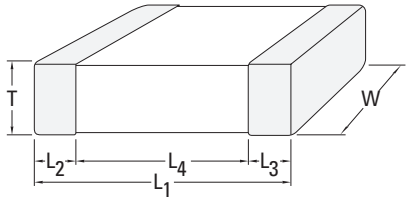
New products in this CMC section

Range extensions on almost all series
New series are:

- NP0 16 V
- X7R 10 V
- Y5V 10 V
- Z5U 25 V
- Low Inductance X7R 50 V
- C-Array X7R 50 V, NME
- C-Array X7R 16 V

Note: for ordering of these products, please contact our local sales representative.

Case size dimensions in mm and inches



Size code	mm						
	L_1	W	T_{min}*	T_{max}*	L_2, L_3 min	L_2, L_3 max	L_4 min
1005	1.0 ± 0.05	0.50 ± 0.05	0.45	0.55	0.20	0.30	0.40
1608	1.6 ± 0.10	0.80 ± 0.07	0.73	0.87	0.20	0.60	0.40
2012	2.0 ± 0.10	1.25 ± 0.10	0.51	1.35	0.25	0.75	0.55
3216	3.2 ± 0.15	1.6 ± 0.15	0.51	1.75	0.25	0.75	1.40
3225	3.2 ± 0.20	2.5 ± 0.20	0.51	1.80	0.25	0.75	1.40
4532	4.5 ± 0.20	3.2 ± 0.20	0.51	1.80	0.25	0.75	2.20
5750	5.7 ± 0.20	5.0 ± 0.20	0.51	1.80	0.25	0.75	2.90

Size code	inches						
	L_1	W	T_{min}*	T_{max}*	L_2, L_3 min	L_2, L_3 max	L_4 min
0402	0.04 ± 0.002	0.02 ± 0.002	0.018	0.022	0.008	0.012	0.016
0603	0.063 ± 0.004	0.032 ± 0.003	0.029	0.035	0.008	0.024	0.016
0805	0.079 ± 0.004	0.049 ± 0.004	0.020	0.053	0.010	0.030	0.022
1206	0.126 ± 0.006	0.063 ± 0.006	0.020	0.069	0.010	0.030	0.056
1210	0.126 ± 0.008	0.098 ± 0.008	0.020	0.072	0.010	0.030	0.056
1812	0.177 ± 0.008	0.126 ± 0.008	0.020	0.072	0.010	0.030	0.088
2220	0.224 ± 0.008	0.197 ± 0.008	0.020	0.072	0.010	0.030	0.114

* Detailed information on thickness can be found in the selection table of each series

Ceramic Multilayer Capacitors

Program survey

SMD TECHNOLOGY

Class 1 NP0

Capacitance	NP0 16 V		NP0 25 V					NP0 50 V (note)							NP0 100 V					NP0 200 V				NP0 500 V			NP0 1 kV		NP0 3 kV		Capacitance
	0402	0603	0402	0603	0805	1206	1210	0402	0603	0805	1206	1210	1812	2220	0603	0805	1206	1210	1812	0805	1206	1210	1812	1206	1210	1812	1812	2220	1808	1812	
pF 0.47								●	●	●	●																				pF 0.47
I E 12								●	●	●	●																				I E 12
3.9								●	●	●	●																				3.9
4.7								●	●	●	●																				4.7
5.6								●	●	●	●																				5.6
6.8								●	●	●	●																				6.8
8.2								●	●	●	●																				8.2
10								●	●	●	●				●	●	●			●	●			●					●	●	10
12								●	●	●	●				●	●	●			●	●			●					●	●	12
15								●	●	●	●				●	●	●			●	●			●					●	●	15
18								●	●	●	●				●	●	●			●	●			●					●	●	18
22								●	●	●	●				●	●	●			●	●			●					●	●	22
27								●	●	●	●				●	●	●			●	●			●					●	●	27
33								●	●	●	●				●	●	●			●	●			●					●	●	33
39								●	●	●	●				●	●	●			●	●			●					●	●	39
47								●	●	●	●				●	●	●			●	●			●	●				●	●	47
56								●	●	●	●				●	●	●			●	●			●	●					●	56
68								●	●	●	●				●	●	●			●	●			●	●					●	68
82								●	●	●	●				●	●	●			●	●			●	●					●	82
100								●	●	●	●				●	●	●			●	●			●	●		●	●		●	100
120								●	●	●	●				●	●	●			●	●			●	●		●	●			120
150								●	●	●	●				●	●	●			●	●			●	●		●	●			150
180								●	●	●	●				●	●	●			●	●			●	●		●	●			180
220			▲					●	●	●	●				●	●	●			●	●			●	●		●	●			220
270	●		▲						●	●	●				●	●	●			●	●			●	●		●	●			270
330	●		▲						●	●	●				●	●	●			●	●			●	●		●	●			330
390	●								●	●	●				●	●	●			●	●			●	●		●	●			390
470	●								●	●	●				●	●	●			●	●			●	●		●	●			470
560									●	●	●				●	●	●			●	●			●	●		●	●			560
680									●	●	●				●	●	●				●			●	●		●	●			680
820				●					▲	●	●					●	●				●			●	●		●	●			820
1000				●					▲	●	●	●				●	●				●			●	●		●	●			1000
1200				●					▲	●	●	●				●	●				●				●		●	●			1200
1500				●						●	●	●				●	●				●				●		●	●			1500
1800		●								●	●	●				●	●					●			●			●			1800
2200		●								●	●	●	●			●	●					●				●		●			2200
2700		●								●	●	●	●			●	●					●				●		●			2700
3300		●			●					▲	●	●	●				●					●				●		●			3300
3900					●					▲	●	●	●				●						●								3900
4700					●					▲	●	●	●				●						●								4700
5600										▲	●	●	●				●						●								5600
6800											●	●	●				●														6800
8200						●					▲	●	●					●													8200
10 000						●					▲	●	●	●				●													10 000
12 000							●				▲	▲	●	●					●												12 000
15 000							●				▲	▲	●	●					●												15 000
18 000							●					▲	●	●					●												18 000
22 000							●					▲	●	●					●												22 000
27 000													▲	●																	27 000
33 000													▲	●																	33 000
39 000														●																	39 000
47 000														●																	47 000
56 000														▲																	56 000
68 000														▲																	68 000
82 000														▲																	82 000
100 000														▲																	100 000

Quick reference data

Dielectric : EIA/IEC, CECC		COG/NP0/CG
Rated voltage		16 V, 25 V, 50/63 V, 100 V, 200 V, 500 V, 1 kV, 3 kV
Tolerance	C < 10 pF	± 0.1 pF, ± 0.25 pF, ± 0.5 pF
	C ≥ 10 pF	± 1%, 2%, 5%, 10%
Tan δ	C < 10 pF	$\leq 10 \left(\frac{3}{C} + 0.7\right) \times 10^{-4}$; max: 30×10^{-4}
	C ≥ 10 pF	$\leq 10 \times 10^{-4}$
Insulation resistance		> 100 GΩ or R x C > 1000 sec.
Temperature coefficient		
0805, 1206	C < 10 pF	0 ± 150 ppm/K
0402, 0603	C < 10 pF	0 ± 30 ppm/K
	C ≥ 10 pF	0 ± 30 ppm/K
Climatic category		55/125/56
Measuring voltage		1 Vrms
Measuring frequency		
	C ≤ 1000 pF	1 MHz
	C > 1000 pF	1 kHz

● = Standard technology, noble metal electrode type
▲ = Compact technology, noble metal electrode type

note: Compact series meet IEC 60063

PHILIPS

Ceramic Multilayer Capacitors

Program survey

Class 2 X7R

Capacitance	X7R 10 V			X7R 16 V				X7R 25 V							X7R 50 V (note)							X7R 50 V LI	X7R 100 V				X7R 200 V				X7R 500 V			X7R 1 kV		Capacitance
	0603	0805	1206	0402	0603	0805	1206	0402	0603	0805	1206	1210	1812	2220	0402	0603	0805	1206	1210	1812	2220	0612	0805	1206	1210	1812	0805	1206	1210	1812	1206	1210	1812	1808	1812	
pF 100															●	●■																				nF 0.1
120															●	●■						LI														0.12
150															●	●■																				0.15
180															●	●■	●■						●				●									0.18
220															●	●■	●■	●■					●	●			●									0.22
270															●	●■	●■	●■					●	●			●									0.27
330															●	●■	●■	●■					●	●			●									0.33
390															●	●■	●■	●■					●	●			●									0.39
470															●	●■	●■	●■					●	●			●				●					0.47
560															●	●■	●■	●■					●	●			●				●					0.56
680															●	●■	●■	●■					●	●			●	●			●					0.68
820															●	●■	●■	●■					●	●			●	●			●					0.82
1000															●	●■	●■	●■					●	●			●	●			●			●	●	1
1200															●	●■	●■	●■					●	●			●	●			●			●	●	1.2
1500															●	●■	●■	●■					●	●			●	●			●			●	●	1.5
1800															●	●■	●■	●■					●	●			●	●			●			●	●	1.8
2200															●	●■	●■	●■					●	●			●	●			●			●	●	2.2
2700															●	●■	●■	●■					●	●			●	●				●		●	●	2.7
3300								●							●	●■	●■	●■					●	●			●	●				●		●	●	3.3
3900								●								●■	●■	●■					●	●			●	●				●			●	3.9
4700				●				●								●■	●■	●■					●	●			●	●				●			●	4.7
5600				●												●■	●■	●■					●	●			●	●				●			●	5.6
6800				●												●■	●■	●■					●	●			●	●				●			●	6.8
8200				●												●■	●■	●■					●	●			●	●				●			●	8.2
10 000				●					●■	●■						●■	●■	●■	●■			●	●	●				●					●		●	10
12 000				●					●■	●■						●■	●■	●■	●■			●	●	●				●					●			12
15 000				●					●■	●■						●■	●■	●■	●■			●	●	●				●					●			15
18 000				●					●■	●■						●■	●■	●■	●■			●	●	●				●								18
22 000				●	●■				●■	●■						■	●■	●■	●■			●	●	●				●	●							22
27 000					●■				●■	●■							●■	●■	●■				●	●				●	●							27
33 000					●■					●■							●■	●■	●■					●					●							33
39 000					●■					●■							●■	●■	●■					●					●							39
47 000					●■	●■				●■							●■	●■	●■					●	●				●	●						47
56 000					●■	●■				●■							●■	●■	●■					●	●				●	●						56
68 000					●■	●■				●■							●■	●■	●■					●	●					●						68
82 000					●■	●■				●■							●■	●■	●■					●	●					●						82
100 000					●■	●■				●■	●■						●■	●■	●■	●■				●	●	●				●						100
120 000						●■				▲	●■							●■	●■	●■					●	●				●						120
150 000	■					●■					●■							●■	●■	●■					●	●										150
180 000	■					●■					●■							●■	●■	●■						●										180
220 000	■	■				●■	●■				●■	●■						●■	●■	●■	●■					●										220
270 000		■				●■	●■				●■	●■							▲	●■	●■					●										270
330 000		■				●■	●■				●■	●■							▲	●■	●■					●										330
390 000		■				●■	●■				▲	●■							▲	●■	●■															390
470 000		■				●■	●■				▲	●■							▲	●■	●■															470
560 000		■					●■					▲								▲	●■															560
680 000		■					●■					▲								▲	●■															680
820 000		■					●■					▲	▲							▲	●■															820
1 000 000		■	■				●■					▲	▲							▲	●■															1 000
1 200 000			■										▲								▲															1 200
1 500 000			■										▲								▲															1 500
1 800 000			■										▲								▲															1 800
2 200 000			■											▲							▲															2 200
2 700 000														▲																						2 700
3 300 000														▲																						3 300
3 900 000														▲																						3 900
4 700 000														▲																						4 700

Quick reference data

Dielectric : EIA/IEC, CECC	X7R/ 2R1
Rated voltage	10 V, 16 V, 25 V, 50/63 V, 100 V, 200 V, 500 V, 1 kV
Tolerance	± 5%, 10%, 20%
Tan δ V rated ≥ 25 V V rated ≤ 16 V	≤ 2.5% ≤ 3.5%
Insulation resistance: noble metal electrode type base metal electrode type	 > 100 GΩ or R x C > 1000 sec. R x C > 500 sec.
Temperature characteristics	± 15%
Climatic category	55/125/56
Ageing per time decade	typical 1%
Measuring voltage Measuring frequency	1 Vrms 1 kHz

● = Standard technology, noble metal electrode type
■ = Standard technology, base metal electrode type
▲ = Compact technology, noble metal electrode type

LI = Low Inductance
note: Compact series meet IEC 60063

Ceramic Multilayer Capacitors

Program survey

SMD TECHNOLOGY

Class 2 Y5V and Z5U

Capacitance	Y5V 10 V			Y5V 16 V				Y5V 25 V			Y5V 50 V			Z5U 25 V		Z5U 50 V		
	0603	0805	1206	0402	0603	0805	1206	0603	0805	1206	0603	0805	1206	0603	1206	0805	1206	1210
µF 0.010				■				■			■	■		■		■	■	
0.012														■		■	■	
0.015				■				■			■	■		■		■	■	
0.018														■		■	■	
0.022				■				■			■	■		■		■	■	
0.027														■		■	■	
0.033				■				■			■	■		■		■	■	
0.039														■		■	■	
0.047				■				■			■	■		■		■	■	
0.056														■		■	■	
0.068				■				■			■	■		■		■	■	
0.082														■		■	■	
0.10				■				■	■	■	■	■	■	■		■	■	■
0.12																■	■	■
0.15					■				■	■		■	■			■	■	■
0.18																■	■	■
0.22					■				■	■		■	■			■	■	■
0.27																	■	■
0.33					■				■	■		■	■				■	■
0.39																	■	■
0.47					■	■				■			■		■		■	■
0.56															■			■
0.68						■				■			■		■			■
0.82															■			■
1.0	■		■			■	■			■			■		■			■
1.2																		
1.5			■			■	■											
1.8																		
2.2		■	■			■	■											
2.7																		
3.3		■	■				■											
3.9																		
4.7			■				■											
5.6																		
6.8			■															
8.2																		
10			■															

Quick reference data

Dielectric : EIA/IEC, CECC	Y5V/2F4	Z5U/2E6
Rated voltage	10 V, 16 V, 25 V, 50 V	25 V, 50 V
Tolerance	± 20%, -20%/+80%	± 20%, -20%/+80%
Tan δ	all 25 & 50 V, except 0603 100 nF and 1206 1 µF ≤ 5% 0603 100 nF and 1206 1 µF ≤ 7% all 16 V ≤ 9%	≤ 4%
Insulation resistance: base metal electrode type	R x C > 100 sec.	R x C > 100 sec.
Temperature characteristic	+30% at -25°C to -80% at 85°C	+22%/-56%
Climatic category	25/085/56	10/085/21
Ageing per time decade	typical 7%	typical 3%
Measuring voltage Measuring frequency	1 Vrms 1 kHz	0.5 Vrms 1 kHz

• = Standard technology, noble metal electrode type
■ = Standard technology, base metal electrode type

Class 2 C-Array

Capacitance	X7R 16 V	X7R 25 V	X7R 50 V	Y5V 25 V
	4x 0603	4x 0603	4x 0603	4x 0603
pF 220			•	
270			•	
330			•	
390			•	
470			•	
560			•	
680			•	
820			•	
1000			•	
1200			•	
1500			•	
1800			•	
2200			•	
2700			•	
3300			•	
3900			•	
4700			•	
5600			•	
6800			•	
8200			•	
10 000	•■	•	•	■
12 000	•	•		■
15 000	•■	•		■
18 000	•	•		■
22 000	•■	•		■
27 000	•	•		■
33 000	•■	•		■
39 000	•■	•		■
47 000	•■	•		■
56 000	•			■
68 000	•■			■
82 000	•			■
100 000	•■			■

Class 1 C-Array

Capacitance	NP0 50/63 V
	4x 0603
pF 22	•
27	•
33	•
39	•
47	•
56	•
68	•
82	•
100	•
120	•
150	•
180	•
220	•
270	•
330	•
390	•
470	•
560	•
680	•
820	•
1000	•

Class 1 Narrow tolerance

Capacitance	NP0 50 V			
	0402	0603	0805	1206
pF 0.47	•	•	•	•
I E 12	•	•	•	•
3.9	•	•	•	•
4.7	•	•	•	•
5.6	•	•	•	•
6.8	•	•	•	•
8.2	•	•	•	•
10	•	•	•	•
12	•	•	•	•
15	•	•	•	•
18	•	•	•	•
22	•	•	•	•
27	•	•	•	•
33	•	•	•	•
39	•	•	•	•
47	•	•	•	•
56	•	•	•	•
68	•	•	•	•
82	•	•	•	•
100	•	•	•	•
120	•	•	•	•
150	•	•	•	•
180	•	•	•	•
220	•	•	•	•
270		•	•	•
330		•	•	•
390		•	•	•
470		•	•	•
560		•	•	•
680		•	•	•
820			•	•
1000			•	•
1200			•	•
1500			•	•
1800			•	•
2200			•	•
2700			•	•
3300				•
3900				•
4700				•
5600				•
6800				•

Class 1 Microwave

Capacitance	NP0 50 V		
	0603	0805	1206
pF 0.47	•	•	•
I E 12	•	•	•
3.9	•	•	•
4.7	•	•	•
5.6	•	•	•
6.8	•	•	•
8.2	•	•	•
10	•	•	•
12	•	•	•
15	•	•	•
18	•	•	•
22	•	•	•
27	•	•	•
33	•	•	•
39	•	•	•
47	•	•	•
56		•	•
68		•	•
82		•	•
100			•
120			•

PHILIPS

Ceramic Multilayer Capacitors

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2238 57	NP0 50 V, Microwave	Ni-barrier	25	2254 91 . .1	NP0 25 V	Ni-barrier	19
2238 58 . .5	X7R 50 V	Ni-barrier	28	2254 91 . .5	X7R 25 V	Ni-barrier	28
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2238 78 . .9	Y5V 16 V	Ni-barrier	37	2255 12 . .6	C-Array X7R 25 V, NME	Ni-barrier	42
2238 86	NP0 50 V	Ni-barrier	20	2255 12 . .9	C-Array Y5V 25 V	Ni-barrier	43
2238 87	X7R 25 V, Compact	Ni-barrier	46	2255 14 . .1	C-Array NP0 50 / 63 V	Ni-barrier	41
2238 877	NP0 25 V, Compact (size 0402)	Ni-barrier	44	2255 14 . .6	C-Array X7R 50 V, NME	Ni-barrier	42
2238 89 . .0	NP0 50 V / 63 V, Compact	Ni-barrier	44	2256 04 . .1	NP0 3 kV	Ni-barrier	24
2238 89 . .6	X7R 50 V / 63 V, Compact	Ni-barrier	46	2256 00 . .6	X7R 1 kV, NME	Ni-barrier	34
2238 91 . .1	NP0 25 V	Ni-barrier	19	2256 06 . .6	Low Inductance X7R 50 V	Ni-barrier	35
2238 91 . .5	X7R 25 V	Ni-barrier	28				

Ceramic Multilayer Capacitors

NP0, 16 V

NEW

Cap.	last two digits of 12 NC	0402	0603
pF 270	42		
330	43	0.5 ± 0.05	
390	44		
470	45		
560	46		
680	47		
820	48		
1 000	49	in columns : Thickness class	
1 200	51		
1 500	52		
1 800	53		
2 200	54		0.8 ± 0.07
2 700	55		
3 300	56		
Tape width		8 mm	

Thickness classes and packaging quantities

Thickness classes (mm)	8 mm tape width amount per reel		amount per bulk case	
	180 mm / 7"	330 mm / 13"		
	paper	paper	0402	0603
0.5 ± 0.05	10 000	50 000	50 000	-
0.8 ± 0.07	4 000	20 000	-	15 000

Ordering information

Clear text code (preferred)

0402CH271J7B200 (example)

0402	CH	271	J	7	B	2	0	0
Size code	Temp. char.	Cap. in pF	Tolerance	Voltage	Termination	Packaging	Marking	Range identifier
0402 0603	CH = NP0	271 = 270 pF i.e. the third digit signifies the multiplying factor 1 = x 10 2 = x 100	F ± 1 % G ± 2 % J ± 5 % K ± 10 %	7 = 16 V	B = Ni-barrier	2 = 180 mm / 7" paper 3 = 330 mm / 13" paper P = bulk case	0 = no marking	0 = conv. ceramic

12NC

22xx 78 x x1 x x x

Carrier type
- 38 paper
- 54 bulk

Size code
- 7 0402 Ni-barrier
- 6 0603 Ni-barrier

Packaging
- 1 reel ∅ 180 mm
- 5 reel ∅ 330 mm
- 4 bulk case

Capacitance value (see selection chart)

Tolerance code
- 3 1%
- 4 2%
- 5 5%
- 6 10%

Ceramic Multilayer Capacitors

NP0, 25 V

General purpose series

Cap.	last two digits of 12 NC	0603	0805	1206	1210
pF 820	48				
1000	49				
1200	51	0.8 ± 0.07			
1500	52				
1800	53				
2200	54				
2700	55				
3300	56		0.85 ± 0.1		
3900	57		1.25 ± 0.1		
4700	58				
5600	59				
6800	61				
8200	62			0.85 ± 0.1	
10 000	63				
12 000	64				
15 000	65				0.5 to 1.0
18 000	66				
22 000	67				0.9 to 1.3
Tape width		8 mm			

in columns : Thickness class

Ordering information

12NC

22xx 91x x1xxx

Carrier type
- 22 blister
- 38 paper
- 54 bulk

Size
- 6 0603
- 0 0805
- 1 1206
- 2 1210

Packaging
- 1 reel ∅ 180 mm / 7"
- 5 reel ∅ 330 mm / 13"
- 4 bulk case

Capacitance value (see selection chart)

Tolerance
- 3 ± 1%
- 4 ± 2%
- 5 ± 5%
- 6 ± 10%

Clear text code (preferred)

0805CG102J8B200 (example)

0805	CG	332	J	8	B	2	0	0
Size code	Temp. char.	Cap. in pF	Tolerance	Voltage	Termination	Packaging	Marking	Range identifier
0603 0805 1206 1210	CG = NP0	332 = 3300 pF i.e. the third digit signifies the multiplying factor 1 = x 10 2 = x 100 3 = x 1000	F ± 1 % G ± 2 % J ± 5 % K ± 10 %	8 = 25 V	B = Ni-barrier	2 = 180 mm / 7" paper 3 = 330 mm / 13" paper B = 180 mm / 7" blister F = 330 mm / 13" blister P = bulk case	0 = no marking	0 = conv. ceramic

Thickness classes and packaging quantities

Thickness classes (mm)	8 mm tape width amount per reel				amount per bulk case	
	180 mm / 7"		330 mm / 13"			
	paper	blister	paper	blister	0603	0805
0.8 ± 0.07	4 000	-	15 000	-	15 000	-
0.85 ± 0.1	4 000	-	15 000	-	-	8 000
0.5 to 1.0	-	4 000	-	10 000	-	-
0.9 to 1.3	-	3 000	-	10 000	-	-
1.25 ± 0.1	-	3 000	-	10 000	-	5 000

Ceramic Multilayer Capacitors

NP0, 50 V

SMD TECHNOLOGY

		General purpose series							Narrow tolerance					
														
Cap.	last three digits of 12 NC	**0402**	**0603**	**0805**	**1206**	**1210**	**1812**	**2220**	**0402**	**0603**	**0805**	**1206**	**Cap.**	last three digits of 12 NC
pF 0.47	477												pF 0.47	477
0.56	567												0.56	567
0.68	687												0.68	687
0.82	827												0.82	827
1.0	108												1.0	108
1.2	128												1.2	128
1.5	158												1.5	158
1.8	188												1.8	188
2.2	228												2.2	228
2.7	278												2.7	278
3.3	338												3.3	338
3.9	398												3.9	398
4.7	478												4.7	478
5.6	568												5.6	568
6.8	688												6.8	688
8.2	828	0.5 ± 0.05											8.2	828
10	109												10	109
12	129												12	129
15	159		0.8 ± 0.07						0.5 ± 0.05				15	159
18	189												18	189
22	229												22	229
27	279			0.6 ± 0.1						0.8 ± 0.07			27	279
33	339												33	339
39	399												39	399
47	479				0.6 ± 0.1						0.6 ± 0.1		47	479
56	569												56	569
68	689												68	689
82	829											0.6 ± 0.1	82	829
100	101												100	101
120	121												120	121
150	151												150	151
180	181												180	181
220	221												220	221
270	271												270	271
330	331												330	331
390	391												390	391
470	471												470	471
560	561												560	561
680	681												680	681
820	821												820	821
1000	102												1000	102
1200	122												1200	122
1500	152			0.85 ± 0.1							0.85 ± 0.1		1500	152
1800	182												1800	182
2200	222			1.25 ± 0.1							1.25 ± 0.1		2200	222
2700	272					0.5 to 1.0							2700	272
3300	332												3300	332
3900	392				0.85 ± 0.1							0.85 ± 0.1	3900	392
4700	472						0.5 to 1.0						4700	472
5600	562				1.15 ± 0.1							1.15 ± 0.1	5600	562
6800	682												6800	682
8200	822												8200	822
µF 0.010	103												10 000	103
0.012	123												12 000	123
0.015	153												15 000	153
0.018	183						0.9 to 1.3	0.5 to 1.0					18 000	183
0.022	223												22 000	223
0.027	273												27 000	273
0.033	333												33 000	333
0.039	393												39 000	393
0.047	473							0.9 to 1.3					47 000	473
Tape width		8 mm					12 mm		8 mm					Tape width

in columns : Thickness class

Thickness classes and packaging quantities

Thickness classes (mm)	8 mm tape width amount per reel				12 mm tape width amount per reel		amount per bulk case		
	180 mm / 7"		330 mm / 13"		180 mm / 7" / blister				
	paper	blister	paper	blister	1812	2220	0402	0603	0805
0.5 ± 0.05	10 000	-	50 000	-	-	-	50 000	-	-
0.6 ± 0.1	4000	-	20 000	-	-	-	-	-	10 000
0.85 ± 0.1	4000	-	15 000	-	-	-	-	-	8000
0.5 to 1.0	-	4000	-	10 000	2000	1500	-	-	-
0.8 ± 0.07	4000	-	15 000	-	-	-	-	15 000	-
0.9 to 1.3	-	3000	-	10 000	1500	-	-	-	-
1.15 ± 0.1	-	3000	-	10 000	-	-	-	-	-
1.25 ± 0.1	-	3000	-	10 000	-	-	-	-	5000

Ordering information

Clear text code (preferred)

0805CG102J9B200 (example)

0805	CG	102	J	9	B	2	0	0
Size code	Temp. char.	Cap. in pF	Tolerance	Voltage	Termination	Packaging	Marking	Range identifier
0402 0603 0805 1206 1210 1812 2220 (AgPd only)	CG = NP0	102 = 1000 pF i.e. the third digit signifies the multiplying factor 8 = x 0.01 9 = x 0.1 0 = x 1 1 = x 10 2 = x 100 3 = x 1000	Gen. purp. C ± 0.25 pF D ± 0.5 pF G ± 2 % J ± 5 % K ± 10 % Narrow tol. B = 0.1 pF F = ± 1 %	9 = 50 V	B = Ni-barrier A = AgPd (2220 only)	2 = 180 mm / 7" paper 3 = 330 mm / 13" paper B = 180 mm / 7" blister F = 330 mm / 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

12NC

22xx 86 x xxxxx

Carrier type
- 22 blister
- 38 paper
- 54 bulk

Size code
- 9 0402
- 7 0603
- 1 0805
- 3 1206
- 2 1210
- 5 1812
- 6 2220 (AgPd only)

Packaging
- 1 reel ∅ 180 mm / 7"
- 7 reel ∅ 330 mm / 13"
- 4 bulk case

Tolerance code

General purpose series	Narrow tolerance series
NiSn terminations 4 ± 0.25 pF for C = 5.6 to 8.2 pF ± 2% for C ≥ 10 pF 5 ± 0.25 pF for C = 0.47 to 4.7 pF ± 0.5 pF for C = 5.6 to 8.2 pF ± 5% for C ≥ 10 pF 6 ± 10% for C ≥ 10 pF AgPd terminations (2220 only) 1 ± 2% for C ≥ 10 pF 2 ± 5% for C ≥ 10 pF 3 ± 10% for C ≥ 10 pF	4 ± 0.1 pF for C = 0.47 to 4.7 pF 8 ± 0.1 pF for C = 5.6 to 8.2 pF 8 ± 1% for C ≥ 10 pF

Capacitance value (see selection chart)

Ceramic Multilayer Capacitors

NP0 100 V, 200 V, 500 V

SMD TECHNOLOGY

		100 V					200 V				500 V				
															
Cap.	last two digits of 12 NC	**0603**	**0805**	**1206**	**1210**	**1812**	**0805**	**1206**	**1210**	**1812**	**1206**	**1210**	**1812**	**Cap.**	last two digits of 12 NC
pF 10	23													pF 10	23
12	24													12	24
15	25													15	25
18	26													18	26
22	27													22	27
27	28													27	28
33	29													33	29
39	31													39	31
47	32	0.8 ± 0.07												47	32
56	33		0.6 ± 0.1											56	33
68	34			0.6 ± 0.1										68	34
82	35						0.6 ± 0.1				0.6 ± 0.1			82	35
100	36													100	36
120	37							0.6 ± 0.1						120	37
150	38													150	38
180	39													180	39
220	41													220	41
270	42											0.8 to 1.0		270	42
330	43						0.85 ± 0.1							330	43
390	44													390	44
470	45													470	45
560	46						1.25 ± 0.1				0.85 ± 0.1			560	46
680	47													680	47
820	48										1.15 ± 0.1			820	48
1000	49							0.85 ± 0.1						1000	49
1200	51											0.9 to 1.3		1200	51
1500	52		0.85 ± 0.1					1.15 ± 0.1						1500	52
1800	53								0.8 to 1.0			1.2 to 1.75		1800	53
2200	54		1.25 ± 0.1											2200	54
2700	55								0.9 to 1.3				0.9 to 1.3	2700	55
3300	56													3300	56
3900	57			0.85 ± 0.1						0.8 to 1.0				3900	57
4700	58									0.9 to 1.3				4700	58
5600	59			1.15 ± 0.1										5600	59
6800	61													6800	61
8200	62				0.5 to 1.0									8200	62
µF 0.010	63													10 000	63
0.012	64					0.5 to 1.0								12 000	64
0.015	65													15 000	65
0.018	66					0.9 to 1.3								18 000	66
0.022	67													22 000	67
Tape width		8 mm				12 mm	8 mm			12 mm	8 mm		12 mm	Tape width	

in columns :
Thickness class

Thickness classes and packaging quantities

Thickness classes (mm)	8 mm tape width amount per reel				12 mm tape width amount per reel		amount per bulk case	
	180 mm / 7"		330 mm / 13"		180 mm / 7" / blister			
	paper	blister	paper	blister	1812	2220	0603	0805
0.6 ± 0.1	4000	-	20 000	-	-	-	-	10 000
0.85 ± 0.1	4000	-	15 000	-	-	-	-	8000
0.8 to 1.0	-	4000	-	10 000	2000	-	-	-
0.5 to 1.0	-	4000	-	10 000	2000	1500	-	-
0.8 ± 0.07	4000	-	15 000	-	-	-	15 000	-
0.9 to 1.3	-	3000	-	10 000	1500	-	-	-
1.15 ± 0.1	-	3000	-	10 000	-	-	-	-
1.25 ± 0.1	-	3000	-	10 000	-	-	-	5000
1.2 to 1.75	-	2500	-	7000	1200	-	-	-

Ordering information

Clear text code (preferred)

0805CG102G0B200 (example)

0805 Size code	**CG** Temp. char.	**102** Cap. in pF	**G** Tolerance	**0** Voltage	**B** Termination	**2** Packaging	**0** Marking	**0** Range identifier
0603 0805 1206 1210 1812	CG = NP0	102 = 1000 pF i.e. the third digit signifies the multiplying factor 0 = x 1 1 = x 10 2 = x 100 3 = x 1000	G ± 2 % J ± 5 % K ± 10 %	0 = 100 V B = 200 V D = 500 V	B = Ni-barrier	2 = 180 mm / 7" paper 3 = 330 mm / 13" paper B = 180 mm / 7" blister F = 330 mm / 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

12NC

22xx xxx x1xxx

Carrier type
- 22 blister
- 38 paper
- 54 bulk

Rated voltage - Termination
- 60 100 V Ni-barrier
- 93 200 V Ni-barrier
- 97 500 V Ni-barrier

Size
- 6 0603
- 0 0805
- 1 1206
- 2 1210
- 4 1812

Packaging
- 1 reel ∅ 180 mm / 7"
- 5 reel ∅ 330 mm / 13"
- 4 bulk case

Capacitance value (see selection chart)

Tolerance
- 4 ± 2% for C ≥ 10 pF
- 5 ± 5% for C ≥ 10 pF
- 6 ± 10% for C ≥ 10 pF

Ceramic Multilayer Capacitors

NP0 1 kV, 3 kV

SMD TECHNOLOGY

1 kV

Cap.	last two digits of 12 NC	1812	2220
pF 100	36		
120	37		
150	38		
180	39		
220	41		
270	42	0.5 to 1.0	
330	43		
390	44		
470	45		0.5 to 1.0
560	46		
680	47		
820	48		
1000	49		
1200	51	0.9 to 1.3	
1500	52		
1800	53		
2200	54		
2700	55		0.9 to 1.3
3300	56		
Tape width		12 mm	

in columns : Thickness class

3 kV

Cap.	last two digits of 12 NC	1808	1812
pF 10	23		
12	24		
15	25		
18	26		
22	27	1.2 to 1.75	1.2 to 1.75
27	28		
33	29		
39	31		
47	32		
56	33		
68	34		1.6 to 2.2
82	35		
100	36		
Tape width		12 mm	

in columns : Thickness class

Thickness classes and packaging quantities

Thickness classes (mm)	12 mm tape width amount per reel		
	180 mm / 7" / blister		
	1808	1812	2220
0.5 to 1.0	-	2000	1500
0.9 to 1.3	-	1500	1500
1.2 to 1.75	1000	1000	-
1.6 to 2.2	1000	1000	-

Ordering information (for both 1 kV and 3 kV series)

Clear text code (preferred)

1812CG102JEBB00 (example)

1812	CG	102	J	E	B	B	0	0
Size code	Temp. char.	Cap. in pF	Tolerance	Voltage	Termination	Packaging	Marking	Range identifier
1808 1812 2220	CG = NP0	101 = 100 pF i.e. the third digit signifies the multiplying factor 1 = x 10 2 = x 100	G ± 2 % J ± 5 % K ± 10 %	E = 1 kV G = 3 kV	A = AgPd (2220 only) B = Ni-barrier	B = 180 mm / 7" blister	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

12NC

22xx xxx x1xxx

Carrier type
- 50 blister
- 56 bulk (3 kV only)

Termination
- 00 NiSn - 1 kV
- 01 AgPd - 1 kV (2220 only)
- 04 NiSn - 3 kV

Size
- 3 1808
- 4 1812
- 5 2220

Packaging
- 1 reel ∅ 180 mm / 7"

Tolerance
- 4 ± 2%
- 5 ± 5%
- 6 ± 10%

Capacitance value (see selection chart)

Ceramic Multilayer Capacitors

Microwave series NP0 50 V

		50 V		
				
Cap.	last two digits of 12 NC	**0603**	**0805**	**1206**
pF 0.47	05			
0.56	06			
0.68	07			
0.82	08			
1.0	09			
1.2	11			
1.5	12			
1.8	13			
2.2	14			
2.7	15			
3.3	16			
3.9	17			
4.7	18	0.8 ± 0.07		
5.6	19		0.6 ± 0.1	
6.8	21			0.6 ± 0.1
8.2	22			
10	23			
12	24			
15	25			
18	26			
22	27			
27	28			
33	29			
39	31			
47	32			
56	33			
68	34			
82	35			
100	36			
120	37			
Tape width		8 mm		

in columns : Thickness class

High frequency properties

The first parallel resonance in the S21 and S12 scattering parameter lies above 2 GHz and the second above 3 GHz.

Ordering information

12NC

22xx xxx x1xxx

Carrier type
- 38 paper
- 54 bulk

Size - Termination
- 578 0603 Ni-barrier
- 574 0805 Ni-barrier
- 576 1206 Ni-barrier

Packaging
- 1 reel ∅ 180 mm / 7"
- 5 reel ∅ 330 mm / 13"
- 4 bulk case

Capacitance value (see selection chart)

Tolerance
- 0 ± 0.1 pF for C < 10 pF
- 1 ± 0.25 pF for C < 10 pF
- 2 ± 0.5 pF for 5 pF ≤ C < 10 pF
- 3 ± 1% for C ≥ 10 pF
- 4 ± 2% for C ≥ 10 pF
- 5 ± 5% for C ≥ 10 pF
- 6 ± 10% for C ≥ 10 pF

Clear text code (preferred)

0805CG109G9B20M (example)

0805 Size code	**CG** Temp. char.	**109** Cap. in pF	**G** Tolerance	**9** Voltage	**B** Termination	**2** Packaging	**0** Marking	**M** Range identifier
0603 0805 1206	CG = NPO	109 = 1 pF i.e. the third digit signifies the multiplying factor 8 = x 0.01 9 = x 0.1 0 = x 1 1 = x 10	B ± 0.1 pF C ± 0.25 pF D ± 0.5 pF F ± 1 % G ± 2 % J ± 5 % K ± 10 %	9 = 50 V	B = Ni-barrier	2 = 180 mm / 7" paper 3 = 330 mm / 13" paper P = bulk case	0 = no marking 2 = 2-character marking in North America only	M = micro-wave

Thickness classes and packaging quantities

Thickness classes (mm)	**8 mm tape width amount per reel**		**amount per bulk case**	
	180 mm / 7"	330 mm / 13"		
	paper	paper	0603	0805
0.6 ± 0.1	4000	20 000	-	10 000
0.8 ± 0.07	4000	15 000	15 000	-

Ceramic Multilayer Capacitors

Bulk case packaging

Ceramic Multilayer Capacitors

X7R 10 V

	10 V			
NEW				

Cap.	last two digits of 12 NC	0603	0805	1206	Cap.	last two digits of 12 NC
µF 0.15	52				µF 0.15	52
0.18	53	0.8 ± 0.07			0.18	53
0.22	54		0.6 ± 0.10		0.22	54
0.27	55				0.27	55
0.33	56				0.33	56
0.39	57		0.85 ± 0.10		0.39	57
0.47	58				0.47	58
0.56	59				0.56	59
0.68	61		1.25 ± 0.10		0.68	61
0.82	62	in columns : Thickness class			0.82	62
1.0	63			0.85 ± 0.10	1.0	63
1.2	64				1.2	64
1.5	65				1.5	65
1.8	66			1.15 ± 0.10	1.8	66
2.2	67				2.2	67
Tape width		8 mm				Tape width

Thickness classes and packaging quantities

Thickness classes (mm)	8 mm tape width amount per reel				amount per bulk case	
	180 mm / 7"		330 mm / 13"			
	paper	blister	paper	blister	0603	0805
0.6 ± 0.1	4 000	-	20 000	-	-	10 000
0.85 ± 0.1	4 000	-	15 000	-	-	8 000
0.8 ± 0.07	4 000	-	15 000	-	15 000	-
1.15 ± 0.1	-	3 000	-	10 000	-	-
1.25 ± 0.1	-	3 000	-	10 000	-	5 000

Ordering information

Clear text code (preferred)

08052R105K6BB0D (example)

0805	2R	105	K	6	B	B	0	D
Size code	Temp. char.	Cap. in pF	Tolerance	Voltage	Termination	Packaging	Marking	Range identifier
0603 0805 1206	2R = X7R	105 = 1 000 000 pF i.e. the third digit signifies the multiplying factor 3 = x 1000 4 = x 10 000 5 = x 100 000	K ± 10 %	6 = 10 V	B = Ni-barrier	2 = 180 mm / 7" paper 3 = 330 mm / 13" paper B = 180 mm / 7" blister F = 330 mm / 13" blister P = bulk case	0 = no marking	D = BME

12NC

22xx xxx x5xxx

Carrier type
- 22 blister
- 38 paper
- 54 bulk

Rated voltage - Termination
- 24 10 V; Ni-barrier

Size code
- 6 0603
- 0 0805
- 1 1206

Capacitance value (see selection chart)

Tolerance code
- 6 ± 10%

Packaging
- 1 reel ∅ 180 mm; 7"
- 5 reel ∅ 330 mm; 13"
- 4 bulk case

Ceramic Multilayer Capacitors

X7R 16 V, 25 V, 50 V

SMD TECHNOLOGY

		16 V			25 V				50 V							
																
Cap.	last two digits of 12 NC	**0603**	**0805**	**1206**	**0603**	**0805**	**1206**	**1210**	**0603**	**0805**	**1206**	**1210**	**1812**	**2220**	**Cap.**	last two digits of 12 NC
pF 100	09														pF 100	09
120	11														120	11
150	12														150	12
180	13														180	13
220	14														220	14
270	15														270	15
330	16														330	16
390	17														390	17
470	18														470	18
560	19														560	19
680	21														680	21
820	22														820	22
1 000	23														1 000	23
1 200	24								0.8 ± 0.07						1 200	24
1 500	25									0.6 ± 0.1					1 500	25
1 800	26														1 800	26
2 200	27														2 200	27
2 700	28														2 700	28
3 300	29														3 300	29
3 900	31										0.85 ± 0.1				3 900	31
4 700	32														4 700	32
5 600	33														5 600	33
6 800	34														6 800	34
8 200	35														8 200	35
10 000	36														10 000	36
12 000	37														12 000	37
15 000	38				0.8 ± 0.07										15 000	38
18 000	39					0.6 ± 0.1									18 000	39
22 000	41														22 000	41
27 000	42														27 000	42
33 000	43											0.5 to 1.0			33 000	43
39 000	44	0.8 ± 0.07								0.85 ± 0.1					39 000	44
47 000	45														47 000	45
56 000	46		0.6 ± 0.1			0.85 ± 0.1									56 000	46
68 000	47														68 000	47
82 000	48									1.25 ± 0.1					82 000	48
100 000	49														100 000	49
120 000	51														120 000	51
150 000	52		0.85 ± 0.1				0.85 ± 0.1								150 000	52
180 000	53										1.15 ± 0.1	0.9 to 1.3			180 000	53
220 000	54												0.5 to 1.0		220 000	54
270 000	55			0.85 ± 0.1			1.15 ± 0.1	0.5 to 0.1							270 000	55
330 000	56														330 000	56
390 000	57		1.25 ± 0.1											0.5 to 1.0	390 000	57
470 000	58							0.9 to 1.3					0.9 to 1.3		470 000	58
560 000	59														560 000	59
680 000	61			1.15 ± 0.1											680 000	61
820 000	62														820 000	62
1 000 000	63													0.9 to 1.3	1 000 000	63
Tape width		8 mm			8 mm				8 mm				12 mm			Tape width

in columns :
Thickness class

Ceramic Multilayer Capacitors

X7R 16 V, 25 V, 50 V

Thickness classes and packaging quantities

Thickness classes (mm)	8 mm tape width amount per reel				12 mm tape width amount per reel		amount per bulk case	
	180 mm / 7"		330 mm / 13"		180 mm / 7" blister			
	paper	blister	paper	blister	1812	2220	0603	0805
0.6 ± 0.1	4 000	4 000	20 000	10 000	-	-	-	10 000
0.85 ± 0.1	4 000	4 000	15 000	10 000	-	-	-	8 000
0.5 to 1.0	-	4 000	-	10 000	2 000	1 500	-	-
0.8 ± 0.07	4 000	4 000	15 000	15 000	-	-	15 000	-
0.9 to 1.3	-	3 000	-	10 000	1 500	1 500	-	-
1.15 ± 0.1	-	3 000	-	10 000	-	-	-	-
1.25 ± 0.1	-	3 000	-	10 000	-	-	-	5 000

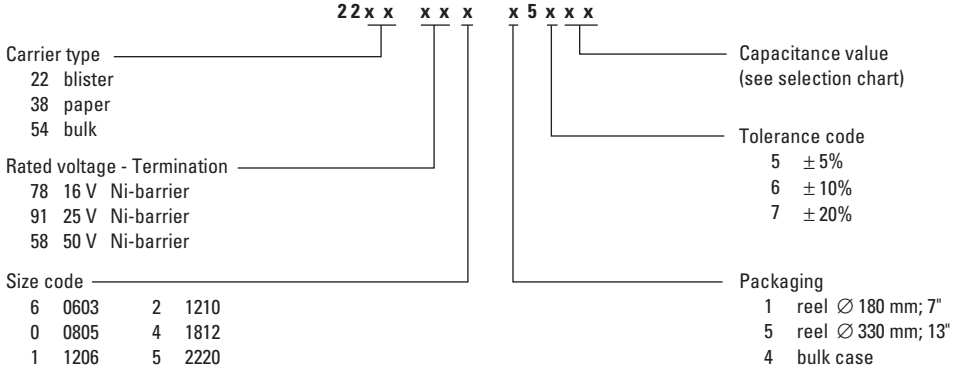
Ordering information

Clear text code (preferred)

12062R104K9B20D (example)

1206 Size code	**2R** Temp. char.	**104** Cap. in pF	**K** Tolerance	**9** Voltage	**B** Termination	**2** Packaging	**0** Marking	**D** Range identifier
0603 0805 1206 1210 1812 2220	2R = X7R	104 = 100 000 pF i.e. the third digit signifies the multiplying factor 1 = x 10 2 = x 100 3 = x 1000 4 = x 10 000 5 = x 100 000	J ± 5 % K ± 10 % M ± 20 %	7 = 16 V 8 = 25 V 9 = 50 V	B = Ni-barrier	2 = 180 mm / 7" paper 3 = 330 mm / 13" paper B = 180 mm / 7" blister F = 330 mm / 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	D = BME

12NC



Ceramic Multilayer Capacitors

X7R 16 V, 25 V, noble metal electrode type

SMD TECHNOLOGY

		16 V				25 V						
												
Cap.	last two digits of 12 NC	**0402**	**0603**	**0805**	**1206**	**0402**	**0603**	**0805**	**1206**	**1210**	**Cap.**	last two digits of 12 NC
pF 3300	29										nF 3.3	29
3900	31					0.5 ± 0.05					3.9	31
4700	32										4.7	32
5600	33										5.6	33
6800	34										6.8	34
8200	35										8.2	35
µF 0.010	36	0.5 ± 0.05									10	36
0.012	37										12	37
0.015	38						0.8 ± 0.07				15	38
0.018	39							0.6 ± 0.1			18	39
0.022	41										22	41
0.027	42										27	42
0.033	43										33	43
0.039	44										39	44
0.047	45		0.8 ± 0.07								47	45
0.056	46			0.6 ± 0.1				0.85 ± 0.1			56	46
0.068	47										68	47
0.082	48										82	48
0.10	49										100	49
0.12	51										120	51
0.15	52			0.85 ± 0.1					0.85 ± 0.1		150	52
0.18	53										180	53
0.22	54										220	54
0.27	55				0.85 ± 0.1				1.15 ± 0.1	0.5 to 1.0	270	55
0.33	56										330	56
0.39	57			1.25 ± 0.1		in columns : Thickness class					390	57
0.47	58									0.9 to 1.3	470	58
0.56	59										560	59
0.68	61				1.15 ± 0.1						680	61
0.82	62										820	62
1.0	63										1000	63
Tape width		8 mm										Tape width

Ordering information (also for X7R 50 V page 31)

Clear text code (preferred)

08052R104K8BB00 (example)

0805 Size code	**2R** Temp. char.	**104** Cap. in pF	**K** Tolerance	**8** Voltage	**B** Termination	**B** Packaging	**0** Marking	**0** Range identifier
0402 0603 0805 1206 1210 1812 2220 (AgPd only)	2R = X7R	104 = 100 000 pF i.e. the third digit signifies the multiplying factor 2 = x 100 3 = x 1000 4 = x 10 000 5 = x 100 000	J ± 5 % K ± 10 % M ± 20 %	7 = 16 V 8 = 25 V 9 = 50 V	B = Ni-barrier A = AgPd (2220 only)	2 = 180 mm / 7" paper 3 = 330 mm / 13" paper B = 180 mm / 7" blister F = 330 mm / 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

12NC

22xx xxx x6xxx

Carrier type
- 22 blister
- 38 paper
- 54 bulk

Rated voltage - Termination
- 78 16 V Ni-barrier
- 91 25 V Ni-barrier
- 58 50 V Ni-barrier
- 59 50 V AgPd (2220 only)

Size
- 7 0402
- 6 0603
- 0 0805
- 1 1206
- 2 1210
- 4 1812
- 5 2220

Capacitance value (see selection chart)

Tolerance
- 5 ± 5%
- 6 ± 10%
- 7 ± 20%

Packaging
- 1 reel ∅ 180 mm / 7"
- 5 reel ∅ 330 mm / 13"
- 4 bulk case

Ceramic Multilayer Capacitors

X7R 50 V, noble metal electrode type

50 V

Cap.	last two digits of 12 NC	0402	0603	0805	1206	1210	1812	2220	Cap.	last two digits of 12 NC
pF 100	01								pF 100	01
120	02								120	02
150	03								150	03
180	04								180	04
220	05								220	05
270	06								270	06
330	07								330	07
390	08								390	08
470	09	0.5 ± 0.05							470	09
560	11								560	11
680	12								680	12
820	13		0.8 ± 0.07						820	13
1000	14								1000	14
1200	15								1200	15
1500	16			0.6 ± 0.1					1500	16
1800	17								1800	17
2200	18								2200	18
2700	19								2700	19
3300	21								3300	21
3900	22				0.85 ± 0.1				3900	22
4700	23								4700	23
5600	24								5600	24
6800	25								6800	25
8200	26								8200	26
µF 0.010	27								10 000	27
0.012	28								12 000	28
0.015	29								15 000	29
0.018	31								18 000	31
0.022	32								22 000	32
0.027	33								27 000	33
0.033	34								33 000	34
0.039	35			0.85 ± 0.1		0.5 to 1.0			39 000	35
0.047	36								47 000	36
0.056	37								56 000	37
0.068	38								68 000	38
0.082	39			1.25 ± 0.1					82 000	39
0.10	41								100 000	41
0.12	42								120 000	42
0.15	43								150 000	43
0.18	44				1.15 ± 0.1	0.9 to 1.3	0.5 to 1.0		180 000	44
0.22	45								220 000	45
0.27	46								270 000	46
0.33	47								330 000	47
0.39	48							0.5 to 1.0	390 000	48
0.47	49						0.9 to 1.3		470 000	49
0.56	51								560 000	51
0.68	52								680 000	52
0.82	53								820 000	53
1.0	54							0.9 to 1.3	1 000 000	54
Tape width		8 mm					12 mm			Tape width

in columns : Thickness class

Thickness classes and packaging quantities (also for X7R, 16 V and 25 V page 30)

Thickness classes (mm)	8 mm tape width amount per reel				12 mm tape width amount per reel		amount per bulk case		
	180 mm / 7"		330 mm / 13"		180 mm / 7" / blister				
	paper	blister	paper	blister	1812	2220	0402	0603	0805
0.5 ± 0.05	10 000	-	50 000	-	-	-	50 000	-	-
0.6 ± 0.1	4000	-	20 000	-	-	-	-	-	10 000
0.85 ± 0.1	4000	-	15 000	-	-	-	-	-	8000
0.5 to 1.0	-	4000	-	10 000	2000	1500	-	-	-
0.8 ± 0.07	4000	-	15 000	-	-	-	-	15 000	-
0.9 to 1.3	-	3000	-	10 000	1500	1500	-	-	-
1.15 ± 0.1	-	3000	-	10 000	-	-	-	-	-
1.25 ± 0.1	-	3000	-	10 000	-	-	-	-	5000

Ceramic Multilayer Capacitors

X7R 100 V, 200 V, 500 V, noble metal electrode type

SMD TECHNOLOGY

		100 V				200 V				500 V				
														
Cap.	last two digits of 12 NC	**0805**	**1206**	**1210**	**1812**	**0805**	**1206**	**1210**	**1812**	**1206**	**1210**	**1812**	**Cap.**	last two digits of 12 NC
pF 180	13												pF 180	13
220	14												220	14
270	15												270	15
330	16												330	16
390	17												390	17
470	18												470	18
560	19												560	19
680	21												680	21
820	22					0.85 ± 0.1							820	22
1000	23									1.15 ± 0.1			1000	23
1200	24	0.6 ± 0.1											1200	24
1500	25												1500	25
1800	26												1800	26
2200	27												2200	27
2700	28												2700	28
3300	29						0.85 ± 0.1				0.9 to 1.3		3300	29
3900	31		0.85 ± 0.1										3900	31
4700	32												4700	32
5600	33												5600	33
6800	34					1.25 ± 0.1					1.2 to 1.75		6800	34
8200	35												8200	35
µF 0.010	36												10 000	36
0.012	37											0.9 to 1.3	12 000	37
0.015	38												15 000	38
0.018	39	0.85 ± 0.1											18 000	39
0.022	41						1.15 ± 0.1						22 000	41
0.027	42							0.8 to 1.0					27 000	42
0.033	43												33 000	43
0.039	44												39 000	44
0.047	45							0.9 to 1.3					47 000	45
0.056	46								0.5 to 1.0				56 000	46
0.068	47			0.5 to 1.0									68 000	47
0.082	48		1.15 ± 0.1										82 000	48
0.10	49								0.9 to 1.3				100 000	49
0.12	51			0.9 to 1.3									120 000	51
0.15	52				0.5 to 1.0								150 000	52
0.18	53												180 000	53
0.22	54												220 000	54
0.27	55				0.9 to 1.3								270 000	55
0.33	56												330 000	56
Tape width		8 mm			12 mm	8 mm			12 mm	8 mm		12 mm	Tape width	

in columns : Thickness class

Thickness classes and packaging quantities

Thickness classes (mm)	8 mm tape width amount per reel				12 mm tape width amount per reel	amount per bulk case
	180 mm / 7"		330 mm / 13"		180 mm / 7" / blister	
	paper	blister	paper	blister	1812	0805
0.6 ± 0.1	4000	-	20 000	-	-	10 000
0.85 ± 0.1	4000	-	15 000	-	-	8000
0.8 to 1.0	-	4000	-	10 000	-	-
0.5 to 1.0	-	4000	-	10 000	2000	-
0.9 to 1.3	-	3000	-	10 000	1500	-
1.15 ± 0.1	-	3000	-	10 000	-	-
1.25 ± 0.1	-	3000	-	10 000	-	5000
1.2 to 1.75	-	2500	-	10 000	-	-

Ceramic Multilayer Capacitors

X7R 100 V, 200 V, 500 V, noble metal electrode type

Ordering information

Clear text code (preferred)

18122R104KBBB00 (example)

1812 Size code	**2R** Temp. char.	**104** Cap. in pF	**K** Tolerance	**B** Voltage	**B** Termination	**B** Packaging	**0** Marking	**0** Range identifier
0805 1206 1210 1812	2R = X7R	104 = 100 000 pF i.e. the third digit signifies the multiplying factor 1 = x 10 2 = x 100 3 = x 1000 4 = x 10 000	J ± 5 % K ± 10 % M ± 20 %	0 = 100 V B = 200 V D = 500 V	B = Ni-barrier	2 = 180 mm / 7" paper 3 = 330 mm / 13" paper B = 180 mm / 7" blister F = 330 mm / 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

12NC

22xx xxx x6xxx

Carrier type
- 22 blister
- 38 paper
- 54 bulk

Rated voltage - Termination
- 60 100 V Ni-barrier
- 93 200 V Ni-barrier
- 97 500 V Ni-barrier

Size
- 0 0805
- 1 1206
- 2 1210
- 4 1812

Capacitance value (see selection chart)

Tolerance
- 5 ± 5%
- 6 ± 10%
- 7 ± 20%

Packaging
- 1 reel ∅ 180 mm / 7"
- 5 reel ∅ 330 mm / 13"
- 4 bulk case

Ceramic Multilayer Capacitors

X7R 1 kV, noble metal electrode type

SMD TECHNOLOGY

	1 kV	
		
Cap.	last two digits of 12 NC	**1808**	**1812**
pF 1000	23		
1200	24		
1500	25		
1800	26	1.2 to 1.75	
2200	27		
2700	28		
3300	29		1.2 to 1.75
3900	31		
4700	32		
5600	33		
6800	34		
8200	35		
10 000	36		
Tape width		12 mm	

Thickness classes and packaging quantities

Thickness classes (mm)	12 mm tape width amount per reel	
	180 mm / 7" / blister	
	1808	1812
1.2 to 1.75	1000	1000

Ordering information

12NC

22xx 00x x6xxx

Carrier type
- 50 blister
- 56 bulk

Size
- 3 1808
- 4 1812

Capacitance value (see selection chart)

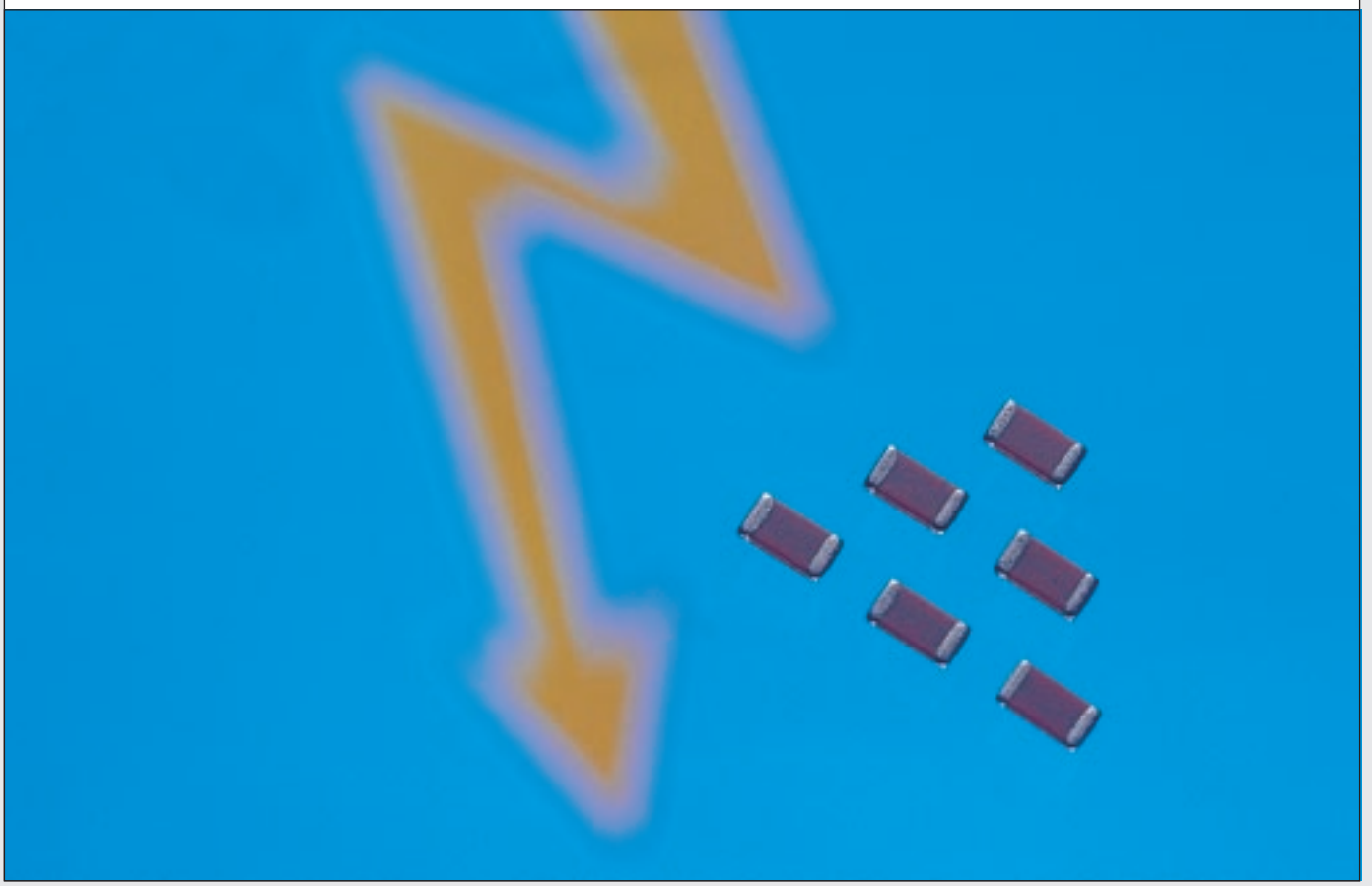
Tolerance
- 5 ± 5%
- 6 ± 10%
- 7 ± 20%

Packaging
- 1 reel ∅ 180 mm / 7"

Clear text code (preferred)

18082R102KEBB00 (example)

1808 Size code	**2R** Temp. char.	**102** Cap. in pF	**K** Tolerance	**E** Voltage	**B** Termination	**B** Packaging	**0** Marking	**0** Range identifier
1808 1812	2R = X7R	102 = 1000 pF i.e. the third digit signifies the multiplying factor 2 = x 100 3 = x 1000	J ± 5 % K ± 10 % M ± 20 %	E = 1 kV	B = Ni-barrier	B = 180 mm / 7" blister	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic



Ceramic Multilayer Capacitors

X7R 50 V, Low inductance

		50 V
NEW		
Cap.	last two digits of 12 NC	**0612**
pF 10 000	36	
12 000	37	
15 000	38	Thickness class: 0.85 ± 0.1
18 000	39	
22 000	41	
Tape width		8 mm

Thickness classes and packaging quantities

Thickness classes (mm)	8 mm tape width amount per reel			
	180 mm / 7"		330 mm / 13"	
	paper	blister	paper	blister
0.85 ± 0.10	4000	4000	15 000	10 000

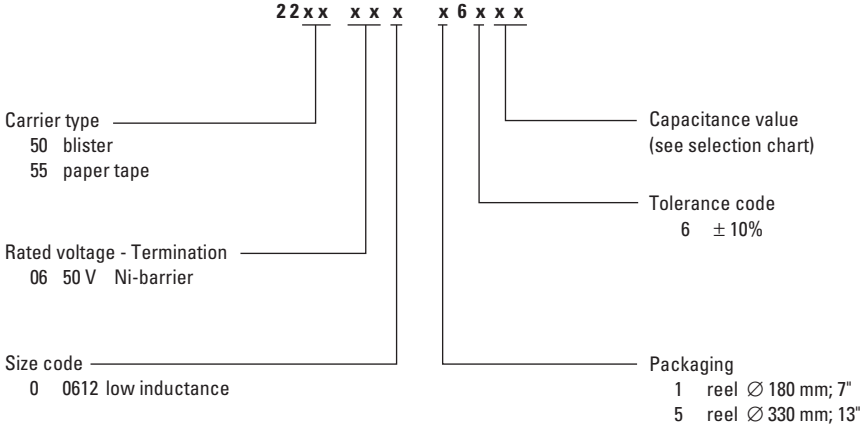
Ordering information

Clear text code (preferred)

06122R223K9BB0L (example)

0612 Size code	**2R** Temp. char.	**223** Cap. in pF	**K** Tolerance	**9** Voltage	**B** Termination	**B** Packaging	**0** Marking	**L** Range identifier
0612	2R = X7R	223 = 22 000 pF i.e. the third digit signifies the multiplying factor 3 = x 1000	K ± 10 %	9 = 50 V	B = Ni-barrier	2 = 180 mm / 7" paper 3 = 330 mm / 13" paper B = 180 mm / 7" blister F = 330 mm / 13" blister	0 = no marking	L = low inductance

12NC



Ceramic Multilayer Capacitors

Y5V 10 V

		10 V				
NEW						
Cap.	last two digits of 12 NC	**0603**	**0805**	**1206**	**Cap.**	last two digits of 12 NC
µF 1.0	63	0.8 ± 0.07		0.85 ± 0.10	nF 1 000	63
1.5	65				1 500	65
2.2	67		1.25 ± 0.10		2 200	67
3.3	69	in columns : Thickness class		1.15 ± 0.10	3 300	69
4.7	72				4 700	72
6.8	74			1.60 ± 0.15	6 800	74
10.0	76				10 000	76
Tape width		8 mm				Tape width

Thickness classes and packaging quantities

Thickness classes (mm)	8 mm tape width amount per reel				amount per bulk case	
	180 mm / 7"		330 mm / 13"			
	paper	blister	paper	blister	0603	0805
0.8 ± 0.07	4 000	-	15 000	-	15 000	-
0.85 ± 0.10	4 000	-	15 000	-	-	-
1.15 ± 0.10	-	3 000	10 000	10 000	-	-
1.25 ± 0.10	-	3 000	10 000	10 000	-	5 000
1.60 ± 0.15	-	2 000	7 000	7 000	-	-

Ordering information

Clear text code (preferred)

06032F105Z24BB0D (example)

0603 Size code	**2F** Temp. char.	**105** Cap. in pF	**Z** Tolerance	**6** Voltage	**B** Termination	**B** Packaging	**0** Marking	**D** Range identifier
0603 0805 1206	2F = Y5V	105 = 1 000 000 pF i.e. the third digit signifies the multiplying factor 5 = x 100 000 6 = x 1 000 000	Z = –20 % / +80%	6 = 10 V	B = Ni-barrier	2 = 180 mm / 7" paper 3 = 330 mm / 13" paper B = 180 mm / 7" blister F = 330 mm / 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	D = BME

12NC

22xx xxx x9xxx

Carrier type
- 22 blister
- 38 paper
- 54 bulk

Rated voltage - Termination
- 24 10 V Ni-barrier

Size code
- 6 0603
- 0 0805
- 1 1206

Capacitance value (see selection chart)

Tolerance code
- 8 –20 % / +80%

Packaging
- 1 reel ∅ 180 mm; 7"
- 5 reel ∅ 330 mm; 13"
- 4 bulk case

Ceramic Multilayer Capacitors

Y5V 16 V, 25 V, 50 V

		16 V				25 V				
										
Cap.	last two digits of 12 NC	**0402**	**0603**	**0805**	**1206**	**0603**	**0805**	**1206**	**Cap.**	last two digits of 12 NC
µF 0.010	36								nF 10	36
0.015	38								15	38
0.022	41								22	41
0.033	43	0.5 ± 0.05				0.8 ± 0.07			33	43
0.047	45								47	45
0.068	47								68	47
0.10	49						0.6 ± 0.1		100	49
0.15	52						0.85 ± 0.1	0.6 ± 0.1	150	52
0.22	54		0.8 ± 0.07						220	54
0.33	56						1.25 ± 0.1		330	56
0.47	58			0.85 ± 0.1				0.85 ± 0.1	470	58
0.68	61								680	61
1.0	63				0.85 ± 0.1			1.15 ± 0.1	1000	63
1.5	65			1.25 ± 0.1					1500	65
2.2	67								2200	67
2.7	68								2700	68
3.3	69				1.15 ± 0.1				3300	69
3.9	71								3900	71
4.7	72								4700	72
Tape width		8 mm				8 mm				Tape width

		50 V		
Cap.	last two digits of 12 NC	**0603**	**0805**	**1206**
µF 0.010	05			
0.015	06			
0.022	07			
0.033	08	0.8 ± 0.07	0.6 ± 0.1	
0.047	09			
0.068	11			
0.10	12			
0.15	13		0.85 ± 0.1	0.6 ± 0.1
0.22	14			
0.33	15		1.25 ± 0.1	
0.47	16			0.85 ± 0.1
0.68	17			
1.0	18			1.15 ± 0.1
Tape width		8 mm		

Ordering information

12NC 22xx xxx x9xxx

Carrier type
- 22 blister
- 38 paper
- 54 bulk

Rated voltage - Termination
- 78 16 V Ni-barrier
- 91 25 V Ni-barrier
- 58 50 V Ni-barrier

Size
- 7 0402
- 6 0603
- 0 0805
- 1 1206

Capacitance code (see selection chart)

Tolerance
- 7 ± 20%
- 8 -20/+80%

Packaging
- 1 reel ∅ 180 mm / 7"
- 5 reel ∅ 330 mm / 13"
- 4 bulk case

Clear text code (preferred)

12062F105M8BB0D (example)

1206 Size code	**2F** Temp. char.	**105** Cap. in pF	**M** Tolerance	**8** Voltage	**B** Termination	**B** Packaging	**0** Marking	**D** Range identifier
0402 0603 0805 1206	2F = Y5V	105 = 1 000 000 pF i.e. the third digit signifies the number of zeros	M ± 20 % Z = - 20 %/ + 80 %	7 = 16 V 8 = 25 V 9 = 50 V	B = Ni-barrier	2 = 180 mm / 7" paper 3 = 330 mm / 13" paper B = 180 mm / 7" blister F = 330 mm / 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	D = BME

Thickness classes and packaging quantities

Thickness classes (mm)	**8 mm tape width amount per reel**				**amount per bulk case**		
	180 mm / 7"		330 mm / 13"				
	paper	blister	paper	blister	0402	0603	0805
0.5 ± 0.05	10 000	-	50 000	-	50 000	-	10 000
0.6 ± 0.1	4000	-	10 000	-	-	-	10 000
0.85 ± 0.1	4000	-	10 000	-	-	-	8000
0.8 ± 0.07	4000	4000	15 000	15 000	-	15 000	-
1.25 ± 0.1	-	3000	-	10 000	-	-	5000
1.15 ± 0.1	-	3000	-	10 000	-	-	-

Ceramic Multilayer Capacitors

Z5U 25 V

	25 V	
NEW		

Cap.	last two digits of 12 NC	0603	1206
µF 0.010	36		
0.012	37		
0.015	38		
0.018	39		
0.022	41		
0.027	42	0.80 ± 0.07	
0.033	43		
0.039	44		
0.047	45		
0.056	46		
0.068	47		
0.082	48		
0.10	49		
0.12	51		
0.15	52		
0.18	53		
0.22	54		
0.27	55		
0.33	56		
0.39	57		
0.47	58		
0.56	59		
0.68	61		1.15 ± 0.1
0.82	62		
1.0	63		
Tape width		8 mm	

in columns : Thickness class

Ordering information

12NC

22xx 62 x x8xxx

Carrier type
- 22 blister
- 38 paper
- 54 bulk

Size
- 5 0603
- 7 1206

Packaging
- 1 reel ∅ 180 mm; 7"
- 5 reel ∅ 330 mm; 13"
- 4 bulk case

Capacitance value (see selection chart)

Tolerance code
- 7 ± 20%
- 8 – 20 / + 80%

Clear text code (preferred)

06032E104Z8B20D (example)

0603 Size code	**2E** Temp. char.	**104** Cap. in pF	**Z** Tolerance	**8** Voltage	**B** Termination	**2** Packaging	**0** Marking	**D** Range identifier
0603 1206	2E = Z5U	104 = 100 000 pF i.e. the third digit signifies the multiplying factor 3 = x 1000 4 = x 10 000 5 = x 100 000	M = ± 20 % Z = – 20 / + 80%	8 = 25 V	B = Ni-barrier	2 = 180 mm / 7" paper 3 = 330 mm / 13" paper B = 180 mm / 7" blister F = 330 mm / 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	D = BME

Thickness classes and packaging quantities

Thickness classes (mm)	8 mm tape width amount per reel				amount per bulk case
	180 mm / 7"		330 mm / 13"		
	paper	blister	paper	blister	0603
0.80 ± 0.07	4 000	-	15 000	-	15 000
1.15 ± 0.1	-	3 000	-	10 000	-

Ceramic Multilayer Capacitors

Z5U 50 V

50 V

Cap.		last two digits of 12 NC	0805	1206	1210
µF	0.010	36			
	0.012	37			
	0.015	38			
	0.018	39			
	0.022	41			
	0.027	42			
	0.033	43	0.6 ± 0.1		
	0.039	44			
	0.047	45		0.6 ± 0.1	
	0.056	46			
	0.068	47			
	0.082	48			
	0.10	49			
	0.12	51	0.85 ± 0.1		
	0.15	52			
	0.18	53	1.25 ± 0.1		
	0.22	54			
	0.27	55			0.5 to 1.0
	0.33	56		0.85 ± 0.1	
	0.39	57			
	0.47	58		1.15 ± 0.1	
	0.56	59			
	0.68	61			
	0.82	62			
	1.0	63			0.9 to 1.3
Tape width			8 mm		

in columns : Thickness class

Ordering information

12NC

22xx 62x x8xxx

Carrier type
- 22 blister
- 38 paper
- 54 bulk

Size
- 0 0805
- 1 1206
- 2 1210

Packaging
- 1 reel ∅ 180 mm / 7"
- 5 reel ∅ 330 mm / 13"
- 4 bulk case

Capacitance value (see selection chart)

Tolerance
- 7 ± 20%
- 8 -20/+80%

Clear text code (preferred)

12062E104Z9B20D (example)

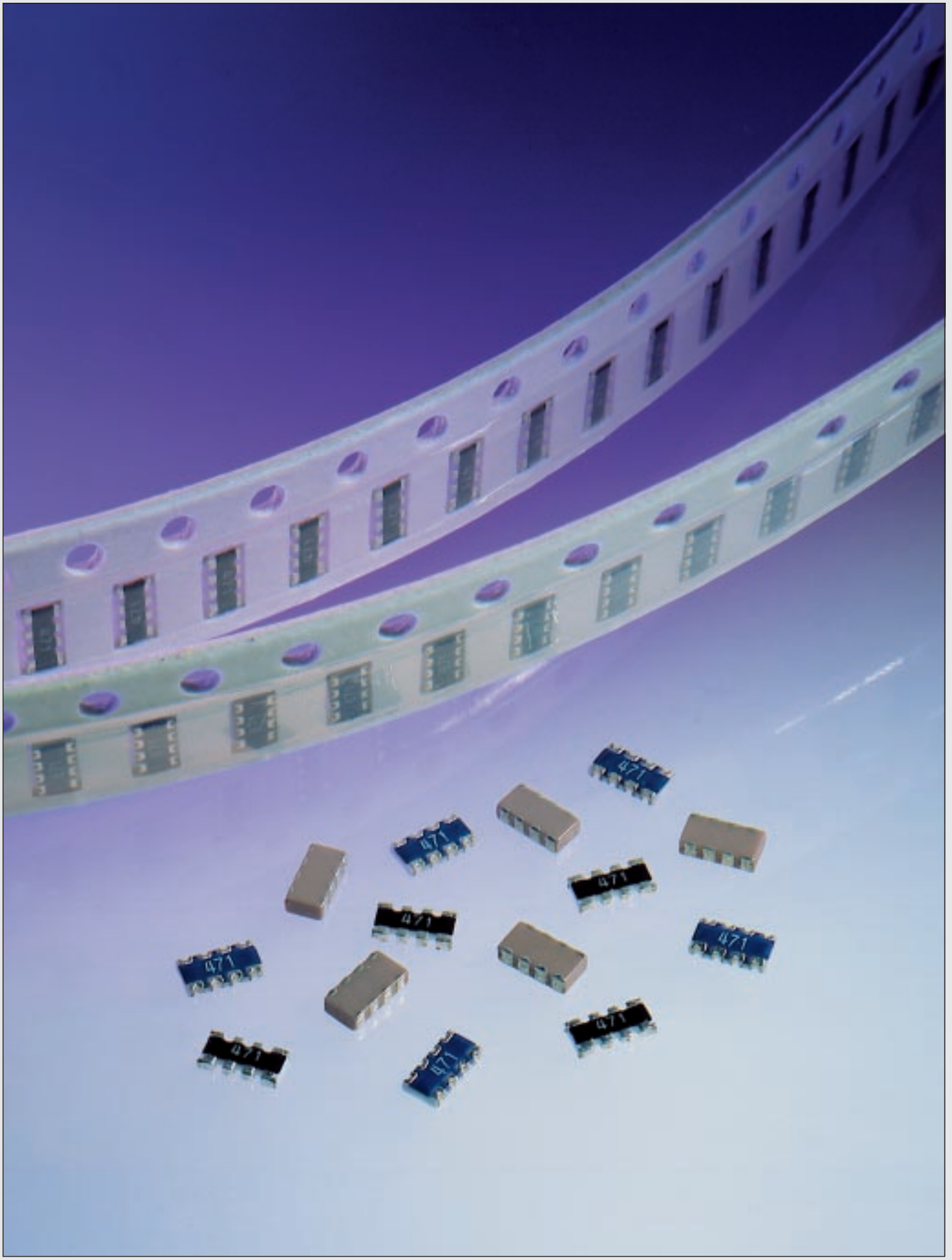
1206 Size code	**2E** Temp. char.	**104** Cap. in pF	**Z** Tolerance	**9** Voltage	**B** Termination	**2** Packaging	**0** Marking	**D** Range identifier
0805 1206 1210	2E = Z5U	104 = 100 000 pF i.e. the third digit signifies the multiplying factor 3 = x 1000 4 = x 10 000 5 = x 100 000	M = ± 20 %	9 = 50 V	B = Ni-barrier	2 = 180 mm / 7" paper 3 = 330 mm / 13" paper B = 180 mm / 7" blister F = 330 mm / 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	D = BME

Thickness classes and packaging quantities

Thickness classes (mm)	8 mm tape width amount per reel				amount per bulk case
	180 mm / 7"		330 mm / 13"		
	paper	blister	paper	blister	0805
0.6 ± 0.1	4000	-	10 000	-	10 000
0.85 ± 0.1	4000	-	10 000	-	8 000
0.5 to 1.0	-	4000	-	10 000	-
0.9 to 1.3	-	3000	-	10 000	-
1.15 ± 0.1	-	3000	-	10 000	-
1.25 ± 0.1	-	3000	-	10 000	5 000

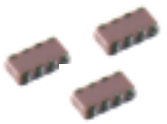
Ceramic Multilayer Capacitors

C & R Arrays



Ceramic Multilayer Capacitors

C-Array NP0 50 / 63 V

	NP0 50/63 V
	

Cap.	last two digits of 12 NC	0612 (4 x 0603)
pF 22	27	
27	28	
33	29	
39	31	
47	32	
56	33	
68	34	
82	35	
100	36	Thickness class
120	37	0.8 ± 0.1
150	38	
180	39	
220	41	
270	42	
330	43	
390	44	
470	45	
560	46	
680	47	
820	48	
1000	49	
Tape width		8 mm

Thickness classes and packaging quantities

Thickness classes (mm)	8 mm tape width amount per reel	
	180 mm / 7" / blister	
	paper	blister
0.8 ± 0.1	4000	4000

Ordering information

12NC

22xx xxx x1xxx

Carrier type
- 50 blister
- 55 paper

Termination
- 14 50/63 Ni-barrier

Size
- 6 0612 (4 x 0603)

Capacitance value (see selection chart)

Tolerance
- 5 ± 5%
- 6 ± 10%

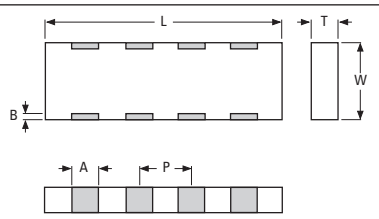
Packaging
- 1 reel ∅ 180 mm / 7"

Clear text code (preferred)

0612CG102J9B200 (example)

0612	CG	102	J	9	B	2	0	0
Size code	Temp. char.	Cap. in pF	Tolerance	Voltage	Termination	Packaging	Marking	Range identifier
0612 (4 x 0603)	CG = NP0	102 = 1000 pF i.e. the third digit signifies the multiplying factor 0 = x 1 1 = x 10 2 = x 100	J ± 5 % K ± 10 %	9 = 50/ 63 V	B = Ni-barrier	2 = 180 mm / 7" paper B = 180 mm / 7" blister	0 = no marking	0 = conv. ceramic

Mechanical data



Case Size		L	W	T_{min}	T_{max}	A	B	P
0612 (4 x 0603)	mm	3.20 ± 0.15	1.6 ± 0.15	0.8	1.20	0.4 ± 0.15	0.3 ± 0.15	0.8 ± 0.15
	inches	0.125 ± 0.006	0.063 ± 0.006	0.031	0.047	0.018 ± 0.006	0.012 ± 0.006	0.031 ± 0.004

Ceramic Multilayer Capacitors

C-Array X7R 16 V, 25 V, 50 V, noble metal electrode type

SMD TECHNOLOGY

	16 V	25 V	50 V
			NEW 

Cap.	last two digits of 12 NC	0612 (4 x 0603)		
pF 220	14			
270	15			
330	16			
390	17			
470	18	in columns : Thickness class		
560	19			
680	21			
820	22			
1 000	23			
1 200	24			
1 500	25			0.8 ± 0.1
1 800	26			
2 200	27			
2 700	28			
3 300	29			
3 900	31			
4 700	32			
5 600	33			
6 800	34			
8 200	35			
10 000	36			
12 000	37			
15 000	38			
18 000	39			
22 000	41		0.8 ± 0.1	
27 000	42			
33 000	43	0.8 ± 0.1		
39 000	44			
47 000	45			
56 000	46			
68 000	47			
82 000	48			
100 000	49			
Tape width		8 mm		

Ordering information

12NC

22xx xxx x6xxx

Carrier type
- 50 blister
- 55 paper

Termination
- 10 16 V Ni-barrier
- 12 25 V Ni-barrier
- 14 50/63 V Ni-barrier

Size
- 6 0612 (4 x 0603)

Packaging
- 1 reel ∅ 180 mm / 7"

Tolerance
- 5 ± 5%
- 6 ± 10%
- 7 ± 20%

Capacitance value (see selection chart)

Clear text code (preferred)

06122R104J8B200 (example)

0612 Size code	**2R** Temp. char.	**473** Cap. in pF	**J** Tolerance	**8** Voltage	**B** Termination	**2** Packaging	**0** Marking	**0** Range identifier
0612 (4 x 0603)	2R = X7R	473 = 47 000 pF i.e. the third digit signifies the multiplying factor 1 = x 10 2 = x 100 3 = x 1000 4 = x 10 000	J ± 5 % K ± 10 % M ± 20 %	7 = 16 V 8 = 25 V 9 = 50 V	B = Ni-barrier	2 = 180 mm / 7" paper B = 180 mm / 7" blister	0 = no marking	0 = conv. ceramic

Thickness classes and packaging quantities

Thickness classes (mm)	8 mm tape width amount per reel			
	180 mm / 7"		330 mm / 13"	
	paper	blister	paper	blister
0.8 ± 0.1	4000	4000	10 000	10 000

For mechanical data see page 43

Ceramic Multilayer Capacitors

C-Array X7R, Y5V

nF Cap.	last two digits of 12 NC	X7R 16 V NEW 0612 (4 x 0603)	Y5V 25 V 0612 (4 x 0603)
10 000	36		
12 000	37		
15 000	38		
18 000	39		
22 000	41		
27 000	42	0.6 ± 0.1	0.6 ± 0.1
33 000	43		
39 000	44		
47 000	45		
56 000	46		
68 000	47		
82 000	48		
100 000	49		
Tape width		8 mm	8 mm

Ordering information

12NC

22xx xxx xxxxx

- Carrier type: 50 blister; 55 paper
- Termination: 10 16 V Ni-barrier; 12 25 V Ni-barrier
- Size: 6 0612 (4 x 0603)
- Dielectric: 5 X7R; 9 Y5V
- Tolerance: 6 ± 10% (X7R only); 8 − 20/ + 80% (Y5V only)
- Capacitance value (see selection chart)
- Packaging: 1 reel ∅ 180 mm / 7"

Clear text code (preferred)

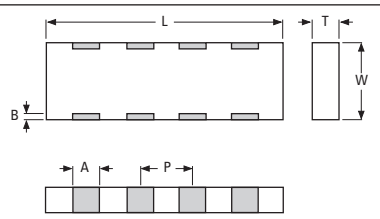
06122R104K8B20D (example)

0612 Size code	2R Temp. char.	104 Cap. in pF	K Tolerance	7 Voltage	B Termination	2 Packaging	0 Marking	D Range identifier
0612 (4 x 0603)	2R - X7R 2F - Y5V	104 = 100 000 pF i.e. the third digit signifies the multiplying factor 3 = x 1000 4 = x 10 000	X7R: K ± 10 % Y5V: Z − 20 %/ + 80 %	X7R: 7 = 16 V Y5V: 8 = 25 V	B = Ni-barrier	2 = 180 mm / 7" paper B = 180 mm / 7" blister	0 = no marking	D = BME

Thickness classes and packaging quantities

Thickness classes (mm)	8 mm tape width amount per reel			
	180 mm / 7"		330 mm / 13"	
	paper	blister	paper	blister
0.6 ± 0.1	4000	4000	10 000	10 000

Mechanical data



Case Size		L	W	T_{min}	T_{max}	A	B	P
0612 (4 x 0603)	mm	3.20 ± 0.15	1.6 ± 0.15	0.50	1.20	0.4 ± 0.1	0.3 ± 0.2	0.8 ± 0.1
	inches	0.125 ± 0.006	0.063 ± 0.006	0.020	0.047	0.016 ± 0.006	0.012 ± 0.006	0.031 ± 0.004

Ceramic Multilayer Capacitors

Compact series NP0 25 V, 50 V/63 V

SMD TECHNOLOGY

		25 V	50 V/63 V							
										
Cap.	last two digits of 12 NC	**0402**	**0603**	**0805**	**1206**	**1210**	**1812**	**2220**	**Cap.**	last two digits of 12 NC
pF 220	41								pF 220	41
270	42	0.5 ± 0.05							270	42
330	43								330	43
390	44								390	44
470	45								470	45
560	46								560	46
680	47								680	47
820	48								820	48
1000	49		0.8 ± 0.07						1000	49
1200	51								1200	51
1500	52						in columns : Thickness class		1500	52
1800	53								1800	53
2200	54								2200	54
2700	55			0.85 ± 0.1					2700	55
3300	56								3300	56
3900	57								3900	57
4700	58			1.25 ± 0.1					4700	58
5600	59								5600	59
6800	61				0.85 ± 0.1	0.85 ± 0.1			6800	61
8200	62								8200	62
µF 0.010	63					0.9 to 1.3			10 000	63
0.012	64				0.9 to 1.3				12 000	64
0.015	65					1.2 to 1.75	0.85 ± 0.1		15 000	65
0.018	66					1.6 to 2.2			18 000	66
0.022	67						0.9 to 1.3		22 000	67
0.027	68						1.2 to 1.75		27 000	68
0.033	69								33 000	69
0.039	71							0.9 to 1.3	39 000	71
0.047	72								47 000	72
0.056	73							1.2 to 1.75	56 000	73
0.068	74								68 000	74
0.082	75							1.6 to 2.2	82 000	75
0.10	76								100 000	76
Tape width		8 mm						12 mm		Tape width

Thickness classes and packaging quantities

Thickness classes (mm)	**8 mm tape width amount per reel**				**12 mm tape width amount per reel**		**amount per bulk case**		
	180 mm / 7"		330 mm / 13"		180 mm / 7" / blister				
	paper	blister	paper	blister	1812	2220	0402	0603	0805
0.5 ± 0.05	10 000	-	50 000	-	-	-	50 000	-	-
0.85 ± 0.1	4000	4000	10 000	10 000	-	-	-	-	8000
0.8 ± 0.07	4000	-	15 000	-	-	-	-	15 000	-
0.9 to 1.3	-	3000	-	8000	1500	1500	-	-	-
1.25 ± 0.1	-	3000	-	8000	-	-	-	-	5000
1.2 to 1.75	-	2500	-	7000	1000	1000	-	-	-
1.6 to 2.2	-	-	-	-	1000	1000	-	-	-

Ordering information

Clear text code (preferred)

0603CG102G9B20C (example)

0603 Size code	**CG** Temp. char.	**102** Cap. in pF	**G** Tolerance	**9** Voltage	**B** Termination	**2** Packaging	**0** Marking	**C** Range identifier
0402 0603 0805 1206 1210 1812 (AgPd only) 2220 (AgPd only)	CG = NPO	102 = 1000 pF i.e. the third digit signifies the multiplying factor 1 = x 10 2 = x 100 3 = x 1000 4 = x 10 000	F ± 1 % G ± 2 % J ± 5 % K ± 10 %	8 = 25 V 9 = 50 V/ 63 V	B = Ni-barrier A = AgPd (2220 and 1812 only)	2 = 180 mm / 7" paper 3 = 330 mm / 13" paper B = 180 mm / 7" blister F = 330 mm / 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	C = compact

12NC

22xx xxx x0xxx

Carrier type
- 22 blister
- 38 paper
- 54 bulk

Rated voltage - Termination
- 87 25 V Ni-barrier
- 89 50 V/63 V Ni-barrier
- 90 50 V/63 V AgPd (1812 and 2220 only)

Size
- 7 0402
- 6 0603
- 0 0805
- 1 1206
- 2 1210
- 4 1812 (AgPd only)
- 5 2220 (AgPd only)

Capacitance value (see selection chart)

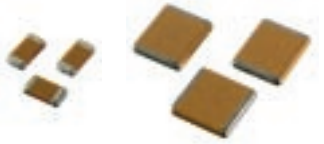
Tolerance
- 3 ± 1%
- 4 ± 2%
- 5 ± 5%
- 6 ± 10%

Packaging
- 1 reel ∅ 180 mm / 7"
- 8 reel ∅ 330 mm / 13"
- 4 bulk case

Ceramic Multilayer Capacitors

Compact series X7R 16 V, 25 V, 50 V/63 V

SMD TECHNOLOGY

	16 V	25 V					50 V/63 V						
													
Cap.	last two digits of 12 NC	**1206**	**0805**	**1206**	**1210**	**1812**	**2220**	**0805**	**1206**	**1210**	**1812**	**2220**	**Cap.**	last two digits of 12 NC
µF 0.039	44												µF 39	44
0.047	45		0.6 ± 0.1					0.85 ± 0.1					47	45
0.056	46												56	46
0.068	47							1.25 ± 0.1					68	47
0.082	48		0.85 ± 0.1										82	48
0.10	49								0.6 ± 0.1				100	49
0.12	51		1.25 ± 0.1	0.6 ± 0.1					0.85 ± 0.1				120	51
0.15	52												150	52
0.18	53								0.9 to 1.3				180	53
0.22	54			0.85 ± 0.1	0.6 ± 0.1				1.2 to 1.75	0.85 ± 0.1			220	54
0.27	55												270	55
0.33	56			0.9 to 1.3						0.9 to 1.3	0.6 ± 0.1		330	56
0.39	57			1.2 to 1.75	0.85 ± 0.1					1.2 to 1.75			390	57
0.47	58										0.85 ± 0.1		470	58
0.56	59	0.85 ± 0.1			0.9 to 1.3								560	59
0.68	61										0.9 to 1.3		680	61
0.82	62				1.2 to 1.75						1.2 to 1.75		820	62
1.0	63	0.9 to 1.3			1.6 to 2.2	0.9 to 1.3						0.9 to 1.3	1000	63
1.2	64												1200	64
1.5	65					1.2 to 1.75						1.2 to 1.75	1500	65
1.8	66												1800	66
2.2	67						0.9 to 1.3					1.6 to 2.2	2200	67
2.7	68						1.2 to 1.75						2700	68
3.3	69												3300	69
3.9	71						1.6 to 2.2						3900	71
4.7	72												4700	72
Tape width		8 mm	8 mm			12 mm		8 mm			12 mm			Tape width

in columns : Thickness class

Thickness classes and packaging quantities

Thickness classes (mm)	8 mm tape width amount per reel				12 mm tape width amount per reel		amount per bulk case
	180 mm / 7"		330 mm / 13"		180 mm / 7" / blister		
	paper	blister	paper	blister	1812	2220	0805
0.6 ± 0.1	4000	4000	10 000	10 000	2000	-	10 000
0.85 ± 0.1	4000	4000	10 000	10 000	-	-	8000
0.9 to 1.3	-	3000	-	8000	1500	1500	-
1.25 ± 0.1	-	3000	-	8000	-	-	5000
1.2 to 1.75	-	2500	-	7000	1000	1000	-
1.6 to 2.2	-	-	-	-	1000	1000	-

Ordering information

Clear text code (preferred)

18122R105K9BB0C (example)

1812 Size code	**2R** Temp. char.	**105** Cap. in pF	**K** Tolerance	**9** Voltage	**B** Termination	**B** Packaging	**0** Marking	**C** Range identifier
0805 1206 1210 1812 2220 (AgPd only)	2R = X7R	105 = 1 000 000 pF i.e. the third digit signifies the multiplying factor 3 = x 1000 4 = x 10 000 5 = x 100 000	J ± 5 % K ± 10 % M ± 20 %	7 = 16 V 8 = 25 V 9 = 50 V/ 63 V	B = Ni-barrier A = AgPd (2220 only)	2 = 180 mm / 7" paper 3 = 330 mm / 13" paper B = 180 mm / 7" blister F = 330 mm / 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	C = compact

12NC

22xx xxx x6xxx

Carrier type
- 22 blister
- 38 paper
- 54 bulk

Rated voltage - Termination
- 95 16 V Ni-barrier
- 87 25 V Ni-barrier
- 88 25 V AgPd (2220 only)
- 89 50/63 V Ni-barrier
- 90 50/63 V AgPd (2220 only)

Size
- 0 0805
- 1 1206
- 2 1210
- 4 1812
- 5 2220

Tolerance
- 5 ± 5%
- 6 ± 10%
- 7 ± 20%

Packaging
- 1 reel ∅ 180 mm / 7"
- 8 reel ∅ 330 mm / 13"
- 4 bulk case

Capacitance value (see selection chart)

Fixed Resistors, SMD

Fixed Resistors

General information

Standard series of values in a decade according to IEC 63

E6 series:	10	15	22	33	47	68						
E12 series:	10	12	15	18	22	27	33	39	47	56	68	82
E24 series:	10 33	11 36	12 39	13 43	15 47	16 51	18 56	20 62	22 68	24 75	27 82	30 91
E48*/E96 series:	**100** **133** **178** **237** **316** **422** **562** **750**	102 137 182 243 324 432 576 768	**105** **140** **187** **249** **332** **442** **590** **787**	107 143 191 255 340 453 604 806	**110** **147** **196** **261** **348** **464** **619** **825**	113 150 200 267 357 475 634 845	**115** **154** **205** **274** **365** **487** **649** **866**	118 158 210 280 374 499 665 887	**121** **162** **215** **287** **383** **511** **681** **909**	124 165 221 294 392 523 698 931	**127** **169** **226** **301** **402** **536** **715** **953**	130 174 232 309 412 549 732 976

* E48 values in bold are the alternate values of E96

Ordering information 12 NC

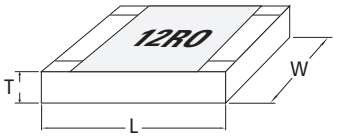
The first 8 or 9 digits of the 12 digit catalogue number are given under "Ordering information Preferred types" (see following pages)
The remaining 4 or 3 digits represent the resistance value with the last digit indicating the multiplier as shown in the table

Example:

1 Ω = 1008 or 108
33 kΩ = 3303 or 333
10 MΩ = 1006 or 106

Last digit of 12 NC	
Resistance	Last digit
0.1 to 0.976 Ω	7
1 to 9.76 Ω	8
10 to 97.6 Ω	9
100 to 976 Ω	1
1 to 9.76 kΩ	2
10 to 97.6 kΩ	3
100 to 976 kΩ	4
1 to 9.76 MΩ	5
10 to 68 MΩ	6

Case size dimensions



Size code	L (mm)	W (mm)	T (mm)	Mass (g)
0402	1.0	0.5	0.35	0.05
0603	1.6	0.8	0.45	0.4
0805	2.0	1.25	0.55	0.55
1206	3.2	1.6	0.55	1.0
1218	3.05	4.6	0.55	3.0
2010	5.0	2.5	0.55	2.5
2512	6.4	3.1	0.55	4.25

Resistor size 0402

General Purpose / Precision Resistors

	SMD				R-Array (note)		R-Network
	Thick film						
	1206	0805	0603	0402	4 x 0603	4 x 0402	1206
5%, 2%	RC01	RC11	RC21	RC31			
5%					ARC241 ARV241	ARV341	8R Network
1% (TC 200)				RC32			
1% (TC 100)	RC02H	RC12H	RC22H		ARC242		
1% (TC 50)	RC02G	RC12G					

TC = Temperature Coefficient

Power Resistors

	SMD			
	Thick film			
P_{nom} at 70 °C	5%, 1%	5%, 2%, 1%	5%, 2%, 1%	5%, 2%
0.5 Watt		PRC111		
1 Watt	PRC201		PRC221	PRC221 Low ohmic

High / Ultra-High Precision Resistors

			High precision		Ultra-high precision
			Thick film	Thin film	Thin film
			0.5%	0.5%	0.1%
SMD	1206	TC 50	RC03G		
		TC 25		TFR01	MPC01
	0805	TC 50	RC13G		
		TC 25		TFR11	MPC11
	0603	TC 25		TFR21	MPC21
	0402	TC 25		TFR31	
	0201	TC 25		TFR41	

Application Specific Resistors

	SMD		
	1206	0805	0603
High ohmic / High voltage	HRC01	HRC11	HRC21
Low ohmic	LRC01 (5%) LRC02 (1%)	LRC11	
Fusible (non flammable)	FRC01		
Surge	SRC01		
Trimmable	RC02TR	RC12TR	RC22TR

note: ARC : conCave type termination
ARV : conVex type termination

General purpose and Precision

NEW

Series	RC01	RC02G	RC02H	RC11	RC12G	RC12H	RC21	RC22H	RC 31	RC 32
Case size	**1206** (3.2 x 1.6 mm)			**0805** (2.0 x 1.25 mm)			**0603** (1.6 x 0.8 mm)		**0402** (1.0 x 0.5 mm)	
Tolerance	5% 2%	1%		5% 2%	1%		5% 2%	1%	5% 2%	1%
Power P_{70}	0.25 W	0.25 W	0.25 W	0.125 W			0.063 W		0.063 W	
Temp range (°C)	-55 to 155	-55 to 155	-55 to 155	-55 to 155	-55 to 155	-55 to 155	-55 to 155	-55 to 155	-55 to 125	-55 to 125
U_{max}	200 V			150 V			50 V		50 V	
E-Series	E24	E24/E96		E24	E24/E96		E24	E24/E96	E24	E24/E96
Resistance range including temperature coefficient (TC)										
0 Ω	Jumper 2322 711 91032			Jumper 2322 730 91002			Jumper 2322 702 96001			
0.1 Ω										
1 Ω	TC 0 / +500		TC 0 / +500	TC 0 / +500		TC 0 / +500	TC 0 / +500	TC 0 / +500	6.8 Ω TC 0 / +500	TC 0 / +500
10 Ω										
100 Ω		90 Ω			90 Ω					
1 kΩ	TC 200									
10 kΩ		TC 50	TC 100	TC 200	TC 50	TC 100	TC 200	TC 100	TC 200	TC 200
100 kΩ										
1 MΩ		2.74 MΩ			2.74 MΩ				2.2 MΩ	1 MΩ
10 MΩ										
Remarks										

Ordering information Preferred types

Series	RC01	RC02G	RC02H	RC11	RC12G	RC12H	RC21	RC 22H	RC 31	RC 32
Range	E24, 5%, 2%	E24, 1%	E24, 1%	E24, 5%, 2%	E24, 1%	E24, 1%	E24, 5%, 2%	E24, 1%	E24, 5%, 2%	E24, 1%
Quantity	5000	5000	5000	5000	5000	5000	5000	5000	10 000	10 000
Packing	reel paper tape	reel plastic tape	reel plastic tape/ paper tape	reel paper tape	reel plastic tape	reel plastic tape/ paper tape	reel paper tape	reel paper tape	reel paper tape	reel paper tape
Cat. number	2322 711 61...* 2322 711 41...**	2322 723 6....	2322 724 6....	2322 730 61...* 2322 730 31...**	2322 733 6....	2322 734 6....	2322 702 60...* 2322 702 65...**	2322 704 6....	2322 705 70...* 2322 705 75...**	2322 706 7....
Note	*= 5%, **= 2%			See page 50 for E24 values, the last 4 or 3 digits of the catalogue number and size information						

	High precision	High precision, high stability					Ultra high precision, high stability		
		NEW 					 NEW		
Series	**RC03G**	**RC 13G**	**TFR 01**	**TFR 11**	**TFR 21**	**TFR 31**	**TFR 41**	**MPC 01**	**MPC 11**	**MPC 21**
Case size	**1206**	**0805**	**1206**	**0805**	**0603**	**0402**	**0201**	**1206**	**0805**	**0603**
Tolerance	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.1%	0.1%	0.1%
Power P_{70}	0.25 W	0.125 W	0.125 W	0.1 W	0.063 W	0.063 W	0.05 W	0.125 W	0.1 W	0.063 W
Temp range	– 55 to 125 °C		– 55 to 125 °C					– 55 to 125 °C		
U_{max}	200 V	150 V	150 V	100 V	75 V	25 V	15 V	150 V	100 V	75 V
E-Series	E24/E96	E24/E96	E24/E96	E24/E96	E24/E96	E24/E96	E24/E96	E24/E96 and others	E24/E96 and others	E24/E96
Resistance range including temperature coefficient (TC)	90 Ω TC 100 250 Ω TC 50 2.74 MΩ	90 Ω TC 50 2.74 MΩ	TC 50 97.6 Ω TC 25 1 MΩ	TC 50 97.6 Ω TC 25 1 MΩ	10 Ω TC 50 97.6 Ω TC 25 360 kΩ	TC 100 97.6 Ω TC 25 100 kΩ	33 Ω TC 25 22 kΩ	10 Ω TC 50 51 Ω TC 25 1 MΩ	100 Ω TC 10 249 kΩ	TC 50 33 Ω TC 25 1 MΩ	100 Ω TC 25 332 kΩ
Remarks	thick film technology		thin film technology					thin film technology		

Ordering information Preferred types

Series	**RC03G**	**RC 13G**	**TFR 01**	**TFR 11**	**TFR 21**	**TFR 31**	**TFR 41**	**MPC 01**	**MPC 11**	**MPC 21**
Range	E24, 90 Ω-2.74 MΩ	E24, 90 Ω-2.74 MΩ	E24, 10 Ω-1 MΩ	E24, 10 Ω-1 MΩ	E24, 10 Ω-360 kΩ	E24, 10 Ω-100 kΩ	E24, 33 Ω-22 kΩ	E24, 10 Ω-1 MΩ	E24, 10 Ω-1 MΩ	E24, 100 Ω-332 kΩ
Quantity	5000	5000	5000	5000	5000	10 000	10 000	5000	5000	5000
Packing	reel plastic tape	reel plastic tape	reel paper tape	reel paper tape	reel paper tape	reel paper tape	reel paper tape	reel plastic tape	reel plastic tape	reel plastic tape
Cat. number	2322 725 2....	2322 738 2....	2350 611 6.... (TC 25)	2350 601 6.... (TC 25)	2350 604 6.... (TC 25)	2350 607 6.... (TC 25)	2350 614 6.... (TC 25)	2322 740 3....* 2322 741 3....**	2322 781 3....	2322 744 3....	2322 747 3....
Note	* TC 50, **TC 25		See page 50 for E24 values, the last 4 or 3 digits of the catalogue number and size information							

	Network	Arrays				Trimmable		
	NEW				NEW			NEW
								
Series	**8R network**	**ARC 241**	**ARC 242**	**ARV 241**	**ARV 341**	**RC 02TR**	**RC 12TR**	**RC 22TR**
Case size	**1206**	**4x 0603**			**4x 0402**	**1206**	**0805**	**0603**
Tolerance	5%	5%	1%	5%	5%	0 to –20% or 0 to –30%	0 to –20% 0 to –30%	0 to –20% 0 to –30%
Power P_{70}	1/32 W	0.063 W	0.063 W	0.063 W	0.063 W	0.25 W	0.125 W	0.063 W
Temp range	– 55 to 125 °C	– 55 to 155 °C			– 55 to 125 °C	– 55 to 155 °C		– 55 to 125 °C
U_{max}	25 V	50 V	50 V	50 V	50 V	200 V	150 V	50 V
E-Series	E24	E24	E96	E24	E24	E24	E24	E24
Resistance range including temperature coefficient (TC) 0 Ω		Jumper 2350 034 91001		Jumper 2350 035 91001	Jumper 2350 033 91002			
0.1 Ω								
1 Ω							1 Ω	
						TC 250	TC 250 10 Ω	TC 500
10 Ω	TC 0 / +500							
100 Ω								
1 kΩ	TC 200	TC 200	TC 100	TC 200	TC 300	TC 100	TC 100	TC 100
10 kΩ								
100 kΩ								
1 MΩ							1 MΩ	
						TC 200	TC 200	TC 200
10 MΩ								
Remarks		concave terminations	concave terminations	convex terminations	convex terminations note: concave available soon			

Ordering information Preferred types

Series	**RNA 310**	**ARC 241**	**ARC 242**	**ARV 241**	**ARV 341**			
Range	E24, 5% 10 Ω - 100 kΩ	E24, 5% 10 Ω - 1 MΩ	E24, 1% 10 Ω - 1 MΩ	E24, 5% 10 Ω - 1 MΩ	E24, 5% 10 Ω - 1 MΩ			
Quantity	5000	5000	5000	5000	5000			
Packing	reel paper tape	reel paper tape	reel paper tape	reel paper tape	reel paper tape			
Cat. number	2350 230 10...	2350 034 10...	2350 024 1....	2350 035 10...	2350 033 10...			
Note	See page 50 for E24 values, the last 4 or 3 digits of the catalogue number and size information							

	Power			Power, low ohmic			Fusible
					NEW 	NEW 	
Series	**PRC 201**	**PRC 111**	**PRC 221**	**PRC 201**	**PRC 111**	**PRC 221**	**FRC 01**
Case size	**1218** (3.0x4.6 mm)	**2010** (5.0x2.5 mm)	**2512** (6.4x3.1 mm)	**1218** (3.0x4.6 mm)	**2010** (5.0x2.5 mm)	**2512** (6.4x3.1 mm)	**1206** (3.2x1.6 mm)
Tolerance	5% 1%	5%, 2% 1%	5%, 2% 1%	5%, 2% 1%	5%, 2% 1%	5%, 2% 1%	5%
Power P_{70}	1 W	0.5 W	1 W	1 W	0.5 W	1 W	0.125 W
Temp range	-55 to 155 °C	-55 to 125 °C	-55 to 125 °C	-55 to 155 °C	-55 to 125 °C	-55 to 125 °C	-55 to 125 °C
U_{max}	200 V	200 V	250 V	200 V	200 V	250 V	200 V
E-Series	E24	E24 E96	E24 E96	E24/E96	E24/E96	E24/E96	E24/E96
Resistance range including temperature coefficient (TC) 0 Ω		Jumper 2322 760 90003	Jumper 2322 762 90000	0.02 Ω	0.01 Ω 0.02 Ω	0.01 Ω 0.02 Ω	
0.1 Ω				0.1 Ω TC 2000 to TC 250	TC 1500 to TC 75	TC 1500 to TC 75	
1 Ω	1 Ω	1 Ω	1 Ω				
	TC 200	TC 300	TC 300 5 Ω	0.99 Ω	0.99 Ω	0.99 Ω	TC 250 5 Ω
10 Ω		TC 200	TC 200 10 Ω				TC 200
100 Ω							
1 kΩ	TC 100	TC 100	TC 100				510 Ω
10 kΩ							
100 kΩ							
1 MΩ		TC 200	TC 200				
10 MΩ		10 MΩ	10 MΩ				
Remarks	terminations on the long side improve heat transfer and reduce stresses				specifications available on request		non flammable specified interruptions

Ordering information Preferred types

Series	**PRC 201**	**PRC 111**	**PRC 221**	**PRC 201**	**PRC 111**	**PRC 221**	**FRC 01**
Range	E24, 5% 1 Ω - 1 MΩ	E24, 5% 1 Ω - 1 MΩ	E24, 5% 1 Ω - 1 MΩ	E24, 5% 0.02 Ω - 0.99 Ω	E24, 5% 0.01 Ω - 0.99 Ω	E24, 5% 0.01 Ω - 0.99 Ω	E24, 5% 1 Ω - 510 Ω
Quantity	5000	5000	5000	5000	4000	4000	5000
Packing	reel blister tape	reel blister tape	reel blister tape	reel blister tape	reel blister tape	reel blister tape	reel paper tape
Cat. number	2322 735 60...	2322 760 60...	2322 762 60...	2322 735 60...	for ordering contact your local Philips sales representative		2322 750 6....
Note	See page 50 for E24 values, the last 4 or 3 digits of the catalogue number and size information						

	Low ohmic			High ohmic			Surge
		NEW			NEW	NEW	NEW
							
Series	**LRC 01**	**LRC 02**	**LRC 11**	**HRC 01**	**HRC 11**	**HRC 21**	**SRC 01**
Case size	**1206**	**1206**	**0805**	**1206**	**0805**	**0603**	**1206**
Tolerance	5%	1%	5% / 2%	5% / 2%	5% / 2%	5% / 2%	5% / 2%
Power P_{70}	0.25 W	0.25 W	0.125 W	0.25 W	0.125 W	0.063 W	0.25 W
Temp range	-55 to 125 °C			-55 to 125 °C		-55 to 155 °C	-55 to 155 °C
U_{max}	200 V	200 V	150 V	200 V	150 V	50 V	200 V
E-Series	E24	E96	E24	E24	E24	E24	E24
Resistance range including temperature coefficient (TC) 0 Ω	0.02 Ω	0.02 Ω	0.02 Ω				
0.1 Ω	TC 1500 to TC 75	TC 1500 to TC 75	TC 1500 to TC 75				
1 Ω							1 Ω
							TC 0 / +500
10 Ω							
100 Ω							TC 200
1 kΩ							
10 kΩ							
100 kΩ							100 kΩ
1 MΩ				11 MΩ - 100 MΩ TC 300	11 MΩ - 100 MΩ TC 300	11 MΩ TC 300 22 MΩ	
10 MΩ							
Remarks							

Ordering information Preferred types

Series	**LRC01**	**LRC02**	**LRC11**	**HRC01**	**HRC11**	**HRC21**	**SRC01**
Range	E24, 5% 0.02 Ω - 1 Ω	E24, 1% 0.02 Ω - 1 Ω	E24, 5%, 2% 0.02 Ω - 1 Ω	E24, 5%, 2% 11 MΩ - 100 MΩ	E24, 5%, 2% 11 MΩ - 100 MΩ	E24, 5%, 2% 11 MΩ - 22 MΩ	E24, 5%, 2% 1 Ω - 100 kΩ
Quantity	5000	5000	5000	5000	5000	5000	5000
Packing	reel paper tape	reel paper tape	reel paper tape	reel paper tape	reel paper tape	reel paper tape	reel paper tape
Cat. number	2350 510 10...	2350 510 12...	5% 2350 511 10... 2% 2350 511 11...	5% 2350 520 10... 2% 2350 520 11...	5% 2350 521 10... 2% 2350 521 11...	5% 2350 522 10... 2% 2350 522 11...	5% 2350 550 10... 2% 2350 550 11...
Note	See page 50 for E24 values, the last 4 or 3 digits of the catalogue number and size information						

High-frequency Inductors (thin-film)

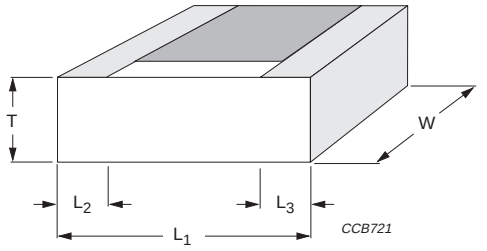
High-frequency Inductors (thin-film)

NEW

Series		THL 0603	THL 0402
Case size		0603	0402
Tolerance:			
1.0 < = L < = 8.2 nH		± 0.2 nH	± 0.2 nH
10 < = L < = 15 nH		± 2%	± 2%
L > = 15 nH		± 2%	± 3%
Temp range		–55 to +125 C°	
E-Series		E24	E24
Inductance value	last two digits of 12 NC	**0603**	**0402**
(nH) 1.0	11		
1.2	31		
1.5	15		
1.8	17		
2.2	19		
2.7	22		
3.3	24		
3.9	26		
4.7	28		
5.6	31	TC	TC
6.8	33	0 / +125	0 / +125
8.2	35		
10	37		
12	39		
15	42		
18	44		
22	46		
27	48		
33	51		
39	53		
47	55		
56	57		
68	59		
82	62		
100	64		
Tape width		8 mm	

Ordering information 12NC

Series	THL 0603	THL 0402
Quantity	5000	10 000
Packing	reel paper tape	reel paper tape
Cat. number	9365 006 122..	9365 007 122..
Note	See selection chart (above) for the last two digits of 12 NC refering to the inductance value	



case size	mm		inches	
	0402	0603	0402	0603
L_1	1.0 ± 0.1	1.6 ± 0.1	0.04 ± 0.004	0.063 ± 0.004
W	0.5 ± 0.1	0.8 ± 0.1	0.02 ± 0.004	0.032 ± 0.004
T	0.4 ± 0.1	0.45 ± 0.1	0.016 ± 0.004	0.018 ± 0.004
L_2	0.25 ± 0.05	0.3 ± 0.2	0.0098 ± 0.002	0.012 ± 0.002
L_3	0.25 ± 0.05	0.3 ± 0.2	0.0098 ± 0.002	0.012 ± 0.002

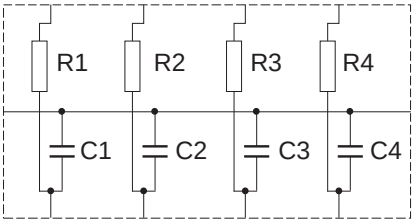
RC networks

Monolayer RC network

NEW

Series	RCB 210	
Case size	1608 (4.0 x 2.1 mm)	
Tolerance	R: 5%	C: +30% to –20%
Temp. coeff.	R: ±200 x 10^{-6}K	C: +20% to –55%
Temp range	–25 to +85°C	
$Power_{max}$ P_{70}	0.063 W / element	
U_{max}	25 V (DC or RMS)	
E-Series	R: E6	C: E3
Packing	4000 pcs in blister tape on reel	

RC range		Catalogue number	Marking code
R (Ω) 33	C (pF) 180	2350 321 20001	702
22	100	2350 321 20002	13
100	47	2350 321 20003	32
22	10	2350 321 20004	515
47	22	2350 321 20005	21
22	22	2350 321 20006	11
22	47	2350 321 20007	12
47	47	2350 321 20008	22
47	100	2350 321 20009	23
100	22	2350 321 20010	31
100	100	2350 321 20011	33
220	22	2350 321 20012	41
220	47	2350 321 20013	42
220	100	2350 321 20014	43
470	22	2350 321 20015	51
470	47	2350 321 20016	52
470	100	2350 321 20017	53
1000	22	2350 321 20018	61
1000	47	2350 321 20019	62
1000	100	2350 321 20020	63
100 000	22	2350 321 20021	502
33	47	2350 321 20022	503
33	33	2350 321 20023	504
100	33	2350 321 20024	505
1000	33	2350 321 20025	506
47	33	2350 321 20026	507
2200	47	2350 321 20027	508
82 000	33	2350 321 20028	509
22	33	2350 321 20029	510
47 000	100	2350 321 20030	511
15 000	47	2350 321 20031	512
33	10	2350 321 20032	513
47	10	2350 321 20033	514
330	100	2350 321 20034	516
10	10	2350 321 20035	517
15	15	2350 321 20036	518
10	15	2350 321 20037	519
15	10	2350 321 20038	520
27	47	2350 321 20039	521
33	100	2350 321 20040	522
100	10	2350 321 20041	523
10	100	2350 321 20042	524
10	22	2350 321 20043	525
10	47	2350 321 20044	526
1000	10	2350 321 20045	527
220	10	2350 321 20046	528
470	10	2350 321 20047	529
22	180	2350 321 20048	701
47	180	2350 321 20049	703
68	180	2350 321 20050	704
4700	180	2350 321 20051	705
100	180	2350 321 20052	706
82	100	2350 321 20053	530

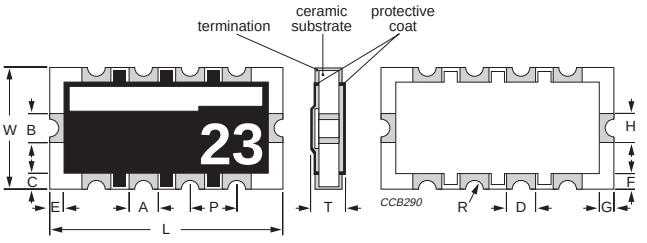


R1 = R2 = R3 = R4
C1 = C2 = C3 = C4

Functional diagram

Mechanical data

top view: capacitor **bottom view: resistor**



Dimensions in mm	
L	4.00 + 0.30 / –10
W	2.10 ± 0.20
A and B	0.50 ± 0.20
C and E	0.25 ± 0.20
H	0.50 ± 0.20
R	0.15 + 0.05 / –0.10
T	0.65 + 0.20 / –0.10
D	0.45 ± 0.20
F and G	0.40 ± 0.20
P	0.80 ± 0.10

Application Specific Integrated Products (ASIPs)

Application Specific Integrated Products (ASIPs)

8-channel half-T filter with 2 kV and 8 kV ESD protection

IP2000 and IP2050 series for EMI/RFI filtering

The Philips IP2000 series of Application Specific Integrated Products (ASIPs) is an 8-channel half-T filter incorporating ESD protection of >2 kV. IP2000 devices are fabricated using thin film-on-silicon technology and integrate 8 resistors, 8 capacitors and 16 diodes in a single 20 pin QSOP package.

Resistance and capacitance variation, channel to channel, using thin film-on-silicon technology is far superior in comparison to resistance and capacitance variation using thick film-on-ceramic technology.

The IP2000 should be used to provide line termination and EMI/RFI filtering of undesired high frequency signals in Electronic Data Processing (EDP) or telecommunication applications.

The IP2000 series of devices, together with their self-contained ESD protection, help maintain signal integrity on digital transmission lines by reducing digital undershoot conditions.

Quick Reference Data	IP 2000	IP 2050
Electrical characteristics at 25°C		
Resistance	±10%	±10%
Capacitance	±20%	±20%
Operating voltage, V_{CC}	0 to +5.5 V	0 to +5.5 V
ESD protection	IEC 61000-4-2, level 1 (2 kV contact)	IEC 61000-4-2, level 4 (8 kV contact, 15 kV air discharge)
Power rating per channel	100 mW, package limited	100 mW, package limited
Package ratings		
Maximum dissipation at:		
T_{amb} = 70 °C	1 W	1 W
T_{amb} = 85 °C	0.83 W	0.83 W
Operating temperature	–25 to +85°C	–25 to +85°C
Storage temperature	–60 to +150°C	–60 to +150°C

Ordering information

Ordering code

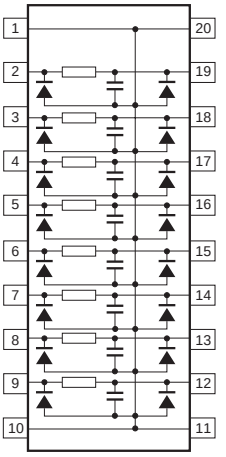
xxxxxx CY20-xxx

- Philips series: IP 2000, IP 2050
- Operating temperature range: C –25 to +85°C
- Packaging: Y QSOP
- Number of pins
- R/C code
- Packaging - Quantity: R reel: 180 mm (7") - 600 pcs; S reel: 330 mm (13") - 2000 pcs; T tube - 56 pcs

Standard R/C values

R/C code	R value	C value
01	10 Ω	15 pF
02	10 Ω	47 pF
03(1)	27 Ω	15 pF
04(1)	33 Ω	15 pF
05(1)	33 Ω	47 pF
06(1)	33 Ω	220 pF
07(1)	47 Ω	33 pF
08	100 Ω	47 pF
09	47 Ω	47 pF
10	39 Ω	220 pF

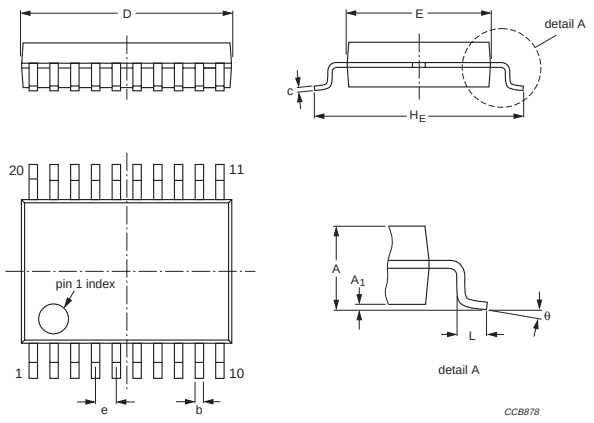
1. These parts are currently available



Functional diagram

Package outline

QSOP20 plastic shrink small outline package;
20 leads; narrow body width 3.81 mm.



Package dimensions in mm

	Min.	Max.
A	1.35	1.75
A_1	0.10	0.30
b	0.20	0.30
c	0.15	0.25
D	8.55	8.74
E	3.81	3.99
H_E	5.79	6.20
e	0.635 nom.	
L	0.40	1.27
θ	0	8 deg.

IP4150 series for IEEE1284 for parallel ports

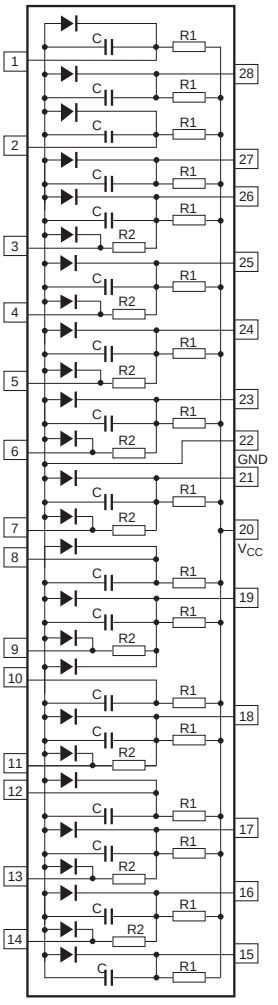
The Philips IP4150 is a one chip solution for filtering / termination for IEEE 1284 interface. It is a 17-channel RC array which incorporates ESD protection and is manufactured using thin film-on-silicon substrate technology. The IP4150 integrates 26 resistors, 17 capacitors and 26 diodes in a single plastic QSOP package.

Resistance and capacitance variation, channel to channel, using thin film-on-silicon technology is far superior in comparison to resistance and capacitance variation using thick film-on-ceramic technology.

These filter / termination arrays are configured as low pass filters with high impedance pull-up resistors.
As filters, the IP4150 will pass low frequency digital data and attenuate undesired high frequency signals. As terminations, the IP4150 will reduce reflections caused by the transmission line effects of long cable lines.

The integrated diodes of the IP4150 provide in-system ESD protection up to 8 kV for the I/O pins that interface with the external connector. Furthermore, the diodes help maintain signal integrity on digital transmission lines by reducing logic undershoot conditions.

Quick Reference Data	IP 4150
Electrical characteristics at 25°C	
Resistance	±10%
Capacitance	±20%
Operating voltage, V_{CC}	0 to +5.5 V
Power rating per resistor	100 mW, package limited
Package ratings	
Maximum dissipation at:	
T_{amb} = 70 °C	1 W
Operating temperature	–25 to +85°C
Storage temperature	–65 to +150°C



Functional diagram

Ordering information

Ordering code

IP4150 CY28-xxx

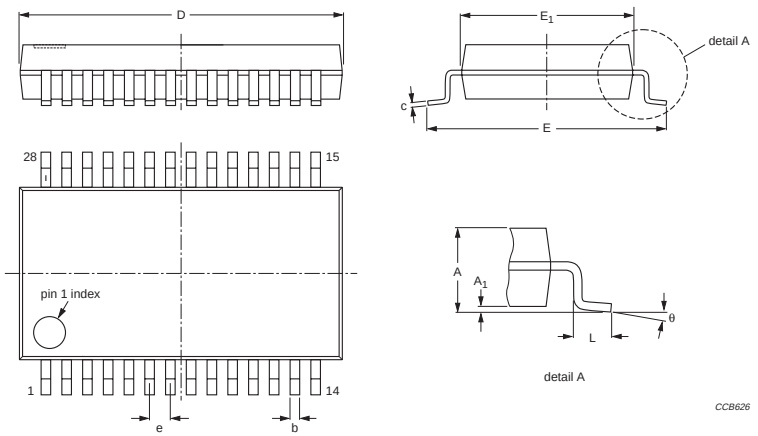
- Philips series: IP 4150
- Operating temperature range: C –25 to +85°C
- Packaging: Y QSOP
- Number of pins
- Packaging - Quantity: S reel: 330 mm (13") - 1000 pcs; T tube - 48 pcs
- R/C code

Standard R/C values

R/C code	Resistance value		Capacitance value
	R1	R2	C
01	2.2 Ω	33 Ω	220 pF
02	4.7 Ω	33 Ω	180 pF

Package outline

QSOP28 plastic shrink small outline package; 28 leads; body width 3.9 mm.



Package dimensions in mm

	Min.	Max.
A	1.35	1.75
A_1	0.10	0.25
b	0.20	0.30
c	0.18	0.25
D	9.80	10.0
E	5.79	6.20
E_1	3.81	3.99
e	0.635 basic	
L	0.40	1.27
θ	0	8 deg.

Ferrite Ceramics

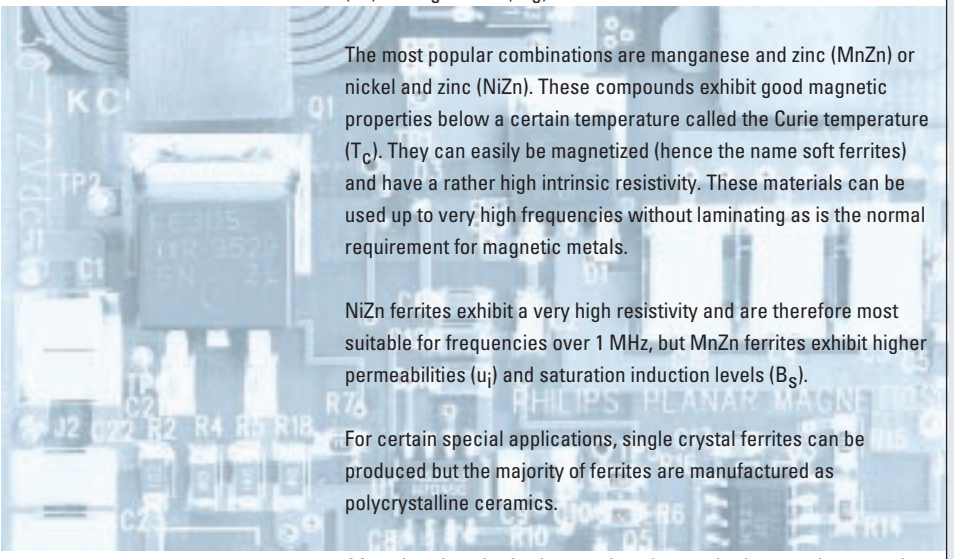
Soft ferrite cores are widely used throughout industry. The number of applications is growing and is virtually limitless.

Main application areas are:

- **Consumer electronics**
- **Lighting**
- **Automotive electronics**
- **Electronic data processing (EDP)**
- **Telecommunications**
- **Measurement and control**

Ferrites are dark grey or black ceramic materials. They are very hard, brittle and chemically inert. Most modern magnetically soft ferrites have a cubic structure.

The general composition of such ferrites is $MeFe_2O_4$ where Me represents one or several of the divalent transition metals such as manganese (Mn), zinc (Zn), nickel (Ni), cobalt (Co), copper (Cu), iron (Fe) or magnesium (Mg).



The most popular combinations are manganese and zinc (MnZn) or nickel and zinc (NiZn). These compounds exhibit good magnetic properties below a certain temperature called the Curie temperature (T_C). They can easily be magnetized (hence the name soft ferrites) and have a rather high intrinsic resistivity. These materials can be used up to very high frequencies without laminating as is the normal requirement for magnetic metals.

NiZn ferrites exhibit a very high resistivity and are therefore most suitable for frequencies over 1 MHz, but MnZn ferrites exhibit higher permeabilities (u_i) and saturation induction levels (B_S).

For certain special applications, single crystal ferrites can be produced but the majority of ferrites are manufactured as polycrystalline ceramics.

After sintering, the ferrite core has the required magnetic properties, and dimensions are typically within 2% of nominal because of spread in shrinkage. If this tolerance is too large or if some surfaces require a smooth finish (e.g. mating faces between core halves) a grinding operation is necessary. Usually diamond-coated wheels are used. For high permeability materials, very smooth, glossy polished pole faces are required. If an airgap is needed in the application, it is made by undercutting the appropriate pole face.

PRODUCT STATUS DEFINITIONS

STATUS	INDICATION	DEFINITION
Prototype	prot	These are products that have been made as development samples for the purposes of technical evaluation only. The data for these types is provisional and is subject to change.
Design-in	des	These products are recommended for new design.
Preferred		These products are recommended for use in current designs and are available via our sales channels.
Support	sup	These products are **not** recommended for new designs and may not be available through all of our sales channels. Customers are advised to check for availability.

Ferrite Ceramics

Application matrix

Application area / Magnetic function	Telecommunication	Electronic Data Processing (EDP)	Sound and Vision	Lighting
Current transformers	3C81, 3E5, 3C90 3E6, 3E27 Ring cores (T)	3C81, 3E5, 3E6, 3E27 Ring cores (T)	3C81, 3E5, 3E6, 3E27 U, Ring cores (T)	
Inductive delay lines	3E5, 3E6, 3E7, 3E27 Ring cores (T)	3E5, 3E6, 3E7, 3E27 Ring cores (T)	3E5, 3E6, 3E7, 3E27 Ring cores (T)	
Driver transformers	3C81, 3C90, 3F3, 3E27 Ring cores (T), E, ER, EP, EFD, RM/I, P/I	3C81, 3C90, 3F3, 3E27 Ring cores (T), E, ER, EP, EFD, RM/I, P/I	3C81, 3C90, 3F3, 3E27 Ring cores (T), E, ER, EP, EFD, RM/I, P/I	3C81, 3C90, 3F3, 3F4, 3E27 Ring cores (T), E, ER, EP, EFD, RM/I, P/I
EMI-suppressors and filters	4C65, 4B1, 3B1, 4A11, 4A15, 3C11, 3E25, 3E5, 3E27, 3S1, 3S4, 4S2 BD, BDW, BDS, WBS, WBC, CMS, MHC, BC, Cable shields, Ring cores (T)	4C65, 4B1, 3B1, 4A11, 4A15, 3C11, 3E25, 3E5, 3E27, 3S1, 3S4, 4S2 BD, BDW, BDS, WBS, WBC, CMS, MHC, BC, Cable shields, Ring cores (T)	4C65, 4B1, 3B1, 4A11, 4A15, 3C11, 3E25, 3E5, 3E27, 3S1, 3S4, 4S2 BD, BDW, BDS, WBS, WBC, CMS, ROD, TUB, MHC, BC, Cable shields, Ring cores (T)	4C65, 4B1, 3B1, 4A11, 4A15, 3C11, 3E25, 3E5, 3E27, 3S1, 3S4, 4S2 BD, BDW, BDS, WBS, WBC, CMS, ROD, TUB, MHC, BC, Cable shields, Ring cores (T)
Filter inductors (signal)	3D3, 3H3, 3C81, 3C90 RM, P, PT, PTS			
Magnetic recording heads		8E1, 8E2, 8E21, 8X1 BAR, PLT	8E1, 8E2, 8E21, 8X1 BAR, PLT	
Proximity switches	3D3 PH			
Tuning coils and antennas	4E1, 4D2, 4C65, 4B1, 3B1 ROD, TUB		4E1, 4D2, 4C65, 4B1, 3B1 ROD, TUB	
Wideband transformers	3E1, 3E4, 3E5, 3E6, 3E7, 3E27, 3E28, 3C81, 3C90 RM/I, P/I, E, ER, EFD, EP, Ring cores (T), MHB	3E1, 3E4, 3E5, 3E6, 3E7, 3E27, 3E28, 3C81, 3C90 RM/I, P/I, E, ER, EFD, EP, Ring cores (T)	3E1, 3E4, 3E5, 3E6, 3E7, 3E27, 3E28, 3C81, 3C90 RM/I, P/I, E, ER, EFD, EP, Ring cores (T)	

Domestic Appliances	Automotive Electronics	Measurement, Control, Scientific and Medical	Electric Tools	EMC services and Equipment
	3C81, 3E5, 3E6, 3E27	3C81, 3E5, 3E6, 3E27, 4C65		
	U, Ring cores (T)	U, Ring cores (T)		
		3E5, 3E6, 3E7, 3E27		
		Ring cores (T)		
3C81, 3C90, 3E27	3C81, 3C90, 3E27	3C81, 3C90, 3F3, 3E27	3C81, 3C90, 3E27	
Ring cores (T), E, ER, EP, EFD, RM/I, P/I	Ring cores (T), E, ER, EP, EFD, RM/I, P/I	Ring cores (T), E, ER, EP, EFD, RM/I, P/I	Ring cores (T), E, ER, EP, EFD, RM/I, P/I	
4C65, 4B1, 3B1, 4A11, 4A15, 3C11, 3E25, 3E5, 3E27, 3S1, 3S3, 3S4, 4S2	4C65, 4B1, 3B1, 4A11, 4A15, 3C11, 3E25, 3E5, 3E27, 3S1, 3S3, 3S4, 4S2	4C65, 4B1, 3B1, 4A11, 4A15, 3C11, 3E25, 3E5, 3E27, 3S1, 3S3, 3S4, 4S2	4C65, 4B1, 3B1, 4A11, 4A15, 3C11, 3E25, 3E5, 3E27, 3S1, 3S3, 3S4, 4S2	4C65, 4B1, 3B1, 4A11, 4A15, 3C11, 3E25, 3E5, 3E27, 3S1, 3S3, 3S4, 4S2
BD, BDW, BDS, WBS, WBC, CMS, ROD, TUB, MHC, BC, Cable shields, Ring cores (T)	BD, BDW, BDS, WBS, WBC, CMS, ROD, TUB, MHC, BC, Cable shields, Ring cores (T)	BD, BDW, BDS, WBS, WBC, CMS, ROD, TUB, MHC, BC, Cable shields, Ring cores (T)	BD, BDW, BDS, WBS, WBC, CMS, ROD, TUB, MHC, BC, Cable shields, IMP, Ring cores (T)	BD, BDW, BDS, WBS, WBC, CMS, ROD, TUB, MHC, BC, Cable shields, Ring cores (T)
		3D3, 3H3, 3C81, 3C90		
		RM, P		
		8E1, 8E2, 8E21, 8X1		
		BAR, PLT		
		3D3		
		PH		
	4B1, 3B1, 3C90	4E1, 4D2, 4C65, 4B1, 3B1		
	ROD, TUB	ROD, TUB		
	3E1, 3E4, 3E5, 3E6, 3E7, 3E27, 3E28, 3C81, 3C90	3E1, 3E4, 3E5, 3E6, 3E7, 3E27, 3E28, 3C81, 3C90		3E1, 3E4, 3E5, 3E6, 3E7, 3E27, 3E28, 3C81, 3C90
	RM/I, P/I, E, ER, EFD, EP, Ring cores (T)	RM/I, P/I, E, ER, EFD, EP, Ring cores (T)		RM/I, P/I, E, ER, EFD, EP, Ring cores (T)

Ferrite Ceramics

Materials and applications

Filter inductors (signal)

Ferrite filter inductors are used in combination with high quality capacitors in very stable and selective filters. The following design parameters are important for high quality filter inductors:

- low losses, high Q
- precise inductance
- high stability over periods of time
- fixed temperature dependence

The quality factor (Q) of a filter inductor should generally be as high as possible. For this reason filter materials such as 3H3 and 3D3 have low magnetic losses in their frequency ranges.

These materials also have controlled temperature factors (α_F) to compensate the negative temperature coefficients of the filter capacitors. The drift of permeability with time D_F (desaccomodation factor) is kept as low as possible in these filter materials. A recent application is in low-pass filters for ADSL. Since there is bias current, 3C81 or 3C90 are used because of their higher saturation level.

Ferrite choice	
frequency range	
< 300 kHz	*3H3, 3C81, 3C90*
300 kHz - 2 MHz	*3D3*

Wideband transformers

Pulse and signal transformers, also known as wideband transformers, are frequently used in communications systems and digital networks such as ISDN and XDSL.
They provide impedance matching and galvanic isolation and transform signal amplitudes. Signal power levels are usually low. To transmit analog signals or digital pulses with little distortion, good wideband characteristics are needed.
The principal functions of the transformer core are to provide optimum coupling between the windings, and a high inductance under pulse conditions.
To achieve this, high permeability ferrite materials such as 3E27, 3E4, 3E5, 3E6 and 3E7 are used. When there is a DC component in the signal it is often better to take a lower permeability grade such as 3E1 or the special DC-bias material 3E28. The trend is towards smaller and lower profile pulse transformers. With the increasing integration of digital electronics, magnetic components are becoming the biggest components on the PCB. Increasing the material permeability and using closed magnetic cores, like ring cores, are two ways to achieve miniaturization.
However, other cores are also widely used but with polished pole faces to eliminate the effect of the gap between core halves as much as possible.

Ferrite choice	
without DC	*3E4, 3E27, 3E5, 3E6, 3E7*
with DC	*3H3 3E1, 3E28*

Inductive delay lines

In many electronic devices it is necessary to delay pulses for a short, well defined time (some nano- or microseconds). One method of doing this is to pass the pulses through an inductor-capacitor network.
The inductance delays the rise of the current until the ferrite core saturates.

The delay time is determined by the saturation flux in the ferrite core and the applied voltage.

Requirements for the material are:

- high pulse permeability
- high saturation flux density

The main application area is in data processing. As the inductor should be as compact as possible, small ring cores are mostly used to avoid the degrading effect of the parasitic airgap.

Ferrite choice
3E27, 3E5, 3E6, 3E7

Proximity switches

Magnetic proximity switches generally consist of a PH core half and a winding on a coil former. This inductor is part of a tuned oscillator circuit. A magnetic flux protrudes in front of the core. When a conductive object moves into this stray flux, eddy currents start to flow in it, lowering the quality factor (Q) of the circuit. When this decreases below a critical level, the oscillator stops and the object is detected.
There are applications throughout industry in all sorts of mechanisations to detect positions of moving parts. The ferrite used should have a low loss level at the frequency of the oscillator. (e.g. 1 MHz), therefore an appropriate filter grade like 3D3 performs well.

As temperature stability must be resonably good, grades with controlled temperature behaviour are chosen. However, since the magnetic circuit is open this is not very critical. For a good detection range the Q of the circuit should be as high as possible. This Q-factor is controlled mainly by the resistance of the winding. Magnetic losses in the ferrite generally contribute less then 10% because of the open circuit.

Ferrite choice	
frequency range	
< 2 MHz	*3D3*

Typical mechanical and thermal properties

Property	MnZn ferrite	NiZn ferrite	unit
Young's modulus	(90 – 150) x 10^3	(80 – 150) x 10^3	N/mm^2
Compressive strength	200 – 600	200 – 700	N/mm^2
Tensile strength	20 – 65	30 – 60	N/mm^2
Vickers hardness	600 – 700	800 – 900	N/mm^2
Coefficient of linear expansion	(10 – 12) x 10^{-6}	(7 – 8) x 10^{-6}	K^{-1}
Specific heat	700 – 800	≈ 750	$Jkg^{-1}\ K^{-1}$
Thermal conductivity	(3.5 – 5.0) x 10^{-3}	(3.5 – 5.0) x 10^{-3}	$Jmm^{-1}s^{-1}\ K^{-1}$

The above figures are the average values measured on a wide range of commercially available MnZn and NiZn materials

Current transformers

A current transformer is used to measure or detect a current without making contact. A common example is a ring core with a winding around a current carrying wire. The magnetic field around the wire creates a flux in the ring core which leads to an output voltage directly proportional to the current in the winding.

In effect the wire acts as a one-turn primary for the current transformer. This principle is often used to measure currents in power converters, or to detect current in an earth-leak safety switch.
A split ring core or two U-core halves are used in applications such as oscilloscope measuring probes. The sensitivity of this type of transformer if largely controlled by the material permeability. So, depending on the current range, a high permeability grade is chosen. For AC the highest occuring frequency determines the choice of the material.

Ferrite choice

frequency range	
< 100 kHz	3E5, 3E6, 3E7
< 500 kHz	3E27
< 1 MHz	3B7, 3C81,3C90, 3F3
< 10 MHz	4C65

Core shapes

Ring cores	U cores

Driver transformers

In many electronic circuits, small tansformers are used to drive or trigger transistors, thyristors of MOSFETS. It is a convenient way to provide galvanic isolation and synchronisation or reversal of drive pulses.

Sometimes these transformers operate under low- signal conditions but in most cases they have to operate at high flux density. MOSFET gates have high capacitances and therefore require high currents to switch fast.

The choice of ferrite depends on these drive conditions and operating frequency. For low power the high permeability grades are suitable, more severe conditions require power materials.

Ferrite choice

low - level drive	3H3, 3B7, 3E1, 3E27
high - level drive	3C81, 3C90, 3F3

Ferrite Ceramics

Materials and applications

property	test conditions				filter inductors			wideband transformers						
symbol	f (khz)	$\hat{B}$ or H	T (°C)	unit	3D3	3H3	3B7	3E1	3E4	3E27	3E28	3E5	3E6[1)]	3E7[1)]
μ_i (±20%)	< 10	< 0.1mT	25	-	750	2000	2300	3800	4700	6000	4000	10000	12000	15000
tan δ/μ_i	10												≤ 10	≤ 10
	30					≤ 1.6						≤ 25	≤ 30	≤ 30
	100					≤ 2.5	≤ 5	≤ 20	≤ 20	≤ 15	≤ 5	≤ 75		
	300				≤ 10			≤ 150	≤ 150					
	500						≈ 25							
	1000	< 0.1mT	25	($x10^{-6}$)	≤ 30		≈ 120							
	3000													
	10000													
η_B	10	1.5-3 mT	25	$10^{-3}T^{-1}$				≤ 1.2	≤ 1			≤ 1	≤ 1	≤ 1
	100				≤ 1.8	≤ 0.6								
α_F	< 10	< 0.1mT	5 to 25	$10^{-6}K^{-1}$		0.7 ± 0.3								
			25 to 55			0.7 ± 0.3								
			25 to 70		1.5 ± 1	0.7 ± 0.3	0 ± 0.6							
D_F	10	< 0.1mT	25	($x10^{-6}$)	≤ 12	≤ 3	≤ 3.5	≤ 5	≤ 5					
	100													
B	10	250A/m	100	mT	≈ 260	≈ 250	≈ 300	≈ 200	≈ 210	≈ 250	≈ 260	≈ 210	≈ 210	≈ 210
		3000A/m	25		≈ 400	≈ 400	≈ 450	≈ 400	≈ 400	≈ 400	≈ 400	≈ 380	≈ 380	≈ 380
H_c	10		25	A/m	≈ 75	≈ 15	≈ 15	≈ 12	≈ 10	≈ 5	≈ 5	≈ 5	≈ 4	≈ 4
B_r	10		25	mT	≈ 150	≈ 70	≈ 150	≈ 100	≈ 100	≈ 100	≈ 100	≈ 80	≈ 100	≈ 100
T_c			25	°C	≥ 200	≥ 160	≥ 170	≥ 125	≥ 125	≥ 150	≥ 145	≥ 125	≥ 130	≥ 130
ρ	DC			Ω m	≈ 2	≈ 2	≈ 1	≈ 1	≈ 1	≈ 0.5	≈ 1	≈ 0.5	≈ 0.1	≈ 0.1
density				kg/m^3	≈ 4700	≈ 4700	≈ 4800	≈ 4800	≈ 4800	≈ 4800	≈ 4800	≈ 4900	≈ 4900	≈ 4900
ferrite type					MnZn	MnZn	MnZn	MnZn	MnZn	MnZn	MnZn	MnZn	MnZn	MnZn

Properties measured on sintered, unground ring cores of dimensions ∅25 x ∅15 x 10 mm which are not subjected to external stresses.

[1)] Measured on sintered, unground ring cores of dimensions ∅14 x ∅9 x 5 mm which are not subjected to external stresses.

Products generally comply with the material specification. However deviations may occur due to shape, size and grinding operations etc.
Specified product properties are given in the data sheets or product drawings.

property	test conditions				general purpose transformers and inductors		
symbol	f (khz)	$\hat{B}$ or H	T (°C)	unit	3C81	3C90	3F3
μ_i (±20%)	≤ 10	≤ 0.1mT	25		2700	2300	1800
B	10	250A/m	100	mT	≈ 330	≥ 340	≥ 330
		3000A/m	25		≈ 450	≈ 450	≈ 450
H_c	10		25	A/m	≈ 15	≈ 15	≈ 15
B_r	10		25	mT	≈ 110	≈ 170	≈ 150
Pv	25	200 mT	100	kW/m^3	≤ 185	≤ 80	
	100	100 mT				≤ 80	≤ 80
	100	200 mT				≈ 450	
	400	50 mT					≤ 150
	500	50 mT					
	500	100 mT					
	1000	30 mT					
	3000	10 mT					
	10000	5 mT					
T_c				°C	≥ 210	≥ 220	≥ 200
ρ	DC			Ω m	≈ 1	≈ 5	≈ 2
density				kg/m^3	≈ 4800	≈ 4800	≈ 4750
ferrite type					MnZn	MnZn	MnZn

Properties measured on sintered, unground ring cores of dimensions ∅25 x ∅15 x 10 mm which are not subjected to external stresses.

[1] average values

Products generally comply with the material specification. However deviations may occur due to shape, size and grinding operations etc. Specified product properties are given in the data sheets or product drawings.

Ferrite Ceramics

Materials for EMI-suppression

property	conditions				EMI-suppression			
symbol	f (MHz)	B̂ or H	T (°C)	unit	3S1	3S3	3S4	4S2
μ_i	≤ 0.01	≤ 0.1mT	25		≈ 4000	≈ 350	≈ 1700	≈ 700
$\lvert Z \rvert$ [1)]	1	≤ 0.1mT	25	Ω	≥ 30			
	3						≥ 25	
	10				≥ 60			
	30					≥ 25	≥ 60	≥ 50
	100					≥ 60	≥ 80	
	300					≥ 100	≥ 90	≥ 90
B	≤ 0.01	250A/m	100	mT	≈ 180	≈ 250	≈ 140	≈ 180
		3000A/m	25		≈ 400	≈ 350	≈ 350	≈ 350
H_c	0.01		25	A/m	≈ 10	≈ 60	≈ 20	≈ 30
B_r				mT	≈ 120	≈ 230	≈ 170	≈ 120
T_c				°C	≥ 125	≥ 225	≥ 110	≥ 125
ρ	DC		25	Ω m	≈ 1	≈ 10^4	≈ 10^3	≈ 10^5
density				kg/m^3	≈ 4900	≈ 4800	≈ 4800	≈ 5000
ferrite type					MnZn	MnZn	MnZn	NiZn

Products generally comply with the material specification. Deviations may occur due to shape, size and grinding operations etc. Specified product properties are given in the data sheets or product drawings.

Properties measured on sintered, non ground ring cores of dimensions ∅25 x ∅15 x 10 mm which are not subjected to external stresses.
1) Measured on a bead ∅5 x ∅2 x 10 mm

EMI-suppression

The task of an Electro Magnetic Interference filter is to block high frequency noise, while allowing the signal to pass with negligible attenuation. In principle, an EMI-filter is a low-pass filter. In some cases, like in complete mains filters, inductive components (L) and capacitors (C) are combined to form an LC circuit. Near the frequency of parallel resonance high impedance levels are obtained to block major interference signals. Often only a ferrite component is added to the circuit.

Suppression beads and wideband chokes show high impedance levels over a wide frequency range caused by ferrimagnetic resonant losses in the ferrite material. Our range of S materials was developed for maximum impedance to cover the frequency range up to 1 GHz.

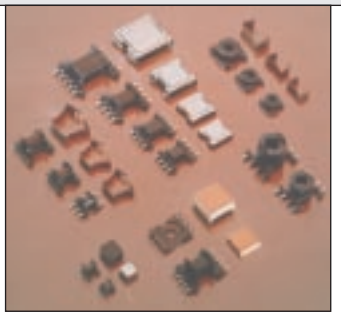
frequency range	
< 30 MHz	*3S1*
30 MHz - 1000 MHz	*3S3, 3S4, 4S2*

Our bobbins and our clips…
…your basis for perfect windings

The components you use can affect the quality of your products. Every individual part of an assembly may influence the reliability or performance, so choosing the best is not just important, it's essential – particularly with critical wound components. The cores, bobbin and windings depend on the integrity of each other to operate as an effective functional component.

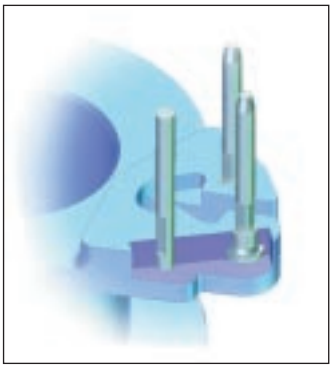
Philips Components makes ferrite cores to meet exacting requirements. And to ensure a perfect winding every time, the Bobbins & Accessories Group manufactures and supplies precision bobbins and support products. The bobbins are designed for perfect windings and zero-defect mounting on and in printed circuit boards. The materials and surface treatments we use withstand the insertion forces and high temperatures of assembly and soldering. We have a full range of multifunctional bobbins and accessories for surface-mount and through-hole wound components.

In addition to our bobbins, we have an extensive range of mounting clips. Our clips, both for through-hole and surface-mount wound components, provide a clean and easy way of assembling the individual parts to a functional component. The materials and surface treatments used in our clips are carefully selected and ensure an even clamping force over the lifetime of the component. As well as providing industry-standard clipping solutions, we have a range of specific clips, where the function of a multiple part clip has been replaced by a single clip. So, providing you with the best assemblyfriendly and cost-effective solution where possible.



Our design expertise…
…your key to a total solution

Our standard product ranges cover most applications, but we can also design a part to meet your specific requirements. Our engineers have unparalleled experience in designing and engineering products in record time, drawing on the extensive production technology and materials engineering expertise available within Philips. Utilizing the latest full 3D CAD system we are ensuring the shortest possible time to market.



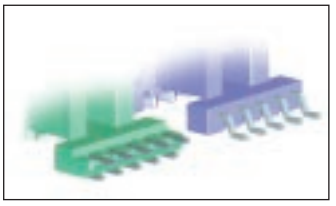
Our technological competence…
…your access to quality products

We have developed and refined different production processes to enable us to make bobbins with their own specific characteristics and properties. There are two printed circuit board mounting technologies (through-hole and surface-mount), and for each we have two separate production techniques.

Pin through-hole technology (mounted in the PCB)

- In-moulded pins – specially shaped pins are inserted in the mould prior to injection, so that when the material flows around them, 100 per cent fixation is guaranteed. This in turn, ensures excellent positioning and fixation in the PCB. The pins have a square-shaped base to prevent the wire slipping during wrapping.

- Post-inserted pins – a two-step production process involving the insertion of the pins after the plastic part has been moulded. Depending on the application, round- or square-section wires are used for the pins. This is the more cost-effective through-hole bobbin manufacturing technique.



Surface-Mount Device technology (mounted on the PCB)

- Gullwing-shaped pins – another 'in-moulding' process similar to that described above but employing a leadframe. Once the moulding has taken place, the redundant leadframe metal is cut off, leaving the gullwing pins protruding from the bobbin.
- C-shaped pins – a 'C-shaped' pin makes the bobbin easier to wind, so our SMD bobbins are usually made this way. C-pins are also thicker and wider than most gullwing pins, and therefore stronger.

Design innovation

Metal pick-and-place caps for SMD bobbins, for example, combine both the fixing and pick-and-place functions in a single clamp. This reduces the total number of parts from three to one. The C-shaped pin construction has mechanical advantages too, as it separates the wire termination function from electrical connection, and so ensuring excellent coplanarity.

Our choice of materials…
…your assurance of conformity

When selecting materials for our products, the design, production process, electrical- and mechanical requirements are important factors. But above all, we aim for optimum performance at an acceptable price. Many materials are used, ranging from industry-standard polyamide (PA) to the more exotic liquid crystal polymers (LCP) and thermosetting phenolic materials (PF).

Meeting today's standards

- Underwriter Laboratories (UL) compliance – all polymeric materials used in our bobbins and accessories are tested and in full compliance with UL.
- Environmental acceptance – as part of our ISO 14001 certification, all materials are screened and shown to be free from banned substances according to agreed Philips standards.

Matching materials to special requirements

- Smaller surface-mount bobbins – are made from high-performance thermoplastic LCP.
- Larger bobbins – are made from thermosetting materials because thick winding wires require extra mechanical stability at high soldering temperatures.
- Square section pins – help reduce the number of wrappings needed to secure copper wires to the pins.

Ferrite Ceramics

Bobbins & Accessories

Core Type	Pin Through-Hole (PTH)	Surface-Mount Device (SMD)	Specials
E (EF)	 Sizes: E13, 16, 20, 30, 32, 42, 55, 65 Clips and Clasps available for most products	 Sizes: E5.3, 6.3, 8.8, 13, 16 Multi-section, Caps and Clips available	 Sizes: E16, 20 High insulation two pieces male/ female bobbins
EFD	 Sizes: EFD15, 20, 25, 30 15 and 20 L-pin, low build height	 Sizes: EFD10, 12, 15, 20 One piece pick and place metal Covers/ Clamps, C-pin design	
ETD	 Sizes: ETD29, 34, 39, 44, 49, 54, 59 Complete range in-moulded pins. Clips available		 Sizes: ETD34 Two pieces male/female high insulation factor in-moulded pins
EP	 Sizes: EP7, 10, 13, 17, 20 All phenolic parts, both single Clips and Clasps/ Springs available	 Sizes: EP7, 10, 13 Single Clips, C-pins phenolic version	
ER		 9.5, 11, 14.5 Gullwing pin type in high performance thermoplastic. Clamps available	
RM	 Sizes: RM4, 5, 6, 7, 8, 10, 12, 14 Clips available, both in-moulded and post-inserted pin versions	 Sizes: RM4, 5, 6 Both phenolic and thermoplastic types, multi-section, low profile Clips available	 Sizes: RM4, 5, 6, 8, 10, 14 In-moulded L-pin version for easy winding
P + PQ	 Sizes: P11, 14, 18, 22, 26, 30, 36, 42 Multi-section, complete range of Bobbins, Tag-plates, Springs, Containers. High stability assembled product		 Sizes: PQ20, 26, 32, 35 L-pin post-inserted versions in high performance thermo-plastic material
Special Products		 Sizes: T9 Cover and Tagplate, C-pin version	 Custom Designs for all core types
Special Products	 Sizes: E16, 20 High insulating and coupling factor. Robust design in phenolic material.	 Sizes: FRM9,11.5 C-pin version in high performance thermo-plastic material.	 Sizes: E14, 18, 22 Range of Clamps available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Ferrite Ceramics

Integrated Inductive Components (IIC)

For the majority of today's designs it is desirable to have low profile inductive components. The new Integrated Inductive Component (IIC) is such a device.
This product consists of a rectangular ferrite sleeve with an inserted copper lead frame. This sleeve is pressed in one piece although the slot is only 0.75 mm high. The lead frame is surrounded by a moulding of a high tech resin to keep the leads together and to insulate them from the ferrite core. After insertion the leads are bent in a so-called gull wing shape to form contact pads, just like with most standard SMD ICs.

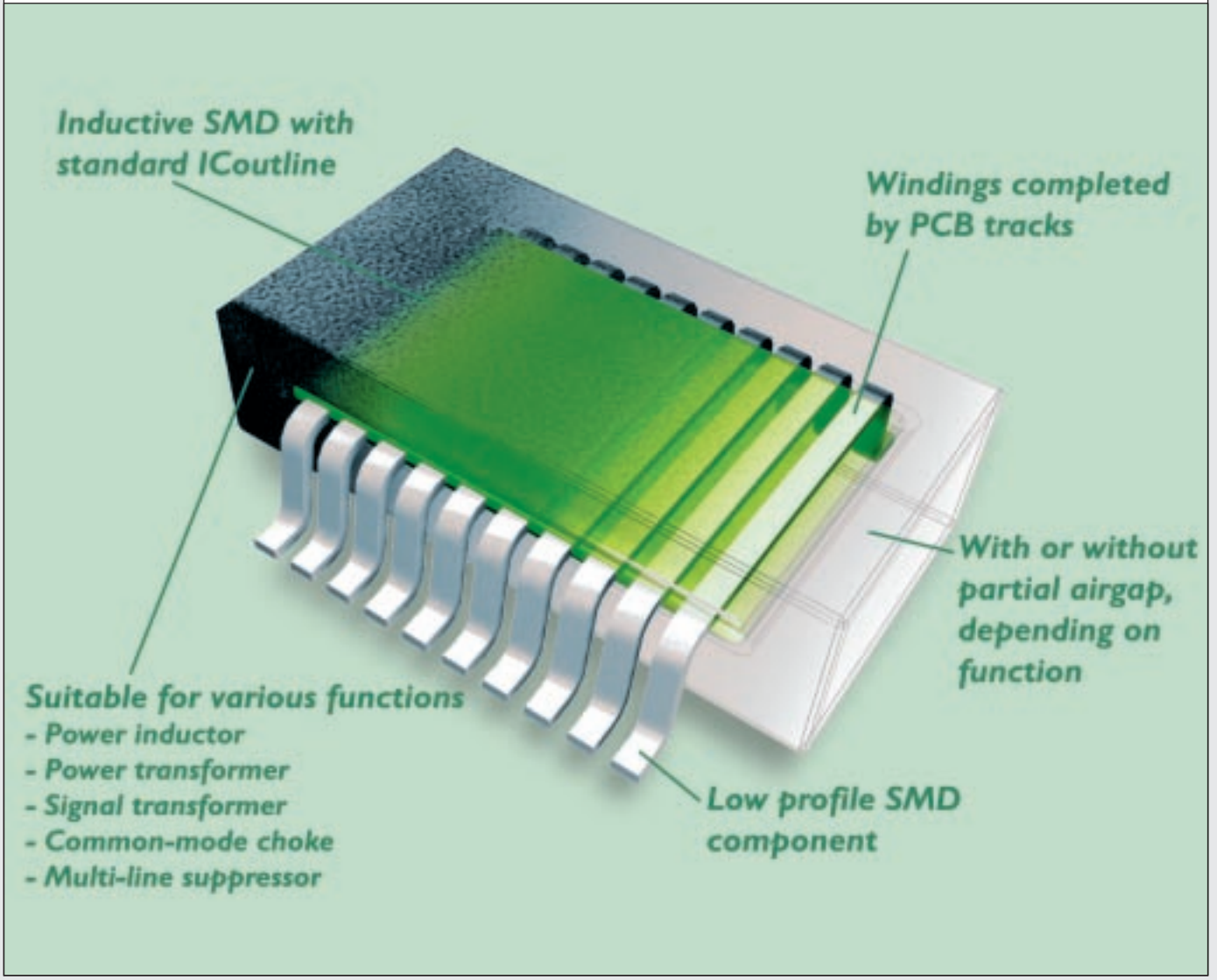
In fact, the finished product really looks like an IC from the outside. It closely resembles the SOT outline and can be handled by standard pick and place equipment as well as soldered together with other ICs on the board.

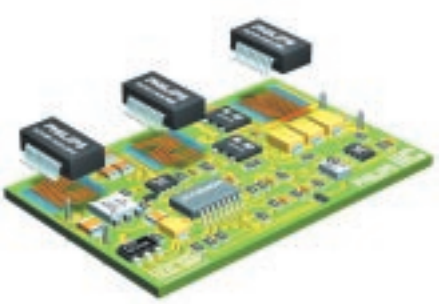
The leads in the moulding form one half of a winding which is completed by a track on the PCB. In this way, depending on the PCB layout, one or more windings with up to 10 turns in total can be constructed.

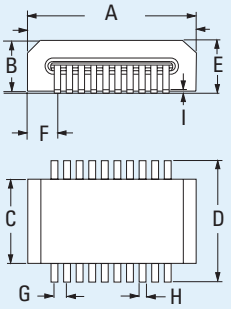
The IIC design can perform several magnetic functions. For signal transformers (pulse or wideband) it is important to have a high primary inductance. This level controls low frequency performance. Our high permeability material 3E6 helps to reach the required levels in spite of the low number of turns. Required low leakage inductances can be obtained by means of a bifilar winding configuration. IIC10 is not suitable if a safety barrier is required.
In 3S4 material it performs well as multi-line suppressor for up to 10 lines.

Summary:

- Inductive SMD component that looks like a standard IC outline (SOT).
- Windings are completed by PCB tracks.
- Automatic placement and soldering together with other ICs on the board.
- Suitable for reflow soldering.
- Wide range of magnetic functions can be realized with the same product, depending on track layout.
- Superior physical properties.
- Available in standard EIA and EIAJ tape-and-reel.
- Operating temperature -55°C to +150°C.

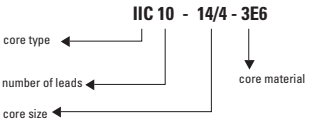






Core type		IIC10-14/4
effective core parameters	core factor Σ l/A(mm^{-1})	2.47
	eff. volume V_e (mm^3)	338
	eff. length l_e (mm)	28.9
	eff. area A_e (mm^2)	11.7
	min. area A_{min} (mm^2)	11.7
	mass of core set (g)	≈ 1.85
dimensions (mm)	A	14.4 ± 0.2
	B	4 ± 0.08
	C	7.2 ± 0.15
	D	10.45 max
	E	4.38 max
	F	2.7 ± 0.2
	G	1.0
	H	0.6 max
	I	0.3

type number	AL (nH) at B ≤ 0.1 mT, f ≤ 10 kHz, T = 25°C	$\|Z\|_{typ}$ (Ω) at 100 MHz for 1 turn, T = 25°C
IIC10-14/4-3E6 des	6000 ± 30%	-
IIC10-14/4-3S4 des	-	≈ 35



Ferrite Ceramics

Multilayer Suppressors (MLS)

Applications

Multilayer suppressors are a powerful solution for EMI/RFI attenuation for electronic equipment. Supplied in four standard sizes (0603, 0805, 1206 and 1806), they have impedances between 30 and 1000 Ω at 100MHz.

When installed in series with signal and/or power circuits, high frequency noise is suppressed. There is no need for ground termination, which makes these devices very suitable for circuits with difficult ground.
Typical suppression frequencies range from 10MHz to 1000MHz and rated currents are between 0.1 and 0.6 A.

Multilayer suppressors are specially designed to reduce noise in low impedance circuits while keeping the signal free from distortion. This is because at the interfering frequencies these components behave resistive. The high frequency noise is converted into heat rather than reflected to the source. This dissipation prevents ringing and parasitic oscillations.

These characteristics can be used for many different purposes:

- Absorption of generated noise.
- In digital signals from high speed clock oscillators, for filtering and wave-shape correction.
- Prevention of high frequency interference entering circuit electronics.

Product Construction

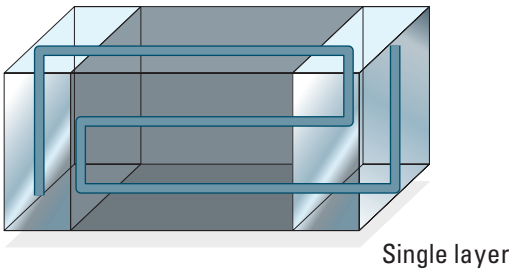
The use of silver for electrodes and terminations in multilayer suppressors ensures high electrical conductivity, which minimizes heat generation and cross talk.

The internal construction can be single layer or multilayer, depending on impedance requirements. Single layer products have a 'meander' design and are suitable for lower impedances, while multilayer types have alternating layers of ferrite and conductor piled up to achieve higher impedance levels.

The terminal electrode forms a conductive connection to the circuit. It is formed by three layers:

- Silver: for a good conductivity
- Nickel: protects silver termination against leaching
- Tin-lead: applied to insure good solderability

The products are suitable for both reflow and wave soldering.



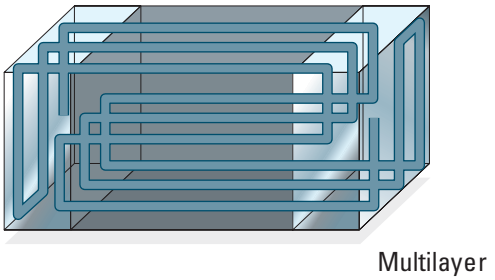


Fig.1 Internal structure of Multilayer Suppressors

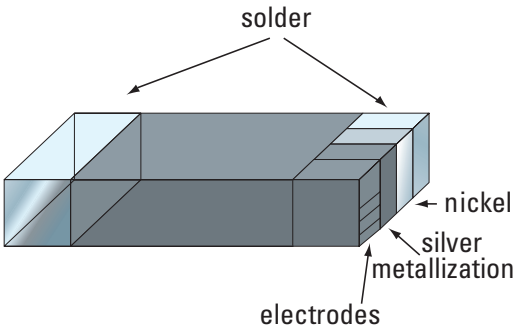
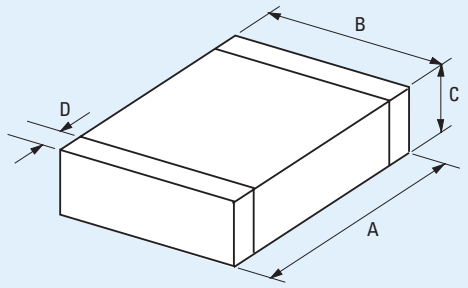


Fig.2 Structure of electrodes.



Size	A (mm)	B (mm)	C (mm)	D (mm)	Weight (mg)
0603	1.60 ± 0.15	0.80 ± 0.15	0.74 ± 0.15	0.36 ± 0.15	≈ 5
0805	2.00 ± 0.20	1.25 ± 0.20	0.90 ± 0.20	0.51 ± 0.25	≈ 11
1206	3.20 ± 0.20	1.60 ± 0.20	1.10 ± 0.20	0.51 ± 0.25	≈ 28
1806	4.50 ± 0.25	1.60 ± 0.25	1.60 ± 0.25	0.61 ± 0.25	≈ 55

type number	size	Z@100MHz	R_{DC} max (Ω)	I max (mA)
MLS0603-4S7-600 des	0603	60	0.4	300
MLS0603-4S7-101 des	0603	100	0.7	200
MLS0603-4S7-121 des	0603	120	0.8	200
MLS0603-4S7-151 des	0603	150	0.9	200
MLS0603-4S7-301 des	0603	300	1.2	150
MLS0603-4S7-601 des	0603	600	1.8	150
MLS0603-4S7-102 des	0603	1000	2.0	100
MLS0805-4S4-300 des	0805	30	0.1	600
MLS0805-4S4-600 des	0805	60	0.2	400
MLS0805-4S7-121 des	0805	120	0.3	300
MLS0805-4S7-301 des	0805	300	0.3	200
MLS0805-4S7-601 des	0805	600	0.6	200
MLS0805-4S7-102 des	0805	1000	0.8	150
MLS1206-4S4-300 des	1206	30	0.1	600
MLS1206-4S4-700 des	1206	70	0.2	400
MLS1206-4S4-900 des	1206	90	0.2	400
MLS1206-4S4-121 des	1206	120	0.2	300
MLS1206-4S4-601 des	1206	600	0.4	200
MLS1206-4S7-102 des	1206	1000	0.6	150
MLS1806-4S4-800 des	1806	80	0.1	600
MLS1806-4S4-151 des	1806	150	0.2	500

MLS0603 - 4S7 - 600

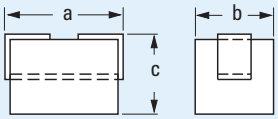
- core type
- core size
- core material
- impedance
  - first 2 digits are significant
  - last digit is number of zeros
  - examples:
    - 600 - 60
    - 101 - 100
    - 121 - 120
    - 151 - 150
    - 301 - 300
    - 102 - 1000

- R_{DC}: resistance of component for DC current
- Maximum rated current: measure of current capacity of the component. When the maximum rated current is applied, temperature rise shall not exceed 20°C
- Standard tolerance on impedance is ±25%
- Other tolerances or electrical specifications can be provided upon request
- Operating temperature: -55°C - +125°C

Ferrite Ceramics

Beads and Chokes

SMD beads



BDS3/1.8/5.3-3S1		
a	b	c
5.3 ± 0.35	3.05 ± 0.15	1.8 max
$\|Z\|_{typ}$ = 28 Ω (10 MHz)		

BDS3/1.8/5.3-4S2		
a	b	c
5.3 ± 0.35	3.05 ± 0.15	1.8 max
$\|Z\|_{typ}$ = 38 Ω (100 MHz)		

BDS3/3/4.6-3S1		
a	b	c
4.6 ± 0.3	3.05 ± 0.15	3 max
$\|Z\|_{typ}$ = 45 Ω (10 MHz)		

BDS3/3/4.6-4S2		
a	b	c
4.6 ± 0.3	3.05 ± 0.15	3 max
$\|Z\|_{typ}$ = 50 Ω (100 MHz)		

BDS3/3/8.9-3S1		
a	b	c
8.9 ± 0.35	3.05 ± 0.15	3 max
$\|Z\|_{typ}$ = 80 Ω (10 MHz)		

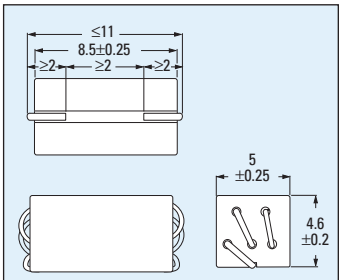
BDS3/3/8.9-4S2		
a	b	c
8.9 ± 0.35	3.05 ± 0.15	3 max
$\|Z\|_{typ}$ = 100 Ω (100 MHz)		

BDS4.6/3/8.9-4S2		
a	b	c
8.9 ± 0.35	4.6 ± 0.3	3 max
$\|Z\|_{typ}$ = 100 Ω (100 MHz)		

Our range of SMD beads replace the well known beads on wire in applications where SMD components are required.
They consist of a rectangular ferrite body and a lenght of flat copper wire, which is inserted through the ferrite and bent around to form two solder pads. The wire is presoldered and complies with solderability test TA (method 1) in IEC 68-2-58 part 2.

Taping method IEC 286-3 and 481-1.

SMD wide band chokes



WBS1.5-5/4.8/10-3S4
$\|Z\|_{typ}$ = 230 Ω (10 MHz)

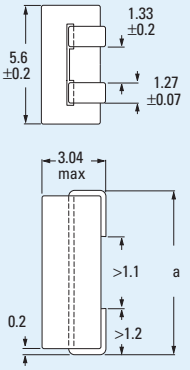
WBS1.5-5/4.8/10-4B1
$\|Z\|_{typ}$ = 500 Ω (100 MHz)

WBS2.5-5/4.8/10-3S4
$\|Z\|_{typ}$ = 300 Ω (10 MHz)

WBS2.5-5/4.8/10-4B1
$\|Z\|_{typ}$ = 850 Ω (100 MHz)

The design of this product is based on our well known range of through-hole wide-band chokes. In these products the conductor wire is wound through holes in a multi-hole ferrite core, thus separating them physically and reducing coil capacitance. The result is a high impedance over a wide frequency range, a welcome feature for many interference problems. The present SMD design preserves the excellent properties and reliability of the original wide-band chokes by keeping the number of electrical interfaces to an absolute minimum.

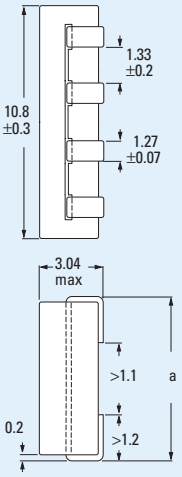
SMD common mode chokes



CMS2-5.6/3/4.8-4S2
a = 4.75 ± 0.3 mm
$\|Z\|_{typ}$ = 35 Ω (100 MHz)

CMS2-5.6/3/8.9-4S2
a = 8.9 – 0.5 mm
$\|Z\|_{typ}$ = 60 Ω (100 MHz)

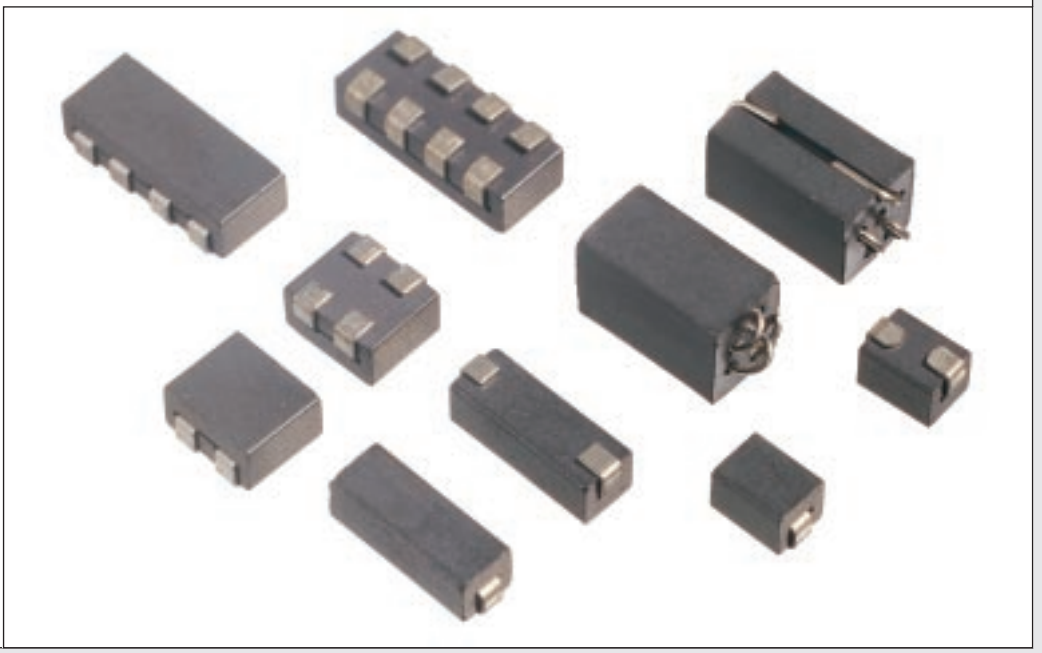
In SMD Common mode chokes 2 or 4 conductors within a single soft-ferrite block are connected along their lengths by an air gap. Common-mode signals - interference signals passing in the same direction along the input and output channels of a device (a IC for instance) - reinforce the magnetic flux around both conductors, and are therefore attenuated. In contrast, the wanted signal passing along the input and



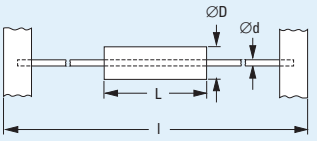
CMS4-11/3/4.8-4S2	
a = 4.75 ± 0.3 mm	
inner channel	$\|Z\|_{typ}$ = 23 Ω (100 MHz)
outer channel	$\|Z\|_{typ}$ = 30 Ω (100 MHz)

CMS4-11/3/8.9-4S2	
a = 8.9 – 0.5 mm	
inner channel	$\|Z\|_{typ}$ = 45 Ω (100 MHz)
outer channel	$\|Z\|_{typ}$ = 60 Ω (100 MHz)

output channels cancel the flux around the conductors and therefore passes unattenuated.



beads on wire

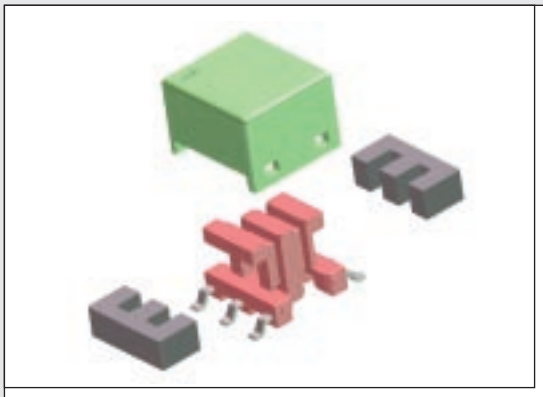


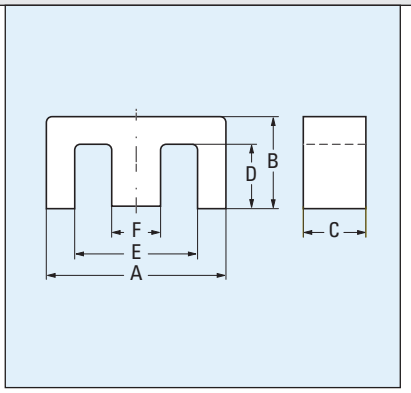
type number	dimensions				$\lvert Z \rvert_{typ}$ (Ω) at 100 MHz
	D	L	l	d	
BDW3.5/3.5-3S4	3.5 ± 0.2	3.5 − 0.5	64.4	0.64	43
BDW3.5/6-3S4-L63	3.5 ± 0.2	6.0 ± 0.25	75.4	0.64	100
BDW3.5/3.5-4S2	3.5 ± 0.2	3.5 − 0.5	64.4	0.64	58
BDW3.5/4.7-4S2	3.5 ± 0.2	4.7 − 0.5	64.4	0.64	75
BDW3.5/5.3-4S2	3.5 ± 0.2	5.25 ± 0.25	64.4	0.64	82
BDW3.5/6-4S2	3.5 ± 0.25	6.0 ± 0.25	64.4	0.64	100
BDW3.5/6.7-4S2	3.5 ± 0.2	6.7 ± 0.25	64.4	0.64	110
BDW3.5/7.6-4S2	3.5 ± 0.2	7.6 ± 0.35	64.4	0.64	131
BDW3.5/8.9-4S2	3.5 ± 0.2	8.9 ± 0.35	64.4	0.64	146
BDW3.5/9.5-4S2	3.5 ± 0.25	9.5 ± 0.3	64.4	0.64	150
BDW3.5/11-4S1	3.5 ± 0.25	11.4 ± 0.4	64.4	0.64	180
BDW3.5/14-4S1	3.5 ± 0.25	13.8 ± 0.5	64.4	0.64	220

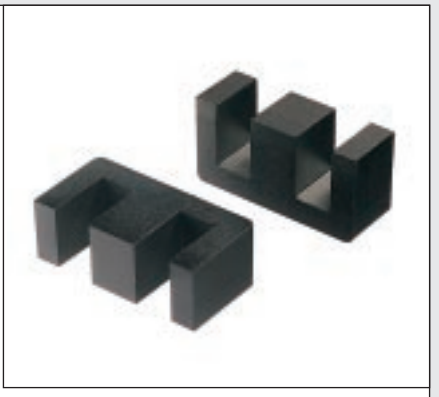
Beads-on-wire are suitable to suppress unwanted signals between parts of a PCB. They consist of a suppression bead fixed on a length of wire and taped on a bandolier. The bandolier fits most commonly used automatic mounting machines.
The tape complies to tape standards IEC 286 part 1 and EIA-RS-96-D.

Ferrite Ceramics

E cores (IEC 1246)







The shape of E cores is derived from the classical iron sheet lamination cores. For the original E range in fact the dimensions of the existing lamination range were taken so that already commercially available coil formers and mounting hardware could be used. The former EF range has been optimized for the use of ferrite as a core material. Cross sections were rearranged resulting in a homogenious magnetic flux density in the core and more space for the windings. Main use is as power transformer or choke in SMPS. E cores have a simple shape and can therefore be produced more economically than more complicated cores.

A drawback is the rectangular cross-section of the centre pole which makes it more difficult to wind, especially with heavy wires. Also the structure of the core is rather open resulting in stray flux sometines causing interference problems.

Summary:

- simple, economic shape
- square cross-section, not easy for heavy wires
- large effective ferrite area
- low magnetic self shielding

	Core type (old core description)	E5.3/2.7/2	E6.3/2.9/2	E8.8/4.1/2
effective core parameters	core factor Σ l/A(mm^{-1})	4.70	3.67	3.13
	eff. volume V_e (mm^3)	33.3	40.6	78
	eff. length l_e (mm)	12.5	12.2	15.6
	eff. area A_e (mm^2)	2.66	3.3	5.0
	min. area A_{min} (mm^2)	2.63	2.6	3.6
	mass of core half (g)	≈ 0.08	≈ 0.12	≈ 0.25
dimensions (mm)	A	5.25 ± 0.1	6.3 - 0.25	9 ± 0.4
	B	2.65 ± 0.05	2.9 - 0.1	4.1 – 0.2
	C	2.0 - 0.1	2.0 - 0.1	2.0 – 0.2
	D	1.9 + 0.15	1.85 + 0.1	2.03 + 0.32
	E	3.8 + 0.2	3.6 + 0.2	5.2 ± 0.13
	F	1.4 - 0.1	1.4 - 0.1	1.9 ± 0.12
coil formers	CP			
	CPH			
	CPHS	1S - 4P 1S - 6P 2S - 4P 2S - 6P	1S - 4P 1S - 6P 2S - 4P 2S - 6P	
	CPV			
	CSH			
mounting parts	CLM	■		
	CLA			
	CLI			
	SPR			
	COV	■	■	

Core type		E5.3/2.7/2	E6.3/2.9/2	E8.8/4.1/2
high μ HALVES	3E1		700	
	3E5	1400	1700	
	3E6	1600	2100	2500 prot

1950 — ungapped core half. A_L = 1950 nH measured in combination with another ungapped core half.

A_L value (nH) measured at $\hat{B} \leq 0.1$ mT, $f \leq 10$ kHz, T = 25°C

A_L tolerance: ± 25% | + 40% / − 30%

E 5.3/2.7/2 - 3E5

- core type
- core size
- core material

C S H S - E5.3/2.7/2 - 1S - 10P - X

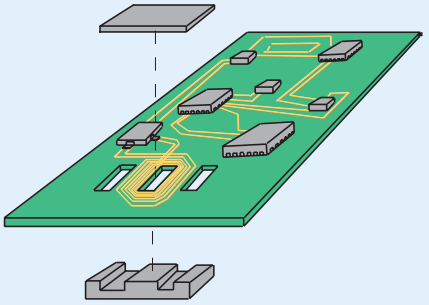
- coil former (bobbin)
- special version
- plastic material type: P- thermoplastic S- thermoset
- associated core type
- number & type of pins D - dual termination F - flat L - long
- mounting orientation: H- horizontal V- vertical
- number of sections
- mounting type: S- surface mount

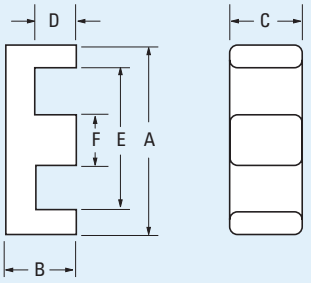
CLM - E5.3/2.7/2

- hardware type CLM - clamp CLA - clasp SPR - spring CLI - clip
- associated core type

Ferrite Ceramics

Planar E cores





E core (E)

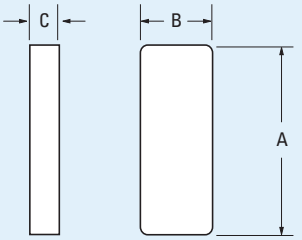


plate (PLT)

Planar magnetics offer an attractive alternative to conventional core shapes when a low profile of magnetic devices is required. Basically this is a construction method of inductive components whose windings are fabricated using printed circuit tracks or copper stampings separated by insulating sheets or constructed from multilayer circuit boards. These windings are placed in low profile ferrite EE- or E-PLT combinations. Planar devices can be constructed as stand alone components or 'integrated' into a multilayer mother board with slots for the ferrite E-core.

Principal advantages of planar magnetics are:

- Low profile construction
- Low leakage inductance
- Excellent repeatability of parasitic properties
- Ease of construction and assembly
- Cost effective
- Greater reliability
- Excellent thermal characteristics, easy to heatsink.

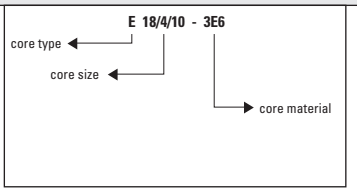
The Philips range of planar E cores are all made from press tooling. This gives the advantage of radiused corners and edges. It also means that clamp recesses can be incorporated.

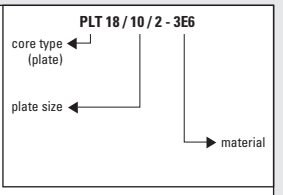
Core type	dimensions (mm)						effective core parameters				
	A	B	C	D	E	F	core factor Σ l/A (mm^{-1})	eff. volume V_e (mm^3)	eff. length l_e (mm)	eff.[1] area A_e (mm^2)	mass of core half (g)
E14/3.5/5 (E-E combination)	14 ± 0.3	3.5 ± 0.1	5 ± 0.1	2 ± 0.1	11 ± 0.25	3 ± 0.05	1.43	300	20.7	14.5	≈ 0.6
PLT14/5/1.5 (E-PLT combination)	14 ± 0.3	5 ± 0.1	1.5 ± 0.05	-	-	-	1.16	240	16.7	14.5	≈ 0.5
E18/4/10 (E-E combination)	18 ± 0.35	4 ± 0.1	10 ± 0.2	2 ± 0.1	14 ± 0.3	4 ± 0.1	0.616	960	24.3	39.5	≈ 2.4
PLT18/10/2 (E-PLT combination)	18 ± 0.35	10 ± 0.2	2 ± 0.05	-	-	-	0.514	800	20.3	39.5	≈ 1.7
E22/6/16 (E-E combination)	21.8 ± 0.4	5.7 ± 0.1	15.8 ± 0.3	3.2 ± 0.1	16.8 ± 0.4	5 ± 0.1	0.414	2550	32.5	78.5	≈ 6.5
PLT22/16/2.5 (E-PLT combination)	21.8 ± 0.4	15.8 ± 0.3	2.5 ± 0.05	-	-	-	0.332	2040	26.1	78.5	≈ 4

[1] $A_{min} = A_e$

Core type		E14/3.5/5	E18/4/10	E22/6/16
Matching plates		PLT14/5/1.5	PLT18/10/2	PLT22/16/2.5
high μ halves	3E6 des	5600 / 6400	13500 / 15500	22000 / 26000

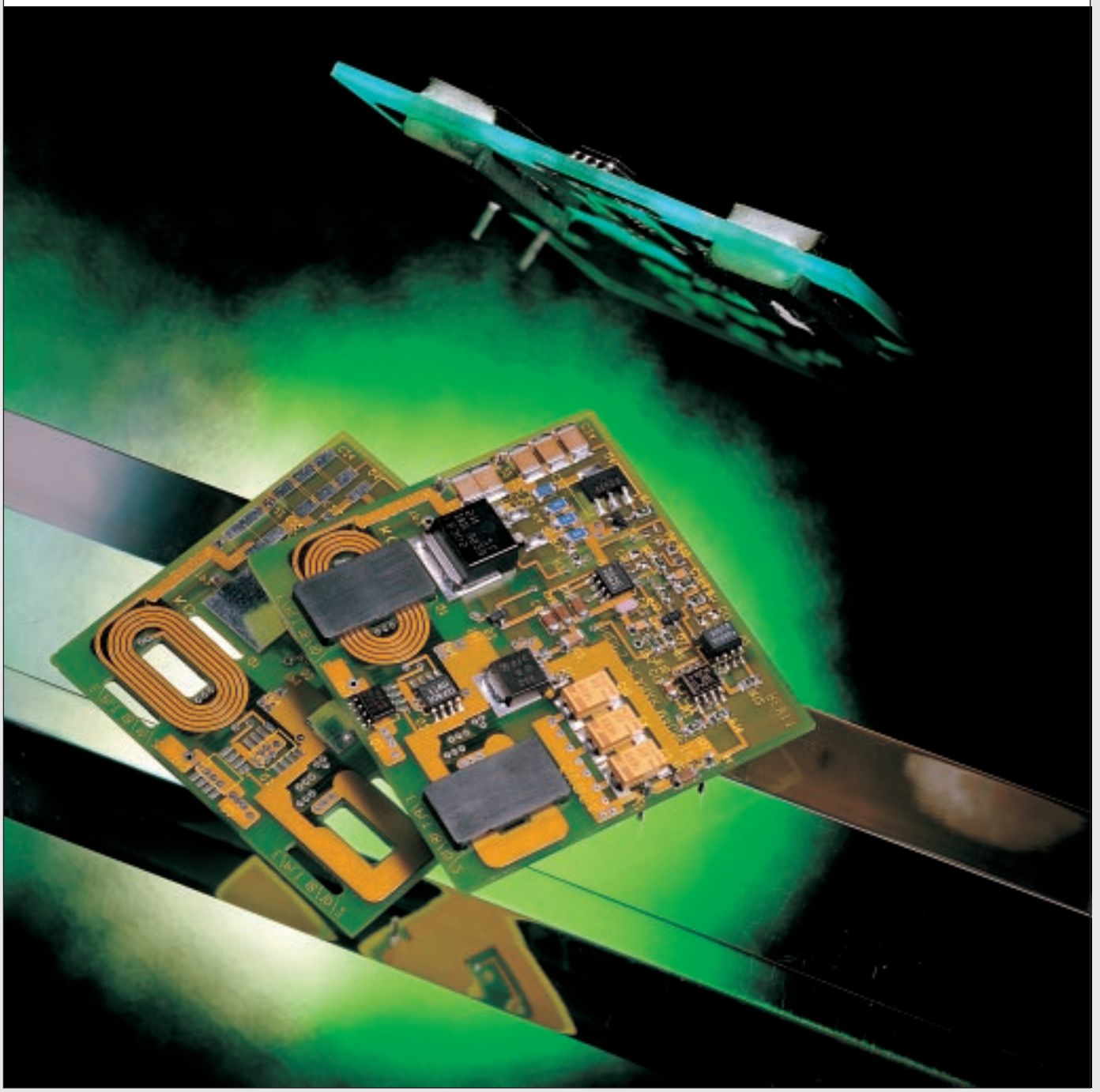
1100/1300 — ungapped core half. A_L = 1100/1300 nH measured in combination with an ungapped half / plate.





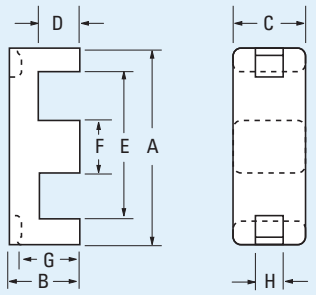
A_L value (nH) measured at $\hat{B} \leq 0.1$ mT, f ≤ 10 kHz, T = 25°C

A_L tolerance: + 40% / − 30%



Ferrite Ceramics

Planar E cores with recess



E core with recess

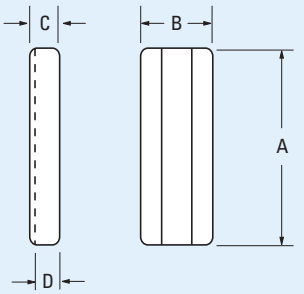


plate with slot (PLT/S)

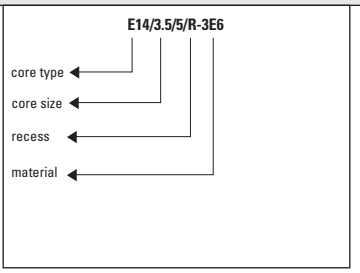
For those customers not in favor of glueing we developed a new range of planar E cores with matching plates and metal clamps. These cores can easily be mounted together with the PCB winding without the use of any glue. The E cores have recesses (E/R) to prevent the clamp from slipping off. The plates have slots (PLT/S) to limit any sideways movement during vibrations or shocks.
This clamping method is only available for E-PLT-combinations, not for EE-combinations. It is particularly suitable for the cores in high permeability materials like 3E6. Any glue on the mating faces would potentially degradel the high A_L value of these core assemblies. Planar cores in high μ material 3E6 are recommended for use in common mode input filters or in wideband transformers.

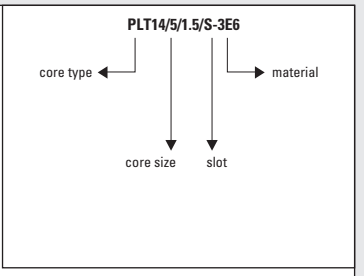
Summary:

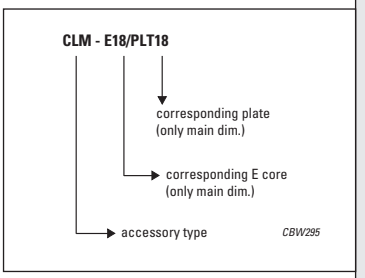
- no glue necessary
- plate with slot to prevent sideways movement
- no A_L reduction of high permeability cores due to glue on the mating faces

	Core type	E14/3.5/5/R	PLT14/5/1.5/S (E-PLT combination)	E18/4/10/R	PLT18/10/2/S (E-PLT combination)	E22/6/16/R	PLT22/16/2.5/S (E-PLT combination)
effective core parameters	core factor Σ l/A(mm^{-1})	-	1.15	-	0.498	-	0.324
	eff. volume V_e (mm^3)	-	230	-	830	-	2100
	eff. length l_e (mm)	-	16.4	-	20.3	-	26.1
	eff. area A_e (mm^2)	-	14.2	-	40.8	-	80.4
	min. area A_{min} (mm^2)	-	10.9	-	35.9	-	72.6
	mass of core half (g)	≈ 0.6	≈ 0.5	≈ 2.4	≈ 1.7	≈ 6.5	≈ 4
dimensions (mm)	A	14 ± 0.3	14 ± 0.3	18 ± 0.35	18 ± 0.35	21.8 ± 0.4	21.8 ± 0.4
	B	3.5 ± 0.1	5 ± 0.1	4 ± 0.1	10 ± 0.2	5.7 ± 0.1	15.8 ± 0.3
	C	5 ± 0.1	1.8 ± 0.05	10 ± 0.2	2.4 ± 0.05	15.8 ± 0.3	2.9 ± 0.05
	D	2 ± 0.1	1.5 ± 0.1	2 ± 0.1	2 ± 0.1	3.2 ± 0.1	2.5 ± 0.1
	E	11 ± 0.25	-	14 ± 0.3	-	16.8 ± 0.4	-
	F	3 ± 0.05	-	4 ± 0.1	-	5 ± 0.1	-
	G	2.8 ± 0.15	-	3.3 ± 0.15	-	4.7 ± 0.15	-
	H	2.5 + 0.2	-	2.5 + 0.2	-	2.8 + 0.2	-
mounting parts	CLM		■		■		■

Core type	E14/3.5/5/R	E18/4/10/R	E22/6/16/R
Matching plates	PLT14/5/1.5/S	PLT18/10/2/S	PLT22/16/2.5/S
core HALVES for use in combination with a plate — 3E6 des	6400	15500	26000







E/R = E core with recess
PLT/S = Plate with slot

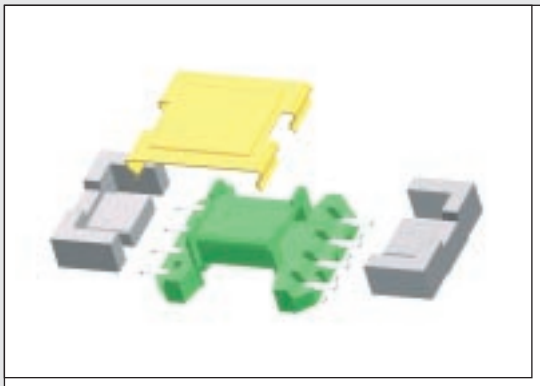
A_L value (nH) measured at $\hat{B} \leq 0.1$ mT, $f \leq 10$ kHz, T = 25°C

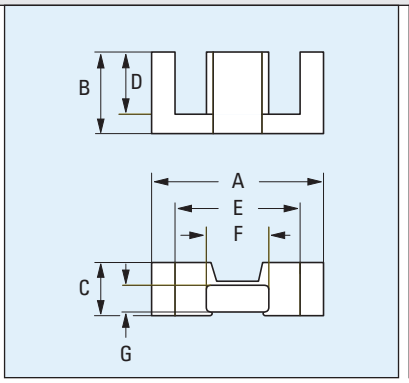
A_L tolerance: $^{+40\%}_{-30\%}$

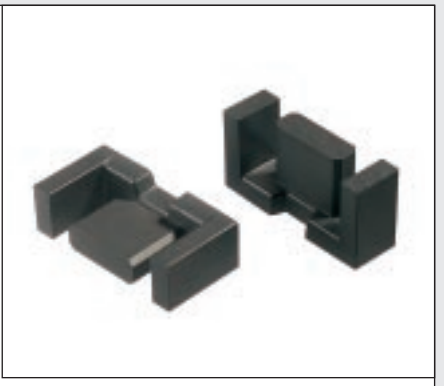
1280 — ungapped core half, A_L = 1280 nH measured in combination with a plate.

Ferrite Ceramics

EFD cores







Economic Flat Design (EFD) power transformer cores offer a significant advance in circuit miniaturization. Their low build height and high throughput power-density make them ideally suited to applications where space is at a premium.

Throughput power of a ferrite core transformer is essentially proportional to its volume. So the transformer is one of the main limitations in a DC-DC converter's size. Now, with the introduction of the EFD system, a significant reduction in transformer core height has been achieved.

EFD transformer cores combine both extreme flatness with a very high throughput power-density for frequencies up to 1 MHz and higher.

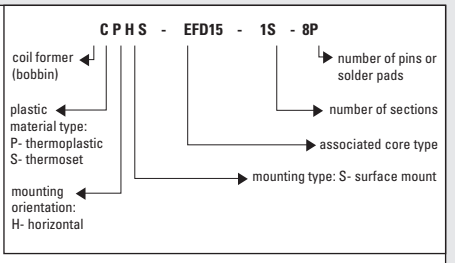
Every transformer, based on the EFD range, has a lower building height than any other existing low-profile design with the same magnetic volume. This is achieved by placing the centre pole of the core always in the centre of the finished transformer, thus making maximum use of the winding area.

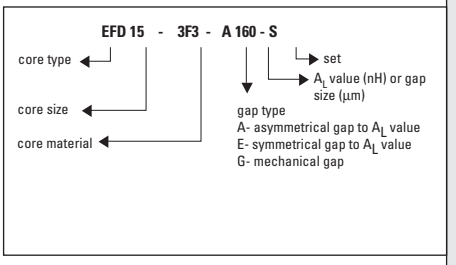
Summary:

- very low build height
- very high throughput power density
- complete range of accessories including SMD coil formers
- available from several sources

Core type		EFD10	EFD12	EFD15
effective core parameters	core factor Σ l/A(mm^{-1})	3.29	2.50	2.27
	eff. volume V_e (mm^3)	171	325	510
	eff. length l_e (mm)	23.7	28.5	34.0
	eff. area A_e (mm^2)	7.2	11.4	15.0
	min. area A_{min} (mm^2)	6.5	10.7	12.2
	mass of core half (g)	≈ 0.45	≈ 0.9	≈ 1.4
dimensions (mm)	A	10.5 ± 0.3	12.5 ± 0.3	15 ± 0.4
	B	5.2 ± 0.1	6.2 ± 0.1	7.5 ± 0.15
	C	2.7 ± 0.1	3.5 ± 0.1	4.65 ± 0.15
	D	3.75 ± 0.15	4.55 ± 0.15	5.5 ± 0.25
	E	7.65 ± 0.25	9 ± 0.25	11 ± 0.35
	F	4.55 ± 0.15	5.4 ± 0.15	5.3 ± 0.15
	G	1.45 ± 0.05	2 ± 0.1	2.4 ± 0.1
coil formers	CPHS	1S - 8P	1S - 8P	1S - 8P 1S - 10P
	CSHS			1S - 8P
	CPH			1S - 8P
	CSH			1S - 8P
mounting parts	CLI			■
	CLM	■	■	■

	Core type	EFD10 SETS des	EFD12 SETS des	EFD15 SETS
cores for general purpose transformers and power applications	3C90	A25-S	A40-S	A63-S
		A40-S	A63-S	A100-S
		A63-S	A100-S	A160-S
		585-S	825-S	950-S
	3F3	A25-S	A40-S	A63-S
		A40-S	A63-S	A100-S
		A63-S	A100-S	A160-S
		500-S	700-S	780-S
high μ cores	3E4	1400-S	1900-S	2000-S
	3E5	2000-S	2800-S	2500-S





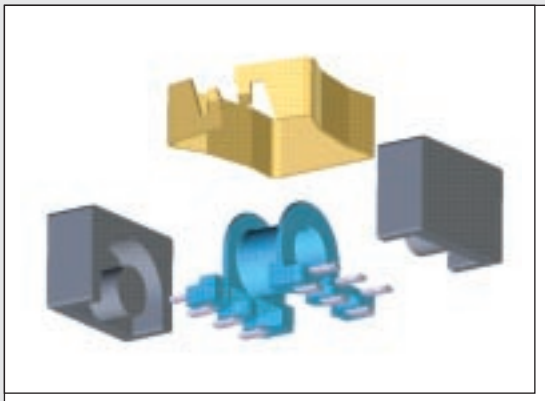
A_L value (nH) measured at $\hat{B} \leq 0.1$ mT, $f \leq 10$ kHz, T = 25°C

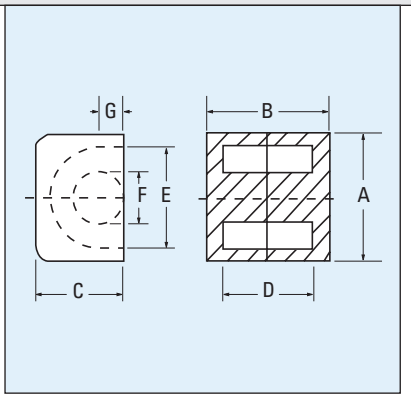
A_L tolerance: ± 5% | ± 8% | ± 10% | ± 25% | + 40% / − 30%

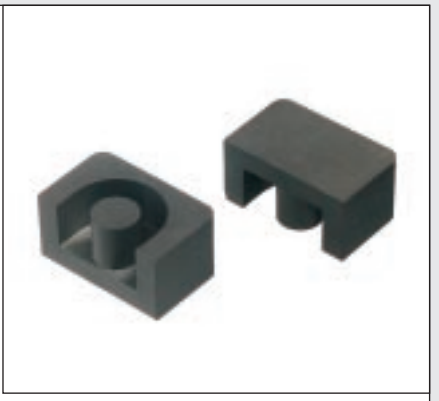
A160-S — gapped core set with asymmetrical gap (A). A_L = 160 nH.
1200 — ungapped core half. A_L = 500 nH measured in combination with another ungapped core half.

Ferrite Ceramics

EP cores







The EP core range was specially designed for wideband transformer applications. The shape of the assembly is almost cubical, allowing high packing densities on the PCB. The winding except the bottom is completely surrounded by ferrite. Shielding from neighbouring cores is therefore excellent. The bobbins have two rows of pins allowing easy design of multiple output transformers. Cores are available in high permeability materials for wide band transformers and in power materials for small power transformers.

Summary:

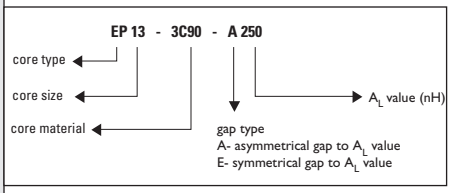
- cubical design for dense packing
- excellent magnetic shielding
- easy design of multiple output transformers

Core type		EP7	EP10	EP13	EP17	EP20
effective core parameters	core factor Σ l/A(mm^{-1})	1.45	1.70	1.24	0.870	0.520
	eff. volume V_e (mm^3)	165	215	472	999	3230
	eff. length l_e (mm)	15.5	19.3	24.2	29.5	41.1
	eff. area A_e (mm^2)	10.7	11.3	19.5	33.7	78.7
	min. area A_{min} (mm^2)	8.55	8.55	14.9	25.5	60.8
	mass of core set (g)	≈ 0.8	≈ 1.1	≈ 2.4	≈ 5	≈ 16
dimensions (mm)	A	9.4 - 0.4	11.5 ± 0.3	12.8 - 0.6	18 ± 0.4	24 ± 0.5
	B	7.5 - 0.2	10.2 ± 0.2	13 - 0.3	16.8 ± 0.2	21.4 ± 0.2
	C	6.5 - 0.3	7.6 ± 0.2	9 - 0.4	11 ± 0.25	15 ± 0.35
	D	5 + 0.4	7.85 - 0.4	9 + 0.4	11.4 ± 0.3	14.4 ± 0.3
	E	7.2 + 0.4	9.4 ± 0.2	9.7 + 0.6	12 ± 0.4	16.5 ± 0.4
	F	3.4 - 0.2	3.3 ± 0.15	4.5 - 0.3	5.7 ± 0.18	8.8 ± 0.25
	G	1.7 ± 0.1	1.8 ± 0.13	2.4 ± 0.1	3.3 ± 0.2	4.5 ± 0.2
coil formers	CSH	1S - 6P 1S - 6P - B 2S - 6P - T	1S - 8P - A 1S - 8P 2S - 8P - A	1S - 10P 2S - 10P	1S - 8P 2S - 8P	1S - 10P 2S - 10P
	CSHS	1S - 6P	1S - 8P	1S - 10P		
	CPHS	1S - 6P	1S - 8P	1S - 8P		
mounting parts	CLI	■	■	■		
	CLI/P	■				
	CLA	■	■	■	■	■
	SPR	■	■	■	■	■

core SETS for general purpose transformers and power applications

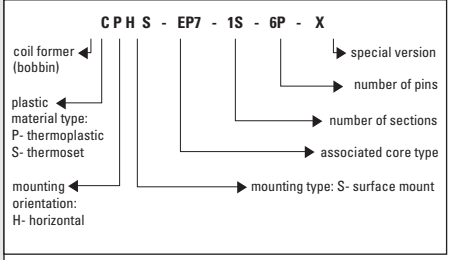
Core type	EP7	EP10	EP13	EP17	EP20
3D3	A40	A40	A63		
	A63	A63	A100		
	A100	A100	A160		
	530	470	670		
3H3	A40	A40	A63		
	A63	A63	A100		
	A100	A100	A160		
	A160	A160			
	A250				
	1120	1025	1475		
3C81	E25	E25	E40	E63	E160
	A40	A40	A63	A100	A250
	A63	A63	A100	A160	A315
	A100	A100	A160	A250	A400
	A160	A160	A250	A315	A630
	≥ 875	≥ 900	≥ 1250	≥ 1950	≥ 3450
3C90	E25	E25	E40	E63	E160
	A40	A40	A63	A100	A250
	A63	A63	A100	A160	A315
	A100	A100	A160	A250	A400
	A160	A160	A250	A315	A630
	1200	1140	1650	2485	4435
3E1	2100	2000	2600		
3E27	≥ 2500	≥ 2500	≥ 3400	≥ 5300	≥ 8700
3E4		3200	4400		
3E5	5200	4800	7000	≥ 8000	≥ 13500
3E6	5800	6900	10000		

E63 — gapped core set with A_L = 63 nH, symmetrical gap (E).
A315 — gapped core set with A_L = 315 nH, asymmetrical gap (A).
1200 — ungapped core set, A_L = 1200 nH.



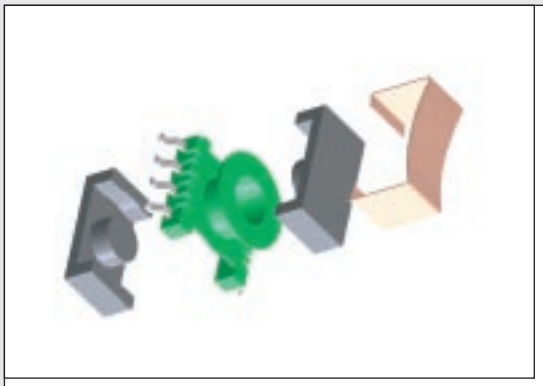
A_L value (nH) measured at $\hat{B} \leq 0.1$ mT, f ≤ 10 kHz, T = 25°C

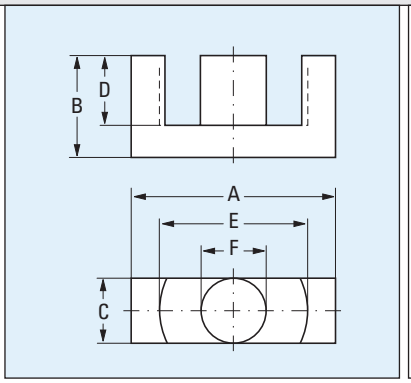
A_L tolerance: ± 3% | ± 5% | ± 10% | ± 25% | + 30% / − 20% | + 40% / − 30%



Ferrite Ceramics

ER cores





The ER core design is derived from the original E core and, like ETD and EC cores, has a round centre pole and outer legs with a radius to accomodate round coil formers.
These cores are mainly used for power transformers. The round centre pole allows the use of thicker wires while the shorter turn length keeps the copper losses low.
The smaller sizes, ER 9.5, ER11 and ER 14.5, are very suitable to build small SMD power and signal tranformers. For both sizes matching SMD coil formers and clips are available.

Summary:

- round centre pole
- outer legs with a radius
- for the smaller sizes, SMD coilformers and clamps are available
- moderate shielding

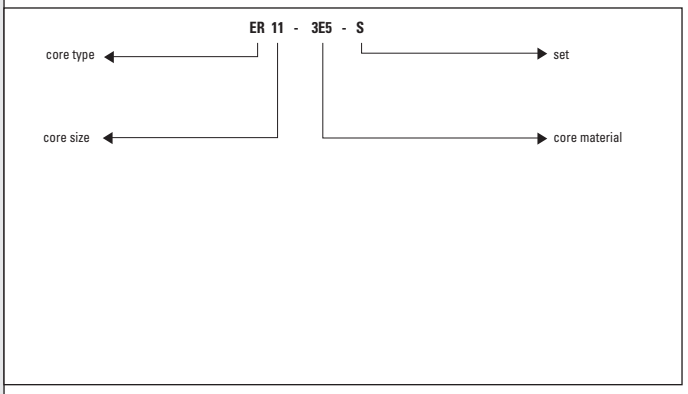
	Core type	ER9.5	ER11	ER14.5
effective core parameters	core factor Σ l/A(mm^{-1})	1.67	1.23	1.08
	eff. volume V_e (mm^3)	120	174	333
	eff. length l_e (mm)	14.2	14.7	19.0
	eff. area A_e (mm^2)	8.47	11.9	17.6
	min. area A_{min} (mm^2)	7.6	10.3	16.6
	mass of core half (g)	≈ 0.35	≈ 0.5	≈ 0.9
dimensions (mm)	A	9.5 - 0.3	11 - 0.35	14.5 ± 0.2
	B	2.45 ± 0.05	2.45 ± 0.05	2.95 ± 0.05
	C	5 - 0.2	6 - 0.2	6.8 - 0.2
	D	1.6 + 0.15	1.5 + 0.15	1.55 + 0.2
	E	7.5 + 0.25	8.7 + 0.3	11.8 ± 0.2
	F	3.5 - 0.2	4.25 - 0.25	4.8 - 0.2
coil formers	CPVS	1S - 8P	1S - 10P 1S - 12P	1S - 10P
	CSVS		1S - 12P	
mounting parts	CLM	■	■	■

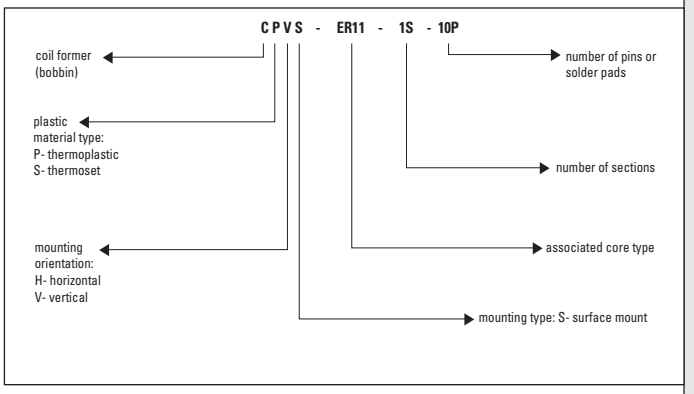
Core type		ER9.5 SETS des	ER11 SETS des	ER14.5 SETS prot
high μ cores	3E5	3600-S	5000-S	
	3E6	4800-S	6700-S	7900-S

4800-S — ungapped core set, A_L = 4800 nH.

A_L value (nH) measured at $\hat{B} \leq 0.1$ mT, $f \leq 10$ kHz, T = 25°C

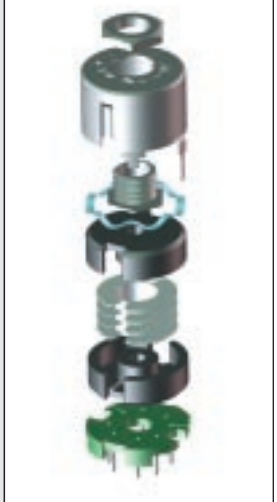
A_L tolerance: +40% / −30%

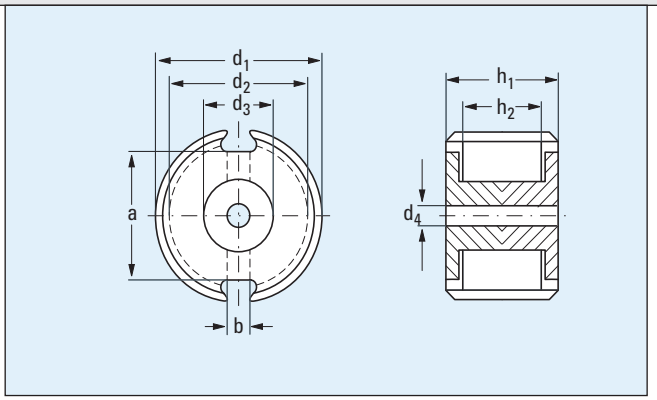




Ferrite Ceramics

P cores (IEC 133)



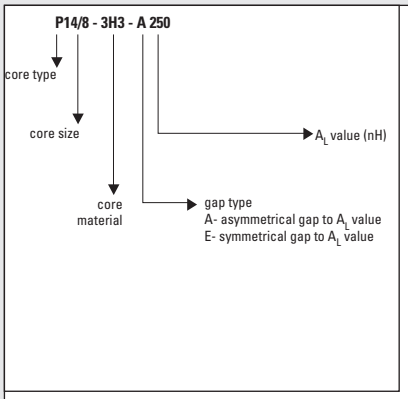


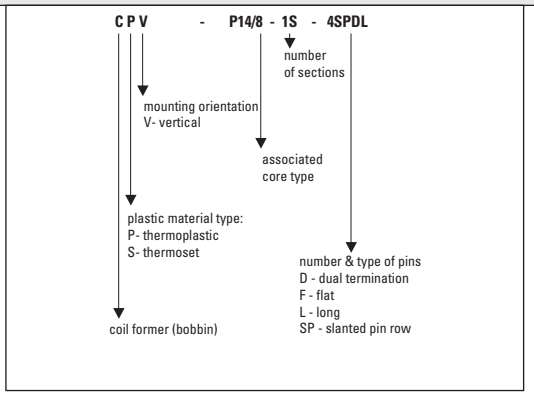
The P core is the earliest design for telecom filter inductors. As with RM-cores there is a complete, standardized range (IEC 133). The cores are available in a range of A_L-values from many suppliers. The core surrounds the winding almost completely so magnetic shielding is outstanding. The slots in the core are rather narrow which complicates assembly and mounting. A complete range of accessories is available, but most are not optimized for easy automatic handling.

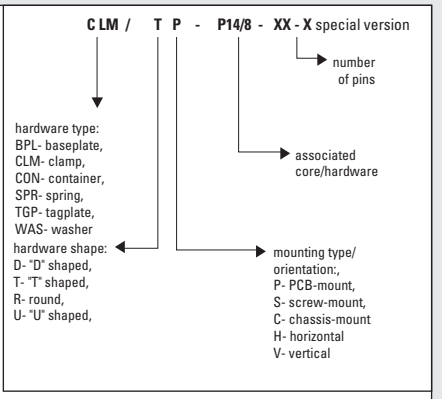
Summary:

- excellent magnetic shielding
- complete range of sizes and material grades
- not easy to assemble and mount
- difficult to get leads out
- mains insulation difficult

	Core type	P7/4	P9/5	P11/7	P14/8	P18/11
effective core parameters	core factor Σ l/A(mm^{-1})	1.43	1.24	0.956	0.789	0.597
	eff. volume V_e (mm^3)	70.0	126	251	495	1120
	eff. length l_e (mm)	10.0	12.5	15.5	19.8	25.8
	eff. area A_e (mm^2)	7.0	10.1	16.2	25.1	43.3
	min. area A_{min} (mm^2)	5.18	8.0	13.3	19.8	36.1
	mass of core set (g)	≈ 0.5	≈ 0.8	≈ 1.8	≈ 3.2	≈ 6.0
dimensions (mm)	a	5.5 ± 0.2	6.5 ± 0.25	6.8 ± 0.25	9.5 ± 0.3	13.4 ± 0.3
	b	1.6 + 0.3	2 ± 0.2	2.2 ± 0.3	2.7 + 1.2	3.8 ± 0.6
	d1	7.4 - 0.3	9.3 - 0.3	11.3 - 0.4	14.3 - 0.5	18.4 - 0.8
	d2	5.8 + 0.25	7.5 + 0.25	9 + 0.4	11.6 + 0.4	14.9 + 0.5
	d3	3 - 0.12	3.9 - 0.2	4.7 - 0.2	6 - 0.2	7.6 - 0.3
	d4	1.4 + 0.06	2.1 ± 0.1	2.1 ± 0.1	3.1 ± 0.1	3.1 ± 0.1
	h1	4.2 - 0.2	5.4 - 0.3	6.5 + 0.1 / -0.2	8.4 + 0.1 / -0.2	10.6 ± 0.1
	h2	2.8 + 0.2	3.6 + 0.3	4.4 + 0.3	5.6 + 0.4	7.2 + 0.4
coil formers	CP	1S	1S	1S 2S - A 3S - A	1S 2S 3S - A	1S 2S 3S
	CPV				1S - 4SPD 1S - 4SPDL 2S - 4SPD 2S - 4SPDL 1S - 6PD 1S - 6PDL 2S - 6PD 2S - 6PDL	1S - 6PD 1S - 6PDL 2S - 6PD 2S - 6PDL 3S - 6PD 3S - 6PDL
mounting parts	TGP			4P	6P	8P
	CON			■	■	■
	SPR			■	■	■
	CLM/TP		■	■	■	■
	CLM/TS					
	WAS-CLM/TP				■	■
	WAS-CLM/TS					







	Core type	P22/13	P26/16
effective core parameters	core factor Σ l/A(mm^{-1})	0.497	0.400
	eff. volume V_e (mm^3)	2000	3530
	eff. length l_e (mm)	31.5	37.6
	eff. area A_e (mm^2)	63.4	93.9
	min. area A_{min} (mm^2)	51.3	76.5
	mass of core set (g)	≈ 12	≈ 20
dimensions (mm)	a	15 ± 0.4	18 ± 0.4
	b	3.8 ± 0.6	3.8 ± 0.6
	d1	22 - 0.8	25.5 ± 0.5
	d2	17.9 + 0.6	21.2 + 0.8
	d3	9.4 - 0.3	11.5 - 0.4
	d4	4.4 + 0.3	5.4 + 0.2
	h1	13.4 ± 0.2	16 ± 0.2
	h2	9.2 + 0.4	11 + 0.4
coil formers	CP	1S 2S 3S	1S 2S 3S
	CPV	1S - 6PD 1S - 6PDL 2S - 6PD 2S - 6PDL 3S - 6PD 3S - 6PDL	1S - 6PD 1S - 6PDL 2S - 6PD 2S - 6PDL 3S - 6PD 3S - 6PDL
mounting parts	TGP	8P	8P
	CON	■	■
	SPR	■	■
	CLM/TP		■
	CLM/TS	■	
	WAS-CLM/TP		
	WAS-CLM/TS	■	

[1] only one slot

Ferrite Ceramics

P cores (IEC 133)

	Core type	P7/4	P9/5	P11/7	P14/8	P18/11	P22/13	P26/16
core SETS for signal filter applications	3D3 sup	480	E40	E16	E40	E63	E40	E100
			E63	E25	E63	E100	E63	E160
			630	E40	E100	E160	E100	E250
				E63	1000	1400	E160	2150
				A100			1700	
				800				
	3H3 sup			A160	A160	E160	E160	E160
				A250	A250	A250	E250	E250
				1650	A315	A315	A315	E315
					A400	A400	A400	E400
					2150	A630	A630	A630
						3100	3900	5000
high μ SETS	3E1 sup				3700	5400	6900	9000
	3E27				5750	7500	9250	12000
	3E4 sup			4100	5300	7550	9450	12100
	3E5	3500	4500	6400	8300	12000	15000	19000

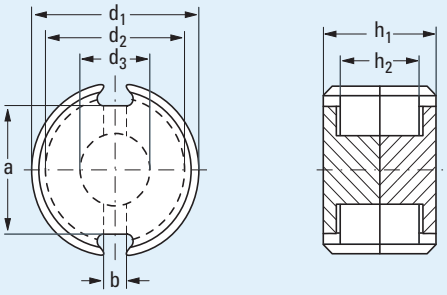
E63 — gapped core set with A_L = 63 nH, symmetrical gap (E).
A315 — gapped core set with A_L = 315 nH, asymmetrical gap (A).
1960 — ungapped core set, A_L = 1960 nH.

A_L value (nH) measured at $\hat{B} \leq 0.1$ mT, $f \leq 10$ kHz, T = 25°C

A_L tolerance: ± 3% | ± 5% | ± 8% | ± 10% | ± 25% | + 40% / − 30%

Ferrite Ceramics

P/I cores



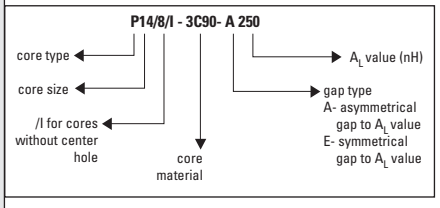
P cores with solid centre poles have approximately a 15% higher effective area than the corresponding P cores with central hole. This makes them more suitable for applications where high flux densities are used. This will be the case in power conversion where the P core is still popular mainly because of its excellent magnetic shielding. This helps to avoid EMI problems, especially at higher switching frequencies.

	Core type	P11/7/I	P14/8/I	P18/11/I	P22/13/I	P26/16/I
effective core parameters	core factor Σ l/A(mm^{-1})	0.860	0.700	0.560	0.450	0.360
	eff. volume V_e (mm^3)	309	628	1270	2460	4370
	eff. length l_e (mm)	16.3	21.0	26.7	33.3	39.6
	eff. area A_e (mm^2)	19.0	29.9	47.5	73.4	110
	min. area A_{min} (mm^2)	13.9	21.3	42.9	53.6	82.8
	mass of core set (g)	≈ 1.9	≈ 3.5	≈ 7	≈ 13	≈ 21
dimensions (mm)	a	6.8 ± 0.25	9.5 ± 0.3	13.4 ± 0.3	15 ± 0.4	18 ± 0.4
	b	2.2 ± 0.3	3.3 ± 0.6	3.8 ± 0.6	3.8 ± 0.6	3.8 ± 0.6
	d1	11.1 ± 0.2	14.05 ± 0.25	17.9 ± 0.3	21.5 ± 0.3	25.5 ± 0.5
	d2	9.2 ± 0.2	11.8 ± 0.2	15.1 ± 0.25	18.2 ± 0.3	21.6 ± 0.4
	d3	4.6 ± 0.1	5.9 ± 0.1	7.4 ± 0.15	9.2 ± 0.15	11.3 ± 0.2
	h1	6.6 ± 0.15	8.4 ± 0.15	10.6 ± 0.15	13.4 ± 0.2	16.2 ± 0.2
	h2	4.6 ± 0.15	5.8 ± 0.2	7.4 ± 0.2	9.4 ± 0.2	11.2 ± 0.2

remark: for coil formers and mounting parts see P cores

Core type		P11/7/I	P14/8/I	P18/11/I	P22/13/I	P26/16/I
core SETS for general purpose transformers and power applications	3C81	A63	A100	A160	A250	E250
		A100	A160	A250	A315	A315
		A160	A250	A315	A400	A400
		A250	A315	A400	A630	A630
		A315	A400	A630	A1000	A1000
		2100	2900	4200	5330	7000
	3C90	A63	A100	A160	A250	E250
		A100	A160	A250	A315	A315
		A160	A250	A315	A400	A400
		A250	A315	A400	A630	A630
		A315	A400	A630	A1000	A1000
		2010	2695	3660	4785	6230

E63 — gapped core set with A_L = 63 nH, symmetrical gap (E).
A315 — gapped core set with A_L = 315 nH, asymmetrical gap (A).
2100 — ungapped core set, A_L = 2100 nH.



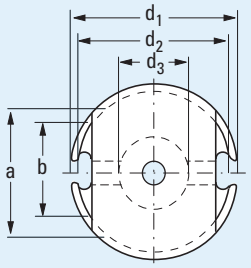
A_L value (nH) measured at $\hat{B} \leq 0.1$ mT, f ≤ 10 kHz, T = 25°C

A_L tolerance: ± 3% | ± 5% | ± 25%

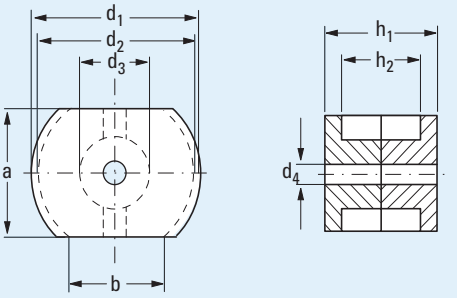
remark: for coil formers and mounting parts see P cores

Ferrite Ceramics

PT and PTS cores



PT assembly

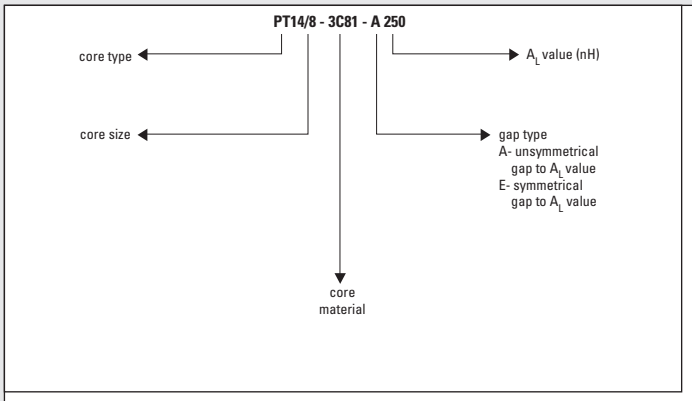


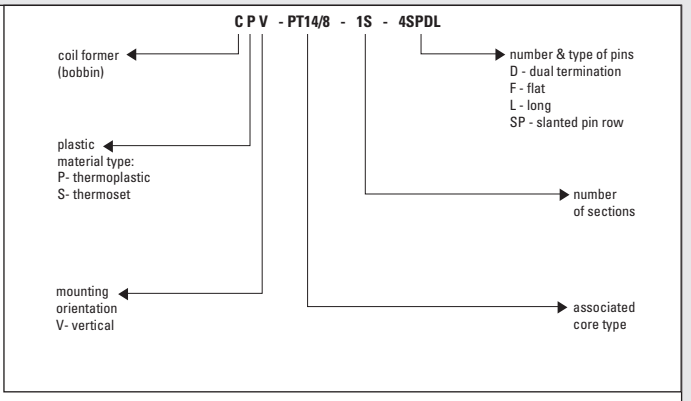
PTS assembly

A disadvantage of the classical P core design has always been the narrow wire slots, making it difficult to make strong coil formers with integrated solder pins.
In the PT and PTS design this problem is solved by cutting away the sides of one core half. This creates ample room for wires and coil former flanges.
A range of special PT coil formers in available but also most standard P core accessories can be used.

- complete range of core sizes
- special coil formers with integrated pins
- also P core accessories can be used

	Core type	PT14/8	PTS14/8	PT18/11	PTS18/11	PT23/11
effective core parameters	core factor Σ l/A(mm^{-1})	0.910	1.02	0.670	0.770	0.470
	eff. volume V_e (mm^3)	492	495	1110	1070	1740
	eff. length l_e (mm)	21.1	22.5	27.2	28.7	28.6
	eff. area A_e (mm^2)	23.3	22.0	40.6	37.2	61.0
	min. area A_{min} (mm^2)	19.9	19.9	32.9	-	53.6
	mass of core set (g)	≈ 2.8	≈ 2.5	≈ 6	≈ 5	≈ 10.5
dimensions (mm)	a	9.4 ± 0.15	9.4 ± 0.15	11.94 ± 0.2	11.94 ± 0.2	15.2 ± 0.25
	b	8.6 min	8.6 min	10.5 min	10.5 min	13.2 min
	d1	14.05 ± 0.25	14.05 ± 0.25	18.0 ± 0.4	18.0 ± 0.4	22.9 ± 0.45
	d2	11.8 ± 0.2	11.8 ± 0.2	15.15 ± 0.25	15.15 ± 0.25	18.3 ± 0.35
	d3	5.9 ± 0.1	5.9 ± 0.1	7.4 ± 0.15	7.4 ± 0.15	9.7 ± 0.2
	d4	3.1 ± 0.075	3.1 ± 0.075	3.1 ± 0.075	3.1 ± 0.075	5.1 ± 0.1
	h1	8.3 ± 0.15	8.3 ± 0.015	10.6 ± 0.15	10.6 ± 0.15	11 ± 0.25
	h2	5.8 ± 0.2	5.8 ± 0.2	7.4 ± 0.2	7.4 ± 0.2	7.6 ± 0.25
coil formers	CPV	1S - 6P	1S - 6P			1S - 10P
mounting parts	BPL/D-CLM/C	■	■			
	CLM/C	■	■			
	WAS-CLM/C	■	■			





	Core type	PTS23/11	PT23/18	PTS23/18
effective core parameters	core factor Σ l/A(mm^{-1})	0.550	0.670	0.770
	eff. volume V_e (mm^3)	1810	2590	2630
	eff. length l_e (mm)	31.6	41.6	45.1
	eff. area A_e (mm^2)	57.2	62.2	58.3
	min. area A_{min} (mm^2)	53.6	53.6	53.6
	mass of core set (g)	≈ 9	≈ 14	≈ 13
dimensions (mm)	a	15.2 ± 0.25	15.2 ± 0.25	15.2 ± 0.25
	b	13.2 min	13.2 min	13.2 min
	d1	22.9 ± 0.45	22.9 ± 0.45	22.9 ± 0.45
	d2	18.3 ± 0.35	18.3 ± 0.35	18.3 ± 0.35
	d3	9.7 ± 0.2	9.7 ± 0.2	9.7 ± 0.2
	d4	5.1 ± 0.1	5.1 ± 0.1	5.1 ± 0.1
	h1	11 ± 0.25	18 ± 0.35	18 ± 0.356
	h2	7.5 ± 0.25	14.4 ± 0.35	14.4 ± 0.35
coil formers	CPV	1S - 10P	1S - 10P	1S - 10P
mounting parts	BPL/D-CLM/C			
	CLM/C			
	WAS-CLM/C			

Ferrite Ceramics

PT and PTS cores

	Core type	PT14/8	PTS14/8	PT18/11	PTS18/11	PT23/11	PTS23/11	PT23/18	PTS23/18
core SETS for general purpose transformsers and power applications	3C81	A63 A100 A160 A250	A63 A100 A160 A250	A100 A160 A250 A315	A100 A160 A250 A315	A160 A250 A315 A400	A160 A250 A315 A400	A160 A250 A315 A400	A160 A250 A315 A400
		A315	A315	A400	A400	A630	A630	A630	A630
		2400	2330	3130	3000	5500	4890	4100	3800
high μ SETS	3E27	4500	4370	5760	5140	8400	7250	6400	5945
	3E5	≥ 5350	≥ 4800	≥ 7940	≥ 7045	≥ 11250	≥ 10220	≥ 8400	≥ 8170

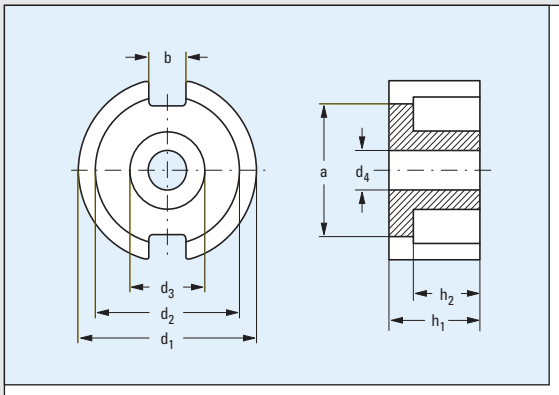
E63 — gapped core set with A_L = 63 nH, symmetrical gap (E).

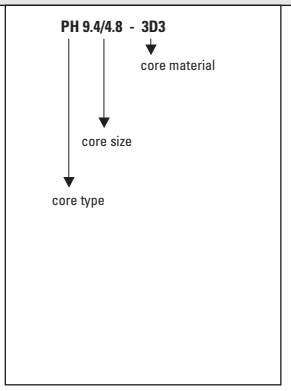
A315 — gapped core set with A_L = 315 nH, asymmetrical gap (A).

2000 — ungapped core set, A_L = 2000 nH.

A_L value (nH) measured at $\hat{B} \leq 0.1$ mT, f ≤ 10 kHz, T = 25°C

A_L tolerance: ± 3% | ± 5% | ± 25%





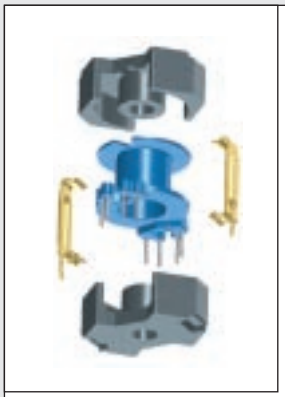
The PH core range consists of potcore halves specially designed for use in proximity switches. Their shape is derived from the IEC standard P-core range. Outside diameters are adapted to fit standardized sizes of proximity switch housings.
Since the cores are used as halves, their height is increased to accommodate the winding.
A complete range of coil formers is available.

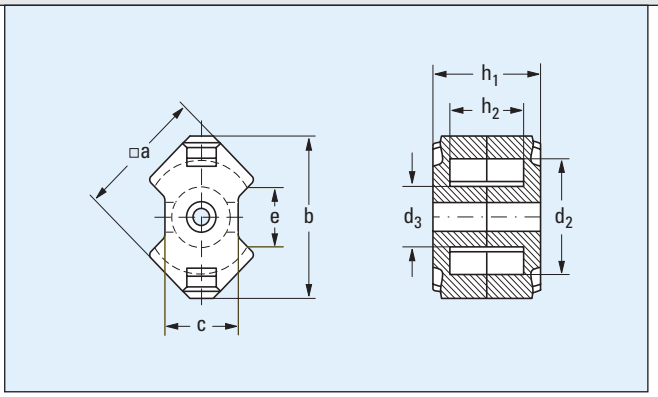
Summary:
- range of standard sizes
- higher shape than normal P cores to accommodate windings

Core type		PH5.6/3.6-3D3	PH7.4/3.9-3D3	PH9.4/4.8-3D3
dimensions (mm)	a	4 ± 0.2	5.7 ± 0.4	6.5 ± 0.3
	b	1.5 ± 0.15	1.6 + 0.3	2 ± 0.2
	d1	5.75 - 0.35	7.4 - 0.3	9.4 - 0.4
	d2	4.5 + 0.35	5.8 + 0.25	7.5 + 0.35
	d3	2.5 - 0.1	3 - 0.12	3.9 - 0.2
	d4	0.95 + 0.1	1.38 + 0.1	2 + 0.1
	h1	3.6 - 0.25	3.95 - 0.3	4.8 - 0.4
	h2	2.8 + 0.25	2.8 + 0.2	3.55 + 0.3

Ferrite Ceramics

RM cores (IEC 431)





RM cores were designed for use in high Q, high stability filter inductors. Their shape allows economic utilization of surface area on the PCB. The range is standardized in IEC 431 and is available worldwide from many suppliers. The sizes are based on the standard PCB grid distance. RM 5, for instance, fits on a board space of 5 x 5 modules of 2.5 mm grid. Coil formers and clips were optimized for automated winding and mounting.
The slots provide sufficient space for leads of windings. Magnetic shielding is not as good as with P-cores, but still effective.

Summary:

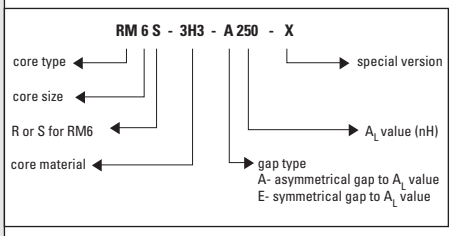
- standardized range
- complete range of accessories
- easy for automated winding
- simple mounting system
- efficient utilization of PCB area
- wider slots to get leads out
- good magnetic shielding
- good selection of coil formers

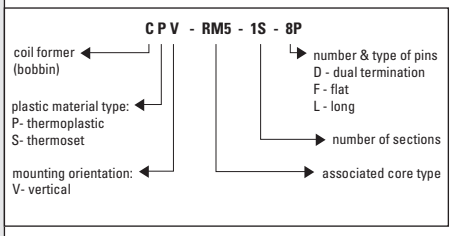
	Core type	RM4	RM5	RM6S	RM8
effective core parameters	core factor Σ l/A(mm^{-1})	1.94	1.01	0.863	0.683
	eff. volume V_e (mm^3)	230	450	840	1850
	eff. length l_e (mm)	21.3	21.4	27.3	35.5
	eff. area A_e (mm^2)	11.0	21.2	31.0	52.0
	min. area A_{min} (mm^2)	8.1	14.8	23.8	39.5
	mass of core set (g)	≈ 1.4	≈ 3.0	≈ 4.5	≈ 10.9
dimensions (mm)	a	9.8 - 0.4	12.3 - 0.5	14.7 - 0.6	19.7 - 0.8
	b	11 - 0.5	14.9 max	17.9 - 0.7	23.2 - 0.9
	c	4.6 - 0.2	7.4 - 0.4	8.2 - 0.4	11 - 0.5
	d2	7.95 + 0.4	10.2 + 0.4	12.4 + 0.5	17 + 0.6
	d3	3.9 - 0.2	4.9 - 0.2	6.4 - 0.2	8.55 - 0.3
	e	5.8 min	6.0 min	8.4 min	9.5 min
	h1	10.4 ± 0.1	10.4 ± 0.1	12.4 ± 0.1	16.4 ± 0.1
	h2	7 + 0.4	6.3 + 0.4	8 + 0.4	10.8 + 0.4
coil formers	CSV	1S - 6P	1S - 4P 2S - 4P 1S - 5P 1S - 6P 2S - 5P 2S - 6P	1S - 4P 2S - 4P 1S - 6P 2S - 6P 1S - 8P	1S - 8P 1S - 12P 2S - 8P 2S - 12P
clips	CLI/P	RM4/5	RM4/5	RM6	RM8

remark: coil formers CSV series with other pin configurations available on request.

Core type		RM4	RM5	RM6S	RM8
core SETS in materials for low flux level applications	3D3	E40 A63 400	E40 E63 E100 800	E63 E100 A160 950	E100 E160 1240
	3H3	A63 A100 A160 900	A160 A250 A315 A400 1650	A160 A250 A315 A400 2100	A250 A315 A400 A630 2850

E63 — gapped core set with A_L = 63 nH, symmetrical gap (E).
A315 — gapped core set with A_L = 315 nH, asymmetrical gap (A).
950 — ungapped core set, A_L = 950 nH.



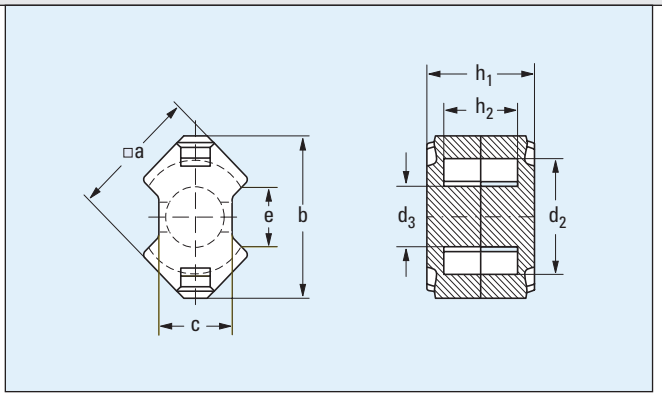


A_L value (nH) measured at $\hat{B} \leq 0.1$ mT, f ≤ 10 kHz, T = 25°C

A_L tolerance: ± 3% | ± 5% | ± 8% | ± 10% | ± 25%

Ferrite Ceramics

RM/I cores



For applications other than filter inductors the centre hole in the RM core is not necessary. Inductance adjustment is generally not required. For wideband and power transformers core performance can be improved by using a solid centre pole. A_L-values will be higher and less flux concentrations occur in the core because its cross section has become more uniform.

Although RM cores were not designed for the function of power transformer or output choke they are frequently used for this purpose. Reason is the availability of a complete and standardized range of cores and accessories. For power applications a range of special, dual termination, coil formers is available.

Summary:

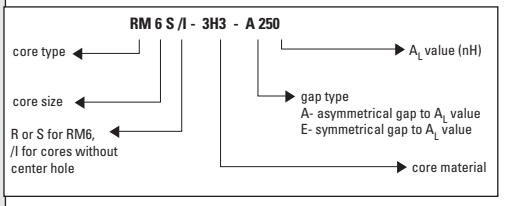
- standardized range
- complete range of coil formers
- simple assembly and mounting
- small winding area

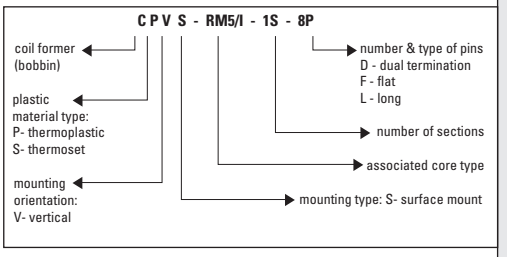
remark: coil formers CSV series with other pin configurations available on request.

	Core type	RM4/I	RM5/I	RM6S/I	RM8/I	RM10/I
effective core parameters	core factor Σ l/A(mm^{-1})	1.69	0.935	0.784	0.604	0.462
	eff. volume V_e (mm^3)	322	574	1090	2440	4310
	eff. length l_e (mm)	23.3	23.2	29.2	38.4	44.6
	eff. area A_e (mm^2)	13.8	24.8	37.0	63.0	96.6
	min. area A_{min} (mm^2)	11.5	18.1	31.2	55.4	89.1
	mass of core set (g)	≈ 1.7	≈ 3.3	≈ 4.9	≈ 12.0	≈ 22
dimensions (mm)	a	9.8 - 0.4	12.3 - 0.5	14.7 - 0.6	19.7 - 0.8	24.7 - 1.1
	b	11 - 0.5	14.9 max	17.9 - 0.7	23.2 - 0.9	28.5 - 1.3
	c	4.6 - 0.2	6.8 - 0.4	8.2 - 0.4	11 - 0.5	13.5 - 0.5
	d2	7.95 + 0.4	10.2 + 0.4	12.4 + 0.5	17 + 0.6	21.2 + 0.9
	d3	3.9 - 0.2	4.9 - 0.2	6.4 - 0.2	8.55 - 0.3	10.9 - 0.4
	e	5.8 min	6 min	8.4 min	9.5 min	10.9 min
	h1	10.4 ± 0.1	10.4 ± 0.1	12.4 ± 0.1	16.4 ± 0.1	18.6 ± 0.1
	h2	7 + 0.4	6.3 + 0.4	8 + 0.4	10.8 + 0.4	12.4 + 0.6
coil formers	CPV	1S - 6PD	1S - 8PD	1S - 8PD	1S - 12PD	1S - 12PD
	CSV	1S - 6P	1S - 6P 2S - 6P	1S - 6P 2S - 6P	1S - 12P 2S - 12P	1S - 12P 2S - 12P
	CPVS	1S - 6P	1S - 8P	1S - 8P		
	CSVS		1S - 8P	1S - 8P		
clips	CLI	RM4/5	RM4/5	RM6	RM8	
	CLI/P	RM4/5/I	RM4/5/I	RM6/I	RM8/I	RM10/I

	Core type	RM4/I	RM5/I	RM6S/I	RM8/I	RM10/I
core SETS for general purpose transformers	3C81			A63 A100 A160 A250 A315 3000	E100 A160 A250 A315 A400 3400	E160 A250 A315 A400 A630 5400
	3C90		A63 A100 A160 A250 A315 2000	A63 A100 A160 A250 A315 A400 A630 2600	A100 A160 A250 A315 A400 3600	A160 A250 A315 A400 A630 4950
	3D3 des			A160 A250 A315 1050	A250 A315 A400 1400	A315 A400 A630 1900
	3H3 des			A315 A400 A630 2350	A400 A630 A1000 3250	A400 A630 A1000 4400
high μ SETS	3E1	1800	3150	4100	5800	8000
	3E4	2500	4500	5750	8000	11000
	3E27		4975	6000	8000	10700
	3E5	3500	6700	8600	12500	16000
	3E6		9500	12500	18000	

E63 — gapped core set with A_L = 63 nH, symmetrical gap (E).
A315 — gapped core set with A_L = 315 nH, asymmetrical gap (A).
2000 — ungapped core set, A_L = 2000 nH.



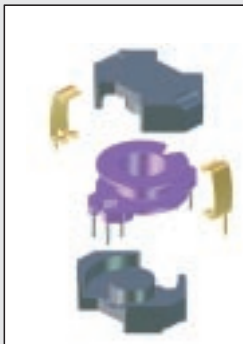


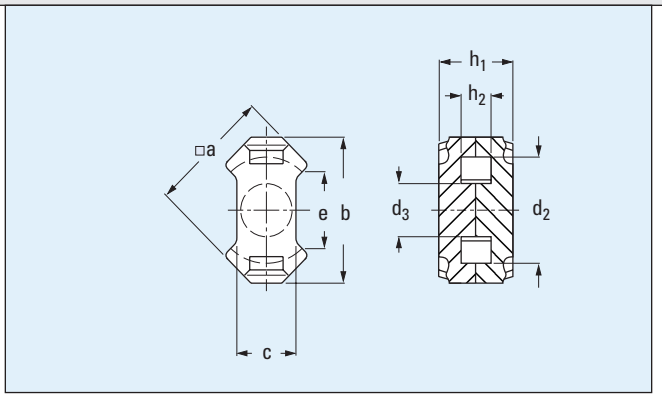
A_L value (nH) measured at B ≤ 0.1 mT, f ≤ 10 kHz, T = 25°C

A_L tolerance: ± 3% | ± 5% | ± 8% | ± 10% | ± 25% | + 40% / − 30%

Ferrite Ceramics

RM/ILP cores





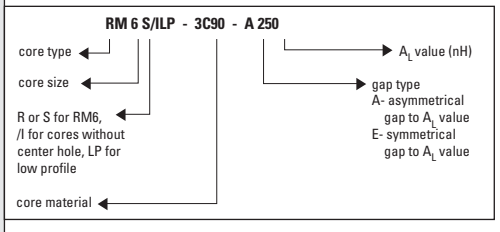
These low-profile RM cores have solid centre poles and a lower height than the standard RM range. They are ideal to construct transformers and inductors with a lower build height needed for low profile equipment. The cores can also be used for planar designs, either combined with PCB windings as a stand-alone device, or with integrated PCB-windings.

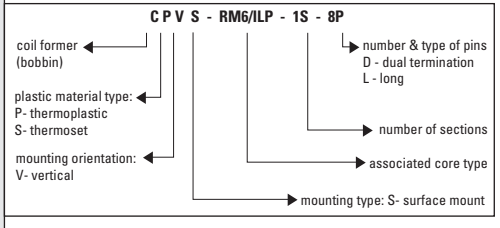
Summary:

- low build height
- suitable for planar designs

Core type		RM4/ILP	RM5/ILP	RM6S/ILP	RM8/ILP	RM10/ILP
effective core parameters	core factor Σ l/A(mm^{-1})	1.20	0.710	0.580	0.440	0.340
	eff. volume V_e (mm^3)	251	430	820	1860	3360
	eff. length l_e (mm)	17.3	17.5	21.8	28.7	33.9
	eff. area A_e (mm^2)	14.5	24.5	37.5	64.9	99.1
	min. area A_{min} (mm^2)	11.3	18.1	31.2	55.4	89.1
	mass of core set (g)	≈ 1.5	≈ 2.2	≈ 4.2	≈ 10	≈ 17
dimensions (mm)	a	9.8 - 0.4	12.3 - 0.5	14.7 - 0.6	19.7 - 0.8	24.7 - 1.1
	b	11 - 0.5	14.6 - 0.6	17.9 - 0.7	23.2 - 0.9	28.5 - 1.3
	c	4.6 - 0.2	6.8 - 0.4	8.2 - 0.4	11 - 0.5	13.5 - 0.5
	d2	7.95 + 0.4	10.2 + 0.4	12.4 + 0.5	17 + 0.6	21.2 + 0.9
	d3	3.9 - 0.2	4.9 - 0.2	6.4 - 0.2	8.55 - 0.3	10.9 - 0.4
	e	5.8 min	> 6	> 8.4	> 9.5	> 10.9
	h1	7.8 - 0.2	7.8 - 0.2	9 - 0.2	11.6 - 0.2	13 - 0.2
	h2	4.3 + 0.4	3.6 + 0.4	4.5 + 0.4	5.9 + 0.4	6.7 + 0.4
coil formers	CSV				1S - 10P 1S - 12P	
	CPV					1S - 12PD
	CPVS		1S - 8P	1S - 8P		
	CSVS	1S - 8P	1S - 8P	1S - 8P		
clips	CLI	RM4/5/ILP	RM4/5/ILP	RM6/ILP		
	CLI/P				RM8/ILP	RM10/ILP

	Core type	RM4/ILP des	RM5/ILP des	RM6S/ILP des	RM8/ILP des	RM10/ILP des
core SETS for general purpose transformers and power applications	3C90	1400	2350	3175	4550	6300
	3D3			A160	A250	A315
				A250	A315	A400
				A315	A400	A630
				1350	1850	2500
	3H3			A315	A400	A400
				A400	A630	A630
				A630	A1000	A1000
				2900	4100	5600
high μ SETS	3E5	5000	8500	10500	16000	22000
	3E6	6700	11500	15000	23000	32000





1300 — ungapped core set, A_L = 1300 nH

A_L value (nH) measured at $\hat{B} \leq 0.1$ mT, $f \leq 10$ kHz, T = 25°C

A_L tolerance: ±3% | ±5% | ±8% | ±10% | ±25%

Ferrite Ceramics

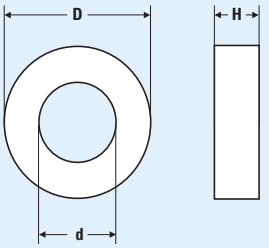
Ferrite ring cores (toroids)

Ring cores have the best possible shape from the magnetic point of view. The flux path is completely closed so the capabilities of the ferrite are fully exploited.
Especially for high permeability ferrites the effect of even a minor airgap in the magnetic circuit can spoil up to 50% of the effective permeability.
A further advantage is the very low leakage field which makes it a suitable shape for power and pulse transformers.

Ring cores are mainly used for pulse- and wide band transformers and interference suppression coils but also in special power supplies.

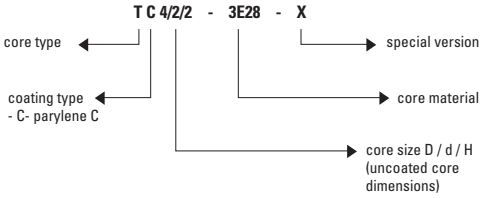
Summary:

- simple economic shape
- very low stray flux and leakage inductance
- not easy to wind



Core type	dimensions (mm)			effective core parameters				
	outside diameter D	inside diameter d	height H	core factor Σ l/A(mm^{-1})	eff. volume V_e (mm^3)	eff. length l_e (mm)	eff. area A_e (mm^2)	mass (g)
TC2.5/1.3/0.8	2.54 ± 0.1	1.27 ± 0.1	0.8 ± 0.1	11.3	2.7	5.53	0.49	0.012
TC2.5/1.3/1.3	2.54 ± 0.1	1.27 ± 0.1	1.27 ± 0.1	7.14	4.29	5.53	0.78	0.022
TC2.5/1.5/0.8	2.5 ± 0.1	1.5 ± 0.1	0.8 - 0.1	16.4	2.21	6.02	0.37	0.012
TC3.1/1.3/1.3	3.05 ± 0.15	1.27 ± 0.5	1.27 ± 0.15	5.65	6.35	5.99	1.06	0.033
TC3.1/1.8/2	3.05 ± 0.15	1.78 ± 0.15	2.03 ± 0.15	5.74	9.1	7.23	1.25	0.047
TC3.4/1.8/1.3	3.43 ± 0.13	1.78 ± 0.13	1.27 ± 0.13	7.93	7.3	7.62	0.96	0.035
TC3.5/1.8/1.8	3.46 ± 0.15	1.78 ± 0.1	1.78 ± 0.1	5.31	11.0	7.65	1.44	0.050
TC3.5/1.8/2	3.5 ± 0.15	1.78 ± 0.1	2.0 ± 0.1	4.72	12.4	7.65	1.62	0.054
TC3.9/2.2/1.3	3.94 ± 0.13	2.24 ± 0.13	1.27 ± 0.13	9.20	9.2	9.2	1.00	0.045
TC4/2/1.6	4.0 ± 0.15	2.0 ± 0.1	1.6 ± 0.1	5.66	13.4	8.71	1.54	0.06
TC4/2/2	4.0 ± 0.15	2.0 ± 0.1	2.0 ± 0.1	4.54	16.7	8.71	1.92	0.074
TC4/2.2/1.1	4.0 ± 0.15	2.2 ± 0.1	1.1 ± 0.1	9.55	8.82	9.18	0.961	0.040
TC4/2.2/1.6	4.0 ± 0.15	2.2 ± 0.1	1.6 ± 0.1	6.56	12.9	9.2	1.40	0.060
TC4/2.2/1.8	4.0 ± 0.15	2.2 ± 0.1	1.78 ± 0.1	5.9	14.3	9.18	1.56	0.070
TC5.8/3.1/1.5	5.84 ± 0.13	3.05 ± 0.13	1.52 ± 0.13	6.52	26.1	13.0	2.00	0.12
TC5.8/3.1/3.2	5.84 ± 0.13	3.05 ± 0.13	3.17 ± 0.13	3.05	55.6	13.0	4.27	0.25
TC5.8/3.1/4.6	5.84 ± 0.13	3.05 ± 0.13	4.57 ± 0.13	2.11	80.2	13.0	6.15	0.37
TC5.9/3.1/3.1	5.85 ± 0.15	3.05 ± 0.15	3.05 ± 0.15	3.16	53.8	13.0	4.12	0.14
TC6/4/2	6.0 ± 0.15	4.0 ± 0.15	2.0 ± 0.1	7.75	30.2	15.3	1.97	0.15
TC6/4/3	6.0 ± 0.15	4.0 ± 0.15	3.0 ± 0.15	5.17	45.2	15.3	2.96	0.16
TC6.3/3.8/2.5	6.3 ± 0.25	3.8 ± 0.15	2.5 ± 0.15	4.97	46.5	15.2	3.06	0.23
TC9/6/3	9.0 ± 0.2	6.0 ± 0.2	3.0 ± 0.15	5.17	102	22.9	4.44	0.5
T9.5/4.8/3.2	9.5 ± 0.25	4.75 ± 0.13	3.2 ± 0.13	2.89	146	20.7	7.16	0.7
TC9.5/4.8/3.2	9.5 ± 0.35	4.75 ± 0.15	3.2 ± 0.15	2.89	146	20.7	7.16	0.7
TC9.5/4.8/4.8	9.5 ± 0.35	4.75 ± 0.15	4.78 ± 0.15	1.90	226	20.7	10.9	1.0

T = Toroid (Ring Core), TC = Toroid parylene C coated



Isolation voltage

cores with parylene coating (TC): 1000 V_{DC}

Core type / Material Colour Code	4A11	3B7	3D3	3E6	3E7	3E27	3E28	3S4
TC2.5/1.3/0.8	94	-	-	-	-	-	-	-
TC2.5/1.3/1.3	150	-	-	1835	-	-	-	300 des
TC2.5/1.5/0.8	-	-	-	765	-	-	-	-
TC3.1/1.3/1.3	190	-	-	-	-	-	-	-
TC3.1/1.8/2	-	-	-	-	-	-	1100 des	-
TC3.4/1.8/1.3	-	375 sup	110 sup	1580	-	-	-	-
TC3.5/1.8/1.8	-	-	-	-	-	-	950 des	-
TC3.5/1.8/2	-	-	-	-	-	-	1060 des	-
TC3.9/2.2/1.3	-	325 sup	97 sup	-	-	-	-	-
TC4/2/1.6	-	-	-	-	-	-	1220 des	-
TC4/2/2	-	-	-	-	-	-	1110 des	-
TC4/2.2/1.1	92	-	-	1315	-	-	-	-
TC4/2.2/1.6	134	-	-	1915	-	-	-	325 des
TC4/2.2/1.8	-	-	-	2128	-	-	-	-
TC5.8/3.1/1.5	-	450 sup	-	-	-	890	-	-
TC5.8/3.1/3.2	-	940 sup	-	-	-	-	-	-
TC5.8/3.1/4.6	-	1360 sup	-	-	-	-	-	-
TC5.9/3.1/3.1	-	-	-	3960	-	-	-	-
TC6/4/2	114	-	-	1620	-	-	-	275 des
TC6/4/3	-	-	-	2430	-	-	-	-
TC6.3/3.8/2.5	-	-	-	2530	3600 des	-	-	-
TC9/6/3	-	-	-	2435	-	-	-	-
T9.5/4.8/3.2	-	1000 sup	-	-	-	-	-	-
TC9.5/4.8/3.2	-	1000 sup	330 sup	4390	5323 des	2135	-	-
TC9.5/4.8/4.8	-	-	-	6626	-	-	-	-

1200 — nominal A_L value (nH) measured at $\hat{B} \leq 0.1$ mT, $f \leq 10$ kHz, T = 25°C

1) coated with parylene C (no colour code)
2) lacquered with polyurethane
3) uncoated

A_L tolerance: ± 20% | ± 25% | ± 30% | + 40% / − 30% | + 25% / − 20% | + 30% / − 40% | + 20% / − 40%

T = Toroid (Ring Core), TN = Toroid Nylon coated, TC = Toroid parylene C coated

Ferrite Ceramics

Microwave ferrites

property	conditions				microwave ferrites		
symbol	f (MHz)	H (A/m)	T (°C)	unit	5G1	5G2	5G8
J_S		8×10^5	25 ± 5	mT	178 ± 9	100 ± 9	182.5 ± 9
ΔH	9600			A/m	2000 ± 600	1800 ± 600	< 800
ΔH_K	9600			A/m	> 24	–	> 24
H_C		800		A/m	35	–	15.9
tan $\delta(\varepsilon)$	9600			$.10^4$	< 2	< 2	< 3
ε^1_r					15.5 ± 0.5	14.6 ± 0.5	15.3 ± 0.75
g			25 ± 5		2.00	2.05	2.00
B_r		800		mT	120	–	102
B_s		800		mT	145	–	–
T_C				°C	240	220	230
ρ			25 ± 5	Ωm	$> 10^4$	$> 10^4$	$> 10^8$
density				kg/m^3	5140	5060	5210

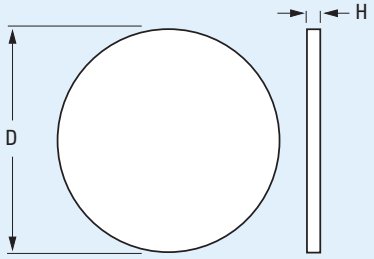
Microwave components

Isolators and circulators are key components in microwave technology. Isolators are used to separate an amplifier from its load, to avoid possible damage by reflected power. Circulators make it possible for transmitters to share the same antenna, or to use an antenna for simultaneous transmission and reception. Both components are based on special microwave ferrite grades, usually yttrium ferrites, also known as garnets.

Our product range

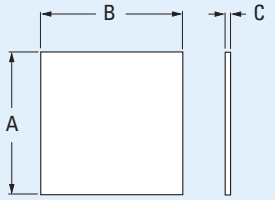
We offer microwave ferrite materials as blocks, discs and substrates, in standard sizes or user-defined.

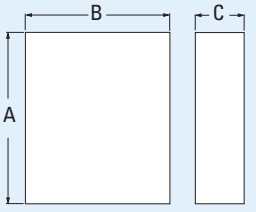
discs



type number	D (mm)	H (mm)	mass (g)
DSC25/1.5-5G1	25	1.5	≈ 3.8
DSC27/1.5-5G1	27	1.5	≈ 4.4
DSC32/1-5G1	32	1.0	≈ 4.1
DSC32/2-5G1	32	2.0	≈ 8.2
DSC37/1-5G1	37	1.0	≈ 5.5
DSC37/1.5-5G1	37	1.5	≈ 8.2
DSC51/1.5-5G1	51	1.5	≈ 10.5
DSC56/2.9-5G1	56	2.9	≈ 12.5
DSC67/2-5G1	67	2.0	≈ 36
DSC20/1-5G2	20	1.0	≈ 1.6
DSC25/1-5G2	25	1.0	≈ 2.5
DSC25/1-5G8	25	1.0	≈ 2.5

plates





PLT25/25/0.5-5G1

A	B	C
$25.4^{+0.01}_{-0.04}$	$25.4^{+0.01}_{-0.04}$	0.51 ± 0.005
mass (g)		
≈ 1.6		

PLT104/90/32-5G1

A	B	C
103.5 ± 0.3	89.5 ± 0.5	31.5 ± 0.5
mass (g)		
≈ 1500		

PLT38/25/0.5-5G1

A	B	C
$38.1^{+0.01}_{-0.04}$	$25.4^{+0.01}_{-0.04}$	0.51 ± 0.005
mass (g)		
≈ 2.4		

property	conditions				ferrites for magnetic recording			
symbol	f (kHz)	$\hat{B}$ or H	T (°C)	unit	8E1	8E2	8E21	8X1
μ_i	≤ 10	≤ 0.1	25		3200	2800	3600	1800[1)]
B_s	ballistic	250	25	mT	400	490	490	490
tan δ / μ_i	100	≤ 0.1	25	$.10^{-6}$	3	3	2.5	2
η_B	100	1.5 to 3	25	$.10^{-3}\ T^{-1}$	0.5	0.5	0.5	–
P_V	45	100	25	kW/m^3	40	40	20	–
			85		60	60	20	–
T_C	10	≤ 0.1		°C	180	180	210	180
ρ	DC		25	Ωm	≈ 5	≈ 5	≈ 3	≈ 0.003
density			25	kg/m^3	≈ 4700	≈ 4700	≈ 4750	≈ 5000

Properties measured on sintered, unground ring cores of dimensions ∅25 x ∅15 x 10 which are not subjected to external stresses.

Note: 1 Typical μ_i = 600 at 5 MHz measured on a ring core ∅9 x ∅5 x 0.2 mm.

Magnetic heads

Magnetic heads are devices that can read and write on magnetic media such as tapes and discs. They are used throughout industry, from simple audio cassette recorders and video recorders to advanced disc drives in computer peripherals.

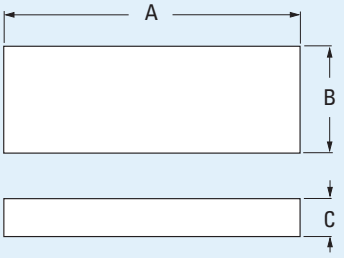
The basic function is always the same: a small soft magnetic circuit with a winding and a short airgap running in contact or almost in contact with the magnetic recording medium.

During writing, the coil induces a magnetic flux which protrudes from the airgap, thus aligning the magnetic particles in the medium. During reading the field of the aligned particles is detected by the core area around the airgap which generates a voltage in the winding.

For the writing operation, it is important that the ferrite has a high saturation flux density, for reading the permeability should be high enough to cover the entire frequency range used. Some magnetic heads, like video heads, are so small that the use of a polycrystalline material leads to unacceptable spread in properties. The active area would contain only a few crystals which have different properties depending on orientation of their crystal lattices. Therefore, for such heads, monocrystals are used, which are cut in the preferred crystal plane. Especially for magnetic heads running in contact with the tape, the ferrite should be dense, virtually without pores and resistant to abrasion. Most of the designs are customized. Blocks and plates can be delivered to manufacturers of the complete devices for further machining.

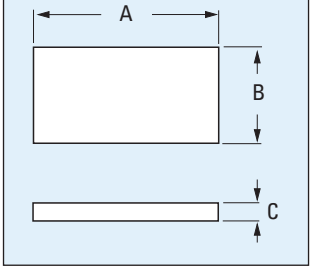
Ferrite choice	
audio heads	*8E1, 8E2, 8E21*
video heads	*8X1*

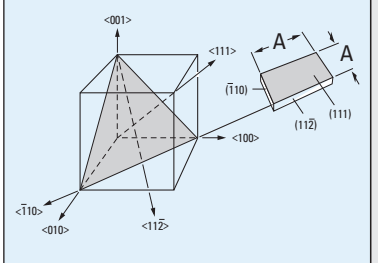
plates and bars



type number	A (mm)	B (mm)	C (mm)
PLT100/28/13-8E1	100	28	12.5
PLT100/35/7.8-8E2	100	35	7.8
PLT100/35/13-8E1	100	35	12.5
PLT100/35/14-8E1	100	35	14
PLT100/49/14-8E1	100	49	14
BAR215/39/26-8E21	215	39	26

single-crystal plates





type number	A (mm)	A (mm)	B (mm)	orientation
PLT16/8/1.5-8X1	16	8	1.52	111

Single-crystal ferrite

This MnZn single-crystal ferrite is mainly used for the manufacture of video recorder heads. The unique magnetic properties, homogeneity, outstanding wear resistance and the possibility to machine this material to extremely tight tolerances, makes 8X1 ideal for this and other applications where a specified signal level with high information density on a narrow track is required. The magnetic and mechanical characteristics of MnZn single-crystal ferrites depend on the direction of orientation of the crystal.

Piezoelectric Ceramics

The nature of piezoelectric ceramics

Piezoelectricity is the general term to describe the property exhibited by certain crystals of becoming electrically polarized when stress is applied to them. Quartz is a good example of a piezoelectric crystal. If stress is applied to such a crystal, it will develop an electric moment proportional to the applied stress.

This is the direct piezoelectric effect. Conversely, if it is placed in an electric field, a piezoelectric crystal changes its shape slightly. This is the inverse piezoelectric effect.

An important group of piezoelectric materials are the piezoelectric ceramics, of which PXE (Philips trade mark) is an example. These are polycrystalline ferroelectric materials with the perovskite crystal structure. They have the general formula ABO_3, in which A denotes a large divalent metal ion such as Pb and B denotes a small tetravalent metal ion such as Zr or Ti.

PXE can be fashioned into components of almost any shape and size. As well as being strongly piezoelectric, PXE is hard, chemically inert and unaffected by humid environments.

PXE ceramics are solid solutions of lead titanate ($PbTiO_3$) and lead zirconate ($PbZrO_3$), modified by additives, a group of piezoceramics generally known as PZT. They are available in several grades distinguished by their electrical and physical properties to meet particular requirements.

In a ferroelectric crystal, each cell of the crystal lattice spontaneously polarizes along one of the allowed directions. This spontaneous polarization disappears at a critical temperature (the Curie temperature), above which the crystal becomes paraelectric.

A PXE ceramic may be regarded as mass of minute crystallites, randomly oriented. After it has been sintered,the ceramic material will be isotropic and will exhibit no piezoelectric effect because of this random orientation. The ceramic may be made piezoelectric in any chosen direction by a poling treatment which involves exposing it to a strong electric field. When the field is removed, the dipoles remain locked in formation (i.e. making it anisotropic), as well as making it permanently piezoelectric. This poling treatment is usually the final stage of PXE component manufacture.

A PXE component will usually have metal electrodes deposited on its surface perpendicular to its poling axis.

Application areas

The piezoelectric effect is used in many interesting applications throughout industry.

- Conversion of mechanical into electrical energy (generators), e.g. spark igniters, solid-state batteries.
- Conversion of mechanical force into electrical signals (sensors), e.g. crash sensor, knock sensor.
- Conversion of electrical signals into mechanical displacement (actuators), e.g. linear motors, pneumatic valves, fuel-injection valves, printers.
- Conversion of electrical into mechanical energy (transducers), e.g. buzzers, echo-sounders, ultrasonic cleaning, atomizers.

Piezoelectric Ceramics

Materials properties

Electrical connections

An electrical contact can be made by soldering, glueing or clamping wires to the silver, nickel or gold electrodes.

Soldering

The electrode surface should be free from grease and dust.When tarnished, an india rubber eraser may be used to lightly clean the silver.

Suggested soldering method:

- soldering iron: standard 25 to 50 W type with copper bit
- soldering iron temperature: 300 to 350°C for silver electrodes and 400°C for nickel electrodes
- preferred solder: Sn/Pb 60/40, with slightly activated resin, e.g.. 'Fluitin' (SnPb 60/1532); 'Billiton' (SnPb 60/RS4); or 'Multicore' (SnPb 60/366)
- soldering time: 1 to 3 s
- standard wire diameter: 0,3 mm, or fine-stranded flex

The soldering time should be kept as short as possible; otherwise, the disc or plate may be partly depolarized (to an extent dependent upon temperature and time).

Safety and environmental aspects

Environmental aspects of piezoceramics

Our piezoceramic products generally consist of one or more layers of ceramic materials (PXE) covered with metal electrodes.
The chemical composition of the range of PXE grades is Pb(ZrTi) Ox (lead titanate zirconate) with some minor dopants of, for example La. Sr or Fe.
More exactly PXE5 has the following main composition (weight percent)

PbO	66%
ZrO_2	21%
TiO_2	11%

Silver (Ag) electrodes have a thickness of some microns (µm) whereas nickel (Ni), electrodes, combined with some chromium (Cr) have a thickness of about 0,5 µm. Materials and electrodes contain no measurable amounts of cadmium (Cd).

General warnings

- With strong acids, the metals chromium, nickel and silver may be partially extracted. Other metals may also be extracted on a smaller scale, due to their very strong chemical bonds.
- In a fire, at temperature higher than 800°C, lead oxide will evaporate from the products.
- Dispose as industrial, chemical or special waste depending on local rules and circumstances.

	property and symbol	PXE 5	PXE 52	PXE 59	unit
thermal data	**Curie temperature**	285	165	360	°C
	specific heat	420	420	420	J/kg K
	thermal conductivity	1.2	1.2	1.2	W/m K
mechanical data	**density** ρ_m	7.8	7.8	7.9	10^3 kg/m^3
	compliance				
	s^E_{33}	18	20	18	10^{-12}/Pa
	s^E_{11}	15	16	16	10^{-12}/Pa
	s^E_{55}	39	-	45	10^{-12}/Pa
	Poisson's ratio σ	0.3	0.3	0.35	
	mechanical quality factor for radial mode Q^E_m	75	65	80	
	frequency constants				
	N^E_p	1975	1925	1970	Hzm or m/s
	$N^D_3 = 1/2\upsilon^D_3$	1850	1800	2060	Hzm or m/s
	$N^E_1 = 1/2\upsilon^E_1$	1450	1400	1400	Hzm or m/s
	$N^E_5 = 1/2\upsilon^E_5$	930	-	900	Hzm or m/s
	compressive strength	> 600	> 600	> 600	10^6 Pa
	tensile strength	80	80	100	10^6 Pa

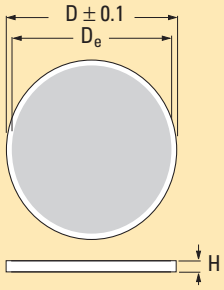
Properties measured on discs of dimensions ∅16 x 1

	property and symbol	PXE 5	PXE 52	PXE 59	unit
electrical data	relative permittivity (ε_o= 8.85 x 10^{-12} F/m)				
	$\varepsilon^{T}_{33}/\ \varepsilon_o$	2100	3900	1850	
	$\varepsilon^{T}_{11}/\ \varepsilon_o$	1800	3300	1650	
	resistivity ρ	5	1	5	$10^{10}\ \Omega$m
	time constant $\rho\varepsilon^{T}_{33}$ (25°C)	> 300	> 500	> 100	minute
	dielectric loss factor tan δ	20	16	17	10^{-3}
electro-mechanical data	coupling factor				
	k_p	0.68	0.70	0.66	
	k_{33}	0.75	0.80	0.71	
	k_{31}	0.38	0.39	0.37	
	k_{15}	0.66	-	0.68	
	piezoelectric charge constants				
	d_{33}	500	700	460	10^{-12} C/N or m/V
	d_{31}	– 215	– 280	– 195	10^{-12} C/N or m/V
	d_{15}	515	-	550	10^{-12} C/N or m/V
	piezoelectric voltage constants				
	g_{33}	24	20	28	10^{-3} Vm/N or m^2/C
	g_{31}	– 10	– 10	– 13	10^{-3} Vm/N or m^2/C
	g_{15}	33	-	37	10^{-3} Vm/N or m^2/C
time stability (%)	coupling factor k_p	– 0.5	– 0.6	– 0.1	relative change per time decade (days)
	permittivity ε^{T}_{33}	– 1.0	– 1.0	– 2	
	frequency constant N^{E}_{p}	0.5	0.3	0.1	
	quality factor Q^{E}_{m}	-	–3.0	0.1	
	dielectric loss factor tan δ	-	-	– 0.1	

Piezoelectric Ceramics

Discs

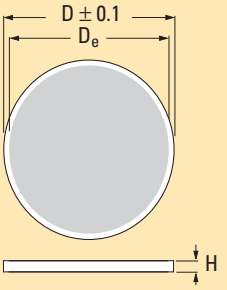
discs with nickel electrodes



type number	D (mm)	De (mm)	H (mm)	Cap. (pF)
DSC5/0.3-PX5-N	5	5.0 ± 0.1	0.3 ± 0.03	1220 ± 25%
DSC5/0.5-PX5-N	5	5.0 ± 0.1	0.5 ± 0.03	750 ± 25%
DSC5/1-PX5-N	5	5.0 ± 0.1	1.0 ± 0.03	375 ± 25%
DSC5/2-PX5-N	5	5.0 ± 0.1	2.0 ± 0.1	185 ± 25%
DSC10/0.2-PX5-N	10	9.0 ± 0.3	0.2 ± 0.03	5900 ± 25%
DSC10/0.5-PX5-N	10	9.0 ± 0.3	0.5 ± 0.03	2360 ± 25%
DSC10/1-PX5-N	10	9.5 ± 0.3	1.0 ± 0.03	1390 ± 25%
DSC10/2-PX5-N	10	9.5 ± 0.3	2.0 ± 0.1	700 ± 25%
DSC10/3-PX5-N	10	9.5 ± 0.3	3.0 ± 0.1	460 ± 25%
DSC10/5-PX5-N	10	9.5 ± 0.3	5.0 ± 0.1	280 ± 25%
DSC16/0.2-PX5-N	16	15.0 ± 0.3	0.2 ± 0.03	17000 ± 25%
DSC16/0.5-PX5-N	16	15.5 ± 0.3	0.5 ± 0.03	6800 ± 25%
DSC16/1-PX5-N	16	15.5 ± 0.3	1.0 ± 0.03	3620 ± 25%
DSC16/2-PX5-N	16	15.5 ± 0.3	2.0 ± 0.1	1800 ± 25%
DSC16/3-PX5-N	16	15.5 ± 0.3	3.0 ± 0.1	1200 ± 25%
DSC20/0.2-PX5-N	20	19.0 ± 0.3	0.2 ± 0.03	27000 ± 25%
DSC20/0.5-PX5-N	20	19.5 ± 0.3	0.5 ± 0.03	10800 ± 25%
DSC20/1-PX5-N	20	19.5 ± 0.3	1.0 ± 0.03	5700 ± 25%
DSC20/2-PX5-N	20	19.5 ± 0.3	2.0 ± 0.1	2850 ± 25%
DSC25/0.2-PX5-N	25	24.0 ± 0.3	0.2 ± 0.03	42925 ± 25%
DSC25/0.5-PX5-N	25	24.5 ± 0.3	0.5 ± 0.03	17200 ± 25%
DSC25/1-PX5-N	25	24.5 ± 0.3	1.0 ± 0.03	9000 ± 25%
DSC25/2-PX5-N	25	24.5 ± 0.3	2.0 ± 0.1	4500 ± 25%

remark: Other grades and sizes are available on request. The positive pole is marked.

discs with silver electrodes

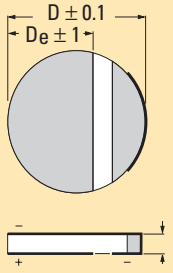


type number	D (mm)	De (mm)	H (mm)	Cap. (pF)
DSC5/0.3-PX5-S	5	= D	0.3 ± 0.03	1220 ± 25%
DSC5/0.5-PX5-S	5	= D	0.5 ± 0.03	750 ± 25%
DSC5/1-PX5-S	5	= D	1.0 ± 0.03	375 ± 25%
DSC5/2-PX5-S	5	= D	2.0 ± 0.1	185 ± 25%
DSC10/0.5-PX5-S	10	9 ± 0.3	0.5 ± 0.03	2360 ± 25%
DSC10/1.0-PX5-S	10	= D	1.0 ± 0.03	1460 ± 25%
DSC10/2-PX5-S	10	= D	2.0 ± 0.1	730 ± 25%
DSC10/3-PX5-S	10	= D	3.0 ± 0.1	490 ± 25%
DSC10/5-PX5-S	10	= D	5.0 ± 0.1	290 ± 25%
DSC16/0.5-PX5-S	16	15 ± 0.3	0.5 ± 0.03	6800 ± 25%
DSC16/1-PX5-S	16	= D	1.0 ± 0.03	3735 ± 25%
DSC25/0.5-PX5-S	25	24 ± 0.3	0.5 ± 0.03	17200 ± 25%
DSC25/1-PX5-S	25	= D	1.0 ± 0.03	9125 ± 25%
DSC25/2-PX5-S	25	= D	2.0 ± 0.1	4560 ± 25%
DSC32/14-PX41-S-T	31.75 ± 0.5	-	≈ 14.3[1)]	650 ± 25%
DSC25/10-PX41-S-T	25.4 ± 0.5	-	≈ 10.2[2)]	550 ± 25%
DSC25/1-PX42-S	25.0 ± 0.1	-	1 ± 0.1	5750 ± 25%
DSC25/2-PX42-S	25.0 ± 0.1	-	2 ± 0.1	2870 ± 25%
DSC38/3-PX42-S	38.0 ± 0.5	-	3 ± 0.1	4430 ± 25%
DSC38/6-PX42-S	38.0 ± 0.5	-	6 ± 0.1	2215 ± 25%
DSC50/3-PX42-S	50.0 ± 1.0	-	3 ± 0.1	7670 ± 25%
DSC50/6-PX42-S	50.0 ± 1.0	-	6 ± 0.1	3835 ± 25%

Remark: Other grades and sizes are available on request. The positive pole is marked.

[1)] Tuned for 151 kHz [2)] Tuned for 200 kHz

discs with linear wrap-around electrode

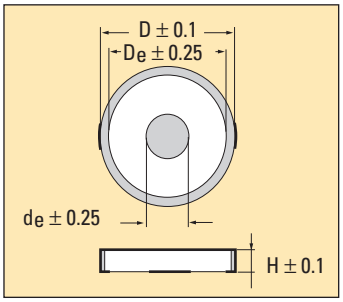


DSC10/1/WL-PX5-S		
D (mm)	D_e (mm)	H (mm)
10	6.5	1
capacitance (pF)		
1000 ± 25%		

DSC16/1/WL-PX5-S		
D (mm)	D_e (mm)	H (mm)
16	10	1
capacitance (pF)		
2600 ± 25%		

These discs are designed for connecting both electrodes from one side by means of a wrap-around electrode as shown. They are therefore particularly suitable for bonding to flat substrates where electrical connection to both sides is difficult.Other grades and sizes are available on request.

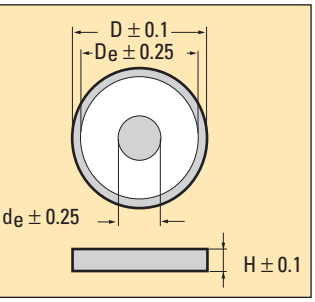
discs with round wrap-around electrode



DSC20/0.9/WR-PX42-S			
D (mm)	D_e (mm)	d_e (mm)	H (mm)
20	17	7	0.85
capacitance (pF)			
730 ± 20%			

DSC20/1.2/WR-PX42-S			
D (mm)	D_e (mm)	d_e (mm)	H (mm)
20	17	7	1.2
capacitance (pF)			
520 ± 20%			

discs with round wrap-around electrode

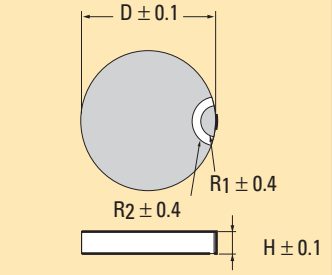


DSC16/2/WR-PX5-G			
D (mm)	D_e (mm)	d_e (mm)	H (mm)
16	13.1	7	2
capacitance (pF)			
490 ± 20%			

DSC25/2/WR-PX5-G			
D (mm)	D_e (mm)	d_e (mm)	H (mm)
25	22.7	8	2
capacitance (pF)			
640 ± 20%			

DSC25.4/2/WR-PX5-G			
D (mm)	D_e (mm)	d_e (mm)	H (mm)
25.4	22.7	8	2
capacitance (pF)			
640 ± 20%			

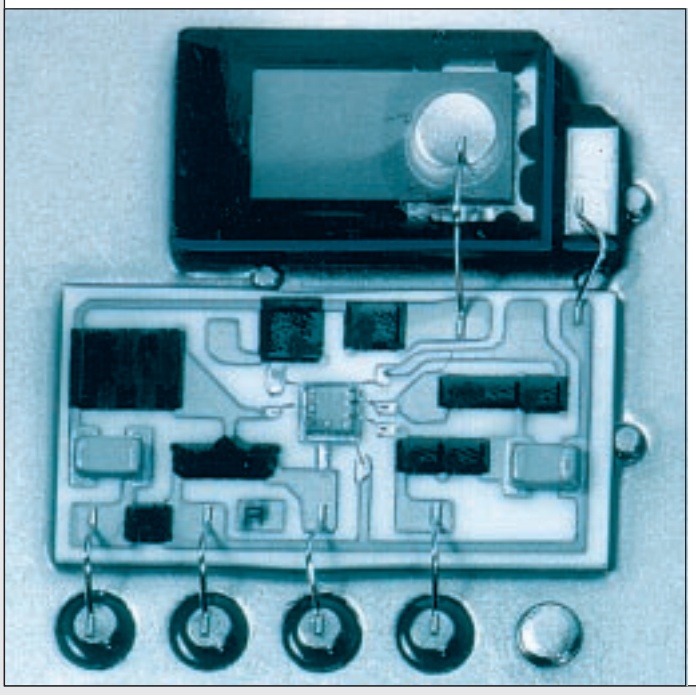
discs with circular wrap-around electrode



DSC16/1/WC-PX5-S			
D (mm)	R1 (mm)	R2 (mm)	H (mm)
16	2.6	3.6	1
capacitance (pF)			
3350 ± 25%			

DSC20/1/WC-PX5-S			
D (mm)	R1 (mm)	R2 (mm)	H (mm)
20	3	4	1
capacitance (pF)			
5230 ± 25%			

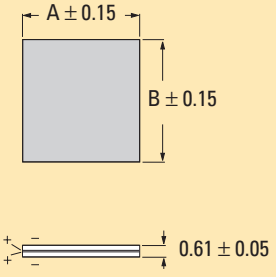
DSC25/1/WC-PX5-S			
D (mm)	R1 (mm)	R2 (mm)	H (mm)
25	3	4	1
capacitance (pF)			
8200 ± 25%			



Piezoelectric Ceramics

Bimorph elements

series bimorph elements

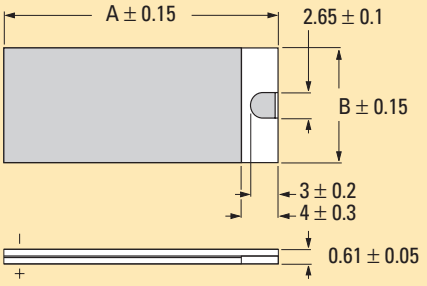


Type number	A (mm)	B (mm)	Capacitance (pF)
BIMS4/4/0.6-PX5-N	4.0	4.0	420 ± 20%
BIMS6/4/0.6-PX5-N	6.0	4.0	630 ± 20%
BIMS8/4/0.6-PX5-N	8.0	4.0	840 ± 20%
BIMS10/4/0.6-PX5-N	10.0	4.0	1050 ± 20%
BIMS12/4/0.6/PX5-N	12.0	4.0	1250 ± 20%
BIMS6/6/0.6-PX5-N	6.0	6.0	950 ± 20%
BIMS8/6/0.6-PX5-N	8.0	6.0	1250 ± 20%
BIMS10/6/0.6-PX5-N	10.0	6.0	1600 ± 20%
BIMS12/6/0.6-PX5-N	12.0	6.0	1900 ± 20%
BIMS8/8/0.6-PX5-N	8.0	8.0	1700 ± 20%
BIMS10/8/0.6-PX5-N	10.0	8.0	2100 ± 20%
BIMS12/8/0.6-PX5-N	12.0	8.0	2550 ± 20%
BIMS10/10/0.6-PX5-N	10.0	10.0	2650 ± 20%
BIMS12/10/0.6-PX5-N	12.0	10.0	3150 ± 20%
BIMS12/12/0.6-PX5-N	12.0	12.0	3800 ± 20%
BIMS13/1.6/0.6-PX5-N	12.7	1.6	535 ± 20%
BIMS16/1.6/0.6-PX5-N	15.5	1.6	650 ± 20%
BIMS70/1.6/0.6-PX5-N	70.0	1.6	3000 ± 20%

A range of square and rectangular bimorphs in grade PXE 5 for use as sensors in record players, accelerometers, detection systems in machinery, medical equipment and air transducers. The electrodes are nickel-plated. Series bimorphs are not recommended for use as actuators.

Remark: Other sizes are available on request

parallel bimorph elements



Type number	A (mm)	B (mm)	Cap. (pF)[1]	F_r MIN. (Hz)	Defl. (μm)[2]
BIMP15/6/0.6-PX5-N	15	6	9000	2200	85 ± 20%
BIMP20/6/0.6-PX5-N	20	6	13000	1000	195 ± 20%
BIMP25/6/0.6-PX5-N	25	6	16500	500	335 ± 20%
BIMP30/6/0.6-PX5-N	30	6	20000	350	525 ± 20%
BIMP35/6/0.6-PX5-N	35	6	24000	240	750 ± 20%
BIMP15/12/0.6-PX5-N	15	12	18000	2200	85 ± 20%
BIMP20/12/0.6-PX5-N	20	12	25000	1000	195 ± 20%
BIMP25/12/0.6-PX5-N	25	12	33000	500	335 ± 20%
BIMP30/12/0.6-PX5-N	30	12	40000	350	525 ± 20%
BIMP35/12/0.6-PX5-N	35	12	48000	240	750 ± 20%

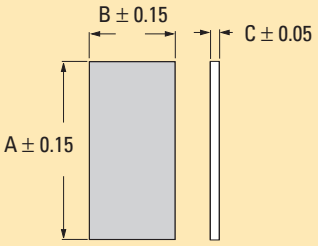
A range of rectangular parallel bimorph elements in grade PXE 5.The electrodes are nickel-plated and the inner electrode is accessible through a small cut-out in the upper plate. Parallel bimorphs are especially recommended for use as actuators.

Remark: Other sizes are available on request

[1] The capacitance between the central electrode and the interconnected outer electrodes

[2] Deflection peak-to-peak at 300 V peak-to-peak (± 150 V) with free length is A - 5mm
Bimorph not mechanically loaded

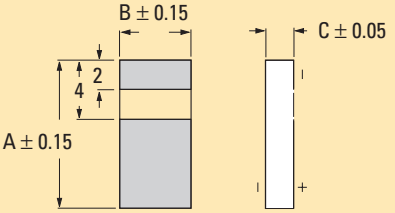
square and rectangular plates



type number	A (mm)	B (mm)	C (mm)	capacitance (pF)
nickel electrodes				
PLT4/4/0.3-PX5-N	4	4	0.3	990 ± 20%
PLT6/6/0.3-PX5-N	6	6	0.3	2230 ± 20%
PLT8/4/0.3-PX5-N	8	4	0.3	1980 ± 20%
PLT8/8/0.3-PX5-N	8	8	0.3	3960 ± 20%
PLT10/10/0.3-PX5-N	10	10	0.3	6200 ± 20%
PLT12/4/0.3-PX5-N	12	4	0.3	2970 ± 20%
PLT12/6/0.3-PX5-N	12	6	0.3	4460 ± 20%
PLT12/6/0.5-PX5-N	12	6	0.5	2670 ± 20%
PLT12/6/1.0-PX5-N	12	6	1.0	1340 ± 20%
PLT12/12/0.3-PX5-N	12	12	0.3	8920 ± 20%
silver electrodes				
PLT12/6/0.5-PX5-S	12	6	0.5	2670 ± 20%
PLT12/6/1-PX5-S	12	6	1	1340 ± 20%
PLT12/6/1.3-PX5-S	12	6	1.25	1070 ± 20%
PLT16/12/1-PX5-S	16	12	1	3500 ± 20%

The material grade in the tables is PXE 5, but other grades and sizes are available on request (any thickness between 0.2 and 3.0 mm is possible). The positive pole is marked.

plates with wrap-around electrodes



type number	A (mm)	B (mm)	C (mm)	capacitance (pF)
PLT10/4/1/W-PX5-S	10	4	1	480 ± 25%
PLT10/4/2/W-PX5-S	10	4	2	240 ± 25%
PLT10/5/1/W-PX5-S	10	5	1	600 ± 25%
PLT10/5/2/W-PX5-S	10	5	2	300 ± 25%
PLT15/5/2/W-PX5-S	15	5	2	550 ± 25%

These plates have provision for connecting both electrodes from one side by means of a wrap-around electrode as shown. They are therefore particularly suitable for bonding to flat substrates where electrical connection to both sides is difficult. The material is PXE 5, but other grades and sizes are available on request.

Notes