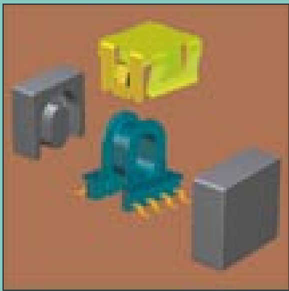
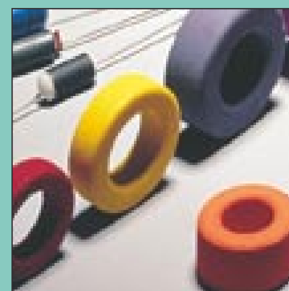
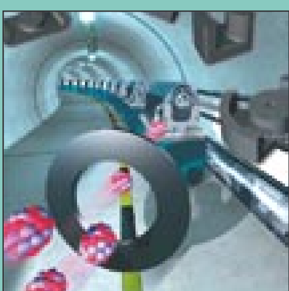
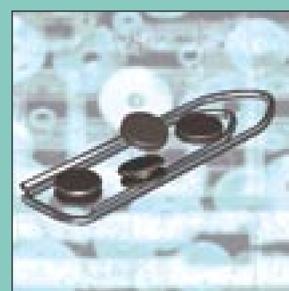
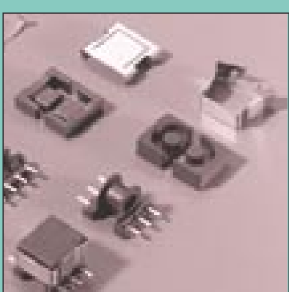
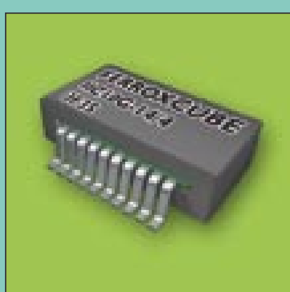
PRODUCT SELECTION GUIDE 2003

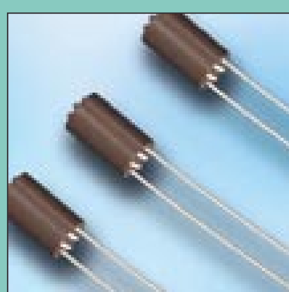


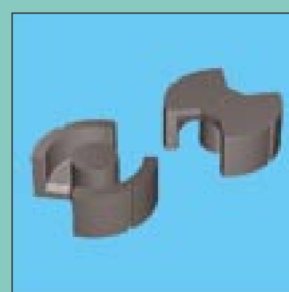


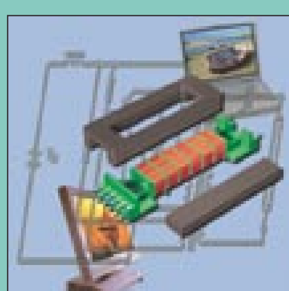
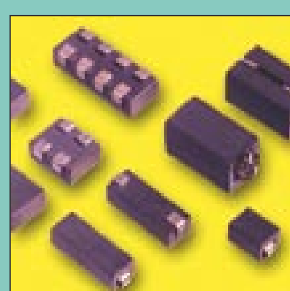
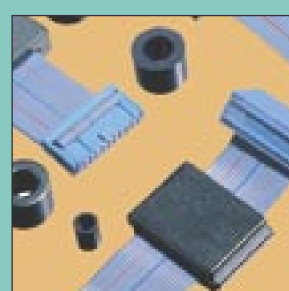










FERROXCUBE
A YAGEO COMPANY

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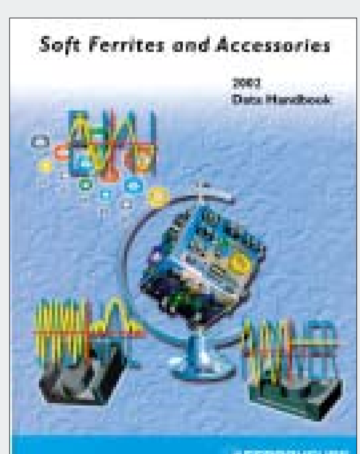
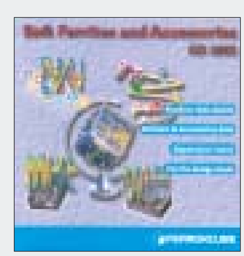
This Selection Guide offers an overview of the product ranges made by FERROXCUBE

It contains short-form data for quick selection by development engineers and offers an overview for purchasing, production and service departments. For information on availability and prices, please contact our Sales representatives.

Comprehensive data can be found in Data Handbook "Soft Ferrites and Accessories 2002" as well as on the CD2002. For the latest info, please visit our web site on www.ferroxcube.com.





FERROXCUBE

Formerly a Philips Components company we now belong to the Yageo Corporation, one of the world's strongest suppliers of passive components. Building on our Philips magnetic components heritage, FERROXCUBE can offer customers the highest level of support in the development of their new innovative designs. Our competencies cover soft ferrite products and accessories. All developed to meet today's demanding high-frequency, low-loss and environmental requirements. We also offer extensive design-in support including application information and software to help equipment manufacturers optimize their new designs. Contact us to find out!

FERROXCUBE, widely recognized as a leading supplier of ferrite components, has manufacturing operations, sales offices, and customer service centers all over the world. Ferrite components and accessories from FERROXCUBE are used in a wide range of applications, from telecommunications and computing electronics through consumer electronic products to automotive.

Innovation for tomorrow's applications.
As a leading innovator in ferrite-ceramic technology, we supply one of the broadest ranges of high-quality, innovative products and place strong emphasis on miniaturization of magnetic functions. Our aim -to support today's digital electronics markets with products combining miniaturization with ever-greater functionality.

Business excellence
For us, the ferrite components business is more than supplying high-quality products. It's about striving for quality and excellence in everything we do, including customer support and service.

Committed to environmental care.
Our commitment towards excellence applies also to the environment. We strive for highest standards of health and safety for everyone.

Advanced application support gives you the edge

Modern requirements for magnetic products are often so specific that only customized products will suffice. This means your supplier must be able to offer comprehensive design and application support.

Our application teams are always ready to answer enquiries from customers and to work with them in solving specific design problems.

To support their activities, we use our own software tools to optimize core shapes for new standard ranges and customized designs.

Innovative solutions in ferrite components

Our ferrite-based products, have been developed to support today's manufacturers throughout the industry in their drive for ever higher functionality, greater miniaturization, reduced power consumption and lower weight. What's more, our Innovation Centers, strategically located worldwide, are constantly developing solutions for designs with functions such as RF filtering and tuning, impedance matching, line termination, signal delay, coupling and safety isolation for today's and future generations of equipment. As pioneers in interference suppression, we offer a broad range of ceramic-based solutions for both on-board and in-line EMI suppression. We are constantly working to develop ever more effective solutions for EMI suppression to support manufacturers in meeting current and future EMC (Electromagnetic Compatibility) requirements.

Innovative solutions we offer include:

- Low-profile planar cores offering exceptionally low build height in transformer designs and excellent thermal characteristics.
- Integrated Inductive Components (IICs) which integrate several inductive functions required of a circuit into a compact IC-like surface-mount package.
- Low-loss ferrite cores that allow exceptional levels of transformer miniaturization.
- New core shapes and a new ferrite material for DSL transformers featuring very low THD-levels.
- Ferrite EMI suppression products in a broad range of shapes and configurations meeting the diverse requirements of our customers
- Toroids in high-permeability (10000) ferrite materials for highly-effective damping and filtering
- Multilayer suppressors offering the benefits of effective noise attenuation and miniaturization

We also assist 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.

Ordering information

The products in this guide are identified by type numbers. All physical and technical properties of the product are covered by these numbers. They are therefore recommended for both ordering and use on technical drawings and equipment parts lists. The 12-digit code, used in former editions of our data handbooks, also appears on Smallest Packaging Quantities (SPQ). These are packs which are ready for shipment to our customers. The information on the bar coded label consists of:

Technical information:

- Type number
- 12-digit code number
- Delivery and/or production batch numbers

Logistic information:

- 12-digit code number
- Quantity
- Country of origin
- Production week
- Production centre.

During all stages of the production process, data are collected and documented with reference to a unique batch number, which is printed on the packaging label. With this batch number it is always possible to trace the results of process steps afterwards and in the event of customer complaints, this number should always be quoted.

Products are available throughout their life cycle. A short definition of product status is given in the table. Besides the products listed in this catalog, we can also offer customized or application specific ferrite cores, bobbins and accessories.

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

PRODUCT STATUS DEFINITIONS

STATUS	INDICATION	DEFINITION
Prototype	prot	These are products that have been made as development samples for the purpose 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 designs.
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 our sales channels. Customers are advised to check for availability.

The nature of Soft Ferrites

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

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 (Tc) 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 have higher permeabilities (μ_i) and saturation induction levels (Bs).

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.

Environmental aspects of Soft Ferrites

Our range of soft ferrites has the general composition $MeFe_20_4$ where Me represents one or several of the divalent transition metals such as manganese (Mn), zinc (Zn) or nickel (Ni). To be more specific, all materials starting with digit 3 are manganese zinc ferrites based on the MnZn composition. Their general chemical formula is:

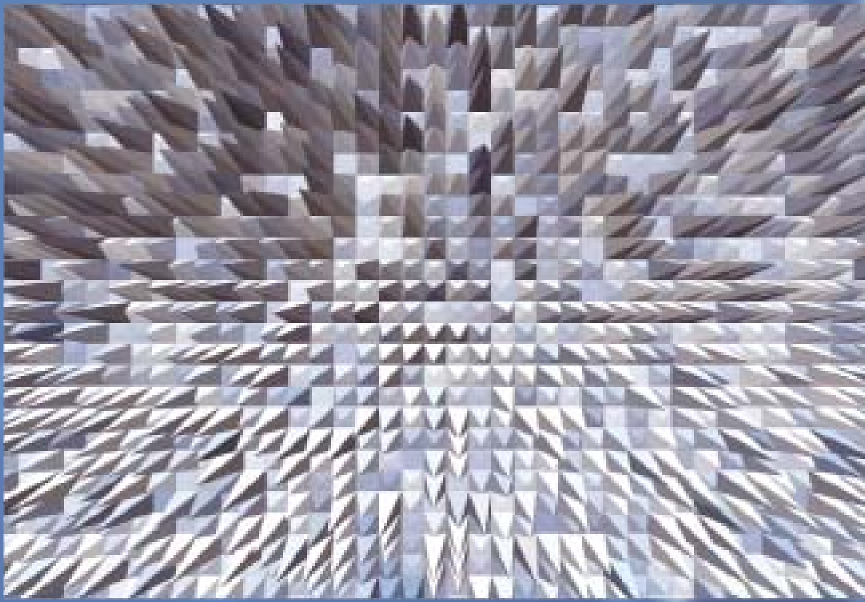
$Mn_\delta\ Zn(1\text{-}\delta)\ Fe_2O_4$

Materials starting with digit 4 are nickel zinc ferrites based on the NiZn composition. Their general chemical formula is:

$Ni_\delta\ Zn(1\text{-}\delta)\ Fe_2O_4$

General warning rules

With strong acids, the metals iron, manganese, nickel and zinc may be partially extracted. In the event of fire, dust particles with metal oxides will be formed. Disposal as industrial waste, depending on local rules and circumstances.



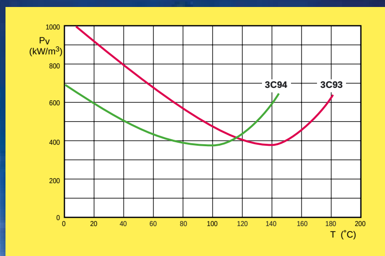
Need more information? Visit our web site on www.ferroxcube.com

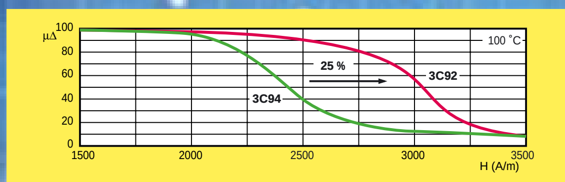
Our new site reflects our new focus on supporting the fast growing digital-electronics markets with a truly global range of ferrite products, bobbins and accessories. Here you will find extensive data on our full product range, plus application information to support your design-indecisions.

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. It also provides direct links to the web-sites of our distributors.

Our worldwide sales offices and distributors are happy to answer any questions you may have.

New products and Highlights





Application Matrix

POWER CONVERSION				
Application area / Magnetic function	Telecommunication	Electronic Data Processing (EDP)	Sound and Vision	Lighting
Current transformers	3B7, 3C81, 3C90, 3C91, 3C92, 3E5, 3E6, 3E7, 3E27, 3F35, 4C65	3B7, 3C81, 3C90, 3C91, 3C92, 3E5, 3E6, 3E7, 3E27, 3F35, 4C65	3B7, 3C81, 3C90, 3C91, 3C92, 3E5, 3E6, 3E7, 3E27, 3F35, 4C65	
	Toroids, U cores	Toroids, U cores	Toroids, U cores	
Driver transformers	3B7, 3C81, 3C90, 3C91, 3C92, 3C94, 3E27, 3F35, 3H3	3B7, 3C81, 3C90, 3C91, 3C92, 3C94, 3E27, 3F35, 3H3	3B7, 3C81, 3C90, 3C91, 3C92, 3C94, 3E27, 3F35, 3H3	3B7, 3C81, 3C90, 3C91, 3C92, 3C94, 3E27, 3F35, 3H3
	E, EFD, EP, planar ER, P/I, RM/I, Toroids	E, EFD, EP, planar ER, P/I, RM/I, Toroids	E, EFD, EP, planar ER, P/I, RM/I, Toroids	E, EFD, EP, planar ER, P/I, RM/I, Toroids
Magnetic regulators	3R1	3R1	3R1	
	Toroids, IIC	Toroids, IIC	Toroids, IIC	
Power inductors	2P, 3C81, 3C90, 3C91, 3C92, 3C94, 3F3, 3F35, 3F4	2P, 3C30, 3C81, 3C90, 3C91, 3C94, 3F3, 3F35, 3F4	2P, 3C30, 3C81, 3C90, 3C91, 3C94, 3F3, 3F35, 3F4	2P, 3C30, 3C81, 3C90, 3C91, 3C94, 3F3, 3F35, 3F4
	E, Planar E, EQ, EQ/LP, ER, Planar ER, ETD, P/I, PM, PQ, PT, PTS, RM/I, RM/ILP, U, Toroids, Gapped toroids, BC, D	E, Planar E, EQ, EQ/LP, ER, Planar ER, ETD, P/I, PM, PQ, PT, PTS, RM/I, RM/ILP, U, Toroids, Gapped toroids, BC, D	E, Planar E, EQ, EQ/LP, ER, Planar ER, ETD, P/I, PM, PQ, PT, PTS, RM/I, RM/ILP, U, Toroids, Gapped toroids, BC, D	E, Planar E, EQ, EQ/LP, ER, Planar ER, ETD, P/I, PM, PQ, PT, PTS, RM/I, RM/ILP, U, Toroids, Gapped toroids, BC, D
Power transformers	3C81, 3C90, 3C91, 3C92, 3C93, 3C94, 3C96, 3F3, 3F35, 3F4, 3F45, 3F5, 4F1	3C81, 3C90, 3C91, 3C92, 3C93, 3C94, 3C96, 3F3, 3F35, 3F4, 3F45, 3F5, 4F1	3C81, 3C90, 3C91, 3C92, 3C93, 3C94, 3C96, 3F3, 3F35, 3F4, 3F45, 3F5, 4F1	3C81, 3C90, 3C91, 3C92, 3C93, 3C94, 3C96, 3F3, 3F35, 3F4, 3F45, 3F5, 4F1
	E, Planar E, EC, EFD, EPX, EQ, EQ/LP, ER, Planar ER, ETD, P/I, PM, PQ, PT, PTS, RM/I, RM/ILP, Toroids	E, Planar E, EC, EFD, EPX, EQ, EQ/LP, ER, Planar ER, ETD, P/I, PM, PQ, PT, PTS, RM/I, RM/ILP, Toroids	E, Planar E, EC, EFD, EPX, EQ, EQ/LP, ER, Planar ER, ETD, P/I, PM, PQ, PT, PTS, RM/I, RM/ILP, Toroids	E, Planar E, EC, EFD, EPX, EQ, EQ/LP, ER, Planar ER, ETD, P/I, PM, PQ, PT, PTS, RM/I, RM/ILP, Toroids
Line output transformers (LOT)		3C30, 3C34	3C30, 3C34	
		UR	UR	
LCD backlight transformers	3C90, 3C91	3C90, 3C91	3C90, 3C91	
	FRM & BAR, EFD	FRM & BAR, EFD	FRM & BAR, EFD	
Power inductors on PCB	3C30, 3F35, 3F4	3C30, 3F35, 3F4	3C30, 3F35, 3F4	
	MLI, MLH, IIC	MLI, MLH, IIC	MLI, MLH, IIC	

POWER CONVERSION				
Domestic Appliances	**Automotive Electronics**	**Measurement, Control, Scientific and Medical**	**Electric Tools**	**EMC services and Equipment**
	3B7, 3C81, 3C90, 3C91, 3C92, 3E5, 3E6, 3E7, 3E27, 3F35, 4C65	3B7, 3C81, 3C90, 3C91, 3C92, 3E5, 3E6, 3E7, 3E27, 3F35, 4C65		
	Toroids, U cores	Toroids, U cores		
3B7, 3C81, 3C90, 3C91, 3C92, 3C94, 3E27, 3F35, 3H3	3B7, 3C81, 3C90, 3C91, 3C92, 3C94, 3E27, 3F35, 3H3	3B7, 3C81, 3C90, 3C91, 3C92, 3C94, 3E27, 3F35, 3H3	3B7, 3C81, 3C90, 3C91, 3C92, 3C94, 3E27, 3F35, 3H3	
E, EFD, EP, planar ER, P/I, RM/I, Toroids	E, EFD, EP, planar ER, P/I, RM/I, Toroids	E, EFD, EP, planar ER, P/I, RM/I, Toroids	E, EFD, EP, planar ER, P/I, RM/I, Toroids	
3R1				
Toroids, IIC				
2P, 3C30, 3C81, 3C90, 3C91, 3C94, 3F3, 3F35, 3F4	2P, 3C30, 3C81, 3C90, 3C91, 3C94, 3F3, 3F35, 3F4	2P, 3C30, 3C81, 3C90, 3C91, 3C94, 3F3, 3F35, 3F4		
E, Planar E, EQ, EQ/LP, ER, Planar ER, ETD, P/I, PM, PQ, PT, PTS, RM/I, RM/ILP, U, Toroids, Gapped toroids, BC, D	E, Planar E, EQ, EQ/LP, ER, Planar ER, ETD, P/I, PM, PQ, PT, PTS, RM/I, RM/ILP, U, Toroids, Gapped toroids, BC, D	E, Planar E, EQ, EQ/LP, ER, Planar ER, ETD, P/I, PM, PQ, PT, PTS, RM/I, RM/ILP, U, Toroids, Gapped toroids, BC, D		
3C81, 3C90, 3C91, 3C92, 3C93, 3C94, 3C96, 3F3, 3F35, 3F4, 3F45, 3F5, 4F1	3C81, 3C90, 3C91, 3C92, 3C93, 3C94, 3C96, 3F3, 3F35, 3F4, 3F45, 3F5, 4F1	3C81, 3C90, 3C91, 3C92, 3C93, 3C94, 3C96, 3F3, 3F35, 3F4, 3F45, 3F5, 4F1		
E, Planar E, EC, EFD, EPX, EQ, EQ/LP, ER, Planar ER, ETD, P/I, PM, PQ, PT, PTS, RM/I, RM/ILP, Toroids	E, Planar E, EC, EFD, EPX, EQ, EQ/LP, ER, Planar ER, ETD, P/I, PM, PQ, PT, PTS, RM/I, RM/ILP, Toroids	E, Planar E, EC, EFD, EPX, EQ, EQ/LP, ER, Planar ER, ETD, P/I, PM, PQ, PT, PTS, RM/I, RM/ILP, Toroids		
		3C15, 3C30, 3C34, 3C81		
		UR		
	3C90, 3C91			
	FRM & BAR, EFD			
	3C30, 3F35, 3F4	3C30, 3F35, 3F4		
	MLI, MLH, IIC	MLI, MLH, IIC		

Application Matrix

SIGNAL PROCESSING				
Application area / Magnetic function	Telecommunication	Electronic Data Processing (EDP)	Sound and Vision	Lighting
Filter inductors (signal)	3B7, 3D3, 3H3			
	P, PT, RM			
Inductive delay lines	3E27, 3E5, 3E6, 3E7, 3E8	3E27, 3E5, 3E6, 3E7, 3E8	3E27, 3E5, 3E6, 3E7, 3E8	
	Toroids	Toroids	Toroids	
Proximity switches	3B7, 3D3			
	PH			
Tuning coils and antennas	3B1, 3C90, 4B1, 4C65, 4D2, 4E1		3B1, 3C90, 4B1, 4C65, 4D2, 4E1	
	ROD, TUB		ROD, TUB	
Wideband transformers	3C11, 3E27, 3E28, 3E5, 3E55, 3E6, 3E7, 3E8, 3H3	3C11, 3E27, 3E28, 3E5, 3E55, 3E6, 3E7, 3E8, 3H3	3C11, 3E27, 3E28, 3E5, 3E55, 3E6, 3E7, 3E8, 3H3	
	E, EFD, EP, EP/LP, EPX, Planar ER, P/I, RM/I, RM/ILP, Toroids, Gapped toroids, MHB	E, EFD, EP, EP/LP, EPX, Planar ER, P/I, RM/I, RM/ILP, Toroids, Gapped toroids, MHB	E, EFD, EP, EP/LP, EPX, Planar ER, P/I, RM/I, RM/ILP, Toroids, Gapped toroids, MHB	

EMI SUPPRESSION				
Application area / Magnetic function	Telecommunication	Electronic Data Processing (EDP)	Sound and Vision	Lighting
EMI-suppression on PCB	3B1, 3S1, 3S4, 4A15, 4B1,4S2, 4S4, 4S7	3B1, 3S1, 3S4, 4A15, 4B1,4S2, 4S4, 4S7	3B1, 3S1, 3S4, 4A15, 4B1,4S2, 4S4, 4S7	
	BDW, BDS, CMS, WBC, WBS, MLS, MLP, MLN, IIC	BDW, BDS, CMS, WBC, WBS, MLS, MLP, MLN, IIC	BDW, BDS, CMS, WBC, WBS, MLS, MLP, MLN, IIC	
EMI-suppression in power lines	2P, 3B1, 3C90, 3S1, 3S3, 3S4, 4A15, 4B1, 4S2	2P, 3B1, 3C90, 3S1, 3S3, 3S4, 4A15, 4B1, 4S2	2P, 3B1, 3C90, 3S1, 3S3, 3S4, 4A15, 4B1, 4S2	2P, 3B1, 3C90, 3S1, 3S3, 3S4, 4A15, 4B1, 4S2
	ROD, BC, BD, BDW, MHC, WBC, Toroids	ROD, BC, BD, BDW, MHC, WBC, Toroids	ROD, BC, BD, BDW, MHC, WBC, Toroids	ROD, BC, BD, BDW, MHC, WBC, Toroids
EMI-suppression in mains filters	2P, 3C11, 3E25, 3E26, 3E27, 3E5, 3E6, 3S4, 4A11, 4A15, 4C65	2P, 3C11, 3E25, 3E26, 3E27, 3E5, 3E6, 3S4, 4A11, 4A15, 4C65	2P, 3C11, 3E25, 3E26, 3E27, 3E5, 3E6, 3S4, 4A11, 4A15, 4C65	2P, 3C11, 3E25, 3E26, 3E27, 3E5, 3E6, 3S4, 4A11, 4A15, 4C65
	Toroids (T, TC, TL, TN, TX), U cores (U), ROD	Toroids (T, TC, TL, TN, TX), U cores (U), ROD	Toroids (T, TC, TL, TN, TX), U cores (U), ROD	Toroids (T, TC, TL, TN, TX), U cores (U), ROD
EMI-suppression on signal wires and cables	3B1, 3C11, 3C90, 3E25, 3E26, 3E27, 3E5, 3E6, 3S1, 3S4, 4A11, 4A15, 4B1, 4C65, 4S2	3B1, 3C11, 3C90, 3E25, 3E26, 3E27, 3E5, 3E6, 3S1, 3S4, 4A11, 4A15, 4B1, 4C65, 4S2	3B1, 3C11, 3C90, 3E25, 3E26, 3E27, 3E5, 3E6, 3S1, 3S4, 4A11, 4A15, 4B1, 4C65, 4S2	
	BD, MHC, Cable shields, TUB, Toroids (T, TC, TL, TN, TX)	BD, MHC, Cable shields, TUB, Toroids (T, TC, TL, TN, TX)	BD, MHC, Cable shields, TUB, Toroids (T, TC, TL, TN, TX)	
EMI-absorbing powders and surfaces	4S60	4S60		
	Tiles (PLT), Granules, Powders	Tiles (PLT), Granules, Powders		

SIGNAL PROCESSING				
Domestic Appliances	**Automotive Electronics**	**Measurement, Control, Scientific and Medical**	**Electric Tools**	**EMC services and Equipment**
		3B7, 3D3, 3H3		
		P, PT, RM		
		3E27, 3E5, 3E6, 3E7, 3E8		
		Toroids		
		3B7, 3D3		
		PH		
	3B1, 3C90, 4B1, 4C65, 4D2, 4E1	3B1, 3C90, 4B1, 4C65, 4D2, 4E1		
	ROD, TUB	ROD, TUB		
	3C11, 3E27, 3E28, 3E5, 3E55, 3E6, 3E7, 3E8, 3H3	3C11, 3E27, 3E28, 3E5, 3E55, 3E6, 3E7, 3E8, 3H3		3C11, 3E27, 3E28, 3E5, 3E55, 3E6, 3E7, 3E8, 3H3
	E, EFD, EP, EP/LP, EPX, Planar ER, P/I, RM/I, RM/ILP, Toroids, Gapped toroids, MHB	E, EFD, EP, EP/LP, EPX, Planar ER, P/I, RM/I, RM/ILP, Toroids, Gapped toroids, MHB		E, EFD, EP, EP/LP, EPX, Planar ER, P/I, RM/I, RM/ILP, Toroids, Gapped toroids, MHB

EMI SUPPRESSION				
Domestic Appliances	**Automotive Electronics**	**Measurement, Control, Scientific and Medical**	**Electric Tools**	**EMC services and Equipment**
	3B1, 3S1, 3S4, 4A15, 4B1,4S2, 4S4, 4S7	3B1, 3S1, 3S4, 4A15, 4B1,4S2, 4S4, 4S7		3B1, 3S1, 3S4, 4A15, 4B1,4S2, 4S4, 4S7
	BDW, BDS, CMS, WBC, WBS, MLS, MLP, MLN, IIC	BDW, BDS, CMS, WBC, WBS, MLS, MLP, MLN, IIC		BDW, BDS, CMS, WBC, WBS, MLS, MLP, MLN, IIC
2P, 3B1, 3C90, 3S1, 3S3, 3S4, 4A15, 4B1, 4S2	2P, 3B1, 3C90, 3S1, 3S3, 3S4, 4A15, 4B1, 4S2	2P, 3B1, 3C90, 3S1, 3S3, 3S4, 4A15, 4B1, 4S2	2P, 3B1, 3C90, 3S1, 3S3, 3S4, 4A15, 4B1, 4S2	2P, 3B1, 3C90, 3S1, 3S3, 3S4, 4A15, 4B1, 4S2
ROD, BC, BD, BDW, MHC, WBC, Toroids	ROD, BC, BD, BDW, MHC, WBC, Toroids	ROD, BC, BD, BDW, MHC, WBC, Toroids	ROD, BC, BD, BDW, MHC, WBC, Toroids	ROD, BC, BD, BDW, MHC, WBC, Toroids
2P, 3C11, 3E25, 3E26, 3E27, 3E5, 3E6, 3S4, 4A11, 4A15, 4C65		2P, 3C11, 3E25, 3E26, 3E27, 3E5, 3E6, 3S4, 4A11, 4A15, 4C65	2P, 3C11, 3E25, 3E26, 3E27, 3E5, 3E6, 3S4, 4A11, 4A15, 4C65	2P, 3C11, 3E25, 3E26, 3E27, 3E5, 3E6, 3S4, 4A11, 4A15, 4C65
Toroids (T, TC, TL, TN, TX), U cores (U), ROD		Toroids (T, TC, TL, TN, TX), U cores (U), ROD	Toroids (T, TC, TL, TN, TX), U cores (U), ROD	Toroids (T, TC, TL, TN, TX), U cores (U), ROD
	3B1, 3C11, 3C90, 3E25, 3E26, 3E27, 3E5, 3E6, 3S1, 3S4, 4A11, 4A15, 4B1, 4C65, 4S2	3B1, 3C11, 3C90, 3E25, 3E26, 3E27, 3E5, 3E6, 3S1, 3S4, 4A11, 4A15, 4B1, 4C65, 4S2		3B1, 3C11, 3C90, 3E25, 3E26, 3E27, 3E5, 3E6, 3S1, 3S4, 4A11, 4A15, 4B1, 4C65, 4S2
	BD, MHC, Cable shields, TUB, Toroids (T, TC, TL, TN, TX)	BD, MHC, Cable shields, TUB, Toroids (T, TC, TL, TN, TX)		BD, MHC, Cable shields, TUB, Toroids (T, TC, TL, TN, TX)
	4S60	4S60		4S60
	Tiles (PLT), Granules, Powders	Tiles (PLT), Granules, Powders		Tiles (PLT), Granules, Powders

Materials and Applications

Property	Test conditions				Power transformers and power inductors															
Symbol	f (kHz)	B_{peak} or H	T (ºC)	unit	3C30	3C34	3C81	3C90	3C91	3C92	3C93	3C94	3C96	3F3	3F35	3F4	3F45[1]	3F5[1]	4F1	3R1
μ_i (± 20%)	≤ 10	≤ 0.1 mT	25		2100	2100	2700	2300	3000	1500	1800	2300	2000	2000	1400	900	900	650	≈ 80	800
B	10	250 A/m	100	mT	≥ 370	≥ 370	≈ 330	≥ 340	≥ 330	≈ 410	≈ 380	≥ 340	≥ 370	≥ 330	≥ 330	≥ 300	≈ 330	≈ 220	≥ 100	≥ 285
		1200 A/m	100		≈ 440	≈ 440	≈ 360	≈ 380	≈ 370	≈ 460	≈ 430	≈ 380	≈ 440	≈ 370	≈ 420	≈ 350	≈ 370	≈ 340	≈ 300	≈ 340
		3000 A/m	25		≈ 500	≈ 500	≈ 450	≈ 450	≈ 450	≈ 550	≈ 530	≈ 450	≈ 500	≈ 450	≈ 500	≈ 400	≈ 420	≈ 390	≈ 350	≈ 420
H_c	10		25	A/m	≈ 15	≈ 15	≈ 15	≈ 15	≈ 15	≈ 15	≈ 15	≈ 15	≈ 15	≈ 15	≈ 40	≈ 60	≈ 60	≈ 60	≈ 150	≈ 40
B_r	10		25	mT	≈ 180	≈ 180	≈ 110	≈ 170	≈ 110	≈ 170	≈ 170	≈ 170	≈ 170	≈ 150	≈ 200	≈ 150	≈ 150	≈ 150	≈ 200	≈ 340
P_v	25	200 mT	100	kW/m³	≤ 80		≤ 185	≤ 80												
	100	100 mT			≤ 80	≤ 80		≤ 80	≈ 55[2]	≈ 50	≈ 50	≤ 60	≤ 45	≤ 80						
	100	200 mT			≈ 450	≤ 400		≈ 450	≈ 330[2]	≈ 350	≈ 350	≤ 400	≤ 330							
	200	100 mT				≈ 170														
	400	50 mT										≤ 170	≤ 140	≤ 150	≤ 80					
	500	50 mT									≈ 300				≤ 120					
		100 mT													≈ 800					
	1000	30 mT														≤ 200				
		50 mT															≈ 300			
		70 mT															≈ 700			
	3000	10 mT														≤ 320	≤ 320	≈ 100	≤ 200	
		30 mT																≈ 900		
	10000	5 mT																	≤ 200	
T_c				ºC	≥ 240	≥ 240	≥ 210	≥ 220	≥ 220	≥ 280	≥ 240	≥ 220	≥ 240	≥ 200	≥ 240	≥ 220	≥ 300	≥ 300	≥ 260	≥ 230
ρ	DC			Ωm	≈ 2	≈ 5	≈ 1	≈ 5	≈ 5	≈ 5	≈ 5	≈ 5	≈ 5	≈ 2	≈ 10	≈ 10	≈ 10	≈ 10	$\approx 10^5$	$\approx 10^3$
density				kg/m³	≈ 4800	≈ 4800	≈ 4800	≈ 4800	≈ 4800	≈ 4800	≈ 4800	≈ 4800	≈ 4800	≈ 4750	≈ 4750	≈ 4700	≈ 4800	≈ 4750	≈ 4600	≈ 4700
ferrite type					MnZn	MnZn	MnZn	MnZn	MnZn	MnZn	MnZn	MnZn	MnZn	MnZn	MnZn	MnZn	MnZn	MnZn	NiZn	MnZn

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

1) preliminary specification

2) at 60 °C

Iron Powder Materials

Property	Test conditions				Output chokes / EMI-suppression				
Symbol	f (kHz)	B_{peak} or H	T (ºC)	unit	2P40	2P50	2P65	2P80	2P90
μ_i (± 10%)	≤ 10	≤ 0.1 mT	25		40	50	65	80	90
B	10	25000 A/m	25	mT	900	1000	1150	1400	1600
H_c	10		25	A/m	2000	1800	1500	1200	900
B_r	10		25	mT	250	300	350	400	450
T_{max}				ºC	140	140	140	140	140
material					Fe	Fe	Fe	Fe	Fe

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.

Power transformers/inductors

Power conversion is a major application area for modern ferrites. The introduction of Switched Mode Power Supplies (SMPS) has stimulated the development of a number of new ferrites and core shapes for power transformers, ouput chokes and input filters.

Power transformers and inductors generally operate under loss or saturation limited conditions. This requires special power ferrites with high saturation levels and low losses. The power handling capability of a transformer is determined by circuit topology, frequency, core geometry and ferrite material, available winding area, and by other factors which depend on the specific application.

Each of the core types was developed for a specific application, therefore they all have advantages and drawbacks. The choice of a core type for a specific design depends on the design considerations and sometimes on the personal preference of the designer.

Ferrite choice

frequency range	
< 100 kHz	3C81, 3C90, 3C91, 3C92, 3C93, 3C94, 3C96
< 400 kHz	3C92, 3C93, 3C94, 3C96
200-1000 kHz	3F35, 3F4
1-4 MHz	3F4, 3F45, 3F5, 4F1
> 3 MHz	4F1

Output chokes

Output chokes have to operate with a DC load which causes a bias magnetic field. In a closed ferrite circuit this can easily lead to saturation. Power ferrites such as 3C90 or 3F35 start saturating at field strengths of about 50 A/m. Permeability drops sharply and the inductor looses its effectivity.
There are two remedies against this effect:

- gapped ferrite cores
- a material with a low permeability and high saturation

The effect of an airgap in the circuit is that a much higher field strength is needed to saturate a core. For each operating condition an optimum airgap length can be found. In a design, the maximum output current (I) and the value of inductance (L) necessary to smooth the ripple current to the required level must be known. The product I^2L is a measure of the energy which is stored in the core during one half cycle.

Toroids made of compressed iron powder have a rather low permeability (max. 90) combined with a very high saturation level (up to 1500 mT). The permeability is low because the isolating coating on the iron particles acts as a so called distributed airgap. Therefore, 2P toroids can operate under bias fields of up to 2000 A/m.

Ferrite choice

frequency range	
< 500 kHz	2P.., 3C90, 3C92, 3C94
< 1 MHz	3C90, 3C92, 3C94, 3F35

Magnetic regulators

Saturable inductors can be used to regulate several independent outputs of an SMPS by blocking the secondary of the transformer during variable lenghts of time. The circuits required are both simple and economic and can easily be integrated. 3R1 ferrite material is a good alternative to amorphous metal, often used for these applications.
In technical performance 3R1 is comparable to amorphous metal, its price level is much lower.
The squareness of the B-H loop would be spoiled by any airgap in the magnetic circuit, so a toroid or IIC without partial gap is the recommended shape.

Ferrite choice

3R1

Core shapes

toroids, IIC

Line output transformers

Line output transformers (LOT) form a specific group of power transformers. They are used in TV sets and monitors to provide the voltage for the deflection coil and the high voltage for the picture tube. Traditionally the operating frequency is rather low (16 kHz) so a high throughput power density can only be achieved by means of a high flux density in the core. The high voltage output requires a special, resin potted winding. A large winding area is required and normally all windings are on one of the legs. A special U core type, with one round and one rectangular leg has become a standard for this application.
Switching frequency has recently increased to 32, 64 or 128 kHz for applications such as HDTV and special monitors. For these applications, 3C30 and 3C34 with low losses up to 300 kHz in combination with high saturation levels are available.

Ferrite choice

frequency range	
16 kHz	3C30
32 kHz	3C30
64 kHz	3C30, 3C34
128 kHz	3C34

Core shapes

UR cores

Materials and Applications

Property	MnZn ferrites	NiZn ferrites	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	$J\ kg^{-1}\ K^{-1}$
Termal conductivity	(3.5 - 5.0) x 10^{-3}	(3.5 - 5.0) x 10^{-3}	$J\ mm^{-1}\ s^{-1}\ K^{-1}$

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 toroid 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, 3C91, 3C92, 3F35
< 5 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, 3E27
high - level drive	3C81, 3C90, 3C91, 3C92, 3F35

Materials and Applications

Property	Test conditions				Filter inductors			Wideband transformers						
Symbol	f (kHz)	B_{peak} or H	T (ºC)	unit	3D3	3H3	3B7	3E27	3E28	3E5	3E55	3E6[1)]	3E7[1)]	3E8[1)]
μ_i (± 20%)	≤ 10	≤ 0.1 mT	25		750	2000	2300	6000	400	10000	10000	12000	15000	18000
$\tan\delta/\mu_i$	10	≤ 0.1 mT	25	$(\times 10^{-6})$							≤ 10	≤ 10	≤ 10	≤ 10
	30					≤ 1.6				≤ 25	≤ 30	≤ 30	≤ 30	≤ 30
	100					≤ 2.5	≤ 5	≤ 15	≤ 5	≤ 75				
	300				≤ 10									
	500						≈ 25							
	1000				≤ 30		≈ 120							
	3000													
	10000													
η_B	10	1.5 - 3 mT	25	$10^{-3}\ T^{-1}$						≤ 1	≤ 0.2	≤ 1	≤ 1	≤ 1
	100				≤ 1.8	≤ 0.6								
α_F	≤ 10	≤ 0.1 mT	5 - 25	$10^{-6}\ K^{-1}$		0.7 ± 0.3								
			25 - 55			0.7 ± 0.3								
			25 - 70		1.5 ± 1	0.7 ± 0.3	0 ± 0.6							
D_F	10	≤ 0.1 mT	25	$(\times 10^{-6})$	≤ 12	≤ 3	≤ 3.5							
	100													
B	10	250 A/m	100	mT	≈ 260	≈ 250	≈ 300	≈ 250	≈ 260	≈ 210	≈ 200[2)]	≈ 210	≈ 210	≈ 150
		3000 A/m	25		≈ 400	≈ 400	≈ 450	≈ 400	≈ 400	≈ 380	≈ 380	≈ 380	≈ 380	≈ 380
H_c	10		25	A/m	≈ 75	≈ 15	≈ 15	≈ 5	≈ 5	≈ 5	≈ 5	≈ 4	≈ 4	≈ 4
B_r	10		25	mT	≈ 150	≈ 70	≈ 150	≈ 100	≈ 100	≈ 80	≈ 150	≈ 100	≈ 100	≈ 100
T_c				ºC	≥ 200	≥ 160	≥ 170	≥ 150	≥ 145	≥ 125	≥ 100	≥ 130	≥ 130	≥ 100
ρ	DC			Ωm	≈ 2	≈ 2	≈ 1	≈ 0.5	≈ 1	≈ 0.5	≈ 0.1	≈ 0.1	≈ 0.1	≈ 0.1
density				kg/m^3	≈ 4700	≈ 4700	≈ 4800	≈ 4800	≈ 4800	≈ 4900	≈ 5000	≈ 4900	≈ 4900	≈ 5000
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.

2) at 80 °C

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.

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 (αF) to compensate the negative temperature coefficients of the filter capacitors. The drift of permeability with time DF (desaccomodation factor) is kept as low as possible in these filter materials.

- ♦ high saturation flux density

A recent application is in low-pass filters for ADSL. Since there is dc bias current, power materials like 3C81, 3C90, 3C91 or 3C92 are used because of their higher saturation level.

Ferrite choice	
frequency range	
< 300 kHz	3H3, 3C81, 3C90, 3C91, 3C92
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 DSL.
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, 3E5, 3E6, 3E7 and 3E8 are used. When there is a DC component in the signal it is often better to take a lower permeability grade such as the special DC-bias material 3E28.
For DSL transformers Total Harmonic Distortion (THD) is a critical factor. The new low THD ferrite material 3E55 helps to solve many design problems.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 toroids, 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	3C11, 3E27, 3E5, 3E55, 3E6, 3E7, 3E8
with DC	3H3 3E55, 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 toroids are mostly used to avoid the degrading effect of the parasitic airgap.

Ferrite choice
3E27, 3E5, 3E6, 3E7, 3E8

Core shapes
small toroids

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 production equipment 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 material like 3D3 performs well.

As temperature stability must be resonably good, materials 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

Core shapes
PH cores

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.

Ferroxcube 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 assembly-friendly 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 of our Philips heritage. Utilizing the latest full 3D CAD system we are ensuring the shortest possible time to market.

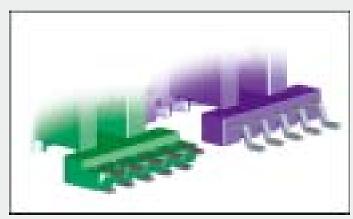
Our technological competence…
…your access to quality products

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

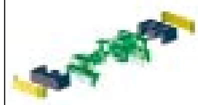
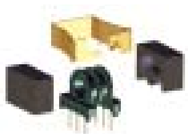
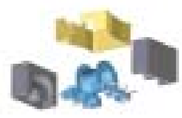
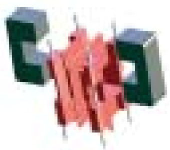
When selecting materials for our products, the design, production process, electrical and mechanical requirements are important factors. But above all, we aim for optimum performance at an acceptable price. Many materials are used, ranging from industry-standard polyamide (PA) to the more exotic liquid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

Core type	Pin Through-Hole (PTH)	Surface-Mount Device (SMD)	Specials
E (EF)	 Sizes: E13, 16, 19, 20, 25, 30, 32, 34, 41, 42, 47, 55, 56, 65 Clips and Clasps available for most products	 Sizes: E5.3, 6.3, 13 Multi-section, Caps and Clips available	 Sizes: E20 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, 25 One piece pick and place metal Covers / Clamps, C-pin design (except for EFD25)	
ETD + EPX	 Sizes: ETD29, 34, 39, 44, 49, 54, 59 Complete range in-moulded pins. Clips available	 Sizes: EPX7, 9 Gullwing pin type with 2.0/2.54 mm distance. Clamps available	 Sizes: ETD34 Two pieces male/female high insulation factor
EP	 Sizes: EP7, 10, 13, 17, 20 (also for EP13/LP) All phenolic parts, both single Clips and Clasps / Springs available	 Sizes: EP5, 7, 10, 13 Single Clips, also C-pins phenolic version	
ER + EQ	 EQ30 Phenolic part, 10 pins	 ER9.5, 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, low profile Clips available	 Sizes: RM5, 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
U + Special products	 Sizes: U10, 15 15 multi-section	 Sizes: T9 Cover and Tagplate, C-pin version	 Custom Designs for all core types
Special products	 Sizes: E16 High insulating and coupling factor. Robust design in phenolic material.	 Sizes: FRM 9,10,12,15 high performance thermo-plastic material, FRM9 is C-pin version.	 Sizes: E14, 18, 22 Range of Clamps available

P/I uses P accessories
PT & PTS use proper or P accessories


PHILIPS

Integrated Inductive Components (IIC)

The IIC design

For the majority of today's designs it is desirable to have low profile inductive components. This allows designers not only to make low profile equipment, but also to place the component anywhere on the PC board without need to adapt the equipment housing. This is especially true when the inductive component matches the height of other components on the board, for instance ICs.
A possible way to reach this goal is demonstrated in the new Integrated Inductive Component (IIC). This consists of a rectangular ferrite sleeve with a copper lead frame inserted. The lead frame is moulded with a high-tech resin to secure the leads and insulate them from the ferrite core. After insertion the leads are bent into a 'gull wing' shape to form contact pads as with most surface-mount ICs. The finished product looks like an IC from the outside (SOT). It can be handled by standard pick-and-place equipment and soldered on the board along with other ICs.
The leads in the moulding form one half of a winding which is completed by a track on the PC board. In this way, depending on the board layout, core material and configuration, several magnetic functions can be realized.

IIC with partial / full airgap

This product type has an airgap to improve energy storage capability. With partial gap, its performance has all the characteristics of a stepped choke. Possible magnetic functions are :

- power inductor
- output choke
- EMI-choke with bias

Power inductors are used in modern high-frequency DC/DC buck/boost converters or resonant converters. Because operating frequencies are usually high (≥ 200 kHz), inductors with a lower number of turns can be used.This makes IIC10 suitable for these applications. The curves of L as a function of DC bias show the effect of its airgap. For most applications, high saturation flux density and low power losses are key requirements. Therefore 3C30 is the ideal material here. However for very high frequencies (≥ 500 kHz), 3F35 or3F4 would be a better choice.

EMI-chokes often suffer from saturation when used without current compensation in lines with DC or AC bias currents. The airgap avoids complete saturation to a large extend. The suppression effect remains at an acceptable level for high current levels.

IIC without airgap

This design is suitable for the following magnetic functions:

- power transformer
- common-mode choke

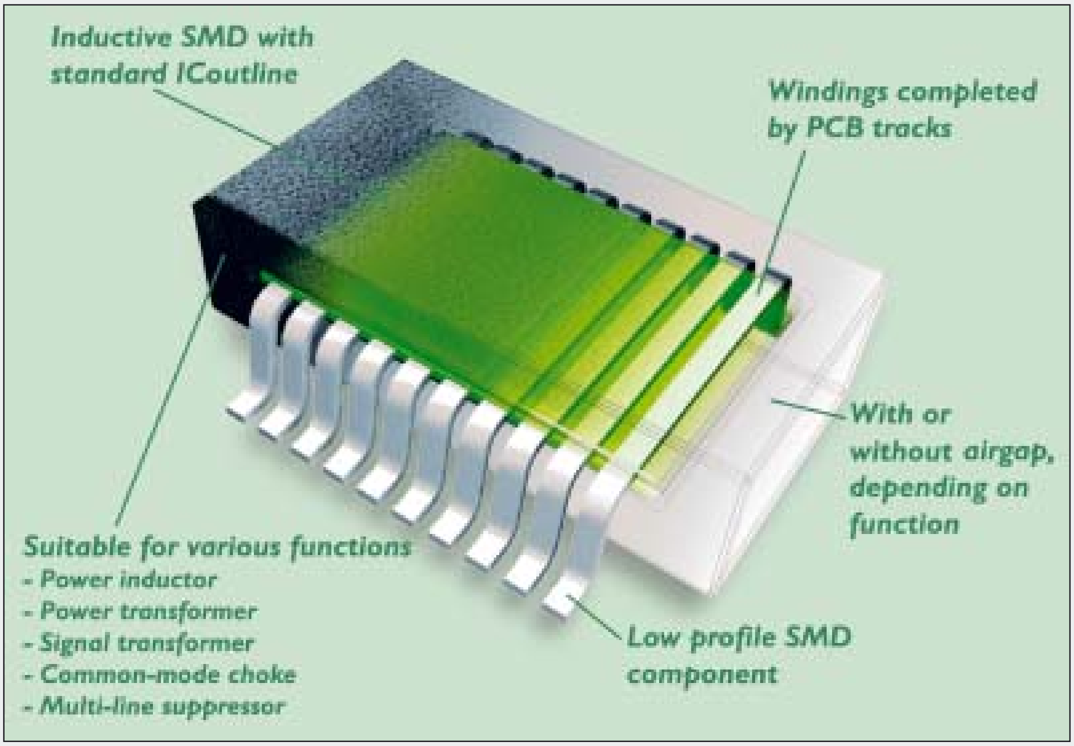
The IIC can be used as a low profile power transformer in high-frequency DC/DC converters, especially those working with low voltage and power levels.

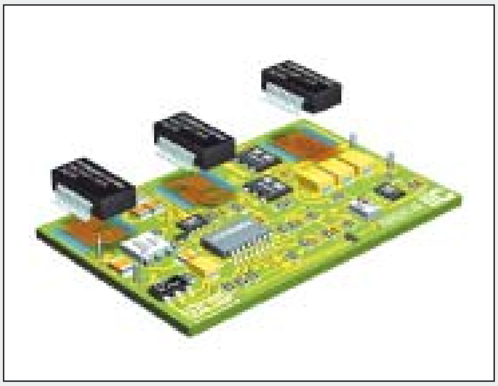
Although isolation voltage is specified at 500 V, the IIC10 should not be used in AC/DC applications as a safety isolation transformer. The short distance between the leads makes it unsuitable for that function.

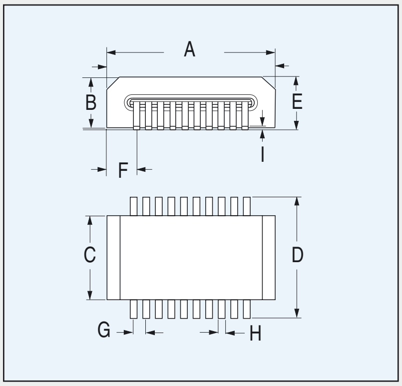
Made in our top-quality 3S4 suppression material or the high-permeability 3E6, the design is ideal for common-mode choke in signal or supply lines, especially if these carry large currents. The sturdy lead frame will take almost any current surge without damage.

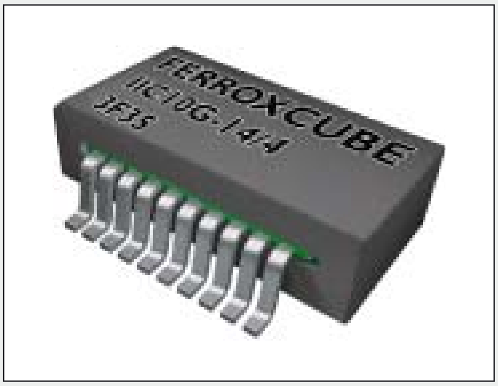
Features and Benefits:

- ♦ Inductive surface-mount component that looks like a standard IC outline (SOT).
- ♦ Windings are completed by PC board 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.







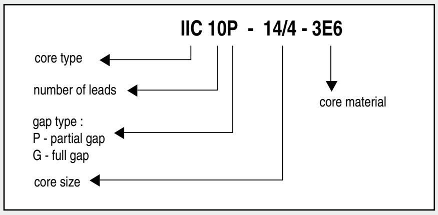


	Core type	IIC10-14/4 IIC10P-14/4
efective core parameters	core factor Σ I/A(mm^{-1})	2.47
	eff. volume V_e (mm^3)	338
	eff. length l_e (mm)	28.9
	eff. area A_e (mm^2)	11.7
	min. area A_{min} (mm^2)	11.7
	mass (g)	≈ 1.85
dimensions (mm)	A	14.4 ± 0.2
	B	4 ± 0.08
	C	7.2 ± 0.15
	D	10.45 max
	E	4.38 max
	F	2.7± 0.2
	G	1.0
	H	0.6 max
	I	0.3

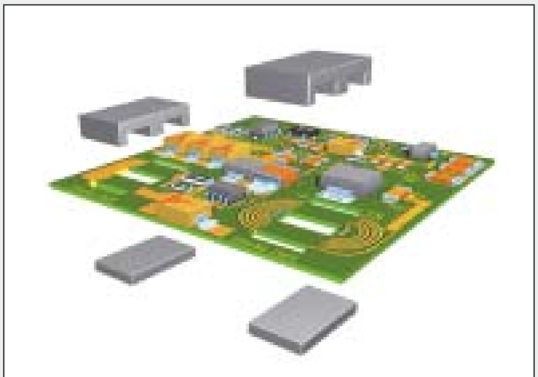
IICs without airgap	A_L (nH) at B = 0.1 mT f = 10 kHz T = 25 °C	A_L (nH) at B = 0.1 mT f = 500 kHz T = 25 °C	A_L (nH) at B = 0.1 mT f = 1 MHz T = 25 °C	|Z|typ (Ω) at 100 MHz for 1 turn T = 25 °C	E.T (Vμs) f = 100 kHz H = 800 A/m I_{reset} = 70 mA T = 100 °C
IIC10-14/4-3E6	600 ± 30 %	-	-	-	-
IIC10-14/4-3F4	-	-	450 ± 25 %	-	-
IIC10-14/4-3F35	-	700 ± 25 %	-	-	-
IIC10-14/4-3R1	-	-	-	-	≥ 33
IIC10-14/4-3S4	-	-	-	≈ 35	-

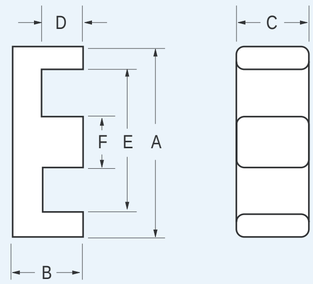
IICs with partial airgap	L (μH) for 10 turns no bias current f = 100 kHz T = 25 °C	L (μH) for 10 turns no bias current f = 500 kHz T = 25 °C	L (μH) for 10 turns no bias current f = 1 MHz T = 25 °C	L (μH) for 10 turns bias current 1 A f = 100 kHz T = 25 °C	L (μH) for 10 turns bias current 1 A f = 500 kHz T = 25 °C	L (μH) for 10 turns bias current 1 A f = 1 MHz T = 25 °C
IIC10P-14/4-3C30	92 ± 25 %	-	-	≥ 5	-	
IIC10P-14/4-3F4	-	-	45 ± 25 %	-	-	≥ 5
IIC10P-14/4-3F35	-	70 ± 25 %	-	-	≥ 5	

IICs with full airgap	L (μH) for 10 turns no bias current f = 500 kHz T = 25 °C	L (μH) for 10 turns no bias current f = 1 MHz T = 25 °C	L (μH) for 10 turns bias current 4 A f = 500 kHz T = 25 °C	L (μH) for 10 turns bias current 4 A f = 1 MHz T = 25 °C
IIC10G-14/4-3F35	8 ± 15 %	-	≥ 6	
IIC10G-14/4-3F4		7.5 ± 15 %	-	≥ 5.5



Planar E cores





E core (E)

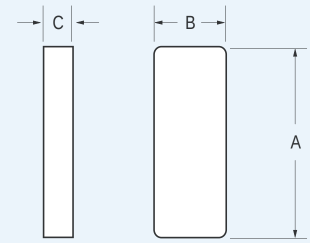


plate (PLT)

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 Ferroxcube 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^3)	eff. area A_e (mm^2)	min. area A_{min} (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	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	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	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	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	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	78.5	≈ 4
E32/6/20 (E-E combination)	31.75 ± 0.64	6.35 ± 0.13	20.32 ± 0.41	3.18 ± 0.13	24.9 min	6.35 ± 0.13	0.323	5380	41.7	129	129	≈ 13
PLT32/20/3 (E-PLT combination)	31.75 ± 0.64	20.32 ± 0.41	3.18 ± 0.13	-	-	-	0.278	4560	35.9	129	129	≈ 10
E38/8/25 (E-E combination)	38.1 ± 0.76	8.26 ± 0.13	25.4 ± 0.51	4.45 ± 0.13	30.23 min	7.62 ± 0.15	0.272	10200	52.6	194	194	≈ 25
PLT38/25/4 (E-PLT combination)	38.1 ± 0.76	25.4 ± 0.51	3.81 ± 0.13	-	-	-	0.226	8460	43.7	194	194	≈ 18
E43/10/28 (E-E combination)	43.2 ± 0.9	9.5 ± 0.13	27.9 ± 0.6	5.4 ± 0.13	34.7 min	8.1 ± 0.2	0.276	13900	61.7	225	225	≈ 35
PLT43/28/4 (E-PLT combination)	43.2 ± 0.9	27.9 ± 0.6	4.1 ± 0.13	-	-	-	0.226	11500	50.8	225	225	≈ 24
E58/11/38 (E-E combination)	58.4 ± 1.2	10.5 ± 0.13	38.1 ± 0.8	6.5 ± 0.13	50 min	8.1 ± 0.2	0.268	24600	81.2	305	305	≈ 62
PLT58/38/4 (E-PLT combination)	58.4 ± 1.2	38.1 ± 0.8	4.1 ± 0.13	-	-	-	0.224	20800	68.3	305	305	≈ 44
E64/10/50 (E-E combination)	63.8 ± 1.3	10.2 ± 0.13	50.3 ± 1	5.1 ± 0.13	53.6 ± 1.1	10.2 ± 0.2	0.156	40700	79.7	511	511	≈ 100
PLT64/50/5 (E-PLT combination)	63.8 ± 1.3	50.3 ± 1	5.08 ± 0.13	-	-	-	0.136	35500	69.0	522	522	≈ 78

Core type		E14/3.5/5	E18/4/10	E22/6/16	E32/6/20	E38/8/25	E43/10/28	E58/11/38	E64/10/50
Matching plates		PLT14/5/1.5	PLT18/10/2	PLT22/16/2.5	PLT32/20/3	PLT38/25/4	PLT43/28/4	PLT58/38/4	PLT64/50/5
	3C90	1280 / 1500	3200 / 3680	5150 / 6150	6425 / 7350	7940 / 9250	8030 / 9250	8480 / 9970	14640/16540
	3C92 prot	960 / 1130	2330 / 2690	3700 / 4410	5000 / 5760	6100 / 7150	6300 / 7460	6600 / 7770	11200 / 12700
	3C93 prot	1100 / 1300	2700 / 3100	4300 / 5000	5900 / 6780	7250 / 8500	7310 / 8700	7710 / 9070	13300/15050
	3C94 des			A160 - E	E160 - E	E250 - E	E250 - E	E315 - E	E630 - E
				A160 - P	A160 - P	A250 - P	A250 - P	A315 - P	A630 - P
			A100 - E	A250 - E	E250 - E	E315 - E	E315 - E	E400 - E	E1000 - E
			A100 - P	A250 - P	A250 - P	A315 - P	A315 - P	A400 - P	A1000 - P
		A63 - E	A160 - E	A315 - E	A315 - E	E400 - E	E400 - E	E630 - E	A1600 - E
		A63 - P	A160 - P	A315 - P	A315 - P	A400 - P	A400 - P	A630 - P	A1600 - P
		A100 - E	A250 - E	A400 - E	A400 - E	A630 - E	A630 - E	A1000 - E	A2500 - E
		A100 - P	A250 - P	A400 - P	A400 - P	A630 - P	A630 - P	A1000 - P	A2500 - P
		A160 - E	A315 - E	A630 - E	A630 - E	A1000 - E	A1000 - E	A1600 - E	A3150 - E
		A160 - P	A315 - P	A630 - P	A630 - P	A1000 - P	A1000 - P	A1600 - P	A3150 - P
		1280 / 1500	3200 / 3680	5150 / 6150	6425 / 7350	7940 / 9250	8030 / 9250	8480 / 9970	14640/16540
	3C96 des			A160 - E	E160 - E				
				A160 - P	A160 - P				
			A100 - E	A250 - E	E250 - E				
			A100 - P	A250 - P	A250 - P				
		A63 - E	A160 - E	A315 - E	A315 - E				
		A63 - P	A160 - P	A315 - P	A315 - P				
		A100 - E	A250 - E	A400 - E	A400 - E				
		A100 - P	A250 - P	A400 - P	A400 - P				
		A160 - E	A315 - E	A630 - E	A630 - E				
		A160 - P	A315 - P	A630 - P	A630 - P				
		1200 / 1350	2900 / 3250	4600 / 5450	6425 / 7350				
	3F3	1100 / 1300	2700 / 3100	4300 / 5000	5900 / 6780	7250 / 8500	7310 / 8700	7710 / 9070	13300/15050
	3F35 des			A160 - E					
				A160 - P					
			A100 - E	A250 - E					
			A100 - P	A250 - P					
		A63 - E	A160 - E	A315 - E					
		A63 - P	A160 - P	A315 - P					
		A100 - E	A250 - E	A400 - E					
		A100 - P	A250 - P	A400 - P					
		A160 - E	A315 - E	A630 - E					
		A160 - P	A315 - P	A630 - P					
		900 / 1050	2200 / 2500	3500 / 4100					
	3F4 des			A160 - E	E160 - E	E250 - E	E250 - E	E315 - E	E630 - E
				A160 - P	A160 - P	A250 - P	A250 - P	A315 - P	A630 - P
			A100 - E	A250 - E	E250 - E	E315 - E	E315 - E	E400 - E	E1000 - E
			A100 - P	A250 - P	A250 - P	A315 - P	A315 - P	A400 - P	A1000 - P
		A63 - E	A160 - E	A315 - E	A315 - E	E400 - E	E400 - E	E630 - E	A1600 - E
		A63 - P	A160 - P	A315 - P	A315 - P	A400 - P	A400 - P	A630 - P	A1600 - P
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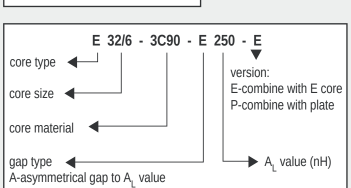
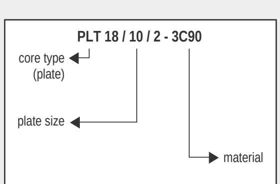
		A100 - P	A250 - P	A400 - P	A400 - P	A630 - P	A630 - P	A1000 - P	A2500 - P
		A160 - E	A315 - E	A630 - E	A630 - E	A1000 - E	A1000 - E	A1600 - E	A3150 - E
		A160 - P	A315 - P	A630 - P	A630 - P	A1000 - P	A1000 - P	A1600 - P	A3150 - P
		650/780	1550 / 1800	2400 / 2900	3200 / 3700	3880 /4600	3870 / 4660	4030 / 4780	6960 / 7920
high µ halves	3E6	5600 / 6400	13500 / 15500	22000 / 26000					

- E160 - E — gapped core half with symmetrical gap (E). AL = 160 nH measured in combination with an Equal-gapped E core half.
- A25 - E — gapped core half with asymmetrical gap (A). AL = 25 nH in combination with an ungapped E core half.
- A25 - P — gapped core half with asymmetrical gap (A). AL = 25 nH in combination with a plate.
- 1100/1300 — ungapped core half. AL = 1100/1300 nH measured in combination with an ungapped half / plate.

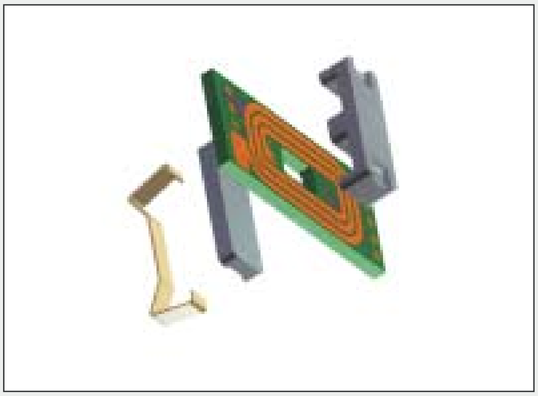


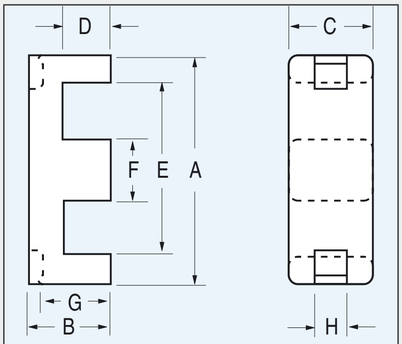


A_L value (nH) measured at $B \leq 0.1$ mT, $f \leq 10$ kHz, $T = 25°C$

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

Planar E cores with recess





E core with recess (E/R)

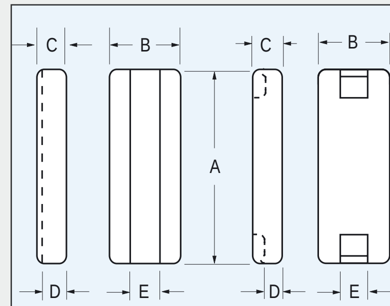


plate with slot (PLT/S)

plate with recess (PLT/R)

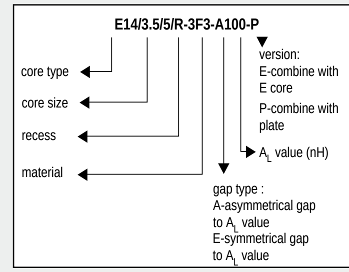
For those customers not in favor of glueing we developed a new range of planar E cores with matching plates and metal clamps. These cores can easily be mounted together with the PCB winding without the use of any glue. The E cores have recesses (E/R) to prevent the clamp from slipping off. The plates have slots (PLT/S) to limit any sideways movement during vibrations or shocks. The combinations with recessed plate need clips on the side.
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 AL 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.

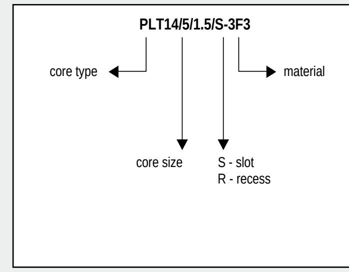
Summary:
- no glue necessary
- plate with slot or recess to prevent sideways movement
- no AL reduction of high permeability cores due to glue on the mating faces

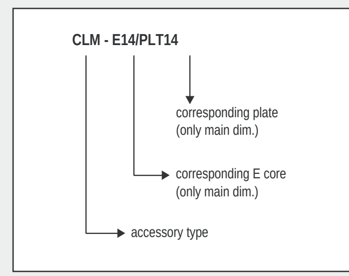
	Core type	E14/3.5/5/R	PLT 14/5/1.5/S (E-PLT combina-tion)	E18/4/10/R	PLT 18/10/2/S (E-PLT combina-tion)	E22/6/16/R	PLT 22/16/2.5/S (E-PLT combina-tion)	E32/6/20/R	PLT 32/20/3/R (E-PLT combina-tion)
efective core parameters	core factor Σ l/A(mm^{-1})		1.15		0.498		0.324		0.278
	eff. volume V_e (mm^3)		230		830		2100		4560
	eff. length l_e (mm)		16.4		20.3		26.1		35.1
	eff. area A_e (mm^2)		14.2		40.8		80.4		130
	min. area A_{min} (mm^2)		10.9		35.9		72.6		119
	mass of core half (g)	≈ 0.6	≈ 0.5	≈ 2.4	≈ 1.7	≈ 6.5	≈ 4	≈ 13	≈ 10
dimensions (mm)	A	14 ± 0.3	14 ± 0.3	18 ± 0.35	18 ± 0.35	21.8 ± 0.4	21.8 ± 0.4	31.75 ± 0.64	31.75 ± 0.64
	B	3.5 ± 0.1	5 ± 0.1	4 ± 0.1	10 ± 0.2	5.7 ± 0.1	15.8 ± 0.3	6.35 ± 0.13	20.32 ± 0.41
	C	5 ± 0.1	1.8 ± 0.05	10 ± 0.2	2.4 ± 0.05	15.8 ± 0.3	2.9 ± 0.05	20.32 ± 0.41	3.18 ± 0.13
	D	2 ± 0.1	1.5 ± 0.1	2 ± 0.1	2 ± 0.1	3.2 ± 0.1	2.5 ± 0.1	3.18 ± 0.2	5.3
	E	11 ± 0.25	2.5 + 0.2	14 ± 0.3	2.5 + 0.2	16.8 ± 0.4	2.9 + 0.2	24.9 min	5 + 0.2
	F	3 ± 0.05	-	4 ± 0.1	-	5 ± 0.1	-	6.35 ± 0.13	-
	G	2.8 ± 0.15	-	3.3 ± 0.15	-	4.7 ± 0.15	-	5.3	-
	H	2.5 + 0.2	-	2.5 + 0.2	-	2.8 + 0.2	-	5 + 0.2	-
mounting parts	CLM		■		■		■		
	CLI								

Planar E cores with recess

	Core type	E14/3.5/5/R	E18/4/10/R	E22/6/16/R	E32/6/20/R
	Matching plates	PLT14/5/1.5/S	PLT18/10/2/S	PLT22/16/2.5/S	PLT32/20/3/R
	3C90	1500	3680	6150	7350
	3C92 prot	960 / 1130	2330 / 2690	3700 / 4410	5000 / 5760
	3C93 prot	1100 / 1300	2700 / 3100	4300 / 5000	5900 / 6780
	3C94 des	A63-P	A100-P	A160-P	A160-P
		A100-P	A160-P	A250-P	A250-P
		A160-P	A250-P	A315-P	A315-P
		1500	A315-P	A400-P	A400-P
			3680	A630-P	A630-P
				6150	7350
	3C96 des			A160 - P	A160 - P
			A100 - P	A250 - P	A250 - P
		A63 - P	A160 - P	A315 - P	A315 - P
		A100 - P	A250 - P	A400 - P	A400 - P
		A160 - P	A315 - P	A630 - P	A630 - P
		1350	2500	4100	7350
	3F3	1300	3100	5000	6780
	3F35 des			A160 - P	
			A100 - P	A250 - P	
		A63 - P	A160 - P	A315 - P	
		A100 - P	A250 - P	A400 - P	
		A160 - P	A315 - P	A630 - P	
		1050	2500	4100	
	3F4 des	A63-P	A100-P	A160-P	A160-P
		A100-P	A160-P	A250-P	A250-P
		A160-P	A250-P	A315-P	A315-P
		780	A315-P	A400-P	A400-P
			1800	A630-P	A630-P
				2900	3700
high µ halves	3E6	6400	15500	26000	





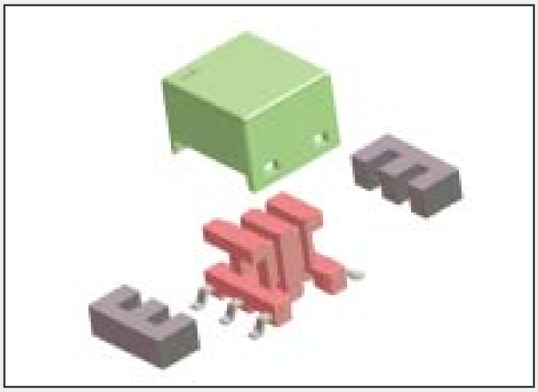


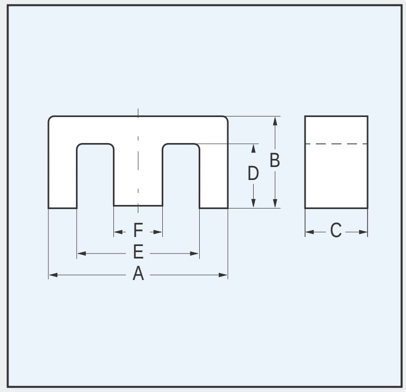
A63-P	gapped core half with asymmetrical gap (A). AL = 63 nH measured in combination with a plate.
1280	ungapped core half. AL = 1280 nH measured in combination with a plate.

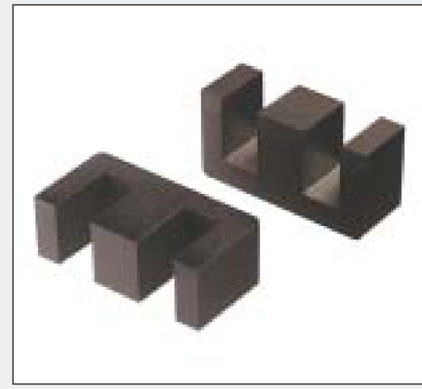
A_L value (nH) measured at B ≤ 0.1 mT, f ≤ 10 kHz, T = 25°C

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

E cores







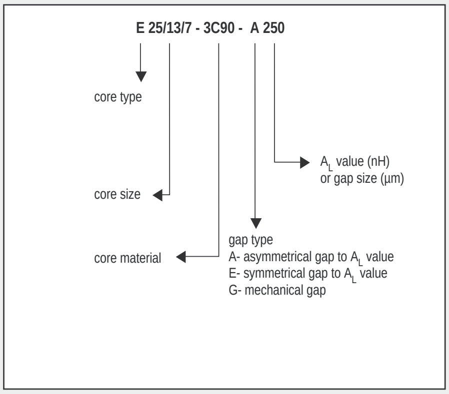
The shape of E cores is derived from the classical iron sheet lamination cores. For the original E range in fact the dimensions of the existing lamination range were taken so that already commercially available coil formers and mounting hardware could be used. The former EF range has been optimized for 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.

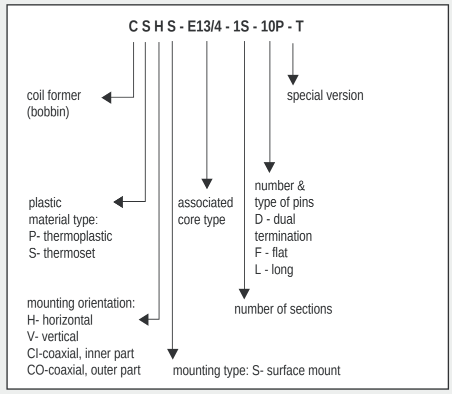
A drawback is the rectangular cross-section of the centre pole which makes it more difficult to wind, especially with heavy wires. Also the structure of the core is rather open resulting in stray flux sometimes causing interference problems.

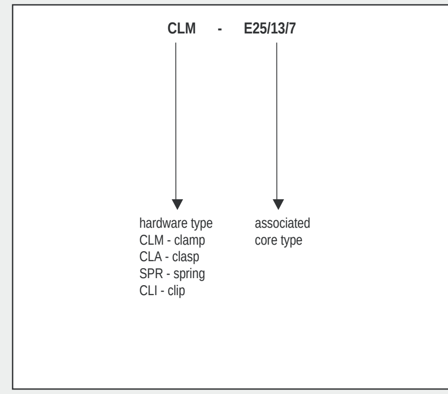
Summary:

- 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	E13/6/3	E13/6/6 (814E250)	E13/7/4 (EF12.6)	E16/8/5 (EF16)
efective core parameters	core factor Σ l/A(mm^{-1})	4.70	3.67	3.13	2.74	1.37	2.39	1.87
	eff. volume V_e (mm^3)	33.3	40.6	78	281	559	369	750
	eff. length l_e (mm)	12.5	12.2	15.6	27.8	27.7	29.7	37.6
	eff. area A_e (mm^2)	2.66	3.3	5.0	10.1	20.2	12.4	20.1
	min. area A_{min} (mm^2)	2.63	2.6	3.6	10.1	20.2	12.2	19.3
	mass of core half (g)	≈ 0.08	≈ 0.12	≈ 0.25	≈ 0.7	≈ 1.4	≈ 0.9	≈ 2.0
dimensions (mm)	A	5.25 ± 0.1	6.3 – 0.25	9 ± 0.4	12.7 ± 0.25	12.7 ± 0.25	12.6 + 0.5 / –0.4	16 + 0.7 / –0.5
	B	2.65 ± 0.05	2.9 – 0.1	4.1 – 0.2	5.7 ± 0.13	5.7 ± 0.13	6.5 – 0.2	8.2 – 0.3
	C	2.0 – 0.1	2.0 – 0.1	2.0 – 0.2	3.18 ± 0.13	6.4 ± 0.13	3.7 – 0.3	4.7 – 0.4
	D	1.9 + 0.15	1.85 + 0.1	2.03 + 0.32	4.1 ± 0.13	4.1 ± 0.13	4.5 + 0.3	5.7 + 0.4
	E	3.8 + 0.2	3.6 + 0.2	5.2 ± 0.13	9.5 ± 0.25	9.5 ± 0.25	8.9 + 0.6	11.3 + 0.6
	F	1.4 – 0.1	1.4 – 0.1	1.9 ± 0.12	3.2 ± 0.13	3.2 ± 0.13	3.7 – 0.3	4.7 – 0.3
bobbins	CP					1S		
	CPH						1S - 6P	1S - 6P
	CPHS	1S - 4P 1S - 6P 2S - 6P	1S - 4P 1S - 6P 2S - 4P 2S - 6P					
	CSH						1S - 6P - C 1S - 6P - CA 1S - 8P 1S - 10P - C	1S - 6P - C 1S-9P 1S - 14P
	CSHS						1S - 10P	
mounting parts	CLM	■						
	CLA							
	CLI	■						
	SPR							
	COV	■	■				■	

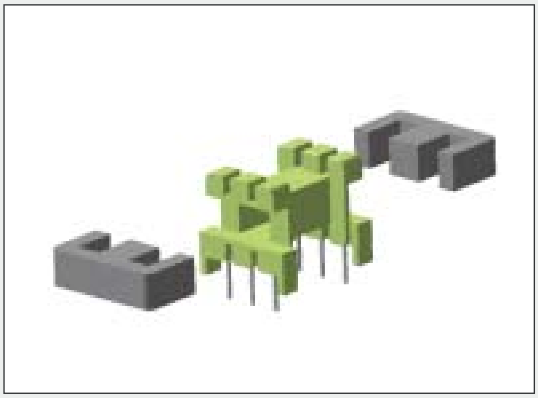


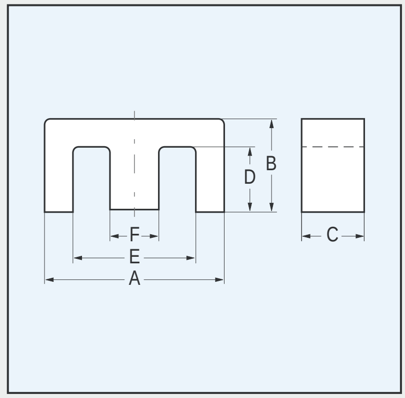




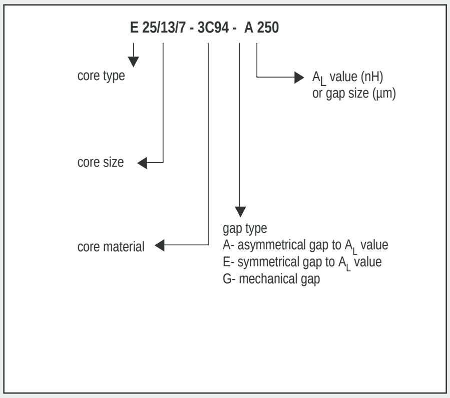
	Core type (old core description)	E16/12/5 (EL16)	E19/8/5 (813E187)	E19/8/9 (813E343)	E20/10/5	E20/10/6 (EF20)	E20/14/5 (EC19)	E22/16/10	E25/9/6	E25/10/6 (812E250)
efective core parameters	core factor Σ l/A(mm^{-1})	2.85	1.77	0.960	1.37	1.45	2.54	0.695	1.23	1.24
	eff. volume V_e (mm^3)	1070	900	1650	1340	1490	1513	5143	1860	1930
	eff. length l_e (mm)	55.3	39.9	39.9	42.8	46.0	62.0	59.8	47.4	49.0
	eff. area A_e (mm^2)	19.4	22.6	41.3	31.2	32.0	24.4	86	38.4	39.5
	min. area A_{min} (mm^2)	19.4	22.1	41.1	25.2	32.0	22.8	80	37.0	37.0
	mass of core half (g)	≈ 2.6	≈ 2.3	≈ 4	≈ 4	≈ 3.7	≈ 4.3	≈ 14	≈ 4.8	≈ 4.8
dimensions (mm)	A	16 ± 0.3	19.1 ± 0.4	19.05 ± 0.38	20.7–1.1	20+0.8 /–0.6	20 ± 0.3	22 ± 0.5	25.4 ± 0.6	25.4 ± 0.6
	B	12.25 ± 0.2	8.1 ± 0.13	8.05 ± 0.13	10 ± 0.2	10.2 – 0.4	13.55 ± 0.15	15.75 ± 0.5	9.45 ± 0.2	9.65 ± 0.2
	C	4.85 ± 0.2	4.7 ± 0.13	8.71 ± 0.13	5.3 – 0.4	5.9 – 0.5	5 ± 0.2	10 ± 0.25	6.3 ± 0.3	6.35 ± 0.25
	D	10.25 ± 0.25	5.7 ± 0.13	5.69 ± 0.13	6.3 + 0.4	7 + 0.4	11.15 ± 0.15	9.75 ± 0.25	6.5 ± 0.3	6.4 min
	E	12 ± 0.3	14.3 ± 0.3	14.33 ± 0.3	12.8 + 0.8	14.1 + 0.8	14.3 min	13 min	19.3 ± 0.5	18.8 min
	F	4 ± 0.2	4.7 ± 0.13	4.75 ± 0.13	5.2 – 0.4	5.9 – 0.4	4.55 ± 0.15	8 ± 0.25	6.35 ± 0.25	6.35 ± 0.25
bobbins	CP		1S	1S	1S					1S
	CPH		1S - 8PD			1S - 8P				1S - 10P 1S - 10PD - A
	CPCI					1S - 5P				
	CPCO					1S - 5P				
	CPHS									
	CPV				1S - 6P					
	CSH				1S - 8P	1S - 8P - C				

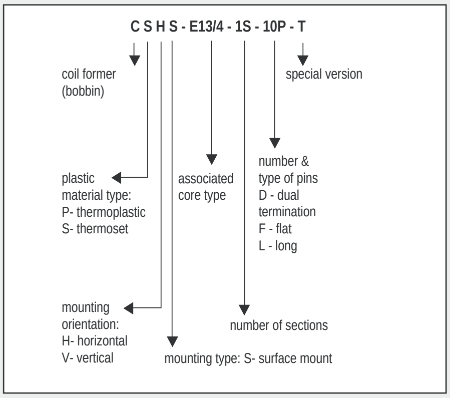
E cores

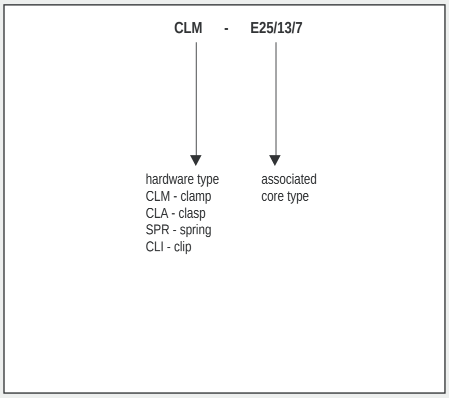




	Core type (old core description)	E25/13/7 (EF25)	E25/13/11	E30/15/7	E31/13/9	E32/16/9 (EF32)	E34/14/9 (E375)	E35/18/10	E36/21/12	E41/17/12 (E21)	E42/21/15
efective core parameters	core factor Σ l/A(mm^{-1})	1.11	0.733	1.12	0.740	0.894	0.850	0.807	0.762	0.517	0.548
	eff. volume V_e (mm^3)	2990	4500	4000	5150	6180	5590	8070	12160	11500	17300
	eff. length l_e (mm)	58.5	57.5	67.0	61.9	74	69.3	80.7	96	77.0	97.0
	eff. area A_e (mm^2)	52.0	78.4	60.0	83.2	83	80.7	100	126	149	178
	min. area A_{min} (mm^2)	52.0	78.4	49.0	83.2	83	80.7	100	121	142	175
	mass of core half (g)	≈ 8	≈ 11	≈ 11	≈ 13	≈ 16	≈ 14	≈ 15	≈ 31	≈ 30	≈ 44
dimensions (mm)	A	25 + 0.8/–0.7	25 + 0.8/–0.7	30.8 – 1.4	30.9 ± 0.5	32 + 0.9/–0.7	34.3 ± 0.6	35 ± 0.5	36 ± 0.7	40.6 ± 0.65	43 – 1.7
	B	12.8 – 0.5	12.8 – 0.5	15 ± 0.2	13.4 ± 0.15	16.4 – 0.4	14.1 ± 0.15	17.5 ± 0.25	21.75 – 0.4	16.6 ± 0.2	21 ± 0.2
	C	7.5 – 0.5	11 – 0.5	7.3 – 0.5	9.4 ± 0.3	9.5 – 0.7	9.3 ± 0.25	10 ± 0.3	12 – 0.6	12.4 ± 0.3	15.2 – 0.6
	D	8.7 + 0.5	8.7 + 0.5	9.7 + 0.5	8.6 min	11.2 + 0.6	9.8 ± 0.13	12.5 ± 0.25	15.75 + 0.6	10.4 min	14.8 + 0.6
	E	17.5 + 1.0	17.5 + 1.0	19.5 + 1.0	21.9 min	22.7 + 1.2	25.5 min	24.5 min	24.5 + 1.2	28.6 min	29.5 + 1.4
	F	7.5 ± 0.5	7.5 ± 0.5	7.2 – 0.5	9.4 ± 0.25	9.5 – 0.6	9.3 ± 0.2	10 ± 0.3	10.2 – 0.5	12.45 ± 0.25	12.2 – 0.5
bobbins	CP			1S			1S			1S	1S
	CPH	1S - 10P				1S - 12P	1S - 12PD			1S - 12PD	1S-10PD-A 1S-10P
	CPHS										
	CPV	1S - 6P									
	CSH	1S - 8P - C		1S - 10P 1S - 12P - C							
mounting parts	CLM										
	CLA			■							■
	CLI	■									
	SPR			■							■







	Core type (old core description)	E42/21/20	E42/33/20	E47/20/16	E50/27/15	E55/28/21	E55/28/25	E56/24/19(E75)	E65/32/27	E71/33/32	E80/38/20
efective core parameters	core factor Σ l/A(mm^{-1})	0.417	0.614	0.380	0.530	0.350	0.239	0.320	0.274	0.218	0.470
	eff. volume V_e (mm^3)	22700	34200	20800	26900	44000	52000	36000	79000	102000	72300
	eff. length l_e (mm)	97.0	145	88.9	120	124	123	107	147	149	184
	eff. area A_e (mm^2)	233	236	234	225	353	420	337	540	683	392
	min. area A_{min} (mm^2)	233	234	226	213	345	411	337	530	676	392
	mass of core half (g)	≈ 56	≈ 82	≈ 53	≈ 68	≈ 108	≈ 130	≈ 90	≈ 205	≈ 260	≈ 180
dimensions (mm)	A	43 – 1.7	42 + 1/ – 0.7	46.9 ± 0.8	50 ± 1	56.2 – 2.1	56.2 – 2.1	56.1 ± 1	65.0+1.5/–1.2	70.5 ± 1	80 ± 1.6
	B	21 ± 0.2	32.8 – 0.4	19.6 ± 0.2	27.2 ± 0.2	27.5 ± 0.3	27.5 ± 0.3	23.6 ± 0.25	32.8 – 0.6	33.2 – 0.5	38.1 ± 0.3
	C	20 – 0.8	20 – 0.8	15.6 ± 0.25	14.6 ± 0.4	21.0 – 0.8	25 – 0.8	18.8 ± 0.25	27.4 – 0.8	32 – 0.8	19.8 ± 0.4
	D	14.8 + 0.6	26 + 1	12.1 min	18.6 ± 0.13	18.5 + 0.8	18.5 + 0.8	14.6 ± 0.13	22.2 + 0.8	21.9 + 0.7	28.2 ± 0.3
	E	29.5 + 1.4	29.5 + 1.4	32.4 ± 0.65	34.1 min	37.5 + 1.5	37.5 + 1.5	38.1 min	44.2 + 1.8	48 + 1.5	59.1 min
	F	12.2 – 0.5	12.2 – 0.5	15.6 ± 0.25	14.6 ± 0.4	17.2 – 0.5	17.2 – 0.5	18.8 ± 0.25	20 – 0.7	22 – 0.7	19.8 ± 0.4
bobbins	CP	1S		1S		1S - A 1S	1S	1S	1S		
	CPH	1S - 12PD		1S - 12PD		1S - 14P		1S - 12PD			
	CPHS										
	CPV										
	CSH										
mounting parts	CLM										
	CLA					■			■		
	CLI										
	SPR					■			■		

E cores

Core type (old core description)		E5.3/2.7/2	E6.3/2.9/2	E8.8/4.1/2	E13/6/3	E13/6/6 (814E250)	E13/7/4 (EF12.6)	E16/8/5 (EF16)	E16/12/5 (EL16)	E19/8/5 (813E187)
core HALVES for general purpose transformers and power applications	3C81					1950				1500
	3C90				730	1470	800	1100	800	1170
	3C91 des					A63				E63
						A100				E100
						A160				A160
						A250				A250
						A315				A315
						1950				1500
	3C94				A63	A63	A63	A63		E63
					A100	A100	A100	A100		E100
					A160	A160	A160	A160		A160
					A250	A250	A250	A250		A250
					A315	A315	A315	A315		A315
		300	400	530	730	1470	800	1100	800	1170
	3C96 des				A63	A63	A63	A63		E63
					A100	A100	A100	A100		E100
					A160	A160	A160	A160		A160
					A250	A250	A250	A250		A250
					A315	A315	A315	A315		A315
		275	380	480	730	1470	800	1100	800	1000
	3F3	265	360	460		A63	A63	A63		E63
						A100	A100	A100		E100
						A160	A160	A160		A160
						A250	A250	A250		A250
						A315	A315	A315		A315
						1250	700	980		1000
	3F35 des	225	300	380		1000	560	760		810
	3F4 des	165	225	280						
high μ core halves	3C11									
	3E26								2000	
	3E27				1300	2600	1500	2200		2300
	3E5	1400	1700							
	3E6	1600	2100	2500						

E63 — gapped core half with symmetrical gap (E). A_L = 63 nH measured in combination with an Equal-gapped core half.

A315 — gapped core half with asymmetrical gap (A). A_L = 315 nH measured in combination with a non-gapped core half.

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

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

A_L tolerance: ± 5% | ± 8% | ± 10% | ± 15% | ± 20% | ± 25% | + 30% – 20% | + 40% – 30%

Core type (old core description)		E19/8/9 (813E343)	E20/10/5	E20/10/6 (EF20)	E20/14/5 (EC19)	E22/16/10	E25/9/6	E25/10/6	E25/13/7 (EF25)	E25/13/11
core HALVES for general purpose transformers and power applications	**3C81**	2740						2340	2460	
	3C90	2150	1500	1450	900	3090	2000	1600	1900	2800
	3C91 des	E63						E63	E63	
		E100						A100	A100	
		A160						A160	A160	
		A250						A250	A250	
		A315						A315	A315	
		2740						2340	2460	
	3C94	E63	A63	A63		A63		E63	E63	E63
		E100	A100	A100		A100		A100	A100	E100
		A160	A160	A160		A160		A160	A160	A160
		A250	A250	A250		A250		A250	A250	A250
		A315	A315	A315		A315		A315	A315	A315
		2150	1500	1450	900	3090	2000	1600	1900	2800
	3C96 des	E63	A63	A63				E63	E63	E63
		E100	A100	A100				A100	A100	E100
		A160	A160	A160				A160	A160	A160
		A250	A250	A250				A250	A250	A250
		A315	A315	A315				A315	A315	A315
		1830	1400	1350				1470	1650	2700
	3F3	E63	A63	A63				E63	E63	E63
		E100	A100	A100				A100	A100	E100
		A160	A160	A160				A160	A160	A160
		A250	A250	A250				A250	A250	A250
		A315	A315	A315				A315	A315	A315
		1830	1400	1350				1470	1650	2700
	3F35 des	1490	1060	1000				1150	1250	2000
	3F4 des									
high μ core halves	**3C11**		2600	2600				2600	3100	
	3E26				2300					
	3E27	4250	2800	2700				3200	4000	

E63 — gapped core half with symmetrical gap (E). A_L = 63 nH measured in combination with an Equal-gapped core half.

A315 — gapped core half with asymmetrical gap (A). A_L = 315 nH measured in combination with a non-gapped core half.

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

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

A_L tolerance: ± 5% | ± 8% | ± 10% | ± 15% | ± 20% | ± 25% | + 30% − 20% | + 40% − 30%

E cores

	Core type (old core description)	E30/15/7	E31/13/9	E32/14/9 (EF32)	E34/14/9 (E375)	E35/18/10	E36/21/12	E41/17/12	E42/21/15	E42/21/20
core HALVES for general purpose transformers and power applications	3C81	2500	3735		3200			5370	5300	6950
	3C90	1900	2970	2500	2440	2500	2650	4100	3950	5000
	3C91 des	E100	E100		E100			E100	E100	E100
		A160	E160		E160			E160	E160	E160
		A250	A250		A250			E250	E250	E250
		A315	A315		A315			A315	A315	E315
		A400	A400		A400			A400	A400	A400
		A630	A630		A630			A630	A630	A630
		2500	3735		3200			5370	5300	6950
	3C94	E100	E100	E100	E100	E100	E100	E100	E100	E100
		A160	E160	E160	E160	E160	E160	E160	E160	E160
		A250	A250	A250	A250	A250	E250	E250	E250	E250
		A315	A315	A315	A315	A315	A315	A315	A315	E315
		A400	A400	A400	A400	A400	A400	A400	A400	A400
		A630	A630	A630	A630	A630	A630	A630	A630	A630
		1900	2970	2500	2440	2500	2650	4100	4100	5200
	3C96 des	E100	E100	E100	E100					
		A160	E160	E160	E160					
		A250	A250	A250	A250					
		A315	A315	A315	A315					
		A400	A400	A400	A400					
		A630	A630	A630	A630					
		1600	2650	2300	2125					
	3F3	E100	E100	E100	E100			E100	E100	E100
		A160	A160	E160	E160			E160	E160	E160
		A250	A250	A250	A250			E250	E250	E250
		A315	A315	A315	A315			A315	A315	E315
		A400	A400	A400	A400			A400	A400	A400
		A630	A630	A630	A630			A630	A630	A630
		1600	2650	2300	2125			3575	3600	4600
	3F35 des	1250	1950	1700	1680					
	3F4 des									
high µ core halves	3C11	3300		4000					8000	
	3E27	4100	6790	5000	4700			9400	8000	10500

E63 — gapped core half with symmetrical gap (E). A_L = 63 nH measured in combination with an Equal-gapped core half.

A315 — gapped core half with asymmetrical gap (A). A_L = 315 nH measured in combination with a non-gapped core half.

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

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

A_L tolerance: ± 5% | ± 8% | ± 10% | ± 15% | ± 20% | ± 25% | + 30% − 20% | + 40% − 30%

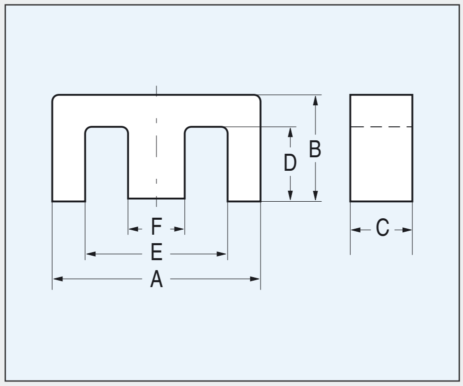
	Core type (old core description)	E42/33/20	E47/20/16	E50/27/15	E55/28/21	E55/28/25	E56/24/19 (E75)	E65/32/27	E71/33/32	E80/38/20
core HALVES for general purpose transformers and power applications	3C81		7540	5500	8625		9500			6730
	3C90	4000	5500	4350	6300	8000	6900	8600	10800	5070
	3C91 des		E100	E100	E100		E100			E100
			E160	E160	E160		E160			E160
			E250	E250	E250		E250			E250
			E315	E315	E315		E315			E315
			E400	E400	E400		E400			E400
			A630	A630	E630		E630			E630
			7540	5500	8625		9500			6730
	3C94	E100	E100	E100	E100	E100	E100	E100	E100	E100
		E160	E160	E160	E160	E160	E160	E160	E160	E160
		E250	E250	E250	E250	E250	E250	E250	E250	E250
		A315	E315	E315	E315	E315	E315	E315	E315	E315
		A400	E400	E400	E400	E400	E400	E400	E400	E400
		A630	A630	A630	E630	E630	E630	E630	E630	E630
		4000	5600	4350	6400	8000	6900	8600	10800	5070
	3F3	E100	E100		E100	E100		E100	E100	E100
		E160	E160		E160	E160		E160	E160	E160
		E250	E250		E250	E250		E250	E250	E250
		A315	E315		E315	E315		E315	E315	E315
		A400	E400		E400	E400		E400	E400	E400
		A630	A630		E630	E630		E630	E630	E630
		3700	5100		5700	7400		7300	10000	4590
	3F35 des									
	3F4 des									
high μ core halves	3C11				12800			16700		
	3E27		11475		15400		14580			

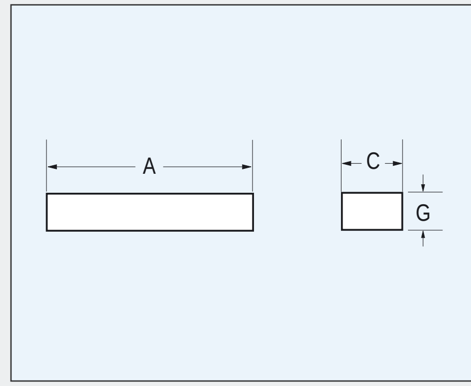
E63	gapped core half with symmetrical gap (E). A_L = 63 nH measured in combination with an Equal-gapped core half.
A315	gapped core half with asymmetrical gap (A). A_L = 315 nH measured in combination with a non-gapped core half.
1950	ungapped core half. AL = 1950 nH measured in combination with another ungapped core half.

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

A_L tolerance: ± 5% (pink), ± 8% (grey), ± 10% (light blue), ± 15% (yellow), ± 20% (peach), ± 25% (light green), +30% −20% (brown), +40% −30% (violet)

EI cores





The shape of EI cores, more precisely a core set consisting of an E core and an I core, is magnetically equivalent to an E core set with shorter legs. For typical characteristics, see therefore the E core section.

Summary:

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

	Core type	E16/12/5	E20/14/5	E22/15/6	E25/17/6	E28/17/11	E30/21/11	E33/23/13	E35/24/10	E40/27/12
	Matching bar	I16/2.4/5	I20/2.3/5	I22/4/6	I25/3/6	I28/3.5/11	I30/5.5/11	I33/5/13	I35/5/10	I40/7.5/12
efective core parameters	core factor Σ l/A(mm^{-1})	1.85	1.76	1.33	1.27	0.588	0.524	0.567	0.786	0.542
	eff. volume V_e (mm^3)	701	913	1450	2070	4120	6720	7910	6270	11100
	eff. length l_e (mm)	35.8	40.1	44.0	51.3	49.2	59.2	66.9	70.2	77.5
	eff. area A_e (mm^2)	19.4	22.8	33.1	40.3	83.7	113	118	89.3	143
	min. area A_{min} (mm^2)	19.4	22.0	32.0	39	83.7	104	114	88.0	133
	mass of E core (g)	≈ 2.7	≈ 3.8	≈ 5.9	≈ 8.0	≈ 17	≈ 25	≈ 31	≈ 24	≈ 42
	mass of I core (g)	≈ 0.9	≈ 1.1	≈ 2.3	≈ 2.5	≈ 5.1	≈ 8.6	≈ 10	≈ 7.4	≈ 17
dimensions (mm)	A	16 ± 0.3	20 ± 0.3	22 ± 0.5	25.4 ± 0.5	28 ± 0.55	30.25 ± 0.6	33 ± 0.65	34.9 ± 0.7	40.2 ± 0.7
	B	12.25 ± 0.2	13.55 ± 0.15	15 ± 0.25	17 ± 0.25	17.3 ± 0.25	21.3 ± 0.25	23.75 ± 0.25	23.8 ± 0.25	27.25 ± 0.25
	C	4.85 ± 0.2	5 ± 0.2	5.75 ± 0.25	6.35 ± 0.25	10.75 ± 0.2	10.65 ± 0.35	12.7 ± 0.3	9.5 ± 0.35	11.85 ± 0.35
	D	10.25 ± 0.25	11.5 ± 0.15	11 ± 0.25	13.83 ± 0.3	12.8 ± 0.2	16.3 ± 0.3	19.25 ± 0.25	19.05 ± 0.4	20.25 ± 0.25
	E	12 ± 0.3	14.3 min	15.95 min	18.64 min	18.6 min	19.85 min	23.6 min	24.93 min	29 ± 0.5
	F	4 ± 0.2	4.55 ± 0.15	5.75 ± 0.25	6.35 ± 0.15	7.25 ± 0.25	10.65 ± 0.25	9.7 ± 0.3	9.4 ± 0.25	11.85 ± 0.35
	G	2.4 ± 0.2	2.3 ± 0.2	4 ± 0.2	3.18 ± 0.2	3.5 ± 0.2	5.5 ± 0.2	5 ± 0.2	4.75 ± 0.2	7.5 ± 0.3

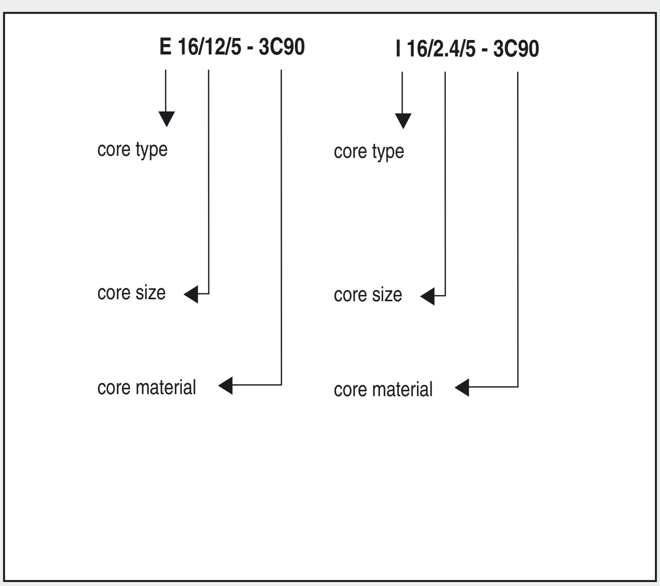
EI cores

Core type		E16/12/5	E20/14/5	E22/15/6	E25/17/6	E28/17/11	E30/21/11	E33/23/13	E35/24/10	E40/27/12
Matching bar		I16/2.4/5	I20/2.3/5	I22/4/6	I25/3/6	I28/3.5/11	I30/5.5/11	I33/5/13	I35/5/10	I40/7.5/12
core **halves** for general purpose transformers and power applications	**3C90**	1000	1290	1750	1750	3625	4300	4300	2960	4110
	3F3			1500		3420				

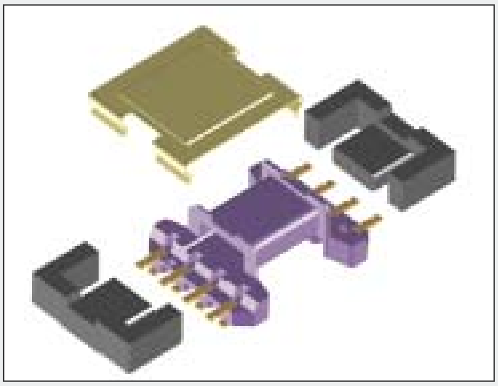
12000 — ungapped E core half, AL = 1200 nH measured in combination with an I core half.

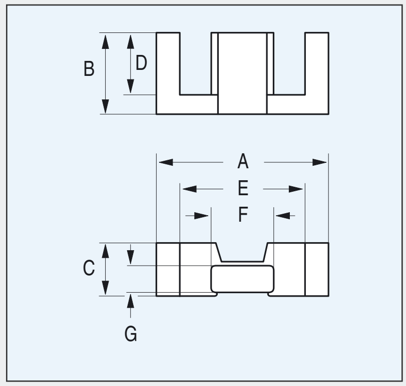
A_L tolerance: ± 25%

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



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.

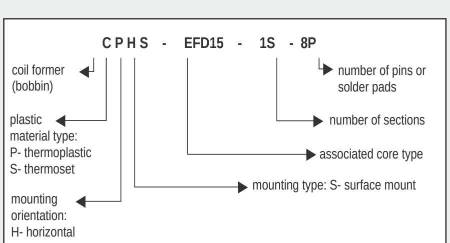
Summary:

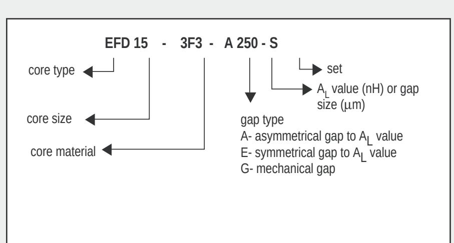
- very low build height
- very high throughput power density
- complete range of accessories including SMD coil formers
- available from several sources

	Core type	EFD10	EFD12	EFD15	EFD20	EFD25	EFD30
efective core parameters	core factor Σ l/A(mm^{-1})	3.29	2.50	2.27	1.52	1.00	0.98
	eff. volume V_e (mm^3)	171	325	510	1460	3300	4700
	eff. length l_e (mm)	23.7	28.5	34.0	47.0	57.0	68.0
	eff. area A_e (mm^2)	7.2	11.4	15.0	31.0	58.0	69.0
	min. area A_{min} (mm^2)	6.5	10.7	12.2	29.0	55.0	66.0
	mass of core half (g)	≈ 0.45	≈ 0.9	≈ 1.4	≈ 3.5	≈ 8	≈ 12
dimensions (mm)	A	10.5 ± 0.3	12.5 ± 0.3	15 ± 0.4	20 ± 0.55	25 ± 0.65	30 ± 0.8
	B	5.2 ± 0.1	6.2 ± 0.1	7.5 ± 0.15	10 ± 0.15	12.5 ± 0.15	15 ± 0.15
	C	2.7 ± 0.1	3.5 ± 0.1	4.65 ± 0.15	6.65 ± 0.15	9.1 ± 0.2	9.1 ± 0.2
	D	3.75 ± 0.15	4.55 ± 0.15	5.5 ± 0.25	7.7 ± 0.25	9.3 ± 0.25	11.2 ± 0.3
	E	7.65 ± 0.25	9 ± 0.25	11 ± 0.35	15.4 ± 0.5	18.7 ± 0.6	22.4 ± 0.75
	F	4.55 ± 0.15	5.4 ± 0.15	5.3 ± 0.15	8.9 ± 0.2	11.4 ± 0.2	14.6 ± 0.25
	G	1.45 ± 0.05	2 ± 0.1	2.4 ± 0.1	3.6 ± 0.15	5.2 ± 0.15	4.9 ± 0.15
bobbins	CPHS	1S - 8P	1S - 8P	1S - 10P	1S-10P		
	CSHS			1S - 8P	1S - 10P	1S-12P	
	CPH			1S - 8P	1S - 10P		
	CSH			1S - 8P	1S - 8P	1S - 10P	1S - 12P
mounting parts	CLI			■	■	■	■
	CLM	■	■	■	■	■	

	Core type	EFD10	EFD12	EFD15	EFD20	EFD25	EFD30
	3C90	585-S	825-S	950-S	1300	2200	2100
	3C94	A25-S	A40-S	A63-S	E63	A160	A160
		A40-S	A63-S	A100-S	A100	A250	A250
		A63-S	A100-S	A160-S	A160	A315	A315
		585-S	825-S	950-S	A250	A400	A400
					A315	A630	A630
					1300	2200	2100
	3C96 des				E63	A160	A160
					A100	A250	A250
		A25-S	A40-S	A63-S	A160	A315	A315
		A40-S	A63-S	A100-S	A250	A400	A400
		A63-S	A100-S	A160-S	A315	A630	A630
		525-S	750-S	850-S	1200	2000	1900
	3F3	500-S	700-S	780-S	1200	2000	1900
	3F35 des	400-S	550-S	630-S	920	1500	1450
	3F4 des	A25-S	A40-S	A63-S	E63	A160	A160
		A40-S	A63-S	A100-S	A100	A250	A250
		A63-S	A100-S	A160-S	A160	A315	A315
		280-S	380-S	400-S	A250	A400	A400
					A315	A630	A630
					650	1000	1000
high μ cores	3E5 des	2000-S	2800-S	3600-S			

E63-S — gapped core set with symmetrical gap (E). A_L = 63 nH.
A315-S — gapped core set with asymmetrical gap (A). A_L = 315 nH.
12000 — ungapped core half. AL = 1200 nH measured in combination with another ungapped core half.



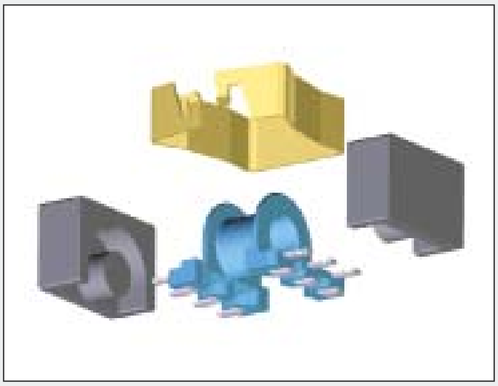


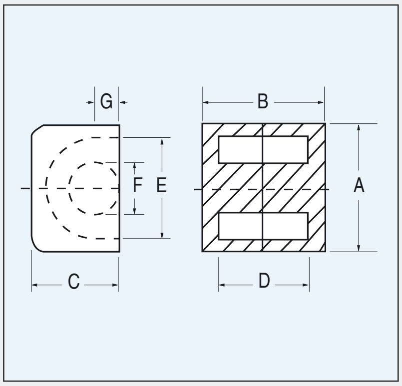
A_L value (nH) measured at B ≤ 0.1 mT, f ≤ 10 kHz, T = 25°C

A_L tolerance:

± 3% | ± 5% | ± 8% | ± 10% | ± 25% | + 40% − 30%

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	EP5	EP7	EP10	EP13	EP17	EP20
efective core parameters	core factor Σ l/A(mm^{-1})	3.20	1.45	1.70	1.24	0.870	0.520
	eff. volume V_e (mm^3)	28.7	165	215	472	999	3230
	eff. length l_e (mm)	9.70	15.5	19.3	24.2	29.5	41.1
	eff. area A_e (mm^2)	3.00	10.7	11.3	19.5	33.7	78.7
	min. area A_{min} (mm^2)	2.27	8.55	8.55	14.9	25.5	60.8
	mass of core set (g)	≈ 0.5	≈ 0.8	≈ 1.1	≈ 2.4	≈ 5	≈ 16
dimensions (mm)	A	6 ± 0.15	9.4 – 0.4	11.5 ± 0.3	12.8 – 0.6	18 ± 0.4	24 ± 0.5
	B	5.6 ± 0.1	7.5 – 0.2	10.2 ± 0.2	13 – 0.3	16.8 ± 0.2	21.4 ± 0.2
	C	3.8 ± 0.1	6.5 – 0.3	7.6 ± 0.2	9 – 0.4	11 ± 0.25	15 ± 0.35
	D	4.0 ± 0.2	5 + 0.4	7.85 – 0.4	9 + 0.4	11.4 ± 0.3	14.4 ± 0.3
	E	4.4 ± 0.15	7.2 + 0.4	9.4 ± 0.2	9.7 + 0.6	12 ± 0.4	16.5 ± 0.4
	F	1.7 ± 0.1	3.4 – 0.2	3.3 ± 0.15	4.5 – 0.3	5.7 ± 0.18	8.8 ± 0.25
	G	0.9 ± 0.1	1.7 ± 0.1	1.8 ± 0.13	2.4 ± 0.1	3.3 ± 0.2	4.5 ± 0.2
bobbins	CSH		1S - 4P - B 1S - 6P 1S - 6P - B 2S - 4P - TA 2S - 6P - T	1S - 8P 2S - 8P	1S - 10P 1S - 10P - T 2S - 10P	1S - 8P 2S - 8P	1S - 10P - T 2S - 10P - T
	CSHS		1S - 5P 1S - 6P 1S - 8P - L 2S - 8P - L	1S - 8P-T	1S - 10P-T		
	CPH						
	CPHS	1S - 6P		1S - 8P-T 2S - 8P	1S - 10P 2S - 10P - T		
mounting parts	CLI	■	■	■	■		
	CLI/P		■				
	CLA		■	■	■	■	■
	SPR		■	■	■	■	■

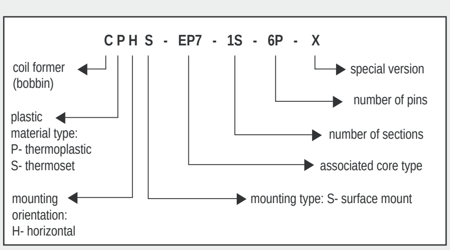
	Core type	EP5	EP7	EP10	EP13	EP17	EP20
core sets for general purpose transformers and power applications	3D3		A40	A40	A63		
			A63	A63	A100		
			A100	A100	A160		
			530	470	670		
	3H3		A40	A40	A63		
			A63	A63	A100		
			A100	A100	A160		
			A160	A160			
			A250				
			1120	1000	1500		
	3C81		1300	1200	1700	2670	4900
	3C91 des		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
			1300	1200	1700	2670	4900
	3C94	A16	E25	E25	E40	E63	E160
		A25	A40	A40	A63	A100	A250
		A40	A63	A63	A100	A160	A315
		A63	A100	A100	A160	A250	A400
		400	A160	A160	A160	A315	A630
			1200	1140	1650	2500	4435
	3C96 des		E25	E25	E40	E63	E160
		A16	A40	A40	A63	A100	A250
		A25	A63	A63	A100	A160	A315
		A40	A100	A100	A160	A250	A400
		A63	A160	A160	A160	A315	A630
		380	1120	1000	1500	2200	3850
	3F3		1000	1000	1325	2200	3550
	3F35 des	A16	850	800	1100		
		A25					
		A40					
		A63					
		320					
	3E27		3400	3400	4600	7100	11600
	3E5		5200	4800	7000	10000	
	3E55 des	A16	5200	4800	A100		
		A25			A160		
		A40			A250		
		A63			A400		
		2000			A630		
					7000		
	3E6	2200	5800	5400	8500		

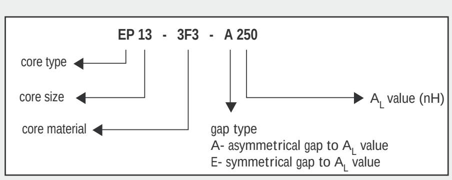
E63- — gapped core set with symmetrical gap (E). A_L = 63 nH.
A315- — gapped core set with asymmetrical gap (A). A_L = 315 nH.
12000 — ungapped core set. AL = 1200 nH.

A_L tolerance:

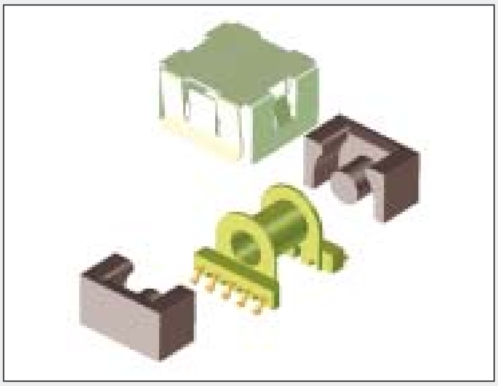
± 3% | ± 5% | ± 8% | ± 10% | ± 12% | ± 15% | ± 25% | + 30% – 20% | + 40% – 30%

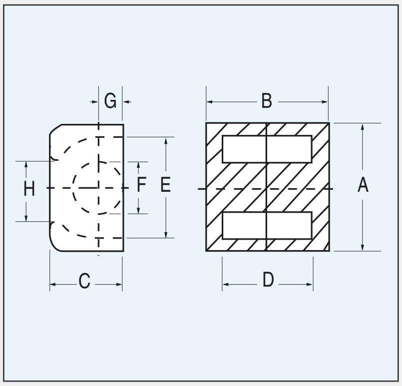
A_L value (nH) measured at B ≤ 0.1 mT, f ≤ 10 kHz, T = 25°C

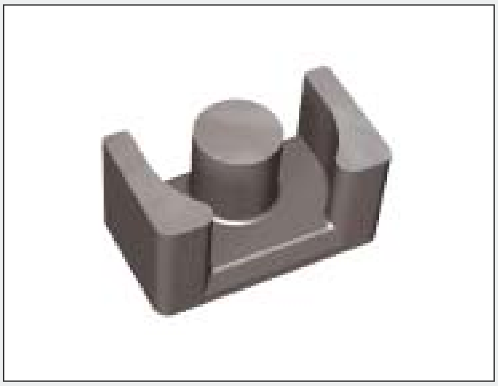




EP/LP cores





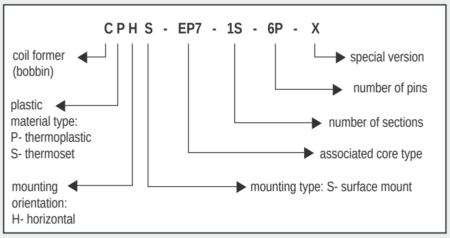


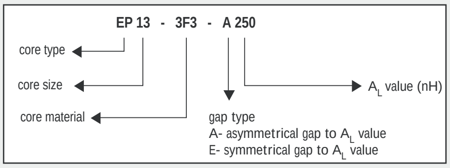
The EP/LP core range was specially designed for wideband transformer applications where low build height is a must. The board area occupied by the assembly is almost a square, allowing high packing densities on the PCB. The bobbins have two rows of pins allowing easy design of multiple output transformers.
Cores are available in high permeability materials, including the new low THD material 3E55, for wide band transformers and in power materials for small power transformers.

Summary:
- square design for dense packing
- lower build hight than EP
- easy design of multiple output transformers

Core type		EP13/LP
efective core parameters	core factor Σ I/A(mm^{-1})	1.42
	eff. volume V_e (mm^3)	501
	eff. length l_e (mm)	26.7
	eff. area A_e (mm^2)	18.8
	min. area A_{min} (mm^2)	14.9
	mass of core set (g)	≈
dimensions (mm)	A	12.8 – 0.6
	B	13 – 0.3
	C	7.18 ± 0.2
	D	9 + 0.4
	E	9.7 + 0.6
	F	4.5 – 0.3
	G	2.4 ± 0.1
	H	6.8 ± 0.15
bobbins	CSH	1S - 10P 2S - 10P
	CSHS	1S - 10P-T
	CPH	
	CPHS	1S - 10P
mounting parts	CLM	■
	CLI/P	
	CLA	
	SPR	

	Core type	EP13/LP
core sets for general purpose transformers and power applications	3C94 des	1400
	3C96 prot	1200
	3F35 prot	950
	3E55 des	A100
		A160
		A250
		A315
		A400
		A630
		6000
	3E6	6700



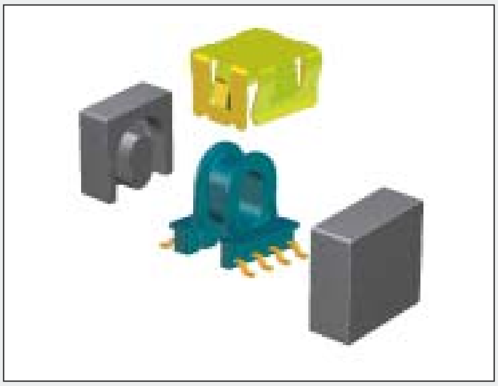


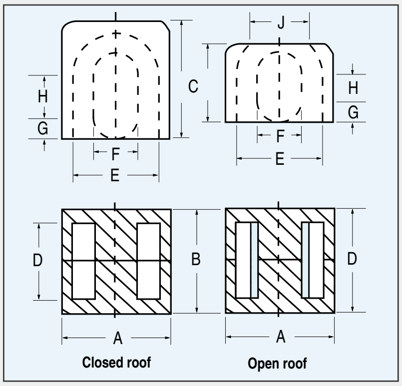
E63-	gapped core set with symmetrical gap (E). A_L = 63 nH.
A315-	gapped core set with asymmetrical gap (A). A_L = 315 nH.
12000	ungapped core set. AL = 1200 nH.

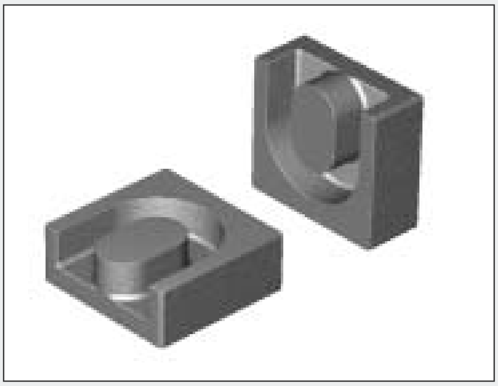
A_L tolerance:

± 3%	± 5%	± 8%	± 12%	± 15%	± 25%	+ 30% – 20%	+ 40% – 30%

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







EPX cores were derived from EP cores specially for pulse transformers in ISDN and ADSL applications. In comparison to EP cores they feature an increased centre pole area and achieve the same A_L and THD performance in a smaller core volume. The new EPX designs, complete with SMD bobbin and clip, satisfy the need for slimmer pulse transformers.

They are available in the high permeability material 3E6 for ISDN pulse transformers and in the low harmonic distortion material 3E55 for ADSL wideband applications. Power materials are introduced along with these.

Summary:
- increased centre pole area
- same performance as EP cores in a smaller volume
- SMD bobbins and clips available

Core type		EPX7	EPX8	EPX9	EPX10
Shape		closed roof	closed roof	closed roof	open roof
efective core parameters	core factor Σ l/A(mm^{-1})	0.931	1.04	1.15	1.45
	eff. volume V_e (mm^3)	255	279	304	325
	eff. length l_e (mm)	15.4	17.0	18.7	21.7
	eff. area A_e (mm^2)	16.5	16.4	16.3	15.0
	min. area A_{min} (mm^2)	14.5	14.5	14.5	12.5
	mass of core set (g)	≈ 1.2	≈ 1.3	≈ 1.4	≈ 1.5
dimensions (mm)	A	9.4 – 0.4	9.4 – 0.4	9.4 – 0.4	11.8 – 0.6
	B	7.5 – 0.2	8.5 – 0.2	9.5 – 0.2	10.4 – 0.2
	C	9 – 0.4	9 – 0.4	9 – 0.4	7.85 – 0.4
	D	4.6 + 0.4	5.6 + 0.4	6.6 + 0.4	7.2 + 0.4
	E	7.2 + 0.4	7.2 + 0.4	7.2 + 0.4	9.1 + 0.4
	F	3.4 – 0.2	3.4 – 0.2	3.4 – 0.2	3.45 – 0.3
	G	1.7 ± 0.1	1.7 ± 0.1	1.7 ± 0.1	1.85 ± 0.1
	H	2.3	2.3	2.3	1.4
	J				5.0
bobbins	CSH				
	CSHS	1S-8P 1S-8P-T		1S-8P 1S-8P-T	
	CPH				
	CPHS				
mounting parts	CLM	■		■	

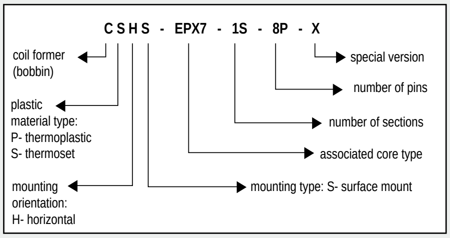
	Core type	EPX7	EPX8	EPX9	EPX10
core SETS for general purpose transformers and power applications	3C94 des	1950	1800	1700	1400
	3C96 prot	1750	1650	1550	1250
	3F35 prot	1400	1300	1200	950
	3E55 des	A63	A63	A63	A63
		A100	A100	A100	A100
		A160	A160	A160	A160
		A250	A250	A250	A250
		A315	A315	A315	A315
		A400	A400	A400	A400
		8400	7800	7300	6000
	3E6	9300	8700	8200	6600

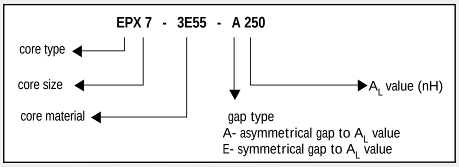
E63- — gapped core set with symmetrical gap (E). A_L = 63 nH.
A315- — gapped core set with asymmetrical gap (A). A_L = 315 nH.
12000 — ungapped core set. AL = 1200 nH.

A_L tolerance:

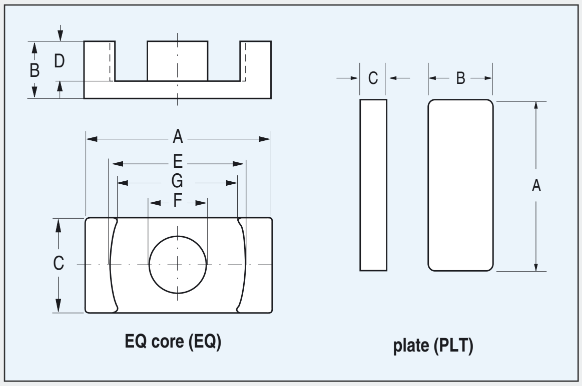
± 3% | ± 5% | ± 8% | ± 12% | ± 15% | ± 25% | + 30% − 20% | + 40% − 30%

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





EQ cores



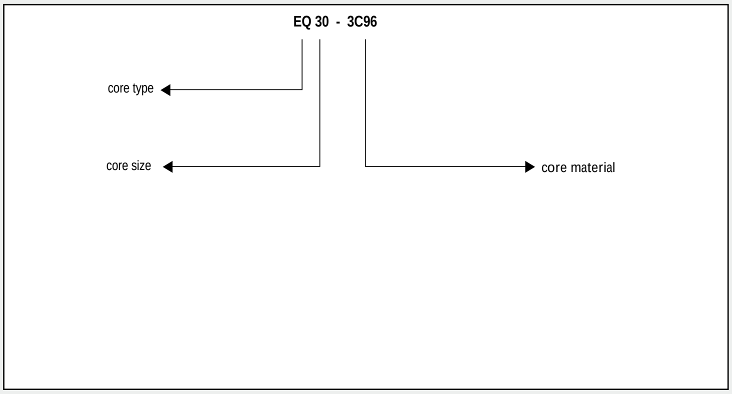
The EQ core design is derived from the ER and PQ. The range is optimized for use in compact AC/DC notebook adapters and DC/DC converters.
For instance, the EQ30 has the capability to handle a power range of 50 to 70 W (flyback topology) in an enclosed casing of a notebook adapter or 100 to 150 W in low profile DC/DC converter .
The advantages of EQ cores are a simple core shape, round centre pole, high A_e value , a large winding window, low profile and a large surface area for heat dissipation.

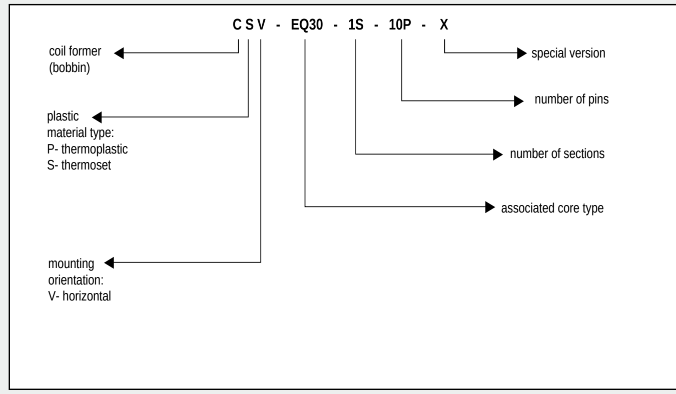
Summary :

- Simple core shape
- Round centre pole
- High A_e value
- Large winding window
- Low profile
- Large surface area for heat dissipation

	Core type	EQ13	PLT13/9/1 (EQ/PLT combination)	EQ20/R [1]	PLT20/14/2/S [2] (EQ/PLT combination)
efective core parameters	core factor Σ l/A(mm^{-1})	0.911	0.803	0.563	0.420
	eff. volume V_e (mm^3)	348	315	1960	1500
	eff. length l_e (mm)	17.5	15.9	33.2	25.1
	eff. area A_e (mm^2)	19.9	19.8	59	59.8
	min. area A_{min} (mm^2)	19.2	19.2	55	55
	mass of core half (g)	≈ 0.9	≈ 0.6	≈ 5.5	≈ 3
dimensions (mm)	A	30 ± 0.4	12.8 ± 0.3	20 ± 0.35	20 ± 0.35
	B	8 ± 0.15	8.7 ± 0.25	6.3 ± 0.1	14 ± 0.3
	C	20 ± 0.3	1.1 ± 0.1	14 ± 0.3	2.3 ± 0.05
	D	5.3 ± 0.2	-	4.1 ± 0.15	-
	E	26 ± 0.4	-	18 ± 0.35	-
	F	11 ± 0.2	-	8.8 ± 0.15	-
	G	19.45 ± 0.4	-	12.86 ± 0.35	-
bobbins	CSV				

[1] Core has clip recesses
[2] Plate has a slot to accomodate a mounting clip. (Similar to Planar E cores with recess.)





Core type		EQ25	EQ25/LP	PLT25/18/2 (EQ/LP/PLT combination)	EQ30	PLT30/20/3 (EQ/PLT combination)
efective core parameters	core factor Σ l/A(mm^{-1})	0.414	-	0.294	0.426	0.292
	eff. volume V_e (mm^3)	4145	-	2370	4970	3400
	eff. length l_e (mm)	41.4	-	26.4	46	31.5
	eff. area A_e (mm^2)	100	-	89.7	108	108
	min. area A_{min} (mm^2)	95	-	82.8	95	95
	mass of core half (g)	≈ 12	≈ 8.5	≈ 5	≈ 13.5	≈ 8
dimensions (mm)	A	25 ± 0.4	25 ± 0.4	25 ± 0.4	30 ± 0.4	30 ± 0.4
	B	8 ± 0.1	5.6 ± 0.05	18 ± 0.3	8 ± 0.15	20 ± 0.3
	C	18 ± 0.3	18 ± 0.3	2.3 ± 0.05	20 ± 0.3	2.7 ± 0.1
	D	5.15 ± 0.15	3.2 ± 0.15	-	5.3 ± 0.2	-
	E	22 ± 0.4	22 ± 0.4	-	26 ± 0.4	-
	F	11 ± 0.2	11 ± 0.2	-	11 ± 0.2	-
	G	14.5 min	14.5 min	-	19.45 ± 0.4	-
bobbins	CSV				1S - 10P	

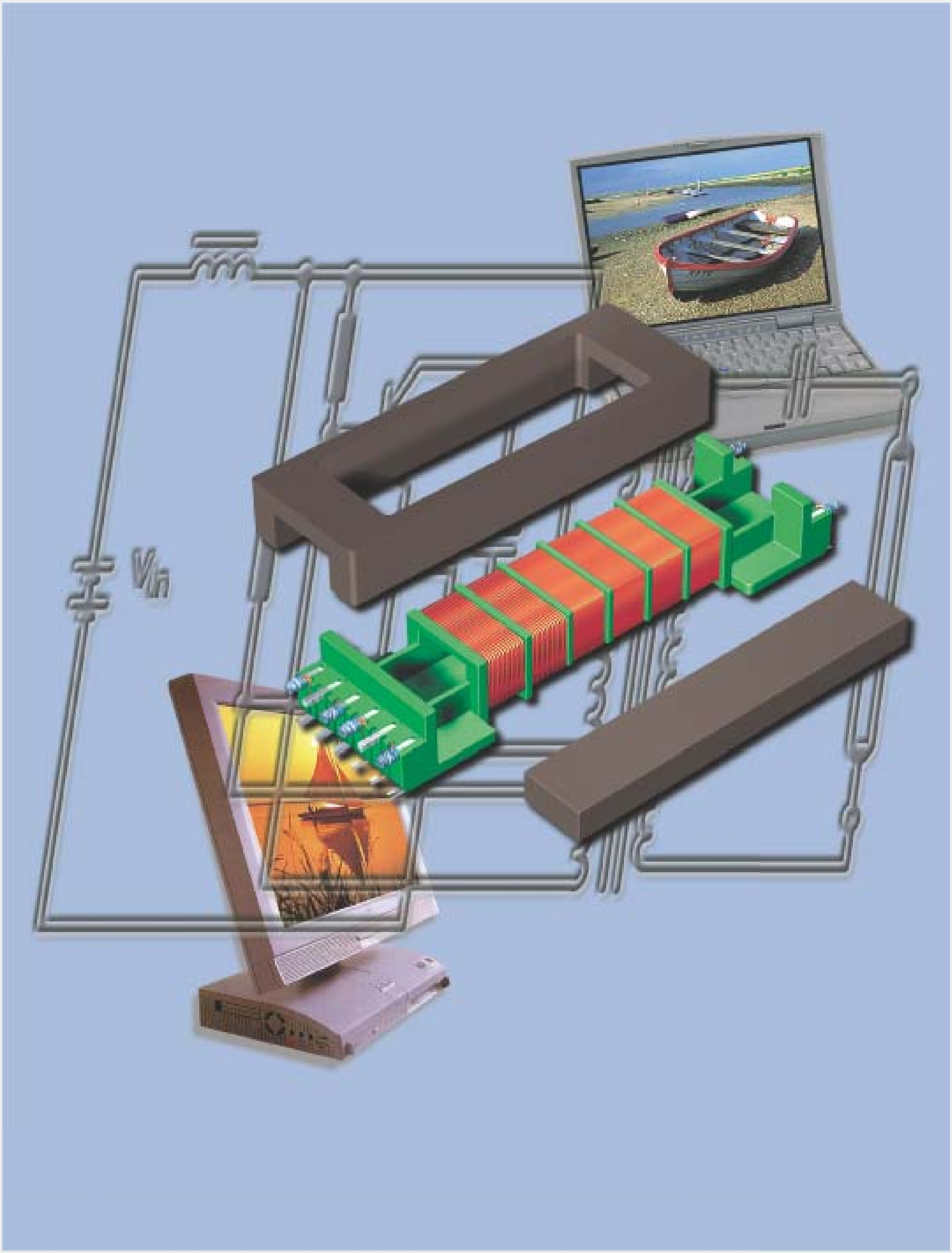
EQ cores

Core type		EQ13	EQ13 + PLT13/9/1	EQ20/R	EQ20/R + PLT20/14/2/S	EQ25	EQ25/LP + PLT25/18/2	EQ30	EQ30 + PLT30/20/3
core **halves** for power applications	3C94	1700	1800	3500	4750	4800	6100	4300	6550
	3C96 des	1600	1700	3150	4350	4400	5600	3900	6000
	3F35 des	1300	1350	2400	3300	3350	4350	3050	4600
	3F4 des	950	1000	1700	2200	2300	3100	2150	3200

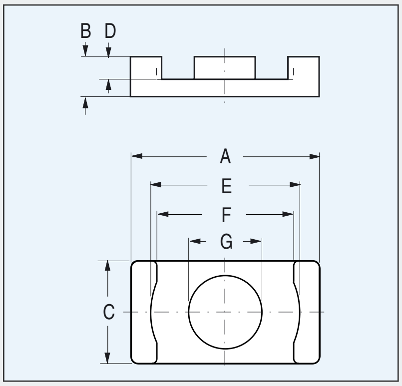
12000 — ungapped core half, AL = 1200 nH measured in combination with another ungapped core half.

A_L tolerance: ± 25%

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


Vin

Planar ER cores



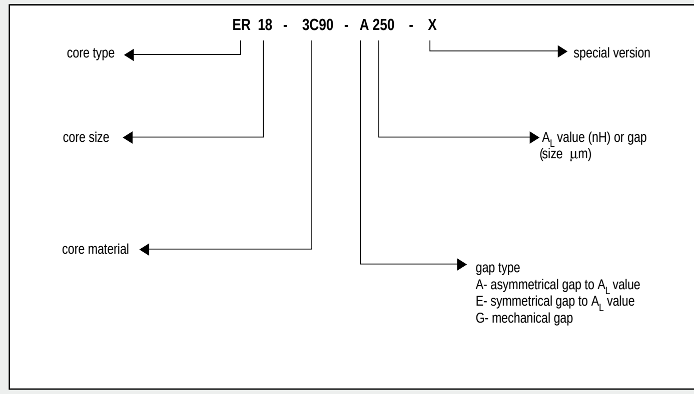
The ER core design is derived from the original E core and, like ETD and EC cores, has a round centre pole and outer legs with a radius to accomodate round coil formers.
These cores are mainly used for power transformers. The round centre pole allows the use of thicker wires while the shorter turn length keeps the copper losses low.
Planar ER cores are very suitable to build small SMD or planar power and signal tranformers. For the 3 smallest sizes matching SMD coil formers and clips are available.

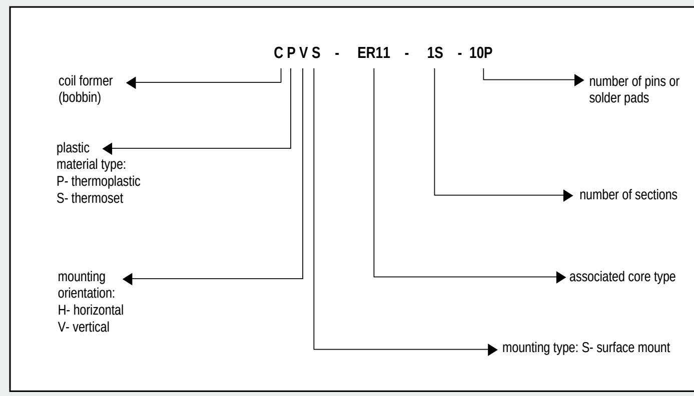
Summary:

- 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	ER18	ER23
efective core parameters	core factor Σ l/A(mm^{-1})	1.67	1.23	1.08	0.730	0.530
	eff. volume V_e (mm^3)	120	174	333	667	1340
	eff. length l_e (mm)	14.2	14.7	19.0	22.1	26.6
	eff. area A_e (mm^2)	8.47	11.9	17.6	30.2	50.2
	min. area A_{min} (mm^2)	7.6	10.3	17.3	30.1	50.0
	mass of core half (g)	≈ 0.35	≈ 0.5	≈ 0.9	1.6	3.2
dimensions (mm)	A	9.5 – 0.3	11 – 0.35	14.5 ± 0.2	18.0 ± 0.35	23.2 ± 0.45
	B	2.45 ± 0.05	2.45 ± 0.05	2.95 ± 0.05	3.15 ± 0.1	3.6 ± 0.1
	C	5 – 0.2	6 – 0.2	6.8 – 0.2	9.7 ± 0.2	12.5 ± 0.25
	D	1.6 + 0.15	1.5 + 0.15	1.55 + 0.2	1.6 ± 0.1	1.6 ± 0.1
	E	7.5 + 0.25	8.7 + 0.3	11.8 ± 0.2	15.6 ± 0.3	20.2 ± 0.4
	F	7.1 + 0.2	8 + 0.2	11.8 ± 0.2	13.5 min	17.5 min
	G	3.5 – 0.2	4.25 – 0.25	4.8 – 0.2	6.2 ± 0.15	8.0 ± 0.2
bobbins	CPVS	1S - 8P	1S - 10P	1S - 10P		
mounting parts	CLM	■	■	■		

cores for general purpose transformers and power applications	Core type	ER9.5 SETS	ER11 SETS	ER14.5 SETS	ER18 SETS	ER23 SETS
	3C92 des	63-S	100-S	100-S	A160-S	A250-S
		100-S	160-S	160-S	A250-S	A400-S
		160-S	250-S	250-S	A400-S	A630-S
		750-S	1050-S	1250-S	1900-S	2800-S
	3C93 prot	850-S	1200-S	1400-S	2200-S	3200-S
	3C94 des	A63-S	A100-S	A100-S		
		A100-S	A160-S	A160-S		
		A160-S	A250-S	A250-S		
		1000-S	1400-S	1600-S		
	3C96 prot	900-S	1250-S	1500-S	A160-S	A250-S
					A250-S	A400-S
					A400-S	A630-S
					2400-S	3400-S
	3F3	A63-S	A100-S	A100-S		
		A100-S	A160-S	A160-S		
		A160-S	A250-S	A250-S		
		850-S	1200-S	1400-S		
	3F35 prot	700-S	1000-S	1150-S	A160-S	A250-S
					A250-S	A400-S
					A400-S	A630-S
					1800-S	2600-S
	3F4 des	A40-S	A63-S	A100-S		
		A63-S	A100-S	A160-S		
		A100-S	A160-S	A250-S		
		525-S	725-S	850-S		
	3E5	3600-S	5000-S			
	3E6	4800-S	6700-S	7900-S		





A63-S-	gapped core set with asymmetrical gap (A), A_L = 63 nH.
1000-S-	ungapped core set, A_L = 1000 nH.
2900	ungapped core half, AL = 2900 nH measured in combination with another ungapped core half.

A_L tolerance:

± 3%	± 5%	± 8%	± 12%	± 15%	± 25%	+ 30% − 20%	+ 40% − 30%

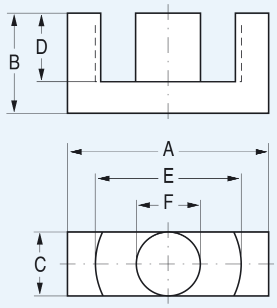
A_L value (nH) measured at B ≤ 0.1 mT, f ≤ 10 kHz, T = 25°C

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.

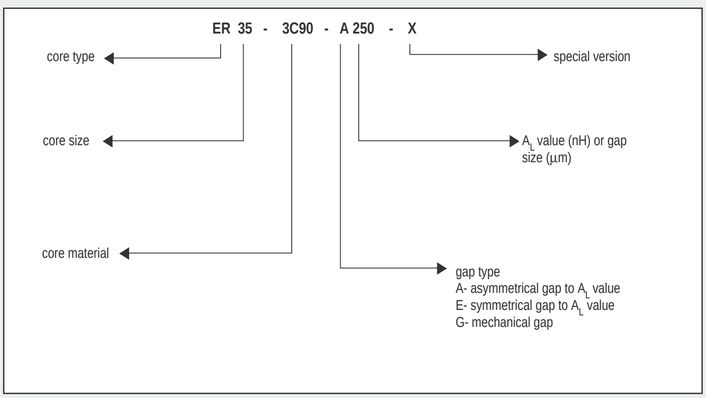
Summary:

- round centre pole
- outer legs with a radius
- moderate shielding



	Core type	ER28	ER28L	ER35	ER35W	ER40	ER42	ER42A	ER48	ER54
efective core parameters	core factor Σ l/A(mm^{-1})	0.786	0.928	0.849	0.900	0.658	0.509	0.582	0.392	0.370
	eff. volume V_e (mm^3)	5260	6140	9710	9548	14600	19200	16800	25500	23000
	eff. length l_e (mm)	64.0	75.5	90.8	92.7	98	98.8	99	100	91.8
	eff. area A_e (mm^2)	81.4	81.4	107	103	149	194	170	255	250
	min. area A_{min} (mm^2)	77.0	77.0	100	100	139	189	170	248	240
	mass of core half (g)	≈ 14	≈ 16	≈ 23	≈ 27	≈ 37	≈ 50	≈ 42	≈ 64	≈ 61
dimensions (mm)	A	28.55 ± 0.55	28.55 ± 0.55	35 ± 0.65	35 ± 0.65	40 ± 0.7	42 ± 0.75	42 + 1.0 / – 0.7	48 ± 1	53.5 ± 1
	B	14 ± 0.2	16.9 ± 0.25	20.7 ± 0.2	20.9 ± 0.2	22.4 ± 0.2	22.4 ± 0.2	21.8 ± 0.4	21.1 – 0.4	18.3 ± 0.2
	C	11.4 ± 0.35	11.4 ± 0.35	11.4 ± 0.35	11.3 ± 0.35	13.4 ± 0.35	15.6 ± 0.4	15.6 ± 0.4	21 + 0.3 / – 0.5	17.95 ± 0.35
	D	9.75 ± 0.4	12.65 ± 0.4	14.75 ± 0.35	15 ± 0.2	15.45 ± 0.35	15.45 ± 0.35	15.6 + 0.7	14.7 + 0.7	11.1 ± 0.3
	E	21.75 ± 0.5	21.75 ± 0.5	26.15 ± 0.55	27.1 ± 0.7	29.6 ± 0.6	30.05 ± 0.65	30.4 + 1.2	38 + 0.5 / – 0.8	40.65 ± 0.85
	F	9.9 ± 0.25	9.9 ± 0.25	11.3 ± 0.25	11.3 ± 0.25	13.3 ± 0.25	15.5 ± 0.3	15 – 0.6	18 ± 0.3	17.9 ± 0.4

Core type		ER28 HALVES	ER28L HALVES	ER35 HALVES	ER35W HALVES	ER40 HALVES	ER42 HALVES	ER42A HALVES	ER48 HALVES	ER54 HALVES
cores for general purpose transformers and power applications	3C90	2900	2500	2800	3000	3600	4600	4000	5700	6100
	3C94	2900	2500	2800		3600	4600	4000	5700	6100



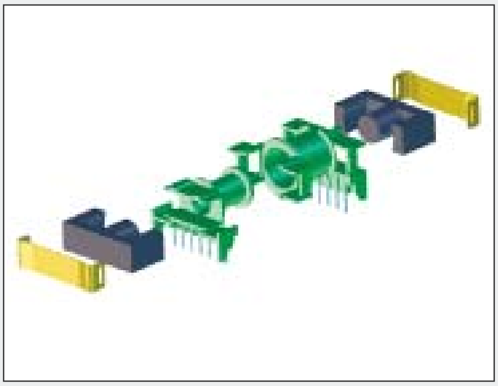
A63-S-	gapped core set with asymmetrical gap (A), A_L = 63 nH.
1000-S-	ungapped core set, A_L = 1000 nH.
2900	ungapped core half, AL = 2900 nH measured in combination with another ungapped core half.

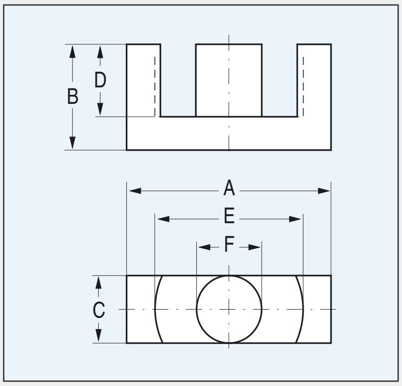
A_L tolerance:

± 3%	± 5%	± 8%	± 12%	± 15%	± 25%	+ 30% − 20%	+ 40% − 30%

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

ETD cores





The ETD core design is a further development of E cores. They are optimized for use in SMPS transformers with switching frequencies between 50 and 200 kHz. The designation ETD (Economic Transformer Design) implies that this design achieves maximum throughput power related to volume and weight of the total transformer. Shielding is somewhat improved compared with E cores. The matching coil formers are suitable for many winding types and can be handled on automatic equipment. Clips are easy to mount and the range is available from several major suppliers.

Summary:

- optimized shape for AC/DC SMPS transformers up to 200 kHz
- lowest weight and volume for throughput power
- efficient mounting parts
- moderate shielding

	Core type	ETD29	ETD34	ETD39	ETD44	ETD49	ETD54	ETD59
efective core parameters	core factor Σ l/A(mm^{-1})	0.947	0.810	0.737	0.589	0.534	0.454	0.378
	eff. volume V_e (mm^3)	5470	7640	11500	17800	24000	35500	51500
	eff. length l_e (mm)	72	78.6	92.2	103	114	127	139
	eff. area A_e (mm^2)	76	97.1	125	173	211	280	368
	min. area A_{min} (mm^2)	71	91.6	123	172	209	280	368
	mass of core half (g)	≈ 14	≈ 20	≈ 30	≈ 47	≈ 62	≈ 90	≈ 130
dimensions (mm)	A	30.6 – 1.6	35 – 1.6	40 – 1.8	45 – 2	49.8 – 2.2	54.5 ± 1.3	59.8 ± 1.3
	B	15.8 ± 0.2	17.3 ± 0.2	19.8 ± 0.2	22.3 ± 0.2	24.7 ± 0.2	27.6 ± 0.2	31.0 ± 0.2
	C	9.8 – 0.6	11.1 – 0.6	12.8 – 0.6	15.2 – 0.6	16.7 – 0.6	18.9 ± 0.4	21.65 ± 0.45
	D	11 ± 0.3	11.8 + 0.6	14.2 + 0.8	16.1 + 0.8	17.7 + 0.8	20.2 ± 0.4	22.5 ± 0.4
	E	22 + 1.4	25.6 + 1.4	29.3 + 1.6	32.5 + 1.6	36.1 + 1.8	41.2 ± 1.1	44.7 ± 1.1
	F	9.8 – 0.6	11.1 – 0.6	12.8 – 0.6	15.2 – 0.6	16.7 – 0.6	18.9 ± 0.4	21.65 ± 0.45
bobbins	CPH	1S-13P	1S - 14P	1S - 16P	1S - 18P	1S - 20P	1S - 22P	1S - 24P
	CPV							
	CSV							
	CSCI		1S - 7P-T					
	CSCO		1S - 7P-T					
mounting parts	CLI	■	■	■	■	■	■	■

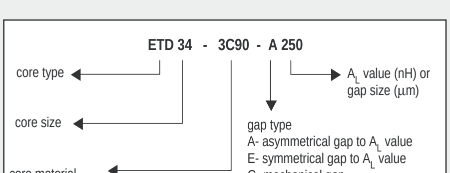
	Core type	ETD29	ETD34	ETD39	ETD44	ETD49	ETD54	ETD59
core halves for power applications	3C90	2350	2700	3000	3800	4200	5000	6000
	3C94	2350	2700	3000	3800	4200	5000	6000
	3C96 des	2200	2500	2800	3500	3900	4600	5600
	3F3	2200	2500	2800	3500	3900	4600	5600
	3F35 des	1600	1850					

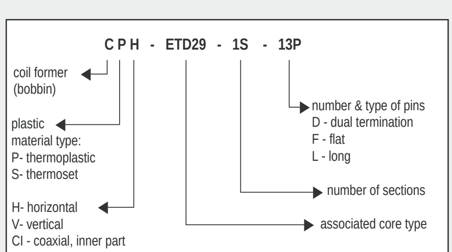
2900 — ungapped core half, AL = 2900 nH measured in combination with another ungapped core half.

A_L tolerance:

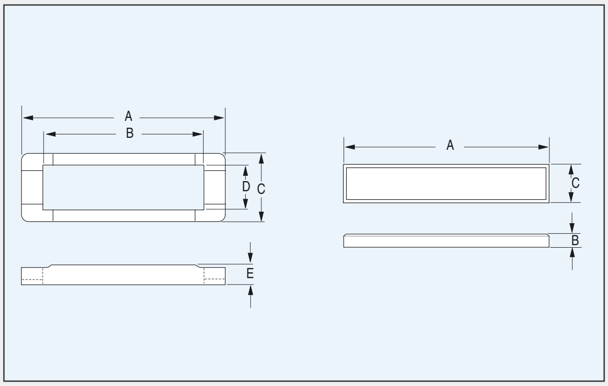
± 3% | ± 5% | ± 8% | ± 12% | ± 15% | ± 25% | + 30% − 20% | + 40% − 30%

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





Frame and Bar cores



Cores with a design similar to Frame and Bar cores have been available from Philips under the name of H cores, since 1971. They were mainly applied as signal transformers in Telecom applications. The new Frame and Bar cores have been modified to a slim and elongated rectangular shape in order to meet the dimension requirements of a flat LCD panel. The elongated rectangular shape is also optimized to accommodate the large number of turns required to generate the high ignition voltage (1400 Vrms) for a backlight discharge lamp. Besides this, the Frame and Bar core is also easy to assemble into a transformer and has been adopted as a standard core for the LCD backlight inverter transformer. A backlight inverter is an electronic DC to AC circuit that drives a Cold Cathode Fluorescent Lamp (CCFL) for the backlighting of a notebook LCD display or LCD monitor .

Summary :
- Narrow design
- Easy to assemble
- Large winding space to accommodate a large number of turns

	Core type	FRM 20/5/15	FRM 21/4/12	FRM 24/3.9/10	FRM 27/3.8/9	BAR 20/3/5.5	BAR 22/2/6	BAR 25/2.2/4	BAR 28/3.8/2.3
efective core parameters	core factor Σ l/A(mm^{-1})	3.29	5.06	5.65	5.56	3.29	5.06	5.65	5.56
	eff. volume V_e (mm^3)	655	312	370	504	655	312	370	504
	eff. length l_e (mm)	46	40	45.8	52.1	46	40	45.8	50
	eff. area A_e (mm^2)	14	7.9	8.1	9.7	14	7.9	8.1	9.0
	min. area A_{min} (mm^2)	7.4	5.7	6	8.7	7.4	5.7	6	8.7
	mass of core half (g)	≈ 2.1	≈ 1.5	≈ 1.3	≈ 1.6	≈ 1.5	≈ 1	≈ 1.2	≈ 1.2
dimensions (mm)	A	19.7 ± 0.3	21 ± 0.2	23.8 ± 0.3	26.7 ± 0.7	19.9 ± 0.3	21.8 ± 0.3	24.7 ± 0.3	28 ± 0.5
	B	15.6 ± 0.3	16.2 ± 0.3	19.2 ± 0.3	19.7 ± 0.6	2.85 ± 0.05	1.8 ± 0.1	2.15 ± 0.05	3.8 ± 0.1
	C	14.8 ± 0.3	11.8 ± 0.25	9.8 ± 0.2	9.0 ± 0.3	5.45 ± 0.15	5.5 ± 0.2	4.4 ± 0.2	2.3 ± 0.1
	D	11.4 ± 0.25	8.9 ± 0.2	7.3 ± 0.2	6.5 ± 0.2				
	E	4.6 ± 0.1	4.0 ± 0.1	3.85 ± 0.1	3.8 ± 0.2				
bobbins	CPHS	■	■	■	■				
mounting parts	COV	■							

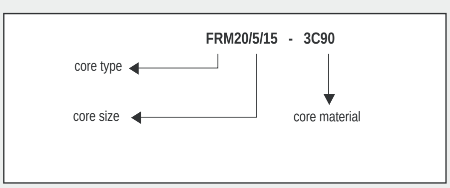
	Core type	FRM20/5/15	FRM21/4/12	FRM24/3.9/10	FRM27/3.8/9
	Matching cores	**BAR20/3/5.5**	**BAR22/2/6**	**BAR25/2.2/4**	**BAR28/3.8/2.3**
core **halves** for power applications	**3C90**	500	400	370	350
	3C91 des	600	470	440	420

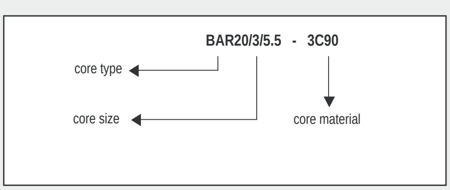
600 — ungapped core set, AL = 500 nH..

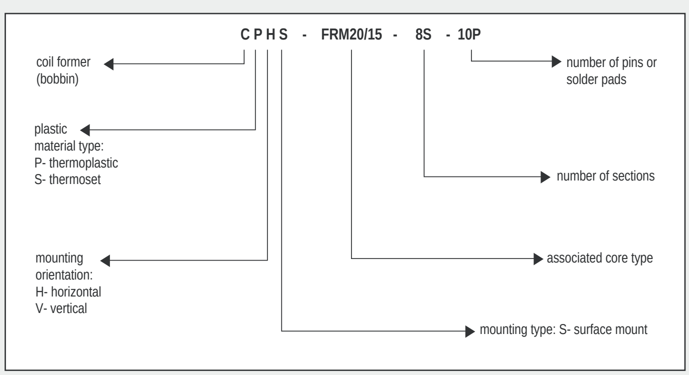
A_L tolerance:

± 3% | ± 5% | ± 8% | ± 12% | ± 15% | ± 25% | + 30% − 20% | + 40% − 30%

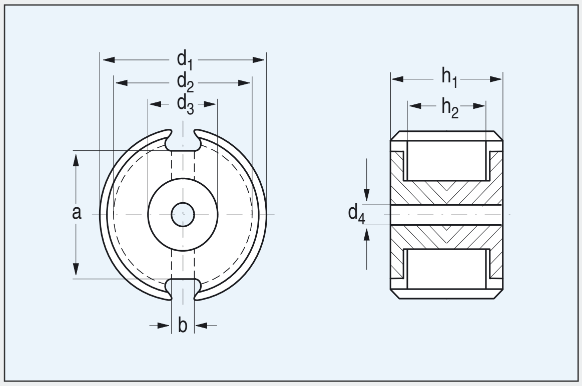
A_L value (nH) measured at B ≤ 0.1 mT, f ≤ 10 kHz, T = 25°C







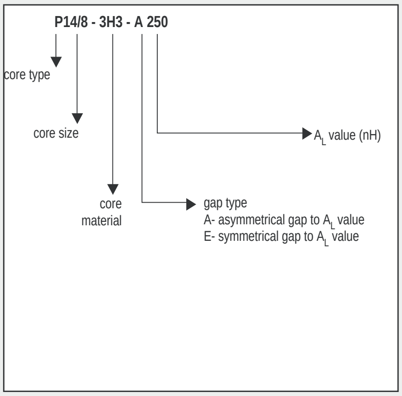
P cores

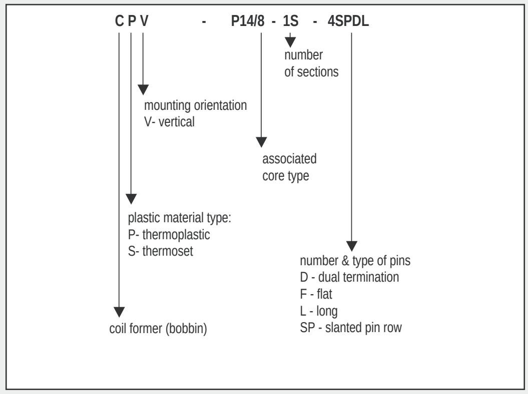


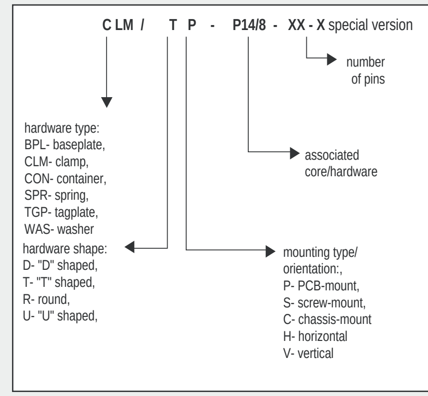
The P core is the earliest design for telecom filter inductors. As with RM-cores there is a complete, standardized range (IEC 133). The cores are available in a range of AL-values from many suppliers. The core surrounds the winding almost completely so magnetic shielding is outstanding. The slots in 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	P9/5	P11/7	P14/8	P18/11	P22/13	P26/16
efective core parameters	core factor Σ l/A(mm^{-1})	1.24	0.956	0.789	0.597	0.497	0.400
	eff. volume V_e (mm^3)	126	251	495	1120	2000	3530
	eff. length l_e (mm)	12.5	15.5	19.8	25.8	31.5	37.6
	eff. area A_e (mm^2)	10.1	16.2	25.1	43.3	63.4	93.9
	min. area A_{min} (mm^2)	7.9	13.2	19.8	36.0	50.9	77.4
	mass of core set (g)	≈ 0.8	≈ 1.8	≈ 3.2	≈ 6.0	≈ 12	≈ 20
dimensions (mm)	a	6.5 ± 0.25	6.8 ± 0.25	9.5 ± 0.3	13.4 ± 0.3	15 ± 0.4	18 ± 0.4
	b	2 ± 0.2	2.2 ± 0.3	2.7 + 1.2	3.8 ± 0.6	3.8 ± 0.6	3.8 ± 0.6
	d1	9.3 – 0.3	11.3 – 0.4	14.3 – 0.5	18.4 – 0.8	22 – 0.8	25.5 ± 0.5
	d2	7.5 + 0.25	9 + 0.4	11.6 + 0.4	14.9 + 0.5	17.9 + 0.6	21.2 + 0.8
	d3	3.9 – 0.2	4.7 – 0.2	6 – 0.2	7.6 – 0.3	9.4 – 0.3	11.5 – 0.4
	d4	2.1 ± 0.1	2.1 ± 0.1	3.1 ± 0.1	3.1 ± 0.1	4.4 + 0.3	5.4 + 0.2
	h1	5.4 – 0.3	6.5 + 0.1 / – 0.2	8.4 + 0.1 / – 0.2	10.6 ± 0.1	13.4 ± 0.2	16 ± 0.2
	h2	3.6 + 0.3	4.4 + 0.3	5.6 + 0.4	7.2 + 0.4	9.2 + 0.4	11 + 0.4
bobbins	CP	1S 1S-A	1S 1S-A 2S - A 3S - A	1S 1S-A 2S 2S-A 3S - A	1S 1S-A 2S 2S-A 3S 3S-A	1S 1S-A 2S 2S-A 3S 3S-A	1S 1S-A 2S 2S-A 3S 3S-A
	CPV			1S - 4SPD 1S - 4SPDL 2S - 4SPD 2S - 4SPDL 1S - 6PD 1S - 6PDL 2S - 6PD 2S - 6PDL 2S-6SP	1S - 6PD 1S - 6PDL 2S - 6PD 2S - 6PDL 3S - 6PD 3S - 6PDL	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		4P	6P	8P	8P	8P
	CON		■	■	■	■	■
	SPR		■	■	■	■	■
	CLM/TP	■	■	■	■		■
	CLM/TS					■	
	WAS-CLM/TP			■	■		
	WAS-CLM/TS					■	







	Core type	P30/19	P36/22	P42/29	P66/56
efective core parameters	core factor Σ l/A(mm^{-1})	0.330	0.264	0.259	0.172
	eff. volume V_e (mm^3)	6190	10700	18200	88200
	eff. length l_e (mm)	45.2	53.2	68.6	123
	eff. area A_e (mm^2)	137	202	265	717
	min. area A_{min} (mm^2)	116	172	214	591
	mass of core set (g)	≈ 34	≈ 54	≈ 104	≈ 550
dimensions (mm)	a	20.5 ± 0.5	26.2 ± 0.6	32 ± 0.7	
	b	4.3 ± 0.6	4.9 ± 0.6	5.1 ± 0.6	7.26 ± 0.25
	d1	30 ± 0.5	36.2 – 1.2	42.4 ± 0.7	66.29 ± 1.19
	d2	25 + 0.8	29.9 + 1	35.6 + 1.4	54.51 ± 1.02
	d3	13.5 – 0.4	16.2 – 0.6	17.7 – 0.6	28.19 ± 0.61
	d4	5.4 + 0.2	5.4 + 0.2	5.4 + 0.2	6.5 ± 0.15
	h1	18.8 ± 0.2	21.7 ± 0.3	29.4 ± 0.1	57.3 ± 0.5
	h2	13 + 0.4	14.6 + 0.4	20.3 + 0.4	43.28 ± 0.5
bobbins	CP	1S 1S-A 2S 2S-A 3S 3S-A	1S 1S-A 2S 2S-A 3S 3S-A	1S 1S-A 2S 2S-A	1S
	CPV	1S - 6PD 1S - 6PDL			
mounting parts	TGP	9P	10P	10P	
	CON	■	■	■	
	SPR	■	■	■	
	CLM/TP				
	CLM/TS	■			
	WAS-CLM/TP				
	WAS-CLM/TS				

P cores

	Core type	P9/5	P11/7	P14/8	P18/11	P22/13	P26/16	P30/19	P36/22	P42/29	P66/56
cores sets for signal filter applications	3D3 sup	E40	E16	E40	E63	E40	E100				
		A63	E63	E63	E100	E63	E160				
		630	E40	E100	E160	E100	E250				
			E63	1000	1400	E160	2150				
			A100			1700					
			800								
	3H3 sup	E40	A160	A160	E160	E160	E160				
		A63	A250	A250	A250	E250	E250				
		1100	1650	A315	A315	A315	E315				
				A400	A400	A400	E400				
				2150	A630	A630	A630				
					3100	3900	5000				
cores sets for power applications	3C81	1350	2050	2800	4000	5200	6700	8300	10800	11500	18200
	3C91 des	1350	A100	E63	E100	A160	E160	E250	E315	E315	
			A160	A100	A160	A250	A250	A315	E400	E400	
			A250	A160	A250	A315	A315	A400	A630	A630	
			2050	A250	A315	A400	A400	A630	A1000	A1000	
				A315	A400	A630	A630	A1000	A1600	A1600	
				2800	4000	5200	6700	8300	10800	11500	18200
	3F3	1100	A100	E63	E100	A160	E160		E250		
			A160	A100	A160	A250	A250	E250	E315	E315	
			A250	A160	A250	A315	A315	A315	E400	E400	
			1650	A250	A315	A400	A400	A400	A630	A630	
				A315	A400	A630	A630	A630	A1000	A1000	
				2000	2850	3530	4600	A1000	A1600	A1600	
								5750	7350	7700	12350
high μ sets	3E27	2300	3400	5750	7500	9250	12000	15100	17500	19000	

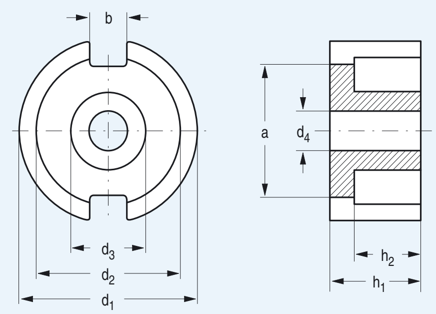
E63-	gapped core set with symmetrical gap (E). A_L = 63 nH.
A315-	gapped core set with asymmetrical gap (A). A_L = 315 nH.
12000	ungapped core set. AL = 1200 nH.

A_L tolerance:

± 3% | ± 5% | ± 8% | ± 12% | ± 15% | ± 25% | + 30% − 20% | + 40% − 30%

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

PH cores

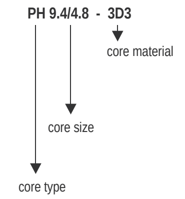


The PH core range consists of potcore halves specially designed for use in proximity switches. Their shape is derived from the IEC standard P-core range. Outside diameters are adapted to fit standardized sizes of proximity switch housings.
Since the cores are used as halves, their height is increased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

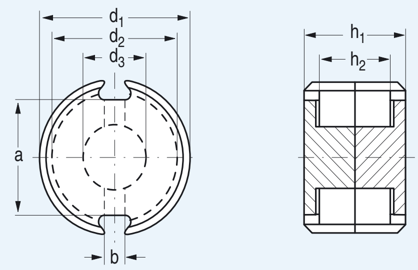
Summary:

- range of standard sizes
- higher shape than normal P core halves to accommodate windings

Core type		PH5.6/3.6-3D3	PH7.4/3.9-3D3	PH9.4/4.8-3D3	PH14/7.5-3D3	PH26/9.2-3D3
dimensions (mm)	a	4 ± 0.2	5.7 ± 0.4	6.5 ± 0.3	9.5 ± 0.3	18 ± 0.4
	b	1.5 ± 0.15	1.6 + 0.3	2 ± 0.2	3.3 ± 0.6	3.8 ± 0.6
	d1	5.75 – 0.35	7.4 – 0.3	9.4 – 0.4	14.4 – 0.6	25.5 ± 0.5
	d2	4.5 + 0.35	5.8 + 0.25	7.5 + 0.35	11.6 + 0.5	21.2 + 0.8
	d3	2.5 – 0.1	3 – 0.12	3.9 – 0.2	6 – 0.2	11.5 – 0.4
	d4	0.95 + 0.1	1.38 + 0.1	2 + 0.1	3 + 0.1	5.4 + 0.2
	h1	3.6 – 0.25	3.95 – 0.3	4.8 – 0.4	7.5 – 0.2	9.2 – 0.45
	h2	2.8 + 0.25	2.8 + 0.2	3.55 + 0.3	5.6 + 0.3	5.9 + 0.4
mass of core half (g)		0.2	0.4	0.7	3	12



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.

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
efective 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)	13.7	23.6	37.4	58.1	87.0
	mass of core half (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

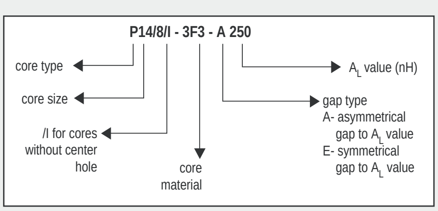
Core type		P11/7/I	P14/8/I	P18/11/I	P22/13/I	P26/16/I
cores sets for general purpose transformers and power applications	3C81	2100	2900	4200	5330	7000
	3C90	A63	A100	A160	A250	E250
		A100	A160	A250	A315	A315
		A160	A250	A315	A400	A400
		A250	A315	A400	A630	A630
		A315	A400	A630	A1000	A1000
		2010	2695	3660	4785	6230
	3C91 des	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
	3F3	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
		1750	2400	3110	4070	5250

E250- — gapped core set with symmetrical gap (E). A_L = 250 nH.
A315- — gapped core set with asymmetrical gap (A). A_L = 315 nH.
2400 — ungapped core set. AL = 2400 nH.

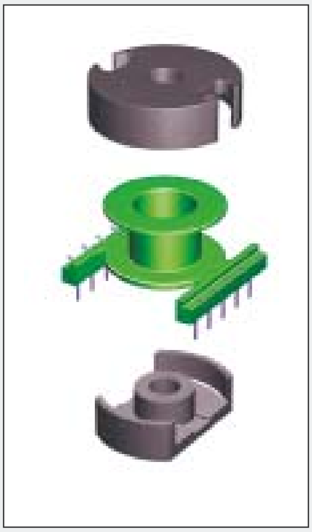
A_L tolerance:

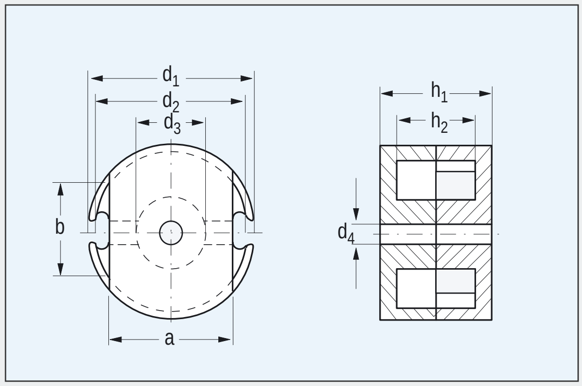
± 3%	± 5%	± 8%	± 12%	± 15%	± 25%	+ 30% − 20%	+ 40% − 30%

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



PT cores





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 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 is 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	PT18/11	PT23/11	PT23/18
efective core parameters	core factor Σ l/A(mm^{-1})	0.910	0.670	0.470	0.670
	eff. volume V_e (mm^3)	492	1110	1740	2590
	eff. length l_e (mm)	21.1	27.2	28.6	41.6
	eff. area A_e (mm^2)	23.3	40.6	61.0	62.2
	min. area A_{min} (mm^2)	19.9	32.9	53.6	53.6
	mass of core set (g)	≈ 2.8	≈ 6	≈ 10.5	≈ 14
dimensions (mm)	a	9.4 ± 0.15	11.94 ± 0.2	15.2 ± 0.25	15.2 ± 0.25
	b	8.6 min	10.5 min	13.2 min	13.2 min
	d1	14.05 ± 0.25	18.0 ± 0.4	22.9 ± 0.45	22.9 ± 0.45
	d2	11.8 ± 0.2	15.15 ± 0.25	18.3 ± 0.35	18.3 ± 0.35
	d3	5.9 ± 0.1	7.4 ± 0.15	9.7 ± 0.2	9.7 ± 0.2
	d4	3.1 ± 0.075	3.1 ± 0.075	5.1 ± 0.1	5.1 ± 0.1
	h1	8.3 ± 0.15	10.6 ± 0.15	11 ± 0.25	18 ± 0.35
	h2	5.8 ± 0.2	7.4 ± 0.2	7.5 ± 0.25	14.4 ± 0.35
bobbins	CPV	1S - 6P 1S - 10P		1S - 10P	1S - 10P
mounting parts	BPL/D-CLM/C	■			
	CLM/C	■			
	WAS-CLM/C	■			

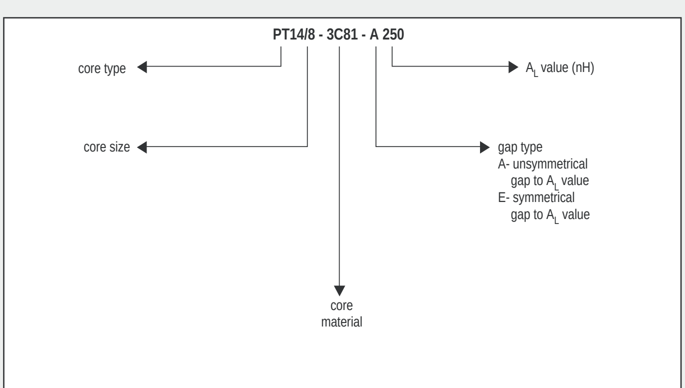
Core type		PT14/8	PT18/11	PT23/11	PT23/18
cores **sets** for general purpose transformers and power applications	3C81	2400	3130	5500	4100
	3C91 des	A63	A100	A160	A160
		A100	A160	A250	A250
		A160	A250	A315	A315
		A250	A315	A400	A400
		A315	A400	A630	A630
		2400	3130	5500	4100
	3F3	A63	A100	A160	A160
		A100	A160	A250	A250
		A160	A250	A315	A315
		A250	A315	A400	A400
		A315	A400	A630	A630
		1650	2500	3700	2750
	3E27	4500	5760	8400	6400

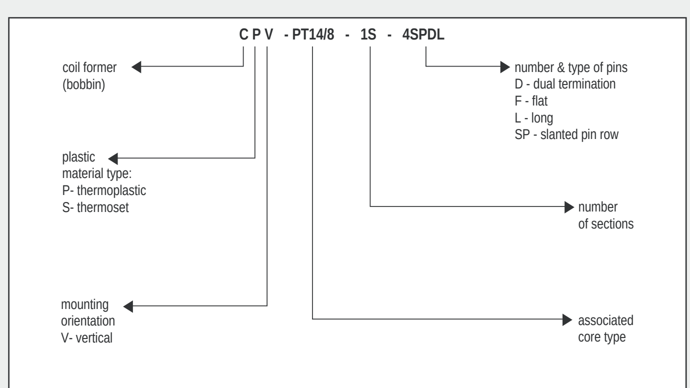
E250- — gapped core set with symmetrical gap (E). A_L = 250 nH.
A315- — gapped core set with asymmetrical gap (A). A_L = 315 nH.
2400 — ungapped core set. AL = 2400 nH.

A_L tolerance:

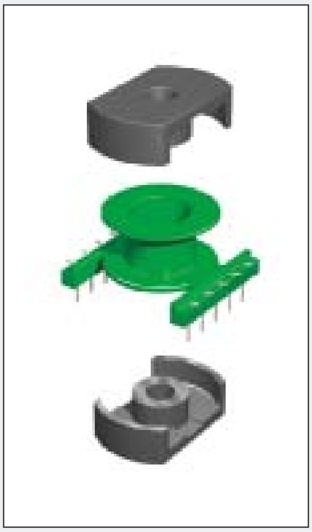
± 3% | ± 5% | ± 8% | ± 12% | ± 15% | ± 25% | + 30% − 20% | + 40% − 30%

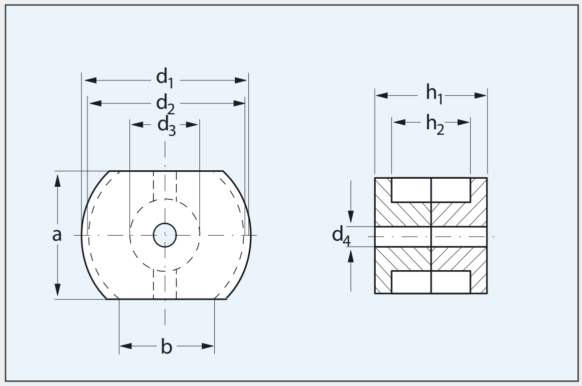
A_L value (nH) measured at B ≤ 0.1 mT, f ≤ 10 kHz, T = 25°C





PTS cores





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 PTS design this problem is solved by cutting away the sides of both core halves. This creates ample room for wires and coil former flanges.
A range of special PTS coil formers is 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 for most sizes

	Core type	PTS14/8	PTS18/11	PTS23/11	PTS23/18	PTS30/19/I	PTS34/19/I	PTS40/27/I
efective core parameters	core factor Σ l/A(mm^{-1})	1.02	0.770	0.550	0.770	0.412	0.339	0.346
	eff. volume V_e (mm^3)	495	1070	1810	2630	5940	8140	14400
	eff. length l_e (mm)	22.5	28.7	31.6	45.1	49.5	52.5	70.5
	eff. area A_e (mm^2)	22.0	37.2	57.2	58.3	120	155	204
	min. area A_{min} (mm^2)	19.9	32.9	53.6	53.6	111	145	201
	mass of core set (g)	≈ 2.5	≈ 5	≈ 9	≈ 13	≈ 31	≈ 46	≈ 66
dimensions (mm)	a	9.4 ± 0.15	11.94 ± 0.2	15.2 ± 0.25	15.2 ± 0.25	20.3 ± 0.25	24 ± 0.3	28.3 ± 0.35
	b	8.6 min	10.5 min	13.2 min	13.2 min	17.8 min	17.0 min	20.0 min
	d1	14.05 ± 0.25	18.0 ± 0.4	22.9 ± 0.45	22.9 ± 0.45	30 ± 0.5	33.5+0.3/–0.5	39.8+0.2/–0.7
	d2	11.8 ± 0.2	15.15 ± 0.25	18.3 ± 0.35	18.3 ± 0.35	25.4 ± 0.4	27+0.3/–0.5	33.2+0.2/–0.6
	d3	5.9 ± 0.1	7.4 ± 0.15	9.7 ± 0.2	9.7 ± 0.2	13.3 ± 0.2	13.85 ± 0.25	16 ± 0.25
	d4	3.1 ± 0.075	3.1 ± 0.075	5.1 ± 0.1	5.1 ± 0.1	0	0	0
	h1	8.3 ± 0.15	10.6 ± 0.15	11 ± 0.25	18 ± 0.35	18.8 ± 0.2	19.4 ± 0.2	26.9 ± 0.2
	h2	5.8 ± 0.2	7.4 ± 0.2	7.5 ± 0.25	14.4 ± 0.35	13.2 ± 0.2	13.4 ± 0.2	19.7 ± 0.3
bobbins	CPV	1S - 6P 1S - 10P		1S - 10P	1S - 10P			
mounting parts	BPL/D-CLM/C	■						
	CLM/C	■						
	WAS-CLM/C	■						

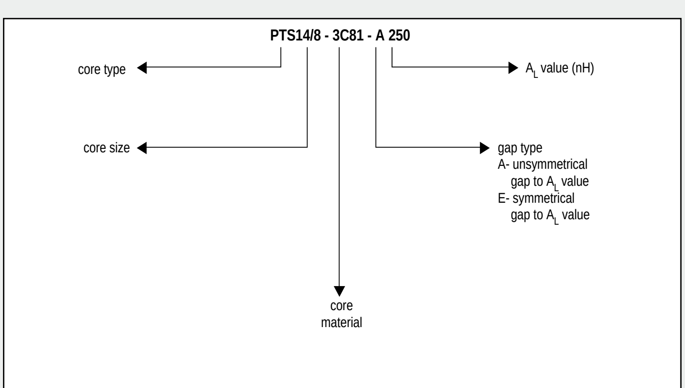
Core type		PTS14/8	PTS18/11	PTS23/11	PTS23/18	PTS30/19/I	PTS34/19/I	PTS40/27/I
cores sets for general purpose transformers and power applications	3C81	2330	3000	4890	3800			
	3C91 des	A63	A100	A160	A160			
		A100	A160	A250	A250			
		A160	A250	A315	A315			
		A250	A315	A400	A400			
		A315	A400	A630	A630			
		2330	3000	4890	3800			
	3C92 des					3830	4770	4740
	3C94 des					5400	6800	6800
	3C96 prot					4840	6070	6060
	3F3	A63	A100	A160	A160			
		A100	A160	A250	A250			
		A160	A250	A315	A315			
		A250	A315	A400	A400			
		A315	A400	A630	A630			
		1625	2225	3280	2500			
	3F35 prot					3600	4500	4470
	3E27	4370	5140	7250	5945			

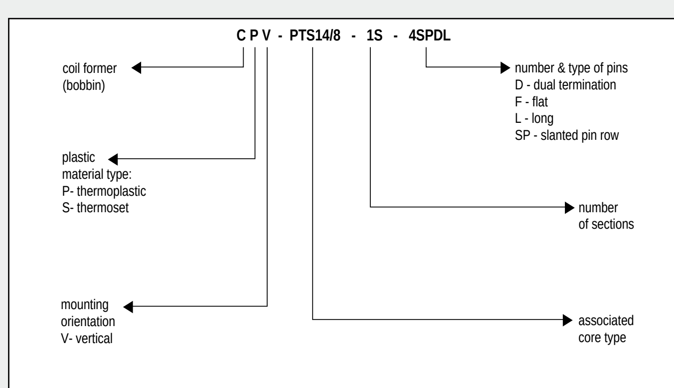
E250- — gapped core set with symmetrical gap (E). A_L = 250 nH.
A315- — gapped core set with asymmetrical gap (A). A_L = 315 nH.
2400 — ungapped core set. AL = 2400 nH.

A_L tolerance:

± 3% | ± 5% | ± 8% | ± 12% | ± 15% | ± 25% | + 30% – 20% | + 40% – 30%

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

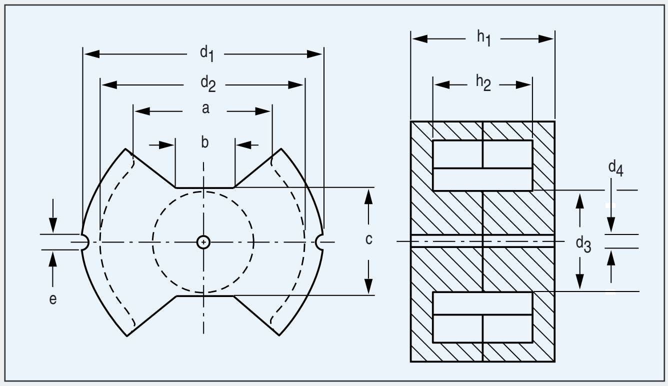




PM cores

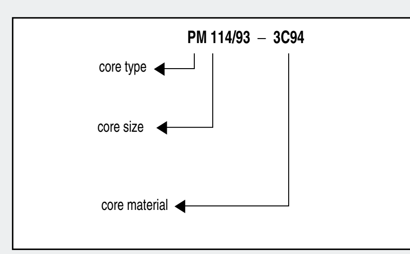
PM cores are a variation on classic P cores, suitable for large high power transformers and energy storage chokes. They have larger wire slots facilitating easy assembly, but still the good shielding of a closed core shape. PM cores can be found in transmission and radar equipment and in various high power industrial installations.

Summary :
- good shielding
- easy assembly
- robust core shape
- available in state of the art power materials



	Core type	PM87/70	PM114/93
efective core parameters	core factor Σ l/A(mm^{-1})	0.161	0.116
	eff. volume V_e (mm^3)	133000	344000
	eff. length l_e (mm)	146	200
	eff. area A_e (mm^2)	910	1720
	min. area A_{min} (mm^2)	700	1380
	mass of core set (g)	770	1940
dimensions (mm)	a	41 ± 1.5	53.5 ± 1.5
	b	13	20
	c	35 ± 1	44 ± 1
	d1	87 – 3	114 – 4.5
	d2	67.1 + 2.1	88 + 3.7
	d3	31.7 – 1	43 – 1.4
	d4	8.5 + 0.3	5.4 + 0.4
	e	5 – 0.4	5.3 + 0.4
	h1	70 – 0.8	93 – 1
	h2	48 + 0.8	63 + 1.6

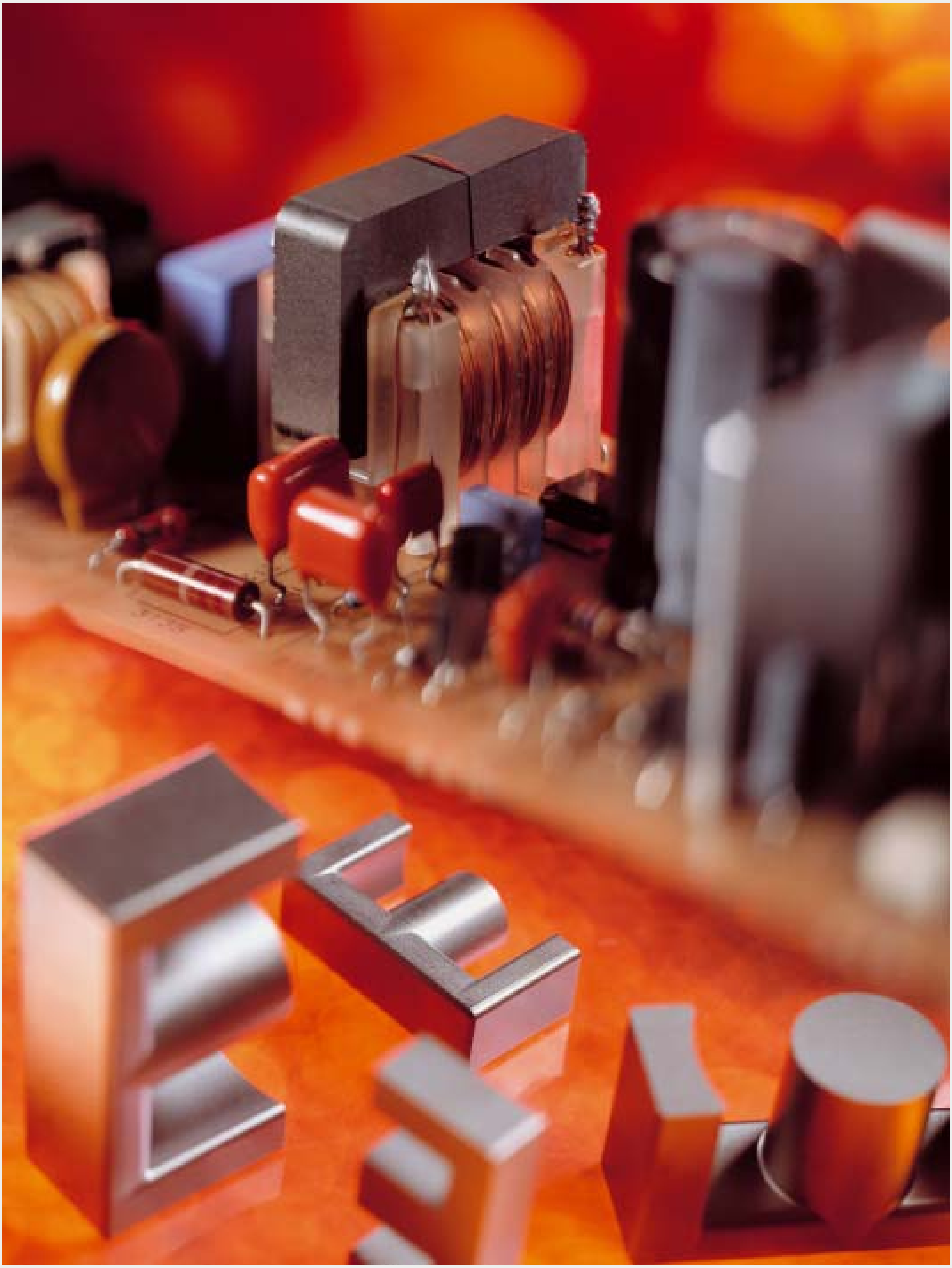
	Core type	PM87/70	PM114/93
Core sets	3C90	A13800	A20000
	3C94	A13800	A20000



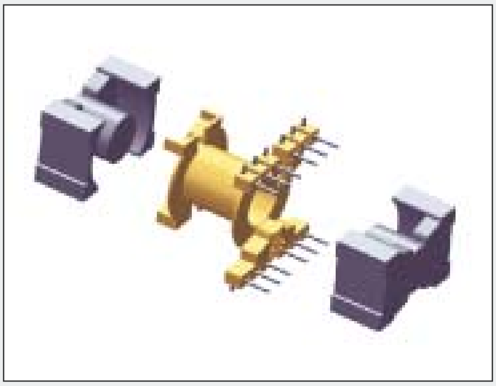
A315-1200
- gapped core set with asymmetrical gap (A). A_L = 315 nH.
- ungapped core set. AL = 1200 nH.

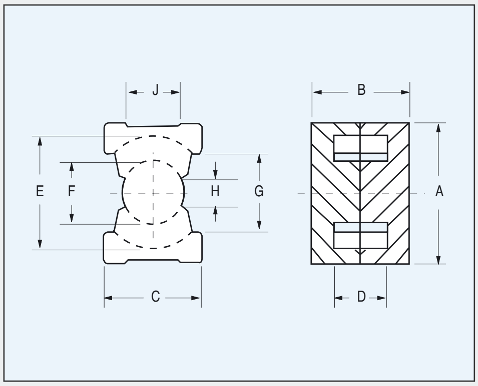
A_L tolerance: ± 25%

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



PQ cores





PQ cores, like RM/I cores, have round solid centre poles and round winding areas.
On the outside the design is rectangular. Top and bottom of a core set are completely flat, allowing good thermal contact with heat sinks.
PQ cores are mainly used in power conversion. Therefore they are only offered in power materials. For most core sizes matching coil formers are available.

	Core type	PQ20/16	PQ20/20	PQ26/20	PQ26/25	PQ32/20	PQ32/30	PQ35/35	PQ40/40	PQ50/50
efective core parameters	core factor Σ l/A(mm^{-1})	0.607	0.731	0.372	0.451	0.331	0.447	0.454	0.507	0.345
	eff. volume V_e (mm^3)	2330	2850	5470	6530	9440	12500	16300	20500	37100
	eff. length l_e (mm)	37.6	45.7	45	54.3	55.9	74.7	86.1	102	113
	eff. area A_e (mm^2)	61.9	62.6	121	120	169	167	190	201	328
	min. area A_{min} (mm^2)	59.1	59.1	109	108	142	142	162	175	314
	mass of core set (g)	≈ 11	≈ 14	≈ 29	≈ 32	≈ 47	≈ 62	≈ 80	≈ 95	≈ 195
dimensions (mm)	A	21.3 ± 0.4	21.3 ± 0.4	27.3 ± 0.46	27.3 ± 0.46	33 ± 0.5	33 ± 0.5	36.1 ± 0.6	41.5 ± 0.9	51 ± 0.7
	B	16.2 ± 0.2	20.2 ± 0.2	20.2 ± 0.25	24.7 ± 0.25	20.6 ± 0.25	30.3 ± 0.25	34.7 ± 0.25	39.8 ± 0.3	50 ± 0.5
	C	14 ± 0.4	14 ± 0.4	19 ± 0.45	19 ± 0.45	22 ± 0.5	22 ± 0.5	26 ± 0.5	28 ± 0.6	32 ± 0.6
	D	10.3 ± 0.3	14.3 ± 0.3	11.5 ± 0.3	16.1 ± 0.3	11.5 ± 0.3	21.3 ± 0.3	25 ± 0.3	29.5 ± 0.4	36.1 ± 0.6
	E	18 ± 0.4	18 ± 0.4	22.5 ± 0.46	22.5 ± 0.46	27.5 ± 0.5	27.5 ± 0.5	32 ± 0.5	37 ± 0.6	44 ± 0.7
	F	8.8 ± 0.2	8.8 ± 0.2	12 ± 0.2	12 ± 0.2	13.5 ± 0.25	13.5 ± 0.25	14.4 ± 0.25	14.9 ± 0.3	20 ± 0.35
	G	12 min	12 min	15.5 min	15.5 min	19 min	19 min	23.5 min	28 min	32 min
	H	4 min	4 min	6 min	6 min	5.5 min	5.5 min	6 min	6.05 min	8.15 min
	J	7.9 min	7.9 min	10.5 min	10.5 min	11.6 min	11.6 min	11.8 min	15 min	18 min
bobbins	CPV	1S - 14P 1S - 14PD	1S - 14P 1S - 14PD	1S - 12P 1S - 12PD	1S - 12P 1S - 12PD	1S - 12P 1S - 12PD	1S - 12P 1S - 12PD			
mounting parts	CLM/P	■	■	■	■	■	■	■	■	

cores sets for general purpose transformers and power applications

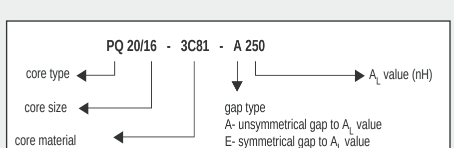
Core type	PQ20/16	PQ20/20	PQ26/20	PQ26/25	PQ32/20	PQ32/30	PQ35/35	PQ40/40	PQ50/50
3C81	4080	3580	7020	6010	7560	6570	6000		
3C90	3250	2820	5530	4700	6000	5040	5200		
3C91 des	A160	A160	E250	E250	E315	E315	E315		
	A250	A250	A315	A315	A400	A400	A400		
	A315	A315	A400	A400	A630	A630	A630		
	A400	A400	A630	A630	A1000	A1000	A1000		
	A630	A630	A1000	A1000	A1600	A1600	A1600		
	4080	3580	7020	6010	7560	6570	6000	6100	9200
3C94 des	A160	A160	E250	E250	E315	E315	E315		
	A250	A250	A315	A315	A400	A400	A400		
	A315	A315	A400	A400	A630	A630	A630		
	A400	A400	A630	A630	A1000	A1000	A1000		
	A630	A630	A1000	A1000	A1600	A1600	A1600		
	3600	3150	6200	5250	6800	5600	5200	4900	7400
3C96 prot	3250	2820	5530	4700	6000	5040	4700	4200	6300
3F3	A160	A160	E250	E250	E315	E315	E315		
	A250	A250	A315	A315	A400	A400	A400		
	A315	A315	A400	A400	A630	A630	A630		
	A400	A400	A630	A630	A1000	A1000	A1000		
	A630	A630	A1000	A1000	A1600	A1600	A1600		
	3080	2650	5200	4390	6000	4580	4570		
3F35 prot	2300	2000	3900	3300	4550	3500			

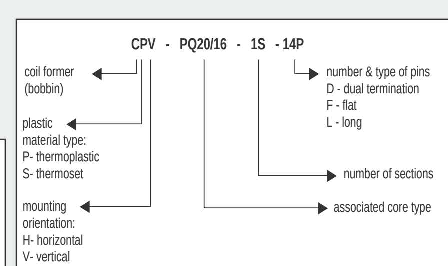
E250- — gapped core set with symmetrical gap (E). A_L = 250 nH.
A315- — gapped core set with asymmetrical gap (A). A_L = 315 nH.
2400 — ungapped core set. A_L = 2400 nH.

A_L tolerance:

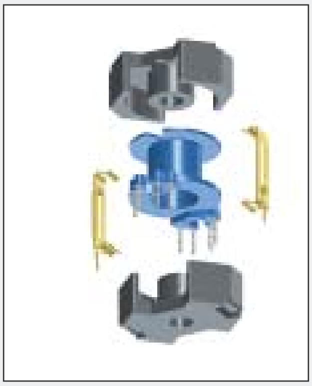
± 3% | ± 5% | ± 8% | ± 12% | ± 15% | ± 25% | + 30% − 20% | + 40% − 30%

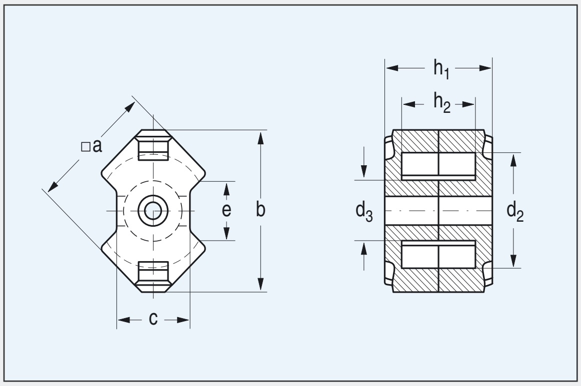
A_L value (nH) measured at B ≤ 0.1 mT, f ≤ 10 kHz, T = 25°C





RM cores





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
efective core parameters	**core factor** Σ **I/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)	≈ 1.5	≈ 3.1	≈ 5.1	≈ 11
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
bobbins	**CSV**	1S - 5P 1S - 6P 1S - 6P - T 2S - 5P	1S - 4P 1S - 4P - T 2S - 4P 1S - 5P 1S - 6P - G 1S - 6P - T 2S - 5P 2S - 6P	1S - 4P 2S - 4P 1S - 6P 2S - 6P 1S - 8P	1S - 8P 1S - 12P 2S - 8P 2S - 12P
mounting parts	**CLI/P**	RM4/5	RM4/5	RM6	RM8

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

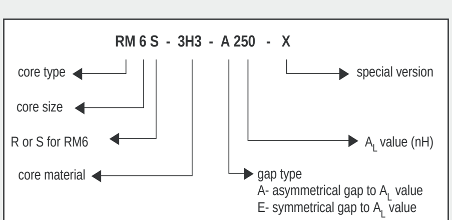
Core type		RM4	RM5	RM6S	RM8
cores sets for low flux level applications	3D3	E40	E40	E63	E100
		A63	E63	E100	E160
		400	E100	A160	1240
			800	950	
	3H3	E63	A160	A160	A250
		E100	A250	A250	A315
		A160	A315	A315	A400
		900	A400	A400	A630
			1650	2100	2850

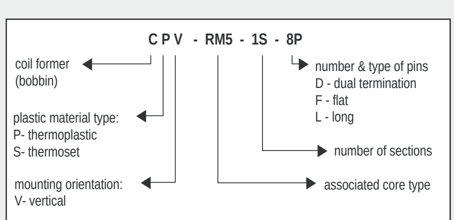
E63- — gapped core set with symmetrical gap (E). A_L = 63 nH.
A315- — gapped core set with asymmetrical gap (A). A_L = 315 nH.
1200 — ungapped core set. AL = 1200 nH.

A_L tolerance:

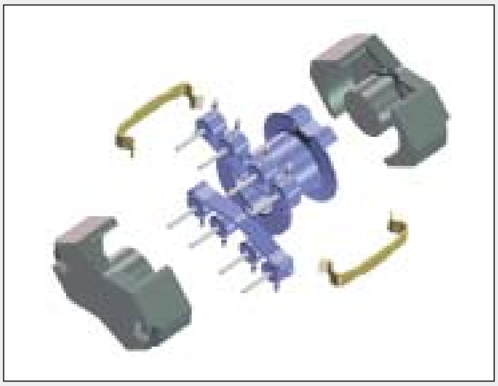
± 3% | ± 5% | ± 8% | ± 12% | ± 15% | ± 25% | + 30% − 20% | + 40% − 30%

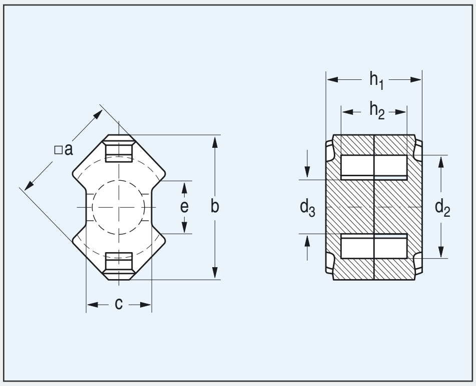
A_L value (nH) measured at B ≤ 0.1 mT, f ≤ 10 kHz, T = 25°C





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. AL-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

	Core type	RM4/I	RM5/I	RM6S/I	RM8/I	RM10/I	RM12/I	RM14/I
efective core parameters	core factor Σ l/A(mm^{-1})	1.69	0.935	0.784	0.604	0.462	0.388	0.353
	eff. volume V_e (mm^3)	322	574	1090	2440	4310	8340	13900
	eff. length l_e (mm)	23.3	23.2	29.2	38.4	44.6	56.6	70.0
	eff. area A_e (mm^2)	13.8	24.8	37.0	63.0	96.6	146	198
	min. area A_{min} (mm^2)	11.5	18.1	31.2	55.4	89.1	125	168
	mass of core set (g)	≈ 1.7	≈ 3.2	≈ 5.5	≈ 13	≈ 22	≈ 46	≈ 69
dimensions (mm)	a	9.8 – 0.4	12.3 – 0.5	14.7 – 0.6	19.7 – 0.8	24.7 – 1.1	29.8 – 1.1	34.7 – 1.2
	b	11 – 0.5	14.9 max	17.9 – 0.7	23.2 – 0.9	28.5 – 1.3	37.4 – 1.3	42.2 – 1.4
	c	4.6 – 0.2	6.8 – 0.4	8.2 – 0.4	11 – 0.5	13.5 – 0.5	16.1 – 0.5	19 – 0.6
	d2	7.95 + 0.4	10.2 + 0.4	12.4 + 0.5	17 + 0.6	21.2 + 0.9	25 + 1	29 + 1.2
	d3	3.9 – 0.2	4.9 – 0.2	6.4 – 0.2	8.55 – 0.3	10.9 – 0.4	12.8 – 0.4	15 – 0.6
	e	5.8 min	6 min	8.4 min	9.5 min	10.9 min	12.9 min	17 min
	h1	10.4 ± 0.1	10.4 ± 0.1	12.4 ± 0.1	16.4 ± 0.1	18.6 ± 0.1	24.5 ± 0.1	30.1 ± 0.1
	h2	7 + 0.4	6.3 + 0.4	8 + 0.4	10.8 + 0.4	12.4 + 0.6	16.8 + 0.6	20.8 + 0.6
bobbins	CPV	1S - 6PD	1S - 8PD	1S - 8PD	1S - 12PD	1S - 12PD	1S - 12PD	1S - 12PD
	CSV	1S - 6P	1S - 6P 2S - 6P	1S - 6P 2S - 6P 1S - 8P	1S - 12P 2S - 12P	1S - 12P 2S - 12P	1S - 12P	1S - 12P
	CPVS	1S - 6P						
	CSVS		1S - 8P	1S - 8P 1S - 8P - B 1S - 8P - T				
mounting parts	CLI	RM4/5/I	RM4/5/I	RM6/I	RM8/I			
	CLI/P	RM4/5/I RM4/5	RM4/5/I RM4/5	RM6/I RM6	RM8/I RM8	RM10/I	RM12/I	RM14/I

cores sets for general purpose transformers and power applications

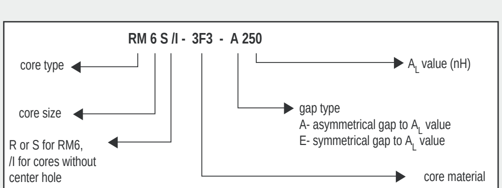
Core type		RM4/I	RM5/I	RM6S/I	RM8/I	RM10/I	RM12/I	RM14/I
3D3 des				A160	A250	A315		
				A250	A315	A400		
				A315	A400	A630		
				1050	1400	1900		
3H3 des				A315	A400	A400		
				A400	A630	A630		
				A630	A1000	A1000		
				2350	3250	4400		
3C81				3000	4100	5500		
3C90		1125	2000	2600	3300	4500	5600	6600
3C91 des				A63	E100	E160		
				A100	A160	A250		
				A160	A250	A315		
				A250	A315	A400		
				A315	A400	A630		
				3000	4100	5500		
3C94		1125	A63	A63	A100	A160	A160	A250
			A100	A100	A160	A250	A250	A315
			A160	A160	A250	A315	A315	A400
			A250	A250	A315	A400	A400	A630
			A315	A315	A400	A630	A630	A1000
			2000	A400	3300	4500	5600	6600
				A630				
				2600				
3C96 des		1000	A63	A63	A100	A160	A160	A250
			A100	A100	A160	A250	A250	A315
			A160	A160	A250	A315	A315	A400
			A250	A250	A315	A400	A400	A630
			A315	A315	A400	A630	A630	A1000
			1800	A400	3000	4050	5050	5700
				A630				
				2350				
3F3		950	1700	2150	3000	4050	5050	5700
3F35 des		A100	A63	A63	A100	A160		
		A160	A100	A100	A160	A250		
		A250	A160	A160	A250	A315		
		800	A250	A250	A315	A400		
			1300	A315	A400	A630		
				1750	2400	3100		
3F4 des		A100	A100	A63	A100			
		A160	A160	A100	A160			
		A250	A250	A160	A250			
		560	900	A250	A315			
				A315	A400			
				1250	1700			
3E27			4975	6000	8000	10700		
3E5		3500	6700	8600	12500	16000		
3E6			8500	11000	15500			

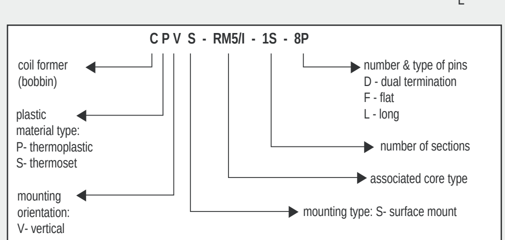
E63-	gapped core set with symmetrical gap (E). A_L = 63 nH.
A315-	gapped core set with asymmetrical gap (A). A_L = 315 nH.
1200	ungapped core set. AL = 1200 nH.

A_L tolerance:

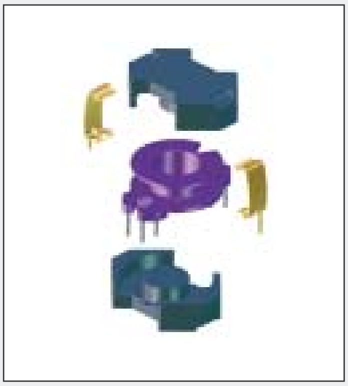
± 3% | ± 5% | ± 8% | ± 12% | ± 15% | ± 25% | +30% −20% | +40% −30%

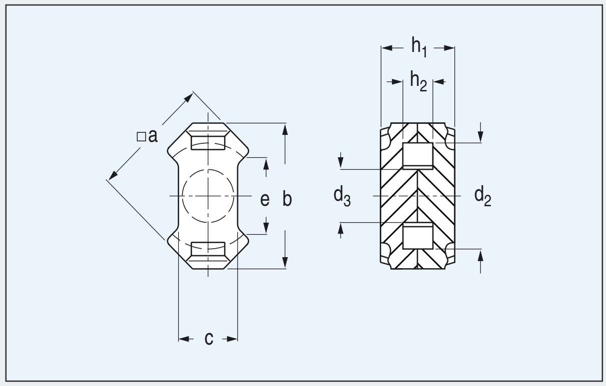
A_L value (nH) measured at B ≤ 0.1 mT, f ≤ 10 kHz, T = 25°C





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	RM12/ILP	RM14/ILP
efective core parameters	core factor Σ l/A(mm^{-1})	1.20	0.710	0.580	0.440	0.340	0.280	0.250
	eff. volume V_e (mm^3)	251	430	820	1860	3360	6200	10230
	eff. length l_e (mm)	17.3	17.5	21.8	28.7	33.9	42.0	50.9
	eff. area A_e (mm^2)	14.5	24.5	37.5	64.9	99.1	148	201
	min. area A_{min} (mm^2)	11.3	18.1	31.2	55.4	89.1	125	168
	mass of core set (g)	≈ 1.3	≈ 2.6	≈ 4.4	≈ 10	≈ 17	≈ 35	≈ 55
dimensions (mm)	a	9.8 – 0.4	12.3 – 0.5	14.7 – 0.6	19.7 – 0.8	24.7 – 1.1	29.8 – 1.1	34.7 – 1.2
	b	11 – 0.5	14.9 max	17.9 – 0.7	23.2 – 0.9	28.5 – 1.3	37.4 – 1.3	42.2 – 1.4
	c	4.6 – 0.2	6.8 – 0.4	8.2 – 0.4	11 – 0.5	13.5 – 0.5	16.1 – 0.5	19 – 0.6
	d2	7.95 + 0.4	10.2 + 0.4	12.4 + 0.5	17 + 0.6	21.2 + 0.9	25 + 1	29 + 1.2
	d3	3.9 – 0.2	4.9 – 0.2	6.4 – 0.2	8.55 – 0.3	10.9 – 0.4	12.8 – 0.4	15 – 0.6
	e	5.8 min	6 min	8.4 min	9.5 min	10.9 min	12.9 min	17 min
	h1	7.8 – 0.2	7.8 – 0.2	9 – 0.2	11.6 – 0.2	13– 0.2	16.8 – 0.2	20.5 – 0.2
	h2	4.3 + 0.4	3.6 + 0.4	4.5 + 0.4	5.9 + 0.4	6.7 + 0.4	9 + 0.5	11.1 + 0.6
bobbins	CPV					1S-12PD		
	CSV				1S-10P 1S-12P			
	CSVS	1S-8PL	1S-8P	1S-8P 1S-8P-B				
mounting parts	CLI	RM4/5/ILP	RM4/5/ILP	RM6/ILP				
	CLI/P				RM8/ILP	RM10/ILP		

cores sets for general purpose transformers and power applications

Core type		RM4/ILP	RM5/ILP	RM6S/ILP	RM8/ILP	RM10/ILP	RM12/ILP	RM14/ILP
cores sets for general purpose transformers and power applications	3D3 des			A160	A250	A315		
				A250	A315	A400		
				A315	A400	A630		
				1350	1850	2500		
	3H3 des			A315	A400	A400		
				A400	A630	A630		
				A630	A1000	A1000		
				2900	4100	5600		
	3C90	1400	2350	3175	4100	5600	7100	8400
	3C94 des	1400	A160	A315	A250	A315	A315	A400
			A250	A400	A315	A400	A400	A630
			A315	A630	A400	A630	A630	A1000
			2350	3175	4100	5600	7100	8400
	3C96 prot	1250	A160	A315	A250	A315	A315	A400
			A250	A400	A315	A400	A400	A630
			A315	A630	A400	A630	A630	A1000
			2100	2900	3800	5200	6700	7700
	3F3	1200	2000	2700	3800	5200	6700	7700
	3F35 prot	A100	A100	A160	A250	A315		
		A160	A160	A250	A315	A400		
		A250	A250	A315	A400	A630		
		1000	1700	2200	3100	4000	5000	5800
	3F4 des	A100	A100	A160	A250			
		A160	A160	A250	A315			
		A250	A250	A315	A400			
		750	1250	1600	2200	3000	3600	4200
	3E5	5000	8500	10500	16000	22000		
	3E6	6000	10000	13000	19500	27000		

A315-1200

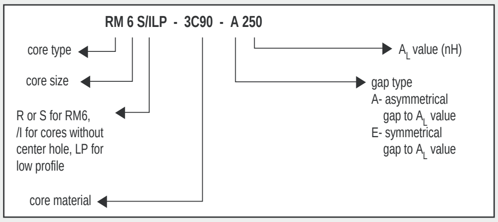
A315 – gapped core set with asymmetrical gap (A). A_L = 315 nH.

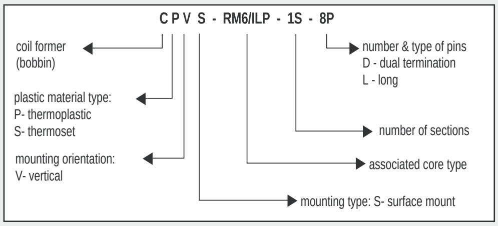
1200 – ungapped core set. AL = 1200 nH.

A_L tolerance:

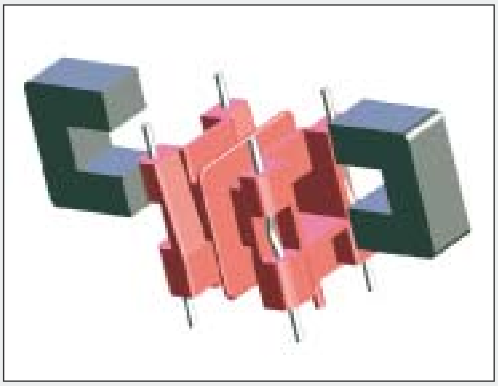
± 3% | ± 5% | ± 8% | ± 12% | ± 15% | ± 25% | + 30% − 20% | + 40% − 30%

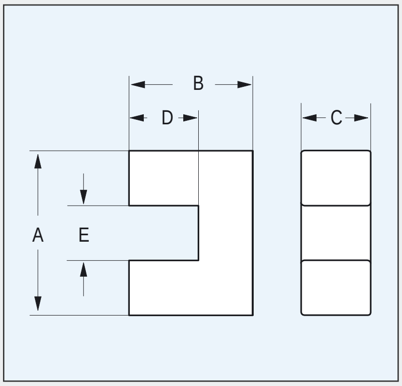
A_L value (nH) measured at B ≤ 0.1 mT, f ≤ 10 kHz, T = 25°C

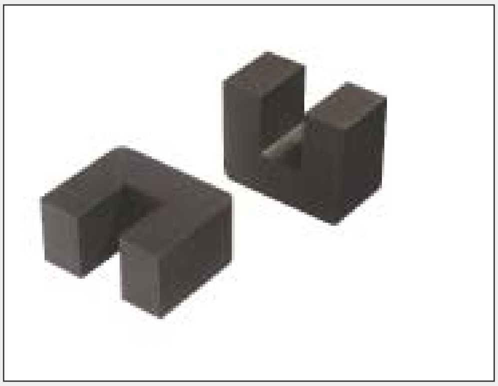




U cores



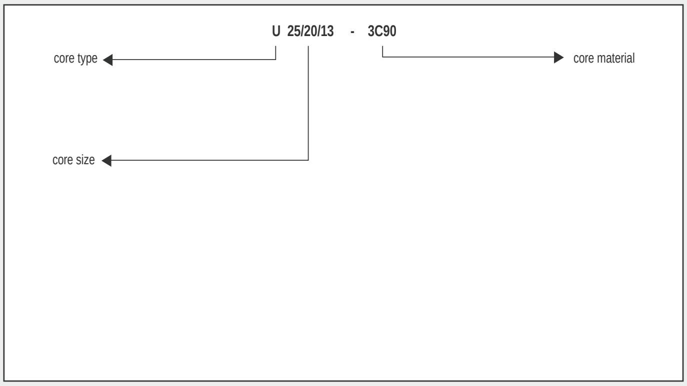


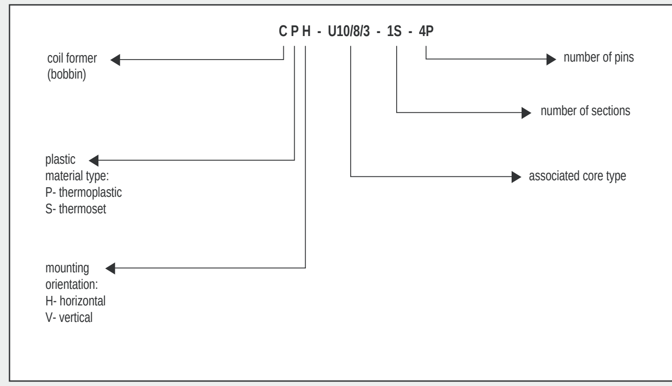


U cores, with rectangular cross-sections, are easy to produce and are relatively inexpensive. For this reason they are very popular in low cost applications such as interference filters and output chokes in radio and TV equipment. There is no real optimization for transformer winding designs and the core is rather bulky.
Large U cores like U93 and U100 are suitable for very high throughput powers. They can be stacked to form transformers, capable of handling several kW's in applications such as industrial HF welding.

Summary:
- simple, economic shape
- can be stacked for high power
- bulky sizes
- no self-shielding

	Core type	U10/8/3	U11/8/5	U15/11/6	U20/16/7	U25/16/6 (376U250)
efective core parameters	core factor Σ l/A(mm^{-1})	4.74	3.20	1.60	1.21	2.07
	eff. volume V_e (mm^3)	309	501	1680	3800	3380
	eff. length l_e (mm)	38.3	40.0	52	68	83.6
	eff. area A_e (mm^2)	8.07	12.5	32.3	56	40.3
	min. area A_{min} (mm^2)	7.91	12.5	32.3	56	40.3
	mass of core half (g)	≈ 0.9	≈ 1.5	≈ 4	≈ 9	≈ 8
dimensions (mm)	A	9.9 ± 0.3	10.5 ± 0.2	15.4 ± 0.5	20.8 ± 0.6	25.4 + 0.5/ – 0.4
	B	8.2 – 0.2	7.8 ± 0.1	11.45 ± 0.2	15.6 ± 0.2	15.9 ± 0.13
	C	2.85 ± 0.15	5 ± 0.15	6.25 + 0.4	7.5 ± 0.25	6.4 ± 0.13
	D	5 + 0.3	5.3 ± 0.3	6.4 ± 0.35	8.3 ± 0.3	9.5 ± 0.13
	E	4.35 ± 0.2	5.5 ± 0.2	5.4 ± 0.4	6.4 ± 0.4	12.7 ± 0.25
bobbins	CPH	1S - 4P		1S - 4P 2S - 4P		
core halves	3C81					1400
	3C90	420	680	1400	1900	1200
	3C91 des					1400
	3C94	470	680	1400	1900	1200
	3C11			2400	3100	2050
	3E27		1200	3400	4800	2500





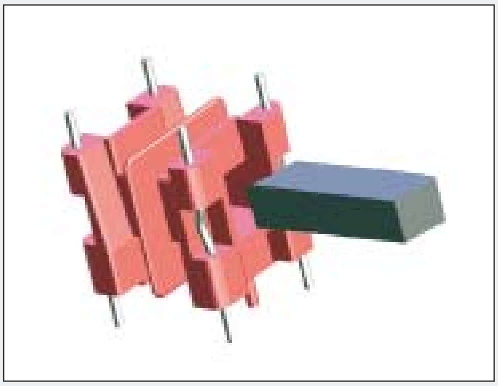
	Core type	U25/20/13	U30/25/16	U33/22/9 (1F30)	U67/27/14 (1F10)	U93/76/16	U93/52/30	U93/76/30	U100/57/25
efective core parameters	core factor Σ l/A(mm^{-1})	0.850	0.690	1.27	0.850	0.790	0.307	0.421	0.478
	eff. volume V_e (mm^3)	9180	17900	9490	35200	159000	217000	297000	199000
	eff. length l_e (mm)	88.2	111	110	173	354	258	354	308
	eff. area A_e (mm^2)	104	161	86.5	204	448	840	840	645
	min. area A_{min} (mm^2)	104	161	86.5	204	448	840	840	645
	mass of core half (g)	≈ 23.5	≈ 43	≈ 24	≈ 85	≈ 400	≈ 560	≈ 760	≈ 500
dimensions (mm)	A	24.8 ± 0.7	31.3 ± 0.7	33.3 ± 0.8	67.3 ± 1.3	93 ± 1.8	93 ± 1.8	93 ± 1.8	101.6 ± 2
	B	19.6 ± 0.2	25.3 ± 0.2	22.2 ± 0.15	27 ± 0.15	76 ± 0.5	52 ± 0.5	76 ± 0.5	57.1 ± 0.4
	C	12.7 ± 0.3	16 + 0.5/ – 0.1	9.4 ± 0.25	14.3 ± 0.4	16 ± 0.6	30 ± 0.6	30 ± 0.6	25.4 ± 0.8
	D	11.4 ± 0.4	14.9 ± 0.4	12.7 ± 0.25	12.7 ± 0.25	48 ± 0.9	24 ± 0.45	48 ± 0.9	31.7 ± 0.75
	E	8.4 ± 0.4	10.5 ± 0.5	14.3 ± 0.5	38.8 ± 0.8	36.2 ± 1.2	36.2 ± 1.2	36.2 ± 1.2	50.8 ± 1
bobbins	CPH								
core halves	3C81			2300	3800				
	3C90	2900	3700			3400	8700	6400	5500
	3C91 des			2300	3800				
	3C94	2900	3700			3400	8700	6400	5500
	3C11	5000							
	3E27	6300							

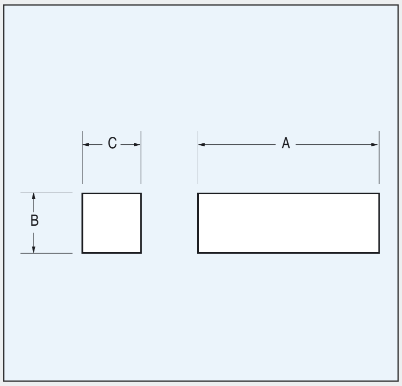
3700 — AL = 3700 nH measured in combination with another ungapped core half.

A_L tolerance: ± 25%

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

I cores



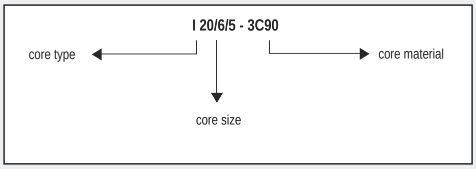


I cores are often used in combination with U-cores to build a simple transformer or inductor.
The smaller types, I20/6/5 and I25/6/6 fit the range of U coil formers.
This combination is suitable for easy to wind inductors in applications such as interference filters and output chokes.
As with rods, the magnetic circuit is open which is an advantage when the currents have a high DC content.

Summary:
- simple, economic shape
- often combined with U cores
- for open circuit inductors
- no self-shielding

	Core type	I20/6/5 1),2)	I25/6/6 (376B250) + U25/16/6	I25/7/7 1)	I93/28/16 + U93/76/16	I93/28/30 + U93/52/30 or U93/76/30	I100/25/25 + U100/57/25
dimensions (mm)	A	19.8 ± 0.5	25.4 +0.64 / –0.25	25 ± 0.7	93 ± 1.8	93 ± 1.8	101.6 ± 2
	B	6.3 ± 0.25	6.4 ± 0.13	7.5 + 0.2/ – 0.3	27.5 ± 0.5	30 ± 0.6	25.4 ± 0.8
	C	5.1 ± 0.2	6.4 ± 0.13	7.5 + 0.2/ – 0.3	16 ± 0.6	27.5 ± 0.5	25.4 ± 0.8
	mass (g)	≈ 3	≈ 4.5	≈ 7	≈ 200	≈ 370	≈ 300
cores	3C81		1750				
	3C90	■	1500	■	4600	10700 8700	6700
	3C91 des		1750				
	3C94	■	1500	■	4600	10700 8700	6700
	3C11		2500				
	3E27		3000				

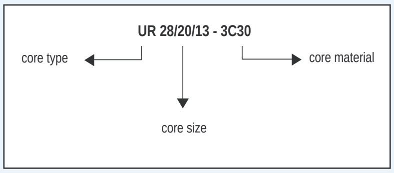
1) To be used as bar core (without counter part)
2) Same coil former as U15/11/6

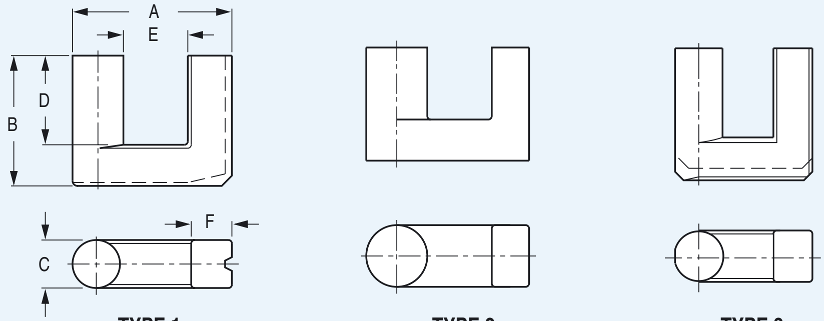


A_L tolerance: ± 25%

UR cores

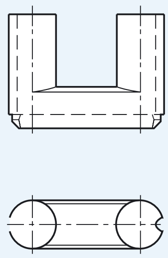
This type is suitable for Line Output Transformers (LOT) in TV-sets. The round leg allows easy winding, also of strip conductors. Because of the high voltages involved, the round shape helps to prevent corona effect.



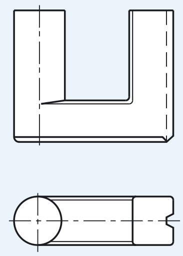


TYPE 1 TYPE 2 TYPE 3

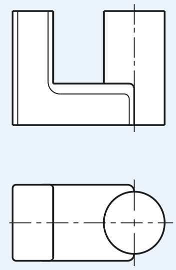
Core type	Shape	dimensions (mm)						effective core parameters				
		A	B	C	D	Emin	F	core factor Σ l/A (mm^{-1})	eff. volume V_e (mm^3)	eff. length l_e (mm)	eff. area A_e (mm^2)	mass of core half (g)
UR28/20/14	6	28.3	20.4	11.2	13.0	8.5	7.5	0.990	9460	97	98	25
UR35/28/13	5	35.2	28.3	12.7	18.8	13.1	9.3	1.100	15900	132	120	42
UR39/35/15	3	38.7	35.2	14.9	24.8	15.0	9.1	1.094	24300	163	149	64
UR42/21/12	4	41.8	20.6	11.9	11.1	18.2	11.9	1.09	11800	113	104	31
UR42/32/15	5	42.5	31.8	15.2	20.2	14.4	12.0	0.832	26670	149	179	69
UR43/34/16	2	42.1	34.0	15.8	24.0	15.7	9.6	0.982	27100	163	166	71
UR44/36/15	1	43.8	35.9	14.65	24.45	16.65	11.8	1.006	28700	170	169	71
UR47/36/16	5	47.55	35.7	15.95	23.8	18.25	12.6	0.900	33800	174	194	86
UR48/39/17	5	48.0	39.4	17.0	26.4	17.4	13.0	0.865	39990	186	215	99
UR64/29/14	4	64.0	29.5	13.8	18.1	36.1	13.8	1.26	27000	185	147	71
UR64/40/20	7	64.0	40.5	20.0	26.5	23.2	20.0	0.726	61000	210	290	160



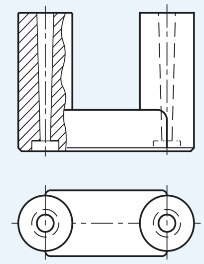
TYPE 4



TYPE 5



TYPE 6



TYPE 7

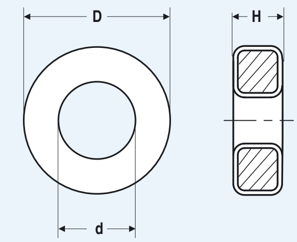
Shape	product range		
	3C81/3F3	3C30	3C34
6	-	UR28/20/13 - 3C30	UR28/20/13 - 3C34
5	-	UR35/28/13 - 3C30	UR35/28/13 - 3C34
3	-	UR39/35/15 - 3C30	UR39/35/15 - 3C34
4	UR42/21/12 - 3C81	-	-
5	-	UR42/32/15 - 3C30	UR42/32/15 - 3C34
2	-	UR43/34/16 - 3C30	UR43/34/16 - 3C34
1	-	UR44/36/15 - 3C30	UR44/36/15 - 3C34
5	-	UR47/36/16 - 3C30	UR47/36/16 - 3C34
5	-	UR48/39/17 - 3C30	UR48/39/17 - 3C34
4	UR64/29/14 - 3C81	-	-
7	-	-	-
7	UR64/40/20 - 3F3	-	-

Our present selection is displayed in the table above. In principle any core type can be supplied in all available grades.
Other customized shapes can be manufactured on request.

Ferrite Toroids

Toroids 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

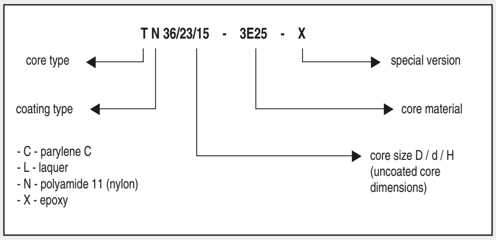


Core type	dimensions (mm)			efective core parameters				
	outside diameter D	inside diameter D	height H	core factor Σ l/A(mm^{-1})	eff. volume V_e (mm^3)	eff. length l_e (mm)	eff. area A_e (mm^2)	mass (g)
TC2.5/1.3/0.8	2.54 ± 0.1	1.27 ± 0.1	0.8 ± 0.1	11.3	2.7	5.53	0.49	0.012
TC2.5/1.3/1.3	2.54 ± 0.1	1.27 ± 0.1	1.27 ± 0.1	7.14	4.29	5.53	0.76	0.022
TC2,5/1.3/2.5	2.54 ± 0.1	1.27 ± 0.1	2.54 ± 0.1	3.57	8.57	5.53	1.55	0.044
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
TC2.5/1.5/1-S	2.5 ± 0.1	1.5 ± 0.1	1.0 ± 0.1	12.3	2.94	6.02	0.489	0.015
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	5.75	9.10	7.23	1.26	0.05
TC3.4/1.8/1.3	3.43 ± 0.18	1.78 ± 0.18	1.27 ± 0.18	7.93	7.3	7.62	0.96	0.035
TC3.4/1.8/2	3.35 ± 0.13	1.78 ± 0.13	2.03 ± 0.13	4.90	11.6	7.54	1.54	0.059
TC3.4/1.8/2.1	3.38 ± 0.13	1.78 ± 0.13	2.06 ± 0.13	4.97	11.5	7.54	1.52	0.06
TC3.4/1.8/2.3	3.43 ± 0.15	1.78 ± 0.1	2.3 ± 0.1	4.16	14.0	7.63	1.83	0.068
TC3.5/1.6/1.3	3.5 ± 0.15	1.6 ± 0.15	1.27 ± 0.15	6.32	8.3	7.25	1.15	0.043
TC3.5/1.8/1.3	3.46 ± 0.15	1.78 ± 0.1	1.27 ± 0.1	7.44	7.87	7.65	1.03	0.04
TC3.5/1.8/1.5	3.46 ± 0.13	1.78 ± 0.13	1.5 ± 0.13	6.30	9.30	7.65	1.21	0.05
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	0.06
TC3.5/1.8/2	3.46 ± 0.15	1.78 ± 0.1	2.0 ± 0.1	4.73	12.4	7.6	1.62	0.05
TC3.9/1.8/1.8	3.94 ± 0.2	1.78 ± 0.15	1.78 ± 0.15	4.44	14.8	8.1	1.83	0.086
TC3.9/1.8/2.5	3.94 ± 0.15	1.78 ± 0.15	2.54 ± 0.15	3.11	21.1	8.1	2.6	0.12
TC3.9/2.2/1.3	3.94 ± 0.17	2.24 ± 0.18	1.27 ± 0.18	9.20	9.2	9.2	1.00	0.045
TC4/1.8/0.8	4.0 ± 0.15	1.78 ± 0.1	0.8 – 0.1	10.3	6.43	8.16	0.79	0.035
TC4/2/2	4.0 ± 0.15	2.0 ± 0.1	2.0 ± 0.1	4.54	16.7	8.71	1.92	0.095
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	0.04
TC4/2.2/1.3	4.0 ± 0.15	2.2 ± 0.1	1.27 ± 0.1	8.28	10.2	9.18	1.11	0.05
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	0.06
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	0.07
TC4/2.2/2	4.0 ± 0.15	2.2 ± 0.1	2.0 ± 0.1	5.26	16.1	9.18	1.75	0.08
TC4.8/2.3/1.3	4.8 ± 0.15	2.3 ± 0.1	1.27 ± 0.1	6.73	15.5	10.2	1.52	0.09
TC5.8/3.1/0.8	5.84 ± 0.15	3.05 ± 0.15	0.75 ± 0.1	12.9	13.2	13.0	1.01	0.07
TC5.8/3.1/1.5	5.84 ± 0.18	3.05 ± 0.18	1.52 ± 0.18	6.52	26.1	13.0	2.00	0.13
TC5.8/3.1/3.2	5.84 ± 0.15	3.05 ± 0.15	3.17 ± 0.15	3.04	55.8	13.0	4.28	0.31
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	0.23
TC6.3/3.8/2.5	6.3 ± 0.15	3.8 ± 0.15	2.5 ± 0.15	4.97	46.5	15.2	3.06	0.23
TC7.6/3.2/4.8	7.6 ± 0.25	3.18 ± 0.2	4.78 ± 0.2	1.51	148	15.0	9.92	0.7
TC7.6/3.2/5.2	7.6 ± 0.25	3.18 ± 0.2	5.15 ± 0.2	1.41	160	15.0	10.6	0.75
TC8.2/3.7/4	8.2 ± 0.25	3.73 ± 0.15	4.0 ± 0.15	1.99	144	16.9	8.5	0.7
TC9/6/3 1)	9.0 ± 0.2	6.0 ± 0.2	3.0 ± 0.15	5.17	102	22.9	4.44	0.5
TL9/6/3 1)	9.3 ± 0.4	5.75 ± 0.3	3.25 ± 0.3	5.17	102	22.9	4.44	0.5
TN9/6/3 1)	9.5 ± 0.3	5.4 ± 0.3	3.4 ± 0.25	5.17	102	22.9	4.44	0.5
TC9.5/4.8/3.2	9.5 ± 0.31	4.75 ± 0.18	3.2 ± 0.18	2.98	144	20.7	6.95	0.7
TN10/6/4	10.6 ± 0.3	5.2 ± 0.3	4.4 ± 0.3	3.07	188	24.1	7.8	0.95

T = Toroid (Ring Core), TN = Toroid Nylon coated, TL = Toroid Laquered, TX = Toroid epoXy coated, TC = Toroid parylene C coated

1) 8-pad SMD tag plate (TGPS9) and cover (COV9) are available

Core type	dimensions (mm)			efective 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)
TX10/6/4	10.25 ± 0.4	5.75 ± 0.3	4.25 ± 0.3	3.07	188	24.1	7.8	0.95
TX13/7.1/4.8	12.95 ± 0.4	6.9 ± 0.35	5.03 ± 0.3	2.40	361	29.5	12.3	1.8
TN13/7.5/5	13.0 ± 0.35	6.8 ± 0.35	5.4 ± 0.3	2.46	368	30.1	12.2	1.8
TX13/7.5/5	12.75 ± 0.4	7.25 ± 0.35	5.25 ± 0.3	2.46	368	30.1	12.2	1.8
TX13/7.9/6.4	12.95 ± 0.4	7.67 ± 0.4	6.6 ± 0.4	2.21	442	31.2	14.1	2.2
TN14/9/5	14.6 ± 0.4	8.2 ± 0.35	5.5 ± 0.3	2.84	430	35	12.3	2.1
TX14/9/5	14.25 ± 0.4	8.75 ± 0.35	5.25 ± 0.3	2.84	430	35	12.3	2.1
TN14/9/9	14.8 ± 0.4	8.0 ± 0.4	9.5 ± 0.4	1.58	774	35	22.1	3.8
TX14/9/9	14.25 ± 0.4	8.75 ± 0.35	9.25 ± 0.4	1.58	774	35	22.1	3.8
TX16/9.1/4.7	16.13 ± 0.5	8.82 ± 0.4	4.95 ± 0.3	2.53	548	37.2	14.7	2.7
TN16/9.6/6.3	16.7 ± 0.5	8.7 ± 0.4	6.8 ± 0.4	1.95	760	38.5	19.7	3.8
TX16/9.6/6.3	16.25 ± 0.5	9.35 ± 0.4	6.55 ± 0.4	1.95	760	38.5	19.7	3.8
TN19/11/10	19.7 ± 0.6	9.7 ± 0.4	10.5 ± 0.5	1.08	1795	44.0	40.8	9.2
TN19/11/15	19.9 ± 0.6	9.5 ± 0.4	15.5 ± 0.55	0.718	2692	44.0	61.2	13.8
TN20/10/7	20.6 ± 0.6	9.2 ± 0.4	7.5 ± 0.45	1.30	1465	43.6	33.6	7.7
TX20/10/7	20.25 ± 0.6	9.75 ± 0.4	7.25 ± 0.45	1.30	1465	43.6	33.6	7.7
TX22/14/6.4	22.35 ± 0.7	13.47 ± 0.6	6.75 ± 0.4	2.20	1340	54.2	24.8	6.5
TX22/14/13	22.35 ± 0.7	13.47 ± 0.6	13.1 ± 0.5	1.07	2750	54.2	50.9	14
TN23/14/7	23.7 ± 0.7	13.1 ± 0.6	7.5 ± 0.45	1.81	1722	55.8	30.9	8.4
TN25/15/10	25.8 ± 0.7	14.0 ± 0.6	10.6 ± 0.5	1.23	2944	60.2	48.9	15
TX25/15/10	25.25 ± 0.7	14.75 ± 0.6	10.4 ± 0.5	1.23	2944	60.2	48.9	15
TN26/15/10	26.8 ± 0.7	13.5 ± 0.6	10.6 ± 0.5	1.08	3360	60.1	55.9	17
TX26/15/10	26.25 ± 0.7	14.25 ± 0.6	10.4 ± 0.5	1.08	3360	60.1	55.9	17
TN26/15/20	26.9 ± 0.7	13.2 ± 0.6	20.5 ± 0.6	0.538	6720	60.1	112	34
TN29/11/6	29.6 ± 0.7	10.0 ± 0.4	6.4 ± 0.4	1.04	2680	52.9	50.8	14
TN29/19/7.5	29.7 ± 0.7	18.2 ± 0.6	8.1 ± 0.5	1.98	2700	73.2	36.9	13.5
TX29/19/7.5	29.25 ± 0.7	18.75 ± 0.6	7.9 ± 0.5	1.98	2700	73.2	36.9	13.5
TX29/19/7.6	29.25 ± 0.7	18.75 ± 0.6	8.0 ± 0.5	2.06	2600	73.2	35.5	13
TN29/19/15	29.9 ± 0.7	18.1 ± 0.6	15.5 ± 0.6	0.98	5410	73.2	73.9	28
TX29/19/15	29.25 ± 0.7	18.75 ± 0.6	15.4 ± 0.5	0.98	5410	73.2	73.9	28
TL32/19/13	31.75 ± 0.8	18.75 ± 0.7	12.9 ± 0.5	0.99	5820	76	76.5	29
TN32/19/13	32.2 ± 0.8	18.1 ± 0.6	13 ± 0.5	0.99	5820	76	76.5	29
TN36/23/10	36.8 ± 0.9	22.1 ± 0.7	10.7 ± 0.6	1.40	5730	89.6	63.9	28
TX36/23/10	36.25 ± 0.9	22.75 ± 0.7	10.56 ± 0.5	1.46	5540	89.7	61.8	27
TN36/23/15	36.9 ± 0.9	21.9 ± 0.7	15.7 ± 0.6	0.935	8600	89.6	95.9	42
TX36/23/15	36.25 ± 0.9	22.75 ± 0.7	15.6 ± 0.6	0.96	8440	89.7	94.1	40
TX39/20/13	39.15 ± 0.9	19.3 ± 0.7	13.2 ± 0.5	0.76	9513	84.9	112	45
TX42/26/13	42.1 ± 1.1	25.9 ± 0.8	13 ± 0.5	1.076	9860	103	95.8	53
TX42/26/18	42.1 ± 1.1	25.9 ± 0.8	18 ± 0.7	0.769	13810	103	134	55
TX50/30/19	50.4 ± 1.1	29.7 ± 0.8	19.5 ± 0.6	0.65	22378	120.4	186	100
TX51/32/19	51.05 ± 1.5	31.5 ± 1	19.5 ± 0.6	0.73	21500	125	172	100
TL55/32/18	55.8 ± 1.7	32.1 ± 1	18.3 ± 0.9	0.651	26580	131.5	202	134



Isolation voltage

Toroids with polyamide, epoxy and laquer coating (TN, TX and TL)

diameter:
- < 12 : 1000 V_{DC}
- 12-20 : 1500 V_{DC}
- > 20 : 2000 V_{DC}

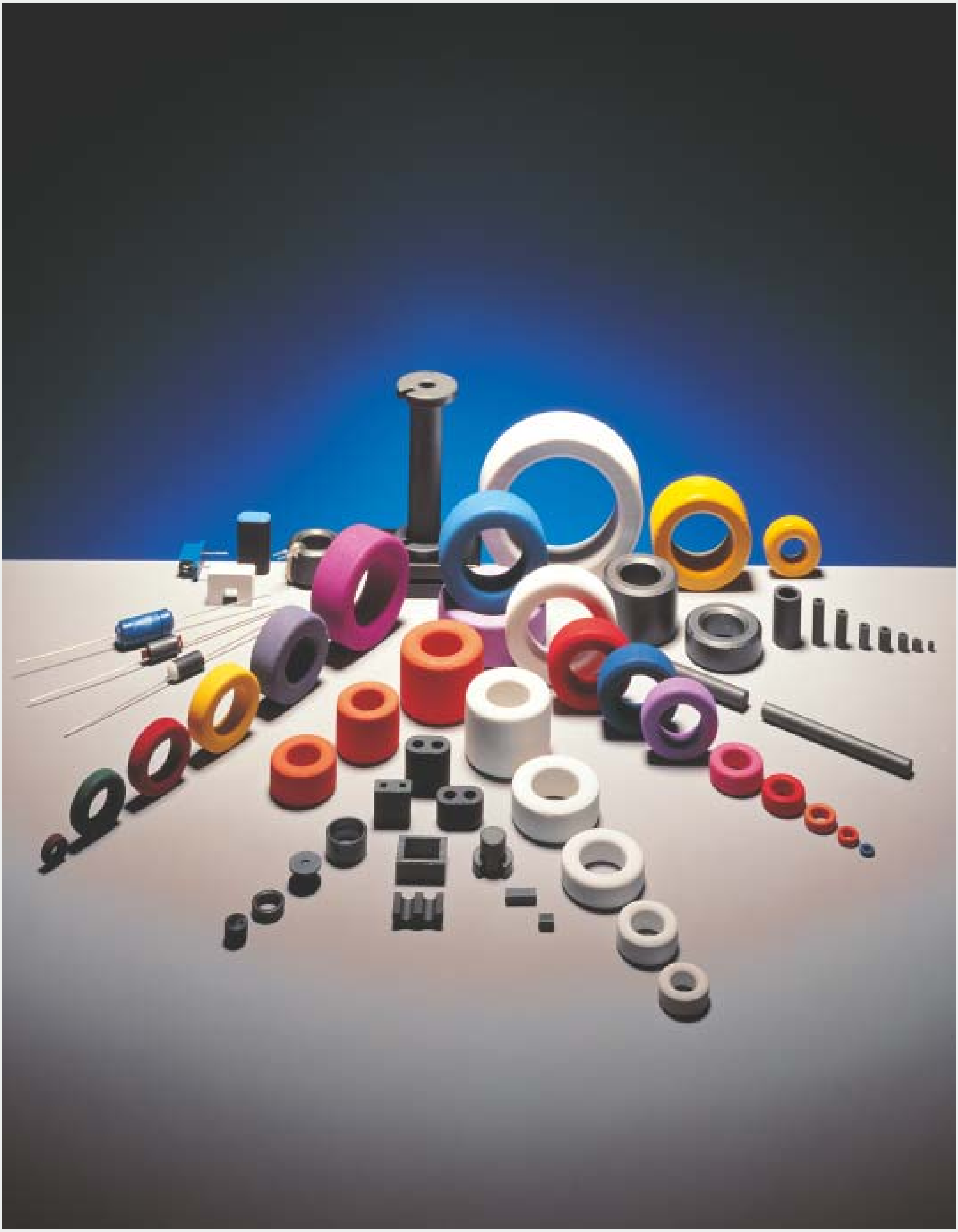
Toroids with parylene coating (TC): 1000 V_{DC}

T = Toroid (Ring Core), TN = Toroid Nylon coated, TL = Toroid Laquered, TX = Toroid epoXy coated, TC = Toroid parylene C coated

Ferrite Toroids

Core type	dimensions (mm)			efective 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)
TL58/41/18	58.7 ± 1.1	40.5 ± 0.9	17.9 ± 0.7	1.0	23200	152.4	152.4	110
TL63/38/25	63.4 ± 2.1	37.7 ± 1.3	25.3 ± 1	0.497	46500	152	306	220
TX63/38/25	63.4 ± 2.1	37.7 ± 1.3	25.3 ± 1	0.497	46500	152	306	220
TL74/39/13	73.9 ± 1.52	38.61 ± 1.32	12.95 ± 0.5	0.80	34300	165	208	170
TX74/39/13	73.9 ± 1.52	38.61 ± 1.32	12.95 ± 0.5	0.80	34300	165	208	170
TL80/40/15	80.4 ± 2.6	39.7 ± 1.3	15.3 ± 0.6	0.604	50200	174	288	240
TL87/54/14	87.4 ± 1.35	54 ± 1	13.8 ± 0.45	0.987	46400	214	217	220
T87/56/13	87 ± 1.25	56 ± 0.9	12.7 ± 0.25	1.123	42133	217.5	194	200
TL102/66/15	102.4 ± 2.1	65.5 ± 1.4	15.3 ± 0.7	0.956	68200	255	267	325
T107/65/18	107 ± 2	65 ± 1.3	18 ± 0.35	0.700	96000	259	370	456
TL107/65/18	107.4 ± 2	64.7 ± 1.4	18.3 ± 0.55	0.700	96000	259	370	456
T107/65/25	107 ± 2	65 ± 1.3	25 ± 0.75	0.504	133000	259	514	680
T140/106/25	140 ± 3	106 ± 2	25 ± 1	0.903	161100	382	422	800

T = Toroid (Ring Core), TN = Toroid Nylon coated, TL = Toroid Laquered, TX = Toroid epoXy coated, TC = Toroid parylene C coated



Ferrite Toroids

Core type \ Material / Colour code	3B7	3C11	3C81	3C90	3D3	3E5	3E6	3E7	3E8	3E25
TC2.5/1.3/0.8										
TC2.5/1.3/1.3							1835 des			970 des
TC2.5/1.3/2.5										
TC2.5/1.5/0.8							765 des			
TC2.5/1.5/1-S						920 des	1020 des			
TC3.1/1.3/1.3							2225 des			1225 des
TC3.1/1.8/2										
TC3.4/1.8/1.3	375 sup				110 sup		1580 des			
TC3.4/1.8/2								3080 des		1420 des
TC3.4/1.8/2.1										1420 des
TC3.4/1.8/2.3										
TC3.5/1.6/1.3		862								
TC3.5/1.8/1.3										
TC3.5/1.8/1.5										
TC3.5/1.8/1.8										
TC3.5/1.8/2										
TC3.9/1.8/1.8										
TC3.9/1.8/2.5										
TC3.9/2.2/1.3	325 sup				97 sup					
TC4/1.8/0.8										
TC4/2/2		1190								
TC4/2.2/1.1						1120	1315 des			725
TC4/2.2/1.3										720
TC4/2.2/1.6						1630	1915 des			1050
TC4/2.2/1.8							2130 des			
TC4/2.2/2									3590 prot	1315 des
TC4.8/2.3/1.3	430 sup									
TC5.8/3.1/0.8										
TC5.8/3.1/1.5	450 1) sup						1960		2940 prot	
TC5.8/3.1/3.2	940 sup				310 des		4130 des			
TC5.9/3.1/3.1							3960 des			
TC6/4/2						1380	1620 des			890
TC6/4/3							2430 des			

12000 — nominal A_L value (nH) measured at B ≤ 0.1 mT, f ≤ 10 kHz, T = 25°C

1) outer diameter = 6.0 ± 0.18 mm

A_L tolerance: ± 20% | ± 25% | ± 30% | + 20% – 40% | + 25% – 20% | + 30% – 40% | + 40% – 30%

Core type \ Material (Colour code)	3E27	3E28	3F3	3F4	3R1	3S4	4A11	4A15	4B1	4C65
TC2.5/1.3/0.8							94 des			
TC2.5/1.3/1.3						300 des	150 des			
TC2.5/1.3/2.5		1400 des								
TC2.5/1.5/0.8										
TC2.5/1.5/1-S	513 des	410 des					71 des			
TC3.1/1.3/1.3							190 des			
TC3.1/1.8/2		1100 des								
TC3.4/1.8/1.3	660									
TC3.4/1.8/2										
TC3.4/1.8/2.1		1045 des								
TC3.4/1.8/2.3		1207 des								
TC3.5/1.6/1.3										
TC3.5/1.8/1.3	930 des						120 des			
TC3.5/1.8/1.5								170 des		
TC3.5/1.8/1.8		950 des								
TC3.5/1.8/2		1060 des								
TC3.9/1.8/1.8		1400 des								
TC3.9/1.8/2.5		2020 des								
TC3.9/2.2/1.3	575									
TC4/1.8/0.8		486 des								
TC4/2/2	1623 des	1110 des								
TC4/2.2/1.1			260				92			16
TC4/2.2/1.3							122			
TC4/2.2/1.6			380			325 des	134			24
TC4/2.2/1.8										
TC4/2.2/2										
TC4.8/2.3/1.3	1030 des									
TC5.8/3.1/0.8		390 des								
TC5.8/3.1/1.5	890								50 des	25
TC5.8/3.1/3.2		1650 des								
TC5.9/3.1/3.1										
TC6/4/2			325			275 des	114			20
TC6/4/3										

12000 — nominal A_L value (nH) measured at $B \leq 0.1$ mT, $f \leq 10$ kHz, $T = 25$°C

■ = available (no AL spec.)

A_L tolerance: ± 20% | ± 25% | ± 30% | + 20% – 40% | + 25% – 20% | + 30% – 40% | + 40% – 30%

Ferrite Toroids

Core type \ Material / Colour code	3B7	3C11 *white*	3C81 *brown/white*	3C90 *ultramarine*	3D3	3E5 *yellow/white*	3E6 *purple/white*	3E7	3E8	3E25 *orange*
TC6.3/3.8/2.5						2150	2530 des	3600 des		1390
TC7.6/3.2/4.8				1915			8360 des		12500 prot	
TC7.6/3.2/5.2										
TC8.2/3.7/4								7560 des		
TC9/6/3						2070	2435 des			
TL9/6/3						2070				
TN9/6/3				560						1340
TC9.5/4.8/3.2	1000 sup		1200		330 sup		4390 des	5323 des	6590 prot	
TN10/6/4		1750		940 des	306					2250
TX10/6/4						3470	4085 des			
TX13/7.1/4.8			1475	1260 des	415 sup		5400 des			
TN13/7.5/5		2200		1170 des						2810
TX13/7.5/5						4340	5095 des			
TX13/7.9/6.4			1620	1380 des			5900 des			3000
TN14/9/5		1900		1015 des						2430
TX14/9/5						3760	4415 des			
TN14/9/9		3400		1825 des						4370
TX14/9/9						6760	7955 des			
TX16/9.1/4.7			1400	1215 des			5200 des			
TN16/9.6/6.3		2700		1480 des						3540
TX16/9.6/6.3						5470	6430 des			
TN19/11/10		5000		2680 des						6420
TN19/11/15		7500		4020 des						9630
TN20/10/7		4150		2230 des						5340
TX20/10/7						8250	9685 des			
TX22/14/6.4			1650	1400 des	454		6000 des			
TX22/14/13				2795			12080 des			
TN23/14/7		3000		1600 des						3820
TN25/15/10		4400		2350 des						5620
TX25/15/10						8680	10200 des			
TN26/15/10		5000		2645 des						6420
TX26/15/10						10000				
TN26/15/20		10000		5400 des						12800
TN29/11/6		5100		2780						
TN29/19/7.5		2700		1460						3550

12000 — nominal A_L value (nH) measured at $B \leq 0.1$ mT, $f \leq 10$ kHz, $T = 25°C$

A_L tolerance: ± 20% | ± 25% | ± 30% | + 20% – 40% | + 25% – 20% | + 30% – 40% | + 40% – 30%

T = Toroid (Ring Core), TN = Toroid Nylon coated, TL = Toroid Laquered, TX = Toroid epoXy coated, TC = Toroid parylene C coated

Core type \ Material / Colour code	3E27 *green*	3E28	3F3 *blue*	3F4 *beige*	3R1 *black*	3S4	4A11 *pink*	4A15	4B1	4C65 *violet*
TC6.3/3.8/2.5			500				177			
TC7.6/3.2/4.8		3800 des								
TC7.6/3.2/5.2		3580 des								
TC8.2/3.7/4							440 des			
TC9/6/3										
TL9/6/3										
TN9/6/3			440		■		170			30
TC9.5/4.8/3.2	2135		890							
TN10/6/4			740		■		286			52
TX10/6/4										
TX13/7.1/4.8	2750		990							
TN13/7.5/5			900	460 des	■		360	610		64
TX13/7.5/5										
TX13/7.9/6.4	3000		1100							
TN14/9/5			790		■		310			55
TX14/9/5										
TN14/9/9			1430				560			
TX14/9/9										
TX16/9.1/4.7	2600									
TN16/9.6/6.3			1160				450			
TX16/9.6/6.3										
TN19/11/10										
TN19/11/15										
TN20/10/7										121
TX20/10/7										
TX22/14/6.4	3055									75
TX22/14/13	6110		2200							
TN23/14/7			1250		■		485			87
TN25/15/10			1840							
TX25/15/10										
TN26/15/10							817			
TX26/15/10										
TN26/15/20										
TN29/11/6										
TN29/19/7.5										

12000 — nominal A_L value (nH) measured at B ≤ 0.1 mT, f ≤ 10 kHz, T = 25°C

■ = available (no AL spec.)

A_L tolerance: ± 20% | ± 25% | ± 30% | + 20% – 40% | + 25% – 20% | + 30% – 40% | + 40% – 30%

T = Toroid (Ring Core), TN = Toroid Nylon coated, TL = Toroid Laquered, TX = Toroid epoXy coated, TC = Toroid parylene C coated

Ferrite Toroids

Core type \ Material / Colour code	3B7	3C11 *white*	3C81 *brown/white*	3C90 *ultramarine*	3D3	3E5 *yellow/white*	3E6 *purple/white*	3E25 *orange*
TX29/19/7.5							6340 des	
TX29/19/7.6			1740					
TN29/19/15				2960		10780		7000
TX29/19/15							12850 des	
TL32/19/13						10700		
TN32/19/13		5450		2910 des				6950
TN36/23/10		3900		2060 des				
TX36/23/10								
TN36/23/15		5800		3090 des				7390
TX36/23/15			3670	3090		11400	13600 des	
TX39/20/13			4700	3800 des			16700 des	
TX42/26/13		5000		2690 des				6425
TX42/26/18						12900		
TX50/30/19							19400 des	
TX51/32/19			4800	3980 des			17300 des	8890
TL55/32/18								10620
TL58/41/18		5400		2890 des				6900
TL63/38/25								13900
TX63/38/25							25280 des	
TL74/39/13							15776 des	
TX74/39/13			4350	3620 des				8060
TL80/40/15				4780				
TL87/54/14		5470 des		2930 des				
T87/56/13							11190 des	
TL102/66/15		5300						7900 des
T107/65/18								
TL107/65/18								9900 des
T107/65/25								
T140/106/25				3200				7700 des

12000 — nominal A_L value (nH) measured at B ≤ 0.1 mT, f ≤ 10 kHz, T = 25°C

A_L tolerance: ± 20% | ± 25% | ± 30% | + 20% – 40% | + 25% – 20% | + 30% – 40% | + 40% – 30%

T = Toroid (Ring Core), TN = Toroid Nylon coated, TL = Toroid Laquered, TX = Toroid epoXy coated, TC = Toroid parylene C coated

Core type \ Material / Colour code	3E27 *green*	3E28	3F3 *blue*	3F4 *beige*	3R1 *black*	3S4	4A11 *pink*	4B1	4C65 *violet*
TX29/19/7.5									
TX29/19/7.6	3225								
TN29/19/15									
TX29/19/15									
TL32/19/13									
TN32/19/13			2270				885		
TN36/23/10									112
TX36/23/10									
TN36/23/15			2420		■	2285 des	940		170
TX36/23/15	6800								
TX39/20/13	8720		3150						
TX42/26/13	6425						820		
TX42/26/18									
TX50/30/19									
TX51/32/19	8890		3200						
TL55/32/18	10620						1350		
TL58/41/18									
TL63/38/25			4550						
TX63/38/25									
TL74/39/13									
TX74/39/13			2900						
TL80/40/15									
TL87/54/14									
T87/56/13									
TL102/66/15									165 des
T107/65/18				1354 des					
TL107/65/18			3230						
T107/65/25			4485 des	1870 des					
T140/106/25									

12000 — nominal A_L value (nH) measured at B ≤ 0.1 mT, f ≤ 10 kHz, T = 25°C

■ = available (no AL spec.)

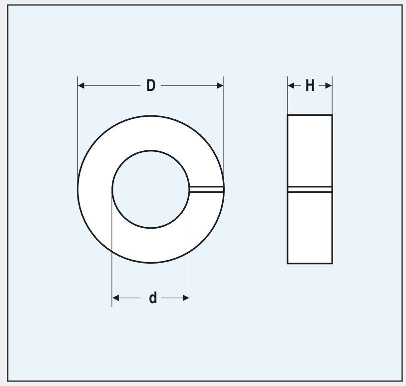
A_L tolerance: ± 20% | ± 25% | ± 30% | + 20% – 40% | + 25% – 20% | + 30% – 40% | + 40% – 30%

T = Toroid (Ring Core), TN = Toroid Nylon coated, TL = Toroid Laquered, TX = Toroid epoXy coated, TC = Toroid parylene C coated

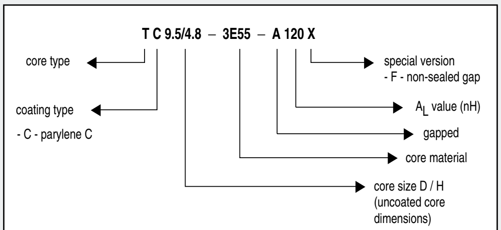
Gapped Ferrite Toroids

Gapped toroids share properties with ungapped toroids like a simple economic shape. Ferroxcube has developed a range of gapped toroids, both in power material 3C94, for power applications, and in special, high perm, stable µ(T) material 3E55 with low THD for telecom applications.
They are parylene coated and the gap is sealed with special glue, which is temperature resistant up to 250 °C, thus avoiding product deterioration, even under extreme operating conditions.

Summary :
- simple economic shape
- different A_L-values possible
- compact and robust product
- not easy to wind



Core type	dimensions (mm)			efective 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)
TC4/2.2/0.8	4.0 ± 0.15	2.2 ± 0.1	0.8 ± 0.075	13.1	6.42	9.18	0.699	0.03
TC4.5/2.3/0.8	4.45 ± 0.18	2.29 ± 0.13	0.76 +0.2/−0.08	11.9	8.19	9.87	0.829	0.04
TC4.5/2.3/1.1	4.45 ± 0.18	2.29 ± 0.13	1.14 ± 0.08	8.35	11.7	9.87	1.18	0.06
TC5.8/3.1/3.1	5.84 ± 0.15	3.05 ± 0.15	3.05 ± 0.15	3.17	53.5	13.0	4.11	0.27
TC5.8/3.1/3.5	5.84 ± 0.15	3.05 ± 0.15	3.5 ± 0.15	2.76	61.4	13.0	4.71	0.29
TC6.3/3.8/3.2	6.3 ± 0.15	3.8 ± 0.15	3.18 ± 0.15	3.91	59.2	15.2	3.89	0.28
TC7.6/3.2/3.2	7.6 ± 0.25	3.18 ± 0.15	3.18 ± 0.15	2.27	98.8	15.0	6.60	0.47
TC7.6/3.2/4.8	7.6 ± 0.25	3.18 ± 0.15	4.78 ± 0.2	1.51	148	15.0	9.92	0.71
TC9.5/4.8/4.8	9.5 ± 0.3	4.78 ± 0.2	4.78 ± 0.2	1.91	225	20.8	10.8	1.1
TC10/6/4	10 ± 0.2	6.0 ± 0.2	4.0 ± 0.15	3.07	188	24.1	7.8	0.95



Isolation voltage

Toroids with parylene (TC) : 1000 V_{DC}

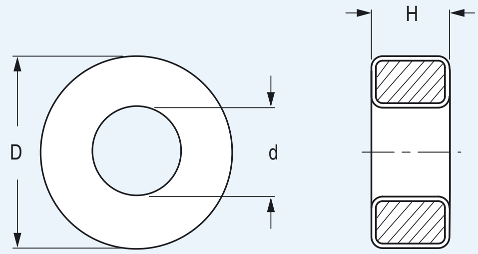
cores for telecom transformers and power applications

Core type		TC4/2.2/0.8	TC4.5/2.3/0.8	TC4.5/2.3/1.1	TC5.8/3.1/3.1	TC5.8/3.1/3.5	TC6.3/3.8/3.2	TC7.6/3.2/3.2	TC7.6/3.2/4.8	TC9.5/4.8/4.8	TC10/6/4
	3C94 des	A13	A15.9	A25.5							A50F
	3E55 des				A55	63	A22	A43	A63	A80	
							A40		A78	A120	
							A63		A110	A120F	
										A145F	

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

A_L tolerance: ± 10% ± 15%

Iron Powder Toroids



Due to the high saturation flux density of iron powder (950...1600 mT) these ring cores are very suitable for output chokes carrying high DC currents. Another application is found in lamp dimmers as ballast choke.

The cores are made of electrolytic iron powder, mixed with a small amount of resin for insulation. The they are coated with polyamide 11 (thickness 0.1 - 0.3 mm). The isolation voltage between core and winding is up to 1500 V.

Summary:
- high saturation flux density
- suitable for output chokes
- for EMI-suppression with high DC bias

	Core type	TN7.5/4.1/3	TN12/8/4.4	TN17/9.8/4.4	TN20/13/6	TN24/15/7.5	TN27/15/11	TN33/20/11
efective core parameters	core factor Σ l/A(mm^{-1})	3.58	3.30	2.55	2.44	1.76	1.02	1.23
	eff. volume V_e (mm^3)	83	290	635	1020	1895	3720	5200
	eff. length l_e (mm)	17.3	30.9	40.2	49.9	57.8	61.6	80.0
	eff. area A_e (mm^2)	4.81	9.37	15.8	20.4	32.8	60.4	65.0
	mass of core half (g)	≈ 0.6	≈ 2	≈ 5	≈ 7.5	≈ 13	≈ 25	≈ 35
dimensions (mm)	D	8.1 ± 0.3	13.0 ± 0.3	17.8 ± 0.3	20.5 ± 0.5	24.3 ± 0.5	27.5 ± 0.5	33.6 ± 0.5
	d	3.5 ± 0.3	7.4 ± 0.3	8.9 ± 0.3	12.3 ± 0.5	13.8 ± 0.5	14.0 ± 0.5	19.2 ± 0.5
	H	3.3 ± 0.5	4.8 ± 0.5	4.8 ± 0.5	6.5 ± 0.5	8.1 ± 0.5	11.4 ± 0.5	11.5 ± 0.5
A_L (nH) ± 10%	2P40 *dark yellow*	14	15	20	21	29	49	41
	2P50 *dark blue*	18	19	25	26	36	62	51
	2P65 *dark red*	23	25	32	34	47	80	67
	2P80 *dark green*	28	31	40	41	57	94	82
	2P90 *dark brown*	30[1)]	33[1)]	42[1)]	44[1)]	61[1)]	105[1)]	87[1)]

[1)]AL tolerance: + 10/ -15%

T N 20/13/6 - 2P90
- T: core type
- N: coating type N- polyamide 11 (nylon)
- 20/13/6: core size
- 2P90: core material

Materials and Applications for EMI-suppression

Property	Test conditions				EMI-suppression												
Symbol	f (kHz)	B_{peak} or H	T (ºC)	unit	3B1	3C11	3E5	3E6 1)	3E7 1)	3E8 1)	3E25	3E26	3E27	4A11	4A15	4B1	4C65
μ_i (± 20%)	≤ 10	≤ 0.1 mT	25		900	4300	10000	12000	15000	18000	6000	7000	6000	850	1200	250	125
$\tan\delta/\mu_i$	30	≤ 0.1 mT	25	(x 10^{-6})			≤ 25	≤ 30	≤ 30	≤ 30							
	100					≤ 20	≤ 75				≤ 25	≤ 20	≤ 15				
	300					≤ 200					≤ 200						
	450				≤ 50												
	1000													≤ 100	≤ 300	≤ 90	
	3000													≤ 1000	≤ 1500	≤ 300	≤ 80
	10000																≤ 130
B	10	250 A/m	100	mT	≈ 200	≈ 180	≈ 210	≈ 210	≈ 210	≈ 200	≈ 180	≈ 290	≈ 280	≈ 180	≈ 180	≈ 260	≈ 250
		3000 A/m	25		≈ 370	≈ 340	≈ 380	≈ 380	≈ 380	≈ 380	≈ 380	≈ 450	≈ 400	≈ 320	≈ 340	≈ 350	≈ 380
H_c			25	A/m	≈ 25	≈ 10	≈ 5	≈ 4	≈ 4	≈ 4	≈ 5	≈ 5	≈ 5	≈ 35	≈ 25	≈ 150	≈ 250
B_r				mT	≈ 190	≈ 120	≈ 80	≈ 100	≈ 100	≈ 100	≈ 100	≈ 120	≈ 120	≈ 110	≈ 150	≈ 240	≈ 280
T_c				ºC	≥ 150	≥ 125	≥ 125	≥ 130	≥ 130	≥ 100	≥ 125	≥ 155	≥ 150	≥ 125	≥ 125	≥ 250	≥ 350
ρ	DC		25	Ωm	≈ 0.2	≈ 1	≈ 0.5	≈ 0.1	≈ 0.1	≈ 0.1	≈ 0.5	≈ 0.5	≈ 0.5	≈ 10^5	≈ 10^5	≈ 10^5	≈ 10^5
density				kg/m^3	≈ 4800	≈ 4900	≈ 4900	≈ 4900	≈ 4900	≈ 5000	≈ 4900	≈ 4900	≈ 4800	≈ 5100	≈ 5100	≈ 4600	≈ 4500
ferrite type					MnZn	MnZn	MnZn	MnZn	MnZn	MnZn	MnZn	MnZn	MnZn	NiZn	NiZn	NiZn	NiZn

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.

Property	Test conditions				EMI-suppression			
Symbol	f (MHz)	B_{peak} or H	T (ºC)	unit	3S1	3S3	3S4	4S2
μ_i (± 20%)	≤ 0.01	≤ 0.1 mT	25		≈ 4000	≈ 350	≈ 1700	≈ 700
|Z| 1)	1	≤ 0.1 mT	25	Ω	≥ 30			
	3						≥ 25	
	10				≥ 60			
	30					≥ 25	≥ 60	≥ 50
	100					≥ 60	≥ 80	
	300					≥ 100	≥ 90	≥ 90
B	0.01	250 A/m	100	mT	≈ 180	≈ 250	≈ 140	≈ 180
		3000 A/m	25		≈ 400	≈ 350	≈ 350	≈ 350
H_c			25	A/m	≈ 10	≈ 60	≈ 20	≈ 30
B_r			25	mT	≈ 120	≈ 230	≈ 170	≈ 120
T_c				ºC	≥ 125	≥ 225	≥ 110	≥ 125
ρ	DC			Ωm	≈ 1	≈ 10^4	≈ 10^4	≈ 10^5
density				kg/m^3	≈ 4900	≈ 4800	≈ 4800	≈ 5000
ferrite type					MnZn	MnZn	MnZn	NiZn

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 a bead of dimensions ∅ 5 x ∅ 2 x 10 mm.

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.

EMI-suppression on PCB

Suppression beads and wideband chokes show high impedance levels over a wide frequency range caused by ferrimagnetic resonant losses in the ferrite material. This impedance is used to absorb interference signals over a wide frequency range. Our S-materials were developed for maximum impedance for frequencies up to 1 GHz. In multilayer suppressors several layers of ferrite are used to create more winding turns, resulting in higher impedance levels

frequency range	
< 30 MHz	*3B1, 3S1*
30 MHz - 1000 MHz	*3S4, 4A15, 4B1, 4S2*

Core shapes
BDW, BDS, CMS, WBC, WBS,
multilayer suppressors, IIC

EMI-suppression in power lines

Often a DC supply or AC current is passing through the inductor to allow normal operation of the connected equipment. This current induces a high magnetic field strength in the ferrite core, which can lead to saturation. Impedance levels then decrease along with permeability, especially at low frequencies. The influence of a bias current can be limited by choosing a ferrite core with a lower permeability, an airgap or with an open magnetic circuit, like rods, tubes or bobbin cores.
When the interference is common-mode, current compensation can be applied to avoid negative effects.
In common-mode chokes 2 similar windings on a ferrite core carry opposing currents. The magnetic fluxes resulting from bias currents or large differential signals cancel out. In this way saturation as well as damping of the useful signals is avoided.

frequency range	
< 30 MHz	*2P, 3B1, 3C90, 3S1*
30 MHz - 1000 MHz	*3S3, 3S4, 4A15, 4B1, 4S2*

Core shapes
iron powder ring cores, bobbin cores and rods
BD, BDW, MHC, WBC

EMI-suppression in mains filters

In mains input filters, effective use is made of the permeability of the ferrite to form an LC filter. To save volume, the permeability of the ferrite core must be as high as possible in the frequency range of the interfering signal. Ring cores are therefore very popular for this application (no airgap) but also U-cores have been used. It is important to take into account any magnetic bias field, caused by DC or low frequency AC-currents. To avoid saturation of the ferrite, the use of current-compensation is common practice.
Two windings with an equal number of turns are applied to the core. The winding directions are such that the incoming current through one winding and the equally large outgoing current through the other generate opposite fluxes of equal magnitude. Current-compensation would be almost ideal with both windings along the total circumference, one over the other. But in practical cases each winding is placed on one half of the core because of insulation requirements.
However, a current-compensated choke is only active against common-mode interference. If differential-mode suppression is required, cores with an airgap or made of a low permeability material like iron powder should be applied.

frequency range	
< 500 kHz	*3C11, 3E25, 3E26, 3E27, 3E5, 3E6*
500 kHz - 3 MHz	*3C90*
3 MHz - 30 MHz	*4A11, 4A15*
> 30 MHz	*3S4, 4C65*

Core shapes
ring cores, U cores

EMI-suppression on signal wires and cables

When interference signals are conducted by cables of a considerable length these will act as an antenna and radiate RF power. Special cable shields are available to suppress the currents and to avoid problems with EMC limits. The product can be in one piece for mounting during manufacturing or split for retrofit solution.
A split product uses special clamps to prevent a parasitic airgap with loss of impedance. Toroids can be effective as well, especially when more than a single turn is required to reach the minimum damping. Also here current-compensation is applied.
In the case of an I/O cable, such as coax or flat cable, the problem is not saturation by high currents.
The reason for the current-compensation is now that the actual signal is also of RF frequency and it would be suppressed together with the interference. The current-compensated inductor has the limitation that it is only active against common-mode interference.

frequency range	*material*
< 30 MHz	*3B1, 3C11, 3C90, 3E25, 3E26, 3E27, 3E5, 3E6, 3S1*
30 MHz - 1000 MHz	*3S4, 4B1, 4S2, 4A11, 4A15, 4C65*

Core shapes
cable shields, tubes and beads
ring cores and multi-hole beads

Materials and Applications for EMI-suppression

Ferrites supporting the drive for Electromagnetic Compatibility

To help circuit designers meet EMC requirements, Ferroxcube supplies a broad range of ferrite products for interference-suppression applications. We offer smart solutions to comply with stringent EMC regulations. In the field of electromagnetic compatibility several trends attribute to a growing necessity of EMC engineering.

In signal processing :

- Change from analogue to digital (steep pulse edges, overshoot, ringing).
- Increase of clock frequencies.

In power conversion :

- Change from linear to switched-mode power supplies (high switching frequency, harmonics).
- Increase of switching frequencies.

These trends, directed to functional upgrading or reducing cost, inevitably also contribute to an increasing level of electromagnetic interference (EMI). Together with the increasing use of electronics this leads to a general EMC degradation. As a consequence, legislation is getting world-wide more strict.

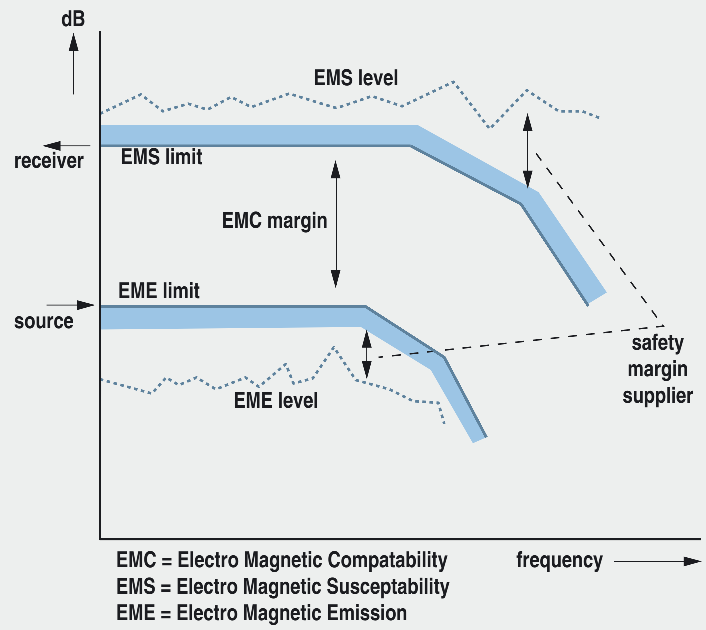
The most important regulations are the European Norms (EN) which are applicable in all European Union (EU) and European Free Trade Associated (EFTA) countries, FCC in the United States and VCCI in Japan. The uniform legislation in the European Union is along the lines of the EMC directive 89/336/EEC. For every product to which no specific European Norm applies, a general regulation is mandatory. These are the so called Generic Requirements (residential, commercial and light industry : EN 61000-6-3 for emissions and EN 61000-6-1 for immunity). This includes all electric and electronic products, no matter how trivial they seem to be. All equipment has to be tested to acquire the CE mark before being offered on the market. Since the European EMC regulations are the most advanced, they are used as a yardstick worldwide.

Regulations

Historically, all EMC regulations stated emission limits only. These define the maximum level of interference allowed as a function of frequency.
In case of conducted interference it applies to the voltage on all inputs and outputs of the equipment, in case of radiated interference it applies to the field strength at a certain distance. Often two levels are stated :

- Class A for commercial and industrial areas.
- Class B for domestic and residential areas.

Class B is always stricter than class A. Recently, also immunity is becoming subject of regulation. Taking into account the severity of the EMC problem, equipment must also be able to operate without functional degradation in a minimum EMI ambient.
The difference between the actual level of emissions or susceptibility and the EMC limits is the required attenuation by filtering or shielding.



Principles of Electromagnetic Compatibility

Sources and propagation

The source determines whether the interference is a transient or random variation in time or a periodical signal. The frequency spectrum will be continuous for a random interference source. Examples are commutation motors, broadcast transmitters etc. Switched-mode power supplies generate periodic signals, causing emissions with a line spectrum.
In practice both types of sources can be broadband.

Interferences can propagate as an electromagnetic wave in free space, but also as a current via conductive paths such as the mains network, to which the majority of electrical equipment is connected.
Below 30 MHz this is the main propagation mode. Effective suppression is achieved by placing a high impedance in series (inductor), a low impedance in parallel (capacitor) or a combination of both (filter).

Propagation via the mains can take place in two different modes: common-mode and differential-mode or a mix of both.

Common-mode :
Phase and null interference voltages are equal. This is likely to occur if phase and null are close together and interference is coupling in from an external field (radiation or cross-talk).

Differential-mode :
Phase and null interference voltages have opposite phase angle but equal magnitude. This is likely to occur in case of switching equipment connected to the mains.

Design considerations

When starting a design, many problems can be avoided by using good design practices. In order of priority these are :

- avoid generating interference by lowering clock rates and/or using smoother pulse shapes
- keep away from the interference source by separating power components and circuits from signal tracks
- impede its propagation by decreasing the length of conductors and component leads
- suppress with ferrites and/or capacitors

The following points should be considered while taking EMI-suppression measures:

- The insertion of ferrite components lowers equally well emission and susceptibility, the essence is blocking the propagation path. The ferrite part should always be located as close to the source as possible. All intermediate circuitry and cable length acts as antenna and produces radiated interference.
- The ferrite and the conductor should be close together. Beads, tubes and cable shields should fit close around the wire or cable. If this is not the case, stray flux is generated, which converts into mutual inductance if other circuits are close enough to be in the stray field.
- Especially for open core types like rods and bobbin cores, stray flux can be a problem. Bobbin cores are better than rods in this respect. Apart from keeping distance to other circuit parts, the positioning is important. For long thin rods a horizontal position is the best. The core axis is horizontal and the magnetic field almost parallel to the PCB. This results in low induced voltages in PCB tracks.
- For inductors with many turns, the winding method influences the parasitic coil capacitance. Too high capacitance values causes early frequency roll-off of the impedance. Methods to reduce parasitic capacitance are multi-chamber winding (separation of turns in groups), and 90 degree cross-winding (electrical decoupling of adjacent turns).

EMI-suppression with ferrites

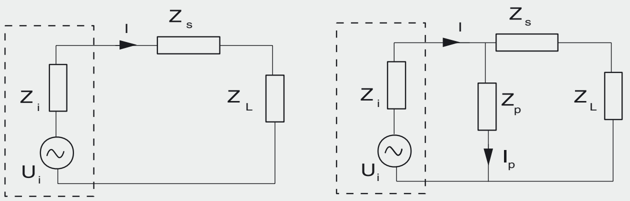
At RF frequencies a ferrite inductor shows a high impedance which suppresses unwanted interference. The resulting voltage over the load impedance will be lower than without suppression component, the ratio of the two is the insertion loss.

The insertion loss is expressed as:

$$IL = 20 \cdot \log_{10} \left(E_o / E \right) \quad [\text{dB}]$$

$$= 20 \cdot \log_{10} \frac{|Z_i + Z_L + Z_S|}{|Z_i + Z_L|} \quad [\text{dB}]$$

where E is the voltage on the load with inductor and E_o without.



At low frequencies, a ferrite inductor behaves like a low-loss inductance. Interferences occur at elevated frequencies and there the picture changes. Losses start to increase and at a certain frequency, the ferrimagnetic resonant frequency, permeability drops rapidly and the impedance becomes almost completely resistive. For applications where inductance is required the operating frequency should stay well below this resonance. However, effective interference suppression is achieved up to much higher frequencies. The impedance peaks well above the resonant frequency and the ferrite is effective in a wide frequency band around it.

The material choice depends on the critical interference frequencies. Ideally the maximum in the impedance curve should coincide with these frequencies. According to Snoek's law, the resonant frequency is inversely proportional to the initial permeability.
The higher the interference frequency, the lower the material permeability should be. The whole RF spectrum can be covered with a few materials if the right permeability steps are chosen.
Our range of S-materials (e.g. 3S1, 3S3, 3S4, 4S2) are optimized to offer high impedance levels over a wide frequency range.
At the resonant frequency and above, the impedance is largely resistive, which is a favourable characteristic of ferrites.
A resistive impedance dissipates interfering signals rather than reflecting them back to the source. Small oscillations at high frequency could otherwise damage semiconductors or negatively affect circuit operation. Therefore it is better to absorb them.

Materials and Applications for EMI-suppression

Sample boxes containing specially selected ranges of ferrite products are available from Ferroxcube to help equipment manufacturers develop optimum solutions for EMI-suppression. Each sample box contains an assortment of suppression cores that aids circuit designers in the often trial-and-error process of finding the most suitable EMI-suppression component.

Surface Mount Beads and Chokes box

Contains a range of beads, common mode chokes and wideband chokes for Surface Mount applications. These SMD components are suitable to prevent generated interference and to suppress incoming noise signals and parasitic oscillations. All products are delivered in tape-and-reel according to IEC and EIA standards ready for use on automatic mounting machines.

Ordering code: SAMPLEBOX9

Cable shielding sample box

Offers a broad range of cable shielding products. This includes tubular cable shields for coaxial cables and rectangular cores for flat ribbon cables as well as split types for retro-fit solutions with the proper accessories. These products provide a high level of impedance over a wide frequency range and allow EMI-suppression techniques to be used on both internal and external cabling in electronic equipment.

Ordering code: SAMPLEBOX10

EMI-suppression Products box

Contains leaded cores for automatic insertion in PCB's with different design configurations, plus beads and multihole cores in several materials, specially developed for interference applications, and ranging from small to large sizes to cover the different mechanical requirements for the particular design.

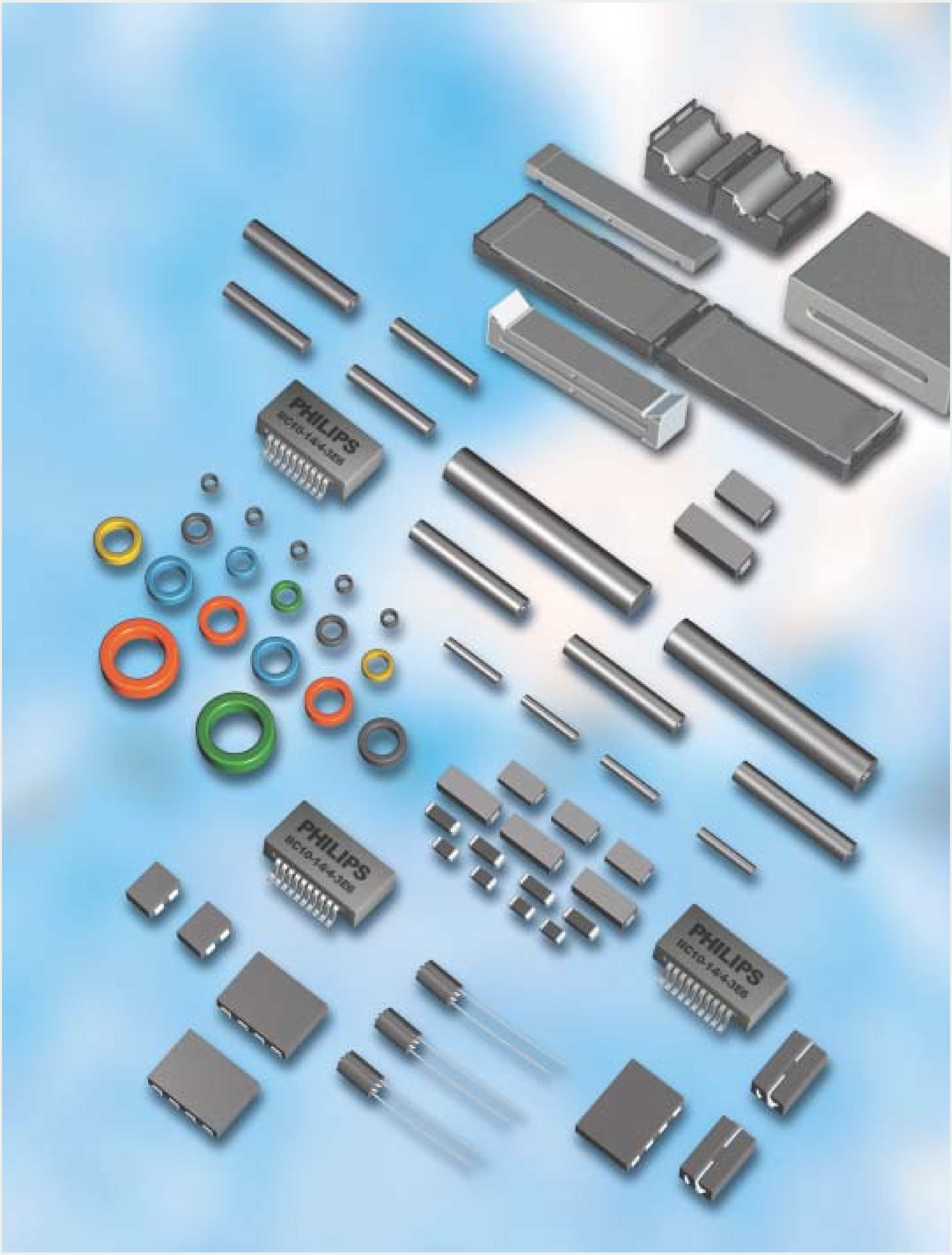
Ordering code: SAMPLEBOX11

Multilayer Suppressors box

Contains a selection of suppressors in 4 different sizes: 0603, 0805, 1206 and 1806.

Ordering code: SAMPLEBOX12

All sample boxes come with a specific brochure with all necessary information about product types, product description, location of the components and electrical performance and characteristics.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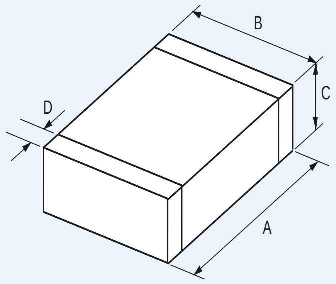
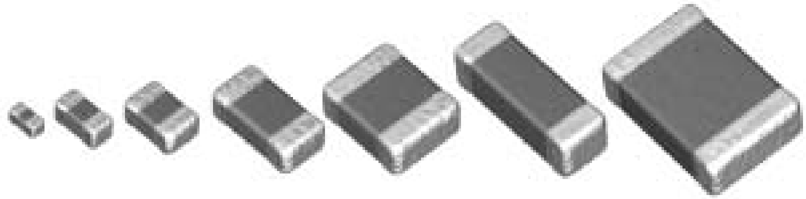
Multilayer Suppressors





Multilayer products are truly miniature components and have connecting surfaces that solder directly to the solder lands on a substrate. The multilayer electrode and terminations are made of silver to ensure high electrical conductivity. The electrode is embedded in a ferrite monolithic structure, which provides a good magnetic shielding and makes it very appropriate for high density mounting.
Multilayer suppressors are a powerful solution for EMI/RFI attenuation in a variety of electronic equipment.
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 where this is difficult to achieve. Typical suppression frequencies range from 10MHz to 1000MHz and rated currents are 0.1 and 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.

Features:

- Monolithic structure for closed magnetic path and high reliability.
- Standard EIA and EIAJ sizes: 0402, 0603, 0805, 1206, 1210, 1806, 1812.
- This multilayer chip suppressor results in magnetic shielding: the absence of leakage flux makes it most suitable for high density mounting.
- Suitable for wave and reflow soldering.
- Wide range of impedance values.
- Superior physical properties.
- Available in standard EIA and EIAJ tape-and-reel.
- Operating temperature -40ºC to +125ºC.
- 100% sorting out on impedance.

Size	A (mm)	B (mm)	C (mm)	D (mm)	mass (mg)
0402	1.0 ± 0.15	0.50 ± 0.15	0.50 ± 0.15	0.25 ± 0.15	≈ 1
0603	1.6 ± 0.20	0.80 ± 0.15	0.80 ± 0.15	0.40 ± 0.20	≈ 5
0805	2.0 ± 0.20	1.25 ± 0.20	0.90 ± 0.20	0.50 ± 0.30	≈ 11
1206	3.2 ± 0.20	1.60 ± 0.20	1.10 ± 0.20	0.50 ± 0.30	≈ 28
1210	3.2 ± 0.20	2.50 ± 0.20	1.30 ± 0.20	0.50 ± 0.30	≈ 50
1806	4.5 ± 0.25	1.60 ± 0.20	1.60 ± 0.20	0.50 ± 0.30	≈ 55
1812	4.5 ± 0.25	3.20 ± 0.20	1.50 ± 0.20	0.50 ± 0.30	≈ 100

- **M**ulti-**L**ayer **S**uppressor : **MLS 0603-4S4-600**
  1 2 3 4

1. Product type
2. Size
3. Internal code
4. Impedance value

- **M**ulti-**L**ayer **P**ower bead : **MLP 1806-151**
  1 2 3

1. Product type
2. Size
3. Impedance value

- **M**ulti-**L**ayer **N**arrow band : **MLN 1206-201**
  1 2 3

1. Product type
2. Size
3. Impedance value

Impedance value

- Expressed in ohm (Ω).
- First two digits are significant figures.
- Last digit is the number of zeros to follow.
- Examples:

070	7 Ω
600	60 Ω
101	100 Ω
151	150 Ω
152	1500 Ω
102	1000 Ω

Tolerance:
Standard products have a tolerance on impedance of ±25%.

Multilayer Suppressor - MLS (general purpose)

Type Number	Size	Z±25% at 100 MHz (Ω)	R_{DCmax} (Ω)	I_{max} (mA)
MLS0402-4S4-060	0402	6	0.05	500
MLS0402-4S4-100	0402	10	0.05	500
MLS0402-4S4-400	0402	40	0.3	300
MLS0402-4S4-800	0402	80	0.4	200
MLS0402-4S4-121	0402	120	0.5	200
MLS0402-4S4-241	0402	240	0.5	200
MLS0402-4S4-481	0402	480	0.8	100
MLS0603-4S4-110	0603	11	0.05	500
MLS0603-4S4-190	0603	19	0.08	500
MLS0603-4S7-300	0603	30	0.1	400
MLS0603-4S7-400	0603	40	0.1	400
MLS0603-4S7-600	0603	60	0.1	300
MLS0603-4S7-800	0603	80	0.15	300
MLS0603-4S7-101	0603	100	0.25	250
MLS0603-4S7-121	0603	120	0.3	250
MLS0603-4S7-151	0603	150	0.3	250
MLS0603-4S7-221	0603	220	0.3	200
MLS0603-4S7-301	0603	300	0.35	230
MLS0603-4S7-451	0603	450	0.5	200
MLS0603-4S7-601	0603	600	0.45	210
MLS0603-4S7-751	0603	750	0.7	200
MLS0603-4S7-102	0603	1000	0.6	190
MLS0603-4S4-152	0603	1500	1	50
MLS0805-4S4-070	0805	7	0.1	600
MLS0805-4S4-090	0805	9	0.1	600
MLS0805-4S4-110	0805	11	0.1	600
MLS0805-4S4-170	0805	17	0.1	500
MLS0805-4S4-300	0805	30	0.1	600
MLS0805-4S4-600	0805	60	0.1	600
MLS0805-4S7-700	0805	70	0.15	500
MLS0805-4S7-800	0805	80	0.15	500
MLS0805-4S7-121	0805	120	0.2	400
MLS0805-4S7-151	0805	150	0.25	200
MLS0805-4S7-221	0805	220	0.3	300
MLS0805-4S7-301	0805	300	0.3	200
MLS0805-4S7-401	0805	400	0.3	300
MLS0805-4S7-501	0805	500	0.4	300
MLS0805-4S7-601	0805	600	0.3	200
MLS0805-4S4-751	0805	750	0.5	200
MLS0805-4S7-102	0805	1000	0.5	200
MLS0805-4S7-152	0805	1500(1)	0.6	200
MLS0805-4S4-202	0805	2000	0.8	100
MLS1206-4S4-190	1206	19	0.05	600
MLS1206-4S4-260	1206	26	0.05	600
MLS1206-4S4-300	1206	30	0.1	600
MLS1206-4S4-500	1206	50	0.1	500
MLS1206-4S4-600	1206	60	0.1	500
MLS1206-4S4-700	1206	70	0.1	600
MLS1206-4S4-900	1206	90	0.15	500
MLS1206-4S4-121	1206	120	0.15	500
MLS1206-4S4-151	1206	150	0.15	500
MLS1206-4S4-201	1206	200	0.2	400
MLS1206-4S4-401	1206	400	0.2	400
MLS1206-4S4-501	1206	500	0.2	400
MLS1206-4S4-601	1206	600	0.3	400
MLS1206-4S7-102	1206	1000	0.4	200
MLS1206-4S7-122	1206	1200(1)	0.4	200
MLS1206-4S7-202	1206	2000(2)	0.6	200
MLS1210-4S4-320	1210	32	0.2	500
MLS1210-4S4-600	1210	60	0.2	500
MLS1210-4S4-900	1210	90	0.2	500
MLS1806-4S4-500	1806	50	0.2	600
MLS1806-4S4-600	1806	60	0.2	600
MLS1806-4S4-800	1806	80	0.1	600
MLS1806-4S4-101	1806	100	0.3	500
MLS1806-4S4-151	1806	150	0.2	500
MLS1806-4S4-171	1806	170	0.3	500
MLS1812-4S4-700	1812	70	0.3	500
MLS1812-4S4-121	1812	120	0.3	500

(1) at 50 MHz
(2) at 30 MHz

- 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 can be provided upon request.
- Operating temperature: -40°C to +125°C.

Multilayer Suppressors

Multilayer Power Beads - MLP (high current)

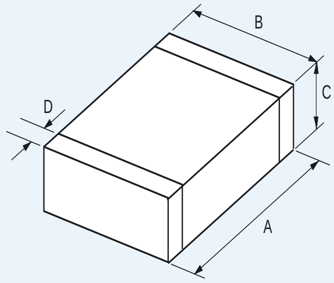
Type Number	Size	Z±25% at 100 MHz (Ω)	R_{DCmax} (Ω)	I_{max} (mA)
MLP0603-110	0603	11	0.02	4000
MLP0603-250	0603	25	0.03	3000
MLP0603-400	0603	40	0.035	3000
MLP0603-600	0603	60	0.04	2500
MLP0603-121	0603	120	0.05	1800
MLP0603-301	0603	300	0.1	2000
MLP0603-501	0603	500	0.15	1500
MLP0603-601	0603	600	0.2	1000
MLP0603-102	0603	1000	0.25	800
MLP0805-110	0805	11	0.01	6000
MLP0805-170	0805	17	0.02	5000
MLP0805-300	0805	30	0.02	4000
MLP0805-600	0805	60	0.03	3000
MLP0805-800	0805	80	0.04	3000
MLP0805-121	0805	120	0.04	3000
MLP0805-201	0805	200	0.05	2500
MLP0805-301	0805	300	0.08	2000
MLP0805-601	0805	600	0.1	2000
MLP0805-102	0805	1000	0.12	1500
MLP1206-190	1206	19	0.015	6000
MLP1206-320	1206	32	0.015	4000
MLP1206-500	1206	50	0.02	4000
MLP1206-700	1206	70	0.025	3000
MLP1206-800	1206	80	0.025	3000
MLP1206-101	1206	100	0.03	2500
MLP1206-301	1206	300	0.06	2000
MLP1206-601	1206	600	0.1	1800
MLP1206-102	1206	1000 (1)	0.15	1500
MLP1206-122	1206	1200 (1)	0.18	1500
MLP1206-152	1206	1500 (1)	0.2	1200
MLP1210-600	1210	60	0.025	4000
MLP1210-900	1210	90	0.025	3000
MLP1806-500	1806	50	0.02	6000
MLP1806-600	1806	60	0.02	5000
MLP1806-800	1806	80	0.025	4000
MLP1806-151	1806	150	0.1	2000
MLP1812-700	1812	70	0.03	6000
MLP1812-121	1812	120	0.03	4000

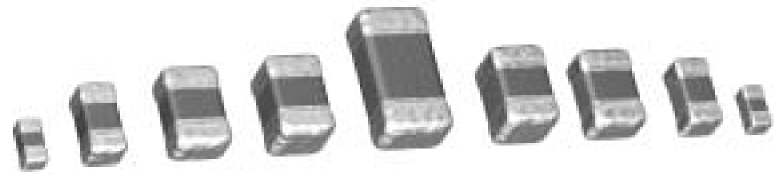
(1) at 50 MHz

Multilayer Narrow Band - MLN

Type Number	Size	Z±25% at 100 MHz (Ω)	R_{DCmax} (Ω)	I_{max} (mA)
MLN0603-060	0603	6	0.05	500
MLN0603-100	0603	10	0.07	400
MLN0603-400	0603	40	0.30	300
MLN0603-800	0603	80	0.40	300
MLN0603-121	0603	120	0.40	300
MLN0603-241	0603	240	0.40	200
MLN0603-301	0603	300	0.50	200
MLN0603-481	0603	480	0.60	150
MLN0603-601	0603	600	0.60	100
MLN0805-060	0805	6	0.07	800
MLN0805-110	0805	11	0.10	700
MLN0805-260	0805	26	0.20	600
MLN0805-320	0805	32	0.20	600
MLN0805-600	0805	60	0.30	500
MLN0805-750	0805	75	0.30	500
MLN0805-900	0805	90	0.30	500
MLN0805-121	0805	120	0.40	400
MLN0805-151	0805	150	0.40	400
MLN0805-171	0805	170	0.50	400
MLN0805-221	0805	220	0.50	300
MLN0805-301	0805	300	0.50	300
MLN0805-401	0805	400	0.50	300
MLN0805-501	0805	500	0.50	200
MLN0805-601	0805	600	0.50	200
MLN0805-102	0805	1000	0.60	100
MLN0805-122	0805	1200	0.70	100
MLN0805-152	0805	1500	0.70	100
MLN1206-320	1206	32	0.20	600
MLN1206-600	1206	60	0.30	500
MLN1206-800	1206	80	0.30	500
MLN1206-900	1206	90	0.30	500
MLN1206-121	1206	120	0.40	400
MLN1206-151	1206	150	0.40	400
MLN1206-201	1206	200	0.50	300
MLN1206-221	1206	220	0.50	300
MLN1206-351	1206	350	0.60	300
MLN1206-401	1206	400	0.60	300
MLN1206-601	1206	600	0.80	300
MLN1206-122	1206	1200	1.00	200

Multilayer Inductors





Multilayer products are truly miniature components and have connecting surfaces that solder directly to the solder lands on a substrate. The multilayer electrode and terminations are made of silver to ensure high electrical conductivity. The electrode is embedded in a ferrite monolithic structure, which provides a good magnetic shielding and makes it very appropriate for high density mounting.

Our range of multilayer chip inductors offers magnetic shielding, in five standard sizes (0402, 0603, 0805, 080505 and 1206), which are specially designed for electronic products. It offers minimum flux leakage thus eliminating cross talk. They have inductances between 1 nH and 18 µH.

Features:

- Monolithic structure for closed magnetic path and high reliability.
- Standard EIA and EIAJ sizes: 0402, 0603, 0805, 080505, 1206.
- This multilayer chip inductor results in magnetic shielding: the absence of leakage flux makes it most suitable for high density mounting.
- Suitable for wave and reflow soldering.
- Wide range of inductance values.
- Superior physical properties.
- Available in standard EIA and EIAJ tape-and-reel.
- Operating temperature -40ºC to +125ºC.
- 100% sorting out on inductance.

Multilayer Inductor MLI

Size	A (mm)	B (mm)	C (mm)	D (mm)	mass (mg)
0603	1.6 ± 0.15	0.80 ± 0.15	0.80 ± 0.15	0.30 ± 0.20	≈ 5
0805	2.0 ± 0.20	1.25 ± 0.20	0.90 ± 0.20	0.50 ± 0.30	≈ 11
080505	2.0 ± 0.20	1.25 ± 0.20	1.25 ± 0.20	0.50 ± 0.30	≈ 15
1206	3.2 ± 0.20	1.60 ± 0.20	1.10 ± 0.20	0.50 ± 0.30	≈ 28

Multilayer Inductor MLH

Size	A (mm)	B (mm)	C (mm)	D (mm)	mass (mg)
0402	1.0 ± 0.15	0.50 ± 0.15	0.50 ± 0.15	0.25 ± 0.15	≈ 1
0603	1.6 ± 0.20	0.80 ± 0.15	0.80 ± 0.15	0.30 ± 0.20	≈ 5
0805	2.0 ± 0.20	1.25 ± 0.20	*	0.50 ± 0.30	≈ 11

* NOTE:
for types L < 180 nH 0.90 ± 0.20
for types L ≥ 180 nH 1.20 ± 0.30

- **MultiLayer Inductor: MLI 0805-R68-10**
  1 2 3 4

1. Product type
2. Size
3. Inductance value
4. Tolerance (%)

- **MultiLayer inductor High frequency: MLH 0402-4N7-03**
  1 2 3 4

1. Product type
2. Size
3. Inductance value
4. Tolerance

Inductance value:

- Expressed in nH or µH
- Three different methods to indicate value:

4N7	4.7 nH
82N	82 nH
R10	0.10 µH
1R8	1.8 µH
820	82 µH
151	150 µH

Tolerance:

- Last two digits represent tolerance: ‘05’, ‘10’ or ‘20’ in %
- In MLH ‘03’ = ± 0.3 nH in absolute value, ‘5’ = ± 5% in percentage.

Multilayer Inductors - MLI (general purpose)

Type Number	L(μH)	L tol.	Q min	L,Q test f (MHz)	SRF min (MHz)	R_{DC} max (Ω)	I max (mA)
MLI0603-47N-20	0.047	±20%	20	50	260	0.3	50
MLI0603-68N-20	0.068	±20%	20	50	250	0.3	50
MLI0603-82N-20	0.082	±20%	20	50	245	0.3	50
MLI0603-R10-10	0.1	±10%	30	25	240	0.5	50
MLI0603-R12-10	0.12	±10%	30	25	205	0.5	50
MLI0603-R15-10	0.15	±10%	30	25	180	0.6	50
MLI0603-R18-10	0.18	±10%	30	25	165	0.6	50
MLI0603-R22-10	0.22	±10%	30	25	150	0.8	50
MLI0603-R27-10	0.27	±10%	30	25	136	0.8	50
MLI0603-R33-10	0.33	±10%	30	25	125	0.85	35
MLI0603-R39-10	0.39	±10%	30	25	110	1	35
MLI0603-R47-10	0.47	±10%	30	25	105	1.35	35
MLI0603-R56-10	0.56	±10%	30	25	95	1.55	35
MLI0603-R68-10	0.68	±10%	30	25	85	1.7	35
MLI0603-R82-10	0.82	±10%	30	25	75	2.1	35
MLI0603-1R0-10	1.0	±10%	35	10	65	0.6	25
MLI0603-1R2-10	1.2	±10%	35	10	60	0.8	25
MLI0603-1R5-10	1.5	±10%	35	10	55	0.8	25
MLI0603-1R8-10	1.8	±10%	35	10	50	0.95	25
MLI0603-2R2-10	2.2	±10%	35	10	45	1.15	15
MLI0603-2R7-10	2.7	±10%	35	10	40	1.35	15
MLI0603-3R3-10	3.3	±10%	35	10	38	1.55	15
MLI0603-3R9-10	3.9	±10%	35	10	36	1.7	15
MLI0603-4R7-10	4.7	±10%	35	10	33	2.1	15
MLI0603-5R6-10	5.6	±10%	35	4	22	1.55	5
MLI0603-6R8-10	6.8	±10%	35	4	20	1.7	5
MLI0603-8R2-10	8.2	±10%	30	4	18	2.1	5
MLI0603-100-10	10	±10%	30	2	17	2.55	5
MLI0805-47N-20	0.047	±20%	25	50	320	0.2	300
MLI0805-68N-20	0.068	±20%	25	50	280	0.2	300
MLI0805-82N-20	0.082	±20%	25	50	255	0.2	300
MLI0805-R10-10	0.1	±10%	30	25	235	0.3	250
MLI0805-R12-10	0.12	±10%	30	25	220	0.3	250
MLI0805-R15-10	0.15	±10%	30	25	200	0.4	250
MLI0805-R18-10	0.18	±10%	30	25	185	0.4	250
MLI0805-R22-10	0.22	±10%	30	25	170	0.5	250
MLI0805-R27-10	0.27	±10%	30	25	150	0.5	250
MLI0805-R33-10	0.33	±10%	30	25	145	0.55	250
MLI0805-R39-10	0.9	±10%	30	25	135	0.65	250
MLI0805-R47-10	0.47	±10%	30	25	125	0.65	250
MLI0805-R56-10	0.56	±10%	30	25	115	0.75	150
MLI0805-R68-10	0.68	±10%	30	25	105	0.8	150
MLI0805-R82-10	0.82	±10%	30	25	100	1	150
MLI0805-1R0-10	1.0	±10%	45	10	75	0.45	50
MLI0805-1R2-10	1.2	±10%	45	10	65	0.5	50
MLI0805-1R5-10	1.5	±10%	45	10	60	0.5	50
MLI0805-1R8-10	1.8	±10%	45	10	55	0.6	50
MLI0805-2R2-10	2.2	±10%	45	10	50	0.65	30
MLI080505-2R7-10	2.7	±10%	45	10	45	0.75	30
MLI080505-3R3-10	3.3	±10%	45	10	41	0.8	30
MLI080505-3R9-10	3.9	±10%	45	10	38	0.9	30
MLI080505-4R7-10	4.7	±10%	45	10	35	1	30
MLI080505-5R6-10	5.6	±10%	45	4	32	0.9	15
MLI080505-6R8-10	6.8	±10%	45	4	29	1	15
MLI080505-8R2-10	8.2	±10%	45	4	26	1.1	15
MLI080505-100-10	10	±10%	45	2	24	1.15	15
MLI080505-120-10	12	±10%	45	2	22	1.25	15
MLI080505-150-10	15	±10%	30	1	19	0.8	5
MLI080505-180-10	18	±10%	30	1	18	0.9	5
MLI1206-47N-20	0.047	±20%	25	50	320	0.15	300
MLI1206-68N-20	0.068	±20%	25	50	280	0.25	300
MLI1206-R10-10	0.1	±10%	30	25	235	0.25	250
MLI1206-R12-10	0.12	±10%	30	25	220	0.3	250
MLI1206-R15-10	0.15	±10%	30	25	200	0.3	250
MLI1206-R18-10	0.18	±10%	30	25	185	0.4	250
MLI1206-R22-10	0.22	±10%	30	25	170	0.4	250
MLI1206-R27-10	0.27	±10%	30	25	150	0.5	250
MLI1206-R33-10	0.33	±10%	30	25	145	0.6	250
MLI1206-R39-10	0.39	±10%	30	25	135	0.5	200
MLI1206-R47-10	0.47	±10%	30	25	125	0.6	200
MLI1206-R56-10	0.56	±10%	30	25	115	0.7	150
MLI1206-R68-10	0.68	±10%	30	25	105	0.8	150
MLI1206-R82-10	0.82	±10%	30	25	100	0.9	150
MLI1206-1R0-10	1.0	±10%	45	10	110	0.4	100
MLI1206-1R2-10	1.2	±10%	45	10	100	0.5	100
MLI1206-1R5-10	1.5	±10%	45	10	90	0.5	80
MLI1206-1R8-10	1.8	±10%	45	10	80	0.5	70
MLI1206-2R2-10	2.2	±10%	45	10	70	0.6	60
MLI1206-2R7-10	2.7	±10%	45	10	70	0.6	60
MLI1206-3R3-10	3.3	±10%	45	10	60	0.7	60
MLI1206-3R9-10	3.9	±10%	45	10	55	0.8	50
MLI1206-4R7-10	4.7	±10%	45	10	50	0.9	50
MLI1206-5R6-10	5.6	±10%	45	4	32	0.7	25
MLI1206-6R8-10	6.8	±10%	45	4	29	0.8	25
MLI1206-8R2-10	8.2	±10%	45	4	26	0.9	25
MLI1206-100-10	10	±10%	45	2	24	1	25
MLI1206-120-10	12	±10%	45	2	22	1.05	15
MLI1206-150-10	15	±10%	35	1	19	0.7	5
MLI1206-180-10	18	±10%	35	1	18	0.75	5

- R_{DC}: Resistance of component for DC current.
- Maximum rated current: measure of current capacity of the component.
- Other tolerances can be provided upon request.
- Operating temperature: -40°C to +125°C.

Multilayer Inductors

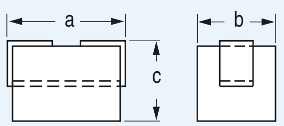
Multilayer Inductors - MLH (high frequency)

Type Number	L (nH) 100 MHz	L tol.	Q min 100 MHz	Q typ 100 MHz	Q typ 800 MHz	SRF min (MHz)	R_{DC} max (Ω)	I max (mA)
MLH0402-1N0-03	1.0	±0.3	8	9	28	6000	0.10	300
MLH0402-1N2-03	1.2	±0.3	8	9	28	6000	0.10	300
MLH0402-1N5-03	1.5	±0.3	8	10	28	6000	0.10	300
MLH0402-1N8-03	1.8	±0.3	8	10	28	6000	0.10	300
MLH0402-2N2-03	2.2	±0.3	8	10	29	6000	0.12	300
MLH0402-2N7-03	2.7	±0.3	8	11	30	6000	0.12	300
MLH0402-3N3-03	3.3	±0.3	8	11	30	5200	0.15	300
MLH0402-3N9-03	3.9	±0.3	8	11	31	5150	0.15	300
MLH0402-4N7-03	4.7	±0.3	8	11	31	4800	0.18	300
MLH0402-5N6-03	5.6	±0.3	8	11	31	4100	0.20	300
MLH0402-6N8-5	6.8	±5%	8	11	33	3800	0.25	300
MLH0402-8N2-5	8.2	±5%	8	12	32	3500	0.25	300
MLH0402-10N-5	10.0	±5%	8	12	32	3300	0.30	300
MLH0402-12N-5	12.0	±5%	8	12	31	2600	0.30	300
MLH0402-15N-5	15.0	±5%	8	12	30	2300	0.40	300
MLH0402-18N-5	18.0	±5%	8	12	29	2050	0.50	300
MLH0402-22N-5	22.0	±5%	8	12	28	1900	0.60	300
MLH0402-27N-5	27.0	±5%	8	12	27	1700	0.70	300
MLH0402-33N-5	33.0	±5%	8	10	25	1550	1.5	200
MLH0402-39N-5	39.0	±5%	8	10	25	1450	1.8	200
MLH0402-47N-5	47.0	±5%	8	9	22	1300	2.0	200
MLH0402-56N-5	56.0	±5%	8	10	21	1250	2.0	200
MLH0603-1N0-03	1.0	±0.3	10	12	50	6000	0.10	500
MLH0603-1N2-03	1.2	±0.3	10	13	65	6000	0.10	500
MLH0603-1N5-03	1.5	±0.3	10	13	47	6000	0.10	500
MLH0603-1N8-03	1.8	±0.3	10	13	51	6000	0.10	500
MLH0603-2N2-03	2.2	±0.3	11	13	46	6000	0.10	500
MLH0603-2N7-03	2.7	±0.3	11	13	45	6000	0.10	500
MLH0603-3N3-03	3.3	±0.3	11	13	51	5900	0.12	500
MLH0603-3N9-03	3.9	±0.3	11	13	52	5600	0.14	500
MLH0603-4N7-03	4.7	±0.3	11	13	41	4800	0.16	500
MLH0603-5N6-5	5.6	±0.3	11	13	41	4350	0.18	500
MLH0603-6N8-5	6.8	±5%	11	13	44	3750	0.22	500
MLH0603-8N2-5	8.2	±5%	11	13	44	3300	0.24	500
MLH0603-10N-5	10.0	±5%	11	13	45	2850	0.26	400
MLH0603-12N-5	12.0	±5%	13	15	46	2500	0.28	400
MLH0603-15N-5	15.0	±5%	13	15	48	2150	0.32	400
MLH0603-18N-5	18.0	±5%	13	15	48	2100	0.35	400
MLH0603-22N-5	22.0	±5%	15	17	45	1850	0.40	400
MLH0603-27N-5	27.0	±5%	15	17	43	1680	0.45	400
MLH0603-33N-5	33.0	±5%	15	18	39	1580	0.55	400
MLH0603-39N-5	39.0	±5%	15	18	37(1)	1400	0.60	300
MLH0603-47N-5	47.0	±5%	15	18	35(1)	1200	0.70	300
MLH0603-56N-5	56.0	±5%	15	18	32(1)	1100	0.75	300
MLH0603-68N-5	68.0	±5%	15	18	34(1)	1050	0.85	300
MLH0603-82N-5	82.0	±5%	15	18	32(1)	900	1.0	300
MLH0603-R10-5	100	±5%	15	18	20(1)	850	1.2	300
MLH0603-R12-5	120	±5%	8(3)	16(3)	23(2)	730	1.6	250
MLH0603-R15-5	150	±5%	8(3)	14(3)	23(2)	650	2.0	250
MLH0603-R18-5	180	±5%	8(3)	14(3)	21(2)	570	2.4	250
MLH0603-R22-5	220	±5%	8(3)	13(3)	20(2)	530	2.8	200
MLH0805-1N5-03	1.5	±0.3	11	13	40	6000	0.10	500
MLH0805-1N8-03	1.8	±0.3	11	13	45	6000	0.10	500
MLH0805-2N2-03	2.2	±0.3	11	13	48	6000	0.10	500
MLH0805-2N7-03	2.7	±0.3	11	13	40	6000	0.10	500
MLH0805-3N3-03	3.3	±0.3	13	15	56	6000	0.13	500
MLH0805-3N9-03	3.9	±0.3	13	15	54	5400	0.15	500
MLH0805-4N7-03	4.7	±0.3	13	15	50	4500	0.20	500
MLH0805-5N6-03	5.6	±0.3	13	15	53	4000	0.23	500
MLH0805-6N8-5	6.8	±5%	13	15	51	3650	0.25	500
MLH0805-8N2-5	8.2	±5%	13	15	53	3000	0.28	500
MLH0805-10N-5	10.0	±5%	14	16	45	2500	0.30	500
MLH0805-12N-5	12.0	±5%	14	16	48	2450	0.35	400
MLH0805-15N-5	15.0	±5%	15	17	48	2000	0.40	400
MLH0805-18N-5	18.0	±5%	15	17	43	1750	0.45	400
MLH0805-22N-5	22.0	±5%	15	17	47	1700	0.50	400
MLH0805-27N-5	27.0	±5%	16	18	38	1550	0.55	400
MLH0805-33N-5	33.0	±5%	17	19	35	1350	0.60	400
MLH0805-39N-5	39.0	±5%	19	21	40	1300	0.65	400
MLH0805-47N-5	47.0	±5%	19	21	38	1200	0.70	400
MLH0805-56N-5	56.0	±5%	16	21	31	1150	0.75	400
MLH0805-68N-5	68.0	±5%	19	21	28	1000	0.80	400
MLH0805-82N-5	82.0	±5%	20	22	16	850	0.90	400
MLH0805-R10-5	100	±5%	21	23	-	730	1.0	400
MLH0805-R12-5	120(3)	±5%	13(3)	22	-	650	1.2	300
MLH0805-R15-5	150(3)	±5%	13(3)	22	-	550	1.4	300
MLH0805-R18-5	180(3)	±5%	13(3)	23	-	500	1.6	300
MLH0805-R22-5	220(3)	±5%	12(3)	20	-	450	1.8	300
MLH0805-R27-5	270(3)	±5%	12(3)	20	-	400	2.0	300
MLH0805-R33-5	330(3)	±5%	12(3)	22	-	380	3.0	300
MLH0805-R39-5	390(3)	±5%	10(3)	17	-	330	3.5	300
MLH0805-R47-5	470(3)	±5%	10(3)	17	-	300	4.0	300

(1) at 500 MHz
(2) at 300 MHz
(3) at 50 MHz

EMI-suppression products

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) 1)		

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) 1)		

BDS3/3/4.6-3S1		
a	b	c
4.6 ± 0.3	3.05 ± 0.15	3 max
|Z| typ = 45 Ω (10 MHz) 1)		

BDS3/3/4.6-4S2		
a	b	c
4.6 ± 0.3	3.05 ± 0.15	3 max
|Z| typ = 50 Ω (100 MHz) 1)		

BDS3/3/8.9-3S1		
a	b	c
8.9 ± 0.35	3.05 ± 0.15	3 max
|Z| typ = 80 Ω (10 MHz) 2)		

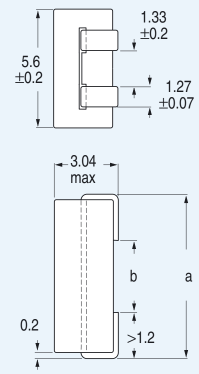
BDS4.6/3/8.9-4S2		
a	b	c
8.9 ± 0.35	4.6 ± 0.3	3 max
|Z| typ = 100 Ω (100 MHz) 2)		

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 60068-2-58.

Taping method IEC 60286-3, EIA 481-1 and 481-2.

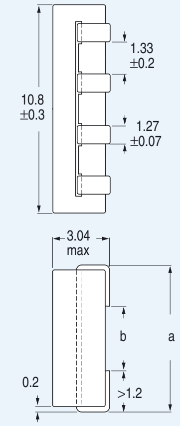
1) DC resistance < 0.6 mΩ
2) DC resistance < 1.0 mΩ

SMD common mode chokes



CMS2-5.6/3/4.8-4S2
a = 4.75 ± 0.3 and b > 1.1
|Z| typ = 35 Ω (100 MHz)
CMS2-5.6/3/8.9-4S2
a = 8.9 – 0.5 and b > 5
|Z| typ = 60 Ω (100 MHz)

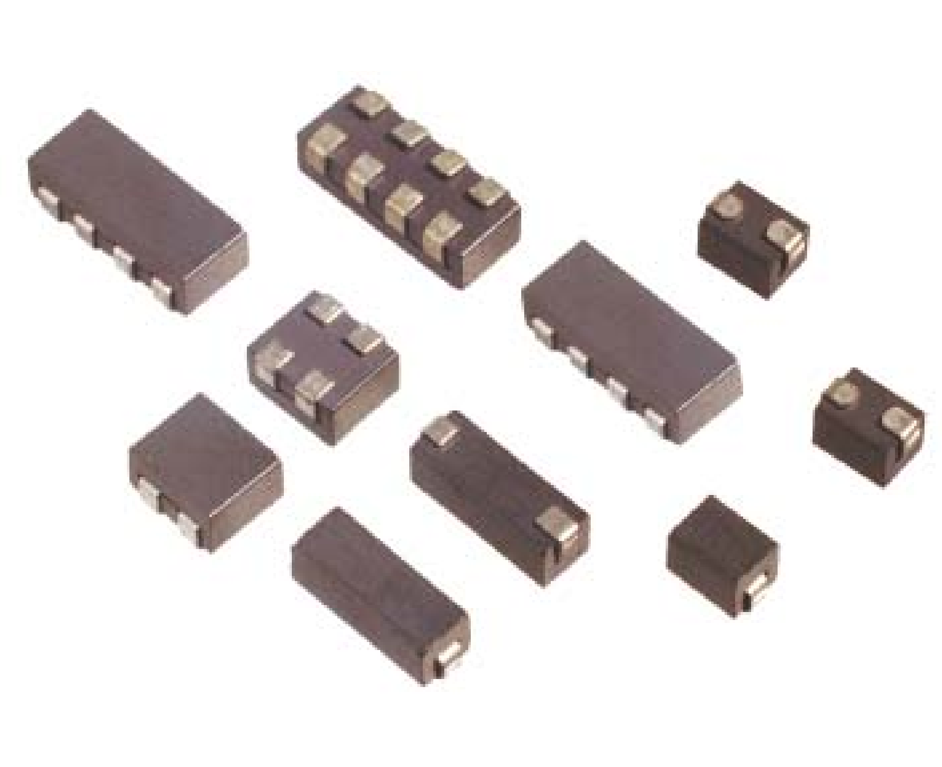
In SMD Common mode chokes 2 or 4 conductors within a single soft-ferrite block are connected along their lengths by an air gap. Common-mode signals - interference signals passing in the same direction along the input and output channels of a device (an IC for instance) - reinforce the magnetic flux around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



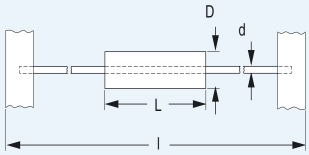
CMS4-11/3/4.8-4S2	
a = 4.75 ± 0.3 and b > 1.1	
inner channel	|Z| typ = 23 Ω (100 MHz)
outer channel	|Z| typ = 30 Ω (100 MHz)
CMS4-11/3/8.9-4S2	
a = 8.9 – 0.5 and b > 5	
inner channel	|Z| typ = 45 Ω (100 MHz)
outer channel	|Z| typ = 60 Ω (100 MHz)

The wire is presoldered and complies with solderability test TA (method 1) in IEC 60068-2-58.

Taping method IEC 60286-3, EIA 481-1-A and 481-2.



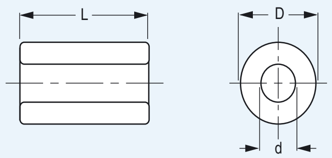
Beads on wire



Type Number	dimensions				|Z| typ (Ω) at 100 MHz
	D	L	l	d	
BDW3.5/3.5-4S2	3.5 ± 0.2	3.5 – 0.5	64.4	0.65	58
BDW3.5/4.7-4S2	3.5 ± 0.2	4.7 – 0.5	64.4	0.65	75
BDW3.5/5.3-4S2	3.5 ± 0.25	5.25 ± 0.25	64.4	0.64	82
BDW3.5/6-4S2	3.5 ± 0.2	6.0 ± 0.25	64.4	0.65	100
BDW3.5/6.7-4S2	3.5 ± 0.2	6.7 ± 0.25	64.4	0.65	110
BDW3.5/7.6-4S2	3.5 ± 0.2	7.6 ± 0.35	64.4	0.65	131
BDW3.5/8.9-4S2	3.5 ± 0.2	8.9 ± 0.35	64.4	0.65	146
BDW3.5/9.5-4S2	3.5 ± 0.25	9.5 ± 0.3	64.4	0.64	150
BDW3.5/11-4S2	3.5 ± 0.25	11.4 ± 0.4	64.4	0.64	180
BDW3.5/14-4S2	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 60286 part 1 and EIA-RS-96-D.

EMI-suppression beads



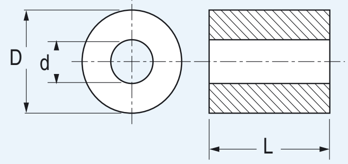
Type Number	dimensions			|Z| typ (Ω) at 10 MHz
	D	L	L	
BD3/0.7/4-3S1	3 ± 0.1	0.7 + 0.1	4 ± 0.2	49
BD3/1/10-3S1	3 ± 0.1	1 + 0.1/– 0.05	10 ± 0.3	91
BD5.1/0.8/4-3S1	5.1 – 0.3	0.75 + 0.1	4 ± 0.2	66
BD5.1/0.8/10-3S1	5.1 – 0.3	0.75 + 0.1	10 ± 0.3	160
BD5.1/1.5/4-3S1	5.1 – 0.3	1.5 + 0.15	4 ± 0.2	40
BD5.1/1.5/10-3S1	5.1 – 0.3	1.5 + 0.15	10 ± 0.3	100
BD5.1/2/4-3S1	5.1 – 0.3	2 + 0.2	4 ± 0.2	30
BD5.1/2/10-3S1	5.1 – 0.3	2 + 0.2	10 ± 0.3	76

Type Number	dimensions			|Z| typ (Ω) at 100 MHz
	D	L	L	
BD1.9/0.8/9.8-4S2	1.9 + 0.2	0.8 + 0.2	9.75 – 0.2	69
BD3/0.7/4-4S2	3 ± 0.1	0.7 + 0.1	4 ± 0.2	63
BD3/0.8/10-4S2	3 ± 0.1	0.75 + 0.1	10 ± 0.3	156
BD3/1/4-4S2	3 ± 0.1	1 + 0.1/– 0.05	4 ± 0.2	48
BD3/1/10-4S2	3 ± 0.1	1 + 0.1/– 0.05	10 ± 0.3	119
BD3.5/1.3/3.3-4S2	3.5 ± 0.2	1.3 ± 0.1	3.25 ± 0.25	40
BD3.5/1.3/6-4S2	3.5 ± 0.2	1.3 ± 0.1	6 ± 0.25	60
BD3.5/1.3/13-4S2	3.5 ± 0.2	1.3 ± 0.1	12.7 ± 0.35	125
BD5.1/0.8/4-4S2	5.1 – 0.3	0.75 + 0.1	4 ± 0.2	85
BD5.1/0.8/10-4S2	5.1 – 0.3	0.75 + 0.1	10 ± 0.3	213
BD5.1/1.5/4-4S2	5.1 – 0.3	1.5 + 0.15	4 ± 0.2	51
BD5.1/1.5/10-4S2	5.1 – 0.3	1.5 + 0.15	10 ± 0.3	130
BD5.1/2/4-4S2	5.1 – 0.3	2 + 0.2	4 ± 0.2	40
BD5.1/2/7.1-4S2	5.1 – 0.3	2 + 0.2	7.1 ± 0.2	78
BD5.1/2/10-4S2	5.1 – 0.3	2 + 0.2	10 ± 0.3	100
BD6.4/3/25-4S2	6.35 ± 0.15	2.95 + 0.45	25.4 ± 0.75	200
BD7.7/2.3/7.6-4S2	7.65 - 0.25	2.25 + 0.25	7.55 ± 0.25	92
BD8/1.5/4-4S2	8 ± 0.2	1.5 + 0.15	4 ± 0.2	71
BD8/1.5/10-4S2	8 ± 0.2	1.5 + 0.15	10 ± 0.3	181
BD8/2/4-4S2	8 ± 0.2	2 + 0.2	4 ± 0.2	61
BD8/2/10-4S2	8 ± 0.2	2 + 0.2	10 ± 0.3	151
BD8/3/4-4S2	8 ± 0.2	3 + 0.2	4 ± 0.2	43
BD8/3/10-4S2	8 ± 0.2	3 + 0.2	10 ± 0.3	106

Colour marking: 4S2 has a flash of yellow paint.

Cable Shields

Tubular Cable Shields



Type Number	dimensions			|Z| typ (Ω) at 100 MHz
	D	L	L	
CST7.8/5.3/9.8-3S4	7.8 ± 0.2	5.3 + 0.3	9.8 ± 0.2	50
CST8/5.3/10-3S4	8 – 0.4	5.3 + 0.3	10 – 0.4	50
CST8.3/3.5/10-3S4	8.3 – 0.4	3.5 + 0.3	10 – 0.6	96
CST9.5/4.8/4.8-4S2	9.5 ± 0.25	4.75 ± 0.25	4.8 ± 0.2	35
CST9.5/4.8/6.4-4S2	9.5 ± 0.25	4.75 ± 0.25	6.35 ± 0.35	50
CST9.5/4.8/9.5-4S2	9.5 ± 0.25	4.75 ± 0.15	9.5 ± 0.3	70
CST9.5/4.8/10-4S2	9.5 ± 0.25	4.75 ± 0.15	10.4 ± 0.25	80
CST9.5/4.8/13-4S2	9.5 ± 0.25	4.75 ± 0.15	12.7 ± 0.5	95
CST9.5/4.8/19-4S2	9.5 ± 0.25	4.75 ± 0.15	19.05 ± 0.7	145
CST9.5/5.1/15-3S4	9.5 ± 0.3	5.1 ± 0.15	14.5 ± 0.45	110
CST9.5/5.1/15-4S2	9.5 ± 0.3	5.1 ± 0.15	14.5 ± 0.45	110
CST9.7/5/5.1-4S2	9.65 ± 0.25	5 ± 0.2	5.05 – 0.45	43
CST14/6.4/5.3-4S2	14.3 ± 0.45	6.35 ± 0.25	5.3 -0.45	60
CST14/6.4/10-4S2	14.3 ± 0.45	6.35 ± 0.25	10.1 ± 0.4	105
CST14/6.4/14-4S2	14.3 ± 0.45	6.35 ± 0.25	13.8 ± 0.4	150
CST14/6.4/15-4S2	14.3 ± 0.45	6.35 ± 0.25	15 ± 0.45	170
CST14/6.4/29-4S2	14.3 ± 0.45	6.35 ± 0.25	28.6 ± 0.75	250
CST14/7.3/29-4S2	14.3 ± 0.45	7.25 ± 0.15	28.6 ± 0.75	215
CST16/7.9/14-4S2	16.25 -0.75	7.9 ± 0.25	14.3 ± 0.35	113
CST16/7.9/29-4S2	16.25 -0.75	7.9 ± 0.25	28.6 ± 0.75	213
CST17/9.5/13-3S4	17.45 ± 0.35	9.53 ± 0.25	12.7 ± 0.5	90
CST17/9.5/13-4S2	17.45 ± 0.4	9.5 ± 0.25	12.7 ± 0.5	88
CST17/9.5/29-3S4	17.45 ± 0.35	9.53 ± 0.25	28.55 ± 0.75	200
CST17/9.5/29-4S2	17.45 ± 0.35	9.53 ± 0.25	28.55 ± 0.75	250
CST17/11/60-3S4	17.2 – 1.2	11 ± 0.5	60 – 2.5	320
CST19/10/15-4S2	19 – 0.65	10.15 ± 0.25	14.65 -0.75	110
CST19/10/29-4S2	19 – 0.65	10.15 ± 0.25	28.6 ± 0.75	196
CST19/11/12-3S4	19 ± 0.4	10.6 ± 0.3	11.5 ± 0.4	75
CST26/13/21-4S2	25.9 ± 0.75	12.8 ± 0.25	21.3 ± 0.5	180
CST26/13/29-4S2	25.9 ± 0.75	12.8 ± 0.25	28.6 ± 0.8	225
CST29/19/7.5-4S2	29 ± 0.75	19 ± 0.5	7.5 ± 0.25	47

Cable Shields for Round Cable (split)

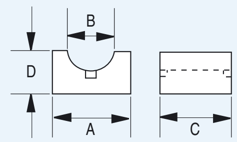


fig. 1

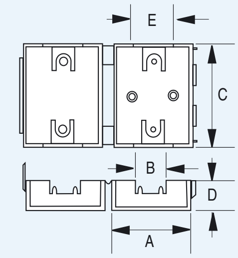


fig. 2

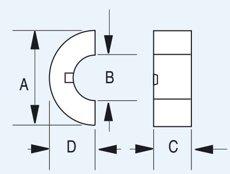


fig. 3

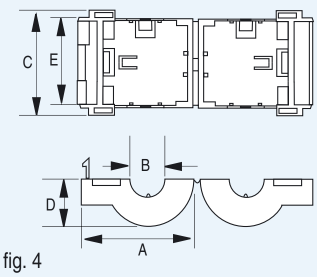


fig. 4

Type Number	fig. nr.	dimensions					|Z| typ (Ω) at 100 MHz
		A	B	C	D	E	
CSA15/7.5/29-4S2	2	15 ± 0.25	6.6 ± 0.3	28.6 ± 0.8	7.5 ± 0.15	-	275
CSA19/9.4/29-4S2	2	18.65 ± 0.4	10.15 ± 0.3	28.6 ± 0.8	9.4 ± 0.15	-	225
CSA26/13/29-4S2	2	25.9 ± 0.5	13.05 ± 0.3	28.6 ± 0.8	12.8 ± 0.25	-	250
CSC16/7.9/14-4S2	4	15.9 ± 0.4	7.9 ± 0.3	14.3 ± 0.4	7.95 ± 0.2	-	113
Round cable shields in matching nylon cases							
CSA15/7.5/29-4S2-EN	2+ 3	17.9	7.0	32.3	9.2	9.0	275
Nylon case	3	17.9	7.0	32.3	9.2	9.0	-
CSA19/9.4/29-4S2-EN	2+ 3	22.1	10.2	32.3	11.7	9.0	225
Nylon case	3	22.1	10.2	32.3	11.7	9.0	-
CSA26/13/29-4S2-EN	2+ 3	29	13.4	32.5	14.8	18.0	250
Nylon case	3	29	13.4	32.5	14.8	18.0	-
CSC16/7.9/14-4S2-EN	4+ 5	24.7	7.6	22.8	10.2	17.8	113
Nylon case	5	24.7	7.6	22.8	10.2	17.8	

Cable shields are ideal to suppress high frequency noise on cables. For maximum efficiency the ferrite should be placed as close as possible to the conductors. Therefore we offer several sizes to fit most standard round and flat cables. The split cable shields can be mounted with metal clips or nylon cases without removing connectors.

Cable Shields

Flat Cable Shields (split)

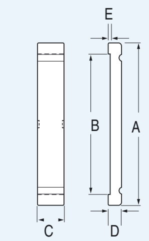


fig. 1

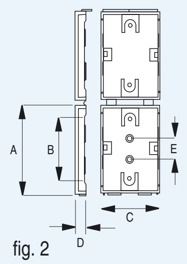


fig. 2

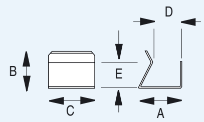


fig. 3

Type Number	fig. nr.	dimensions					|Z| typ (Ω) at 100 MHz
		A	B	C	D	E	
CSU45/6.4/29-4S2	1	45.1 ± 0.75	34.4 ± 0.7	28.6 ± 0.7	6.35 ± 0.25	0.85 ± 0.2	225
CSU76/6.4/13-3S4	1	76.2 ± 1.5	65.3 ± 1.3	12.7 ± 0.4	6.35 ± 0.25	0.85 ± 0.2	110
CSU76/6.4/15-3S4	1	76.2 ± 1.5	65.3 ± 1.3	15.0 ± 0.6	6.35 ± 0.25	0.85 ± 0.2	159
CSU76/6.4/29-4S2	1	76.2 ± 1.5	65.3 ± 1.3	28.6 ± 0.8	6.35 ± 0.25	0.85 ± 0.2	215
CSU76/6.4/29-3S4	1	76.2 ± 1.5	65.3 ± 1.3	28.6 ± 0.8	6.35 ± 0.25	0.85 ± 0.2	235
CLI-CSU6.4	3	16.1	11.0	12.7	11.4	8.0	-
Flat cable shields in matching nylon cases							
CSU45/6.4/29-4S2-EN	1+ 2	49.5	34.3	32.3	8.1	20	225
Nylon case	2	49.5	34.3	32.3	8.1	20	-
CSU76/6.4/29-4S2-EN	1+ 2	80.8	65.5	32.3	8.1	50.8	215
Nylon case	2	80.8	65.5	32.3	8.1	50.8	-

*) can be supplied with nylon case upon request

Flat Cable Shields

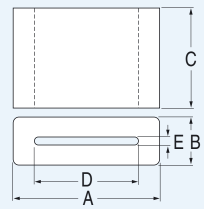


fig. 4

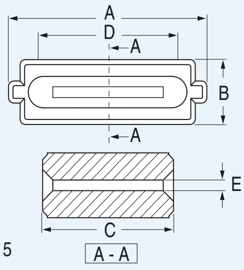
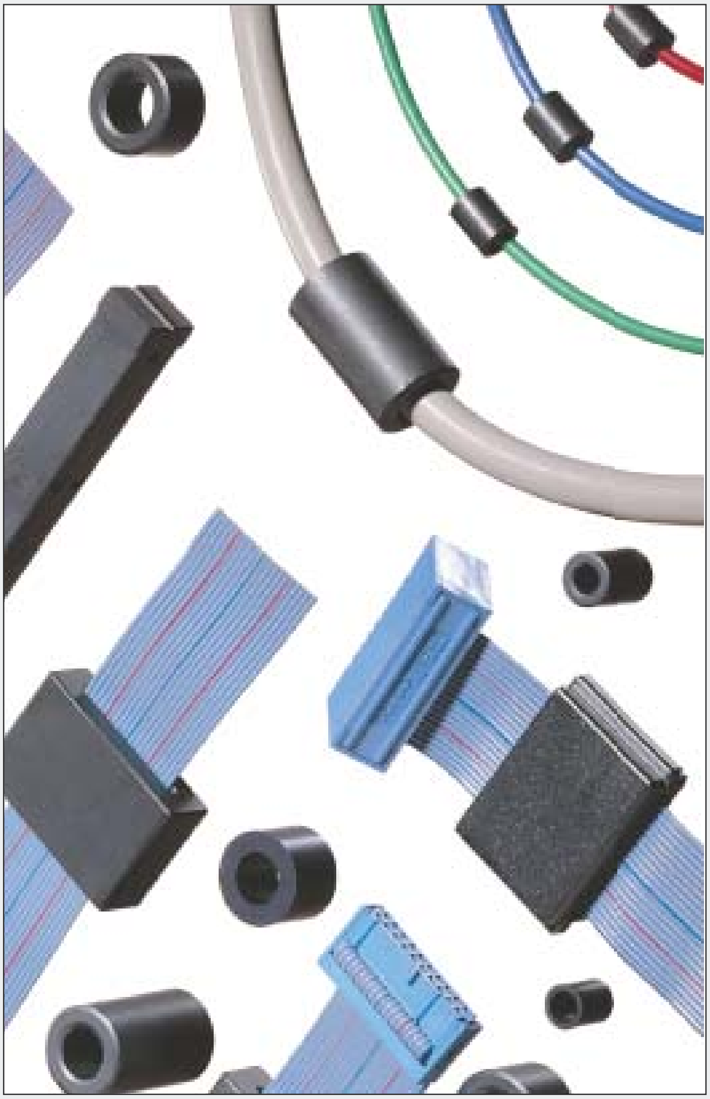
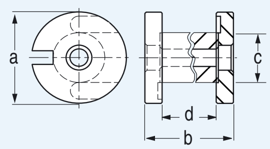


fig. 5

Type Number	fig. nr.	dimensions					|Z| typ (Ω) at 100 MHz
		A	B	C	D	E	
CSF38/12/25-3S4	4	38.1 ± 1.0	12.1 ± 0.35	25.4 ± 0.75	26.7 ± 0.75	1.9 ± 0.35	215
CSF38/12/25-3S4-S	5	38.5 ± 0.6	12.1 ± 0.4	25.4 ± 0.8	26.8 ± 0.8	1.9 ± 0.4	196



Bobbin Cores



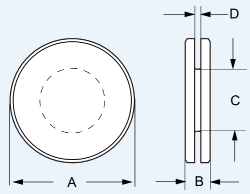
BC13/4.8/16-3C90 [1]			
a	b	c	d
12.8 – 0.5	16	4.8 ± 0.2	10
AL (nH) ≈ 50			
BC22/12/14-3C90			
a	b	c	d
22 ± 1	14 ± 1	12 ± 0.3	8.6 ± 0.6
AL (nH) ≈ 86			
BC22/12/18-3C90			
a	b	c	d
22 ± 1	18 ± 1	12 ± 0.3	12.6 ± 0.6
AL (nH) ≈ 85			
BC22/12/19-3C90			
a	b	c	d
22 ±1	18.5 ±1	12 ± 0.3	10.5 + 0.6
AL (nH) ≈ 94			
BC22/12/38-3C90			
a	b	c	d
22 ± 1	38 ± 1.4	12 ± 0.3	30 + 1.4
AL (nH) ≈ 74			
BC23/12/14-3C90 [2]			
a	b	c	d
22.6 ± 1	14 ± 1	12 ± 0.3	8.6 ± 0.6
AL (nH) ≈ 92			

Bobbin cores are easy to wind with thick copper wire. Application is mainly as power inductor in output stages of converters or as EMI choke in lines with high DC currents. The magnetic circuit is open, resulting in high current capability, but also in quite some stray flux.
AL measured with fully wound bobbin

1) no central hole, 2 wire slots

2) no wire slots

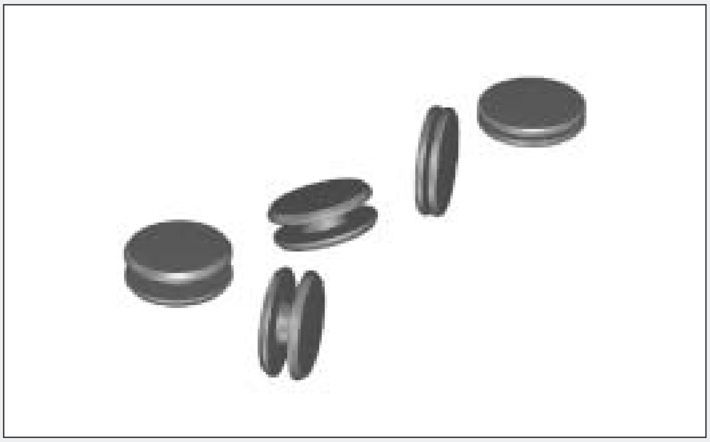
Miniature Drum Cores



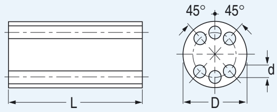
Type Number	dimensions			
	A	B	C	D
D38152012-3C92	3.8 ± 0.15	2.0 ± 0.1	1.5 ± 0.1	1.2 ± 0.1
D41150803-3C92	4.1 ± 0.15	0.8 ± 0.1	1.5 ± 0.1	0.3 ± 0.1
D41150803-4A11	4.1 ± 0.15	0.8 ± 0.1	1.5 ± 0.1	0.3 ± 0.1
D41150803-4B1	4.1 ± 0.15	0.8 ± 0.1	1.5 ± 0.1	0.3 ± 0.1
D41151306-4A11	4.11 ± 0.15	1.27 ± 0.1	1.45 ± 0.1	0.64 ± 0.1
D41151407-3C92	4.1 ± 0.15	1.4 ± 0.1	1.5 ± 0.1	0.7 ± 0.1
D41151407-4A11	4.1 ± 0.15	1.4 ± 0.1	1.5 ± 0.1	0.7 ± 0.1
D41151407-4B1	4.1 ± 0.15	1.4 ± 0.1	1.5 ± 0.1	0.7 ± 0.1
D41151811-3C92	4.1 ± 0.15	1.8 ± 0.1	1.5 ± 0.1	1.1 ± 0.1
D41161004-3C92	4.1 ± 0.15	1.0 ± 0.1	1.6 ± 0.1	0.35 ± 0.1
D41161609-4B1	4.1 ± 0.15	1.6 ± 0.1	1.6 ± 0.1	0.9 ± 0.1
D42180903-3C92	4.2 ± 0.15	0.9 ± 0.1	1.8 ± 0.1	0.28 ± 0.1
D42182012-3C92	4.2 ± 0.15	2.0 ± 0.1	1.8 ± 0.1	1.2 ± 0.1
D42200903-4B1	4.2 ± 0.15	0.9 ± 0.1	2.0 ± 0.1	0.3 ± 0.1
D42201105-3C92	4.2 ± 0.15	1.1 ± 0.1	2.0 ± 0.1	0.5 ± 0.1
D58150803-3C92	5.8 ± 0.15	0.8 ± 0.1	1.5 ± 0.1	0.3 ± 0.1

Mini drum cores are used wherever miniaturization requires very small and thin inductors. They can be found as micro power inductors in applications such as telecom, lap tops, set-top boxes and hand held equipment.

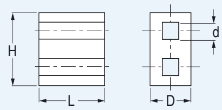
Summary :
- very low profile (height down to 0.8 mm)
- advanced power and high resistivity materials
- very high saturation
- broad bandwidth
- micro-precision in mechanical dimensions
- custom designs possible



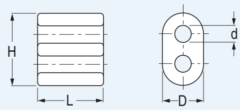
Multi Hole Cores



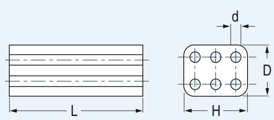
MHC6



MHR2



MHB2



MHR6

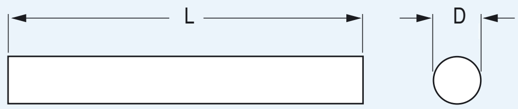
Type Number	dimensions			
	D	L	l	d
MHC6-6/10-3S4	6 ± 0.3	0.7 + 0.2	10 ± 0.5	-
MHC6-6/10-4B1	6 ± 0.3	0.7 + 0.2	10 ± 0.5	-
MHC6-6/5-4B1	6 ± 0.3	0.7 + 0.2	5 – 0.2	-
MHB2-14/8.5/8-4B1	8.5 – 0.5	3.5 + 0.5	8 ± 0.3	14 ± 0.5
MHB2-14/8.5/14-4B1	8.5 – 0.5	3.5 + 0.5	14 ± 0.4	14 ± 0.5
MHB2-13/8/6-4B1 [1)]	8.0 ± 0.3	3 ± 0.3	6 ± 0.3	13 ± 0.3
MHB2-13/8/6-3C90[1)]	8.0 ± 0.3	3 ± 0.3	6 ± 0.3	13 ± 0.3
MHR2-11/5.4/11-4A11	5.4 ± 0.3	2.0 ± 0.3	10.9 ± 0.3	10.8 ± 0.3
MHR2-11/5.4/11-3C90	5.4 ± 0.3	2.0 ± 0.3	10.9 ± 0.4	10.8 ± 0.3
MHR6-6.1/4/10-3B1	4 ± 0.2	0.7 + 0.3	10 ± 0.5	6.1 ± 0.3

Multi-hole cores are used for small HF transformers, for voltage or impedance matching in TV, communications, data transmission, instrumentation and similar applications. They are available with 2 and 6 holes (twin cores and six-hole cores), in round and rectangular shapes.

[1)] Chamfered holes and sides.

Summary :
- wide range of shapes
- several materials
- for HF matching and suppression

Rods



Material	Type number	Dimensions (mm)	
		D	L
3B1	ROD1.6/9-3B1-D	1.6 + 0.05	9 ± 0.2
	ROD2/20-3B1-D	2 – 0.05	20 – 0.9
	ROD3/15-3B1-D	3 – 0.05	15 – 0.8
	ROD3/20-3B1-D	3 – 0.05	20 – 0.9
	ROD3/25-3B1-D	3 – 0.05	25 – 1.0
	ROD4/15-3B1-D	4 – 0.05	15 – 0.8
	ROD4/20-3B1-D	4 – 0.05	20 – 0.9
	ROD4/25-3B1-D	4 – 0.05	25 – 1.0
	ROD5/20-3B1-D	5 – 0.05	20 – 0.9
	ROD5/25-3B1-D	5 – 0.05	25 – 1.0
	ROD5/30-3B1-D	5 – 0.05	30 – 1.2
	ROD6/30-3B1-D	6 – 0.10	30 – 1.2
	ROD6/40-3B1-D	6 – 0.10	40 – 1.6
	ROD6/50-3B1-D	6 – 0.10	50 ± 1.0
	ROD8/50-3B1	8 – 0.40	50 ± 1.0
	ROD8/150-3B1	8 – 0.40	150 ± 3
	ROD8/200-3B1	8 – 0.40	200 ± 4
3S3	ROD3/20-3S3	3 – 0.3	20 ± 0.4
	ROD3.3/17-3S3	3.3 ± 0.10	17 ± 0.3
	ROD5/20-3S3	5 – 0.30	20 ± 0.5
	ROD5/25-3S3	5 – 0.30	25 – 1.0
	ROD5.3/18-3S3	5.25 – 0.3	18 ± 0.3
	ROD6/25-3S3	6 – 0.30	25 ± 0.6
	ROD6/30-3S3	6 – 0.30	30 ± 0.9
	ROD6.5/25-3S3	6.5 – 0.30	25 ± 0.6
	ROD8/25-3S3	8 – 0.5	25 ± 0.75
	ROD8/32-3S3	8 – 0.5	32 – 2
4B1	ROD1.6/9-4B1-D	1.6 + 0.05	9 ± 0.2
	ROD2/20-4B1-D	2 – 0.05	20 – 0.9
	ROD3/15-4B1-D	3 – 0.05	15 – 0.8
	ROD3/20-4B1-D	3 – 0.05	20 – 0.9
	ROD3/25-4B1-D	3 – 0.05	25 – 1.0
	ROD4/15-4B1-D	4 – 0.05	15 – 0.8
	ROD4/20-4B1-D	4 – 0.05	20 – 0.9
	ROD4/25-4B1-D	4 – 0.05	25 – 1.0
	ROD5/20-4B1	5 – 0.30	20 ± 0.5
	ROD5/20-4B1-D	5 – 0.05	20 – 0.9
	ROD5/25-4B1-D	5 – 0.05	25 – 1.0
	ROD5/30-4B1-D	5 – 0.05	30 – 1.2
	ROD6/30-4B1-D	6 – 0.10	30 – 1.2
	ROD6/40-4B1-D	6 – 0.10	40 – 1.6
	ROD6/50-4B1-D	6 – 0.10	50 ± 1.0
	ROD6.5/25-4B1	6.5 – 0.30	25 ± 0.6
	ROD8/32-4B1	8 – 0.5	32 -2
	ROD8/50-4B1	8 – 0.40	50 ± 1.0
	ROD8/150-4B1	8 – 0.40	150 ± 3
	ROD8/200-4B1	8 – 0.40	200 ± 4
	ROD10/200-4B1	10 – 0.50	200 ± 4

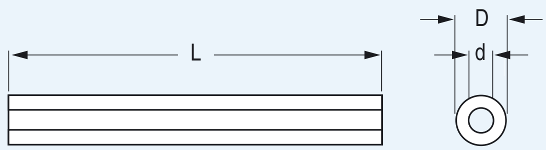
Generally, ferrite rods are used as the core of solenoidal chokes. Such a choke can carry a high DC current without being saturated because of the open magnetic circuit. In most cases, the frequency range will not be limited by the material, but by the coil capacitance. Curvature and mechanical tolerances of the standard range fulfil the requirements of DIN41291 or its equivalent IEC 60233-1966.

The L value and Q factor are measured (up to 6 mm outer diameter) in a standard coil, according to DIN 41276 or its equivalent IEC 732-1982, and compared with a standard rod.

Summary :

- For solenoidal coils
- Open circuit, no self shielding
- Not easily saturated by load currents

Tubes



Material	Type number	Dimensions (mm)		
		D	d	L
3B1	TUB3.1/1.3/19-3B1-DL	3.1 – 0.02	1.3 + 0.2	18.8 – 0.5
	TUB3.5/1.2/5-3B1	3.5 – 0.25	1.2 + 0.15	5 – 0.3
	TUB3.5/1.3/3-3B1	3.5 + 0.1/– 0.2	1.3 + 0.2	3 + 0.5
	TUB3.5/1.3/7.5-3B1	3.5 ± 0.2	1.3 + 0.2	7.5 + 0.5
	TUB3.7/1.2/3.5-3B1	3.7– 0.4	1.2 + 0.2	3.5 – 0.5
	TUB4/1.6/15-3B1	4 – 0.25	1.6 + 0.15	15 – 0.8
	TUB4/1.6/40-3B1	4 – 0.25	1.6 + 0.15	40 – 1.6
	TUB4/2/5-3B1	4 ± 0.2	2 ± 0.2	5 ± 0.5
	TUB4.1/2/7-3B1-D	4.1 + 0.1	2 + 0.2	7 ± 0.2
	TUB4.1/2/11-3B1-D	4.1 + 0.1	2 + 0.2	11 ± 0.2
	TUB4.2/2/12-3B1-DL	4.15 – 0.05	2 + 0.2	12.2 – 0.4
	TUB4.3/2/15-3B1	4.3 – 0.2	2 + 0.2	15.4 – 0.8
	TUB4.3/2/26-3B1	4.3 – 0.2	2 + 0.2	25.5 – 1
	TUB5.3/3/22-3B1	5.3 – 0.2	3 + 0.2	22.4 – 0.8
	TUB6/3/20-3B1	6 – 0.3	3 + 0.2	20 – 0.9
	TUB8/4/20-3B1	8 – 0.4	4 + 0.3	20 – 0.9
	TUB8/4/40-3B1	8 – 0.4	4 + 0.3	40 – 1.6
	TUB8/4.2/51-3B1	8 – 0.4	4.2 + 0.6	51.4 – 2.8
	TUB9.5/6.5/17-3B1	9.5 ± 0.3	6.5 ± 0.2	17 + 0.5/– 0.4
	TUB10/4.2/20-3B1	10 – 0.5	4.2 + 0.3	20 – 0.9
3C90	TUB4/1.6/40-3C90	4 – 0.25	1.6 + 0.15	40 – 1.6
	TUB5/2/50-3C90	5 – 0.3	2 + 0.2	50 ± 1
	TUB6/3/20-3C90	6 – 0.3	3 + 0.2	20 – 0.9
	TUB6/3/30-3C90	6 – 0.3	3 + 0.2	30 – 1.2
	TUB8/4/40-3C90	8 – 0.4	4 + 0.3	40 – 1.6
	TUB10/4.2/20-3C90	10 – 0.5	4.2 + 0.3	20 – 0.9
	TUB10/6.5/20-3C90	10 – 0.5	6.5 + 0.4	20 – 0.9
4B1	TUB3.5/1.2/5-4B1	3.5 – 0.25	1.2 + 0.15	5 – 0.3
	TUB3.7/1.2/3.5-4B1	3.7 – 0.4	1.2 + 0.2	3.5 – 0.5
	TUB3.8/2.8/8-4B1	3.8 ± 0.1	2.8 ± 0.1	8 ± 0.25
	TUB4/1.6/15-4B1	4 – 0.25	1.6 + 0.15	15 – 0.8
	TUB4/1.6/40-4B1	4 – 0.25	1.6 + 0.15	40 – 1.6
	TUB4/3/9.5-4B1	4 ± 0.1	3 + 0.2	9.45 + 0.75
	TUB4.1/2/7-4B1	4.1 + 0.2	2 + 0.2	7 ± 0.2
	TUB4.1/2/26-4B1	4.1 + 0.2	2 + 0.2	25.5 – 1
	TUB4.2/2/12-4B1-DL	4.15 – 0.05	2 + 0.2	12.2 – 0.4
	TUB4.3/2/15-4B1	4.3 – 0.2	2 + 0.2	15.4 – 0.8
	TUB6/3/20-4B1	6 – 0.3	3 + 0.2	20 – 0.9
	TUB6/3/30-4B1	6 – 0.3	3 + 0.2	30 – 1.2
	TUB8/4/20-4B1	8 – 0.4	4 + 0.3	20 – 0.9
	TUB8/4.2/51-4B1	8 – 0.4	4.2 + 0.6	51.4 – 2.8
	TUB10/6.5/20-4B1	10 – 0.5	6.5 + 0.4	20 – 0.9

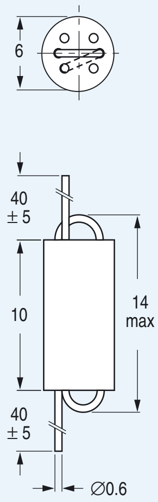
Tubes can be used in solenoid coils with almost the same effect as rods. The inner hole is often used to insert wires to make a ferrite coil former. In EMI suppression applications tubes can also be shifted over wires. Because the magnetic flux path is then closed, a steep increase in impedance results.

In such cases however the sensitivity for DC currents is rather high. Curvature and mechanical tolerances of the standard range fulfil the requirements of DIN 41291 or its equivalent IEC 60233-1966.

Summary :
- Full range of standard sizes
- For general EMI suppression
- With wires inserted used as ferrite coil former

Wideband Chokes

WBC1.5/A



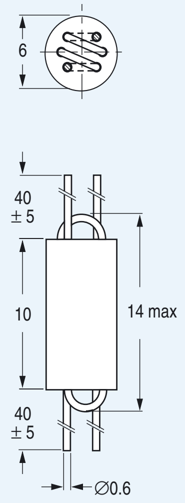
WBC1.5/A-4S2	
|Z| at frequency	
Ω	MHz
213[1]	10
400[1]	50
470[1]	100

WBC1.5/A-3S4	
|Z| at frequency	
Ω	MHz
≥ 300	120

WBC1.5/A-4B1	
|Z| at frequency	
Ω	MHz
≥ 350	250

[1] Minimum guaranteed impedance is IZI typ -20%.

WBC1.5/1.5/A



WBC1.5/1.5/A-4S2	
|Z| at frequency	
Ω	MHz
213[3]	10
400[3]	50
470[3]	100

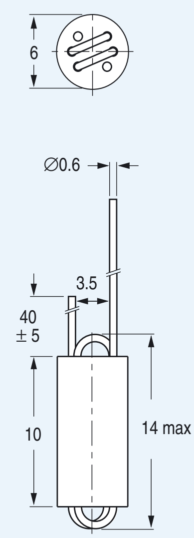
WBC1.5/1.5/A-3S4	
|Z| at frequency	
Ω	MHz
≥ 700[2]	50

WBC1.5/1.5/A-4B1	
|Z| at frequency	
Ω	MHz
≥ 800[2]	110

WBC1.5/1.5/A-4A15	
|Z| at frequency	
Ω	MHz
1000[3]	50
1000[3]	180

[2] IZI measured with both windings connected in series.
[3] Minimum guaranteed impedance is IZI typ -20%; measured with one winding.

WBC2/R

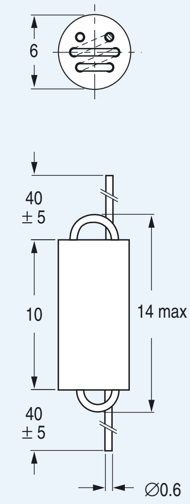


WBC2/R-4S2	
|Z| at frequency	
Ω	MHz
300[1]	10
650[1]	50
600[1]	100

WBC2/R-4A15	
|Z| at frequency	
Ω	MHz
≥ 730	50
≥ 750	180

[1] Minimum guaranteed impedance is IZI typ -20%.

WBC2.5/A



WBC2.5/A-4S2	
|Z| at frequency	
Ω	MHz
400[1]	10
850[1]	50
725[1]	100

WBC2.5/A-3S4	
|Z| at frequency	
Ω	MHz
≥ 600	50

WBC2.5/A-4B1	
|Z| at frequency	
Ω	MHz
≥ 700	180

WBC2.5/A-4A15	
|Z| at frequency	
Ω	MHz
800[1]	50
820[1]	180

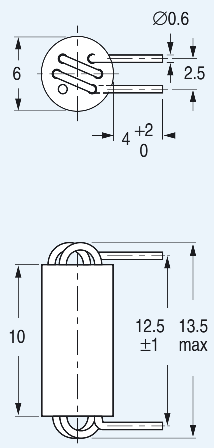
[1] Minimum guaranteed impedance is IZI typ -20%.

Wide-band chokes are an alternative to a bead when more impedance or damping is required. 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 design has excellent properties and reliability by keeping the number of electrical interfaces to an absolute minimum.

[1] Minimum guaranteed impedance is $|Z|_{typ}$ – 20 %.
[2] |Z| measured with both windings connected in series.
[3] Minimum guaranteed impedance is $|Z|_{typ}$ – 20 % ; measured with one winding.

Wideband Chokes

WBC2.5/R



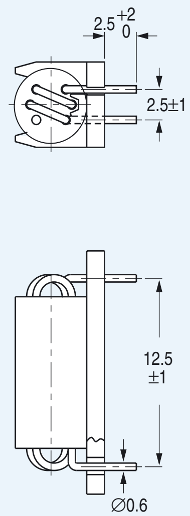
WBC2.5/R-3S4	
|Z| at frequency	
Ω	MHz
≥ 600	50

WBC2.5/R-4B1	
|Z| at frequency	
Ω	MHz
≥ 700	75

WBC2.5/R-4S2	
|Z| at frequency	
Ω	MHz
400[1]	10
850[1]	50
725[1]	100

[1] Minimum guaranteed impedance is IZI typ -20%.

WBC2.5/SP

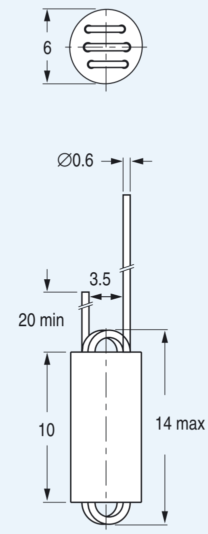


colour code
3S4 = blue
4B1 = green

WBC2.5/SP-3S4	
|Z| at frequency	
Ω	MHz
≥ 600	50

WBC2.5/SP-4B1	
|Z| at frequency	
Ω	MHz
≥ 700	75

WBC3/R



WBC3/R-4S2	
|Z| at frequency	
Ω	MHz
500[1]	10
1000[1]	50
688[1]	100

WBC3/R-3S4	
|Z| at frequency	
Ω	MHz
≥ 650	63

WBC3/R-4B1	
|Z| at frequency	
Ω	MHz
≥ 800	110

WBC3/R-4A15	
|Z| at frequency	
Ω	MHz
≥ 1000	50
≥ 1000	180

[1] Minimum guaranteed impedance is IZI typ -20%.

Specialty Ferrite materials and applications

Property	Test conditions				Specialty Ferrites				
Symbol	f (kHz)	B_{peak} or H	T (ºC)	unit	4E2	4M2	4B3	8C12	8C11
μ_i (± 20%)	≤ 10	≤ 0.1 mT	25		25	140	300	900	1200
B	10	250 A/m	100	mT	≈ 150	≈ 150	≈ 250	≈ 150	≈ 200
		3000 A/m	25		≈ 320	≈ 300	≈ 400	≈ 270	≈ 300
H_c			25	A/m	≈ 400	≈ 100	≈ 60	≈ 30	≈ 20
B_r				mT	≈ 200	≈ 100	≈ 200	≈ 110	≈ 150
T_c				ºC	≥ 400	≥ 200	≥ 250	≥ 125	≥ 125
ρ	DC		25	Ωm	≈ 10^5	≈ 10^5	≈ 10^5	≈ 10^5	≈ 10^5
density				kg/m^3	≈ 4000	≈ 5000	≈ 5000	≈ 5100	≈ 5100
ferrite type					NiZn	NiZn	NiZn	NiZn	NiZn

Properties measured on sintered, unground ring cores of dimensions ∅ 25 x ∅ 15 x 10 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.

Accellerator cores and pulse shapers

Scientific particle accellerators generally use large ferrite rings to tune caveties and concentrate the beam. Ferrite pole pieces, often called kicker magnets, concentrate the magnetic flux bursts which deflect the beam into experiment chambers. Ferrite rings on supply lines of e.g. short pulsed radar equipment, delay current rise until they saturate causing very steep pulses.

Ferrite choice	
frequency range	
< 1 *MHz*	*8C11, 8C12*
< 10 *MHz*	*4B3, 4M2*
< 100 *MHz*	*4E2*

Machined ferrite products

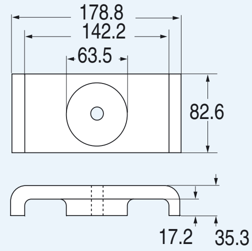
Machined ferrites and specialty shapes

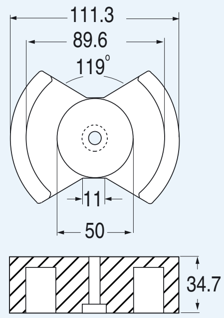
We stock blocks of most of our material grades and are able to machine all sorts of prototype cores from these blocks. Very close tolerances can be realized, if required.

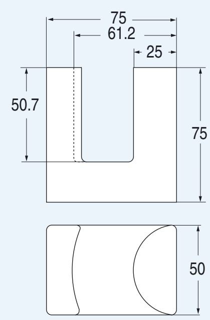
Ferrites are very hard and brittle and, therefore, difficult to work. Machining and grinding ferrites and similar materials to micron precision places stringent requirements on machines and men. To attain optimum standards requires very close cooperation between us and the manufacturers of the machines and the machine tools we use.

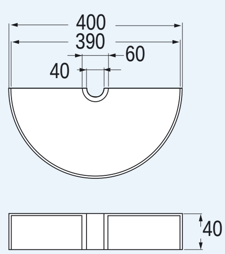
There are several reasons to go for machined ferrite cores. Sometimes samples are required on very short notice, while pressing tools are not yet available. On other occasions only a limited number of cores will be needed and it is not worthwhile to make a tool at all. Cores can be so complicated or large that machining is the only viable solution. A good example of a shape that can easily be produced is a planar E core. In a rectangular block of the right dimensions only 2 rectangular grooves have to be made.

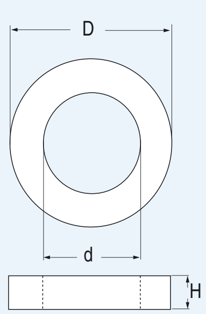
The following drawings provide a good impression of the variety of cores we have produced. For some of the cores we also have pressing tools available.

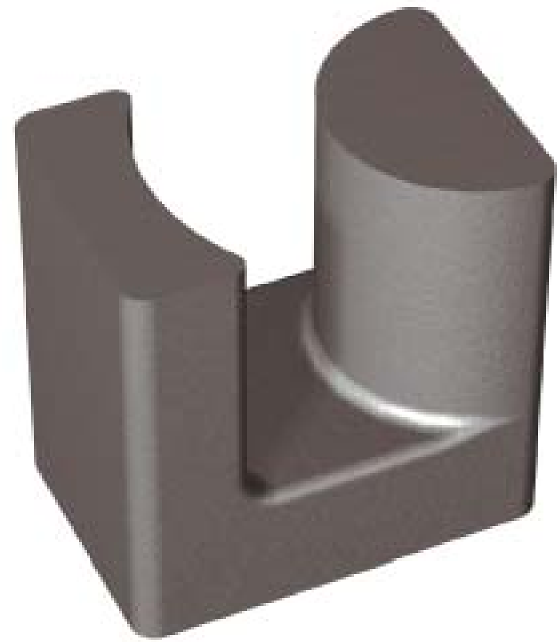




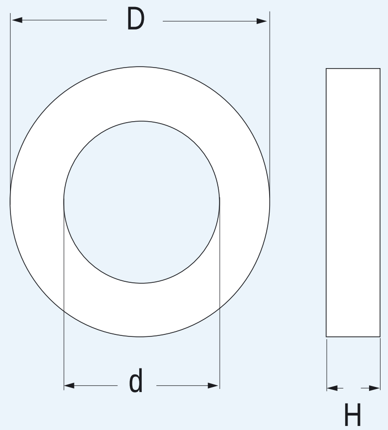








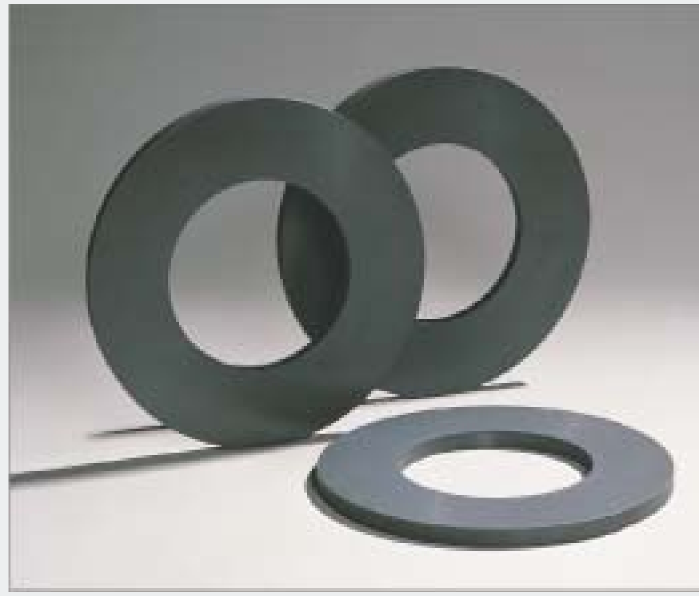
Ferrite Toroids for Particle Accelerators

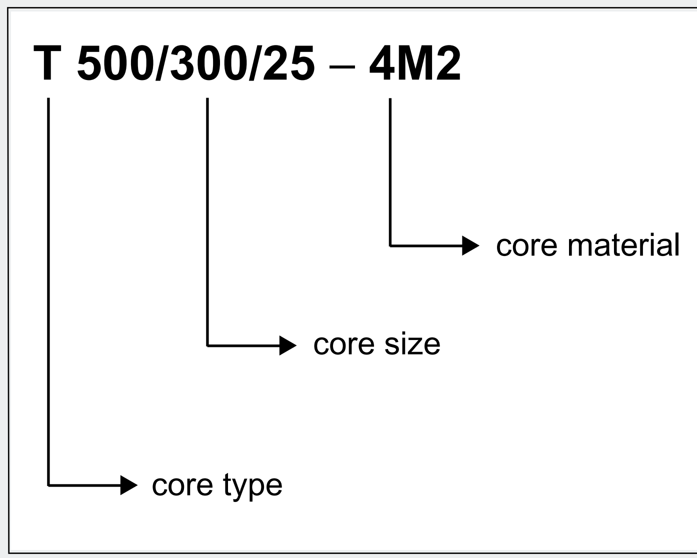


Material	Type Number	dimensions			mass (g)
		D	d	H	
4B3	T500/240/25-4B3	500 ± 2	240 ± 0.2	25 ± 0.2	≈ 19000
4M2	T76/38/13-4M2	76.2 ± 0.1	38.1 ± 0.1	12.7 ± 0.1	≈ 220
	T500/300/25-4M2	500 ± 0.1	300 ± 0.1	25 ± 0.1	≈ 16000
8C11	T76/38/13-8C11	76.2 ± 0.1	38.1 ± 0.1	12.7 ± 0.1	≈ 220
	T170/110/20-8C11	170 ± 0.2	110.2 ± 0.2	20 ± 0.2	≈ 1300
	T240/160/20-8C11	240 ± 0.3	160 ± 0.3	20 ± 0.3	≈ 2500
8C12	T76/38/13-8C12	76.2 ± 0.1	38.1 ± 0.1	12.7 ± 0.1	≈ 220
	T498/270/25-8C12	498 ± 0.1	270 ± 0.2	25 ± 0.2	≈ 17000
	T498/300/25-8C12	498 ± 0.1	300 ± 0.2	25 ± 0.2	≈ 15000

Our range of large ring cores and blocks was developed especially for use in scientific particle accelerators. Applications include kicker magnets and acceleration stations. Dynamic behaviour under pulse conditions is important for both applications, so special ferrite grades are optimized for low losses at high flux densities. These large rings have also been used successfully in delay lines for very high powers such as in pulsed lasers or radar equipment. Sizes other than those mentioned in the tables can be made on request.

- standard range of sizes
- optimized grades for particle accelerators
- other sizes on request





Definition of terms

Permeability

When a magnetic field is applied to a soft magnetic material, the resulting flux density is composed of that of free space plus the contribution of the aligned domains.

$$B = \mu_0 H + J \quad \text{or} \quad B = \mu_0 (H + M) \qquad [1]$$

where $\mu_0 = 4\pi.10^{-7}$ H/m, J is the magnetic polarization and M is the magnetization.
The ratio of flux density and applied field is called absolute permeability.

$$\frac{B}{H} = \mu_0\left(1 + \frac{M}{H}\right) = \mu_{absolute} \qquad [2]$$

It is usual to express this absolute permeability as the product of the magnetic constant of free space and the relative permeability (μ_r).

$$\frac{B}{H} = \mu_0 \mu_r \qquad [3]$$

Since there are several versions of μ_r depending on conditions the index 'r' is generally removed and replaced by the applicable symbol e.g. μ_i, μ_a, μ_Δ etc.

Initial permeability

The initial permeability is measured in a closed magnetic circuit (ring core) using a very low field strength.

$$\mu_i = \frac{1}{\mu_0} \times \frac{\Delta B}{\Delta H} \quad (\Delta H \to 0) \qquad [4]$$

Initial permeability is dependent on temperature and frequency.

Effective permeability

If an airgap is introduced in a closed magnetic circuit, magnetization becomes more difficult. As a result, the flux density for a given magnetic field strength is lower.
Effective permeability is dependent on the initial permeability of the soft magnetic material and the dimensions of airgaps and circuit.

$$\mu_e = \frac{\mu_i}{1 + \frac{G \times \mu_i}{l_e}} \qquad [5]$$

where G is the gap length and l_e is the effective length of magnetic circuit. This simple formula is a good approximation only for small airgaps. For longer airgaps some flux will cross the gap outside its normal area (fringing flux) causing an increase of the effective permeability.

Amplitude permeability

The relationship between higher field strength and flux densities without the presence of a bias field, is given by the amplitude permeability (μ_a).

$$\mu_a = \frac{1}{\mu_0} \times \frac{B}{H} \qquad [6]$$

Since the BH loop is far from linear, values depend on the applied field strength.

Incremental permeability

The permeability observed when an alternating magnetic field is superimposed on a static bias field, is called the incremental permeability.

$$\mu_\Delta = \frac{1}{\mu_0}\left[\frac{\Delta B}{\Delta H}\right]_{H_{DC}} \qquad [7]$$

If the amplitude of the alternating field is negligibly small, the permeability is then called the reversible permeability (μ_{rev}).

Effective core dimensions

To facilitate calculations on a non-uniform soft magnetic core, the effective dimensions are given on each data sheet. These dimensions, effective area (A_e), effective length (l_e) and effective volume (V_e) define a hypothetical ring core which would have the same magnetic properties as the non-uniform core.
The reluctance of the ideal ring core would be:

$$\frac{l_e}{\mu \times A_e} \qquad [9]$$

For the non-uniform core shapes, this is usually written as:

$$\frac{1}{\mu_e} \times \Sigma\frac{l}{A} \qquad [10]$$

the core factor divided by the permeability.
The inductance of the core can now be calculated using this core factor:

$$L = \frac{\mu_0 \times N^2}{\frac{1}{\mu_e} \times \Sigma\frac{l}{A}} = \frac{1.257 \times 10^{-9} \times N^2}{\frac{1}{\mu_e} \times \Sigma\frac{l}{A}} \text{(in H)} \qquad [11]$$

The effective area is used to calculate the flux density in a core, for sine wave:

$$B = \frac{U\sqrt{2} \times 10^9}{\omega A_e N} = \frac{2.25U \times 10^8}{fNA_e} \text{(in mT)} \qquad [12]$$

for square wave:

$$B = \frac{0.25U \times 10^9}{fNA_e} \text{(in mT)} \qquad [13]$$

where:
A_e is the effective area in mm^2 .
U is the voltage in V
f is the frequency in Hz
N is the number of turns.

The magnetic field strength (H) is calculated using the effective length (l_e):

$$H = \frac{IN\sqrt{2}}{l_e} \text{(A/m)} \qquad [14]$$

If the cross-sectional area of a core is non-uniform, there will always be a point where the real cross-section is minimal. This value is known as A_{min} and is used to calculate the maximum flux density in a core. In well designed ferrite core a large difference between A_e and A_{min} is avoided. Narrow parts of the core could saturate or cause much higher hysteresis losses.

Inductance factor (A_L)

To facilitate inductance calculations, the inductance factor, known as the A_L value (nH), is given in each data sheet. The inductance factor of a core is defined as:

$$L = N^2 \times A_L \text{ (nH)} \qquad [15]$$

The value of A_L is calculated from the core factor and the effective permeability:

$$A_L = \frac{\mu_0 \mu_e \times 10^6}{\Sigma(l/A)} = \frac{1.257\mu_e}{\Sigma(l/A)} \text{ (nH)} \qquad [16]$$

Inductance calculations on rods and tubes

Rods and tubes are generally used to increase the inductance of a coil. The magnetic circuit is very open and therefore the mechanical dimensions have more influence on the inductance than the ferrite's permeability (see Fig.1) unless the rod is very slender. In order to establish the effect of a rod on the inductance of a coil, the following procedure should be carried out:

- Calculate the length to diameter ratio of the rod (l/d).
- Find this value on the horizontal axis and draw a vertical line.

The intersection of this line with the curve of the material permeability gives the effective rod permeability (μ_{rod}).

The inductance of the coil, provided the winding covers the whole length of the rod is given by:

$$L = \mu_0 \mu_{rod} \frac{N^2 A}{l} \; (H) \qquad [17]$$

where:
N = number of turns
A = cross sectional area of rod (mm^2)
l = length of coil. (mm)

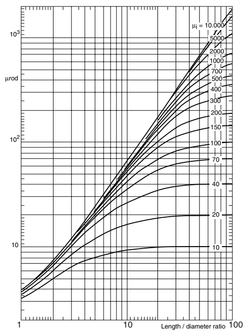


Fig.1 Rod permeability (μ_{rod}) as a function of length to diameter ratio with material permeability as a parameter.