Product Line Catalogue

Soft Ferrite Materials & Components

for Power, Signal and EMC Applications

MMG Canada Limited

MMG-Neosid has been manufacturing magnetic materials since its foundation in 1936 and now manufactures an extensive range of soft ferrite components and accessories. These are used in the Industrial, Computer, Telecommunications and Automotive/ Aerospace industries and include both Mn-Zn and Ni-Zn ferrite components, thermoset/thermoplastic formers and bobbins, and clips.

We also offer a range of toroids and rods (leaded and un-leaded) in Iron and Nickel-Iron Powders including Molypermalloy.

Isotropic hard ferrite magnets and resin bonded Neodymium-Iron-Boron magnets are also available from Huntingdon Magnets - a division of MMG-Neosid, based in Letchworth.

Always sensitive to market changes, MMG-Neosid is constantly developing new ferrite materials and component geometries to meet changing customer requirements and it is the experience gained from this that allows us to provide the very best of technical support and assistance to our customers at all stages of their projects.

Our ISO 9002 accreditation forms the basis of our Quality Assurance Policy but we would like to think we go beyond the scope of this and offer quality in every aspect of the way we do business.

MMG Companies: MMG-Neosid
Huntingdon Magnets
MMG-North America
MMG Canada Ltd

The Company's policy is one of continuous improvement and development and the right to change materials, designs, dimensions and descriptive matter, etc. at any time without notice is reserved.
Specifications and information contained within this brochure are intended for guidance only.

MMG-Neosid has exercised the utmost care and attention in compiling the information contained in this brochure and believes it to be accurate and reliable.
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Material Characteristics

The following data tabulates the specified material characteristics of MMG ferrites.
Supplementary graphs show typical performance. These are given for guidance only.

Data is derived from measurements on toroidal cores and the values obtained cannot be directly transferred to products of another shape and size.

The Nickel-Zinc ferrites (mainly used in open-circuit configurations) are described by Loss Factors corresponding to the sum of the residual and eddy current losses.
The grades of Manganese-Zinc ferrites mainly developed for power applications are characterised by the Power Loss Density under specified conditions.
Other Manganese-Zinc ferrites, especially those used in low frequency telecommunication applications, are characterised by both the residual and eddy current loss factor and the hysteresis loss factors.

Information given for individual grades of ferrite specify the typical or maximum Loss Factors for a range of frequencies where these losses remain fairly low. Generally speaking, these loss factors increase with frequency at a steady rate, slowly at first and then rapidly increasing to overtake the frequency rise. The point at which this accelerated rate of increase of loss factors occurs depends upon the composition and sintering conditions and may vary between batches of cores.

At frequencies well outside their normal range of application, all ferrites exhibit high loss characteristics, and are extensively used for suppression purposes.

Applications Guide

MMG ferrites are used in an extensive range of products and applications. Electronics applications are constantly developing. Listed below is an applications guide outlining the most popular use of MMG material grades. It is intended for guidance only.

Pot cores/RM cores for inductors, transformers -
Grades: P11, P12, F58, F5A, F44, F45, F47, F9, F9C, F10, F39

Low power and pulse transformer cores -
Grades: F9, F9C, F10, F39, F14

Balun cores -
Grades: P11, F9, F9C, F10, F19, F14

High power transformer core (E,U & Ring) -
Grades: F5A, F44, F45, F47

Suppression cores -
Grades: F9, F9C, F10, F39, F19, F14

Toroidal cores -
Grades: All grades.

Aerial Rods and slabs -
Long and medium waves:
Grades: F14
Short wave and VHF:
Grades: F16, F25, F28, F29

Screw cores, rods, pins and tubes -
Grades: F14, F25, F29

High frequency welding impeders -
Grades: F14, F59

Manganese-Zinc ferrites for Industrial and Professional Applications

Parameter	Symbol	Standard Conditions of test	Unit	F47	F45	F44	F5A
Initial Permeability (nominal)	μ_i	B<0.1mT 10kHz 25°C	-	**1800 ±20%**	**2000 ±20%**	**1900 ±20%**	**2500 ±20%**
Saturation Flux Density (typical)	B_{sat}	H=796 A/m =10 Oe 25°C	mT	**470**	**500**	**500**	**470**
		Static 100°C		**350**	**380**	**400**	**350**
Remanent Flux Density (typical)	B_r	H⇒0 (from near Saturation) 10kHz 25°C	mT	**130**	**165**	**270**	**150**
Coercivity (typical)	H_c	B⇒0 (from near Saturation) 10kHz 25°C	A/m	**24**	**15**	**27**	**15**
Loss Factor (maximum)	$\frac{\tan\delta_{(r+e)}}{\mu_i}$	B<0.1mT 25°C 10kHz	10^{-6}	-	-	-	-
		100kHz		-	-	-	-
		200kHz		-	-	-	-
		1MHz		-	-	-	-
Temperature Factor	$\frac{\Delta\mu}{\mu_i^2.\Delta T}$	B<0.1mT 10kHz +25°C to +55°C	10^{-6}/°C	-	-	-	-
Curie Temperature (minimum)	Θ_C	B<0.10mT 10kHz	°C	**200**	**230**	**230**	**200**
Disaccomodation Factor (max)	$\frac{\Delta\mu}{\mu_i^2.\log_{10}(t_2/t_1)}$	B<0.25mT 10kHz 50°C 10 to 100 mins	10^{-6}	-	-	-	-
Hysteresis Material Constant(max)	η_B	B from 1.5 to 3mT 10kHz 25°C	10^{-6}/mT	-	-	-	-
Resistivity (typical)	ρ	1 V/cm 25°C	ohm-cm	**100**	**100**	**100**	**100**
Amplitude Permeability (minimum)	μ_a	400mT 25°C	-	**2000**	**2500**	**2500**	**2400**
		320mT 100°C		**2500**	**-**	**-**	**1825**
		340mT 100°C		**-**	**2000**	**1900**	**-**
Total Power Loss Density (Maximum)	P_v	200mT; 25kHz 25°C	mW/cm³	**120**	**-**	**200**	-
		200mT; 25kHz 60°C		-	**-**	**-**	**190**
		200mT; 25kHz 100°C		**100**	**-**	**130**	**190**
		200mT; 25kHz 120°C		-	**110**	-	-
		100mT; 100kHz 25°C		**110**	**-**	**250**	-
		100mT; 100kHz 100°C		**80**	**80**	**160**	-
		100mT; 100kHz 120°C		-	-	-	-
		200mT; 100kHz 100°C		-	**400**	**750**	-
		50mT; 400kHz 25°C		**150**	-	-	-
		50mT; 400kHz 100°C		**150**	-	-	-

Typical Core Shapes:	F47	F45	F44	F5A
	ETD **EFD** **Ring** **Planar** **E** **RM**	E ETD EFD Ring RM	**E** **ETD** **EFD** **Ring** **RM & Pot** **U & I** **EP**	E ETD Ring RM U

F9	F9C	F10	F39	P11	P12	F58	Parameter
4400 ±20%	5000 ±20%	6000 ±20%	10 000 ±20%	2250 ±20%	2000 ±20%	750 ±20%	Initial Permeability (Nominal)
380	460	380	380	-	-	450	Saturation Flux Density (Typical)
180	170	100	200	70	35	94	Remanent Flux Density (Typical)
13	13	11	16	18	7	47	Coercivity (Typical)
--- 20 - -	- 20 - -	- 20 - -	- - - -	1.5 5 - -	0.8 2.5 - -	- - 12 20	Loss Factor (Maximum)
0 to +2	-1 to +2	-1 to +2	-	0.5 to 1.5	0.4 to 1.0	0.5 to 2.3	Temperature Factor
130	160	130	125	150	150	200	Curie Temperature (Minimum)
-	-	-	-	4	3	12	Disaccomodation Factor (Max)
-	-	-	-	0.8	0.45	1.8	Hysteresis Material Constant (Max)
50	50	50	100	100	100	100	Resistivity (Typical)
Pot RM E EP U & I	Ring E RM Pot	Ring RM EP Pot	Ring RM EP Pot	RM Pot	RM Pot	RM Pot	

When specifying materials the following component Part No. suffixes apply.

Material Grade	Part No. suffix
F47	-47
F45	-45
F44	-44
F5A	-49
F9	-36
F9C	C36
F10	-37
F39	-39
P11	-41
P12	-42
F58	-58

Data is derived from measurements on toroidal cores.

These values cannot be directly transferred to actual products. The product related data can be taken only from the relevant product specification.

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Nickel-Zinc ferrites for Industrial and Professional Applications

Parameter of test	Symbol	Standard Conditions	Unit	F19	F14	F16
Initial Permeability (nominal)	μ_i	B<0.1mT 10kHz 25°C	-	**1000 ±20%**	**220 ±20%**	125 ±20%
Saturation Flux Density (typical)	B_{sat}	H=796 A/m =10 Oe 25°C Static	mT	**260**	**350**	340
Remanent Flux Density (typical)	B_r	H⇒0 (from near Saturation) 10kHz 25°C	mT	**130**	**270**	165
Coercivity (typical)	H_c	B⇒0 (from near Saturation) 10kHz 25°C	A/m	**53**	**172**	200
Loss Factor (maximum)	$\frac{\tan\delta_{(r+e)}}{\mu_i}$	B<0.1mT 25°C 250kHz 500kHz 1MHz 2MHz 3MHz 5MHz 10MHz 15MHz 20MHz 40MHz 100MHz 200MHz	10^{-6}	 **-** **130** **350** **-** **-** **-** **-** **-** **-** **-** **-** **-**	 **-** **40** **42** **50** - - - - - - - -	 - - 60 - - 65 100 - - - - -
Temperature Factor	$\frac{\Delta\mu}{\mu_i^2.\Delta T}$	B<0.1mT 10kHz +25°C to +55°C	10^{-6}/°C	**3 to 6.5**	**12 to 30**	20 to 50
Curie Temperature (minimum)	Θ_X	B<0.10mT 10kHz	°C	**120**	**270**	270
Resistivity (typical)	ρ	1 V/cm 25°C	ohm-cm	**10^5**	**10^5**	10^5
		Typical Core Shapes:		Ring Beads Tubes Flat Cable Suppressor	Rods Chokes	On Request

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F25*	F28*	F29*	
50 ±20%	30 ±20%	12 ±20%	Initial Permeability (Nominal)
-	-	-	Saturation Flux Density (Typical)
-	-	-	Remanent Flux Density (Typical)
-	-	-	Coercivity (Typical)
- - 50 50 55 65 75 100 125 300 - -	- - - - - - 80 - - - 250 -	- - - - - - 100 - - - 200 1000	Loss Factor (Maximum)
10 to 15	30	50	Temperature Factor
450	500	500	Curie Temperature (Minimum)
10^5	10^5	10^5	Resistivity (Typical)
Rods Slabs	Rods Slabs	Rods Slabs	

When specifying materials the following component Part No. suffixes apply.	Material Grade	Part No. suffix
	F19	-38
	F14	-31
	F16	-32
	F25	-34
	F28	-46
	F29	-35

* These are perminvar ferrites and undergo irreversible changes of characteristics (permeability increases and loss factors become much greater - especially at high frequencies) if subjected to strong magnetic fields or mechanical shock.

Data is derived from measurements on toroidal cores.

These values cannot be directly transferred to actual products. The product related data can be taken only from the relevant product specification.

F47

Material Type: Manganese-Zinc Ferrite

Properties:
*Higher frequency power grade
*Low losses in recommended frequency range
*High saturation
*Medium Permeability
*Losses minimised 60°C - 80°C

Frequency Range: 300kHz to 1MHz (depending upon flux density)

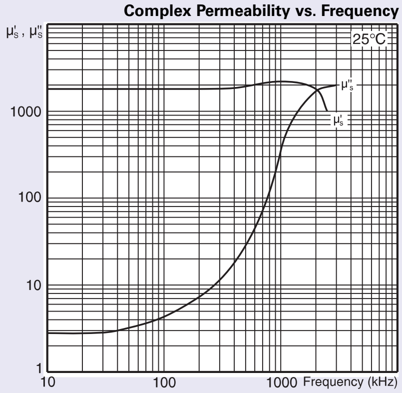
Typical Applications: SMPS.

Available core shapes: E, ETD, EFD, RM, Ring Cores.

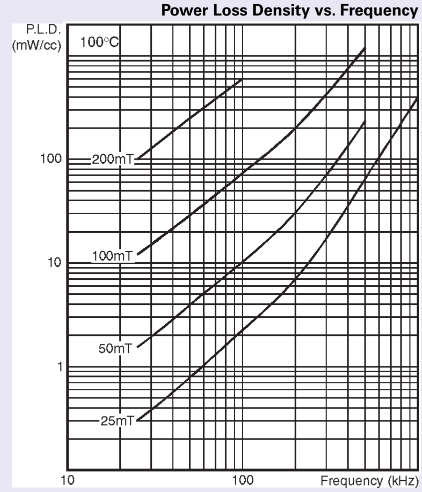
Material Specification

Parameter	Symbol	Standard Conditions of test	Unit	F47
Initial Permeability *(nominal)*	-	B<0.1mT 10kHz 25°C	-	**1800** *±20%*
Saturation Flux Density *(typical)*	B_{sat}	H=796 A/m = 10 Oe 25°C 100°C	mT	**470** **350**
Remanent Flux Density *(typical)*	B_r	H→ 0 (from near Saturation) 10kHz 25°C	mT	**130**
Coercivity *(typical)*	H_c	B→ 0 (from near Saturation) 10kHz 25°C	A/m	**24**
Curie Temperature *(minimum)*	Θ_c	B<0.10mT 10kHz	°C	**200**
Resistivity *(typical)*	ρ	1 V/cm 25°C	ohm-cm	**100**
Amplitude Permeability *(minimum)*	μ_a	400mT 25°C 340mT 100°C	-	**2500** **2000**
Total Power Loss Density	P_v	100mT; 100kHz 25°C (typ.) 100mT; 100kHz 100°C (max.) 50mT; 400kHz 25°C (typ.) 50mT; 400kHz 100°C (max.)	mW/cm³	**110** **80** **150** **150**

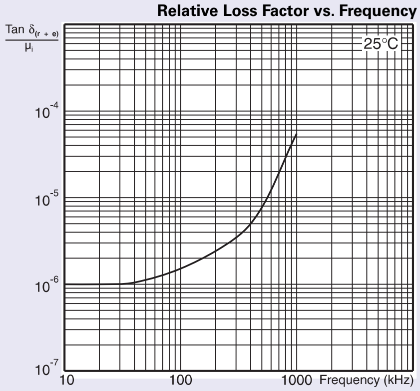
Complex Permeability vs. Frequency



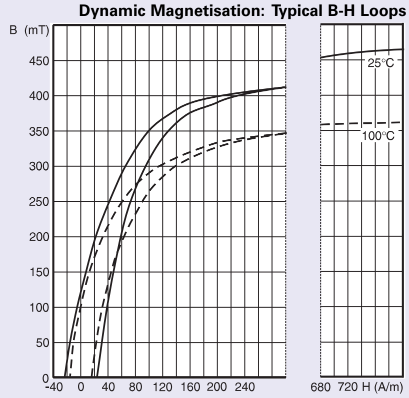
Power Loss Density vs. Frequency



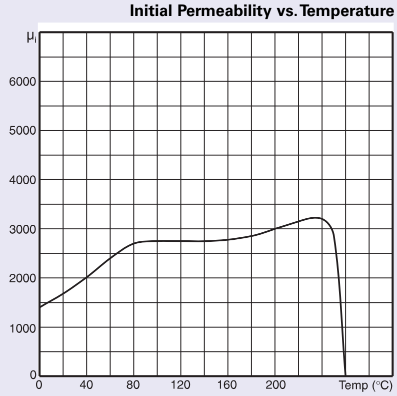
Relative Loss Factor vs. Frequency



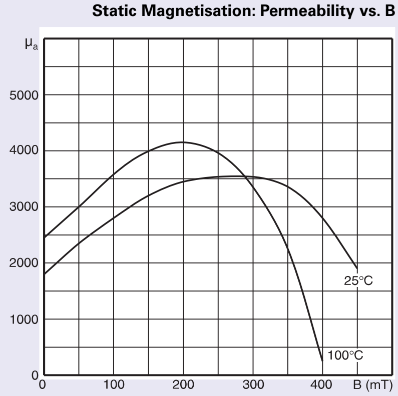
Dynamic Magnetisation: Typical B-H Loops



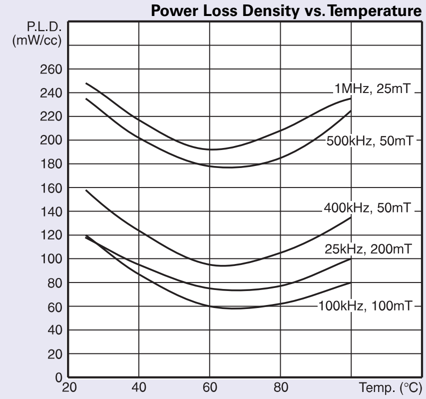
Initial Permeability vs. Temperature



Static Magnetisation: Permeability vs. B



Power Loss Density vs. Temperature



Data derived from measurements on a ring core of 30mm outside diameter.

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F45

Material Type: Manganese-Zinc Ferrite

Properties: *Low loss power grade.
*High saturation
*Losses minimised 80°C - 100°C
*Medium permeability

Frequency range: Up to 500kHz (depending upon flux density)

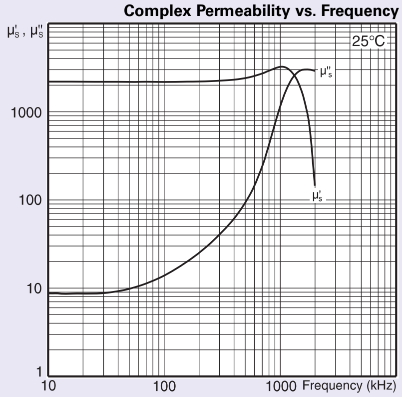
Typical Applications: SMPS.

Available core shapes: E, U, ETD, RM, Ring Cores.

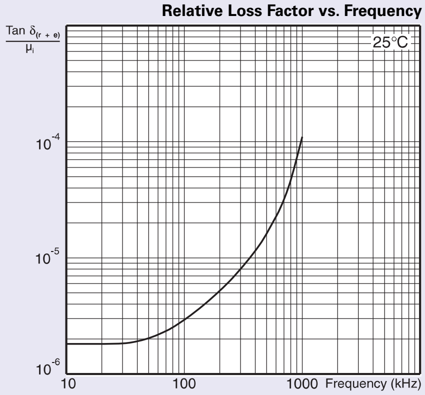
Material Specification

Parameter	Symbol	Standard Conditions of test	Unit	F45
Initial Permeability *(nominal)*	-	B<0.1mT 10kHz 25°C	-	**2000** *±20%*
Saturation Flux Density *(typical)*	B_{sat}	H=796 A/m = 10 Oe 25°C 100°C	mT	**500** **380**
Remanent Flux Density *(typical)*	B_r	H→ 0 (from near Saturation) 10kHz 25°C	mT	**165**
Coercivity *(typical)*	H_c	B→ 0 (from near Saturation) 10kHz 25°C	A/m	**15**
Curie Temperature *(minimum)*	Θ_c	B<0.10mT 10kHz	°C	**230**
Resistivity *(typical)*	ρ	1 V/cm 25°C	ohm-cm	**100**
Amplitude Permeability *(minimum)*	μ_a	400mT 25°C 340mT 100°C	-	**2500** **2000**
Total Power Loss Density *(maximum)*	P_v	100mT; 100kHz 100°C 200mT; 100kHz 100°C	mW/cm³	**80** **400**

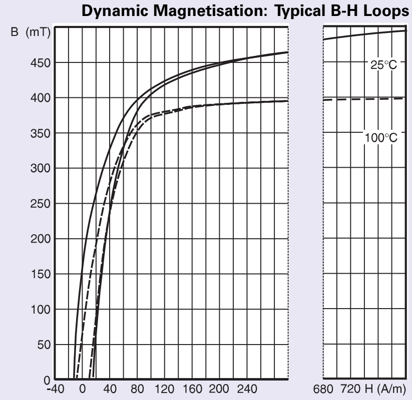
Complex Permeability vs. Frequency



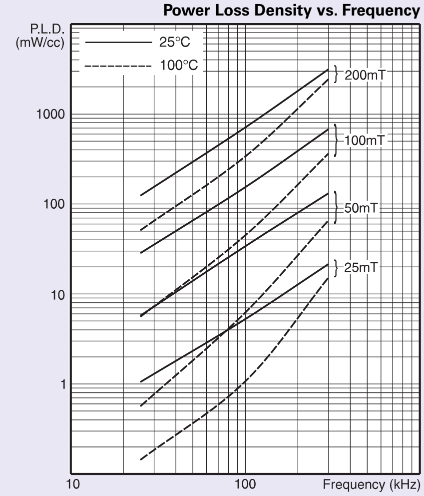
Relative Loss Factor vs. Frequency



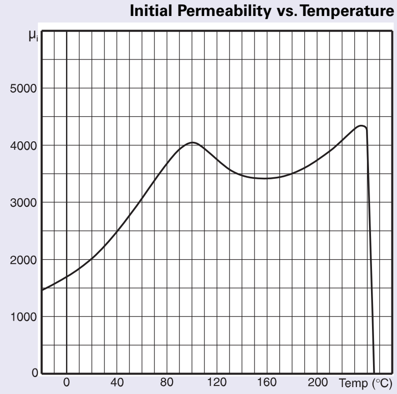
Dynamic Magnetisation: Typical B-H Loops



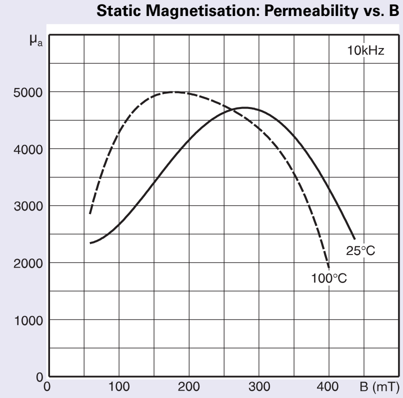
Power Loss Density vs. Frequency



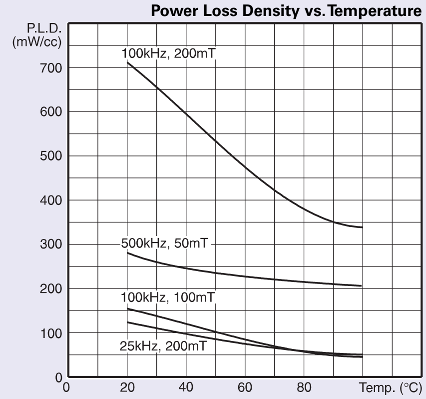
Initial Permeability vs. Temperature



Static Magnetisation: Permeability vs. B



Power Loss Density vs. Temperature



Data is derived from measurements on a ring core of 30mm outside diameter.

F44

Material Type: Manganese-Zinc Ferrite

Properties:
*Higher saturation power grade
*Higher amplitude permeability
*Low power losses in recommended frequency range
*Losses minimised above 70°C
*Medium permeability

Frequency range: Up to 300kHz (depending upon flux density)

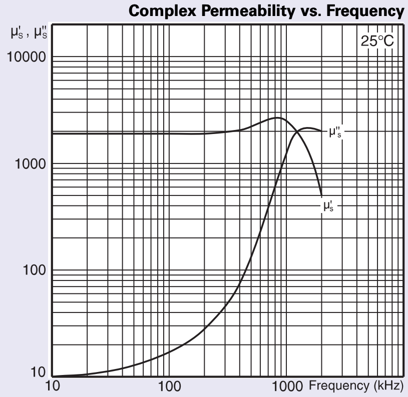
Typical Applications: SMPS, EHT Transformers, converters.

Available core shapes: E, U, ETD, EFD,EP,Pot, RM, Ring Cores.

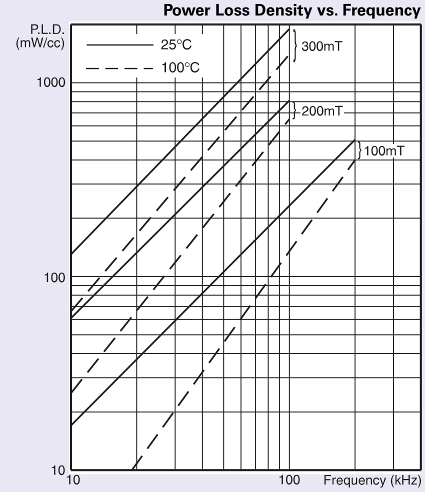
Material Specification

Parameter	Symbol	Standard Conditions of test	Unit	F44
Initial Permeability *(nominal)*	-	B<0.1mT 10kHz 25°C	-	**1900** *±20%*
Saturation Flux Density *(typical)*	B_{sat}	H=796 A/m = 10 Oe 25°C 100°C	mT	**500** **400**
Remanent Flux Density *(typical)*	B_r	H→ 0 (from near Saturation) 10kHz 25°C	mT	**270**
Coercivity *(typical)*	H_c	B→ 0 (from near Saturation) 10kHz 25°C	A/m	**27**
Curie Temperature *(minimum)*	Θ_c	B<0.10mT 10kHz	°C	**230**
Resistivity *(typical)*	ρ	1 V/cm 25°C	ohm-cm	**100**
Amplitude Permeability *(minimum)*	μ_a	400mT 25°C 340mT 100°C	-	**2500** **1900**
Total Power Loss Density *(maximum)*	P_v	200mT; 25kHz 25°C 200mT; 25kHz 100°C 100mT; 100kHz 25°C 100mT; 100kHz 100°C 200mT; 100kHz 100°C	mW/cm³	**200** **130** **250** **160** **750**

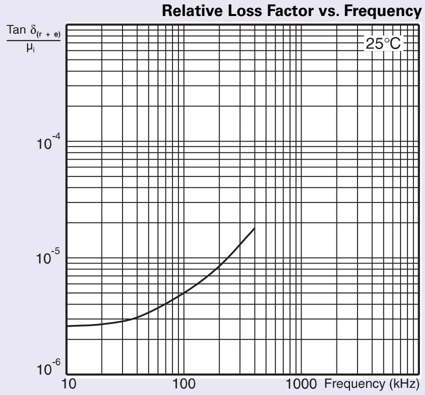
Complex Permeability vs. Frequency



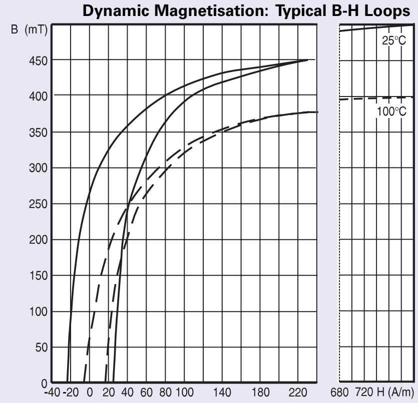
Power Loss Density vs. Frequency



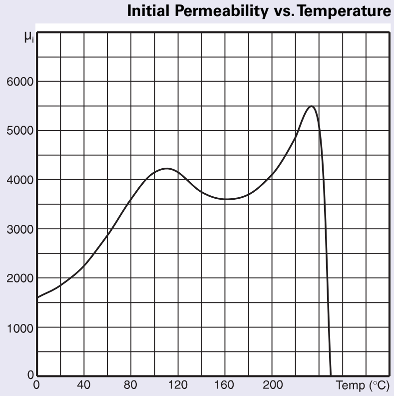
Relative Loss Factor vs. Frequency



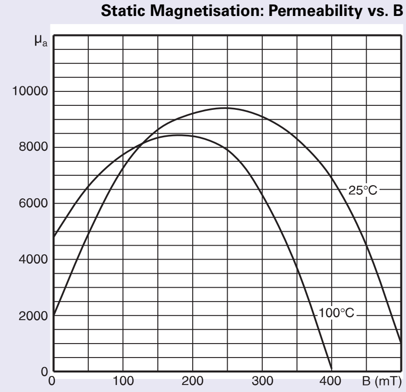
Dynamic Magnetisation: Typical B-H Loops



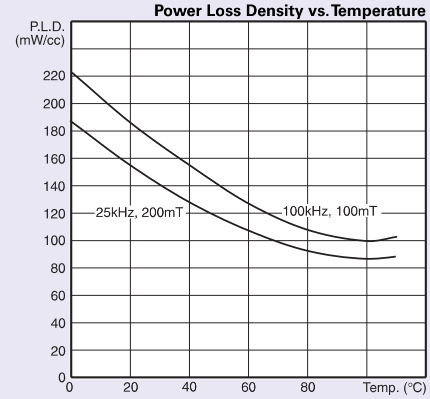
Initial Permeability vs. Temperature



Static Magnetisation: Permeability vs. B



Power Loss Density vs. Temperature



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Data is derived from measurements on a ring core of 30mm outside diameter.

F5A

Material Type: Manganese-Zinc Ferrite

Properties:
*Higher permeability power grade
*High saturation
*Low loss
*Losses minimised 50°C - 80°C

Frequency range: Up to 150/200kHz (depending upon flux density)

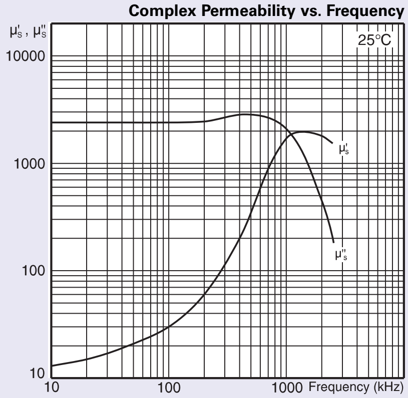
Typical Applications: Power Supplies, EHT Transformers.

Available core shapes: E, U, ETD, RM, Ring Cores.

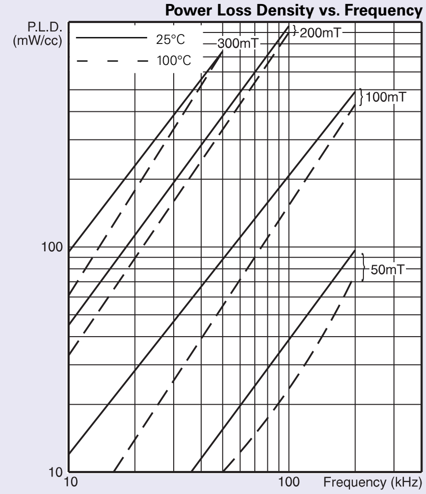
Material Specification

Parameter	Symbol	Standard Conditions of test	Unit	F5A
Initial Permeability *(nominal)*	-	B<0.1mT 10kHz 25°C	-	**2500** *±20%*
Saturation Flux Density *(typical)*	B_{sat}	H=796 A/m = 10 Oe 25°C 100°C	mT	**470** **350**
Remanent Flux Density *(typical)*	B_r	H→ 0 (from near Saturation) 10kHz 25°C	mT	**150**
Coercivity *(typical)*	H_c	B→ 0 (from near Saturation) 10kHz 25°C	A/m	**15**
Curie Temperature *(minimum)*	Θ_c	B<0.10mT 10kHz	°C	**200**
Resistivity *(typical)*	ρ	1 V/cm 25°C	ohm-cm	**100**
Amplitude Permeability *(minimum)*	μ_a	400mT 25°C 320mT 100°C	-	**2400** **1825**
Total Power Loss Density *(maximum)*	P_V	200mT; 25kHz 60°C 200mT;25kHz 100°C	mW/cm³	**190** **190**

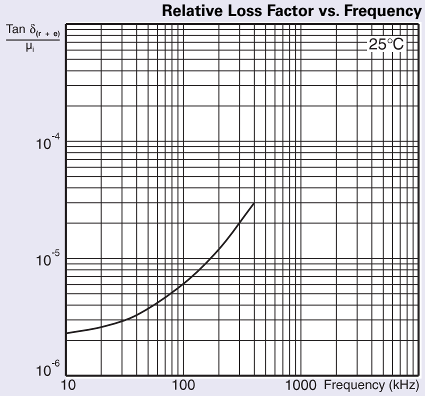
Complex Permeability vs. Frequency



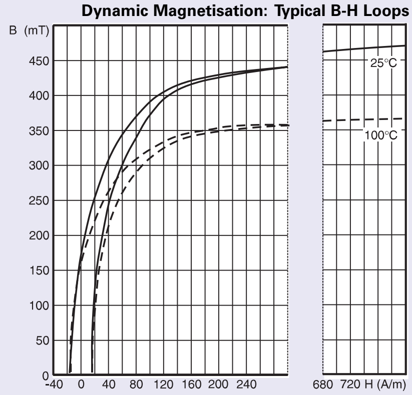
Power Loss Density vs. Frequency



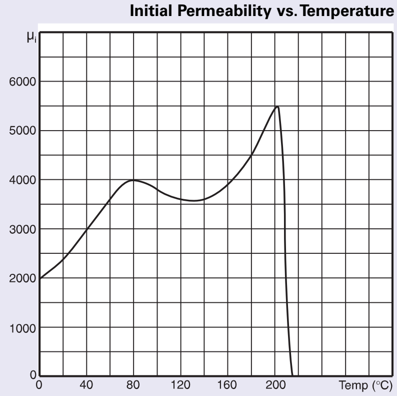
Relative Loss Factor vs. Frequency



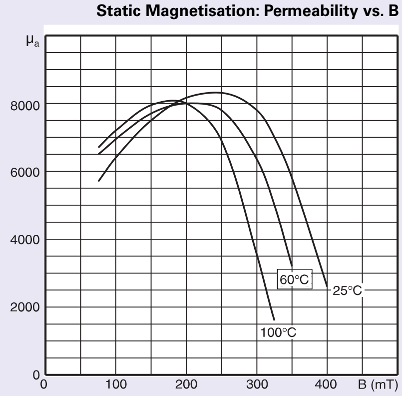
Dynamic Magnetisation: Typical B-H Loops



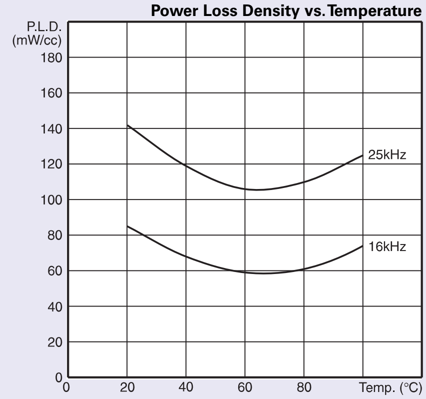
Initial Permeability vs. Temperature



Static Magnetisation: Permeability vs. B



Power Loss Density vs. Temperature



Data is derived from measurements on a ring core of 30mm outside diameter.

F9

Material Type: Manganese-Zinc Ferrite

Properties: High permeability.

Frequency range: Depends on application

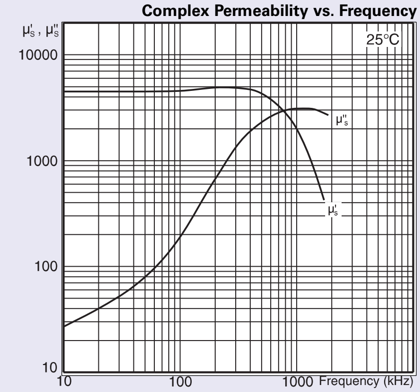
Typical Applications: Wideband & Pulse Transformers, Filter & Interference Suppression applications.

Available core shapes: Ring, E, EP, U, RM & Pot Cores.

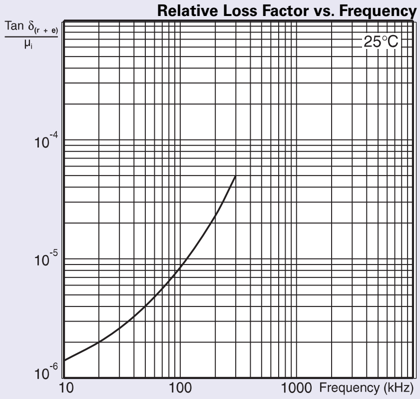
Material Specification

Parameter	Symbol	Standard Conditions of test	Unit	F9
Initial Permeability *(nominal)*	-	B<0.1mT 10kHz 25°C	-	**4400** *±20%*
Saturation Flux Density *(typical)*	B_{sat}	H=796 A/m = 10 Oe 25°C	mT	**380**
Remanent Flux Density *(typical)*	B_r	H→ 0 (from near Saturation) 10kHz 25°C	mT	**180**
Coercivity *(typical)*	H_c	B→ 0 (from near Saturation) 10kHz 25°C	A/m	**13**
Loss Factor *(maximum)*	$\frac{\tan\delta_{(r+e)}}{\mu_i}$	B<0.10mT 10kHz 25°C	10^{-6}	**20**
Curie Temperature *(minimum)*	Θ_C	B<0.10mT 10kHz	°C	**130**
Temperature Factor	$\frac{\Delta\mu}{\mu_i^2.\Delta T}$	+25°C to +55°C B<0.10mT 10kHz	°C	**0 to +2**
Resistivity *(typical)*	ρ	1 V/cm 25°C	ohm-cm	**50**

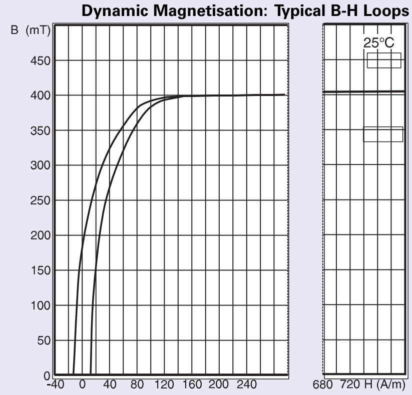
Complex Permeability vs. Frequency



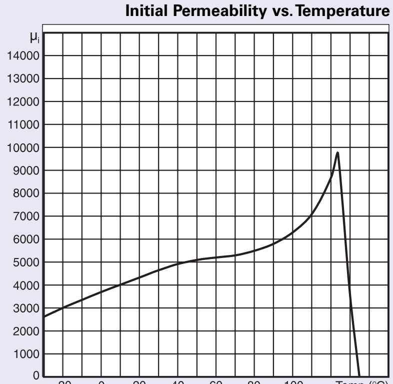
Relative Loss Factor vs. Frequency



Dynamic Magnetisation: Typical B-H Loops



Initial Permeability vs. Temperature



Data is derived from measurements on a ring core of 30mm outside diameter.

F9C

Material Type: Manganese-Zinc Ferrite

Properties: *High permeability
*High saturation
*Improved frequency response (depending on application)
*High Curie temperature

Frequency range: Depends on application

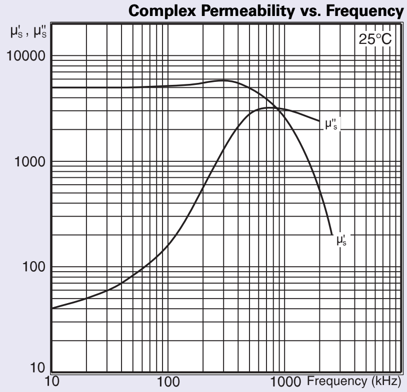
Typical Applications: Specially developed for Mains filtering, Wideband and Pulse Transformers

Available core shapes: Ring, E, RM & Pot Cores.

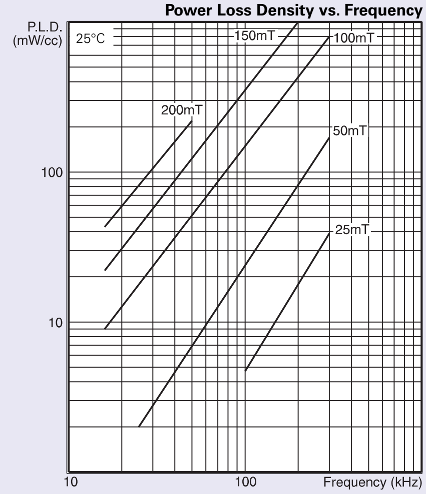
Material Specification

Parameter	Symbol	Standard Conditions of test	Unit	F9C
Initial Permeability *(nominal)*	-	B<0.1mT 10kHz 25°C	-	**5000** *±20%*
Saturation Flux Density *(typical)*	B_{sat}	H=796 A/m = 10 Oe 25°C	mT	**460**
Remanent Flux Density *(typical)*	B_r	H→ 0 (from near Saturation) 10kHz 25°C	mT	**170**
Coercivity *(typical)*	H_c	B→ 0 (from near Saturation) 10kHz 25°C	A/m	**13**
Loss Factor *(maximum)*	$\frac{\tan\delta_{(r+e)}}{\mu_i}$	B<0.10mT 10kHz 25°C	10^{-6}	**20**
Curie Temperature *(minimum)*	Θ_C	B<0.10mT 10kHz	°C	**160**
Temperature Factor	$\frac{\Delta\mu}{\mu_i^2.\Delta T}$	+25°C to +55°C B<0.10mT 10kHz	°C	**-1 to +2**
Resistivity *(typical)*	ρ	1 V/cm 25°C	ohm-cm	**50**

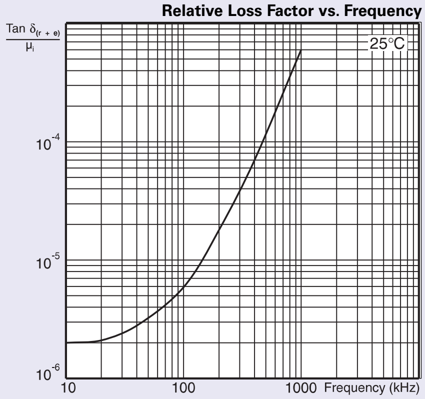
Complex Permeability vs. Frequency



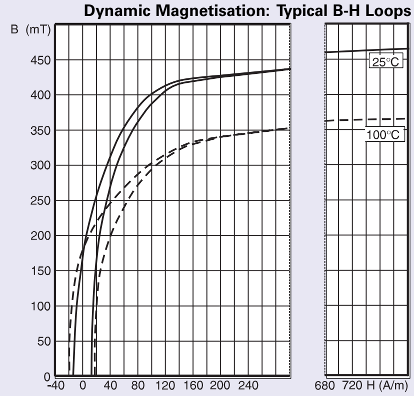
Power Loss Density vs. Frequency



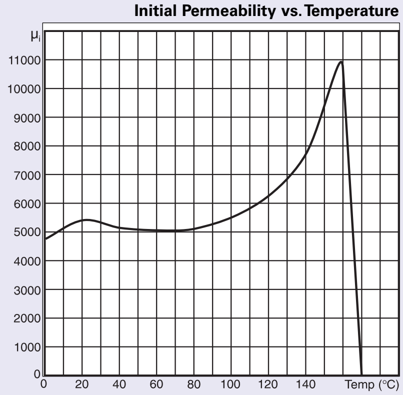
Relative Loss Factor vs. Frequency



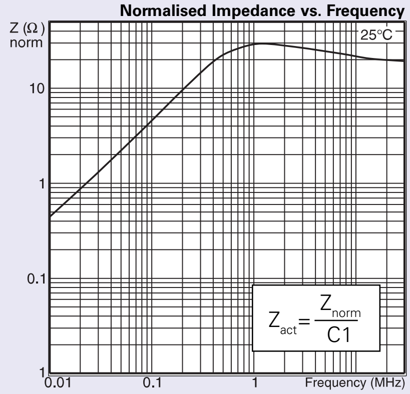
Dynamic Magnetisation: Typical B-H Loops



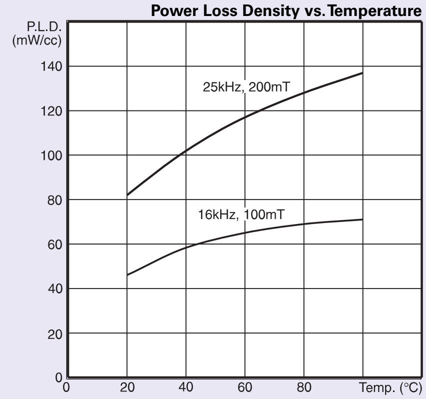
Initial Permeability vs. Temperature



Normalised Impedance vs. Frequency



Power Loss Density vs. Temperature



Data is derived from measurements on a ring core of 30mm outside diameter.

F10

Material Type: Manganese-Zinc Ferrite

Properties: High permeability.

Frequency range: Depends on application

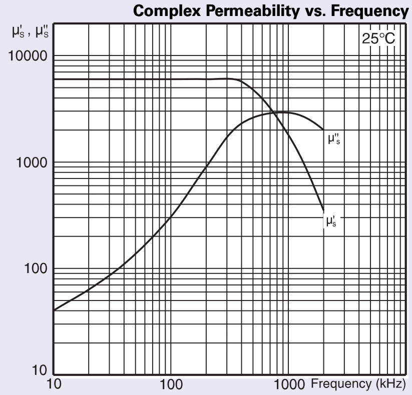
Typical Applications: Wideband, Pulse Transformers and Filter applications.

Available core shapes: Ring, E, EP, RM & Pot Cores.

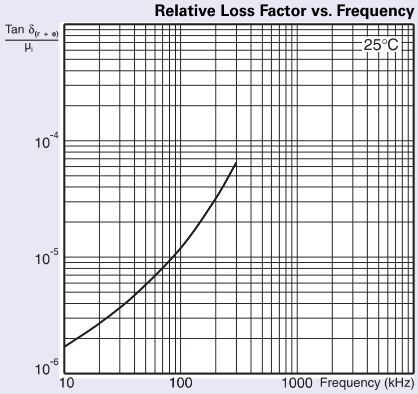
Material Specification

Parameter	Symbol	Standard Conditions of test	Unit	F10
Initial Permeability *(nominal)*	-	B<0.1mT 10kHz 25°C	-	**6000** *±20%*
Saturation Flux Density *(typical)*	B_{sat}	H=796 A/m = 10 Oe 25°C	mT	**380**
Remanent Flux Density *(typical)*	B_r	H→ 0 (from near Saturation) 10kHz 25°C	mT	**200**
Coercivity *(typical)*	H_c	B→ 0 (from near Saturation) 10kHz 25°C	A/m	**16**
Loss Factor *(maximum)*	$\frac{\tan \delta_{(r+e)}}{\mu_i}$	B<0.10mT 10kHz 25°C	10^{-6}	**-**
Curie Temperature *(minimum)*	Θ_C	B<0.10mT 10kHz	°C	**130**
Temperature Factor	$\frac{\Delta\mu}{\mu_i^2 . \Delta T}$	+25°C to +55°C B<0.10mT 10kHz	°C	**-1 to +2**
Resistivity *(typical)*	ρ	1 V/cm 25°C	ohm-cm	**50**

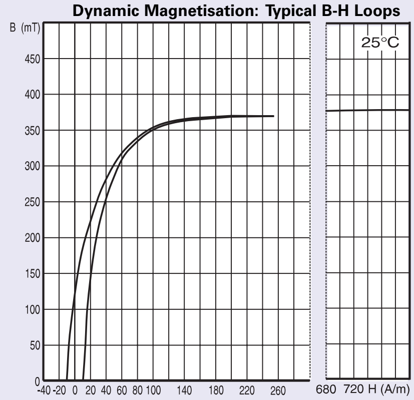
Complex Permeability vs. Frequency



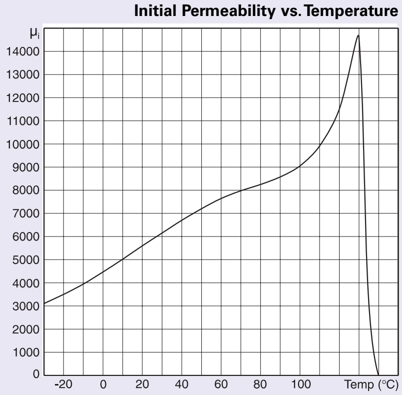
Relative Loss Factor vs. Frequency



Dynamic Magnetisation: Typical B-H Loops



Initial Permeability vs. Temperature



MMG

Data is derived from measurements on a ring core of 30mm outside diameter.

F39

Material Type: Manganese-Zinc Ferrite

Properties: Very high permeability

Frequency range: Depends on application

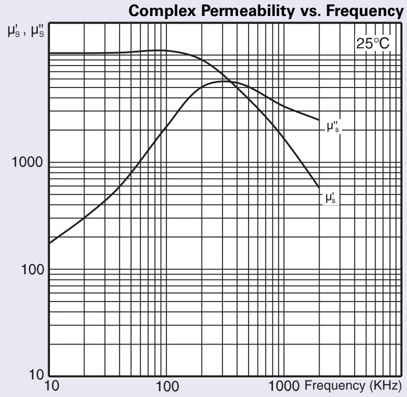
Typical Applications: Broadband and Pulse Transformers, Balanced (common-mode) chokes and inductors for filters.

Available core shapes: EP, Pot, RM, Ring Cores.

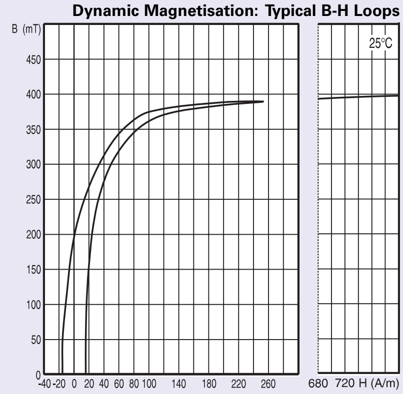
Material Specification

Parameter	Symbol	Standard Conditions of test	Unit	F39
Initial Permeability *(nominal)*	-	B<0.1mT 10kHz 25°C	-	**10 000** *±30%*
Saturation Flux Density *(typical)*	B_{sat}	H=796 A/m = 10 Oe 25°C	mT	**380**
Remanent Flux Density *(typical)*	B_r	H→ 0 (from near Saturation) 10kHz 25°C	mT	**200**
Coercivity *(typical)*	H_c	B→ 0 (from near Saturation) 10kHz 25°C	A/m	**16**
Loss Factor *(maximum)*	$\frac{\tan\delta_{(r+e)}}{\mu_i}$	B<0.10mT 10kHz 25°C	10^{-6}	**-**
Curie Temperature *(minimum)*	Θ_C	B<0.10mT 10kHz	°C	**125**
Temperature Factor	$\frac{\Delta\mu}{\mu_i^2.\Delta T}$	+25°C to +55°C B<0.10mT 10kHz	°C	**-**
Resistivity *(typical)*	ρ	1 V/cm 25°C	ohm-cm	**100**

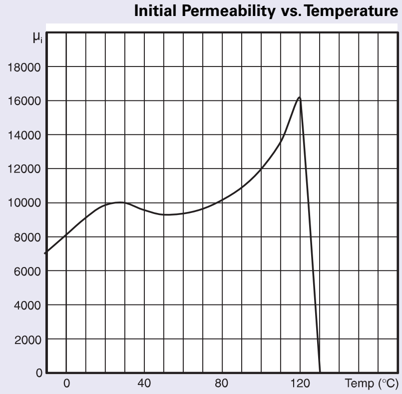
Complex Permeability vs. Frequency



Dynamic Magnetisation: Typical B-H Loops



Initial Permeability vs. Temperature



MMG

Data is derived from measurements on a ring core of 30mm outside diameter.

P11

Material Type: Manganese-Zinc Ferrite

Properties: *High stability of inductance
*Low temperature coefficient
*Low loss factors
*Medium permeability

Frequency range: Depends on application

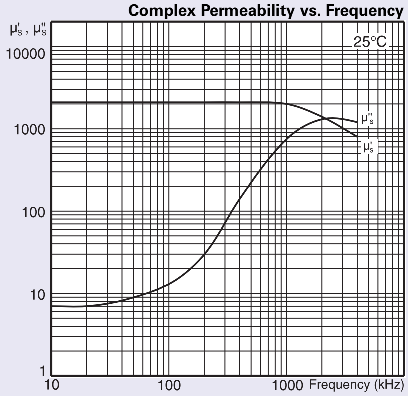
Typical Applications: Filter networks and proximity detectors

Available core shapes: RM and Pot Cores.

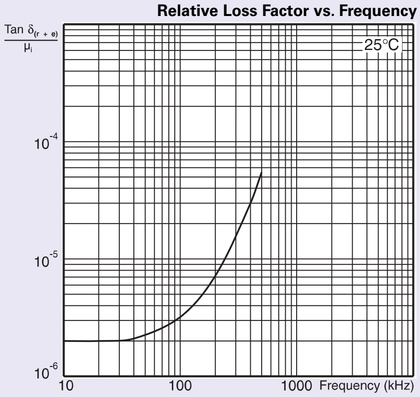
Material Specification

Parameter	Symbol	Standard Conditions of test	Unit	P11
Initial Permeability *(nominal)*	-	B<0.1mT 10kHz 25°C	-	**2250** *±20%*
Saturation Flux Density *(typical)*	B_{sat}	H=796 A/m = 10 Oe 25°C	mT	**-**
Remanent Flux Density *(typical)*	B_r	H→ 0 (from near Saturation) 10kHz 25°C	mT	**70**
Coercivity *(typical)*	H_c	B→ 0 (from near Saturation) 10kHz 25°C	A/m	**18**
Loss Factor *(maximum)*	$\frac{\tan\delta_{(r+e)}}{\mu_i}$	B<0.10mT 10kHz 25°C 100kHz	10^{-6}	**1.5** **5**
Curie Temperature *(minimum)*	Θ_C	B<0.10mT 10kHz	°C	**150**
Hysteresis Material Constant *(maximum)*	η_B	B from 1.5 to 3mT 10kHz 25°C	10^{-6}/°C	**0.8**
Disaccommodation Factor *(maximum)*	$\frac{\Delta\mu}{\mu_i^2 . \log_{10}(t_2/t_1)}$	10 to 100mins. 50°C B<0.25mT 10kHz	10^{-6}	**4**
Temperature Factor	$\frac{\Delta\mu}{\mu_i^2 . \Delta T}$	+25°C to +55°C B<0.10mT 10kHz	°C	**0.5 to 1.5**
Resistivity *(typical)*	ρ	1 V/cm 25°C	ohm-cm	**100**

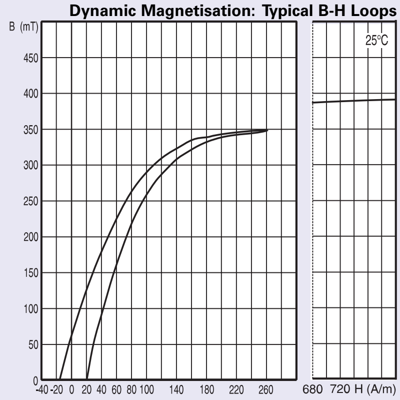
Complex Permeability vs. Frequency



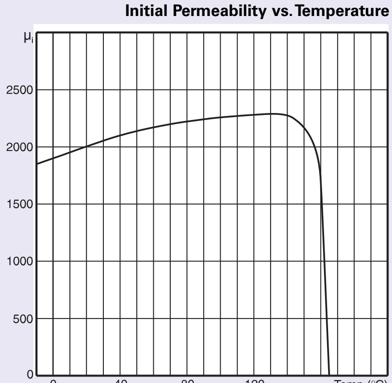
Relative Loss Factor vs. Frequency



Dynamic Magnetisation: Typical B-H Loops



Initial Permeability vs. Temperature



MMG

Data is derived from measurements on a ring core of 30mm outside diameter.

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P12

Material Type: Manganese-Zinc Ferrite

Properties: *High stability of inductance
*Low temperature coefficient
*Low loss factors
*Medium permeability

Frequency range: Depends on application.

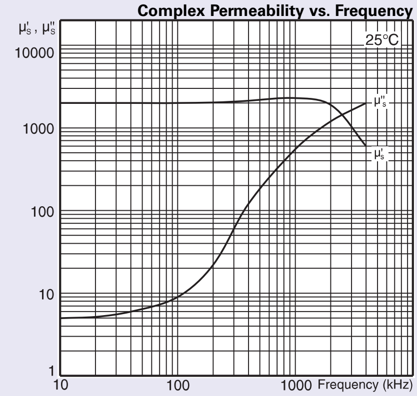
Typical Applications: Filter networks.

Available core shapes: RM and Pot cores.

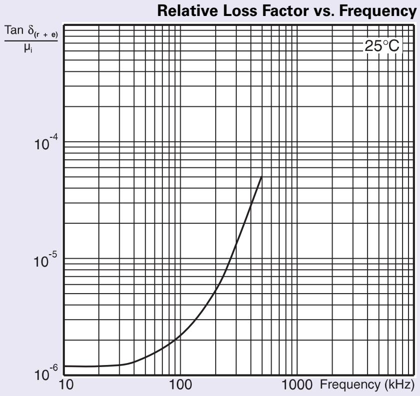
Material Specification

Parameter	Symbol	Standard Conditions of test	Unit	P12
Initial Permeability *(nominal)*	-	B<0.1mT 10kHz 25°C	-	**2000** *±20%*
Saturation Flux Density *(typical)*	B_{sat}	H=796 A/m = 10 Oe 25°C	mT	**-**
Remanent Flux Density *(typical)*	B_r	H→ 0 (from near Saturation) 10kHz 25°C	mT	**35**
Coercivity *(typical)*	H_c	B→ 0 (from near Saturation) 10kHz 25°C	A/m	**7**
Loss Factor *(maximum)*	$\frac{\tan \delta_{(r+e)}}{\mu_i}$	B<0.10mT 25°C 10kHz 100kHz	10^{-6}	**0.8** **2.5**
Curie Temperature *(minimum)*	Θ_C	B<0.10mT 10kHz	°C	**150**
Hysteresis Material Constant *(maximum)*	η_B	B from 1.5 to 3mT 10kHz 25°C	10^{-6}/°C	**0.45**
Disaccommodation Factor *(maximum)*	$\frac{\Delta\mu}{\mu_i^2 . \log_{10}(t_2/t_1)}$	10 to 100mins. 50°C B<0.25mT 10kHz	10^{-6}	**3**
Temperature Factor	$\frac{\Delta\mu}{\mu_i^2 . \Delta T}$	+25°C to +55°C B<0.10mT 10kHz	°C	**0.4 to 1**
Resistivity *(typical)*	ρ	1 V/cm 25°C	ohm-cm	**100**

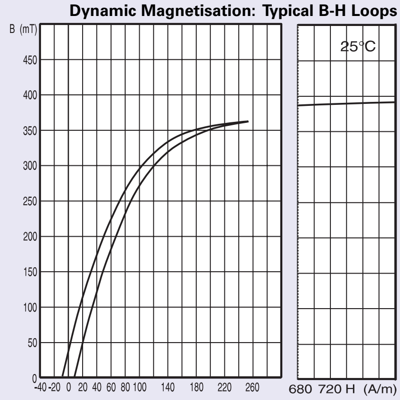
Complex Permeability vs. Frequency



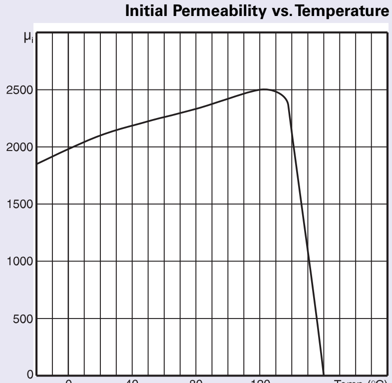
Relative Loss Factor vs. Frequency



Dynamic Magnetisation: Typical B-H Loops



Initial Permeability vs. Temperature



Data is derived from measurements on a ring core of 30mm outside diameter.

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F58

Material Type: Manganese-Zinc Ferrite

Properties: *High stability of inductance
*Low temperature coefficient
*Low loss factors at higher frequencies in the recommended range

Frequency range: 200kHz-1MHz (Subject to application)

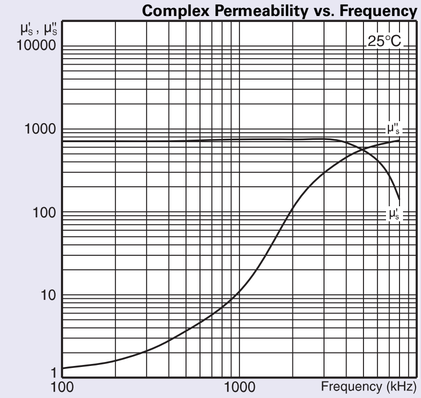
Typical Applications: Filter applications, proximity switches and gate drive transformers for SMPS.

Available core shapes: RM and Pot Cores

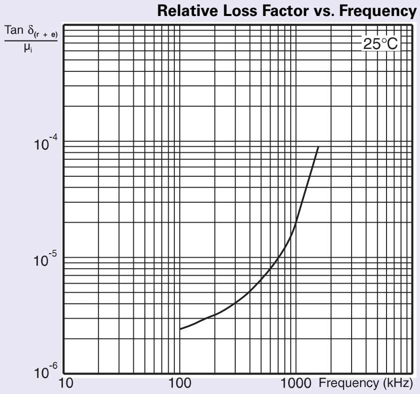
Material Specification

Parameter	Symbol	Standard Conditions of test	Unit	F58
Initial Permeability *(nominal)*	-	B<0.1mT 10kHz 25°C	-	**750** *±20%*
Saturation Flux Density *(typical)*	B_{sat}	H=796 A/m = 10 Oe 25°C	mT	**450**
Remanent Flux Density *(typical)*	B_r	H→ 0 (from near Saturation) 10kHz 25°C	mT	**94**
Coercivity *(typical)*	H_c	B→ 0 (from near Saturation) 10kHz 25°C	A/m	**47**
Loss Factor *(maximum)*	$\frac{\tan\delta_{(r+e)}}{\mu_i}$	B<0.10mT 25°C 200kHz 1MHz	10^{-6}	**12** **20**
Curie Temperature *(minimum)*	Θ_C	B<0.10mT 10kHz	°C	**200**
Hysteresis Material Constant *(maximum)*	η_B	B from 1.5 to 3mT 10kHz 25°C	10^{-6}/ °C	**1.8**
Disaccommodation Factor *(maximum)*	$\frac{\Delta\mu}{\mu_i^2 . \log_{10}(t_2/t_1)}$	10 to 100mins. 50°C B<0.25mT 10kHz	10^{-6}	**12**
Temperature Factor	$\frac{\Delta\mu}{\mu_i^2 . \Delta T}$	+25°C to +55°C B<0.10mT 10kHz	°C	**0.5 to 2.3**
Resistivity *(typical)*	ρ	1 V/cm 25°C	ohm-cm	**100**

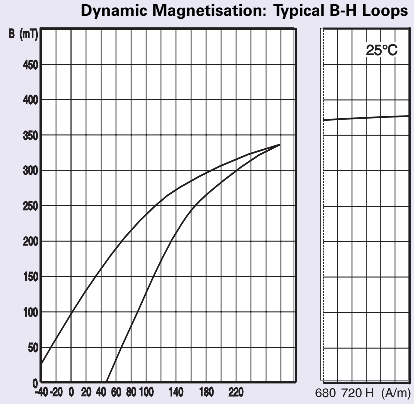
Complex Permeability vs. Frequency



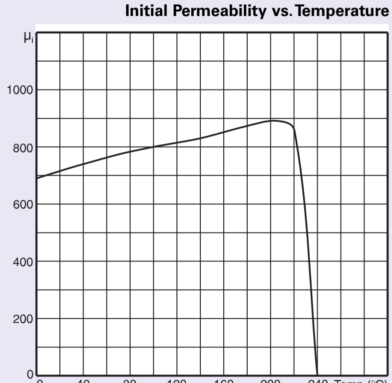
Relative Loss Factor vs. Frequency



Dynamic Magnetisation: Typical B-H Loops



Initial Permeability vs. Temperature



MMG

Data is derived from measurements on a ring core of 30mm outside diameter.

F19

Material Type: Nickel-Zinc Ferrite

Properties:
*Medium permeability
*Low loss factors at low frequencies
*High impedance at megahertz frequencies

Frequency range: 100kHz - 1MHz (Low losses)
25MHz - 100MHz (High impedance)

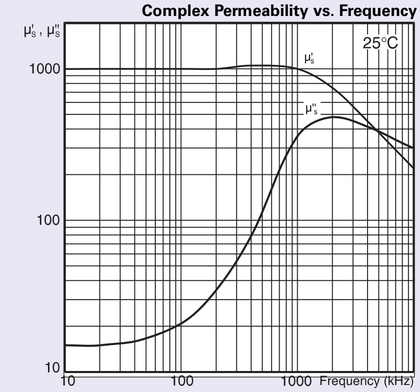
Typical Applications: SMD suppression

Available core shapes: Ring cores, beads, sleeves, cable suppressors, SM beads.

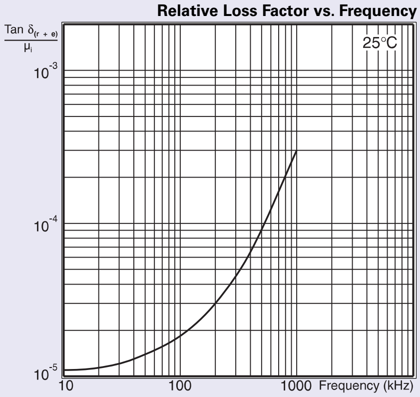
Material Specification

Parameter	Symbol	Standard Conditions of test	Unit	F19
Initial Permeability *(nominal)*	-	B<0.1mT 10kHz 25°C	-	**1000** *±20%*
Saturation Flux Density *(typical)*	B_{sat}	H=796 A/m = 10 Oe 25°C	mT	**260**
Remanent Flux Density *(typical)*	B_r	H→ 0 (from near Saturation) 10kHz 25°C	mT	**165**
Coercivity *(typical)*	H_c	B→ 0 (from near Saturation) 10kHz 25°C	A/m	**53**
Loss Factor *(maximum)*	$\frac{\tan\delta_{(r+e)}}{\mu_i}$	B<0.10mT 25°C 500kHz 1MHz	10^{-6}	**130** **350**
Curie Temperature *(minimum)*	Θ_C	B<0.10mT 10kHz	°C	**120**
Temperature Factor	$\frac{\Delta\mu}{\mu_i^2.\Delta T}$	+25°C to +55°C B<0.10mT 10kHz	°C	**3 to 6.5**
Resistivity *(typical)*	ρ	1 V/cm 25°C	ohm-cm	**10^4**

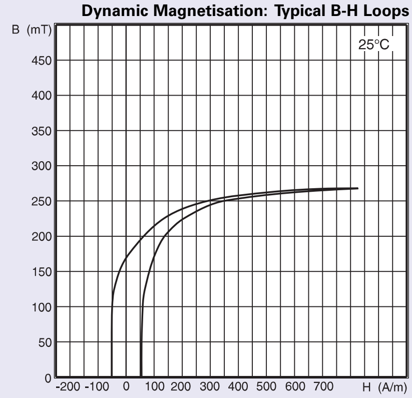
Complex Permeability vs. Frequency



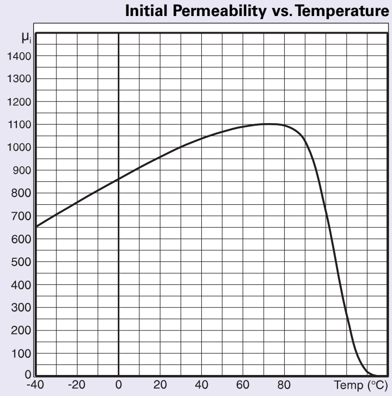
Relative Loss Factor vs. Frequency



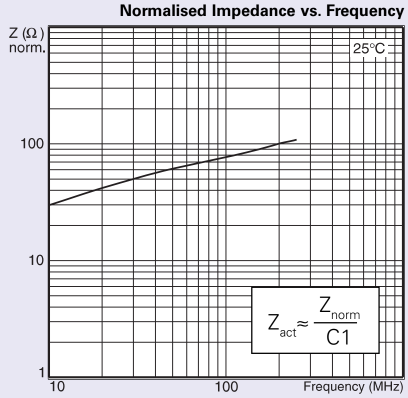
Dynamic Magnetisation: Typical B-H Loops



Initial Permeability vs. Temperature



Normalised Impedance vs. Frequency



MMG

Data is derived from measurements on a ring core of 30mm outside diameter.

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F14

Material Type: Nickel-Zinc Ferrite

Properties: *Low loss factors at medium frequencies
*High suppression impedance at high frequencies

Frequency range: Up to 3MHz (Low losses)
Over 100MHz (Suppression)

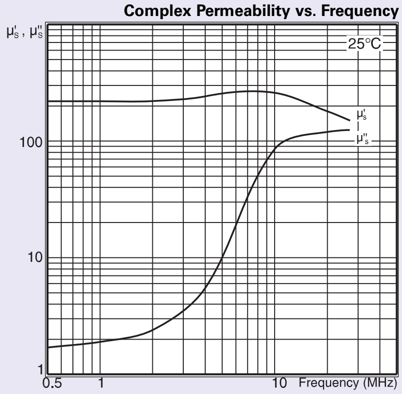
Typical Applications: RF Suppression, balun transformers, aerial rods, medium frequency tuned circuits.

Available core shapes: Rods, Chokes.

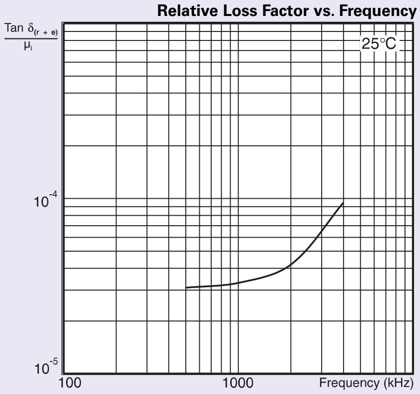
Material Specification

Parameter	Symbol	Standard Conditions of test	Unit	F14
Initial Permeability *(nominal)*	-	B<0.1mT 10kHz 25°C	-	**220** *±20%*
Saturation Flux Density *(typical)*	B_{sat}	H=796 A/m = 10 Oe 25°C	mT	**350**
Remanent Flux Density *(typical)*	B_r	H→ 0 (from near Saturation) 10kHz 25°C	mT	**217**
Coercivity *(typical)*	H_c	B→ 0 (from near Saturation) 10kHz 25°C	A/m	**172**
Loss Factor *(maximum)*	$\frac{\tan \delta_{(r+e)}}{\mu_i}$	B<0.10mT 500kHz / 1MHz / 25°c 2MHz	10^{-6}	**40** / **42** / **50**
Curie Temperature *(minimum)*	Θ_C	B<0.10mT 10kHz	°C	**270**
Temperature Factor	$\frac{\Delta\mu}{\mu_i^2 . \Delta T}$	+25°C to +55°C B<0.10mT 10kHz	°C	**12 to 30**
Resistivity *(typical)*	ρ	1 V/cm 25°C	ohm-cm	**10^5**

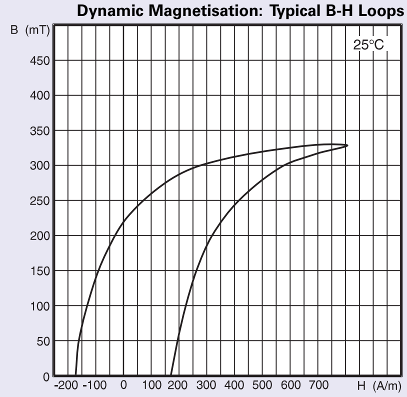
Complex Permeability vs. Frequency



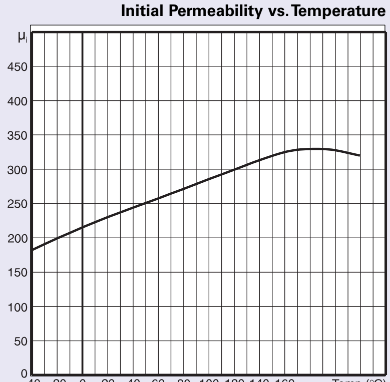
Relative Loss Factor vs. Frequency



Dynamic Magnetisation: Typical B-H Loops



Initial Permeability vs. Temperature



Data is derived from measurements on a ring core of 30mm outside diameter.

F16

Special Grade

Material Type: Nickel-Zinc Ferrite

Properties: Low loss factors at high frequency

Frequency range: 500kHz-10MHz
(Subject to application)

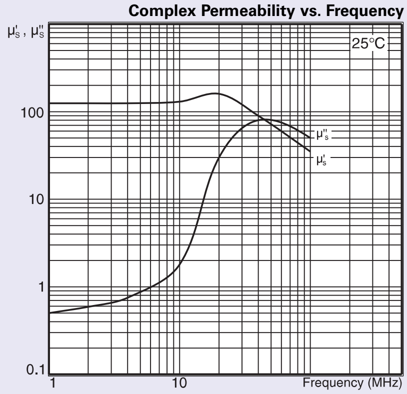
Typical Applications: Aerial rods and tuned circuits.

Available core shapes: On request.

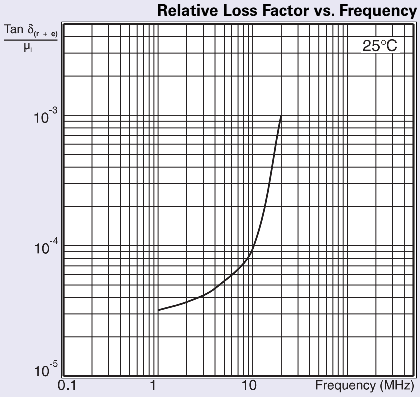
Material Specification

Parameter	Symbol	Standard Conditions of test	Unit	F16
Initial Permeability *(nominal)*	-	B<0.1mT 10kHz 25°C	-	**125** *±20%*
Saturation Flux Density *(typical)*	B_{sat}	H=796 A/m = 10 Oe 25°C	mT	**340**
Remanent Flux Density *(typical)*	B_r	H→ 0 (from near Saturation) 10kHz 25°C	mT	**260**
Coercivity *(typical)*	H_c	B→ 0 (from near Saturation) 10kHz 25°C	A/m	**200**
Loss Factor *(maximum)*	$\frac{\tan\delta_{(r+e)}}{\mu_i}$	B<0.10mT 25°c 1MHz 5MHz 10MHz	10^{-6}	**60** **65** **100**
Curie Temperature *(minimum)*	Θ_C	B<0.10mT 10kHz	°C	**270**
Temperature Factor	$\frac{\Delta\mu}{\mu_i^2.\Delta T}$	+25°C to +55°C B<0.10mT 10kHz	°C	**20 to 50**
Resistivity *(typical)*	ρ	1 V/cm 25°C	ohm-cm	**10^5**

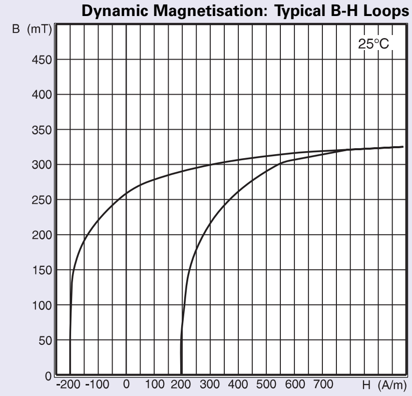
Complex Permeability vs. Frequency



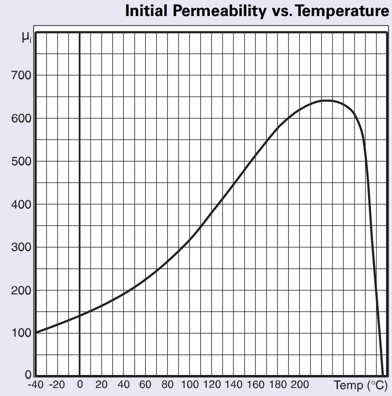
Relative Loss Factor vs. Frequency



Dynamic Magnetisation: Typical B-H Loops



Initial Permeability vs. Temperature



MMG

Data is derived from measurements on a ring core of 145x3.8x12mm (ODxIDxHT)

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F25 F28 F29 Special Grades

Material Type: Nickel-Zinc Ferrite

Properties: *Perminvar
*Very high Q at high frequency

Frequency range: 1MHz + depending on material grade

Typical Applications: Aerial rods and high frequency tuned circuits.

Available core shapes: On request.

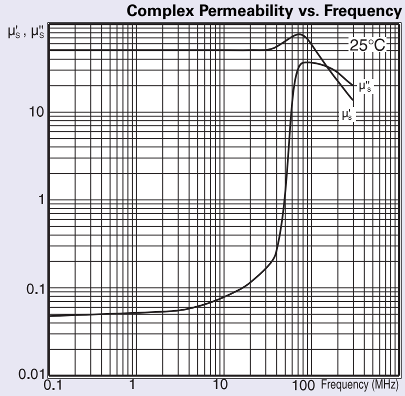
Note: Perminvar ferrites undergo irreversible changes of characteristics if subject to strong magnetic fields or mechanical shock.

Material Specifications

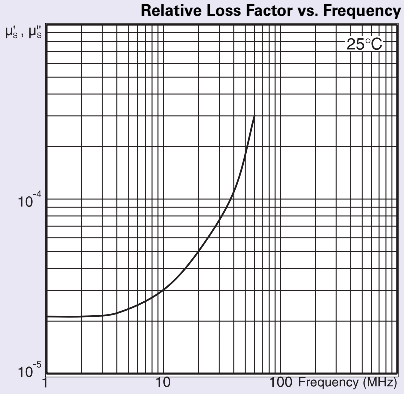
Parameter	Symbol	Standard Conditions of test		Unit	F25	F28	F29
Initial Permeability *(nominal)*		B<0.1mT 10kHz	25°C	-	**50** *±20%*	**30** *±20*	**12** *±20*
Loss Factor *(maximum)*	$\frac{\tan\delta_{(r+e)}}{\mu_i}$	B<0.10mT	1MHz	10^{-6}	**50**	-	-
			2MHz		**50**	-	-
			3MHz		**55**	-	-
			5MHz		**65**	-	-
			10MHz		**75**	**80**	**100**
			15MHz		**100**	-	-
			20MHz		**125**	-	-
			40MHz		**300**	-	-
			100MHz		-	**250**	**200**
			200MHz		-	-	**1000**
Curie Temperature *(minimum)*	Θ_C	B<0.10mT	10kHz	°C	**450**	**500**	**500**
Temperature Factor	$\frac{\Delta\mu}{\mu_i^2.\Delta T}$	+25°C to +55°C B<0.10mT	10kHz	°C	**15**	**10 to**	**3050**
Resistivity *(typical)*	ρ		1 V/cm 25°C	ohm-cm	**10^5**	**10^5**	**10^5**

F25

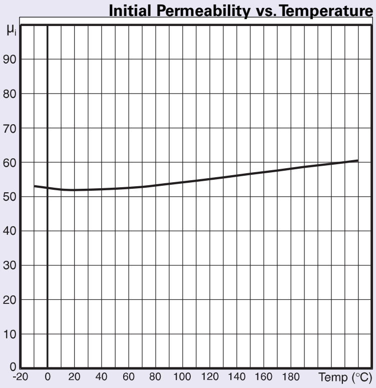
Complex Permeability vs. Frequency



Relative Loss Factor vs. Frequency

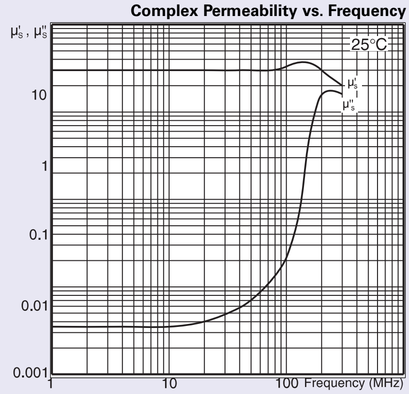


Initial Permeability vs. Temperature

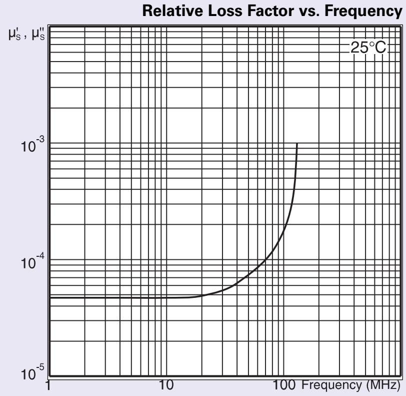


F28

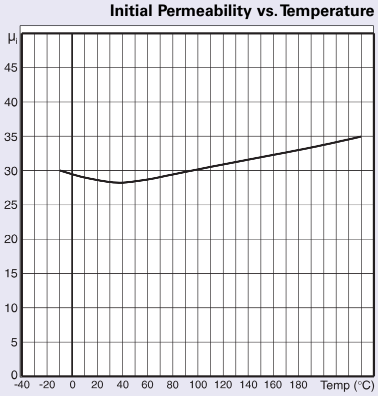
Complex Permeability vs. Frequency



Relative Loss Factor vs. Frequency

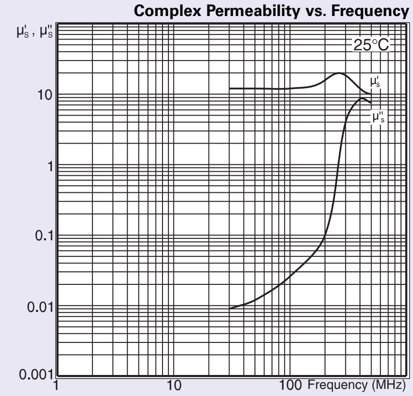


Initial Permeability vs. Temperature

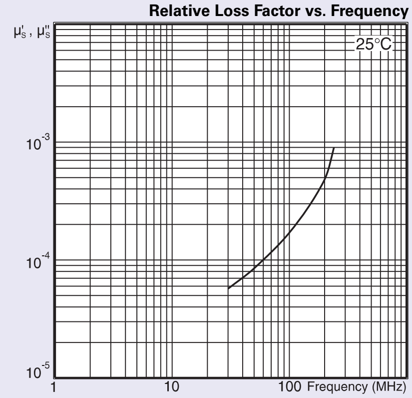


F29

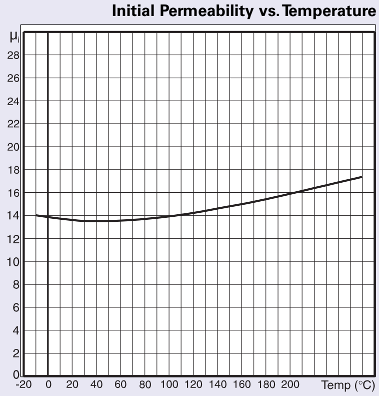
Complex Permeability vs. Frequency



Relative Loss Factor vs. Frequency



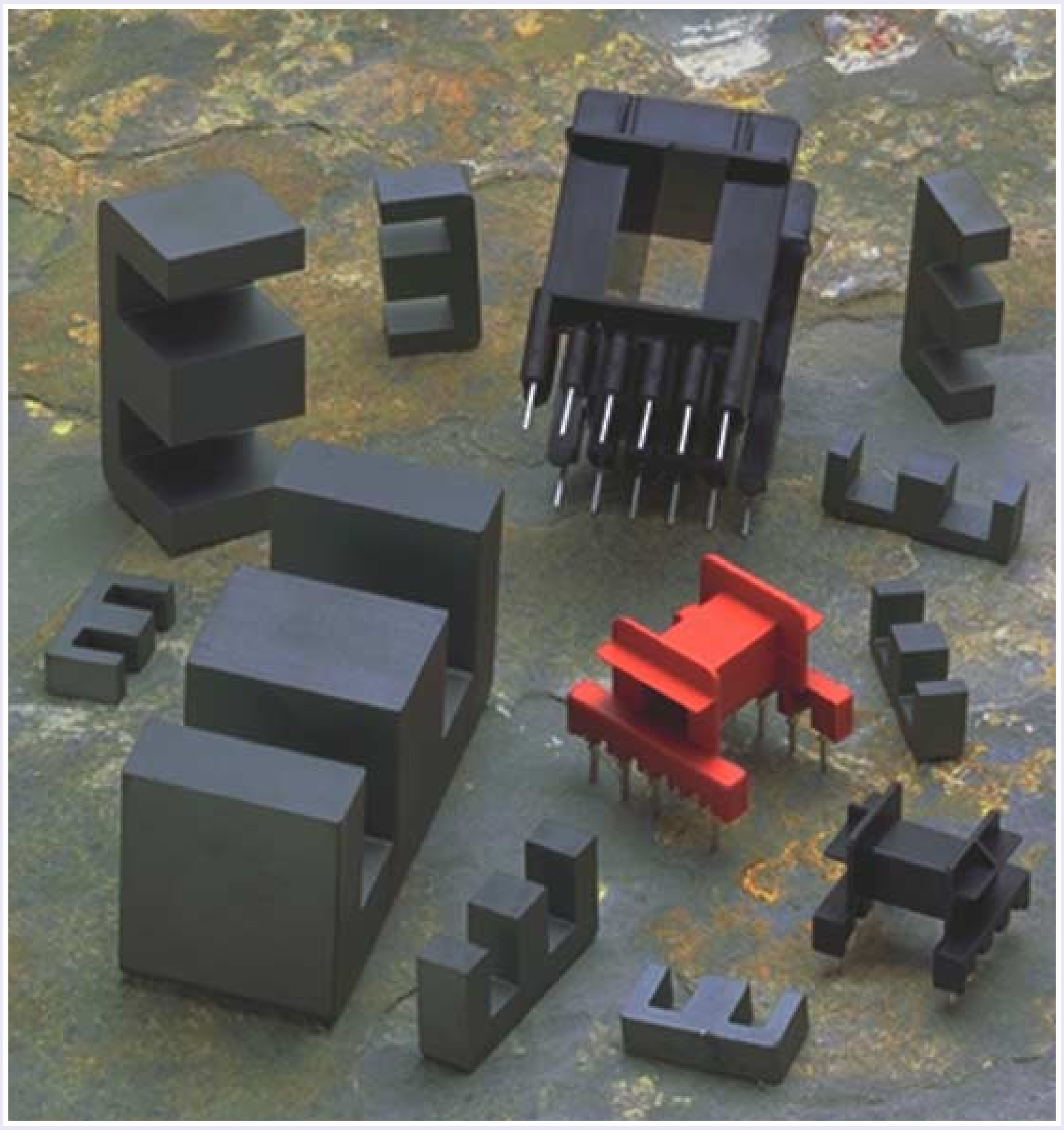
Initial Permeability vs. Temperature



MMG

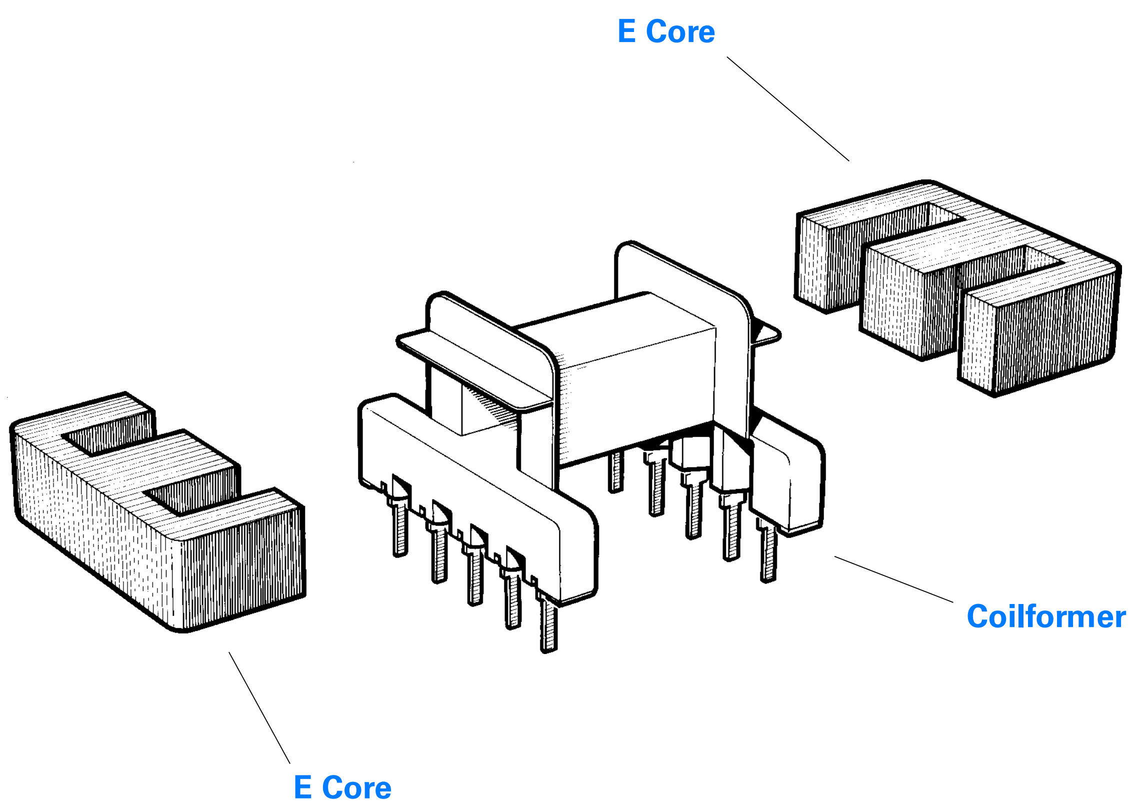
Data is derived from measurements on a ring core of 14.5x3.8x12mm (OD x ID x HT)

E Cores and Accessories



EF 12.6	32-200-	EF 25	32-190-	E 41/16/12	32-330-
EF 16	32-370-	E 25/9.5/6	32-030-	E 42/15	32-110 -
E 19/8/5	32-160-	E 30/30/7	32-130-	E 42/20	32-120-
E 20/10/5	32-140-	EF 32	32-360-	E 55/21	32-150-
EF 20	32-180-	E 34/8	32-010-	E 55/25	32-170-
		E 34/14	32-320-	E 65/27	32-240-
		E 41/9	32-020-	E 70/32	32-250-

E Series
Components



E Cores

E Cores were one of the first ferrite cores to be manufactured, being derived from their respective iron lamination size. Having rectangular limbs they are relatively easy to manufacture and as such a vast range exists in the marketplace. MMG-Neosid's range reflects a selection of cores that have become, over many years, worldwide standards through continued use. E cores are particularly suitable for power transformers and filters at low frequencies. They are not suitable in high frequency applications as the rectangluar centre limb leads to higher leakage inductance and winding resistance.

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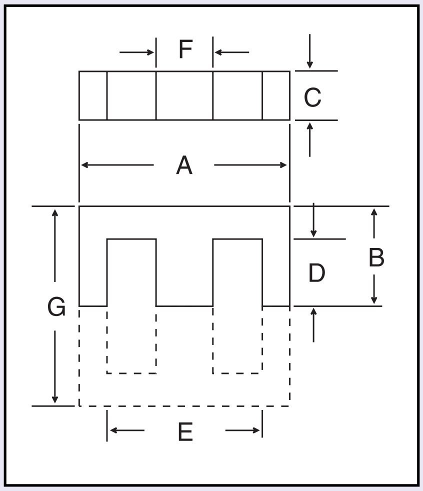
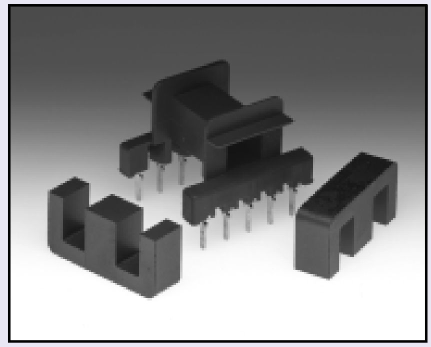
Core Dimensions (mm)

A	12.20 - 13.10	F	3.40 - 3.70
B	6.30 - 6.50	G	12.60 - 13.00
C	3.40 - 3.70		
D	4.20 - 4.50		
E	8.90 - 9.50		



EF 12.6
32-200-



Core Parameters

In accordance with IEC Document 60205.

Parameter	Σℓ/A	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	2.28mm^{-1}	29.60mm	13.00mm^2	12.20mm^2	384.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F9	1000	+30/-20%	-	1814	32-200-36
F44	760	+30/-20%	-	1380	32-200-44

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

Bobbins/Coil Formers

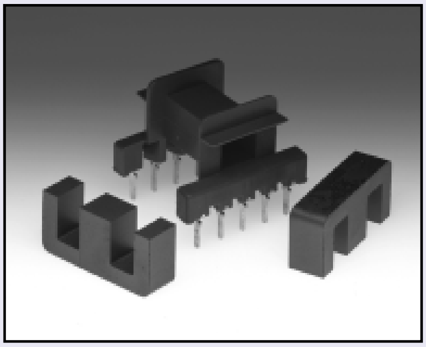
Mounting	No. of Sections	Pins	Part Number
Horizontal	1	6	59-200-66
SMD	1	10	59-205-76

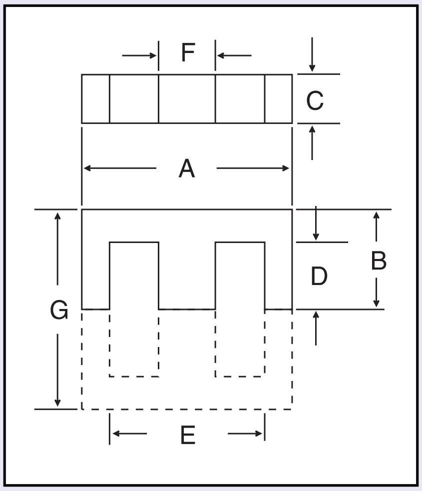
Clips

Part Number
76-075-95

MMG

EF 16
32-370-





Core Dimensions (mm)

A	15.50 - 16.70	F	4.30 - 4.70
B	7.90 - 8.20	G	15.80 - 16.40
C	4.30 - 4.70		
D	5.70 - 6.10		
E	11.30 - 11.90		

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma\ell/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	1.87mm^{-1}	37.60mm	20.10mm^2	19.40mm^2	754.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F9	1400	+30/-20%	-	2083	32-370-36
F44	960	+30/-20%	-	1428	32-370-44

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Horizontal	1	6	59-370-66
Vertical	1	6	59-375-66

Clips

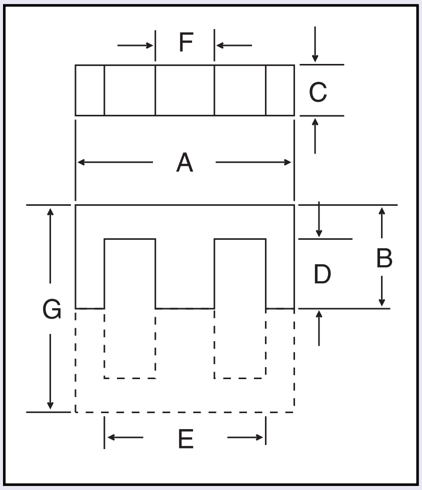
Part Number
76-076-95

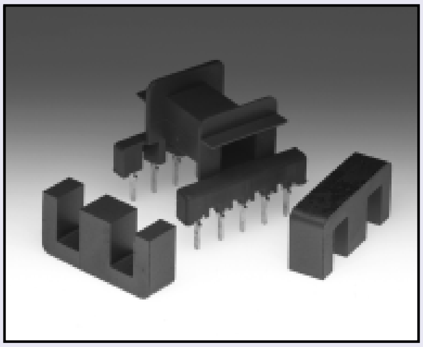
MMG

E 19/8/5
32-160-

Core Dimensions (mm)

A	18.80 - 19.80	F	4.57 - 4.93
B	7.95 - 8.20	G	15.90 - 16.40
C	4.57 - 4.93		
D	5.59 - 5.84		
E	13.80 - 15.30		





Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma l/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	l_e	A_e	A_{min}	V_e
Value	$1.78mm^{-1}$	40.00mm	$22.50mm^2$	-	$900.00mm^3$

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	970	+30/-20%	-	1375	32-160-44
F5A	1190	+30/-20%	-	1685	32-160-49
F9	2160	+30/-20%	-	3060	32-160-36
F9C	2350	+30/-20%	-	3330	32-160C36

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

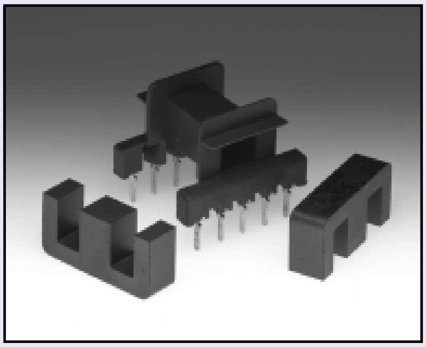
Bobbins/Coil Formers

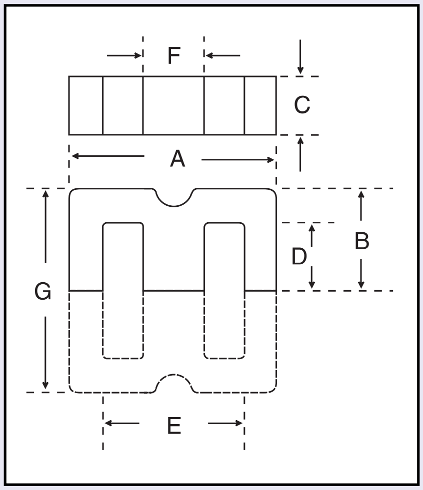
Mounting	No. of Sections	Pins	Part Number
Horizontal	1	8	59-160-76

MMG

E 20/10/5

32-140-





Core Dimensions (mm)

A	19.60 - 20.70	F	4.80 - 5.20
B	9.80 - 10.20	G	19.60 - 20.40
C	4.90 - 5.30		
D	6.30 - 6.70		
E	12.80 - 13.40		

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma \ell / A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	1.37mm^{-1}	43.00mm	31.00mm^2	25.50mm^2	1330.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	1390	+30/-20%	-	1515	32-140-44
F9	2500	+30/-20%	-	2725	32-140-36

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

Bobbins/Coil Formers

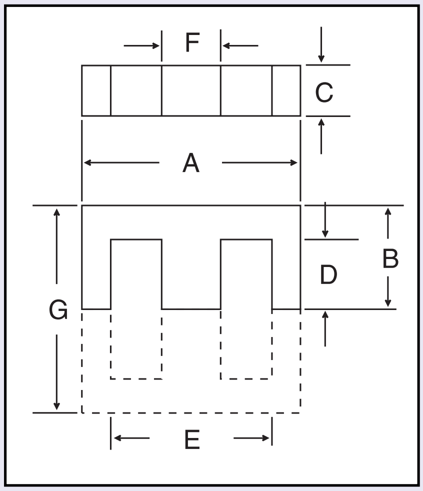
Mounting	No. of Sections	Pins	Part Number
Horizontal	1	8	59-140-64

Clips

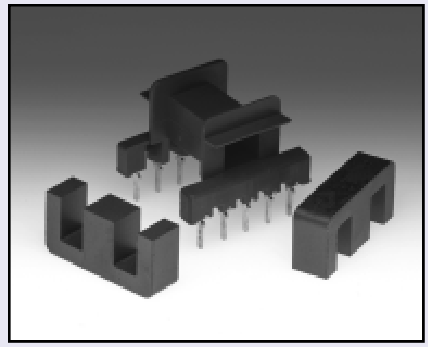
Part Number
76-077-95

Core Dimensions (mm)

A	19.60 - 20.70	F	5.60 - 5.90
B	9.80 - 10.10	G	19.60 - 20.20
C	5.50 - 5.90		
D	7.00 - 7.30		
E	14.10 - 14.70		



EF 20
32-180-



Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma \ell / A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	1.34mm^{-1}	44.90mm	33.50mm^2	31.40mm^2	1500.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	1300	+30/-20%	-	1385	32-180-44
F9	2500	+30/-20%	-	2585	32-180-36

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

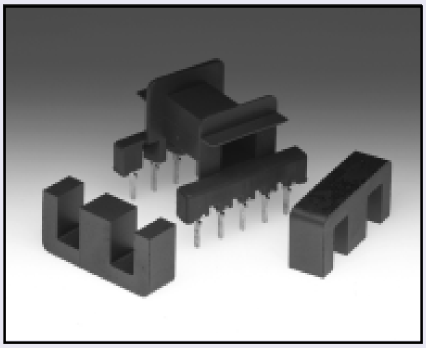
Bobbins/Coil Formers

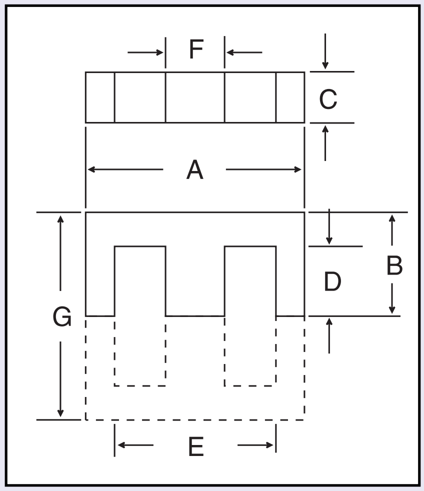
Mounting	No. of Sections	Pins	Part Number
Horizontal	1	8	59-180-66

Clips

Part Number
76-077-95

EF 25
32-190-





Core Dimensions (mm)

A	24.30 - 25.40	F	7.00 - 7.50
B	12.30 - 12.80	G	24.60 - 25.60
C	6.90 - 7.50		
D	8.70 - 9.20		
E	17.50 - 18.30		

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma\ell/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	1.09mm^{-1}	57.50mm	52.50mm^2	51.50mm^2	3020.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F47	1550	+30/-20%	-	1345	32-190-47
F44	1710	+30/-20%	-	1485	32-190-44
F45	1900	+30/-20%	-	1650	32-190-45
F9	3100	+30/-20%	-	2690	32-190-36
F10	4500	+30/-20%	-	3900	32-190-37

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

Bobbins/Coil Formers

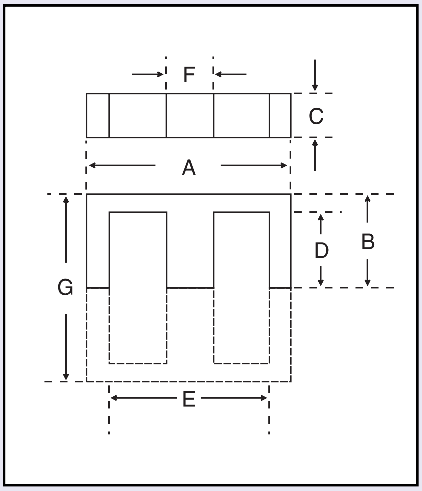
Mounting	No. of Sections	Pins	Part Number
Horizontal	1	10	59-190-66
Horizontal	2	10	59-191-66

Clips

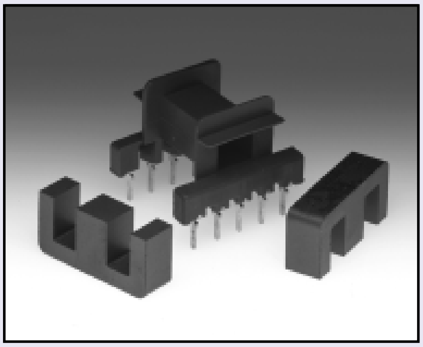
Part Number
76-078-95

Core Dimensions (mm)

A	24.77 - 26.03	F	6.07 - 6.47
B	9.40 - 9.65	G	18.80 - 19.30
C	6.07 - 6.47		
D	6.30 - 6.68		
E	19.05 - 20.07		



E 25/9.5/6
32-030-



Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma\ell/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	1.28mm^{-1}	48.70mm	38.10mm^2	-	1860.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	1480	+30/-20%	-	1510	32-030-44
F5A	1835	+30/-20%	-	1870	32-030-49
F9	2740	+30/-20%	-	2790	32-030-36
F9C	3280	+30/-20%	-	3340	32-030C36
F10	4000	+30/-20%	-	4075	32-030-37
F39	8570	+40/-30%	-	8730	32-030-39

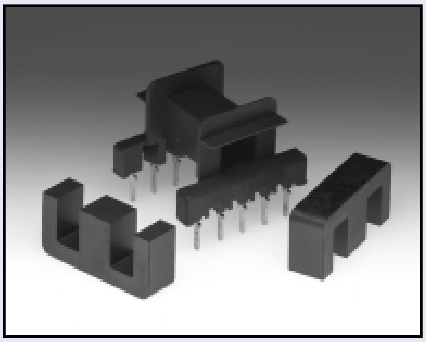
Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

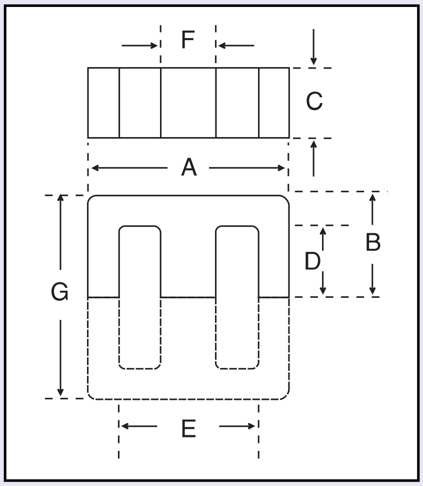
Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Horizontal	1	0	59-030-66
Horizontal	1	10	59-031-66

MMG

E 30/30/7
32-130-





Core Dimensions (mm)

A	29.40 - 30.80	F	6.80 - 7.20
B	14.80 - 15.20	G	29.60 - 30.40
C	6.80 - 7.30		
D	9.20 - 9.70		
E	19.50 - 20.30		

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma\ell/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	1.12mm^{-1}	67.00mm	60.00mm^2	-	4000.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	1800	+30/-20%	-	1605	32-130-44
F45	1800	+30/-20%	-	1605	32-130-45
F9	3300	+30/-20%	-	2940	32-130-36

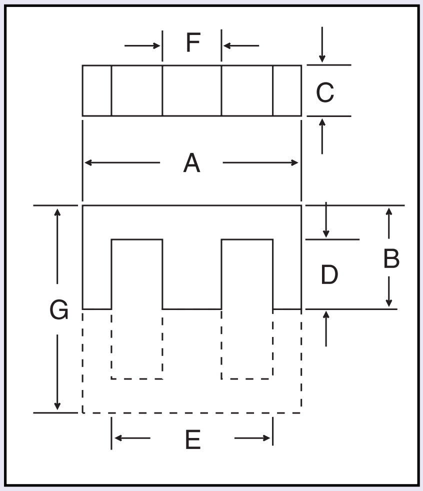
Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

Bobbins/Coil Formers

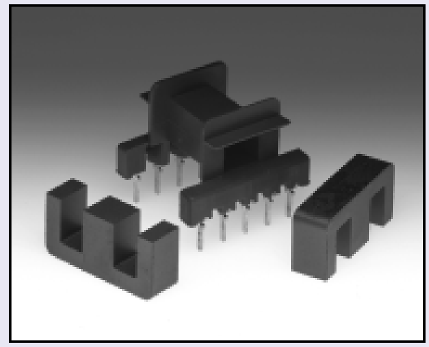
Mounting	No. of Sections	Pins	Part Number
Horizontal	1	10	59-130-64
Horizontal	1	12	59-130-66

Core Dimensions (mm)

A	31.30 - 32.90	F	8.90 - 9.50
B	15.80 - 16.40	G	31.60 - 32.80
C	8.80 - 9.50		
D	11.20 - 11.80		
E	22.70 - 23.70		



EF 32
32-360-



Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma \ell / A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.89mm^{-1}	74.31mm	83.16mm^2	81.40mm^2	6180.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	2135	+30/-20%	-	1510	32-360-44

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

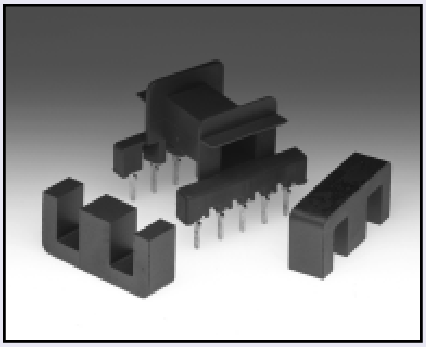
Bobbins/Coil Formers

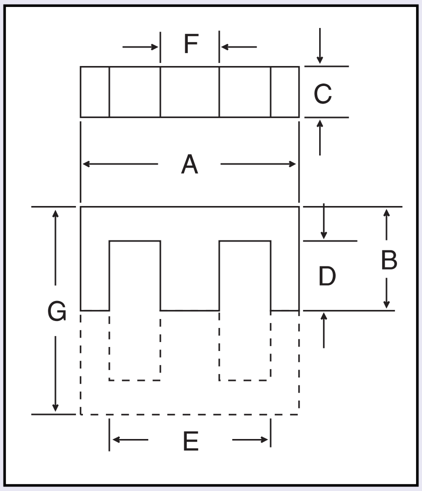
Mounting	No. of Sections	Pins	Part Number
Horizontal	1	12	59-360-66

Clips

Part Number
76-079-95

E 34/8
32-010-





Core Dimensions (mm)

A	33.26 - 35.02	F	10.81 - 11.45
B	13.05 - 13.16	G	26.10 - 26.32
C	7.63 - 8.12		
D	8.28 - 8.78		
E	23.86 - 25.32		

Core Parameters

In accordance with IEC Document 60205.

Parameter	Σℓ/A	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.808mm^{-1}	62.50mm	77.40mm^2	-	4840.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F9	4100	+30/-20%	-	2640	32-010-36
F44	2250	+30/-20%	-	1450	32-010-44

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

Bobbins/Coil Formers

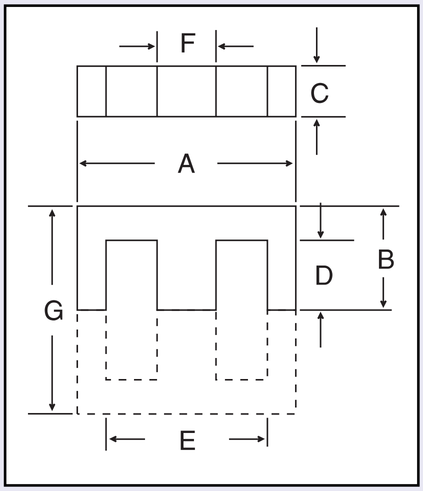
Mounting	No. of Sections	Pins	Part Number
Horizontal	1	-	59-010-66

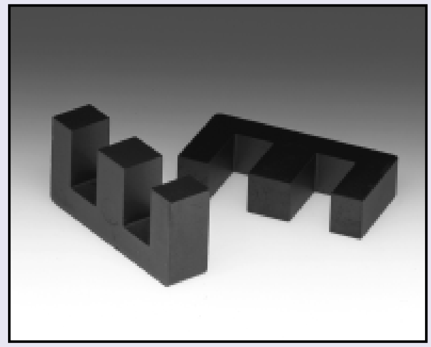
MMG

E 34/14 (US E375)
32-320-

Core Dimensions (mm)

A	34.16 - 35.20	F	9.27 - 9.53
B	14.27 - 14.53	G	18.54 - 19.06
C	9.02 - 9.52		
D	9.53 - 9.77		
E	25.02 min.		





Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma \ell / A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.79mm^{-1}	69.17mm	87.96mm^2	-	6084.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	2380	+30/-20%	-	1490	32-320-44
F5A	2890	+25/-25%	-	1810	32-320-49
F9C	4800	+30/-20%	-	30200	32-320C36

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

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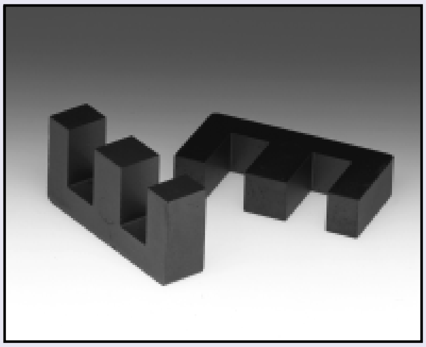
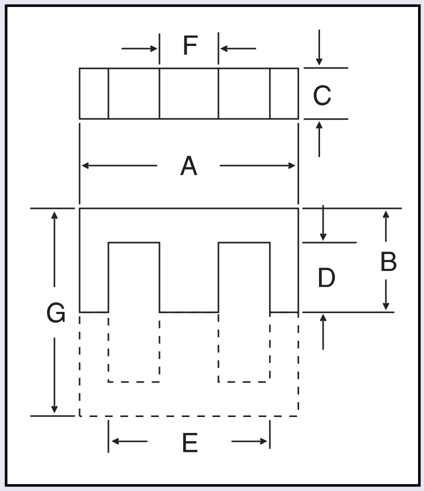
E 41/9
32-020-





Core Dimensions (mm)

A	39.72 - 42.28	F	11.54 - 11.98
B	22.22 - 22.33	G	44.44 - 44.66
C	8.70 - 8.98		
D	16.21 - 17.19		
E	28.00 - 29.10		

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma \ell / A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	$0.973mm^{-1}$	102mm	$105mm^2$	-	$10,600mm^3$

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F9	3750	+30/-20%	-	2900	32-020-36
F44	1875	+30/-20%	-	1450	32-020-44

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

Bobbins/Coil Formers

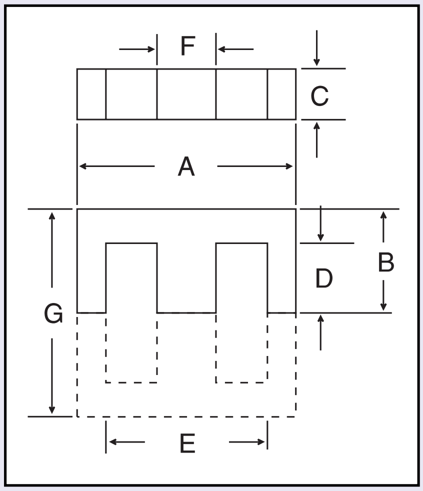
Mounting	No. of Sections	Pins	Part Number
Horizontal	1	-	59-020-66

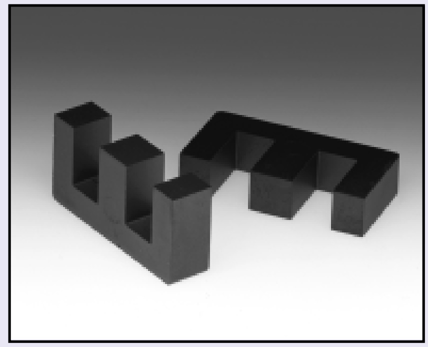
Two bobbins are required for each pair of E cores.

E 41/16 (US E21)
32-330-

Core Dimensions (mm)

A	39.84 - 41.44	F	12.20 - 12.70
B	16.30 - 16.66	G	32.60 - 33.32
C	12.20 - 12.70		
D	10.41 - 10.67		
E	28.58 min.		





Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma\ell/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	$0.50mm^{-1}$	77.23mm	$153.00mm^2$	-	$11841.00mm^3$

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	3585	+30/-20%	-	1425	32-330-44
F5A	4375	+30/-20%	-	1740	32-330-49

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Horizontal	1	12	59-330-66

Two bobbins are required for each pair of E cores.

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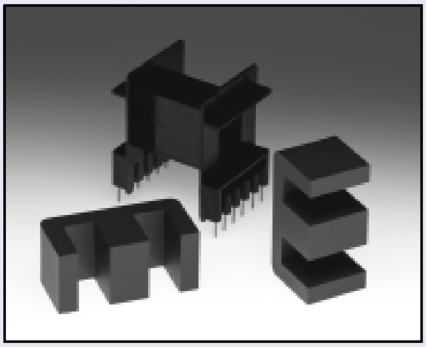
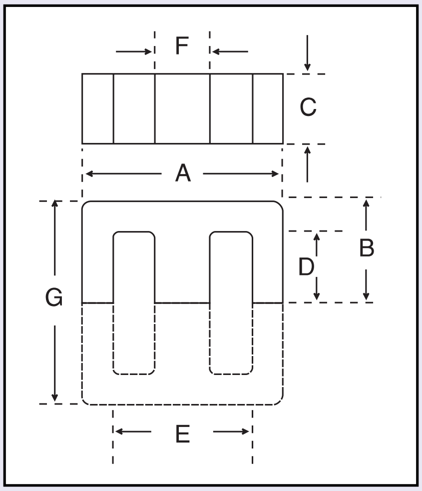
E 42/15
32-110-





Core Dimensions (mm)

A	41.30 - 43.00	F	11.70 - 12.20
B	20.80 - 21.20	G	41.60 - 42.40
C	14.70 - 15.20		
D	14.80 - 15.40		
E	29.50 - 30.70		

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma\ell/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.54mm^{-1}	97.00mm	181.00mm^2	175.00mm^2	17600.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	3500	+30/-20%	-	1490	32-110-44
F45	3815	+30/-20%	-	1625	32-110-45
F9C	7700	+30/-20%	-	3280	32-110C36

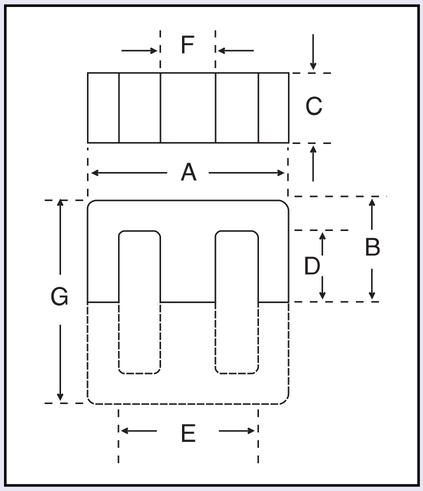
Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

Bobbins/Coil Formers

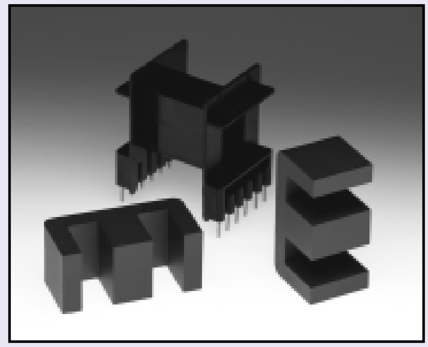
Mounting	No. of Sections	Pins	Part Number
Horizontal	1	10	59-110-66
Horizontal	1	12	59-113-66

Core Dimensions (mm)

A	41.30 - 43.00	F	11.70 - 12.20
B	20.80 - 21.20	G	41.60 - 42.40
C	19.40 - 20.00		
D	14.80 - 15.40		
E	29.40 - 30.70		



E 42/20
32-120-



Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma l/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	l_e	A_e	A_{min}	V_e
Value	$0.41mm^{-1}$	97.00mm	$240.00mm^2$	$232.00mm^2$	$23300.00mm^3$

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	4560	+30/-20%	-	1470	32-120-44

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Horizontal	1	12	59-120-66

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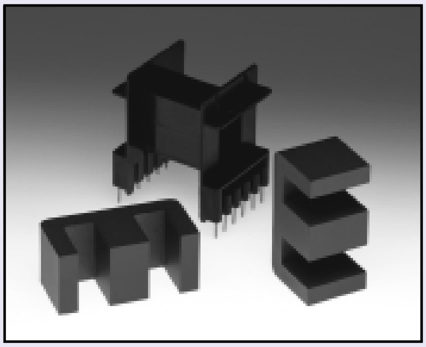

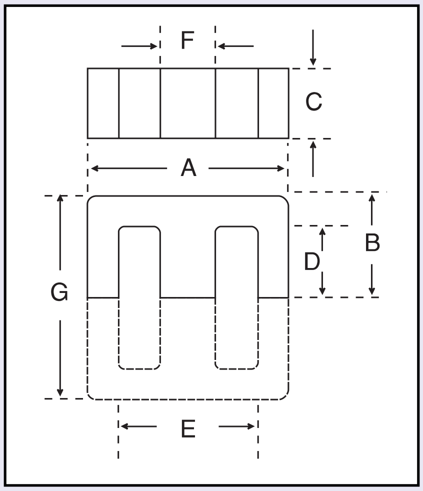

Core Dimensions (mm)

A	54.10 - 56.20	F	16.70 - 17.20
B	27.20 - 27.80	G	54.40 - 55.60
C	20.40 - 21.00		
D	18.50 - 19.10		
E	37.50 - 38.70		

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma l/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	l_e	A_e	A_{min}	V_e
Value	0.35mm^{-1}	123.00mm	355.00mm^2	350.00mm^2	43700.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	5570	+30/-20%	-	1550	32-150-44
F5A	6366	+30/-20%	-	1775	32-150-49
F9	11040	+30/-20%	-	3075	32-150-36

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Horizontal	1	14	59-150-66

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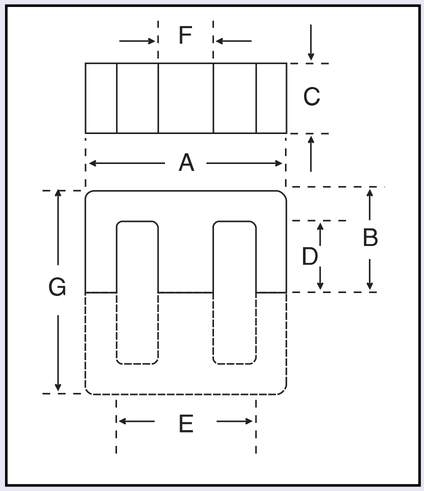
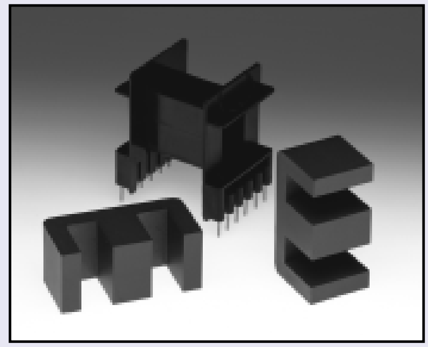
Core Dimensions (mm)

A	54.10 - 56.20	F	16.70 - 17.20
B	27.20 - 27.80	G	54.40 - 55.60
C	24.40 - 25.00		
D	18.50 - 19.10		
E	37.50 - 38.70		



E 55/25
32-170-



Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma l/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	l_e	A_e	A_{min}	V_e
Value	0.29mm^{-1}	123.00mm	420.00mm^2	420.00mm^2	52000.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	6875	+30/-20%	-	1585	32-170-44
F5A	7600	+30/-20%	-	1755	32-170-49

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Horizontal	1	14	59-170-66

MMG

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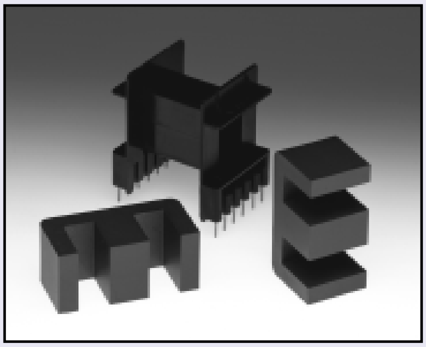
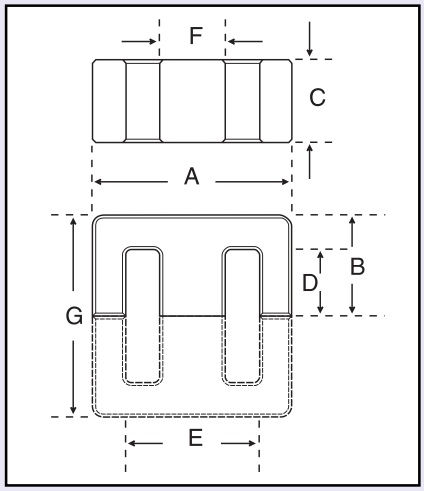
E 65/27
32-240-





Core Dimensions (mm)

A	63.80 - 66.50	F	19.30 - 20.00
B	32.20 - 32.80	G	64.40 - 65.60
C	26.80 - 27.40		
D	22.20 - 22.90		
E	44.20 - 45.70		

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma\ell/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.28mm^{-1}	147.00mm	532.00mm^2	532.00mm^2	78200.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	7430	+30/-20%	-	1625	32-240-44
F5A	10250	+30/-20%	-	2240	32-240-49
F44	470 Approx.	-	2.00 ±0.10 mm	105	32-242-44

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

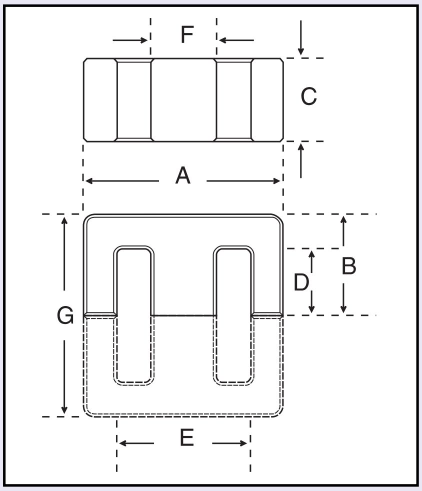
Bobbins/Coil Formers

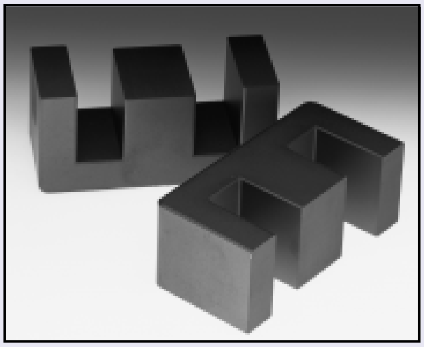
Mounting	No. of Sections	Pins	Part Number
Horizontal	1	16	59-240-66

E 70/32
32-250-

Core Dimensions (mm)

A	68.65 - 70.35	F	21.78 - 22.48
B	32.00 - 32.50	G	64.00 - 65.00
C	31.42 - 32.08		
D	21.24 - 21.74		
E	47.63 - 49.13		





Core Parameters

In accordance with IEC Document 60205.

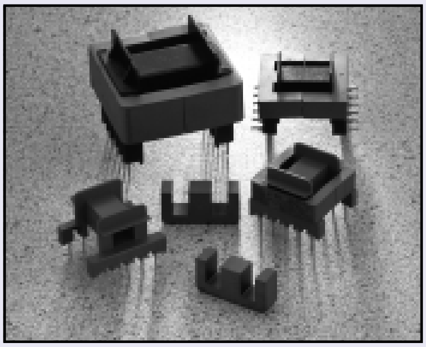
Parameter	Σℓ/A	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.21mm^{-1}	146.00mm	697.00mm^2	671.00mm^2	101922.00mm^3

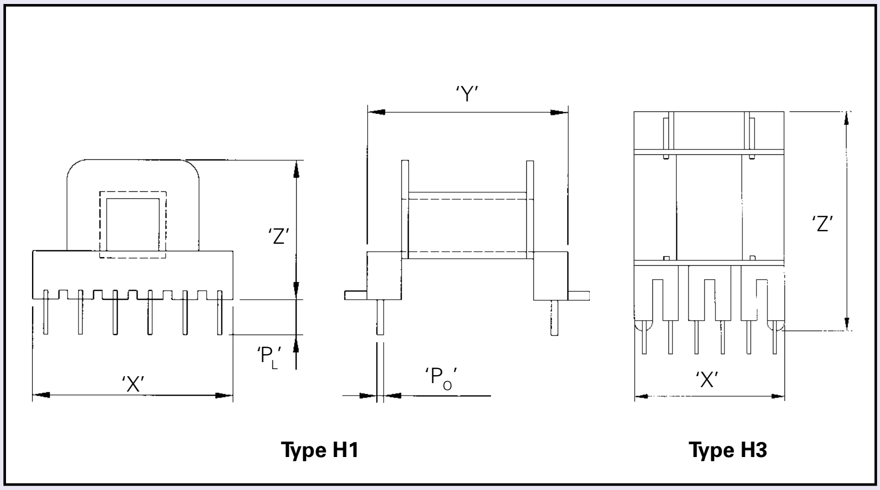
Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	9060	+30/-20%	-	1514	32-250-44
F5A	11125	+30/-20%	-	1860	32-250-49

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

EE Coilformers 59-XXX-





Part No.	Type	Dimensions			Winding Data		No. of sections
		'X'	'Y'	'Z'	A_N (mm²)	I_N (mm)	
59-140-64	H_1	17.50	17.50	11.80	25.0	30.0	Single
59-030-66	H_4	21.10	18.60	12.90	56.2	41.0	Single
59-031-66	H_1	24.00	18.90	19.90	52.3	41.8	Single
59-130-66	H_1	28.8	28.8	20.0	83.4	44.8	Single
59-010-66	H_4	23.60	20.30	16.20	73.4	55.3	Single
59-020-66*	H_4	27.70	24.90	16.0	97.3	61.2	Single
59-100-66	H_1	29.0	38.0	35.0	165.0	90.0	Single
59-113-66	H_3	29.0	39.7	38.6	180	88	Single
59-120-66	H_3	29.0	39.7	42.9	180	98	Single
59-150-66	H_3	37.0	44.7	47.4	280	110	Single
59-170-66	H_3	37.0	44.7	51.4	280	117	Single
59-240-66	H_3	40.0	52.6	55.9	414	134	Single

* Two coilformers required for a pair of E Cores. 32-020-XX

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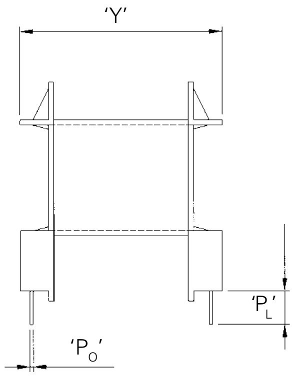
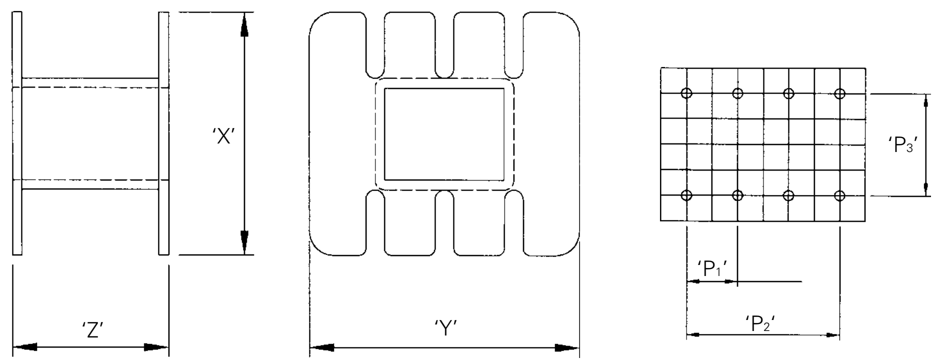


Type H3

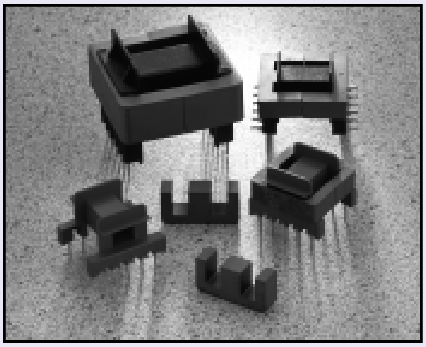


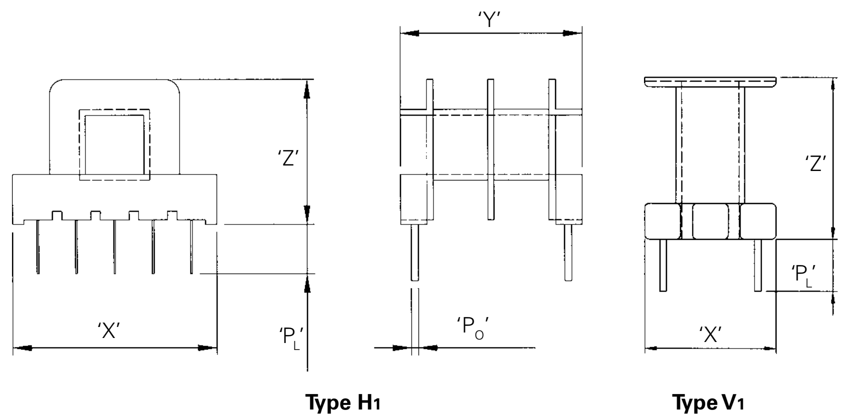
Type H4

Pin Details						Material	Clip Part Number
8	0.85	5.0	20.0	15.0	3.50	Glass filled Phenolic	76-077-95
-	-	-	-	-	-	Glass filled Nylon 66	-
10	0.95*	5.08	20.32	15.24	5.0	G.F. Nylon 66 (VO)	-
12	0.95*	5.00	25.0	25.0	5.0	G.F. Nylon 66 (VO)	-
-	-	-	-	-	-	G.F. Nylon 66	-
-	-	-	-	-	-	G.F. Nylon 66	-
10	1.10**	5.00	20.0	35.0	10.5	G.F. Nylon 66	-
12	Sq.0.70	5.08	25.40	35.56	4.1	G.F. Nylon 66 (VO)	-
12	Sq.0.70	5.08	25.40	35.56	4.1	G.F. Nylon 66 (VO)	76-069-95
14	Sq.0.70	5.08	30.48	40.64	4.5	G.F. Nylon 66 (VO)	76-069-75
14	Sq.0.70	5.08	30.48	40.64	4.5	G.F. Nylon 66 (VO)	76-069-75
16	Sq.1.0	5.08	35.56	45.72	4.5	G.F. Nylon 66 (VO)	-

* Fitted with rectangular tag 0.95 x 1.1mm
** Fitted with rectangular tag 0.6 x 1.1mm

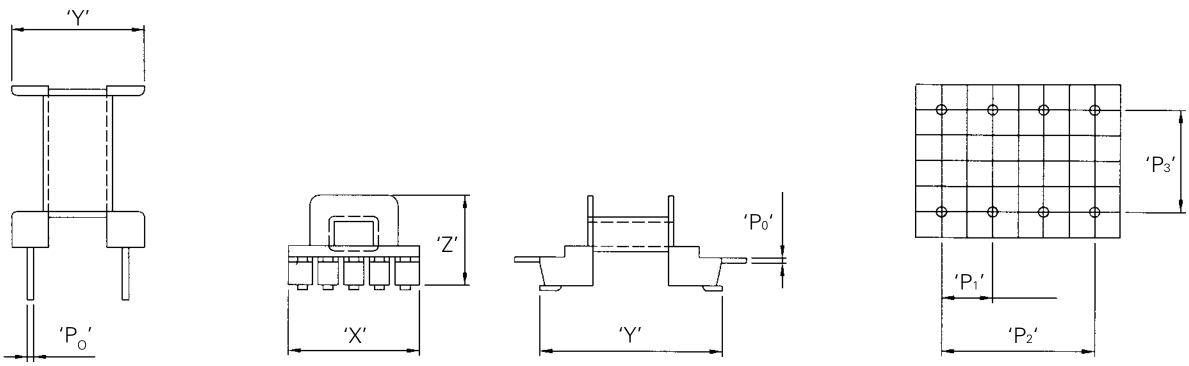
EF Coilformers
59-XXX-





Part No.	Type	Dimensions			Winding Data		No. of sections
		'X'	'Y'	'Z'	A_N (mm²)	l_N (mm)	
59-200-66	H1	12.70	12.70	9.60	11.6	24.0	Single
59-201-66	H1	12.70	12.70	9.60	10.8	24.0	Double
59-205-76	SMD	13.00	18.00	8.90	12.0	30.6	Single
59-206-76	SMD	13.00	18.00	8.90	11.2	30.6	Double
59-370-66	H1	13.10	16.00	11.10	21.6	33.0	Single
59-371-66	H1	13.10	16.00	11.10	20.10	33.0	Double
59-375-66	V1	11.10	11.10	16.00	21.6	33.0	Single
59-376-66	V1	11.10	11.10	16.00	20.1	33.0	Double
59-180-66	H1	20.00	20.00	15.50	34.8	39.0	Single
59-181-66	H1	20.00	20.00	15.50	32.1	39.0	Double
59-185-66	V1	13.90	13.90	16.80	34.8	39.0	Single
59-186-66	V1	13.90	13.90	16.80	32.1	39.0	Double
59-190-66	H1	27.00	24.10	19.10	56.4	48.0	Single
59-191-66	H1	27.00	24.10	19.10	53.1	48.0	Double
59-196-64	V1	17.20	17.20	20.80	56.4	52.0	Single
59-360-66	H1	32.00	29.40	23.70	96.9	60.0	Single
59-361-66	H1	32.00	29.40	23.70	92.4	60.0	Double
59-365-66	V1	22.20	22.20	27.20	96.9	600	Double

MMG



Type V1 **Type SMD**

Pin Details						Material	Clip Part Number
No. of	P_0	P_1	P_2	P_3	P_L		
6	0.66*	5.08	10.16	10.16	5.50	G.F. Nylon 66 (VO)	76-075-95
6	0.66*	5.08	10.16	10.16	5.50	G.F. Nylon 66 (VO)	76-075-95
10	0.45*	2.54	10.16	16.20	-	PPS (VO)	76-075-95
10	0.45*	2.54	10.16	16.20	-	PPS (VO)	76-075-95
6	0.66*	5.00	10.00	12.50	5.50	G.F. Nylon 66	76-076-95
6	0.66*	5.00	10.00	12.50	5.50	G.F. Nylon 66	76-076-95
6	0.66*	3.75	7.50	7.50	5.50	G.F. Nylon 66	76-076-95
6	0.66*	3.75	7.50	7.50	5.50	G.F. Nylon 66	76-076-95
8	0.66*	5.00	15.0	15.0	3.50	G.F. Nylon 66	76-077-95
8	0.66*	5.00	15.0	15.0	3.50	G.F. Nylon 66	76-077-95
6	0.66*	5.00	10.0	10.0	5.00	G.F. Nylon 66	76-077-95
6	0.66*	5.00	10.0	10.0	5.00	G.F. Nylon 66	76-077-95
10	0.95†	5.08	20.32	20.32	5.20	G.F. Nylon 66 (VO)	76-078-95
10	0.95†	5.08	20.32	20.32	5.20	G.F. Nylon 66 (VO)	76-078-95
6	0.85	5.08	10.16	12.70	9.00	G.F. Phenolic	76-078-95
12	0.88**	5.08	25.40	25.40	3.50	G.F. Nylon 66	76-079-95
12	0.88**	5.08	25.40	25.40	3.50	G.F. Nylon 66	76-079-95
6	0.88**	7.50	15.0	15.0	5.0	G.F. Nylon 66	76-079-95

* Rectangular wire 0.66 x 0.45mm
** Rectangular wire 0.88 x 0.60mm
† Tag 0.95 x 0.45mm

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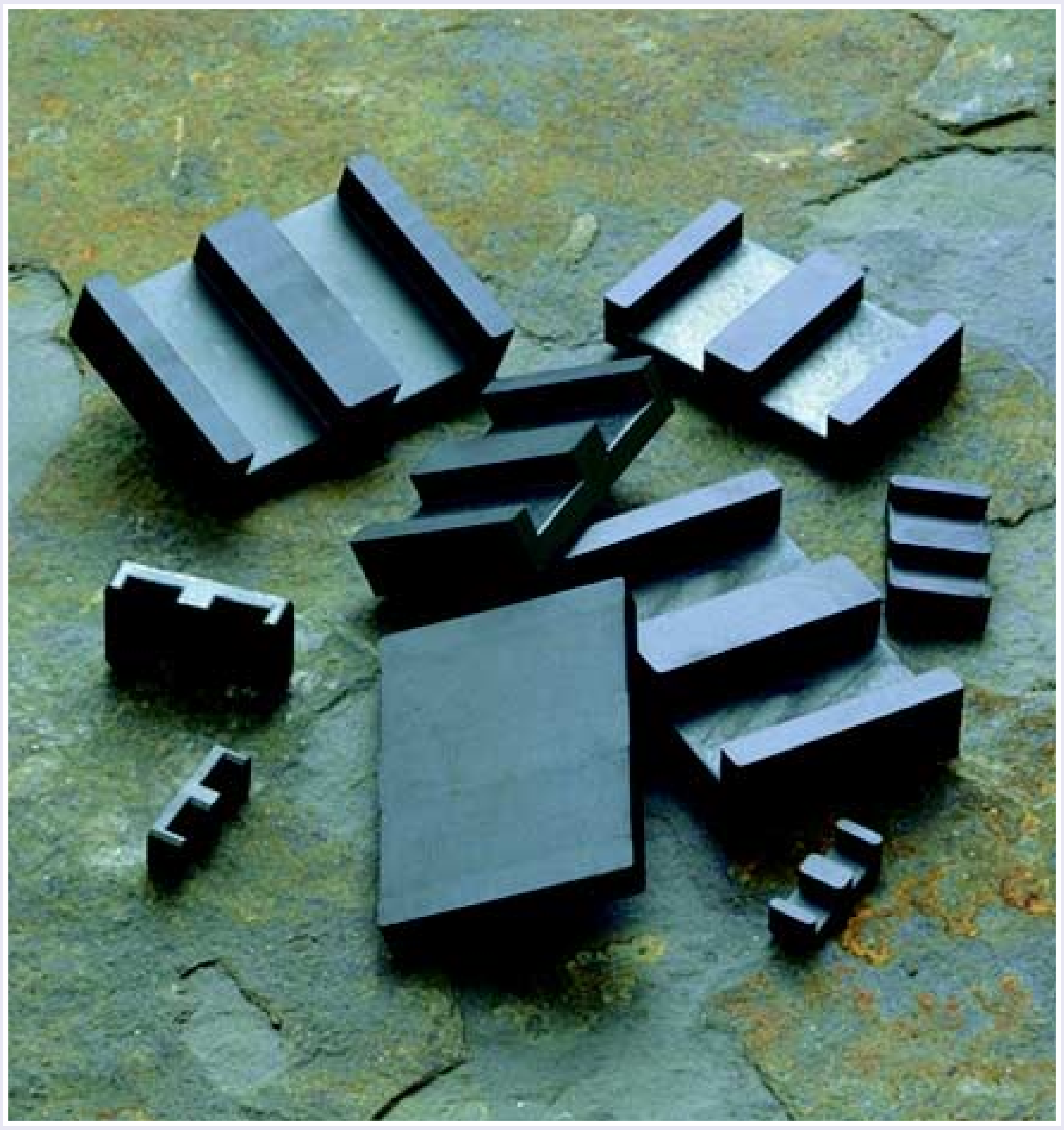
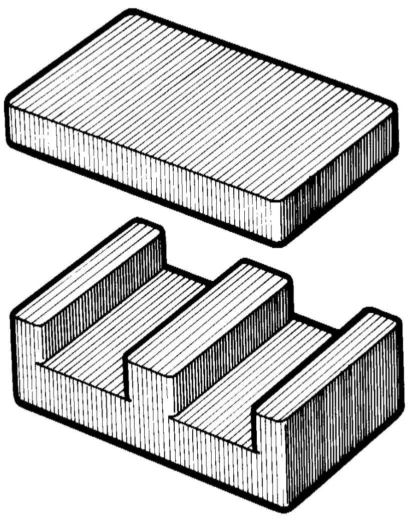
Planar E Cores

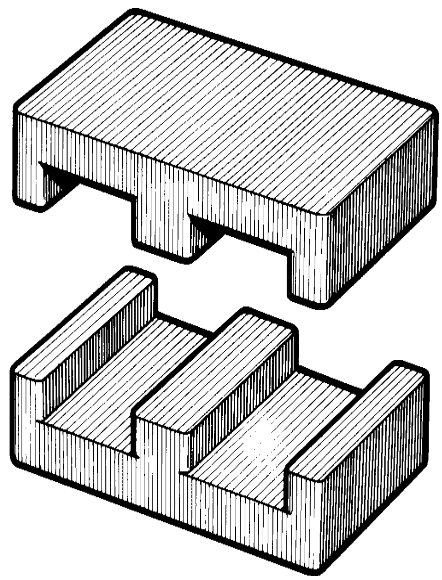


E 14/3.5/5	32-9140-
E 18/4/10	32-9180-
E 22/6/16	32-9210-
E 32/6/20	32-9320-
E 38/8/25	32-9380-
E 64/10/50	32-9640-

Planar E Series
Components



EI Pair



EE Pair

Planar E Cores

Many next generation electronics equipment will use switched mode power supplies where the voltage transformation unit is integrated on a circuit card. As cards may be racked with minimal clearances, low profile components are necessary. Planar assemblies differ radically from conventional transformers as wire windings are replaced by stacks of flat spiral laminations. In some cases the winding can be replaced by printing circuit tracks, with the E core inserted through the board. The planar E core’s low profile shape and ease of construction offers significant advantages including: Fast error-free winding; excellent heat sinking properties and efficient repeatable performance at low cost.

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Planar Magnetic Devices

Planar technology stems from the demand for reduction in size, weight and profile of switching power supplies. These can be achieved by increasing the switching frequency of the device allowing the reactive components - capacitors and wound cores to be smaller. On the magnetic design side, it also decreases the number of turns required of the winding reducing copper loss and magnetising current.

The design of the planar core range helps overcome many of the problems associated with high frequency transformers, including the hysteresis and eddy current losses in the material, and the skin effect and proximity losses of the winding. The main losses have been reduced by the development of high frequency power materials, F44 and F47 that together cover the range 100kHz - 1MHz.

Planar magnetics do not rely on the traditional wire wound bobbins but substitute the precision and repeatability of printed circuit technology.

Planar Design

The utilisation of skin depth or current penetration in the copper conductor at high frequencies is the key to planar design.

The relationship between skin depth (penetration) and frequency is:

$$D = \frac{k}{\sqrt{f}}$$

where: f = frequency (Hz)
k = thermal constant (72 at 70°C)

At 100kHz, D = 0.228mm which drops to 0.1mm at 500kHz.

Multi-layer PCB technology can closely control the track width and height, helping to optimise this relationship. For high current densities a number of track layers can be assembled in parallel. Proximity and eddy current losses are also reduced by utilising the track thickness. Planar construction onto PCB's can be top mounting or through-board.

Key to Design Terminology

Thermal Resistance

Thermal resistance is defined as the temperature in degrees Celcius per Watt of power dissipated in the core. It can be used to determine the approximate power loss in the core for a given temperature rise ie. for a given ΔT and power loss density, core volume required can be calculated.

$$R_{th} = 23 \times AP^{-0.37}$$

where $AP = A_e \times A_W$
(see 'Area Product' below)

Flux Density

The current that passes through the winding induces a magnetic field, expressed in Tesla, within the core material. The voltage across a winding is related to the flux density by:

$$B = \frac{V_{rms}}{\sqrt{2} x \pi x N x A_e x f}$$

where, N = No. of turns.

Power Loss Density

Sometimes abbreviated to PLD, this is the total material losses at a given frequency and flux density divided by the volume of ferrite.

$$PLD = Total\ loss/Effective\ Volume, V_e$$

also,

Total Power Loss(W) = Temp. rise/Thermal Resistance

So for a given temperature in the transformer, a core size can be selected (assuming that losses are split equally between the winding and the core).

Power loss can be approximated for a required frequency and flux density by the Steinmetz equation:

$$PLD = k \times f^{1.62} \times B^{2.3}$$

where, k is derived from the power loss data (206×10^{-6} for F44 at 100°C)

This is an emperical estimation and cannot be claimed to hold over a wide range of conditions and core sizes.

Area Product

This is the relationship between winding area, A_W and core cross-sectional area, A_e.

$$AP = A_e \times A_w \quad (cm^4)$$

This factor affects the current density, $J_{p(max)}$ in the primary windings.

$$J_{P(max)} = 450 \times AP^{-0.125}$$
(empirically derived)

By knowing the current density, the required wire area can be found using:

$$Axp = I_{(max)} / J_{P(max)} \quad (m^2)$$

But due to the skin effect at high frequencies, as discussed earlier, the cross-sectional area of the copper strands can be reduced. In conventional transformer design the primary would be made up from multi-strand wire. In planar design, this would equate to multi-layer boards with the reduced track thickness. For high currents, boards can be connected in parallel. The secondary copper cross-section can be calculated from the secondary current.

$$I_s = \frac{I_{0(max)}}{\sqrt{2}} \quad \text{(Amps)}$$

and the cross-section from:

$$A_{XS} = I_S / J_{P(max)}$$

The track size can then be calculated as above.
Another empirically derived relationship is that with frequency, flux density and input power.

$$AP = \left[\frac{11.1 x P_{in}}{k x \Delta B x f}\right]^{1.143}$$

where:
k = circuit topology factor.
(0.141 for Half Bridge, 0.2 for flyback)
From this the power handling capability for each core can be found. However, as with conventional transformers the insulation between the windings and associated creepage distance reduces the winding area, AW, which in turn reduces the core power handling level.

Creepage Distance

The distance between the outer and inner most winding of the primary or secondary and the corresponding turns of the next set of windings (typical values, 2 & 4mm).

Core Parameters

ℓ_e = Effective magnetic path length (mm).
A_e = Effective magnetic area (mm^2).
V_e = Effective magnetic volume (mm^3).
C_1 = Core constant $\Sigma\ell/A$ (mm^{-1}).

Inductance Factor, A_L

Used to calculate the inductance for a given number of turns (in nano-Henrys).

Typical Values for Planar E & I Cores

Core Type	Thermal Resistance R_{th} (°C/W)	Area Product (cm^4)	Power Rating* (W)
EE 14/3.5/5	92.6	0.02	20
EI 14/3.5/5	120.0	0.01	10
EE 18/4/10	58.8	0.08	40
EI 18/4/10	76.0	0.04	20
EE 22/6/16	32.6	0.30	120
EI 22/6/16	46.6	0.15	60
EE 32/6/20	25.4	0.77	280
EI 32/6/20	32.9	0.38	140
EE 38/8/25	17.3	1.93	640
EI 38/8/25	23.2	0.98	320
EE 64/10/50	9.4	11.30	2600
EI 64/10/50	12.1	5.66	1300

* Assuming power out is 90% of input power and $f x \Delta B = 20x10^3$ for a flyback circuit.

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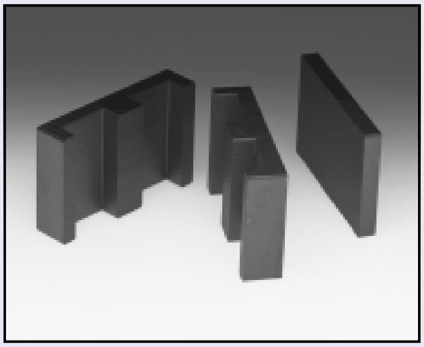
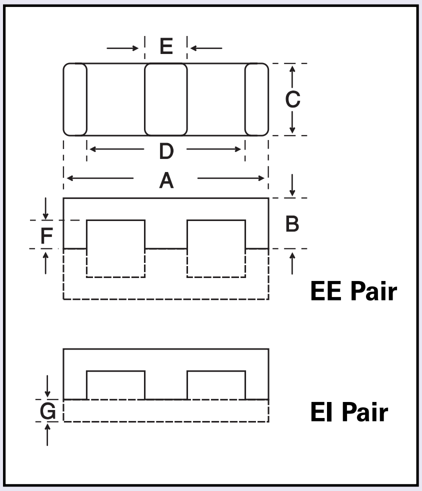
E 14/3.5/5
32-9140-





Core Dimensions (mm)

A	13.70 - 14.30	F	1.90 - 2.20
B	3.40 - 3.60	G	1.45 - 1.55
C	4.80- 5.10		
D	10.75 - 11.25		
E	2.75 - 3.05		

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma \ell / A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
EE Pair	$1.43mm^{-1}$	20.70mm	$14.50mm^2$	-	$300.00mm^3$
EI Pair	$1.16mm^{-1}$	16.70mm	$14.50mm^2$	-	$240.00mm^3$

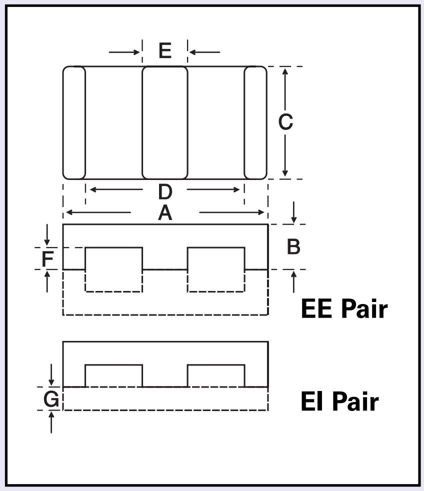
Electrical Specification

Material	A_L Value	Tolerance	Eff. Permeability	Part No. E Core	Part No. I Bar
E + E Pair					
F47	1100	+25/-25%	1250	32-9140-47	-
E + I Pair					
F47	1300	+25/-25%	1200	32-9140-47	33-9140-47

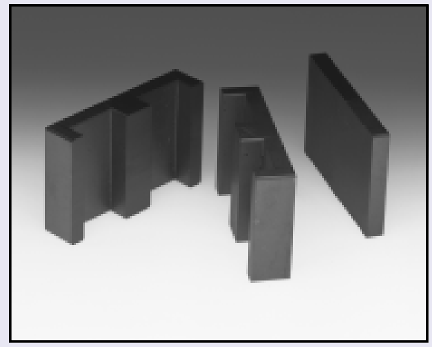
Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

Core Dimensions (mm)

A	17.65 - 18.35	F	1.90 - 2.20
B	3.90 - 4.10	G	1.90 - 2.10
C	9.80 - 10.20		
D	13.70 - 14.30		
E	3.80 - 4.10		



E 18/4/10
32-9180-



Core Parameters

In accordance with IEC Document 60205.

Parameter	Σℓ/A	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
EE Pair	0.62mm^{-1}	24.30mm	39.50mm^2	-	960.00mm^3
EI Pair	0.51mm^{-1}	20.30mm	39.50mm^2	-	800.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Eff. Permeability	Part No. E Core	Part No. I Bar
E + E Pair					
F47	2700	+25/-25%	1330	32-9180-47	-
E + I Pair					
F47	3100	+25/-25%	1260	32-9180-47	33-9180-47

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

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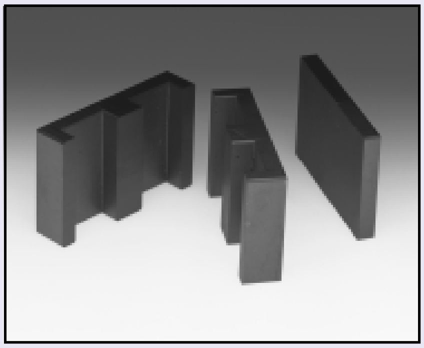
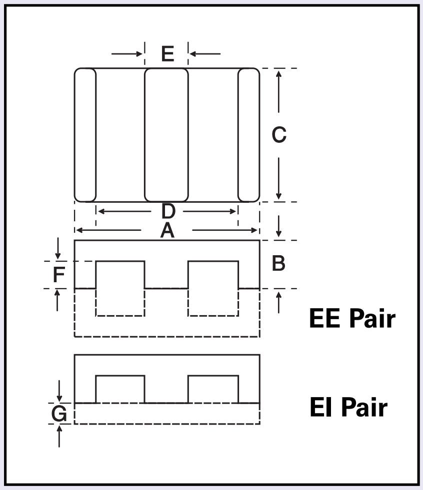
E 22/6/16
32-9210-





Core Dimensions (mm)

A	21.40 - 22.20	F	3.10 - 3.40
B	5.60 - 5.80	G	2.45 - 2.55
C	15.50 - 16.10		
D	16.40 - 17.20		
E	4.70 - 5.10		

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma \ell / A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
EE Pair	$0.41 mm^{-1}$	32.50mm	$78.50 mm^2$	-	$2550.00 mm^3$
EI Pair	$0.33 mm^{-1}$	26.10mm	$78.50 mm^2$	-	$2040.00 mm^3$

Electrical Specification

Material	A_L Value	Tolerance	Eff. Permeability	Part No. E Core	Part No. I Bar
E + E Pair					
F47	4300	+25/-25%	1405	32-9210-47	-
E + I Pair					
F47	5000	+25/-25%	1315	32-9210-47	33-9210-47

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

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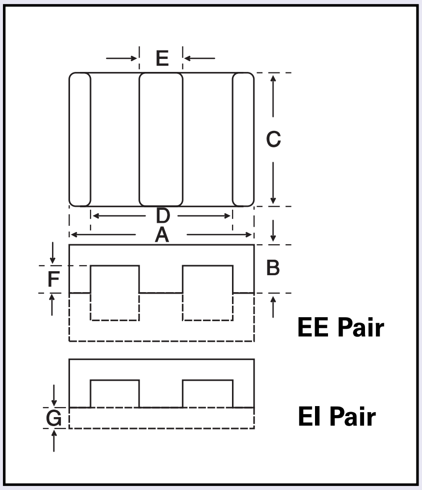
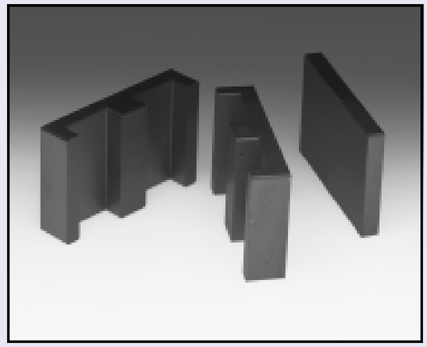
Core Dimensions (mm)

A	31.11 - 32.39	F	3.08 - 3.38
B	6.22 - 6.48	G	3.05 - 3.31
C	19.91 - 20.73		
D	24.90 - 25.90		
E	6.12 - 6.48		



E 32/6/20
32-9320-



Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma l/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	l_e	A_e	A_{min}	V_e
EE Pair	$0.32mm^{-1}$	41.70mm	$129.00mm^2$	-	$5380.00mm^3$
EI Pair	$0.28mm^{-1}$	35.90mm	$129.00mm^2$	-	$4560.00mm^3$

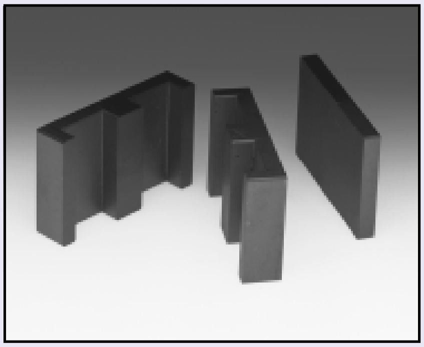
Electrical Specification

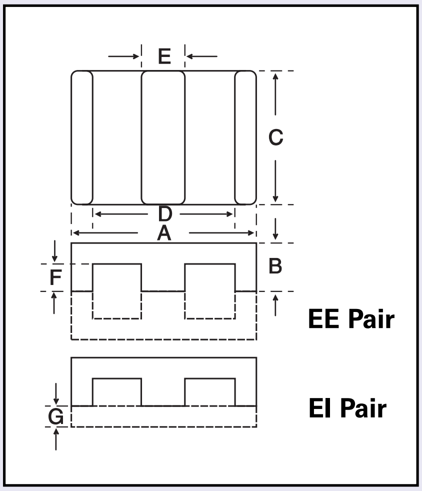
Material	A_L Value	Tolerance	Eff. Permeability	Part No. E Core	Part No. I Bar
E + E Pair					
F47	5900	+25/-25%	1500	32-9320-47	-
E + I Pair					
F47	6780	+25/-25%	1510	32-9320-47	33-9320-47
E + E Pair					
F44	6425	+25/-25%	1635	32-9320-44	-
E + I Pair					
F44	7350	+25/-25%	1635	32-9320-44	33-9320-44

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

MMG

E 38/8/25
32-9380-





Core Dimensions (mm)

A	37.34 - 38.86	F	4.32 - 4.72
B	8.13 - 8.39	G	3.68 - 3.94
C	24.89 - 25.91		
D	30.25 - 31.45		
E	7.40 - 7.80		

Core Parameters

In accordance with IEC Document 60205.

Parameter	Σℓ/A	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
EE Pair	0.27mm^{-1}	52.60mm	194.00mm^2	-	10200.00mm^3
EI Pair	0.23mm^{-1}	43.70mm	194.00mm^2	-	8460.00mm^3

Electrical Specification

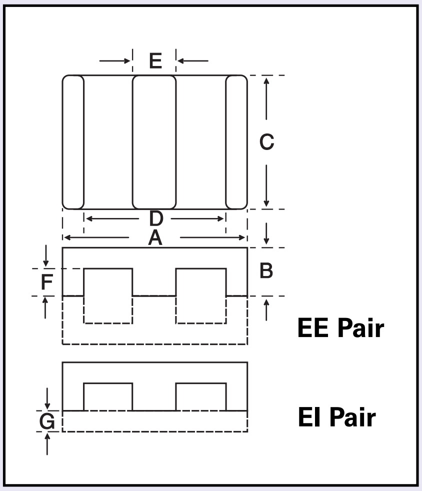
Material	A_L Value	Tolerance	Eff. Permeability	Part No. E Core	Part No. I Bar
E + E Pair					
F47	7250	+25/-25%	1550	32-9380-47	-
E + I Pair					
F47	8500	+25/-25%	1555	32-9380-47	33-9380-47
E + E Pair					
F44	7940	+25/-25%	1705	32-9380-44	-
E + I Pair					
F44	9290	+25/-25%	1700	32-9380-44	33-9380-44

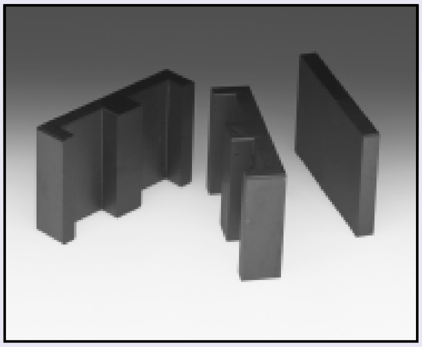
Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

E 64/10/50
32-9640-

Core Dimensions (mm)

A	62.50 - 65.10	F	4.97 - 5.23
B	10.07 - 10.33	G	4.95 - 5.21
C	49.30 - 51.30		
D	52.50 - 54.70		
E	10.00 - 10.40		





Core Parameters

In accordance with IEC Document 60205.

Parameter	Σℓ/A	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
EE Pair	0.16mm^{-1}	79.70mm	511.00mm^2	-	40700.00mm^3
EI Pair	0.14mm^{-1}	69.60mm	511.00mm^2	-	35500.00mm^3

Electrical Specification

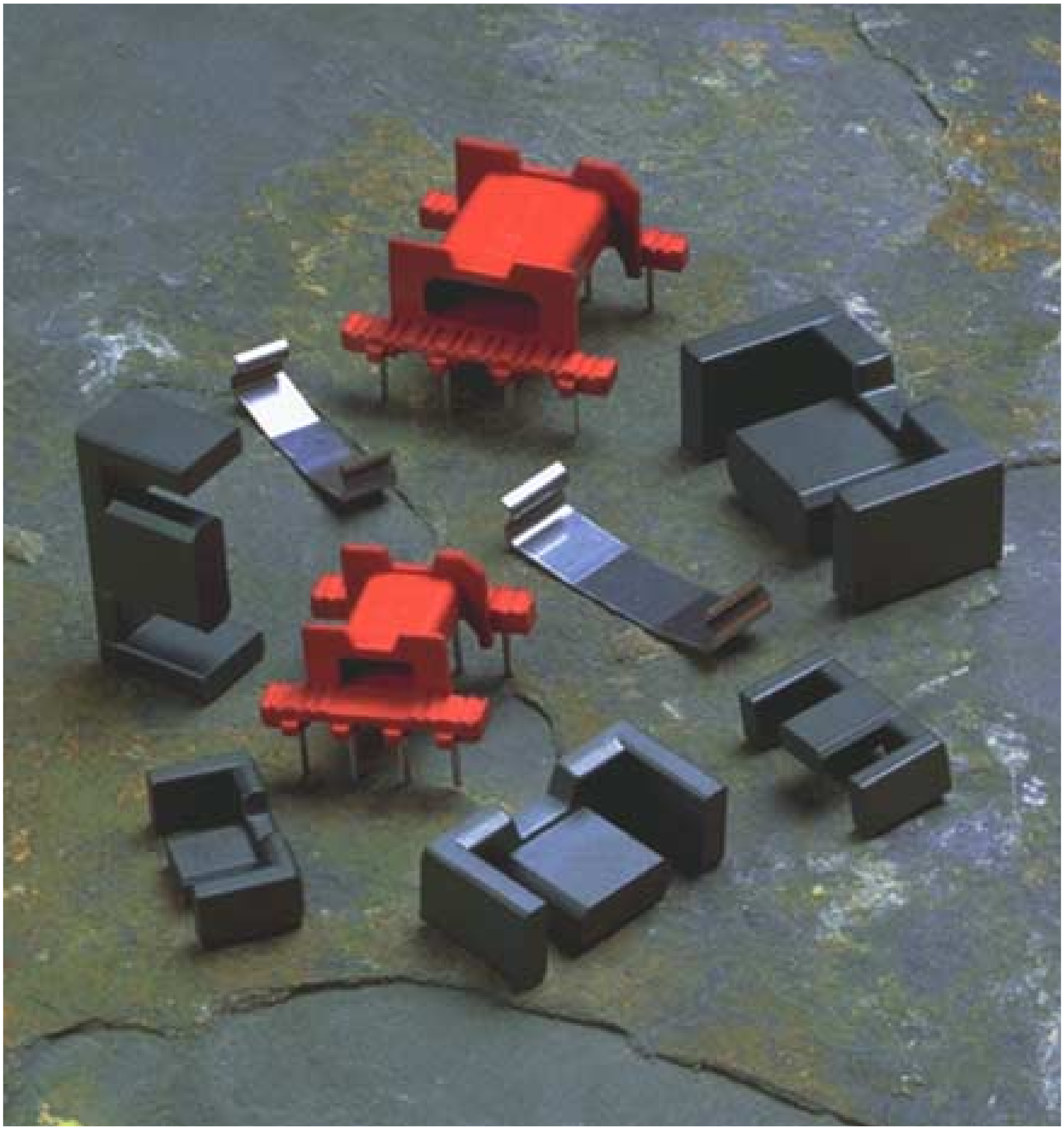
Material	A_L Value	Tolerance	Eff. Permeability	Part No. E Core	Part No. I Bar
E + E Pair					
F47	12720	+25/-25%	1620	32-9640-47	-
E + I Pair					
F47	14360	+25/-25%	1600	32-9640-47	33-9640-47
E + E Pair					
F44	13300	+25/-25%	1695	32-9640-44	-
E + I Pair					
F44	15050	+25/-25%	1675	32-9640-44	33-9640-44

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

MMG

EFD Cores and Accessories

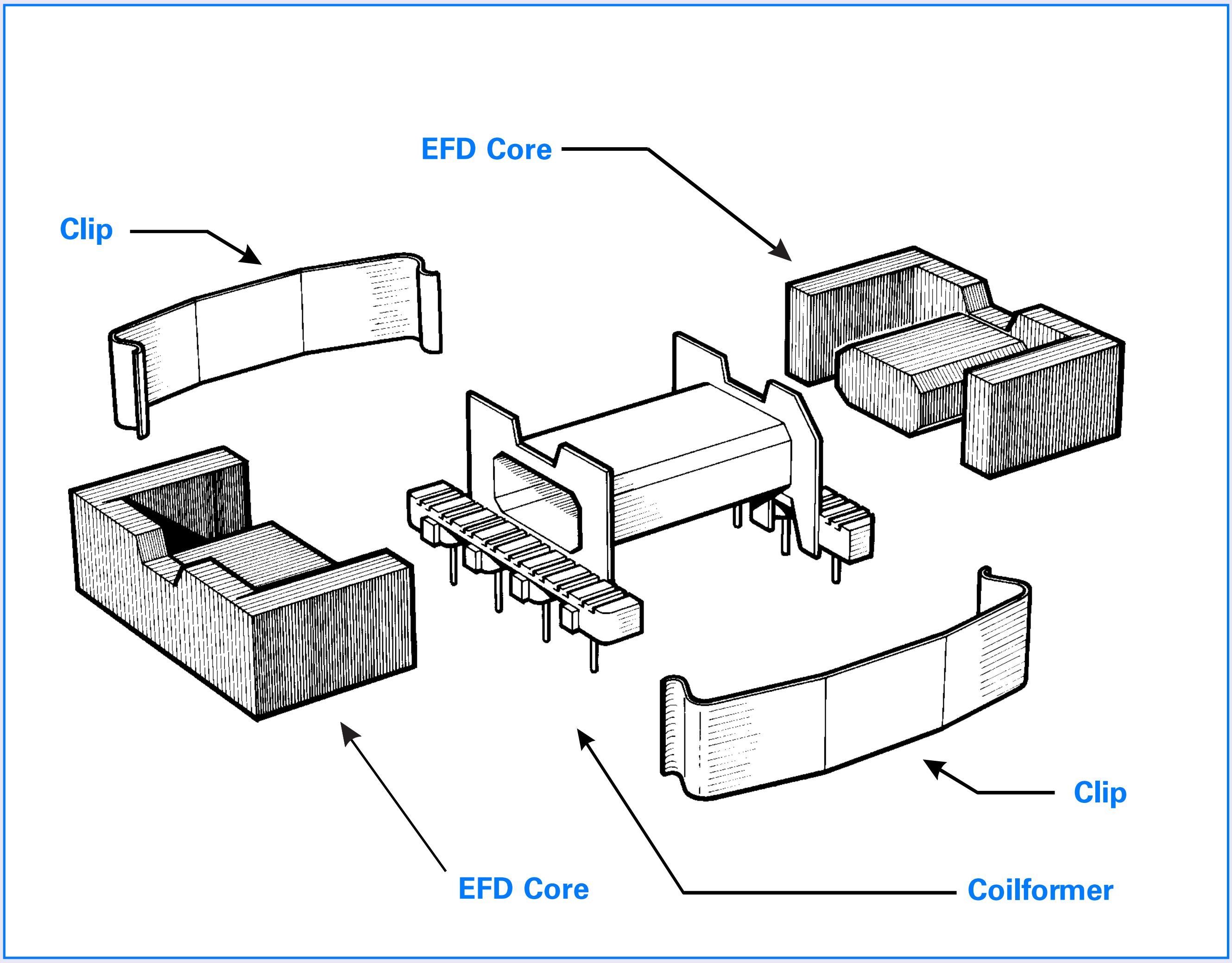
Low Profile Components



EFD 15 32-**720**-
EFD 20 32-**740**-
EFD 25 32-**760**-

MMG

EFD Series
Components

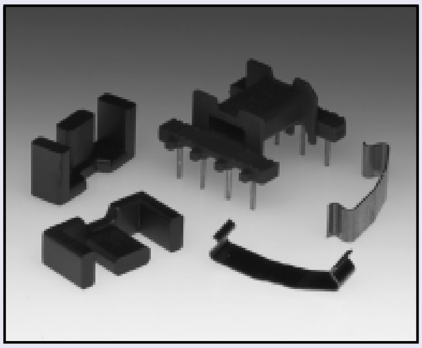


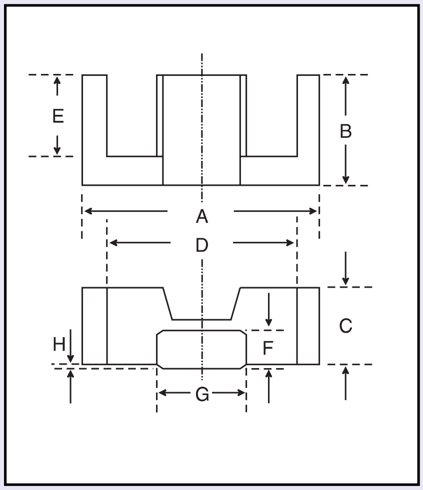
EFD Cores

EFD (**E**conomical **F**lat **D**esign) cores have been developed in recent years to meet the increasing demand for low profile components in power transformer design. A combination of very low height and excellent throughput power, when compared to other cores of a similar height, make these cores ideal where space considerations are a priority.

EFD Cores are available in a range of sizes and materials together with their associated coilformers and clips.

EFD 15
32-720-





Core Dimensions (mm)

A	14.60 - 15.40	F	2.30 - 2.50
B	7.35 - 7.65	G	5.15 - 5.45
C	4.50 - 4.80	H	0.20 Ref
D	10.65 - 11.35		
E	5.25 - 5.75		

Core Parameters

In accordance with IEC Document 60205.

Parameter	Σℓ/A	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	2.27mm^{-1}	34.00mm	15.00mm^2	12.20mm^2	510.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F47	650	+30/-20%	-	1175	32-720-47
F44	675	+30/-20%	-	1220	32-720-44
F45	780	+30/-20%	-	1410	32-720-45
F44	164	+15/-15%	0.10 Approx.	295	32-721-44
F47	164	+15/-15%	0.10 Approx.	295	32-721-47
F44	100	+10/-10%	0.17 Approx.	180	32-722-44
F47	100	+10/-10%	0.17 Approx.	180	32-722-47

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.
*A_L Value shown is obtained when tested with an ungapped half core of the same grade.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Horizontal	1	8	59-720-76

Clips

Part Number
76-070-95

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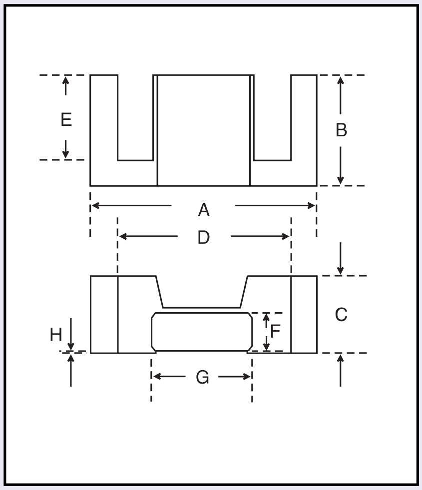
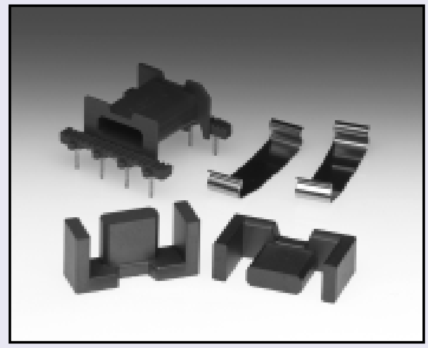
EFD 20

32-740-

Core Dimensions (mm)

A	19.45 - 20.55	F	3.45 - 3.75
B	9.85 - 10.15	G	8.70 - 9.10
C	6.50 - 6.80	H	0.17 Ref
D	14.90 - 15.90		
E	7.45 - 7.95		





Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma\ell/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	1.52mm^{-1}	47.00mm	31.00mm^2	29.00mm^2	1460.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F47	1075	+30/-20%	-	1300	32-740-47
F44	1120	+30/-20%	-	1355	32-740-44
F45	1200	+30/-20%	-	1450	32-740-45
F44	160	+10/-10%	0.20 Approx.	195	32-741-44
F47	160	+10/-10%	0.20 Approx.	195	32-741-47
F44	100	+10/-10%	0.35 Approx.	120	32-742-44
F47	100	+10/-10%	0.35 Approx.	120	32-742-47

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.
*A_L Value shown is obtained when tested with an ungapped half core of the same grade.

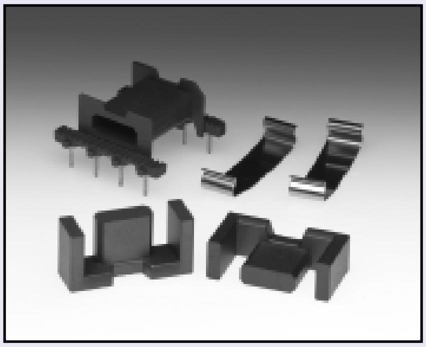
Bobbins/Coil Formers

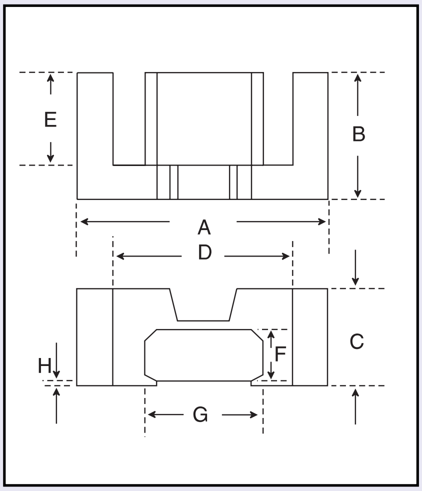
Mounting	No. of Sections	Pins	Part Number
Horizontal	1	8	59-740-76

Clips

Part Number
76-071-95

EFD 25
32-760-





Core Dimensions (mm)

A	24.45 - 25.65	F	8.90 - 9.30
B	12.35 - 12.65	G	11.20 - 11.60
C	8.90 - 9.30	H	0.60 Ref
D	18.10 - 19.30		
E	9.05 - 9.55		

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma\ell/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	1.00mm^{-1}	57.00mm	58.00mm^2	57.00mm^2	3300.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F47	1720	+30/-20%	-	1370	32-760-47
F44	1790	+30/-20%	-	1425	32-760-44
F45	2000	+30/-20%	-	1590	32-760-45
F44	315	+10/-10%	0.20 Approx.	250	32-761-44
F47	315	+10/-10%	0.20 Approx.	250	32-761-47
F44	250	+10/-10%	0.30 Approx.	200	32-762-44
F47	250	+10/-10%	0.30 Approx.	200	32-762-47
F44	160	+10/-10%	0.60 Approx.	125	32-763-44
F47	160	+10/-10%	0.60 Approx.	125	32-763-47

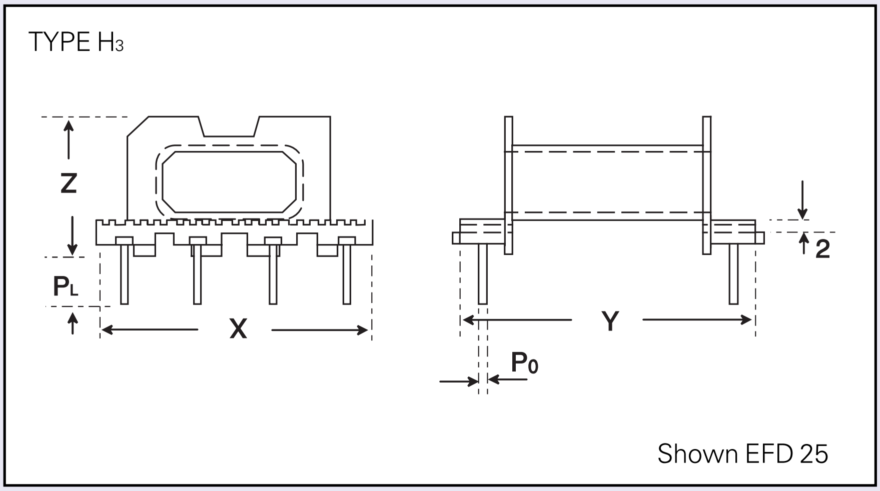
Part numbers refer to half cores. Other material grades and gap lengths may be available on request.
*A_L Value shown is obtained when tested with an ungapped half core of the same grade.

Bobbins/Coil Formers

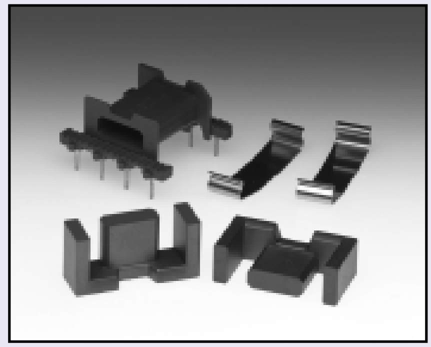
Mounting	No. of Sections	Pins	Part Number
Horizontal	1	10	59-760-76

Clips

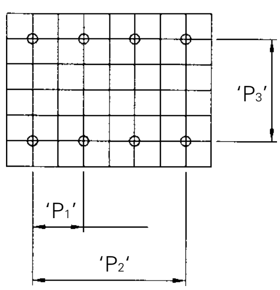
Part Number
76-072-95



EFD Coilformers 59-720/740/760



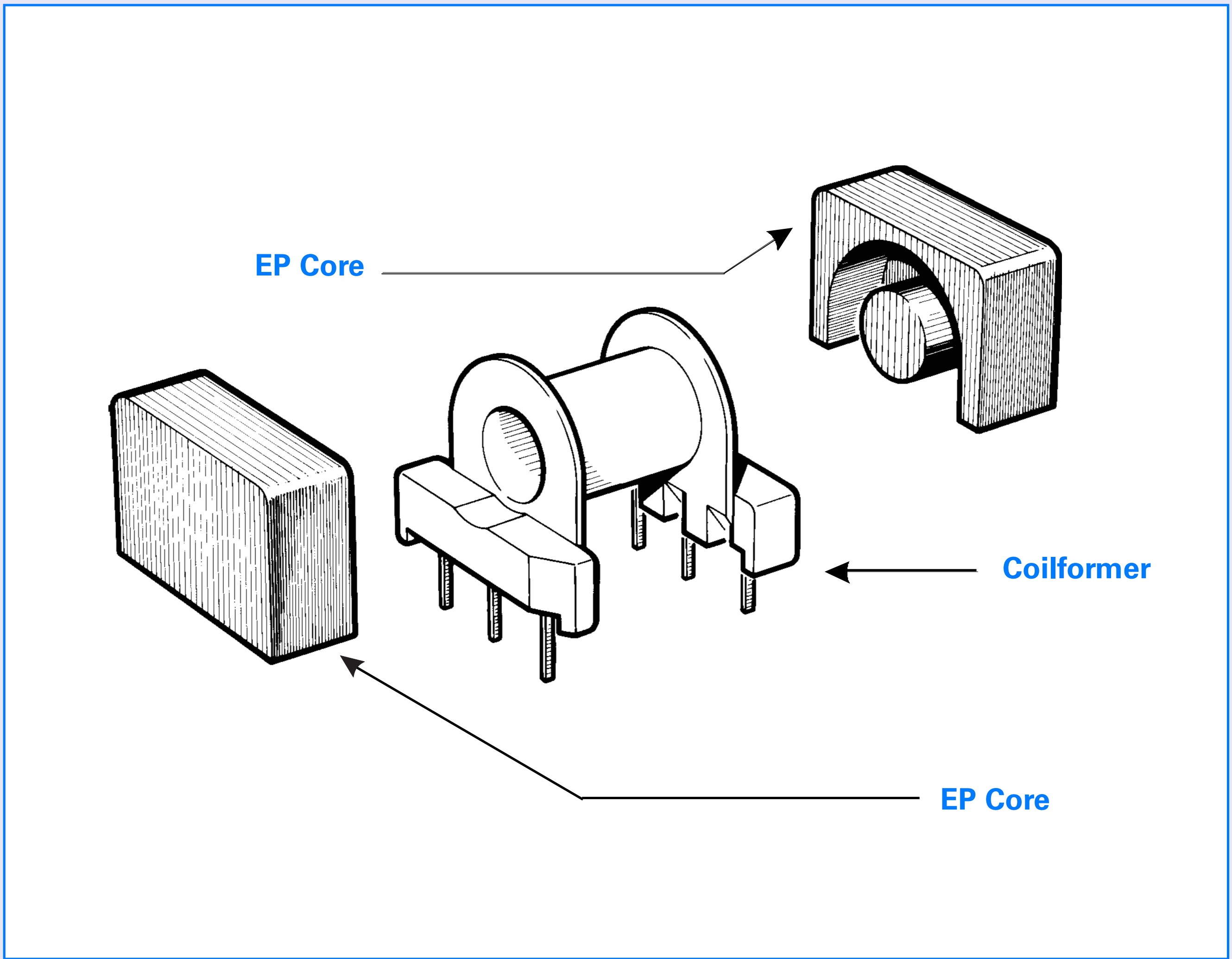
Part No.	Type	Dimensions			Winding Data		No. of sections
		'X'	'Y'	'Z'	A_N (mm²)	I_N (mm)	
59-720-76	H_3	16.0	16.5	8.0	15.6	29.0	Single
59-740-76	H_3	21.0	20.0	10.0	27.9	40.0	Single
59-760-76	H_3	26.0	26.0	12.4	41.2	50.0	Single



Pin Details						Material	Clip Part Number
No. of	P_0	P_1	P_2	P_3	P_L		
8	0.7/0.5	3.75	11.25	13.75	3.5	Glass filled Nylon 66	76-070-95
8	0.7/0.5	5.00	15.00	17.50	3.5	Glass filled Nylon 66	76-071-95
10	0.7/0.5	5.00	20.00	22.50	3.5	Glass filled Nylon 66	76-072-95

EP Cores and Accessories

EP 7	32-**810**-
EP 10	32-**820**-
EP 13	32-**800**-
EP 17	32-**830**-
EP 20	32-**840**-



EP Cores

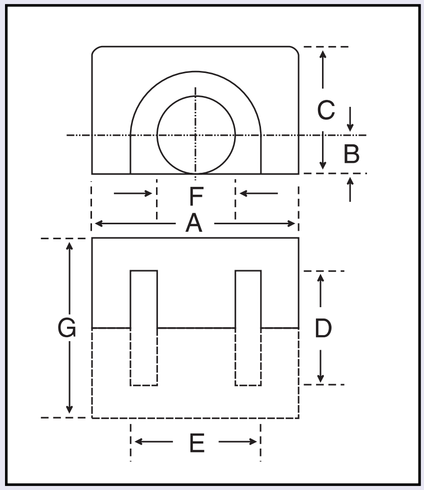
EP Cores have a particularly compact, low profile shape and offer excellent shielding from adjacent cores due to the winding being almost completely surrounded by the ferrite core. This allows for high packing densities on printed circuit boards. Originally designed for broadband, small power transformers and signal transmission applications, EP cores are well suited for the demanding properties required from modern electronic components.

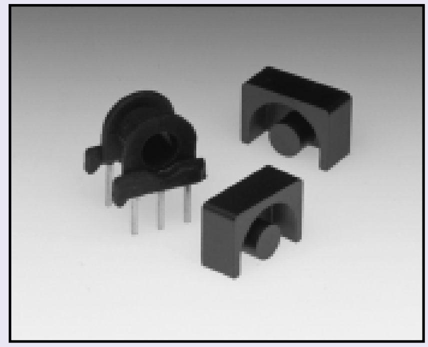
EP Cores are available in a range of sizes and materials together with their associated coilformers.

EP 7
32-810-

Core Dimensions (mm)

A	9.00 - 9.40	F	3.20 - 3.40
B	1.60 - 1.80	G	7.30 - 7.50
C	6.20 - 6.50		
D	5.00 - 5.40		
E	7.20 - 7.60		





Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma l/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	l_e	A_e	A_{min}	V_e
Value	$1.52mm^{-1}$	15.70mm	$10.30mm^2$	$8.50mm^2$	$162.00mm^3$

Electrical Specification

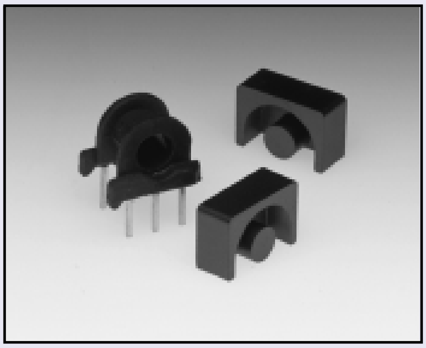
Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F5A	1200	+30/-20%	-	1450	32-810-49
F9	2000	+30/-20%	-	2420	32-810-36
F10	3400	+30/-20%	-	4115	32-810-37
F39	5200	+40/-30%	-	6290	32-810-39

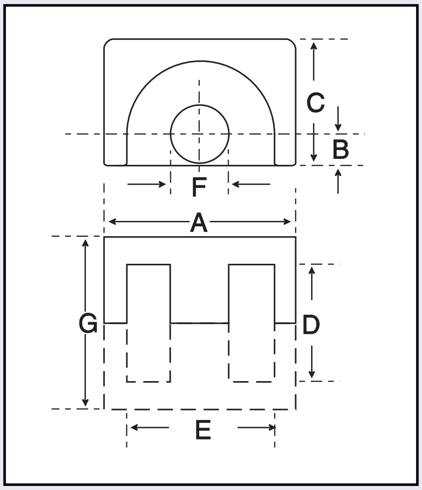
Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Horizontal	1	6	59-810-64
Horizontal	2	6	59-811-64

EP 10
32-820-





Core Dimensions (mm)

A	11.20 - 11.80	F	3.15 - 3.45
B	1.75 - 1.95	G	10.20 - 10.40
C	7.45 - 7.85		
D	7.20 - 7.60		
E	9.20 - 9.60		

Core Parameters

In accordance with IEC Document 60205.

Parameter	Σℓ/A	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	1.70mm^{-1}	19.20mm	11.30mm^2	8.50mm^2	217.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F5A	1063	+30/-20%	-	1435	32-820-49
F9	2000	+30/-20%	-	2700	32-820-36
F10	3200	+30/-20%	-	4330	32-820-37
F39	4800	+40/-30%	-	6495	32-820-39

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

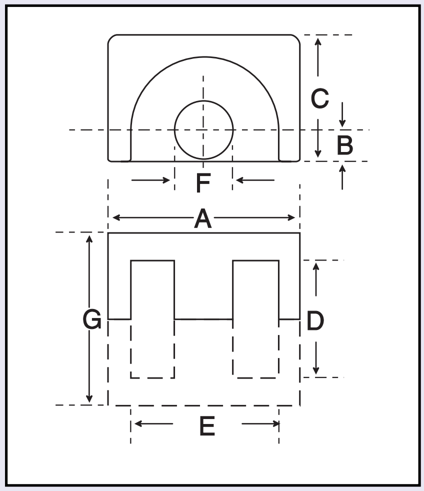
Bobbins/Coil Formers

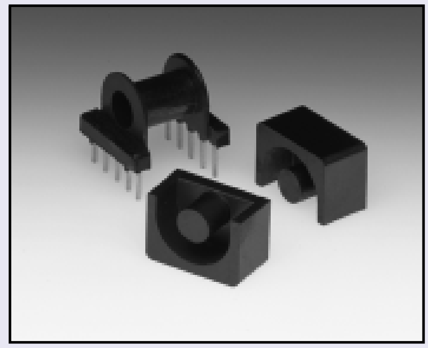
Mounting	No. of Sections	Pins	Part Number
Horizontal	1	8	59-820-64
Horizontal	2	8	59-821-64

EP 13
32-800-

Core Dimensions (mm)

A	12.20 - 12.80	F	4.20 - 4.50
B	2.30 - 2.50	G	12.70 - 13.00
C	8.60 - 9.00		
D	9.00 - 9.40		
E	9.70 - 10.30		





Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma \ell / A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	1.24mm^{-1}	24.20mm	19.50mm^2	14.90mm^2	472.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	1235	+30/-20%	-	1220	32-800-44
F9	2800	+30/-20%	-	2760	32-800-36
F10	4400	+30/-20%	-	4340	32-800-37
F39	7000	+40/-30%	-	6905	32-800-39

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Horizontal	1	10	59-805-64
Horizontal	2	10	59-806-64

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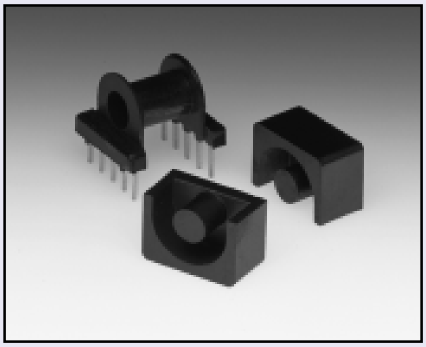
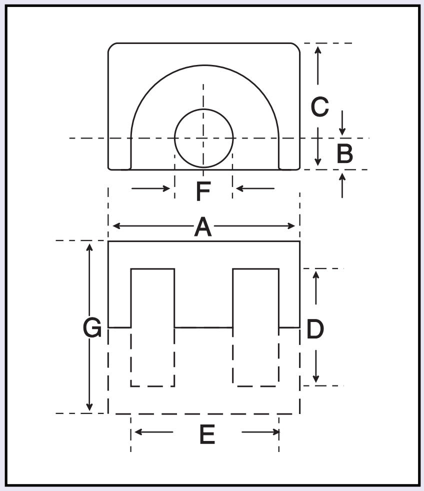




Core Dimensions (mm)

A	17.50 - 18.50	F	5.50 - 5.85
B	3.05 - 3.45	G	16.60 - 17.00
C	10.75 - 11.25		
D	11.20 - 11.80		
E	11.50 - 12.50		

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma \ell / A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	$0.84mm^{-1}$	28.50mm	$33.90mm^2$	$25.50mm^2$	$966.00mm^3$

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	2130	+30/-20%	-	1425	32-830-44
F9	4310	+30/-20%	-	2880	32-830-36
F10	6875	+30/-20%	-	4595	32-830-37
F39	11400	+40/-30%	-	7620	32-830-39

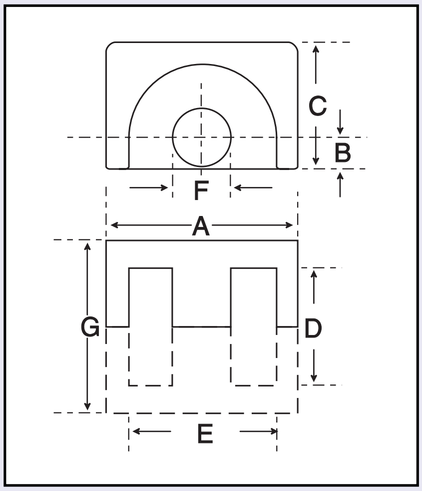
Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

Bobbins/Coil Formers

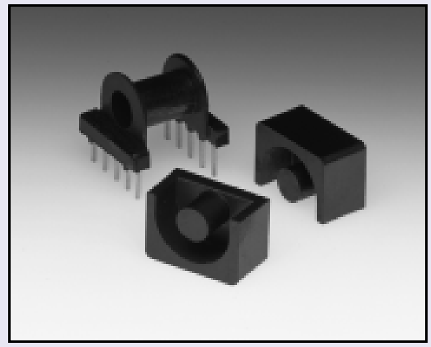
Mounting	No. of Sections	Pins	Part Number
Horizontal	1	8	59-830-64
Horizontal	2	8	59-831-64

Core Dimensions (mm)

A	23.50 - 24.50	F	8.50 - 9.00
B	4.30 - 4.70	G	21.20 - 21.60
C	14.60 - 15.30		
D	14.00 - 14.60		
E	16.10 - 16.90		



EP 20
32-840-



Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma l/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	l_e	A_e	A_{min}	V_e
Value	0.51mm^{-1}	40.00mm	78.00mm^2	60.00mm^2	3120.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F9	6700	+30/-20%	-	2720	32-840-36
F10	11200	+30/-20%	-	4545	32-840-37
F39	18700	+40/-30%	-	7590	32-840-39

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Horizontal	1	10	59-840-64
Horizontal	2	10	59-841-64

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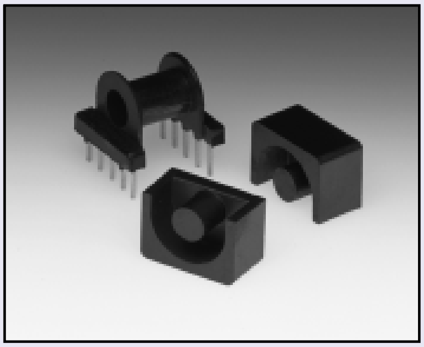
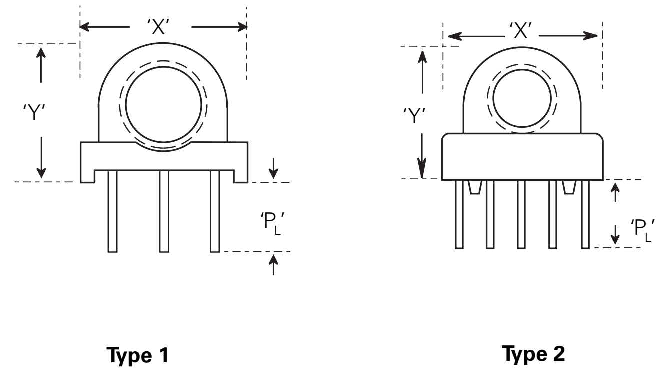
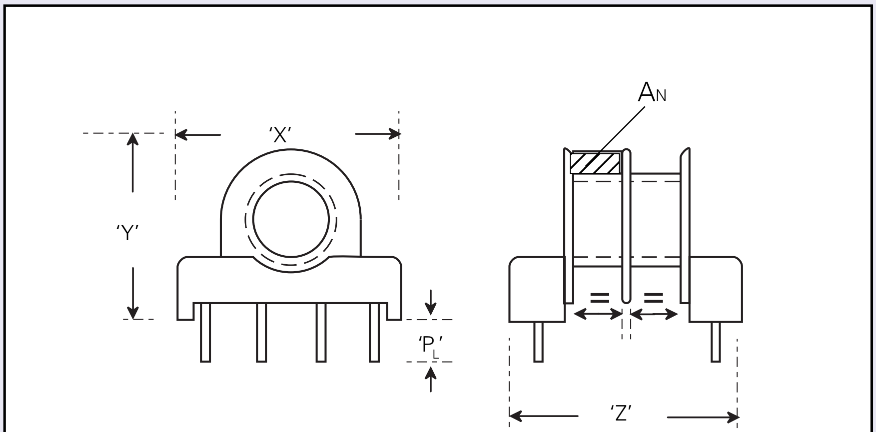
EP Coilformers
59-8XX-



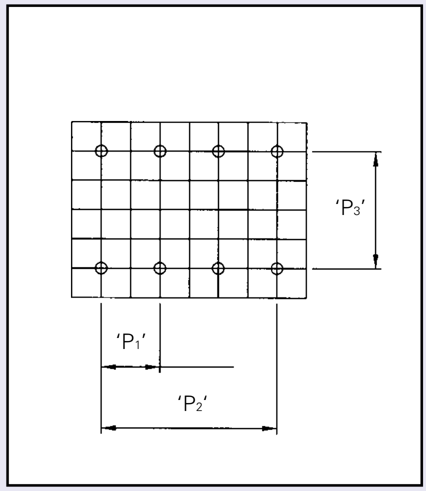


Part No.	Type	Dimensions			Winding Data		No. of sections
		'X'	'Y'	'Z'	A_N (mm^2)	l_N (mm)	
59-810-64	1	9.10	7.85	7.30	3.7	17.9	1
59-811-64	1	9.10	7.85	7.30	1.6	17.9	2
59-820-64	3	10.90	10.30	10.90	11.4	21.5	1
59-821-64	3	10.90	10.30	10.90	5.0	21.5	2
59-801-64	1	12.50	10.80	13.40	13.8	23.8	1
59-803-64	1	12.50	10.80	13.40	7.5	23.8	2
59-805-64	2	12.50	10.80	13.40	13.8	23.8	1
59-806-64	2	12.50	10.80	13.40	7.5	23.8	2
59-830-64	3	18.85	14.0	18.85	18.8	28.8	1
59-831-64	3	18.85	14.0	18.85	8.9	28.8	2
59-840-64	3	24.55	17.90	21.35	33.8	38.9	1
59-841-64	3	24.55	17.90	21.35	15.9	38.9	2

All formers are pinned using 0.46mm square wire plated to meet solderability to meet IEC 68-2-20B, Test T. Maximum soldering temperature 400°C , 2 seconds. Pin pull out 2.7N min.



Type 3 **Double section shown**



Pin Dimensions					Material
No. of pins*	P_1	P_2	P_3	P_L	
6	2.50	5.00	5.00	3.60	GRF Phenolic
6	2.50	5.00	5.00	3.60	GRF Phenolic
8	2.54	7.62	7.62	4.50	GRF Phenolic
8	2.54	7.62	7.62	4.50	GRF Phenolic
6	3.80	7.60	11.40	3.60	GRF Phenolic
6	3.80	7.60	11.40	3.60	GRF Phenolic
10	2.54	10.16	10.16	4.60	GRF Phenolic
10	2.54	10.16	10.16	4.60	GRF Phenolic
8	5.08	15.24	15.24	3.00	GRF Phenolic
8	5.08	15.24	15.24	3.00	GRF Phenolic
8	5.08	20.32	17.78	5.40	GRF Phenolic
8	5.08	20.32	17.78	5.40	GRF Phenolic

* Other pin configurations can be supplied on request.

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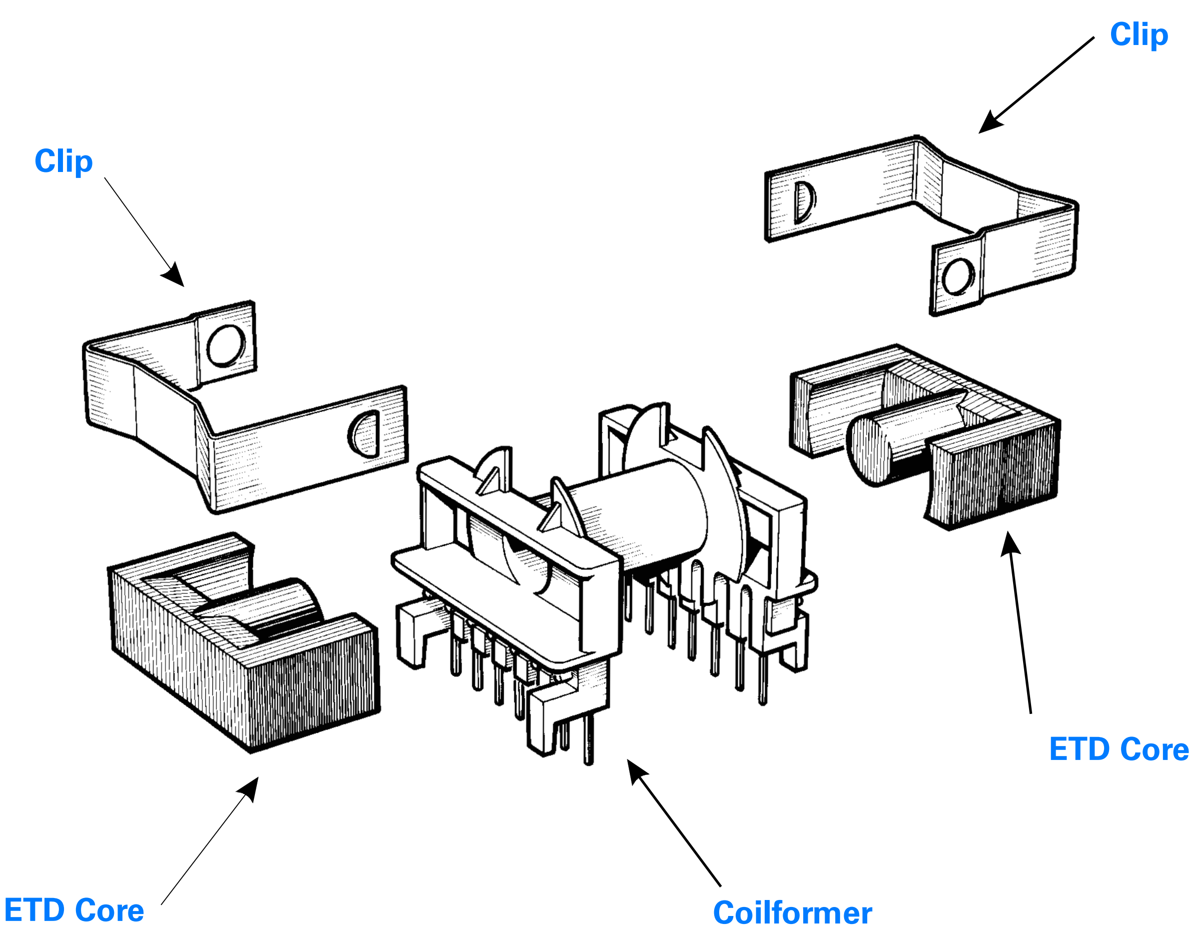
ETD Cores and Accessories

(IEC Standard 1185)

ETD 29	32-**580**-
ETD 34	32-**500**-
ETD 39	32-**520**-
ETD 44	32-**540**-
ETD 49	32-**560**-

MMG



ETD Cores

ETD (**E**conomical **T**ransformer **D**esign) cores were developed specifically for Power Transformer cores used in Switched Mode power supplies. The combined cross-sectional area of the two outer limbs equals the cross-sectional area of the centre limb allowing an even flux distribution throughout the core. This ensures the absence of localised 'hot spots' that can reduce performance at high frequencies or high flux levels. Their round centre limb provides for minimal winding resistance, leakage inductance and copper eddy current losses.

ETD Cores are available in a range of sizes and materials together with their associated coilformers (both Horizontal and Vertical mounting) and clips.

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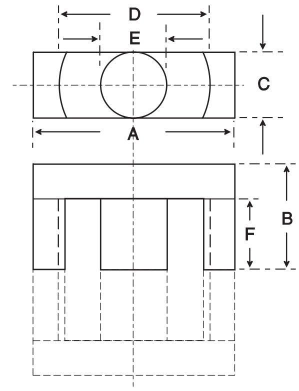
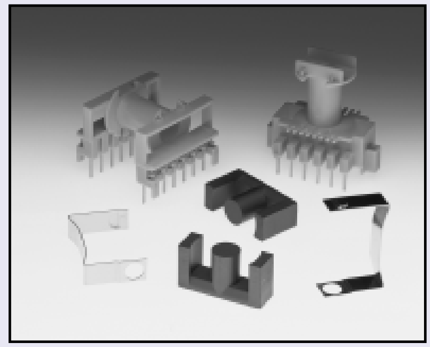
ETD 29
32-580-

Core Dimensions (mm)

A	29.00 - 30.60
B	15.60 - 16.00
C	9.20 - 9.80
D	22.00 - 23.40
E	9.20 - 9.80
F	10.70 - 11.30



In accordance with IEC Standard 1185



Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma\ell/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.93mm^{-1}	70.40mm	76.00mm^2	70.00mm^2	5376.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F47	1800	+30/-20%	-	1332	32-580-47
F44	1950	+30/-20%	-	1443	32-580-44
F45	2000	+30/-20%	-	1480	32-580-45
F5A	2350	+30/-20%	-	1739	32-580-49
F44	800 Approx.	-	0.1 ± 0.03 mm	590	32-586-44
F44	460 Approx.	-	0.2 ± 0.03 mm	340	32-587-44
F44	220 Approx.	-	0.5 ± 0.03 mm	160	32-588-44
F44	125 Approx.	-	1.0 ± 0.05 mm	92	32-589-44

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

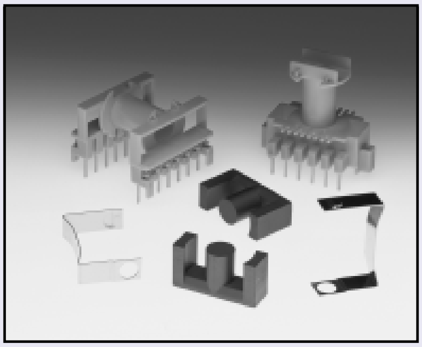
Bobbins/Coil Formers

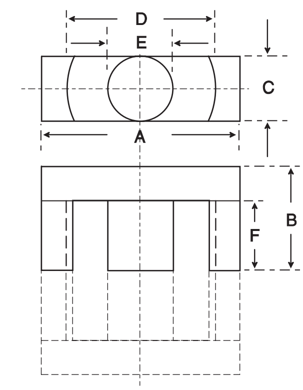
Mounting	No. of Sections	Pins	Part Number
Horizontal	1	14	59-580-76
Vertical	1	12	59-585-76

Clips

Part Number
76-055-95
76-055-95

ETD 34
32-500-





In accordance with IEC Standard 1185

Core Dimensions (mm)

A	33.40 - 35.00	F	11.80 min
B	17.10 - 17.50		
C	10.50 - 11.10		
D	25.60 - 27.00		
E	10.50 - 11.10		

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma\ell/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	$0.81mm^{-1}$	78.60mm	$97.10mm^2$	$91.60mm^2$	$7640.00mm^3$

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	2250	+30/-20%	-	1450	32-500-44
F45	2400	+30/-20%	-	1546	32-500-45
F5A	2840	+30/-20%	-	1830	32-500-49
F44	1000 Approx.	-	0.1 ± 0.03 mm	645	32-506-44
F44	580 Approx.	-	0.2 ± 0.03 mm	375	32-507-44
F44	275 Approx.	-	0.5 ± 0.03 mm	175	32-508-44
F44	160 Approx.	-	1.0 ± 0.05 mm	100	32-509-44

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Horizontal	1	14	59-500-76
Vertical	1	14	59-505-76

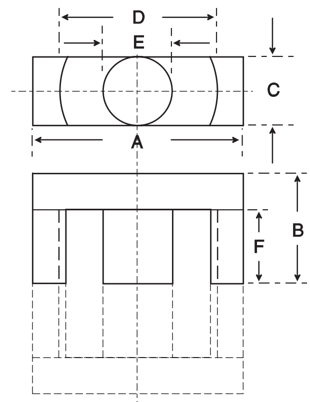
Clips

Part Number
76-050-95
76-050-95

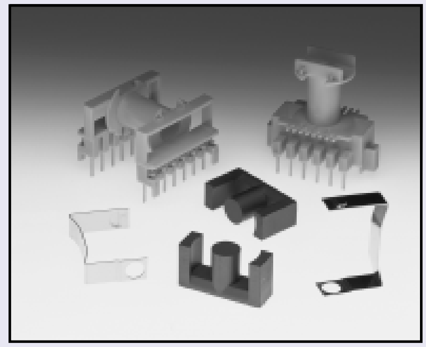
ETD 39
32-520-

Core Dimensions (mm)

A	38.20 - 40.00	F	14.20 min
B	19.60 - 20.00		
C	12.20 - 12.80		
D	29.30 - 30.90		
E	12.20 - 12.80		



In accordance with IEC Standard 1185



Core Parameters

In accordance with IEC Document 60205.

Parameter	Σℓ/A	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.74mm^{-1}	92.20mm	125.00mm^2	123.00mm^2	11500.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	2470	+30/-20%	-	1455	32-520-44
F5A	3210	+30/-20%	-	1890	32-520-49
F44	1250 Approx.	-	0.1 ± 0.03 mm	735	32-526-44
F44	720 Approx.	-	0.2 ± 0.03 mm	425	32-527-44
F44	350 Approx.	-	0.5 ± 0.03 mm	205	32-528-44
F44	200 Approx.	-	1.0 ± 0.05 mm	120	32-529-44

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Horizontal	1	16	59-520-76
Vertical	1	16	59-525-76

Clips

Part Number
76-051-95
76-051-95

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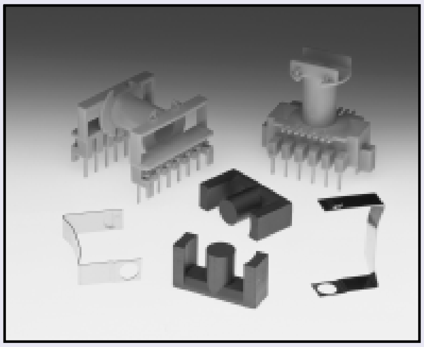
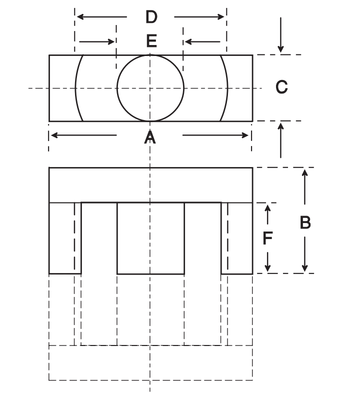
ETD 44
32-540-





In accordance with IEC Standard 1185

Core Dimensions (mm)

A	43.00 - 45.00	F	16.10 min
B	22.10 - 22.50		
C	14.40 - 15.20		
D	32.50 - 34.10		
E	14.40 - 15.20		

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma\ell/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.60mm^{-1}	103.00mm	173.00mm^2	172.00mm^2	17800.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	3100	+30/-20%	-	1480	32-540-44
F5A	3920	+30/-20%	-	1870	32-540-49
F44	1670 Approx.	-	0.1 ± 0.03 mm	800	32-546-44
F44	970 Approx.	-	0.2 ± 0.03 mm	460	32-547-44
F44	470 Approx.	-	0.5 ± 0.03 mm	225	32-548-44
F44	270 Approx.	-	1.0 ± 0.05 mm	130	32-549-44

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Horizontal	1	18	59-540-76
Vertical	1	18	59-545-76

Clips

Part Number
76-052-95
76-052-95

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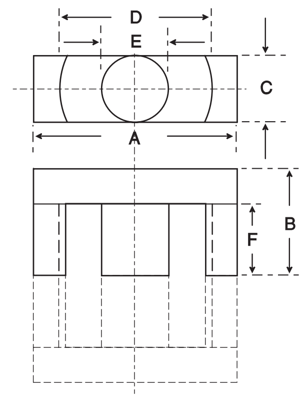
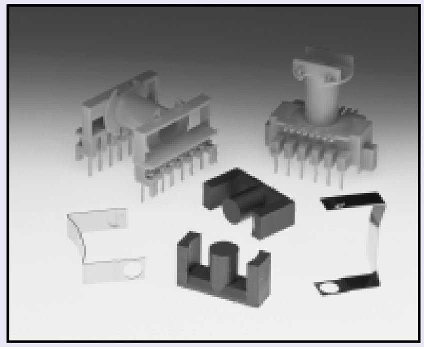
ETD 49
32-560-

Core Dimensions (mm)

A	47.60 - 49.80	F	17.70 min
B	24.50 - 24.90		
C	15.90 - 16.70		
D	36.10 - 37.90		
E	15.90 - 16.70		



In accordance with IEC Standard 1185



Core Parameters

In accordance with IEC Document 60205.

Parameter	Σℓ/A	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.54mm^{-1}	114.00mm	211.00mm^2	209.00mm^2	24000.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	3525	+30/-20%	-	1515	32-560-44
F5A	4400	+30/-20%	-	1890	32-560-49
F44	2000 Approx.	-	0.1 ± 0.03 mm	860	32-566-44
F44	1165 Approx.	-	0.2 ± 0.03 mm	500	32-567-44
F44	570 Approx.	-	0.5 ± 0.03 mm	245	32-568-44
F44	335 Approx.	-	1.0 ± 0.05 mm	145	32-569-44

Part numbers refer to half cores. Other material grades and gap lengths may be available on request.

Bobbins/Coil Formers

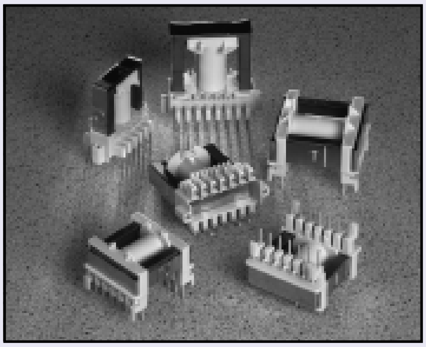
Mounting	No. of Sections	Pins	Part Number
Horizontal	1	20	59-560-76
Vertical	1	20	59-565-76

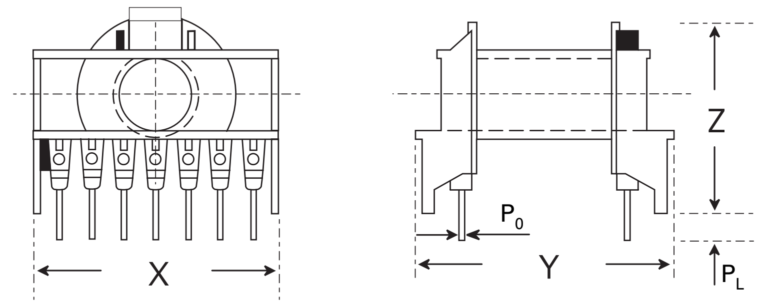
Clips

Part Number
76-053-95
76-053-95

MMG

ETD Coilformers
59-5XX-

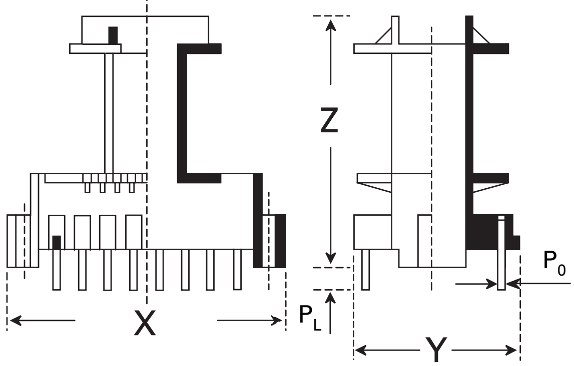




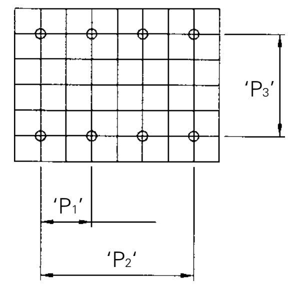
Type H_2

Part No.	Type	Dimensions			Winding Data		No. of sections
		'X'	'Y'	'Z'	A_N (mm²)	l_N (mm)	
59-580-76	H_2	34.0	37.0	28.0	89.0	53.0	Single
59-585-76	V_2	34.6	24.0	40.9	89.0	53.0	Single
59-500-76	H_2	38.5	40.0	30.4	123.0	60.0	Single
59-505-76	V_2	38.8	26.4	43.2	123.0	60.0	Single
59-520-76	H_2	43.5	45.0	33.4	177.0	69.0	Single
59-525-76	V_2	43.5	29.0	47.9	177.0	69.0	Single
59-540-76	H_2	48.8	50.0	36.0	214.0	77.0	Single
59-545-76	V_2	48.8	31.5	51.8	214.0	77.0	Single
59-560-76	H_2	53.5	55.0	38.2	273.0	85.0	Single
59-565-76	V_2	53.5	34.0	56.0	273.0	85.0	Single

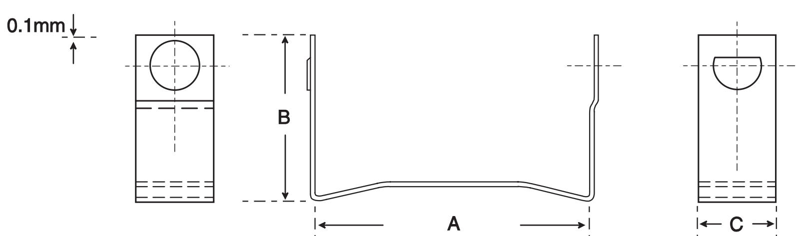
Clip Part Number	Core size	Dimensions		
		'A'	'B'	'C'
76-055-95	ETD 29	30.8	21.0	8.0
76-050-95	ETD 34	35.0	22.5	10.0
76-051-95	ETD 39	40.0	25.0	12.0
76-052-95	ETD 44	45.0	27.5	14.0
76-053-95	ETD 49	49.8	29.9	16.0



Type V2



Pin Details						Material	Clip Part Number
No. of	P_0	P_1	P_2	P_3	P_L		
14	1.1/0.75	5.08	30.48	25.40	4.5	PETP	76-055-95
12	1.1/0.75	5.08	25.40	20.32	4.5	PETP	76-055-95
14	1.1/0.75	5.08	30.48	25.40	4.5	PETP	76-050-95
14	1.1/0.75	5.08	30.48	22.86	4.5	PETP	76-050-95
16	1.1/0.75	5.08	35.56	30.48	4.5	PETP	76-051-95
16	1.1/0.75	5.08	35.56	25.40	4.5	PETP	76-051-95
18	1.1/0.75	5.08	40.64	35.56	4.5	PETP	76-052-95
18	1.1/0.75	5.08	40.64	27.94	4.5	PETP	76-052-95
20	1.1/0.75	5.08	45.72	40.64	4.5	PETP	76-053-95
20	1.1/0.75	5.08	45.72	30.48	4.5	PETP	76-053-95



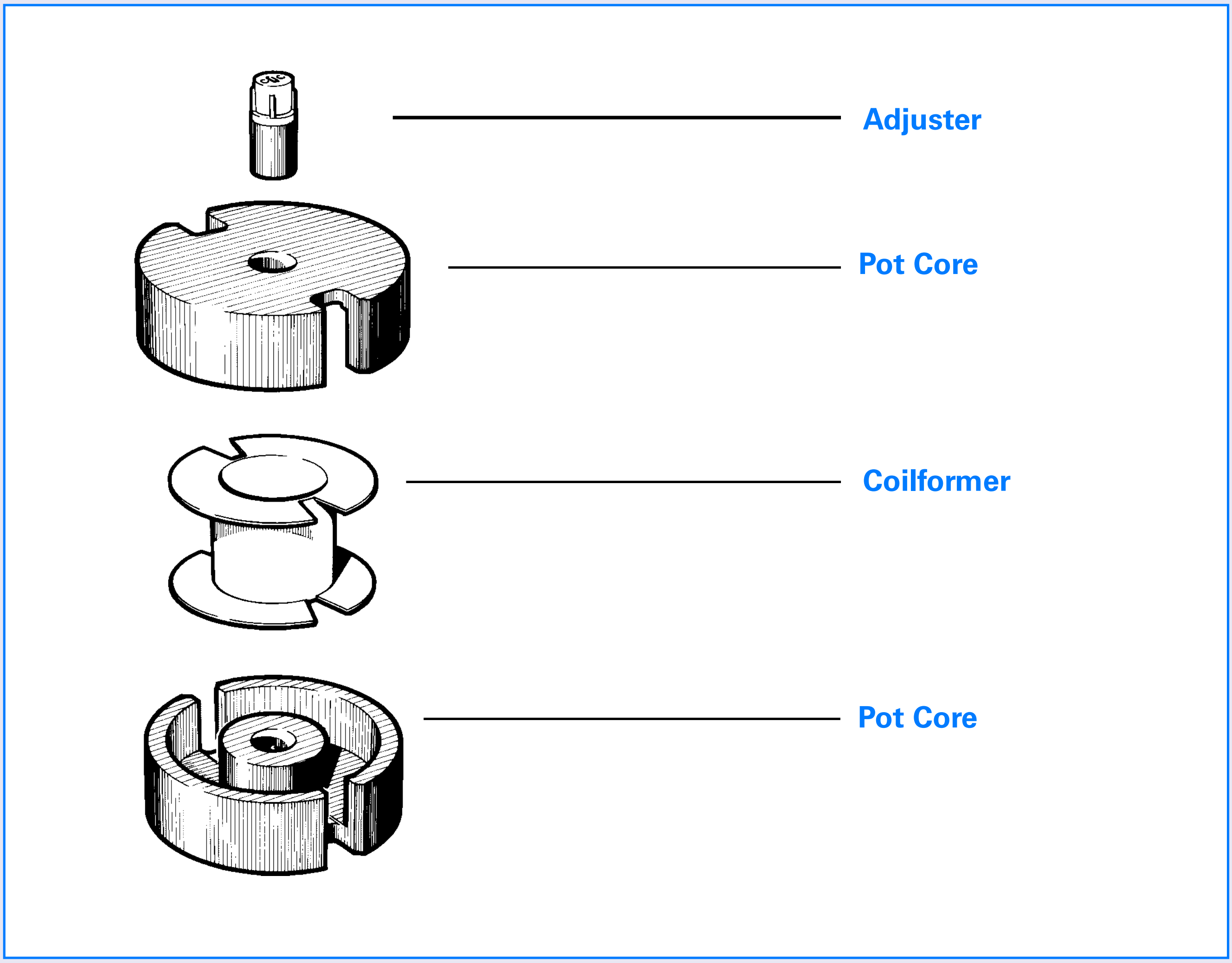
2 Slot Pot Cores and Accessories

(IEC Standard 133)

9 x 5mm	29-350-	**22 x 13mm**	29-550-
11 x 7mm	29-400-	**26 x 16mm**	29-600-
14 x 8mm	29-450-	**30 x 19mm**	29-620-
18 x 11mm	29-500-	**36 x 22mm**	29-6500-

MMG

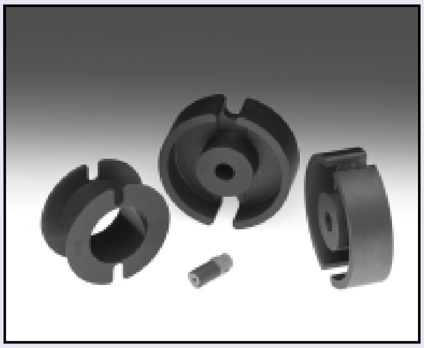
2 Slot Pot Core
Components

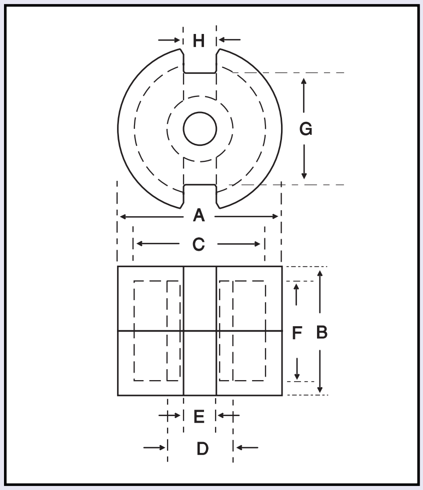


2 Slot Pot Cores

As 2 slot pot cores are one of the oldest core designs, they are available in a wide range of worldwide standardised sizes - according to IEC 133. Originally produced for filter inductors, pot cores are becoming increasingly popular in power applications. With the introduction of new EMC legislation, electromagnetic screening has become a prime concern in core selection. The pot core's shape almost completely encloses the windings and whilst this can be a hinderance for access purposes, it provides excellent screening.

9 x 5mm
29-350-





Core Dimensions (mm)

A	9.00 - 9.30	F	3.58 - 3.90
B	5.20 - 5.40	G	5.50 - 5.80
C	7.51 - 7.75	H	2.10 - 2.30
D	3.70 - 3.90		
E	1.80 - 2.20		

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma \ell /A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	1.25mm^{-1}	12.20mm	9.80mm^2	8.00	120.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	1160	+30/-20%	-	1450	29-350-44

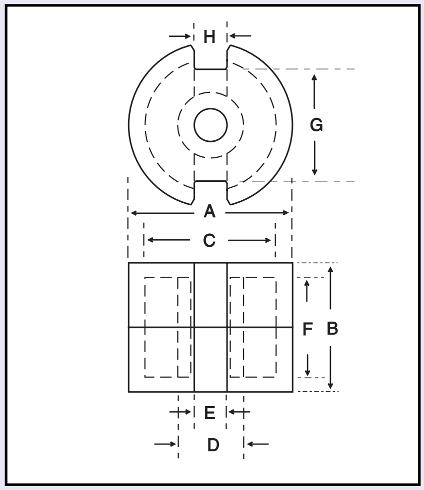
Part numbers refer to half cores.

Bobbins/Coil Formers

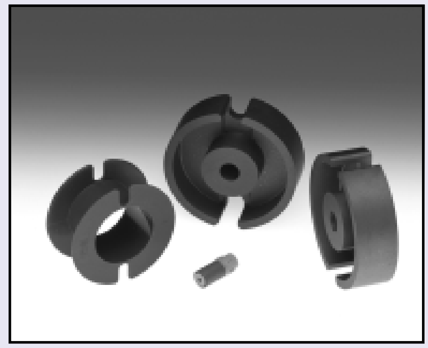
Mounting	No. of Sections	Pins	Part Number
Horizontal	1	-	60-351-76

Core Dimensions (mm)

A	10.90 - 11.30	F	4.40 - 4.68
B	6.40 - 6.60	G	7.20 - 7.70
C	9.00 - 9.40	H	2.65 - 3.05
D	4.50 - 4.70		
E	2.00 - 2.10		



11 x 7mm
29-400-



Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma l/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	l_e	A_e	A_{min}	V_e
Value	$1.00mm^{-1}$	15.90mm	$15.90mm^2$	13.30	$252.00mm^3$

Electrical Specification

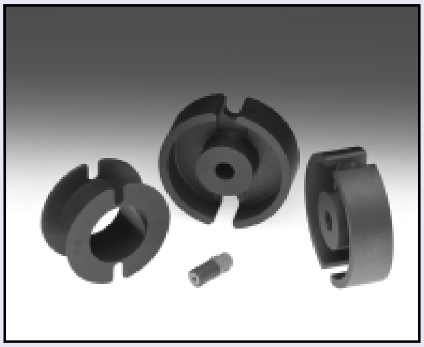
Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F47	1455	+30/-20%	-	1160	29-400-47
F44	1580	+30/-20%	-	1255	29-400-44
F5A	1880	+30/-20%	-	1495	29-400-49
P11	1600	+30/-20%	-	1275	29-400-41

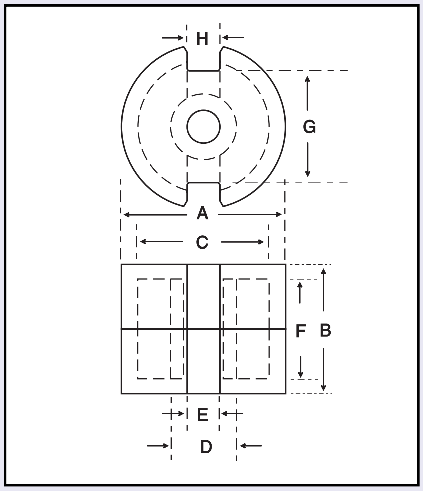
Part numbers refer to half cores.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Horizontal	1	-	60-400-76
Horizontal	2	-	60-401-76

14 x 8mm
29-450-





Core Dimensions (mm)

A	13.80 - 14.20	F	5.60 - 6.00
B	8.20 - 8.50	G	8.70 - 10.20
C	11.60 - 12.00	H	2.50 - 3.50
D	5.80 - 6.00		
E	3.00 - 3.15		

Core Parameters

In accordance with IEC Document 60205.

Parameter	Σℓ/A	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.79mm^{-1}	20.00mm	25.00mm^2	20.00	500.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F47	1875	+30/-20%	-	1180	29-450-47
F44	2090	+30/-20%	-	1315	29-450-44
F9	4600	+30/-20%	-	2890	29-450-36
P11	2300	+30/-20%	-	1445	29-450-41
P11	100	+3/-3%	0.40	63	29-4504-41 *
P11	250	+5/-5%	0.10	155	29-4506-41 *

Part numbers refer to half cores unless otherwise indicated.

* Part number refers to a pair of cores fitted with a threaded insert for adjustable inductance assemblies.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Horizontal	1	0	60-451-72

Adjusters

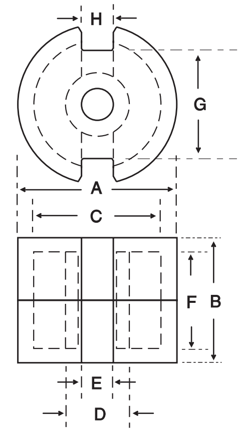
A_L Value	Part Number
100	64-4813-66
250	64-4814-66

MMG

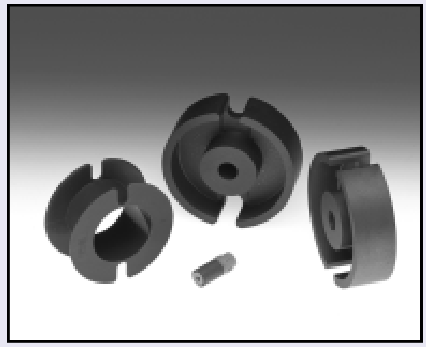
18 x 11mm
29-500-

Core Dimensions (mm)

A	17.60 - 18.20	F	7.20 - 7.60
B	10.40 - 10.70	G	12.20 - 14.00
C	14.90 - 15.40	H	2.80 - 4.00
D	7.30 - 7.60		
E	3.00 - 3.15		



In accordance with IEC Standard 133



Core Parameters

In accordance with IEC Document 60205.

Parameter	Σℓ/A	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.60mm^{-1}	26.00mm	43.00mm^2	36.10	1120.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F47	2500	+30/-20%	-	1195	29-500-47
F44	2600	+30/-20%	-	1240	29-500-44
F9	5600	+30/-20%	-	2675	29-500-36
F10	6450	+30/-20%	-	3080	29-500-37
F39	12600	+30/-20%	-	6015	29-500-39
P11	3100	+30/-20%	-	1480	29-500-41
P11	100	+3/-3%	0.68	48	29-5004-41 *
P11	250	+3/-3%	0.25	119	29-5006-41 *

Part numbers refer to half cores unless otherwise indicated.

* Part number refers to a pair of cores fitted with a threaded insert for adjustable inductance assemblies.

Bobbins/Coil Formers

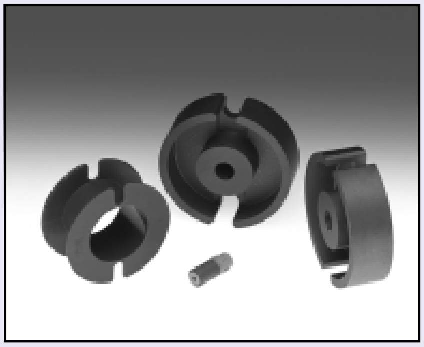
Mounting	No. of Sections	Pins	Part Number
Horizontal	1	0	60-501-72

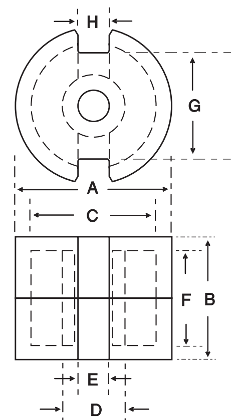
Adjusters

A_L Value	Part Number
100	64-4824-66
250	64-4823-66

MMG

22 x 13mm
29-550-





In accordance with IEC Standard 133

Core Dimensions (mm)

A	21.20 - 22.00	F	9.20 - 9.60
B	13.20 - 13.60	G	14.50 - 16.60
C	17.90 - 18.50	H	3.20 - 4.40
D	9.10 - 9.40		
E	4.40 - 4.55		

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma l/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	l_e	A_e	A_{min}	V_e
Value	0.497mm^{-1}	31.50mm	63.40mm^2	51.3mm^2	2000.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	3500	+30/-20%	-	1500	29-550-44
F5A	4650	+30/-20%	-	1840	29-550-49
F5A	250	+30/-20%	0.25	99	29-556-49**
F9	6860	+30/-20%	-	2710	29-550-36
F10	8600	+30/-20%	-	3400	29-550-37
P11	4650	+30/-20%	-	1840	29-550-41
P11	100	±3%	1.10	40	29-5504-41*
P11	250	±3%	0.25	99	29-5506-41*

Part numbers refer to half cores unless otherwise indicated.

* Part number refers to a pair of cores fitted with a threaded insert for adjustable inductance assemblies.
** Part number refers to a pair of cores.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Horizontal	1	0	60-551-72

Adjusters

A_L Value	Part Number
100	64-4834-66
250	64-4833-66

MMG

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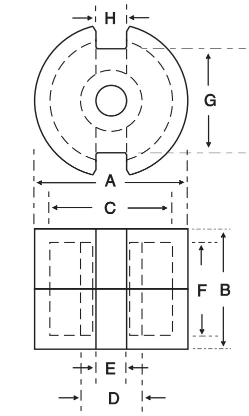
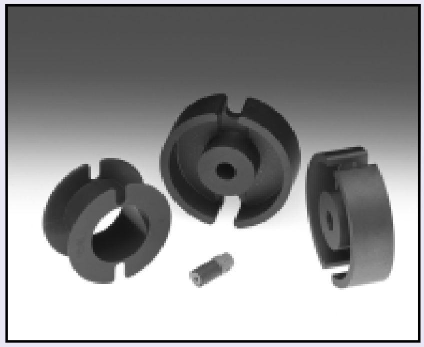
26 x 16mm
29-600-

Core Dimensions (mm)

A	25.00 - 26.00	F	11.00 - 11.40
B	15.90 - 16.30	G	17.50 - 20.00
C	21.20 - 22.00	H	3.20 - 4.40
D	11.10 - 11.40		
E	5.40 - 5.60		



In accordance with IEC Standard 133



Core Parameters

In accordance with IEC Document 60205.

Parameter	Σl/A	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	l_e	A_e	A_{min}	V_e
Value	$0.40mm^{-1}$	37.50mm	$94.00mm^2$	76.50	$3525.00mm^3$
Solid**	$0.35mm^{-1}$	39.50mm	$112.00mm^2$	86.50	$4410.00mm^3$

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	4650	+30/-20%	-	1480	29-600-44
F5A	6000	+30/-20%	-	1910	29-600-49
F9	9000	+30/-20%	-	2865	29-600-36
F10	12000	+30/-20%	-	3820	29-600-37
F9	10000	±3%	-	2810	29-610-36**
F39	25000	+40/-30%	-	7020	29-610-39**
P11	5200	+30/-20%	-	1655	29-600-41
P11	100	±3%	1.60	32	29-6004-41*
P11	250	±3%	0.48	80	29-6006-41*
P11	400	±3%	0.25	127	29-6008-41*

Part numbers refer to half cores unless otherwise indicated.

* Part number refers to a pair of cores fitted with a nut for adjustable inductance assemblies.
** Part number denotes solid core.

Bobbins/Coil Formers

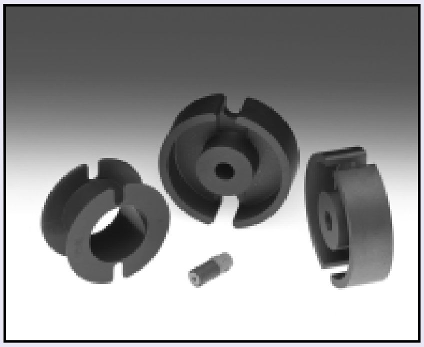
Mounting	No. of Sections	Pins	Part Number
Horizontal	1	0	60-601-72

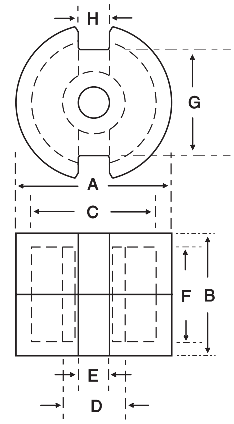
Adjusters

A_L Value	Part Number
100/250	64-4844-66
400	64-4843-66

MMG

30 x 19mm
29-620-





In accordance with IEC Standard 133

Core Dimensions (mm)

A	29.50 - 30.50	F	13.00 - 13.40
B	18.60 - 19.00	G	20.50 - 21.40
C	25.00 - 25.80	H	3.70 - 4.70
D	13.10 - 13.50		
E	5.40 - 5.60		

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma\ell/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	$0.33mm^{-1}$	45.00mm	$136.00mm^2$	115	$6120.00mm^3$

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	6000	+30/-20%	-	1575	29-620-44
F5A	7500	+30/-20%	-	1970	29-620-49
F5A	250	+30/-20%	0.70	65	29-625-49**
F9	10500	+30/-20%	-	2760	29-620-36
F10	14500	+30/-20%	-	3810	29-620-37
P11	6300	+30/-20%	-	1654	29-620-41
P11	400	±3%	0.40	105	29-6208-41*
P11	1000	±3%	0.14	263	29-6210-41*
P11	1600	±5%	0.08	420	29-6211-41*

Part numbers refer to half cores.

* Part number refers to a pair of cores fitted with a threaded insert for adjustable inductance assemblies.
** Part number refers to a pair of cores.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Horizontal	1	0	60-621-72

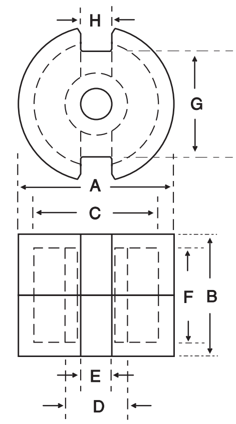
Adjusters

A_L Value	Part Number
400	64-4843-66
1000/1600	64-4845-66

MMG

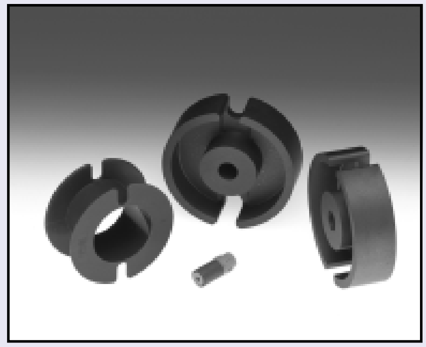
Core Dimensions (mm)

A	35.00 - 36.20	F	14.60 - 15.00
B	21.40 - 22.00	G	24.25 max
C	29.90 - 30.90	H	4.50 - 5.00
D	15.60 - 16.20		
E	5.20 - 5.60		



In accordance with IEC Standard 133

36 x 22mm
29-6500-



Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma\ell/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.26mm^{-1}	53.0mm	202mm^2	172	10700mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	7300	+30/-20%	-	1570	29-6500-44
F9	15200	+30/-20%	-	3145	29-6500-36
P11	8400	+30/-20%	-	1740	29-6500-41
P11	1000	±3%	0.20	206	29-6510-41 *
P11	1600	±3%	0.10	331	29-6511-41 *

Part numbers refer to half cores.

* Part number refers to a pair of cores fitted with a nut for adjustable inductance assemblies.

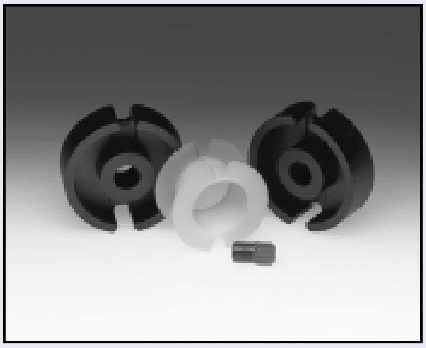
Bobbins/Coil Formers

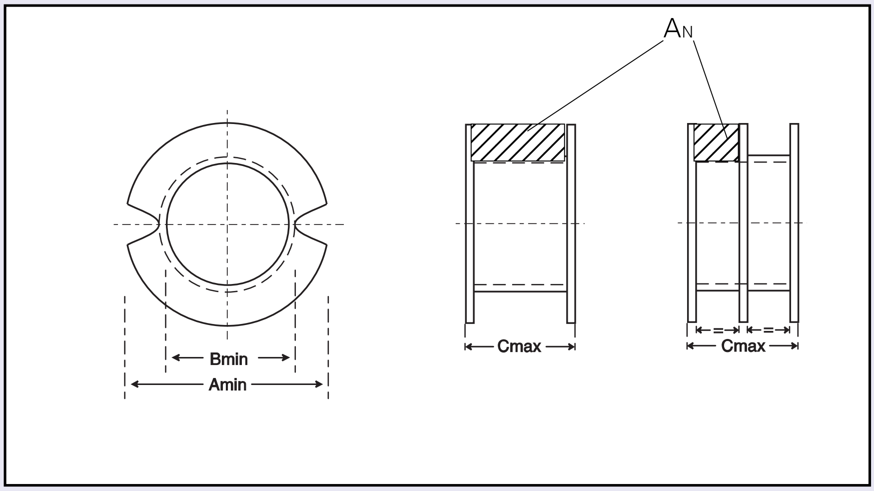
Mounting	No. of Sections	Pins	Part Number
Horizontal	1	-	60-651-67

Adjusters

A_L Value	Part Number
1000/1600	64-4845-66

Pot Core Bobbins 60-3/4/5/600-





Part No.	Core Type	Dimensions			Winding Data		No. of sections
		'A'	'B'	'C'	AN (mm²)	lN (mm)	
60-351-76	P9/5	7.40	4.00	3.50	3.60	19.20	Single
60-352-76					3.20	19.20	Double
60-401-76	P11/7	8.90	4.80	4.20	4.20	27.0	Single
60-402-76					3.80	22.00	Double
60-451-72	P14/9	11.50	6.10	5.40	8.60	28.00	Single
60-452-72					3.90	28.00	Double
60-501-72	P18/11	14.80	7.70	7.00	16.80	36.00	Single
60-502-72					7.80	36.00	Double
60-551-72	P22/13	17.80	9.60	9.00	25.00	44.00	Single
60-552-72					11.50	44.00	Double
60-601-72	P26/16	20.90	11.70	10.80	35.00	52.00	Single
60-602-72					16.00	52.00	Double
60-621-72	P30/19	24.70	13.70	12.80	51.00	60.00	Single
60-622-72					23.50	60.00	Double
60-651-72	P36/22	29.60	16.50	14.40	63.00	73.00	Single

The above components are manufactured in Polyacetal - colour white
Maximum working temperature 110°C
The exception to this is the P9/5 and P11/7 which are moulded in Polyethelyne Teraphalate.
Half height bobbins for proximity sensors are also available on request.

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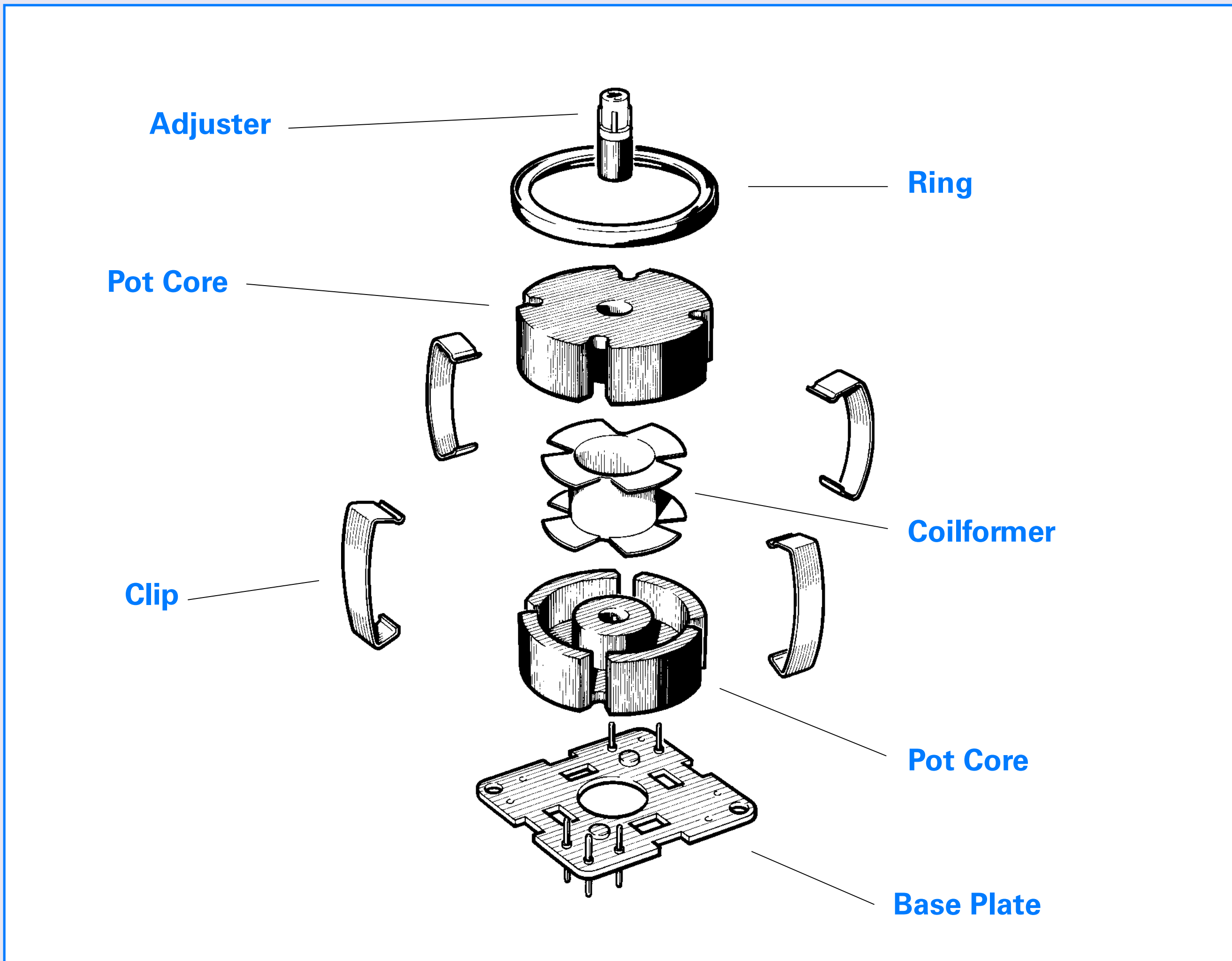
4 Slot Pot Cores and Accessories

10 x 7mm	29-**1010**-	**25 x 16mm**	29-**1170**-
14 x 9mm	29-**1050**-	**30 x 19mm**	29-**1200**-
18 x 11mm	29-**1090**-	**35 x 23mm**	29-**1250**-
21 x 14mm	29-**1130**-	**45 x 29mm**	29-**1280**-

4 Slot Pot Core
Components



4 Slot Pot Cores

MMG offer a wide range of 4 Slot Pot cores based on the old ‘VINKOR’ series.
The cores are supplied gapped to an effective permeability range and are adjustable for tuned filters up to 5MHz. The larger cross-sectional area offered by the 4 Slot range allows for a higher power setting than the conventional 2 Slot version.
Also with the advantage of 2 more slots they can be used in applications where ½ and ¼ turns are required. A full range of bobbins and mounting assemblies are also available.

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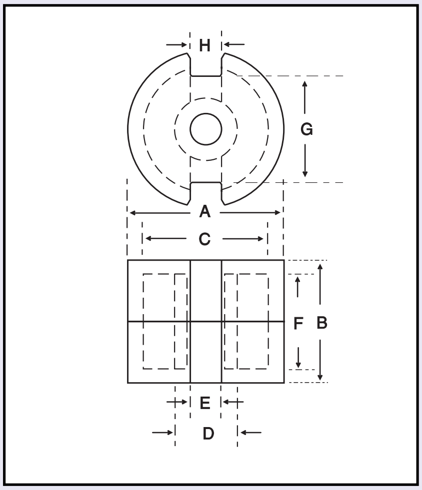
10 x 7mm
29-1010



Core Dimensions (mm)

A	9.78 - 10.22	F	4.20 - 4.60
B	6.70 - 6.90	G	6.54 - 6.86
C	8.14 - 8.54	H	-
D	4.14 - 4.38		
E	2.00 - 2.10		

Core Parameters

In accordance with IEC Document 60205.

Parameter	Σl/A	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	l_e	A_e	A_{min}	V_e
Value	1.02mm^{-1}	13.40mm	13.20mm^2	-	177.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F9C	3125	+30/-20%	-	2540	29-1000C36
P11	49	±3%	0.23	40	29-1010-41 *
P11	78	±3%	0.17	63	29-1011-41 *
P11	123	±3%	0.10	100	29-1012-41 *

Part numbers refer to half cores.
* Part number refers to a pair of cores fitted with a threaded insert for adjustable inductance assemblies.

Bobbins/Coil Formers

Style	No. of Sections	Pins	Part Number
Vertical	1	-	60-1000-72

Adjusters

A_L Value	Part Number
49/78/123	64-7203-66

Mounting Assy

Clip (x4)	Ring	Base Plate
76-7701-95	76-7702-95	70-7703-90

MMG

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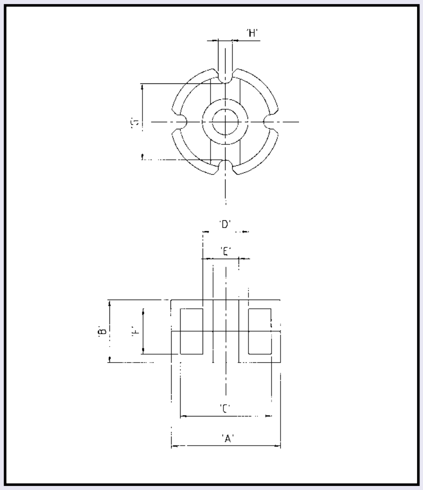
14 x 9mm
29-1050

Core Dimensions (mm)

A	13.70 - 14.30	F	5.60 - 6.00
B	8.90 - 9.10	G	9.72 - 10.20
C	11.41 - 11.91	H	1.50 - 1.90
D	5.90 - 6.20		
E	3.50 - 3.65		



Core Parameters

In accordance with IEC Document 60205.

Parameter	Σℓ/A	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.72mm^{-1}	18.70mm	25.90mm^2	-	484.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
P11	2125	+30/-20%	-	1220	29-1040-41
F58	70	±3%	0.48	40	29-1050-58*
P11	110	±3%	0.28	63	29-1051-41*
P11	175	±3%	0.17	100	29-1052-41*
P11	279	±3%	0.10	160	29-1053-41*
P11	437	±5%	0.04	250	29-1054-41*

Part numbers refer to half cores.
Other material grades and gap lengths may be available on request.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Horizontal	1	-	60-1040-72

Mounting Assy

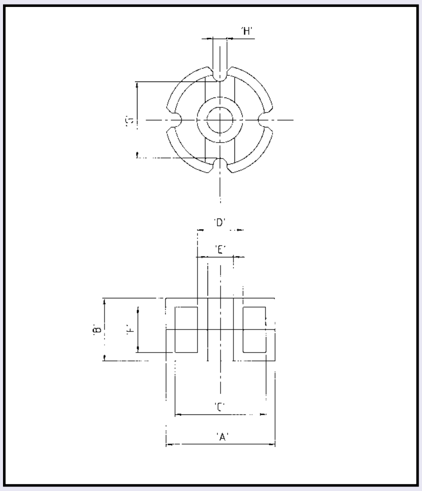
Clip (x4)	Ring	Base Plate
76-7711-95	76-7712-95	70-7712-90

Adjusters

A_L Value	Part Number
110/70	64-4824-66
175/279	64-4823-66
437	64-4825-66

MMG

18 x 11mm
29-1090



Core Dimensions (mm)

A	17.62-18.38	F	7.20-7.60
B	11.10-11.30	G	12.37-12.97
C	14.84-15.50	H	2.20-2.80
D	7.74-8.14		
E	4.47-4.65		

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma\ell/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.55mm^{-1}	24.70mm	44.30mm^2	-	1090.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
P11	3280	+30/-20%	-	1460	29-1080-41
P11	142	±3%	0.40	63	29-1091-41*
F58	142	±3%	0.40	63	29-1091-58*
P11	225	±3%	0.25	100	29-1092-41*
P11	360	±3%	0.13	160	29-1093-41*
P11	563	±5%	0.06	250	29-1094-41*

Part numbers refer to half cores.

* Part number refers to a pair of cores supplied with nut for adjustable inductance assemblies.

Bobbins/Coil Formers

Style	No. of Sections	Pins	Part Number
Horizontal	1	-	60-1080-72

Adjusters

A_L Value	Part Number
142	64-4834-66
225/360/563	64-4833-66

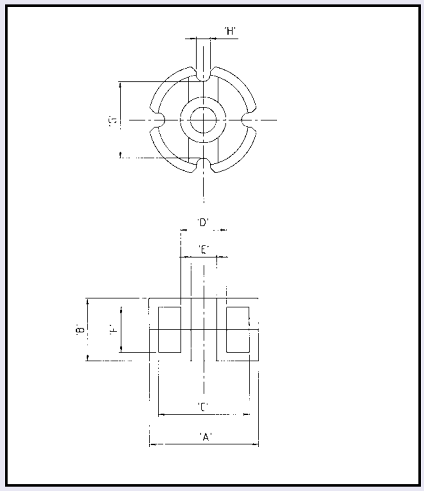
Mounting Assy

Clip (x4)	Ring	Base Plate
76-7721-95	76-7722-95	70-7722-90

MMG

Core Dimensions (mm)

A	21.05 - 21.95	F	8.60 - 9.00
B	13.50 - 13.70	G	15.00 - 15.75
C	17.69 - 18.47	H	2.40 - 3.00
D	9.41 - 9.87		
E	4.47 - 4.65		



21 x 14mm
29-1130

Core Parameters

In accordance with IEC Document 60205.

Parameter	Σℓ/A	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.425mm^{-1}	30.70mm	73.20mm^2	-	2220.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
P11	4290	+30/-20%	-	1450	29-1120-41
P11	186	±3%	0.48	63	29-1131-41*
F58	186	±3%	0.48	63	29-1131-58*
P11	296	±3%	0.30	100	29-1132-41*
P11	473	±3%	0.15	160	29-1133-41*
P11	739	±3%	0.07	250	29-1134-41*

Part numbers refer to half cores.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Horizontal	1	0	60-1120-76

Mounting Assy

Clip (x4)	Ring	Base Plate
76-7731-95	76-7732-95	70-7732-90

Adjusters

A_L Value	Part Number
186	64-4834-66
296/473/739	64-4835-66

MMG

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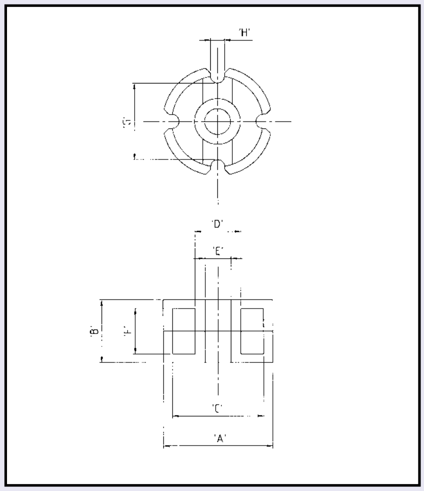
25 x 16mm
29-1170



Core Dimensions (mm)

A	24.87 - 25.93	F	10.20 - 10.60
B	15.90 - 16.10	G	18.06 - 18.94
C	21.06 - 21.94	H	2.70 - 3.30
D	11.05 - 11.59		
E	5.20 - 5.46		

Core Parameters

In accordance with IEC Document 60205.

Parameter	Σ*l*/A	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	l_e	A_e	A_{min}	V_e
Value	0.364mm^{-1}	36.40mm	99.90mm^2	-	3630.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
P11	5210	+30/-20%	-	1510	29-1160-41
F58	138	±3%	1.07	40	29-1170-58*
P11	218	±3%	0.58	63	29-1171-41*
F58	218	±3%	0.58	63	29-1171-58*
P11	345	±3%	0.37	100	29-1172-41*
P11	552	±3%	0.18	160	29-1173-41*
P11	863	±3%	0.09	250	29-1174-41*
P11	1381	±3%	0.05	400	29-1175-41*

Part numbers refer to half cores unless otherwise indicated.

* Part number refers to a pair of cores supplied with nut.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Horizontal	1	0	60-1160-72

Mounting Assy

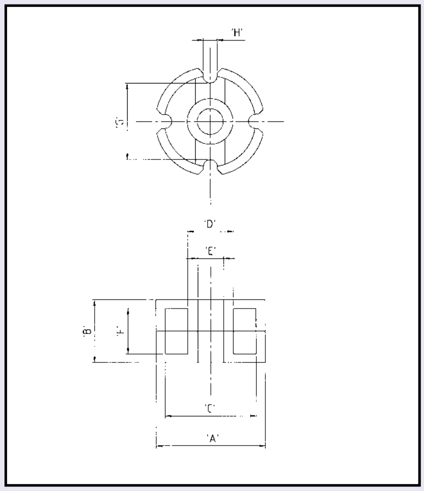
Clip (x4)	Ring	Base Plate
76-7741-95	76-7742-95	70-7742-90

Adjusters

A_L Value	Part Number
138/218/345	64-4844-66
552	64-4843-66
863/1381	64-4845-66

Core Dimensions (mm)

A	28.88 - 30.10	F	12.00 - 12.40
B	18.70 - 18.90	G	20.75 - 21.01
C	23.88 - 24.92	H	3.10 - 3.91
D	13.39 - 14.05		
E	5.20 - 5.46		



30 x 19mm
29-1200

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma l/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	l_e	A_e	A_{min}	V_e
Value	0.283mm^{-1}	43.20mm	153mm^2	-	6590.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
P11	7270	+30/-20%	-	1640	29-1200-41
F9C	14065	+30/-20%	-	3170	29-1200C36
F58	111	±3%	1.44	25	29-1205-58*
P11	280	±3%	0.71	63	29-1211-41*
P11	444	±3%	0.46	100	29-1212-41*
P11	711	±3%	0.23	160	29-1213-41*
P11	1176	±3%	0.06	400	29-1215-41*

Part numbers refer to half cores.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Horizontal	1	0	60-1200-72

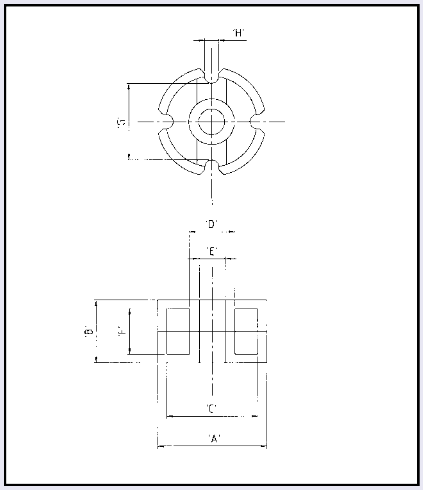
Mounting Assy

Clip (x4)	Ring	Base Plate
76-7751-95	76-7752-95	70-7752-90

Adjusters

A_L Value	Part Number
111	64-4844-66
280/444/711	64-4843-66
1176	64-4845-66

35 x 23mm
29-1250



Core Dimensions (mm)

A	34.75 - 36.25	F	14.58 - 14.98
B	22.70 - 22.92	G	25.17 - 25.43
C	28.70 - 29.92	H	3.61 - 4.39
D	15.80 - 16.61		
E	5.20 - 5.46		

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma l/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	l_e	A_e	A_{min}	V_e
Value	$0.236mm^{-1}$	52.50mm	$223mm^2$	-	$11,700mm^3$

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F9C	16690	+30/-20%	-	3135	29-1240C36
P11	8690	+30/-20%	-	1632	29-1240-41
F58	213	±3%	-	40	29-1250-58*
F58	336	±3%	0.86	63	29-1251-58*
P11	336	±3%	0.86	63	29-1251-41*
P11	533	±3%	0.55	100	29-1252-41*
P11	852	±3%	0.28	160	29-1253-41*
P11	1331	±-3%	0.14	250	29-1254-41*
P11	2130	±3%	0.08	400	29-1255-41*

Part numbers refer to half cores.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Horizontal	1	0	60-1240-72

Mounting Assy

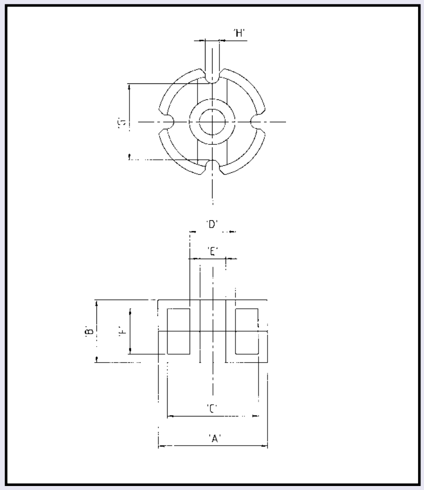
Clip (x4)	Ring	Base Plate
76-7761-95	76-7762-95	70-7762-90

Adjusters

A_L Value	Part Number
213	64-4844-66
336/533	64-4843-66
852/1331/2130	64-4863-66

Core Dimensions (mm)

A	44.08 - 45.92	F	18.80 - 19.20
B	29.10 - 29.30	G	32.54 - 34.14
C	36.55 - 38.13	H	3.60 - 4.60
D	19.70 - 20.68		
E	5.00 - 5.45		



45 x 29mm
29-1280-

Core Parameters

In accordance with IEC Document 60205.

Parameter	Σ*l*/A	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	l_e	A_e	A_{min}	V_e
Value	0.185mm^{-1}	67.00mm	362mm^2	-	24,300mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
P11	11040	+30/-20%	-	1625	29-1280-41
F44	10600	+30/-20%	-	1560	29-1280-44
F9C	18750	+30/-20%	-	2760	29-1280C36

Part numbers refer to half cores.

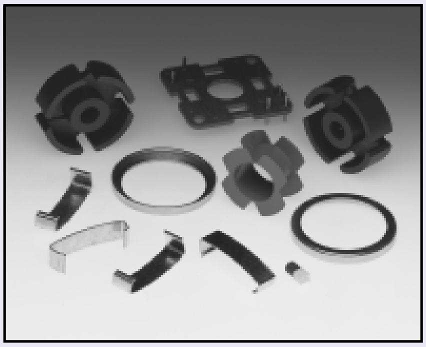
Bobbins/Coil Formers

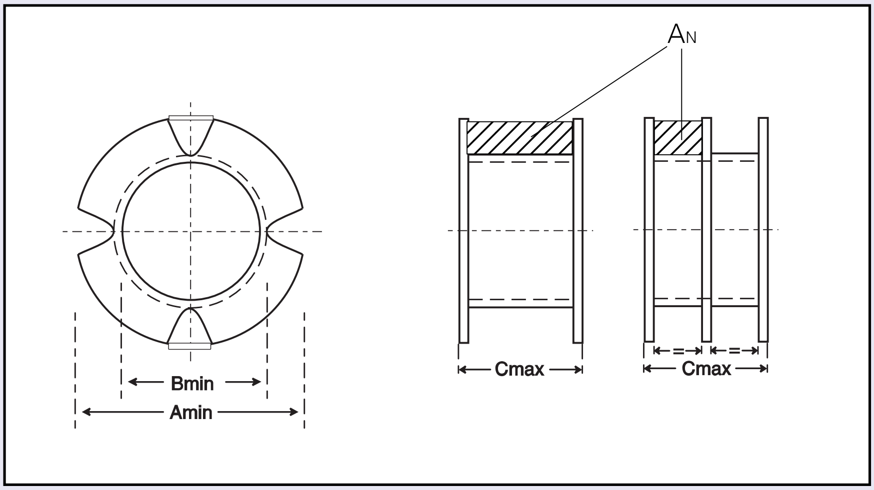
Style	No. of Sections	Pins	Part Number
Vertical	1	-	60-1280-72

Mounting Assy

Clip (x4)	Ring	Base Plate
76-7771-95	76-7772-95	70-7772-90

Pot Core Bobbins 60-1XXX-

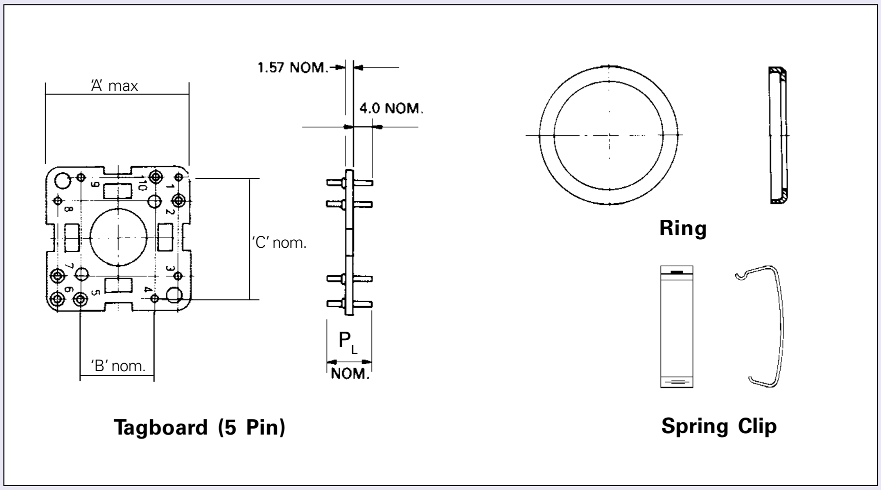


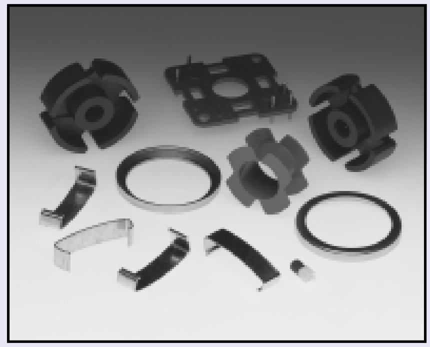


Part No.	Core Type	Dimensions			Winding Data		No. of sections
		'A'	'B'	'C'	AN (mm²)	IN (mm)	
60-1000-72	10x7	8.13	4.39	4.20	5.6	20.5	Single
60-1040-72	14x9	11.40	6.20	5.60	10.2	28.8	Single
60-1080-72	18x11	14.83	8.15	7.20	17.4	37.4	Single
60-1081-72	18x11	14.83	8.15	7.20	6.7	17.4	Double
60-1120-72	21x14	17.68	9.88	8.60	24.7	44.7	Single
60-1160-72	25x16	21.05	11.60	10.20	35.7	26.6	Single
60-1200-72	30x19	23.86	14.06	12.00	43.5	61.5	Single
60-1201-72	30x19	23.86	14.06	12.00	15.7	61.5	Double
60-1240-72	35x23	28.68	16.62	14.58	65.9	73.4	Single
60-1280-72	45x29	36.54	20.69	18.80	114.0	92.8	Single

* Manufactured in Polyacetal - colour green
Flammability - UL-HB
Maximum working temperature 110°C

Pot Core Accessories





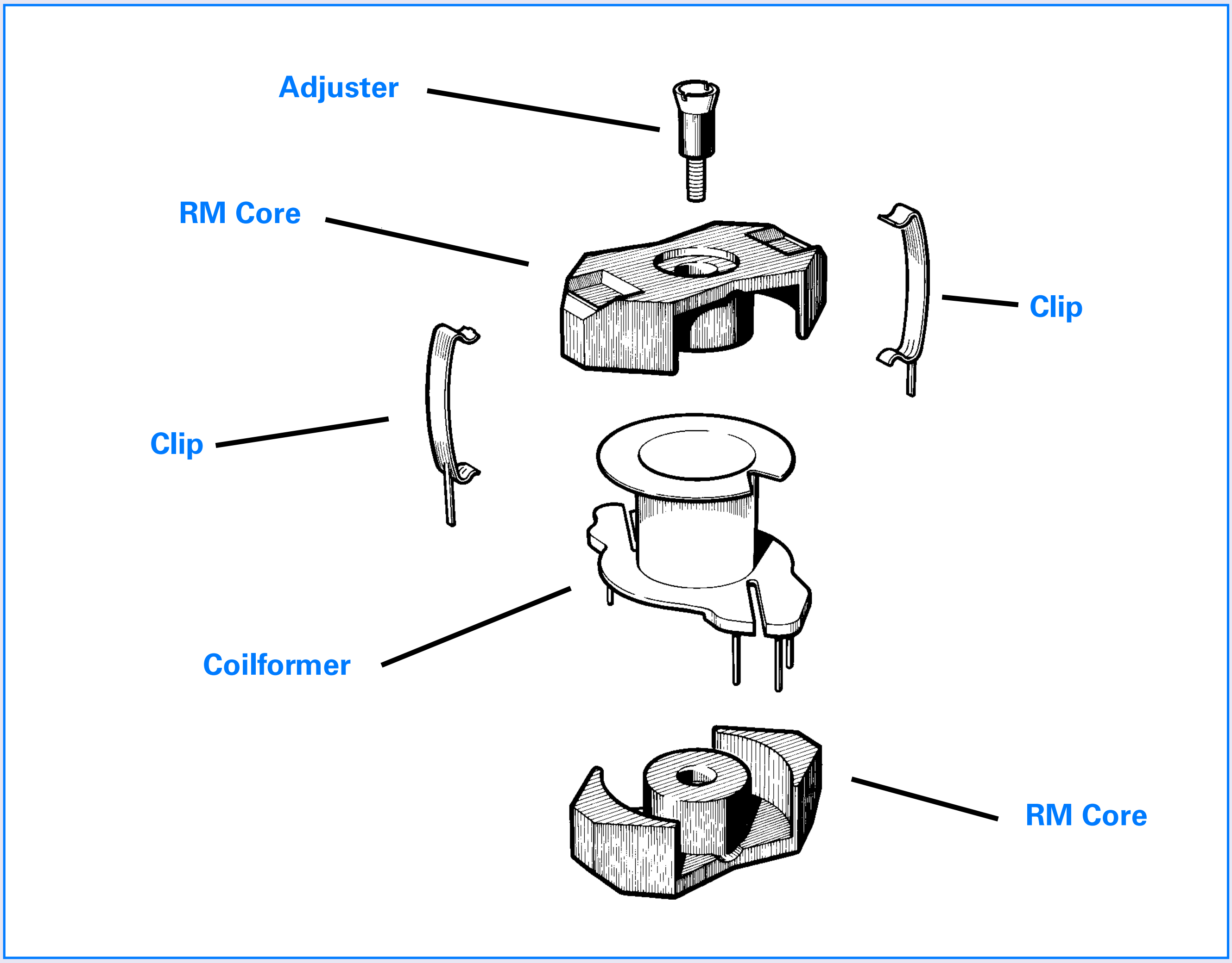
Part Code	Pin Details				Spring Clip Part No.	Ring Part Number
	A	B	C	P_L		
70-7703-90*	13.34	10.16	10.16	9.65	76-7701-95	76-7702-95
70-7712-90	19.65	10.16	15.24	9.65	76-7711-95	76-7712-95
70-7722-90	22.15	12.7	17.78	9.65	76-7721-95	76-7722-95
70-7732-90	24.65	15.24	20.32	9.65	76-7731-95	76-7732-65
70-7742-90	30.15	25.24	25.40	9.65	76-7741-95	76-7742-95
70-7752-90	32.95	17.78	27.94	9.65	76-7751-95	76-7752-95
70-7762-90	40.15	22.86	33.02	9.65	76-7761-95	76-7762-95
70-7772-90	50.15	33.02	43.18	9.65	76-7771-95	76-7772-95

*4 pin version.
Base plates are manufactured from SRBP with tinned brass pins.
Spring clips are made from spring steel and nickel flash dipped .
The securing rings are turned from zinc plated mild steel.
These may also be used with the 2 slot version and an alternative ring and clip may be quoted in some cases.

RM Cores and Accessories
(IEC Standard 431)

RM 4	29-900-	RM 6	29-730-	RM 8	29-790-	RM 12i SOLID	29-940-
RM 4 SOLID	29-920-	RM 6 SOLID	29-750-	RM 8 SOLID	29-810-	RM 14i SOLID	29-980-
RM 5	29-700-	RM 7	29-7600-	RM 10	29-830-		
RM 5 SOLID	29-720-	RM 7 SOLID	29-7800-	RM 10 SOLID	29-850-	R 6	29-950-

RM Core
Components



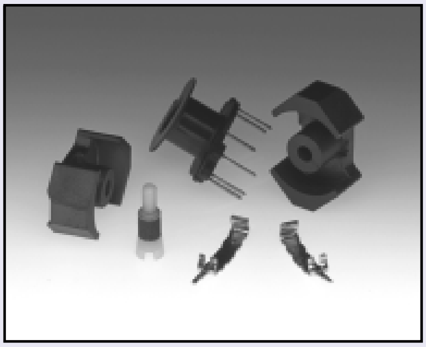
RM Cores

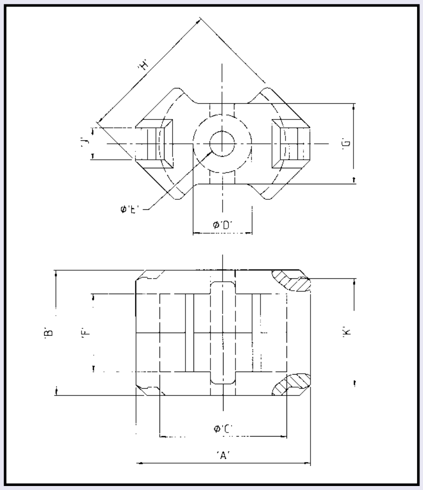
RM (Rectangular modulus) cores arose due to the demand for coil formers with integrated pins that allow for efficient winding and high PCB packing densities. Clamps engaging in recesses in the core base hold the cores in place, meaning glue is not normally required in this process.
All the cores adhere to specifications laid down in IEC 431 and in DIN 41980. The coil formers adhere to DIN 41981.
RM cores are designed for two main applications:

- -Highly stable, extremely low loss filter inductors and other resonance determining inductors (F58, P11).
- -Low distortion broadband transmission at low signal modulation (F39, F10, F9).

RM cores can also be supplied without the centre hole. These have a higher A_L value and cross sectional area and are used for power transformer applications (F47, F44, F45, F5A).

RM 4
29-900-





Core Dimensions (mm)

A	10.60 - 11.00	F	7.00 - 7.40
B	10.30 - 10.50	G	4.40 - 4.60
C	7.95 - 8.35	H	9.50 - 9.80
D	3.70 - 3.90	J	2.50 - 2.70
E	2.00 - 2.10	K	8.76 - 9.26

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma \ell / A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	1.90mm^{-1}	21.0mm	11.0mm^2	-	232.0mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F9	1700	+30/-20%	-	2570	29-900-36
F44	800	+30/-20%	-	1210	29-900-44
P11	900	+30/-20%	-	1360	29-900-41
P11	63	±3%	0.18	95	29-901-41*
P11	100	±3%	0.12	150	29-902-41*
P11	160	±3%	0.06	240	29-903-41*
P11	250	±3%	0.03	375	29-904-41*
P11	100	±3%	0.12	150	29-912-41**
P11	160	±3%	0.06	240	29-913-41**
P11	250	±3%	0.03	375	29-914-41**

*Part number refers to a pair of cores fitted with a nut for adjustable inductance assemblies.

**Part number denotes a gapped pair without nut. Other part numbers refer to half cores.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Vertical (AS)	1	4	60-901S64
Vertical (AS)	1	6	60-903S64

Other pin lengths or variation may be listed at the end of this section

Adjusters

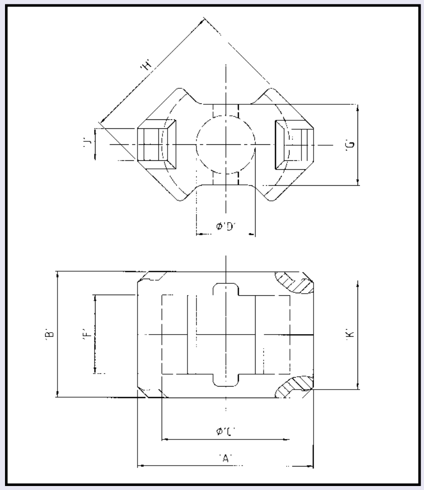
A_L Value	Part Number
63/100	64-020-66
160/250	64-021-66
Clip	76-024-95

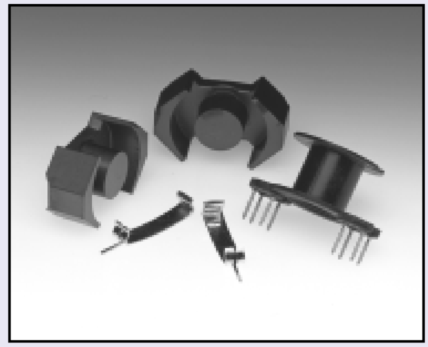
MMG

RM 4 SOLID
29-920-

Core Dimensions (mm)

A	10.60 - 11.00	F	7.00 - 7.40
B	10.30 - 10.50	G	4.40 - 4.60
C	7.95 - 8.35	H	9.50 - 9.80
D	3.70 - 3.90	J	2.50 - 2.70
E	——	K	8.76 - 9.26





Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma \ell / A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	1.70mm^{-1}	22.0mm	13.0mm^2	11.3mm^2	286.0mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F9	1900	+30/-20%	-	2570	29-920-36
F10	2800	+30/-20%	-	3790	29-920-37
F39	3700	+40/-30%	-	5000	29-920-39
F44	860	+30/-20%	-	1160	29-920-44
F44	100	±5%	0.35	75	29-921-44*
F44	160	±5%	0.20	120	29-922-44*
F44	250	±5%	0.10	188	29-923-44*

Part numbers refer to half cores.

*Part number refers to a pair of cores.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Vertical (AS)	1	4	60-901S64
Vertical (AS)	1	6	60-902S64

Other pin lengths and versions may be listed at the end of this section

Clip

Part Number
76-024-95

MMG

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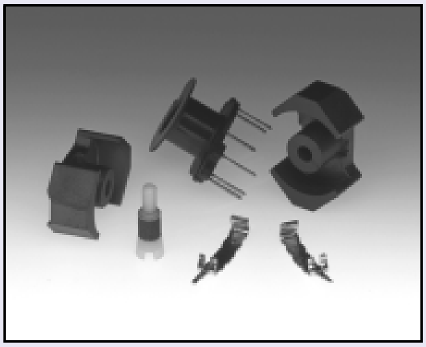
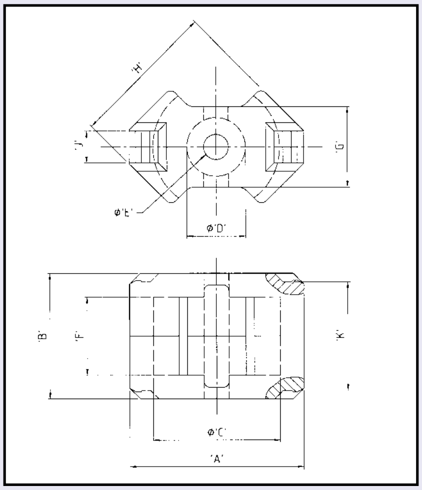
RM 5-
29-700-





Core Dimensions (mm)

A	14.00 - 14.60	F	6.30 - 6.70
B	10.30 - 10.50	G	6.40 - 6.80
C	10.20 - 10.60	H	11.80 - 12.30
D	4.70 - 4.90	J	2.50 - 2.70
E	2.00 - 2.10	K	8.76 - 9.26

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma\ell/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	1.00mm^{-1}	20.80mm	20.80mm^2	15.0mm^2	430.0mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F10	4800	+30/-20%	-	3820	29-700-37
F39	6000	+40/-30%	-	4775	29-700-39
P11	1840	+30/-20%	-	1460	29-700-41
P11	100	±3%	0.18	80	29-701-41*
P11	160	±3%	0.12	128	29-702-41*
P11	250	±3%	0.06	200	29-703-41*
P11	315	±3%	0.03	250	29-704-41*
P11	100	±5%	0.18	80	29-711-41**
P11	160	±5%	0.12	128	29-712-41**
P11	250	±5%	0.06	200	29-713-41**

*Part number refers to a pair of cores fitted with a nut for adjustable inductance assemblies.

**Part number denotes a pair of cores without nut. Other part numbers refer to half cores.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Vertical (AS)	1	4	60-701S64
Vertical (AS)	1	6	60-702S64

Other pin lengths or variation may be listed at the end of this section

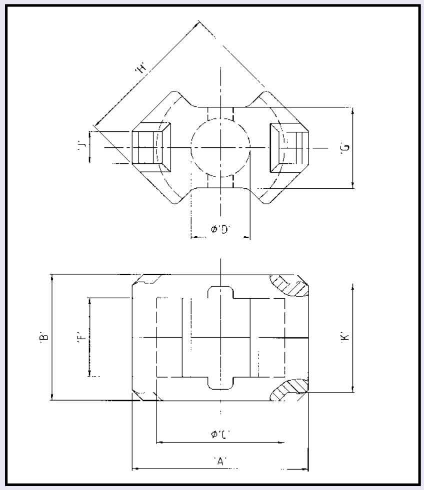
Adjusters

A_L Value	Part Number
100/160	64-020-66
250/315	64-021-66
Clip	76-024-95

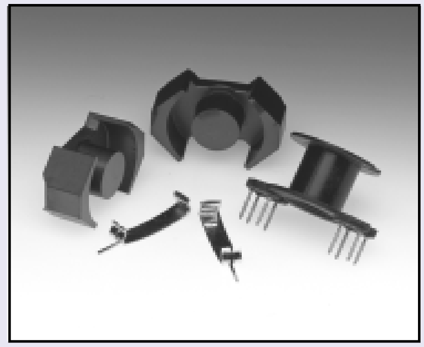
MMG

Core Dimensions (mm)

A	14.00 - 14.60	F	6.30 - 6.70
B	10.30 - 10.50	G	6.40 - 6.80
C	10.20 - 10.60	H	11.80 - 12.30
D	4.70 - 4.90	J	2.50 - 2.70
E	——	K	8.76 - 9.26



RM 5 SOLID
29-720-



Core Parameters

In accordance with IEC Document 60205.

Parameter	Σℓ/A	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.93mm^{-1}	22.10mm	23.80mm^2	18.0mm^2	526.0mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F9	3840	+30/-20%	-	2840	29-720-36
F10	4815	+30/-20%	-	3563	29-720-37
F39	6700	+40/-30%	-	4960	29-720-39
F47	1520	+30/-20%	-	1125	29-720-47
F44	1570	+30/-20%	-	1160	29-720-44
F44	100	±5%	0.35	74	29-721-44*
F44	160	±5%	0.20	118	29-722-44*
F44	250	±5%	0.12	185	29-723-44*

Part numbers refer to half cores.

*Part number refers to a pair of cores.

Bobbins/Coil Formers

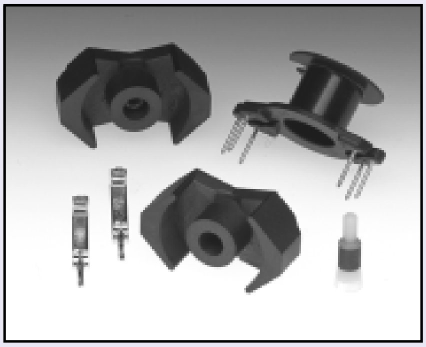
Mounting	No. of Sections	Pins	Part Number
Vertical (AS)	1	4	60-701S64
Vertical (AS)	1	6	60-702S64

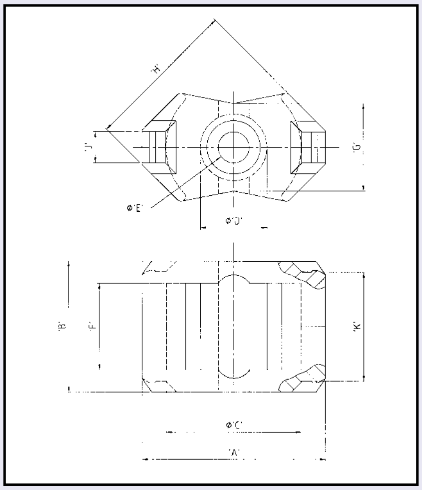
Other pin lengths and versions may be listed at the end of this section

Clip

Part Number
76-024-95

RM 6
29-730-





Core Dimensions (mm)

A	17.30 - 17.90	F	8.00 - 8.40
B	12.30 - 12.50	G	7.80 - 8.20
C	12.40 - 12.90	H	14.10 - 14.70
D	6.10 - 6.40	J	2.80 - 2.90
E	2.80 - 3.00	K	10.10 - 10.58

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma \ell / A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.87mm^{-1}	27.0mm	31.0mm^2	-	840.0mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F58	890	+30/-20%	-	615	29-730-58
P11	2000	+30/-20%	-	1385	29-730-41
F58	40	±3%	-	28	29-7302-58*
F58	63	±3%	0.60	44	29-7303-58*
F58	100	±3%	0.38	70	29-7304-58*
P11	100	±3%	0.50	70	29-7304-41*
P11	160	±3%	0.20	110	29-7305-41*
P11	250	±3%	0.11	175	29-7306-41*
P11	400	±3%	0.05	275	29-7308-41*
P11	630	±10%	0.03	436	29-7309-41*

*Part number refers to a pair of cores fitted with a nut for adjustable inductance assemblies.
Non adjustable cores may also be available on request. Part numbers refer to half cores.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Vertical (AS)	1	4	60-731-64
Vertical (AS)	1	6	60-7303-64

Other pin lengths or variation may be listed at the end of this section

Adjusters

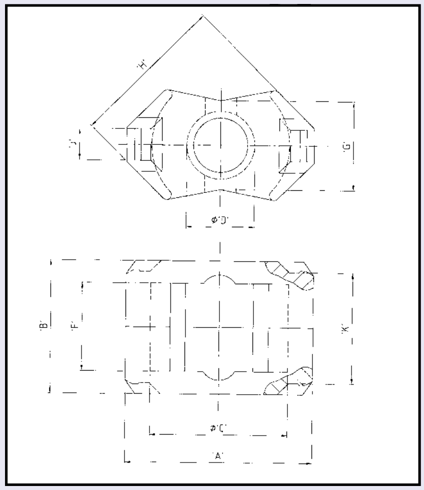
A_L Value	Part Number
65/100/160	64-025-66
250	64-026-66
400/630	64-027-66

Clip

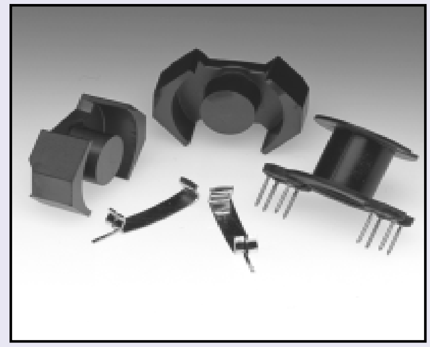
76-020-95

Core Dimensions (mm)

A	17.30 - 17.90	F	8.00 - 8.40
B	12.30 - 12.50	G	7.80 - 8.20
C	12.40 - 12.90	H	14.10 - 14.70
D	6.10 - 6.40	J	2.80 - 2.90
E	——	K	10.10 - 10.58



RM 6 SOLID
29-750-



Core Parameters

In accordance with IEC Document 60205.

Parameter	Σℓ/A	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.78mm^{-1}	29.0mm	37.0mm^2	31.0mm^2	1090.0mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F9	4300	+30/-20%	-	2670	29-750-36
F10	6200	+30/-20%	-	3850	29-750-37
F39	8600	+40/-30%	-	5330	29-750-39
F47	2050	+30/-20%	-	1270	29-750-47
F45	2400	+30/-20%	-	1490	29-750-45
F44	2000	+30/-20%	-	1370	29-750-44
F44	100	±5%	0.50	62	29-751-44*
F44	160	±5%	0.20	100	29-752-44*
F44	250	±5%	0.11	155	29-753-44*
F44	400	±5%	0.05	248	29-755-44*

Part numbers refer to half cores.
*Part number refers to a pair of cores.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Vertical (AS)	1	4	60-731-64
Vertical (AS)	1	6	60-7303-64

Other pin lengths and versions may be listed at the end of this section

Clip

Part Number
76-020-95

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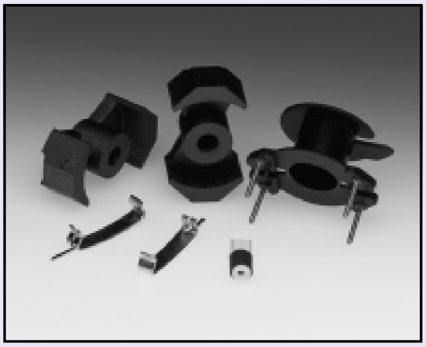
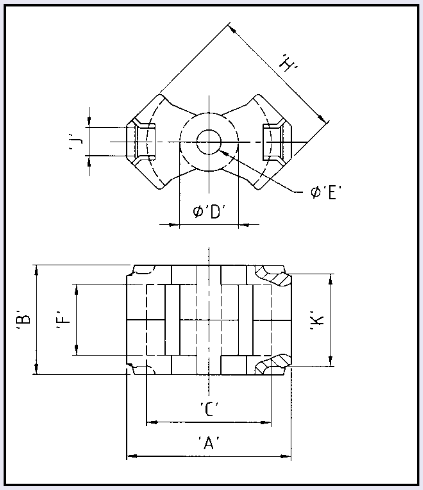
29-7600-





Core Dimensions (mm)

A	19.50 - 20.30	F	8.50 - 8.90
B	13.30 - 13.50	G	——
C	14.76 - 15.36	H	16.50 - 17.20
D	6.96 - 7.24	J	3.20 - 3.60
E	2.94 - 3.12	K	11.06 - 11.54

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma l/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	l_e	A_e	A_{min}	V_e
Value	0.74mm^{-1}	29.80mm	40.00mm^2	-	1200.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F9	4690	+30/-20%	-		29-7600-36
P11	2860	+30/-20%	-		29-7600-41
P11	100	±3%	0.76		29-7604-41 *
P11	160	±3%	0.40		29-7605-41 *
P11	250	±3%	0.25		29-7606-41 *
P11	400	±3%	0.15		29-7608-41 *
P11	100	±5%	0.70		29-7704-41 **
P11	160	±5%	0.40		29-7705-41 **
P11	250	±5%	0.25		29-7706-41 **
P11	400	±5%	0.15		29-7708-41 **

Part numbers refer to half cores.
**Part number denotes solid core.

*Part number refers to a pair of cores fitted with a nut for adjustable inductance assemblies.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Vertical (AS)	1	4	60-7601-64
Vertical (AS)	1	6	60-7604-64

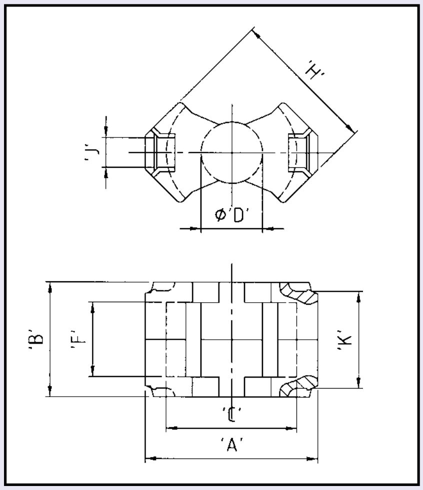
Other pin lengths or variation may be listed at the end of this section

Adjusters

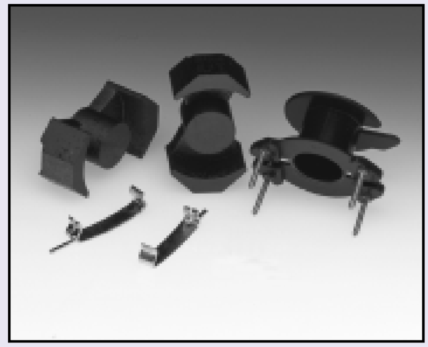
A_L Value	Part Number
63/100/160	64-025-66
250	64-026-66
400/630	64-027-66
Clip	76-021-95

Core Dimensions (mm)

A	19.50 - 20.30	F	8.50 - 8.90
B	13.30 - 13.50	G	——
C	14.76 - 15.36	H	16.50 - 17.20
D	6.96 - 7.24	J	3.20 - 3.60
E	——	K	11.06 - 11.54



RM 7 SOLID
29-7800-



Core Parameters

In accordance with IEC Document 60205.

Parameter	Σℓ/A	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.70mm^{-1}	30.40mm	43.0mm^2	39.0mm^2	1340.0mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F9	5000	+30/-20%	-	3150	29-7800-36
F10	7000	+30/-20%	-	3900	29-7800-37
F39	10000	+40/-30%	-	5700	29-7800-39
F44	2370	+30/-20%	-	1320	29-7800-44
F5A	2850	+30/-20%	-	1590	29-7800-49
F44	100	±5%	0.70	55	29-7804-44*
F44	160	±5%	0.40	90	29-7805-44*
F44	250	±5%	0.25	140	29-7806-44*
F44	400	±5%	0.15	225	29-7808-44*

Part numbers refer to half cores.
*Part number refers to a pair of cores.

Bobbins/Coil Formers

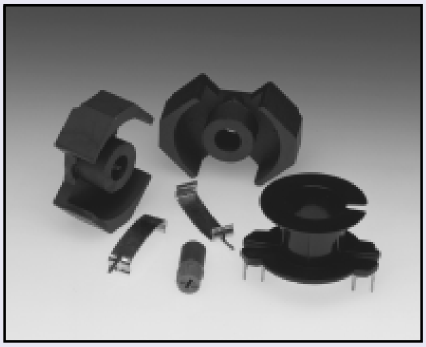
Mounting	No. of Sections	Pins	Part Number
Vertical (AS)	1	4	60-7601-64
Vertical (AS)	1	8	60-7604-64

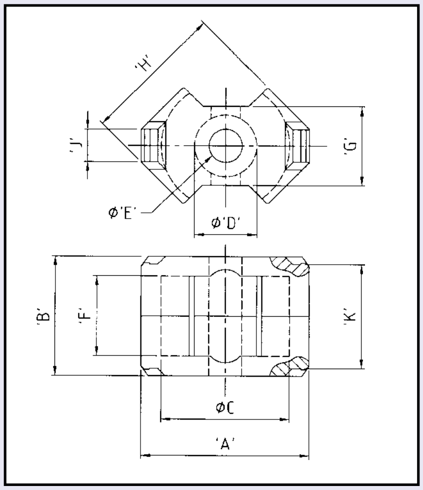
Other pin lengths and versions may be listed at the end of this section

Clip

Part Number
76-021-95

RM 8
29-790-





Core Dimensions (mm)

A	22.30 - 23.20	F	10.80 - 11.20
B	16.30 - 16.50	G	10.50 - 11.40
C	17.00 - 17.70	H	18.90 - 19.70
D	8.25 - 8.55	J	4.30 - 5.10
E	4.40 - 4.60	K	14.06 - 14.54

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma\ell/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.68mm^{-1}	35.50mm	52.00mm^2	-	1850.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
P11	2500	+30/-20%	-	1350	29-790-41
F58	1170	+30/-20%	-	630	29-790-58
F58	63	±3%	1.40	34	29-7903-58*
F58	100	±3%	0.80	54	29-7904-58*
P11	100	±3%	0.86	54	29-7904-41*
P11	160	±3%	0.40	86	29-7905-41*
P11	250	±3%	0.23	135	29-7906-41*
P11	315	±3%	0.18	170	29-7907-41*
P11	400	±3%	0.13	216	29-7908-41*
P11	630	±3%	0.08	341	29-7909-41*

Part numbers refer to half cores.
Non adjustable type may be available on request.

*Part number refers to a pair of cores fitted with a nut for adjustable inductance assemblies.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Vertical (Z)	1	8	60-792-64
Vertical (AS)	1	12	60-793-64

Other pin lengths or variation may be listed at the end of this section

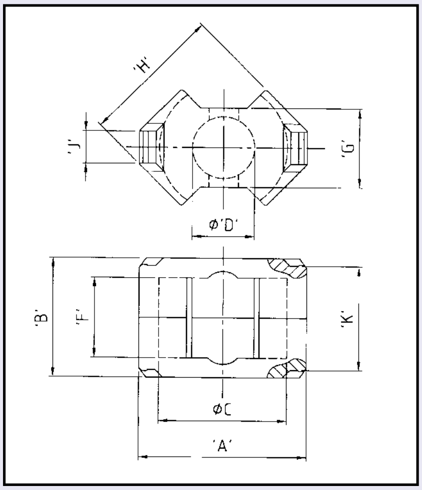
Adjusters

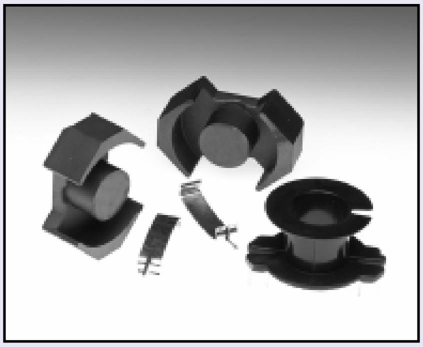
A_L Value	Part Number
63/100/160	64-4834-66
250/400	64-4833-66
630	64-4835-66
Clip	76-022-95

RM 8 SOLID
29-810-

Core Dimensions (mm)

A	22.30 - 23.20	F	10.80 - 11.20
B	16.30 - 16.50	G	10.50 - 11.00
C	17.00 - 17.70	H	18.90 - 19.70
D	8.25 - 8.55	J	4.30 - 5.10
E	——	K	14.06 - 14.54





Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma l/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	l_e	A_e	A_{min}	V_e
Value	0.59mm^{-1}	38.0mm	64.0mm^2	55.0mm^2	2430.0mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F9	5700	+30/-20%	-	2675	29-810-36
F10	8375	+30/-20%	-	3930	29-810-37
F39	12500	+40/-30%	-	5870	29-810-39
F44	2905	+30/-20%	-	1365	29-810-44
F45	3300	+30/-20%	-	1550	29-810-45
F5A	4000	+30/-20%	-	1880	29-810-49
F44	100	±5%	0.70	47	29-811-44*
F44	160	±5%	0.40	75	29-812-44*
F44	250	±5%	0.25	117	29-813-44*
F44	315	±5%	0.15	188	29-814-44*

Part numbers refer to half cores. *Part number refers to a pair of cores.

Bobbins/Coil Formers

Mounting	No. of Sections	Pins	Part Number
Vertical (Z)	1	8	60-792-64
Vertical (AS)	1	12	60-793-64

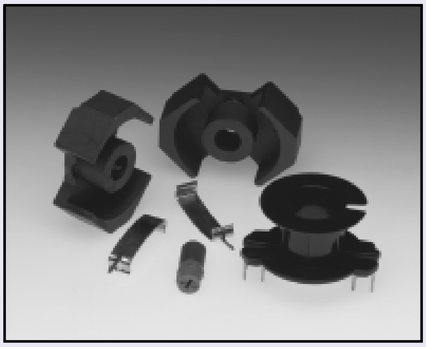
Other pin lengths and versions may be listed at the end of this section

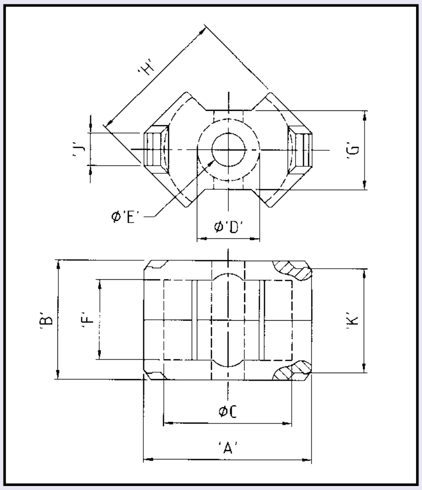
Clip

Part Number
76-022-95

MMG

RM 10
29-830-





Core Dimensions (mm)

A	27.20 - 28.40	F	12.40 - 13.00
B	18.50 - 18.70	G	13.00 - 13.50
C	21.20 - 22.10	H	23.60 - 24.70
D	10.50 - 10.90	J	5.00 - 5.20
E	5.40 - 5.60	K	15.96 - 16.94

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma\ell/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.50mm^{-1}	42.00mm	83.00mm^2	-	3470.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
P11	3960	+30/-20%	-	1575	29-830-41
F58	1600	+30/-20%	-	635	29-830-58
F58	63	±3%	2.60	25	29-8303-58*
F58	100	±3%	1.50	40	29-8304-58*
P11	160	±3%	0.90	64	29-8305-41*
P11	250	±3%	0.55	99	29-8306-41*
P11	400	±3%	0.21	159	29-8308-41*
P11	630	±3%	0.13	250	29-8309-41*
P11	1000	±3%	0.08	398	29-8310-41*

Part numbers refer to half cores.
Non adjustable type may be available on request.

*Part number refers to a pair of cores fitted with a nut for adjustable inductance assemblies.

Bobbins/Coil Formers

Style	No. of Sections	Pins	Part Number
Vertical (Z)	1	8	60-822-64
Vertical (AS)	1	12	60-823-64

Other pin lengths or variation may be listed at the end of this section

Adjusters

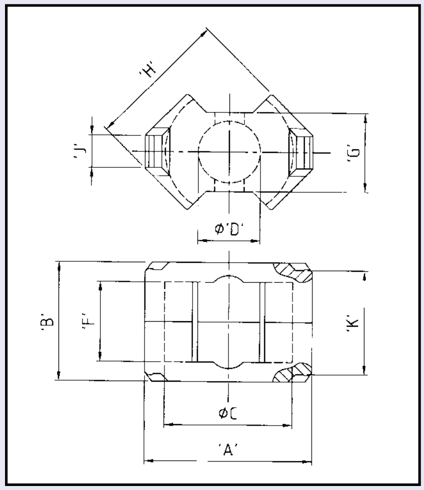
A_L Value	Part Number
63/100/160/250	64-8104-66
400/630	64-4843-66
1000	64-4845-66
Clip	76-023-95

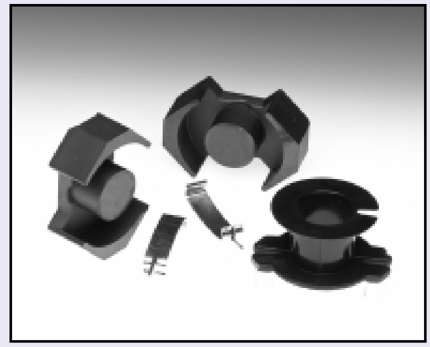
MMG

RM 10 SOLID
29-850-

Core Dimensions (mm)

A	27.20 - 28.40	F	12.40 - 13.00
B	18.50 - 18.70	G	13.00 - 13.50
C	21.20 - 22.10	H	23.60 - 24.70
D	10.50 - 10.90	J	5.00 - 5.20
E	—	K	15.96 - 16.44





Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma\ell/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	$0.45mm^{-1}$	44.0mm	$98.0mm^2$	$90.0mm^2$	$4310.0mm^3$

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F9	7875	+30/-20%	-	2820	29-850-36
F10	11000	+30/-20%	-	3940	29-850-37
F39	16000	+40/-30%	-	5730	29-850-39
F44	3800	+30/-20%	-	1360	29-850-44
F45	4200	+30/-20%	-	1505	29-850-45
F5A	4490	+30/-20%	-	1610	29-850-49
F44	160	±5%	0.90	57	29-862-44*
F44	250	±5%	0.55	89	29-863-44*
F44	400	±5%	0.21	143	29-865-44*
F44	630	±5%	0.13	225	29-866-44*

Part numbers refer to half cores. *Part number refers to a pair of cores.

Bobbins/Coil Formers

Style	No. of Sections	Pins	Part Number
Vertical (Z)	1	8	60-822-64
Vertical (AS)	1	12	60-823-64

Other pin lengths and versions may be listed at the end of this section

Clip

Part Number
76-023-95

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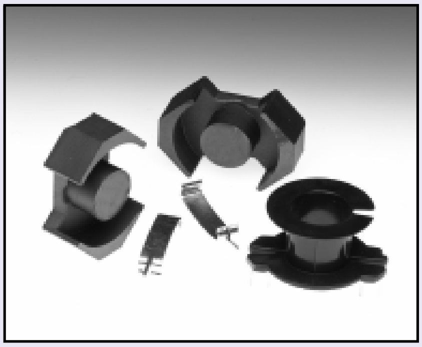
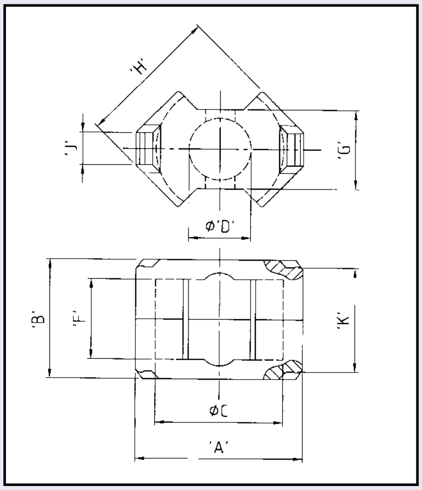
RM 12i SOLID
29-940-





Core Dimensions (mm)

A	36.10 - 37.40	F	16.80 - 17.70
B	24.30 - 24.60	G	15.60 - 16.10
C	25.00 - 26.00	H	27.70 - 28.80
D	12.40 - 12.80	J	4.90 - 5.10
E	——	K	21.40 - 21.98

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma \ell / A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.388mm^{-1}	56.60mm	146.00mm^2	125mm^2	8340.00mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F47	4750	+30/-20%	-	1465	29-940-47
F44	5000	+30/-20%	-	1545	29-940-44
F5A	5800	+30/-20%	-	1790	29-940-49
F5A	160	±5%	1.50	49	29-941-49*
F5A	250	±5%	0.90	77	29-942-49*
F5A	400	±5%	0.50	123	29-943-49*

Part numbers refer to half cores. *Part number refers to a pair of cores.

NOTE: This core range now complies with the new industrial requirements for power handling and should be ordered as replacements for previous RM12 cores supplied under Part no's. 29-930-xx to 29-939-xx.
The clips 76-030-95 are also **not** compatible with this new range.

Bobbins/Coil Formers

Style	No. of Sections	Pins	Part Number
Vertical (AS)	1	12	60-930-64
Vertical (DIL)	1	12	60-940-76

Other pin lengths or variation may be listed at the end of this section

Clip

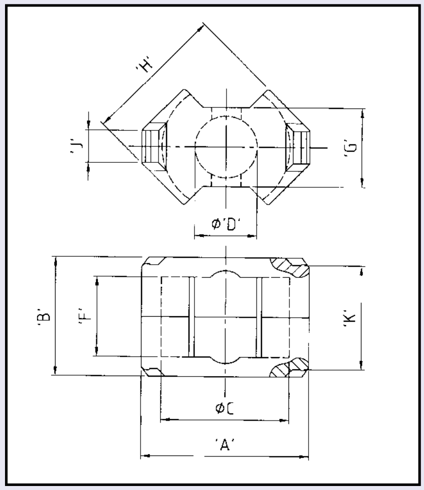
Part Number
76-085-95

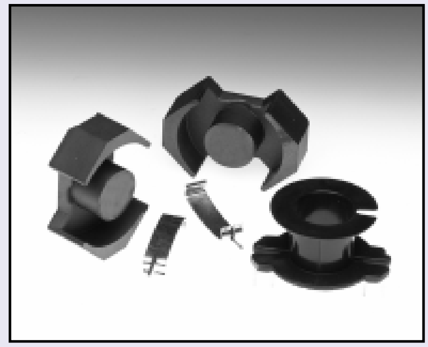
MMG

RM 14i SOLID
29-980-

Core Dimensions (mm)

A	40.80 - 42.40	F	20.80 - 21.40
B	30.00 - 30.20	G	18.40 - 19.00
C	29.00 - 30.20	H	33.50 - 34.70
D	14.50 - 15.00	J	5.60 - 5.80
E	—	K	26.80 - 27.28





Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma l/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	l_e	A_e	A_{min}	V_e
Value	0.353mm^{-1}	70.0mm	198.0mm^2	168.0mm^2	13,900.0mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F47	5400	+30/-20%	-	1520	29-980-47
F5A	6600	+30/-20%	-	1855	29-980-49
F5A	250	±5%	1.40	70	29-981-49*
F5A	400	±5%	0.80	112	29-982-49*
F5A	630	±5%	0.47	177	29-983-49*
F5A	1000	±5%	0.27	281	29-984-49*

Part numbers refer to half cores.

*Part number refers to a pair of cores.

NOTE: This core range now complies with the new industrial requirements for power handling and should be ordered as replacements for previous RM14 cores supplied under Part nos. 29-880-xx to 29-890-xx.
The clips 76-029-95 are also **not** compatible with this new range.

Bobbins/Coil Formers

Style	No. of Sections	Pins	Part Number
Vertical (AS)	1	12	60-882-64
Vertical (DIL)	1	12	60-990-76

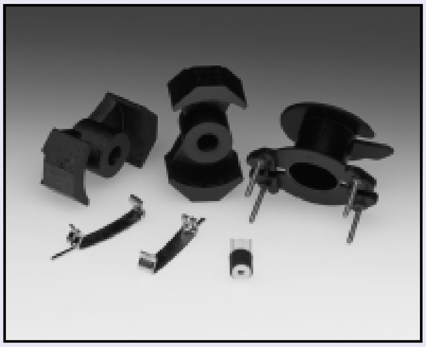
Other pin lengths and versions may be listed at the end of this section

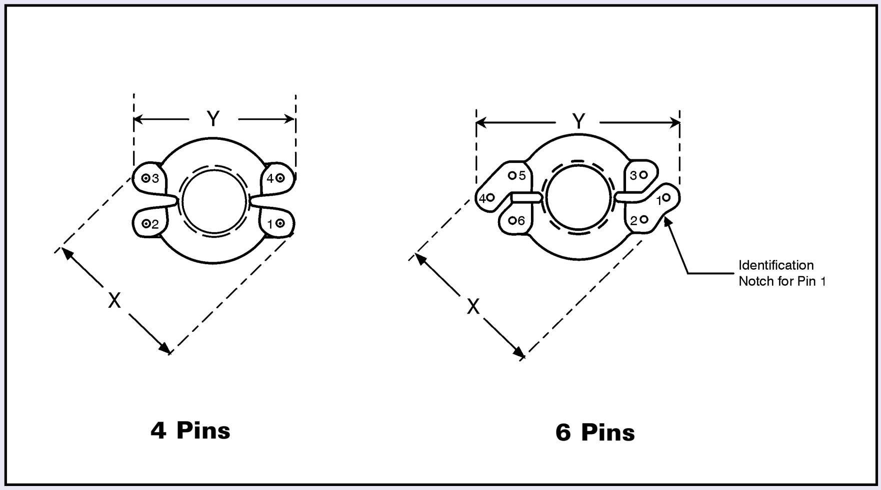
Clip

Part Number
76-086-95

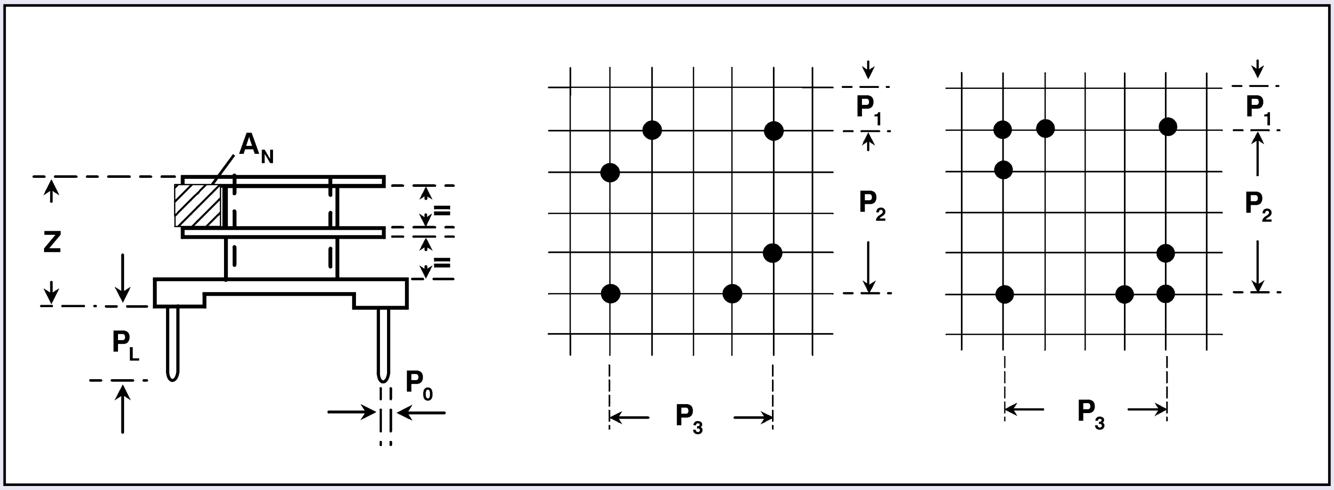
MMG

RM Bobbins





Part No.	Type	Dimensions			Winding Data		No. of sections
		'X'	'Y'	'Z'	A_N (mm²)	l_N (mm)	
60-901S64	RM4	9.7	9.4	7.55	7.7	20.0	1
60-904S64	RM4	9.7	9.4	7.55	3.65	20.0	2
60-903S64	RM4	9.7	12.8	7.55	7.7	20.0	1
60-906S64	RM4	9.7	12.8	7.55	3.65	20.0	2
60-701S64	RM5	12.5	12.9	6.90	9.50	25.0	1
60-703S64	RM5	12.5	12.9	6.90	4.35	25.0	2
60-702S64	RM5	12.5	16.2	6.90	9.50	25.0	1
60-704-64	RM5	12.5	16.2	6.90	4.35	25.0	2
60-731-64	RM6	15.0	16.6	8.50	15.0	30.0	1
60-734S64	RM6	15.0	16.6	8.50	7.0	30.0	2
60-7303-64	RM6	15.0	19.9	8.60	15.0	30.0	1
60-733-64	RM6	15.0	19.9	8.60	7.0	30.0	2
60-7313-64	RM6	15.0	19.9	8.60	15.0	30.0	2
60-736-64	RM6	15.0	19.9	8.60	7.0	30.0	2
60-951-64	R6	15.0	19.7	8.50	15.5	30.0	1



Pin Details						Material	Clip Part Number
No. of	P_0	P_1	P_2	P_3	P_L		
4	0.45	2.54	7.62	7.62	4.5	Glass filled Phenolic	76-024-95
4	0.45	2.54	7.62	7.62	4.5	Glass filled Phenolic	76-024-95
6	0.45	2.54	7.62	7.62	4.5	Glass filled Phenolic	76-024-95
6	0.45	2.54	7.62	7.62	4.5	Glass filled Phenolic	76-024-95
4	0.45	2.54	10.16	10.16	4.5	Glass filled Phenolic	76-024-95
4	0.45	2.54	10.16	10.16	4.5	Glass filled Phenolic	76-024-95
6	0.5	2.54	10.16	10.16	4.5	Glass filled Phenolic	76-024-95
6	0.5	2.54	10.16	10.16	4.5	Glass filled Phenolic	76-024-95
4	0.6	2.54	12.7	12.7	5.0	Glass Filled Phenolic	76-020-95
4	0.6	2.54	12.7	12.7	5.0	Glass Filled Phenolic	76-020-95
6	0.6	2.54	12.7	12.7	5.0	Glass Filled Phenolic	76-020-95
6	0.6	2.54	12.7	12.7	5.0	Glass Filled Phenolic	76-020-95
6	0.6	2.54	12.7	12.7	5.0	Glass Filled Phenolic	76-020-95
6	0.6	2.54	12.7	12.7	5.0	Glass Filled Phenolic	76-020-95
6	0.6	2.54	12.7	12.7	6.50	Glass Filled Phenolic	76-020-95

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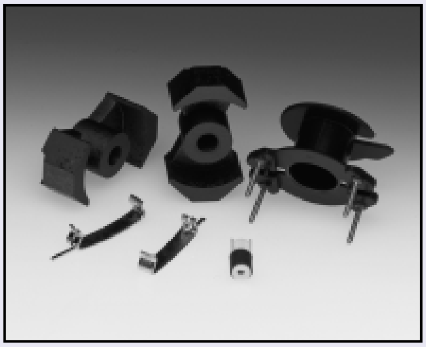
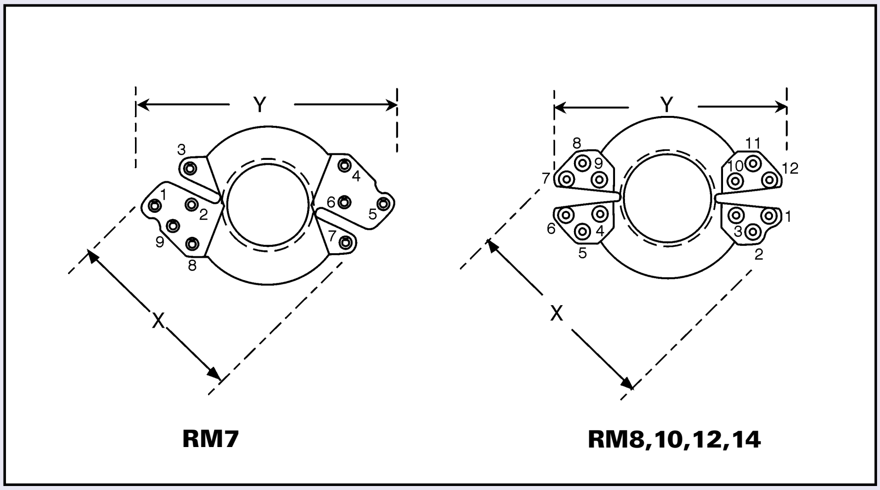
RM Bobbins





Part No.	Type	Dimensions			Winding Data		No. of sections
		'X'	'Y'	'Z'	A_N (mm²)	l_N (mm)	
60-7601-64	RM7	17.2	16.2	9.2	21.4	35.6	1
60-7604-64	RM7	17.2	23.3	9.2	21.4	35.6	1
60-760-64	RM7	17.1	23.4	9.2	21.4	35.6	1
60-7902-64	RM8	20.0	24.6	12.0	30.0	42.0	1
60-790-64	RM8	20.0	24.6	12.0	30.0	42.0	1
60-792-64	RM8	20.0	24.6	12.0	30.0	42.0	1
60-792A64	RM8	20.0	24.6	12.0	30.0	42.0	1
60-795-64	RM8	20.0	24.6	12.0	14.2	42.0	2
60-793-64	RM8	20.0	24.6	12.0	30.0	42.0	1
60-796-64	RM8	20.0	24.6	12.0	14.2	42.0	2
60-822-64	RM10	25.5	26.8	13.3	41.5	52	1
60-825-64	RM10	25.5	26.8	13.3	19.5	52	2
60-823-64	RM10	25.5	26.8	13.3	41.5	52	1
60-826-64	RM10	25.5	26.8	13.3	19.5	52	2
60-930-64	RM12i	30.0	38.2	18.0	73	61.0	1
60-881-64	RM14i	35.5	41.9	21.5	107	71.0	1
60-882-64	RM14i	35.5	41.9	21.5	107	71.0	1

All bobbins are manufactured in Glass reinforced flame resistant Phenolic (See Plastics section for material specifications). Pin solderability to I.E.C 68-2-20B Test T.

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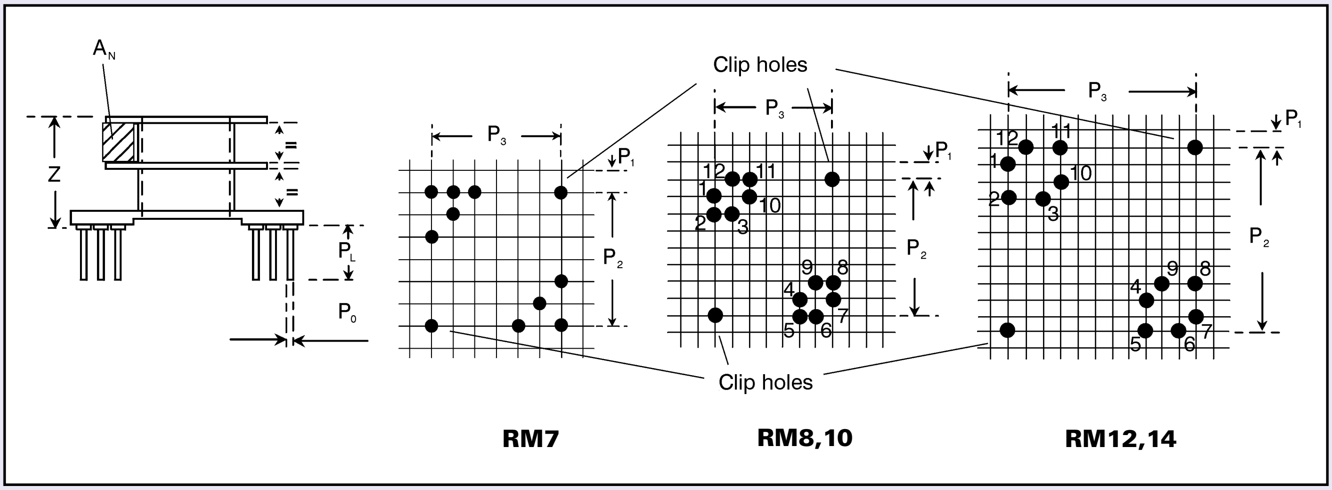
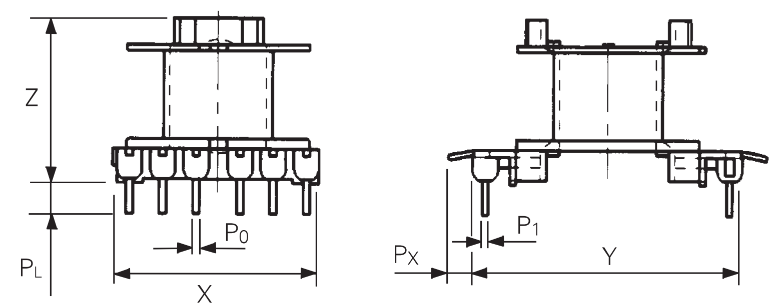


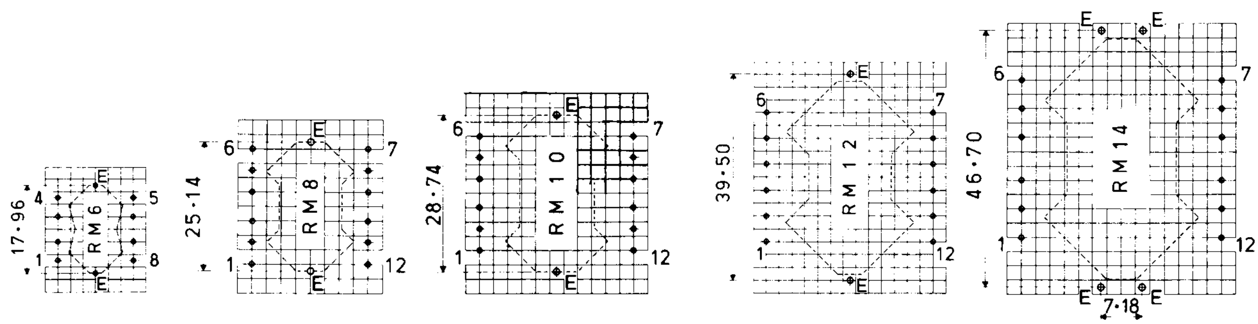
Pin Details						Pin Configuration	Clip Part Number
No. of	P_0	P_1	P_2	P_3	P_L		
4	0.60	2.54	15.24	15.24	6.0	3,4,7,8	76-021-95
8	0.60	2.54	15.24	15.24	6.0	1,2,3,4,5,6,7,8	76-021-95
5	0.60	2.54	15.24	15.24	6.3	3,4,5,7,9	76-021-95
5	0.60	2.54	17.78	17.78	5.5	1,2,5,8,11	76-022-95
8	0.60	2.54	17.78	17.78	5.5	1,2,5,6,7,8,11,12	76-022-95
8	0.60	2.54	17.78	17.78	5.0	1,3,4,6,7,9,10,12	76-022-95
8	0.60	2.54	17.78	17.78	7.2	1,3,4,6,7,9,10,12	76-022-95
8	0.60	2.54	17.78	17.78	5.0	1,3,4,6,7,9,10,12	76-022-95
12	0.60	2.54	17.78	17.78	5.0	All	76-022-95
12	0.60	2.54	17.78	17.78	5.5	All	76-022-95
8	0.70	2.54	20.32	20.32	5.5	1,3,4,6,7,9,10,12	76-023-95
8	0.70	2.54	20.32	20.32	5.5	1,3,4,6,7,9,10,12	76-023-95
12	0.70	2.54	20.32	20.32	5.5	All	76-023-95
12	0.70	2.54	20.32	20.32	5.5	All	76-023-95
12	0.83	2.54	27.94	27.94	6.3	All	76-085-95
10	0.85	2.54	33.02	33.02	6.3	1,2,3,4,6,7,9,10,11,12	76-086-95
12	0.85	2.54	33.02	33.02	6.3	All	76-086-95

RM Power Bobbins

Material:
Glass fibre re-inforced PETP
Flammability:
Meets UL94V-O
Temp. class:
H, 180°C
Pin material:
Tinned bronze
Max. soldering temp:
350°C, 2 secs.



Part No.	Type	Dimensions			Winding Data		No. of sections
		'X'	'Y'	'Z'	A_N (mm²)	l_N (mm)	
60-750-76	RM6	15.6	18.3	13.0	15	30	1
60-810-76	RM8	23.3	23.3	16.6	30	42	1
60-850-76	RM10	23.2	31.0	19.3	42	52	1
60-940-76	RM12i	28.4	36.1	23.5	72	61	1
60-980-76	RM14i	31.6	38.7	28.5	106	72	1



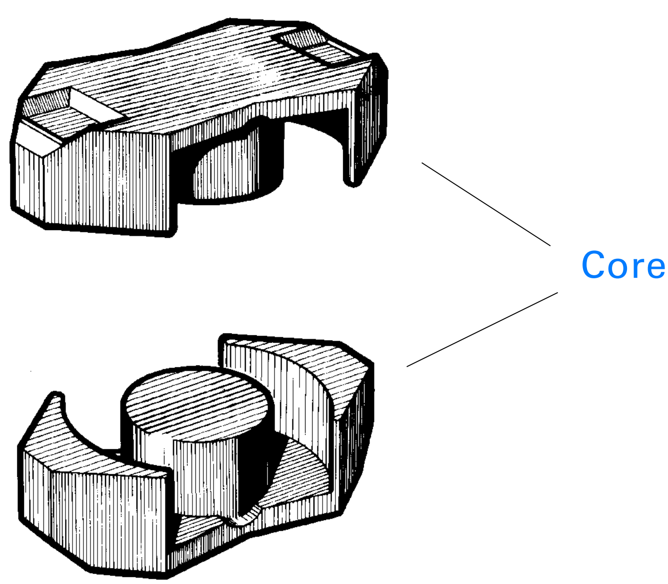
RM6 **RM8** **RM10** **RM12** **RM14**

Part No.	Pin Details					Clip Part Number
	No. of	P_0	P_1	P_L	P_X	
60-750-76	8	0.8	0.3	4.0	2.5	76-020-95
60-810-76	12	0.8	0.3	3.8	2.0	76-022-95
60-850-76	12	0.8	0.3	3.3	2.8	76-023-95
60-940-76	12	0.8	0.3	3.5	2.5	76-085-95
60-980-76	12	0.8	0.3	3.2	2.5	76-086-95

Low Profile RM Cores

RM 6	29-**220**-
RM 8	29-**240**-
RM 10	29-**250**-
RM 12	29-**260**-
RM 14	29-**270**-

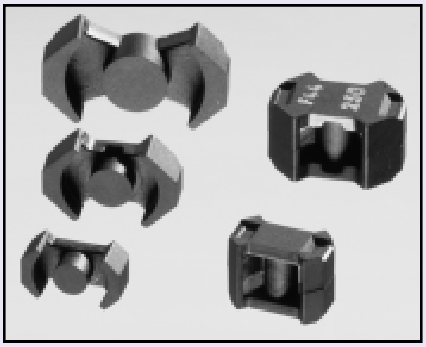
RM Core (Low Profile) Components

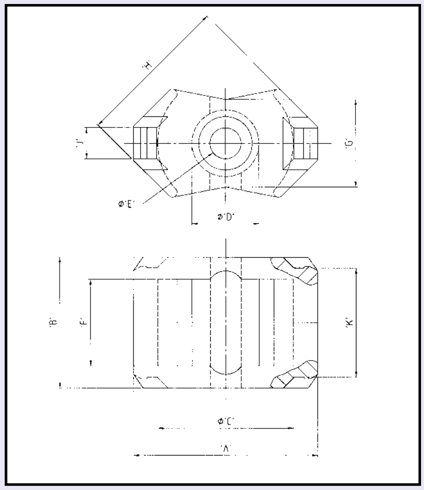


Low Profile RM Cores

With the increasing miniaturisation of electronic circuits and Switched Mode power supplies being integrated into PCB philosophy, low profile components are necessary to overcome height restrictions. In some cases the conventional Windings can be replaced by printed circuit tracks directly onto the PCB.
The RM core's low profile shape and ease of construction give significant advantages including, fast error free winding and efficient repeatable performance.

RM 6 LOW PROFILE 29-220-





Core Dimensions (mm)

A	17.30 - 17.90	F	4.50 - 4.90
B	8.80 - 9.00	G	7.80 - 8.20
C	12.40 - 12.90	H	14.10 - 14.70
D	6.10 - 6.40	J	2.80 - 2.90
E	2.80 - 3.00	K	6.60 - 7.08

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma\ell/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	$0.58mm^{-1}$	21.8mm	$37.5mm^2$	$31.2mm^3$	$820.0mm^3$

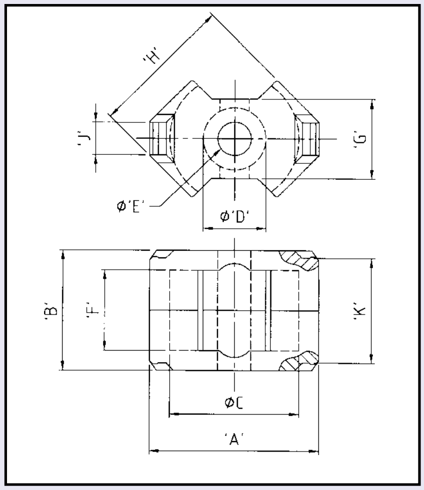
Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F47	2400	+30/-20%	-	1110	29-220-47
F44	2500	+30/-20%	-	1155	29-220-44
F45	2600	+30/-20%	-	1200	29-220-45
F10	6600	+30/-20%	-	3050	29-220-37
F39	10500	+40/-30%	-	4850	29-220-39
F9C	5500	+30/-20%	-	2540	29-220C36

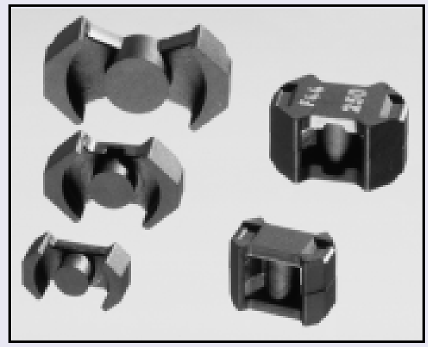
Part numbers refers to half cores
Gapped core pairs may be available on request.

Core Dimensions (mm)

A	22.30 - 23.20	F	5.90 - 6.30
B	11.40 - 11.60	G	10.50 - 11.00
C	17.00 - 17.70	H	18.90 - 19.70
D	8.25 - 8.55	J	4.30 - 5.10
E	——	K	9.16 - 9.64



RM 8 LOW PROFILE
29-240-



Core Parameters

In accordance with IEC Document 60205.

Parameter	Σℓ/A	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	$0.44mm^{-1}$	28.7mm	$64.9mm^2$	$55.4mm^2$	$1860.0mm^3$

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	3600	+30/-20%	-	1260	29-240-44
F45	3750	+30/-20%	-	1310	29-240-45
F39	15000	+40/-30%	-	5250	29-240-39
F9C	7050	+30/-20%	-	2470	29-240C36

Part numbers refers to half cores
Gapped core pairs may be available on request.

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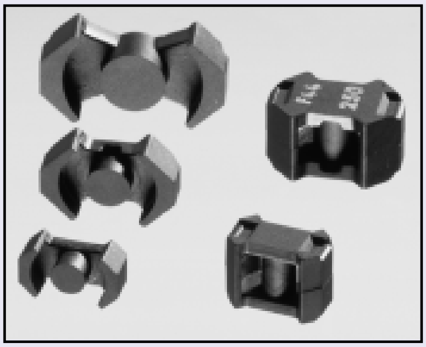
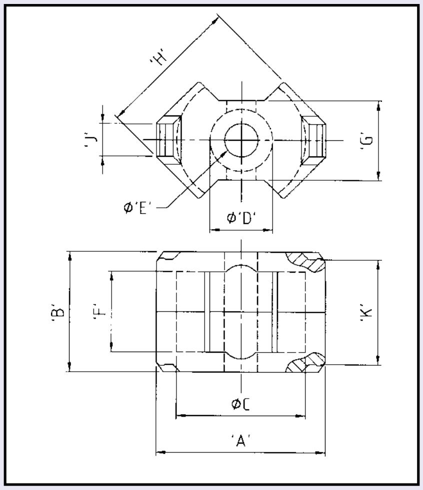
RM 10 LOW PROFILE 29-250-





Core Dimensions (mm)

A	27.20 - 28.40	F	6.70 - 7.10
B	12.80 - 13.00	G	13.00 - 13.50
C	21.20 - 22.10	H	23.60 - 24.70
D	10.50 - 10.90	J	5.00 - 5.20
E	——	K	10.26 - 10.74

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma \ell / A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	$0.34mm^{-1}$	33.9mm	$99.1mm^2$	$93.3mm^3$	$3360.0mm^3$

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F44	4700	+30/-20%	-	1270	29-250-44
F45	4900	+30/-20%	-	1325	29-250-45
F39	19500	+40/-30%	-	5275	29-250-39
F9C	10500	+30/-20%	-	2840	29-250C36

Part numbers refers to half cores.
Gapped cores may be available on request.

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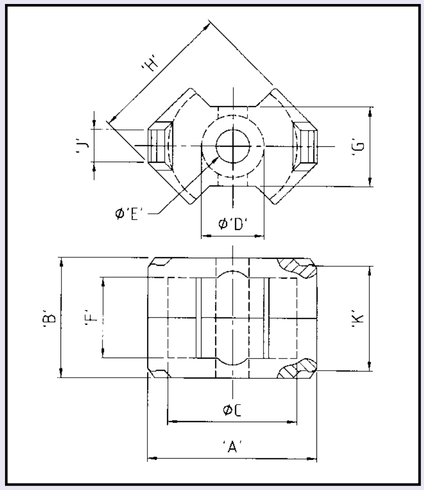
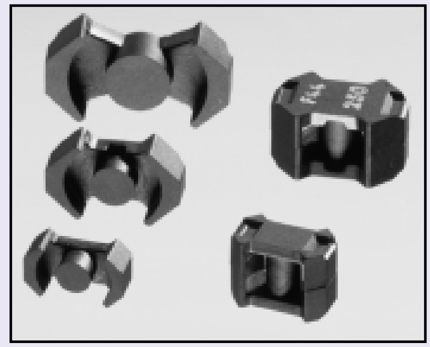
RM 12 LOW PROFILE
29-260-

Core Dimensions (mm)

A	36.10 - 37.40	F	9.00 - 9.50
B	16.60 - 16.80	G	15.60 - 16.10
C	25.00 - 26.00	H	27.70 - 28.80
D	12.40 - 12.80	J	4.90 - 5.10
E	——	K	13.56 - 14.04





Core Parameters

In accordance with IEC Document 60205.

Parameter	Σl/A	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.28mm^{-1}	42.0mm	147.5mm^2	124.7mm^2	6195.0mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F47	5600	+30/-20%	-	1250	29-260-47
F44	6000	+30/-20%	-	1335	29-260-44
F45	6300	+30/-20%	-	1400	29-260-45
F39	23800	+40/-30%	-	5305	29-260-39
F9C	12750	+30/-20%	-	2840	29-260C36

Part numbers refers to half cores
Gapped cores may be available on request.

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RM 14 LOW PROFILE
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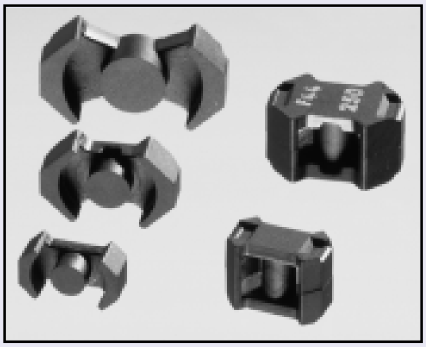

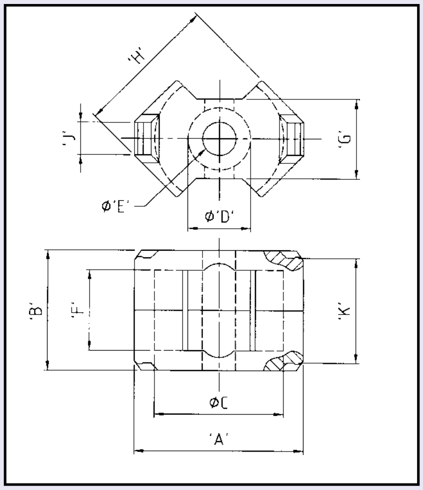

Core Dimensions (mm)

A	40.00 - 42.40	F	11.10 - 11.70
B	20.30 - 20.50	G	18.40 - 19.00
C	29.00 - 30.20	H	33.50 - 34.70
D	14.50 - 15.00	J	5.60 - 5.80
E	——	K	17.06 - 17.54

Core Parameters

In accordance with IEC Document 60205.

Parameter	$\Sigma\ell/A$	Effective Length	Effective Area	Minimum Area	Effective Volume
Symbol	C_1	ℓ_e	A_e	A_{min}	V_e
Value	0.25mm^{-1}	50.9mm	201.0mm^2	170.0mm^3	10230.0mm^3

Electrical Specification

Material	A_L Value	Tolerance	Gap Length	Eff. Permeability	Part Number
F47	6280	+30/-20%	-	1250	29-270-47
F44	6710	+30/-20%	-	1335	29-270-44
F45	7040	+30/-20%	-	1400	29-270-45
F39	26640	+40/-30%	-	5300	29-270-39
F9C	14275	+30/-20%	-	2840	29-270C36

Part numbers refers to half cores.
Gapped cores may be available on request.

U Cores and Accessories

U12.7	34-491	U31	34-025	U47	34-533
U+I 12.7	33/34-490	U59	34-044	U53	34-513/514
U13.5	34-031	U101/25.4	34-029	U58	34-525
U15	34-010	U101/12.7	34-030	U59	34-517
U20	34-012	UR29/18	34-543	U70	34-515
U25	34-015/016/018	UR37/25	34-521	U81	34-537
		UR42/32	34-536	U30/7.5	34-546
		U26.5	34-540	U42/10.5	34-531
		U41	34-548/539	U60	34-520

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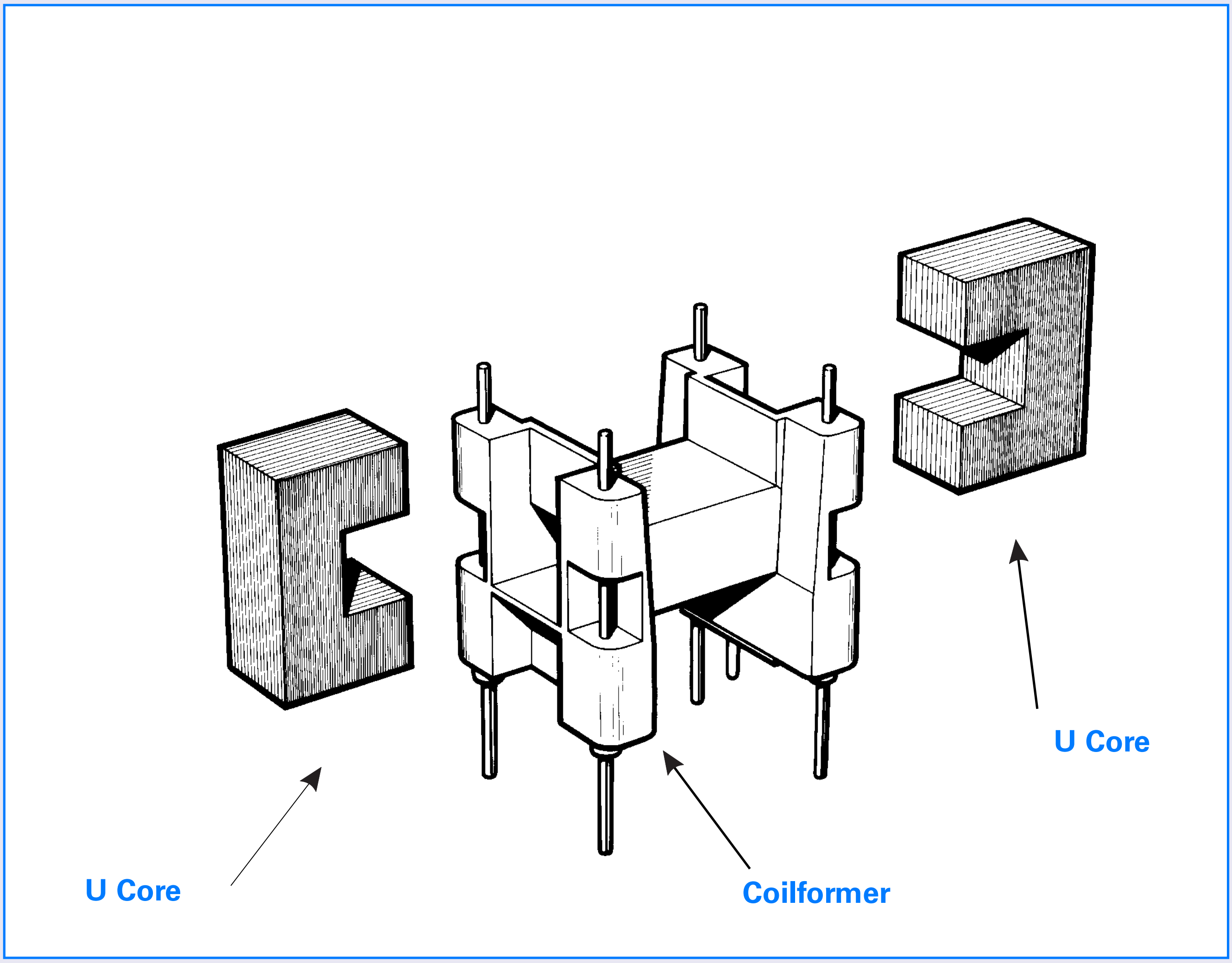

U & I Cores

These cores are used for the construction of transformers in the frequency range from 10 to 500kHz. The transferable outputs will be determined by core geometry, and the upper frequency limits by the material selected.
Other applications are in line transformers producing an electron deflection beam for CRT's, and new areas of design are emerging in the automotive industry.
Materials used for these applications are characterised by high flux density, low specific power losses and the decline of losses dependant on temperature in the range from 20°C to 100°C.

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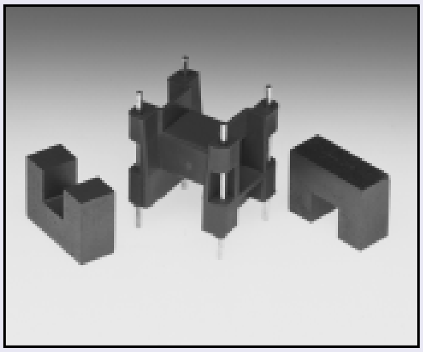
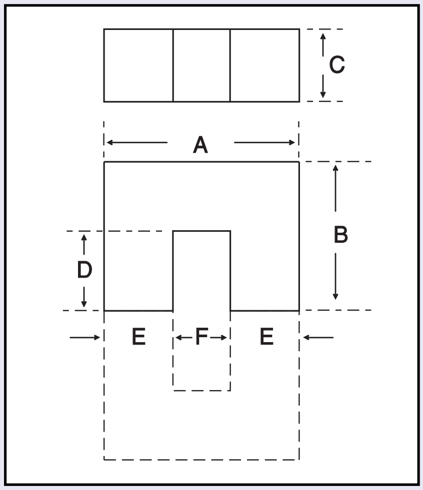
Square



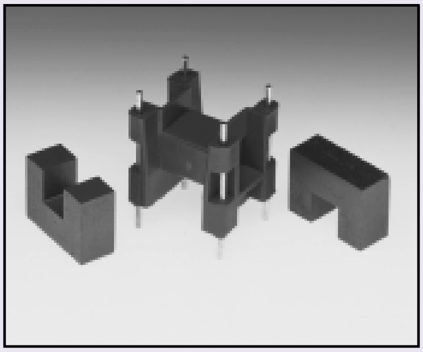


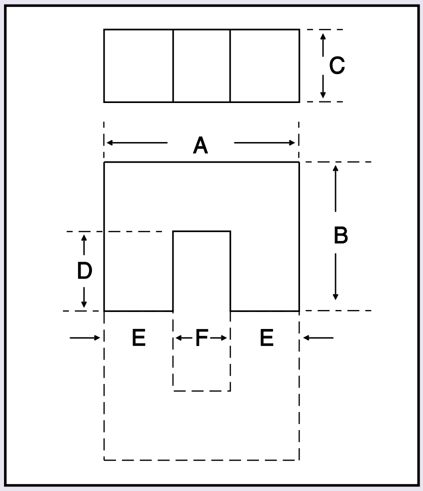
Description	U12.7		U+I 12.7	U13.5	U15		
Part No.	34-491-36	34-491-49	33/34-490-36	34-031-36	34-010-36	34-010-39	34-010-44
Material	F9	F5A	F9	F9	F9	F39	F44
Dimensions A	12.70	12.70	12.70	13.50	15.20	15.20	15.20
Dimensions B	6.35	6.35	6.35	9.7	11.20	11.20	11.20
Dimensions C	4.95	4.95	4.95	4.80	6.45	6.45	6.45
Dimensions D	3.81	3.81	3.81	6.25	6.00	6.00	6.00
Dimensions E	2.54	2.54	2.54	3.34	5.00	5.00	5.00
Dimensions F	7.30min	7.30min	7.30min	6.50min	5.00min	5.00min	5.00min
Dimensions G	-	-	8.90	-	-	-	-
Tolerance	860	500	1000	1060	2625	5000	1120
A_L Value	+30/-20%	+30/-20%	+30/-20%	±25%	+30/-20%	+40/-30%	+30/-20%

Core Parameters In accordance with IEC Document 60205.

C_1	3.05mm^{-1}	3.05mm^{-1}	2.62mm^{-1}	3.01mm^{-1}	1.50mm^{-1}	1.50mm^{-1}	1.50mm^{-1}
l_e	38.45	38.45	33.00	49.20	48.00	48.00	48.00
A_e	12.60mm^2	12.60mm^2	12.60mm^2	16.31mm^2	32.00mm^2	32.00mm^2	32.00mm^2
V_e	484.0mm^3	484.0mm^3	416.0mm^3	803.0mm^3	1540.0mm^3	1540.0mm^3	1540.0mm^3

Square



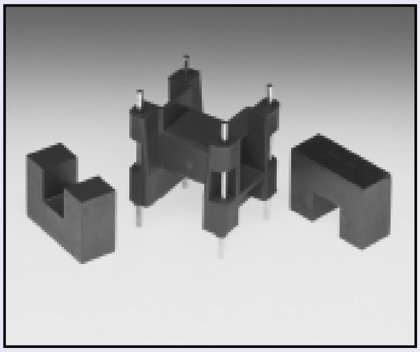


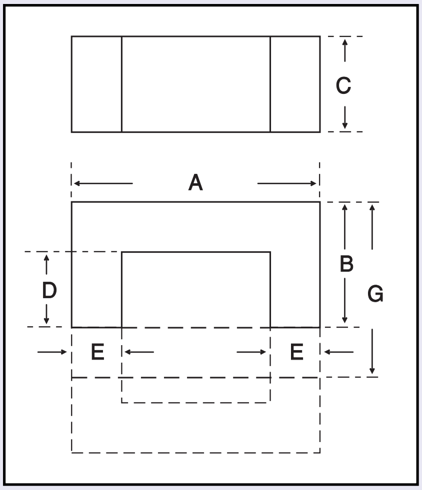
U20	U25				U31	U59	Description
34-012-44	34-015-44	34-015-49	34-016-44	34-018-36	34-025-36	34-032S49	Part No.
F44	F44	F5A	F44	F9	F9	F5C	Material
21.00	24.75	24.75	24.75	24.65	31.00	59.00	Dimensions A
15.38	19.43	19.43	19.43	17.20	15.50	55.00	Dimensions B
7.50	12.70	12.70	7.0	7.30	16.00	15.27	Dimensions C
8.24	11.33	11.33	11.33	11.10	8.70	40.00	Dimensions D
7.40	8.30	8.30	8.30	7.23	7.00	15.00	Dimensions E
6.0min	8.0min	8.0min	8.0min	9.90min	16.0min	28.5min	Dimensions F
-	-	-	-	-	-	-	Dimensions G
1560	2480	2900	1240	2475	4500	2530	A_L Value
+30/-20%	+30/-20%	+30/-20%	+30/-20%	+30/-20%	+30/-20%	±30%	Tolerance

Core Parameters

1.24mm^{-1}	3.05mm^{-1}	2.62mm^{-1}	3.01mm^{-1}	1.50mm^{-1}	1.50mm^{-1}	1.50mm^{-1}	C_1
68.0	86.0	86.0	86.0	87.0	90.0	187.0	l_e
54.9mm^2	105.0mm^2	105.0mm^2	52.5mm^2	54.0mm^2	112.0mm^2	225.0mm^2	A_e
3730mm^3	9030mm^3	9030mm^3	4515mm^3	4700mm^3	10079mm^3	42100mm^3	V_e

Square

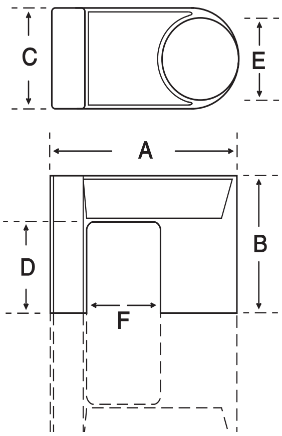




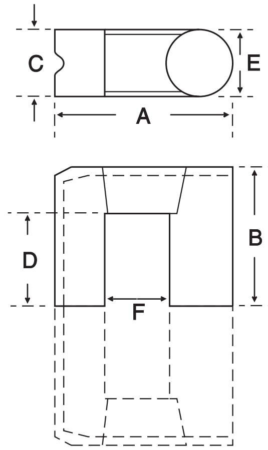
Description		U101/25.4		I101/25.4		U101/12.7
Part No.		34-029-44	34-029-49	33-029-44	33-029-49	34-030-49
Material		F44	F5A	F44	F5A	F5A
Dimensions	A	101.6	101.6	101.6	101.6	101.6
	B	57.15	57.15	25.4	25.4	57.15
	C	25.40	25.40	25.40	25.40	12.70
	D	31.75	31.75	0.45	0.45	31.75
	E	25.40	25.40	25.40	25.40	25.40
	F	49.78	49.78	49.78	49.78	49.78
	G	25.40	25.40	25.40	25.40	25.4
A_L Value		4500	5400	5625	6750	2060
Tolerance		+30/-20%	+30/-20%	+30/-20%	+30/-20%	+30/-20%

Core Parameters In accordance with IEC Document 60205.

C_1	0.478	0.478	0.380	0.380	0.956
l_e	308.40	308.40	245.00	245.00	308.40
A_e	645.20	645.20	645.00	645.20	322.60
V_e	198980.00	198980.00	158000.00	158000.00	99482.00



Style I



Style II

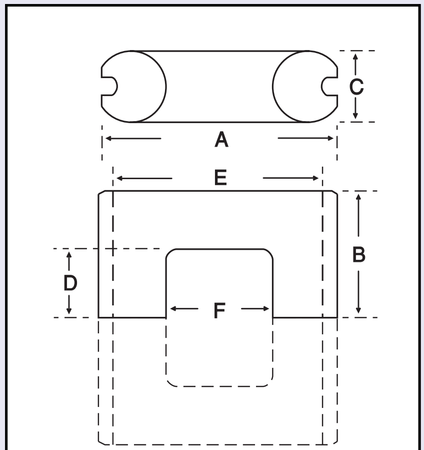
Square/Round

Description	UR29/18	UR37/25		UR42/32
Style	I	I	I	II
Part No.	34-543-44	34-521-44	34-521-49	34-536-44
Material	F44	F44	F5A	F44
Dimensions A	29.0	36.9	36.9	42.5
Dimensions B	17.8	28.2	28.2	31.65
Dimensions C	16.0	18.0	18.0	18.0
Dimensions D	11.7	16.5	16.5	20.9
Dimensions E	11.0	14.7	14.7	15.85
Dimensions F	11.0 MIN	13.9 MIN	13.9 MIN	16.58 MIN
Dimensions G	5.8	7.3	7.3	9.85
A_L Value	2000	2200	3000	2425
Tolerance	+30/-20%	+30/-20%	+30/-20%	+30/-20%

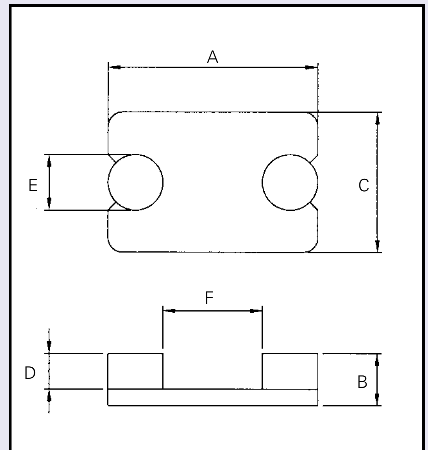
Core Parameters In accordance with IEC Document 60205.

C_1	0.945	0.833	0.833	0.862
ℓ_e	90.9	125.0	125.0	160.3
A_e	96.2	150.0	150.0	186.0
V_e	8744	18750	18750	29820

Round



Style I



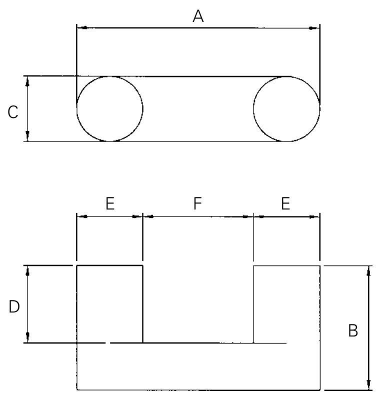
Style II

All dimensions are nominal unless stated.

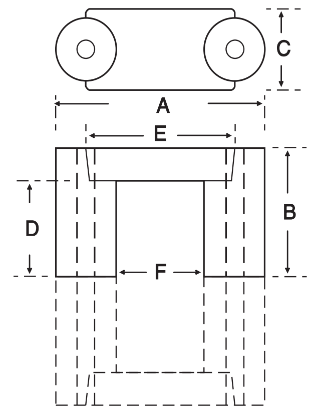
Description		U26.5	U41		U47	U53		U58
Style		I	I	I	III	I	I	III
Part No.		34-540-49	34-548-49	34-539-49	34-533-49	34-513-49	34-514-49	34-525-44
Material		F5A	F5A	F5A	F5A	F5A	F5A	F44
Dimensions	A	26.54	41.15	41.15	47.3	52.8	52.8	58.8
	B	20.07	17.45	20.62	39.00	23.70	27.50	30.10
	C	9.40	11.70	11.70	15.25	11.30	11.30	16.50
	D	14.60	7.94	11.10	27.00	14.20	17.50	19.00
	E	20.18 MIN	34.70 MIN	34.70 MIN	15.00	46.00	46.00	15.85
	F	7.87	18.70 MIN	18.70 MIN	16.75 MIN	29.50 MIN	29.50 MIN	26.9 MIN
	G	1.14	3.18	3.18	15.00	3.40	3.40	15.85
A_L Value		1790	2550	2375	2600	1500	1300	2250
Tolerance		+30/-20%	+30/-20%	+30/-20%	+30/-20%	+30/-20%	+30/-20%	+30/-20%

Core Parameters In accordance with IEC Document 60205.

C_1	1.59	1.05	1.18	1.03	1.58	1.74	0.918
l_e	95.40	103.00	116.00	184.00	146.00	162.00	174.00
A_e	60.00	98.00	98.10	177.70	93.00	93.00	189.60
V_e	5724.00	10094.00	11300.00	32700.00	13650.00	15100.00	32990.00



Style III



Style IV

Round

U59		U70	U81	U30/7.5	U42/10.5	U60	Description
III	III	I	I	II	II	IV	Style
34-517-44	34-517-49	34-515-44	34-537-49	34-546-44	34-551-44	34-520-49	Part No.
F44	F5A	F44	F5A	F44	F44	F5A	Material
59.20	59.20	69.80	80.80	30.00	42.00	60.50	A (Dimensions)
34.46	34.46	29.70	44.53	7.60	10.50	35.80	B (Dimensions)
16.30	16.30	16.00	15.00	20.00	28.00	23.00	C (Dimensions)
27.05	27.05	15.90	30.55	5.0	7.0	26.50	D (Dimensions)
15.50	15.50	59.20 MIN	77.00	8.00	11.00	43.75	E (Dimensions)
26.90 MIN	26.90 MIN	37.2 MIN	50.8 MIN	13.70 MIN	19.70 MIN	26.75	F (Dimensions)
15.90	15.90	4.80	3.56	-	-	17.0	G (Dimensions)
2240	2690	2220	1810	1000	1850	1730	A_L Value
+30/-20%	+30/-20%	+30/-20%	+30/-20%	+30/-20%	+30/-20%	+30/-20%	Tolerance
							Core Parameters
0.935	0.935	1.02	1.52	1.28	0.845	0.90	C_1
164.0	164.0	184.0	268.5	64.49	89.2	189.0	l_e
179.0	179.0	181.0	177.2	50.11	105.6	210.0	A_e
33650.00	33650.00	33300.00	47600.00	3230.00	9420.00	39700.00	V_e

MMG

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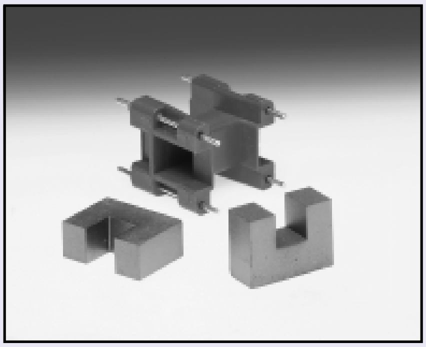
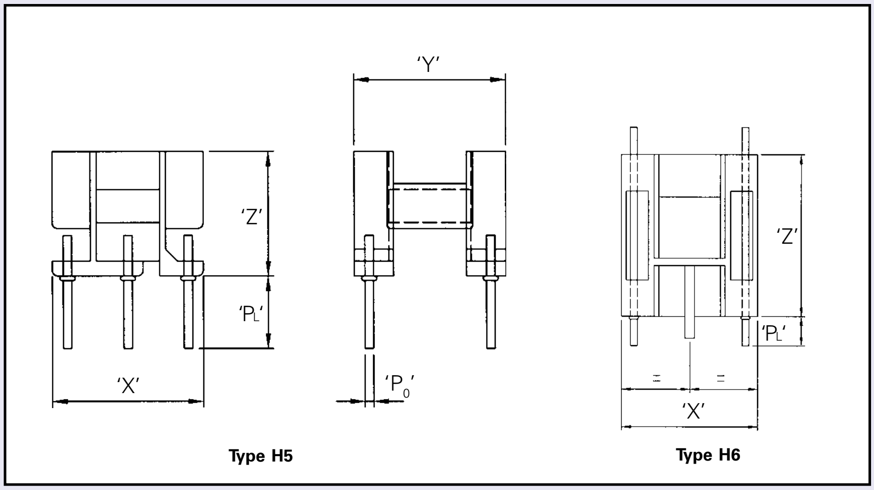
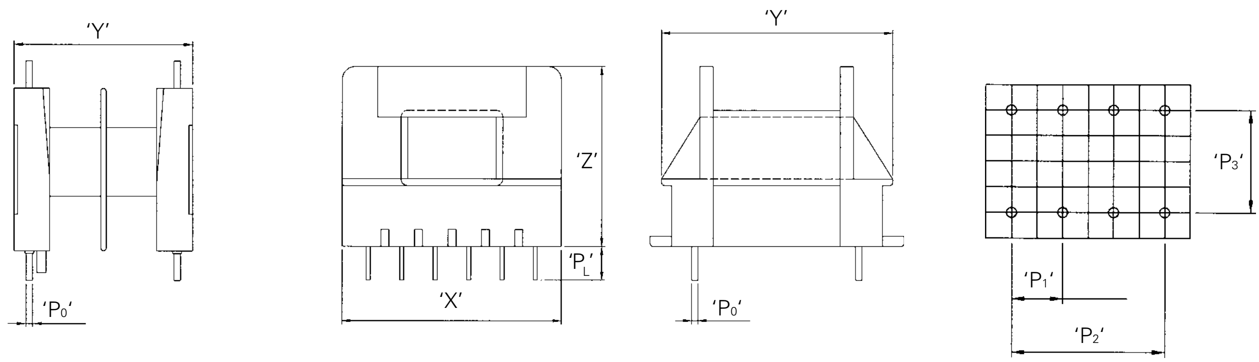
U,U+I Coilformers





Part No.	Type	Dimensions			Winding Data		No. of sections
		'X'	'Y'	'Z'	A_N (mm²)	l_N (mm)	
59-490-66	H5	12.70	12.70	10.50	19.4	25.3	Single
59-112-66	H6	16.20	18.10	17.2	45.0	38.6	Single
59-100-66	H6	18.50	24.50	22.0	72.5	41.5	Single
59-115-66	H7	32.80	34.50	26.9	133.0	61.0	Single



Type H6

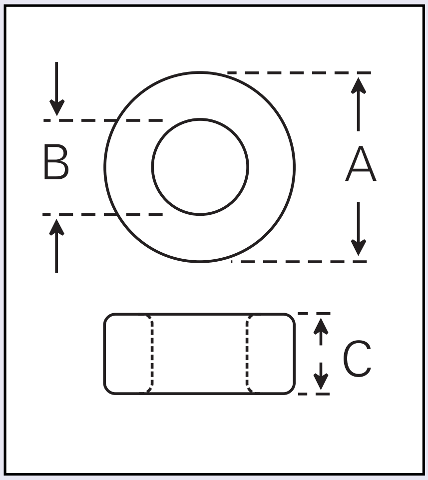
Type H7

Pin Details						Material	Used with Part Number
No. of	P_0	P_1	P_2	P_3	P_L		
6	0.71	5.08	10.16	10.16	6.0	Glass filled Nylon 66 (VO)	33/34-490-00
4	0.91	12.7	12.7	15.24	4.0	Glass filled Nylon 66 (VO)	34-010-00
4	1.00	15.24	15.24	20.32	4.0	Glass filled Nylon 66	34-012-00
12	0.95*	5.00	25.0	27.5	5.0	Glass filled Nylon 66 (VO)	34-015-00

Ring Cores

Ferrite	28-**700**-
Ferrite	28-**3200**-
MPP	18-**0703**-
Iron Powder	17-**1204**-

Ring Cores
28-XXXX-



Ring Core - Ferrite

Ring cores manufactured from ferrite offer an efficient shape for a variety of wide band, pulse, power transformers and inductors.
The part No's below are for parylene or epoxy coated cores. Alternative coatings or un-coated cores and other sizes may be available on request.

Part No.	Dimensions			Core Constants			
	'A'	'B'	'C'	L_e mm	A_e mm^2	V_e mm^3	C_1 mm^{-1}
28-3200-	2.03	1.27	1.00	5.00	0.37	1.86	13.40
28-3250-	2.54	1.27	1.27	5.53	0.77	4.29	7.14
28-3251-	2.54	1.78	1.27	6.64	0.48	3.17	13.91
28-3351-	3.51	1.78	1.27	7.70	1.06	8.15	7.29
28-3391-	3.94	1.78	1.27	8.10	1.30	10.55	6.23
28-3482-	4.83	2.29	2.3	10.21	2.78	28.35	3.68
28-3581-	5.84	3.05	1.52	13.03	2.05	26.67	6.38
28-3583-	5.84	3.05	3.05	13.03	4.11	53.52	3.17
28-704-	6.35	3.18	3.00	13.84	4.57	63.25	3.03
28-3763-	7.62	3.18	3.18	14.98	6.63	99.29	2.26
28-3764-	7.62	3.18	4.78	14.98	9.90	148.32	1.51
28-770-	9.52	4.75	3.18	20.71	7.29	150.87	2.84
28-7107-	10.00	6.00	4.00	24.07	7.83	188.44	3.08
28-712-	12.70	6.35	6.35	27.66	19.37	535.77	1.43
28-719-	12.70	7.92	6.35	31.22	14.90	465.05	2.10
28-717-	12.85	7.35	5.00	30.14	13.40	403.78	2.25
28-718-	12.85	7.35	6.35	30.14	17.02	572.81	1.77
28-794-	13.90	7.50	7.00	31.57	21.70	685.23	1.45
28-785-	14.00	9.00	5.00	34.98	12.30	430.19	2.84
28-784-	14.00	9.00	9.00	34.98	22.14	774.35	1.58

Ordering information: Suffix the material code at the end of the part no.
i.e. A core 12.7 x 7.75 x 6.3 / F9C Epoxy coated is 28-718C36

Coated Ring Cores:

Coating Characteristics

Dielectric breakdown strength and approximate thickness per surface for coated cores is as follows:

Epoxy; 1000V dc for cores up to 10mm outside diameter
1500V dc for cores >10mm and </=20mm outside diameter
2000V dc for cores >20mm outside diameter
Coating thickness is 0.25mm approx. per surface.

Parylene; 500V ac (single layer); >0.013mm approx. per surface
1000V ac (double layer); >0.026mm approx. per surface

Note: With some grades of ferrite the A_L value may be up to 20% lower when coated.

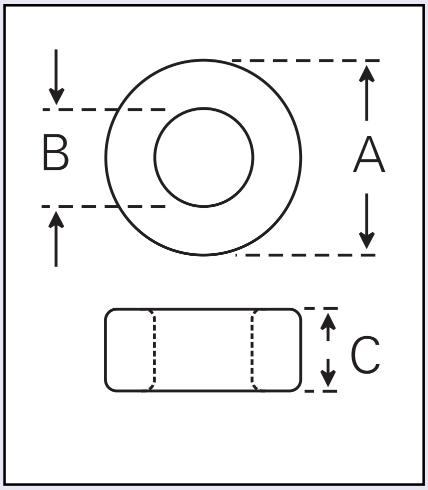
The A_L values listed below carry the corresponding tolerances for material grade and ordering code.

A_L Tolerance	Material	Order Code
A_L +30/-25%	F47	-47
A_L +30/-25%	F44	-44
A_L +30/-25%	F5A	-49
A_L +30/-25%	F9	-36
A_L ±30%	F10	-37
A_L ±40%	F39	-39
A_L +30/-25%	F9C	C36

Power			High Permeability			Suppression
F47	F44	F5A	F9	F10	F39	F9C
				555	925	465
				1055	1760	880
				540	900	450
				1035	1725	860
				1210	2015	1005
				2050	3415	1705
				1185	1975	985
				2375	3960	1980
750	790	1040		2490	4160	2075
				3335	5555	2775
				4980	8300	4150
800	840	1150	1945	2653	4425	2210
740	-	1000	-	2455	4050	2000
-	1670	-	3710	5430	8830	4320
1080	1140	-	-	3600	6000	2965
1000	1060	-	2340	3245	5600	2800
	1320	1755			7100	
					8640	4530
795	840			2540	4420	2160
		1950		4800	8000	3900

Dimensions shown are nominal for uncoated cores (mm).

Ring Cores
28-XXXX-



Ring Core - Ferrite

Ring cores manufactured from ferrite offer an efficient shape for a variety of wide band, pulse, power transformers and inductors.
The part No's below are for parylene or epoxy coated cores. Alternative coatings or un-coated cores and other sizes may be available on request.

Part No.	Dimensions			Core Constants			
	'A'	'B'	'C'	L_e mm	A_e mm^2	V_e mm^3	C_1 mm^{-1}
28-759-	16.70	9.60	5.0	39.45	17.33	683	2.28
28-763-	16.70	9.60	6.35	39.45	21.84	861	1.81
28-723-	19.05	12.70	9.52	48.50	29.88	1449	1.62
28-7116-	20.0	10.0	6.80	43.60	33.10	1443	1.32
28-757-	20.0	10.0	10.0	43.60	48.92	2135	0.90
28-782-	22.1	13.7	6.35	54.19	26.10	1414	2.07
28-795-	22.1	13.7	12.7	54.19	51.6	2791	1.05
28-755-	24.0	12.0	12.0	52.0	69.2	3598	0.76
28-780-	25.0	15.0	10.0	60.2	49.0	2950	1.23
28-736-	25.0	15.0	16.0	60.2	78.3	4711	0.77
28-760-	31.5	19.6	7.0	77.3	40.88	3160	1.78
28-756-	31.5	19.6	12.5	77.3	73.0	5645	1.06
28-7140-	36.0	23.0	16.0	89.65	95.89	8596	0.93
28-744-	38.1	25.4	15.90	97.10	99.4	9650	0.97
28-743-	38.1	25.4	19.05	97.10	119.4	11580	0.81
28-796-	38.1	19.6	12.70	84.21	113.24	9545	0.74
28-797-	38.1	19.6	25.40	84.29	226.49	19090	0.37
28-7132-	49.0	31.8	19.0	123.05	160.88	19796	0.76
28-761-	63.0	38.0	25.0	152.0	305.0	46530	0.50
28-7797-	78.0	45.0	14.0	183.8	225.26	41403	0.82

Ordering information: Suffix the material code at the end of the part no.
i.e. A core 12.7 x 7.75 x 6.3 / F9C Epoxy coated is 28-718C36

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Coated Ring Cores:

Coating Characteristics

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1500V dc for cores >10mm and </=20mm outside diameter
2000V dc for cores >20mm outside diameter
Coating thickness is 0.25mm approx. per surface.

Parylene; 500V ac (single layer); >0.013mm approx. per surface
1000V ac (double layer); >0.026mm approx. per surface

Note: With some grades of ferrite the A_L value may be up to 20% lower when coated.

The A_L values listed below carry the corresponding tolerances for material grade and ordering code.

A_L Tolerance	Material	Order Code
A_L +30/-25%	F47	-47
A_L +30/-25%	F44	-44
A_L +30/-25%	F5A	-49
A_L +30/-25%	F9	-36
A_L ±30%	F10	-37
A_L ±40%	F39	-39
A_L +30/-25%	F9C	C36

Power			High Permeability			Suppression
F47	F44	F5A	F9	F10	F39	F9C
	1050		2330	3320	4855	2710
	1325		2995	4190	6980	3470
	1470		3400	4650	7720	3880
						4760
	2635					
	1170		2675	3645	6020	3040
	2310	2940		7285	12030	6110
	3160	4200		10000	16640	8400
	1940			6130	10220	5110
			7200	9650		8175
			2925			3260
	2255	2655	5220	7120	11860	6000
	2555			8060	13440	6720
	2450			7770		6450
	2935		6800		15500	7725
		4220		10130		8490
				20260		16880
	3120	4110	7230	9860		8215
			11120	15170		12640
		3830				7650

Dimensions shown are nominal for uncoated cores (mm).

EMC/EMI Suppression and other ferrites

Beads
Sleeves
Rings
Surface Mount Beads
Balun & Multi-Aperture Cores

Ribbon Cable Suppressors
Small Rods
Antenna Rods
Axial leaded Choke Cores

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Electromagnetic Compatibility

Electromagnetic compatibility (interference suppression) aims at maintaining an environment in which electrical and electronic apparatus can operate without being unduly affected by spurious signals. It covers two fields:

1. *The prevention of excessive polluting signals being sent out from electrical appliances, industrial equipment and electronic devices.*

2. *The protection of sensitive devices by making them immune to spurious signals not regarded as excessive by national and international regulations, and controlling the emission of interference.*

There are two ways in which spurious signals can propagate from their sources to the endangered devices:

1. *By conductance - mains pollution, earth coupling, common current or voltage tracks.*

2. *By radiation - disturbance sources include elements capable of acting as transmitters.*

Ferrite components are efficient and cost effective for the prevention of - and protection against - spurious signals transmitted by conductance and radiation.

Suppression components are offered in a number of ferrite materials, optimising impedance over a wide range of frequencies. The most popular materials are described below.

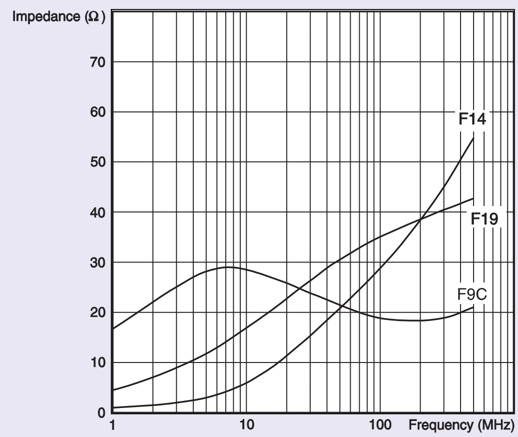
F9C - A high permeability Manganese-Zinc ferrite with peak suppression performance up to 10MHz.

F19 - A high permeability Nickel-Zinc ferrite offering peak performance over a wide range from 20MHz to 200MHz.

F14 - Lower permeability Nickel-Zinc ferrites offering peak performance at high frequencies >200MHz.

A graphical representation of material performance is shown below.

Normalised Impedance vs. Frequency



Flat Ribbon Cable Suppressors

A simple method of suppression of RFI in ribbon cables is offered by MMG - Flat ribbon cable suppressors in F19 material.
These components are available in two types: the solid single piece version through which the cable is threaded, and the split version which may be conveniently fitted to existing equipment assemblies using clips.

Beads and tubes

Cylindrical beads are among the simplest components for suppression use and are threaded over conductors, as the impedance is, in general, directly proportional to the length of the bead. It should be noted that at frequencies above each material’s optimum range, it is advisable to use a number of shorter beads in preference to a single long bead.

Two terminal (leaded) chokes

In their simplest form, chokes are ferrite rods with a single winding, preferably close to the rod because distant turns hardly couple to the rod and contribute very little to the inductance of a choke. Such chokes may be used as LC filter components or inserted in the lines to and from devices producing (asymmetrical) interference. At low frequencies, the reactance is low and does not affect the flow of desired currents, but at higher frequencies the reactance is high enough to attenuate the interference, generating in or endangering the protected device.
Ferrite ring, pot, RM and other closed cores can provide much higher inductance values required for suppression at lower frequencies, but they are more prone to saturation when high operational currents have to be handled. In some conditions, iron powder toroids, having much higher saturation induction than any other ferrite grade, may be useful.

Toroidal cores

Toroidal cores are widely used as designed filters and chokes in electronic circuits, for example, Mains filters, common and differential mode chokes. They have the advantage of being large enough to allow for multiple turns of wire.

Surface mount beads

The MMG surface mount bead inductors in grade F19 give excellent suppression of RFI in the range 10-300MHz. Two sizes are available and are supplied on reels for automatic insertion.

Multi-Aperture cores

Multi-Aperture cores are designed as suppression components which are compact in size and provide high resistive impedence over a wide frequency band. These cores avoid the self resonance effects experienced with single aperture cores wound with multiple turns.

Transformer (Balun) cores

Originally designed for balun transformers, matching balanced to unbalanced circuits in the television frequency spectrum, these cores can also be used for wideband and pulse transformers and interference suppression.

Surface mount four-way bead

A multi-hole bead for printed circuit boards offers excellent attenuation at frequencies from 25-100MHz. Good isolation between each single turn winding means the bead can be used on up to four lines simultaneously or with two, three or four turns on a single line.

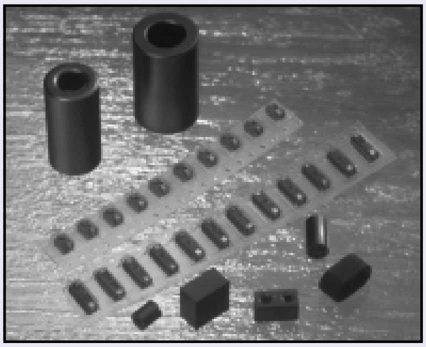
Rods and Slabs

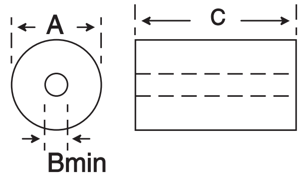
Small rods are generally used to increase the inductance of a coil. The magnetic current is considered to be very open and therefore the mechanical dimensions of the rod or slab have more influence on the inductance than the ferrite material’s permeability.
With the magnetic circuit being open, rods can be used at higher current levels than other ferrite components and some typical applications are in-line chokes, ignition coils, loud speaker crossovers.
The high surface resistivity of Ni-Zn material lends itself to being directly wound.
Long rods can be used for receiving antenna and MMG recommend:-

F6 LW up to 500kHz
F14 MW/SW up to 2MHz
F16 MW/SW up to 10MHz.

Fluted rods in F6 are designed to stop dimensional resonance at the lower kHz frequency range.

Beads and Sleeves





Beads and Sleeves

Beads and Sleeves

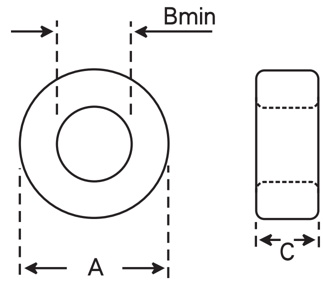
Small beads can be used to remove the parasitic interference on PCB by slipping over the legs of transistors and the pins on connectors.

The large MMG range of sleeves are designed to slip over 4,7,9 and 13mm co-axial cable used for data transfer between computers and hardware.

Beads	Dimensions			Electrical Data			
Part No.	'A'	'B'min	'C'	C_1	Z (TYP) 25MHz	Z (TYP) 100MHz	Material
35-002-31	3.50	1.20	3.0	2.115	28	37	F14
35-002-38	3.50	1.20	3.0	2.115	25	34	F19
35-010-38	4.00	1.50	4.0	1.714	30	42	F19
35-011-31	4.00	1.50	5.0	1.371	43	58	F14
35-011-38	4.00	1.50	5.0	1.371	38	53	F19
35-013-38	4.00	1.50	6.3	1.088	48	67	F19
35-018-31	4.00	1.50	9.5	0.722	82	110	F14
35-018-38	4.00	1.50	9.5	0.722	72	101	F19
35-031-31	4.00	2.00	4.0	2.438	15	20	F14
35-031-38	4.00	2.00	4.0	2.438	13	19	F19
35-032-38	4.00	2.00	5.0	1.95	27	37	F19
Sleeves							
28-133-38	9.52	4.50	9.75	0.927	26	40	F19
28-106-38	10.00	5.90	7.6	1.62	27	40	F19
28-123-38	12.30	4.74	12.0	0.556	85	140	F19
28-010-38	12.30	4.74	25.4	0.267	157	243	F19
28-074-38	14.30	7.00	28.6	0.326	150	220	F19
28-108-38	17.50	9.30	12.7	0.824	55	88	F19
28-129-38	17.50	9.30	14.0	0.747	64	96	F19
28-076-38	17.50	9.30	28.5	0.367	136	218	F19
28-112-38	28.60	13.50	23.6	0.303	145	250	F19

Rings

Ring Cores in F19 are advantageous in that multiple turns are possible in situations where a single turn does not provide the desired level of attenuation. Listed below are the typical impedance details for material grade F19.



Rings

Rings

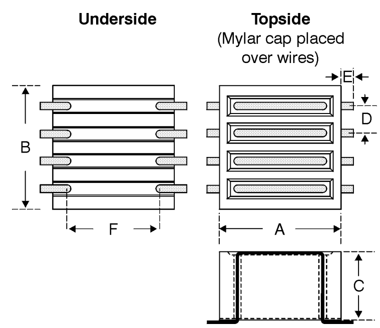
Part No.	Dimensions 'A'	'B'min	'C'	Electrical Data C_1	Z (TYP) 10MHz	Z (TYP) 25MHz	Z (TYP) 100MHz
28-002-38	6.35	3.00	3.96	2.29	13	21	31
28-070-38	9.52	4.50	3.18	2.84	11	17	25
28-012-38	12.70	6.10	6.35	1.43	21	34	50
28-094-38	14.0	7.32	7.0	1.48	20	32	49
28-085-38	14.0	8.60	5.0	2.84	11	17	25
28-072-38	17.2	9.70	5.1	2.27	13	21	32
28-0629-38	19.1	6.18	8.9	0.64	47	75	113
28-071-38	21.0	12.40	6.35	1.97	15	24	37
28-095-38	22.1	13.47	12.70	1.05	29	46	69
28-109-38	25.4	12.40	6.35	1.42	21	34	51
28-090-38	25.4	12.40	12.70	0.71	42	68	101
28-068-38	28.0	17.6	7.5	1.90	16	25	38
28-077-38	31.5	19.0	9.0	1.38	21	34	50
28-087-38	31.5	19.0	15.9	0.83	36	58	87
28-096-38	38.1	19.1	12.7	0.74	41	65	97
28-0645-38	63.0	37.1	12.7	0.98	31	49	73

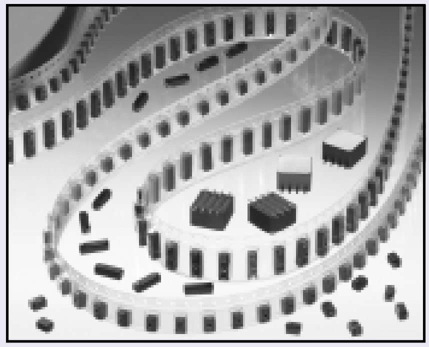
These Ring Core sizes may be available in other grades of Ferrite powder other than F19. - See Ring Core section.
These core sizes may also be pressed in taller or shorter versions to increase or reduce the typical inductance.

Surface Mount 4-Way Bead

Surface Mount 4-Way Beads

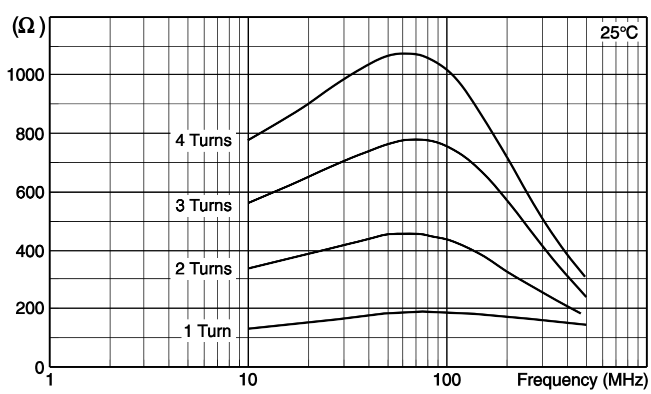
Good isolation between each single turning means that the 4 way bead can be used on up to four lines simultaneously or with two, three or four turns on a single line.
Beads are supplied loose packed. Tape and reel specifications for automatic insertion equipment can be discussed.



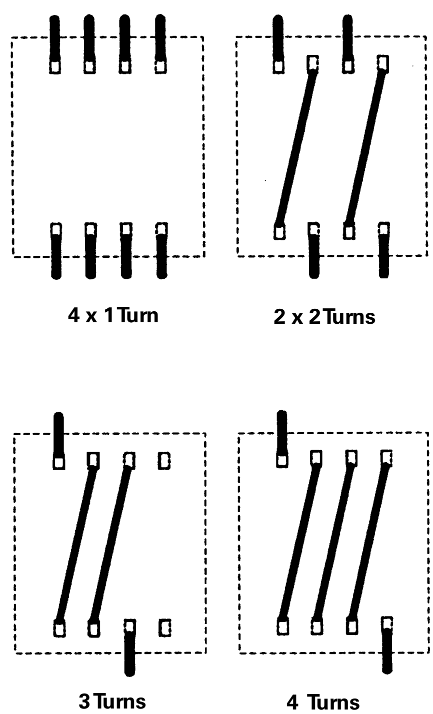


Part No.	Dimensions						Electrical Data	
	'A'	'B'	'C'	'D'	'E'	'F'	Z (TYP) 25MHz	Z (TYP) 100MHz
48-057-38	10.86	10.86	6.35	2.54	1.0	7.62	160	190

Impedence



Typical Impedence vs. Frequency



Winding Arrangements

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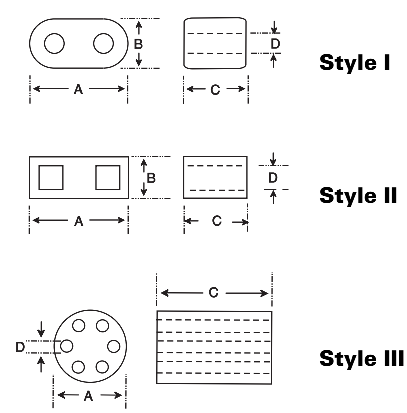
Balun & Multi-Aperture Cores



Part No. suffix
The Part No. material ordering suffix codes are as follows:-

Grade	Suffix
F16	-32
F14	-31
F19	-38
F9	-36
F9C	C36
F39	-39

	Style	I	I	I	I	I	II	III
	Part No.	42-033*	42-034*	42-035*	42-002	42-001	42-003	35-001
Dimensions	A	3.51	6.98	6.98	13.35	13.35	10.80	6.0
Dimensions	B	2.06	3.94	3.94	7.37	7.37	5.40	-
Dimensions	C	2.54	3.18	7.62	6.60	13.46	10.90	10.0
Dimensions	D	0.79	1.85	1.85	3.81	3.81	2.00	0.90
Dimensions	$\Sigma \ell / A$	1.82	1.82	0.76	0.99	0.49	0.34	-
Material	F16	85	90	220				
Material	F14				320	645		800
Material	F19	600	650	1560				2500
Material	F9						15620	
Material	F9C	3530*	3825*	9180*				
Material	F39	7055*	7655*	18360*				

* These cores can be supplied parylene coated to give a 500V dielectric breakdown.
Other coatings may be available on request. i.e. Enamel and Epoxy.
To order a parylene coated core replace the '0' in the Part No. with a '3'. i.e. An F16 Balun core 6.98 x 3.94 x 3.18 will be order code 42-034-32. But a parylene coated version will be 42-334-32.

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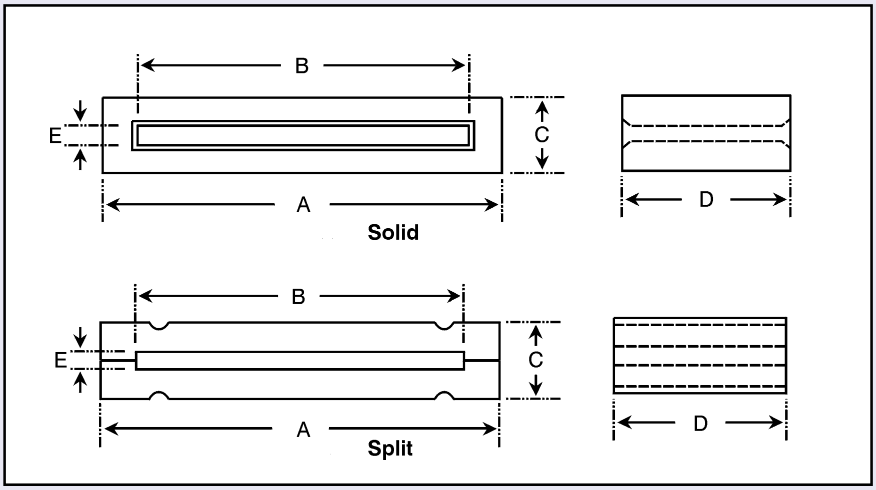
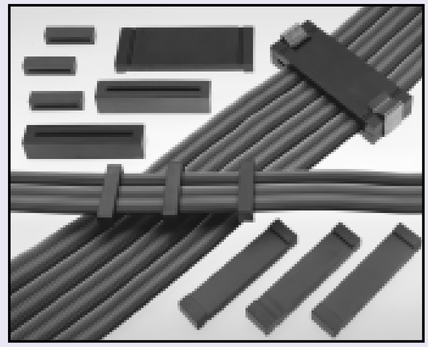
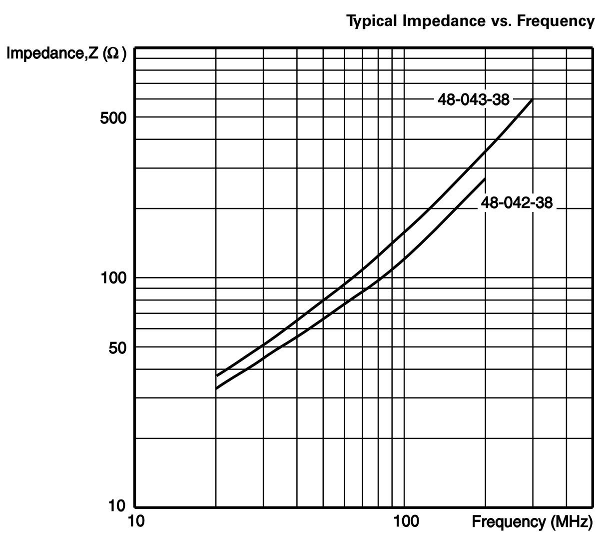
Ribbon Cable Suppressors

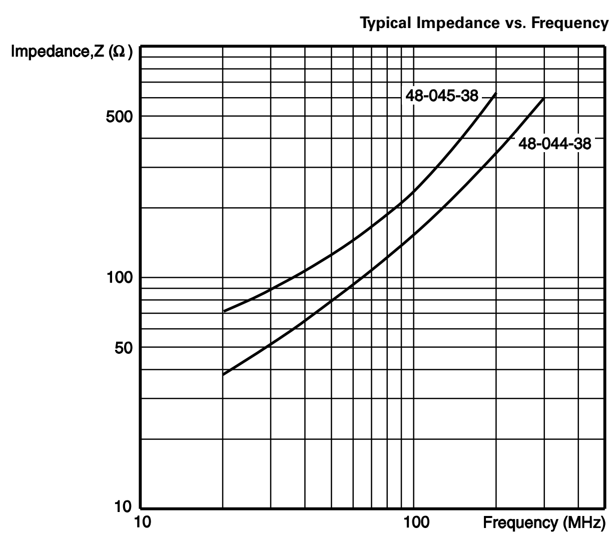




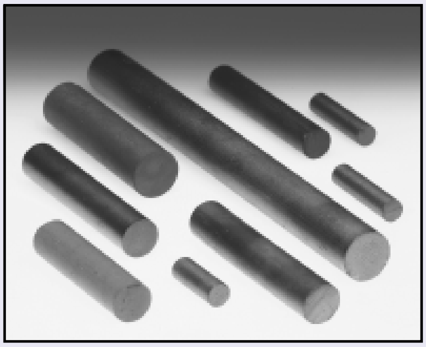
Part Number	Type	Cable Size	Dimensions A	B	C	D	E	Typical impedance Z(Ω) 25MHz	100MHz
48-042-38	Solid	16 Way	28.0±0.6	23.0±0.5	7.7±0.25	7.0±0.25	1.5±0.25	39	122
48-043-38	Solid	34Way	60.0±1.3	48.3±1.0	12.0±0.25	12.7±0.25	1.9±0.25	50	130
48-044-38	Split	34Way	60.0±1.3	48.3±1.0	12.7±0.5	12.7±0.4	1.7±0.5	50	130
48-045-38	Split	50Way	76.2±1.5	65.3±1.0	12.7±0.5	28.6±0.6	1.66±0.4	90	250

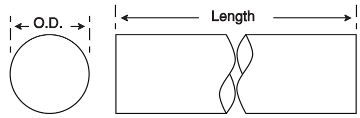
Clamps: 48-044-38 and 48-045-38 may be clamped together using clips (Part No. 76-061-95).





Small Rods
36-XXX-





Small Rods

These can be used to increase the inductance of a coil.
F14 can be used for in-line chokes and suppressors as well as small antennae up to 1MHz.
F6 can be used for motor suppression and in-line chokes as well as loud speaker crossover network energy storage inductors.

Plain

O.D.	Length	F6 Part Number	F14 Part Number
1.6 ±0.08	28.0 ±0.80	-	36-106-31
2.0 ±0.30	25.4 ±0.80	-	36-151-31
3.2 ±0.15	25.4 ±0.76	-	36-253-31
4.0 ±0.17	20.0 ±0.40	36-309-26	36-306-31
5.0 ±0.15	20.0 ±0.60	-	36-960-31
5.0 ±0.15	30.0 ±0.60	-	36-381-31
6.35 ±0.25	19.0 ±0.50	36-452-26	36-452-31
6.35 ±0.25	25.4 ±0.80	36-453-26	36-453-31
6.35 ±0.25	35.0 ±1.0	-	36-462-31
6.35 ±0.25	38.0 ±1.20	36-456-26	36-456-31
8.0 +0/-0.4	27.0 ±1.00	-	36-552-31
9.50 ±0.29	25.4 ±0.76	36-601-26	36-601-31
9.50 ±0.29	50.8 ±1.50	36-606-26	36-606-31
10.0 +0/-0.5	30.0 ±1.00	-	36-652-31
10.0 +0/-0.5	45.0 ±0.35	36-667-26	-
12.7 +0.15/-0.38	25.4 ±0.76	36-701-26	-
12.7 ±0.30	50.8 ±1.50	36-702-26	-
15.9 ±0.30	50.8 ±0.60	36-755-26	-
19.05 ±0.57	38.1 ±1.14	36-803-26	-

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Antenna Rods
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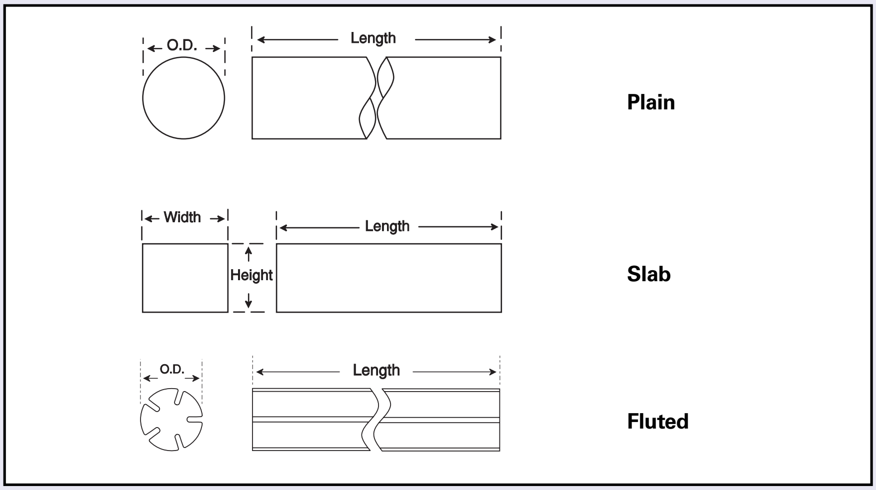

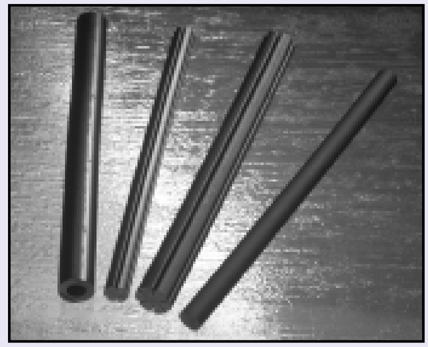

Plain

O.D.	Length	Depth	F6 Part Number	F14 Part Number
7.92 ±0.24	203.2 ±6.10	-	-	37-155-31
8.0 +0/-0.4	200 ±4.0	-	37-206-26	-
8.0 ±0.24	150 ±3.0	-	37-207-26	-
8.0 ±0.24	160 ±3.2	-	37-208-26	37-208-31
9.5 ±0.28	203.2 ±4.0	-	-	37-256-31
10.0 +0/-0.5	160 ±3.2	-	37-305-26	37-305-31
10.0 +0/-0.5	200 ±4.0	-	37-307-26	37-307-31
12.7 ±0.38	200 ±4.0	-	37-359-26	-

Slab

Width	Height	Length	F6 Part Number	F14 Part Number
18.0 +0/-0.7	3.5 +0/-0.4	100 ±2.0	-	39-052-31
18.25 ±0.55	3.78 ±0.12	80 ±1.6	-	39-043-31

Fluted

O.D.	Length	No. of Flutes	F6 Part Number	F14 Part Number
6 ±0.3	100 ±2.0	4	38-003-26	-
6 ±0.3	200 ±4.0	4	38-004-26	-
8 ±0.3	150 ±3.0	5	38-005-26	-
8 ±0.3	200 ±4.0	5	38-007-26	-
10 ±0.3	150 ±3.0	6	38-012-26	-
10 ±0.3	200 ±4.0	6	38-014-26	-

MMG

Plastic Products

Plastics

Plastic is used extensively in the manufacture of coil formers and bobbins because its ease and speed of moulding allows the creation of a wide range of shapes.

Many different plastic materials are now available which are ideally suited for such use depending upon the requirements of the application. For many applications *thermoplastics* such as Nylon and Polymide can be used in the manufacturing process. The material is inexpensive and parts can be produced very quickly, resulting in a low cost product. However, they can be dimensionally unstable and might soften during soldering or when being operated in a component under load.

Advanced thermoplastic materials are now available but when a rigid and stable component that can operate in high ambient temperatures is required then *thermoset* plastic should be seriously considered.

Where *thermoplastic* products such as Glass Fibre Reinforced Nylon 66 may withstand Class B temperatures (130°C) , *thermoset* plastic will remain rigid up to 185 °C and survive soldering temperatures of 400°C. The penalty is in their cost where the more expensive material and longer cycle times increase the final component cost.

The stability of both types of material can be improved by filling the plastic with Glass Fibre and plastics such as Nylon 66 are also available with a halogen free additive which gives them flame retardant properties to meet UL94VO.

MMG-Neosid manufacture both *thermoset* and *thermoplastic* components which may be roughly divided into two groups: self supporting coil formers and core bobbins.

The Table below compares the the specifications for two types of material:

	Glass Reinforced Flame resistant NYLON 66	**Glass Reinforced Flame resistant PHENOLIC**
Relative density	1380 Kg/m³	1640 Kg/m³
Cold Water Absorbtion	0.75%	0.1%
Melting Point	260°C	N/A
Maximum Service Temp (20,000hrs)	120°C	150°C
Heat Deflection under load (at 1.8 MPa)	250°C	190°C
Co-ef of Linear Expansion	$30x10^6/^oC$	$18\text{-}28\ x10^6/^oC$
Flammability	UL94VO	UL94VO
Tensile Breaking Strength	150/110 MPa	70/90 MPa
Volume Resistivity	10^{12}-10^{14} Ohms/cm	10^{11}-10^{12} Ohms/cm
Dielectric Strength	25KV/mm	30KV/mm
Tracking Resistance	350V	125V

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Bobbins:

Data on the common bobbins is given in the main ferrite component sections of this catalogue. The following tables summarise the range of bobbins available from MMG- Neosid.

Bobbins for E U I cores:

Part Number	Type	Vert/Horiz	Sections	Pins	Material
59-490-66	U+I 12.7	H	1	4	Glass filled Nylon 66
59-112-66	U15 x6.5	H	1	4	Glass filled Nylon 66
59-100-66	U21 x 7.5	H	1	4	Glass filled Nylon 66
59-115-66	U25/20	H	1	12	Glass filled Nylon 66
59-140-64	E20x10x5	H	1	8	Glass filled Phenolic
59-030-66	E25x19x6	-	1	0	Glass filled Nylon 66
59-031-66	E25x19x6	H	1	10	Glass filled Nylon 66
59-130-66	E30x30x7	H	1	12	Glass filled Nylon 66 (VO)
59-010-66	E34x26x8	-	1	0	Glass filled Nylon 66
59-020-66	E41x44x9	-	1	0	Glass filled Nylon 66
59-110-66	E42/15	H	1	10	Glass filled Nylon 66 (VO)
59-113-66	E42/15	H	1	12	Glass filled Nylon 66 (VO)
59-120-66	E42/20	H	1	12	Glass filled Nylon 66 (VO)
59-150-66	E55/21	H	1	14	Glass filled Nylon 66 (VO)
59-170-66	E55/25	H	1	14	Glass filled Nylon 66 (VO)
59-240-66	E65/27	H	1	16	Glass filled Nylon 66 (VO)
59-205-76	EF12.6	SMD	1	8	Glass Polyethelene Sulphide
59-206-76	EF12.6	SMD	2	8	Glass Polyethelene Sulphide
59-200-66	EF12.6	H	1	6	Glass filled Nylon 66
59-201-66	EF12.6	H	2	6	Glass filled Nylon 66
59-375-66	EF16	V	1	6	Glass filled Nylon 66
59-376-66	EF16	V	2	6	Glass filled Nylon 66
59-370-66	EF16	H	1	6	Glass filled Nylon 66
59-371-66	EF16	H	2	6	Glass filled Nylon 66
59-180-66	EF20	H	1	8	Glass filled Nylon 66
59-181-66	EF20	H	2	8	Glass filled Nylon 66
59-185-66	EF20	V	1	6	Glass filled Nylon 66
59-186-66	EF20	V	2	6	Glass filled Nylon 66
59-196-66	EF25	V	1	6	Glass filled Nylon 66 (VO)
59-190-66	EF25	H	1	10	Glass filled Nylon 66 (VO)
59-191-66	EF25	H	2	10	Glass filled Nylon 66 (VO)

Part Number	Type	Vert/Horiz	Sections	Pins	Material
59-365-66	EF32	V	1	6	Glass filled Nylon 66
59-361-66	EF32	H	2	12	Glass filled Nylon 66
59-360-66	EF32	H	1	12	Glass filled Nylon 66
59-720-76	EFD15	H	1	8	Glass filled Nylon 66
59-740-76	EFD20	H	1	8	Glass filled Nylon 66
59-760-76	EFD25	H	1	10	Glass filled Nylon 66
59-810-64	EP7	H	1	6	Glass filled Phenolic
59-811-64	EP7	H	2	6	Glass filled Phenolic
59-820-64	EP10	H	1	8	Glass filled Phenolic
59-821-64	EP10	H	2	8	Glass filled Phenolic
59-803-64	EP13	H	2	6	Glass filled Phenolic
59-800-64	EP13	H	1	5	Glass filled Phenolic
59-802-64	EP13	H	2	5	Glass filled Phenolic
59-801-64	EP13	H	1	6	Glass filled Phenolic
59-805-64	EP13	H	1	10	Glass filled Phenolic
59-806-64	EP13	H	2	10	Glass filled Phenolic
59-830-64	EP17	H	1	8	Glass filled Phenolic
59-831-64	EP17	H	2	8	Glass filled Phenolic
59-840-64	EP20	H	1	10	Glass filled Phenolic
59-841-64	EP20	H	2	10	Glass filled Phenolic
59-585-76	ETD29	V	1	12	PETP
59-580-76	ETD29	H	1	14	PETP
59-500-76	ETD34	H	1	14	PETP
59-505-76	ETD34	V	1	14	PETP
59-525-76	ETD39	V	1	16	PETP
59-520-76	ETD39	H	1	16	PETP
59-540-76	ETD44	H	1	18	PETP
59-545-76	ETD44	V	1	18	PETP
59-560-76	ETD49	H	1	20	PETP
59-565-76	ETD49	V	1	20	PETP

Bobbins for Pot Cores:

Part Number	Type	Sections	Pins	Material
60-351-76	P/ CORE 9X5	1	-	PETP
60-352-76	P/ CORE 9X5	2	-	PETP
60-1000-72	P/CORE 10x7 (4 Slot)	1	-	Polyacetal
60-401-76	P/CORE 11X7	2	-	PETP
60-400-76	P/CORE 11X7	1	-	PETP
60-452-72	P/CORE 14X8	2	-	Polyacetal
60-451-72	P/CORE 14X8	1	-	Polyacetal
60-1040-72	P/CORE 14x9 (4 Slot)	1		Polyacetal
60-501-72	P/CORE 18X11	1	-	Polyacetal
60-502-72	P/CORE 18X11	2	-	Polyacetal
60-1080-72	P/CORE 18x11 (4 Slot)	1		Polyacetal
60-1120-72	P/CORE 21x14 (4 Slot)	1		Polyacetal
60-551-72	P/CORE 22x13	1	-	Polyacetal
60-552-72	P/CORE 22x13	2	-	Polyacetal
60-632-66	P/CORE 23/15x11 (Wide slot)	1	10	G/F Nylon 66
60-635-66	P/CORE 23/15x18 (Wide slot)	1	10	G/F Nylon 66
60-1160-72	P/CORE 25x16 (4 Slot)	1		Polyacetal
60-601-72	P/CORE 26x16	1	-	Polyacetal
60-602-72	P/CORE 26x16	2	-	Polyacetal
60-621-72	P/CORE 30x19	1	-	Polyacetal
60-622-72	P/CORE 30x19	2	-	Polyacetal
60-637-66	P/CORE 30/20x19 (Wide slot)	1	10	G/F Nylon 66
60-1200-72	P/CORE 30x19 (4 Slot)	1		Polypropylene
60-1240-72	P/CORE 35x23 (4 Slot)	1		Polyacetal
60-651-76	P/CORE 36x22	1		PETP
60-1280-72	P/CORE 45x29 (4 Slot)	1		Polyacetal

Bobbins for RM cores:

Part Number	Type	Style	Sections	Pins	Pin length	Material
60-904S64	RM4	AS	2	4	4.5	Glass Filled Phenolic
60-906S64	RM4	AS	2	6	4.5	Glass Filled Phenolic
60-901S64	RM4	AS	1	4	4.5	Glass Filled Phenolic
60-903S64	RM4	AS	1	6	4.5	Glass Filled Phenolic
60-701S64	RM5	AS	1	4	4.5	Glass Filled Phenolic
60-702S64	RM5	AS	1	6	4.5	Glass Filled Phenolic
60-703-64	RM5	AS	2	4	4.5	Glass Filled Phenolic

Bobbins for RM cores:

Part Number	Type	Style	Sections	Pins	Pin length	Material
60-704-64	RM5	AS	2	6	4.5	Glass Filled Phenolic
60-951-66	R6	AS	1	6	6.5	Glass Filled Phenolic
60-7303-64	RM6	AS	1	6	5.0	Glass Filled Phenolic
60-7313-64	RM6	AS	2	6	5.0	Glass Filled Phenolic
60-733-64	RM6	AS	1	6	5.0	Glass Filled Phenolic
60-731-64	RM6	AS	1	4	5.0	Glass Filled Phenolic
60-736-64	RM6	AS	2	6	5.0	Glass Filled Phenolic
60-734S64	RM6	AS	2	4	5.0	Glass Filled Phenolic
60-750-76	RM6i	D.I.L.	1	8	4.3	PETP
60-7601-64	RM7	AM	1	4	6.0	Glass Filled Phenolic
60-7604-64	RM7	AS	1	8	6.0	Glass Filled Phenolic
60-760-64	RM7	AG	1	5	6.3	Glass Filled Phenolic
60-7902-64	RM8	AP	1	5	5.5	Glass Filled Phenolic
60-796-64	RM8	AS	2	12	5.5	Glass Filled Phenolic
60-793-64	RM8	AS	1	12	5.5	Glass Filled Phenolic
60-792-64	RM8	Z	1	8	5.5	Glass Filled Phenolic
60-790-64	RM8	Euro	1	8	5.0	Glass Filled Phenolic
60-792A64	RM8	Z	1	8	7.2	Glass Filled Phenolic
60-795-64	RM8	Z	2	8	5.5	Glass Filled Phenolic
60-810-76	RM8	D.I.L.	1	12	4.3	PETP
60-8207-64	RM10	AS	1	12	5.5	Glass Filled Phenolic
60-8208-64	RM10	Z	1	8	5.5	Glass Filled Phenolic
60-826-64	RM10	AS	2	12	5.5	Glass Filled Phenolic
60-823-64	RM10	AS	1	12	5.5	Glass Filled Phenolic
60-822-64	RM10	Z	1	8	5.5	Glass Filled Phenolic
60-825-64	RM10	Z	2	8	5.5	Glass Filled Phenolic
60-850-76	RM10	D.I.L.	1	12	4.8	PETP
60-930-64	RM12	AS	1	12	6.3	Glass Filled Phenolic
60-940-76	RM12	D.I.L.	1	12	4.8	PETP
60-882-64	RM14	AS	1	12	6.3	Glass Filled Phenolic
60-881-64	RM14	AX	1	10	6.3	Glass Filled Phenolic
60-980-76	RM14	D.I.L.	1	12	4.8	PETP

KEY:-

Style	**Pins Fitted**		
AS	All	AP	1,2,5,8,11
DIL	All	AX	1,2,3,4,6,7,9,10,11,12
Z	1,3,4,,6,7,9,10,12	AM	3,4,7,8
Euro	1,2,5,6,7,8,11,12	AG	3,4,5,7,9

Definitions and Properties of Soft Ferrites

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Definitions of Component Parameters

1. Ferrites

Ferrites are crystalline oxides manufactured by ceramic technology. They belong to a class of materials which exhibit the technically useful property of ferromagnetism.

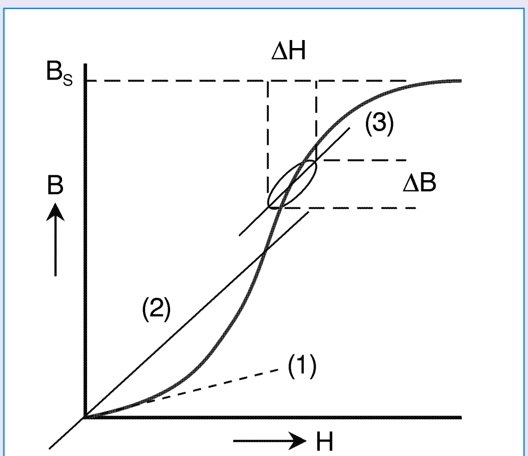
In metals, ferromagnetism is due to the atomic forces aligning adjacent electron 'spins' in parallel, creating very strong magnetic fields within a body.

Ferrites differ from metals in that they are oxides with a 'spinel' crystalline structure. This contains two magnetically opposing layers and can be represented as successive planes of metallic ions separated by oxygen ions. Interactions between metal and oxygen result in a reduction of electron conductivity compared to a metallic material, giving ferrites their high resistivity and low losses at high frequencies. The opposing spins also result in a lower polarisation than for metals and correspondingly lower saturation flux densities.

2. Permeability

The principal properties of ferrites which determine their technical performance are permeability and its variation in response to external field, to frequency and to temperature.

Permeability is defined as the ratio between the magnetic flux density induced in the material and the magnetic force which causes it.
A schematic view of this relationship is shown below and has led to several concepts of permeability.



(1) Intrinsic Permeability (ring core)
(2) Amplitude Permeability
(3) Incrimental Permeability

2.1 Intrinsic Permeability

Intrinsic permeability is the ratio between flux density ΔB in a closed ring core, and the applied field strength ΔH at very low a.c. fields.

$$\mu_i = \frac{1}{\mu_o} \cdot \frac{\Delta B}{\Delta H} \quad (\text{Lim.}\Delta H \rightarrow 0)$$

where μ_o is the magnetic field constant:

$$\mu_o = 4\pi \times 10^{-7} \ \frac{H}{m} \text{ or } \frac{T}{(A/m)}$$

Measurements are genarally made at a flux density <0.1mT for ring cores and <1mT for components with a sheared flux path.
Intrinsic permeability is calculated from:

$$\mu_i = \frac{10^{-6}}{\mu_o} \cdot \frac{L}{n^2} \cdot \sum \frac{\ell}{A}$$

$$\sum \frac{\ell}{A} = \text{Geometric core constant, } C_1 \ (\text{mm}^{-1})$$

n = Number of Turns
L = Inductance (nH)

$$= \frac{1}{0.4\pi} \cdot \frac{L}{n^2} \cdot \sum \frac{\ell}{A}$$

The intrinsic permeability is also known as the initial permeability (reference to its position on the B vs. H curve), and as the 'toroidal' permeability (reference to its measurement on ring cores).

2.2 Geometric core constants

For a thin walled toroid, a uniform and magnetic flux density may be assumed. For thick toroids and other components, where the cross-sectional area varies along the flux path, it is necessary to calculate 'effective' magnetic dimensions.

Geometric core constants are calculated from component dimensions according to the IEC document 60205, giving constants:

$$C_1 \left(\sum \frac{\ell}{A}\right) \text{ and } C_2 \left(\sum \frac{\ell}{A^2}\right)$$

Geometric Core Constant:

$$\sum \frac{\ell}{A} = C_1 \quad (\text{mm}^{-1})$$

Effective Length

$$L_e = \frac{C_1^2}{C_2} = \frac{\left(\sum \frac{\ell}{A}\right)^2}{\sum \frac{\ell}{A^2}} \quad (\text{mm})$$

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Effective Area

$$A_e = \frac{C_1}{C_2} = \frac{\sum \frac{l}{A}}{\sum \frac{l}{A^2}} \quad (mm^2)$$

Effective Volume

$$V_e = \frac{C_1^{\ 3}}{C_2^{\ 2}} = l_e . A_e \quad (mm^3)$$

2.3 Effective Permeability (μ_e)

In most cases ferrite cores contain an air gap, either purposely introduced for a specific magnetic performance or caused by grinding the mating faces.

This results in the permeability of the core being lower than the intrinsic permeability of the material. This reduced permeability is calculated from the inductance of a winding on the core and is the effective permeability, μ_e.

$$\mu_e = \frac{1}{\mu_o} \cdot \frac{L}{n^2} \cdot \sum \frac{l}{A}$$

(See section ***'Gapped Cores'***)
The effective permeability is used in the calculation of losses, temperature coefficient and disaccommodation.

2.4 Inductance Factor (A_L)

It is usual to provide information on the expected inductance when winding a specific core. This information is given by the A_L, inductance factor.

As inductance of a coil is proportional to the square of the number of turns , A_L is the inductance per turn squared.

$$A_L = \frac{L\,(nH)}{n^2} = \frac{\mu_e}{\sum \frac{l}{A}} \cdot \mu_o$$

A_L values are generally measured using fully wound coil formers.
The number of turns required to produce a specific inductance is:

$$n = \sqrt{\frac{L}{A_L}}$$

2.5 Rod Permeability (μ_{rod})

Many ferrite cores, of which aerial rods and screw cores are typical examples, are used in such a manner that the ferrite material only occupies part of the path of the magnetic lines generated by the current flowing in the winding. The magnetic circuit is then virtually open and very strong demagnetising fields appear at the end faces of the core. Depending on the length-to-diameter ratio for cylindrical cores, the permeability (rod permeability) can be calculated from the intrinsic permeability of the material.

Because of the nature of the magnetic circuit, rod permeability is always much lower than the intrinsic permeability of the material, and the difference between these permeabilities increases as the length-to-diameter ration decreases.

For guidance a graph of μ_{rod} vs. length-to-diameter ratio is given in the component pages for rods.

2.6 Amplitude Permeability (μ_a)

When a high alternating magnetic field is applied, as in power transformers, the curve of the B vs. H path causes the permeability to change during the cycle.

The definition of permeability which is of greater use to the designer is the amplitude permeability, μa, generally at specific flux densities and temperatures.

$$\mu_a = \frac{1}{\mu_o} \cdot \frac{\hat{B}}{\hat{H}}$$

where B is the peak flux density in Tesla (sinusoidal induction) and H is the peak field strength in A/m.

In the case of measurements carried out on the winding of a gapped core the result is an 'effective' amplitude permeability in which the amplitude permeability of an equivalent toroid is reduced by the reluctance of the air gap.

In the material data pages amplitude permeabilities are indicated for toroidal cores. In the component specifications the effective amplitude permeabilities are given.

For components where the cross sectional area of the flux path varies, μ_a is measured setting the peak flux density in the minimum cross section (i.e. the voltage calculation uses A_{min} in place of A_e).

For ferrites used in power applications, information generally includes the bottom limit of the amplitude permeability, at 25°C and 100°C

2.7 Incremental Permeability (μ_D)

Where a d.c current is applied to a winding, producing a biasing field (H_B), the operating point of a small a.c. excitation is moved to a higher point on the B-H curve.

The amplitude permeability of the a.c. excursion is termed the incremental permeability.

$$\mu_\Delta = \frac{1}{\mu_o}\left[\frac{\Delta B}{\Delta H}\right]_{H_B} \quad (\text{Lim.}\Delta H \rightarrow 0)$$

For further discussion refer to section ***'Gapped Cores D.C. Loading'.***

2.8 Saturation Induction (B_{Sat})

Saturation flux density (B_S) as that value obtained for a field strength of 800A/m (10 Oersted).

$$B_S = H + 4\pi J_S$$

where J_S is the saturation polarisation of the material.

The saturation induction is an important parameter in the design of power transformers. Although it is an intrinsic property, saturation induction is normally indirectly specified in component data pages for transformer cores as a minimum value of amplitude permeability.

3.0 Losses (general)

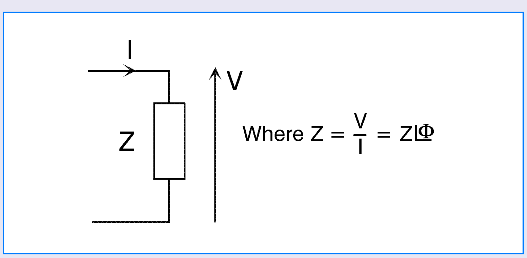
Losses associated with a coil wound on a ferrite core can be represented by the resistive component of its impedance at any frequency and any field strength.

$$Z = R_{wind} + R_h + R_r + R_e + j\omega L$$

R_{wind}	is the winding resistance loss
R_h	is the hysteresis loss of the core
R_r	is the residual loss of the core
R_e	is the eddy current loss of the core
jwL	is the inductive reactance of the core

3.1 Impedance (Z)

The ratio of r.m.s. voltage over r.m.s. current in a circuit with sinusoidal excitation is defined as the impedance and is expressed in Ohms.

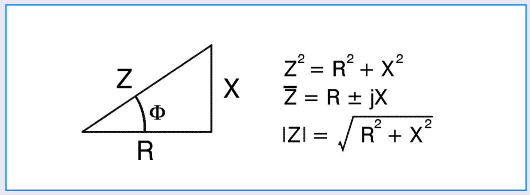


Φ is the angle by which voltage leads the current.
Hence,

Resistance, $R = Z\cos\Phi$ (ohms)

and Reactance, $X = Z\sin\Phi$ (ohms)

This can be represented in the impedance triangle,



For suppression applications it is advantageous to maximise the resistive component at the interfering frequency.
In the material data pages for F9C and F19 impedance is shown as the modulus value Z only.
In some component pages and in the EMC section impedance may be expressed in ohms as;
R + jX, or Z Φ , or as the modulus value.

3.2 Complex Permeability (μ)

The complex permeability (μ) expands the permeability concept using complex notation to include both an inductive component (real, inductive permeability, μ') and the loss component (imaginary, resistive permeability, μ").

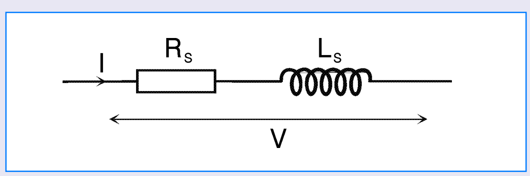
$$\mu = \mu' - j\mu''$$

The impedance (Z) of a loss-free winding would be expressed as:

$$Z = j\omega\mu L_0$$

where L_0 is the inductance of a winding on a core with unit permeability.

For a wound ferrite component the impedance can be represented by an inductive reactance in combination with a loss resistance.
For series representation:



$$\frac{V}{I} = Z = R_s + j\omega L_s$$

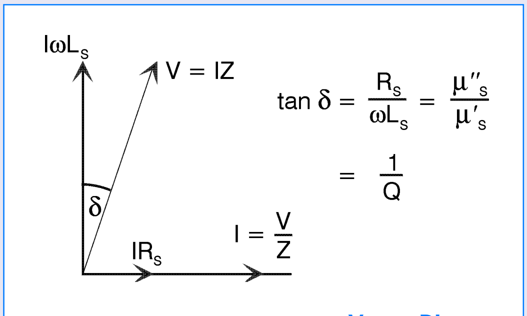
$$= j\omega\mu L_0 = j\omega L_0\,(\mu' - j\mu''_s)$$

Hence:

$$R_s = \omega L_0\,\mu''_s$$

$$\omega L_s = \omega L_0\,\mu'_s$$

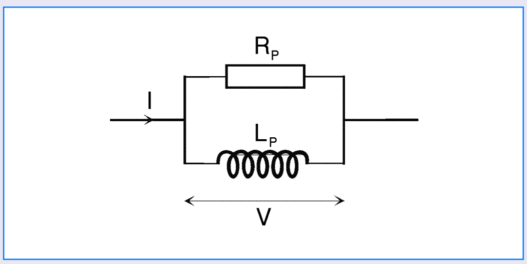
The inclusion of the resistive loss results in a reduction of the phase angle between voltage and current from 90° by an angle δ, the loss angle.



Vector Diagram

Q is the magnification factor (see section 3.3) Curves of real and imaginary components of complex permeability (series representation) as a function of frequency are given in the material data pages. As measurements are made at low field strength (<0.1mT) the real component corresponds to the intrinsic initial permeability of the material.

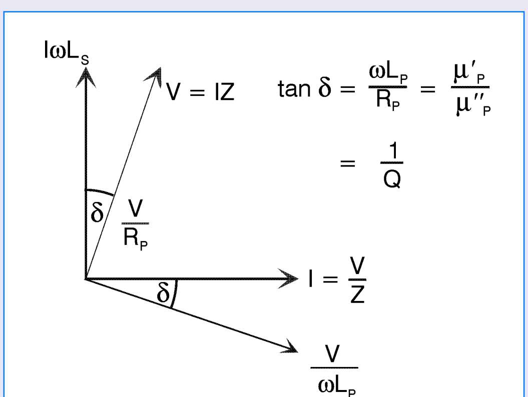
For parallel representation:



$$\frac{1}{z} = \frac{1}{R_p} + \frac{1}{j\omega L_p} = \frac{1}{j\omega L_o}\left(\frac{1}{\mu'_p} - \frac{1}{j\mu''_p}\right)$$

giving:

$$R_p = \omega L_o \mu''_p ,$$
$$\omega L_p = \omega L_o \mu'_p$$



Vector Diagram

The conversion between series and parallel mode measurement is:

$$R_s = R_p / (1 = Q^2) = R_p / (1+1/\tan^2\delta)$$
$$L_s = L_p / (1+1/Q^2) = L_p / (1+ \tan^2\delta)$$

and

$$\mu'_p = \mu'_s(1+\tan^2\delta)$$
$$\mu''_p = \mu''_s(1+1/\tan^2\delta)$$

It is common practice to give curves of complex permeability in the series form. However, it should be noted that the series change in real permeability can be misleading, with graphs showing permeability falling off rapidly at high frequencies; this is only a mathematical representation and at this point parallel permeability should be used.

Although series representation befits suppression and wide band applications, it is physically more correct to consider the parallel form and conversion to this is preferable in transformer applications where a more useful expression of in-phase and out-of-phase current can be gained.

3.3 Q (Magnification Factor)

The quality of an inductor in a resonant circuit is commonly described by the Q factor, the ratio of reactance and resistance at a given frequency,

$$Q = \frac{\omega L}{R}$$

As the Q of capacitors is high, the Q of a resonant circuit, which is the ratio between the centre frequency and the spacing between ±3dB points on the resonance curve, is determined by the Q of the inductor.

$$Q = \frac{1}{\tan\delta} = \frac{1}{\mu_i \,.\, \text{Loss Factor}}$$

In open-circuit cores, the true Q value is dependant on the properties of the ferrite material and shape and size of the core. It can only be found by measuring the Q value of the winding, both with and without the core and calculating the a.c. resistance of the winding. Therefore,

$$R_{total} = R_{ferrite} + R_{wind}$$
$$= \frac{\omega L}{Q_{total}}$$

where L is the inductance of the coil with the core.

$$R_{wind} = \frac{\omega L}{\mu_{coil} \cdot Q_{wind}}$$

as the inductance of the winding without the core is reduced by a factor of μ_{coil} (the ratio of inductance of coil with core to inductance of coil without core).

The direct comparison of the values of Q is only possible when all conditions of measurement are held constant.

3.4 Losses at low magnetising field strengths

For individual grades of ferrite information on losses at low field strengths is given by the loss factors normalised to unit intrinsic permeability. It is understood that the loss coefficients are always proportional to the effective permeability of such cores.

3.4.1 Loss Factor (residual and eddy current)

Residual and eddy current losses are measured together at a flux density of <0.1mT for ring cores, and <1mT for components with a sheared flux path.

$$L.F. = \frac{R_{(r+e)}}{\omega L} \cdot \frac{1}{\mu_i}$$

$$= \frac{\tan \delta_{(r+e)}}{\mu_i} = \frac{1}{\mu_i \cdot Q_{(r+e)}}$$

For a gapped core with an effective permeability μ_e, the residual & eddy current loss coefficient is:

i.e. it is reduced by a factor of μ_e/μ_i

Similarly the $Q_{(r+e)}$ is increased by a factor of μ_i/μ_e

3.4.2 Hysteresis Loss (Low magnetising field strengths)

Hysteresis loss must be normalised not only with respect to unit intrinsic permeability, but also with respect to unit flux density.

Hysteresis material constant (η_B)(IEC Publication 125, 128).

$$\eta_B = \frac{\tan \delta_h}{\mu i \cdot \hat{B}} \quad (\text{mT x } 10^{-6})$$

where $\tan \delta_h = R_h/\omega L$ and B is the peak flux density. This definition is quoted in the material data pages where measurement of R_s and L_s are made on an impedance analyser at two peak fluxdensities of 1.5 and 3.0mT.

Where a sheared or gapped core is involved, the hysteresis loss is reduced by a factor μ_e/μ, and $\tan \delta_h = \eta_B \cdot \mu_e \cdot B$.

3.5 Losses at high magnetising field strengths. Power Loss Density (P_V)

The previous hysteresis loss factors can only be applied when the flux density in the core is relatively low (up to say, 20mT).

When the flux density is high, as in power applications, the losses are specified as the power loss density (P_V) (i.e. total power losses per unit volume of the core) at a given frequency and flux density.

The power loss density may be empirically expressed as a function of frequency and flux density by the relation:

$$P_v = k.f^a.B^b \quad \text{mW/cm}^3$$

where constant 'a' has values between 1.3 & 1.6.
constant 'b' has values between 2.2 & 2.6.
'k' is a constant dependant upon temperature.

Power losses are expressed in the material data for power ferrites in mW/cm^3. In component data it is more commonly expressed in total power loss (Watts) at specific flux densities, frequencies and temperatures, assuming sinusoidal induction.

3.6 Frequency Range

The range of frequencies in which a grade of ferrite material may be used depends upon the conditions of the application and on the configuration of the core.

The upper limit of the range is based on the rapid rise of loss factor at and above a certain frequency. This point is easily measured for any given core. If the core is to be used in a transformer, the circumstances are different. It is not only the loss in the core and winding that is significant but the relationship between the shunt reactance of the transformer winding and the impedance of the source or load circuit is also of fundamental importance.

MMG

Leakage inductance also determines the losses in the transformer at the high-frequency end of its working range.

It must be clearly stated that manufacturers test their products at frequencies specified in their tabulated publications and the behaviour of ferrite material outside these frequencies cannot be guaranteed.

4. Stability

4.1 Temperature Factor and Temperature Coefficient

Temperature coefficient is the proportional inductance rise per °C.

$$T.C. = \frac{\Delta L}{L\Delta T} = \frac{\Delta\mu}{\mu\Delta T}$$

Where ΔT is the temperature rise (°C) causing the change ΔL in inductance (or Δμ permeability).

Temperature Factor is normalised to the unit permeability and is expressed in ppm/°C and given for a specified temperature range (25°C to 55°C).

$$T.F. = \frac{\Delta\mu}{\mu_i\Delta T} / \mu_i$$

$$= \frac{\Delta\mu}{\mu_i^2.\Delta T}$$

When a core has a closed magnetic path with a gap the μ_e is used.

Temperature Coefficient = T.F. x μ_e

i.e. T.C. reduced by μ_e/μ_i.

In open-circuit core configurations the temperature coefficient can only be ascertained by direct measurement in each specific case.

4.2 Curie Temperature, (θ_c)

The **Curie temperature** is the temperature above which the disruption of magnetic ordering by increasing thermal motion causes the material to lose its ferromagnetic character, and the permeability falls to near unity. This is a reversible effect and lowering the temperature below the Curie Point restores the permeability.

The **Curie temperature** of each material is defined in the data pages at the temperature where the intrinsic permeability has fallen to 10% of its room temperature value.

4.3 Disaccommodation Factor

After a ferrite core has been subjected to a shock (thermal, mechanical or magnetic) its permeability abruptly increases and immediately begins drifting downwards. This continues for a very long period. The decrease in permeability is linear when plotted on a logarithmic scale,

This form of instability is termed **disaccommodation**.

$$DF = \frac{\mu_2 - \mu_1}{\mu_1.\log_{10} t_2/t_1}$$

where μ_1 is the permeability at the time t_1, and μ_2 is the permeability at the time t_2. The relative inductance drop in the period 1 to 10 hours after the shock is the same as the in the period 1 to 10 years, so that the long-term instability of the inductance can be predicted.

In the case of a core with a closed magnetic path, but containing a gap the μ_e is used.

i.e. Disaccommodation = D.F. x μ_e

i.e. the coefficient is reduced by a factor μ_e/μ_i

The relationship in the case of open circuit cores is not so simple and it is generally not possible to predict the actual value of their disaccommodation coefficients.

Specified disaccommodation measurements in the data pages are carried out at 50°C.

5.0 Resistivity

Ferrites are semi-conducting materials and their resistivity varies with the grade of ferrite.

For nickel-zinc ferrites, the resistivity is of the order of 10^5 to 10^7 ohm-cm. For manganese-zinc ferrites, it is appreciably lower, say 10^1 to 10^3 ohm-cm, but remaining very much higher than the resistivity of metals and metallic alloys.

6.0 Dielectric Constant

Manganese-zinc ferrites have high values of dielectric constant which in some cases may approach 10^6 at a frequency of 1kHz. The value of the dielectric constant drops with the frequency, not very rapidly at first but then more and more steeply until at very high frequencies it approaches a value of 10.

Because of the high dielectric constant of some cores (particularly when they are made from Manganese Zinc) it is important to insulate the winding from the core with a layer of tape. In this way, losses due to increased self capacitance will be reduced.

7.0 Physical Parameters

Exact values of the physical parameters of ferrite components cannot be given as those obtained will depend both upon the type of material used and the conditions under which it is manufactured. However, the table below indicates the order of magnitude of these values:

Tensile Strength:	20 N/mm^2
Compressive Strength:	100 N/mm^2
Hardness:	10000 N/mm^2 (Vickers HV_{15})
Linear Expansion Coefficient:	10 x10^{-6}/°C (Room Temperature)
Youngs Modulus:	1.5 x 10^5 N/mm^2
Thermal Conductivity:	4 x 10^{-3} J/mm sec °C
Density:	4 to 5 g/cm^3

8.0 Perminvar Ferrites

Magnetically Permivar ferrites are those which have undergone further heat treatment after sintering to increase the alignment of their magnetic domains. Such materials are characterised by their high values of Q and low losses at high frequencies and are ideal for tuned applications. It should be noted that permivar ferrites may be irreversibly degraded if subjected to a strong magnetic field, excessive heat or mechanical shock.

9. Manufacturing Considerations

9.1 General Manufacturing Process

Commercially available ferrite materials fall into two main classes - Manganese Zinc ferrite and Nickel Zinc ferrite. Both are manufactured in the same way but display different electrical characteristics and this allows their use in a wide variety of applications.

Ferrite is a ceramic material made from three principle metal oxides -Iron, Manganese (or Nickel) and Zinc. These are intimately mixed in exact proportions, granulated and pre-fired (a process known as "calcining") at a temperature of 1000°C to partially form the final material. The pre-fired granules are then ground into a fine powder in a ball mill and a binding material is added. After drying, the powder is ready to be pressed, extruded or injection

moulded into the required component shape.
The "green" components thus formed are sintered at between 1200oC and 13500C
where they densify and shrink to formed a fully formed cubic crystalline material with
its cells arranged in a spinel lattice.

9.3 Physical Shrinkage

The exact amount by which a ferrite component shrinks during manufacture will
depend on the material and the process itself, but is typically about 11%- 18%.

Controlling the final size of a component is difficult since the shrinkage can vary both within a batch and between batches. As a result, the specified tolerances on the dimensions of such components is usually wide and if closer dimensions are required, the component must be ground or lapped. This adds cost to a component so it is often desirable to make allowances in the design to accommodate the wider tolerances.

The following information on general dimensional tolerances is given as guidance to those specifying new components:

(a) Pressed Parts:

Between pressed faces:
The greater of ± 2% or ± 0.25mm (Mn-Zn)
The greater of ± 3% or ± 0.30mm (Ni-Zn)

Between pressed-ground faces ± 0.2mm
Between ground-ground faces ± 0.05mm

(b) Extruded Parts:

As detailed in the data sheets for rods and tubes

(c) Injection Moulded Parts:

The greater of ± 3% or ± 0.30mm

An MMG Sales department should be contacted in the early stages of design if closer tolerances than those shown above are required.

10.0 Effects of Mechanical Stressing

When a ferrite component is physically stressed it undergoes changes in its electrical characteristics. Compression beyond an ill defined limit causes a decrease in effective permeability at low flux densities and an increase in the losses - an effect which is also seen in metal alloy cores if there are stamped or spirally wound.

Unfortunately, ferrite components can be stressed by three commonly used practices:

1. During the grinding of their surfaces

2. Whilst they are being clamped together as a complete core

3. When they are being encapsulated in a synthetic resin as an insulating coating

During the **grinding** of polycrystalline ferrites, stresses are applied to the surface and underlying layers which lead to the permanent deformation of the structure.
However, it is possible to grind until a perfect, stress-free finish is obtained but economical factors generally prohibit this in all but the manufacture of specialist, high permeability components.

Clamping a pair of cores is another process which can induce enough stress to impair the performance of the core assembly. If the clamping is relatively light and the applied force is directed along the axis of the mating cores, the effect can be beneficial with the permeability increased and the losses reduced. However, if the clamping force is great, subjecting the mating surfaces to high stress levels, the electromagnetic characteristics will be degraded and structural damage (cracking) may occur in the polycrystalline structure of the ferrite .

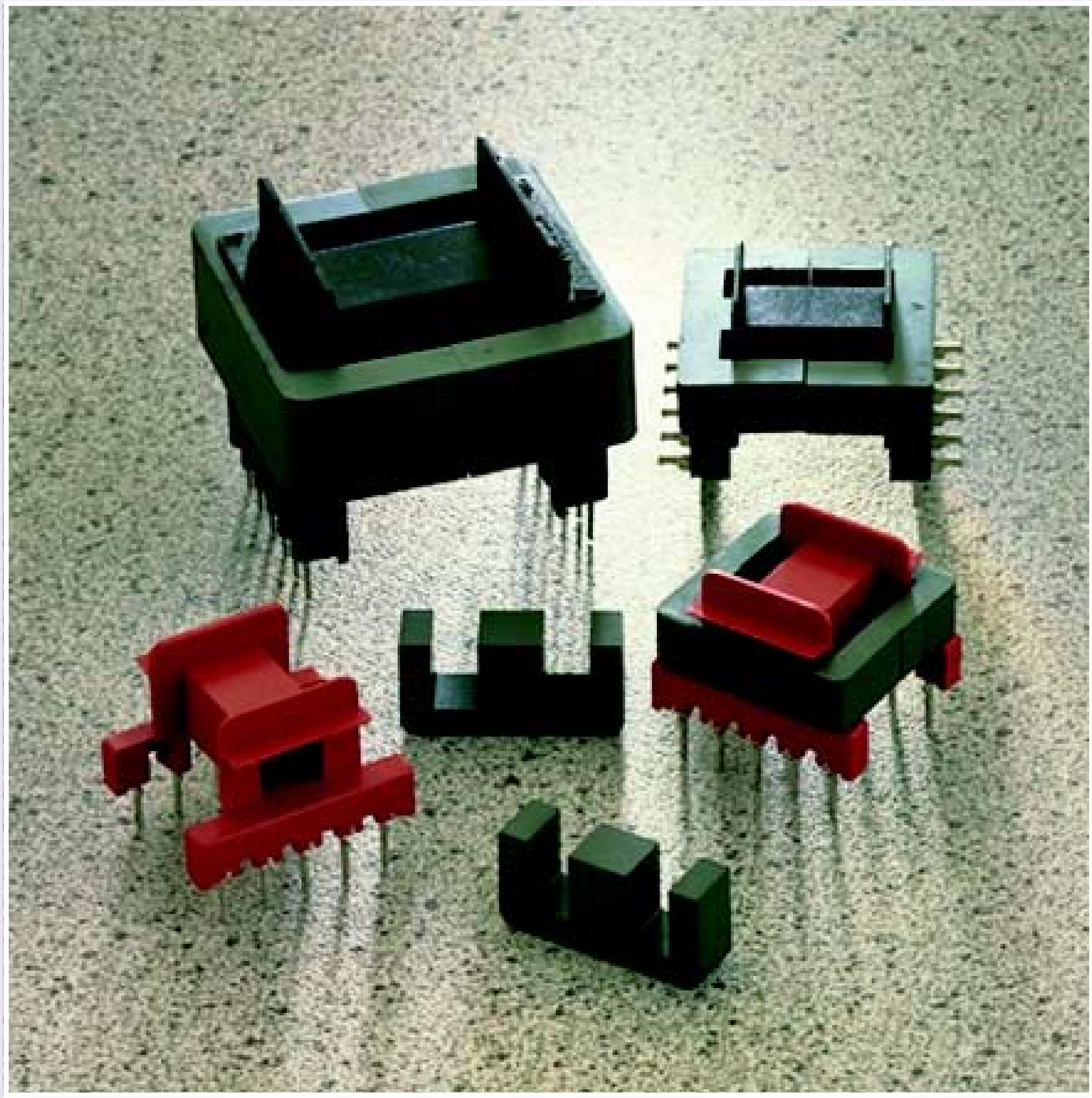
The third and most common cause of stress in finished ferrite components (particularly toroids) is when they are **encapsulated** in either an epoxy or nylon coating. The ferrite is heated, either when the coating is applied or afterwards and when both cool, the difference in the thermal coefficients of expansion of the ferrite and the coating, produces stresses in the ferrite which may reduce its permeability by as much as 20%.
This effect is reduced if components are coated in wet epoxy or enclosed in plastic caps but these processes are expensive and are generally reserved for higher permeability toroids.

Alternatively, the shrinkage of compounds used for potting may be reduced by adding an inorganic material such as silica or glass fibre to the coating material.

The shape of the hysteresis loop is changed by any compression to the core; if the magnetostriction (a small change in the dimension parallel to the direction of the applied field) is negative, as with Ni-Zn ferrites, the loop becomes more square. If the magnetostriction is positive, the loop becomes less square.

Finally, if a core is gapped, all effects of stressing are greatly diminished (unless the stress effects the actual length of the gap itself!)

Gapped Cores



Effect of an air gap

A method is described below for the approximate evaluation of the effective permeability, μ_e of gapped E and U cores, at low flux densities. The A_L values which are of greater direct interest to the user, are related to μ_e by the formula:

$$A_L = \frac{0.4\pi.\mu_e}{\Sigma\frac{l}{A}} \quad \text{or} \quad \mu_e = \frac{A_L \Sigma\frac{l}{A}}{0.4\pi} \quad ...(1)$$

where A_L (the inductance of one turn) is in nH.

$\Sigma\frac{l}{A}$ (given in the component pages for specific cores) is in mm^{-1}.

The demagnetising effect of magnetic poles on both sides of an air gap makes the effective permeability of a gapped core lower than the intrinsic permeability of the core material. The extent of this reduction in value depends on the magnetic reluctance of the flux path in the core and on the reluctance of the air gap. It can be written:

$$\mu_e = \frac{R_m}{R_m + R_{gap}}.\mu_i \quad ...(2)$$

where R_m is the reluctance of the flux path in the core and R_{gap} is the reluctance of the air gap.

The value of R_m can be calculated from the published geometric parameters of the core and the value of the intrinsic permeability of the core material.

$$R_m = \frac{l_e}{A_e}.\frac{1}{\mu_i} \quad ...(3)$$

where l_e is the effective length and A_e is the effective cross-sectional area of magnetic path.

To take the published l_e value for the above expression is not strictly correct; the length of the gap should be subtracted from l_e which is always given for an ungapped core, however the error is generally small.

The value of R_{gap} is:

$$R_{gap} = \frac{l_{gap}}{A_{gap}} \quad (\mu \text{ of air is } 1) \quad ...(4)$$

While the total length of the air gap, l_{gap}, presents no problems, the cross-sectional area of the gap, is more difficult to ascertain. The magnetic flux between pole faces on both sides of the gap is not strictly contained within the area of the poles. The magnetic lines barrel out and, therefore, the cross-sectional area of the gap reaches its maximum halfway between the poles.

MMG

The effect can be taken into account by introducing a correction factor, K (greater than 1):

$$A_{gap} = k.A_{pole} \quad ...(5)$$

where A_{pole} is the area of this part of the core where the gap is situated.

In the design of U and E cores, the general tendency is to maintain the same cross-sectional area in all core parts, so that the same flux density is maintained and the losses are not increased in the narrower parts (losses increase with flux density raised to the power of 2.2 to 2.6). Nevertheless, A_{pole} is not necessarily identical with A_e. However to simplify the calculations, it can be approximated that $A_{pole} = A_e$.

For an E42 core (32-110-25), $A_e = 181mm^2$.
$A_{pole} = 178.7mm^2$

For E56 x 37 x 19 (32-620-25), $A_e = 211mm^2$,
$A_{pole} = 201mm^2$.

For U 65 x 37 x 19 (34-510-25), $A_e = 241mm^2$,
$A_{pole} = 248mm^2$.

Formula (4) can now be written as follows:

$$R_{gap} = \frac{l_{gap}}{k.A_e} \quad ...(6)$$

Introducing expressions (3) and (6) into (2):

$$\mu_e = \frac{l_e . \mu_i}{l_e + \frac{l_{gap}}{k}.\mu_i} \quad ...(7)$$

The value of k can be determined only experimentally (and not very accurately). In approximate calculation, the following values may be taken:

Gap length	mm	0.1	0.2	0.5	1.0	2.0	3.0	4.0
k	-	1.1	1.2	1.3	1.4	1.5	1.65	1.8
$\frac{l_{gap}}{k}$	mm	0.09	0.17	0.38	0.71	1.33	1.82	2.22

If the total gap consists of two gaps, located in different parts of the magnetic circuit, a value of k should be taken which corresponds to the half length of the total gap.

Formula (7) can be rearranged to show directly the value of l_{gap}/k as a function of μ_e and μ_i:

$$\frac{l_{gap}}{k} = l_e\left(\frac{1}{\mu_e} - \frac{1}{\mu_i}\right)$$

or in terms of A_L:

$$\frac{l_{gap}}{k} = l_e\left(\frac{0.4\pi}{A_L.\Sigma\frac{l}{A}} - \frac{1}{\mu_i}\right)$$

Since the value of k depends on l_{gap}, some trial calculations may be needed before the physical length of the air gap can be calculated for a required value of A_L; the third row of figures in the table relating l_{gap} and k, will help these calculations.

When the magnetic circuit of an E or U core has no intentional air gaps, the roughness of the mating surfaces produces an effect equivalent to the existence of a very small gap. The length of this gap is of the order of 0.01mm for U cores and 0.015mm for E cores. For this length of the gap, k is obviously 1.

Since the initial permeabilities of the ferrite grades used for U and E cores are in the order of 1500-3000, even very small gaps seriously reduce the effective permeability, as the following example will show:

$$\mu_e = \frac{50}{50 + 0.015 \times 2000} = 1250$$

assume l_{gap} = 0.015mm, μ_i = 2000, l_e = 50mm

Obviously the larger the core is (and its l_e), the higher the μ_e.

The above method for evaluating the effect of the air gap is only approximate and can be used only for the preliminary calculation, but not as a source of exact design data. This can only be obtained experimentally from careful measurement of the gapped cores.

This method can also be used for preliminary evaluation of the amplitude permeability at high flux densities, although the errors will be greater because the determination of reluctance under the conditions of large cyclic variations of the magnetising field strength is more difficult than when the flux density is very low.

DC Loading

An approximate method is described below for finding the length of the gap required to ensure that the inductance remains constant when a DC current flows through the winding on a given core. Conversely the method can be used to determine the DC loading, compatible with constant inductance, when the length of the gap in a core is known.

For a given type of core, both the total DC loading (ampere turns) and the number of turns required for a given inductance vary with the length of the gap.

With a current, I, flowing through n turns of the winding, the total magnetomotive force applied to the magnetic circuit (I.n. ampere turns) generates a magnetic flux which flows through the core and through the gap. This causes the magnetisation of the core to be moved to a point on its B-H curve where the slope of the minor loops (dB/dH, corresponding to the small AC current used for inductance measurements) ceases to be identical with the effective permeability (measured with no DC loading). The point on the B-H curve at which the change in the slope of the minor loop begins, marks the limit of the permissible DC loading.

The flux produced by DC current in a gapped magnetic circuit is:

$$\Phi = \frac{\text{magnetomotive force}}{\text{reluctance of the core + reluctance of the air gap}}$$

$$= \text{const.} \frac{I.n}{R_{core}+R_{gap}} \quad ...(1)$$

or:

$$(I.n)_{total} = \text{const.}\ (R_{core} + R_{gap}) \cdot \Phi \quad ...(2)$$

In other words, the total magnetomotive force can be divided into two parts: $(I.n.)_{core}$, required to overcome the reluctance of the core path and the other $(I.n.)_{gap}$, required to overcome the reluctance of the air gap.

The reluctance of any path is proportional to its length and inversely proportional to its cross-sectional area and permeability. This provides the means to separate the above two parts of the magnetomotive force:

$$(I.n.)_{core} = (I.n.)_{total} \cdot \frac{R_{core}}{R_{core} + R_{gap}} \quad ...(3)$$

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$$(I.n.)_{gap} = (I.n.)_{total} \cdot \frac{R_{gap}}{R_{core} + R_{gap}} \quad ...(4)$$

Assuming that the cross-sectional areas of the core and of the gap are the same, the separation of the magnetomotive force would be related to the respective lengths and to the ferrite permeability. However, the cross-sectional areas cannot be regarded as identical because of the barrelling effect in the air gap. This effectively increases the cross-sectional area of the gap compared with the surface area of the core faces. The core faces bordering on the gap may be approximated to A_e because the error is small and the method itself is an approximation.

The barrelling effect (i.e. the increase in the cross-sectional area of the gap) is expressed by a factor, k (see section U,E and I cores - Effect of an air gap). whose value increases with the length of the gap. The reluctance of the air gap therefore decreases by the same factor.

The magnetomotive force for the air gap can now be written:

$$(I.n.)_{gap} = (I.n.)_{total} \cdot \frac{l_{gap}/k.A_e}{l_e/A_e \cdot \mu_i + l_{gap}/k.A_e}$$

$$= (I.n.)_{total} \cdot \frac{l_{gap}/k}{l_e/\mu_i + l_{gap}/k} \quad ...(5)$$

where μ_i is the intrinsic permeability of the core material.

An inductance of L requires n=1000, $\sqrt{L/A_L}$ turns, where L is in mH and A_L in nH.

$$\text{the value of } A_L = \frac{0.4\pi.\mu_e}{\Sigma l/A} = \frac{0.4\pi.\mu_e}{l_e/A_e} \text{ (nH)}$$

where l_e is in mm and A_e in mm^2 as given in the product data section and μ_e is the effective permeability:

$$\mu_e = \frac{l_e . \mu_i}{l_e + \mu_i . l_{gap}/k}$$

so that

$$A_L = \frac{0.4\pi}{l_e/A_e} \cdot \frac{l_e . \mu_i}{l_e + \mu_i . l_{gap}/k} = \frac{0.4\pi.A_e}{l_e/\mu_i + l_{gap}/k} \quad ...(6)$$

Using the above formula for the calculation of the number of turns (n) required for an inductance of L mH, equation (5) for the $(I.n.)_{gap}$ becomes, after some rearrangements and substituting 0.892 for the square root of $1/(0.4\pi)$ and V_e for $A_e . l_e$:-

$$(I.n)_{gap} = 1000.I. \frac{l_{gap}/k}{l_e/\mu_i + l_{gap}/k} \cdot \sqrt{\frac{L}{0.4\pi.A_e} \cdot (l_e/\mu_i + l_{gap}/k)}$$

$$= 892.I. \frac{l_{gap}}{k} \sqrt{\frac{L}{V_e} \cdot \frac{\mu_i}{1 + \mu_i \cdot \frac{l_{gap}}{l_e.k}}} \quad ...(7)$$

The magnetic field strength in the gap, H, is:

$$H_{gap} = \frac{(I.n.)_{gap}}{l_{gap}} = \frac{10.(I.n.)_{gap}}{l_{gap}} \left(\frac{A}{cm}\right)$$

where, l_{gap} is in mm. When equation (7) is combined with the above,

$$H_{gap} = 8920.I. \frac{l_{gap}}{k} \sqrt{\frac{L}{V_e} \cdot \frac{\mu_i}{1 + \mu_i \cdot \frac{l_{gap}}{l_e.k}}} \quad ...(8)$$

The above equation states the relationship between the DC loading current, the type of core (V_e and l_e), the required inductance and the length of the air gap.

The survey of various available data for the permissible DC loading shows that for typical ferrite grades with an intrinsic permeability of about 2000 and saturation induction of 400mT or higher, the inductance hardly varies until the DC current brings the core material to a flux density of about one half of the saturation induction, i.e. to 200mT. The flux density in the gap is somewhat lower than in the core, because of the barrelling effect.

A more conservative value would therefore assume that the flux density in the air gap must not exceed 170mT (1700 Gauss) and the maximum permitted field strength in the air gap is 1700 Gauss or 1350A/m.

Putting this value into (8), taking μi = 2000 and transforming the equation so as to show the maximum permitted DC current, we obtain:

$$I_{max} = 0.00338k \sqrt{\frac{V_e}{L}\left(1 + 2000 \cdot \frac{l_{gap}}{l_e.k}\right)} \quad ...(9)$$

To facilitate the calculations, the number of turns, required for L mH, can be obtained from equation (6),

$$n = 1000.\sqrt{\frac{L}{0.4\pi . V_e . l_e} . l_e \left(\frac{1}{\mu_i} + \frac{l_{gap}}{l_e . k} \right)}$$

$$= 19.95\, l_e \sqrt{\frac{L}{V_e} \left(1 + 2000 . \frac{l_{gap}}{l_e . k} \right)} \quad ...(10)$$

Equation (9) gives only a very approximate value for the maximum DC loading permitted for constant inductance, and equation (10) gives a smaller number of turns for a given L than the number which would be derived, taking into account the bottom limit of intrinsic permeability.
Using equations (9) and (10), I_{max} and n have been calculated for a range of air gaps found in common core types that may be used with a DC load. The results are shown in the table below based on L = 1mH. For E cores which have, nearly always, only one gap in the centre leg, factor k has been taken from data shown on page 13.

NOTE that, if the considered value of inductance is L mH and not 1 mH, the value of I shown in the table must be divided by √L while the number of turns, n, must be multiplied by √L. The product (I.n.) (= magnetomotive force) remains constant, since it is a function of the effective magnetic path length of the core, l_e, of the length of the air gap and of the intrinsic permeability of the core material.

Permissible DC Current (A) and number of turns required for 1 mH

Assumptions:
1. Intrinsic Permeability = 2000.
2. Area of core faces bordering the air gap = A_e.
3. Maximum permitted field strength in the air gap = 135000A/m.
4. Effective magnetic path length of cores not changed by the introduction of the air gap.
5. Numerical values of the factor k expressing the barrelling effect of flux lines in the gap.

Gap	E 42/15		E42/20		E55/21		E55/25		E65/27	
(mm)	I	n	I	n	I	n	I	n	I	n
0.05	0.68	21	0.78	18	1.02	16	1.08	14	1.27	13
0.10	0.87	25	1.00	21	1.27	19	1.33	17	1.55	16
0.15	1.01	28	1.16	24	1.46	21	1.57	19	1.81	17
0.20	1.13	31	1.30	27	1.63	23	1.78	21	2.05	19
0.25	1.25	34	1.44	29	1.79	25	1.95	22	2.24	20
0.30	1.35	36	1.56	31	1.94	27	2.12	24	2.42	22
0.40	1.56	40	1.79	35	2.22	29	2.42	27	2.76	24
0.50	1.74	44	2.00	38	2.47	32	2.70	29	3.07	26
0.60	1.91	47	2.19	41	2.70	34	2.95	31	3.34	28
0.70	2.06	50	2.37	44	2.92	36	3.18	33	3.61	30
0.80	2.21	53	2.54	46	3.12	38	3.41	35	3.86	31
0.90	2.35	56	2.71	49	3.32	40	3.62	37	4.10	33
1.00	2.49	58	2.86	51	3.51	42	3.83	38	4.33	34
1.10	2.62	60	3.02	53	3.70	44	4.02	40	4.54	36
1.20	2.75	63	3.17	54	3.88	45	4.20	41	4.74	37
1.30	2.87	65	3.30	56	4.04	47	4.38	43	4.94	38
1.40	2.98	67	3.43	58	4.20	48	4.55	44	5.13	40
1.50	3.09	69	3.56	60	4.36	50	4.72	45	5.32	41
1.60	3.20	71	3.68	62	4.51	51	4.88	47	5.50	42
1.80	3.42	74	3.94	64	4.82	53	5.20	49	5.86	44
2.00	3.62	77	4.17	67	5.10	56	5.51	51	6.20	46

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Product Quality

Committed to Quality

MMG-Neosid is committed to quality and recognizes the need to manufacture products to meet the highest quality standards of the marketplace, together with first class customer service in all its aspects. Our quality assurance team constantly monitor performance of product and service to maintain the high standards and to promote continued improvement.
The quality system operated complies with the standard BS EN ISO 9000.

Product Quality

A comprehensive analysis of the manufacturing process, giving full traceability of materials and test data is an ongoing operation. Strategically placed checks where materials and products are subject to approval testing, monitors the complex process. A flow chart overleaf shows these QA control measures.

Final Inspection

At the end of the manufacturing process each batch of components is subjected to final inspection. A sampling system in accordance with BS6001 (identical to ISO 2859-1) is used to select samples for test. Acceptable quality levels (AQL's) are set for different classes of defects. Emphasis is placed on continuous process monitoring and improvement, to build in quality.

Fitness for Use and Reliability

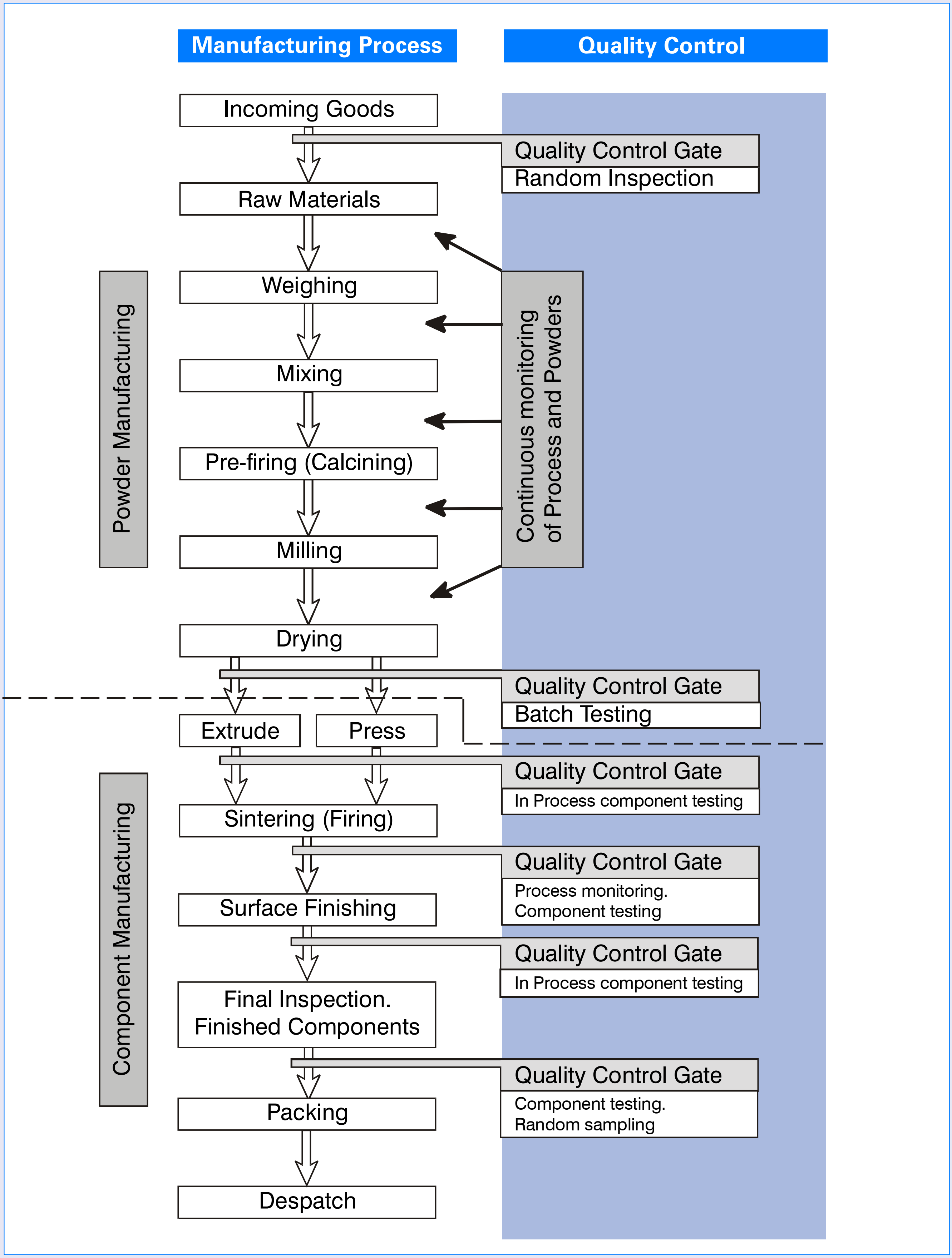
Once assembled into finished tested product, it is particularly rare for ferrite components to fail during normal use. In general, soft ferrite cores form a single component in a wound product. Many sources of failure for the product may not be the fault of the ferrite core. MMG-Neosid considers customer feedback an integral part of the QA process, ensuring possible future problems are averted at an early stage.

Classification of Defects

Every manufactured component has a mechanical and electrical specification developed not just through standard performance data but also through many years of manufacturing experience and a broad knowledge base of the applications for which they are intended. If a component does not comply with these specifications it is considered defective. Defects are classified into two distinct categories; major and minor.

Major defects are those affecting the fit of the components into their respective accessories (mechanical) or the ability of the finished assembled product to function (electrical). Minor defects are those that do not affect the performance of the finished product.

Sequence of Quality Assurance in Manufacturing



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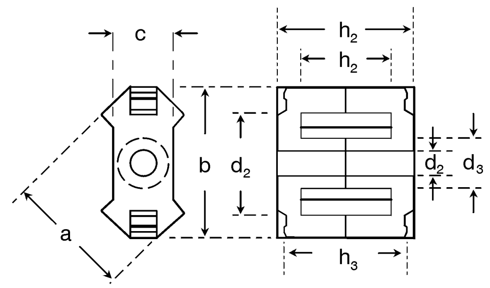
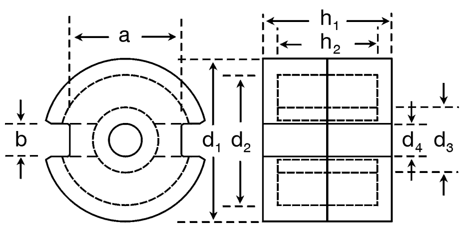
Classification of Mechanical Defects

RM Cores



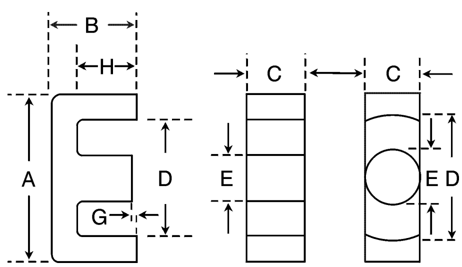
Classification	
Major Defect	Minor Defect
d_2 min.	d_2 max.
d_3 max.	d_3 min.
h_2 min.	h_2 max.
h_3	a
d_4	c
b	
h_1	

Pot Cores



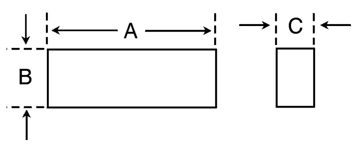
Classification	
Major Defect	Minor Defect
d_1 max.	d_1 min.
d_2 min.	d_2 max.
d_3 max.	d_3 min.
h_2 min.	h_2 max.
d_4	b max.
b min.	a
h_1	

E/ETD Cores



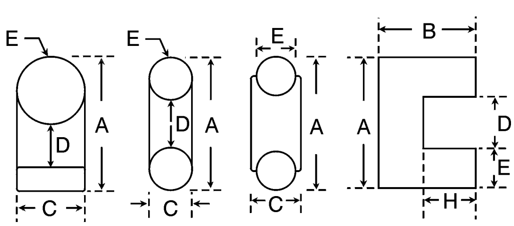
Classification	
Major Defect	Minor Defect
A max.	A min.
B	
C max.	C min.
D min.	D max.
E max.	E min.
H min.	H max.
G	

I Cores



Classification	
Major Defect	Minor Defect
A	
B	
C	

U Cores



Classification	
Major Defect	Minor Defect
A max.	A min.
C max.	C min.
D min.	D max.
E max.	E min.
H min.	H max.
B	

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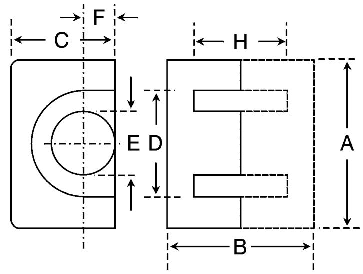
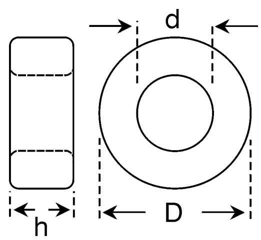
Classification of Mechanical Defects

EP Cores



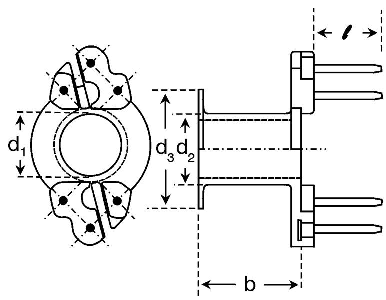
Classification	
Major Defect	Minor Defect
A max.	A min.
B	
	C
D min.	D max.
E max.	E min.
F max.	F min.
H min.	H max.

Toroidal Cores



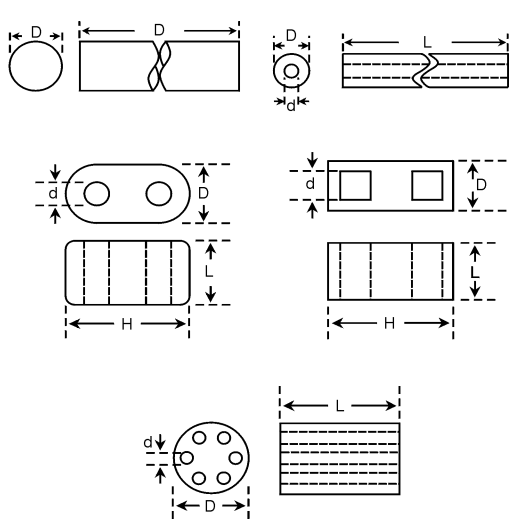
Classification	
Major Defect	Minor Defect
h max.	h min.
D max.	D min.
d min.	d max.

Coilformers



Classification	
Major Defect	Minor Defect
b	
d_1 min.	d_1 max.
d_2 max.	d_2 min.
d_3 max.	d_3 min.
ℓ	
Solderability	
Terminal Pitch	

Rods/ Beads/ Multi-Aperture Cores



Classification	
Major Defect	Minor Defect
D max.	D min.
d min.	d max.
L	
	H

Terms and Conditions of Sale

1. INTERPRETATION
In these terms and conditions "the Company" means Neosid Limited "the Buyer" means the party with whom the Company is contracting and "goods", where the context so permits and requires, means the goods and/or services which the Company contracts to supply and/or to provide and "Conditions" means the following terms and conditions of sale.

2. THESE CONDITIONS APPLY
2.1 Unless the Company shall otherwise expressly agree in writing every offer, tender, quotation, acceptance and contract for the sale or supply of goods, including services ancillary thereto, by the Company is made subject to these conditions and all other terms and conditions proposed by the Buyer are expressly excluded. No modification of these terms and conditions shall be effective unless reduced to writing and signed by a person duly authorised by the Company. No binding contract shall be created by the acceptance of a quotation or offer made by the Company until notice of acceptance of the order in writing signed by a person duly authorised shall have been given to the Company by the Buyer.
2.2 In the absence of any agreement in writing expressly excluding or varying the Conditions the Conditions apply to contracts for the sale of goods arising on acceptance by the Company, by whatever means, of any order received via the interchange of data by teletransmission (Electronic Data Exchange).

3. BUYER'S CREDIT STATUS
Unless and until the credit status of the Buyer has been approved by the Company the acceptance by the Company of any order is conditional on its approval of such credit status.

4. PRICES
4.1 All tender prices are based on costs payable by the Company ruling on the date of tender. Such costs may increase between tender and delivery date. The Company shall have the right, by giving notice to the Buyer at any time before delivery, to increase the price of any goods to reflect any increase in cost to the Company. Exercise by the Company of this right shall not entitle the Buyer to cancel the contract.
4.2 Where any additional or changed information is submitted to the Company by the Buyer after the date of the Contract the Company reserves the right to increase prices to cover any additional costs (including additional overheads) incurred by the Company as a result of such alteration and/or to extend the delivery period.
4.3 All prices are ex works unless otherwise stated. Carriage by whatever method may, at the Company's option, be charged to the Buyer in addition.
4.4 The Company shall be entitled to charge at such rate as shall be fair and reasonable for all preliminary or development work which the Company carries out at the request of the Buyer.
4.5 Unless previously withdrawn a quotation is available for the period stated therein or, if no period is stated, for thirty days from its date, and lapses if not previously accepted, at the end of that time.
4.6 The Company shall be entitled to make a surcharge for fulfilling any order with a value less than such minimum as the Company shall from time to time fix as its current minimum order price.
4.7 Where the Buyer requests items to be supplied with release certificates the Company reserves the right to make an extra and reasonable charge for providing such certificates.

5. QUANTITY
The price quoted is for the stated quantities only and not for materially lesser or greater quantities.

6. SCHEDULE ORDERS
6.1 A Schedule Order, when accepted by the Company, shall constitute authority for the manufacture of all goods in the Schedule Order. The Buyer shall be obliged to take delivery of and pay for all goods in the Schedule Order.
6.2 The Buyer shall take delivery of goods in a Schedule Order within twelve months from the date of acceptance of the Schedule Order by the Company.
6.3 The Buyer shall be entitled by notice in writing to bring forward or to postpone the date of delivery of goods in a Schedule Order but, unless the Company expressly otherwise agrees in writing, not in the case of custom goods by less than eight weeks' notice and in any other case by less than four weeks' notice.
6.4 The Buyer shall at all times be liable to pay to the Company all costs and losses incurred by the Company in respect of goods in a Schedule Order including (but without limitation) those in respect of finished goods, work in progress, materials acquired by the Company for the purpose of fulfilling the Schedule Order and manufacturing tools.

7. INVOICING AND PAYMENT
7.1 The Company will be entitled to invoice the Buyer on the date on which the goods are despatched. If the Company agrees at the request of the Buyer to defer delivery of any goods or suspends delivery of any goods in accordance with condition 7.8 or extends the delivery in accordance with condition 4.2 or 8.2, the Company will be entitled to invoice the Buyer for such goods on the date on which they would otherwise have been due for despatch.
7.2 In the case of contracts for the supply by the Company of custom goods, charges for design artwork and tooling charges may be invoiced by the Company at the time of shipment of the first prototype. Minor component or layout changes not affecting costs may at the Company's discretion be accepted without extra charge, provided notification is received in writing before design starts or within three working days of receipt by the Company of the Buyer's order, whichever is the earlier. The Company reserves the right to invoice at the time of shipment of the first prototype any additional design tooling or prototype manufacturing charges arising from changes requested by the Buyer after the contract has been entered into.
7.3 Unless the Company notifies the Buyer otherwise, payment is due, whether or not title to the goods has passed to the Buyer, by the end of the month following the month of invoice.
7.4 Unless otherwise expressly agreed in writing by the Company, payment in full without discount shall be made in Pounds Sterling and the Buyer shall not be entitled for any reason to withhold payment of the amount shown on the invoice as due.
7.5 Payment is made and received only at the time when cash is handed to a duly authorised representative of the Company who issues an official written receipt therefor or when any cheque or draft sent or delivered to the Company is cleared and/or the Company's bank account credited with the relevant amount, and not at any earlier time.
7.6 If goods are for delivery outside the United Kingdom, the Company, unless otherwise agreed with the Buyer, shall be entitled to payment by irrevocable letter of credit confirmed by a bank approved in writing by the Company against the usual documents. The Buyer shall reimburse to the Company any costs and expenses which are incurred by the Company in receiving payment by irrevocable letter of credit.
7.7 The Company reserves the right to charge interest at the rate of three per cent per annum above Midland Bank plc base rate for the time being on all overdue accounts from the due date until the date of actual payment.
7.8 Failure to make payment on due date shall constitute a breach of contract and without prejudice to any other rights which it may have against the Buyer the Company may suspend all further deliveries of goods under all contracts then in existence between the Company and the Buyer until payment of all sums payable by the Buyer under that contract and of all other sums then due and payable to the Company by the Buyer has been made in full and/or may terminate the contract.
7.9 If the Company exercises its right to suspend delivery of goods in accordance with Condition 7.8 the dates for delivery of all goods under all contracts in existence at the time when the Company exercises such right of suspension shall, unless the Company otherwise decides, be postponed by a period equal in length to that of the delay in payment by the Buyer entitling the Company to suspend deliveries (or, if the suspension shall be in respect of payments due on more than one date, for the period during which the earliest such payment shall be delayed).
7.10 Time for payment is of the essence.

8. MANUFACTURING SPECIFICATIONS
8.1 The Company reserves the right to supply, without additional cost to the Buyer, goods with a technical specification higher than that of the goods which it has contracted to supply.
8.2 Where any specification is to be supplied by the Buyer it must be supplied within fourteen days of the contract being entered into. Delay in the supply of such specification will entitle the Company to defer delivery of the goods by a period equivalent to the delay.
8.3 Where goods have been supplied to the Buyer's specification, the Company accepts no liability for any defect in goods which meet that specification and the Buyer shall indemnify the Company against all actions, claims, costs and proceedings, in respect of such goods including claims that the specification or goods infringe(s) any patent, registered design, copyright or other industrial or intellectual property right of any third party. The Company gives no warranty as to the fitness for any particular purpose of goods so supplied to the Buyer's own specification and accepts no liability for clerical or stenographical errors on any drawings or specification provided by the Buyer.

9. DELIVERY
9.1 Although the Company will make every effort to deliver on the agreed date, time for delivery is not of the essence of the contract. Any quoted delivery date or period is a business estimate only and is conditional on the Buyer, at the time of placing the order, providing the Company with such information concerning the Buyer's requirements as enables the Company to fulfil the order. The Company shall be not liable for any loss or damage whatsoever caused by delayed delivery of goods. Delay in delivery will not entitle the Buyer to rescind the contract.
9.2 Goods will be deemed to be delivered within five days after the date of invoice, unless prior to the expiry of such five days, the Buyer notifies the Company and any carrier in writing of non-delivery.
9.3 The Buyer must notify the Company by telephone of any non delivery or short delivery or loss of or damage to goods in transit immediately upon delivery of the goods or of the invoice therefor (whichever is the earlier) and must confirm the same in writing within seventy two hours thereafter; the Buyer shall at the same time notify any carrier in writing of any such loss or damage and, if relevant, shall enter a note of the same on the carrier's receipt. If the Buyer fails to give notice as provided above and the Company is precluded from making recovery whether from any insurer or any other third party in respect of the loss or damage complained of, then the Buyer shall be liable to pay for the goods as though no such loss or damage had occurred.
9.4 If any carrier of any consignment of goods receives an unqualified receipt therefor by or on behalf of the Buyer, the Company shall have no liability to the Buyer for loss of or damage in transit to such goods or for misdelivery or non delivery thereof.
9.5 The Company may at its discretion deliver the goods by instalments in any sequence.
9.6 If the goods are delivered by instalments each instalment shall be deemed to be the subject of a separate contract and no default or failure by the Company in respect of any one or more instalments shall avoid the contract in respect of goods previously delivered or undelivered goods.
9.7 If the goods are to be delivered to the Buyer at any location other than premises of the Company, delivery shall be deemed to take place on arrival of the vehicle transporting the goods at that location and the Buyer shall be responsible for unloading the goods. Personnel of the Company involved in such unloading shall be deemed to be under the control and direction of the Buyer. The Company shall have no liability for any act or omission of any such personnel done or failed to be done in the course of such unloading.

10. FAILURE TO TAKE DELIVERY
10.1 If goods are ready for delivery and the Buyer fails to take delivery at the time required by the contract the Company shall be entitled:-
10.1.1 to invoice such goods forthwith; and
10.1.2 to charge at rates giving an economic return for the handling and storage of such goods, and for their insurance, from the date of invoice to the date when the Buyer takes delivery or the Company disposes of the same.
10.2 If the Buyer fails to take delivery within thirty days of date of invoice it shall be deemed to have repudiated the contract and without prejudice to any other right which it may have against the Buyer, the Company shall be entitled to resell the goods.

11. WARRANTY AGAINST DEFECTS
11.1 The Company warrants that at the time when they leave the premises of the Company all goods correspond with their specification and are free from defect in material and workmanship provided that the Company's liability under this warranty shall be limited to either, at the Company's discretion, replacement or repair of goods free of cost to the Buyer or payment by the Company to the Buyer of an amount not exceeding the original purchase price of the goods in respect of which notice of the defect is given to the Company within twelve months of the date of invoice and which are returned to the Company carriage paid within seven days of the Buyer first becoming aware of the defect.
11.2 The warranty contained in condition 11.1 above is given in lieu of and shall be deemed to exclude all other warranties and conditions whether express or implied and whether arising by common law statute or otherwise other than relating to title to the goods.
11.3 The warranty contained in condition 11.1 above does not apply to and the Company accepts no responsibility for defects in goods which have been tested in accordance with the Buyer's express contractual requirements and have satisfied such tests.
11.4 Unless otherwise expressly agreed by the Company the warranty contained in condition 11.1 does not apply to and the Company accepts no responsibility for:-
11.4.1 damage occurring in transit
11.4.2 goods which have suffered or been subject to use otherwise than in accordance with the instructions or advice of the Company or undue wear and tear, accident, mis-use, improper application, neglect or overloading;
11.4.3 goods which have not been operated and maintained in accordance with written operation and maintenance instructions supplied by the Company; or
11.4.4 consumable items.
11.5 The Buyer shall not rely upon any representation concerning any goods supplied unless the same shall have been made by a person authorised by the Company in writing.

12. TESTS
If the Buyer requires special tests, witness tests or site tests the Company shall be entitled to make a reasonable charge for conducting them, unless the Company shall otherwise have agreed in writing.

13. RETENTION OFTITLE
13.1 The legal and equitable title to the goods supplied under the contract (in this condition referred to as "the contract goods" which expression includes any of them) will not pass to the Buyer until the price for the contract goods has been paid in full and until such payment the Buyer will hold them in a fiduciary capacity as bailee for the Company.
13.2 Notwithstanding the provisions of condition 13.1 above, the Buyer shall be entitled to dispose of the goods for the account of the Company (but so that any warranties, conditions or representations given or made by the Buyer to his customer shall not bind the Company which shall be indemnified by the Buyer in respect thereof) and to pass good title to the goods to any customer which is a bona fide purchaser for value without notice of the Company's rights.
13.3 Where the contract goods are resold by the Buyer and at the time of such resale the property in such goods has not passed to the Buyer then the proceeds of such resale will be held by the Buyer in a fiduciary capacity on trust for the Company and the Buyer will account to the Company for the same to the extent necessary to pay the price for the contract goods and the Company shall have the additional right to recover in the name of the Buyer (for which purpose the Company is hereby appointed the Buyer's attorney) any price payable to the Buyer by his customer but if it shall exercise such right the Company shall account to the Buyer for the balance of the amounts recovered after recouping all debts due to the Company from the Buyer and the costs of such recovery.
13.4 The Buyer shall so long as the Company is entitled to the property in the contract goods store the contract goods so that they are identifiable as the property of the Company.
13.5 Without prejudice to any of the Company's other rights (whether to damages or under contract or otherwise howsoever) the Company may at any time after the price for the contract goods has become due and remains unpaid rescind the contract and/or recover any contract goods which are still the property of the Company. By entering into this contract the Buyer hereby authorises the Company's servants and agents to enter into any premises of the Buyer for that purpose.

14. RISK
14.1 Risk in the goods shall pass to the Buyer on delivery thereof.
14.2 The Buyer shall keep the goods fully insured against all risks normally insured against throughout the period between the risk therein passing to the Buyer and the property therein ceasing to remain with the Company.
14.3 All items and materials which are the property of the Buyer or which are supplied by the Buyer to the Company shall while in the possession of the Company or in transit to or from the Buyer be at the Buyer's risk, unless otherwise expressly agreed in writing by the Company.

15. COMPANY'S REMEDIES
15.1 If the Buyer shall make default in any material respect in its obligations to the Company, or if any distress or execution shall be levied upon the Buyer's property or assets, or if the Buyer shall make or offer any arrangement or composition with its creditors or if there shall be any other grounds upon which the Buyer shall become insolvent for the purposes of the Insolvency Act 1986 or any resolution or petition to wind up the Buyer or for the appointment of an administrator of the Buyer shall be passed or presented the Company (without prejudice to any other right to which it may be entitled):-
15.1.1 may suspend or terminate the contract or any unfulfilled part thereof without prejudice to its existing rights thereunder;
15.1.2 may stop any goods in transit;
15.1.3 may recover from the Buyer's premises any goods which are the property of the Company; and
15.1.4 shall be entitled to claim against the Buyer for any loss or damage sustained as a result of such suspension or termination.
15.2 If items or materials supplied by the Buyer for working by the Company are defective the Buyer shall be liable to the Company for the cost of all work performed by the Company thereon including work to remedy such defects.

16. LIMITATION OF LIABILITY
16.1 Except as otherwise expressly provided in these conditions, or in respect of personal injury or death caused by the negligence of the Company, the Company shall be under no liability in respect of the quality, condition or description of the goods or for loss or damage including consequential loss or damage howsoever caused to the Buyer or to any other person, and whether for breach of any express or implied provision of the contract or for negligence, breach of statutory or other duty on the part of the Company or otherwise arising out of or in connection with the performance or non-performance or purported performance of the contract.
16.2 If items or materials are supplied by the Buyer to the Customer for work to be performed on them or for incorporating with goods to be supplied by the Company to the Buyer the liability of the Company for defective work shall be limited to rectifying the work or satisfactorily repairing the work or to carrying out like work on replacement items or materials supplied by the Buyer free of charge and in no event shall any such liability of the Company continue after the items concerned have been inspected or delivered or left the United Kingdom whichever shall be the earliest.

17. INDEMNITY BY BUYER
The Buyer shall indemnify the Company against all liabilities costs and expenses which the Company may incur by reason of any claim by any subsequent purchaser or user of the goods or of any product incorporating the goods or manufactured by using the goods or by reason of any claim by any relative or dependant of such purchaser or user arising from any defect or alleged defect in the goods or in such product except and to the extent that such liabilities, costs and expenses arise from a breach by the Company of its obligations under these conditions.

18. RETURNED GOODS
18.1 No contract for goods ordered may be cancelled by the Buyer and save as otherwise provided in these conditions no goods may be returned without the prior written consent of the Company.
18.2 If the Company agrees to accept return of any goods the Buyer shall be obliged to effect the return of such goods in good condition and at its own risk and cost.
18.3 Notwithstanding any agreement to accept return of goods the Company will not be obliged to accept delivery of any returned goods unless they are returned in cartons which are undamaged and which have not been opened since their despatch by the Company.

19. HEALTH AND SAFETY
19.1 The Company has available up-to-date information and/or product literature concerning the conditions necessary to ensure that the goods supplied will be safe and without risk to health when properly used. This information is and will remain available from the Company.
19.2 The Buyer shall be solely responsible for and shall keep the Company indemnified against any loss, liability or expenses arising directly or indirectly from use of the goods other than in accordance with their specification or the Company's operating instructions or the information and product literature referred to in condition 19.1 or (where no such specifications or instructions exist) in a manner which could not reasonably be considered to be safe and without risk.
19.3 If the Company has an obligation under the contract to carry out installation works the Buyer is responsible for ensuring that any site at which installation is to be carried out the condition of the site and activities of the Buyer and of third parties at the site comply with statutory requirements relating to conditions of work performance of such activities and otherwise and that the servants agents sub-contractors and officers of the Company are not exposed to risks to their health and safety during or as a result of working at the site.

20. INSTALLATION
Where the obligations of the Company include installation, the Buyer will provide suitable access to the installation site and conditions for safe and unobstructed installation and all lighting heating and power supplies and facilities (including without limitation lifting tackle cranes and scaffolding) which the Company requires for or in connection with the installation. If at the time when delivery of the goods is effected installation cannot be undertaken by reason of any failure by the Buyer to comply with its obligations under the foregoing provisions of this paragraph, all expenses and extra costs incurred by the Company as a result of or in connection with the inability to undertake installation and/or any resulting delay in installation, including a reasonable charge for the time of employees, will be charged by the Company to the Buyer.

21. EXPORT ONLY
21.1 If the Company concludes the contract of carriage and/or arranges for the insurance of the goods for transit the Company shall be deemed to be acting solely as the Buyer's agent and sub-sections (2) and (3) of Section 32 of the Sale of Goods Act 1979 shall not be applicable.
21.2 In the case of any goods to be exported from the United Kingdom, the Buyer is responsible for obtaining import authorisations, and the Company shall have no obligation to despatch the goods unless and until the Buyer has provided all documentation and information necessary for export and import of the goods to be effected.

22. SPECIFICATIONS ETC
Except as otherwise expressly agreed in writing, all specifications, patterns, drawings, unregistered designs, dies, moulds, tools and the like produced by the Company shall remain the property of the Company. The Buyer may not utilise, reproduce or communicate knowledge of such items and the Buyer shall return the same to the Company at the Company's request.

23. CUSTOMER RETURNABLE PACKAGES
If the contract is for the supply of goods to be delivered in the United Kingdom and the Customer and the Buyer have not otherwise agreed, customer returnable packages used for delivery of the goods shall remain the property of the Company and must be returned by the Buyer to the Company within one month of such delivery in the same condition as received by the Buyer. Customer returnable packages not so returned will be charged at replacement cost and the Buyer shall be liable to the Company accordingly.

24. TECHNICAL DATA
Whilst every effort has been made to ensure the accuracy of any technical data provided to the Buyer, the Company accepts no liability arising from errors or omissions therein. Illustrations, photographs, weights, dimensions and descriptions are illustrative and for general guidance and do not form the basis of any sale by description. Performance figures quoted by the Company for its products are similarly illustrative and for general guidance, are based upon experience and are not warranted.

25. PRINCIPALS
The contract is between the Company and the Buyer and shall not be assignable without the express written consent of the Company. The Company reserves the right to subcontract the fulfilment of any order or contract or any part thereof.

26. FORCE MAJEURE
The Company shall not be liable for failure to comply with any of its obligations under the contract in the event that compliance is delayed or prevented by any cause whatsoever beyond its reasonable control, including, but not limited to, war, riot. strike, lock-out, act of God, storm, fire, earthquake, explosion, flood, confiscation, action of any government or government agency or shortage.

27. RIGHTS OF COMPANY
No forbearance or indulgence by the Company shown or granted to the Buyer in respect of the terms and conditions of sale of the goods shall affect or prejudice the rights of the Company against the Buyer.

28. SET OFF
The Buyer shall not be entitled to the benefit of any set-off to which the Buyer might be otherwise entitled in law or in equity. All sums payable under the contract will be payable without any deduction and the Company shall be entitled in the event of non-payment to obtain and enforce judgement thereon without any stay of execution pending the determination of any cross or counter claim by the Buyer.

29. CONFIDENTIAL
The existence of the contract its content and subject matter are confidential and shall not be disclosed by the Buyer without the prior written consent of the Company.

30. EFFECT OF INVALID PROVISIONS
If any provision of the contract is held to be invalid, illegal or unenforceable in any way, the validity, legality and enforceability of the remaining provisions shall not be affected or impaired in any way.

31. NOTICE
Any notice under the contract shall be in writing sent by first class pre-paid letter post or facsimile transmission confirmed by first class pre-paid letter post. Any notice to the Company shall be addressed to the Company at its registered office and to the Buyer at the address notified by the Buyer to the Company for that purpose or if none is so notified to the address of the Buyer last known to the Company. A notice given as aforesaid by post shall be deemed served forty eight hours after posting and by facsimile at the time of transmission thereof.

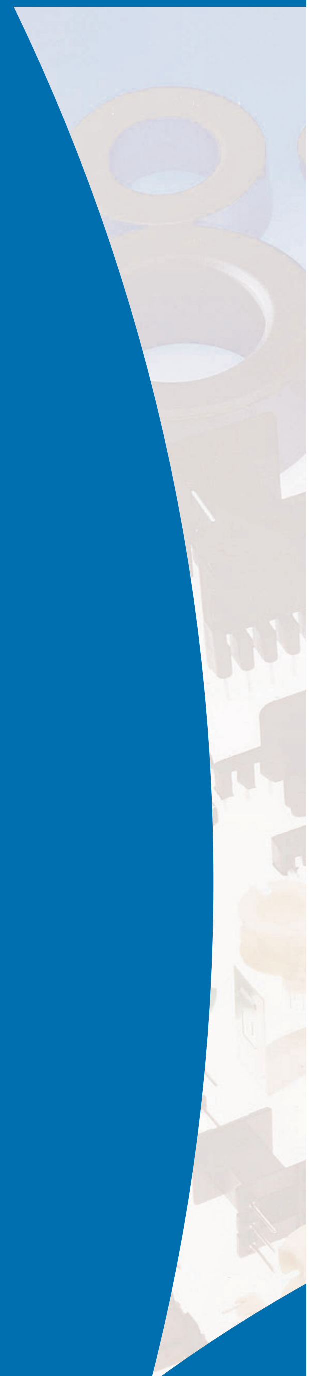
32. HEADINGS
Headings are inserted for convenience only and shall not affect the meaning or construction of these conditions.

33. PROPER LAW
These conditions and the contract shall be subject to and construed in accordance with English Law and the parties hereby agree to accept the exclusive jurisdiction of the English Courts in all matters connected therewith or relating thereto.

December 1997
Issue 1

Symbol	Unit	Definition
A_L	Henrys	**Inductance Factor** is the inductance per turn squared in nH (L/n^2)
A_e	mm^2	**Effective cross sectional area** of core
A_{min}	mm^2	**Minimum cross sectional** area of core
ℓ_e	mm	**Effective magnetic path length**
V_e	mm^3	**Effective volume of core**
C_1	mm^{-1}	**Geometric Core constant** ($\Sigma \ell / A$)
μ_i	-	**Initial (or intrinsic) permeability** is the ratio between flux density ΔB in a closed ring core, and the applied field strength ΔH at very low a.c. fields (ΔH>0)
B_{sat}	mT	**Saturation Flux Density** is the maximum flux density achieved with a field of 796A/m (or 10 Oersteds) applied.
B_{rem}	mT	**Remanent Flux Density** is the flux density remaining in the core (following magnetisation to saturation) in the absence of an applied field.
H_c	A/m	**Coersive Force** is the applied field strength required to reduce the remanent flux density to zero.
η_B	10^{-6}	**Hysteresis Material Constant** is the hysteresis loss normalised to unit intrinsic permeability and flux density.
μ_e	-	**Effective permeability** for cores with air gaps.

Symbol	Unit	Definition
Θ_c	°C	**Curie Temperature** is that temperature above which ferrite materials lose their ferromagnetic properties and permeability drops to 1. This phenomenon is completely reversible and ferromagnetic properties return when the temperature is reduced below Θ_c.
ρ	Ω-cm	Electrical **Resistivity** of ferrite material
μ_a	-	**Amplitude Permeability** is the core permeability at relatively high applied field strengths. μ_a is usually specified at given flux densities and temperatures.
P_v	mW/cm^3	**Power Loss Density** (sometimes referred to as PLD) is the power loss in the core per unit volume at specified flux densities and temperatures.
$\frac{\tan \delta_{(r+e)}}{\mu_i}$	10^{-6}	**Relative Loss Factor** is the loss coefficient normalised to intrinsic permeability, associated with low field strength conditions.
$\frac{\Delta\mu}{\mu_i^2 . \Delta T}$	10^{-6}/°C	**Temperature Factor** is the proportional rise in inductance per degree Celsius normalised per unit intrinsic permeability.
$\frac{\Delta\mu}{\mu_i^2 \log_{10}(t_2/t_1)}$	-	The **Disaccommodation Factor** is the proportional decrease of permeability after magnetic conditioning over a given time interval relative to the initial permeability prior to magnetic disturbance.
A_N	mm^2	**Winding Area** is the area available on the bobbin for winding.
l_N	mm	**Winding Length** is the average length of a single turn.
A_R	-	**Resistance Factor** is the approximate resistance of the winding per turn squared.



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