



## **Ferrites and accessories**

RM 12, RM 12 LP  
Core and accessories

**Series/Type:**            **B65815, B65816**

**Date:**                    May 2017

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**RM 12**

**Core and accessories**

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	Core	B65815	3

Example of an assembly set

**Also available:**

Coil former for power applications

B65816 5

RM 12 low-profile:

Core

B65815P 7

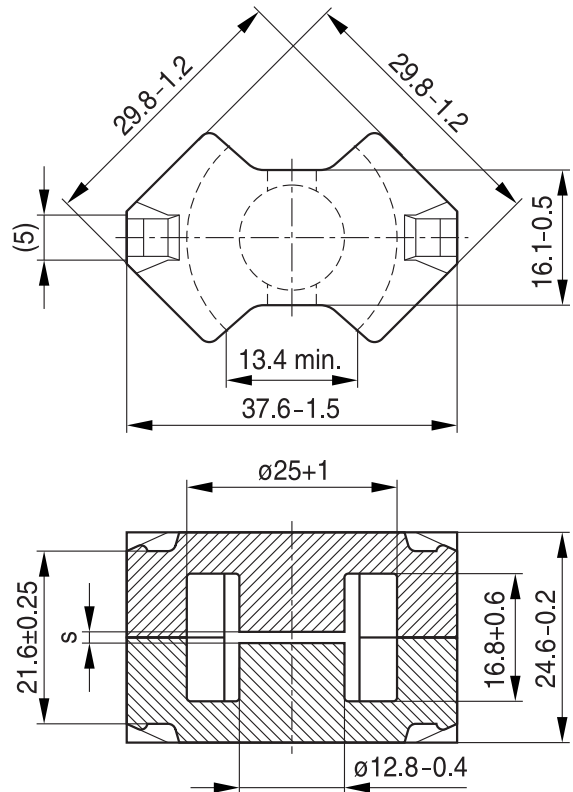
<b>RM 12</b>
<b>Core</b> <span style="float: right;"><b>B65815</b></span>

- Optimized core cross section and increased thickness of base for power applications
- Without center hole
- Delivery mode: sets

**Magnetic characteristics (per set)**

$\Sigma l/A = 0.39 \text{ mm}^{-1}$   
 $l_e = 57 \text{ mm}$   
 $A_e = 146 \text{ mm}^2$   
 $A_{min} = 125 \text{ mm}^2$   
 $V_e = 8320 \text{ mm}^3$

**Approx. weight 45 g/set**



**Gapped ( $A_L$  values/air gaps examples)**

FRM0356-U

Material	$A_L$ value	s approx. mm	$\mu_e$	Ordering code
	nH			-E without center hole
N41	160 ±3%	1.30	50	B65815E0160A041
	250 ±3%	0.70	78	B65815E0250A041
	400 ±5%	0.35	124	B65815E0400J041
	1000 ±5%	0.12	311	B65815E1000J041

**Ungapped**

Material	$A_L$ value	$\mu_e$	$P_V$	Ordering code
	nH		W/set	-E without center hole
N30	8700 +30/-20%	2700		B65815E0000R030
N49	3700 +30/-20%	1150	< 1.41 ( 50 mT, 500 kHz, 100 °C)	B65815E0000R049
N87	5300 +30/-20%	1640	< 4.50 (200 mT, 100 kHz, 100 °C)	B65815E0000R087
N97	5300 +30/-20%	1640	< 3.60 (200 mT, 100 kHz, 100 °C)	B65815E0000R097
N41	6000 +30/-20%	1860	< 1.50 (200 mT, 25 kHz, 100 °C)	B65815E0000R041

Other  $A_L$  values/air gaps and materials available on request – see Processing remarks on page 8.

**Coil former**

Material: GFR thermosetting plastic (UL 94 V-0, insulation class to IEC 60085:  
 $F \triangleq$  max. operating temperature 155 °C), color code black  
 Sumikon PM 9630® [E41429 (M)], SUMITOMO BAKELITE CO LTD

Solderability: to IEC 60068-2-20, test Ta, method 1 (aging 3): 235 °C, 2 s

Resistance to soldering heat: to IEC 60068-2-20, test Tb, method 1B: 350 °C, 3.5 s

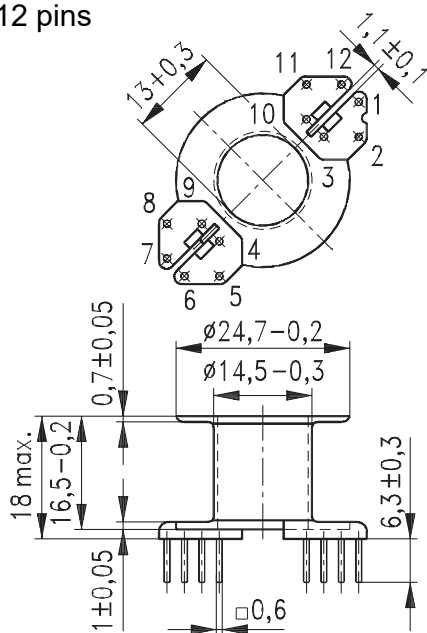
Winding: see Processing notes, 2.1

Pins: Squared pins

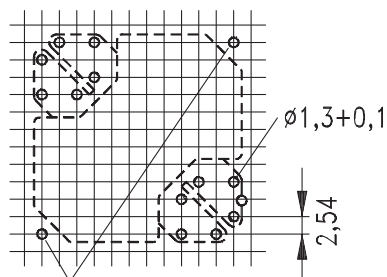
For matching clamp see page 6.

Sections	$A_N$ mm <sup>2</sup>	$l_N$ mm	$A_R$ value $\mu\Omega$	Pins	Ordering code
1	73	61	28.7	12 11	B65816N1012D001 B65816N1011D001

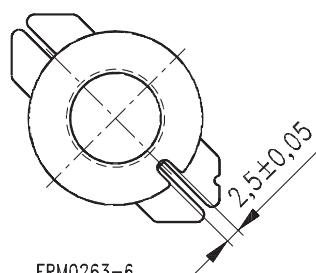
12 pins



pin 9 omitted in the 11-pin version



Ground  $\varnothing$  1.3 $\pm$ 0.1



Hole arrangement  
 View in mounting direction

**Coil former for power applications**

Material: GFR polyterephthalate (UL 94 V-0, insulation class to IEC 60085:  
 $F \triangleq$  max. operating temperature 155 °C), color code black  
 Valox 420-SE0 [E45329 (M)] SABIC INNOVATIVE PLASTICS B V

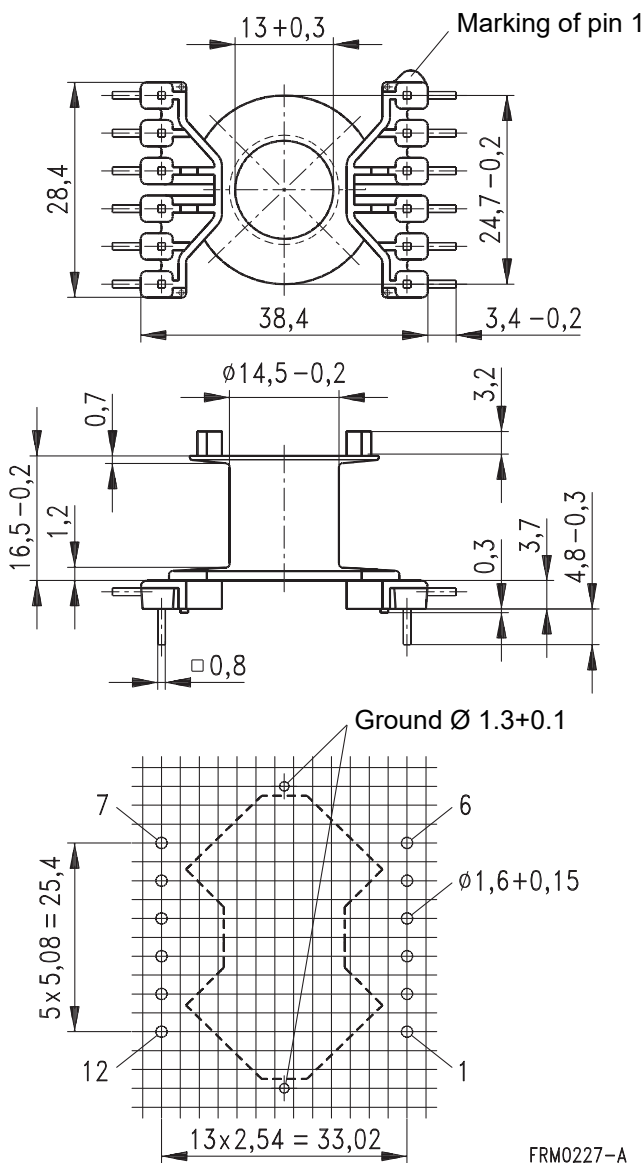
Solderability: to IEC 60068-2-20, test Ta, method 1 (aging 3): 235 °C, 2 s

Resistance to soldering heat: to IEC 60068-2-20, test Tb, method 1B: 350 °C, 3.5 s

Winding: see Processing notes, 2.1

For matching clamp see page 6.

Sections	$A_N$ mm <sup>2</sup>	$l_N$ mm	$A_R$ value $\mu\Omega$	Pins	Ordering code
1	72	61	28.7	12	B65816C1512T001



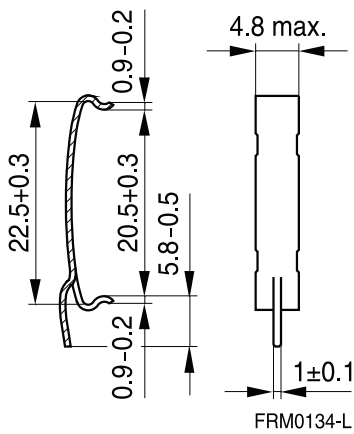
Hole arrangement  
 View in mounting direction  
 (Note half pitch!)

FRM0227-A

**Clamp**

- With ground terminal, made of spring steel (tinned), 0.5 mm thick
- Solderability to IEC 60068-2-20, test Ta, method 1 (aging 3): 235 °C, 2 s

	Ordering code
Clamp (ordering code per piece, 2 are required)	B65816A2002X000



**RM 12 »Low Profile«**
**Core**
**B65815P**

- For compact transformers
- Without center hole
- Delivery mode: sets

**Magnetic characteristics (per set)**

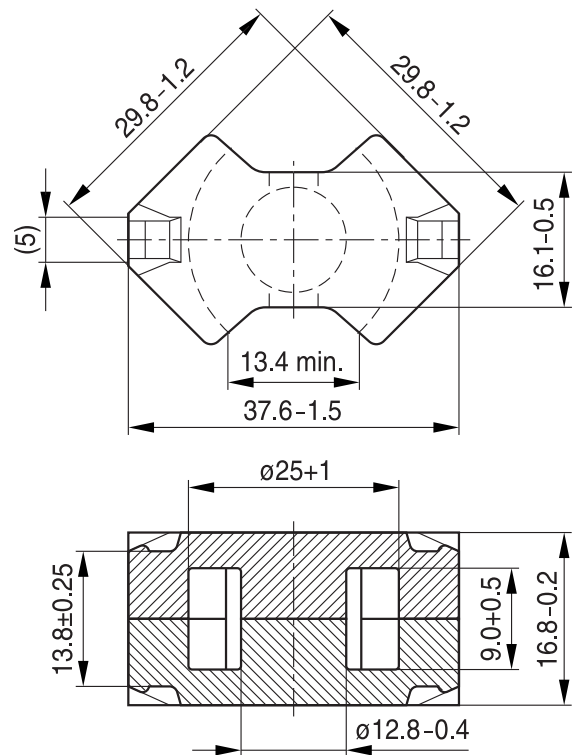
$$\Sigma l/A = 0.29 \text{ mm}^{-1}$$

$$l_e = 42 \text{ mm}$$

$$A_e = 147.5 \text{ mm}^2$$

$$A_{\min} = 124.7 \text{ mm}^2$$

$$V_e = 6195 \text{ mm}^3$$

**Approx. weight 33.6 g/set**


FRM0357-3

**Ungapped**

Material	$A_L$ value	$\mu_e$	$P_V$	Ordering code
	nH		W/set	
N49	4500 +30/-20%	1020	< 1.21 ( 50 mT, 500 kHz, 100 °C)	B65815P0000R049
N92	4800 +30/-20%	1090	< 3.70 (200 mT, 100 kHz, 100 °C)	B65815P0000R092
N87	6300 +30/-20%	1430	< 3.36 (200 mT, 100 kHz, 100 °C)	B65815P0000R087

 Other  $A_L$  values/air gaps and materials available on request – see Processing remarks on page 8.

## Ferrites and accessories

### Cautions and warnings

#### Mechanical stress and mounting

Ferrite cores have to meet mechanical requirements during assembling and for a growing number of applications. Since ferrites are ceramic materials one has to be aware of the special behavior under mechanical load.

As valid for any ceramic material, ferrite cores are brittle and sensitive to any shock, fast temperature changing or tensile load. Especially high cooling rates under ultrasonic cleaning and high static or cyclic loads can cause cracks or failure of the ferrite cores.

For detailed information see data book, chapter “*General - Definitions, 8.1*”.

#### Effects of core combination on $A_L$ value

Stresses in the core affect not only the mechanical but also the magnetic properties. It is apparent that the initial permeability is dependent on the stress state of the core. The higher the stresses are in the core, the lower is the value for the initial permeability. Thus the embedding medium should have the greatest possible elasticity.

For detailed information see data book, chapter “*General - Definitions, 8.1*”.

#### Heating up

Ferrites can run hot during operation at higher flux densities and higher frequencies.

#### NiZn-materials

The magnetic properties of NiZn-materials can change irreversible in high magnetic fields.

#### Ferrite Accessories

EPCOS ferrite accessories have been designed and evaluated only in combination with EPCOS ferrite cores. EPCOS explicitly points out that EPCOS ferrite accessories or EPCOS ferrite cores may not be compatible with those of other manufacturers. Any such combination requires prior testing by the customer and will be at the customer's own risk.

EPCOS assumes no warranty or reliability for the combination of EPCOS ferrite accessories with cores and other accessories from any other manufacturer.

#### Processing remarks

The start of the winding process should be soft. Else the flanges may be destroyed.

- Too strong winding forces may blast the flanges or squeeze the tube that the cores can not be mounted any more.
- Too long soldering time at high temperature (>300 °C) may effect coplanarity or pin arrangement.
- Not following the processing notes for soldering of the J-leg terminals may cause solderability problems at the transformer because of pollution with Sn oxyde of the tin bath or burned insulation of the wire. For detailed information see chapter “*Processing notes*”, section 2.2.
- The dimensions of the hole arrangement have fixed values and should be understood as a recommendation for drilling the printed circuit board. For dimensioning the pins, the group of holes can only be seen under certain conditions, as they fit into the given hole arrangement. To avoid problems when mounting the transformer, the manufacturing tolerances for positioning the customers' drilling process must be considered by increasing the hole diameter.



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## Ferrites and accessories

### Symbols and terms

Symbol	Meaning	Unit
A	Cross section of coil	mm <sup>2</sup>
A <sub>e</sub>	Effective magnetic cross section	mm <sup>2</sup>
A <sub>L</sub>	Inductance factor; $A_L = L/N^2$	nH
A <sub>L1</sub>	Minimum inductance at defined high saturation ( $\hat{=} \mu_a$ )	nH
A <sub>min</sub>	Minimum core cross section	mm <sup>2</sup>
A <sub>N</sub>	Winding cross section	mm <sup>2</sup>
A <sub>R</sub>	Resistance factor; $A_R = R_{Cu}/N^2$	$\mu\Omega = 10^{-6} \Omega$
B	RMS value of magnetic flux density	Vs/m <sup>2</sup> , mT
$\Delta B$	Flux density deviation	Vs/m <sup>2</sup> , mT
$\hat{B}$	Peak value of magnetic flux density	Vs/m <sup>2</sup> , mT
$\Delta \hat{B}$	Peak value of flux density deviation	Vs/m <sup>2</sup> , mT
B <sub>DC</sub>	DC magnetic flux density	Vs/m <sup>2</sup> , mT
B <sub>R</sub>	Remanent flux density	Vs/m <sup>2</sup> , mT
B <sub>S</sub>	Saturation magnetization	Vs/m <sup>2</sup> , mT
C <sub>0</sub>	Winding capacitance	F = As/V
CDF	Core distortion factor	mm <sup>-4.5</sup>
DF	Relative disaccommodation coefficient $DF = d/\mu_i$	
d	Disaccommodation coefficient	
E <sub>a</sub>	Activation energy	J
f	Frequency	s <sup>-1</sup> , Hz
f <sub>cutoff</sub>	Cut-off frequency	s <sup>-1</sup> , Hz
f <sub>max</sub>	Upper frequency limit	s <sup>-1</sup> , Hz
f <sub>min</sub>	Lower frequency limit	s <sup>-1</sup> , Hz
f <sub>r</sub>	Resonance frequency	s <sup>-1</sup> , Hz
f <sub>Cu</sub>	Copper filling factor	
g	Air gap	mm
H	RMS value of magnetic field strength	A/m
$\hat{H}$	Peak value of magnetic field strength	A/m
H <sub>DC</sub>	DC field strength	A/m
H <sub>c</sub>	Coercive field strength	A/m
h	Hysteresis coefficient of material	10 <sup>-6</sup> cm/A
h/ $\mu_i^2$	Relative hysteresis coefficient	10 <sup>-6</sup> cm/A
I	RMS value of current	A
I <sub>DC</sub>	Direct current	A
$\hat{I}$	Peak value of current	A
J	Polarization	Vs/m <sup>2</sup>
k	Boltzmann constant	J/K
k <sub>3</sub>	Third harmonic distortion	
k <sub>3c</sub>	Circuit third harmonic distortion	
L	Inductance	H = Vs/A

**Ferrites and accessories**
**Symbols and terms**

Symbol	Meaning	Unit
$\Delta L/L$	Relative inductance change	H
$L_0$	Inductance of coil without core	H
$L_H$	Main inductance	H
$L_p$	Parallel inductance	H
$L_{rev}$	Reversible inductance	H
$L_s$	Series inductance	H
$l_e$	Effective magnetic path length	mm
$l_N$	Average length of turn	mm
$N$	Number of turns	
$P_{Cu}$	Copper (winding) losses	W
$P_{trans}$	Transferrable power	W
$P_V$	Relative core losses	mW/g
PF	Performance factor	
$Q$	Quality factor ( $Q = \omega L/R_s = 1/\tan \delta_L$ )	
$R$	Resistance	$\Omega$
$R_{Cu}$	Copper (winding) resistance ( $f = 0$ )	$\Omega$
$R_h$	Hysteresis loss resistance of a core	$\Omega$
$\Delta R_h$	$R_h$ change	$\Omega$
$R_i$	Internal resistance	$\Omega$
$R_p$	Parallel loss resistance of a core	$\Omega$
$R_s$	Series loss resistance of a core	$\Omega$
$R_{th}$	Thermal resistance	K/W
$R_V$	Effective loss resistance of a core	$\Omega$
$s$	Total air gap	mm
$T$	Temperature	$^{\circ}\text{C}$
$\Delta T$	Temperature difference	K
$T_C$	Curie temperature	$^{\circ}\text{C}$
$t$	Time	s
$t_v$	Pulse duty factor	
$\tan \delta$	Loss factor	
$\tan \delta_L$	Loss factor of coil	
$\tan \delta_r$	(Residual) loss factor at $H \rightarrow 0$	
$\tan \delta_e$	Relative loss factor	
$\tan \delta_h$	Hysteresis loss factor	
$\tan \delta/\mu_i$	Relative loss factor of material at $H \rightarrow 0$	
$U$	RMS value of voltage	V
$\hat{U}$	Peak value of voltage	V
$V_e$	Effective magnetic volume	$\text{mm}^3$
$Z$	Complex impedance	$\Omega$
$Z_n$	Normalized impedance $ Z _n =  Z  / N^2 \times \epsilon (l_e/A_e)$	$\Omega/\text{mm}$

## Ferrites and accessories

### Symbols and terms

Symbol	Meaning	Unit
$\alpha$	Temperature coefficient (TK)	1/K
$\alpha_F$	Relative temperature coefficient of material	1/K
$\alpha_e$	Temperature coefficient of effective permeability	1/K
$\epsilon_r$	Relative permittivity	
$\Phi$	Magnetic flux	Vs
$\eta$	Efficiency of a transformer	
$\eta_B$	Hysteresis material constant	mT <sup>-1</sup>
$\eta_i$	Hysteresis core constant	A <sup>-1</sup> H <sup>-1/2</sup>
$\lambda_s$	Magnetostriction at saturation magnetization	
$\mu$	Relative complex permeability	
$\mu_0$	Magnetic field constant	Vs/Am
$\mu_a$	Relative amplitude permeability	
$\mu_{app}$	Relative apparent permeability	
$\mu_e$	Relative effective permeability	
$\mu_i$	Relative initial permeability	
$\mu_p'$	Relative real (inductive) component of $\bar{\mu}$ (for parallel components)	
$\mu_p''$	Relative imaginary (loss) component of $\bar{\mu}$ (for parallel components)	
$\mu_r$	Relative permeability	
$\mu_{rev}$	Relative reversible permeability	
$\mu_s'$	Relative real (inductive) component of $\bar{\mu}$ (for series components)	
$\mu_s''$	Relative imaginary (loss) component of $\bar{\mu}$ (for series components)	
$\mu_{tot}$	Relative total permeability derived from the static magnetization curve	
$\rho$	Resistivity	$\Omega\text{m}^{-1}$
$\Sigma l/A$	Magnetic form factor	$\text{mm}^{-1}$
$\tau_{Cu}$	DC time constant $\tau_{Cu} = L/R_{Cu} = A_L/A_R$	s
$\omega$	Angular frequency; $\omega = 2 \Pi f$	s <sup>-1</sup>

All dimensions are given in mm.

**SMD** Surface-mount device

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