

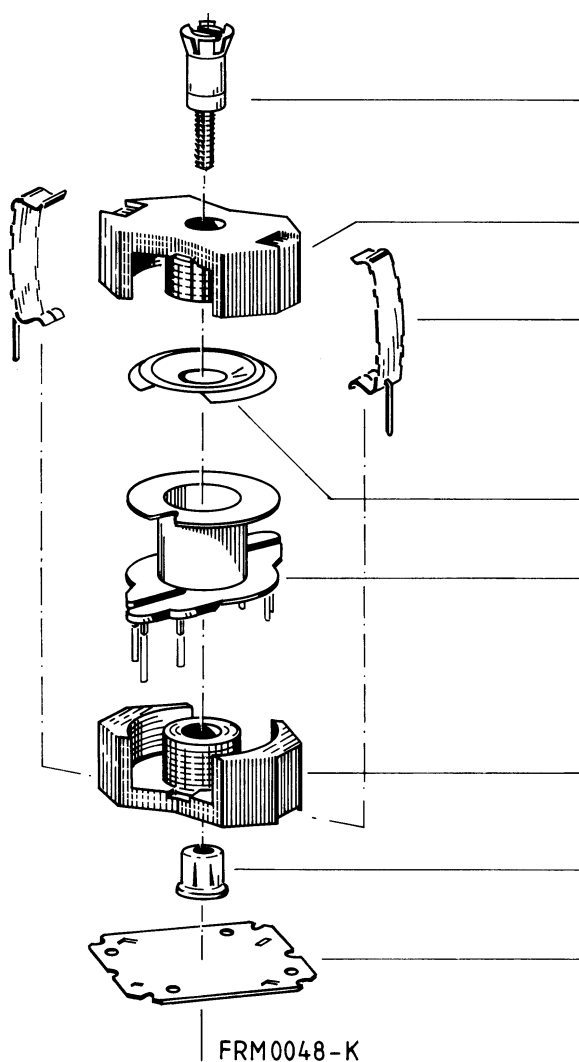


## **Ferrites and accessories**

RM 6, RM 6 LP  
Cores and accessories

**Series/Type:** B65807, B65808, B65821, B65659

**Date:** June 2013



| Individual parts           | Part no. | Page |
|----------------------------|----------|------|
| Adjusting screw            | B65659   | 11   |
| Core                       | B65807   | 3    |
| Clamps                     | B65808   | 9    |
| Insulating washer 1        | B65808   | 9    |
| Coil former                | B65808   | 5, 6 |
| Core                       | B65807   | 3    |
| Threaded sleeve (glued-in) |          |      |
| Insulating washer 2        | B65808   | 9    |

FRM0048-K

Example of an assembly set

**Also available:**

|                                    |         |    |
|------------------------------------|---------|----|
| Coil former for SMPS transf.       | B65808  | 7  |
| Coil former for power applications | B65808  | 8  |
| SMD coil former                    | B65821  | 10 |
| Clamp                              | B65808  | 10 |
| <u>RM 6 low profile:</u>           |         |    |
| Core                               | B65807P | 12 |

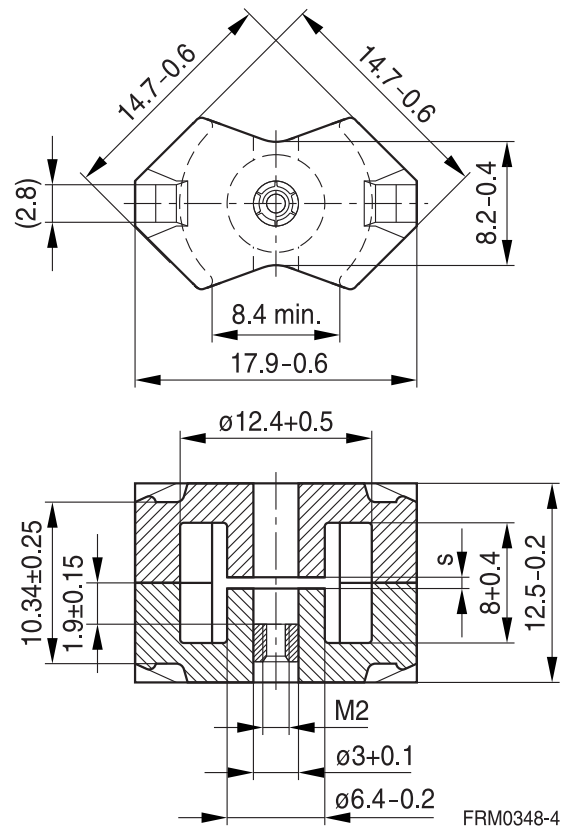
- To IEC 62317-4
- Core without center hole for transformer applications
- Delivery mode: sets

**Magnetic characteristics (per set)**

|              | with center hole | without center hole |                  |
|--------------|------------------|---------------------|------------------|
| $\Sigma I/A$ | 0.86             | 0.78                | mm <sup>-1</sup> |
| $I_e$        | 26.9             | 28.6                | mm               |
| $A_e$        | 31.3             | 36.6                | mm <sup>2</sup>  |
| $A_{min}$    | —                | 31                  | mm <sup>2</sup>  |
| $V_e$        | 840              | 1050                | mm <sup>3</sup>  |

**Approx. weight (per set)**

| m | 4.9 | 5.1 | g |
|---|-----|-----|---|
|   |     |     |   |


**Gapped**

| Material | $A_L$ value<br>nH                        | s<br>approx.<br>mm           | $\mu_e$                  | Ordering code <sup>1)</sup><br>-J without center hole<br>-N with threaded sleeve<br>-C with center hole |
|----------|--|------------------------------|--------------------------|---|
| K1       | 40 ±3%                                   | 0.80                         | 27.4                     | B65807+0040A001   |
| M33      | 63 ±3%<br>100 ±3%                        | 0.60<br>0.38                 | 43.2<br>68.5             | B65807+0063A033<br>B65807+0100A033  |
| N48      | 160 ±3%<br>250 ±3%<br>315 ±3%<br>400 ±3% | 0.22<br>0.12<br>0.08<br>0.05 | 109<br>171<br>215<br>274 | B65807+0160A048<br>B65807+0250A048<br>B65807+0315A048<br>B65807+0400A048                                |
| N41      | 250 ±3%                                  | 0.17                         | 155                      | B65807J0250A041   |

1) Replace the + by the code letter "C" or "N" for the required version. Standard version is "C".

**Ungapped**

| Material | A <sub>L</sub> value<br>nH | μ <sub>e</sub> | P <sub>V</sub><br>W/set          | Ordering code<br>-C with center hole<br>-J without center hole |
|----------|----------------------------|----------------|----------------------------------|--|
| N48      | 2200 +30/-20%              | 1500           |                                  | B65807C0000R048  |
| N45      | 3500 +30/-20%              | 2180           |                                  | B65807J0000R045  |
| N30      | 4300 +30/-20%              | 2670           |                                  | B65807J0000R030  |
| T35      | 6200 +30/-20%              | 3860           |                                  | B65807J0000R035  |
| T38      | 8600 +40/-30%              | 5350           |                                  | B65807J0000Y038  |
| T66      | 12300 +40/-30%             | 7650           |                                  | B65807J0000Y066  |
| N49      | 1700 +30/-20%              | 1060           | < 0.15 ( 50 mT, 500 kHz, 100 °C) | B65807J0000R049  |
| N87      | 2400 +30/-20%              | 1490           | < 0.51 (200 mT, 100 kHz, 100 °C) | B65807J0000R087  |
| N97      | 2400 +30/-20%              | 1490           | < 0.39 (200 mT, 100 kHz, 100 °C) | B65807J0000R097  |
| N41      | 3100 +30/-20%              | 1930           | < 0.16 (200 mT, 25 kHz, 100 °C)  | B65807J0000R041  |

**Coil former, squared pins**

Material: GFR thermosetting plastic (UL 94 V-0, insulation class to IEC 60085:  
 $H \triangleq$  max. operating temperature 180 °C), color code black  
 Sumikon PM 9630® [E41429 (M)], SUMITOMO BAKELITE CO LTD

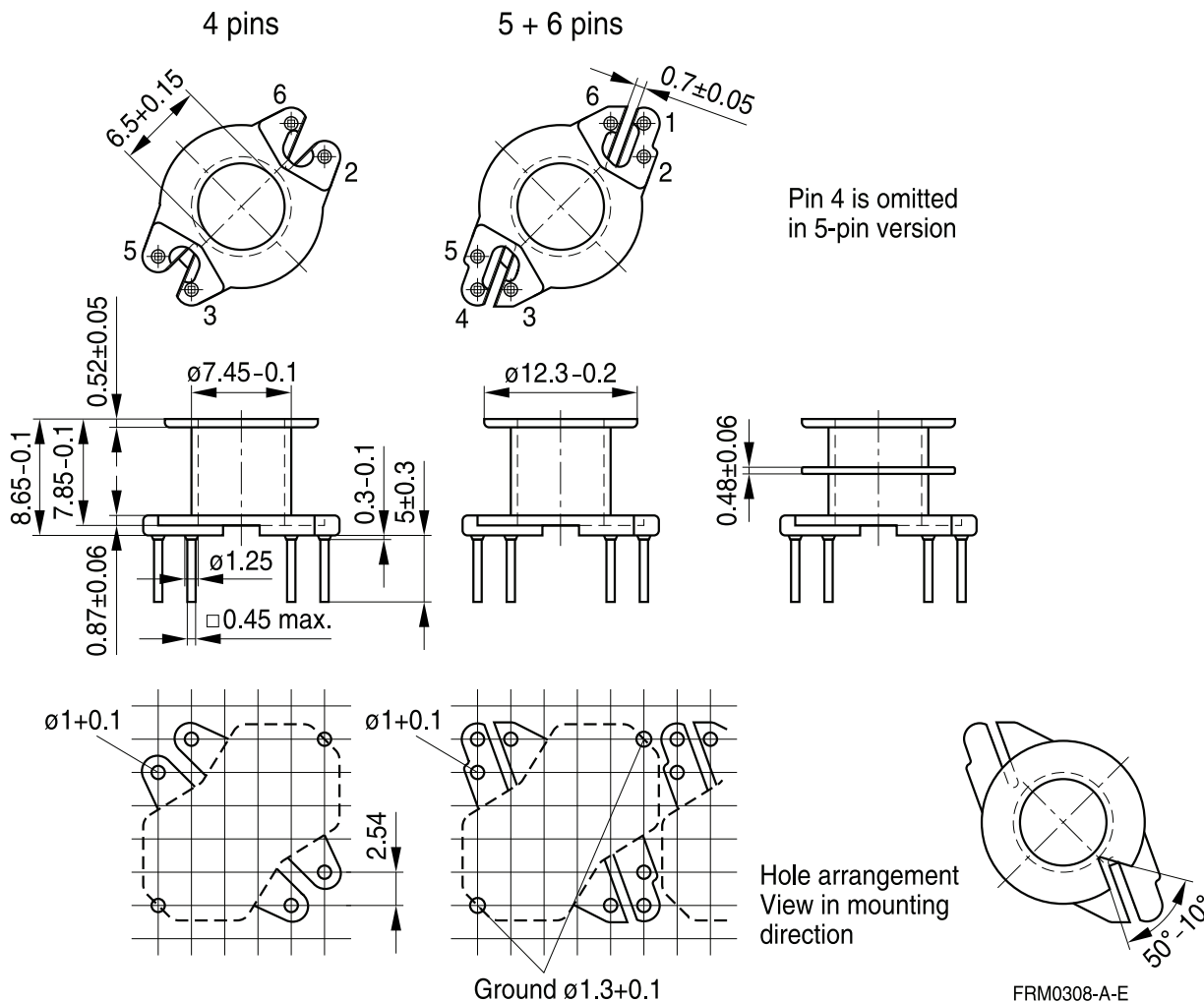
Solderability: to IEC 60068-2-20, test Ta, method 1 (aging 3): 235 °C, 2 s

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

Winding: see Data Book 2013, chapter "Processing notes, 2.1"

For matching clamp and insulating washers see page 9.

| Sections | $A_N$<br>mm <sup>2</sup> | $l_N$<br>mm | $A_R$ value<br>$\mu\Omega$ | Pins        | Ordering code   |
|----------|--------------------------|-------------|----------------------------|-------------|---|
| 1        | 15                       | 30          | 69                         | 4<br>5<br>6 | B65808N1004D001<br>B65808N1005D001<br>B65808N1006D001 |
| 2        | 14                       | 30          | 73                         | 4<br>6      | B65808N1004D002<br>B65808N1006D002                    |



**Coil former, pins squared in the start-of-winding area**

Material: GFR thermosetting plastic (UL 94 V-0, insulation class to IEC 60085:  
 $H \triangleq$  max. operating temperature 180 °C), color code white  
 Bakelite UP 3420® [E61040 (M)], HEXION SPECIALTY CHEMICALS GMBH

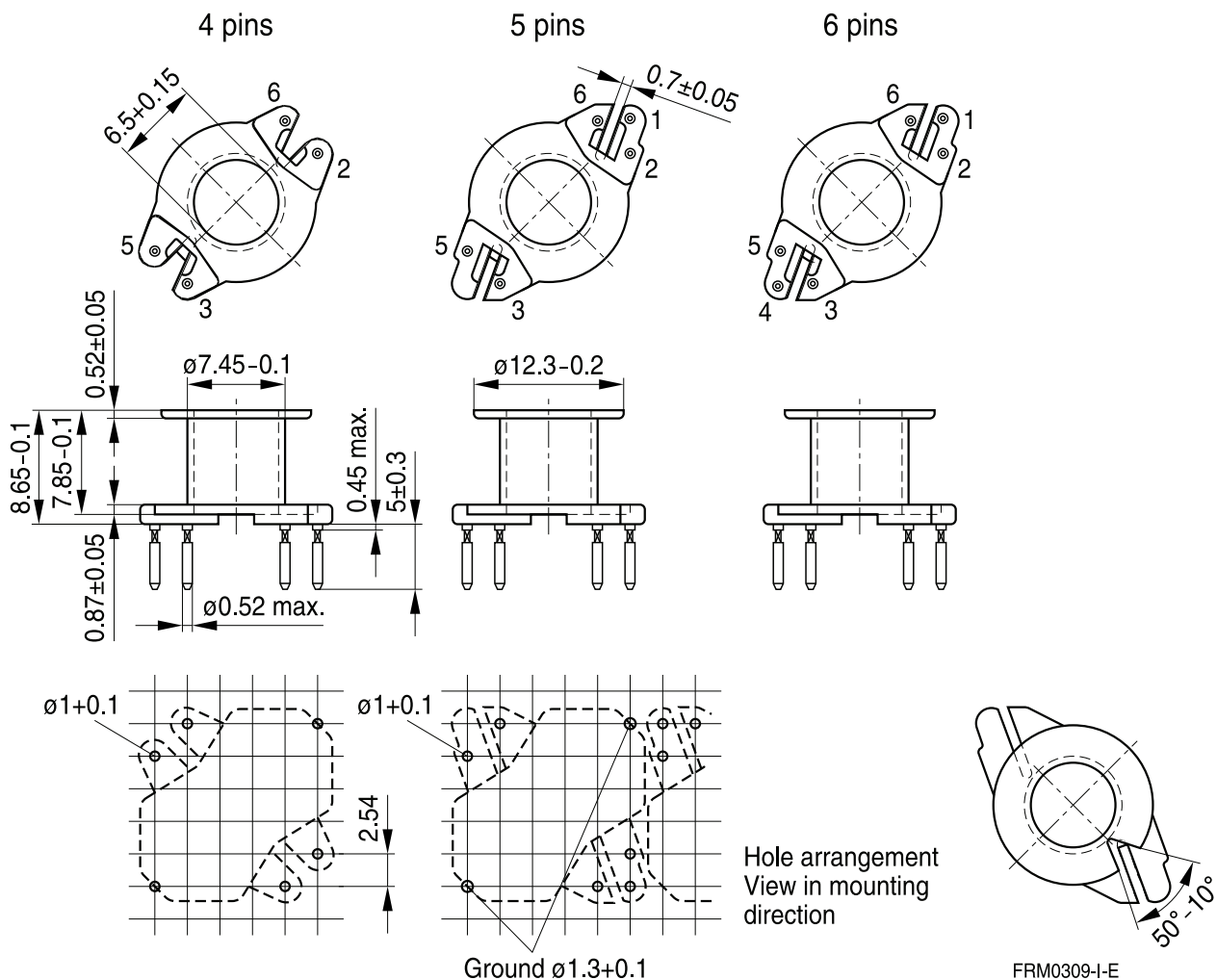
Solderability: to IEC 60068-2-20, test Ta, method 1 (aging 3): 235 °C, 2 s

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

Winding: see Data Book 2013, chapter "Processing notes, 2.1"

For matching clamp and insulating washers see page 9.

| Sections | $A_N$<br>mm <sup>2</sup> | $l_N$<br>mm | $A_R$ value<br>$\mu\Omega$ | Pins        | Ordering code   |
|----------|--------------------------|-------------|----------------------------|-------------|---|
| 1        | 15                       | 30          | 69                         | 4<br>5<br>6 | B65808P1004D001<br>B65808P1005D001<br>B65808P1006D001 |



**Coil former for SMPS transformers with line isolation**

The creepage distances and clearances are designed such that the coil former is suitable for use in SMPS transformers with line isolation.

- Closed center flange with external wire guide
- Pins squared in the start-of-winding area
- Optimized for use with automatic winding machines

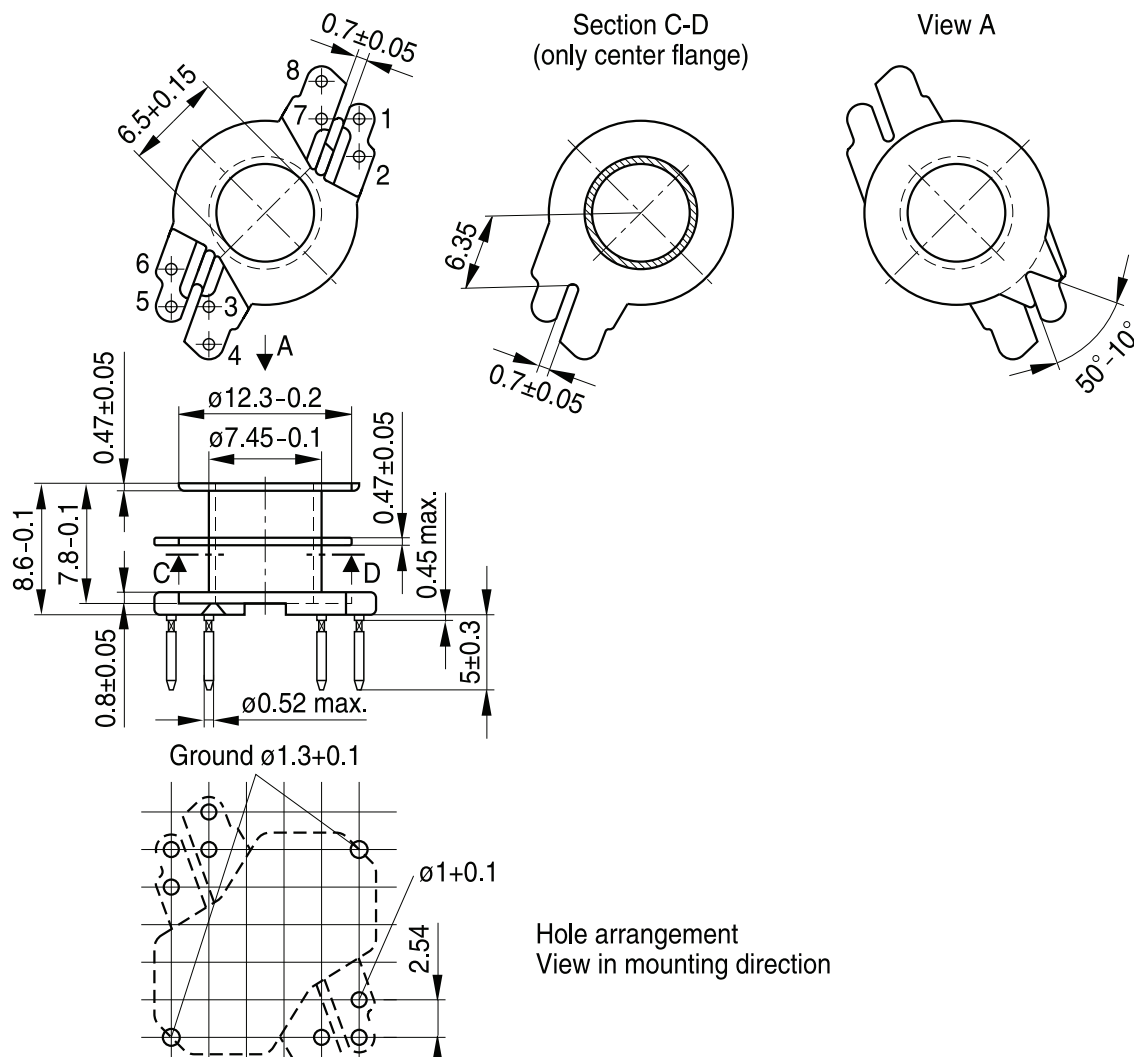
Material: GFR thermosetting plastic (UL 94 V-0, insulation class to IEC 60085:  
 $F \triangleq$  max. operating temperature 155 °C), color code black  
 Sumikon PM 9630® [E41429 (M)], SUMITOMO BAKELITE CO LTD

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 Data Book 2013, chapter "Processing notes, 2.1"

| Sections | $A_N$<br>mm <sup>2</sup> | $l_N$<br>mm | $A_R$ value<br>$\mu\Omega$ | Pins | Ordering code   |
|----------|--------------------------|-------------|----------------------------|------|-----------------|
| 2        | 14                       | 30          | 73                         | 8    | B65808S1108D002 |



Hole arrangement  
View in mounting direction

**Coil former for power applications with angled pins**

Optimized for automatic winding

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)], GE PLASTICS B V

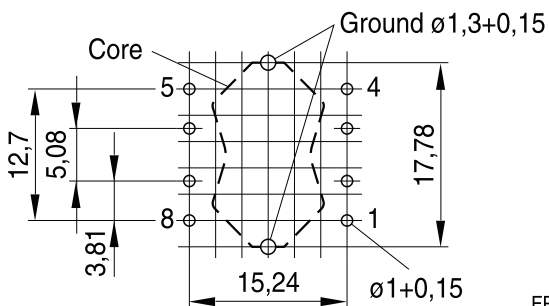
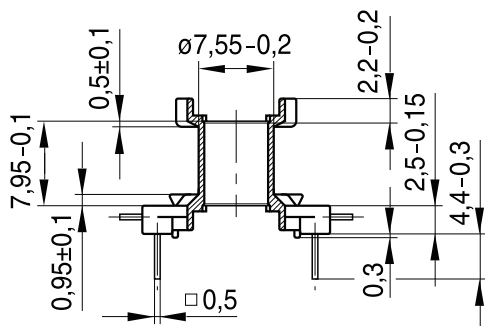
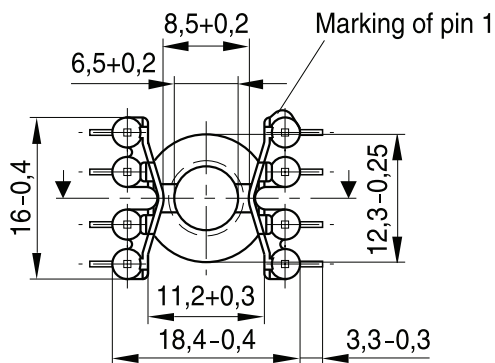
Solderability: to IEC 60068-2-20, test Ta, method 1 (aging 3): 235 °C, 2 s

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

Winding: see Data Book 2013, chapter "Processing notes, 2.1"

For matching clamp and insulating washer 1 see page 9.

| Sections | $A_N$<br>mm <sup>2</sup> | $l_N$<br>mm | $A_R$ value<br>$\mu\Omega$ | Pins | Ordering code   |
|----------|--------------------------|-------------|----------------------------|------|-----------------|
| 1        | 15                       | 30          | 69                         | 8    | B65808E1508T001 |


 Hole arrangement  
View in mounting direction

FRM0298-Y



**Clamp**

- With ground terminal, made of stainless spring steel (tinned), 0.4 mm thick
- Solderability to IEC 60068-2-20, test Ta, method 1 (aging 3): 235 °C, 2 s
- Also available as strip clamp on reels on request

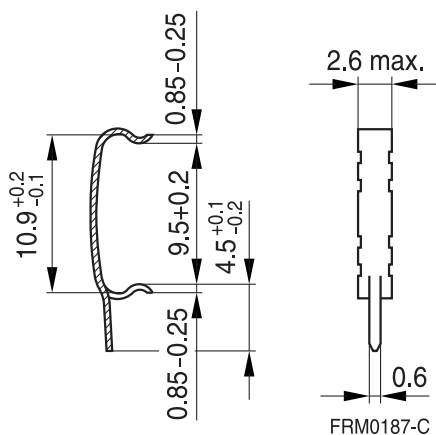
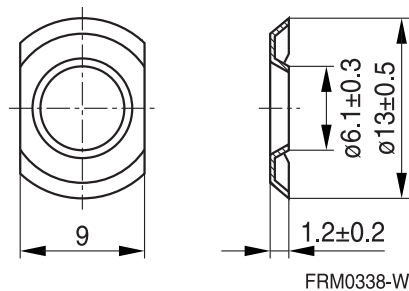
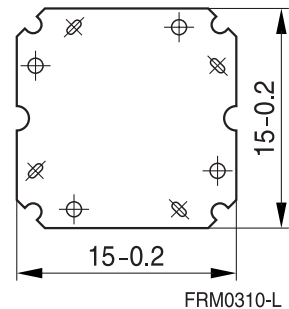
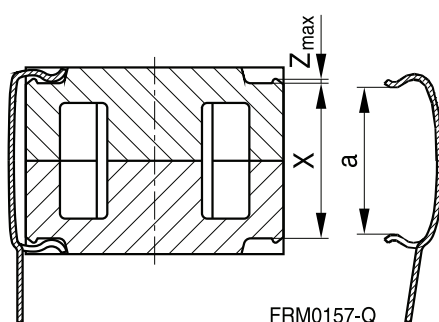
**Insulating washer 1 between core and coil former**

- For tolerance compensation and for insulation
- Made of polycarbonate (UL 94 V-0, insulation class to IEC 60085: E  $\geq$  120 °C), 0.08 mm thick Aryphan F685, [E167358 (M)], natural color, LOFO HIGH TECH FILM GMBH

**Insulating washer 2 for double-clad PCBs**

- Made of polycarbonate (UL 94 V-0, insulation class to IEC 60085: E  $\geq$  120 °C), 0.25 mm thick Makrofol FR7-2, [E118859 (M)], natural color, BAYER MATERIALSCIENCE AG

|   | Ordering code   |
|---|-----------------|
| Clamp (ordering code per piece, 2 are required) | B65808B2203X000 |
| Insulating washer 1 (reel packing, PU = 1 reel) | B65808A5000X000 |
| Insulating washer 2 (bulk)                      | B65808C2005X000 |

**Clamp**

**Insulating washer 1 (preliminary data)**

**Insulating washer 2**

**Clamping forces for RM 6**


$F_{min}$ : Extension of clamp from  $a$  to  $a_2 = X_{min}$   
 $F_{max}$ : Extension of clamp from  $a$  to  $a_1 = X_{max}$

|                              |           |          |
|------------------------------|-----------|----------|
| Clamp opening $a$ (mm)       |           | 9.5 +0.2 |
| Core nose $Z_{max}$ (mm)     |           | 0.22     |
| Height of core pair $X$ (mm) | $X_{min}$ | 10.1     |
|                              | $X_{max}$ | 10.6     |
| Clamping force $F$ (N)       | $F_{min}$ | 7        |
|                              | $F_{max}$ | 50       |

**SMD**
**SMD coil former with gullwing terminals**

Material: GFR liquid crystal polymer (UL 94 V-0, insulation class to IEC 60085:  
 $F \triangleq$  max. operating temperature 155 °C), color code black  
 Vectra E 130i [E106764 (M)], POLYPLASTICS CO LTD  
 Vectra E 130i [E83005 (M)], TICONA

Solderability: to IEC 60068-2-58, test Td, method 6 (Group 3): 245 °C, 3 s

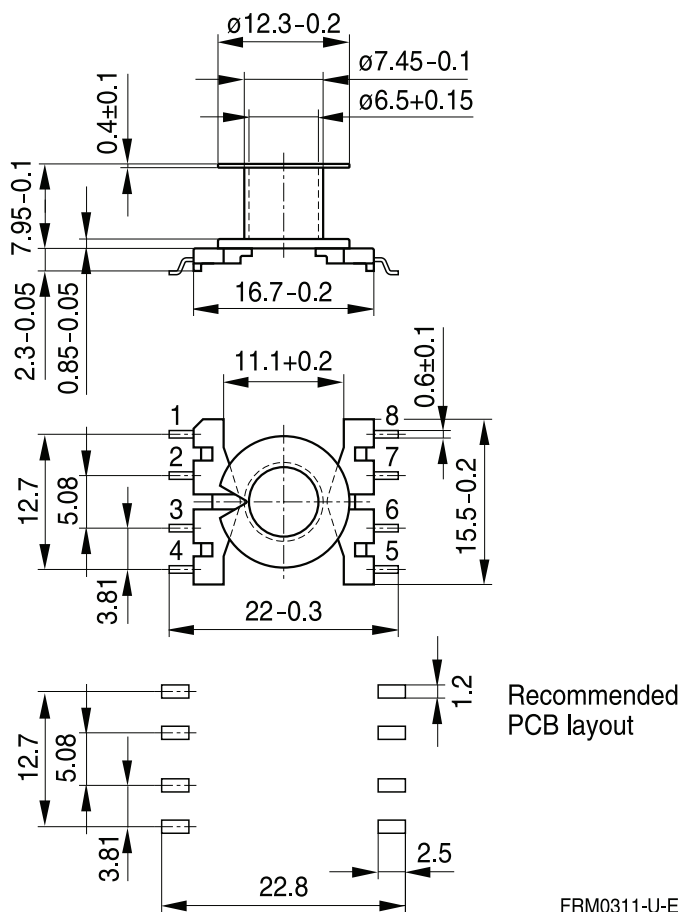
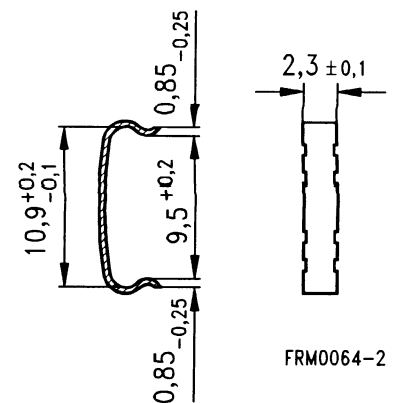
Resistance to soldering heat: to IEC 60068-2-58, test Td, method 6 (Group 3): 255 °C, 10 s  
 permissible soldering temperature for wire-wrap connection on coil former: 400 °C, 1 s

Winding: see Data Book 2013, chapter "Processing notes, 2.1"

**Clamp**

- Without ground terminal, made of stainless spring steel, 0.435 mm thick
- Also available as strip clamp on request

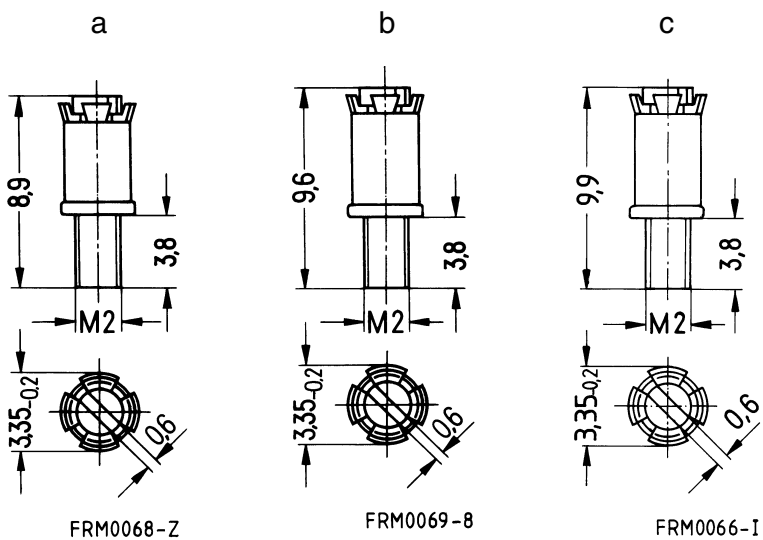
| Sections  | $A_N$<br>mm <sup>2</sup> | $l_N$<br>mm | $A_R$ value<br>$\mu\Omega$ | Terminals | Ordering code   |
|---|--------------------------|-------------|----------------------------|-----------|-----------------|
| 1   | 16.2                     | 31          | 66                         | 8         | B65821C1008T001 |
| Clamp (ordering code per piece, 2 are required) |                          |             |                            |           | B65808J2204X000 |

**Coil former**

**Clamp**


**Adjusting screw**

- Tube core with thread and core brake made of GFR polyterephthalate  
Pocan B3235® [E245249 (M)], LANXESS AG

| Figure | Tube core       |          |            | Ordering code   |
|--------|-----------------|----------|------------|-----------------|
|        | ∅ × length (mm) | Material | Color code |                 |
| a      | 2.62 × 3.6      | N22      | red        | B65659F0001X023 |
| b      | 2.75 × 4.4      | N22      | black      | B65659F0003X023 |
| c      | 2.82 × 4.4      | N22      | yellow     | B65659F0004X023 |



**RM 6 »Low Profile«**
**Core**
**B65807P**

- To IEC 62317-4
- For compact transformers
- Without center hole
- Delivery mode: sets

**Magnetic characteristics (per set)**

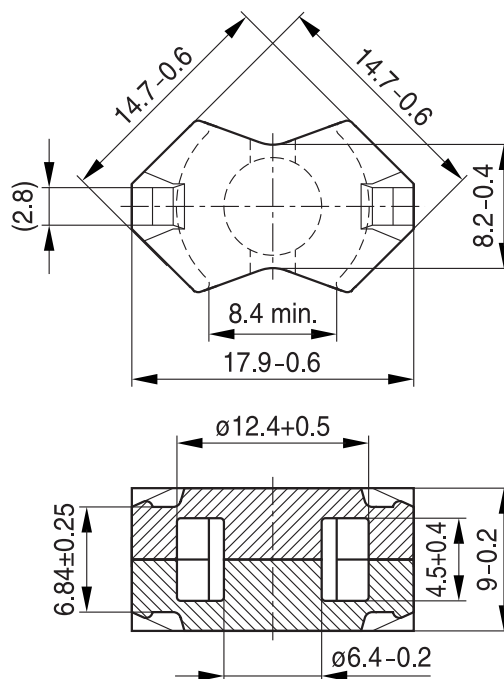
$$\Sigma l/A = 0.58 \text{ mm}^{-1}$$

$$l_e = 21.8 \text{ mm}$$

$$A_e = 37.5 \text{ mm}^2$$

$$A_{\min} = 31.2 \text{ mm}^2$$

$$V_e = 820 \text{ mm}^3$$

**Approx. weight 4.0 g/set**


FRM0349-C

**Ungapped**

| Material | $A_L$ value<br>nH | $\mu_e$ | $P_V$<br>W/set                   | Ordering code   |
|----------|-------------------|---------|----------------------------------|-----------------|
| T38      | 10500 +40/-30%    | 4860    |                                  | B65807P0000Y038 |
| N49      | 2200 +30/-20%     | 1020    | < 0.14 ( 50 mT, 500 kHz, 100 °C) | B65807P0000R049 |
| N92      | 2300 +30/-20%     | 1060    | < 0.44 (200 mT, 100 kHz, 100 °C) | B65807P0000R092 |
| N87      | 3000 +30/-20%     | 1390    | < 0.40 (200 mT, 100 kHz, 100 °C) | B65807P0000R087 |

### 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 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 chapter “*Definitions*”, section 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 chapter “*Definitions*”, section 8.2.

### 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.

### Processing notes

- The start of the winding process should be soft. Else the flanges may be destroyed.
- To strong winding forces may blast the flanges or squeeze the tube that the cores can no more be mount.
- To 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 oxyd of the tin bath or burned insulation of the wire. For detailed information see chapter “*Processing notes*”, section 8.2.
- 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.

**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 \varepsilon (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<br>derived from the static magnetization curve   |                                   |
| $\rho$       | Resistivity  | $\Omega m^{-1}$                   |
| $\Sigma l/A$ | Magnetic form factor   | mm <sup>-1</sup>                  |
| $\tau_{Cu}$  | 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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