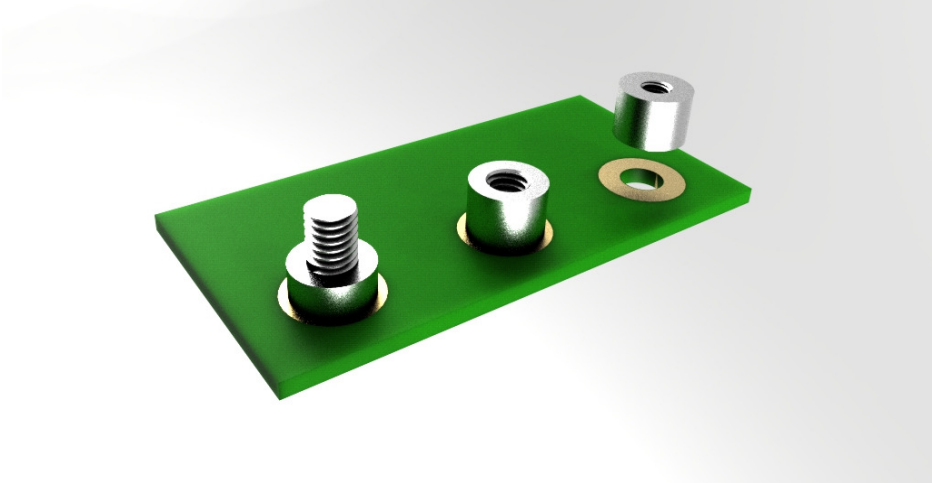
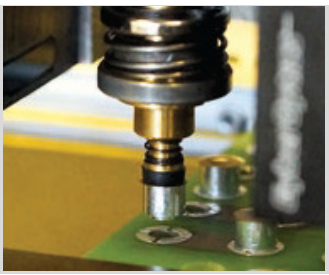
WÜRTH ELEKTRONIK

REDCUBE SMD Terminals
Design Guide



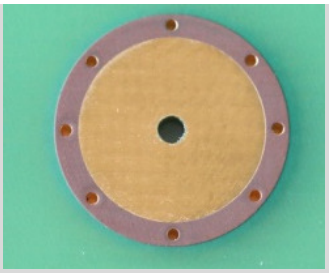
70A SMD
Technology
Small Size
High Current

Contents

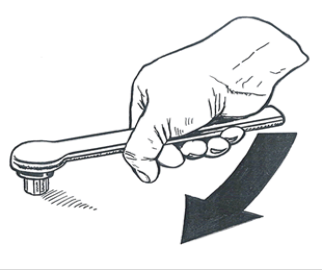


Surface-Mount-Technology & Assembly

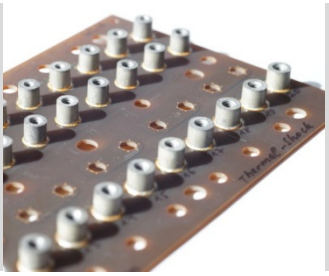
Surface



Pad Geometry & Stencil



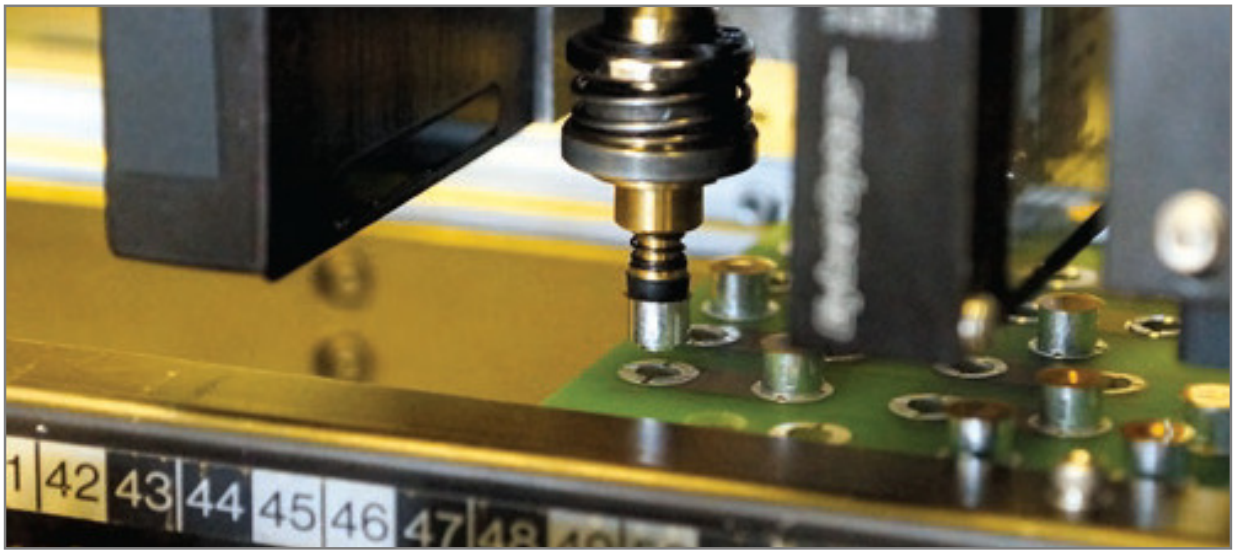
Technical Data



Qualification

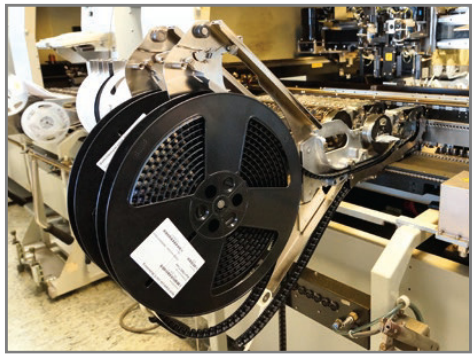
- *Reliability Test*

REDCUBE SMD



Today, modern electronic boards are mainly assembled with automatic placement machines and are subsequently soldered in the reflow process. This permits a high component density in the smallest of spaces. Here the high level of heat generation is an issue faced often by developers.

- **REDCUBE** SMD are the result of the consistent advancement of our products for the benefit of our customers.. **REDCUBE** SMD combine the advantages of SMD assembly in conjunction with high-current technology. Within seconds, **REDCUBE** SMD Terminals can be assembled off the reel onto the circuit board with all other SMD components and subsequently soldered in the reflow process.



- The large-area connection to the pad results in a low contact resistance and low self-heating. Currents of up to 70 A are possible depending on the layout. At the
- same time, the components offer high holding forces and torques.

Low contact resistances guarantee
low temperature on the circuit board

Component Assembly

The assembly process of REDCUBE SMD can be performed both manually and fully automated.

- Placement by hand is possible for small or sample series. In case of **REDCUBE** SMD with through hole threads, attention must be paid that no solder paste gets into the thread.

- In fully automated assembly, **REDCUBE** SMD Terminals are packaged on the reel and, like the other SMD components, are ready for automatic processing. The **REDCUBE** SMD Terminals are picked up from the belt with a vacuum pipette and are placed on the circuit board. The picking from the belt is defined by the picking area, the weight of the component and the negative pressure generated by the vacuum pipette.

- In order to ensure trouble-free processing with all automatic placement machines, **REDCUBE** SMD are equipped with a capton foil or pick and place cap. The pick and place cap is made of LCP material and was specifically developed for the soldering process. After soldering, the cap or the capton foil is disposed of. The capton foil is especially designed with a tab to facilitate removal. **REDCUBE** SMD with M4 outer thread have no pick and place cap, as the picking area is large enough in this case.

Coating

Tin is not necessarily tin!

In the electroplating facility there are many ways of influencing the coating process with pre-treatments and post-treatments, as well as the addition of organic additives, such as oxidation stabilizers, grain refiners and brighteners. So that is why not all tin-plating is alike. As presented in the right picture, an incorrect coating can lead to discolorations, tin spalling and a poor soldering result.

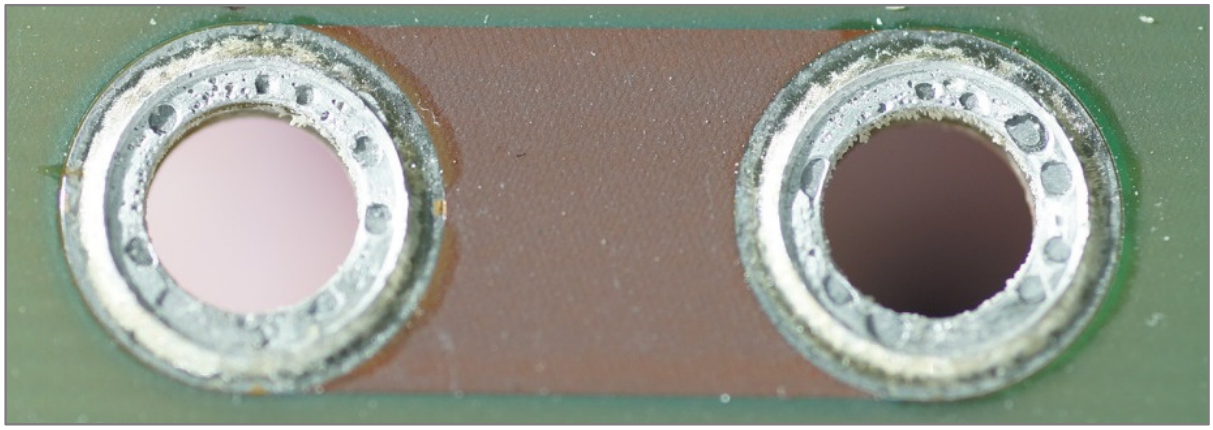
Soldering result: incorrect coating

Perfect Solder Joint:

- For **REDCUBE** SMD a special solder surface has been developed for the hot-air reflow technique. Different tin coatings were investigated in many series of experiments to attain optimal wetting and the best holding forces.
- Similarly, a barrier layer and a coating thickness adapted to the component volume is crucial for the perfect soldering result. Applying tin on the surface too thickly can lead to accumulations, the “orange peel” effect and melting of the surface in the soldering process. Subsequent connection of the **REDCUBE** SMD with the cable lug can result in significantly higher resistance at the point of contact.

Soldering result: too much tin

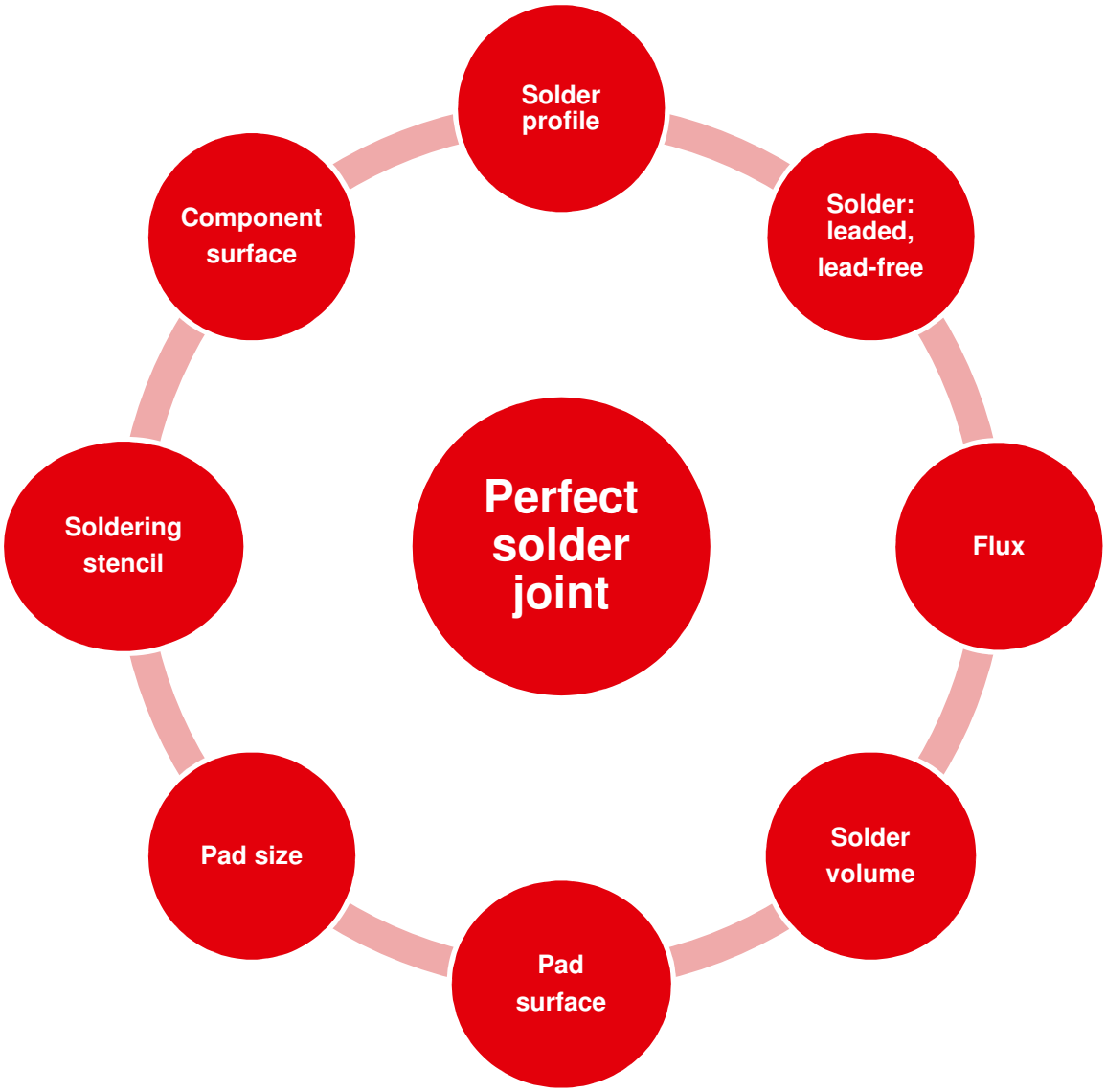
- In contrast, too little tin applied causes poorer wetting and can have a negative impact on the air voids (see picture below) in the solder joint. On account of the large contact surface, air voids cannot be excluded, but because the holding forces are mainly defined by the meniscus formation, they are not so critical in practice.



Soldering result: too less tin

Perfect Solder Joint

The soldering result is influenced by many factors. Many variables should be considered throughout the treatment process in order to obtain an optimal solder joint. Effective wetting and a well formed meniscus are essential for the holding forces and low contact resistances on the circuit board.



Pad Geometry

In addition to the special solder surface, the holding force of REDCUBE SMD Terminals is also determined by the correct pad geometry.

- The solder result and the resulting holding forces depend on optimal pad geometry. On the basis of the IPC TM 650 test method, the pad size was specially matched to the component in terms of the adhesive strength of copper layers on FR4, such that no further layout design measures are generally necessary (Fig. 1).

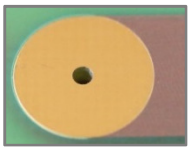


Figure 1

- If higher strength is required, there are some simple ways of improving the stability of the pad. The simplest way is to create the copper area larger than the solder pad. The larger contact area to the FR4 material achieves greater stability (Fig. 2).

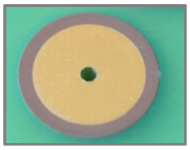


Figure 2

- In addition, the copper surface can be configured with vias. A via has the effect of a „rivet“ and enhances the connection to the base material of the circuit board (Fig. 3).

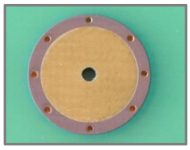


Figure 3

- An equally popular method of strengthening SMD pads is to place the via directly in the pad. It should be kept in mind that the fluid solder can flow downwards through the vias and there may not be sufficient solder available for the solder joint (Fig. 4).

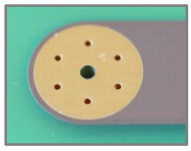


Figure 4

Stencil

- The solder stencil (Fig. 5) should be designed as recommended on the **REDCUBE** SMD datasheet. The drill holes in the circuit board must be covered by the stencil, such that no solder flows into the holes.

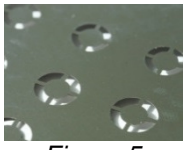
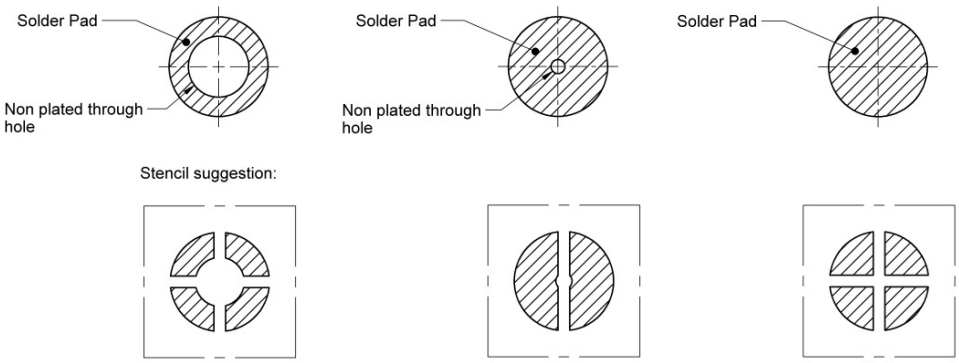


Figure 5



- The drill hole in the circuit board for the alignment pin and the screw must not be through-contacted! (Fig. 6)

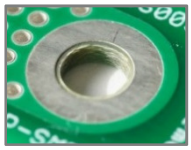
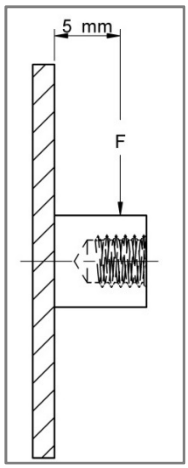


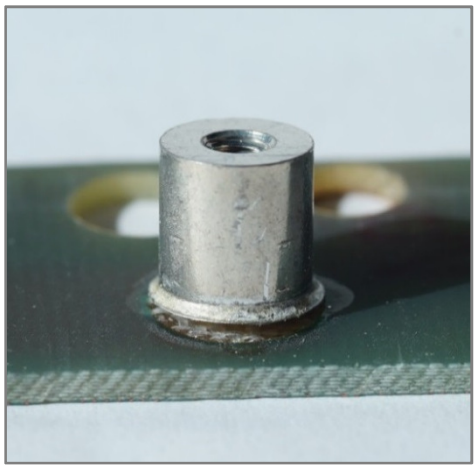
Figure 6

Tearing Force

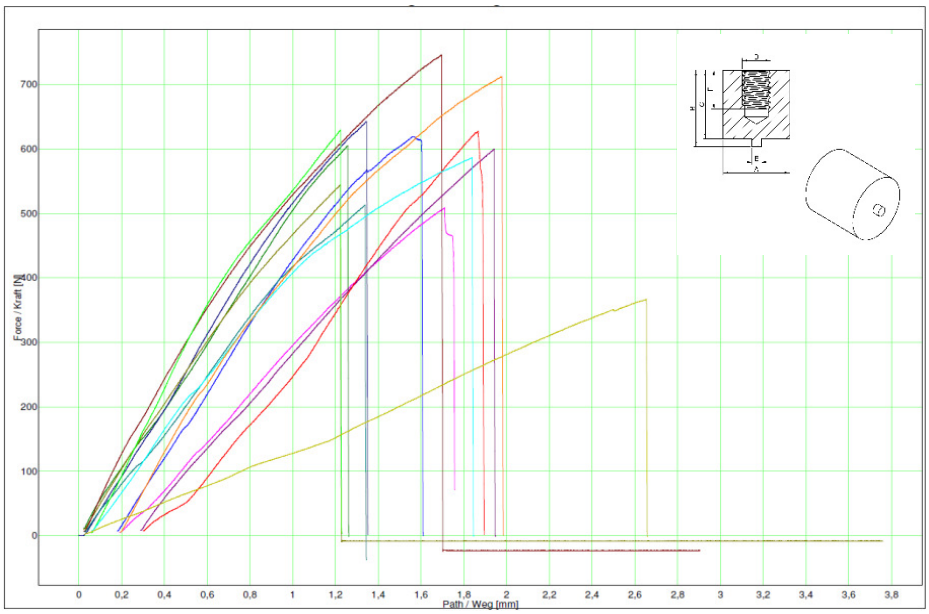
Measurement of the tearing force of **REDCUBE** SMD should simulate a load similar in strength to that of a strong pull on the cable if the cable lug is screwed to the component. The tearing forces on the component from the circuit board were measured in numerous experiments by applying and measuring a force at a 5 mm distance. The force was increased linearly up until tearing.

The torque formula ***M=F*l*** allows the tearing force to be determined for every other length.





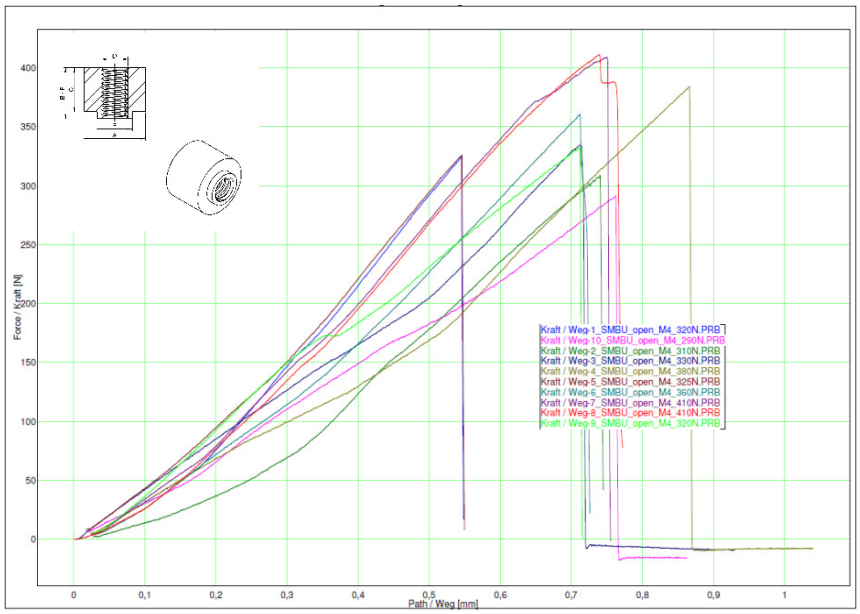
In the lower graph, the tearing forces for **REDCUBE** SMD with a threaded blind hole are presented. The maximum tearing force was 745 N, i.e. a weight of over 70 kg has to hang on the cable such that the **REDCUBE** SMD is torn off the circuit board. On average most values were above 500 N.



Assuming a typical holding force of 60 N/mm² for a good hexagonal crimp on the tubular cable lug, for a 2.5 mm² cable the cable would already slip out of the cable lug at 150 N. This value is even lower for simple crimping of cable lugs.

Tearing Force

Due to the drill hole in the circuit board, the tearing forces for **REDCUBE** SMD with through threads are lower as a result of the lower contact area on the pad. The tearing forces are presented in the lower graph. The max. tearing force was 410 N. On average, the values were above 300 N.



Permitted torque

REDCUBE SMD Terminals offer a large-area connection and transmission of high currents in circuit boards. The maximum permitted torque has to be observed in order to prevent mechanical destruction of the parts!

Mechanical properties for brass (reference values):

- Material: CuZn39Pb3
- Shear strength: 350 N/mm²
- Tensile strengtht: 480 N/mm²
- Elastic limit: 340 N/mm²
- Elongation: 20%
- Eleastic modulus: 96 kN/mm²
- Torsional modulus: 32 kN/mm² (Shear modulus))

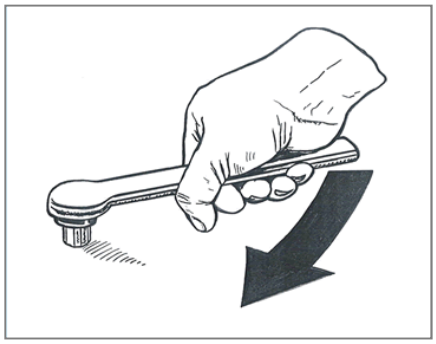


Table for REDCUBE SMD

Thread size (metric)	M3 through thread	M4 through thread	M3 closed thread	M4 closed thread
Max. tightening torque [Nm] *	0,5	1,2	0,5	1,2
Min. breaking torque [Nm] **	3,0	2,9	3,8	3,8
Max. breaking torque [Nm]	4,1	3,9	4,6	4,6
Mean breaking torque (30 pcs) [Nm]	3,6	3,5	4,3	4,3

* Based on DIN267 Part 25 (breaking torques); values for brass material (MS 63)

** Determined values (torques). Destruction of the components or the solder joint is to be assumed at these mechanical loads. The components must never be loaded above these values.

The breaking torque is strongly dependent on the quality of the solder joint and the screw used. As apparent from the table, the breaking torque exceeds the prescribed tightening torque many times over.

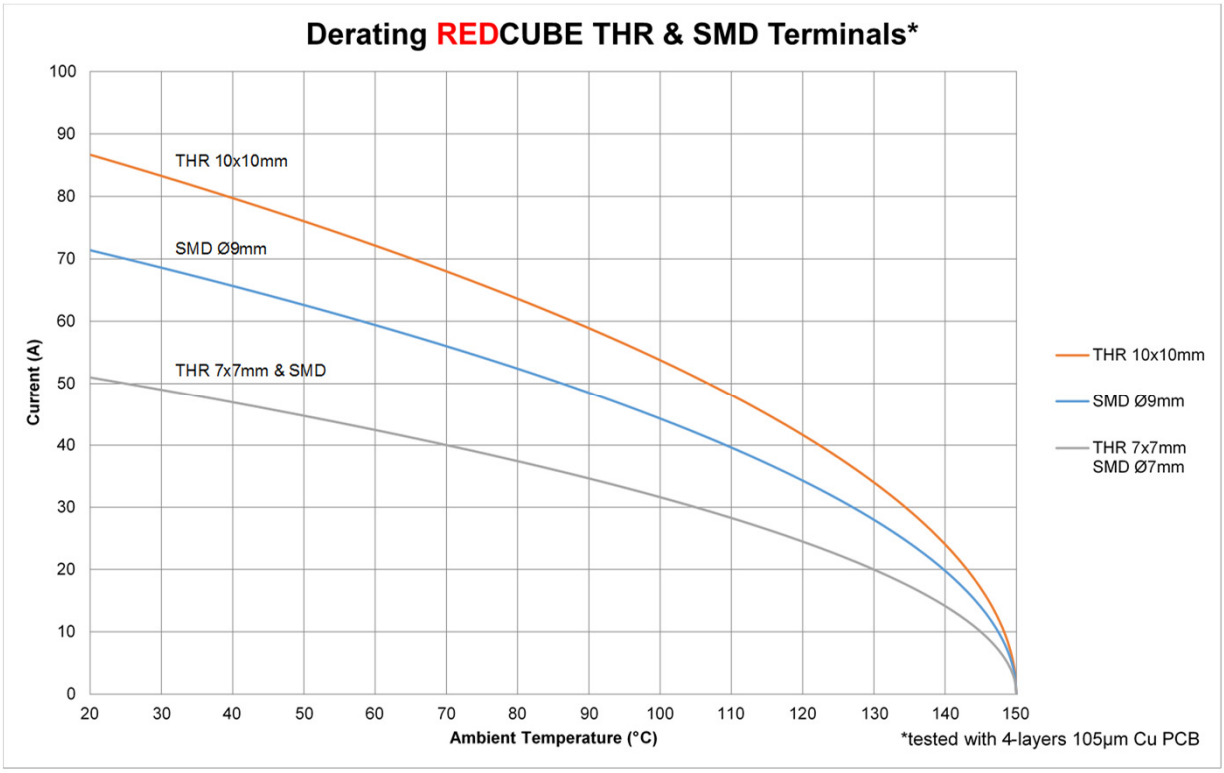
REDCUBE SMD may only be loaded with the values from the ‚max. tightening torque‘ line in the table!

Current Carrying Capacity

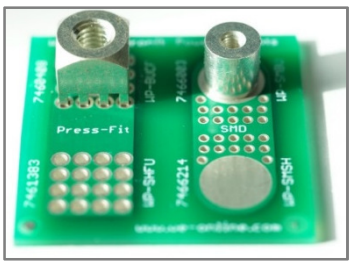
The low contact resistances of REDCUBE SMD Terminals are achieved as a result of the large-area connection to the pad. This ensures a low level of heat development and favors the overall temperature performance on the circuit board.

Currents up to 100 A are achieved with multilayer circuit boards and large cable cross-sections. In many cases, the cable cross-section is the limiting factor. According to VDE0100, a 4 mm² can only be used up to a maximum of 42 A continuous current at 20 °C. So the cable limits the current before the **REDCUBE** SMD.

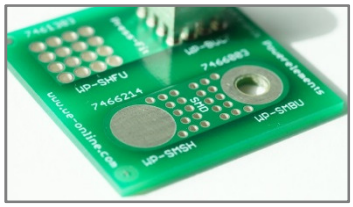
The derating curve shown below was measured with 6 mm² and a 2 x 70µm circuit board.



As shown in the pictures, the current transmission into the lower layers must be through the additional vias. A 0.3-0.4 mm diameter and min. 25 µm copper-plating per via are recommended. The distribution of current in the lower layers is problematic for currents above 70 A, as the current carrying capacity of the vias is limited and a large amount of space is required on the board.



It is therefore recommended to switch to **REDCUBE** PRESS-Fit for even higher currents. The press-fit technology still offers unrivaled low contact resistances and even better temperature characteristics.



Product overview

The space saving design of REDCUBE SMD combine the advantages of SMD mounting in conjunction with high current technology.

REDCUBE SMD

- Material: Brass
- Surface: Tin plated
- Heat resistance: up to 150°C
- Tightening Torque: M3 (0.5Nm), M4 (1.2Nm)

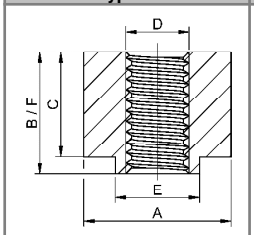
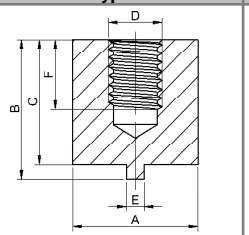
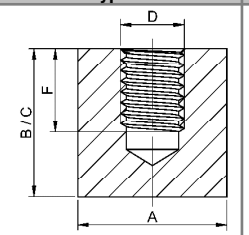
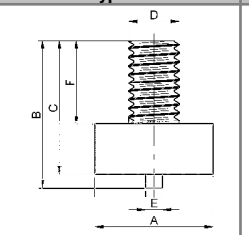
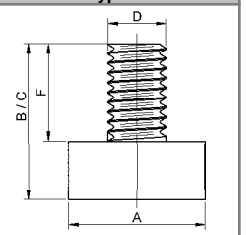
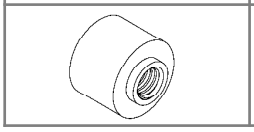
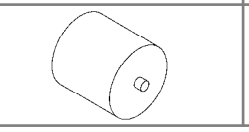
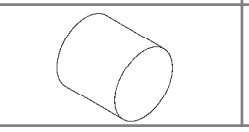
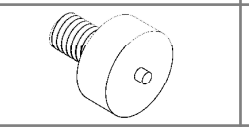
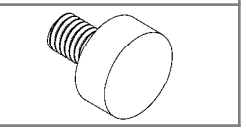
Characteristics

- High current carrying capacity and mechanical forces
- Simple and fast automated assembly
- Low initial time and cost
- High packing density
- Low resistance and minimal self-heating

Applications

- Space-saving PCB Design
- Solderable high current Wire-to-Board connections with a focus on automated assembly

Order Code Bulk	Order Code Reel	Diameter A (mm)	Total height B (mm)	Body length C (mm)	Thread size D (mm)	Socket/Pin Diameter E (mm)	Thread length F (mm)	Format type	Type	Current I (A)
746 600 330	746 600 330R	7	4	3	M3	4	4	A	Bush	50
746 600 430	746 600 430R	7	4	3	M4	5	4	A	Bush	50
746 600 3	746 600 3R	7	6	5	M3	4	6	A	Bush	50
746 600 4	746 600 4R	7	6	5	M3	5	6	A	Bush	50
746 600 5	746 600 5R	9	6	5	M5	6	6	A	Bush	70
746 610 3	746 610 3R	7	7.8	7	M3	1	4	B	Bush	50
746 610 4	746 610 4R	7	7.8	7	M4	1	4	B	Bush	50
746 610 5	746 610 5R	9	7.8	7	M5	1	4	B	Bush	70
746 620 3	746 620 3R	7	7	7	M3	-	4	C	Bush	50
746 620 4	746 620 4R	7	7	7	M4	-	4	C	Bush	50
746 620 5	746 620 5R	9	7	7	M5	-	4	C	Bush	70
746 611 3	746 611 3R	7	8.8	8	M3	1	5	D	Shank	50
746 611 4	746 611 4R	7	8.8	8	M4	1	5	D	Shank	50
746 621 3	746 621 3R	7	8	8	M3	-	5	E	Shank	50
746 621 4	746 621 4R	7	8	8	M4	-	5	E	Shank	50

Type A	Type B	Type C	Type D	Type E
				
				

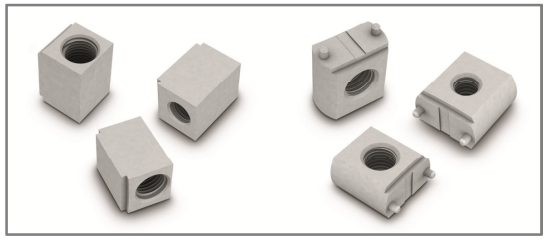
➢ All articles are listed in our catalogue: **Electronic Interconnect & Electromechanical Solutions – Catalogue**

Product preview

The new angled REDCUBE SMD version, allows angled current-carrying Board-to-Board connection as well as pure mechanical angled SMD connections.

REDCUBE SMD

- Material: Brass
- Surface: Tin plated
- Heat resistance: up to 150°C
- Tightening torque: 0.4Nm



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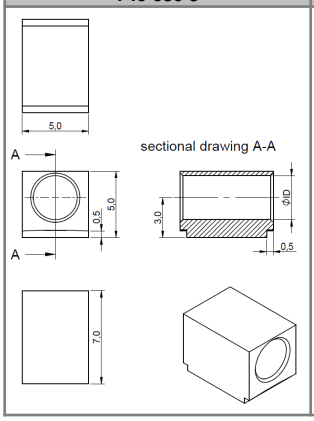
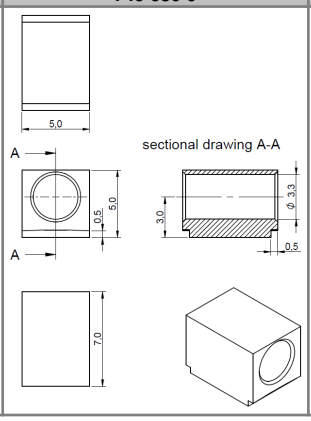
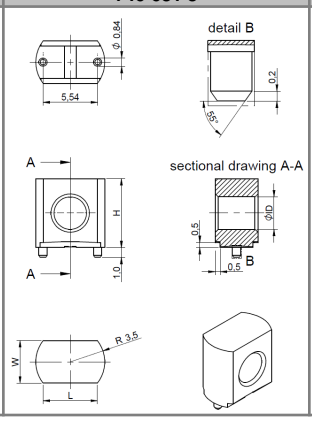
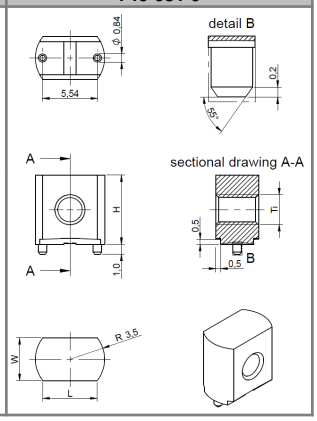
- High current carrying capacity and mechanical forces
- Simple and fast automated assembly
- Low initial time and cost
- High packing density
- Low resistance and minimal self-heating

Applications

- Angled assembling of cable or two angled connection of two PCBs with each other
- Angled assembling of PCBs on housings

Order Code Bulk	Order Code Reel	PCS per Reel	Length L (mm)	Width W (mm)	Height H (mm)	Thread size	Inner Diameter (mm)	Current I (A)
746 630 3	746 630 3R	1600	7	5	5	M3	-	50
746 630 0	746 630 0R	1600	7	5	5	-	3.3	50
746 631 3	746 631 3R	1000	5.5	4.33	7	M3	-	50
746 631 0	746 631 0R	1000	5.5	4.33	7	-	3.3	50

746 630 3	746 630 0	746 631 3	746 631 0
			

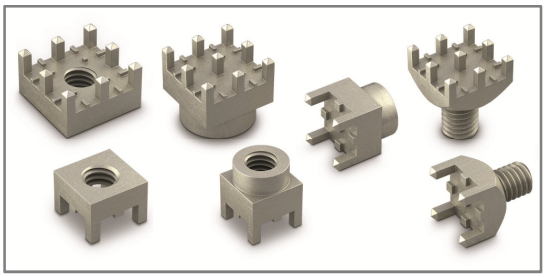
➢ All articles are listed in our catalogue: **Electronic Interconnect & Electromechanical Solutions – Catalogue**

Product preview

REDCUBE THR combine the advantage of Through Hole Technology – the high mechanical stability – with the timesaving pick and place mounting and efficient reflow soldering.

REDCUBE THR Terminals are designed for reflow soldering. They have a special pin design for best soldering results and currents up to 85 A.

Milling from solid material REDCUBE THR guarantee significant higher ampacity with much better torques compared to stamped contacts.



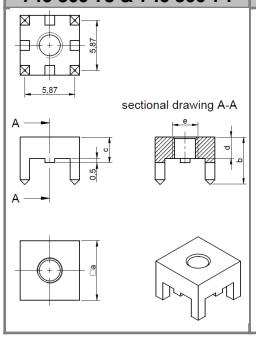
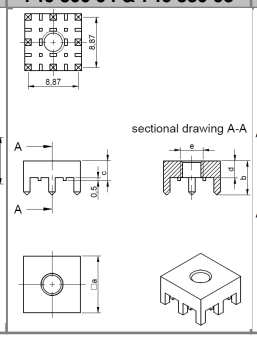
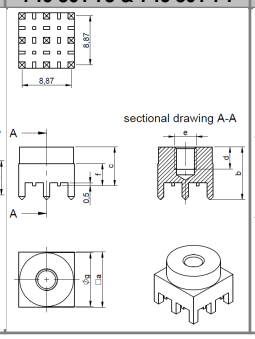
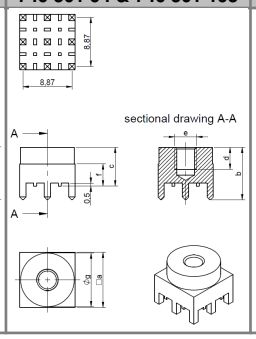
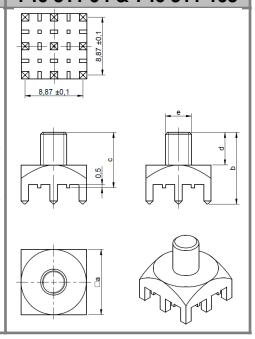
REDCUBE THR

- Material: Brass
- Surface: Tin plated
- Heat resistance: up to 150°C
- Tightening torque: M3 (0.5Nm), M4 (1.2Nm), M5 (2.2Nm)

Characteristics and applications

- Through Hole Reflow Soldering
- Low initial time and cost
- High mechanical torques and forces
- Small size
- Solderable Wire-to-Board connections

Order Code Bulk	Order Code Reel	a (mm)	b (mm)	c (mm)	d (mm)	f (mm)	Thread e	Pins	Type	Current I (A)
746 500 73	746 500 73R	7	5.5	3	2.5	-	M3	4	Bush	50
746 500 74	746 500 74R	7	5.5	3	2.5	-	M4	4	Bush	50
746 500 94	746 500 94R	10	6	3.5	3	-	M4	8	Bush	85
746 550 95	746 550 95R	10	6.5	4	3.5	-	M5	8	Bush	85
746 501 73	746 501 73R	7	8.5	6	3.5	3.5	M3	4	Bush	50
746 501 74	746 501 74R	7	9	6.5	4	4	M4	4	Bush	50
746 501 94	746 501 94R	10	9.5	7	4	4	M4	9	Bush	85
746 501 95	746 501 95R	10	9.5	7	4	4	M5	9	Bush	85
746 511 73	746 511 73R	7	11	8.5	4	-	M3	4	Shank	50
746 511 74	746 511 74R	7	11	8.5	4	-	M4	4	Shank	50
746 511 75	746 511 75R	7	13	10.5	4	-	M5	4	Shank	50
746 511 94	746 511 94R	10	11	8.5	9	-	M4	9	Shank	85
746 511 95	746 511 95R	10	13	10.5	9	-	M5	9	Shank	85

746 500 73 & 746 500 74	746 500 94 & 746 550 95	746 501 73 & 746 501 74	746 501 94 & 746 501 195	746 511 94 & 746 511 195
				

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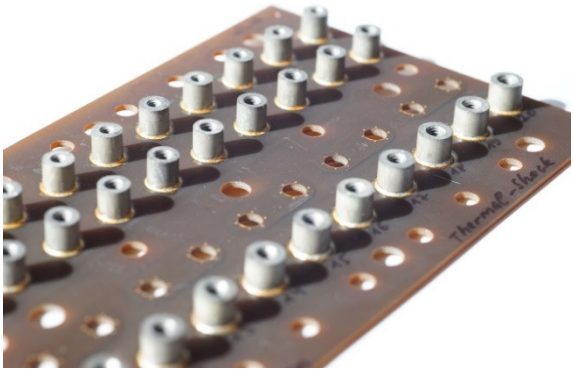
Reliability Test

The reliability of REDCUBE SMD Terminals is often proved in different qualification programs, tests and in field.



Five Time Reflow Test according to:

- **J-STD-020D**

Solderability according to:

- **JESD22-B102**

Environmental tests according to:

- **MIL-STD-202, Method 107**
  - ✓ Thermal Shock, -55°C/+150°C, 500 cycles
- **MIL-STD-202 Method 106**
  - ✓ Moisture Resistance, 65±2 °C, 95%RH, 500h

Mechanical tests according to:

- **MIL-STD-202, Method 204:**
  - ✓ Vibration, 10g´s for 20 minutes, 15 Hz to 2000 Hz, 12 cycles per axis

Electrical tests according to:

- **IEC 60512-2-1** Connectors for electronic equipment - Tests and measurements - Part 2-1: Electrical continuity and contact resistance tests; Test 2a: Contact resistance; Millivolt level method
- **IEC 60512-2-5** Connectors for electronic equipment - Tests and measurements - Part 5-2: Current-carrying capacity tests; Test 5b: Current-temperature derating

- ➢ **REDCUBE SMD** *display very high reliability*
- ➢ *The requirements of the relevant standards are exceeded by far.*

WÜRTH ELEKTRONIK

more than you expect

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