The Red Cube and Its Fellows

Figure 1: The rectangular SMD terminals are designed for rated currents up to a maximum of 50 A and require only a small solder area in the M3 package.

REDCUBE Terminals for High Current Connections

Contributed by **Würth Elektronik**

With the REDCUBE terminals, Würth Elektronik offers a product group with high current contact solutions in various designs. The terminals owe their name to an innovative variant with a quick-locking system, which actually brings the manufacturer's company colour onto printed circuit boards in the form of a red cube. On closer inspection, even the less colourful models in the product series compete with their red counterparts in terms of functionality.

When it comes to connecting power connectors to the PCB, many users have two options in mind: classic, automated SMT assembly and manual THT assembly. There are good reasons why surface mount technology and through-hole technology are so well known and popular. For connections in the low voltage and mA range, SMT assembly is and remains the most effective and cost-efficient method (**Figure 1**). In the fully automated assembly process, the components are placed by pick and place onto the printed circuit board, which is already covered with solder paste. In the subsequent reflow process, the solder is liquefied — hence the name reflow — to bond the components to the PCB. The special feature of this process is that both sides of the PCB can be processed in the same process.

While SMT assembly was the domain of low currents, it has now also established itself in the midfield. Wire-to-board connectors with currents of around 5 A are already standard. SMT connections are also gaining ground for terminal blocks up to 10 A.

And what needs to be considered on the cable side for currents above 10 A? Higher currents result in increased heat generation, which has to be handled with a larger cable cross-section. As a result, the mechanical load on the PCB connection increases. The SMT connection cannot withstand this. That is why many are switching to through-hole assembly.

The Square Thing Must Go Into the Round Thing

THT connectors are leaded components, with small connection pins that are later inserted by hand through a through-hole in the PCB and connected to the board using wave soldering. The THT assembly takes place after the SMT production. This means that both sides of the board are usually already assembled and the risk of damaging components that have already been soldered on during wave soldering is often high. Therefore, manual soldering or selective soldering must often be used. These additional production steps cause corresponding additional costs in production. But do you really have to deal with this time and cost factor every time the current intensities increase? No!

Anybody who needs to apply up to 85 A (at 20°C) to the PCB can stick to classic SMT assembly with the REDCUBE SMD product family in order to connect single wires to the PCB. In addition, those who do not want to do without the mechanical load capacity of THT components for small and medium currents do not have to deviate from the reflow process. Power connectors with THR (through hole reflow) connections can be assembled together with SMT components in the same reflow process. In reflow soldering, the components are exposed to higher temperatures than in wave soldering, however. For this reason, both connectors and pin contacts must be adapted to THR assembly in terms of design and material. The design modifications can be found on the underside of the housing: Spacer pins create space for the solder paste and promote airflow under the housing so that the soldering temperature can be evenly distributed in the PCB. The contact pins must also feature the

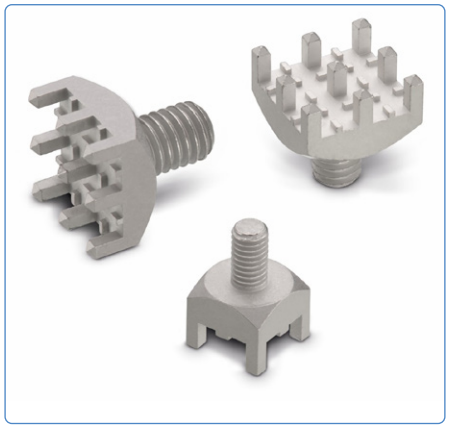

Figure 2: Instead of the common bracket elements on the market, the REDCUBE THR terminals have a special and massive pin design, which provides a perfect soldering result and a high mechanical stability.

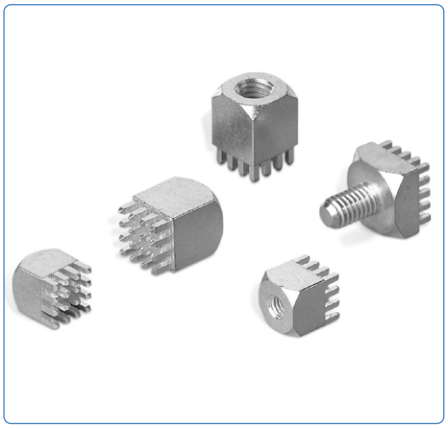

Figure 3: Press-Fit terminals combine a very high current carrying capacity with high mechanical stability, while still allowing seamless and thus cost-effective integration into the pick-and-place process.

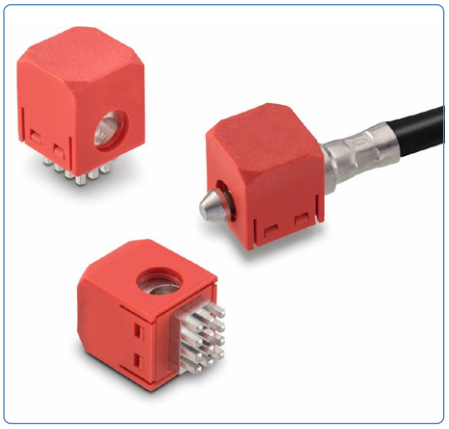

Figure 4: The REDCUBE Plug series offers four different plug-in connections from 50 to 120 A for simple and fast wire-to-board high-current connection.

correct length for the THR technology, so that neither the stability of the contact pin in the through-hole is impaired nor solder paste is pressed through the through-hole and causes solder beads. All these adjustments and the additional cost of tape and reel packaging result inevitably in a higher price for the THR elements. But therefore switch to the conventional THT assembly? Particularly when THT components are only used in isolated cases, the THR process is noticeably more cost-effective in terms of its overall cost. In addition, significant space savings on the board can be achieved with this process.

Whether it is a forklift, elevator or simply a battery charging connection, high vibration resistance is a key requirement for power connectors in applications where they are subject to regular movement or many mating cycles. REDCUBE THR power connectors are particularly suitable for such applications because their contact pins are rigid rather than flexible, unlike those of other power connectors (**Figure 2**). Note that the pin geometry also plays an important role in the THR process, as it must be taken into account when calculating the solder paste volume. There is a simple formula for determining the required solder paste volume:

(volume of through hole - pin volume in via) x 2.

The factor 2 is necessary because only 50% of the solder paste is metallic and additives such as flux vanish in the process. Optimal is a filling level of 100% — according to IPC-A-610D a more than 75% filled solder joint is acceptable.

No Soldering! Press-In!

So how can connections be made on a printed circuit board that are required to carry an even higher current and whose connection must be mechanically much more stable and reliable over a long period of time, for example in wind turbines, than a soldered connection can ever achieve? This is where press-fit technology comes in.

Pressing the pins into the PCB, a high friction between pin and plated through-hole generates a homogeneous cold-welding between materials (**Figure 3**). This results in a gastight, strong mechanical connection with contact resistance less than 200 μΩ. No other technology transfers power up to 500 A at this low heat development. In principle, the vias are produced in the same way as the holes for accommodating THT components. Consequently, there is no need for any changeover in PCB production. The main difference to THT assembly, on the other hand, is that soldering does not guarantee the solder introduced into the holes will also rise up the entire sleeve. Not only will this affect the mechanical stability but also the long-term reliability if the sleeve is not filled to 75%. This also results in much higher contact resistances. Press-fit terminals are different: If a solid press-fit pin on a 2.4 mm thick PCB is bonded to the sleeve at each corner with more than 3° after the press-fit process, the press-fit zone has a lower electrical resistance than the brass pin itself and therefore does not represent an electrical or thermal bottleneck. Normally, the tether angle is many times higher, providing a high safety buffer to the electrical connection. Another advantage over soldering is that printed circuit boards with a thickness of up to 3.2 mm and high copper occupancy can be easily processed. In order to make the advantages of connection by press-fit technology available to a wide range of applications, Würth Elektronik offers the REDCUBE Press-Fit Terminals made of brass with a tin-plated surface in different variants: Internal thread (two-row, circumferential or full-surface), external thread full-surface, 90° two-row or full-surface as well as two-part as basic and support element.

For anyone looking for a quick and easy way to implement a wire-to-board high-current connection, Würth Elektronik offers the REDCUBE Plug, the latest addition to the series (**Figure 4**). This connector also comes with all the advantages of press-fit technology and completely without washers and nuts/screws. The small red cube made of glass-fiber-reinforced plastic is capable of accommodating four different plug-in connections ranging from 50 to 120 A. The screwless connection is made by manually actuating the housing from above and inserting the corresponding plug. By means of spring force, the plug is automatically locked in the housing. The connection can also be released again in this way. The REDCUBE Plug is pressed in according to the same principle as the REDCUBE Press-Fit. On the cable side, the cable connector and cable, with cross-sections of 4, 6, 10 or 16 mm², are connected together using a hexagonal crimp. This releasable, multi-pluggable wire-to-board and board-to-board connection is particularly suitable for installation in small spaces or in hard-to-reach places, as no tools are required. For use in chargers, REDCUBE Plugs can be supplied in other colors making them easier to distinguish.

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