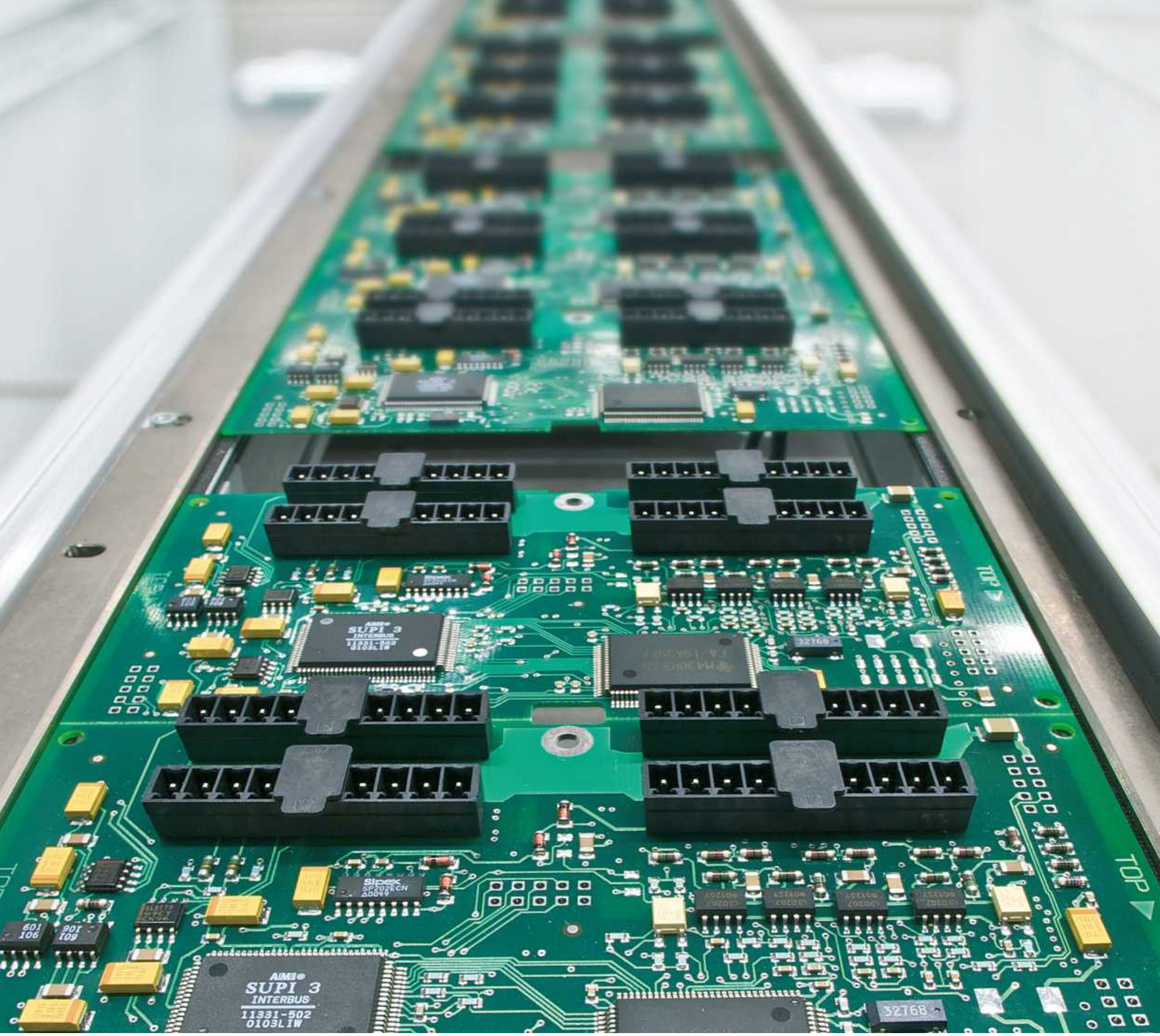


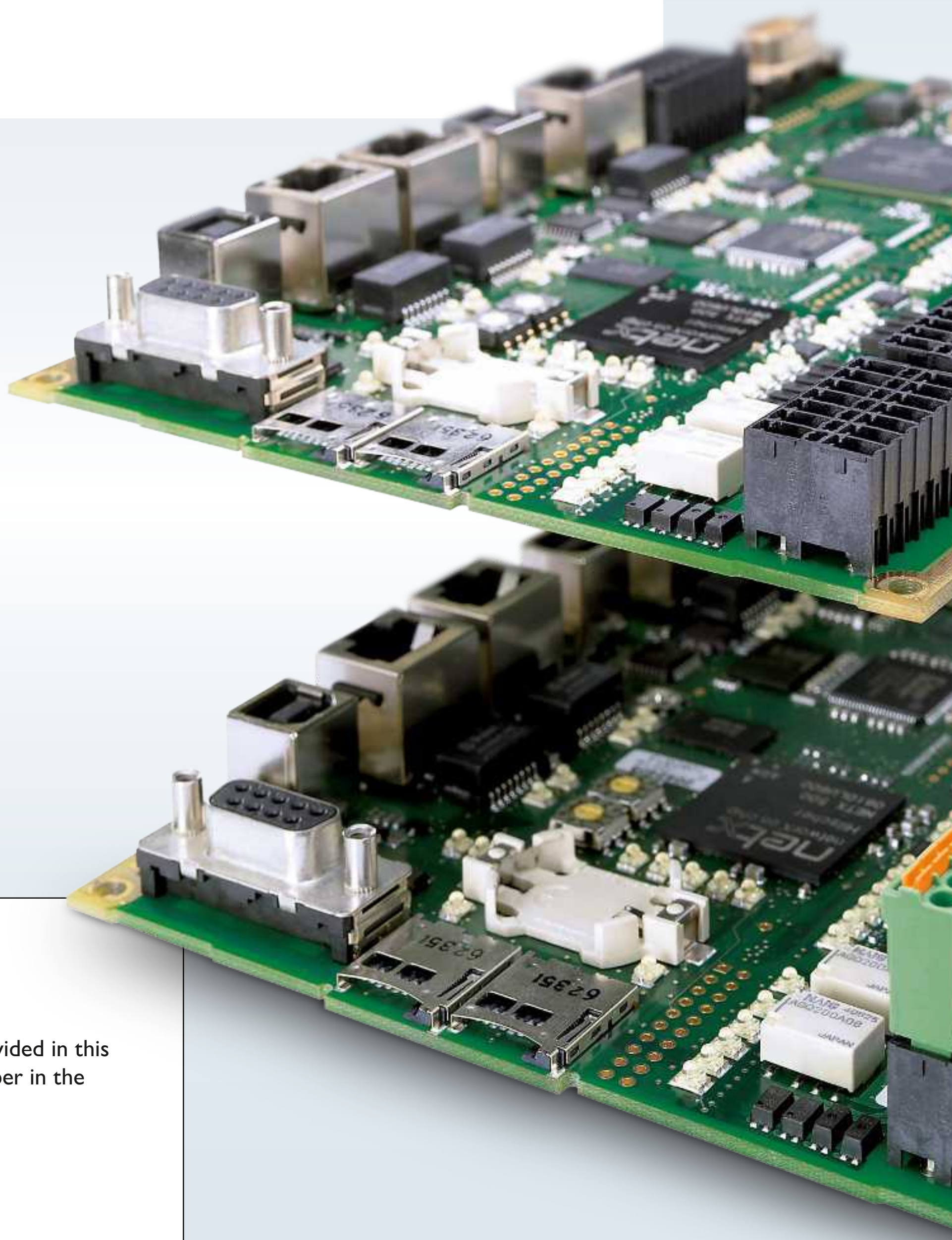
Connectors for SMT production

Basic principles and product overview

PHOENIX CONTACT

Surface mount technology (SMT) – a modern production process

Modern module manufacturing is characterized by high functional and component density with growing demand for miniaturization and reduced surface requirements of the components on the PCB. At the same time, the focus is also on cost-optimized manufacturing. Over the last few years this has had a significant influence on the increasing integration of components and connectors that were previously conventionally assembled using wave soldering technology.



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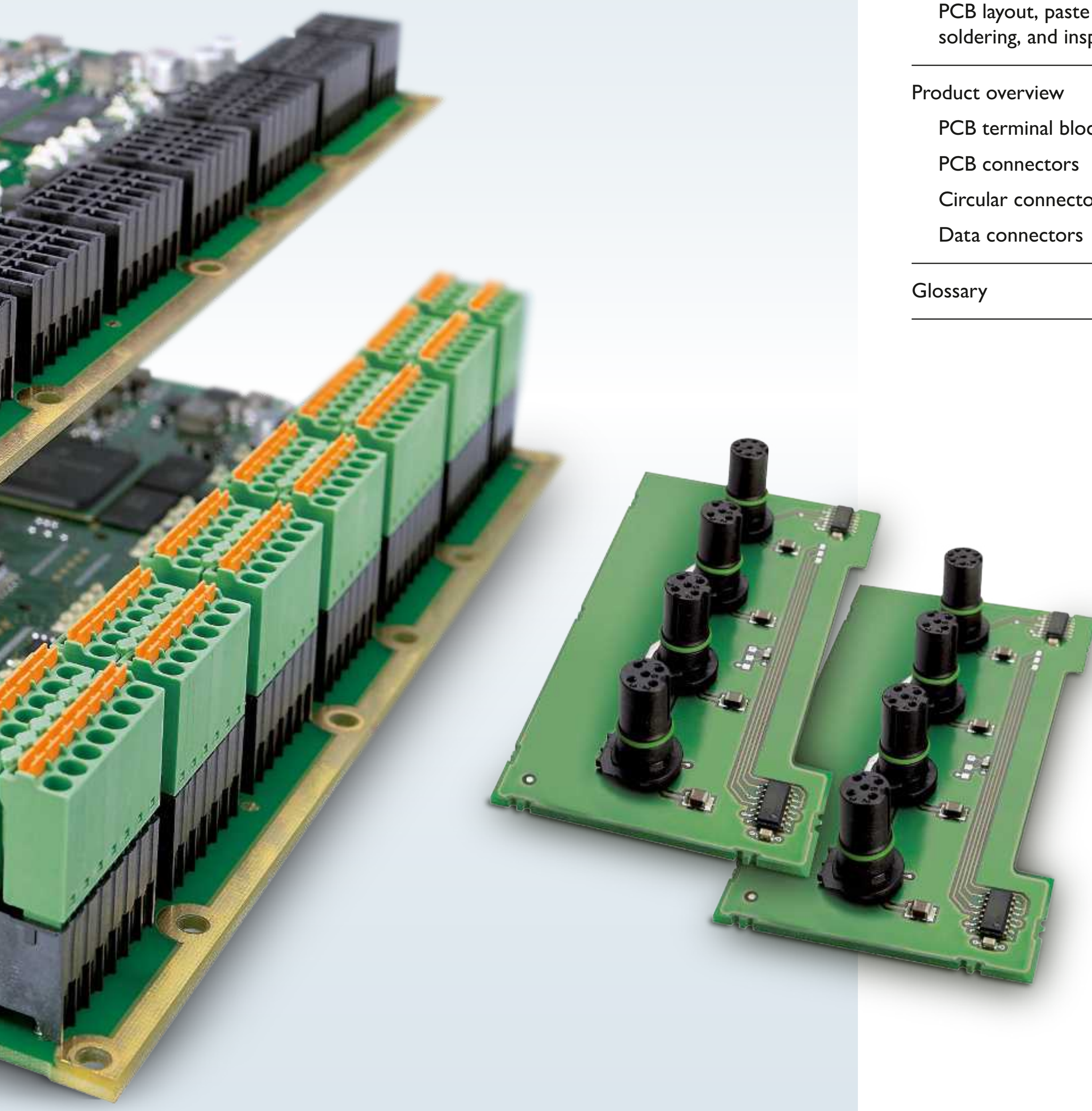


1 Surface mount technology – the basis for module manufacturing

Surface mount technology is the basis for modern module manufacturing and is the result of decades of optimization in the module manufacturing process. Module manufacturing can be optimized and transformed into a cost-effective, high-quality, and less error-prone production process by switching from wired components that are mostly assembled by hand to surface-mounted components that support automated assembly.

In contrast to the through-hole assembly of wired components, SMD components have solderable connection surfaces that are soldered directly onto the top side of the PCB. In this process, the contact surfaces of the PCB are printed with solder paste, a mixture of solder particles and flux. The solder contacts on the SMD components are set into the paste and then soldered in the reflow oven (Fig. 1).

A driving factor in the development of SMD components is miniaturization and the associated increase in contact density and functionality on the PCB. The focus was therefore on the optimization of components with an electronic function (resistors, diodes, or ICs). With the increasing availability of components, interface components such as connectors also came under the spotlight. Connectors with low current loads and low requirements in terms of mechanical strain are already used in SMDs. There are currently two ways of integrating connectors with high requirements in terms of current carrying capacity and mechanical functions:

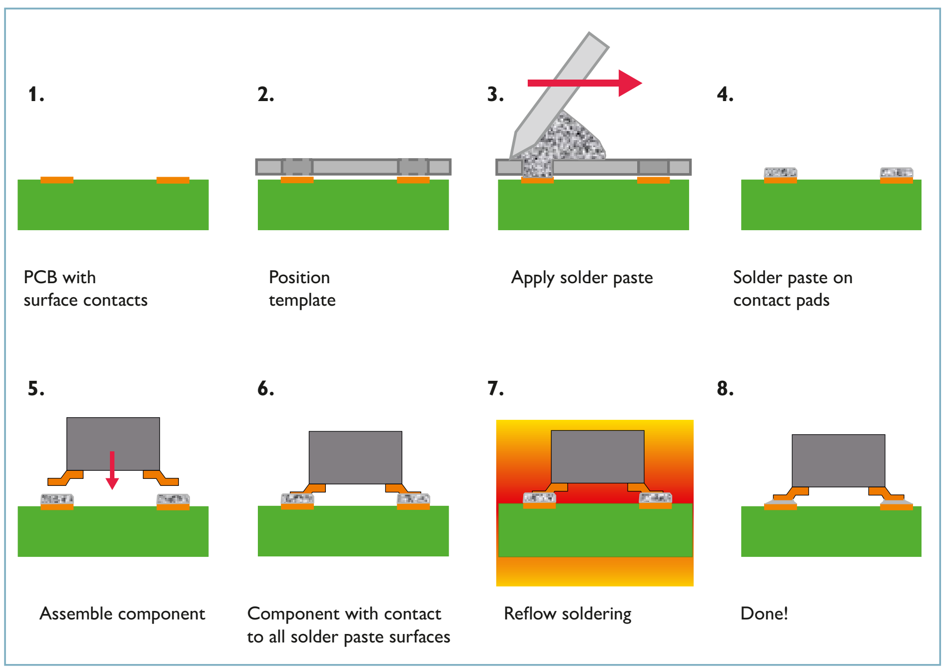


Fig. 1: Sequence for the surface mount process

1. The connectors are treated as standard components and wave soldered in a second process step.
2. The connectors are integrated into the SMD process using THR technology.

2 Basic principles of through-hole reflow technology

The through-hole reflow soldering process applies the process steps of SMT manufacturing to a PCB with through-contacted holes and to components with through-hole contacts. The functional principle of this method is today regarded as being established and has been accounted for in a separate standard, DIN EN 61760-3. The results of the soldering process satisfy the respective requirements of IPC A 610.

The THR process makes it possible to combine the mechanical stability of wired components with the efficiency of SMT. In the THR process, the solder paste is pressed into the through-contacted holes using the same process equipment. The amount of solder paste pressed into the holes must be balanced with the volume necessary for the final soldering spot.

Once the solder paste has been applied, the THR component is assembled in the holes. During this process, some of the solder is pushed through the bottom of the hole by the pin tip, but remains adhered to the pin tip. In the melting process in the reflow oven, this solder draws back into the hole and forms corresponding solder menisci on both sides. The mechanical stability of THR soldering spots is comparable with that of wave-soldered spots (Fig. 2).

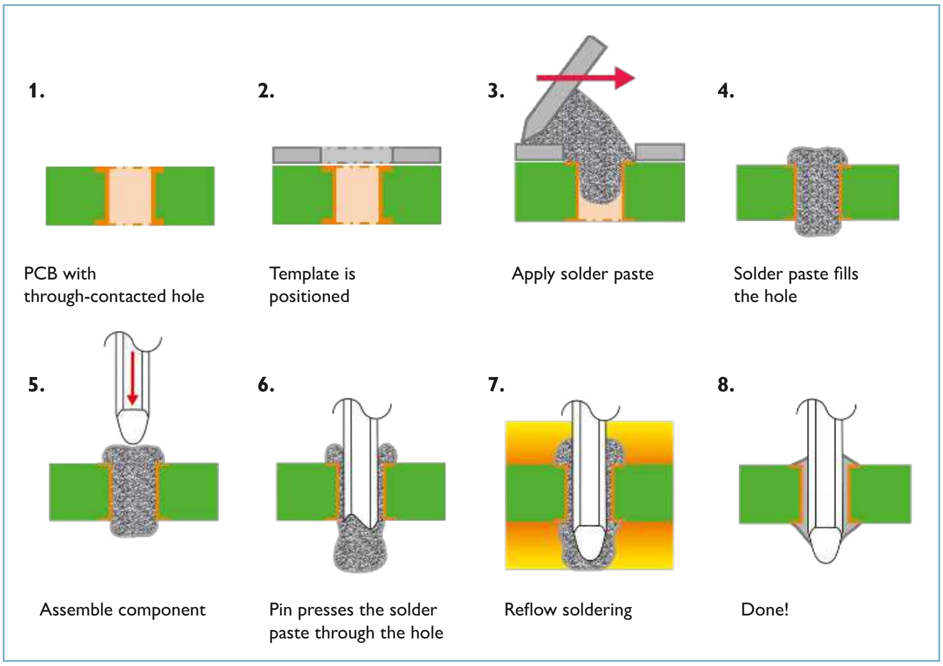


Fig. 2: Sequence for the through-hole reflow process

3 SMD and THR connectors for the reflow process

The use of components for different soldering technologies often necessitates the provision of several systems (wave/reflow soldering system) and the PCB being assembled in stages. The concurrent use of SMD and THR PCB connection technology is aimed at reducing the number of production steps and manufacturing the module using just one soldering process. Adjustments to existing production equipment or to the process control system are to be avoided wherever possible here. Regardless of which mounting type is used – SMD or THR – the components must be developed for the individual process steps of SMT mounting and the respective requirements.

Alongside the requirements on the components themselves, the components and the processing of these must be integrated into the process chain accordingly. The fundamental steps in the chain are: application of the solder paste via printing (Fig. 3), component assembly (Fig. 4), reflow soldering (Fig. 5), and finally inspection with a qualitative assessment of the soldering spots (Fig. 6).

The aim of this integration is to be able to concurrently process wired through-hole THR components and surface-mountable SMT components – using the same equipment, in the same process, and under the same conditions. Only then is a reduction in the number of process steps (e.g., no additional wave soldering) and more cost-effective module manufacturing achieved.

Fig. 3: Printing

Fig. 4: Assembly

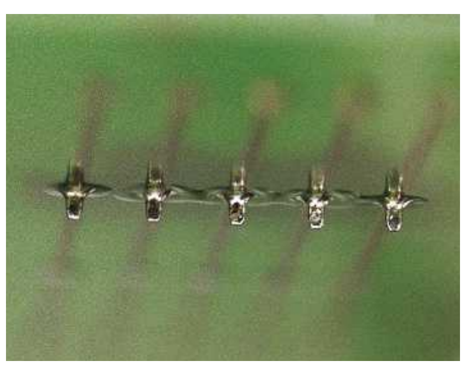


Fig. 5: Reflow soldering

Fig. 6: Inspection

4 Requirements for connectors for the reflow process

For use in the SMT process, the components must satisfy certain requirements regarding their geometry, the materials and surfaces used, and the packaging. Additional adjustments are necessary, especially for connectors.

4.1 Universally applicable requirements

The following requirements apply both to connectors solely intended for SMDs and to THR connectors.

High temperature plastics – HT
Short-term high temperature resistance is the foremost consideration in the requirements profile for a plastic intended for use in SMD or THR components. At the same time, however, the performance spectrum of the component should deviate as little as possible from that of a wave-solderable version. The insulation data of HT plastics is sometimes significantly below that of standard plastics. Therefore, lower rated data/rated voltages are to be expected.

These days, depending on the requirements, polyamides (e.g., PA 4.6), LCPs (liquid crystal polymers), or PCTs are used. Decisive factors in the selection are, amongst other things, the planned geometry of the component, the envisaged process window (temperature load) in the reflow oven, the planned expenditure for packaging and, associated with this, ultimately the price.

The processability of a component made of a particular high-temperature plastic is generally qualified in accordance with standard IPC/JEDEC J-STD-020.

Suction surfaces for optimum assembly
Automatic assembly is a prerequisite for SMD mounting. Alongside the appropriate delivery methods, e.g., tape or tray form, the focus is on removal from the packaging. Components must have smooth suction surfaces in order that they can, wherever possible, be picked up by the mounting head of the machine without the use of any special grippers or special pipettes (Fig. 7/8). It is then possible to suck them up and move them using standard vacuum pipettes. If appropriate surfaces are not available or are too small, the component must be fitted with additional pick-and-place pads (Fig. 9).

Ideally, a component capable of automated assembly will not have an additional pad.

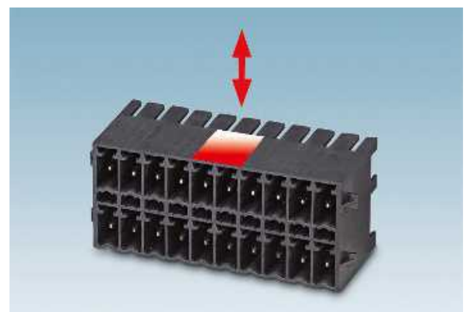


Fig. 7: Component shape-supporting suction surface

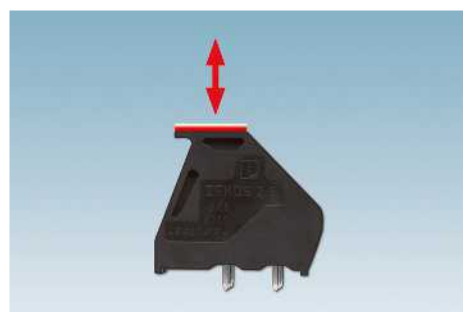


Fig. 8: Integrated raised suction surface

Fig. 9: Additional pick-and-place pad

Clearances on the bottom of the component

The contact of solder paste on plastic parts and the undefined melting-on can lead to residual solder balls or solder bridges which, at worst, cause short circuits in the module. Where possible, the components should have large clearances (Fig. 10) around the solder pin or the surface contact and be equipped with spacers known as standoffs. Furthermore, it must also be ensured through the layout of contact pads (Fig. 11) or residual rings that there is no contact between the insulating body of the component and the solder paste.

Colored SMD/THR components

Components for the reflow soldering process should ideally be black – this ensures very clear demarcation between the contacts and the housing and facilitates image capture via camera systems for the assembly process.

Colored components (Fig. 12) can only be made available if the thermal stability of their color pigments is sufficient and, for certain applications, if the pigments are UV stable (Fig. 13). The color palette that is currently available is limited and dependent on the base material (polyamide or polymer). Thanks to improved exposure and contrast imaging, modern camera systems are capable of capturing the necessary details despite the poor contrast of the metals against the colored housings.

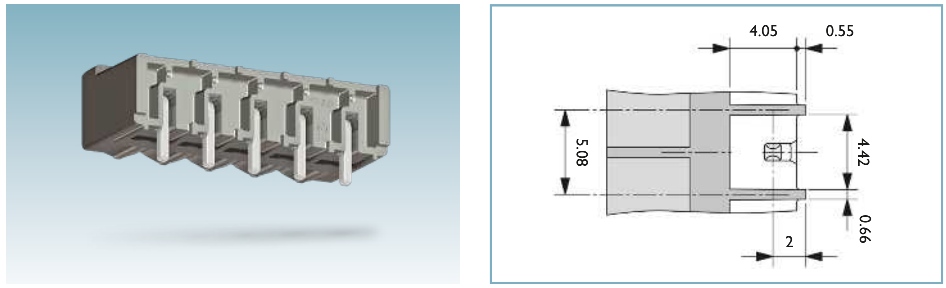


Fig. 10: Example of documentation for the possible clearance below a THR connector

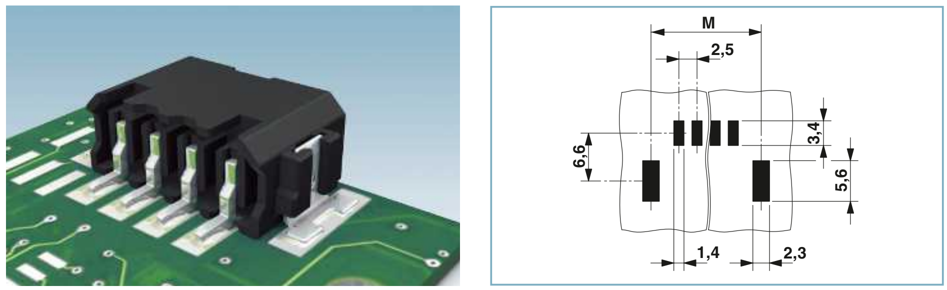


Fig. 11: Example of layout recommendations for an SMD connector

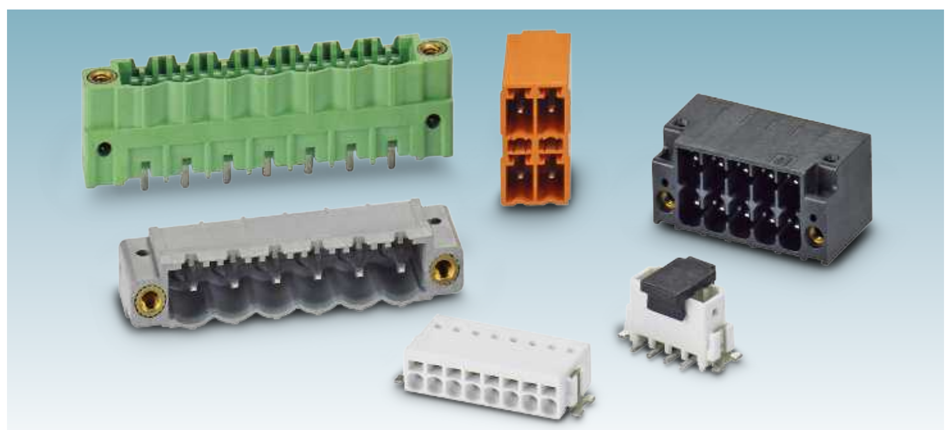


Fig. 12: Color versions

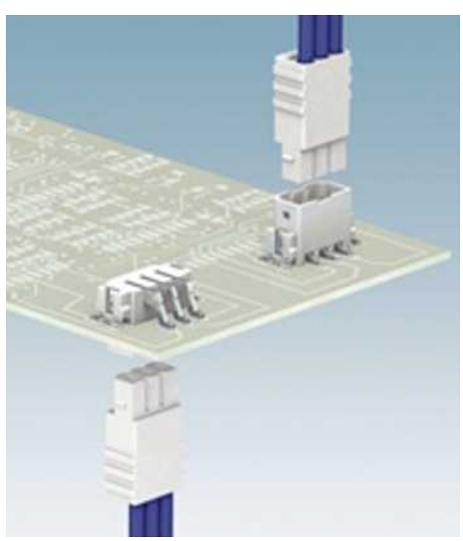


Fig. 13: SMD connectors in white for light connections are also UV-resistant

Gold-plated contacts

The use of gold-plated contact systems, especially in the solder area, is generally categorized as critical because tin-gold structures are formed which become brittle over time, potentially damaging the soldering spot. In contrast to wave soldering, a certain amount of gold remains in the soldering spot of THR and SMD components due to the limited amount of solder paste or solder. In many cases, this risk can be avoided. For example, Phoenix Contact provides pins that are partially gold plated (Fig. 14). The contact side is gold-plated as normal, the solder side is tin-plated (Fig. 15).

If, due to the manufacturing process or the specific application, fully gold-plated contacts are nevertheless used (Fig. 16), the amount of gold remaining in the soldering spot must be determined. In accordance with EN 61191, this may not exceed 1.4%. All Phoenix Contact SMD/THR contact systems are calculated on this basis.

Fig. 14: Partially gold-plated pins

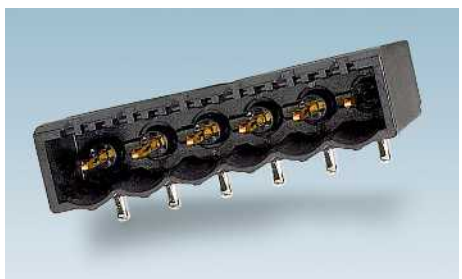


Fig. 15: THR pin strip with partially gold-plated pins

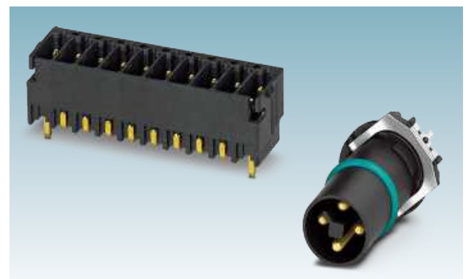
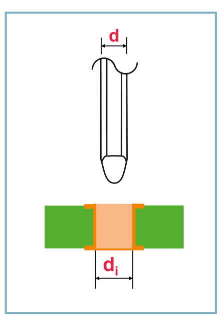


Fig. 16: Connectors with fully gold-plated SMD contacts – EN 61191 compliant

4.2 Specific requirements for THR components

Area of application of THR technology

The process window of the pin-in-paste method is determined by the relationship between the pin cross-section, hole diameter, and PCB thickness. In addition, there are also certain special requirements, primarily concerning the pin length and the position tolerance of the pins.



	Pin diagonal (d)	Recommended hole diameter (di)
Pin solder flange	1.58 mm 1.2 x 1.2 square pin	1.9 mm
CC-COMBICON	1.23 mm 1 x 1 square pin	1.6 mm
MC-COMBICON	1.15 mm 0.8 x 0.8 square pin	1.4 mm
Micro-COMBICON	0.9 mm 0.64 x 0.64 square pin	1.2 mm

Fig. 17: Relationship between pin diagonals and the recommended hole diameter, based on a PCB thickness of 1.6 mm

Area of application of pin-in-paste technology

The process window in which the pin-in-paste method can be used is determined by the solder paste and the relationship between the hole diameter and the PCB thickness. The smaller the hole diameter, the more difficult it is to generate sufficient through-print and therefore to fill the hole 100%.

The lower diameter limit for a 1.6 mm PCB is approximately 1.0 mm. The upper limiting diameter of approximately 2.0 mm is defined by the risk of paste discharge directly during screen printing, i.e., the paste cannot maintain its position in the hole.

Examples of common combinations are shown in the table (Fig. 17).

The purpose of correlating the hole dimensions and pin diameter is to ensure that the pin strips can be processed without difficulty. Ultimately, it must be possible for the operator to produce soldering spots that satisfy the requirements of class 3 of IPC A-610.

Pad design/residual ring
With regard to dimensioning the residual ring, the same requirements as those for wave-soldered pads largely apply. Taking into consideration the air clearances and creepage distances and the clearance below the component around the pin, the ring width should be between 0.2 and 0.5 mm. The potentially larger volume of paste on wider rings can have a positive effect on the soldering quality (meniscus formation).

Hole diameter
The use of THR technology requires modifications to the PCB layout. Selecting the correct hole diameter is important here. On the one hand, selecting a suitable hole diameter is important for ensuring the reflow of the solder in the reflow process; on the other hand, the hole size affects the ability to use automated assembly. Through the use of a suitable hole size, production tolerances are compensated and reliable assembly is possible.
In practice, the longer the component the greater the production tolerances. To increase the assembly reliability of large, high-position components, it may be necessary to increase the internal diameter even further by up to 0.1 mm. For Phoenix Contact THR components, the recommended hole diameters for the individual series are documented based on the number of positions (e.g., see table for M12 THR connectors (Fig. 18)).

Position tolerance – swash circumference
The position tolerance of pins in through-hole pin strips indicates the permissible positional deviation of the pin tip from the zero position in the x or y direction. More illustrative is the swash circumference concept, which describes a circle with corresponding diameter for the deviation of the pin tip around the zero position. For example, in this case, a position tolerance of ±0.2 mm describes a circle with a diameter of 0.4 mm, the center of which is the ideal zero position of the pin tip. The current THR standard, DIN EN 61760-3, specifies ±0.2 mm as the maximum permissible position tolerance. This corresponds to a swash circumference with diameter 0.4 mm. The position tolerance of the pin tip in the hole is indicated by the swash circumference (Fig. 19).

All Phoenix Contact THR components satisfy the requirements of the standard. Furthermore, a corresponding product portfolio is available for applications that require a position tolerance of ±0.1 mm.

THR product family (straight)				Recommended layout*		
Number of positions	Coding	Design [male/female]	Pin Ø [mm]	Hole	Residual ring	Template
4	A, D	Male/female	1	1.3	2	1.9
4	T	Male/female	1.3	1.6	2.6	2.4
4	S (cross)	Male/female	1.3	1.6	2.6	2.4
4/5	L, K	Male/female	1.3	1.6	2.6	2.4
4/5	L, K (FE/PE)	Male/female	1.15	1.45	2.6	2.4
5	A, B	Male/female	1	1.3	2	1.9
8	A	Male/female	0.8	1.1	2.1	1.9
8	X	Female	0.8	1.1	1.75	1.65
8	Y	Female	0.8/0.8	1.1	1.8	1.7
12	A	Male/female	0.6	1	1.7	1.6
17	A	Male/female	0.6	1	1.45	1.35

THR/wave product family (angled)				Recommended layout*		
Number of positions	Coding	Design [male/female]	Pin Ø [mm]	Hole	Residual ring	Template
4	A, D	Male/female	1	1.3	1.9	1.8
5	A, B	Male/female	1	1.3	2	1.9
8	A	Male/female	0.8	1.1	1.9	1.8
8	X	Female	0.8	1.1	1.75	1.65
8	Y	Female	0.8	1.1	1.8	1.7
12	A	Male/female	0.8	1.1	1.5	1.4
17	A	Male/female	0.8	1.1	1.5	1.4

SMD product family				Recommended layout*	
Number of positions	Coding	Design [male/female]	Pin Ø [mm]	Residual ring	Template
4	A, D	Male/female	0.9	1.9	1.7
4	T	Male/female	1.3	2.3	2.1
5	A, B	Male/female	0.9	1.9	1.7
8	A	Male/female	0.9	1.9	1.7
8	X	Female	0.7	1.7	1.5
8	Y	Female	0.7/0.9	1.7/1.9	1.5/1.7
12	A	Male/female	0.7	1.7	1.5
17	A	Male/female	0.7	1.45	1.35

Fig. 18: M12 PCB design

* For a PCB thickness of 1.6 mm

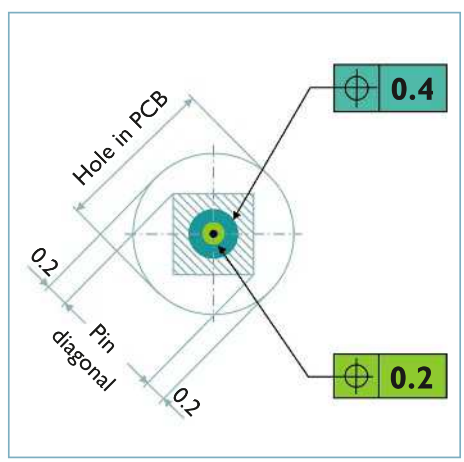


Fig. 19: Position tolerance of the pin tip in the hole – in accordance with the requirements of the standard, the tolerance of possible swash circumferences is 0.4 mm

Solder pin length
The soldering method and the type of soldering process (convection or vapor phase) should also be taken into consideration when selecting the right solder pin length. Pin protrusions between 0.4 and 1.0 mm are generally recommended these days. For a 1.6 mm thick PCB, this means a pin length of 2 mm to 2.6 mm from the bottom of the component in order to minimize the risk of paste loss (solder paste dropping). This applies in particular to the vapor phase process, because here, regardless of the solder applied, the condensate adds additional load to the solder ball at the pin tip and can lead to solder paste dropping. However, very good soldering spots can be created with extremely short pins countersunk in the PCB.

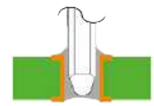
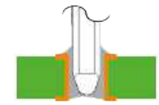
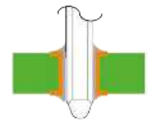
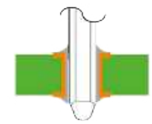
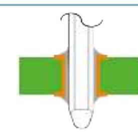
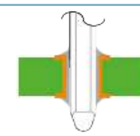
Pin length (standards)	THR convection	THR vapor phase
1.4 mm Countersunk pin 	Limited inspection 	Limited inspection 
2.0 mm Standard 	Ideal 	Ideal 
2.6 mm Standard 	Ideal 	Ideal 

Fig. 20: Pin lengths for use in standard PCBs with a thickness of 1.6 mm

With regard to IPC inspection, specific qualification criteria have not as yet been defined, meaning that the risk must be assessed on an individual basis (Fig. 20).

4.3 Specific requirements for SMD components

The connection contacts of SMD components are also subject to tolerance specifications. In addition, they require fixing elements to hold their position during the reflow process.

Coplanarity and paste coating thickness
The coplanarity of the surface contacts of SMD connectors should be within 0.1 mm and 0.15 mm in accordance with DIN EN 61760-1. A clean contact of the connections with the paste is, however, fundamentally dependent on the paste coating thickness. These days, this is normally between 100 and 150 µm. Accordingly, the coplanarity must therefore be 0.08 mm to 0.1 mm. Here, the possible coating thickness of the solder paste that can be applied depends on the particle diameter of the tin particles in the paste. Solder pastes are classified by type according to the particle size.
A coplanarity of 100 µm means that all contact areas in one plane must be within a tolerance of 0+0.1 mm (ideally 0+0.08 mm), otherwise contact with the solder paste may not be ensured in certain cases. In this case, the coating thickness of the solder paste must be at least 120 µm to ensure reliable contact (Fig. 21).

Position tolerance
The requirements regarding the position tolerance of SMD connection/solder contacts are comparable to those for THR pins. In this case, however, the position tolerance in the x and y direction is specified rather than the swash circumference. But depending on pitch, it should be in the range of ±0.1 mm, as per the SMD layout tolerance.

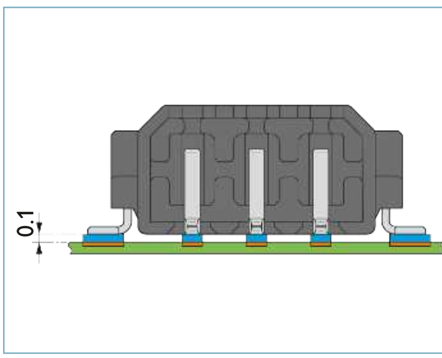


Fig. 21: Coplanarity of all component contacts of 0.1 mm

Mounting bosses
Mounting bosses are plastic pins that are integrated into the housing of the component, positioned in holes without surface coating. They prevent the component twisting in the event of floating during the soldering process and therefore prevent an impermissible lateral offset to the layout. Whether mounting bosses are necessary or not depends on the weight of the component. As a general rule, the same position tolerances also apply to the mounting boss holes (Fig. 22).

Armatures
SMD armatures for connectors primarily have two functions. First, to increase the secure positioning on the PCB and the mechanical stability when the connector is being plugged in and unplugged. Second, the additional armature surface can generate the necessary additional adhesion for overhead soldering during assembly on both sides (Fig. 23).

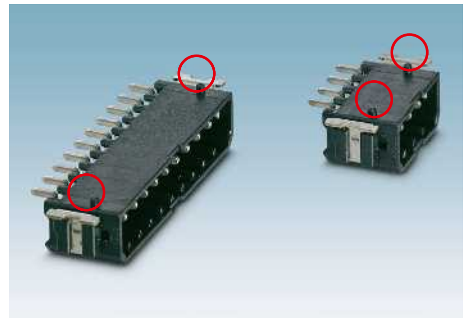


Fig. 22: Connectors with positioning pins (mounting bosses)

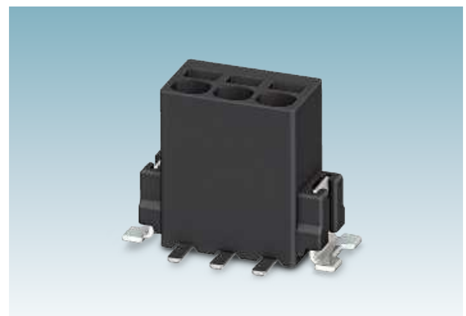


Fig. 23: PCB terminal block with lateral SMD armature

4.4 Specific requirements for combination SMD/THR components

SMD contacts and THR armature metals
Connectors solely intended for SMDs are used in device connection technology primarily within the device as board-to-board connections or wire-to-board connections, and less as direct external device connections.

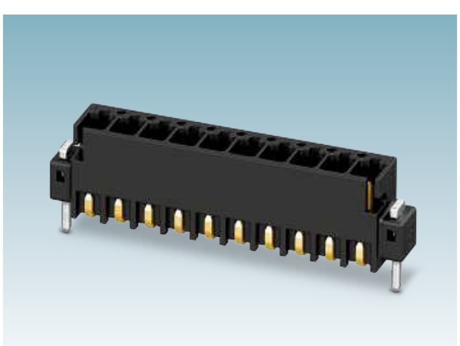


Fig. 24: Combination connector with SMD contacts and THR armature

For external device connections and for end user operation, the same high mechanical load values are required as for those of wave-soldered or THR-soldered through-hole connections. These are difficult to achieve with a pure SMD connector with similar connector dimensions. The use of connectors with SMD contacts and THR armature metals is ideal in this case (Fig. 24).

This type of connector must also satisfy the aforementioned requirements for SMD and THR connectors. At the same time, this combination provides clear advantages.

Double function for THR armature pins
In addition to the necessary mechanical stability, the THR armatures additionally perform the function of the mounting bosses and secure the connector against movement during the soldering process. In the area of the SMD contacts, the space on the secondary side of the PCB can be used for the layout.

5 Qualification of components for the reflow process

Connectors for use in the SMT process are primarily tested in accordance with the latest version of qualification standard IPC/JEDEC J-STD-020. The focus is the basic moisture absorption in plastics, which under the influence of the temperature load during soldering can lead to the destruction of the component through blistering, delamination, or deformation.

Depending on the component dimensions and geometry as well as the choice of plastic, a level is qualified which clearly determines the treatment of the component from manufacture through to its use in the SMT process.

5.1 Peak and classification temperatures for reflow components

In a basic sequence of tests, efforts are made to subject the component to the maximum optimized peak temperature (measured on the top of the component) within a simulated reflow soldering over a period of up to 30 seconds. These days, the desired peak temperature is approximately 260°C.

However, the standard only requires these high temperatures in practice for small components with a comparatively low housing or wall thickness. As the housing or wall thickness increases or the housing volume grows, lower temperature values apply. This does not mean that efforts should not continue to be made to test at as high a peak temperature as possible, merely that this is not required.

This is due to the fact that THR/SMD connectors are often among the largest components on the board. All other components heat up much more quickly due to their lower thermal masses, and must therefore withstand significantly higher peak temperatures over a longer period. Balanced thermal management should therefore protect the smaller components and securely solder the larger components despite the lower heating temperatures.

A classification temperature (Tc) is defined so that manufacturers and operators have an equal understanding of the maximum permissible peak temperatures. Furthermore, by stating Tc +5°C for qualification and TC -5°C for soldering, a temperature safety buffer is provided in order that the destruction of a component can be ruled out as far as possible (Fig. 25).

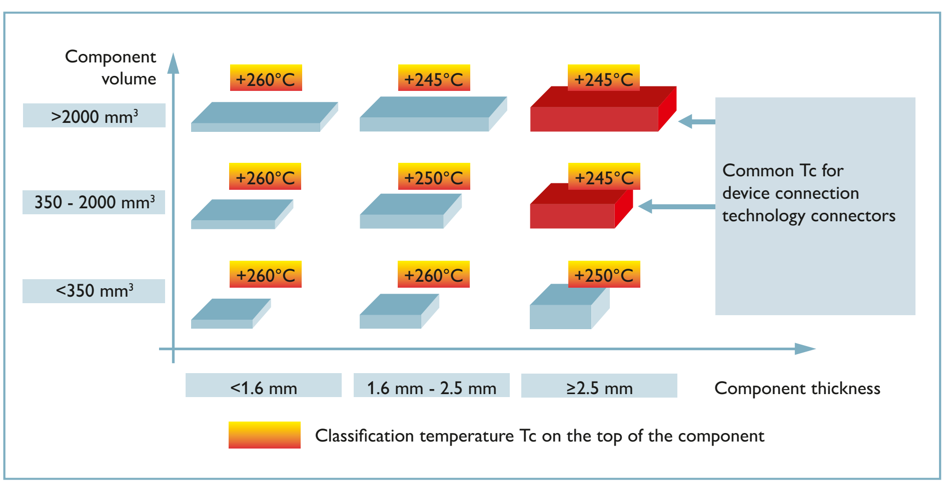


Fig. 25: Determination of the classification temperature based on housing volume and thickness for lead-free soldering processes

5.2 Moisture sensitivity level for reflow components

Along with the classification temperature, the moisture sensitivity level (MSL) is the parameter which precisely describes the treatment of the component during the reflow process. Levels 1 to 6 are assigned depending on the capacity of the component to absorb moisture (Fig. 26).

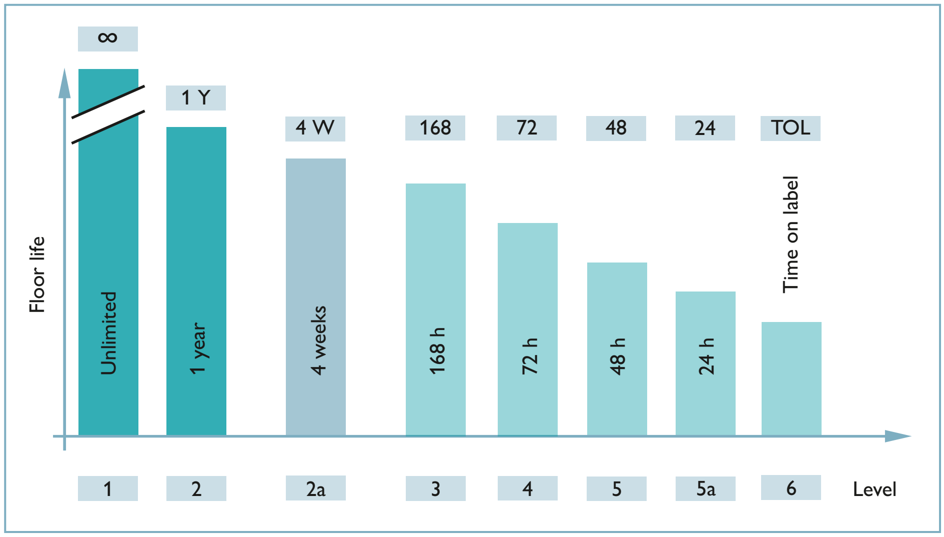


Fig. 26: MSLs and their associated floor life

5.3 Maximum permissible floor life = safe processing without damage in the reflow process

Exposed processing means the removal of the previously defined dry component from its air-tight packaging and the processing of this component within the time specified by the level. During this time, the component can absorb moisture without suffering damage in the reflow process.

Components that cannot absorb moisture or only small amounts are therefore candidates for level 1 (unlimited) without additional dry packaging (dry bag). These can be stored in the open and have an unlimited floor life for the process.

Components that absorb moisture are classified with floor lives from 1 year (level 2) down to just a few hours (level 3 - 6). These components need dry bag packaging. The floor life begins when the bag is opened and ends on expiry of the time specified by the level. The risk of component damage increases significantly upon expiry of the floor time (Fig. 27). In order to be used again, the components must be dried (rebaked) and returned to their initial state.

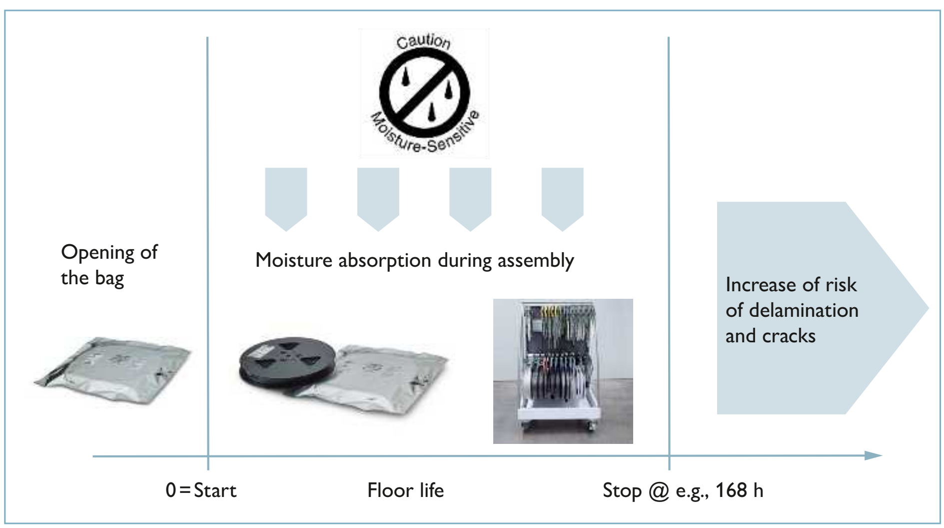


Fig. 27*: Floor life, example of the process for MSL 3 components

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5.4 Test cycle, qualification of the moisture sensitivity level (MSL)

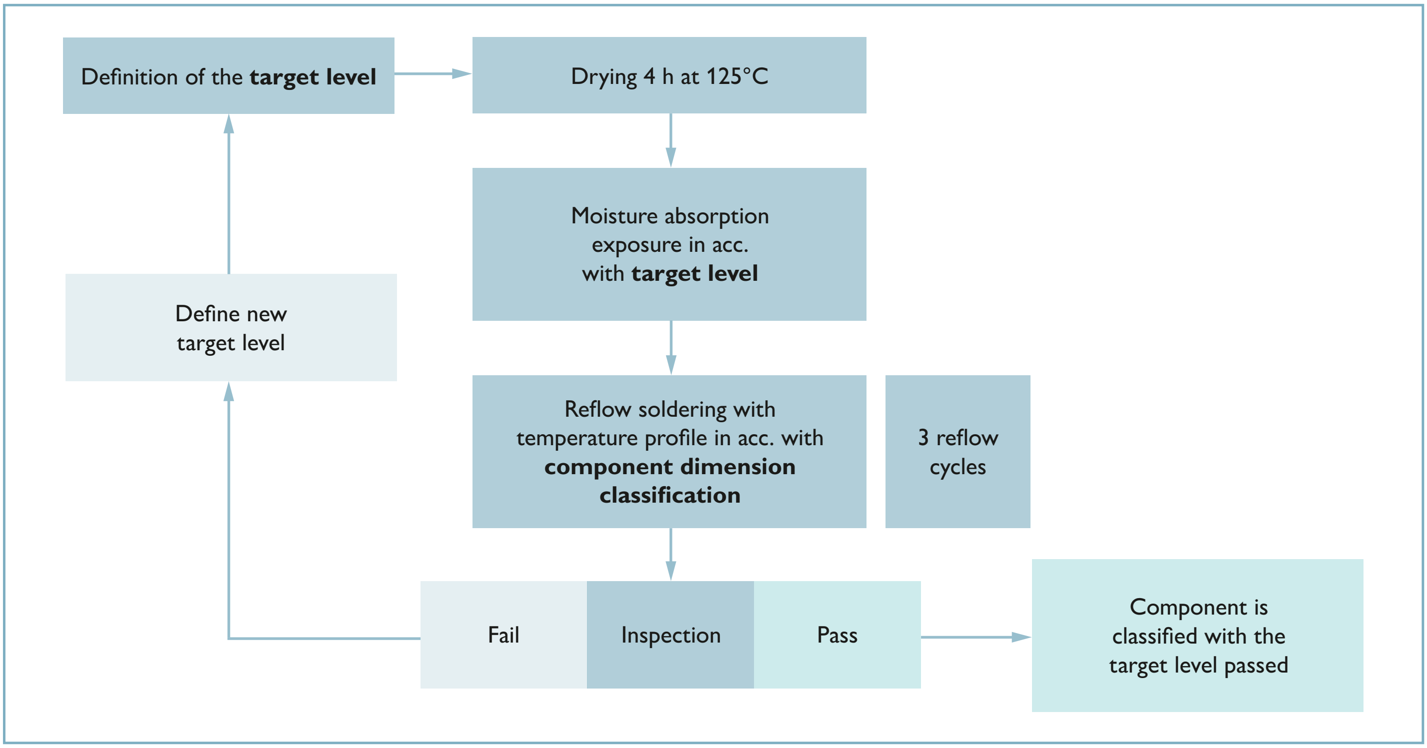

Fig. 28: Test cycle with which the target level is tested

The tests are normally first performed with classification temperatures of 260°C. It is only if the component does not pass the test that the classification temperature is reduced to 250°C or 245°C for certain component dimensions in accordance with the standard; however, the desired level is maintained for the time being. If this test is not passed either, a new target level is determined and the test cycle is restarted with a classification temperature of 260°C. The final moisture sensitivity level is only established when the component completes the test without any damage. The components are then packed and labeled in accordance with the standard specifications (Fig. 28).
The components are to be inspected for damage after each new test cycle. Blister formation (Fig. 29) on the component surface requires particular attention – it may be necessary to take micro-sections to determine if there is any internal damage (cracks) (Fig. 30). Fused surfaces and deformations will also result in the component not passing a target level.

Fig. 29: Failed level – blister formation

Fig. 30: Failed level – cracks

5.5 Qualification profile vs. operator profile

Even though the qualification profile is close to real-world conditions, there may be deviations from the real profiles of the operator. Ultimately, the suitable soldering profile depends on many factors. The process engineer needs to find a compromise between board size and thickness, component types and density, solder paste and system equipment, and many other factors in order to solder the module cleanly. The qualification profiles and their classification temperatures therefore serve as a reference point for the process engineer as to whether the components can be soldered using the actual profile (Fig. 31/32).

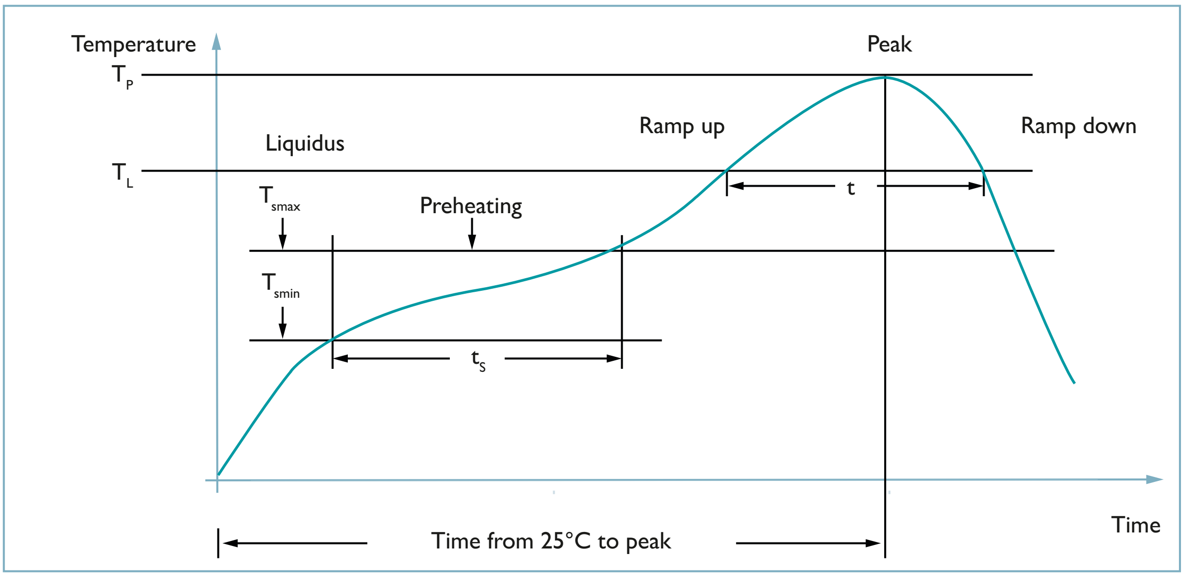

Fig. 31*: Idealized qualification profile in accordance with the standard

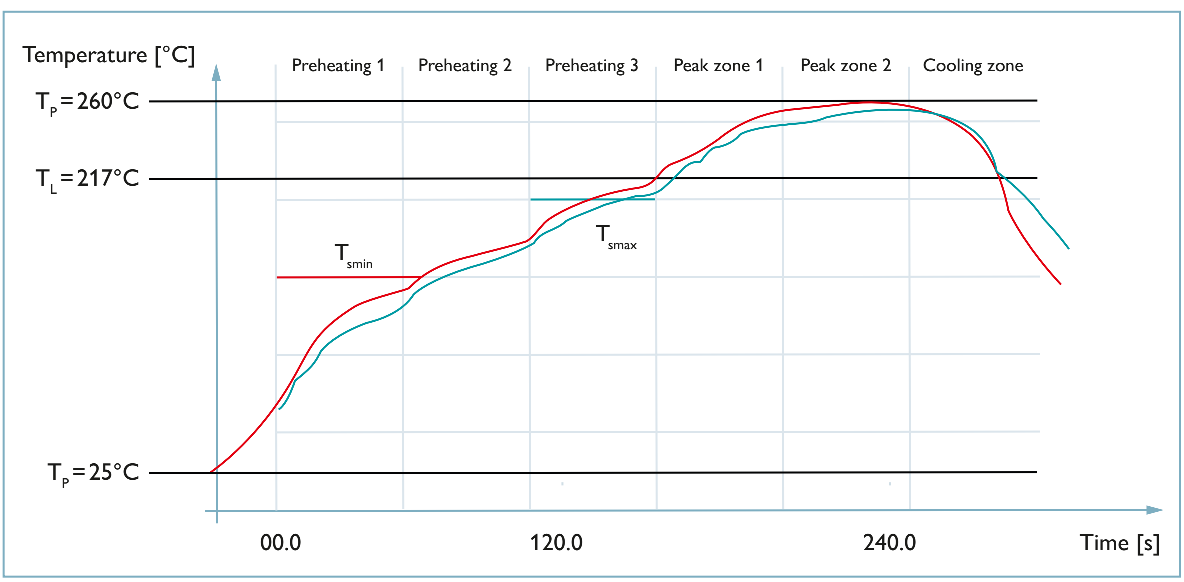

Fig. 32: Recorded actual operator profile

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5.6 Packaging

Based on the moisture sensitivity level (MSL) determined in accordance with IPC/JEDEC J-STD 020, there are two types of packaging.

Level 1
Components achieving MSL 1 do not require any special protective measures to prevent moisture absorption. Simple packaging in a protective bag that is electrostatically conductive is sufficient (Fig. 33).

Level goods
Level goods, i.e., goods with MSL 2 or higher, require dry bags that are also electrostatically conductive. Packaging is performed in accordance with IPC/JEDEC-033 with appropriate desiccants, moisture indicators, and nitrogen flushing and is concluded with the bag being partially vacuumed and sealed (Fig. 34/35).

Fig. 33: MSL 1 goods in an antistatic polybag

Fig. 34: Components in tape form in a dry bag

Fig. 35: Components as bulk goods in a carton in a dry bag

Moisture-sensitive goods in dry bags are also marked with a special label including corresponding warning information. The following information is required at the very least:

- The MSL (top right)
- The shelf life in the sealed dry bag
- The peak temperature value at which qualification was performed
- The maximum floor life of the component, during which it can be processed within the scope of the qualification values without risk
- The date the dry bag was sealed (Fig. 36)

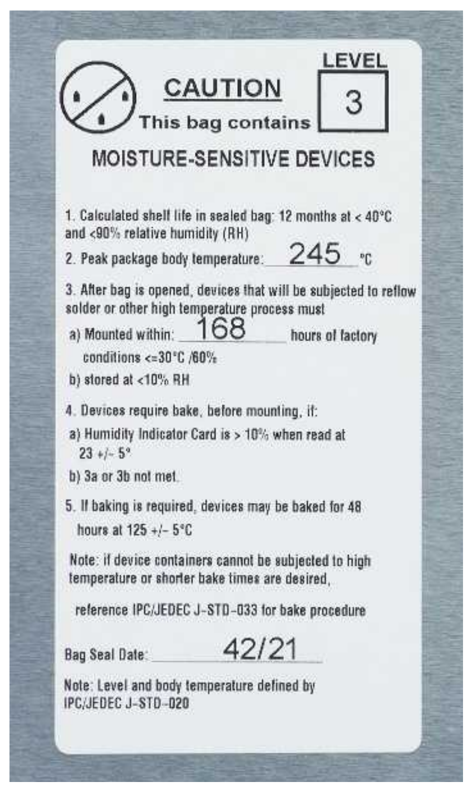


Fig. 36: Identification

6 Process integration – PCB layout, paste printing, assembly, soldering, and inspection

Optimum process integration begins with the PCB layout. It is at this early stage that the foundations for the best possible soldering results are laid. The correct paste application has a significant impact on the end result, but there are also corresponding conditions for the error-free positioning of components during assembly. The soldering process and subsequent inspection are well described in standards. Each process step places requirements on the components which they in turn must satisfy through the optimum selection of materials and product design.

6.1 PCB layout

SMD layout
The pad size for a certain solder contact size and the overall layout (arrangement and spacing of the pads) are usually recommended in the manufacturer's proposed layout. The proposed layout takes into consideration a sufficient area to produce soldering spots in accordance with the desired class of IPC A-610.

The arrangement of the contacts in relation to each other is largely influenced by the required air clearances and creepage distances. Tolerances that must be observed for the component and during assembly which affect lateral overhang and contact overlap influence the pad spreads. Connection surfaces oversized for safety reasons should also be avoided, as well as connection pads that are potentially too small and tend to have too much lateral overhang. Ultimately, the layout is a compromise which may be optimized at any time based on individual experience (Fig. 37).

THR layout – pad design/residual ring
With regard to dimensioning the residual ring, the same requirements as those for wave-soldered pads largely apply. Taking into consideration the air clearances and creepage distances and the clearance below the component around the pin, the ring width should be between 0.2 and 0.5 mm. The potentially larger volume of paste on wider rings can have a positive effect on the soldering quality (meniscus formation).

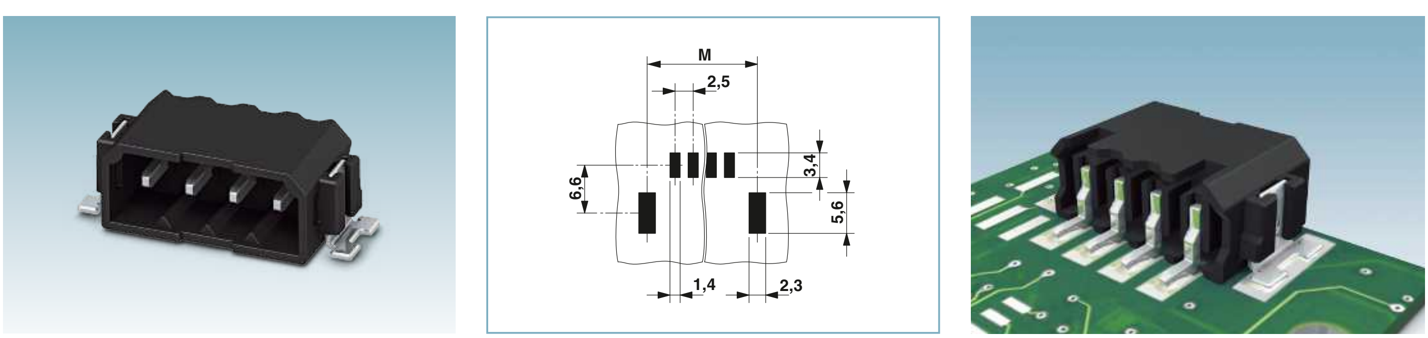
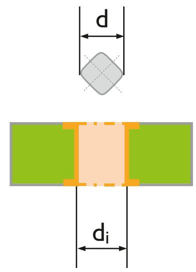


Fig. 37: Example of a recommended layout for an SMD connector

THR layout – hole diameter
The hole diameter for THR connectors depends on the pin geometry and the PCB thickness – see “Area of application of THR technology”, page 9. An optimum relationship between the hole diameter and pin geometry balances manufacturing tolerances, and ensures collision-free assembly and sufficient solder flow during soldering. As a rule of thumb, the diameter of the hole should be approximately 0.3 mm larger than the diagonal of the pin (Fig. 38). Proposed layouts for a recommended hole diameter are documented in the item drawings. Furthermore, the position tolerance of the contact pins can also be determined (Fig. 39).



d = Diagonal of the square pin used
d_i = Internal diameter of the hole

As a rule of thumb, the following applies when determining a suitable hole diameter:

$$d_i = d + 0.3 \text{ mm}$$

Fig. 38: Recommended relationship between hole diameter and pin diagonal

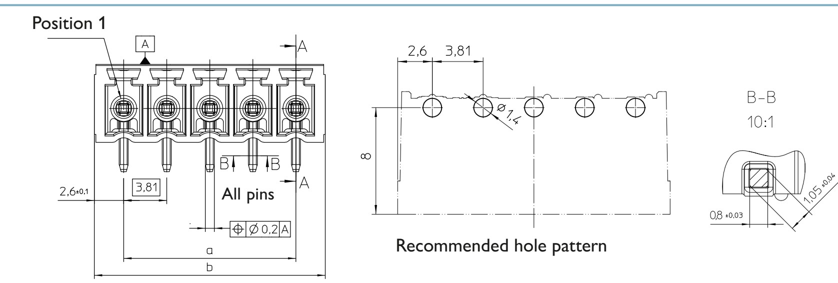


Fig. 39: Layout and tolerance drawing of a typical THR component

6.2 Paste printing

In the printing process, the solder paste is applied concurrently for SMD components (surface printing) and THR components (through-printing) to the pads/residual rings using a template or it is applied in the holes. Templates with a thickness of 100 to 150 µm are currently used (Fig. 40).

SMD paste printing
The smallest SMD pads of a layout and the coplanarity of the components have a significant influence on the paste requirements and therefore the selection of the template thickness and the class of solder paste. Normally, possible combinations are tested and can be called up in the series process for setting the process chain. Tuning the parameters and printer setting is based more on experience than on normative specifications.

THR paste printing
The coordinated printing processes for the main SMD printing should not be influenced, or only slightly influenced, by concurrent THR printing. On the printer itself, the through-printing can, however, be modified by the squeegee blade angle or squeegee blade speed (where applicable through cartridge printing in closed systems) (Fig. 41).

Fig. 40: Squeegee blade system for applying solder paste

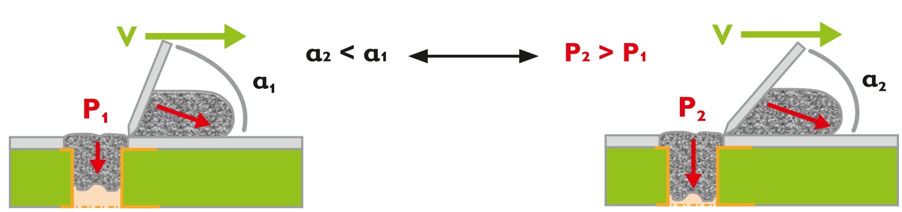


Fig. 41: Change of the blade angle – increase in through-printing

THR paste volume – base parameters

The volume of the paste printing must be twice as large as the volume that the solder takes after melting. Approximately half (by volume) of the solder paste consists of solder aids such as activators and fluxes, the rest is made up of solder in particle form with a standard particle size of between 25 and 45 µm. Paste types are classed according to the particle diameter, among other things.

The necessary volume must be generated through the appropriate design of the layout, optimized printer parameters, and based on the behavior of the solder paste. Ideally, there is no overprinting on the upper residual ring (less soiling) and a slight through-print on the secondary side of the PCB at 100% hole-fill (Fig. 42).

The template cutout (Fig. 43) is designed with a diameter that is approximately 0.1 mm smaller so that the template lays on the residual ring (Fig. 44).

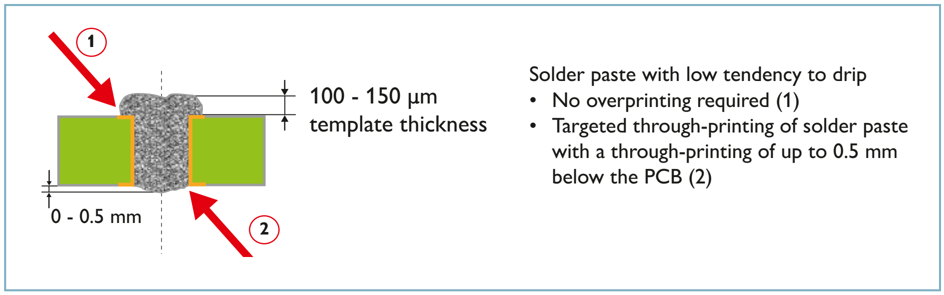


Fig. 42: Base pressure (ideal)

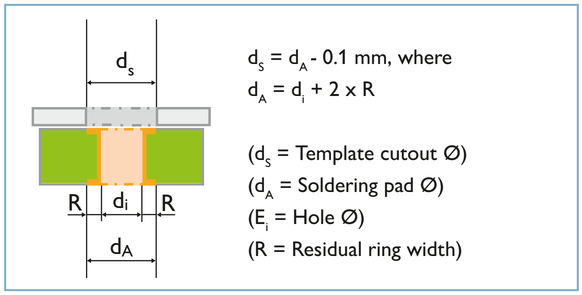


Fig. 43: Recommended template cutout

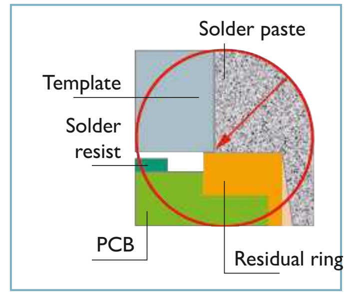


Fig. 44: Template positioned on the residual ring – no overprinting

This is intended to prevent the overprinting of solder paste on the solder resist. The necessary solder deposit results from the through-printed paste on the secondary side of the PCB. This method prevents soiling due to paste and reduces the risk of solder beading.

THR paste volume – additional areas

In certain applications, especially those where the solder paste is more likely to drip, the through-printing is reduced (Fig. 45). The missing paste volumes must therefore be generated elsewhere.

The simplest way of reducing the through-printing is by adjusting the squeegee blade angle, or alternatively by adding bars to the template (see "THR paste volume – reduced pressure", page 21).

Less through-printing means a lower solder volume. To compensate for this, in certain spatial conditions, additional paste volumes can be made available through additional areas adjoining the residual ring. The melting paste flows out of these areas back to the residual ring and therefore increases the solder volume (Fig. 46).

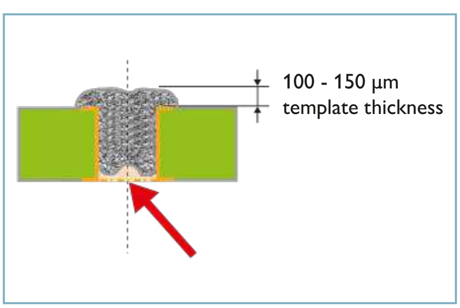


Fig. 45: Reduced paste printing – less through-printing

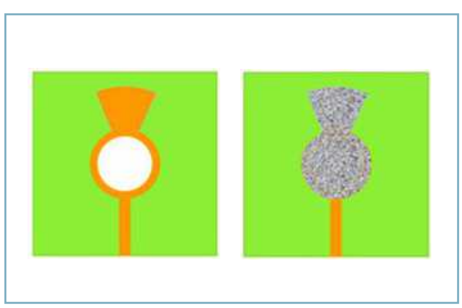


Fig. 46: Layout area for additional solder paste volume: layout and after printing

THR paste volume – reduced pressure
If the solder paste used tends to drip or if the holes for the components used are very large, another strategy must be pursued. In this case, incorporating bars in the template to limit the paste through-printing is recommended (Fig. 47). The reduction of the solder volume in the through-printing can be achieved through concurrent targeted overprinting or additional reflow areas on the PCB surface (Fig. 48).

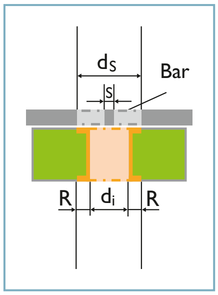


Fig. 47: Template with bar of width S

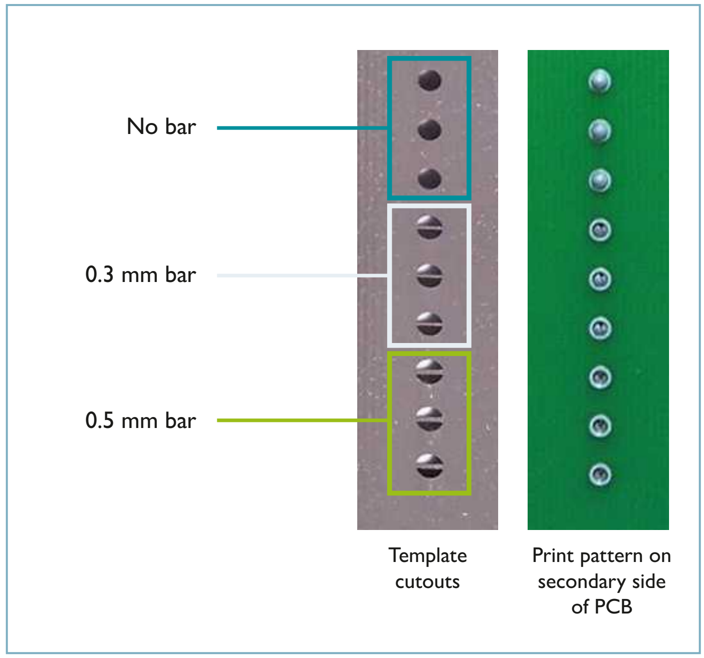


Fig. 48: Through-printing reduction through bars, alternative cutouts with bars, and larger diameters

6.3 Assembly

PCB connection elements are normally assembled by hand, especially for wave soldering processes. There are significant cost advantages associated with integrating THR or SMD connectors into automated assembly within reflow processes.

Automated assembly – pick-and-place
Due to their size and weight, THR/SMD pin strips or PCB terminal blocks can usually only be assembled using pick-and-place machines. In this process, components are picked up using standard vacuum pipettes.

For full integration into the process, the maximum available free assembly height of the machine and the component weight must be taken into consideration. It may be necessary to reduce the assembly speed in order to prevent component losses.

The component is picked up at a defined position (e.g., in the case of a tape, from the first cavity in the feeder, Fig. 49). The component is then measured via the camera (Fig. 50) and then placed on the PCB (Fig. 51).

For this process, the components must be available in standard forms of packaging for SMT. For connectors and PCB terminal blocks, the most common form of packaging is tape-on-reel. For very large or geometrically challenging components, flat magazines (trays) can also be used as an alternative.


Fig. 49: Component picked from the tape


Fig. 50: Camera image capture for component measurement

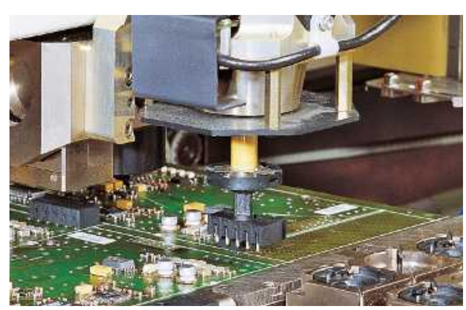


Fig. 51: Component placed on the PCB

Tape-on-reel packaging

The most popular form of delivery for SMT assembly processes is tape-on-reel packaging (Fig. 52). Tape widths of between 16 mm and 104 mm are used for standard THR components.

Due to the component size, tapes with very deep-drawn cavities are necessary – especially when dealing with tall components. A suitable feeder with a corresponding amount of free space must therefore be available. Furthermore, it must be ensured that the radius of the feeder is sufficient and that there is enough space for the tape to be fed into and out of the machine (Fig. 53).

The space available at the feeder table of a machine is always tight (Fig. 54), especially if the feeder trolley is fixed and cannot be modified. This means that the use of the available space must always be optimized. Feeders in standard widths of between 16 mm and 56 mm are therefore preferred, 72 mm or 104 mm wide feeders are only installed in exceptional circumstances. This, however, also limits the component lengths/sizes in the tape. For larger components, both custom-made tapes and feeders are necessary. These are not unusual, but are uncommon and expensive. In such cases, it may be necessary to switch to the alternative – tray packaging.

Fig. 52: Tape-on-reel packaging

Fig. 53: Equipped feeder

Fig. 54: Limited space available at the feeder table

Tray packaging in a flat magazine

The alternative use of flat magazines depends on several factors. In terms of components, the external dimensions primarily determine the limits within which the use of tapes is still expedient. Components with large volumes in terms of length or height also fit in a tape, but the availability of suitable feeders, a smaller number of packing units per tape, or dimensional limitations (deflection radius in the feeder) make their use in a tape system uneconomical. In this case, a flat magazine can be an economically attractive alternative (Fig. 55/56).

Often, however, when it comes to the equipment, it is the availability of a tray feeder unit (tray tower, Fig. 57) alone that determines whether it is possible to benefit from this advantage. Where a tray tower is not integrated, retrofitting is not expedient in most cases, as it is cheaper to have larger tapes custom made and purchase a wider feeder. Choosing the appropriate form of packaging for a particular application is therefore very much dependent on the existing assembly system and the components involved.

Fig. 55: M12 THR connectors in a tray

Fig. 56: High-volume THR components in a tray

Fig. 57: Tray feeder unit (tray tower)

6.4 SMT soldering

SMT soldering is a form of reflow soldering (see “Surface mount technology – the basis for module manufacturing” on page 4). The solder paste positioned between the solder attachment surface (PCB pad) and SMD component contact melts once the liquidus temperature is reached, fills the area between the contact and pad, and then forms a concave solder fillet around the edge of the contact. This ensures the mechanical and electrical connection of the component to the PCB.


Fig. 58: Paste drops on pin tips

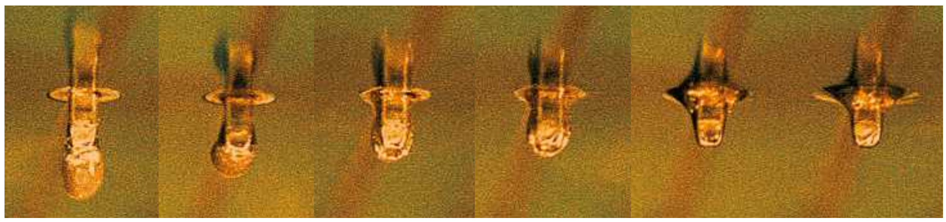


Fig. 59: Melting process in the reflow oven


Fig. 60: Convection soldering oven

THR – through-hole reflow
The soldering of pins positioned in paste is a special type of SMT soldering. After assembly, the paste surrounds the pin tip in the form of a paste drop below the hole (Fig. 58). In the soldering process, the paste melts and pulls back through the hole along the pin flank due to the capillary effect. In the subsequent cooling phase, part of the solder sinks below once again and forms the characteristic solder cone (Fig. 59). The pin protrusion below the PCB plays a significant role in the melting of the solder. The through-printed solder paste should still maintain contact with the hole (residual ring) to achieve a good reflow effect. Short pin lengths reduce the risk of paste loss due to dripping.

Soldering technologies
These days, the main systems used in SMD manufacturing are convection soldering systems followed by vapor phase soldering systems. Convection soldering ovens (Fig. 60) have a modern heat management system with controllable lower and upper heat. Once a profile has been loaded, they serve as feed ovens for high-volume series. When it comes to THR technology, there are just a few model-specific limitations.

With the development of the vapor phase soldering oven (Fig. 61) through to the inline system, this soldering technology is gaining further significance. In the case of a constant soldering profile, the system offers greater manufacturing scope with respect to the module size and frequently changing series. When using THR components, it should be noted that additional condensate can settle on the paste drop. This increases the risk of paste loss due to dripping. Dripping can be counteracted by selecting


Fig. 61: Solder chamber during vapor phase

a shorter solder pin length. Furthermore, concave components that collect the condensate should not be used. It may be necessary for potentially concave components to be fitted with run-off openings.

Standardization of the reflow soldering process

The current standards relating to the reflow soldering process should be broken down into standards that describe the process and standards for the qualification of components.

1. A standard that mainly describes the requirements for SMD components and the soldering process itself is DIN EN 61760-1 – Surface mounting technology – Standard method for the specification of surface mounting components (SMDs).
2. This series of standards has been extended to include THR components in Part 3. DIN EN 61760-3 – Surface mounting technology – Standard method for the specification of components for through-hole reflow (THR) soldering – describes the requirements for THR components and for the soldering process itself.
3. The process conditions described in DIN IEC 60068-2-58 – Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD) – are used for qualification. The soldering profiles described in the application area of the standard can be used as the basis for the development of real soldering profiles.
4. A qualifying test for components can be found in standard IPC/JEDEC J-STD-020 – Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices.

This standard is used by Phoenix Contact for THR and SMD connectors and their testing. The test cycle is described in "Qualification of components for the reflow process" (see page 13). Basically, this standard only describes the qualification conditions for the housing plastic, it does not qualify the soldering.

One thing to note about the qualification is the clear distinction between the maximum temperature loads for the manufacturer and those for the operator. A safety temperature buffer is specified here, which aims to avoid any overload by the operator.

Recommended soldering profile

Phoenix Contact qualifies reflow-solderable connectors and PCB terminal blocks in accordance with IPC/JEDEC J-STD 020. With information on the respective moisture sensitivity level and the classification temperature, the process operator is able to closely estimate the processability of the components in their line with their individual profiles. In practice, soldering profiles based on IPC/JEDEC J-STD 020 are more conservative, so that soldering is performed at the lower limit of thermal loads.

There is no one soldering profile that covers all components. The soldering profile is very individual and takes into consideration all of the process parameters – from the components, PCB, and solder paste to the equipment used (oven). It represents a compromise between all influencing factors with the aim of achieving optimum soldering results of a defined quality.

The additional parameters and assignments in the aforementioned standard regarding the comparable component volume, the component thickness, and the maximum peak body temperatures enable a stress-reduced temperature load to protect components that cannot be subjected to such high loads (see "Qualification profile vs. operator profile", page 16).

6.5 Inspection

Reference
Standard IPC A 610 – Acceptability of Electronic Assemblies – can be used for the inspection of soldering spots of reflow-soldered components. In principle there is a requirement for Phoenix Contact connectors and PCB terminal blocks to enable soldering spots in accordance with class 3 of the aforementioned standard – products of the highest reliability. The responsibility for creating the soldering spot lies with the process operator.

Requirements for THR soldering spots
The target requirements for a class 3 soldering spot for plated-through holes, vertical filling with capillary fill are as follows:

- Fill level:
  The vertical filling (capillary fill) should be 100%. But a reduction to 75% is permissible (Fig. 62).
- Wetting of the primary side:
  The primary side is the component side. The aim here is 360° wetting all around the connection wire.
  But a minimum wetting of 270° is permissible (Fig. 63).
- Wetting of the secondary side:
  The secondary side of the PCB is the side without components. Again, the aim here is 360° wetting all around the connection wire. But a minimum wetting of 330° is permissible (Fig. 64).
- Residual ring coverage on the primary side: The connection area (the soldering pad) must not be wetted with solder. Ideally, the solder cone should be visible (Fig. 65).
- Residual ring coverage on the secondary side: The connection area (the soldering pad) must be fully wetted with solder. Ideally, the solder cone should be visible (Fig. 66).

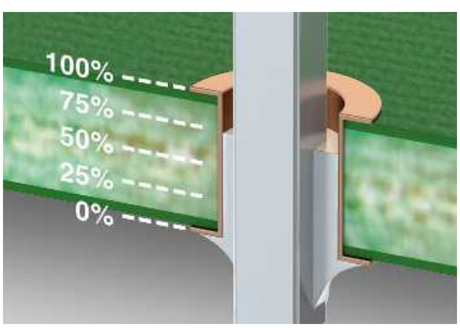


Fig. 62*: Fill level, min. 75% vertical solder filling required


Fig. 63*: Wetting of primary side 270° or 75%


Fig. 64*: Wetting of secondary side 330° or 92%

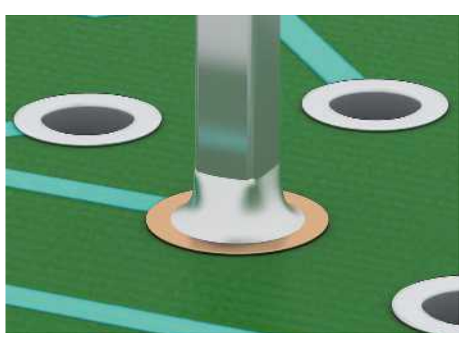


Fig. 65*: Residual ring coverage on primary side 75%, wetting of the soldering pad is not necessary

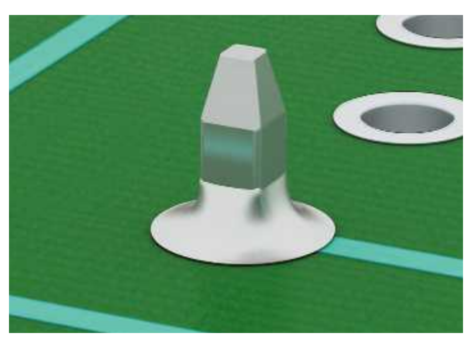


Fig. 66*: Residual ring coverage on secondary side, ideally fully wetted, min. 75%

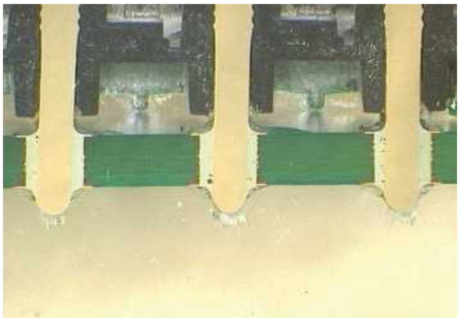


Fig. 67: Assessment of the fill level for a 2.6 mm pin in a 1.6 mm thick PCB

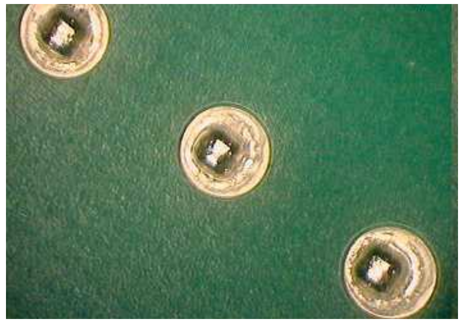


Fig. 68: Complete wetting of the soldering pad and 100% perimeter wetting

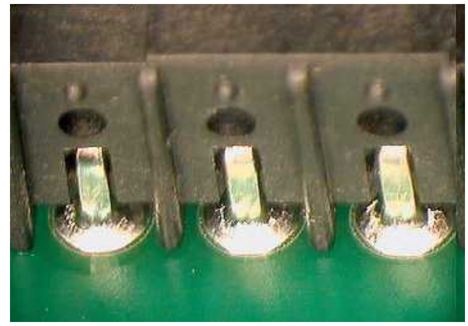


Fig. 69: Typical lean THR soldering spot on the secondary side of the PCB with more than 75% soldering pad wetting and 100% perimeter wetting

Soldering spots with pin ends protruding – standard pin

The pin slightly protruding out of the secondary side of the PCB satisfies the minimum requirement for an assessable soldering spot in accordance with the standard. With the optimum configuration of all parameters, the requirements for all criteria are 100% satisfied. In the micro-section, a fill level of at least 75% is achieved. A small solder cone forms on both sides (Fig. 67 - 69).

Soldering spots with countersunk pin

Where space is needed on the secondary side of the PCB, it is expedient to use countersunk pins in the layout. A countersunk pin is a pin that does not protrude out of the hole on the secondary side of the PCB and whose soldering spot can therefore not be assessed based on the usual aforementioned criteria of IPC-A-610. This is permissible if the pin lengths are reduced by the manufacturer and the component sits directly flush on the primary side of the PCB.

Certain strategies for quality assessment need to be developed in this case. Here, micro-sections show a reliable fill level and good formation of the solder cone below the component (Fig. 70 - 72).

Quality of THR soldering spots

THR soldering spots have a shape that is very similar to that of soldering spots created during wave or selective soldering. The main difference is the shape of the solder cone. Since less solder is available for the process, the solder cones that are formed are smaller or not fully developed. This special appearance must be discussed with the Quality Assurance department or taken into account when using automatic inspection systems (AOI).

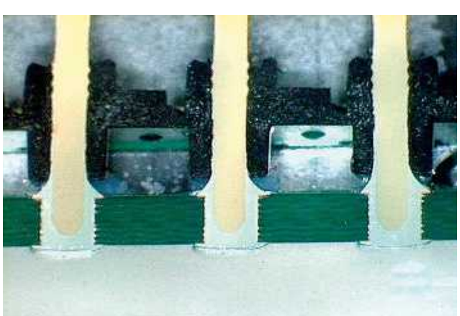


Fig. 70: Assessment of the fill level for a 1.4 mm pin in a 1.6 mm thick PCB

Fig. 71: Assessment of the perimeter wetting and soldering pad wetting not defined in IPC

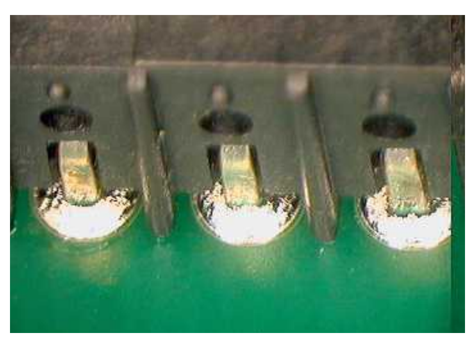


Fig. 72: Soldering spot on the primary side of the PCB: perimeter wetting and soldering pad wetting in accordance with standard

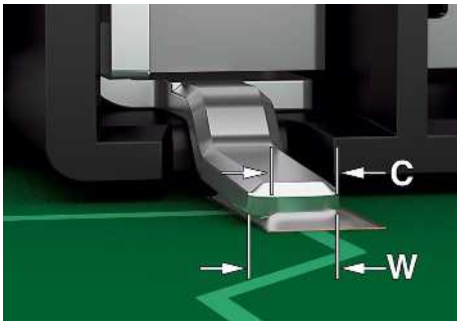


Fig. 73*: Flat gullwing connections, minimum width at the end of the soldering spot (C)

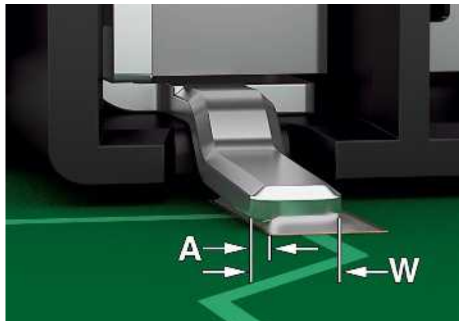


Fig. 74*: Flat gullwing connections, lateral overhang (A)

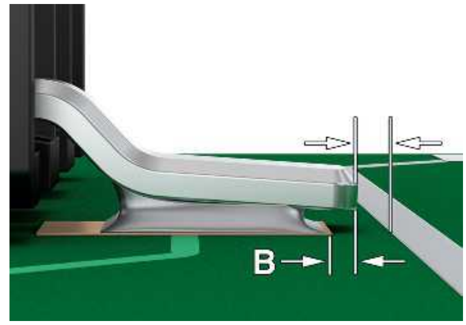


Fig. 75*: Flat gullwing connections, tip overhang (B)

Requirements for SMD soldering spots

The coplanarity of the contacts and the matching of the contact surface of the connection contact to the soldering pad surface are crucial for the creation of high-quality SMD soldering spots. Solder connections for SMD connectors from Phoenix Contact are to be categorized as both flat gullwing connections and connections with flattened pins or jointed soldering spots/I connections (M12).

The most important points when assessing an SMD soldering spot (gullwing) are the maximum lateral and tip overhang as well as the width at the end of the soldering spot. Furthermore, the minimum length of the soldering spot and the maximum height of the soldering spot on the heel need to be assessed. For the corresponding relationship between the dimensions of the contact and conductive path geometry and the shape and dimensions of soldering spots, refer to IPC A 610 for execution in accordance with the desired class (ideally class 3).

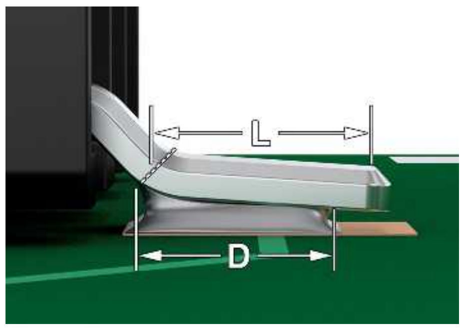


Fig. 76*: Flat gullwing connections, minimum length of the soldering spot at the side (D)

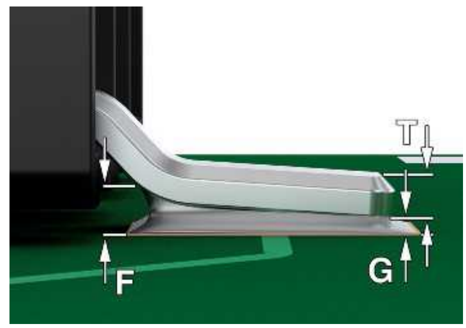
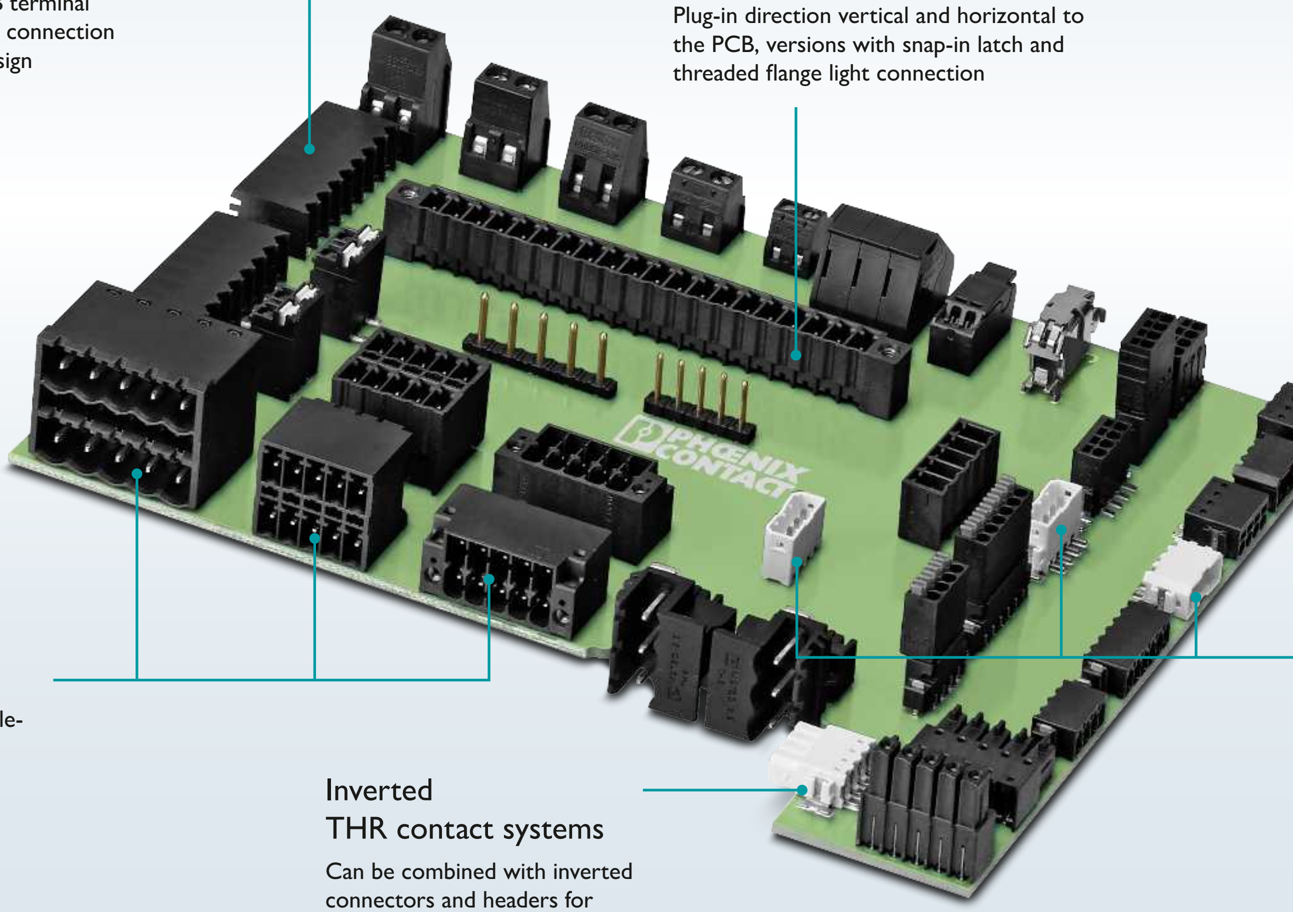


Fig. 77*: Flat gullwing connections, minimum height of the soldering spot at the heel (F)

PCB connection technology for THR and SMT soldering processes

Phoenix Contact offers a wide range of PCB terminal blocks, PCB connectors, and circular and data connectors for THR and SMT soldering. They enable you to automate your manufacturing process efficiently and combine high mechanical stability with high assembly density in a single production sequence.



Push-in connection

SPT-THR/SMD PCB terminal blocks with Push-in connection in SMD or THR design

Single-level THR headers

Plug-in direction vertical and horizontal to the PCB, versions with snap-in latch and threaded flange light connection

High density

High-position double-level, space-saving THR pin strips

Inverted THR contact systems

Can be combined with inverted connectors and headers for touch-proof applications

Seamless shielding

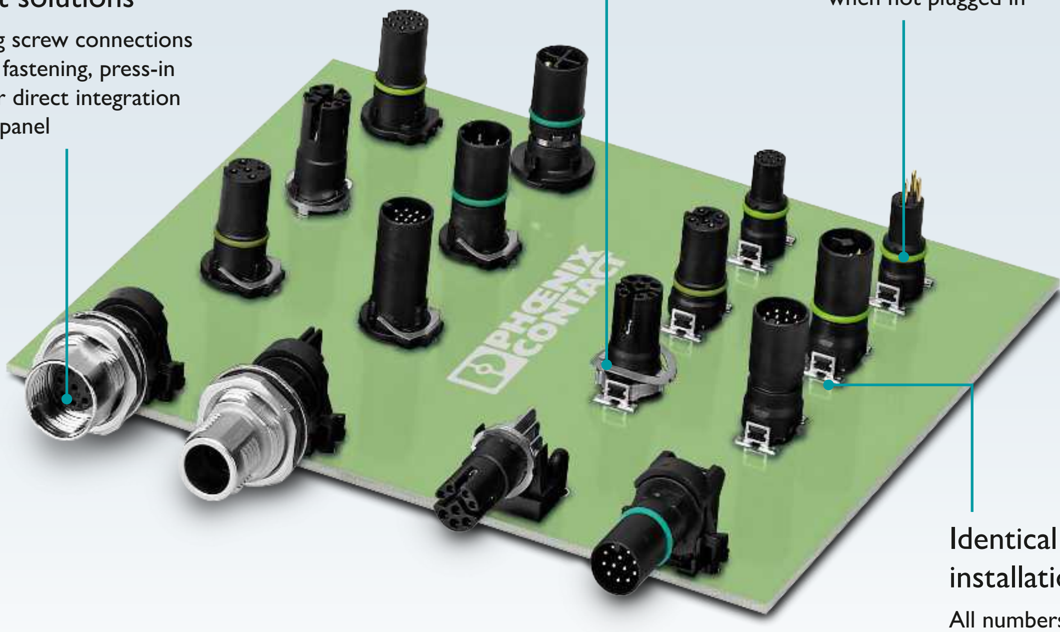
Shield connection to the PCB via shield spring

Wide range of device port solutions

Use of housing screw connections with threaded fastening, press-in contour, or for direct integration into the front panel

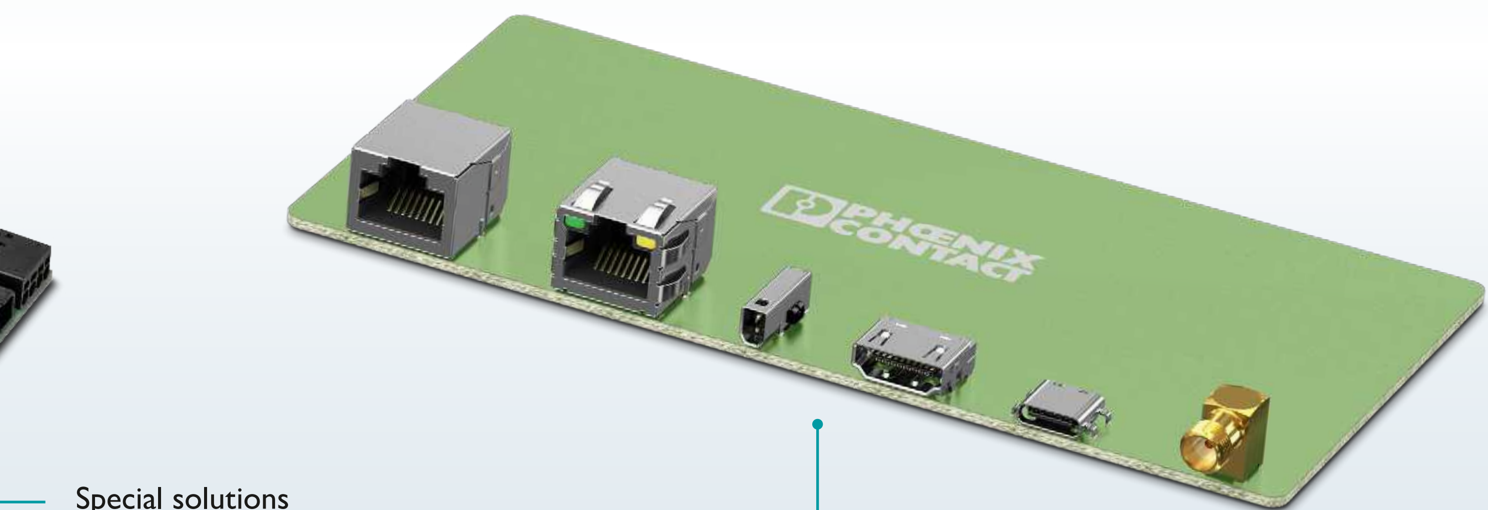
Reliable protection

Additional gasket for the device when not plugged in



Identical mechanical installation conditions

All numbers of positions and codings on one PCB level



Special solutions

White connection technology for light connection applications

Reliable data connectors for copper and FO applications

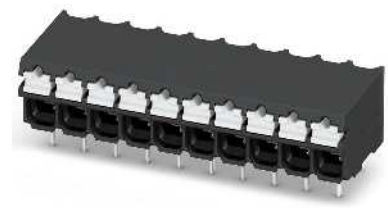
Phoenix Contact offers the right data connector for your industrial and semi-industrial application. From SPE, RJ45, HDMI, USB, and coaxial to FO applications, Phoenix Contact has a comprehensive portfolio of different pin connector patterns for a wide range of transmission properties.

Product overview

PCB terminal blocks

PCB terminal blocks enable the easy and safe transmission of signals, data, and power directly to the PCB. The space-saving connection method is suitable for numerous applications in the process industry and industrial environments.

- For conductor cross-sections from 0.14 mm^2 to 6 mm^2
- For currents up to 41 A and voltages up to 320 V (IEC)
- With screw, spring, or insulation displacement connection
- For 2.5 mm to 5.08 mm pitch

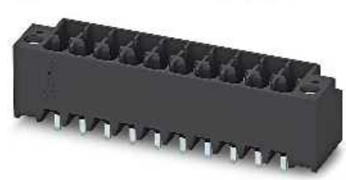


More information starting on page 30

PCB connectors

Our PCB connectors offer a universal, maintenance-friendly conductor connection for almost all device designs from a wide range of industries and markets.

- For conductor cross-sections from 0.14 mm^2 to 2.5 mm^2
- For currents up to 12 A and voltages up to 320 V (IEC)
- With screw, spring, insulation displacement, or crimp connection



More information starting on page 33

Circular connectors

The circular connectors from the PLUSCON circular product family are available in a variety of sizes for use in industrial automation.

- M8 connectors for transmitting signals and data
- M12 connectors for transmitting signals, data, and power

More information starting on page 38

Data connectors

Phoenix Contact offers a comprehensive portfolio of data connectors from RJ45 to USB and HDMI, up to coaxial and FO connections, as well as for SPE.

- Reliable data transmission with the RJ45 Industrial Connection System
- Future-proof networking from the sensor right through to the cloud with SPE data connectors
- Coaxial device connectors for transmitting WLAN, Bluetooth, LTE, or 5G signals.
- USB type A and type C jacks for industrial applications
- Secure transmission of audio and video with HDMI type A jacks.
- Fiberglass device connection for secure data transmission

More information starting on page 31

PCB terminal blocks – 0.5 mm² to 1.5 mm²

PCB terminal blocks, nominal cross-section up to 0.5 mm²

	Screw connection with tension sleeve						
	Product family	**Notes**	**No. of positions**	**Pitch**	**Current[1] (A)**	**Voltage[1) 2)] (V)**	**Connection direction**
	MPT-THR 0,5	THR soldering	2 - 12	2.54	6 IEC 6 UL (B)	160 IEC 150 UL (B)	0°
	MPT-SMD 0,5	SMT soldering	2 - 12	2.54	6 IEC 6 UL (B)	160 IEC 150 UL (B)	0°

i Web code: #1231	Push-in spring connection						
	Product family	**Notes**	**No. of positions**	**Pitch**	**Current[1] (A)**	**Voltage[1) 2)] (V)**	**Connection direction**
	PTSM 0,5/..-H-THR	Black, THR soldering	2 - 8	2.5	6 IEC 5 UL (B)	160 IEC 150 UL (B)	0°
	PTSM 0,5/..-V-THR	Black, THR soldering	2 - 8	2.5	6 IEC 5 UL (B)	160 IEC 150 UL (B)	90°
	PTSM 0,5/..-H-SMD	Black, SMT soldering	2 - 8	2.5	6 IEC 5 UL (B)	160 IEC 150 UL (B)	0°
	PTSM 0,5/..-V-SMD	Black, SMT soldering	2 - 8	2.5	6 IEC 5 UL (B)	160 IEC 150 UL (B)	90°
	PTSM 0,5/..-H-THR	White, THR soldering Higher voltage possible (IEC in accordance with II/2: 320 V)	2 - 8	2.5	6 IEC 5 UL (B)	160 IEC 150 UL (B)	0°
	PTSM 0,5/..-V-THR	White, THR soldering Higher voltage possible (IEC in accordance with II/2: 320 V)	2 - 8	2.5	6 IEC 5 UL (B)	160 IEC 150 UL (B)	90°
	PTSM 0,5/..-H-SMD	White, SMT soldering 1-pos. also available Higher voltage possible (IEC in accordance with II/2: 320 V)	1 - 8	2.5	6 IEC 5 UL (B)	160 IEC 150 UL (B)	0°
	PTSM 0,5/..-V-SMD	White, SMT soldering Higher voltage possible (IEC in accordance with II/2: 320 V)	2 - 8	2.5	6 IEC 5 UL (B)	160 IEC 150 UL (B)	90°

i Web code: #1232	Insulation displacement connection (IDC)						
	Product family	**Notes**	**No. of positions**	**Pitch**	**Current[1] (A)**	**Voltage[1) 2)] (V)**	**Connection direction**
	PTQ 0,3	–	2	2.5	4 IEC 2 UL (B)	160 IEC 150 UL (B)	0°

PCB terminal blocks, nominal cross-section up to 1.5 mm²

	Screw connection with tension sleeve						
	Product family	**Notes**	**No. of positions**	**Pitch**	**Current[1] (A)**	**Voltage[1,2] (V)**	**Connection direction**
	MKDS-THR 1	THR soldering	2 - 12	3.5/ 3.81	13.5 IEC[3] 10 UL (B)[4]	200 IEC[3] 300 UL (B, D)[4]	0°
	MKDS-SMD 1	SMT soldering	2 - 12	3.5/ 3.81	13.5 IEC[3] 10 UL (B)[4]	200 IEC[3] 300 UL (B, D)[4]	0°

i Web code: #1236	Push-in spring connection						
	Product family	**Notes**	**No. of positions**	**Pitch**	**Current[1] (A)**	**Voltage[1,2] (V)**	**Connection direction**
	SPT-THR 1,5/..H	THR soldering, various pin lengths available	2 - 12	3.5/3.81	13.5 IEC 10 UL (B, D)	160 IEC 300 UL (B, D)	0°
	SPT-THR 1,5/..-V	THR soldering, various pin lengths available	2 - 12	3.5/3.81	13.5 IEC 10 UL (B, D)	160 IEC 300 UL (B, D)	90°
	SPT-SMD 1,5/..-H	SMT soldering	2 - 12	3.5/3.81	13.5 IEC 10 UL (B, D)	160 IEC 300 UL (B, D)	0°
	SPT-SMD 1,5/..-V	SMT soldering	2 - 12	3.5/3.81	13.5 IEC 10 UL (B, D)	160 IEC 300 UL (B, D)	90°
	SPT-THR 1,5/..-H	THR soldering, various pin lengths available	2 - 12	5.0/5.08	13.5 IEC 10 UL (B, D)	320 IEC 300 UL (B, D)	0°
	SPT-THR 1,5/..-V	THR soldering, various pin lengths available	2 - 12	5.0/5.08	13.5 IEC 10 UL (B, D)	320 IEC 300 UL (B, D)	90°
	SPT-SMD 1,5/..-H	SMT soldering	2 - 12	5.0/5.08	13.5 IEC 10 UL (B, D)	320 IEC 300 UL (B, D)	0°
	SPT-SMD 1,5/..-V	SMT soldering	2 - 12	5.0/5.08	13.5 IEC 10 UL (B, D)	320 IEC 300 UL (B, D)	90°

1) Use Groups A - F in accordance with UL
2) IEC rated insulation voltage with overvoltage category III / pollution degree 2
3) This technical data is expected, final tests not yet performed
4) The specified value is expected upon approval

PCB terminal blocks – 2.5 mm² to 6 mm²

PCB terminal blocks, nominal cross-section up to 2.5 mm²

i Web code: #2669	Push-in spring connection						
	Product family	**Notes**	**No. of positions**	**Pitch**	**Current[1] (A)**	**Voltage[1) 2)] (V)**	**Connection direction**
	SPT-THR 2,5/..-H	THR soldering	2 - 12	5.0	24 IEC 20 UL (B) 10 (D)	400 IEC 300 UL (B) 300 (D)	0°
	SPT-THR 2,5/..-V	THR soldering	2 - 12	5.0	24 IEC 20 UL (B) 10 (D)	400 IEC 300 UL (B) 300 (D)	90°

PCB terminal blocks, nominal cross-section up to 6 mm²

i Web code: #0724	Special spring connection design						
	Product family	**Notes**	**No. of positions**	**Pitch**	**Current[1] (A)**	**Voltage[1) 2)] (V)**	**Connection direction**
	PTSPL 6	Without insulating housing With SUNCLIX spring connection	1	–	41 IEC 30 UL	–	0°

1) Use Groups A - F in accordance with UL
2) IEC rated insulation voltage with overvoltage category III/pollution degree 2

PCB connectors – 0.5 mm²

PCB connectors, nominal cross-section up to 0.5 mm²

Web code: #0735	Headers: THR soldering, male						
	Product family	**Notes**	**No. of positions**	**Pitch**	**Current[1] (A)**	**Voltage[1] [2] (V)**	**Connection direction**
	MC 0,5/..-G-THR	Lateral THR armature	2 - 16	2.54	6 IEC 6 UL (B)	160 IEC 150 UL (B)	0°
	MCV 0,5/..-G-THR	Lateral THR armature	2 - 16	2.54	6 IEC 6 UL (B)	160 IEC 150 UL (B)	90°
	DMC 0,5/..-G1-THR	Double-row, lateral THR armature, integrated THR armature	2 - 3 4 - 16	2.54	6 IEC 6 UL (B)	160 IEC 150 UL (B)	0°
	DMCV 0,5/..-G1-THR	Double-row, lateral THR armature, integrated THR armature	2 - 3 4 - 16	2.54	6 IEC 6 UL (B)	160 IEC 150 UL (B)	90°

Web code: #0736	Headers: SMT soldering, male						
	Product family	**Notes**	**No. of positions**	**Pitch**	**Current[1] (A)**	**Voltage[1] [2] (V)**	**Connection direction**
	MC 0,5/..-G-SMD	Lateral THR armature	2 - 16	2.54	6 IEC 6 UL (B)	160 IEC 150 UL (B)	0°
	MCV 0,5/..-G-SMD	Lateral THR armature	2 - 16	2.54	6 IEC 6 UL (B)	160 IEC 150 UL (B)	90°
	DMC 0,5/..-G1-SMD	Double-row, lateral THR armature, integrated THR armature	2 - 3 4 - 16	2.54	6 IEC 6 UL (B)	160 IEC 150 UL (B)	0°
	DMCV 0,5/..-G1-SMD	Double-row, lateral THR armature, integrated THR armature	2 - 3 4 - 16	2.54	6 IEC 6 UL (B)	160 IEC 150 UL (B)	90°

Web code: #0741	Headers: THR soldering, male						
	Product family	**Notes**	**No. of positions**	**Pitch**	**Current[1] (A)**	**Voltage[1] [2] (V)**	**Connection direction**
	PTSM 0,5/..-HH-THR	Black	2 - 10	2.5	6 IEC 5 UL (B)	160 IEC 150 UL (B)	0°
	PTSM 0,5/..-HV-THR	Black	2 - 10	2.5	6 IEC 5 UL (B)	160 IEC 150 UL (B)	90°
	PTSM 0,5/..-HH-THR	White, higher voltage possible (IEC in accordance with II/2: 320 V)	2 - 8	2.5	6 IEC 5 UL (B)	160 IEC 150 UL (B)	0°
	PTSM 0,5/..-HV-THR	White, higher voltage possible (IEC in accordance with II/2: 320 V)	2 - 8	2.5	6 IEC 5 UL (B)	160 IEC 150 UL (B)	90°

PCB connectors – 0.5 mm² to 1.5 mm²

PCB connectors, nominal cross-section up to 0.5 mm²

Web code: #0743	Headers: SMT soldering, male						
	Product family	**Notes**	**No. of positions**	**Pitch**	**Current[1] (A)**	**Voltage[1] [2] (V)**	**Connection direction**
	PTSM 0,5/..-HH-SMD	Black	2 - 10	2.5	6 IEC 5 UL (B)	160 IEC 150 UL (B)	0°
	PTSM 0,5/..-HH-SMD	White, higher voltage possible (IEC in accordance with II/2: 320 V)	2 - 8	2.5	6 IEC 5 UL (B)	160 IEC 150 UL (B)	0°
	PTSM 0,5/..-HV-SMD	White, higher voltage possible (IEC in accordance with II/2: 320 V)	2 - 8	2.5	6 IEC 5 UL (B)	160 IEC 150 UL (B)	90°
	PTSM 0,5/..-HTB-SMD	White, higher voltage possible (IEC in accordance with II/2: 320 V)	2 - 8	2.5	6 IEC 5 UL (B)	160 IEC 150 UL (B)	-90°

Web code: #0744	Inverted headers: SMT soldering, female						
	Product family	**Notes**	**No. of positions**	**Pitch**	**Current[1] (A)**	**Voltage[1] [2] (V)**	**Connection direction**
	PTSM 0,5/..-HHI-SMD	Black	2 - 8	2.5	6 IEC 5 UL (B)	160 IEC 150 UL (B)	0°
	PTSM 0,5/..-HHI-SMD	White, higher voltage possible (IEC in accordance with II/2: 320 V)	2 - 8	2.5	6 IEC 5 UL (B)	160 IEC 150 UL (B)	0°

Web code: #0747	Insulation displacement connection (IDC)						
	Product family	**Notes**	**No. of positions**	**Pitch**	**Current[1] (A)**	**Voltage[1] [2] (V)**	**Connection direction**
	PST 1,0/..-H	–	2 - 16	3.5	8 IEC 10 UL (B)	250 IEC 300 UL (B)	0°
	PST 1,0/..-V	–	2 - 16	3.5	8 IEC 10 UL (B)	250 IEC 300 UL (B)	90°

Web code: #0748	Insulation displacement connection (IDC)						
	Product family	**Notes**	**No. of positions**	**Pitch**	**Current[1] (A)**	**Voltage[1] [2] (V)**	**Connection direction**
	FK-MPT 0,5/..-ICA	Header for FK-MPT 0,5/..-V PCB terminal blocks	2 - 16	3.5	3 IEC 4 UL (B, D)	250 IEC 300 UL (B, D)	0°
	FK-MPT 0,5/..-ICVA	Header for FK-MPT 0,5/..-V PCB terminal blocks	2 - 16	3.5	3 IEC 4 UL (B, D)	250 IEC 300 UL (B, D)	90°

PCB connectors, nominal cross-section up to 1.5 mm²

i Web code: #0760	Headers: SMT soldering, male						
	Product family	**Notes**	**No. of positions**	**Pitch**	**Current[1] (A)**	**Voltage[1) 2)] (V)**	**Connection direction**
	MC 1,5/..-G-THR MC 1,5/..-GF-THR	Without flange With threaded flange	2 - 12 2 - 20	3.5 3.81	8 IEC 8 UL (B, D)	160 IEC 300 UL (B, D)	0°
	MCV 1,5/..-G-THR MCV 1,5/..-GF-THR	Without flange With threaded flange	2 - 12 2 - 20	3.5 3.81	8 IEC 8 UL (B, D)	160 IEC 300 UL (B, D)	90°
	DMC 1,5/..-G1-THR DMC 1,5/..-G1F-LR-THR	Without flange With threaded flange and with lock-and-release locking system	2 - 20	3.5	8 IEC 8 UL (B)	160 IEC 150 UL (B)	0°
	DMCV 1,5/..-G1-THR DMCV 1,5/..-G1F-LR-THR	Without flange With threaded flange and with lock-and-release locking system	2 - 20	3.5	8 IEC 8 UL (B)	160 IEC 150 UL (B)	90°
	MCDN 1,5/..-G1-THR MCDN 1,5/..-G1-RN-THR	Without flange With snap-in latch	2 - 20	3.5/3.81 3.5	8 IEC 8 UL (B)	160 IEC 150 UL (B)	0°
	MCDNV 1,5/..-G1-THR MCDNV 1,5/..-G1-RN-THR	Without flange With snap-in latch	2 - 20	3.5/3.81 3.5	8 IEC 8 UL (B)	160 IEC 150 UL (B)	90°

i Web code: #0761	Inverted headers: THR soldering, female						
	Product family	**Notes**	**No. of positions**	**Pitch**	**Current[1] (A)**	**Voltage[1) 2)] (V)**	**Connection direction**
	IMC 1,5/..-G-THR IMC 1,5/..-G-RN-THR	Without flange With snap-in latch	2 - 12	3.5	8 IEC 8 UL (B, D)	160 IEC 300 UL (B, D)	0°
	IMCV 1,5/..-G-THR IMCV 1,5/..-G-RN-THR	Without flange With snap-in latch	2 - 12	3.5	8 IEC 8 UL (B, D)	160 IEC 300 UL (B, D)	90°

1) Use Groups A - F in accordance with UL
2) IEC rated insulation voltage with overvoltage category III / pollution degree 2

PCB connectors – 2.5 mm² to 10 mm²

PCB connectors, nominal cross-section up to 2.5 mm²

Web code: #0752	Pin strips: THR soldering						
	Product family	Notes	No. of positions	Pitch	Current[1] (A)	Voltage[1) 2)] (V)	Connection direction
	PST 1,3/..-H	THR-/wave-solderable	2 - 16	5.0	12 IEC 16 UL (B) 10 UL (D)	320 IEC 300 UL (B) 300 UL (D)	0°
	PST 1,3/..-V	THR-/wave-solderable	2 - 16	5.0	12 IEC 16 UL (B) 10 UL (D)	320 IEC 300 UL (B) 300 UL (D)	90°

Web code: #0789	Headers: THR soldering, male						
	Product family	Notes	No. of positions	Pitch	Current[1] (A)	Voltage[1) 2)] (V)	Connection direction
	CCA 2,5/..-G CC 2,5/..-GF CCA 2,5/..-G-RN CC 2,5/..-GF-LR	Without flange With threaded flange With snap-in latch With lock-and-release locking system	2 - 24 2 - 12 2 - 12 2 - 24	5.0/5.08 5.08 5.08 5.0/5.08	12 IEC 10 UL (B) 10 UL (D)	320 IEC 300 UL (B) 300 UL (D)	0°
	CCVA 2,5/..-G CCV 2,5/..-GF CCVA 2,5/..-G-RN CCV 2,5/..-GF-LR	Without flange With threaded flange With snap-in latch With lock-and-release locking system	2 - 24 2 - 12 2 - 12 2 - 24	5.0/5.08 5.08 5.08 5.0/5.08	12 IEC 10 UL (B) 10 UL (D)	320 IEC 300 UL (B) 300 UL (D)	90°
	CCDN 2,5/..-G1-THR CCDN 2,5/..-G1F-THR	Without flange With threaded flange	2 - 18	5.0/5.08	12 IEC 10 UL (B) 10 UL (D)	400 IEC 300 UL (B) 300 UL (D)	0°
	MSTBO 2,5/..-G1R-THR MSTBO 2,5/..-G1L-THR	Right version Left version	2 - 4	5.0	16 IEC	400 IEC 300 UL (B) 300 UL (D)	0°

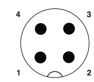
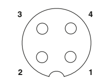
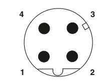
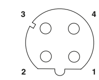
PCB connectors, nominal cross-section up to 4 mm²

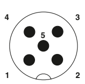
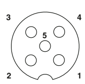
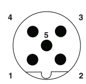
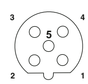
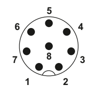
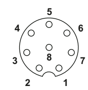
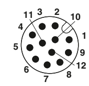
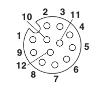
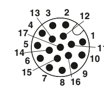
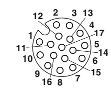
	Headers: THR soldering, male						
	Product family	Notes	No. of positions	Pitch	Current[1] (A)	Voltage[1) 2)] (V)	Connection direction
	PC 4/..-G-6,35	Without flange, with top lock and center flange	2 - 12	6.35	24 IEC[3] 22 UL (B)[4] 22 UL (C)[4] 22 UL (F)[4]	1000 IEC[3] 600 UL (B)[4] 600 UL (C)[4] 600 UL (F)[4]	0°

1) Use Groups A - F in accordance with UL
2) IEC rated insulation voltage with overvoltage category III/pollution degree 2
3) This technical data is expected, final tests not yet performed
4) The specified value is expected upon approval

PCB connectors for conductor cross-sections up to 10 mm² (AWG 8)

i Web code: #2667	Headers: THR soldering, male						
	Product family	**Notes**	**No. of positions**	**Pitch**	**Current[1] (A)**	**Voltage[1) 2)] (V)**	**Connection direction**
	PC 6/...-G-THR PC 6/...-GL-THR	Without flange With center flange	2 - 6	7.62	41 IEC 35 UL (B, C) 35 UL (F)	630 IEC 300 UL (B, C) 600 UL (F)	0°
	PC 6/...-GU-THR PC 6/...-GLU-THR	Without flange With center flange	2 - 6	7.62	41 IEC 35 UL (B, C) 35 UL (F)	630 IEC 300 UL (B, C) 600 UL (F)	180°
	PCV 6/...-G-THR PCV 6/...-GL-THR	Without flange With center flange	2 - 6	7.62	41 IEC 35 UL (B, C) 35 UL (F)	630 IEC 300 UL (B, C) 600 UL (F)	90°
	PCH 6/...-G-THR PCH 6/...-GL-THR	Without flange With center flange	3 - 5 Power (+4 or +6 signal)	7.62 (3.81)	41 (8) IEC 35 (6) UL (B, C) 35 (6) UL (F)	630 (160) IEC 300 (300) UL (B, C) 600 (160) UL (F)	0°

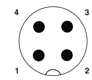
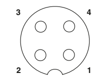
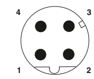
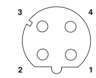
M12, solder connection, PCB mounting		4-pos.			
For reflow soldering processes	Coding	A		D	
	Rated voltage	250 V		250 V	
	Nominal current	4 A		4 A	
Web code: #1167	Pin assignment	Male	Female	Male	Female
					
Two-piece, THR contact carriers					
 	Straight, shielded, THR, in tray	1439939		1552214	1551451
	Straight, shielded, THR, on reel	1457500*	1457623*	1457513*	1457636*
	Straight, THR, in tray	1437164	1439942	–	1414071
	Straight, THR, on reel	1457490*	1457610*	–	–
Two-piece, housing screw connections for THR soldering contact carriers					
 	Screw versions with O-ring, rear mounting, M15 x 1 screw fastening				
	SPEEDCON screw versions with O-ring, rear mounting, M15 x 1 screw fastening				
 	Clip-in versions, for straight, two-piece socket contact carriers, tolerance-compensating, rear snap-in mounting (not for S-coded THR contact carriers)	For housing panel thickness of 1.0 ... 1.8 mm			
		For housing panel thickness of 1.7 ... 2.5 mm			
		For housing panel thickness of 2.4 ... 3.2 mm			
	Threaded sleeve	For housing panel thickness of 3.1 ... 3.9 mm			
	Fixing sleeve, can be used universally with any threaded sleeve	Color			
 	SPEEDCON screw versions with O-ring, front mounting, M12 x 1 screw fastening				
	Screw versions with O-ring, front mounting, M12 x 1 screw fastening				
	SPEEDCON screw versions with flat gasket, front mounting, M12 x 1 screw fastening				
 	Press-in versions, front mounting				

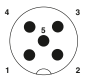
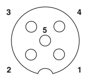
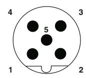
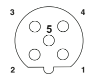
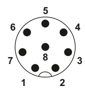
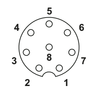
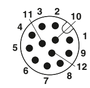
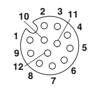
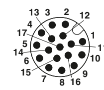
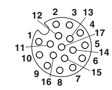
5-pos.				8-pos.		12-pos.		17-pos.	
A		B		A		A		A	
60 V		60 V		30 V		30 V		30 V	
4 A		4 A		2 A		1.5 A		1.5 A	
Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
									
1432350	1432363	1552230	1551435	1557581	1551422	1442065*	1442052*	1442081*	1442078*
1457539*	1457652*	1457542*	1457665*	1457568*	1457681*	1457584*	1457704*	1457607*	1457720*
1552227	1551448	–	1414070	1552269	1557808	1441985*	1441970*	1442007*	1441998*
1457526*	1457649*	–	–	1457555*	1457678*	1457571*	1457694*	1457597*	1457717*
Male: 1413997[1)] / 1413996[2)] / Female: 1414004[1)] / 1414003[2)]									
Male: 1413999[1)] / 1413998[2)] / Female: 1414020[1)] / 1414005[2)]									
		Female: 1419630[5)]							
		Female: 1419631[5)]							
		Female: 1419633[5)]							
		Female: 1419634[5)]							
Black	Blue	Water blue	Red	Yellow	Green	Violet	Orange		
1419697	1417782	1417783	1417784	1417785	1417787	1417788	1417789		
Male: 1551493[4)] / Female: 1552243[4)]									
Male: 1416145[4)] / 1417984[5)] / Female: 1416144[4)] / 1417989[5)]									
Male: 1436709[3)] / Female: 1432460[3)]									
Male: 1437892[5)] / Female: 1437889[5)]									

* Contact carrier with assembly pad
1), 2) Distance from PCB upper edge to housing front panel rear edge: 1) 6 mm / 2) 6.8 mm
3), 4), 5) Distance from PCB upper edge to housing front panel outer edge: 3) 6 mm 4) 7.5 mm / 5) 9 mm

Further housings, such as our push-pull screw connections, can be found in our “M5 to M12 circular connectors” brochure.

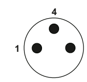
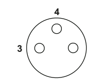
Circular connectors, signal

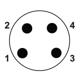
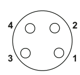
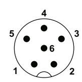
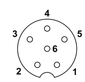
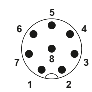
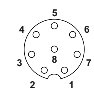
M12, solder connection, PCB mounting		4-pos.			
For reflow soldering processes	Coding	A		D	
	Rated voltage	250 V		250 V	
	Nominal current	4 A		4 A	
Web code: #0215	Pin assignment	Male	Female	Male	Female
					
Two-piece, SMD contact carriers					
 	**Straight, SMD, in tray**	1411924*	1411907	1411925*	1411912
	Straight, SMD, on reel	1411982*	1411974	1411983*	1411975
 	**Straight, shielded, SMD, in tray,** additional gasket for the device when not plugged in	1411955*	1411949	1411956*	1411950
	Straight, shielded, SMD, on reel, additional gasket for the device when not plugged in	1412010*	1412004	1412011*	1412005
 	**Straight, SMD, in tray,** additional gasket for the device when not plugged in	1411941*	1411935	1411942*	1411936
	Straight, SMD, on reel, additional gasket for the device when not plugged in	1411996*	1411990	1411997*	1411991
Two-piece, housing screw connections for SMD contact carriers					
 	**Screw versions, rear mounting, M15 x 1 screw fastening**				
	SPEEDCON screw versions, rear mounting, M15 x 1 screw fastening				
 	**Clip-in versions, tolerance-compensating, rear snap-in mounting, threaded sleeve**	For housing panel thickness of 0.9 ... 1.6 mm			
		For housing panel thickness of 1.6 ... 2.3 mm			
		For housing panel thickness of 2.3 ... 3.0 mm			
	Fixing sleeve, can be used universally with any threaded sleeve	Color			
 	**Screw versions, front mounting, M14 x 1 screw fastening**				
	M14 x 1 flat nut				
 	**Press-in versions, front mounting**				

5-pos.				8-pos.		12-pos.		17-pos.	
A		B		A		A		A	
60 V		60 V		30 V		30 V		30 V	
4 A		4 A		2 A		1.5 A		1.5 A	
Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
									
1411926*	1411913	1411927*	1411914	1411928*	1411915	1411929*	1411916	1411930*	1411917
1411984*	1411976	1411985*	1411977	1411986*	1411978	1411987*	1411979	1411988*	1411980
1411957*	1411951	1411958*	1411952	1411959*	1411953	1411960*	1411954	1411961*	1411966[1)]
1412012*	1412006	1412013*	1412007	1412014*	1412008	1412015*	1412009	1412016*	1412018[1)]
1411943*	1411937	1411944*	1411938	1411945*	1411939	1411946*	1411940	1411947*	–
1411998*	1411992	1411999*	1411993	1412000*	1411994	1412001*	1411995	1412002*	–
Male: 1414000[2)] / Female: 1414021[2)]									
Male: 1414002[2)] / Female: 1414023[2)]									
		Female: 1419569[3)]							
		Female: 1419570[3)]							
		Female: 1419571[3)]							
Black		Water blue		Green		Violet			
1419568		1419565		1419566		1419567			
Male: 1412078[3)] / Female: 1412079[3)]									
1412077									
Male: 1412080[3)] / Female: 1412081[3)]									

* Contact carrier with assembly pad
1) Without additional gasket for the device when not plugged in
2) Distance from PCB upper edge to housing front panel rear edge: 6 mm
3) Distance from PCB upper edge to housing front panel outer edge: 9 mm

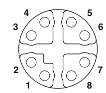
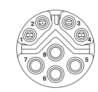
Circular connectors, signal

Signal – M8, solder connection, PCB mounting		3-pos.	
For reflow soldering processes	Coding	A	
	Rated voltage	50 V AC / 60 V DC	
	Nominal current	4 A	
Web code: #0219	Pin assignment	Male	Female
			
Two-piece, SMD contact carriers			
	**Straight, SMD, in tray**	1412225*	1412220
	Straight, SMD, on reel	1412248*	1412243
	**Straight, shielded, SMD, in tray,** additional gasket for the device when not plugged in	1412240*	1412235
	Straight, shielded, SMD, on reel, additional gasket for the device when not plugged in	1412263*	1412257
	**Straight, SMD, in tray,** additional gasket for the device when not plugged in	1412233*	1412227
	Straight, SMD, on reel, additional gasket for the device when not plugged in	1412255*	1412250
Two-piece, housing screw connections for SMD contact carriers			
	**Screw versions, rear mounting, M12 x 1 screw fastening**		
	**Screw versions, front mounting, M10 x 0.75 screw fastening**		
	M10 x 0.75 flat nut		
	**Press-in versions for front mounting**		

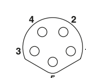
4-pos.		6-pos.		8-pos.	
A		A		A	
50 V AC / 60 V DC		30 V AC / 30 V DC		30 V AC / 30 V DC	
4 A		2 A		1.5 A	
Male	**Female**	**Male**	**Female**	**Male**	**Female**
					
1412226*	1412221	–	1412223	–	1412224
1412249*	1412244	–	1412246	–	1412247
1412241*	1412236	–	1412238	–	1412239
1412264*	1412258	–	1412261	–	1412262
1412234*	1412228	–	1412230	–	1412232
1412256*	1412251	–	1412253	–	1412254
Male: 1412505[1)] / Female: 1412506[1)]					
Male: 1412502[2)] / Female: 1412504[2)]					
1412508					
Male: 1412500[2)] / Female: 1412501[2)]					

* Contact carrier with assembly pad
1) Distance from PCB upper edge to housing front panel rear edge: 6 mm
2) Distance from PCB upper edge to housing front panel outer edge: 9 mm

Circular connectors, data

M12 for networks		**8-pos.**	**8-pos.**
For reflow soldering processes	**Coding**	X (CAT6$_A$)	Y (hybrid)
	Rated voltage	50 V AC / 60 V DC	30 V
	Nominal current	0.5 A	0.5 A / 6 A
	Conductor cross-section	0.25 mm²	0.14/0.5 mm²
Web code: #0240	**Pin assignment**	**Female**	**Female**
			
Two-piece, contact carriers for wave and reflow soldering processes			
Ethernet 	**Straight, shielded, THR, in blister packaging**	1402457	–
	Straight, shielded, THR, on reel	1413446*	–
	Straight, shielded, SMD, in tray	1411964*	–
	Straight, shielded, THR, on reel	1424180	–
Hybrid 	**Straight, shielded, THR, in blister packaging**	–	1405225
	Straight, shielded, THR, on reel	–	1413445*
	Straight, shielded, SMD, in tray	–	1411965*

Housing screw connections for SMD contact carriers, see page 42/43.

M8 for fieldbuses			**5-pos.**
	Coding		B
	Rated voltage		30 V AC / 30 V DC
	Nominal current		3 A
	Conductor cross-section		0.25 mm²
Web code: #0237	**Pin assignment**		**Female**
			
Two-piece, SMD contact carriers for reflow soldering processes			
	**Straight, SMD in tray**		1412222
	Straight, SMD on reel		1412245
	Straight, SMD in tray, additional gasket for the device when not plugged in		1412229
		Shielded	1412237
	Straight, SMD on reel, additional gasket for the device when not plugged in		1412252
		Shielded	1412259

Housing screw connections for SMD contact carriers, see page 42/43.

* Contact carrier with assembly pad
1) Distance from PCB upper edge to housing front panel rear edge: 6 mm
2) Distance from PCB upper edge to housing front panel outer edge: 9 mm

Data connectors

RJ45 INDUSTRIAL PCB jacks				
Web code: #2059				
Soldering process	Wave / THR			
Orientation	90° horizontal		180° vertical	
Housing shield springs	Yes	No	Yes	No
Without LED	1099280	1091946	1099279	1091942
With LED	1099281	1091950	1099282	1091947
Without LED, short solder contacts	1321248	1321104	1321249	1321106
With LED, short solder contacts	1321246	1321101	1321247	1321102

RJ45 single-port/multi-port PCB jacks						
Web code: #2341						
Soldering process	SMD			Wave / THR		Wave / THR
Orientation	180° vertical	90° horizontal		180° vertical	90° horizontal	90° horizontal
RJ45 ports	1 port					2 ports
Locking clip		Top	Bottom		Top	Top
Without LED	1149611	1149882	1149874			
With LED		1149873				
Without LED, short solder contacts				1337238	1337240	1337251
With LED, short solder contacts				1337239	1337243	1337254

SPE PCB and device connectors					
Web code: #2341					
Description	SPE IP20 PCB connectors		SPE M8 device connectors		
Soldering process	Wave / THR		SMD	Wave / THR	
Type of contact	Pin contact				
Orientation	180° vertical	90° horizontal	180° vertical		90° horizontal
Without LED	1163798	1163797	1215777	1163793	1163795
With LED		1215778			

Data connectors

USB device connectors

Web code: #2888					
Version	USB 2.0	USB 3.2 Gen. 1	USB 2.0	USB 3.2 Gen. 2	
Type	USB type A	USB type A	USB type C		
Orientation	90° horizontal	180° vertical	90° horizontal	180° vertical	90° horizontal
Soldering process	SMD	THR	SMD		SMD/THR
Item no.	1332634	1430989	1332645	1332646	1332643

HDMI device connectors

Web code: #2889		
Version	HDMI 2.0	
Type	HDMI type A	
Orientation	90°	180°
Soldering process	SMD	
Item no.	1332071	1332073

Coaxial PCB connectors

Web code: #2890		
Soldering process	Wave / THR	Wave / THR
Series	SMA	R-SMA
Version	90°	90°
Item no.	1340151	1340150

Data connectors

FO transceivers								
Web code: #2893								
Type	SFP				SFP+			
Wavelength	850 nm	850 nm	1310 nm	1310 nm	850 nm	850 nm	1310 nm	1310 nm
Temperature range	-25 … +70°C	-40 … +85°C	-25 … +70°C	-40 … +85°C	-25 … +70°C	-40 … +85°C	-25 … +70°C	-40 … +85°C
Item no.	1334209	1334210	1334212	1334213	1334214	1334215	1334218	1334219

Cages and PCB connectors				
Web code: #2893				
Form factor	SFP/SFP+			
Mounting	Press-in			SMD
Module slots	1	2	4	
Item no.	1334220	1334221	1334222	1334224

Glossary

Antistatic PE bag
Electrostatically conductive polyethylene bag used as packaging for THR/SMD components.

AOI
Automated optical inspection
Devices with camera systems that are able to inspect soldering spots. A comparison is made between the captured image of the soldering spot and reference images.

Armature
Additional design element made of metal with a relatively large contact surface, usually mounted on the side of components. When soldered, it provides additional fixing for the SMD component and lessens the load on the current carrying contacts.

Blister
Synonym for tape, in this case more in connection with drawings for production documentation – blister drawing.

Capillary effect
In general, the behavior of fluid in contact with tubes or hollow shaped geometries. Here, the effect of the solder filling in and through the hole in which the pin is positioned from the bottom to the top side of the PCB.

Caution label
Warning information on a label on outer packaging (mostly dry bags) regarding the handling of potentially moisture-sensitive materials.

Classification temperature
Working temperature for the component determined through testing in accordance with JEDEC J-STD-020. The manufacturer must test approximately 5°C above this temperature, the operator solders approximately 5°C below this temperature. This prevents any misunderstandings regarding the maximum load of the component.

Clearances
Insulation coordination
Minimum distance through air between two live metal parts that must be maintained in order to prevent voltage flashover.

Concave components
Components which, due to the geometry of their housing, tend to accumulate condensates in the vapor phase soldering oven. Without suitable run-off options, these components remove the condensate from the soldering process. A high condensate loss level makes the process expensive.

Contact pads
Any type and form of metallic contact surface for the application of solder on the top side of the PCB (in contrast to the conductive path).

Convection soldering
Reflow soldering through heat transfer via hot gases (air or nitrogen).

Coplanarity
Coplanarity refers to the maximum distance of all connection contacts (including armatures) of an SMD component from the contact surface (in this case the PCB surface). It is a measure of whether all contacts have contact with the paste and are therefore able to form soldering spots at a defined paste thickness.

Countersunk pin
A pin with a pin length that is less than the thickness of the PCB. The resulting soldering spot does not form a visible solder cone on the secondary side.

Creepage distances
Insulation coordination
Minimum distance across the insulating medium between two live metal parts that must be maintained in order to prevent voltage flashover.

Dry bag
Outer packaging that significantly reduces the access of air to the contents and keeps the contents dry for a defined period of time.

Feeder
Feeder unit for tapes on pick-and-place machines.

Floor life
Applies to dried, moisture-sensitive components. Upon opening the dry outer packaging (dry bag) the exposure time (floor life) begins, which depending on the MSL is a measure for problem-free processing in the reflow oven. Once the floor life has expired, there is an increased risk of damage to the component. In order that it can be used again, the component must be re-dried.

Gullwing
Refers to a certain type of contact geometry on components. In particular the arched, angled component connections on ICs (integrated circuits) or also pin strips are named after the style of the winged doors on the legendary Mercedes-Benz 300 SL.

Inline system
Layout of a production line in a physically connected line; all units (printer, assembly machine, reflow oven, AOI, and accessory components) are arranged one after the other in the process sequence. Advantage: transparent, reproducible process. Disadvantage: the slowest device determines the process speed.

IPC
Association Connecting Electronics Industries – standardization organization based in Illinois, USA, involved in electronics production.

JEDEC
Solid State Technology Association – US organization involved in the standardization of semiconductors.

Level goods
Common designation for all components that have an MSL higher than 1 in accordance with IPC-J-STD-020 and must therefore be handled in a special way due to their moisture absorption capability.

Mounting bosses
Additional design elements (part of the component housing), usually in the form of pins, which are positioned in holes on the PCB to prevent the component twisting due to floating during the soldering process.

MSL
Moisture sensitivity level
Degree of ability of a plastic to absorb moisture and the classification of the sensitivity to high temperatures during processing.

Peak temperature
Also often referred to as peak body temperature, this is the maximum temperature occurring on the top side of the component for which the component is designed.

Pick-and-place
Assembly method used in the automated assembly of a component, in this case mainly picking up an individual component and placing the component onto the PCB.

Pin-in-paste technology
Another name for THR technology.

Positioning pins
See Mounting bosses.

Primary side
Refers to the side of the PCB to which the solder is to flow during the soldering process (in the case of wave soldering, for example, the top side). This perspective has been adopted for reflow soldering.

Residual ring/solder ring
A ring of defined width around a hole for the application of a solder contact. The solder meniscus forms between the surface of the ring and the surface of the connection contact.

Secondary side
Refers to the side of the PCB on which the solder normally meets the solder contact first (in the case of wave soldering, for example, the bottom side). This perspective has been adopted for reflow soldering.

Selective soldering
Type of wave soldering in which individual solder contacts or limited groups are soldered by spatially limited small soldering waves.

SMD
Surface mount device
Surface-mountable component which can be processed via SMT. The terms SMD and SMT are often used synonymously.

SMT
Surface mount technology
SMT is a technology for the mounting of modules and soldering in the soldering process.

Soldering pad
Normally a hole with a ring-shaped contact surface (residual ring/solder ring) surrounding the hole. The hole can be through-contacted.

Solder beading
When solder paste is applied, it is possible that non-metallic, coated (solder resist) surfaces may be printed. During the melting process, individual solder beads may form that initially cling to the flux on the PCB. However, this increases the risk of uncontrolled detachment and movement of the beads across the PCB, and leads to a higher incidence of short circuit during operation.

Solder meniscus/solder cone
Geometric shape of the area of two metal surfaces/edges connected via solder (e.g., cone shape in the case of protruding stud contacts on PCBs). Mostly a concave, overrunning surface; with an increasing solder deposit, the radius decreases to a convex, bulbous accumulation in the event of a solder surplus.

Solder paste
Pasty mix of solder particles and flux for soldering components, predominantly in SMT. Solder pastes are classified according to the particle size.

Suction surface
Planar, smooth (defined roughness) surface of sufficient size on the top of the component for picking up (with vacuum pipette) by the assembly system. Can be a direct part of the geometry or an additional component in the form of a pick-and-place pad or foil adhesive spot.

Swash circumference
Pin position tolerance
The deviation of the pin end from its ideal setpoint as defined in a drawing. It can be understood to be a circle around the ideal center point. Normatively defined as a ±0.2 mm position deviation or a circle diameter of 0.4 mm. There appears to be a technical trend towards tighter tolerances of the position deviation to ±0.1 mm or a circle diameter of 0.2 mm.

Tape
Tape-on-reel packaging
Packaging material in taped format. The items are in individual cavities in a deep-drawn tape reel. The abbreviation for tape-on-reel is ToR.

Tape-on-reel
See Tape

THR
Through-hole reflow
Mounting method for through-hole components for the soldering process (THR). Mounting of wired components whose contacts are pushed into holes on the PCB filled with solder paste and then soldered using the reflow soldering process.

Tray
Flat magazine
Type of packaging – plastic tray of defined dimensions with pressed chambers for the ordered, targeted picking of components. The use of this type of packaging is dependent on the availability of appropriate tray towers/feeder stations on the assembly line.

Vapor phase soldering
Reflow soldering through heat transfer via vapor.

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