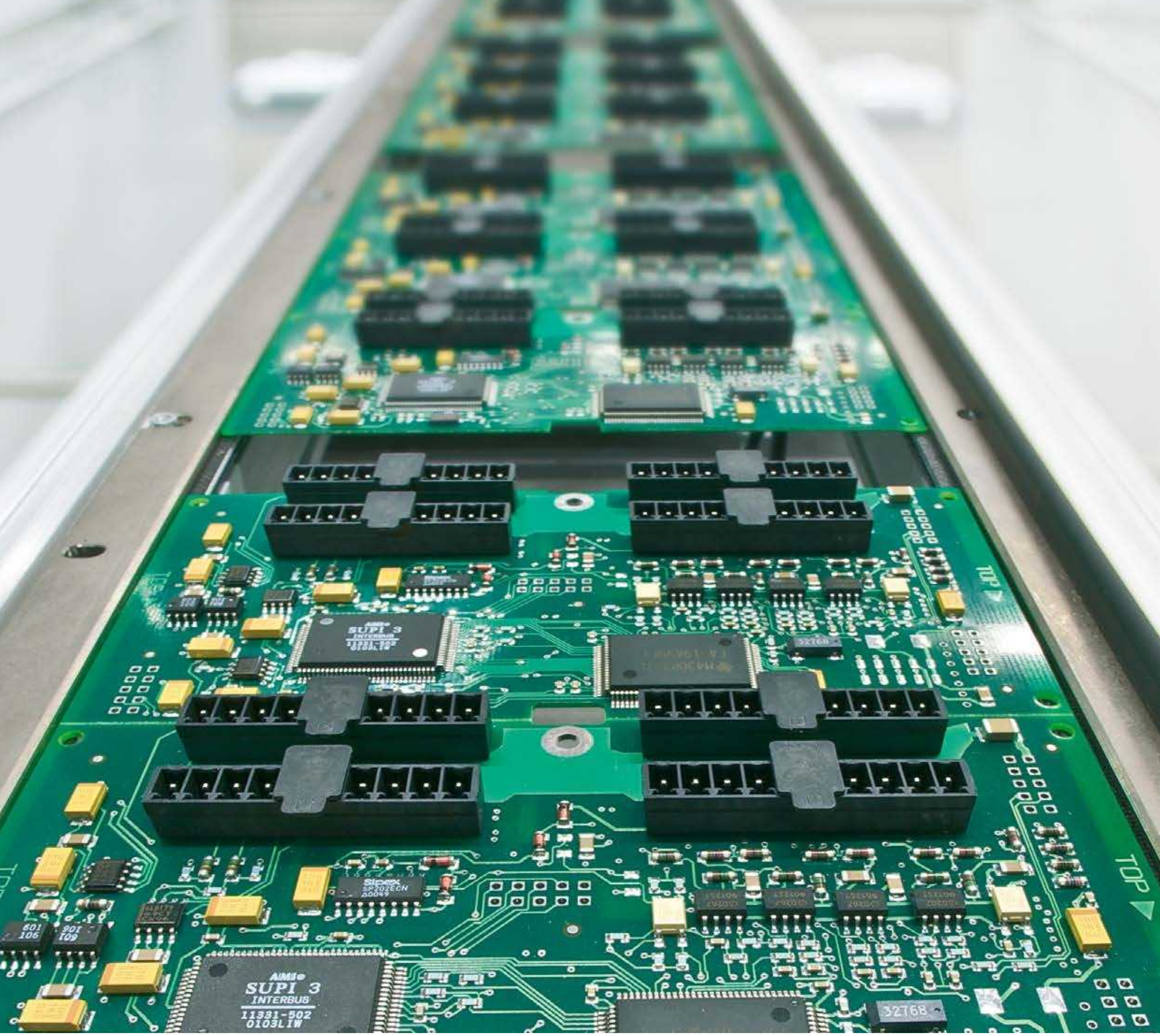

Connectors for SMT production

Basic principles and product overview

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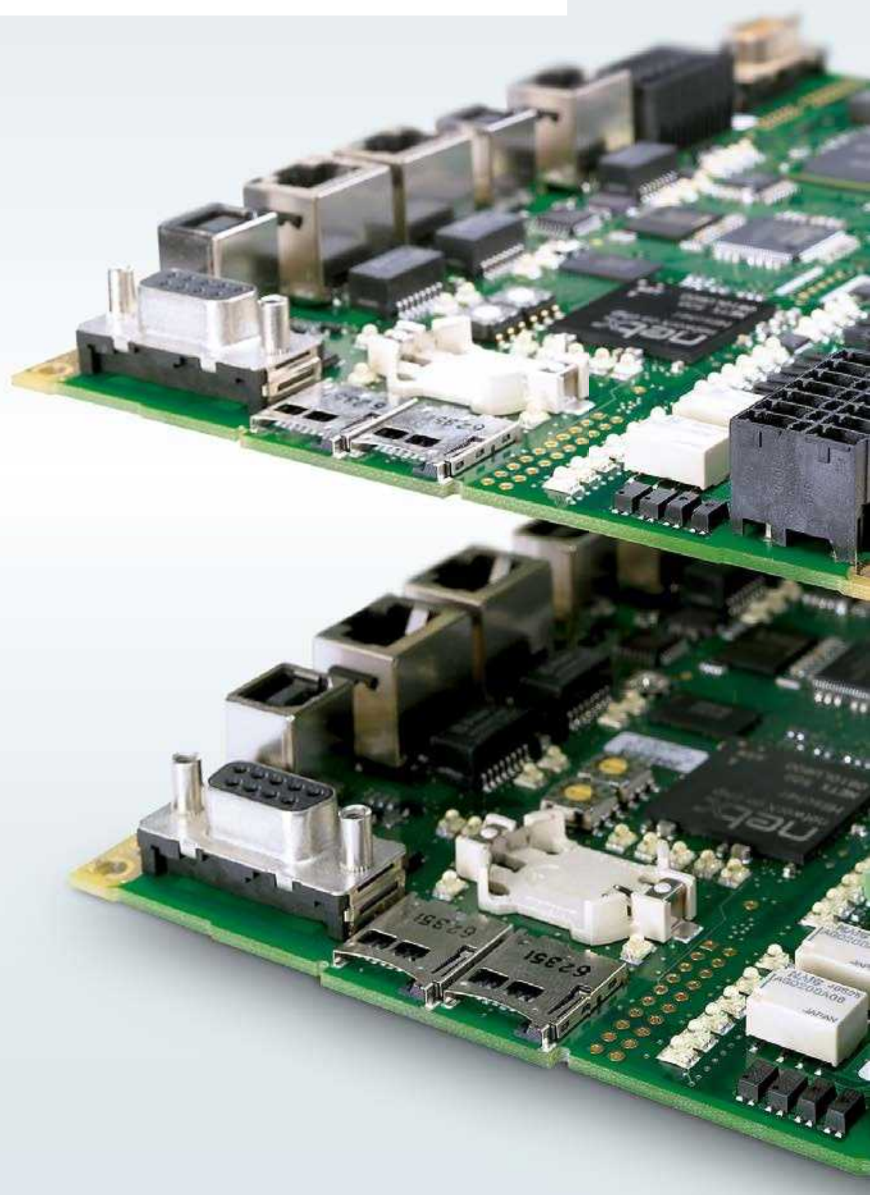
Surface Mount Technology SMT – A modern production process

Modern module manufacturing is characterized by high functional and component densities with an increasing demand for miniaturization and reduced surface requirements of the components on the printed-circuit board. At the same time, the focus is also on cost-optimized manufacturing – which over the last few years 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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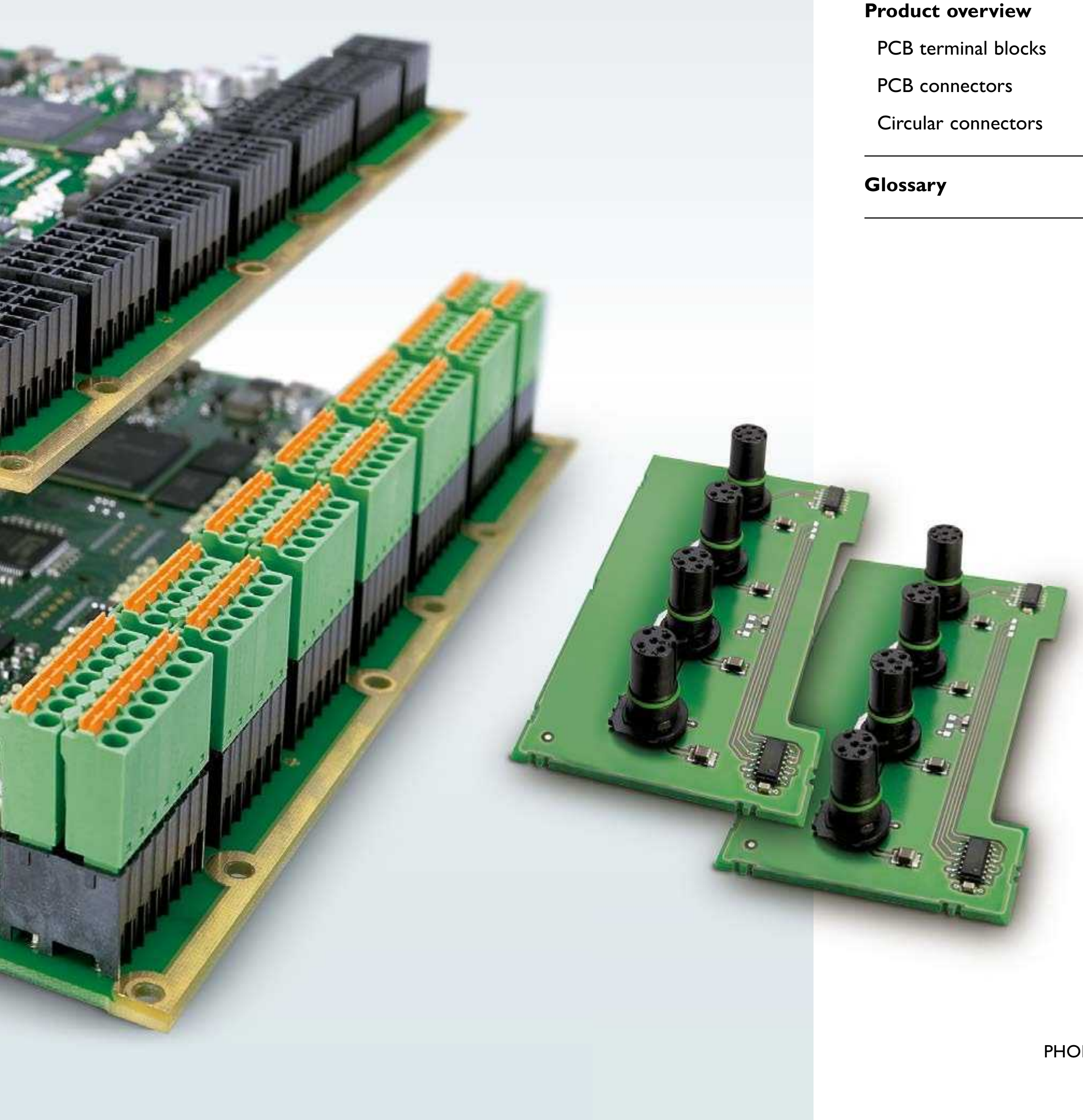


Contents

1 Surface Mount – Basic principles of module manufacturing

Surface mount technology is the basic principle in modern module manufacturing and is the result of decades of optimizing the module manufacturing process. The changeover from wired components mostly assembled by hand to surface-mounted components that can be assembled in an automated process enables module manufacturing to be optimized with regard to a cost-effective, high-quality and less error-prone production process.

In contrast to the through-hole assembly of wired components, SMD components have solderable connection surfaces that are soldered directly onto the upper side of the printed-circuit board. In this process, the contact surfaces of the printed-circuit board 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 printed-circuit board. 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 on mechanical strain are already used in SMDs today. Today, there are two options for integrating connectors with high requirements on current carrying capacity and mechanical functions –

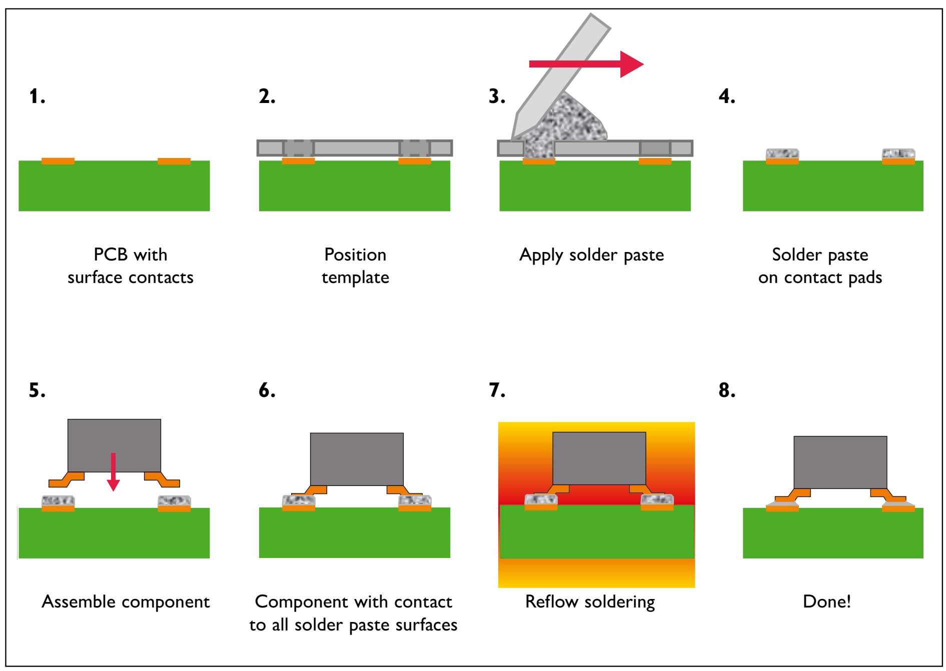


Fig. 1: The "Surface Mount" process sequence

either as standard components wave-soldered in a second process step, or alternatively integration via THR technology during the SMD process.

2 Basic principles of through hole reflow technology

The through hole reflow soldering method applies the process steps of the SMT manufacturing process 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 normatively 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 provides the means of combining the mechanical stability of wired components with the efficiency of surface mounting technology. 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 volumes 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 soldering menisci on both sides. The mechanical stability of THR soldering spots is comparable with that of wave-soldered spots (Fig. 2).

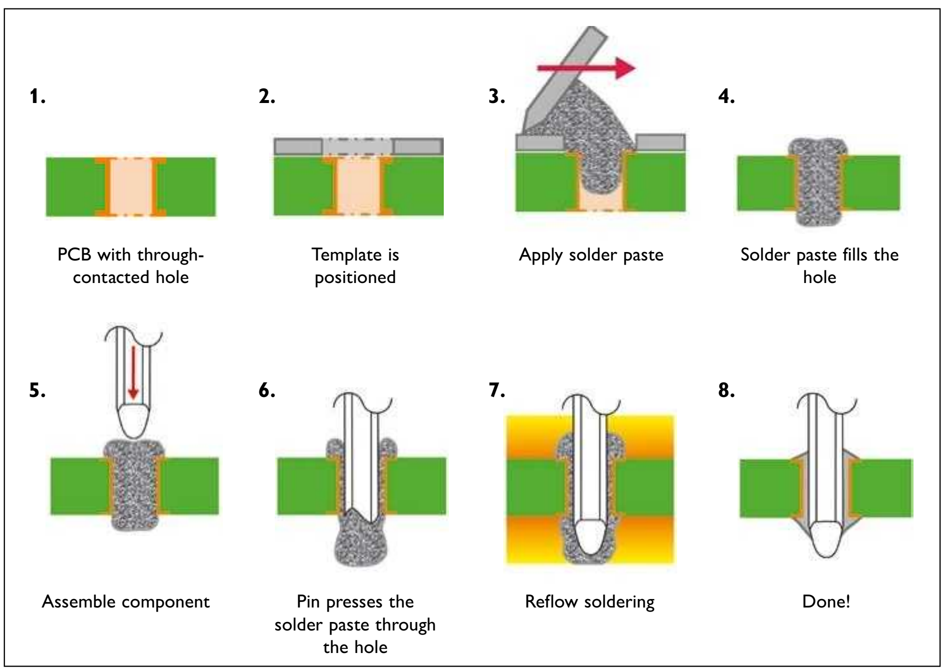


Fig. 2: The through hole reflow process sequence

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 printed-circuit board 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 whenever possible here. Regardless of which assembly method 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 of the number of process steps (e.g. no additional wave-soldering) and the more cost-effective manufacture of the modules achieved.

Fig. 3: Printing

Fig. 4: Assembly

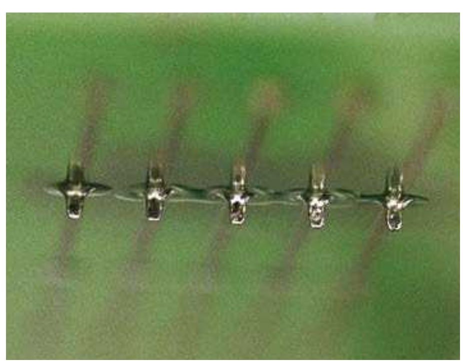


Fig. 5: Reflow soldering

Fig. 6: Inspection

4 Requirements on 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 packaging. Additional adjustments are necessary for connectors in particular.

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 lies in part significantly below that of standard plastics. Therefore, lower rated data/rated voltages are to be expected.

Today, depending on the requirements, polyamides (e.g. PA 4.6), LCPs (liquid crystal polymers) and PCTs are used. Decisive factors in the selection are, amongst others, 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 the standard IPC/JEDEC J-STD-020.

Suction areas for optimum assembly

Automatic assembly is a prerequisite for SMD mounting. Alongside the approved delivery methods, e.g. in a tape or tray system, 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 automatic devices 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 being assembled via an automatic device will not have an additional pad.

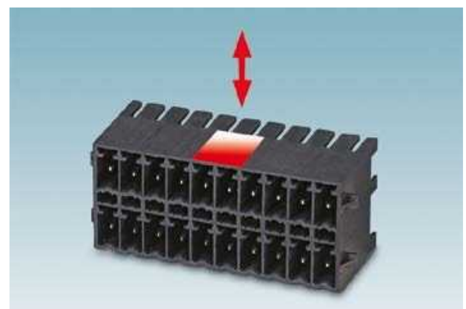


Fig. 7: Component shape-supporting suction surface

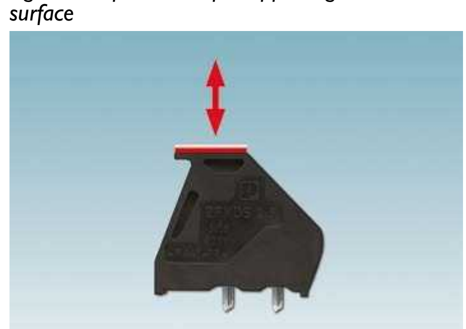


Fig. 8: Integrated raised suction surface

Fig. 9: Additional pick-and-place pad

Clearances on the component underside

The contact of solder paste on plastic parts and the undefined melting-on can lead to residual solder balls or solder bridges which, in the worst case, cause short circuits in the module. Accordingly, the components are to be equipped with large clearances (Fig. 10) around the solder pin or the surface contact wherever possible and have spacers, so-called "stand offs". Furthermore, it must also be assured 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 are to be black wherever possible – this ensures a particularly good 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 their color pigments are suitably thermally stable and, for certain applications, UV-stable (Fig. 13). The color palette available today is limited and dependent on the base material (polyamide or polymer). Modern camera systems, thanks to improved exposure and contrast imaging, are capable of capturing the necessary details despite a poor contrast of the metals to the colored housings.

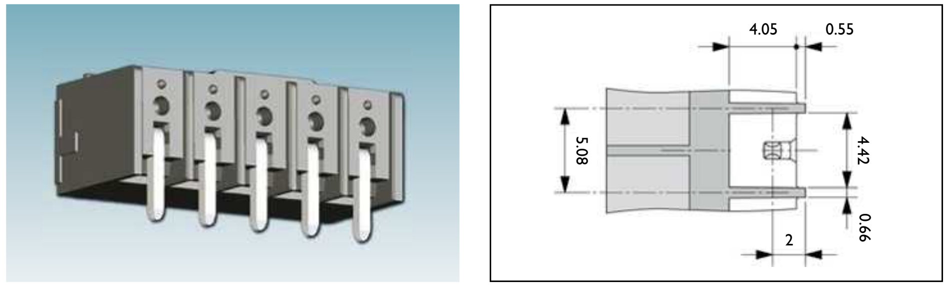


Fig. 10: Example of documentation for the possible clearances below a THR connector

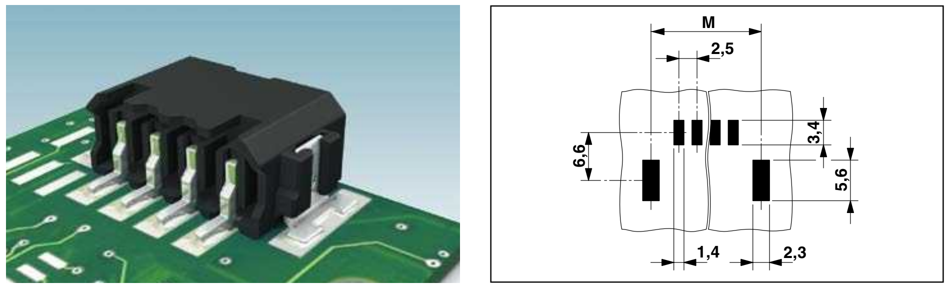


Fig. 11: Example of layout recommendations for an SMD connector

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, in particular in the solder area, are 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/solder.

In many cases, this risk can be bypassed. For example, Phoenix Contact has pins available 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 for application reasons, fully gold-plated contacts are used nevertheless (Fig. 16), the amount of gold remaining in the soldering spot must be specified.

In accordance with EN 61191, this may not exceed 1.4%. All Phoenix Contact SMD/THR contact systems are calculated using this as a basis.

Fig. 14: Partially gold-plated pins

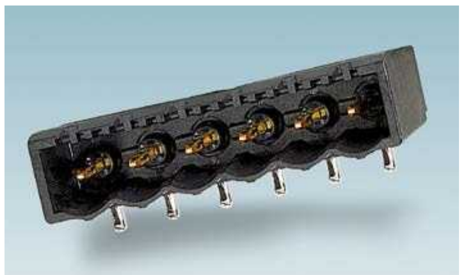


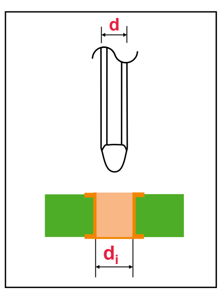
Fig. 15: THR pin strip with partially gold-plated pins

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

4.2 Specific requirements on THR components

Area of application of THR technology

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



	Pin diagonal (d)	Hole diameter (d_i)
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

Relationship between pin diagonals and 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 printed-circuit board 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 printed-circuit board 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. The purpose of correlating the hole dimensions and pin diameter is ensuring that the pin strips can be processed without difficulty. Ultimately, it must be possible for the operator to manufacture soldering spots that satisfy the requirements of class 3 of the IPC A-610.

Pad design/residual ring

With regard to dimensioning the residual ring, the same requirements as those on 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. A suitable hole diameter is on the one hand important for ensuring the reflow of the solder in the reflow process, and on the other hand the hole size affects the ability to assemble using automatic devices. Through the use of a suitable hole size, production tolerances are compensated and reliable assembly is possible.
In practice, increasing component lengths result in larger production tolerances. To increase the assembly reliability of high-position, large components, it can be necessary to increase the internal diameter even further by up to 0.1 mm. For Phoenix Component THR components, the recommended hole diameters are documented as a function of the number of positions for each individual series.

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. A position tolerance of, for example, ±0.2 mm describes in this case a circle with a diameter of 0.4 mm, the center of which being the ideal zero position of the pin tip. The current THR standard DIN EN 61760-3 specifies the maximum permissible position tolerance as being ±0.2 mm – equating to a swash circumference of 0.4 mm. Position tolerance of the pin tip in the hole – tolerance of possible swash circumferences in accordance with standard requirements is a diameter of max 0.4 mm.

All Phoenix Contact THR components satisfy the standard requirements. Furthermore, a broad product portfolio is available for applications in which the requirement on the position tolerance is ±0.1 mm (Fig. 17).

THR product range (straight)				Recommended layout*		
Pos.	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
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 range (angled)				Recommended layout*		
Pos.	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 range				Recommended layout*	
Pos.	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

M12 PCB configuration

**for a PCB thickness of 1.6 mm*

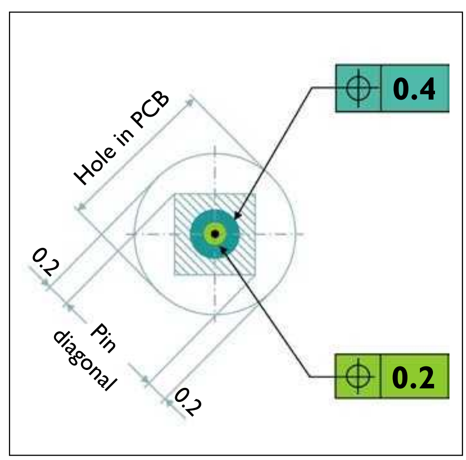


Fig. 17: Position tolerance of the pin tip in the hole – the tolerance of possible swash circumferences in accordance with standard requirements is a diameter of max 0.4 mm

Solder pin length

The soldering method and the type of soldering process should also be taken into consideration when selecting the right solder pin lengths. Today, pin protrusions between 0.4 and 1.0 mm are generally recommended – for a 1.6 mm thick printed-circuit board, this means a pin length of 2 mm to 2.6 mm from the underside 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 vapor 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. With regard to IPC inspection, qualification criteria have not as yet been defined, meaning that the risk must be assessed on an individual basis (Fig. 18).

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. 18: Pin lengths for use in standard PCBs of 1.6 mm thickness

4.3 Specific requirements on 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 SMD connector surface contacts 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. Today, this is normally between 100 to 150 µm. Accordingly, the coplanarity must therefore be 0.08 mm to 0.1 mm. The possible coating thickness of the solder paste that can be applied depends here on the particle diameter of the tin particles in the paste.

Solder pastes are classified by type depending on 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, otherwise the contact to 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 secure contact (Fig. 19).

Position tolerance

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

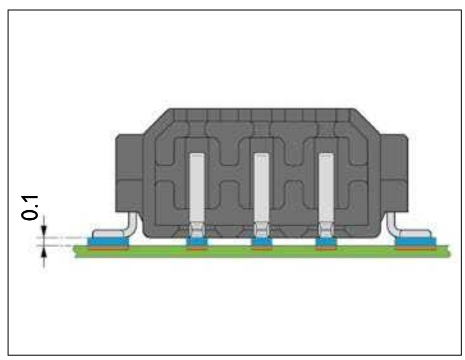


Fig. 19: Coplanarity of all component contacts 0.1 mm

Mounting bosses

Mounting bosses are plastic pins 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. 20).

Armatures

SMD armatures for connectors primarily have two functions. First of all to increase the secure positioning on the printed-circuit board and the mechanical stability when the connector is being plugged and unplugged. Secondly, the additional armature flange can generate the necessary adhesion for overhead soldering during two-side assembly (Fig. 21).

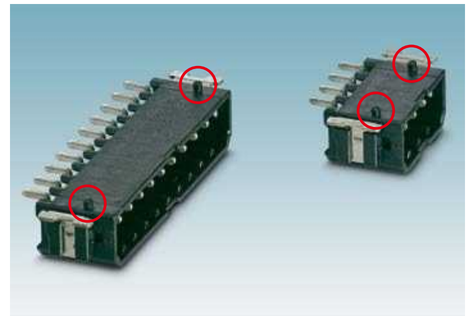


Fig. 20: Connectors with mounting bosses

Fig. 21: PCB terminal block with lateral SMD armatures

4.4 Specific requirements on combination SMD/THR components

SMD contacts and THR armature metals

Pure SMD connectors 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.

For external device connections and for end user operation, the same high 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 of similar connector dimensions. The use of connectors with SMD contacts and THR armature metals is ideal in this case (Fig. 22).

This type of connector must also satisfy the above listed requirements on SMD and THR connectors. At the same time, this combination results in decisive advantages.

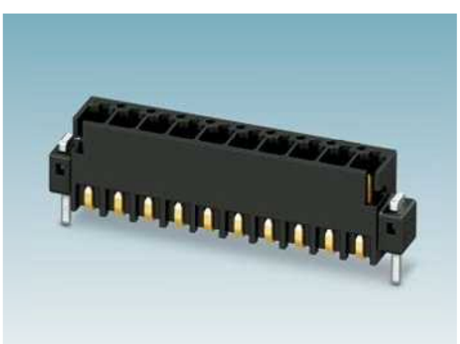


Fig. 22: Combination connector with SMD contacts and THR armatures

Double function for THR armature pins

Alongside the necessary mechanical stability, the THR armatures additionally adopt 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 printed-circuit board 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 the 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 so-called 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 component top side) within a simulated reflow soldering over a period of up to 30 seconds. Today, desired peak temperatures are approximately 260°C.

The standard, however, only demands these high temperatures in practice for small components with comparatively low housing or wall thicknesses. With increasing housing or wall thicknesses or larger housing volumes, lower temperatures 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 these are not necessary.

This is due to the fact that THR/SMD connectors are often included amongst 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 conserve the smaller components and securely solder the larger components despite lower heating temperatures.

A so-called classification temperature Tc is defined in order that manufacturers and operators have the same understanding of the maximum permissible peak temperatures. Furthermore, 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. 23).

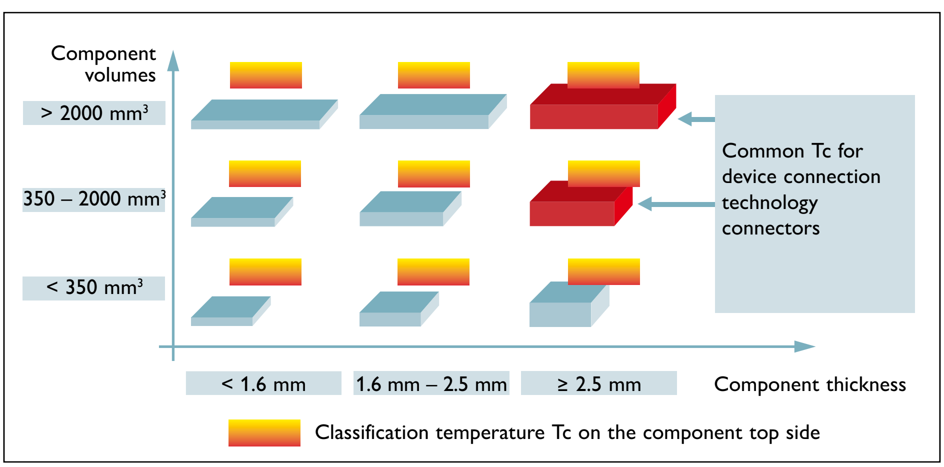


Fig. 23: Determination of the classification temperature depending on housing volumes and thickness for a lead-free soldering process

5.2 Moisture Sensitivity Level for reflow components

Alongside the classification temperature, the MSL (Moisture Sensitivity Level) 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. 24).

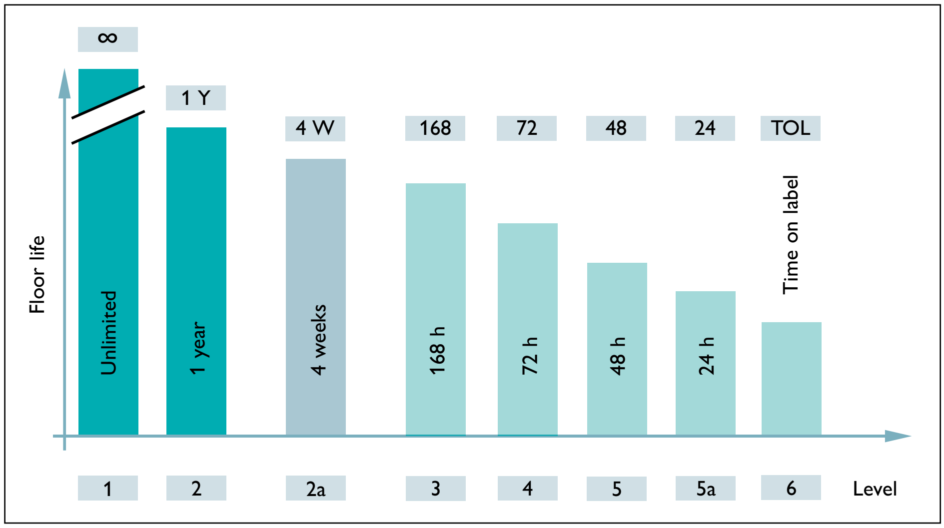


Fig. 24: MSLs and their floor lives

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 can not absorb moisture or only little amounts are therefore candidates for level 1, "unlimited", without additional dry packaging (dry bag). These can often be stored 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 once the bag is opened, and ends upon expiry of the time specified by the level. Upon

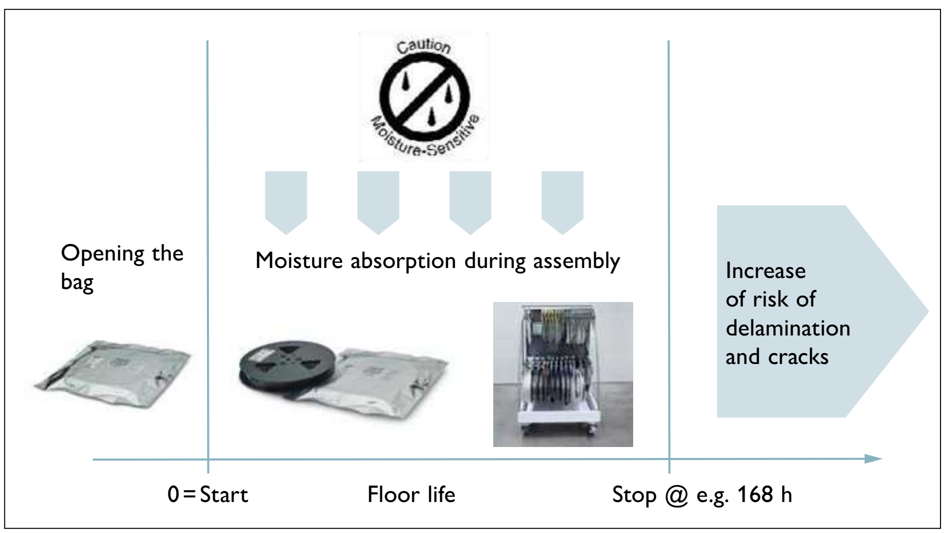


Fig. 25: Floor life time, example of the process with components of MSL 3*

expiry of the floor life, the components must be returned to the starting state via a re-bake process (Fig. 25).

5.4 Test cycle, qualification of the Moisture Sensitivity Levels (MSL)

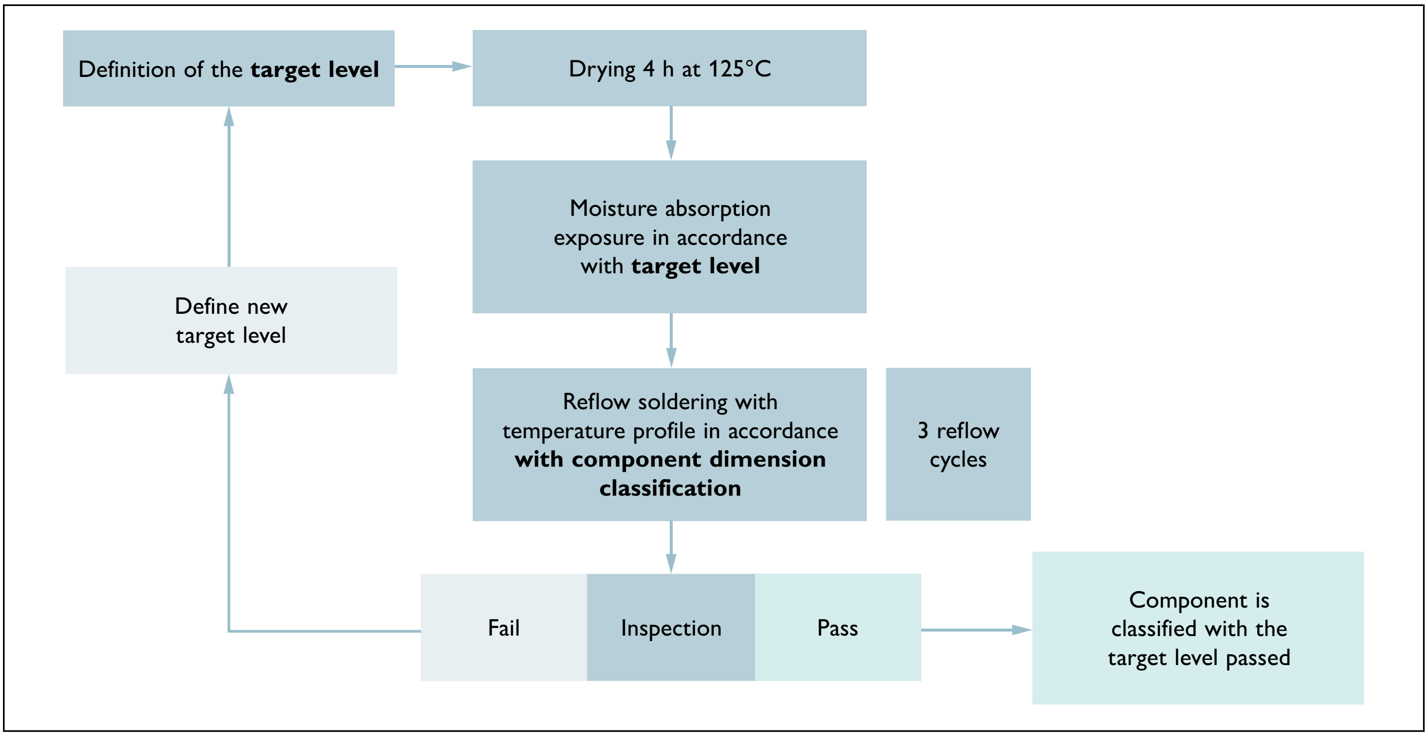


Fig. 26: Test cycle with which the target level is tested

The tests are normally first performed with classification temperatures of 260°C. Only if the component does not pass the test, the classification temperature is reduced to 250°C or 245°C for certain component dimensions in accordance with the standard; however, the level strived for is first of all maintained. 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 determined only if the component completes the test without any damage. The components are then packed and labeled in accordance with the standard specifications (Fig. 26).

The components are to be inspected for damage after each new test cycle. Attention is primarily paid to the formation of blisters (Fig. 27) on the component surface – it may be necessary to take micro-sections to determine any internal damage (cracks) (Fig. 28). Fused surfaces and deformations also result in the component not passing a target level.

Fig. 27: Failed level – blister formation

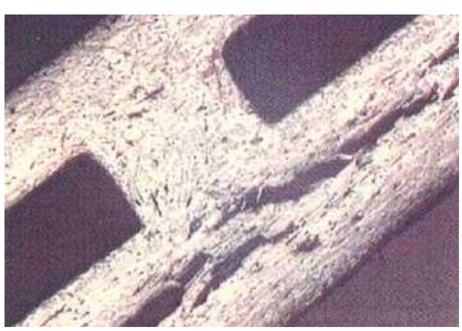


Fig. 28: Failed level – cracks

5.5 Qualification profile vs. operator profile

Even though the qualification profile is close to conditions in practice, 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 others in order to solder the module cleanly. The qualification profile with its classification temperatures therefore serves as a reference point for the process engineer as to whether the components can be soldered using the actual profile (Fig. 29/30).

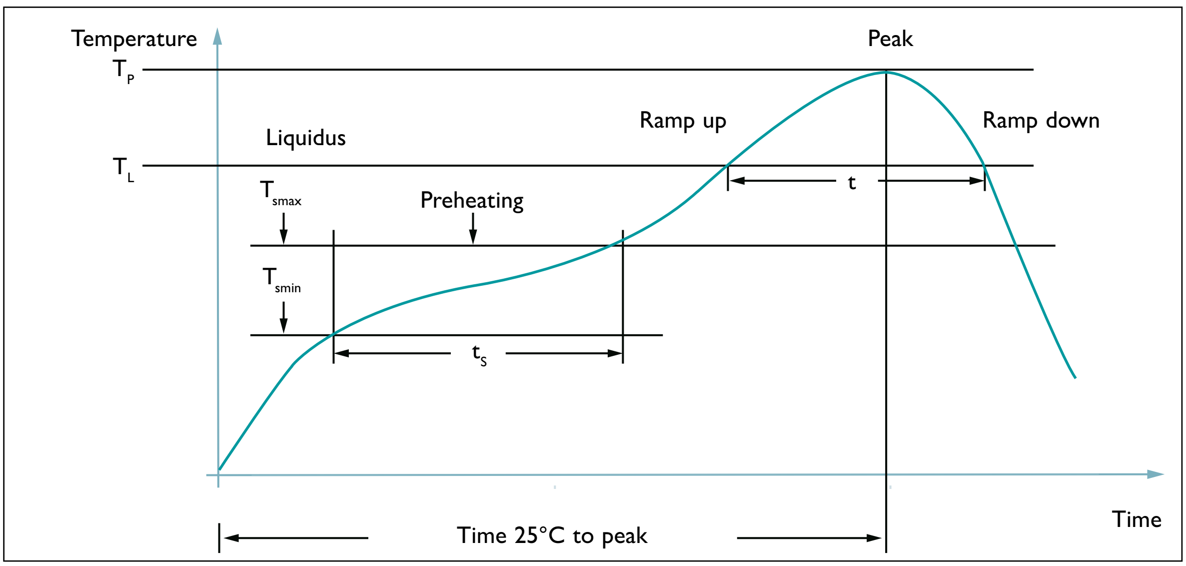


Fig. 29: Idealized qualification profile in accordance with standard*

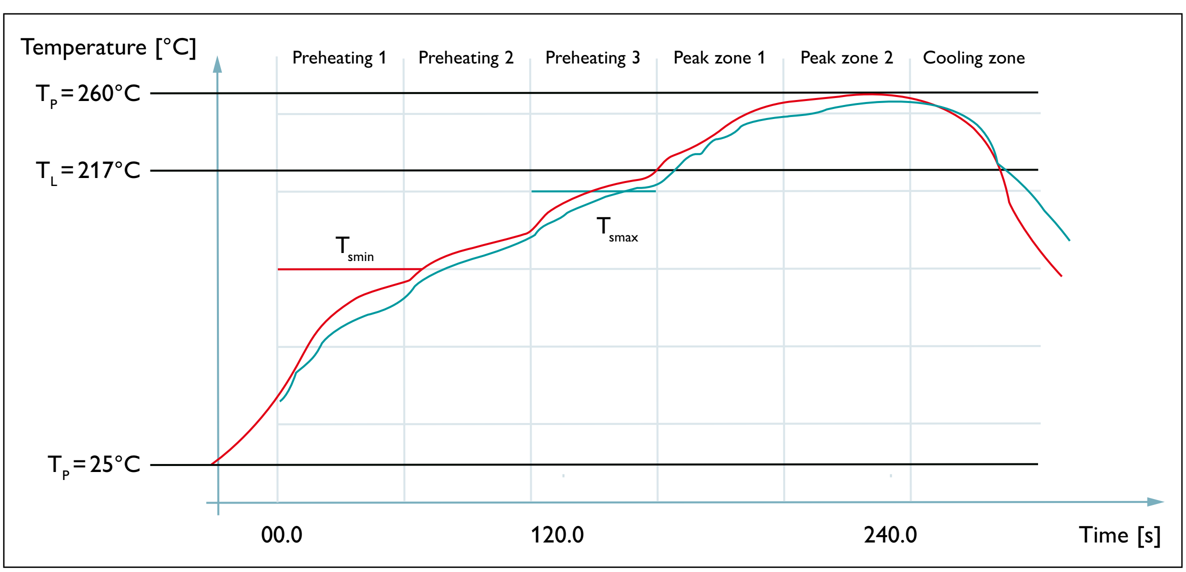


Fig. 30: Recorded actual operator profile

5.6 Packaging

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

Level 1

Components achieving MSL 1 do not need any special protective measures for the prevention of moisture absorption. Simple packaging in a protective bag that is electrostatically conductive is sufficient (Fig. 31).

Level goods

Level goods, i.e. goods with MSL 2 or higher, need so-called dry bags that are also electrostatically conductive. Packaging is performed in accordance with IPC/EDEC-033 with appropriate desiccants, moisture indicators and nitrogen flushing and concluded with the bag being partially vacuumed and sealed (Fig. 32/33).

Fig. 31: MSL 1 goods in an anti-static polybag

Fig. 32: Components in a tape in the dry bag

Fig. 33: Components as bulk material in a carton in the dry bag

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

- The MSL level (top right)
- The shelf life in the dry bag
- The peak temperature value at which the 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. 34)

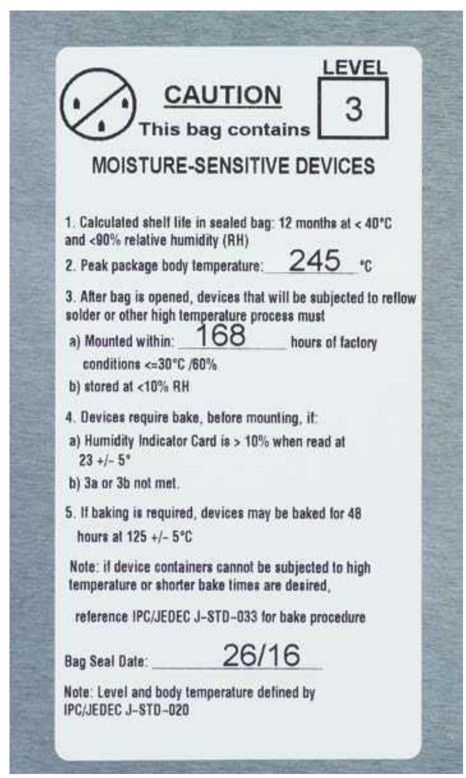


Fig. 34: Marking

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

Optimum process integration begins with the PCB layout. As early as this stage, 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 the components during assembly. The soldering process and the subsequent inspection are well described in standards. Each process step places requirements on the components which these in turn have to satisfy through the optimum selection of material and product design.

6.1 PCB layout

SMD layout

The pad size for a certain solder contact size and the entire layout (arrangement and distance of the pads from one another) are generally recommended in a layout proposal by the manufacturer. The layout proposal takes into consideration an area sufficient to be able to generate soldering spots in accordance with the desired class of IPC A-610.

The arrangement of the contacts in relation to each other is mainly influenced by the necessary air clearances and creepage distances.

Tolerances for the component and for during assembly that affect the lateral projection and contact overlapping have an influence on 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. 35).

THR layout – pad design/residual ring

With regard to dimensioning the residual ring, the same requirements as those on 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).

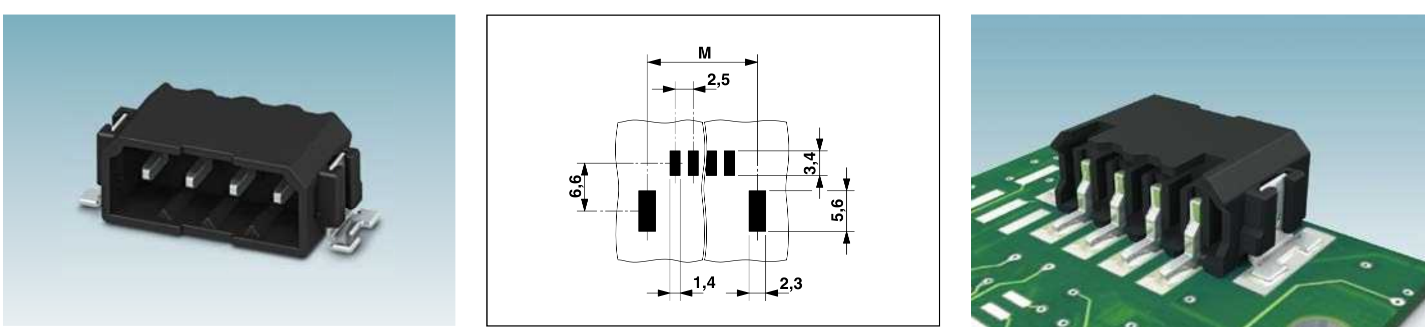


Fig. 35: Example of layout recommendations for an SMD connector

THR layout – hole diameter

The hole diameter for THR connectors depends on the pin geometry and the printed-circuit board thickness – see Area of application of THR technology, page 9. An optimum relationship between hole diameter and pin geometry balances manufacturing tolerances, 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. 36). Layout proposals for a recommended hole diameter are documented in the article drawings. Furthermore, the position tolerance of the contact pin can also be used (Fig. 37).

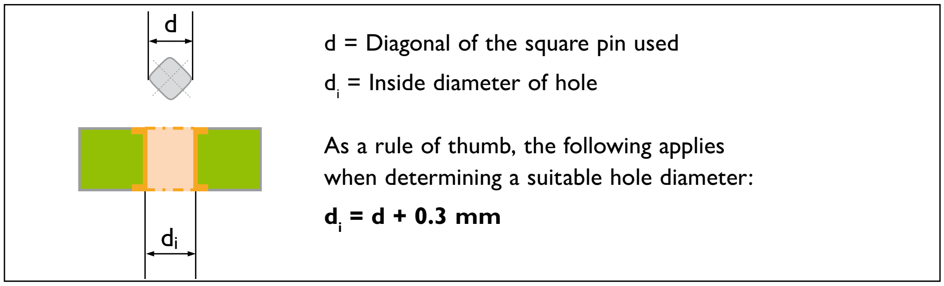


Fig. 36: Recommendation on the relationship between hole diameter and pin diagonal

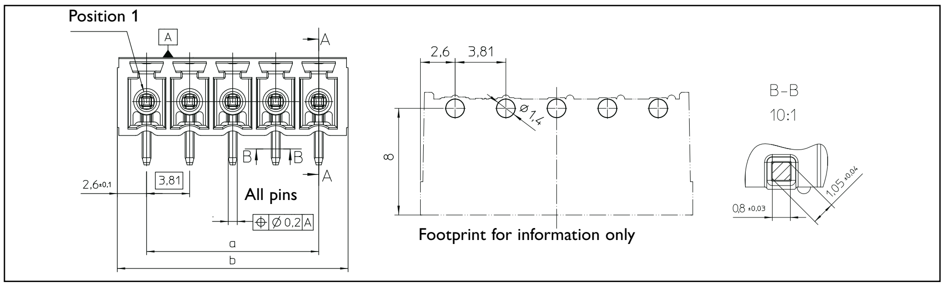


Fig. 37: Layout and tolerance drawing of a typical THR component

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 applied in the holes. Templates with a thickness of 100 to 150 µm are currently used (Fig. 38).

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 the setting of 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 should not be influenced, or only slightly, by a concurrent THR printing. On the printer itself, the through-printing can, however, be changed by the squeegee blade angle or squeegee blade speed (where applicable through cartridge printing in closed systems) (Fig. 39).

Fig. 38: Squeegee blade system

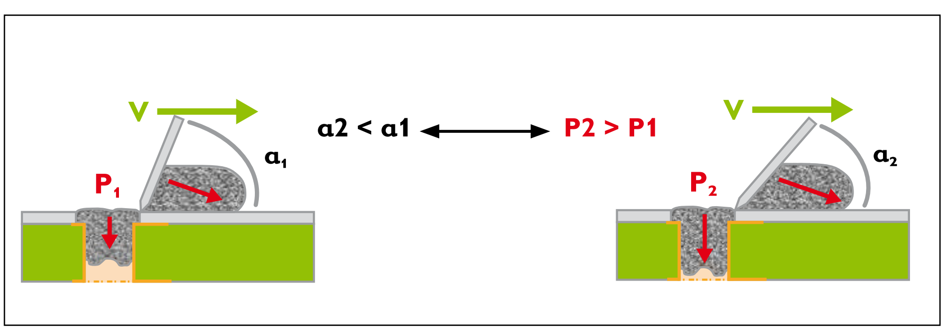


Fig. 39: Change of the squeegee blade – increase in through-printing

THR paste volumes – 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 classified amongst other things by particle diameter.

The necessary volume must be generated through the appropriate design of the layout, optimized printer parameters and depending 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. 40).

The template cutout (Fig. 41) is designed with a diameter of approximately 0.1 mm less, in order that the template lays on the residual ring (Fig. 42).

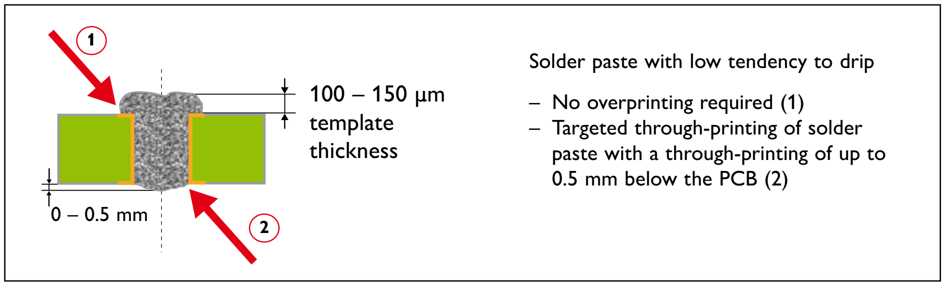


Fig. 40: Base pressure (ideal)

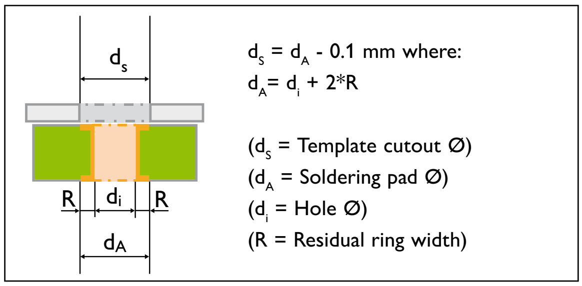


Fig. 41: Recommended template cutout

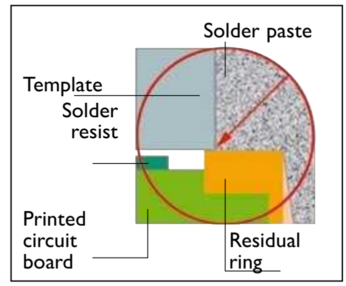


Fig. 42: Template positioned on the residual ring – no overprinting

The overprinting of solder paste on the solder resist is thereby purposefully avoided. 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 balls forming.

THR paste volumes – additional areas

In certain applications, in particular with an increased tendency for solder paste to drop, the through-printing is reduced (Fig. 43). The missing paste volumes must therefore be generated at other positions.

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

A lower 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. 44).

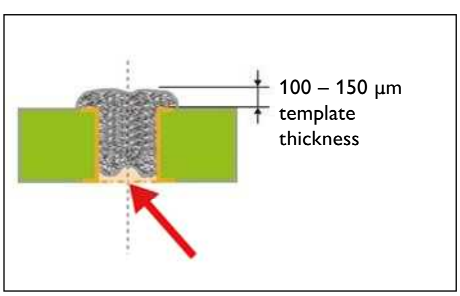


Fig. 43: Reduced paste printing – less through-printing

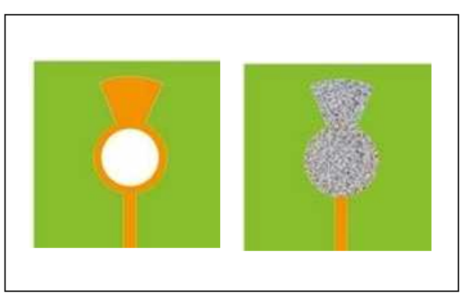


Fig. 44: Layout area for additional solder paste volume: layout/after printing

THR paste volumes – reduced pressure

If the solder paste used tends to drop or if the holes for the components used are very large, another strategy must be pursued. In this case, introducing bars into the template to limit the paste through-printing is recommended (Fig. 45). 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. 46).

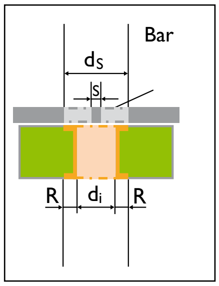


Fig. 45: Template with bar of width S

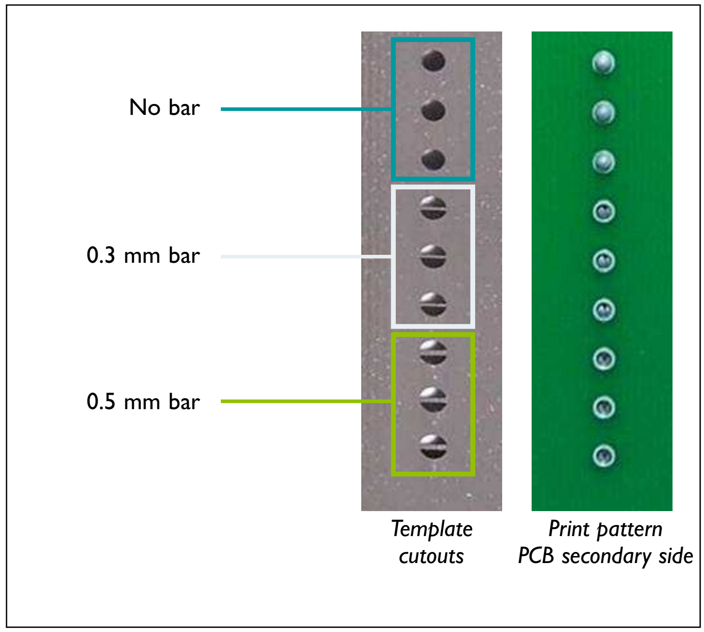


Fig. 46: Through-printing reduction through bars, alternative cutouts with bars and larger diameters

6.3 Assembly

PCB connection elements are normally assembled by hand, particularly 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 automatic devices. In this process, components are picked up using standard vacuum pipettes.

For full integration into the process, the available maximum free assembly height of the automatic device and the component weight must be taken into consideration. It may be necessary to reduce the assembly speed in order to avoid 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. 47), it is then measured via the camera (Fig. 48), and then placed on the PCB (Fig. 49).

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

Fig. 47: Component picked from the tape

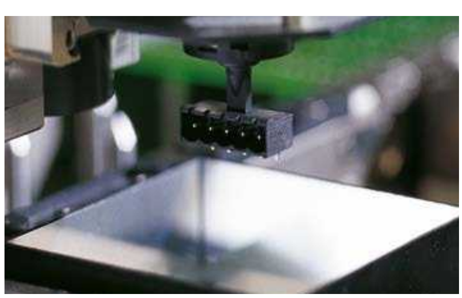


Fig. 48: Camera image capture for component measuring

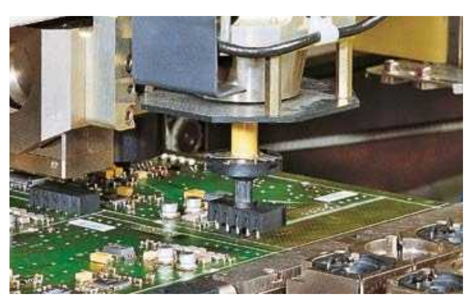


Fig. 49: Component placed on the PCB

Tape-on-reel packaging

The most popular form of delivery for SMT assembly processes is the tape-on-reel packaging (Fig. 50). Tape widths of between 16 mm and 104 mm are used for standard THR components.

Due to the component size, in particular with tall components, tapes with very deep-drawn cavities are necessary. 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 input and output of the tape in the automatic device (Fig. 51).

The space available at the feeder table of an automatic device is always tight (Fig. 52), especially if the feeder trolley is fixed and can not be modified. As a result, it is always necessary to optimize the space available. 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 trays and feeders are necessary. These are not unusual, but are uncommon and expensive. In these cases, it may be necessary to switch to the alternative tray packaging.

Fig. 50: Tape-on-reel packaging

Fig. 51: Equipped feeder

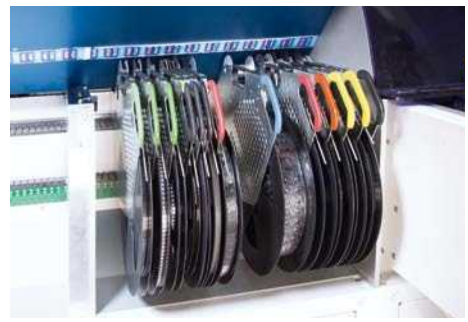


Fig. 52: Limited space at the feeder table

Tray packaging in the flat magazine

The alternative use of flat magazines depends on several factors. In terms of components, the outer 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, low packaging 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. 53/54). Often, however, in terms of operating equipment, the availability of a tray feeder unit (tray tower, Fig. 55) alone determines whether this advantage can be utilized. Where a tray tower is not integrated, a retrofit is in most cases not expedient, and having larger tapes custom made and purchasing a wider feeder is cheaper. The decision for an appropriate packaging option is therefore very dependent in each individual case on the existing assembly system and the components.

Fig. 53: M12 THR connectors in a tray

Fig. 54: High-volume THR components in a tray

Fig. 55: Tray feeder unit (tray tower)

6.4 SMT soldering

SMT soldering is reflow soldering (see also section Surface Mount – Basic principles of 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 printed-circuit board.

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. 56). 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. 57). The pin protrusion below the printed-circuit board plays a significant role in the melting of the solder. The through-printed solder paste should still retain contact to the hole (residual ring), to achieve a good reflow effect. Short pin lengths reduce the risk of paste loss due to dripping.

Fig. 56: Paste drops on pin tips

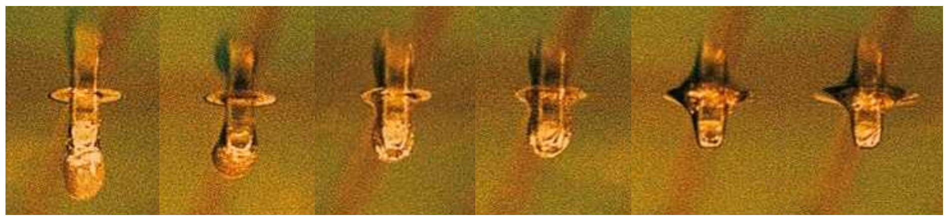


Fig. 57: Melting process in the reflow oven

Fig. 58: Convection soldering oven

Soldering technologies

In SMD manufacture, convection soldering systems are mainly used today, followed by vapor phase soldering systems. Convection soldering ovens (Fig. 58) 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. With regard to the THR technology, there are just a few model-specific limitations.

With the development of the vapor phase soldering oven (Fig. 59) through to the inline system, this soldering technology is gaining further significance. The system offers, for a constant soldering profile, an increased manufacturing range in terms of the module size and often increasing 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 through dripping.

Fig. 59: Solder chamber during a vapor phase

This dripping can be counteracted by selecting 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 in connection with the reflow soldering process should be broken down into process describing standards and component qualifying standards.

1. A standard mainly describing the requirements on 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 standard series has been extended with Part 3 to include THR components. DIN EN 61760-3 – Surface mounting technology: Standard method for the specification of components for Through Hole Reflow (THR) soldering – describes requirements on THR components and also on 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) – serve 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 the standard IPC/JEDEC J-STD-020-Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface-Mount Devices.

This standard is drawn upon in the development of Phoenix Contact THR and SMD connectors and they are then tested. The test cycle is described in the section 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.

The peculiarity of the qualification is the clear distinction between the maximum temperature loads on the side of the manufacturer and of the operator. A safety temperature buffer is specified here, which aims to avoid an overload on the side of 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 his line with his individual profile. In practice, the soldering profile is set conservatively on the basis of IPC/JEDEC J-STD 020 in order to solder at the lower limit of the thermal loads.

There is not one soldering profile covering all components. The soldering profile is very individual and takes into consideration all of the parameters of the process, the components, the printed-circuit board through the solder paste all the way to the equipment (oven). It is a compromise of all influencing factors with the target being an optimum soldering result in a defined quality.

The additional parameters and assignments in the above listed standard in terms of comparable component volumes, the component thickness and the maximum peak body temperatures enable a stress-reduced temperature load to conserve components that can not be subject to such high loads (see page 16 – Qualification profile vs. operator profile).

6.5 Inspection

Reference

The 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 above listed standard – products of the highest reliability. The responsibility for creating the soldering spot lies with the process operator.

Requirements on THR soldering spots

The requirements to be strived for on a soldering spot of class 3 for plated-through holes, vertical filling with capillary fill are as follows:

- Fill level:
  The vertical filling (capillary fill) should be 100%. A reduction to 75% is not permissible (Fig. 60).
- Wetting of the primary side:
  The primary side is the component side. The aim is for a wetting 360° all around the connection wire. A wetting of 270° is the minimum permissible (Fig. 61).
- Wetting of the secondary side:
  The secondary side of the printed-circuit board is the side without components. The aim here is also for a wetting 360° all around the connection wire. A wetting of 330° is the minimum permissible (Fig. 62).
- Residual ring covering on the primary side: The connection area (the soldering pad) must not be wetted with solder. Ideally, the solder cone should be visible (Fig. 63).
- Residual ring covering on the secondary side: The connection area (the soldering pad) must be fully wetted with solder. Ideally, the solder cone should be visible.

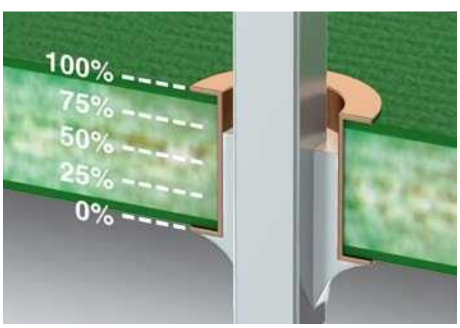


Fig. 60: Fill level, minimum 75% vertical solder filling required*

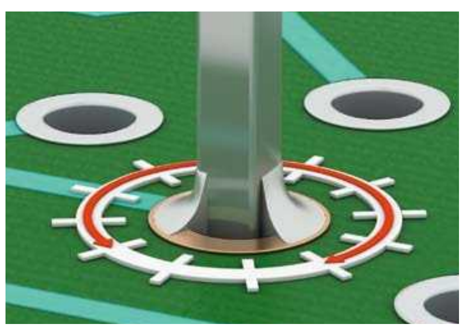


Fig. 61: Wetting of primary side 270° or 75%*

Fig. 62: Wetting of secondary side 330° or 92%*

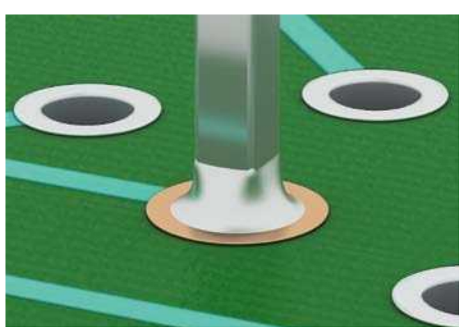


Fig. 63: Residual ring cover primary side 75%, wetting of the soldering pad not necessary*

Fig. 64: Residual ring covering, the soldering pad must be fully wetted*

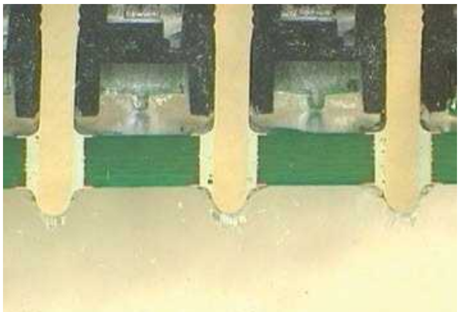


Fig. 65: Assessment of the fill level for 2.6 mm pin in 1.6 mm thick PCB

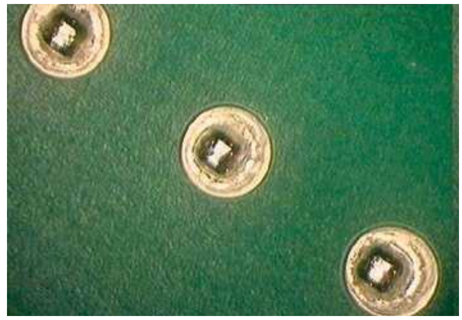


Fig. 66: Complete wetting of the soldering pad and 100% perimeter wetting

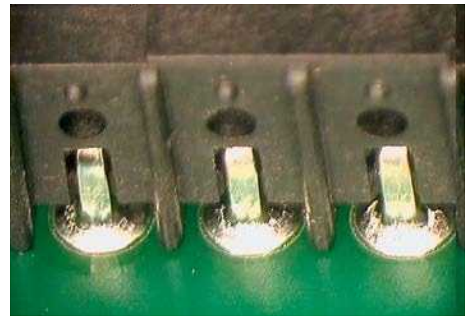


Fig. 67: Typical lean THR soldering spot on the secondary side of the PCB with more than 75% soldering pad wetting and 100% perimeter wetting

Soldering spots with pin ends protruding – standard pin

The pin slightly protruding out of the printed-circuit board secondary side satisfies the minimum requirement for an assessable soldering spot in accordance with the standard. With optimum configuration of all parameters, the requirements for all criteria are satisfied 100%. In the micro-section, a fill level of at least 75% is achieved. A small solder cone forms on both sides (Fig. 65 – 67).

Soldering spots with countersunk pin

Where space is needed on the secondary side of the printed-circuit boards, it is expedient to utilize so-called 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 printed-circuit board and whose soldering spot can therefore not be assessed using the normal above listed criteria of the IPC-A-610 standard. This is permissible if the pin lengths are reduced by the manufacturer and the component sits directly flush on the printed-circuit board primary side.

Certain strategies for quality assessment need to be developed in this case. Micro-sections show here a reliable fill level and a good formation of the solder cone below the component (Fig. 68 to 70).

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).

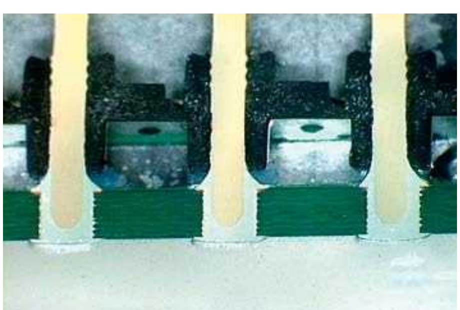


Fig. 68: Assessment of the fill level for 1.4 mm pin in a 1.6 mm thick PCB

Fig. 69: Assessment of the perimeter wetting and soldering pad wetting not defined in IPC

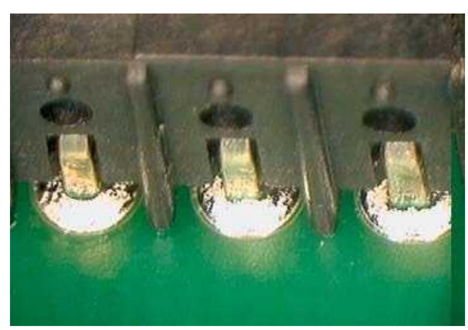


Fig. 70: Soldering spot on the primary side: perimeter wetting and soldering pad wetting in accordance with standard

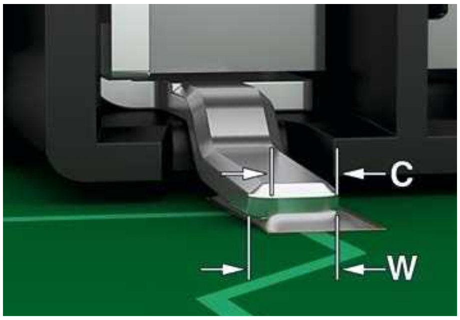


Fig. 71: Flat gullwing connection, minimum width at the end of the soldering spot (C)*

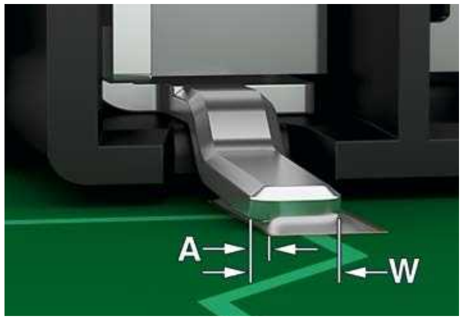


Fig. 72: Flat gullwing connection, side overhang (A)*

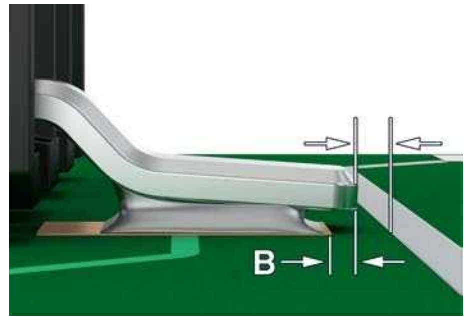


Fig. 73: Flat gullwing connection, end overhang (B)*

Requirements on SMD soldering spots

The coplanarity of the contacts and the matching of the contact surface of the connection contact to the soldering pad surface is decisive for the creation of high quality SMD soldering spots. Solder connections for Phoenix Contact SMD connectors 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 side- 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 are to be assessed. Depending on the design, IPC class 3 can be achieved here.

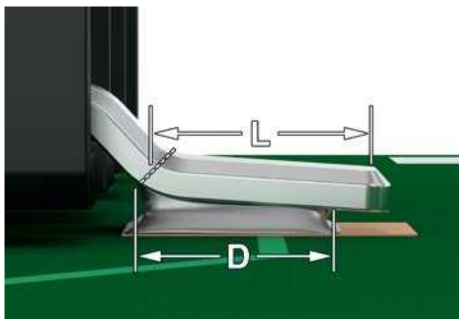


Fig. 74: Flat gullwing connection, minimum length of the soldering spot at the side (D)*

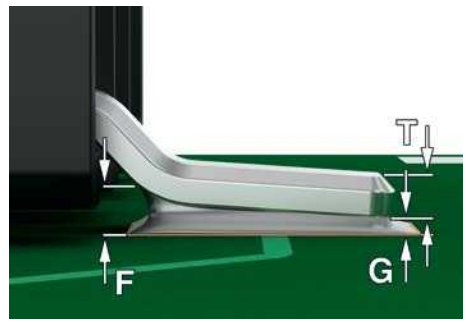
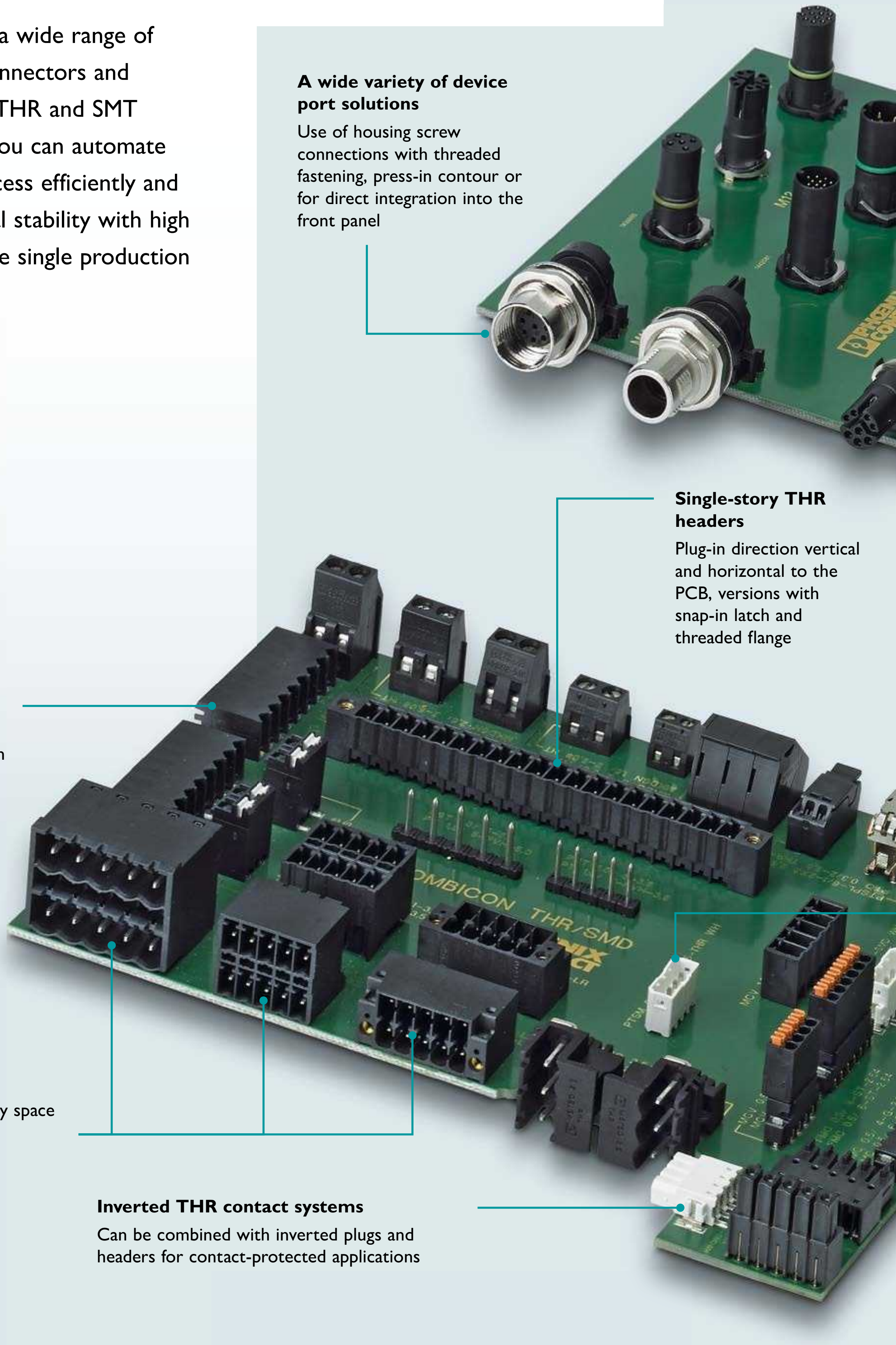


Fig. 75: Flat gullwing connection, minimum height of the soldering spot at the heel (F)*

PCB terminal blocks, connectors and circular connectors

Phoenix Contact offers a wide range of PCB terminal blocks, connectors and circular connectors for THR and SMT soldering. With these, you can automate your manufacturing process efficiently and combine high mechanical stability with high assembly densities in one single production sequence.



A wide variety of device port solutions
Use of housing screw connections with threaded fastening, press-in contour or for direct integration into the front panel

Single-story THR headers
Plug-in direction vertical and horizontal to the PCB, versions with snap-in latch and threaded flange

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

High density
High-position two-story space saving THR pin strips

Inverted THR contact systems
Can be combined with inverted plugs and headers for contact-protected applications

Seamless shielding

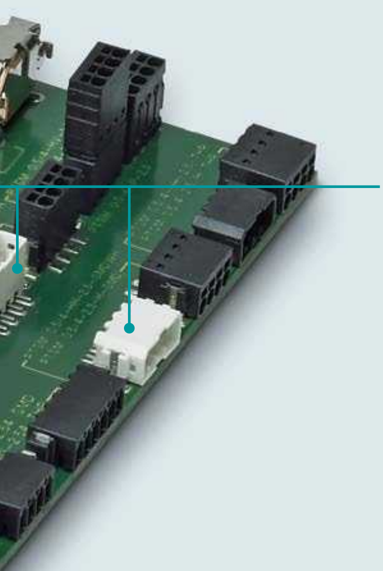
Shield connection to the PCB via shield spring

Reliable protection

Additional gasket for the device when not plugged in

Identical mechanical installation conditions

All numbers of positions and coding on one PCB level



Special solutions

White connection technology for light connection applications

PCB terminal blocks

PCB terminal blocks make it possible to transmit signals, data and power directly to the printed-circuit board easily and reliably. The space-saving connection method is ideal for numerous applications in process industry and industrial environments.

- For conductor cross sections from 0.14 mm² to 6 mm²
- For currents up to 41 A and voltages up to 320 V (IEC)
- With screw, spring or insulation displacement connection
- For pitches from 2.5 mm to 5.08 mm

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PCB connectors

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

- For conductor cross sections from 0.14 mm² to 2.5 mm²
- For currents up to 12 A and voltages up to 320 V (IEC)
- With screw, spring, insulation displacement or crimp connection

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Circular connectors

The circular connectors from the PLUSCON circular product range 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

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PCB terminal blocks
0.5 mm² to 6 mm²

PCB terminal blocks, nominal cross section up to 0.5 mm²

Web code: #1231	Push-in spring connection						
	Product range	Notes	Number 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 Also available as 1-pos. 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°

Web code: #1232	IDC insulation displacement connection						
	Product range	Notes	Number 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

i Web code: #1233	Screw connection with tension sleeve						
	Product range	**Notes**	**Number of positions**	**Pitch**	**Current[1] (A)**	**Voltage[1) 2)] (V)**	**Connection direction**
	MKDS 1/..-HT	High-temperature resistant plastic	2–4	3.5/3.81	13.5 IEC 10 UL (B, D)	200 IEC 300 UL (B, D)	0°
	MKDS 1/..-SMD	SMT soldering	2–12	3.81	8 IEC 10 UL (B, D)	160 IEC 300 UL (B, D)	0°

i Web code: #1235	Screw connection with tension sleeve						
	Product range	**Notes**	**Number of positions**	**Pitch**	**Current[1] (A)**	**Voltage[1) 2)] (V)**	**Connection direction**
	MKDSN 1,5/..-HT	High-temperature resistant plastic, low-profile design	2/3-pos. Can be aligned	5.0/5.08	13.5 IEC 10 UL (B, D)	320 IEC 300 UL (B, D)	0°
	MKDS 1,5/..-HT	High-temperature resistant plastic	2/3-pos. Can be aligned	5.0/5.08	17.5 IEC 15 UL (B) 10 UL (D)	320 IEC 300 UL (B) 300 UL (D)	0°

i Web code: #1236	Push-in spring connection						
	Product range	**Notes**	**Number 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 at overvoltage category III/pollution degree 2

PCB terminal blocks, nominal cross section up to 2.5 mm²

Web code: #1237	Screw connection with tension sleeve						
	Product range	Notes	Number of positions	Pitch	Current[1] (A)	Voltage[1) 2)] (V)	Connection direction
	MKDN 2,5/..-HT	High-temperature resistant plastic	2/3-pos. Can be aligned	5.0/5.08	16 IEC 20 UL (B) 10 UL (D)	320 IEC 300 UL (B) 300 UL (D)	0°
	MKDS 3/..-HT	High-temperature resistant plastic	2/3-pos. Can be aligned	5.0/5.08	24 IEC 15 UL (B) 10 UL (D)	320 IEC 300 UL (B) 300 UL (D)	0°

Web code: #1238	Spring-cage connection						
	Product range	Notes	Number of positions	Pitch	Current[1] (A)	Voltage[1) 2)] (V)	Connection direction
	ZFKDS 2,5-THT	High-temperature resistant plastic	2–12	5.08	24 IEC 10 UL (B, D)	320 IEC 300 UL (B, D)	45°

PCB terminal blocks, nominal cross section up to 6 mm²

Web code: #0724	Special spring connection design						
	Product range	Notes	Number 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°
	PT-SG	Without insulating housing With grapple spring connection	1		41 IEC	-	-90°

PCB connectors
0.5 mm² to 2.5 mm²

PCB connectors, nominal cross section up to 0.5 mm²

Web code: #0735	Headers: THR soldering, male						
	Product range	Notes	Number of positions	Grid	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 range	Notes	Number of positions	Grid	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 range	Notes	Number of positions	Grid	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°

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

PCB connectors, nominal cross section up to 0.5 mm²

Web code: #0743	Headers: SMT soldering, male						
	Product range	**Notes**	**Number of positions**	**Grid**	**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 range	**Notes**	**Number of positions**	**Grid**	**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	Pin strips: THR soldering						
	Product range	**Notes**	**Number of positions**	**Grid**	**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	Headers: THR soldering						
	Product range	**Notes**	**Number of positions**	**Grid**	**Current[1] (A)**	**Voltage[1, 2] (V)**	**Connection direction**
	FK-MPT 0,5/..-ICA	Header for PCB terminal blocks FK-MPT 0.5/..-V	2–16	3.5	3 IEC 4 UL (B, D)	250 IEC 300 UL (B, D)	0°
	FK-MPT 0,5/..-ICVA	Header for PCB terminal blocks FK-MPT 0.5/..-V	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: THR soldering, male						
	Product range	Notes	Number of positions	Grid	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 Lock and Release locking	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 Lock and Release locking	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 range	Notes	Number of positions	Grid	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°

PCB connectors, nominal cross section up to 2.5 mm²

i Web code: #0752

	Pin strips: THR soldering						
	Product range	Notes	Number of positions	Grid	Current[1] (A)	Voltage[1) 2)] (V)	Connection direction
	PST 1,3/..-H	THR/wave soldering-capable	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 soldering-capable	2–16	5.0	12 IEC 16 UL (B) 10 UL (D)	320 IEC 300 UL (B) 300 UL (D)	90°

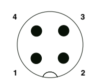
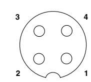
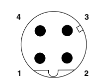
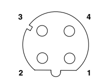
i Web code: #0789

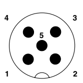
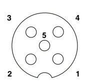
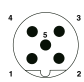
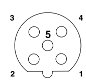
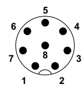
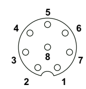
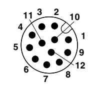
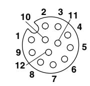
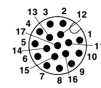
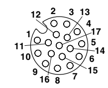
	Headers: THR soldering, male						
	Product range	Notes	Number of positions	Grid	Current[1] (A)	Voltage[1) 2)] (V)	Connection direction
	CCA 2,5/..-G CC 2,5/..-GF CCA 2,5/..-G-RN CC 2,5/..-GF-LR	Without flange With threaded flange With snap-in latch With Lock and Release locking	2–24 2–24 2–12 2–12	5.08	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	2–24 2–24 2–12 2–12	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°

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

Circular connectors

Signal – M12, solder connection, PCB mounting — 4-pos.

		A		D	
For reflow soldering processes	**Coding**	**A**		**D**	
	Rated voltage	250 V		250 V	
	Nominal current	4 A		4 A	
		Pin	**Socket**	**Pin**	**Socket**
i Web code: #1167	**Pin assignment**				
Two-piece, THR contact carrier					
	**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 1.0 ... 1.8 mm			
		For housing panel thickness 1.7 ... 2.5 mm			
		For housing panel thickness 2.4 ... 3.2 mm			
	Threaded sleeve	For housing panel thickness 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	
Pin	Socket	Pin	Socket	Pin	Socket	Pin	Socket	Pin	Socket
									
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*

Pin: 1413997[1)]/1413996[2)]/Socket: 1414004[1)]/1414003[2)]

Pin: 1413999[1)]/1413998[2)]/Socket: 1414020[1)]/1414005[2)]

Socket: 1419630[5)]

Socket: 1419631[5)]

Socket: 1419633[5)]

Socket: 1419634[5)]

Black	Blue	Water blue	Red	Yellow	Green	Violet	Orange	
1419697	1417782	1417783	1417784	1417785	1417787	1417788	1417789	

Pin: 1551493[4)]/Socket: 1552243[4)]

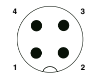
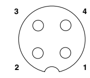
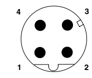
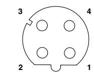
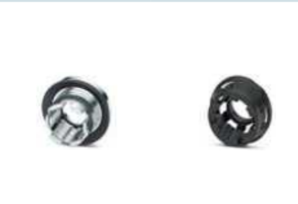
Pin: 1416145[4)]/1417984[5)]/Socket: 1416144[4)]/1417989[5)]

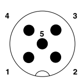
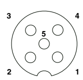
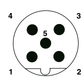
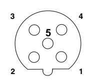
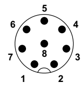
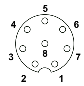
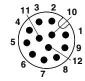
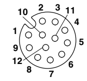
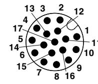
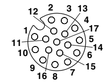
Pin: 1436709[3)]/Socket: 1432460[3)]

Pin: 1437892[5)]/Socket: 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

Signal – M12, solder connection, PCB mounting

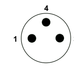
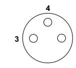
		4-pos.			
For reflow soldering processes	**Coding**	**A**		**D**	
	Rated voltage	250 V		250 V	
	Nominal current	4 A		4 A	
Web code: #0215	**Pin assignment**	**Pin** 	**Socket** 	**Pin** 	**Socket** 
Two-piece, SMD contact carrier					
	Straight, **SMD, in tray**	1411924*	1411907	1411925*	1411912
	Straight, **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 0.9 ... 1.6 mm			
		For housing panel thickness 1.6 ... 2.3 mm			
		For housing panel thickness 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	
Pin	Socket	Pin	Socket	Pin	Socket	Pin	Socket	Pin	Socket
									
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*	–

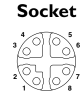
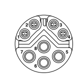
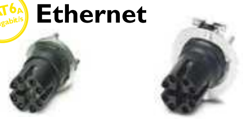
Pin: 1414000[2]/Socket: 1414021[2]									
Pin: 1414002[2]/Socket: 1414023[2]									
		Socket: 1419569[3]							
		Socket: 1419570[3]							
		Socket: 1419571[3]							
Black		Water blue		Green		Violet			
1419568		1419565		1419566		1419567			
Pin: 1412078[3]/Socket: 1412079[3]									
		1412077							
Pin: 1412080[3]/Socket: 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 plate rear edge: 6 mm
3) Distance from PCB upper edge to housing front plate outer edge: 9 mm

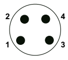
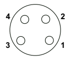
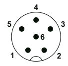
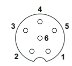
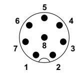
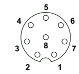
Signal – M8, solder connection, PCB mounting

		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**	**Pin** 	**Socket** 
Two-piece, SMD contact carrier			
	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**		

Data – M12 for networks

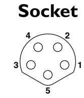
		8-pos.	8-pos.
For reflow soldering processes	**Coding**	**X (CAT6$_A$)**	**Y (hybrid)**
	Rated voltage	50 V AC/60 V DC	30 V
	Nominal current	0.5 A	0.5 A/6 A
		0.25 mm²	0.14/0.5 mm²
Web code: #0240	**Pin assignment**	**Socket** 	**Socket** 
Two-piece, contact carrier for wave and reflow soldering processes			
Ethernet 	Straight, shielded, **THR, in blister pack**	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 pack**	–	1405225
	Straight, shielded, **THR, on reel**	–	1413445*
	Straight, shielded, **SMD, in tray**	–	1411965*

Housing screw connections for SMD contact carriers, see above.

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	
Pin	Socket	Pin	Socket	Pin	Socket
					
1412226*	1412221	–	1412223	–	1412224
1412249*	1412244	–	1412246	–	1412247
1412241*	1412236	–	1412238	–	1412239
1412264*	1412258	–	1412261	–	1412262
1412234*	1412228	–	1412230	–	1412232
1412256*	1412251	–	1412253	–	1412254

Pin: 1412505[1]/Socket: 1412506[1]
Pin: 1412502[2]/Socket: 1412504[2]
1412508
Pin: 1412500[2]/Socket: 1412501[2]

Data – 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	
i **Web code:** #0237	**Pin assignment**		Socket 	
Two-piece, SMD contact carrier for reflow soldering processes				
DeviceNet 	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

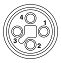
Housing screw connections for SMD contact carriers, see above.

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

Power – M12 up to 16 A/630 V

For reflow soldering processes

Web code: #0240

	4 (3+PE)-pos.		4-pos.	
Coding	S (AC)		T (DC)	
Rated voltage	630 V		60 V	
Nominal current	12 A		12 A	
Pin assignment	Pin 	Socket 	Pin 	Socket 

Two-piece, THR contact carrier

	Pin	Socket	Pin	Socket
Straight, THR, in blister pack	1406410	1406409	1406396	1406411
Straight, THR, on reel	1418343	1418344	1418339*	1418340*
Straight, shielded, THR, in blister pack	–	–	1406397	1406412
Straight, shielded, THR, on reel	–	–	1418341*	1418342*

Two-piece, SMD contact carrier

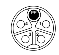
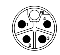
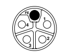
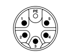
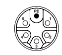
	Pin	Socket	Pin	Socket
Straight, SMD, in tray	–	–	1411931*	1411918
Straight, SMD, on reel	–	–	1411989*	1411981
Straight, shielded, SMD, in tray	–	–	–	1411967
Straight, shielded, SMD, on reel	–	–	–	1412019

	Pin	Socket	Pin	Socket
Straight, SMD, in tray, additional gasket for the device when not plugged in	–	–	1411948*	–
Straight, SMD, on reel, additional gasket for the device when not plugged in	–	–	1412003*	–

	Pin	Socket	Pin	Socket
Straight, shielded, SMD, in tray, additional gasket for the device when not plugged in	–	–	1411962*	–
Straight, shielded, SMD, on reel, additional gasket for the device when not plugged in	–	–	1412017*	–

Housing screw connections for S and T-coded THR contact carriers, see page 36. Housing screw connections for T-coded SMD contact carriers, see page 38.
* Contact carrier with assembly pad

Power – M12 up to 16 A/630 V

		5 (4+PE)-pos.		5 (4+FE)-pos.		6 (5+PE)-pos.	
For reflow soldering processes	**Coding**	**K (AC)**		**L (DC)**		**M (AC)**	
	Rated voltage	630 V		630 V		630 V	
	Nominal current	16 A		16 A		8 A	
Web code: #0240	**Pin assignment**	**Pin** 	**Socket** 	**Pin** 	**Socket** 	**Pin** 	**Socket** 

Two-piece, THR contact carrier

	5 (4+PE)-pos. Pin	5 (4+PE)-pos. Socket	5 (4+FE)-pos. Pin	5 (4+FE)-pos. Socket	6 (5+PE)-pos. Pin	6 (5+PE)-pos. Socket
Straight, THR, in tray*	1420819	1420821	1420817	1420818	1420822	1420823
Straight, THR, on reel*	1420830	1420831	1420828	1420829	1420832	1420833
Straight, shielded, THR, in tray*	–	–	1421314	1421315	–	–
Straight, shielded, THR, on reel*	–	–	1421317	1421318	–	–

Two-piece, housing screw connections for K, L and M-coded THR contact carriers

Screw versions, front mounting, M14 x 1 screw fastening	**Pin:** 1420824[2)]/**Socket:** 1420825[2)]
M14 x 1 flat nut	1412077
Screw versions, rear mounting, M15 x 1 screw fastening	**Pin:** 1420826[1)]/**Socket:** 1420827[1)]

K and M-coding: PE applied to housing, L-coding: FE separately applied to the PCB, not combined with accessible metal parts, no protective function
* 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

Glossary

Antistatic PE bag
Polyethylene bag that is electrostatically conductive for packaging THR/SMD components.

AOI
Automatic 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, mostly mounted on the side of components. Soldered, it provides additional securing of the SMD component and for the relief of 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 lower to the upper side of the printed-circuit board.

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

Classification temperature
Working temperature determined on the component via 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 misunderstandings of the maximum load of the components.

Clearances
Insulation coordination: minimum distance through air between two voltage-carrying metal parts that must be maintained at a minimum to avoid 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 possibilities, these components remove the condensates from the soldering process. A high condensate loss level makes the process expensive.

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

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

Coplanarity
Coplanarity indicates 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 to the paste and are therefore able to form soldering spots at a defined paste thickness.

Countersunk pin
A pin whose pin length is smaller 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 voltage-carrying metal parts that must be maintained at a minimum to avoid 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 the assembly automatic devices.

Floor life
Exposure time. Applies to dried, moisture-sensitive components. Upon opening the dry outer packaging (dry bag) the exposure time begins, which depending on MSL is a measure for harmless 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
Designates a certain type of contact geometry on components. In particular the arched, angled component connections on ICs (Integrated Circuits) or also pin strips are so called 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 device, reflow oven, AOI and accessory components) stand one after the other in the process sequence. Advantage: transparent, replicable process. Disadvantage: the slowest device determines the process speed.

IPC
Association Connecting Electronics Industries – standardization organization with headquarters in Illinois, USA, involved with electronic production.

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

Level goods
Common designation for all components that in accordance with IPC-J-STD-020 have an MSL higher than 1 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), mostly in the form of pins, that 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 designated 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 automatic 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.

Primary side
Indicates 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 upper side). This perspective has been adopted for reflow soldering.

Residual ring/solder ring
A ring 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
Indicates the side of the PCB on which the solder normally meets the solder contact first (in the case of wave soldering, for example, the lower 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-mount component which can be processed via SMT. The terms SMD and SMT are often used synonymously.

SMT
Surface Mount Technology
Surface mounting technology 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 meniscus/solder cone
Geometric form 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 increases up 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 depending on the particle size.

Suction surface

Planar, smooth (defined roughness) surface of sufficient size on the upper side of the component for picking up (vacuuming up with low-pressure 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 set point 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 diameter of the circle of 0.4 mm. Indications are that there is a technical trend towards tighter tolerances of the position deviation to ±0.1 mm or diameter of the circle of 0.2 mm.

Tape-on-reel

See Tape

Tape

Tape packaging. Type of packaging as tape material. The articles are in individual cavities in a deep-drawn tape reel. English also ToR – designated as Tape-on-reel.

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 via the reflow soldering method.

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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