DIGITAL WE DAYS 2024

HOW TO SOLDER COMPONENTS ON PCB BY USING THROUGH HOLE REFLOW PROCESS

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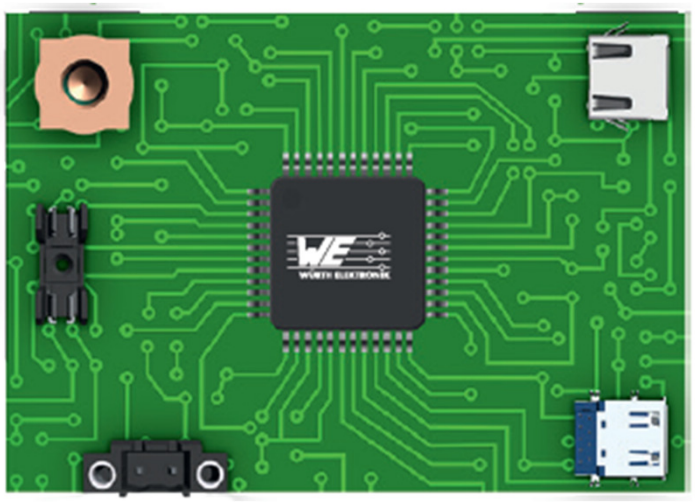
Agenda

- 1. Emergence of THR
- 2. Requirements for the product and its basic materials
- 3. Layout and stencil suggestions
- 4. Process and stages of processing
- 5. Quality requirements according to IPC-A-610
- 6. Advantages of THR
- 7. Summary
- 8. Questions



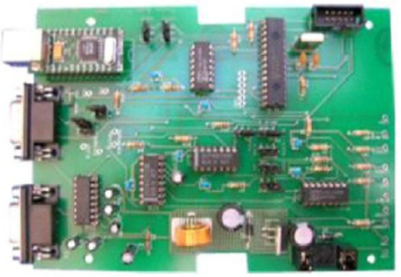
Source: Flyer BCF THR technology

Emergence of THR

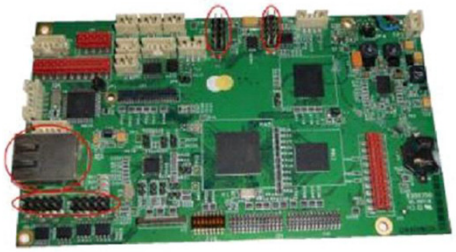
- Since the 50s THT (Trough Hole Technology)
- More and more SMT (Surface Mount Technology) since the 80s
- Thermal stress
- The solution is THR (Trough Hole Reflow)

50s

80s



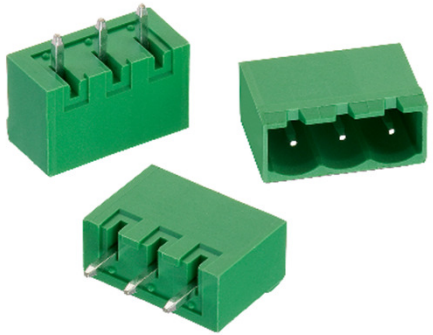
today

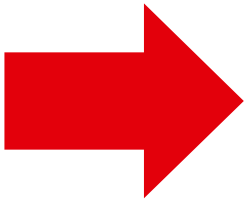


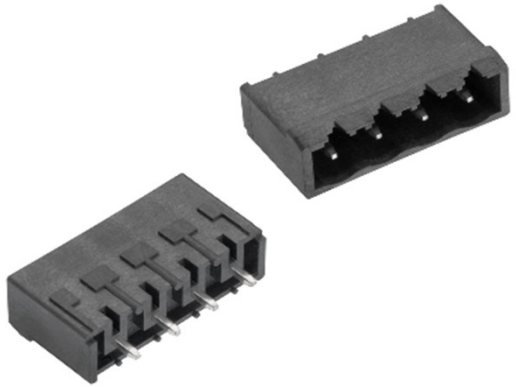
Source : Trilogy of connectors picture 2.68

Requirements for the product and its basic materials

- **What has to be changed for a THR item?**







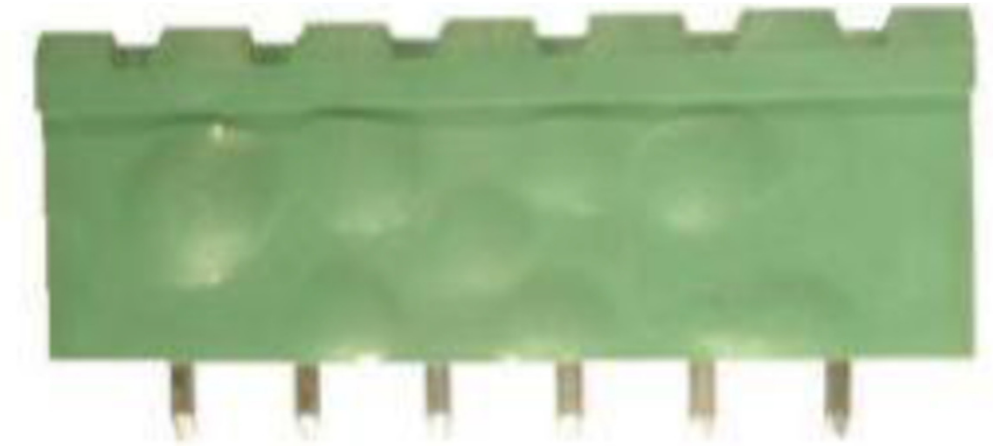
- Material (Housing & Contacts)
- Housing Design (Dimensions)

Source : Homepage 691311500103

Source : Homepage 691701510004B

Requirements for the product and its basic materials / housing

- **For other polymers (e.g. PA9T) the moisture content must be considered in connection with the thermal effect in the reflow soldering process**



Source : Trilogy of connectors picture 2.79

Requirements for the product and its basic materials / housing

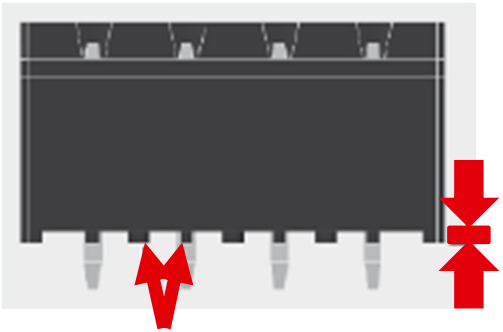
- **The plastic must be suitable for temperatures up to 260°C according IPC/JEDEC J-STD-020D**

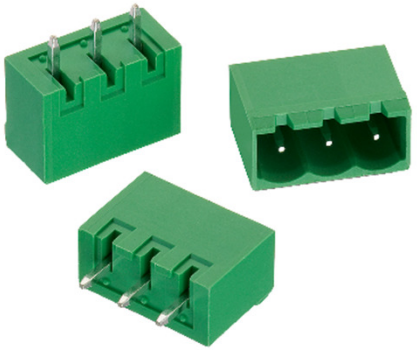
Source : Trilogy of connectors picture 2.80

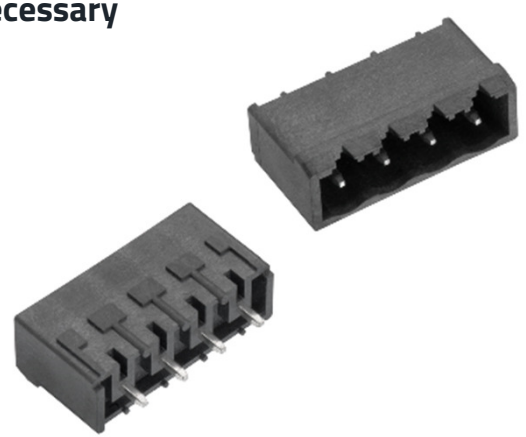
- **Often LCP (Liquid Crystal Polymer) is used**
  - High temperature resistant
  - No deformation (easy to place, no difference between the part and the pitch of the pcb)
  - Moisture Sensitivity Level (MSL) 1

Requirements for the product and its basic materials / housing

- **For a component to become THR-compatible, changes to the housing shape are also necessary**







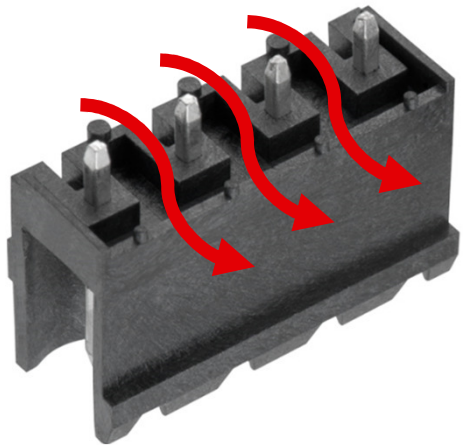
- **The pins provide the necessary distance to the solder paste (min. 0.3mm - better 0.5mm).**
- **Coplanarity less than 0.15mm according to DIN EN 61760-3**
- **Allow visual inspection**
- **Allow air flow under the housing**
- **Solder paste depot under the component**

Source : Trilogy of connectors picture 2.81

Source : Homepage 691311500103 / 691701510004B

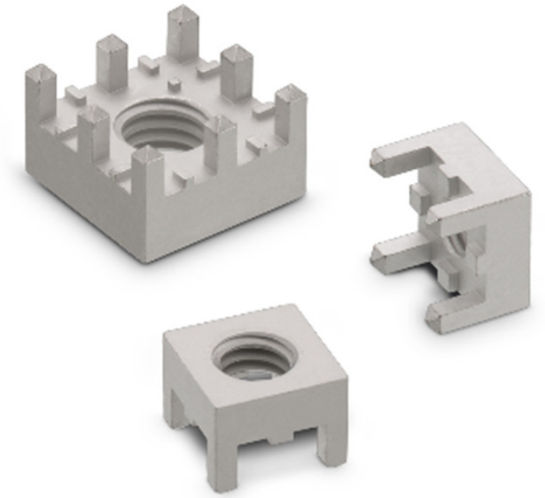
Requirements for the product and its basic materials / housing

- **Due to the airflow, the heat is transported to the solder joint**



- **Also big components are THR compatible**

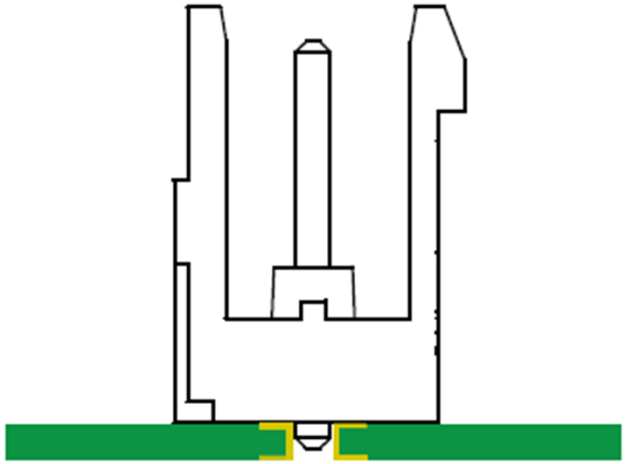
Source : Homepage 691701500004B



Source : https://katalog.we-online.de/de/em/WP-THRBU_THROUGH-HOLE

Requirements for the product and its basic materials / contacts

- **Also the pins has to be customized**
- **What do you notice in this example?**
  - With too short pins, the mechanic stability is not given
  - According to DIN EN 61760-3 the pin should min. 0,5mm look out (not mandatory)
  - Visual inspection not possible
  - IPC-A-610 may not be met



Source : Trilogy of connectors picture 2.84

Requirements for the product and its basic materials / contacts

- **A short excursion into the IPC-A-610 and the 3 general classes for electronic products**

- **Class 1: General electronic products**
  - No increased demands on the function

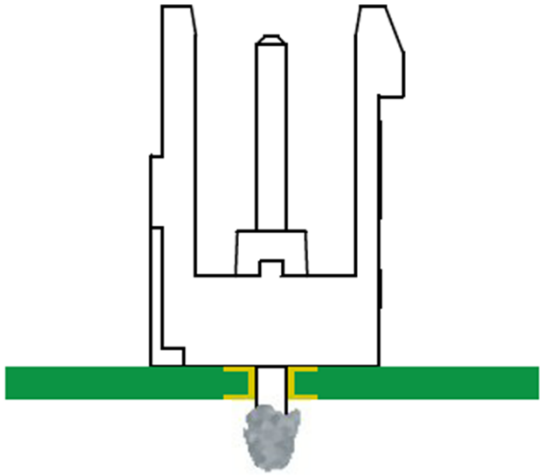
- **Class 2: Electronic products with increased demands**
  - Products with permanent functionality
  - Interruptions in operation are not desired, but not critical
  - No special ambient conditions

- **Class 3: high-performance electronics**
  - Products with permanent function / availability
  - interruptions are critical
  - Exceptional environmental conditions

Source : Marketing

Requirements for the product and its basic materials / contacts

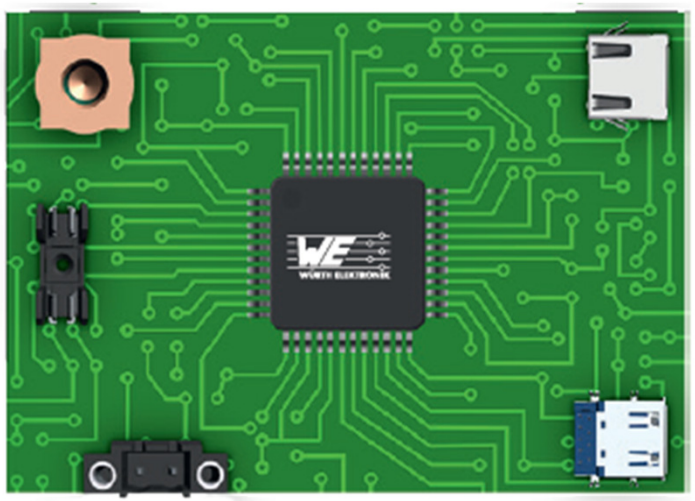
- **Also the pins has to be customized**
- **What do you notice in this example?**
  - If the pin is too long, the solder paste can be pushed out by the pin
  - Solder balls could be created
  - A visual inspection is difficult
  - We use 2.6mm pin length



Source : Trilogy of connectors picture 2.85

Layout and stencil suggestions

- **The components are now considered completely**
- **The following points are required for the layout and stencil calculation:**

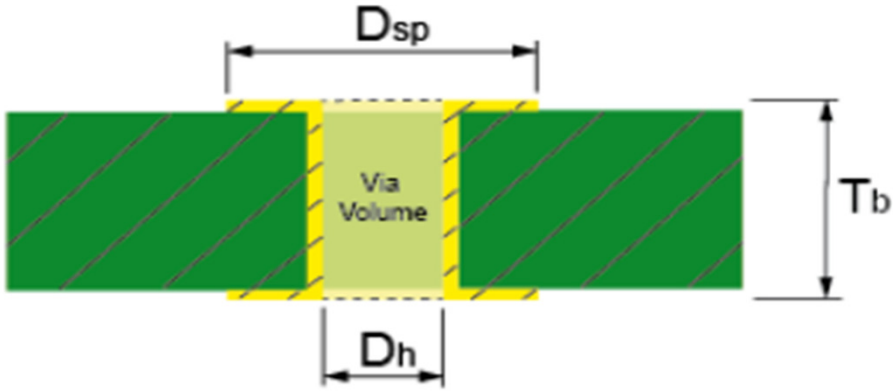


Source : Flyer BCF THR_technology

Layout and stencil suggestions

- **Layout suggestion and volume calculation of the PCB (assembly hole)**
  - **The volume calculation of the hole**

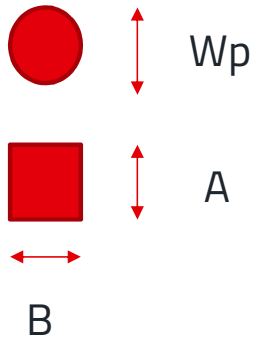
    Vpcb = $\pi \frac{Dh^2}{4} \cdot Tb$
  - Tb: pcb thickness
  - Dh: hole diameter
  - Dsp: solderpad diameter

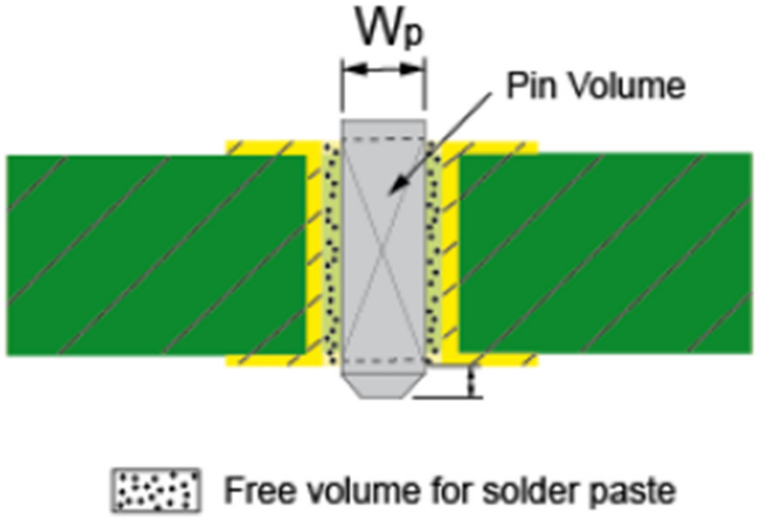


Source : Definition of the stencil design for our THR WE France

Layout and stencil suggestions

- **Volume calculation of the pin**
  - Vpin = π x pin radius² x pcb thickness
  - For round pins: pin radius= $\frac{Wp}{2}$
  - For regtangular: pin radius= $\sqrt{\frac{A \cdot B}{\pi}}$

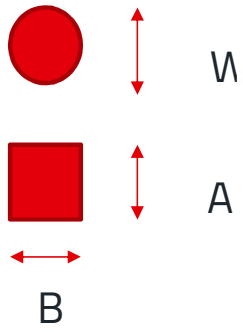


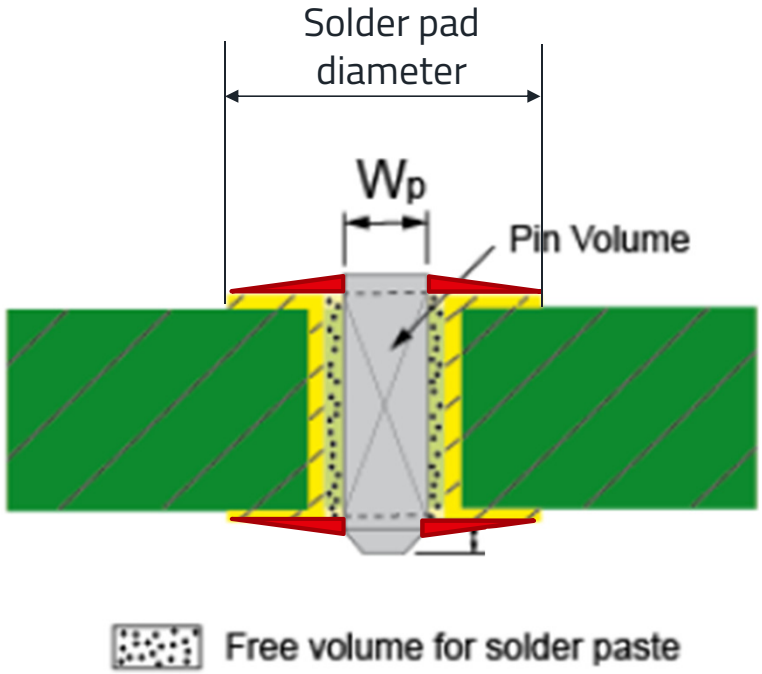


Source : Definition of the stencil design for our THR WE France

Layout and stencil suggestions

- **Volume calculation of the fillet with the Pappus-Guldin for**
  - Vfillet = 0,215 x C² x (0,2334 x C + pin radius) x 2 π
  - For round pins: pin radius = $\frac{Wp}{2}$
  - For regtangular: pin radius = $\sqrt{\frac{AxB}{\pi}}$
  - C = $\frac{solder\ pad\ diameter - pin\ diameter}{2}$

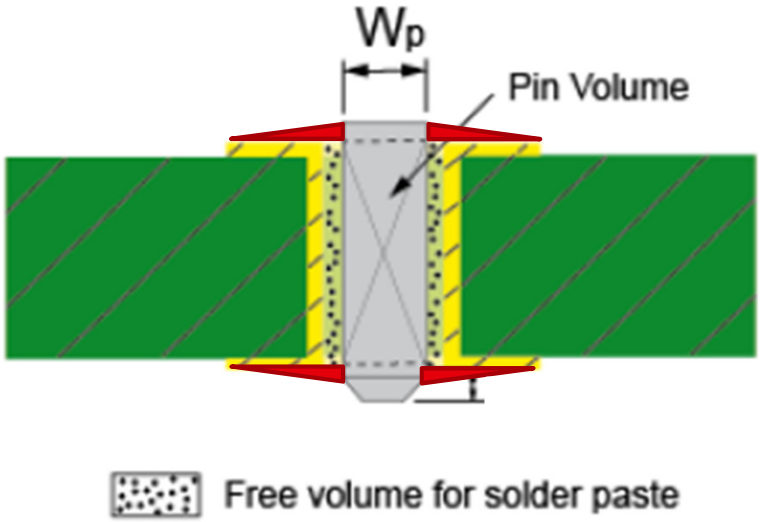




Source : Definition of the stencil design for our THR WE France

Layout and stencil suggestions

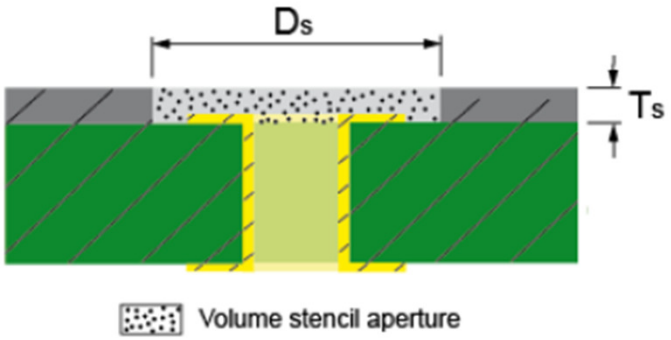
- **Calculation of the solder paste volume and the stencil opening**
- Volume of the solder paste= Vpaste= (2x Vfillet + Vpcb – Vpin) x 2



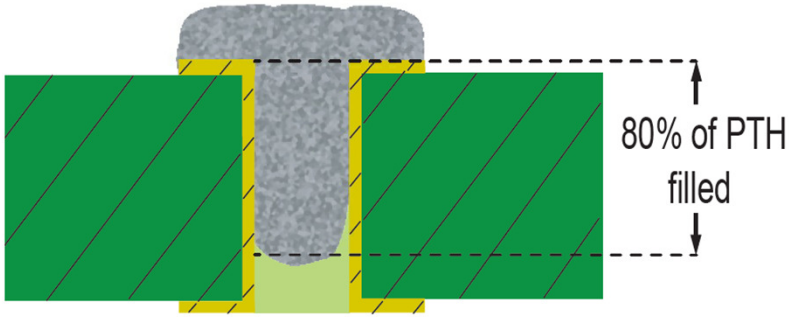
Source : Trilogy of connectors picture 2.101

Layout and stencil suggestions

- **Calculation of the solder paste volume and the stencil opening**
- Volume of the solder paste= Vpaste= (2x Vfillet + Vpcb – Vpin) x 2
- **The total volume is taken x 2 as common solder pastes have a metallic content of 50%.**
- Stencil opening (mm²) = $\frac{Vpaste}{Ts\ (stencil\ thickness)}$
- **Note paste in hole (varies depending on diameter and stencil height, example is at 150µm height)**



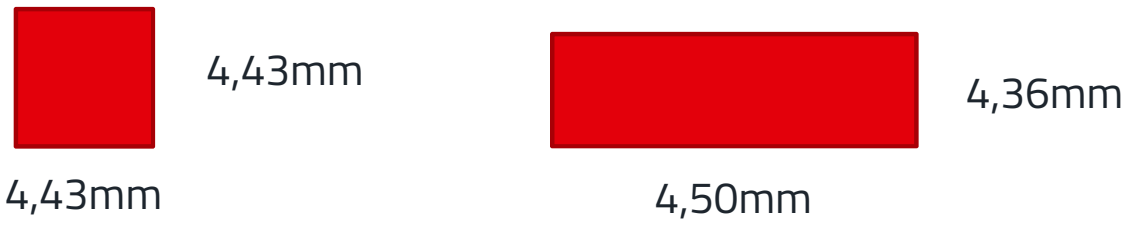
Quelle: Definition of the stencil design for our THR WE France

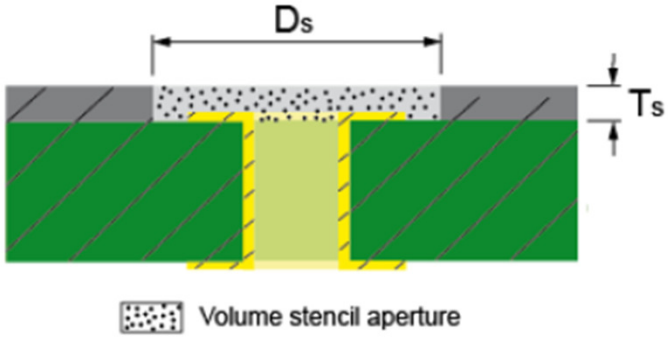


Source : Trilogy of connectors picture 2.101

Layout and stencil suggestions

- **Calculation of the stencil opening**
  - Diameter for a round opening=2x$\sqrt{\frac{Stencil\ opening\ in\ mm^2}{\pi}}$
  - Sides of a square opening=$\sqrt{stencil\ opening\ in\ mm^2}$
  - If one side is given
    $stencil\ opening\ in\ mm^2$ divide with this side
  - Example: 19,62mm² stencil opening:





Source : Definition of the stencil design for our THR WE France

Layout and stencil suggestions

- **Or ask us:**

THR (trough hole reflow) stencil calculation

WÜRTH ELEKTRONIK by Jiri

Fill in yellow fields

for circular pin

solder pad diameter	2,00 [mm]
plated hole diameter	1,20 [mm]
pin diameter	0,60 [mm]
board thickness	1,60 [mm]
paste reduction factor	0,50
stencil thickness	0,20 [mm]
V_{pin}	0,45 [mm²]
V_{hole}	1,81 [mm²]
$V_{fillets}$	0,60 [mm²]
V_{total}	1,96 [mm²]
V_{paste}	3,92 [mm²]
stencil aperture	19,61 [mm²]
if rounded : diameter	5,00 [mm]
if square: plain	4,43 [mm]
if rectangular: enter first plain	4,50 [mm]
second plain	4,36 [mm]

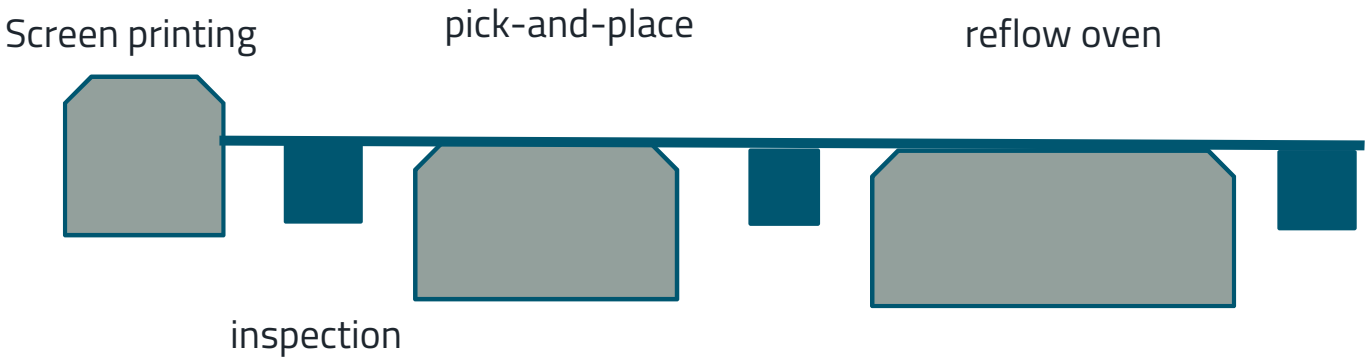
for rectangular pin

solder pad diameter	2,00 [mm]
plated hole diameter	1,20 [mm]
pin width	0,90 [mm]
pin length	0,90 [mm]
board thickness	1,60 [mm]
paste reduction factor	0,50
stencil thickness	0,20 [mm]
V_{pin}	1,30 [mm²]
V_{hole}	1,81 [mm²]
$V_{fillets}$	0,40 [mm²]
V_{total}	0,92 [mm²]
V_{paste}	1,84 [mm²]
stencil aperture	9,18 [mm²]
if rounded : diameter	3,42 [mm]
if square: plain	3,03 [mm]
if rectangular: enter first plain	3,10 [mm]
second plain	2,96 [mm]

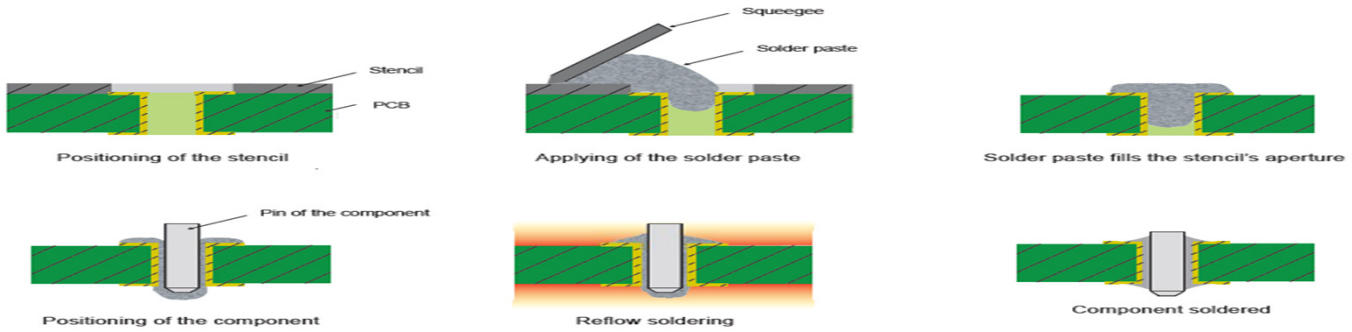
Source : Stencil calculator WE

Process and stages of processing

- **Production process**
  - Like an SMD component
  - Fully automatic assembly
  - Soldering in reflow oven

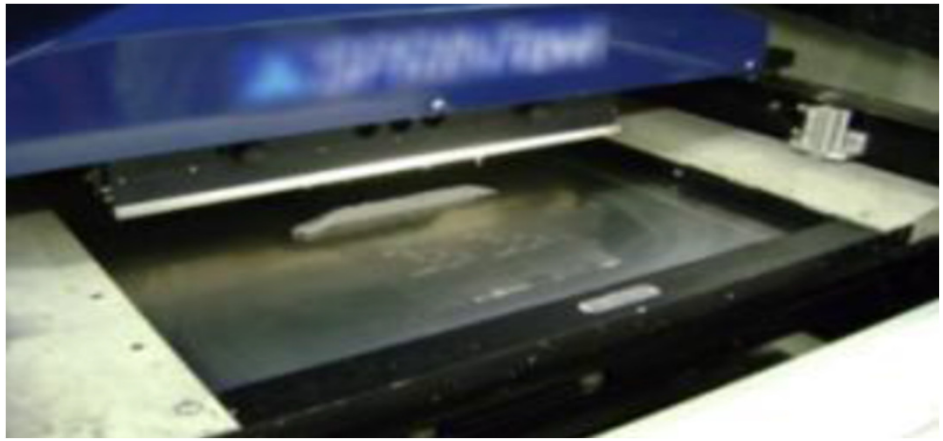


- **States of PCB and Soldering Process**



Process and stages of processing

- **Screen printing / paste printing**

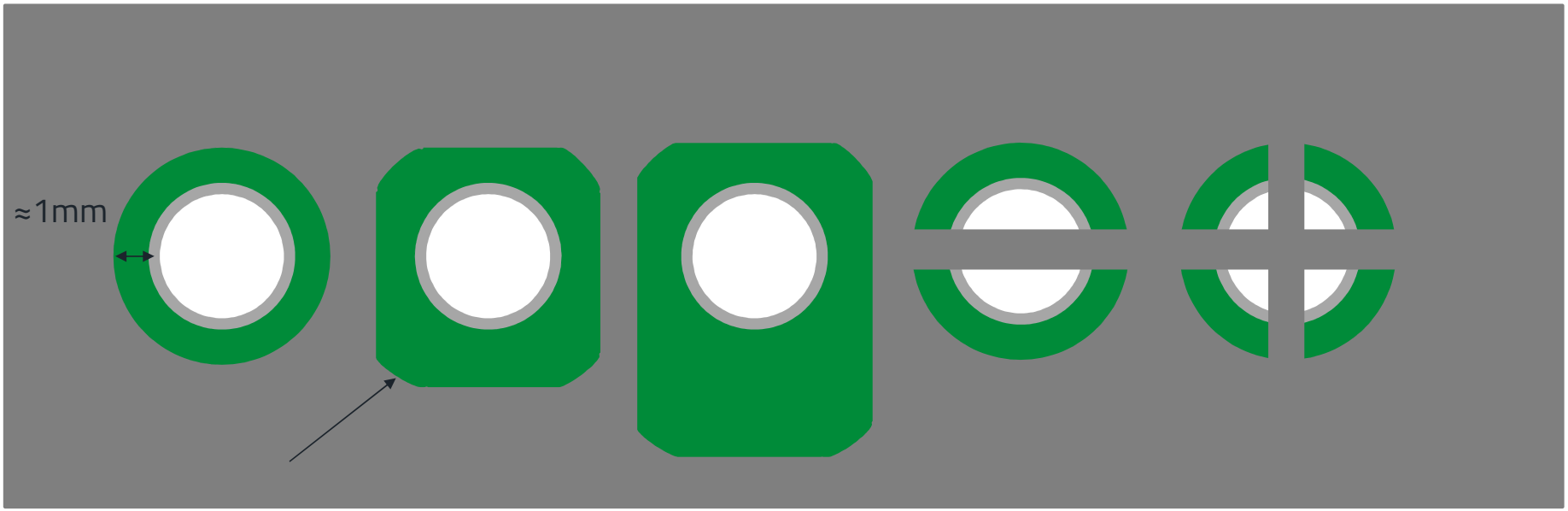


Choice of the Stencil thickness and design
PCB design and connector layout
Choice of the solder Paste
Speed. Pressure and angle of the squeegee used to apply solder Paste to PCB

Source : Trilogy of connectors picture 2.87

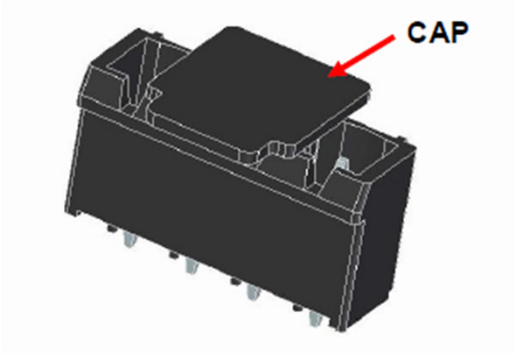
Layout and stencil suggestions

- **solder Paste and examples for a stencil opening**

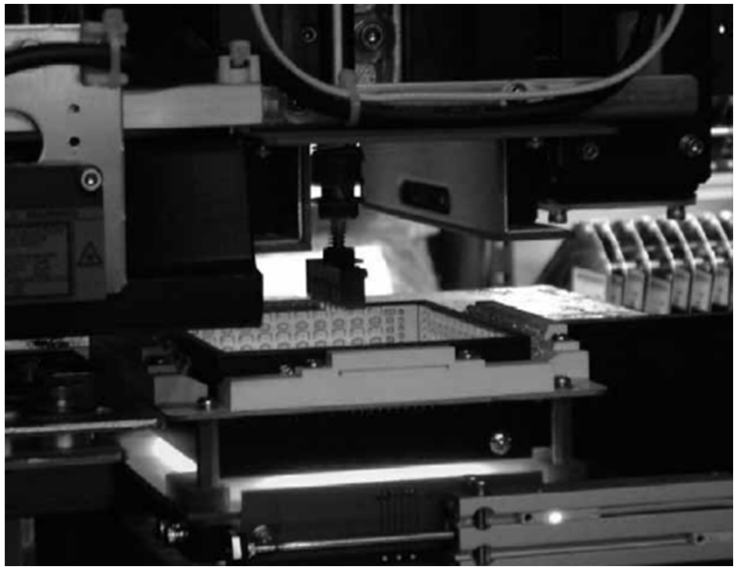


Process and stages of processing

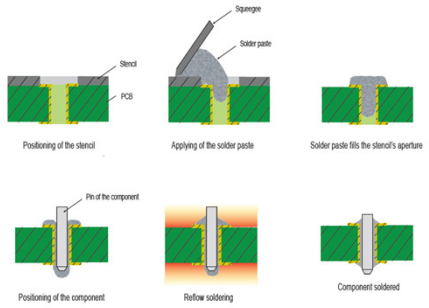
- **Pick and Place**



Source : Trilogy of connectors picture 2.99



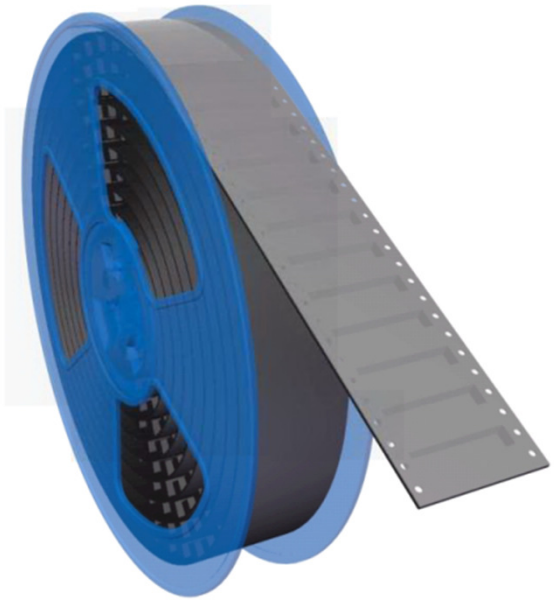
Source : Trilogy of connectors picture 2.96



Source: Trilogy of connectors picture 2.87

Process and stages of processing

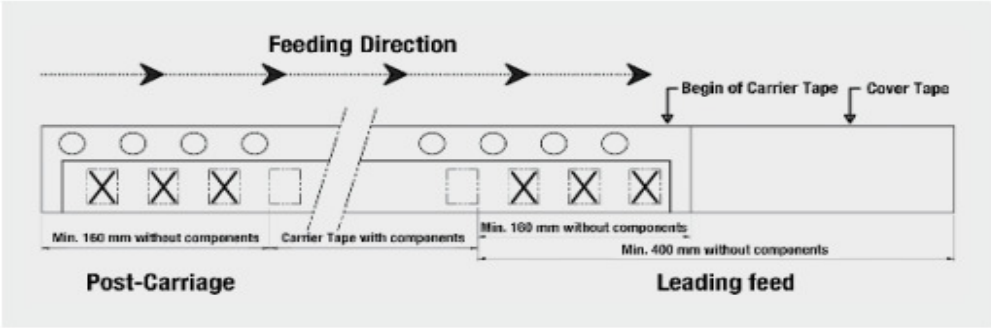
- **Pick and Place**



Source: Trilogy of connectors picture 2.97

Peel force of Cover Tape	Limits	in average
Pulling force [N] Max	0.74 ±0.34	0.74 ±0.15
Pulling weight [g] Max	75 ±35	75 ±15

Pulling force of cover tape

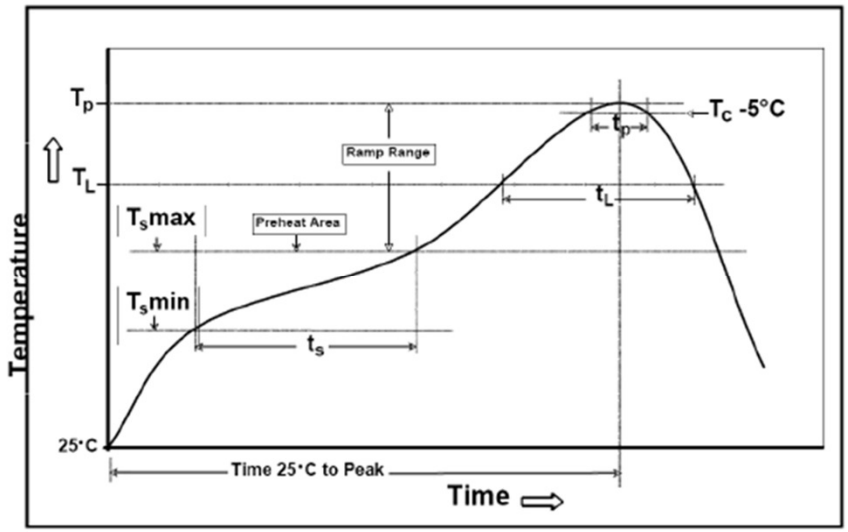


Post-carriage and leading feed

Source : Trilogy of connectors picture 2.98

Process and stages of processing

- **Reflow oven / if necessary cleaning**



refer to IPC/JEDEC J-STD-020D

Profile Feature	Pb-Free Assembly
Average Ramp-Up Rate (Ts_{max} to Tp)	3°C/second max.
Preheat - Temperature Min (Ts_{min}) - Temperature Max (Ts_{max}) - Time (ts_{min} to ts_{max})	 150°C 200°C 60-180 seconds
Time maintained above: - Temperature (T_L) - Time (t_L)	 217°C 60-150 seconds
Peak/Classification Temperature (Tp)	See Table 2
Time within 5°C of actual Peak Temperature (tp)	20-30 seconds (WE-GF/WE-LAN: 10 s; Tp=245°C)
Ramp-Down Rate	6°C / sec max.
Time 25°C to Peak Temperature	8 minutes max.

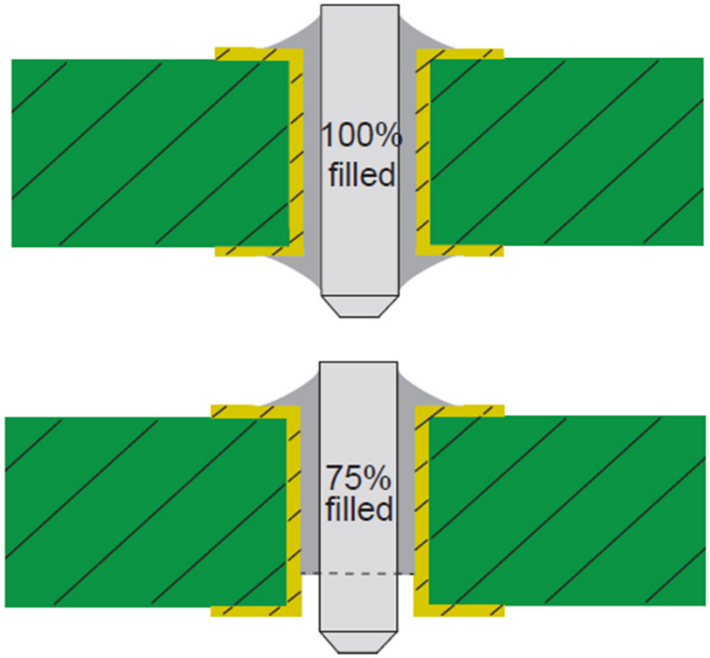
Table 2 Package Classification Reflow Temperature

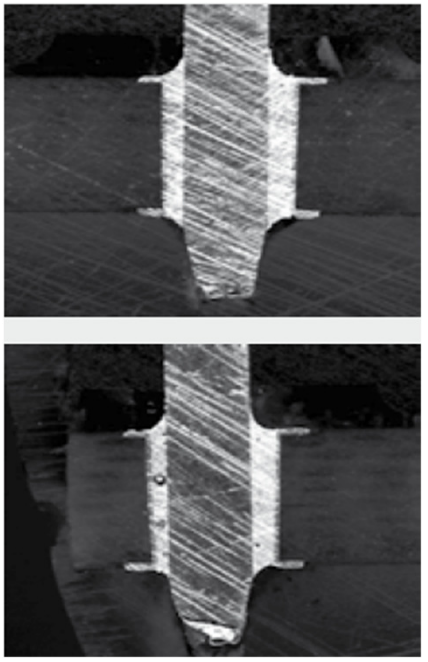
Package Thickness	Volume mm^3 <350	Volume mm^3 350 - 2000	Volume mm^3 >2000
<1.6 mm	260 +0 °C *	260 +0 °C *	260 +0 °C *
1.6 mm - 2.5 mm	260 +0 °C *	250 +0 °C *	245 +0 °C *
≥2.5 mm	250 +0 °C *	245 +0 °C *	245 +0 °C *

refer to IPC/JEDEC J-STD-020D

Quality requirements according to IPC-A-610

- **Soldering quality on the first look**
  - The plated trough hole must minimum be filled to 75%

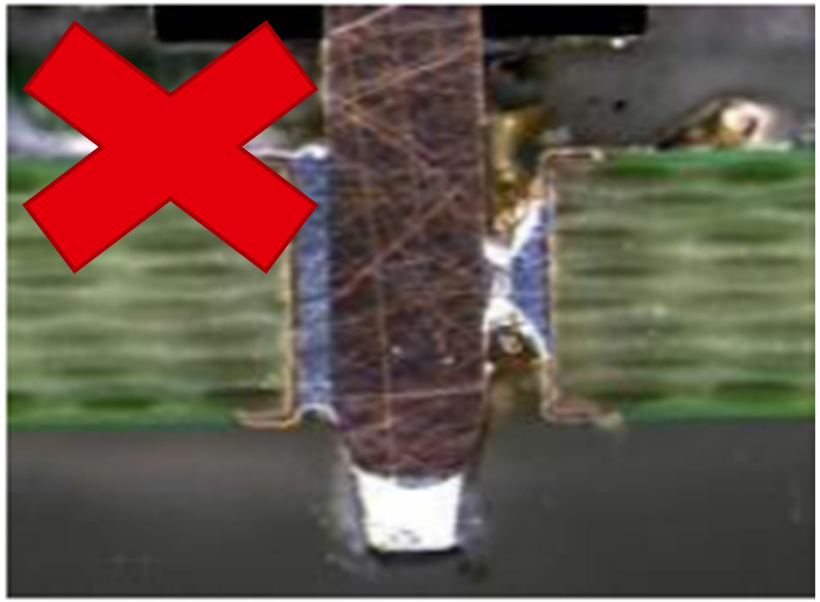




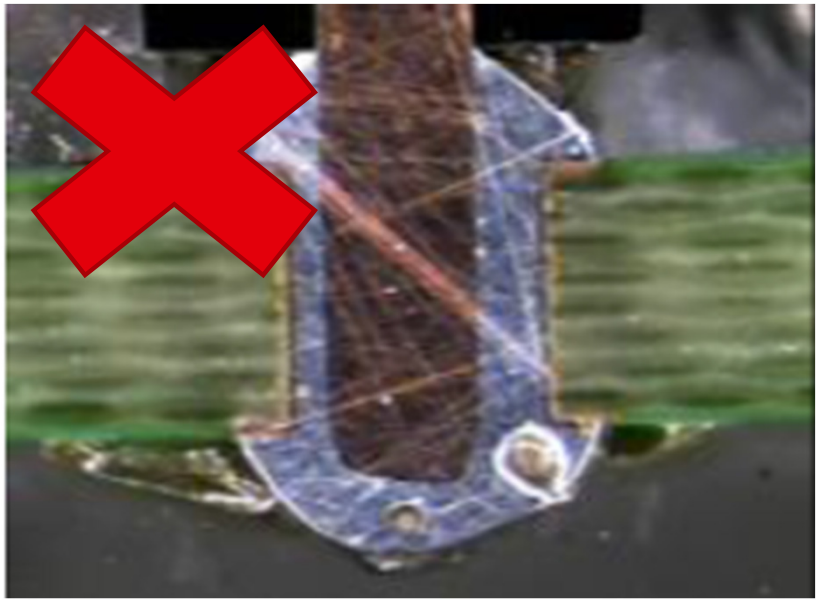
Source: Trilogy of connectors picture 2.103

Quality requirements according to IPC-A-610

- **Soldering quality on the second look**
- **Are the following examples IPC compliant?**



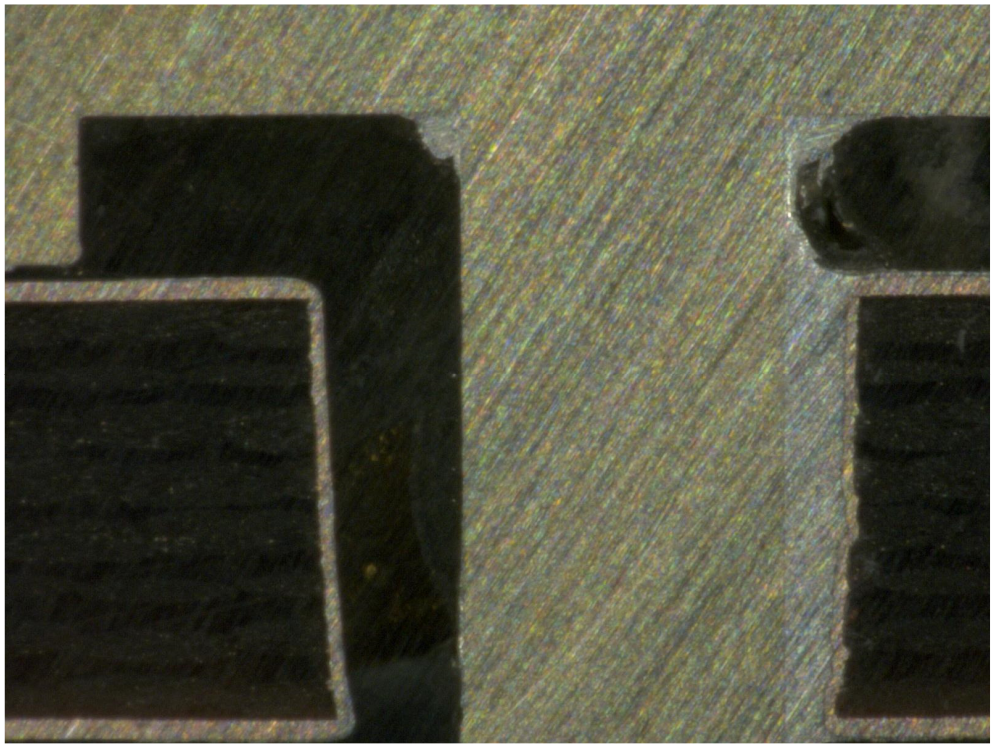
Source: Trilogy of connectors picture 2.104



Source: Trilogy of connectors picture 2.105

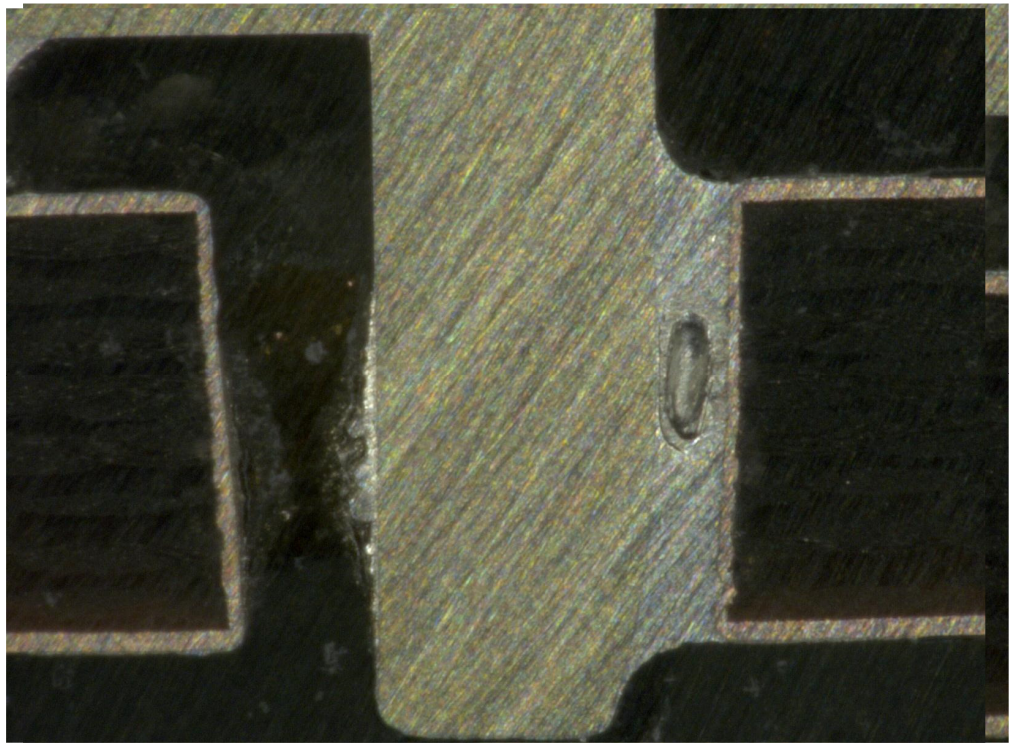
Quality requirements according to IPC-A-610

- **Soldering quality on the second look**



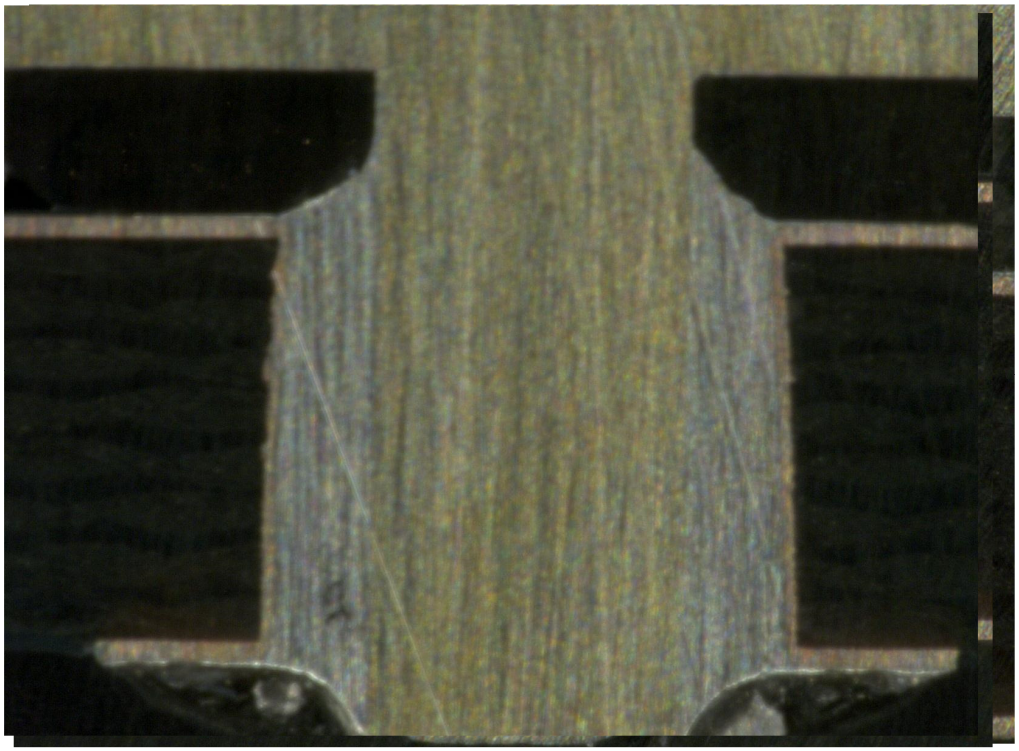
Quality requirements according to IPC-A-610

- **Soldering quality on the second look**



Quality requirements according to IPC-A-610

- **Soldering quality on the second look**



Advantages of THR

- **Like THT, THR resists mechanical stress, which is particularly useful for end user interfaces**
- **Like SMD is THR soldered in the reflow process**
- **This saves one production step (selective soldering is not necessary)**
- **It saves time and**

Source: Flyer BCF THR_technology

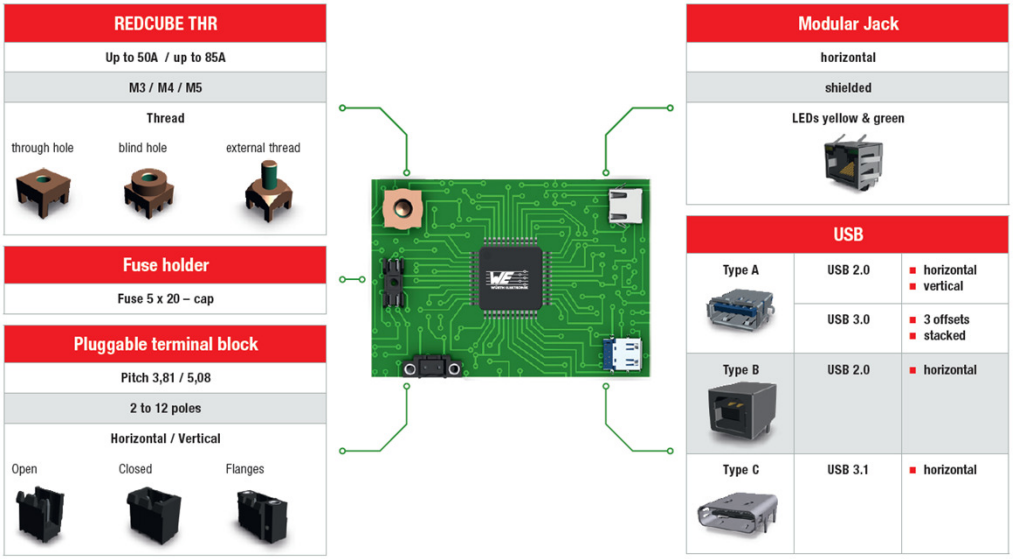
Modular Jack		
horizontal		
shielded		
LEDs yellow & green 		

USB		
Type A 	USB 2.0	■ horizontal ■ vertical
	USB 3.0	■ 3 offsets ■ stacked
Type B 	USB 2.0	■ horizontal
Type C 	USB 3.1	■ horizontal

Source: Flyer BCF THR_technology

Summary

- **Dimensions and material of the housing must be changed**
- **Pins are shorter**
- **Combines the advantages of technologies (SMT / THT)**
- **Soldering in the reflow process**
- **The manufacturing process can be optimized**
- **Saves time and money**



Source: Flyer BCF THR_technology

Questions

& Answers

We are here for you now!
Ask us directly via our chat or via E-Mail.

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