Press-Fit Technology for High Current Applications

High Quality Solutions from Würth Elektronik
Press-Fit System

- A powerful electrical connection is made when a pin is pressed into the plated through-hole, which creates a gas-tight electrical connection.

- The through-hole plating for a press-fit system is essentially made in the same way as are the holes for accepting components for THT soldering. Thus, there are no changes required in the manufacturing of printed circuit boards.

- One prominent characteristic of the press-fit system, compared to the soldering system, is that it produces not only an electrical connection, but also, an extraordinarily strong mechanical connection between the inserted components and the printed circuit board.

  Continuous and extremely homogenous material transition between press pin and through-hole plating.

- With regard to long-term reliability, the press-fit system is convincing since it has the lowest FIT value (Failure in Time) of the overall system. It is up to 30 times better than that of an SMD solder joint. A single, solid, press pin has a typical extraction force of 100N or approximately 70% of the insertion force. Thus, press-fit connections are predestined to provide not only electrical, but also mechanical connection solutions for electrical components.

- If after press insertion, a solid press pin in a 2.4mm thick printed circuit board fits on each corner with more than 3° against the sleeve, the press connection zone has a lower electrical resistance than the brass pin itself. Thus, it does not pose an electrical or thermal bottleneck. The connection surface angle is normally much greater, which provides a generous safety buffer for the electrical connection.
Press-Fit System Advantages

Advantages of press-fit technology:

- Much more reliable than soldering connections
- Extremely high environmental stability
- Very high current-carrying capacity
- Low self heating
- High process safety
- No cold solder joints and solder bridges
- Simple and quick processing

- Press-Fit technology provides a number of advantages in comparison to solder technology. Very thick circuit boards with high copper coating can be processed easily. Furthermore, two-sided mounting of circuit boards is possible and enables a very compact design of modules. As a result, current paths in particular are shortened, which is thermally very beneficial for the processing of high currents.

- There is a reliable contact between the pin and the copper layer over the complete case length of a press-fit zone. It is not guaranteed for soldering that the solder rises the complete length of the via, whereby many higher transition resistances are produced. Therefore, long-term reliability and mechanical stability are also not as high as they are with press-fit technology.

- The processing of press-fit elements integrates seamlessly in the production process of the systems and is very cost-effective. Several power elements can be press-fitted simultaneously, using press-fitting tools. In doing so, the circuit boards, in contrast to soldering, are not loaded thermally.
Materials and tolerances

Power elements from Würth Elektronik are manufactured from the material CuZn39Pb3 and is therefore RoHS-compliant according to the RoHS stipulation concerning copper alloys.

The circuit board thickness should ideally be between 1.6 and 3.2mm. Tested surfaces are immersion tin, HAL and lead-free HAL. The immersion tin coating process is recommended. Using this process usually guarantees that the tin is evenly distributed in the case where the tolerances can be complied with more easily, and chip formation can be prevented. Due to the uneven distribution of the tin in the case for the HAL process, we recommend the immersion tin process for circuit board thickness of 2.4mm and greater.

Unless otherwise noted in the corresponding drawing, Würth Elektronik power elements have quadratically designed press-fit pins. The through-hole plating in the PCB must, therefore, have the following characteristics:

<table>
<thead>
<tr>
<th>Drill hole specification for chemical surfaces</th>
<th>Drill hole specification for HAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \phi 1.6 \pm 0.03 ) ( \phi 1.475 \pm 0.05 )</td>
<td>( \phi 1.6 \pm 0.03 ) ( \phi 1.45 \pm 0.05 )</td>
</tr>
</tbody>
</table>

Current load

Using the power elements from Würth Elektronik, currents of more than 300A can be carried on the circuit board. The current-carrying capacity of any press-fit element must always be considered in the context of the complete system. Many factors, such as conductor path thickness, conductor path width, cable cross section, ambient temperature and heat distribution should be taken into account for the selection of the individual press-fit elements.

In comparison with a solder connection (R = 300 to 400μOhm), the press-fit zone itself, with 100 to 200μOhm has extremely low resistance, so the limiting factor can usually be found in the layout of the connected conductor paths or the connection of external feed lines to a press-fitted component.

The challenge for the design of high current systems is the optimum interaction of all system components!
Application Examples

Our power elements have a very wide range of possible applications: power elements are used very frequently in the connection of wiring with cable lugs on circuit boards.

The mounting of a copper rail for increasing the current-carrying capacity is also possible by using power elements. In doing so, the copper rail can be installed in two different ways. On the one hand, it can be press-fitted under the circuit board, and on the other hand, it can be screwed onto the power elements. For pressing, the maximum overall thickness of the circuit board with the copper rail must not exceed 3.2mm.

There is also an ideal possibility for mounting laminated fuses. Power elements are ideally suited for fulfilling purely mechanical functions such as connecting circuit board and case. With two-part power elements it’s possible to sustain an extremely stable Board-to-Board connection with current carrying capacity up to 300A.

Possibility for installing a fuse

High current Board-to-Board connection up to 200A
Processing

Press-Fit technology

- Other components should be at least 4mm away from the press-fit hole.
- The hole should be at least 3mm away from the edge.
- No special tools are necessary for the press-fitting; a simple toggle press is usually sufficient.
- The press-fit force-per-pin should be at least 40N; this is typically 150N/pin.
- The press-fit zone must be supported during the press-fit process. Without support, deflection of the circuit board can occur during pressing. It must be ensured for pneumatic presses that the stroke cycle is not performed unevenly.
- The stroke cycle should be performed at right angles to the circuit board. After the press-fitting, the pins should slightly protrude from the circuit board.
- For two-part press-fit elements, the base element must always be pressed to the circuit board first.

Solderability

- Our power elements are designed for the press fit system. Alternative processing methods, such as soldering, are not contemplated.
- Due to the high heat absorption, press fitting of the power elements should be performed last, after all soldering processes.
- It is also not recommended to resolder the press-fitted power elements. Resoldering can result in partial destruction of the cold weld and delamination in the circuit board whereby mechanical stability of the press-fit zone can be permanently lost.
Permitted Torques

Power elements provide wide area connection and carrying of high currents in circuit boards. The maximum permissible torques must be complied with to prevent mechanical destruction of the elements! Due to the material, these differ significantly from standard fastening materials used.

Mechanical characteristics (guide values):

- Material: CuZn39Pb3
- Shear strength: 350N/mm²
- Tensile strength: 480N/mm²
- Yield strength: 340N/mm²
- Elongation: 20%
- E-modulus: 96kN/mm²
- Torsion modulus: 32kN/mm² (shear modulus)

<table>
<thead>
<tr>
<th>Thread Dimension (metric)</th>
<th>M3</th>
<th>M4</th>
<th>M5</th>
<th>M6</th>
<th>M8</th>
<th>M10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. tightening torque [Nm]*</td>
<td>0.5</td>
<td>1.2</td>
<td>2.2</td>
<td>3.9</td>
<td>9.0</td>
<td>17.0</td>
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<tr>
<td>Breaking torque [Nm]**</td>
<td>1.5</td>
<td>4.0</td>
<td>6.0</td>
<td>10.0</td>
<td>32.5</td>
<td>32.5</td>
</tr>
<tr>
<td>Breaking torque [Nm]***</td>
<td>9.0</td>
<td>16.0</td>
<td>16.0</td>
<td>25.0</td>
<td>25.0</td>
<td>36.0</td>
</tr>
</tbody>
</table>

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

** Determined values (torques). For these mechanical loads, destruction of the threaded shank occurred. The components must never be loaded above these values.

*** Determined values (torques). For these mechanical loads, destruction of the press-fit pins occurred (approx. 1Nm/pin). The components must never be loaded with these values.

The maximum permissible torque changes greatly with the material composition alloy parts. Safety margins must also be taken into account for practical use. For this reason, power elements are only permitted to be loaded with the breaking torque values for brass material - (according to row 2 / table).
Power Elements with Solid Pin

Features

- Material: Brass
- Surface: tin plated
- Holding forces according to IEC 352-5
- Press-in force: max. 250N per Pin, min. 40N per Pin
- Extraction force: typically about 100N per Pin
- PCB thickness: 1.6 – 3.2mm
- Force-fitting speed: 100-250mm/min

Derating Measurement for Power Elements with Pin-Plate Circumference*

![Graph showing derating measurement for power elements with pin-plate circumference.](image)

- 20 Pins, circumference
- 16 Pins, circumference
- 12 Pins, circumference
- Cable 70mm², I=245A
- Cable 35mm², I=158A
- Cable 16mm², I=98A

Derating Measurement for Power Elements with 2-row Pin-Plate*

![Graph showing derating measurement for power elements with 2-row pin-plate.](image)

- 12 Pins, 2-row
- 10 Pins, 2-row
- 8 Pins, 2-row
- Cable 16mm², I=98A
- Cable 6mm², I=54A

*tested with 2-layers 70µm Cu PCB
# Power Elements in Press-Fit Technology

<table>
<thead>
<tr>
<th>Bushes with Two Rows Pin-Plate</th>
<th>Bushes with Pin-Plate Circumference</th>
<th>Bushes with Full Plain Pin-Plate</th>
<th>Shanks with Full Plain Pin-Plate</th>
<th>90° with Two Rows Pin-Plate</th>
<th>90° with Full Plain Pin-Plate</th>
<th>Two Part Power Elements, Ground Element</th>
<th>Support Element</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
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</table>

## Pins

<table>
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<tr>
<th>Threads</th>
<th>M3:</th>
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</tr>
</tbody>
</table>

**Material:** Brass (CuZn39Pb3)

<table>
<thead>
<tr>
<th>Thread Size</th>
<th>M2.5</th>
<th>M3</th>
<th>M4</th>
<th>M5</th>
<th>M6</th>
<th>M8</th>
<th>M10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torque (Nm)</td>
<td>0.29</td>
<td>0.50</td>
<td>1.20</td>
<td>2.20</td>
<td>3.90</td>
<td>9.00</td>
<td>17.00</td>
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</tbody>
</table>

All articles are listed in our catalogue: *Electronic Interconnect & Electromechanical Solutions – Catalog*
Our Requirements for Press-Fit Technology

Transition resistance according to press-fit standard: IEC 60512-2

Tests with different climatic conditions according to press-fit standard IEC 60512-6 and IEC 60512-11-1
- IEC 68-2-1: Coldness
- IEC 68-2-2: Dry Heat
- IEC 68-2-30: Damp Heat, cyclic

Fast temperature cycles according to IEC 60512-6
- IEC 68-2-14: Dry Heat

Tests in industrial climate: IEC 60512-11-7
- IEC 68-2-52: Salt Spray, cyclic
- IEC 68-2-60: Corrosive Gas

Vibration tests according to press-fit standard: IEC 60512-4
- IEC 68.2.6: Vibration Sinusoidal
- IEC 68-2-7: Acceleration Centrifugal
- IEC 68-2-27 and -29: Multiple Shocking
- IEC 68-2-64: Broad Band Noise
- IEC 68-2-64: Vibration in cold Atmosphere
- IEC 68-2-50 / 51: Vibration in warm Atmosphere

- Press-Fit connections show extremely high environmental stability
- Requirements of the relevant standards are greatly exceeded