

Molex Incorporated
Automotive Press-Fit Pin
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Press-Fit Technology Clear Choice for Automotive Applications

Market demand is high for economical in-vehicle navigation, infotainment, electric and hybrid drivetrains. Advanced vehicle safety features, such as anti-lock brakes, stability control, and sensor controlled tire pressure monitoring, are proliferating. Automotive manufacturers need cost-effective strategies for designing and assembling durable electrical and electronic systems.

Increasingly, they are turning to press-fit technology to augment and replace solder joints. An elastic pin and a plated through-hole (PTH) are the principle elements of press-fit technology. The PTH drilled into a layered circuit board is electroplated, typically with copper, to create the circuit on insertion of the press-fit pin. Key benefits are a highly reliable connection and electrical contact.

Standard press-fit types used in other industries perform well in controlled environment applications. Automotive applications require higher ampacity and resistance to vibration, thermal shock and environmental conditions. Technological advances address these challenges and make a compelling case for OEMs and Tier 1 automotive suppliers to switch from wave-soldering to press-fit technology.

Press-fit Interface options

Also known as compliant pins, press-fit pins typically have an elastic cross-section with a larger diameter than the PTH. During assembly, the pin's press-fit zone deforms to create an interface with the rigid PTH. Integrated into automotive connectors and modules, press fit pins allow for larger PTH tolerances than non-compliant solid pins. Available in a range of sizes, shapes, patterns and pitches, a press-fit connector may comprise a single pin or any number of pins depending on the application requirement.

The spring-like response of flexible press fit pins helps protect the PTH integrity. There is a smaller hole tolerance of the plated drill holes on the PCB substrate, so plating thickness directly affects insertion force and must be closely controlled to allow proper pin insertion, without creating excess friction that can result in slivering.

The resulting connection is permanent, highly reliable, and provides a shock-resistant and gas-tight interface with no risk of corrosion. The entry angle is an important parameter affecting insertion force and to prevent damage of the PTH. The contour of the outer surface of the compliant zone is also a significant contributor to determining insertion force and mitigating the potential of wall damage.

Press fit pin connections can be used on both sides of the PC-board, which enables flexible double-sided through-hole and SMT PCB assemblies. Multiple stacked PCBs may require board-to-board press fit tail sockets. As modules for engines and transmissions shrink in size, press-fit pins can help protect sensitive components and save valuable space in tight pin configurations. In smaller package applications, such as sensors and switches, press-fit pins are often molded directly into the housing.

Image: chart – Press-fit Material Thickness, Nominal PCB Hole Size, Mating Blade Width:

Press-Fit Material Thickness (mm)	Nominal PCB Hole Size (mm)	Mating Blade Width (mm)
0.40	0.60	0.50
0.62	1.00	0.64/1.20
0.80	1.45	1.50/2.80

Balancing low insertion force and high retention is especially important in automotive applications. A popular and preferred press-fit style, the economical Eye of the Needle (EON) interface provides excellent electrical contact and retention force to ensure connectivity in harsh conditions.

Effects of Excess Insertion Force

Tin Whiskers:

Stress activates whisker growth on a pure Sn surface, which can jeopardize module functionality by causing a short circuit between the tracks on the PCB. Design guidelines to mitigate Whisker growth include reduction of insertion force and reduction of Sn surface thickness.

Jet Effect:

During press-fit pin insertion, PCB mechanical damage can occur. If friction is too high, the surface will scratch down and allocate in front of the press-in direction, which further increases friction. Eventually the PTH will be cut off and pushed out the bottom. Reducing insertion forces prevents the Jet Effect.

Whitening Effect:

Until the pin reaches final position, the structure of the PCB layers is stressed by the pin force. If forces are excessive or the PTH unstable, the force can cause the PCB to partially delaminate. Over time, cracks allow humidity ingress, which results in reduced isolation performance. Reduction of insertion force and high quality PCB production mitigate the Whitening Effect.

Thermal Design Benefits

Most automotive applications fall under SAE class II (105°C) category for passenger compartment electronics and SAE class III (125°C) category for under the hood electronics. SAE Class IV (150°C) category applications are less common.

If secondary soldering is required, the processes introduce heat that can damage the PCB and attached electronics. Press-fit technology entirely eliminates the extra heat cycle and allows secondary connections using force only for assembly.

Technologies for emissions reductions and fuel economy, in conjunction with in-vehicle electronics, navigation and safety features, all contribute to heat build-up in the engine compartment. Press-fit pins provide a reliable interface that naturally dissipates thermal heat, with a significantly higher heat threshold and lower failure rate than solder joints. Suitable for low to very high current applications, press-fit pins do not cause thermal heat build-up common to soldered joints.

By eliminating the high temperature solder process, press-fit pins eliminate the risk of solder slugs, which can jump during the assembly process, cold solder joints and flux residue, which potentially cause short circuits or PCB damage.

Migration to Press-Fit Pin Technology

In migrating from soldering to press-fit pin technology it is important to work with an experienced supplier. Numerous factors affect press-pin force resistance, including material thickness, blade width and PCB PTH diameter. Even a minor change in plating diameter can have a huge influence on insertion and retention force. Such variations can mean the difference between recurring critical faults or a high performing connection.

As industry standards evolve, press-fit pin technology offers narrower pin spacing and size to keep pace with higher density, electronic and electrification trends. Automobile manufacturers can realize significant application and PCB assembly cost savings with versatile press-fit technology, while meeting stringent manufacturing requirements and global initiatives.