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CONNECT TECHNOLOGY
WITH CONFIDENCE

# FLOATING BOARD-TO-BOARD CONNECTORS

## SUPPORTING HIGH-SPEED, AUTOMATED ASSEMBLY FOR MULTIPLE PCB CONNECTORS

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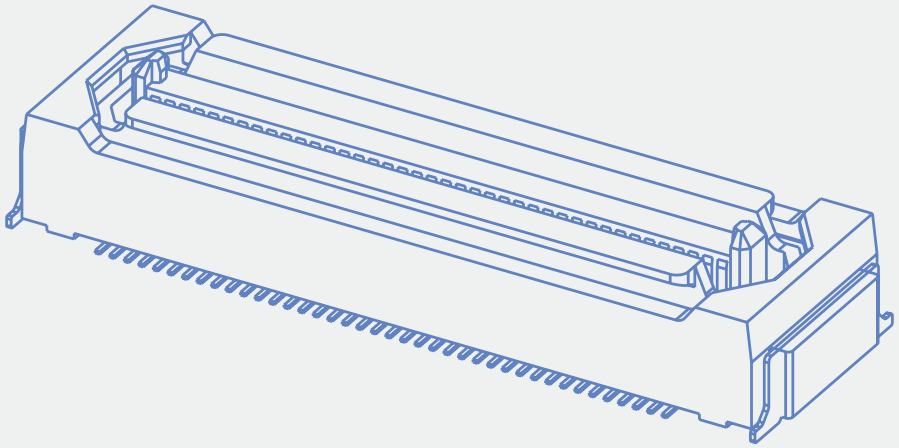

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# Abstract

**Developers of modern electronic systems are faced with demands to design high-performance solutions that keep size and weight as low as possible. In addition, pressure to minimize lead times and time-to-market means such systems are increasingly likely to be manufactured using high-speed automated assembly. These issues are particularly relevant when it comes to the growing number of physical connections needed to transfer data and/or power to and from PCBs - connections that often necessitate use of multiple connectors between board pairs. This is fueling demand for robust, small form factor, high-pin-count board-to-board connectors that address today's data and power transfer requirements while mitigating mating misalignment during high-speed manufacture.**

**One way to address these demands is to specify 'floating' connectors, which are capable of absorbing misalignments and small movements in multiple axes. Here, we look at the challenges designers face when specifying board-to-board connectors and explain how the latest floating connector technologies address those challenges.**

An insatiable demand to add features, increase speeds, reduce losses and enhance ease of use is driving the need for higher performance, more compact and more lightweight electronics in everything from consumer products and electric vehicles (EVs) to robotics and data communications. At the same time, OEMs want to deliver solutions to market quickly and with the lowest possible cost, so as to achieve competitive advantage, capture market share and ensure commercial success.

To meet these challenges, designers are adapting their approach. Modular design, in particular, is becoming more common as it offers a number of advantages. In a family of products, common elements such as the microprocessor or communication interfaces are increasingly being designed on their own boards and then re-used across a product portfolio. A modular approach also allows different form factors to be achieved depending on how the various modular boards are placed relative to each other. This brings flexibility to fit in a small available space within a larger system, or to meet important ergonomic requirements in portable devices.

Clearly, there is a need for the boards in a modular design to reliably connect with each other, allowing the passage of signals and/or power from one board to another. This typically requires compact board-to-board interconnections. These fine-pitch interconnects can comprise many pins across multiple connectors and are now regularly expected to support data transfer rates as high as 12Gbps and power transfer with currents up to 3A.

## Deploying Effective Board-to-Board Connectors

As mechanical devices, connectors are affected by the physical operating environment and mechanical attributes of the design. Naturally, applications where there is only a single board-to-board connector between any pair of boards will be simpler than those requiring multiple interconnects. However, the reality is increasingly that several connectors are often necessary to supply a high density of connections at multiple positions. The number of connectors will also be dictated by other design-related issues such as available space and the impact of propagation delays and noise.

Deploying multiple board-to-board connectors between a pair of boards necessitates very precise placement on the PCB, while the need for automated manufacturing demands that this placement be performed at high speed. However, with two or more connectors mating the same two PCBs, the level of placement accuracy is often outside the parameters of even the best modern manufacturing processes.

Misalignment by even sub-millimeter distances - whether due to PCB manufacture, paste location, pick-and-place accuracy or a combination of these factors - will put undue stress (such as excessive side-loading) on the board-to-board connectors. This can cause damage, leading to quality and yield issues during manufacture and the potential for reduced system reliability during operation in the field.

Reliability risk is increased in applications that encounter some levels of vibration or shock - whether it be the daily use of a portable device or the operation of a moving vehicle or a factory automation system. And this can be particularly critical when using very fine pitch connectors that accommodate a large number of contacts within a very small footprint.

Furthermore, where designs are enclosed to protect sensitive electronics then temperature changes can also contribute to stress on connectors, especially if the materials differ or there are differences in board thicknesses.

Figure 1: Applications with multiple board-to-board connectors are the most challenging from a connector placement perspective

## Introducing Floating Connectors

'Floating' connectors address the challenges associated with deploying multiple board-to-board connectors between a pair of PCBs. These devices incorporate a spring-like mechanism that gives them an element of elasticity, allowing them to tolerate misalignment and movement in several axes. Deploying floating connectors simplifies automated manufacture and can contribute to improved connection integrity as the spring-like terminals can reduce stress caused by shock or vibration during operational lifetime.

Floating connectors use a novel contact type that is capable of flexing. These contacts are typically incorporated into the male half of the connector pair. Combined with housings that are suspended by the contacts, this leads to a spring-like action. Thanks to this action, floating connectors are able to maintain connection integrity while accommodating a difference in position across multiple axes - effectively 'floating' the contact areas both along and across the connector to absorb the difference. Because of this, floating connectors will tolerate the small misalignments that can occur during automated manufacture. This allows pick-and-place processes to be deployed for boards with multiple connectors in cases where the sum of misalignments might, otherwise, present challenges for high-speed, high-precision mating.

By reducing the limitations on the number of connectors that can be deployed, floating connectors also give system developers far greater design flexibility. The need for filtering, for example, can be reduced by choosing to separate noisy digital, sensitive analog and power signals. For complex boards, smaller connectors can be placed in multiple locations, eliminating the need for running long traces to a single connector. Apart from the space required to run these traces, long traces also run the risk of introducing noise and propagation delays that can negatively impact circuit operation.

The spring-based 'suspension' mechanism inherent in floating connectors will also contribute to connection integrity during operation. For example, floating connectors can mitigate the possibility of performance degradation or failure from 'fretting' - a situation that occurs when long-term vibration causes the plating to wear from rigid mating pins, exposing the underlying alloy to potential oxidation.

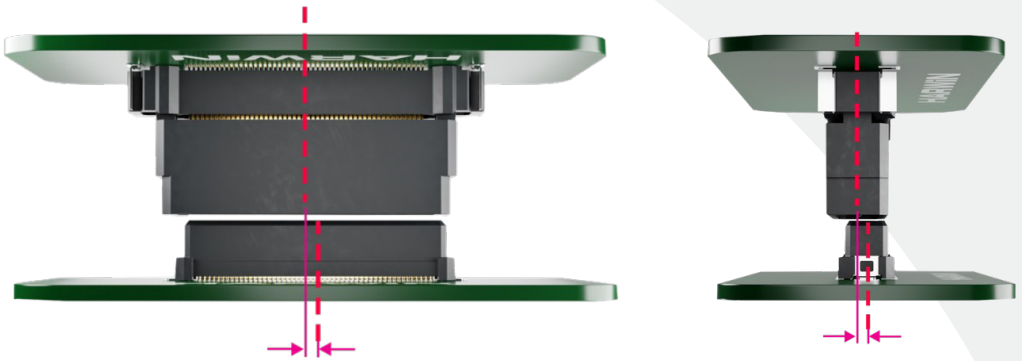


Figure 2: Floating connectors are tolerant of manufacturing misalignment and can reduce stresses due to shock and vibration

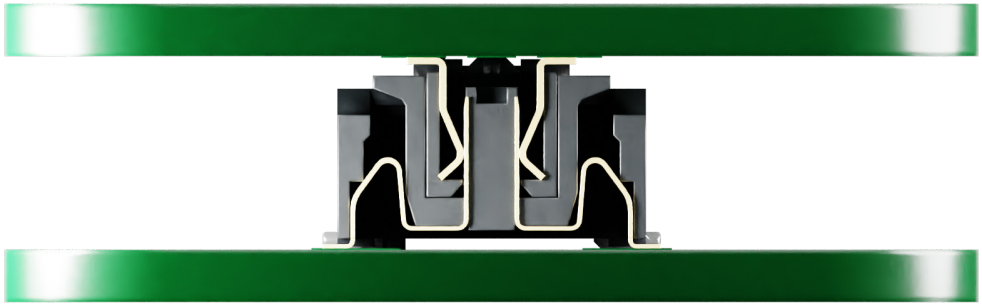


Figure 3: Cross-section of mating connectors showing floating male contacts

## Applications for Floating Connectors

Floating connectors are ideal for high-performance applications with multiple micro-pitch interconnects where automated, pick-and-place processes are used to populate the boards. They should also be considered for applications that could be exposed to some level of vibration or shock or changes in temperature during their operating life.

In determining whether to use conventional or floating connectors, designers should consider a number of criteria, including:

- What are the data rate and power transfer requirements of the application?
- Does the target form factor restrict height or board space?
- Is there a requirement for multiple board-to-board connectors per board pair?
- Is automated assembly required now or in the future?
- What is the operational life of the target application?
- What stresses might the connector be exposed to during operational life?

Depending on the answers to these questions then an evaluation of whether floating connectors are likely to provide quality and reliability benefits should be undertaken.


Figure 4: Floating connectors can be used in almost all applications

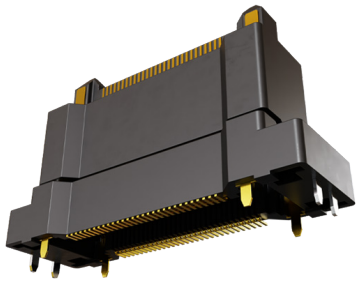
## Harwin's Flecto Floating Connector Family

One of the most recent additions to the world of floating board-to-board connectors is the Flecto range from Harwin. This comprehensive family of connectors offers a number of innovative features that allow for multiple connections between a pair of PCBs, without any placement accuracy issues. Specifications for the Flecto range of auto-placement-ready connectors are shown in Figure 5.

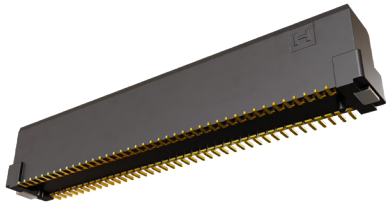
The range comprises five series with three different fine pitch options. In all cases, the floating mechanism is incorporated into the male connector.

- F10 series: 0.50mm (.0197") pitch, all signal
- F11 series: 0.5mm (.0197") pitch, signal + power
- F12 series: 0.5mm (.0197) pitch, all signal
- F20 series = 0.635mm (.025") pitch, all signal
- F30 series = 0.80mm (.0315") pitch, all signal

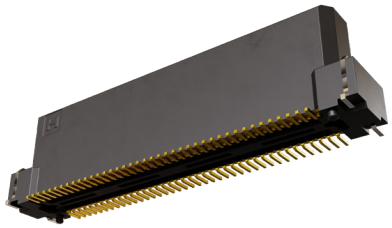
F10/12: 0.50mm



F11: 0.50mm



F20: 0.635mm



F30: 0.80mm

| Materials | Electrical | Mechanical | Environmental |
|---|---|---|---|
| Housings:<br>**High Temperature LCP, UL94V-0** | Current per contact:<br>**Up to 0.5A (signal)**<br>**3.0A max (power)** | Durability:<br>**Up to 100 operations** | Operating temperature:<br>**-55°C to +105°C (signal+power)**<br>**-40°C to +105°C (signal only)** |
| Contacts:<br>**Copper alloy** | Maximum voltage:<br>**Up to 250V AC/DC** | X / Y / Z axis misalignment:<br>**Up to ±0.8mm** | Vibration resistance:<br>**10-55Hz, 1.5mm pk-pk for 6 hrs** |
| Contact Finish:<br>**Gold on contact area**<br>**Gold or tin on terminations** | Data rate:<br>**Up to 8Gb/s (0.50mm pitch)**<br>**Up to 12Gb/s (0.635mm pitch)**<br>**Up to 5Gb/s (0.80mm pitch)** | Pitch:<br>**0.50mm (.0197")**<br>**0.635mm (.025")**<br>**0.80mm (.0315")** | Shock resistance:<br>**50G (490m/s²)** |
| SMT Retention Tabs:<br>**Brass, Tin finish** | Insulation resistance:<br>**100MΩ min** | Board-to-Board height (vertical):<br>**5.98mm to 29.90mm nominal** | Compliance:<br>**RoHS Compliant**<br>**REACH / CMRT statements** |

Figure 5: The Flecto range of floating connectors features a range of contact pitches, sizes and features

To ensure that the range can address the growing need for high-speed communications, products in the Flecto family have been tested for insertion loss (see Figure 6) and Near End Cross Talk (NEXT). As a result of this testing and evaluation, the range is rated for data transfer at 12Gbit/s - performance similar to that found in standards such as SAS (Serial Attached SCSI), which is widely used in enterprise server and storage applications.

Featuring between 30 and 160 contacts, the F10 series has mating heights of between 17.9mm and 29.9mm depending upon the configuration chosen. The F11 series features vertical and horizontal female connectors, allowing boards to be connected parallel to each other or at right angles. Nominal mating heights are 15mm and 20mm, with 20 to 120 signal contacts available. The F11 range includes the four power contacts built into location posts either end - these help with blind mating. Power ratings are 3A per contact.

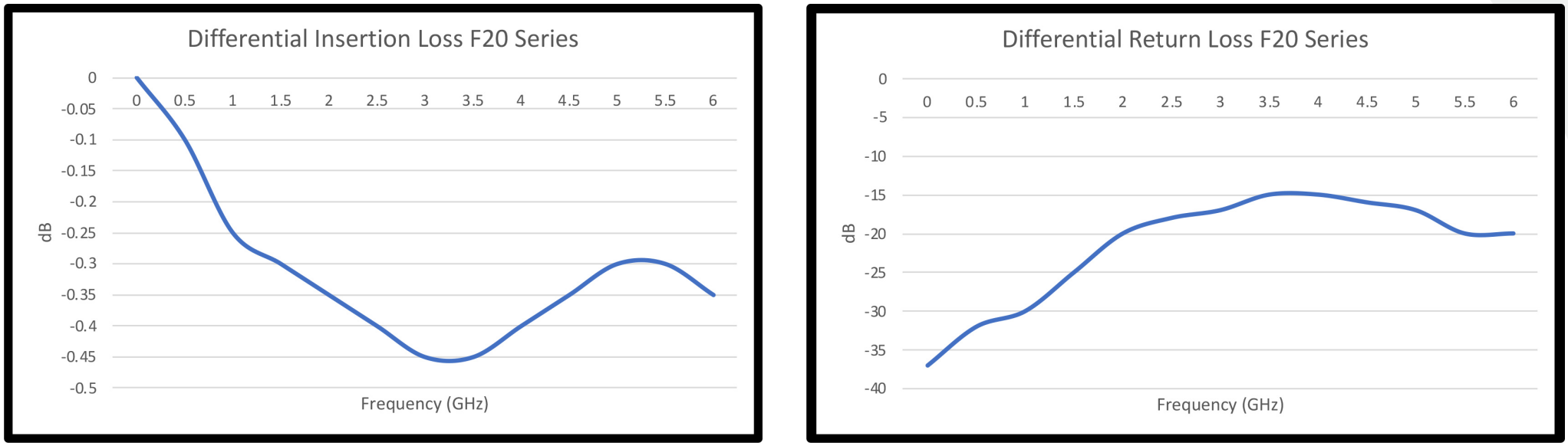



**Figure 6: Low-loss performance of Flecto connectors ensures efficient high-speed transmission (example shows F20 series)**

F12 connectors are available with 40 contacts and, with a board-to-board mounting height of just 7.65mm, are optimized for ultra-compact parallel connections.

Both the F20 and F30 series offer three different height female connectors. The former is available with 60 or 80 contacts and the latter with 60, 80 or 100 contacts. Nominal mating heights for the F20 series are 5.98mm, 9.88mm and 14.88mm and between 8mm and 24.7mm in the case of the F30 series.

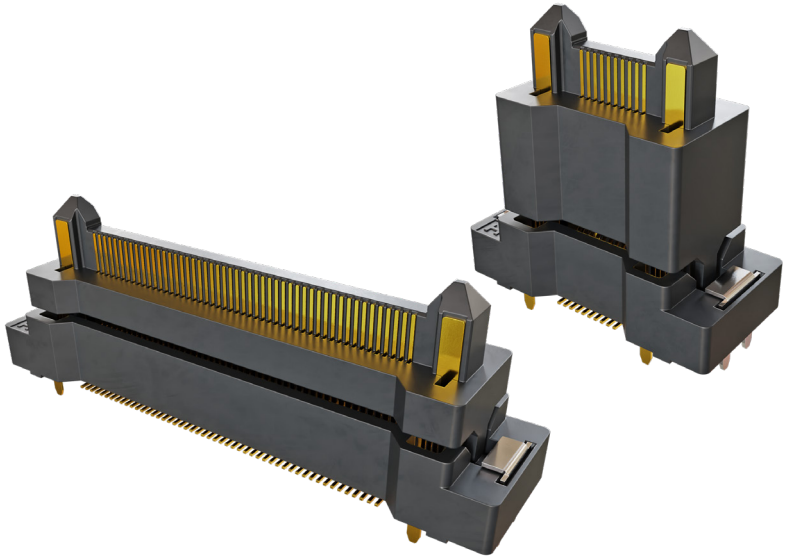


Figure 7: Power contacts also help with blind mating

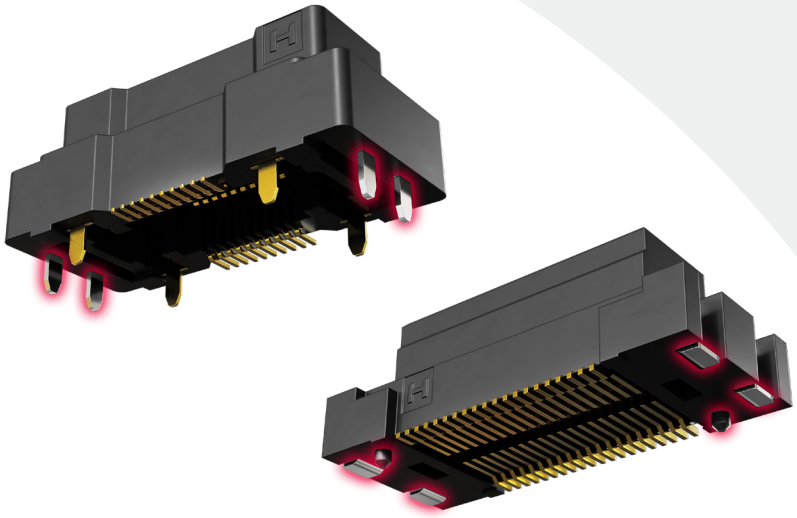


Figure 8: Retention tabs and through-board pins enhance the mechanical rigidity of Flecto connectors

Fully RoHS-compatible and free of REACH SVHCs, the Flecto family manufactured using materials that do not contain lead, brominated flame retardants, red phosphor (PFOS/PFOA) or antimony.

As you would expect with products targeted at ease of use in automated assembly environments, all Flecto board-to-board connectors are available in tape-and-reel.

Vertical connectors are fitted with disposable pick-and-place caps or tape while horizontal connectors can be placed using the flat surface on the connector housing.

Flecto signal-only connectors feature location pegs to eliminate movement during solder reflow. These are augmented with retention tabs to provide additional mechanical strength for surface mount connectors.

On the mixed signal and power connectors, through-board solderable posts are provided for both location accuracy and enhanced mechanical strength. The latter ensures resistance to shocks as high as 50G.

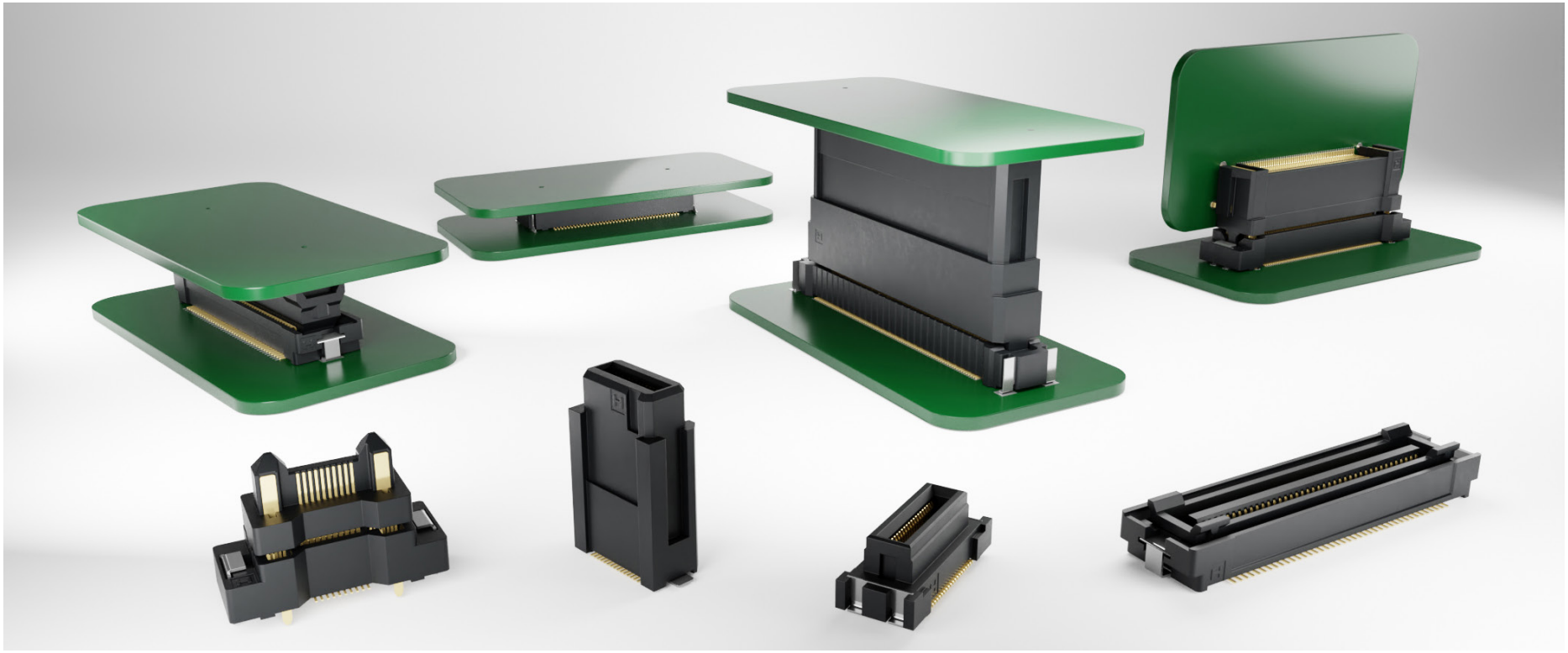
A number of the connectors in the family feature shrouded contacts to prevent accidental damage when no mating connector is present, while others offer polarization within the shroud to ensure mating is only possible in one direction.

**Summary**

Interconnect is an integral and important aspect of every electronic design. Board-to-board connectors can allow designers to follow a modular design path, separating key elements of a system. This facilitates re-use across other designs, shortening time-to-market and reducing design risk. Additionally, these connectors support the development of compact, multi-board solutions that allow for small form-factor designs able to fit into space-constrained environments.

However, the increased demand for multiple connectors per board pair increases the possibility of potential misalignment during automated pick-and-place and solder reflow processes. This, in turn, can lead to manufacturing quality issues if the connectors experience unintended strain. In addition, once the systems are in the field, these stresses may be exacerbated by additional stresses resulting from short-term or long-term exposure to shock, vibration or changes in temperature. By accommodating and absorbing misalignments and small movements in multiple axes, floating board-to-board connectors such Harwin's new Flecto range allow OEMs to deploy automated manufacturing techniques for PCBs featuring multiple connectors without compromising data performance and power transfer capabilities.

As a result, these connectors are ideal for applications ranging from industrial automation and electric vehicles to security systems, IoT devices as well as consumer and business electronics and a whole host of embedded systems.



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