Choosing a 2-mm connector

Not all such connectors offer the same degree of density and performance

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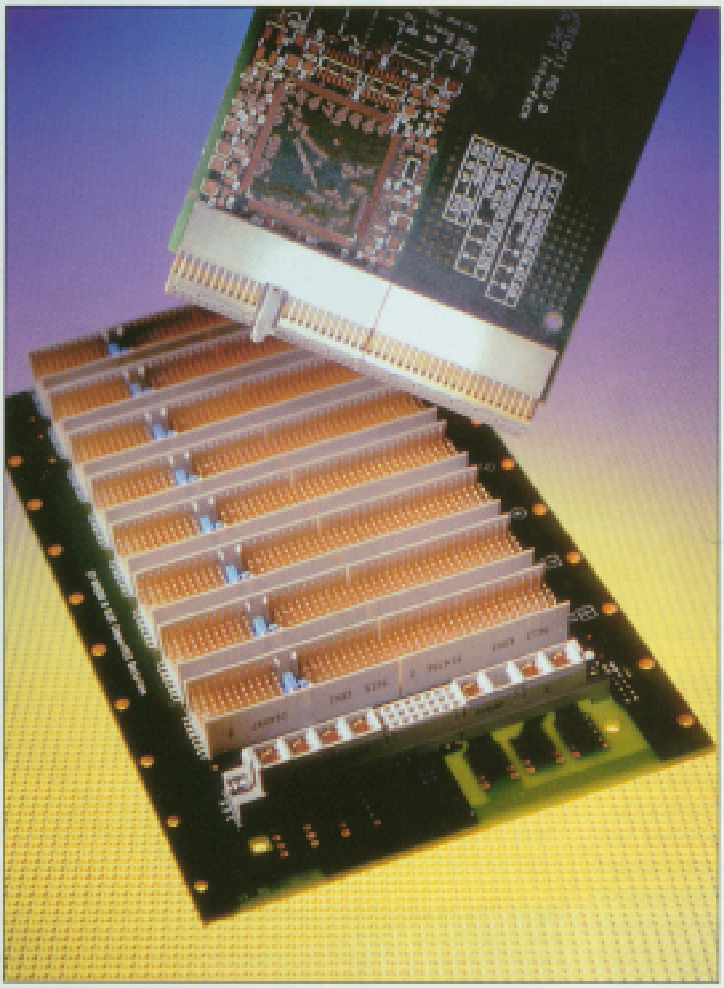
When selecting a 2-mm connector, it is necessary for the designer to choose carefully. Just knowing a connector is a 2-mm connector is not enough—there are really three distinctly separate and non-intermateable connector families: Futurebus, Teradyne's HDM, and Hard Metric.

All three families use a 2-mm grid and come in modular formats, but the similarity ends there. Each family has different pc-board hole sizes, contact sizes, shield configurations, keying methods, and electrical characteristics.

Of the three types, the Futurebus style is currently the most popular. Market research firm Bishop and Associates (Chicago) estimates that in 1995 the sales of this family totaled $51 million; Hard Metric connectors, $25 million; and HDM connectors, $6 million.



High density and performance are benefits of using 2-mm connectors, like this one from ERNI Components.

Physical differences

All three connector designs consist of multi-row pin headers on the backplane, right-angle female connectors on the daughtercard, and a 2-mm grid spacing (see *Fig. 1*). The HDM style has exposed terminals on the right-angle daughtercard female connector, while the Futurebus and Hard Metric connectors have encapsulated terminals. The Futurebus connector was first implemented with exposed terminals, so some versions remain that way even today.

Exposed right-angle terminals do not perform well in high-speed applications, as they create an impedance discontinuity, which can result in reflections and signal "ringing." To prevent this, the Hard Metric design covers the entire conductor path in a plastic dielectric. This closely matches the condition of the signal path in the pc boards and therefore eliminates the impedance discontinuity.

Another visible difference among the connectors is the distance from the surface of the backplane to the first signal row. This distance ranges from a low of 14.0 mm for the Hard Metric system to 17.0 mm for the Futurebus system. The signal arrives sooner at the daughtercard when the distance is shorter.

A further refinement intended to reduce signal skew from the inner rows to the outermost rows was introduced in the Hard Metric design. The path of the inner conductor on the right-angle female connector is serpentine to increase the distance, while the outer rows have curvilinear 45° paths. The result is a uniform signal path that exhibits less skew from row to row than either the Futurebus or HDM designs.

The Hard Metric connector also features a narrower width than the Futurebus or HDM designs. The 5 + 2-row (five rows for signals and two rows for shielding) Hard Metric backplane connector is 3 mm narrower than either the 5 + 2-row Futurebus connector or the six-row HDM connector. As a result, the Hard Metric design preserves more space on the backplane for components that must be placed between the connectors.

Some companies have needed more signal pins than the 5 + 2-row designs offer. In response, suppliers have begun to offer Hard Metric designs as wide as 10 rows. Not surprisingly, the narrower Hard Metric design lends itself more readily for expansion to an 8 + 2-row configuration than the wider Futurebus and HDM connectors.

The mating distances also differ among the three product families. Mating distance is measured from the rear edge of the daughtercard to the front surface of the backplane, when the daughtercard is fully seated. The Futurebus mating distance is 10 mm, while the mating distance for both Hard Metric and HDM is 12.5 mm. The 12.5-mm measurement is important because it matches the mating distance of the established DIN 41612 connectors.

Matching mating distances allows industries that use Eurocard packaging (IEC 273, IEEE 1101, or 1101.10) to build systems that combine the popular 96-pin DIN connectors and the newer Hard Metric and HDM connectors. This supports existing architectures while allowing the addition of new features that require the greater signal density of 2-mm connectors. The VME64 Extensions committee chose the Hard Metric connector system for the P0/J0 connector because of this advantage.

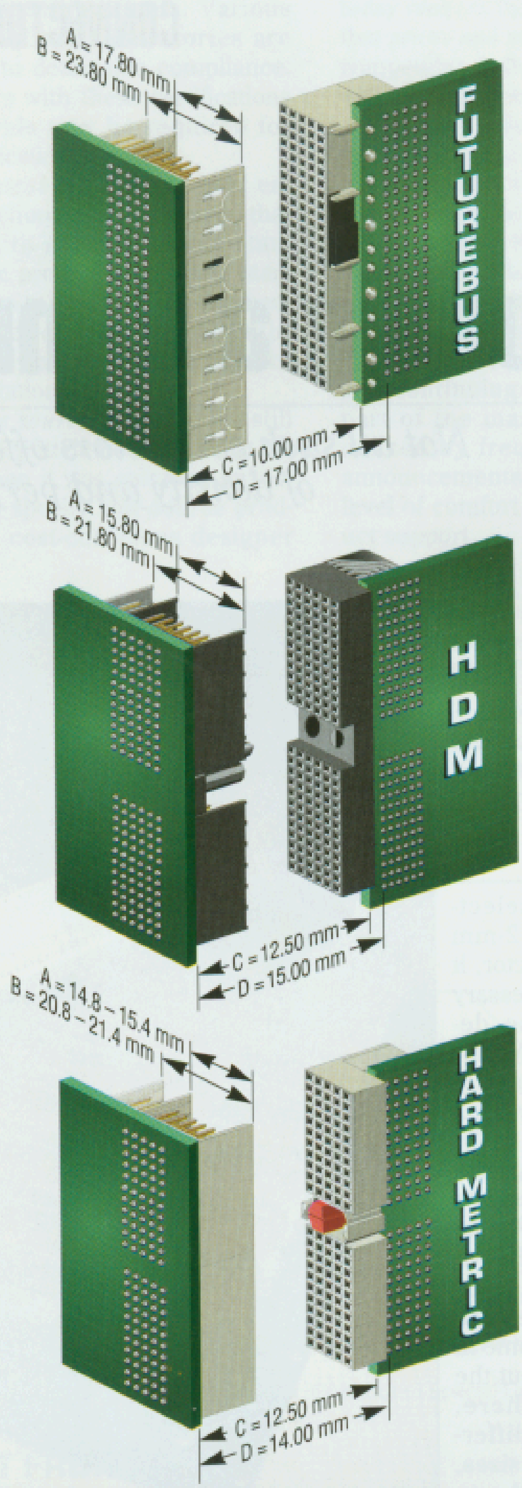


Fig. 1. The three types of 2-mm connectors include the Futurebus (top), HDM (center), and Hard Metric (bottom) styles. All three designs consist of multi-row pin headers on the backplane and right-angle female connectors on the daughtercard.

Electrical performance

Electrical characteristics among the three types of connectors also vary. Compared to the other 2-mm connectors, the Hard Metric connector exhibits better contact resistance and lower signal propagation delays. This becomes important because as

Comparison of 2-mm Connector Families

Design Criteria		Connector Families		
		Futurebus	HDM™	Hard Metric
General specification		IEC 1076-4-104	Proprietary	IEC 1076-4-101
Number of rows (signal and ground)		5 + 2	6*	5 + 2
Total contacts per linear inch		88	76	88
Number of standard modules		7	3	6
Width of male housing		17.8 mm	15.8 mm	14.8 to 15.4 mm
Distance from daughtercard to row A		7.00 mm	2.50 mm	1.50 mm
Mated distance from backplane to row A		17.0 mm	15.0 mm	14.0 mm
Signal mating levels/step distance		5 / 0.75 mm	3 / 0.50 mm	3 / 1.50 mm
EMI shielding		Yes+	Yes	Yes
Extended guidance features		Add-on module+	Add-on module	Integrated
Coding locations		Integrated	Add-on module	Integrated
Coding combinations per location		3	8	70
Reverse connector configuration vertical male		Yes	Yes	Yes
Standard connector configuration vertical female		Yes+	No	Yes+
Power contact modules		Yes	Yes	Yes
Coaxial contact modules		Yes	No	Yes
Maximum contact resistance of mated pair		50 mΩ	40 mΩ	20 mΩ
Propagation delay (max)++		210 ps	235 ps	135 ps
Pc-board plated hole size		0.70 mm	0.70 mm	0.60 mm
Press-fit termination	Daughtercard	Yes	No	Yes
	Backplane	Yes	Yes	Yes
Major manufacturers		AMP, Berg, Cannon, CECO, FCI	Molex, Teradyne	AMP, ERNI, FCI

*Shield pins implemented through signal pins. +Not defined in (IEC) specification. ++Published industry test results.

rise times approach 250 ps, even minor mechanical design differences can significantly affect a signal's electrical characteristics.

The Hard Metric connector's combination of plastic-encapsulated terminals and the low-skew of its serpentine conductors improves electrical performance. The connector's electrical characteristics have been credited with some important design wins, such as the CompactPCI computer bus architecture.

The accompanying *table* summarizes the physical and performance features of the three types of 2-mm connectors, listing many of the details defined in the relevant connector standards. However, not all features of each connector are part of a standard. For instance, the ground-return shields offered by several companies for the Futurebus style connector are not actually defined by the standard. In the case of Hard Metric connectors, the shields are fully defined by the IEC 1076-4-101 standard.

A critical difference among the three 2-mm connectors is their conformance with global standards. The international standard defining the Hard Metric family is IEC-1076-4-101, and the standard defining the Futurebus connector family is IEC-1076-4-104. However, the HDM connector family is a proprietary design and does not conform with any existing (industry or global) standard.

Other criteria

Besides electrical performance, other issues should be considered when choosing a 2-mm connector:

System environmental factors. Mating cycles, vibration, shock, ambient temperatures, and atmospheric factors such as humidity and salt spray must also be considered. Often, a manufacturer offers the same connector with different contact plating or header wall thickness for special applications.

Special options. Designers need connector systems with the flexibility to meet undefined future requirements. Each connector style has special options and features that can be adapted when the requirements are presented. These options include coding, high-frequency contacts, high-current contacts, shrouds, cable connectors, shielding, and special pin loading for early-mate and mid-plane applications.

Termination methods. Today's higher-layer-count backplanes and daughtercards often necessitate press-fit termination or surface-mount termination rather than conventional through-hole soldered termination.

Certification. Underwriters Laboratories (UL), Bell Research Corp. (Bellcore), Canadian Standards Organization (CSA), Technischer uberwachungsverein (TUV), and Verband Deutscher Elektrotechniker (VDE) all have their own standards and requirements. Various commercial test laboratories are equipped to determine compliance. Connectors with these certifications or approvals may be required for some applications.

Intermateability. This is best ensured by choosing a connector that conforms to existing global standards. The process of defining standards helps to unify designs and ensures that companies will not casually deviate from their present implementations.

Multiple sources. Companies still have not forgotten the abuses that occurred when it was common for designers to specify sole-source products. The cost-conscious designer today realizes that the best insurance that prices and availability will remain competitive is the use of connectors with several approved suppliers.

Product support. A nearby manufacturing location can often save days—or even weeks—when obtaining a new pin loading.

Availability. Future availability is often difficult for a designer to determine when choosing connector styles for new product applications. The presence of a global standard and continuing investment on the part of the manufacturer, as evidenced by frequent new product announcements, can give a higher level of comfort for long-term product support.

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