

3M's Industry Leading High Speed Cable to Board Solutions

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Abstract

3M Engineers have invented a simple high performance cable-to-board interconnect solution to enhance capability of systems that use 2mm Latch Eject Headers. This common footprint solution allows a Hardware Packaging Engineer to upgrade painlessly without a major circuit board change. The Systems Architect is allowed to tailor as-needed electrical performance up to 12 Gb/s using the same 2mm family of products. The Components Engineer can simplify his options using a standard footprint for a wide variety of performance needs.

This paper shows this new family of products along with supporting data to demonstrate performance and value. Electrical performance for legacy ribbon cable will be benchmarked with data. New interconnect art will be shown with the physical product changes along with increasing electrical performance stepping up to 12 Gb/s. Comparative impedance profiles, attenuation, eye patterns and cross-talk will be based on standardized cable lengths of 12 inches. All interconnect systems discussed will be supported with data from a custom test board with 2mm spacing in a 2x10 signal array format. The varying cabling options will include 3M's low loss coaxial and twin axial cables

3M's Industry Leading High Speed Cable to Board Solutions

When designing a high speed cable to board interconnect high speed designers have to consider and ultimately compromise on one or more of these criteria:

1. Electrical Performance
2. Signal Density
3. Mechanical Reliability / Robustness
4. Cost

This decision problem is magnified by the fact that today's designers frequently need to re-design systems to upgrade performance several times during the system's life time.

3M has developed a forward thinking interconnect system including cabling spanning multiple levels of required electrical and mechanical performance. This solution is based on a building block approach of interchangeable

and compatible headers, latching systems, connectors, and cable assemblies.

The key to this approach is to enable designers to design without compromise to their current requirements but also have the freedom to increase signal performance to meet future requirements without changing the solution footprint. A simple exchange of a component will achieve this electrical upgrade.

Why are designers forced into a compromised solution?

Over the last decade many solutions have been developed to address each one of these compromises.

Ribbon Cable Interconnects

Ribbon cable has provided a low speed cost effective i.e. simple design / mass

terminated cable solution for PCB wire to board interconnects but is intrinsically limited by signal performance above 500MHz.

Shielded Ribbon Cable Interconnects (3M™ Pleated Foil Cable)

Improves cable impedance matching and enhances signal performance over standard ribbon cable but is limited by connector losses.

Backplane Assemblies (Fully Shielded Controlled Impedance Cable and Connectors)

Typically higher bandwidth, designs are vendor dependent including cable assemblies. No industry standardization yet. 3M has developed 2mm Hard Metric assemblies such as 2mm **HS** to 2mm SCI cable assemblies.

With recent technological breakthroughs in electrical performance, 3M's industry leading latch-eject cable assemblies enable engineers to design without compromise today.

By standardizing on a 2mm footprint and packaging around a latch eject header system, 3M has invented a unique family of cable to board interconnects that perform up to 12Gb/s. The 2mm open pin field footprint with latch eject mechanism drives high density and mechanical reliability for these robust cable to board solutions.

3M's latch eject cable to board solutions span the range of price performance required by current and anticipated future applications.

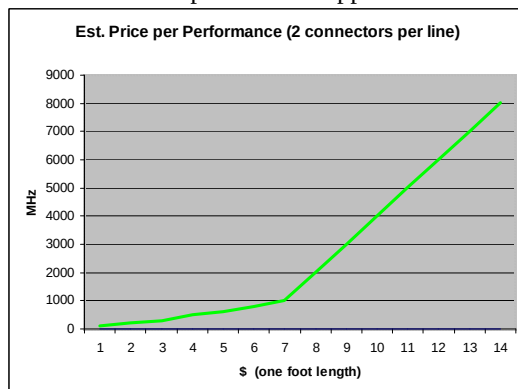


Fig. A: Rough Price Comparison for a 1 Foot Cable Assembly Based on Bandwidth

3M's *highest* electrical performance (i.e. up to 12 Gb/s) latch eject header **HPLEH** is characterized by a unique ground design that maintains signal isolation and controls

impedance through the header and shielded controlled impedance (SCI) cable connector. Also discussed in this paper are the *mid-range* performance **HS-LEH-S** and *low-range* performance **LEH**.

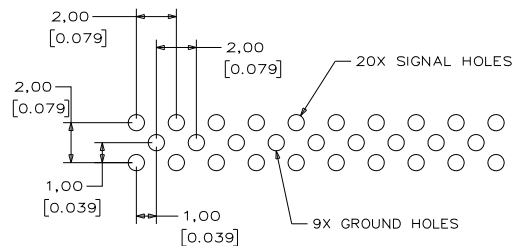
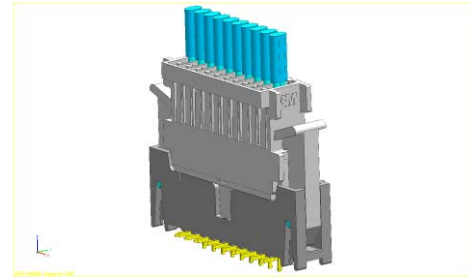


Fig. B: picture of 2x10 2mm HS-LEH (LEH for the rest of this paper) and mated connector / PCB footprint, HPLEH grounds shown for reference along with LEH balanced signals (outer rows) or signal/ground for unbalanced signal transmission.

Strategically placed ground contacts in the header system that mate to the connector assembly enables a highly stable signal path by lower ground loop inductance and thus matching characteristic impedance of the signal path, i.e. 50ohms unbalanced, 100ohms balanced.

2mm SCI Cable Assemblies and Options

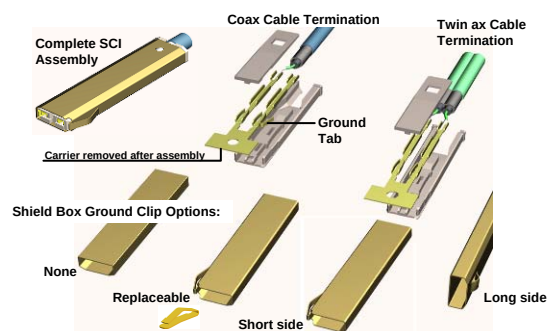
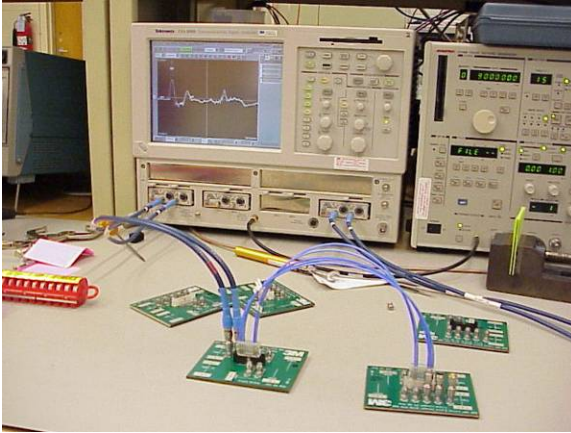


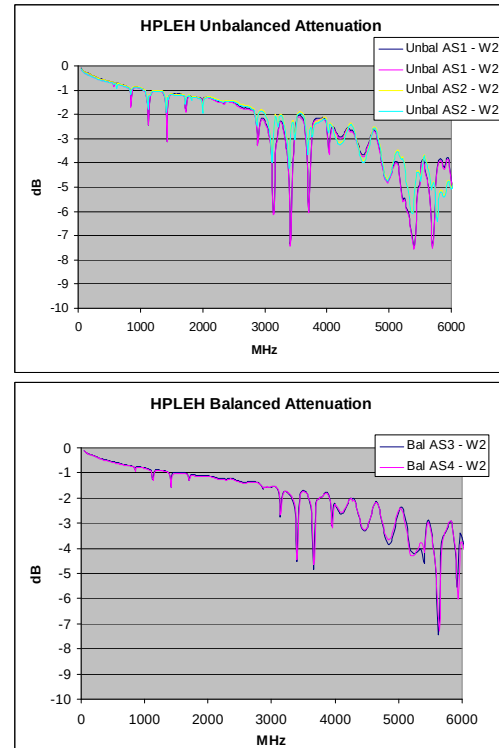
Fig C. Coaxial vs. Twin axial SCI connectors



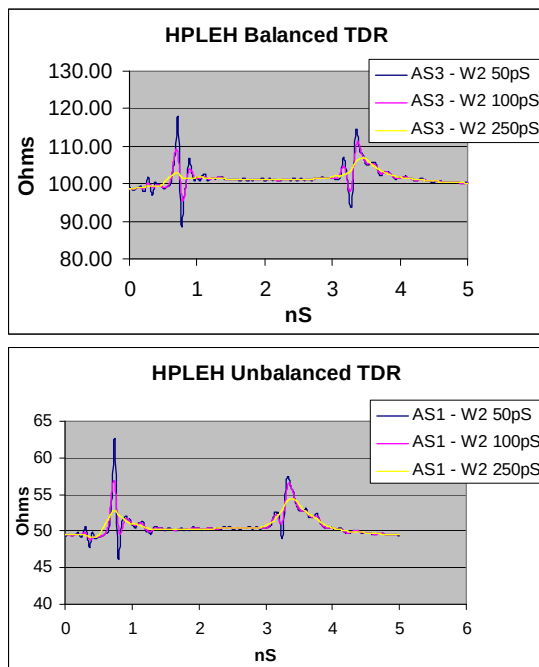
**Fig. D: Common Test Set-up;
2 headers connected by 12" cable assemblies**

HPLEH High Performance (header + carrier + connector + 12" cable)

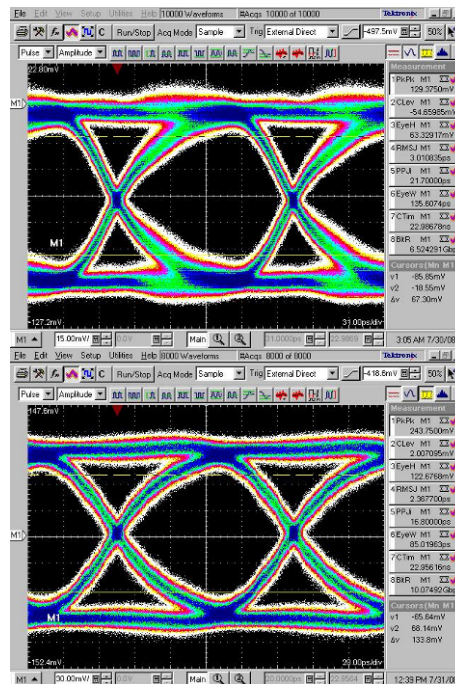
1. Impedance Profile (various rise-times 50ps, 100ps, 250ps).
2. Attenuation as shown in Fig. F.
3. Eye Patterns at 50% opening with maximum performance in Gb/s as shown.
4. Cross-talk (See Cross-talk summary page).



**Fig. F: HPLEH Attenuation Chart;
unbalanced (top) balanced (bottom)**



**Fig. E: HPLEH Impedance Profile Charts;
balanced (top) unbalanced Cable (bottom)**



**Fig. G: HPLEH Eye Patterns; unbalanced 6.5
Gb/s (top) balanced 10Gb/s (bottom)
HS-LEH - S (Simplified)**

Electrical Performance (header + carrier + connector + 12" cable):

1. Impedance Profile (various rise-times 50ps, 100ps, 250ps)
2. Attenuation as shown in Fig. I.
3. Eye Patterns at 50% with maximum performance in Gb/s as shown.
4. Cross-talk (See Cross-talk summary page).

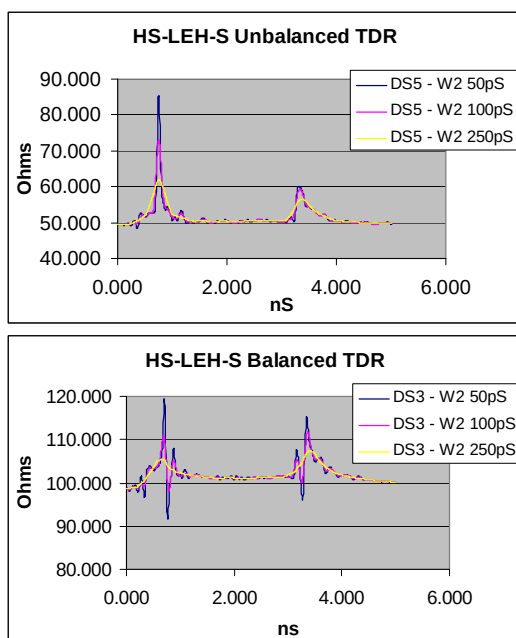


Fig. H: HS-LEH-S Impedance Profile Charts; unbalanced (top) balanced (bottom)

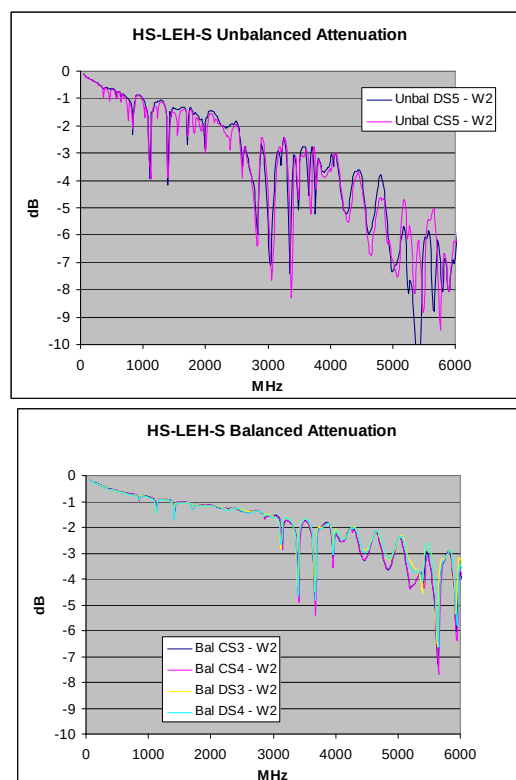


Fig. I: HS-LEH-S Attenuation Chart; Unbalanced (top) Balanced (bottom)

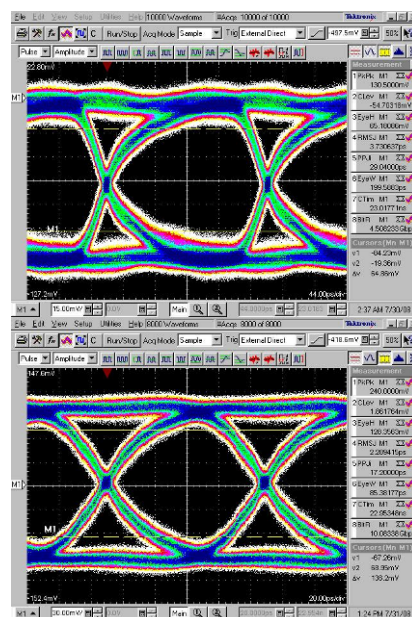


Fig. J: HS-LEH-S Eye Patterns; Unbalanced 4.5 Gb/s(top) Balanced 10Gb/s (bottom)

The most cost effective medium performance solution enables up to 1GHz single ended.

LEH - Standard Latch Eject Header with 3M SCI

Electrical Performance (header + carrier + connector + 12" cable):

1. Impedance Profile (various rise-times 50ps, 100ps, 250ps).
2. Attenuation as shown in Fig. L.
3. Eye Patterns shown at 50% eye opening at bit rates identified in Figure M.
4. Cross-talk (See Cross-talk summary page)

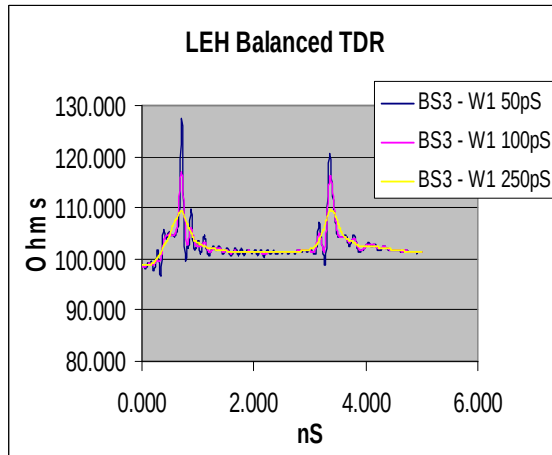
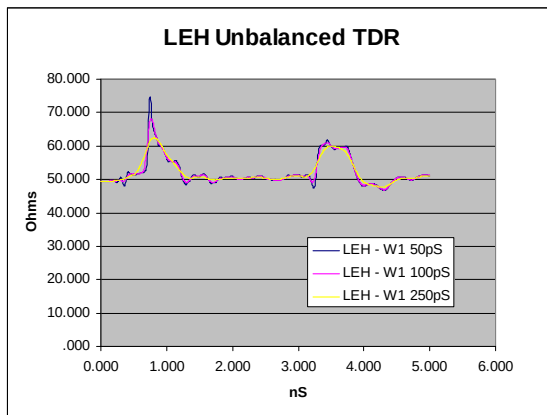


Fig. K: LEH Impedance Profile Charts; Unbalanced (top) Balanced (bottom)

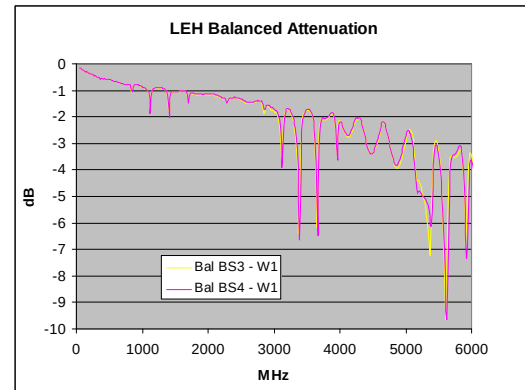
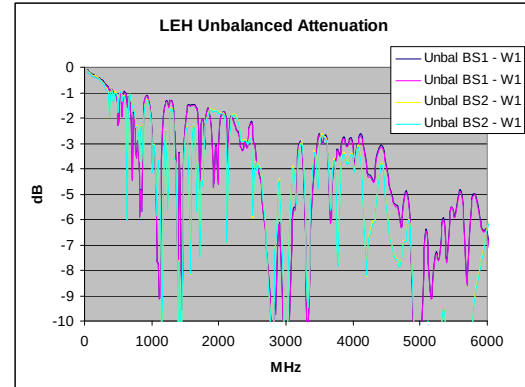


Fig. L: LEH Attenuation Chart; Unbalanced (top) Balanced (bottom)

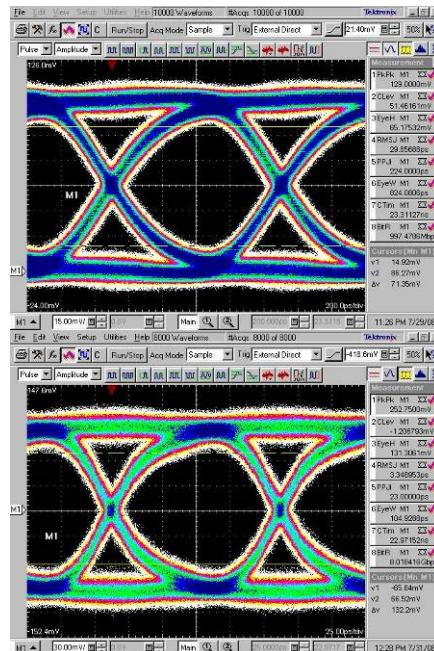


Fig. M: LEH Eye Patterns; Unbalanced 1.0 Gb/s (top) Balanced 8Gb/s (bottom)

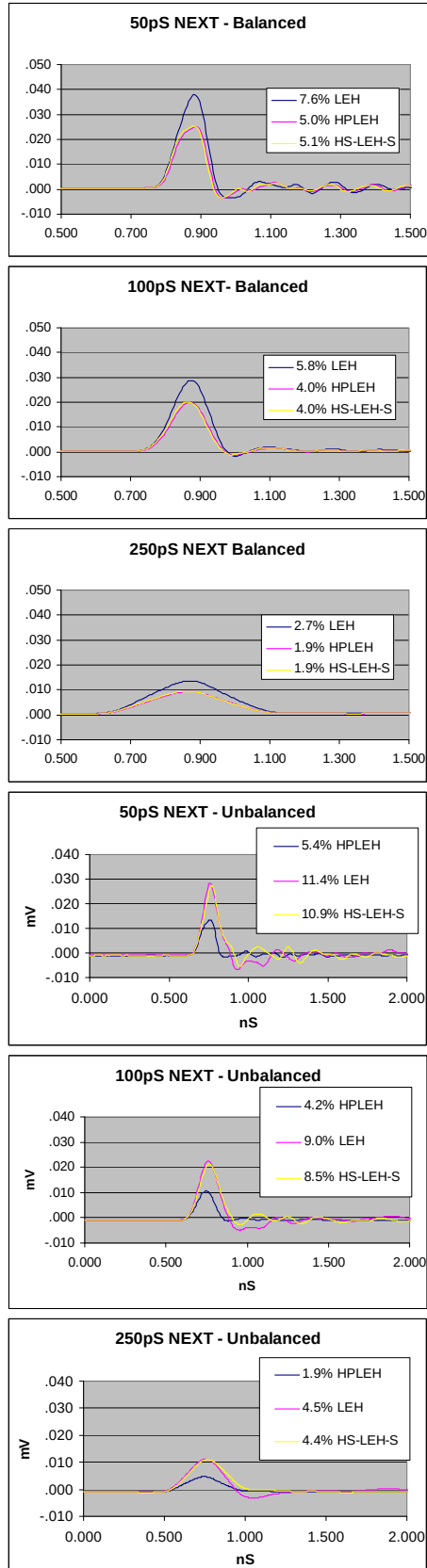


Fig. N: Near End Crosstalk Summary

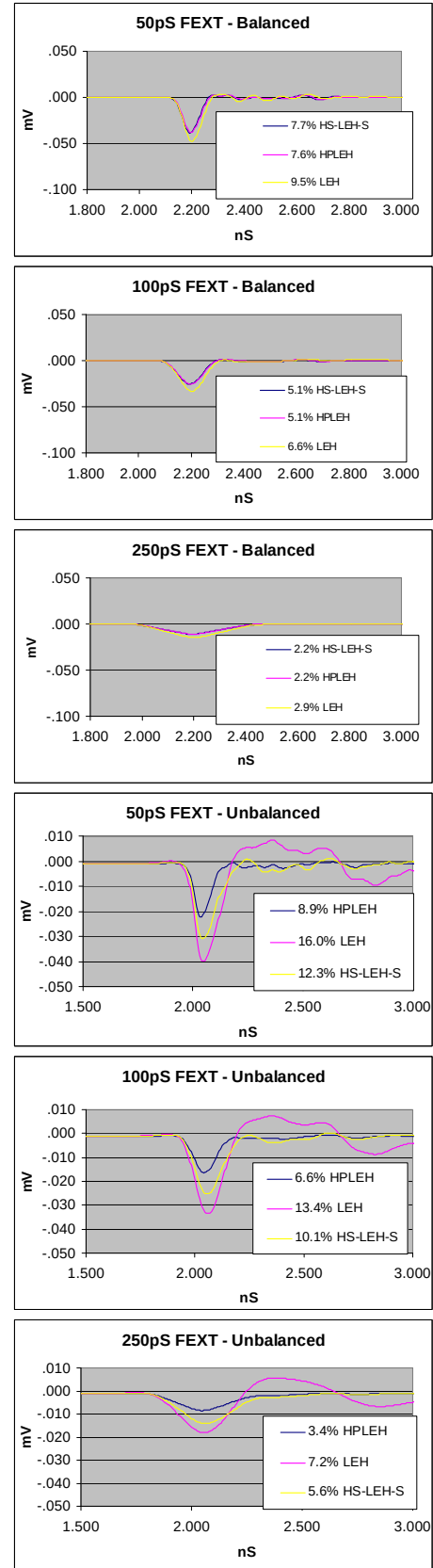


Fig. O: Far End Crosstalk Summary

SUMMARY

How should a designer select the "Best" solution for their application?

1. Electrical Performance Charts (3 high speed options vs. legacy low speed solutions)
 - A. Bandwidth
 - B. Cross-talk
2. Signal Density / Mechanical Packaging
3. Scalability for future systems plus cost considerations looking forward.

How does 3M's latch eject header system enable the designer to future-proof the design?

Costs associated with future redesigns can be minimized by employing this 3M family of high speed cable interconnects by providing an industry standardized 2mm footprint with a broad selection of electrical performance upgrades.