HIGH-SPEED I/O INTERCONNECT SOLUTIONS ADDRESS INDUSTRY TRENDS FOR CONSUMER AND ENTERPRISE MARKETS

Steve Figuerado, Field Application Engineer

HIGH-SPEED I/O INTERCONNECT SOLUTIONS ADDRESS INDUSTRY TRENDS FOR CONSUMER AND ENTERPRISE MARKETS

Two key industries that advanced high-speed I/O (HSIO) technology excels in are gaming and entertainment and enterprise. World demand for gaming/entertainment systems continues to be healthy and is forecast to continue rising annually. Next-generation televisions (UHDTV, more commonly known as 4K by consumers) keep on pushing video signal delivery well beyond traditional High Definition Multimedia Interface (HDMI) and high definition (HD) rates. The emerging 4K TV technology doubles previous HD resolution rates (see Figure 1).

In enterprise markets, the “internet of things” (IoT) trend continues to drive enterprise market with cloud, streaming and server/storage-related solutions.

Background of the HSIO Development

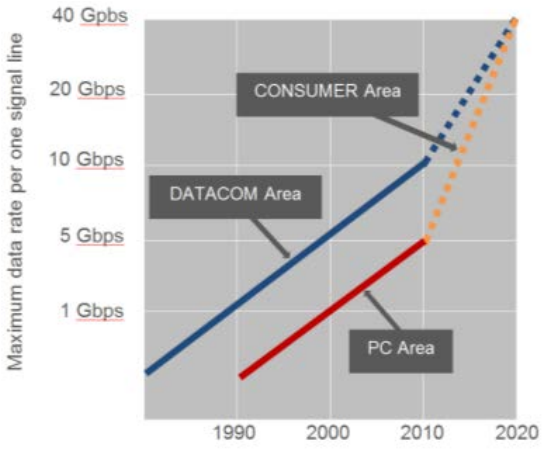


Figure 1. High-speed data transmission is required in consumer markets. Main Applications: Integrated interface for data transmission and high-speed interface for HDTV

Typical trends align with those of other computing and electronic devices. Form factors continue to decrease in physical size while demanding increased bandwidth and performance. New applications discussed here fulfill these high-speed video and data requirements using versatile HSIO interconnects coupled with high-speed, twisted-pair cable technology.

The Problem

As devices continue to become smaller and thinner while demanding increasing bandwidth, the main dilemma is how to accommodate larger form factor, high-speed input modules (e.g., high-end graphics generators) within the ever-shrinking available space of output devices.

Not only do these platforms require more compact solutions, but they also demand methods for maintaining a robust and reliable interconnect and meeting a wide range of performance requirements, intuitive end-user access, and versatile adaptations—all within a cost-effective model.

The main objective is to have an output device with a high-speed cable coupled with a high-speed input device. The larger input device can then be placed in a more remote location from the output device. This input device may sometimes be referred to as a docking device, depending on the specific application (as in a gaming or video device). In an enterprise product, the input device may simply be located remotely from the output device (as in a fixed-size I/O generator and graphics processing unit).

Solutions

HSIO connector technology coupled with high-speed twisted pair cable technology make up the basic set of building blocks for these solutions. This technology's versatility excels at meeting multiple requirements. One example would be for an entertainment solution to employ a cabled connection between a thin LCD device (e.g., TV) and its remote processing unit. This approach is sometimes referred to as a one cable concept (OCC). Similar examples exist within the gaming industry.

A PCIe Generation 3 (Gen 3 data rates of 8Gbps @ 85 ohms) solution, offering scaling ability to higher bandwidths for PCIe Generation 4 (Gen 4 data rates of 16 Gbps), is one good example of a possible solution for an enterprise-type products. Many data rates are supported, such as USB (2, 3, 3.1, etc.), Display Port (DP, versions 1.3, 1. 4), HDMI, etc. Typical cabled lengths are up to two meters with extended lengths under evaluation between three and four meters. Data rates have also been demonstrated in lab tests to exceed 20+ Gbps per lane with a goal to reach 40 Gbps within one year (as shown in Figure 2). In some cases, higher speed performance may offer simplified silicon solutions at the computing device and not be restricted to any single data rate.

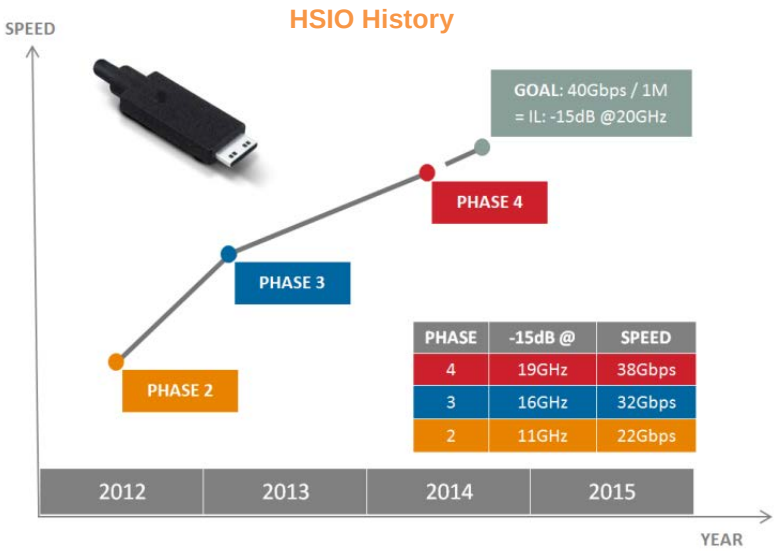


Figure 2. HSIO data rates and scaling to 40Gbps

High-speed twisted pair cables can be tuned for other signal impedance control, such as 85 ohms, 100 ohms, etc.

Some high-speed data solutions may potentially be coupled with power requirements exceeding 200 watts/20 volts (DC). Maintaining low levels of insertion loss and cross talk are achieved by specific cable construction methods. Typical connector contacts are capable of 1.5 amps. Various widths can be considered for higher amperages as required.

Analysis and Simulation

Managing multiple signal frequencies and data rates when combining within a common application has presented many challenges with signal integrity. Identifying analytical gaps and implementing simulation software for electromagnetic interference (EMI) and target radio frequency (RF) simulations further demonstrate the ability to tune this technology, achieving successful solutions across multiple usage models. Versatility and longevity are some of the key attributes for integration capabilities.

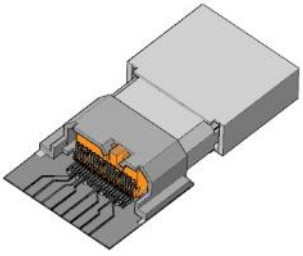


Figure 3. This right-angle receptacle and mated plug assembly was used for simulation models.

Channel simulation capabilities are commonly performed to help develop optimal designs while minimizing design cycles. Both cable construction and connector contact designs are included in simulations and analysis. Figures 3, 4 and 5 show some key simulation results in different RF modes.

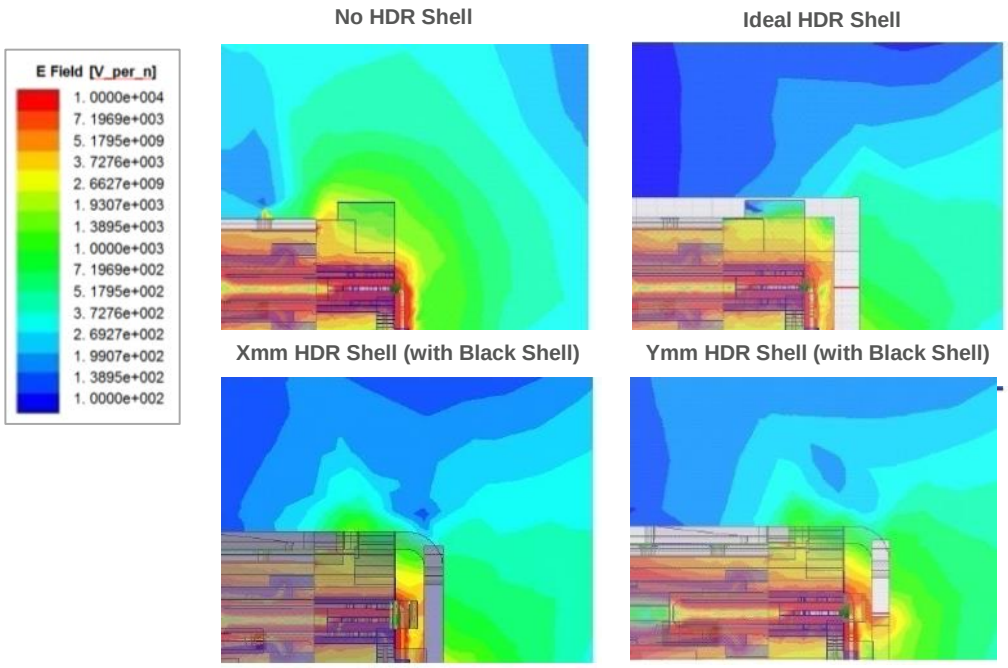


Figure 4. For simulation model, near-field distribution (V/m), 2.4 GHz frequency targeted, common mode.

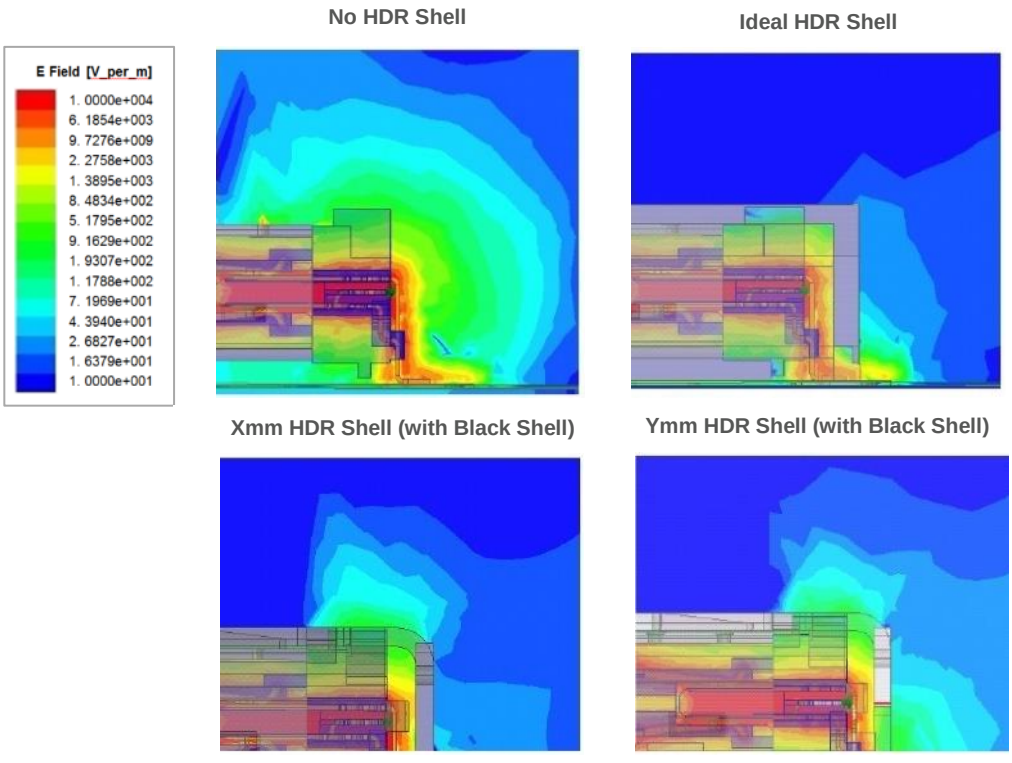
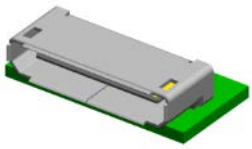


Figure 5. For simulation model, near-field distribution (V/m), 2.4 GHz frequency targeted, differential mode.

HSIO Receptacle Technology

Generally, HSIO technology uses a single row of SMT (surface-mount technology) pads and contacts attached at the PCB (printed-circuit board) end, referred to as the fixed connection. Typical pitch configuration is on a 0.4 mm fine pitch. Finer pitches may be possible and are currently being explored.



Receptacle with pads on tongue

The mated plug or receptacle interconnect (referred to as the separable connection) is then configured as a dual-row tongue/slot and typically uses a wider pitch. Plug and receptacle contact and pad pitches are typically 0.5 mm to 0.6 mm, and are designed for repeated alignment and reliable connections. These contact pitches can be tuned for subsequent performance requirements. In some cases, using a wider pitch may help achieve more effective cost targets while still enabling sufficient design margin for the ability to scale to next-generation products with little design refinement.

Plug with snout

Grounding is a key differentiator with this technology. Differential or single-ended pair grounding can be tailored as needed by combining and “weaving” ground pads within multiple signal pads and contacts. Combining power and ground is subsequently available as needed. Separating pad planes on the plug and receptacle’s mating tongue or slot between opposing rows is an additional key attribute. Figure 6 shows a typical wiring diagram of a HSIO receptacle.

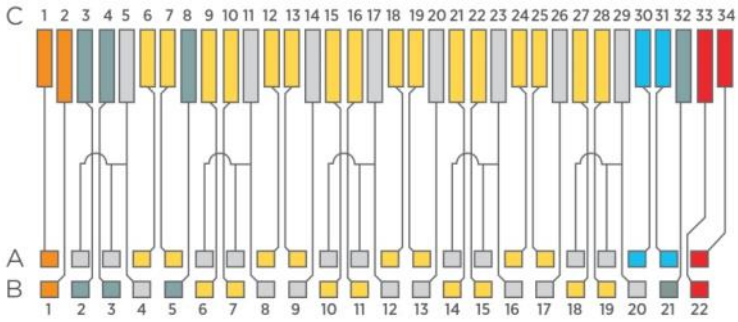


Figure 6. Typical receptacle wiring diagram.

In most cases, these interconnects are capable of meeting 10,000 mate/un-mate mechanical cycles. Electronic Components Industry Association (ECIA, formerly the Electronic Industry Association) industry standards are the typical protocol for product qualifications. Detailed product specifications will report final results accordingly. Gold plating in key areas is typical and can be specified as needed. Higher conductivity contact materials are always available for specific needs as required.

Conclusion

Meeting the needs of increasing data rates and smaller device form factors will continue to challenge copper inter-connect solutions. Copper-based solutions using these HSIO technologies will continue to be cost effective solutions into the foreseeable future.

Steve Figuerado is a field application engineer for the Data and Devices Division at TE Connectivity. He has more than 25 years of experience in product design on large-system impact printing and mid-range/X86 server computing/storage. He received his education in Mathematics and Mechanical Engineering at Austin Community College and Broome Community College in Texas.

Contributors: Jim McGrath, Dwip Shah, Takeshi Nakashima, Izumi Hasegawa, Calvin Feng, Noah Zhang

FOR MORE INFORMATION:

TE Connectivity Technical Support Center
USA: +1 (800) 522-6752
Canada: +1 (905) 475-6222
Mexico: +52 (0) 55-1106-0800
Latin/South America: +54 (0) 11-4733-2200
Germany: +49 (0) 6251-133-1999
UK: +44 (0) 800-267666
France: +33 (0) 1-3420-8686
Netherlands: +31 (0) 73-6246-999
China: +86 (0) 400-820-6015

For other country numbers, go to te.com/supportcenter

te.com

[DOCUMENT # 1-1773856-2]