

Built for the Field: Connectors for Agriculture

It's no surprise that smart technologies developed for automotive systems have made their way into off-highway vehicles. In agriculture, these innovations are powering a new generation of autonomous sprayers, precision planters, and drone-based monitoring systems, leveraging artificial intelligence (AI), big data, machine vision systems, and LiDAR to boost productivity and sustainability. This digital transformation depends on the seamless integration of interoperable software and hardware systems, with minimal human interaction. At the core of these systems are high-performance connectors, ensuring reliable data flow and scalable integration in harsh, real-world conditions.

KEY CONNECTIVITY AND CONNECTOR CHALLENGES FOR AGRICULTURE OEMS

Advanced sensors, real-time monitoring equipment, AI and machine learning algorithms, GPS and LiDAR navigation systems, standardized communication protocols, and robust actuators are all essential to the development of semi- and fully autonomous tractors, sprayers, planters, harvesters, and drones. Agricultural OEMs face significant technical, operational, and economic challenges when integrating these technologies into modern farm machinery.

Data Throughput & Signal Integrity

AI, machine vision systems, LiDAR, and other real-time systems generate large, continuous data streams. Real-time processing for smart seeding, crop health analysis, and autonomous navigation requires connectors with high data transmission rates and robust EMI shielding to ensure zero data loss or delays, especially under harsh operating conditions. The growing use of multiple high-resolution cameras and multi-sensor arrays further elevates these bandwidth requirements.

Miniature & Multi-Functional

As machinery becomes more compact, sensor-rich, and complex, OEMs benefit from high-density miniature connectors and/or hybrid solutions that combine signal and power into a single connector. These connectors support flexible system integration and upgrades, reducing weight, bulk, and installation complexity.

Rugged & Environmental Resistant

Connectors in agricultural equipment must be durable and withstand harsh field conditions, including vibration, heat, moisture, dust, and chemicals. They must also maintain stable electrical performance and signal integrity over time. Even though many

high-tech systems, such as GPS and LiDAR, are housed in hermetically sealed enclosures to protect against the elements, vibration remains a major design challenge.

Simplified Maintenance & Repairs

Maintaining autonomous systems with minimal human oversight is challenging, especially in unpredictable farming environments where downtime can disrupt operations. Connectors with quick-lock or push-pull mechanisms enable fast, tool-less servicing, improving reliability and reducing maintenance time.

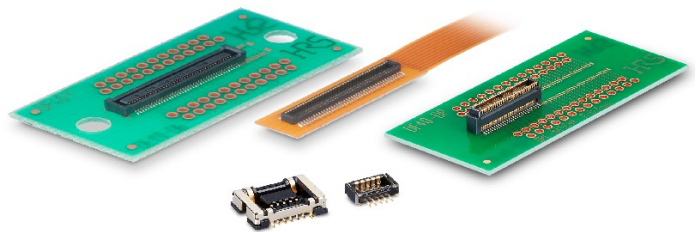
SOLUTION EXAMPLES

1. High-speed FPC-to-Board

High-speed connectors enable agricultural equipment to leverage AI, big data, machine learning, and cloud computing through rapid data transfer. These connectors are essential for real-time data collection, analysis, and decision-making in smart farming systems.

Connectors that support PCIe Gen4 signaling offer data rates of up to 16 Gbps—twice the speed of PCIe Gen3 (8 Gbps). Designed for high-speed performance, Hirose's [DF40T Series](#) PCIe Gen4 board-to-board and FPC-to-board connectors enable fast, reliable communication between CPUs (Central Processing Unit) and peripheral subsystems, making them ideal for next-generation electronic designs.

Designed for durability, the DF40T features a long, effective mating length for high contact reliability. Its space-saving design, heat resistance, and high-speed transmission capabilities simplify both design and assembly. The DF40T and DF40F also offer floating contact designs that absorb misalignment, providing flexibility when multiple board-to-board connectors are used on the same board.



2. Miniature Ethernet

The [ix Industrial connector](#) is 75% smaller than traditional RJ45 connectors, enabling space-saving integration in agricultural machinery in compact agricultural

machinery. Its unique shell design offers high PCB retention force and resistance to cable pulling and prying, ensuring reliable performance.

The 360-degree shield provides excellent protection against electromagnetic interference, critical for maintaining signal integrity in electrically noisy farm settings. Supporting Cat.5e (1 Gbps) and Cat.6A (10 Gbps) speeds, the ix Industrial delivers the high-speed data transfer needed for real-time image processing in machine vision systems.

Certified as a GigE Vision standard connector, the ix Industrial is ideal for machine vision cameras used in crop monitoring, pest detection, and harvest automation.

3. Circular

The [HR34B Series](#) circular connector is ideal for RTK-GNSS/GPS applications due to its compact size and robust construction. It fits easily into space-constrained agricultural equipment and withstands vibrations and impacts common in farming operations.

The HR34B is rated IP67/IP68 when fully mated, protecting against water and dust. Its push-on bayonet lock mechanism enables quick, secure connections, which is crucial for the efficient installation and maintenance of GPS guidance systems in the field.

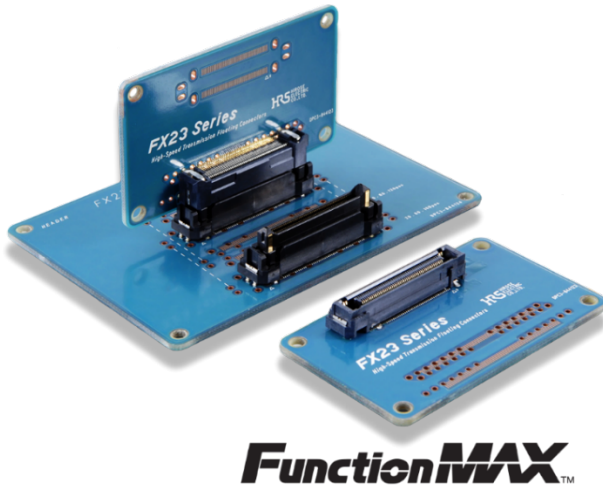


4. Micro Coaxial

Micro coaxial connectors, like the [U.FL-K Series](#), combine small size with high-frequency capability and low signal loss, making them well-suited for RTK-GNSS/GPS applications. These connectors are also highly durable and vibration-resistant, supporting stable connections in challenging agricultural environments.

5. Multi-functional

Many OEMs use compact hybrid solutions that combine power and signal in a single interface to simplify designs. The [FX23 Series](#), for example, supports high-speed



signal (up to 16 Gbps) and power delivery (3 A per pin with 4 dedicated power pins), making it ideal for complex agricultural applications.

The FX23 Series provides a versatile and reliable solution that supports the industry's shift towards highly integrated farming equipment. Like the DF40T and DF40F, it includes a floating contact design for flexible alignment in multi-connector layouts.

6. Rugged

Designed for high performance in harsh environments, the [LF Series](#) meets Cat.5e (1 Gbps) and Cat.6A (10 Gbps) requirements for fast data transmission. Its metal shell construction provides IPX7/IPX8 protection against water and dust.

A folded shield braid and contact springs offer superior EMI protection, maintaining signal integrity in electrically noisy farm environments. The bayonet locking system guarantees secure mating, even in high-vibration applications.

CONCLUSION

Modern autonomous and semi-autonomous agricultural equipment and precision agriculture equipment reflect a rapid digital transformation, reshaping the industry to meet demands for farming productivity and sustainability. Systems embedded with AI, big data, machine vision systems, and GPS have become the norm, enabling smarter, data-driven decision-making in the field. These technologies depend on the seamless flow of high-speed data, even under harsh environmental conditions.

Innovative, high-performance connectors from Hirose play a critical role in enabling this exchange —delivering the reliability, durability, and bandwidth required for today's precision systems. As autonomous farming continues to evolve, Hirose's cutting-edge connector solutions offer the speed, resiliency, and scalability needed to power the next generation of smart agricultural machinery.