ECHELON

ISO Standard FT Networking Delivers Superior Connectivity for IoT Devices

Free topology (FT) wiring provides a cost-effective networking solution, while addressing many of the limitations and complexities of RS-485

Overview

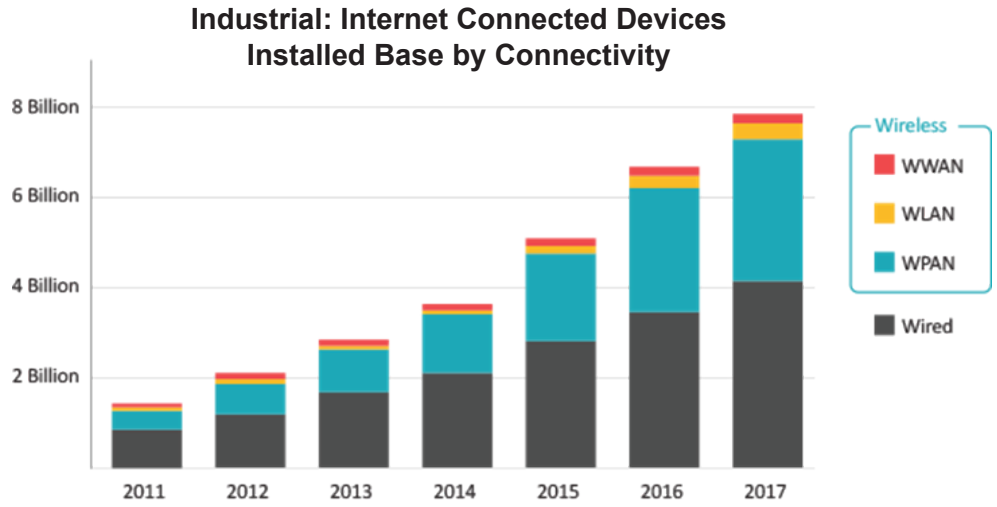
When comparing FT (ISO/IEC 14908-2) and RS-485 (EIA-485) networking, including the pros and cons of each technology, ease of installation, and total cost of ownership, the benefits of FT become abundantly clear. This paper is recommended for product developers considering RS-485 as their wired networking solution.

Introduction

Internet of Things (IoT) solutions developers face myriad decisions beyond simply defining a feature set. Recent studies have shown that only a quarter of IoT projects are successful. Well-informed hardware and application platform selections, including the networking protocol stack, can help IoT projects get off to a good start, but the choice of communication media is arguably one of the most critical decisions that must be made.

This paper addresses the major considerations for developers who want the increased reliability and security of wired versus wireless networking, and who are considering RS-485 as their wired solution. It compares FT (ISO/IEC 14908-2) and RS-485 (EIA-485) networking, exploring the pros and cons of each technology, ease of installation, and total cost of ownership.

The communication media and protocol selected for an IoT application typically dictates and limits the following system attributes: communication frequency and latency; topology and installation; number of devices supported; system reliability; system security; and device, installation and maintenance costs. A key decision is whether to use wired or wireless communication. In its paper *World Market for Connected Devices*, IHS forecast about a 50/50 split of the 8-billion device IoT market in 2017 (see chart).



Wireless communication is sometimes preferred to increase mobility and portability, for example to provide monitoring and control of IoT devices from a smart phone or tablet. Wired communication may be preferred to increase communication reliability and security, for example to provide control of fixed devices like variable air volume controllers, smart room speakers, or train brakes.

Smart wired IoT devices need these attributes: ease of installation; simple, reliable network communication; cost-effective local processing; flexibility and scalability; and low cost-of-ownership. Free topology twisted pair networking solutions deliver many practical benefits when compared to the more familiar RS-485 twisted pair networking, especially for today's increasingly rigorous requirements and expectations.

Free topology (FT) networking, defined by the international standard ISO/IEC 14908-2, has changed the landscape for companies developing solutions for applications ranging from building controls to gas pumps to automation equipment for dairy farms, industrial processes and transportation. Manufacturers have discovered they can save both time and money on new, easier to install product designs based on FT networking rather than on RS-485.

Ease of Installation

Installers and system integrators appreciate the benefits of systems built on forgiving platforms, and FT is far superior to RS-485 when considering the effort required to install devices.

Free topology is just that – free of the strict constraints of the linear bus topology required for RS-485. Free topology networks may be wired using bus, star, and loop topologies, or even a mixed combination of these. Even better, FT is polarity insensitive and requires only two wires, eliminating any possibility of miswiring network connections. It operates on inexpensive unshielded single twisted pair cable or ubiquitous Cat 5 cable, and is also compatible with shielded twisted pair cable for retrofit installations. FT may be terminated in just one place, with the termination located anywhere in the network. Finally, FT networks continue to operate even if there is a wiring or device fault. With these attributes, FT network installation and maintenance are fast, cost effective, and error free.

RS-485 requires skilled technicians for installation and troubleshooting. Costly shielded cable (usually three conductors plus shield), along with more connections per device and the need to maintain polarity, result in a high probability of wiring faults during initial network installation. In addition, RS-485 networks typically require two terminations, one at each end of the bus. Some RS-485 protocols such as BACnet MS/TP require token passing which causes an entire network to fail whenever there is a device or cable fault, and makes troubleshooting a painstaking process. RS-485 installations that omit the shield connection and only use two wires are extremely sensitive to ground-loop issues and are far less reliable than two-wire FT or three-wire RS-485.

The benefits of installing an FT network go beyond just topology. FT transceivers are always isolated and use a communication transformer to achieve isolation with a simple two-wire connection per device, ensuring robust communication. The RS-485 standard is designed to handle a -7V to +12V input range. In real world applications, ground potentials vary widely from node to node resulting in common-mode voltages beyond this range, such as +/-24V. Non-isolated RS-485 transceivers will often fail if common-mode voltages fall outside the -7V to +12V range. Isolated RS-485 transceivers are available that are tolerant to higher common-mode voltages, but are typically much more expensive than their non-isolated counterparts. These isolated RS-485 transceivers typically require an isolated signal common connection, which in turn requires a three-wire connection, further increasing the possibility of wiring faults and other problems that can be very difficult to diagnose and locate.

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Free topology networks also offer superior RF noise immunity to ensure better communication in environments with significant noise producers such as motors with variable frequency drives. Communication failures can occur for RS-485 transceivers that do not provide the RF immunity required by the commonly used EN 61000-4-6 Level 3 design standard. In harsh industrial environments, common mode RF noise may be injected into the twisted pair cable with a 10VRMS range, or 50.9V peak-to-peak range. If this occurs, it can be costly and time consuming to identify the source of the noise and design and install filters to compensate. FT transceivers meet the strict immunity requirements specified by EN 61000-4-6 Level 3.

Simple and Reliable Network Communication

A key attribute of many IoT devices is the need to efficiently exchange simple pieces of data. For example, an IoT temperature sensor only needs to report a single temperature value in Celsius or Fahrenheit per message, and an IoT light-level sensor only needs to report a single light-level value in Lux per message. FT technology supports ISO/IEC 14908-1 standard network communication to efficiently, reliably, and securely exchange data between individual things, groups of things, and between things and Internet cloud services.

In addition, FT supports network tools that can automatically assign addresses to network devices, speeding system configuration. RS-485 solutions typically require installers to set device addresses, requiring advance planning and careful execution. Incorrect addressing is yet another source of difficult-to-isolate system problems that create uncertainty and finger pointing, and increase project costs.

FT technology supports application messaging between devices so that messaging services for peer-to-peer communication can be provided that are similar to RS-485-based or IP-based messaging services. FT technology adds support for a simple data exchange service based on network variables, where exchanging a simple datapoint value on a network such as a temperature or light-level value is as easy as writing and reading a value within a traditional single-device application.

> “System-on-chip (SoC) components with integrated FT transceivers provide an elegant and economical solution that is ideal for simple products, including many edge devices.”

FT technology includes assured delivery services so that message and data exchanges are reliably delivered, and senders are notified if any messages or datapoint updates are not delivered as expected.

Cost-effective Local Processing

IoT device applications often require local processing. For example, readings from smart sensors must be filtered and normalized. Actuators often require some closed loop control that is optimally provided locally by the device attached to the actuator.

The most cost-effective way to implement a smart sensor or smart actuator is to handle all the application processing and network communication in the same processor used to read the sensor state or control the actuator state. System-on-chip (SoC) components with integrated FT transceivers (pictured at right) provide an elegant and economical solution that is ideal for simple products, including many edge devices.

Sometimes a second processor is required, or is more cost effective. A second processor may be needed to augment the processing power provided by a single-chip solution. Or, an existing product design may already have been implemented with a processor and application, and all that is required to transform it to an IoT device is a low-level transceiver to provide the wired network connectivity. FT technology supports cost-effective two-chip solutions where

the application and, optionally, the upper layers of the networking protocol stack run on one processor, and the FT chip is used as a simple network transceiver, optionally also running a networking protocol stack.

Flexibility and Scalability

Free topology networks can support up to 64 devices per twisted pair segment, twice as many as typical RS-485 networks, and the free topology and single termination anywhere in the network make them easy to expand. If the needs of a facility change, FT installers can simply tap into an FT network at any point to add devices, or add a branch at any point to support additional devices. Some RS-485 transceivers can support more than 32 devices per network, but the higher device count sometimes comes at the expense of shorter maximum cable lengths or slower speeds due to limitations of RS-485 signaling.

RS-485 network additions must maintain linear topology and terminations at both ends of the network, complicating expansion. If a device is added beyond the end of the network, the network termination at the end must be moved. While it is possible to scale installations, repeaters must be added if the network device limit will be exceeded. FT networks can also be scaled with repeaters. With the higher device limit, half as many repeaters are required for large FT installation than for large RS-485 installations.

> “. . . the installed cost of FT solutions is competitive compared to RS-485, and installers and owners are better served by more flexible and reliable solutions.”

Cost of Ownership

Factoring in labor and materials for installation and maintenance, the installed cost of FT solutions is competitive compared to RS-485, and installers and owners are better served by more flexible and reliable solutions.

While the initial component cost of network transceivers for FT technology may be slightly higher than the isolated RS-485 options that are sometimes used in the IoT market, the difference is far less than it once was thanks to newer low-cost FT chipsets. And once the cost of labor to install, troubleshoot and maintain the system is included, FT solutions frequently have a compelling advantage in total cost of ownership.

Conclusion

Savvy developers of a wide variety of IoT and other wired network devices have capitalized on FT solutions, providing improved and cost-effective capabilities for their customers. Whether or not their applications required interoperability, they found FT to be the best fit for wired device networking. As FT components costs come down and labor costs continue to increase, FT technology has reached the tipping point when compared to RS-485 in a cost-benefit analysis. With IoT system owners demanding robust control solutions, the time has come for OEMs and system integrators to embrace the benefits of FT networking.

Note: Please see comparison summary chart of FT and RS-485 on the following page.

Summary: FT vs. RS-485

FT (ISO/IEC 14908-2)		RS-485(EIA-485)
• Minimal installer expertise needed • Only 2 connections per device • Polarity insensitive	EASE OF INSTALLATION	• Requires skilled technician • Typically 3 connections per device (with isolated ground) • Must maintain polarity
• Choice of unshielded or shielded twisted pair, or low-cost CAT 5 cable • Lower installed cost with small premium on transceiver cost	COST OF INSTALLATION	• Requires costly shielded cable • Low transceiver cost • Locating installation faults offsets savings on equipment
• Individual faults do not degrade network performance • Electrically isolated • Conducted RF immunity; meets EN 61000-4-6 Level 3 standard	PERFORMANCE & RELIABILITY	• Vulnerable to total network loss upon fault • Susceptible to RF interference; varies per device
• Up to 64 network devices • Supports mixed topologies	FLEXIBILITY	• Up to 32 network devices • Options to extend to 256 • Requires linear bus topology
• Easy to expand	SCALABILITY	• Expansion requires extensive and expensive rewiring
• Ease of fault detection minimizes repair time and system down time	MAINTENANCE & TROUBLESHOOTING	• Difficulty in locating network faults extends repair time and increases down time

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