

How 10BASE-T1L Single-pair Ethernet Brings the Network Edge Closer with Fewer Cables



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Ethernet is all around us – from points of sale in stores, LED signage in stadiums and even some parts of the industrial automation process. Despite its ubiquity, however, there are areas where it has yet to achieve wide and consistent usage. In this article, I'll focus on one area in particular, long-distance (>1 km) two-wire networking at 10 Mbps, in remote industrial, building and process automation applications, like the field sensor in [Figure 1](#).



Figure 1. A Field Sensor That Can Use 10BASE-T1L Ethernet

There are several reasons why Ethernet hasn't "reached" these applications yet – most notably that until recently, there wasn't an Ethernet specification supporting this cable length. Without a defined specification, designers had to use existing Ethernet standards for some parts of network development and other methods for the remainder. But that approach creates several challenges, such as the addition of gateways to support the mix of protocols, which greatly increases system complexity.

There's also the challenge of cable usage, as standard Ethernet implementations, shown in [Figure 2](#), typically use two to four twisted-pair cables and are not designed for single-pair communications.

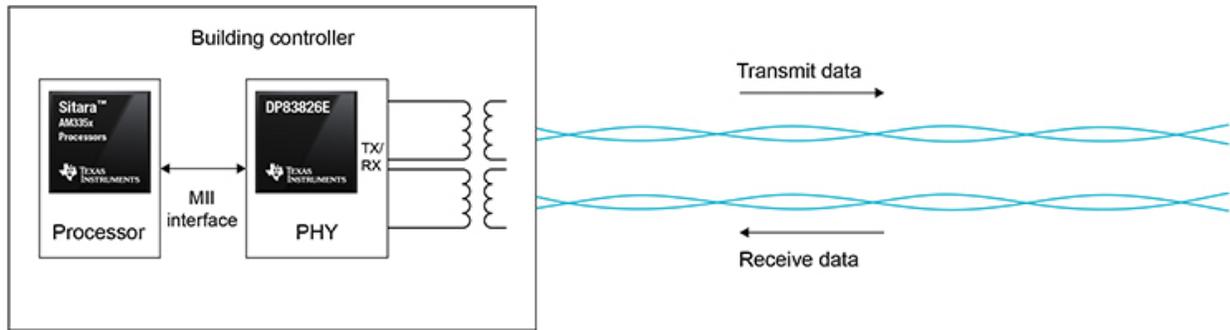
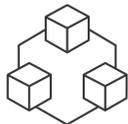


Figure 2. Standard Ethernet Interface for 10/100-Mbps Communications in a Building Control Application

Because many factory and building automation designers are likely already using existing single-pair fieldbus technologies, such as 4-to 20-mA current loops, Highway Addressable Remote Transducer, (HART) and Control and Communication (CC)-Link for long-distance applications, adding Ethernet to their network through protocol conversion could increase cable cost and weight.

Fortunately, single-pair Ethernet PHYs, especially those for the 10BASE-T1L standard, are designed to help engineers looking to increase the bandwidth of their industrial communications and unify their network under a single interface protocol without increasing cable costs or network complexity.

Transmit 10-Mbps Ethernet signals farther with a single cable



Meet the [DP83TD510E](#), an Ethernet PHY for the IEEE 802.3cg 10BASE-T1L specification. This device is designed to extend industrial communications up to 2 km in process, factory and building automation applications.

What is single-pair Ethernet?

At its most basic level, single-pair Ethernet is Ethernet over a single twisted pair of wires. The standard also enables the coexistence of power and data on a single pair of wires, which is referred to as power over data line.

The overall single-pair Ethernet specification comprises three different categories, shown in [Table 1](#).

Table 1. Single-pair Ethernet category specification requirements and associated TI Ethernet PHYs

Standards	IEEE 802.3cg 10BASE-T1L	IEEE 802.3bw 100BASE-T1	IEEE 802.3bp 1000BASE-T1
Bandwidth	10Mbps	100Mbps	1000Mbps
Cable reach specification	1,000 m (2.4 V p2p); 200 m (1 V p2p)	50 m	15 m
Power dissipation	<110 mW	<220 mW	<600 mW
Communication	Full duplex	Full duplex	Full duplex
Media Access Control interface	Media Independent Interface (MII), Reduced Media Independent Interface (RMII)	MII, RMII, Serial Gigabit Media Independent Interface (SGMII), Reduced Gigabit Media Independent Interface (RGMII)	RGMII, SGMII
Available TI PHY	DP83TD510E	DP83TC811	DP83TG720

The categories of single-pair Ethernet use the nomenclature “xBASE-T1.” 1-Gbps single-pair Ethernet is 1000BASE-T1, 100 Mbps is 100BASE-T1, and 10 Mbps is 10BASE-T1L or 10BASE-T1S, depending on its implementation. All three versions have a ratified Institute of Electrical and Electronics Engineers (IEEE) 802.3

specification associated with them. [Table 1](#) summarizes the key differences between each category. For the purposes of this discussion, we'll focus on 10BASE-T1L for longer-distance networking at 10 Mbps.

What are the key benefits of 10BASE-T1L single-pair Ethernet?

In addition to using fewer cables, single-pair Ethernet helps eliminate the need for protocol conversions and other interventions to enable fast, seamless data transfer between operator and edge node. This freedom of data transfer overcomes the challenges mentioned above and supports the large amounts of data needed for enhanced predictive maintenance and system health, safety and throughput.

Expanded connectivity enables the use of Ethernet networking from an app on any internet-connected device to the most remote edge node, such as a field transmitter or building controller, as shown in [Figure 3](#), without sacrificing distance or data rate. In some cases, it's possible to reuse existing wire harnesses when upgrading from some legacy fieldbus protocols.

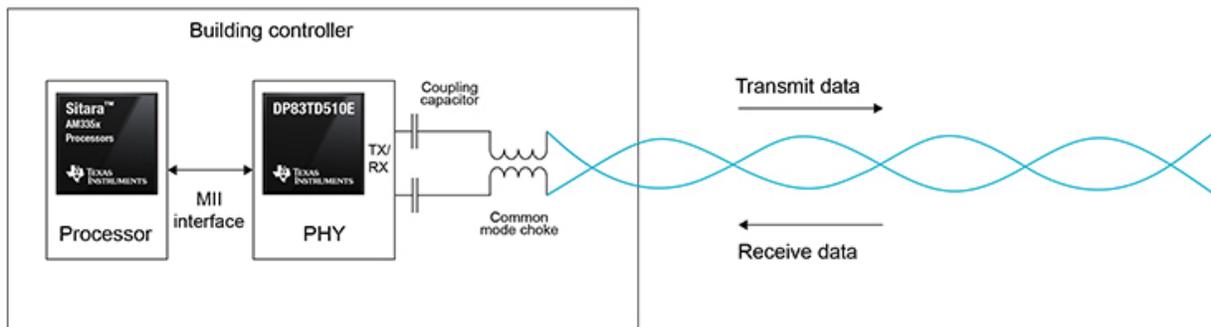


Figure 3. Single-pair Ethernet Interface for 10-Mbps Communications in a Building Controller

The low-power consumption of 10BASE-T1L single-pair Ethernet physical layers (PHYs) like the [DP83TD510E](#) leaves more room in the system power budget for other critical system components. This increased power efficiency matters, since it reduces overall operating costs and can potentially lead to lower carbon emissions. Low power consumption also helps support intrinsic safety implementations defined in the Ethernet Advanced Physical Layer specification by meeting that standard's external termination scheme. For more information on how the DP83TD510E helps designers extend their network cable reach, see the application note, "[Extend Network Reach and Connectivity with IEEE 802.3cg 10BASE-T1L Ethernet PHYs.](#)"

To see the DP83TD510E in action, watch our video, "[Long-distance connectivity: 10BASE-T1L single-pair Ethernet PHY demo.](#)" This demonstration shows how the DP83TD510E enables long-distance 10-Mbps communications between a water sensor and flood indicator.

With the development of IEEE 802.3cg, it's now feasible to transmit data faster and farther over one pair of twisted wires. This innovation enables designers to take Ethernet to the most remote edge node of a network and supports the same network protocol wherever they are located in the world.

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