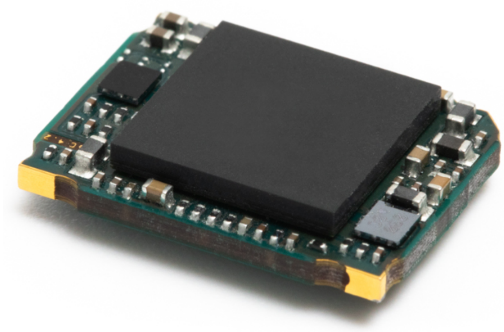
# periCORE

## Cable Performance



Application Note

Perinet
Seamless IoT Connectivity

**Abstract**

SPE, and 100BASE-T1 in particular, brings native IP connectivity to the compact sensors and actuators that previously relied on proprietary fieldbus systems. IEEE Std 802.3bw [6] specifies a nominal reach of 15m without shielding, a figure established for the automotive environment and its specific cabling and noise conditions. In practice, substantially greater distances are achievable with full link performance, even over legacy wiring.

This application note documents the measured reach of *periCORE* across a representative set of cable types found in commercial and residential buildings, from standard Ethernet and data-grade telephone wiring, over which the full 100 Mbit/s link reached up to **180**m, down to simple doorbell wire that still carried it **100**m.

The results confirm that existing wiring without shielding can be reused without new SPE-specific cabling, reducing project cost and installation effort, and serve as a practical planning reference for building automation and brownfield IIoT deployments.

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# Document Information

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# Contents

# 1 Introduction

Determining the cable reach of SPE links is essential for planning *periCORE* deployments over existing wire infrastructure. This application note documents the measured reach of *periCORE* over a representative set of cable types commonly found in commercial and residential buildings, so installers can assess whether the wiring already in place is suitable and over what span a reliable link can be expected. Most measurements were performed between two *periCORE* Development Boards [1] as link endpoints, and additional measurements used a *periMICA* [3] or a *periTUNNEL* [5] as one endpoint.

## 1.1 Single Pair Ethernet

Single Pair Ethernet (SPE) describes a single twisted pair of wires that is one aspect of the physical layer for an Ethernet based communication. The periCORE uses a point-to-point full-duplex communication scheme with 100Mbits/s throughput on the physical layer as specified by the IEEE [8]. Figure 1 shows conventional Ethernet compared to SPE on a simplified overview.

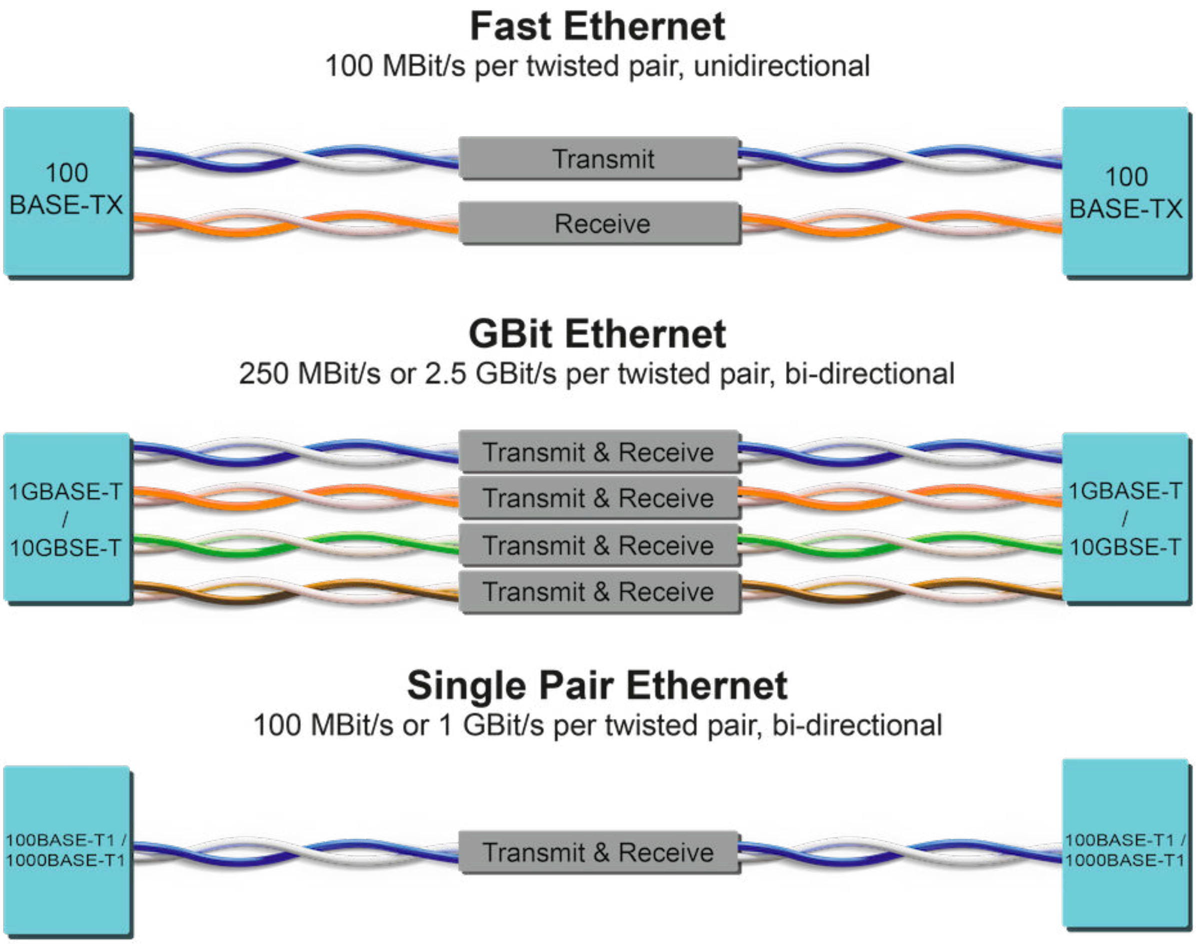


Figure 1: Single Pair Ethernet compared to other Ethernet technologies.

# 2 Reach Beyond the Specification

IEEE Std 802.3bw [6] defines the 100BASE-T1 physical layer for operation over a single balanced twisted pair, with a nominal reach of 15m. This figure was established for the automotive environment and reflects its specific cabling and noise conditions. In practice, and particularly in industrial and building environments, substantially greater distances are achievable with full link performance, even over legacy wiring. This makes 100BASE-T1 a compelling choice for building automation and brownfield IIoT applications.

A wide range of cable types already installed in buildings can carry 100BASE-T1 traffic without modification. Standard Ethernet cable is the most straightforward choice, but telephone cabling including ISDN and DSL subscriber lines, KNX bus cable, and even simple doorbell wire are all viable options. This eliminates the need for new SPE-specific cabling infrastructure, reduces project cost, shortens installation time, and avoids disruptive work on cable ducts or building fabric.

# 3 Performance Measurements

Reach measurements were performed over a representative set of cable types commonly found in commercial and residential buildings, connected between two *periCORE* Development Boards. For additional measurements on U/UTP Cat 5e (BC), one endpoint was replaced by a *periMICA* or a *periTUNNEL*. Throughput was verified using iperf2.

## 3.1 Tested Cable Types

**U/UTP Cat 5e (BC)** 24 AWG bare copper. 4 twisted pairs, solid copper[7]. Standard LAN cabling in offices, homes, and data centers. PoE-compatible.

**U/UTP Cat 5e (CCA)** 24 AWG Copper Clad Aluminum CCA. 4 twisted pairs, copper-clad aluminium core. Low-cost Cat 5e alternative with reduced reach. No PoE support and not compliant with cabling standards.

**KNX cable** J-Y(ST)Y 2×2×0.8 mm. Static shield, 2 twisted pairs. Power Hybrid variant available with additional 230 V load conductors in the same outer sheath. Originally an intercom and telephone signal cable, today widely used as KNX building automation bus. The Power Hybrid variant suits installation points that need bus and mains supply together.

**Data-grade telephone cable** j-2Y(ST)Y 2×2×0.6 mm. Static shield, star-quad (4 conductors). Developed as a higher-grade cable for ISDN and analogue subscriber lines. Today used for DSL/VDSL subscriber distribution and for doorbell wiring.

**Shielded Telephone cable** J-Y(ST)Y 2×2×0.6 mm. Static shield, 2 twisted pairs. Standard in-building telephone and ISDN installation cable. Common in older buildings, rarely installed new today.

**Telephone cable** J-YY 2×2×0.6 mm. Unshielded, star-quad (4 conductors). Older in-building telephone cable, predates shielded house wiring. Found in legacy installations only, no longer installed new.

**Doorbell wire** YV 2×0.6 mm. Unshielded, 2 conductors, solid copper, PVC insulation. Doorbell circuits and low-voltage SELV switching. Still widely installed today.

## 3.2 Test Setup

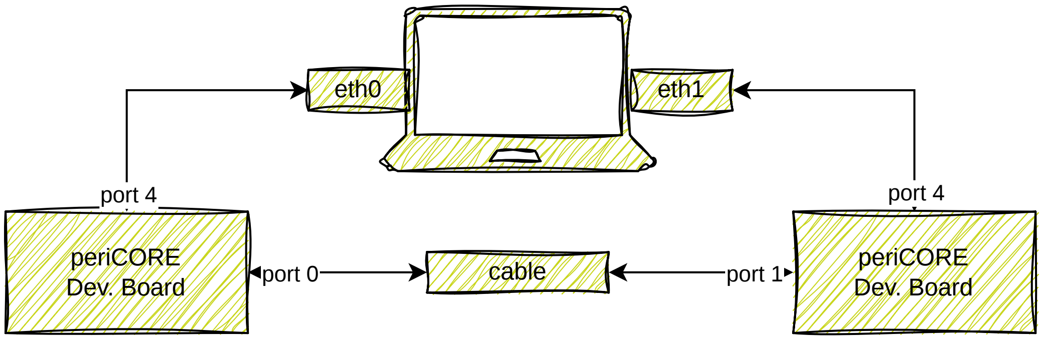


Figure 2: Test setup: two *periCORE* Development Boards connected over the cable under test.

Each *periCORE* Development Board exposes two SPE ports, PORT0 and PORT1, accessible via either the M8H DaughterBoard [2, Appendix B.1] or the Harting T1 Industrial Jack DaughterBoard [2, Appendix B.3]. The measurements in this application note were performed using the M8H DaughterBoard. The Harting T1 Industrial Jack DaughterBoard incorporates an integrated transformer; both daughterboards are otherwise interchangeable and achieve equivalent results. To ensure stable and reproducible measurements, the laptop used as the test host should be connected to a power supply rather than running on battery.

Figure 3: Physical setup of the two *periCORE* Development Boards and the DUT.

Cables can be terminated in two ways: soldered directly to the daughterboard, or terminated with an M8H connector and plugged into the daughterboard. LEDs D2 and D3 on the Development Board indicate link status. Link establishment on 100BASE-T1 is effectively binary. When a link is present, full throughput is available. When the cable exceeds the maximum reach for the given type, the link drops entirely.

## 3.3 periMICA and periTUNNEL Test Setup

The test setup for the additional devices was analogous to the setup described in Section 3.2, with one *periCORE* Development Board replaced by a *periMICA* or a *periTUNNEL*. The *periMICA* was configured as the PHY master. For the *periTUNNEL*, an RJ45-Clamp device was used and configured to SPE slave mode [4]. In both cases, the two endpoints were operated from the same power supply so that they share a common ground reference.

## 3.4 Throughput Measurements

Throughput was measured using iperf2 for both TCP and UDP. The script starts an iperf2 server bound to one *periCORE* interface, and then runs the client from the opposing interface.

```
# server
iperf2 -s -B <eth0>

# client
iperf2 -c <eth0> -B <eth1> -i 1 -t 60 -d
```

Listing 1: TCP throughput measurement commands.

```
# server
iperf2 -s -B <eth0> -u

# client
iperf2 -c <eth0> -B <eth1> -u -b 100M -i 1 -t 60 -d
```

Listing 2: UDP throughput measurement commands.

Both TCP and UDP were measured bidirectionally (`-d`), with interval reporting every second (`-i~1`) over a duration of 60 seconds (`-t~60`).

# 4 Results

## 4.1 Measured Reach between two periCORE Development Boards

| Reach | Cable type | Description |
|---|---|---|
| **180**m | U/UTP Cat 5e (BC) | 24 AWG bare copper. 4 twisted pairs, solid copper [7] |
| **180**m | Data-grade telephone cable | j-2Y(ST)Y 2×2×0.6 mm. Static shield, star-quad (4 conductors) |
| **140**m | U/UTP Cat 5e (CCA) | 24 AWG Copper Clad Aluminum CCA. 4 twisted pairs, copper-clad aluminium core [7] |
| **100**m | Doorbell wire | YV 2×0.6 mm. Unshielded, 2 conductors, solid copper, PVC insulation |
| **95**m | KNX cable | J-Y(ST)Y 2×2×0.8 mm. Static shield, 2 twisted pairs. Power Hybrid variant available with additional 230 V load conductors in the same outer sheath. |
| **75**m | Telephone cable | J-YY 2×2×0.6 mm. Unshielded, star-quad (4 conductors) |
| **60**m | Shielded Telephone cable | J-Y(ST)Y 2×2×0.6 mm. Static shield, 2 twisted pairs |

Table 1: Measured *periCORE* reach over existing cable types at 100 Mbit/s.

## 4.2 Endpoint Device Comparison

| Reach | Cable type | Link endpoints |
|---|---|---|
| **180**m | U/UTP Cat 5e (BC) | *periCORE* Development Board [1] ↔ *periCORE* Development Board |
| **170**m | U/UTP Cat 5e (BC) | *periTUNNEL* [5] ↔ *periCORE* Development Board |
| **90**m | U/UTP Cat 5e (BC) | *periMICA* [3] [1] ↔ *periCORE* Development Board |

Table 2: Measured reach on U/UTP Cat 5e (BC) with different link endpoints at 100 Mbit/s.

## 4.3 Cable Selection Guidelines

The 100BASE-T1 PHY is designed for a balanced link with a differential characteristic impedance of 100Ω. The reach a cable can achieve depends mainly on how closely and how stably it holds an impedance near this value up to about 66MHz. Where the impedance departs from 100Ω, part of the signal is reflected rather than delivered to the receiver, which together with the cable's attenuation limits the achievable distance.

A stable impedance comes from uniform, controlled construction: a constant conductor spacing and a regular twist along the full length, supported by a low-loss insulation material. Cables built for digital data services such as Ethernet, ISDN, and DSL are made to controlled-impedance specifications in this band and reach the furthest. Cables developed for analogue

[1] Measured with periMICA SPEC 00013 [3], with a 100BASE-T1 interface.

signalling, such as telephone interior wiring or KNX bus cable, were never characterised at these frequencies and reach correspondingly less far.

This gives a clear ordering. Standard Ethernet cable and the data-grade j-2Y(ST)Y both reach around 180m at 100 Mbit/s between two Development Boards (Table 1), and a cable of comparable data-grade quality can be expected to reach similar distances. The PVC-insulated J-Y(ST)Y and J-YY reach considerably less. For Cat 5e, conductor material matters: copper-clad aluminium (CCA) reaches measurably less far than bare copper (BC).

Doorbell wire does not have a standardised impedance, so it varies between products and the reach measured here should be treated as indicative.

# 5 Conclusion

The 15m nominal reach that IEEE Std 802.3bw [6] specifies for 100BASE-T1 is a value tailored to its original target domain, the automotive in-vehicle network. There, a link segment is short by design, and the engineering budget is spent on surviving the harsh electromagnetic environment of a vehicle and the connectors of a wiring harness rather than on distance. The 15m figure is therefore a domain-specific design point, not a physical limit of the technology.

In commercial and residential buildings, the constraints are different and the available cabling is far better behaved. As Figure 4 shows, *periCORE* sustained the full 100 Mbit/s link well beyond the automotive figure on every cable tested, reaching up to 180m over ordinary Cat 5e installation cable. Distances of this order are comparable to, and on data-grade cable exceed, the 100m channel that mainstream twisted-pair Ethernet physical layers such as 100BASE-TX and 1000BASE-T are built for. The cable runs encountered in a typical building installation are therefore unproblematic for SPE.

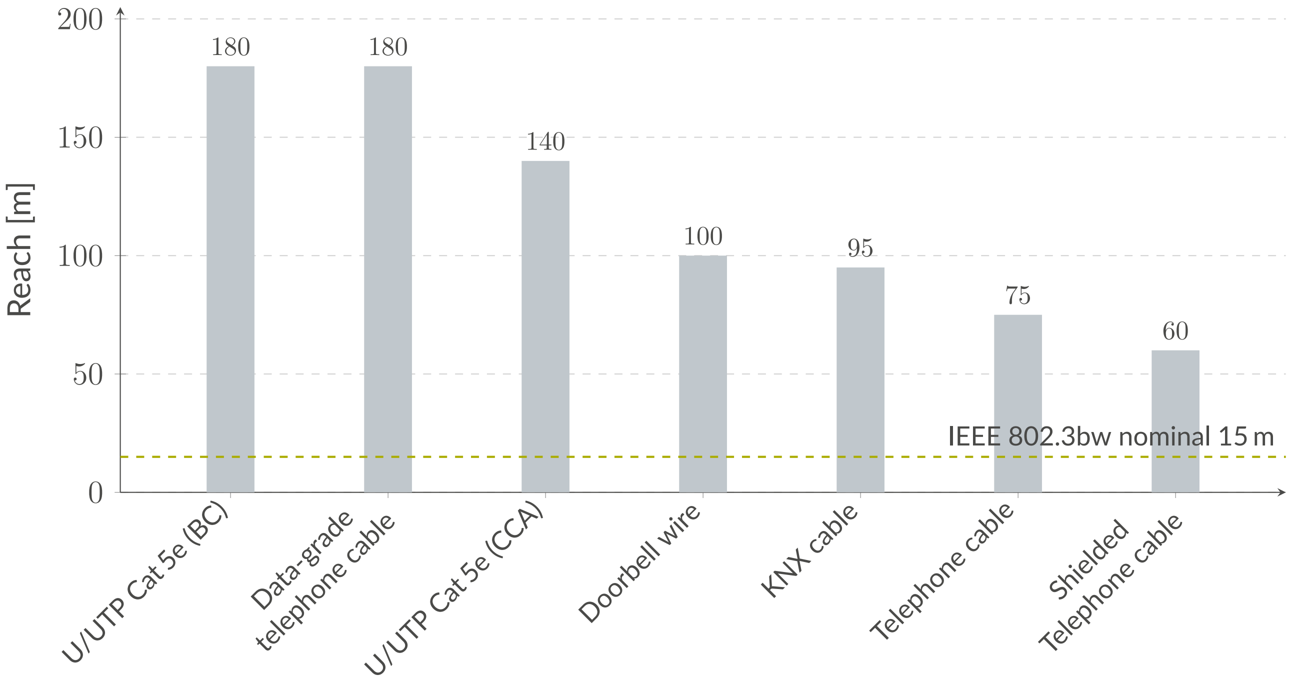


Figure 4: Measured *periCORE* reach by cable type at 100 Mbit/s, compared with the IEEE Std 802.3bw nominal reach of 15 m.

This headroom is not accidental. The 100BASE-T1 PHY carries data full-duplex over a single balanced pair, and to do so it actively separates the outgoing and incoming signals on that one pair using a hybrid coupler and an adaptive echo canceller. Combined with PAM3 line coding and an adaptive equaliser that compensates for the cable's frequency-dependent attenuation, these mechanisms let the receiver recover a clean signal even from wiring that was never characterised for high-frequency data transmission. It is this signal processing in the PHY that allows SPE to absorb the impedance discontinuities and additional attenuation of reused, non-optimal cabling and still close the link at the distances reported here.

# A List of Figures

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# D Glossary

**100BASE-T1** A Ethernet Standard where two endpoints are connected by a single twisted pair cable. It is one of the so-called Single Pair Ethernet (SPE) standards. It operates in full-duplex with a data rate of 100 MBit per second. Furthermore, it uses PAM-3 modulation with a voltage level from -1 to +1V, differentially on the two wires. 1, 5, 8, 10, 12

**DSL** Digital Subscriber Line, a family of technologies for transmitting digital data over telephone lines. 5, 6, 10

**full-duplex** In a full-duplex system, both parties can communicate with each other simultaneously. Transmitting or receiving of information is operated independently contrary to a half-duplex scheme.. 4

**IIoT** Industrial Internet of Things. 1, 5

**ISDN** Integrated Services Digital Network, a set of communication standards for simultaneous digital transmission of voice, video, data, and other services over traditional telephone circuits. 5, 6, 10

**KNX** A standardised (ISO/IEC 14543), open, vendor-neutral building automation bus for controlling lighting, heating, ventilation, and other building services. 5, 6, 10, 11

**PHY** Physical layer. Lowest layer of the OSI model. 10, 12

**SELV** Safety Extra Low Voltage. 6

**SPE** Single Pair Ethernet. 1, 4, 5, 7, 12

**TCP** Transmission Control Protocol. 9

**UDP** User Datagram Protocol, a connectionless transport-layer protocol. 9

**VDSL** Very High Speed Digital Subscriber Line, a high-speed variant of DSL. 6

# E References


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[6] "IEEE Standard for Ethernet Amendment 1: Physical Layer Specifications and Management Parameters for 100 Mb/s Operation over a Single Balanced Twisted Pair Cable (100BASE-T1)". In: *IEEE Std 802.3bw-2015* (2016), pp. 1–92. DOI: 10.1109/IEEESTD.2016.7433918.

[7] ISO/IEC. *Information technology — Generic cabling for customer premises — Part 1: General requirements*. International Standard. Geneva, Switzerland, 2017.

[8] "ISO/IEC/IEEE International Standard - Part 3: Standard for Ethernet - Amendment 1: Physical Layer Specifications and Management Parameters for 100 Mb/s Operation over a Single Balanced Twisted Pair Cable (100BASE-T1)". In: *ISO/IEC/IEEE 8802-3:2017/Amd 1:2017(E)* (2018), pp. 1–92. DOI: 10.1109/IEEESTD.2018.8310988.

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[11] Dr.-Ing. Karsten Walther. "Method for Identifying Network Services in a Network Having Internet-of-Things Network Subscribers". Pat. 102019126486.3. Perinet GmbH. https://patents.google.com/patent/EP4038863A1/en. Aug. 10, 2022. URL: http://v3.espacenet.com/textdoc?IDX=EP4038863.

# F List of Patents

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# G Contact & Support

For customer support, please call us at **+49 30 863 206 701** or send an e-mail to *support@perinet.io*.

For complete contact information visit us at www.perinet.io

# H Revision History

| Revision | Date | Author(s) | Description |
|---|---|---|---|
| 1 | 2026-06-30 | jalb, shoe | Initial Release |
| 2 | 2026-08-05 | jalb, shoe | Add measurements for periTUNNEL(Table 2), periMICA(Table 2) |