

IEEE Standard for Broadband over Power Line Networks: Medium Access Control and Physical Layer Specifications

Developed by the

Power Line Communications Standards Committee
of the
IEEE Communications Society

IEEE Std 1901™-2020
(Revision of IEEE Std 1901-2010)

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Approved

IEEE SA Standards Board

Abstract: Physical (PHY) and media access control (MAC) layers of a broadband powerline communication technology for local area networks (LANs), Smart Energy, Smart Grid, Internet of Things, transportation platforms (vehicle) applications, and other data distribution are defined in this standard. The balanced and efficient use of the power line communications channel by all classes of BPL devices is the main focus of this standard, defining detailed mechanisms for coexistence and interoperability between different BPL devices, and ensuring that desired bandwidth and quality of service may be delivered. The necessary security questions are addressed to ensure the privacy of communications between users and to allow the use of BPL for security sensitive services.

Keywords: access devices, adaptive power management, broadband over power lines (BPLs), coexistence protocol (CXP), convolutional turbo code, cosine modulated filter banks, extended ISP (E-ISP), fast Fourier transform orthogonal frequency division multiplexing (FFT OFDM), flexible channel wavelet (FCW) PHY/MAC, IEEE 1901™, in-home devices, Internet of Things (IoT), intersystem protocol (ISP), low-density parity check code (LDPC), medium access control (MAC), power line communication (PLC), physical layer (PHY), privacy, quality of service (QoS), security, sine modulated filter banks, wavelet orthogonal frequency division multiplexing (wavelet OFDM)

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Introduction

This introduction is not part of IEEE Std 1901-2020, IEEE Standard for Broadband over Power Line Networks: Medium Access Control and Physical Layer Specifications.

This revision gives users, in one document, IEEE Std 1901 for Broadband over Power Line Networks with all the amendments that have been published to date.

IEEE Std 1901 was developed on requirements collected from a large diversity of entities [semiconductors, integrators, consumer electronics (CE) companies, utilities, telcos, information technology (IT) companies, and transportation companies] that participated in the project. It provides a flexible architecture supporting integrated access, Smart Grid, building, in-home, and transportation platforms (vehicle) applications. It addresses a large diversity of topologies. It operates on physical media such as, but not limited to, electric power lines (AC or DC) and coaxial cables.

The physical layer (PHY) procedures specify either a wavelet orthogonal frequency division multiplexing (wavelet OFDM) or a fast Fourier transform orthogonal frequency division multiplexing (FFT OFDM) modulation scheme. It also specifies different modes for operations in different wavelet channels (frequency bands) with different values of carrier spacing (flexible channel wavelet FCW) for Internet of Things applications (IoTPLC).

The coexistence procedures allow the fair and efficient coexistence of the broadband over power line (BPL) systems. The intersystem protocol (ISP) enables various BPL systems to share power line communication resources in time (time domain multiplex), in frequency (frequency domain multiplex), or both.

Incorporating published amendments

The original standard was published in 2010. The current revision, IEEE Std 1901-2020, incorporates the following amendment into the 2010 revision:

- IEEE Std 1901a™-2019, IEEE Standard for Broadband over Power Line Networks: Medium Access Control and Physical Layer Specifications—Amendment: Enhancement for Internet of Things Applications.

Technical corrections, clarifications, and enhancements

In addition, this revision specifies technical corrections and clarifications to IEEE Std 1901™-2010. See Annex Z.

New clauses from 2010 revision to 2020 revision

Clause 17 and Clause 18 were added according to IEEE Std 1901a-2019.

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- 11, Multiple networks using the FFT PHY
- 12, PHY service specification
- 13, FFT physical layer
- Annex C.3, BT FFT TDMA scheduling example 3
- Annex G, (Informative) Priority mapping
- Annex I, (Informative) DSN in-home security—state transition diagrams
- Annex J, (Informative) DSN in-home security—test vectors
- Annex K, (Informative) Bridging and routing that use IEEE 1901 FFT stations as one or more of their portals
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- Annex M, (Informative) IEEE 1901 FFT and TIA-1113 coexistence
- Annex N, (Informative) Fair share between IEEE 1901 access and IEEE 1901 in-home using the same PHY
- Annex O, (Informative) IEEE 1901 access and IEEE 1901 in-home synchronization and interoperability
- Annex V, (Informative) Transmit spectrum mask example

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IEEE Standard for Broadband over Power Line Networks: Medium Access Control and Physical Layer Specifications

1 Overview

1.1 Scope

The scope of this standard is to define medium access control (MAC) and physical layer (PHY) specifications for high-speed (>100 Mb/s at the physical layer) communication devices via electric power lines, so-called broadband over power line (BPL) devices as well as lower speed Internet of Things communication devices. This standard uses transmission frequencies below 100 MHz. It is usable by all classes of BPL devices, including BPL devices used for the first-mile/last-mile connection (<1500 m to the premise) to broadband services as well as BPL devices used in buildings for local area networks (LANs), Smart Energy/Smart Grid applications, transportation platform (vehicle) applications, Internet of Things applications, and other data distribution (<100 m between devices). This standard focuses on the balanced and efficient use of the power line communications channel by all classes of BPL devices, defining detailed mechanisms for coexistence and interoperability between different BPL devices, and assuring that desired bandwidth and quality of service may be delivered. The standard addresses the necessary security questions to provide privacy of communications between users and allow the use of BPL for security-sensitive services. It is limited to the physical layer and the medium access sublayer of the data link layer, as defined by the International Organization for Standardization (ISO) Open Systems Interconnection (OSI) Basic Reference Model.

1.2 Purpose

New modulation techniques offer the possibility to use the power lines for high-speed communications. This new high-speed medium is open and locally shared by several BPL devices. Without an independent, openly defined standard, BPL devices serving different applications will conflict with one another and provide unacceptable service to all parties. The standard will provide a minimum implementation subset that allows fair coexistence of the BPL devices. The full implementation will provide interoperability among BPL devices, as well as interoperability with other networking protocols, such as bridging for seamless interconnection via IEEE Std 802.1X™-2020.¹ It is also the intent of this effort to progress quickly toward a robust standard so power line applications may begin to impact the marketplace. The standard also complies with electromagnetic compatibility (EMC) limits set by national regulators, so as to enable successful coexistence with wireless and telecommunications systems.

1.3 Protocols

The defined protocols provide connectivity over power lines to automatic machinery, equipment, or stations that are connected to power lines, including:

- Functions and services required by an IEEE-1901-conformant device to operate within networks as well as the aspects of station portability (relocation) within those networks.

¹ Information on references can be found in Clause 2.