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## Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks — Specific requirements —

Part 15-4:

## Wireless medium access control (MAC) and physical layer (PHY) specifications for low-rate wireless personal area networks (WPANs)

*Technologies de l'information — Télécommunications et échange d'information entre systèmes — Réseaux locaux et métropolitains — Exigences spécifiques —*

*Partie 15-4: Spécifications du contrôle d'accès du milieu sans fil (MAC) et de la couche physique (PHY) pour les réseaux personnels sans fil de faible débit (WPAN)*

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Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York • NY 10016-5997, USA
E-mail stds.ipr@ieee.org
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ISO/IEC/IEEE 8802 consists of the following parts, under the general title *Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks — Specific requirements*:

— *Part 15-4: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (WPANs).*

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IEEE Standard for
Information technology—
Telecommunications and information
exchange between systems—
Local and metropolitan area networks—
Specific requirements

# Part 15.4: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (WPANs)



IEEE Computer Society

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**IEEE Std 802.15.4™-2006**
(Revision of
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# IEEE Standard for Information technology— Telecommunications and information exchange between systems— Local and metropolitan area networks— Specific requirements—

# Part 15.4: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (WPANs)



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**Abstract:** IEEE Std 802.15.4-2003 defined the protocol and compatible interconnection for data communication devices using low-data-rate, low-power, and low-complexity short-range radio frequency (RF) transmissions in a wireless personal area network (WPAN). This revision extends the market applicability of IEEE Std 802.15.4, removes ambiguities in the standard, and makes improvements revealed by implementations of IEEE Std 802.15.4-2003.
**Keywords:** ad hoc network, low data rate, low power, LR-WPAN, mobility, PAN, personal area network, radio frequency, RF, short range, wireless, wireless personal area network, WPAN

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# Introduction

This introduction is not part of IEEE Std 802.15.4-2006, IEEE Standard for Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements—Part 15.4: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (WPANs).

This standard defines the protocol and interconnection of devices via radio communication in a personal area network (PAN). The standard uses carrier sense multiple access with collision avoidance (CSMA-CA) medium access mechanism and supports star as well as peer-to-peer topologies. The media access is contention based; however, using the optional superframe structure, time slots can be allocated by the PAN coordinator to devices with time critical data. Connectivity to higher performance networks is provided through a PAN coordinator.

This revision was initiated to incorporate additional features and enhancements as well as some simplifications to the 2003 edition of this standard. The standard now includes two optional physical layers (PHYs) yielding higher data rates in the lower frequency bands and, therefore, specifies the following four PHYs:

— An 868/915 MHz direct sequence spread spectrum (DSSS) PHY employing binary phase-shift keying (BPSK) modulation
— An 868/915 MHz DSSS PHY employing offset quadrature phase-shift keying (O-QPSK) modulation
— An 868/915 MHz parallel sequence spread spectrum (PSSS) PHY employing BPSK and amplitude shift keying (ASK) modulation
— A 2450 MHz DSSS PHY employing O-QPSK modulation

The 868/915 MHz PHYs support over-the-air data rates of 20 kb/s, 40 kb/s, and optionally 100kb/s and 250kb/s. The 2450 MHz PHY supports an over-the-air data rate of 250 kb/s. The PHY chosen depends on local regulations and user preference.

This revision also incorporates the following additions and enhancements to the 2003 edition:

— Adds support for a shared time base through the addition of a data time stamping mechanism
— Adds extensions of the 2.4GHz derivative modulation yielding higher data rates at the lower frequency bands
— Incorporates a mechanism for communicating the revision level on a frame-by-frame basis
— Adds support for beacon scheduling
— Allows synchronization of broadcast messages in beacon-enabled PANs
— Improves usage of security suite

Also, this revision incorporates the following changes and simplifications:

— Makes GTS support optional
— Removes restrictions for manually enabling the receiver
— Simplifies passive and active scan procedures
— Allows for more flexibility in the CSMA-CA algorithm
— Reduces association time in nonbeacon networks

This revision is backward-compatible to the 2003 edition; in other words, devices conforming to this standard are capable of joining and functioning in a PAN composed of devices conforming to IEEE Std 802.15.4-2003.

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### Errata

Errata, if any, for this and all other standards can be accessed at the following URL: http://standards.ieee.org/reading/ieee/updates/errata/index.html. Users are encouraged to check this URL for errata periodically.

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# IEEE Standard for Information technology— Telecommunications and information exchange between systems— Local and metropolitan area networks— Specific requirements—

# Part 15.4: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (WPANs)



## 1. Overview

### 1.1 General

Wireless personal area networks (WPANs) are used to convey information over relatively short distances. Unlike wireless local area networks (WLANs), connections effected via WPANs involve little or no infrastructure. This feature allows small, power-efficient, inexpensive solutions to be implemented for a wide range of devices.

This document defines a standard for a low-rate WPAN (LR-WPAN).

### 1.2 Scope

The scope of this revision is to produce specific enhancements and corrections to IEEE Std 802.15.4, all of which will be backwards compatible with IEEE Std 802.15.4-2003. These enhancements and corrections include resolving ambiguities, reducing unnecessary complexity, increasing flexibility in security key usage, considerations for newly available frequency allocations, and others.

IEEE Std 802.15.4 defines the physical layer (PHY) and medium access control (MAC) sublayer specifications for low-data-rate wireless connectivity with fixed, portable, and moving devices with no battery or very limited battery consumption requirements typically operating in the personal operating space (POS) of 10 m. It is foreseen that, depending on the application, a longer range at a lower data rate may be an acceptable tradeoff.

It is the intent of this revision to work toward a level of coexistence with other wireless devices in conjunction with Coexistence Task Groups, such as IEEE 802.15.2 and IEEE 802.11/ETSI-BRAN/MMAC 5GSG.

### 1.3 Purpose

The purpose of this revision is to extend the market applicability of IEEE Std 802.15.4 and to remove ambiguities in the standard. Implementations of the 2003 edition of this standard have revealed potential areas of improvements. Additional frequency bands are being made available in various countries that are attractive for this application space.

## 2. Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

FIPS Pub 197, Advanced Encryption Standard (AES).[1]

IEEE Std 802®, IEEE Standards for Local and Metropolitan Area Networks: Overview and Architecture.[2]

ISO/IEC 8802-2 (IEEE Std 802.2™), Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks — Specific requirements — Part 2: Logical link control.[3]

ISO/IEC 9646-7 (ITU-T Rec. X.296), Information technology — Open systems interconnection — Conformance testing methodology and framework — Part 7: Implementation conformance statements.



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