



IEEE Standard for Local and Metropolitan Area Networks— Part 15.7: Short-Range Optical Wireless Communications

Amendment 1: Higher Rate, Longer Range Optical Camera Communication (OCC)

IEEE Computer Society

Developed by the
LAN/MAN Standards Committee

IEEE Std 802.15.7a™-2024
(Amendment to IEEE Std 802.15.7™-2018)

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IEEE SA Standards Board

Abstract: The existing OCC physical layer of IEEE Std 802.15.7-2018 is amended with one PHY specification for a higher rate and longer range.

Keywords: amendment, higher rate, IEEE 802.15.7, IEEE 802.15.7a, longer range, OCC, optical camera communication, optical wireless communication, physical layer

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Introduction

This introduction is not part of IEEE Std 802.15.7a-2024, IEEE Standard for Local and Metropolitan Area Networks—Part 15.7: Short-Range Optical Wireless Communications—Amendment 1: Higher Rate, Longer Range Optical Camera Communication

This amendment adds new transmission modes with higher rates and longer ranges to IEEE Std 802.15.7-2018.

It also adds mobility support, long-range communication, multiple-input-multiple-output [e.g., multiple-input-multiple-output orthogonal frequency-division multiplexing (MIMO-OFDM)], and artificial intelligence-based (AI-based) PHY layer.

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NOTE—The editing instructions contained in this amendment define how to merge the material contained therein into the existing base standard and its amendments to form the comprehensive standard.

The editing instructions are shown in ***bold italic***. Four editing instructions are used: change, delete, insert, and replace. ***Change*** is used to make corrections in existing text or tables. The editing instruction specifies the location of the change and describes what is being changed by using strikethrough (to remove old material) and underline (to add new material). ***Delete*** removes existing material. ***Insert*** adds new material without disturbing the existing material. Insertions may require renumbering. If so, renumbering instructions are given in the editing instruction. ***Replace*** is used to make changes in figures or equations by removing the existing figure or equation and replacing it with a new one. Editing instructions, change markings, and this NOTE will not be carried over into future editions because the changes will be incorporated into the base standard.

3. Definitions, acronyms, and abbreviations

3.2 Acronyms and abbreviations

Insert the following acronyms to the list of subclause 3.2 in alphabetical order:

BPPM	bi-level pulse position modulation
HOOK-OFDM	hybrid on-off keying orthogonal frequency division multiplexing
HS2PSK-OFDM	hybrid spatial 2-phase-shift keying orthogonal frequency division multiplexing

MIMO-COOK	multiple input multiple output camera on-off keying
MIMO-OOK	multiple input multiple output on-off keying
O-NOMA	optical non-orthogonal multiple access
RS-OFDM	rolling shutter orthogonal frequency division multiplexing
SN	sequence number

4. General description

4.4 Architecture

4.4.1 PHY types

Insert the following new list item in 4.4.1:

- g) PHY VII: This PHY is intended for use with discrete light sources with a data rate up to 9.6 Mbps for Internet of Things (IoT) applications using a high-speed camera considering low mobility (<10 km/h), as defined in Table 79a.

4.4.1.1 PHY frame structure

Change the second paragraph of subclause 4.4.1.1 as indicated:

Use of over-the-air PHY frame configuration is forbidden for PHY IV, PHY V, ~~and~~ PHY VI, and PHY VII. It is mandatory that PHY frame configuration be done via the PHY PAN information base (PHY PIB). This is due to the fact that unlike traditional wireless local area networks (LANs) and personal area networks (PANs), the data rates associated with optical camera communications (OCC) are such that the configuration overhead cannot be tolerated. In other words, there is no “base default” transmission mode. In addition, it is anticipated that the configuration will be with application layer “APPs” that are specifically loaded to support a particular OCC PHY mode. The PHY PIB is not transmitted; rather, it is written by the DME and is read by the PHY.

4.4.1.2 Interoperability and coexistence between PHY types

Change the first paragraph of subclause 4.4.1.2 as indicated:

The PHY types coexist but do not interoperate. PHY I and PHY II occupy different spectral regions in the modulation-domain spectrum, which enables frequency division multiplexing (FDM) as a coexistence mechanism, as shown in Figure 4. PHY I and PHY III also occupy different spectral regions in the modulation-domain spectrum, with different data rates and different optical rate support, providing coexistence. However, the optical clock frequencies used for PHY II and PHY III overlap, causing significant overlap in the frequency domain spectrum. In addition, not all devices support the multiple optical frequency bands needed for PHY III. Hence, all PHY III devices shall use a PHY II ~~device for device-discovery mode~~ to support coexistence with PHY II. PHY IV, PHY V, ~~and~~ PHY VI, and PHY VII are spectrally located below PHY I and use highly directive receivers (e.g., cameras) to coexist via spatial division multiplexing.

Replace Figure 4 with the following:

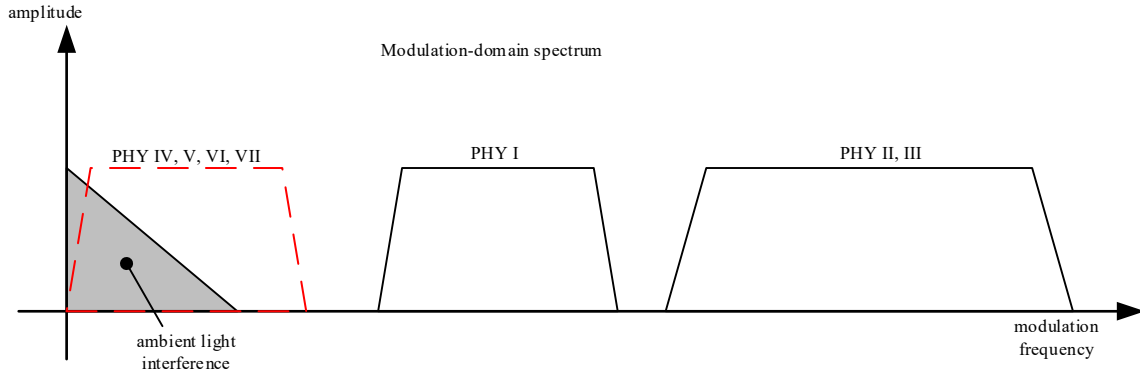


Figure 4—FDM separation of the PHY types in the modulation domain

4.8 Some media access mechanisms by PHY types

Insert the following list items in 4.8 following item “Invisible data embedding (IDE)”:

- Rolling shutter orthogonal frequency division multiplexing (RS-OFDM)
- Multiple input multiple output camera on-off keying (MIMO-COOK)
- Optical non-orthogonal multiple access (O-NOMA)
- Multiple input multiple output on-off keying (MIMO-OOK)
- Hybrid on-off keying-orthogonal frequency division multiplexing (HOOK-OFDM)
- Hybrid spatial 2-phase-shift keying-orthogonal frequency division multiplexing (HS2PSK-OFDM)
- Bi-level pulse position modulation (BPPM)

5. MAC protocol specifications

5.1 MAC functional description

5.1.2 Starting an OWPAN

5.1.2.4 Device discovery

Change the title of subclause 5.1.2.4.2 and the contents as follows:

5.1.2.4.2 PHY IV, PHY V, ~~and PHY VI, and PHY VII~~

Device types PHY IV, PHY V, ~~and PHY VI, and PHY VII~~ are not interoperable.

5.2 MAC frame formats

Change the fourth paragraph of subclause 5.2 as indicated:

Use of over-the-air MAC frame configuration shall not be done for PHY IV, PHY V, ~~and PHY VI, and~~ PHY VII, which shall accomplish MAC frame configuration via the MAC PIB. There shall be no “base default” transmission mode for PHY VI, ~~and PHY VII~~. The MAC PIB shall not be transmitted; rather, it shall be written by the DME and shall be read by the MAC sublayer.

5.2.1 General MAC frame formats

5.2.1.1 Frame Control field

Insert the following new subclause 5.2.1.1.5 after subclause 5.2.1.1.4 as follows:

5.2.1.1.5 PHY VII

The frame control field shall be present when the MIMO-OOK PHY is used and shall be omitted otherwise. The MIMO-OOK Frame Control field shall be formatted as illustrated in Figure 50a.

Bits: 0-2	3	4	5	6	7
Frame type	Reserved	Security Enabled	Frame Pending	Destination OWPAN Address	Source OWPAN Address

Figure 50a—Format of the MIMO-OOK Frame Control field

- a) **Frame Type subfield.** This field shall be set to one of the nonreserved values listed in Table 10a.

Table 10a—Values of the MIMO-OOK Frame Type subfield

Frame type value b2 b1 b0	Description
000	Beacon
001	Data
010	Command
011–111	Reserved

- b) **Security Enable subfield.** The Security Enabled subfield shall be set to one if the frame is protected by the MAC sublayer. This subfield shall be set to zero otherwise.
- c) **Frame Pending subfield.** The Frame Pending subfield shall be set to one if the device sending the frame has more data for the recipients. Otherwise, this subfield shall be set to zero. The Frame Pending subfield shall be used only with a Data frame. For synchronization frames, the Frame Pending field shall be set to zero.
- d) **Destination OWPAN Address subfield.** If the Destination OWPAN Address is zero, then the Destination Address field of the generic MAC header shall not be included.
- e) **Source OWPAN Address subfield.** If the Source OWPAN Address is zero, then the Source Address field of the generic MAC header shall not be included.

5.2.1.2 Sequence Number field

Insert the following new subclause 5.2.1.2.5 after subclause 5.2.1.2.4 as follows:

5.2.1.2.5 PHY VII

The Sequence Number field shall not be used except in the MIMO-OOK PHY mode.

The Sequence Number field is one octet in length and specifies the sequence identifier for the frame.

5.2.1.3 Destination OWPAN Identifier field

Delete subclauses 5.2.1.3.2 through 5.2.1.3.4.