IEEE 802.15
Wireless Specialty Networks

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| IEEE P802.15.13Text proposal for clause 9 |
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Abstract

# This document contains proposed text for clause 9 of IEEE P802.15.13.

# PHY services

This clause specifies the services provided by the PHY to the MAC layer. Implementations are expected to tightly integrate the MAC and PHY. Hence, the interfaces to the PHY, i.e. the PD- and PLME-SAP are usually not exposed by a standards-compliant chip, thus being specified in an abstract way.

The PHY is responsible for the following tasks:

* Activation and deactivation of the OWC transceiver
* Data transmission and reception
* Channel estimation for received frames
* Error correction
* Synchronization

Moreover, this subclause specifies requirements that are common to all of the IEEE 802.15.13 PHYs.

Constants and attributes that are specified and maintained by the PHY are written in the text of this clause in italics. Constant attributes have a general prefix of “a”, e.g., aMaxPHYFrameSize, and are listed in XXX. Variable attributes have a general prefix of “phy”, e.g., phyCCAMode, and are listed in XXX.

## PD-SAP

The PD-SAP constitutes a logical interface for requesting PSDU transmissions from the PHY at the MAC layer and indicating PSDU receptions to the MAC layer from the PHY layer. The PD-SAP is not explicitly specified within this standard but assumed to be vendor-internal.

In order to refer to different generic functions of PHYs in the MAC, the subsequent clauses describe specific functions and properties of PHYs during transmission and reception. This is required to refer to certain functionality of different PHYs on the MAC layer without knowing the PHY’s specifics.

### PHY MCS

IEEE 802.15.13 PHYs are able to apply different MCS to transmissions of PSDUs. The MAC selects the MCS to use for every PSDU transmission through the PD-SAP.

Each PHY defines a base MCS, which is used to transmit specific frames such as the beacon or RA control frames. The base MCS should be the most robust MCS in order to reliably convey control information between two MACs.

### Receive timestamping

Each PHY shall be able to take a timestamp based on a device-local clock at the start of the reception of the preamble of a PPDU. The timestamp serves the MAC for synchronization if needed.

### Multi-OFE channel estimation

Some PHYs support concurrent channel estimation between a multiple transmitters and a single receiver. This is achieved by simultaneously transmitting signals from the transmitters which overlap in time and space at the receiver. However, distinct channel estimation is still possible through pilot symbol design and assigning the transmitters different orthogonal “divisions” of the pilot signal. Pilot symbol design may involve assignment of different parts of the spectrum or different spreading codes per division for example.

Multi-OFE pilots have, in contrast to conventional pilots, more than one division. Supporting PHYs in this standard support up to 32 orthogonal divisions. Furthermore, a single PPDU may include up to 7 sequential multi-OFE pilot symbols.

A coordinator supporting the *capMultiOfeEstimation* capability shall support the transmission of Multi-OFE channel estimation pilots. For a given PPDU, which is designated by the MAC to contain multi-OFE pilots, a PHY receives through the PD-SAP the division and symbol position of the requested pilot.

A device supporting the *capMultiOfeEstimation* capability shall support measuring the channel from multiple simultaneous transmitters based on multi-OFE pilots. The measured CSI shall comprise the received signal strength from every transmitter (OFE) for all relevant taps, as well as the delay for all taps.

### Multi-OFE transmission

The MAC may instruct the PHY layer to transmit a single PSDU over multiple optical frontends. This is commonly the case in the MIMO star topology. The addressing of individual OFEs is a realization-detail and out of scope of the standard.

## PLME-SAP

The PLME-SAP constitutes a logical interface to invoke management functions on the PHY from the MAC layer. The PLME-SAP is assumed to be vendor-internal and is hence not specified within this standard. The PLME-SAP primarily exposes PHY PIB attributes to the MAC, through whose MLME primitives values for the PIB attributes shall be read- and writable by the DME. These PHY PIB attributes are listed in 9.2.1.

### PHY PIB Attributes

PHY PIB attributes determine the behavior of the PHY during transmissions and receptions, analogously to what MAC PIB attributes do for the MAC. In order to make attributes accessible from the DME, PHY PIB attributes can be read or written via the MLME-GET and MLME-SET primitives. The get / set column indicates whether an attribute can be read (get) or written (write) through the MLME-SAP

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| **Name** | **Description** | **get/set** | **Range** | **Unit** |
| *phyTxDelay* | The exact time between starting the transmission of a PSDU on the MAC sublayer and transmission of the first PPDU signal sample at the point of transmission. | get | [1, 65535] | µs |
| *phyRxDelay* | The exact time between receiving the first sample of the PPDU preamble and the instant in time when the complete PSDU is available to the MAC sublayer. | get | [1, 65535] | µs |
| *phyMaxPsduSize* | The maximum supported PSDU size. This attribute is PHY-specific. | get | [1, 65535] | octets |
| *phyMultiOfeDivisions* | The number of orthogonal pilot divisions (e.g. subcarrier spacings or Hadamard codes). This attribute shall be present if the device implements the *capMultiOfeEstimation* capability. | get | [1, 32] | distinct orthogonal pilots |
| *phyMultiOfeSymbols* | The number of consecutive additional channel estimation symbols supported by the PHY. This attribute shall be present if the device implements the *capMultiOfeEstimation* capability. | get | [0, 7] | symbols |

Table : PHY PIB attributes

## PHY requirements

This clause lists requirements on standard-compliant PHY implementations.

### Optical mapping

A high switching level from the PHY, applied to the light source, shall result in a high radiated intensity. A low switching level from the PHY, applied to the light source, shall result in a reduced radiated intensity. The extinction ratio, defined as the ratio of the high radiated intensity to the low radiated intensity, is at the discretion of the implementer.

### Optical frontend characteristics

If multiple optical frontends are used for transmission to a single optical receiver, it is recommended that the optical frontends have similar frequency responses in order to improve joint signal quality at the receiver. The digital input to all the optical sources from the PHY shall be synchronized in frequency and timing to at least XXX.

### Transceiver timing

If a PHY operates in time division half-duplex mode, it may require a certain time to switch between transmit and receive mode. Each PHY states its required turnaround time so the MAC is able to regard for it.

Each PHY shall be able to receive PPDUs back-to-back. Hence, PHYs are expected to be able to process the second of two subsequently received PPDUs without any time between the last signal part of the first PPDU and the first signal part of the second PPDU. Hence, PHYs do not require any inter-PPDU space at the receiver.