## 32.3.2 LC Common Mode

### 32.3.2.1 Introduction

The LC common mode PHY is based on the OFDM PHY in 17. In the following, the differences to the OFDM PHY in Clause 17 are described.

All LC STAs should support the mandatory features defined in Clause 17, except:

17.3.8.4 – Operating channel frequencies

17.3.8.5 – Transmit and receive in-band and out-of-band spurious emissions

17.3.9.3 – Transmit spectrum mask

17.3.9.7.2 – Transmitter center frequency leakage

17.3.10.3 – Adjacent channel rejection

17.3.10.4 – Nonadjacent channel rejection

### 32.3.2.2 CM Mode-specific service parameter list

TXVECTOR is the same as in section 17.2.2.

RXVECTOR is the same as in section 17.2.3, except that the parameters RX\_ANTENNA, CH\_BANDWIDTH \_IN\_NON\_HT and DYN\_BANDWIDTH \_IN\_NON\_HT are not used.

TXSTATUS is the same as in section 17.2.4.

### 32.3.2.3 CM PHY

### 32.3.2.3.1 Introduction

The CM PHY should be the same as in 17.3 except for the data scrambling which is described in **32.3.2.3.2 PHY DATA scrambler and descrambler**, the light interface, which is described in **32.3.2.3.3 Light Interface**, operation specification in 32.3.2.3.4 PHY operating specifications (general).

The CM PHY may also support a Relayed CCA mechanism to aid the channel sensing in light communications which is described in 32.3.2.5 Relayed CCA mechanism.

### 32.3.2.3.2 PHY DATA scrambler and descrambler

Unlike the text in section 17.3.5.5, the scrambler seed should be initialized with a pseudorandom nonzero value. It should not convey any information.

#####

### 32.3.2.3.3 Light Interface

Figure 1 illustrates how a light emitting diode (LED) is connected to the TX OFDM PHY and a photo diode (PD) to the RX OFDM PHY.



Figure 1: Interfacing OFDM PHY to light emitter and receiver

In the TX chain, the I and Q samples from the baseband should be quadrature modulated, see 32.3.2.3.4 for center frequencies. A DC bias is added before the signal is fed to the LED because the current through a diode can only be positive as illustrated in Figure 2.



Figure 2: Operation of LED with DC bias

In the RX chain, the light variations produced by the LED are converted into a current by a photo diode (PD) and amplified by a transimpedance amplifier (TIA). The DC component is removed, the signal should be downconverted to baseband and fed to the RX OFDM PHY.

### 32.3.2.3.4 PHY operating specifications (general)

### 32.3.2.3.4.1 General

The operating specifications should be the same as in section 17.3.8 except for the changes made to support LC in the following sub-clauses. In addition, 17.3.8.5 is not required in the LC CM PHY.

### 32.3.2.3.4.2 Outline description

The outline should be the same as in section 17.3.8.2. In Figure 17-12 the antennas should be replaced by optical frontends (OFE)s, for example as described in document IEEE 802.11-19/0087r1.

### 32.3.2.3.4.3 Regulatory requirements

The IEC 60825-1 laser eye safety regulations should apply to all LC devices.

### 32.3.2.3.4.4 Operating channel frequencies

The LC common mode should operate at a center frequency of 26 MHz. The common bandwidth should be

20 MHz. This centre frequency should correspond to LC channel 0.

### 32.3.2.3.4.5 CCA requirements

### 32.3.2.4 OFDM PLME

This should be the same as in section 17.4, except that the parameter “dot11RegDomainsImplementedValue” in Table 17.20 does not apply to the LC Common Mode.

### 32.3.2.5 Relayed CCA mechanism

Due to the nature of light communications, the CCA mechanism may not work on STA side. The relayed CCA mechanism could work with the assistance of the AP. In general, the AP could detect the transmission from any STA as described in **32.3.2.3.**4**.**5 **CCA requirements**. Then, the AP may disseminate the channel occupation information among the STAs within its coverage.

When the AP receives a transmission from a STA or transmissions from multiple STAs, it may retransmit the received packet if it does not have any packet in its queue. The retransmission would be a broadcast to all the STAs within its range, so that the STAs may be able to obtain the occupation status of the uplink channel from the assistance of the AP. STAs that successfully receive the retransmission from the AP would mark the medium ‘busy’ as in the CCA mechanism, except the sender(s) who are using the uplink channel.

When the AP has a packet to transmit, it stops the retransmission in the relayed CCA mechanism, and switches to the transmission of the new packet immediately.

Figure 3 illustrates an example of channel access with relayed CCA mechanism. The AP may retransmit packet received from STA1 and STA2 on the downlink channel. Other STAs could mark the uplink channel as ‘busy’ in the CCA.indication in order to avoid the collisions on the uplink channel. The AP could switch from retransmission of received packet to its own queue as shown in the example of Packet 3 and 4’s switch.

Figure 3 An example of channel access with relayed CCA mechanism

**AP**

**STA1**

**STA2**

Packet 1

Retransmission

Packet 1

Backoff

Relayed CCA Busy

Packet 2

Packet 3

Retransmission Packet 3

Relayed CCA Busy

Delay (ns)

Delay (ns)

Delay (ns)

## 32.3.3 LC High Efficiency (HE) Mode

### 32.3.3.1 Introduction

The LC HE Mode PHY should be based on the HE PHY in Clause 27. In the following, the differences to the HE PHY in clause 27 are described.

### 32.3.3.2 LC HE PHY service interface

The LC HE PHY service interface should be the same as in 27.2 except for the following fields which should be set to zero,

1. BEAMFORMED
2. BEAM\_CHANGE

because beamforming is not supported.

### 32.3.3.3 LC HE PHY

The subclause should be the same as section 27.3 except for the light interface which is described in **32.3.3.3.1 Light Interface**, the channel numbering which is described in **32.3.3.3.2 Channel numbering**, regulatory requirements as described in **32.3.3.3.3 Regulatory Requirements**.

In addition, the following subclauses in 27.3 may not apply to LC HE PHY:

27.3.16 — SU-MIMO and DL MU-MIMO beamforming

27.3.23 — Channel numbering

The LC HE PHY should support the Relayed CCA mechanism as described in 32.3.2.5 Relayed CCA mechanism.

### 32.3.3.3.1 Light Interface

### 32.3.3.3.1.1 Introduction

The light interface should be an extension of the light interface described in **32.3.2.3.3**  to multiple TX and RX streams.

### 32.3.3.3.1.2 Multiple transmitters and receivers

Figure 4 shows multiple LEDs connected to the TX baseband and Figure 5 shows multiple PDs connected to the RX baseband.

The LEDs may all operate at the same wavelength or at different wavelengths.

The TX baseband outputs should be all quadrature modulated to the same common center frequency, see **32.3.3.3.2 Channel numbering** for details.



Figure 4: Connecting multiple LEDs to TX baseband



Figure 5: Connecting multiple PDs to RX baseband

### 32.3.3.3.2 Channel numbering

The centre frequencies and channel numbering depending on the channel bandwidth are shown in Table 1.

Table 1: Channelization



### 32.3.3.3.3 Regulatory Requirements

The IEC 60825-1 laser eye safety regulations should apply to all LC devices.

### 32.3.3.4 LC PHY PLME

This section should be the same as section 27.4 except the following changes.

A new value for the PHY MIB attribute “dot11PHYType” should be introduced, LC. LC indicates an LC PHY with the light interface described in **32.3.3.3.1 Light Interface**.

### 32.3.3.5 Parameters for HE-MCSs

This section should be the same as section 27.5.

### 32.3.3.6 Parameters for HE-SIG-B-MCSs

This section should be the same as section 27.6.