EEE LPI Signaling

Contribution to IEEE 802.3cy

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Introduction

- Previous contributions jonsson_majomard_3cy_01_05_03_22 jonsson_zimmerman_majomard_3cy_01a_05_17_22, and jonsson_etal_3cy_01b_05_24_22 suggested changes to the excising EEE text to help clarify the transition to quiet mode

- This presentation proposes specific changes to the LPI Signaling text

Proposed Text Changes

Proposed Updates for the 802.3cy EEE Text

Change the text in 165.3.6.2 to

During the quiet period the PCS transmitter shall pass zeros to the PMA via the PMA_UNITDATA.request primitive. The receiver should ignore transmissions during first 150 ns following the transition to the quiet period and ignore other transmissions outside of the specified refresh and ALERT intervals.

Proposed Updates for the 802.3cy EEE Text

Change the text in 165.4.3.1 to

The symbols to be transmitted by the PMA are denoted by tx_symb. PMA Transmit generates a pulse-amplitude modulated signal on each pair in the following form:

$$s(t) = \sum_{n=0}^{\infty} a_n h_T(t - nT) \qquad (165-12)$$

In Equation (165–12), a_n is the PAM modulation to be transmitted at time nT, and $h_T(t)$ denotes the system symbol response at the MDI. This symbol response shall comply with the electrical specifications given in 165.5.6.(165–12).

When the tx_mode is SEND_N, tx_symb represents the PCS-encoded 25GMII data stream, a_n is the PAM4 modulation symbol from the set {–1, –1/3, +1/3, +1}.

During training or quiet-refresh signalling, tx_mode is SEND_Z or SEND_T. During training or quiet-refresh signalling, PMA Transmit the value of a_n is a PAM modulation symbol {+1, 0, -1}.

NOTE – during the first 150 ns following a transition to quiet-refresh signalling, the output of the transmitter may be ignored by the receiver.

Proposed Updates for the 802.3cy EEE Text

Change the text in 165.3.6.1

EEE-capable PHYs shall synchronize refresh intervals during the LPI mode. A PHY in SLAVE mode is responsible for synchronizing its partial PHY frame count (PFC24) to the MASTER's PFC24 during PAM2 training. For the requirements on the SLAVE and the MASTER frame alignment, see 165.4.2.4.10.

Refresh signaling is derived by tracking the RS-FEC frame count as shown in Figure 165–13, where:

RS-FEC frame count = floor (PFC24 / 4) mod 96.

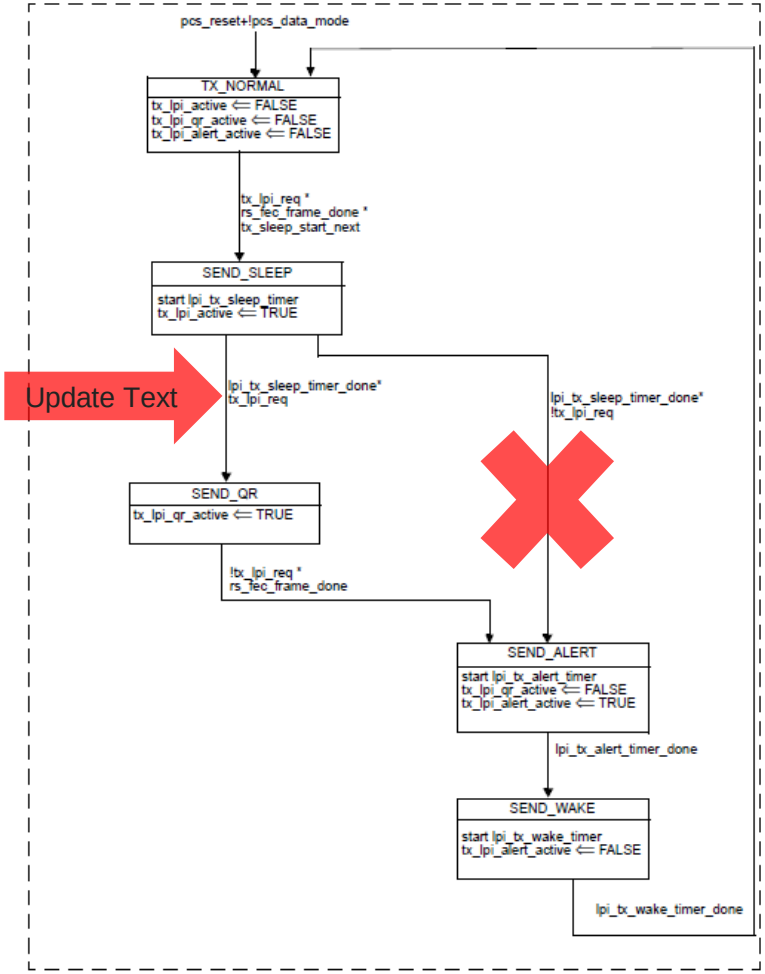
Following the transition to PAM4, the PCS continues with the RS-FEC frame count and uses the count to generate refresh, alert, and wake control signals for the transmit functions.

Alert, a four RS-FEC frame long sequence (alert_length), shall start four frames after ~~at~~ the beginning of any eighth PHY frame boundary counting from the start of the QR cycle. The MASTER and SLAVE shall derive the tx_refresh_active and tx_alert_start_next signals from the transmitted PHY frames as shown in Table 165–5 and Table 165–6. When Slow Wake is active, alert can be transmitted in only a single QR cycle location, stating at frame 92.

Proposed Updates for the 802.3cy EEE Text

Change in 165.3.7.3

- Update figure 165-20 to eliminate transition from SEND_SLEEP to SEND_ALERT
- In the path from SEND_SLEEP to SEND_QR, change “lpi_tx_sleep_timer_done*tx_lpi_req” to “lpi_tx_sleep_timer_done”



NOTE—This figure is mandatory for PHYs with the EEE capability.

Figure 165–20—EEE transmit state diagram

Proposed Updates for the 802.3cy EEE Text

lpi_slave_offset | 42

lpi_master_offset | 90 Add Row

Table 165–4—LPI timing parameters

Parameter	Number of RS-FEC frame periods
alert_length	4
alert_period	8
lpi_offset	52
lpi_qr_time	96
lpi_quiet_time	95
lpi_refresh_time	1

Proposed Updates for the 802.3cy EEE Text

Table 165–5—Synchronization logic derived from slave signal RS-FEC frame count

Slave-side variable	Condition (where u = RS-FEC frame count)	Slow Wake
lpi_slave_offset – lpi_refresh_time ≤mod(u, lpi_qr_time) < lpi_slave_offset	lpi_offset – lpi_refresh_time ≤mod(u, lpi_qr_time) < lpi_offset	0 or 1
mod(u, alert_period) = alert_period – alert_length	mod(u, alert_period) = alert_period/2 –1	0
mod(u, lpi_qr_time) = lpi_slave_offset + lpi_refresh_time + 1	mod(u, lpi_qr_time) = lpi_qr_time/2 + alert_period/2 –1	1

Table 165–6—Synchronization logic derived from master signal RS-FEC frame count

Master-side variable	Condition (where v = RS-FEC frame count)	Slow Wake
lpi_master_offset – lpi_refresh_time ≤mod(v, lpi_qr_time) < lpi_master_offset	mod(v, lpi_qr_time) ≥ lpi_quiet_time	0 or 1
mod(v, alert_period) = alert_period – alert_length	mod(v, alert_period) = alert_period –1	0
mod(v, lpi_qr_time) = lpi_master_offset + lpi_refresh_time + 1	mod(v, lpi_qr_time) = lpi_qr_time –1	1

Proposed Updates for the 802.3cy EEE Text

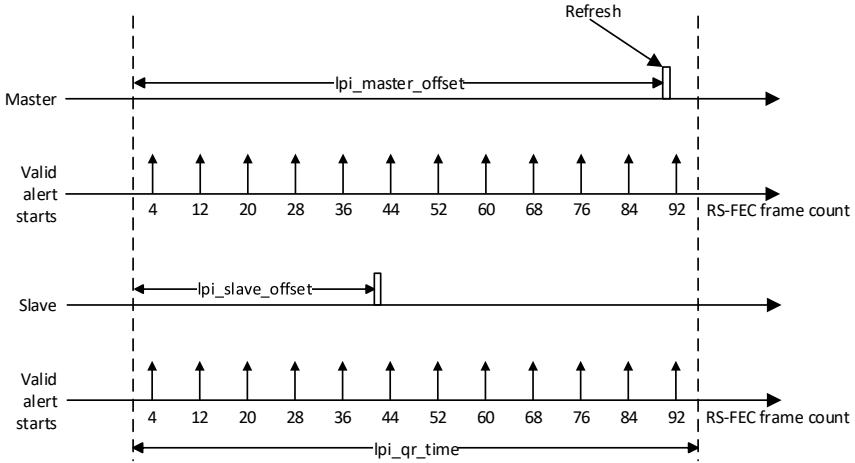


Figure 165–13—Timing periods for LPI signals when Slow Wake not active

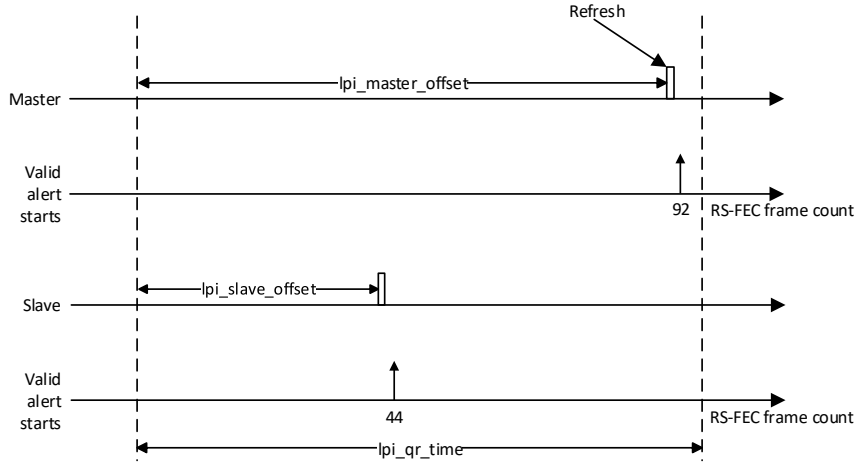


Figure 165–14—Timing periods for LPI signals when Slow Wake is active

Straw Poll

I support adopting the proposed clarifying text updates on slides 4 through 10 of this presentation

Y: N:

Motion

Move to adopt the text updates on slides 4 through 10 of this presentation with editorial license to implement

M: Ragnar Jonsson
S:

Technical (>=75%)
Y: D: A:
Motion Passes/Fails

Backup Slides

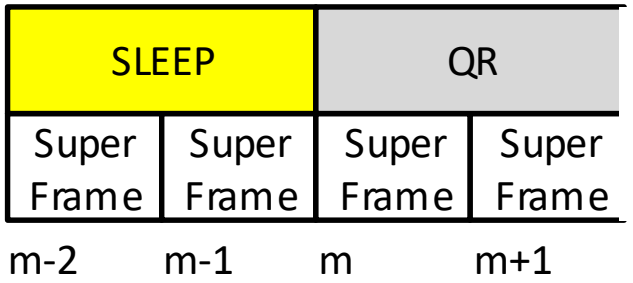
From jonsson_etal_3cy_01b_05_24_22

Engineering consideration for the EEE signaling

1) The SLEEP and WAKE signals should always start and end at super-frame boundary
2) The WAKE signal should immediately follow the ALERT signal
3) The end of ALERT signal should be aligned with end of super frame
4) The duration of the ALERT signal should be 4 RS-FEC frames
5) Master and Slave should have predefined offset between the start of their respective QR sequence
6) It is OK to have overlap between Master and Slave ALERT signals
7) There should be no overlap between REFRESH and ALERT signals
8) The REFRESH signal duration is always a single RS-FEC frame
9) The REFRESH signal does not need to end at the end of a super frame

SLEEP Frame Alignment

- The SLEEP and WAKE signals should always start and end at super-frame boundary

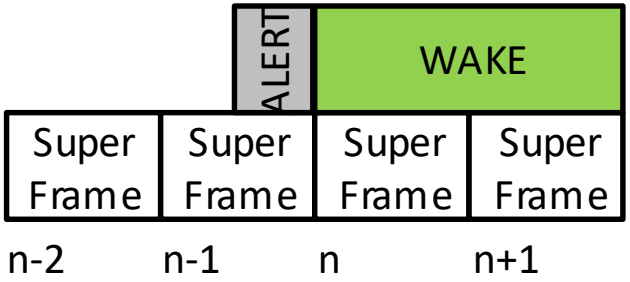


Longest Super-Frame has 8 RS-FEC frames

QR cycle must start at an 8 frame Super-Frame boundry

ALERT and WAKE Frame Alignment

- The SLEEP and WAKE signals should always start and end at super-frame boundary
- The duration of the ALERT signal should be 4 RS-FEC frames
- The WAKE signal should immediately follow the ALERT signal
- The end of ALERT signal should be aligned with end of super frame

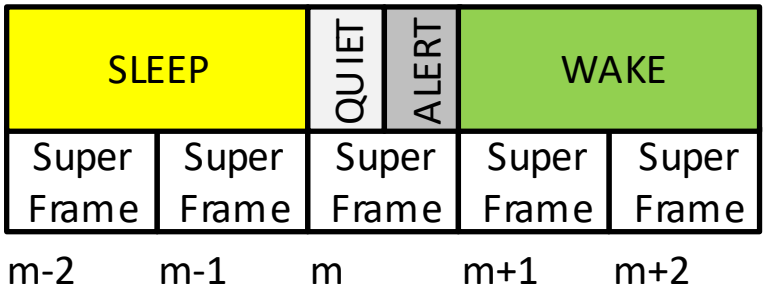


Super-Frame is 8 RS-FEC frames
ALERT is 4 RS-FEC frames

ALERT must start at 5th RS-FEC frame in an 8 frame Super-Frame

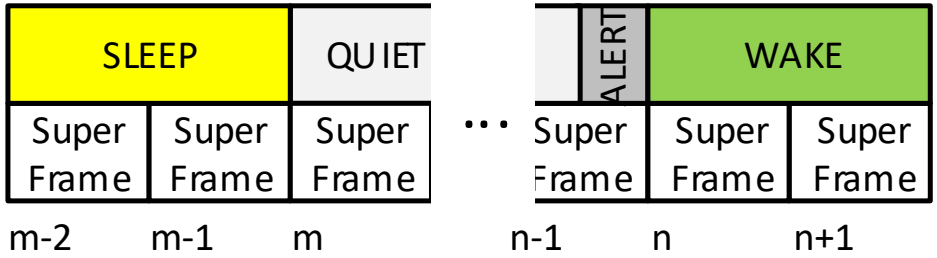
Shortest Possible LPI Signaling

- The constraints on SLEEP and WAKE signal frame alignment, force at least one Super-Frame separation between them
- Same constraints force the first four RS-FEC frame periods to be a QUIET signal in the QR cycle

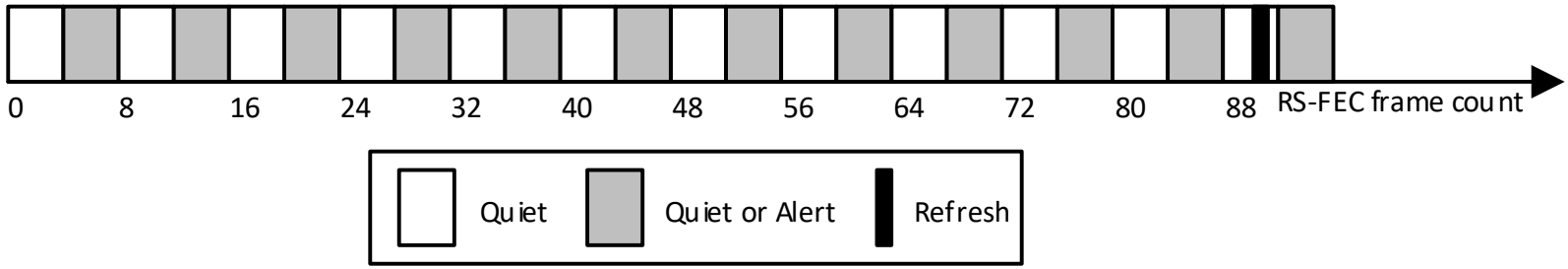


General LPI Signaling

- The separation between SLEEP and WAKE signals must always be an integer multiple of Super-Frames (8 RS-FEC frames)
- ALERT signal can be allowed at the end of any Super-Frame during the QR cycle

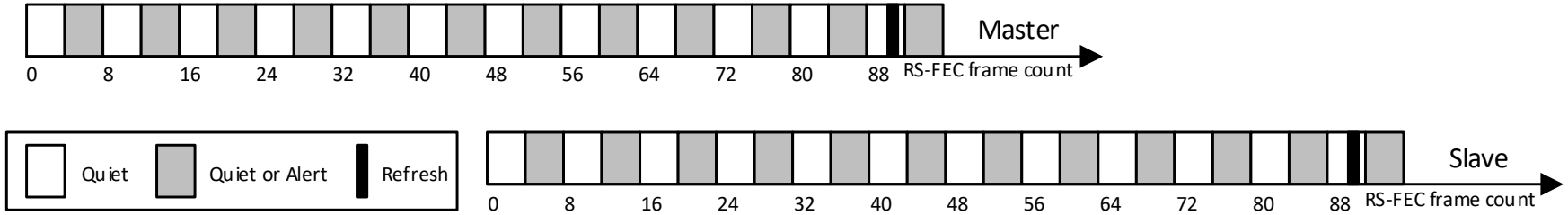


Placing the Refresh Signal



- ALERT signal is allowed in the last four frames of any Super-Frame
- REFRESH and ALERT signals should not “collide”
- REFRESH signal should be placed in one of the four first frames in a Super-Frame
- Frame 90 would be a good place for the REFRESH signal

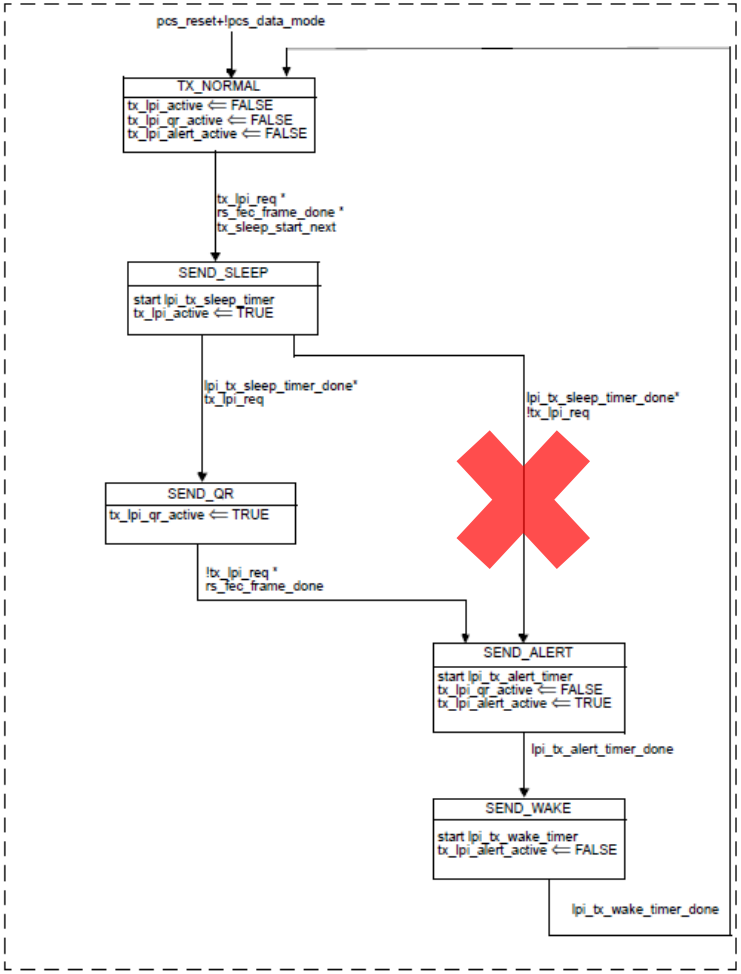
Master/Slave QR Cycle Offset



- The master and slave REFRESH signals should not “collide”
- This can be avoided by offsetting the slave QR cycle relative to the master QR cycle
- For a 96 frame QR cycle, 48 frames is a good choice for the slave QR cycle offset

Sleep to Alert Transition

- Because of frame alignment constraints, the SEND_SLEEP state can never transition straight into SEND_ALLERT



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