Timing parameters for Energy Efficient Ethernet Backplane

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Comment #124: T_{WR} for 10GBASE-KR

- The values for T_{WR} in Table 49–3 are too large
  - They significantly exceed the minimum permissible value of $T_{w\_sys\_tx}$ per Table 78–4
  - Packet(s) transmitted immediately following the minimum deferral time, but before rx_tw_timer_done, will be lost and no wake error will be recorded to account for their absence

- The rationale for the current T_{WR} values may be found in comment #130 submitted against Draft 2.1
  - If the PHY wakes while in the TX_REFRESH state, scrambler bypass will be delayed
  - The receiver requires scrambler bypass to obtain block lock when the FEC sublayer is used
  - However, there was no need to increase T_{WR} when the FEC sublayer is not used

Comment #124: Suggested remedy

- Modify the LPI transmit state diagram
  - Define refresh to be TX_ALERT and TX_WAKE immediately followed by TX_SLEEP
  - If scr_bypass_enable = TRUE, unconditionally enter TX_SCR_BYPASS when rx_tw_timer_done
  - From TX_SCR_BYPASS, move to TX_SLEEP (refresh) or TX_ACTIVE (wake) when one_us_timer_done
- Greatly simplifies state diagram structure
- PHY power-up sequence is identical for refresh, wake, and wake from refresh
- T_{WR} can be set to a value that accurately accounts for wake errors

NOTE: Rotate your computer 90° for the optimal viewing experience

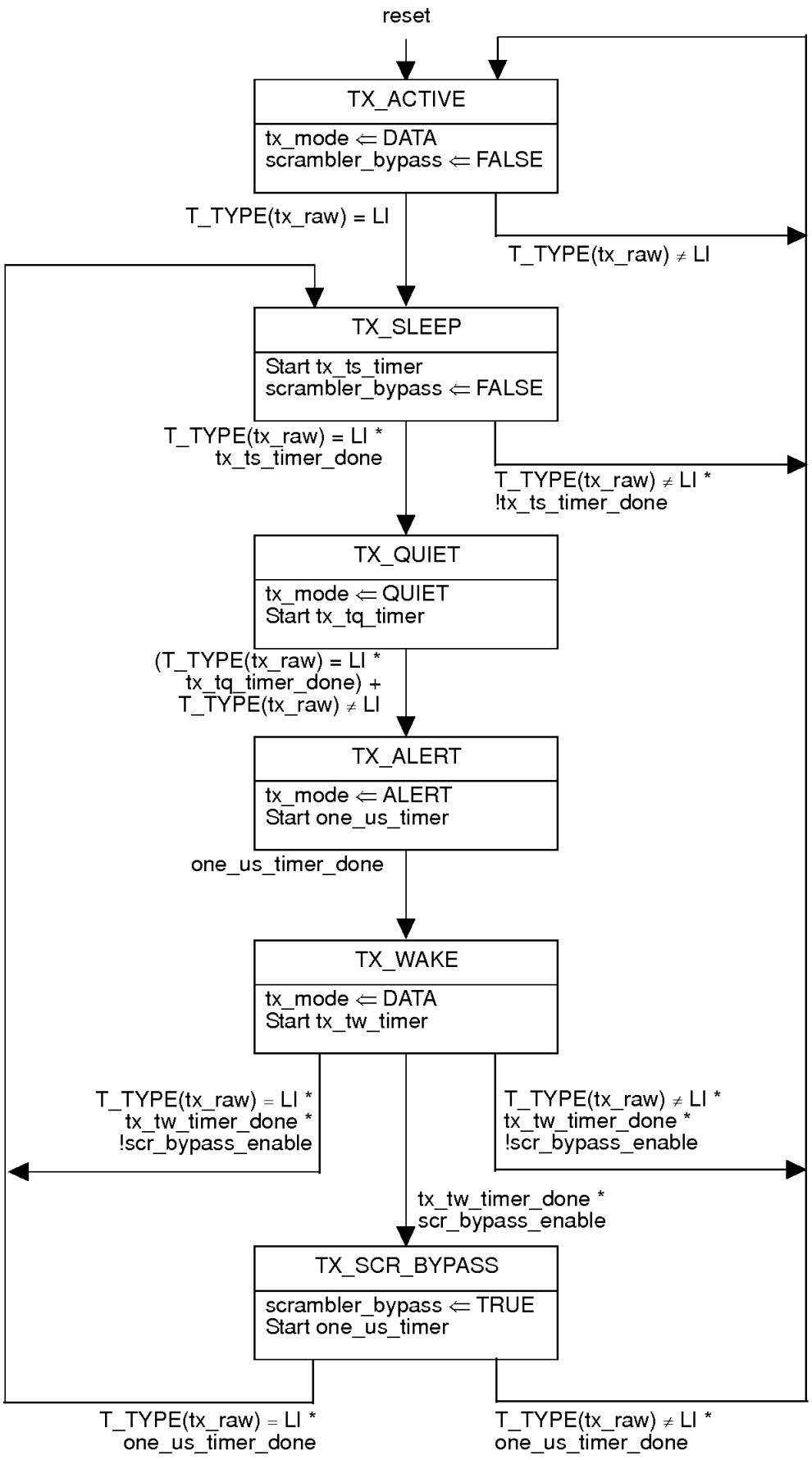
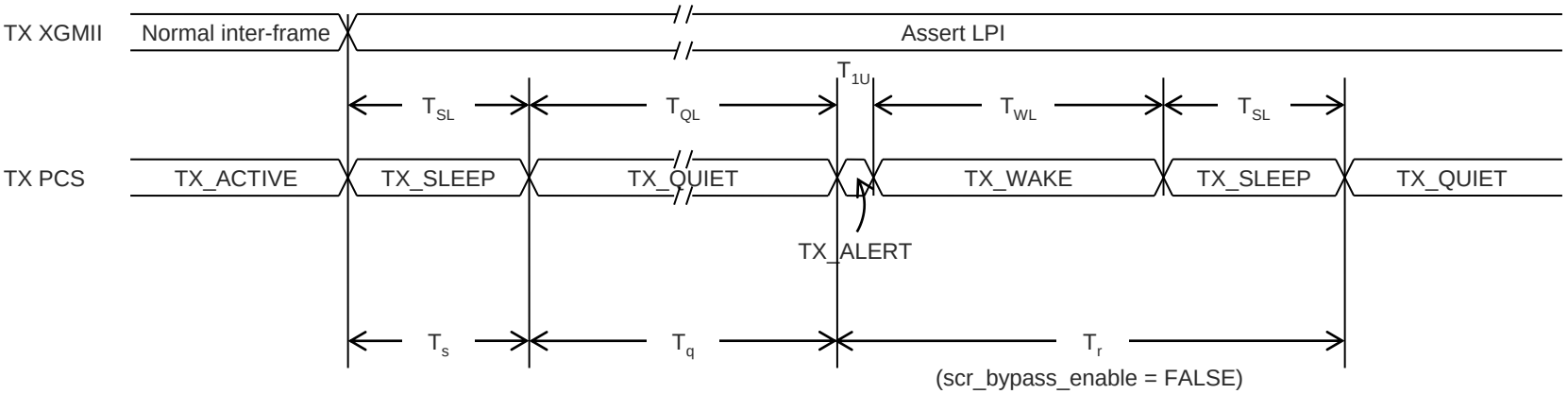


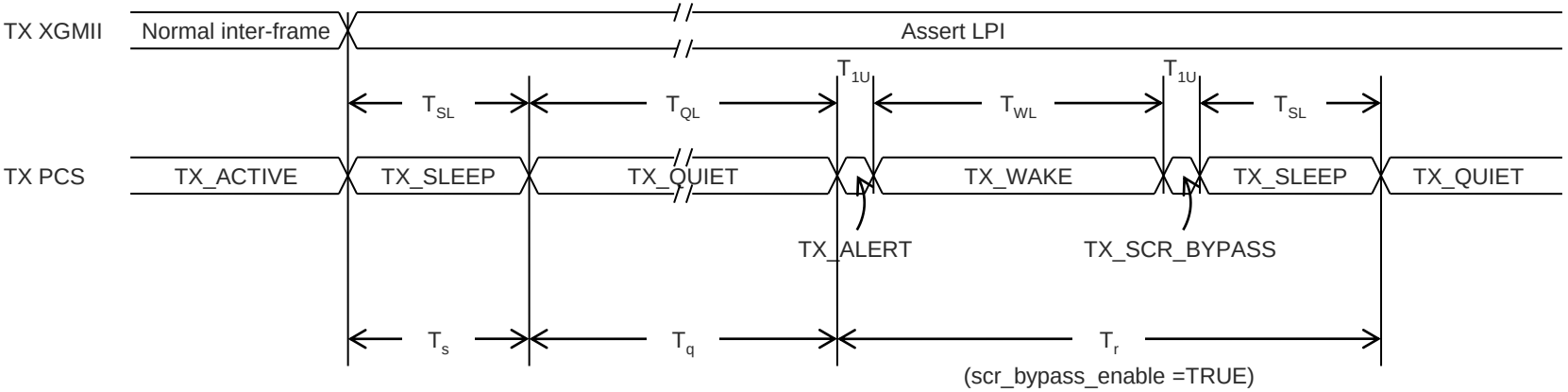
Figure 49–16—LPI Transmit state diagram

Timing diagram: SLEEP to REFRESH

SLEEP to REFRESH (scr_bypass_enable = FALSE):

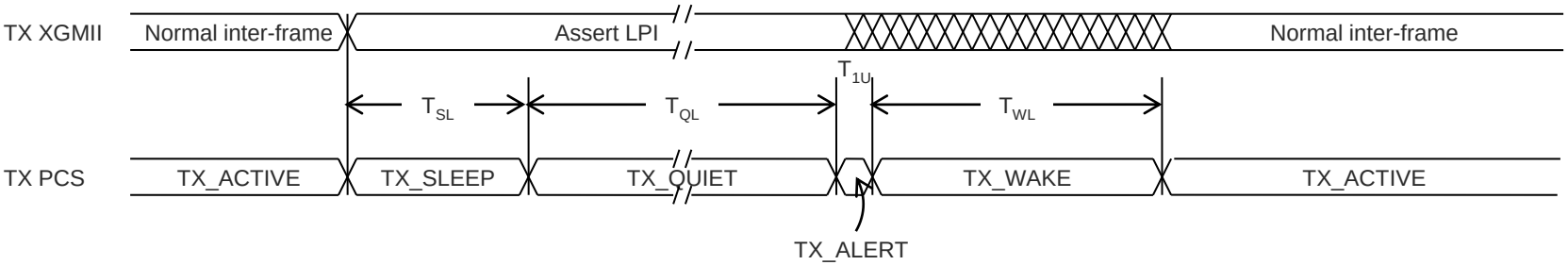


SLEEP to REFRESH (scr_bypass_enable = TRUE):

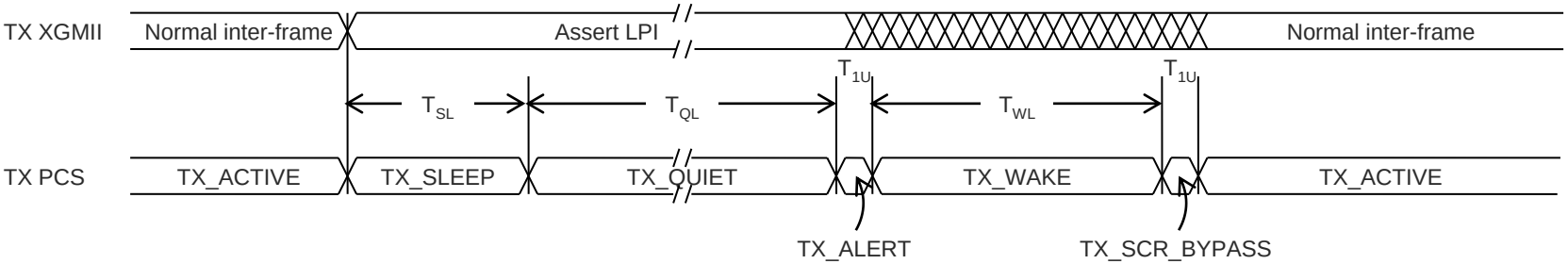


Timing diagram: WAKE from REFRESH

WAKE from REFRESH (scr_bypass_enable = FALSE):

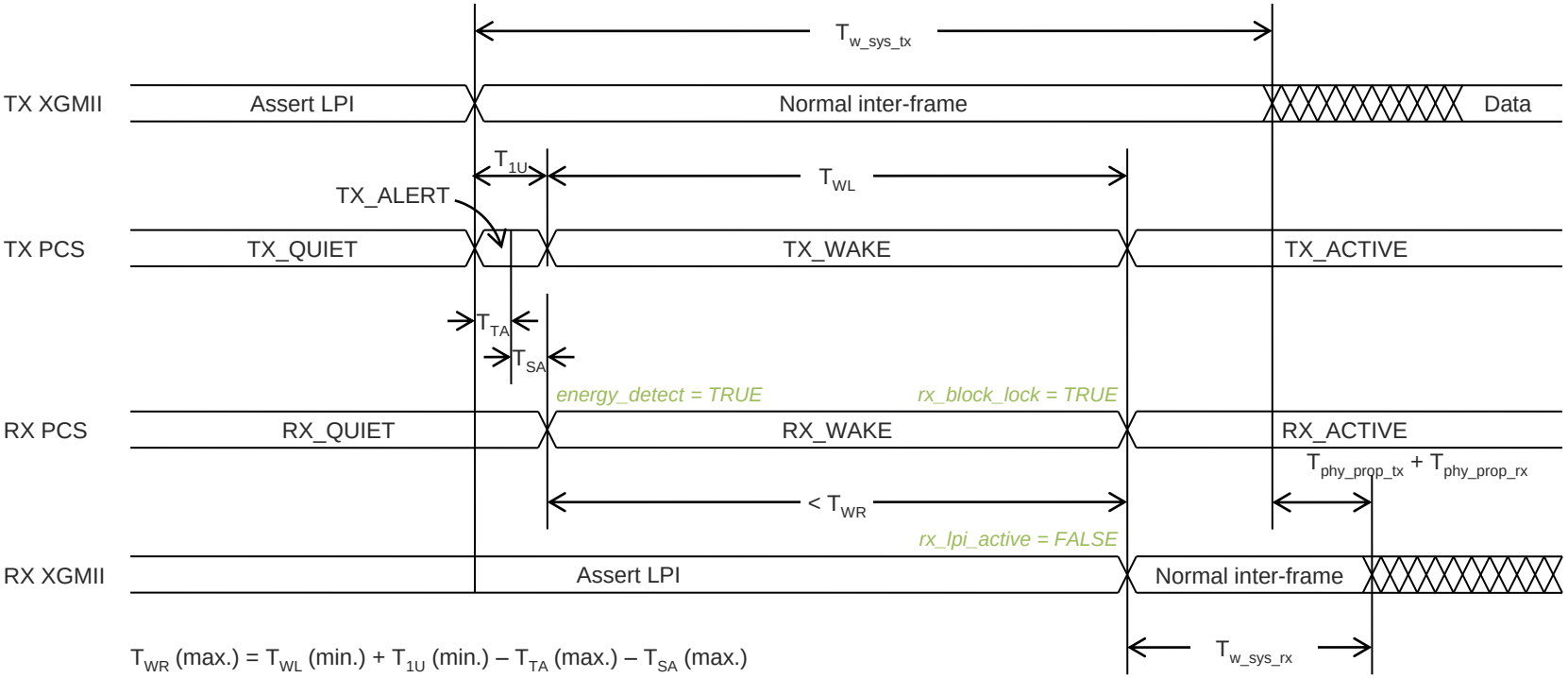


WAKE from REFRESH (scr_bypass_enable = TRUE):



Timing diagram: WAKE from QUIET, no FEC

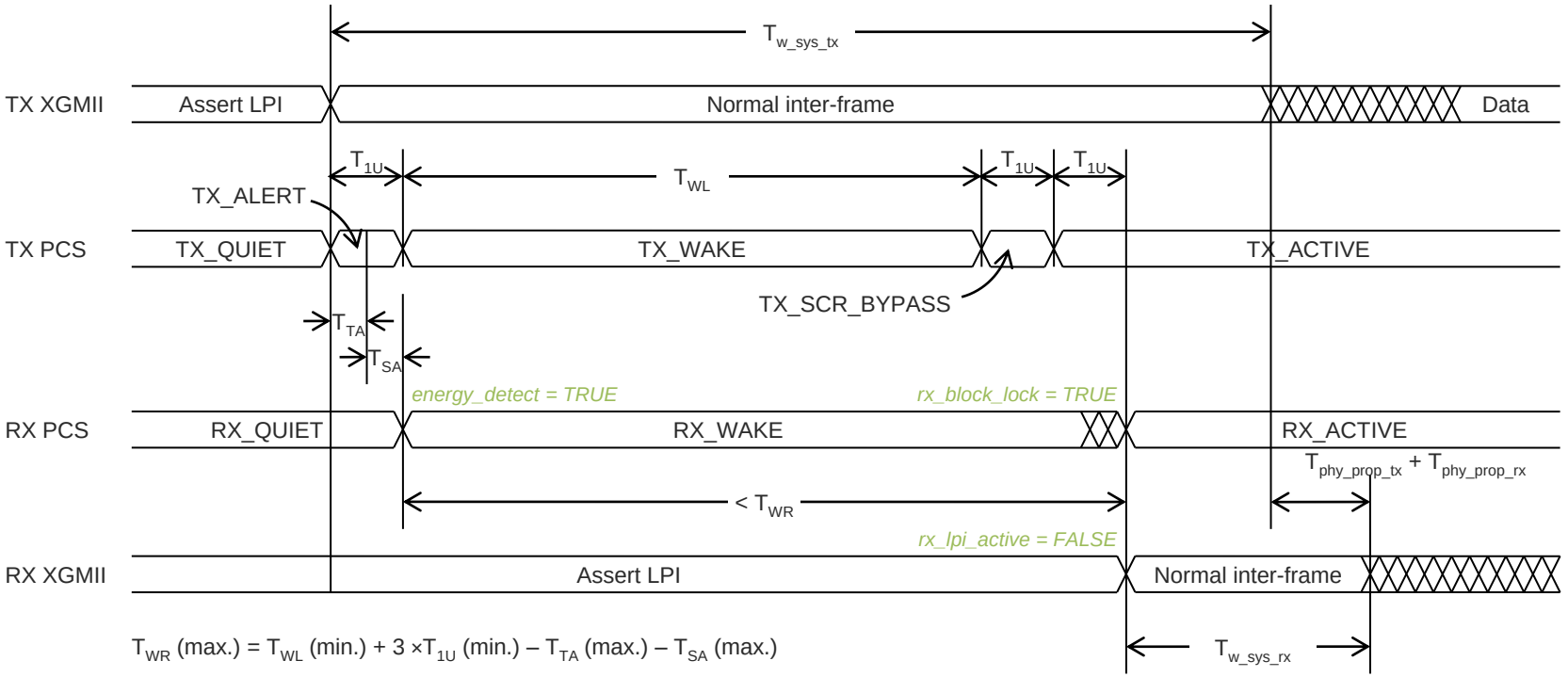
WAKE from QUIET (scr_bypass_enable = FALSE):



T_{WR} (max.) = T_{WL} (min.) + T_{1U} (min.) – T_{TA} (max.) – T_{SA} (max.)

Timing diagram: WAKE from QUIET, with FEC

WAKE from QUIET (scr_bypass_enable = TRUE):



Timing parameters

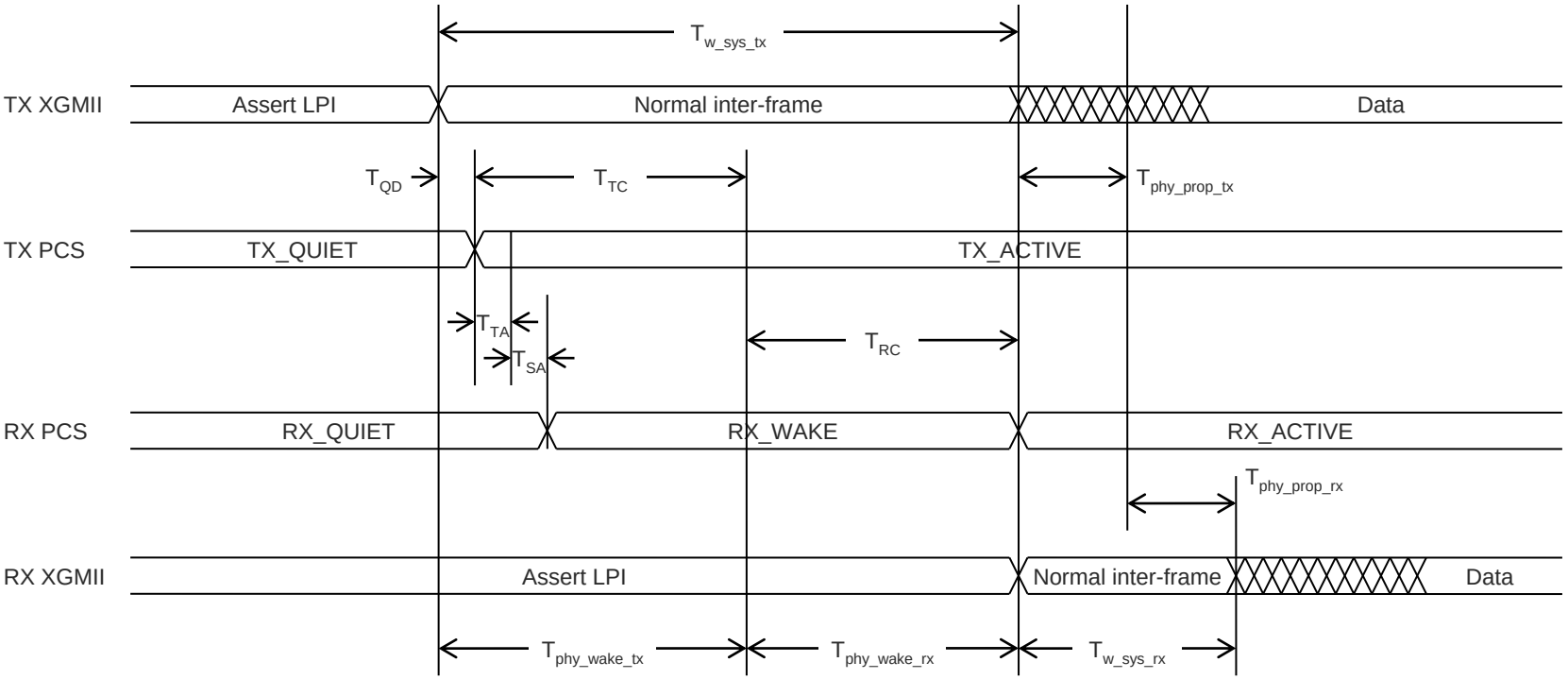
- Comment #124: Update T_{WR} in Table 49–3
  - Proposed changes to the LPI state diagram also require modification of the T_r range in Table 78–2
- Timer tolerances
  - Comment #138: Table 78–2 implies a 10% tolerance but Table 48–9 and 49–2 define a 1% tolerance and Table 36–3a does not define a tolerance
  - Comment #121: one_us_timer has no defined tolerance
  - Comment #111 (R. Horner): Define one_us_timer to be exactly five FEC blocks
  - Comments #178 and #191(M. Brown): T_{SL} and T_{UL} tolerances are too tight
- Comments #134, 300, 302: Define the time the transmitter is allowed to achieve full compliance following wake

More nit-picking on timing

- Table 78–4 needs to be updated
  - Table 78–2 added a row for XGXS (XAUI) so shouldn't Table 78–4 add one as well (even though neither are PHYs as suggested by the table caption)
  - Re-order the rows in some logical fashion
  - $T_{phy\_shrink\_tx}$ and $T_{phy\_shrink\_rx}$ should be "max" values
- Suggested remedy
  - The following tables attempt to address all of these considerations

Reference timing diagram

WAKE from QUIET :



- As a matter of convention, transmitter wake time shrinkage will be referred to the point where the transmitter delivers a compliant signal (T_{QD} + T_{TC})
- Assume T_{QD} (max) = $T_{phy\_prop\_tx}$ (min)

Proposal for Clause 36

Table 36-3a — Transmitter LPI timing parameters (proposed)

Parameter	Description	Min	Max	Units
T_{SL}	Local Sleep Time from entering the TX_SLEEP state to when tx_quiet is set to TRUE	19.9	20.1	µs
T_{QL}	Local Quiet Time from when tx_quiet is set to TRUE to entry into the TX_REFRESH state	2.5	2.6	ms
T_{UL}	Local Refresh Time from entry into the TX_REFRESH state to entry into the TX_QUIET state	19.9	20.1	µs

Table 36-3b — Receiver LPI timing parameters (proposed)

Parameter	Description	Min	Max	Units
T_{QR}	The time the receiver waits for signal_detect to be set to OK while in the RX_SLEEP and RX_QUIET states before asserting rx_fault	3	4	ms
T_{SR}	The maximum time allowed between entry into the RX_SLEEP state and signal_detect being set to FAIL.	22	24	µs
T_{WR}	Time the receiver waits in the RX_WAKE state before indicating a wake time fault		11	µs
T_{WTF}	Wake time fault recovery time		1	ms

Proposal for Clause 48

Table 48-9 — Transmitter LPI timing parameters (proposed)

Parameter	Description	Min	Max	Units
T_{SL}	Local Sleep Time from entering the TX_SLEEP state to when tx_quiet is set to TRUE	19.9	20.1	µs
T_{QL}	Local Quiet Time from when tx_quiet is set to TRUE to entry into the TX_REFRESH state	2.5	2.6	ms
T_{UL}	Local Refresh Time from entry into the TX_REFRESH state to entry into the TX_QUIET state	19.9	20.1	µs

Table 48-10 — Receiver LPI timing parameters (proposed)

Parameter	Description	Min	Max	Units
T_{QR}	The time the receiver waits for signal_detect to be set to OK while in the RX_SLEEP and RX_QUIET states before asserting rx_fault	3	4	ms
T_{WR}	Time the receiver waits in the RX_WAKE state before indicating a wake time fault		9	µs
T_{WTF}	Wake time fault recovery time		1	ms

Proposal for Clause 49

Table 49-2 — Transmitter LPI timing parameters (proposed)

Parameter	Description	Min	Max	Units
T_{SL}	Local Sleep Time from entering the TX_SLEEP state to when tx_mode is set to QUIET	4.9	5.1	µs
T_{QL}	Local Quiet Time from when tx_mode is set to QUIET to entry into the TX_ALERT state	1.7	1.8	ms
T_{WL}	Time spent in the TX_WAKE state	10.9	11.1	µs
T_{LU}	Time spent in the TX_ALERT and TX_SCR_BYPASS states	1.1	1.3	µs

Table 49-3 — Receiver LPI timing parameters (proposed)

Parameter	Description	Min	Max	Units
T_{QR}	The time the receiver waits for energy_detect to be set to TRUE while in the RX_SLEEP and RX_QUIET states before asserting rx_fault	2	3	ms
T_{WR}	Time the receiver waits in the RX_WAKE state before indicating a wake time fault (when scr_bypass_enable = FALSE)		11.5	µs
T_{WR}	Time the receiver waits in the RX_WAKE state before indicating a wake time fault (when scr_bypass_enable = TRUE)		13.7	µs
T_{WTF}	Wake time fault recovery time		10	ms

Clause 74

T_{HO}	Hold-off timer starting when rx_mode is set to DATA. FEC cannot set SIGNAL_OK to TRUE until this timer expires or the transition to scrambler_bypass = FALSE is detected.	13.7		µs

Proposal for Clause 78 (insert rows in speed order)

Table 78-2 — Summary of the key EEE parameters for supported PHYs (proposed)

Protocol	T_s μs		T_q μs		T_r μs	
	min	max	min	max	min	max
1000BASE-KX	19.9	20.1	2,500	2,600	19.9	20.1
XAUI	19.9	20.1	2,500	2,600	19.9	20.1
10GBASE-KX4	19.9	20.1	2,500	2,600	19.9	20.1
10GBASE-KR	4.9	5.1	1,700	1,800	16.9	17.5

Table 78-4 — Summary of the LPI timing parameters for supported PHYs (proposed)

PHY Type	Case	$T_{w\_sys\_tx}$ (min), in μs	T_{w_phy} (min), in μs	$T_{phy\_shrink\_tx}$ (max), in μs	$T_{phy\_shrink\_rx}$ (max), in μs	$T_{w\_sys\_rx}$ (min), in μs
1000BASE-KX		13.26	11.25	5.0	6.5	1.76
XGXS (XAUI)		12.38	9.25	5.0	4.5	2.88
10GBASE-KX4		12.38	9.25	5.0	4.5	2.88
10GBASE-KR	Case-1	15.38	12.25	5.0	7.5	2.88
	Case-2	17.38	14.25	5.0	9.5	2.88

NOTE: Insert rows in speed order.