Minimum Transmit Quiet time of EEE 100BASE-TX

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IEEE 802.3az Task Force

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Contributors and Supporters

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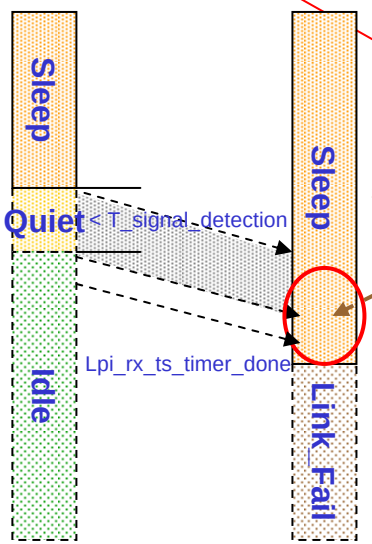
Scenario

- In the Transmit State Diagram of Figure 24-8, the TX_QUIET state has a maximum timer lpi_tx_tq_timer but lacks a minimum timer.
- The transmitter may enter the TX_QUIET state briefly and return to the IDLE state anytime when it receives a De-assert LPI from MII.
- The duration of transmitter staying in the TX_QUIET state may be too short to effectively assert the Signal_detection (5us maximum assertion time) of the receiver at the remote link partner.
- The transmitter's first 5us symbols after the undetectable short quiet state may not comply with the jitter spec as defined in 25.4.6.
- The receiver Equalizer (EQ) and Clock Recovery (CR) may lose the track due to the period of "no-signal" or "out-of-spec signal" in the received channel.
- Finally, the receiver may stay in the RX_SLEEP state unable to decode the symbols correctly, and eventually move to LPI_LINK_FAIL state when the lpi_rx_ts_timer is up.
- This scenario is an overlook and may cause interoperability issue.

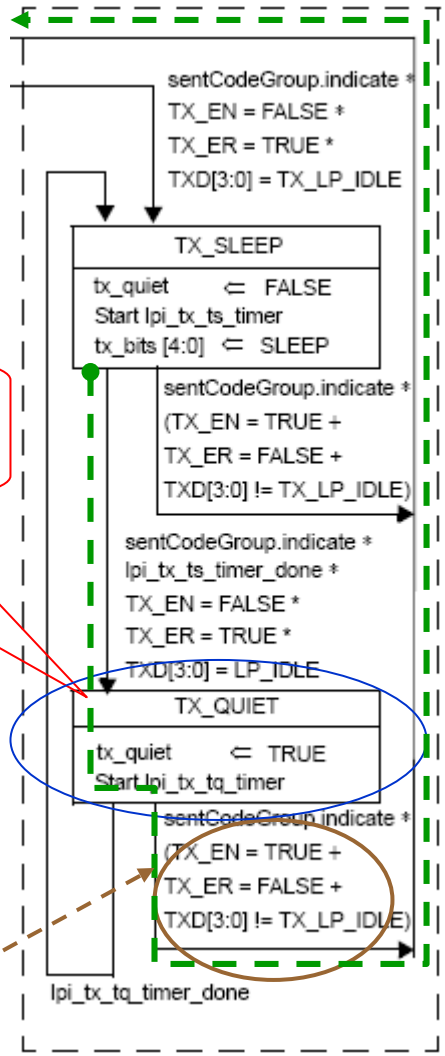
Corner Case illustrated

- The Transmitter gets into Quiet state and exits to Idle state too quickly => less than a signal_detection time
- The Receiver continues waiting in Sleep state with a possible messed-up Clock/Data Recovery & Equalizer
- The Receiver finally exits to unintended LPI_Link_Fail state

Suggest a Minimum duration for TX_QUIET state. Implement it with a new **lpi_tx_tm_timer ≥ signal_detection time**



Received signal does not comply with spec.



Stays in Quiet too short

Figure 24-8 Transmit State Diagram

Receiver unable to respond

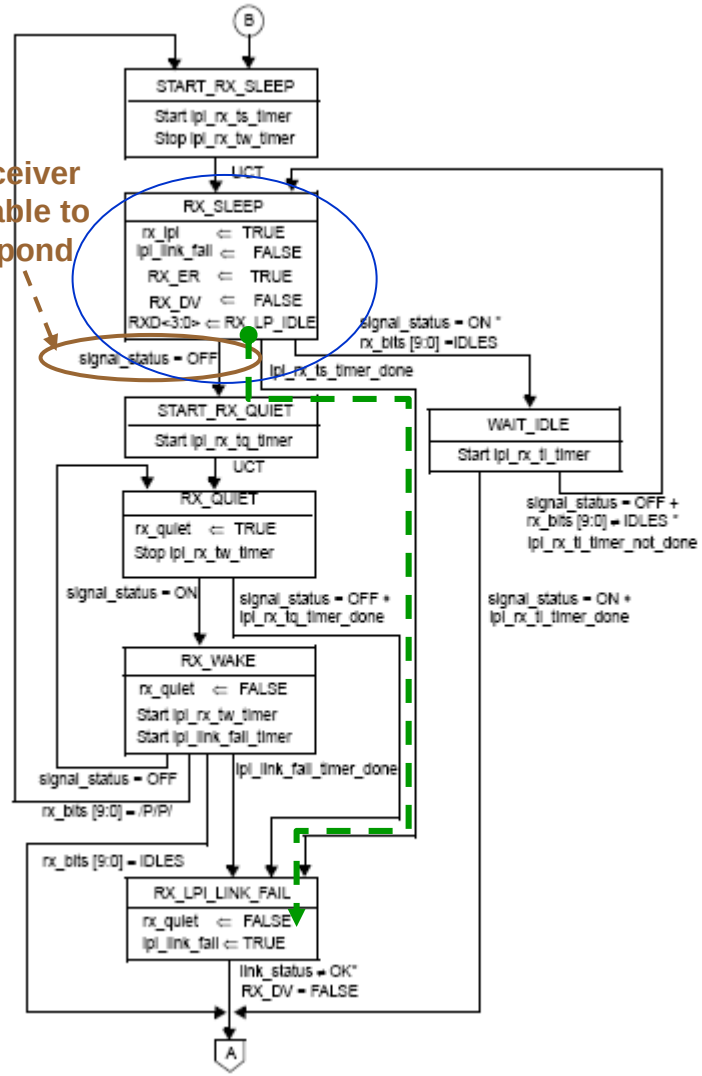


Figure 24-11b Receive State Diagram

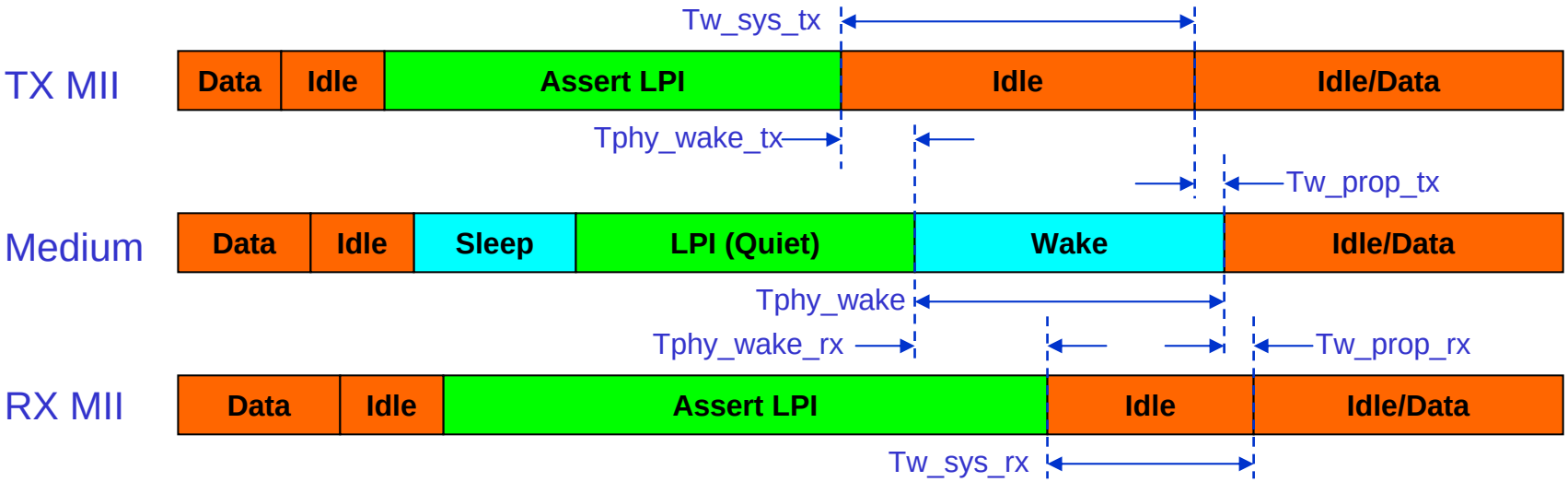
A 2nd thought of Signal_detection time

- Is it meaningful to shorten the signal_detection time?
  - The design of signal detection circuitry in 100BASE-TX is easier than that of 1000BASE-T
    - Both have the same symbol rate: 125MHz
    - MLT3 code produces more frequent full swing amplitude change
    - The signal_detection time of 1000BASE-T is 0.5 μs
  - We can change the maximum Assert time (and De-assert time) of Signal_detection of PMD in LPI mode to 1 μs without causing any penalty
- Does it affect subclause 24.4.6?

  "Total transmit jitter with respect to a continuous unjittered reference shall not exceed 1.4 ns peak-to-peak with the exception that the jitter contributions from the clock transitions occurring during the TX_QUIET state and the first 5 μs of the TX_SLEEP state are ignored."
  - No, this 5 μs jitter spec is used to provide enough time for transmitter to stabilize its AFE/DSP blocks after a Quiet state.
- Parameters affected in Table 25-3 :

Characteristics	Minimum	Maximum	Units
Assert time LPI mode		1	μs
De-assert time LPI mode		1	μs

Review of Wake Shrinkage Time



Tw_sys_tx (min) = Tw_sys_rx (min) + Tphy_shrink_tx (max) + Tphy_shrink_rx (max)

Tw_phy (min) = Tphy_wake (min) + Tphy_shrink_tx

Tw_sys_rse (min) = Greater {Tw_sys_tx (min), Tw_phy (min) }

Tphy_shrink_tx (max) = Tphy_wake_tx (max) – Tphy_prop_tx (min)

Tphy_shrink_rx (max) = Tphy_wake_rx (max) – Tphy_prop_rx (min)

Revisit of 100BASE-TX Wake Shrinkage Time

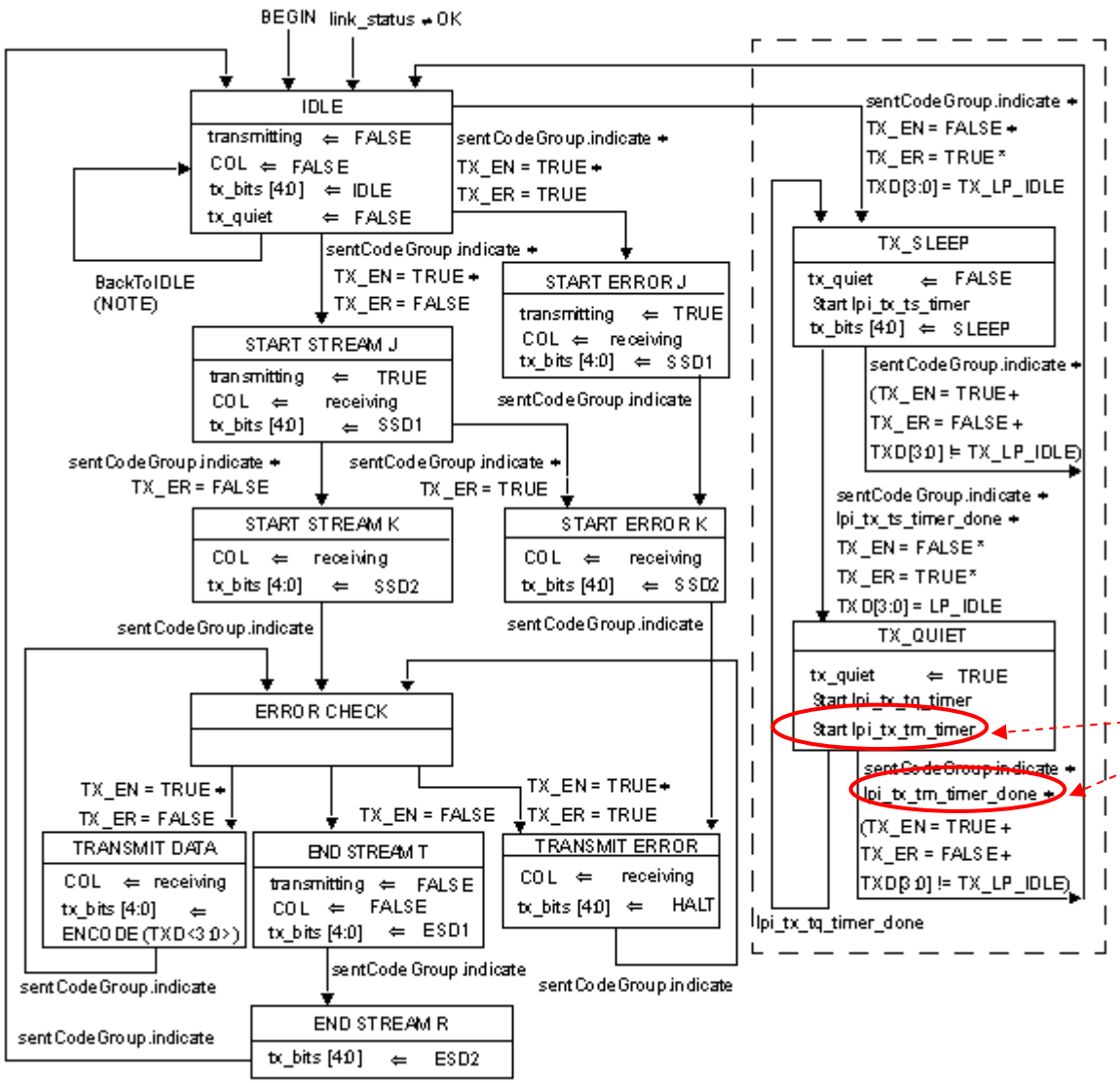
Timing Parameter	Old (us)	New (us)	Comments
Tw_sys_rse (min)	30	30	= Max {Tw_sys_tx (min), Tw_phy (min) }
Tw_phy (min)	20.5	18	= Tphy_wake_rx (min) + Tphy_shrink_tx
Tw_sys_tx (min)	30	30	= Tw_sys_rx (min) + Tphy_shrink_tx (max) + Tphy_shrink_rx (max)
Tw_sys_rx (min)	10	12.5	Arbitrary number > 0
Tphy_shrink_tx (max)	5	6.5	= Tphy_wake_tx (max) – Tphy_prop_tx
Tphy_shrink_rx (max)	15	11	= Tphy_wake_rx (max) – Tphy_prop_rx
Tphy_wake_tx (max)	5.1	6.6	= TX min Quiet time (max) + TX AFE/DSP stabilize time + TX PCS Latency (Tphy_prop_tx)
Tphy_wake_rx (max)	15.5	11.5	= RX Signal detection time + RX AFE/DSP stabilize time + RX PCS Latency (Tphy_prop_rx)
Tphy_prop_tx	0.1	0.1	Single fixed value
Tphy_prop_rx	0.5	0.5	Single fixed value
TX min Quiet time (max)	N/A	1.5	TX min Quiet time range : 1 μs to 1.5 μs
TX AFE/DSP stabilize time	5	5	Maximum value (refer to subclause 24.4.6)
RX Signal detection time	5	1	Maximum value
RX AFE/DSP stabilize time	10	10	Maximum value

The Fix

- Change the maximum Assert time and De-assert time of Signal_detection of PMD in LPI mode (refer to Table 25-3) to 1 μs
- Modify the Transmit State Diagram (Fig 24-8)
  - Add a new timer lpi_tx_tm_timer in TX_QUIET state with a value range between 1 μs to 1.5 μs, and start it when entering TX_QUIET state
  - Change the branch condition between TX_QUIET and IDLE from "sentCodeGroup.indicate * (TX_EN = TRUE +TX_ER = FALSE + TXD[3:0] != TX_LP_IDLE)" to "sentCodeGroup.indicate * lpi_tx_tm_timer_done * (TX_EN = TRUE +TX_ER = FALSE + TXD[3:0] != TX_LP_IDLE)"
- Parameters are modified in Table 78-4: Summary of the LPI timing parameters for supported PHYs (numbers in parenthesis are old number)

PHY Type	Case	Tw_sys_tx	Tw_phy	Tphy_shrink_tx	Tphy_shrink_rx	Tw_sys_rx
100BASE -TX		30	18 (20.5)	6.5 (5)	11 (15)	12.5 (10)

The modified Figure 24-8



Thank you!