Energy Efficient Ethernet 1000BASE-T LPI Request During Retraining

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Overview

- Allowing the encoding of LPI requests in 1000BASE-T EEE during retraining provides no benefit but introduces a small performance degradation.

- This presentation describes the specification changes required so that the PHY transmitter ignores LPI requests while it is training.

- This presentation is submitted as a detailed suggested remedy to Comment #62 submitted against IEEE P802.3az/D2.2.

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Issue Summary

- For 1000BASE-T, because $Sd_n[2]$ also encodes *loc_rcv_status*, the PHY can only use 3 of the 4 pairs to provide a reliable indication of scrambler lock.

$$Sd_n[2] = \begin{cases} Sc_n[2] \wedge TXD_n[2] \text{ if } (tx\_enable_{n-2} = 1) \\ Sc_n[2] \wedge 1 \text{ else if } ((loc\_rcvr\_status = \text{OK}) \text{ and } (tx\_mode \neq \text{SEND\_Z}) \\ Sc_n[2] \text{ else} \end{cases}$$

$$Sd_n[3] = \begin{cases} Sc_n[3] \wedge TXD_n[3] \text{ if } (tx\_enable_{n-2} = 1) \\ Sc_n[3] \wedge 1 \text{ else if } ((loc\_lpi\_req = \text{TRUE}) \text{ and } (tx\_mode \neq \text{SEND\_Z})) \\ Sc_n[3] \text{ else} \end{cases}$$

- For EEE, if the PHY needs to encode LPI during training, then $Sd_n[3]$ is used so that only 2 of the 4 pairs can effectively be used.
- This constraint results in a small but non-zero degradation in the robustness of the link-up process.
- Even if a PHY is allowed to encode LPI during training, the link cannot actually enter a low power state during this time.

➢ Permitting the encoding of the LPI command during training offers no real benefit yet results in a slight degradation in robustness.

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Summary of Required Changes: Ignore LPI Requests During Training

- Introduce a variable, *loc_lpi_en*, that the PHY Control State diagram sets to FALSE when it is training and to TRUE otherwise.
- Use this variable in the Local LPI Request state diagram to prevent encoding LPI requests during training.
- Add a description of *loc_lpi_en* to the PCS Transmit and state diagram variables.
- Define a PMA primitive that allows communication of *loc_lpi_en* between the PHY Control and Local LPI Request Functions.
- Illustrate the communication of *loc_lpi_en* in the Functional, PCS, and PMA block diagrams.
- Add a PICs item for *loc_lpi_en* such that it shall be FALSE in the absence of the EEE capability.

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loc_lpi_en Description

- Add the following description to the end of section 40.3.3.1 (PCS state variables):

  loc_lpi_en

  The loc_lpi_en variable is generated by the PMA PHY Control function and indicates whether or not the local PHY may encode loc_lpi_req. It is passed to the PCS Local LPI Request function via the PMA_LOCLPIEN.indication primitive. In the absence of the optional EEE capability, the PHY operates as if the value of this variable is FALSE.

  Values: TRUE or FALSE

- Add the following description to the end of section 40.4.5.1 (state diagram variables):

  loc_lpi_en

  The loc_lpi_en variable is generated by the PMA PHY Control function and indicates whether or not the local PHY may encode loc_lpi_req. It is passed to the PCS Local LPI Request function via the PMA_LOCLPIEN.indication primitive. In the absence of the optional EEE capability, the PHY shall operate as if the value of this variable is FALSE.

  Values: TRUE: The PHY is able to encode loc_lpi_req.

  FALSE: The PHY is not able to encode loc_lpi_req.

State Diagram Changes

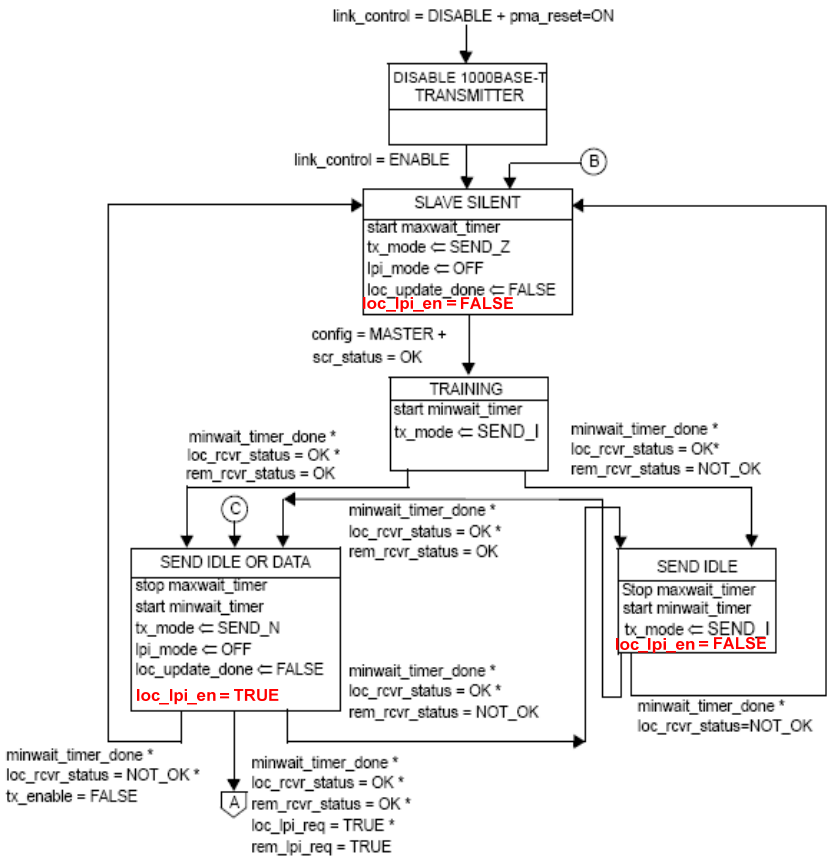


Figure 40–15a—PHY Control state diagram, part a

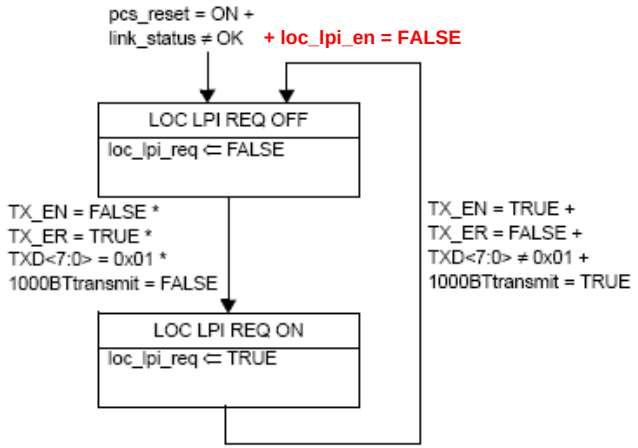
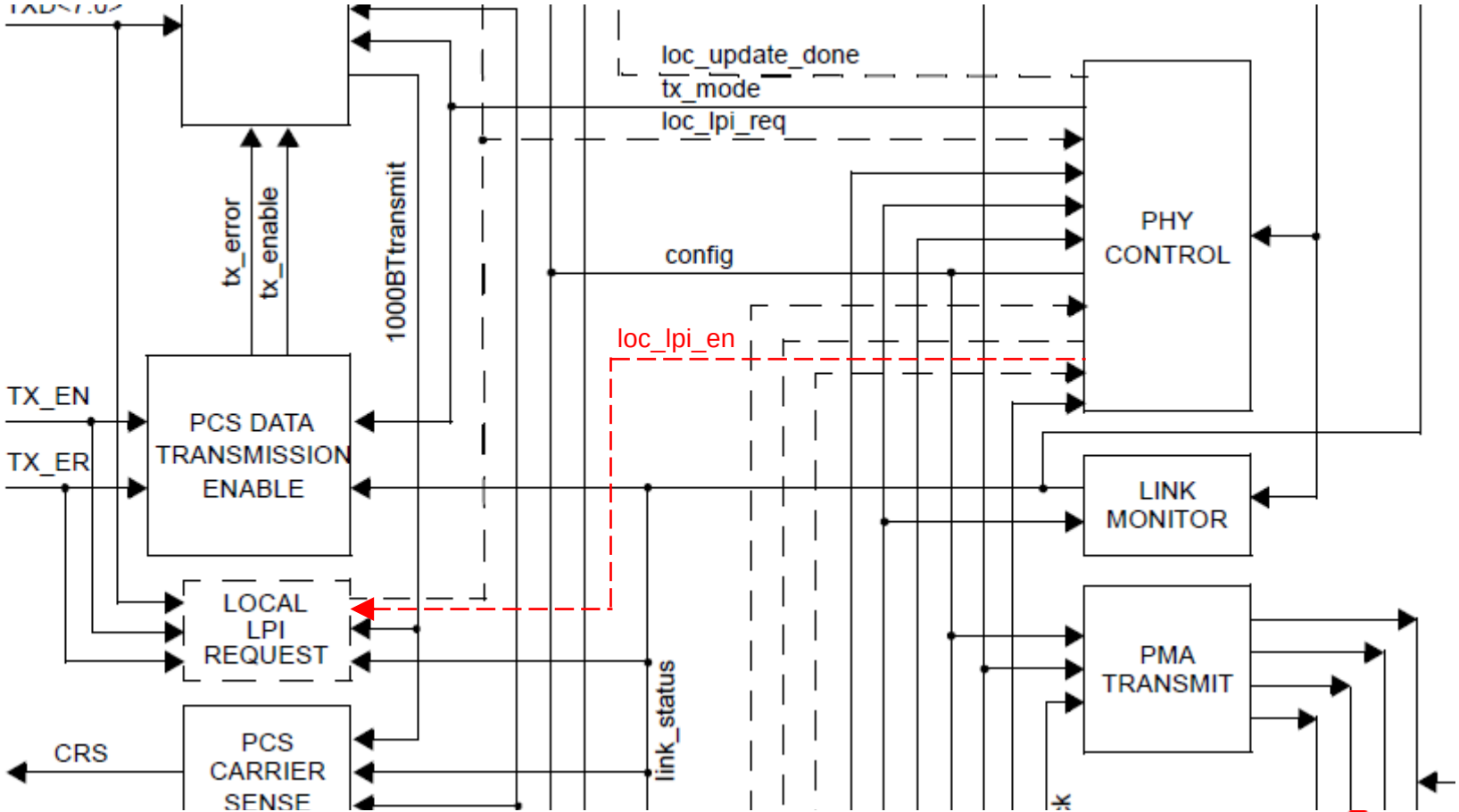


Figure 40–9—PCS Local LPI Request state diagram (optional)

Change to Figure 40-3 Functional Block Diagram



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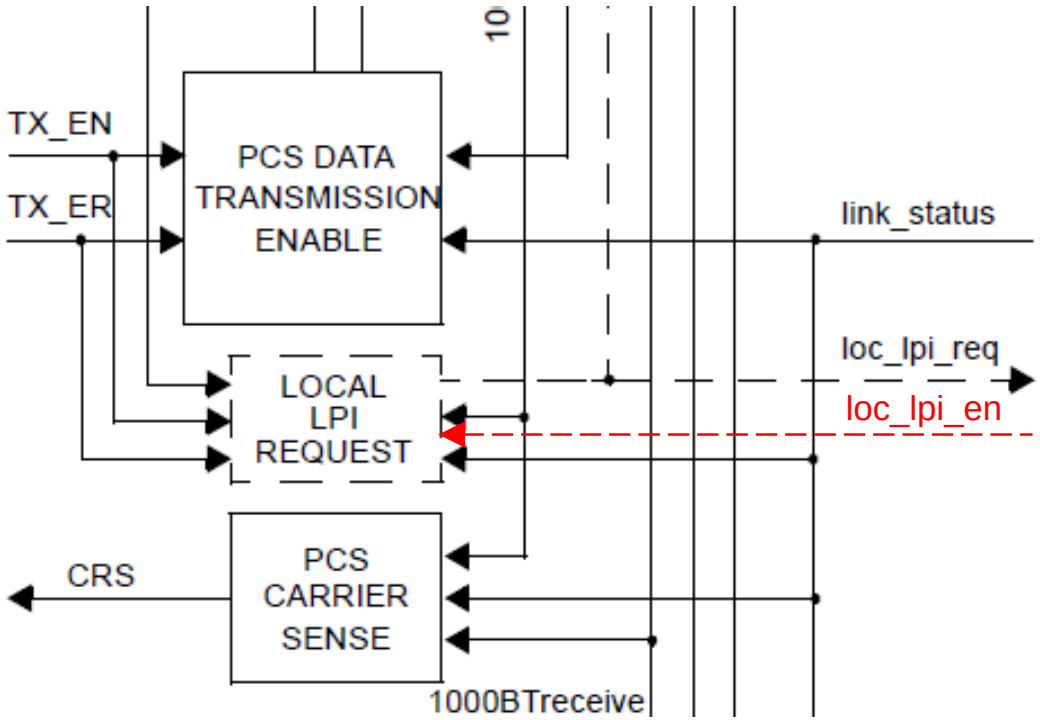
Change to Figure 40-5
PCS Reference Diagram



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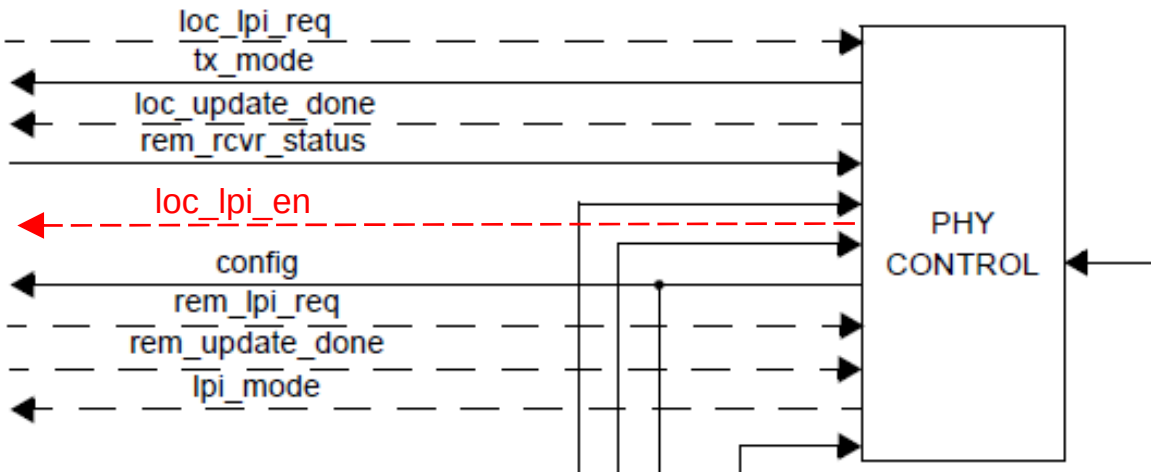
Change to Figure 40-14
PMA Reference Diagram



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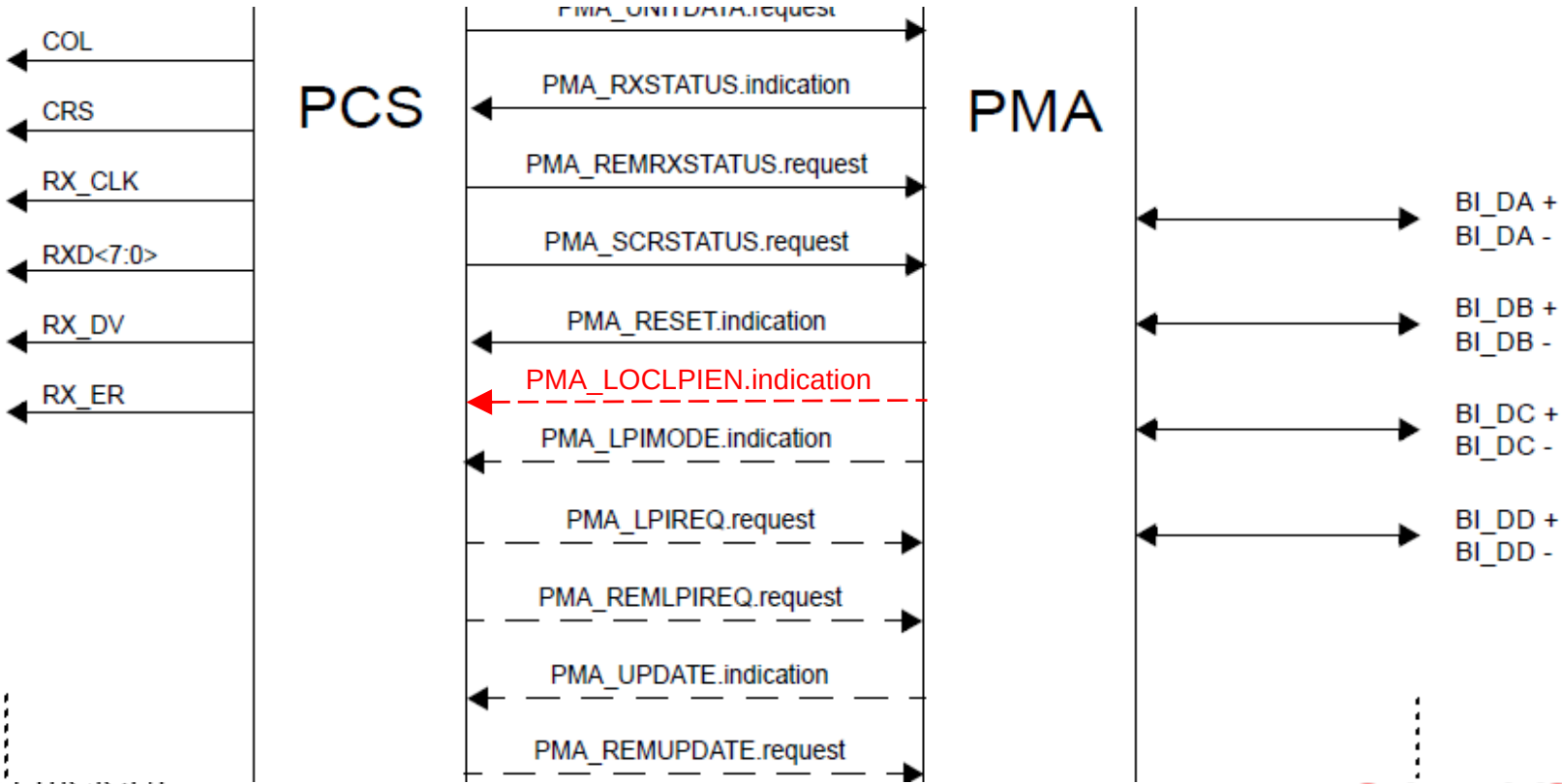
Changes to 40.2.2 and Figure 40-4 1000BASE-T Service Interfaces

- Add to the list of PMA Service Interfaces in 40.2.2 (page 91 line 49):
  - PMA_LOCLPIEN.indication(loc_lpi_en)



40.2.16 Service Primitive Description

40.2.16 PMA_LOCLPIEN.indication

This primitive is generated by the PMA to indicate that the PHY is able to encode loc_lpi_req.

40.2.16.1 Semantics of the primitive

PMA_LOCLPIEN.indication(loc_lpi_en)

PMA_LOCLPIEN.indication specifies to the PCS Local LPI Request function, via the parameter loc_lpi_en, whether or not the PHY is able to encode loc_lpi_req. The parameter loc_lpi_en can take on one of the following values of the form:

TRUE This value is asserted with then PHY is able to encode loc_lpi_req.

FALSE This value is asserted when the PHY is not able to encode loc_lpi_req.

40.2.16.2 When generated

The PMA PHY Control function generates PMA_LOCLPIEN.indication messages continuously.

40.2.16.3 Effect of receipt

Upon receipt of this primitive, the PCS performs its Local LPI Request function as described in 40.3.1.6.

PICs Addition

- Add to the table in 40.12.5 (replacing xx with appropriate number):

  PMFxx In the absence of the optional EEE capability, the PHY shall Operate as if the value of loc_lpi_en is FALSE.

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Thank you!