Editor's note:
This text is the output from the 10GBASE-T ad hoc in response to comment #186 on draft 2.1.
This document provides text to specify:
(1) a EEE LPI link monitor capability
and
(2) a EEE fast retrain capability.

45. Management Data Input/Output (MDIO) Interface

Insert a new subclause 45.2.1.75a after the existing 45.2.1.75 as shown below:

45.2.1.75a 10GBASE-T fast retrain status and control register (Register 1.147)

Table 45–49a—10GBASE-T fast retrain status and control register bit definitions

Bit(s)	Name	Description	R/W[a]
1.147.15:11	LP fast retrain count	Counts the number of fast retrains requested by the link partner	RO/NR
1.147.10:6	LD fast retrain count	Counts the number of fast retrains requested by the local device	RO/NR
1.147.5:1	Reserved	Value always 0, writes ignored	RO
1.147.0	Fast retrain enable	1 = Fast retrain capability is enabled 0 = Fast retrain capability is disabled	R/W

[a]R/O = Read only, R/W = Read/Write, NR = Non Roll-over

45.2.1.75a.1 Fast retrain enable

This bit maps to lpi_fr_en as defined in 55.4.5.1.

Note: Disabling this bit while a link is up will cause the PHY to stop supporting fast retrain and the link will drop if the link partner initiates a fast retrain.

45.2.1.75a.2 LD fast retrain count

These bits map to fr_tx_counter as defined in 55.4.5.1. The counter is a 5-bit count of the number of 10GBASE-T fast retrains requested by the local device. These bits shall be reset to all zeros when read or upon execution of the PCS reset. These bits shall be held at all ones in the case of overflow.

45.2.1.75a.3 LP fast retrain count

These bits map to fr_rx_counter as defined in 55.4.5.1. The counter is a 5-bit count of the number of 10GBASE-T fast retrains requested by the link partner. These bits shall be reset to all zeros when read or upon execution of the PCS reset. These bits shall be held at all ones in the case of overflow.

Edit Table 45-140 10GBASE-T AN control register as shown below

45.2.7.10 10GBASE-T AN control register (Register 7.32)

Table 45–140—10GBASE-T AN control register

Bit(s)	Name	Description	R/W[a]
7.32.1	Fast retrain ability	1 = Advertise PHY as 10GBASE-T fast retrain capable 0 = Do not advertise the PHY as 10GBASE-T fast retrain capable	R/W

[a]R/W = Read/Write, R/O = Read only

Insert 45.2.7.10.5a Fast retrain ability as a new subclause after the existing 45.2.7.10.5

45.2.7.10.5a Fast retrain ability

Bit 7.32.1 is used to select whether or not Auto-Negotiation advertises the ability to support 10GBASE-T fast retrain. If bit 7.32.1 is set to one the PHY shall advertise fast retrain ability. If bit 7.32.1 is set to zero the PHY shall not advertise fast retrain ability.

Edit Table 45-141 10GBASE-T AN control register as shown below

45.2.7.11 10GBASE-T AN status register (Register 7.33)

Table 45–141—10GBASE-T AN control register

Bit(s)	Name	Description	R/W[a]
7.33.1	Fast retrain ability	1 = Link partner is capable of 10GBASE-T fast retrain 0 = Link partner is not capable of 10GBASE-T fast retrain	R/O

[a]RO = Read only, SC = Self-clearing, LH = Latching high

Insert 45.2.7.11.8 Fast retrain ability as a new subclause after the existing 45.2.7.10.5

45.2.7.11.8 Fast retrain ability

When read as a one, bit 7.33.1 is used to indicate that the link partner has the ability to support the fast retrain capability as specified in 55.4.2.5.15. When read as a zero, bit 7.33.1 indicates that the PHY lacks the ability to support the fast retrain capability.

55. Physical Coding Sublayer (PCS), Physical Medium Attachment (PMA) sublayer and baseband medium, type 10GBASE-T

55.1 Overview

Insert the following text after the existing text in 55.1
PHYs with the EEE capability may also support a fast retrain mechanism.

55.1.3 Operation of 10GBASE-T

Insert the following text before the last paragraph of 55.1.3

10GBASE-T PHYs may optionally support a fast retrain mechanism. This function allows PHYs to quickly recover from link degradation without a normal 2 second retrain.

55.1.3.2 Physical Medium Attachment (PMA) sublayer

Insert the following text after the last paragraph of 55.1.3.2

The PMA sublayer may also support a fast retrain function. The fast retrain function is specified in 55.4.2.5.15.

55.4.2.2 PMA Transmit function

Change text in 55.4.2.2 PMA Transmit function as shown below:

The PMA Transmit function comprises four synchronous transmitters to generate four pulse-amplitude modulated signals on each of the four pairs BI_DA, BI_DB, BI_DC, and BI_DD. While send_fail is FALSE and ALERT is not indicated by tx_symb_vector then PMA transmit shall continuously transmit onto the MDI pulses modulated by the symbols given by tx_symb_vector[BI_DA], tx_symb_vector[BI_DB], tx_symb_vector[BI_DC], and tx_symb_vector[BI_DD], respectively after processing with the THP, optional transmit filtering, digital to analog conversion (DAC) and subsequent analog filtering. When ALERT is indicated by tx_symb_vector the alert signal is transmitted as specified in 55.4.2.2.1. When send_fail is TRUE the link failure signal is transmitted as specified in 55.4.2.2.2. The four transmitters shall be driven by the same transmit clock, TX_TCLK. The signals generated by PMA Transmit shall follow the mathematical description given in 55.4.3.1, and shall comply with the electrical specifications given in 55.5.

Insert the following text after the existing text in 55.4.2.2 PMA Transmit function:

EEE capable PHYs shall implement a PMA Transmit function that generates the alert signal as defined in 55.4.2.2.1. PHYs that support the Fast Retrain capability shall implement a PMA Transmit function that generates the link failure signal as defined in 55.4.2.2.2. If ALERT is indicated by tx_symb_vector at the same time as send_fail is TRUE then link failure signaling is transmitted.

55.4.2.2.2 Link failure signal

Insert the following text after subclause 55.4.2.2.1 in draft 2.2

PHYs that support the fast retrain capability transmit the link failure signal under the control of the Fast Retrain state diagram. The link failure signal indicates to the link partner that a link failure has been detected and that the link partners should begin the fast retrain procedure.

The link failure signal is sent for 4 LDPC frames and begins on a LDPC frame boundary. The link failure signal is transmitted without THP filtering. The link failure signal is transmitted on pair A when the PHY operates as a MASTER. The alert signal is transmitted on pair C when the PHY operates as a SLAVE.

When the PMA_CONFIG.indication parameter config is MASTER the link failure signal is composed of 7 repetitions of the following 128 symbol PAM2 sequence, followed by 128 zero symbols.

xFR_Master = xPR_Master × -1

When the PMA_CONFIG.indication parameter config is SLAVE the link failure signal is composed of 7 repetitions of the following 128 symbol PAM2 sequence, followed by 128 zero symbols.

xFR_Slave = xPR_Slave × -1

55.4.2.5.15 Fast retrain function

Insert the following subclause after subclause 55.4.2.5.15 in draft 2.2

PHYs that support the fast retrain capability shall implement the fast retrain state diagram shown in Figure 55–27b. PHYs may request a fast retrain by setting the variable loc_fr_req to TRUE. This causes the transmission of an easily-detected link failure signal. After transmitting the link failure signal the PHY shall transition to the PMA_Coeff_Exch state and send PAM2 signaling within a time period equivalent to 9 LDPC frame periods after completing the link failure signal.

After the detection of the link failure signal, a PHY shall transition to the PMA_Coeff_Exch state and respond with PAM2 signaling within a time period equivalent to 9 LDPC frame periods after receiving the link failure signal.

Note that reliable traffic on the transmitter may be interrupted when the local receiver requests a fast retrain.

Following the link failure signal, the two link partners transition back to the PMA_Coeff_Exch state and follow the training procedure described in 55.4.2.5.14, with the exception that the initial infofield countdown values are reduced as indicated in Figures 55-25 and 55-26.

To ensure interoperability the training times in Table 55–6a should be observed during the fast retrain.

Table 55–6a—Recommended fast retrain sequence timing

State	Recommended maximum time (ms)
PMA_Coeff_Exch state	20
PMA_Fine_Adjust state	10

55.4.2.6a Refresh Monitor function

Insert the following subclause after subclause 55.4.2.6 in draft 2.2

The Refresh monitor is required for PHYs which support the EEE capability. The Refresh monitor operates when the PHY is the low power receive mode. The Refresh monitor shall comply with the state diagram of Figure 55–27a. The function forces a link retrain if a refresh signal is not reliably detected within a moving

time window equivalent to 50 complete quiet-refresh cycles (nominally equal to 8.192 ms), when the PHY is in the lower power receive mode.

55.4.5.1 Variables

Insert the following variable definitions after all existing variable definitions in the existing 55.4.5.1

The following variable is required only for PHYs that support the EEE capability

lpi_refresh_detect
Set TRUE when the receiver has reliably detected refresh signaling and FALSE otherwise. The exact criteria left to the implementor.

The following four variables are required only for PHYs that support the fast retrain capability:

lpi_fr_en
Set TRUE through a management register. Advertised/resolved during autoneg.

loc_fr_req
Set TRUE when the receiver has detected a link failure condition and is requesting a fast retrain, set FALSE otherwise.

loc_fr_detect
Set TRUE when the receiver has reliably detected the link failure signal. It is highly recommended that loc_fr_detect is qualified with the reception of errored blocks at the LDPC decoder output. Set FALSE when the link failure signal is not detected.

send_link_fail
Set TRUE indicates that the PMA should send the link failure signal. When FALSE the variable has no effect.

55.4.5.2 Timers

Insert the following timer definitions after all existing variable definitions in the existing 55.4.5.2

The following timer is required only for PHYs that support the EEE capability.

lpi_refresh_rx_timer
Determines the maximum period of time the PHY has to reliably detect refresh signaling before a full retrain is performed. Has a period equal to us. Has a period equal to 50 complete quiet-refresh signal periods, which is equivalent to 8.192ms.

The following two timers are required only for PHYs that support the fast retrain capability:

link_fail_sig_timer
Determines the period of time the PHY sends the link failure signal. Has a period equal to 4 LDPC frame periods.

fr_maxwait_timer
Determines the period of time the PHY has to set PCS_Status=OKAY following a fast retrain before the fast retrain is aborted and a full retrain performed. Has a period equal to 30ms.

55.4.5.4 Counters

Insert the following counter definitions after all existing counter definitions in the existing 55.4.5.4

The following two counters are required only for PHYs that support the fast retrain capability:

fr_tx_counter

Counts the number of times the PHY initiates a fast link retrain by transmitting the link failure signal.

fr_rx_counter

Counts the number of times the PHY begins a fast link retrain in response to the detection of link failure signalling from the link partner.

55.4.6 State diagrams

55.4.6.1 PHY Control state diagram

NOTE: For PHYs which do not support the fast retrain capability the variable fast_retrain_flag is set to FALSE

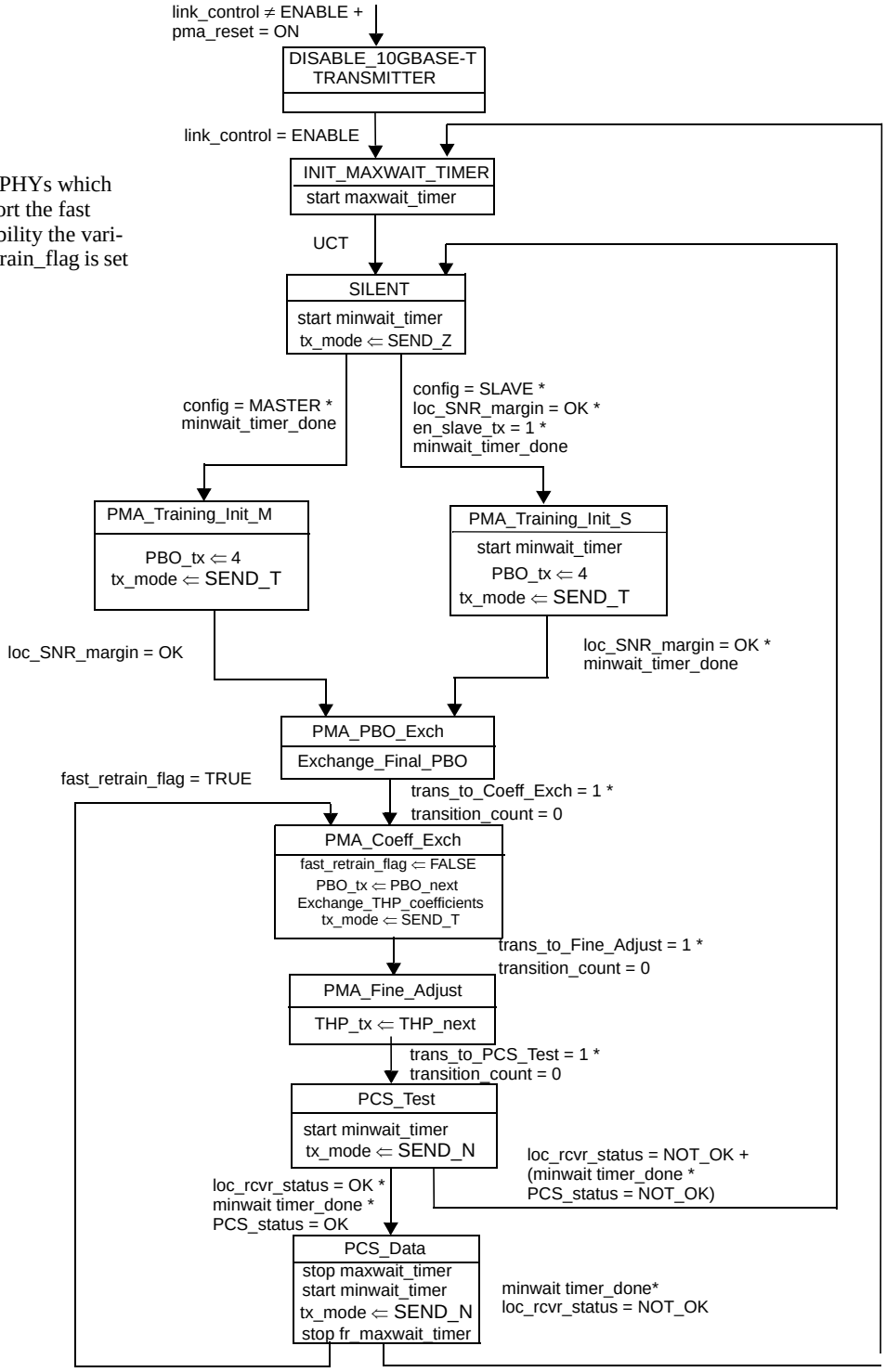

Figure 55–24—PHY Control state diagram

55.4.6.2 Transition counter state diagrams

Edit the existing state diagrams in 55.4.6.2, Figure 55–25 and Figure 55–26, as shown

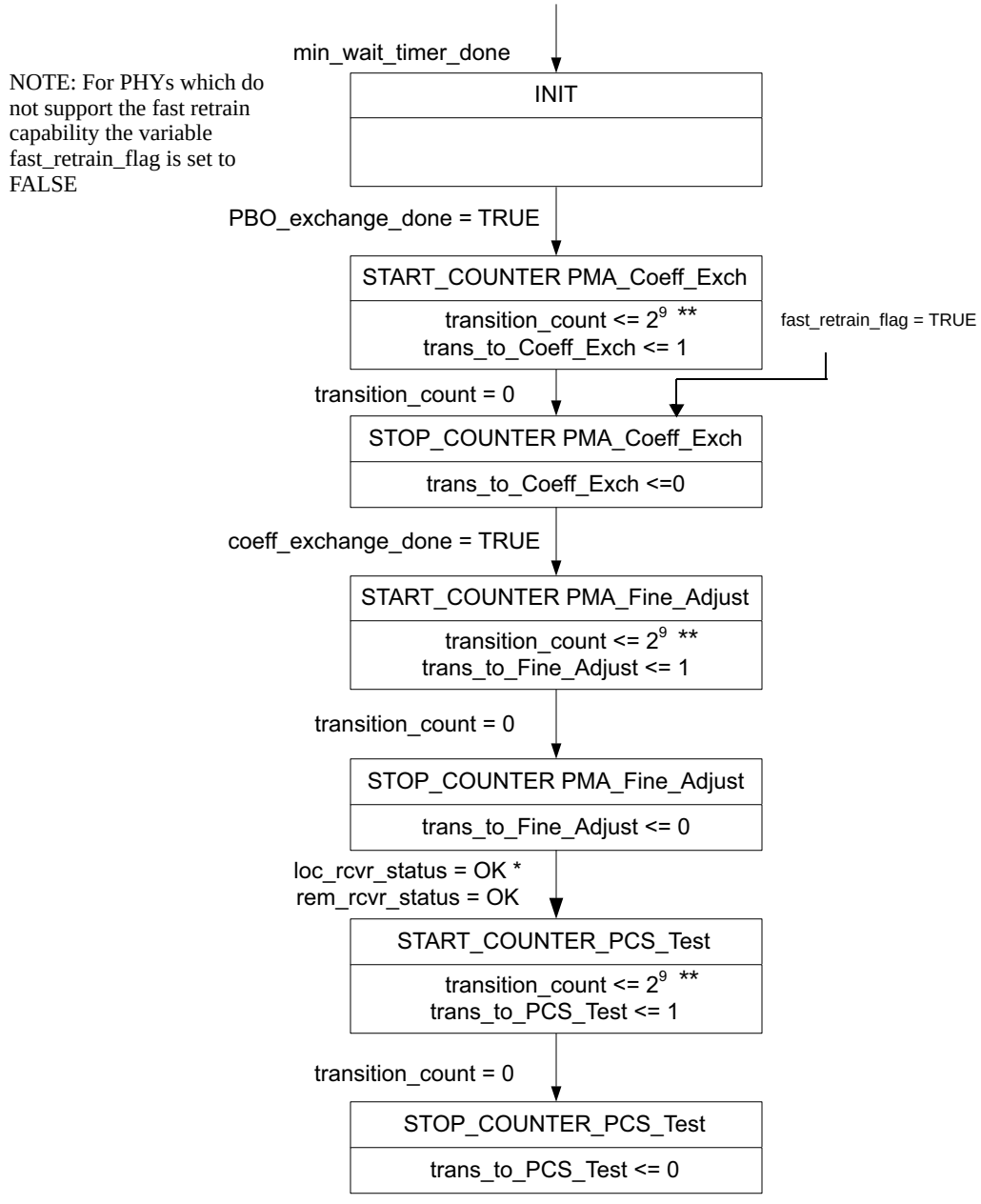

Figure 55–25—MASTER transition counter state diagram

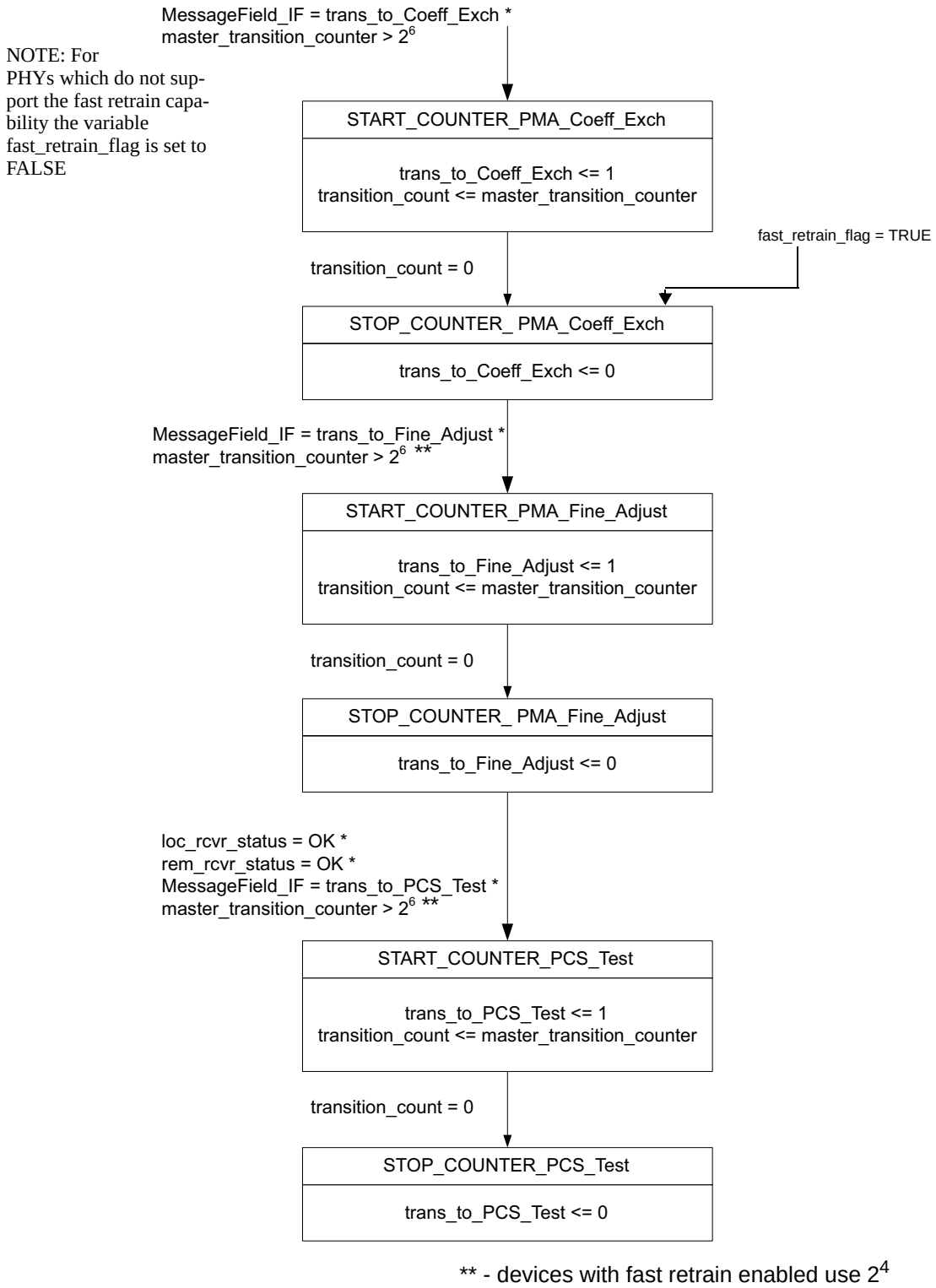

Figure 55–26—SLAVE transition counter state diagram

55.4.6.4 EEE Refresh monitor state diagram

Insert a new subclause 55.4.6.4 after subclause 55.3.6.3, containing Figure 55-27a, as shown below

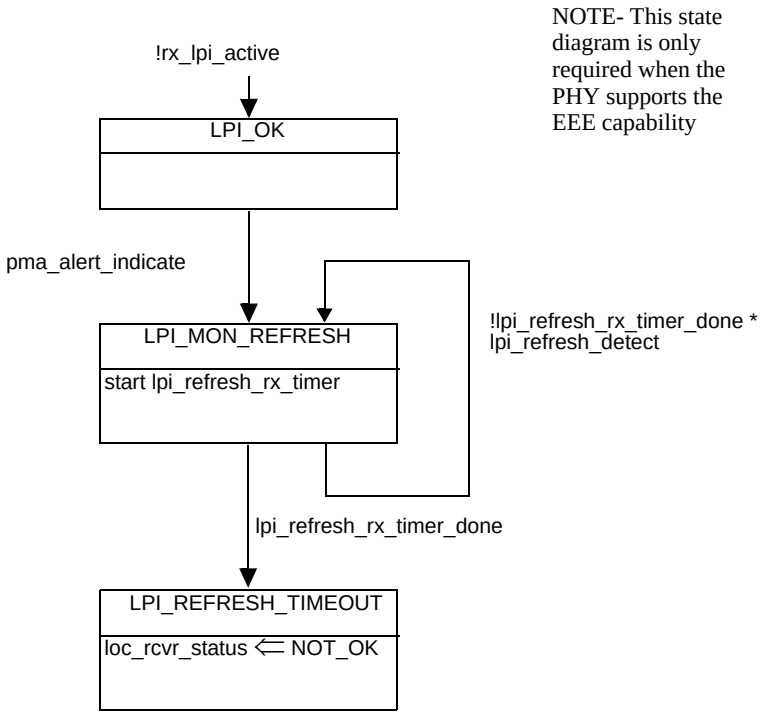

Figure 55–27a—EEE Refresh monitor state diagram

55.4.6.5 Fast Retrain state diagram

Insert a new subclause 55.4.6.5 after subclause 55.3.6.4, containing Figure 55-27b, as shown below

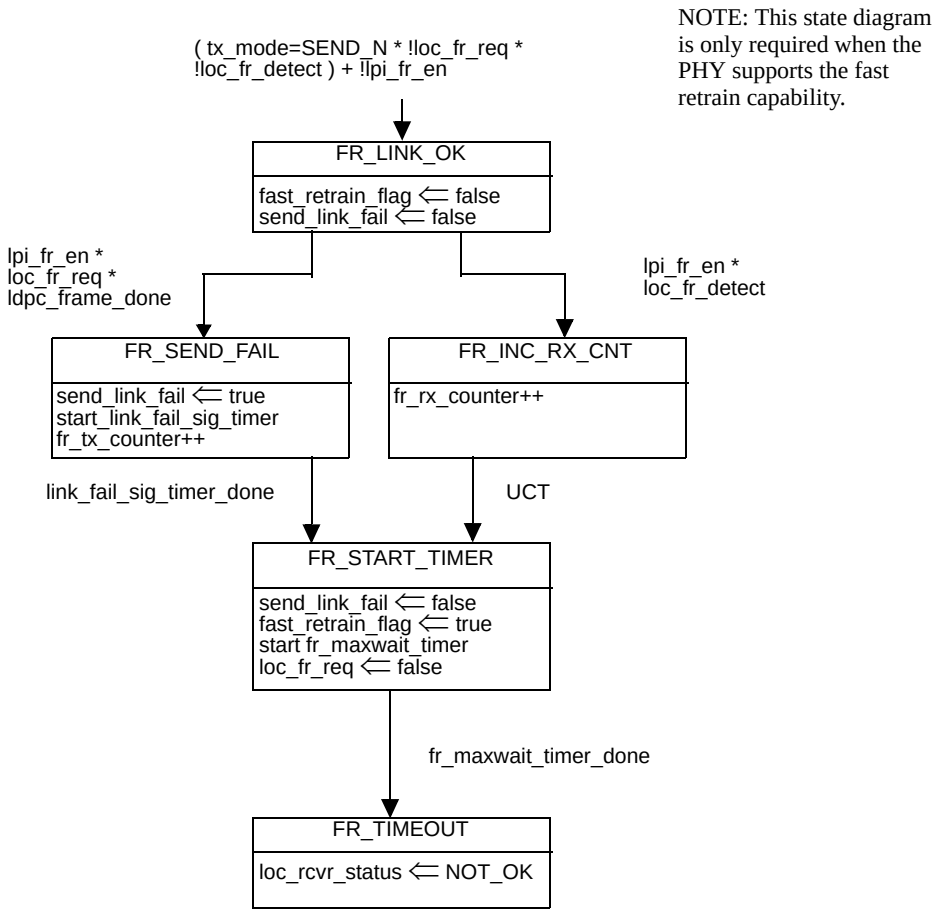

Figure 55–27b—Fast retrain control state diagram

55.4.2.4 PMA Receive function

Insert the following text after the existing text in 55.4.2.4:

PHYs that support the fast retrain capability shall set link_fail_detect to TRUE when the link failure signal is reliably detected at the receiver. The PMA receive function asserts link_fail_detect after the entire link failure signal (3.5 LDPC frame periods of the xfr_master or xfr_slave sequence and 0.5 frames of silence) has been detected. The link failure signal is specified in 55.4.2.2.2. The criterion used to generate link_fail_detect is left to the implementor. It is highly recommended that the generation of link_fail_detect is qualified with repeated errored frames at the LDPC decoder output.

55.4.4 Automatic MDI/MDI-X configuration

Edit the draft 2.2 text as follows:

For EEE capable PHYs, the MDI/MDIX function configuration shall apply to refresh and alert signaling. For PHYs with the fast retrain capability, the MDI/MDIX function configuration shall apply to link failure signaling.

55.6.1 Support for Auto-Negotiation

Change the list by adding (e) as a new item in the list as shown below:

a) To negotiate that the PHY is capable of supporting 10GBASE-T transmission.
b) To determine the MASTER-SLAVE relationship between the PHYs at each end of the link.
c) To determine whether the local PHY performs PMA training pattern reset.
d) To determine whether the local PHY supports the EEE capability.
e) To determine whether the local PHY supports the fast retrain capability

Edit the row for bit U19 in Table 55-11 as shown below:

Table 55–7—10GBASE-T Base and next pages bit assignments

Extended next page (Unformatted Message Code Field)		
U31:U21	Reserved, transmit as 0	
U20	LD PMA training reset request (1 = Local Device requests that Link Partner reset PMA training PRBS every frame 0 = Local Device requests that Link Partner run PMA training PRBS continuously)	Defined in 45.2.7.10.5
U19	Fast retrain ability (1 = Advertise PHY as supporting fast retrain, 0 = Advertise PHY as not supporting fast retrain)	Defined in 45.2.7.10

55.12 Protocol implementation conformance statement (PICS) proforma for Clause 55—Physical Coding Sublayer (PCS), Physical Medium Attachment (PMA) sublayer and baseband medium, type 10GBASE-T

55.12.2 Major capabilities/options

Insert the row shown below as the last row in the table:

Item	Feature	Subclause	Status	Support	Value/Comment
*EEE	Support of EEE capability		O	Yes [ ] No [ ]	
*FR	Support of Fast Retrain capability		O	Yes [ ] No [ ]	

55.12.4 Physical Medium Attachment (PMA)

Insert rows PMF8b, PMA10a, PMF16b, PMF16c, PMF16d and PMF18a after rows PMF8, PMF10, PMF16, PMF16 and PMF18 respectively:

Item	Feature	Subclause	Status	Support	Value/Comment
PMF8b	Link failure signaling	55.4.2.2	FR:M	Yes [ ] No [ ]	
PMF10a	Detect link failure signaling	55.4.2.4	FR:M	Yes [ ] No [ ]	
PMF16b	Implements fast retrain state diagram	55.4.2.5.15	FR:M	Yes [ ] No [ ]	
PMF16c	Transmit PAM2 within 9 LDPC frame periods following link failure tx	55.4.2.5.15	FR:M	Yes [ ] No [ ]	
PMF16d	Transmit PAM2 within 9 LDPC frame periods following link failure rx	55.4.2.5.15	FR:M	Yes [ ] No [ ]	
PMF17a	Refresh monitor state diagram	55.4.2.6a	EEE:M	Yes [ ] No [ ]	