Proposed text for 149.4.2.4.10

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149.4.2.4.10 Startup sequence

The start-up sequence shall comply with the state diagram description given in Figure 149–31. If the Auto-Negotiation function is not implemented, or disabled (mr_autoneg_en = false), PMA_CONFIG is predetermined to be MASTER or SLAVE via management control during initialization or via default hardware setup.
The Auto-Negotiation function is optional for 2.5GBASE-T1, 5GBASE-T1, and 10GBASE-T1 PHYs. If the Auto-Negotiation function is implemented and enabled, Auto-Negotiation is the source of control (via link_control) and MASTER/SLAVE configuration; however, if Auto-Negotiation is either not enabled or is not implemented, the Link Synchronization function is the source of control (via sync_link_control) and MASTER/SLAVE configuration.

During startup, prior to entering the COUNTDOWN state, the SLAVE shall align its transmit 65B-RS-FEC frame to within +0/–4 * S partial PHY frames of the MASTER as seen at the SLAVE MDI. The SLAVE InfoField partial PHY frame Count shall match the MASTER InfoField partial PHY frame Count for the aligned frame.

In the TRAINING state, PAM 2 transmission is used and PHY Capabilities are exchanged with Infofields as specified in 149.4.2.4.5.

At any time following the TRAINING state, if the local receiver status (indicated by loc_rcvr_status) transitions to NOT_OK, PHY Control returns to the SILENT state and attempts a retrain, until maxwait_timer expires.

The operation of the maxwait_timer requires that the PHY complete the start-up sequence from state INIT_MAXWAIT_TIMER to SEND_DATA in the PHY Control state diagram state diagram (Figure 149–31) in less than 1990 ms to avoid link_status being changed to FAIL by the Link Monitor state diagram (Figure 149–32).

Commenter's note (not part of proposed text) – the yellowed text said 97.5 ms, which agrees with the 100msec objective. However, the definition of the maxwait timer says 2000 ms +/- 10 ms.

The below is not part of the proposed text, but is an optional markup of the lengthier description in 1000BASE-T1. It is for the Task force to discuss whether we really need it. I recommend leaving it out, as the state diagram is the normative requirement and is clear.

If the Auto-Negotiation function is used, during the Auto-Negotiation process PHY Control is in the DISABLE_TRANSMITTER state and the transmitter is disabled. If the Auto-Negotiation function is not used, during the PHY Link Synchronization stage the PHY Control remains in the DISABLE_TRANSMITTER state and the Link Synchronization function (see 149.4.2.6) is the data source for the PMA Transmit function.

When the Auto-Negotiation asserts link_control = ENABLE, or PHY Link Synchronization process asserts sync_link_control = ENABLE, PHY Control enters the INIT_MAXWAIT_TIMER state. Upon entering the INIT_MAXWAIT_TIMER state, the maxwait_timer is started. PHY Control then transitions to the SILENT state where the minwait_timer is started and the PHY transmits zeros (tx_mode = SEND_Z).

In MASTER mode PHY Control transitions to the TRAINING state once the minwait_timer expires.

Upon entering the TRAINING state, the minwait_timer is started and the PHY Control asserts tx_mode = SEND_T sending PAM2 together with InfoFields. The PHY Control also sets PMA_state = 00 and sends the PHY capability bits (Table 149-9)..

Initially the MASTER is not ready for the SLAVE to respond and sets en_slave_tx = 0, which is communicated to the link partner via the InfoField. After the MASTER has sufficiently converged the necessary circuitry, the MASTER sets en_slave_tx = 1 to allow the SLAVE to transition to TRAINING.

In SLAVE mode PHY Control transitions to the TRAINING state only after the SLAVE PHY sets loc_SNR_margin = OK, which generally occurs after the SLAVE acquires timing, converges its equalizers and acquires its descrambler state.

Upon entering the TRAINING state, the minwait_timer is started and the PHY Control asserts tx_mode = SEND_T sending PAM2 together with InfoFields. The PHY Control also sets PMA_state = 00 and sends the PHY capability bits.

After the PHY completes successful training and establishes proper receiver operations, PCS Transmit conveys this information to the link partner via transmission of the parameter InfoField value loc_rcvr_status. The link partner's value for loc_rcvr_status is stored in the local device parameter rem_rcvr_status. Upon expiration of the minwait_timer and when the condition loc_rcvr_status = OK and rem_rcvr_status = OK is satisfied, PHY control transitions to the COUNTDOWN state.

Upon entering the COUNTDOWN state, PHY Control sets PMA_state = 01 and DataSwPFC24 to the value of the partial PHY frame count which will count down. When the count of partial PHY frames reaches zero, the PHY enters the TX_SWITCH state and switches the transmitter from PAM2 to PAM4, asserting tx_mode = SEND_N and begins transmitting (PAM4) idles.

Once the remote PHY has also transitioned to TX_SWITCH, and the local PHY has received a valid (PAM4) PHY frame containing idles, PHY control transitions to the PCS_TEST state and starts minwait timer. Upon expiration of the minwait_timer, if the PCS_status is NOT_OK, the PHY returns to the SILENT state and attempts retraining until the maxwait_timer expires. If the PCS_status is OK and the loc_rcvr_status is OK, PHY control transitions to the SEND_DATA state.

Upon entering the SEND_DATA state, PHY Control starts the minwait_timer and enables frame transmission to the link partner by asserting tx_mode = SEND_N.