201.6.2.3 PMA Receive function

The low speed PMA Receive function comprises a receiver for the DME signal on the MDI. PMA Receive contains the circuits necessary to both detect symbol sequences from the signals received at the MDI, and to present these sequences to the PCS Receive function. The PMA translates the signals received at the MDI into the PMA_UNITDATA.indication parameter rx_symb. The quality of these symbols shall allow RFER of less than 2 x after RS-FEC decoding, over a channel meeting the requirements of 201.11 for balanced pair cabling and of 201.12 for coaxial cabling.

The low speed direction PMA Receiver function uses the parameters pcs_status and scr_status, along with other applicable receiver status, and generates the loc_rcvr_status variable accordingly The loc_rcvr_status variable is expected to become NOT_OK when the link partner's tx_mode changes to SEND_Z from any other value (see the PHY Control state diagram in Figure 149-32). The precise algorithm for generation of loc_rcvr_status is implementation dependent.

The receiver uses the sequence of symbols during the training sequence to detect and correct for pair polarity swaps.

The PMA Receive fault function is optional. The PMA Receive fault function is the logical OR of the

link_status = FAIL and any implementation specific fault. If the MDIO interface is implemented, then this function shall contribute to the receive fault bit specified in 45.2.1.7.5 and 45.2.1.193.7.

201.6.2.4 PHY Control function

The Message and PHY Capability Bits in 201.4.5 are as described in 149.4.2.4.4 and 149.4.2.4.5.

All reserved fields shall be set to 0.

The PMA MDIO function mappings are as described in 149.4.2.4.9.

201.7 Common PMA functions

This clause describes items that apply to both the fast and slow directions.

201.7.1 PHY Control Function

201.7.1.1 Startup Sequence

The startup sequence shall comply with the state diagram description given in Figure 201–21. If the Auto-Negotiation function is not implemented, or disabled (mr_autoneg_en = FALSE), PMA_CONFIG is predetermined to be LEADER or FOLLOWER via management control during initialization or via default hardware setup. The Auto-Negotiation function is optional for MultiG+100M/100M+MultiGBASE-T1/V1 PHYs. If the Auto-Negotiation function is implemented and enabled, Auto-Negotiation is the source of control (via link_control) and LEADER/FOLLOWER 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 LEADER/FOLLOWER configuration.

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.

The startup timing shall comply with Table 201–10 for LEADER and Table 201–11 for FOLLOWER. See Table 201–1 for the definition of *S*.

Table 201–10—Startup timing maximums for LEADER

Timing interval	Maximum time (ms)
From entry to SILENT state until en_follower_tx = 1 is transmitted	40 – 0.384 / *S*
From entry of SILENT state until entry to COUNTDOWN state	95.975 – 0.384 / *S*
Entry to COUNTDOWN until entry of TX_SWITCH	0.384 / *S*
Entry to exit of PCS TEST	1.025
Total (Entry to SILENT to exit of PCS TEST)	97

Table 201–11—Startup timing maximums for FOLLOWER

Timing interval	Maximum time (ms)
Entry to exit of SILENT state	40
Entry of SILENT state to exit of TRAINING state	95.975 – 0.384 / *S*
Entry to COUNTDOWN until entry of TX_SWITCH	0.384 / *S*
Entry to exit of PCS TEST	1.025
Total (Entry to SILENT to exit of PCS TEST)	97

201.7.1.2 State diagram variables

auto_neg_imp
This variable indicates if an optional Auto-Negotiation sublayer is associated with the PMA.
Values:
TRUE: An optional Auto-Negotiation sublayer is associated with the PMA.
FALSE: An optional Auto-Negotiation sublayer is not associated with the PMA.

config
The PMA generates this variable continuously and passes it to the PCS via the PMA_CONFIG.indication primitive.
Values: MASTER or SLAVE.

en_slave_tx
The en_slave_tx variable in the Infofield received by the SLAVE.
Values:
0: MASTER is not ready for the SLAVE to transmit.
1: MASTER is ready for the SLAVE to transmit.

infofield_complete
This variable indicates that a complete set of Infofield messages has been sent (see 149.4.2.4 for HS_PATH.).
Values:

FALSE: A complete set of Infofield messages has not been sent.
TRUE: A complete set of Infofield messages has been sent.

link_control

This variable is defined in 201.2.1.1.1.

link_status

The link_status parameter set by PMA Link Monitor state diagram and communicated through the PMA_LINK.indication primitive.
Values: OK or FAIL.

loc_countdown_done

This variable is set to FALSE when the PHY Control state diagram is in the DISABLE_TRANSMITTER state and is set to TRUE immediately after transmitting the last bit of the DataSwPFC24–1 partial PHY frame.

loc_rcvr_status

Variable set by the PMA Receive function to indicate correct or incorrect operation of the receive link for the local PHY.
Values:
OK: The receive link for the local PHY is operating reliably.
NOT_OK: Operation of the receive link for the local PHY is unreliable.

loc_SNR_margin

This variable reports whether the local device has sufficient SNR margin to continue to the next state. The criterion for setting the parameter loc_SNR_margin is left to the implementer.
Values:
OK: The local device has sufficient SNR margin.
NOT_OK: The local device does not have sufficient SNR margin.

pcs_data_mode

Generated by the PMA PHY Control function and indicates whether or not the local PHY may transition its PCS state diagrams out of their initialization states. The current value of the pcs_data_mode is passed to the PCS via the PMA_PCSDATAMODE.indication primitive.

phy_role

This variable indicates which side of the asymmetrical line the device is on.
Values:
PHY_S: MultiG+100MBASE-T1/V1 PHY.
PHY_D: 100M+MultiGBASE-T1/V1 PHY.

pma_reset

Allows reset of the PHY Control and Link Monitor state diagrams.
Values: ON or OFF.

PMA_state

Variable for the value transmitted in the PMA_state<7:6> of the Infofield by the local PHY.
Values:
00: TRAINING state
01: COUNTDOWN state

rem_countdown_done

This variable is set to FALSE when the PHY Control state diagram is in the

DISABLE_TRANSMITTER state or SILENT state and is set to TRUE once the receiver has transitioned from PAM2 to PAM4.

rem_rcvr_status

Variable set by the PCS Receive function to indicate whether correct operation of the receive link for the remote PHY is detected or not.

Values:

- OK: The receive link for the remote PHY is operating reliably.
- NOT_OK: Reliable operation of the receive link for the remote PHY is not detected.

sync_link_control

This variable is defined in 201.7.3.1.

tx_mode

The PMA generates this variable continuously and passes it to the PCS via the PMA_TXMODE.indication primitive.

Values:

- SEND_N: This value is continuously asserted when transmission of sequences of symbols representing a XGMII data stream take place.
- SEND_T: This value is continuously asserted when transmission of sequences of symbols representing the training sequences of symbols is to take place.
- SEND_Z: This value is asserted when transmission of zero symbols is to take place.

201.7.1.3 State diagram timers

All timers operate in the manner described in 14.2.3.2.

minwait_timer

A timer used to determine the minimum amount of time the PHY Control stays in the SILENT, TRAINING, PCS_TEST, and PCS_DATA states. The timer shall expire 975 μs ± 50 μs after being started.

201.7.1.4 State diagrams

The PHY Control state diagram is shown in Figure 201–21.

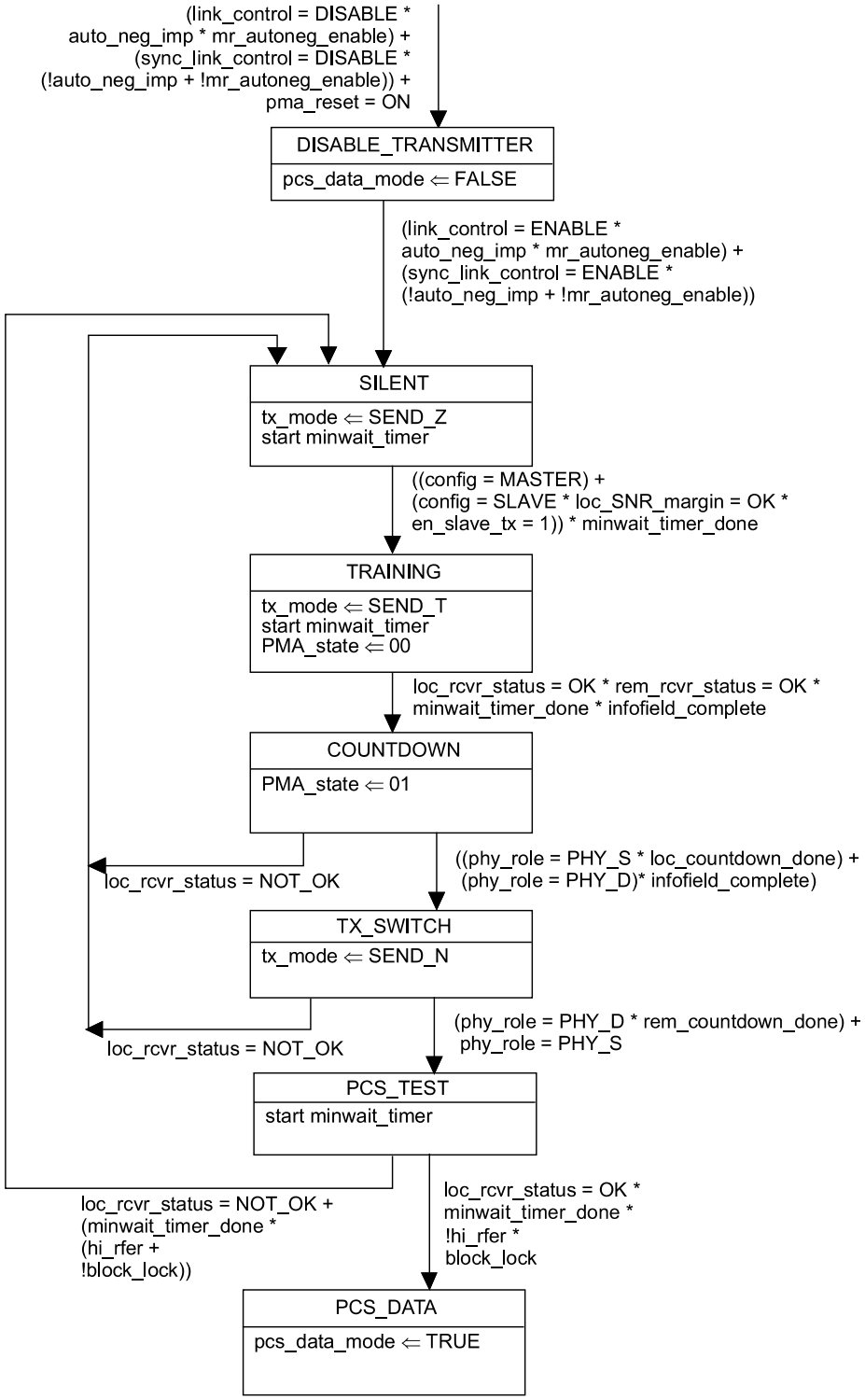


Figure 201–21—PHY Control state diagram

201.7.2 Link Monitor function

Link Monitor determines the status of the underlying receive channel and communicates it via the variable link_status. Failure of the underlying receive channel causes the PMA to set link_status to FAIL, which in turn causes the PMA's clients to stop exchanging frames and restart the Auto-Negotiation (if enabled) or Link Synchronization (if Auto-Negotiation is not enabled) process.

The Link Monitor function shall comply with the state diagram of Figure 201–22.

Upon power on, reset, or release from power down, the Auto-Negotiation function sets link_control = DISABLE, or PHY Link Synchronization algorithms set sync_link_control = DISABLE. During this period, link_status = FAIL is asserted. When the Auto-Negotiation function establishes the presence of a remote MultiG+100M/100M+MultiGBASE-T1/V1 PHY, link_control is set to ENABLE, or when the PHY Link Synchronization finishes the synchronization function, sync_link_control is set to ENABLE, and the Link Monitor state diagram begins monitoring the PCS and receiver lock status. As soon as reliable transmission is achieved, the variable link_status = OK is asserted, upon which further PHY operations can take place.

201.7.2.1 State diagram variables

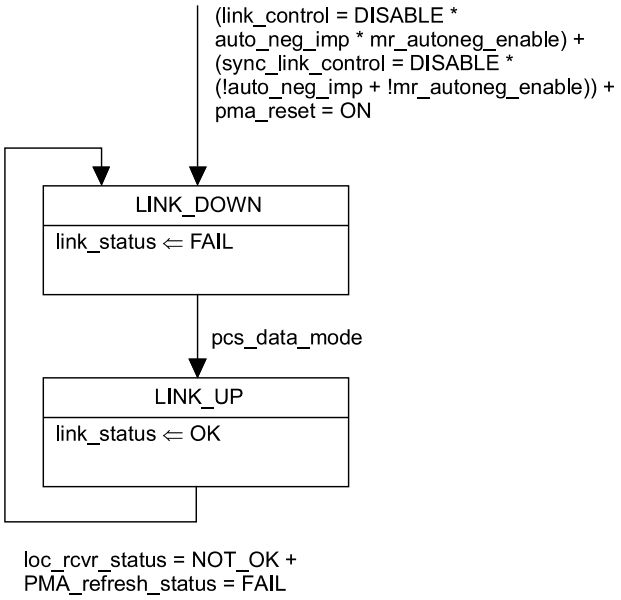
The variables defined in 201.7.1.2 apply to this clause.

201.7.2.2 State diagram timers

The variables defined in 201.7.1.3 apply to this clause.

201.7.2.3 State diagrams

The Link Monitor state diagram is shown in Figure 201–22.



NOTE—The variables link_control and link_status are designated as link_control_mGigT1 and link_status_mGigT1, respectively, by the Auto-Negotiation Arbitration state diagram (Figure 98–7) if the optional Auto-Negotiation function is implemented.

Figure 201–22—Link Monitor state diagram

201.7.3 PHY Link Synchronization

If the optional Clause 98 Auto-Negotiation function is disabled or not implemented, then the Link Synchronization function shall establish the start of PHY PMA training as defined in 201.6.2.4.

When operating, the Link Synchronization function is the data source for the PMA Transmit function (see 201.6.2.2), and uses a signal, SEND_S. This signal is used by the LEADER and FOLLOWER to discover the link partner and synchronize the start of PMA training. The structure of the Link Synchronization signaling is shown in Figure 201–23.

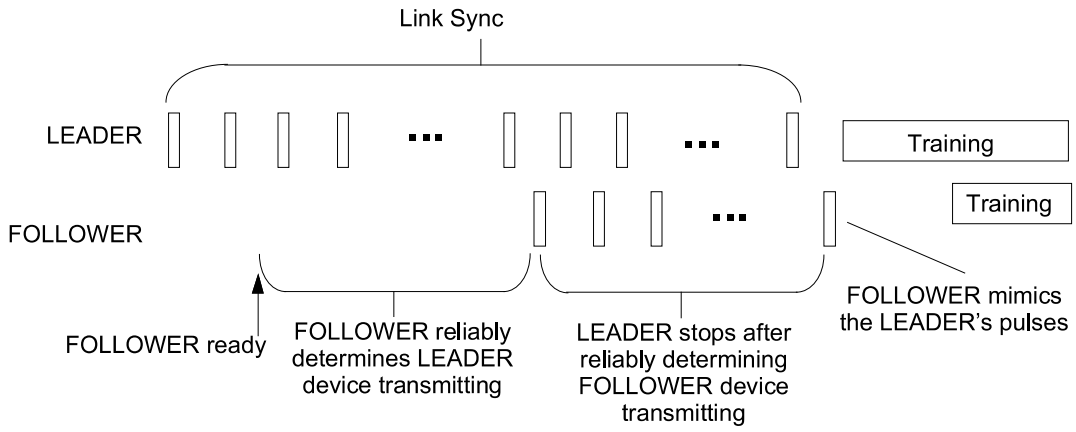


Figure 201–23—Link Synchronization signaling structure

A SEND_S pulse is defined to be a 4-bit pulse of 1001 mapped to DME symbols. The polarity of the DME symbols can be of either polarity and can vary between SEND_S pulses. At the LEADER, each DME symbol time is nominally 25.6/3 ns (8.533 ns) +/- 50ppm. At the FOLLOWER each DME symbol time is nominally 25.6/3 ns +/-15%. The large tolerance is to accommodate crystal-less implementations at the FOLLOWER. See 201.4.2.2.16 for details on the DME symbols.

At the LEADER, SEND_S signal is defined to be a periodic signal with a SEND_S pulse (34.133ns) followed by 116 DME symbol periods of quiet for a total of 120 DME symbol periods (1024ns) per interval.

When the FOLLOWER detects sufficient number of the LEADER's SEND_S pulses to determine that the LEADER is active, the FOLLOWER shall output SEND_S signal defined as the following. The SEND_S signal is normally quiet, with the SEND_S pulse being output 435 +/- 50ns after the detection of the start of the LEADER's SEND_S pulse at the FOLLOWER's receiver.

The SENDS_S pulse timing is shown in Figure 201–24.

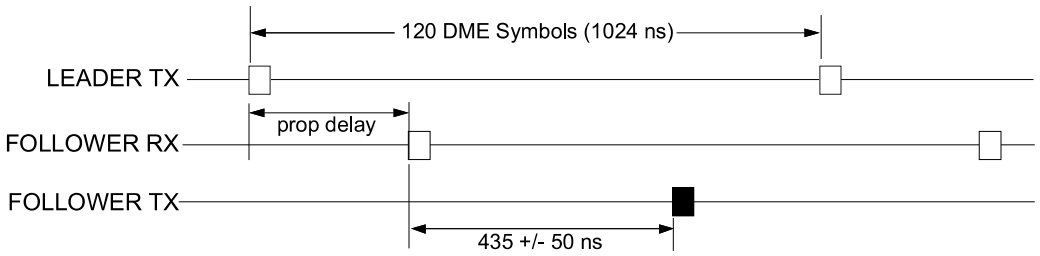


Figure 201–24—Link Synchronization timing

201.7.3.1 State diagram variables

force_config
This variable indicates whether the PHY operates as a LEADER or as a FOLLOWER. The variable takes on one of the following values:
LEADER: This value is continuously asserted when the PHY operates as a LEADER.
FOLLOWER:This value is continuously asserted when the PHY operates as a FOLLOWER.

force_phy_type
This variable indicates what speed the PHY is to operate when Auto-Negotiation is disabled or not implemented. The variable takes on one of the following values:
10G+100M-T1/V1:If Auto-Negotiation is disabled or not implemented and 10G+100MBASE-T1/V1 is selected.
5G+100M-T1/V1:If Auto-Negotiation is disabled or not implemented and 5G+100MBASE-T1/V1 is selected.
2.5G+100M-T1/V1: If Auto-Negotiation is disabled or not implemented and 2.5G+100MBASE-T1/V1 is selected.
100M+10G-T1/V1:If Auto-Negotiation is disabled or not implemented and 100M+10GBASE-T1/V1 is selected.
100M+5G-T1/V1:If Auto-Negotiation is disabled or not implemented and 100M+5GBASE-T1/V1 is selected.
100M+2.5G-T1/V1:If Auto-Negotiation is disabled or not implemented and 100M+2.5GBASE-T1/V1 is selected.
Other values are implementation-dependent and beyond the scope of this clause.

link_status
The link_status parameter is set by PMA Link Monitor and passed to the PCS via the PMA_LINK.indication primitive. This variable takes the values of OK or FAIL.

mr_autoneg_enable:
see 98.5.1.

mr_main_reset
see 98.5.1.

power_on
see 98.5.1.

send_s_sigdet
This variable indicates whether the sufficient SEND_S pulses of the SEND_S signal was detected

with proper spacing. At least 3 consecutive valid SEND_S pulses shall be detected before setting this variable from FALSE to TRUE. At least 3.1us period with no SEND_S pulses detected shall be detected before setting this variable from TRUE to FALSE.
Values:
TRUE: SEND_S signal detected.
FALSE: SEND_S signal not detected.

sync_link_control
This variable indicates the data source for the PMA Transmit function.
Values:
DISABLE: The data source is the PHY Link Synchronization function (sync_tx_symb).
ENABLE: The data source is PMA_UNITDATA.request (tx_symb).

201.7.3.2 State diagram timers

break_link_timer
see 98.5.2.

link_fail_inhibit_timer
see 98.5.2.

sigdet_wait_timer
This timer is used to control the wait time after transmitting or detecting the end of SEND_S. The timer shall expire 5 µs ± 0.15 µs after being started.

201.7.3.3 Messages

sync_tx_symb
The value of sync_tx_symb is set by the Link Synchronization state diagram and indicates the symbols sent from the PHY Link Synchronization block to PMA Transmit. The Link Synchronization block generates sync_tx_symb synchronously with every transmit clock cycle.
Values:
SEND_S: Transmit the SEND_S signal defined in 201.7.3.
SEND_Z: Transmit a zero value.

201.7.3.4 State diagrams

The PHY Link Synchronization state diagram is shown in Figure 201–25.

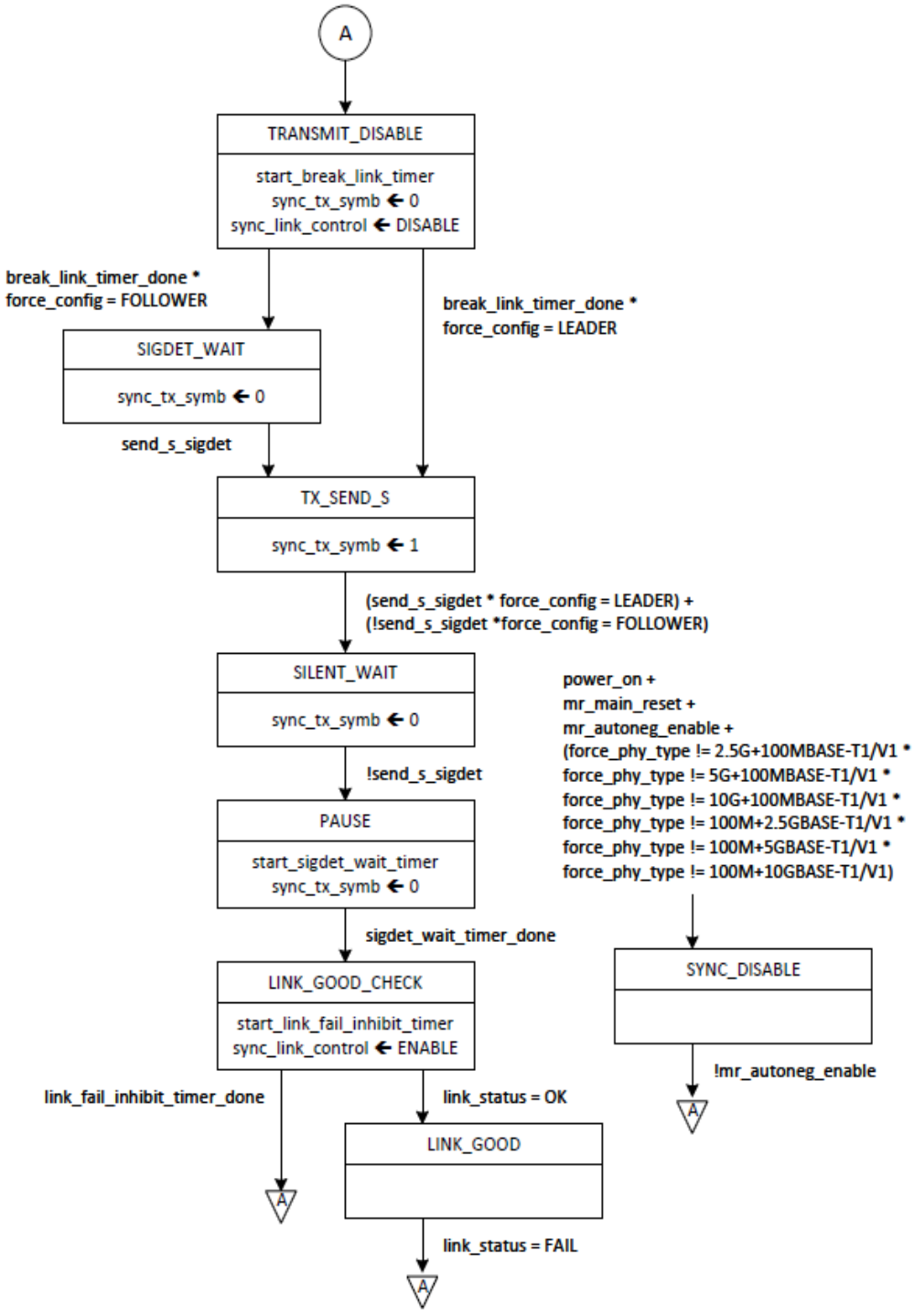


Figure 201–25—PHY Link Synchronization state diagram