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IEEE 802.3cg

10BASE-T1S Autoneg and Link Status Indication

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- Problem statement:
  - 10BASE-T1S defines support for Clause 98 Auto-Negotiation (AN)
  - AN requires a link status indication to work properly
    - Comment #204 on D2.0 from Steffen Graber
    - 10BASE-T1S in current draft has no such concept of link status
      - There is no training phase and no continuous IDLE indication on the line

- Background
  - AN is optional
  - AN is not defined for multi-drop
  - With an AN/non-AN link, AN cannot complete and link will stay down forever
    - Remark: only true for Clause 98 AN

- Requirements for link status indication:
  - Reception of a number of HB in a certain time indicates the link is up
  - Missing HB / packets for a certain amount of time results in a link down
  - HB must not affect traffic during normal operation
- Proposed solution
  - Add a link monitor state machine in the PMA
  - Add FSM in PCS TX to transmit a heartbeat (HB) signal on the line periodically
    - HB is preempted by the MAC transmitting and by PLCA
      - Reception of a valid data packet counts as an HB
  - Add FSM in PCS RX to generate a PCS status indication based on HB / packet reception
  - Report link up when at least one HB / valid packet is received
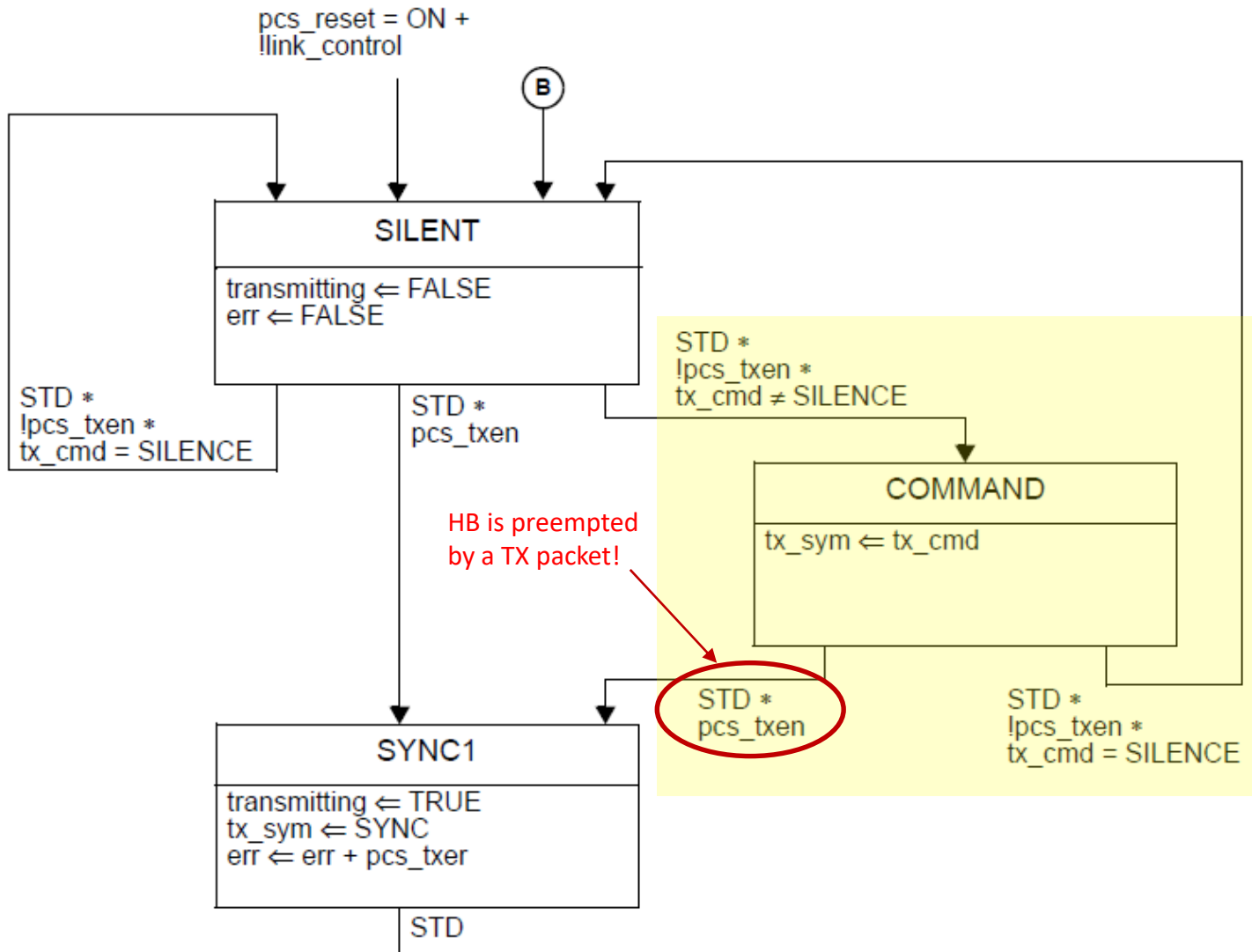 - Report link down if no HB / valid packets are received in a certain time interval

Figure 147-4 PCS Transmit state diagram (part a)

Not interfering with TX from MII: re-use of PCS TX COMMAND state to send HB on the line

HEARTBEAT is a repeated 'T' (01101) 5B symbol. Such symbol is already used as ESD but it can be re-used for this purpose (no ambiguities)

It is transmitted by PCS TX, using the already available tx_cmd variable.

The tx_cmd variable is used by PLCA RS to convey BEACON and COMMIT commands to the PHY. PLCA takes precedence over the HB.

- Point-to-Point full-duplex case
  - No additional problems (HBs cannot collide!)
- Point-to-Point half-Duplex case
  - Possible collisions between HB and data packets
    - Data will be re-transmitted by MAC (normal CSMA/CD behavior)
    - HB re-transmitted after jamming, during IPG (collisions are no more possible)
  - Use auto-neg master/slave negotiation to select which PHY has to send unsolicited HB
    - Only the master sends unsolicited HB
    - Slave PHY replies to HB messages with HB in turn
      - This minimizes the chance of collision between packets and HB
        » Collisions between HBs are not possible
    - NOTE: 10BASE-T1S does not require master/slave negotiation for normal operation
      - Not a far-end echo canceled system, no clock looping
  - PLCA works on multi-drop networks where AN is not defined, thus it does not need an HB concept.
    - Disable HB if PLCA is enabled / detected
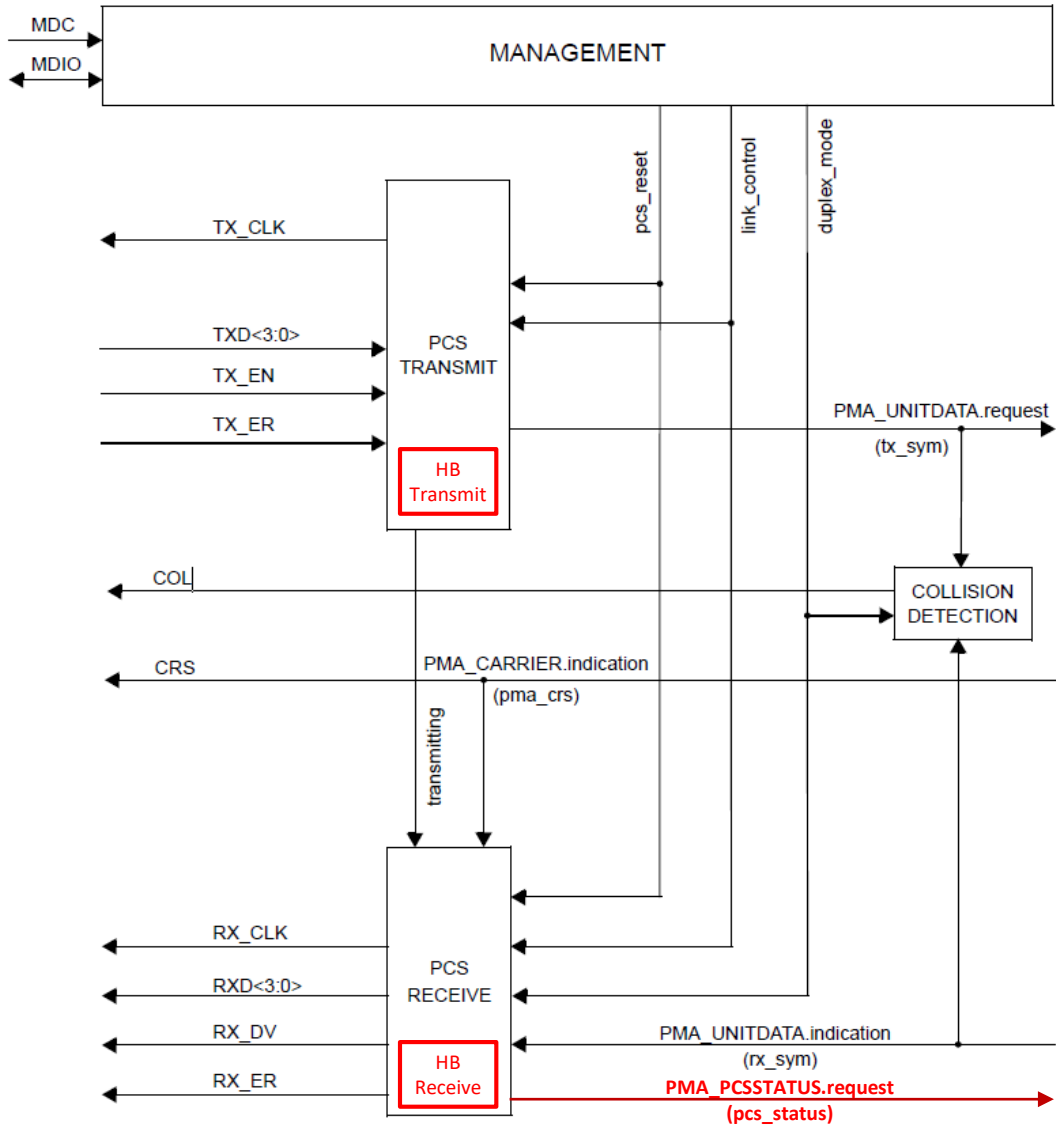
Modifications to PCS / PMA (add PMA primitives)
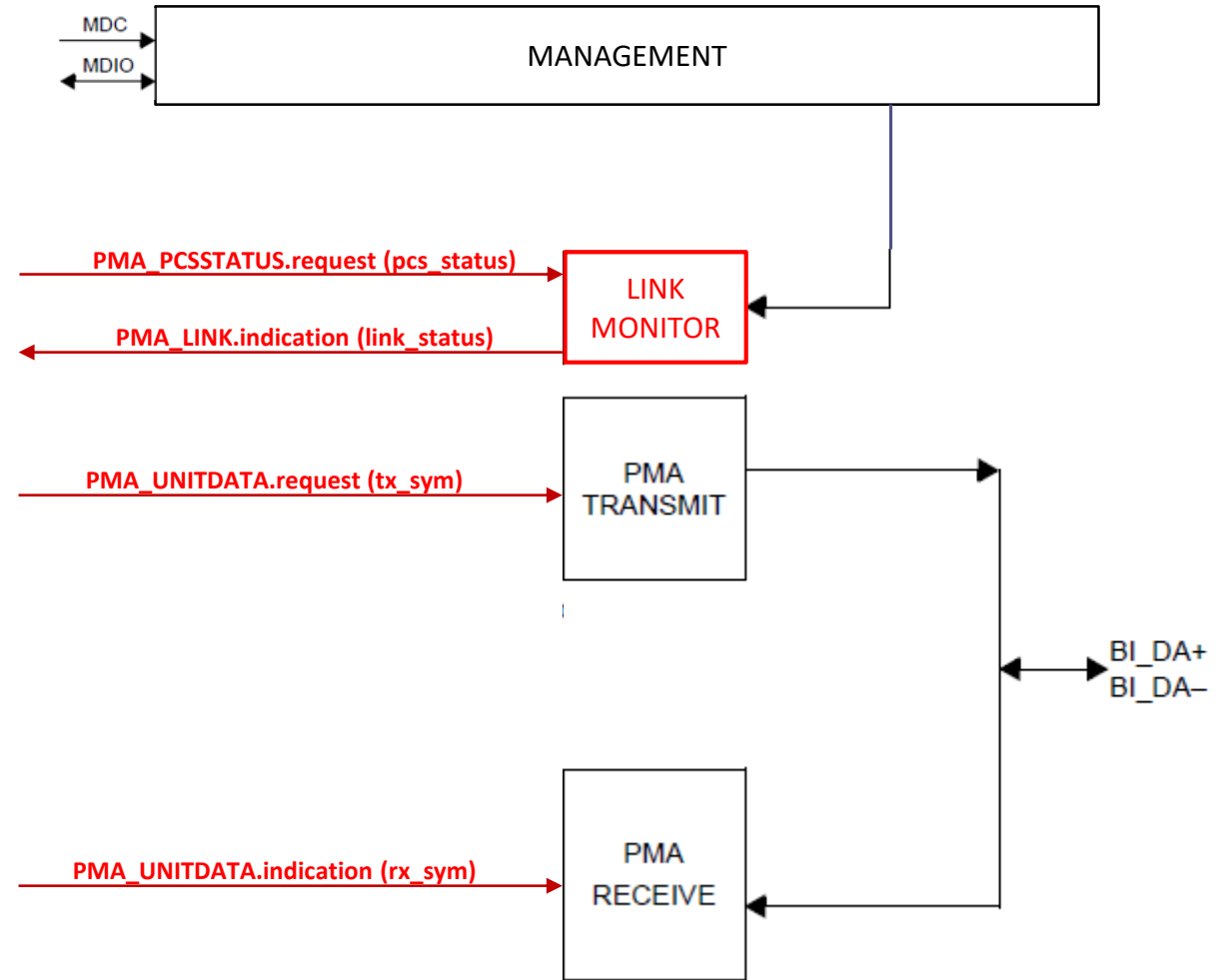
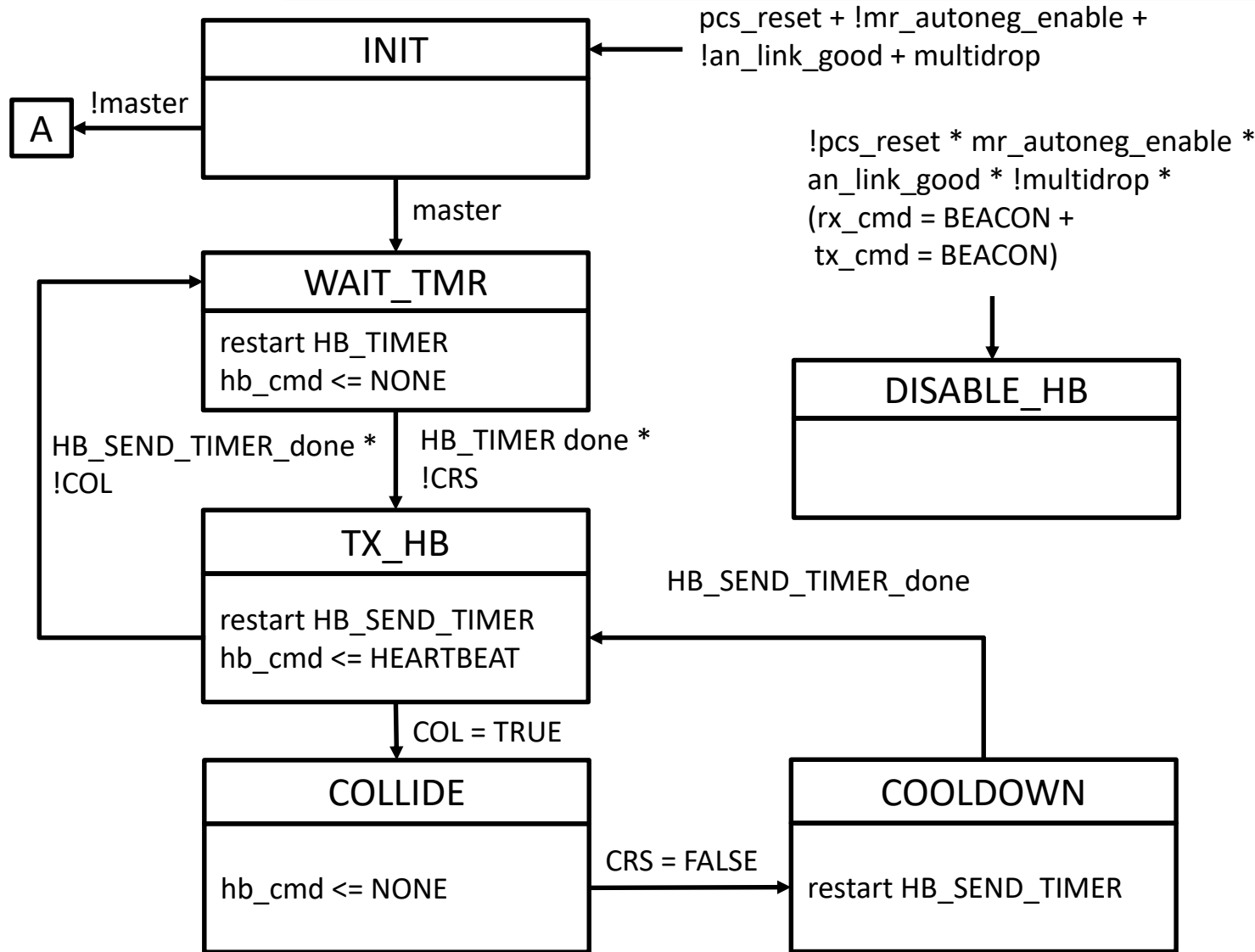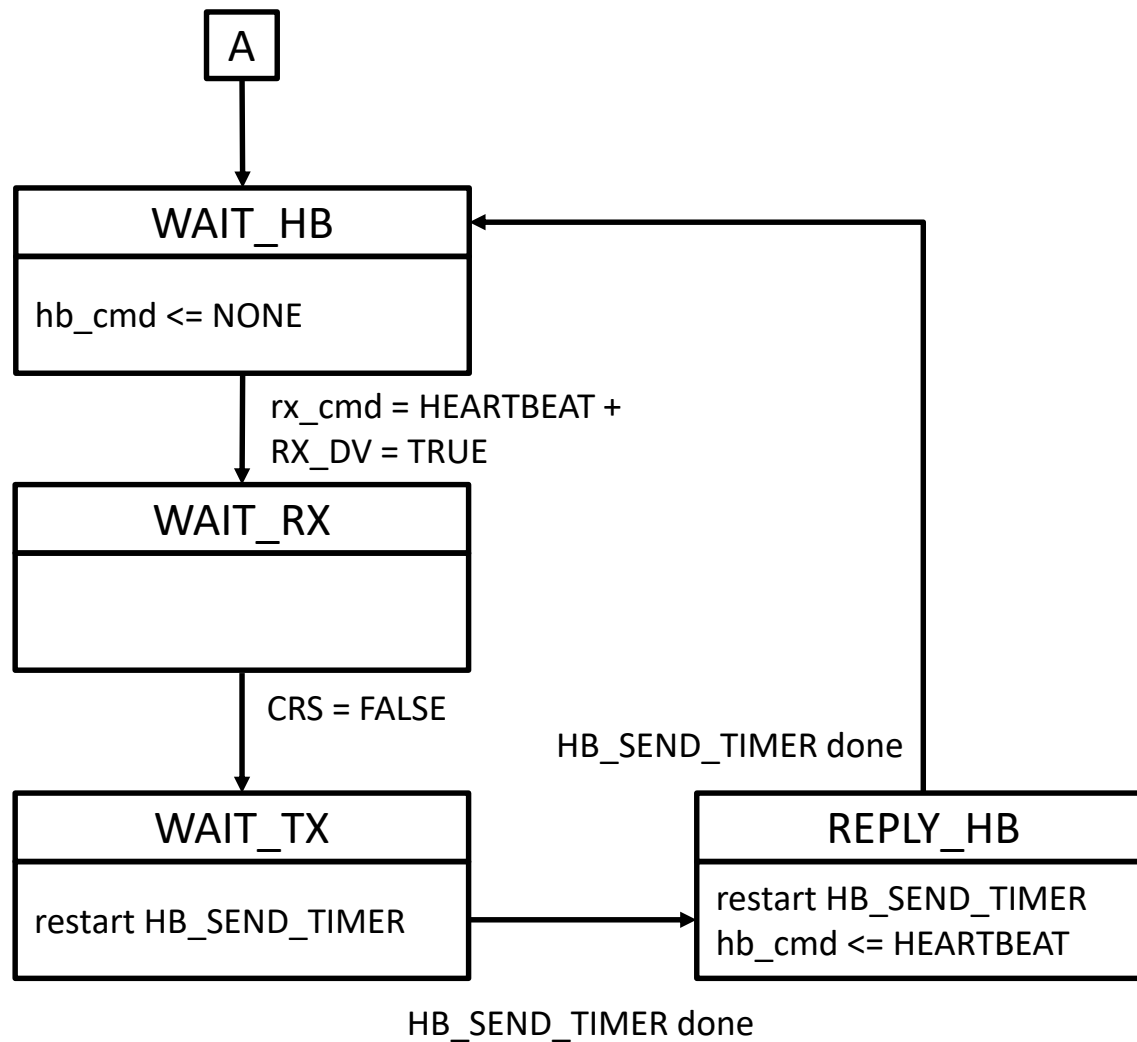

Figure 147–3—PCS reference diagram

Figure 147-TBD – PMA functional block diagram

- HB_TIMER = 50 ms
- HB_SEND_TIMER = duration of HB on the line = 20 bit-times
- mr_autoneg_enable = Auto-Negotiation supported and enabled
- an_link_good = Auto-Negotiation complete
- multidrop = Multidrop mode (register 1.2299.10)
- master = TRUE when master role negotiated using method in 98.2.1.5 and Table 98-4
- rx_cmd = enumerated value set to 'BEACON' when a BEACON indication is generated as specified in 147.3.7.1. Set to 'COMMIT' when a COMMIT indication is generated as specified in 147.3.7.2. Set to 'HEARTBEAT' when a HB is detected on the line. Set to 'NONE' otherwise.

State diagram text:

pcs_reset + !mr_autoneg_enable + !an_link_good + multidrop

INIT

!master → A

master

WAIT_TMR
restart HB_TIMER
hb_cmd <= NONE

HB_SEND_TIMER_done * !COL

HB_TIMER done * !CRS

!pcs_reset * mr_autoneg_enable * an_link_good * !multidrop * (rx_cmd = BEACON + tx_cmd = BEACON)

DISABLE_HB

TX_HB
restart HB_SEND_TIMER
hb_cmd <= HEARTBEAT

HB_SEND_TIMER_done

COL = TRUE

COLLIDE
hb_cmd <= NONE

CRS = FALSE

COOLDOWN
restart HB_SEND_TIMER

- HB_SEND_TIMER = duration of HB on the line = 20 bit-times
- mr_autoneg_enable = Auto-Negotiation supported and enabled
- an_link_good = Auto-Negotiation complete
- multidrop = Multidrop mode (register 1.2299.10)
- hb_cmd = enumerated value. Values: HEARTBEAT, NONE.
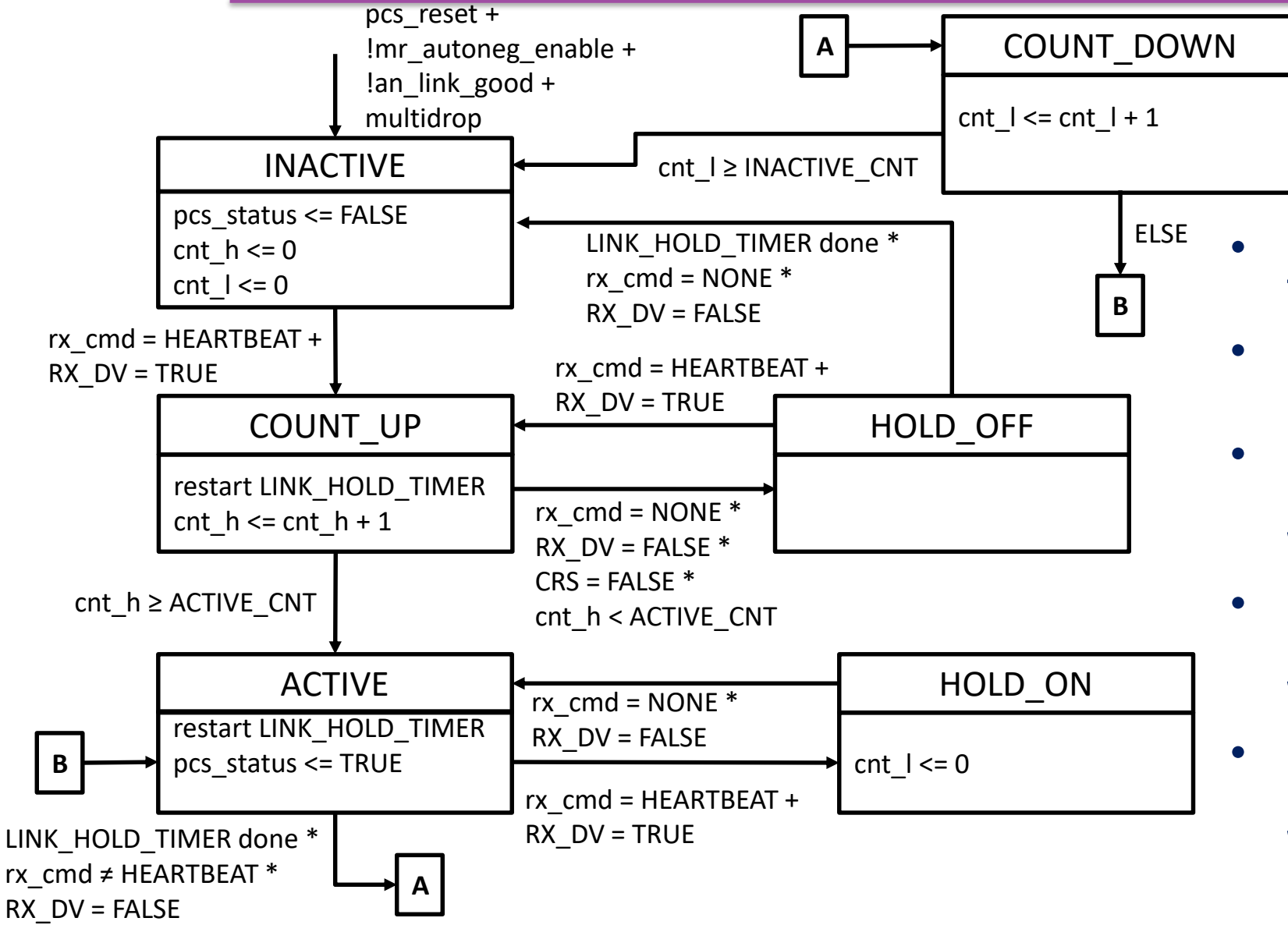
- cnt_l = counter of HB when pcs_status is TRUE
- cnt_h = counter of HB when pcs_status is FALSE
- ACTIVE_CNT = number of HB required to signal pcs_status = TRUE
  Value: 1
- INACTIVE_CNT = number of HB required to signal pcs_status = FALSE
  Value: 5
- LINK_HOLD_TIMER: time after which the count of HB is reset
  Value: 50 ms

- tx_cmd
  - 5B symbol to be transmitted when the PCS Transmit function is in COMMAND state. The tx_cmd variable is assigned according to PLCA RS signaling over MII interface, as defined in 22.2.2.4, 148.4.3.1.1, and 148.4.3.1.2. It is also set according to the value of the hb_cmd variable, defined in 147.x.x.x.
    The following mapping shall be used:
    - tx_cmd <= 'N' when a BEACON request is asserted
    - tx_cmd <= 'J' when a COMMIT request is asserted
    - tx_cmd <= 'T' when hb_cmd variable is set to HEARTBEAT and none of the previous requests is asserted.
    - tx_cmd <= 'I' otherwise.
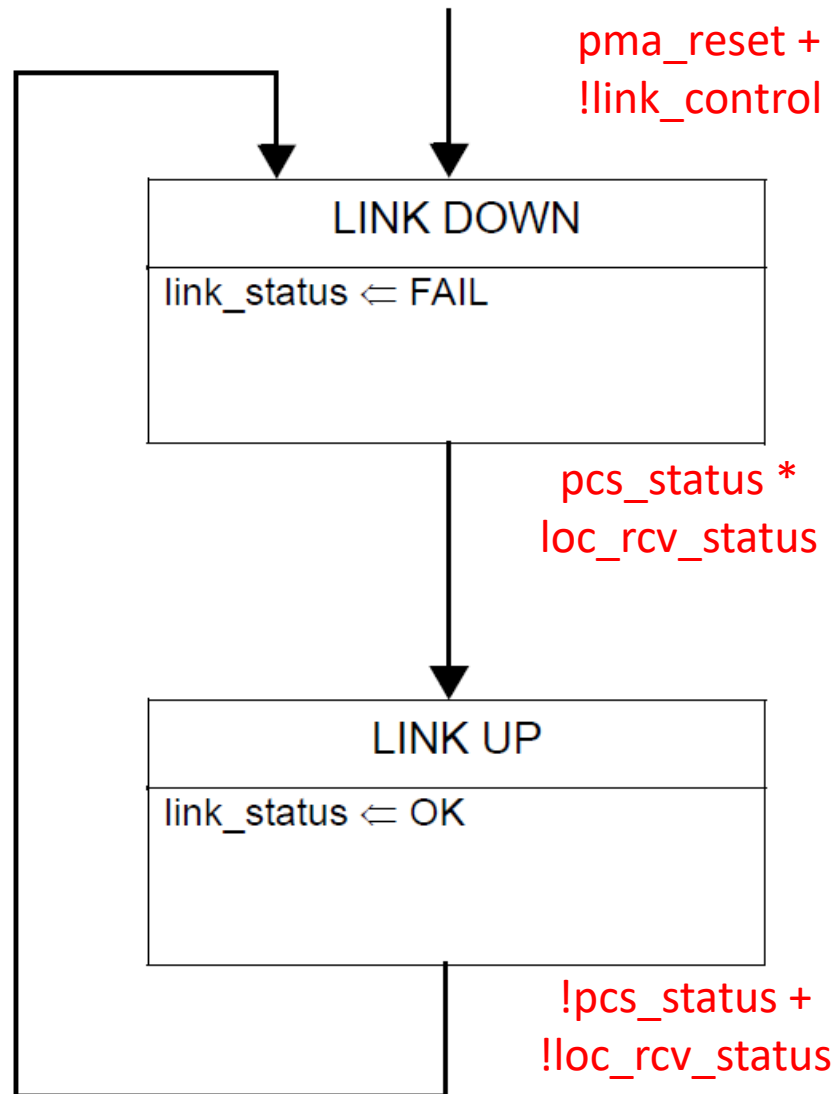
- link_control: generated by management

- pcs_status: conveyed by PCS via the PMA_PCSSTATUS.request primitive

- loc_rcv_status: implementation defined variable, indicating the PMA is ready to receive data from the line

- link_status: parameter of the generated PMA_LINK.indication primitive

THANK YOU!