Transceiver friendly auto-negotiation signaling for 802.3ap

Pat Thaler
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Agilent Technologies

Problem Statement

Auto-negotiation with SSP bursts requires additional capabilities in the transceiver, e.g.

- Transmitter must be turned on and off relatively quickly (to produce 100 ns bursts)
- Receiver must have envelope detector to detect bursts

If auto-negotiation is used to pass information during training, SSP bursts don't provide continuous signal

- PLL will have to acquire lock and receiver will have to adapt at start of each training sequence

Ideally, auto-negotiation signaling should require little or no additional transceiver capability and should provide continuous signal

Objectives for auto-negotiation signaling

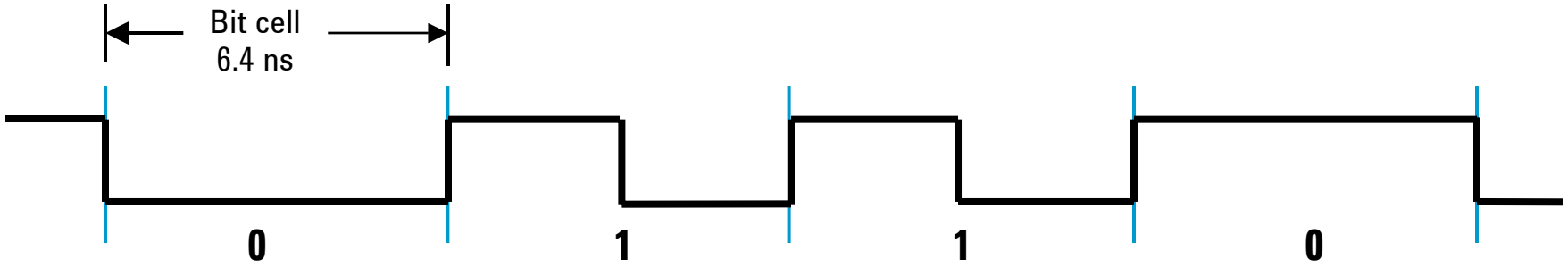
- Provide continuous clock information
- DC balanced
- Low enough in frequency to operate on untrained link
- High enough in frequency to require minimal additional passband
- Simple encoder/decoder independent of PCS encoding
- Minimal additional requirements on transceivers
- Minimize adaptation of Clause 28 state machines
- Different from expected training signals

Overview

Signal with Differential Manchester at 312.5 MBaud

- One symbol at this rate is
  - 33 symbols of 10.3125 GBaud (10 Gig 64B/66B)
  - 10 symbols of 3.125 GBaud (XAUI 8B/10B)
  - 4 symbols of 1.25 GBaud (1 Gig 8B/10B)
- Maximum distance between transitions: 6.4 ns
- Coding rule is the same as Clause 28 with signal transitions replacing pulses.

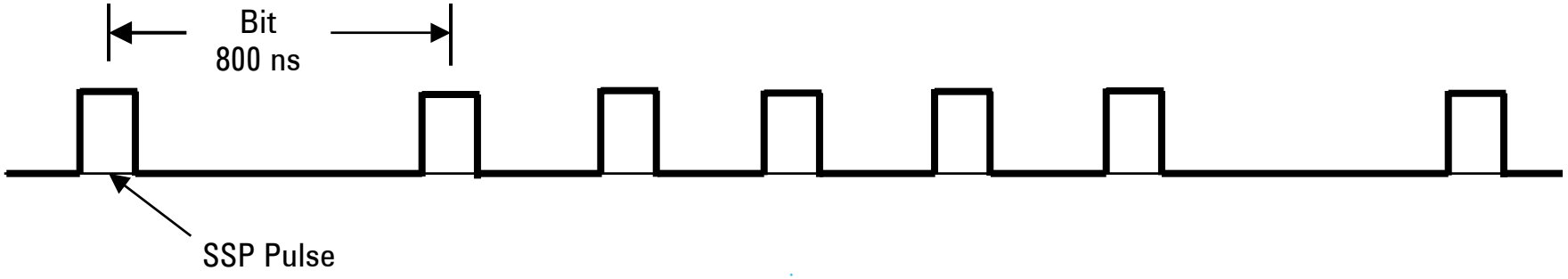
Differential Manchester



Encoding rules

- Bit cell edge always has a transition
- Bit cell center has transition for 1, no transition for 0

Equivalent SSP signal

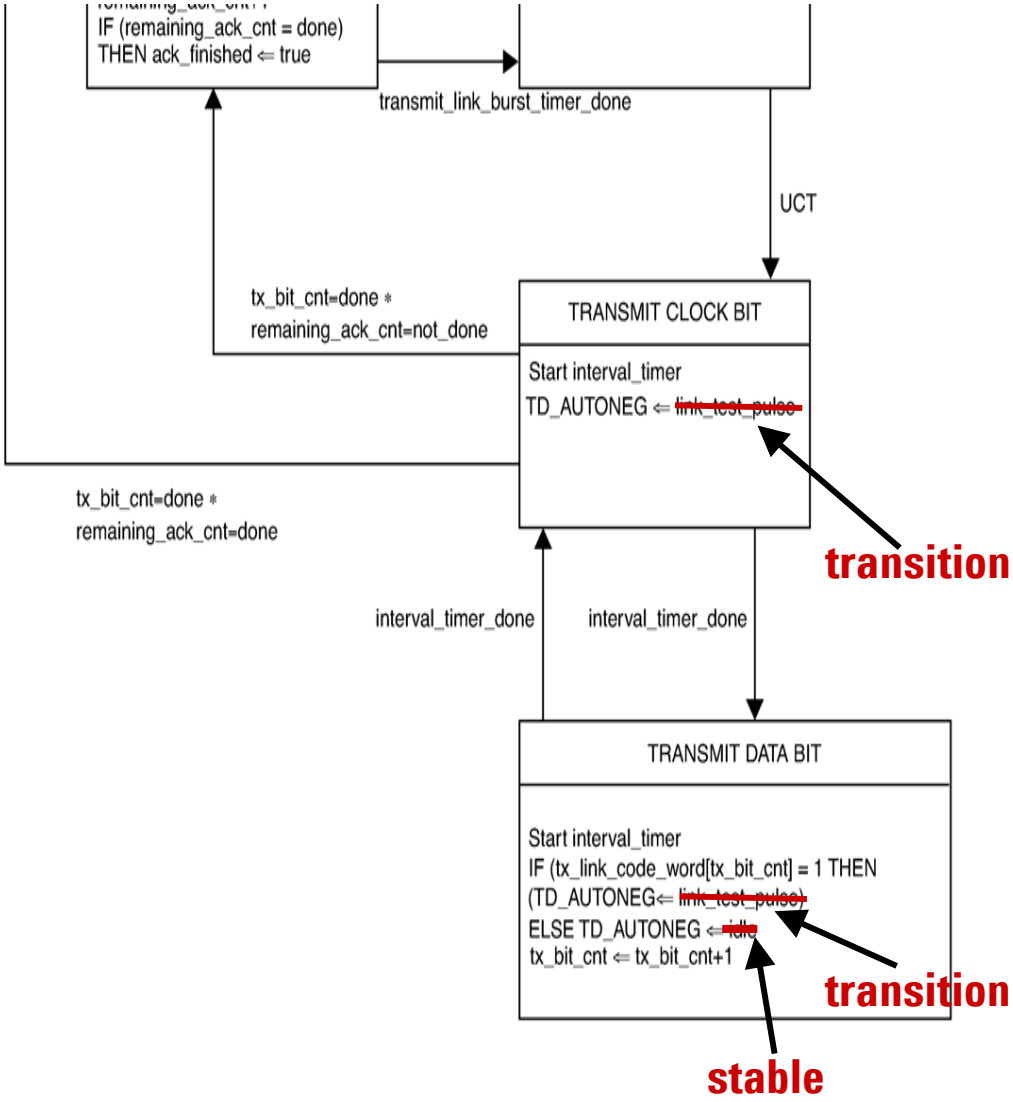


Modifying transmit state machine for differential Manchester

Change TD_AUTONEG values to:

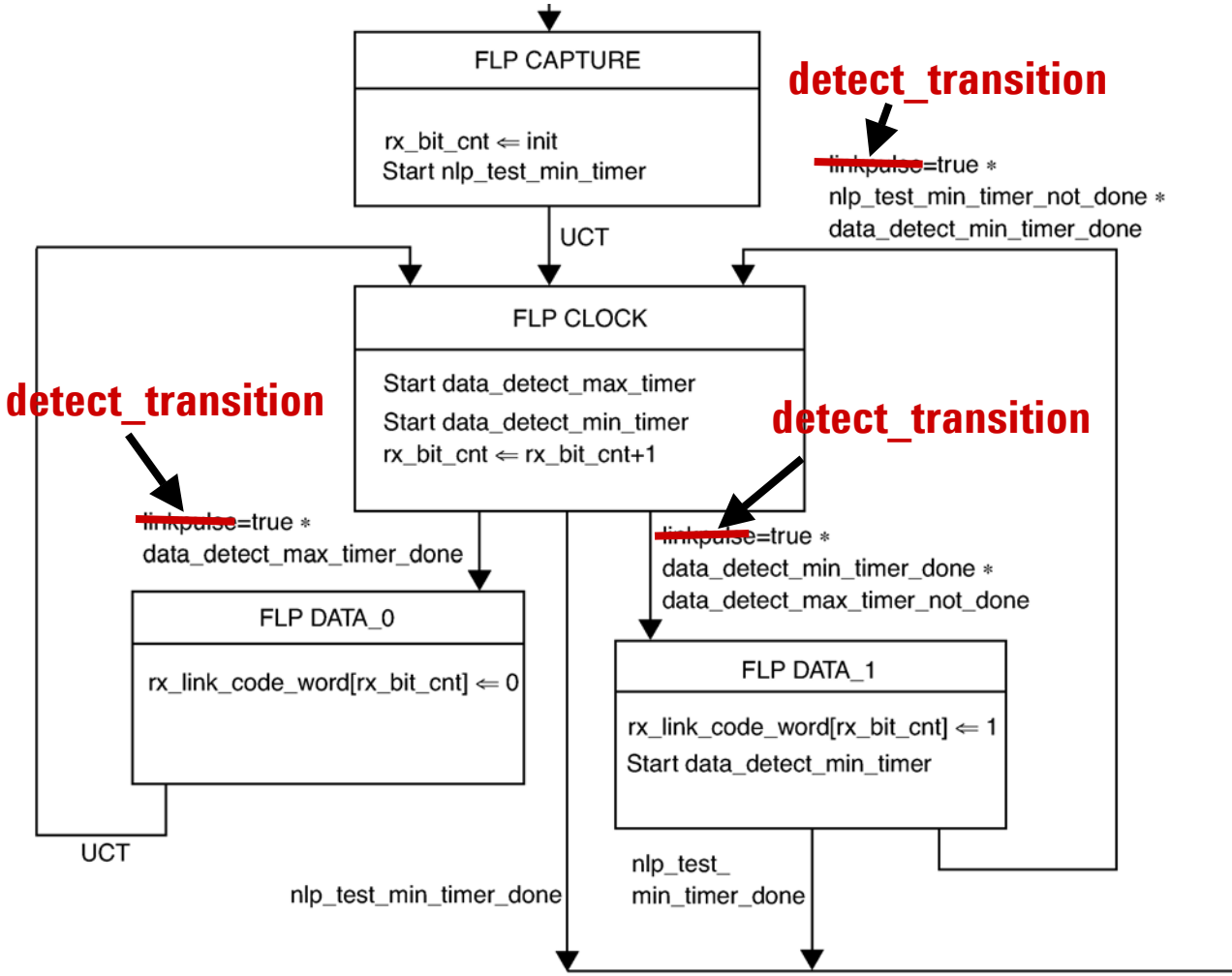
transition - change signal level from 1 to 0 or 0 to 1

stable - maintain current signal level



Modifying receive state machine for differential Manchester

replace linkpulse variable with detect_transition variable - value is true when a transition in the level of the received signal is detected



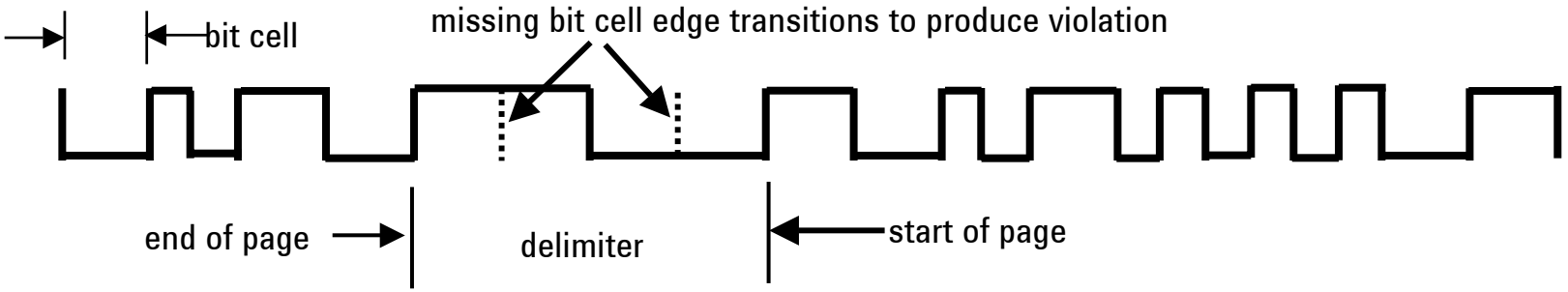
Delimiting pages

Two alternatives are proposed:

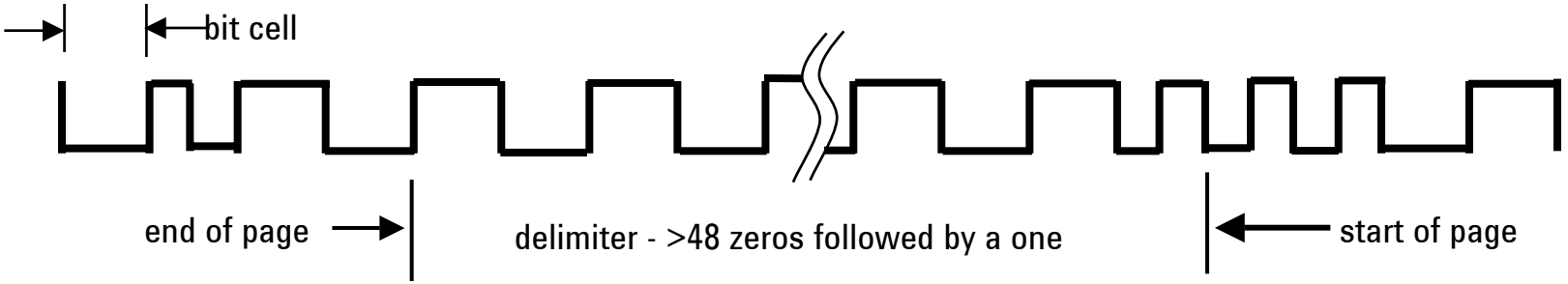
- **Manchester violation -** Between pages transmit current signal level for 2 bit cells followed by alternate signal level for 2 bit cells. Thus two bit cell edge transitions are omitted - a Manchester violation that is detected as the start delimiter.
- **Run of zeros delimiter -** Delimiter is n zeros followed by a one where n is greater than the page length. Detection is done by maintaining a count of contiguous zeros received. When a 1 is received and the count is greater than page length, a page will start on the next bit cell.

Delimiter examples

Manchester violation delimiter



Run of zeros delimiter

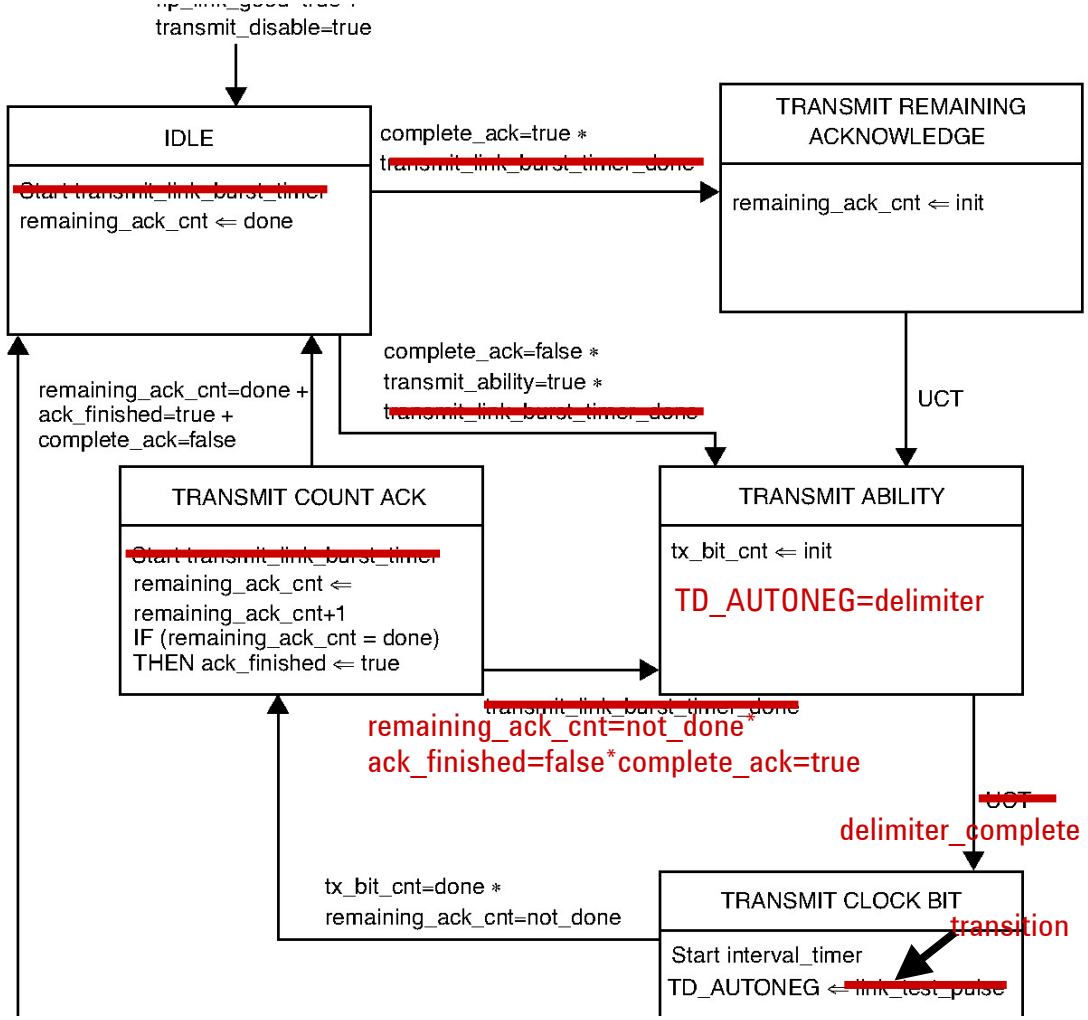


Transmit state machine for Manchester violation delimiter

TD_AUTONEG gets an additional value - delimiter

delimiter sends current value for 4 intervals and opposite value for 4 intervals

new variable delimiter_complete is asserted when the delimiter has been sent.



Transmit state machine for run of zeros delimiter

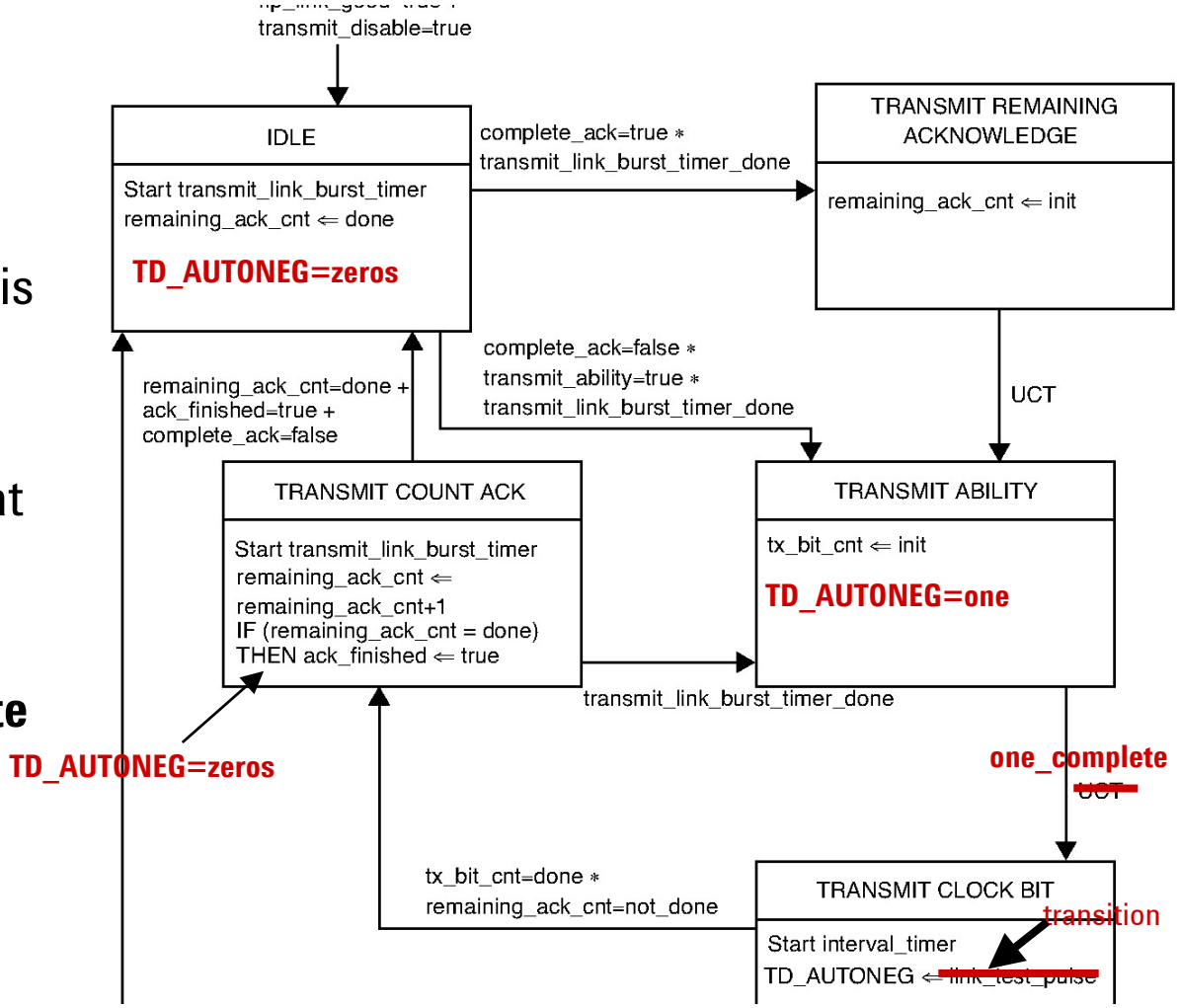
TD_AUTONEG gets two additional values -

zeros - transmit with a transition every two intervals until a new value is assigned.

one - transmit for two intervals with a transition at the beginning of each interval

new variable one_complete is asserted when the one has been sent.

transmit_link_burst_timer must be a multiple of two intervals



Delimiter Comparison

Manchester violation

+ faster

+? easier to detect

- introduces lower frequency content

Run of zeros

+ same frequency content as pages

- slower