Eye safety control method for 802.3cz

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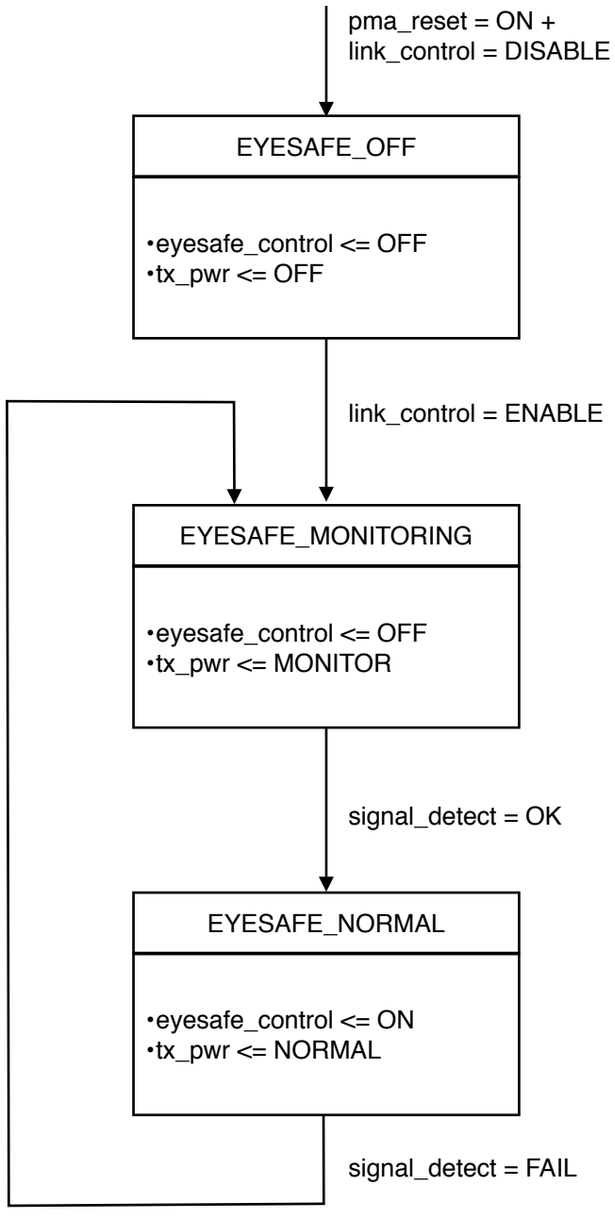
Introduction

- Eye safety is key for automotive applications
  - Even if these connections are “under the hood”, it could be easy for any non-trained car user to unplug a connection and be exposed to the laser radiation
  - To avoid any labelling and additional precautions, either the Laser Class 1 or Laser Class 1M should be achieved per IEC 60825
  - Laser Class 1M is as Class 1 without including optical instruments for intra-beam viewing
- Eye safety requirement
  - In other automotive optical communications networks, i.e. MOST and GEPOF, Laser Class 1 is a requirement
  - 802.3cz PMD should have meeting Laser Class 1 as an objective
- In [1], AOP measurements at TP1 were presented for several characterized VCSELs in cold, room and hot temperatures
- Based on realistic optical coupling design, AOP at MDI, TP2 and TP3 were calculated for BC (butt-coupling) and EBO (expanded beam optics) connectivity
- Eye-safety limits were calculated for Class 1 and Class 1M considering BC and EBO
- A simple general method for eye safety control was proposed that allows to meet eye-safety limit regardless the used optical connectivity, BC or EBO

State diagram for eye safety control



- **eyesafe_control:** variable set by the PMA eye safety control state diagram to control the operation of the PMA TX and RX.
  (Modify PHY TX control and PHY RX control state diagrams to respond to open-ended eyesafe_control = OFF)
  Values:
  - OFF: PMA is disabled
  - ON: PMA is enabled
- **tx_pwr:** controls the PMD transmitter power
  Values:
  - OFF: PMD TX does not generate optical signal ($AOP_{TP1'} = 0$ mW)
  - MONITOR: PMD TX generates optical signal with $AOP_{TP1'}$ below eye safety limits and AOP_{TP2} higher than a threshold ($AOP_{TP2\text{-}MON\text{-}MIN}$) to guarantee signal_detect = OK is produced in the link partner
  - NORMAL: PMD TX generates optical signal as needed for reliable link operation and that may overpass the eye-safety limits
- **signal_detect:** parameter indicating whether the PMD is detecting average optical power over a threshold at the receiver or not.
  - OK: PMD is detecting average optical power over a threshold
  - FAIL: PMD is detecting average optical power below a threshold

Parameters to be defined in the PMD sublayer

- Signal detect thresholds:
  - $AOP_{TP3\text{-}WU}$ (TBD): if $AOP_{TP3} > AOP_{TP3\text{-}WU}$, then the parameter signal_detect = OK
  - $AOP_{TP3\text{-}SD}$ (TBD): if $AOP_{TP3} < AOP_{TP3\text{-}SD}$, then the parameter signal_detect = FAIL
  - For $AOP_{TP3\text{-}SD} \leq AOP_{TP3} \leq AOP_{TP3\text{-}WU}$, the value of signal_detect is unspecified (uncertainty range)
- Eye safety monitoring thresholds:
  - $AOP_{TP2\text{-}MON\text{-}MIN}$ (TBD): the min AOP at TP2 to guarantee signal_detect = OK in the link partner considering the max insertion loss of the channel
  - $AOP_{MDI\text{-}MON\text{-}MAX}$ (TBD): the max AOP at the MDI that meets eye-safety limits for a specific launching condition.
- Launching condition has to be defined and it depends on BC or EBO MDI
- $t_{TX\text{-}NORMAL\text{-}to\text{-}MON\text{-}MAX}$ (TBD): max time between signal_detect OK to FAIL transition and tx_pwr NORMAL to MON transition
  - It is implementable to be < 100 µs.

References

- [1] R. Pérez-Aranda, “Eye safety analysis for 802.3cz links,” December 2020, [Online], Available: https://www.ieee802.org/3/cz/public/22_dec_2020/perezaranda_3cz_01_221220_eyesafety.pdf

Motion

- Move to adopt the eye-safety control method in the baseline

Thank you!