40GBASE-T SUGGESTIONS

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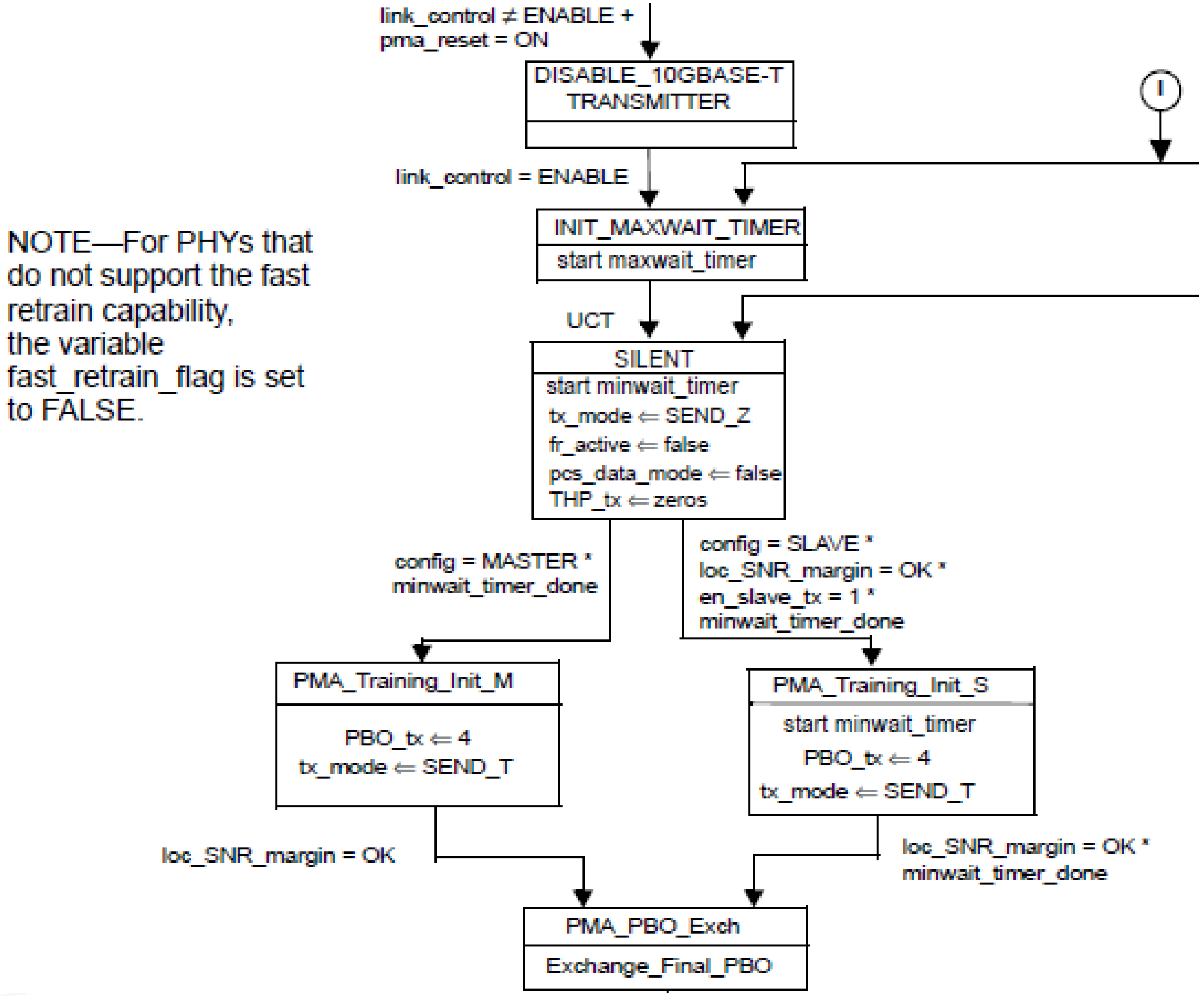
July 7th, 2014

Improve startup time: Change PTS

- 10GBASE-T Periodic Training Sequence (PTS) usage
  - 10GBASE-T PTS is (to my knowledge) not used in the field.
    - “A sequence of 16384 bits is not rich enough to adapt the ~32K filter coefficients of FFE, FEXT and ENC.”
- Correlation is a robust method to find the position in a (short) bit pattern.
  - Correlation (used in PTS) is faster than blind equalization (used in CTS).
  - Blind equalization may challenge the filter adaptation resources of 40G.
  - Correlation can accommodate higher variability in the insertion loss (IL)
    - suck outs may create notches in the IL.
- Change from 10GBASE-T standard:
  - switch to continuous training sequence (CTS) after “the eye is opened.”
  - Both Slave and Master expect the link partner to switch from PTS to CTS, when they transition
    - from the PMA_state<7:6>=00 indicates PMA_Training_Init_M or PMA_Training_Init_S,
    - to the PMA_state<7:6>=01 indicates PMA_PBO_Exch.

55.4.6.1 PHY Control state diagram

- At the transition from
  - PMA_Training_Init_M and PMA_Training_Init_S
- to PMA_PBO_Exch
- the transceiver of both link partners stops to reinitialize the value of its scrambler state every 16384 symbol periods.

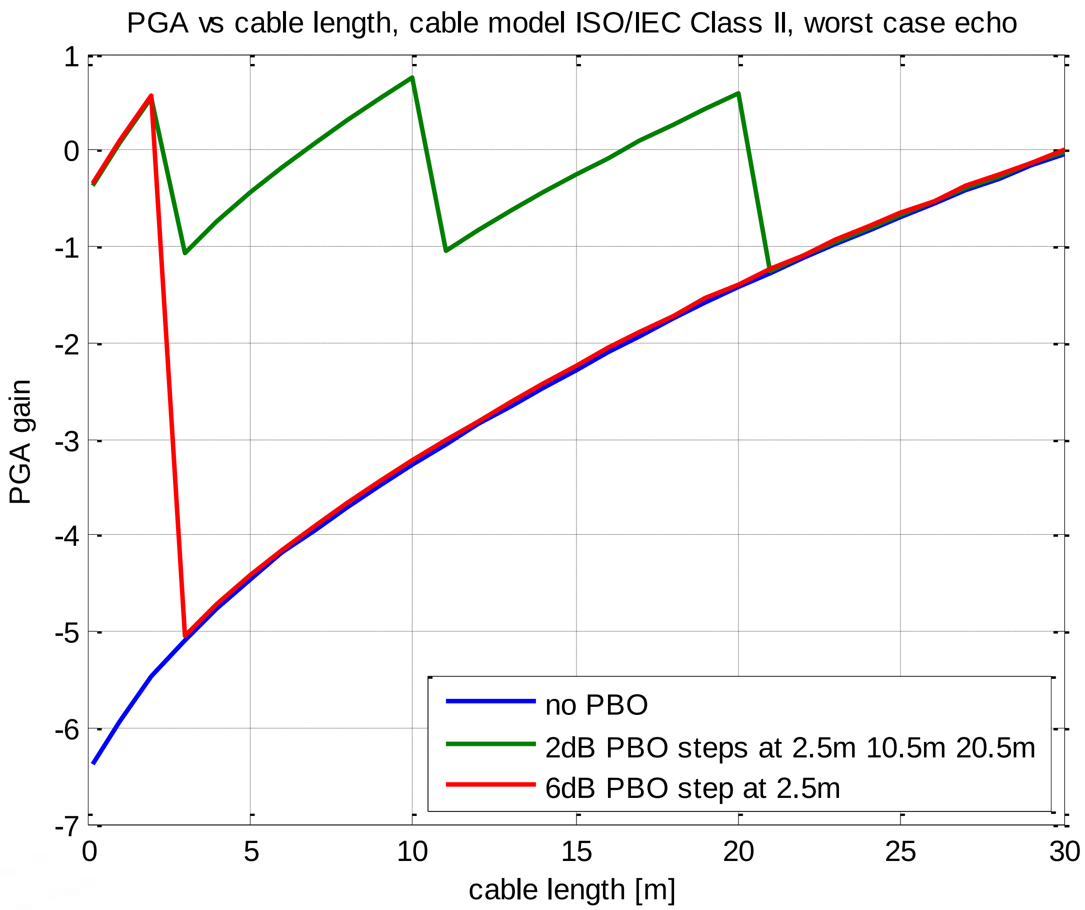


Improve startup time: PBO

- No power back off (PBO)
  - Avoiding the PBO negotiation and switching speeds up startup time.
  - PBO is not needed for interference management.
  - PBO does not help power consumption, worst case is the only number the customer cares about.
  - Arbitrary threshold
    - 10GBASE-T cable length estimator weak => there may be a 2dB PBO difference for the same cable.
    - Proposed 6dB PBO steps for 40GBASE-T => 6dB difference for the same cable close to the cable length threshold is now possible.
- 0dBm for startup and normal data for all cable length.
- Optional: short reach mode using PBO

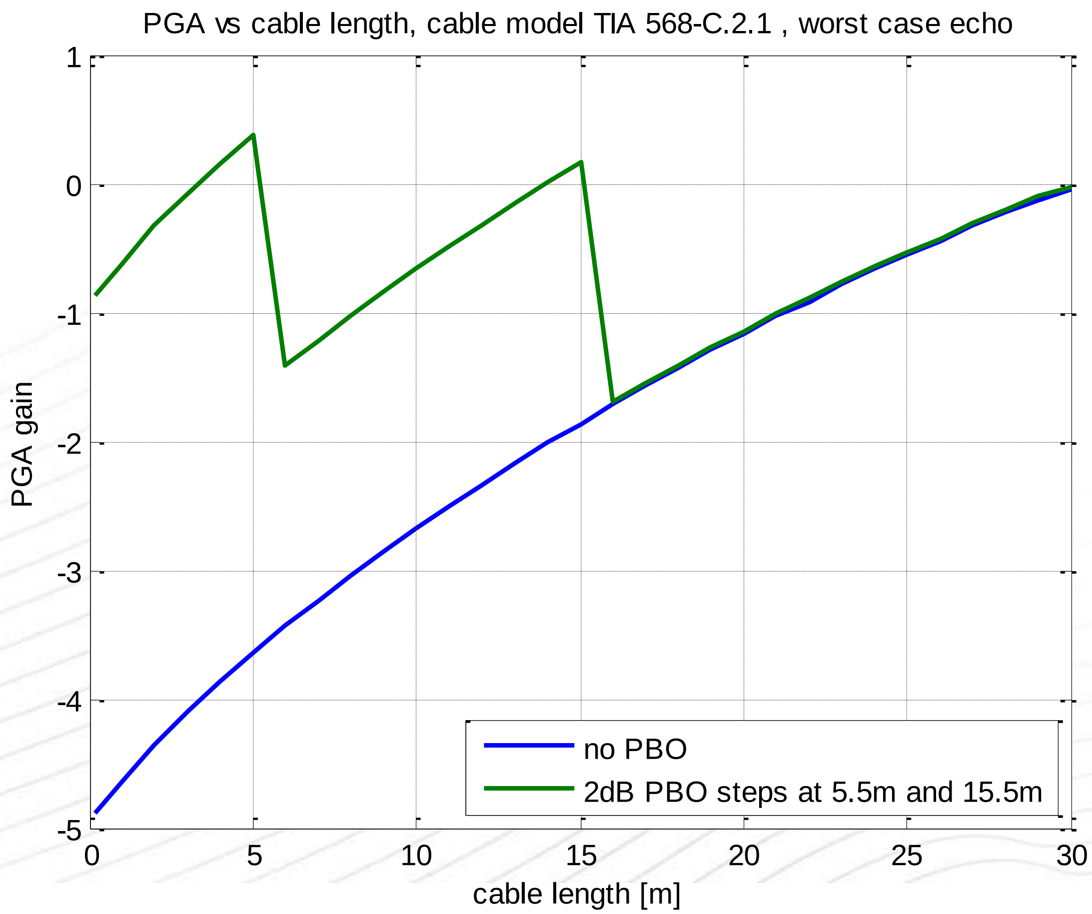
If a PBO is included in the standard

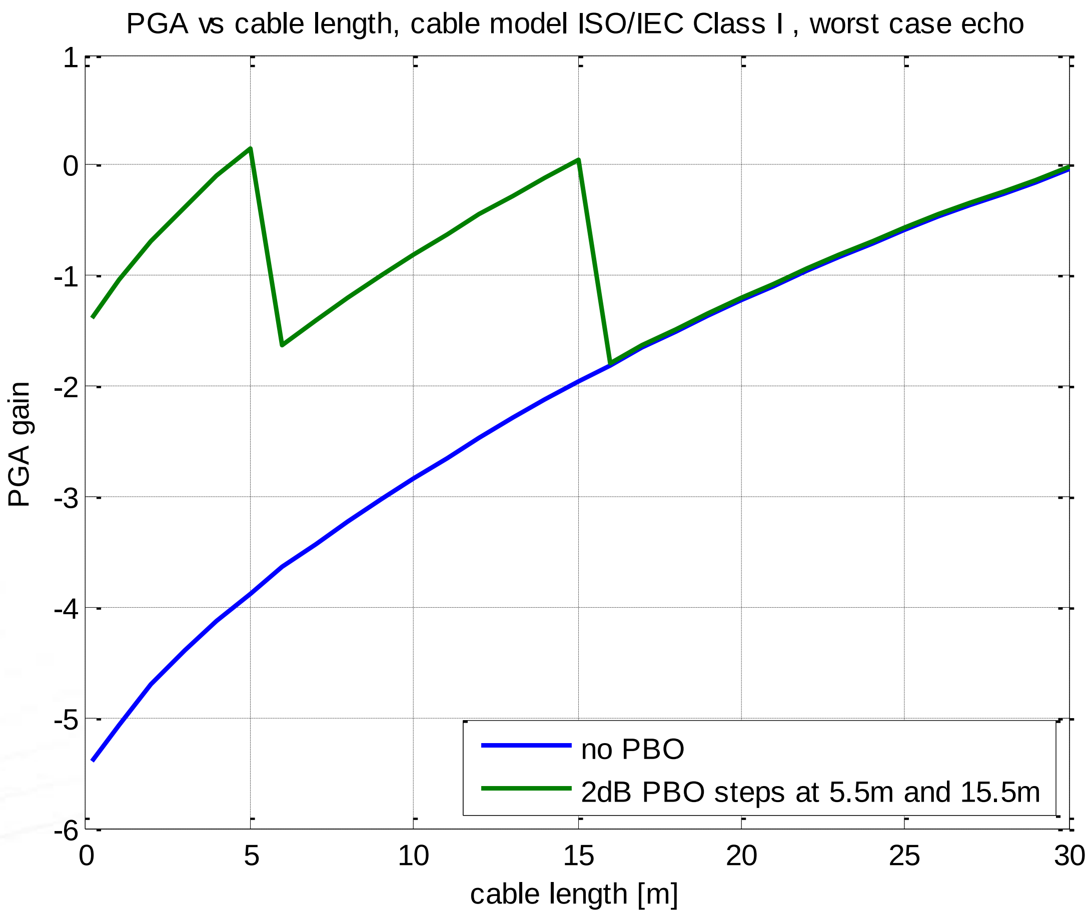
- Start up with 0dB PBO
  - XTalk minimized by shielded cables/connectors.
  - PBO is kept steady for the challenging long cables.
  - Startup time is negligible compared to usage, no power hit.
- Propose 2dB steps for PBO
  - cable length steps at
    - 6dB PBO for cable length less than 2.5
    - 4dB PBO for cable length between 2.5m and 10.5m
    - 2dB PBO for cable length between 10.5m and 20.5m
    - 0db PBO for cable length exceeding 20.5m
- Criteria for cable length threshold
  - Consider worst case insertion loss and echo.
  - Minimum phase impulse response from limit line.
  - 20MHz corner frequency HPF.
  - 1750MHz corner frequency LPF.
  - Input to ADC saturates with probability 1e-15.
  - Keep positive PGA gain to a minimum.



Additional Cable models

- Only 4dB PBO and 2dB PBO needed
- Cable length thresholds at 2.5m and 15.5m





Transmit power spectral density (PSD) and power level

- Range of transmit power from 3.2dBm to 5.2dBm was appreciated for 10GBASE-T
  - Process, voltage and temperature variations may result in power variations.
    - Tighter range results in higher power consumption of the transmitter.
  - Suggest similar range for 40GBASE-T: -0.8dBm to 1.2dBm for a 0dBm/Hz “nominal” transmit power.
- Reduce power numbers by 10dBm/Hz in equation (55-9) and (55-10)
- Spread frequencies by factor 4.

Common mode noise

- Quote of 10GBASE-T spec:
  - 55.5.4.3 Common-mode noise rejection
    - This specification is provided to limit the sensitivity of the PMA receiver to common-mode noise from the cabling system. Common-mode noise generally results when the cabling system is subjected to electromagnetic fields.
    - The common-mode noise can be *simulated* using the cable clamp test defined in 40.6.1.3.3. A 6 dBm sine wave signal from 80 MHz to 1000 MHz can be used to *simulate* an external electromagnetic field. Operational requirements of the transceiver during the test are *determined by the manufacturer*. A system integrating a 10GBASE-T PHY may perform this test.
- Suggestion: drop this paragraph
  - Cable clamp test defined in 40.6.1.3.3. (GPHY standard!) may not “simulate” electro magnetic chamber for 40GBASE-T.
  - Operational requirements not specified.
  - Is this a cable/connector test or a 10GBASE-T PHY test?

Transmitter timing jitter

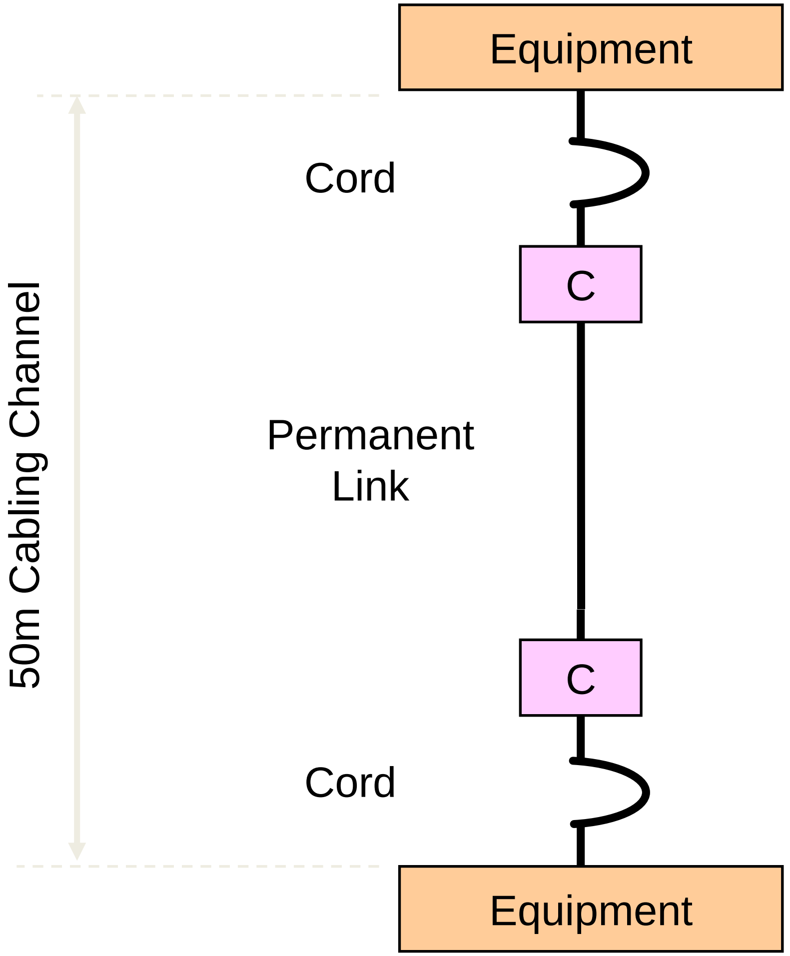
- Scale with frequency
- 10GBASE-T: 200MHz => 40GBASE-T: 800MHz
- Timing jitter:
  - 10GBASE-T: RMS period jitter: 5.5ps
  - 40GBASE-T: total RMS jitter for 300Hz to 100MHz: 1.3ps

Alien cross talk

- Shape: flat
  - Cable models result in almost flat behavior from 200MHz to 2GHz.
  - Specify a flat noise spectrum, otherwise spectral shape needs to be published.
- Level
  - 10GBASE-T specified -141.9 dBm/Hz.
  - Nominal power reduction of
    - 4dBm for 10GBASE-T to
    - 0dBm for 40GBASE-T.
  - Increased bandwidth from
    - 400MHz for 10GBASE-T (resulting in an adjustment of -86dB to compute dBm/Hz) to
    - 1.6GHz for 40GBASE-T (resulting in an adjustment of -92dB to compute dBm/Hz).
  - Highest acceptable number: -152dBm/Hz.
  - Shielding should result in at least -162dBm/Hz (20dB better than CAT6a).

BACKUP: channels

Comparison of TIA & ISO/IEC Next Gen Cabling



- both use 30m channel with 2 connectors
- TIA cordage ≤12m, de-rated by wire gauge
  - 12m max with 23AWG, 0% IL de-rated
  - 10m max with 24AWG, 20% IL de-rated
  - 8m max with 26AWG, 50% IL de-rated
- ISO/IEC uses 2m cords & 50% IL de-rating
- TIA Cat 8 based on Cat 6_A components with some enhancements
- ISO/IEC Class I & II based on both Cat 6_A/7_A components with some enhancements
- TIA upper frequency 2GHz, ISO/IEC 1.6GHz with possible extension to 2GHz
- TIA-568-C.2.1 standard in development
- ISO/IEC 11801-99-1 TR published

Comparison of TIA & ISO/IEC Next Gen Cabling

	TIA-568-C.2.1 D0.5 Cat 8 Channel	ISO/IEC 11801-99-1 PDTR Class I Channel	ISO/IEC 11801-99-1 PDTR Class II Channel
RL	631<f<1000 36-10*log(f) 1000<f<2000 6dB	631<f<1000 36-10*log(f) 1000<f<2000 6dB	631<f<1000 35-9*log(f) 1000<f<2000 8dB
IL	0.52(1.8√f+0.005f+0.25/√f) +0.02√f + 0.0324√f (ILD)	0.52(1.8√f+0.005f+0.25/√f) +0.02√f	0.914√f+0.003f+0.182/√f
TCL	26-17*log(f/100)	1<f<30 61-15*log(f) 30<f<2000 68.3-20*log(f)	1<f<30 61-15*log(f) 30<f<2000 68.3-20*log(f)
ELTCTL	1<f<79.5 38-20*log(f/100)	1<f<30 30-20*log(f/100)	1<f<30 30-20*log(f/100)
CA	100<f<2000 90-20*log(f)	30<f<100 40dB 100<f<2000 80-20*log(f)	30<f<100 40dB 100<f<2000 80-20*log(f)
PSANEXT	1<f<100 100-10*log(f) 100<f<2000 100-15*log(f)	1<f<100 100-10*log(f) 100<f<2000 110-15*log(f)	1<f<100 105-10*log(f) 100<f<2000 115-15*log(f)
PSAACRF	56-20*log(f/100)	56-20*log(f/100)	61-20*log(f/100)

Comparison of TIA & ISO/IEC Next Gen Cabling

	TIA-568-C.2.1 D0.5 Cat 8 Channel @ 1GHz	ISO/IEC 11801-99-1 PDTR Class I Channel @ 1GHz	ISO/IEC 11801-99-1 PDTR Class II Channel @ 1GHz
RL	6.0dB	6.0dB	8.0dB
IL	35.3dB	33.5dB	31.5dB
NEXT	16.9dB	22.6dB	47.9dB
TCL	9.0dB	8.3dB	8.3dB
CA	30.0dB	20.0dB	20.0dB
PSANEXT	65.0dB	65.0dB	70.0dB
PSAACRF	36.0dB	36.0dB	41.0dB