40GBASE-T SUGGESTIONS

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July 7th, 2014

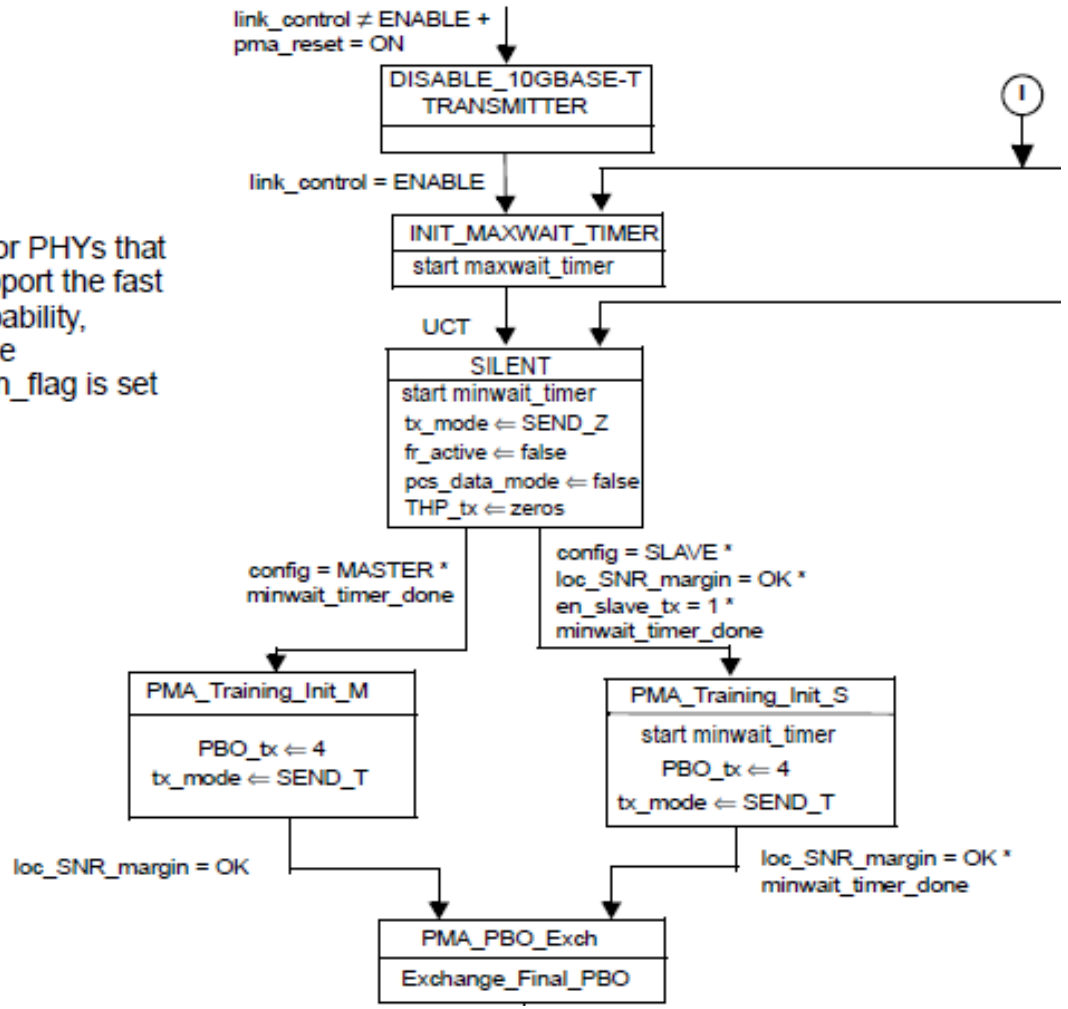
Improve startup time: Change PTS

- 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.

NOTE—For PHYs that do not support the fast retrain capability, the variable fast_retrain_flag is set to FALSE.

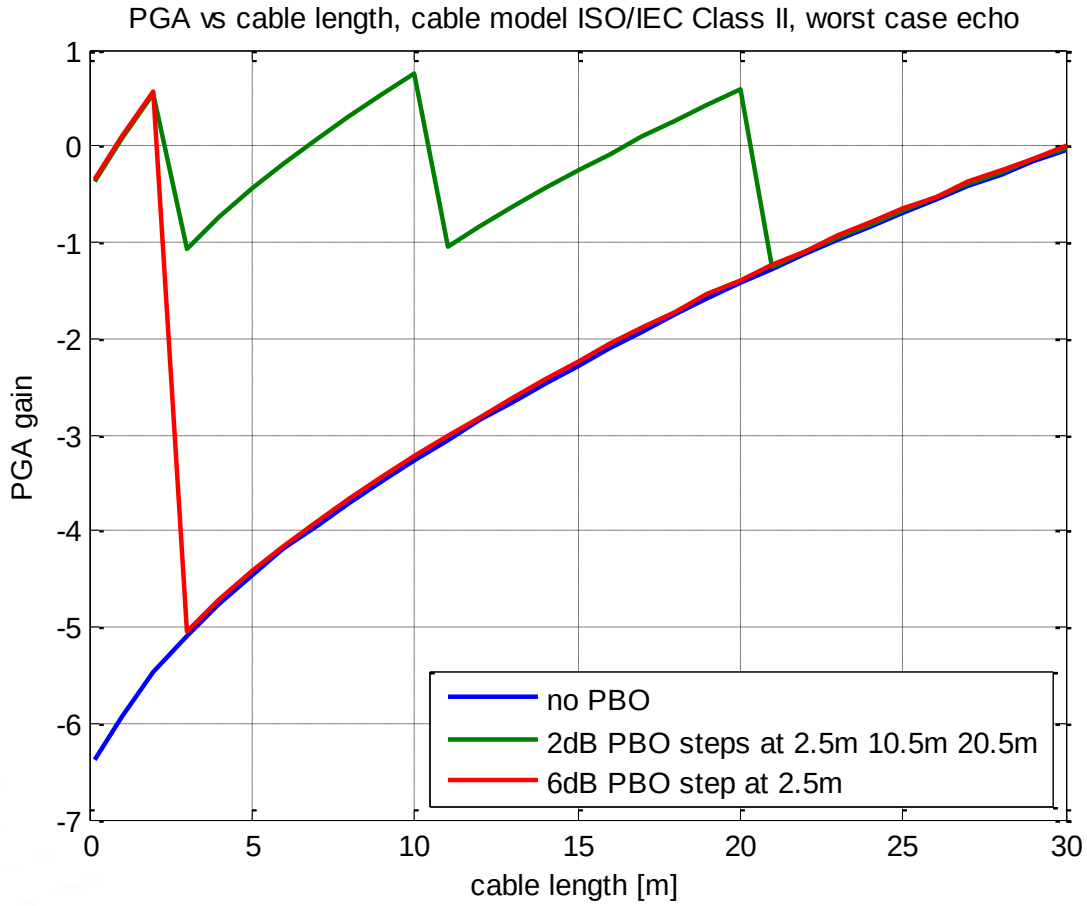


Improve startup time: PBO

- 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

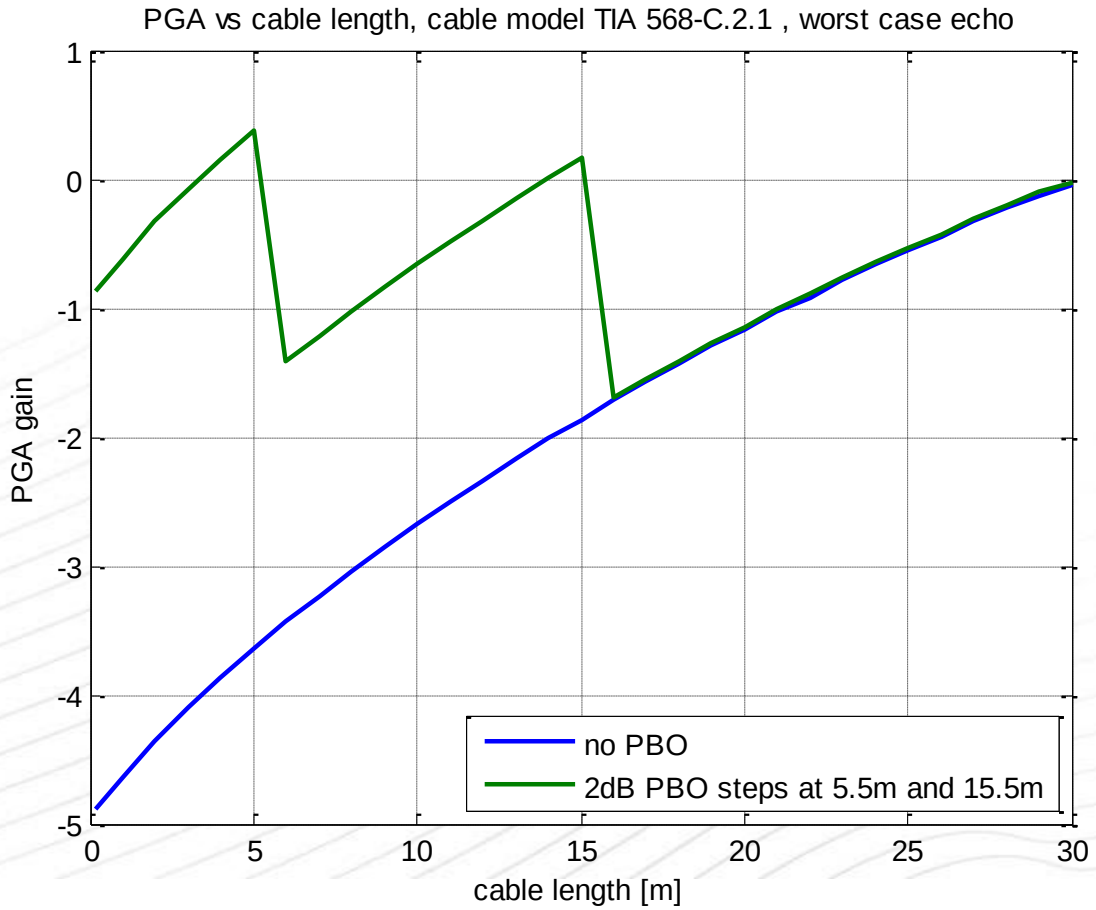
If a PBO is included in the standard

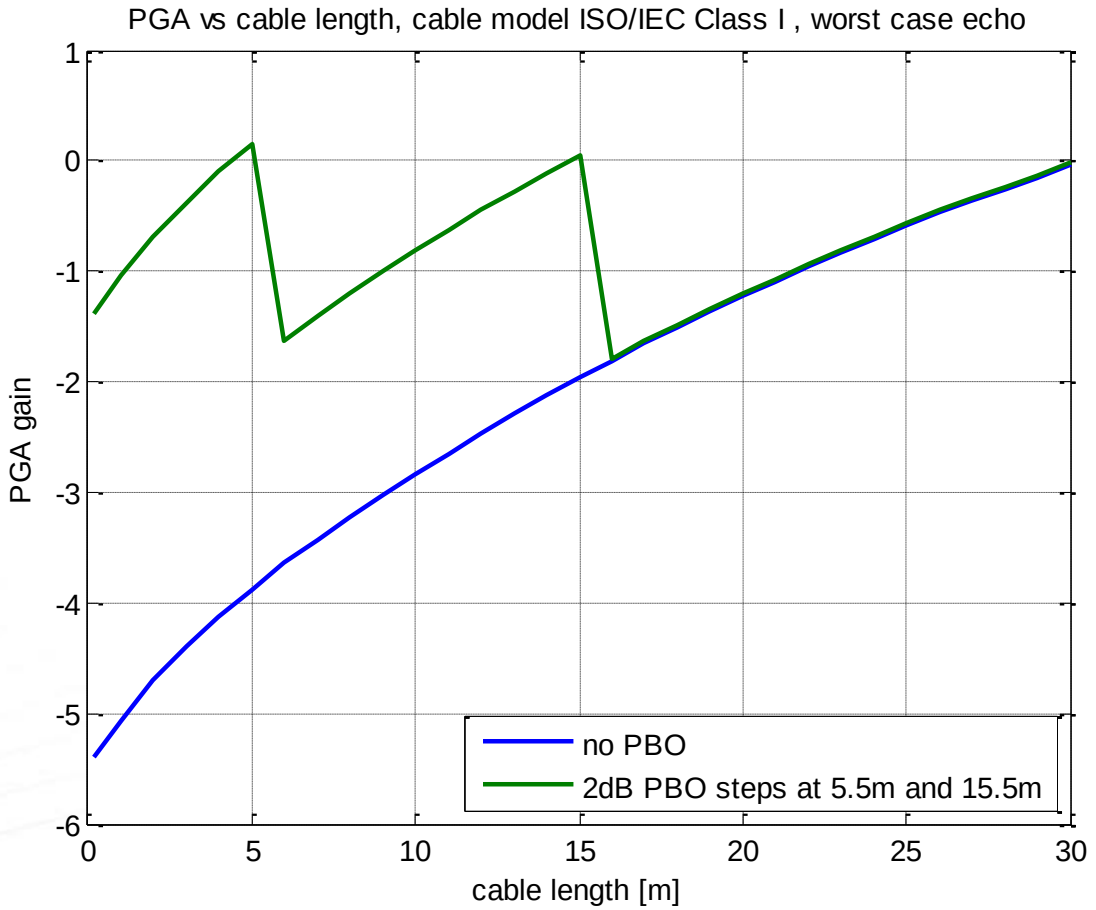
- Start up with 0dB PBO
  - XTalk minimized by shielded cables/connectors.
  - PBO is kept steady for the challenging long cables.
  - Startup time is negligible compared to usage, no power hit.
- Propose 2dB steps for PBO
  - cable length steps at
    - 6dB PBO for cable length less than 2.5
    - 4dB 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

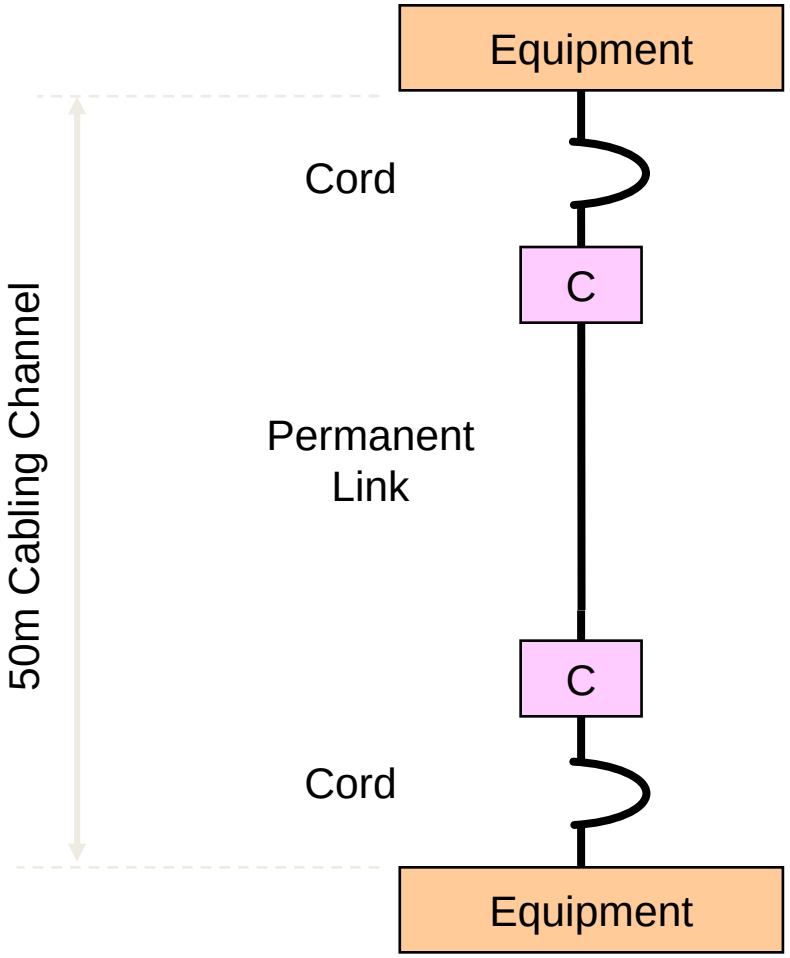
- Scale with frequency
- 10GBASE-T: 200MHz => 40GBASE-T: 800MHz
- Timing jitter:
  - 10GBASE-T: RMS period jitter: 5.5ps
  - 40GBASE-T: total RMS jitter for 300Hz to 100MHz: 1.3ps

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 50m 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 only planned

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