Link Synchronization for ACT

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Overview

- Link Synchronization (LS) signalling is a simple and robust mechanism defined in IEEE 802.3ch and 802.3bp for link-partner discovery and to synchronize the start of training

- It consists of a burst of PRBS PAM2 signal with a duration of 1.25 microsecond (or 1.0 us for

- LS, as specified in 802.3ch, provides the same simplicity and robustness for the high-speed direction in ACT

- This presentation proposes a LS signal for low-speed direction of ACT

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Link Synchronization Signal

- PRBS length: 255

- Clock
  - 802.3ch: 5625/8 MHz
  - 802.3pb: 750 MHz

- Burst duration
  - 802.3ch = 1.25 us
  - 802.3pb = 1.0 us

- Period (Master) = 5 us

97.1.2.4 Link Synchronization

The Link Synchronization function is used when Auto-Negotiation is disabled to synchronize between the MASTER PHY and SLAVE PHY before training starts. Link Synchronization provides a fast and reliable mechanism for the link partner to detect the presence of the other, validate link, and start the timers used by the link monitor. Link Synchronization operates in a half-duplex fashion. Based on timers, the MASTER PHY sends a synchronization sequence for 1 μs. If there is no response from the SLAVE, the MASTER repeats by sending a synchronization sequence every 5 μs. If the slave detects the sequence, it responds with a synchronization sequence for 1 μs (after the MASTER has stopped transmitting). If no other detection happens after the SLAVE response for 4 μs then Link Synchronization is successfully complete, link monitor timers are started, and the PHY Control state machine starts Training. Link synchronization is defined in 97.4.2.6.

Link Synchronization employs the SEND_S signal to achieve synchronization prior to link training. If the PHY is configured as MASTER, Link Synchronization shall employ Equation (149–10) as the PN sequence generator.

$$p_M(x) = x^8 + x^4 + x^3 + x^2 + 1 \qquad (149\text{–}10)$$

If the PHY is configured as SLAVE, Link Synchronization shall employ Equation (149–11) as PN sequence generator.

$$p_{MS}(x) = x^8 + x^6 + x^5 + x^4 + 1 \qquad (149\text{–}11)$$

The period of both PN sequences is 255.

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LS Signal Detection

- A robust method to detect LS signal is through matched filtering

- The high peak of the filter output (comparing to the RMS) is the signature of LS signal

- Peak-to-RMS ratio (PRR) may be used as the figure of merit of the LS signal and the detector

- PRR ≈ 20 dB in 802.3ch

802.3ch

normalized output of matched filter

ns

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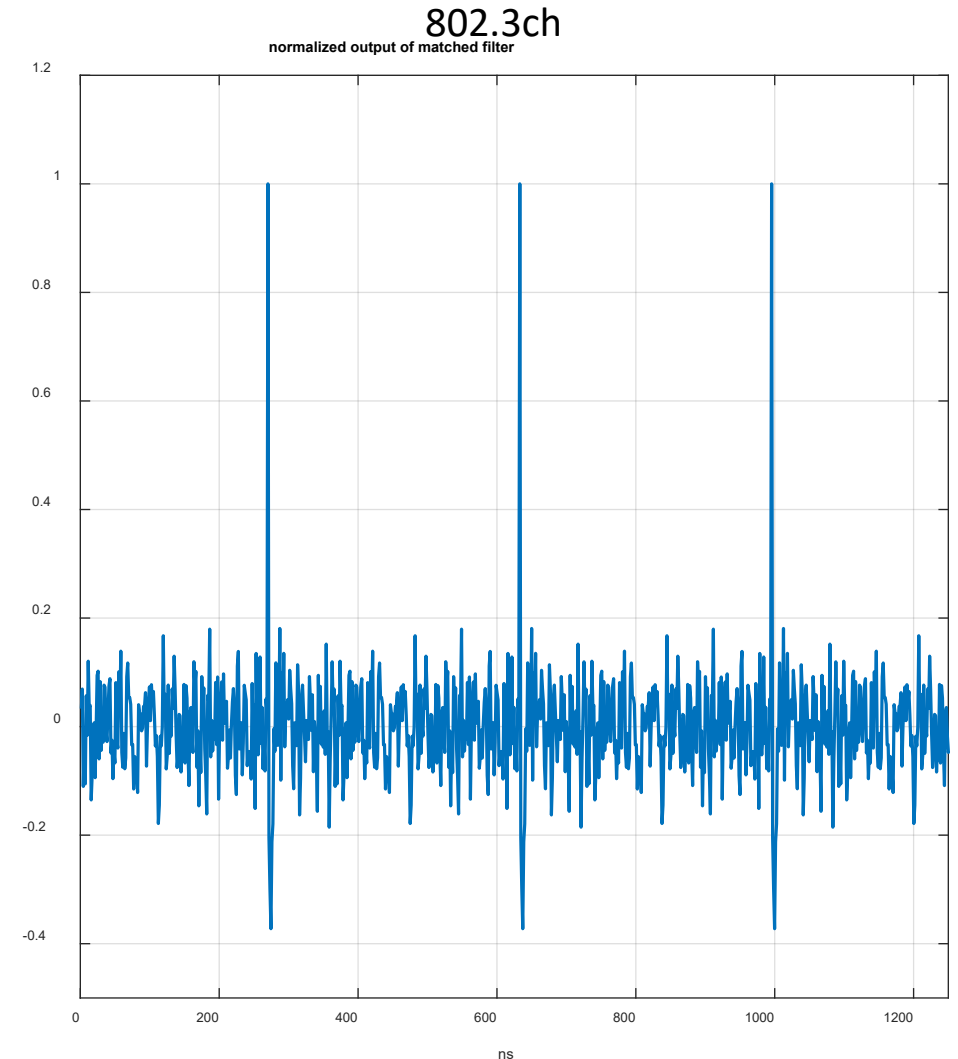
Upstream Direction: LS with PAM2

- With symbol rate of 5625/48 MHz in upstream direction, there is room for 146 symbols with 1.25 us burst

- Allow 2 peaks to accommodate a large frequency offset

- Considering PRBS of length 63 with PAM2 modulation with no spreading

  ➔ PRR ≈ 13 dB

- Cross-correlator power is diffused over multiple samples due to PoC filter

Upstream: PAM2
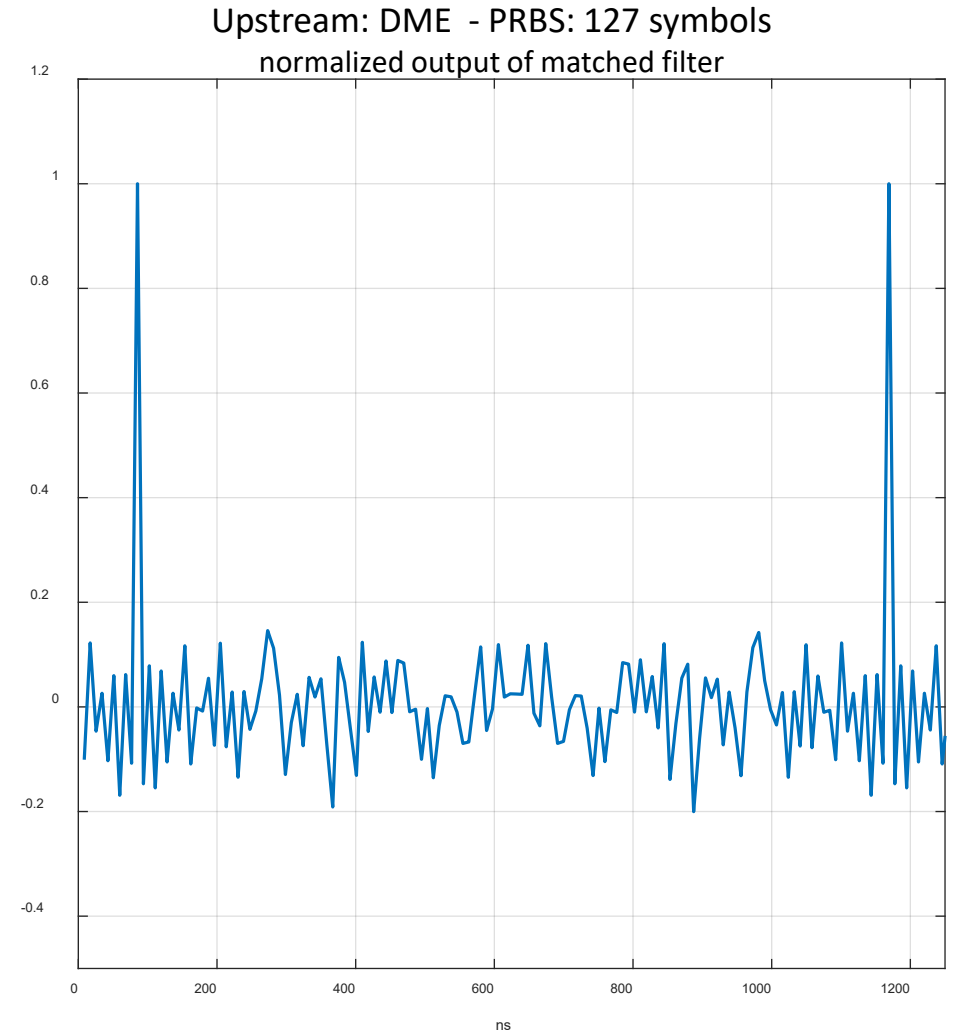normalized output of matched filter

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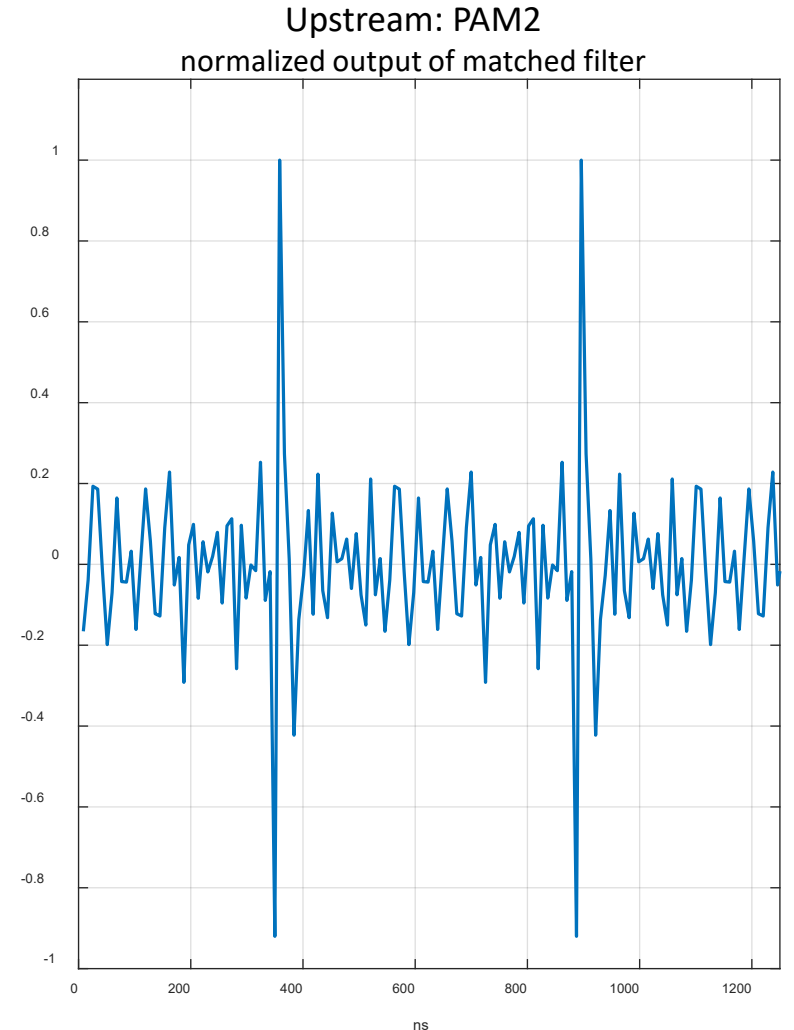
Upstream Direction: LS with DME

Using DME to spread signal content to higher frequency and away from PoC pole, upstream receiver consists of:

1. DME matched filter, and

2. LS matched filter

➜ PRR ≈ 18.6 dB

Upstream: DME - PRBS: 127 symbols
normalized output of matched filter

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Upstream Options

- Link Synchronization detection starts with no timing lock between link-partners

- A crystal-less scenario may have to accommodate for up to 25% frequency offset

- Following options allows at least one peak within a LS burst

PRBS Length		Burst Length (us)	Number of Peaks	PRR (dB)
symbols	us			
113	1.0	1.25	1	**18.4**
233	2.0	2.50	1	**20.4**
63	0.5	1.25	2	**16.5**

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Summary

- Link Synchronization signal as specified in 802.3ch offers a robust and simple method to synchronize the training for link-partners

- It can be use as specified in 802.3ch in downstream direction

- ACT can use similar signalling in upstream direction once combined with Differential Manchester Encoding

- A PRBS length of 127 provide sufficiently high PRR for robust detection

- Options for longer PRBS and longer burst may also be considered for even higher PRR

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Thank You