Link Sync Proposal

William Lo

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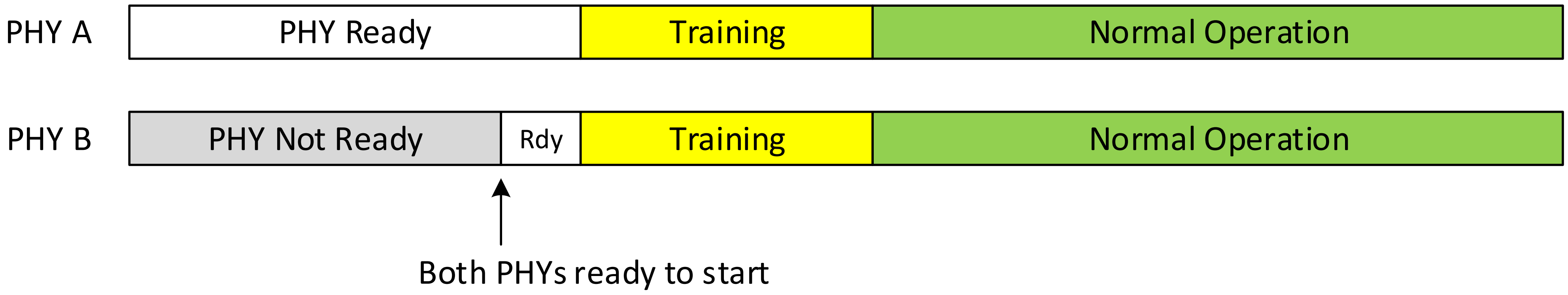
Additional Contributor

- Saman Behtash – Axonne Inc.

Why Synchronization Required At Start

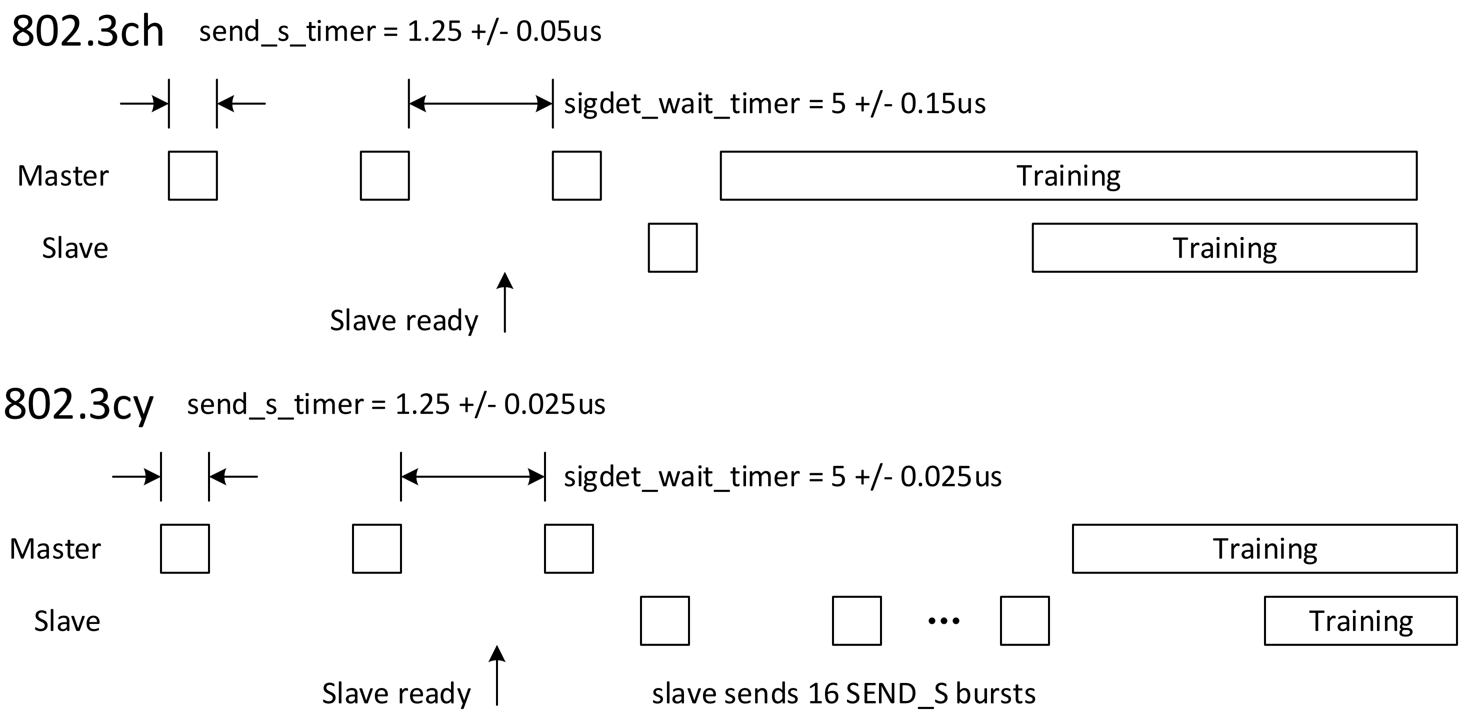
- One device may be ready before other
- Makes sure both devices are ready for orderly start of training
- One method is to use link sync



Sync Sequence 802.3ch and 802.3cy

- Highly reliable PRBS sequence detection in presence of noise with matched filter implementation

- 802.3cy slave sends 16 SEND_S bursts instead of 1



- SEND_S - 703.125 MHz PAM2
- PRBS sequence period 255 symbols

Proposal for asymmetric Link Sync

- Use 802.3cy state machine with modified SEND_S by slave
- Downstream SEND_S and spacing identical to 802.3ch and 802.3cy
  - 802.3cy spacing tolerance a little tighter but can also use 802.3ch

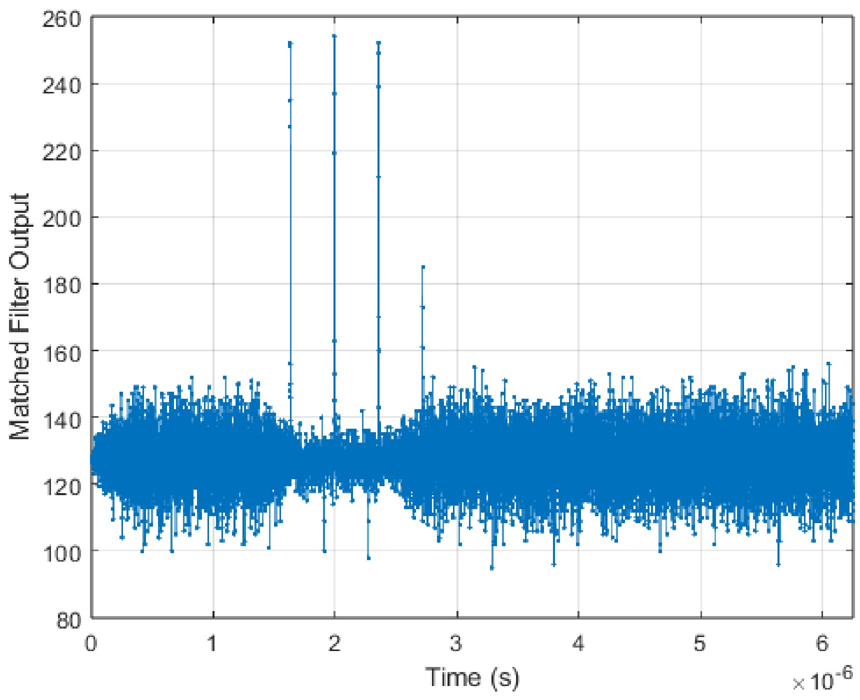
Parameter	**Downstream**	**Upstream**
SEND_S PN bit rate	703.125 MHz	117.1875 MHz
Coding	PAM2	DME
send_timer	1.25 +/- 0.025 us	exactly 148 PRBS bits
sigdet_wait_timer	5 +/- 0.025 us	exactly 588 PRBS bits
PN Sequence length	255 bits	63 bits

Upstream Link Sync Bursts

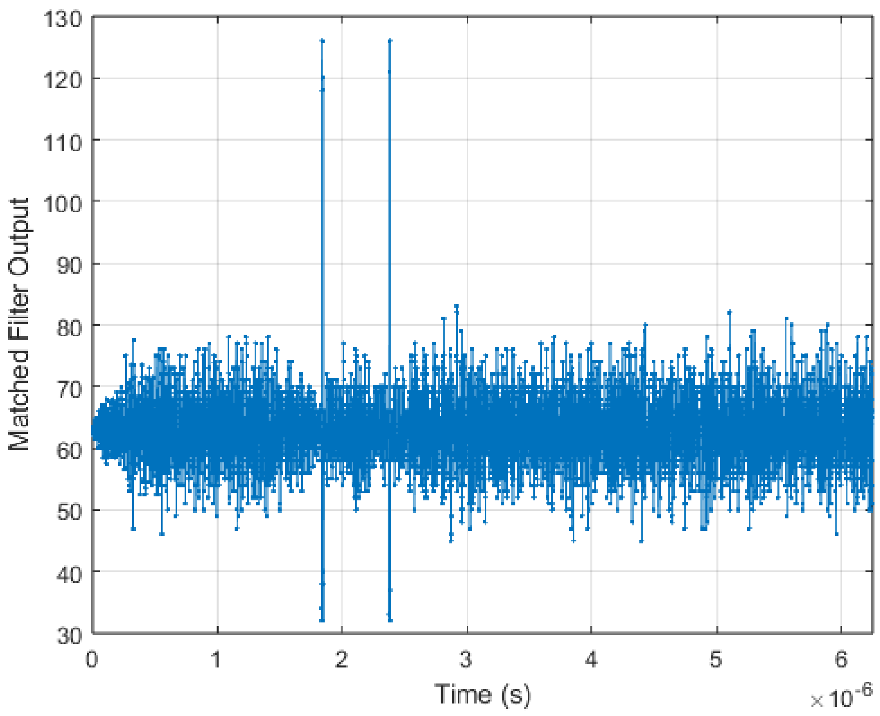
- Run at same 117.1875 MHz rate as normal operation except
  - Overlay with DME for effective toggle rate of 234.375 MHz
- The PRBS sequence is continuous between burst and quiet
  - 63-bit repeating sequence transmitted for 148 bits and masked for 586 bits
  - No variability – this would be useful as seen later

SNR at Matched Filter – System +/-50 ppm

Downstream PAM2



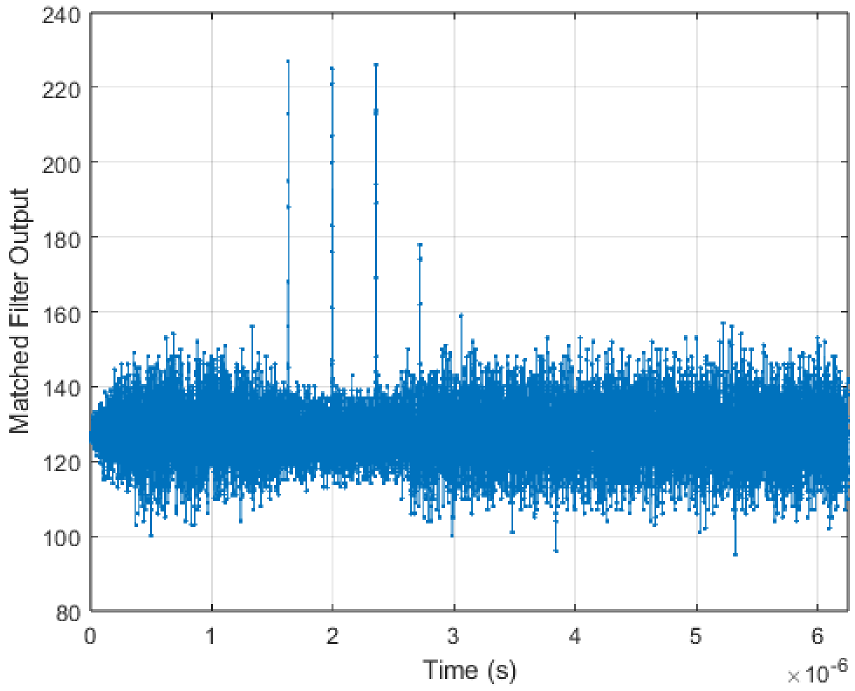
Upstream DME



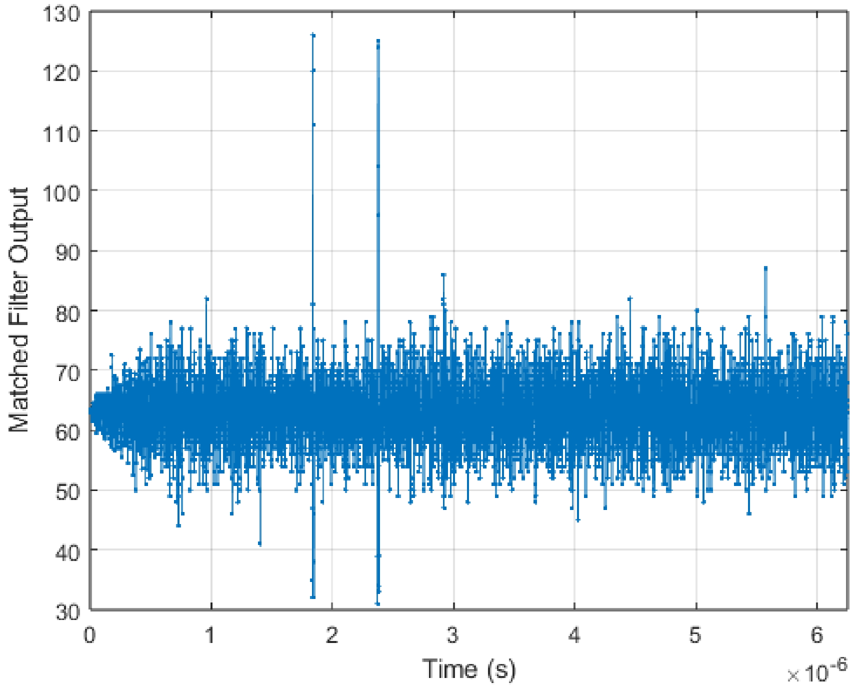
- Note: DME peak is 2x63 since both halves of DME symbol is compared

SNR at Matched Filter – System +/-5000 ppm

Downstream PAM2

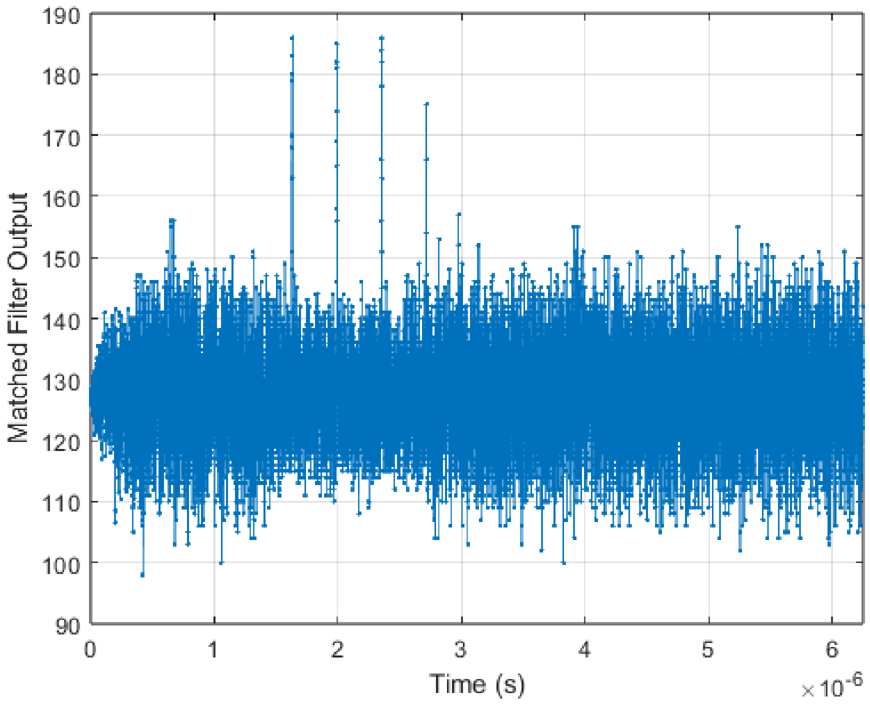


Upstream DME

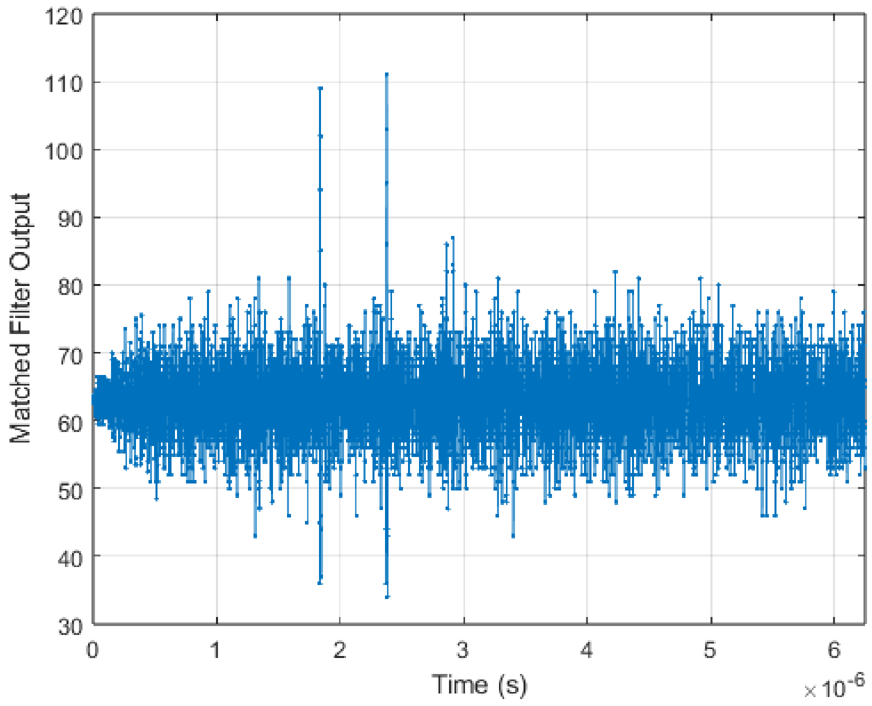


SNR at Matched Filter – System +/-10000 ppm

Downstream PAM2



Upstream DME



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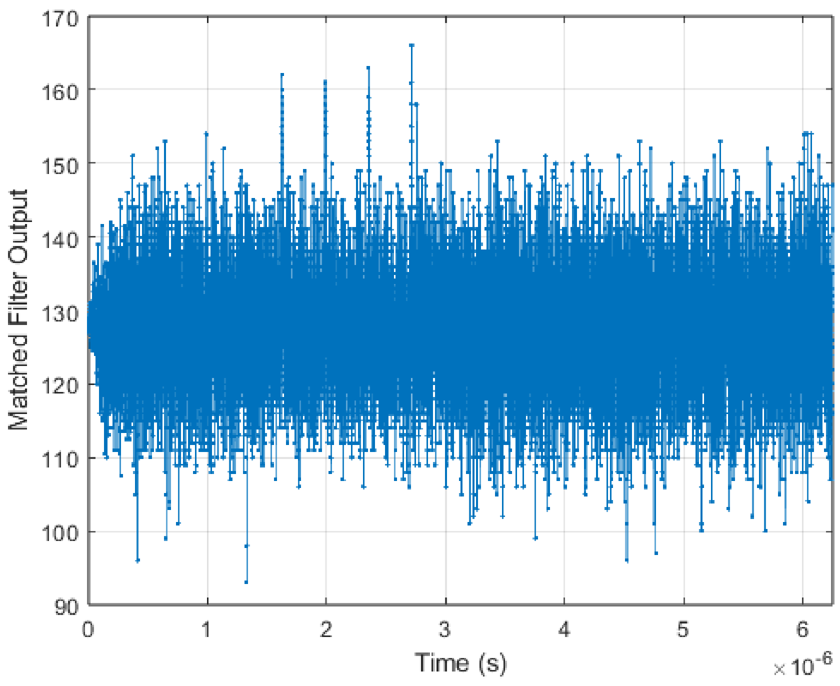
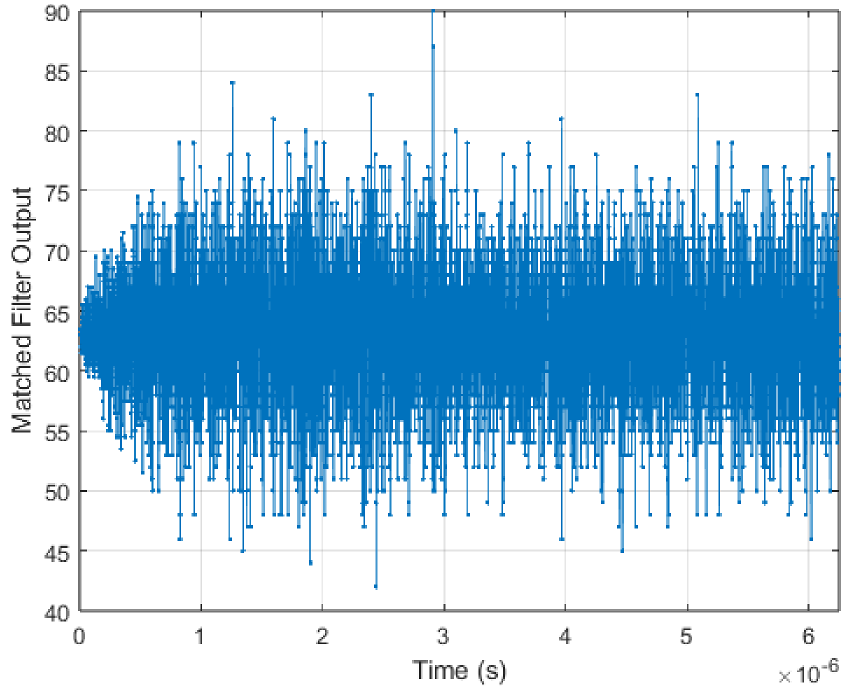
SNR at Matched Filter – System +/-20000 ppm

Downstream PAM2



Upstream DME



- Matched filter falling apart

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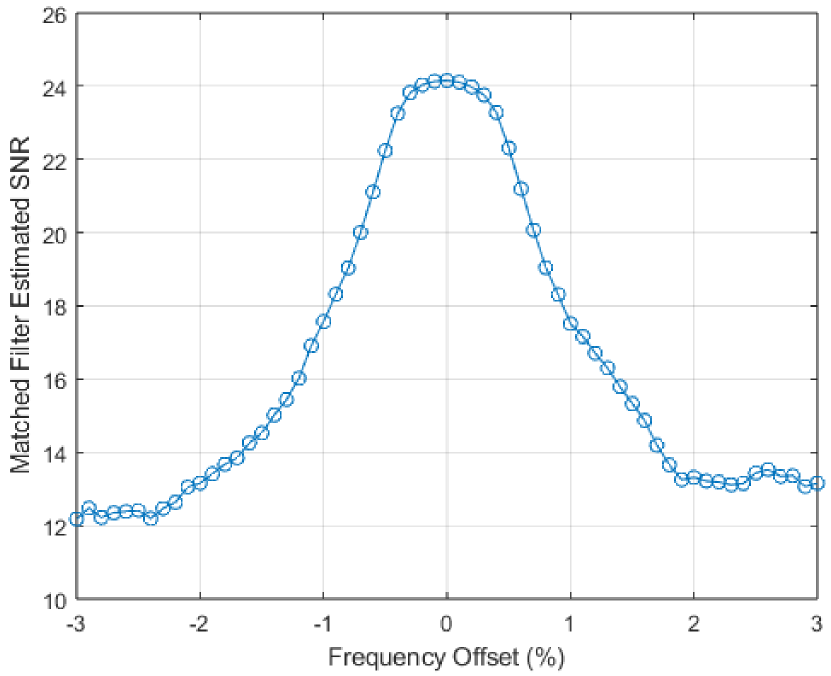
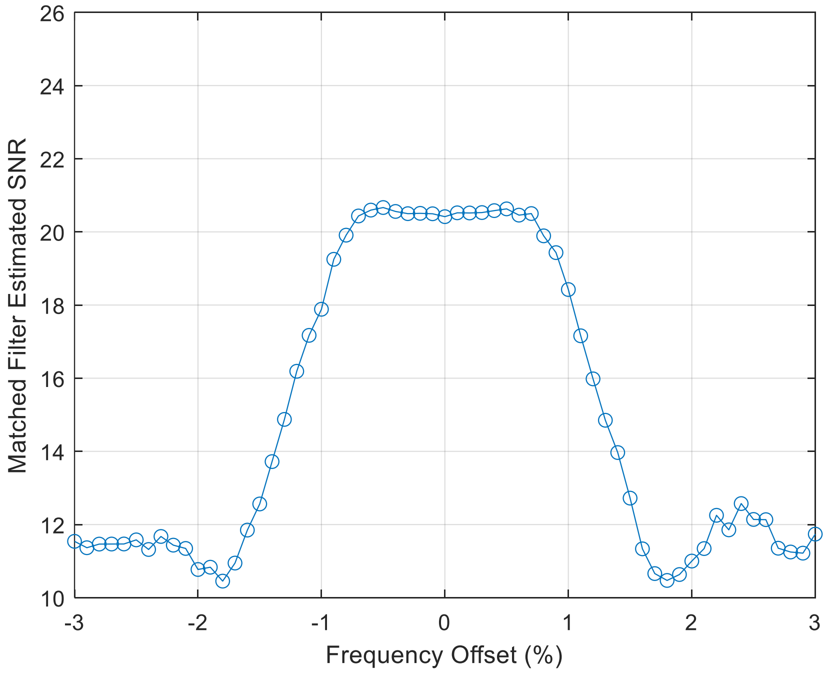
SNR vs Freq Offset

Downstream PAM2



Upstream DME



- Downstream roll off increases quickly larger than +/-5000 PPM (+/-0.5%)

How to Detect SEND_S in Crystal-less System

- Slave need to lock frequency close enough before transmitting downstream SEND_S to master.
  - Lock close enough for link sync to be reliable.
  - No need to lock to 0 PPM. This is done during training phase

- Assume PLL naturally oscillate near the frequency of interest
  - Reasonable implementation is +/-15% of center frequency +/-150,000 PPM
  - Actual implementations can be much tighter
  - Smaller range reduces lock time

- Blind search
  - Set PLL to certain frequency and see whether peaks are detected in matched filter
  - If not then try next frequency
  - Need many upstream SEND_S pulses to hone in

System parameters to be in compliance

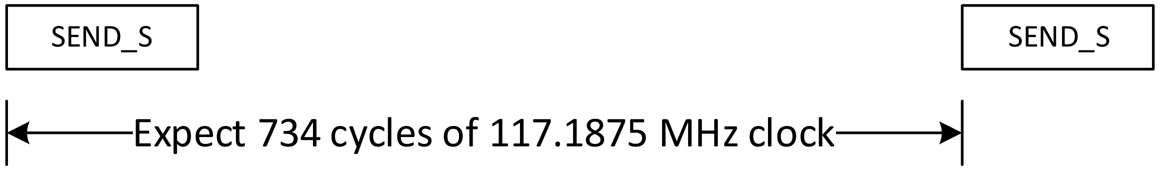
- PPM slave transmitter frequency offset from master reference before sending SEND_S
  - Recommend link_sync_freq_offset <= +/-5000 PPM
  - Implication: Master downstream link sync receiver tolerate at least this offset
  - Modification of meaning of send_s_sigdet from
    - TRUE: SEND_S signal detected, else FALSE to
    - TRUE: SEND_S signal detected * (slave transmitter frequency offset from master within link_sync_freq_offset) else FALSE
  - Slave does not transmit SEND_S until frequency offset is less than link_sync_freq_offset

- Time for slave to be ready to accept link sync pulses to time it start to send SEND_S given the master is already sending SEND_S.
  - Recommend slave_link_sync_freq_acq_time < 2ms
  - Time in SIGDET_WAIT state given master is already sending SEND_S

Speeding up Frequency Acquisition

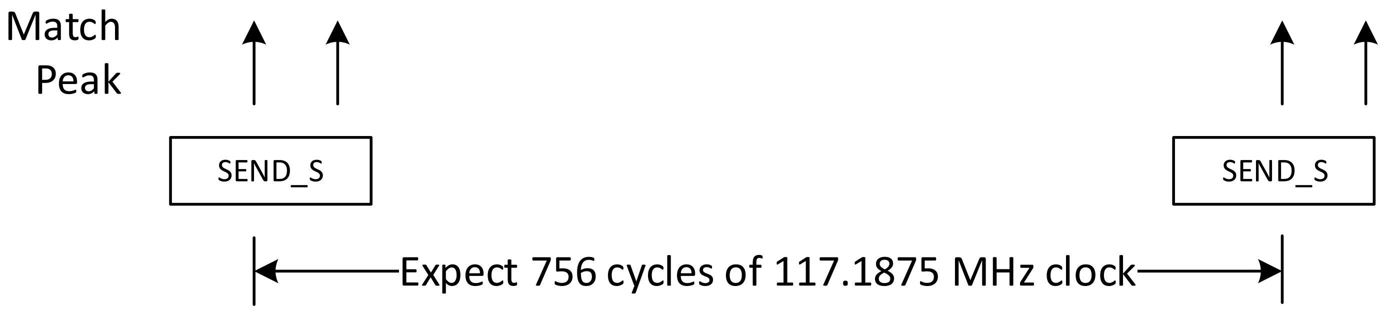
- Recommended slave_link_sync_freq_acq_time of 2ms plenty of time to blind search. More than 300 SEND_S bursts.

- Take advantage of fixed non-variable SEND_S burst duration and spacing
  - Count the number of local PLL clock cycles between SEND_S
  - Rough estimate of where local PLL frequency needs to be based on count vs expected count difference.
  - Reduces search space of blind search.



Speeding up Frequency Acquisition

- Take advantage non-stop PRBS sequence
  - Count the number of local PLL clock cycles between matched filter peaks in SEND_S bursts
  - Can get within less than +/- 2000 PPM (1/756 = 0.13%)



DME During Link Sync instead of PAM2

- DME allows optional further fine tuning of frequency loop during SEND_S bursts

Other Misc Recommendations

- Why PRBS sequence of 63 and not 127 for DME option
  - SEND_S burst is 148 bits. A sequence of 63 guarantees at least 1 strong peak and sometimes 2 peaks. A sequence of 127 does not guarantee a strong peak in every DME burst using a fixed sequence matched filter

- Why 802.3cy state machine and not 802.3ch
  - Extra SEND_S pulses from slave insures master matched filter has more opportunities to detect SEND_S when frequency offset is a large as +/-5000 PPMs.

Summary

- Reuse 802.3cy link sync state machine
  - Minor modification from 802.3ch state machine
- Reuse 802.3ch / 802.3cy downstream SEND_S
- Upstream SEND_S Characteristics
  - DME at same rate as normal data
  - Exact SEND_S pulse duration – no variability
  - Exact spacing between SEND_S pulses – no variability
  - Use PRBS with sequence length of 63 instead of the downstream 255 length
  - PRBS keeps advancing between SEND_S bursts
- Specify 2 parameters to ease interoperability
  - link_sync_freq_offset
  - slave_link_sync_freq_acq_time

THANK YOU

Backup

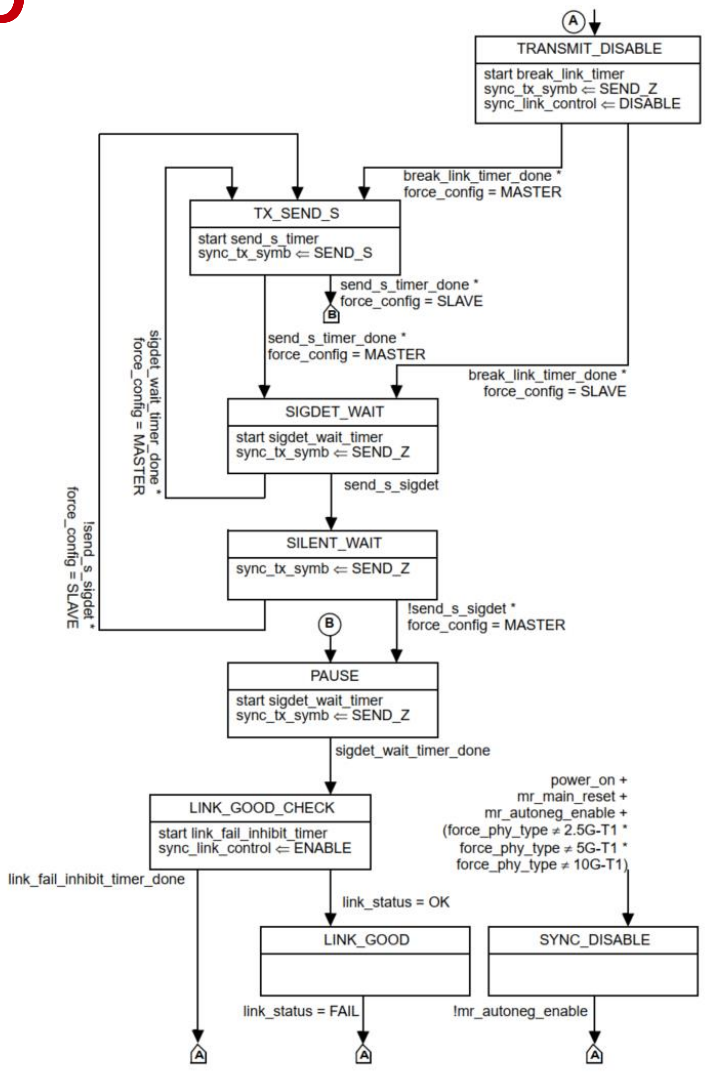


Figure 149–31—PHY Link Synchronization state diagram

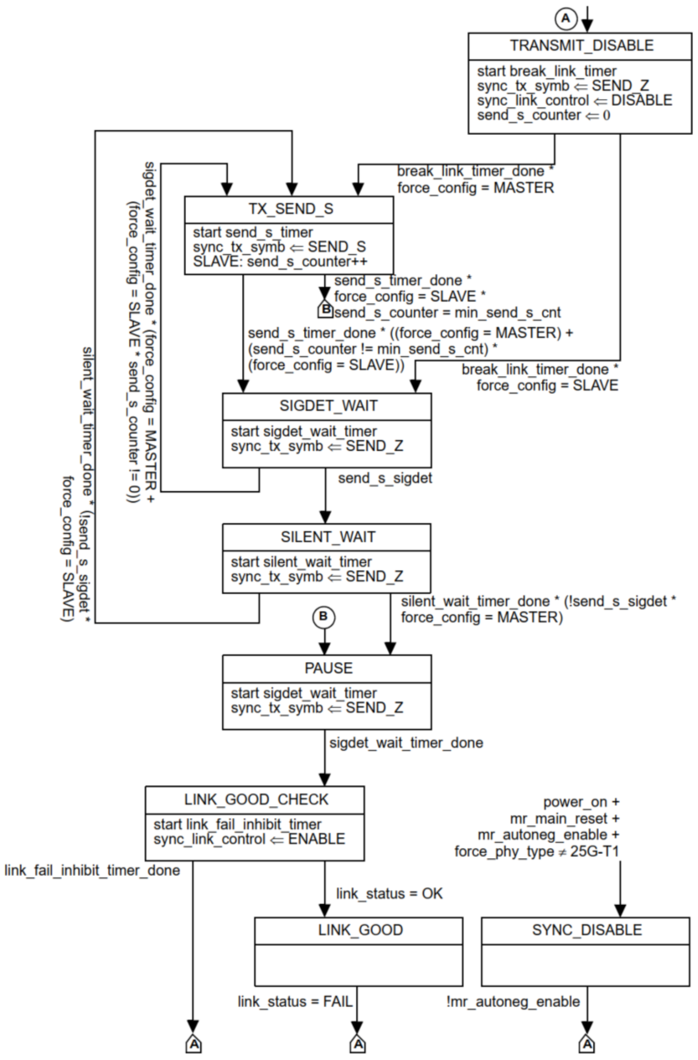


Figure 165–21—PHY Link Synchronization state diagram