Training & EEE Baseline

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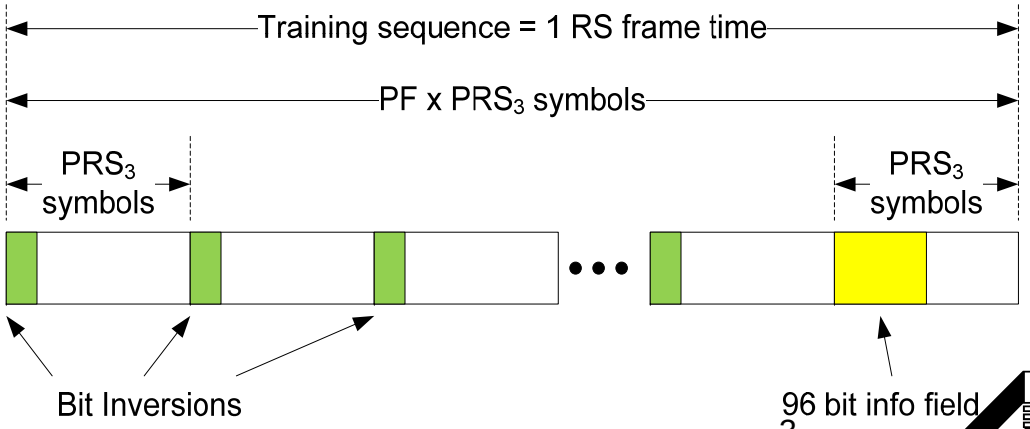
Parameters for this Baseline

- **Optimized to work with RS(450, 406, 2^9), PAM3, 750MBaud/s**

Symbol	Definition	Values
RS3	# PAM3 symbols per RS frame	2700
RST	Duration of RS frame (ns)	3600
PRS3	# PAM3 symbols per partial RS frame	180
PRST	Duration of partial RS frame (ns)	240
PF	# partial frames per RS frame	15
QRF	# RS frame per quiet refresh cycle	24
QRT	Duration of quiet refresh cycle (ns)	86400
2 x AF	# partial RS frames separating alert	30
2 x AlertGranularityT	Alert Granularity (ns)	7200
Refresh_LPI	# partial RS frames for refresh	6
Refrest_T	Duration for refresh (ns)	1440
QR Ratio	Quite/Refresh Ratio	60
Enter_LPI_RS	# RS frames with all LPI to enter LPI	1
Alert_T	Sense window (ns)	Implementation Dependent
Exit_LPI_RS	# RS frames with all idles upon exit LPI	1

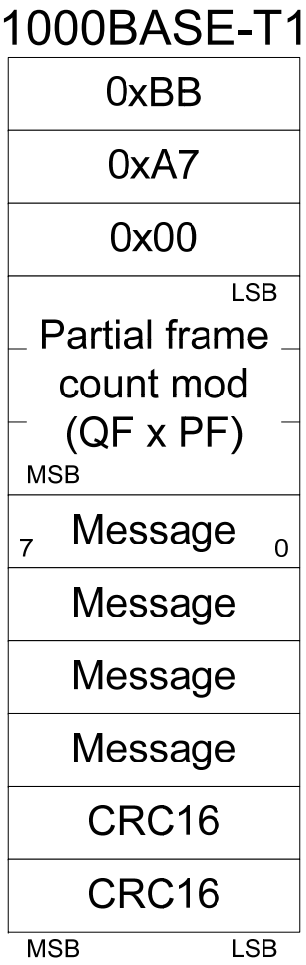
1000BASE-T1 Training

- XOR training sequence with scrambler sequence
- Issue – 1 RS frame a lot longer than 1 LDPC frame
  - RS(450, 406, 2^9) = 3600 ns
- Want bit inversion and info field to occur more frequently given nosier environment
- Solution – Introduce partial RS frame
  - Divide RS frame time into PF number of PRS_3 symbol groups
  - Info field occurs once per RS frame time. Indicated by XORed 0xBBA7 pattern
  - Info field first 96 bits of PRS_3 symbol group to avoid offset calculations.



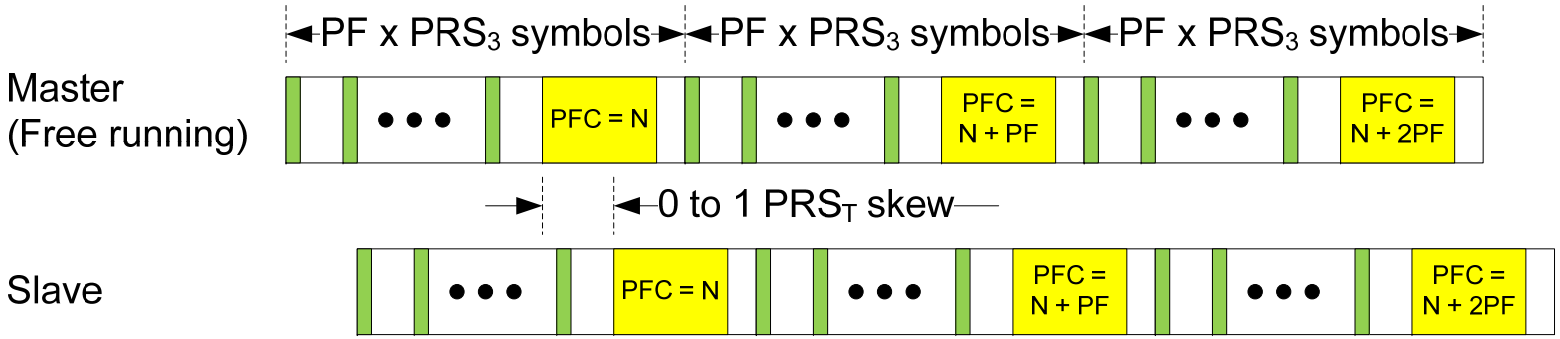
Info Field

- 96 bits.
- Partial RS Frame Count (PFC) used to establish time synchronization for EEE
  - Free running on 1000BASE-T1 master
  - Slave must match partial frame count (PFC) to within +0/-1 partial RS frame measured at the receiver input
- LSB transmitted first
- Message format defined in another baseline



Example of slave partial RS frame count matching

- **PF x PRS_3 symbols per training sequence**
- **Master free runs and increments PFC by PF every training sequence**
  - **Rolls over – but in theory should not**
- **Slave locks to within +0/-1**
  - **Slave accepts master PFC only if CRC16 is good.**
  - **Robust to noise since not every info field needs to be processed to recover master PFC**

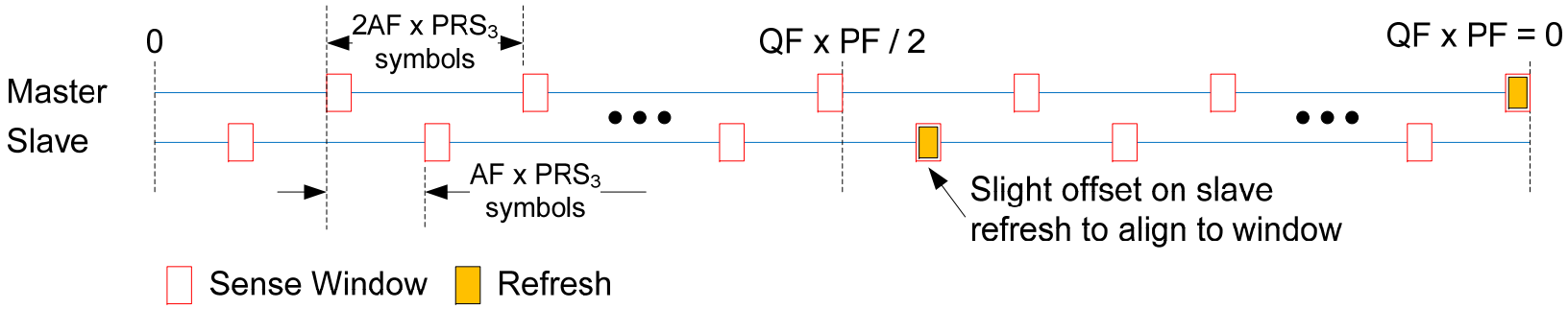


EEE - Entering LPI

- **If LPI seen on GMII fill remaining bytes in RS frame with LPI symbol. Then send Enter_LPI_RS number of RS frame with nothing but LPI symbols.**

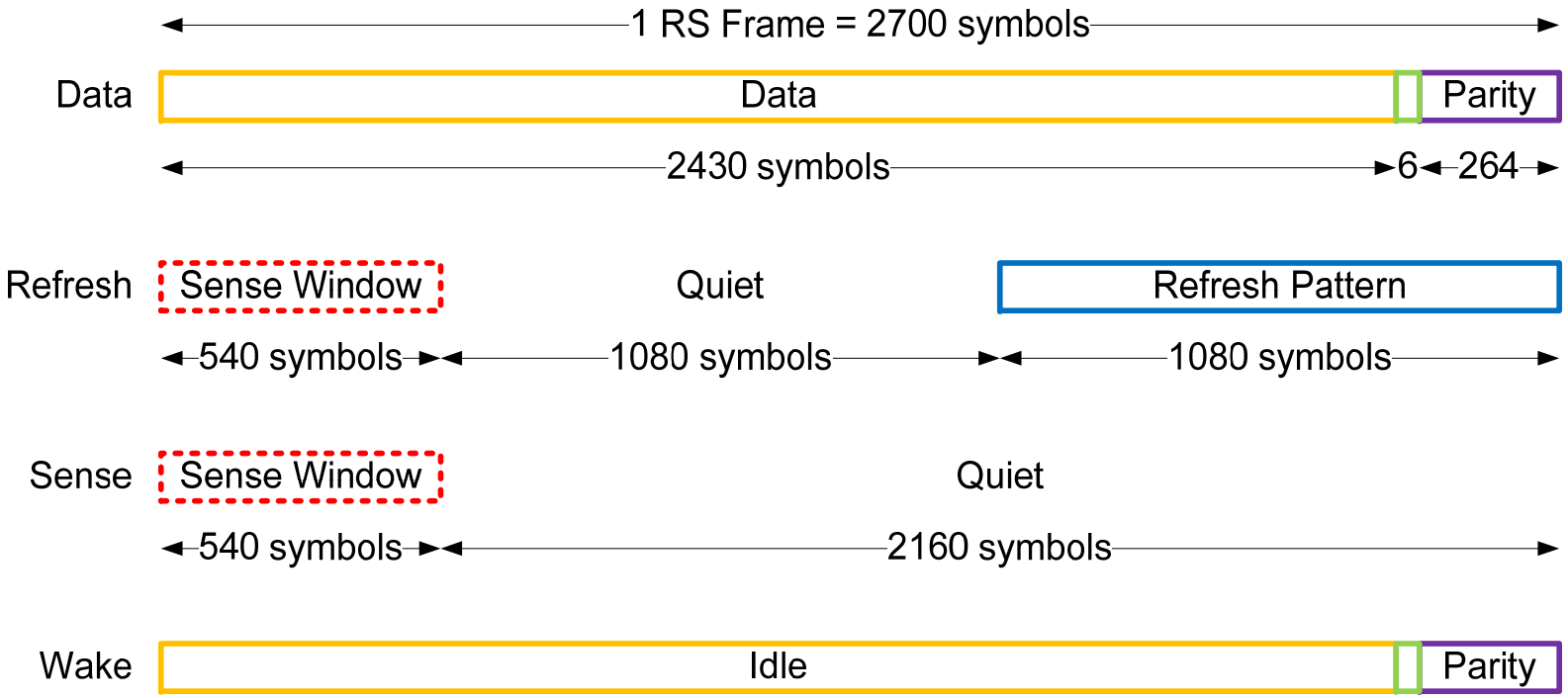
EEE – Quiet/Refresh and Sense

- **Master and Slave Refresh Staggered as shown**
- **Use wake time of 16.5us**
- **Allow wake frame to be sent only during certain windows**
  - **Allows receiver to power down outside window**
  - **Stagger windows between master and slave so wake frame never overlap**
  - **Will increase worst case wake time waiting for window**
  - **Align refresh with sense window**
  - **Space sense windows 2 x AF x PRS_3 symbols apart and stagger master and slave windows by AF x PRS_3**



Quiet / Refresh / Sense – With actual numbers

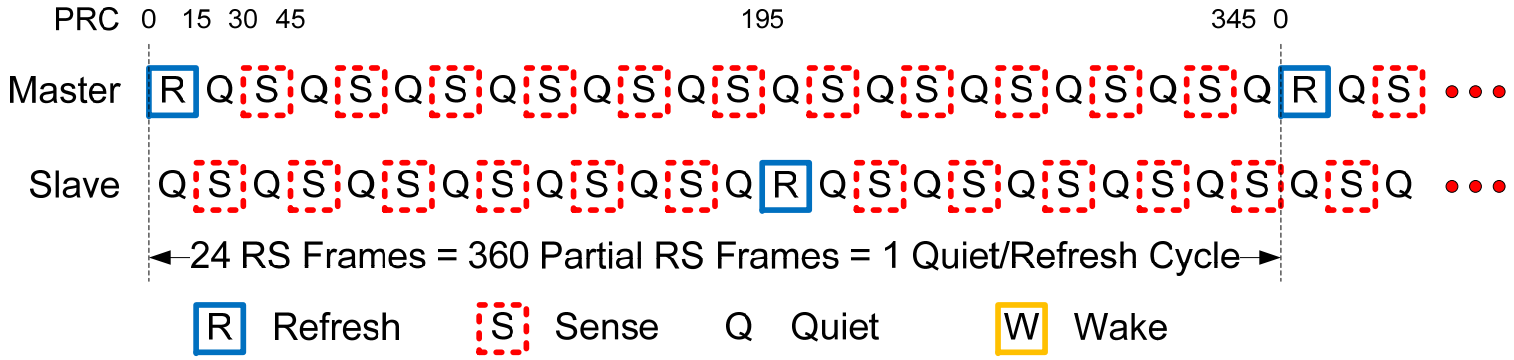
- **Every 2700 symbol can have 1 of 5 activities**
  - **Data – Regular RS frame**
  - **Refresh – a sense window followed by refresh pattern**
  - **Sense – a sense window only**
  - **Quiet – pure quiet period.**
  - **Wake – wake pattern – simply a data frame with all idles**



*sense window shown as 540 symbols as an example. Actual duration is left to the implementer

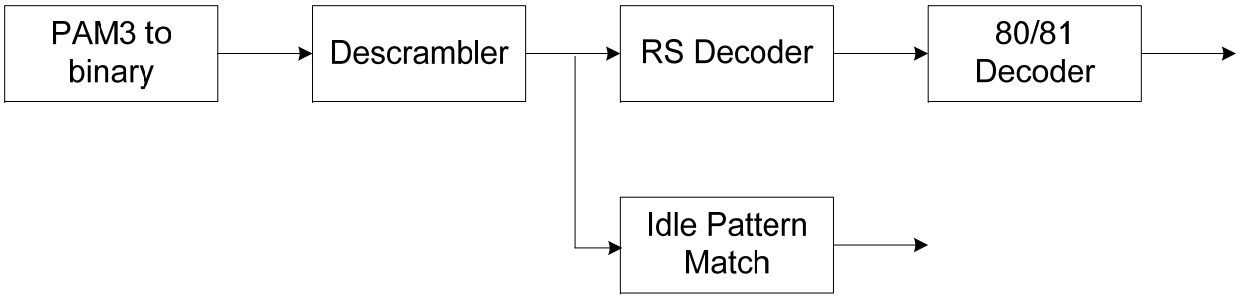
Quiet Refresh Cycle – With actual numbers

- Every quiet/refresh cycle consists of 24 RS Frame times
- Same as 360 80/81 encoder transfers
- Same as 360 Partial RS Frame times
- Quiet and Sense are offset between master and slave
- Wake can only be sent during PHYs Quiet time
  - Coincides with link partners sense window



EEE – Exit LPI Procedure

- **Send Exit_LPI_RS RS frame with all bytes idles**
  - **This is the wake frame. Alert pattern not needed.**
- **Lets the main data path warm up**
  - **Worst case wakeup time 2 x RS_T + latency = 2 x 3.6us + approx 5us = 12.2us**
- **Optional parallel path for early detection of sufficient number of idles bytes in pattern match to exit LPI**
  - **Data is not corrected by RS**



Refresh Pattern

- **Use data scrambler sequence with all zero data**