Fast-160 Presentation

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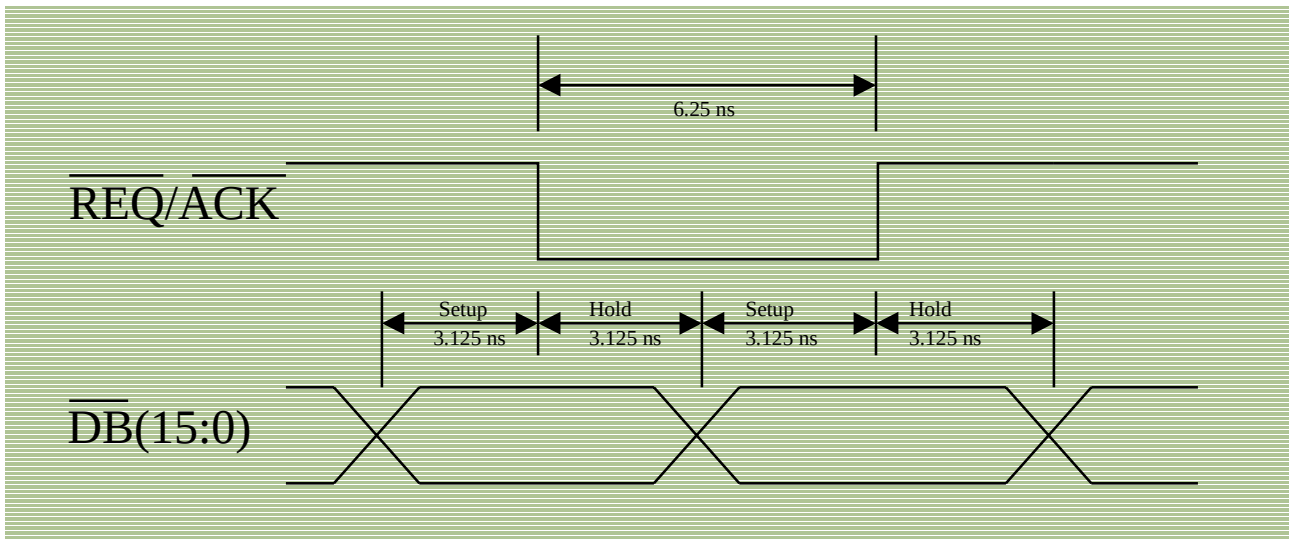
SCSI Fast-160

- F-160 Transfer (320 Mbytes/Sec for Wide bus)
  - Maintains existing protocol & Driver/Receiver types
  - Double REQ/ACK frequency
- Skew compensation methodology
  - Use training sequence for determining skew
- ISI pre-compensation in the REQ/ACK and data driver

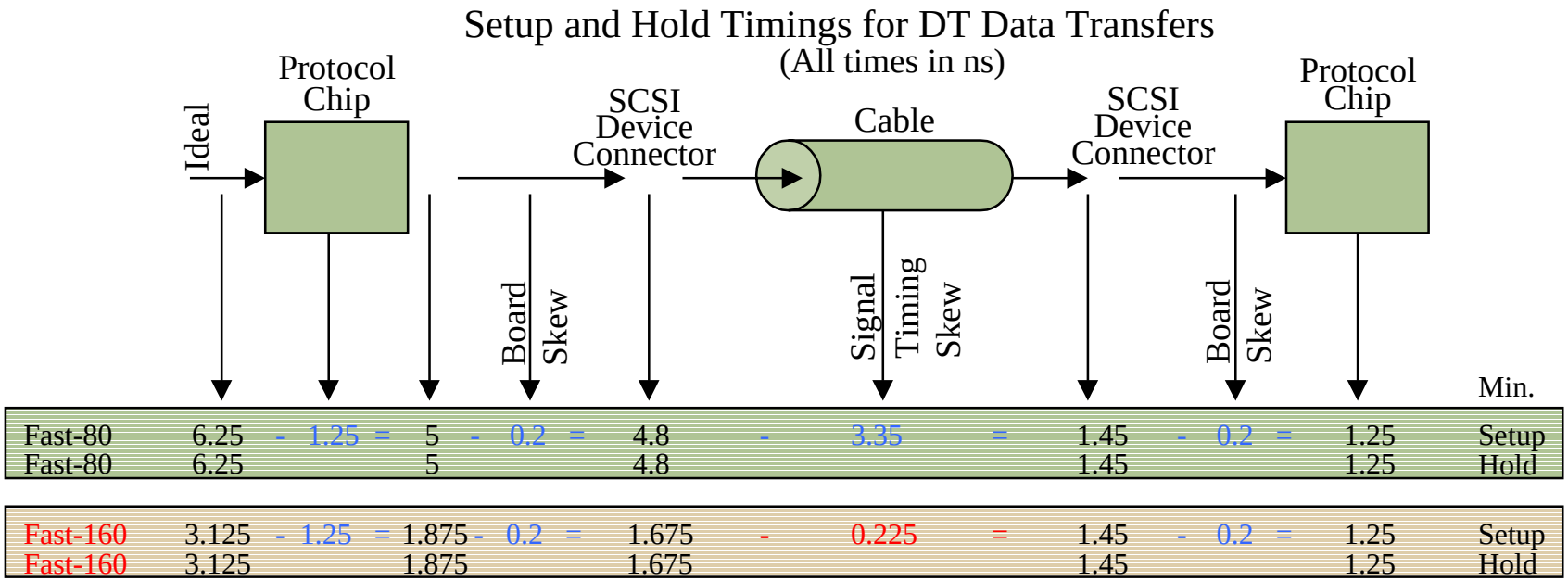
F-160 Transfer (2X Scale of F-80)

- Double existing F-80 ACK/REQ Frequency
  - 320 Mbytes/Sec for Wide bus (vs. 160 Mbytes/sec)
  - Transfer 2-bytes every 6.25 ns (vs. 12.5 ns)
  - 3.125 ns nominal Setup/Hold time (vs. 6.25 ns)



F-160 Transfer (2X Scale of F-80)

- 3.125 ns Setup/Hold time leaves very little (0.225 ns) remaining cable plant budget for “Signal Timing Skew”
  - Signal timing skew includes cable skew and signal distortion skew
  - Signal distortion skew includes ISI (inter-symbol interference) and signal crossing time through the receiver detection range

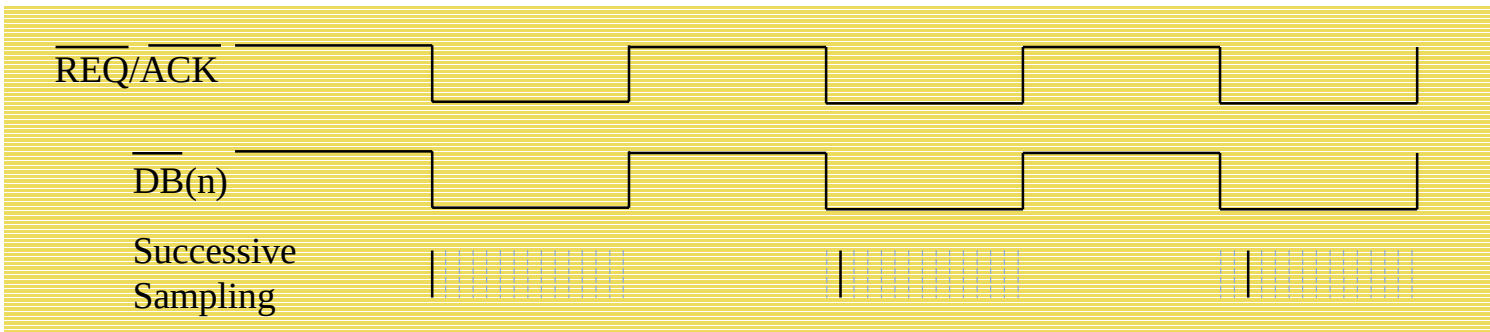


Signal Skew Limits Direct Scaling

- System skew is dominated by time invariant parameters (during data transfer)
  - Sender ASIC skew (silicon process, logic)
  - Sender board skew (trace length and impedance control, pin cap.)
  - Cable plant skew (physical wire impedance variations, lumped/distributed loading, stubs and connectors)
  - Receiver board skew
  - Receiver ASIC skew
- This system skew can be greatly reduced by realigning the strobe and data to the desired relationship by de-skewing logic at the receiver
- Each receiving device realigns data and strobe bits uniquely according to skew detected by dedicated logic for each bit

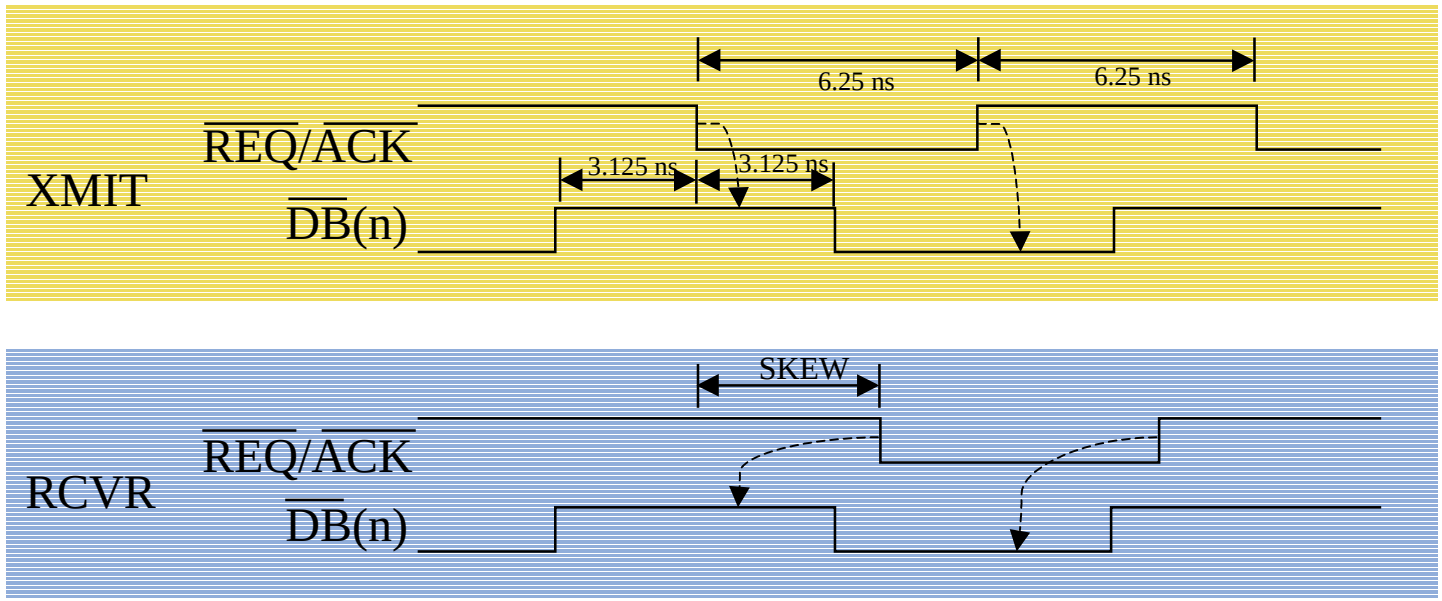
Signal Skew Detection

- Strobe to signal skew is measured by successive sampling of the data bit by delayed versions of the REQ/ACK strobe
  - Optimal setup/hold relationship can be determined by digital solution
  - Accuracy will be determined by the sampling resolution
- This setup/hold relationship is then used for data transfer
- A “training sequence” is used to establish a known strobe/data relationship between sender and receiver, so that the receiver can measure skew



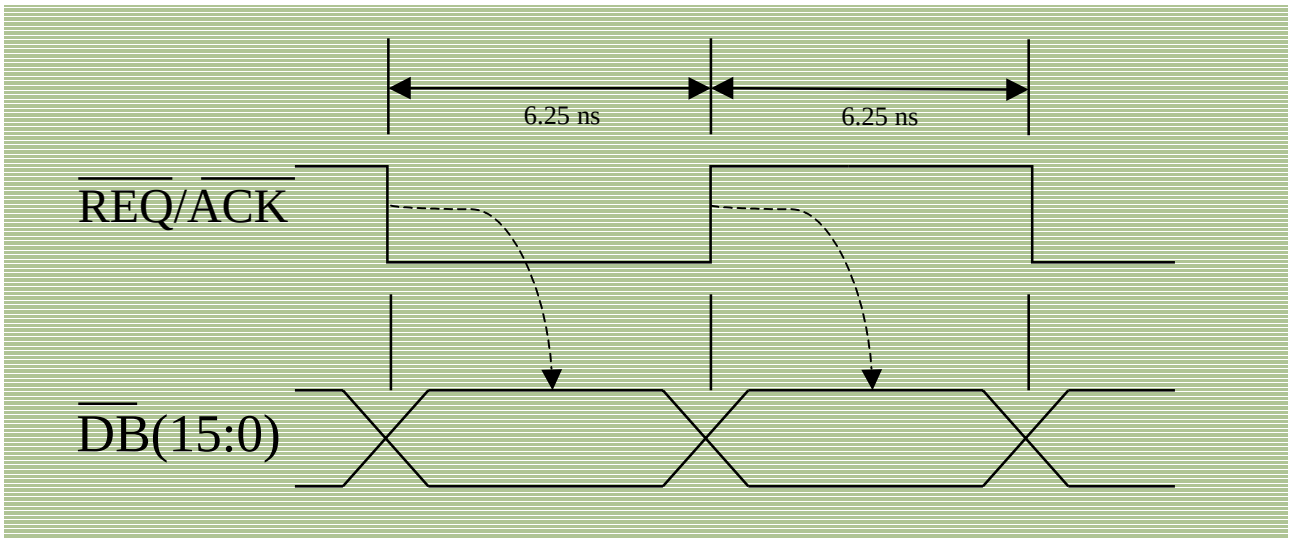
Skew Compensation Limitation

- With 50% Setup/Hold, REQ/ACK to data relationship moves into the next cell time, to return to strobe centering, strobe and data must be adjusted
  - Data bits need to be delayed individually and REQ/ACK needs to be delayed also when REQ/ACK proceeds data center (not preferred)
  - Otherwise, REQ/ACK needs to be delayed individually per data bit (preferred) and all data bits delayed by a fixed amount (not preferred)



F-160 Transfer (Early Strobe Solution)

- Proposing to align strobe and data so individual data bits do not have to be delayed by a fixed amount
  - Double ACK/REQ Frequency
  - 320 Mbytes/Sec for Wide bus (transfer 2-bytes every 6.25 ns)
  - 0ns Setup / 6.25 ns Hold time (nominal), for positive delay strobe alignment



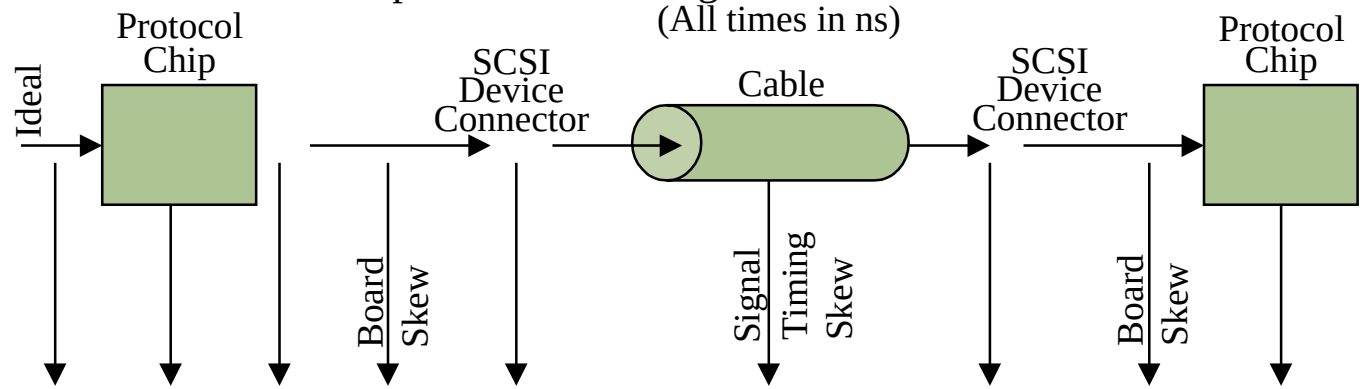
Skew Compensation Timing Budget

- Maximum skew to be compensated is 5.4 ns
  - Sender ASIC skew - 1.25 ns
  - Sender board skew - 0.2 ns
  - Cable plant skew - 2.5 ns for 25 m cable (30 ps/ft)
  - Receiver board skew - 0.2 ns
  - Receiver ASIC skew - 1.25 ns
- Allows de-skew logic to delay REQ/ACK by less than 6.25 ns (F-160 DT period)

F-160 Transfer (with Skew Comp.)

- Cable plant budget for “Signal Timing Skew” can be increased by de-skewing data
  - e.g. cable plant budget for “Signal Timing Skew” can be increased to 3.85 ns by de-skewing data by 3.625 ns

Setup and Hold Timings for DT Data Transfers
(All times in ns)



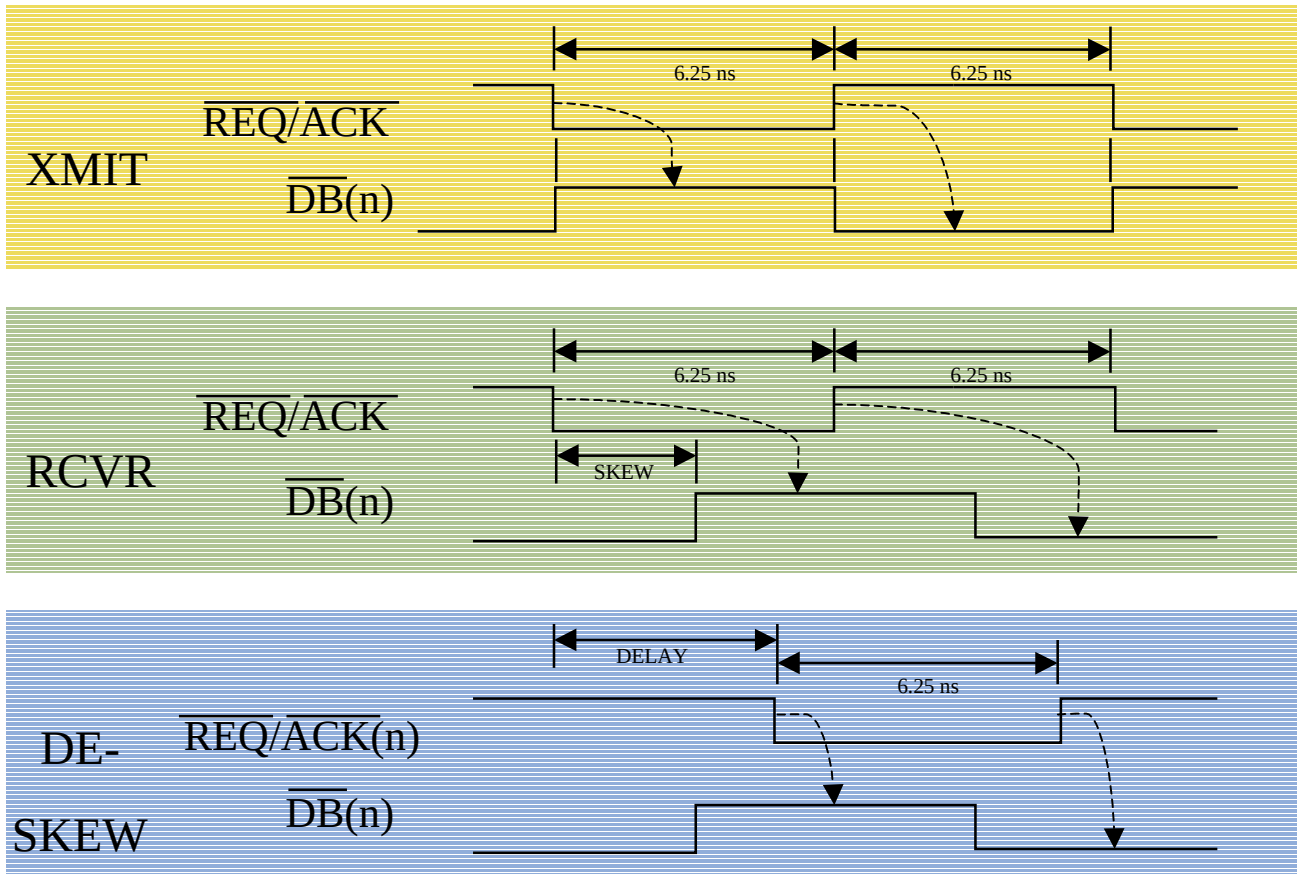
Fast-80	6.25	-	1.25	=	5	-	0.2	=	4.8	-	3.35	=	1.45	-	0.2	=	1.25	Setup
Fast-80	6.25				5				4.8				1.45				1.25	Hold
Fast-160	3.125	-	1.25	=	1.875	-	0.2	=	1.675	-	3.85	=	(2.175)	-	0.2	=	(2.375)	Setup
Fast-160	3.125				1.875				1.675				(2.175)				(2.375)	Hold

For 1.25 ns setup/hold at protocol chip, [2.375 + 1.25] = 3.625 ns of de-skewing is needed + 3.625

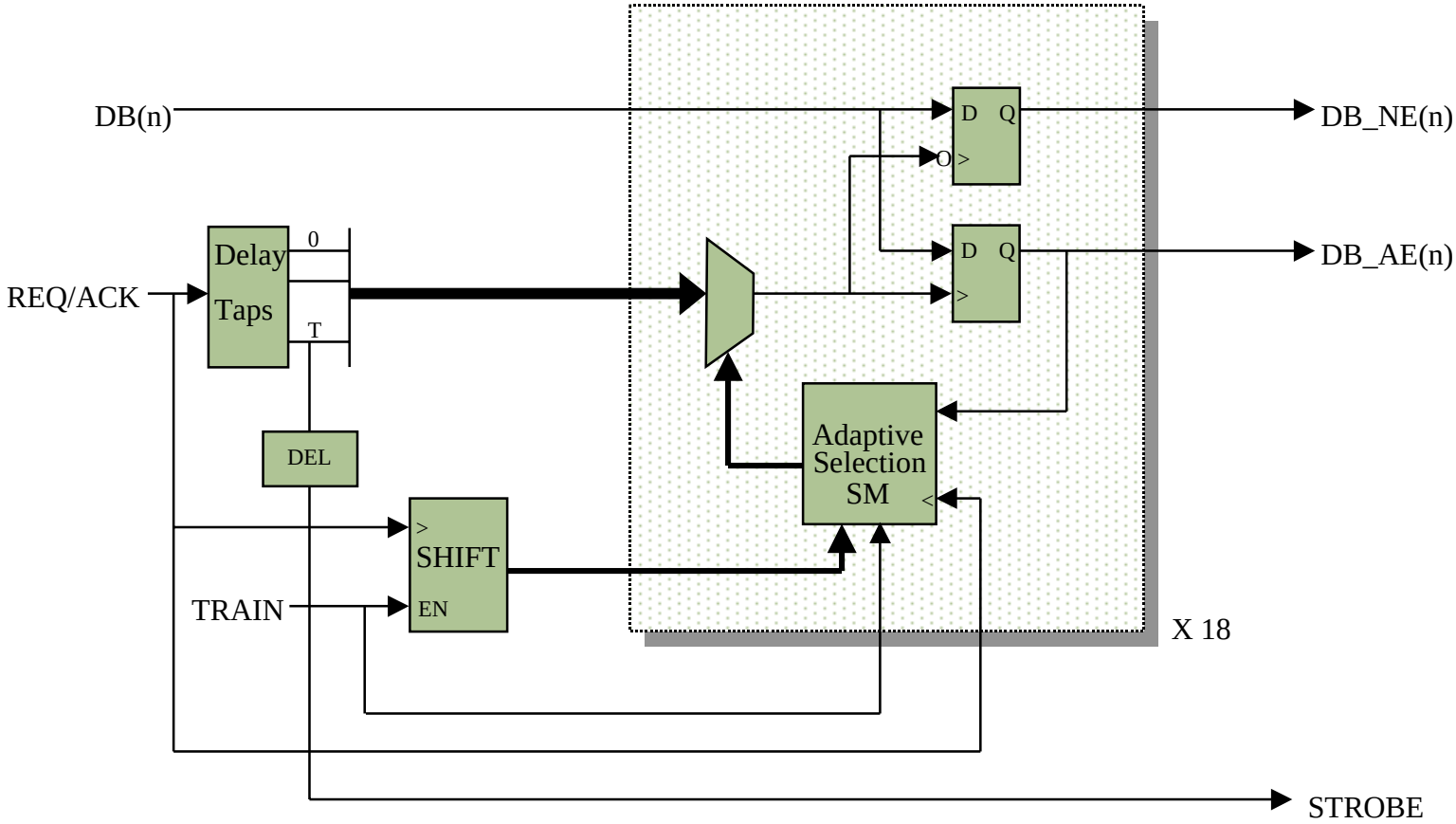
1.25	Setup
1.25	Hold

Skew Compensation

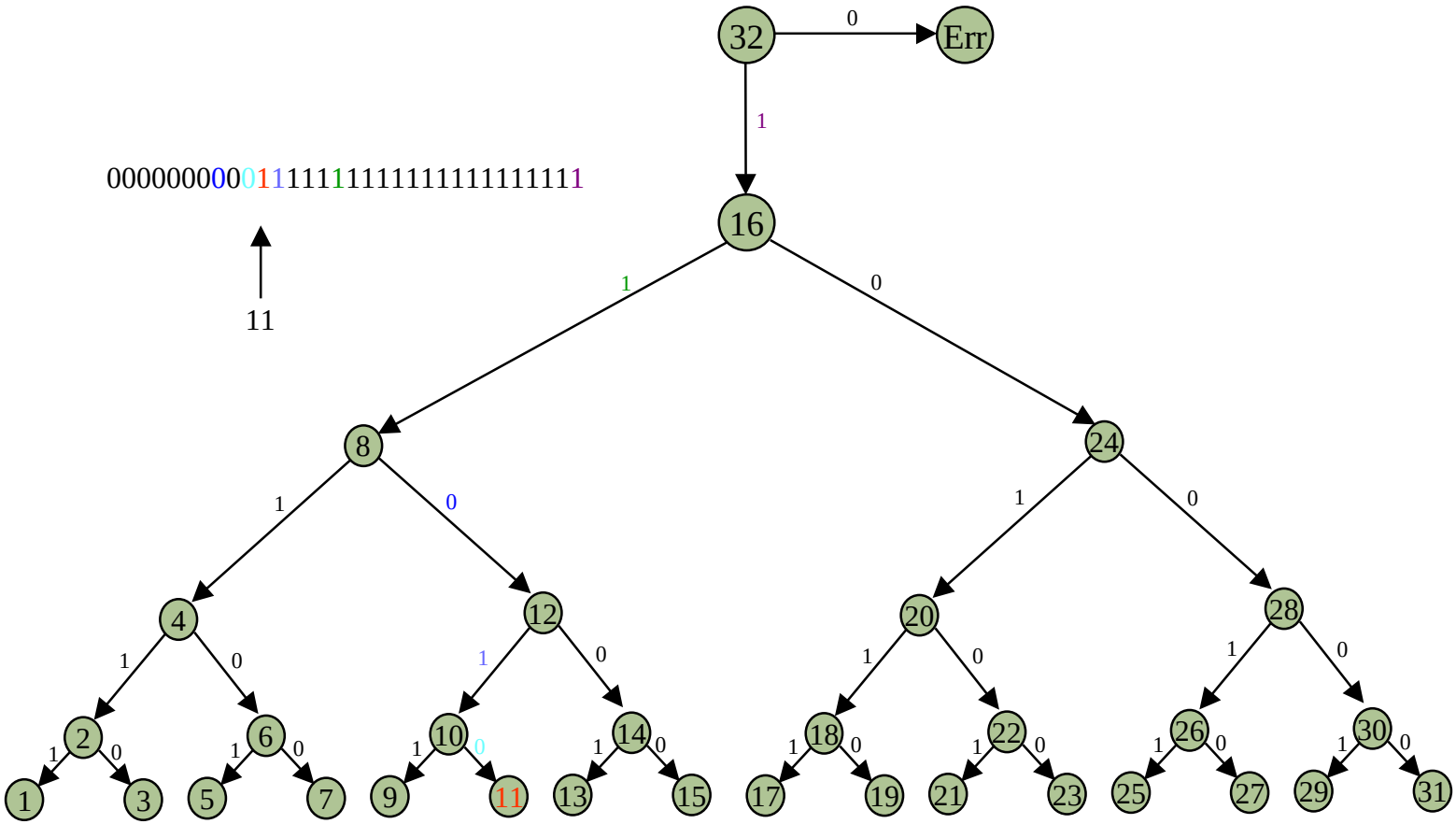
- De-skew data in the receiver by delaying REQ/ACK per data bit



Adaptive Skew Compensation Training

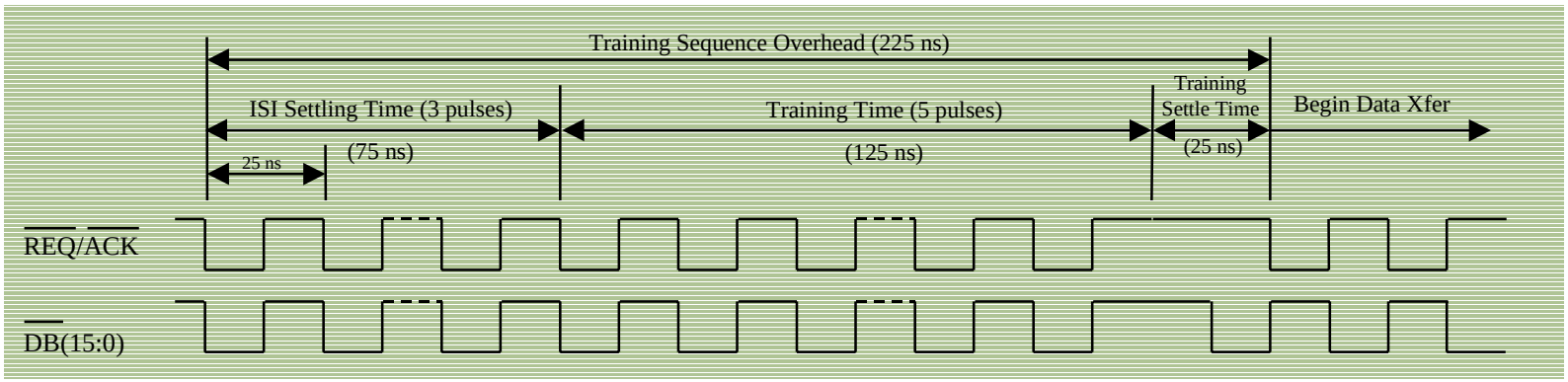


Adaptive Skew Compensation Training

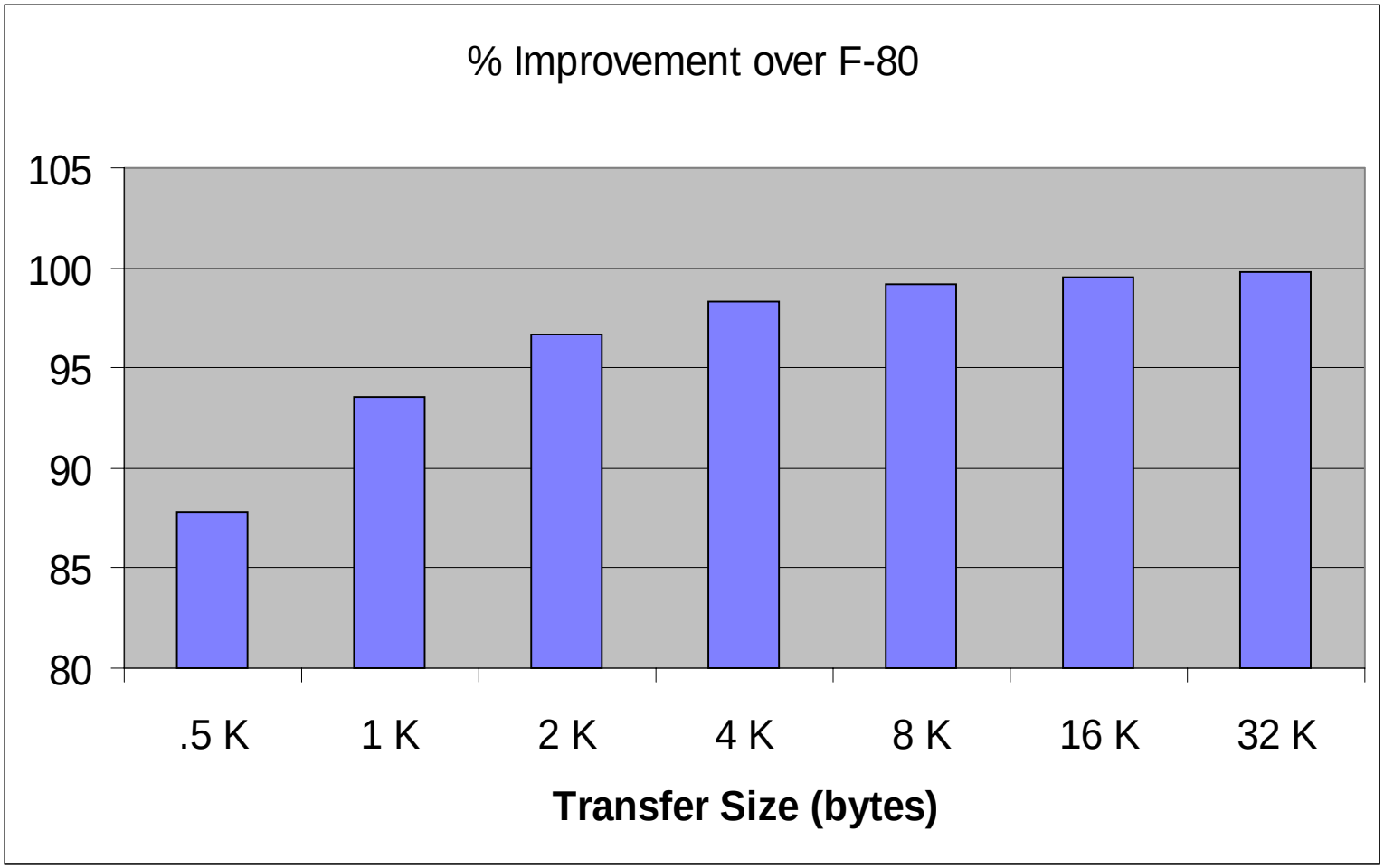


Skew Comp. - Training Sequence

- Train at beginning of every data phase (no setup required to be remembered)
- Single edge training requires massive amount of logic per data bit (not preferred)
- Training is done on assertion edge only, negation edge skew differences assumed to be acceptably small
- Count fixed # of REQ/ACKs for training at F-80 rate (DT period of 12.5 ns)
  - First 3 pulses for ISI settling time
    - 3 pulses => 6 F-80 DT periods => 75 ns
  - Then, 5 pulses for training for 5 training edges
    - e.g. 32 samples requires 2^5 = 32 => 5 training edges => 10 F-80 DT periods => 125 ns



Training Sequence Overhead



Secondary Effects - ISI

- ISI (Inter Symbol Interference) such as first pulse problem
- Skew compensation alone may be sufficient to bring timing margin back to F-80 levels
- Additional compensation will improve timing margin

ISI Pre-compensation

- Driver adjusts strength for first pulse problem by lowering the strength for runs (or incrementing the strength for non-runs)