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To:     T10 Technical Committee
From:   Bill Galloway
Subj:   Timing for ATN and P_CRCA signals in SPI-4


The timing of the ATN and P_CRCA signals is not the same as data signals with paced transfers. Some of the time these signals are timed against the data originator clock (free running) and some of the time these signals are timed against the data recipient clock (not free running). The ATN signal is never de-skewed and the P_CRCA signal is only de-skewed against the target data originator clock. To keep the timing simple, the times are only calculated with the non free running clock (worst case).

Table 1 contains all of the numbers from the Fast-160 Timing Budget Template (00-323r3) that are needed to calculate receive setup and hold times.


### Table 1 Receive setup/hold time calculation

| Item | Time | Comments |
|---|---|---|
| Receiver time asymmetry | 0,35 ns | |
| System noise at receiver | 0,25 ns | |
| Chip noise in receiver | 0,20 ns | |
| Receiver amplitude time skew | 0,20 ns | |
| Receiver chip skew | 0,75 ns | |
| One x trace skew | 0,20 ns | Only at receiver |
| Flip Flop setup/hold time | 1,00 ns | Arbitrary |
| TOTAL | 2,95 ns | Round to 3,00 ns |

Table 2 contains all of the numbers from the Fast-160 Timing Budget Template (00-323r3) that are needed to calculate transmit setup and hold times.

Table 2 Transmit setup/hold time calculation

| Item | Time | Comments |
|---|---|---|
| REQ (ACK) period tolerance | 0,12 ns | Not divided by 2 |
| Driver time asymmetry | 0,50 ns | |
| System noise at launch | 0,25 ns | |
| Crosstalk | 0,70 ns | |
| Clock jitter | 0,50 ns | Times 2 |
| Transmitter chip skew | 0,75 ns | |
| Cable skew | 2,50 ns | |
| One x trace skew | 0,20 ns | Only at transmitter |
| May detect to shall detect ambiguity | 1,50 ns | From Fast-80 |
| ISI of REQ (ACK) after compensation | 1,00 ns | |
| ISI of ATN or P_CRCA | 2,00 ns | |
| Receive setup/hold time | 3,00 ns | From Table 1 |
| TOTAL | 13,02 ns | Round to 14,00 ns |

Based on these tables I propose that 3,00 ns be used for the Fast-160 **ATN receive setup time**, and that 14,00 ns be used for the Fast-160 **ATN transmit setup time** in Table 32. To clarify for pacing transfers the time descriptions should be changed to the following.

**9.2.2 ATN transmit setup time**
The minimum time provided by the transmitter between the assertion of the ATN signal and the negation of the ACK signal. When information unit transfers are enabled, the setup time is to the negation of the ACK signal corresponding to the last iuCRC transfer of an information unit.

Specified to provide the increased ATN receive setup time, subject to intersymbol interference, cable skew, and other distortions.

**9.2.3 ATN receive setup time**
The minimum time required at the receiver between the assertion of the ATN signal and the negation of the ACK signal to recognize the assertion of an Attention Condition. When information unit transfers are enabled, the setup time is to the negation of the ACK signal corresponding to the last iuCRC transfer of an information unit.

Specified to ease receiver timing requirements.

NOTE 24 – Versions of this standard prior to SPI-3 provided two system deskew delays of setup time.

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The wording for flow control does not specify the timing of PCRC_A transitions precisely enough. I propose that we add four new times to the Fast-160 column of Table 32. The transmit times should be 14,00 ns and the receive times should be 3,00 ns as calculated in Table 1 and Table 2 above.

**9.2.x Flow Control receive hold time**
The maximum time required by the initiator between the assertion of the REQ signal corresponding to the last iuCRC transfer of a SPI data streaming information unit and the changing of the P_CRCA signal.

Specified to ease receiver timing requirements.

**9.2.x Flow Control receive setup time**
The maximum time required by the initiator between the assertion of the P_CRCA signal and the assertion of the REQ signal corresponding to the last iuCRC transfer of a SPI data streaming information unit. Also, the maximum time required by the initiator between the negation of the P_CRCA signal and the assertion of the REQ signal corresponding to any valid data transfer of a SPI L_Q information unit.

Specified to ease receiver timing requirements.

**9.2.x Flow Control transmit hold time**
The minimum time provided by the target between the assertion of the REQ signal corresponding to the last iuCRC transfer of a SPI data streaming information unit and the changing of the P_CRCA signal.

Specified to provide the increased P_CRCA receive setup time, subject to intersymbol interference, cable skew, and other distortions.

**9.2.x Flow Control transmit setup time**
The minimum time provided by the target between the assertion of the P_CRCA signal and the assertion of the REQ signal corresponding to the last iuCRC transfer of a SPI data streaming information unit. Also, the minimum time provided by the target between the negation of the P_CRCA signal and the assertion of the REQ signal corresponding to any valid data transfer of a SPI L_Q information unit.

Specified to provide the increased P_CRCA receive setup time, subject to intersymbol interference, cable skew, and other distortions.


With these new times the section titled **Paced information unit transfers** can be simplified. Remove the flow control description from the middle of the data transfer description and break flow control out into a separate paragraph.  Replace with the following:

If flow control is enabled and the current SPI data streaming information unit is the last SPI data stream information unit of the stream then the target shall assert the PCRC_A signal. The target shall assert the P_CRCA signal a minimum of a Flow Control transmit setup time before the end of the last information unit and shall keep the P_CRCA signal asserted for a Flow Control transmit hold time. The target shall not assert the PCRC_A signal until a minimum of a Flow Control hold time after the end of the previous information unit. The target shall negate the P_CRCA signal a minimum of a Flow Control transmit setup time before the start of the next information unit.

NOTE xx – The earlier in a SPI data streaming information unit that the target asserts the P_CRCA signal, the better the initiator may manage data pre-fetch.