

Fast SCSI Timing Problems and Solutions

Current SCSI-2 Timing

AT THE CONNECTORS,

1. Transmitter must drive data at least 25ns before asserting REQ/ACK.
2. Transmitter must hold data at least 35ns after asserting REQ/ACK.
3. Receiver must read data at most 10ns after seeing REQ/ACK asserted.

Problems

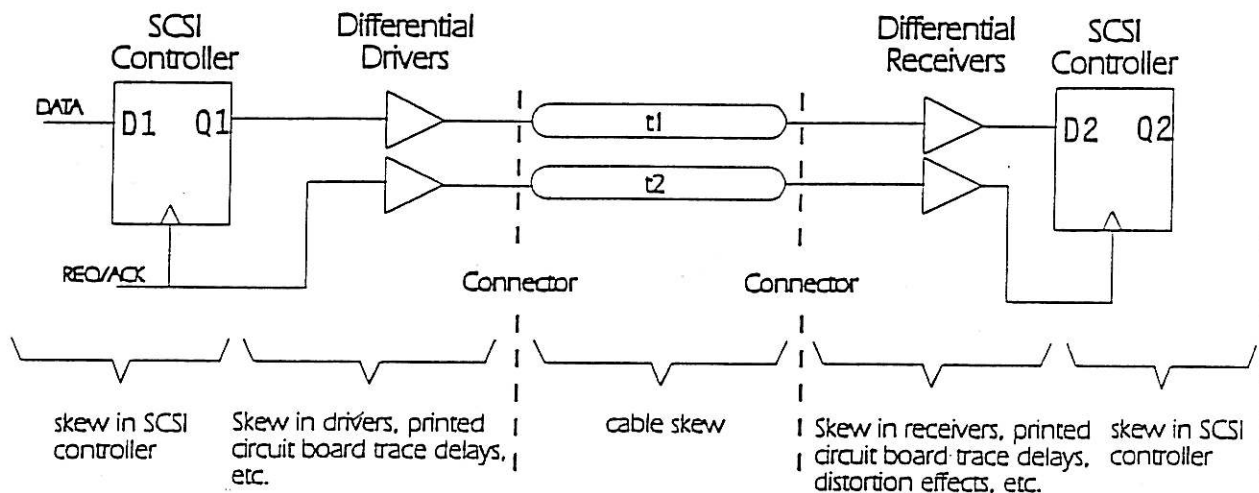
Spec was written with silicon in mind, but requiring measurements at the connectors creates ambiguity.

1. No mention of setup time required by devices at their connectors. This means the most rigid interpretation of the spec requires zero setup, which means the chip must tolerate NEGATIVE setup after accounting for skews on the controller or host adapter assembly. This is overly stringent.
2. Likewise, hold time is specified as 10ns at the connector. Accounting for skews behind the connectors, hold time at the chips must be less than 10ns. This is overly stringent.
3. Appendix on jitter budget adds to the confusion by not honoring connector boundaries (see "deskew delay" definition in Rev 1.0h, appendix B).

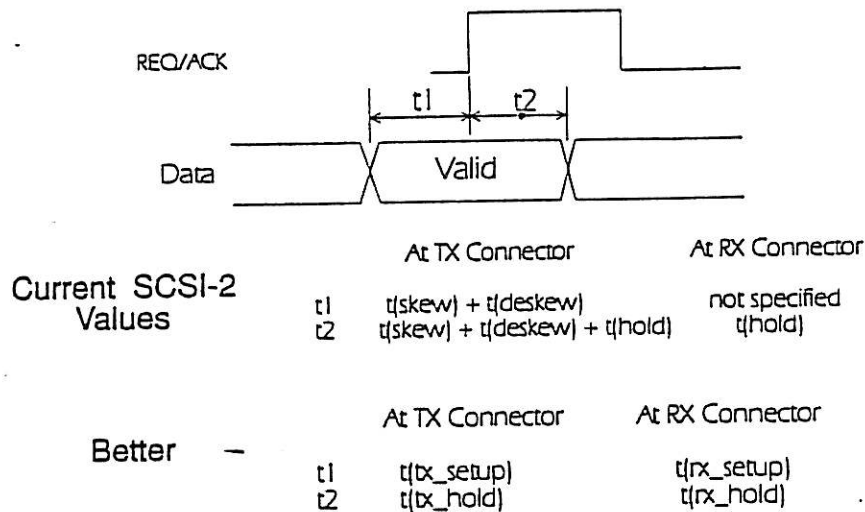
Kurt Chan
11 Feb 92

 **HEWLETT
PACKARD**
ROSEVILLE NETWORKS DIVISION

Proposal 1: Measure SCSI Device Timing at the SCSI Connectors



Proposal 2: Apply Standard Timing Terminology



where the following definitions apply

- $t(\text{tx_setup})$: the minimum time data shall be valid prior to the assertion of REQ/ACK at the connector of the transmitting device
- $t(\text{tx_hold})$: the minimum time data shall be valid following the assertion of REQ/ACK at the connector of the transmitting device
- $t(\text{rx_setup})$: the minimum time data shall be valid prior to the assertion of REQ/ACK at the connector of the receiving device

Proposal 3: Simplify Jitter Budget

Current SCSI-2 Values

5ns clock offset
3ns transmitting logic skew
1ns foil delay
6ns transmitter propagation delay skew
1ns foil delay
1ns drop cable propagation delay
CONNECTOR
5ns external cable - skew between pairs
1ns distortion due to cable imbalance
2ns distortion due to intersymbol interference
2ns bias distortion
CONNECTOR
1ns drop cable propagation delay
1ns foil delay
9ns receiver skew
1ns foil delay
5ns logic setup/hold

*deskew delay

Transmitter

Receiver

Suggested Changes

TX_chip ns: Total SCSI controller skew
TX_other ns: Other sources of skew in TX device

CONNECTOR

4ns external cable - skew between pairs
(25m * .15ns/m = 3.75ns, round up to 4ns)

CONNECTOR

RX_other ns: Other sources of skew in RX device, including skew due to distortion
RX_chip ns: Total SCSI controller receiver skew

1. Remove deskew delay from standard
2. Create five sources of skew in the system:
 - a) The TX chip
 - b) Everything else behind the TX connector
 - c) The RX chip
 - d) Everything else behind the RX connector, including distortion effects
 - e) The intrinsic delay skew of the cable
3. Subtract (c) from (a). This is the total available skew credit.
4. Add (b)+(d)+(e). This is the total available skew deficit.
5. The result of (4) must not exceed the result of (3).

Proposal 4: Develop Meaningful External Driver Specs

Existing differential driver specs for propagation delay look like:

		TRANSMITTER					RECEIVER				
		min	max	skew[1]	skew[2]	skew[3]	min	max	skew[1]	skew[2]	skew[3]
75LBC676	tp(HL)	7	17	10	2	N/A	10	20	10	6	N/A
	tp(LH)	7	17	10	2	N/A	12	22	10	6	N/A
DS36954	tp(HL)	9	19	10	6	N/A	9	19	10	3	N/A
	tp(LH)	9	19	10	6	N/A	9	19	10	3	N/A
DS36F95	tp(HL)	6	16	10	N/A	N/A	14	24	10	N/A	N/A
	tp(LH)	6	16	10	N/A	N/A	14	24	10	N/A	N/A
DS36950	tp(HL)	9	19	10	6	N/A	9	19	10	3	N/A
	tp(LH)	9	19	10	6	N/A	9	19	10	3	N/A
75LBC976	tp(HL)	7	17	10	N/A	5	7	17	10	N/A	5
	tp(LH)	7	17	10	N/A	5	7	17	10	N/A	5

skew[1]: Max difference between any 2 channels on any two parts

skew[2]: Max difference between any 2 channels on the same part

skew[3]: Same as skew[1] but all parts operating at 5V VCC and within 5 degrees C of one another

Proposed spec: The maximum difference in propagation delay between any two drivers or any two receivers on the REQ, ACK, DATA, or PARITY signals should be no greater than 6 nanoseconds when the drivers have the same VCC voltage and are operating within 5 degrees Centigrade of one another (ambient temperature).

Creating New SCSI-3 Specs

1. Survey SCSI protocol chip vendors for worst-case setup/hold times:

- a) TX setup
- b) TX hold
- c) RX setup
- d) RX hold

2. From Rev10h, Appendix B, arrive at a meaningful skew budget for TX_other and RX_other. For each chip apply these values:

$$TX_connector_setup = TX_chip_setup + TX_other$$

$$TX_connector_hold = TX_chip_hold + TX_other$$

$$RX_connector_setup = RX_chip_setup + RX_other$$

$$RX_connector_hold = RX_chip_hold + RX_other$$

3. Subtract all RX_connector values from the corresponding TX_connector values for all vendor combinations. Subtract an additional 4ns for the cable.

4. Wherever the result is greater than zero an incompatibility exists.

5. If there are no differences greater than zero,

a) The largest RX_chip and the smallest TX_chip values form a set of silicon RECOMMENDATIONS.

b) The largest RX_connector and smallest TX_connector values form a set of SCSI device REQUIREMENTS.

Worksheet

	TIMING AT CHIP PADS				EXTRAPOLATED TO CONNECTOR			
	Transmit		Receive		Transmit		Receive	
	Setup	Hold	Setup	Hold	Setup	Hold	Setup	Hold
Vendor A	30	42	0	20				
Vendor B	35	45	5	15				
Vendor C	35	45	0	10				
Vendor D								
Vendor E								

Setup Time Margin
 $TX_conn_setup - RX_conn_setup - 4$

	Transmitting Device				
	A	B	C	D	E
A					
B					
C					
D					
E					

Hold Time Margin
 $TX_conn_hold - RX_conn_hold - 4$

	Transmitting Device				
	A	B	C	D	E
A					
B					
C					
D					
E					

FAX

TO: Kurt Chan
Hewlett-Packard
Roseville Networks Division
916-786-9185 (fax)
916-785-5621 (voice)

FROM:

	Async	Synchronous, 5MHz and Below	Fast Synchronous
TX setup time			
TX hold time			
RX setup time			
RX hold time			