To: T10 Technical Committee
From: Stephen Finch, STMicroelectronics (steve.finch@st.com)
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Subject: 07-058r2 SAS-2 OOB and SSC

Revision history
Revision 0 (25 January 2007). First revision
Revision 1 (2 February 2007). Changed reference table to show timing value for +2400ppm and -2400ppm instead of +2300ppm and -2300ppm. Change values to be put into tables based upon these new values. Made change to table 73 to keep original values for use by devices that do not use SSC, and a separate row for devices that may support SSC.
Revision 2 (9 February 2007). Changed table 73 back to original format. Changed values in the single line defining OOBI to reflect values at +2400ppm and -2400ppm. Added note just below table 73 indicating that the specification changed from previous versions of the standard.

Related documents
sas2r08 - Serial Attached SCSI - 2 (SAS-2) revision 8

Overview
The SAS OOB signaling defined in SAS-1 did not allow for Spread Spectrum Clocking (SSC).

SSC has been added to the SAS-2 draft (clause 5.3.8).

Some SAS-2 devices that have more than one phy want to utilize a common transmit clock in order to reduce implementation costs. If one of the phys has successfully completed speed negotiation with SSC enabled, then the common clock will be modulated per the SSC requirements.

Any additional phy may then enter an OOB sequence. The current requirements for OOB signaling utilize an OOBI timing parameter based upon the non-SSC clock tolerances. If the additional phy transmits its OOB signals using the transmit clock it would be in violation of the current definition.

This proposal changes the definition of OOBI to allow SSC to be enabled or disabled when transmitting OOB signals (COMWAKE, COMINIT and COMSAS).

Discussion

Detection of OOB signals is based upon carrier detection during bursts and the lack of a carrier during spaces. The content of the bursts are not important. In fact, SAS-2 indicates the bursts may/should consist of D24.3 characters and this would not allow dword synchronization to be accomplished, thus the content could not be received.

The transmitter is required to send bursts and spaces of defined sizes based upon the transmitter clock. The transmitter clock with SSC off is defined as ±100ppm. With SAS SSC on the range becomes +2300 ppm to -2300 ppm. (NOTE: I did no include SATA SSC timings.)

The receiver detects the bursts and spaces based upon time, and not any clock. The detection process defines a range of times that determine what a valid burst or space can be. These are relatively loose in comparison to the transmission requirements.

This proposal does not change the requirements of the receiver, only the transmitter.

The following table provides the actual timings of all bursts and spaces given the various clock tolerances:

		COMWAKE Space; All Bursts	COMWAKE Negation	COMINIT Space	COMINIT Negation	COMSAS Space	COMSAS Negation
OOBI's	1	160	280	480	800	1440	2400
Nominal (ns)	0.6666667	106.667	186.667	320.000	533.333	960.000	1600.000
-100ppm (ns)	0.6666000	106.656	186.648	319.968	533.280	959.904	1599.840
+100ppm (ns)	0.6667334	106.677	186.685	320.032	533.387	960.096	1600.160
-2400ppm (ns)	0.6650667	106.411	186.219	319.232	532.053	957.696	1596.160
+2400ppm (ns)	0.6682667	106.923	187.115	320.768	534.613	962.304	1603.840

For reference, here are the receiver requirements:

Burst: (For COMWAKE, COMINIT or COMSAS)
May detect $T_{burst} \leq 100$ ns
Shall detect $T_{burst} > 100$ ns

Space Detection:

Table 76 — OOB signal receiver device idle time detection requirements

Signal	may detect	shall detect	shall not detect
COMWAKE	35 ns ≤ T_{idle} < 175 ns	101,3 ns ≤ T_{idle} ≤ 112 ns	T_{idle}< 35 ns or T_{idle} ≥ 175 ns
COMINIT/ COMRESET	175 ns ≤ T_{idle} < 525 ns	304 ns ≤ T_{idle} ≤ 336 ns	T_{idle} < 175 ns or T_{idle} ≥ 525 ns
COMSAS	525 ns ≤ T_{idle} < 1 575 ns	911,7 ns ≤ T_{idle} ≤ 1 008 ns	T_{idle} < 525 ns or T_{idle} ≥ 1 575 ns

Negation Detection:

Table 77 — OOB signal receiver device negation time detection requirements

Signal	shall detect
COMWAKE	T_{idle} > 175 ns
COMINIT/COMRESET	T_{idle} > 525 ns
COMSAS	T_{idle} > 1 575 ns

The proposal modifies the following table:

Table 73 — OOB signal timing specifications

Parameter	Minimum	Nominal	Maximum	Comments
OOB Interval (OOBI) [a]	666,600 ps	666,$\overline{6}$ ps	666,733 ps	The time basis for burst times and idle times used to create OOB signals. Based on 1,5 Gbps clock tolerance (see table 52 in 5.3.3).
COMSAS detect timeout	13,65 µs			The minimum time a receiver device shall allow to detect COMSAS after transmitting COMSAS. Derived from: OOBI x 512 x 40
[a] OOBI is different than UI(OOB) defined in SATA (e.g., SAS has tighter clock tolerance). This is a fixed value equal to the UI for 1,5 Gbps, regardless of the actual transfer rate being used to create the burst time.				

Proposal

Modify the Table 73 to read:

Table 73 — OOB signal timing specifications

Parameter	Minimum	Nominal	Maximum	Comments
OOB Interval (OOBI) [a]	665,067 ps	666,6 ps	668,267 ps	The time basis for burst times and idle times used to create OOB signals. Based on 1,5 Gbps clock tolerance (see table 52 in 5.3.3 and table 61 in 5.8.3.1).
COMSAS detect timeout	13,65 µs			The minimum time a receiver device shall allow to detect COMSAS after transmitting COMSAS. Derived from: OOBI x 512 x 40
[a] OOBI is different than UI(OOB) defined in SATA (e.g., SAS has tighter clock tolerance). This is a fixed value equal to the UI for 1,5 Gbps, regardless of the actual transfer rate being used to create the burst time.				

Note : Previous versions of this standard based OOBI on the nominal 1,5 Gbps UI with physical link rate long term stability tolerance but not with physical link rate SSC modulation (see table 53 in 5.3.3).