To: T10 Technical Committee
From: Bill Bissonette (Bill.Bissonette@intel.com)
Date: December 8, 2004
Subject: 05-009r0 SAS-1.1 OOB Amplitude Measurement Method

Revision history

Revision 0 (December 3, 2004) First revision

Related documents

SAS1r07 - Serial Attached SCSI 1.1 revision 7
04-370r1 - Merge IT and IR with XT and XR
SATA 1.0a
SATA II Electrical specification 1.0

Overview

Minimum OOB amplitudes are specified in Table 30 of SAS1r07 as 240mV and Rob Elliott's 04-370r1 proposal tentatively specifies 225mV for SATA devices in a SAS system. However, the measurement method for this is not specified in SAS. It has been presumed by some that the measurement would be similar to data signal measurements with an eye diagram, but OOB signaling and, in particular, reception/detection is very different than for in-band data signaling in that they are not referenced to sample times – only signal levels and transitions. This document proposes a method for measuring OOB signaling at the XR and IR compliance points that is more in line with the intent of OOB squelch and burst envelope detection.

The proposed text attempts to avoid any reference to in-band type timing reference by referencing OOB signal transitions, OOB signal amplitudes and requiring the use of a continuous time measurement method.

Proposed changes

1. Modify note C in table 4 of SAS1 as follows:

Current text

C With a measurement bandwidth of 1,5 times the baud rate (i.e., 4,5 GHz for 3,0 Gbps).

Proposed text

C With a measurement bandwidth of 1,5 times the baud rate (i.e., 4,5 GHz for 3,0 Gbps) using a continuous time oscilloscope with a sampling rate of at least 10GSa/S, each signal level shall exceed the specified minimum differential amplitude before transitioning to the opposite bit value or termination of the burst.

In other words: Any sequence encoding a 1 or a 0 (from 1 to 5 'UI') must exceed the minimum differential amplitude sometime before the end of that sequence. The worst case condition, of course, is transitions in subsequent bits (e.g. 1-0-1-0) after 5 bits of 'soaking' at a particular value.

2. Create a new note (X) for the OOB noise amplitude specification in table 4 that reads:

X With a measurement bandwidth of 1,5 times the baud rate (i.e., 4,5 GHz for 3,0 Gbps) using a continuous time oscilloscope with a sampling rate of at least 10GSa/S, no signal level shall exceed the specified amplitude during idle times.

Background information

SATA doesn't specify OOB amplitude measurement very well either, but does state:

> **6.4.20 Squelch Detector Tests**
>
> The squelch detector is an essential function in receiving OOB signaling. There are two conditions to test: when above the maximum threshold the detector shall detect, and when below the minimum threshold the detector shall not detect. Figure 72 shows the test setup to set the proper level of the OOB signal.
>
> Note the same method is used to calibrate the Lab-Sourced signal amplitude as in section 6.4.5. To ensure the proper detection, multiple tests must be done and the statistics of the results presented to show compliance.
>
> Note: the pattern content in the OOB can affect the detection.
>
> The timing of the gaps in the OOB bursts shall be varied to ensure compliance to the OOB timing specification (see Table 7).

SAS 'shall not detect' levels are implied by the maximum noise during OOB detection (120mV). In general, squelch detector levels are set somewhere between the minimum OOB level and the maximum noise level for optimum detection of valid OOB bursts and rejection of noise that may be erroneously interpreted as OOB bursts.

The following figure (from SATA1.0a) is an example OOB burst detector that infers the intended detection methodology. Each '0' to '1' (or idle to '1') transition to a differential amplitude that exceeds the receiver threshold causes a pulse (the length of which is the delay through the inverter) that charges the RC network which, in turn, holds the detection as valid to the next signal transition. The AND gate would be an XOR gate to detect transitions in either direction. Specifications for idle time between bursts allow for the 'slop' associated with the level detection hold-over time.

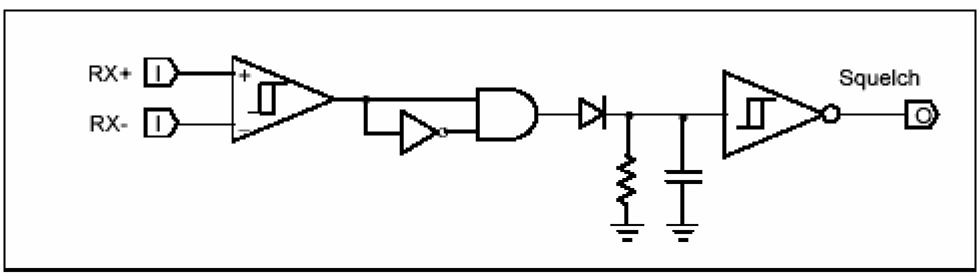

Figure 33 – Squelch detector

For amplitude and timing measurements, SATA II also states:

> **6.2.2.6.1 OOB Signal Detection Threshold**
>
> Differential signal amplitude detected as activity by the squelch detector during OOB signaling. V_{diffRX} signals less than the minimum V_{thresh} defined in Table 7 shall not be detected as activity. Signal levels greater than the maximum V_{thresh} defined in Table 7 shall be detected as activity.
>
> **6.2.2.6.3 COMINIT/RESET and COMWAKE Transmit Burst Length**
>
> Burst length in terms of UI_{OOB} as measured from 100mV differential crosspoints of first and last edges of a burst.
>
> **6.2.2.6.4 COMINT/RESET Transmit Gap Length**
>
> Gap length in terms of UI_{OOB} as measured from 100mV differential crosspoints of last and first edges of bursts.
>
> **6.2.2.6.5 COMWAKE Transmit Gap Length**
>
> Gap length in terms of UI_{OOB} as measured from 100mV differential crosspoints of last and first edges of bursts.