To: T10 Technical Committee
From: Rob Elliott, HP (elliott@hp.com)
Date: 27 June 2006
Subject: 06-301r0 SAS-2 PHYSICAL address frame

**Revision history**
Revision 0 (27 June 2006) First revision

**Related documents**
sas2r04a - Serial Attached SCSI - 2 (SAS-2) revision 4a
05-397 SAS-2 Start-up training sequence (Harvey Newman, Infineon)
06-263 SAS-2 Spread-spectrum clocking (Rob Elliott, HP)
06-295 SAS-2 Speed negotiation (Amr Wassal and Robert Watson, PMC-Sierra)

**Overview**
06-295 defines a new format for the G3 speed negotiation window that negotiates 1.5 Gbps, then exchanges phy capability information after sending and receiving ALIGN (1)s.

The format of that information needs to be defined. One possible approach, shown in this proposal, is to use a new PHYSICAL address frame.

Benefits include:

a) Leverage address frame definitions in the standard
b) Leverage generation and decode logic already in the ASIC
c) Provides 27.5 bytes of payload - extensible for future versions of SAS (e.g., communicate information to help the transmitter choose its amplitude and preemphasis settings)

Caveats include:

a) Address frames are scrambled
b) Address frames include a CRC
c) Existing address frame logic may be difficult to activate before the SP state machine sends Phy Layer Ready (SAS) to the link layer
d) May provide too many reserved bytes than will ever be needed, just wasting gates in an ASIC

Suggested fields are:

a) PHYSICAL LINK RATES SUPPORTED (1.5, 3, 6 Gbps): 1.5 and 3 Gbps are included so they can be negotiated with SSC enabled. Many reserved bits for future rates.
b) RX SPREAD SPECTRUM CLOCKING SUPPORTED (none, down-spreading, center-spreading): all reception types are required by SAS-2, so this is technically just informational. If a phy receives this set to 00h, it should not transmit with SSC in the final SNW if possible.

NOTE 1 - A SAS disk drive that transmits with down-spreading SSC at all times will ignore the field.

c) CURRENT TX SPREAD SPECTRUM CLOCKING (none, down-spreading, center-spreading): indicates if the G3 SNW is already using SSC (e.g., for a disk drive that is always transmitting with SSC, this should only down-spreading). The PHYSICAL address frame could be exchanged later on during operation (not currently defined) where all phys might set it to something.
d) TX SPREAD SPECTRUM CLOCKING SUPPORTED (none, down-spreading, center-spreading): indicates the capabilities. A SAS phy only does down-spreading, while an expander phy supports both (if it supports SATA) or center-spreading only (if it does not).

**Suggested changes**

**6.7.4.2 SAS speed negotiation sequence**

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Editor's Note 1: In the G3 SNW definition, add a rule that if the G3 SNW window completes without

receiving a valid PHYSICAL address frame, consider the window failed.

## 7.8 Address frames

### 7.8.1 Address frames overview

Address frames are used for the identification sequence, ~~and for~~ connection requests, and the G3 speed negotiation window.

Address frames are preceded by SOAF and followed by EOAF as shows in figure 1.

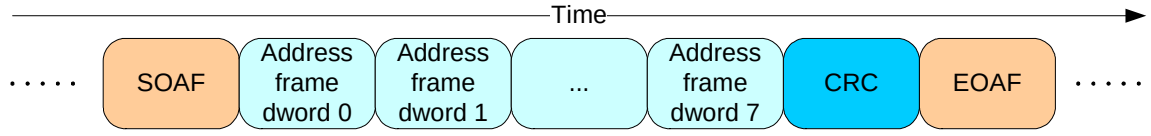


**Figure 1 — Address frame transmission**

Address frames shall only be sent outside connections. Address frames shall not be terminated early. All data dwords in an address frame shall be scrambled.

Table 1 defines the address frame format.

**Table 1 — Address frame format**

| Byte\Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | ADDRESS FRAME TYPE | | | |
| 1 | | | | | | | | |
| ... | | | Frame type dependent bytes | | | | | |
| 27 | | | | | | | | |
| 28 | (MSB) | | | | | | | |
| ... | | | CRC | | | | | |
| 31 | | | | | | | | (LSB) |

The ADDRESS FRAME TYPE field specifies the type of address frame and is defined in table 2. This field determines the definition of the frame type dependent bytes.

**Table 2 — ADDRESS FRAME TYPE field**

| Code | Frame type | Description |
|---|---|---|
| 0h | ~~Identify~~IDENTIFY | Identification sequence |
| 1h | ~~Open~~OPEN | Connection request |
| 2h | PHYSICAL | Physical layer capabilities |
| All others | Reserved | |

The CRC field contains a CRC value (see 7.5) that is computed over the entire address frame prior to the CRC field.

Address frames with unknown address frame types, incorrect lengths, or CRC errors shall be ignored by the recipient.

Editor's Note 2: If a shortened frame is preferred for this purpose (to avoid wasting gates that may never be needed), the generic address frame format could be variable length with each specific frame type defining its own length. PHYSICAL could easily be 16 bytes long. If the SSC fields were packed more efficiently or eliminated (only one bit "Receiving SSC supported/not supported" is all that interoperability demands), 8 bytes should suffice. A smaller CRC could also be deployed.

### 7.8.2 PHYSICAL address frame [all new, no changes marked]

Table 3 defines the PHYS address frame format used for the G3 SNW.

**Table 3 — IDENTIFY address frame format**

| Byte\Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | Reserved | | | | ADDRESS FRAME TYPE (2h) | | | |
| 1 | Reserved | | | | | | | |
| 2 | PHYSICAL LINK RATES SUPPORTED | | | | | | | |
| 3 | RX SPREAD SPECTRUM CLOCKING SUPPORTED | | | | | | | |
| 4 | TX SPREAD SPECTRUM CLOCKING SUPPORTED | | | | | | | |
| 5 | CURRENT TX SPREAD SPECTRUM CLOCKING | | | | | | | |
| 6 | Reserved | | | | | | | |
| 27 | | | | | | | | |
| 28 | (MSB) | | | CRC | | | | |
| 31 | | | | | | | | (LSB) |

The PHYSICAL LINK RATES SUPPORTED field indicates the physical links rates supported by the phy, and is defined in in table 4.

**Table 4 —** PHYSICAL LINK RATES SUPPORTED **field**

| Code | Description |
|---|---|
| xxxxxxxx1b | 1,5 Gbps is supported |
| xxxxxxxx0b | 1,5 Gbps is not supported |
| xxxxxxx1xb | 3 Gbps is supported |
| xxxxxxx0xb | 3 Gbps is not supported |
| xxxxxx1xxb | 6 Gbps is supported |
| xxxxxx0xxb | 6 Gbps is not supported |
| All others | Reserved |
| [a] x means don't care (i.e., one or zero) | |

Editor's Note 3: One byte supports up to SAS-8 at 192 Gbps

The RX SPREAD SPECTRUM CLOCKING SUPPORTED field indicates the types of SSC supported by the phy's receiver, and is defined in in table 5. Phys shall set this field to 03h.

**Table 5 —** RX SPREAD SPECTRUM CLOCKING SUPPORTED **field**

| Code | Description |
|---|---|
| xxxxxxx1b | Phy supports receiving with down-spreading SSC |
| xxxxxxx0b | Phy does not support receiving with down-spreading SSC |
| xxxxxx1xb | Phy supports receiving with center-spreading SSC |
| xxxxxx0xb | Phy does not support receiving with center-spreading SSC |
| All others | Reserved |
| [a] x means don't care (i.e., one or zero) | |

The TX SPREAD SPECTRUM CLOCKING SUPPORTED field indicates the types of SSC supported by the phy's transmitter, and is defined in in table 6. A SAS phy shall set this field to 01h. An expander phy shall set this field to 02h if it does not support being attached to SATA devices and 03h if it supports being attached to SATA devices.

**Table 6 —** TX SPREAD SPECTRUM CLOCKING SUPPORTED **field**

| Code | Description |
|---|---|
| xxxxxxx1b | Phy supports transmitting with down-spreading SSC |
| xxxxxxx0b | Phy does not support transmitting with down-spreading SSC |
| xxxxxx1xb | Phy supports transmitting with center-spreading SSC |
| xxxxxx0xb | Phy does not support transmitting with center-spreading SSC |
| All others | Reserved |
| [a] x means don't care (i.e., one or zero) | |

The CURRENT TX SPREAD SPECTRUM CLOCKING field indicates the type of SSC currently being used by the phy's transmitter, and is defined in in table 7.

**Table 7 —** CURRENT TX SPREAD SPECTRUM CLOCKING **field**

| Code | Description |
|---|---|
| 00h | Phy is not transmitting with SSC |
| 01h | Phy is transmitting with down-spreading SSC |
| 02h | Phy is transmitting with center-spreading SSC |
| All others | Reserved |

The CRC field is defined in 7.8.1.