To: T10 Technical Committee
From: Rob Elliott, HP (elliott@hp.com)
Date: 6 July 2006
Subject: 06-301r1 SAS-2 PHYSICAL address frame

Revision history
Revision 0 (27 June 2006) First revision
Revision 1 (6 July 2006) Changed the address frame type from 2h to 8h

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 (or possibly 3 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 (i.e., frame size is too large), 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): the receiver will be required by SAS-2 to support all the types, so this is just informational. An OEM could force this to 00h (by mechanisms outside the scope of the standard) to try to force SSC off in the other device, if possible. A SAS disk drive that transmits with down-spreading SSC at all times will ignore the field and continue to transmit with down-spreading SSC, so there's no guarantee that the request will be honored.
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 indicate down-spreading). A future version of the standard could allow the PHYSICAL address frame to be exchanged later on during operation, where it might be more useful.
d) TX SPREAD SPECTRUM CLOCKING SUPPORTED (none, down-spreading, center-spreading): indicates the transmitter capabilities. A SAS phy only supports none and down-spreading, while an expander phy supports all three (if it supports SATA) or none and center-spreading only (if it does not). A SAS disk drive that always transmits with SSC would indicate it doesn't support none.

Suggested changes

6.7.4.2 SAS speed negotiation sequence

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, the phy shall 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.

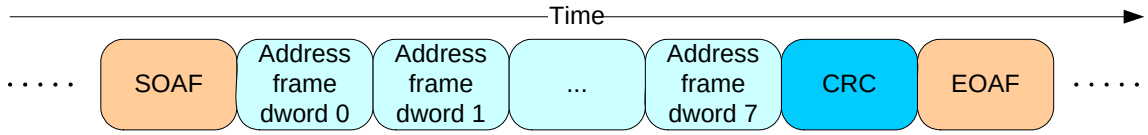

Figure 1 — Address frame transmission

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								
27				Frame type dependent bytes				
28	(MSB)							
31				CRC				(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
8h	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)							
31	CRC							(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. A phy shall set this field to 03h (i.e., both down-spreading SSC and center-spreading SSC).

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 (i.e., down-spreading SSC only). An expander phy shall set this field to 02h (i.e., center-spreading SSC only) if it does not support being attached to SATA devices and 03h (i.e., down-spreading SSC and center-spreading SSC) 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.