To: T10 Technical Committee
From: Rob Elliott, HP (elliott@hp.com)
Date: 8 April 2004
Subject: 03-240r1 SAS-1.1 Internal wide connector and cable

Revision history
Revision 0 (2 July 2003) First revision
Revision 1 (8 April 2004) Updated to match SFF-8484 revision 0.3, which now has 6 sideband signals, and mention SFF-8485 (SGPIO) as an optional use for those sideband signals.

Related documents
sas1r03 - Serial Attached SCSI 1.1 revision 3
sff-8484r0.4 - Multi Lane Internal Serial Attachment Connector (Brian Miller, Amphenol)
sff-8485r0.3 - Serial GPIO (Rob Elliott)

Overview
A 4-wide internal cable and connector solution is being designed for connecting controllers (e.g. PCI cards) to backplanes. It is intended to be used in place of 4 SATA host connectors (on the controller) to 4 separate SATA cables to 4 SATA host connectors (on the backplane). This cable/connector is being proposed for both SATA II and SAS.

Figure 1 shows the connector. It follows the design of the SATA host connector. Either a round cable or a ribbon-like cable could be used.
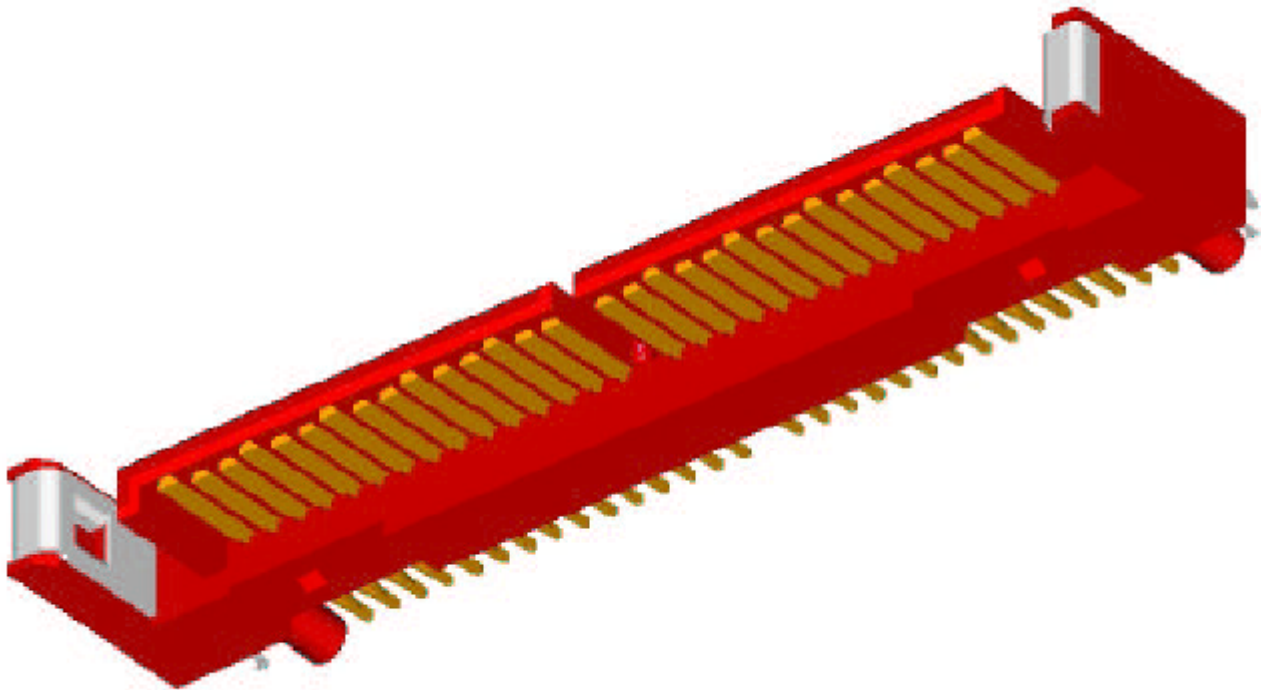

Figure 1 — 4-wide connector picture (from Amphenol)

Editor's Note 1: Need an updated figure showing 6 sidebands. Better yet, want two 3D line drawing figures for inclusion in the plug and receptacle sections of the standard itself.

> Editor's Note 2: SFF-8484 also defines a two lane interface. This proposal is not adding support for that into SAS-1.1.

The connector includes 4 high-speed serial channels and 6 sideband signals (in the middle). It is split into two tongues for stability.

SAS-1.1 should recognize this as a standard connector and define signal assignments for it. It should also define electrical characteristics for interoperability points at the connector - that is deferred to another proposal.

Suggested changes

2.4 Other references

SFF-8223, *2.5" Drive Form Factor with Serial Connector*

SFF-8323, *3.5" Drive Form Factor with Serial Connector*

SFF-8523, *5.25" Drive Form Factor with Serial Connector*

SFF-8410, *HSS Copper Testing and Performance Requirements*

SFF-8460, *HSS Backplane Design Guidelines*

SFF-8470, *Shielded High Speed Multilane Copper Connector*

SFF-8482, *Internal Serial Attachment Connector*

SFF-8485, *Multi Lane Internal Serial Attachment Connector*

> NOTE 1 - NOTE 3 - For more information on the current status of the SFF documents, contact the SFF Committee at 408-867-6630 (phone), or 408-867-2115 (fax). To obtain copies of these documents, contact the SFF Committee at 14426 Black Walnut Court, Saratoga, CA 95070 at 408-867-6630 (phone) or 408-741-1600 (fax) or see http://www.sffcommittee.org.

5.2 Passive interconnect

5.2.1. SATA cables and connectors [no changes]

5.2.2 SAS cables and connectors

This standard supports external cabled, internal narrow cabled, internal wide cabled, and internal backplane environments.

Figure 42 shows a schematic representation of the cables and connectors defined in this standard to support an external cabled environment.

[figure not shown]

Figure 42 — SAS cables and connectors - external environment

Figure 43 shows a schematic representation of the cables and connectors defined in this standard for internal narrow cabled and internal backplane environments.

[figure not shown]

Figure 43 — SAS cables and connectors - internal narrow cabled and internal backplane environments

Figure 2 shows a schematic representation of the cables and connectors defined in this standard for the internal wide environment.

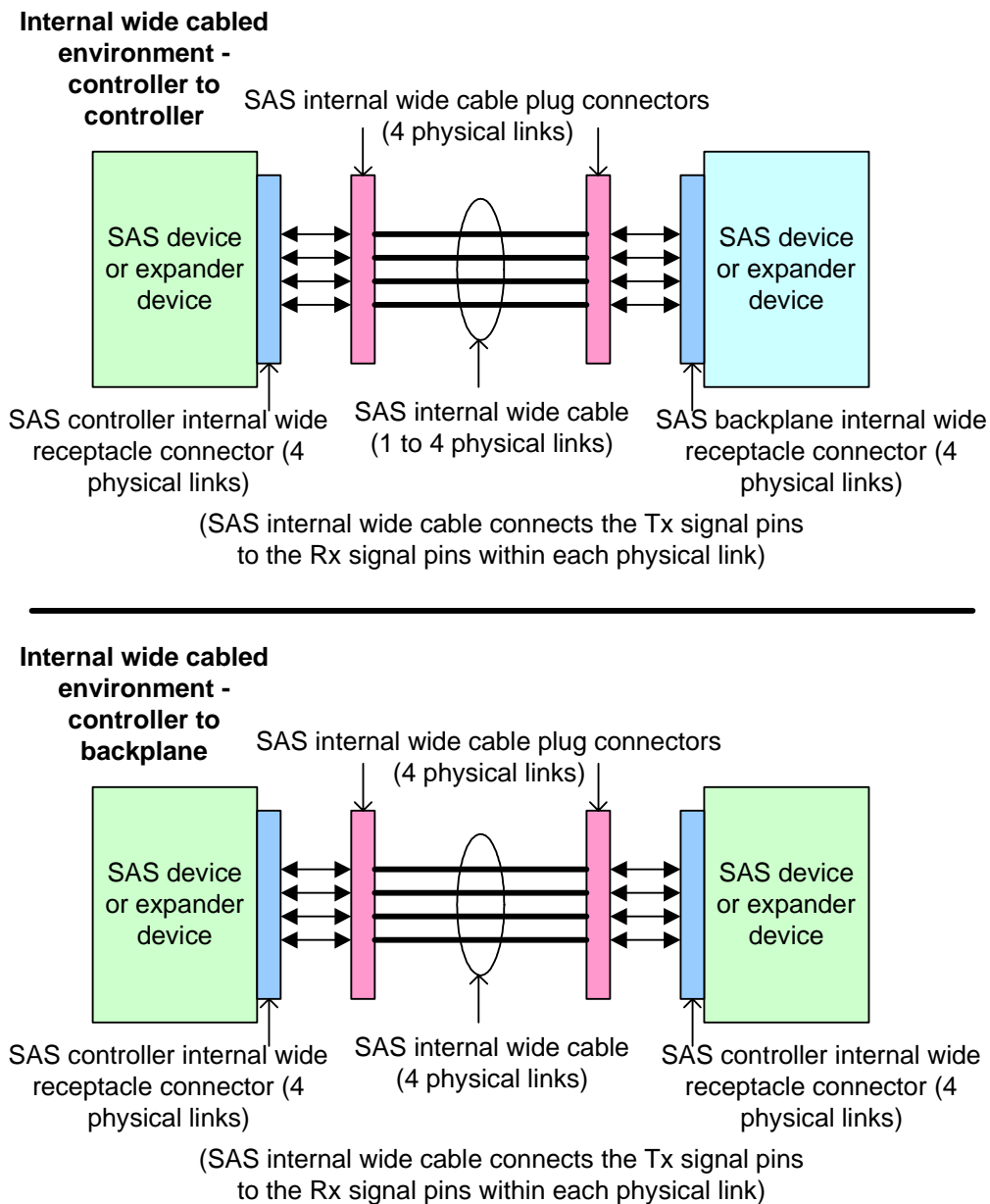**Internal wide cabled environment - controller to controller**

SAS internal wide cable plug connectors
(4 physical links)

SAS device or expander device

SAS device or expander device

SAS controller internal wide receptacle connector (4 physical links)

SAS internal wide cable
(1 to 4 physical links)

SAS backplane internal wide receptacle connector (4 physical links)

(SAS internal wide cable connects the Tx signal pins
to the Rx signal pins within each physical link)

Internal wide cabled environment - controller to backplane

SAS internal wide cable plug connectors
(4 physical links)

SAS device or expander device

SAS device or expander device

SAS controller internal wide receptacle connector (4 physical links)

SAS internal wide cable
(4 physical links)

SAS controller internal wide receptacle connector (4 physical links)

(SAS internal wide cable connects the Tx signal pins
to the Rx signal pins within each physical link)

Figure 2 — SAS cables and connectors - internal wide cabled environment

The internal wide connectors have different pinouts for the controller side and the backplane side so one side's Tx signals are attached to the other side's Rx signals. Two controllers may also be attached together, provided all four physical links are used, since one side's physical link 0 is attached to the other side's physical link 3.

The internal wide connector contains 6 sideband signals which are crossed when attaching a controller to a backplane but are not crossed when attaching a controller to a controller.

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Table 21 summarizes the connectors defined in this standard.

Table 21 — Connectors [table 21]

Type of connector	Physical links	Reference	Attaches to	Physical links	Reference
SAS plug	2	5.2.3.2	SAS internal cable receptacle	1 or 2	5.2.3.3
			SAS backplane receptacle	2	5.2.3.4
SAS internal cable SATA-style signal cable receptacle	1	ATA/ATAPI -7 V3	SATA-style host plug	1	ATA/ATAPI -7 V3
SAS internal cable receptacle	1 or 2	5.2.3.3	SAS plug	2	5.2.3.2
			SATA device plug	1	SATA
SAS backplane receptacle	2	5.2.3.4	SAS plug	2	5.2.3.2
			SATA device plug	1	ATA/ATAPI -7 V3
SAS internal wide receptacle	4	5.2.3.x	SAS internal wide cable plug	4	5.2.3.y
SAS external cable plug	4	5.2.3.6	SAS external receptacle	4	5.2.3.7
SAS external receptacle	4	5.2.3.6	SAS external cable plug	4	5.2.3.6

The SATA device plug connector (e.g., used by a SATA device) may be attached to a SAS backplane receptacle connector or a SAS internal cable receptacle connector, connecting the primary signal pairs and leaving the secondary signal pairs unconnected.

See SFF-8223, SFF-8323, and SFF-8523 for the connector locations on common form factors.

5.2.3 Connectors

5.2.3.1 Connectors overview

SAS connectors should be marked with the SAS icon (see Annex L).

5.2.3.2 SAS plug connector

SAS target devices supporting internal environments shall use the SAS plug connector. The SAS plug connector is defined in SFF-8482. It attaches to a SAS internal cable receptacle connector or a SAS backplane receptacle connector.

Table 22 defines the pin assignments.

5.2.3.3 SAS internal cable receptacle connector

SAS internal cables shall use a SAS internal cable receptacle connector on the SAS target device end. The SAS internal cable receptacle connectors are defined in SFF-8482. The single-port version attaches to either:

 a) a SAS plug connector, providing contact for the power pins and only the primary physical link; or
 b) a SATA device plug connector, providing contact for the power pins and the primary physical link.

The dual-port version attaches to:

 a) a SAS plug connector, providing contact for the power pins and only the primary physical link;
 b) a SAS plug connector, providing contact for the power pins and both the primary and secondary physical links; or
 c) a SATA device plug connector, providing contact for the power pins and the primary physical link.

Table 22 defines the pin assignments. The secondary physical link (i.e., pins S8 through S14) is not supported by the single-port internal cable receptacle.

5.2.3.4 SAS backplane receptacle connector

SAS backplanes shall use the SAS backplane receptacle connector. The SAS backplane receptacle connector (see SFF-8482) attaches to either:

    a) a SAS plug connector, providing contact for the power pins and both primary and secondary physical links; or

    a) a SATA device plug connector, providing contact for the power pins and the primary physical link.

Table 22 defines the pin assignments.

5.2.3.5 SAS internal connector pin assignments

Table 22 defines the SAS target device signal assignments for pins in the SAS internal connector.

Table 22 — SAS target device connector pin assignments

[table not shown]

SAS target device signal assignments, except for the addition of the secondary physical link when present, are in the same locations as they are in a SATA device. On cable assemblies, backplanes, or any other connection media, the Tx signal from one internal connector pair shall be connected to the corresponding Rx signal of the other internal connector pair (i.e., the TP+ signal pin of connector 1 shall connect to the RP+ signal pin of connector 2) if there is an internal connector at both ends of the transmission media.

The TP+, TP-, RP+, and RP- signals are used by the primary physical link. The TS+, TS-, RS+, and RS- signals are used by the secondary physical link.

5.2.3.x SAS internal wide cable plug connector

SAS internal wide cables shall use the SAS internal wide cable plug connector. The SAS internal wide cable plug connector is defined in SFF-8484. The SAS internal wide cable plug connector attaches to a SAS internal wide receptacle connector, providing contact for up to four physical links.

    Editor's Note 3: want a 3D line drawing figure of the plug connector to go here

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Table 999 and table 1000 define the pin assignments.

5.2.3.y SAS internal wide receptacle connector

The SAS internal wide receptacle connector is defined in SFF-8484. The SAS internal wide receptacle connector attaches to a SAS internal wide cable plug connector, providing contact for up to four physical links.

    Editor's Note 4: want a 3D line drawing figure of the receptacle connector to go here

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Table 999 and table 1000 define the pin assignments.

0.0.0.1 SAS internal wide connector pin assignments

Table 999 defines how the connector signal pairs are used in internal wide connectors for controller applications using one, two, three, or four of the physical links. Internal wide cables should be labeled to indicate how many physical links are included (e.g., 1X, 2X, 3X, and 4X on each connector's housing).

Table 999 — Controller physical link usage in SAS internal wide connector

Signal	Signal pin to use based on number of physical links supported by the cable			
	One	**Two**	**Three**	**Four**
Rx 0+	S2	S2	S2	S2
Rx 0-	S3	S3	S3	S3
Tx 0-	S5	S5	S5	S5
Tx 0+	S6	S6	S6	S6
Rx 1+	N/C	S8	S8	S8
Rx 1-	N/C	S9	S9	S9
Tx 1-	N/C	S11	S11	S11
Tx 1+	N/C	S12	S12	S12
Sideband 0	SB14	SB14	SB14	SB14
Sideband 1	SB15	SB15	SB15	SB15
Sideband 2	SB16	SB16	SB16	SB16
Sideband 3	SB17	SB17	SB17	SB17
Sideband 4	SB18	SB18	SB18	SB18
Sideband 5	SB19	SB19	SB19	SB19
Rx 2+	N/C	N/C	S21	S21
Rx 2-	N/C	N/C	S22	S22
Tx 2-	N/C	N/C	S24	S24
Tx 2+	N/C	N/C	S25	S25
Rx 3+	N/C	N/C	N/C	S27
Rx 3-	N/C	N/C	N/C	S28
Tx 3-	N/C	N/C	N/C	S30
Tx 3+	N/C	N/C	N/C	S31
SIGNAL GROUND	G1, G4, G7, G10, G13, G20, G23, G27, G29, G32			
CHASSIS GROUND	Housing			
Key: N/C = not connected				

The sideband signals are vendor-specific but may be used as an SGPIO initiator interface (see SFF-8485).

Editor's Note 5: Should the sidebands be: a) vendor-specific b) vendor-specific but *may* be SGPIO

c) vendor-specific but *should* be SGPIO d) *shall* be SGPIO

Editor's Note 6: awaiting a version of SFF-8484 that names its signals. Assume for now that they are numbered 1 through 32 with S denoting signal pins, G denoting ground pins, and SB denoting the sideband pins in the middle.

Table 1000 defines how the connector signal pairs are used in internal wide connectors for backplane applications using one, two, three, or four of the physical links. Internal wide cables should be labeled to indicate how many physical links are included (e.g., 1X, 2X, 3X, and 4X on each connector's housing).

Table 1000 — Backplane physical link usage in SAS internal wide connector

Signal	Signal pin to use based on number of physical links supported by the cable			
	One	Two	Three	Four
Rx 3+	S2	S2	S2	S2
Rx 3-	S3	S3	S3	S3
Tx 3-	S5	S5	S5	S5
Tx 3+	S6	S6	S6	S6
Rx 2+	N/C	S8	S8	S8
Rx 2-	N/C	S9	S9	S9
Tx 2-	N/C	S11	S11	S11
Tx 2+	N/C	S12	S12	S12
Sideband 5	SB14	SB14	SB14	SB14
Sideband 4	SB15	SB15	SB15	SB15
Sideband 3	SB16	SB16	SB16	SB16
Sideband 2	SB17	SB17	SB17	SB17
Sideband 1	SB18	SB18	SB18	SB18
Sideband 0	SB19	SB19	SB19	SB19
Rx 1+	N/C	N/C	S21	S21
Rx 1-	N/C	N/C	S22	S22
Tx 1-	N/C	N/C	S24	S24
Tx 1+	N/C	N/C	S25	S25
Rx 0+	N/C	N/C	N/C	S27
Rx 0-	N/C	N/C	N/C	S28
Tx 0-	N/C	N/C	N/C	S30
Tx 0+	N/C	N/C	N/C	S31
SIGNAL GROUND	G1, G4, G7, G10, G13, G20, G23, G26, G297, G32			
CHASSIS GROUND	Housing			
Key: N/C = not connected				

The sideband signals are vendor-specific but may be used as an SGPIO target interface (see SFF-8485).

5.2.4 Cables

5.2.3.6 SAS external cable plug connector

SAS external cables shall use the SAS external cable plug connector. The SAS external cable plug connector is defined in SFF-8470 as the 4x configuration with thumbscrews. No special SAS keying is provided. The SAS external cable plug connector attaches to a SAS external receptacle connector, providing contact for up to four physical links.

Table 23 defines the pin assignments.

5.2.3.7 SAS external receptacle connector

SAS devices with external ports shall use the SAS external receptacle connector. The SAS external receptacle connector is defined in SFF-8470 as the 4x configuration with thumbscrews. No special SAS keying is provided. The SAS external receptacle connector attaches to a SAS external cable plug connector, providing contact for up to four physical links.

Table 23 defines the pin assignments.

5.2.3.8 SAS external connector pin assignments

Table 23 defines how the connector signal pairs are used in external connectors for applications using one, two, three, or four of the physical links. External cables should be labeled to indicate how many physical links are included (e.g., 1X, 2X, 3X, and 4X on each connector's housing).

Table 23 — Physical link usage in SAS external connector

[table not shown]

SIGNAL GROUND shall not be connected to CHASSIS GROUND in the cable connector.

5.2.4 Cables

5.2.4.1 SAS internal cables

SAS internal cables shall use a SAS internal cable receptacle connector on the SAS target device end and a SATA-style cable receptacle (see ATA/ATAPI-7 V3) on the SAS initiator device or expander device end. The power and READY LED signal connection is vendor specific.

A SAS initiator device shall use a SATA-style host plug connector (see ATA/ATAPI-7 V3) for connection to the SAS internal cable. The signal assignment for the SAS initiator device or expander device with this connector shall be the same as that defined for a SATA host (see ATA/ATAPI-7 V3).

Figure 44 shows destination signal assignments and a connection diagram for the SAS single-port internal cable.

[figure not shown]

Figure 44 — SAS single-port internal cable assembly and destination pin assignments

Figure 45 shows destination signal assignments and a connection diagram for the SAS dual-port internal cable.

[figure not shown]

Figure 45 — SAS dual-port internal cable assembly and destination pin assignments

5.2.4.x SAS internal wide cables

SAS internal wide cables shall use a SAS internal wide cable receptacle connector on each end. One connector shall have its key on the other side, causing the Tx pins on one side to route to the Rx pins on the other side. The Tx signal from one connector shall be connected to the corresponding Rx signal on the other connector (e.g., a Tx (S2) of one connector shall connect to Rx (S27) of the other connector. The physical link number of that pin depends on the application).

Although the connector always supports four physical links, the cable may support one, two, three, or four physical links when used for controller-to-backplane applications. The cable shall support four physical links for controller-to-controller applications.

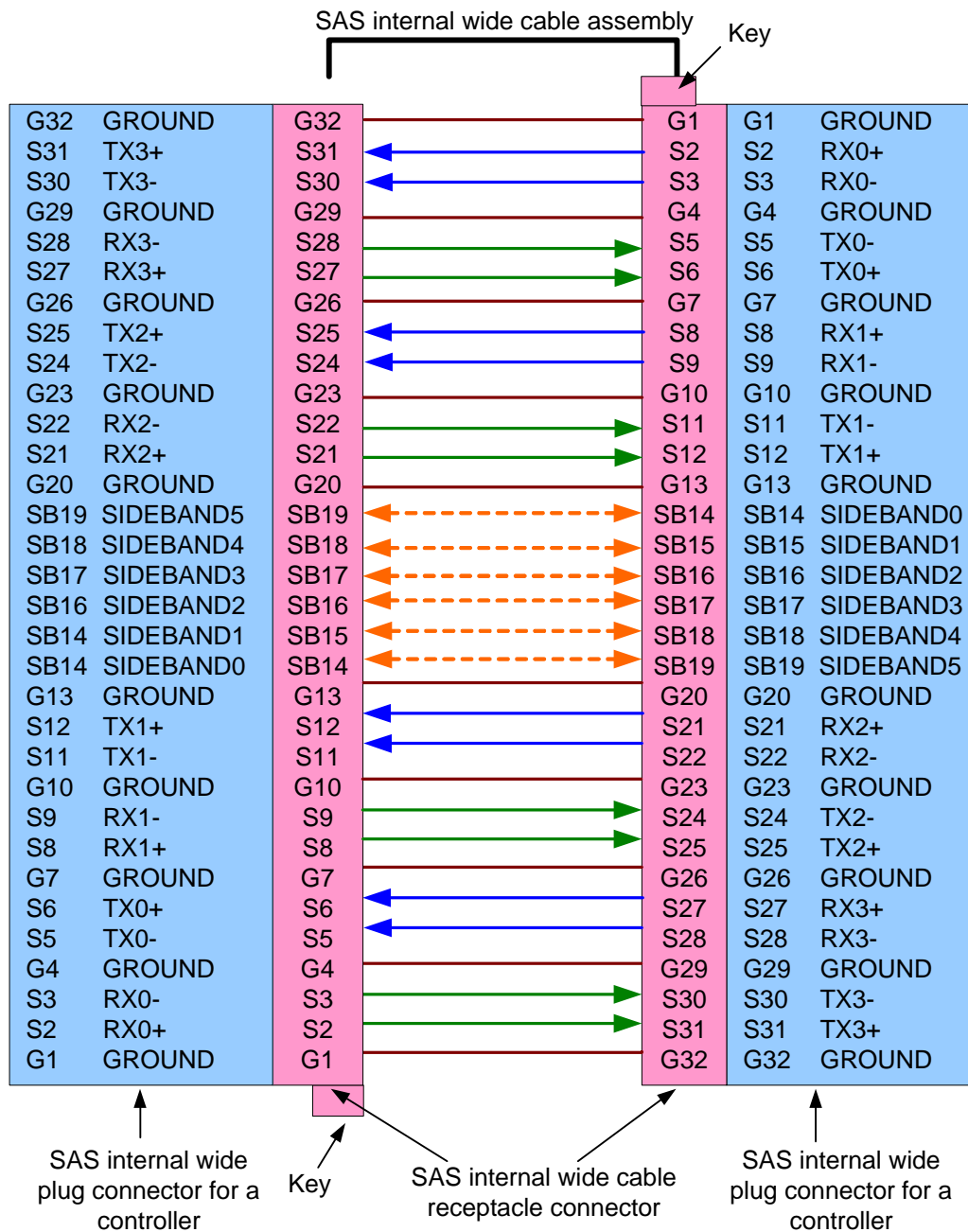Figure 3 shows the SAS internal wide cable attaching two controllers.

Figure 3 — SAS internal wide cable attaching controller to controller

NOTE 2 - For controller to controller applications, all four physical links should be used, because one side's physical link 0 is the other side's physical link 3. If both sides just used physical link 0, they would not communicate. The sideband signals are also crossed.

Figure 4 shows the SAS internal wide cable being used to attach a controller to a backplane.
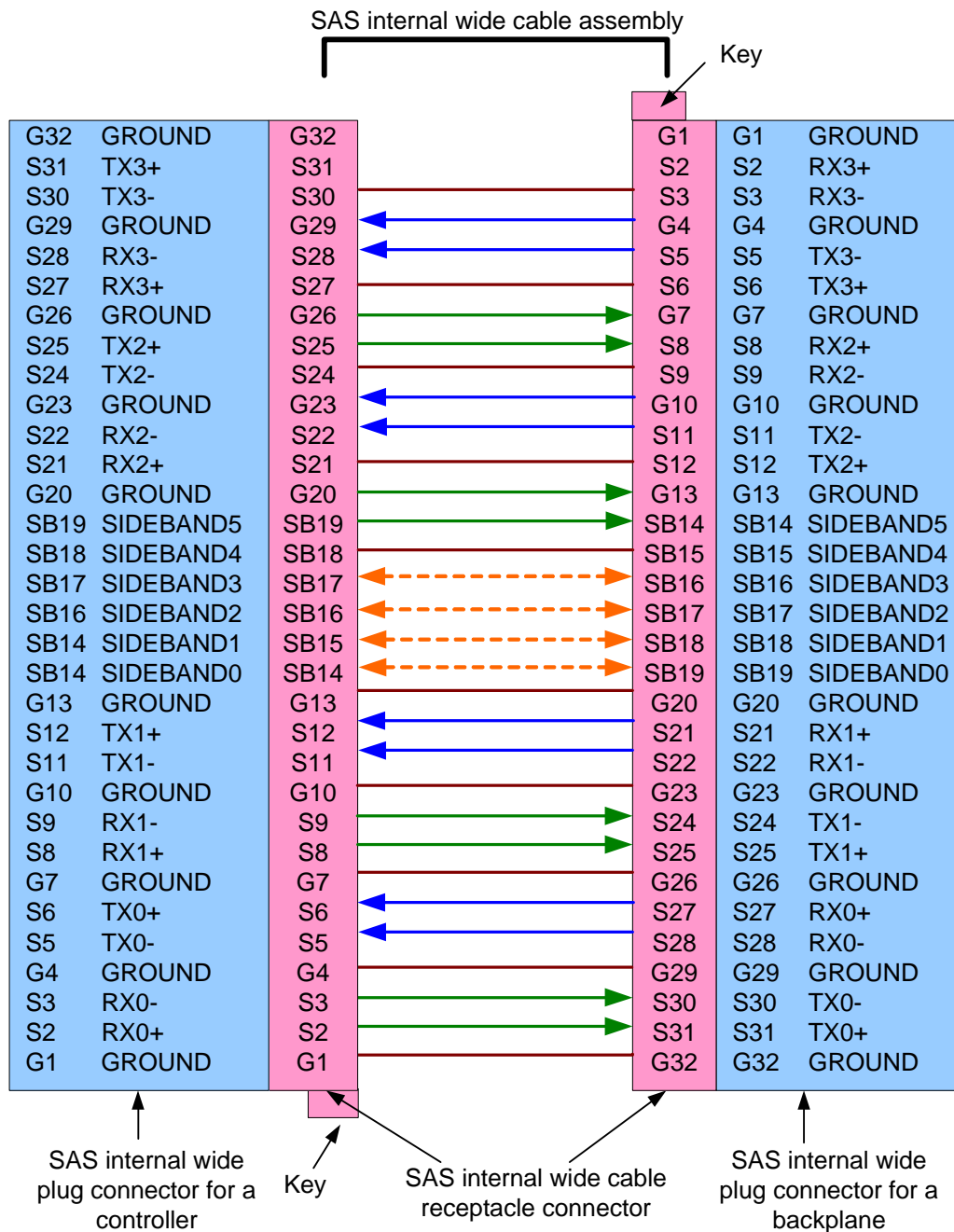
SAS internal wide cable assembly

Key

G32	GROUND	G32		G1	G1	GROUND
S31	TX3+	S31		S2	S2	RX3+
S30	TX3-	S30		S3	S3	RX3-
G29	GROUND	G29		G4	G4	GROUND
S28	RX3-	S28		S5	S5	TX3-
S27	RX3+	S27		S6	S6	TX3+
G26	GROUND	G26		G7	G7	GROUND
S25	TX2+	S25		S8	S8	RX2+
S24	TX2-	S24		S9	S9	RX2-
G23	GROUND	G23		G10	G10	GROUND
S22	RX2-	S22		S11	S11	TX2-
S21	RX2+	S21		S12	S12	TX2+
G20	GROUND	G20		G13	G13	GROUND
SB19	SIDEBAND5	SB19		SB14	SB14	SIDEBAND5
SB18	SIDEBAND4	SB18		SB15	SB15	SIDEBAND4
SB17	SIDEBAND3	SB17		SB16	SB16	SIDEBAND3
SB16	SIDEBAND2	SB16		SB17	SB17	SIDEBAND2
SB14	SIDEBAND1	SB15		SB18	SB18	SIDEBAND1
SB14	SIDEBAND0	SB14		SB19	SB19	SIDEBAND0
G13	GROUND	G13		G20	G20	GROUND
S12	TX1+	S12		S21	S21	RX1+
S11	TX1-	S11		S22	S22	RX1-
G10	GROUND	G10		G23	G23	GROUND
S9	RX1-	S9		S24	S24	TX1-
S8	RX1+	S8		S25	S25	TX1+
G7	GROUND	G7		G26	G26	GROUND
S6	TX0+	S6		S27	S27	RX0+
S5	TX0-	S5		S28	S28	RX0-
G4	GROUND	G4		G29	G29	GROUND
S3	RX0-	S3		S30	S30	TX0-
S2	RX0+	S2		S31	S31	TX0+
G1	GROUND	G1		G32	G32	GROUND

SAS internal wide plug connector for a controller

Key

SAS internal wide cable receptacle connector

SAS internal wide plug connector for a backplane

Figure 4 — SAS internal wide cable attaching controller to backplane

NOTE 3 - For controller to backplane applications, up to four physical links may be used. The sideband signals are not crossed.

5.2.4.2 SAS external cables

The SAS external cable connectors are defined in SFF-8470 as the 4x configuration with thumbscrews. The external cable does not include power or the READY LED signal.

Although the connector always supports four physical links, the cable may support one, two, three, or four physical links.

On external cable assemblies, the Tx signal from one connector shall be connected to the corresponding Rx signal of the other connector (e.g., Tx 0+ (S16) of one connector shall connect to Rx 0+ (S1) of the other connector) (see 5.2.3.6).

SIGNAL GROUND shall not be connected to CHASSIS GROUND in the cable.

5.2.5 Backplanes

Backplane designs should follow the recommendations in SFF-8460.