

To: T10 Technical Committee  
From: Rob Elliott, HP (elliott@hp.com)  
Date: 15 September 2004  
Subject: 03-240r6 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.

Revision 2 (28 April 2004) Changed G27 to G26 in table 999. Changed G297 to G29 in table 1000. Corrected table captions in figure 2. Fixed arrows in figure 4. Added wording options for sideband SGPIO requirements. Corrected SFF-8484 number in references and added SFF-8485.

Revision 3 (20 May 2004) Incorporated changes from 20 May 2004 SAS physical WG teleconference.

Revision 4 (7 September 2004) Incorporated comments from July 2004 SAS physical WG, including adding support for fanout (octopus) cable variants and making sideband usage for SGPIO be a NOTE.

Revision 5 (11 September 2004) Incorporated comments from 9 September 2004 SAS physical WG teleconference (04-299r0). Reversed the names of the fanout cables, so "controller-based fanout" means the controller side has the 4x connector and "backplane-based fanout" means the backplane side has the 4x connector.

Revision 6 (15 September 2004) Incorporated comments from 14 September 2004 SAS physical WG meeting. Removed S, SB, and G prefixes to match decision reached for SFF-8484.

### **Related documents**

sas1r05 - Serial Attached SCSI 1.1 revision 5

sff-8484r0.5 (30 April 2004) - Multi Lane Internal Serial Attachment Connector (Brian Miller, Amphenol)

sff-8485r0.4 (25 May 2004) - Serial GPIO (Rob Elliott, HP)

04-194r4 - SAS-1.1 Internal Wide Connector/Cable Electrical Requirements (Barry Olawsky, HP)

### **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 plug used on the backplanes. It follows the design of the SATA host connector.



**Figure 1 — Internal wide connector plug picture (from Amphenol)**

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Editor's Note 1: The connector ended up with 6 sidebands in the middle rather than 4 as shown.

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Editor's Note 2: SFF-8484 also defines a two lane interface. This proposal is not adding support

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[for that into SAS-1.1. That could be proposed separately later on if needed.](#)

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The connector interface 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. Electrical characteristics for interoperability points at the connector are proposed in 04-195r4.

### **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-8484, \*Multi Lane Internal Serial Attachment Connector\*](#)

[SFF-8485, \*Serial GPIO \(SGPIO\) Bus\*](#)

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 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 42 not shown]

Figure 42 — SAS cables and connectors - external environment

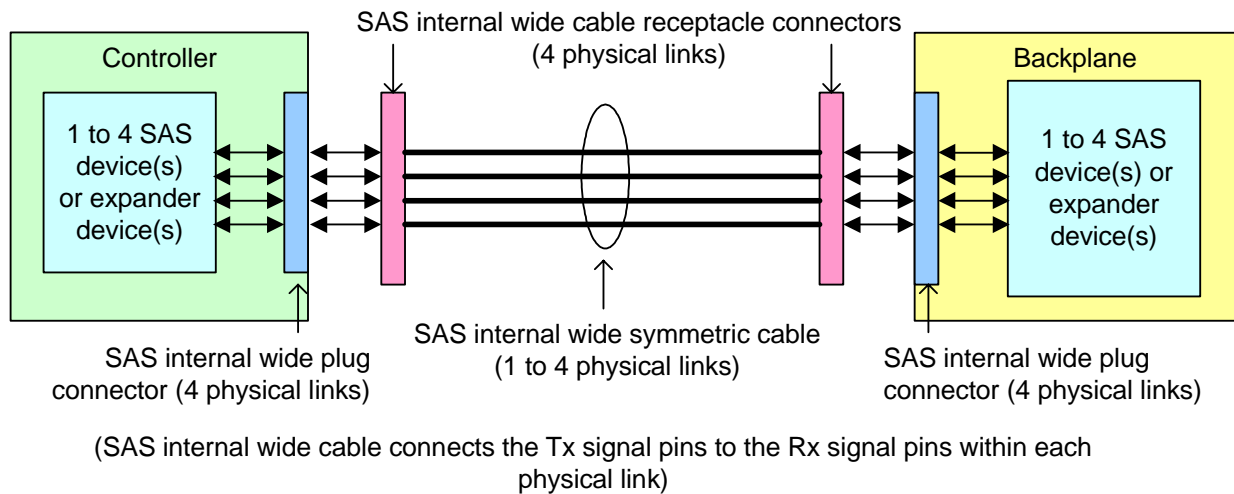
Figure 43 shows a schematic representation of the cables and connectors defined in this standard for internal [cabled and internal backplane](#) environments.

[figure 43 not shown]

Figure 43 — SAS cables and connectors - internal [cabled and internal backplane](#) environments

[Figure 2 shows a schematic representation of the cables and connectors defined in this standard for the internal wide cabled environment attaching a controller to a backplane using a symmetric cable.](#)

#### Internal wide cabled environment - controller to backplane - symmetric cable



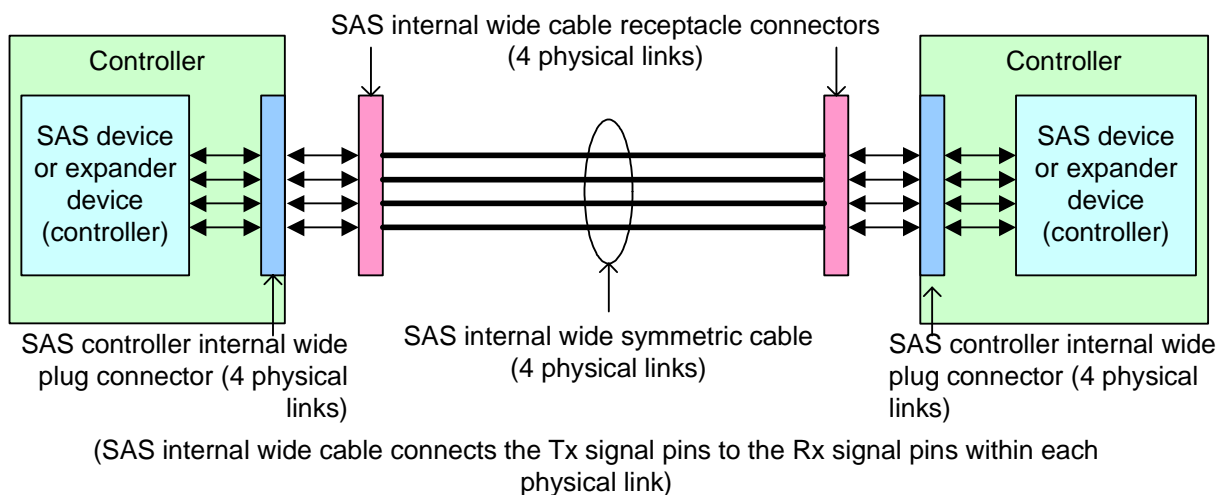
**[Figure 2 — Internal wide cabled environment - controller to backplane - symmetric cable](#)**

[The SAS internal wide symmetric cable provides one to four physical links, and may be used as any combination of wide links and narrow links \(see 4.1.3\) using those physical links.](#)

[The internal wide cable receptacle connectors have different pinouts for the controller end and the backplane end so one end's Tx signals are attached to the other end's Rx signals.](#)

[Two controllers may also be attached together with a symmetric cable that provide 4 physical links if all four physical links are used by each controller, since one end's physical link 0 is attached to the other end's physical link 3. Figure 3 shows the internal wide cabled environment attaching a controller to a controller using a symmetric cable.](#)

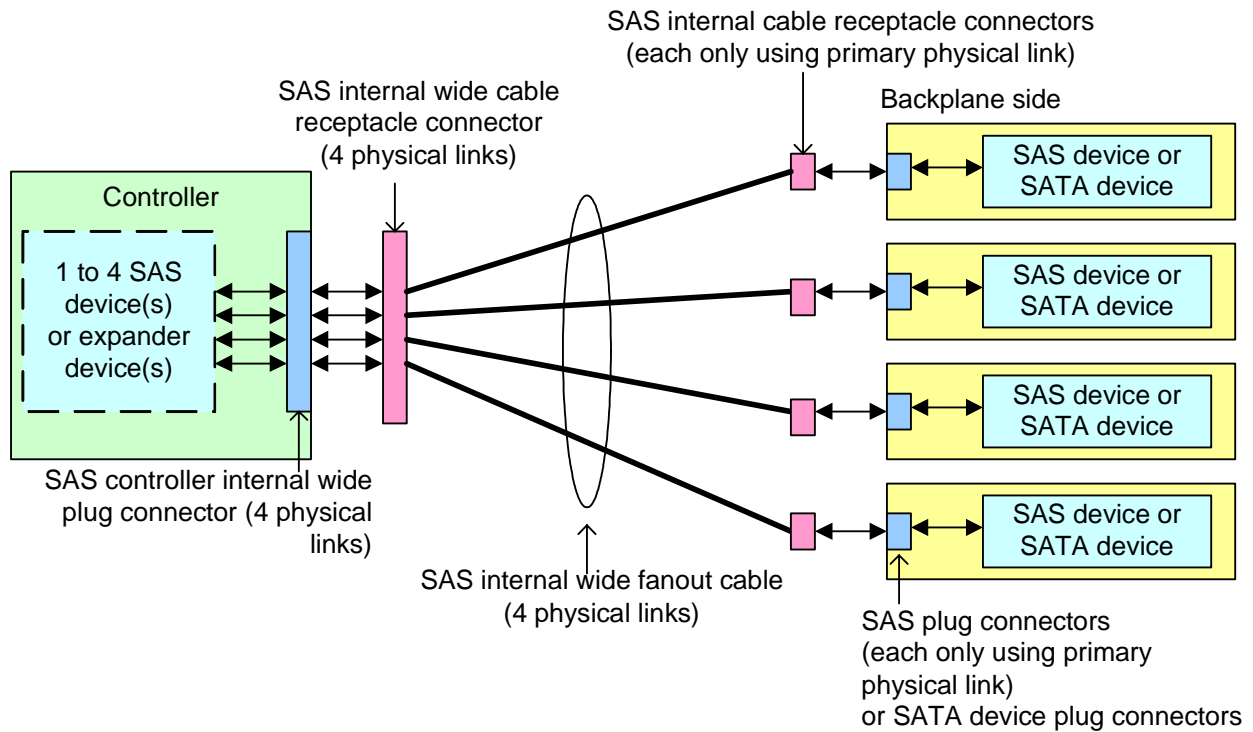
#### Internal wide cabled environment - controller to controller - symmetric cable



**[Figure 3 — Internal wide cabled environment - controller to controller - symmetric cable](#)**

[Figure 5 shows a schematic representation of the cables and connectors defined in this standard for the internal wide cabled environment using a controller-based fanout cable.](#)

#### Internal wide cabled environment - controller-based fanout cable

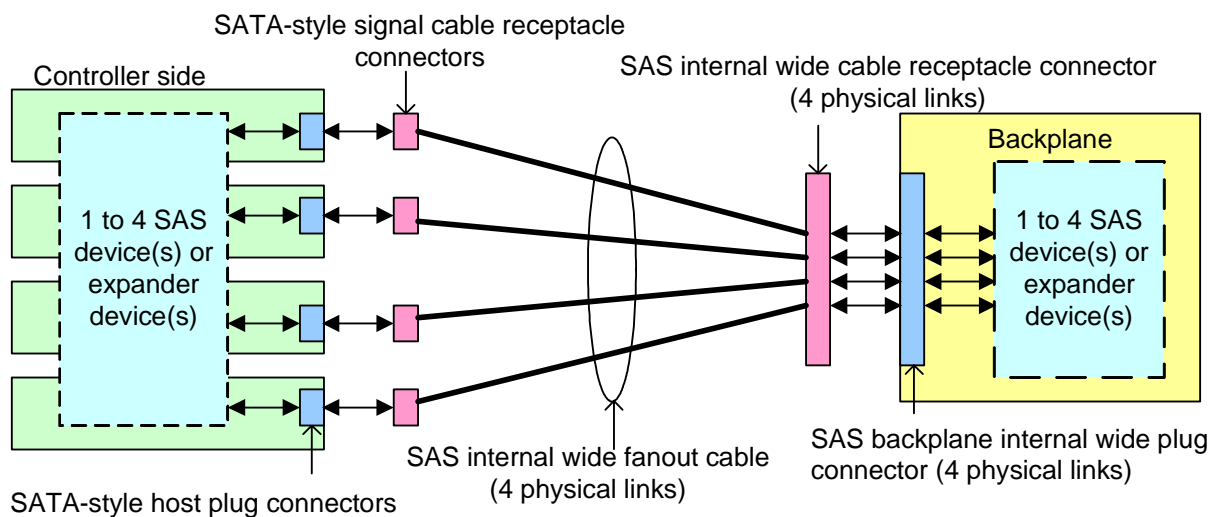


(the cable connects the Tx signal pins to the Rx signal pins within each physical link)

**Figure 4 — Internal wide controller-based fanout cable environment**

[Figure 5 shows a schematic representation of the cables and connectors defined in this standard for the internal wide cabled environment using a backplane-based fanout cable.](#)

#### Internal wide cabled environment - backplane-based fanout cable



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

**Figure 5 — Internal wide backplane-based fanout cable environment**

## 5.2.3 Connectors

### 5.2.3.1 Connectors overview

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
<a href="#">SAS internal wide cable receptacle</a>	<a href="#">4</a>	<a href="#">5.2.3.x</a>	<a href="#">SAS internal wide plug</a>	<a href="#">4</a>	<a href="#">5.2.3.y</a>
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 ([see 5.2.3.5](#)) 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. [\[new para\]](#)

The single-port version attaches to either:

- a SAS plug connector, providing contact for the power pins and only the primary physical link; or
- 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 ([see 5.2.3.5](#)) 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. [\[new para\]](#)

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 ([see 5.2.3.5](#)) defines the pin assignments.

#### 5.2.3.5 SAS internal connector [s](#) pin assignments

Table 22 defines the SAS target device signal assignments for pins in the ~~SAS internal connector~~ [SAS plug connector \(see 5.2.3.2\)](#), [SAS internal cable receptacle connector \(see 5.2.3.3\)](#), and [SAS backplane receptacle connector \(see 5.2.3.4\)](#).

**Table 22 — SAS target device connector pin assignments**

[table 22 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 plug connector](#)

[SAS internal wide cables shall use the SAS internal wide plug connector. The SAS internal wide plug connector is defined in SFF-8484.](#)

[The SAS internal wide plug connector attaches to a SAS internal wide cable receptacle connector, providing contact for up to four physical links and six sideband signals.](#)

[Table 999 and table 1000 \(see 5.2.3.z\) define the pin assignments.](#)

#### [5.2.3.y SAS internal wide cable receptacle connector](#)

[The SAS internal wide cable receptacle connector is defined in SFF-8484.](#)

[The SAS internal wide cable receptacle connector attaches to a SAS internal wide plug connector, providing contact for up to four physical links and six sideband signals.](#)

[Table 999 and table 1000 \(see 5.2.3.7\) define the pin assignments.](#)

#### [5.2.3.z SAS internal wide connector pin assignments](#)

[Table 999 defines how the connector signal pairs are used in SAS internal wide plug connectors \(see 5.2.3.x\) and SAS internal wide cable receptacle connectors \(see 5.2.3.y\) for controller applications using one, two, three, or four of the physical links. SAS 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 connectors [all new]**

Signal	Signal pin to use based on number of physical links supported by the cable <sup>a</sup>			
	One	Two	Three	Four
Rx 0+	2	2	2	2
Rx 0-	3	3	3	3
Tx 0-	5	5	5	5
Tx 0+	6	6	6	6
Rx 1+	N/C	8	8	8
Rx 1-	N/C	9	9	9
Tx 1-	N/C	11	11	11
Tx 1+	N/C	12	12	12
Sideband 0	14	14	14	14
Sideband 1	15	15	15	15
Sideband 2	16	16	16	16
Sideband 3	17	17	17	17
Sideband 4	18	18	18	18
Sideband 5	19	19	19	19
Rx 2+	N/C	N/C	21	21
Rx 2-	N/C	N/C	22	22
Tx 2-	N/C	N/C	24	24
Tx 2+	N/C	N/C	25	25
Rx 3+	N/C	N/C	N/C	27
Rx 3-	N/C	N/C	N/C	28
Tx 3-	N/C	N/C	N/C	30
Tx 3+	N/C	N/C	N/C	31
SIGNAL GROUND	1, 4, 7, 10, 13, 20, 23, 26, 29, 32			
<sup>a</sup> N/C = not connected				

[The use of the sideband signals by a controller is vendor-specific. One implementation of the sideband signals by a controller is an SGPIO initiator interface \(see SFF-8485\). Other implementations shall be compatible with the signal levels defined in SFF-8485.](#)

[Table 1000 defines how the connector signal pairs are used in SAS internal wide plug connectors \(see 5.2.3.x\) and SAS internal wide cable receptacle connectors \(see 5.2.3.y\) 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 connectors [all new]**

Signal	Signal pin to use based on number of physical links supported by the cable <sup>a</sup>			
	One	Two	Three	Four
Rx 3+	N/C	N/C	N/C	2
Rx 3-	N/C	N/C	N/C	3
Tx 3-	N/C	N/C	N/C	5
Tx 3+	N/C	N/C	N/C	6
Rx 2+	N/C	N/C	8	8
Rx 2-	N/C	N/C	9	9
Tx 2-	N/C	N/C	11	11
Tx 2+	N/C	N/C	12	12
Sideband 5	14	14	14	14
Sideband 4	15	15	15	15
Sideband 3	16	16	16	16
Sideband 2	17	17	17	17
Sideband 1	18	18	18	18
Sideband 0	19	19	19	19
Rx 1+	N/C	21	21	21
Rx 1-	N/C	22	22	22
Tx 1-	N/C	24	24	24
Tx 1+	N/C	25	25	25
Rx 0+	27	27	27	27
Rx 0-	28	28	28	28
Tx 0-	30	30	30	30
Tx 0+	31	31	31	31
SIGNAL GROUND	1, 4, 7, 10, 13, 20, 23, 26, 29, 32			
<sup>a</sup> N/C = not connected				

[The use of the sideband signals by a backplane is vendor-specific. One implementation of the sideband signals by a backplane is an SGPIO target interface \(see SFF-8485\). Other implementations shall be compatible with the signal levels defined in SFF-8485.](#)

### 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 four lane free (plug) connector with jack screws. The SAS external cable plug connector shall not include keys and may include key slots. Key slots are not defined by this standard. The SAS external cable plug connector attaches to a SAS external receptacle connector, providing contact for up to four physical links.



Table 23 (see 5.2.3.8) 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 four lane fixed (receptacle) connector with jack screws. The SAS external cable receptacle connector shall not include keys and may include key slots. Key slots are not defined by this standard. The SAS external receptacle connector attaches to a SAS external cable plug connector, providing contact for up to four physical links.

Table 23 (see 5.2.3.8) 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 23 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 44 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 45 not shown]

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

### 5.2.4.x SAS internal wide cables

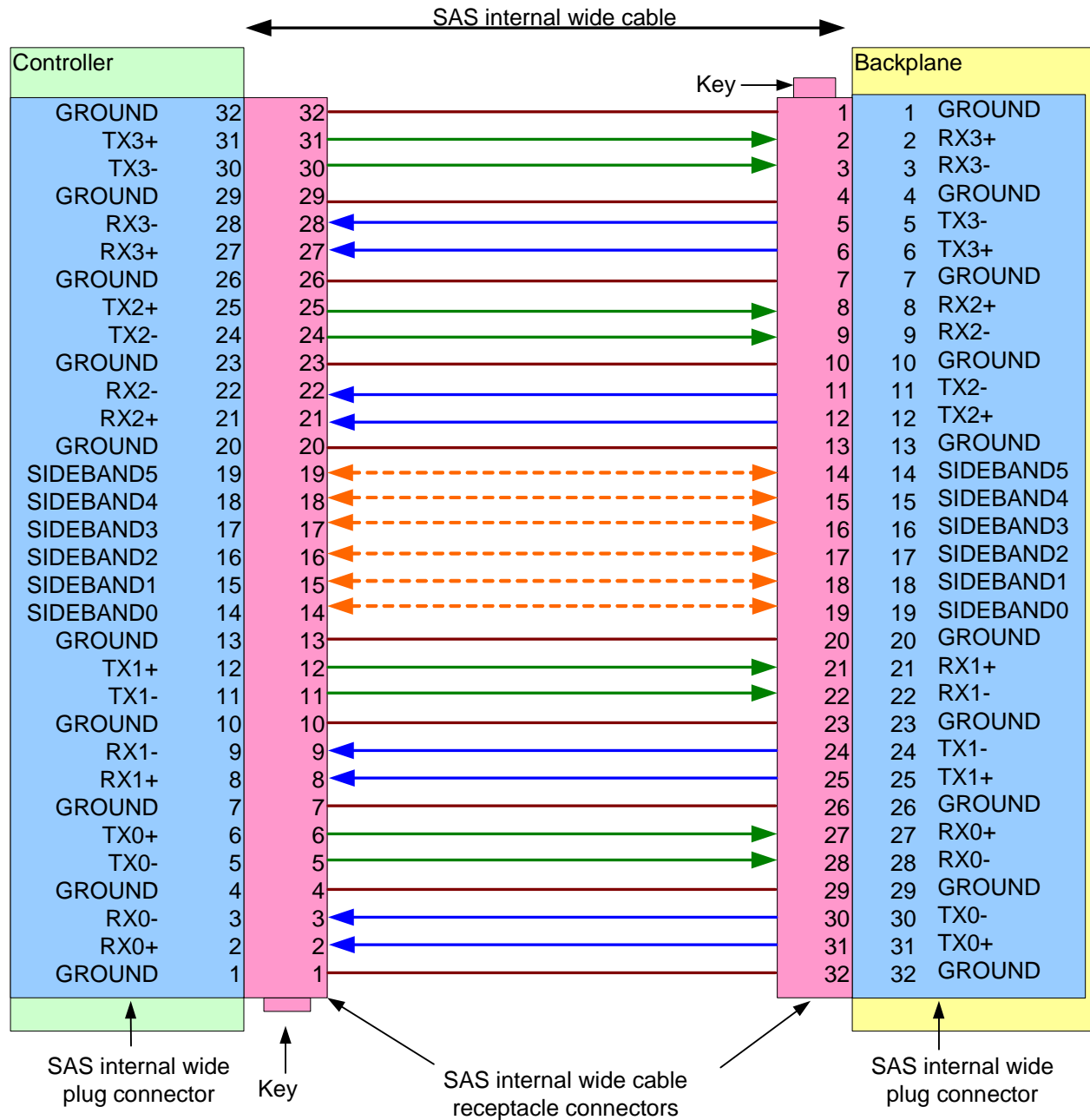
There are several types of SAS internal wide cable defined:

- a) symmetric cable: SAS internal wide cable receptacle connectors on each end;
- b) controller-based fanout cable: SAS internal wide cable receptacle connector on one end (i.e., the controller end) and four SAS internal cable receptacle connectors on the other end (i.e., the backplane end); and
- c) backplane-based fanout cable: Four SATA-style signal cable receptacle connectors on one end (i.e., the controller end) and a SAS internal wide cable receptacle connector on the other end (i.e., the backplane end).

In the symmetric cable, one connector shall have its key on the opposite end of the other connector, causing the Tx pins on one end to route to the Rx pins on the other end. The Tx signal from one connector shall be connected to the corresponding Rx signal on the other connector (e.g., a Tx (pin 6) of one connector shall connect to an Rx (pin 27) of the other connector. The physical link number of that pin depends on the application).

Although the SAS internal wide cable receptacle connector always supports four physical links, the SAS internal wide 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.

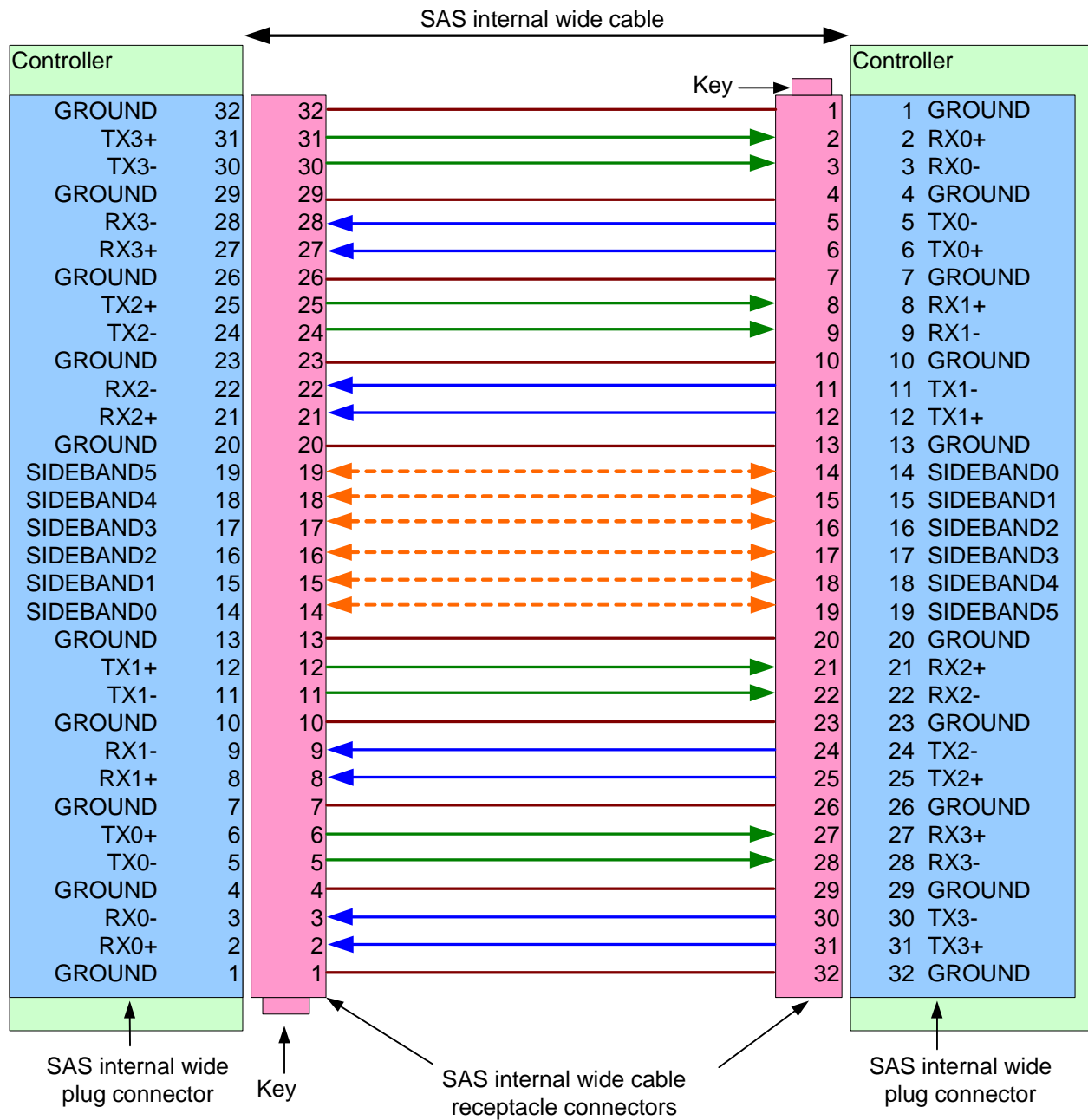
Figure 6 shows the SAS internal wide cable being used to attach a controller to a backplane.



**Figure 6 — SAS internal wide cable attaching controller to backplane**

NOTE 2 - For controller to backplane uses, up to four physical links may be used. SIDE BAND signals on the controller are attached to the corresponding SIDE BAND signals on the backplane (e.g., SIDE BAND0 of the controller is attached to SIDE BAND0 of the backplane).

[Figure 7 shows the SAS internal wide cable attaching two controllers.](#)



**Figure 7 — SAS internal wide cable attaching controller to controller**

NOTE 3 - For controller to controller uses, all four physical links should be used, because one controller's physical link 0 is attached the other controller's physical link 3. If both controllers used only physical link 0, they would not communicate.

NOTE 4 - For controller to controller uses, SIDEBAND signals on one controller are not attached to their corresponding SIDEBAND signals on the other controller (e.g. SIDEBAND0 of one controller is attached to SIDEBAND5 of the other controller).

Figure 8 shows the SAS internal wide controller-based fanout cable.

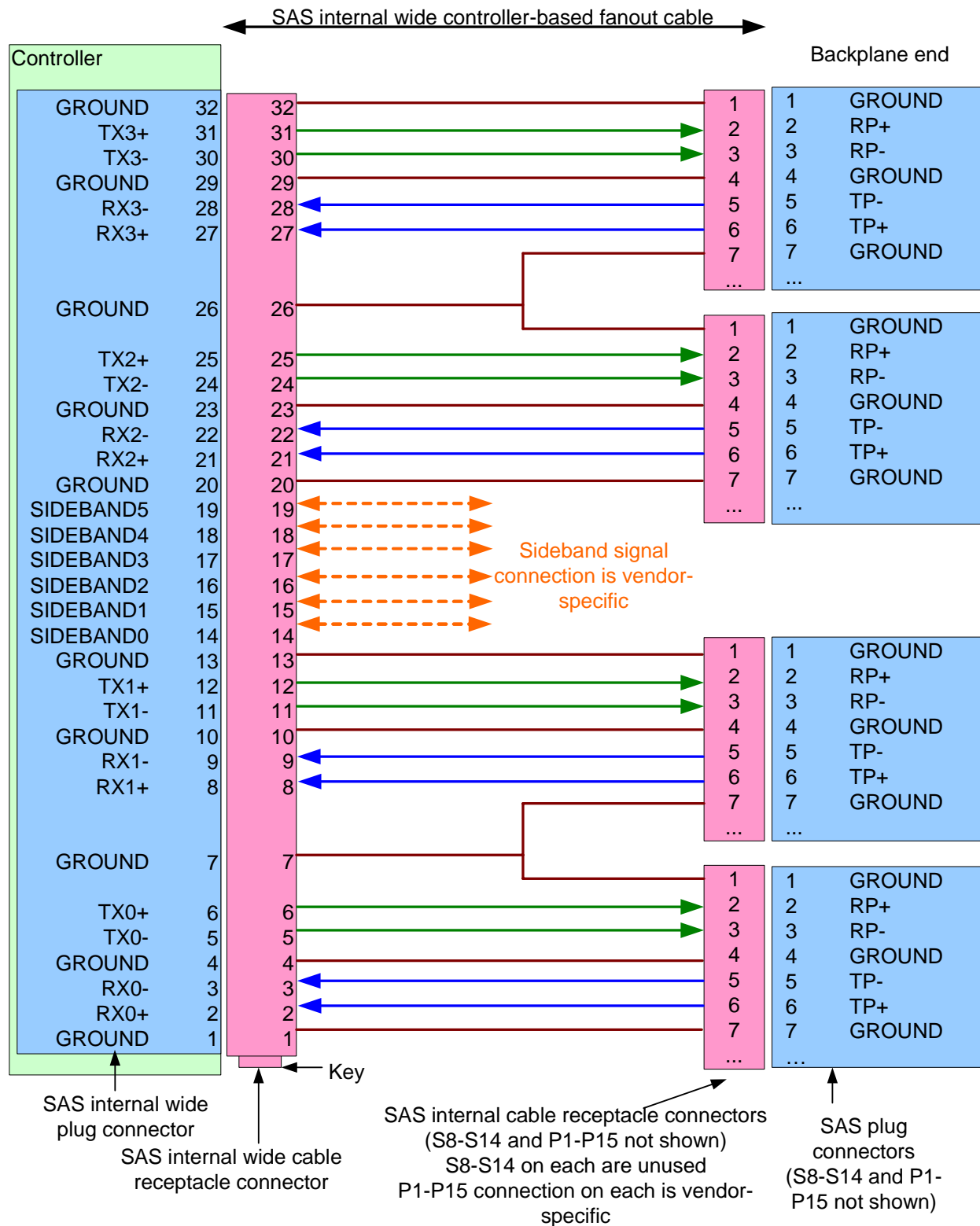
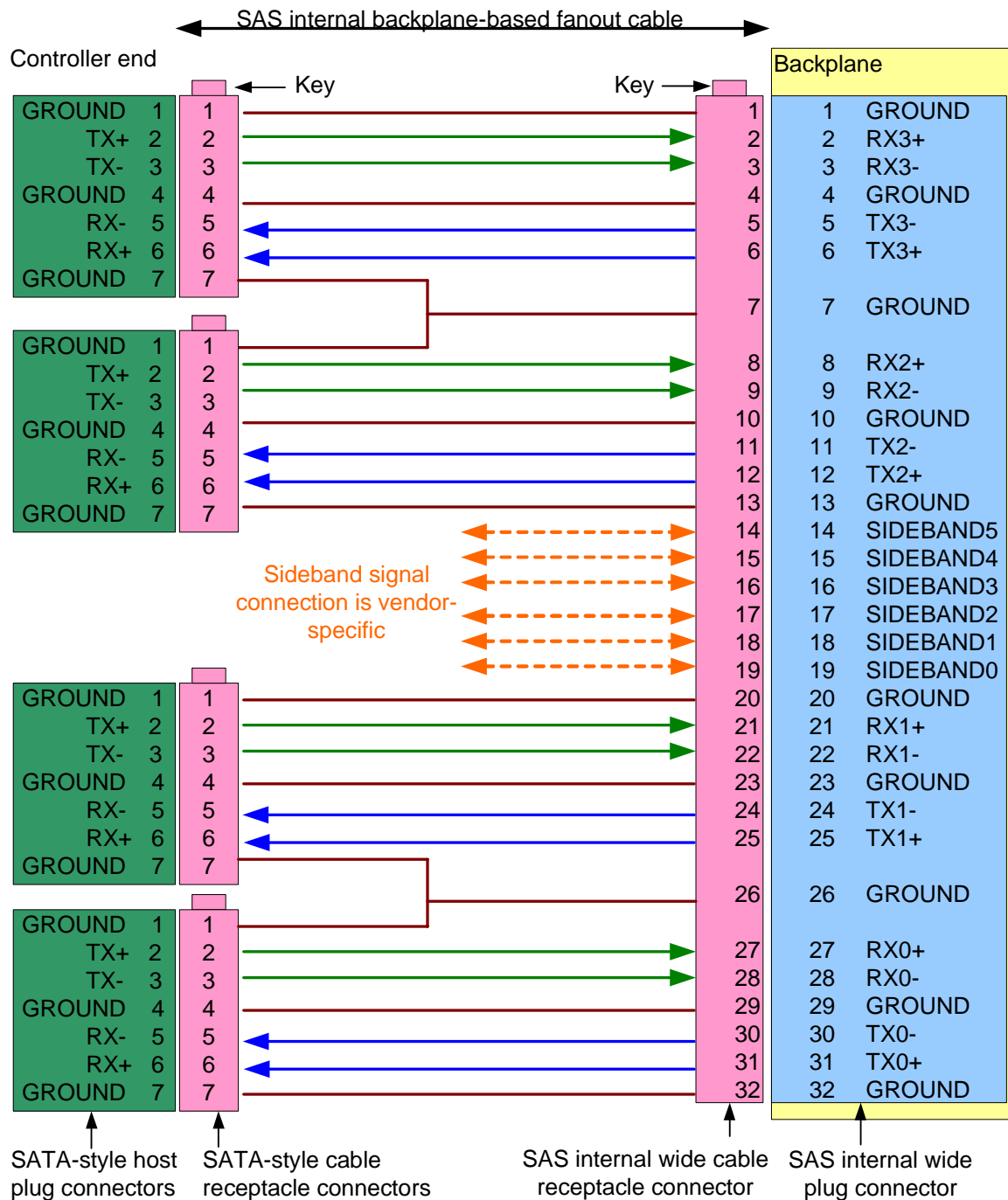


Figure 8 — SAS internal wide controller-based fanout cable

[Figure 9 shows the SAS internal wide backplane-based fanout cable.](#)



**Figure 9 — SAS internal wide backplane-based fanout cable**

#### 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.