AIAA S-133-4-201X

Standard

Space Plug-and-Play Architecture Standard

Physical Interface

AIAA

AIAA S-133-4-201X

Space Plug-and-Play Architecture (SPA) Standard

Physical Interface

Draft November 2012

Sponsored by

American Institute of Aeronautics and Astronautics

Approved XX Month 201X

Abstract

The Space Plug and Play Architecture (SPA) Physical Interface specifies the mechanical requirements and physical mounting considerations for SPA devices and panels.

Published by
American Institute of Aeronautics and Astronautics
1801 Alexander Bell Drive, Reston, VA 20191

Printed in the United States of America

Contents

Figures

Tables

Foreword

This standard was developed through a partnership of the Air Force Research Laboratory Space Vehicles Directorate, the Air Force Office of Operationally Responsive Space, numerous government contractor teams, independent contractor teams, and academic experts. The Space Plug-and-Play Architecture is a collection of standards developed to facilitate rapid constitution of spacecraft systems using modular components. In order for a SPA system to meet expected performance requirements, the SPA components and spacecraft must conform to a consistent and widely agreed upon grounding approach. This document includes specifications for SPA device and panel mechanical features.

At the time of approval, the members of the AIAA SPA Standards Committee were:

Fred Slane, Chair	Space Infrastructure Foundation
Jeanette Arrigo	Sierra Nevada Corporation
Scott Cannon	Utah State University
Ken Center	PnP Innovations
Don Fronterhouse*	PnP Innovations
Rod Green	Design Net Engineering Group
Jane Hansen	HRP Systems
Doug Harris	The Aerospace Corporation, ORS Office
Paul Jaffe	U.S. Naval Research Laboratory
Stanley Kennedy*	Comtech Aero-Astro
Ronald Kohl	R.J. Kohl & Associates
Bill Kramer	Independent Consultant
Ramon Krosley	Independent Consultant
Denise Lanza	SAIC
James Lyke	Air Force Research Laboratory
Joseph Marshall	BAE Systems
Gerald Murphy*	Design Net Engineering Group
Gary Rodriguez	SysRand Corporation
Steven Schenk	Comtech Aero-Astro
Robert Vick*	SAIC

The above consensus body approved this document in Month 201X.

The AIAA Standards Executive Council (VP-Standards Laura McGill, Chairperson) accepted the document for publication in Month 201X.

*Alternate CoS participant.

The AIAA Standards Procedures dictates that all approved Standards, Recommended Practices, and Guides are advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. There is no agreement to adhere to any AIAA standards publication and no commitment to conform to or be guided by standards reports. In formulating, revising, and approving standards publications, the committees on standards will not consider patents that may apply to the subject matter. Prospective users of the publications are responsible for protecting themselves against liability for infringement of patents or copyright or both.

Introduction

The space plug-and-play architecture (SPA) standards are a collection of documents designed to facilitate rapid constitution of spacecraft systems using modular components. This document details the features for mechanical mounting, thermal control and interface connectors of SPA devices on a SPA-compliant spacecraft.

The standard mechanical interface is a bolted connection to a regularly spaced grid of threaded holes. The grid spacing and fastener size are specified.

Thermal control of SPA devices is accomplished by the rejection of dissipated power to the mounting surface (conduction) or to the surrounding environment (radiation). The spacecraft provides a conductive interface for the SPA devices; however, the device designer may choose other approaches such as heat rejection to space via radiators.

The SPA electrical connector interface consists of one or more connectors that contain provisions for power, data, a timing synchronization pulse, grounding connections, and (if specified) a Test Bypass (TB) data interface.

There are two broad categories of requirements specified in this document that must be satisfied for integration of SPA devices. First, specific interface requirements must be met by both SPA devices and the SPA spacecraft, such as mounting hole pattern dimensions. Second, SPA device data must be provided with the item at the time of delivery. This data allows the SPA spacecraft developer to configure the spacecraft for proper integration and operation of the SPA device.

1 Scope

Mechanical, thermal and electrical connector interface requirements are contained in this document. These requirements include details of the mounting hole pattern, fastener clearance-hole sizes and thermal control approaches.

Reporting requirements for mechanical and thermal design data, such as mass, center of gravity, envelope, radiator and heater locations, and so forth are described.

This standard does provide some limited electrical interface requirements. Electrical power service requirements are included in AIAA S-133-5-2012. A more extensive common reference for both standards is AIAA S-122-2007, *Electrical Power Systems for Unmanned Spacecraft*. This document identifies the significant features of the SPA interface connector(s) and the associated cabling to allow SPA device and cable manufacturers to build systems that interconnect successfully with SPA-enabled spacecraft. The connector type and pin assignments are described, along with definitions of connector gender and mechanical mounting. Requirements are provided for the associated cabling, including details of shielding, shield termination, insulation and cable impedance

Optional SPA connector interfaces are described in the following sections by type (i.e., Type A, Type B, etc.).

2 Tailoring

When viewed from the perspective of a specific program or project context, the requirements defined in this Standard may be tailored to match the actual requirements of the particular program or project. Tailoring of requirements shall be undertaken in consultation with the procuring authority where applicable.

NOTE Tailoring is a process by which individual requirements or specifications, standards, and related documents are evaluated and made applicable to a specific program or project by selection, and in some exceptional cases, modification and addition of requirements in the standards.

3 Applicable Documents

The following documents contain provisions which, through reference in this text, constitute provisions of this standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

AIAA S-122-2007	Electrical Power Systems for Unmanned Spacecraft
AIAA G-133-10-201X	SPA System Capabilities
AIAA S-133-5-2012	SPA 28V Power Service
ECSS-E-ST-50-12C	SpaceWire Cabling
GSFC S311-P-4	Connectors: Electrical, Subminiature, Rack and Panel
MIL-DTL-24308	Connectors: Electric, Rectangular, Nonenvironmental, Miniature, Polarized Shell, Rack and Panel
MIL-DTL-83513	Connectors: Electric, Rectangular, Microminiature, Polarized Shell

4 Vocabulary

4.1 Acronyms and Abbreviated Terms

AIAA	American Institute of Aeronautics and Astronautics
ANSI	American National Standards Institute
AWG	American Wire Gauge
CG	Center of Gravity
DGND	Digital Ground
HSSI	High-Speed Serial Interface
IGES	Initial Graphics Exchange Specification
MKS	Meters, Kilograms, Seconds
MLI	Multi-Layer Insulation
NASTRAN	NASA Structural Analysis—a finite element analysis program
PPS	Pulse per second
RTN	Return
SPA	Space Plug-and-Play Architecture
SPW	SpaceWire
STEP	Standard for the Exchange of Project Model Data
TB	Test Bypass

4.2 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

SPA Application
A software SPA component

SPA Compliant
Adheres to applicable SPA standards

SPA Component
A SPA compliant hardware or software component

SPA Core Component
A SPA component that provides one or more SPA services

SPA Device
A hardware SPA component

5 Mechanical Requirements for SPA Devices

5.1 Device Mounting

SPA devices shall include a set of mounting holes which align to a regularly spaced grid pattern. (Example: Figure 1 – Typical SPA device mounting pattern).

In the typical implementation, SPA devices are mounted to the spacecraft structure with fasteners passing through clearance holes located on the device and mating with threaded features on the spacecraft.

5.1.1 Mounting Method

SPA devices shall provide clearance holes to accommodate mounting fasteners.

5.1.2 Recommended Fastener Size

Fastener type, size, and material are to be determined by the integrator of the SPA device.

The fastener clearance hole sizes specified herein are intended for ANSI #8 (0.164 in.) or Metric M4 sized fasteners.

5.1.3 Mounting Pattern

The mounting pattern shall be a two-dimensional grid pattern with a typical center-to-center hole spacing of 5.0 cm.

5.1.4 Number of Mounting Holes

The number of mounting holes and overall mounting pattern size shall be determined by the device designer in accordance with the strength requirements for the end-use. However, it is recommended there shall not be less than two mounting holes used for an individual device.

5.1.5 Device Mounting Hole Size and Positional Tolerance

Device mounting features shall be a ∅0.478 cm (∅0.188 in.) nominal diameter clearance holes.

Device mounting hole diameter tolerance shall be -0.003 / +0.028 cm (-0.001 / +0.011 in)

Device mounting hole patterns shall maintain a positional tolerance of ∅0.025 cm (∅0.010 in) at a nominal mounting hole diameter of ∅0.188 in.

The device mounting hole positional tolerance shall be at maximum material condition.

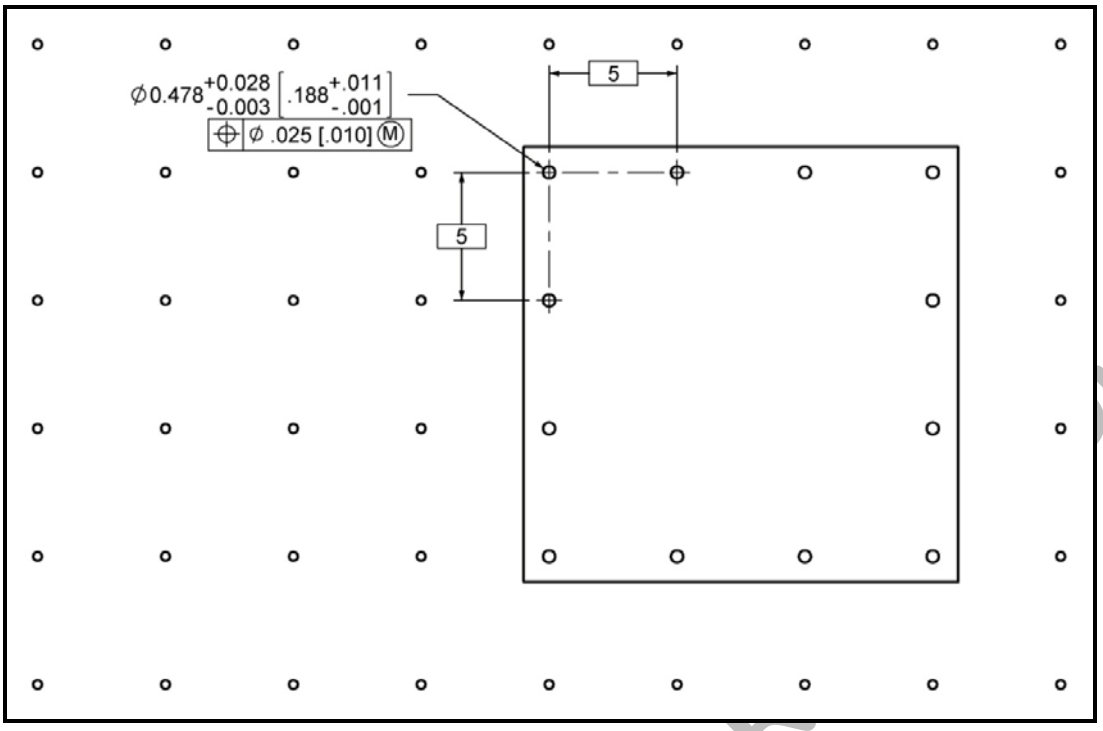

Figure 1 – Typical SPA device mounting pattern. (Primary dimensional units are in centimeters, secondary units are in inches.)

5.1.6 Mounting Fastener Access

The device design shall allow access to mounting fasteners for fastener installation, run-in, and application of final torque.

5.1.7 Mounting Surface Flatness

The device and spacecraft mounting surfaces are recommended to have a flatness of no more than 0.0005 in. per 1.0 in. of linear distance, or 0.008 in., whichever is greater.

EXAMPLE A device with a 30 cm (11.811 in.) linear dimension of mounting footprint is recommended to be flat within 0.008 in. A device with a 60 cm (23.622 in.) mounting footprint is recommended to be flat within 0.012 in.

5.1.8 Mounting Surface Conductivity

The mounting surfaces shall be electrically conductive such that the device and spacecraft are bonded with a maximum resistance of 2.5mΩ across each faying surface. This is consistent with AIAA S-122-2007.

5.1.9 Mounting Surface Properties

5.1.9.1 All metal surfaces shall be passivated, plated, treated, or otherwise finished to provide an inert exposed surface to prevent corrosion.

5.1.9.2 Surface treatments shall not inhibit electrical conductivity as specified in section 5.1.8 of this document.

5.2 Dynamic Requirements

Two cases for SPA device dynamics are provided under this specification:

a) SPA devices shall have no significant modes below 100Hz, or,

b) In cases where a SPA device has significant modes below 100Hz, a structural mathematical model (finite-element model) shall be provided with delivery of the device, sufficiently detailed to allow integration with the spacecraft structural model for prediction of worst-case deformations and stresses. It is recommended that the model shall be supplied in a NASTRAN-compatible format.

5.3 Deployables, Actuators, and Moving Mechanical Assemblies

5.3.1 In order to meet the goals of rapid integration, SPA devices shall not employ pyrotechnic or explosive actuators such as initiators.

5.3.2 This type of deployment mechanism requires special consideration and clearance on the structure that will increase the complexity of device placement. Nonexplosive actuators shall be used for all deployments and actuations, such as shape-memory alloy devices, paraffin actuators, or equivalent.

5.3.3 Shock sensitive devices and locations shall be identified.

5.4 Protective Covers

5.4.1 Protective covers shall be provided to preclude entrance of foreign particles to sensitive areas and to preclude damage during handling, assembly, integration, and test.

5.4.2 Protective covers not required for on-orbit operation shall be color-coded with a red finish and shall be marked with the words “REMOVE BEFORE FLIGHT.”

5.5 Maintainability

5.5.1 All devices shall be designed so that they can be replaced without adjustment.

5.5.2 All devices shall be designed to be installed with standard tools.

5.5.3 All devices shall be designed to be installed and removed from the spacecraft without disassembly of the device.

5.5.4 All mounting bolts, connectors, flight plugs, temporary vacuum seals, and nonflight protective covers shall be readily accessible while the device is mounted on the spacecraft.

5.6 Reporting of Device Physical Characteristics

SPA devices shall be delivered with the following documentation and engineering data.

5.6.1 Envelope and Mounting

a) A drawing depicting the overall envelope dimensions shall be provided.

b) The device coordinate system and origin shall be shown on the envelope drawing.

c) A drawing depicting the mounting hole locations, size, and flange thickness shall be provided.

d) A solid model of the envelope and mounting details in STEP or IGES format shall be provided.

5.6.2 Mass, Center of Gravity, and Inertia Reporting

Mass properties of SPA devices shall be provided at device delivery.

a) Required: The mass of the device shall be reported to an accuracy of 5% or 0.5 kg (1.1lbm), whichever is less.

b) Recommended: The center of gravity location reported in the device coordinate system to an accuracy of 5 mm (0.2 in.) in any direction.

c) Recommended: The inertia tensor, reported in the device coordinate system at the center of mass, shall be reported to an accuracy of 10%. It shall be specified whether the inertia tensor is calculated with a positive or negative integral.

d) Data shall be reported in the MKS system of units (i.e., meters, kilograms, or seconds).

5.6.3 Connector Type and Location Reporting

a) The type and location of all interface connectors shall be depicted on the device envelope drawing or a separate drawing.

b) For each connector depicted on the drawing, the location of "Pin 1" shall be shown to identify connector orientation.

5.6.4 Field of View Reporting

The boresight, field of view, and field of regard (if applicable) shall be described and provided on a drawing with definition relative to the device coordinate system.

5.6.5 Special Instructions

Special mounting, alignment, installation, integration, or testing requirements shall be identified, if applicable.

6 Thermal Requirements for SPA Devices

6.1 General Thermal Requirements

6.1.1 SPA Device Thermal Control Approach

SPA device thermal dissipations shall be conducted to the spacecraft through the device mounting surface or radiated to the surroundings.

6.1.2 Thermal Mounting Surfaces

a) The spacecraft shall provide a thermally conductive mounting surface to accommodate a recommended thermal flux of 0.20 W/cm^2.

b) SPA devices that require thermal isolation from the spacecraft shall be responsible for providing thermal isolation features as an integral part of the SPA device. These may include, but are not limited to, low-conductivity spacers, stand-offs, or flexures.

6.1.3 Device Thermal Interface Materials

Devices shall be mounted to the spacecraft without any thermal interface filler (i.e., wet-mounting).

6.1.4 Thermal Control External Surface Conductivity

a) The external surfaces of thermal control materials, including multilayer insulation (MLI) blankets, radiator surfaces, and thermal control tapes, shall be conductive to dissipate charge build-up. The maximum recommenced resistivity is 10KΩ/square.

b) MLI blankets shall be grounded to the device chassis.

6.1.5 Special Instructions

Special requirements for device thermal envelopes, operation modes, and other restrictions shall be provided as applicable.

6.2 Reporting of Device Thermal Characteristics

SPA devices shall be delivered with the following documentation and engineering data related to thermal characteristics to facilitate spacecraft design activities.

6.2.1 Thermal Design Approach

The thermal design approach related to requirements imposed on the spacecraft configuration shall be reported. This includes:

a) SPA device thermal control approach (i.e., mounting surface conduction, radiation to space, radiation to surrounding spacecraft surfaces).

b) Thermal radiator area, location, field-of-view requirements.

c) Exterior surface finish descriptions, including emissivity and solar absorptivity.

d) A device thermal model to be integrated into the overall spacecraft thermal model.

6.2.2 Thermal Dissipation Levels

The thermal dissipation of the SPA device in all operational modes shall be reported.

6.2.3 Heaters and Heater Control

The details of internal device heaters shall be reported, including heater power, control set-points, operational modes, and any additional information for incorporation into the spacecraft thermal model.

7 SPA Interface Connector and Cabling Requirements

7.1 Introduction

The SPA device interface consists of connecting SPA devices to a spacecraft infrastructure. The connection of the SPA devices to the spacecraft is made at SPA endpoint connectors. The direction of power or data flow is referred to as “to SPA device” or “to SPA endpoint” when toward the SPA device, and “to host” when in the opposite direction toward the power source or data router.

7.2 Hot Plugging

The SPA endpoint connectors are not intended for “hot-plugging.” SPA-compliant devices are not required to operate when a SPA endpoint connector is mated while voltage is present on the power pins.

7.3 Valid Connector Types

There are five types of SPA connectors which can be used for different configuration needs. These are shown in Table 1 – Connectors, function, and cross-reference.

Table 1 – Connectors, function, and cross-reference

Connector	Function	Section
25-Pin Micro-D	Basic Endpoint (4.5A Power/Data/Sync/Test)	8
15-Pin D Subminiature 30A	Adds 30A current for more power	9
25-Pin D Subminiature 50A	Adds 50A current for more power	10
15-Pin D Subminiature 12A	12A Power/Sync/Test	11
8-Pin Dual Quadrax	High Speed Serial Interface Data	12

7.3.1 25-Pin Micro-D SPA Endpoint SpaceWire and Power Connector

The 25-pin Micro-D SPA Basic Endpoint and Power connector is the simplest connector for SPA devices. It hosts essential data connections, including Test Bypass, and minimal power (up to 4.5A). Section 8 contains details of this connector and its cable requirements.

7.3.2 15-Pin D Subminiature 30A Power Connector

The 15-pin D-Subminiature 30A Power connector brings 30A of additional current for higher power devices. Section 9 contains details of this connector and its cable requirements.

7.3.3 25-Pin D Subminiature 50A Power Connector

The 25-pin D-Subminiature 50A Power connector brings 50A of additional current for higher power devices. Section 10 contains details of this connector and its cable requirements.

7.3.4 15-Pin 12A Power/Sync/Test Connector

The 15-pin D-Subminiature power/sync/test connector is a synchronization, power (up to 12A) and test connector. Section 11 contains details of this connector and its cable requirements.

7.3.5 8-Pin Dual Quadrax High-Speed Serial Interface (HSSI) Connectors

The 8-pin Quadrax data connector provides a high speed serial interface for higher data rate devices. Section 12 contains details of this connector and its cable requirements.

7.4 Valid Connector Combinations

Valid connector combinations are identified as Type A, B, C, and D as shown in Table 2 – Valid connector combinations. AIAA S-133-5-2012 – SPA 28V Power Service contains more information on the 4.5A, 30A, and 50A services.

The Type A SPA Endpoint interface consists of one connector, the 25-pin Micro-D Power/data/sync/test connector. General device connections will use this connector.

The Type B SPA Endpoint interface consists of two connectors, a 25-pin Micro-D Power/data/sync/test connector and a 15-pin D-Subminiature 30A Power Interface Connector.

The Type C SPA Endpoint interface consists of two connectors, a 15-pin 12A Power/sync/test connector and a Dual Quadrax HSSI data connector, to allow connection of high-speed differential primary and redundant signals.

The Type D SPA Endpoint interface consists of two connectors, a 25-pin Micro-D Power/data/sync/test connector and a 25-pin D-Subminiature 50A Power Interface Connector.

Table 2 – Valid connector combinations

Type	Combination	Purpose
A	• 25-pin Micro-D Power/Data/Sync/Test Connector	General Basic device connections requiring up to 4.5A
B	• 25-pin Micro-D Power/Data/Sync/Test Connector • 15-pin D-Subminiature 30A Power Connector	Device connections requiring up to 30A
C	• 15-pin D-Subminiature 12A Power/Sync/Test Connector • 8-pin Dual Quadrax High Speed Serial Interface Data Connector	Device connections using high speed differential and redundant signals and up to 12A
D	• 25-pin Micro-D Power/Data/Sync/Test Connector • 25-pin D-Subminiature 50A Power Connector	Device connections requiring up to 50A

8 SPA Endpoint 2-Pin Micro-D Basic Connector and Cable

8.1 25-Pin Micro-D Power, Data, Sync, and Test Connector

The SPA Endpoint Basic interface consists of the 25-pin Micro-D power, data, sync and test connector.

8.1.1 SPA Endpoint Connector Type

The SPA endpoint Basic interface connector shall be 25-contact Micro-D connector per MIL-DTL-83513.

8.1.2 SPA Endpoint Basic Connector Gender

The spacecraft or system side of the SPA endpoint basic connector shall have the “plug” gender installed. The SPA device shall have a “receptacle” gender installed. The definition of “plug” and “receptacle” genders is as specified in MIL-DTL-83513.

8.1.3 SPA Endpoint Basic Connector Mechanical Mounting Hardware

The SPA endpoint basic connectors shall be secured with #2-56 jackpost and jackscrew hardware.

8.1.4 SPA Endpoint Basic Connector Pin Assignments

Pin assignments for the SPA endpoint Basic connector shall be as specified in Table 3 – SPA endpoint basic connect pin assignments.

Table 3 – SPA endpoint basic connector pin assignments

Pin Number	Signal	Comments	SPA Device Direction
1	SpW Data In +	SpaceWire Data In, Positive	Input
2	SpW Strobe In +	SpaceWire Strobe In, Positive	Input
3	SpW Data Out +	SpaceWire Data Out, Positive	Output
4	SpW Strobe Out +	SpaceWire Strobe Out, Positive	Output
5	PPS +	Pulse Per Second, Positive	Input
6	TB From Host +	Test Bypass Input, Positive	Input
7	TB To Host +	Test Bypass Output, Positive	Output
8	NC (Spare)	No Connect (Spare)	N/A
9	+28V	+28V Power Bus	Input
10	+28V	+28V Power Bus	Input
11	+28V	+28V Power Bus	Input
12	+28V	+28V Power Bus	Input
13	Chassis Gnd	Chassis Ground	N/A
14	SpW Data In -	SpaceWire Data In, Negative	Input
15	SpW Strobe In -	SpaceWire Strobe In, Negative	Input
16	SpW Data Out -	SpaceWire Data Out, Negative	Output
17	SpW Strobe Out -	SpaceWire Strobe Out, Negative	Output
18	PPS -	Pulse Per Second, Negative	Input
19	TB From Host -	Test Bypass Input, Negative	Input
20	TB To Host -	Test Bypass Output, Negative	Output
21	DGND	SPA device digital ground	N/A
22	+28V RTN	+28V Power Bus Return	Output
23	+28V RTN	+28V Power Bus Return	Output
24	+28V RTN	+28V Power Bus Return	Output
25	+28V RTN	+28V Power Bus Return	Output

8.2 SPA Endpoint Basic Interface Wiring and Cable Assemblies

Refer to Figure 2 – SPA endpoint basic cable detail.

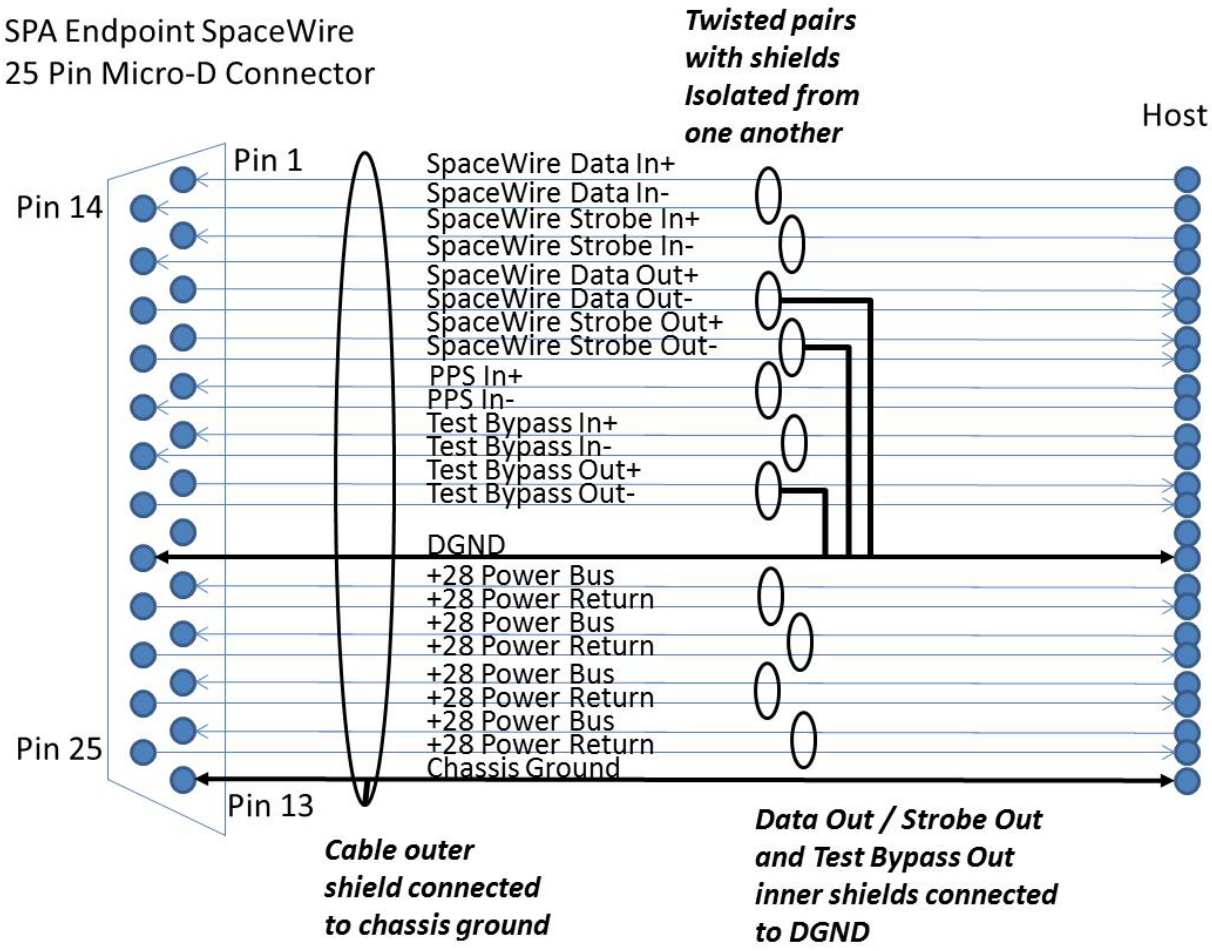

Figure 2 – SPA endpoint basic cable detail

8.2.1 SPA Endpoint Basic Interface Cable Assemblies

SpaceWire signals on the SPA endpoint basic cable shall conform to Standard ECSS-E-ST-50-12C for four twisted, shielded pairs. In addition:

a) SpaceWire wiring may use 26AWG wire in its construction.

b) An outer conductive shield shall enclose the entire SPA cable. The ECSS-E-ST-50-12C specification calls for an outer shield for only the four SpaceWire differential pair; however, an overall SPA cable shield may be used after consideration of the environment and verification testing approach.

8.2.2 SPA Endpoint Basic Interface Cable Overall Shield Termination

The SPA endpoint basic cable shields shall be connected to chassis, device, or host.

8.2.3 SPA Endpoint Basic Interface Power Bus Wiring

a) Power bus and power return wiring shall be twisted pairs.

b) Power bus and power return wiring is intended for a maximum combined current rating of 4.5A.

c) Power bus wiring shall be a minimum wire gauge of 26AWG.

8.2.4 SPA Endpoint Basic Interface Pulse-per-Second Wiring

a) SPA PPS wiring pairs shall be twisted pairs.

b) SPA PPS wiring shall be a minimum wire gauge of 26AWG.

8.2.5 SPA Endpoint Basic Interface Test Bypass Wiring

a) SPA Test Bypass data differential pairs shall be twisted pairs.

b) SPA Test Bypass wiring shall be a minimum wire gauge of 26AWG.

8.2.6 SPA Endpoint Basic Interface Wiring Harness Overall Shielding

It is recommended that SPA wiring harnesses, including SPA device-to-spacecraft cables, have an overall conductive shield. The overall conductive shield shall be connected to chassis, device, or host.

9 SPA Endpoint 15-Pin D-Subminiature 30A Power Interface Connector and Cable

9.1 15-Pin D-Subminiature 30A Power Connector

9.1.1 SPA Endpoint 30A Power Connector Type

The SPA endpoint 30A power connector shall be a 15-contact D-Subminiature connector per MIL-DTL-24308 or GSFC S311. The SPA Endpoint Type B 30A power connector is intended for a maximum current rating of 30A.

9.1.2 SPA Endpoint 30A Power Connector Gender

The spacecraft or system side of the SPA endpoint connector shall have the “socket” gender installed. The SPA device shall have a “pin” gender installed. The definition of “socket” and “pin” genders is as specified in MIL-DTL-24308 or GSFC S311.

9.1.3 SPA Endpoint 30A Power Connector Mechanical Mounting Hardware

The SPA endpoint 30A power connectors shall be secured with #4-40 jackpost and jackscrew hardware.

9.1.4 SPA Endpoint 30A Power Connector Pin Assignments

Pin assignments for the SPA endpoint 30A power connector shall be as specified in Table 4 – SPA Endpoint 30A power interface connector pin assignments.

Table 4 – SPA Endpoint 30A power interface connector pin assignments

Pin Number	Signal	Comments	SPA Device Direction
1	+28V 30A Power	+28V 30A Power Service	Input
2	+28V 30A Power	+28V 30A Power Service	Input
3	+28V 30A Power	+28V 30A Power Service	Input
4	+28V 30A Power	+28V 30A Power Service	Input
5	+28V 30A Power	+28V 30A Power Service	Input
6	+28V 30A Power	+28V 30A Power Service	Input
7	+28V 30A Power	+28V 30A Power Service	Input
8	NC	No Connect	N/A
9	+28V 30A Power RTN	+28V 30A Power Service Return	Output
10	+28V 30A Power RTN	+28V 30A Power Service Return	Output
11	+28V 30A Power RTN	+28V 30A Power Service Return	Output
12	+28V 30A Power RTN	+28V 30A Power Service Return	Output
13	+28V 30A Power RTN	+28V 30A Power Service Return	Output
14	+28V 30A Power RTN	+28V 30A Power Service Return	Output
15	+28V 30A Power RTN	+28V 30A Power Service Return	Output

9.2 SPA Endpoint 30A Power Interface Wiring and Cable Assemblies

Refer to Figure 3 – SPA endpoint 30A power cable detail.

9.2.1 SPA Endpoint 30A Power Cable Overall Shield Termination

The SPA Endpoint 30A Power Interface cable shields shall be connected to chassis.

9.2.2 SPA Endpoint 30A Power Interface Wiring

a) Power bus and power return wiring shall be twisted pairs.

b) Power bus and power return wiring is intended for a maximum combined current rating of 30A.

c) Power bus wiring shall be a minimum wire gauge of 20AWG.

9.2.3 SPA Endpoint 30A Power Interface Wiring Harness Overall Shielding

It is recommended that SPA wiring harnesses, including SPA device-to-spacecraft cables, have an overall conductive shield. The overall conductive shield shall be connected to chassis.

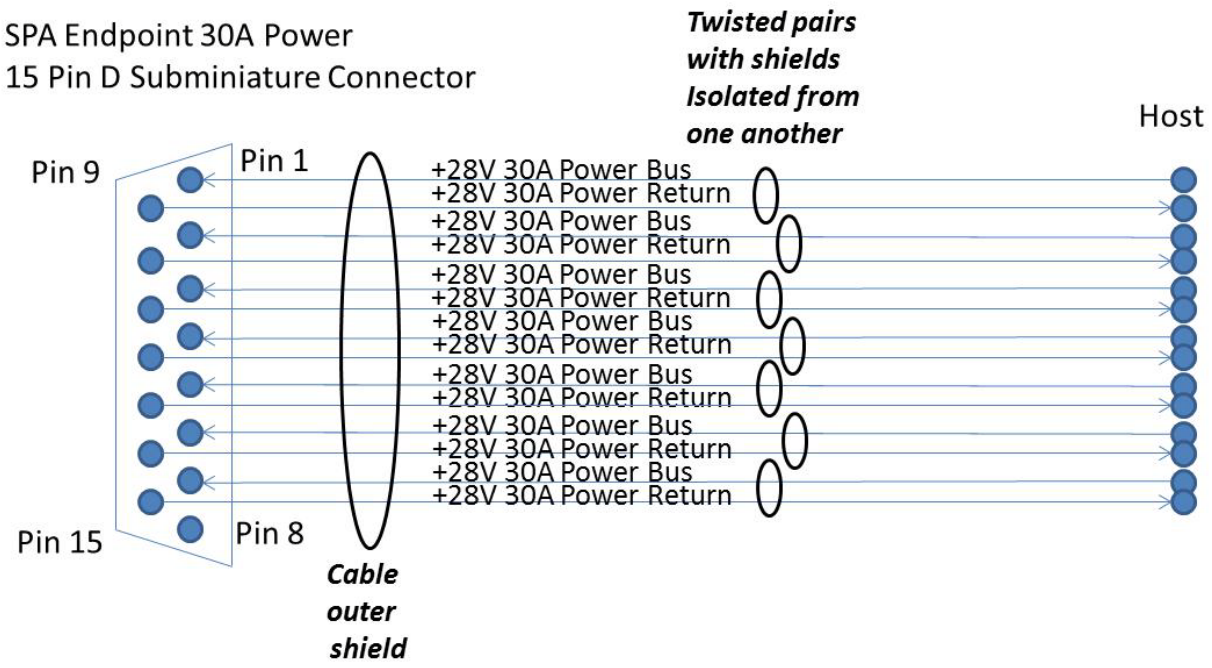

Figure 3 – SPA endpoint 30A power cable detail

10 SPA Endpoint 25-Pin D-Subminiature 50A Power Interface Connector and Cable

10.1 25-Pin D-Subminiature 50A Power Connector

10.1.1 SPA Endpoint 50A Power Interface Connector Type

The SPA endpoint 50A power interface connector shall be a 25-contact D-Subminiature connector per MIL-DTL-24308 or GSFC S311. The SPA Type C 50A power connector is intended for a maximum current rating of 50A.

10.1.2 SPA Endpoint 50A Power Interface Connector Gender

The spacecraft or system side of the SPA endpoint connector shall have the “socket” gender installed. The SPA device shall have a “pin” gender installed. The definition of “socket” and “pin” genders is as specified in MIL-DTL-24308 or GSFC S311.

10.1.3 SPA Endpoint 50A Power Interface Connector Mechanical Mounting Hardware

The SPA endpoint 50A power interface connectors shall be secured with #4-40 jackpost and jackscrew hardware.

10.1.4 SPA Endpoint 50A Power Interface Connector Pin Assignments

Pin assignments for the SPA endpoint 50A power interface connector shall be as specified in Table 5 – SPA endpoint 50A power interface connector pin assignments.

Table 5 – SPA endpoint 50A power interface connector pin assignments

Pin Number	Signal	Comments	SPA Device Direction
1	+28V 50A Power	+28V 50A Power Service	N/A
2	+28V 50A Power	+28V 50A Power Service	N/A
3	+28V 50A Power	+28V 50A Power Service	N/A
4	+28V 50A Power	+28V 50A Power Service	N/A
5	+28V 50A Power	+28V 50A Power Service	N/A
6	+28V 50A Power	+28V 50A Power Service	N/A
7	+28V 50A Power	+28V 50A Power Service	N/A
8	+28V 50A Power	+28V 50A Power Service	N/A
9	+28V 50A Power	+28V 50A Power Service	N/A
10	+28V 50A Power	+28V 50A Power Service	N/A
11	+28V 50A Power	+28V 50A Power Service	N/A
12	+28V 50A Power	+28V 50A Power Service	N/A
13	NC	No Connect	N/A
14	+28V 50A Power RTN	+28V 50A Power Service Return	N/A
15	+28V 50A Power RTN	+28V 50A Power Service Return	N/A
16	+28V 50A Power RTN	+28V 50A Power Service Return	N/A
17	+28V 50A Power RTN	+28V 50A Power Service Return	N/A
18	+28V 50A Power RTN	+28V 50A Power Service Return	N/A
19	+28V 50A Power RTN	+28V 50A Power Service Return	N/A
20	+28V 50A Power RTN	+28V High Power Service Return	N/A
21	+28V 50A Power RTN	+28V High Power Service Return	N/A
22	+28V 50A Power RTN	+28V High Power Service Return	N/A
23	+28V 50A Power RTN	+28V High Power Service Return	N/A
24	+28V 50A Power RTN	+28V High Power Service Return	N/A
25	+28V 50A Power RTN	+28V High Power Service Return	N/A

10.2 SPA Endpoint 50A Power Interface Wiring and Cable Assemblies

Refer to Figure 4 – SPA endpoint 50A power cable detail.

10.2.1 SPA 50A Power Interface Bus Wiring

a) Power bus and power return wiring shall be twisted pairs.

b) Power bus and power return wiring is intended for a maximum combined current rating of 50A.

c) Power bus wiring shall be a minimum wire gauge of 20AWG.

10.2.2 SPA Wiring Harness Overall Shielding

It is recommended that SPA wiring harnesses, including SPA device-to-spacecraft cables, have an overall conductive shield. The overall conductive shield shall be connected to chassis.

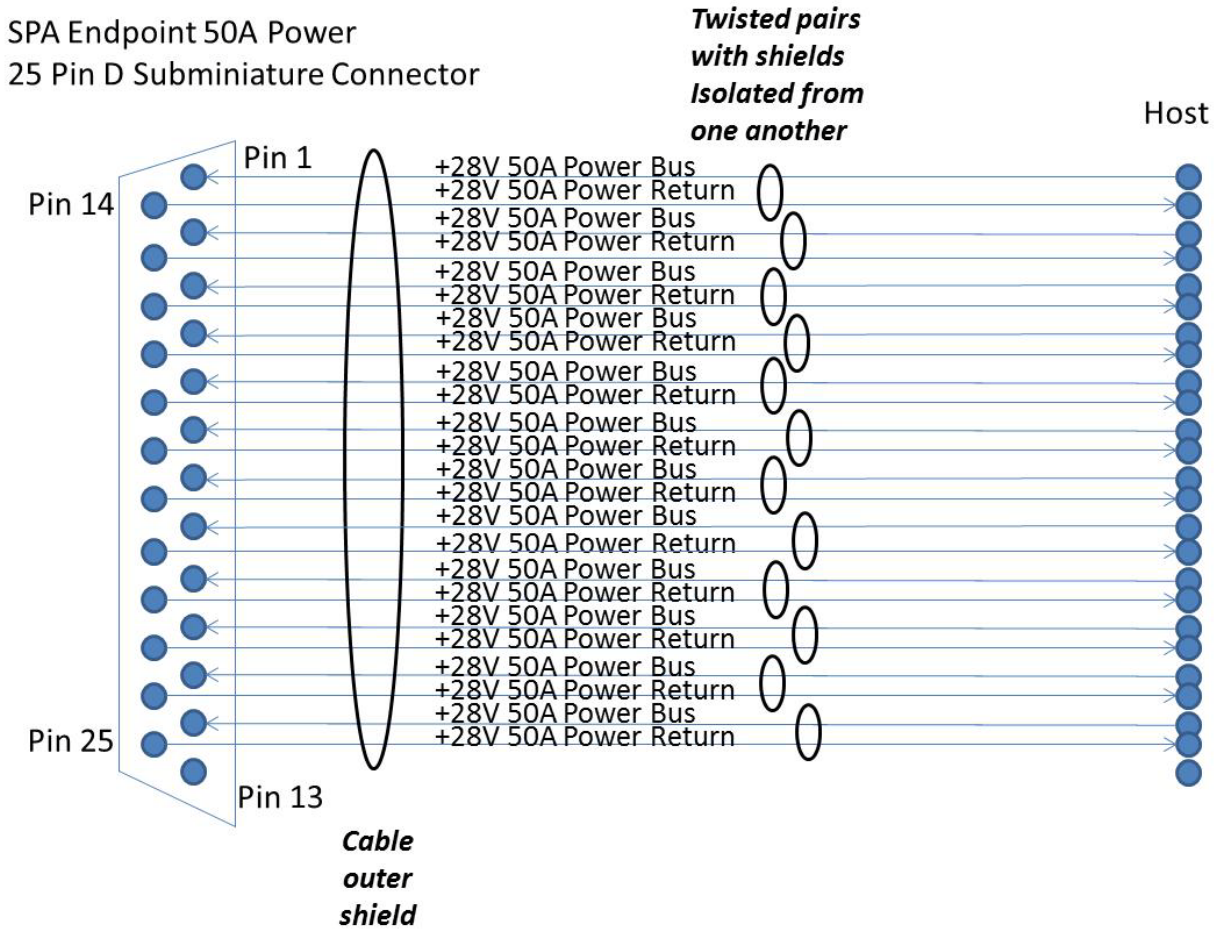

Figure 4 – SPA endpoint 50A power cable detail

11 SPA Endpoint 15-Pin D-Subminiature 12A Power, Synchronization, and Test Interface Connector and Cable

11.1 15-Pin D-Subminiature Power, Synchronization, and Test Connector

11.1.1 SPA Endpoint 12A Power, Sync and Test Connector Type

The SPA endpoint 12A power, synchronization and test connector shall be a 15-pin D-Subminiature connector.

11.1.2 SPA Endpoint 12A Power, Sync, and Test Connector Gender

The spacecraft or system side of the SPA endpoint 12A Power, Sync and Test connector shall have the "plug" gender installed. The SPA device shall have a "receptacle" gender installed. The definition of "plug" and "receptacle" genders is as specified in MIL-DTL-24308.

11.1.3 SPA Endpoint 12A Power, Sync, and Test Connector Mechanical Mounting Hardware

The SPA endpoint 12A power, synchronization and test connectors shall be secured with #2-56 jackpost and jackscrew hardware.

11.1.4 SPA Endpoint 12A Power, Sync, and Test Connector Pin Assignments

Pin assignments for the SPA endpoint 12A power, sync and test connector shall be as specified in Table 6 – SPA endpoint 12A power/sync/test connector pin assignments.

Table 6 – SPA endpoint 12A power/sync/test connector pin assignments

Pin Number	Signal	Comments	SPA Device Direction
1	TB From Host +	Test Bypass Input, Positive	Input
2	TB From Host -	Test Bypass Input, Negative	Input
3	PPS +	Pulse Per Second, Positive	Input
4	+28V RTN	+28V Power Bus Return	Output
5	+28V	+28V Power Bus	Input
6	TB To Host +	Test Bypass Output, Positive	Output
7	TB To Host -	Test Bypass Output, Negative	Output
8	PPS -	Pulse Per Second, Negative	Input
9	+28V RTN	+28V Power Bus Return	Output
10	+28V	+28V Power Bus	Input
11	NC	No Connect	N/A
12	Chassis Gnd	Chassis Ground	N/A
13	DGND	SPA device digital ground	N/A

14	+28V RTN	+28V Power Bus Return	Output
15	+28V	+28V Power Bus	Input

11.2 SPA Endpoint 12A Power, Sync, and Test Wiring and Cable Assemblies

Refer to Figure 5 – SPA endpoint power/sync/test cable detail.

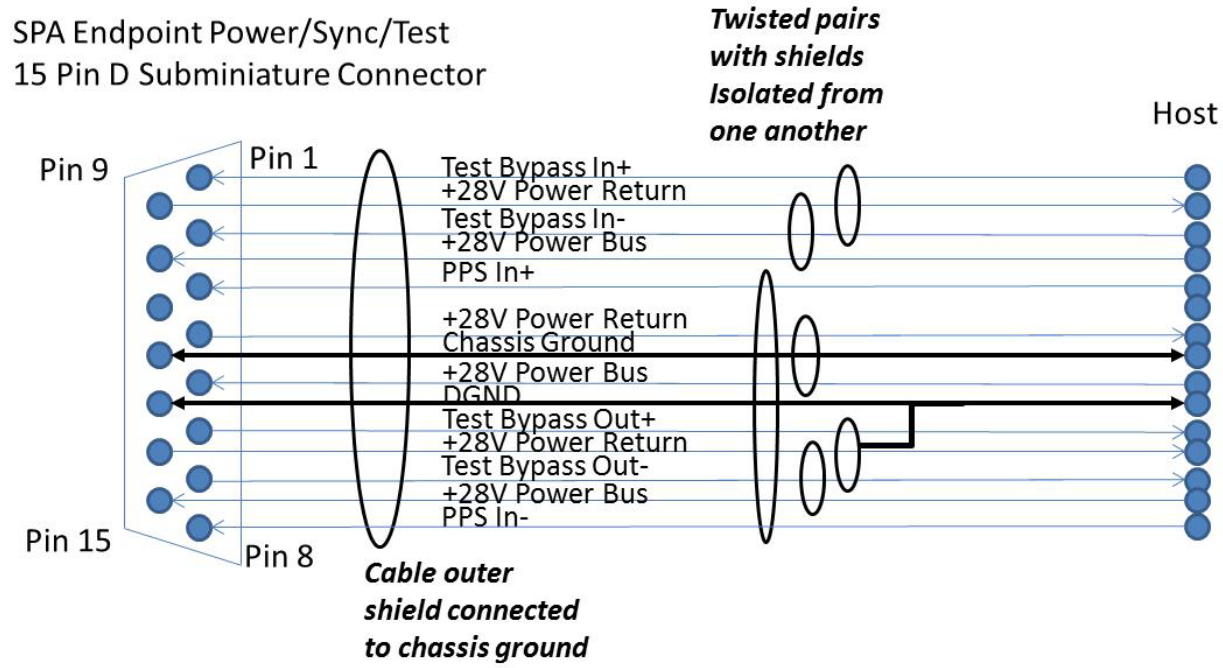

Figure 5 – SPA endpoint power/sync/test cable detail

11.2.1 SPA Endpoint 12A Power, Sync, and Test Cable Overall Shield Termination

The SpaceWire cable shields shall be connected to chassis.

11.2.2 SPA Endpoint 12A Power, Sync, and Test Power Bus Wiring

a) Power bus and power return wiring shall be twisted pairs.

b) Power bus and power return wiring is intended for a maximum combined current rating of 12A.

c) Power bus wiring shall be a minimum wire gauge of 20AWG.

11.2.3 SPA Endpoint 12A Power, Sync, and Test Bypass Wiring

a) SPA Test Bypass data differential pairs shall be twisted pairs.

b) SPA Test Bypass wiring shall be a minimum wire gauge of 26AWG.

11.2.4 SPA Endpoint 12A Power, Sync, and Test Pulse-per-Second Wiring

a) SPA PPS wiring pairs shall be twisted pairs.

b) SPA PPS wiring shall be a minimum wire gauge of 26AWG.

11.2.5 SPA Endpoint 12A Power, Sync, and Test Wiring Harness Overall Shielding

It is recommended that SPA wiring harnesses, including SPA device-to-spacecraft cables, have an overall conductive shield. The overall conductive shield shall be connected to chassis.

12 SPA Endpoint Dual Quadrax HSSI Connector and Cable

12.1 8-Pin Dual Quadrax HSSI Connectors

12.1.1 SPA Endpoint Dual Quadrax HSSI Connector Type

The SPA endpoint dual HSSI connector shall be a pair of quadrax cables, connected to the system with a dual-quadrax cable socket as shown in Figure 6 – Pin locations for dual quadrax as mounted.

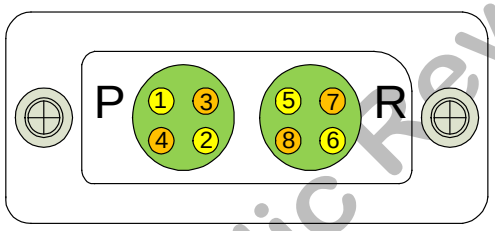

Figure 6 – Pin locations for dual quadrax as mounted

12.1.2 SPA Endpoint Dual Quadrax HSSI Connector Gender

The spacecraft or system side of the SPA endpoint connector shall have the “socket” gender installed. The SPA device shall have a “pin” gender installed. The definition of “socket” and “pin” genders is as specified in MIL-DTL-24308.

12.1.3 SPA Endpoint Dual Quadrax HSSI Connector Mechanical Mounting Hardware

The SPA endpoint dual quadrax HSSI connectors shall be secured with #4-40 jackpost and jackscrew hardware.

12.1.4 SPA Endpoint Dual Quadrax Connector Pin Assignments

Pin assignments for the SPA endpoint dual quadrax HSSI connector shall be as specified in Table 7 – SPA endpoint dual quadrax HSSI connector.

Table 7 – SPA endpoint dual quadrax HSSI connector

Pin Number	Signal	Comments	SPA Device Direction
1	Primary Signal, Tx +	Differential Data from Endpoint to Host, Positive	Output
2	Primary Signal, Rx +	Differential Data from Host to Endpoint, Positive	Input
3	Primary Signal, Tx -	Differential Data from Endpoint to Host, Negative	Output
4	Primary Signal, Rx -	Differential Data from Host to Endpoint, Negative	Input
5	Redundant Signal, Tx +	Differential Data from Endpoint to Host, Positive	Output
6	Redundant Signal, Rx +	Differential Data from Host to Endpoint, Positive	Input
7	Redundant Signal, Tx -	Differential Data from Endpoint to Host, Negative	Output
8	Redundant Signal, Rx -	Differential Data from Host to Endpoint, Negative	Input

12.2 SPA Endpoint Dual Quadrax HSSI Wiring and Cable Assemblies

Refer to Figure 7 – SPA endpoint HSSI cable detail.

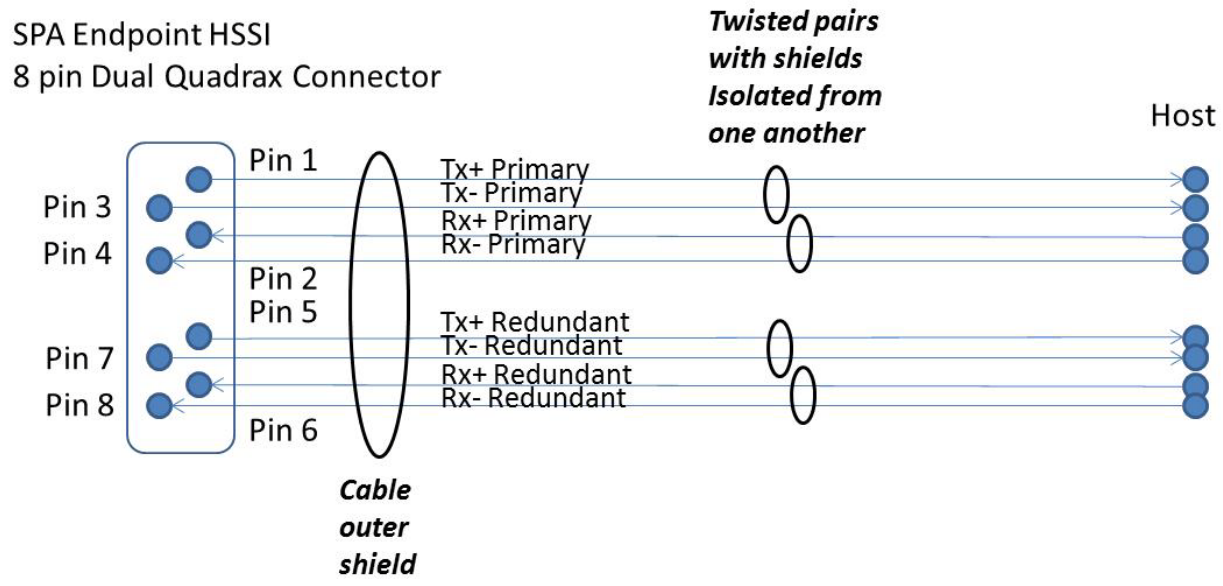

Figure 7 – SPA endpoint HSSI cable detail

Annex A Sample HSSI Part Numbers (Informative)

Table A.1 lists the part numbers used for a sample implementation of the SPA endpoint interface dual quadrax HSSI as described in Section 12. It is provided for the reader's reference.

Table A.1 – Part list for sample SPA data dual quadrax HSSI connector

Item	Description	Part Number
1	Sabritec Rugged D-Sub Connector (Pin)	RDC-1-N-1-2-P-RA (Pin, Right-Angle)
4	Size 9 Quadrax Pin Contact, 100 ohm (2 needed for primary and redundant)	019235-8000
2	Sabritec Rugged D-Sub Connector (Socket)	RDC-1-N-1-2-S-RA (Socket, Right-Angle)
5	Size 9 Quadrax Socket Contact, 100 ohm (2 needed for primary and redundant)	019135-8000
3	Sabritec Quad D-Sub Receptacle Cable Mount 2 Contact Cable Mount	012800-3002
6	100 Ohm Ethernet AWG 24 Quad Cable (Sabritec)	540-1183-000

American Institute of
Aeronautics and Astronautics

1801 Alexander Bell Drive, Suite 500
Reston, VA 20191-4344

ISBN XXX-X-XXXXX