NAVIGATING THE SOSA TECHNICAL STANDARD 1.0 FOR INTERCONNECT SELECTION

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The Sensor Open Systems Architecture (SOSA™) Consortium has released the Technical Standard for SOSA™ Reference Architecture Edition 1.0, which will have a significant role in standardizing embedded systems of the future. This white paper outlines the interconnect defined within the SOSA Technical Standard and explains how a system designer can use the standard (and related standards) to select appropriate connector and cabling options.

The SOSA Technical Standard defines the interconnect within the chassis and the external I/O. Within a chassis, standardization of backplane slots and plug-in card interfaces is important to assure functionality across multiple suppliers, facilitate upgrades, and reduce complexity. Outside the box, it is critical for sensor and mission systems and subsystems to communicate – this requires standard physical connectors with defined pin assignments.

SOSA aimed to leverage technology that was already in use – as a result, the majority of connector solutions are defined in other industry standards and already being utilized in industry. On the other hand, select requirements for next generation sensor systems drove efforts for new interconnect designs and VITA standards, where an existing solution did not exist. Let's break down the interconnect for SOSA aligned systems, and how the designer can select the appropriate connectors. We'll do this by looking at hardware design (within the VPX systems) and then address the external cabling.

Connections Inside the Chassis

SOSA adopted OpenVPX system architecture for hardware – within a chassis, a backplane has multiple slots to support plug-in cards (PICs) with specific functions to support the system application. SOSA selected a specific subset of slot profiles that are defined in VITA 65 for the SOSA Technical Standard – this supports the large majority of use cases and minimizes proliferation.

A SOSA system designer would select the appropriate slot profile based on the PIC requirements. The slot requirements would vary whether the PIC was a switch, a payload, a radial clock, etc. Once a slot profile is determined, the connectors to populate within the slot can be identified..The applicable VITA standards for connectors at the PIC/backplane interface are VITA 46 (for utility and high speed copper signals), VITA 67 (RF connector modules), VITA 66 (Optical and hybrid RF/optical connector modules). For VPX power supplies, the connectors are defined by the VITA 62 standards. There are various dot specifications within each of these standards which will be discussed later.

Slot Profiles

OpenVPX slot profiles are defined in ANSI/VITA 65.0. Let's look at an example – Slot Profile SLT3 - PA Y - 1F1U1S1S1U1U2F1H - 14.6.11-n is a 3U payload slot. VPX (VITA 46) Connectors are populated in the slot positions P0/J0 and P1/J1 and VITA 46.0 and 65.0 define the pin assignments within those connectors to assure interoperability between different PIC suppliers. The P2/J2 position within the slot is an aperture to support optical or coaxial interconnects. For the aperture in P2/J2, on the backplane there is an opening for a connector module to be mounted, with cabling passing through the backplane.

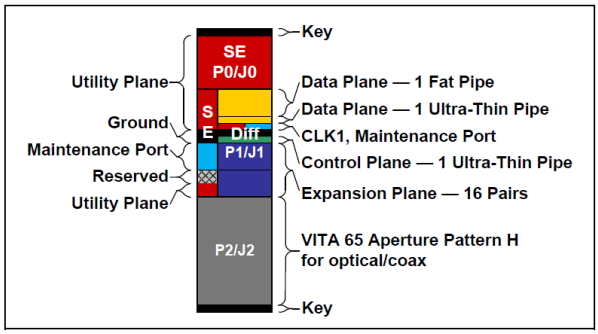


Figure 14.6.11-1 SLT3-PAY-1F1U1S1S1U1U2F1H-14.6.11-n

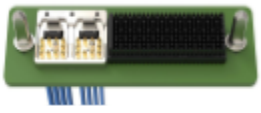
The specific dash number on the slot profile (-n) will determine what is populated in P2/J2 position. The tables within the SOSA Technical Standard list the options that are supported for SOSA aligned systems.

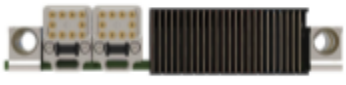
Slot Profile SLT3-PAY-1F1U1S1S1U1U2F1H-14.6.11-n - Dash Number Options

Dash Number	VITA 65.1 Connector Module	Aperture H Fill	Backplane Connector Module Image	MT Loading and Optical Profile (per VITA 65.0)
0		Empty	-	-
1*	6.4.5.6.1	Hybrid_66.4+67.1-6.4.5.6.1		-
2*	6.4.5.6.3	10_SMPM_contacts-6.4.5.6.3		-
4	6.4.5.6.4	14_SMPM_contacts-6.4.5.6.4		-
5	6.4.5.6.7	19_SMPS_contacts-6.4.5.6.7		-
6	6.4.5.6.8	2_Style_C_inserts_and_10_NanoRF_contacts-6.4.5.6.8		MT-MM12-1F-6.5.2.2
10	6.4.5.6.9	1_Style_C_insert_and_14_NanoRF_contacts-6.4.5.6.9		MT-MM12-1F-6.5.2.2
12	6.4.5.6.10	2_Style_C_inserts_and_20 NanoRF_contacts-6.4.5.6.10		MT-MM12-1F-6.5.2.2
14	6.4.5.6.11	2_Style_D_inserts-6.4.5.6.11		MTA-MM12-3F-6.5.2.2 MTB-MM24-6.5.3.5 MTC-MM24-6.5.3.5

* These Slot Profile dash options are legacy.

In this slot profile example, there are options for coaxial contacts only, optical interfaces only, or hybrids which are connector blocks retaining both coax and optical interconnect. Depending on the function of the PIC and the signal requirements, the designer would select the appropriate slot profile. If the selected slot profile were SLT3-PAY-1F1U1S1S1U1U2F1H-14.6.11-12, for example the PIC and backplane would look like below.

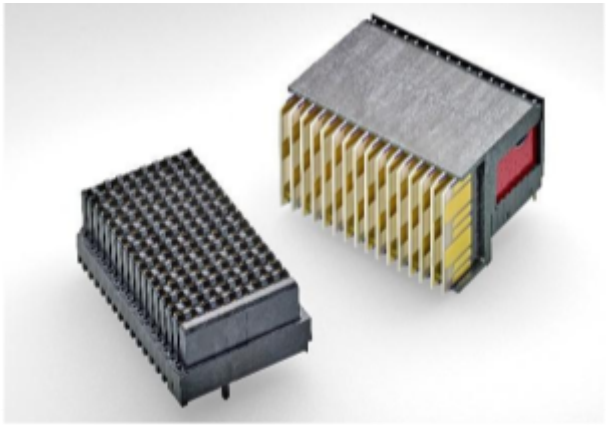




VPX Connectors (VITA 46)

All SOSA slot profiles use VITA 46 VPX connectors. The VITA 46.0 standard is based on TE Connectivity's (TE's) MULTIGIG RT connector family. Original variants MULTIGIG RT 2 and ruggedized MULTIGIG RT 2-R connectors meet VITA 46.0 and support data rates to 10 Gb/s. MULTIGIG RT 2-R connectors feature a quad redundant contact interface and are designed for environments with extreme vibration per testing established in the VITA 72 study group - 3dB above the VITA 47.3 requirements and adding 12 hours vibration in the z axis.

The MULTIGIG RT 3 connector was developed and introduced in 2019 to support data rates to 25-32 Gb/s (for 100GBase-KR4 Ethernet and PCIe Gen 5), and with the same robust contact interface as MULTIGIG RT 2-R connector to support the harshest environments. The higher data rate connectors are defined by VITA 46.30 and 46.31.

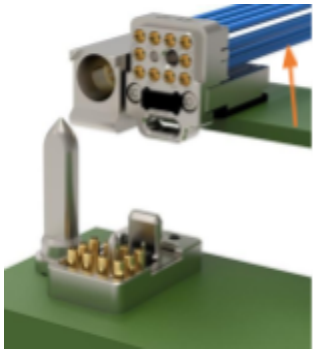


RF Connector Modules (VITA 67.3)

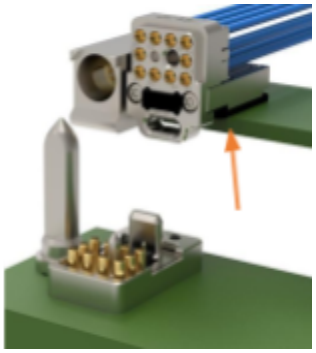
SOSA utilizes slot profiles following VITA 67.3 for RF connections between the PIC and backplane. Three RF contact interfaces are available. SMPM was the original VITA 67 interface and in 2020, higher density interfaces SMPS and NanoRF were added which support frequencies to 70 GHz. These solutions all feature spring loaded contacts with alignment on the backplane, which allows direct fixed termination of contacts to the plug-in card and mezzanine cards.

Optical Connector Modules (VITA 66.5)

Optical connector modules for slot profiles in the SOSA standard follow the VITA 66.5 standard, including hybrid connectors that include both RF and optics in the same connector module. Style C, Style D and Style C-Hybrid are supported in SOSA slot profiles. Style D offers the highest optical density with three MT interfaces in a half size module, while Style C-Hybrid integrates coax and optical contacts in the same connector module to optimize density. The example in the previous diagram is a C-Hybrid with 20 NanoRF coaxial contacts and 2 MT's. All of the VITA 66.5 connector modules in the SOSA standard can have the lower MT cabled and routed to a mid-board transceiver on the PIC or can attach to an edge mounted transceiver to save PIC space and eliminate cabling. Both implementations have the same mating interface to the backplane.



Cabled Optical Termination



Edge Mount Transceiver

XMC Connectors

The SOSA standard does not define a specific XMC connector for use in the XMC mezzanine card interface on the PICs. There are three connector variants - VITA 42, VITA 61 and VITA 88. VITA 61 was developed around TE's Mezalok connector family. The Mezalok connector product was developed specifically for harsh environments and has been tested by TE to 2000 thermal cycles -55 to 125C and extreme levels of vibration as defined in the VITA 72 Study Group (consistent with MULTIGIG RT 2-R connector).

Power Supply Connectors (VITA 62)

SOSA systems will use VPX power supplies following the VITA 62 standards. VITA 62.0 is the base standard and recent additions 62.1 and 62.2 support higher input voltage (270V DC) and three-phase power respectively. The connectors in these standards are based on TE's MULTIBEAM XLE connectors and are specified for use in the power supplies and corresponding backplane slots.

Summary of Connections inside the Chassis

The system designer has options for building a SOSA aligned system. Selected slot profiles will define the interconnect required at the plug-in card / backplane interface and will incorporate copper connections for high and low speed signaling and power, with options for RF and/or optics.

TE offers a slot profile interconnect guide that will break down the TE connector part numbers for each position within a slot – for both the PIC and the backplane. The link to this document is included in the Resources at the end of the paper.

External connections

The SOSA Technical Standard defines the physical connectors and specific pinouts for the sensor system connection at the panel and the mating umbilical assembly connector. For each function (DC power, low loss RF, optics, …), there is a specific interconnect defined. These connectors differ depending on the sensor class based on size. SOSA aligned systems utilize class 1, 2, 3 and 5.

SENSOR CLASSES

Class	Sensor Package Diameter
Class 1	>19 in.
Class 2	13 to <19 in.
Class 3	9 to <13 in.
Class 4	6 to <9 in.
Class 5	<6 in.

We'll review the interconnects for the different class groups defined below.

SENSOR CLASSES 1, 2 AND 3

The connector standards for each class/function are shown in the figure below.

Connector Designation		Connector Standard	Contacts	Class 1 and 2			Class 3		
				Shell Size	Keying	Insert	Shell Size	Keying	Insert
J1	DC Power	MIL-DTL-38999/ Series III	MIL-C-39029	21	N	21-11	19	N	19-11
J2	Signal	MIL-DTL-38999/ Series III	MIL-C-39029	25	N	25-7	19	N	19-35
J3	Video (Copper)	MIL-DTL-38999/ Series III	MIL-C-39029	21	N	21-11	17	N	17-6
J4	Fiber Optic	MIL-DTL-38999/ Series III	MIL-PRF-29504	19	N	19-11	13	N	13-4
J5	GPS antenna	MIL-PRF-39012	N/A	TNC	-	-	TNC	-	-
J6	Aux DC Power	MIL-DTL-38999/ Series III	MIL-C-39029	21	A	21-11	19	A	19-11
J7	High Speed Copper	VITA 76	N/A	17	N	-	17	N	-
J8	High Density RF	MIL-DTL-38999/ Series III	Size 12 SMPM per SOSA standard	25	N	25-19	21	N	21-11
J9	Low Loss RF	MIL-DTL-38999/ Series III	Size 8 BMB per SOSA standard	25	N	25-8	21	N	21-75
J10	AC Power	MIL-DTL-38999/ Series III	MIL-C-39029	17	N	17-6	N/A		
J11	High Voltage DC	MIL-DTL-38999/ Series III	MIL-C-39029	15	N	15-5	11	N	11-5
J12	Key Fill (non GPS)	MIL-DTL-55116 U-283	N/A	N/A	N/A	N/A	N/A		
J13	Key Fill (GPS)	MIL-DTL-55116 U-283	N/A	N/A	N/A	N/A	N/A		
J14	High Density Fiber	VITA 87	MT per IEC 61754-5	15	N	VITA 87	13	N	VITA 87
J15	High Density Fiber	VITA 87	MT per IEC 61754-5	11	N	VITA 87	11	N	VITA 87
J16	External Battery	MIL-DTL-38999/ Series III	MIL-C-39029	9	N	9-35	9	N	9-35

Let's look deeper at the standards defining the SOSA interconnect outside the box.

MIL-DTL-38999

For many functions, MIL-DTL-38999 connectors were selected by the SOSA Consortium because of their broad supply base, wide range of insert options, and extensive use in embedded systems today. The SOSA Technical Standard specifies a certain shell size, keying, insert and contact type for each electrical function at the panel to promote interoperability between system components and manufacturers. Electrical contacts are defined by MIL-C-39029 for the MIL-DTL-38999 connectors, with exception of optical and coaxial interfaces.

Optical connections (J4, J14, J15)

For the fiber optic J4 connector, a MIL-DTL-38999 connector is used with individual optical termini per MIL-PRF-29504. The requirement for higher optical density at the panel drove the effort

to standardize multi-fiber MTs in a M38999 circular connector under VITA 87. This interconnect is specified for high density fiber connectors J14 and J15. J14 is a size 15 connector with 4 MT's for Class 1 and 2 sensors, and size 13 connector with 2 MT's for Class 3 sensors. J15 is a size 11 connector with a single MT for Classes 1, 2 and 3 sensors. Each MT can support up to 24 optical fibers, bringing unprecedented optical bandwidth density outside the box.

Coaxial connections (J8 and J9)

High Density (J8) and Low Loss (J9) RF connectors are defined in the SOSA Technical Standard. These connectors use standard MIL-DTL-38999 shells and inserts. For high density RF, size 12 contacts based on the SMPM interface are specified. For low loss RF, size 8 contacts based on the BMB interface. These coaxial contact interfaces are defined in MIL-STD-348 with additional requirements defined in the SOSA Technical Standard.

GPS Antenna connection (J5)

TNC RF connectors as defined in MIL-PRF-39012 and MIL-STD-348B are used for the GPS antenna interface. These are rugged threaded coaxial connectors rated to 11 GHz and higher.

High Speed Copper (J7)

For high speed copper supporting protocols such as 10G Ethernet, USB 3.0 and DisplayPort 1.3, the VITA 76 connector was selected. The SOSA Technical Standard specifies a size 17 shell and features 18 differential pairs.

Auxiliary RF Connectors

If high frequency discrete RF signals are required from the antenna, Auxiliary RF connectors are used. The SOSA Technical Standard provides options for coaxial interfaces of different sizes and frequency capabilities, depending on the application – TNC, SMA, 2.4mm, and 1.0mm.

SENSOR CLASS 5

Class 5 is designated for smaller form factor systems, for applications such as tube launch systems and nano-satellites. The connector interface selected for these systems in the SOSA standard is 25 position Micro-D connectors per MIL-DTL-83513.

Summary

A key initiative for the SOSA Consortium was to standardize architecture around the large majority of use cases for sensor systems, to drive interoperability and economies of scale. Interconnect was and still is a key part of this effort. From a plethora of connector solutions used in industry, the SOSA Technical Standard adopted a limited set of solutions for the functions required by today's sensor systems, and provides a path for future growth. The physical interconnect and the pin assignments are defined in the standard to assure interoperability of plug-in cards to the backplane and cabling outside the box.

TE Connectivity has been an active participant in the SOSA Consortium and offers a broad portfolio of connectors and cables aligned with the SOSA Standard. To help select the interconnects for your design, use the references below.

Resources

SOSA Aligned Interconnect Solutions brochure
SOSA Slot Profile Interconnect Guide
www.te.com/sosa

te.com