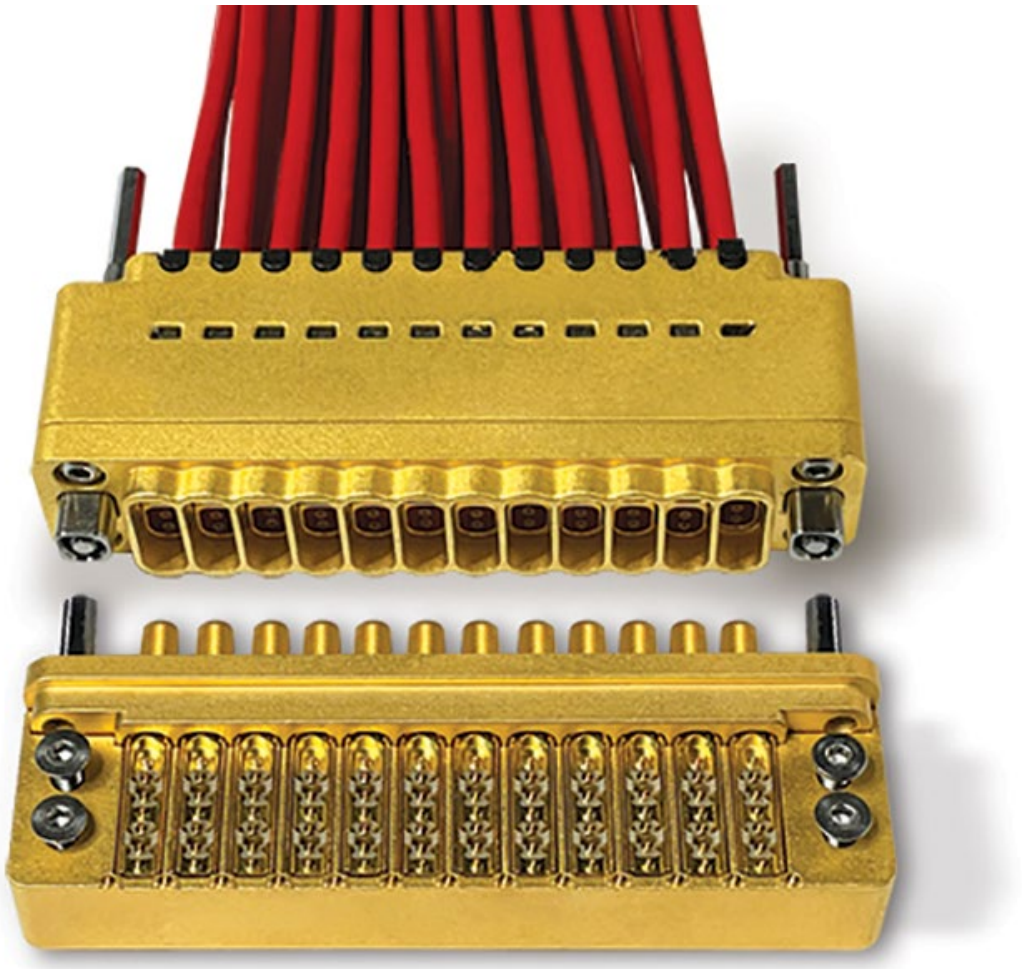
smiths interconnect

White Paper

NXS Series Interconnect System

Technical Attributes



Abstract

Space architectures are continuing to follow the trend of either daughter card to backplane or point to point system designs. The highest degree of flexibility is typically achieved using a point to-point approach as seen in frame slice and SpaceWire or SpaceFibre architectures. SpaceFibre is a multi-Gbits/s, onboard network technology for spaceflight applications, which runs over electrical or fibre-optic cables. There is an ever-increasing demand for rugged, high speed (up to 50 Gbps) connections, with the combination of controlled impedance differential pair signals together with the ability to add customizable modules, all with solderless board mounting. This technology will revolutionize the way in which space craft are designed and built by providing an unparalleled level of signal density and flexibility. The satellite market is moving away from RF Analog based payloads providing low speed telecommunication signaling, to a new Digital Transparent Processor architecture for high throughput satellites. Smiths Interconnect has developed, tested, and qualified such a connector. This connector labeled NXS, is an advanced high speed interconnect solution to offer next generation data on demand, meeting both point to point and backplane connector requirements. The system has proven to be able to withstand space application requirements, including extreme levels of vibration, shock and climatic testing and offers a reliable way to implement high density interconnections with high-speed signal transmission requirements. The presentation will show what the next generation system looks like for daughter card to backplane and point to point system designs. It will explain how high data rate and high speed can be incorporated into one modular ultra-flexible system. The presentation will provide an answer to how extremely high EMI attenuation can be achieved in a modular interconnect system, while meeting rigorous shock and vibration performance levels.

1. Introduction

The NXS Series is a space qualified high performance Interconnect System offering high data transmission capability in a solderless high density light weight modular configuration, primarily intended for satellite and space applications, and supporting ESCC, ECSS and other demands. Using controlled impedance differential pair signals, each quad module comprising two differential pairs achieves digital data transmission rates up to 50 Gbps.

2. Physical Configuration

NXS in both 4 and 12 bay format supports cable to PCB or flexi-rigid interconnect, enabling various configurations suitable for Spacewire and other architecture including daughtercard to backplane or module to module arrangements. The receptacle can form part of a daughtercard assembly or can be mounted to the equipment panel or chassis in an input/output or point to point application. Savers are used to facilitate test and integration activities without causing wear or damage to connectors. These are removed at the final stage of system build.

Fig 1 – Typical 4 bay receptacle and cabled plug

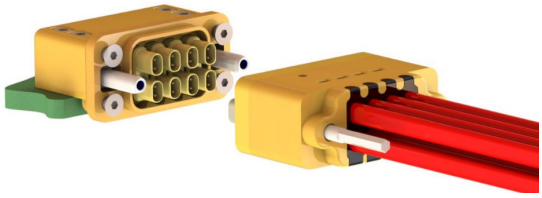
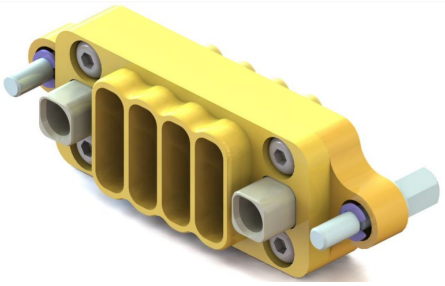


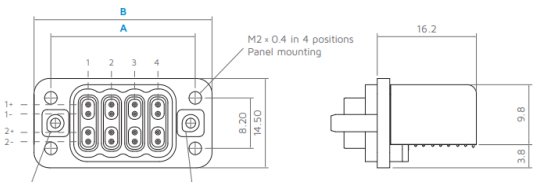
Fig 2 – 4 bay plug Saver



3. Connector Dimensions

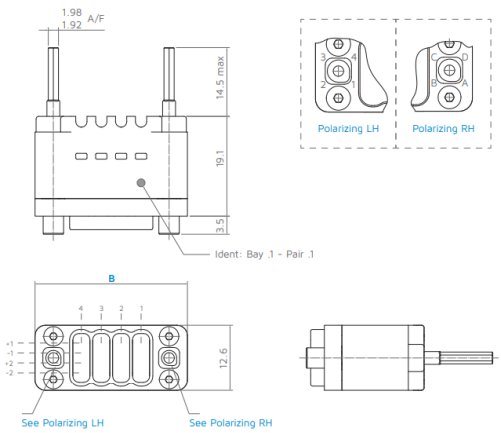
NXS has been designed to have compact dimensions for optimal signal density, whilst also being compatible with typical shielded twinax cable, PCB layout design and isolation between modules. Figs 3 and 4 show the outline dimensions for the 4 and 12 bay connectors.

Fig 3 – NXS Receptacle Dimensions



Number of ways	A	B
4	23.6	29.1
12	54.0	59.5

Fig 4 – NXS Plug Dimensions



4. Performance Summary

NXS is designed to offer balanced performance characteristics meeting the demands of data transmission in the space industry. Fig 5 shows the main performance parameters.

Fig 5 – NXS Performance Summary

Parameter	Level
Working Voltage	50 V RMS
Current	1 A
Date Transmission Rate	Up to 50 Gbps per channel
Impedance	100 Ω +/- 10%
Contact resistance	150 mΩ max
Insulation Resistance	1 GΩ min
Operating Temperature	-40°C to +125°C
Durability (saver fitted)	500 cycles

5. Mass

Low mass is a key driver in the design of NXS. Carbon reinforced PEEK composite polymer with gold over nickel plating is used for the main housings of the connector and titanium is used for hardware components, keeping the mass to a minimum whilst achieving other requirements including mechanical strength and outgassing.
A simple weight comparison between NXS and another interconnect system is shown below.

Description	Total Mass	Total Mass Savings
4 Way Space Fibre Type A, 1 metre cable	407.2 g	
NXS Composite 4 way Dual Twinax, 1 metre cable	117.5 g	290 g/mated pair

6. Modularity

The 4 and 12 bay NXS connectors enable flexible and configurable system arrangements to be accommodated, with the added potential for mixing different contact or cable types in one connector housing. Connector bays can use one or two twinax differential pairs cabled as required, and other insert types such as low level power are planned for development.

7. Hyperboloid Contact Technology

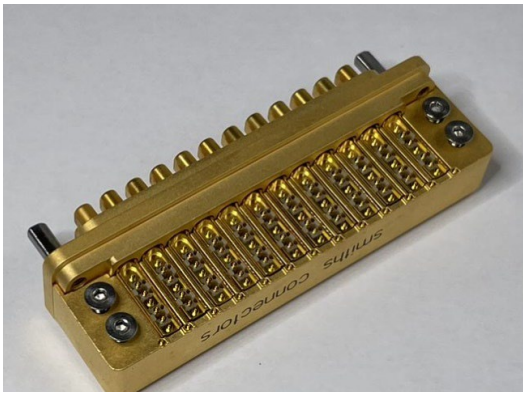
NXS uses the proven and well known Hyperboloid contact at the interface, ensuring the highest level of performance and reliability for critical applications. Multiple linear contact paths give low contact resistance which remains stable over the lifetime of the equipment, critical for space applications. Along with long term reliability, the Hyperboloid contact has low insertion and extraction forces, giving high durability and long life, as well as an immunity to shock and vibration and the most demanding environments.
The NXS interface contact, named 'Micro-boloid' has a male pin of nominal diameter 0.4mm.

Fig 6 – Hyperboloid Contact

8. Solderless Termination

The NXS receptacle uses spring probe technology mating with gold plated target pads for the PCB interface, for differential pair contacts and ground contacts. This approach gives a number of benefits for system design, build integration, performance, test and repair.
Conventionally soldered PCB connectors can present significant challenges. The connector must either experience the PCB soldering reflow process or be soldered after the main PCB assembly as a separate operation. Both of these situations make consistent achievement of the necessary quality requirements difficult and potentially costly.
Additionally, through-hole soldered connectors occupy a large area on both sides of the board, making this space unavailable for other componentry or circuit tracking, and soldered connectors are difficult or impractical to replace or rework. The use of spring probe contact technology removes all of these obstacles and enables a higher performing and simplified PCB design with the potential for solid ground planes to be used and no requirement for plated through holes.

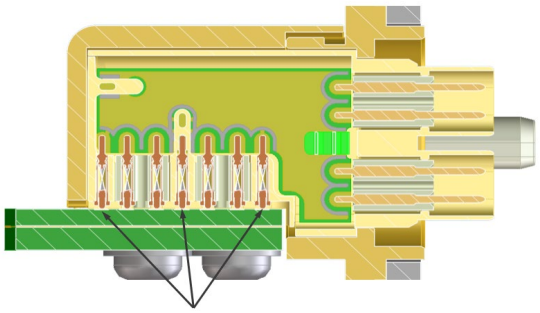
Fig 7 – Spring Probe Terminations



9. EMI Performance

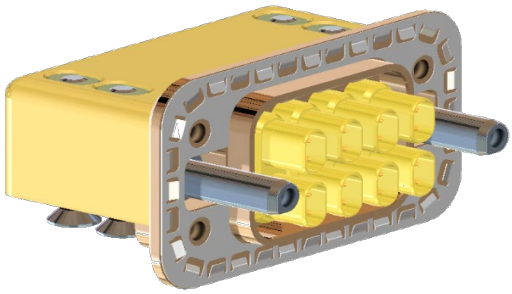
Each quadrax module comprising two differential pairs is fully shielded from end to end using gold plated metallic housings giving a high level of EMI immunity and channel isolation. The shielding and ground path extends from the twinax cable shield, through the plug and receptacle, to the multiple solderless spring probe ground contacts at the receptacle to PCB interface.

Fig 8 – NXS Receptacle cross-section



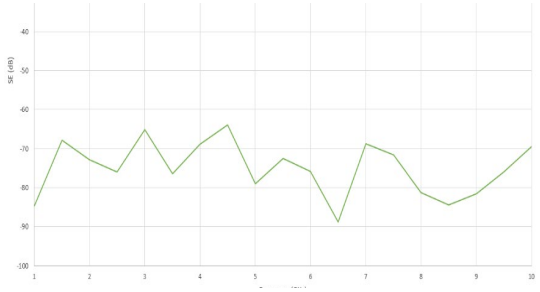
Where the NXS interface penetrates the housing of shielded equipment, a specifically designed EMI gasket combined with a metallic connector housing provides robust and reliable 360 degree shielding around the aperture.

Fig 9 – Receptacle with EMI Gasket



The EMI shielding effectiveness level achieved by this arrangement exceeds 65dB attenuation at 10 GHz.

Fig 10 – Shielding Effectiveness



10. Data Transmission Performance

The following shows some typical key data transmission test results, for one 100Ω differential pair. (Each quadrax module contains two differential pairs).

Fig 11 – TDR Plot, Connector only

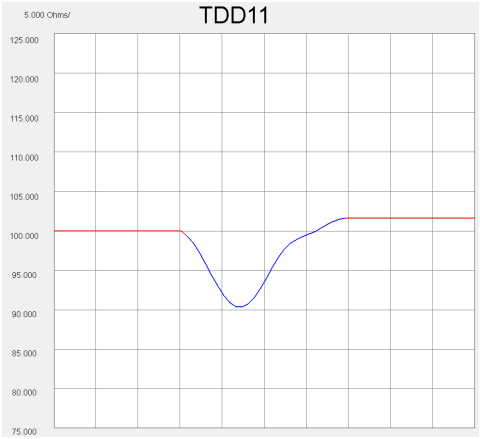
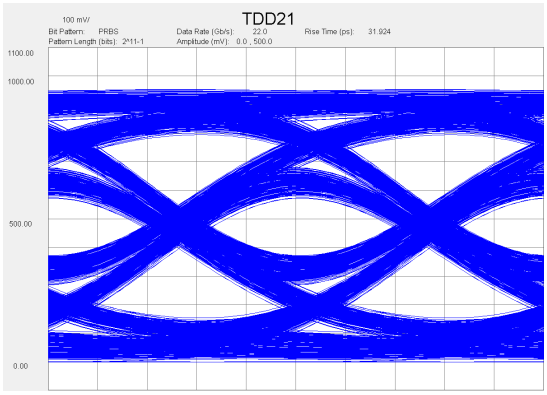


Figure 12 shows NXS connector eye diagram performance at 22 Gbps.

Fig 12 – Eye Diagram, 22 Gbps



Figures 13 shows eye diagram performance at 25 Gbps, including 3dB pre-emphasis - a technique commonly used to improve digital transmission signal quality

Fig 13 – Eye Diagram, 25 Gbps 3dB pre-emphasis

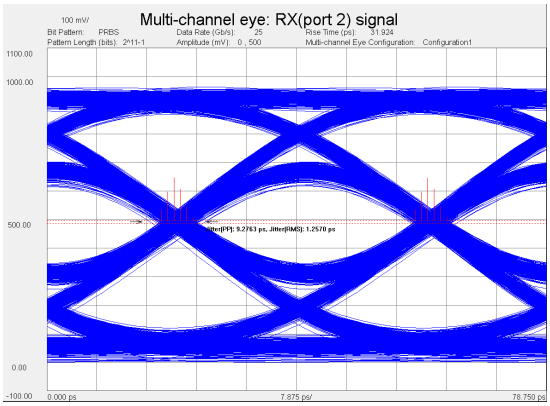


Fig 13a – Eye Diagram Data

Name	Result
Eye Level Zero (mV):	187.7052
Eye Level One (mV):	795.3711
Eye Level Mean (mV):	491.5381
Eye Amplitude (mV):	607.6659
Eye Height (mV):	36.8371
Eye Height (dB):	-28.6743
Eye Width:	32.4794
Eye Opening Factor:	0.0606
Eye Signal to Noise:	3.1936
Eye Duty Cycle Dist:	0.0904
Eye Duty Cycle Dist (%):	0.2261
Eye Rise Time (10-90):	30.1795
Eye Fall Time (10-90):	30.1224
Eye Jitter (PP):	9.2763
Eye Jitter (RMS):	1.2570

Figs 14 and 15 show insertion and return loss plots, indicating data transmission performance capability beyond 22Gbps.

Fig 14 – Insertion Loss, 22 GHz

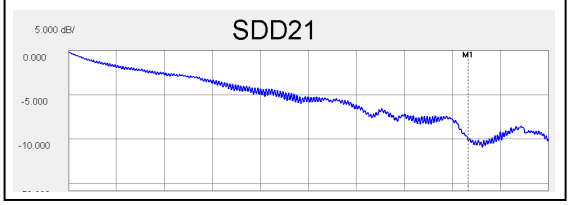


Fig 15 – Return Loss, 22 GHz