INTRODUCTION

There is an ever increasing demand for rugged, high speed (> 6.25 GBPS), modular and configurable connections, with the capability to support controlled impedance differential signal pairs, power pins, and discrete pins in a single connector housing. The satellite market is moving away from lower speed RF analog based payloads providing for telecommunication signaling, to a new Digital Transparent Processor architecture. This technology was introduced and qualified in 2017 for 10 Gbps PCB to cable applications. Smiths Interconnect has developed, and tested this interconnect system for specific applications. Smiths is now finalizing the launch of the full platform of modules to support advanced high speed interconnect solution to offer next generation data on demand, power, fiber optics and low speed signal capabilities to meet both point to point and backplane connector requirements. The ELARA system has proven to be able to withstand space application requirements, including extreme levels of vibration, shock and climatic testing and offer a reliable way to implement high density interconnections with high speed signal transmission requirements.

NEXT GENERATION INTERCONNECTION SYSTEM

The ELARA connector series has been designed for extreme levels of shock and vibration with a new micro-boloid contact technology, and the option of aluminum or lower mass using innovative composite shell materials with gold over nickel, and nickel plated variants. The system has also been updated and is expected to exceed electromagnetic interference shielding requirements of D38999 (the target is -70 dB attenuation at 10 GHz). It is designed with housings to support 4, and 8 bay configurations. These bays can accept any combination of 7 highly configurable and interchangeable modules. It is blind mateable, hot pluggable (for voltages <5V), and scope proof, with ultra-low mating forces and low outgassing materials. The connector features a very low mass composite material shell, translating into a lightweight, yet robust construction, well suited for extreme levels of shock and vibration near the launcher.

MODULE CONFIGURATIONS

a. Split Quadrax – Two Twinax Cables in a Common Contact Assembly (100 Ω each pair)
b. Twinax – Discrete Twinax with Two / Bay (100 Ω)
c. Power Module – 4 x 5 A Contacts
d. Mid-power Module – 5 x 3 A Contacts
e. Low Speed Signal 10 x 1.5A contacts
f. MT Fiber Optic Ferrule – up to a 12 fiber single mode ribbon
g. MT Fiber Optic Ferrule – up to 12 fiber multi-mode ribbon

(Fig. 1 & Fig. 2)

Additional modules are under development including a 50Ω coaxial contact, as well as PCB mount configurations. At present, only a. and b. above are fully qualified with the balance of the module qualifications in process.
ELECTROMAGNETIC INTERFERENCE PROTECTION

The EMI protection level is targeted at -65 dB attenuation for the carbon filled composite housing systems and -70 dB attenuation for the aluminum housing systems, measured at 10 GHz. The EMI shielding is provided by an encapsulating backshell on the plug side of the interface, which engages an EMI grounding spring on the receptacle side housing at the bulkhead. This allows the shield on the exiting cable to be terminated on the contact outer body for the twinax contacts and at the backshell exit for the other copper conductors. The fiber optic cables will not need to be shielded beyond the exit of the backshell, with any energy radiating from the rear of the connector attenuated within the backshell cavity (Fig. 3-6). Preliminary shielding effectiveness data for frequency bands of 4 to 8 GHz and 8 to 10 GHz is shown in Fig. 7 & Fig. 8.
Fig. 4 - Bulkhead Mounted In-line Configuration

Fig. 5 - Bulkhead Mounted PCB to Plug Configuration

Fig. 6 - Plug Assembly Encapsulated in EMI Backshell
SPLIT QUADRAx AND DISCRETE TWINAx QUALIFICATION

The high speed modules have been developed in two configurations. The first configuration has two twinax cables combined into a single, four inner terminal, quadrax contact (Fig. 9). The second configuration has two discrete differential twinax cables terminated to their own discrete twinax contact, keeping the grounding outer body separated by differential contact pairs (Fig. 10).

The original high speed module housing was constructed and qualified using gold plated conductive PEEK plastic to provide basic ground continuity and EMI shielding. The next generation version of the product (currently undergoing qualification), has two housing material options for improved performance. These options are gold plated aluminum and gold plated conductive liquid crystal polymer. The new materials will provide superior ground continuity and in the
case of the LCP, significantly enhanced moldability. The newly integrated EMI encapsulating backshell will also provide a very high degree of EMI attenuation.

Both the existing and new connector designs share the same stable controlled characteristic impedance as seen in Fig. 11. The impedance of the connector is maintained at 100 Ω ± 5%. The termination to the PCB is accomplished using a spring probe interface, thus eliminating the effects of a large plated through-hole for a solder tail or a press-fit pin. The time domain reflectometer (TDR) impedance results will be further improved, with either an optimized PCB or cable to cable in-line connection. The non-optimized PCB can be made more electrically consistent through control of the depth and diameter of the blind vias used to connect the surface target pads to the internal traces. This would significantly reduce the capacitive dips seen at the PCB to connector transition.

![Fig. 11 – End to End TDR Trace – Non-optimized Test PCB](image)

The high speed performance observed during qualification, met all requirements before and after environmental conditioning. The readings were completed using a non-optimized PCB and bent twinax cables, to further evaluate end to end worst case conditions. The eye patterns shown below represent system performance at 3.75 Gbps (Fig. 12), and 6.25 Gbps (Fig. 13). The test set-up is shown in Fig. 14. The system results in the bent cable condition were required to meet a jitter level of 96 ps max., differential skew of 35 ps max., Insertion Loss (7dB max. @ 5 GHz & 15 dB max. @ 10 GHz) and Return Loss (20 dB min. @ 10 GHz), after thermal aging, thermal cycling, mechanical shock and vibration.

![Fig. 12 – Eye Pattern at 3.75 Gbps (Jitter 25.83 ps)](image)
CONCLUSIONS

The ELARA modular connector systems has demonstrated very solid performance in both ECSS based testing as well as the additional application specific high speed signal integrity evaluations. The connector system has already proven its ability to meet the next generation of flexible interconnect application, as demanded by DTP and SpaceWire. The connector has completed qualification for the high speed modules for space applications. The platform qualification and release of the interconnect system is underway and is intended to augment the existing product with a backwards compatible interface. This release includes greater capability in EMI attenuation, as well as the completion of power, low speed signal and MT ferrule based fiber optic modules in an 8 Bay and 4 Bay configuration (Fig. 15 & Fig. 16). In the future, additional modules are planned to support other fiber optic variants, higher density and 50Ω coaxial interconnects.
Fig. 15 – 8 Bay Plug Assembly

Fig. 16 – 4 Bay In-line Connector Assembly

REFERENCES
