TERADYNE
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Achieving MIL/Aero ATE Standardization with Scalable Test Interface Solutions

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Abstract

Teradyne's customers are facing divergent needs. The adoption of new technologies and capabilities in Teradyne products continues to accelerate, yet systems need to be supported for longer operational lifetimes. This necessitates a standardized ATE approach that is scalable and robust to support the full life of the program.

This paper discusses practices for test interfacing that protect against obsolescence and provide forward migration paths. The latest technologies and solutions to interface to Teradyne's high speed digital and optical products are presented.

Automating Electronic Test

Up until the 1960s, testing was a benchtop activity based on hand probing, turning knobs on instruments such as oscilloscopes, and observing their displays. The computer revolution ushered in automatic testing:

- Instruments
  - Stimulus, Measurement
- Computer Control
  - Replaced buttons and knobs with automatic control of the instrument
- Switching systems
  - Replaced hand probing with switching systems
- Mass Interconnect
  - Replaced dedicated test systems with standard multi-use test systems
- Modular System-Level Platforms
  - Increased modularity, scalability, supportability
  - Utilized open architecture VXI, PXI, LXI

Mass Interconnect

The mass interconnect is a key element of the modern ATE system. It enables a standard test system to test multiple units under test (UUTs) and subsystems. A standard interface connector adapter (ICA) is provided on the test system, and multiple interface test adapters (ITAs) facilitate fast and easy system adaptation for testing a particular UUT.

ITA/ICA systems are built for reliable, repeatable operation over 10k to 100k+ remove and replace cycles. This is much higher than the cycles available on typical test instruments or UUTs.

Figure 1 shows an example of an ICA with three ITAs for testing various UUT systems of an aircraft.

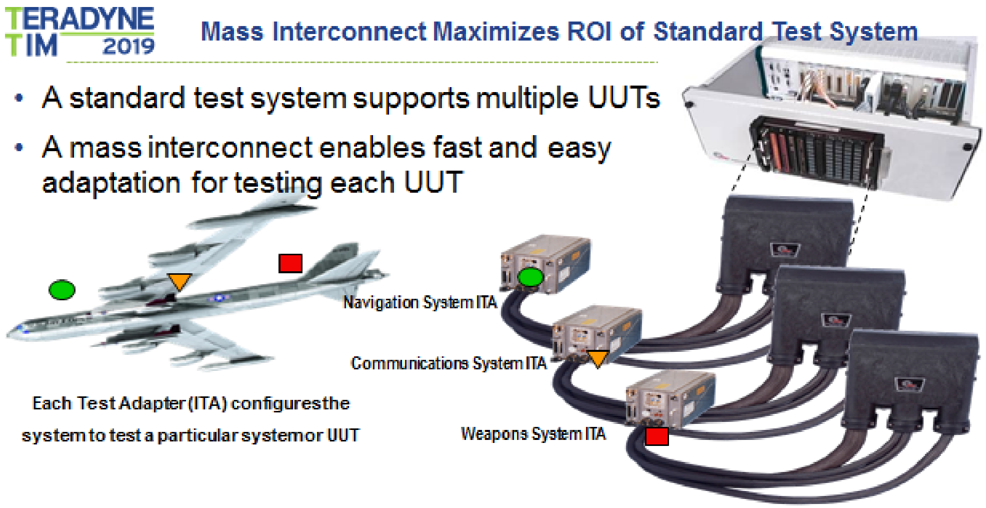

Figure 1, ICA with multiple ITAs

Virginia Panel Corporation (VPC) provides interface solutions based on a core set of blocks, pins, and patchcords, which are used across a wide range of standard mechanical interface systems. These mechanical systems are manufactured to tight tolerances to maintain precision alignment and provide mechanically advantaged engagement of the ITA to the ICA. This enables test system integrators to implement a flexible system wiring scheme that is modular and scalable, as well as expandable to meet future requirements. Figure 2 shows typical modules, contacts, and patchcords.

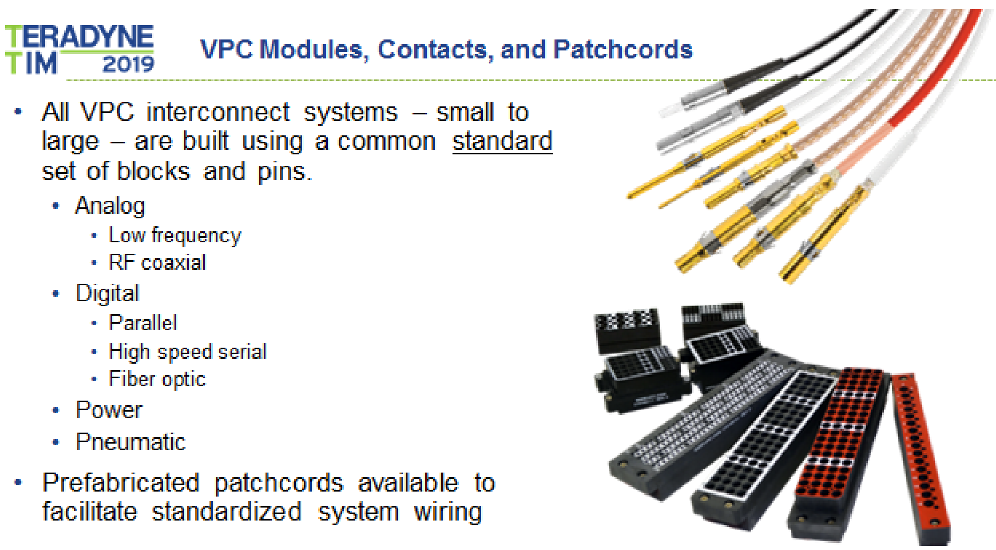

Figure 2, Standardized set of Modules, Contacts, and Patchcords

These have been used extensively in Teradyne Spectrum systems. Figure 3 shows an example of Teradyne Spectrum-9100 using VPC funnels. This enables the instrument module and its corresponding ICA block to be removed and replaced together for rapid system maintenance.

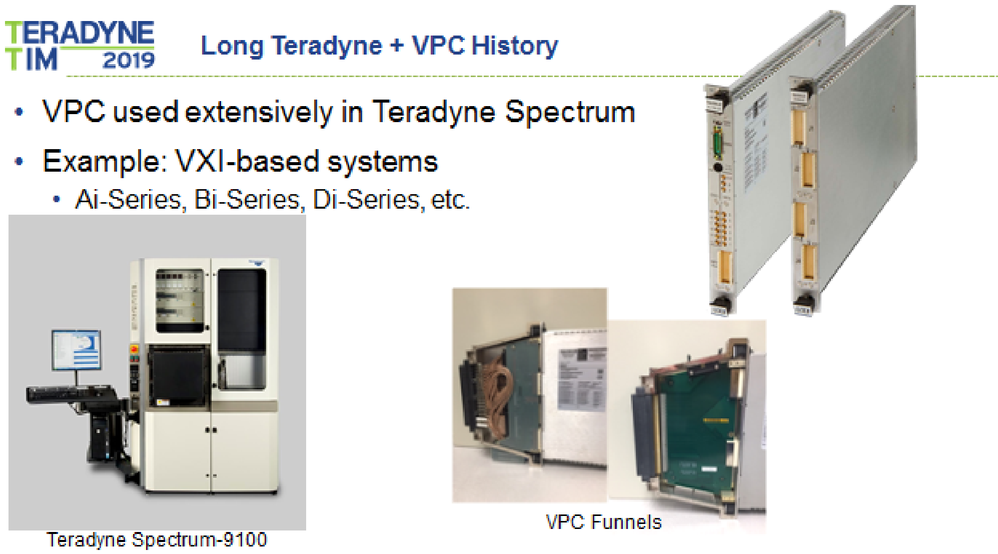

Figure 3, Teradyne Spectrum 9100-with VPC 90 Series and VXI funnels

The Challenge

MIL/Aero test system users now face divergent requirements that are challenging to reconcile.

Units and systems being tested are incorporating new technologies and capabilities at an ever faster pace. Test Instrument and system providers such as Teradyne are responding to these needs with new test capabilities. For example, Teradyne High Speed Subsystem (HSSub) Bus Instrumentation provides extensive new test capabilities for high speed serial digital communications.

At the same time as test requirements are expanding, required operational support lifetimes are lengthening. For example, an airframe may be fitted with modernized electronics multiple times within its operational lifetime. This often extends to the operational support lifetime of the test system as well. This necessitates a **standardized core test system approach** that is **scalable** and **extensible** to support the full life of the program.

Teradyne and VPC have collaborated to implement a robust standardized test system interface approach to achieve these system-level objectives. As such, Teradyne has been very influential on VPC's product roadmap.

High Speed Serial Digital

Serial digital operates by sending a bitstream rather than a broadside digital vector. See figure 4.

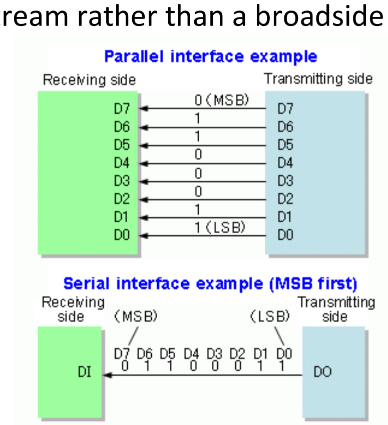

Figure 4, Parallel vs. Serial Digital Data Transmission

The following are examples of current high speed serial signals:

- **Communications**
  - **Ethernet – 10 GbE**
  - **USB – 3.1 Gen2 (10 Gbps)**
  - **FPGA SerDes MGTs**
  - **Custom buses**
- **Display Protocols**
  - **HDMI**
  - **VHDCI**
  - **DisplayPort**
  - **DVI-I**

Teradyne supports serial testing with the High Speed SubSystem (HSSub), which includes bus instrumentation modules to meet a wide range of standard protocols. In addition, user programmable FPGAs on some of these instruments can be used for testing custom bus protocols.

VPC has developed our VTAC connector system to support high speed serial signals. VTAC provides a fully controlled 100 ohm differential signal path all the way through the connector, delivering up to 12.5 Gbps communications. This new pin achieves >150k remove/replace cycles. Figure 5 shows the inside of a VTAC connector.

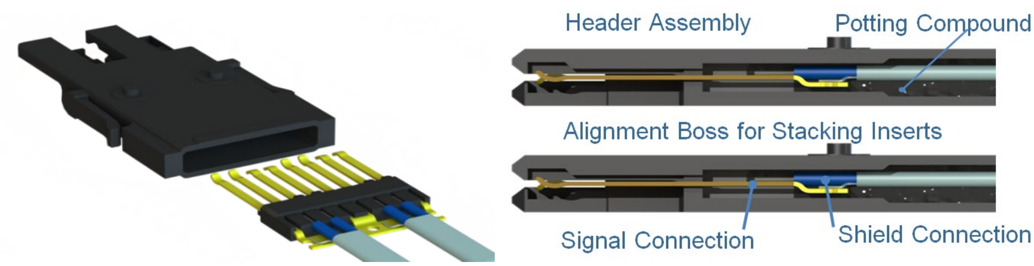

Figure 5, VPC VTAC 12.5 Gbps Serial Digital Connectors

VPC has been expanding available Patchcord and PCB solutions utilizing the VTAC connector system. Teradyne input has been influential in helping develop our product roadmap.

VPC engineers design for key parameters including:

- Insertion Loss
- Crosstalk
- Impedance matching
- Propagation delay and skew
- Return Loss
- Rise Time Degradation
- Signal Trace Design

Figure 6 shows some of the many VTAC mounting possibilities.

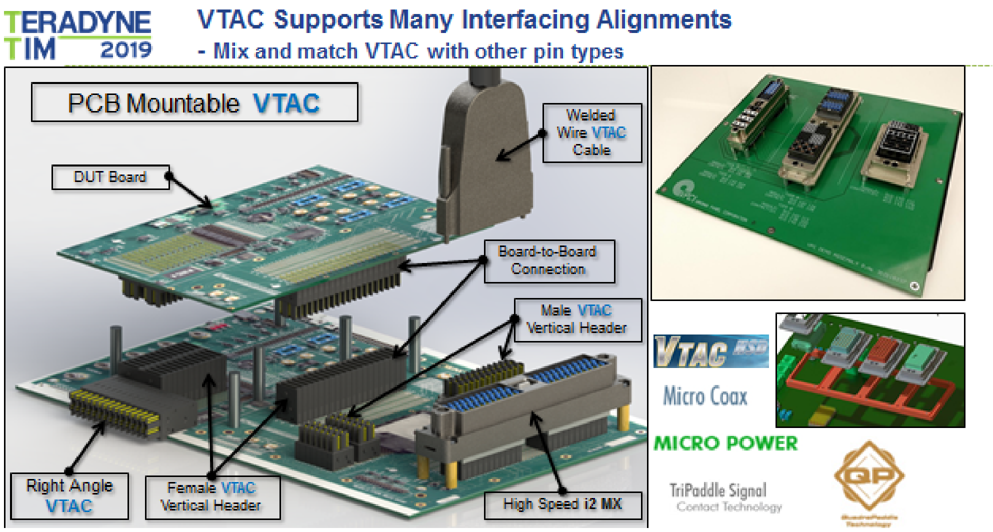

Figure 6, VTAC mounting options – PCB and Patchcord

Test Interface Standardization

Teradyne and VPC standardized on the G20 Pull-thru for the HSSub. Pull-thru funnels were implemented for each Teradyne module, aligning directly into the interface receiver. The PXI module and its associated funnel can be removed and replaced in less than 10 minutes, ensuring system uptime. Figure 7 shows the HSSub with VPC G20 Pull-Thru.

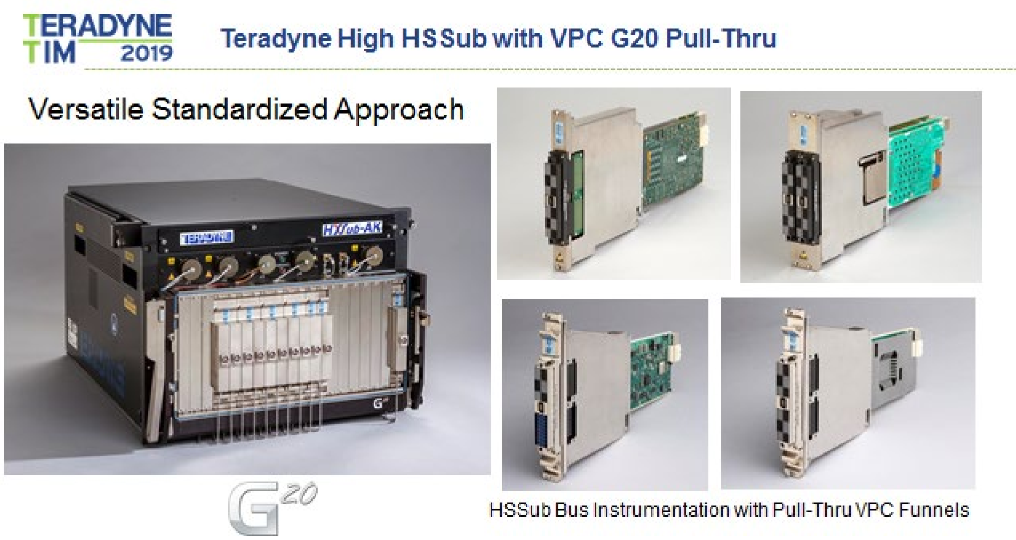

Figure 7, Teradyne HSSub with VPC G20 Pull-Thru

For larger requirements, Teradyne uses the G20x, which accommodates 8 additional ICA blocks for wiring in resources from elsewhere in the system. Figures 8 and 9 show an example of a complex ITA hosted on the expanded G20x interface.

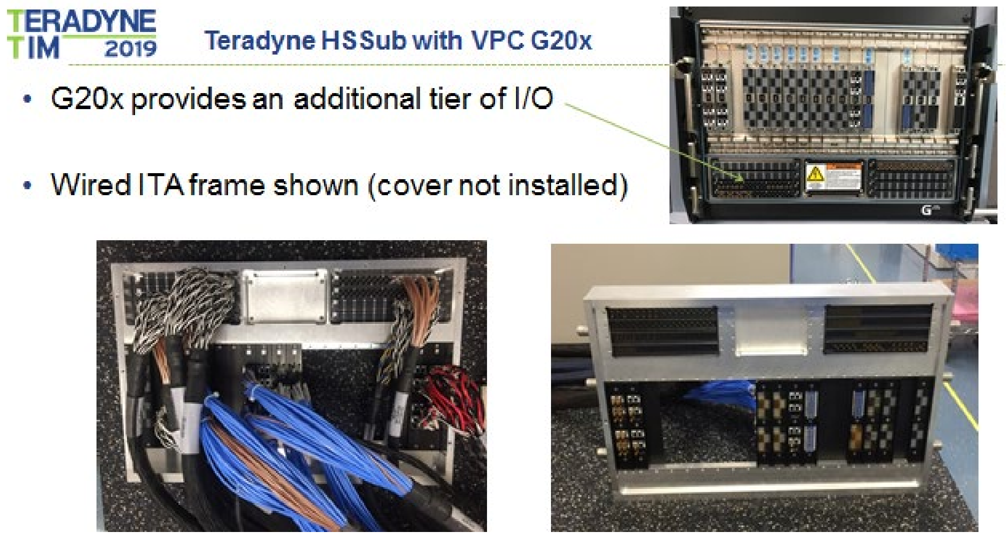

Figure 8, Teradyne HSSub with VPC G20x

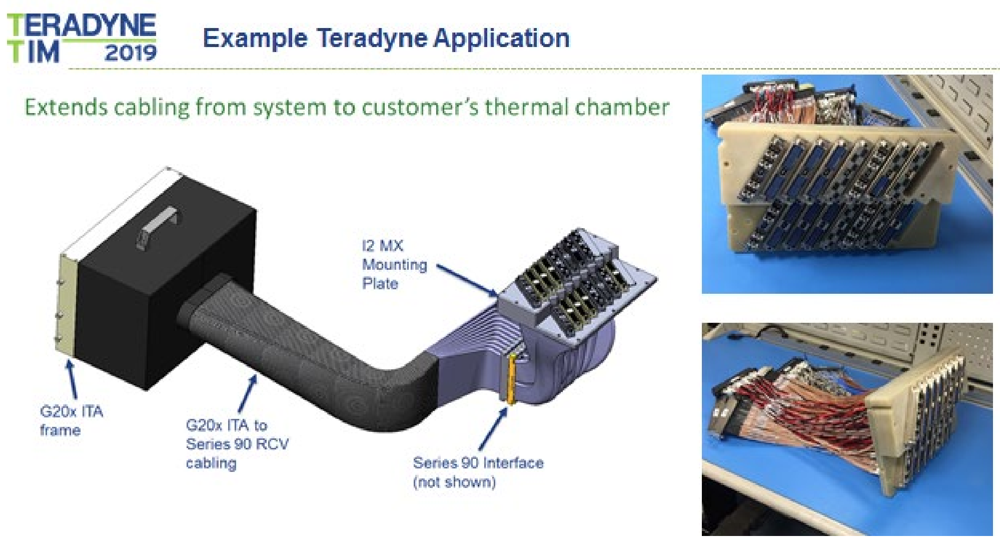

Figure 9, Example G20x ITA and Harness

For small requirements, a full sized ITA is not required. Teradyne utilizes the VPC i2MX to connect directly to an individual module within the test set, as shown in Figure 10. Note that the i2MX can also be used to bring additional external test functionality *into* the test station while minimizing the redesign of test station and ITA wiring.

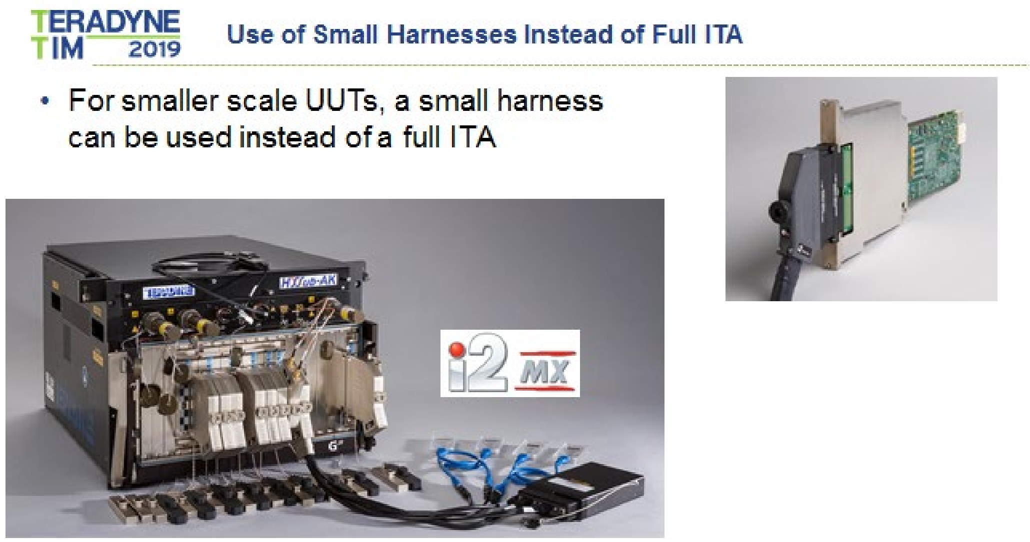

Figure 10, Teradyne HSSub with VPC G20 and i2MX harnesses (no ITA)

The use of VPC G20, G20X, and i2MX platforms along with standard VPC blocks, pins, and patchcords provides an extremely versatile, supportable, and scalable solution.

<u>Fiber Optics</u>

This interface standard is extensible to support new requirements. Teradyne provides optical test solutions such as VERTA and the HSSub-6100 Bus Instrumentation, as shown in Figure 11.

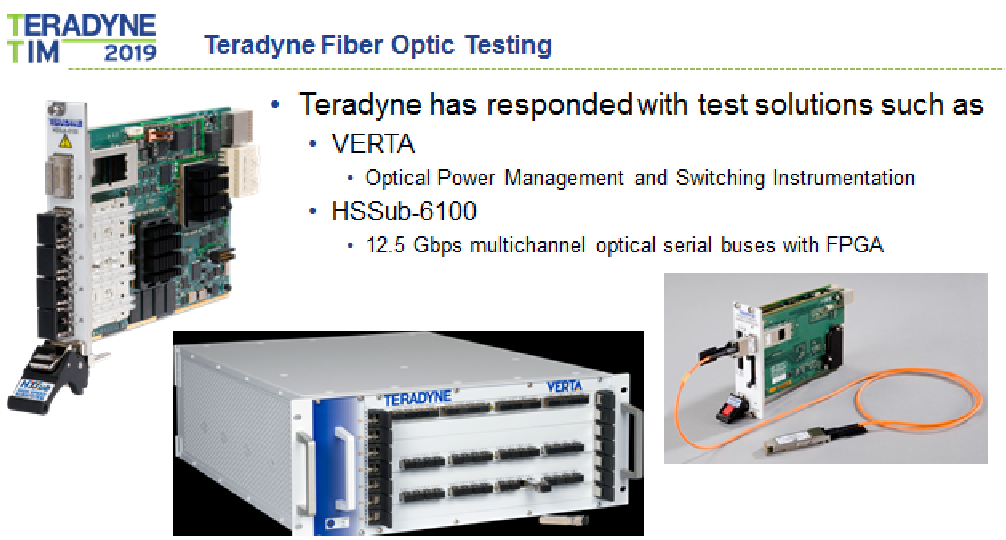

Figure 11, Teradyne Fiber Optic Test Equipment

VPC fiber optic interface solutions include both glass and polymer fiber optic interconnections. While these have excellent specifications, they require the customer to inspect, clean and polish the ends of the optical fiber to maintain these specifications.

Teradyne encouraged VPC to offer an expanded beam solution to reduce the need for cleaning and polishing. Lenses diffuse the beam before the connection and refocus it after the connection, as shown in Figure 12. This eliminates the need for the fibers to come into direct contact, thus minimizing the impact of dust. Cycle testing has shown that little to no maintenance of the contacts is required. VPC is currently introducing this as a standard option. Figure 13 shows a comparison of the three types of fiber interconnects available.

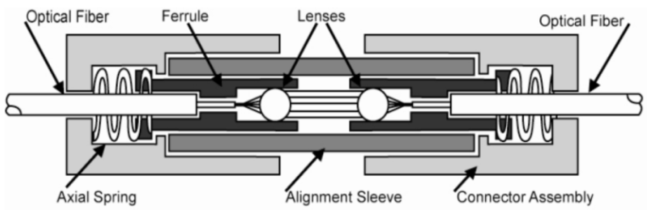

Figure 12, Fiber Optic Expanded Beam

Interface Type	Material	Coupling	Cleaning and Polishing Required	Specified Maximum Insertion Loss	Typical Initial Insertion Loss	Mating Cycles
Multimode Glass Optical Fiber (GOF)	Glass	Butt-Coupled	Yes	1.5 dB	Superior	5000
Single Mode Polymer Optical Fiber (POF)	Polymer	Butt-Coupled	Yes	4 dB	Good	5000
Expanded Beam	Polymer	Expanded Beam	No	2 dB	Medium	100,000

Figure 13, Comparison of VPC Fiber Optic Solutions

RF / Microwave

Another area of platform extension is RF/Microwave, where there has been an increasing demand for higher frequencies. In some cases this is due to the UUT frequency, while in other cases it is a desire for higher performance testing, i.e. to “make the wiring disappear from the test”.

VPC is currently introducing 50GHz pins that work in existing mini-coax installations for both new and upgraded systems. Additional details are shown in Figure 14.

Figure 14, VPC 50GHz Contacts

High Power

Some emerging applications are extremely power hungry. Rail guns use electromagnetic energy to shoot a high velocity kinetic projectile. Laser guns deliver high optical energy to a target. Newer generations of traditional applications can also use a lot of power.

VPC high power pins deliver up to 600V @ 150A per pin, and are good for 10k insertion cycles. Figure 15 shows an example of their use in Teradyne systems.

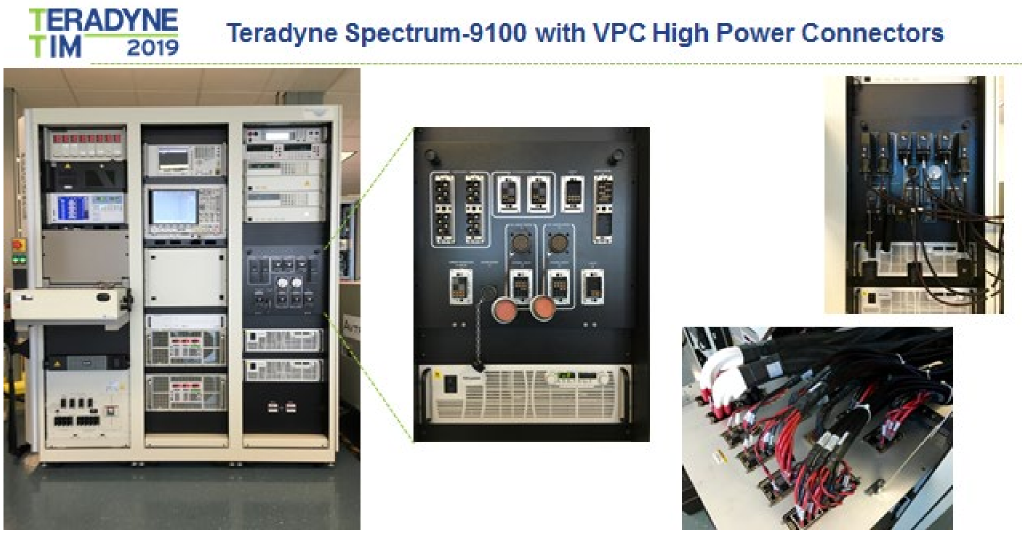

Figure 15, VPC Teradyne Spectrum-9100 with VPC High Power Interfaces

Summary

The ideal MIL/Aero test system ensures long term support by:

- Utilizing standard, robust, and supportable "building blocks"
- Implementing a modular, scalable, and expandable approach
- Maintaining flexibility to incorporate new technologies
- Remaining independent of underlying instrument platforms (PXI, VXI, etc.)

Teradyne and VPC have collaborated to implement a test interface approach that meets the above and is optimized for the Aerospace/Defense customer.