Severe Environment Testing (SET) Initiative

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From continuous shock loadings to temperature extremes, severe environments can pose major challenges to engineers specifying the necessary interconnect systems. Recognizing the need for products that have been tested above and beyond current standards, Samtec developed the Severe Environment Testing (SET) Initiative.

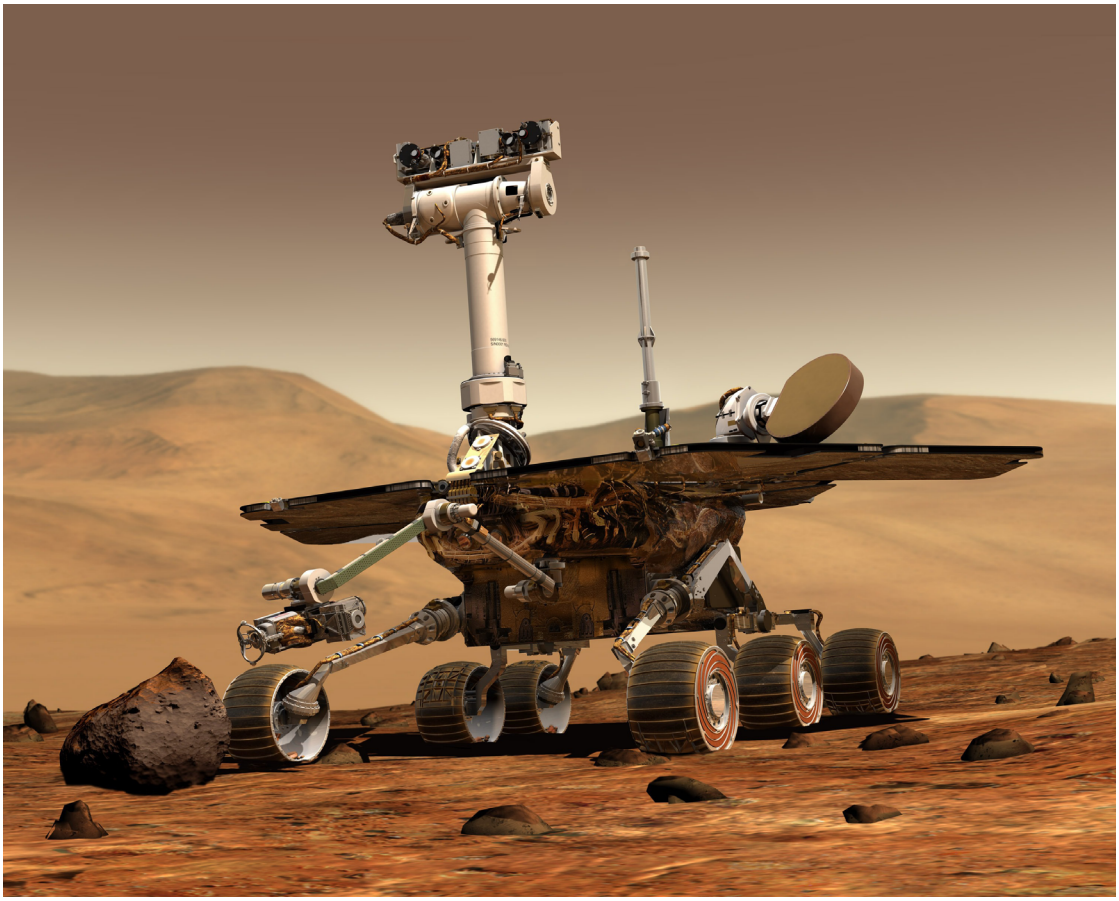

Figure 1: *Severe environments can take many different forms, involving extremes in temperature such as those experienced by the rovers. Image provided courtesy of* ***Pixabay.***

This whitepaper reviews severe environments and introduces the SET Initiative. It discusses test standards before delving into what makes SET testing different. Finally, examples of SET-certified products and applications are discussed.

Examples of Severe Environments

Severe environments can involve extreme temperatures, pressures, voltages or currents, and issues such as shock exposure or vibration. Some specific examples from various industries include the following:

- Altitudes over 70,000 feet combined with extreme voltage conditions
- 15kV of electrostatic discharge
- Continuous shocks with random vibrations
- Thermal reliability between -65°C and 125°C
- Non-operating class temperatures

Finding connector solutions that can perform in such aggressive operating environments can prove challenging. Samtec developed their SET initiative guided by such challenges.

SET Initiative

Samtec's **Severe Environment Testing Initiative** **(Figure 2)** involves testing certain Samtec interconnects beyond typical industry requirements and standards. SET's overarching goal is to ensure reliability and performance in some of the most extreme operating environments.

Figure 2: *The seal of approval by Samtec Severe Environment Tested Initiative ensures that certain products can survive in severe environments, requiring testing beyond typical standards. Source.*

The SET was developed explicitly for system designers and engineers seeking additional qualification data for Catalog Of The Shelf (COTS) products being used in severe environments and has already proven beneficial in providing performance confidence for rugged Mil/Aero industries and applications along with the automotive, industrial, and medical industries. The SET testing standards have been developed using VITA 47.0 through 47.3 combined with industry feedback concerning existing test information available for COTS products.

Testing Specifications

Samtec offers **three levels of testing**: DQT, LP, and SET.

Design Qualification Testing (DQT): this is the testing that All Samtec series undergo. It includes Normal Force, Thermal Aging, Mating/Unmating/Durability, IR/DWV, Current Carrying Capacity (CCC), and Mechanical Shock/Random Vibration/Low Level Circuit Resistance (LLCR) and Event Detection.

Extended Life Product™ (ELP) testing: ELP-certified products are tested to additional, rigorous standards that evaluate contact resistance in simulated storage and field conditions. Products are also exposed to 10-year Mixed Flowing Gas, where sulfur dioxide, chlorine, hydrogen sulfide, and nitrogen dioxide flow around parts for 14 days. Finally, they are tested for high mating cycles (250 to 2,500).

SET Initiative: additional testing for interconnect systems intended for severe environments.

Other tests may include

- VITA™ 47.1 Module Insertions
- VITA™ 47.3 Humidity
- VITA™ 47.1 Operating Shock Class OS2
- VITA™ 47.1 Vibration Class VS3
- Exceeds VITA™ 47.1 Temperature Cycling Class C4
- Exceeds VITA™ 47.1 Non-Operating Temperature Class C4
- VITA™ 47.1 Electrostatic Discharge Resistance
- Exceeds VITA™ 47.1 Altitude for DWV (Dielectric Withstand Voltage)

Standard SET qualification tests include a combination of LLCR, DWV, mechanical shock, vibration, humidity, and temperature cycling. SET takes these standard qualification tests and expands the specifications required to pass the test—proving to the designer that the interconnect can be used in severe environments. An example report from SET testing can be found **here.**

Note that, although not considered a “level” of testing, Samtec also offers NASA-specific testing. In fact, SET products are approved for Class D missions. Samtec also utilizes NASA outgassing data to determine if specific products meet NASA’s ASTM E595-77/84/90 test requirements.

How SET Differs

The SET goes above and beyond standard testing, especially in dielectric withstanding voltage at altitude, electrostatic discharge, temperature shock, non-operating class temperatures, and mechanical shock and vibration.

Mating / Unmating / Durability

Focus is also placed on mating / unmating, because severe environments may involve rough handling and multiple mating cycles; the interconnect must be rugged and not suffer signal degradation. With SET conditions, mating / unmating / durability tests are intensified. In a standard test of this type, the Relative Humidity (RH) is held at a range of 90 – 98% for 10 days with 100 mating and unmating cycles at a temperature of +25°C to +64°C. For SET, however, the RH is increased to 100% with 250 mating and unmating cycles for 10 days at a temperature of +25°C to +64°C.

The connectors are then measured for mating/unmating forces, cycled 250 times, and LLCR, which is the baseline for the mating / unmating / durability test, is tested again. If the connectors have a max delta of less than 15mΩ they will move to the following test sequence. The remaining test sequences involve Thermal Shock per EIA-364-32, LLCR, Humidity, LLCR, and Mating/Unmating Forces.

Dielectric Withstanding Voltage at Altitude

Dielectric Withstanding Voltage (DWV) is a standard electronics test; testing at an altitude of 70,000 ft adds to the difficulty but can be necessary for applications such as aerospace (Figure 3). In a typical DWV test, the connectors are tested by applying the testing voltage for 60 seconds. The part is considered to pass if there were no electrical arcs, and testing voltage = .75 x breakdown voltage. For DWV at Altitude, the test is conducted in an altitude chamber to simulate an altitude of 70,000 feet with a test voltage of 300VAC. Connectors pass the test if they have not suffered an electric breakdown.

Figure 3: *Aerospace applications, including space exploration, can require dielectric withstanding voltage at altitude. Image provided courtesy of Pixabay.*

Electrostatic Discharge

While Electrostatic Discharge (ESD) is not typically tested for electrical connectors, there are instances in severe environments where engineers need to know how the components will handle ESD. This ESD test is based on EN61000-4-2 from VITA 47. ESD events range from 0 to 15kV as discharged through a 150pf capacitor through a 330-ohm resistor.

The connectors are exposed to 5, 10, and 15kV (10 times at each level) and then visually inspected for damage. For ESD tests of this type, a visual inspection of the connector is sufficient to determine if the connector passed because the only damage that could occur would be to the plating.

Temperature Shock

Temperature cycling evaluates the temperature shock that can occur when temperature variation is extreme. A typical thermal shock test takes a connector set from -55°C to +85°C through 100 cycles with a 30-minute dwell time at each temperature. The SET version of this test increases the temperature range to -65°C to +125°C through 500 cycles with a 30-minute dwell. During this test, the parts are tested for LLCR to look for increases in resistance through the system.

Non-Operating Class Temperature

In some applications, it can be just as important to know at what temperature range a connector can operate at peak levels as at what temperature the connector fails. For Non-Operating Class Temperature testing, the connector is LLCR tested, exposed to -55°C to 105°C for 100 cycles, then tested for LLCR again, exposed to -65°C to 125°C for 100 cycles, and finally tested for LLCR again. Assuming the product maintains a delta of ≤5 mΩ for LLCR from the start of the test to the end, it is considered a stable product within those temperature ranges.

Mechanical Shock and Vibration

Mechanical Shock / Random Vibration testing measures a connector set's performance under exposure to random vibrations and mechanical shocks. The standard random vibration test uses 7.56 gRMS for 2 hours per axis; the SET version of this test using 12 gRMS, 5 – 2000Hz for 1 hour per axis. Event detection continuously monitors the contact set for discontinuities during the vibration test.

For mechanical shock, the standard version of this test uses a 100G Peak Shock for 6 milliseconds, half-sine; the SET version uses 40G Peak shock for 11 milliseconds, half-sine. LLCR is used before and after the test to evaluate the effects of the test and look for changes in the contact system resistance.

SET Applications and Products

The following are specific examples of severe environments with the SET product, including connects, pins, arrays, and contacts, used in those environments.

- Altitudes over 70,000 feet combined with extreme voltage conditions – **EdgeRate** (rugged, high-speed connector strips)
- 15kV of electrostatic discharge: **TigerClaw** (contacts, see Figure 4)
- Continuous shocks with random vibrations: **TigerEye** (contacts, see Figure 4)
- Thermal reliability temperature cycling between -65°C and 125°C and
- Non-operating class temperatures: **Searay**

Figure 4: *The TigerClaw and Tiger Eye contacts. Source.*

The **Tiger Eye** Series SFM/TFM/SFSDT high-cycle, high-reliability connector systems are SET-tested, as are Samtec's **LSHM(-S)** high-density, rugged connector for use in board-to-board and board-to-cable applications with optional shielding for EMI protection. In addition, there is Samtec **URSA I/O** – Series B1SDT/P1M ultra-rugged cable system.

Conclusion

There are several benefits to using Samtec products that are SET testing and certified. Higher degree of reliability in severe environments and reduced failure risk stand out immediately, along with cost-effectiveness over the long term. The performance of SET-certified products has been measured and quantified in extreme environments, adding to user confidence. Finally, using such heavily tested products instills confidence in end users as well. Contact Powell today to learn more about the SET Initiative and the impact it can have on the success of your design. For more information visit **www.powell.com** or reach out to a Powell representative at **samtecinfo@powell.com.**