System Development

HALT, HASS for Embedded Boards

HALT/HASS Testing Goes Beyond the Norm

The defense industry is looking to HALT/HASS testing methodologies for greater levels of system reliability. The overall investment reduces development time with improved performance

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The increased focus on network-centric warfare in today's military operations has expanded the use of embedded systems in the deployment of mobile, mission-computing and high-performance applications. These embedded systems must be rugged enough to handle the toughest environmental conditions such as extreme temperatures, yet be efficient enough to meet application needs for power and heat dissipation. For many embedded applications in the mobile and mission-computing segments, HALT (Highly Accelerated Life Testing) and HASS (Highly Accelerated Stress Screening) testing is a necessity. Given the recent shift from internal, proprietary developments to solutions built from commercial off-the-shelf components, the military is now looking outside of its engineering ranks to guarantee that its components are rigorously temperature tested.

Aerospace and Defense end users are requiring Original Equipment Manufacturers (OEMs) to adhere to HALT/HASS testing methodologies in order to ensure greater levels of product quality and reliability. In today's economy, spending time and resources performing these tests, not to mention investing in the test equipment itself, could be a weighty proposition. Companies may find it difficult to balance the upfront commitment with smaller budgets and reduced manpower. However, unexpected failure modes and/or high failure rates can result in expensive field service calls or significant downtime. As a result, product failures usually end up costing manufacturers more in the end.

Figure 1

Talon Unmanned Ground Vehicles (UGVs) made by Foster-Miller are rugged, lightweight tracked vehicles that are widely used for explosive ordnance disposal (EOD), reconnaissance, communications, sensing, security, defense and rescue.

For OEMs, finding a partner to perform HASS/HALT testing in-house is crucial to managing testing expenses. Equally important is finding a vendor that utilizes best testing practices, including extended temperature testing. Given the cost and security implications associated with military deployments, it is important to test at a wide temperature spectrum and high vibration levels upfront. By partnering with a HALT/HASS testing specialist, OEMs can reduce development time as well as deploy military applications quickly and cost-effectively with improved performance.

COM Express Can Take the Heat

The standards-based, highly reliable architecture of COM Express is an ideal fit for many military applications in the mobile and mission-computing segments, including ruggedized multipurpose computers and unmanned

Figure 2

Shown here is a HALT (Highly Accelerated Life Testing) chamber containing a chassis/board-level system under test.

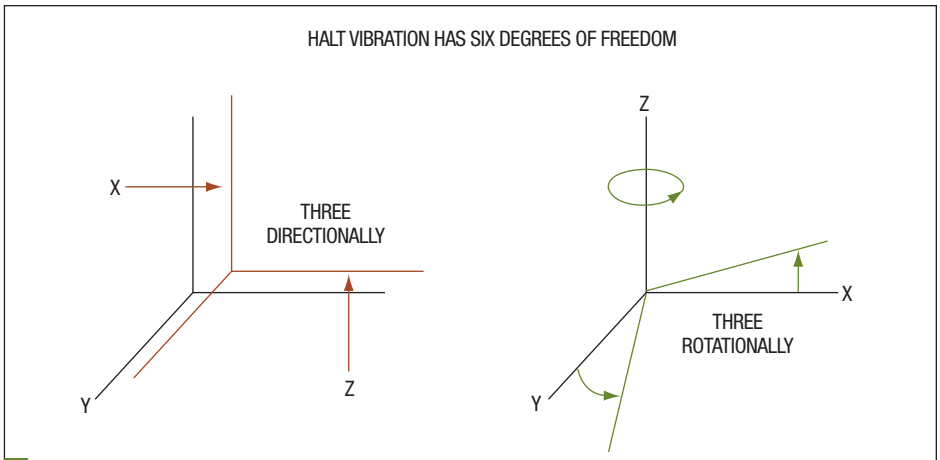

Figure 3

Unlike traditional vibration tests, HALT covers six degrees of vibration movement.

vehicles. COM Express is the PICMG specification for Computer-on-Module, and solutions based on this form factor reap the benefits of modularity, scalability and ease of upgradeability. In addition, COM Express-based solutions are highly integrated and compact, delivering high-performance processing within a small, low-power embedded form factor. Those aspects make it an ideal platform for portable, battery-powered applications and helps designers meet the unique enclosure needs for aircraft and ships. COM Express solutions leverage the latest Intel mobile processors and chipsets, are engineered to support current performance requirements such as PCI Express and SATA, and most importantly, are rugged enough to handle the harshest environmental factors.

Systems like Unmanned Ground Vehicles (UGVs) (Figure 1) or man-wearable computers must be ruggedized to stand up to extreme temperatures, shock, vibration and G-forces, in the air, under water or on the ground, and must perform reliably under extreme temperatures and vibration conditions in the field. Portable and in-vehicle devices are additional applications that can benefit from a COM Express embedded component. Mobile computing applications and wearable units must be lightweight, rugged and perform reliably under extreme temperatures in the field.

Testing Rugged Form Factors for Tactical Apps

Though there are varying degrees of ruggedness for different military embedded applications, HALT and HASS are advanced approaches to testing in the design stage and manufacturing stage to ensures that solutions are capable of operating at extended temperatures under harsh vibration reliably.

The first step in extended temperature testing is to demonstrate a product's capability by employing HALT (Highly Accelerated Life Testing) techniques. Figure 2 shows a HALT chamber containing a chassis/board-level system under test. HALT is used in the design phase to explore and maximize the full limits of a product design. This testing consists of a stepped thermal and vibration stress process during which the actual limits of the design and component performance are determined. As Figure 3 shows, HALT covers six degrees of vibration movement. As failure modes are discovered, they are corrected by design or component improvement until no further improvement is practical or is limited by the fundamental limit of the underlying technologies. By establishing that the design and components are capable of operating not only to the extended temperature specification but well beyond, HALT demonstrates the true operational limits of the product. The concept and execution of maximizing the design margin is critical to successfully producing reliable, extended temperature products.

As shown in Figure 4, note that the HALT range exceeds the product operating specifications by a large margin. Even with ongoing production variation represented by the normal curves, note that the operating limits never fall within the product specification range. In other words, with enough margin, the product becomes immune to normal variation and will thus produce very high yields and sustained conformance to the product specifications during production life. Once the HALT process demonstrates sufficient margin, ongoing monitoring of that margin must take place to ensure the detection of changes that could affect the performance.

The Next Step: HASS

Once rigorous testing has established the product capability for extended tem-

perature operation, it is critical to also have a process for ongoing monitoring of that capability. The HASS (Highly Accelerated Stress Screening) process is used to accomplish this next phase in the process. HASS screen limits can be set beyond the product specification to ensure that the product maintains operating margin. In order for HASS to be truly effective, it must be performed on 100 percent of the products manufactured. In this way, an OEM can guarantee that each product not only meets the extended temperature requirement, but that it does so with additional operating margin, ensuring long-term performance and reliability.

By driving operating margin into the design, an OEM can become immune to material and process variation in manufacturing, attain high yields during all production phases, and have sustained reliability and low warranty costs, all with no surprises in the field. So to recap, HALT drives the design to its fullest capability, and HASS ensures at the production end that each and every product operates at the specified range.

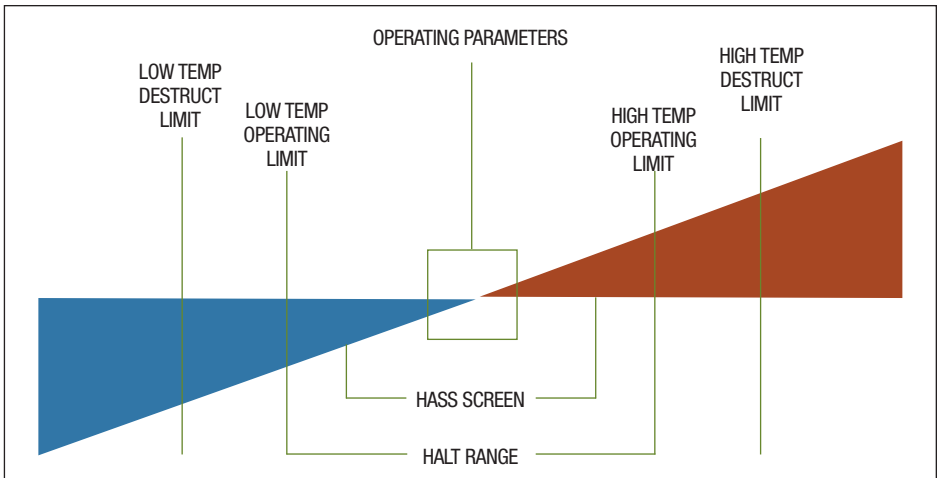

Figure 4

The HALT range exceeds the product operating specifications by a large margin. With enough margin, the product becomes immune to normal variation and will thus produce very high yields and sustained conformance to the product specs during production life.

Partnering with Experts Reduces Cost, Risk

It is critical that an OEM not just perform HALT/HASS testing, but also that they employ industry-leading best practices to deliver extreme capability and sustained reliability to their customers. However, robust HASS/HALT testing can be quite costly and time-consuming for an OEM to conduct in-house. To overcome these resource drains, OEMs are turning to their ecosystem partners to share the responsibility and costs involved with testing their solution's components, and to save precious time in the development process.

Extended temperature and vibration testing can be an expensive, time-consuming process that requires specific facilities and staff who are able to identify and work through the unique challenges of HALT/HASS testing to achieve success. The ideal ecosystem partner for COM Express has a solid reputation for employing manufacturing and engineering best practices and has a proven track record of successful embedded deployments in the field. They will also have invested significantly in state-of-the-art testing equipment, saving its customers from investing significant upfront capital expenditures, along with operating expenditures in terms of precious engineering resources that could be allocated elsewhere.

Deployment-Ready Systems

When a partner undertakes the screening of its COM Express products, it assumes the associated risks. Since the partner specifies the products' operating range, then it is held responsible for any fallout that may occur. In the past, a mil-aero end user could face "hit or miss" success when purchasing commercial off-the-shelf components. Although several components of a solution may not be mil-grade, the OEM can leverage its partners' expertise to ensure that the entire solution meets the end user's specific temperature requirements, providing a warranty for extended temperature.

Lastly, time-to-market goals depend on thorough and upfront testing. Partnering with a company with a proven track record of qualified and fielded deployments provides OEMs with a fast path through the testing process. These resources help OEM customers quickly and economically identify and correct product issues before they become costly customer support problems in the field.

RadiSys is an example of an embedded computing provider that employs HALT testing to meet and exceed the published product specifications—providing significant operating margins for harsh environments. The company also implements an on-going HASS program for consistent monitoring of extended temperature products to ensure their reliability during field deployment and throughout the lifetime of the product. The Extended Temperature line products are designed with high-capability components and are subjected to an extensive suite of environmental tests to demonstrate capability of operation in -25° to +70°C temperature range. ▮▮

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