Technical white paper

Building reliability into HP Workstations

Table of contents

System reliability is essential for workstation users. At HP, we recognize that professionals can't settle for anything less than the highest levels of reliability. System crashes, component breakdowns, and sluggish performance can bring work to a halt and result in several hours or days of lost productivity. That's why we design our workstations to meet the challenges of the most demanding workloads and duty cycles— an HP focus for the past 30 years. Three decades of workstation engineering innovation has created a level of reliability that is widely recognized in the industry.

Here are some of the things we do to make the HP Workstation name synonymous with rock-solid reliability.

A strenuous design standard

We design our systems based on workstation application demands, a rigorous customer use model and a design standard that goes beyond just the warranty period. Our design model is based on "Class 2" electronics[1]—a level reserved for highly reliable systems with demanding workloads. Class 2 electronics assumes a use model well beyond the normal limited work cycle of a typical home computer or consumer electronic device, which are usually specified as Class 3.

HP Workstations are designed and built for mission-critical workloads and always-on environments. As such, they employ many of the same types of components used in servers. These components include Intel® Xeon® processors, error correcting code (ECC) memory, and enterprise-class storage technologies, such as 15K Serial-Attached SCSI (SAS) and solid-state drives (SSDs).

We offer power supplies with high standards for hold-up time, capacitor life, and operating temperature. Long hold-up can help sustain reliable power delivery in spite of poor AC power conditions. Capacitors are chosen to provide long lifetimes at elevated temperatures. Every new aluminum electrolytic "can" capacitor must pass a rigorous set of reliability tests before it can be considered in our designs. We work closely with processor suppliers such as Intel to ensure our power delivery and cooling solutions meet or exceed all of the suppliers' specifications for both steady state and transient workloads. We design for high operating temperatures to meet the demanding workloads of workstation customers.

Even the smallest and most common electronic components, like resistors and capacitors, are carefully chosen based on quality, reliability, and top performance. A dedicated team in the HP Workstation Research and Development organization performs a thorough assessment of every critical component and tracks even the smallest manufacturing changes to these components during the lifetime of the product.

Brutal three-axis testing

In choosing workstation components, we don't stop at the specifications in the manufacturer's data sheet. In our workstations test lab in Fort Collins, Colorado, we subject components to rigorous testing to verify their performance under extreme conditions. In brutal three-axis testing—where frequency, voltage, and temperature are varied—our engineers push the limits of processors, memory, and other system parts.

This testing goes far beyond the boundaries of typical use models. Inspired by a long history of workstation technologies development, including HP-designed processors and chipset or graphics chips, this three-axis testing uses proprietary tools and techniques, and stresses components in ways that help detect potential design or component weaknesses that would otherwise go unnoticed. Various memory DIMM modules, for example, often fail our three-axis testing, and are disqualified by HP despite being used by other workstation manufacturers. Memory suppliers, in turn, often look to HP to identify design and silicon issues in their products.

Ultimately, this aggressive testing program yields extremely reliable end-products. It allows us to design and ship workstations with robust functional margins and components that can easily handle the conditions and workloads of professional environments from car test tracks to oil fields, from manufacturing floors to construction trailers and other rugged environments.

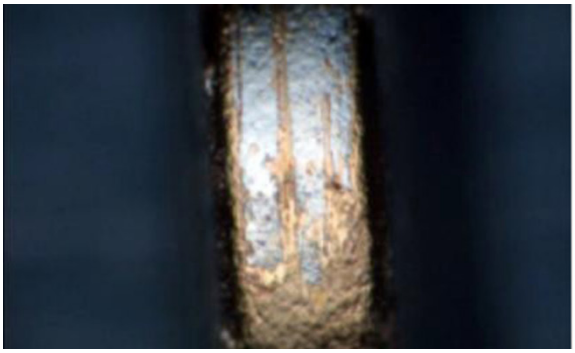
Materials and chemical testing

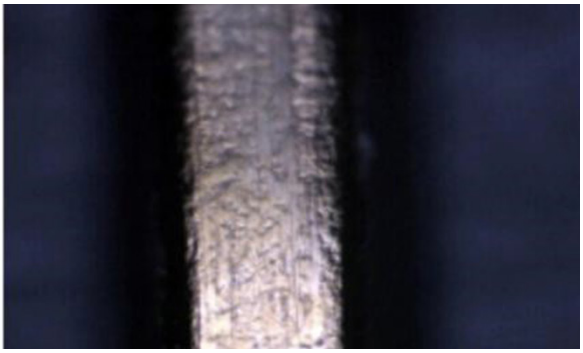
We achieve a high level of I/O, memory, and other component reliability through our adherence to strict standards for materials selection and our tight control of the HP-approved vendor list. And we don't stop there. Working in our state-of-the-art materials analysis lab, our test engineers and materials scientists physically deconstruct workstation components to study the materials and the chemicals used in them, employing advanced scientific equipment such as spectrometers, electron microscopes, and X-ray machines.

Figure 1. The HP Workstations Materials Science Lab, a state of the art facility used to test HP Workstation products beyond standard industry practices.

Selecting high-quality materials and processes is key to achieving high reliability; cutting corners typically results in premature failures. Our analysis, specifications, and selection processes drive designs that use above-standard quality components. One example of this is memory DIMM sockets. Each socket comprises hundreds of contacts whose material interface, if not carefully selected, deposited and controlled, can lead to corrosion. A corroded contact can create a point of failure on a system motherboard in a data-sensitive area. The quality of the materials and the chemicals used in our DIMM sockets, such as the thickness and quality of the gold plating deposition process, are carefully evaluated. If necessary, we work with the manufacturers to drive the parts to the proper quality levels. The gold plating standards chosen by HP Workstations is the result of decades of scientifically based reliability testing and is significantly higher than what is found on consumer products.

Figure 2. A failing (left) and passing (right) result from the standard socket wear testing procedure. The gray patches in the failing image are regions where the gold has been inadvertently removed by normal insertion of a memory stick, exposing the base nickel beneath. This nickel can then corrode, increasing resistance at the contact surface. This can lead to system malfunction and failure.





This same level of materials analysis was used during our conversion to low-halogen systems[2]. The HP Workstation R&D team did not treat all available unrestricted materials as acceptable options. We engaged in a thorough analysis of the new materials that would need to be used on workstation motherboards to ensure that the low-halogen materials met our reliability and performance expectations. The result of this analysis was low-halogen materials that exceeded our expectations in almost every reliability and performance category while producing a product with a reduced environmental impact.[2]

One system, multiple tests

Rather than running different tests on different systems, we take a single system and put it through a series of physical tests, including vibration and shock tests, to see how well it holds up under combined stresses. In addition, a system goes through a series of operational and non-operational temperature extreme tests. We then correct any issues and repeat the cycle. We continue to test until we achieve the high level of quality our customers expect.[3]

Figure 3. Examples of the tools used to shake and drop our products, simulating real world shipping and usage events

We know that system reliability doesn't happen simply by connecting the best components together. While high quality components are an essential piece of the reliability puzzle, there must be an iterative test-analyze-fix process. Our current platforms undergo extensive testing and validation, including functional, electromagnetic, shock, vibration, acoustics, temperature, humidity, environmental compliance, compatibility and integration. This iterative process has been integral to the development of HP Workstations for 30 years.

Enterprise-class qualification

We carefully qualify many components that are selected for their enterprise-class reliability and performance, such as ECC memory, SSDs, graphics cards, and SAS hard drives. Our qualification processes start with industry-standard tests and benchmarks, but go above and beyond to also make use of proprietary HP test tools and techniques that have their origins in our long history in the workstation market. These processes comprehensively cover the software, hardware, and firmware interactions of the components with the system and other components. Proprietary hardware and software test tools backed by dedicated test developers, enable HP to test and validate new, state-of-the-art subsystems and high-speed interfaces before still-to-be-developed third party devices are available.

In some cases, this rigorous qualification enables us to find issues that have been previously overlooked by our component suppliers. Our strong relationships and influence with these partners enable us to obtain and integrate improved components into our systems, many of which are unique to HP Workstations. Frequently, we discover that very large expansion cards, like workstation graphics, require additional mechanical reinforcement to pass the rigorous requirements of worldwide shipping. Our team of mechanical engineers works closely with companies like Intel, NVIDIA® and AMD to produce these HP Workstation-only reinforcements. This helps ensure that the entire product arrives in working condition and continues to function at peak performance throughout its lifetime-even when packed with large, powerful graphics and compute cards.

Components in our systems often use firmware and driver versions with HP-specific enhancements or improvements to help ensure a seamless user experience.

Exacting standards

We are unyielding in our adherence to HP quality standards. For example, the power supply unit (PSU), like the rest of the system, undergoes rigorous testing to verify functionality which includes extensive temperature, input voltage and frequency testing. We also give special attention to the choice of aluminum electrolytic capacitors. Through component evaluation in our materials analysis lab, we know that poorly constructed capacitors can lead to bulging and venting and result in an early failure. We examine capacitors at a molecular level to ensure consistent quality, and also work directly with the suppliers on construction and enhanced reliability testing in order to ensure the highest quality possible. We require our power supply vendors to justify changes in capacitors by providing evidence of compliance and test results for not only industry standards but also HP-designed reliability testing.

By enabling our workstation engineers to select better components, we increase our design margins and improve the overall reliability of HP Workstations.

A few other examples of our exacting quality standards:

- We qualify and test every DIMM type, vendor, and revision used in our workstations.
- Compared to common industry practices, we use highly-rated critical electrical components for system stability and long lifetime, as dictated by our design standards.
- We use multi-point thermal sampling to optimize the acoustic and thermal performance of HP Workstations.
- We develop and perform reliability test methods to check every connector in a system for durability and reliability over the lifetime of the product.
- Manufacturing processes are tightly controlled to ensure that any component change that could affect reliability is carefully evaluated by our engineers.
- Every stacked-core inductor in the product is tested for proper materials composition and construction.

Building reliable solutions

At the broader ecosystem level, we work closely with our technology partners to deliver reliable workstation solutions. A few examples:

- We work with leading independent software vendors (ISVs) through the HP Application Competency Centers, which are virtual teams that often include an HP engineer residing on site at the ISV. These engineers test and certify our workstations so we are confident in the total solution quality.
- We share our unique graphics qualification tools and processes with our graphics suppliers to ensure that their products meet our requirements for reliability and performance.
- We ship our workstations with HP Performance Advisor, a software application that helps the user identify the proper drivers and settings for specific technical applications to optimize performance.

This behind-the-scenes work helps us ensure that the HP Workstation is ready for the rigors of any work environment and the steep demands of professional applications.

A system you can trust

Workstation professionals demand solutions that continue to improve throughout their lifecycles. That's why we promote a quality-focused culture here at HP, with incentives for our partners who consistently uphold and surpass our high standards for quality. Our extensive product testing and early warning programs detect and address potential concerns before they become problems. We monitor and measure the quality of components and platforms to ensure we are delivering reliable solutions. All of these activities—including customer comments and input—feed back into our design and engineering helping to ensure that preventive actions are implemented to address any issues discovered across the lifecycle. Ultimately, our intense focus on reliability gives our users greater peace of mind when running professional applications on an HP Workstation.

Additional resources
hp.com/go/whitepapers

[1] Class 2 electronics as defined by the IPC-A610E standard "Acceptability of Electronic Assemblies."
[2] External power supplies, power cords, cables and peripherals are not Low Halogen. Service parts obtained after purchase may not be Low Halogen.
[3] HP Total Test Process results are not a guarantee of future performance under these test conditions.

Sign up for updates
hp.com/go/getupdated

Share with colleagues

Rate this document

4AA4-3573ENW, January 2015