

## SSD Testing Made Easy With Teledyne LeCroy

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### Summary

Solid-state storage (SSD) has become the cornerstone of modern computing, offering superior performance, reliability, and durability compared to traditional mechanical hard drives.

While SSDs offer numerous advantages, including faster data access, lower power consumption, and enhanced durability, they are not immune to issues such as data loss, performance degradation, and unexpected failures.

This necessitates comprehensive testing to ensure that SSDs meet the demands of modern computing with professional test tools like Teledyne LeCroy's OakGate SSD Test Solutions.

This paper explores the reasons why solid-state storage testing is crucial in today's technology landscape, addressing issues related to performance, reliability, and data security.

### Introduction

Solid-state storage has revolutionized the world of data storage and retrieval, replacing conventional hard disk drives (HDDs) in many applications. While SSDs offer numerous advantages, including faster data access, lower power consumption, and enhanced durability, they are not immune to issues such as data loss, performance degradation, and unexpected failures. This necessitates comprehensive testing to ensure that SSDs meet the demands of modern computing.

### Reasons for Testing SSDs

One of the primary reasons for testing solid-state storage devices is to guarantee consistent performance. SSDs are known for their impressive read and write speeds, but their performance can fluctuate under various conditions, including workload intensity and temperature. Testing allows manufacturers and users to understand an SSD's performance profile, ensuring it meets specified requirements and can handle real-world workloads effectively.



Reliability is paramount when it comes to data storage, especially in critical applications such as enterprise servers and data centers. Solid-state storage testing helps identify potential points of failure, such as NAND cell wear-out, firmware bugs, or controller issues. By identifying and addressing these issues, manufacturers can produce more reliable SSDs, and users can make informed decisions about their storage solutions.

Another vital aspect of solid-state storage testing is evaluating the endurance and longevity of SSDs. NAND flash memory has a finite number of write-erase cycles, and excessive writes can lead to data corruption or drive failure. Through thorough testing, manufacturers can determine an SSD's endurance rating, helping users select the appropriate drive for their specific needs.

Data security is a predominate concern in today's digital age. Testing solid-state storage devices includes examining their data retention capabilities and resistance to data breaches. By understanding potential vulnerabilities,

manufacturers can implement advanced encryption and security features to protect sensitive information stored on SSDs.

Testing is essential not only for individual SSDs but also for their compatibility with various hardware and software environments. Ensuring that SSDs work seamlessly with different operating systems and platforms is crucial for user satisfaction and system stability.

## Benefits of a Rigorous Test Plan

- **Quality Assurance:** Testing ensures that the SSDs meet the manufacturer's specified quality standards. This helps prevent subpar or defective products from reaching the market, which could damage the manufacturer's reputation and result in costly recalls and warranty claims.
- **Performance Verification:** Testing allows manufacturers to verify that the SSDs meet the promised performance metrics, such as read and write speeds. This helps establish consumer trust by delivering products that perform as advertised.
- **Reliability and Durability:** Testing helps identify potential points of failure in SSDs, such as firmware bugs, controller issues, or NAND cell wear-out. Addressing these issues before selling the products improves the overall reliability and durability of the SSDs.
- **Endurance Assessment:** SSDs have a limited number of write-erase cycles, which can vary depending on the type of NAND flash used. Testing helps determine the endurance rating of an SSD, allowing manufacturers and users to select the appropriate drive for specific workloads to ensure long-term reliability.
- **Data Security:** Rigorous testing can reveal vulnerabilities in data security features, such as encryption and data retention capabilities. Manufacturers can then implement necessary safeguards to protect sensitive information stored on SSDs, which is especially crucial in enterprise and government applications.
- **Compliance with Standards:** Manufacturers must often adhere to industry and regulatory standards. Testing helps confirm that SSDs comply with these standards, ensuring that they are safe, reliable, and secure for use in various applications.
- **Customer Satisfaction:** By delivering SSDs that have undergone rigorous testing, manufacturers can increase customer satisfaction. Users can trust that these products will perform reliably, which can lead to positive reviews, repeat business, and brand loyalty.
- **Reduced Warranty Claims:** Proper testing can identify potential issues early in the manufacturing process, reducing the likelihood of SSD failures and warranty claims. This helps manufacturers save on warranty-related expenses.
- **Market Competitiveness:** In a competitive market, consumers have numerous options when choosing SSDs. Manufacturers that invest in thorough testing can stand out by offering products that are not only faster and more



reliable but also more thoroughly vetted.

- **Long-Term Reputation:** A manufacturer's reputation is closely tied to the quality of its products. Consistently delivering tested, reliable SSDs can help build a positive long-term reputation, fostering trust among consumers and business partners.

## SSD Testing Made Easy with Teledyne LeCroy



Testing solid-state storage products is a crucial part of the manufacturing process to ensure quality, reliability, and performance.

By implementing comprehensive testing procedures, solid-state storage manufacturers can ensure that their products meet high-quality standards, perform reliably in various conditions, and provide customers with a positive user experience.

Teledyne LeCroy OakGate SSD Test Solutions were specifically designed to make comprehensive SSD testing easy. OakGate's SSD test and validation appliances and software are the industry's most advanced with an unprecedented level of functionality, performance, and ease

of use for testing storage devices.

OakGate's products have been hardened over fifteen years in intense test environments at major SSD customer sites worldwide. Our products have been deployed by top tier components suppliers, drive manufacturers, and storage system OEMs worldwide. OakGate's integrated SSD test software called SVF/Enduro was developed from the ground up to provide the following comprehensive test coverage:

- **Product Validation:** Designed to test functional integrity of the product and uncover bugs. The user can do so via complex traffic generation and error injection.
- **Protocol Conformance:** Provides a large set of built-in tests that helps verify conformance with a specific protocol that the device supports. The user can of course add his own unique tests as well.
- **Performance Benchmarking:** Allows the user to measure the true performance of the device under various workloads and generate all kinds of graphs and histograms.

Around these three core pillars, the software incorporates a number of advanced capabilities.

- **Command Level Analyzer:** The command level analyzer records each command and lets the user go back analyze what led to a specific error. The analyzer provides real-time protocol analysis capability, statistics collection, and error states identification, allowing for fast isolation of an I/O or error condition.
- **Power Control and Measurement:** Users can perform power cycling and power measurements on an individual DUT basis. Additionally, users can test all the device's sideband signals.

- **Flexibility:** Users can their write their own test scripts to exercise specific functionality. For example customers can write Python test scripts and run those through our REST APIs.
- **Automation:** Users can automate their test plans with nightly firmware builds. Additionally, these tests can be integrated into customer’s test framework.
- **Push-button Testing:** For users who need simple push-button testing, the software is integrated with hundreds of canned “directed” tests easily selected from drop-down menus.

Here is a comprehensive guide on how a solid-state storage manufacturer can test their products with OakGate solutions.

## 1. Functionality Testing

- a. **Functional Integrity:** Ensure the SSD functions the way it was designed to and operating properly.
- b. **Error Handling:** Confirm the SSD is handling error conditions correctly by injecting errors while running complex traffic patterns.
- c. **Data Validation:** Verify data is being written (write) and returned (read) correctly.

## 2. Performance Testing

- a. **Sequential Read/Write Speed:** Measure the maximum sequential read and write speeds of the SSD under ideal conditions.
- b. **Random Read/Write Speed:** Evaluate the SSD's random read and write performance using various block sizes and access patterns, as this is critical for real-world use.
- c. **IOPS (Input/Output Operations Per Second):** Determine the SSD's IOPS performance for both read and write operations, which is especially important for database and server applications.

## 3. Data Security Testing

- a. **Encryption Testing:** Verify that the SSD's encryption features work as expected and cannot be easily bypassed.
- b. **Secure Erase Functionality:** Ensure that the secure erase functionality effectively wipes all data from the SSD, preventing data recovery.
- c. **Data Retention Testing:** Assess the SSD's ability to retain data over an extended period without corruption or data loss.

## 4. Quality Assurance and Reliability Testing

- a. **Burn-In Testing:** Subject the SSDs to extended periods of continuous operation to identify early failures and ensure long-term reliability.
- b. **Firmware Testing:** Verify that the firmware is stable, bug-free, and provides consistent performance.

## 5. Compliance Testing

- a. **Protocol Conformance:** Ensure that the SSD complies with industry standards such as NVMe and PCI Express. Test the NVMe command specifications thoroughly. Includes positive and negative testing.

## 6. Data Recovery Testing

- a. **Data Recovery Scenarios:** Test the SSD's ability to recover data in the event of accidental deletion or drive failure.

## 7. Real-World Workload Testing

- a. **Simulated Workloads:** Perform testing with real-world simulated application workloads to assess the SSD's performance in typical usage scenarios.
- b. **Power Control and Management:** Generate complex traffic patterns and test how the SSD handles power interruptions or loss under stress.

## Summary

In conclusion, solid-state storage testing is of critical importance in today's technology landscape. It ensures the performance, reliability, and longevity of SSDs, which are integral components of modern computing systems. Moreover, it contributes to data security and compatibility, providing users with the confidence that their data is safe and their storage devices work seamlessly with their systems. As the demand for solid-state storage continues to grow, so too does the need for comprehensive testing to meet the ever-increasing expectations of consumers and businesses alike.

By implementing these comprehensive testing procedures with professional SSD test and validation tools from Teledyne LeCroy, solid-state storage manufacturers can ensure that their products meet high-quality standards, perform reliably in various conditions, and provide customers with a positive user experience.

This, in turn, helps build trust and a positive reputation in the market. By investing in solid-state storage testing, manufacturers can produce high-quality SSDs, and consumers can make informed decisions about their storage solutions, ultimately contributing to a more reliable and secure digital ecosystem.

For more information and/or demonstration of OakGate SSD Test Solutions and other Teledyne LeCroy products, visit <https://www.teledynelecroy.com/oakgate> or contact us by email at [sales@oakgatetech.com](mailto:sales@oakgatetech.com).