Virtium
Memory and Storage Solutions

White Paper

What Makes a Successful Embedded SSD Design?

Introduction

The embedded storage market is full of various solutions touted as “industrial grade” by their suppliers. But, not all of these SSDs are created equal. Many of the supposed “industrial” SSDs are actually originally built as consumer-grade devices. They are then repackaged and marketed as industrial embedded SSDs, yet lack much of what these devices should have.

An OEM seeking a true and fully supported embedded industrial SSD solution should look for essential features (e.g. power-fail protection, enhanced endurance, wide temperature support), proprietary firmware, stringent testing methods, a supplier with a strong relationship with NAND manufacturers, and quality components.

Essential Features

There are many features that are required to meet the enhanced reliability needed by industrial-embedded systems that consumer-grade devices simply don’t have. Many times, these industrial-embedded systems operate in extreme environments or are running critical field applications. Simply designing to an industry standard (e.g. MO-297) and using off-the-shelf industrial-rated components is not enough. These drives would fail qualification, or worse, would fail after being deployed.

The following features should be included:

- SLC NAND flash options – SLC NAND is rated much higher in endurance and reliability compared to MLC NAND flash so is the best solution for long-lifecycle (5+ years) deployments as well as deployments in difficult to reach locations and/or those with harsh environmental conditions where temperatures fall outside of the commercial 0C to 70C range. SLC NAND flash is also typically supported by NAND flash manufacturers for a much longer period of time (5+ years) than MLC NAND flash, which has been on a 12-18 month die shrink/transition rate over the past several years.
- Support of advanced flash management – enables more robust operation with higher endurance, data integrity, and data retention
- Integration of power-fail corruption mitigation technologies - many embedded systems need power-fail protection as they run 24/7/365 and are often deployed in environments with unreliable or inconsistent power sources; without a robust power-fail mitigation mechanism, a deployed system runs a higher risk of failing
- Backed with extensive design and reliability testing – industrial-grade devices should undergo intensive testing as there are hundreds of different applications they can be used for

Proprietary Firmware

OEMs should also seek out an SSD supplier that develops its own proprietary firmware instead of one that incorporates firmware from a third party developer. Suppliers building their own firmware from the ground up have full control of it. A deep and thorough understanding of the controller design allows for more reliable firmware development accompanied by proven testing capabilities.

A proprietary firmware allows for:

- Firmware fine tuning – an internal team can quickly and frequently make changes to the firmware to improve performance, instead of having to wait for the outside firmware developer
- Timely bug fixes – problems can be resolved much faster between the customer and SSD supplier, with no middleman to slow the process down
- Implementation of advanced flash management features – a more knowledgeable supplier has the expertise to integrate these features to enable better performance and longer drive life
- Designing for customer specific applications – many customers still need support for their outdated legacy systems, which frequently have unique timings and power requirements
- Compatibility with non-traditional operating systems – these include in-house developed solutions, real-time operating systems, and Linux variants, so customers are ensured of broader support for their applications

With complete control of the proprietary firmware, better and more efficient product designs can be achieved.

Testing, Screening, and a Strong Manufacturing Relationship

Embedded industrial SSDs must have hardware designs with self-testing and screening methods that are suited for high-volume manufacturing. The test programs are used to reach deep into the memory array to uncover inherent flash media weaknesses. These weaknesses can then be overcome with firmware changes and more sophisticated flash management features.

Similar to the design in a car engine, self-testing programs act as the mechanics of the drive and help ensure long-term functionality and reliability. It's important that proprietary firmware initially be "tuned" with an SSD's flash to ensure it will function reliably over the life of the drive. Each type of flash media has its own unique program and erase characteristics that can be affected by timing, voltage, etc. Using "cookie cutter" firmware will simply not recognize the intricacies of the flash and won't be as efficient as one specifically built for it. Constant tweaks and fixes that are necessary after the initial tuning are also identified by the self-testing programs.

Before a drive is even shipped, thorough screening is performed during the manufacturing process. Here, embedded flash and built-in self-tests are run at the controller level to scan the flash media for bad blocks that don't meet a set threshold. This is where it helps to know that your industrial-grade SSD supplier has a strong and strategic relationship with leading flash media manufacturers.

Therefore, it is crucial when selecting an embedded-industrial SSD supplier that the company has extensive NAND flash experience that extends beyond standard datasheet knowledge. Comprehensive understanding of the various types of NAND are required by engineering teams in order to develop controller and firmware technology that can most effectively manage the specific flash media. This includes having knowledge of specific modes and other intricacies within the flash to conduct thorough testing. NAND manufacturers typically provide access to these modes and programming options to select suppliers with which they have strategic relationships.

Quality Components

Much planning goes into the choice of components from both quality and product longevity perspectives. This is simply because industrial customers frequently require long product lifecycles. Duty ratings and tolerances are key concerns to customers, so their products can endure rigorous workloads and extreme environments.

Care must be taken to identify components that have long product lifecycles and a clear migration path to their replacements. It can be costly and time-consuming to frequently qualify and re-qualify drives. Embedded systems OEMs want assurance that the SSD they're buying is exactly the same as the first one they bought. The longer a component will be supported and produced, the better. But, this isn't always possible and replacement components must be fully tested by SSD suppliers so product change notifications (PCNs) and samples of the new solutions can be provided for qualification.

Another point of differentiation of a true industrial embedded SSD supplier is that they must offer a locked bill-of-materials and support rigorous PCN processes in order to provide successful and complete industrial-grade SSD solutions.

Conclusion

All of the above must be taken into consideration by an OEM before making a selection on an industrial SSD supplier. While there may be some short term cost disadvantages, the long term advantages will far outweigh them.

Virtium's state-of-the-art SSD design center has an experienced team of firmware, hardware and test engineers that is focused on solid state storage development and in-depth characterization of Virtium SSDs applied to varying embedded workloads.

Virtium's StorFly® PE products are optimized for higher reliability embedded applications requiring increased performance, such as networking appliances or industrial computing and would be an excellent choice for any OEM seeking a complete and fully supported embedded industrial SSD solution. Learn more at www.virtium.com/storfly.

Virtium manufactures memory and storage solutions for the world's top industrial embedded OEMs. For 18 years we have designed, built and supported our products in the USA - fortified by a network of global locations. Our world-class technology and unsurpassed support provide a superior customer experience that continuously results in better industrial embedded products for our increasingly interconnected world.

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30052 Tomas | Rancho Santa Margarita, CA 92688
Phone: 949-888-2444 | Fax: 949-888-2445
www.virtium.com