Virtium
Memory and Storage Solutions

White Paper

Choices in Advanced-TCA Storage Technology

Introduction

Along with compactness, higher functionality and density, as well as reliability, non-volatility, faster access speed, and lighter weight make AMC with Flash a significant new technology.

Comparison between Hard Disk Drive (HDD), Solid State Drive (SSD), and Flash-on-board options to help the AdvancedTCA community better understand the technology that best fits various applications.

The applications for AdvancedTCA continue to challenge electrical and mechanical engineers by constantly demanding more functionality in smaller spaces. In addition to the overriding macro trends in the marketplace for higher density and reliability, the need for physical compactness of the technology in storage media is quickly becoming an absolute requirement in AdvancedTCA and MicroTCA.

Advanced Mezzanine Card with Hard Disk Drive (AMC-HDD) and AMC with Solid State Drive (AMC-SSD) are technologies that aimed at filling the overall needs for the AdvancedTCA community with regard to higher density, reliability, and costs. Despite the unique advantages of these technologies as well as their timeliness to the market, these ad hoc solutions have yet to meet the compactness requirement that is so crucial for the end users of AdvancedTCA products.

AMC with HDD

The HDD has come a long way since its invention 52 years ago but surprisingly has not changed much in the past five years. When we look at their basic design we see that HDDs are not much different today than the original drives installed in the first IBM PCs in the early 1980s. However, in terms of their capacity, storage, reliability, and other functional characteristics, hard drives have improved dramatically.

The consistent trend in HDD form factors is for ever-smaller drives. Larger size 5.25" drives have now virtually disappeared from the mainstream PC market, and 3.5" drives dominate the desktop and server segment. In the embedded telecom market, particularly in AdvancedTCA, 2.5" drives mounted on AdvancedTCA blades and AMC boards are prevalent in most applications because of their higher densities and competitive prices.

Over the next few years, desktop and server drives will transition to the 2.5" form factor, giving HDD extended life. In the AdvancedTCA environment however, SSDs have made a bigger impact due to improved reliability over HDD. Figure 1 illustrates the HDD mounted in the AMC board in a cross-section view.

Figure 1: Mounted Drive

AMC with SSD

In response to increased demands for smaller, faster, and better products, the first SSD made its debut in 1978. SSDs have come a long way since their introduction, when they included a rechargeable battery to preserve the memory chip contents. It wasn't until 1995 that the first Flash-based SSDs were introduced. Since then SSDs have been used successfully as hard disk drive replacements in many applications, including AdvancedTCA.

The military and aerospace industries, as well as other mission-critical applications, drove early SSD growth. These applications required high reliability to provide greater resilience to physical vibration, shock, and extreme temperature fluctuations.

Today, the SSD storage medium is not magnetic and has no moving arm like a hard disk. It is built with NAND Flash or DRAM and/or a combination of both technologies, and in some applications it is a good alternative to rotating disk drives.

SSDs built with Flash have nonvolatile memory, which makes them a more rugged, compact alternative for high-end applications. Unlike their predecessors, they don't require batteries. In addition, non-volatility allows Flash SSDs to retain memory even during unexpected power outages, ensuring data retrievability. Relative to HDD, SSD is more flexible in increasing densities and is more easily upgradeable.

AdvancedTCA and AMC modules deliver high-performance networking and storage solutions at the board and blade level, but in some cases the SSD form factor limits these solutions. The AMC-SSD has the same footprint as the AMC-HDD - leaving no room for adding more components. The introduction of Flash-on-board has brought a new dimension to the dilemma by mounting the Flash components directly on the AMC module, providing more functionality, less weight, and a smaller size.

AMC with Flash Technology On Board

Industry-wide problems such as space constraints, mechanical breakdown of the hard drive, and high temperatures in demanding embedded environments were not being fully addressed with existing solutions.

By directly incorporating NAND Flash on the AMC board, memory designers are given unprecedented freedom and space to mount additional components onto the AdvancedTCA system board without encroaching on any height, width, or depth restrictions - a critical benefit not found with existing SSD or HDD drive alternatives. AMC-SSD has the same footprint as AMC-HDD, thus SSD does not solve the form factor and weight issues. The physical size of SSD limits its potential to upgrade and increase density when compared to Flash.

Figure 2 illustrates the clearance gained as additional space for future density stacking as well as an air gap, allowing better thermal management.

Figure 2: Board Clearance

In contrast to AMC-HDD, the AMC with Flash has no mechanical seek or rotation latency and no moving parts, giving it superior ruggedness to endure in vibrational and shock-prone environments, which could lead to catastrophic failures with total loss of stored memory. In addition to access speed, NAND Flash technology brings a higher level of functionality for storing multimedia applications. With smart wear leveling, Error Correction Code (ECC), and Single-Level Cell (SLC)

NAND Flash on board, reliability is aligned with its silicon components. The AMC module becomes a lighter product by eliminating the heavier SSD or HDD and simplifying design and procurement efforts.

Mounting Flash components directly on the AMC board simplifies the interface and eliminates issues with disk rotation speed. This process and architecture provides a higher reliability than any rotating disk currently available and improves the performance and redundancy of the drive.

AMC with Flash offers a high availability platform and increased reliability storage option for mission-critical applications requiring 99.999 percent uptime and 15 to 20 years of field service life. Plus, its ability to deliver superior ruggedness in harsh environments makes this solution a fundamental player in military operations, such as defense, aerospace, or aviation applications.

Cost is always an important factor and concern in many consumer systems. Designers are always evaluating the "cost versus features" trade-off. It is also a primary consideration by managers that if a desired system can be brought to the market for an affordable price, that product should succeed. As indicated by market trends, solid state memory capacities are increasing while the cost per bit of Flash continues to decline at notable pace, making AMC with Flash a readily viable solution for the AdvancedTCA platform.

AMC-HDD might have a slightly lower price, but does it have the features and benefits of a chip on board option? It is clear that issues do exist in regards to storage on an AMC, but getting over this hurdle depends on the choice of AMC-HDD, AMC-SSD, or AMC with Flash technology. Also, the risk of HDD storage malfunctioning is three to four times that of an SSD. Incorporating a Flash on board AMC solution eliminates the impact of infringing on the AMC height and depth standards (form factor) and as a plus allows additional space for more functionality to address thermal issues. Critically examining the system integration times for SSD and for Flash reveals economic benefits: engineers will need less time to validate AMC with Flash because it can be assembled and integrated on the board. The cost savings in reduced engineering time for Flash clearly outweighs the initial procurement outlay.

Solid state storage provides the user with high performance, high reliability, and greater design flexibility and a lower total cost of ownership. AMC with Flash provides for higher data reliability (non-volatility), multiyear product life cycles, and high shock and vibration tolerances. It is not uncommon to see greater than 4,000,000,000 hours MTBF while operating over temperatures ranging from -40 ºC to +85 ºC.

Figure 1 compares AMC-HDD, AMC-SDD, and AMC with Flash on board, shown left to right in Figure 2.

Summary

The technologies and solutions described in this article creatively address the needs of the AdvancedTCA market. It is quite compelling that perhaps the new Flash on board technology overall could emerge as the next evolutionary products and as the storage media of choice for achieving higher functionality and density, best reliability and nonvolatility, faster access speed, lighter weight, and most of all for its compactness that meets form factor constraints. Logic would suggest that AMC with Flash "fits the bill" as a new and significant technology driving even greater growth and development in AdvancedTCA applications.

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