Solid State Storage for Medical Equipment Applications

Utilizing the ideal storage solution in a medical device can be the difference between a success story and a failure. Due to an array of benefits in terms of size, power consumption, reliability, and durability, solid state storage fulfills the need for many medical devices. This article provides a comparison of solid state storage to other alternatives when used specifically in medical device technology.

By Gary Drossel
The medical industry has very demanding requirements, especially with regard to storage. The requirements for size, power consumption, reliability, and durability in medical systems are among the toughest designers have to consider. It is because of these considerations that choosing the right type of storage for a particular medical device application has become increasingly more complex.Several popular storage solutions have been adopted by medical equipment manufacturers with the leading choices being hard drives and solid-state storage. As technology develops, host system speeds get faster, form factors get smaller, and more is required of medical devices. Solid-state storage increasingly shows it has the performance, scalability, security, and endurance to meet the designer's needs. However, not all solid-state storage solutions are created equal. To determine the best storage solution, designers must be able to compare many factors between hard drives, consumer grade flash cards, and advanced solid-state storage technology.

Storage Considerations

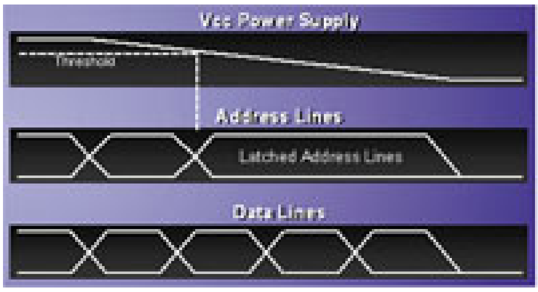
Current trends in the healthcare industry are to make medical devices as portable and space-saving as possible. The use of medical devices outside of hospitalsin places such as rest homes, aircraft, and paramedic vehiclesis becoming more common. In-flight medical equipment adds the elements of temperature and altitude to a designer's concerns. Operating rooms are becoming more streamlined requiring that more equipment fit into less space which translates into physically smaller and lower power medical devices. In addition, medical equipment needs to be extra durable to ensure that they are reliable even with rugged use or exposed to wide temperature and altitude variations. Other storage design consideration concerns include how power anomalies affect data integrity with the common practice of devices suddenly switched off and on; frequent alternation between AC and battery backup power; and encountering the spikes, surges, brownouts, and blackouts common in most commercial power supplies.In 1996, Congress passed the Health Insurance Portability and Accountability Act (HIPAA). Among the provisions of this sweeping legislation is the requirement that patient information be standardized, easily collectible, match the correct patient, and be kept private. This has added more concerns for designers, as data must be protected from unauthorized access. HIPAA also requires specified retention periods for some various types of medical information, regardless of media they are stored on. These retention requirements can stretch up to 21 years of age for pediatric records, or beyond the lifetime of adult patients.

Storage System Comparisons

Solid-state storage offers several advantages over traditional storage solutions. First, solid-state storage has no moving parts, a definite plus when the environment is considered. Medical equipment with solid-state storage is not susceptible to shock or vibration. Rotating hard drives, with a moving actuator arm and spinning platter have a much greater chance of malfunctioning when bumped or moved suddenly. Often, simply moving a hard drive in close proximity to another machine (exposing it to vibration) can prove detrimental. Hard drives have lower temperature and altitude tolerances as well, a factor that comes into play more and more as medical equipment is deployed in mobile environments such as airplanes and life flight helicopters.Another key benefit using solid-state storage affords to designers is with regard to power consumption. Low-power applications increase performance and extend battery life. On average, traditional hard drives are rated at a consumption of 2.5 watts (W), while the average solid-state drive has a rating of a significantly less 0.2 W. This is almost 13 times less than the traditional hard drive's consumption.

Where power requirements are a concern, so too is physical space. Rotating hard drives are confined largely to 2.5- and 3.5-inch form factors. Solid-state storage, on the other hand, is far more flexible. Solid-state storage can be deployed in a number of smaller industry-standard form factors such as CompactFlash or 1.8-inch drives. Choosing solid-state storage can be an important step in designing lighter, more portable equipment.

Making the Move to Solid-State Storage



Solid-state storage offers many advantages to the medical system designer. But not all solid-state storage is created equal, and traditional solid-state flash card technology originally developed for consumer applications may not stand the rigors of the medical industry. Comparing the three most popular storage solutions will help designers put their features into better perspective (see Chart).
Advanced storage technology can be understood best by looking beyond product specifications and form factors. As in any application, there are design trade-offs between performance, reliability, and price. In consumer and commercial applications, devices contain only data. In industrial-grade applications needed for medical applications, storage systems often have an operating system, mission critical data files, and the need for advanced security to protect patient data and software IP.

Overcoming Medical Equipment Market Concerns

Handling Power Anomalies

Approximately 75% of storage product field failures are due to power disruptions. Spikes, brownouts, surges, and blackouts are especially worrisome when it comes to healthcare, as they can cause medical devices to operate improperly or cease functioning altogether.Advanced solid-state storage has integrated voltage detection circuitry that can detect any possible power problems. When a voltage threshold has been reached, the drive sends a busy signal to the host system ceasing command transmission until the power level stabilizes. Address lines can then be latched, ensuring data is written to the proper location to prevent sector overwrites which can cause drive corruption (Figure 1). This is even more critical in medical devices that have been designed for low power for extra performance and extended battery life. During an under voltage situation, there may not be enough voltage to power the device and the memory components, causing the host system to continue to send data which can corrupt the drive.

Multi-Year Product Lifecycles

Medical equipment is expected to have a long operational life, often seeing frequent use in less-than-optimal conditions. Such equipment is often expensive to replace, and thus the storage integrated into the medical equipment must be engineered for a long operational field life. In addition, since many medical devices require approval from the U.S. FDA, any forced changes or upgrades may require reevaluation or re-certification that can be costly and delay time-to-market.Products with true multi-year product lifecycles incorporate many variables.

Endurance

There are three main factors that designers must consider when calculating drive endurance: storage media, wear-leveling, and error correction (ECC).Advanced solid-state storage optimizes all three of these elements. The most advanced storage media available can achieve maximum endurance and performance to meet the critical requirements of the medical market. A high ECC algorithm should be integrated to provide exponentially better error correction than standard ECC algorithms specified in storage media used in consumer applications. By combining advanced storage media and superior ECC with a proprietary wear-leveling algorithm that evenly distributes wear over the entire solid-state drive, endurance rates could be achieved that are more than 200 times better than products designed for the consumer electronics market.

Forecasting Useable Life

Traditional flash cards run until they fail. This often occurs suddenly and without warning, leading to maintenance calls, the loss of data, and, in the medical industry, potentially life-threatening emergencies. Advanced solid-state storage uses self-monitoring analysis and reporting technology which allows users to monitor the exact amount of useable storage a drive has left. In this way, the medical equipment can accurately forecast when a potential failure will occur, thus avoiding unexpected failures which can lead to a critical or life-threatening situation.

Preventing Costly Product Requalifications

Product requalification is a frequent and very costly fact of life for systems that use many traditional storage products. Based on the timing of technology advancements made by the supplier, forced product requalifications occur whenever the current drive becomes obsolete. This can be especially worrisome for medical devices, which require government certifications as well. An architecture that supports both current and previous product developments eliminates this problem. Requalifications then coincide with scheduled technology advancements as opposed to product obsolescence. This results in a substantial cost savings.

HIPAA Requirements

With the passage of HIPAA in 1996, data security is now of paramount concern for medical device designers. Among other things, HIPAA provides for the safeguarding of individually-identifiable health information to ensure patient privacy. Again, advanced solid-state storage better prepares designers for this requirement.Using host-controlled security features, advanced solid-state storage can provide security at a number of levels to meet HIPAA requirements. Varying levels of access can be set up on a single drive. The drive can be partitioned into zones with different levels of security assigned to each zone. For routine confidentiality, data can be password protected to ensure only authorized healthcare professionals can update patient information. In other cases, data can have read-only access, granting users the ability to look up the information when needed but not change it. With many medical devices, data needs to be input, used for a patient, and then changed for another patient. The fast data erasure in the form of sweep or scrub feature provided by advanced solid-state storage would be invaluable for equipment used in this manner.

Conclusion

Requirements for smaller size, low power consumption, high reliability, and durability in medical systems have lead many medical equipment designers to recognize the advantages of solid-state storage. But a thorough comparison of the options currently available makes it apparent that not all solutions are created equal. Therefore, designers must evaluate storage solutions based on their ability to effectively handle power anomalies, provide ample endurance to perform in products with multi-year lifecycles, accurately forecast usable storage life, offer enhanced security, and provide highly reliable storage management technology. By integrating storage with these benefits, medical equipment designers can rely on the highest security, eliminating field failures from power disturbances, preventing costly product requalifications, and doing away with unscheduled downtime.When comparing traditional solid-state storage originally designed for consumer applications with advanced solid-state storage technology, advanced solid-state storage technology clearly meets the specific requirements of medical systems applications.Chart: Comparison of the three most popular storage solution systems

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