

WHITE PAPER

How to Choose Portable Memory for Embedded Systems

COMPARING CONSUMER AND OEM MEMORY DEVICES

Looking beyond “**will it work?**” helps guarantee successful embedded designs.



While most embedded system components are sourced from OEM-focused manufacturers, portable memory devices are a gray area. The high-volume consumer electronics market – estimated at \$200 billion annually¹ – creates significant demand for USB flash drives, SD cards and other consumer-focused portable memory devices. For embedded system designers, the economies of scale these devices offer can be appealing.

But manufacturers of consumer memory devices are primarily focused on the needs of the fast-changing consumer electronics market. In response, a lesser-known category of OEM-focused portable memory systems is providing alternatives that meet requirements unique to non-consumer embedded designs.

This paper provides engineers with guidance when choosing portable memory devices for use in embedded systems. The two major categories of portable memory devices – consumer and OEM – each offer unique advantages and disadvantages. Most important for engineers, however, is how the two categories perform when integrated into embedded designs in commercial, industrial, government, military, medical and other demanding OEM environments.

DESIGN CONSIDERATIONS FOR PORTABLE MEMORY

Access control and rights management, usage monitoring, data logging, in-field firmware updates, product authentication – these are just a small sampling of potential applications for portable memory in embedded systems. Additionally, the environmental factors and expected use of the system also influence which portable memory solution is the best fit for the application.

As a result, the potential design considerations for portable memory systems are extensive:

- **Communications interface/protocol**
- **Connector durability**
- **Cost**
- **Data throughput speed**
- **Environmental ratings**
- **Ergonomic factors**
- **Footprint/form factor of connector**
- **Insertion cycle life**
- **Memory capacity**
- **Number of write cycles**
- **Physical size of device**
- **Product availability**
- **Product life cycle**
- **Ruggedness of device**

Some of these design considerations may be mutually exclusive. For example, small size typically precludes rugged construction. Prioritizing the design considerations makes it easier to determine which features are most important for a particular application.

¹ Consumer Electronics: Global Industry Guide, February, 2011

THE BENEFITS OF CONSUMER MEMORY IN OEM DESIGNS

In addition to SD cards and USB flash drives, other consumer memory devices used in OEM designs may include SDHC, microSD and CompactFlash cards. While these NAND-flash-based devices are primarily designed for PCs/laptops, digital cameras, cell phones and MP3 players, the principal benefits that are intended for consumer electronics can also apply to non-consumer embedded devices:

CORNER-STORE AVAILABILITY

The widespread availability of USB flash drives and SD cards makes consumer memory a convenient option. Most users are already familiar with their operation, and it is easy for OEMs and end users to obtain these devices from electronics retailers (both online and from brick and mortar outlets).

HIGH MEMORY CAPACITY

Transferring data to and from embedded systems often only requires kilobits or megabits of memory capacity, but higher capacities available in consumer memory devices may be required in some cases. Video logging, for example, can require gigabytes of memory capacity. However, some OEM memory devices are now being offered with gigabyte capacities matching those of consumer memory products.

LOW-COST

The up-front cost-per-bit of most consumer memory devices is low. If an OEM application requires thousands of portable memory devices over the life of the design, cost can be an important consideration.

SMALL SIZE

Handheld embedded designs often require a small portable memory device to fit in the system. In these applications, a microSD card may be the most attractive option due to its small size.



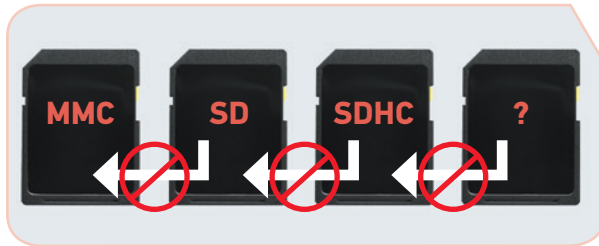
Consumer memory devices are known for offering high memory capacities, among other benefits. However, some OEM memory devices are now being offered with gigabyte capacities matching those of consumer memory products.

OVERLOOKED CONSUMER MEMORY CONSIDERATIONS

While consumer memory products are not explicitly designed for non-consumer OEM designs, they do offer unique benefits. However, these benefits may also have unintended consequences:

DOES CORNER-STORE AVAILABILITY REDUCE CONTROL, RISK UNAUTHORIZED ACCESS?

With hundreds of different models of consumer memory products available, OEMs cannot test, approve and support every device that physically fits. Despite manufacturers' attempts to ensure compatibility (e.g., Secure Digital specification), some manufacturers' models will work, while others won't. A lack of control over which devices will work can increase support costs and can be inconvenient for end users.



Additionally, technology standards change. The transition from SD to SDHC provides a recent example – a system designed to use SD cards prior to the release of SDHC will not work with SDHC cards unless the system's firmware is updated. Likewise, the fast-changing consumer electronics market virtually guarantees that a new technology will emerge in the future with its own compatibility issues.

Finally, using a consumer memory device may increase the risk of data theft. A misplaced or stolen USB flash drive is not protected from an unauthorized user accessing its data from a PC, for example. Likewise, using a USB receptacle in an embedded design allows any USB flash drive to plug in, which can increase the risk that data could be pulled off the system or that a virus or other malware could be transferred to the embedded device.

ARE HIGH MEMORY CAPACITIES UNNECESSARY?

Most consumer memory devices today start at 1GB (or higher). As such, embedded systems that require only kilobits or megabits of memory to perform a desired task are essentially paying for capacity they don't need.

IS SMALL SIZE ALWAYS PREFERABLE?

Some designs may actually require a larger portable memory device. For example, a portable memory device must be able to be easily inserted and removed by a user wearing gloves in certain military applications.

While not always apparent early in the design process, these overlooked considerations should be examined before deciding whether consumer memory meets not only the design criteria, but the expected use as well.

UNIQUE DEMANDS OF OEM EMBEDDED SYSTEM DESIGNS

Non-consumer OEM systems – those intended for use in commercial, industrial, government, medical, military and other demanding settings – are usually manufactured and designed to last years. As a result, portable memory used in these systems must provide long-term availability and reliability. The environmental conditions in which OEM designs operate can be demanding as well, and there is often an increased emphasis on secure access. Demands that are unique to OEM designs illustrate why consumer memory devices' light-duty construction, low cycle life connectors, lack of security features and short product life cycles can be detrimental to non-consumer applications.

RUGGED CONSTRUCTION NEEDED IN HARSH ENVIRONMENTS

Many non-consumer OEM designs are exposed to harsh environments. Some outdoor applications (military, construction, agriculture, etc.) use portable memory devices to transfer operation and maintenance data between the base and vehicles in the field. The memory device may be exposed to vibration, dirt, moisture, shock, temperature extremes and rough use. Light-duty consumer memory devices and receptacles do not provide sufficient protection or the environmental ratings needed for harsh environments.

FREQUENT USE, LONG-LASTING DESIGNS DEMAND DURABLE CONNECTOR SYSTEMS

Vending machines, for example, may utilize portable memory to provide cashless vending in non-networked environments. A user can use the memory device to purchase merchandise from the machine (e.g. snacks, beverages or even industrial supplies). These machines often see 50-60 cashless transactions per day. Rated at just 1,500 cycles, a USB mating receptacle could wear out in as little as 25-30 days.

MANY OEM APPLICATIONS REQUIRE INCREASED SECURITY

Accidental “data spillage” and virus uploads have been under the microscope in the government and commercial sectors in recent years. In response, some government branches and corporations have banned the use of consumer memory devices to decrease security risks. The widespread availability of devices and systems with USB and SD card interfaces leaves sensitive data vulnerable to data theft and malicious viruses.

LONG-TERM AVAILABILITY NEEDED OVER THE LIFE OF SYSTEMS

Consumer memory is driven by the consumer electronics market and therefore subject to short product life cycles and frequent obsolescence. Traffic light controllers are an example of long-lasting OEM designs that need a portable memory solution that offers long-term availability.

Technicians use portable memory to upload setup parameters to the controllers. These important pieces of transportation infrastructure are fielded for a decade or more, so a consumer-based memory device would likely become obsolete over the life of the controllers.

The inability to meet demands for rugged construction, a high mating cycle life, secure form factors or long-term availability best exemplifies when consumer memory devices should not be considered for embedded designs.

THE BENEFITS OF OEM PORTABLE MEMORY

In response to the unmet needs of many embedded systems, a less familiar category of portable memory devices—OEM portable memory—is emerging with a unique focus on OEMs. These devices provide the rugged construction, high mating cycle life, secure form factors and long-term availability that consumer memory products do not deliver.

Some manufacturers of portable memory produce “industrial” versions of consumer memory products (such as industrial CompactFlash cards or industrial SD cards). These so-called “industrial” devices may offer an extended temperature range, use slightly more robust materials and support a higher number of write cycles. However, they still share the drawbacks associated with consumer memory devices: non-robust, low-cycle-life connectors; non-secure form factors; potential obsolescence issues and a lack of harsh environment ratings.



Figure 1 – A typical OEM portable memory system consisting of (1) a receptacle and (2) a memory key or token.

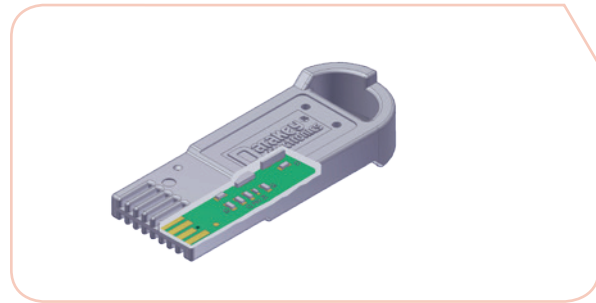


Figure 2 – Memory token using solid over-molding.

For the purpose of this guide, true OEM portable memory devices are defined as purpose-built systems that provide:

UNIQUE FORM FACTORS FOR CONTROLLED AVAILABILITY, AND BASELINE (PHYSICAL) SECURITY

OEM portable memory is most accurately described as a memory system as opposed to a singular device. Figure 1 shows an example of a typical OEM portable memory system, which consists of (1) a receptacle that integrates into the host system and (2) a memory key or token that plugs into the receptacle. The token or key will only physically interface with its unique mating receptacle, which means OEMs only have to test and support one approved device.

Additionally, unique form factors prevent most unauthorized data transfers, help protect the host system from malicious files and can provide a new potential revenue stream when an OEM becomes the exclusive source of new/replacement keys or tokens.

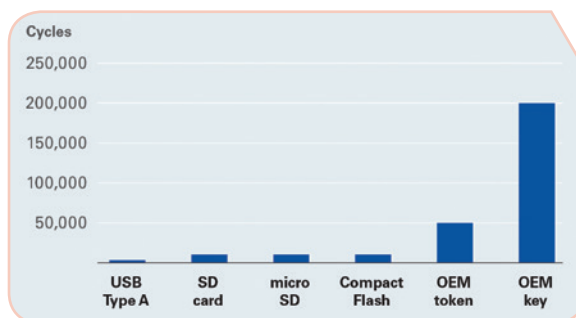
TRULY RUGGED CONSTRUCTION FOR HARSH ENVIRONMENTS AND LONG-LASTING DESIGNS

Truly rugged portable memory can withstand extreme temperatures, rough use, sterilization, chemical exposure, static electricity, dust, dirt, moisture, shock and vibration. To meet these harsh environment requirements, some manufacturers use a solid over-molding process that encases electronic components in specially engineered composite plastic materials (see Figure 2).

The environmental capabilities of portable memory devices do little good unless the receptacle is also protected. Receptacles in OEM memory systems should also carry ratings consistent with the harsh environments where they will operate. These environmental ratings may include IP ratings, such as IP65 or IP67, or military environmental ratings such as MIL-STD-810. These environmental ratings allow OEM memory systems to operate in harsh environments where consumer memory devices would not survive.

HIGH MATING-CYCLE LIFE

OEM memory systems offer a higher number of mating cycles between the memory device and its mating receptacle: ranging from 50,000 cycles to 200,000 cycles for certain OEM receptacles. For example, an OEM memory receptacle rated at 50,000 insertion cycles would last a minimum of thirteen-and-a-half years if used 10 times per day. To put that into perspective, a typical USB connector (rated at 1,500 insertion cycles) that sees the same 10 insertions per day will reach its rated cycle life in just five months.



Receptacle Cycle life – insertions/removals

LONG-TERM AVAILABILITY

Many OEM memory products have been available unchanged for over 20 years. Lower-capacity devices that utilize EEPROM or NOR flash non-volatile memory technology have a proven track record of long-term availability and are available from multiple manufacturers. This longevity significantly reduces the likelihood that OEMs will have to re-qualify new memory devices over the life of a system.

OVERLOOKED OEM MEMORY CONSIDERATIONS

While OEM memory systems typically do a better job of meeting the unique requirements of OEM applications, there are some design considerations that should be weighed against the benefits offered by consumer memory devices.

IS OEM MEMORY AFFECTED BY THE CONSUMER MEMORY MARKET?

Unlike low-capacity OEM memory, high-capacity OEM memory typically utilizes NAND flash technology. As a result, the long-term availability of high-capacity devices is somewhat reliant on the consumer market. However, OEM memory systems based on NAND flash technology typically offer better long-term availability than consumer products by using qualified/consistent sources, utilizing configuration control, and providing built-to-last designs.

IS OEM MEMORY FOCUSED ON LOW-CAPACITY APPLICATIONS?

Many OEM memory systems are geared towards the low-capacity applications that are more prevalent in non-consumer embedded systems. However, as previously stated, some newer OEM memory systems offer higher capacities that match those of consumer memory products. Most important to engineers is that the chosen memory solution be offered in a range of memory capacities that best meets the specific memory capacity needs of the system.

IS OEM MEMORY MORE EXPENSIVE?

Bit-for-bit, OEM memory is typically more expensive. However, the longevity and consistency that OEM memory systems provide usually result in a lower total cost over the life of the system. Compared to consumer memory devices, OEM memory systems reduce the likelihood that OEMs will have to waste valuable engineering time re-qualifying new memory devices or redesigning their systems because of memory device failure or obsolescence.

WHICH IS “BETTER”? IT DEPENDS ON THE APPLICATION.

Deciding between “consumer” and “OEM” is a likely first step in choosing a portable memory solution for an embedded design. In many cases, both will work. For successful OEM designs, however, engineers need to look beyond “will it work?” and consider the long-term implications and the environment in which the system will be used.

While consumer-focused components are less prevalent in non-consumer OEM designs, it is hard to argue with the convenience, high memory capacity, small size and low cost that USB flash drives, SD cards and other consumer devices can provide. Nonetheless, the short life of consumer memory products is inescapably tied to the fast-paced consumer electronics market.

Manufacturers of consumer memory products are not “anti-OEM” – they’re meeting the demands of a consumer market that simply does not care about or have a need for performance requirements that are unique to non-consumer, OEM applications. When rugged construction, a high mating cycle life, secure form factors and/or long-term availability are higher priorities, a purpose-built OEM memory system is likely a better fit.