

TRANSFERRING DATA IN NON-NETWORKED APPLICATIONS

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Introduction

Even though an increasing number of embedded applications are networked via wired or wireless methods, many system designers are consciously deciding that in their new applications, data transport will be done through non-networked means. In applications where networking is not possible or practical, engineers are faced with the challenge of transferring data to and from their products through a portable data carrier – a physical device containing non-volatile memory used for data storage and transfer. The type of data that can be transferred includes firmware updates, feature enhancements, calibration data, configuration/recipe uploads, data logs, usage monitoring/limiting, and more.

There are a number of options for portable data carriers available, and engineers need to be sure that what they choose is well suited for their application. Commonly, consumer-based options such as smart cards, USB flash drives, memory cards, etc. are not rugged enough for OEM applications and come with many hidden costs and risks.

Networked vs. Non-Networked Data Transport

When designing a new product that requires data transport, the design team must not only factor in the BOM costs for adding either a network interface or a portable data carrier connector, they must also consider their customer's environment and installation and support costs. When a customer's environment already has a network, adding a node to that existing network can typically be done at a relatively low cost, especially when the network is wireless. However, if no network exists, implementing one may require a substantial investment by the customer and may ultimately factor into whether a product is selected or rejected.

When considering a network interface for an OEM product, it is often helpful to look at the pros and cons of data transfer via a network. Some of these pros and cons are listed in the tables below.

The Pros of Choosing a Network Interface For Data Transfer:

- Can allow for the automated transfer of data
- With LANs, WANs and the Internet, data can be quickly and inexpensively transferred over great distances
- Simplifies sending the data to multiple places
- If the customer's network already exists, connecting the OEM's product to it requires minimal/no additional hardware

The Cons of Choosing a Network Interface For Data Transfer:

- **Increased Development Costs.** Networked applications are typically more complex, take longer to develop, take longer to test and debug and have increased development costs (must purchase TCP/IP Stack, etc.) The application must also account for network downtime.
- **Time-to-market.** Creating, debugging, testing and productizing networked applications typically have long development cycles.
- **End User Hardware Costs** (network cables, cable trays/conduit, routers, wireless base stations, etc.)
- **End User Installation Costs** (pull and secure network cables, install routers/wireless base stations, etc.)
- **End User IT Costs.** The IT department has to install, support and secure the network and ensure sufficient up-time.
- **End User Security.** Network and data must continuously be secured from emerging security threats (hackers, malware, etc.).
- **Network Downtime.** Data transfer is dependent on the network being up. As stated above, the end user's IT department must ensure sufficient uptime and the application must account for some downtime.
- **The end user's environment may make connection to a network impractical/impossible** due to remote location, no infrastructure, electrical noise, etc.

When choosing whether or not to implement a network interface for data transport, the design team must weigh all the pros and cons listed above, being sure to consider not only the OEM's costs, but also the costs that the End User will incur. In many applications, a close examination of the pros and cons will warrant further investigation into non-networked data transport solutions.

Portable Memory Selection Considerations

Consumer Devices vs. Rugged OEM Data Carriers

Once the decision to explore non-networked solutions has been reached, the designers next need to determine which type of portable data carrier they will use. Often, the first portable data carriers that come to mind are consumer devices, like USB flash drives or memory cards (like those found in digital cameras).

While the design team may appreciate these products' wide availability, this can be both an asset and a liability. While it is convenient for end users to obtain a USB flash drive (or memory card) from their local electronics store or corner drug store, it is virtually impossible for the design team to account for and test all of the devices a user could purchase. Design teams might consider testing a number of devices and then publish a list of supported devices, but there is no guarantee that the end users will actually use those devices. Further, because they are consumer products, these devices typically have very short product life cycles. This would necessitate frequent qualification testing of new devices and frequent communication with the end users so they always know the list of approved devices (along with how to get any product firmware updates needed to support these new devices).

Another factor to consider when looking at using a consumer memory device in an embedded system is the environment where the product will operate. Consumer memory devices (and their mating

connectors) are not typically designed to hold up in harsh environments. The design team should consider whether temperature, vibration, shock, moisture, chemicals or other environmental factors may adversely affect the memory device.

Another perhaps less-obvious factor to consider is that consumer memory devices have multiple uses. This can lead to misuse or even theft of the data carrier (OEMs who have adopted consumer-based data carriers frequently report that the devices “go home” to be used for family photos, etc.). So, while using consumer memory devices as a portable data carrier in an OEM product may seem to be an attractive option, it should be thoroughly qualified so that it meets the functional, environmental and life-cycle requirements of the product. The sections below look at these three factors in more detail.

Functionality

A variety of data carriers with non-volatile read/write memory ICs exist. EEPROM and Flash products are the most common. Specific considerations in selecting the optimal memory include the built-in serial interface(s) of the OEM's microcontroller, the memory capacity needed, the transfer rate (clock speed) required, and what the designer prefers.

Embedded microprocessor applications often require far less memory capacity than PC applications - making consumer products overkill and more expensive than the traditional options available to embedded systems engineers. However, there are a growing number of embedded applications requiring the transfer of large data files.



Portable data carriers, such as Datakey Electronics' selection of memory Keys and Tokens are typically used for data transfer and access control applications.

Today there are high capacity portable data carriers that meet an OEM's requirement for ruggedness, long-term availability and product stability. These new devices provide access to the memory via a compact set of commands, freeing the embedded engineer from having to do all of the low-level programming associated with implementing consumer devices in an embedded system. This generic way of interfacing with the memory helps to provide long-term availability, as it provides a common interface regardless of the particular memory with which it is interfacing. This is important since the higher capacity NAND flash market is driven so much by consumer product requirements—NAND flash hardware has short product life cycles (typically measured in months, not years).

Further, options designed specifically for OEMs often offer greater security, more extreme environmental performance, and can eliminate any multi-vendor incompatibility issues that require OEM support.

So when considering a portable data carrier, it is important to consider the functional requirements. Some of the items to consider are listed below.

Functionality Considerations:

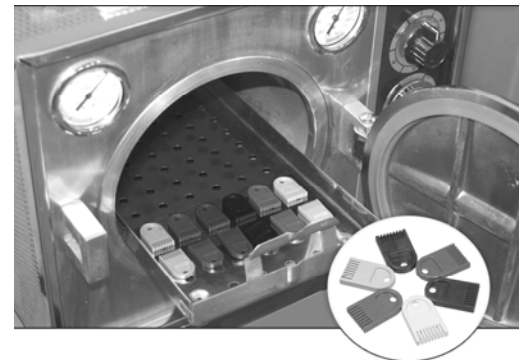
- Memory Size – Right size for your application; don't pay for more than you need
- Memory Size – Consider possible future needs; will big enough today be big enough tomorrow?
- Data Transfer Rate
- Communications Interface – SPI, I²C, Microwire, USB, RS-232, etc.
- Security Features – Unique Interface, Encryption, Unique Serial Number, Copy Proof
- Physical Form Factor – Shape, Color, Branding, Ease of Use, Ergonomics
- Cost – Cost of Connector and Cost of Data Carrier

Environmental

Data carriers used in light duty OEM consumer products typically use less durable materials, contacts, and connectors than OEM industrial products, which often have more demanding requirements. OEM applications which require high-cycle life, reliable repeated use, and survival in harsh environments (where they are exposed to water, chemicals, dirt, extreme temperatures, etc.) need a tougher portable data carrier. It is important to select a portable data carrier that meets the product's environmental needs and life-cycle expectations. Data carriers used in extremely harsh military or industrial environments may require even more heavy-duty materials and contact mechanisms.

Careful analysis of the physical and environmental requirements in which the data carrier will be used is essential. Features such as physical size, data carrier retention, durability, ESD performance, convenience, and other preferences should be reviewed. How often the data carrier will be used and under what conditions are also important factors that will influence the ideal selection. In most cases, the cost of the data carrier will be significantly less than 1% of the OEM's overall product cost. Despite its relatively low cost, the data carrier system performs a vital role in the product's operation, so reliable operation is crucial, especially when downtime can be painfully expensive.

Typical consumer memory card manufacturers do not provide receptacles nor guarantee any performance of a mated data carrier/receptacle system. The designer must consider these details as well. On the other hand, some OEM-focused data carrier systems do address the receptacle as well, which eliminates the need for the design engineer to modify a mating connector to meet specific environmental requirements.



Autoclave qualification of portable data carriers is a common requirement of medical OEMs.

The table below lists some of the environmental factors to consider when selecting a portable data carrier.

Environmental Considerations:

- Durability – The ability of the data carrier to last for the life of the product
- Reliability – Provides dependable operation the first time/every time
- Ruggedness – The ability of the data carrier to withstand harsh environmental conditions
- Retention Force – How much force is required to remove the data carrier from the connector?
- Environmental Conditions:
 - Debris – Dirt, Dust, Sand, etc.
 - Operating Temperature Range – Extreme Heat and/or Extreme Cold
 - High Humidity
 - Wash-down – Waterproof/Water Resistant
 - Harsh Chemicals
 - Shock & Vibration
 - ESD Protection
- Can Survive Sterilization (EtO, Autoclave, etc.)
- Number of Mating Cycles – How many insertions can the carrier/connector handle?

Product Life-Cycle

Design engineers must evaluate all life-cycle factors up-front. Post-release engineering support is often not considered in cost evaluations, but can have devastating effects on the financial success of a product. In evaluating the most cost-effective solution, overall system and support costs are often more important than the cost of the data carrier alone.

Most OEM products have life-cycles measured in years, not months. Therefore, long-term availability is particularly important for the portable data carriers selected for use in non-networked environments. Since the OEM product isn't networked, the portable data carrier is likely the only practical way to get information in or out of the device. If the portable data carrier becomes obsolete or its electrical/programming interface changes, this could force the OEM to embark on a costly re-qualification or re-design process.

During the initial selection, the designer also needs to consider what the system might need in the future. Some examples to consider are the possible growth path requirements of the project, such as if larger memory capacities, faster transfer rates, integrated memory management features, or the ability to add features (for example, firmware update capability) would benefit the design. A data carrier that is part of a "family" will provide the highest probability of seamlessly addressing future requirements.

The table below summarizes some of the factors to consider, with respect to product life-cycle, when selecting a portable data carrier system.

Product Life-Cycle Considerations:

- Long-term Availability – The data carrier and mating connector need to be available unchanged for the life of the product (years, not months)
- Memory Size – Consider possible future needs. Will big enough today be big enough tomorrow?
- Single Manufacturer for Data Carrier & Mating Connector – This simplifies long-term planning and provides a single-source for support
- Readily available – Product is available to be shipped as needed

Conclusion

Portable data carriers are one of the most practical and versatile data transport technologies in use today. When designed to survive in the “real world,” they can serve a countless variety of needs. As memory technology continues to advance, and as new applications surface, the range of uses for portable data devices will also grow. Then, as now, the key to selecting the right portable data carrier will be in anticipating how it must perform in the product’s specific application environment. In many cases, the best solution is one that is designed specifically for OEMs and embedded systems.

Datakey Electronics offers a full catalog of data carrier system solutions that are extremely rugged and reliable. These products can be used over and over in the harshest environments and have proven long-term availability that is essential to most OEM applications.

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