



## **Removable Small Form Factor Storage Devices For Consumer Electronics and Information Appliances**

*The storage requirements for consumer electronics and information appliances continue to grow as applications become more sophisticated and begin to merge with each other. The high growth digital camera market is a prime example of where the professional photographer or serious enthusiast demands high resolution shots that can be quickly stored and ported to a laptop for printing. Today's storage media for digital cameras does not yet support the increased need for the high capacity required for high resolution image storage at an economical price.*

*Or consider the business executive who wants to carry total laptop PC functionality in a handheld device. The need to store full function applications and large information databases requires the portable storage media to have large capacity in a small, light, industry-standard form factor. PC cards, also known as Personal Computer Memory Card International Association (PCMCIA) cards, have partially met these requirements. However, their average cost per megabyte (MB) makes them impractical as a choice for higher capacity storage requirements.*

*To compound matters, there has been a recent convergence of the consumer electronics and personal computing industries. Consumers have become more knowledgeable on how computing applications can dramatically improve the performance of digital cameras and other products. As consumers begin to invest in systems that may include a video capture device and a computing platform, storage requirements will continue to increase exponentially.*

*IBM has recognized the need for a new paradigm in consumer storage media that transcends today's storage products by offering both high capacity and portability in an interface standard recognized by the consumer electronics and information appliance industries. This storage solution is intended to provide increased functionality within and between these portable consumer products. It directly addresses existing storage capacity limitations, thus enabling the creation of new product systems that represent a convergence of consumer electronic and information appliance designs.*

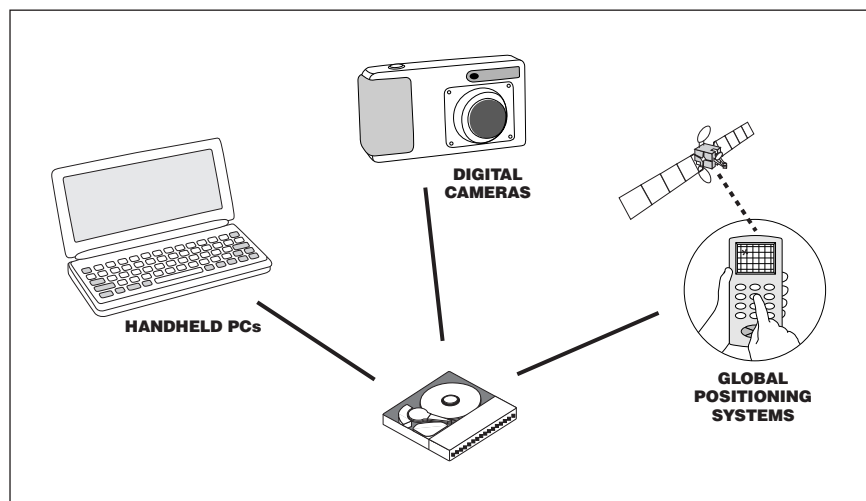


### **The IBM 170 MB and 340 MB microdrive**

The IBM 170 MB and 340 MB microdrives will set a new storage solution standard for this emerging class of mobile system products. The microdrive product line has been designed to serve two market needs. First, the IBM 170 MB and 340 MB microdrives support the increasing demand for fast, portable, high-capacity storage for today's digital cameras and handheld PCs at an economical price. Second, the microdrive enables the creation of new systems solutions that connect consumer electronics with information technology.

The first microdrive products offer 170 MB and 340 MB of storage capacity in a standard CompactFlash Type II form factor. IBM supports the CompactFlash Type II standard because we believe it best supports a portable interface that has been accepted by both the consumer electronics and information appliance markets. Digital camera and handheld PC manufacturers originally designed this interface to accommodate compact flash memory cards. These manufacturers will clearly benefit from the new microdrive storage class that offers greater capacity and economy within the same form factor.

This paper gives an overview of the different form factors that have been employed for portable storage to date. A comparison of the form factors is presented to help the product designer select the most appropriate storage solution.



*Figure 1: Microdrive applications*

### **Different form factors**

The original premise for establishing an industry standardized portable form factor was to support laptop PC memory upgrades from multiple vendors as well as to provide a platform for added functionality such as PC modems and fax cards. The PCMCIA form factor was the first offering.

As personal digital assistants (PDAs) entered the market, embedded DRAM was sufficient to support the operating system and applications software. As feature sets were enhanced, PCMCIA slots were added to the PDAs for memory expansion and functional add-ons. Digital cameras experienced a similar trend where embedded flash memory was sufficient for entry level equipment. As image storage requirements increased, the CompactFlash Type I standard was implemented in digital cameras to enable removable storage.

Different form factors have been developed to support consumer electronics and mobile computing. The PC card and CompactFlash form factors are the most widely accepted in these industries. Other form factors are endorsed by OEM consortiums. These include the miniature card, multimedia card, memory stick and smart media card.

There are two primary implementations of removable flash memory today. The first approach integrates the flash memory with an ATA controller which together simulate a hard disk drive to the host. PC and compact flash memory cards employ this architecture. The miniature card implementation uses linear memory and external Flash Translation Layer (FTL) software residing in the host. Finally, smart media uses an external host-supported ATA controller.

The clear benefit of the combination of an ATA controller and flash memory within the removable card is that these devices are easy to integrate into host systems and are supported by standard ATA/IDE interface drivers. The disadvantage to this approach is that complex embedded logic requires additional memory overhead.

The microdrive design by IBM supports this integrated approach to reduce host support requirements. The high capacity points of the IBM 170 MB and 340 MB microdrives make the embedded logic memory requirements relatively small. The microdrive also employs the CompactFlash interface form factor which provides a lighter and smaller solution compared to PC cards.



### **PC cards**

The PC card form factor, also referred to as PCMCIA, has two modes—flash memory and flash disk. The PC card has three interface types which designate different heights.

Type I	85.6 mm x 54.0 mm x 3.3 mm
Type II	85.6 mm x 54.0 mm x 5.0 mm
Type III	85.6 mm x 54.0 mm x 10.5 mm

Type I is mostly used for memory cards (SRAM, Flash, Flash Disk)

Type II is primarily used for I/O cards (Modem, LAN, GPS, etc.)

Type III is mostly used by 1.8-inch disk drives

The use of Type II PC cards became quite popular by notebook PC users. Some Type II cards and Type III cards offer higher storage capacity, but their cost and size (specifically the Type III), make them an impractical choice for many portable applications. More details on the PC card standard can be found at [www.pc-card.com](http://www.pc-card.com).

### **Compact flash card**

The CompactFlash form standard has two height types:

Compact Flash Type I	42.8 mm x 36.4 mm x 3.3 mm
Compact Flash Type II	42.8 mm x 36.4 mm x 5.0 mm

The CompactFlash card has a noticeably smaller form factor than the PC card which allows the end product designer to allocate less space for removable storage. The CompactFlash form factor also provides better portability than the PC card due to its smaller size. CompactFlash Type I slots are prevalent in many digital cameras and some handheld PC products. CompactFlash Type II slots are being designed into these products as well as printers, video cameras, etc. The increased height of Type II supports high capacity, small form factor removable storage such as the microdrive. The Type II specification is backward compatible with CompactFlash Type I.

The CompactFlash technical subcommittee has released a new update of the specification, opening the current maximum power consumption of 75 mA (3.3V) and 90 mA (5V) to 500 mA. This specification evolution is reflecting the need of the industry for all new versions of CompactFlash cards. It is also backward compatible with already existing host systems (like PDAs or digital cameras) in the market; for most systems, the new application devices may work. However, a detailed analysis of the product and compact flash card specifications must be made. In addition, compact flash card

manufacturers will often provide a list of supported host devices. The solid state based compact flash cards are offered in a large variety of capacity points up to 64 MB. More information on the CompactFlash form factor can be accessed on the Web at [www.ibm.com/harddrive](http://www.ibm.com/harddrive) or through the CompactFlash Association at [www.compactflash.org](http://www.compactflash.org).

### **Smart media and other types of cards**

The smart media card, the multimedia card, the memory stick and the miniature card are all solid state memory cards that have different levels of market acceptance. Every card needs specific support by the host system. Capacity points for these storage solutions range up to 16 MB today.

The multimedia card is one-fourth the size of a compact flash card. Because of their size, multimedia cards are primarily designed into portable phones. Memory sticks also provide a small form factor (approximately equal to the length of a AA battery). Miniature cards are another form of portable storage whose architecture was created by Intel® to provide an alternative to existing standards. These products have up to 8 MB of capacity.

### **Interchangeability**

In most cases, stored data is downloaded to a desktop or laptop PC for post-processing. The data transfer from a handheld device, such as a digital camera to a computer, can be accomplished in one of four ways:

- Direct cable connection (serial or parallel with corresponding software)
- IR transfer
- Use of a separate reader/writer for the removable card
- Special adapter

The Direct Cable Connection to the handheld device is often very slow (if the serial connection is used) which prohibits its use until the data transfer is complete. The handheld device is also constrained during parallel data transfer even though the out of service time is less.

The IR connection has a significant advantage of not using cable, but is still slow for larger files.

Separate reader/writer devices free the user from waiting for the data to download. PC card and compact flash reader/writer devices are available today.



Adapters are used in different form factors. The most common is the adapter in the PC card format. Compact flash, smart media and multimedia cards can use this type of adapter, although each card needs a special one. The PC card/compact flash adapter is a very effective one because it provides a passive mechanical connection between both the cards and the computer. There is also a 3.5-inch floppy card adapter for the smart media card. The highest data exchange will be reached by the microdrive in the IDE mode to the bus system of the computer using a native CompactFlash slot or the PC card adapter.

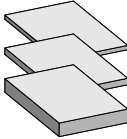





Storage Device	Size	Typical Capacity <sup>1</sup>	Optional Adapter
 <p><b>PC card (PCMCIA)</b>            - Type I            - Type II            - Type III</p>	85.6 x 54.0 x 33.3 mm 85.6 x 54.0 x 5.0 mm 85.6 x 54.0 x 10.5 mm	Memory <= 128 MB I/O applications 1.8-inch Hard disk drive	Ext. Reader/Writer Notebook slot
 <p><b>Compact flash card</b>            - Type I            - Type II</p>	42.8 x 36.4 x 3.3 mm 42.8 x 36.4 x 5.0 mm	2 MB-64 MB (I/O, <b>Microdrive</b> )	Ext. Reader/Writer PC card adapter
 <p><b>Smart media card</b></p>	45 x 37 x 0.76 mm	16 MB	PC card adapter Floppy adapter
 <p><b>Multimedia card</b></p>	32 x 24 x 1.4 mm	8 MB	Under development
 <p><b>Memory stick</b></p>	21 x 50 x 2.8 mm	8 MB	Available
 <p><b>Minature Card</b></p>	38 x 33 x 3.5 mm	8 MB	Under development

Figure 2: Comparison of removable storage cards

<sup>1</sup>These capacity points are based on information available at the time this paper was written and printed. Data is subject to change without notice.

**Summary**

The IBM 170 MB and 340 MB microdrives use the new CompactFlash Type II design to offer a superior combination of size, interchangeability, storage capacity, ruggedness and cost per megabyte. This industry recognized standard provides the same flexibility associated with the PC card interface, but within a smaller form factor. Originally designed to support the digital camera market, the CompactFlash interface standard can now be found in printers, portable computers, and Global Positioning System (GPS) receivers. The IBM 340 MB microdrive will provide a portable storage solution for consumer electronics and information technology using the CompactFlash Type II form factor. For more information, visit our Web site at [www.ibm.com/storage/microdrive](http://www.ibm.com/storage/microdrive).

General product information for other IBM hard disk drive products is available by calling 1 800 IBM-7777 and asking for Dept. Star 30 (outside of North America, call 1 416 383-5161 or fax 1 905 316-4733). For faxed information, contact the IBM TECHFAX service by dialing 1 408 256-5418 from a touchtone phone. Follow the voice prompts to receive a TECHFAX directory. (International callers must call from a phone connected to a fax machine.) Information is also available via the Internet at [www.ibm.com/harddrive](http://www.ibm.com/harddrive). Or, send an e-mail inquiry to [drive@us.ibm.com](mailto:drive@us.ibm.com).





**[www.ibm.com/storage](http://www.ibm.com/storage)**

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9/98  
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G522-2494-00