Secure Digital card

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16 MB SD Card

512 MB SD Card

1 GB SD Card

Secure Digital (SD) is a flash memory memory card format. It is used in portable devices, including digital cameras and handheld computers. SD cards are based on the older Multi Media Card (MMC) format, but most (not all) are physically slightly thicker than MMC cards. They also boast higher data transfer rates, but this is always changing, particularly in light of recent improvements to the MMC standard. Most (not all) offer an optional lock switch on the side to prevent accidental overwriting, and (little-used) DRM features. SD cards generally measure 32 mm × 24 mm × 2.1 mm, but can be as thin as 1.4 mm, just like MMC cards (see below). There are two main types available, ones that run at regular speeds, and high-speed cards that have higher data transfer rates. Some digital cameras require high-speed cards to record video smoothly or capture multiple still photographs in rapid succession.

Devices with SD slots can use the thinner MMC cards, but the standard SD cards will not fit into the thinner MMC slots. SD cards can be used directly in CompactFlash or PC Card slots with an adapter.

MiniSD and MicroSD cards can be used directly in SD slots with an adapter. There are some SD cards that have a USB connector built in for dual-purpose use, and there are readers which allow SD cards to be accessed via many connectivity ports such as USB, FireWire, and the common parallel port. SD cards can also be accessed via a floppy disk drive with a FlashPath adapter.

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Description and market Penetration [edit]

Secure Digital cards are used as storage media by portable devices:

- digital cameras for storing pictures
- camcorders for storing still images and video clips
- PDAs for storing all kinds of data
- mobile phones for storing images, sound clips and other media files
- digital audio players

As of 2005, typical SD card capacities are 128, 256, and 512 MBs, 1, 2 and 4 GBs.

SD/MMC cards have all but replaced Toshiba's SmartMedia as the dominant memory card format used in compact digital cameras. In 2001 SmartMedia had achieved nearly 50% use, but by 2005 SD/MMC had achieved over 40% of the digital camera market and SmartMedia's share had plummeted. A notable majority of the world's leading digital camera manufacturers use SD in their product lines, including Canon, Nikon, Kodak, Panasonic and Konica Minolta. Three major brands, however, have stuck to their

own proprietary formats in their cameras: Olympus and Fuji using xD cards, and Sony using Memory Stick. Additionally, SD has not conquered the Digital SLR market, where CompactFlash remains the most popular format (except the newly-released dSLR D50 by Nikon in April 2005).

The "Secure" in Secure Digital comes from the card's origin. To create the SD card, Toshiba added encryption hardware to the already-extant MMC card, to calm music industry concerns that MMC cards would allow for easy piracy of music. (A similar scheme is the MagicGate standard used in Memory Sticks). In theory, this encryption would allow for Digital rights management schemes on digital music to be easily enforced, but this capability is little used.

With a media card reader — typically a small USB device — a user can access the contents of an SD card using their computer. Some newer computers have such card readers built in.

A recent development is SD cards with built-in USB plugs, to eliminate the need for an SD/USB adapter or SD slot on a PC, though at higher initial cost. One design pioneered by SanDisk featured a folding flap to expose the plug. Although SanDisk was not the first to market a USB enabled SD card, the move did encourage other manufactures to follow suit.

The signature "SD" logo was actually developed for another use entirely: it was originally used for "Super-Density Optical Disk", which was the unsuccessful Toshiba entry in the DVD format wars. This is why the "D" looks so much like half of an optical disk.

Optional Write Protect Switch [edit]

When looking at the card from the top (see pictures) there is one required notch on the right side (the side with the diagonal notched corner). On the left side there is usually a switch. This is the write-protect switch. The MMC card has neither notch.

When this write-protect switch is in the down position (away from the end that is inserted) then it is write protected and read-only. When the switch is in the up position it is write enabled. Since the switch is optional then the card can have no switch and no notch, which makes the card **always** writable, or it can have a larger notch (taking up both positions of the switch) and be a ROM card, or **always** write-protected and read-only.

The switch / notch works in same way as the notches on compact audio cassettes and videotape cassette tapes or floppy disks. A closed or covered notch is writable, while an open notch (or removed tab) is protected.

If the switch becomes broken or falls off then the card will become a write-protected ROM card and no longer be writable. A possible troubleshooting solution would be to apply tape over the notched area

(avoiding the connectors and the other notch) to configure the card in a permanent writable state.

Note: Kingmax SD cards do not come with a write-protect switch, and are thus always write enabled. They are also thinner, at (1.4 mm).

Openness of standards [edit]

MMC cards also work in SD slots

Like most memory card formats, SD is covered by numerous patents and trademarks, and licensing is only available through the Secure Digital Card Association. The SD Card Association's current licensing agreement does not allow for open-source SD drivers, a fact that generates a fair amount of consternation in the open-source and free software communities. The usual workaround is to develop an open-source wrapper for a closed-source SD driver available on the particular platform, but this is far from ideal. Another common workaround is to use the older MMC mode, which all SD cards are required to support by the SD standard.

This means that SD is less open than CompactFlash or USB flash memory drives, which can be implemented for free but require licensing fees for the associated logos and trademarks, but far more open than xD or Memory Stick, where no public documentation nor any documented legacy implementation is available.

Technical explanation [edit]

All SD memory and SDIO cards are required to support the older SPI/MMC mode which supports the slightly slower four-wire serial interface (clock, serial in, serial out, chip select) that is compatible with SPI ports on many microcontrollers. Many digital cameras, digital audio players, and other portable devices probably use MMC mode exclusively. Documentation for this mode can be purchased from the MMCA for $500; however, partial documentation for SDIO is free and there is free documentation available for memory cards as part of some manufacturers datasheets.

MMC mode does not provide access to the proprietary encryption features of SD cards, and the free SD documentation does not describe these features. As the SD encryption exists primarily for media producers, it is not of much use to consumers who typically use SD cards to hold unprotected data.

There are three transfer modes supported by SD: SPI mode (separate serial in and serial out), one-bit SD mode (separate command and data channels and a proprietary transfer format), and four-bit SD mode (uses extra pins plus some reassigned pins) to support four bit wide parallel transfers.

Low speed cards support 0 to 400 kbit/s data rate and SPI and one-bit SD transfer modes. High speed cards support 0 to 100 Mbit/s data rate in four-bit mode and 0–25 Mbit/s in SPI and one-bit SD modes.

Royalties for SD/SDIO licenses are imposed for manufacture and sale of memory cards and host adapters ($1000 per year plus membership at $1500/year) but SDIO cards can be made without royalties and MMC host adapters do not require a royalty. MMC cards had a seven-pin interface, SD and SDIO expanded this to nine pins.

See Legitimacy of standards for background info.

SDIO [edit]

A camera that uses the SDIO interface

SD slots can actually be used for more than flash memory cards. Devices that support **SDIO** (typically PDAs, but occasionally laptops or cell phones) can use small devices designed for the SD form factor, like GPS receivers, Wi-Fi or Bluetooth adapters, modems, barcode readers, IrDA adapters, FM radio tuners, RFID readers, or digital cameras.

A number of other devices have been proposed but not yet implemented, including RS-232 serial adapters, TV tuners, fingerprint scanners, SDIO to USB host/slave adapters (which would allow an SDIO-equipped handheld device to use USB peripherals and/or interface to PCs), magnetic stripe readers, combination Bluetooth/Wi-Fi/GPS transceivers, Ethernet adapters, cellular modems (PCS, CDPD, GSM, etc.), and APRS/TNC adapters.

Different types of MMC/SD cards [edit]

The SD card is not the only flash memory card standard ratified by the Secure Digital Card Association. Other SD Card Association formats include miniSD and microSD (formerly known as TransFlash before ratification by the SD Card Association).

These smaller cards are usable in full size MMC/SD/SDIO slots with an adapter (which must route the electrical connections as well as making physical contact). It should be noted, however, that it is already difficult to create I/O devices in the SD form factor and this will be even more impractical in the smaller sizes.

As SD slots still support MMC cards, the separately-evolved smaller MMC variants are also compatible with SD-supporting devices. Unlike miniSD and microSD (which are sufficiently different from SD to make mechanical adapters impractical), RS-MMC slots maintain backward compatibility with full-sized MMC cards, because the RS-MMC cards are simply shorter MMC cards. More information on these variants can be found in Multi Media Card.

Technical comparison

[edit]

Type	MMC	RS-MMC	MMC Plus	SecureMMC	SD	SDIO	miniSD	microSD
SD Socket	Yes	Mechanical adapter	Yes	Yes	Yes	Yes	Electro-mechanical adapter	Electro-mechanical adapter
Pins	7	7	13	7	9	9	11	9?
Form factor	Thin	Thin/short	Thin	Thin	Thick	Thick	Narrow/ short/thin	Narrow/ short/ extrathin
Width	24 mm	24 mm	24 mm	24 mm	24 mm	24 mm	20 mm	11 mm
Length	32 mm	18 mm	32 mm	32 mm	32 mm	32 mm+	21.5 mm	15 mm
Thickness	1.4 mm	1.4 mm	1.4 mm	1.4 mm	2.1 mm	2.1 mm	1.4 mm	1 mm
SPI mode	Optional	Optional	Optional	Required	Required	Required	Required	Required?
1 bit mode	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4 bit mode	No	No	Yes	?	Optional	Optional	Optional	Optional
8 bit mode	No	No	Yes	?	No	No	No	No
Xfer clock	0–20 MHz	0–20 MHz	0–54 MHz	0–20 MHz?	0–25 MHz	0–25 MHz	0–25 MHz?	0–25 MHz?
Max XFER	20 Mbit/s	20 Mbit/s	416 Mbit/s	20 Mbit/s?	100 Mbit/s	100 Mbit/s	100 Mbit/s	100 Mbit/s
Max SPI XFR	20 Mbit/s	20 Mbit/s	54 Mbit/s	20 Mbit/s	25 Mbit/s	25 Mbit/s	25 Mbit/s	25 Mbit/s
DRM	No	No	No	Yes	Yes	N/A	Yes	Yes
User encrypt	No	No	No	Yes	No	No	No	No
Simplified Spec	Yes	Yes	No	Not yet?	Yes	Yes	No	No
Memb cost	$2500/yr (not required)				$1500/yr (appears required)			
Spec cost	$500		?	?	Member	Member	Member	Member
Host license	No	No	No	No	$1000/yr+memb			
Mem card royalties	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
I/O card royalties	N/A	N/A	N/A	N/A	N/A	$1000/yr +memb	N/A	N/A

Open source compatible	Yes	Yes	Yes?	Yes?	SPI only	SPI only	SPI only	SPI only

Table data compiled mostly from simplified versions of MMC and SDIO specifications and other data on SD card and MMC association web sites. Data for other card variations is interpolated.

Capacity limit in all SD/MMC formats appears to be 128 GB in LBA mode (28-bit sector address).

Most, possibly all, current MMC flash memory cards support SPI mode even if not officially required as failure to do so would severely affect compatibility. All cards currently made by SanDisk, Ritek/Ridata, and Kingmax digital appear to support SPI. Also, MMC cards may be electrically identical to SD cards but in a thinner package and with a fuse blown to disable SD functionality (so no SD royalties need to be paid).

MMC defined the SPI and one-bit MMC/SD protocols. The underlying SPI protocol has existed for years as a standard feature on many microcontrollers. From a societal perspective, the justification for a new incompatible SD/MMC protocol is questionable; the development of a new incompatible and unnecessary protocol may help trade associations collect licensing and membership fees but it raises the cost of hardware and software in many ways. The new protocol used open collector signalling to allow multiple cards on the same bus but this actually causes problems at higher clock rate. While SPI used three shared lines plus a separate chip select to each card, the new protocol allows up to 30 cards to be connected to the same three wires (with no chip select) at the expense of a much more complicated card initialization and the requirement that each card have a unique serial number for plug and play operation; this feature is rarely used and its use is actively discouraged in new standards (which recommend a completely separate channel to each card) because of speed and power consumption issues. The quasi-proprietary one-bit protocol was extended to support four bit wide (SD and MMC) and eight bit (MMC only) transfers for more speed while much of the rest of the computer industry is moving to higher speed narrower channels; standard SPI could simply have been clocked at higher data rates (such as 133 MHz) for higher performance than offered by four-bit SD — embedded CPUs that did not already have higher clock rates available would not have been fast enough to handle the higher data rates anyway. The SD card association dropped support for some of the old one-bit MMC protocol commands and added support for additional commands related to copy protection.

DRM features [edit]

The digital rights management scheme embedded in the SD cards is defined as the Content Protection for Recordable Media (CPRM) by the 4C Entity and is centered around use of the Cryptomeria cipher (also known as *C2*). The specification is kept secret and is only accessible to licensees. DVD-Audio use a very similar scheme known as Content Protection for Prerecorded Media (CPPM).

See also [edit]

- P2 card

External links [edit]

- Secure Digital Association
- MultiMedia Card Association
- SanDisk SD Card Product Manual
- SD Memory Card Physical Layer Specification, version 1.01 (pdf)
- SDIO Card Specification, version 1 (pdf)
- Understanding SD Card Speeds
- Interfacing dsPIC30F4013 to SD Cards

Memory Cards

CompactFlash (CF) | Memory Stick | Multimedia Card (MMC) | PC card | SmartMedia | **Secure Digital** (SD) | xD-Picture

Category: Solid-state computer storage media