

SD Cards

Picking the Right One!

A brief presentation about
Secure Digital (SD) memory cards
by
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What are they?

- **Secure Digital**, officially abbreviated as **SD**, is a proprietary non-volatile memory card format developed by for use in portable devices.
- The standard was introduced in August 1999 by joint efforts between SanDisk, Panasonic (Matsushita) and Toshiba.
- The SD Association (SDA), is a non-profit organization, formed to promote and create SD Card standards.
- Terms: Card = SD Card, Host = Camera/Phone/etc.

This is a crowded space!

- Over the years there have been a lot of competing ideas. Some others are:
 - Floppy Disks/Zip drives
 - USB “Thumb” drives
 - PC (PCMCIA) cards
 - Compact Flash (I and II) cards
 - Sony Memory Stick
 - Etc, etc, etc... (Wikipedia lists 27 types)
- Almost *all* of these are obsolete now.

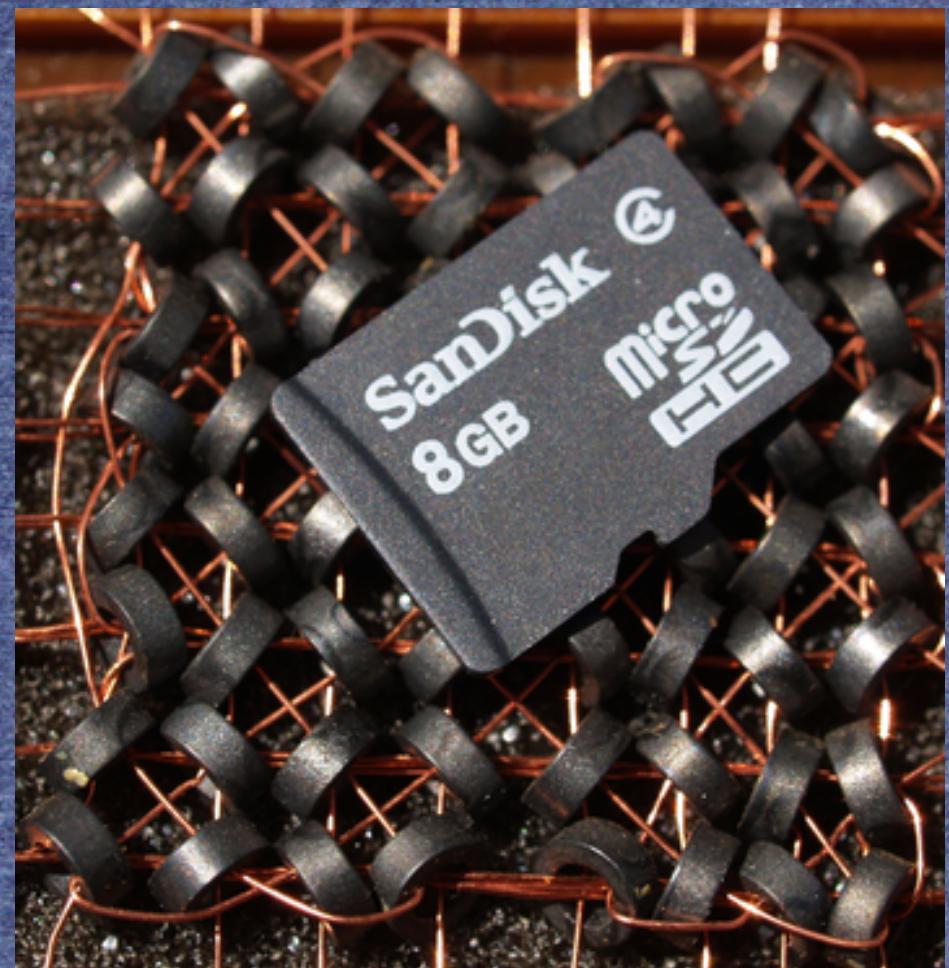
Perspective 1

- To see how much progress has been made, compare the 1956 and 2020 ideas of “mass” storage!
- Price is hard to compare because IBM only leased equipment back then. (\$3200/month)



Perspective 2

- An older slide, the SD card sits atop 8 bytes of core memory.
- Not Gigs, not Megs, not even “K“. Just bytes.
- Even funnier, both costed about \$8!
- That's a **BILLION** times more memory for the same price!



Perspective 3

- For portable devices, the SD card form factor is much smaller than the comparable USB storage device.
- Further, the required host resources are a lot less to support the SD protocol than for USB.



Typical Applications

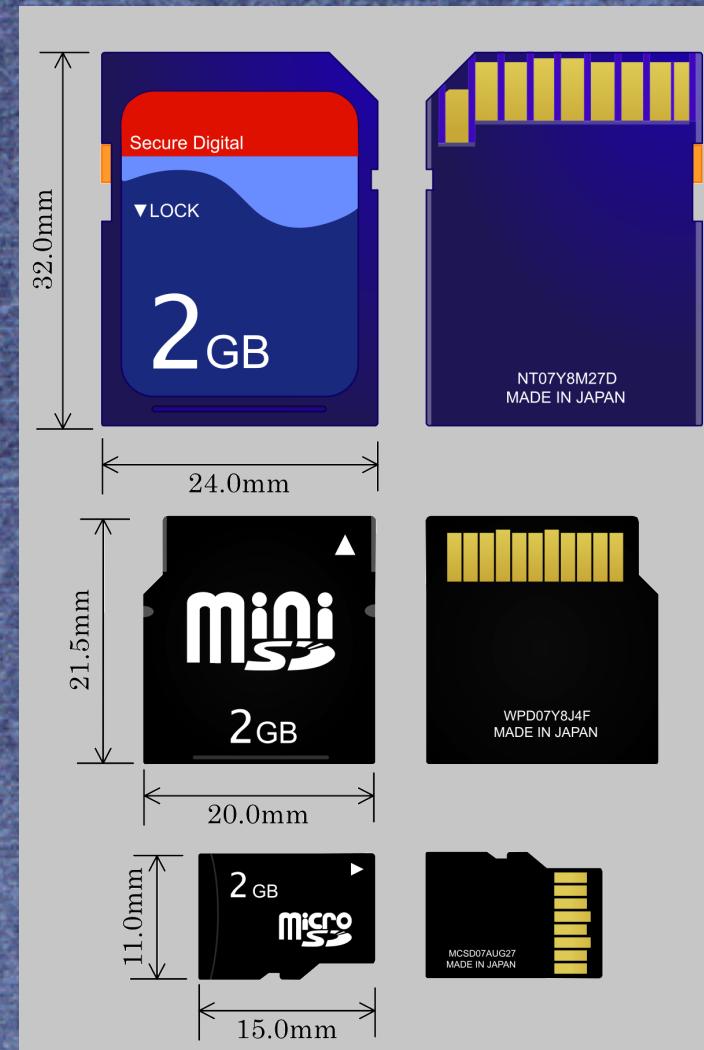
- SD cards are best where small, removable, inexpensive, low power, robust storage is needed.
- The most common applications of SD memory are:
 - Cameras
 - Cell Phones
 - Small form factor computers (Raspberry PI)

SD Card Specifications

- The SD Association (SDA), sets SD Card standards.
- These standards cover:
 - Form Factor
 - Write Speed
 - Bus Speed
 - Capacity Limits
 - Application Ratings

Form Factor

- SD cards come in 3 form factors:
 - Standard – older but still used.
 - Mini – extinct.
 - Micro – the most common of all!



Size Adapters

- Adapters exist to use with older systems.
- This only works to allow a micro SD card in a standard slot. Not vice versa.
- Must fit! There may still be other compatibility issues...



Write Speed

- Write speed is crucial in video applications where large amounts of data are written to large files.
- There are three methods of rating write speed:

MB/s	Speed Class	UHS Speed	Video Speed
90			V90
60			V60
30		U3	V30
10	C10	U1	V10
6	C6		V6
4	C4		
2	C2		

Write Speed Compatibility

- In general, write speed does not affect the host's ability to interact with the device.
- Actual write speed will depend on the *slower* of the host and the card.
- If the card is too slow, the device may not perform well. For example 10MB/s is the *minimum* for 4K video recording (C10, U1, V10). While 30MB/s (U3, V30) is better.
- Consult your device's manual or get support from its manufacturer for guidance on write speed requirements.

For Example...

BEST
Quality SD Cards

4K Video Recording



Bus Speed

- The bus speed indicates how fast the card's bus can move data. In general, the bus operates at the slower of the SD card's speed and the host's speed.
-

Interface	Bus Speed MB/s	Connection	Status
High Speed	25	Standard	OK
UHS-I or I	104	Standard	OK
UHS-II or II	312	2 rows	OK
UHS-III or III	624	2 rows	Not adopted?
SD Express	985	2 rows	Leading Edge

Bus Speed Compatibility

- In general, bus speed does not affect the host's ability to interact with the device.
- Caveat: SD Express cards and hosts do not support UHS-II and UHS-III. So in some systems SD Express cards can actually be slower.
- Actual bus speed will depend on the *slower* of the host and the card.
- Note that bus speed will always be greater than write speed.

Capacity Limits

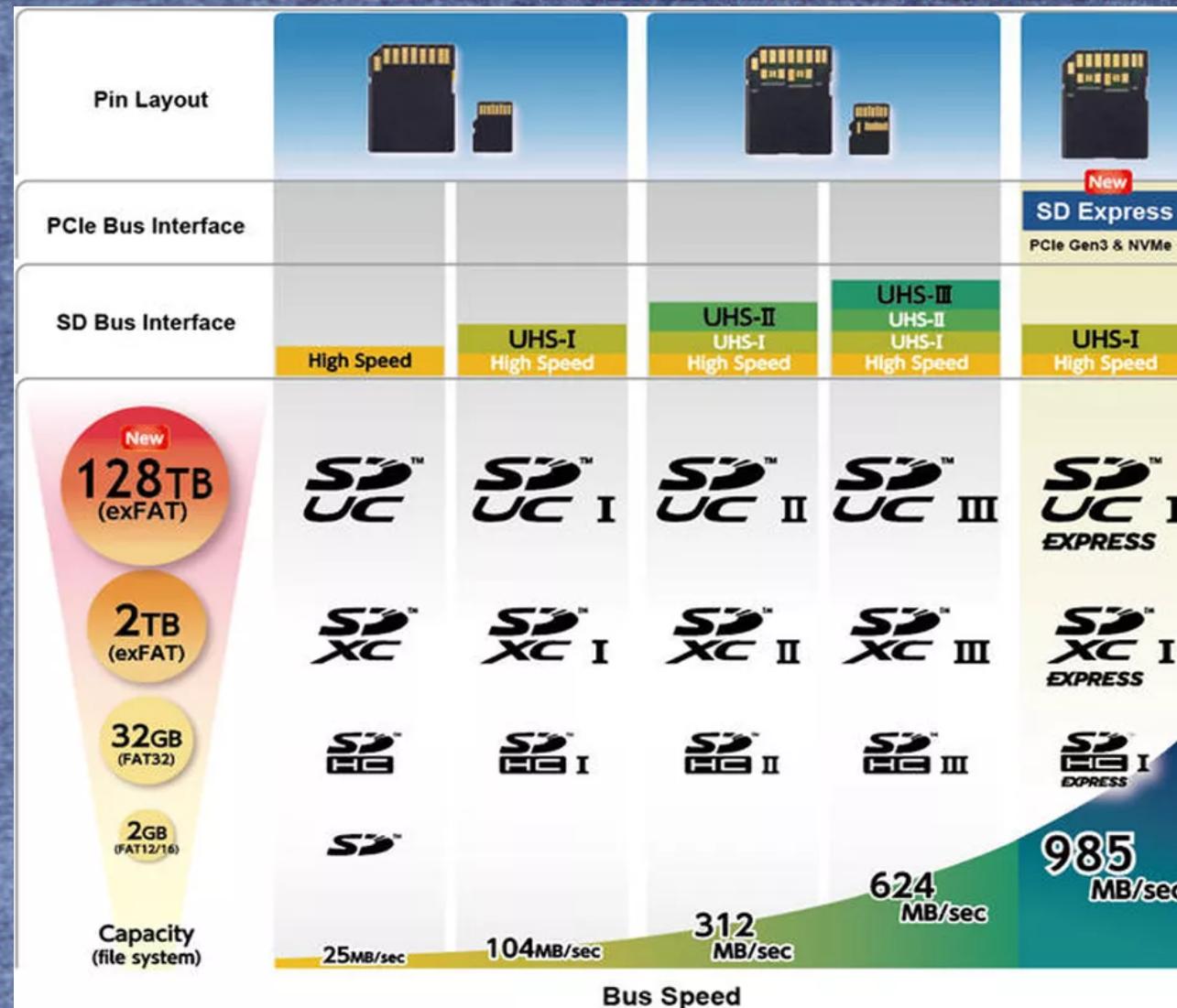
- Different SD card specs have varying maximum capacities. This reflects the march of progress as flash memory capabilities improve over time.

Type	Max Capacity
SD	2 GB
SD HC	32 GB
SD XC	2 TB
SD UC	128 TB

Capacity Limit Compatibility

- This specification is the main cause of SD card compatibility problems.
- Selecting a card in a higher capacity category than the host can handle is *the* major source of these headaches. However, some poorly implemented hosts fail with larger cards of the *same* category.
- In rare cases, devices in a *lower* capacity category can cause problems in poorly designed hosts.
- For this is the one you're going to have to either check the manual or buy devices of the same capacity grade only.

Let's Have a Picture



Application Rating

- As SD cards move into applications beyond cameras, other aspects of performance beyond write speed become important. The application rating focuses on the card's ability to handle many I/O operations and large numbers of files.

Rating	Read IOPS	Write IOPS	Write Speed
A1	1500	500	> 10
A2	4000	1000	> 10

Application Rating Compatibility

- Application ratings help to tell us how well an SD card will perform as the storage for a computer or cell phone.
- This is not usually a work vs. not-work choice. Rather it is more of an OK vs. slow/sluggish thing.
- When the SD card is the main storage (like for a Raspberry PI) this is even more important.
- Even so, a slow card can make your cell phone seem unresponsive.

A Sample

- Micro SD
- SD XC – 128GB
- V30 – 30MB/s write
- U3 – 30MB/s write
- (UHS) I – 104 MB/s bus speed.
- A1 – Application Rating is 1



Consider these choices

- These two devices were part of a bundles with the Raspberry PI 4.
- Both are 32GB
- Both are U1
- But only one is rated for application use with the A1 tag.
- Which might be better in this application?



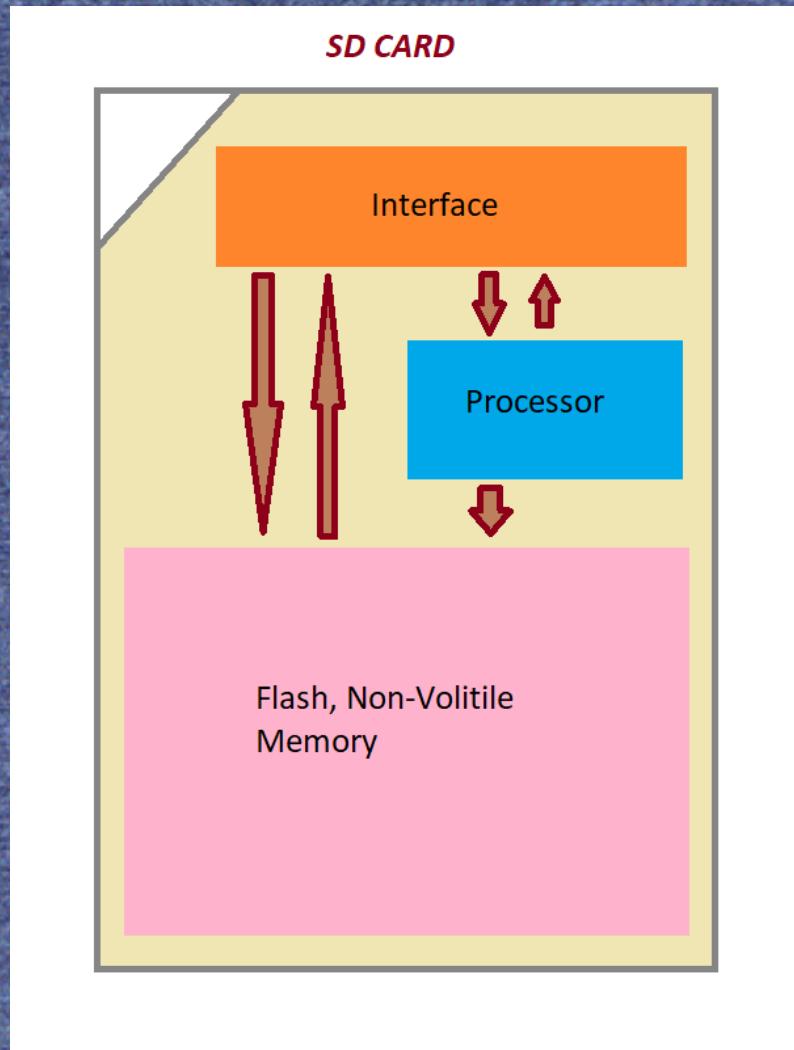
A Confusing Example

- Standard SD
- (UHS) I – 104 MB/s bus speed.
- SD XC – 128GB
- U3 – 30MB/s write?
- C10 – 10MB/s write?
- 95MB/s write?
- Which is it? 95! Likely, this card predates the Vxx speed specs.



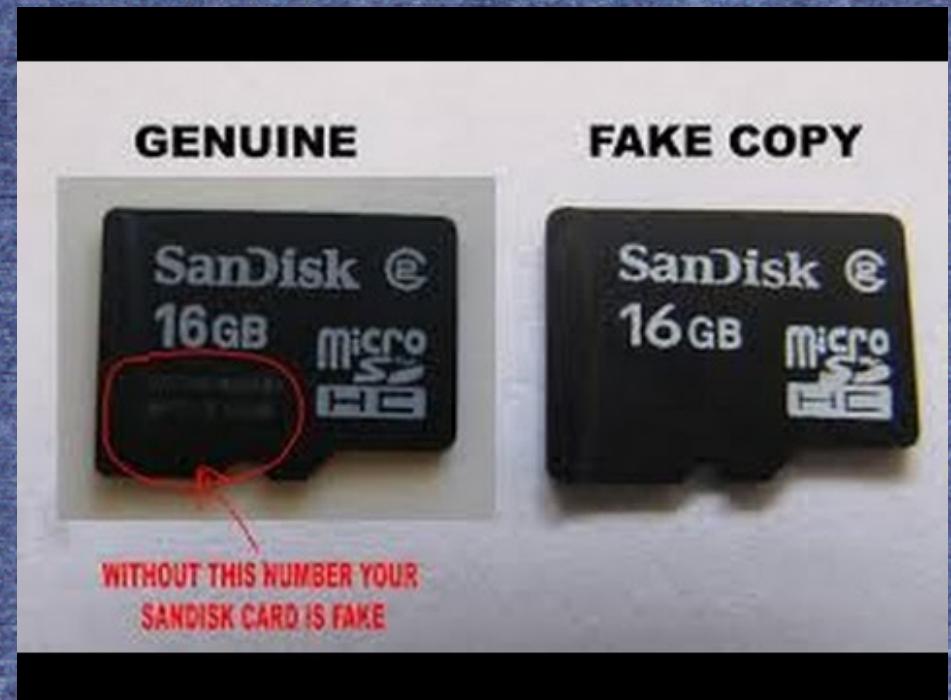
Going Deeper

- Believe it or not, each SD card is actually a tiny computer in itself.
- The processor handles wear levelling, bad block substitution, and stores the drive parameters for the host.



Fake SD Cards 1

- Some fake SD cards have been hacked to report more memory than they actually have and relabelled with the fake stats.
- Initially all is well. When you try to add a lot of files, the device craps out and lose your data/pictures/videos.



Fake SD Cards 2

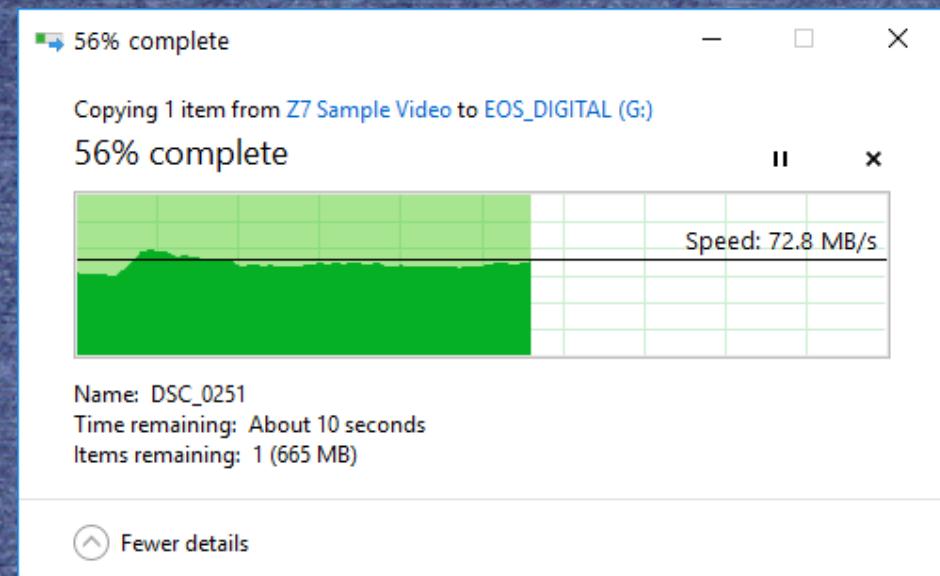
- Relabelled with fake speed ratings, these are cheap, slow, old cards with new specs that indicate high speed.
- They are still slow and will perform poorly in your application.
- Sometimes only the brand name is faked. This allows cheap brands to sell for more.
- Finally, sometimes these crooks sell defective, non-functional devices that just don't work!

Protecting Yourself

- I've read a lot about spotting fakes. It's not easy, these fakes look real. So, what can be done?
- ★ Buy your SD cards from reputable sources. These cards are cheap so the little you save could be more trouble for you.
- ★ Buy retail. Controversial I know but, even Amazon Prime does not always assure you of good devices. Retailers need to stand behind their products.
- ★ Be careful about cheap memory cards. Often times, if the price seems too good to be true, it usually is.

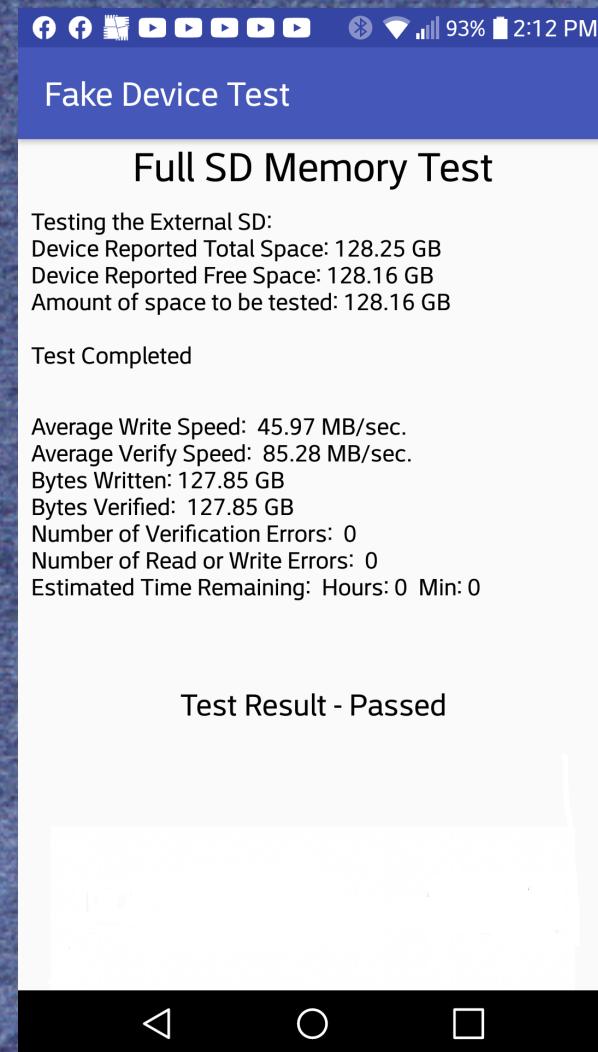
Testing Cards

- OK, you have a card. How do you test it before entrusting priceless vacation photos/videos to it?
- Copy large files to the card. You can verify the speed and capacity. Then test the files. Are they intact? Do they still “Play” correctly?



There's an App for that!

- You can also install an app on your phone to verify cards very thoroughly.
- I installed “Fake Device Test”, free from the Android Play Store.
- It does take a long time. (3+ hours for a 128G card!). It does have ads.



Further Info

Explaining SD Cards

<http://tiny.cc/7wdutz>

Benchmarking SD Cards

<http://tiny.cc/cwdutz>



Hacking SD Cards

- Hacking SD card & flash memory controllers
- <http://tiny.cc/cwdutz>
- Beware SD cards:
Turns out you can hack those, too
- <http://tiny.cc/l9eutz>



Deep Technical Info

- Wikipedia
- [https://en.wikipedia.org/
wiki/SD_card](https://en.wikipedia.org/wiki/SD_card)



- My Summary
- <http://tiny.cc/l9eutz>



More About Detecting Fakes

- How to Identify and Test Fake Memory Cards
- <http://tiny.cc/4deutz>
- Beware: Amazon Still Sells Counterfeit Memory Cards
- <http://tiny.cc/7deutz>



And Even More Fakes!

- 11 Freeware To Detect
Fake USB Flash Drives,
SD Cards And SSD
Disk
- <http://tiny.cc/zzhutz>



One further example

Inbox (1) - peter.camilieri | SanDisk Ultra 32GB microSD | Webinar Registration Success | Hades | How to Drink - You | Prime Video: Farscape | Netflix | Even Bananas 04: Can we s... | Casino World - Play Online | +

amazon.ca/Sandisk-SDSQUAR-032G-GN6MA-Ultra-Micro-Adapter/dp/B073JWXGNT/ref=sr_1_2?dchild=1&lm=A3DWYIK6Y9EEQB&pf_rd_i=3381334011&pf_rd_p=f4f9b7b4-fe0e-5601-8839-220451f9d67&pf_rd_r=760ER7YBW19FRN347Q2T... | Apps | eMail | Tools | Fun | ICE | Yahoo! Mail | My YouTube | DuckDuckGo | Google | Digikey.ca | Wikipedia | bitsavers.org | CTF | Whitby, Ontario - 7... | Kijiji in Oshawa / D... | Your Durham Regio... | Other bookmarks | Reading list

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SanDisk Ultra 32GB microSDHC UHS-I Card with Adapter - 98MB/s U1 A1 - SDSQUAR-032G-GN6MA

Brand: SanDisk

★★★★★ 633,590 ratings | 578 answered questions

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CDN\$ 24.02 <small>prime</small>	CDN\$ 41.50 <small>prime</small>	CDN\$ 47.02
400GB	512GB	
CDN\$ 85.98 <small>prime</small>	CDN\$ 117.03 <small>prime</small>	

Brand SanDisk

Flash memory type Micro SDHC

Colour New

Hardware interface MicroSDHC

Secure digital association speed class

About this item

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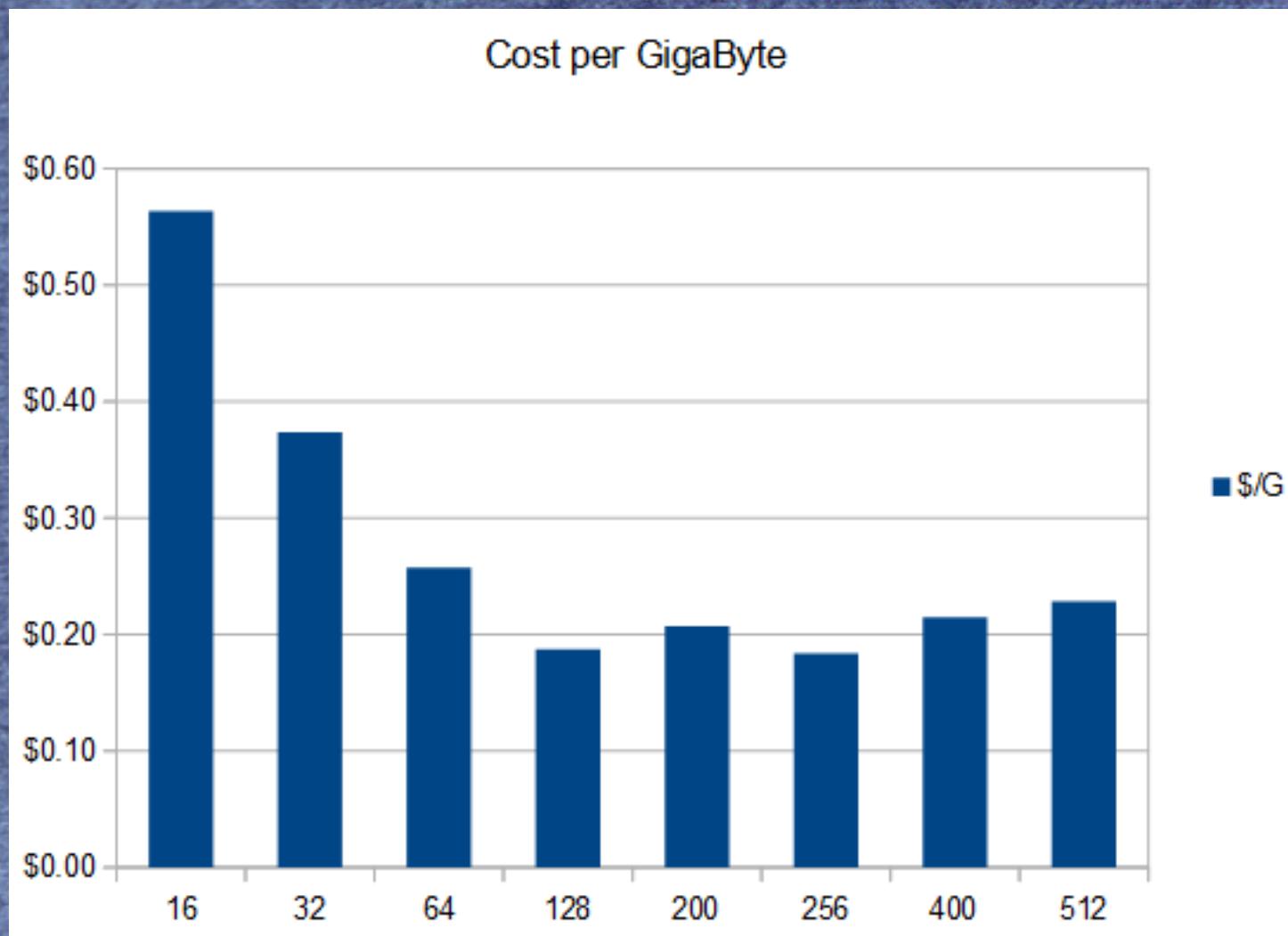
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