

# SD Card + Storage

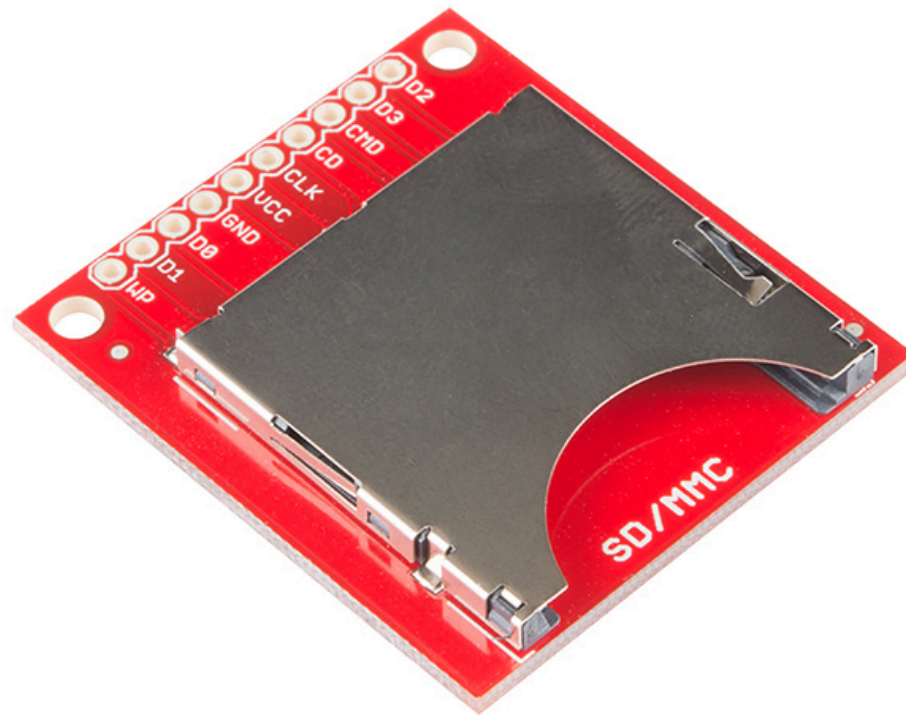
E155

Fall 2014

# Sources/References

- [http://hades.mech.northwestern.edu/index.php/PIC32MX: Interfacing to a Secure Digital \(SD\) Flash Card](http://hades.mech.northwestern.edu/index.php/PIC32MX:_Interfacing_to_a_Secure_Digital_(SD)_Flash_Card)
- <http://www.opensourcepic.com/memory.php>
- [http://www.dejazzer.com/ee379/lecture\\_notes/lec12\\_sd\\_card.pdf](http://www.dejazzer.com/ee379/lecture_notes/lec12_sd_card.pdf)
- [http://elm-chan.org/docs/mmc/mmc\\_e.html](http://elm-chan.org/docs/mmc/mmc_e.html)

# SD Card Reader

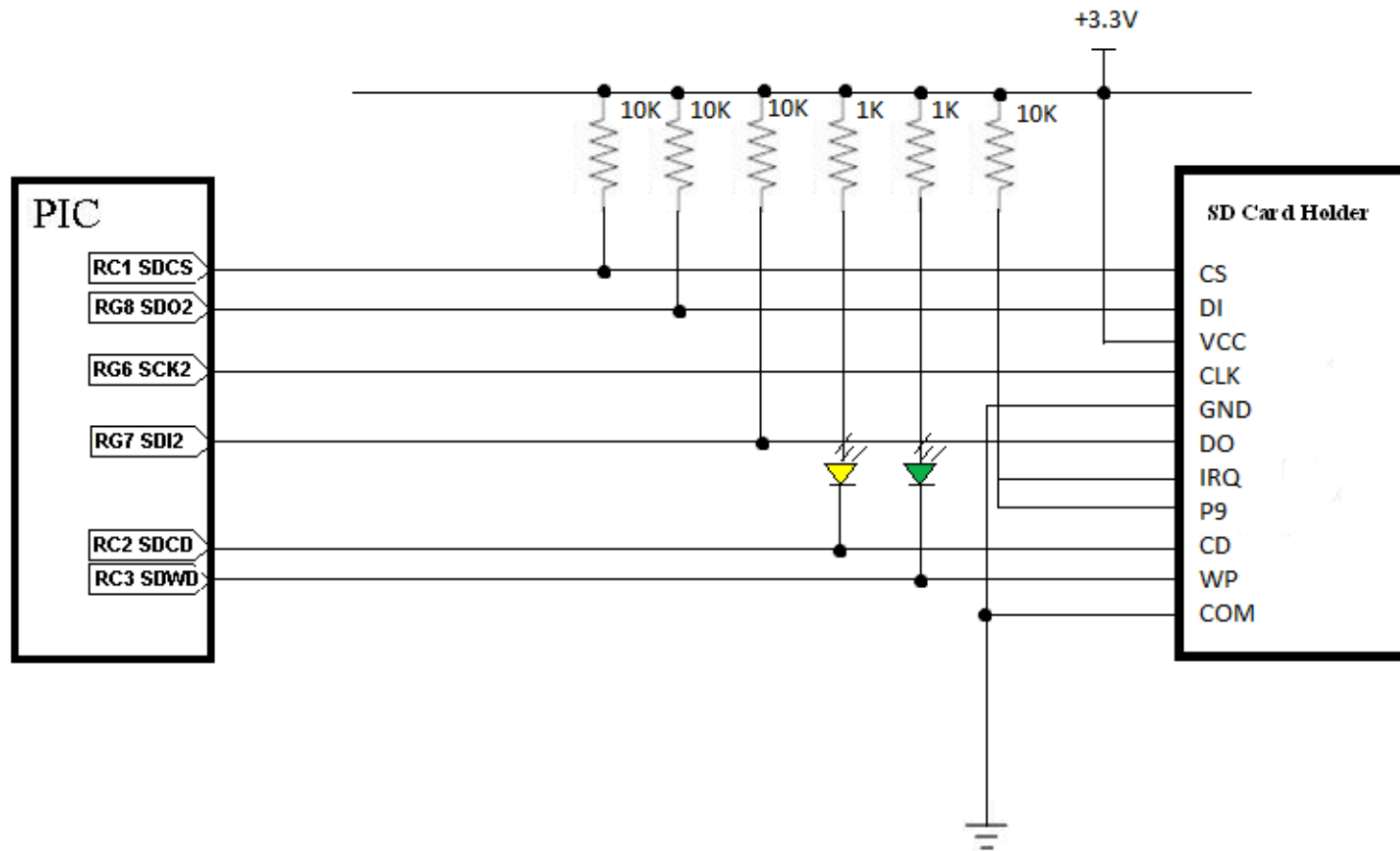


<https://www.sparkfun.com/products/12941>

# Pinout

PIN Label	Function
CS	Chip Select (Low to enable)
DI	Digital Input (Connect to PIC's output)
VCC	3.3V Power
CLK	SPI Clock
GND	Ground
DO	Digital Output (Connect to PIC's input)
IRQ	Not used in SPI
P9	Not used in SPI
CD	Card Detect (Output low if card detected)
WP	Write Protect (Output high if write protected)
COM	Common (Ground if WP and/or CD are in use)

# Circuit



# SD Card Types

Card Type	Year adopted	Size limit	FAT type
SD	2000	4GB	FAT16
SDHC	2006	32GB	FAT32
SDXC	2009	2TB	exFAT

# Example Source

- From

<http://www.opensourcepic.com/memory.php>

# Recommendation

- If you can, use someone else's code
- If you want to roll your own:
  - [http://elm-chan.org/docs/mmc/mmc\\_e.html](http://elm-chan.org/docs/mmc/mmc_e.html)
  - It's just SPI with certain commands
- Place everything in the root directory



**SATA**

# Sources

- Harris and Harris 2<sup>nd</sup> Ed. Chapter 8
- <http://en.wikipedia.org/wiki/SCSI>
- [http://en.wikipedia.org/wiki/Serial\\_ATA](http://en.wikipedia.org/wiki/Serial_ATA)
- Others...

# Hard Drive

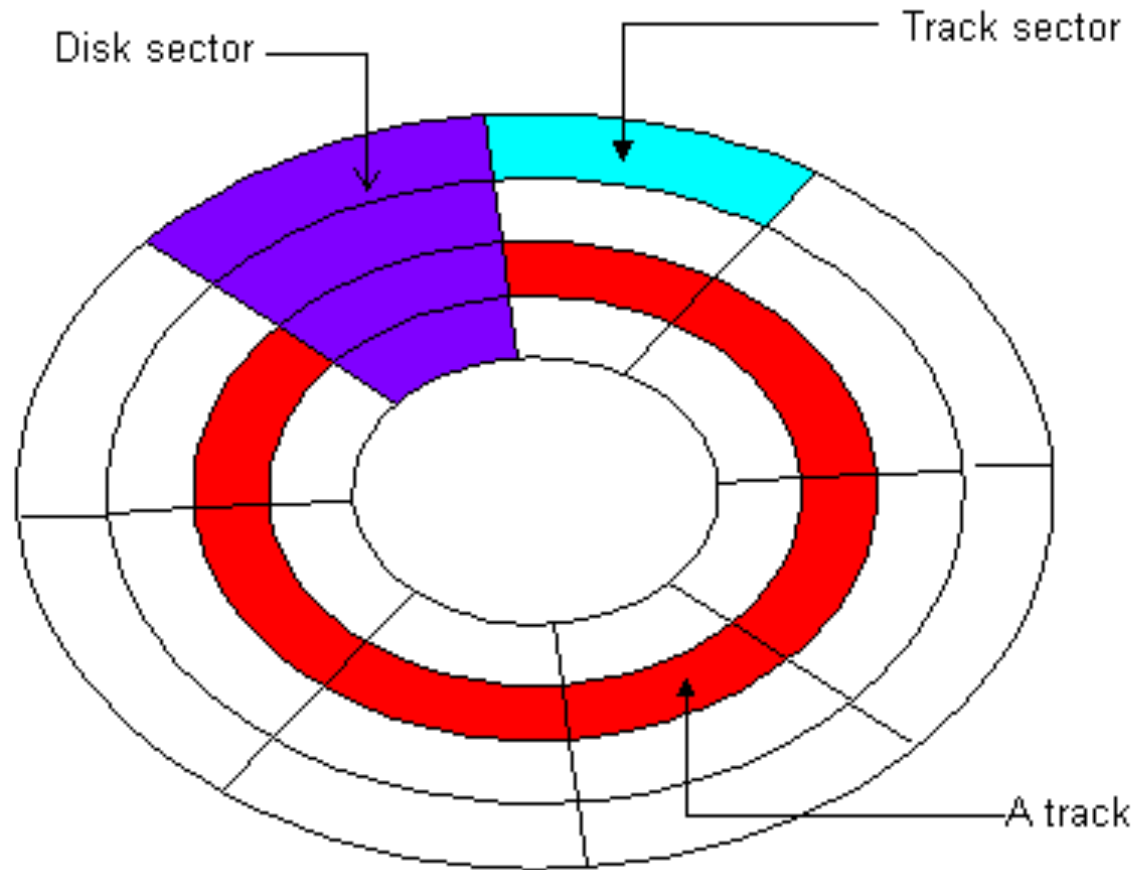


[http://en.wikipedia.org/wiki/Hard\\_disk\\_drive](http://en.wikipedia.org/wiki/Hard_disk_drive)

# Hard Drive Parts

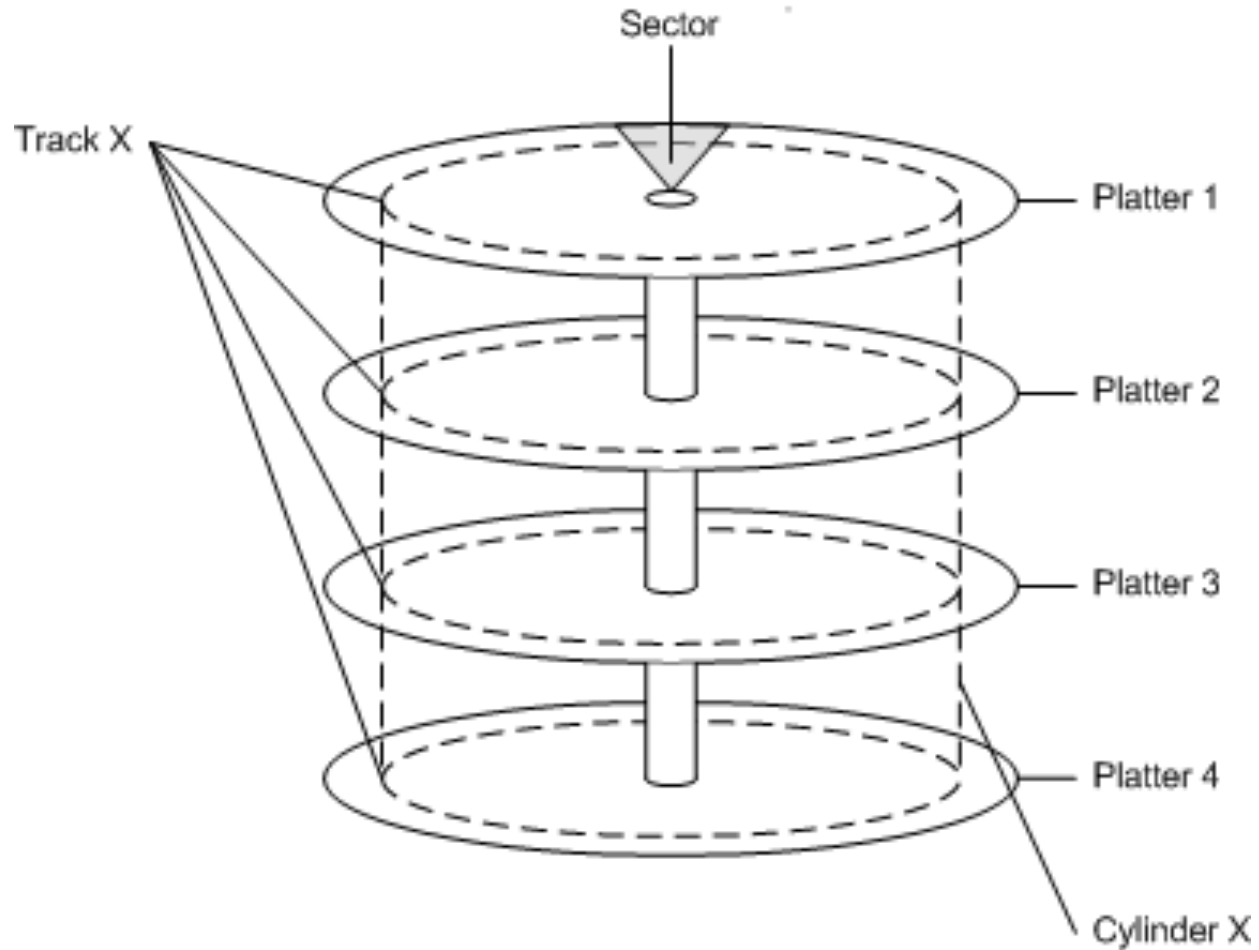
- Arms
- Heads
- Platter
- Track/Cylinder
- Sector

# Hard Disk Parts



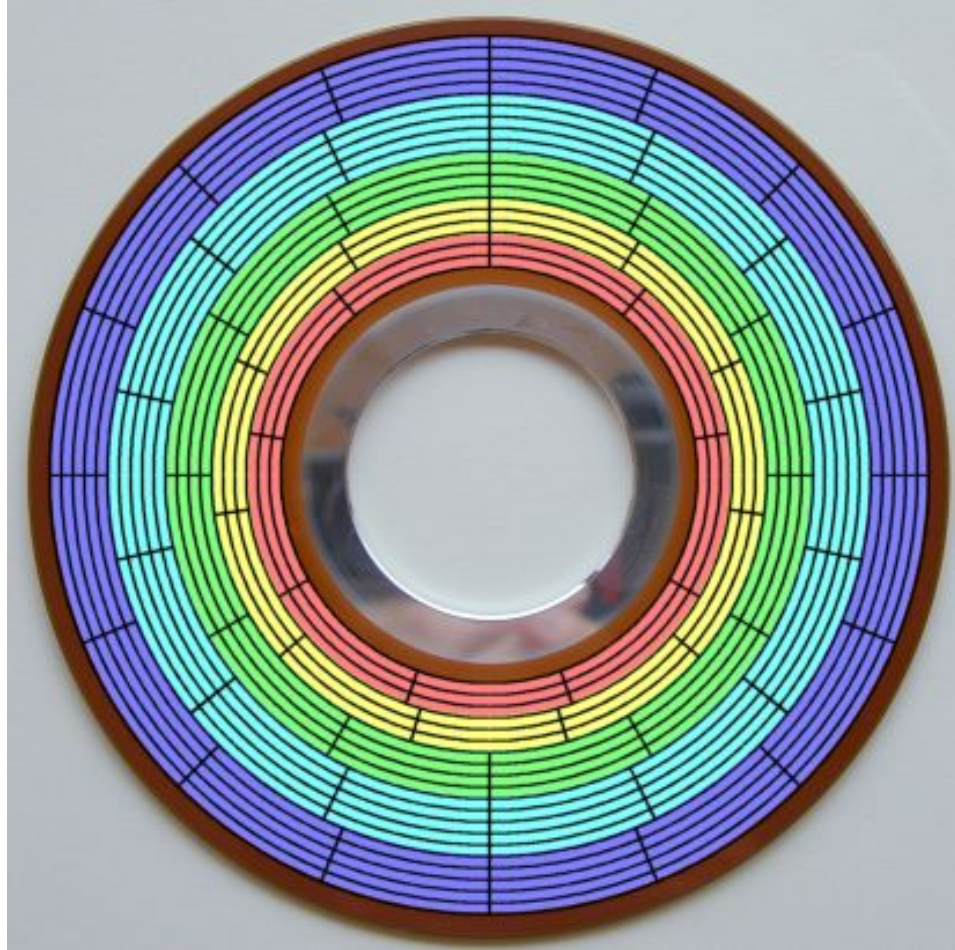
<http://www.installsetupconfig.com/win32programming/windowsdiskapis2.html>

# Hard Disk Construction



<http://www.installsetupconfig.com/win32programming/windowsdiskapis2.html>

# Zones



# Hard Drive Capacities

Form Factor	Width(mm)	Height(mm)	Platters	Cap/Platter	Largest Cap
3.5"	102	25.4	5	1000 GB	4 TB
2.5"	69.9	9.5-15	4	500 GB	2 TB (15 mm)
1.8"	54	8	2	160 GB	320 GB (2009)
1.3"	43		1	40 GB	40 GB (2007)
0.85"	24		1	8 GB	8 GB (2004)
5.25"	146		14	3.36	47 GB (1998)



# Seek

- Position head assembly
  - 3-15 ms
- Wait for the relevant sector

# Rotation Speeds

Rotation Speed (rpm)	Average Latency (ms)
15,000	2
10,000	3
7,200	4.16
5,400	5.55
4,800	6.25

# Hard Drive Interface

- Integrated Drive Electronics (IDE) interface
  - Western Digital
  - Control Data Corporation
  - Compaq Computer
- AT attachment (ATA) standard
  - Evolved from IDE
  - Renamed PATA after SATA was introduced
- First appeared in 1986

# Standards!

- 1986 WD AT Attachment
  - ANSI standard X3.221-1994 (ATA-1)
- 1994 WD Enhanced IDE (EIDE)
  - ANSI standard X3.279-1996 (ATA-2)
  - Officially multiple hard drives

# PATA

- 40-pin connectors
- 80-wire version
  - Reduce capacitive coupling
  - Reduce crosstalk
- Maximum length of 18 inches

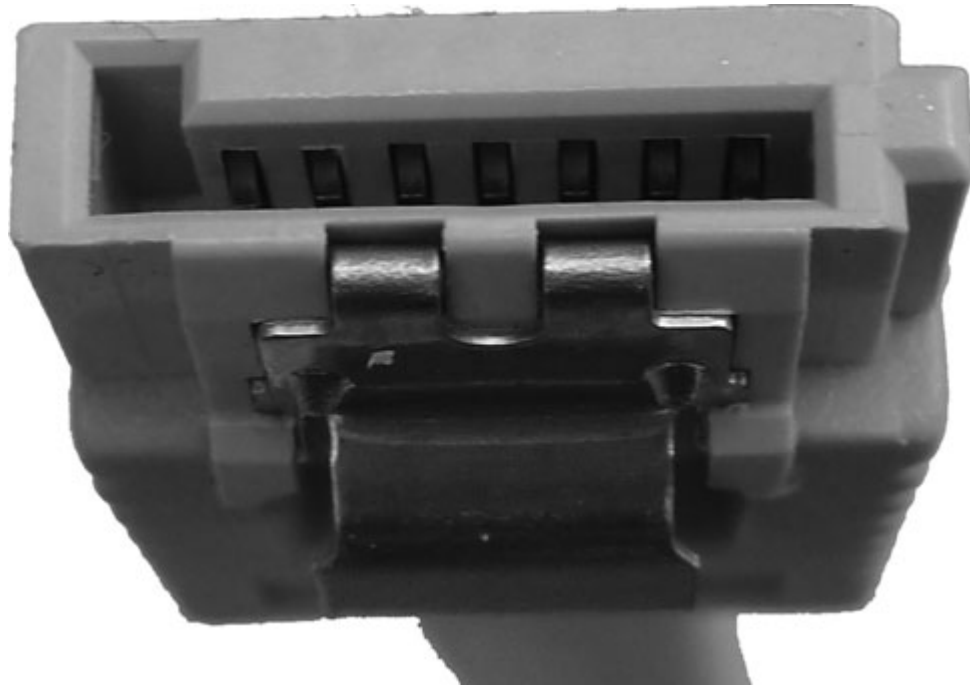


# PATA Speeds

<b>Mode</b>	<b>Cycle Time</b>	<b>Transfer Rate (MB/s)</b>
PIO	600-120 ns	3.3-16.7
Single-word DMA	960-240 ns	2.1-8.3
Multi-word DMA	480-80 ns	4.2-25
Ultra DMA	240-24 ns (div 2)	16.7-167

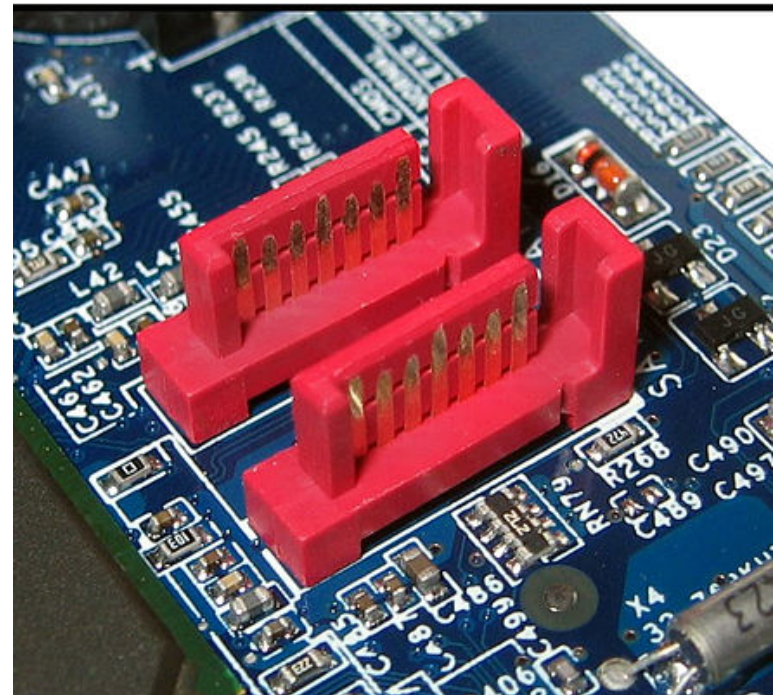
# SATA

- Serial!
- 7-conductor cable



# SATA

- <http://serialata.org/>
- Up to 1m cables
- eSATA up to 2m





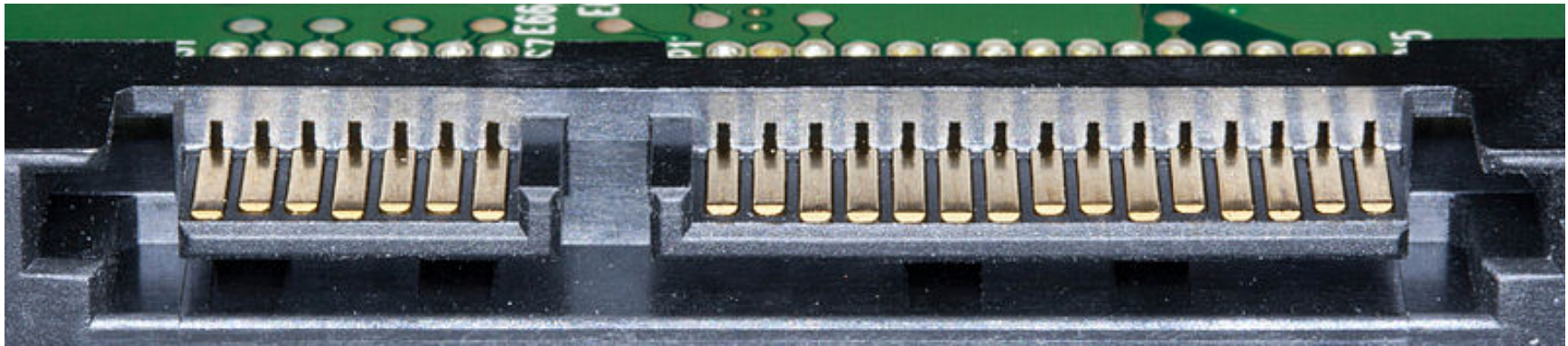
# SATA Spec

- [https://www.sata-io.org/developers/purchase\\_spec.asp](https://www.sata-io.org/developers/purchase_spec.asp)
- \$25 each revision
- \$40 for all of them!
- Members get it free!

# SATA Uses

- Hard drives
- CD drives
- DVD drives
- Blu-ray drives
- Tape devices
- High capacity removable devices
- SSDs

# SATA Ports

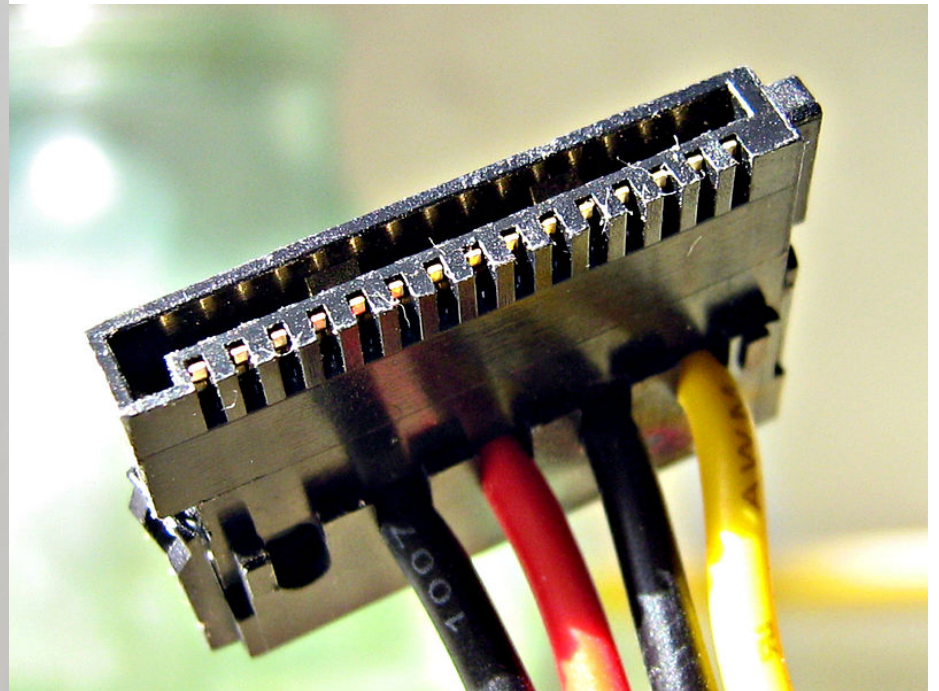


[http://en.wikipedia.org/wiki/Serial\\_ATA](http://en.wikipedia.org/wiki/Serial_ATA)

# SATA Pins

Pin #	Mating	Function
1	First	Ground
2	Second	A+ (Transmit)
3	Second	A- (Transmit)
4	First	Ground
5	Second	B+ (Receive)
6	Second	B- (Receive)
7	First	Ground

# SATA Connectors



[http://en.wikipedia.org/wiki/Serial\\_ATA](http://en.wikipedia.org/wiki/Serial_ATA)

# SATA Speeds

<b>Name</b>	<b>Max Cable Length</b>	<b>Transfer Speed (MB/s)</b>
SATA 1.0	1 m	150
SATA 2.0	1 m	300
SATA 3.0	1 m	600
eSATA	2 m	300

# SCSI

- Small Computer System Interface
- Public in 1981
- 8-16 bit parallel



# Modern SCSI

- Serial Attached SCSI (SAS)
- USB Attached SCSI (UAS)
- iSCSI (SCSI over TCP/IP)



# SCSI Speeds

<b>Interface</b>	<b>Width (bits)</b>	<b>Clock</b>	<b>Bandwidth (MB/s)</b>
SCSI-1	8	5 MHz	5
SCSI-2	16	10 MHz	20
SCSI-3	16	20-160 MHz	40-640
SAS 1.1	1	3 GHz	300
SAS 2.0	1	6 GHz	600
iSCSI	varies	varies	varies

# SCSI Commands

- Test unit ready
- Inquiry
- Request sense – error detection
- Send diagnostic, Receive diagnostic results
- Start/Stop unit
- Read capacity
- Format unit

# SCSI Commands

- SCSI Read format capacities
- Read + variants
- Write + variants
- Log sense
- Mode sense
- Mode select

# Summary

Name	Raw Bandwidth Mb/s	Real Speed (MB/s)	Max Cable (m)
eSATA	3000	300	2
SATA	1,500-6,000	150-600	1
PATA	1,064	133.5	0.46 (18")
SAS	1,500-6,000	150-600	10
USB	12-5,000	1.5-400	3-5
Fibre	10,520	1,000	2-50,000
InfiniBand	10,000	1,000	5-10,000
Thunderbolt	10,000	1,250	3

[http://en.wikipedia.org/wiki/Serial\\_ATA](http://en.wikipedia.org/wiki/Serial_ATA)