220-1101

Internal Expansion
Storage Devices
Power Supplies

Expansion Cards

- Also called an Adapter Card
- Must match the bus type its plugged into
- Most common
  - Video
  - Multimedia
  - Communications
  - Input/Output

Expansion Cards

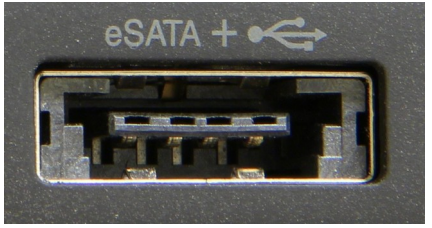
- Video
  - PCIe – Preferred
  - PCI - Uncommon
  - AGP – Obsolete
  - Memory
    - Onboard shares memory with processor
    - 1-2Gb for Everyday use
    - 8Gb GDDR5 for Gaming (24Gb GDDR6 available)
- Soundcard
  - Small 3.5mm jacks
  - Older cards have a DA15 game port

Expansion Cards

- NIC – Network Interface Card
  - RJ45 (Registered Jack)
  - Fibre
  - BNC
  - Wireless
- Modem
  - RJ11

Expansion Cards

- Input / Output
  - All cards are this!
  - Covers remaining cards
  - USB Expansion
  - eSata
  - SCSI



Configuration

- Plug and Play
- Check if settings need to be changed in BIOS

Expansion Card Configuration

- Plug and Play installation
  - Add Hardware Wizard.
  - Scan for new hardware.
  - Select driver or accept default driver.
- Manual installation
  - When Plug and Play installation is not successful.
  - Download driver from manufacturer website.
  - Use Device Manager to manually install driver.
  - Manufacturer installation utility.
  - Sometimes software needs to be installed before hardware attached

Installation

- Ensure the PC is powered off
- Install the card into correct slot
- Connect power if card requires it
- Boot up the PC. Drivers should be automatically installed
- If you have problems:
  - check BIOS settings
  - Use provided utility or manufacturers website

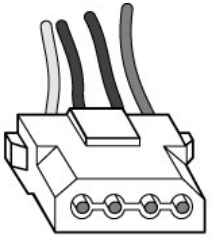
Storage Devices

- HDD – Hard Disk Drive
  - Permanent storage
  - Quick Access
  - Magnetic and/or Solid State Device
- All HDD systems have the following components:
  - Controller. Interfaces the system to the actual HDD. Controls data flow to and from device.
  - Hard Disk (The physical storage medium)
    - Magnetic ones use Platters for storage
  - Host Bus Adapter (HBA)
    - Converts signals from the controller to signals the processor understands
    - Built into Motherboards

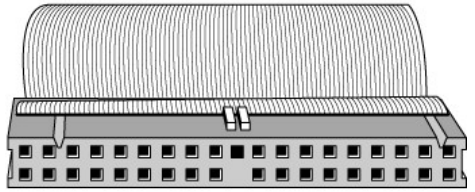
How to differentiate between SATA and PATA

SATA drive
(has card-edge connector)

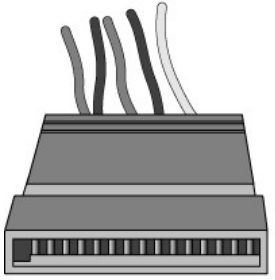
PATA drive
(has pin connector)



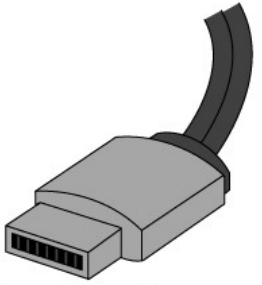
PATA power cable



PATA data cable



SATA power cable

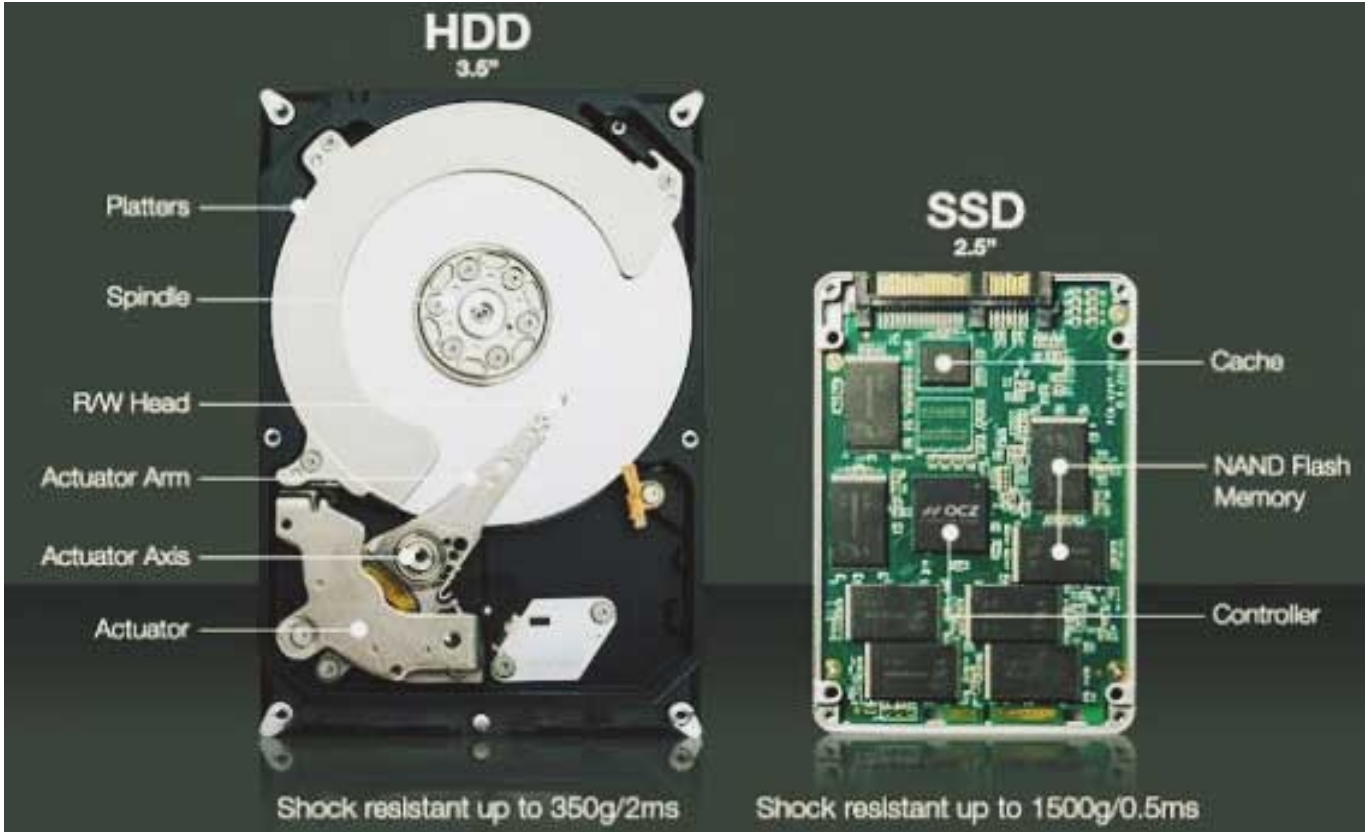


SATA data cable

HDD interfaces

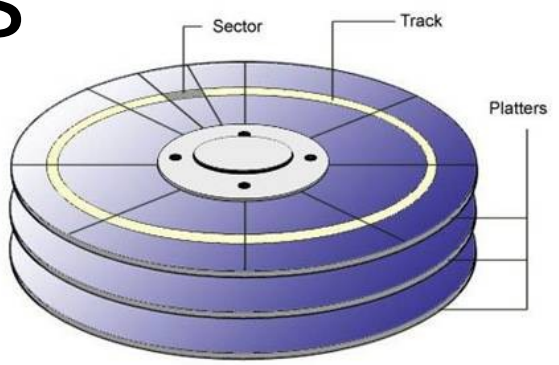
- IDE (PATA) – obsolete
- ATA/100 standard
  - max transfer speed of 100MBps
- ATA/133 and ATA/167
  - rare

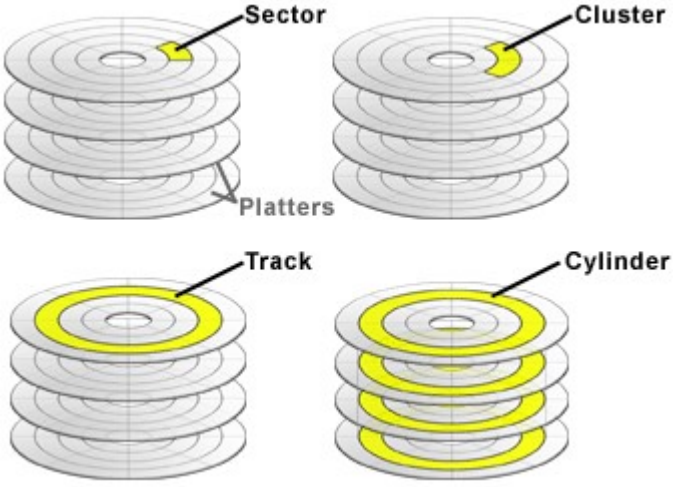
HDD Anatomy


HDD
3.5"
Platters
Spindle
R/W Head
Actuator Arm
Actuator Axis
Actuator
Shock resistant up to 350g/2ms
SSD
2.5"
Cache
NAND Flash Memory
Controller
Shock resistant up to 1500g/0.5ms

HDD Internals

- Hermetically Sealed
- Data stored on platter surface
- Platters spun (RPM)
- Low level formatting to map bad track and sectors
- A sector stores 512 bytes





HDD

- Capacity is defined by the number of sectors
- BIOS is critical in the read/write process
- BIOS must support number of sectors
- CHS – Cylinders/Heads/Sectors
  - The number of sectors on each track
  - The number of read/write heads
  - The number of cylinders (number of tracks on platter surface)

HDD Speeds

- HBA (Host Bus Adapter) speeds getting faster
- Increase platter speed to get more information
- Typical speeds:
  - 5400rpm
  - 7200rpm
  - 10000rpm (also known as 10K)
  - 12000rpm
  - 15000rpm
- Higher speeds produce more heat and consume more energy
- Fastest Platter drives slower than Solid State Drives

HDD Sizes

- Most Common
  - 2.5” and 3.5”
  - 1.8”
- Rare
  - 5.25”

SSD

- Faster, much faster
- 6GB/s Bus
- SATA bus is bottleneck!
- Less power consumption (and therefore less heat)
- Silent
- Reliable (no moving parts)
- Shock resistant
- High Density of storage per CM

SSD

- Expensive per byte
- Limited write operations
  - Increasing number on later devices
  - TBW (Terra Bytes Written)
  - https://crystalmark.info/en/software/crystaldiskinfo/
  - Don’t defrag them
  - Lower capacity (at present) than conventional drives
  - https://www.ontrack.com/en-gb/blog/how-long-do-ssds-really-last
  - https://www.youtube.com/watch?v=hyHMuAdjzfI

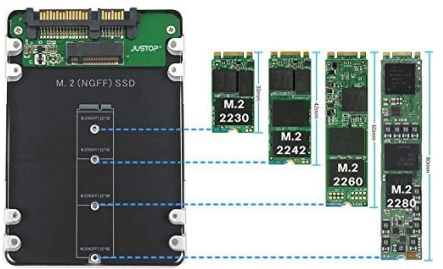
Hybrid Drive

- Combination of Platter and SSD
- Uses SRT (Intel’s Smart Response Technology)
  - Identifies most used data and high value data
  - SSD stores a copy of the most used
- Data randomly accessed will see no performance improvement
- Data accessed for first time not on SSD portion, only repeated access identifies it for SSD storage.
- SSHD (Solid State Hybrid Drive) – more flash memory

M.2 Storage

- Pronounced “M dot 2”
- Ultra small expansion
- Its a form factor, not a bus
- NGFF
  (Next generation form factor)
- M.2 Wi-Fi, Bluetooth, GPS,NFC
  not just PCIe and SATA

Supports Different Sizes M.2 SSD Drives

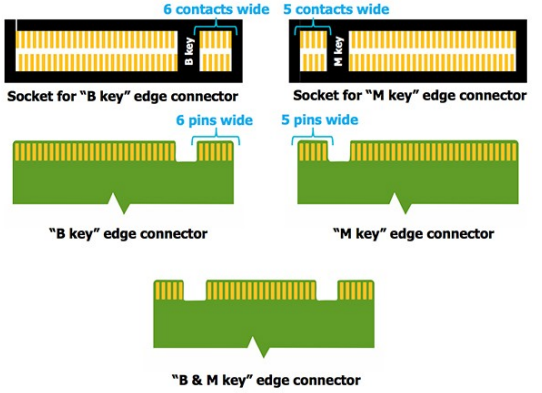


M.2 Keys

- Cards keyed so that they only fit in a slot type

Module Key	Common Interfaces	Typical Usage
A	USB 2.0, PCIe x2	Wireless (Wi-Fi, Bluetooth)
B	SATA, PCIe x2, USB 2.0 and 3.0	SATA and PCIe x2 interfaces
E	PCIe x2, USB 2.0	Wireless
M	PCIe x4, SATA	PCIe x4 SSDs

- Designated Width and length
  2240 is 22mm wide, 40mm long



M.2 PCIe Cards

- PCIe faster than SATA
- Max 960Gb
- 2.4GBps read
- 1.56GBps write

NVMe
(Non-Volatile Memory express)

- Supported by Intel, Samsung, Dell, SanDisk, and Segate.
- Open Standard to optimise data transfer speeds
- 3.5GBps (SATA III SSD limited to 600MBps)
- PCIe slot support (up to 4 lanes)
- Motherboard must support if used as boot drive
- https://www.howtogeek.com/404627/what-are-nvme-drives-and-should-you-buy-one/

NVMe


INTEL® SOLID-STATE DRIVE
750 SERIES
intel


V-NAND SSD
970 EVO
NVMe M.2
SAMSUNG ELECTRONICS CO., LTD.
250GB
SAMSUNG


U.2 PCIE X16

Optical Storage Drives

- Blu-ray Disk (BD)
- Digital Versatile(or video) Disk (DVD)
- Compact Disk (CD)

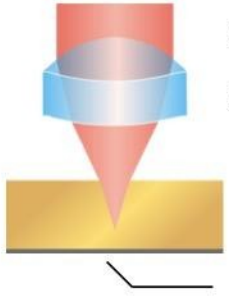
CD-ROM / DVD / BR

- CD-ROM
  - Long term storage
  - Data cannot be erased or changed
  - Approx 700MB capacity
- DVD
  - Single sided 4.7GB
  - Double sided 9.4GB
  - Double Layer Single Side 8.5GB (DVD-DL)
  - Double sided, Double Layer 17.1GB
- BR
  - Higher Density of information
  - Single Layer 25GB
  - Single Side Double Layer 50GB
  - Doublee Side Double Layer 100GB
  - Up to 4 layers have been demonstrated in laboratory conditions

Optical Disc Structure and Capacity Comparison

CDs

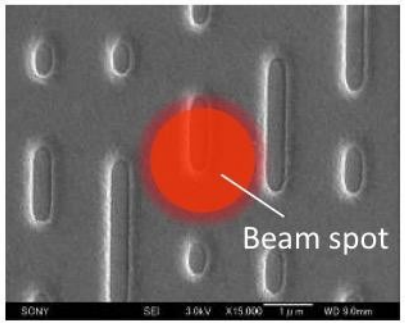
1st CD launched in 1982



780-nm Laser

NA=0.45

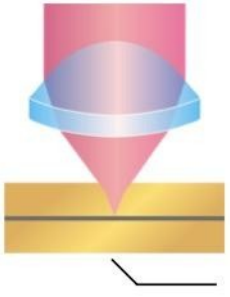
Label side



650 MB - 800 MB

DVDs

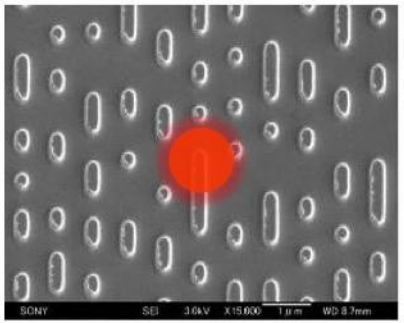
1st DVD launched in 1996



650-nm Laser

NA=0.6

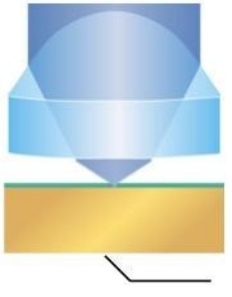
Label side



4.7 GB - 9 GB

Blu-ray™ Discs

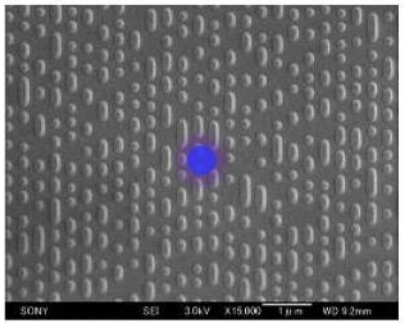
1st Blu-ray™ launched in 2003



400-nm Laser

NA=0.85

Label side



25 GB – 100 GB

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Optical Drive Data Rates

- Rated in transfer speed
- First CD-ROMs transferred at same rate as audio CDs, 150KBps – 1x
  - 2x, 300KBps
- DVD-ROM
  - 1x – 1.4 MBps
  - 9x faster than CD
  - 24x common rate
- BR
  - 1x – 4.5 Mbps
  - 3.25x faster than DVD
  - Approx 30x CD rate
  - 2x for playing films

Recordable Discs

- CDFS – Compact Disk File System
- Laser power varies
  - Melts the surface where data is stored
  - One power level neutralises the surface rather than burning it

Recordable Disks

- CR-R (Compact Disk Recordable)
- CD-RW (Compact Disk Rewritable)

Recordable Disks

- DVD+R, DVD-R, DVD+RW, DVD-RW, DVD-R DL and DVD+R DL
- Capacities
  - 4.7 GB (single-sided/single layer)
  - 9.4 GB (double-sided/single layer)
  - 8.5 GB (single-sided/dual layer)
  - 17.1 GB (double-sided/dual layer)
- DVD-R
  - Specified by DVD Forum founded by Mitsubishi, Sony, Hitachi, and Time Warner
- DVD+R
  - Specified by DVD+RW Alliance supported by Sony, Yamaha, Philips, and Dell.

Recordable Disks

- Different way the data is recorded and read.
- DVD+R advantages
  - Instantly eject DVDs without having to wait for finalized formatting.
  - Record one DVD disc partially on PC and partially on television.
  - Background formatting — while the disc is being formatted, you can simultaneously record on already-formatted portions of the same disc.
  - Enhanced ability to edit filenames, movie and song titles, and playlists.
  - 100 percent compatibility with all other DVD players
- Hybrid drives

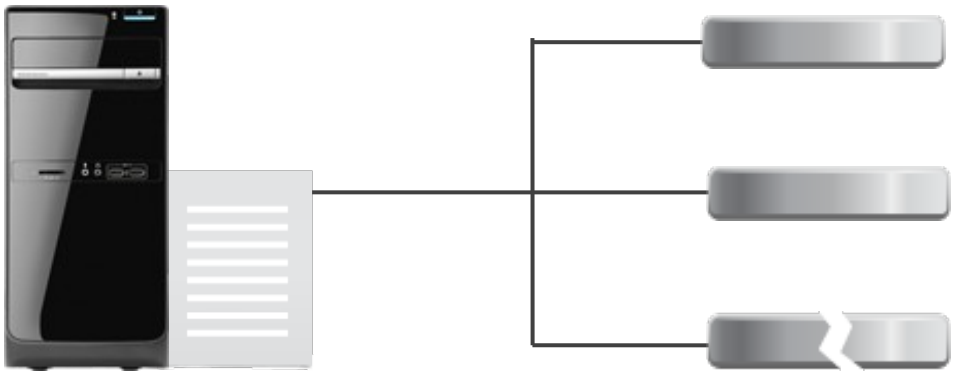
Recordable BD Formats

- Blue Ray Disc Association
- Not RW but RE (re-recordable)
  - BD-R and BD-RE
- Generic BD logo

RAID

- Redundant Array of Independent Disks (originally inexpensive)
  - Vendor-Independent Specifications
  - Fault Tolerance on multiple disks
  - Software or Hardware based
  - Hardware based will require additional hardware
    - RAID configuration appears to user as one disk
    - Can be built into motherboard
  - Microsoft in Windows 8 call RAID as Storage Spaces

RAID



Data written to multiple disks

Data can be restored if one disk fails

Common RAID Levels

- RAID Configurations are also called RAID levels
- 4 Common Levels
  - RAID 0
  - RAID 1
  - RAID 5
  - RAID 10
- Other levels not considered in A+
- https://www.youtube.com/watch?v=U-OCdTeZLac

RAID Type	Description
RAID 0	• Implements **striping**, which is the process of spreading data across multiple drives. Striping can dramatically improve read and write performance. • Provides no fault tolerance because the data is spread across multiple drives, if any one of the drives fails, you will lose all of your data. • You need at least two physical disk drives to implement striping. • The largest size RAID-0 partition that can be created is equal to the smallest available individual partition times the number of drives in the set.
RAID 1	• Two identical drives used for **mirroring** or duplexing. • Mirrored drives share a controller. • Duplexed drives have individual controllers. • Provides redundancy since each drive has the same data on it.
RAID 5	• Spreads data and parity information across multiple drives. • Minimum of three drives needed for implementation. • Parity information used to reconstruct data from failed drives.
RAID 10	• Sometimes called RAID 1+0 • Combination of RAID 0 and RAID 1. • Striping and mirroring to provide both performance and fault tolerance. • Minimum of four disks needed for implementation.

Removable Storage and Media

- Tape Backup
  - Hold more data than other mediums
    - Up to 12TB (192 TB being developed)
  - Batch archival storage, not interactive storage
  - Were considered most reliable
  - Once most common archive method
  - Relatively fast

Flash Memory

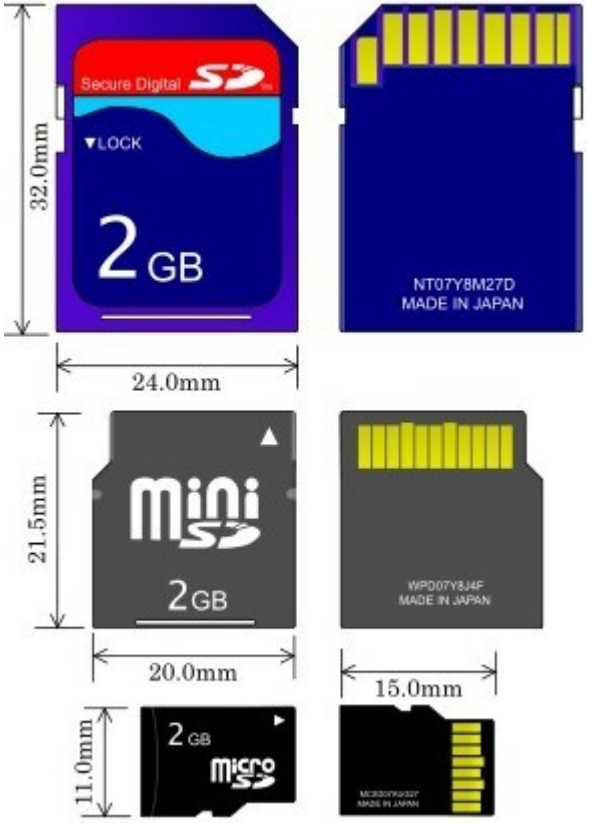
- Memory Cards
- USB keys/sticks
- Name from the ease of electrically altering the data

Memory Cards

- https://photographylife.com/understanding-memory-cards

SD Cards

- SD – Secure Digital
- miniSD
- microSD
- Use adapters for compatibility



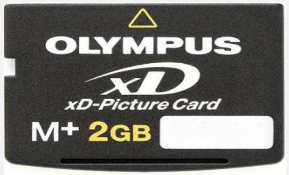
USB Flash Drives

- Most popular type of removable solid state storage
- Known by many names
- Wide range of sizes (5 mm – 50 mm in length)
- Modern units up to 2 TB in storage capacity
- Data transfer rate depends on the USB version
  - Currently up to 420 MB/s read, 380 MB/s write

Memory Cards

Device	Specifications
 **Compact Flash (CF) card**	• Flash memory card that is 43 mm long by 36 mm wide and often used in portable devices for additional storage. • Type I: 3.3 mm thick; Type II: 5 mm thick. • 50-pin contact • Speed: 66 MBps up to 1 Gbps. • Data storage: 100 GB up to 1 TB.
 **SmartMedia (SM) card**	• Flash memory card similar in size to CF cards (44 mm long by 37 mm wide by 0.76 mm thick). • Often used for additional storage in digital cameras, digital recorders, and older PDAs. • Speed: Up to 8 MBps. • Data storage: Up to 128 MB.

Memory Cards

Device	Specifications
 **xD-Picture (xD) card**	• Flash memory card that is 20 mm long by 25 mm wide by 1.77 mm thick. • Designed for use in digital cameras. • Speed: 4 MBps up to 15 MBps for read; 1.3 to 9 MBps for write. • Data storage: 2 to 8 GB.
 **Memory stick (MS)**	• Flash memory card that is 50 mm long by 21.5 mm wide by 2.8 mm thick. • Speed: 2.5 MBps for read; 1.8 MBps for write. • Data storage: Up to 16 GB.

Memory Cards

Device	Specifications


Secure Digital (SD) memory card
	• Dimensions:
	  • Original: 32 mm long by 24 mm wide by 2.1 mm thick.
	  • MiniSD: 21.5 mm long by 20 mm wide by 1.4 mm thick.
	  • MicroSD: 15 mm long by 11 mm wide by 1 mm thick.
	• Speed: 10 to 20 MBps.
	• Data storage: Up to 2 TB.

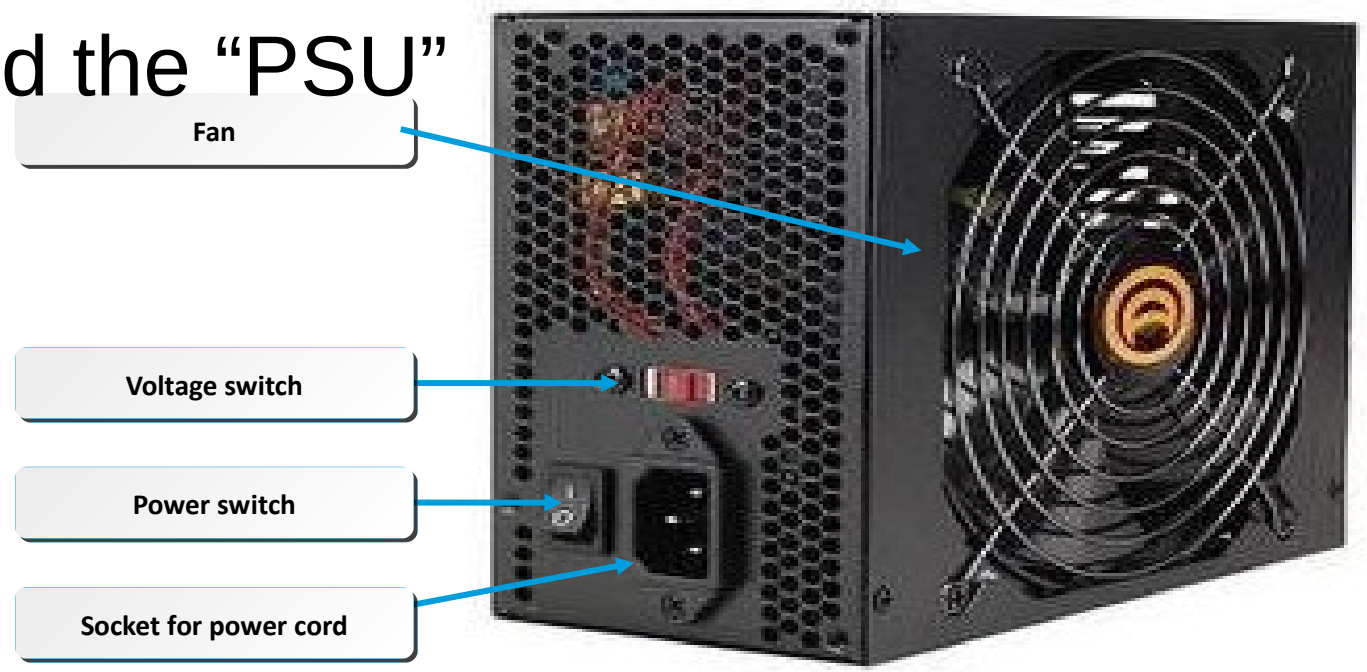

MultiMediaCard (MMC)
	• Dimensions:
	  • Original: 32 mm long by 24 mm wide by 1.5 mm thick.
	  • RS-MMC and MMCmobile: 16 mm long by 24 mm wide by 1.5 mm thick.
	  • MMCmini: 21.5 mm long by 20 mm wide by 1.4 mm thick.
	  • MMCmicro: 12 mm long by 14 mm wide by 1.1 mm thick.
	• Speed: Up to 52 MBps.
	• Data storage: Up to 8 GB.
	• Often compatible with SD card readers.

Swapping Storage

- Hot Swappable
  - Insert and remove with power on
- Cold Swappable
  - System power must be off
- Warm Swappable
  - USB flash drives
  - File system needs to close files before removal
  - Incorrect removal can cause data loss
  - Can be removed with power on if correctly closed

Power Supply

- Converts AC to required voltages (normally DC)
- Often called the “PSU”



PSU

- Never repair, replace
  - Modular Power Supply
- Input 110v or 240v AC
- Output +3.3v, +5v, -5v, +12v, and -12v DC
- Each output is called a Rail
- Dual Rail
  - One for peripherals
  - One for CPU

Redundant Power Supply (RPS)

- Multiple PSU’s
  - Not in Laptops!
  - Rare in desktops
  - For the possibility of one failing
  - Sometimes the second one could be smaller
- Battery backup
  - Uninterruptable Power Supply (UPS)
  - Also acts as a surge suppressor
  - Contain batteries to provide power in the event of power failure
  - Internal fuses to protect loading
  - Check batteries regularly!



Power and Voltage

- PSU rated in Watts
- Capacity of PSU to deliver the voltage
- Most PSUs 200W to 500W
- Power = Voltage * Amps

Motherboard Power Connections

Power Connectors

- Main Power Connector (24 pins)
- CPU power connector (4 or 8 pins, 12v)
- CPU fan connector (3 or 4 pins)
- Legacy ATA ATX P4 or 4 pin connector
- SATA power connector (15 pins)
- PCIe 6 or 8 pin

20+4Pin
(1 x Included)

PCI - E Connectors
(Not Included, Specify if Needed)

SATA
(2 x Included)

Dell 6 Pin Aux
(1 x Included)

Floppy Connectors
(1 x Included)

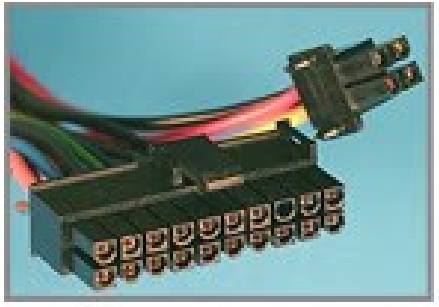
P4 MB Connector
(1 x Included)

4Pin Molex Connector
(3 x Included)

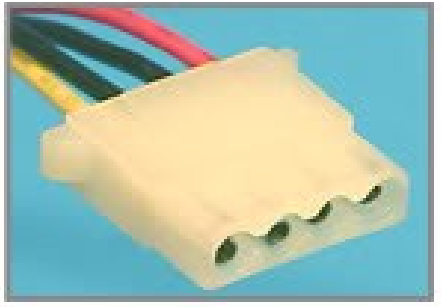
4 Pin "HP Video Power"
(1 x Included)

Molex to two molex Cable
(Not Included, Specify if Needed)

Molex to two sata Cable
(Not Included, Specify if Needed)



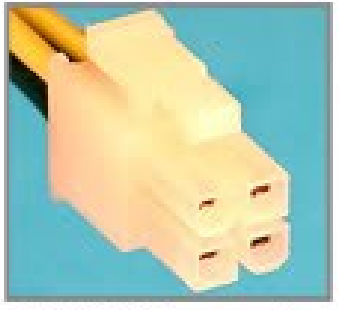
Main Connector
24 (20+4) Pin



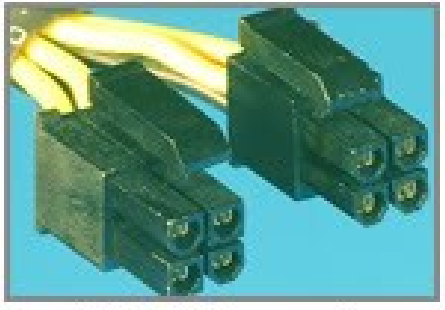
Peripheral Connector
4 Pin (Big)

Floppy Connector
4 Pin (Small)

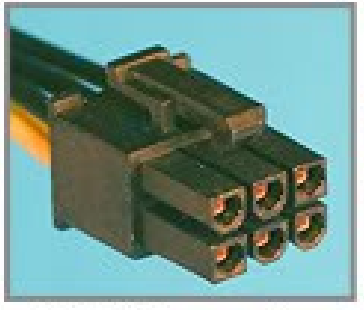
SATA Connector
15 Pin



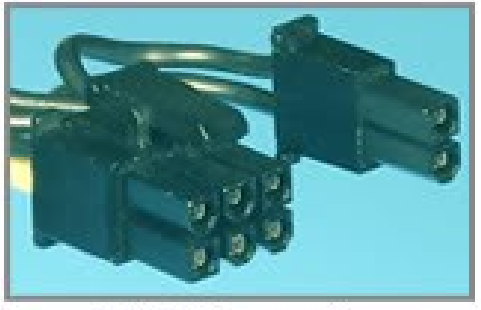
ATX12V Connector
4 Pin



EPS12V Connector
8 (4+4) Pin



PCI-E Connector
6 Pin



PCI-E Connector
8 (6+2) Pin

Need to know

- How to instal and configure expansion cards
- Understand HDD components and anatomy
- Understand SSD and their advantages
- Understand optical storage options
- Understand flash drive options
- Understand RAID 0, 1, 5, and 10
- Know PSU connectors
- Know how to replace a PSU