CHAPTER 5

POWER SUPPLY

CHAPTER OVERVIEW

- **Power Supplies**
  - **1) LINEAR POWER SUPPLY**
  - **2) SMPS**
  - **3)UPS**
- **Power Supply Problems**
- **Connectors**
- **UPS : Types**
- **Protection devices.**

Connectors included on this power supply...

ATX 2.03X1 P4 ATX 12VX1 IDE 4 PINX4 FLOPPY 4 PINX1

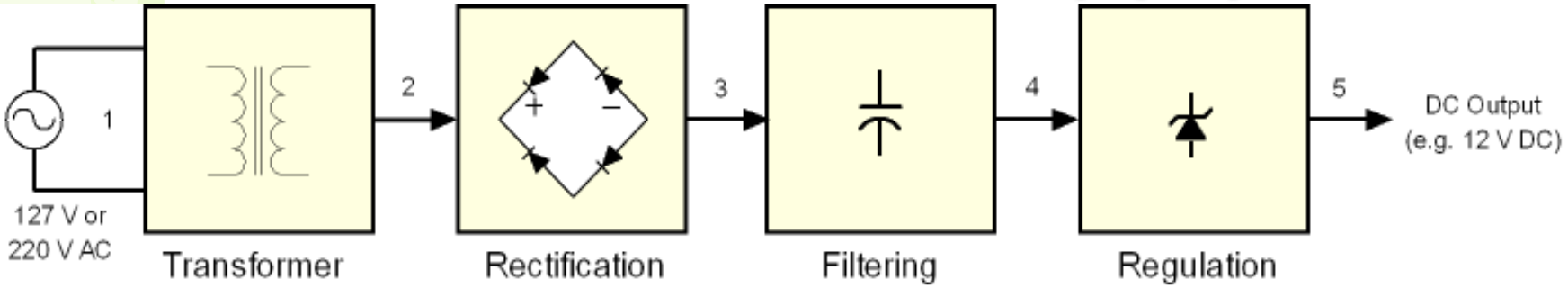
COMPUTER POWER SUPPLY UNIT

- (Computer PSU) typically is designed to convert 110 V or 230 V AC power from the mains to usable low-voltage DC power for the internal components of the computer.
- The most common computer power supplies are built to conform with the ATX form factor,
- The most recent specification of the ATX standard is version 2.2, released in 2004.
- This enables different power supplies to be interchangeable with different components inside the computer..

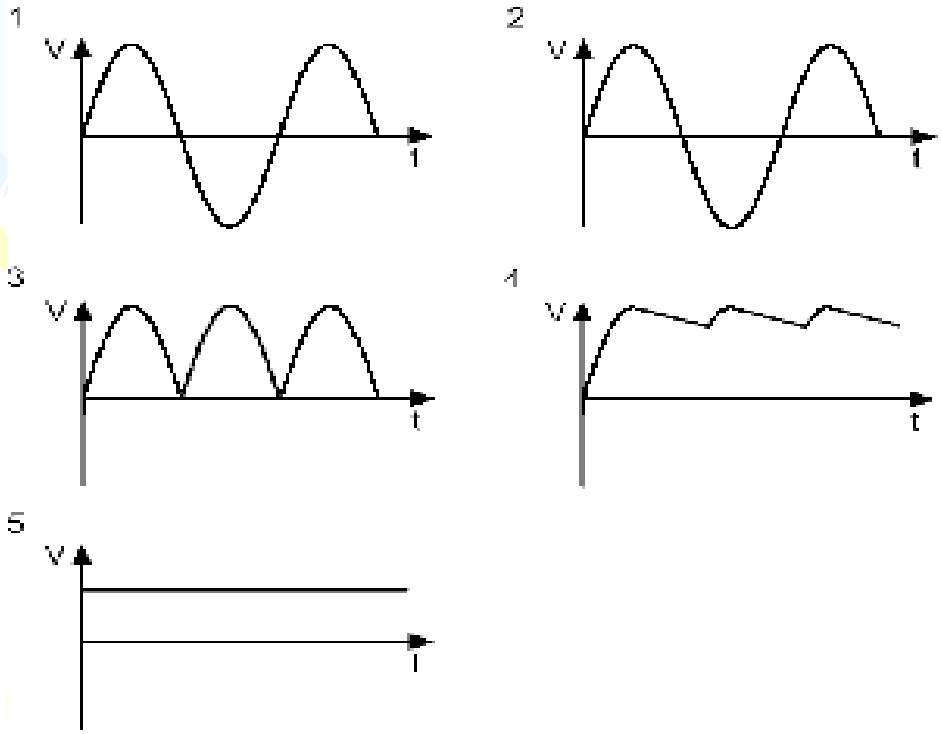
Selection of power supply

- Voltage rating
- Current rating
- Power requirements
- Line regulation
- Load regulation
- Nature of input (AC)
- Usage of computer system
- Spikes and surges in the power
- Efficiency
- Linearity
- Frequency of operation.

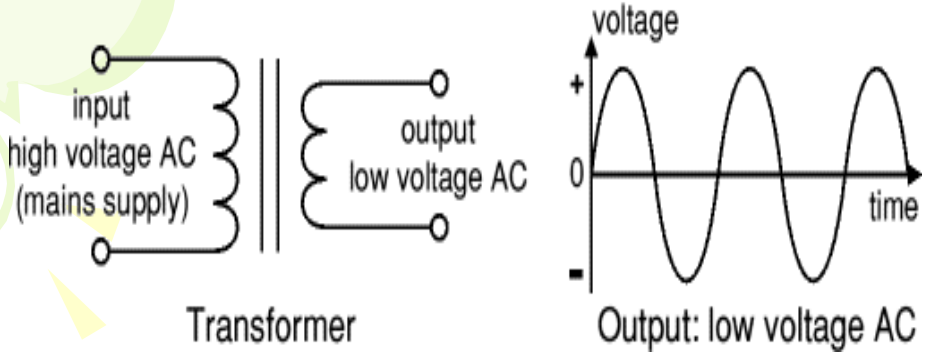
Linear Power Supply



- Power supply convert AC to DC voltages.

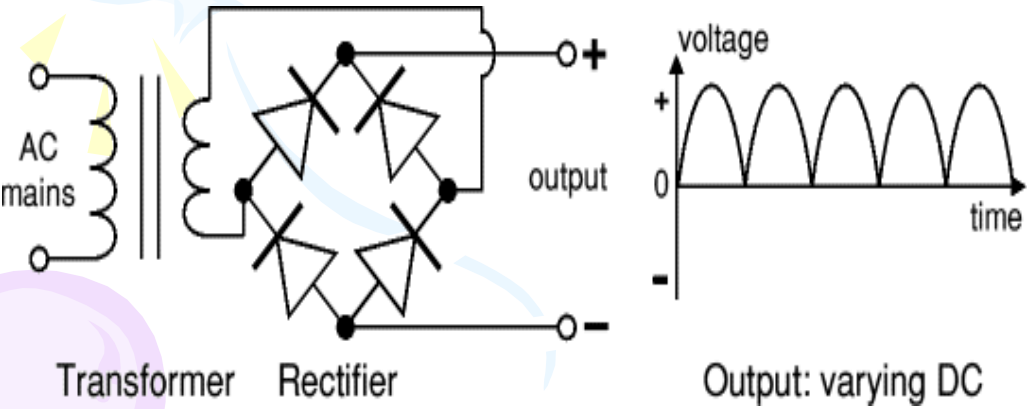


Waveforms found on a linear power supply



Transformer:

Transformer used to convert the voltage from mains to a different ,usually lower voltage. (Step down)

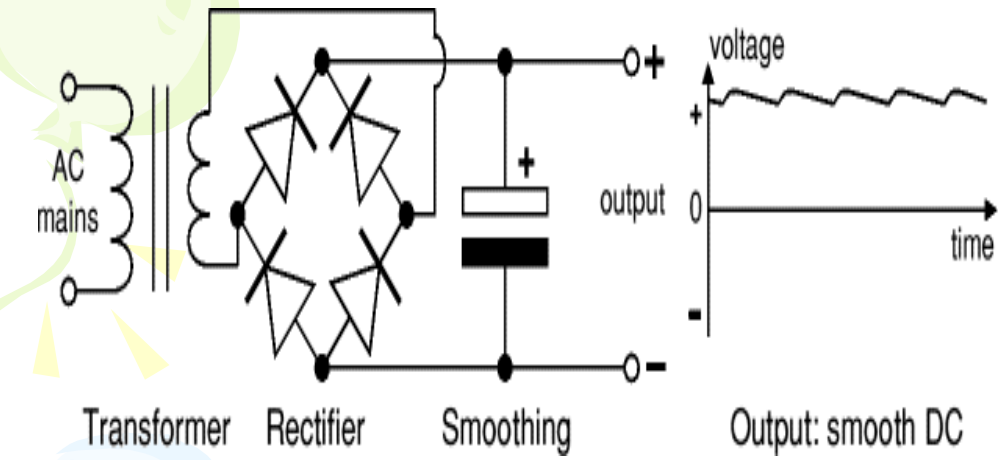


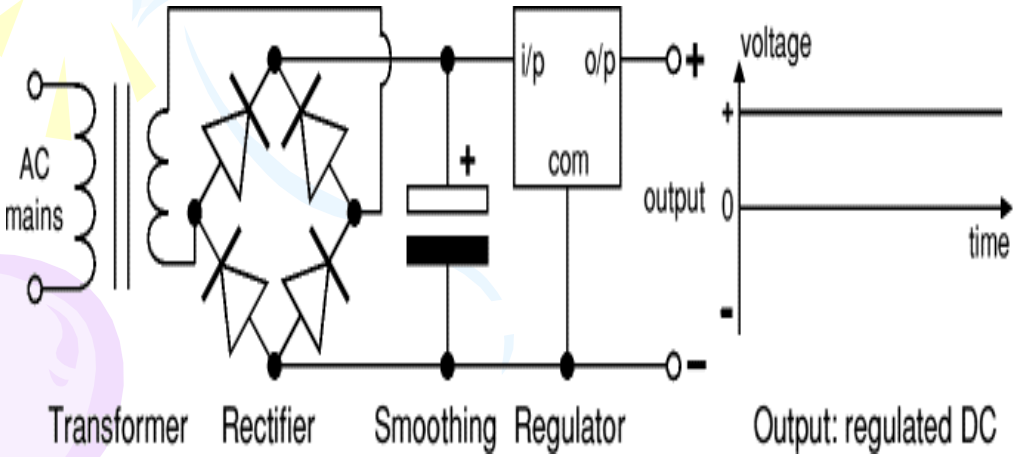
Rectifier:

Then rectification is done by a set of diodes, transforming this AC voltage into pulsating voltage DC

(bridge rectifier)

$$V_{\mathrm{RMS}} = \frac{V_{\mathrm{P}}}{\sqrt{2}}.$$



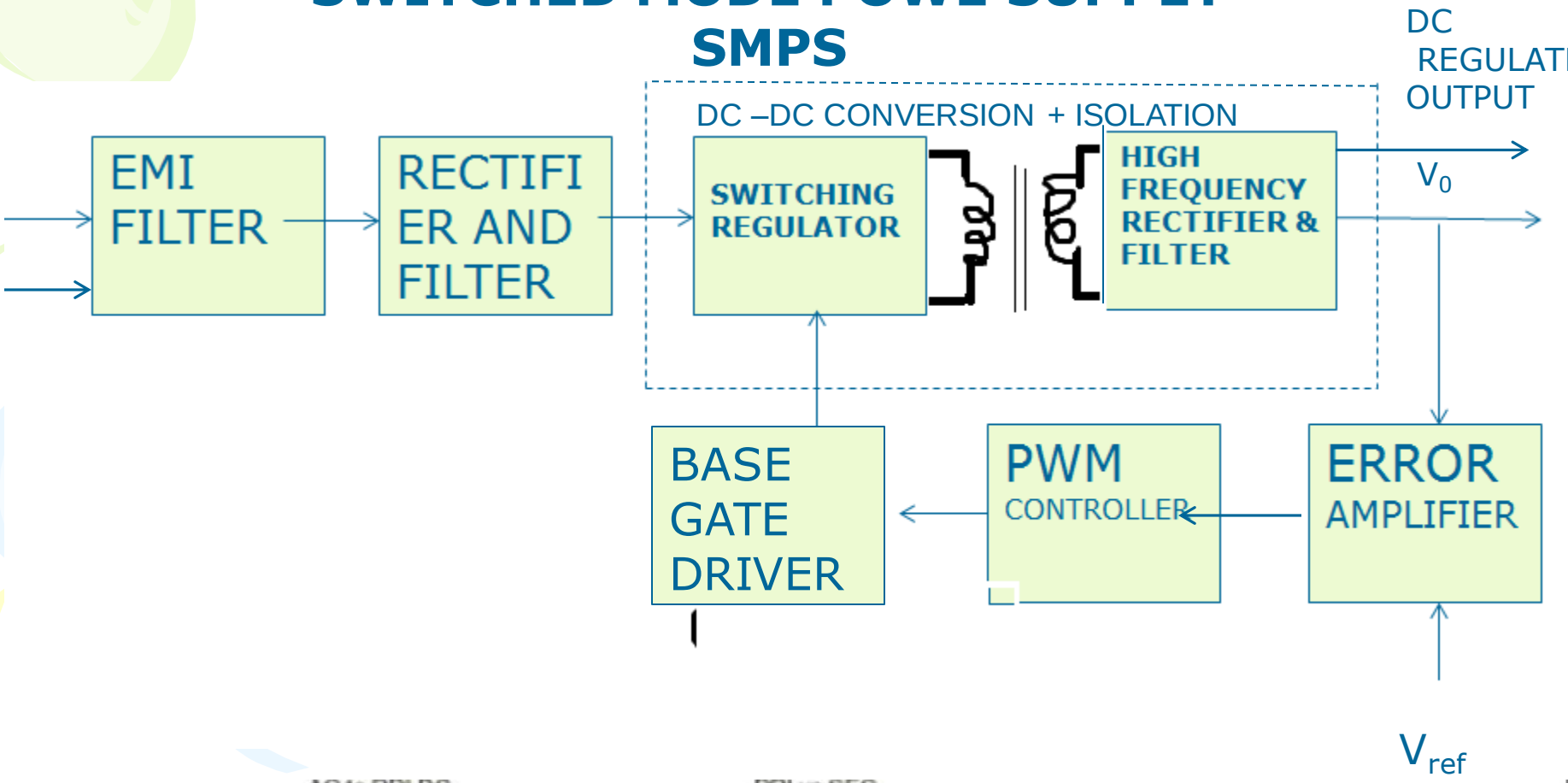


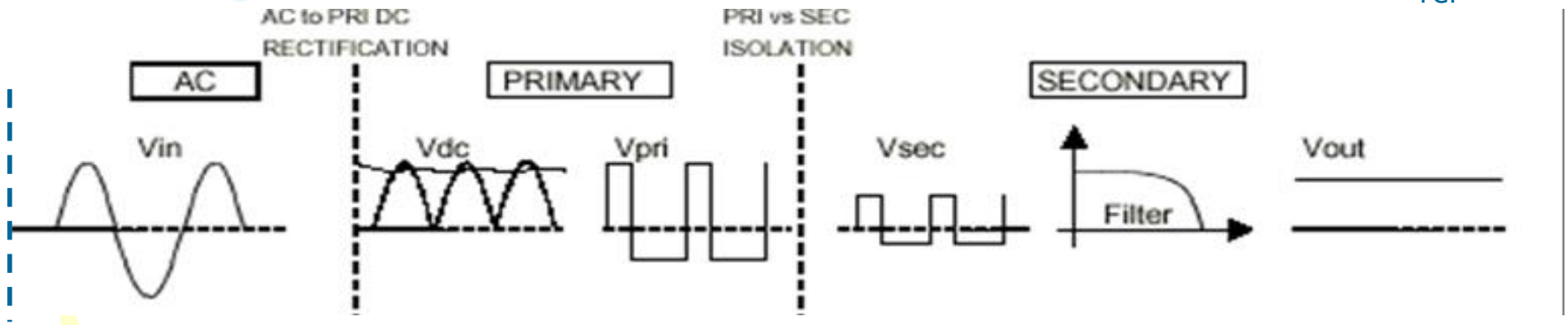
Filter: The next step is filtering, which is done by an electrolytic capacitor, transforming this pulsating voltage into almost DC

DC obtained after the capacitor oscillates a little bit (Ripple)

Regulator: so a voltage regulating stage is necessary, done by a zener diode or by a voltage regulator integrated circuit. After this stage the output is true DC voltage

SWITCHED MODE POWE SUPPLY
SMPS





Explanation

1. AC line voltage is first cleaned by removing *Electromagnetic Interferences* that may be introduced by external noise
2. EMI filter remove noise - AC input
3. Bridge rectifier and pi filter convert AC to DC and remove ripples
4. Unregulated DC fed as input to switching regulator .
5. It will select buck or boost principle based on desired output voltage level
6. The series of square wave pulses produced by switching regulator are isolated and then filtered to produced regulated DC output voltage.
7. To maintain desired voltage level the actual compare with reference voltage
8. If difference found by error amplifier
9. It gives signal to PWM controller
10. PWM controller then adjust the ON period of switch so as to maintain the desired output voltage.

Advantages:-

- SMPS is of Smaller size , lighter in weight and possesses higher efficiency because of its high frequency operation
- SMPS are less sensitive to input voltage variations.
- Lower heat generation

Disadvantages:-

- It is costly and more complex than linear regulators.
- SMPS has higher output ripple and its regulation is worst
- Switching regulators generate electromagnetic and radio frequency interference noise due to high switching current.
- To control radio frequency noise required the use of filters on both input and output of SMPS

Terms between SMPS and Linear power supply

Sl. No.	Terms	Switched Mode Power Supply	Linear Power Supply
1.	Efficiency	65–75 %	25–50 %
2.	Temperature rise	20–40 deg. cen	50–100 deg. cen
3.	Ripple volts	Higher 25 to 50 mV	Even 5 mV possible
4.	Overall regulation	0.3 % is common (% drop on volts)	Even 0.1 % possible
5	RF interference	Can be a problem unless properly shielded	None
6.	Magnetic material	Ferrite core	Steel core
7.	Weight	About 60 watts per kg	20–30 watts per kg
8.	Cost	More parts, special ones, increase the cost	Advantage for smaller units up to 10 W to 15 W, but cost is higher if bigger.
9.	Reliability	Depends on the availability of suitable transistors	More reliable

Power Supply form factor.

- The *form factor* of the power supply refers to its general shape and dimensions.
- The form factor of the power supply must match that of the case that it is supposed to go into, and the motherboard it is to power

Power Supply form factor.

- Early Pc using PC/XT,AT,baby AT and LPX form factors all use mechanical switch to turn computer on and off.

ATX–230W

Power Supply Sizes

- Power supply sizes are based on the type of case and motherboard connections.
- The AT-style is found on older computers and earlier Pentium systems.
- The ATX-style (current technology) is found on Pentium II and later systems.
- You should compare the existing power supply with the new one before replacing it.
- On –off power control circuit. Not the button on ATX boards is built into the MB, on AT style it comes from the PS.

AT style

- The **AT form factor** is the first modern form factor to be widely used. AT (Advanced Technology) was released in 1984 by IBM

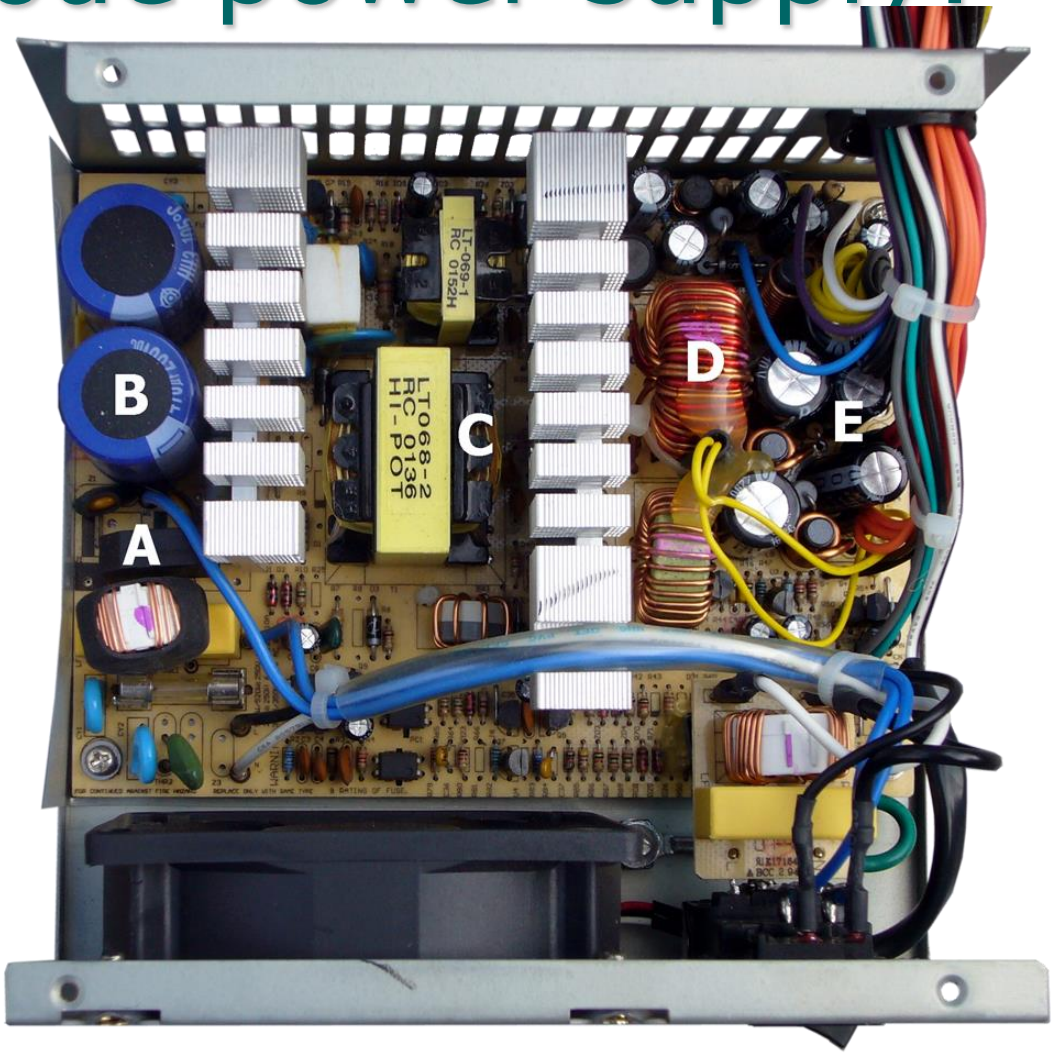
ATX style

- The **ATX** (for **Advanced Technology Extended**) form factor was created by Intel in 1995.
- It was the first big change in computer case and motherboard design in many years.

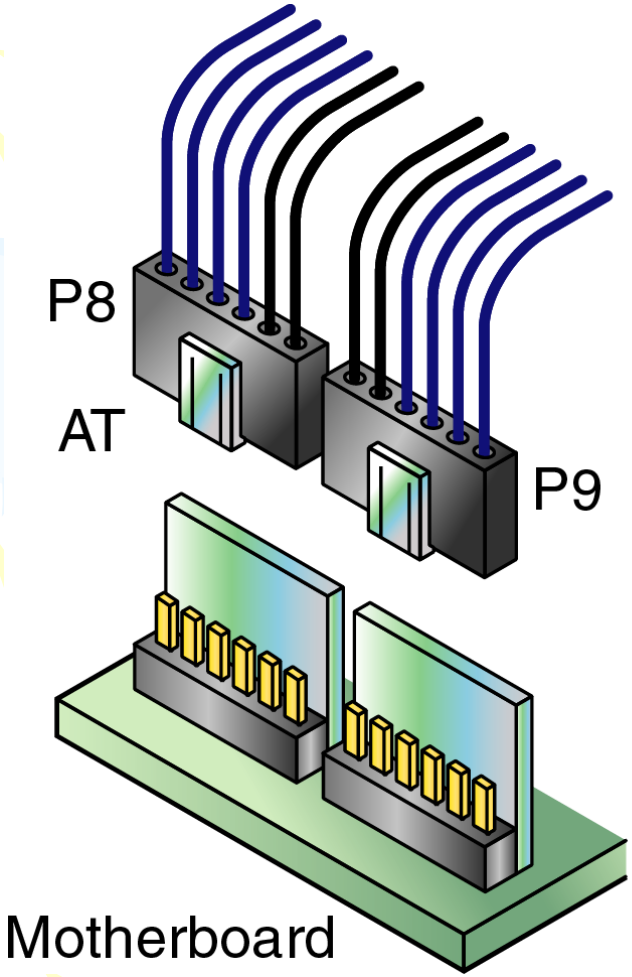
ATX–230W

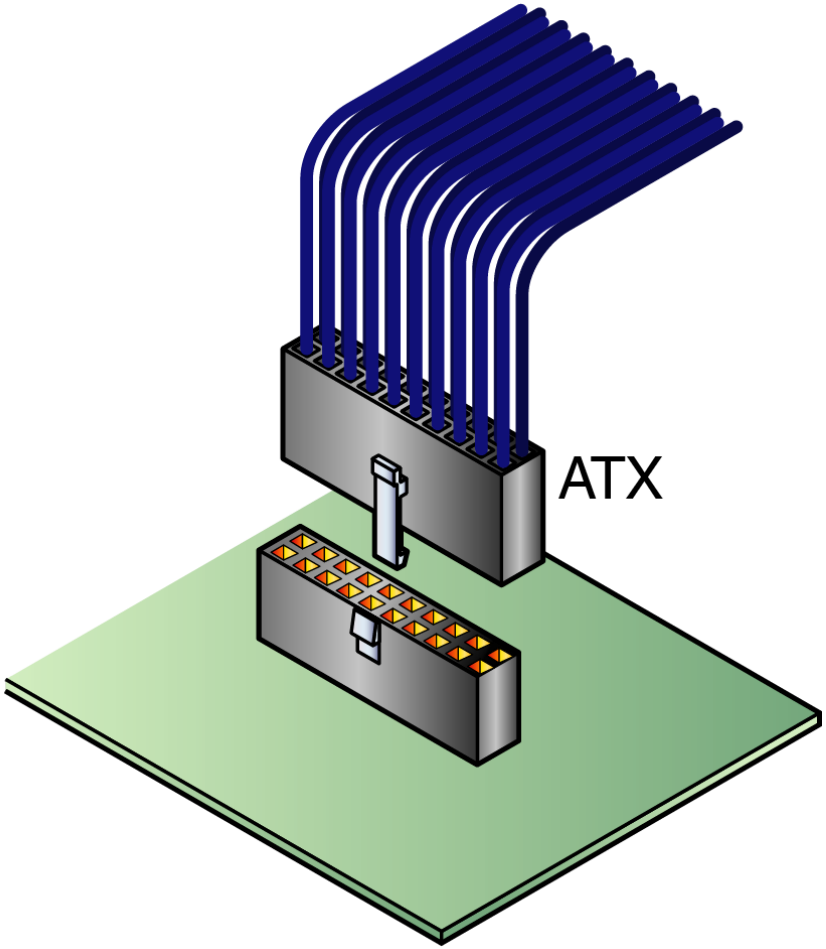
Interior view of an ATX switched-mode power supply:

- A - Bridge rectifier
- B - Input filter capacitors
- C - Transformer
- D - Output filter coil
- E - Output filter capacitors

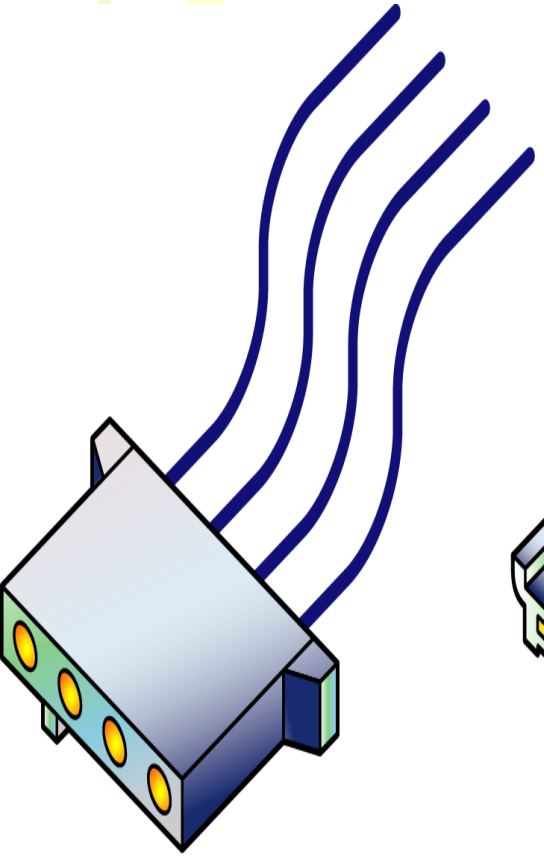


POWER SUPPLY CONNECTORS

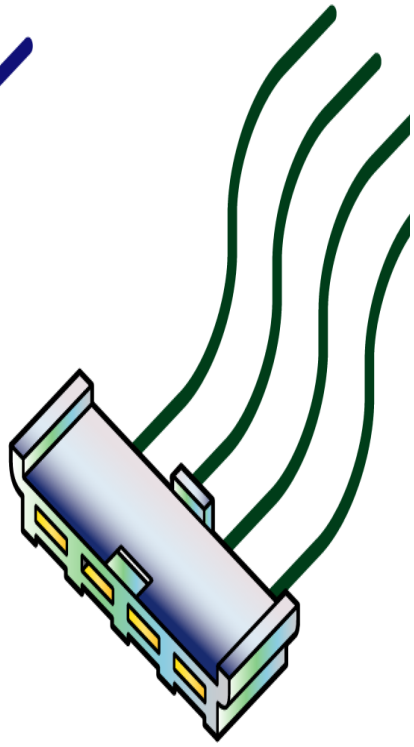




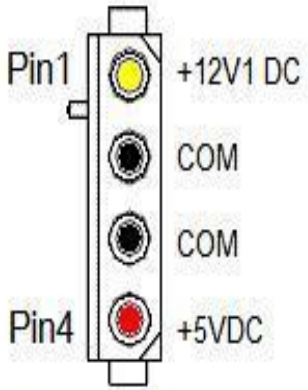
Connections to Peripheral Hardware



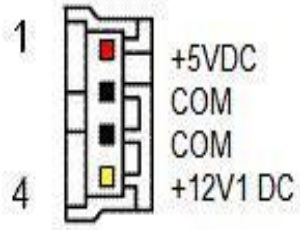
Molex Connector



Mini Connector



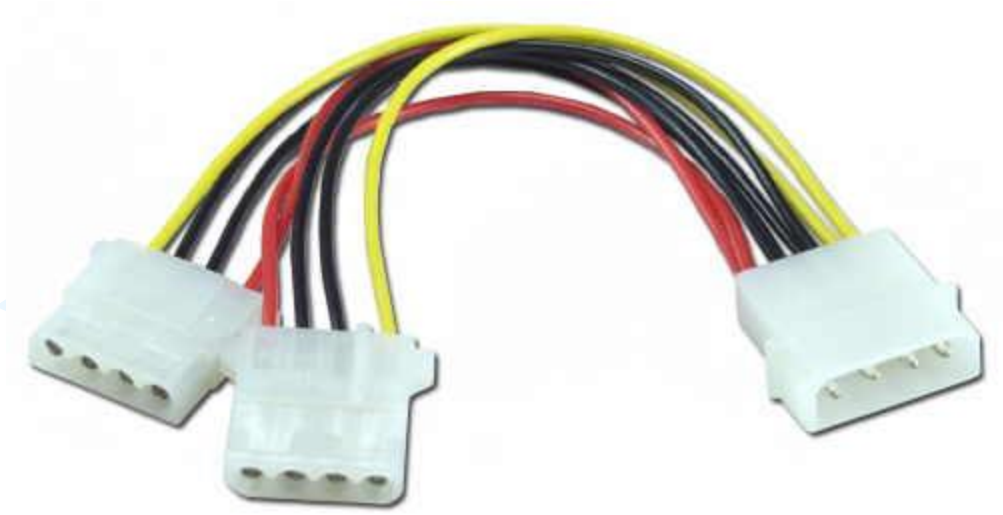
Peripheral Connector



Floppy Drive Connector

Splitter

- A splitter increases the number of connections.



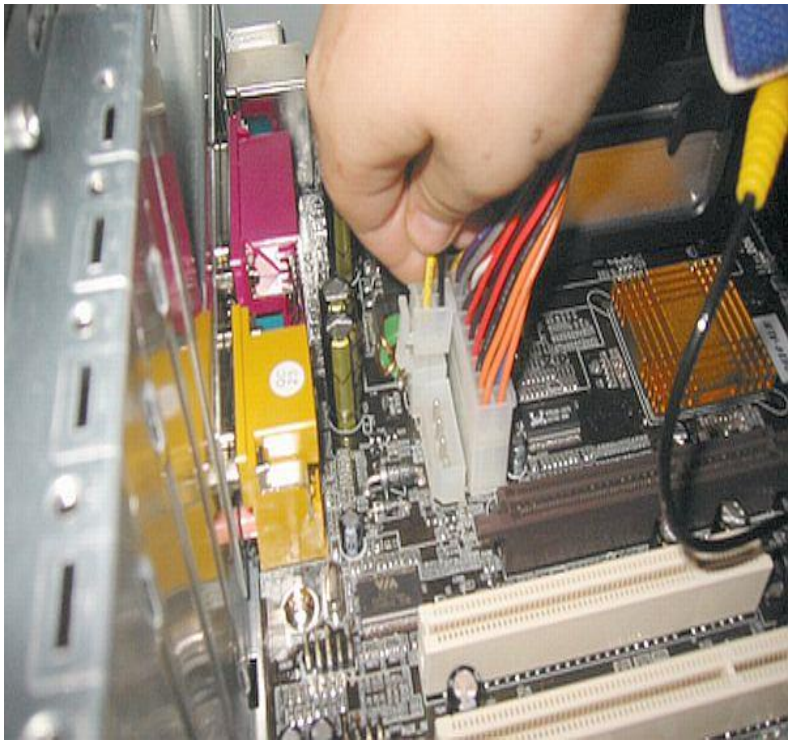
AT style SMPS.

AT power connector (Used on older AT style mainboards)

Color	Pin	Signal
	P8.1	Power Good
	P8.2	+5 V
	P8.3	+12 V
	P8.4	−12 V
	P8.5	Ground
	P8.6	Ground
	P9.1	Ground
	P9.2	Ground
	P9.3	−5 V
	P9.4	+5 V
	P9.5	+5 V
	P9.6	+5 V

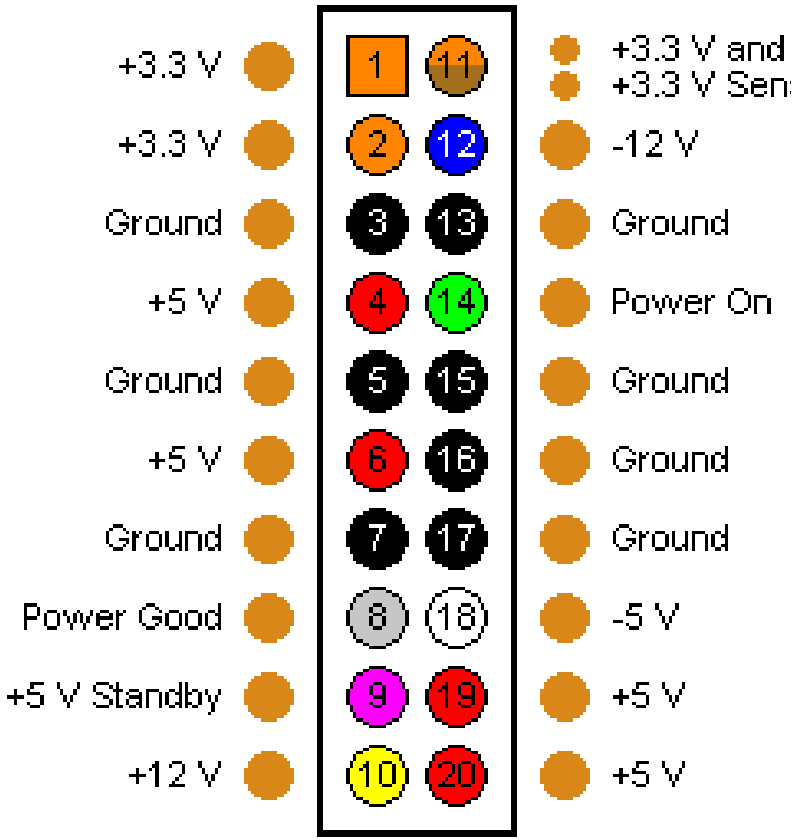
- **AT style computer cases had a power button that was directly connected to system PSU.**
- **The wires are soldered to the power button**
- **AT style SMPS provides DC output on two 6-pin connectors and four 4-pin connector.**
- **The six pin connector carry dc power connections to the motherboard. It carries +5V,-5V,+12V,-12V voltages and PGS(power good signal).**
- **The power good signal is a special flag to the CPU, indicating that the output voltages are stable and usable by the CPU.**
- **In the absence of power good signal CPU remains reset.**

ATX Power supply.



ATX/NLX style SMPS

20 pin ATX power supply connector

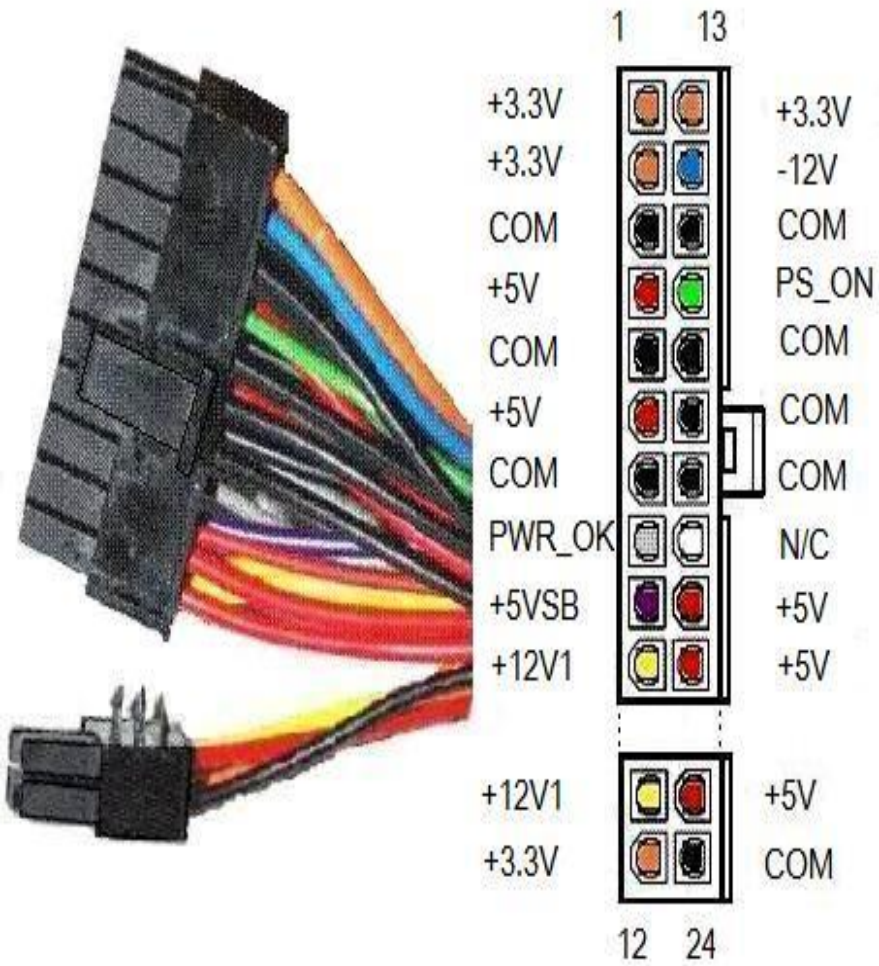


24-pin ATX12V 2.x power supply connector

(20-pin omits the last 4: 11, 12, 23 and 24)

Color	Signal	Pin	Pin	Signal	Color
Orange	+3.3 V	1	13	+3.3 V	Orange
				+3.3 V sense	Brown
Orange	+3.3 V	2	14	−12 V	Blue
Black	Ground	3	15	Ground	Black
Red	+5 V	4	16	Power on	Green
Black	Ground	5	17	Ground	Black
Red	+5 V	6	18	Ground	Black
Black	Ground	7	19	Ground	Black
Grey	Power good	8	20	−5 V (*obsolete*)	White
Purple	+5 V standby	9	21	+5 V	Red
Yellow	+12 V	10	22	+5 V	Red
Yellow	+12 V	11	23	+5 V	Red
Orange	+3.3 V	12	24	Ground	Black

(The four shaded pins — 8, 9, 13, 16 — are information-carrying)



If the motherboard requires 3.3V current over 12A or +5V current over 24A. 24 pin power connector is used.

Use of output voltages of SMPS.

- -12V :

  used on some types of serial port circuits,whose amplifier circuits require both –12v and +12V.
- Not needed on some newer systems
- Older system use it rarely.
- Serial port require little power.
- Most power supplies provide it for compatibility with older hardware.

+12V

Drive motors and dynamic RAM, CMOS RAM.

Use of output voltages of SMPS.

- -5V:- Used on some of earliest PCs for floppy controllers and other circuits used by ISA cards

- +5V :-All Logic chips TTL or CMOS.

- 0V :- Zero volts is the ground of the Pc's electrical system(common earth) .The ground signals are provide by the power supply are used to complete circuits with the other voltages. It provide plane of reference against which other voltages are measured.

- +3.3V :- Not used in baby AT. Newest voltage level provided by modern power supplies ,Introduced with ATX form factor ,now found on the ATX/NLX,SFX,WTX form factors. Used to run newer CPUs, system memory , AGP video cards

Use of output voltages of SMPS

- Power Good Signal :-
- To prevent the computer from starting up prematurely, the power supply puts out a signal to the motherboard called 'PWR OK' after it completes its internal tests and determine that the power is ready for use. Until this signal is sent, motherboard will refuse to start up the computer.
- 5VSB:-
  - Power always on, even when the rest of the power supply is turned off.
  - A small amount of current on this wire that allows the motherboard to control the power supply when it is off.
  - It also permit activities that occur while PC is off
  - Enabling wake up and sleep mode
  - Wake on LAN or ring network

Power supply characteristic

- Rated Wattage :

  To operate different components of PC, power supply must generate rated power. The generated power by power supply as per requirment of system is called rated wattage.

  - Typical power ranges are 200W to 500W
  - General-use computers require 130–205 watts.
  - Servers and high-performance workstations require 350–500 watts.

- Efficiency

  Efficiency is defined as useful power output divided by the total electrical power consumed.

  Efficiency of SMPS is 70-85%

- Regulation

  The ability of SMPS to maintain an output voltage constant as per the rated value irrespective of change in any other parameter.

Load Regulation:

- Sometimes called *voltage load regulation*.
- *This specification refers to the ability of the power supply to maintain constant output voltage irrespective of the change in load.*
- The voltage of a DC power source tends to decrease as its load increases, and vice-versa.
- Better power supplies do a better job of smoothing out these variations.
- Load regulation is usually expressed as a "+/-" percentage value for each of the voltages the power supply delivers. 3% to 5% are typical; 1% is quite good.

Line Regulation:

- This parameter describes the ability of the power supply to maintain its output voltage constant irrespective of change in input source of power supply.

- Again, a value for each output level is usually specified as a "+/-" percentage. +/- 1% to 2% is typical.

Ripple

- Also sometimes called "AC Ripple" or "Periodic and Random Deviation (PARD)" or simply "Noise".
- Periodic noise in constant output voltage of power supply is called as ripple or ripple factor
- The power supply produces DC outputs from AC input. The output isn't "pure" DC. There will be some AC components in each signal, some of which are conveyed through from the input signal, and some of which are picked up from the components in the power supply.
- Typically these values are very small, and most power supplies will keep them within the specification for the power supply form factor.
- Ripple values are usually given in terms of *millivolts, peak-to-peak (mVp-p)*.
- "Lower numbers are better.

Hold (or Hold-up) Time:

- This is the amount of time the power supply will keep producing its output, if it loses its input.

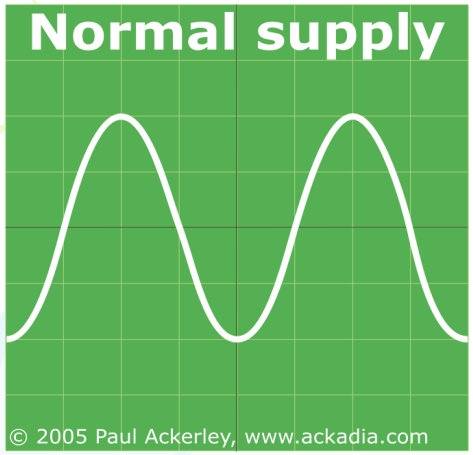
- A typical value is about 20 milliseconds
- It is also important to compare against the switch time of a UPS .
- The hold time should be considerably greater than the switch time to reduce the chances of problems

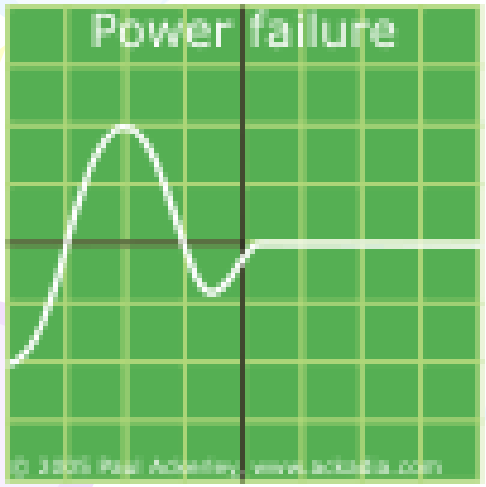
POWER FAILURES

- Power failures can have internal or external causes.
- External failures, which are more common, include:
  - **Surges** (increase in the voltage source, small over voltage conditions for a short time)
  - **Spike** (large over voltage condition measured in nanoseconds)
  - **Sags** (under voltage condition)
  - **Brownouts** (sag longer than 1 second)
  - **Blackouts** (complete power failure)

Power Problems

Blackout

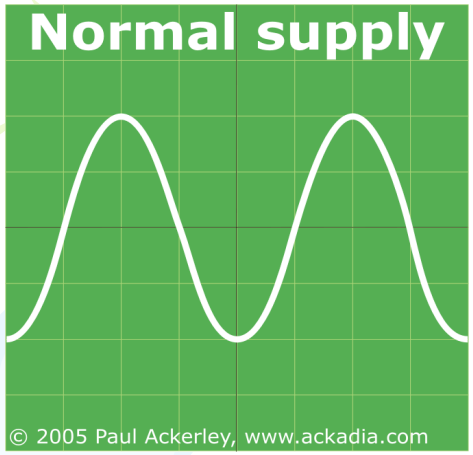


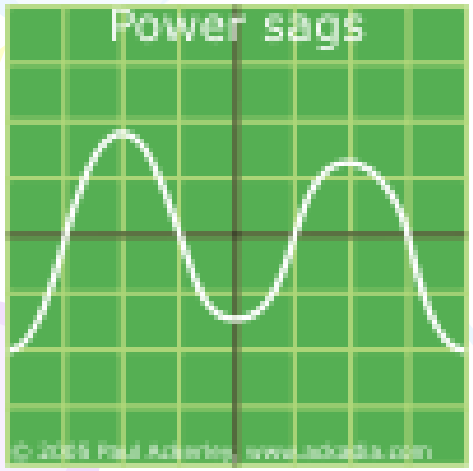


- A Blackout is complete loss of electric power where voltage and current drops to almost zero.
- Caused by physical interruption in the power line due to accidental damage by a person or act of nature.
- Loss of AC will shutdown the computer in few millisecond.
- Loosing power may cause the loss of valuable data, reduction in productivity, corrupt file structure, damage file.
- Protection against blackout is to save work regularly.

Power Problems

Brownouts or Sag

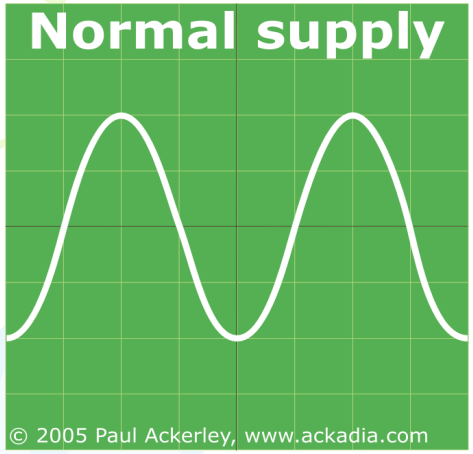


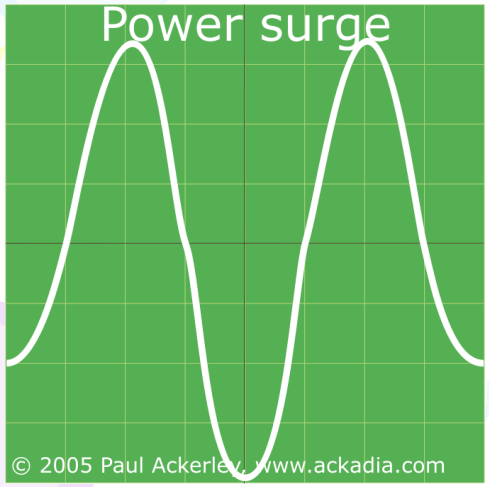


- The under voltage condition called as brownout or sag.
- The high load items like air conditioners, welding machines, motors draw so much current that AC line voltage drops.
- Results in intermittent system operation, can also damage the power supply.
- System hang, random memory errors occur.
- Files may be lost or corrupted on the hard drive

Power Problems

Surge

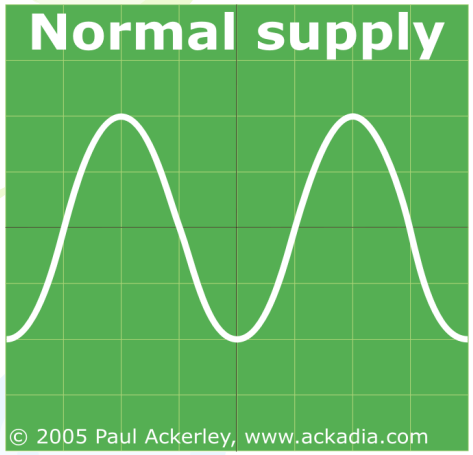


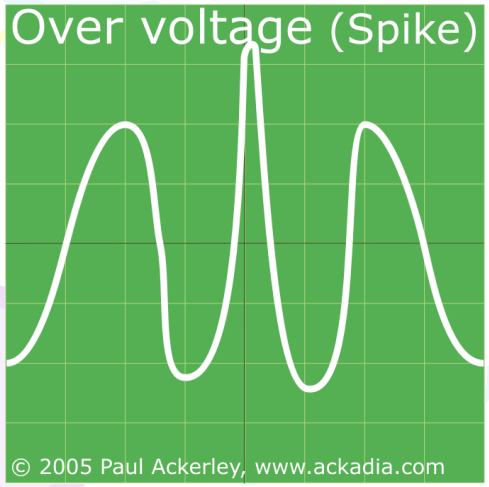


- Surges are small over voltage conditions that take place over relatively long periods.(more than 1 second)
- Excessive voltage creates overheating in the supply and damages the power supply.

Power Problems

Spikes





- A spike is a large over voltage condition that occurs in the milliseconds
- Lightening strikes and high-energy switches can cause spike in AC line.
- Heavy equipment's like drill machines , grinders , welding equipment can produce power spike.
- Spike can damage the PC-SMPS

Symptoms Of Power Problems

- Flickering lights.
- Errors in data transmissions between nodes.
- Unexplained component lockup.
- Premature component failure.
- Hard disk crashes.
- Corruption or loss of data in CMOS and other EPROM circuits.
- System devices behave erratically.
- Frequently aborted modern transfer.
- Waving monitor lines.
- Disk drive write errors.

Common SMPS problems.

- Bad solder connections
- Excessive load
- Low voltage on one or more outputs
- Supply dead, fuse blown- shorted switched mode power transistor and other semiconductors, open fusable resistors, other bad parts
- Supply dead, fuse not blown- bad startup circuit
- One or more outputs out of tolerance or with excessive ripple at switching frequency – leaky filter capacitors on affected output.
- Periodic power cycling, blinking of power light- shorted semiconductors

Protection Devices

1. Surge suppressor

- A **surge protector** (or **surge suppressor**) is a device designed to protect electrical devices from voltage spikes.
- It is a small block with several utility outlet, a power switch and a 3 wire cord for plugging.
- A surge protector attempts to regulate the voltage supplied to an electric device by either blocking or by shorting to ground voltages above a safe threshold.

Surge Suppressors

Rotating Outlets

MMS760RCT

MMS7120RCT

MMS7100RT

MMS780R

Child safety

MMS570

MMS570T

Wall Taps

MMS110

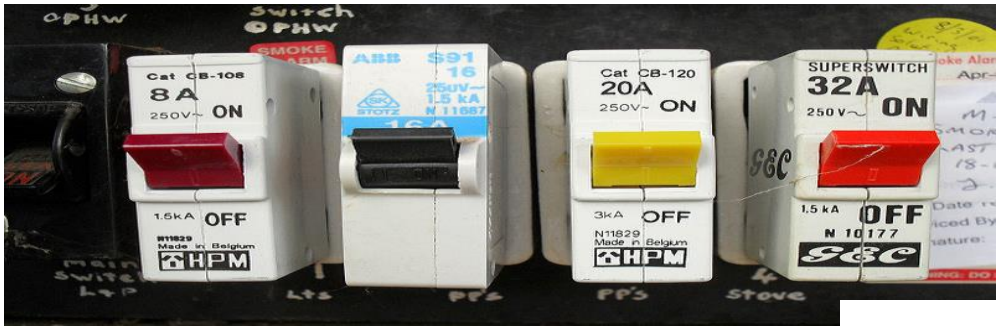
MMS130C

Ruggedized

MMS570

Economy Pair

MMS362P



2. Circuit Breaker

- A **circuit breaker** is an automatically-operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit.
- Its basic function is to detect a fault condition and, by interrupting continuity, to immediately discontinue electrical flow.
- Unlike a fuse, which operates once and then has to be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation.
- Circuit breakers are made in varying sizes, from small devices that protect an individual household appliance up to large switchgear designed to protect high voltage circuits feeding an entire city.

Circuit breaker

1. **Actuator lever -** used to manually trip and reset the circuit breaker. Also indicates the status of the circuit breaker (On or Off/tripped). Most breakers are designed so they can still trip even if the lever is held or locked in the "on" position. This is sometimes referred to as "free trip" or "positive trip" operation.

2. **Actuator mechanism -** forces the contacts together or apart.

3. **Contacts -** Allow current when touching and break the current when moved apart.

4. **Terminals**

Circuit breaker

5. **Bimetallic strip -** A bimetallic strip is used to convert a temperature change into mechanical displacement.

6. **Calibration screw -** allows the manufacturer to precisely adjust the trip current of the device after assembly.

7. **Solenoid -** long, thin loop of wire, often wrapped around a metallic core, which produces a magnetic field when an electric current is passed through it. Solenoids are important because they can create controlled magnetic fields and can be used as electromagnets .

8. **Arc divider / extinguisher**

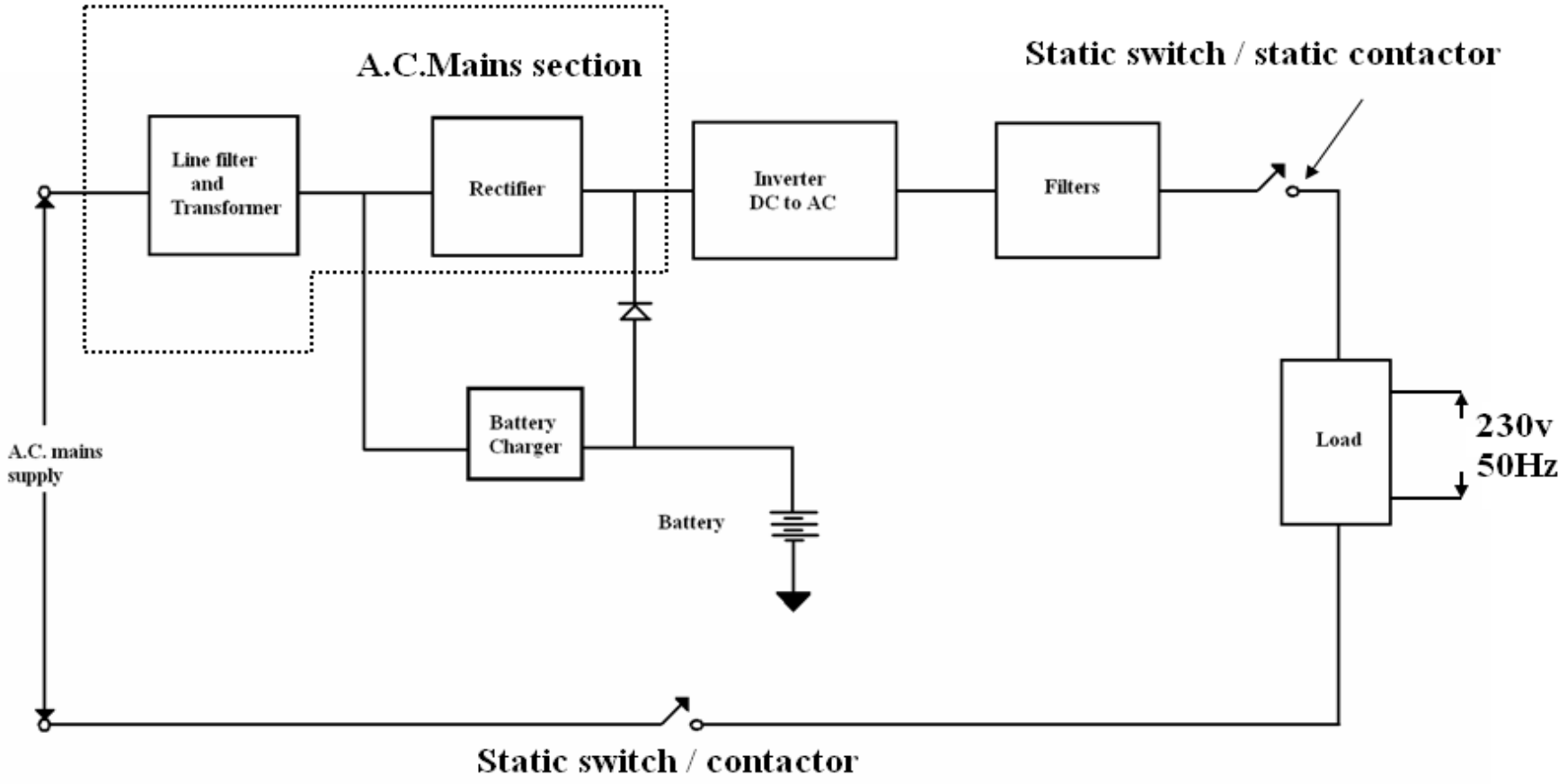
UPS protects system from power problems

- Voltage Surges and spikes
- Voltage sags
- Total power failure
- Frequency difference

Need OF UPS

- Power failure
- Voltage sag
- Voltage spike
- Brownout
- Over-voltage
- Line noise
- Frequency variation
- Switching transient
- Harmonic distortion.

General UPS working



BLOCK DIAGRAM OF UPS

- AC Main Section

  -receives AC supply, filter it with line filter and rectifies it desired level for further circuits.

- Inverter and Filter

  - works with and without power

  - with power , delivers constant 230v , 50Hz output to load.

  - without power ,this takes 12v DC from battery, convert it into 230v , 50Hz with the help of inverter given to output load.

- Battery and Battery Charger:

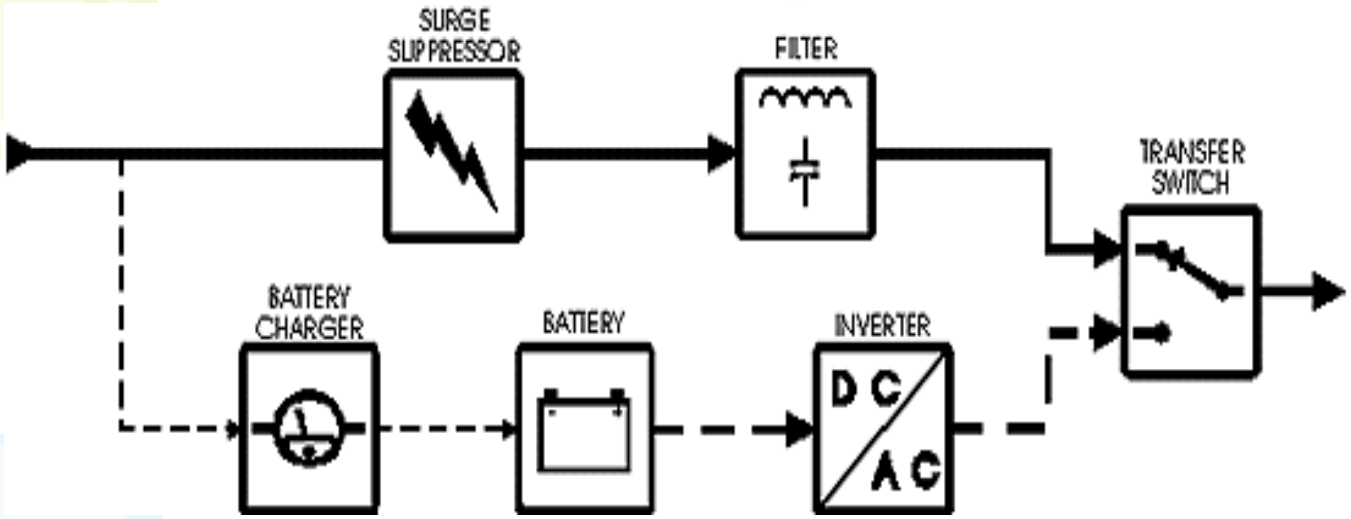
  - with ac supply , charges battery through battery charger.

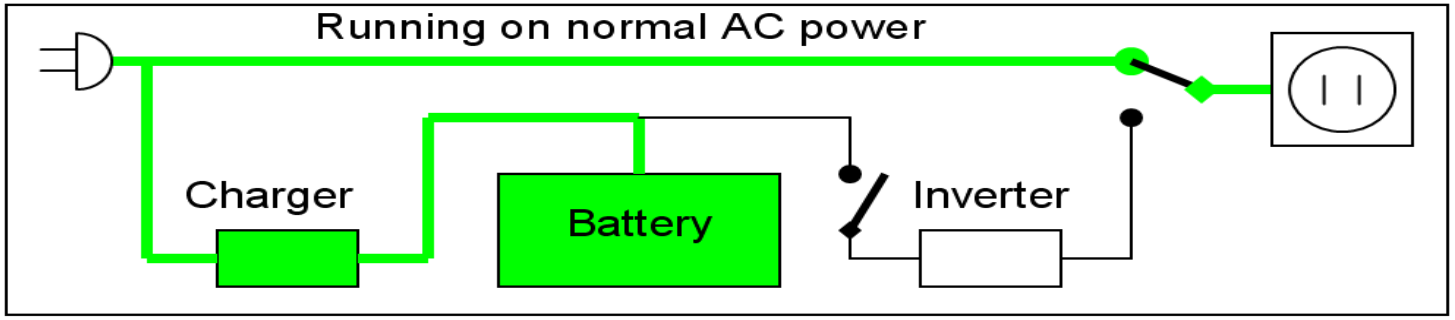
  - battery charger circuit convert input AC to the desired DC level and charges the battery.

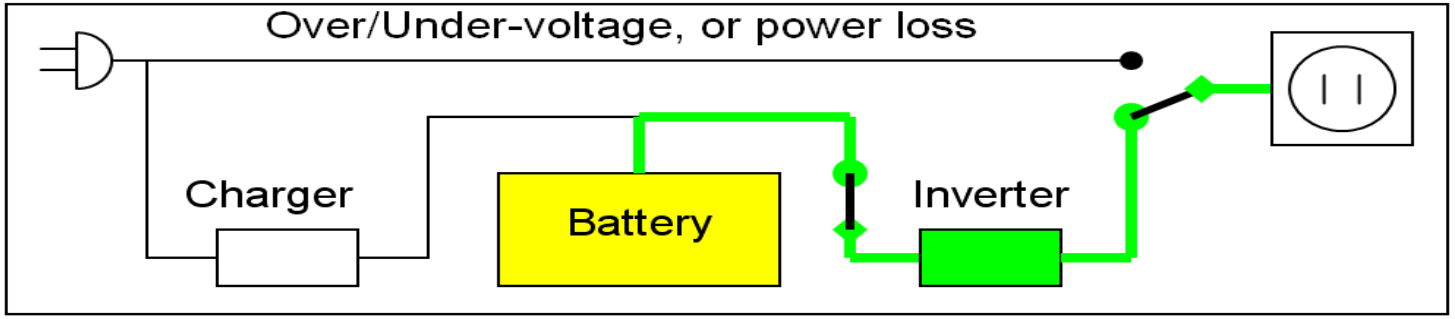
- Static switch / contractor

  In event of power failure the inverter is connected to the load with the help of static contractor switches.

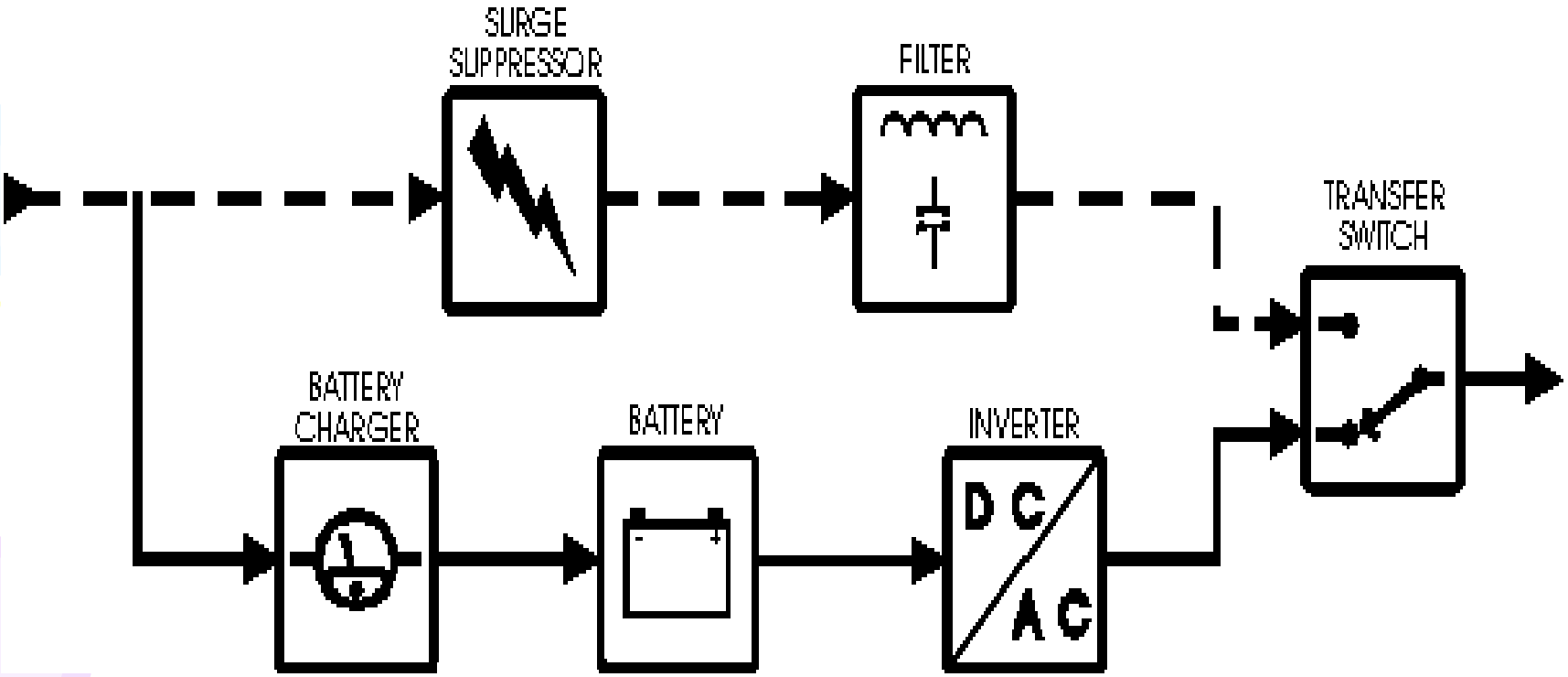
Standby UPS(OFF LINE UPS)







ON LINE UPS


SURGE
SUPPRESSOR
FILTER
TRANSFER
SWITCH
BATTERY
CHARGER
BATTERY
INVERTER
D C
A C

Advantage of OFF LINE UPS

- Lower in cost compared to on-line UPS

Disadvantage of Stand By UPS

High switching is required otherwise there is possibility that cut in power and reboot the system.

Advantages Of on-line ups

- Switch not involved , avoids resetting of PC and spike generation.
- Computer is isolated from AC line problems.
- Provide protection by breaking down and resetting the power.

Disadvantages of on-line UPS

- It is costlier than off-line UPS.
- It generates more heat.
- UPS batteries need to be replaced.
- UPS running its inverter all the time results in a lower efficiency.

Comparison

Off-line UPS

- *Simplest and least expensive.*
- *Battery is charged when Ac mains are on, when AC mains are Off, battery discharges and supplies power to PC.*
- *Switching occur.*
- *Not at high speed, resetting may occur*
- *Spikes are generated.*

On-line UPS

- *Complex and expensive*
- *Battery is continuously charged.,delivers DC power to inverter for converting To AC and supplying To PC.*
- *Switching not occurs.*
- *At high speed , avoid resetting*
- *Spikes not generated*

Advantages Of UPS over normal power supply.

- Provides power backup.
- Surge protection.
- Isolation and proper shielding of power.
- Short-circuit protection.
- Stabilities the power.
- Maintains constant 230V, 50Hz.
- Power conditioning.
- Allows you enough time to save data.
- Avoids data loss.
- Protect OS from corruption .
- Can be controller by OS called smart UPS.

USB

- Peripherals to be connected using single standardized interface socket
- Improve plug and play capabilities (without rebooting)
- Low power consumption without external power supply
- Connect computer peripherals
- Possible to install and remove devices without opening computer case.
- The Universal Serial Bus gives you a single, standardized, easy-to-use way to connect up to 127 devices to a computer.

Cables:

- Maximum length of standard USB cable is 5 meters.
- Primary reason for this limit is the maximum allowed Round trip delay of about 1500ns.
- If USB device does not answer to host commands within the allowed time the host considers command to be lost.
- Maximum delay caused by single cable turns out to be 26 ns.

Sr. No	Name	Cable Color	Description
1	VCC	RED	+5V
2	D-	GREEN	DATA-
3	D+	WHITE	DATA+
4	GND	BLACK	GROUND

USB Features

- **Host** :- The computer acts as the host.
- **Multiple devices** :- Up to **127** devices can connect to the host, either directly or by way of USB hubs.
- **USB Cable length** :- Individual USB cables can run as long as **5 meters**; with hubs, devices can be up to 30 meters away from the host.
- **Transfer rate**:-With USB 2.0,the bus has a maximum data rate of **480 megabits per second**.
- **Ease of installation** :- A USB cable has two wires for power (+5 volts and ground) and a twisted pair of wires to carry the data.
- **Power allocation**:- USB controller in PC detects the presence or absence of the USB device and does allocation of electrical power.
- On the power wires, the computer can supply up to 500 milliamps of power at 5 volts.
- Low-power devices (such as mice) can draw their power directly from the bus.
- High-power devices (such as printers) have their own power supplies and draw minimal power from the bus.
- Hubs can have their own power supplies to provide power to devices connected to the hub.

- **Hot Swappable** :- USB devices are hot-swappable, meaning you can plug them into the bus and unplug them any time.
- **Hot Pluggability** :- without powering off a PC and Plug and play feature in the BIOS together with intelligence in the USB device takes care of detection , device recognition and handling.
- **Hub architecture**
- **Power saving** : -Many USB devices can be put to sleep by the host computer when the computer enters a power-saving mode.
- Supports for **wide range of peripherals**.

RS 232 interface

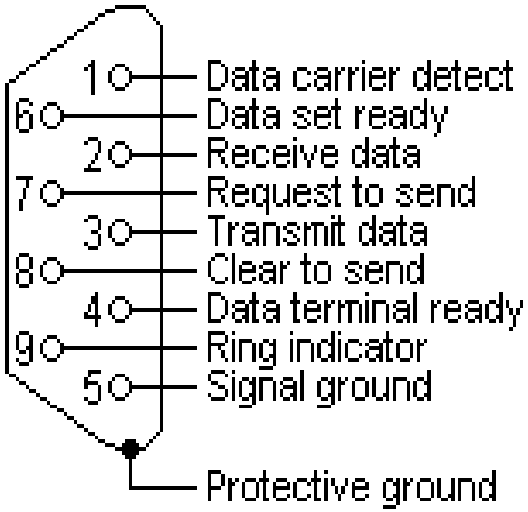
- Developed by Electronics Industries Association (EIA)
- RS – recommended Standards
- Serial communication is the most simplistic form of communication between two devices.
- One important aspect of RS-232 is that it is an asynchronous form of communication.
- Asynchronous communication is important because it is efficient; if no data needs to be sent, the connection is "idle." No additional CPU overhead is required for an idle serial line.

Voltage levels of RS232

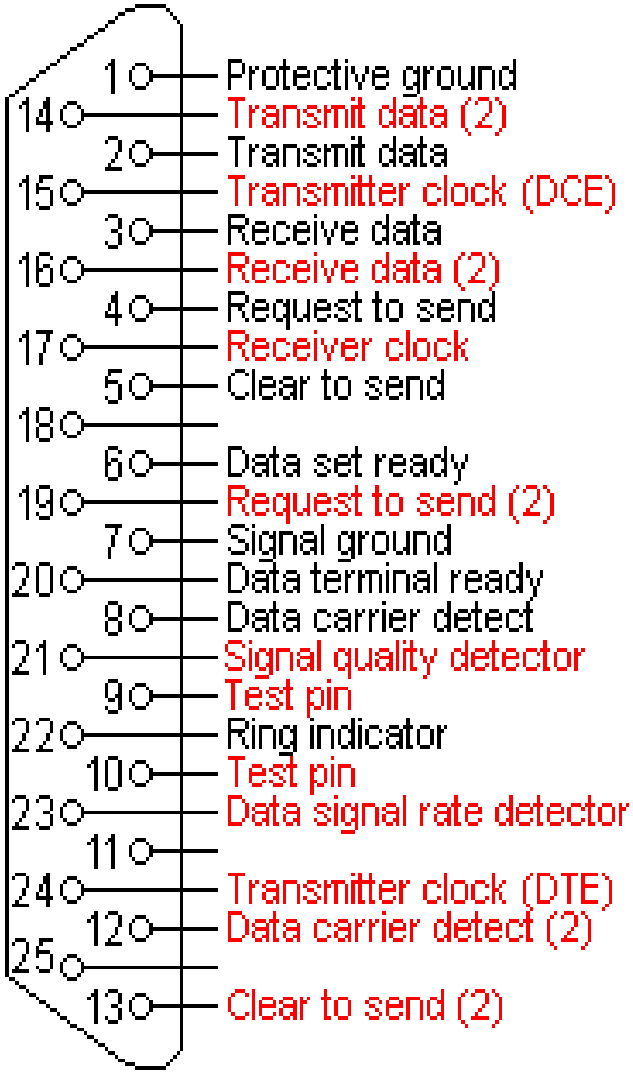
- Logical 1 – Marking estate –indicate negative level - OFF
- Logical 0 – space estate – indicate positive level - ON

Data Signals		
Level	Transmitter	Receiver
Logical 0	+5 V to + 15 V	+3 V to +25 V
Logical 1	-5 V to -15 V	-3 V to -25 V
Undefined	-3V to +3 V	

Control Signals		
Signals	Driver	Terminator
“OFF”	-5 V to -15 V	-3 V to -25 V
“ON”	5 V to 15 V	3 V to 25 V



RS 232 9 pin



RS 232 25 pin