5.3 UNINTERRUPTIBLE POWER SUPPLY (UPS)

Electrical apparatus that provides emergency power to a load when the input power source, typically the utility mains, fails. A UPS differs from an auxiliary or emergency power system or standby generator in that it will provide near-instantaneous protection from input power interruptions, by supplying energy stored in batteries, super-capacitors, or flywheels. The on-battery runtime of most uninterruptible power sources is relatively short (only a few minutes) but sufficient to start a standby power source or properly shut down the protected equipment. A UPS is typically used to protect hardware such as computers, data centers, telecommunication equipment or other electrical equipment where an unexpected power disruption could cause injuries, fatalities, serious business disruption or data loss. The world's largest UPS, the 46-megawatt Battery Electric Storage System (BESS), in Fairbanks, Alaska, powers the entire city and nearby rural communities during outages.
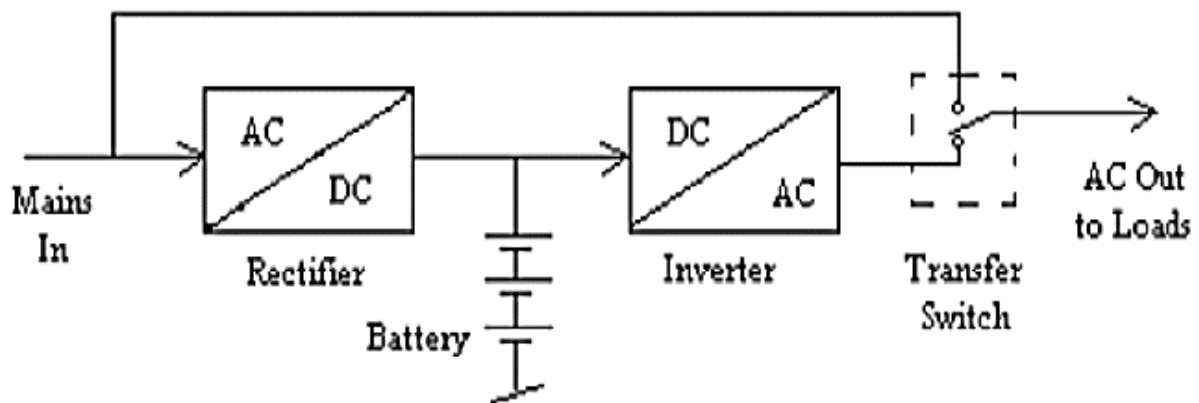

Figure 5.3.1 Basic Block Diagram of UPS

[Source: "Uninterruptible Power Supply", Mohamad Zhafran Zakariya, Page: 8]
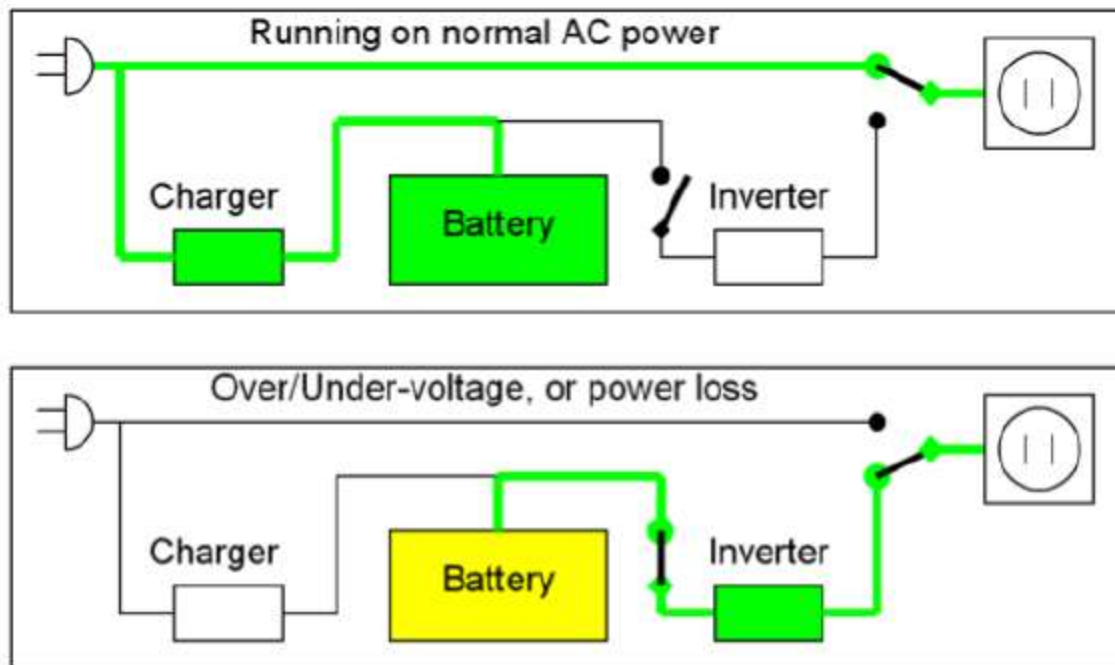
Figure 5.3.2 Basic Operation of UPS

[Source: "Uninterruptible Power Supply", Mohamad Zhafran Zakariya, Page: 9]

TYPES OF UPS

1. Offline UPS
2. Online UPS
3. Line Interactive UPS

An Uninterrupted power supply is essentially a back-up battery to power electronic gadgets like Computer in the event of a power failure. If it happens, the Gadget will draw power from the UPS and will run the load for a prescribed time depending on the capacity of the battery. The change over time from the mains to battery power is a fraction of a second, so that the computer will not shut down. This is essential to protect the data in the computer. Uninterrupted power supply may be AC/AC or AC/DC based on the output power supply. In AC/AC UPS, the energy source is the AC lines and the output is exactly the same voltage generated by the inverter. In AC/DC type, the UPS delivers DC voltage by converting AC to DC.

ONLINE UPS

Online UPS on the other hand uses an Inverter which always on to give sine wave AC in the output socket. The incoming AC is first converted into DC by a transformer to charge the battery as well as to give power to the inverter transformer. The inverter transformer converts the DC to AC continuously to power the load. If power fails, the battery backup circuit switches on and takes the load. Online UPS is more efficient than the Offline UPS and uses a "Constant duty Inverter". It also has a "Static bypass" system that transfers the load to the AC power if the inverter system fails. The advantage of the Online UPS is that, it cleans up the AC waveform by converting it into DC then reconverting this DC to fresh AC. In this type of UPS, the system always remains on battery, whether mains ac is present or not. When mains ac is present, it provides power to DC supply of inverter section as well as charges the battery simultaneously. When mains ac is not present, it will run the connected load till the battery has a recommended dischargeable level.
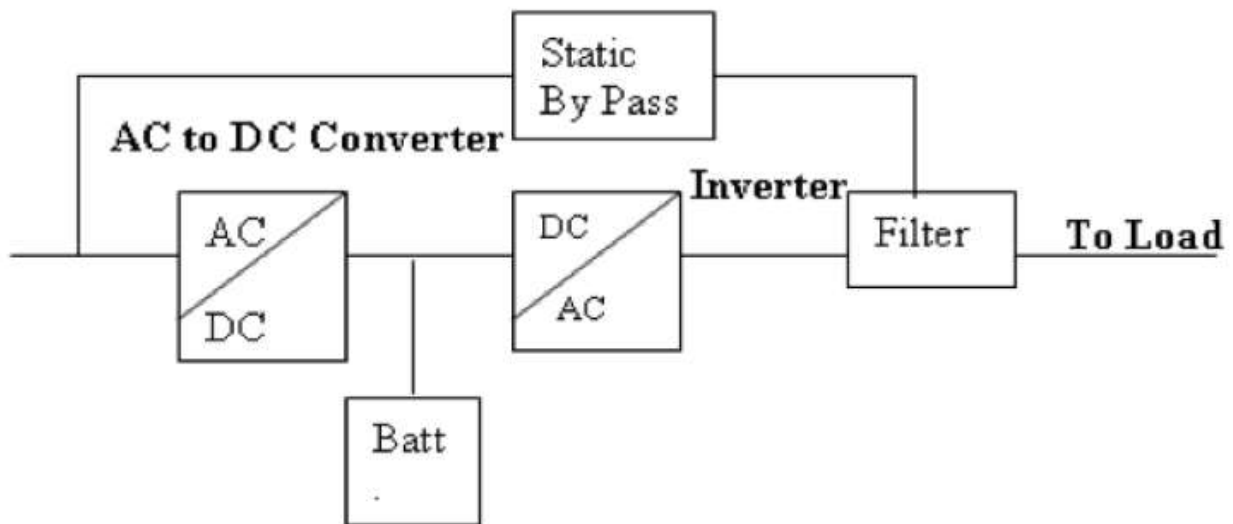

Figure 5.3.3 Block diagram of online UPS

[Source: "Uninterruptible Power Supply", Mohamad Zhafran Zakariya, Page: 15]

OFFLINE UPS

Offline UPS passes the input AC to the output sockets if the AC power is available. It always monitors the voltage level in the mains, and if there is a voltage drop or mains failure, it switches on the inverter to give AC power to the device until the mains supply returns to normal. The switch over time from AC to inverter AC is less than five milli seconds so that the functioning of the gadget is not affected. The mains to battery changeover time or battery to mains changeover time in offline UPS is very low as compared to inverter. Typically, changeover time in inverters is 500 milliseconds & Offline UPS has changeover time of 3-8 milliseconds. In a time, when mains ac is present, Inverter provides the output as is the input mains. While, Offline UPS has built in Automatic Voltage Regulator (AVR) to regulate the output voltage close to 220V ac. Offline UPSs are normal weight UPSs and are widely used for domestic computers.
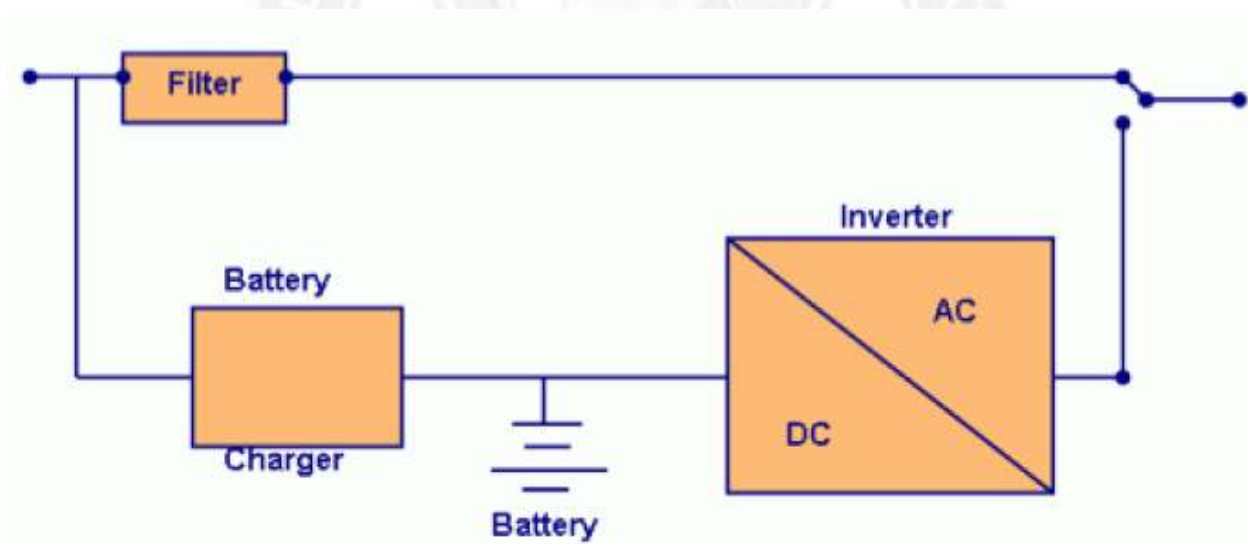

Figure 5.3.4 Block diagram of offline UPS

[Source: "Uninterruptible Power Supply", Mohamad Zhafran Zakariya, Page: 13]

LINE INTERACTIVE UPS

In this design, the battery to AC power converter (inverter) is always connected to the o/p of the UPS. Battery charging is done during times when the I/P AC power is normal when the I/P AC fails, transfer switch opens and then the inverter starts functioning to provide power to load immediately. AC input fails → transfer switch open → inverter ON mode.
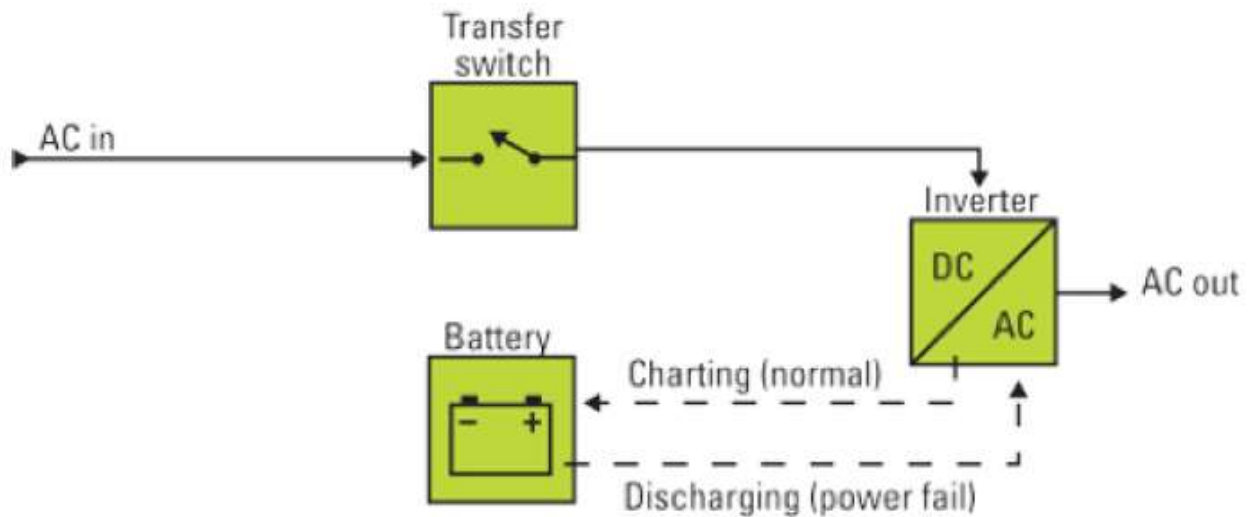

Figure 5.3.5 Block diagram of line interactive UPS

[Source: "Uninterruptible Power Supply", Mohamad Zhafran Zakariya, Page: 17]