

# Difference Between Online and Offline UPS

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## Key Difference - Online vs Offline UPS

UPS or Uninterrupted Power Supply is a device that supplies power to critical loads which should run continuously without an interruption, even during a power outage. UPSs have two types: rotary/mechanical type, which includes [motors and generators](#) as the power source, and static UPSs, which supply backup power through a battery bank and operated on power electronic devices. Online and offline UPSs are categorized under static UPSs depending on their functionality. The key difference between online and offline UPS is that **offline UPSs power-up the load directly from the mains when the main supply is available** whereas **online UPSs supply power to the load through a rectifier-inverter combination without connecting the load directly to the mains.**

## What is an Offline UPS?

The term offline means that the battery bank is not connected (off-line) with the load in normal operation when the mains power is available. In this situation, mains power is directly connected to the output of the load via a static transfer switch which is normally ON. When the mains power is available, the backup battery bank is charged by DC through a charger unit that consists of a rectifier circuit.

At a power outage or at a large under-voltage/overvoltage, the static switch disconnects the main supply from the load and connects the battery to the load within an insignificant time duration. This mains-to-battery transfer time is typically 10-25ms and depends on the [semiconductors](#) or power electronic circuitry that detects the mains power loss and performs the switching.

Since the mains power is directly connected to the load at normal operation, any distortion such as spikes, sags, and noise in the mains obviously appears on the output of the UPS. However, there are UPS systems that do some sort of power conditioning at the output. Line interactive UPSs are such a special type of offline UPSs that deals with small over-voltages or under-voltages that occur in the mains. They employ a multi-tap autotransformer or buck-boost transformer to convert the input mains voltage to the correct output voltage.

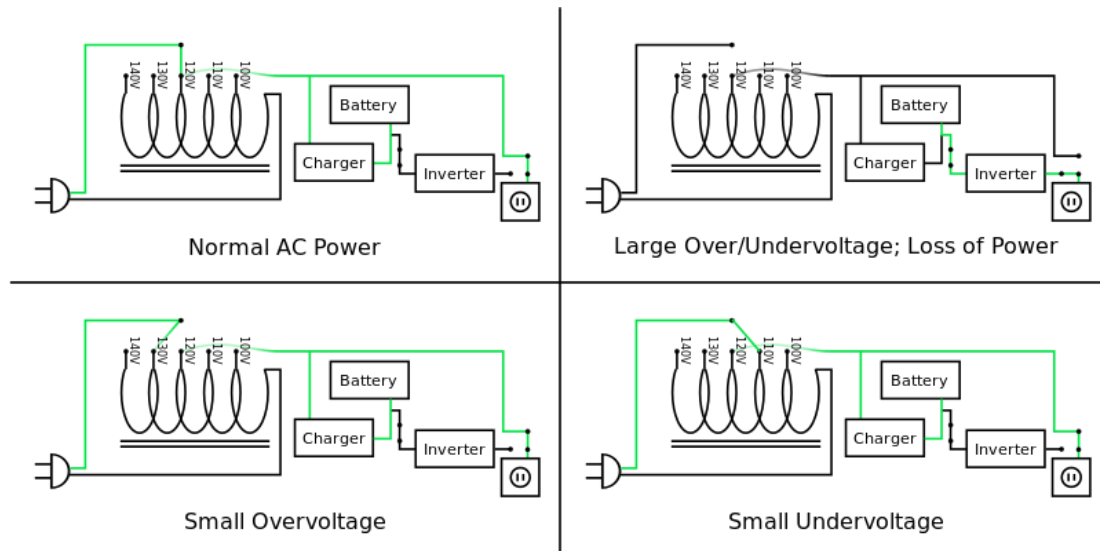
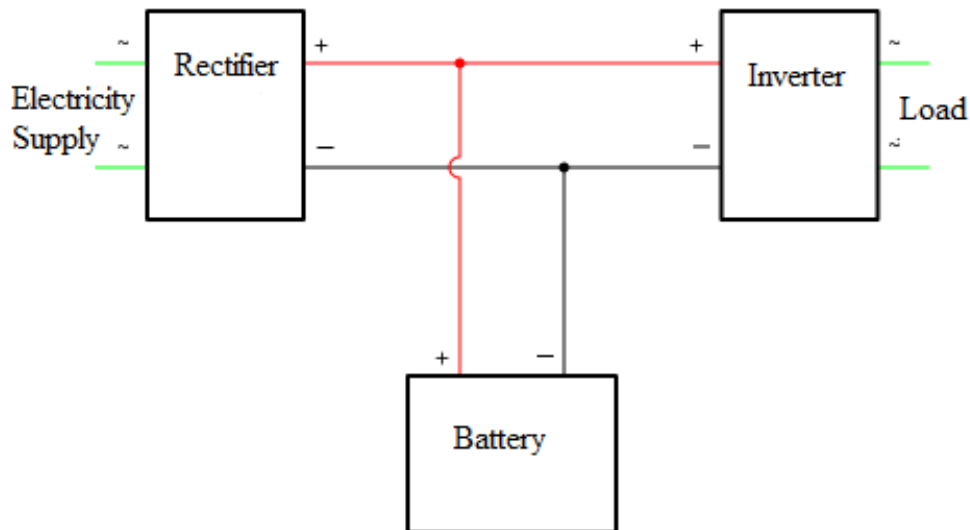


Figure 01: Line Interactive UPS

As there is an inevitable switching time in offline UPSs, there is an obvious blackout of power to the connected loads. Hence, this type of UPSs is used with loads such as desktop computers, printers, emergency lighting circuits, etc. that are able to handle such a small blackout. Offline UPS are the cheapest among all UPSs since they have the simplest design.

## What is an Online UPS?

Online UPSs are used to provide uninterruptable power. In contrast to offline UPSs, online UPS does not connect the mains power to the output. Instead, it supplies AC to the load through the rectifier-inverter combination, simultaneously charging the battery. When there is an interruption, the rectifier stops functioning and the battery bank which is already connected to the inverter provides power to the load. As a result, there would be not any transfer time in online UPSs. These are also called **double-conversion UPSs**, since the input AC is converted to DC by the rectifier, and then back into AC by the inverter.



**Figure 02: A simplified diagram of an online UPS**

Unlike in offline UPS, the static transfer switch in online UPSs is normally OFF. It is only used when there is an overload condition or when a high inrush current is drawn by a connected motor. In such a situation, the power electronic circuit associated with the static switch detects the high current and transfers the supply from the inverter to mains power. This prevents a possible damage to UPS's internal hardware by the high currents.

In online UPSs, the rectifier has to supply power to the load as well as to the battery bank for charging. Therefore, the rectifier should handle a higher load and online UPSs usually come with large heat sinks. Moreover, online UPSs are much more expensive compared to offline UPSs. They are used with commercial applications and places where uninterrupted power supplies are crucial such as data centers and hospital intensive-care units. Although they were used for applications which used more than 10kW, with the dramatic advancement of technology and reduction of costs, online UPSs are now available for devices even less than 500W. Although there is an additional expense, online UPSs provide isolation for the load from the mains supply. Thus, any voltage distortion in the mains does not propagate to the output and the supply voltage to the load will always be clean.

## What is the difference between Online and Offline UPS?

### Online vs Offline UPS

Online UPS does not connect mains power to the load at normal operation or outages. The battery bank is always-on, in-line with the load.

The battery bank of the offline UPSs is not in-line with the load at a normal situation. The mains is connected directly to the load.

### Transfer from Normal to Backup Situations

Since the battery is always connected to the load, there is no transfer time involved in online UPSs. The transfer switch connects the inverter to the load at normal condition.

There is a millisecond of a delay at the transferring due to power line detection and switching by the power electronics circuit.

### Cost

The cost of online UPS is higher since the rectifier is designed to handle high power for the simultaneous battering charging and load-supply.

Offline UPSs are comparatively less expensive due to the simpler design.

### Applications

Sensitive and highly critical loads such as medical instruments, data centers are powered by online UPSs. Due to isolation from mains to the load, there will not be any distortion at the output.

Offline UPSs do not provide isolation. Hence, there will be a voltage distortions of input reflected at the output at normal operation of offline UPS.

## Summary - Online vs Offline UPS

UPSs are meant to provide power to devices without interruption at a power outage or severe voltage sags in mains supply. UPSs are categorized into online and offline UPSs, which are static UPSs operated on semiconductor power electronic devices. Online UPSs are able to provide uninterrupted power without any transfer delay since their battery is always connected to the inverter through which the load is supplied even at the normal operation. In contrast, offline UPSs directly connect mains supply to the load at normal operation and charges battery through the rectifier. At a blackout, the transfer switch connects the inverter to the load to supply AC power from converted DC power in the battery. This is the main difference between online and offline UPS. Unlike offline UPSs, online UPSs provide isolation between mains power and the load. Hence any voltage distortion is not passed to the output voltage by online UPS.

However, at the expense of voltage distortion, cost of offline UPSs are much lower than online UPSs.

**Reference:**

1. "Comparison between Online and Offline Uninterruptible Power Supply." Power Electronics A to Z. N.p., 01 Jan. 2015. Web. [Available here](#). 13 June 2017.
2. Humayun, Naveed. "UPS History." PK UPS. N.p., 10 Jan. 2014. Web. [Available here](#). 13 June 2017.

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