UNINTERRUPTIBLE POWER SUPPLIES

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PREFACE

Author of this e-book has felt need to provide basic and sufficient information about the systems commonly known as **U**ninterruptible **P**ower **S**upplies (UPS) which are in use to condition power and also provide backup power in case of power failure. Basic to very elaborate systems are being manufactured all over the world. Electronics and microprocessor based systems have brought revolution in every field. Now with very extensive use of computer/ microcontroller/microprocessor based systems to replace semi-automatic electromechanical systems it has become necessary to have a very clean input power supply for all these systems to work satisfactorily. Any kind of variations in the input mains power supply damages such systems or the software being used. This situation necessitates conditioning the input mains power supply by eliminating any kind of voltage variation, transients, voltage surge of spikes. Further to this, power backup is essential in case of power failure.

So a power management system is required which can condition the input mains power supply and makes it suitable for use. Such a system is **U**ninterruptible **P**ower **S**upply (UPS). Which kind of UPS is required depends on which kind of systems; machines and critical equipment is to run on the UPS. We may need a basic UPS or a UPS with some additional features all depends upon what is actually required for these systems and machines to work satisfactorily. Therefore it is essential and important that we clearly understand the requirement, what is the work environment which additional features of the UPS are needed. Each additional feature adds to the cost of the UPS. What is most economical UPS for us to work with is important?

In this E-book complete information is provided so that even a person with basic knowledge understands the technical terms commonly used to describe UPS. All such terms are described in a simple way for anyone to understand the concept. The complicated explanations given by venders just to sell their product may not mislead them.

I the author of this E-book am a post graduate with graduation in electrical engineering from Indian Institute of Technology, Delhi (India) and post graduation in electronics from PEC. I have been associated with design and manufacture of electrical motors, control transformers and designing UPS systems for business environment and for industrial use. With vast experience of forty years, I have explained the concept of power conditioning and power backup in simple and clear manner to dispel the confusion created by different versions and explanations creating confusion among buyers.

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INTRODUCTION

To understand the concept of power conditioning i.e. making the input electrical supply suitable for our use, we must look into what kind of Input power mains supply is available to us. What are the defects which have to be removed to make it suitable for use?

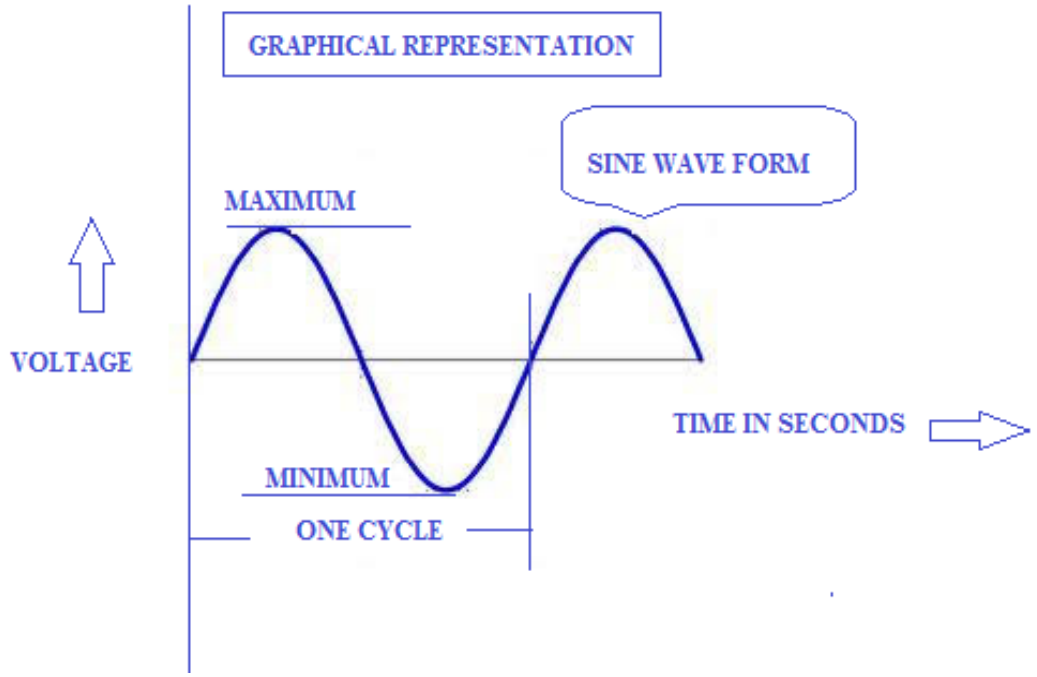
The electrical power which we get is described with the following technical terms;

VOLTAGE: is the electrical potential difference between the two wires connected to our electrical gadgets. This is the electrical driving force which pushes the electrical current through the gadget. If this driving force is low, adequate current does not flow and the system connected does not work properly. This driving force is measured in terms of Volts which is 230V for domestic use. All electrical systems, devices in India are designed to work properly when the voltage is between 200V and 240V. It is considered low below 200V and high above 240V. This means our mains electrical supply must maintain voltage between 200Vand 240v.

CURRENT: The electric flow through wires is known as Electric current. This electric current can only flow if there is a driving electric force present which is voltage. No current can flow if there is no voltage. Electric current is measured in Amperes. Thus flow of electric current depends upon Voltage and the type of load connected.

FREQUENCY: Potential difference or electrical driving force so called voltage can be obtained from a battery or through an electrical generator. Battery gives voltage which does not keep changing with time i.e if battery gives 9 volts it remains at 9 volts till the battery starts getting discharged. This voltage which does not change with time produces electric current which also does not change with time and is known Direct Current (DC). While a generator gives voltage which is continuously changing with time due to mechanical rotation of the generator i.e the voltage rises to a maximum positive value and then falls to lowest negative value. This repeats in a fixed time period. This periodically changing voltage produces current which also changes periodically with time and is known as Alternating current (AC).

WAVE FORM: The variation of voltage or of current in a circuit has a variation pattern. When the variation with time follows a mathematical sine function is known as sine wave form. If it follows a square pattern is known as square wave. The mains electrical utility supply what we get in our houses or business premises has voltage of sine wave pattern. The graphical representation is shown below;



In terms of the above the utility electrical supply we get has the following parameters;

Voltage: 230 Volts
Wave shape: Sine wave
Frequency: 50 C/S or 50 Hz

The utility AC electricity supply is mostly not suitable for electronic, Microprocessor/ microcontroller/computer based systems and equipment. All these are highly sensitive to the common defects in the utility main electrical supply.

The most commonly understood is voltage fluctuations high or low voltage, which is taken care of by adding a voltage stabilizer. There are variations such as sudden short duration high voltage (surge), transient voltage changes, sudden dips and others defects which are described below.

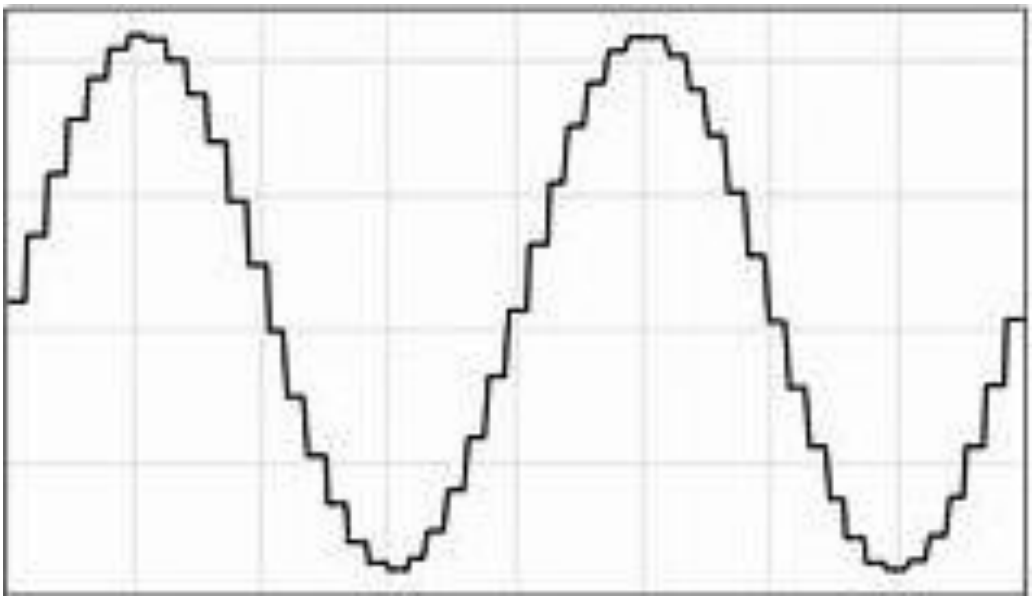
Removing all these defects to make the main utility supply suitable for systems and equipment which are very sensitive to variations stated above by inserting a digitally controlled electrical system is Power Conditioning: in short making the mains power supply suitable by removing defects.

SINE WAVE AND WHY IT IS IMPORTANT

The power that comes straight from the mains is AC. The other form of is DC. The power input required for most of electrical or electronics systems are AC as all these systems are to be energized directly from the mains supply. The mains supply we get is invariably an AC power.

Since all the electrical or electronics systems are designed to work on AC supply which has sine wave form as explained above. Some more budget-friendly UPSs provide output which is not having the pure sine wave form but produce step form sine wave that is rise and fall of voltage is not smooth but steps up and steps down, commonly known as step sine wave.

When the input to electronics systems in fed from a UPS and the wave form is not pure sine wave the systems tend to malfunction because of large number of harmonics are generated. Fans start making noise, overheating etc. So it is extremely desirable to have pure sine wave input of power to all our systems in use.



STEP SINE WAVE

WHAT IS POWER CONDITIONING ?

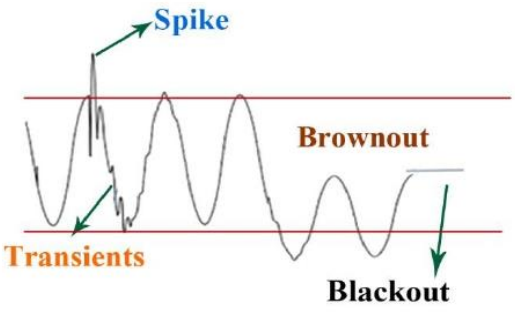
The utility AC electricity supply is mostly not suitable for electronic, Microprocessor / Microcontroller / Computer based gadgets and equipments. All these are highly sensitive to the common defects in the utility main electrical supply such as:

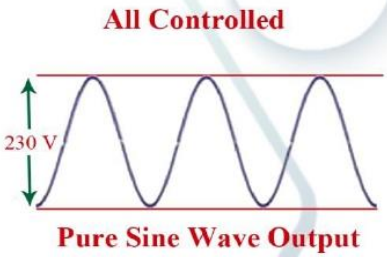
- Brown out.....Constantly low/high voltage.
- Black out.....Power goes off suddenly.
- Sags.....Sudden dip in voltage.
- Surge.....Short duration high voltage.
- Spikes.....Brief but high energy bursts.
- Line noise, frequency variations, switching transients and harmonic distortion.

A Perfect Solution to Condition Mains Power Supply

ONLINE UPS

(Converts & Generates pure supply free from all defects)





SERVO VOLTAGE CONTROLLER

(Only controls high / low / sags in voltage)

Different devices and systems are used to remove these defects as per the need. If only lighting load is connected (Led bulbs), refrigerators or other electrical equipment then mostly it is required to keep the voltage in range and a stabilizer is good enough as the other defects even if these are there in the supply may not damage electrical machines or equipment. If the load connected with mains utility supply is computers or computer/ microcontroller based equipment than these can be damaged by other variations in the utility supply. Sort interruption may erase data; Computer based systems may reboot or the important data is suddenly lost or the device/equipment may get totally damaged.

In short servo voltage stabilizer/controller only stabilizes the voltage within certain limits while online uninterruptible power supply (UPS) removes all the defects as described below;

SERVO VOLTAGE CONTROLLER

Only removes or stabilizes voltage variations which are:

Brown/High out ……... Constantly low/high voltage

ONLINE UPS

Removes all defects whatsoever present in the mains power supply which are:

Brown/High out ……... Constantly low/high voltage

Black out……Power goes off suddenly

Sags ……... Transient under voltage

Surge……... Short duration high voltage

Spikes……. Brief but high energy bursts

UPS also removes line noise, frequency variations, switching transients and harmonic distortion.

Depending on the type of load the power conditioning system is to be selected i.e. only electrical or digitally controlled computerized systems. Only electrical load shall require servo voltage controller/stabilizer as only voltage variations effect the electrical load and other defects in the mains power supply such as transients, surges, spikes and harmonic distortion do not harm these systems.

However in case of mains supply failure the electrical machines shall stop working, as the Servo Voltage stabilizer does not provide power backup. While in case of computerized load any defect in the mains power supply shall affect the working or damage the system therefore, an Online UPS is required. The power backup is also important in case of sudden shutdown, data shall be lost or the program may have to be loaded again or the system may get damaged etc. as such the only solution is an Online UPS. Online UPS shall also provide backup giving time for switching on the alternate power supply generator or for safe shut down time.

WHAT IS AN UNINTERRUPTED POWER SUPPLY?

An uninterruptible power supply protects connected equipment from power problems and provides battery backup power without any interruption during electrical outages. These are commonly called UPS systems or UPS battery backup. UPS systems also regulate and protect attached equipment from abnormal voltages. All UPS systems have critical functions: to provide battery backup power with no interruption and to protect equipment from any kind of mains power defects.

HOW ONLINE UPS CONDITIONS MAINS POWER SUPPLY?

In all types of businesses, hospitals, institutes, call centers just name a few and almost all service providers use large number of computers or computer based electrical and electronics systems. All such systems are very sensitive to the electrical power fed to these. Many kinds of disturbances from the mains power supply damage these equipment and systems.

UPS (uninterruptable power supply) is an electronics system which protects every kind of equipment and machines and also provide backup in case of power failure, which means power without any interruption what so ever.

The concept and working of UPS can be understood in a very simple way. The mains power supply we get is alternating current or AC and all electrical or electronics machines, gadgets, devices, equipment and systems are therefore made to work on AC supply. On the other hand electricity what we get from a battery is of direct current type or DC. UPS takes in AC power and electronically changes it to DC and also obtains DC power from the batteries connected with it. This converted DC and DC from the battery is changed to AC by the UPS and supplied to the electrical or electronics items we use.

This AC is generated within the UPS and is totally free from any disturbance, totally pure AC. Since all disturbances which were present in the mains power supply have been eliminated by converting the incoming mains AC power supply to DC and again this DC power is electronically, using digital technology is converted to AC power, totally clean without any defect, consequently every system connected with the UPS is totally safe.

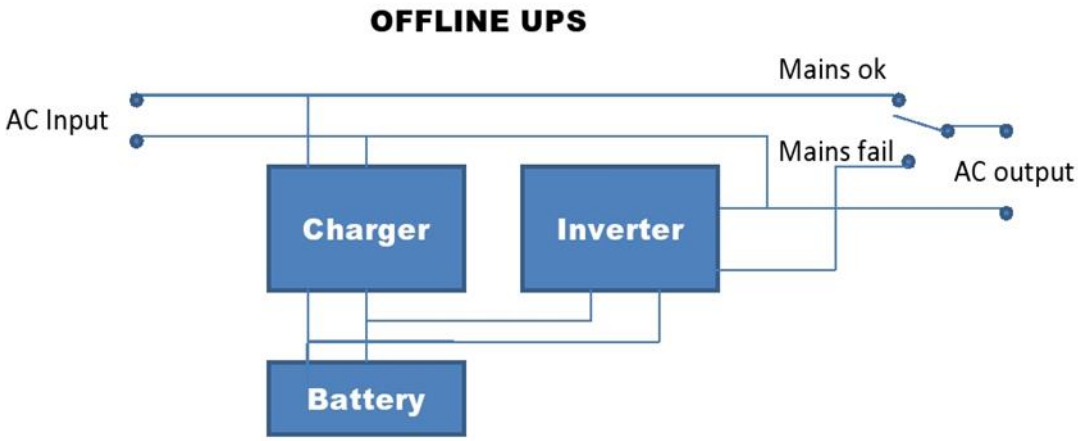
Further when mains power fails, UPS takes DC from the battery and gives instantly AC output supply to the connected items while no interruption is sensed by any load connected to the UPS. This process is commonly called double conversion. UPS gives power to connected load by generating AC from the DC power, either from the converted DC from mains supply or from the connected batteries therefore even if mains supply is normal or fails the connected load gets electronically produced pure, defect free AC power supply from the UPS.

UPS TYPES

There are three main types of UPSs: Offline, Line Interactive and Online.

OFFLINE UPS

Offline UPS is the simplest type, inexpensive version of UPS. These are small rating UPS commonly used to supply power directly from the mains to one or more computers until mains power fails. When the power goes out, the UPS switches to its internal battery to power the computer.



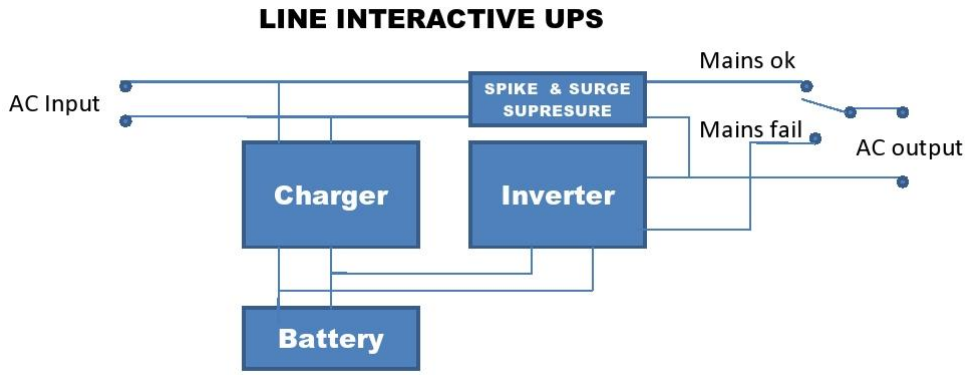
The major trouble with the offline UPS is that it waits until it detects power failure before it switches to battery power.

There is little time taken to switch to batteries and this time is called the “switching time” or “transfer time”, the connected computers might sense interruption. This could cause loss of important, unsaved, data.

Unfortunately, some manufacturers of offline UPS do not provide facility to filter the incoming power or use any circuit for the surge suppression as a measure of cost-saving. Which, in my opinion, are two of the most valuable UPS features those should be available in a UPS.

LINE INTERACTIVE

In a Line Interactive UPS, the power from the mains supply is filtered and regulated before it goes to the load. There is considerable protection provided to the load as voltage is stabilized and the spikes and surges are removed. However when the mains supply fails the ups switches to the battery. The switching time is also

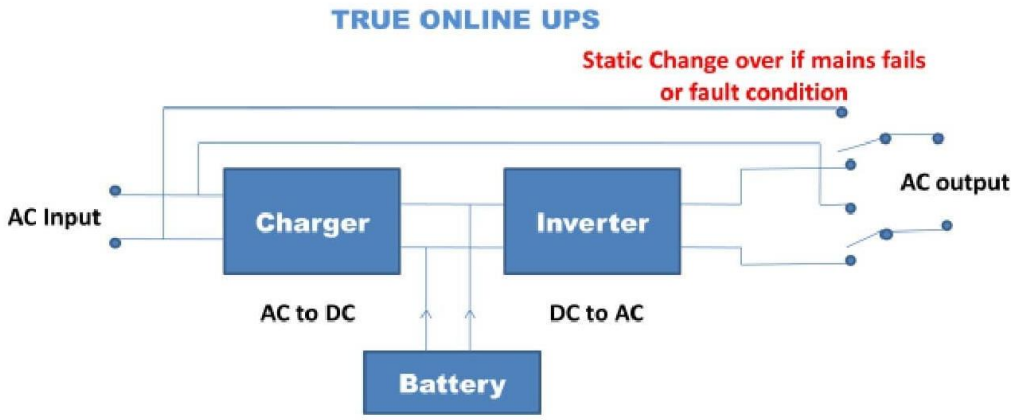


comparatively fast to protect data or to avoid rebooting of computers.

ONLINE UPS

Online UPS, sometimes called a “True Online UPS”. In an Online UPS, the power comes from the battery of the UPS and from the power mains at the same time. The incoming mains power supply which is AC is converted to DC power and this way the UPS is connected to two DC sources. One source is the battery and the other source is the mains power converted to DC. The main power supply is also constantly recharging the battery. If the power goes out, the UPS will keep running on DC power given by the batteries.

Some of the benefits of using an Online UPS are that there is no “transfer time” as battery remains always on float, that is the UPS has not to sense power failure and therefore there is no switching time. The connected load gets uninterrupted power. Second, and maybe even more importantly, is that the main supply is converted to regulated DC power thereby removing all kinds of defects such as spikes surges or transients. In short the UPS does not sense whether the DC supply is coming from the battery or from the mains supply as both are available simultaneously. If one goes the other is there.



Online UPS converts the input DC power to Ac power electronically which is pure AC with a perfect sine wave output. In this way the connected load is fully protected and also gets instant power backup is mains supply fails. The load is always getting Ac power even if mains are there or not. That is why this UPS is known as double conversion Online UPS. It is always supplying power to load which is generated by the UPS and is never connected to the mains supply directly. Online UPSs are generally only available in larger sizes over 3,000 VA.

UPS FEATURES EXPLAINED

While ordering an online UPS, we must know some of the features which are essential over and above our basic requirement of protection and uninterrupted power supply. Some of these features are given below so that we do not forget to get these features which are in fact important for our working environment.

- **Energy-Saving Models**- Such UPS models reduce energy consumption and associated costs. These systems have advanced charging technology which improves input power factor thereby economizing power consumption.

- **Communication Ports** – Some UPS systems are provided with USB, serial (DB9), and/or contact closure communication ports. Mainly required for large setups. These features enable remote power management, and automatic unattended shutdown; systems will shut down when not in use for a certain amount of time.
- **Multifunction LCD Control Panel-** Most of UPS have built in LCD screen which allows access to the status of the UPS system without a computer. It can display helpful information like input voltage or battery capacity. And other important parameters.
- **Alarm-** Audible Alarms indicate various UPS functions. Alarms are excellent warning signals when something is wrong with the UPS or if power from the wall has been lost.
- **Cooling Fan-** Larger UPS systems typically have built-in cooling fans, which may affect the noise level of your environment during operation. Typically, the more power that is flowing through the UPS will cause more heat to build up. If the UPS gets hot enough it could shorten the life of the UPS, the UPS could fail, and could even cause harm to your systems. These fans help to keep the UPS cool and running optimally.
- **Hot-Swap Repair/Replacement-** Even UPSs need maintenance from time to time. A UPS with a Hot-Swap UPS System will allow for servicing the UPS without having to completely shut down of the connected load. They have a detachable power disruption unit with manual bypass switch that enables live UPS repair or replacement.

HOW MUCH POWER DOES YOUR EQUIPMENT REQUIRE?

There are most important considerations when you decide to purchase an UPS. These are;

1. The total electrical load you intend to run on the UPS which means the KVA rating of the UPS.
2. The duration of power backup in minutes is required when the mains supply fails. The UPS must be capable of supplying adequate power to the connected load to enable you to save important work and to safely shut down the systems. Power backup time is the capability of the UPS to provide battery backup power to the connected load/equipment when the utility mains power fails. For larger backup bigger battery bank is required. Since the number of batteries adds to the cost of the system we have to carefully calculate the backup time.

Eel Tec Systems private Limited has developed a comprehensive guide for the calculation of the KVA ratings of the UPS and the battery bank required so that you are able to choose a most economical UPS unit you need with the features you want (and there's no way to get that perfect of a fit without doing the math we outlined above along with some careful comparison shopping), a UPS is no way cheap. However, if you are looking to protect the investment you have made in your computer system, you will want to purchase one right away!

EELTEC team of experts is always available for any information on UPS systems. Our team can visit your premises free of cost to suggest to you a most economical solution for protecting any kind of equipment, machines or systems from damage due to bad mains power supply situation.

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