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An overview of Uninterruptible Power Supply Systems

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Abstract. In the modern world, when there is a power outage or a power failure, telecommunication systems, computer systems, and many other critical equipment, such as medical equipment, require uninterrupted power to support their operation. Uninterruptible power supply (UPS) systems are used for this purpose. Over the years, research on UPS systems and related publications have increased. Also, new opportunities for UPS systems have emerged with the development of novel storage technologies, power electronic topologies, rapid electronic devices, high-performance digital apps, and other technological advances. Servers and storage systems, personal computers, medical equipment, telecommunication systems, and industrial equipment all require clean, stable, and uninterrupted power supply from UPS systems. Several recent studies have focused on the design of UPS systems to provide continuous power under normal or abnormal power conditions, including power outages. Such UPS systems use energy storage technologies such as batteries or flywheels to provide power to loads in the absence of applied power. Typically, static power electronics such as fast-switching high-current insulated gate bipolar transistors (IGBTs) are used to convert power. This article discusses the most typical power line issues and how they relate to the various types of UPS systems available today.

Key words: Uninterruptible Power Supply, solar hybrid system, Static IPS

1. Introduction

UPS is a crucial component of the electrical infrastructure when high levels of power quality and dependability are required. This chapter covers the fundamentals of UPS designs, typical applications for which they are most frequently used, factors to take into account when choosing a UPS, as well as additional elements or options that are crucial when deciding to buy and deploy a UPS system. [1] Distributed generation (DG) is an emerging idea to decentralize the administration of power production. However, without distributed energy storage systems, DG is useless. Since each inverter must appropriately distribute the load while maintaining synchronization, connecting UPS inverters in parallel is more difficult than doing so for DC sources. [2] With the increasing amount of information handled across devices integrated on the internet, embedded application systems require access to devices to better support processing. The need for systematic information storage is also increasing. Data and coding on a serial EEPROM chip store information, and communication with a microcontroller unit takes place via the I2C bus. Users can access local data on web clients or other information devices by integrating UPS file system systems. Chip-based embedded file systems can be critical to the growth of IP networking. [3] Offline UPS is a straightforward design with low cost, a small footprint, and great performance benefits, although it has restrictions for critical loads as the power supply is not unconditional. Therefore, there is no protection against voltage or frequency changes for essential loads. Some power line filtering can be used to remove remarkable waves, spikes, sags, and other irregularities in utility power. However, voltage correction, disturbance rejection, and reaction and of compatible compensations are basically on the application side. Accessible output voltage regulation and no active power line alignment are also limitations. [4].

2. Uninterruptible Power Supply System

When utility mains are not available, electricity can be supplied from a source such as a standard connected equipment UPS, which provides power supply. UPS is mostly used for critical loads and is kept between commercial utility mains. In the event of a power outage or other anomaly, UPS instantly switches to its own power from the grid. A computer can be run with a UPS that can monitor up to 300 VA power. There are different power-rated UPS units available, ranging from full data centers to power up to several megawatts for buildings. Usually, UPS is used in conjunction with generators for large scale power requirements [5]. Simply put, UPS is a device that is used when utility power is not available to run a regulated power supply for equipment use. It provides backup power to important devices to prevent data loss, process interference, or other issues by generating electricity (usually from a generator) until the required loads are available to run. Multiple UPS topologies are used to smooth out frequent sags and waves in incoming power, so electronic and electrical equipment is not harmed [6]. UPSs are necessary in applications that include critical functions such as IT, communication, banks, industry, and hospitals. Smaller power requirements are often handled by single-phase designs, whereas greater power requirements are handled by three-phase systems since UPS systems are designed to connect readily into the conventional electrical infrastructure [7]. In certain developing nations like India, utilities deal with significant power shortages and related power quality issues. Since the difference between the supply and demand for power is widening every year, load shedding is a

serious issue for which there is no likely rapid solution. Due to this, traditional battery-inverter sets and standby petrol or diesel generator sets are rapidly proliferating. [8].

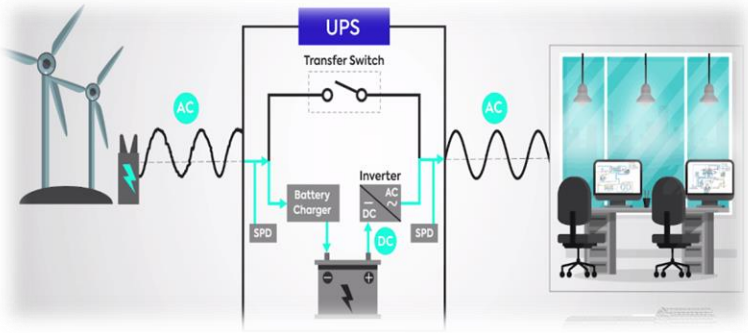

FIGURE 1. Standard parts of ups system

Lead-acid or Ni-Cad batteries are commonly used in most UPS systems. However, these batteries have a short lifespan, short backup time, and are not environmentally friendly due to their chemical components. Battery-backed UPSs also have high maintenance costs and low reliability, along with short backup time. On the other hand, generators-based UPS systems have a longer backup time but create more noise and are loud [9]. To address these issues, newer UPS systems are designed to provide longer backup time, higher efficiency, higher energy density, longer lifespan, lower maintenance costs, and use eco-friendly fuel. When utility power is not available, uninterrupted power supply systems (UPSs) are important to provide power to critical functions or loads. Generally, rechargeable batteries such as Nickel-cadmium or valve-regulated lead-acid (VRLA) are used in UPS systems. [10].

Static UPS: "The most widely used UPS settings are standard UPS settings. They are used in various systems, including low-power telecommunications and personal computing systems, medium-power medical equipment, and high-power utility equipment. Their main advantages include less total harmonic distortion, better performance, and greater reliability. Non-linear and non-equilibrium THD can cause poor performance with loads and higher costs, which are inherent problems of static UPS systems." [11].

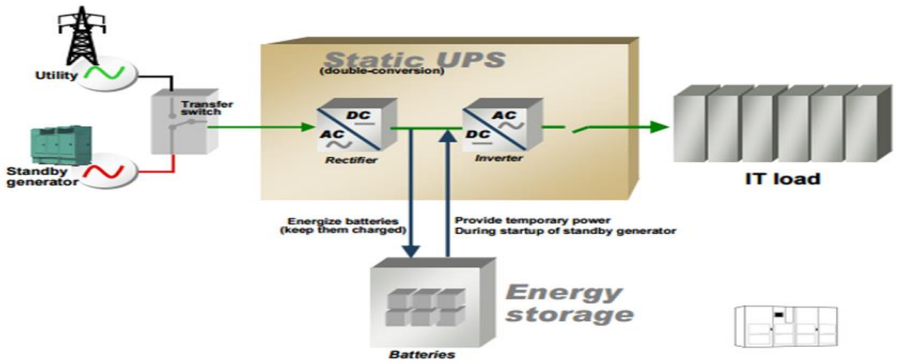

FIGURE 2. Static IPS

On-line UPS: "The inferior topology of some UPS systems can result in lower performance, power conditioning, and load security. Offline and line-interactive UPS systems have larger power loss and worse performance during normal operation compared to online systems, which use a rectifier and inverter to supply power. The main advantage of online systems is complete isolation between input and output voltage, while the main advantage of offline and line-interactive systems is their switching time in case of power failure, which is typically a second. However, offline and line-interactive systems may crash when only the battery charger fails. In service, online systems allow for failure without any disturbance. The principal drawbacks of the inferior topology include low efficiency, excessive THD at the input, and low power factor. Without an additional Power Factor Correction (PFC) circuit, the rectifier can destroy the input current, which increases the price of the UPS system." [14].

Off-line UPS: Additionally referred to as "standby UPS" or "line-preferred UPS," the off-line UPS arrangement has a standard switch, a battery bank, a DC/AC inverter, and an AC/DC converter made up of the output voltage UPS or inverter to increase quality. A filter can be applied to the output. During default operation, the switch is turned on, and as a result, no power from the AC line without conditioning the load is supplied directly. The battery pack is charged through an AC/DC converter [15]. As a result, offline UPS systems are cheaper than online systems. The inverter rated at 100% load demand contains. During normal operation, it is connected in parallel with the load and will be inactive. The key benefits of offline UPS topology are its straightforward design, inexpensive price, and compact size [16]. However, among the main drawbacks is poor performance with loads, non-linearity, and lack of load isolation from the AC line. [17].

Line Interactive UPS: It employs a completely unique design from any other kind of stand-by UPS. An inverter/converter assembly is used in place of the internal components in this UPS. The line voltage is fed into the inverter/converter, which subsequently prepares it for output. Additionally, the device provides the UPS battery with a DC charging voltage [18]. The key advantage of this type of unit is that the inverter/converter is permanently connected to the output. Compared to backup style UPS units, the switching process takes a lot less time [19]. The biggest drawback is the lack of isolation of the transformer at the output, and voltage regulation is also poor, especially under adequate load from the AC line. There is no way to control the output frequency. [20].

Rotary UPS: "It is a battery bank, an AC generator, a DC machine, and an AC motor made up of motors. The electric mechanical connection between the machines has normal functioning, and the stored energy has two modes of operation. During normal operation, the AC motor turns on, which is then powered by the DC machine. The AC generator is provided by the load, which is powered by a DC machine. With stored energy, when operating, the battery bank's DC engine turns on, and then the AC generator turns on [21]. Inside UPS, rotary UPSs are those that transfer loads using rotating components like motors or generators. Basically, in the event of a utility breakdown, moving wheels or other components serve as temporary energy storage sources. A rotary UPS includes static bypass switches, converters, motors, generators, and battery banks. Electric machines include mechanical coupling." [22].

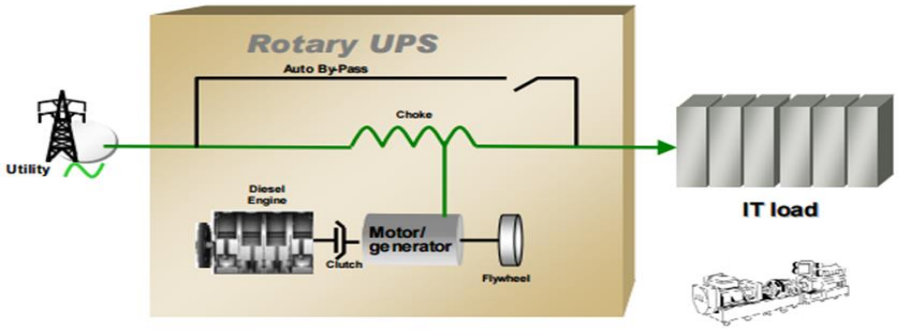

FIGURE 3. Rotary UPS

A cycle where electricity is drawn from the grid Works well in UPS systems. Compared to static UPS systems, rotational UPS systems are substantially more dependable. However, they are significantly bigger, heavier, and need more upkeep [23]**.**

Hybrid Static/Rotary UPS: "The main components of both static and rotary UPS systems are combined in hybrid static/rotary UPS systems. These systems require little maintenance and have a low output impedance, good reliability, excellent frequency stability, and high efficiency. The figure shows a typical hybrid static/rotary UPS, which consists of a fixed switch, an AC motor, an AC generator, a battery bank, and a bi-directional AC/DC converter. Hybrid UPS systems are typically used in high-power applications." [24].

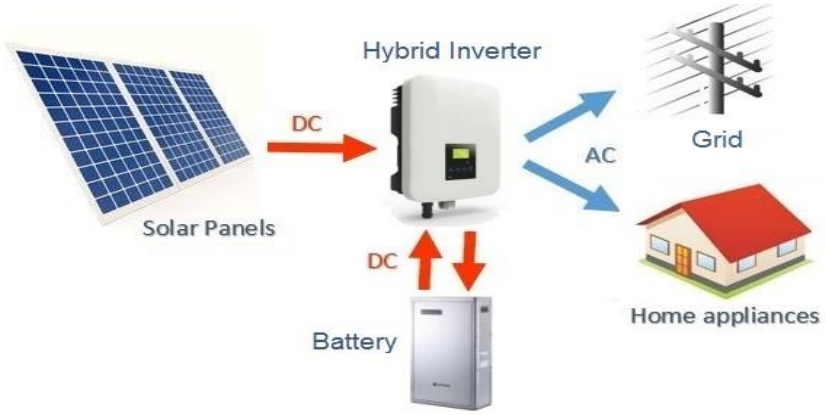

FIGURE 4. Basic layout diagram of a common solar hybrid system

Hybrids, which are various combinations of static inverters and rotary machines, have been created to take advantage of the finest aspects of each. To maximize efficiency and enable direct engine coupling without a flywheel, they first operate the critical load with a high percentage of electricity from the utility line [25]. There are various advantages to hybrid rotary uninterruptible power supply systems, including electrical isolation, streamlined maintenance, and reduced overall maintenance. They also have higher reliability, a longer lifespan (20–30 years), and lower running expenses. The main drawback of a basic hybrid inverter is that it lacks a grid isolation device, preventing it from powering your home during a blackout. [26].

3. Conclusion

Business continuity requires IT to protect the infrastructure from critical computer systems and hidden dangers in the environment, which are common conveniences in the age of the internet. Power outages can cost businesses thousands of

dollars in missed revenue, and the impact can be costly, especially when workers' productivity is affected. Any company, no matter how big or small, is vulnerable to electrical resistances. Power abnormalities can affect your computer, storage, network, and process equipment, which can eventually decrease device performance or lead to early failure. You may only notice power interruptions when the lights are turned on or off. To keep your company's utilities under control, your power bills low, and your data safe and secure, you need high-quality and highly efficient UPS gear as part of a well-structured utility power security solution. With a mission-critical system, operators know they can achieve long-term success with clean and reliable power.

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