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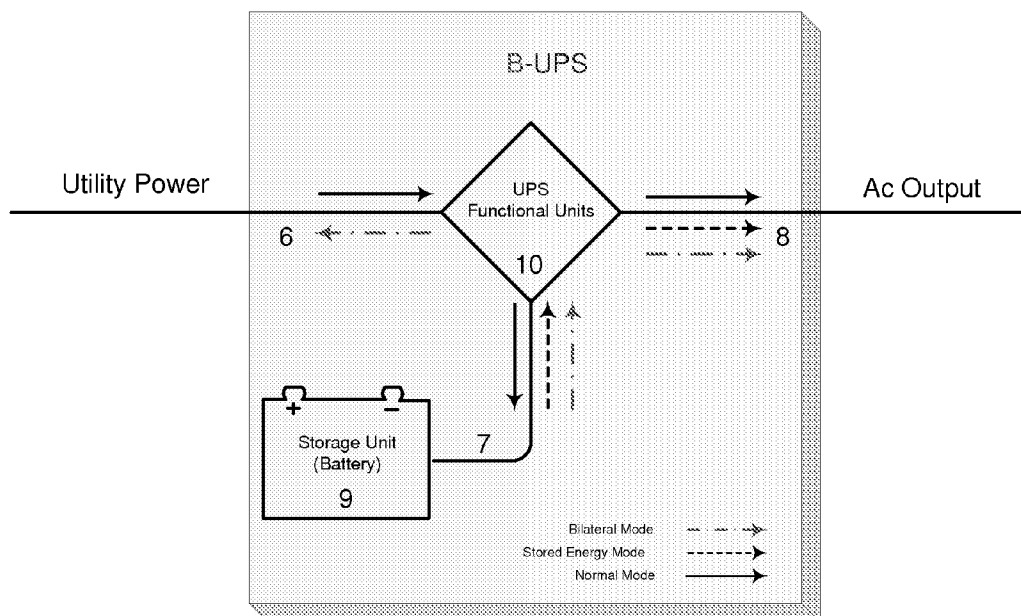
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(54) Title: BILATERAL UNINTERRUPTABLE POWER SUPPLY (UPS) UNIT



B-UPS and its new operational mode

(57) Abstract: Bilateral Uninterruptible power supply (BUPS) unit is a UPS apparatus that can produce and send power into the AC distribution Network while holding continuity to its load power. Large numbers of these units can greatly assist the AC distribution network in producing electrical power and adjusting and flattening the peak points of the usage profile.

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**Description:****BILATERAL UNINTERRUPTIBLE POWER SUPPLY (UPS) UNIT****Field of invention:**

The present invention relates to an uninterruptible power supply (UPS) unit which can direct the current to the AC distribution network while it can hold the continuity of load power. This newly designed UPS can work either in its traditional UPS modes or in its new operational mode which inject power to the system in case of need.

**Background of invention:**

Apparatuses for uninterruptedly supplying power as alternating current to an electrical load are commonly known in the art. The known apparatuses control an output voltage being supplied to the electrical load not only in case of troubled conditions, but also during normal conditions when the electrical load is supplied with power by a public network or by a different external source of power.

Historically, all the applications for the UPS devices have been concentrated on the fact that the device provides the power for system when the input AC power has diminished or is not in the acceptable range.

On the other hand, these days one of the big concerns of all countries is how to manage the power usage in the way that the power usage profile tangents a constant line in theory. Therefore, what is needed in the art is an uninterruptible power supply featuring as an electronic power supply returning power to the whole AC power system when the power system network suffers deficient conditions. This UPS function results in changing in the name of this device as a key feature of this new device is to return the power in the cut off or deficient conditions back to the AC power system network. While traditional UPS devices work exactly in the opposite way and in deficient conditions switch the input power from network to the UPS battery. It should be noted that this new ability for B-UPS units is an add-on capability to the traditional UPS systems so the B-UPS systems can also operate like traditional UPS units.

**Description:**

The main Idea of this invention is a new electrical route from the UPS battery to the AC distribution network in this newly designed UPS units. It means that while the UPS device holds the continuity of load power, it can also provide electrical power for the AC distribution network when the network faces power shortage.

In this invention this new type of UPS is called B-UPS in abbreviation of Bilateral Uninterruptible Power supply because the energy can also flow toward the source in some modes as depicted with red lines in figure 2

With accurate signaling methods and proper priority allocation, the B-UPS can be used in either traditional applications or its new applications in improving the load profile of whole power system network by supplying required power in critical moments. This new ability can be added to the traditional UPS devices with critical changes in hardware and/or software of UPS structure.

The functionality of the B-UPS is like the traditional UPS units, the main difference is a possible mode that the stored energy can be fed to the power system network. One of the most important reasons for using B-UPS units is the ability of returning the stored power of the UPS battery to the network in the peak of load usage profile and charging the battery when the network has better conditions.

It should be noted that the injected power to the AC distribution network is the excess power of UPS battery due to the fact that the UPS units generally produce more power for reliability reasons.

Considerable number of B-UPS units with a proper control link for managing the activities between the UPS and the whole AC distribution network can affect the usage profile enormously. Also in many regions that the usage profile is related to some available parameters like network frequency or sun light, the usage profile can be estimated independently by signal processing algorithms without any access to the AC power system signaling parameters.

The way to determine the maximum and minimum points of the usage profile graph has various methods. The most important thing in this invention is the ability of discharging the B-UPS batteries in the network. After reaching this ability, this method can be used in many applications to improve the power network situation.

Analyzing usage profile in past sampled days leads us to very simple and useful information that can help us to estimate maximum and minimum of usage profile graph with good accuracy. Generally maximum usage occurs at sunset, when most of the users have lighting usage. Although the maximum may not occur exactly at the sunset but studying these graphs in many days can guide us to find relations between sunset time and maximum power usage time that can be used for UPS time table.

In addition exploiting solar energy has many economical and environmental problems. The maximum usage occurs at night when solar energy is no longer available, so it is needed to store energy for then. Storing this energy needs big chemical cells and also it is very expensive. But with these B-UPS units or system of units, one can utilize the solar energy efficiently and hence economically. One of the aims of B-UPS units are to flatten the usage graph at nights with stored power that B-UPS units inject back to the system. Therefore one can envision that at nights the B-UPS units would operate in their new bilateral mode.

One can set these B-UPS units to work in stored energy mode at day. This causes the overall usage during daytimes to exceed the total usage at night while all the B-UPS units in the system are trying to recharge their batteries. In this situation the solar energy can be exploited at day without any need to store it, this takes more efficient advantage of solar energy.

As depicted in figure 2, the stored energy in the battery unit #9 can flow toward the AC distribution network via bilateral line#6. It means that this device can simultaneously supply its dedicated load (with line #8) as well as the AC power system (with line #6).

Another important focus of this invention is when should the B-UPS act in its bilateral mode? The way a B-UPS recognizes its operation mode may vary with different UPS designs. It can be a separated unit that estimates the power network situation and then selects the B-UPS operation mode, or it can be a timetable embedded in the UPS main

micro controller chip that automatically switches the B-UPS mode at predefined times.

The control electronics of this newly designed unit also account for the use-case of encountered the power shortage when the B-UPS unit has just discharged its whole energy into the AC distribution network. The units control system addresses the above mentioned use-case by reserving 20-30% battery back up and not allowing the unit to totally discharge its energy into the AC distribution network.

The critical times that the AC power network needs extra power can be estimated either from power usage per day graphs or it can be estimated adaptively. Estimating the critical points of the usage graph adaptively may require some adaptive algorithms and also data from control lines of the power network. This may make the system more complicated compared to fixed and predefined solutions. On the other hand predefined solutions have less accuracy in contrast with adaptive solutions. In conclusion any of these algorithms can be used for the mode-selective part of a B-UPS.

Testing a UPS battery always needs a special load and a prototype testing system. That is because traditional UPS units have their dedicated load with known specifications, so that load can not sustain high current from battery as it might harm the device when the current is out of range. On the other hand a complete test of a UPS battery needs different-ranged currents from the battery. But with this B-UPS units any current can be derived from the battery and therefore all the standard battery tests can be accomplished even when the UPS is online.

#### **BRIEF DESCRIPTION OF THE DRAWINGS:**

The drawings included herein provide a further understanding of the invention. A brief introduction of the drawings is as follows:

FIG. 1 is a general operational view of a structure of uninterrupted power supply;

FIG. 2 is a newly designed UPS and its modules called Bilateral-UPS with the new capability for returning power back to the power network.

As shown in figure (1) we have two modes for a normal UPS, in the normal mode that the input power is in the acceptable range, the current flows through line #1 and then line #3 to the load. It can also charge the battery unit #4 via line #2.

When there is shortage or unacceptable variation in the input signal in the line #1, the energy stored in the battery unit #4 is then discharged to the load through line #2 and #3, this is referred to as stored energy mode.

Figure (2) illustrates the concept of the B-UPS device and the addition of a new mode of operation, called the bilateral mode. When operating in normal, stored energy mode, this B-UPS has all the functionalities of a normal UPS. However, In the new bilateral operational mode, that occurs when we have been faced with cut off or deficient conditions in the input distribution network, the current is flowed from the battery unit #9 to distribution network via line #7 and #6 and also to the load through line #7 and #8. The unit's battery can simultaneously supply the load and inject power to the network. The whole system is capable of bilateral current movement (especially

line #6). The control electronics include key modifications to the input circuits in UPS Unit #5 to enable and augment the system with this new route to inject power to the distribution network in UPS unit #10.

**Summery of invention:**

The key feature of the present invention which is believed to be novel in UPS apparatuses is the ability of retuning power back to the main power network.

The aforementioned B-UPS unit or system of units can feed power back to the power network while holding continuity to its load power. This new capability can greatly assist in adjusting and flattening the peak points of the usage profile through the day.

In addition, solar energy can be used in the power network without the need of chemical storing devices as mentioned before in the body of this document. So this will enhance the overall efficiency by transforming the solar energy resources into precious electrical energy.

## Claims:

What is claimed is:

- 1- An uninterruptible power supply (UPS) unit which can direct the power toward the AC distribution network while it continuously supplies the load.  
As this new UPS can direct the current in both directions of all the UPS possible paths it is named Bilateral UPS (B-UPS).  
The above mentioned unit can operate in either normal UPS modes (stored energy mode and normal mode as defined in IEC 62040-3) or the new mode called "B-UPS mode".
- 2- An uninterruptible power supply unit according to claim 1 that can charge the batteries in times that AC network has its minimum power usage instead of times that the AC network suffers bad conditions.
- 3- An uninterruptible power supply unit according to claim 1 that can discharge the stored energy in the UPS to the AC distribution network when it is encountered to the maximum power usage in the system.
- 4- An uninterruptible power supply unit according to claim 1 that can adjust that waveform of charging and discharging of batteries in a way that increases the power quality of AC distribution network.
- 5- An uninterruptible power supply unit according to claim 1 that can inject current in some parts of voltage waveform and returning current in some other parts ( in both half-cycles) that causes elimination of unwanted harmonics without any changes in the energy of the batteries.
- 6- An uninterruptible power supply unit according to claim 1 that can use solar energy during the day for charging its battery and returning its energy at night. Indeed, having this feature means that we have reached to a solar energy storing device without any chemical or environmental damage.
- 7- An uninterruptible power supply unit according to claim 1 that is able to discharge the battery with any desirable current into the AC power network. With this ability any required testing graph about battery condition can be plotted whenever it is needed.
- 8- Uninterruptible power supply units according to claim 1 can greatly assist the AC distribution network in producing electrical power and adjusting and flattening the peak points of the usage profile when they are used in large scale number.

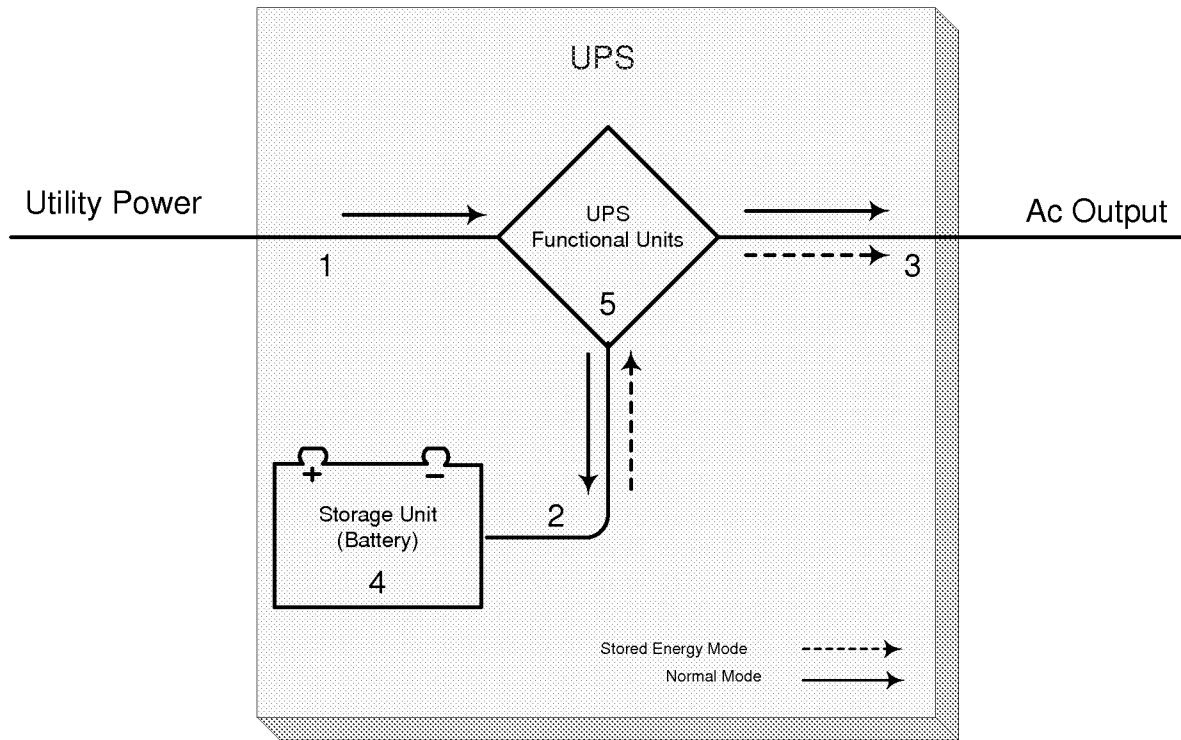


Figure (1) Normal UPS and its different operation modes

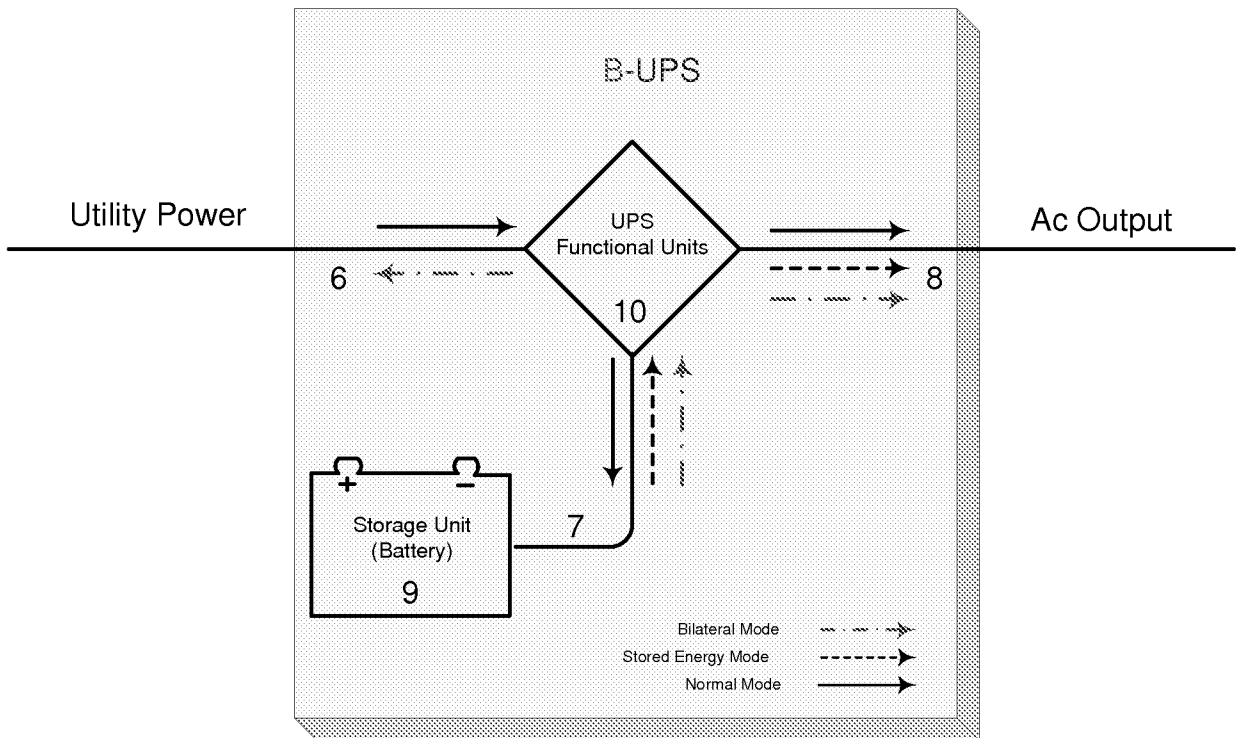


Figure (2) B-UPS and its new operational mode