Single Phase Online UPS Employing Advanced Charging Technology with PFC Rectifier

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Abstract -**High quality and availability of electrical power are now strategic requirements for all sectors of the economy. A breakdown can endanger the smooth running of a company and generate considerable financial costs. Failure of an electrical supply and electrical installation can be a serious human risk, for the operators as well as for the users. Blackouts, brownouts, voltage surges, voltage spikes, harmonics are common day-to-day power problems. Due to these problems we may not get clean power supply. But solutions do exists. Among these solutions, UPS is one of the most commonly used today. An Uninterruptible Power Supply, or UPS, is an electronic device that provides an alternative electric power supply to connected electronic equipment when the primary power source is not available. UPS design at communication center needs highest reliability and maximum availability. UPS's half cost is dependent on Battery. So it is more important to consider the battery life. Battery life mainly depends on three factors: Rate of discharge, charging current, temperature. We cannot control the rate of discharge. We can control only charging current and temperature factors. Using this concept how battery's life can be increased it is illustrated in this paper. With additional voltage and temperature sensor each battery block can be monitored individually.**

Key words - **Clean Power, PFC rectifier, Advanced charging technology (ACT), Back up time (BUT)**

I. Introduction

The UPS device that exists solely to avoid power disruptions. The load is primarily powered by utility power without interaction from the UPS. In the event of power failure or if power exceeds predetermined value, the battery storage mechanism will provide supply to the load. There are mainly three types of UPS. Offline UPS, Online UPS, Line interactive UPS. A variety of design approaches are designed to implement to UPS systems. There are six design types of UPS for various applications:

1. Standby UPS,
2. Line interactive UPS,
3. Standby Ferro type UPS,
4. Double Conversion Online UPS,
5. Delta Conversion Online UPS[1] ,
6. Rotary UPS [2].

Among these UPSs Online UPSs are most preferable type of UPS, due to its zero switching time characteristic, excellent frequency stability and other various factors. In online UPS if we give 230 ± 20% voltage input to the UPS unit, It will give us output in the unique form of 230 ± 1% due to its double conversion operation. So UPS is a one type of power conditioner, improves power quality. Main sub- parts of online UPSs are Rectifier, Inverter, filter, battery bank, protection circuit.

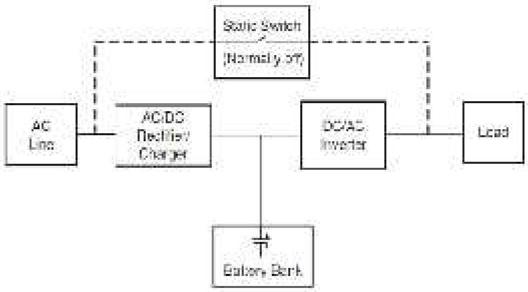

FIGURE 1: Block diagram of Online UPS

Normally there are two modes of operation in UPSs. Mains mode and battery backup mode. If mains supply is available than load will be supplied through the mains and if mains supply fails than UPS provides supply through battery. In double conversion mode supply will initially go through line to – UPS module rectifier part (AC - DC) – some part will flow for battery charging – other part of supply will flows through inverter part (DC – AC) than power supply will be provided to the load. So it is called double conversion online UPS.

The double-conversion system has several advantages:

(1) It provides excellent frequency stability.
(2) There is a high degree of isolation from variations in incoming line voltage and frequency.
(3) A zero transfer time is possible.
(4) Operation is relatively quiet.

Some systems can provide a sinusoidal output waveform with low distortion. [3]

In addition, if the inverter is the PWM type, the high-frequency circuitry may produce electromagnetic interference (EMI). This may require special filtering and shielding to protect sensitive equipment from radiated and conducted interference. The double-conversion UPS may also produce excessive battery ripple current, possibly resulting in reduced battery life.

II. Power Factor Corrected Rectifier

Most electronic equipments works on 50 Hz frequency. Usually power converters use a diode rectifier followed by a bulk capacitor to reduce ripple voltage. It produces pulsating current resulting reducing power quality of the utility grid power. It will adversely affects the users with poor power quality and high harmonic contents.

Active PFC solutions are more suitable options to achieve unity power factor. For this a DC converter with switching frequencies higher than the main line frequency is placed in between the output of the bridge rectifier and the bulk capacitor. The reactive elements of this converter are small because of the converter switching frequency rather than the AC line frequency. The function of this converter is to make the load behave as an ideal resistive load and thus elimination of the generation of linecurrent harmonics. The wave shaping circuit of PFC rectifier is shown in figure 2.

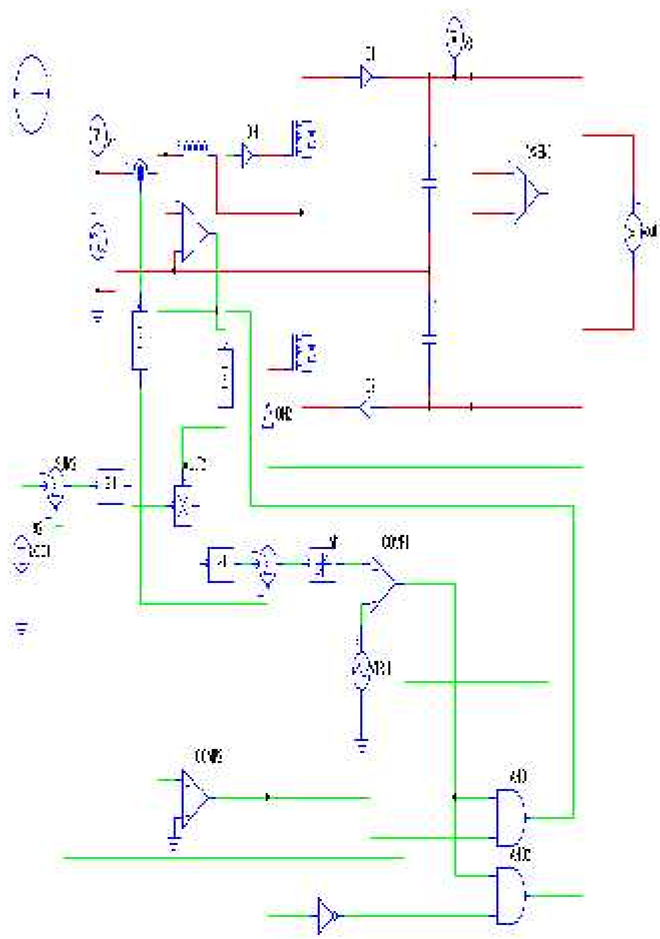

FIGURE 2: Simulation of PFC rectifier using PSIM

Before and After using PFC solution the waveforms of the PFC rectifier will be like as shown below:

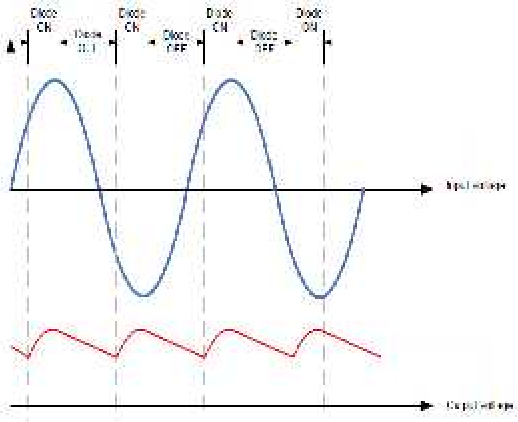

FIGURE 3: Theoretical waveforms of rectifier.

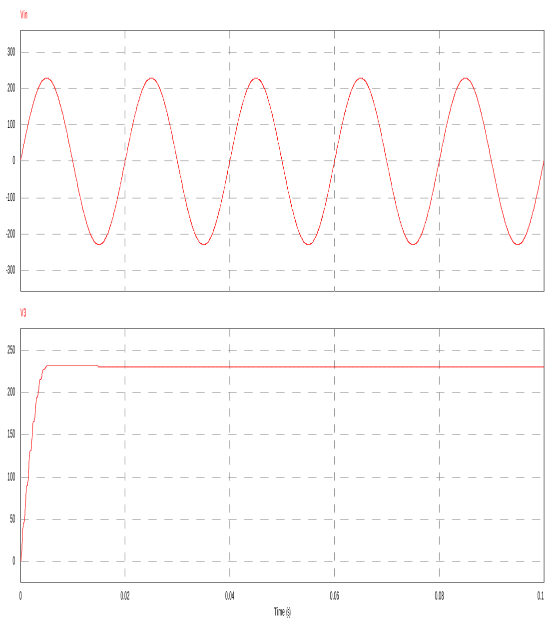

FIGURE 4: Simulation results of PFC rectifier

In all types of UPS the most important thing needed is its battery's long back up time and long life of battery. Due to gasification and sulphation process battery's life may be reduced. Also due to heating of electrolyte battery's life may get reduced. Battery's life can be increased by considering this problem. Battery's life can be increased by less rate charging current. I am going to make a model that will have multiple charging current options. With that whenever we needed emergency of UPS, It will charge earlier and whenever we have enough time to charge we can put it on another mode that will let the battery charge by taking more time on low rate charging current. Model will have two modes High and Low. In high mode it will take less time to charge the battery and on low mode it will take more time for charging on low rate of charging current. It will take more time to charge but will make the battery life longer.[3]

Battery's life is dependent on mainly three factors 1) Charging current, 2) Temperature, 3) Density of electrolyte, 4) Discharge current. We can have temperature probe to know the level of temperature. If the temperature is increased the charging current level should be decreased. It can be possible with advanced technology charger. So that the electrolyte will be less heated and life span of battery can be increased. This is called "Advanced Charging Technology".

Battery's charging current, discharging current, environmental conditions, and temperature of the battery and ambient temperature mainly affects the life of battery. From this we can control charging current and temperature parameters by advanced modern charging technology. During charge mode the battery manager is providing a charge current with a very low level of superimposed AC current **(cc** l%), which is far below the requirements of battery manufacturers.

Sudden changes in demand on power supply and line disturbances are compensated with the DC link capacitor and do not affect the battery. This protects the battery from micro cycles of charging and discharging and therefore extends its lifetime. The charging voltage for the battery is temperature compensated. An overcharge caused by high battery temperature or insufficient charging due to toolow temperature will be avoided. For the protection of the battery, a limit can be placed on the charging current. VLRA batteries typically allow a maximum charge current of:

$I_{max} = C_{10h}/C_{5h}$

In any type of battery we can give maximum charging current of 10% of its rated capacity. By advanced charging technology we can regulate current value to only 1%. With that if ambient temperature increases charging current can be reduced to avoid thermal runway.

III. Design of online UPS employing ACT with external battery charger

To achieve short recharge times for large battery capacities and simultaneously retain the features of the battery manager a new battery charging concept was developed. Design of online UPS with ACT is as shown in figure 5.

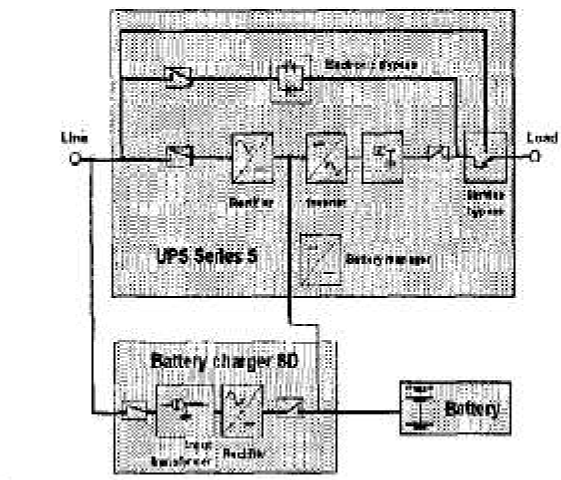

FIGURE 5: Online UPS employing ACT

A transformer provides isolation between AC and DC side of the charger for high flexibility and no interference with the UPS unit. For telecommunication purpose UPS should be charged with less charging time. This UPSs generally provides time between 10 to 45 minutes. We can have two mode of charging in this type of UPSs. We can have two mode of charging in this type of UPS and general UPS.

With the visualization software the battery charger can be monitored and parameterized as **an** integrated componentof the UPS system. The battery charger SD is designed to be used together with ACT UPSs. Design of this type of UPS is same as general UPS including current limiter switch and temperature detector. If we keep battery charging continuously on high charging rate current day by day battery's efficiency may get reduced due to overheating of electrolyte. A graph is shown in figure of Recharging time Vs. BUT in figure 6. Here we can have less time consumption but main disadvantage of high charging current is the battery may be bulged due to overheating. Once the battery is bulged the electrolyte inside the battery initialize to lose its main properties and characteristics. To come out of this problem we can have multiple charging current in the value 1/4, 1/6, 1/8, 1/10 of main current.

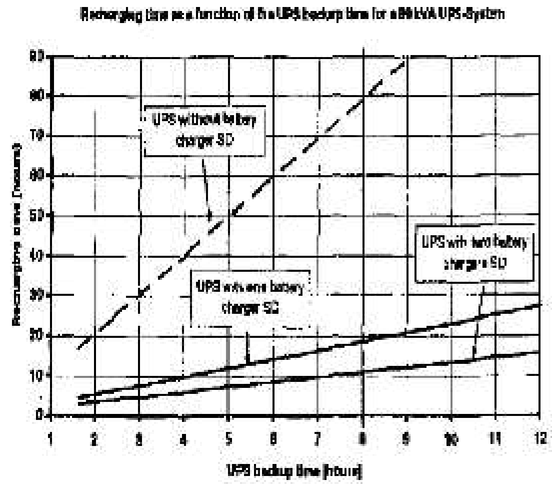

FIGURE 6: Less Recharging time Vs. BUT graph

Conclusion:

From whole the Literature we can conclude that we can make the online UPS more efficient with Half bridge full wave PFC rectifier, H-bridge inverter using SPWM, Multiple current amplitude charging implemented at battery charger section. By that we can increase the life span of battery and increase the efficiency of the battery.

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