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Online Transformer-Less Uninterruptible Power Supply (Ups) System With A Smaller Battery Bank For Low Power Applications

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ABSTRACT

Today there are numerous companies in Iran manufacturing Uninterruptible Power Supplies (UPS). However, in medium and high power range they manufacture online Double conversion transformer based UPSs, with thyristor controlled rectifier. In this paper the power topology, control algorithm and experimental results of the first commercial active front end 30 KVA transformers-less UPS in Iran is presented.

In many critical applications with sensitive loads, it is imperative to use transformer based UPSs. Transformer based UPS is proven technology that improves reliability and provides fault isolation. But today, transformer-less UPS market is growing rapidly. This is due to the benefits such as smaller footprint, higher efficiency and lower cost. Transformer-less UPS is now becoming a mature technology. However, there is no research paper or document describing the power topology and control block diagram of one particular commercial Transformer-less UPS.

INTRODUCTION

Interruption of many manufacturing processes can cause serious loss or damage. Today UPSs are a crucial part of modern industrial systems to prevent interruptions due to power loss or low power quality. In many critical applications with sensitive loads, it is imperative to use transformer based UPSs. Transformer based UPS is proven technology that improves reliability and provides fault isolation. But today, transformer-less UPS market is growing rapidly. This is due to the benefits such as smaller footprint, higher efficiency and lower cost. Transformer-less UPS is now becoming a mature technology.

However, there is no research paper or document describing the power topology and control block diagram of one particular commercial Transformer-less UPS. In this paper the power topology, control algorithm and performance of first commercial 30 KVA Transformer-less UPS prototyped. The control hardware is discussed. In section IV the PWM rectifier topology and hardware are described. Section V discusses the

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bidirectional DC/DC converter followed by DC bus voltage balancing scheme. Final section demonstrates the performance of the UPS.

Uninterruptable power supply (UPS) systems are employed to supply the critical loads with continuous and high quality energy in facilities such as hospitals, data centers, and communication systems etc. There are three primary types of static UPS: on-line, off-line, and line-interactive, which all differ in their ability to perform these critical functions and vary in the degree of security and level of power protection they provide. Line-interactive and off-line UPS systems are limited in their design to smaller applications such as home and small office.

By comparison, on-line UPS systems provide superior electrical performance, reliability, and resilience. Therefore, majority of industrial (factories), infrastructural (hospitals, security centers), financial (banks), etc. systems with several kVA and higher ratings employ on-line UPS systems [1]. A UPS incorporates a rectifier which converts the AC mains voltage to DC voltage and an inverter, which via discrete voltage pulses creates an AC waveform from the DC supply (from the rectifier output) and after an LC filtering stage provides the output to power the connected load. In an on-line UPS, the rectifier and the inverter are designed for continuous operation.

Its inverter operation is unaffected by changes in the voltage or frequency supplied by the mains power. To provide energy source to the constantly running inverter of an on-line UPS, the mains connected rectifier is a very important sub-circuit of the UPS and its performance is essential both to the UPS and to the mains.

With the increased dependence on the critical loads, such as computers, medical support systems and communication systems, more priority will certainly be placed on supplying continuous and disturbance-free power in the future. For these systems where it is impractical for the equipment manufacturer to provide built-in solutions to power-quality problems, the user may find the need for power interface systems. The uninterruptible power supply (UPS) bridges the gap between equipment susceptibilities and power-line disturbances and is designed to provide an alternate source of conditioned, reliable, and seamless electrical power to the equipments. In accordance with the topology or configuration, the UPS can be classified as on-line, off-line and line-interactive types.

The on-line UPS is generally preferred due to the wide tolerance of the input voltage variation, the precise regulation of output voltage and high reliability of the system. A conventional three-phase on-line UPS consists of a rectifier/charger, a battery set, an inverter, a transformer and bypass switches. The rectifier performs power factor correction (PFC) with pulse-width modulation (PWM) strategy and acts as a charger for the battery. On the other hand, the inverter converts the DC-link voltage into the output voltage with PWM strategy. Therefore, the regulated sinusoidal output voltage can be achieved.

The battery which is connected in parallel with the DC-link capacitor is charged when the input voltage is in the normal condition and is discharged when input power loss occurs. However, the conventional UPS has several drawbacks. First, the high-voltage battery set has the problem associated with space, cost, reliability and safety. Secondly, since the transformer is operated at line frequency, the transformer which weighs more than several tens kilograms increases the size, weight and cost of the UPS and makes it difficult to move and install the UPS. Both the neutral points of the input and output are connected at the centre of DC-link capacitors to eliminate a large and heavy transformer. The UPS employ the separate charger/discharger to reduce the voltage of the battery set and the number of batteries.

However, the effort for performance improvement such as increasing the back-up time and alleviating the adverse effect on the output voltage is still necessary. Current regulation is an important issue for power electronic converters, and has particular application for high performance motor drives and boost type pulse width modulated (PWM) rectifiers. Over the last few decades considerable research has been done in this area for voltage source inverters, and from this work three major classes of regulator have evolved, i.e., hysteresis regulators, linear PI regulators, and predictive regulators.

EXISTING SYSTEM:

Uninterruptible Power Supplies (UPS) are widely used to provide reliable and high quality power to critical loads in all grid conditions. This paper proposes a non-isolated online uninterruptible power supply (UPS) system. The proposed system consists of bridgeless PFC boost rectifier, battery charger/discharger, and an inverter. A new battery charger/discharger has been implemented which ensures the bidirectional flow of power between dc-link and battery bank, reducing the battery bank voltage to only 24V, and regulates the dc-link voltage during battery power mode. Operating batteries in parallel improves the battery performance and resolve the problems related to conventional battery banks that arrange batteries in series. A new control method, integrating slide mode and proportional-resonant control, for inverter have been proposed which regulates the output voltage for both linear and non-linear loads. The controller exhibits excellent performance during transients and step changes in load.

PROPOSED SYSTEM

In medium and high power range they manufacture online double conversion transformer based UPSs, with thyristor controlled rectifier. In this paper the power topology, control algorithm and experimental results of the first commercial active front end 30 KVA transformers-less UPS.

CONCLUSION

Power topology, control block diagrams and performance of a commercial active front end transformer-less UPS was presented in this paper. Experimental results verified the performance of the UPS. The input current THD was measured 2.4% with almost unity power factor. The load voltage THD with nonlinear load wad 2.8% with steady state voltage regulation of 0.45%.

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