DESIGN AND IMPLEMENTATION OF BIDIRECTIONAL CONVERTERS WITH CONSTANT AC POWER LOADS

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Abstract— *The bidirectional dc-ac converters are commonly used in UPS applications and battery chargers for electric vehicles (EV). Power conversion units for such applications employ a large electrolytic capacitor at high voltage dc bus, which not only reduces the lifetime but also adds to the weight of the converter. In this a novel bidirectional dual active bridge cascaded three-phase converter (DABCC) with six pulse dc link is proposed. Also, a new closed loop control scheme to implement the Six Pulse Modulation (SPM) technique in dual active bridge cascaded three-phase converter is proposed.*

Keywords— Electric Vehicles, Dual Active Bridge Cascaded Three Phase Converter

1. INTRODUCTION

The dc to three-phase ac interface and vice versa is a common requirement for applications such as uninterrupted power supplies, electric vehicles, grid integrations of renewable energy sources, energy storage systems, and micro grids. In these applications, power converters are preferred to have high efficiency, high power density, high reliability, bi-directional power flow and modularity. Dc-dc converter cascaded with an inverter is an ideal topology. It is now, a worldwide consensus, for the development and integration of Renewable Energy Sources (RES) into the electric power system. The advent of efficient power electronic interfacing converters and their control, has led to further acceptance of RES. The conventional architecture of

Distribution power system has now evolved into Active Distribution Systems and Micro grids. With respect to the grid, the micro grids acts as a controllable unit, comprising of a group of interconnected loads and distributed energy resources, capable of operating in grid-connected and isolated mode. DC micro grids, on the other hand, are a logical result of the fact that most renewable energy sources like produce DC power and can directly be connected to the dc bus serving modern DC loads, thereby increasing the efficiency of operation. The energy storage devices being an integral part of micro grids, also produce DC power. DC micro grids possess simpler control strategy than its ac counter-part and provide more reliable and efficient way of implementing micro grids still several technical challenges associated with DC micro grids.

In a comprehensive study, exploring the ill effects of CPL in DC micro grids, is presented. The authors have investigated and summarized the existing mitigating strategies reported in the literature. On the other hand, control related solutions prove to be a better and more practical solution than the other methods. In an active damping method for a grid connected DC micro grid is proposed. However, the proposed method is limited to the grid-connected case only. A low frequency pole can be observed in the control to output transfer function of the Boost-derived line conditioner, and the closed loop poles could enter in the RHP even with a moderate integrator gain. Hence, proper care must be taken into account while designing feedback compensation for such converters. It is a practical scenario, where the modules/subsystems in a distributed power system such as DC micro grids with cascaded converters are designed based on their own local stability requirements. However, it is a possibility that such subsystems when integrated in the system, may cause system performance degradation or even instability Frequency and phase regulation is more complex in small ac micro grids than in the large traditional ac grid. Increases in the use of renewable distributed generation and improvements in energy-storage technologies make micro grids the best concept for addressing reliability, sustainability, resilience, and energy-efficiency concerns. Because of the dc nature of many renewable sources, energy-storage technologies, and modern loads, integration of resources and loads in a dc bus is attractive in reducing the footprint of the installations, increasing the efficiency, and eventually reducing the cost of the micro grid. To Increase reliability, energy storage systems within a micro grid are essential. Energy is stored while in grid connected mode, when the micro grid’s distributed generation (DG) systems produce excess power, to be used later to supply critical loads during power outages.

In stand-alone mode, they can be used to boost the power supplied by the micro grid if the DG systems cannot meet the expected level of power. To meet these demands, the energy storage system needs to be able to work in grid-connected and stand-alone modes. In the latter mode of operation, the system needs to operate in parallel with other DG systems to meet the variable power demand of the load. To mitigate the above difficulties in this study employ two-layer binary multi objective particle swarm optimization algorithm. The main disadvantage of this algorithm is the runtime cost is high, then to developed TLB-MOPSO algorithm [3] can also find better solution compared to two- stage optimization problem. Therefore, the solution method is effective for solving the above problems and iteration number is low when compared to two stage optimization problem. The definition of preparing on/off schedule of generating units in order to minimize the total production cost of utility and constraints.

2. EXISITING SYSTEM

Three-phase inverters in UPS, electric vehicles and hybrid electric vehicles use intermediate dc link electrolytic capacitor, which has reliability issues and is one prominent cause of inverter failure and limited life. The Large volume of electrolytic capacitor increases size and cost of the system. Recent research on electrolytic capacitor-less inverter using six pulse modulation technique along with high frequency power conversion has attempted to address this issue. However, a closed loop operation and control has not been realized that has some issues due to capacitor less dc link. In this, closed loop operation, design, and implementation of an electrolytic capacitor-less inverter is presented. The unit commitment is defined as the selection process of generators that must be operated to meet the forecasted load demand on the system over a period of time.

3. PROPOSED SYSTEM

Three-phase inverters in UPS, electric vehicles or hybrid electric vehicles use dc link electrolytic capacitor to establish an intermediate dc link, which has reliability issues and is one prominent cause of inverter failure. Large volume of electrolytic capacitor increases size and cost of the system. Recent research on electrolytic capacitor less inverter using six pulse modulation (SPM) technique along with high frequency power conversion has tried to address this issue. The closed loop operation of an electrolytic capacitor less inverter is presented. A tested under different loading conditions to verify the proposed analysis and implemented control system.

4. BLOCK DIAGRAM

Power levels range from very low (small batteries) to very high (high-voltage power transmission). The basic DC-DC converter will take the current and pass it through a "switching element". The block diagram of proposed system is shown in figure 1.

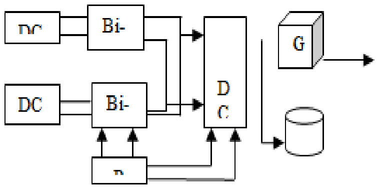


Figure 1: Block Diagram

An electric grid is a network of synchronized power providers and consumers that are connected by transmission and distribution lines and operated by one or more control centres. When most people talk about the power "grid," they're referring to the transmission system for electricity. The continental United States does not have a national grid. Instead, there are three grids: the Eastern Interconnect, the Western Interconnect and the Texas Interconnect. In Alaska and Hawaii, several smaller systems interconnect parts of each state. Increasingly, intelligence is being built into electric grids. Smart grid initiatives seek to improve operations, maintenance and planning by automating operations and ensuring that components of the grid can communicate with each other as required.

5. SYSTEM DISCRIPTION

The power circuit consists of a 100 KW PV array, DC-DC boost converter, five level – three phase voltage source inverter (VSI).Due to the high reverse recovery loss of the diodes at transformer secondary side the switching frequency is relatively low. To alleviate the loss on the diodes, a resonant operating mode with ZCS condition based on the same topology is proposed. Nonetheless, the dc-link capacitor is still large and the lower switch suffers from hard switching of high peak current. The current-fed full-bridge converters are suitable for high power applications .However, start-up circuits are needed since the duty cycle can never be smaller than 0.5. Active clamp circuits are usually adopted to extend the duty cycle range as well as enable ZVS.DC-DC converter that enables using small film capacitors. A dc-link voltage synchronizing control is applied to reduce the high current stress and consequent loss in the converter. For control schemes, two control circuits are working for grid connected PV system. The first control circuit control the DC-DC converter to extract maximum output power from the PV array.

6. DC/AC CONVERTER

The DC to AC converters produce an AC output waveform from a DC source. Applications include speed drives (ASD), uninterruptible power supplies (UPS), Flexible AC transmission systems (FACTS), voltage compensators, and photovoltaic inverters. Topologies for these converters can be separated into two distinct categories: voltage source inverters and current source inverters. Voltage source inverters (VSIs) are named so because the independently controlled output is a voltage waveform. DC to AC power conversion is the result of power switching devices, which are commonly fully controllable semiconductor power switches. The output waveforms are therefore made up of discrete values, producing fast transitions rather than smooth ones.

7. VOLTAGE SOURCE INVERTER CONTROL

In order to manage three phase voltage source inverters (VSI), there are two control approach: current control and voltage control. The voltage controlled VSI use the phase angle connecting the inverter output voltage and the grid voltage to manage the power flow. The current controlled voltage source inverter, the active and reactive components of the current add into the grid are controlled by means of pulse width modulation (PWM) techniques. The current controller of three phases VSI acting an necessary part in controlling grid connected inverters.

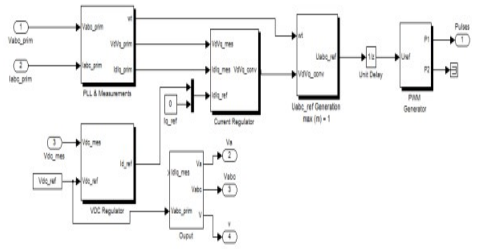


FIGURE 4: VSC MAIN CONTROLLER

8. SIMULATION DIAGRAM

In this model the PV panel is connected with grid system. Due to the irradiation problems a sufficient power will not obtained.

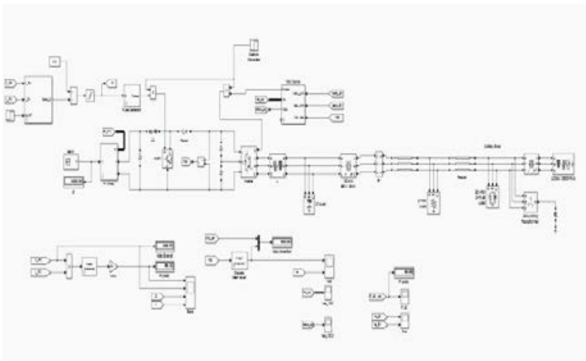
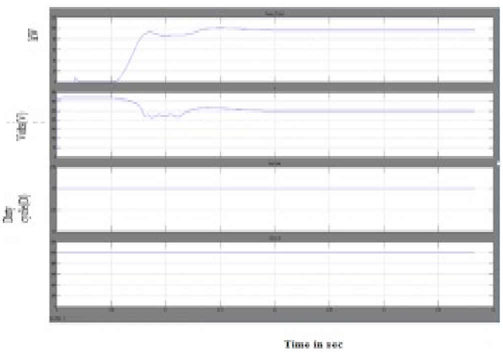


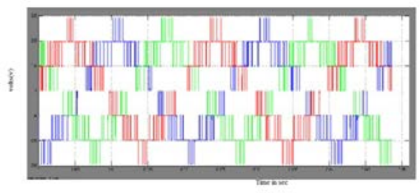
Figure 5. Simulation Diagram

Implementation Of Hysteresis Algorithm Is Required To Overcome This Problem. The Gate Pulse Has Been Generated By Connecting A Voltage Source Inverter With The System. The Pv System, Designed In This Work, Aims To Transfer Electrical Power From Pv Module To The Grid.

9. SIMULATION RESULTS



Voltage source inverters have practical uses in both single-phase and three-phase applications. Single-phase VSIs utilize half-bridge and full-bridge configurations, and are widely used for power supplies, single-phase UPSs, and elaborate high-power topologies when used in multi cell configurations. Three-phase VSIs are used in applications that require sinusoidal voltage waveforms, such as ASDs, UPSs, and some types of FACTS devices such as.



10. CONCLUSION

A closed loop control scheme to effectively implement Six Pulse Modulation (SPM) on a bidirectional cascaded converter connected to ac grid is presented. The design and implementation of a high bandwidth link controller that is required to satisfactorily implement the Six Pulse Modulation (SPM) modulation are given. After analyzing the errors introduced in the pole voltages of an Six Pulse Modulation (SPM) modulated dual active bridge cascaded three-phase converter due to inverter dead time, predominant fifth and seventh harmonic components are noted, and a sixth harmonic resonant controller in the synchronous frame is designed to mitigate them. It is observed that the current stress of the dc link capacitor, for a properly designed Six Pulse Modulation (SPM) modulated inverter, is lower than that of a sine PWM modulated converter. The effectiveness of the proposed Six Pulse Modulation (SPM) modulated closed loop controlled dual active bridge cascaded three-phase converter is validated with an experimental prototype and the experimental results confirmed the effectiveness of the proposed approach.

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