A ZVS Grid-Connected Full-Bridge Inverter with a Novel ZVS SPWM Scheme

Introduction:

The full-bridge inverter is widely used in residential PV generation systems and uninterrupted power supply systems. To reduce the filter size, the inverter is expected to operate with higher frequency whereas the switching frequency is usually limited by switching loss of the power devices. Power MOSFET and IGBT are mostly used in these applications. The switching frequency of MOSFET in full-bridge topology is mainly limited by the inferior dynamic performance of the body-diode. The high $di/dt$ and $dv/dt$ during the reverse recovery process may also damage the device. IGBT with fast anti-parallel diode is used more often than MOSFET in the hard switching full-bridge inverter. However, IGBT’s switching is relatively slower. For these reasons, the switching frequency of hard-switching full-bridge inverter is usually restricted below 20 kHz, which leads to larger filters and lower power Density.

Existing system:

Sine-wave voltage inverter topology, which is made up of a high frequency circuit, a coupled circuit, a bridge circuit, a stand-alone circuit and a grid-connected circuit. The high frequency circuit consists of a switch $M_T$ and diodes ($C_D, E_D$). The switch $M_T$ is conducted the current $I_N i$ from input side to the coupled circuit at a high frequency control, and its across voltage is clamped by the diodes ($C_D, E_D$). The coupled circuit includes a diode $f_D$ and a coupled-inductor $r_1 T$, in which the symbols $d L$ and $f L$ denote the
primary and secondary magnetizing inductance of the coupled-inductor. The additional object of this inductor $dL$ can be used to limit the charge current, and the ascendant rate of the inductor current is proportional to its across voltage. The coupled windings together act as a switch similar to a magnetic switch, such that the secondary-side inductor current $Lf$ is conducted when the switch $(MT)$ is turned off. Moreover, the bridge circuit is composed of diagonally opposite switches $(a+T,b−T)$ and $(b+T,a−T)$ from two leg, inverting the charge current $(Ld)$ to ac side at a 60Hz below 50% duty signal trigger. The stand-alone circuit is made up of a filter capacitor $OC$ and a resonant inductor $OL$. The output voltage $OV$ parallel connected to the filter capacitor $OC$ is served the electric equipment with a smooth sinusoidal wave form such as UPS when the utility power lines are failing. Significantly, the addition resonant inductor $OL$ changes the filter capacitor voltage $OV$ in the zero-across voltage region by a resonant fashion to avoid the short circuit problem from the capacitor through the inverter switches or their body diodes. The function of grid-connected circuit is to transfer the PV energy to the utility power via the inductor $UL$. 
Drawbacks:
- Undesirable sub-harmonics.
- Voltage stress of the inverters is higher than the dc bus voltage.
- High $di/dt$ and $dv/dt$ during the reverse recovery process may also damage the device.

Proposed system:
The dc side ZVS full bridge inverters have the simplest structure. With this principal advantage, this paper mainly focuses on improving the efficiency and power density of dc side ZVS full-bridge inverter. The ZVS full-bridge inverter is based on the topology proposed. High circulation loss is found with existing modulation scheme. In order to optimize the efficiency, a novel ZVS SPWM scheme is proposed. For the purpose of realizing the ZVS condition, an adjustable short-circuit stage controlled by the short-circuit pulse in every switching cycle is designed to reset the energy in the auxiliary resonant branch. The duration of the short-circuit stage varies according to the different load condition for optimizing the efficiency in both light and heavy load cases. The ZVS condition will be analyzed and the design procedure for the ZVS SPWM will be presented in this paper. MOSFETs are utilized and zero-voltage switching for both main and auxiliary switches is realized. The filter is reduced with higher switching frequency.
Advantages:
- High reverse recovery energy.
- Power quality improvement.
- Optimizing the efficiency in both light and heavy load cases.

Applications:
- Residential PV generation systems.
- Uninterrupted power supply systems.
Block diagram:

- **Input DC Supply**
- **Auxiliary Resonant Switching Circuit**
- **Full Bridge Inverter**
- **Load**

- **12V DC**
  - **Isolation Circuit**
  - **Driver Circuit**

- **5V DC**
  - **Buffer Circuit**
  - **Micro Controller Circuit**