FLYBACK CONVERTER FED CURRENT SOURCE INVERTER USING PHOTO VOLTAIC

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Abstract: ***This paper proposes a circuit topology of a single-stage three-phase current-source photovoltaic (PV) grid-connected inverter with high voltage transmission ratio (VTR). Also, an improved zone sinusoidal pulsewidth modulation (SPWM) control strategy and an active-clamped subcircuit that can suppress the energy storage switch's turn-off voltage spike are introduced. The circuit topology, control strategy, steady principle characteristics, and high-frequency switching process are analyzed profoundly, as well as the VTR's expression and design criterion of the center-tapped energy storage inductor. The improved zone SPWM control strategy consists of two control loops, namely, the outer loop of input dc voltage of PV cells with the maximum power point tracking and the inner loop of the energy storage inductor current. The experimental results of a 3-kW 96VDC/380V50Hz3φAC prototype have shown that this kind of a three-phase inverter has the excellent performances such as single-stage power conversion, high VTR and power density, and high conversion efficiency. Nonetheless, it has small energy storage inductor and output CL filter, low output current total harmonic distortion, and flexible voltage configuration of the PV cells. This study provides an effective design method for single-stage three-phase inverting with high VTR.***

INTRODUCTION:

SOLAR photovoltaic (PV) electricity generation is not available and sometimes less available depending on the time of the day and the weather conditions. Solar PV electricity output is also highly sensitive to shading. When even a small portion of a cell, module, or array is shaded, while the remainder is in sunlight, the output falls dramatically. Therefore, solar PV electricity output significantly varies. From an energy source standpoint, a stable energy source and an energy source that can be dispatched at the request are desired.

Different scenarios for PV generation and load supply sequence.

As a result, energy storage such as batteries and fuel cells for solar PV systems has drawn significant attention and the demand of energy storage for solar PV systems has been dramatically increased, since, with energy storage, a solar PV system becomes a stable energy source and it can be dispatched at the request, which results in improving the performance and the value of solar PV systems . There are different options for integrating energy storage into a utility-scale solar PV system. Specifically, energy storage can be integrated into the either ac or dc side of the solar PV power conversion systems which may consist of multiple conversion stages.

Fig. 1 shows different scenarios for the PV generated power time of use. In case (a), the PV energy is always delivered to the grid and there is basically no need of energy storage. However, for cases (b) and (c), the PV energy should be first stored in the battery and then the battery or both battery and PV supply the load. In cases (b) and (c), integration of the battery has the highest value and the RSC provides significant benefit over other integration options when there is the time gap between generation and consumption of power.

A **solar inverter**, or **PV inverter**, converts the variable directcurrent (DC) output of a photovoltaic (PV) solar panel into a utility frequency alternating current (AC) that can be fed into a commercial electrical grid or used by a local, off-grid electrical network. It is a critical component in a photovoltaic system, allowing the use of ordinary commercial appliances. Solar inverters have special functions adapted for use with photovoltaic arrays, includingmaximum powerpoint tracking and anti-islanding protection.

Solar inverters may be classified into three broad types:

Stand-alone inverters, used in isolated systems where the inverter draws its DC energy from batteries charged by photovoltaic arrays. Many stand-alone inverters also incorporate integral battery chargers to replenish the battery from an AC source, when available. Normally these do not interface in any way with the utility grid, and as such, are not required to have anti-islanding protection.

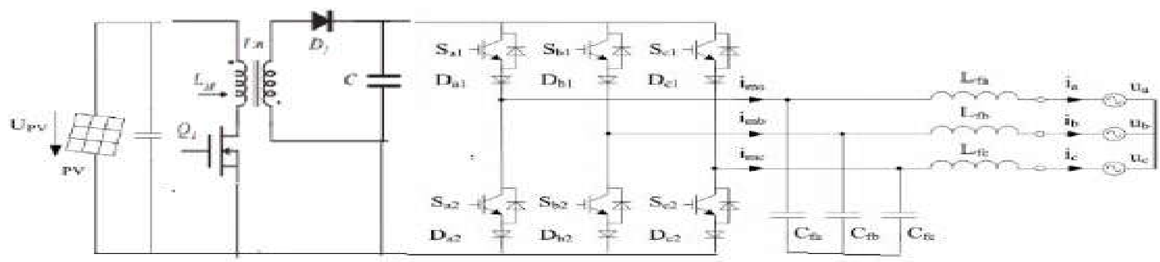
Grid-tie inverters, which match phase with a utility-supplied sine wave. Grid-tie inverters are designed to shut down automatically upon loss of utility supply, for safety reasons. They do not provide backup power during utility outages.

Battery backup inverters, are special inverters which are designed to draw energy from a battery, manage the battery charge via an onboard charger, and export excess energy to the utility grid. These inverters are capable of supplying AC energy to selected loads during a utility outage, and are required to have anti-islanding protection.

MAXIMUM POWER POINT TRACKING :

Solar inverters use *maximum power point tracking* (MPPT) to get the maximum possible power from the PV array.[2] Solar cells have a complex relationship between solar irradiation, temperature and total resistance that produces a non-linear output efficiency known as the *I-V curve*. It is the purpose of the MPPT system to sample the output of the cells and determine a resistance (load) to obtain maximum power for any given environmental conditions. The fill factor, more commonly known by its abbreviation *FF*, is a parameter which, in conjunction with the open circuit voltage and short circuit current of the panel, determines the maximum power from a solar cell

Modified circuit



CONTROL STRATEGY

The circuit topology of single-stage three-phase current-source PV grid-connected inverter with high VTR is shown in Fig. 1. The circuit topology is sequentially cascaded by the input filter capacitor C, the center-tapped energy storage inductor L, three-phase inverting bridge with six serial blocking diodes and an output CL filter. An energy storage switch S is connected between the center tap of L and the negative end of the PV cells, the left and right turns number of L are N_1 and N_2, respectively. Compared to CSI with low VTR [12]-[17], a center tap of the energy storage inductor and an energy storage switch are added to proposed CSI.

An active-clamped subcircuit connected in parallel at both ends of S shown in Fig. 1 is proposed, in order to suppress the turn-off voltage spike of S which is caused by the leakage inductor of L_1. The active-clamped subcircuit is consisted of active-clamped switch S_c and a serial clamping capacitor C_c.

The VTR of the proposed CSI depends on both the energy storage duty ratio and the center tap position of L, and it provides a possibility to realize high VTR inverting.

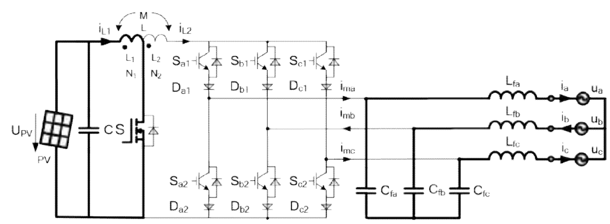
TWO-LOOP IMPROVED ZONE SPWM CONTROL STRATEGY

1) Improved zone SPWM control strategy

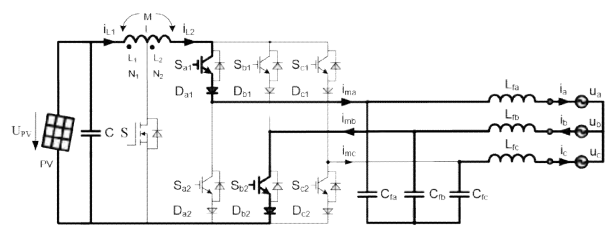
An improved zone SPWM control strategy is proposed in the single-stage three-phase current-source PV grid-connected inverter with high VTR. The reference signal which has the same frequency but different in phase of θ with the grid voltage is divided into six 60° intervals in a line cycle by the zero crossing point, thus there exist only two line voltages that is always ≥ $\sqrt{6}/2U_p$ in every 60° interval, where U_p is RMS value of the phase voltage. This control strategy can ensure the normal operation of CSI in any high frequency (HF) switching period with the condition that output line voltage are not smaller than input voltage i.e. $\sqrt{6}/2U_p \geq U_{PV}$, and obtain high quality of output grid-connected current.

PROPOSED SYSTEM

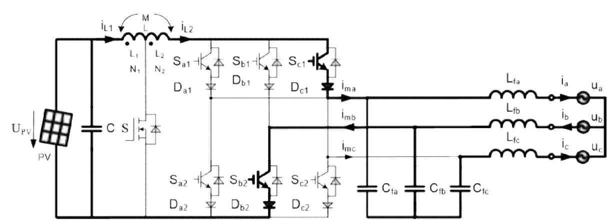
MODES OF OPERAION:



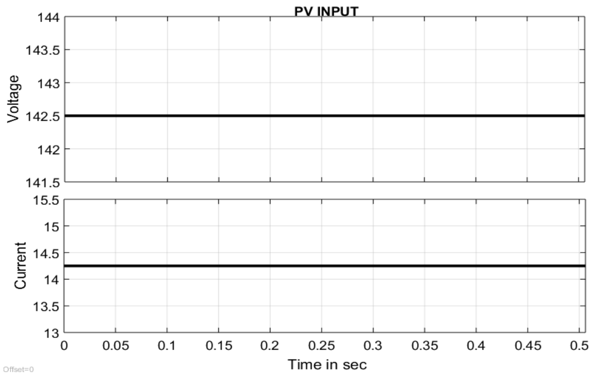
(a) S ON, S_{a1}, S_{c1} OFF



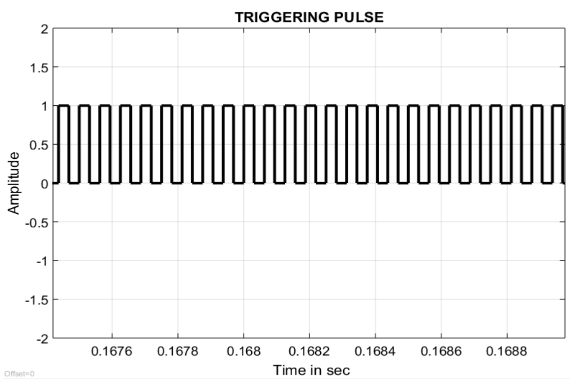
(b) S_{a1} ON, S and S_{c1} OFF



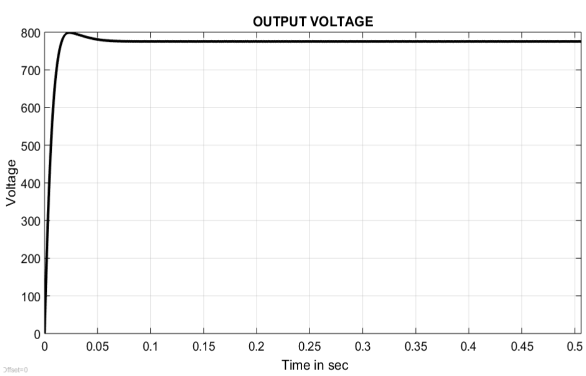
SIMULATION RESULTS:



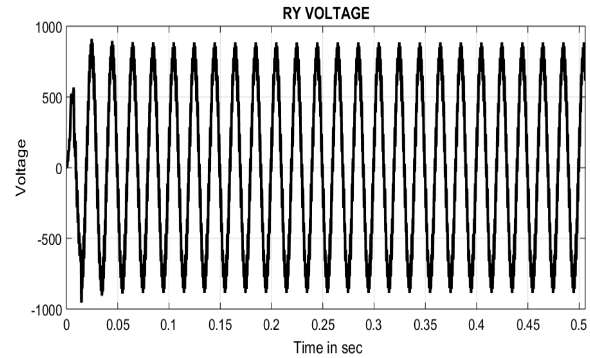
The above waveform shows the input voltage and current



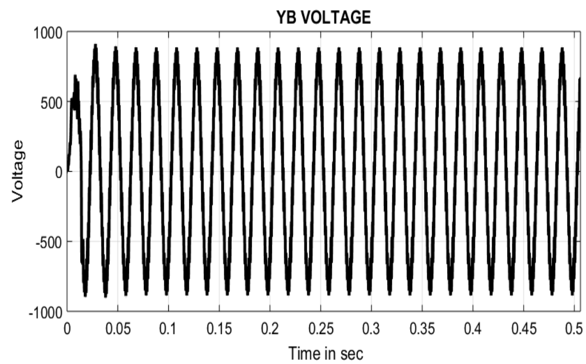
The above waveform shows the triggering pulse



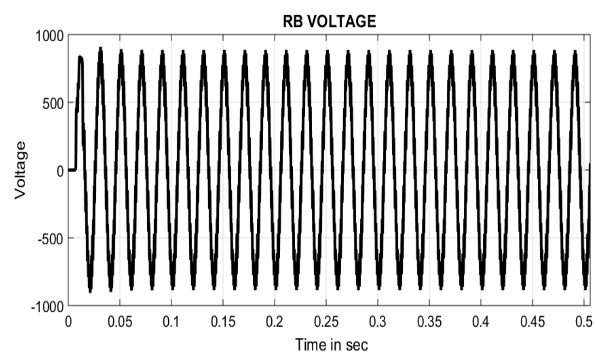
The above waveform shows the output voltage



The above waveform shows the voltage of RY phase

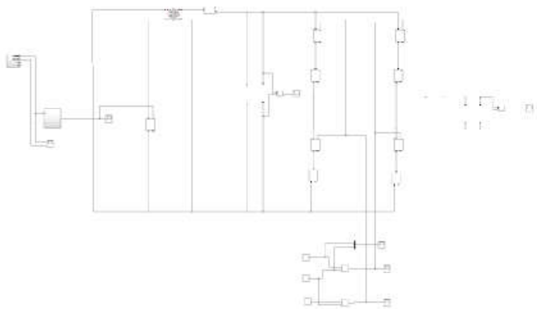


The above waveform shows the voltage of YB phase

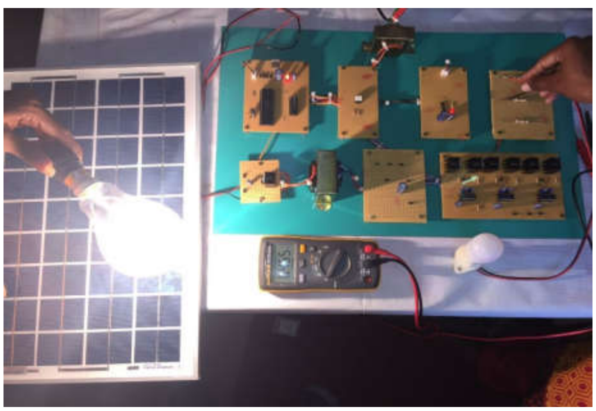


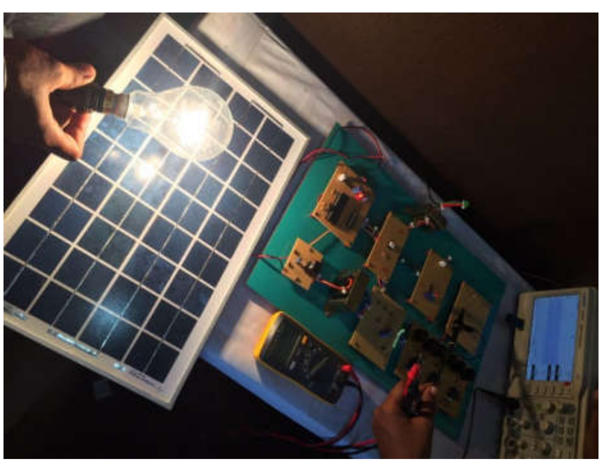
The above waveform shows the voltage of RB phase

SIMULATION BLOCK DIAGRAM:



HARDWARE DESIGN:





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