Design of Push-Pull Converter for High Efficiency Photovoltaic Conversion

Bharat Sheladia
L&T Technology Services

Abstract— This paper design to represents Push-Pull Converter for High Efficiency Photovoltaic Conversion .The energy conversion systems specially dedicated for the conversion of electrical power from solar generators into a grid are evaluate. Lot of systems are basically developed on boosters or inverters counting electronic switches such as MOS or bipolar transistors. The limits of efficiency are speedily reached when high output voltages and high input currents are needed. Behind presentation of some usual classical systems, pointing out their compensation and drawbacks, we propose an original system based on a standard push-pull converter connected through a dynamic modulation control and PID Controller. The main advantage of this combination is the prospect to control the delivered electric power in a wide range between very low to high levels inside the same basic structural design.

Key words: Photovoltaic, Converters, Diode, MOSFET, Wind Transformer, Solar, Power, Push-Pull, Boost, Inverter

I. Introduction

The field of power electronics encompasses the control and conversion of electrical power by means of solid-state electronics. While power may range from mill watts to megawatts, the building blocks of power electronic systems remains surprisingly unchanged. Solid-state switches control the f schemes. Integrated circuits and discrete components operate in conjunction with the power switches, as long as the necessary signal conditioning, gate drive, and analog operations intrinsic to implementing power systems. In additional complicated systems, microprocessors and signal low of electrical energy from input to output through a variety of switching processing integrated circuits coordinate and network circuit operations. The fusion of digital systems with high power electronics yields dynamic and intelligent systems that transparently adapt switching characteristics to meet demanding requirements. As tomorrow’s technological needs necessitate increased efficiency and power density within electrical systems, power electronics continues to develop into tangential engineering fields. Power electronics engineering involves the study and implementation of analog and digital circuits, electronic devices, control and power systems, magnetic, electric machines, and complex mathematical simulation tools. The combined Advancements from every of these fields allow Engineers to design systems with higher efficiency, increased power density, ruggedness of operation, and minimal electrical noise. N implementing a combination of renewable energy and power electronic device, there are few options to be considered in command to produce a properly operating solar inverter system. To satisfy there requirements for the consumers, the implementation of this system must deals with certain aspects of application. The system developed can be simple or complicated depend on the availability of electronic components, the output power desired from solar photovoltaic (PV) module and inverter, and the presentation of the battery itself. A good working system indeed may produce a better performance which can be classified as a perfect system. Several of inverter topologies are studied throughout these years. The method of adding a chopper to conventional inverter topology is approached [2]. not together from that, method using only two power switches to the topology and manipulating suitable switching signal in achieving alternating current (AC) outputs [4]. Most recent come up to is combinational of both push-pull and H-bridge topologies also being proposed [11].. The move towards used is compatible with the current situation of instability of oil and coal prices with global warming phenomenon around the world [2]. This might affect the cost of generating electricity for the consumption in daily life. In fact, this project may turn into a new solution to overcome the problems that related to the increasing charges for electricity operation due to the home appliances usage. in addition, this inverter concept also can be used in industrial applications such as variable speed drives for single-phase and three-phase AC motors, supply or emergency power supplies, induction heater and AC appliances run from an automobile battery [12]. Push-Pull Converter

II. Basic converter operation

The principle configuration of the pulse width modulated push-pull converter is shown in Figure 1-1. The push-pull converter belongs to the family of isolated converters. Galvanic isolation of the secondary is provided by the high frequency transformer. Note that the transformer turns ratio can be optimized for a given application (step-up or step-down). The two power switches operate 180° out of phase—applying rectangular input voltage pulses across the primary windings. Due to the primary winding direction, both switches cannot be turned on instantaneously. An overlap of switch on-time would

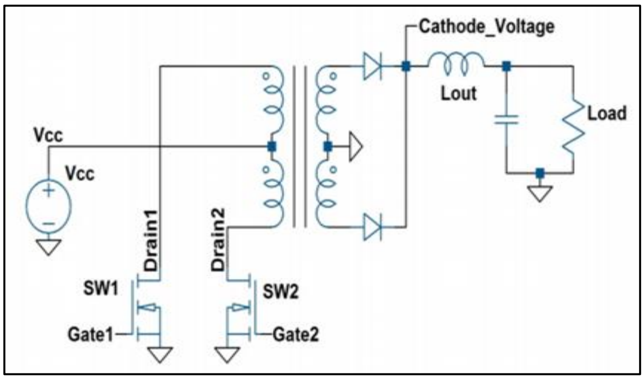

Fig. 1: Push-Pull Converter

Generate opposing flux in the core, cancelling the primary mutual inductance. Assuming a low-impedance source, the switch current would be limited only by the transformer leakage inductance (a parameter most often minimized in push-pull transformer design). As such, the switches would quickly fail under the high switching currents. Switching Characteristics the switch on-time must be limited to less than 50% of the switching period. Therefore, the three possible switching signals are: 1. SW1 is ON, SW2 is OFF 2. SW1 is OFF, SW2 is ON 3. SW1 is OFF, SW2 is OFF

A. Proposed Converter Topology

The proposed converter in Figure 2 utilizes a Buck topology input to regulate the current into the zero-voltage switching boundary-mode parallel resonant push-pull stage. The high-frequency push-pull transformer incorporated into the parallel-resonant tank circuit (L-Res, C_Res) steps the input voltage up and provides isolation to the secondary side of the converter.

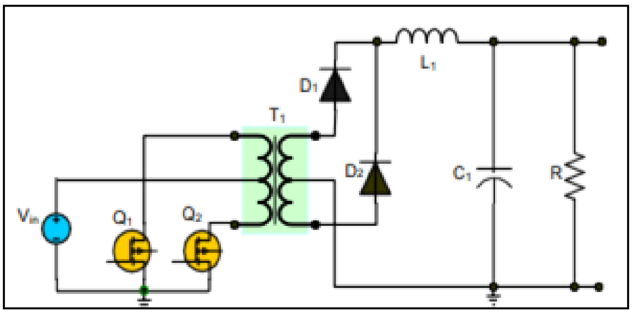

Fig. 2: Proposed DC/DC Push-pull converter

III. PUSH-PULL CONVERTERS

The Figure 1 represents the electronic scheme of the proposed boost voltage converter using the push pull structure. The operation of push-pull converter: When Q1 switches ON, current flows through the upper half of the T1 transformer primary and the magnetic field in T1 expands. The expanding magnetic field in T1 induces a voltage across the T1 secondary; the polarity is such that D2 is forward biased and D1 is reverse-biased. D2 conducts and charges the output capacitor C1 via L1. L1 and C1 form an LC filter network. When Q1 turns OFF, the magnetic field in T1 collapses and after a period of dead time (dependent on the duty cycle of the PWM drive signal), Q2 conducts, current flows through the lower half of T1's primary, and the magnetic field in T1expands. At this point, the direction of the magnetic flux is opposite to that produced when Q1 conducted. The expanding magnetic field induces a voltage across the T1 secondary; the polarity is such that D1 is forward- biased and D2 is reverse-biased. D1 conducts and charges the output capacitor C1 via L1. After a period of dead time, Q1 conducts and the cycle repeats. There are two important considerations with the push-pull converter:

- Both transistors must not conduct together, as this would effectively short circuit the supply. This means that the conduction time of each transistor must not exceed half of the total period (D < 0.5) for one complete cycle, otherwise conduction will overlap.
- The magnetic behavior of the circuit must be uniform; otherwise, the transformer may saturate, and this would cause destruction of Q1 and Q2. This behavior requires that the individual conduction times of Q1 and Q2 must be exactly equal and the two halves of the center-tapped transformer primary must be magnetically identical. These criteria must be satisfied by the control and drive circuit.

IV. IMPLEMENTATION WORK

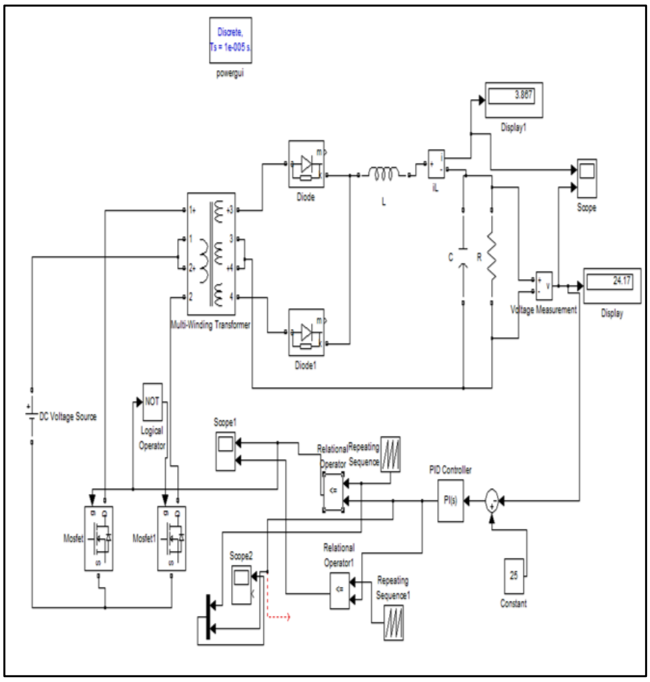

Fig. 3: Implementation System

Additionally, the parallel resonant tank circuit protects the input from an output short circuit condition, allowing the converter to indefinitely sustain an output short. An output resonant voltage multiplier rectifies the secondary voltage 45 and further steps up the output voltage. Traditionally, the inclusion of multiple stages within a converter degrades the overall converter efficiency; however, the high per-stage efficiency minimizes this effect. The converter implements current mode control by sensing the parallel resonant push-pull stage output current rather than the buck input inductor current. With a high voltage gain, inherent short-circuit protection, and high overall efficiency, the proposed topology makes an excellent candidate for an isolated high-voltage converter. Novel Cross-Coupled Gate Drive Architecture Need for High-Performance MOSFET Gate Drive the high switching frequencies encountered in today's DC-DC converters pose a significant challenge to MOSFET gate drive circuitry. In order to minimize switching losses, MOSFET gate voltages are commutated at the fasted possible speeds. Typical MOSFET gate voltage rise and fall times last no more than tens of nanoseconds.11 Due to the inherent capacitance of the MOSFET gate, a high frequency gate drive circuit must be able to rapidly sink and source current out of the MOSFET gate connection. For a specified switching interval (ΔtSW), Simulated Switching Characteristics The offset voltage problems that necessitate the de-coupling circuit during turn-ON actually benefit the switching characteristics during turn-OFF. As the opposite drain voltage falls to zero volts, the cross-coupled diode and the voltage follower force the MOSFET gate voltage to be two diode forward voltage drops above the resonant fall voltage. This prevents the MOSFET from experiencing insufficient gate-source voltage prior to the boundary-mode switching commutation.

V. TEST RESULT AND EXPERIMENTAL WAVEFORMS

A 150W, 34kHz prototype is with the primary/secondary tum ratio of 50 and the MOSFETs are IRF2130 with the conduction resistor of 8moho. In figure 2, the upper is driven pulse, and the bottom is the output voltage of the transformer in a branch. All waveforms are very regular, just as the corresponding normal waveforms in the textboo. The test battery voltage is 4V, and the lowest efficiency is about 75% with the 5A discharging ratio.

VI. SIMULATION OF THE FULL SYSTEM

Figure 6 PID in the system, in turn, is connected to the PID These controllers, variable speed error between the reference and the output signal audited by the push-pull converter is PMDC motor actual speed with PWM method determines the position of the MOSFET switch. Push-pull converter, determines the output voltage of the switch position.

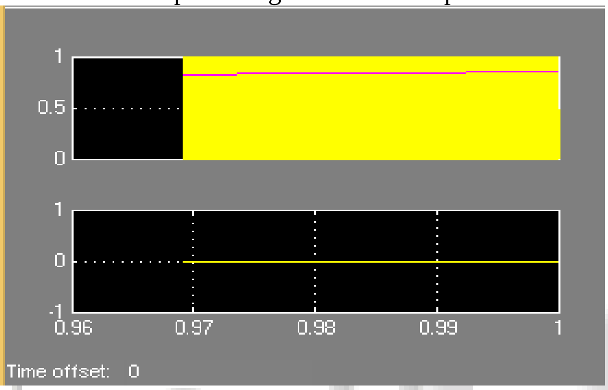

Fig. 4: Variable reference of the PID controller, in response to a push-pull inverter output

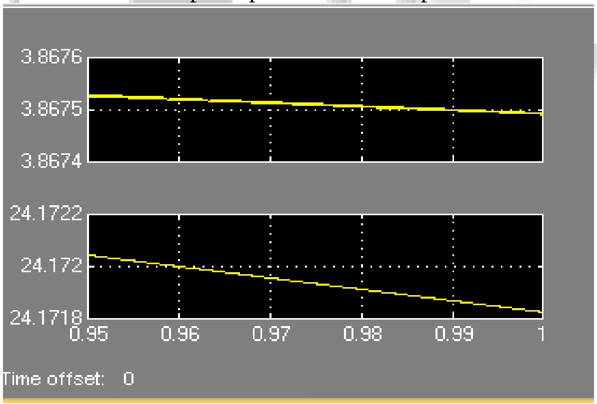

Fig. 5: illustrates the efficiency curves with different discharging currents

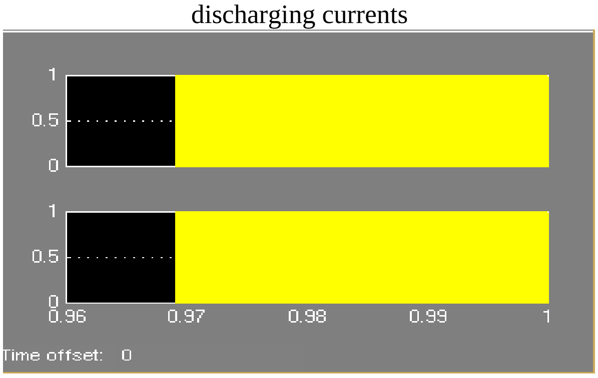

Fig. 6: the upper is driven pulse, and the bottom is the output voltage of the transformer in a branch.

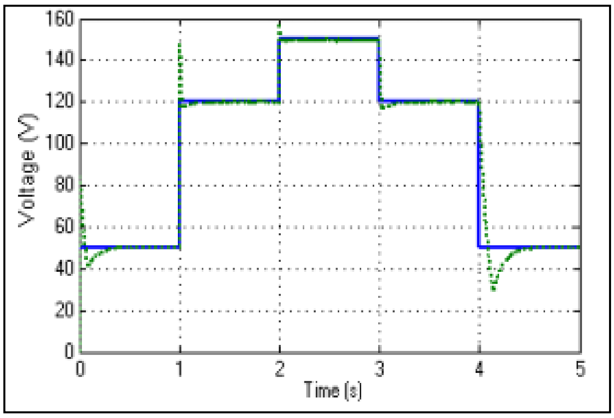

Fig. 7: Push-Pull converter with PID controller References

VII. CONCLUSION

This paper has proposed a novel converter based on a push-pull structural design connected through a winding transformer. This specific architecture provides high competence and high step-up DC-DC conversion with the option of a self-determining impedance adaptation single link to the converter ratio of the transformer. Additionally, Due to its symmetrical operation with two switch elements, this structure allows .the possibility to obtain a high conversion ratio. Finally, the presentation of the implementation of such a converter through the consciousness of a prototype shows the possibility of its integration in distributed photovoltaic generator architectures.

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