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DESIGN AND IMPLEMENTATION OF DC-DC CONVERTER USING H6 BRIDGE

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Abstract:

The High Frequency Inverter is mainly used today in uninterruptible power supply systems, AC motor drives, induction heating and renewable energy source systems. The simplest form of an inverter is the bridge-type, where a power bridge is controlled according to the sinusoidal pulse-width modulation (SPWM) principle and the resulting SPWM wave is filtered to produce the alternating output voltage. In many applications, it is important for an inverter to be lightweight and of a relatively small size. This can be achieved by using a High-Frequency Inverter that involves an isolated DC-DC stage (Voltage Fed Push- Pull/Full Bridge) and the DC-AC section, which provides the AC output. This application report documents the implementation of the Voltage Fed Full Bridge isolated DC-DC converter followed by the Full-Bridge DC-AC converter using TMS320F28069 (C2000™) for High-Frequency Inverters. Since the two added levels are attained by the discharge of the two capacitors of the dc link, the midpoint voltage is balanced and obtained with a specific pulse width modulation (PWM) strategy. This solution is designed for renewable energy systems, where unity power factor operations are generally required. Never the less, a variation of the proposed topology which allows four-quadrant operations.

Keywords: **Bidirectional converters, dc–dc conversion, dual active bridge, efficiency, high-frequency link, isolated converters, Distributed power Generation, DC–AC power conversion, grid-connected converters, Single-phase systems, multilevel converters.**

I. INTRODUCTION

With regard to harmonic distortion content, power factors, and dc components, the output current of grid connected power converters must comply with the requirements of electricity supply companies. Recently, converter topologies employing a high-frequency transformer instead of a line frequency one have been investigated in order to reduce size and weight. The trade-off between high efficiency and low cost is a hard task for these architectures because they require several power stages.

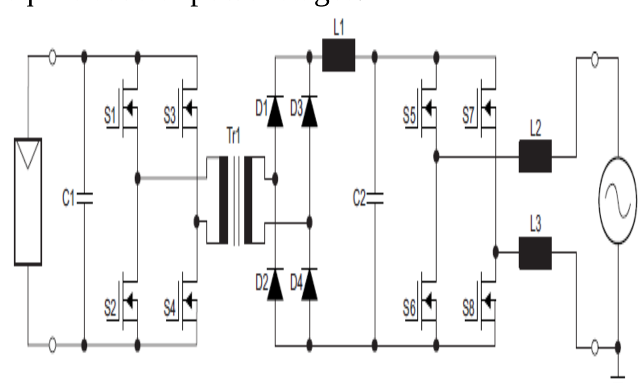

Fig.1 Three - Phase SRF control scheme.

On the other hand, in low-power applications, international standards permit the use of grid connected power converters without any galvanic isolation, thus allowing the so called transformer less architectures. This paper concerns the use of multilevel topologies for single-phase converters, but in order to remain linked to a practical implementation, the unipolar PWM applied to a full bridge topology is taken as reference. It is important to note that, in this paper, the term unipolar

PWM refers to a three-level output voltage, whose first switching harmonic resides at twice the switching frequency. The unipolar PWM is always applied to a full bridge structure.

DC-DC Isolation Stage - High-Frequency Inverter

The selection of the DC-DC isolation stage for the High-Frequency Inverter depends on the KVA requirements of the inverter. The power supply topologies suitable for the High-Frequency Inverter includes push-pull, half-bridge and the full-bridge converter as the core operation occurs in both the quadrants, thereby, increasing the power handling capability to twice of that of the converters operating in single quadrant (forward and fly back converter). The push-pull and half-bridge require two switches while the full-bridge requires four switches. Generally, the power capability increases from push-pull to half bridge to full-bridge.

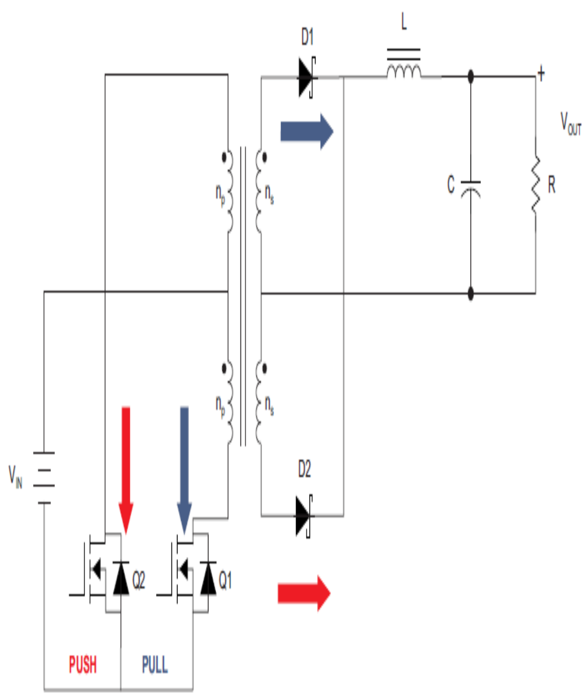

***Fig.2.* Push-Pull Topology**

II. EXISTING METHOD

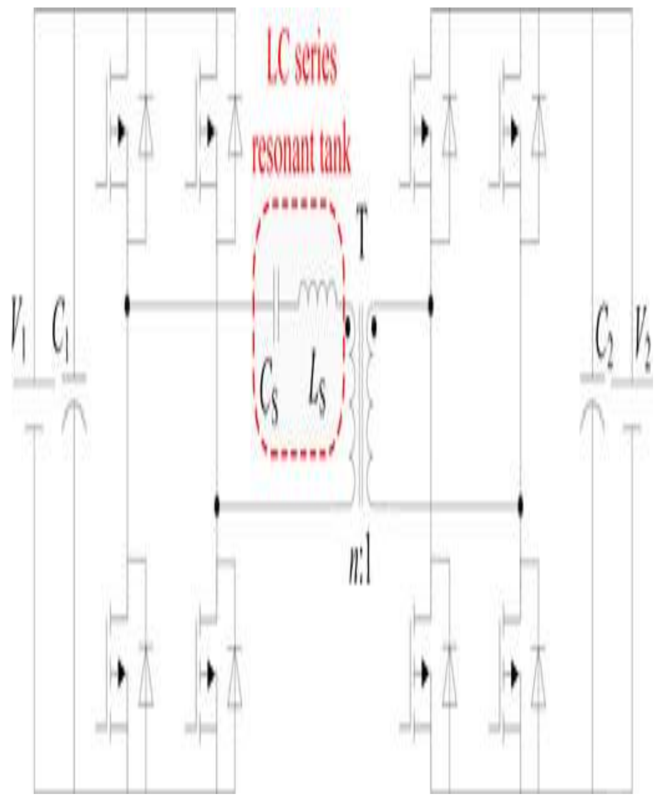

Fig.3 LC-type resonant DAB-IBDC

The TPS control was proposed in as shown in Fig.2. Similar to the DPS control, the cross-connected switch pairs in both full bridges are switched with an inner phase-shift ratio. However, the inner phase-shift ratios may be unequal. TPS control can also control three degrees of freedom. Hence, research on TPS control mainly focuses on the optimization operation field. Literature investigated small signal model for the digital control of DAB -IBDC with TPS control. An optimal modulation scheme that enables minimum conduction and copper losses was presented for DAB-IBDC with TPS control. Based on this, an efficiency-optimized modulation scheme and corresponding design method were developed for an existing DAB-IBDC prototype. A hybrid modulation scheme and a feedback-liberalized control were designed to extend the power range for ultra capacitor application. An optimal modulation strategy for reverse-mode operation of TPS control was analyzed. A stability analysis method to make the stability determination of DAB-IBDC with

TPS control more systematic and precise was discussed. In addition, a comprehensive analysis and experimental verification with pulse width modulation (PWM) control were proposed, and a composite scheme of TPS control was explored that extends the soft-switching range down to zero-load condition, reduces RMS and peak currents, and results in significant size reduction of the transformer.

III. PROPOSED METHOD

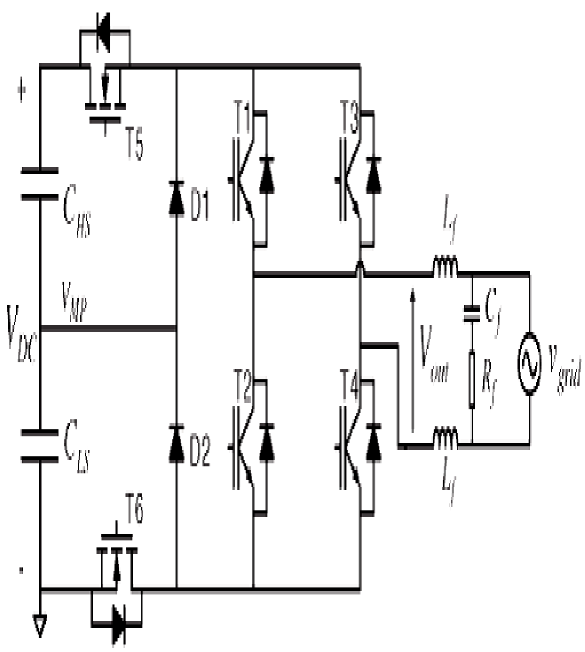

***Fig.4.* Six Level full- H bridge topology proposed**

This converter architecture, known as the H6 Bridge, was originally developed, in combination with a suitable PWM strategy, in order to keep constant the output common-mode voltage in case of a transformer less inverter for photovoltaic applications. With the same purpose, another PWM strategy for the H6 Bridge was developed. In this paper, this converter structure is used to obtain a five-level grid-connected converter for single-phase applications. In steady-state conditions, due to the low voltage drop across the inductance Lf of the output filter, the output voltage of the converter has a fundamental component very close to the grid voltage. The frequencies of these two voltages are identical, whereas the amplitude and their phase displacement are only slightly different. As a consequence, the shape of the modulation index m of the power converter is very similar to the grid voltage waveform.

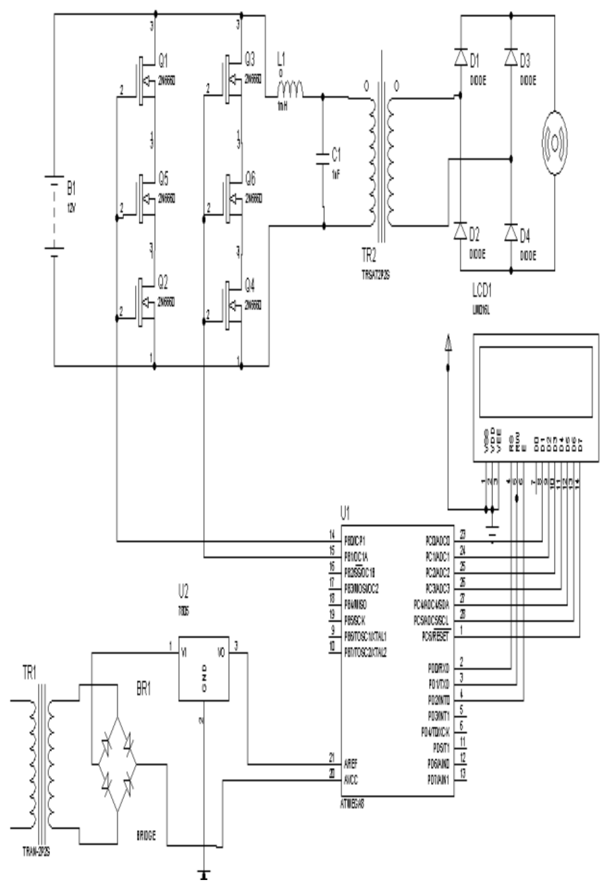

Fig.5. Proposed Inverter

The output voltage of the converter can be written as $Vout = mVdc$ Depending on the modulation index value, the power converter will be driven by dissimilar PWM strategies. As a matter of fact, it is possible to identify four operating zones, and for each zone, the output voltage levels of the power converter will be different, as shown With reference to the schematic, the behaviour of the proposed solution is shown for a whole period of the grid voltage, i.e., of the modulation index. During the positive semi period the transistors T1 and T4 are ON and T2 and T3 are OFF. In Zone 1, T5 is OFF and T6 commutates at the switching frequency, whereas in Zone 2 T5 commutates at the switching frequency and T6 is ON. During the negative semi period the full-bridge changes configuration, with T1 and T4 OFF and T2 and T3 ON. With similarity to Zone 1 and 2, Zone 3 at T5.

IV.WORKING

In Zone 1 the switching of the transistor T6 changes the output value between $+VMP$ [that is provided by the low-side capacitor] and 0 V. It must be noted that only a transistor is switching for every zone.

V.SIMULATION RESULTS

Inverter Output Linearity Range

A simulation design modulation technique as shown in Fig.10 is implemented in MATLAB SIMULINK with the help of pulse generators where the Open loops varied. Using the model grid voltages and currents THD levels are obtained.

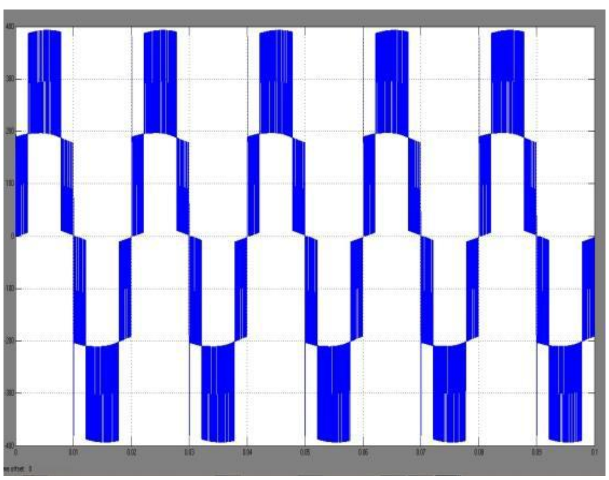

Fig.6. Simulation result

The output voltage of the proposed six - level converter based on a full-bridge converter with two added power switches and two diodes connected to the midpoint of the dc link obtained in the Simulink model is ±400 $volts$peak peak and the output waveforms are showed in Fig. 11

VI. CONCLUSION

This paper has deals with novel Six-level solutions for single-phase grid-connected converters. The converter topologies use to the midpoint voltage of the dc link to provides a two or more output voltage levels, decreasing with a switching power losses and EMI. It has been observed from the simulation results that the overall efficiency of the developed five level inverter is 95% which is more than the conventional DC to AC inverter. Moreover, an effective balancing control was implemented. It is important to note that the five level output voltage is guaranteed only with a unity power factor operations; otherwise, the converter can output only three voltage levels, thus increasing THD and switching loss.

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