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CONTROLLING AND MODELLING OF AN H-BRIDGE DRIVE BY USING SVPWM

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Abstract:- This paper discuss about PV cell energy based space-vector pulse width modulation (SVPWM) control methods applied for an H-bridge inverter feeding a 3-phase permanent magnet synchronous machine (PMSM) in electric-vehicle (EV) applications. EVs require a high degree of availability continuity of service. Advantages using svpwm minimization of switching losses, balancing of switching rate between the three h-bridges, insensitivity to duty cycle, maximization of the drive performance, and reduction of the zero-sequence current ripple. A MATLAB based simulation circuit is designed and verified for the different loads. The proposed circuit reaches up to 92% efficiency. The circuit result performs a satisfactory performance of the topology.

Index Terms: - PV Cells, permanent magnet synchronous machine (PMSM), space vector pulse width modulation (SVPWM), Inverters

1. INTRODUCTION

Thermo mechanical stresses have a significant impact on lifetime power switches. Consequently, there is a degradation of semiconductor devices, which finally forces them into a failed state: short circuit (SC) or open circuit (OC). Such failures occurring on single-power switches can affect the function of power converters and can spread through the traction chain elements. Furthermore, faults may also happen on sensors and can be taken into account by active fault-tolerant control systems. In addition, faults may also occur in the electrical machine and can be considered using fault-tolerant designs, e.g., for a redundant interior-permanent-magnet (IPM) motor structure. The next issue is to investigate whether the innovative control methods can be reconfigured in a switch failure case.

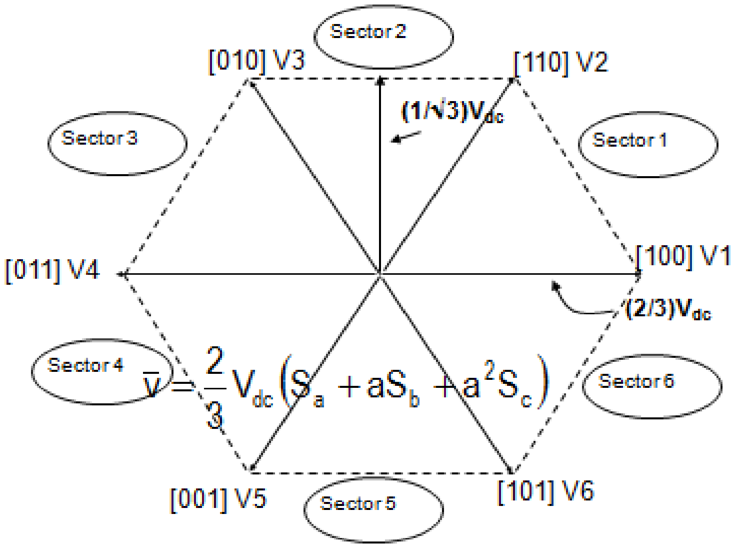

Fig1:- Space vector pulse width modulation

The considered topology uses three bridges instead of the classical use of three half bridges, leading to control strategies that are much more complex but offer new voltage configurations. Therefore, these degrees of freedom are used to design new control methods and will be compared with classical methods in this paper. The next issue is to investigate whether the innovative control methods can be reconfigured in a switch failure case. Both presentations are based on space vector pulse width modulation (SVPWM) technique, which allows the proper analysis of this discrete control problem and to synthesize suitable control strategies.

The rest of this paper is organized as follows: Section II describes the proposed controlling and modelling of an h-bridge drive by using SVPWM converter and operation of the proposed converter. Section III describes the simulation results. Next, Section IV describes conclusion and future scope of the system.

2. Description of circuit and operating principles

A. Description of circuit

Current technology provides “smart” drivers that can provide early detection of a fault occurring in the power switch and can return a feedback fault signal. For instance, a soft turn-off usually handles cross conduction once a fast de saturation detector raises the alarm. The power structure is composed of three H-bridges, each of them supplying a separate PM synchronous machine (PMSM) motor phase. The proposed architecture does not require the fault isolation contactors. The advantage of this architecture is to allow the application of the full dc-link voltage to each PMSM stator winding with this specific architecture, the zero-sequence current is not structurally rejected, unlike the classical solution with a star neutral point topology.

This architecture is fault tolerant and ensures minimum loss control under fault phase conditions. A major advantage of our structure is, in addition to the operation in traction mode, the ability to operate in battery recharge mode with the same hardware, namely, the power converter and the electric machine.

The stator winding terminals are directly connected to one h-bridge. Each h-bridge has four discrete states but can only produce three discrete voltage levels, namely *+vdc, zero, and −vdc.* Together, the three-phase h-bridge inverter provides 27 switching states. To match the PMSM multi machine representation, the output voltage vectors are described in the Concordia reference frame. The stator voltages are divided into four main families according to magnitude and zero-sequence component values.

Minimizing switching losses and ensuring their equal distribution among the three h-bridges. The switching losses are an important part of the semiconductor power losses. Reducing these losses is important to improve the inverter reliability because thermal stress is a key factor of the failure mechanism [19]. For the same reason, ensuring fair switching repartition is crucial.

The SVPWM algorithm blocks generate the required voltages using the technique of switching modulation. SVPWM implementation diagram allowing the determination of the gate signals of the power switches. The three H-bridges are represented by three rectangles. Points inside them depict the number of switches achieved from the beginning of the half period: Red points depict current switches, whereas black points symbolize previous switches. For instance, a single H-bridge needs two switches, i.e., one turn-on switch and one turn-off switch, to switch from the normalized voltage +1 to −1 or vice versa.

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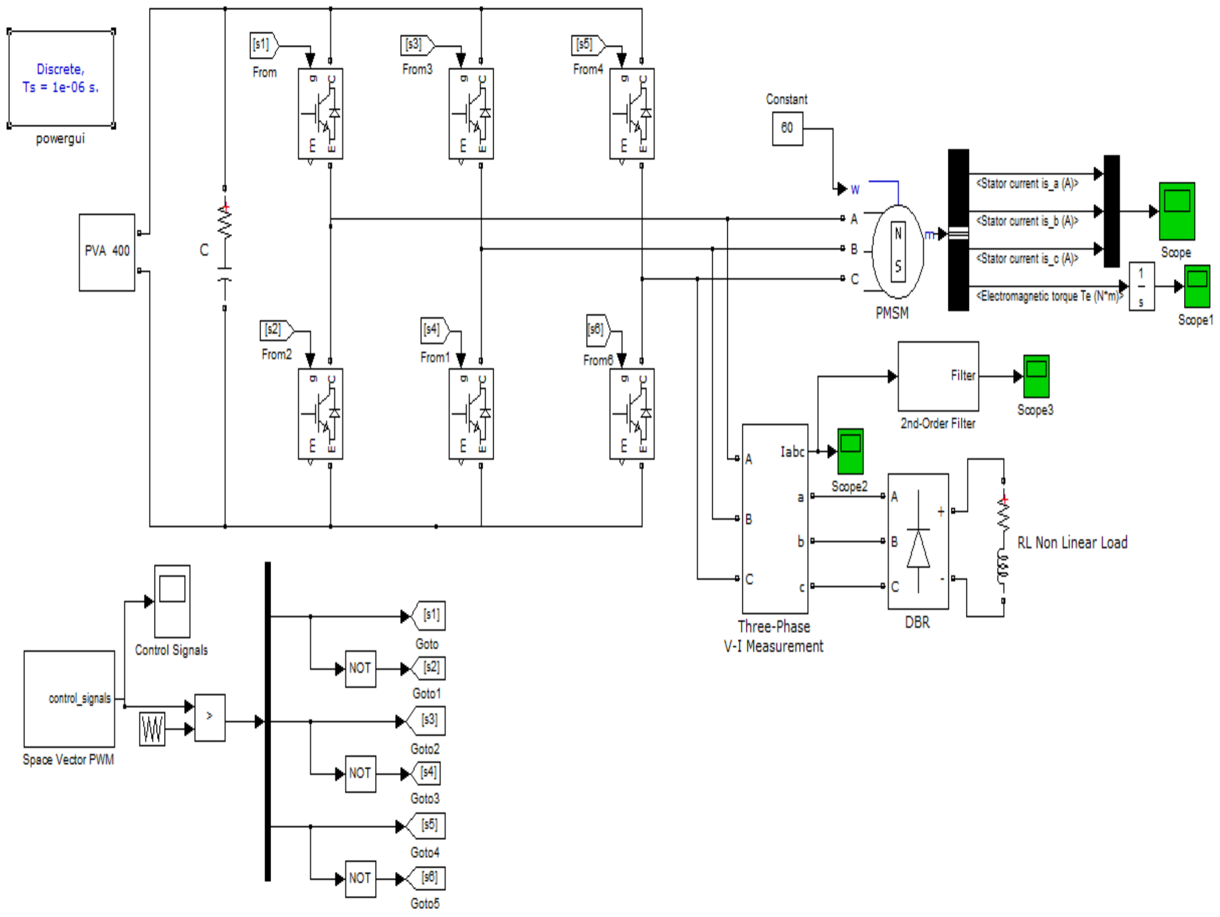

Fig2: - Block diagram

B. Operation of the circuit

The proposed system SVPWM controls technique for a CSI-Bridge drive in electric vehicles. The PV cell voltage is kept constant along the operation. The SVPWM is used trigger the IGBT/Diodes. Large capacitor connected across the PVA panel to Store the input dc. Non-linear load is used to disturb & unbalance the system. The PMSM model does not include a mechanical model. Only steady-state operation at a fixed speed (955 r/min) and with a constant reference torque (60 N-m).

The voltage source inverter converts PV cell voltage i.e., DC to AC during the operation the Switches in any of the three legs of the inverter cannot be switched off simultaneously due to this resulting in the voltages being dependent on the respective line current's polarity. States 7 and 8 produce zero AC line voltages, which result in AC line currents freewheeling through either the upper or the lower components. However, the line voltages for states 1 through 6 produce an AC line voltage consisting of the discrete values of Vi, 0 or –Vi.

For three-phase SPWM, three modulating signals that are 120 degrees out of phase with one another are used in order to produce out of phase load voltages. In order to preserve the PWM

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features with a single carrier signal, the normalized carrier frequency, mf, needs to be a multiple of three. This keeps the magnitude of the phase voltages identical, but out of phase with each other by 120 degrees.

3. SIMULATION RESULTS

A MATLAB based simulation circuit for the controlling and modelling of an h-bridge drive by using SVPWM converter is developed and simulated using MATLAB 2014a version. The proposed circuit parameters & simulation results are listed below.

Table I

Input Voltage	400V
Leakage Inductance	0.265mh
Motor Constant	0.707[V.S/Rad]
Cyclic Inductance	2.652mh
Number Of Pole Pairs	4
Switching Frequency Fs	100KHZ
Rated Power	40KW
Rated RMS Current	66.67A
Phase Resistance R	75mΩ

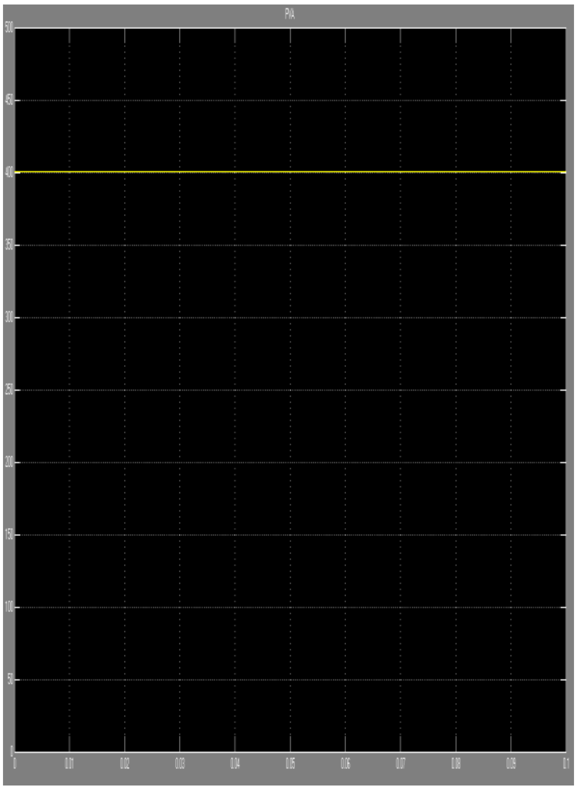

Fig3: - PV Cell voltage

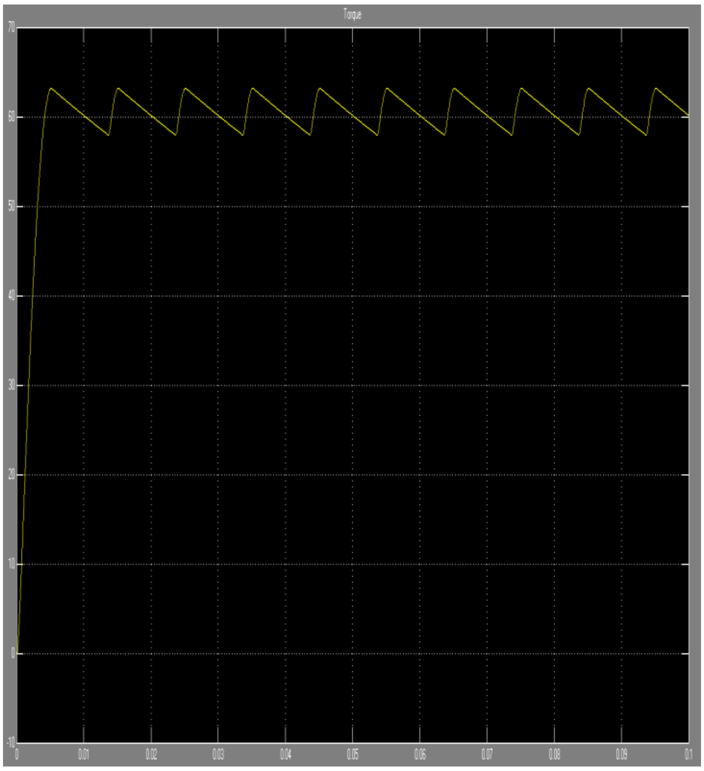

Fig4: - permanent-magnet synchronous machine (PMSM) Torque

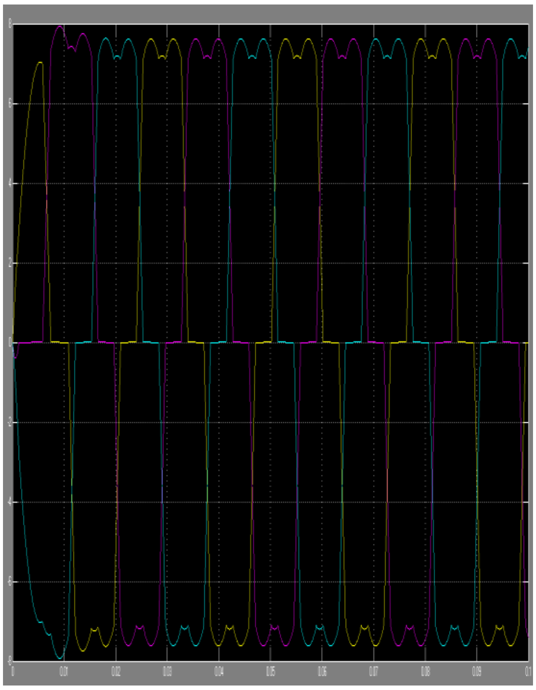

Fig5: - Current wave form before the second order filter

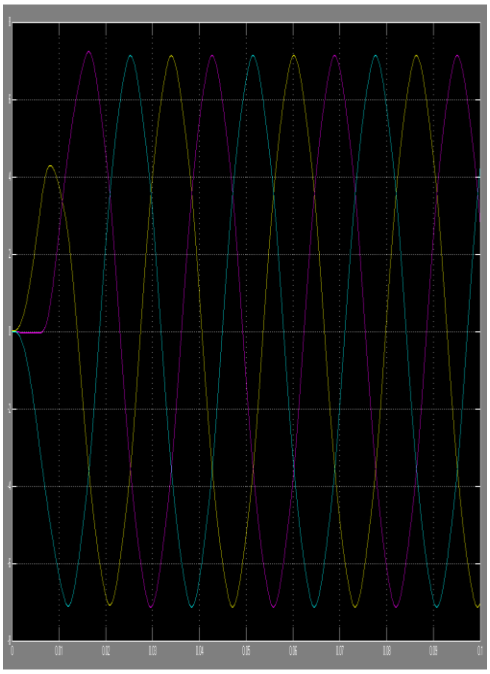

Fig6: - Current wave form after the second order Filter

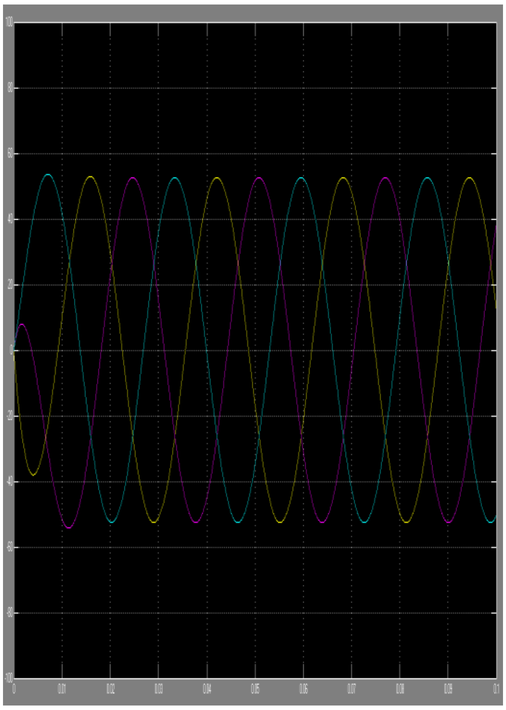

Fig7: - Output Current Waveforms

4. CONCLUSION

This paper has verified H-bridge power converter for a 3-phase PMSM in an EV. Firstly, using a sequence approach, SVPWM control methods have been proposed. Among these, a specific method has combined all the advantages like minimization of switching losses, balancing of switching rate between the three H-bridges, insensitivity to duty cycle, maximization of the drive performance, and reduction of the zero-sequence current ripple. Secondly, power switch failure mode has been fully investigated. The work presented in this paper primarily consider about fault-tolerant control for an EV power train. The proposed circuit is easy to understand and low cost compared to other techniques, which requires many components. The proposed system efficiency is high because it is operated with soft switching technique. By operating with non-linear load is used to determine the PMSM robustness. Power switch failure mode has been fully investigated. Exhaustive analysis of the most common breakdown demonstrates that SC is a critical state regarding the margins left in the control strategy. Future works will be focused on the experimental validation of the SVPWM control methods in normal and degraded operating modes. In contrast with the conventional system, proposed doubly loaded converter improves the overall efficiency.

SVPWM Control technique for an CSI-Bridge Drive in Electric Vehicles is highly promising applications such as High specific power, High efficiency, low total losses, Low THD at the back EMF waveform, Low cogging torque values, Low rotor losses, High thermal endurance, ability to operate in vacuum without intensive cooling.

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