Novel SVM Controlling Technique for Three Phase AC-DC-AC Based SVPWM Matrix Converter

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Abstract* - All grid-tied battery systems require an inverter to interface between ac voltages on the grid and dc voltage from the battery. The inverter acts as a power stream controller. The coveted measure of power used to charge or release the battery is controlled by means of the inverter. An all around controlled VSI gives suppression of low-arrange current harmonics, even under distorted grid voltages. The subsequent line currents ought to be of adequate quality to summon the desired active and reactive powers. Matrix Converters can specifically change over an ac power supply of fixed voltage into an ac voltage of variable abundancy and frequency. Matrix Converter is a solitary stage converter. The grid converters can add to the realization of low volume, sinusoidal input present, bidirectional power stream and lack of massive reactive components. All of the reasons prompt the advancement of Matrix converter. In view of the control strategies utilized as a part of the network converter, the execution differs. So this work investigations the execution of Matrix converter SVPW modulation method. The essential rule and switching succession of these modulation systems are displayed in this work. The yield voltage, yield current waveforms, voltage exchange proportion and THD range of switching waveforms associated with RL load are dissected by utilizing Matlab/Simulink programming. The simulated results are investigated and demonstrate that the THD is better for SVM.

***Keywords* - THD, Matrix Converter, AC-DC-AC.**

I. INTRODUCTION

Due to the fast development of society, the demand for energy is growing more and more prominent. The fossil fuel resource may still afford for consumption in the future centuries, as the shale gas technology matures. However, the requirement of a low Cost of Energy (COE) is becoming more and more urgent, especially considering the by-product of energy utilizaiton like the air pollution or nuclear leak. More renewable and clean energy production in power generation system is thus required.

Meanwhile, power electronics, as the interface between the source and load in the electrical system, enable efficient and flexible conversion of the electrical power by taking advantage of the innovations in active and passive components, circuit topologies, control strategies, control ircuits, and system integrations [3–10]. Therefore, power electronics play a very important role in reducing COE.

An ac-dc-ac power converter is composed of the source and load side converters, the source and load side filters, and dc-link, as shown in Fig. 1.1. Accordingly, the main concerns in the design phase can be categorized into two parts, in terms of the challenges in active and passive components.

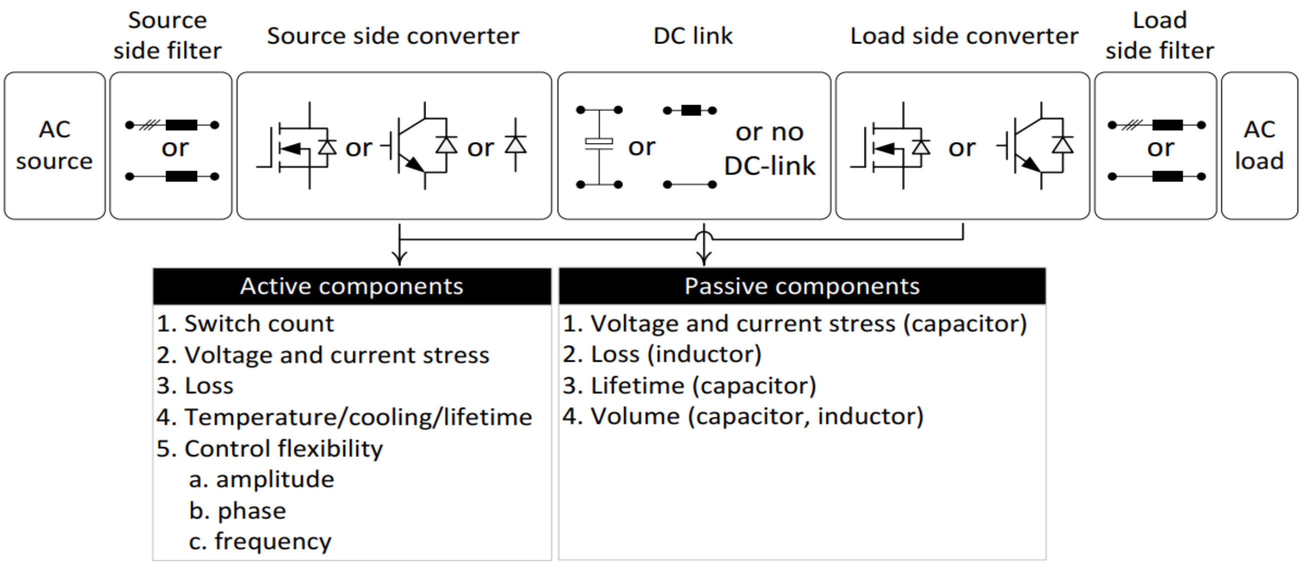

Figure: 1.1 Main concerns in ac-dc-ac power converters.

A. Power Switches

(a) Switch count

The number of switches will influence not only the complexity of the topology but also the number of gate drivers, and thereby the failure possibility, cost, and volume of the gate drivers.

(b) Voltage and current stresses

Voltage and current stresses determine the rating of the power switches and also the circuit topology, where high voltage or current applications may require multi-level or multi-phase topologies. Besides, the voltage and current stresses have impact on the power losses and current ripples of the converter.

(c) Losses

The total power loss will directly affect the efficiency of the power converter, and thereby the cost of energy, as illustrated in (1.1). Moreover, power losses are the main challenge to the cooling system design including the type, complexity, cost and volume of the cooling system.

(d) Temperature

The temperature of the converter closely relates to its power losses and its thermal design, but their concerns are different. From a temperature point of view, its distribution, the highest value and cycling are normally considered instead of its total value. Because the temperature cycling will accelarate the aging of the power switches, the temperature distribution will influence the consistency of the power switches' aging, while the highest temperature will affect the design capacity of the power switches including the cooling system.

(e) Control flexibility

The control flexibility includes the control of the three parameters of the ac side voltage or current, in terms of its amplitude, phase and frequency. Such control flexibility is required by some applications like in Power Factor Correction (PFC) circuits, variable-speed drives, and so on. The cost of the converter may increase in order to achieve a high control flexibility, but on the other hand the power source is better used and the load is better fed by the generated power.

B. DC link

(a) voltage and current stresses

The capacity of the dc-link capacitor is normally designed according to the power imbalance between the source and load. Despite that, in high power applications, the dc-link electrolytic capacitors are normally overdesigned to handle the high current ripple. Thus, the current stress will affect the capacity of the dc-link capacitor. The current stress can also affect the capacity of the dc-link inductor if used. In contrast, the voltage will influence the voltage rating of the dc-link capacitor.

(b) Losses

The losses of the dc link are normally negligible unless a dc-link inductor is used. In that case, the circuit topology becomes a current source converter instead of a voltage source converter with only a dc-link capacitor. The current source converters have been studied for high power applications, but the voltage source converters are still the dominant choice.

(c) Lifetime

The electrolytic capacitor in the dc-link is a weak point of the converter, which may en- counter failure earlier than the other components. The dc-link capacitor is normally overrated in order to reduce the stress for each unit. Another solution is to use film capacitor to replace the electrolytic capacitor. But, both of them will increase the cost and volume of the dc link, and therefore lead to a lower power density.

(d) Volume

The wide-band gap power switches are developing fast e.g. SiC and GaN, which can achieve lower losses and higher switching frequency. Volumes of the heatsink and ac-side power filter can hence be shrinked in the design. However, the dc-link typically does not benefit from it, and the dc-link still keeps the volume and becomes the barrier to achieve a high power density.

The three-phase FB-BTB has more legs than the single-phase case, and thus has more derived possibilities, as seen in Fig. 1.3(b), (c), (d) and (e). Two legs from the input and output are merged together as a common-leg with only two switches in [40]. The common-leg can also be replaced by two flying capacitors. Sharing of the common leg between the input and output will introduce a constraint to the dc-link voltage and also form a highly asymmetrical structure, as experienced by the single-phase B6 converter. Uneven loss and thermal distribution among the switches will then result. The matrix converter is another derived topology of the three-phase FB-BTB, which instead of reducing the number of power switches, gets rid of the bulky electrolytic capacitors placed at the dc-link. The nine-switch converter looks like the matrix converter (see Fig. 1.3(e)), which is also composed of nine but unidirectionally controlled switches.

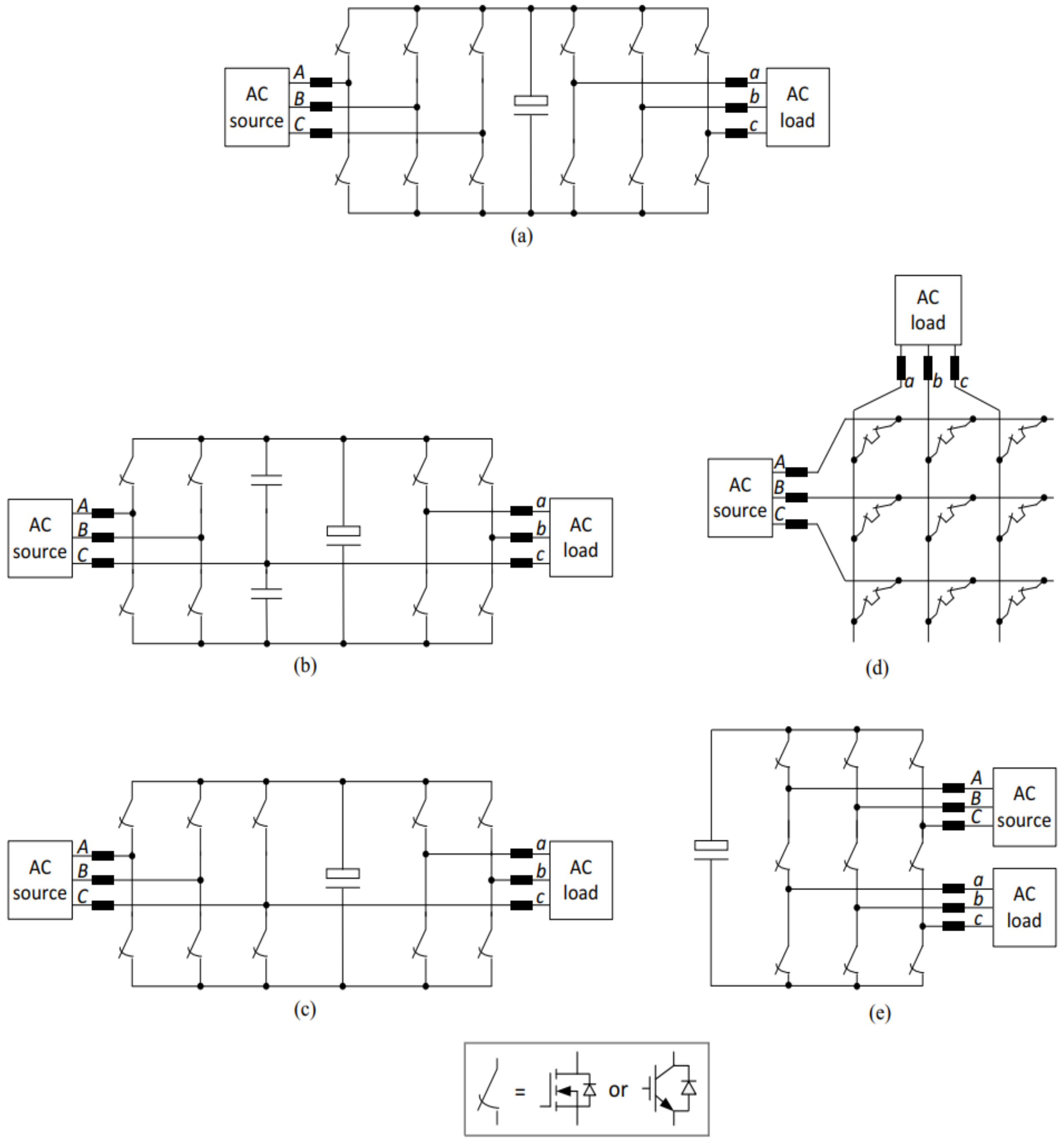

Figure 1.2: Three-phase ac-dc-ac converters. (a) full-bridge back-to-back converter (b) with a common flying capacitor leg (c) with a common half-bridge leg (d) matrix converter (e) nine-switch converter.

II. PROPOSED SYSTEM

Modeling and Simulation of a novel SVM controlling technique for three phase AC-DC-AC based SVPWM matrix converter has proposed in this implimentation. A matrix converter topology that has the same approach as the conventional inverter based converter without including any reactive energy storage as an intermediate DCbus link is discussed. This topology is known as the Indirect SV PWM matrix converter. The indirect SVPWM matrix converter is divided into two portions, a rectifier side, and an inverter side. The rectifier side of the converter is directly connected to the input line side and converts the three-phase input into DC voltage. This DC voltage is supplied in to the inversion side of the converter, which produces the desired frequency range and voltage level for the load. Figure 2.1 shows the proposed system model of three phase AC-DC-AC system. The proposed model consists of a SVPWM Matrix converter block a PWM block three ohase source power grid. The sub block of proposed system model has given in figure 2.2, Proposed SVPWM AC-DC-AC Matrix Converter. Another sublock is given in figure 2.3 AC-DC-AC Conversion Circuit. Figure 2.4 shows the SVM Controlling Block.

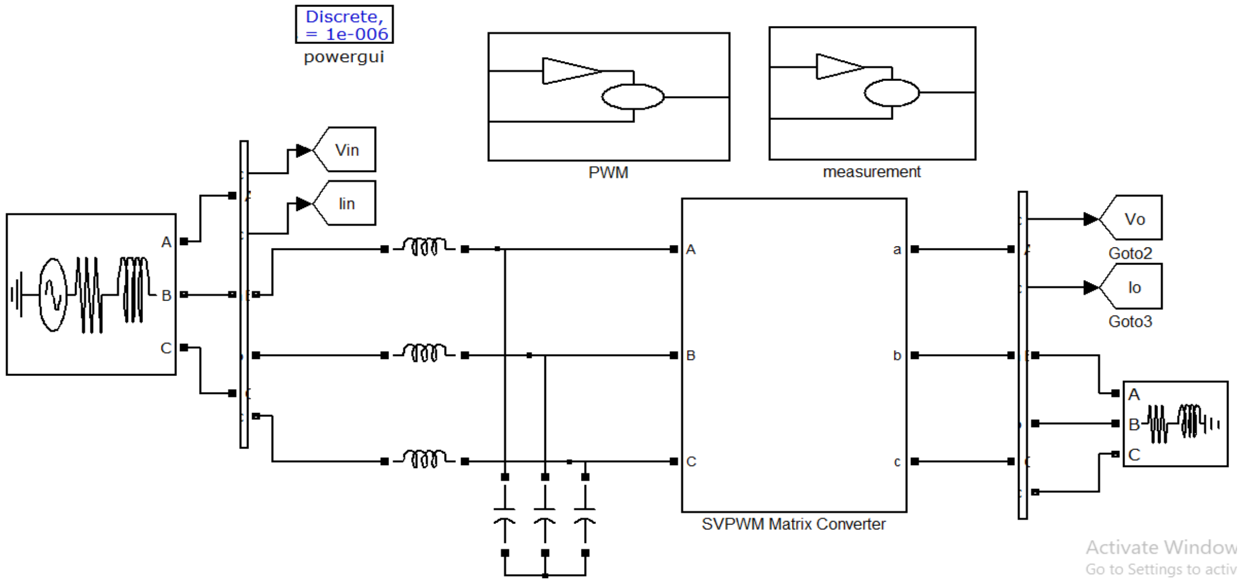

Figure: 2.1 Proposed Three Phase AC-DC-AC System.

SVPWM Matrix Converter

Matrix converter uses a direct conversion AC-AC stage as compared to two stages for the rectifier/inverter solution. Many modulation techniques and mathematical models have been considered by researchers over the years for matrix converters. The Space vector Pulse Width Modulation (SVPWM) has advantages over the commonly used PWM technique where its output voltage is 15.5% greater than conventional PWM technique.

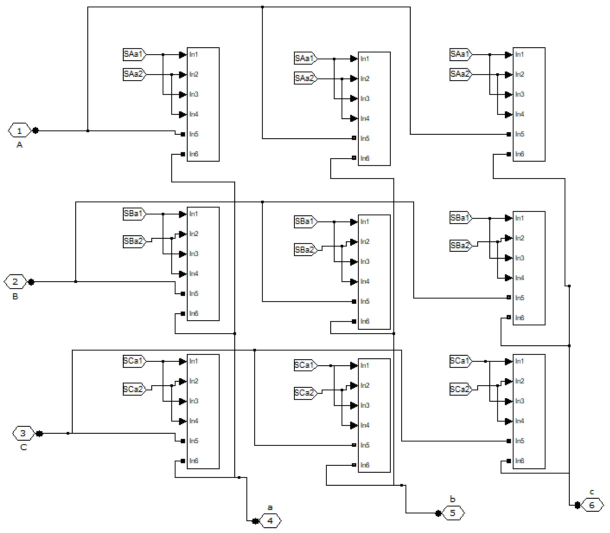

Figure:2.2 Proposed SVPWM AC-DC-AC Matrix Converter.

By injecting selected harmonics into the sinusoidal wave, a modulating signal can be generated. This results in flat topped waveform, amount of over modulation is reduced and it gives increased fundamental amplitude and less distorted output voltage. Phase variables from the three input voltages and currents from the AC side can be expressed in space vectors. SVPWM takes a sinusoidal voltage as an amplitude vector that rotates at a constant angular frequency, ω. This vector is represented in dq plane denoting real and imaginary axes.

SVPWM method is used to generate gate pulses for the six switches in the matrix converter model. The three switches of the upper leg of the rectifier receive the PWM trigger signals and the lower leg of the switches receive the complementary gate signals in order to operate two switches in the same leg for the same phase.

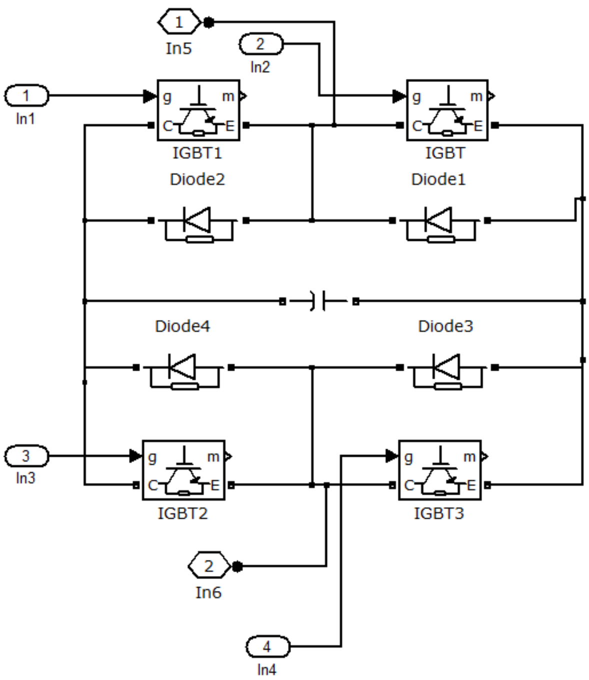

Figure: 2.3 AC-DC-AC Conversion Circuit.

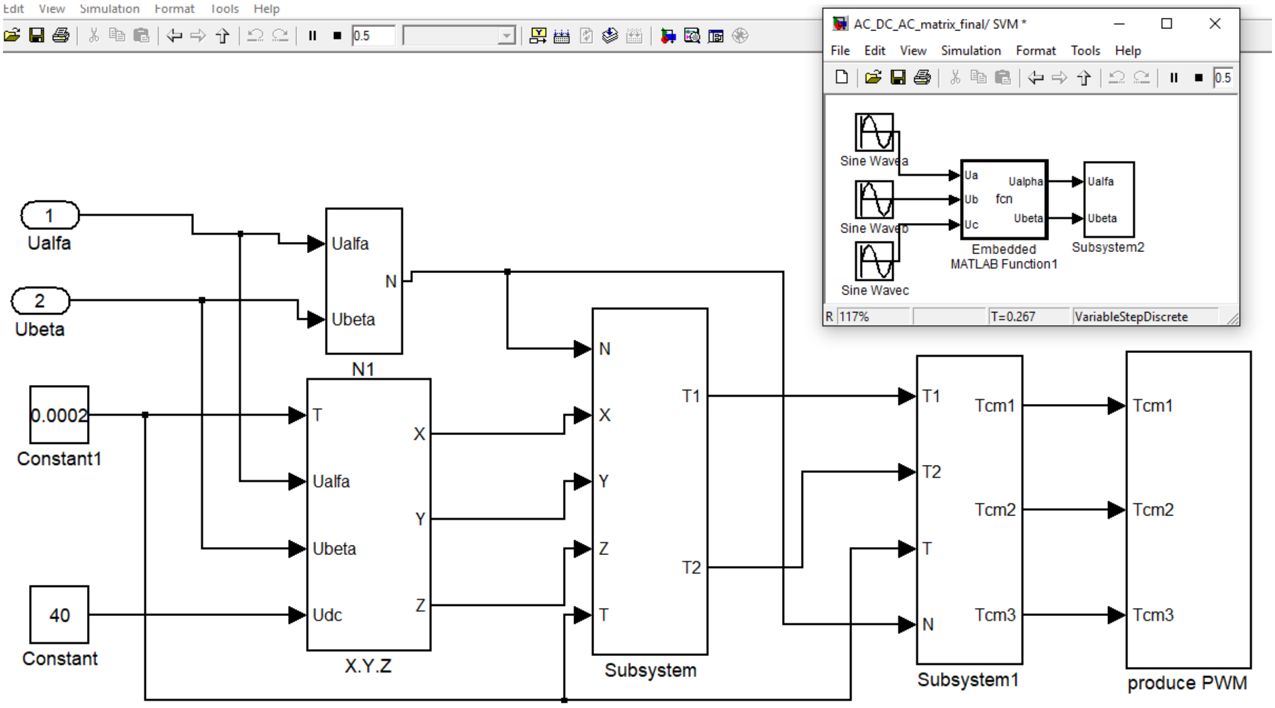

Figure: 2.4 SVM Controlling Block.

III. SIMULATION RESULTS

The proposed model has developed and simulated on in MATLAB Simulink for SVPWM. Their control has also matured after many decades of application. Despite that, there are still possibilities for other topologies as well as control strategies to be developed with enhanced performance for certain specific applications. Simulation waveform of proposed model has shown Matlab Scope.

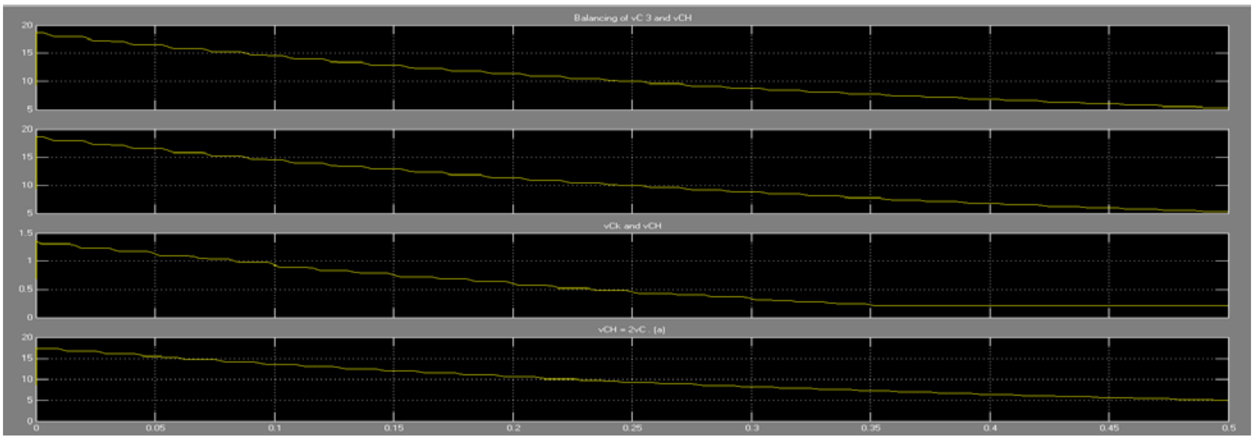

Figure: 3.1 DC Link Voltage Balancing Waveforms.

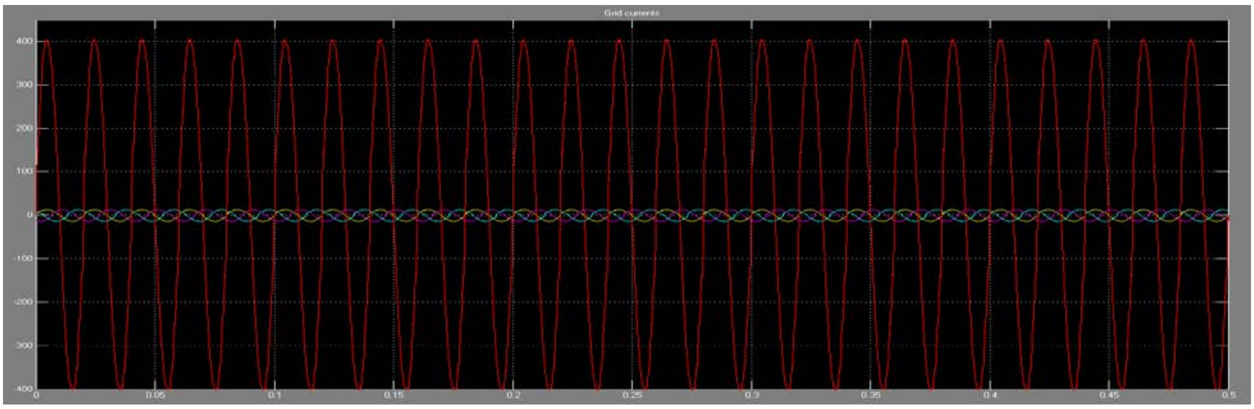

Figure: 3.2 Three Phase Load Current and Voltage.

Harmonics are sinusoidal voltages and currents that have frequencies that are whole multiples of the system frequency (60 Hz). The presence of voltages at other frequencies needs to be avoided for systems to have minimum harmonic contents. The effects of harmonics include system malfunctions, losses, overheating, overloading the power distribution network and poor input power factor. The designed converters add harmonic content in the system and are analyzed.

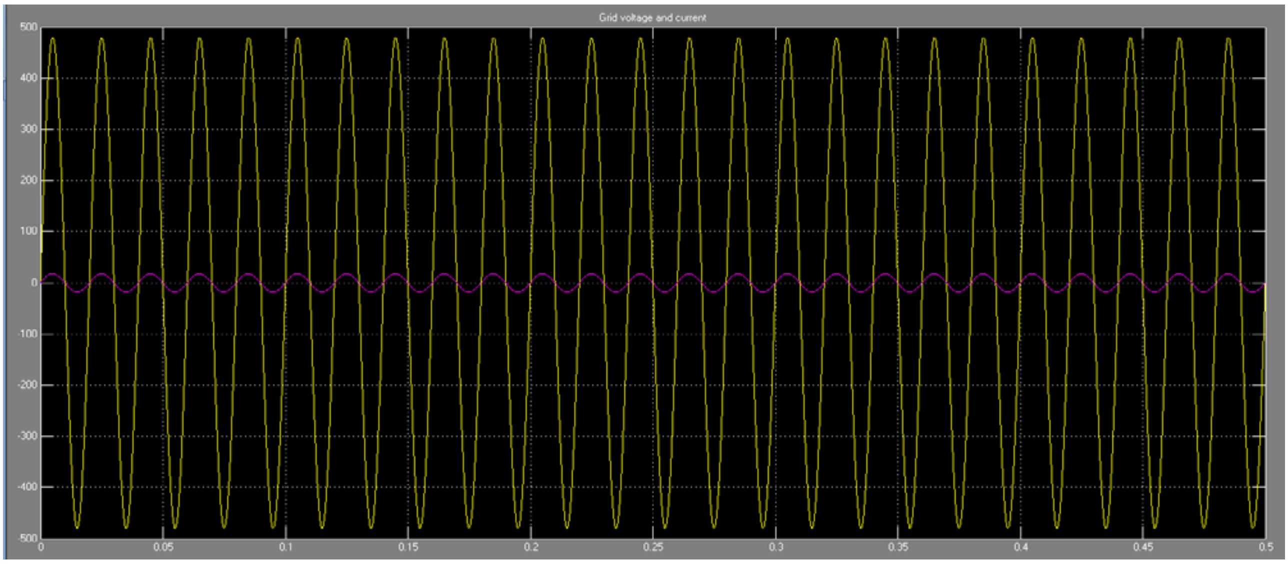

Figure: 3.3 Grid Voltage and Current.

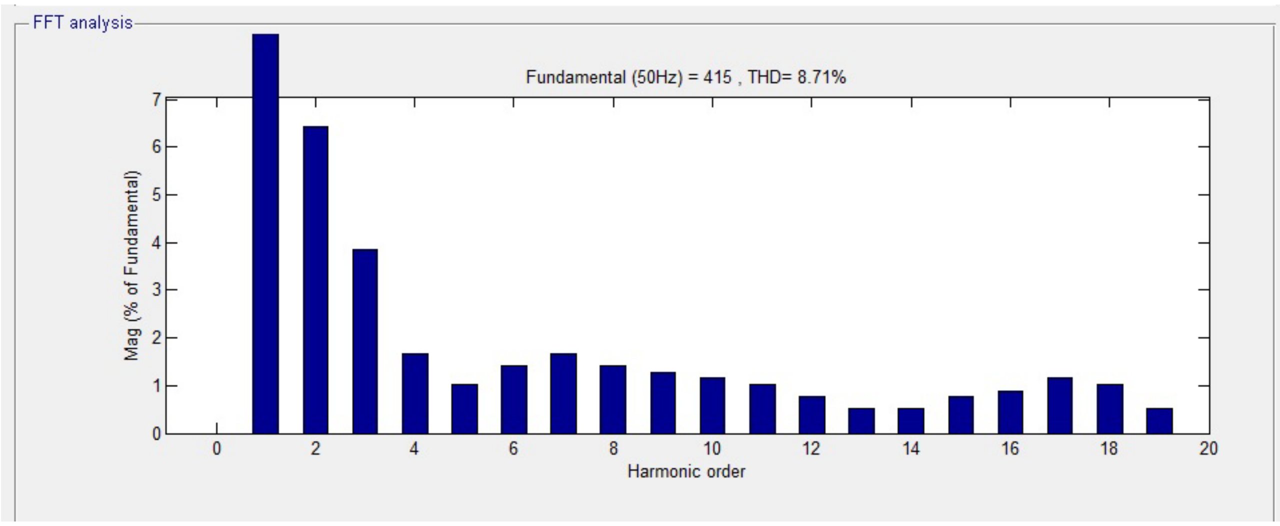

Figure: 3.4 THD of Proposed System.

IV. CONCLUSION

In this work modeling and simulation of a Novel SVM Controlling Technique for three phase AC-DC-AC based SVPWM matrix converter. Power systems operate in stressful conditions and its reliability is of paramount importance to maintain integrity in the network and stability through the power system. In order to have a stable power system, the system is tested under fault conditions and the results are analyzed to know whether the system can clear the fault and return back to normal working conditions without human intervention. The noteworthy harmonic segments are around the switching frequency and no low-order harmonics. However, the converter designed for the system would have higher harmonic content about to 8.71% THD, compared to existing base work.

This research work has covered some key configuration. This converter shows promising THD among many other benefits and needs further investigation.

For future research work,

A feedback system can be introduced to improve voltage regulation in the system. Feedback controllers can also be used to control the active and reactive power of the system to reduce power losses in the system and maintain unity PF.

A Power factor redress circuit can be executed to keep up solidarity power factor regarding yield current.

Passive/active input filters can be implemented for further realization of the system to improve THD of the system.

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