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Quasi-Z-Source Inverter using Space Vector Modulation and Sine PWM Method

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Abstract*: This paper presents the performance comparison of sine PWM and SVPWM based quasi impedance source inverter (QZSI).QZSI are used to boost the DC link voltage and convert DC voltage into AC voltage in a single stage with a concentrated number of semiconducting devices. Space vector pulse width modulation (SVPWM) method is used to control the inverter output voltage and reduce the current harmonic. MPPT technique is also integrated into the SVPWM technique to improve the maximum output power obtained from PV cells. Shoot through concepts is used to increase the DC link voltage and reduce the separate requirement of the boost stage. The projected QSZI inverter is simulated using MATLAB simu-link. SPWM and SVPWM method are used to determine the circuit performance. The circuit performance is compared with simulation results.

***Index Terms*: Sine PWM, Space Vector Modulation, MPPT, Harmonic, and QZSI Inverter.**

I. INTRODUCTION

Everyday electrical power requirements are increasing very fast due to population and technology development. It force to generate more power to compensate for the current demand. Electrical power is generated from a different source such as coal, diesel, and water. The above-said sources are not available for a long time and also produce harmful by-product for the environment. To solve this problem, the renewable energy source is preferred for power generation. Solar energy is the first choice for a renewable energy source [1-2]. Many research works are going on continuously to upsurge theenactment of the solar cells [3-5].MPPT technique is developed for getting maximum power from solar cells [3-7]. The solar cell output voltage boosted with the assistance of a boost converter. Many dc-dc converters were developed to upsurge the dc-link voltage from the solar cell. This additional boost converter is increasing the cost and size of the system. Z-source inverter is developed for boosting the dc voltage with the help of shoot through concepts and without using boost converter [8-9]. A different approach was proposed to improve the impedance source inverter performance and voltage gain [10-11]. Different PWM method with shoot through concept is applied for increasing the voltage gain of the ZSI. [13-15].

The quasi z-source inverter has much compensation, which has more voltage improvement, less capacitor rating, and low harmonic associate than conservative ZSI [12]. The quasi impedance source inverter is projected in these articles. Space vector modulation method and Sine PWM method are applied for controller the inverter output voltage and diminish the harmonics. MPPT technique is integrated with the PWM technique to improve the solar cell output and inverter performance. The circuit performance is compared and verified using simulation results. The following section describes the inverter operation and simulation results.

II. CIRCUIT DESCRIPTION

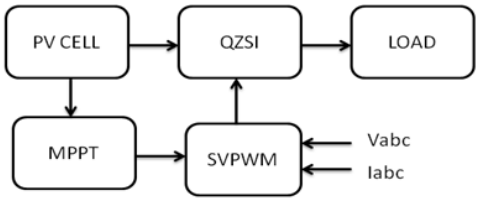

Fig.1 QZSI Inverter-Based Power Conversion System

PV based three-phase QZSI inverter with MPPT and SVPWM control structure block diagram is as shown in Fig1.

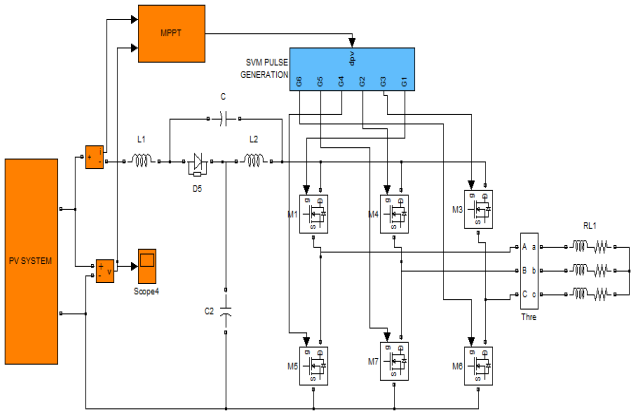

Fig.2 Circuit diagram of QZSI inverter-based power conversion system

The projected circuit diagram is as presented in Figure 2. This inverter has a PV cell, quasi impedance network, three-phase inverter, and load. The MPPT technique (P&O) is used to acquire the extreme power from solar cells.

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The space vector modulation technique is used to control the inverter output voltage and current harmonics. The switching pulses are derived with integrating MPPT and SVPWM technique. The shoot-through operation is used to boost the dc-link voltage. The inverter has three modes of operation such as non-shoot through mode or dynamic mode, shoot through mode and zero modes. During shoot-through mode the two modifications of any one leg or all three legs are shorted minimal period in the inverter. As a result, the more energy is stowed in the capacitor and inductor. This energy is transported to the load during the regular operation. As a consequence, the dc-link voltage is boosted.

III. CONTROL METHOD

The PV based three-phase QZSI inverter is controlled by the P&O algorithm and PWM technique. The MPPT control method is explained detail in [16]. Fig 3 shows the P-V and I-V appearances of the PV array. Fig 4 indications the MPPT control block diagram. The MPPT technique is used to produce the shoot through the epoch for increasing the dc-link voltage it is revealed in Fig 5. The output voltage is measured by varying the intonationcatalogue and sproutconcludedperiod. PWM methods are used to device the current stress and harmonic in the inverter. Sine PWM and SVPWM techniques are used to determine the inverter performance.

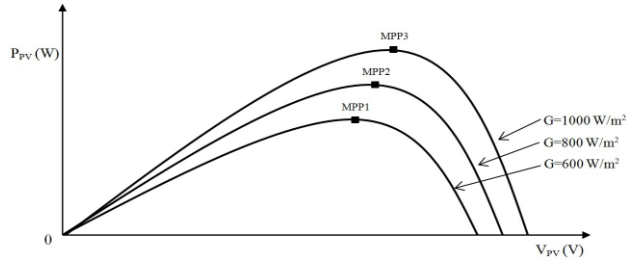

Fig.3 I-V and P-V characteristics of the PV array

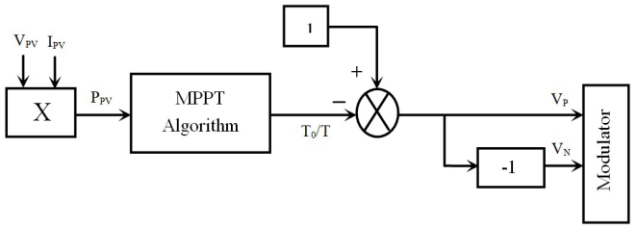

Fig.4 MPPT control block diagram

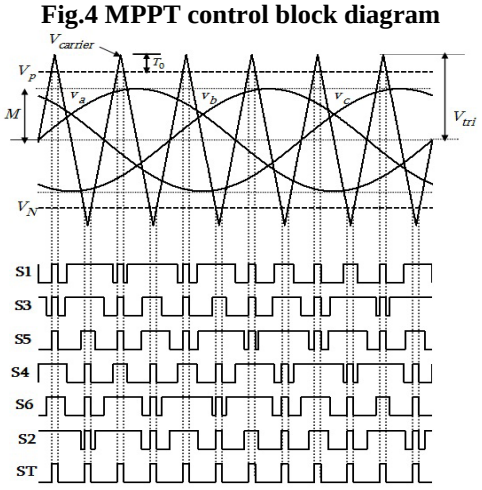

Fig.5 Shoot through period generation using P&O Technique

IV. RESULT AND DISCUSSION

PV based three-phase QZSI inverter with MPPT control based circuit diagram is as shown in Figure 2. This circuit has input PV cells, quasi impedance network, three-phase inverter, and three phase loads. The proposed circuit is simulated using MATLAB simu-link using SPWM and SVPWM. The MPPT controller and PWM method are integrated for increasing the dc-link voltage and reduce the harmonic. SPWM and SVPWM methods are used to determine the inverter performance. The inverter circuit performances are compared to simulation results. Fig 6 shows the Sine PWM pulse generation pattern. In this technique, the sine orientation signal is compared with the triangle exporter signal. SPWM gives better voltage control and harmonic reduction. Figure 7 appearances the Inverter phase output voltage. It has a pulse train output. Figure 8 shows the Inverter output current. This current output has a sinusoidal wave shape. As a result, the current output has a low current harmonic. Fig 9 shows the Inverter line output voltage.

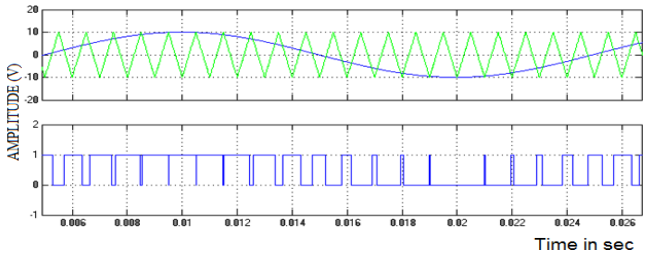

Fig.6 Sine PWM Pulse Generation Method

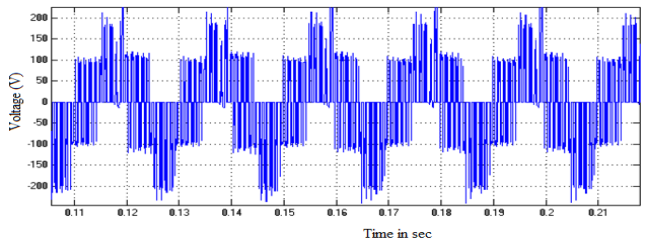

Fig.7 Inverter phase output voltage

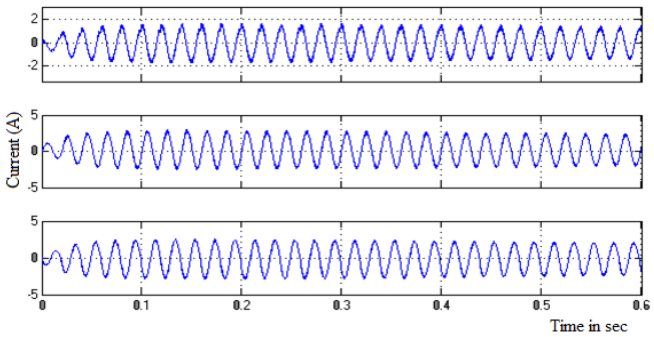

Fig.8 Inverter Phase Current

PV based three-phase QZSI inverter with MPPT control based circuit diagram is as shown in Figure 10. Figure 11 shows the SVM control block diagram using in simulation. The SVM block is used to generate reference current signal from load current and voltage.

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Fig 12 shows the SVPWM pulse generation pattern. In this technique, the SVM orientation signal is associated with the triangle carrier signal. SVPWM gives better voltage control and harmonic reduction. Fig 13 shows the Inverter phase output voltage. It has a pulse train output. Figure 14 expressions the Inverter output current. This current output has a sinusoidal wave shape. As a result, the current output has a low current harmonic. Fig 15 shows the Inverter line output voltage.

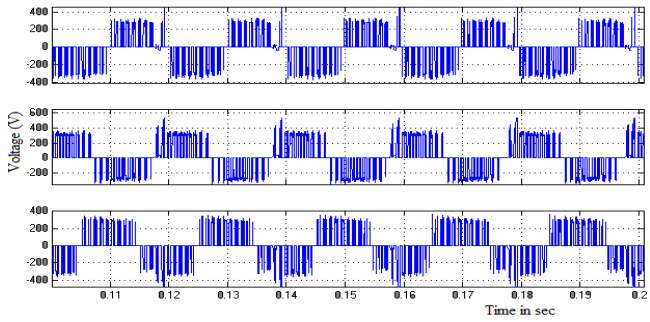

Fig.9 Inverter Line Voltage

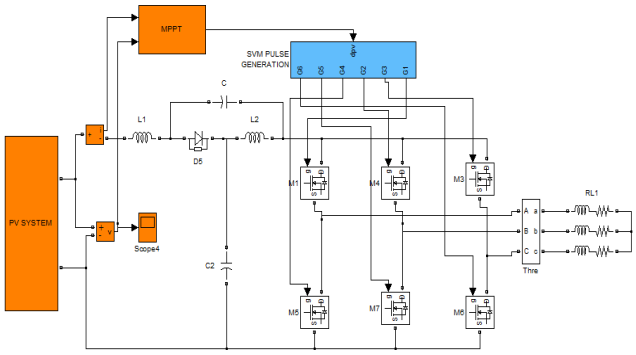

Fig.10 QZSI Inverter Circuit Diagram

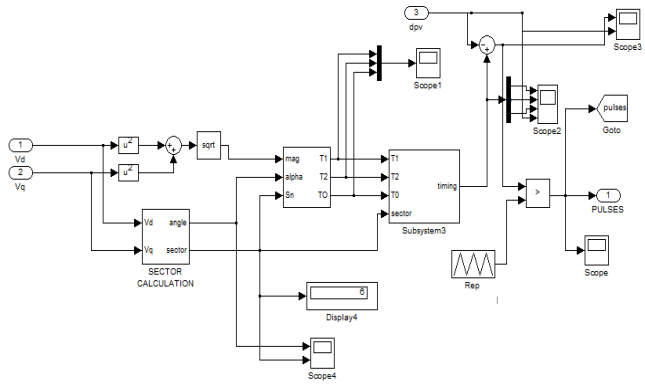

Fig.11 SVM Control Block Diagram

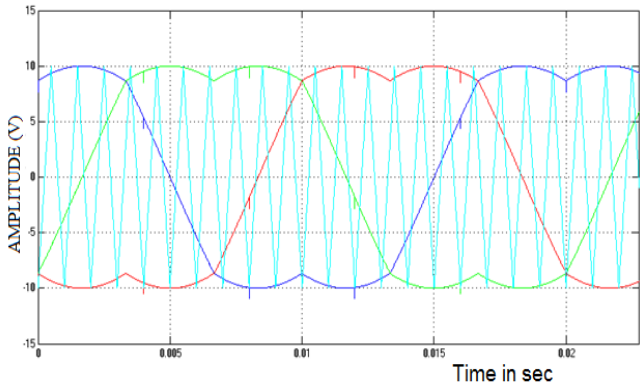

Fig.12 SVM Pulse Pattern

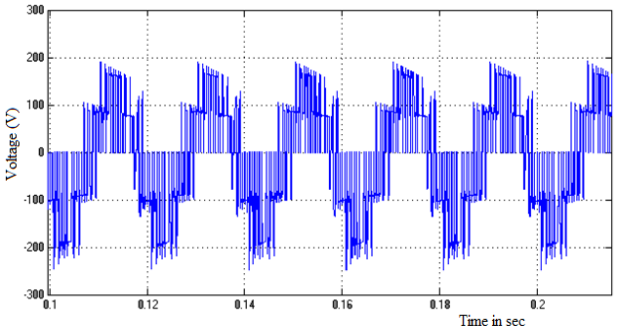

Fig.13 Inverter Phase Output Voltage

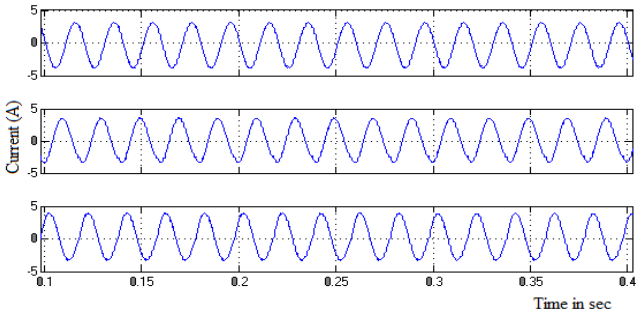

Fig.14 Inverter Output Current

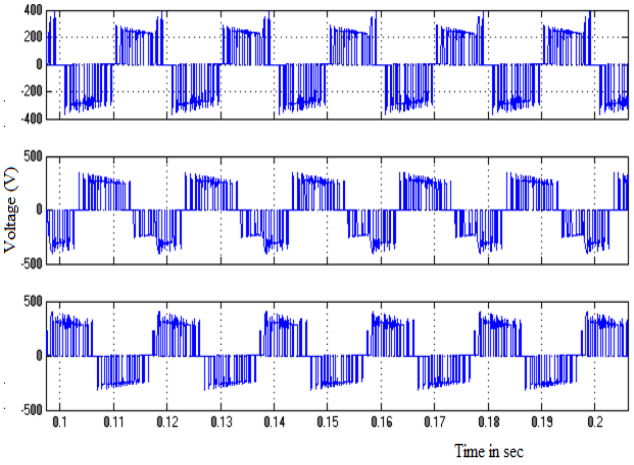

Fig.15 Inverter Line Voltage

V. COMPARATIVE ANALYSIS

Table.1QZSI Circuit Performance

PARAMETER	QZSI SPWM	QZSI SVPWM
INPUT VOLTAGE (V)	110	110
DC LINK OUTPUT (V)	247	272
PHASE VOLTAGE (V)	180	192
LINE VOLTAGE (V)	300	340
CURRENT (A)	2.2	3.6
THD (%)	5.64	3.36

SPWM and SVPWM methods are used to determine the inverter performance. The SVPWM technique has better voltage gain compare than Sine PWM technique. It is shown from Table1. Figure 17 shows the graph between harmonic and shoot through the period of the inverter. The SVPWM technique has less harmonic compare than SPWM technique. It is shown in figure 16. The QZSI inverter has more voltage gain of 2.47 times in SVPWM compare than 2.2 of SPWM method. The QZSI inverter has less current harmonic of 3.36% in SVPWM compare than 5.64% of SPWM method.

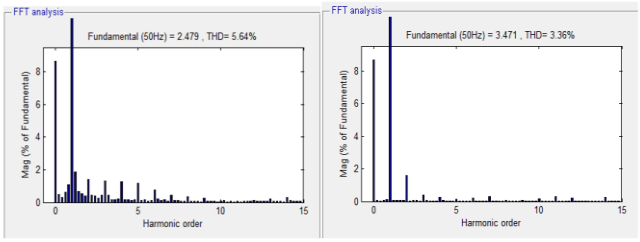

Fig.16 FFT Analysis for Current A) SPWM B) SVPWM

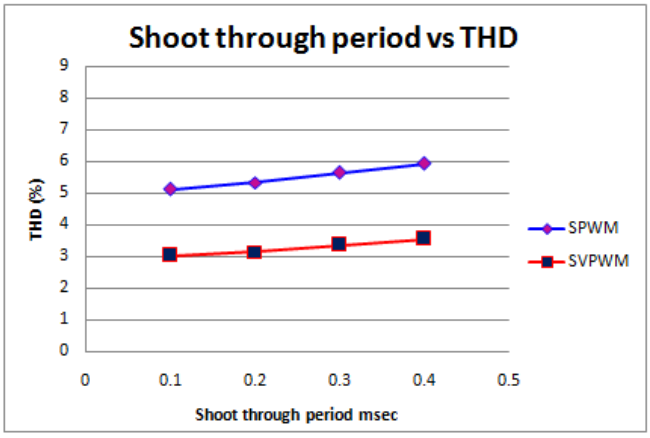

Fig.17 Graphs between Harmonic and Shoot through the Period

VI. CONCLUSION

PV based QSZI inverter with combined MPPT technique and PWM method proposed to determine the inverter performance in this paper. The circuit is replicated using SPWM and SVPWM. The circuit performance is compared with simulation results. The SVPWM technique has better voltage gain and less current harmonic compared than SPWM. It is proved from simulation results.

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