Transistor Clamped Split Phase PWM Inverter

Anna Steffy K.J, S.Renjitha

***Abstract*—The Split Phase PWM inverter which has been used to eliminate the dead time in inverters results voltage distortion due to the nonlinearities uses Advanced unipolar technique to overcome the problem of circulating current in the coupled inductor which is used to prevent the short through problem produces a three level output voltage. This paper propose a split phase PWM inverter uses a Dual reference modulation technique which produces five level output voltage .The circuit consist of an auxillary circuit comprising of four diodes and a switch along with two input capacitor in series. Auxillary circuit is proposed in this paper to obtain five level output voltage which is more suitable for grid connection, reduces EMI, Total Harmonic Distortion ,Smaller filter size. Simulation is done to verify the better performance of transistor clamped split phase PWM inverter**

***Keywords*—Dead time,PWM inverter,Auxilary circuit ; Dual reference modulation technique**

I. INTRODUCTION

The main problems found in the PWM inverter are the voltage distortion caused by the nonlinear characteristics of the switching devices which has been introduced by the necessary dead time to avoid short circuits across the legs of the inverter due to the simultaneous conduction state of two switching devices of the same leg. dead-time, a small interval during which both the upper and lower switches in a phase leg are off, adopted by VSI phase leg in order to guarantee that both switches in an inverter leg never conduct at the same time. A small delay time is added to the gate signal of the turning-on device. This delay, added to the switching devices finite turn-on/off delay time, introduces a load dependent magnitude and phase error in the output voltage. The voltage distortion increases with switching frequency introducing harmonic components and if it is not compensated, may cause instabilities as well as additional losses in the machine being driven.

The Split Phase PWM inverter which has been used to eliminate the dead time in inverters result in voltage distortion due to the nonlinearities uses Advanced unipolar technique to overcome the problem of circulating current in the coupled inductor which is used to prevent the short through problem produces a three level output voltage

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***Anna Steffy K.J**, Electrical and Electronics Engineering department, MG University / KMEA Engineering College. Cochin, India, **S. Renjitha** , Electrical and Electronics Engineering department / MG University / KMEA Engineering College/Cochin,India.*

This paper propose a split phase PWM inverter uses a sinusoidal PWM and Sinusoidal PWM is obtained by comparing a high-frequency carrier with a low-frequency sinusoidal which acts as the modulating signal or reference signal. The carrier has a constant period thereby the switches have constant switching frequency. The switching instant is determined from the crossing of the carrier and the modulating signal. Dual reference modulation technique which produces five level output voltage .The circuit consist of an auxillary circuit comprising of four diodes and a switch along with two input capacitor in series. Auxillary circuit is proposed in this paper to obtain five level output voltage which is more suitable for grid connection, reduces EMI Total Harmonic Distortion , Smaller filter size.

II. SPLIT PHASE PWM INVERTER

Split phase PWM Inverter with no dead time composed of an h bridge with four MOSFET and two ultra fast recover diodes and two coupled inductor to limit the current so there is no direct shoot-through problem but this coupled inductor creates a problem of circulating current. Advanced unipolar technique is used that does not suffer from the circulating current and there by the power loss also reduced significantly.

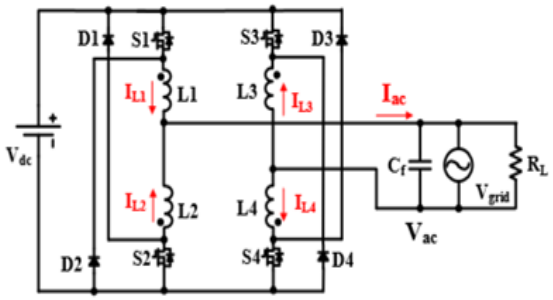

Fig 1 Split Phase PWM Inverter

An advanced control strategy based on the traditional unipolar PWM control scheme. As, there is always a circulating current between L_1/L_2 and L_3/L_4, and the turn on of complimentary device provides the loop for circulating current. Based on this feature, the advanced unipolar PWM control scheme is proposed. In advanced unipolar technique the polarity of the output current is introduced into the control scheme. When the output current is positive, the charging process of the circulating current loop is blocked. Once the charging process of the coupled inductors L_2 and L_3 is shortened to the minimum, the circulating current problem could be minimized.

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DUAL REFERENCE MODULATION TECHNIQUE

This technique has been used here to produce the switching signal for the switches used in the inverters in order to produce five level output. In this modulation technique two reference signals have been used instead of one the reference signal.

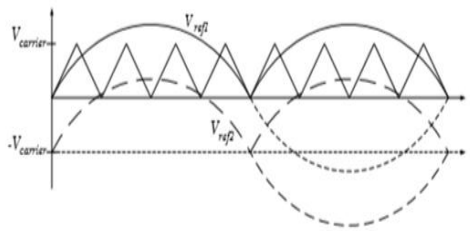

Fig 2 Dual reference modulation technique

In order to generate sinusoidal current with low harmonic distortion, a sinusoidal PWM is used since it is one of the most effective methods. Sinusoidal PWM is obtained by comparing a high-frequency carrier with a low-frequency sinusoid, which is the modulating signal or reference signal. The carrier has a constant period; therefore the switches have constant switching frequency. The switching instant is determined from the crossing of the carrier and the modulating signal.

Both the reference signals V_{ref1} and V_{ref2} are identical to each other except for an offset value equivalent to the amplitude of the carrier signal $V_{carrier}$. Dual reference modulation technique introduced to generate switching signals for the switches and to produce five output voltage level

Dual reference modulation technique is incorporated into the sinusoidal PWM technique to produce PWM switching signals for the full-bridge inverter switches and auxiliary switch. Two reference signals V_{ref1} and V_{ref2} will take turns to be compared with the carrier signal at a time. If V_{ref1} exceeds the peak amplitude of the carrier signal $V_{carrier}$, V_{ref2} will be compared with the carrier signal until it reaches 0. At this point onwards, V_{ref1} takes over the comparison process until it exceeds $V_{carrier}$. This will lead to a switching pattern as shown below. Switches S_2-S_4 will be switching at the rate of the carrier signal frequency while S_5 and S_6 will operate at a frequency equivalent to the fundamental frequency. the level of V_{inv} during S_2-S_6 switch on and off.

S0	S1	S2	S3	S4	Vinv
ON	OFF	OFF	OFF	ON	+Vinv
OFF	ON	OFF	OFF	ON	+Vinv/2
OFF	OFF	OFF	ON	ON	0
ON	OFF	OFF	ON	OFF	-Vinv/2
OFF	OFF	ON	ON	OFF	-Vinv

TABLE 1 switching sequence of 5-level inverter

CIRCUIT DIAGRAM OF TRANSISTOR CLAMPED SPLIT PHASE PWM INVERTER.

Transistor clamped split phase PWM inverter Which consist of dc source that can be a battery solar cell fuel cell or any other renewable source. Then the two capacitors are connected in series connected with the auxillary circuit which is connected with the split phase PWM inverter. The output voltage level of the inverter thus increases .As a result more pure sine wave is obtained with High dynamic performance low THD. An auxillary circuit which comprises of four diode and a switch for voltage clamping along with two series input capacitors before the split phase PWM inverter in order to get 5-level output voltage which is an added advantage and this will make the more pure sinusoidal wave at the output and thereby reduces total harmonic distortion.

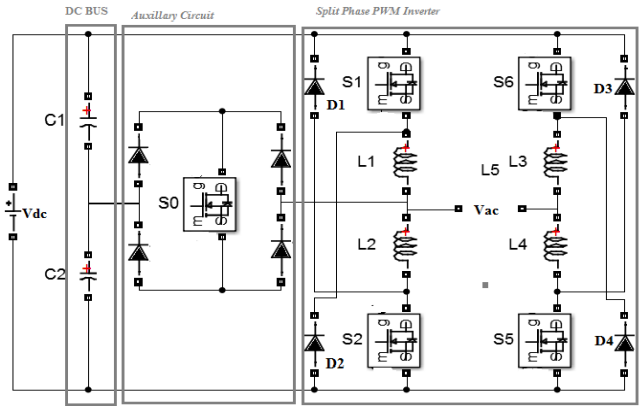

Fig 3 Transistor Clamped Split Phase PWM Inverter

There is no short through between the two MOSFETs in one phase-bridge. When upper switch and lower switch are turned on at the same time, the current is limited by the coupled inductor, so there is no direct shoot-through problem .Another advantage is that it becomes more suitable to be connected to the load.

Advanced control strategy based on the traditional unipolar PWM control scheme. As analyzed in previous session, there is always a circulating current between L_1/L_2 and L_3/L_4, and the turn on of complimentary device provides the loop for circulating current. Unipolar PWM control scheme is proposed. The polarity of the output current is introduced into the control scheme. When the output current is positive, the charging process of the circulating current loop is blocked. Once the charging process of the coupled inductors L_2 and L_3 is shortened to the minimum, the circulating current problem could be minimized. The PWM generation of the advanced unipolar PWM control scheme. When the current is positive, S_1 and S_4 will work, while the S_2 and S_3 will be always off; when the current is negative, S_2 and S_3 will work, S_1 and S_4 will be always off. The switching loss will also be significantly reduced compared with the traditional unipolar PWM control.

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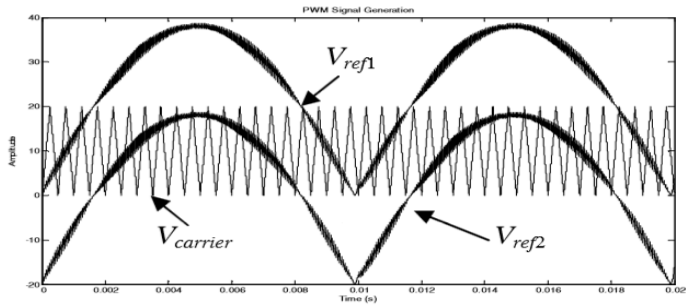
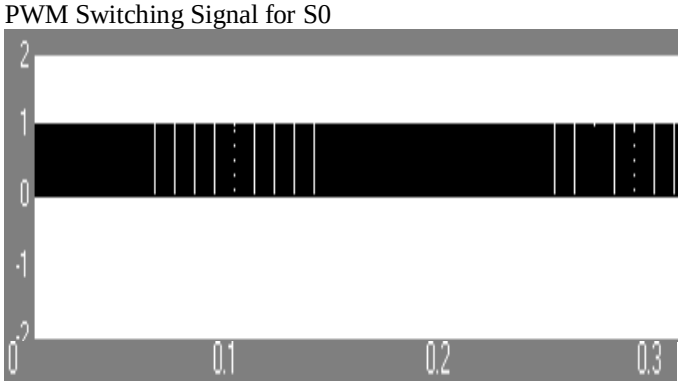
SIMULATION RESULTS

Simulations were performed by using MATLAB SIMULINK to verify that the proposed inverter can be practically implemented in a PV system or Fuel cell. It helps to confirm the PWM switching strategy for the five-level inverter. Then, this strategy is implemented in a real-time environment i.e. the DSP to produce PWM switching signals for the switches. Fig. 4(a) shows the way the PWM switching signals are generated by using two reference signals and a triangular carrier signal.The resulting PWM signals for switches S0 to S6 are shown in Fig 4(b)-(f)



(a)

PWM Switching Signal for S0



(b)

Fig4 PWM switching strategy and PWM signal for S0-S4

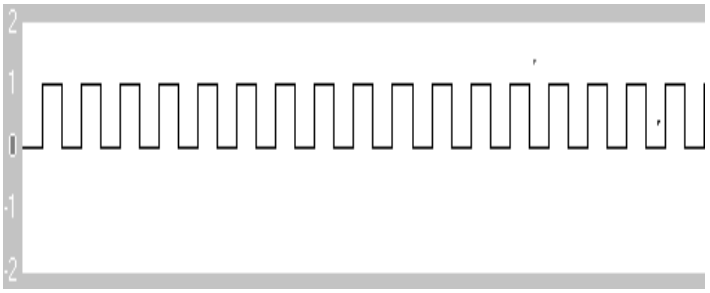
PWM Switching Signal for S1

(c)

PWM Switching Signal for S2

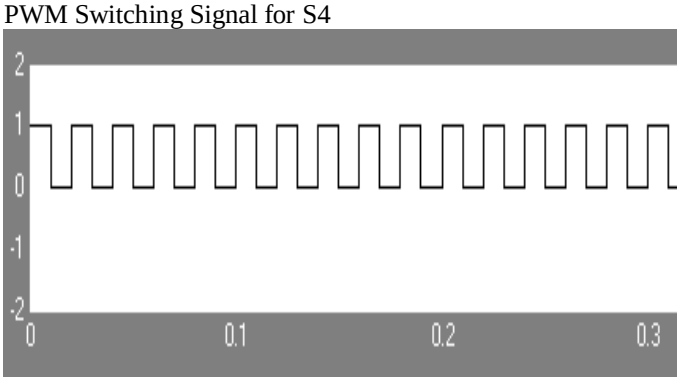
(d)

PWM Switching Signal for S3



(e)

PWM Switching Signal for S4



(f)

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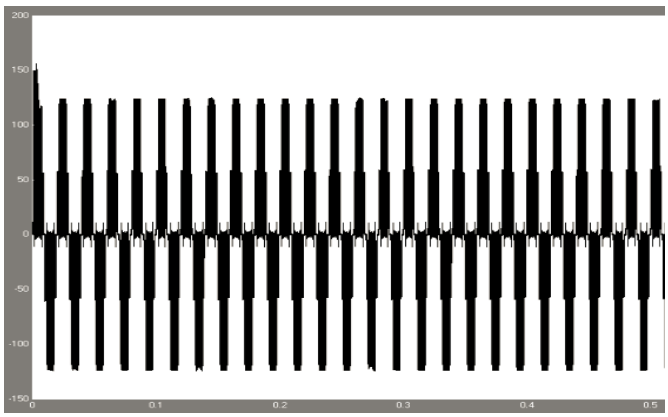

FIG 1.5 OUTPUT 5-LEVEL VOLTAGE WAVEFORM

CONCLUSION

This paper presented a split phase PWM inverter with a dual reference modulation technique for renewable energy circuit topology ,operational principle of the proposed inverter were analyzed in detail. The dual reference modulation technique is used to generate PWM switching signals for the switches**.** Split Phase PWM inverter which has been used to eliminate the dead time in inverters is presented in this paper and thus reduces snubber circuit and elimination of voltage distortion due to the nonlinearities**.** Auxillary circuit is proposed in this paper increased the voltage level of the split phase inverter from three level to five level output voltage which is more suitable for grid connection, Comparison has been made between the five-level and three- level inverter in term of THD**.**.It has been simulated using MATLAB/Simulink and implemented. The capability of the system is analyzed and verified via simulation results. The simulation studies indicate that the that the THD(Total Harmonic Distortion) of the five-level inverter is much less than that of the conventional three-level inverter EMI, ,Smaller filter The proposed scheme is a recommended solution applicable renewable grid tied applications

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AUTHORS' BIOGRAPHY

Anna Steffy K.J is born in India, Kerala. She is currently pursuing her Mtech in Power Electronics at KMEA Engineering college , Edathala affiliated to MG University. She received her Bachelor's Degree in Electrical and Electronics Engineering from Dhanalakshmi Srinivasan Engineering college Perambalur in the year 2013. Her areas of interest includes power electronics and drives.

S.Renjitha is born in India, Kerala. She is working as Assistant Professor at KMEA Engineering College affiliated to MG University. She received her Bachelor's Degree from MES College of Engineering and Kuttipuram in the year 2003 and Mtech Degree in Embedded Systems from Rajagiri School of Engineering And Technology in the year 2012. Her areas of interest includes Embedded Systems Power Electronics and power systems .

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