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Comparison Study of AC Load Waveform before and after LC Filter on Full Bridge Inverter using Multiple Pulse Width Modulation

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ABSTRACT

The system of electrical has a single phase and three phase system. The inverter also holds several types of inverter such as half bridge inverter and full bridge inverter. This paper focused on single phase full bridge inverter using coupled filter of the LC filter. Filter in this study used inductor of 500uH for the DC power source system. The full bridge inverter circuit with the high frequency of the sinusoidal pulse width modulation control was also used. The coupled filter is used in this project to reduce the circulating DC/AC stage. The frequency of the square wave of the full bridge circuit is controlled. This project best suit a capacitive load of 15 Watts bulbs in the input voltage of 17 VDC. The performance of the full bridge circuit with the filter in the waveform before filter, and after the filter is observed. The square wave waveform is the output waveform of the inverter in AC before filtering and after filtering the waveform is the sinusoidal wave.

Keywords: Full bridge inverter, SPWM (sinusoidal pulse width modulation), Filter.

INTRODUCTION

Full Bridge Inverter

The inverter circuit used to convert the DC input power to the AC output load of the system. The arrangement of the power electronic switch is either half bridge inverter or full bridge inverter. When one or two semiconductor switch is used, that is called the half bridge inverter. The full bridge inverter on the other hand has four semiconductor switches for each of the legs. The full bridge inverter has the two of the legs and the semiconductor switch use of the inverter circuit such as MOSFET and IGBT. The two legs of the full bridge circuit connect to load in the middle of the legs. In this project, the full bridge inverter circuit used the IRFP 450 MOSFET as the switch S1, S2, S3 and S4 that connect at the midpoint of the two legs, hence forming the letter H, hence called the H-Bridge inverter. The basic circuit of the full bridge inverter is shown in Figure 1 [1].

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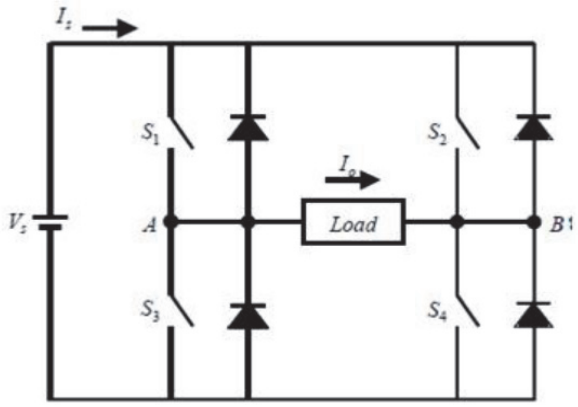

Figure 1: Full bridge inverter circuit

Sinusoidal Pulse Width Modulation (SPWM)

The inverter is significant in ensuring the quality of the electricity. A modified sine wave inverter is the inverter used to convert from the DC power into AC power. The AC output of the inverter will affect the performance of electrical equipment. The alternating current can be feed into the commercial electrical from the transformed DC power inverter. The inverter change the Direct current (DC) into alternating current (AC) of electricity of 120 volts AC (in the United State) or 240 volts AC (if other country from united state)[2][3][4][5].

The PWM technique is either unipolar PWM generator or bipolar PWM generator. For the unipolar PWM generator, a triangular carrier waveform is compared with two different signals which is the positive signal and the negative signal. On the opposite, for the unipolar PWM generator, the output voltage waveform is compared to bipolar switching [1][5]. The amplitude of the significant harmonic and side band is lower for all modulation in order to make it easier and significantly reduced the size for the unipolar voltage switching [1][5].

To compare between the reference voltage waveform, Vr with the triangular carrier signal, Vc and produced the bipolar switching signal; the PWM switching with bipolar voltage switching composed of a comparator is used. The full bridge single phase inverter with switch from S1 to S4 is turn ON and OFF at the same time will apply using the PWM switching. The leg A = leg B. By comparing the reference signal, Vr and the triangular carrier signal, Vc comparison between two signals and the output result waveform is clearly illustrated in [1][3][5].

Filter

The passive component such as capacitors, inductors and resistor is the passive filter component and this project uses the LC filter. A passive filter is the simplest

filter compared to the active filter without the amplifier element, such as transistor and operational amplifier. Passive filters generate a small noise as well as the active filter or the circuit with active gain component. The noise that comes from the resistive component can be reduced in the design by selecting suitable component for the filter [4][6][7].

RESEARCH METHODOLOGY

The four main parts of the circuit is the voltage regulator circuit, controller circuit, full bridge circuit and LC filter circuit is constructed for SPWM inverter. The SPWM inverter system in this project is tested for AC power measured using PM 300 analyzer for current, voltage and power. The signal for SPWM technique is controlled by using microcontroller PIC16F877A. The command using C language was send to produce square waves and PWM output by using MPLAB IDE v8 software. There is two AND gate being in this project which is IC 74LS08 used to convert the square waves and PWM output. The full bridge inverter circuit is used to convert the DC value of 17V to an AC waveform and step up the voltage using a transformer. The square waves and PWM output from the microcontroller is needed to drive the MOSFET IRFP460. The LC filter is a 2.2 uF capacitor, 240 V and a couple of the inductors of 500 uH are used to filter the AC waveform. In this project, the full circuit of the SPWM full bridge inverter using the LC filter is shown in Figure 2 where the circuit is combined into one board [8].

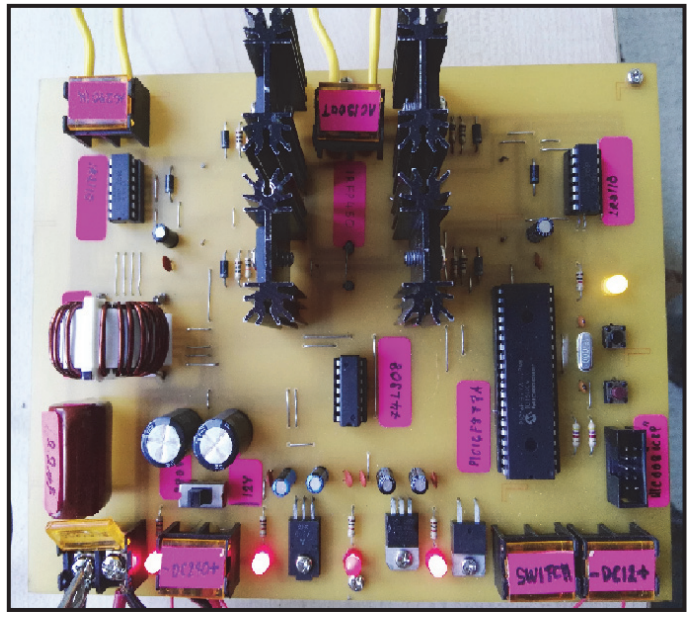

Figure 2: The full circuit of SPWM full bridge inverter using LC Filter [8]

The inverter is the square wave waveform shown in Figure 3 and the waveform of the output voltage of AC with the load of a 15 Watt bulb is applied to this circuit. The sinusoidal waveform appears after using the LC filter. The experiment is test for the input voltage of the 17V in DC and the Figure 3 is the square waveform for the system supply with no load and for the system with load using the same input voltage of DC is shown in Figure 4. Figure 4 shows the output waveform in AC but the waveform has noise and this system use the filter to reduce the noise to get the sinusoidal waveform shown in Figure 5. This experiment use the LC filter to reduce the total harmonic distortion in the inverter output.

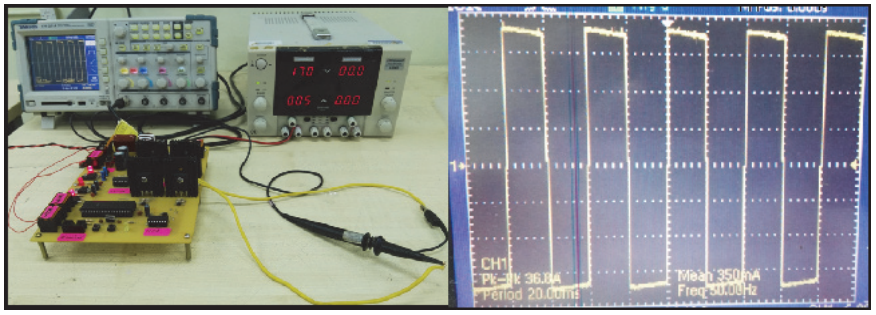

Figure 3: Full Bridge Inverter waveform with no load before filter for 17VDC

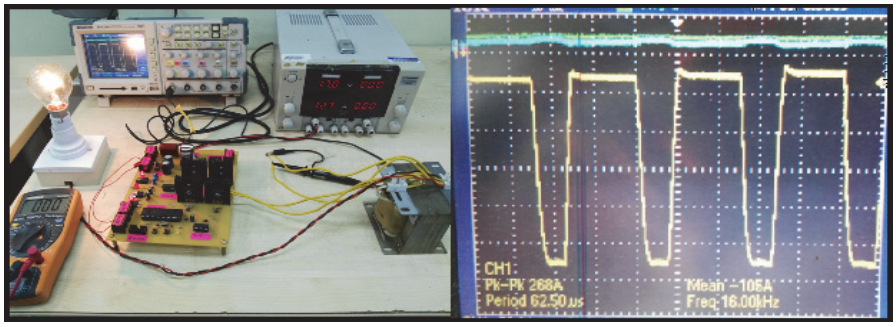

Figure 4: Full Bridge Inverter waveform before filter with load for 17 V DC

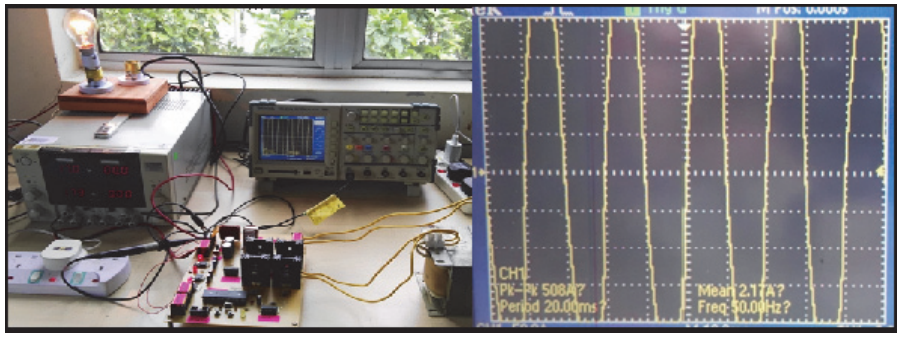

Figure 5: Full Bridge Inverter waveform after filter with load for 17 V DC

RESULTS AND DISCUSSION

The capacitive load is connected to the point after filtering on AC output. Therefore, the full bridge inverter will produced Current Total Harmonic Distortion (CTHD) depended on the type of the AC waveform connected with the capacitive load.

The supply in DC voltage for 17V shows the waveform of the voltage in Figure 6 with the AC voltage after the step up is 236.6 V for the no load and for using the load of the 15 Watts of the bulb for the 17VDC supply is shown in Figure 7 and the output voltage in AC after step up is 201.3V with load. The VTHD of 17VDC supplies is the 13.070% and the CTHD is 12.818%.

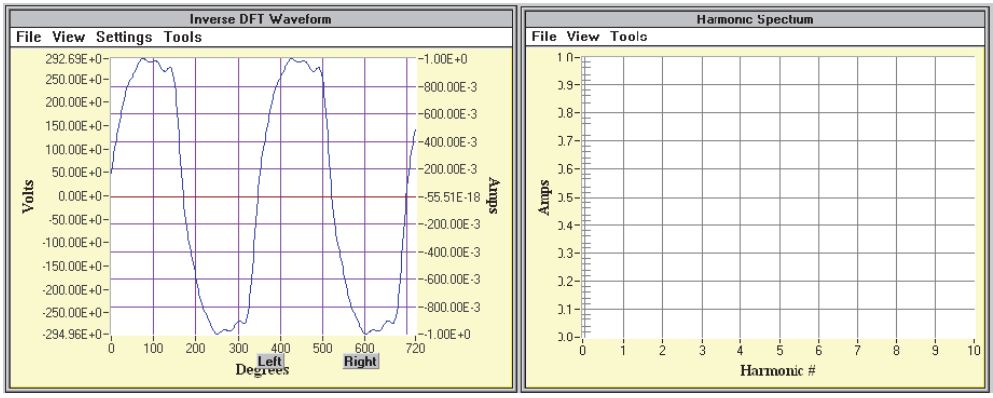

Figure 6: The waveform of the output of AC at 17VDC for no load

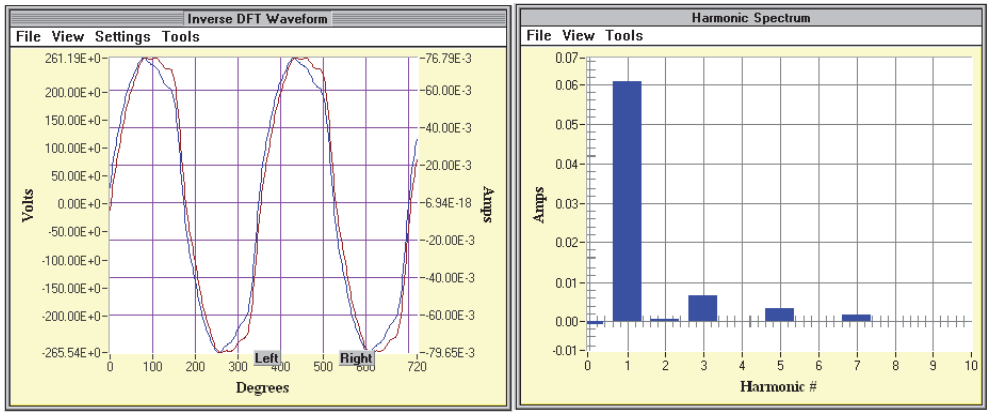

Figure 7: The waveform of the output of AC at 17 VDC for load

CONCLUSIONS

The conclusion is that a sinusoidal pulse with modulation (SPWM) technique for full bridge inverter with LC filter in the DC system is proposed. To generate the sinusoidal waveforms and the switching losses control by the DC/AC stage operates in line frequency square-wave. Both simple and practical SPWM is included in this project. The MPLAB used to simulate the C language to produce a signal for the full bridge inverter circuit. The various parameters for the LC filter controller have been calculated for the Simulink modelling and simulation. The waveform of the SPWM technique before filter, after filtering and after filter with load is shown in this project. This work also presents the VTHD and CTHD of the system for 17 VDC input voltages

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