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# Filter Component Impact on EGS002-based Inverter Circuit Performances

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**Abstract.** This paper examines filter component impact on inverter output. The inverter prototype was designed by using pulse width modulation (PWM) signal generated by EGS002 module, combined with DC voltage source, voltage regulator, MOSFET bridge and low pass filter. As component assembled, the output voltage quality is determined by the choice of filter components. Experiment shows that the calculated values may not suitable as soldering and connection imperfection may change component values. As adjustments were performed, filter components of 12.63 H and 6.5uF generated the finest sinusoidal output of 30.8 V<sub>pp</sub> with frequency of 50,05 Hz.

**Keywords:** Inverter, EGS002 module, low pass filter, sinusoidal voltage

## 1. Introduction

Inverter compliments alternative energy sources such as refilled battery and solar cell. Inverter is often used in remote area where electric supply from the electric company does not exist. Inverter is also applied for stand-alone equipment such as water-pump, street-lighting and other equipment [1].

There are three types of inverter: square-wave, modified sinusoid and sinusoid inverters. The square-wave inverter has the lowest quality but is the lowest in price. Meanwhile, sinusoid inverter is expensive and complicated [2]. Current research has arrived in multilevel inverter [3] and application specific inverter [4].

This paper designed and implemented a sinusoid inverter to convert 12 V DC to 220 V AC by using EGS002 SPWM Driver Board. The EGS002 SPWM Driver Board is a pulse wave modulated (PWM) inverter driver which requires filter to obtain pure sine wave voltage. After designing and implementing the circuit, component adjustments were performed to obtain the expected voltage shape. The following sections discussed the inverter design and implementation, followed by the output signal analysis.

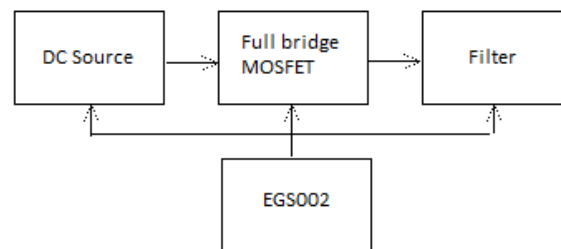
## 2. Inverter Design

In order to realize the expected inverter, the EGS002 SPWM Driver Board is used as the main component. The module employs PWM switching which compare the reference wave to a triangle carrier wave [5]. EGS002 uses an application specific integrated circuit (ASIC) CMOS EG8010 to



manage the circuit. Voltage and current protection, temperature sensor, fan control and indicators are performed by IR2110S. Frequency choices are selected via jumper. EGS002 has been improved from predecessor EGS001 by adding some protection schemes, and liquid display interfacing [6].

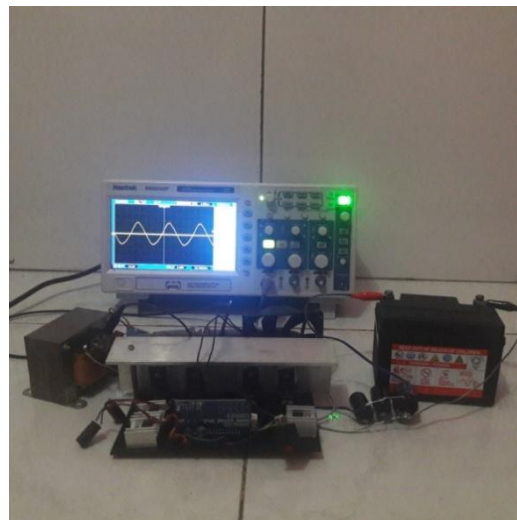
A full H bridge converter is used to change stable DC voltage to AC ripple. The bridge is made from some MOSFET that is controlled EGS002 to switch on and off. A low pass filter is added to reduce high frequency components of the bridge output. Inductor and capacitor combination [7] were employed to perform this task. Figure 1 shows the simplified diagram.



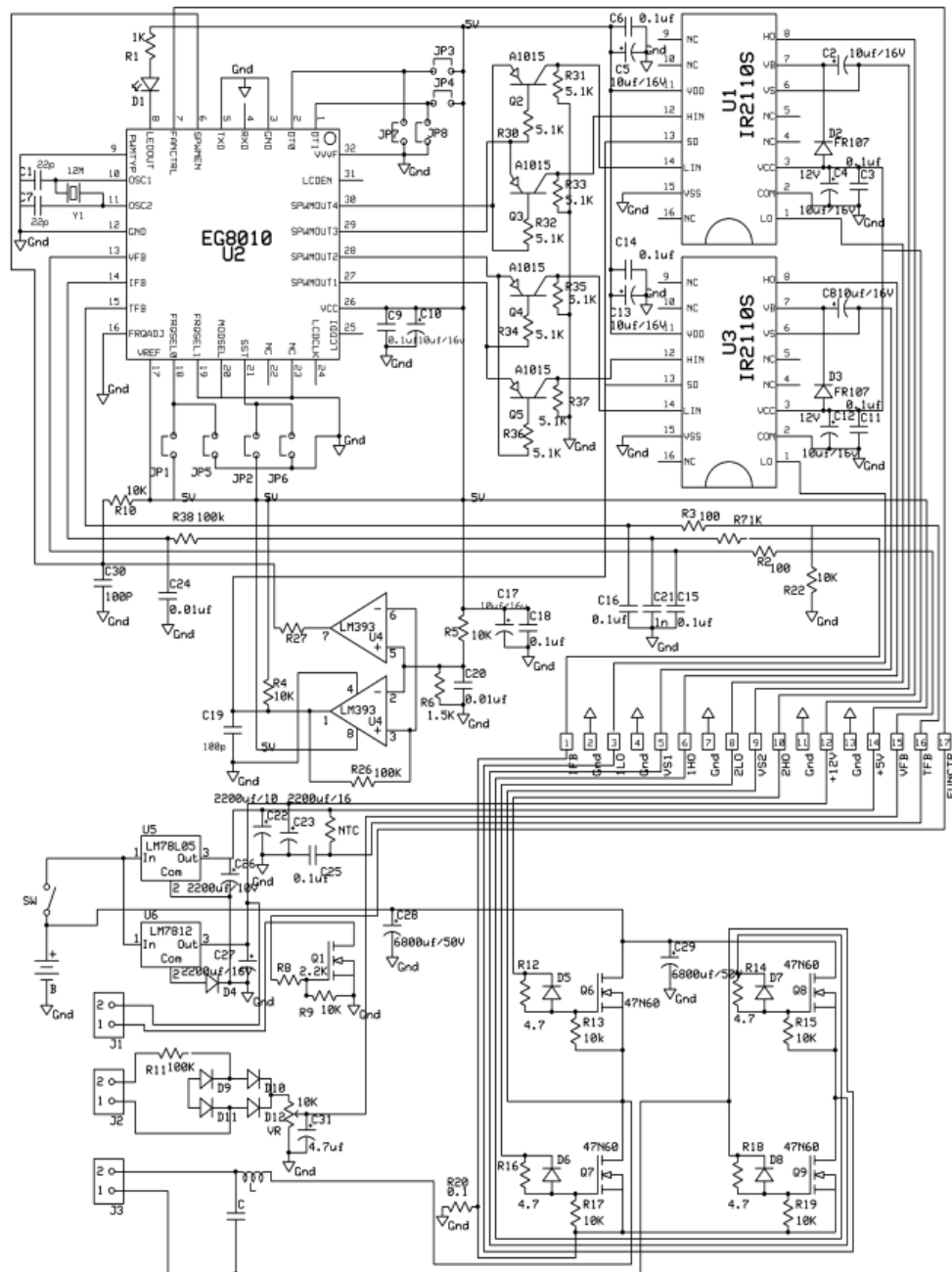
**Figure 1.** Inverter scheme.

In order to realize the inverter circuit, IC 7805 and 7812 were employed for voltage regulator to activate the IC. MOSFET 40N60C3 were employed for the full bridge. The full circuit is shown in Figure 3.

Measurement was performed by setting the circuit as in Figure 2, where output wave form was displayed in an oscilloscope. A 40 AH 12 V Battery was used as the DC voltage source, converted to 220 V AC by the inverter.



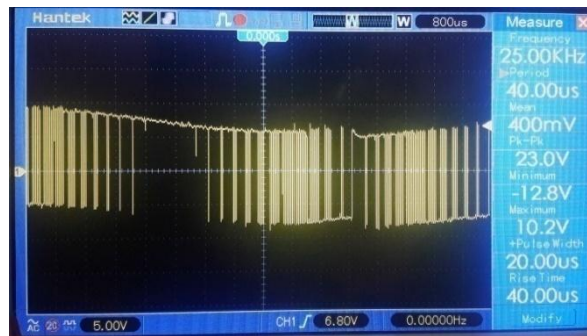
**Figure 2.** Measurement set up.



**Figure 3.** Inverter circuit.

### 3. Capacitor Impact to Inverter Performances

Since voltages to activate IC EGS002 and IR2110S influence the inverter performances, the regulated voltage should be ensured sufficient. Measurement showed that regulated voltages are 5 V and 12.1 V. The battery source was 12.8 V. The PWM voltage generated by MOSFET had frequency of 25 KHz, 23.6 Vpp, minimum voltage was -12.8 V and maximum voltage was 10.2 V.

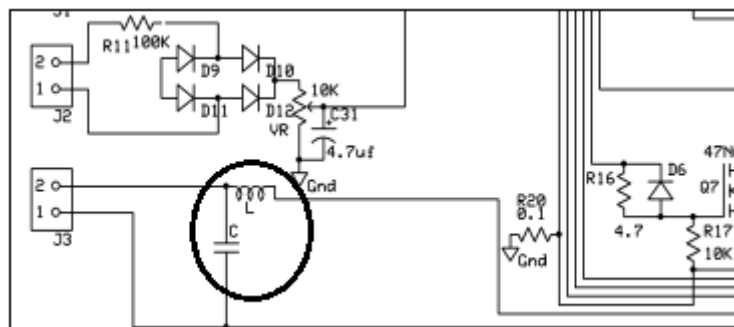


**Figure 4.** PWM output.

Filter circuit within Figure 2 determined the inverter performance. Figure 5 shows second order LC filter. Output input voltage comparison is given by Equation (1) and the resonance frequency in Equation (2):

$$\frac{V_{out}}{V_{in}} = \frac{1}{1 - \omega^2 LC} \quad (1)$$

$$f_c = \frac{1}{2\pi\sqrt{LC}} \quad (2)$$



**Figure 5.** Second order LC filter.

The measurement produced various waveform as LC filter adjusted. Figure 6 shows the variations. The best performance was obtained when LC filter component:  $L=12.63$  H and  $C=6.5$   $\mu\text{f}$  generating 30.8 Vpp (Figure 6d). At this frequency gives 17.57 Hz according to Equation (2). This frequency is far from 50 Hz. This may cause the imprecise component values. Suppose these component values were right, the bode plot was given by (OKAWA Electric Design, 2019) [8] plotted in Figure 7. The gain is about 35 dB at 17.57 Hz and 16.3 dB at 50 Hz. This means, if the L and C are selected so that  $f_c=50\text{Hz}$ , the output may reach 66.13 Vpp.



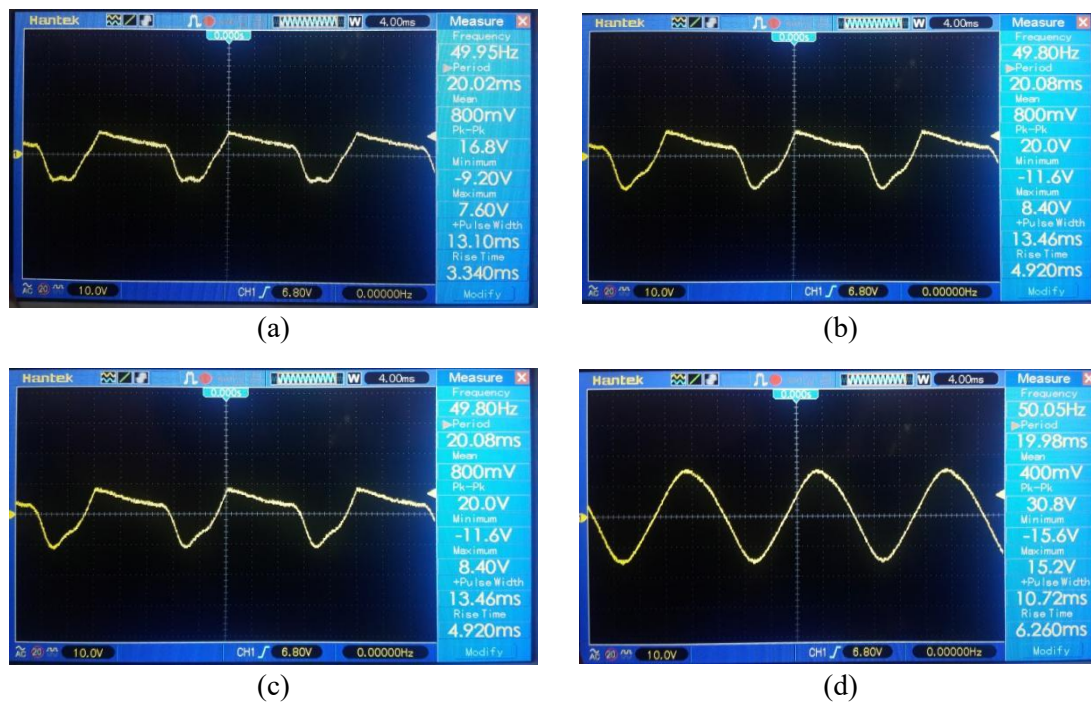


Figure 6. Inverter output to LC filter variations.

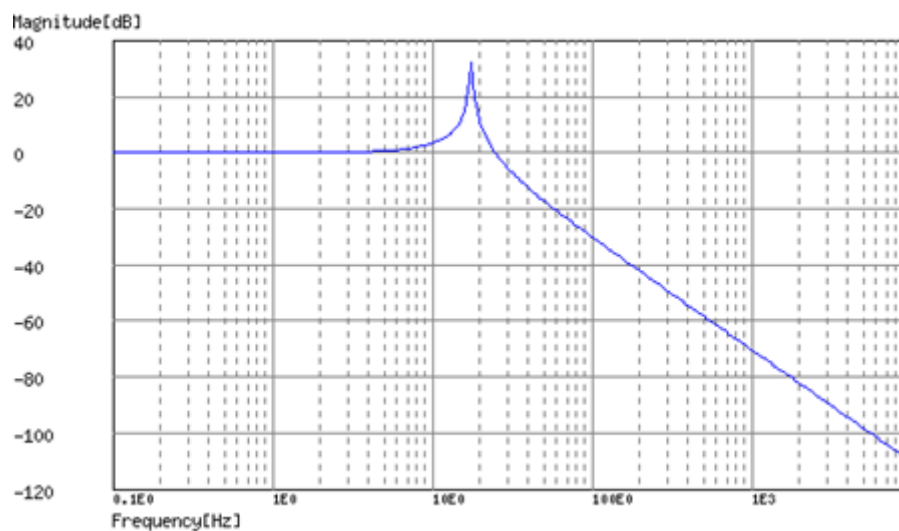


Figure 7. LC Filter bode plot.

#### 4. Conclusions

This paper designed an inverter circuit based on EGS002 where DC voltage was recycled using 40N60C3 H-Bridge MOSFET and the output was filtered by using LC circuit. LC tank was adjusted to get perfect sinusoid shape. The best form was when  $L=12.63$  H and  $C=6.5\mu\text{f}$  generating 30.8 Vpp. Although the plot shows that at these values, circuit was not at 50 Hz, instead it was working at 17.57 Hz, so that output voltage was only 30.8 Vpp. Despite the imperfection, circuits produced sinusoid waveform and filter components held the important role.

## Acknowledgments

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