Journal of Technomaterial Physics Vol. 02, No. 02, 2020 | 75 – 84

talenta PUBLISHER

JoTP
Journal of Technomaterial Physics

Utilization of the EG8010 Microcontroller to Construct a Pure Sine Inverter Using the Single Phase Sinusoidal Inverter ASIC (Application Specific Integrated Circuit) Method

Kurnia Brahmana[1*] and Syukur Fransiskus Jaya Hulu[2]

[1,2]*Department of Physics, Faculty of Mathematics and Natural Science, Universitas Sumatera Utara 20155, Indonesia*

Abstract. A pure sine inverter has been successfully designed by utilizing the EG8010 microcontroller which is used as an alternative energy source when the main power grid is cut. This pure sine inverter tool functions to stop the conversion when the power drops from the minimum value. This tool consists of a microcontroller to run the DC to AC converter instructions for 380 volts. Meanwhile, DC functions as a voltage source that provides the overall voltage. The signal waves that have been converted from DC to AC on the EG8010 Module are needed to control FET which functions as a signal amplifier. This signal is used to drive four FET n-channel and IRF480 which work alternately in sending data to the power FET to form an H-Bridge bridge and the output signal from the H-Bridge. Furthermore, the H-Bridge bridge and the output signal from the H-Bridge are sent through the transformer, so that the final output signal is a pure DC to AC sine wave. The resulting pure sine wave dc to ac can provide a maximum power of 240 watts.

Keyword: Microcontroller EG8010, IRF480, Power H-Bridge, Mosfet, FET

Received 1 July 2020 | Revised [15 July 2020] | Accepted [27 August 2020]

1 Introduction

Utilization of renewable energy is one of the fastest growing solutions in people's lives, especially in the industrial sector. This occurs due to the increasing demand for energy, so that people are looking for solutions to use renewable energy for low cost and environmentally friendly. Solar energy is one of the potential renewable energy sources because of its availability, convenience and use, which is cheaper and optimal operation. Solar energy can be converted into electrical energy so that this condition can be a good solution to overcome the electricity crisis in a country. An AC/ DC power inverter is required to convert the DC voltage collected by the photovoltaic cell into AC voltage. Square-wave inverters have easier and cheaper circuits, but square-wave inverters will lag behind in the process of performance. Then

*Corresponding author at: Jl. Bioteknologi No.1 Kampus USU, Medan, Indonesia, 20155

E-mail address: kurniabrahmana@usu.ac.id

Journal Homepage: https://talenta.usu.ac.id/JoTP

the output data is compared with a sine wave inverter. Sine wave inverter can provide pure sine wave output. Pure sine wave operates in near perfect efficiency, and maximum output [1-6].

Pure sine wave inverter is a tool to convert DC voltage into pure AC in operating AC loads. An inverter cannot generate power but an inverter can only convert DC power into AC power. Pure sine wave inverter is a type of inverter that does not have harmful harmonics for all types of AC loads [1, 3]. There are several methods to generate sinusoidal waves, namely, the Synchronous Pulse Width Modulation (SPWM) method, and the Single Phase Sinusoidal Method (ASIC). The ASIC method has several advantages, one of which is an easier processing, the components used in this method are widely sold, and the output is efficient [7].

Sine wave is one of the basic waveforms that is often used to operate electrical equipment. However, the majority of the current sine waves are supplied only by state electricity companies or can be generated using a generator. So there is a problem that the energy crisis and the cost of supplying electrical energy are getting higher. In this condition, especially in areas that have not been reached by electricity, it is necessary to build a sine wave generator at a lower cost, because the price of inverters sold in companies is relatively expensive [6]. One solution is to use a battery with several electronic circuits added so that it can produce pure sine waves that can be applied to everyday electrical equipment. In this article, an innovation will be made in the manufacture of a pure sine inverter with the single phase sinusoidal inverter ASIC method (Application Specific Integrated Circuit) by utilizing the EG8010 Microcontroller [8-14]. This research is expected to make a pure sine inverter tool that is effective and efficient so that it can be applied optimally in everyday life.

2 Methods

The process of designing a pure sine wave inverter from the EG8010 Microcontroller can be seen in Figure 1 and Figure 2.

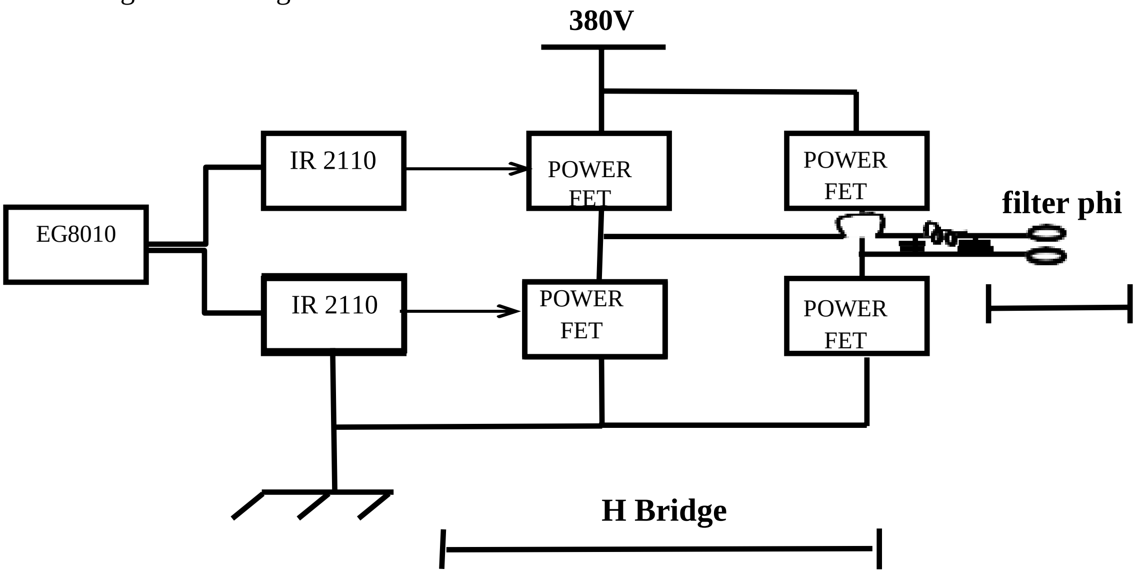

Figure 1. Block diagram of the device

Function of each block of block diagram

1. EG8010 block: EG8010 is a digital pure sine wave inverter ASIC (Application Specific Integrated Circuit) with complete built-in dead time control functions.
2. IR 2110 Block: Controls the voltage and current between the POWER FET
3. Power FET block: Sinusoidal signal amplifier.
4. Phi filter: Filters all excess noise above the critical frequency as close as possible to the desired frequency.
5. 380V DC: The source of the output voltage will be 220VAC and the power to run the circuit on the Microcontroller.
6. 220V AC: The output of the inverter circuit.
7. H Bridge: An H-Bridge or full-bridge converter that has a toggle configuration, consisting of four switches in settings and used as a switch controller.

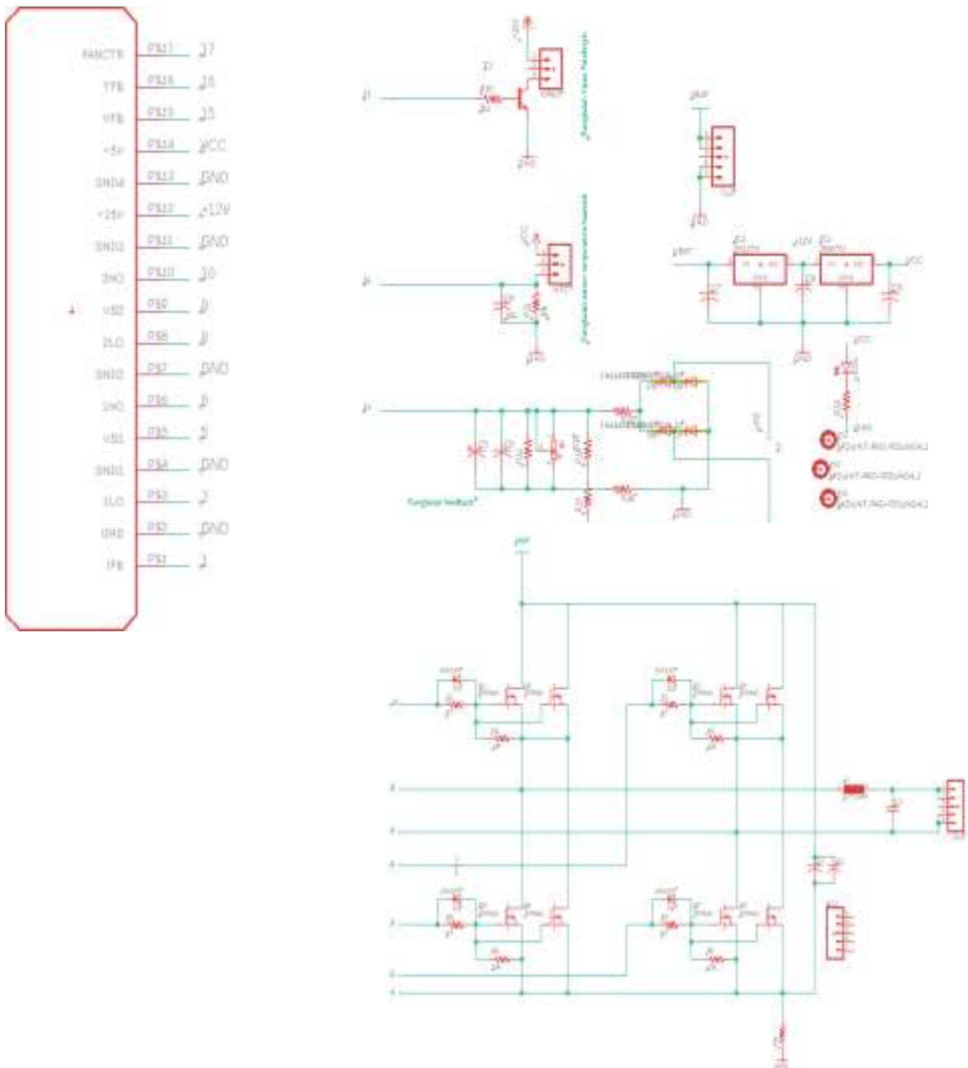

Figure 2. Whole Circuit Trial

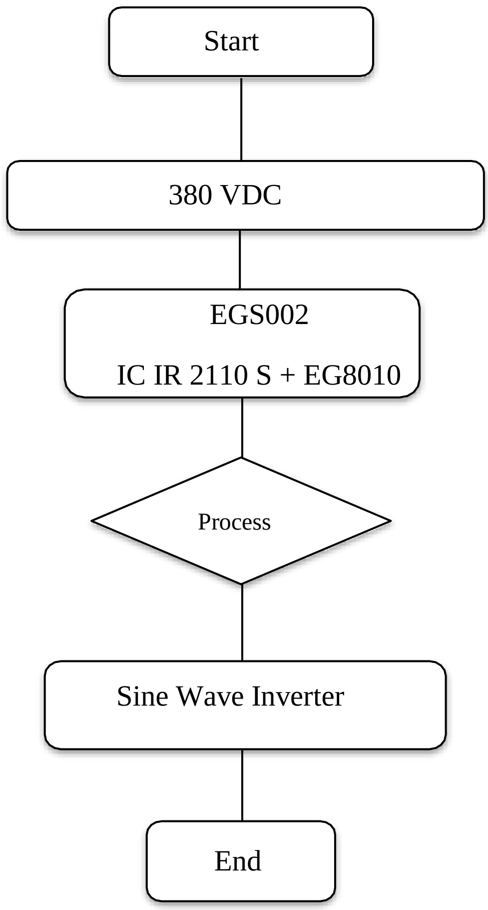

Figure 3. Flowchart

3 Result and Discussion

The AC voltage sensor emits an analog signal that the reading by the sensor is directly received by Arduino via the ADC (Analog Digital Converter) pin, which in this study uses pin A1 on the Arduino board. In this study, resistors were used 670 kΩ and 10 kΩ to a maximum voltage that can be read at 340 volts.

The ACS712 analog value will change according to the current applied and the bias of the circuit. If the ACS712 is connected in a forward biased state according to pins + IP and -IP, the resulting analog value will increase, whereas if connected in a reverse bias state the resulting analog value will decrease. In this research, the current sensor used is the current sensor version ACS712-5A with a range that can be read from -5 A to 5 A. The ACS712-5A current sensor has a sensitivity of 185mV/A and a better resolution than other versions.

Table 1. Testing Data for Pure Sine Inverter DC to AC at 40 Watt Load

No	V_{in} (V)	I_{in} (A)	V_{out}(V)	I_{out}(A)	P_{In}	P_{Out}	Efficiency (%)
1	13.65	2.92	215.2	0.15	39.858	32.280	80.9875
2	13.64	2.86	215.9	0.14	39.010	30.226	77.4819
3	13.65	2.94	215.7	0.15	40.131	32.355	80.6234
4	13.63	2.83	215.9	0.14	38.573	30.226	78.3607
5	13.65	2.94	215.2	0.15	40.131	32.280	80.4365
6	13.65	2.96	215.2	0.15	40.404	32.280	79.8930
7	13.63	2.93	215.9	0.14	39.936	30.226	75.6862
8	13.65	2.83	215.8	0.15	38.629	32.370	83.7960
9	13.65	2.92	215.7	0.14	39.858	30.198	75.7639
10	13.63	2.91	215.1	0.14	39.663	30.114	75.9240
11	13.65	2.94	215.5	0.15	40.131	32.325	80.5487
12	13.65	2.94	215.5	0.15	40.131	32.325	80.5487
13	13.66	2.91	215.7	0.14	39.751	30.198	75.9686
14	13.65	2.94	215.6	0.15	40.131	32.340	80.5860
15	13.65	2.93	215.8	0.14	39.995	30.212	75.5403
16	13.67	2.87	215.9	0.15	39.233	32.385	82.5455
			Average				79.0432

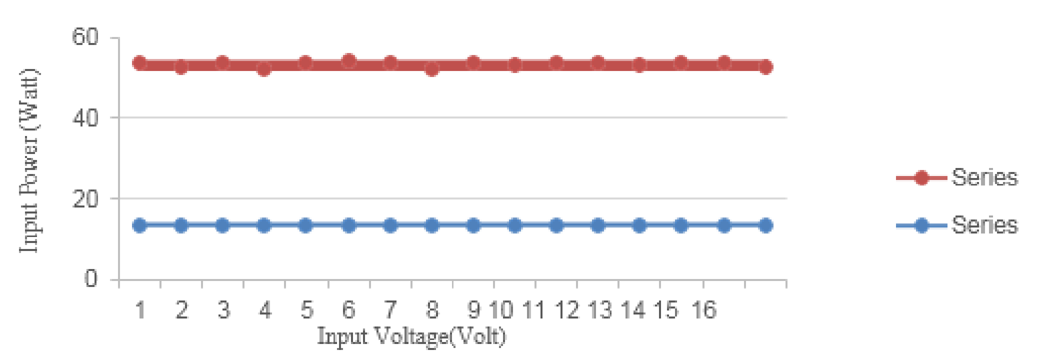

Figure 4. Graph of V Input vs Input Power with a load of 40 Watts

Table 2. Testing Data for Pure Sine Inverter DC to AC at 75 Watt Load

No	V_{in} (V)	I_{in} (A)	V_{out}(V)	I_{out}(A)	P_{In}	P_{Out}	Efficiency (%)
1	13.45	5.55	200.82	0.28	74.648	56.229	75.3268
2	13.48	5.52	211.38	0.27	74.410	57.073	76.7006
3	13.44	5.50	211.38	0.27	73.920	57.073	77.2086
4	13.48	5.51	211.50	0.28	74.275	59.220	79.7310
5	13.40	5.49	200.51	0.28	73.566	56.143	76.3162
6	13.42	5.47	211.50	0.27	73.407	57.105	77.7919
7	13.46	5.48	211.48	0.28	73.761	59.214	80.2790
8	13.44	5.54	211.60	0.28	74.458	59.248	79.5728
9	13.49	5.48	211.70	0.26	73.925	55.042	74.4563
10	13.42	5.46	200.50	0.29	73.273	58.145	79.3537
11	13.44	5.48	211.50	0.28	73.651	59.220	80.4060
12	13.40	5.38	200.20	0.29	72.092	58.058	80.5332
13	13.48	5.50	211.70	0.26	74.140	55.042	74.2406
14	13.41	5.40	211.20	0.27	72.414	57.024	78.7472
15	13.40	5.56	211.50	0.28	74.504	59.220	79.4856
16	13.46	5.54	211.65	0.28	74.568	59.262	79.4733
			Average				78.1014

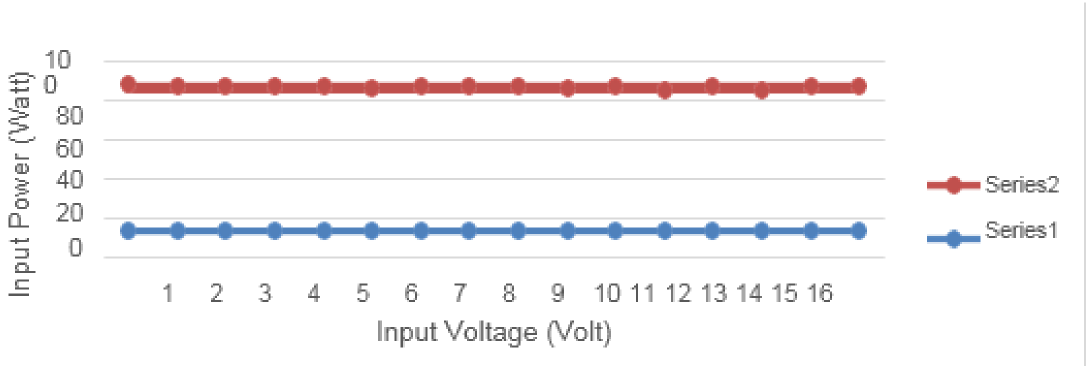

Figure 5. Input Voltage vs Input Power Graph, 75 Watt load

Table 3. Testing Data for Pure Sine Inverter DC to AC at 100 Watt Load

No	V_{in}(V)	I_{in} (A)	V_{out}(V)	I_{out}(A)	P_{In}	P_{Out}	Efficiency (%)
1	13.25	7.42	205.2	0.38	98.315	77.976	79.31241
2	13.26	7.46	205.1	0.37	98.920	75.887	76.71584
3	13.18	7.40	205.3	0.37	97.532	75.961	77.88316
4	13.20	7.50	205.5	0.38	99.000	78.090	78.87879
5	13.22	7.30	205.3	0.36	96.506	73.908	76.58384
6	13.24	7.40	205.4	0.35	97.976	71.890	73.37511
7	13.20	7.20	205.2	0.34	95.040	69.768	73.40909
8	13.18	7.40	205.3	0.33	97.532	67.749	69.46336
9	13.26	7.40	205.5	0.38	98.124	78.090	79.58298
10	13.16	7.44	205.6	0.39	97.910	80.184	81.89528
11	13.18	7.46	205.6	0.38	98.323	78.128	79.46072
12	13.22	7.39	200.7	0.38	97.696	76.266	78.06477
13	13.26	7.45	205.3	0.37	98.787	75.961	76.89372
14	13.28	7.43	205.6	0.38	98.670	78.128	79.18079
15	13.20	7.20	200.2	0.40	95.040	80.080	84.25926
16	13.21	7.42	205.1	0.39	98.018	79.989	81.60627
			Average				77.91034

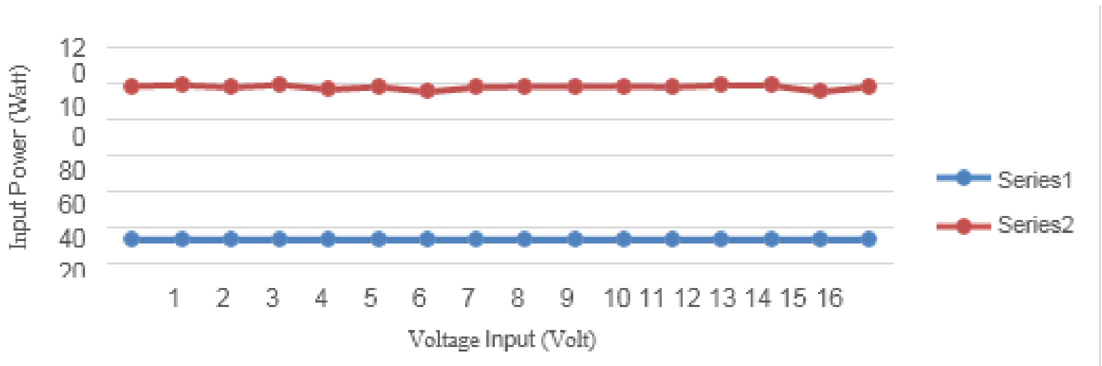

Figure 6. Input Voltage vs Input Power Graph, 100 Watt load

Table 4. Testing Data for Pure Sine Inverter DC to AC at 150 Watt Load

No	V_{in} (V)	I_{in} (A)	V_{out} (V)	I_{out} (A)	P_{In}	P_{Out}	Efficiency (%)
1	12.88	11.20	190.3	0.55	144.256	104.665	72.55504
2	12.90	11.22	192.5	0.58	144.738	111.650	77.13938
3	12.86	11.26	192.3	0.59	144.804	113.457	78.35233
4	12.84	11.20	192.7	0.57	143.808	109.839	76.37892
5	12.84	11.40	192.3	0.58	146.376	111.534	76.19692
6	12.88	11.25	192.4	0.59	144.900	113.516	78.34092
7	12.90	11.26	192.6	0.60	145.254	115.560	79.55719
8	12.84	11.20	188.3	0.60	143.808	112.980	78.56308
9	12.83	11.20	192.6	0.58	143.696	111.708	77.73912
10	12.88	11.28	190.8	0.60	145.286	114.480	78.79609
11	12.90	11.20	192.6	0.58	144.480	111.708	77.31728
12	12.92	11.25	190.7	0.60	145.350	114.420	78.72033
13	12.90	11.18	192.4	0.58	144.222	111.592	77.37516
14	12.80	11.16	192.6	0.56	142.848	107.856	75.50403
15	12.84	11.22	192.3	0.54	144.065	103.842	72.08006
16	12.81	11.16	192.5	0.58	142.960	111.650	78.09899
			Average				77.04468

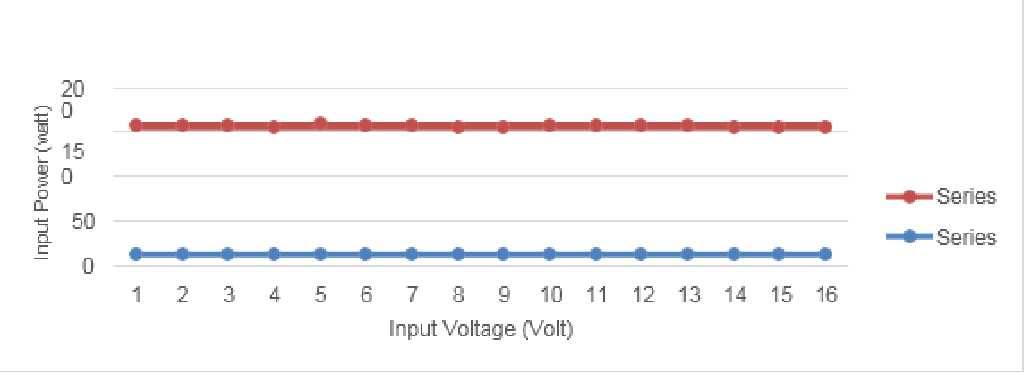

Figure 7. Graph V Input vs Input Power with 150 Watt load

Table 5. Testing Data for Pure Sine Inverter DC to AC at 200 Watt Load

No	V_{in} (V)	I_{in} (A)	V_{out}(V)	I_{out}(A)	P_{In}	P_{Out}	Efficiency (%)
1	12.60	15.72	186.40	0.80	198.0720	149.1200	75.28575
2	12.64	15.70	186.10	0.82	198.4480	152.6020	76.89773
3	12.64	15.72	186.30	0.83	198.7008	154.6290	77.82002
4	12.68	15.72	186.38	0.80	199.3296	149.1040	74.80274
5	12.63	15.70	186.60	0.80	198.2910	149.2800	75.28330
6	12.65	15.78	186.48	0.84	199.6170	156.6432	78.47187
7	12.66	15.75	186.20	0.82	199.3950	152.6840	76.57364
8	12.64	15.70	186.50	0.84	198.4480	156.6600	78.94259
9	12.60	15.74	186.52	0.85	198.3240	158.5420	79.94090
10	12.68	15.77	186.48	0.81	199.9636	151.0488	75.53815
11	12.70	15.74	186.70	0.82	199.8980	153.0940	76.58606
12	12.68	15.75	186.30	0.82	199.7100	152.7660	76.49392
13	12.71	15.78	186.50	0.81	200.5638	151.0650	75.32017
14	12.68	15.76	186.60	0.84	199.8368	156.7440	78.43600
15	12.65	15.68	186.50	0.82	198.3520	152.9300	77.10031
16	12.68	15.76	186.40	0.81	199.8368	150.9840	75.55365
			Average				76.81543

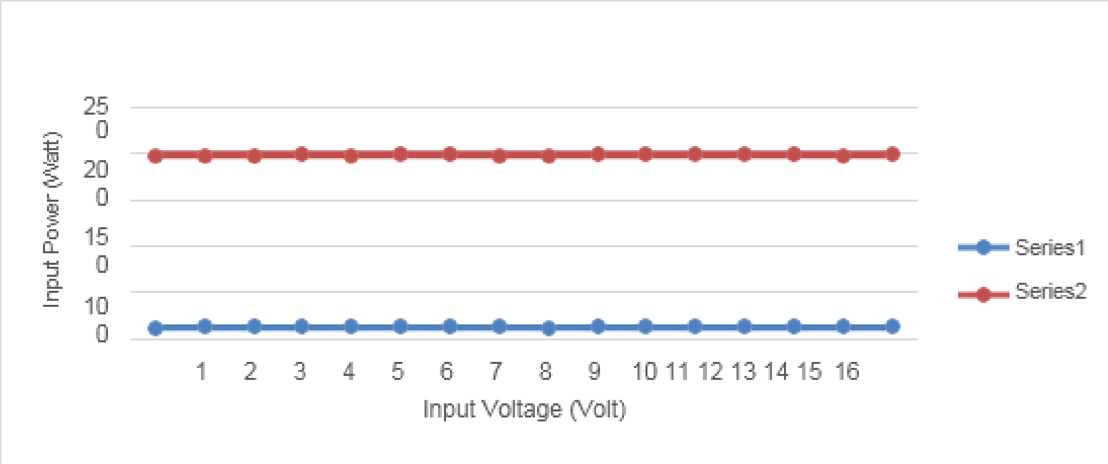

Figure 8. Graph V Input vs Input Power with 200 Watt load

Table 6. Testing Data of Pure Sine Inverter DC to AC with 240 Watt Load

No	V_{in} (V)	I_{in} (A)	V_{out} (V)	I_{out}(A)	P_{In}	P_{Out}	Efficiency (%)
1	12.56	19.90	175.2	1.07	249.944	187.464	75.00240
2	12.56	19.87	175.9	1.08	249.567	189.972	76.12058
3	12.55	19.80	175.7	1.06	248.490	186.242	74.94949
4	12.56	19.87	175.7	1.08	249.567	189.734	76.02538
5	12.53	19.94	175.2	1.07	249.848	187.464	75.03116
6	12.54	19.70	175.2	1.10	247.038	192.720	78.01229
7	12.58	19.86	175.9	1.09	249.839	191.731	76.74188
8	12.57	19.84	175.6	1.08	249.389	189.648	76.04512
9	12.54	19.80	175.7	1.08	248.292	189.756	76.42453
10	12.55	19.90	175.1	1.08	249.745	189.108	75.72043
11	12.54	19.68	175.5	1.05	246.787	184.275	74.66959
12	12.53	19.70	175.5	1.09	246.841	191.273	77.48842
13	12.56	19.88	175.0	1.05	249.693	183.750	73.59043
14	12.57	19.87	175.7	1.08	249.766	189.756	75.97354
15	12.54	19.89	175.6	1.05	249.421	184.380	73.92332
16	12.56	19.70	175.8	1.09	247.432	191.622	77.44431
Average							75.82268

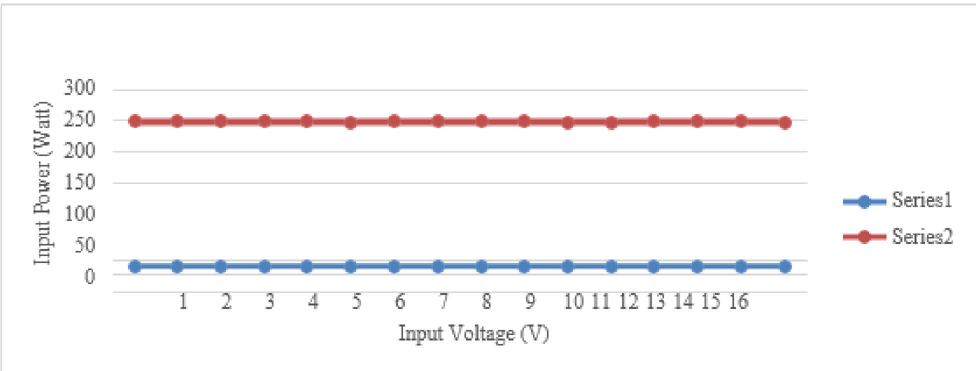

Figure 9. Graph V Input vs Input Power with 240 Watt load

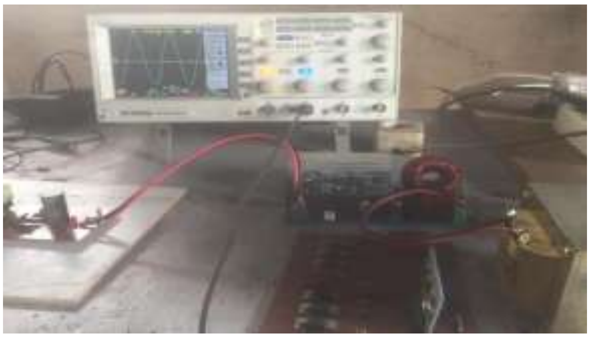

Figure 10. Testing tools

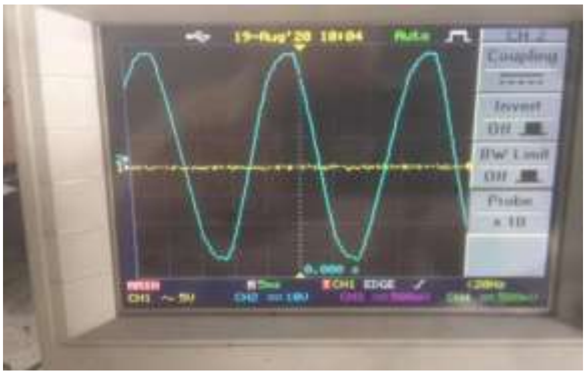

Figure 11. Waveform testing a pure sine wave inverter

4 Conclusion

In this research, it can be concluded that it has succeeded in designing a pure sine wave inverter using the ASIC (Application Specific Integrated Circuit) method. The results of testing the load using the EG8010 Microcontroller can produce a Pure Sinus form with different load power conditions of 40, 75, 100, 150, 200, 240 Watt. When the load is 240 Watt, the inverter output voltage drops to 175 Volt. This is because it is linear with increasing load. Then the benefits generated from the pure sinus inverter are that it can be used for household electronic devices, or other electronic devices. With its output in the form of pure sinus, it will be much safer to use to power electronic equipment.

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