© AUG 2019 | IRE Journals | Volume 3 Issue 2 | ISSN: 2456-8880

Experimental Analysis on a Locally Constructed Inverter

KHIN MAR WIN[1], THET ZIN HTWE[2], DAW AYE THANDAR TUN[3]
[1, 2, 3] *Department of Engineering Physics, Mandalay Technological University, Myanmar*

Abstract- An inverter is designed by using two transformers (a power transformer and a 12V-0V-12V transformer), an LM324N IC, one 4011BCN IC, eight field-effect transistors (IRF Z44N), a DC 12V relay switch, two fuses (a 10A DC fuse and a 3A ac fuse), some active and passive components. The battery voltage and current are measured. The charging level and charging time are also examined.

Indexed Terms- oscillator, discharging time

I. INTRODUCTION

Inverters are very useful electronic devices because they can convert not only ac voltage to dc voltage but also dc voltage to ac voltage when they are connected to a battery. They can be used especially in main ring circuits and lighting circuits but not in heating circuits and large power rating motors. In local market, the available common inverters are China made inverters and local made inverters. The local made inverters are more popular than China made inverters because of their strength and spare parts available facility. China made inverters use the transformer with insufficient power; the wire gates in transformer coils are less than standard size and not perfect standard iron core. So, they cannot provide the maximum power as they express on their device cover. Besides, the output voltages are not stabilizing as local made inverters. The main disadvantages of China made inverters are expensive and rare of spare parts facility. The block diagram of this project is as shown in Figure (1).

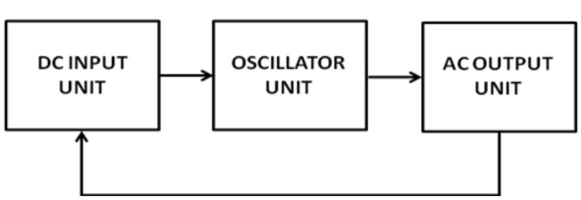

Figure (1) Block diagram of the system

II. EXPERIMENT AND RESULTS

A. Components Used in System

The components used in this project are two transformers (a power transformer and a 12V-0V-12V transformer), one 4011BCN IC, eight IRF Z44N FETs, a DC 12V relay switch, two fuses (a 10A DC fuse and a 3A ac fuse) and some active and passive devices.

- Transformer

A transformer consists of a laminated iron or ferrite core and two or more insulated windings that are most often not connected to each other directly. If one set of winding is used as the input for AC power (the primary winding), the voltage appearing on each of the other winding/windings will be related by the ratio of the number of turns on each of the windings. The current is related by the phenolic inverse of this ratio so that the power does not change. The transformers coils are impregnated in varnish or other protective materials to protect them from mechanical vibration, handling, fungus and moisture. They are most often used to convert the AC line voltage to some other value, lower or higher. The circuit symbol of the transformer is as shown in Figure (2).

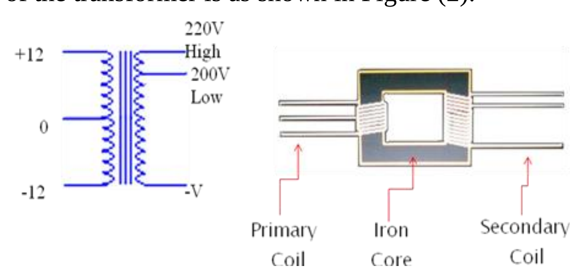

Figure (2) Circuit symbol and construction of the transformer

- 4011BCN IC

It has four 2-input NAND gate inside it as shown in Figure (3). All inputs of the IC are protected by standard CMOS protection circuit. The IC can operate between supply voltage ranges 3V to 18V. It can be used to construct an oscillator circuit.

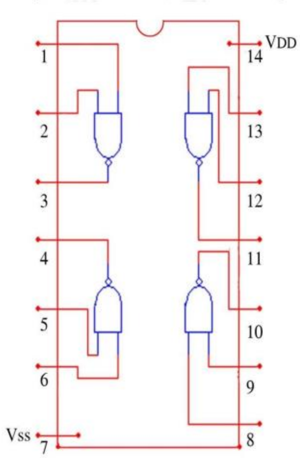

Figure (3) Pin configuration of 4011 BCN IC

- Field-effect Transistor

Field-effect transistors, like bi-polar transistors, have three terminals. They are designed as: source, drain and gate as shown in Figure (4). Source and drain leads are attached to the same block (channel of n or p semiconductor material). A band of oppositely doped material around the channel (between the source and drain leads) is connected to the gate lead.

In normal junction FET operation, the gate source voltage reverse-biases the pn junction, causing an electric field that creates a depletion region in the source-drain channel. In the depletion region, the number of available current carriers is reduced as the reverse biasing voltage increases, making source drain current a function of gate-source voltage. With the input (gate-source) circuit reverse-biased, the FET presents high impedance to its signal source. This is in contrast to low impedance of the forward-biased junction bi-polar transistor base-emitter circuit. Because there is no input current, FETs have less noise than junction transistors.

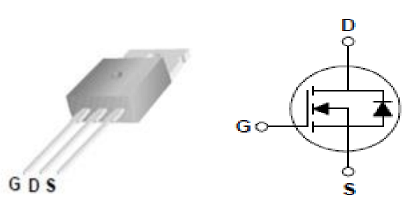

Figure (4) the package and circuit symbol of IRF Z44N field-effect transistor.

- DC 12V Relay Switch

A relay is a device by means of which one circuit is indirectly controlled by a change in the same or in another circuit. An electro-magnetically operated relay normally includes an electro-magnetic (coil) which controls an armature, which in turn actuates (open or close) electrical contacts. The relays are characterized by the coil resistance, coil voltage and the number and types of contacts contained in the relay.

- Fuses

The fuse is used to protect both the wiring from heating and possible fire due to a short circuit or sever overload and to prevent damage to the equipment due to excess current resulting from a failed component or improper use. The fuse is normally placed in an input power line. The source of voltage may be AC or DC.

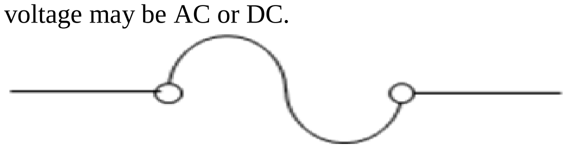

Figure (5) Circuit symbol of a fuse

B. Operation of the System

In this project a 1000W inverter is designed. The system consists of three main units such as DC input unit, oscillator unit and amplified output unit. The other units are the charge limit (inverter limit) unit and battery voltage level indicator unit.

- DC input unit

The DC input unit includes a 12V, 100 ampere hour (AH) battery. The voltage characteristic of the battery is very important to determine whether it is good or not. A standard battery can be used for 20 hours without dropping each cell voltage to 1.7V. This means that a battery with storage capacity 100 ampere hour (AH) can be used for 20 hours with a load current 5A. If 10A load is used with this battery, it can be used for 10 hours in theory. But in practice, it can be used for 8.75 hours only.

- Charging the Battery

The 12V AC sine wave coming from the centre tap of the transformer is passed through the Drain of FET and its phase is converted after passing through the internal rectifier of the FET. This wave is again passed through the Source of the FET and then produces the negative DC voltage. This negative DC voltage is driven into the negative terminal of the battery. By this way, the battery is charged.

C. Standard Voltage Measuring Method

Measuring the DC voltage of the battery with a multi-meter directly cannot give the accurate battery voltage. To get the accurate value of the 12V battery voltage, firstly connect the 12V DC car bulb to the battery for one minute. After one minute, take measuring each cell of the battery under previous condition. Each cell voltage must have 1.95V at least and the voltage difference between two successive cells should be 0.05V. A battery with such condition is good but it needs to charge again. If the voltage difference between two cells is greater the 0.05V, such battery is in defect condition.

Table (2) Voltage measurement value of each cell of 12V battery

Cell	V(V)
First cell	2.01
Second cell	2.02
Third cell	2.00
Fourth cell	1.96
Fifth cell	1.98
Sixth cell	2.01

According to the table results, the maximum difference voltage between two successive cells is 0.04V. This voltage is less than 0.05V, so the battery is serviceable. The standard voltage of each cell of 12V battery is 2.05V. Charging for one hour with appropriate current gives 13.5V (2.2V x 6 cells) for six cells. At the time required to be full charge, two hours, the battery still having 13.2V. When the voltage reaches 14.4V, it is full charge condition. By stopping the charging at full charge condition, the battery voltage will drop to 13.2V. After next one hour, it will continue to drop to 12.6V and after 24 hour without using it, it will give 12.3V. When the battery is used up to the half of the storage ampere left, it will drop to 12V. The battery will be continued to drop the voltage to 10.8V. A battery followed by this condition is a good quality battery. The battery associated with the inverter is also a good quality battery.

Table (3) the battery voltage and charging condition.

V(V)	Condition
14.4	Full Charge
13.2	Cutoff Charge
12.0	Use
10.8V	Recharge Again
2.65 x 6 = 15.9 ~16	The required DC voltage to charge

Trickle Charging Method for 100 AH Battery

To recharge the battery which is almost empty charge, using the trickle charging method is the best one. It contains three steps for charging battery. The table (4) shows the charging level, current setting values and voltage setting values to set during charging process.

Table (4) Charging level, current value and voltage value for trickle charging method

Charging Level	Current (A)	Voltage (V)
First Level	100AH / 20h = 5	10
Second Level	100AH / 5h = 20	14.4
Third Level	100AH / 20h = 5	16.5

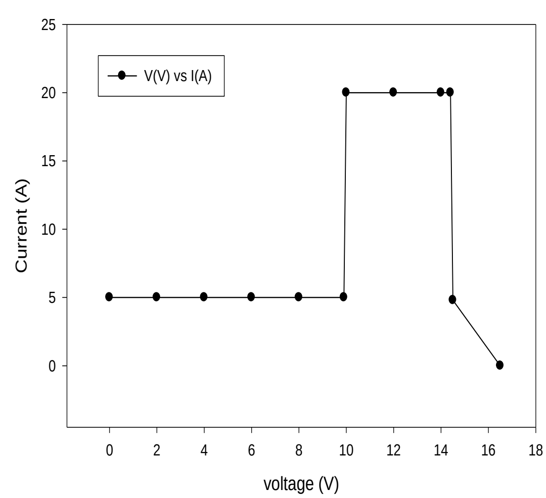

Figure (6) Current-voltage characteristics curve for charging process

D. Oscillator Unit

The main function of the oscillator unit is to generate the squared pulses which are driven into the Gates of the field-effect transistors, Z44. The oscillator circuit is constructed based on the 4011BCN IC as shown in Figure (7).

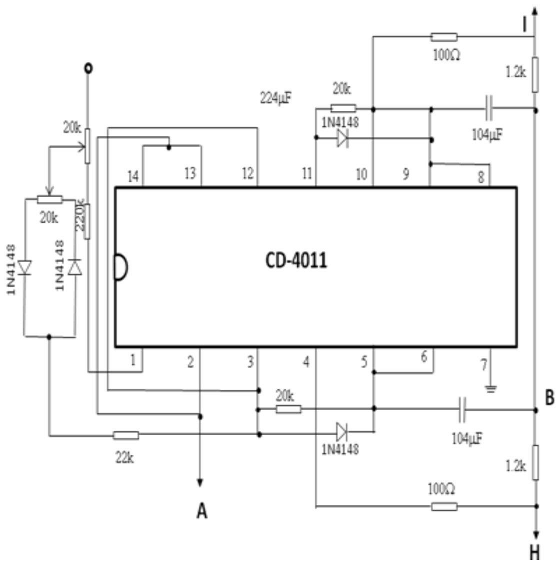

Figure (7) Circuit diagram of the oscillator unit.

E. Amplified Output Unit

The amplified output unit is constructed based on the eight field-effect transistors (FET). These transistors are divided into two groups and each graph consists of four FETs as shown in Figure (8).

- Switches

The inverter consists of two switches and relay AB. The functions of the switches are tabulated in Table (5).

Table (5) Switch mode and function

SWITCH NAME	SWITCH MODE	FUNCTION
SW1	OFF	CHARGING POSITION
	ON	INVERTER POSITION (INV_ON,
SW2	INVERTER HIGH	CHARGING LOW
	INVERTER LOW	CHARGING HIGH
RELAY (RLA and RLB)	OFF	AC DIRECT OUT, BATTERY CHARGE
	ON	MAIN LINE CUTOFF

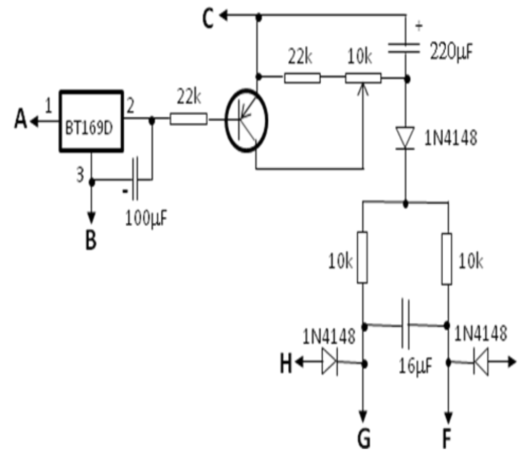

Figure (8) Charge limit / inverter limit circuit

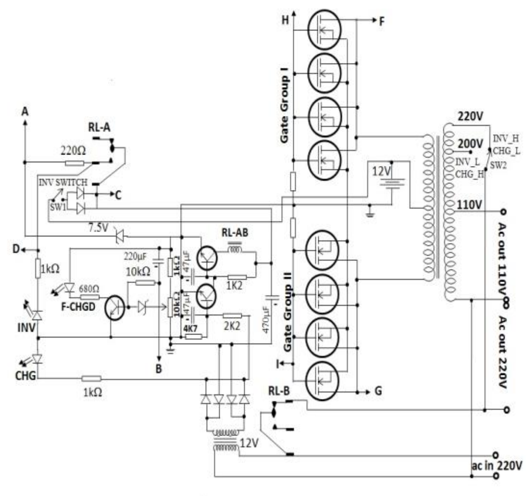

Figure (9) Circuit diagram of the inverter

The circuit diagram of the inverter is as shown in Figure (9). When the inverter is connected to the AC main line and also DC 12V battery, then the switch SW1 is at ON position, the inverter charges the battery. When the AC main line is cutoff, the inverter inverts the dc voltage to ac output.

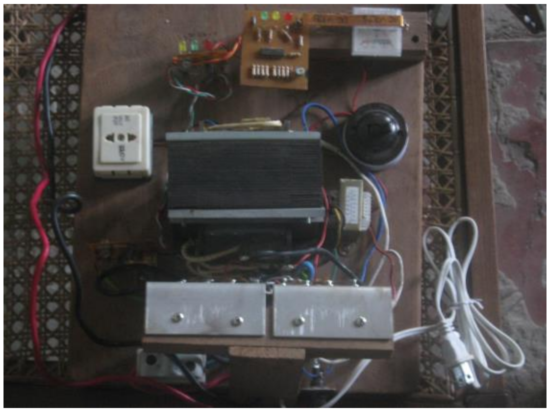

Figure (10) Photograph of the constructed inverter

III. DISCUSSION

To obtain the optimum output result, the components used in this research are selected carefully before the circuit is constructed. The components should have good quality and their accurate value.

In theory, the discharging time of a 100Ah battery can be calculated by equation, $t_{discharging} = 100(Ah) / I(A)$ where I stands for load current in ampere unit and the discharging in hour unit. The constructed 1000W inverter is tested for discharging time and frequency measurements. The tests are taken for several times. The discharging time for 2A, 4A, and 6A load is 50h, 25h and 16h 40min respectively. The data from practical test results follow the theoretical results. The frequency measurements are also taken by using the digital multi-meter VICTOR, VC921 without load condition and with load condition. The output frequencies of battery voltage 8V, 10V and 12V ranges are collected with the digital multi-meter VICTOR, VC921. The frequencies for 8V, 10V and 12V without load are 50.01Hz, 50.02 Hz and 50.02Hz respectively. The frequencies for 8V, 10V and 12V with load are 49.99Hz, 50.0Hz and50.0 Hz respectively.

Precaution must be take care when handle the inverter. It is never connected wrong battery polarity to the inverter. The inverter output is never connected to AC main line directly. It can be safely used to install in separate line.

IV. CONCLUSION

The local made 1000W inverter is successfully constructed. The discharging time recorded for the various load current are agree with the theoretical results. The device is tested for several times with load and without load. The output frequencies of battery voltage 8V, 10V and 12V ranges are collected with the digital multi-meter VICTOR, VC921. The frequencies for 8V, 10V and 12V without load are 50.01Hz, 50.02 Hz and 50.02Hz respectively. The frequencies for 8V, 10V and 12V with load are 49.99Hz, 50.0Hz and50.0 Hz respectively. It is found that all collected frequencies are not much different and stable. So this inverter is reliable and better than any other inverters.

ACKNOWLEDGMENT

We are greatly indebted to Professor Dr Nan Thazin, Head of Department of Engineering Physics, Mandalay Technological University, for her kind permission to carry out this work.

REFERENCES

[1] B. Blick ―Technical Information and Projects, 2002

[2] T. L. Floyd ―Electronic Devices, 2005 (New York: Prentice –Hall)

[3] R. S. Khandpur "Troubleshooting Electronic Equipment" 2006 (New Delhi: Mc Graw – Hill)

[4] C. L. Samuel ― Digital Circuit and Logic Design, 1980 (New Delhi: Prentice – Hall)