DEVELOPMENT OF SMART MULTI-LEVEL INVERTER WITH REMOTE MONITORING SYSTEM

[1]Ravindra Parab, [2]Pawan Pandey
Student M. Tech, Dept. Electrical and Electronics Engineering, Malwa Institute of Technology, Indore[1]
Assistant Professor, Dept. Electrical and Electronics Engineering, Malwa Institute of Technology, Indore[2]

ABSTRACT

This paper deals with a single-phase Multi-level inverter operated with the help of multiple photo Voltaic cells. Initially the simulation would be done with the help of AT mega 328P running on an Arduino UNO to generate the low voltage control signals to operate the MOSFET Switching devices. Further, the control signals would then be triggered by a NodeMCU instead, so that the Inverter parameters and the control signals can be visualized on to the IoT Platform by projecting data to the cloud via ESP8266 enabling remote monitoring of the parameters post Covid-19 pandemic. With connectivity to IoT with the help of an open-source application (ThingSpeak) it'll enable the user to monitor and study the 3, 5 and 7 Multi-Level Inverter outputs in real time, maintaining its health and efficiency for increased performance and reduced production of E-Waste.

Keyword : - Multi-level inverter, Node MCU, AT mega 328P, IoT, ThingSpeak

1. INTRODUCTION

In today's multipurpose world, application of inverters are endless. From industries to residential, they play a vital role in providing constant supply of energy. With use of conventional inverters, they are no longer capable of supplying with enough power as with higher load the inverters tend to lose power and increase the Total Harmonic Distortion in the output. To compensate with that, we use various capacitors and inductors which tend to make the system bulky and highly cost inefficient. Also, post the Covid19 Pandemic, it has become highly difficult to troubleshoot these devices and monitor their health and maintenance.

Thus, introducing Cascaded H-Bridge multi-level inverter for widened spectrum of application in manufacturing industry, automotive industry, aviation industry and much more as a much more reliable source of power. This low power Cascaded H-Bridge multi-level inverter is operated by an Arduino based circuit with its connectivity to IoT, displaying its real time data over the internet which can be accessible to the user from far off locations representing endless possibilities to the next phase of digital revolution. The circuit has three different 3, 5 and 7 phase multi-level inverters connected in series to boost up the power linearly and reducing the Total Harmonic Distortion for steady output. To increase the efficiency of the inverter, it can operate on different power sources including DC Battery, AC-DC Transformers diode and Photovoltaic Panels making it completely eco-friendly thus compliant in deserted locations.

2. OBJECTIVE

To prototype a smart Cascaded Multi-Level H-Bridge Inverter, which would be charged by Solar PV cells and equipped with IoT Connectivity and to allow the user to then remotely monitor the Inverter parameters and Control signal levels through the IoT platform and accordingly assist in maintenance and life monitoring.

3. PROPOSED SYSTEM

The system is designed mainly to assist the user to determine the life cycle and operating levels of the inverter. The system would harness solar energy through the photo-voltaic cells and convert them into an alternating waveform using switching devices.

The Components used are

- NodeMCU
- ATmega328
- Mct2e Optocoupler

- MOSFET IRFP9540
- MOSFET IRF540
- Tip 122
- Tip 127
- Transformer 0-12v 500ma
- Electrolytic Capacitor 1000uf
- Dht11
- LDR

3.1 System 1

The initial prototype would consist of an H-Bridge orientation with the Arduino UNO giving the timed control signals to enable and disable the switching devices. The inverter would be a cascaded orientation, and the waveforms for a 3-level, 5-level and a 7-level inverter would be obtained and verified through an oscilloscope.

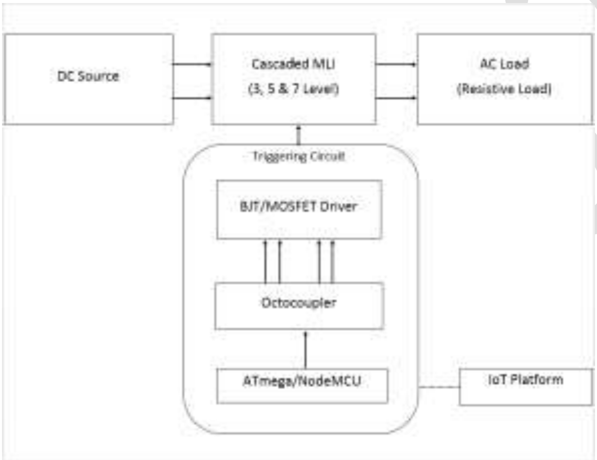

Fig. 1 Block Diagram of Smart Multilevel Inverter

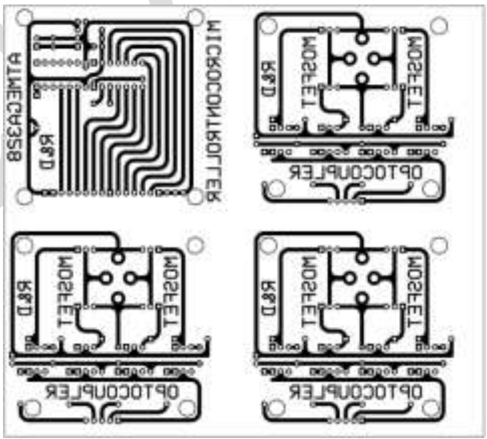

Fig. 2 PCB Design for ATmega 328P controlled Inverter

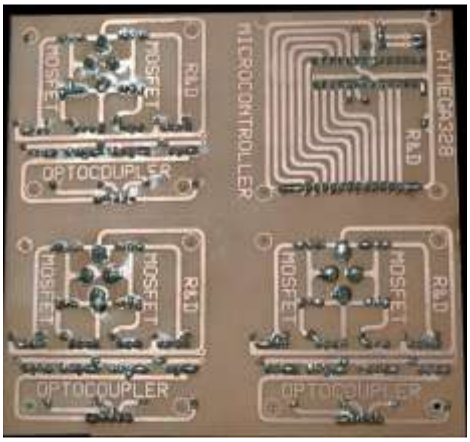

Fig. 3 Fabricated PCB for ATmega 328P controller.

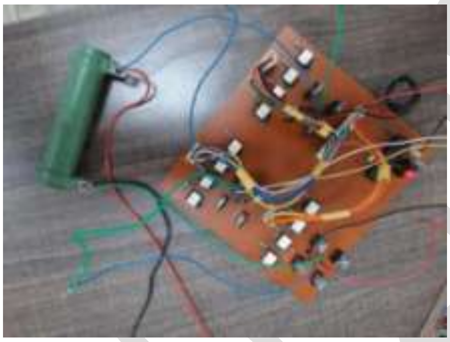

Fig. 4 PCB with connected components and a test load of 500 ohms.

Fig. 5:- 3 level Sinusoidal Output

Fig. 6:- 5 level Sinusoidal Output

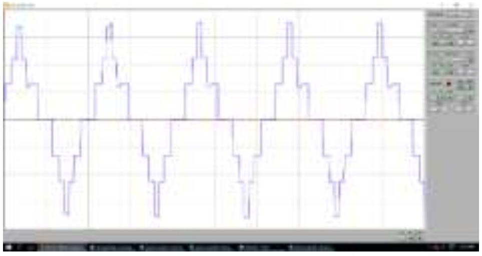

Fig. 7:- 7 level Sinusoidal Output

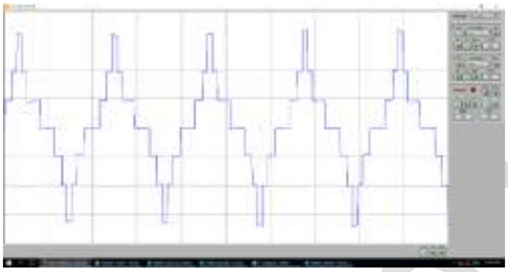

Fig. 8:- 7 level Sinusoidal Output with 500ohm Load

3.1 System 2

The second prototype would see the Arduino UNO being replaced by a NodeMCU to provide seamless internet connectivity. The NodeMCU running on ESP8266 firmware would connect to the ThingSpeak platform running on a HTML Protocol. In addition to the control signals, the NodeMCU would also send the instantaneous 4, 8 and 12 Channels data (For 3-5-7 Levels) onto the cloud platform where the same waveforms can be realized and remotely viewed and monitored by the user.

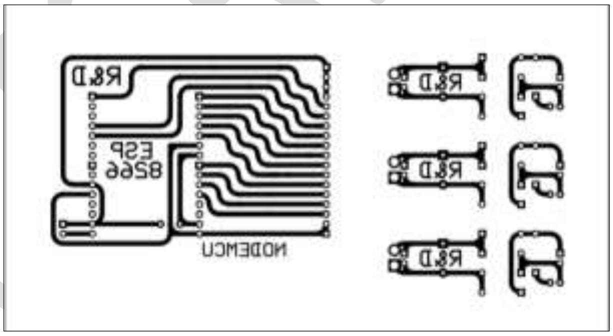

Fig. 9 PCB Design for NodeMCU controlled Inverter

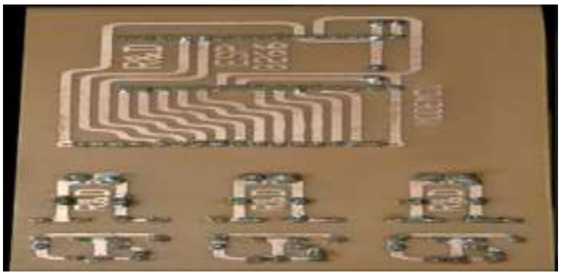

Fig. 10 Fabricated PCB for NodeMCU controller.

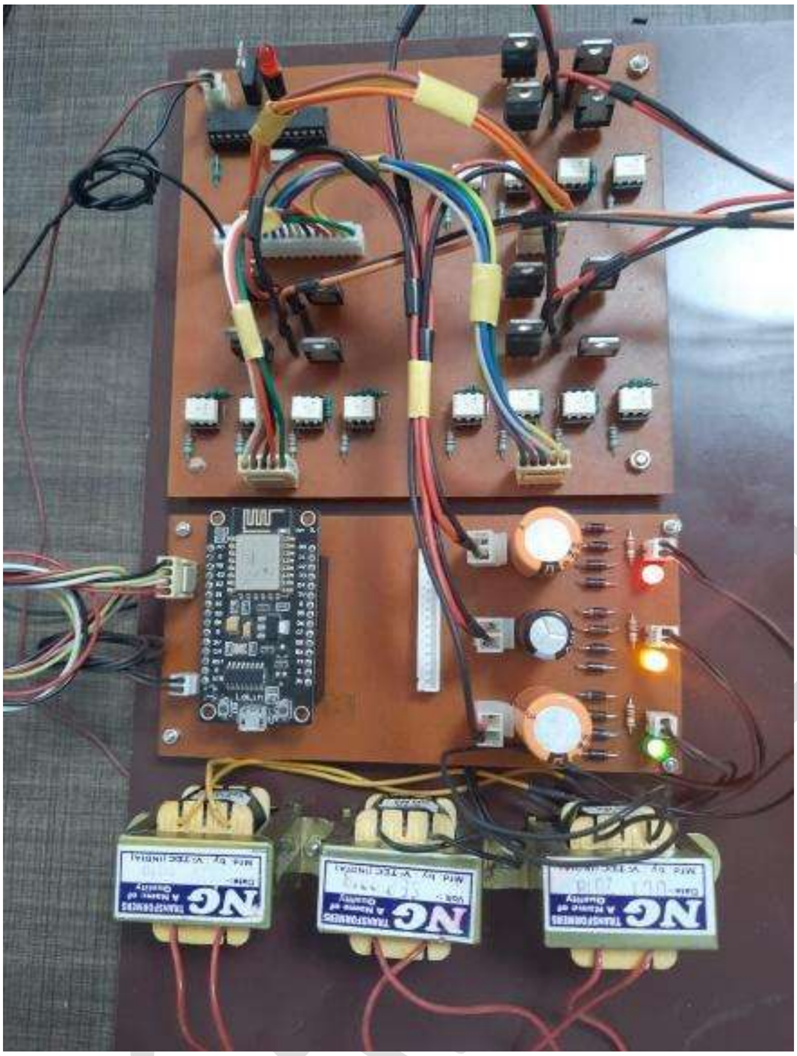

Fig. 11 PCB with connected components

Fig. 12:- 3 Level Inverter Control Signal Values

Fig. 13 3 Level Inverter Control Signal Values

Fig. 14 5 Level Inverter Control Signal Values

Fig. 15 Temperature and Humidity Monitoring of Inverter

4. COMPARISON OF TWO SYSTEMS

S.No	SYSTEM 1	SYSTEM 2
1	Logic level runs on 5V signals	Logic level runs on 3.3V signals
2	Quicker response time and higher frequency	Reduced response time due to connectivity delays.
3	Limited up to 7 level multilevel inverter configuration	Limited up to 5 level multilevel inverter configuration
4	Remote monitoring is not possible	Distant monitoring is possible of all inverter parameters.
5	Easy hardware installation and implementation	Typical hardware installation and implementation

CONCLUSIONS

The two proposed models were prototyped using an ATmega 328p controller and another running on a NodeMCU. The output for 3,5 and 7 levels were verified on an oscilloscope for both systems. The following conclusions were noted:

- Remote monitoring is feasible with a suitable IoT platform to observe the inverter control signals and other parameters such as its Temperature, Humidity or even Light intensity.
- Both systems are cost effective for low to mid-range power outputs, with only the second system being a little complex to design than the other.
- A drawback of the second system is a slight delay, which occurs when data is being transmitted to the IoT platform. This would result in a lower frequency of sinusoidal output as compared to the first system.

REFERENCES

1. A, RATHY G. Iot Based Smart Controlled Inverter. Apr. 2020, Iot Based Smart Controlled Inverter.
2. hatiya, Vinayak k, et al. "Implementation of Iot Based Monitoring and Controlling Solar System." International Journal of Innovative Technology and Exploring Engineering (IJITEE), Volume-9 Issue-5, Mar. 2020.
3. Bhumika V.N, Chethan N.P. "MONITORING OF IOT BASED SMART INVERTER USING RASPBERRY PI." International Journal of Emerging Technologies and Innovative Research JETIR, JETIR, Oct. 2020, www.jetir.org/view?paper=JETIREH06020.
4. Bilhan, Ayse Kocalmis, and Sedat Sunter. "Simulation and Design of Three-Level Cascaded Inverter Based on Soft Computing Method." Tehnički Vjesnik, Strojarski Fakultet u Slavonskom Brodu; Fakultet Elektrotehnike, Računarstva i Informacijskih Tehnologija Osijek; Građevinski i Arhitektonski Fakultet Osijek, 15 Apr. 2020, hrcak.srce.hr/236799.
5. Menon, Gopal G, et al. "IoT Enabled Solar Smart Inverter." International Research Journal of Engineering and Technology (IRJET), Volume: 07 Issue: 04 | Apr 2020, 4 Apr. 2020.
6. Shuvo, Shuvangkar, and Eklas Hossain. "Design and Hardware Implementation Considerations of Modified Multilevel Cascaded H-Bridge Inverter for Photovoltaic System." IEEE Xplore, 24 Jan. 2019, ieeexplore.ieee.org/document/8625414.
7. Singaravelu, T. Design and Implementation of Seven Level Cascaded H-Bridge Inverter Using Low Frequency Transformer with Single DC Source. Apr. 2013,