

# Development of graphical user interface for Power Monitoring and Controlling to reduce energy consumption

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**Abstract** -- The main goal of this paper is development of Graphical user interface for monitoring and controlling the energy usage of AC devices. As per rising the energy uses electricity bill is also increase so, it become necessary to maintain the uses for reduce increasing electricity bills. The system consists of two or more “node” modules and a Central Server Module. The nodes record data about the power consumption of the devices/appliances that are connected, and wirelessly transmit that data to the central server for processing. The server displays the readings from these nodes through a user interface in real-time. The goal of this paper is to help users better understand how power is consumed by their devices and adapt their behaviour to reduce their energy consumption. Moreover, users are able to remotely control the power On/Off of individual devices via the central server.

**Index Terms**– Graphical User Interface , Power Monitoring , Energy usage. Energy management, ESP8266.

## I. INTRODUCTION

Since industries works for 24 hours it is necessary to manage power in industries. Energy management is the predictive, organized and systematic coordination of the procurement, conversion, distribution and use of energy to cover requirements while taking account of ecological and economic aims. The term thus describes actions for the purpose of efficient energy handling. The goal is to facilitate the use and comprehension of power equipment by developing a simple tool that is very intuitive and easy to use. An example of a human machine interface on a PC based power system controller will be demonstrated. In a world of rising energy costs people are starting to look for better ways to help reduce their increasing electric bills. One way of reducing these costs is to monitor how much power is being consumed in real time and from that data make informed decisions about how to manage the electrical devices being powered. A system which can give users an idea of how much power is being, has been, and might be consumed will allow them to adjust their habits and lower the costs.

This article builds a smart monitoring and control system power usage. The system presents the complete picture of current usage of electricity. It uses wireless communication to monitor energy saving and safety use. This can provide the elder a safe and energy-saving environment and service for daily life. It is done by VI circuit to measure electric parameters of all outlets for digitizing electric signal. Then the signal is processed by the microcontroller for analysis and unified output format. The processed measurements are sent by the wireless module. The controlling computer will display parameters to control the state of outlets. A user interface is designed from the user’s perspective.

- So divide this work in to four parts: 1.) VI circuit – Measuring Part  
 2.) Microcontroller Part – Calculating or controlling part  
 3.) Wi- Fi Module – Data transmission Part  
 4.) Graphical User Interface – Monitoring and controlling part

## II. INTRODUCTION TO PERFORMING PARTS

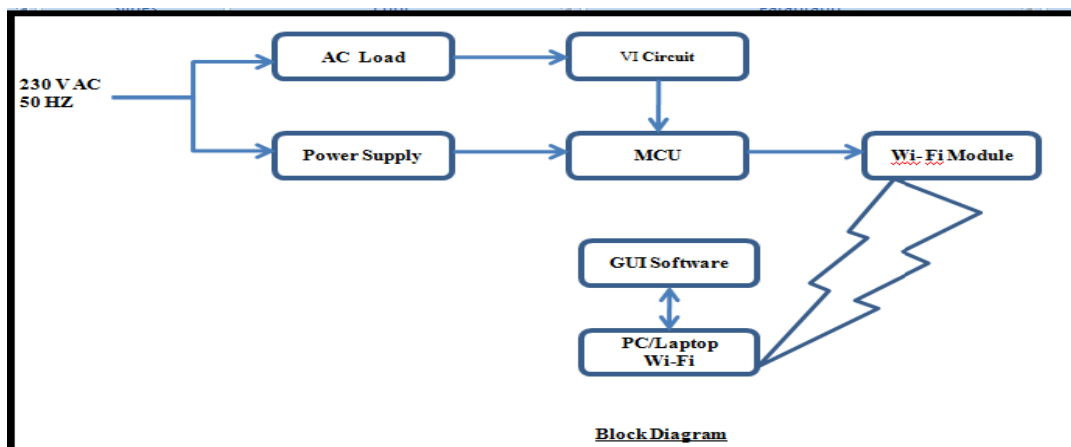


Fig 1. Block Diagram

## 1. VI circuit – Measuring Part

To measure the power consume by the ac load it is necessary to connect it with the AVR MCU. Generally Supply voltage is 230V and 50HZ but microcontroller require small voltage up to +5V so, to obtain require value below two device is used.

- **Step down transformer:** Use 12V and 500 mA transformer to step down the supply voltage.

- **Voltage Divider:** It is used to reduce the transformer output voltage 12V into smaller one. By using two series resistors and input voltage of 12 volt transformer we can reduce the output voltage in range of 0 to 5 volt.

An AC voltage measurement is needed to calculate real power, This measurement can be made safely (requiring no high voltage work) by using an transformer . The transformer provides isolation between the high and low AC voltage.

As in the case of current measurement with a CT sensor the main objective for the signal conditioning electronics detailed below is to condition the output of the transformer so that it meets the input requirements of the Arduino analog inputs: a **positive voltage between 0V and the ADC reference voltage** (Usually 5V or 3.3V - emontx).

The signal conditioning electronics needs to convert the output of the transformer to a waveform that has a positive peak that's less than 5V (3.3V in the case of the emontx) and a negative peak that is more than 0V and so we need to **1) scale down** the waveform and **2) add an offset** so that there is no negative component.

The waveform can be scaled down using a voltage divider connected across the Transformer terminals and the offset (bias) can be added using a voltage source created by another voltage divider connected across the MCU supply (in the same way as we added a bias for the current sensing CT circuit).

**Resistors R2 and R1** form the voltage divider that scales down transformer AC voltage and resistors **R3 and R4** provide the voltage bias. Capacitor **C1** provides a low impedance path to ground for the a.c. signal. R1 and R2 need to be chosen to give a peak-voltage-output of around 1V, for an AC-AC adapter with an AC 9V RMS output a resistor combination of 10k for R1 and 100k for R2 would give a suitable output:

$$\begin{aligned} \text{peak-voltage-output} &= R1 / (R1 + R2) \times \text{peak-voltage-input} \\ &= 10k / (10k + 100k) \times 12.7V \\ &= 1.15v \end{aligned}$$

### 1.1 Voltage Bias

The voltage bias provided by R3 and R4 should be half of the Arduino supply voltage and so R3 and R4 need to be equal. Higher resistance lowers energy consumption. For the emontx where low power consumption on battery power is important we have used 470k resistors for both R3 and R4.

If the MCU is running at 5V the resultant waveform of the circuit has a positive peak of  $2.5V + 1.15V = 3.65V$  and negative peak of 1.35V satisfying the MCU analog input voltage requirements and leaving plenty of room so that there is no risk of over or under voltage.

The 10k and 100k R1 and R2 combination also works fine for 3.3V as used by the emontx. With a positive peak of 2.8V and a negative peak of 0.5V

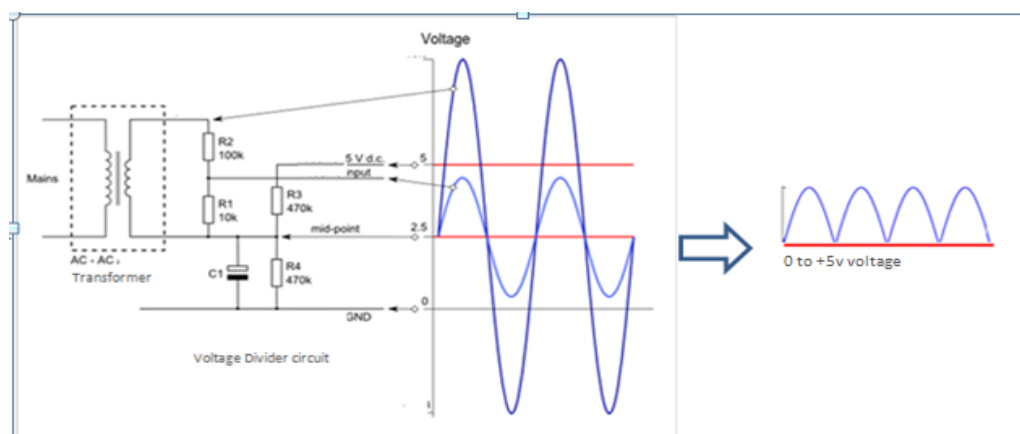


Fig 2. Scaling down the supply voltage

**1.2 Adding a DC Bias :**

If you were to connect one of the CT (+ burden) wires to ground and measure the voltage of the second relative to ground, the signal would oscillate from positive to negative voltage. The Arduino requires a positive voltage only and so by connecting the end of the CT that we just connected to ground to a 2.5 V level (half of the supply voltage) instead, the signal voltage will now oscillate around 2.5 V and remain positive.

Resistors R1 & R2 in the circuit diagram above make up a voltage divider that provides this 2.5 V level (1.65 V for the emonTx). Capacitor C1 has a low reactance - and provides a low impedance path for the alternating current, effectively bypassing the resistor

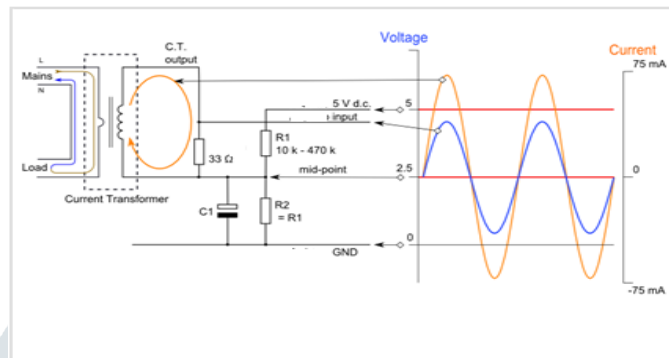


Fig 3. Scaling down the supply voltage

**2.) Microcontroller Part – Calculating or controlling part**

ATmega328P is used as a microcontroller, because it is to programming in c language and easily available

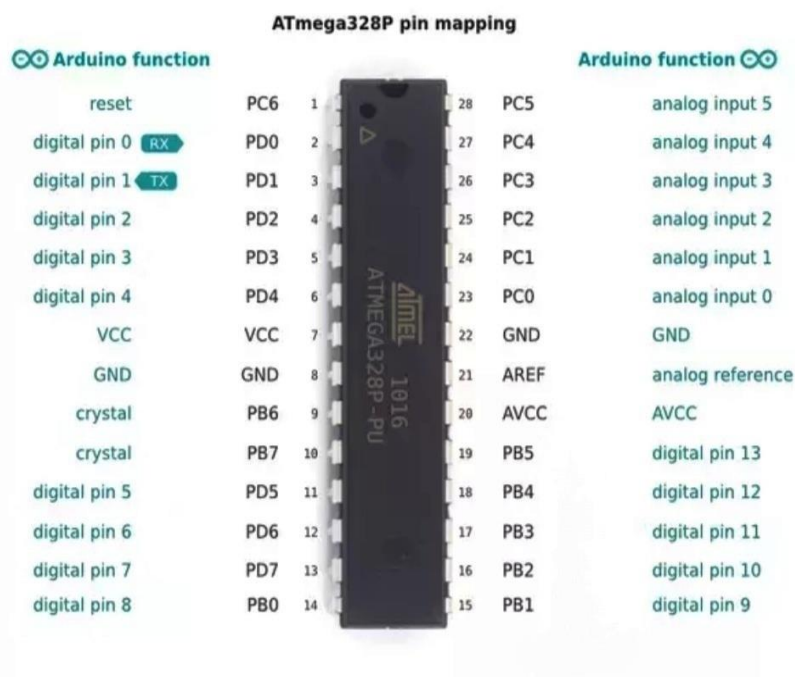


Fig 4. ATmega328P pin Diagram

Now voltage between 0 to 5kg can be given to controller. As per above current is also given. Both Voltage and Current are given to analog pin of MCU. As  $P= VI$  now power consume by ac load is obtain.

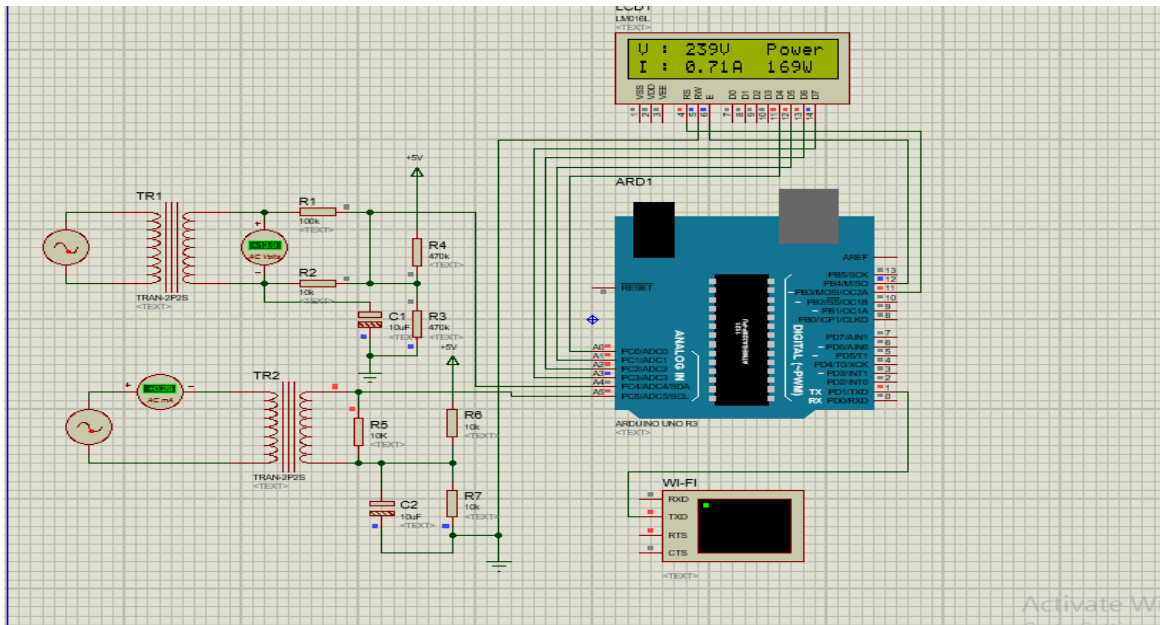
Voltage is given to Analog input 4 ,

Current is given to Analog input 5

As  $P= VI$  now power consume by ac load is obtain.

Now Voltage , current and Power consume by Ac load are obtain and it is display on LCD.

**Simulation :**



**3.) Wi- Fi Module – Data transmission Part**

Wi-Fi Module : ESP8266 Is used. low cost Wi-Fi microchip can give any MCU to Wi-Fi connection.

To use ESP8266 first configuration is require.

Refer following table for configuration of Wi-Fi Module by AT command.

S/N	Commands	Description
1.	AT	Tests AT startup.
2.	AT+RST	Restarts the module.
3.	AT+GMR	Checks version information.
4.	AT+RESTORE	Restores the factory default settings of the module.
5.	AT+CWSAP ?	To Know the SSID and AP mode name AT + CWSAP : FaryLink-96d59F
6.	AT + CWLAP	To list of all available AP
7.	AT+CWJAP_DEF	Connects to an AP; Configuration Saved in the Flash AT+CWJAP_DEF = “ SSID NAME “ , “PASSWORD”
8.	AT + CWSAP_DEF	To change SSID name and Pssword AT + CWSAP_DEF=”LabVIEW “ , “1234567890”
9	AT + CIFSR	To Know the IP address
10	AT+UART_DEF	The default UART configuration, saved in flash. AT+UART_DEF=<baudrate>,<databits>,<stopbits> ,<parity>,<flow control> <ul style="list-style-type: none"> <li>• &lt;baudrate&gt;: UART baud rate</li> <li>• &lt;databits&gt;: data bits <ul style="list-style-type: none"> <li>▸ 5: 5-bit data</li> <li>▸ 6: 6-bit data</li> <li>▸ 7: 7-bit data</li> <li>▸ 8: 8-bit data</li> </ul> </li> <li>• &lt;stopbits&gt;: stop bits <ul style="list-style-type: none"> <li>▸ 1: 1-bit stop bit</li> <li>▸ 2: 1.5-bit stop bit</li> <li>▸ 3: 2-bit stop bit</li> </ul> </li> <li>• &lt;parity&gt;: parity bit <ul style="list-style-type: none"> <li>▸ 0: None</li> <li>▸ 1: Odd</li> <li>▸ 2: Even</li> </ul> </li> <li>• &lt;flow control&gt;: flow control <ul style="list-style-type: none"> <li>▸ 0: flow control is not enabled</li> <li>▸ 1: enable RTS</li> </ul> </li> </ul>

		<ul style="list-style-type: none"> <li>▸2: enable CTS</li> <li>▸3: enable both RTS and CTS</li> </ul> <p>EX : AT+UART_DEF=9600,8,1,0,0</p>
11.	AT+CWMODE_DEF	<p>Sets the Default Wi-Fi mode; Configuration Saved in the Flash                  AT+CWMODE_DEF:&lt;mode&gt;                  &lt;mode&gt;: 1: Station mode                            2 : SoftAP mode                            3: SoftAP+Station mode                  EX :AT+CWMODE_DEF=2</p>
12.	AT+SAVETRANSLINK	<p>Saves the Transparent Transmission Link in Flash                  AT+SAVETRANSLINK=&lt;mode&gt;,&lt;remote IP&gt;,&lt;remote port&gt;, &lt;type&gt;                  [&lt;UDP local port&gt;]</p> <ul style="list-style-type: none"> <li>• &lt;mode&gt;:                     <ul style="list-style-type: none"> <li>*0 : normal mode =ESP8266 will NOT enter UART-Wi-Fi pass through mode on power-up.</li> <li>*1 : transparent mode =ESP8266 enters UART-Wi-Fi pass through mode on power-up.</li> </ul> </li> <li>• &lt;remote IP&gt;: remote IP or domain name.</li> <li>• &lt;remote port&gt;: remote port.</li> <li>• [&lt;type&gt;] (optional): UDP; TCP by default.</li> <li>• [&lt;UDP local port&gt;] (optional): local port when UDP transparent transmission is enabled on power-up.</li> </ul> <p>Ex : AT+SAVETRANSLINK=1,"192.168.4.255",2000,"UDP",2000</p>

Now  
 Rx is connected to Rx of MCU  
 Tx is connected to Tx of MCU

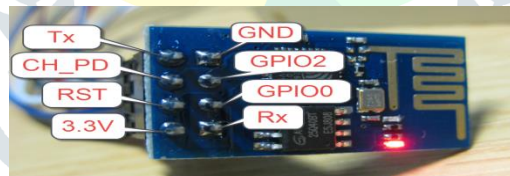


Fig 5. Wi-Fi module ESP8266P

Now above 3 Performing parts are implement in one system which have Four Ac load

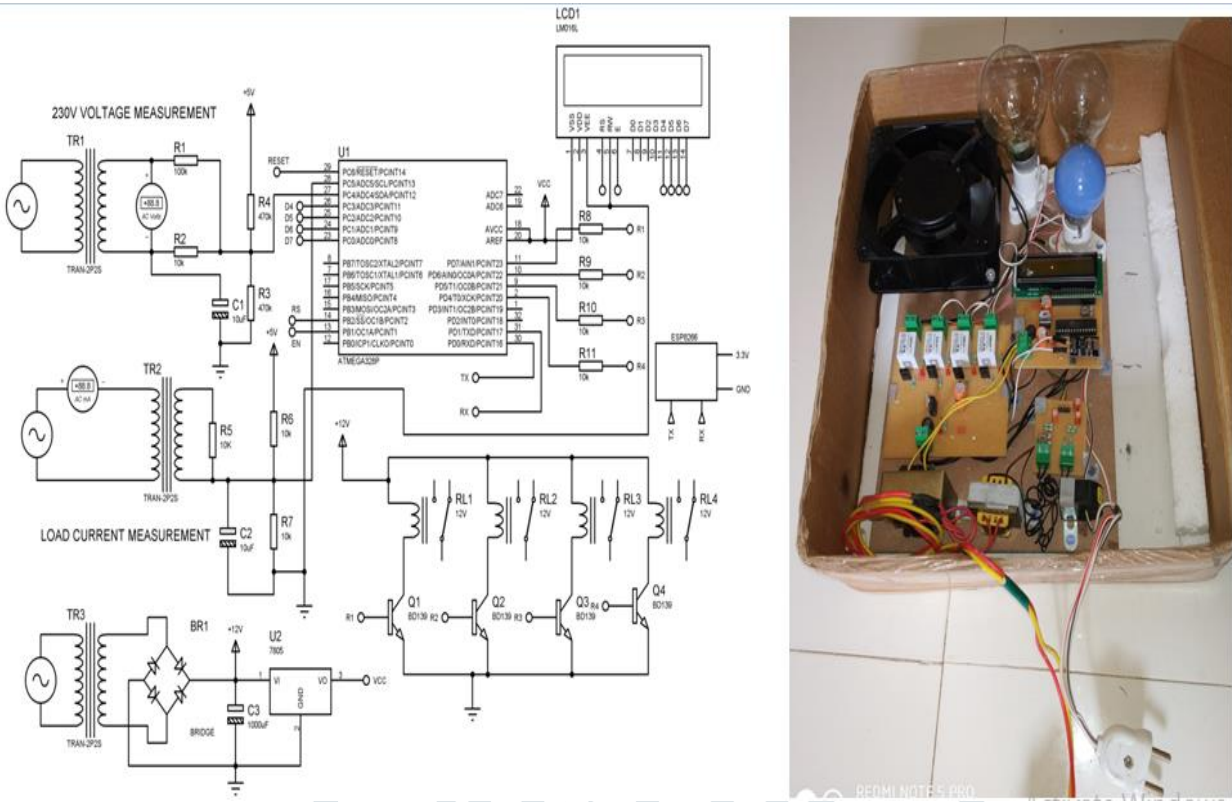


Fig – 6 Circuit Diagram With hardware

**4.) Graphical User Interface – Monitoring and controlling part**

To make this mass of information more accessible and easier to use, the human-machine interface must be designed in a methodical way, from the hardware support to the information provided to the user. The choice of technology is very important, as well as presentation of the data. The technology determines the possibilities and the limitations for the design. Using that technology, the data must be grouped and organized in an intuitive way to allow any user, specialist or unskilled person to navigate easily in the environment and to find the information required.[5]

The GUI software was written for a Windows based personal computer and tested using the LabVIEW software. The main purpose of the GUI software is to display the power consumption data in real time and control the relay for each of the nodes. To achieve these goals, the software is organized into two threads: the transmission thread and the user input thread. The transmission thread consists of the reading the wirelessly transmitted data,. The user input thread allows the software to asynchronously handle input from the user each time the user presses a button on the GUI.[2]

**1. Initial Condition : Voltage =254 V , Current = 0.03 A , Power = 0.0W**



Fig 07. Initial Condition

2 .Load A(18W) ON : Voltage =254 V , Current = 0.14 A , Power = 29W

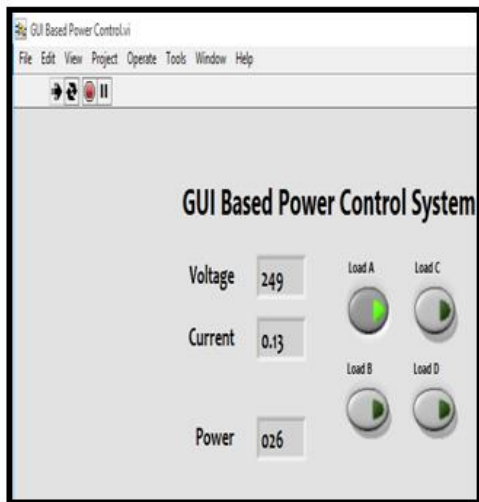


Fig 08. Load A ON

3 : Load A & B(100W) ON : Volt.=255 V , Current = 0.46 A ,Power =115W

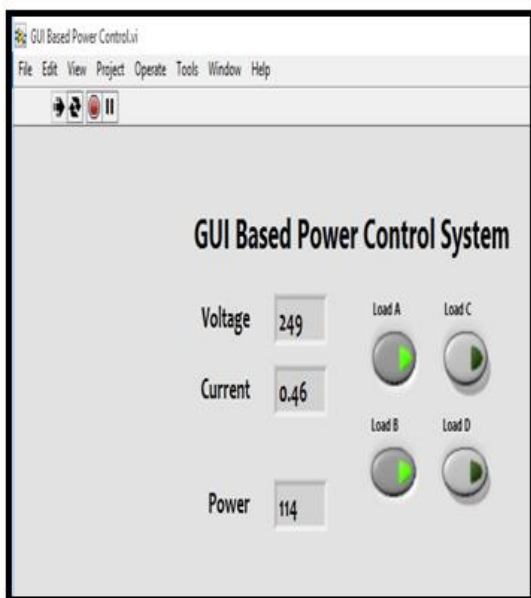


Fig 09. Load A ,& B ON

4 : Load A, B & C (40W) ON : Volt.=255 V, Current = 0.63A ,Power = 158W

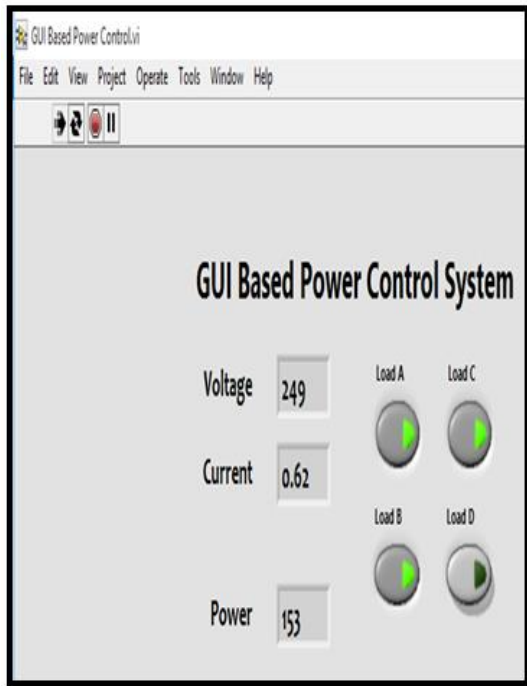


Fig 10. Load A , B & C ON

5 : Load A,B,C &D(15W) ON : Volt :254 V, Current = 0.69A ,Power = 158W

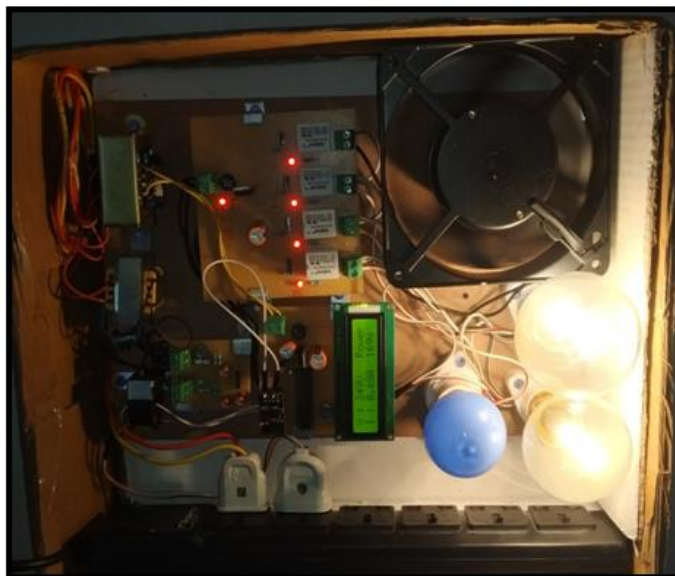
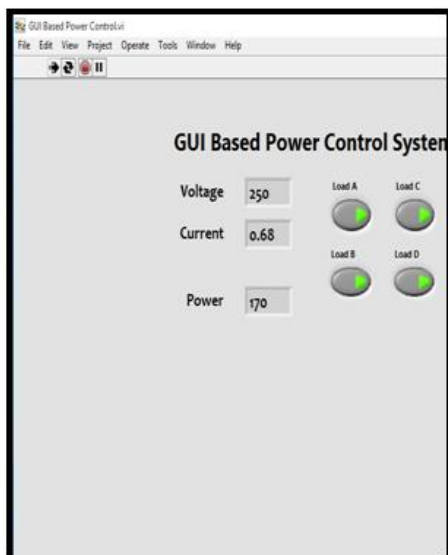


Fig 11. Load A , B ,C & D ON



**Simulation :**

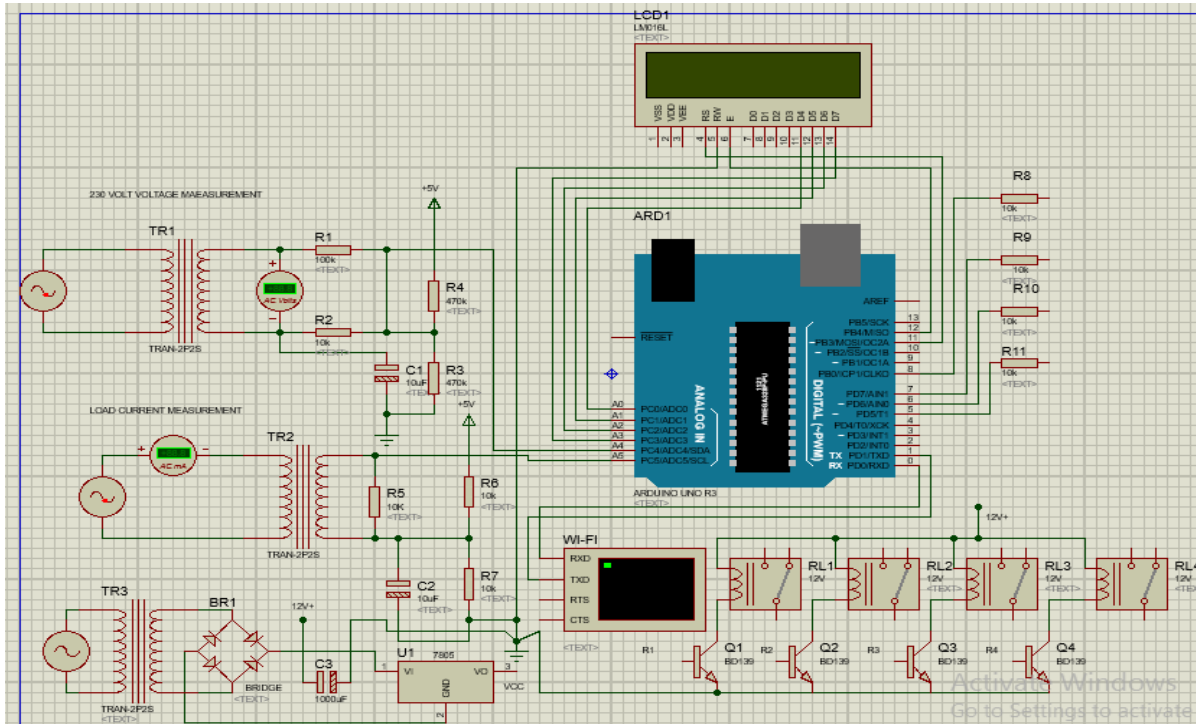


Fig 12. Simulation

**Reading Analysis :**

MODE	NO LOAD	A ON (W)	B ON (W)	CON (W)	D ON (W)	TOTAL POWER (W)	VOLT (V)	CURRENT (A)	ACTUAL POWER (W)	ACTUAL CURRENT (A)
1	0					0	254	0	0.07	0.03
2	0	18				18	254	0.078	29	0.1
3	0	18	100			118	254	0.464	115	0.46
4	0	18	100	40		158	254	0.622	158	0.63
5	0	18	100	40	15	173	254	0.681	174	0.69

**III CONCLUSION**

In this paper a comprehensive approach toward industrial energy management has been taken By monitoring the energy uses in graphical user interface which gives actual data about energy uses. If energy usage is increasing then we can control the energy usage by on/off the AC load.

**IV ACKNOWLEDGMENT**

The satisfaction that comes with successful completion of a task would be but incomplete without the mention of the people who made it possible it gives us immense pleasure to acknowledge all those who have extended their valuable guidance and magnanimous help. The success of any work depends upon the dedication, Sincerity and hard work. It also requires some ingredients such as motivation, guidance, encouragement and time.

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