JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

CONTROLLING OF POWER FACTOR USING ARDUINO

Bakka Cheralu[1], Thummala Raju[2], Goshikonda Sumathi[3]

[1,2,3] Department of Electrical and Electronics Engineering, Kamala Institute of Technology and Science, Singapur, Huzurabad, Karimnagar, Telangana, India-505468

ABSTRACT--In the industrial sector the various motoring loads are continuously running and increasing the inductive load. So, the power factor in the system get reduces due to the inductive reactive power. But the electricity board has a standard limit regarding the power factor values and if the power factorgoes below the specified limit the electricity company charges the penalty to industrial consumer. APFC (Automatic Power Factor Control) device reads power factor from line voltage and line current by determining the delay in the arrival of the current signal with respect to voltage signal from the function generator with high accuracy by using an internal timer. This time values are displayed in LCD modules then the mother board calculates the compensation requirement and accordingly switches on different capacitor banks. Efficient generation of the power at present is crucial as wastage of power is a global concern power factor measures a systems power efficiency and is an important aspect in improving the qualityof supply.

Keywords: Arduino, APFC, Power factor, LCD module

1.INTRODUCTION

Embedded systems are commonly found in consumer, cooking, industrial, automotive, medical, commercial and military applications. Telecommunications systems employ numerous embedded systems from telephone switches for the network to cell phones at the end user. Computer networking uses dedicated routers and network bridges to route data. Consumer electronics include MP3 players, mobile phones, consoles, digital cameras, GPS receivers, and printers. Household appliances, such as microwave ovens washing machines and dishwashers, include embedded systems to provide flexibility, efficiency and features. Advanced HVAC systems use networked thermostats to more accurately and efficiently control temperature that can change by time of day and season. Home automation uses wired- and wireless-networking that can be used to control lights, climate, security, audio/visual, surveillance,etc., all of which use embedded devices for sensing and controlling. Transportation systems from flight to automobiles increasingly use embedded systems.New airplanes contain advanced avionics such as inertial guidance systems and GPS receivers that also have considerable safety requirements. Various electric motors brushless DC motors, induction motors and DC motors use electric/electronic motor controllers Automobiles electric vehicles, and hybrid vehicles increasingly use embedded systems to maximize efficiency and reduce pollution. Other automotive safety systems include anti-lock braking system (ABS), Electronic Stability Control (ESC/ESP), traction control (TCS) and automatic four-wheel drive. Medical equipment uses embedded systems for vital signs monitoring, electronic stethoscopes for amplifying sounds, and various medical imaging (PET, SPECT, CT, andMRI) for non-invasive internal inspections. Embedded systems within medical equipment are often powered by industrial computers.

2.POWER FACTOR CORRECTION

In the present technological revolution power is very precious. So, we need to find out the causes of power loss and improve the power system. Due to industrialization the use of inductive load increases and hence power system losses its efficiency. So, we need to improve the power factor with a suitable method. Whenever we are thinking about any programmable devices then the embedded technology comes into force front. The embedded is now a day very much popular and most the product are developed with Microcontroller based embedded technology. Automatic power factor correction device reads power factor from line voltage and line current by determining the delay in the arrival of the current signal with respect to voltage signal from the function generator with high accuracy by using an internal timer. This time values are then calibrated as phase angle and corresponding power factor. Then the values are displayed in the 2X16 LCD modules. Then the motherboard calculates the compensation requirement and accordingly switches on different capacitor banks. This is developed by using 8051 microcontrollers. Automatic power factor correction techniques can be applied to the industries, power systems and also households to make them stable and due to that the system becomes stable and efficiency of the system as wellas the apparatus increases. The use of microcontroller reduces the power consumption, size and cost.

3.BLOCKDIAGRAM

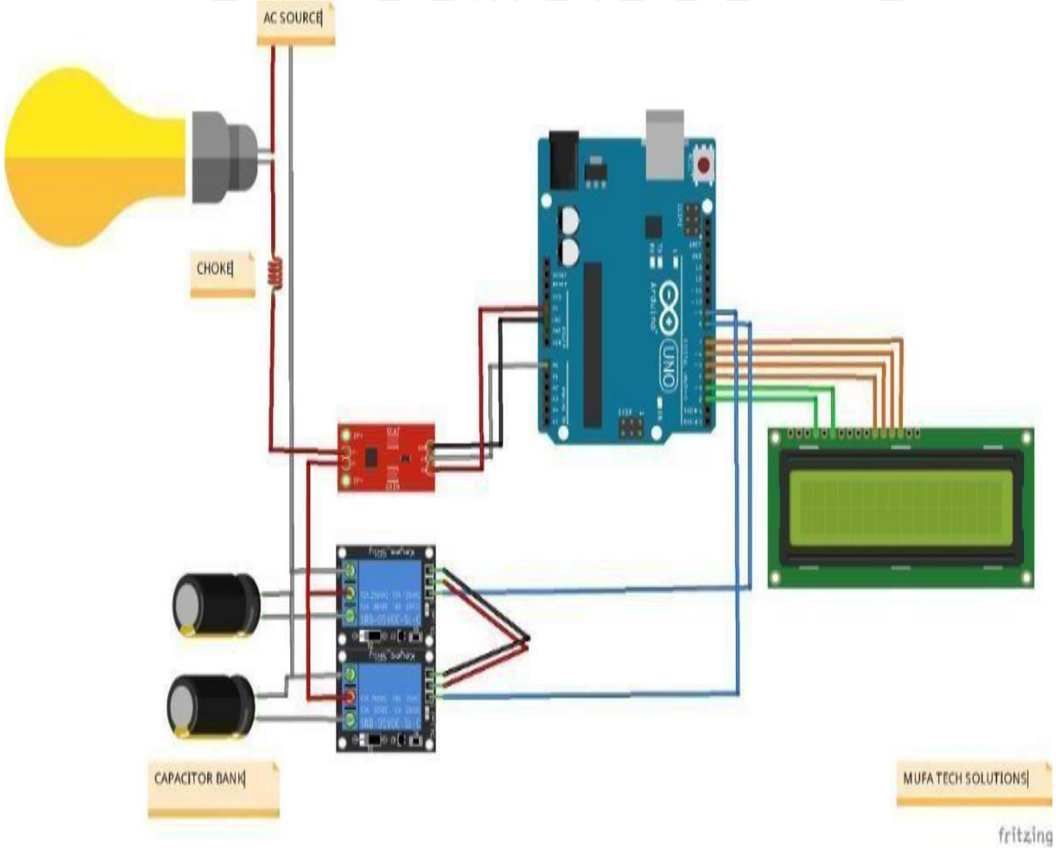


Figure 1. Block diagram

4.SOFTWAREREQUIREMENTS

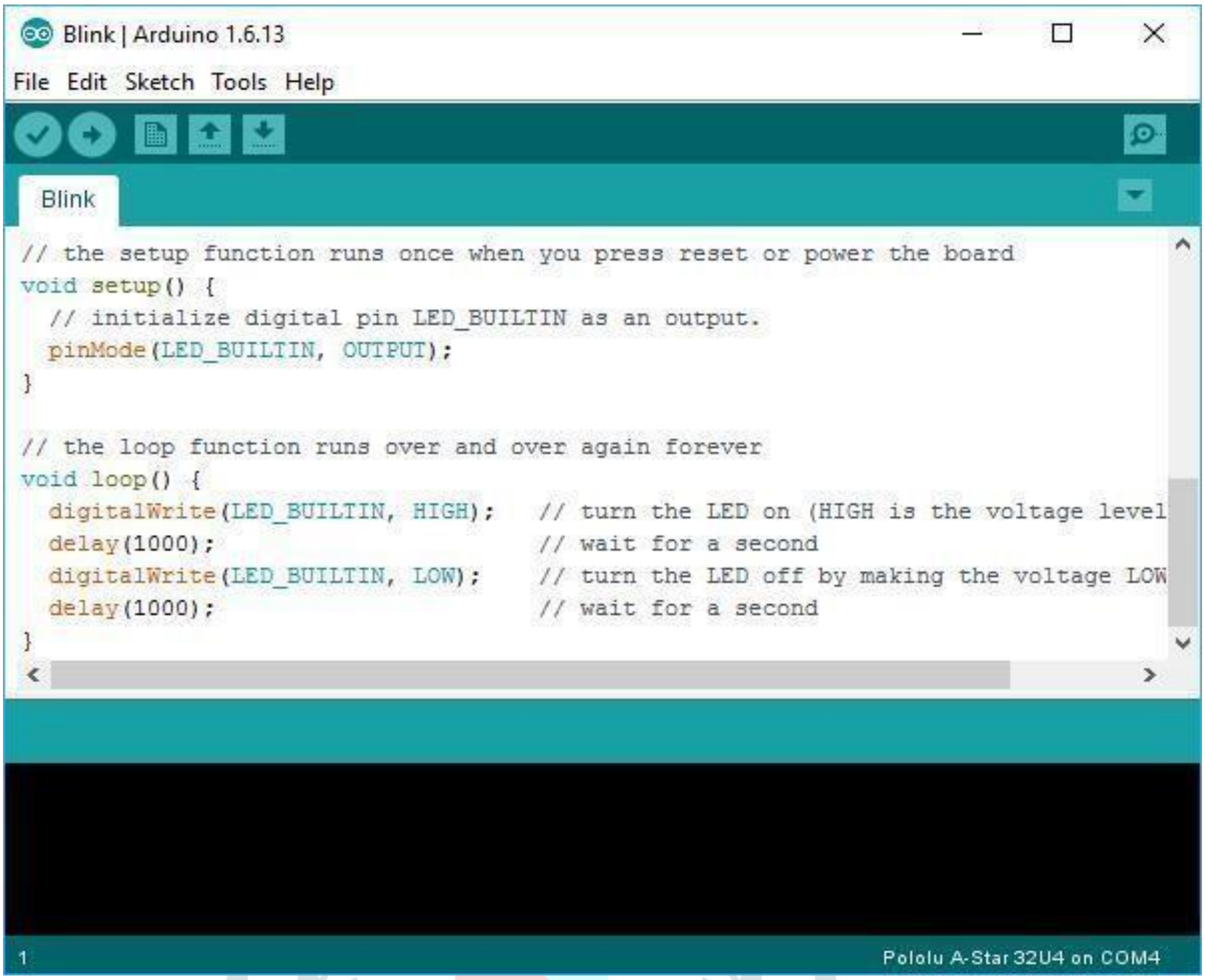
Software used in this project for uploading code onto Arduino is Arduino IDE.

4.1. ARDUINO IDE

IDE stands for Integrated Development Environment. The IDE is a text editor-like program that allows you to write Arduino code. When you open the Arduino program, you are opening the IDE. It is intentionally streamlined to keep things as simple and straightforward as possible. When you save afile in Arduino, the file is called a sketch – a sketch is where you save the computer code you have written. The coding language that Arduino uses is very much like C++, which is a common language in the world of computing. The code you learn to write for Arduino will be very similar to the code you write in any other computer language

Figure 2. Arduino ide

The code you write is "human readable", that is, it will make sense to you (sometimes), andwill be organized for a human to follow. Part of the job of the IDE is to take the human readable code and translate it into machine-readable code to be executed by the Arduino. This process is called compiling. The process of compiling is seamless to the user. All you have to do is press a button. If you have errors in your computer code, the compiler will display an error message at the bottom of the IDE and highlight the line of code that seems to be the issue. The errormessage is meant to help you identify what you might have done wrong – sometimes the messageis very explicit, like saying, "Hey – you forget a semicolon", sometimes the error message is vague.Why be concerned with a semicolon you ask? A semicolon is part of the Arduino language syntax,the rules that govern how the code is written. It is like grammar in writing.



```
// the setup function runs once when you press reset or power the board
void setup() {
  // initialize digital pin LED_BUILTIN as an output.
  pinMode(LED_BUILTIN, OUTPUT);
}

// the loop function runs over and over again forever
void loop() {
  digitalWrite(LED_BUILTIN, HIGH);   // turn the LED on (HIGH is the voltage level
  delay(1000);                       // wait for a second
  digitalWrite(LED_BUILTIN, LOW);    // turn the LED off by making the voltage LOW
  delay(1000);                       // wait for a second
}
```

Figure 3. Program for Arduino

4.2. HOW TO CONNECT ARDUINO BOARD

If you're using a serial board, power the board with an external power supply (6 to 25 voltsDC, with the core of the connector positive). Connect the board to a serial port on your computer. On the USB boards, the power source is selected by the jumper between the USB and power plugs.To power the board from the USB port (good for controlling low power devices like LEDs), placethe jumper on the two pins closest to the USB plug. Either way, connect the board to a USB port on your computer. On Windows, the Add New Hardware wizard will open; tell it you want to specify the location to search for drivers and point to the folder containing the USB drivers you unzipped in the previous step. The power LED should go on.

4.3. HOW TO UPLOAD A PROGRAM

Follow these steps to upload your sketch:

1.Connect your Arduino using the USB cable.
The square end of the USB cable connects to your Arduino and the flat end connects to a USBport on your computer.
2.Choose Tools → Board →Arduino Uno to find your board in the Arduino menu. You can also find all boards through this menu, such as the Arduino MEGA 2560 and ArduinoLeonardo.
3.Choose the correct serial port for your board.

You find a list of all the available serial ports by choosing Tools →Serial Port→ com X or /dev/tty.usbmodemXXXXX. X marks a sequentially or randomly assigned number. In Windows, if you have just connected your Arduino, the COM port will normally be the highest number, such as com 3 or com 15.

Many devices can be listed on the COM port list, and if you plug in multiple Arduinos, each onewill be assigned a new number. On Mac OS X, the /dev/tty.usbmodem number will be randomlyassigned and can vary in length, such as /dev/tty.usbmodem1421 or /dev/tty.usbmodem262471. Unless you have another Arduino connected, it should be the only one visible.
4.Click the Upload button.
This is the button that points to the right in the Arduino environment. You can also use thekeyboard shortcut Ctrl+U for Windows or Cmd+U for Mac OS X.

4.4. HARDWARE REQUIREMENTS

The hardware requirements of this project are

- ARDUINO UNO R3
- 16X2LCD
- 2 Channel Relay module
- Bulb holder
- ACS712 CURRENT SENSOR
- 2.5 MFD CAPACITORS
- CHOKE

4.5. ARDUINO UNO

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twittermessage - and turn it into an output - activating a motor, turning on an LED, publishing somethingonline. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

Over the years Arduino has been the brain of thousands of projects, from everyday objectsto complex scientific instruments. A worldwide community of makers - students, hobbyists, artists,programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open- source, empowering users to build them independently and eventually adapt them to their particular needs. The software, too, is open-source, and it is growingthrough the contributions of users worldwide.

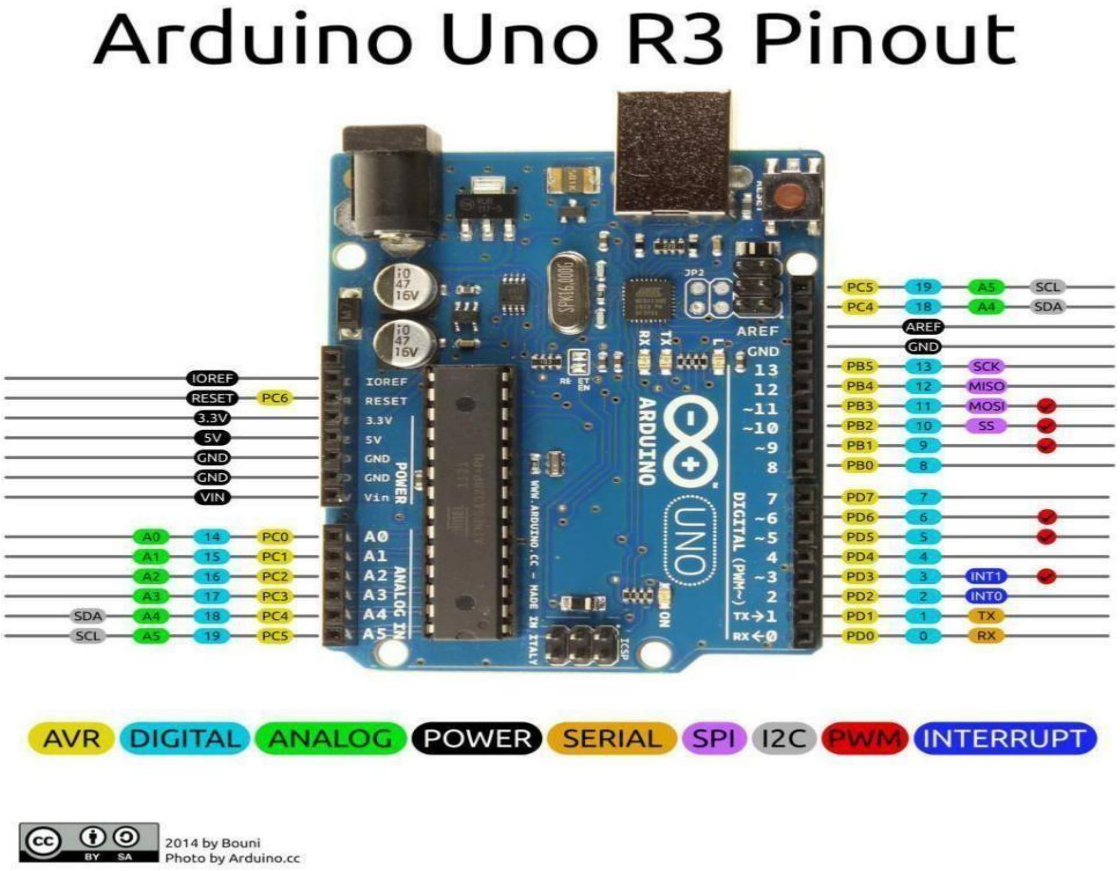


Figure 4. Arduino UNO

4.6. ADVANTAGES OF ARDUINO

• **Inexpensive** - Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino module can be assembled byhand, and even the pre-assembled Arduino modules cost less than $50

• **Cross-platform** - The Arduino Software (IDE) runs on Windows, Macintosh OSX, and Linuxoperating systems. Most microcontroller systems are limited to Windows.

• **Simple, clear programming environment** - The Arduino Software (IDE) is easy-to- use forbeginners, yet flexible enough for advanced users to take advantage of as well. For teachers, it's conveniently based on the Processing programming environment, so students learning to program in that environment will be familiar with how the Arduino IDE works.

• **Open source and extensible software** - The Arduino software is published as opensourcetools, available for extension by experienced programmers. The language can be expanded throughC++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it's based. Similarly, you can add AVR-Ccode directly into your Arduino programs if you want to.

• **Open source and extensible hardware** - The plans of the Arduino boards are published under a Creative Commons license, so experienced circuit designers can make their ownversion of the module, extending it and improving it. Even relatively inexperienced users can buildthe breadboard version of the module in order to understand how it works and save money.

4.7. FEATURES OF ARDUINO UNO

The **Arduino Uno** is a microcontroller board based on the ATmega328. Arduino is an open- source, prototyping platform and its simplicity makes it ideal for hobbyists to use as well as professionals.The Arduino Uno has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analogy inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, anda reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC -to-DCadapter or battery to get started.

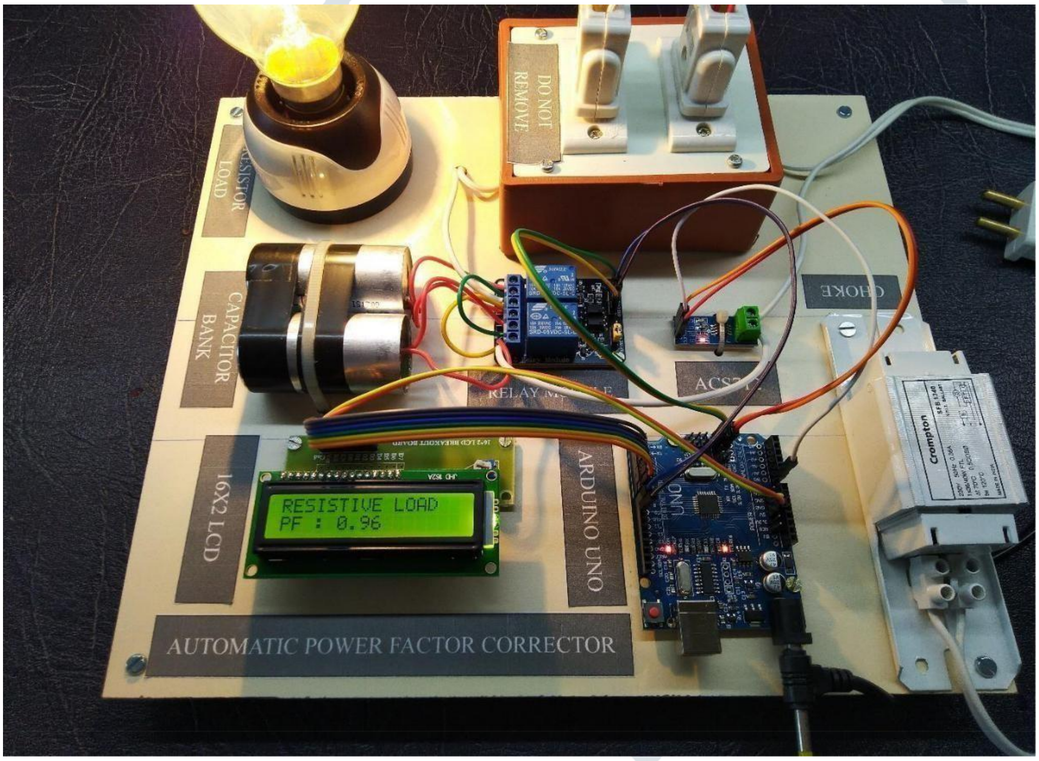
Features of the Arduino UNO:

- Microcontroller: ATmega328
- Operating Voltage: 5V
- Input Voltage (recommended): 7-12V
- Input Voltage (limits): 6-20V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 40 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB of which 0.5 KB used by bootloader
- SRAM: 2 KB (ATmega328)
- EEPROM: 1 KB (ATmega328)
- Clock Speed: 16 M

5. PROGRAM CODE

```
#include "ACS712.h"

ACS712 sensor(ACS712_30A, A0);

int cap1 = 8;
int cap2 = 9;
#include <Liquid Crystal .h>
 Liquid Crystal lcd (2, 3, 4, 5, 6, 7);
void setup() {
pin Mode(cap1, OUTPUT);
pin Mode(cap2, OUTPUT);
 digital Write(cap1, HIGH);
digital Write(cap2, HIGH);
Serial. begin(9600);
 sensor.calibrate();
lcd.begin(16,2);
lcd.setCursor(0,0);
lcd.print("AUTOMATIC POWER ");

lcd.setCursor(0,1);
lcd.print("FACTOR CORRECTOR");
delay(5000);
lcd.clear();
}

void loop() {

float I = sensor.getCurrentAC();
Serial.println(I);
if((I>=0.17)&&(I<=0.24))
{

digitalWrite(cap1, HIGH);
digitalWrite(cap2, HIGH);
 lcd.setCursor(0,0);
lcd.print("NO LOAD                    ");
lcd.setCursor(0,1);
lcd.print("CB DISCONNECTED ");

}

else if((I>=0.77)&&(I<=0.82))

{

digitalWrite(cap1, HIGH);
digitalWrite(cap2, HIGH);
lcd.setCursor(0,0);
lcd.print("RESISTIVE LOAD ");

lcd.setCursor(0,1);
lcd.print("PF : 0.96                    ");
}

else if((I>=0.60)&&(I<=0.68))

{

lcd.setCursor(0,0);
lcd.print("R-L LOAD                    ");
lcd.setCursor(0,1);
 lcd.print("PF : 0.69                 ");
delay(5000);
digitalWrite(cap1, LOW);
delay(2000);
digitalWrite(cap2, LOW);
 lcd.setCursor(0,0);
lcd.print("CB CONNECTED                ");

lcd.setCursor(0,1);
lcd.print("PF : 0.98                ");
while(!(sensor.getCurrentAC()<=0.24));

}
delay(100);

}
```

6. RESULT



This model is used to maintain the power factor constant. The power factor would vary inbetween 0.9 to 1 and this kit make the power factor constant throughout the supply by using capacitor bank. Actually, the power factor would vary when the load is unbalanced, whenever theload is unbalanced or at the time of load shedding these capacitor banks maintains constant power factor, and this Arduino sends the signal whenever the power factor varies.

7. CONCLUSION

It can be concluded that power factor correction techniques can be applied to the industries,power systems and also households to make them stable and due to that the system becomes stableand efficiency of the system as well as the apparatus increases. The use of microcontroller reducesthe costs. Due to use of microcontroller multiple parameters can be controlled and the use of extrahard wares such as timer, RAM, ROM and input output ports reduces. Care should be taken for overcorrection otherwise the voltage and current become more due to which the power system ormachine becomes unstable and the life of capacitor banks reduces.

REFERENCES

1.Nader Barsoum "Programming of Pic Microcontroller for Power Factor Correction"Proceedings of the first Asia International Conference on modeling and simulation (IEEE),2017.

2.Lukas Muller" Using the Arduino uno to tech digital control of power electronics"Institute of electrical and electronics engineering,2018

3.Richard Tingee "Power factor controller- An Integrated Power factor and autoparts"(IEEE),2019.

4.S.B. Jarad, V. D. Lohar, S. P. Choukate, S. D. Mangate. "Automatic Optimization and Control of Power Factor, Reactive Power and Reduction of THD for Linear and Nonlinear Load by Using Arduino UNO." 2018 Second International Conference on Inventive Communication and Computational Technologies (ICICCT). IEEE, 2018.

5.S. Ahmad, R. R. Hasan, R. Hasan, M.A.A. Rakib, M. A. Hasan, M. Zubayar. "A low SAR in-body antenna for wireless monitoring purpose of pacemaker system." 2019 4th International Conference on Electrical Information and Communication Technology (EICT). IEEE, 2019.

6.W. Ali, H. Farooq , M. Jamil , A. Rehman, R. Taimoor, M. Ahmad . "Automatic Power Factor Correction for Single Phase Domestic Loads by Means of Arduino Based TRIAC Control of Capacitor Banks." 2018 2nd International Conference on Energy Conservation and Efficiency (ICECE). IEEE, 2018.

7.M. B. Khan, M. Owais, "Automatic power factor correction unit." 2016 International Conference on Computing, Electronic and Electrical Engineering (ICE Cube). IEEE, 2016.

8.Cataliotti A. and Cosentino V., A PC-based wattmeter for high accuracy power measurements, Instrumentation and Measurement Technology Conference (I2MTC), IEEE 1453–1458 (2010).

9.A. L. Vergara and H. M. Villaruz, "Development of an Arduino-based automated household utility power monitoring system", International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment and Management (HNICEM), pp.1-6, 2014. doi: 10.1109/HNICEM.2014.7016233.

10. M. Margolis, "Arduino Cookbook", ISBN: 978-1-449-31387-6, 2nd Edition, USA, 2012.

11. Arduino, "Arduino Website", Available on: www.arduino.cc (Retrieved July 26, 2016).

12. WEG Automação S.A., "Manual para Correção do Fator de Potência", available on: http://ecatalog.weg.net/files/wegnet/WEG-correcao-dofator-de-potencia-958-manual-portugues-br.pdf (Retrieved July 26, 2016).