



ARDUINO BASED POWER FACTOR CORRECTION

Dr. K. Shivaramakrishna (Associate Professor)
Electrical and Electronics
Department
JB Institute of Engineering and Technology
Hyderabad
Telangana, India

M. Sanjay
Electrical and Electronics
Department
JB Institute of Engineering and Technology
Hyderabad
Telangana, India

G. Lavanya
Electrical and Electronics
Department
JB Institute Of Engineering and Technology
Hyderabad
Telangana, India

B. Vikas
Electrical and Electronics
Department
JB Institute of Engineering and Technology
Hyderabad
Telangana, India

M. Sri Ram Reddy
Electrical and Electronics
Department
JB Institute of Engineering and Technology
Hyderabad
Telangana, India

Abstract- The Power factor control calculate analyzer works rapidly and makes a difference you get it current utilization and drift data . Control quality is an issue in numerous applications and huge businesses nowadays . Control figure includes a critical affect on the current quality of the control framework . Control avoids control figure debasement and decreases control misfortune . This article portrays how to construct a programmable control figure rectifier APFC system to control chassis control utilization and make strides control figure . The arrange is to actualize an open source power control library for exact control estimation.

This paper may be a trial and error approach to energy efficient gadgets with arranged control calculate control utilizing cost saving batteries within the most recent Web of Things IoT applications. Intelligently plan your web have for a cool and fun introduction . The execution of the created gadget demonstrate is assessed with and without stack conditions. The comes about appear that the Arduino control figure redress and vitality checking system is superior than vitality productivity for assist improvement without human mediation by coordinate adjustment on the seat . Taking after the proposed approach, issues related to the quality, punishment and affect of electrical mishances will be decided . The proposed arrange is straightforward , simple to get it , simple to execute and makes a difference create a more robust framework..

Keywords— Power factor, Capacitor bank, APFC system.

I. INTRODUCTION

Inverter-fed DC motor drive applications that use power factor correction (PFC) typically maintain a power factor greater than 0. On the power supply side, diode bridge rectifier-powered DC motor drives draw non-sinusoidal current. Right now the uncontrolled exchanging gadget is of converse extremity, so the stockpile voltage is lower than the capability of the middle of the road circuit capacitor. Notwithstanding, assuming that the inventory voltage is higher than the capacitor voltage, more current will stream. In present day power dispersion frameworks, most loads are inductive and there is a proceeding with interest in further developing power factor (PF).

This task depicts the plan and improvement of a power factor corrector utilizing the PIC microcontroller chip. Using a PIC microcontroller-developed algorithm to guarantee decisions and sufficient switching, the power factor from the load is measured. The trip capacitor locally compensates for excessive reactive power requirements and brings the power factor close to unity. In outline, microcontroller-based programmed power factor remedy utilizing the capacitor switch technique has all the earmarks of being an entirely adaptable arrangement. Nonetheless, dissimilar to the above endeavors, I shunned utilizing a PIC or - like microcontroller to stay away from challenges in programming and troubleshooting. All things being equal, it utilizes the open-source Arduino stage, which is not difficult to program and troubleshoot. Additionally, an operational amplifier and an EXOR gate-based circuit simplify phase measurements between voltage and current on them. To stay away from the adverse consequence of the on his THD, I utilized a thyristor-based capacitor circuit rather than a transfer driver.

II. LITERATURE REVIEW

Design, Fabrication, and Implementation of Microcontroller Controlled Static Var Compensator," by G. PREMKUMAR, appeared in the vol. 81, pp. 43-50, Nov 2013. As depicted in Fig. 1, a specific FACTS (Flexible AC Transmission System) device—the Static Var Compensator (SVC)—has been the focus of this project. For power factor correction and reactive power compensation, the SVC is a tried-and-true method. The SVC has traditionally been utilized as a shunt-connected device that provides the power system with voltage stability and load compensation at specific points, such as transmission line midpoints or close to varying loads. SVCs have gained popularity and are highly regarded in the power industry since the release of the FACTS strategies in 1987 by the Electric Power Research Institute (EPRI). The SVC contain capacitor bank constrained by triac called Thyristor Exchanged capacitor (TSC) and reactor bank constrained by triac called Thyristor controlled reactor (TCR). By controlling overvoltage, controlling voltage flicker, and regulating voltage, these compensators draw reactive power from the line there. Static Var compensators are also known as reactive power switches or systems because they control reactive power through switching.

B. Jamge, "Programmed Power Element Regulator utilizing PSoC3," Global Diary of Designing Exploration and Innovation, vol. 3, pp. 1056-1058, May, 2014. The primary goal of this undertaking is to plan an energy saving plan for a modern appropriation organization. By reducing network losses and upgrading the main electric load operation to a more efficient level, this can be accomplished. The planned plot is worried about further developing the power component of the framework by adding shunt capacitors to the organization at ideal size and area. Modern power framework experiences expansion in power misfortunes and expansion in the sort of burden is went with low power factor which prompts gigantic exchange of receptive power from the utility through the framework. The fundamental downside of this issue is increment in the framework misfortunes and decrease in the voltage level. It can bring about unfortunate dependability, wellbeing issues and higher energy costs. The lower our power factor, the less monetarily our framework works. The genuine measure of force being utilized or dispersed in a circuit is called genuine power. Reactive power is made up of reactive loads like inductors and capacitors. Apparent power is the linear combination of true power and reactive power. Power framework loads comprise of resistive, inductive, and capacitive burdens.

III. PROPOSED SYSTEM

Our project is planned for identification and remedy of single-stage power factor and, with minor changes, three-stage frameworks. We intend to employ a system based on the Arduino microcontroller platform for this purpose. The explanation is the usability and programming of the Arduino stage. Based on the AVR 8-bit microcontroller series, Arduino is a well-liked open source platform for prototyping. Voltage and current from the electrical cable are vented down to low power levels reasonable for Arduino handling utilizing PT and CT transformers. An op-amp-based ZCD circuit is used to determine the zero crossings of both signals. Beats are produced from the two ZCD signals utilizing a computerized EXOR door. The width of this heartbeat is corresponding to the stage distinction between the voltage, current on the electrical cable.

From this information, we can gauge a power factor. Furthermore, this worth is utilized to decide the size of the capacitor that should be turned on the electrical cable to return the power variable to solidarity. The Arduino is programmed to calculate the required capacitance value, the power factor, and the pulse width. The estimated capacitor is then added to the PFC's power line by the Arduino. Further improvement in the power factor is persistently observed by the Arduino to check whether the power factor is accomplished by adding extrapolation capacitors to the electrical cables. The whole interaction stream is shown on the LCD. By utilizing an IOT web server that records the power component of the framework continuously, the result results showed on the LCD show can be gotten, and the power factor is continually observed through this web server.

A. Objective

The principal objective of this undertaking is to expand the power factor which upgrades the effectiveness of the framework.

The undertaking work depicts the plan and improvement of a power factor corrector utilizing PIC microcontroller chip.

A PIC Microcontroller-based algorithm is used to measure power factor from load to bring power factor close to unity by determining and activating sufficient switching of capacitors to meet local demand for excessive reactive power.

IV. METHODOLOGY

The diagram shows the simplified block level configuration of the system.

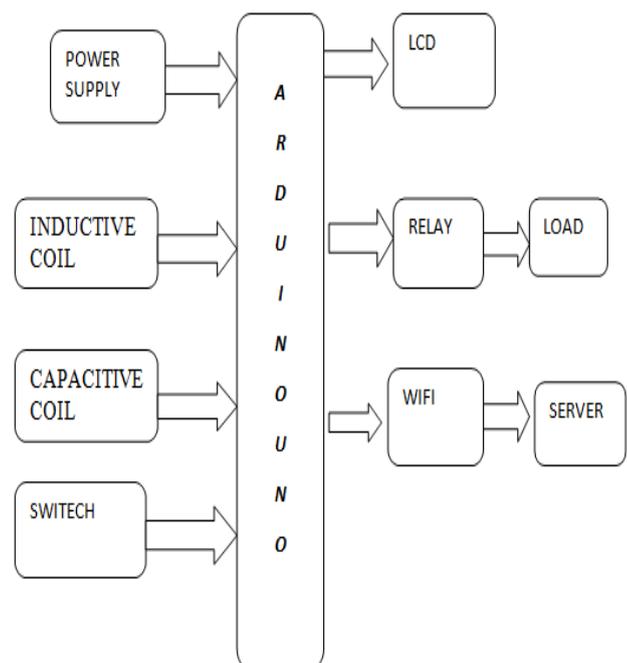


Fig. 1. Block diagram of proposed system

The system's components are depicted in the diagram. In this framework, the contributions of the framework are Power moving through the heaps. Arduino uses these inputs to

compare the various system signals and calculate the power characteristics and power factor. Later, if there is any lagging load in the system, the Arduino detects the lagging power factor through sensors and enables the system's static capacitors to induce leading power factor to lower the lagging power factor. subsequently the framework remedies the power figure the framework.

V. CONSTRUCTION

A. Hardware components:

The diagram shows the construction of the proposed system:

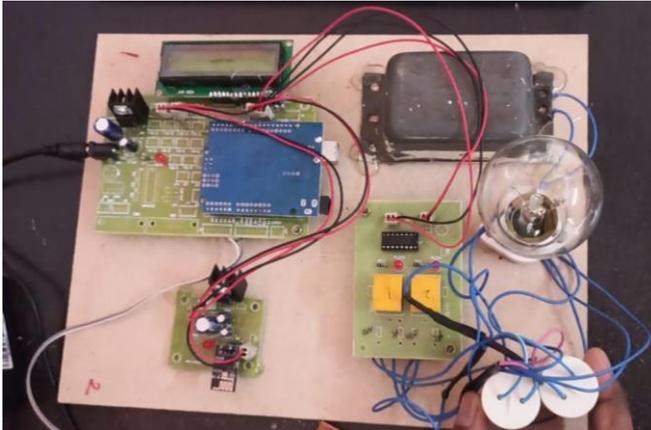


Fig 2(a). Construction circuit of proposed system.

It have various parts present in this system they are:

- a) **Arduino:** The Arduino Uno is a microcontroller board with six analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and 14 digital input/output pins, six of which can be used as PWM outputs.



Fig 2(b) Arduino (ATmega 328)

- b) **LCD Display:** LCD stands for Liquid Crystal Display, used to provide a user interface and debugging. Character-based LCDs are based on Hitachi's HD44780 controllers, with a maximum character count of 80.

- c) **Load Bank:** Load banks generate power demand by using resistive, inductive, and capacitive elements.

- Resistive load components create exact measures of burden at a power factor likening
- Inductive load components use wire loops to create and maintain inductive fields.
- Capacitive load components use capacitors to store electrical charge and give a main power factor.

- d) **Relay:** A relay is an electromagnetic switch used to turn on and off a circuit by a low-power signal or to control multiple circuits. When current flows through the control coil, the electromagnet intensifies and closes the contacts, causing a short circuit or an open circuit.

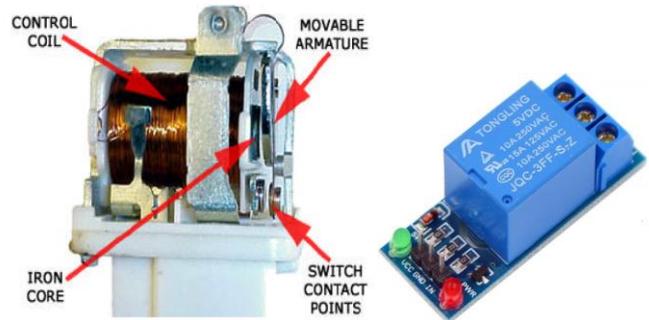


Fig 2(c). Relay construction

- e) **Wi-Fi Module:** Wireless networks use radio waves to communicate, with a wireless router receiving and decoding the signal and sending it to the Internet. The router sends the information to the Internet using a physical, wired Ethernet connection. The process also works in reverse, with the router receiving information from the Internet, translating it into a radio signal and sending it to the computer's wireless adapter.

B. Software components:

Internet of Things (IoT): Web of things (IoT) is a worldwide framework for the data society, empowering progressed administrations by interconnecting (physical and virtual) things in view of existing and developing interoperable data and correspondence advancements. With the Web of Things the correspondence is stretched out by means of Web to everything that encompass us. The Internet of Things encompasses a lot more than just wireless sensor networks, machine-to-machine communication, 2G/3G/4G, GSM, GPRS, RFID, WI-FI, GPS, microcontrollers, microprocessors, and other similar technologies. These are considered just like the empowering innovations that make "Web of Things" applications conceivable. Empowering advances for the Web of Things are thought of as in and can be gathered into three classifications:

- (1) innovations that empower "things" to secure logical data,
- (2) advances that empower "things" to deal with relevant data, and
- (3) advances to further develop security and protection.

The first two categories can be understood as the necessary functional building blocks for incorporating "intelligence" into "things," which are, in fact, the characteristics that set the Internet of Things apart from the conventional Internet. The Internet of Things is not a single technology; rather, it is a combination of various hardware and software technologies. The third category is not a functional requirement but rather a de facto requirement, which would severely limit IoT penetration. The Web of Things gives arrangements in light of the combination of data innovation, which alludes to equipment and programming used to store, recover, and process information and correspondences innovation which incorporates electronic frameworks utilized for correspondence between people or gatherings. In order to meet the requirements of IoT applications for energy efficiency, speed, security, and dependability, a diverse mix of communication

technologies must be adapted. In this setting, it's possible that the diversity will increase to a number of manageable connectivity technologies that meet the needs of IoT applications, are adopted by the market, have already proven to be usable, and are backed by a strong technology alliance. The key enabling technologies for the Internet of Things, such as Ethernet, WI-FI, Bluetooth, ZigBee, GSM, and GPRS, are examples of standards in these categories

VI. WORKING

The system was tested with a 1 series inductive load with a 60-watt resistive load. Inductive loads can be added to or removed from a circuit using the switch. The power factor sensing of the system was checked once for resistive loads and then for additional inductive loads.

the load is purely resistive, the system will detect and the corresponding power factor of 1 will be displayed on the LCD. When the load becomes inductive by adding a inductor in series with the resistor, the net load becomes inductive and the corresponding delay between V and I can be clearly seen on the LCD. The system detects this condition and the corresponding PF is displayed on the LCD. The system reliably detects the PF leading and lagging lines and switches the capacitors from the bank to the to correct this.



Fig 3(a) : The working of APFC proposed system.

The above diagram illustrates the working of the system. When the net inductive load added to the system the lagging power factor in the system rises, hence the relay activates the capacitor bank to develop the leading power factor in the system to reduce the lagging nature of the power. This is the working principle of proposed system.



Fig 3(b) : Power factor when the resistive load connected in the system.

When the resistive load is connected to the system the LCD display shows the power factor unity, because of absence of reactive components the power factor sensed unity by the system by comparing power signal.

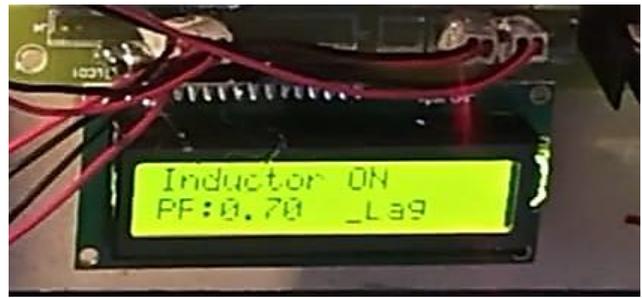


Fig 3(c): Power factor when inductive load connected.

When the inductive load connected series with the given resistive load the lagging power factor induced in the system, because inductor coil has lagging reactive power nature hence the system senses the lagging power factor and it was displayed on LCD screen (0.7).



Fig 3(d): Power factor when capacitive load connected.

When the lagging power induced in the system the lagging power factor sensed by the system and we enable the static capacitor bank in the system to reduce the lagging power factor. The capacitor bank having leading reactive nature hence this leading power factor neutralizes the lagging power in system up-to some extent to improve the required power factor.

Thus, the power factor is corrected in the system using static capacitor. The data of power factor can be recorded using the IOT server to monitor the system power factor time to time. It helps in the data of dropping of power factor and other characteristics of power factor in system are recorded.

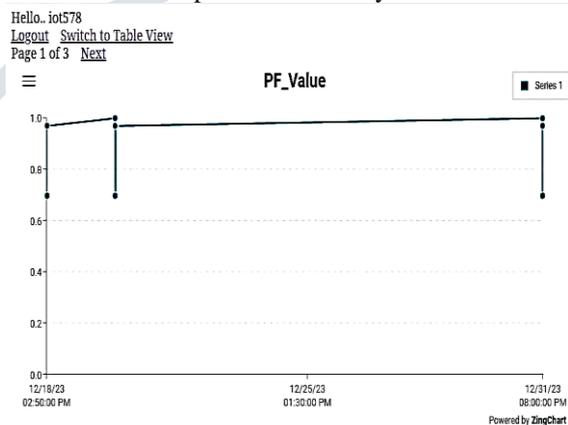


Fig 3(e): Graphical representation of the recorded power factor

The above graphical representation shows the recorded data which shows the characteristics of power factor in the system.

The data can be also recorded in the tabular columns which also shows the time and date of the recorded values of the system.

The below figure shows the web server page of the system which illustrates the power factor according to date and time.

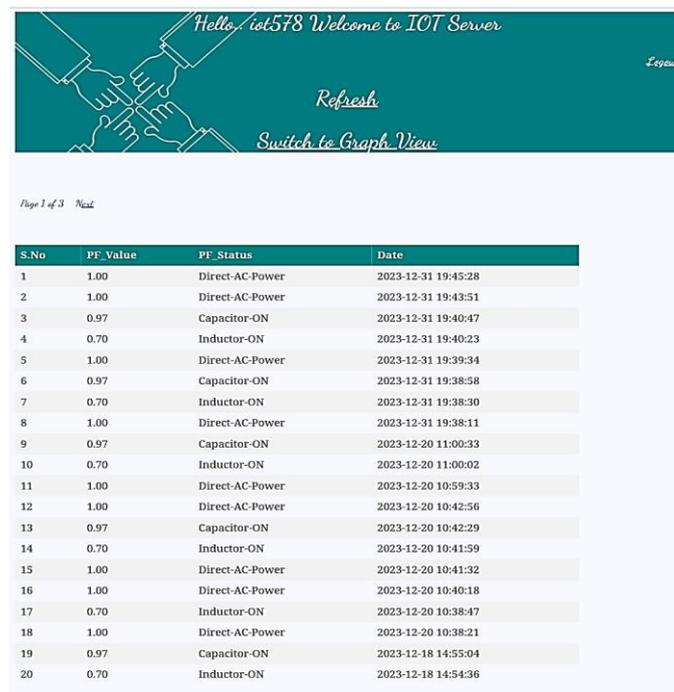


Fig 3(f) IOT server of APFC system showing recorded power factor with date and time

Hence the IOT server shows the recorded data of the system time to time and enables the monitoring of system's power factor from anywhere. The system is connected using the wifi module which can be easily connected and uses ethernet for uploading the data in the server.

VII CONCLUSION

By using the Arduino microcontroller platform, the system becomes an automatic detector of PF lag/lead conditions. Again, the capacitor bank TRIAC-based circuit reduces THD compared to the relay -based circuit. The results obtained under various loading conditions are satisfactory and the system provides a cost-effective solution for automatic power factor improvement in industrial environments. Additionally, the system can be modified to use data logging methods to monitor performance changes over time. The same data logging technology can also be used to more scientifically analyze his PF for a particular facility.

VIII REFERENCES

- [1] G.PREMKUMAR, "Design, Fabrication and Implementation of Microcontroller Controlled Static Var Compensator," International Journal of Computer Applications, vol. 81, pp. 43-50, Nov 2013.
- [2] S. B. Jame, "Automatic Power Factor Controller using PSoC3," International Journal of Engineering Research & Technology, vol. 3, pp. 1056-1058, May. 2014.
- [3] Anant Kumar Tiwari, "Automatic Power Factor Correction Using Capacitive Bank", International Journal Arduino Based Power Factor Correction 8 of Engineering Research and Applications, vol-4, Page393-395, Feb- 2014
- [4] Murad Ali, "Design and Implementation of Microcontroller-Based Controlling of Power Factor Using Capacitor Banks with Load Monitoring", Global Journal of Researches in Engineering Electrical and Electronics Engineering, Vol-13, pp. 21-31, 2013
- [5] Design & Implementation of a Microcontroller Based Automatic Power Factor Rectification System for Different Loads. Md. Mayen Uddin; Abdullah Al Mahmud; Naemul Islam. 2019 1st International Conference on Advances in Science, Engineering and Robotics Technology (ICASERT) Year: 2019
- [6] W. Ali, H. Farooq, M. Jamil, A. U. Rehman, R. Taimoor and 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), Lahore, 2018, pp. 72-76.
- [7] Y. Kabir, Y. M. Mohsin and M. M. Khan, "Automated power factor correction and energy monitoring system," 2017 Second International Conference on Electrical, Computer and Communication Technologies (ICECCT), Coimbatore, 2017, pp. 1-5.
- [8] M. B. Khan and M. Owais, "Automatic power factor correction unit," 2016 International Conference on Computing, Electronic and Electrical Engineering (ICE Cube), Quetta, 2016, pp. 283-288.
- [9] Arduino ICSP Programming Header Pinout, (2013), Retrieved from, <http://www.enchantedage.com/node/244>.
- [10] Jaeger, R. C., and Ballock T. N. (2004), Microelectronic circuit design. 2nd Edition, New York, McGraw-Hill, 1820pp.
- [11] Theraja, B. L., and Theraja A. K. (2013). A Textbook of Electrical Technology. 25th Edition, India, S. Chand and Company Ltd, 2750pp. Power Factor Metering System Using Arduino. Fluminense Federal University, Electric and
- [12] Telecommunications Engineering Master Program – PPGEET Niterói, Rio de Janeiro, Brazil. 6pp
- [13] tedage.com/node/244.

- [14] [2]. Adesina, L. M., and Ebere I. (2016). Practical Approach to Power Factor Correction for a Commercial Electricity Consumer in Nigeria.
- [15] International Journal of Engineering Research & Technology, 5 (12): 519-524.
- [16] [3]. Etisosa, U., Matthew, A., Agharese, E., Ogbemudia, O. G., Osaze, P. U. and Ose, G.O (2009): Energy Efficiency Survey in Nigeria-A Guide for
- [17] Developing Policy and Legislation. Community Research and Development Centre. 37pp.

