IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

"AUTOMATIC POWER FACTOR DETECTION AND CORRECTION"

Ms. VUNNAM SARAYU (Assoc.proff, Dept of Electrical And Electronics Engineering,R.V.R.&J.C College of Engineering , Chowdavaram,Guntur,AP,India)

1. Mr.SHAIK MASTHAN VALI (Dept of Electrical And Electronics Engineering, R.V.R.&J.C College of Engineering, Chowdavaram,Guntur,AP,India)
2. Ms.THUMATI POONAM PRIYA (Dept of Electrical And Electronics Engineering,R.V.R.&J.C College of Engineering , Chowdavaram,Guntur,AP,India)
3. Mr.SHAIK AYAZ(Dept of Electrical And Electronics Engineering, R.V.R.&J.C College ofEngineering, Chowdavaram,Guntur,AP,India)
4. Mr.YEPURI GOVINDHA RAJU(Dept of Electrical And Electronics Engineering, R.V.R.&J.C College of Engineering, Chowdavaram,Guntur,AP,India)

Abstract: In recent years, the power quality of the ac system has become a great concern due to the rapidly increased numbers of electronic equipment, power electronics, and high voltage power system. Most of the commercial and industrial installation in the country has large electrical loads which are more inductive in nature causing lagging power factor which gives heavy penalties to consumers by the electricity board. This situation is taken care of by PFC. Power factor correction is the capacity of absorbing the reactive power produced by a load. In the case of fixed loads, this can be done manually by switching capacitors. However in the case of rapidly varying and scattered loads it becomes difficult to maintain a high power factor by manually switching on/off the capacitors. This drawback is overcome by using an APFC panel. In this project, measuring of power factor from the load is done by using ATMEGA328 microcontroller and trigger required capacitors and extra synchronous condenser in order to compensate reactive power and bring power factor near to unity (1).

Index Terms - Stepdown transformer , Diodes, Ac supply ,Dc supply, Op amp, XOR gate, Resisters, Lcd display, Arduino ,Relays ,Capacitor ,CRO

I. INTRODUCTION:

The power factor of an AC electrical system is the measure of how closely a particular load equalsthe resistance of a pure resistance. It's a proportionof a load's an average power to a resistive load's anaverage power for much the same voltage and the current scale, with a value between 0 and 1. An active power is the actual quantity of the power utilized or lost in a circuit, and it is measured in watts. The product of the sine voltage and current waveforms called an activepower. The energy consumption in the ac circuitdue to the inductive and capacitive fields is knownas the reactive power. KVAR is the unit formeasuring the reactive power. The sum of theactive and reactive power is known as an apparentpower. It's the sum of a circuit's voltage and currentwithout taking the phase angle into the account. Thedistorted. The perfectly resistive load has a power

factor of one Because the sine voltage andcurrent waveforms are in the phase, or the phaseangle variation between both the voltage andcurrent is 0. The power factor is expressed inkilowatts. Reactive power doesn't quite producebeneficial "work," but rather flows between boththe generator and the load during times when thesystem is required to function properly. Inkilovoltamperes, reactive power is measured(kVA). It is visible power when active and reactivepower are combined. In kilovolt-amperes, the
perceived power is measured (kVA).

II. LITERATURE REVIEW:

Power factor is an energy concept that is relatedto power flow in electrical systems. To understandpower factor, it is helpful to understand three different types of power in electrical systems. RealPower is the power that is actually converted into useful work for creating heat, light and motion. Real power is measured in kilowatts (kW) and is totalized by the electric billing meter in kilowatt- hours (kWh). An example of real power is the useful work that directly turns the shaft of a motorReactive Power is the power used to sustain the electromagnetic field in inductive and capacitive equipment. It is the non- working power component. Reactive power is measured in kilovolt-amperes reactive (kVAR). Reactive powerdoes not appear on the customer billing statement.Total Power or Apparent power is the combinationof real power and reactive power. Total power is measured in kilovolt-amperes (kVA) and is totalized by the electric billing meter in kilovolt- ampere-hours (kVAh). Power factor (PF) is definedas the ratio of real power to total power, and is volt-amps unit is used to measure the apparent power(S) (VA). It is more powerful than both activeand reactive power. Because of the reactive power,which is the electric charge in the circuit and is negative, or because the current lags the voltage bya phase angle and returns to the supply, or becauseof a misaligned load, the produced a wave from thepower source is
expressed as a percentage (%).Power factor correction is the process of compensating for the lagging current by creating a leading current by connecting capacitors to the supply. A sufficient capacitance can be connected so that the power factor is adjusted to be as close to unity as possible.Power factor correction (PFC) is a system of counteracting the undesirable effects of electricloads that create a power factor that is less than one(1). Power factor correction may be applied either by an electrical power transmission utility to improve the stability and efficiency of the transmission network or, correction may be installed by individual electrical customers to reduce the costs charged to them by their electricityservice provider. An electrical load that operates onalternating current requires apparent power, whichconsists of real power and reactive power. Real power is the power actually consumed by the load.Reactive power is repeatedly demanded by the loadand returned to the power source, and it is the cyclical effect that occurs when alternating currentpasses through a load that contains a reactive component. The presence of reactive power causesthe real power to be less than the apparent power, so the electric load has a power factor of less than one. The reactive power increases the current flowing between the power source and the load, which increases the power losses through transmission and distribution lines. This results in operational and financial losses for power companies. Therefore, power companies require their customers, especially those with large loads, to maintain their power factors above a specified amount especially around ally 0.90 or higher, or besubject to additional charges. Electrical engineers involved with the generation, transmission, distribution and consumption of electrical power have an interest in the power factor of loads becausepower factors affect efficiencies and costs for boththe electrical power industry and the consumers. Inaddition to the increased operating costs, reactive power can require the use of wiring, switches,circuit breakers, transformers and transmission lines with higher current capacities. Power factor correction attempts to adjust the power factor of anAC load or an AC power transmission system to unity (1) through various methods. Simple methodsinclude switching in or out banks of capacitors or inductors which act to cancel the inductive or capacitive effects of the load, respectively. example, the inductive effect of motor loads may beoffset by locally connected capacitors. It is also possible to effect power factor correction with an unloaded synchronous motor connect across the supply. The power factor of the motor is varied by adjusting the field excitation and be made to behavelike a excited. Non-linear loads create harmonic currents in addition to the original AC currentcapacitor when over There are two types of PFCs:

1. Passive. 2. Active

III. PROPOSED SYSTEM:

A synchronous condenser is a device used in electrical power systems to improve power factor and stabilize voltage levels. It operates like a synchronous motor but without any mechanicalload attached to its shaft. Instead, it generates or absorbs reactive power as needed to adjust thepower factor of the system.

Automatic power factor correction (APFC) systems detect the power factor of the system and control the operation of synchronous condensers tomaintain it within desired limits. These systems utilize various control techniques such as voltage and current sensing, along with sophisticated algorithms to adjust the excitation of the synchronous condenser.

The integration of synchronous condensers withAPFC systems offers several benefits, including:

1. Improved Power Factor: Synchronous condensers help in improving the power factor of the electrical system by supplying or absorbing reactive power as required. This results in reducedreactive power flow in the system and improved overall power quality.
2. Voltage Regulation: Synchronous condensers contribute to voltage regulation by providing or absorbing reactive power, which helps inmaintaining stable voltage levels within acceptablelimits.
3. Enhanced System Stability: By providing dynamic support to the electrical grid, synchronous condensers help in enhancing system stability, particularly during transient conditions such as sudden changes in load or faults.
4. Reduced Line Losses: Improved power factordue to the presence of synchronous condensers leads to reduced line losses in the transmission anddistribution networks, resulting in increased efficiency of the system.
5. Compliance with Regulatory Standards: Many regulatory standards require power factor correction to be implemented to ensure efficient utilization of electrical energy. Synchronous condensers, integrated with APFC systems, facilitate compliance with these standards.

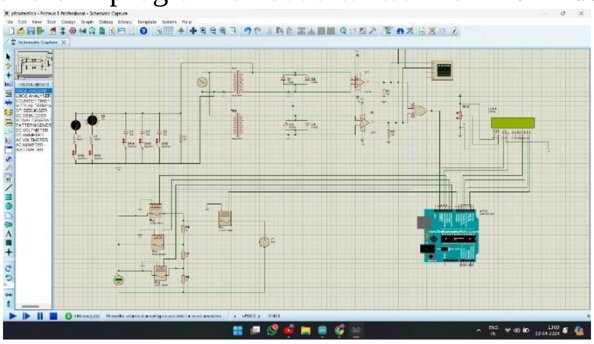
The operation of synchronous condensers for automatic power factor correction involves severalsteps:

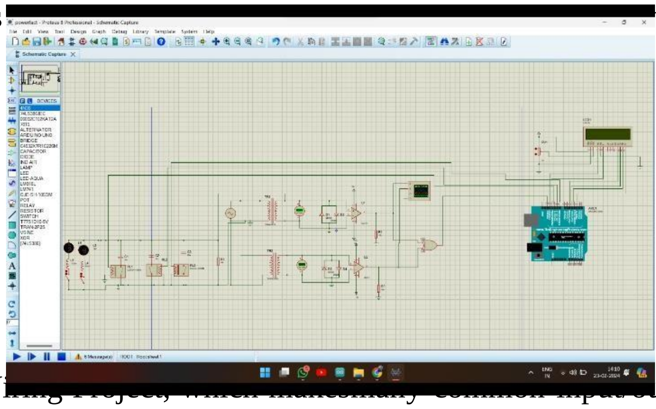
1. Power Factor Detection: APFC systems continuously monitor the power factor of the electrical system using voltage and current sensors.These sensors provide real-time data on the phase angle between voltage and current, which indicatesthe power factor.
2. Control Algorithm: Based on the measured power factor, the control algorithm calculates the required reactive power compensation needed to adjust the power factor to the desired level. This calculation takes into account factors such as system load, voltage level, and network configuration.
3. Excitation Control: The control system adjusts the excitation of the synchronous condenserto generate or absorb the required reactive power. This is achieved by controlling the field current ofthe synchronous condenser's excitation system.
4. Feedback Mechanism: The APFC system continuously monitors the power factor after making adjustments to ensure that it remains withinthe desired range. If deviations are detected, corrective actions are initiated to maintain optimalpower factor correction.
5. Integration with Protection Systems: Synchronous condensers integrated with APFC systems are equipped with protection features to safeguard against over-excitation, overloading, and other abnormal conditions. These protection systems ensure safe and reliable operation of the equipment.

Overall, the integration of synchronous condensers with APFC systems provides aneffective solution for automatic power factor detection and correction in electrical power systems. It helps utilities and industries optimize their power distribution networks, improve energy efficiency, and comply with regulatory requirements.

IV. SOFTWARE:

The Arduino is a single-board microcontroller, intended to make the application of interactiveobjects or environments more accessible. The hardware consists of an opensource hardware boarddesigned around an 8-bit Atmel AVR microcontroller or a 32-bit Atmel ARM. Current models feature a USB interface, 6 analog input pins,as well as 14 digital I/O pins which allow the user to attach various extension boards. Introduced in 2005, at the Interaction Design Institute Ivrea, in Ivrea, Italy, it was designed to give students an inexpensive and easy way to program interactive objects. It comes with a simple Integrated Development Environment (IDE) that runs on regular personal computers and allows writing programs for Arduino using a combination of simple Java and C or C++. The Arduino IntegratedDevelopment Environment (IDE) is a cross platform application written in Java, and is derivedfrom the IDE for the processing programming language and the wiring projects. It is designed to introduce programming to artists and other newcomers unfamiliar with software development.It includes a code editor with features such asSyntax highlighting, Brace matching and Automatic Indentation, and is also capable of compiling and uploading programs to the board with a single click. A program or code written for the Arduino is ith a





software library called ―Wiring‖from the original Wi tput operations much easier. Users need only define two functions to make a runnable cyclic executive program: • setup(): a function run once at the start of a programthat can initialize settings. • loop(): a function called repeatedly until the • board powers off . The previous code will not be seen by a standard C++ compiler as a valid program, so when the user clicksthe "Upload to I/O Board" button in the IDE, a copyof the code is written to a temporary file with an extra include header at the top and a very simple main() function at the bottom to make it a valid C++program. The Arduino IDE uses the GNU tool chain and AVR Libc to compile programs and usesavrdude to upload programs to the board As the Arduino platform uses Atmel microcontrollers, Atmel‘s development environment AVR Studio orthe newer Atmel Studio, may also be used to develop software for the Arduino.

V. MECHANISAM TO CONTROL EXCITATION OF SYNCHRONOUS CONDENSER:

The excitation of a synchronous condenser is controlled through its excitation system, which typically consists of a DC power source (such as agenerator or rectifier), field winding, and control circuitry. The excitation system regulates the magnetic field strength around the rotor, thereby controlling the reactive power output of the synchronous condenser. Here's a breakdown of themechanism used to control the excitation:

1. Voltage Regulator: The excitation systemincludes a voltage regulator that monitors the terminal voltage of the synchronous condenser. If the terminal voltage deviates from the desired setpoint, the voltage regulator adjusts the excitationto maintain the voltage within acceptable limits. This ensures proper voltage regulation in the system.

2. Automatic Voltage Regulator (AVR): In moresophisticated systems, an automatic voltage regulator (AVR) is employed to control the excitation. The AVR continuously compares the measured terminal voltage with the reference voltage and adjusts the excitation currentaccordingly. It uses feedback control loops to maintain voltage stability under varying load conditions.

3. Field Current Control: The excitation systemcontrols the field current supplied to the rotor winding of the synchronous condenser. By varyingthe field current, the excitation system can adjust the strength of the magnetic field, which in turn controls the reactive power output of the condenser.Increasing the field current enhances the magneticfield strength, leading to higher reactive poweroutput, while decreasing the field current reduces the reactive power output.

4. Feedback Control: The excitation system often incorporates feedback control mechanisms toensure accurate and stable operation. Feedbacksignals, such as voltage and current measurements,are continuously monitored and compared withreference values. Any deviations triggeradjustments to the excitation system to correct theoutput accordingly.

5. Protective Features: The excitation system includes protective features to prevent over-excitation or under-excitation of the synchronous condenser. These features may include overvoltageand undervoltage protection, overcurrentprotection, and field discharge protection. Theyensure safe operation of the equipment and preventdamage due to abnormal operating conditions.

6. Remote Control: In modern power systems, excitation control may be integrated into a central control system, allowing for remote monitoring andadjustment of excitation parameters. This enables operators to optimize the performance ofsynchronous condensers based on real-time systemconditions and requirements.

Overall, the excitation control mechanism of a synchronous condenser plays a critical role in regulating reactive power output, voltage stability,and system performance. By accurately controllingthe excitation, utilities and industries caneffectively manage power factor, voltage regulation, and grid stability in electrical power systems.

MECHANISAM TO CONTROL CAPACITOR BANKS:

Controlling a capacitor bank involves managingthe connection and disconnection of capacitor unitsto adjust the system's reactive power and power factor. Here's an overview of the mechanism used to control capacitor banks:

1. Automatic Controller: Capacitor banks are typically equipped with automatic controllers that monitor system parameters such as voltage, current,and power factor. These controllers use predefinedsetpoints and control logic to determine when to connect or disconnect capacitor units.

2. Voltage Sensing: The automatic controller continuously monitors the system voltage. When the voltage drops below a certain threshold, indicating a lagging power factor, the controller triggers the connection of capacitor units to inject reactive power into the system and improve voltagelevels.

3. Current Sensing: Similarly, the controllermonitors system current levels. If the current exceeds predefined limits, indicating high reactivepower demand, the controller may activate additional capacitor units to compensate for the reactive power consumption and maintain the desired power factor.

4. Power Factor Correction: The automatic controller adjusts the operation of the capacitor bank to achieve the desired power factor setpoint. Itcalculates the required reactive powercompensation based on the measured power factorand system load conditions, then activates or deactivates capacitor units accordingly.

5. Switching Devices: Capacitor banks are equipped with switching devices, such ascontactors or thyristor switches, for connecting and

disconnecting individual capacitor units. The automatic controller sends signals to these switching devices to open or close the circuit connections as needed.

6. Time Delay: To prevent rapid switching andmitigate the effects of transient conditions, theautomatic controller often includes time-delay features. These features introduce a delay betweenthe detection of a condition requiring capacitorbank adjustment and the actual switching operation,ensuring smooth and stable operation of the system.

7. Manual Override: In some cases, operators may need to manually control capacitor bank operation, such as during maintenance ortroubleshooting. Capacitor bank controllers may include manual override options that allow operators to manually connect or disconnectcapacitor units as needed.

8. Remote Monitoring and Control: In modern power systems, capacitor bank controllers may be integrated into a central control system, enabling remote monitoring and control. This allows operators to adjust capacitor bank settings, monitorperformance, and respond to system conditionsfrom a centralized location.

By effectively controlling capacitor banks, utilities and industries can optimize power factor, improve voltage stability, and enhance the efficiency and reliability of electrical powersystems.

REFERENCES:

1.Nader Barsoum "Programming of PicMicrocontroller for Power FactorCorrection"Proceedings of the first AsiaInternational 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 SinglePhase Domestic Loads by Means of Arduino BasedTRIAC 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 onComputing, 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. Vergaraand 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 doFator de Potência", available on:http://ecatalog.weg.net/files/wegnet/WEG- correcao-dofator-de-potencia-958-manual- portugues-br.pdf (Retrieved July 26, 2016)