

An Efficient Energy Management System Using PLC For Real Time Applications

Pushpavalli M^{*1}, Dhanasu M^{**2}, Nivetha K^{#3}, Gopinath B^{###4}, Rajalakshmi A^{####5}

* Assistant Professor(Sr.G),Dept.of ECE, Bannari Amman Institute of Technology,
Sathyamangalam,Tamilnadu,India.

** Assistant General Manager(CEM), Salem Steel Plant,
Salem,Tamilnadu,India.

M.E. Embedded Systems, Bannari Amman Institute of Technology,
Sathyamangalam,Tamilnadu,India.

Manager of V.R.K Sago Factory
Salem,Tamilnadu,India.

M.E. Embedded Systems, Bannari Amman Institute of Technology,
Sathyamangalam,Tamilnadu,India.

Abstract- Energy Management System is an important cost factor in real time applications. Energy efficiency improvement is an important way to reduce the costs and to increase predictable earning, especially in times of high energy price volatility. In existing system, nowadays autotransformers are used in industries as an energy management system. In proposed method, the autotransformer is replaced by load based auto switching method to improve the energy efficiency of the system. The shutdown of the entire system is prevented and energy is conserved.

Keywords—Programmable Logic Controller(PLC),CT Coil, PIC Micro controller,Relay.

I. INTRODUCTION

Now-a-days industries life the energy management system is becoming more complicated due to expansion in every unit mainly steel,cement and paper processing unit expansion and updating of machine.The objective of an Energy Management is to achieve and maintain optimum energy procurement and utilisation, throughout the organization .They are 1)To minimize energy costs / waste without affecting production & quality,2)To minimize environmental effects.Energy saving is important and effective at all levels of human organizations – in the whole world, as a nation, as companies or individuals. Energy Conservation reduces the energy costs and improves the profitability.Thailand began the Energy Conservation efforts in the first oil crisis (1973). Then the Energy Conservation Promotion Act was put into force in 1992. In this relation many things have been done including announcement of the National Energy Conservation Strategic Plan (2002-2011) and Five Years Energy Conservation Plan (2002-2006).The nation-wide Energy Conservation efforts

will contribute to lessening dependence on imported energy such as crude oils. Private companies are also sensitive to energy costs, which directly affects their profitability and even their viability in many cases. Especially factories in the industrial sectors are of much concern, because reduced costs by Energy Conservation mean the more competitive product prices in the world market. In existing method,an autotransformer maintaining the frequency is the toughest job, due to this power source failure makes the whole process often get shutdown. In auto-transformer main drawbacks are seasonal failure.So at the time of expansion even the power resource also need to be altered.The main aim is to reduce the completion of auto transformer often fails due to direct type system.so they often get an individual supply for it or often run through generators. In proposed method, the auto transformer is to be replaced through a new idea of load based auto switching methods. In this load based auto switching method each power source will be supply to an individual station according to its power consumption.The whole plant will be divided as the station according to the process plan. In this method a separate station will be created and accordingly power will be managed .

II.THEORY

A. PLC

A Programmable Logic Controller is a specialized computer used to control machines and processes. Initially designed to replace relay logic boards ie., Sequence device actuation and Coordinate activities.Accepts input from a series of switches.Sends output to devices or relays. It uses a programmable memory to store instructions and execute specific

functions that include on/off control, timing, counting, sequencing, arithmetic and data handling. Basically PLC is an assembly of solid-state elements designed to make logical and sequential decisions and provide outputs. PLCs are used for the control and operation of manufacturing process equipment and machinery. PLC has eliminated much of the hardwiring associated with conventional relay control circuits.

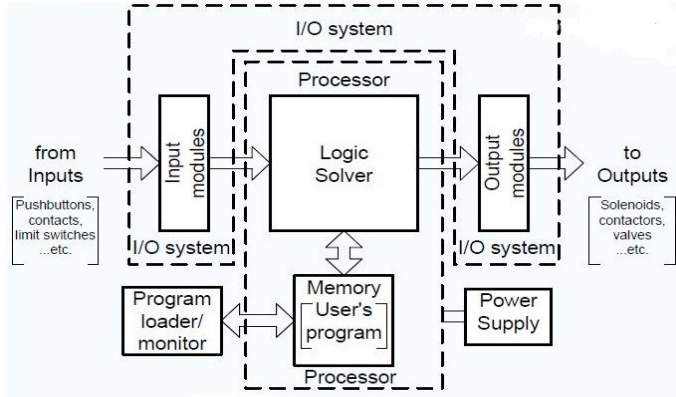


Fig. 1 Block diagram of PLC

A typical PLC can be divided into the following parts

- Central Processing Unit (CPU)
- The Input/output (I/O) section
- The Power supply and
- The Programming device

In proposed system, the PLC select SP4104 is used. A programmable logic controller is specifically computed used to control machine process. It contains 8 analog input and 14 digital output. This analog input measures the current value of the CT coil. The digital output are used to control the relay that switches the power sources.

B. Ladder Logic

The Ladder logic in the PLC is actually a computer Program that the user can enter and change. The ladder diagram language is basically a symbolic set of instructions used to create the controller program. These symbols are arranged to obtain the desired control logic that is to be entered into the memory of the PLC. A ladder diagram consists of individual rungs just like a real ladder. A line showing an input or several inputs and an output is known as a rung. Ladder logic programming is a graphical representation of the program designed to look like relay logic. The many similarities between the ladder diagrams used to program PLCs and the relay ladder logic formerly used to control industrial systems eased the transition from hardwired relay systems to PLC-based systems. The ability to monitor PLC logic in ladder diagram format also made troubleshooting easier for those already familiar with relay -based control systems. A ladder diagram (also called contact symbology) is a means of

graphically representing the logic required in a relay logic system.

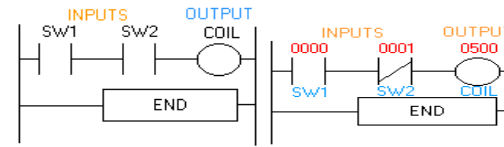


Fig. 2 Example of a Ladder Logic Program

C. PIC Micro Controller

PIC18F4550 belongs to pic18f family of microcontrollers. PIC18F4550 is one among the advanced Microcontrollers from the microchip technology. This microcontroller is very famous in between hobbyist and learners due to its functionalities and features such as ADC and USB Integration. A typical PIC18F4550 comes in various packages like DIP, QPF and QPN. These packages can be selected according to the project requirement. PIC18F4550 is an 8 bit microcontroller. PIC18F4550 has been implemented with Nano WATT technology hence it requires very low power for its operation. PIC18F4550 has 16 bit Instruction Set Architecture, (ISA) which provides a degree of freedom to programmers with various data types, registers, instructions, memory architecture, addressing modes, interrupt and IO operations. PIC18F4550 also has an Extended Instruction Set as a special feature; it's an optional extension to the PIC18 instruction set.

Memory Specifications: A PIC18F4550 has 256 bytes of EEPROM (Electrically Erasable and Programmable Read Only Memory), 2KB of SRAM (Static RAM) and 32KB of flash memory which in return provides another degree of freedom to programmers.

Communication Protocol: PIC18F4550 is remarked as advanced, as it uses well sophisticated protocols for communications. The modern protocols like USB, SPI, EUSART, are well supported in PIC18F4550. These technologies integrate with Nano Watt Technology (as mentioned before) to produce PIC18F4550, a well equipped, low power consuming microcontroller.

A Dedicated ICD/ICSP Port allows the programmers to code and debug easily.

- Enhanced flash programme and the 1KB Dual Access RAM for USB are used for buffering.
- PIC18F4550 consists of up to 13 channels for analog to digital converter. The converter accuracy amounts to 10-bit to convert analog to digital signal relatively.
- PIC18F4550 is compatible to work with different internal and external clock sources. It comes with four built-in timers or an external oscillator can be interfaced for clocking.
- The frequency limit for a PIC18F4550 is from 31 KHz to 48 MHz respectively.
- The microcontroller PIC18F4550 comes with ADC comparators and other such peripherals as an in-built feature.

PIC18F4550's 40 pin DIP (Dual inline package) has got its special reputation in between hobbyist, it's also easily available

in any electronic store. DIP or Dual inline package is nothing but a typical microcontroller with two rows of pins on either side. A 40 pin DIP PIC18F4550 has 20 pin on each row.

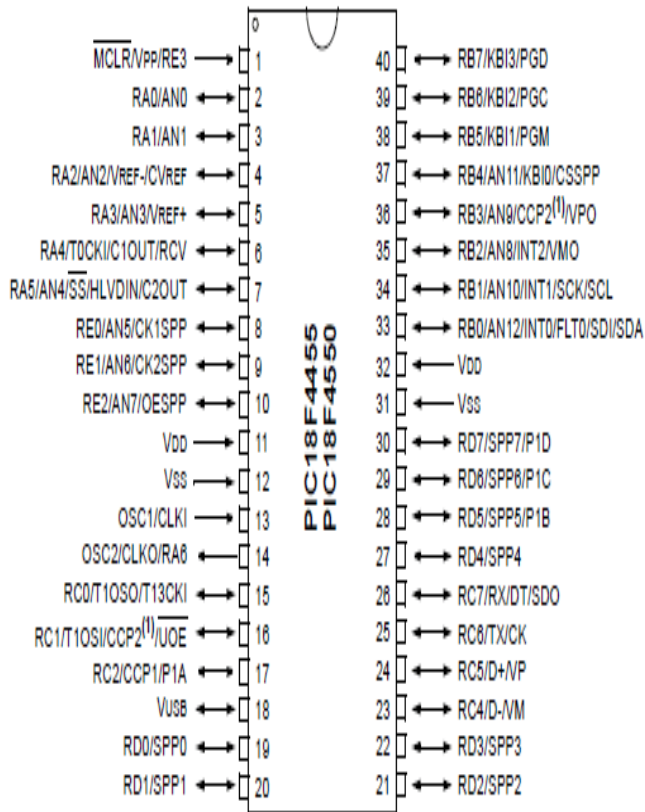


Fig. 3 Pin Diagram

In the energy management system PIC Microcontroller 18f4550 are used for real time applications. It consists of 5 ports. In this we use only port A and port B. In port A has 5 analog input and port B has 7 analog and digital output. In our project PIC Microcontroller is used to create a buffer between PLC and station.

D. CT Coil

The rated accuracy limit factor (Fn) is the ratio of the rated accuracy limit primary current to the rated primary current. A protective current transformer type 5P10 has, for example, the accuracy class 5P and the rated accuracy limit factor 10. For protective current transformers, the accuracy class is determined by the highest permissible percentage composite error at the rated accuracy limit primary current specified for the accuracy class concerned, followed by the letter "P" (referring to protection). The CT accuracy primary limit current defines the highest fault current magnitude at which the CT will meet the specified accuracy. Beyond this level, the secondary current of the CT will be distorted, and this may have severe effects on the performance of the protection relay. In practise, the actual accuracy limit factor (Fa) differs from the rated accuracy limit factor (Fn) and is proportional to the

ratio of the rated CT burden and the actual CT burden. For the reliable and correct operation of the protection relays, the current transformer (CT) has to be carefully chosen. The distortion of the secondary current of a saturated CT may endanger the operation, selectivity and coordination of the protection. A correctly selected CT, on the other hand, enables fast and reliable protection.



Fig. 4 Diagram of CT Coil

In this system, the ratio of measuring the current value from primary to secondary.

CT Coil 400/5 (for station purpose).

CT Coil 51/5 (for Input purpose- EB, Turbine, Generator).

In this project these CT coil are used to measure the power consumed in each station and power produced in each sources.

E. Relay

A switch whose operation is activated by an electromagnet is called a "relay". A relay is an electro-magnetic switch which is useful if you want to use a low voltage circuit to switch on and off a light bulb (or anything else) connected to the 220v mains supply. The diagram below shows a typical relay (with "normally-open" contacts). Relays are components which allow a low-power circuit to switch a relatively high current on and off, or to control signals that must be electrically isolated from the controlling circuit itself generally relay coils are designed to operate from a particular supply voltage, often 12V or 5V. when its connected to that supply voltage. So the basic idea is to choose a relay with a coil designed to operate from the supply voltage, so that your low-power circuitry can control the current through the relays coil. Typically this will be somewhere between 25mA and 70mA. So if your control signal Vin was switching between 0 and +12V.

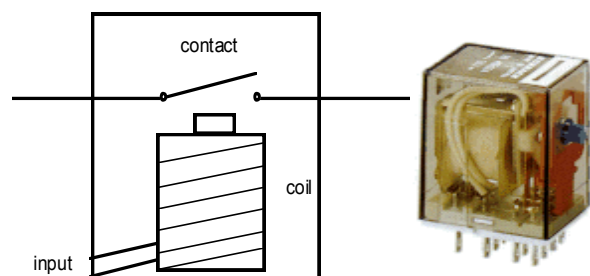


Fig. 5 Diagram of Relay

A Relay consists of two parts, the coil and the contact(s).

Contacts:

- a. Normally open -| |-
- b. Normally closed -|/|-
- c. Off-on transitional -||-
- d. On-off transitional -|/|-

Coil:

- a. Energize Coil-()-
- b. De-energize-(/)-
- c. Latch-(L)-

The relay is an electrical switch that is used to switch and high voltage using an low voltage. In industry oil type contact are used. In this project 15amp single contact PCB relay are used.

III. EXISTING SYSTEM

A. Block Diagram

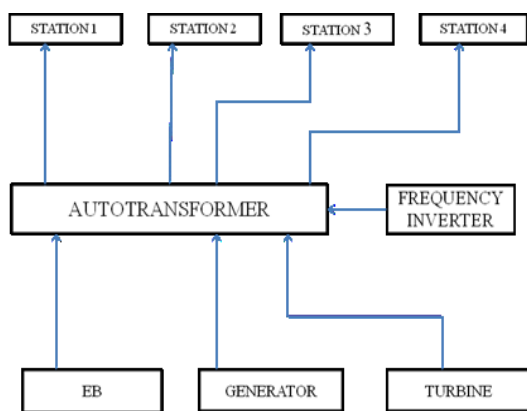


Fig. 6 Existing System Block Diagram

B. Auto Transformer

Auto transformer is another form of reduced voltage motor starter. The auto-transformer starter employs high voltage devices to control the current flow and therefore the voltage applied to the motor. An autotransformer can be used for step-up, step-down and split phase output balancing purposes. While the step-up and step-down functions are fairly straightforward, split phase output balancing may require

some more attention. Autotransformers are often used to step up or step down voltages in the 110-115-120 V range and voltages in the 220-230-240 volt range—for example, providing 110 V or 120 V (with taps) from 230 V input, allowing equipment designed for 100 or 120 volts to be used with a 230 volt supply (as in using US electrical equipment with higher European voltages). An autotransformer has a single winding with two end terminals. The primary voltage is applied across two of the terminals, and the secondary voltage taken from two terminals, almost always having one terminal in common with the primary voltage. The primary and secondary circuits therefore have a number of windings turns in common. Since the volts-per-turn is the same in both windings, each develops a voltage in proportion to its number of turns. In an autotransformer part of the current flows directly from the input to the output, In a step-down transformer the source is usually connected across the entire winding while the load is connected by a tap across only a portion of the winding. In a step-up transformer, conversely, the load is attached across the full winding while the source is connected to a tap across a portion of the winding. In existing method some drawbacks given as,

- In autotransformer maintaining the frequency is the toughest job.
- Due to this power source failure the whole plant often get shutdown.
- In autotransformer main drawbacks seasonal failure.

C. Frequency Inverter

A frequency inverter changes output voltage frequency and magnitude to vary the speed, power, and torque of a connected induction motor to meet load conditions. In fact, the primary difference between the two is that the controls for inverter section in a UPS attempt to maintain consistent voltage and frequency output regardless of current output as opposed to varying voltage and frequency with generally consistent current output to speed up or slow down a motor load. Consequently, frequency inverters are typically rated in terms of maximum current output, while UPSs are rated in terms of power output. Although the exact configuration of each section of the frequency inverter may vary from manufacturer to manufacturer, the basic structure remains the same. The rectifier section consists of an array of fast-acting switches that convert an incoming ac voltage supply to a pulsating dc voltage. The intermediate circuit consists of a dc bus and associated circuitry to stabilize and smooth the pulsating rectifier output. The dc bus voltage is roughly 1.414 times greater than the incoming ac supply voltage, depending on design type. This dc bus voltage is made available to the inverter section, which synthesizes an ac sine wave voltage output from the dc bus voltage.

V.CONCLUSIONS

IV. PROPOSED SYSTEM

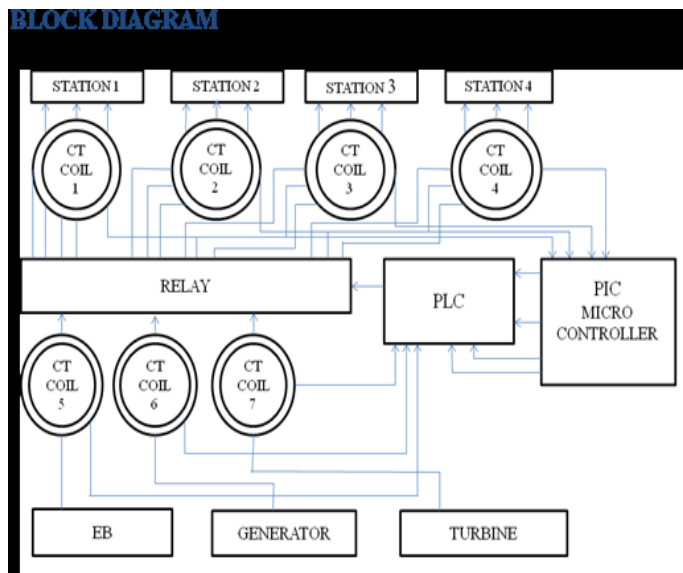


Fig .7 Existing System Block Diagram

- An embedded system based on energy management system using PLC for real time applications is designed.
- The programming is designed by using ladder logic.
- In proposed system the autotransformer is replaced by load based auto switching method.
- In this auto switching method each power source will be supply to an individual station according to it power consumption.
- The whole system will be divided as station according to the process plan.
- Easy to identify problem in every individual station .
- Due to electric problems in the individual station the whole process need not to be shutdown.

In the recent time use of energy management system is an important cost factor. The energy efficient improvement is an important way to reduce the costs and to increases predictable earning, especially in times of high energy price volatility. Since the system operation mainly depends on ladder logic programming, we can extend the system as our interest and requirements. This system is time saving, consumes less power and can be also made easily available. so that the small scale industries,large scale industries can use this system in real time applications whenever and wherever with small investment.

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