RESEARCH ARTICLE OPEN ACCESS

Energy Optimization based on PLC Automation

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Abstract:

In most of the public places electricity is being wasted as most of the common people do not think of switching off the electricity when they leave the places. Example: Offices, Schools, Colleges, Railway Station and so on. Proposed system monitor the presence of people by means of sensing the heat released from human body. As long as the people exist in the area power to the area will be made available. Once the system detects no people exists after a delay time it switches off the electricity to save the energy. Implementation of proposed system does not required cabling, routing and damaging the existing wall to implement the system. This circuit is designed Radio Frequency based wireless system. Thus Sensor detects the human movements and passes the information wirelessly to the RF wireless controller to take the necessary action. RF control has in-built off delay timer to achieve the required control.

INTRODUCTION:

We are seeing that, by 2050 70% of our Indian population lives in cities. Do we have enough infrastructures for meeting that load demand? Do we have any means for not wasting the power that is generated?

We must get smarter, we have technology, and we just have to integrate it and make it work. In such an aspect conversation of power is the key to achieving desired results in today's competitive business environment.

COMPARISION OF MICROPROCESSOR AND PLC:

PLC will be programming using ladder diagram and it is easy for technical's to be dealing with ladder more than C or assembly or other program language. PLCs more suitable for industrial applications.

Heart of all PLC's is a microprocessor. The ladder logic is a very simple way of interfacing to it to do straightforward things like turning motors on and off based on a set of inputs.If anyone want to change the program in microcontrollers to control the applications cannot be done.In PLCs the program can easily be modified and now a days PLCs are becoming advanced than microcontrollers.

PLC voltage range in input output is higher. It suitable to use with relay that has higher coil voltage usually 24VDC and sensor or components that work with higher voltages.

Meanwhile Micro Controller usually use with components with smaller voltages typical 5V and below. But we still able to interface it with higher voltages components depend on how we design the circuit as Micro Controller is a part of PLC.

In terms of programming PLCs are easier to learn.The disadvantage of PLC is more costlier and bulky.

Architecture of PLC:
The architecture of PLC is similar to the of industrial used pc. The PLC contains inputs and outputs. Mainly the inputs contain Limit switches, temp switches, push buttons, A/D, logic and BCD converters. The output comprises of D/A, BCD converters solenoids and alarms.

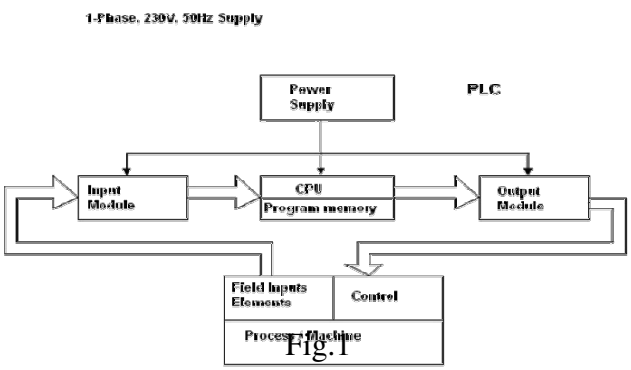


Fig.1

The Fig.1 describes the architecture of PLC which consists of Input module,output module,CPU etc.,

INPUT MOUDLE:
The input module is an interface between the field inputs and the CPU. Limit switches, temp switches, push buttons sigals which are generated are given to the input module.
The input module helps the following ways:

1. It converts the field signal into a standard control signal delivered by input module could be 5V or 9V whereas the field signal received by it could be say 24V DC or 230V AC.
2. If required, it isolates the field signal from the CPU.
3. It sends one input at a time to CPU by multiplexing action thus helping in serial communication.

The input module modules can be of different ways depending on the signals:

1. Analog input module.
2. Digital input module.
3. The typical analog current input modules are 4 to +- 20mA, 0 to +-20mA and analog voltage input modules are 0 to +-50mV and 0 to +-10V.
4. The typical digital input modules are

24V DC, 120V AC and 230V AC.

OUTPUT MODULE:

The output module acts as interface between the CPU and control fields.The output devices are lamps, valves, LEDs, potentiometers etc.,

The output module converts the output signal delivered by the CPU into an appropriate voltage level suitable for the output field device. The voltage signal provided by the CPU could be 5V or 9V, but the output module converts this voltage level into say 24V DC, or 120V AC or 230V AC etc. Thus the output modules on receiving signal from the processor switch voltage to the respective output terminals. This makes the actuators (i.e. contactors, relays etc) or indicating lights etc.

CENTRAL PROCESSING UNIT:

The CPU consists of

a. Arithmetic Logic Unit
b. Program memory
c. Process image memory (i.e. internal memory of CPU)
d. Internal timers and counters
e. Flags .

The input system consists of Digital, Analog and counter unit Output system is constituted with Digital and Analog output modules. The memory (external) will be shared with CPU for its internal usage and two way communications exists. In such PLC's, there will be two ways communication system exists between ALU and I/Os. The power supply feeds to I/Os and as well as CPU and related modules at bus level.

a.Arithmetic Logic Unit (ALU)

ALU is the ―organizer‖ of the PLC .

The following operations are carried out by ALU:

1. It organizes the input of external signals and data.
2. It performs logic operation with the data.
3. It performs calculations.
4. It takes the account of the value of internal timers and counters.
5. It takes account of the signal states of stored in the flags.
6. It stores the signal states of the input in the ―Process Input Image‖ (internal memory of CPU) before each program scanning cycle.
7. It stores the result of the logic operation in the ―process Output Image‖ (internal memory of CPU) during the program scan.
8. It organizes the output of the result.

b.Bus System

Bus system is a path for the transmission of signals. In the programmable controllers, it is responsible for the signal exchange between processor and input / output module.

1. Control bus which transfers control and timing signals for the synchronization of the CPU's activities within the programmable controller

c.Power Supply

The power supply module generates the voltages required for the electronic modules of the PLC from the mains supply. Typically 1 phase, 230V AC supply is converted into 24V DC supply by power supply module. It should be noted that CPU needs 24V DC

input and other voltages required by the PLC hardware such as 5V DC etc. is generated by CPU.

III.PROPOSED METHOD:

PROGRAMMING OF PLC:

EASY PLC has two operating modes such as Run and Stop.

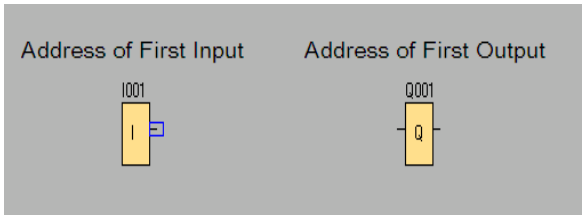
In Run mode, the PLC continuously processes the stored program until the stop mode is selected. PLC may go into the Stop mode by itself incase if any internal fault occurred. While the program is downloaded into the PLC, it goes into stop mode. After the complete loading of new program the PLC automatically switches into Run mode in order to execute and process the program stored in the non-volatile memory. PLC has the internal RTC (Real Time Clock) which is powered by the capacitor to maintain the RTC value. If desire to stop the program execution it can be simply stopped form the XLogic soft PLC programming software.

EXECUTION OF THE PROGRAM:

When the PLC is powered, all the inputs status and values at the input channels are converted into digital values using the voltage level detection and A/D converter. Converted digital values are stored in the Input table (I1, I2, I3 and so on.,). Then the values from the input table are applied into the logic diagram and processor executes the logic. Resultant value from the logic execution is pushed into the PLC output tables (Q1, Q2, Q3 and so on.,). These values are converted into physical output either by energizing the relay via transistor or sending analog output by converting the digital signal into analog value using the D/A converter. Above briefed cycle is executed in less than 20 msec which is named as scan time of the PLC.

Inputs are addressed with letter I and outputs are addressed with letter Q. For example first channel value is fetched into the PLC by addressing it as I1. Similarly the first channel output is activated by addressing the output as Q1. Refer the below figure which shows the addressing method.

<u>Example of input / Output addressing:</u>



HARDWARE SELECTION & PLC POWER SCHEDULING PROGRAM:

HARDWARE SELECTION:

Based on the requirement of saving the energy being spent in a class room, we have selected the Easy PLC kit model ELC-6AC-R in which 4 channels can be used as input and two channels can be used as output. This PLC accepts the 230V inputs and provides the relay output with 10A contact rating. It has the inbuilt RTC (Real Time Clock) which is being used to disconnect the power being sent to the class room during the public holidays and break time in the week days.

Based on the class room dimension, we have selected a PIR (Passive Infra Red) motion detection sensor with detection range of 12 Meter. Since one of the objectives of our project is to use and save the energy being

spent in the class room without altering the existing wiring, we have selected the wireless PIR motion detector. Since 433 Mhz RF frequency is allowed to use by public inside India we have selected the PIR with 433 Mhz RF frequency output. We have selected a 433 Mhz RF receiver kit to receive the motion detection signal from the PIR wireless motion detector wirelessly.

Motion detection signal received from the PIR sensor is transmitted to the Easy PLC to override the time based automatic disconnection of power being sent to the class room.

16 Amp contactor is considered to power the class room. A selector panel is designed to override the PLC logic and for the indication of contactor and motion detection.

Selector panel is equipped with two no of Auto/Manual switch which is being used to bypass the PLC. S1 switch is used to bypass the PLC as well as the motion detector. When there is a malfunction in the PIR sensor or RF receiver, power to the class room can be switched ON by switching the S1 selector into manual mode. This will provide the power directly to the class room. This can only be used when there is a problem in the PLC or PIR circuits. S2 switch can be used to energies the main contactor by switching into manual mode in case if the PLC malfunctions.

There are two indication lamps available in the Selector panel to indicate the status of the main contactor and motion detection. Green color lamp indicates the status of the main contactor. Green lamp glows when the main contactor is energized. Red color lamp indicates the status of the motion detection. Red color lamp glows only when the motion is detected and the main contactor is energized by the motion detection.

Knife disconnects and fused terminals are used for the wiring terminations. This provides easy maintenance as it allows the maintenance personnel to break the circuit by simply removing/disconnecting the fuse terminal or knife disconnects. Secondly the fused terminal block is equipped with led which indicate the fuse failure incase if the fuse is blown.

PROGRAMMING

PLC program is developed in such a way that the power is disconnected when the persons does not exist in the room.the fan will be OFF automatically when the temperature in the room is cool.when the persons exist in the room then the lights and fans will automatically ON. The programming is shown in below Fig.2:

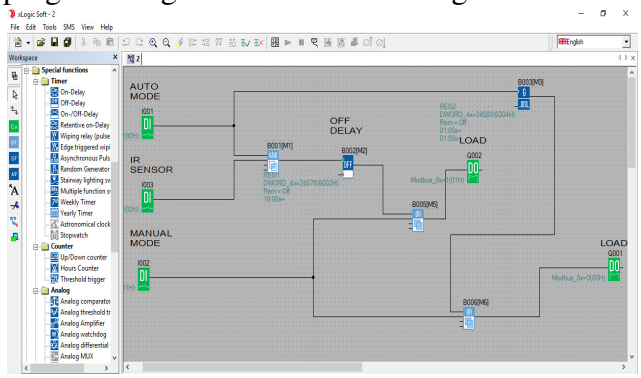


Fig.2

RESULTS AND DISCUSSION:

Below picture shows the complete assembly of our power saving kit. This assembly is

tested against different scenario and captured the picture for reference.

Screenshot taken when the light is ON

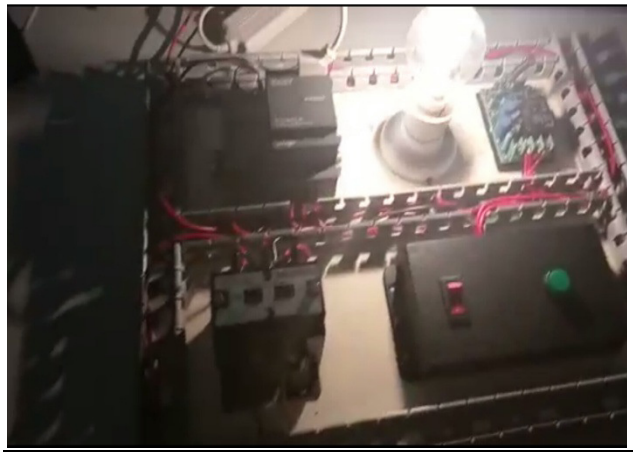


Fig. 3

When the person enters into the room the light is automatically switched on as shown in the above Fig.3.

Screenshot taken when light is OFF:

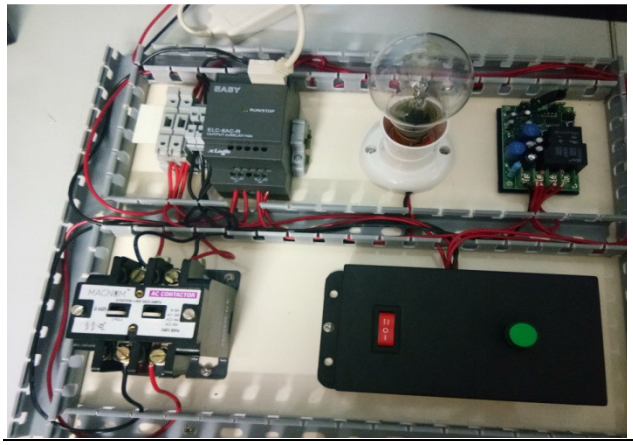


Fig.4

when the person is not available in the room the light is automatically switched off as shown in the above Fig.4.

CONCLUSION:

From the study of the project we sought a way that power can be saved in colleges and institutions through PLC also. The schedule taken here is limited due to the number oinputs and outputs being less. This limitation will be absent when the PLC was of industrial one. The simulation results show how efficient the seven day timer is. The hardware shows the prototype of the college with LED's being illuminated according to the schedule. Thus the simulation results and hardware results show the power scheduling through a timetable of the college. This results show that power can be supplied only when there is a use of that particular room only. By this scheduling electricity bills can be reduced, as not much power is being wasted unnecessarily.

FUTURE SCOPE:

This project can be used widely if the no of outputs and inputs are more. This inputs and outputs can be generally taken depending on our project level. Hence by this project we would like to show that PLC is not only an industrial device but can be used for domestic purposes like saving power. This project has a good demand as the electricity bills were being increasing due to the heavy usage of the power which increases with increase of population, will be reduced. This project can be used in many places like by using sensors and other switches with a good industrial PLC.

REFERENCE:

1.www.sskdeltadesign.com

Author's Profile:

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