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A Review of Automatic Switching by Using PLC System

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Abstract— **The supply of electricity for industrial, commercial and domestic use is highly unstable. This gives rise to the frequent use of alternative sources of power supply to meet up with the energy demands. The introduction of these alternative sources of supply brings forth the challenge of switching smoothly and timely between the mains supply and the alternative sources whenever there is a failure on the mains source. This paper presents design and implementation of automatic switching circuits which is used in PLC automation for constructing a workable automatic change-over switch with generator starting/shut down functions. This switch turns ON the generator automatically in cases of mains power failure and connects the load to the generator output, alternatively it switches OFF the generator automatically once power is restored and returns the load to the mains power with the help of desired range of parameters which may be set by programmer.**

Keywords— **Switching, Power Supply, PLC, Relays Automation, Sensors, Ladder Logic.**

I. INTRODUCTION

Automatic Switching has been a very rapidly growing area of electronics with good potential for further developments. The most attractive applications of this technology are in medium and large scale industries. Every individual that is paying money to have a better standby supply has a right to have maximum satisfaction for its industrial needs. Generally inverters are not supposed to be the best choice for backup supply because inverters becomes fail due to insufficient battery time .In order to get rid of this problem, the user will go for stand by generators that are specifically designed to fulfill industrial needs. The main problems of turning it on / off can be removed by installing the auto transfer switch (ATS) for industrial generators. One of the key functions related to a Gen-set is the changeover switching when the main power source fails. Some papers show that automatic switching a challenge to researchers Sana Sohail, Shahzad Nasim, Faraz Ali's paper [1] presents an economical and easy way for switching application of generator through PLC and monitoring through SCADA incorporated with GSM alerts in industries. An Automatic Transfer Switch enables backup generators, DC to AC inverters redundant UPS or other AC power sources to be used for a single load. An ATS is recommended when no down time from a power outage can be tolerated. Shashank Lingappa M., Vijayavithal Bongale, Sreerajendra [2] proposed that Low Cost Automation (popularly known as LCA), is the introduction of simple pneumatic, hydraulic, mechanical and electrical devices into the existing production machinery, with a view to improving their productivity. L.S. Ezema, B.U. Peter, O.O. Harris [3] provides an automatic switching mechanism that transfers the consumer loads to a power source from a generator in the case of power failure in the mains supply. Failure points are defined as a drop in voltage below a preset setting on any phase Daugherty, Herbert [4] introduces one of the main functions of the control panel is the detection of a drop in voltage or a complete failure of the normal source of power. Saiful Anuar Bin Alwi [5] propose to design and build a system that is called Automatic Main Failure (AMF) System which automatically allow switching from solar cell power supply to a battery as backup power supply.

II. HARDWARE REQUIRED FOR PROTOTYPE MODEL

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A. Relays

The relays used are simple 12 V electromechanical relays. There are 10 relays used in the project. Output of one of the relay is used to trigger PLC. Rest is used to operate ACB of main supply, DG set and load.

B. Rectifier Circuit

This circuit is used to supply to sensors. This circuit is converted from 12V AC to 12V DC.

C. Step down Transformer

A step down transformer of 230/0-12V 1Amp capacity is used to step down voltage so as to be used for hardware implementation.

D. PLC System

In this project, PLC system is used to Programmable Logic Controller of Schneider Company. In this system, we are used to analog inputs.

E. Power supply

A 230V single phase power supply is for the project

F. Load

For convenient and reliable operation of this project, we are used to 10 LED lights which are connected to rectifier output (12V DC).

G. Motor Generator set

The stand-by generator set is commonly used to supply emergency power to most of the power consumers where the mains supply is unstable.

III. Automatic switching techniques

A. Automatic Switching Using Microcontroller

AMF system consists of three main elements which are voltage comparator, PIC microcontroller and relay switch. The voltage comparator is used to set and monitor the voltage level at both power supplies. The PIC microcontroller acts as the brain of the system that monitors the output signal from voltage comparator circuit and control the switching of relay accordingly

B. Automatic Switching Using Labview

One benefit of LabVIEW over other development environments is the extensive support for accessing instrumentation hardware. Drivers and abstraction layers for many different types of instruments and buses are included or are available for inclusion. These present themselves as graphical nodes. The abstraction layers offer standard software interfaces to communicate with hardware devices. The provided driver interfaces save program development time.

C. Automatic Switching Using CMOS

The circuit contains some integrated circuits (IC) more especially the CMOS (complimentary metallic oxide silicon) type. The CMOS consumes less power from the battery. That is why it was incorporated into the circuit. The circuit also consists of relays that provide external switching. These devices are quite robust for efficiency and reliability.

D. Automatic switching using PLC

The circuit contains PLC and relays. The main purpose of PCL is to automatically turn on the Generator, as it senses that the MAIN POWER signal is no more available, then turning it off when the MAIN POWER supply returns, making sure that at no point in time, both supplies are turned ON simultaneously. A delay time is given, for which the PLC waits for the MAIN POWER to return in case of any short power failure, after that time delay it sends a command to the generator, thus turning it ON. Also when the MAIN POWER returns, it waits for a given time interval, so to ensure that MAIN POWER has returned properly, and if the MAIN POWER supply turns off before that time, then PLC keeps the generator ON.

Among all these techniques explained earlier automatic switching using PLC is found to be best possible method and hence is used in this thesis. Using PLC's to achieve automation has following advantages:

i) Consistency in manufacturing can be easily achieved.

ii) Complete control of the manufacturing process can be achieved.

iii) Accuracy and quality can be improved.

iv) Productivity can be improved.

v) Makes it easy to work in difficult or hazardous environment.

vi) Implementation of SCADA and GSM becomes easier.

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IV. DESIGN OF PLC BASED AUTOMATIC TRANSFER SWITCHING

The schematic block diagram of this model has been shown in fig.-1. It consists of different blocks.

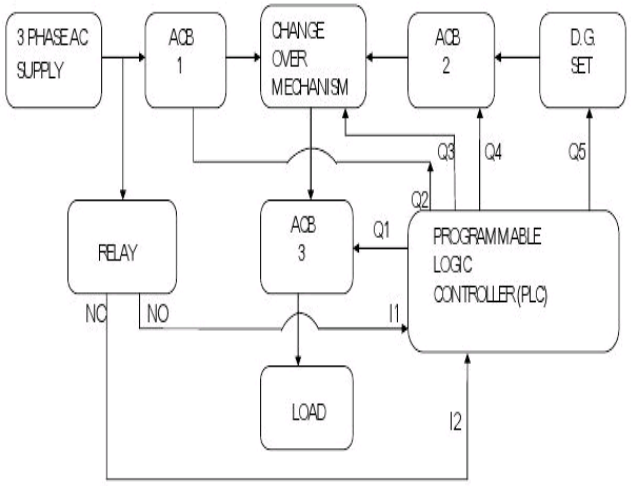

FIG.1- BLOCK DIAGRAM OF PROPOSED PROJECT

A. Electromechanical Relay

An electromagnetic relay consists of a normally open and normally closed switch. This may be explained as follows:

A normally closed (N.C.) contact is a contact that is closed or in a conductive state when it, or the device operating it, is in a de-energized or relaxed state.

A normally open (N.O.) contact is a contact that is open or in a non-conductive state when it, or the device operating it, is in a de-energized or relaxed state.

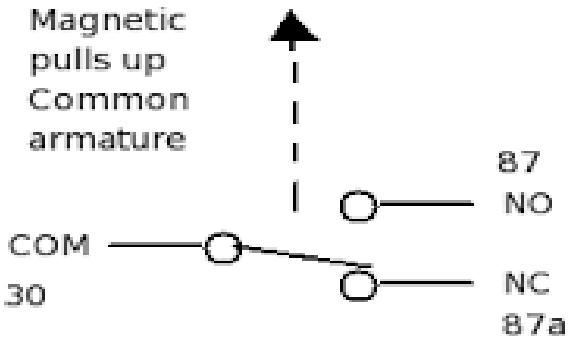

Fig.2- NO NC contact of electromagnetic relay

B. Rectifiers and Filters

In this project IN4007 diode is used for rectification and for filtering purpose a filter capacitor of capacity 2200 micro farad is used.IN4007 diode is normally used for general purpose rectification of power supplies, inverters, converters and freewheeling diodes application.

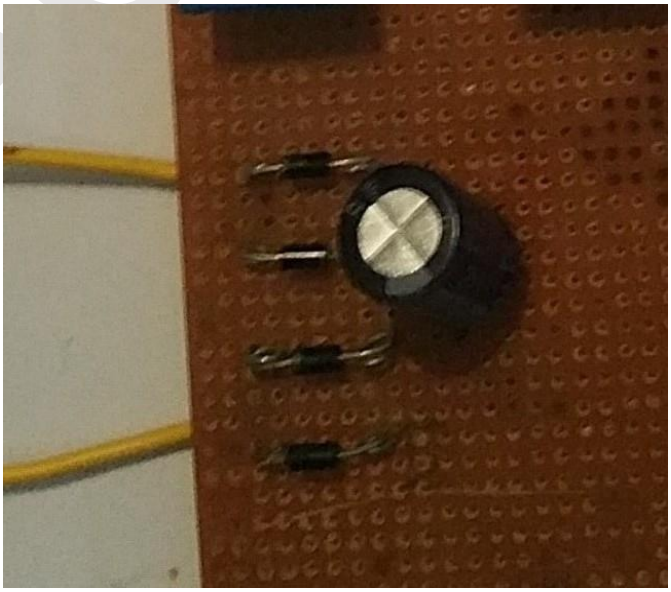

FIG. 3 – SNAP SHOT OF RECTIFIER AND FILTERS

The secondary voltage of transformer is 12V AC. Because of LED light load works on DC, rectification is required to fulfil the necessary condition of load. This section is shown

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in fig.3 above. The rectifier circuit converts AC to DC. In this project, bridge type rectifier is used which consists four diode arrangement.

C. Motor – Generator set

The stand-by generator set is commonly used to supply emergency power to most of the power consumers where the mains supply is unstable.

Features of generator to be used in Automatic change over switch:

The automatic change-over switch can be used in any place where alternative power is needed to complement the main power supply. In this project, a generating set is used as an alternative power supply. Thus, it is very important to note the necessary peripherals to be used with the automatic change-over switch.

(a) The generator must have electrical 'start and stop' facility.

(b) The generator's battery has to be in good condition always.

(c) The inter-connecting cables must be in good order

This rectification is also called full wave rectifier circuit. And also filtering is required for pure dc output. The filtering is made by connecting capacitor between phase and neutral terminal. The rectification and filtering is made in all three phases and all are identical connection.

D. Frequency and Voltage sensing

One of the main functions of the control panel is the detection of a drop in voltage or a complete failure of the normal source of power. In general, all phases are monitored. Failure points are defined as a drop in voltage below a preset setting on any phase. Voltage and frequency information is provided by the sensors in the control panel to determine load availability. The minimal voltage and frequency must be attained before transfer of the load to the new or used generator. This is to ensure the generator set has the ability to accept the load.

E. Time delays

Automatic Transfer Switches come with a wide variety of time delay systems. Time delay functionality is a necessary feature for an automatic transfer switch because of false alarms triggers with the normal power source from a utility company. The most prevalent time delay overrides any momentary normal outages that would cause a false engine start and thus transfer the load. This time delay is 10 seconds.

Once normal power is restored, another time delay is needed to ensure the load is stable enough to switch from backup power. Typically, this delay is between zero to thirty minutes. The control panel should automatically bypass this time delay in returning to the normal source if the new or used generator fails and the normal source of power is working properly again. In most instances it is usually desirable for the load to be transferred to the backup generator as soon as the proper voltage and frequency are reached. However, in some situations end users want to sequence different transfer switches onto the backup generator. When this application is required the controls should include an additional time delay which can be adjusted on each transfer switch so that the loads can be transferred to the new or used generator in whatever order desired. Here time delay is 50 sec.

F. Load

The load is used as LED lights. For normal condition, all LEDs will glow through main power supply while during power failure, switching is done and same LEDs will glow through generator.

V. CONCLUSIONS

In this paper many aspects of automatic transfer systems for the critical power environment are presented. In general, the manufacturer's experiences with these types of systems, along with proper specification are the keys to successful transfer system design and implementation. When properly designed and implemented, automatic transfer systems provide a vital function in the reliable operation of critical power systems. Working in conjunction with alternate power sources and UPS's, automatic transfer systems help to insure that critical system loads receive the reliable power they require in order to function.

Various types of switching techniques are also discussed in this thesis. There are many techniques in automatic switching. Although automatic switching of load using PLC based system is proposed.

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The implementation of this technique is done on both software and hardware form. Ladder diagram programming is done to build up the program.

The overall conclusion of the project is following as below:

If power failure occurs, the relay will sense the absence of power supply and will give output to PLC which in turn operates the motor generator set.

During power failure, ACB of mains is turned OFF and as the required voltage and frequency is achieved by DG set ACB of DG is turned ON.

After restoration of main power this switching process is reversed and after providing a proper delay DG set is turned OFF.

The working has been found successful on the occurrence of power failure.

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