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DESIGN AND IMPLEMENTATION OF AN AUTOMATIC CHANGE OVER SWITCH FOR INDUSTRIAL APPLICATION

A MINOR PROJECT - II REPORT

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BONAFIDE CERTIFICATE

Certified that this **18ECP104L - Minor Project II** report "**DESIGN AND IMPLEMENTATION OF AN AUTOMATIC CHANGE OVER SWITCH FOR INDUSTRIAL APPLICATION"** is the bonafide work of "**ABINAYA T (927621BEC005), DEEPIKA M (927621BEC029), DHANUSRI R P (927621BEC035), DHARSHINI T (927621BEC043) "** who carried out the project work under my supervision in the academic year 2022-2023 EVEN.

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This Minor project-II report has been submitted for the **18ECP104L – Minor Project-II** Review held at M. Kumarasamy College of Engineering, Karur on **__________________.**

PROJECT COORDINATOR

INSTITUTION VISION AND MISSION

Vision

To emerge as a leader among the top institutions in the field of technical education.

Mission

M1: Produce smart technocrats with empirical knowledge who can surmount the global challenges.

M2: Create a diverse, fully -engaged, learner -centric campus environment to provide quality education to the students.

M3: Maintain mutually beneficial partnerships with our alumni, industry and professional associations

DEPARTMENT VISION, MISSION, PEO, PO AND PSO

Vision

To empower the Electronics and Communication Engineering students with emerging technologies, professionalism, innovative research and social responsibility.

Mission

M1: Attain the academic excellence through innovative teaching learning process, research areas & laboratories and Consultancy projects.

M2: Inculcate the students in problem solving and lifelong learning ability.

M3: Provide entrepreneurial skills and leadership qualities.

M4: Render the technical knowledge and skills of faculty members.

Program Educational Objectives

PEO1: **Core Competence:** Graduates will have a successful career in academia or industry associated with Electronics and Communication Engineering

PEO2: **Professionalism:** Graduates will provide feasible solutions for the challenging problems through comprehensive research and innovation in the allied areas of Electronics and Communication Engineering.

PEO3: **Lifelong Learning:** Graduates will contribute to the social needs through lifelong learning, practicing professional ethics and leadership quality

Program Outcomes

PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes

PSO1: Applying knowledge in various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of Engineering application.

PSO2: Able to solve complex problems in Electronics and Communication Engineering with analytical and managerial skills either independently or in team using latest hardware and software tools to fulfil the industrial expectations.

Abstract	Matching with POs, PSOs
AUTOMATIC CHANGE OVER SWITCH	**<<PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11, PO12, PSO1, PSO2>>**

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ABSTRACT

An automatic phase change over switch is designed primarily to disconnect load from its power source and transfer it to a standby source say generator, in case there is a power outage. This operation connects the power supply from the generator to the load after a predetermined time interval. This is intended to normalize the current from the generator. Switching is possible through the use of the relays. The switching process is done in a controlled manner so as to prevent the false starting of generator at very short power outages. Once the supply is restored, the load is transferred back to mains supply. The entire process is controlled by a control unit that keeps sensing to detect that whether the main supply is available or not. Most households, offices, small and medium scale enterprises (SMEs) and multinationals depend on the electrical generator as alternative power supply, hence the need for an automatic changeover switch to facilitate automatic changeover between the mains supply and a generator. Thus, this project sets to present the design and implementation of an automatic changeover switch with a generator trip-off mechanism. The system uses relays, integrated circuits, transistors and electromechanical devices. The design was simulated with the aid of Multisim software and the prototype circuit was implemented. The experimental results from the prototype corroborate with the stimulated results.

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LIST OF ABBREVIATIONS

ACRONYM		ABBREVIATION
ATS	-	Automatic Transfer Switch
PLC	-	Programmable Logic Controller
UPS	-	Uninterrupted Power Supply
TTS	-	Transistor Transistor Logic
EMR	-	Electro Mechanical Relay
LCD	-	Liquid Crystal Display
FET	-	Field Effect Transistor

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

The project is designed for power supply applications. It involves automatic changeover between the main power supply and an auxiliary power supply, such as a generator. The circuit of the project consists of logical control unit and relay switches. The basic operation of the project is to switch ON an auxiliary power supply (like a generator). This operation connects the power supply from the generator to the load after a predetermined time interval. Switching is possible through the use of the relays. The system was designed to automatically change power supply back to the main supply moments after the A.C. mains are restored and to switch OFF the generator. The device removes the stress of manually switching ON the generator when power failure occurs. The operation allows electric current to flow through the motor/starter. It is noted that one of the motors terminals is already connected to 12V+ terminals. The switching of the relay allows the other terminal to be grounded thereby completing the circuit of the electric motor.(Hammed and Mohammed, 2006).

Power supply instability in developing countries creates a need for automation of electrical power generation or alternative sources of power to back up the utility supply. This automation becomes necessary as the rate of power outage becomes predominantly high. Most industries and commercial processes are partly dependent on generators and public power supply which is epileptic especially in tropical.

However, if the starting of the generator is automatically done by a relay which switches the battery voltage to ignition coil of the generator while the main power relay switches the load to either public supply or generator, the down time would greatly be reduce thereby maintaining the tempo of production in such industries. The approach used in this work is the modular approach where the overall design is first broken into functional blocks. Each of these blocks carries out a specific function in the entire system by the interconnections between the block (Kolo, 2007).

Electricity (energy), which plays a major role in economic development of a nation, forms the basis of this study, with interests in human, infrastructural and economic development. In most developing and underdeveloped parts of the world, 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. There is also the need to reduce drudgery from switching between the two sources on the human side. Solving these challenges forms the focus of this work. The Automatic Change-over switch, automatically switches over to the alternative source of power supply (generator) when there is a power outage. It equally switches over to the mains supply when power is restored and turns off the generator automatically. Therefore automatic power change-over switch is a device that links the load and mains supply or the alternative supply together.

This enables the use of either the mains supply or an alternative source when there is outage on the mains source. This could either come in with three phase or single phase. This device maintains constant power supply to the load by automatically activating the generator when there is need. (Boylestad and Nashelsky, 2012).

1.2 AIMS AND OBJECTIVES

Due to inconsistent supply of power, there is a growing need for an alternative source of power supply. The analysis of this project cannot go without enumerating the goals meant to be achieved in the pursuit of this work. This include:

1. To develop a simple low-cost device aimed at easing constant power outage faced by industry, hospitals, schools and homes.
2. To minimize power interruption.

An Engineering Author, "Tony Rudkin" said in his book titled "Upgraded Signal Source with Improved Performance and Reliability" that the cost and depredation associated with breakdown vary from one application to the other, and in some cases, the user has little choice but to ensure that a stand-by unit is available to take over on event of failure of primary system.

If some of these big firm do not make provisions for stand-by power source, frustration could set in which may lead to the closure of business and thus throwing workers into unemployment. Also in the case of hospital, undergoing a surgical operation and power supply suddenly go off, the patient might loose his or her life due to the power outage.

In his book, Tony Rudkin also said that the depredation caused by such reduce efficiency of the organization and leads to a great deal of frustration.

CHAPTER 2

2.1 LITERATURE REVIEW

Uninterrupted continuous power supply is essential to the industrial sector, university operations, and residential sector. These standby power supply systems are used to supply power to several types of loads such as:

- **Essential Loads** particularly in industrial processes where they require high restarting times or high shut down times. So the automatic transfer from the main supplies to the standby generator must be available.
- **Critical Loads** such as elevators, or lighting in the buildings where the automatic changeover is very important especially in hospitals, malls, and public places.
- **Sensitive Loads** such as computers, equipment and appliances in hospitals, microprocessor, controlled industrial machines, and the monitoring system where it is costly to shut them down and may be required to use of Uninterrupted Power Supply (UPS) system until the automatic changeover happens. If a power failure occurs in any hospital or factory, it is essential to switch between the main supplies and the standby generator and make the transition as smooth and safe as possible.

A changeover system is an active and pivotal system. When there is a main electrical failure, the changeover system would switch to standby alternative power supply (generator), and return back to the main supply when it is restored. . The automatic changeover system would ensure that all power sources synchronized before connecting the loads with any source to prevent any feedback current from any source to the load when any one of them takes over.

The changeover would sense the interruption if the main supply remains as unavailable the changeover is sensitive to the fluctuations as voltage drops below a particular level within a specified time in the main power supply line. In this case the automatic changeover would switch on the generator and starts feeding the load through a relay that switches the battery voltage to the ignition of the generator. In a few seconds the generator starts producing full power. During this time, the relays would disconnect the load from the other power supplies simultaneously and connect it to the generator. The changeover senses the main power supply continuously. If it is restored, the changeover would return back the connection between the load and the main supply because of its priority. Then, the generator would shut down after a few seconds. The automatic changeover switch that is being designed would be a complete system with various subsystems and components arranged and linked to function primarily as a means of manipulating the supply of electrical power to any desired load.

The switching that is obtainable from the ordinary changeover system is usually manual, that is, the user would have to move a lever to change from one source to another. This is usually associated with time wasting as well as some health hazards like electric shock. In order to eliminate this human intervention as well as introduce some speed and precision, there is a need for an automatic changeover switch. The switching system selects the available power source without the intervention of the user; hence, ensuring the availability of supply at all times provided that at least one power source is available. The change from one source to another could only be achieved by device or a system that determines when the change should actually take place and which source is to be given preference to supply the load.

The paper deals with single-phase power source instead of three-phase source. The three-phase was left for future work. Under/over voltage relays with timers to delay the start-up operation until the power supply is stable were used. A delay associated with the automatic changeover system could reach 5Sec. An uninterruptable Power Supply (UPS) could be used to cover this period. The design problem could be subdivided into basically two parts: the power part and the control power. The power part would supply and handle all the power requirements of the automatic changeover switch.

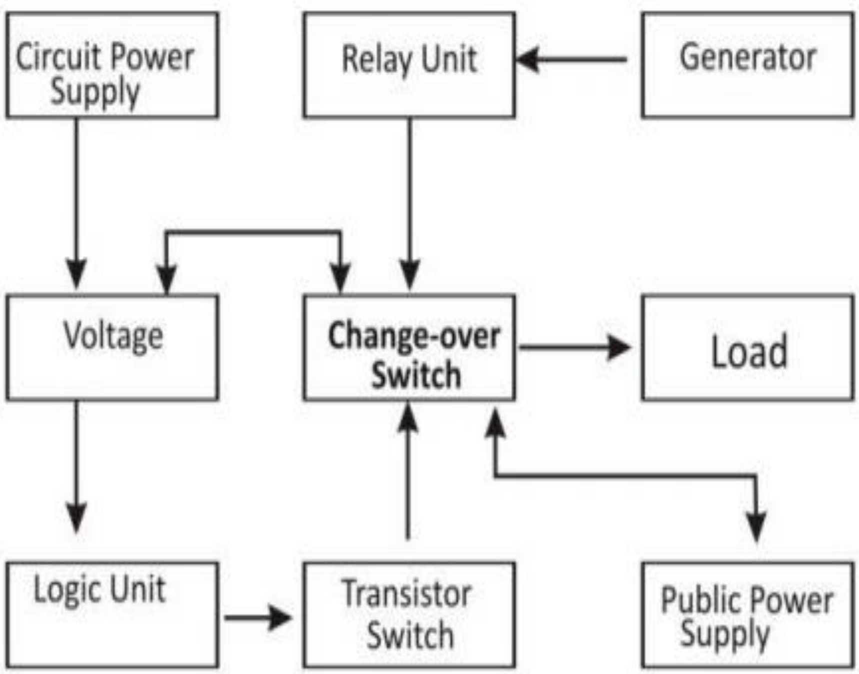

Figure 2.1: The block diagram of the system

2.2 REVIEW OF EXISTING WORK

To ensure the continuity of power supply, many commercial/industrial facilities depend on both utility service and on-site generation (generator set). And because of the growing complexity of electrical systems it becomes imperative to give attention to power supply reliability and stability. Over the years many approaches have been implored in configuring a changeover system. Some of them are discussed below.

2.2.1 MANUAL CHANGEOVER SWITCH BOX

Manual changeover switch box separates the source between a generator and public supply. Whenever there is power failure, changeover is done manually by human and the same happens when the public power is restored and this is usually accompanied with loud noise and electrical sparks.

Limitations of Manual Changeover Switch Box

Below are some of the limitations of manual changeover switch box.

(i) Time wasting whenever there is power failure

(ii) It is strenuous to operate

(iii) It is causes device, process or product damage

(iv) It could cause fire outbreak

(v) It makes a lot of noise.

(vi) Maintenance is more frequent as the changeover action causes wears and tears.

2.2.2 Automatic Changeover System with Electromechanical Relays (EMRs)

A relay is an electromagnetic device that is activated by varying its input in order to get a desired output. Recently, electromechanical relays (EMRs) have been used with other component to implement automatic changeover. Such components could be logic gates, transistors, opto-coupler, microcontroller etc. Most of these components make use of 5v since they are Transistor Transistor Logic (TTL) based. Such control system must be properly isolated from the relay as shown in figure 2.3 to avoid the flow back of ac signal into the control electronics.

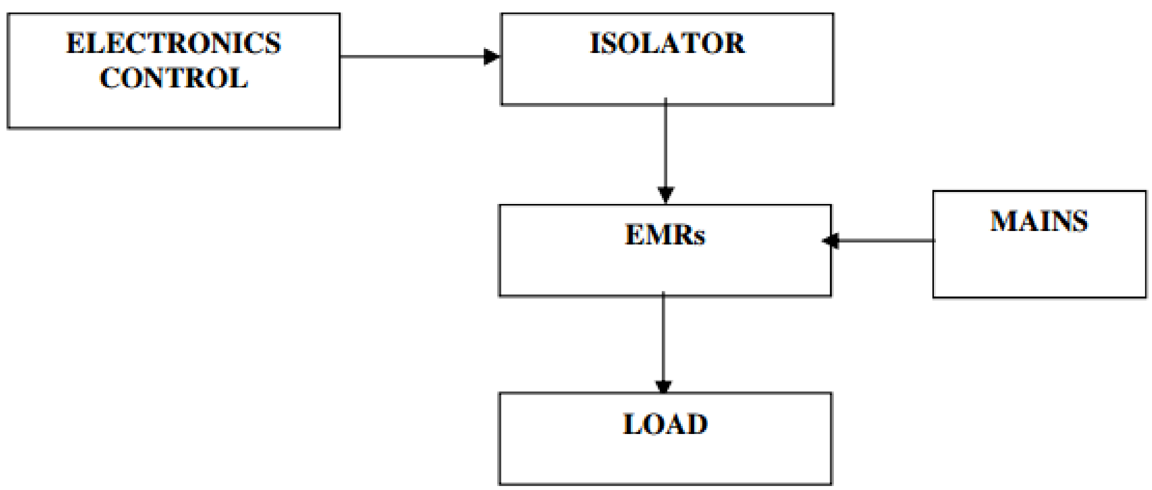

Figure 2.2: Block diagram of automatic changeover system with electromechanical relay.

This type of changeover system is better than the manual changeover with switch box because it is automatic and faster, but has its limitations which are listed below:

• Noise associated with switching of relays.

• Wear and tear.

• Arching which could cause fire outbreak.

2.2.3 CHANGEOVER WITH AUTOMATIC TRANSFER SWITCH

This type of changeover system has an automatic transfer switch which monitors the alternating current (AC) voltage coming from the utility company line for power failure conditions. Upon detection of power failure for predetermined period of time, the standby generator is activated (started), after which the load is transferred from utility to the standby generator. Then, on return of the utility feed, the load is switched back after some time and the generator is stopped.

2.3 DESCRIPTION OF THE NEW SYSTEM

In view of the limitations of the above previous works, this paper proposes and implements a changeover systems that drastically reduced the shortcomings. The noise, arching, wear and tear associated with EMRs are eliminated totally by the introduction of solid state relay. Digital components were also used to make the work more reliable unlike the previously existing ones that make use of circuit breakers. Also an AT89C52 microcontroller was also incorporated to help improve the speed of automation. It also have some important features like liquid crystal display

It also have some important features like liquid crystal display (LCD) which makes the system user friendly, an alarm system for indicating generator failure, automatic phase selector for selecting most appropriate phase, over-voltage and under-voltage level monitoring.

2.4 DESCRIPTION OF SOLID STATE RELAYS

With emergence of semiconductor technology the production of solid state relays were made possible which in many applications out perform their predecessors. A typical solid state relay consists of a light emitting diode (LED) optically coupled to a photovoltaic device such as a Field Effect Transistor (FET). Light from the LED creates a voltage across the photovoltaic array and activates the output FET. FET is the preferred switching element in a solid state relay because it presents comparatively less electric resistant when it is in a conductive state than a triac in the same state and therefore generates less heat.

As a result of this, FET requires smaller heat dissipating fins and could reduce the overall size of the solid state relay. The internal circuitry of a typical solid state relay is shown figure 2.5 while figure 2.6 is a solid state relay from FOTEK:

Figure 2.3:Solid state relay from FOTEK

Advantages of Solid State Relay over Electromechanical Relay

Solid state relay has the following properties which gave it an edge over the EMR:

(1) It has no moving coil part.

(2) It has long operating life.

(3) Bounce-free operation.

(4) It has immunity to electromagnetic interference.

(5) It has high switching speed

(6) It could be controlled by a low signal (3v).

(7) Multi function integration

(8) No arching or sparking.

(9) No acoustical noise.

(10) High reliability.

(11) Resistance to shock and vibration.

(12) Wide input voltage range.

(13) High input-output isolation.

Because of the low signal control feature, solid state relays could be driven directly by the microcontroller the use of interface drivers. This could save space, time and money, reduce component count as well as improve product life, performance and reliability.

CHAPTER 3

METHODOLOGY

The methodology of this research involves the design, construction, development and incorporation of an Automatic Changeover Switch. The incorporation of the Automatic Changeover Switch involves the use of automatic switching between the phases of the mains supply and automatic switching between the generator/backup power supply. The main objective of this research is to compare the stress levels experienced during automatic switching with the aid of the Automatic Changeover Switch and the stress levels experienced when the switching is done manually, analyzing the relationship between them and drawing conclusions based on the analysis. Also the time delay during switching with the use of the Automatic Changeover Switch and with the switching done manually are also compared and analyzed and conclusions are drawn from the analysis.

3.1 COMPONENTS AND MATERIALS

COMPONENTS

The components involved in the construction of the ATS are made up mainly of contactors and relays. This is so because they are very effective when used for electrical controls. They operate on the principle of electromagnetism and can carry out automatic switching very effectively. They are very rugged and durable and their operation is similar but the difference between them is that contactors can switch higher currents. On table 3.1 is a list of components to be used and their ratings.

3.1.1 RELAY

A relay is usually an electromechanical device that is actuated by an electrical current. The current flowing in one circuit causes the opening or closing of another circuit. Relays are like remote control switches and are used in many applications because of their relative simplicity, long life, and proven high reliability. Relays are used in a wide variety of applications throughout industry, such as in telephone exchanges, automatic changeover switch, digital computers and automation systems. Highly sophisticated relays are utilized to protect electric power systems against trouble and power blackouts as well as to regulate and control the generation and distribution of power. Although relays are generally associated with electrical circuitry, there are many other types, such as pneumatic and hydraulic. Input may be electrical and output directly mechanical, or vice versa.

3.1.1 BASIC OPERATION OF RELAY

All relays contain a sensing unit, the electric coil, which is powered by AC or DC current. When the applied current or voltage exceeds a threshold value, the coil activates the armature, which operates either to close the open contacts or to open the closed contacts. When a power is supplied to the coil, it generates a magnetic force that actuates the switch mechanism. The magnetic force is, in effect, relaying the action from one circuit to another. The first circuit is called the control circuit; the second is called the load circuit.

- On/Off Control,
- Limit Control and
- Logic Operation.

On/Off Control: Example: Air conditioning control, used to limit and control a "high power"
load, such as a compressor
Limit Control: Example: Motor Speed Control, used to disconnect a motor if it runs slower or faster than the desired speed
Logic Operation: Example: Test Equipment, used to connect the instrument to a number of testing points on the device under test.

TYPES OF RELAYS

Advantages of Electromechanical relays include lower cost, no heat sink is required, multiple poles are available There are two basic classifications of relays: Electromechanical and Solid State. Electromechanical relays have moving parts, whereas solid state relays have no moving parts., and they could switch AC or DC with equal ease.

Electromechanical Relays

General Purpose Relay: The general-purpose relay is rated by the amount of current its switch contacts could handle. Most versions of the general-purpose relay have one to eight poles and could be single or double throw. These are found in computers, copy machines, and other consumer electronic equipment and appliances. Power Relay: The power relay is capable of handling larger power loads – 10-50 amperes or more. They are usually single-pole or double-pole units.

Solid State Relays

These active semiconductor devices use light instead of magnetism to actuate a switch. The light comes from an LED, or light emitting diode. When control power is applied to the device's output, the light General Purpose Relay is turned on and shines across an open space. On the load side of this space, a part of the device senses the presence of the light, and triggers a solid state switch that either opens or closes the circuit under control. Often, solid state relays are used where the circuit under control must be protected from the introduction of electrical noise.

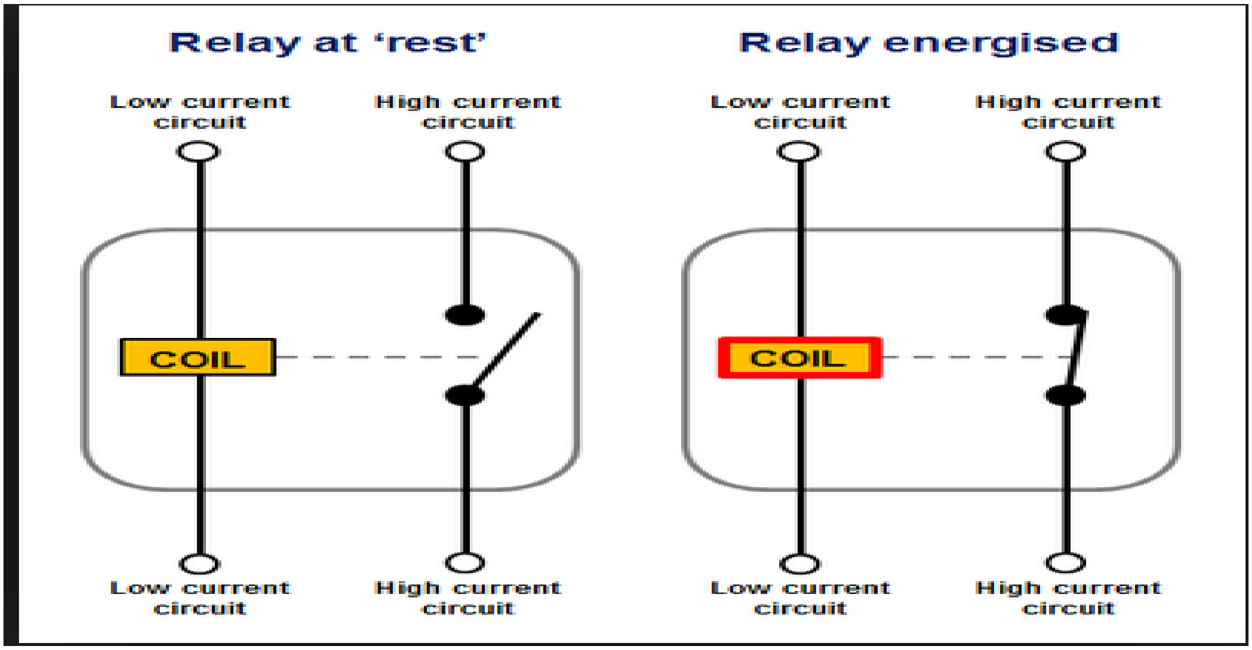

Figure 3.1: Diagram of a Relay switch

3.1.2 CONTACTOR

A contactor is an electrically controlled switch used for switching an electrical power circuit, similar to a relay except with higher current ratings. A contactor is controlled by a circuit which has a much lower power level than the switched circuit. Contactors come in many forms with varying capacities and features. A contactor has three components. The contacts are the current carrying part of the contactor. This includes power contacts, auxiliary contacts, and contact springs. The electromagnet (or "coil") provides the driving force to close the contacts. The enclosure is a frame housing the contact and the electromagnet.

Magnetic blowouts use blowout coils to lengthen and move the electric arc. These are especially useful in DC power circuits. AC arcs have periods of low current, during which the arc could be extinguished with relative ease, but DC arcs have continuous high current, so blowing them out requires the arc to be stretched further than an AC arc of the same current. The magnetic blowouts in the pictured Albright contactor (which is designed for DC currents) more than double the current it could break, increasing it from 600 A to 1,500 A. Sometimes an economizer circuit is also installed to reduce the power required to keep a contactor closed; an auxiliary contact reduces coil current after the contactor closes. A somewhat greater amount of power is required to initially close a contactor than is required to keep it closed. Such a circuit could save a substantial amount of power and allow the energized coil to stay cooler. Economizer circuits are nearly always applied on direct-current contactor coils and on large alternating current contactor coils.

A basic contactor would have a coil input (which may be driven by either an AC or DC supply depending on the contactor design).

3.1.3 Operating principle

Unlike general-purpose relays, contactors are designed to be directly connected to high-current load devices. Relays tend to be of lower capacity and are usually designed for both normally closed and normally open applications. Devices switching more than 15 amperes or in circuits rated more than a few kilowatts are usually called contactors. Apart from optional auxiliary low current contacts, contactors are almost exclusively fitted with normally open ("form A") contacts. Unlike relays, contactors are designed with features to control and suppress the arc produced when interrupting heavy motor currents. When current passes through the electromagnet, a magnetic field is produced, which attracts the moving core of the contactor. The electromagnet coil draws more current initially, until its inductance increases when the metal core enters the coil. When the contactor coil is de-energized, gravity or a spring returns the electromagnet core to its initial position and opens the contacts.

For contactors energized with alternating current, a small part of the core is surrounded with a shading coil, which slightly delays the magnetic flux in the core. The effect is to average out the alternating pull of the magnetic field and so prevent the core from buzzing at twice line frequency. Because arcing and consequent damage occurs just as the contacts are opening or closing, contactors are designed to open and close very rapidly; there is often an internal tipping point mechanism to ensure rapid action. Rapid closing could, however, lead to increase contact bounce which causes additional unwanted open-close cycles. One solution is to have bifurcated contacts to minimize contact bounce; two contacts designed to close simultaneously, but bounce at different times so the circuit would not be briefly disconnected and cause an arc.

A slight variant has multiple contacts designed to engage in rapid succession. The first to make contact and last to break would experience the greatest contact wear and would form a high-resistance connection that would cause excessive heating inside the contactor. However, in doing so, it would protect the primary contact from arcing, so a low contact resistance would be established a millisecond later. Another technique for improving the life of contactors is contact wipe; the contacts move past each other after initial contact on order to wipe off any contamination. (Lanre O.R. 2014). Figure 3.2 is a diagram of contactor switch

Figure 3.2: Diagram of a Contactor switch

3.1.4 DIGITAL MULTIMETER

The digital multimeter, DMM, is one of the most common items of test equipment used in the electronics industry today. While there are many other items of test equipment that are available, the multimeter is able to provide excellent readings of the basic measurements of amps, volts and ohms. In addition to this the fact that these digital multimeters use digital and logic technology, means that the use of integrated circuits rather than analogue techniques, enables many new test features to be embedded in the design. As a result, most of today's digital multimeters incorporate many additional measurements that could be made.

Figure 3.3: Diagram of Digital multimeter

CHAPTER 4

COMPONENTS TESTING AND RESULTS

The importance of testing in the field of Electronic and Electrical Engineering before, during and after the implementation of a design cannot be overemphasized. This is of great importance because there is need to analyze the functions and working conditions of components before using them in a circuit. Various tools and equipment are available for carrying out these tests depending on the kind of test. Circuits could also be simulated using different software packages in order to observe how they work and make necessary corrections and adjustments before implementation on hardware.

In the course of implementing these circuits, the test instruments used were the multimeter, variable and fixed dc supply, variable and fixed ac supply. The 230Vac relays were tested to ascertain their working condition; each of them was tested separately. The relay was plugged to the base and a fixed 230V a.c source was used in energizing it through pins A1 and A2 (the coil) and it was confirmed working. The contacts Normally Open (N.O) and Normally Close (N.C) were also tested using a multimeter in the continuity range. The N.C contacts were short circuited when the relay was not connected to supply (i.e. when the relay was not energized) and open circuited when the relay was energized. Reverse was however the case for the N.O contacts as they were open circuited when the relay was de-energized and short circuited when it was energized.The test on the contactor was carried out using generator supply and a 60W bulb which served as the load.

The supply was connected to the contactor via the terminals A1 and A2 (coil), a neutral and live supply to three of its incomer terminals as the contactor is four pole and the 60W bulb connected to the three corresponding outgoing terminals.

As the voltage was increased, the intensity of the lamp also increased. This implies that the contactor will be suitable for proper operation between 110- 230Vac supply. Likewise the voltmeter was tested by connecting three-single phase supply to its pins. The circuit breakers and indicator lamps were also tested and confirmed working.

4.1 THE AUTO- START SECTION

This is the section that controls the starting of the generator automatically. It comes into operation immediately the primary source of supply fails. The circuit has two relays, a single pole miniature circuit breaker. R1 is a 220/240V ac relay, R2 is a 12V solid state relay. This circuit is governed by the 12V battery of the generator and the supply from mains source. Initially when there is supply from primary source (PHCN), the coil of relay R_1 remains energized and its normally close contact that is connected to breaker B_1 is open. For this circuit to respond and start the generator when there is power outage, breaker B_1 has to be closed because it is only when this circuit breaker is closed, that the battery can supply the circuit power for starting the generator automatically.

4.2 AUTO TRANSFER SECTION

As stated earlier, this section is made up of two parts which are the generator auto – transfer circuit and the primary source auto – transfer circuit. Generator auto – transfer circuit: This circuit is responsible for transferring the load to the generator after the auto – start section has started it in the event of outage from primary source. It ensures that the primary source of supply does not connect to load simultaneously with the generator through its electrical interlock.

The circuit was implemented on a 380mm x 330mm steel plate. The components were first arranged on the plate in order to measure the space for mounting of the rails and the trucking and to minimize the length of cables for the connections. The lines are dimension, while the rails on which the components were fixed and the trucking which will house the cables were cut into sizes as measured, the rails and the trucking were mounted on the steel plate in four rows and mounted on the plate with bolts and nuts after drilling the holes. The first row has on it circuit breakers. The components mounted on the second row are eleven pins relays for generator and utility supply, while the third row has the contactors and isolator switch. The fourth row is the trucking which houses the cables used. The enclosure was 420mm x 370mm x 200mm while the indicator lamps, voltmeters, selector switch and emergency button were fixed on the door of the enclosure. The arrangements of these components were done this way for easy, neat and proper connection.

The circuit was connected up with strict adherence to the circuit design and continuity test was carried out to confirm connections. Circuit breaker B_2 serves the primary mains (PHCN), B_3 for the generator. All other parts of the circuit takes supply from them for proper protection of the circuit. All the cables were passed through the trucking, while the termination of cables strand in each components was done with the used of cable sleeve for neatness and the cables were numbered in case of troubleshooting and all components were properly labelled. Fig 4.2(a) and fig 4.2(b) shows the complete connection of the design automatic power transfer switch.

CHAPTER 5

CIRCUIT TESTING AND RESULTS

The finished work was tested with a 2.0kVA ELEPAQ Generator with a rated capacity of 8.33A as the secondary source and a mini residential apartment with a connected load of about 14A supplied by PHCN as the primary source. The generator kick starter is spring loaded and has three positions namely “OFF”, “ON” and “START”. For the gen to work perfectly with the circuit for automatic starting and transfer, the key must be at the “ON” position. The terminal of the kick starter has six wires connected to it, two of which are for switching off the gen, two for putting it ON and the other two for starting it. In connecting the automatic power transfer switch to the gen, only four of the wires which are used for starting and switching off the gen are needed.

In order to detect the function of each wire, a short test was conducted. A short piece of wire peeled on both ends was taken to be the bridging plug. To find out the wires meant for starting the gen, the key was turned to the ON position and two of the six wires were picked simultaneously at random and bridged with the short piece of wire. When a particular two were bridged, the generator cranked and was about to start indicating the starting wires of the gen. It should be noted however that the generator can either be started by pulling it or with the key.

It can only be started with the key or work with the project if the battery is fully charged and in proper working condition. If the battery is bad, the gen will not work with the ATS and cannot also be started with the key. The user will have to result to pulling it to start. To detect the wires meant for switching off the gen, the gen was started. While it was working, two of the four wires were picked at random and bridged at the terminals. On bridging a particular two, the gen shutdown and the wires were also marked.

CHAPTER 6

CONCLUSION

An automatic power changeover switch has been designed and constructed. The prototype of the automatic power changeover switch worked according to the specification and quite satisfactorily. The device is quite cheap, reliable and easy to operate. Whenever there is power outage, it reduces stress for manpower changeover. The automatic changeover system has immense advantage in every area where uninterrupted power is required. Whenever the reliability of electrical supply from the utilities is low and wherever continuity of supply is necessary, the automatic changeover system switches to an alternative source from main supply and vice versa. This paper designed and implemented a low cost automatic changeover system that can be used mainly in residential building.

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