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DESIGN AND IMPLEMENTATION OF AN AUTOMATIC TRANSFER SWITCH FOR A SINGLE PHASE POWER GENERATOR TRAINING BORD

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ABSTRACT

The life that man lives on the surface of this earth, including its development and prosperity, and the search for inventions and technological innovations, consumes more energy (renewable and non-renewable) and all of these things plunge the person of this age into the cycle of searching for modern means to keep energy uninterrupted.

Especially in the private fields, including medical, financial (banking), telecommunications, oil fields and others, where we need the power to not be cut off even for a moment.

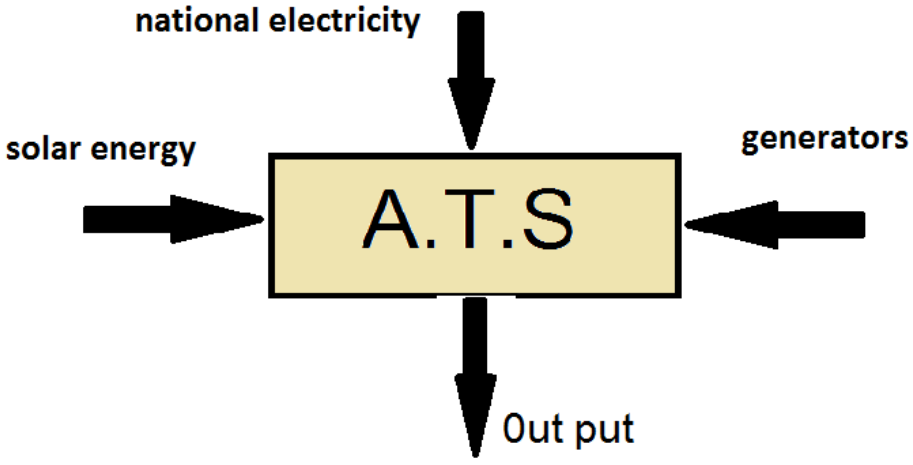
From here came the idea of the research, that we supply energy through more than one source (national electricity - generators - solar energy).

Accordingly, we will need a self-select switch (automatic) that chooses one of these sources as priority.

For the purpose of understanding this situation, the researchers designed and implemented a training panel of electromagnetic pieces (electromagnetic switches [contactor] - relay [Relay] - timer [timer]) with its complements of measuring, control and protection devices in the implementation of the content of the research, and a specific training and test were conducted Those who are interested in this field.

A very high degree of learning and understanding of the subject was achieved, because of its direct audio-visual communication to the subject, in addition to the increased suspense and excitement in implementing the training program.

Keywords: automatic switching, automatic transfer switch, delay timer relays, public utility supply.



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1. INTRODUCTION

The poor state of electrical energy supply and processing in developing and poor countries, with frequent wars, requires alternative sources of electrical power generation to support the energy supply for the community.

Over time, the operation of the electric power supply became a vital matter, as the rate of power outages became high, often at peak times or according to the annual seasons and the need for it as a result of this power outage.

These countries suffer from slow processes of development in both the public and private sectors of their economy, because investors from foreign lands do not feel safe to come and set up businesses and industries, despite the large markets available in these populated countries, due to frequent power cuts. In addition, Delicate operations such as surgery cases in hospitals, money transfers in banks, and data and information transmission in data centers, require a constant supply of electrical power in order to prevent loss of life or data resources that are very costly.

Therefore, for these reasons, the switch has been changed or developed between the sources of electrical supply.

Initially, these switches were designed for manual operations, but due to the many problems causing, and with the increasing technological progress of electrical power control and automation, Automatic Transfer Switch (ATS) was manufactured that eliminates the role of the manpower interaction element in starting the generator and changing the source of Energy from one source to another.

Automatic Transfer Switch (ATS) is an electrical/electronic switch that senses when the power supply or the electrical supply is cut off and automatically starts to operate a secondary source (i.e. a generator) or another source (solar energy) in the event that the secondary source is not equipped.

These switches can be connected with additional circuits, and they are usually in the form of a computer or electrical parts that monitor incoming energy sources, highs or lows of energy, and start the switching or alerting procedure when there is a complete loss of power, or when an error is detected, the switch starts Automatic switching in the operation of the alternative energy source is ready.

The ATS is connected to each of the power sources and supplies the load with power from only one of these sources at any given moment in time, unlike a manual switching system that requires manual pressure in starting the generator and switching from the general supply to the generator or solar source and vice versa The need to evolve a system that effectively manages the energy supply between these sources is essential.

Therefore, it became necessary to design and implement a practical training board, aimed at educating and training engineers, technicians and students in this field.

To understand its working principle and components, all automatic transfer switches consist of three main parts:

- Contacts for connecting and disconnecting the load from the power source.
- A transfer mechanism to transfer contacts from one source to another.
- Intelligent or logic controller to constantly monitor the state of the power supply and thus supply the controller needed for switching, and related circuits to function properly.

The ATS monitors the voltage supply from a single-phase line, the generator supply and solar energy, then its control process is based on the availability or unavailability of the power source from these three sources, which consists of a series of electromagnetic switches (conductors), relays and timers and protection, alarm and indication devices that assist in the operation of the ATS control circuit, as shown in Figure (1)

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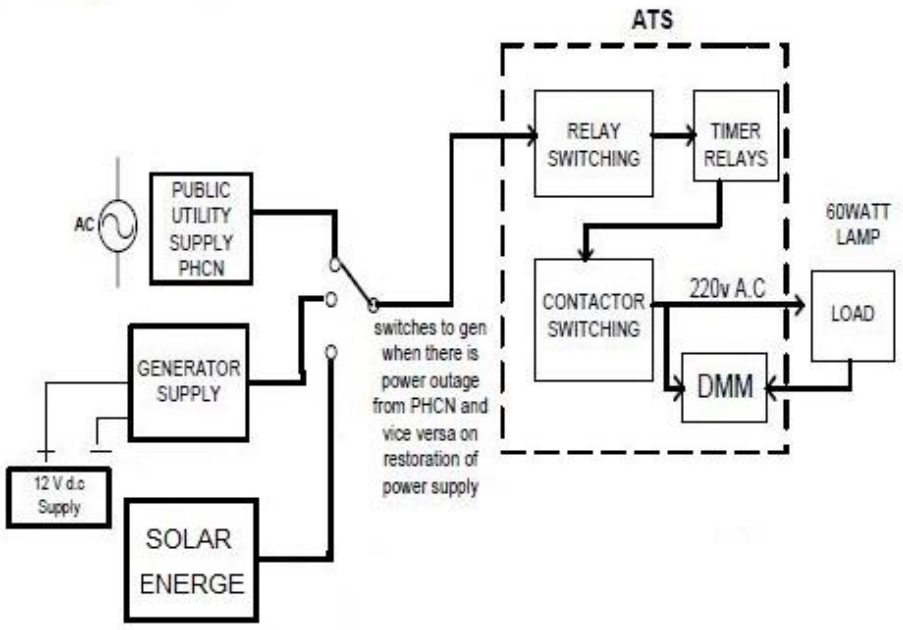

Figure (1) : Block diagram showing principle of the ATS

2. METHODOLOGY

The A.C voltage monitoring and control circuit are designed and constructed. This was achieved by using voltage monitoring relay (VMR) as a primary component of the power sensing and control circuit; which is used for measuring and comparing the voltage level of the utility supply with a set voltage tolerance range (185-250V A.C) while a 12A miniature circuit breaker will act as a switch to the power supply from the public utility end of the ATS.

The power switching circuit was designed. ABB-type power contactors rated 12A, 220V a.c, timer relays to provide some delays (5 seconds) during the starting of the generator and transfer of the connected load vice versa from the both power sources depending on the side with steady electrical power at any point in time are used.

The switching mechanism of the generator is done with a 12V d.c supply battery and auxiliary contacts of the timer relays and the contactor. The automatic ignition and stopping of the generator depends on whether the contactors are energized and de-energized. Display unit was also designed. The digital multimeter (DMM) displaying the output voltage and the rated current of the ATS have a 12V and 5V d.c power supply unit (PSU), a current transformer (C.T), an ADC microcontroller (PIC 16F877) to convert the measured analogue a.c voltage and current to digital values for display on the liquid crystal display (LCD) display.

3. DESIGN STAGES/COMPONENTS

The Relay switching stage: This block consists of the combination of the voltage monitoring relay(VMR) and the finder relays (11-pin relays) which serve as sensor used to determine the availability or non availability of voltage supply from either power sources before triggering the control sections of the ATS. The VMR is used for measuring and comparing the voltage level of the utility supply with a set voltage tolerance range (185-250V A.C).

The Timer relay Stage: This block is made up of delay timer relays operating as normally open timed closed (NOTC) timer relays on each section

of the ATS. The Timer relay on the utility section helps to delay the supply of electric power from the public utility, thus preventing the occurrence electrical damage due to fluctuations in voltage supply.

The Timer relay on the GENERATOR section helps stabilize the power generator and allows it to warm up before it finally supplying power to the connected load. The delay time for the utility timer relay is 5-6 seconds while that of the generator is about 10 seconds.

The contactor switching stage: This block is made up of Contactors on each side of the ATS (i.e. the utility contactor (KN) and the generator contactor (KG)). The function of the contactor is to switch the current to the connected loads easily. This is because they are made to handle large amount of current flow in electrical installations. The maximum load rating of the contactors is 12Amps.

CONTACTOR SELECTION

With the input voltage supply from either power sources (V) = 220-240Va.c supply
Generator power rating (P) = 2.5KVA
Assuming Power factor (Cos Θ) = Unity
Rated generator set current (I) in Ampere = (1.1)
Therefore the contactor selected for the ATS is a 12A rated contactor.
The Digital Multi meter (DMM): The digital Multi Meter in the ATS is an electronic device used in measuring the output voltage, load current and frequency of the supply voltage to the connected load. It consists of a current sensing circuit, amplifying and signal conditioning circuit and a digital display of the measured electrical quantities. The DMM used in the ATS can be divided into four functional units namely;

- The D.C Power supply unit (PSU)
- The Current sensing circuit
- The Precision rectifier and
- The Microcontroller based LCD display unit.

The Power Supply Unit (PSU):

This stage consist of a limiting resistor (440 Ω) resistor connected in series with the half-wave rectifying diode (IN4007), then the 220µF capacitor helps to filter the rectified AC voltage. Connected across this is two 12V Zener diode which gives 24V supply to the MOSFET (IRF460 FET Buffer). The MOSFET provides a high input impedance, high current and voltage for the voltage regulator. The series 78** regulators provide fixed regulated voltages from 5 to 24 V. An unregulated input voltage (Vin) is filtered by the 2200µF capacitor and connected to the IC's IN terminal. The IC's OUT terminal provides a regulated 12 V and 5V, which is filtered by the 470µF capacitor.

4. RESULTS

Various tests were carried out on this project which include relay switching test (this is done to be sure the relays can switch back to generator when the power is out and vice-versa), generator starting test and voltage variation test (this is done to be sure that the output voltage is within permissible limit which is between 195V and 245V) and the testing of the entire ATS.

However, the timer relays provide delay of 5 seconds during the starting of the generator and transfer of the connected load and vice versa.

5. CONCLUSION

The prototype of the system worked according to specification and quite satisfactory. The automatic phase change-over switch is relatively affordable and reliable. It is easy to operate, and it provides a high level of power supply when there are power outages. Finally, it reduces stress associated with manual change-over. However, for future work on this project we recommend that an actuator for mechanical movement of the choke lever should be included for cases where single phase generators without automatic choke controllers are used for testing operations.

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