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Design and Implementation of a Multi-Source Automatic Transfer Switch (ATS) System to Run the Utility Systems Via Different Power Sources and 3-Phase Synchronous Industrial Generator

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Abstract. An automatic transfer switch (ATS) is a device that automatically shifts a power source from its primary source to a backup source when the primary source fails or breaks down. When a primary power system fails, the ATS activates a standby power source, such as an uninterruptible power supply. An ATS can also start longer-term backup power systems, such as Industrial diesel or gas-powered generators, to keep power sources running until utility power comes back. Because of the poor power supply in developing countries, alternative power generation with automation is required to support utility supply. Automation has grown in popularity and now plays a vital role in the electronic industry. Electromechanical relays, magnetic contactors, and delay timers are the main components of designing an ATS, which has three input power and one output power source. To avoid loss of life or data, both of which are very expensive in business operations, delicate processes, and activities in hospitals, the pharmaceutical industry, and many other essential businesses require continuous power support. Therefore, a system that can operate autonomously with little or no human involvement is designed and implemented for a three-phase synchronous industrial generator that will power the utility systems. This project's most exciting feature is its ability to automatically activate the secondary power source once the primary one fails due to a power breakout because it has multiple source inputs and a single output. When both sources fail because of a breakout, it turns on the industrial Generator and turns it off when either the primary or secondary power source is again restored.

Keywords. ATS (Automatic Transfer Switch) System, Automation, Three phases Synchronous Industrial generator, automatic switching, delay timer relays, multi-input power source.

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1. Introduction

An electrical load can be switched between two power sources, such as the primary and backup, using an automatic transfer switch. These switches enable connecting or detaching various power sources from an electric load. However, it is crucial to safely separate the power sources while not in use and to ensure that switching from one power supply to another is controlled and secure. Transfer switches come in two varieties: automated and manual transfer switches. While automated controls run automatically anytime they sense one of the power sources has acquired or lost power, manual switches require an operator to activate them. As a result, this article provides a general overview of one of the ATS kinds. Automated power generation and alternative energy sources must be employed to compensate for the insufficient power supply in emerging nations. The increased frequency of power outages has made automation of electrical power delivery increasingly vital over time [1]. Due to this power loss, the public and commercial sectors of Bangladesh and other developing nations' economies experience slow development. Despite the enormous market readily accessible in such populated countries, investors from other areas do not feel secure coming to establish businesses or industries because of the frequent power outages experienced.

Additionally, complex operations and operations like surgical cases in hospitals, money transfers between banks, and data and information transmission at data centers need a continuous power supply to avoid the loss of life or data resources, all of which might be highly costly to the company's operations. These factors led to the development of automatic multi-source transfer switches, which can power a three-phase industrial generator or other backup generators. These switches were initially intended for manual operation, but as automation and power control technologies advanced, automatic transfer switches (ATS) were developed. It eliminates the need for human involvement while switching from one power source to another and starting a generator. The inspiration for this project's development came from the requirement to create a system that can efficiently regulate the power supply between multiple sources (the primary energy source and a trustworthy secondary backup power source). When the primary energy source fails, the backup generator automatically turns on and off when one of the multi-sources is restored [2].

The remaining five parts have been arranged in reverse chronological order. The study's general review of the literature is presented in Section 2. whereas Section 3 shows the models and methods. Section 4 concentrates on the entire working method and hardware implementation. Section 5 defines of the research were briefly covered. Finally, Section 6 concludes by summarizing the results of this study.

2. Literature Review

If the utility power goes out, a transfer switch checks the supply of electric power and links the load to a backup power source [3]. Depending on whether the utility power source is available, this is built to automatically transfer the power supply to loads from a utility source to a backup source (such as a generator) and vice versa. The backup generator is automatically turned ON and OFF by the automated transfer switch (ATS). J.O. Olowoleni et al. published a research paper on the Construction and Operation of an Electronic Automatic Transfer Switch, describing the Construction of an ATS system. On the other hand, AGBETUYI A. F. et al. published a research article where they

Designed and Constructed an automatic Transfer switch for a single-phase power generator [4]. The development of this project was motivated by the need to create a system that can efficiently regulate the power supply between multiple sources (the primary energy source and a secondary backup power source). When the primary energy source fails, the backup generator automatically turns on and off when one of the multi-sources is restored.

3. Methodology & Modeling

An automated transfer switch (ATS) is an electrical or electronic switch that detects when a primary or public utility supply is disrupted and, if the utility remains down, automatically establishes a backup supply (such as a secondary power source or a generator).

3.1. Vital Components of ATS.

According to [5] and [6], all automated transfer switches for generators are made up of these components: Contacts for attaching and detaching the load from the power source, an Item, and a relay for transferring contacts from one source to another with timer.

3.2. Timer & Relay.

It is made up of delay timer relays that operate ordinarily open timed closed (NOTC) timer relays on each segment of the ATS. The delay period of the utility timer relay is 5-6 seconds, but the Generator's delay time is closer to 10 seconds. Relay controls the generator box.

3.3. Contactor Switching.

The contactor conveniently switches current to the connected loads. It is because they are designed to manage high current flows in electrical installations.

- Primary and Secondary Source is On:

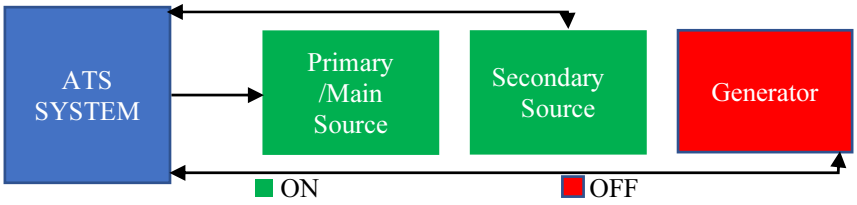

Figure 1. Primary and Secondary source is ON; thus Generator is OFF

ATS system block diagram demonstrates that the industrial Generator stays off when both the primary and secondary sources are on in figure 1.

- Primary Source is OFF, and Secondary Source is ON:

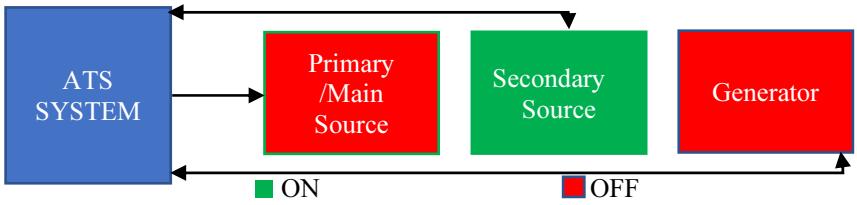

Figure 2. The primary source is OFF, and the Secondary source is ON; thus Generator is OFF

Figure 2 illustrates the block diagram of the ATS system, which shows that the industrial Generator stays off even while the primary source is on.

- Primary Source and Secondary Source are OFF:

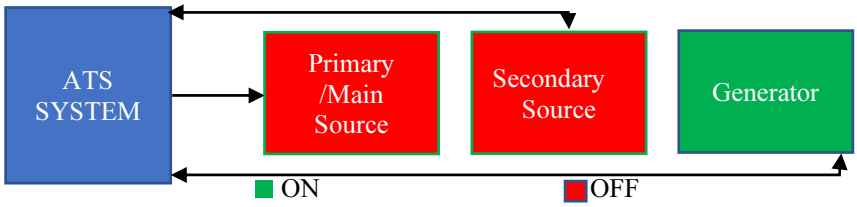

Figure 3. The primary source and Secondary source are OFF; thus Generator is ON

It can be seen in the block diagram of the ATS system (figure 3) that the industrial Generator is activated to supply the utility system when both the primary and secondary sources are gone out.

- When one or both of the primary and secondary sources are active:

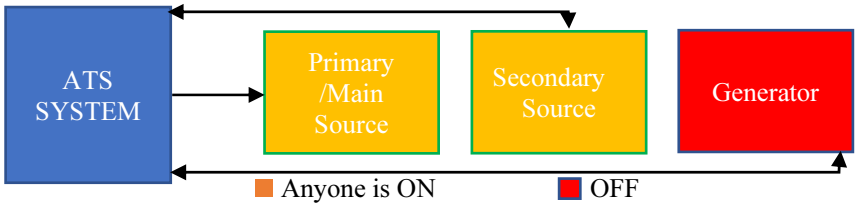

Figure 4. When one or both of the primary and secondary sources are active Generator turns OFF

Figure 4 verifies that the Industrial Generator is turned off when either the Primary or Secondary source is turned on, as depicted in the ATS block diagram.

4. Working Procedure and Hardware Implementation

Figure 5 shows the implemented ATS system where Magnetic Contactor MC1 is used for the primary source, MC2 is used for the secondary source, and MCG is utilized to operate the Generator. The system was likewise designed using timers and relays.

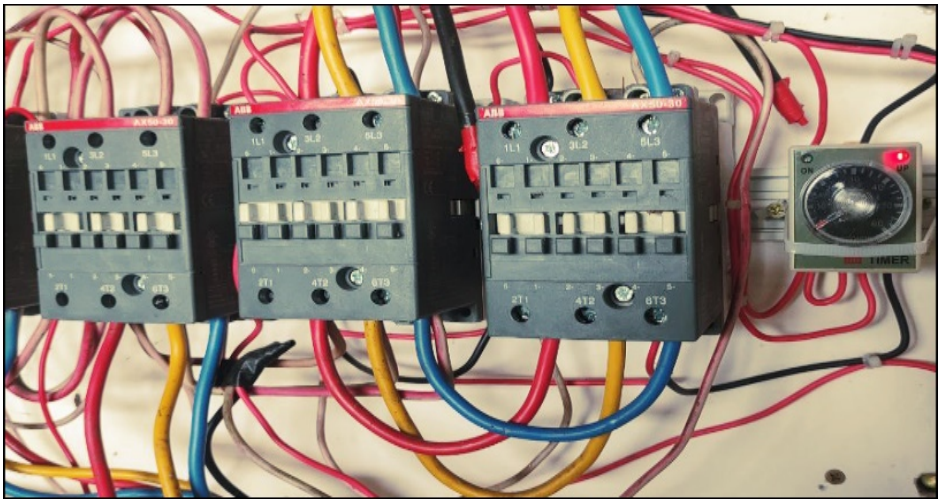

Figure 5. Implemented Multi-Source ATS System to run Utility Systems

A multi-source ATS system was designed to run multiple sources, including an Industrial three-phase synchronous generator in AutoCAD, shown in figure 6.

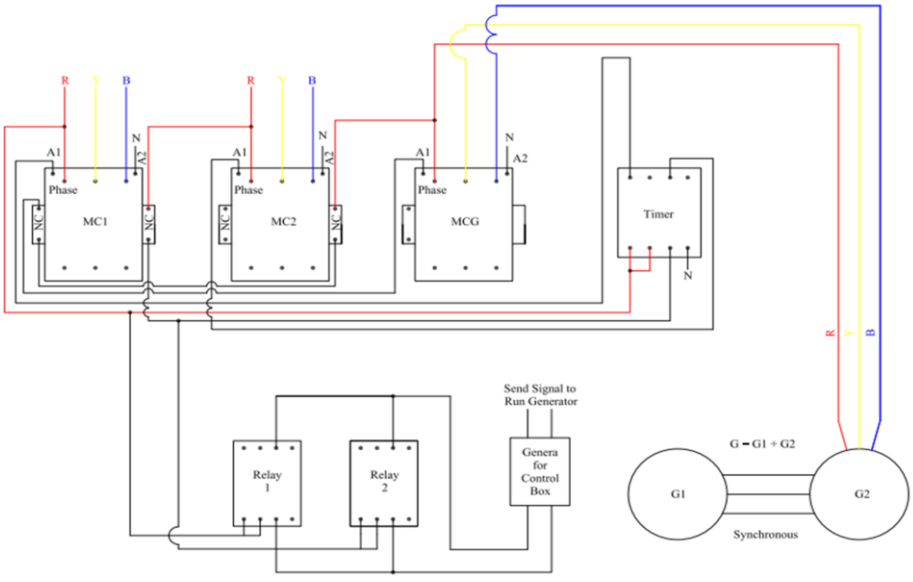

Figure 6. A design of a multi-source ATS system to run an Industrial synchronous Generator (Three Phase)

Power can be supplied between two sources and any system available to run the industrial Generator using this ATS circuit system. To fully automate this circuit, a timer's points seven and eight must be installed from any of the faces of the primary sources magnetic contactor in-line, and a line from point 6 above must be installed in the holding coil a1 of the magnetic contactor of the primary source. A line from anyone's face should be placed from the in-line of the magnetic contactor of the secondary power source at point number four of the timer, coming out of point number three and passing through the NC terminal of the first magnetic contactor to the A1 holding coil of the second magnetic contactor. Neutral should be installed at the second point on the timer,

after which a line from any one phase should be taken from the in-line of the magnetic contactor of the Generator, and it should be reinserted through the NC terminals of the first and second magnetic contactors into the holding coil of the magnetic contactor of the Generator. To start the Generator automatically, two face lines from two lines of the Phase of the primary and secondary source must be installed at point 7 of the two reels, neutral must be placed on the number two ends of the relay, and two source lines must come out with the numbers three and four, which will be required with the Generator's control box.

5. Result & Analysis

Table 1. ATS System Logic Table

Primary Source	Secondary Source	Industrial Generator
ON	ON	OFF
OFF	ON	OFF
OFF	OFF	ON

According to the table 1-ATS System Logic Table, As mentioned above, it is clear that if the secondary source is restored, the Generator will be shut off. If the primary source fails while the secondary source is still operational, the Generator will switch to the secondary source. The ATS system will automatically activate the Industrial Generator to power the utility system if two are not operating.

6. Conclusion

The Automatic Transfer Switch has been conceived and built. The system prototype performed admirably and according to specifications. The automated phase changeover switch is reasonably priced and dependable, and it is simple to use and delivers a high degree of power supply during power outages. Finally, it alleviates the strain involved with the manual changeover. However, we urge that an actuator for the mechanical movement of the choke lever be incorporated in future work on this project for scenarios when single-phase generators without automatic choke controllers are employed for testing activities.

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