ALERT SYSTEM FOR AUTOMATIC TRANSFER SWITCH

Project/Thesis ID. 2023: 111

Session: BSc. Spring 2023

Project Supervisor: Engr. Usman Seljuq

Submitted By

M. Ussama Bin Javed

Fouzan Abbasi

S. M. Muzammil Iqbal

Electrical Department

Sir Syed University Of Engineering & Technology

Certification

This is to certify that **Muhammad Ussama Bin Javed, 2020S-EL-011**, **Fouzan Abbasi, 2020S-EL-019** and **Syed Muhammad Muzammil Iqbal, 2020S-EL-035** have successfully completed the final project **Alert System for Automatic Transfer Switch,** at the **Sir Syed University of Engineering and Technology**, to fulfill the partial requirement of the degree **Electrical Engineering**.

Project Supervisor

Engr. Usman Seljuq

Assistant Professor

19-12-2023

Electrical Engineering Department
Sir Syed University of Engineering & Technology
Karachi.

Chairman

Department of Electrical Engineering, Sir Syed University Of Engineering and Technology

ALERT SYSTEM FOR AUTOMATIC TRANSFER SWITCH

Sustainable Development Goals

(Please tick the relevant SDG(s) linked with FYDP)

SDG No	Description of SDG	SDG No	Description of SDG
SDG 1	No Poverty	SDG 9	Industry, Innovation, and Infrastructure
SDG 2	Zero Hunger	SDG 10	Reduced Inequalities
SDG 3	Good Health and Well Being	SDG 11	Sustainable Cities and Communities
SDG 4	Quality Education	SDG 12	Responsible Consumption and Production
SDG 5	Gender Equality	SDG 13	Climate Change
SDG 6	Clean Water and Sanitation	SDG 14	Life Below Water
SDG 7	Affordable and Clean Energy	SDG 15	Life on Land
SDG 8	Decent Work and Economic Growth	SDG 16	Peace, Justice and Strong Institutions
		SDG 17	Partnerships for the Goals

Range of Complex Problem Solving			
	Attribute	**Complex Problem**	
1	Range of conflicting requirements	Involve wide-ranging or conflicting technical, engineering and other issues.	
2	Depth of analysis required	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	
3	Depth of knowledge required	Requires research-based knowledge much of which is at, or informed by, the forefront of the professional discipline and which allows a fundamentals-based, first principles analytical approach.	
4	Familiarity of issues	Involve infrequently encountered issues	
5	Extent of applicable codes	Are outside problems encompassed by standards and codes of practice for professional engineering.	
6	Extent of stakeholder involvement and level of conflicting requirements	Involve diverse groups of stakeholders with widely varying needs.	
7	Consequences	Have significant consequences in a range of contexts.	
8	Interdependence	Are high level problems including many component parts or sub-problems	
Range of Complex Problem Activities			
	Attribute	**Complex Activities**	
1	Range of resources	Involve the use of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies).	
2	Level of interaction	Require resolution of significant problems arising from interactions between wide ranging and conflicting technical, engineering or other issues.	
3	Innovation	Involve creative use of engineering principles and research-based knowledge in novel ways.	
4	Consequences to society and the environment	Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation.	
5	Familiarity	Can extend beyond previous experiences by applying principles-based approaches.	

Abstract

The project focuses on the development of an automated alert system to notify designated mobile phones of power source transitions and failures. The system aims to ensure timely notifications to users, allowing them to remotely check the power supply status via SMS. Additionally, users can receive automated replies containing relevant information such as the status, load voltage, and load current. The system is designed to enhance user awareness of power supply conditions, enabling proactive responses to power-related issues. Through the integration of SMS notifications and remote status checks, the system aims to improve overall power supply monitoring and management, contributing to enhanced reliability and efficiency.

Undertaking

I certify that the project **Alert System For Automatic Transfer Switch** is our own work. The work has not, in whole or in part, been presented elsewhere for assessment. Where material has been used from other sources it has been properly acknowledged/ referred.

M. Ussama Bin Javed

2020S-EL-011

Fouzan Abbasi

2020S-EL-019

S. M. Muzammil Iqbal

2020S-EL-035

Acknowledgement

I am grateful to Sir Syed University of Engineering and Technology for providing the resources and environment conducive to learning and research. I would like to express my sincere gratitude to Engr. Usman Seljuq, Assistant Professor Sir Syed University of Engineering and Technology for his invaluable guidance and support throughout this project.

We are also thankful to our friends and families whose silent support led us to complete our project.

Table of Contents

List of Figures

List of Acronyms

GSM	Global System for Mobile Communication
ATS	Automatic Transfer Switch
SIM	Subscriber Identity Module
SMS	Short Message Service

List of Equations

Chapter1

1.1 Introduction

The ATS plays a crucial role in managing power transitions during grid failures, but existing systems face challenges in timely fault detection and remote monitoring. The inclusion of a GSM module aims to address these issues by enabling real-time communication. This addition allows for remote monitoring and instant notification of system status, facilitating proactive responses to potential faults. The GSM module serves as a communication bridge, transmitting critical information to designated personnel via mobile networks. By leveraging GSM technology, the project aims to optimize the reliability of power supply systems, particularly in remote or unmanned facilities, through improved communication and monitoring capabilities. The successful implementation of this innovation promises to enhance the efficiency and resilience of critical power infrastructure.

1.2 Statement of the problem

The project aims to develop an advanced alert system for Automatic Transfer Switches (ATS) to address critical challenges in remote monitoring, fuel cost reduction, and overload prevention. The lack of robust remote monitoring capabilities in existing ATS systems hampers real-time assessment and troubleshooting, particularly in unmanned or remote facilities, leading to extended downtimes. Additionally, inefficient fuel consumption practices during extended power outages contribute to unnecessary costs. The absence of intelligent mechanisms to optimize fuel usage based on load demand further exacerbates operational expenses. Moreover, the risk of overloading ATS components during peak demand or sudden load fluctuations poses a threat to system integrity and increases maintenance costs.

1.3 Goals/Aims & Objectives

The proposed project seeks to mitigate these challenges by designing and implementing an intelligent alert system, thereby enhancing their liability, efficiency, and cost-effectiveness of ATS operations in diverse environments. Successful implementation will contribute to improved overall performance and resilience of critical power infrastructure, especially in remote or unmanned facilities.

1.4 Motivation

The motivation behind developing the "Alert System for Automatic Transfer Switch" stems from the critical need to improve the reliability, responsiveness, and efficiency of power infrastructure, particularly in the face of unpredictable power disruptions. Several factors contribute to the motivation for this project such as the enhancement of reliability of the system, timely power system status of the site and more importantly monitoring unmanned facilities and fuel cost effectiveness.

1.5 Assumption and Dependencies

The assumptions for the "Alert System for Automatic Transfer Switch" project include the availability and functionality of both primary and backup power sources, stable GSM network coverage, compatibility with the existing ATS infrastructure, and a continuous power supply for monitoring devices. It is assumed that designated recipients are in place to receive alerts, communication is secure. These assumptions provide a foundation for planning and execution, though they should be validated during the project to ensure successful implementation. Adjustments may be needed based on real-world conditions encountered during deployment.

1.6 Methods

The development of the "Alert System for Automatic Transfer Switch" involves a systematic approach, starting with requirement analysis and component selection, including the ATS, microcontroller, GSM module, and sensors. System design encompasses architecture and logic for fault detection. Programming the microcontroller includes code for ATS control and GSM communication. Rigorous testing validates system performance, and a user interface may be developed for remote monitoring. Optimization and fine-tuning ensure efficiency, and documentation is crucial for future reference. The final steps involve deployment, personnel training, and implementation of the intelligent alert system in the target environment. This comprehensive process ensures the successful creation of an ATS alert system with GSM communication capabilities, enhancing the reliability and responsiveness of critical power infrastructure.

1.7 Report Overview

The report describes the working and methodology for the design and implementation of Alert System for Automatic Transfer Switch. In the chapter 1 we describe the introduction and brief explanation of project.

Chapter 2: It describe the working type and construction methodology of designing a ATS system for small commercial or industrial use. It also explains the importance of presence of ATS especially for small commercial units.

Chapter 3: In this chapter GSM, its uses and construction is described. This chapter explains the working of GSM module by using SIM and sending an SMS for communication purpose and generating alert for the user.

Chapter 4: The brief and precise explanation is written and summarized in chapter 4 for easy understanding of topic/project.

Chapter 5: The future work/recommendations of project must have to be explain for upcoming personals for foe betterment and advancement in technology. In last chapter conclusion of a report for Alert System for Automatic Transfer Switch is expressed which contains the concluding remarks for project and predict the future works which can be done in the project.

Chapter 2

2.1 Automatic Transfer Switch

An Automatic Transfer Switch (ATS) is a pivotal component found in electrical power systems. Its primary function is to automatically manage the transfer of power supply between two sources, typically the main power grid and an auxiliary power source like a backup generator or an alternative power supply. This automated switching mechanism is crucial for ensuring uninterrupted electricity supply, especially in critical environments such as hospitals, data centers, and industrial plants. In these settings, where a momentary power interruption can have far-reaching consequences, ATS systems play a vital role in maintaining continuous operations. Without ATS, the transition between power sources would require manual intervention, leading to potential delays and risks during power outages or when switching between power sources. Therefore, the seamless and automated nature of ATS technology is essential for safeguarding the reliability and stability of electrical power systems in various applications.

According to [1], all automatic transfer switches for generators consist of three parts namely:

- Contacts to connect and disconnect the load to source of power
- A transfer mechanism to move the contacts from one source to another
- An intelligent or logic control unit to constantly monitor the condition of the power sources and so provide the brain necessary for switching and related circuit to operate correctly.

The ATS oversees the voltage supply from a single-phase line and a generator, using this information to control its operation based on the presence or absence of power from either source. It includes a sequence of relays, contactors, and protective devices that contribute to the formation of its control circuit.

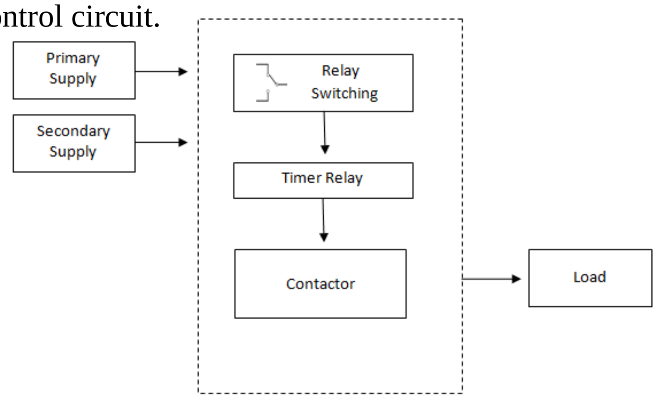

Figure 2.1: Block Diagram of ATS

2.2 Design Stages/ Components

2.2.1 The relay switching

In the relay switching stage, a relay is employed to sense the voltages from both the primary and secondary sources. If the relay detects the presence of voltage from the primary source, it sends a signal to a timer relay, which in turn activates the contactor for the primary source, ensuring that it is engaged and supplying power to the load. Conversely, if the relay does not detect voltage from the primary source, it sends a signal to the timer relay associated with the secondary source, activating the contactor for the secondary source to ensure continuous power delivery to the load. When the primary supply is restored, the system switches back to the primary source, maintaining a seamless transition between power sources.

2.2.2 Timer Relay

The timer relay stage consists of delay timer relays that function as normally open timed closed (NOTC) timer relays, with each section of the ATS equipped with these relays. These timer relays are designed to introduce a delay in the supply of electric power, thereby preventing potential electrical damage caused by fluctuations in voltage supply. In the GENERATOR section, the timer relay serves the additional function of stabilizing the power generator by allowing it to warm up before supplying power to the connected load. This staged approach ensures a controlled and stable transfer of power, enhancing the reliability and safety of the ATS operation.

2.2.3 Contactor Switching

The contactor switching stage comprises contactors located on both sides of the ATS, including the Main contactor and the generator contactor. These contactors are responsible for seamlessly switching the current flow to the connected loads. They are designed to handle significant amounts of current in electrical installations, ensuring smooth and efficient power transfer. The contactors have a maximum load rating of 63 Amps, indicating their capacity to manage substantial electrical loads with reliability and safety.

Calculation for Contactor Rating

$$\text{Rated generator set current (I) in Ampere} = \frac{\text{powerinKVA} \times 1000}{\text{operatingvoltage}} \quad (1)$$

$$= \frac{12 \times 1000}{220}$$

$$= 54.54 \approx 63\text{A}$$

3.1 Working principle of ATS

The working principle of an Automatic Transfer Switch (ATS) is rooted in its ability to continuously monitor the availability and quality of power supply from multiple sources while maintaining a seamless transfer of electrical load between these sources as necessary. This monitoring involves observing various parameters such as voltage, frequency, and other electrical characteristics of both the primary and secondary power sources. During normal operation, when the primary power source (e.g., the utility grid) is operational and meets predefined parameters, the ATS keeps the load connected to the primary source to ensure continuous power supply. However, if the primary source fails or deviates from the specified parameters, indicating its unavailability or unsuitability, the ATS initiates the transfer process. It activates the secondary power source (e.g., a backup generator or an alternative grid connection) to take over the power supply to the load. The transfer process is managed by relays, contactors, and control logic, which ensure that the transition between power sources is smooth and rapid, minimizing any disruption to the powered equipment. Once the primary source is restored and stabilized within acceptable parameters, the ATS initiates another transfer process to seamlessly switch the load back to the primary source. Throughout the entire process, the ATS prioritizes safety and reliability, incorporating protective features to prevent damage to itself or the connected equipment and ensuring that the transfer between sources is reliable and stable. This working principle allows the ATS to provide uninterrupted power supply to critical electrical loads, even in the event of a primary power source failure or disturbance.

Chapter 3

3.1 Global System for Mobile Communication (GSM)

GSM, or Global System for Mobile Communications, is a widely adopted standard for second-generation (2G) digital cellular networks. Operating on a cellular architecture, GSM divides regions into cells served by base stations. It utilizes frequency bands such as 850 MHz, 900 MHz, 1800 MHz, and 1900 MHz, with specific bands allocated based on geographic locations.

GSM employs a combination of Time Division Multiple Access (TDMA) and Frequency Division Multiple Access (FDMA) for communication, allowing multiple users to share the same frequency without interference. Initially focused on voice services, GSM provides digital voice communication with improved sound quality and supports data services like Short Message Service (SMS) and General Packet Radio Service (GPRS).

Subscriber Identity Module (SIM) cards are integral to GSM, containing user-specific information for identity and service details. Security features, including encryption and authentication mechanisms, ensure secure communication.

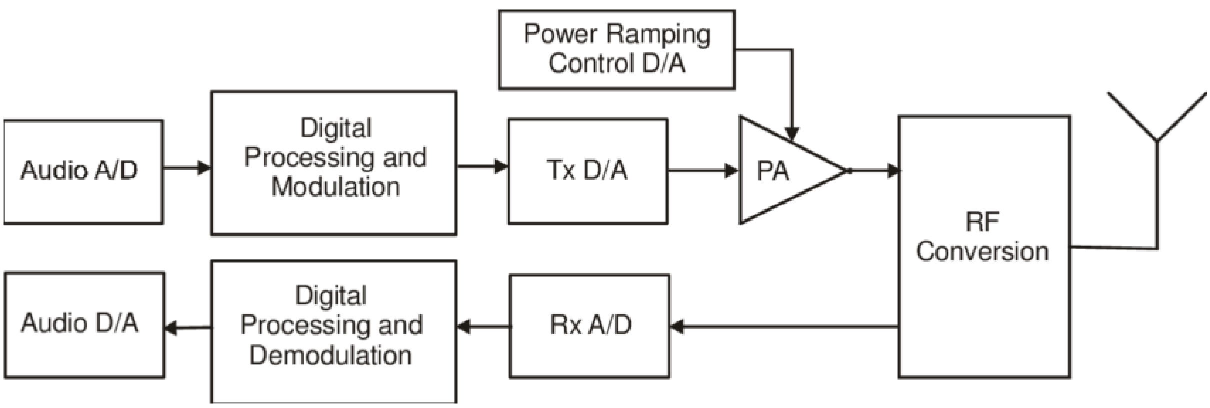

Figure 3.1: Block Diagram of GSM module

3.2 GSM Implementation

Implementing GSM on an Automatic Transfer Switch (ATS) panel is a process that involves integrating GSM technology for remote monitoring. The first step is selecting a suitable GSM module, the GSM module is integrated into the ATS panel's communication interface, which may entail connecting through a microcontroller.. Ensuring a stable power supply for the GSM module is crucial, either by connecting it to the ATS panel's power system. Additionally, installing an external GSM antenna is necessary for optimal signal reception, with careful consideration given to proper antenna placement. Configuration involves setting up the GSM module with essential details like the Access Point Name (APN), SIM card information, and communication parameters, often done through AT commands or a dedicated configuration interface. Specific parameters from the ATS panel, such as power status, voltage levels, current loads, and transfer switch position, are then defined for monitoring through GSM.

3.3 Monitoring Parameters

When GSM technology is integrated into an ATS (Automatic Transfer Switch) panel, it can provide messages indicating changes in voltage and current when the electrical load varies. In simple terms, if there is a shift in the electrical demand or load connected to the ATS panel, the integrated GSM system can send messages to alert relevant stakeholders about the alterations in voltage and current. These messages serve as notifications, keeping users informed about the dynamic electrical conditions and ensuring timely awareness of any fluctuations in the system. This capability enhances remote monitoring and allows for proactive responses to changes in load conditions within the ATS panel.

3.4 Advantages of GSM

Using GSM in ATS panels presents several advantages. The integration of GSM technology enables remote monitoring of Automatic Transfer Switches, allowing for efficient management of power transitions in off-site or challenging access locations. The capability to send real-time alerts and notifications via SMS or calls ensures prompt awareness of power status changes or potential issues. Additionally, GSM-based ATS panels offer enhanced accessibility, versatility in deployment, and cost-effective communication by utilizing existing mobile network infrastructure. The ease of integration into existing systems and the global connectivity of GSM make these panels a practical choice for diverse applications, providing valuable features such as fault diagnosis and seamless operation in regions with reliable mobile network coverage.

Chapter 4

4.1 Summary

The project developed an automated alert system for the Automatic Transfer Switch (ATS) to improve power supply monitoring and management. By leveraging SMS notifications and remote status checks, the system will provide real-time alerts to designated users about power source transitions and failures. This proactive approach will enable users to respond swiftly to potential issues, reducing downtime and enhancing operational efficiency. Moreover, the system will offer automated replies with detailed information about the power supply status, load voltage, and current, empowering users with comprehensive insights. By integrating this system with the ATS, the project seeks to enhance the reliability and effectiveness of power supply monitoring across various industries, ultimately contributing to improved infrastructure resilience. The project signifies the importance of incorporating advanced technology to optimize critical infrastructure components like the ATS, setting a precedent for innovative solutions in power supply management.

4.2 Future Work

Looking to the future work, the "Alert System for Automatic Transfer Switch" holds significant potential for further advancements. Beyond its primary alert and monitoring functions, the system could evolve to encompass comprehensive control features. The integration of GSM technology could extend its capabilities to enable remote operation of the generator set (genset), allowing for seamless control and management of power sources. Additionally, the system could incorporate load balancing mechanisms to dynamically adjust and maintain optimal load distribution. The inclusion of a fuel level indicator, coupled with predictive estimation algorithms, could further enhance operational efficiency by providing real-time insights into fuel consumption and anticipated runtime. This envisioned future for the project aligns with the broader trajectory of smart and adaptive technologies, contributing to a more sophisticated and autonomous management of critical power infrastructure.

Chapter 5

5.1 Conclusion and Recommendation:

In conclusion, the development of an automated alert system for the Automatic Transfer Switch (ATS) represents a significant step towards enhancing power supply monitoring and management. By integrating SMS notifications and remote status checks, the system ensures that users receive immediate alerts regarding power source transitions and failures. This capability allows users to take proactive measures to address any issues promptly, thereby minimizing potential downtime and disruptions. Additionally, the system's ability to provide automated replies with detailed information about the power supply status, load voltage, and current further enhances its utility for users, enabling them to make informed decisions even when not physically present at the site. Overall, the implementation of this automated alert system not only improves the reliability and efficiency of power supply monitoring but also contributes to the overall resilience of critical infrastructure, ensuring continuous operation even in challenging conditions.

This project highlights the significance of leveraging modern technology, such as SMS notifications and remote monitoring, to enhance the functionality of essential infrastructure components like the ATS. By providing real-time alerts and enabling remote status checks, the system empowers users to stay informed and responsive to changes in the power supply environment. Furthermore, the system's automated responses alleviate the need for manual intervention in routine monitoring tasks, freeing up resources and improving operational efficiency. Looking ahead, the successful implementation of this automated alert system serves as a testament to the potential of innovative solutions in advancing the reliability and effectiveness of power supply management, setting a precedent for future developments in the field

Looking ahead, several recommendations can further enhance the automated alert system for the ATS. Firstly, considering the evolving nature of technology, continuous updates and improvements should be prioritized to ensure that the system remains efficient and relevant. This includes exploring advanced monitoring features and integrating with emerging technologies like the Internet of Things (IoT) for enhanced functionality. Additionally, developing a dedicated mobile application could offer users a more intuitive and accessible interface for managing ATS alerts and monitoring power supply status remotely. Furthermore, scalability and adaptability should be key considerations, ensuring that the system can accommodate various ATS configurations and power system setups to cater to diverse user needs. Lastly, comprehensive user training and support resources should be provided to maximize the system's benefits, empowering users to make the most of its capabilities