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# ANALYSIS OF AN ADVANCED AUTOMATIC MAINS FAILURE PANEL WITH DIESEL GENERATOR CONTROL, FAULT DETECTION AND WI-FI

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## ABSTRACT

This paper focuses on the development of an advanced Auto Mains Failure (AMF) panel meant for day to day electrical applications. An AMF panel is unavoidable in areas where a generator is compulsory, like industries, hospitals, educational institutions etc. . It ensures consistent power supply to the load and acts as the switching mechanism between the generator,load and the main power supply. A detailed study about the drawbacks of the present day AMF panel is carried out and a new idea for an advanced AMF panel is put forward. An AMF panel,which can be controlled from a distance using Wi-Fi is presented here. The proposed system displays the diesel generator parameters and indicates the type of fault in the supply mains and saves energy.

**KEYWORDS**:Analog to Digital Converter (ADC),Auto Mains Failure (AMF) panel, Diesel Generator (D.G), Liquid Crystal Display (LCD), Wi-Fi.

## INTRODUCTION

In the present world, uninterrupted power supplies are inevitable. Nowadays, a power system network is highly vulnerable to large scale failures [1]. A fault in an electrical equipment or apparatus is defined as a defect in the electrical circuit due to which current is diverted from the intended path [2]. However, building additional connections to the main supply unit to provide necessary power in case of power failures can be expensive. In such cases, power generation by using D.G sets can be used [3]-[5]. In case of power failure, the D.G sets have to be switched on and when the power supply becomes normal, the D.G sets have to be disconnected. However, switching on and switching off a D.G set again and again manually creates discomfort and delay. Thus, the new idea of bringing up an AMF panel has emerged. An AMF panel is fully automatic. It acts as a switching mechanism between the generator, load and the supply. When the supply is available, AMF panel connects the load to the supply, whereas when the mains supply is unavailable, the AMF panel connects the load to the D.G set. A machine with reasoning, learning, and logical capability that resembles those of human beings can be said to possess artificial intelligence [6]. Since every AMF panel has a microcontroller with it, AMF panels can be considered to possess artificial intelligence. The striking feature of the AMF panel is that it does not require a manual supervision.

Conventional AMF panel had only a start/stop switch [7]. With the technological advancement, present day AMF panel displays the parameters of the main supply like the voltage, current, frequency etc. An AMF panel is shown in figure:1. The large energy wastage in D.G sets, frequent occurrence of faults, no provision for remote control of the AMF panel and D.G sets etc. are the common problems faced in this field.These aspects of the present day AMF panel increases the research interest in the modifications of the existing system. Hardware modeling of the overall system is quite important as it is essentialforthe performance analysis. Detailed block diagram of the hardware wiring model is presented in the next section. Along with this,a comparative study of the proposed system with existing system is made in order to highlight the advantages of the smart AMF panel. Section I presents a block diagram level description of the proposed AMF panel with th D.G control and Wi-Fi. Section II deals with the fault detection by the

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proposed AMF panel. Section III deals with the hardware model of the proposed system. Section IV deals with the comparison of proposed and the existing system. Section V presents the analysis and discussion of hardware model.

## INTRODUCTION TO THE ADVANCED AMF PANEL

Present day AMF panels are modified into the way they become more user friendly by including some additional features. The proposed system consists of an AMF panel indicating the three phases of the supply mains, measures the D.G parameters (fuel level) and indicates the type of fault occurring in the supply mains. A Wi-Fi module is incorporated, which displays the generator parameters from a distance and enables to control the AMF panel with necessary commands. Wi-Fi module is the wireless connection of the local area network, which is less secure than the wired connections [10]. However, there is no relevance in talking about the security aspects of Wi-Fi, since the fuel level of the D.G set is only transmitted through Wi-Fi and that is not much confidential.

***Figure1:AMF panel working [11***

Microcontrollers ATmega-16 and 8051 are used in the proposed system. Both are programmed in embedded-C language. The alarm display panel attached to the ATmega-16 makes the alarm when any of the phases of the supply goes off or when any fault (short circuit, under voltage, or over voltage fault) occurs. The voltage and current of the mains is continuously measured. If it goes beyond the pre-defined cut-off values of the current and the voltage, as programmed in the microcontroller, the microcontroller sends signal to the relay to shift the load to the diesel generator. The auxiliary battery provides power to the load up to when the D.G acquires rated speed. Current and voltage of the diesel generator is also measured. If the D.G runs abnormally, the load is removed from the D.G and thus the load is protected. The LCD incorporated in this system displays the current and voltage of the supply mains and when a fault arises, the type of fault is also displayed. The Wi-Fi module transfers the parameters regarding the D.G and AMF panel to remote wireless devices like mobile phones, laptops etc.Microcontroller 8051 is used to transfer the information about the fuel level in the D.G set to the LCD. Ultrasonic sensor module generates ultrasonic waves, which strike on the upper surface of fuel in the fuel tank. Distance between the fuel surface and the ultrasonic module is noted by the sensor. The module is calibrated initially such that the distance between the fuel surface and the sensor gives the fuel level in the tank.The module passes the information to themicrocontroller and the LCD. The LCD displays thefuel level and the microcontroller transmits the information to the Wi-Fi module, with which the fuel level can be obtained from a distance through a laptop or a mobile phone. Figure:2 shows the block diagram of the smart AMF panel. The P.S.U block represents the power supply unit for the microcontrollers. Microcontroller AT 89S52 is the microcontroller same as INTEL 8051, produced by the manufacturer 'Atmel'. The INTEL 8051 is an 8-bit microcontroller with 128 byte internal RAM and 4 KB internal ROM [12]. INTEL 8051 can be programmed in parallel only. On the other hand, AT 89S52 can be programmed in serial and parallel and it has 'in circuit serial programming' facility. Moreover, it has a RAM of 8 KB memory.

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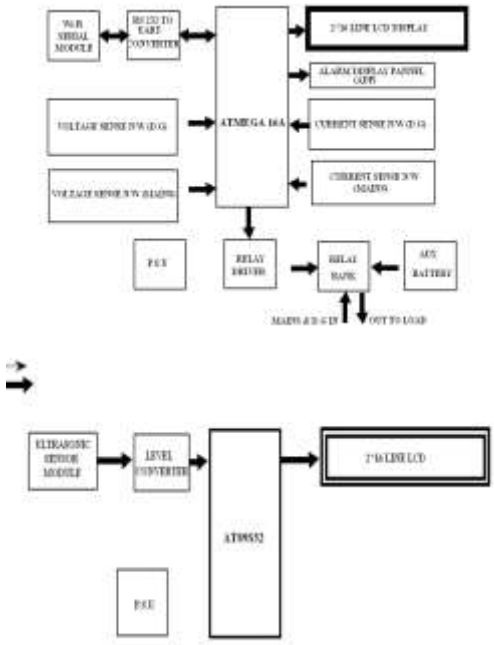

**Figure2:** ***Block diagram of the smart AMF panel***

The voltage and current sensing network of the supply mains and the D.G is connected to the microcontroller AT Mega 16 which has an internal ADC. Microcontrollers with internal ADC can directly accept analog signals for processing [12]. If the supply mains is on, the supply voltage and current is measured by the voltage and current sensing network and through the microcontroller, the readings are displayed on the LCD. On the other hand, if the mains supply is off, that is when the power goes off, the voltage and current of the mains will be zero. When such a situation arises, the microcontroller is programmed in such a way that the relay will disconnect the supply mains and the load, and the generator and the load will get connected. The relay driver is an amplifier which will drive all the relays used in the whole mechanism. There will always be a time lag between the time when the generator attains the rated speed and the time when the generator is made on. The power demand for the load can be supplied by the generator only when it attains rated speed and this interrupts the continuous power supply to the load. The provision of an auxiliary battery, which is attached next to the relay solves this problem. Whenever the supply goes off, the relay switches and the auxiliary battery will get connected to the load. The battery will get disconnected only when the D.G attains rated speed. The time taken by the D.G to attain rated speed is noted and the microcontroller is programmed.

The ultrasonic sensor module measures the fuel level which is in the ASCII format. The level converter converts the data in the ASCII format to TTL format and it is given to the microcontroller AT 89S52 and it is displayed on the LCD.P.S.U block represents the power supply block for the microcontroller AT 89S52. The microcontroller AT 89S52 is connected to the microcontroller AT Mega 16. The alarm display panel connected to AT Mega 16 displays whether the fuel level is normal, low or critical. The data is transferred to the distant places through the Wi-Fi module and the authorities will be informed about the fuel level in the D.G. The Wi-Fi module supports RS-232 serial communication protocol and the microcontroller supports data in TTL format only. The RS-232 to UART converterincorporated between the microcontroller and Wi-Fi module enables the interfacing between the two as these two works in two different logic levels.

## FAULT DETECTION IN THE AMF PANEL

The power system network is subjected to frequent faults such as over voltage and under voltage, short circuit and line break . The proposed AMF panel provides provisions to detect and indicate these faults. The control authority will be informed about the fault from a distance without coming to the control room since a Wi-Fi module is incorporated. **Figure: 3**

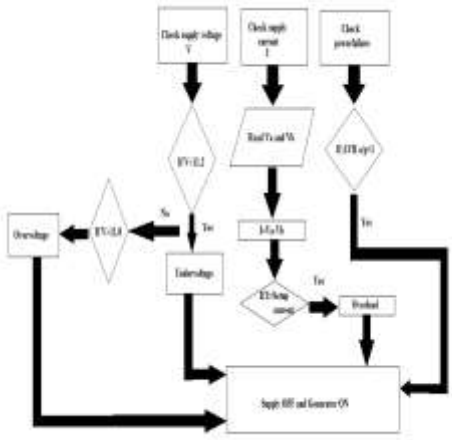

***Figure 3:*** ***Flowchart for fault detection***

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Fault detection by the AMF panel includes checking the supply voltage and current. Predefined values are set for the voltage and current ; the upper and lower limits of voltages being 11.8 and 11.2 respectively. Simple voltage divider network is used for the voltage measurement and resistive network is used for the measurement of current. Flow chart for the fault detection by the AMF panel is shown in fig.3. Voltages and currents are checked whether it crosses the predefined limits and indicates the corresponding fault in the LCD and the generator is switched on. A break in the supply line is indicated by making a switch connected to the supply mains open and it makes the Advanced Virtual Risc(AVR) microcontroller (AT mega 16) input high. Thus a high microcontroller input shows a line break has been occurred and in that case also the supply mains has to be switched off and the generator has to be switched on.

## HARDWARE WORKING MODEL

Hardware working model of the system should be in such a way that it demonstrates the actual working of the system and the results obtained are accurate. Microcontrollers AT mega 16 and 8051 is not replaced. However, instead of a D.G, a battery (12 V) is used. In order to show the measurement of the fuel in the D.G, set a container with a suitable water level is kept. The ultrasonic modules are used to indicate the fuel level (water level in the container). An ultrasonic module is shown in figure:3.

**Figure 3:** ***Ultrasonic sensor module [13]***

In order to demonstrate the fault occurring in the supply system, various fault conditions are initiated. A switch connection in between the supply and the hardware model is kept open, in order to show open circuit fault. A jumper is connected in between two phases to demonstrate short circuit fault. The µc is programmed in such a way that the normal current in the overall system is that current that is drawn by a bulb of sufficient rating(say 60 W). Abulbhaving a power rating above that rating (say 100 W) is introduced in the circuit in order to demonstrate overload. Wi-Fi module and ultrasonic modules are connected as in the block diagram. However, thermal are also used which is explained in section V.

## COMPARISON OF EXISTING SYSTEM AND PROPOSED SYSTEM

Present day AMF panel cannot be controlled from a distance, however in the proposed system a since a Wi-Fi module is incorporated, the AMF panel can be controlled from a distance. Present day AMF panel uses a resistive sensor in order to measure the fuel level in D.G set. The resistive sensor is simply a wire which is dipped in the fuel tank. The resistance of the wire changes in accordance to the fuel in the tank. The use of resistive sensor can create sparks which can pave the way for large fire hazards. With the use of an ultrasonic sensor in the smart AMF panel, that risk is totally eliminated.Industries always appoint a person, who is in charge with AMF panel room and its control. But in this system, manual supervision is not needed, since the system is fully automatic.Present day AMF panel uses a resistive sensor in order to measure the fuel level in D.G set. The resistive sensor is simply a wire which is dipped in the fuel tank. The resistance of the wire changes in accordance to the fuel in the tank. The use of resistive sensor can create sparks which can pave the way for large fire hazards. With the use of an ultrasonic sensor in the smart AMF panel, that risk is totally eliminated

**Table1:** ***Comparison of existing system and proposed system***

| Features | Present AMF panel | Smart AMF panel |
|---|---|---|
| Remote control | Not possible | Possible |
| Fuel level sensor | Resistive sensor | Ultrasonic sensor |
| Manual supervision | Needed | Not needed |
| Fault detection | Not displays the type of fault | Detects and displays the type of fault with an alarm |
| Energy conservation | Not provided | Provided |

Industries always appoint a person, who is in charge with AMF panel room and its control. But in this system, manual supervision is not needed, since the system is fully automatic.The proposed system indicates the type of fault with the supply system but this facility is not provided in the present day AMF

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panel. The generator takes time to attain rated speed; up to that time, the power supply to the load gets interrupted. In this system, such problems are solved by meansof auxiliary battery which provides necessary power to the load up to the rated speed of the generator. The proposed system plays a great role in reducing the large amount of energy wastage associated with the D.G set, which is explained in detail in the next section

## RESULTS AND DISCUSSION

The proposed system measures fuel level with the use of ultrasonic sensor module as explained earlier. The circuit diagram for the same is shown in Fig. 4. The container is filled with water for the demonstration. The fuel level is passed to the microcontroller AT Mega 16, from where the Wi-Fi module transmits the data to distant places. With the help of a laptop or mobile phone, the fuel level of the D.G set can be known from the control room itself. There is no need of coming to the generator room and manually observing the fuel level.

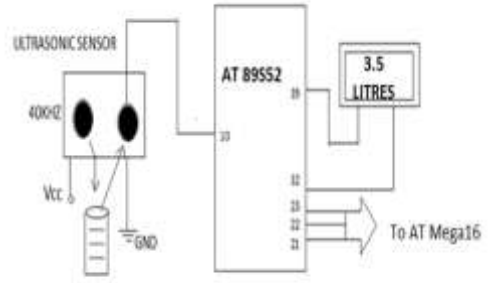


**Figure 4:*Circuit diagram of ultrasonic sensor module***

With the use of proposed system, a large amount of energy wastage in the D.G sets can be solved. The energy wastage is very crucial when the D.G set gets heated up with continuous usage.When the situations of long run power failure occur, the D.G has to work continuously with a large amount of energy wastage in the form of heat in the present day system, where asin the proposed system, the idea of multiple generators areentertained. Thermal sensors LM 35 are provided in the generators. Fig. 5 shows the circuit diagram of the thermal sensor. The power supply is given to the 1st pin and the 3rd pin is grounded. The output voltage for a particular value of temperature is given to the microcontroller. From that voltage, the microcontroller decides which D.G is to be made on, as it is programmed. The capacitors are provided in order to reduce the ripples formed in the D.C, in that circuit. When one of the generators gets heated up, after a particular limit, the thermal sensor detects it and gives information to the micro controller. The microcontroller in turn operates the relay which switches back the load to the second generator. The procedure repeats when second generator becomes heated. Thus, by the use of two generators, wastage of energy in the form of heat is tremendously reduced.

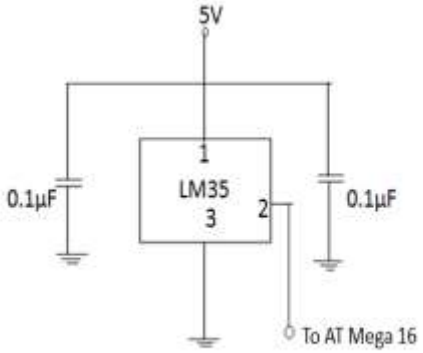


**Figure 5:*circuit diagram of thermal sensor LM 35***

The voltage measurement of the supply mains and the D.G is by the means of voltage divider network, which is shown in Fig. 7. Instead of a D.G, here, a 12 V, 1 A hr, lead acid battery is used and this makes the source voltage 12 V. we know that the maximum voltage to the microcontroller is 5 V.

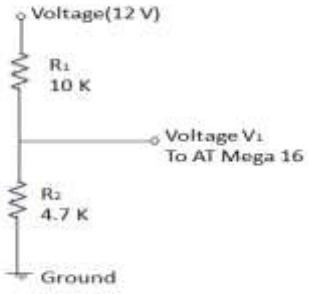


**Figure 7:*voltage divider network***

From the voltage divider rule,

$V1 = V \times \frac{R1}{R1 + R2}$ (1)

Assume R1 to be 10 K.

Then from equation (1),

$R2 = R1 \times \frac{V}{V1} - 1$ (2)

$R2 = 5\ K$

Take R2= 4.7 K (approx.)

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The load is provided with necessary power up to the rated speed of generator by the auxiliary battery.The auxiliary battery is also an equipment to save the energy. Irrespective of the load, the D.G output is always rated. On the other hand, the load on the D.G varies at every instant. When the load is rated, the D.G output is fully utilized, and when the load is not rated, large amount of power gets wasted. The auxiliary battery is a mechanism to solve this problem of energy wastage. The excess power provided by the D.G is used to charge the auxiliary battery.

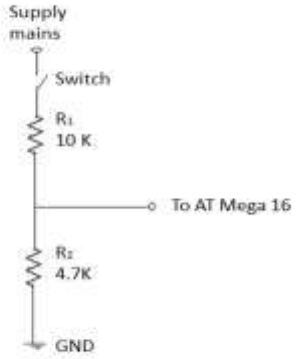


**Figure 7:*Circuit diagram for the supply mains failure detection***

In the hardware model,the supply mains failure is indicated by a voltage divider network attached with a switch. When the switch is closed, it makes 5 V to go to the microcontroller, indicating that the mains power supply exists. Whereas, when the switch is made open, the voltage drop across the resistor R2will become 0 and thus the voltage to the microcontroller will be 0. This indicates the failure of the supply mains and the microcontroller makes the D.G and the load connected. The design of the esistors is same as that of the design of the resistors in the voltage divider network. The measurement of current in the D.G and the supply mains is done with the help of a resistor. A known value of resistance is introduced in the circuit and the voltage drop across the resistor is measured. We know that, in an electrical circuit, the current (I), voltage (V) and the resistance (R) are related as,

$$I = \frac{V}{R} \quad (3)$$

From the above equation, the current can be found out. This method is very simpler and less expensive than other methods.

## CONCLUSION

AMF panel is very significant in the present world, where uninterrupted power supplies are at most needed. There are many drawbacks for the AMF panel that is used nowadays. The generator and AMF panel is usually kept at a distance from the control room due to safety factors. It is a main disadvantage that the present day AMF panel can't be controlled from the control room. Since in the proposed system, a Wi-Fi module is added, the panel can be controlled from a distance. Moreover, the fuel level in the generator can also be seen from a distance. The fuel level is sensed by an ultrasonic sensor, which is cheap, easily available and there are no risks for the occurrence of sparks unlike the resistive sensor used now.

The power supply systems are subjected to frequent faults, which can be identified using the designed AMF panel. An alarm sound will be produced in the case of occurrence of a fault and the load will be disconnected from the power supply in order to protect the load from damage. Hardware modeling will be helpful inorder to validate the results completely before adopting the newly introduced system into action. The proposed idea solves the disadvantages of the present system and moreover it is an innovative concept in the field of energy conservation. The proposed system is unavoidable in the present era having crucial energy crisis.

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## References

[1] Arun Das, Jaydeep Banerjee and ArunabhaSen, "Root cause analysis of failures in interdependent power communication networks" IEEE Transactions on Military Communications Conference 2014.
[2] A textbook on " Switchgear and protection", by J.B Gupta
[3] Singh, and J. Solanki, "Load compensation for diesel generator- based isolated generation system employing DSTATCOM"

ISSN: 2277-9655
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(ISRA), Impact Factor: 2.114

IEEE Transactions on Industry Application , vol. 47, no. 1, pp. 238-244, Jan/Feb.,2011

[4] Wang, and M.H Nehrir, "Power management of a stand-alone wind/photovoltaic/fuel cell energy system", IEEE Transactions on Energy conservation, vol.23, no.3, Sep.2008, pp. 957-967

[5] M. Negnevitsky, A.M.O Haruni, P. Milbourne, J.O Flaherty, D. Capece and T. Nguyen, " Voltage and power management in a microgrid system with diesel generator and energy storage", project sponsored by Aurora Energy Pty Ltd., Hobart, Tasmania, Australia.

[6] A textbook on " Fundamentals of microprocessor and microcomputer", by B. Ram

[7] https://www.google.co.in/#newwindow=1&q=amf+panel+with+ats

[8] R.J Best, D.J Morrow, D.J. McGowan and P.A Crossley, "Synchronous islanded operation of a diesel generator", IEEE Transactions on Power Systems, vol. 22, no.4, pp. 2170-2176, Nov, 2007.

[9] S. Zutobradic, L.Delbianco, " A stochastic approach to internal overvoltages due to earth faults in medium voltage networks, 15-th International Conference CIRED-Electricity Distribution, 2/23, Nice, 1999

[10] Andrew Zafft, Emmanuel Agu, "Malicious Wi-Fi Network: A first look"- 7th IEEE Workshop on Security in Communication Networks, 2012.

[11] https://www.google.co.in/#newwindow=1&q=amf+panel+working

[12] A textbook on "Microprocessors and microcontrollers", by Nagoorkani

[13] https://www.google.co.in/#newwindow=1&q=ultrasonic+sensor+echo+pictures