DESIGN AND IMPLEMENTATION OF THREE PHASES AUTOMATIC CHANGE OVER SWITCH

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ABSTRACT:
Many industries whose machines are three phases depends on three single change over switch which are synchronized in order to switched the required voltage from public to standby generator. The problem with this system is that, if one of the changed over is faulty, switching of the three phase machine will not be effective. It is paramount to note that in industries and organizations where continuity of service is required, a three phase change over switch be install to switch on and off from public power supply to a standby generator. This paper presents the design and implementation of a three phase change over switch using contactors, phase failure relays and change-over delay mechanism. Experiments were carried out to ascertain the functionality of the components and to access the amount of voltage each can receive in order to prevent over voltage.

Key words: *change-over delay mechanism, contactors, phase failure relays,*

1. INTRODUCTION

Economic development of any country depends on Electrical energy. But in most countries, the supply of this electricity for developmental purposes is very unstable. For this reasons most organizations and industries seek for alternative sources of power supply to meet up with the energy demands of the consumers. The problem encountered after seeking this alternative is the gap of time in switching from public power source to another source (standby generator). Researchers then employed the use of change over-switch in order to eliminate the gap of time for switching.

Jonathan [1] designed an automatic changeover between the main power supply and an auxiliary power supply, such as a generator. The basic operation of the project was to switch ON an auxiliary power supply to the load after a predetermined time interval, but [2] improved on the research by designing and constructing a program controlled power change over system that allows users to select the mode they would prefer to have their change over operate. Three modes were achieved, including auto-mode, timed mode and manual mode, which were selected from push buttons. LCD interface was used for the output display.

In another research by [3] they designed a device that maintains constant power supply to the load by automatically activating the generator when there is need. Since the user might not always be in need of the generator, provision was made to prevent the generator from starting should an outage occur while [4] designed and developed a 3-phase automatic changeover system that could detect phase failure and under-voltage thereby changing over to the alternative power supply.

In their research, [5] combined twin functions of automatic changeover and sequential (gradual or step) loading of five seconds to eliminate the need for manual changeover, protect the loads, extend the lifespan of the generator and improve reliability of power supply, while [6] in their research, designed and constructed a microcontroller based automatic power changeover with artificial intelligence for automatic switching. This system has two major sensors; one for the public power supply and the other for the standby generator. public power is available. In this way, the equipments are protected from any fault in the public power supply source.

Similarly [7] designed and constructed an Automatic Transfer Switch with Three Phase Selector. This switch was embedded with a phase selector comprising of a monitoring unit that monitors the three phases and the output that comes from the generator, a control unit that controls the operation of the circuit, relay drivers necessary for driving the relays used for putting OFF and ON the generator and a stepper motor driver unit which is used for moving the stepper motor that controls the choke in starting the generator. Abetuyi and co-workers [8] designed and constructed an Automatic Transfer Switch (ATS) for a Three Phase Power Generator. In their work, the methods employed in designing the ATS involve the use of electromechanical

type relays, contactors, voltage monitoring relays and delay timer relays as main components of the system.
This paper shall help in reducing cost by using few components in actualizing the objectives of the system.

2. DESIGN AND IMPLEMENTATION

The design of the change-over switch begins with knowing the capacity of the generator to be use along with the system. Therefore, a 220V/415V, 15kVA generator operating at 50Hz and a power factor of 0.8 was chosen.
The following analysis determined the rating of the contactors to be used as well as cable size.
Recall:

$$Cos\ \emptyset = \frac{Active\ Power\ (Kw)}{Apparent\ Power\ (KVA)} \quad (1)$$

$$Active\ Power, P = Cos\ \emptyset \times Apparent\ power$$

$$Apparent\ power = 15 \times 10^3 VA$$

$$Phase\ voltage, V_{ph} = 220V,\ Cos\ \emptyset = 0.8,$$

Therefore,

$$Active\ power, P = 0.8 \times 15 \times 10^3 VA$$

$$= 12{,}000W\ \ or\ \ 12kW$$

Also,

$$P = 3V_{ph} I_{ph} Cos\ \emptyset \quad (power\ per\ phase)$$

$$I_{ph} = \frac{P}{3Vph\ Cos\ \emptyset}$$

$$= \frac{12\ 000}{3 \times 220 \times 0.8}$$

$= 22.73A$ (where I_{ph} is the phase current)

For increasedc efficiency, a tolerance of about $+25\%$ will be given.

Thus, the contactor rating will be $= 22.73 + \frac{25}{100} \times 22.73$

$$= 22.73 + 5.68$$

$$= 28.41A$$

The current I_{ph} $(22.73A)$ deduced is current per phase. Thus, the cable to be used should be capable of carrying about 1½ times the current. The operating environment will also play a role.

∴ The required cable should carry a current of at least

$$22.73 + (\frac{3}{2} \times 22.73)$$

$$= 22.73 + 34.095$$

$$= 56.825A \approx 57A$$

The cable size that can carry a current of 57A is 4mm.

3. SIMULATION MODEL

Simulation was carried out using Automation Studio to determine its workability. The following were observed.

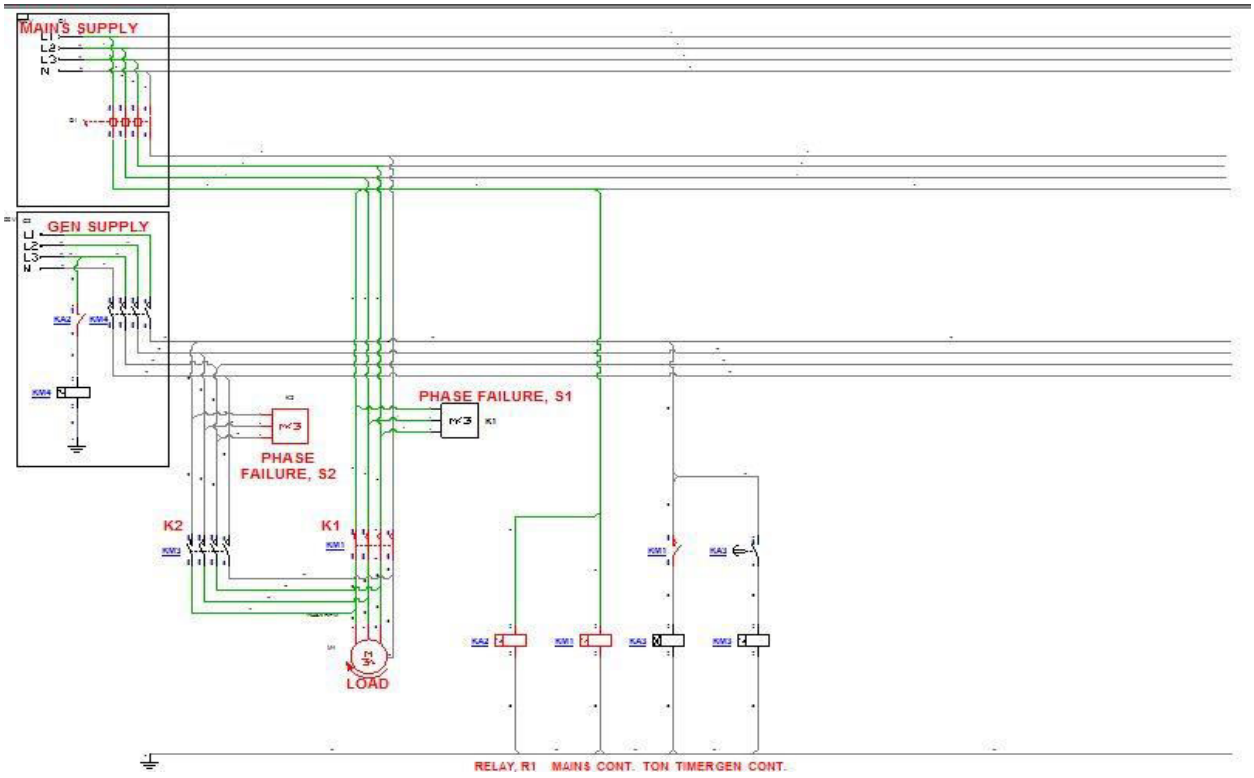

Figure 1: Simulation Model of Mains Supply ON and Generator in the OFF Position

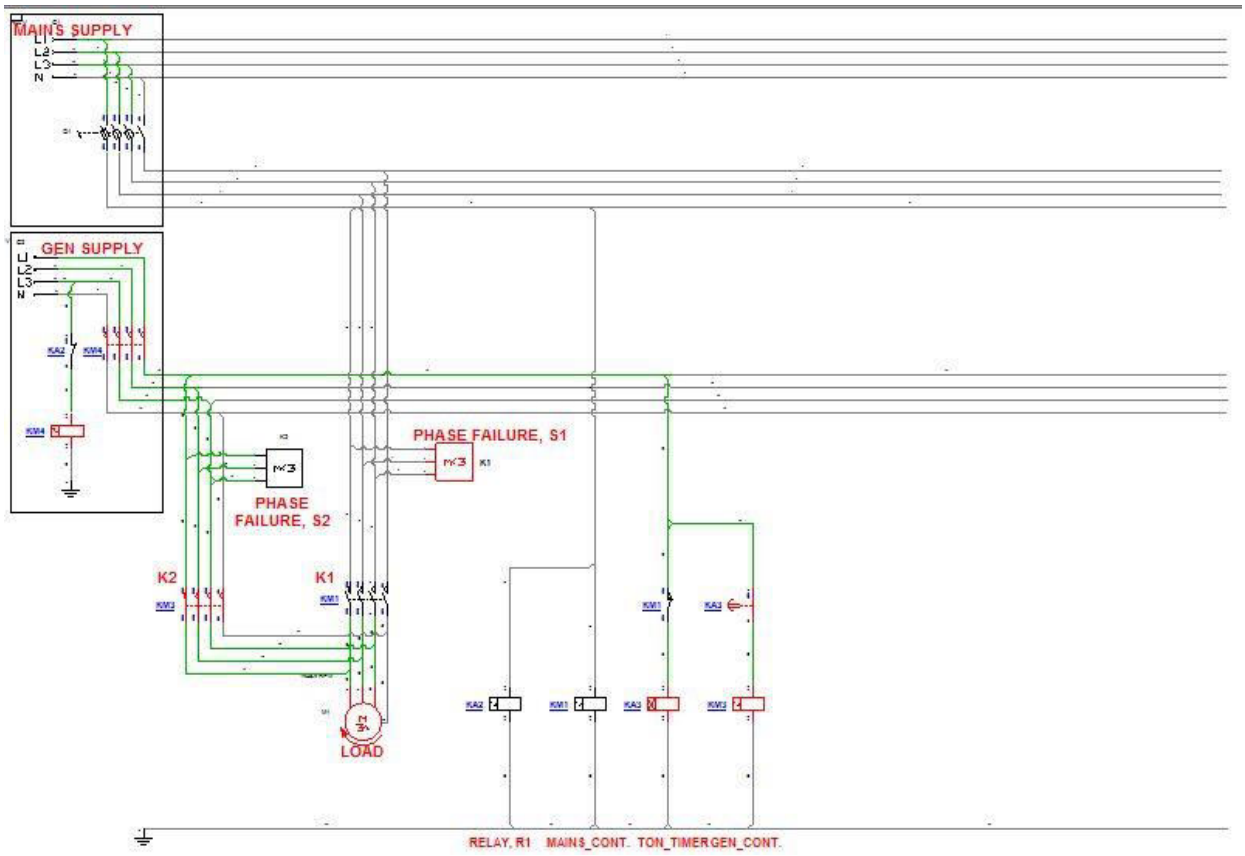

Figure 2: Simulation Model When There is Failure on the Mains Supply and Generator is in use

4. CONSTRUCTION, TESTING, RESULTS AND DISCUSSION

Construction

Continuity test and coil resistance test were carried out on the components (Contactors, Relay, Timer, Phase Failure etc.) to ensure they are functioning properly.

All connections were implemented with the help of the circuit diagram to ensure that it works perfectly before mounting them on the panel. The connections are done according to the circuit diagram presented in

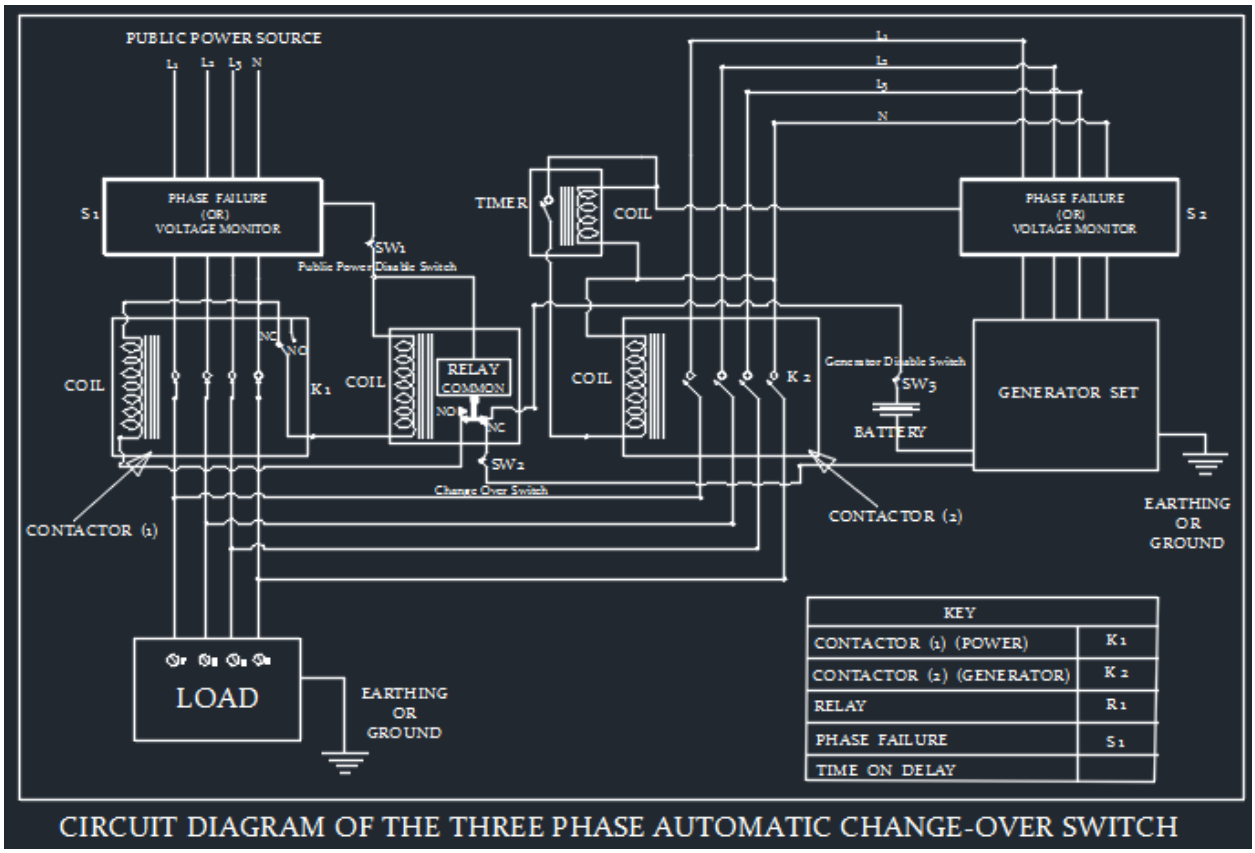

Figure 3: Complete Circuit Diagram of three phases Change over Switch

Testing

After making proper connections of the components of the system, the system was powered and it worked as expected. With power supply from the public source, the generator was made to stay in the OFF position by the system. When there was power outage/failure on the public source, the generator came ON automatically as designed.

Results and Discussion

The circuit diagram of the three phase automatic change over switch was designed to select between two available sources of power giving preference to one out of the two sources. In this case, preference was given to the mains supply.

When public power supply is available as shown in **Fig1**with the green lines indicating supply, it is first fed through a 3-phase failure detector. The phase failure detector monitors all three phases to ensure appropriate supply of mains power. If the three phases are healthy, the phase failure detector connects them to contactor K1 (3 phase four pole contactor) whose output is connected to the load. K1 has a feature of normally closed (NC) contact in it. This contact opens when K1 is energized and also controls the voltage to the coil of contactor K2. As long as this contact is open, K2 which controls the generator output stays de-energized. Thus preventing short circuit. Also, a single phase output voltage from the phase failure is used to energize a 220V AC relay which controls the generator starting mechanism. As long as the relay is energized, the generator is made to stay in the OFF position. If however, there is a phase failure or complete power failure on the public supply, the phase failure detector will cut off power thus de-energizing K1 and the relay. As a result of this, the normally close contact of K1 closes, connecting the coils of K2 to the generator output as shown in **Fig 2** with green lines indicating supply on the generator. In like manner, the mains are disconnected from the load. The de-energized relay connects the generator starter to the battery causing the generator to start. After 10s, the time delay mechanism, energized contactor K2 and connects the load to the generator output, thus, restoring power automatically.

5. CONCLUSION

The design and construction of an automatic 3 phase change over switch was realized using few components as against other work found in the literatures. The system is cheap, portable, durable and reliable and can be used in houses, offices, industrial settings and all environments where constant 3 phase supply are of great importance.

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