International Journal of Academic Engineering Research (IJAER)
ISSN: 2643-9085
Vol. 6 Issue 4, April - 2022, Pages:1-2

Design and Construction of an Improved Intelligent Phase Selection System

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Abstract: *This paper presents a design and construction of an intelligent phase selection system that is capable of comparing three phases and switching the load automatically to a more stable phase out of the three phases and being maintenance friendly in terms of system failure. This work is mainly focusing on providing an improvement on the existing phase selector switches mainly focusing on creating a system which is maintenance friendly and eliminates drop of load during phase change. The system consists of three main parts namely; the transformer, comparators and electrical switching device. The transformer used here is a 240Vac to 12Vac step-down type, the three single phase transformers are used to separately step down the three-individual phase i.e. Red phase, Yellow Phase and the Blue Phase as shown in the block diagram, the out of these transformers is then rectified and smoothened. It is then fed into a voltage regulator which gives a positive output. The regulator outputs are connected to comparators; they are connected in a way that each of them will give out an output through the relays. A more stable phase is then selected by the transistor and loaded with no break in power unless it is lost across all phases.*

Keywords— Phase, Transformer, rectifier, transistor, electricity, power, relay

1. INTRODUCTION

The aim of every electricity user is to have a continuous, efficient and reliable supply of power to the loads. Where this aim is not achieved, there are usually fluctuating supplies of power which are evident in underdeveloped and developing countries like Uganda. These regions experience fluctuation in power, phase interruption and sometimes total power failure which adversely affects the economic development. Most times, commercial and domestic houses experience damages in electrical appliances and downtimes as a result of the nature of power supply.

Electricity supply in Uganda is characterized by frequent power failures and load shedding. It's either the three phases are unavailable or the supply in the three phases are not balanced. To improve on reliability, availability and ensure safe operation of these appliances, optimal performance of systems, reliability and continuity in power supplied to the loads is paramount[1]. This can only be done using an intelligent phase selection system to automatically switch the load to a more stable phase out of the three-phase system.

The main focus of this paper is to provide improvement in already existing phase selector switches from using a single device which is so complex to maintain to a system which performs the same functions but easy to maintain. It is widely a challenge that the existing phase selector devices are inform of a solid-state unit so when any of its components is damaged, the entire unit has to be thrown away and replaced with a new one[2].

The improvement made on the existing phase selector devices is the introduction of LM358 IC operational amplifier to the Zener diode for applications such as generation of reference voltage, as a comparator to different signals and voltage regulation[3][4].The second improvement is using maintenance friendly and cost-efficient components that can be individually replaced when damaged.

2. DESIGN OF THE PROJECT

The design and construction of an improved intelligent phase selection system consists of transformer, rectifier, Transistor and relay.

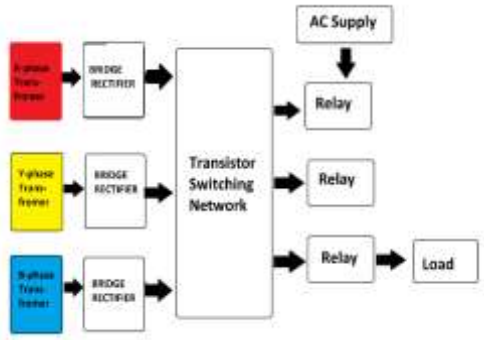

Figure 1: Block diagram of the project

Transformer

The transformers stepped down high voltage AC mains to low voltage AC which is then fed to the bridge rectifier

Rectifier

In this paper, bridge rectifiers were used because of their merits like good stability and full wave rectification. In positive half cycle only two diodes (1 set of parallel diodes) will conduct, in negative half cycle remaining two diodes will conduct and they will conduct only in forward bias only.

BC547 transistor

The BC547 transistor is an NPN Epitaxial Silicon Transistor. It is a general-purpose transistor in small plastic packages. In this paper, BC547 series 45 V, 100 mA NPN general-purpose transistor was used for switching and amplification [5].

Relay

The relay was used to switch on the load using the BC547 transistor output as its input.

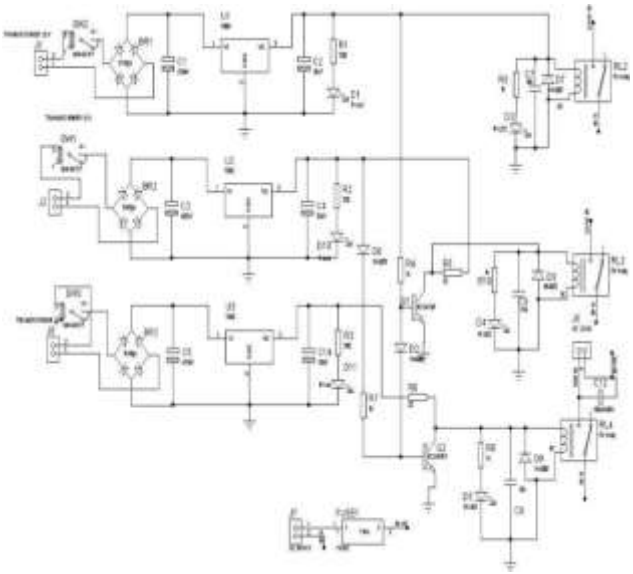

Figure 2: Circuit diagram of the project

Figure 3: Assembled project

3. OPERATION OF THE SYSTEM

Three identical set of circuit, for the three phases i.e. red, yellow and blue as shown in the block diagram are used. Considering the circuit connecting red phase. The main power supply phase R is stepped down by transformer to deliver 12V, 300mA, which is rectified by the bridge rectifier circuit BR1 and filtered by capacitor C1 to produce the operating voltage for regulator LM7805 marked as U1. The voltage at terminal 3 of the regulator is taken from the preset resistor R1 which is used to set the reference voltage according to the requirement. As a result, transistor Q1 does not conduct, relay RL2 remains de-energized and phase R supplies power to load via normally closed (N/C) contact of relay RL2. As soon as phase R voltage goes below 200V. the voltage at pin 3 of LM7805 goes below reference voltage of 5.1V, and its output goes low. As a result, transistors Q1 conducts and relay RL12 energizes and load is disconnected from phase R and connected to phase Y through relay RL3. Similarly, the automatic phase changing of the remaining two phases, via phase Y and phase B can be explained. Switches SW1, SW2 and SW3 are used to close and open each independent phase during testing.

4. CONCLUSION

According to the results obtained from the operation of this project, the project was able to compare phase voltage and select one which is more stable and was also able to switch over to another phase automatically when the present phase became unstable. Compared to the existing phase selector devices which are inform of a solid-state unit and can be damaged when any of the components is impaired, this designed circuit provided the user with a provision of replacing any spoiled component without completely removing the entire unit which made it more user friendly and easy to maintain.

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