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Fault Analysis on Three Phase System by Auto Reclosing Mechanism for Temporary Fault and Permanent Trip for Permanent Fault

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Abstract

The project is developing an automation mechanism for three-stage transmission system. In the event of a temporary error, the project output is reset as it acquires a permanent operating state in the event of a permanent error. Many failures can occur in a three-stage power system that supplies industrial and domestic consumers. This failure is the result of certain errors that can be temporary or permanent. As a result of these breakdowns, the fuel system can suffer significant damage. This can cause power supply disruptions and lead to the shutdown of various industries associated with the system. In a three-phase power system, these errors are categorized as LG (line to ground), LL (line to line), 3L (three lines). This system can overcome such a problem by automatically detecting fault and disconnecting the system from the power source so that widespread damage to system equipment can be avoided. The system automatically distinguishes between temporary disturbance and permanent failure and appropriately cuts power for a short period or long period in a row.

Keywords: Temporary fault; permanent fault; LG, LL and 3L faults; three-phase system

Introduction

A fault in a power system can be referred to any abnormality in the electric current flowing in it. For example, if the current is interrupted by some failure in the circuit, the resulting fault is an open circuit fault. If the current in the circuit bypasses the normal load, it results in a short circuit fault. In a three phase system, the fault may occur between one or more phase and ground or only between phases of the system. Generally, protective devices are used in transmission systems to detect fault conditions and result in operation of circuit breakers or isolators that help in limiting the damage due to the failure[1]. Permanent defects are those that will not disappear when they are turned on and back on. An example of a permanent fault on an overhead line is a broken wire that causes a phase opening or a broken electrode to cause a short circuit between phases. Defects in the underground cables must be considered permanent. Cable malfunctions must be removed without automatic reset and repair of the damaged cable before service restoration. There may be exceptions to this, as in the case of circuits consisting of underground cables and overhead lines[2].

Classification of faults

Transient faults

In a system, if a fault diminishes when power is disconnected for a short period of time and then restored, the fault is referred as a transient fault. A transient fault may also be an insulation fault that temporarily affects a device's dielectric properties. Transient faults may be caused due to momentary tree contact, animal contact, lightning strike, etc.

Persistent faults

Faults that do not diminish when power is disconnected and restored are called persistent faults. Such faults generally occur due to mechanical damage to the cable or other equipment of the system.

Symmetric faults

In a three-phase system, if a fault affects all three phases equally, it is called a symmetric or a balanced fault. Generally symmetric faults constitute about 5% of the total faults.

Asymmetric fault

An unbalanced fault or asymmetric fault results in unequal effect of fault on each of the three phases. Asymmetric faults are further classified as LL or Line to Line fault, LG or Line to Ground fault and LLG or Double Line to Ground fault.

- LL fault is a short circuit between two lines, caused by ionization of air, or when lines come into physical contact, for example due to a broken insulator.
- LG Fault is a short circuit between one line and ground due to physical contact caused by lightning or storm.
- LLG fault occurs when two lines come in contact with the ground and each other. This is mainly caused by storm damage.

Working with block diagram

Working

The project uses 6 numbers step-down transformers for handling the entire circuit under low voltage conditions of 12v only to test the 3 phase fault analysis. The primaries of 3 transformers are connected to a 3 phase supply in star configuration, while the secondary of the same is also connected in star configuration. The other set of 3 transformers with its primary connected in star to 3 phase have their secondary connected in Delta configuration. The outputs of all the 6 transformers are rectified and filtered individually and are given to 6 relay coils. 6 push buttons, every button connected across the relay coil is meant to create a fault condition either at star i.e. LL Fault or 3L Fault. The NC contacts of all the relays are made parallel while all the common points are grounded. The parallel connected points of NC are given to pin2 through a resistor R5 to a 555 timer i.e. wired in mono stable mode.

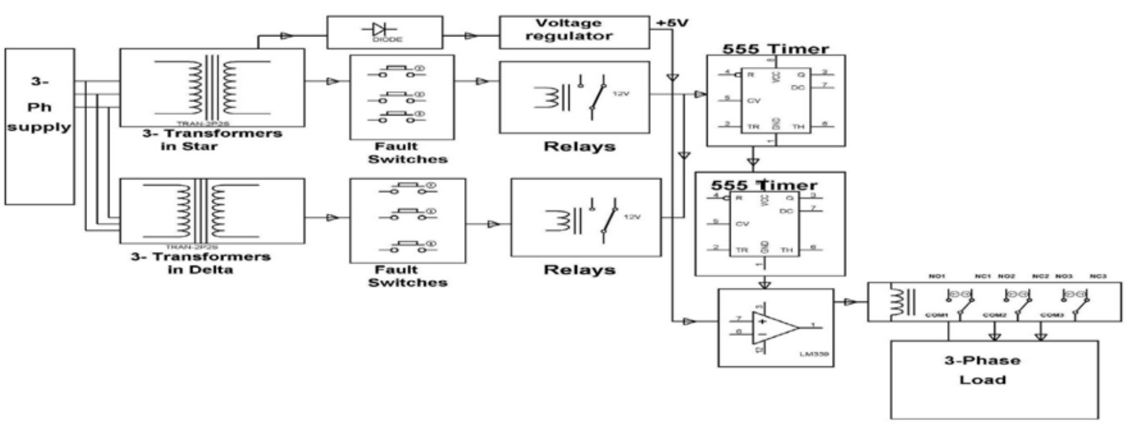

Figure 1: Block Diagram of Three Phase Fault Analysis

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Hardware working model of proposed analysis is given below:

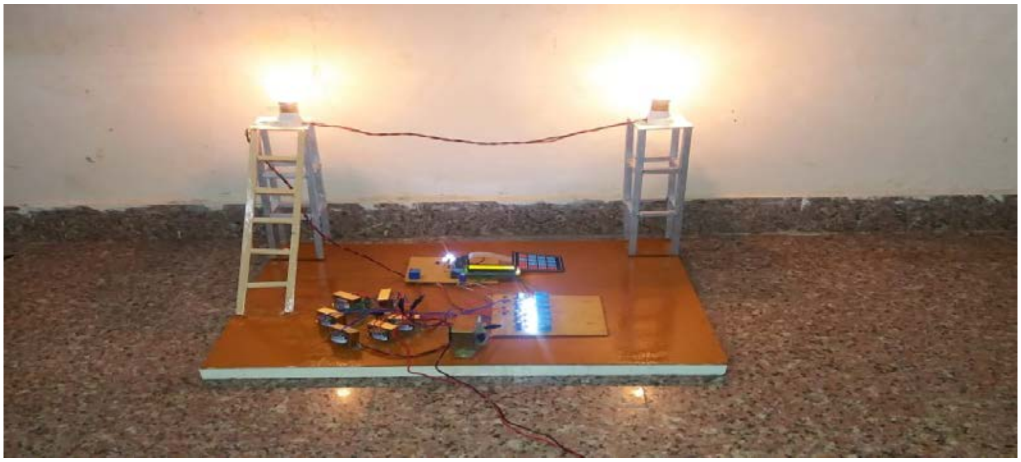

Figure 2:Image of Hardware

Operating procedure

The board is powered from a 3phase supply but all the 6 relay coils get DC voltage and their common point disconnects from the NC and moves on to the NO points there by providing logic high at pin2 of 555 timer U1 i.e. that is kept on mono stable mode. When any push button across the relay is pressed, it disconnects that relay and in the process in common contacts moves to the NC position. It provides a logic low at trigger pin of 555 timer to develop an output that brings the U3 555 timer which is used in a stable mode, for its reset pin to high such that the a stable operation takes place at its output which is also indicated by flashing D11 LED. If the fault is off temporary in nature i.e. if the push button pressed is released immediately the U1monostable disables U3. The output then goes to zero in the event of any push button kept pressed for a longer duration. The mono stable output provides a longer duration active situation for U3 a stable timer, the output of which charges capacitor C13 through R11 such that the output of the comparator goes high so that it drives the relay to disconnect the three phase load

Components used

Transformer

A transformer is a static electrical device that uses inductive coupling between its winding circuits to transfer energy. Due to a varying primary winding current, a varying magnetic flux is generated in the core of the transformer which is then induced to the secondary winding. Due to this varying magnetic flux, a varying electromotive force (EMF) or voltage is generated in the secondary winding. Transformers can vary the relative voltages of the circuit or isolate them, or both.

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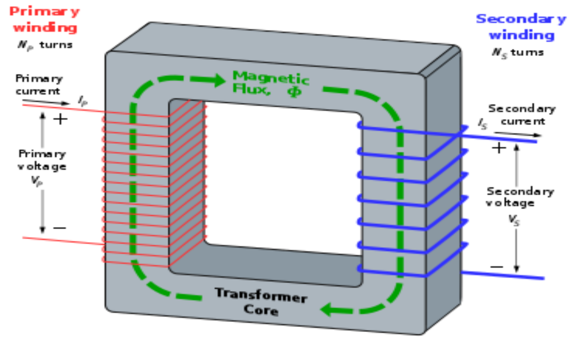

Figure 3: Transformer with Flux Linkages

Voltage regulator

A voltage regulator is so designed that it automatically maintains a constant voltage level. A voltage regulator can be designed as a simple "feed-forward" circuit or can include negative feedback control loops. It can consist of an electromechanical mechanism.

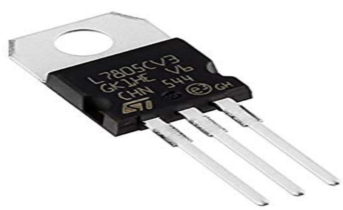

Figure 4: Voltage regulator IC

555 Timer

The 555 Timer IC is an integrated circuit (chip) that is widely used in several multivibrator and timer applications. The design of the IC was given by Hans R. Camenzind in 1970 which was later brought to the market in 1971 by Signetics (later acquired by Philips). This chip provides timing mechanism which is used to differentiate between temporary and permanent faults. The timing of the IC can be varied by varying the value of the resistance and capacitance used along with it.

$$T= (R1+R2)\ C$$

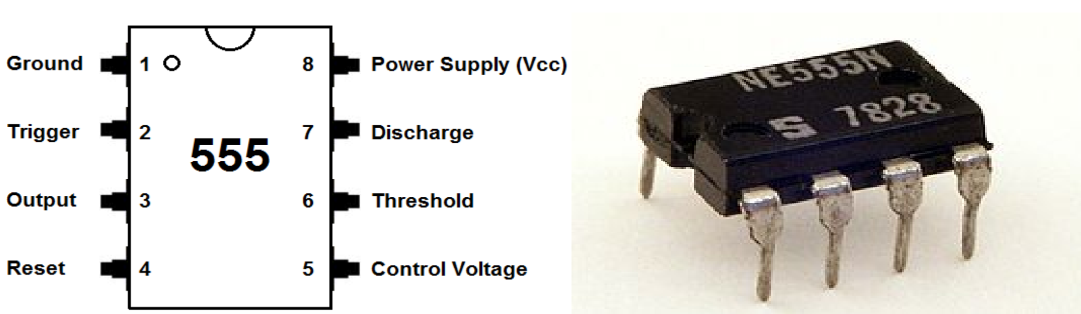

Figure 5: 555 Timer with PIN diagram

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Relay

A relay can be defined as an electrically operated switch. In many relays an electromagnet is used to operate a switching mechanism mechanically, but many other operating principles are also used.Relay control the circuit with a low-power signal. They also provide electrical isolation between control and the controlled circuit. Both DC and AC relays are used in this system.

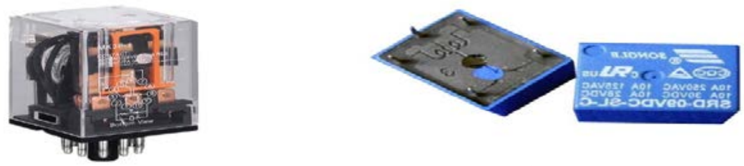

Figure 6: Electromagnetic Relay

Conclusion

This three phase fault analysis system is built using six single phase transformers out of which three are wired in star in star out configuration, and the rest 3 are connected in delta connections. The input to the transformers is 220 volt and output is 12 volt. For introducing faults on the low voltage side, set of switches are used that create LL, LG, and 3L faults. The supply returns to the load in the case of a short duration fault and is referred as a temporary trip while long duration disconnection of supply and load shall result in a permanent trip.

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