Circuit Breaker Based Feeder Pillar

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Abstract

This paper presents a research embodies the design, construction and simulation of a feeder pillar (415V AC) with over current, overload and earth- fault protection. The major reason for this research study is to prevent the constant changing of fuses. It also provides sufficient protection in electric power distribution and easy identification of faults when encountered. This feeder pillar not only distributes power through the channels but also protects the transformer against damage through the use of earth leakage circuit breakers as well as miniature circuit breakers.
Keywords: Feeder Pillar, Low tension lines, Transformer, Relays

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I. Introduction

A Feeder pillar is essential in a power system distribution network to distribute electric power from a step-down transformer to the low-tension (L.T.) lines for the consumers. Electrical power system engineering embraces power generation, transmission, distribution and utilization of electricity. After the generation and distribution of electricity, if it is not well managed by the final consumer, there could be losses and serious problems to the load and user equally. A feeder pillar is an effective electrical enclosure to provide electrical services for low voltage electrical distribution application.

A Feeder pillar consists of a panel which embodies all other sub-units of the feeder pillar, bus-bars in which are connected the incoming and outgoing lines, fuse holders holds the fuses, high-rupturing-capacity fuses for making contact and for protection purposes. It is designed as compact and robust vandalism protection. The purpose of the design of the feeder pillar is to enhance power system protection by introducing relay and breaker instead of high-rupturing-capacity fuses.

This paper consists of a circuit which is designed for single-phase, 230V system, employs power electronics devices and is PCB mounted. This paper describes the circuit which can be used to prevent damage to the connected electrical equipment.

II. Causes of Faults

- Foreign objects coming in contact with bare power lines. The foreign objects may take virtually any form like tree falling across lines, birds shorting out lines, vehicles colliding with towers or poles, animals coming in contact with the wires etc.
- Insulation failure of the equipment caused by lightning or switching surges which initiate faults in the line or equipment.
- Thermal heating cause sagging of power lines. These lines come in contact with each other causing a short circuit.
- Human switching operation errors resulting in faults.
- Abnormal loading in machines, cables and transformers.
- Fog, ice or snow loading on overhead lines.
- Phase failure could be caused by any of the following: unbalanced voltage, single phasing or phase loss, overloads, overvoltage, under voltage, short circuit, phase reversal (incorrect phase sequence).

III. Effects of Faults

- High excitation current is drawn by machines.
- Bearing damage due to current flowing in the bearings.
- Greatly increased damage at the fault location.
- Danger to operating personnel.

- Danger of igniting combustible gas such as methane in hazardous areas giving rise to disaster of horrendous proportions.
- Increased probability of earth faults spreading to other phases.
- Higher mechanical and thermal stressing of all items of plant carrying the current fault.
- Sustained voltage dips resulting in motor (and generator) instability leading to extensive shut- down at the plant concerned and possibly other nearby plants.

IV. SIMULATION OF THE SYSTEM

A. Simulation of System Without Fault:

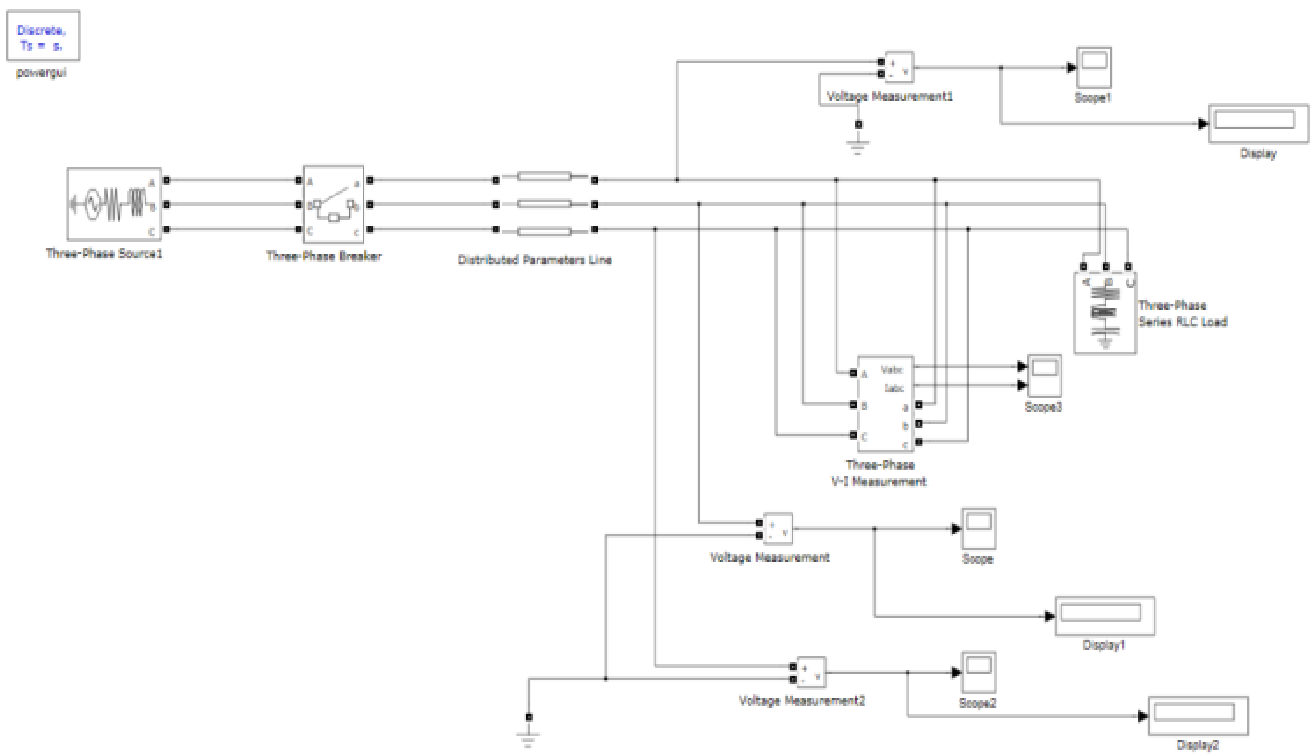

Fig. 1: Simulation of system without fault

B. Waveforms:

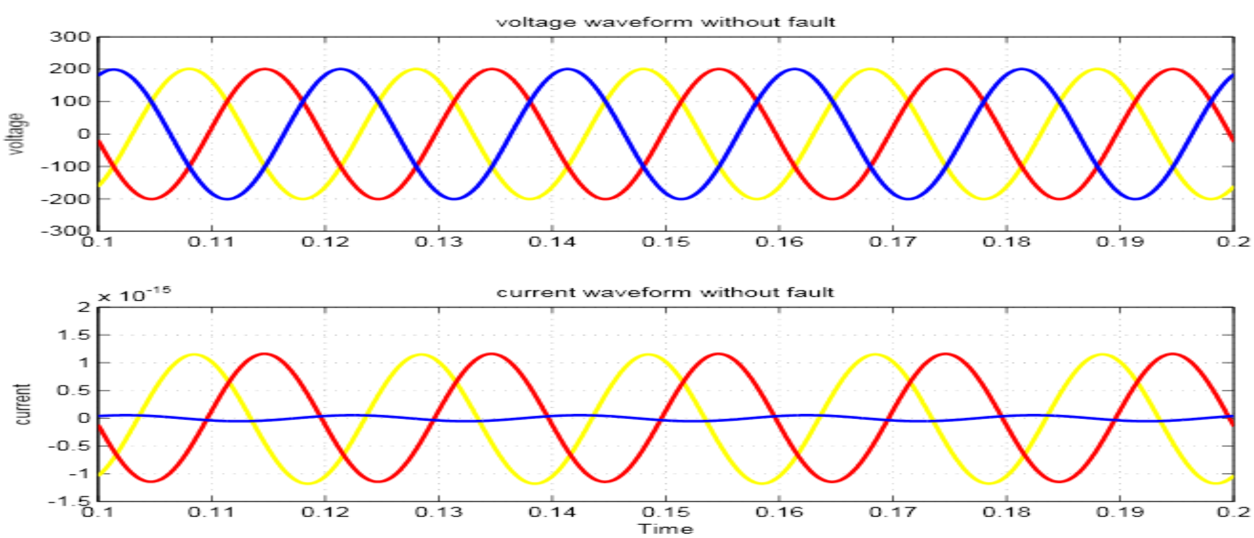

Fig. 2: Waveforms of voltage and current without fault

C. Simulation of System with Fault:

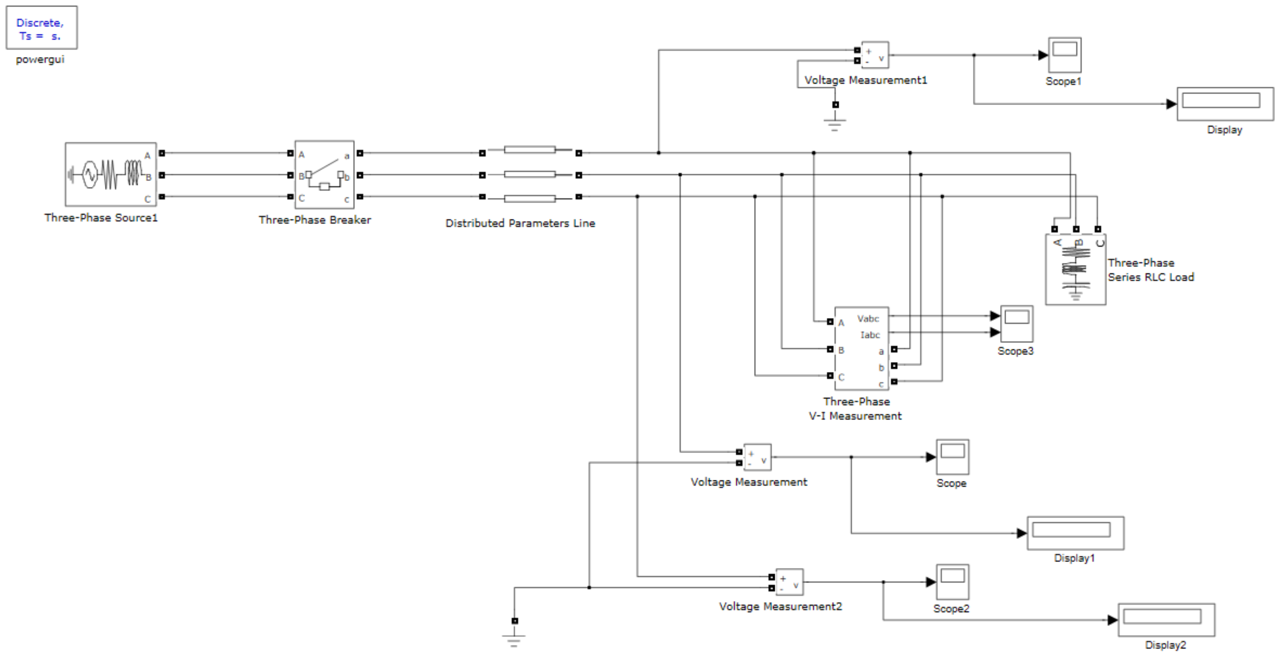

Fig. 3: Simulation of system with fault

D. Waveforms:

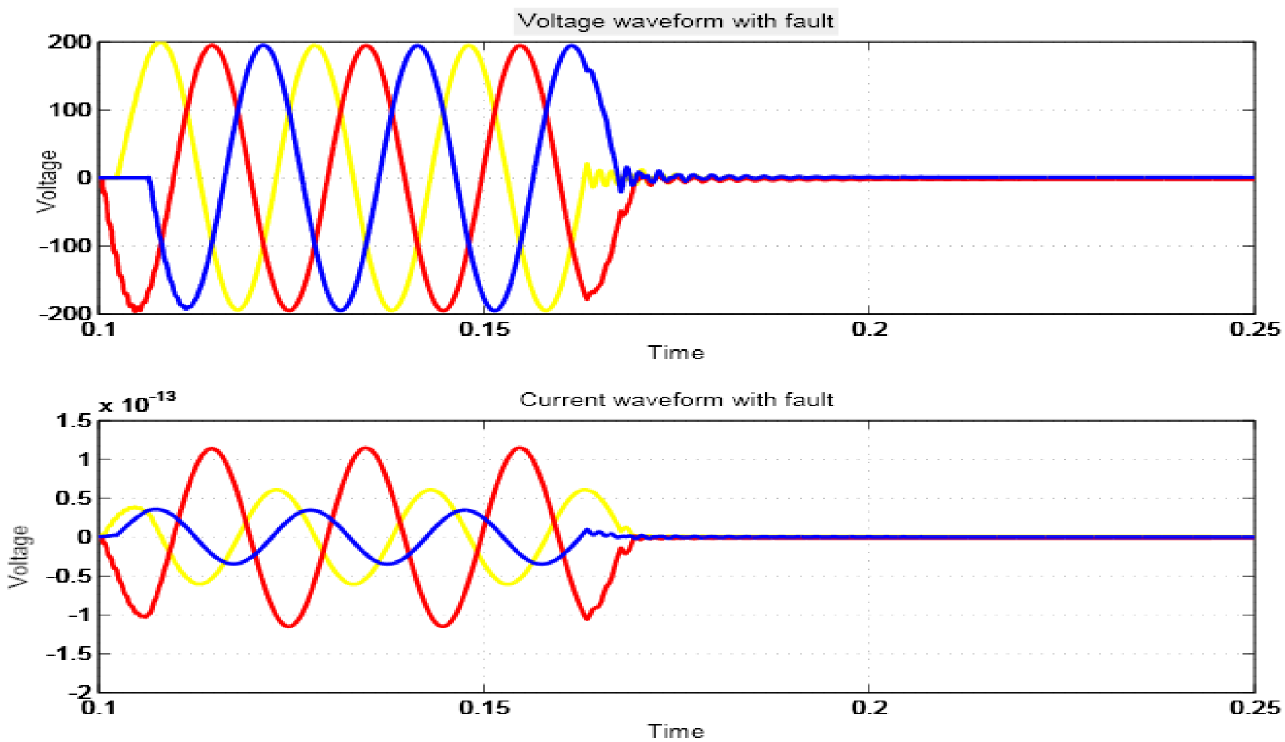

Fig. 4: Waveforms of voltage and current with fault

V. CIRCUIT DIAGRAM

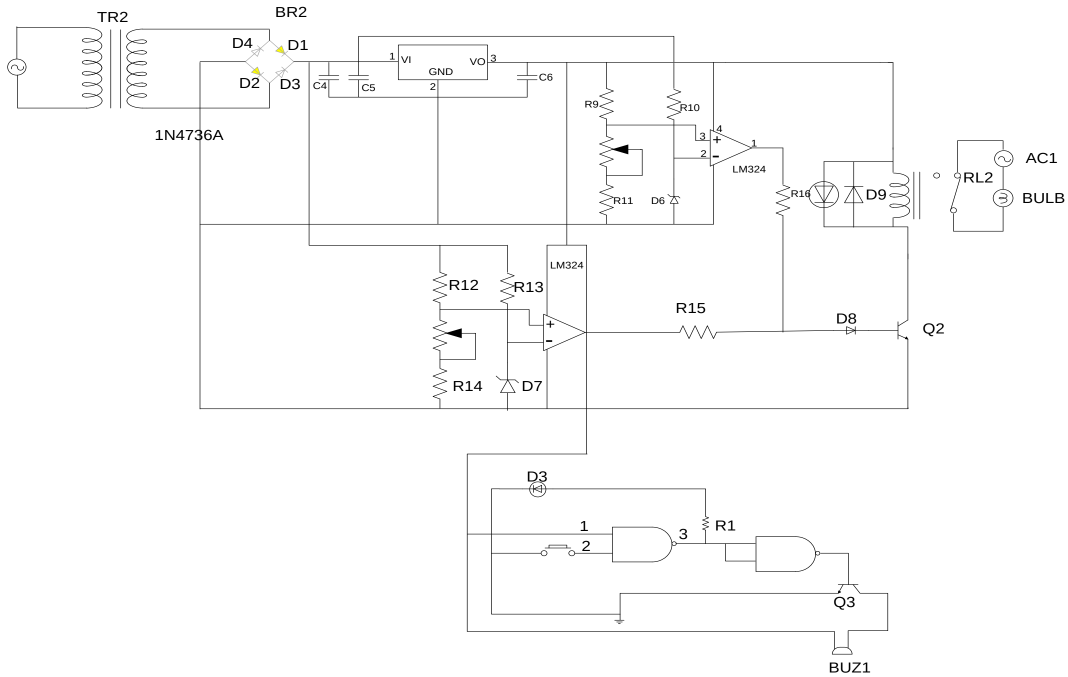

Fig. 5: Circuit Diagram

VI. CIRCUIT OPERATION

As shown in the above block diagram, the mains AC power supplies the power to the whole circuit and for operating loads by using relays, and also for tripping the load (lamps) in the presence of the input voltage which falls above or below a set value. Two comparators used as a window comparator formed out of one quad comparator IC. This operation delivers an error in the output if the input voltage to the comparator crosses the limit beyond the voltage window.

In this circuit, an unregulated power supply is connected to both op-amps terminals, wherein each non-inverting terminal is connected through the two series resistors and a potentiometer arrangement. Similarly, the inverting terminal is also powered through Zener diode and resistance arrangements, as shown in the given under or overvoltage protection circuit.

The Potentiometer's preset VR1 is adjusted such that the voltage at non-inverting is less than 6.8V for stable maintenance of load for the normal supply range of 180V-240V and the voltage of inverting terminal is 6.8V constant due to Zener diode. Hence the op-amp output is zero under this range and thus the relay coil is de-energized and the load is not interrupted during this stable operation.

When the voltage is beyond the 240 V the voltage at the non-inverting terminal is more than 6.8, so the operational amplifier output goes high. This output drives the transistor and thus the relay coil gets energized and finally loads are turned off due to overvoltage. Similarly, for under voltage protection, lower comparator energizes the relay when the supply voltage falls below 180 V by maintaining 6V at the inverting terminal. These under and overvoltage settings can be changed by varying the respective potentiometers.

VII. ADVANTAGES

- Due to phase failure detection and tripping, failure of load instruments and burning out of motor windings can be prevented.
- Student's fatal injuries to the user that could be caused due to earth fault.
- Electrical appliances connected to the system are protected.
- Since the circuit is PCB mounted, it is compact.

VIII. APPLICATIONS

- To protect various equipments from fault.
- Provides sufficient Protection in EPD and identification of faults when there is.

IX. EXPERIMENTAL RESULTS

The faults were created and the variations in the voltage parameters indicating its presence by alarm and trip circuit under faulty conditions.

X. CONCLUSION

The protection system is designed for 230V, single phase AC supply where the use of semiconductor devices increases the accuracy of detection and enhances sensitivity.

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