Open Circuit Fault Detection and Isolation in Distribution Line to prevent Electrical Accidents

A Design Lab Report

submitted by

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ABSTRACT

This project proposes a technique to detect the open circuit fault in the distribution line on the load side to prevent electrical accidents when wire falls on living beings. The technique involves continuous monitoring of voltage and current at the load side when the circuit gets open-circuited. The fault is detected when a sudden drop in current and voltage to zero is observed. It provides the circuit breaker on the substation to be operated promptly to isolate the circuit. This technique offers a reliable and cost-effective method of open circuit detection and provides safety and reliability in distribution networks.

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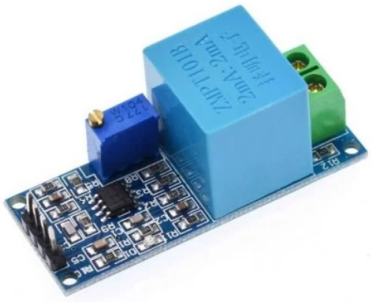
1 Introduction

Distribution networks are critical infrastructure for delivering electricity to end-users. However, faults in distribution lines, such as open circuits, can cause significant disruptions to power supply, as well as pose a serious safety risk to living beings. When an open circuit fault occurs, the current flow is interrupted, and the voltage at the load side drops to zero. If a person comes into contact with the faulty segment, they can be exposed to electric shock, which can be fatal. Therefore, it is essential to detect and isolate open circuit faults in distribution lines promptly. The proposed technique involves continuous monitoring of voltage and current at the load side when the circuit gets open-circuited. The fault is detected when a sudden drop in current and voltage to zero is observed. It provides the circuit breaker on the substation to be operated promptly to isolate the circuit. This technique offers a reliable and cost-effective method of open circuit detection and provides safety and reliability in distribution networks. It is especially important in areas where distribution lines are located in close proximity to living beings, such as residential areas or public spaces. By preventing electrical accidents, this technique can help ensure uninterrupted power supply and enhance the overall quality of life in the communities it serves.

2 Model Components

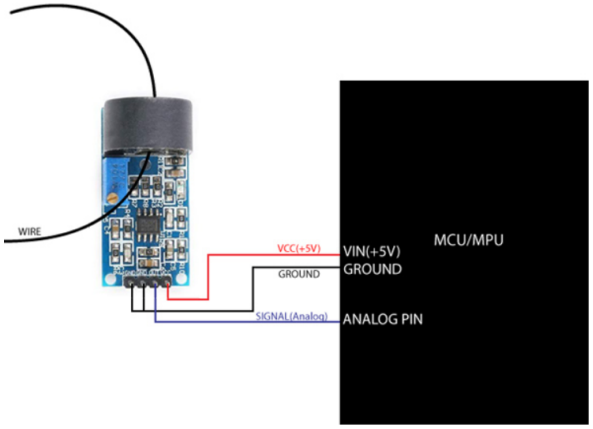
2.1 Voltage Sensor

This project uses ZMPT101B voltage sensor for monitoring of voltage. The module ZMPT101B designed to measure AC voltage in the range of 0 1000V with 0 10mA output. The sensor module is based on transformer principle and amplification of the output voltage so that it can be fed into a microcontroller like Arduino or Raspberry Pi.



2.2 Current Sensor

The current sensor is used to detect the line current in distribution line. The module ZMCT103C works on tranformer principle with turns ratio of 1000:1 for input current of 0 10A and rated output current of 5mA at 5A input. ZMCT103C module can be directly connected to microcontroller.

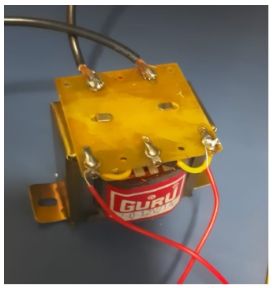


2.3 Power Relay

The Power relay is a circuit breaker device. Power relay of rating 10A, 1000V is used to break the circuit when isolation is required.

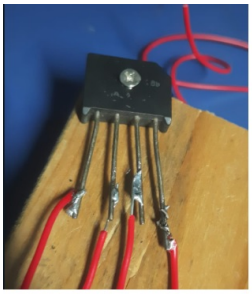
2.4 Transformer

Required for energizing the coil of Power relay. Transormer of turns ratio 240:24 is used to generate DC voltage for power relay coil.



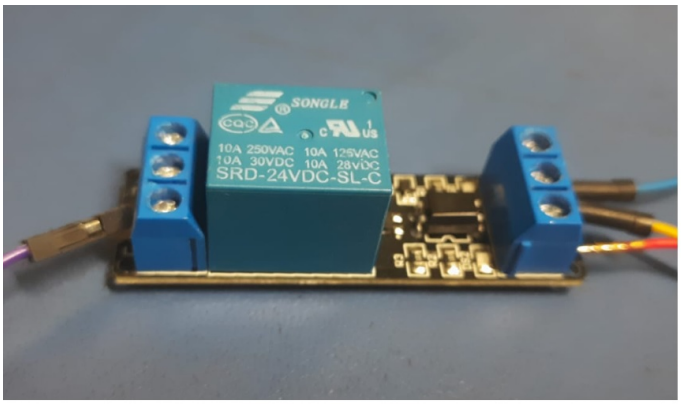
2.5 Rectifier

Full bridge rectifier is used to get DC voltage for the operation of power relay.



2.6 Relay Module

Relay module to be operated by Arduino is used to switch the Power relay.



3 Simulation

Run the simulation and observe the resulting signals.

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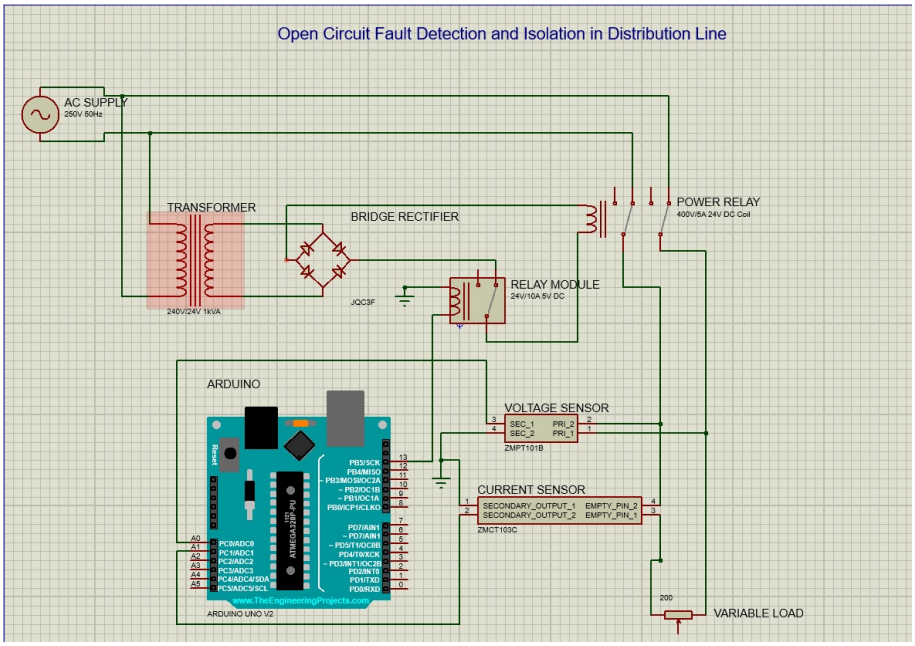
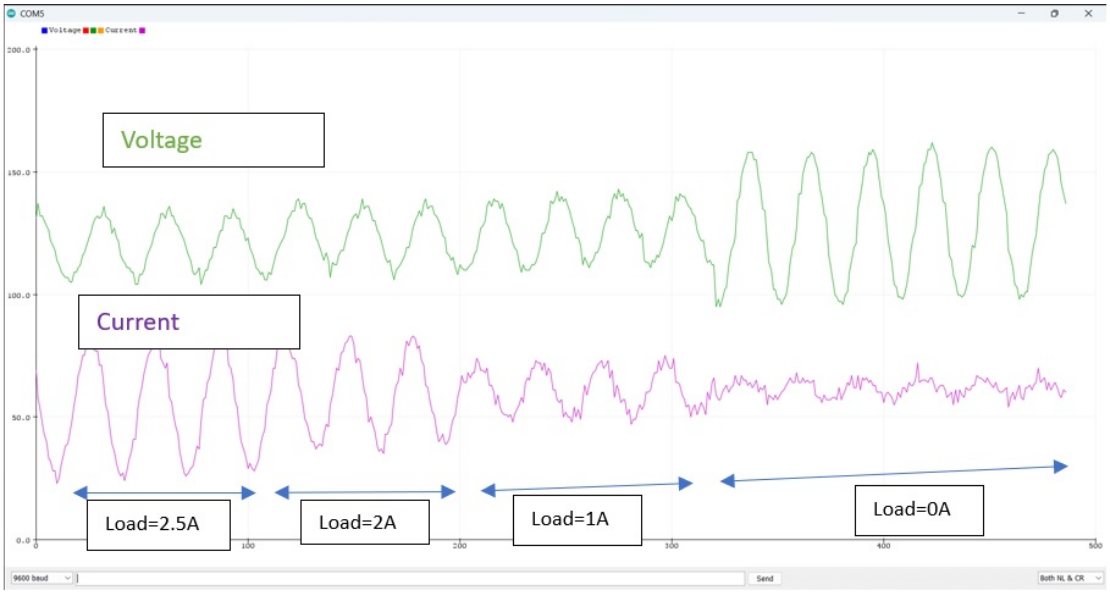
- Model is firstly calibrated to generate the extreme voltage and current swing. The difference of the extreme values are stored.
- Calibration will start from 3 seconds to 8 seconds. Initial values are not used for calibration.
- Calibration will be done with circuit being ON with maximum load.

- Now simulation will start and the readings will be observed.
- whenever sensor detects zero current and zero voltage, relay is triggered to switch OFF the Power relays and hence isolating the circuit.



4 Result

The following result is obtained after running the model.



- Relay operates when circuit current becomes zero.
- Voltage waveform was not accurate due to poor sensitivity.

5 Conclusion

The proposed technique of detecting open circuit fault current in the distribution line using voltage and current gives the expected results, and the model was tested for a maximum of 2.5A current. The limitation of the model is it can not detect well when the impedance is high, i.e., it works well for load>=5A. This technique can be further enhanced by using high-accuracy sensors. The model can be planted on various spots on the distribution line to detect the open circuit fault, which enhances safety and prevents accidents The model was successfully tested for a load of 2.5A. The

6 References

- G. GopalaRao, T. S. Kumar, R. B. Prasad and K. H. Reddy, "Fault Detection and Localization for Overhead 1-kV Distribution Lines with Direct and indirect Measurements," 2022 IEEE 2nd Mysore Sub Section International Conference (MysuruCon), Mysuru, India, 2022, pp. 1-6, doi: 10.1109/MysuruCon55714.2022.9972678.
- Lau SK, Wong HK, Chen S, et al. Detection of open-circuit fault in 11 kV ring circuits by unbalanced current measurement. IEEE Power Systems Conference Exposition 2006, IEEE; 2006. p. 1240–1243.
- Images are taken from Internet.