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Power Distribution Line Fault Determination using DC Injection

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Abstract— Detecting and identifying faults in distribution lines is very necessary for healthy operation of the power system. In distribution lines different faults occur due to weather conditions, insulator failures and other type of power faults. The present fault identification process is completely manual, time consuming and very tedious.In this project we discuss how the fault is identified and the authorized personnel is intimated about it. When the fault occurs the line in which fault has occurred is identified with the help of auxiliary DC backup. The instrument (i.e fault detection and intimation kit) is present on each spur line, which injects DC (pulsed) power into the line and tries to identify the fault. It uses mobile network to communicate the fault location to the control point.

Index Terms— DC Injection, transmission, Fault location, line to line fault, controller , substation,distribution line

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1 INTRODUCTION

Modern electric power systems is a very large network where the electrical power generated reaches the end users. Typical Power System, which consists of three separate components - generation, transmission and distribution. Most of the power generation takes place at generating stations that may contain more than one such alternator-turbine combination. Depending upon the type of fuel used, the generating stations are categorized as thermal, hydro, nuclear etc. Many of these generating stations are remotely located. Hence the electric power generated at any such station has to be transmitted over a long distance to load centers that are usually cities or towns.

The final and the most important component of the power system is the power distribution system. It carries electricity from the transmission system to individual consumers.Nowadays; distribution systems carry a large amount of power as compared to earlier era because of increase in per capital consumption of electricity. The end users expect a reliable and quality power supply, but the existing power system is not very reliable as the faults in the power system are unavoidable. Losses in distribution side are more compared to the transmission side and also the faults in distribution side are more frequent.

The commonly occurring faults in distribution line are Line to line fault, Line to ground fault, Double line to ground fault and, three phase fault. Several methods have been implied for fault determination and location but most of the fault identification methods currently employed is for the transmission side and some for radial fault location.Some of these methods and the traditional fault location methods are Single-ended fault location algorithm, Double- Ended Unsynchronized Fault Location Algorithm, Customer Calls, Line Inspection / Trial and Error Method etc. There are many upcoming methods to make the Power System Protection more reliable, one of which is the 'Traveling Wave Method' which may be used as an alternative for fault location. Another technique that can be used to improve the time efficiency of fault location is 'DC Injection Method'.

2 PROPOSED FAULT DETERMINATION AND LOCATION METHOD

The present fault identification process in many areas is completely manual, time consuming and very tedious. In this project we discuss how the fault is identified and the authorized personnel is intimated about it, thereby making fault identification process more time efficient and saving human efforts.

2.1 Literature Review

DusharlaVenkata Sunil, et.al [1] "An Expert System for Fault Location in Distribution Feeder Line". This paper presents to identify and locate fault in distribution system by using single-ended and double-ended unsynchronized algorithms. Single-ended fault location algorithms only based on single end measures of voltage and current, so they are very easy, low cost of device, and very familiar in digital relays.

"IEEE Guide for Determining Fault Location on AC Transmission and Distribution Lines"[2]. This guide outlines the techniques and application considerations for determining the location of a fault on ac transmission and distribution lines. The document reviews traditional approaches and the primary measurement techniques used in modern devices: one-terminal and two-terminal impedance-based methods and traveling wave methods.

Shunmugam.R, et.al [3] "Distribution Line Fault Detection and Intimation using GSM".This project is locating fault in a power distribution line is a complicated and severe problem in power system. This is designed with micro controller, GSM mobile, Driver circuitand control circuit interfaced with GSM modem. In normal conditions, the system records andperiodically reports the overall performances, whereas, in case of incorrect behaviours, itimmediately informs the operators

2.2 Fault determination and intimation using dc injection (backup) method:

Figure 1 shows the Flow diagram for Fault determination and intimation using dc injection (backup) method.

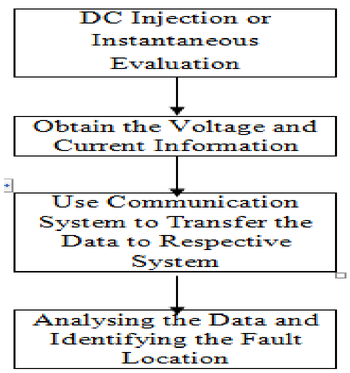

Fig 1

When a fault occurs, the main circuit breaker at the substation trips, then the line in which fault has occurred is identified with the help of auxiliary DC backup. The instrument (i.e. fault detection and intimation kit) is present on the spur lines, which measures the current at the point and transfers the data to the cloud

Once the fault is declared the controller injects a fixed dc voltage in to the line. Due to the large inductance of the line, the current increases linearly with time and reaches the constant value which depends on the line resistance.

$$V_L=L(di/dt)$$
$$di=(V_L/L)dt$$
$$i=\int (V_L/L)\,dt$$
Since V_L= constant dc
$$i=(V_L/L)\int dt$$
$$i=(V_L/L)\,t$$

The current is measured for a fixed duration of time. Hence inductance of the line is known.

$$L=(V_L/i)\,t$$

If the inductance per unit distance is known then the accurate distance also can be identified.

2.3 Fault detection and intimation kit: block diagram and equipment required

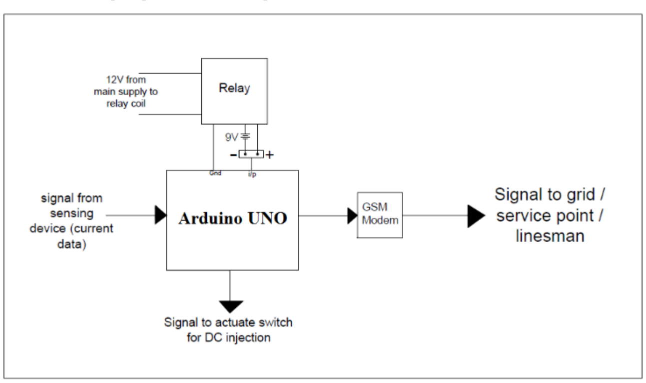

Fig 2

Figure 2 shows a block diagram of fault detection and intimation kit which consists of an Arduino UNO board with complete control over identification of faults.

2.3 Assembly of fault detection and intimation kit on spur line

The Figure 3 shows the assembly of fault detection and intimation kit on a single phase, 50 Hz, 230V spur line.

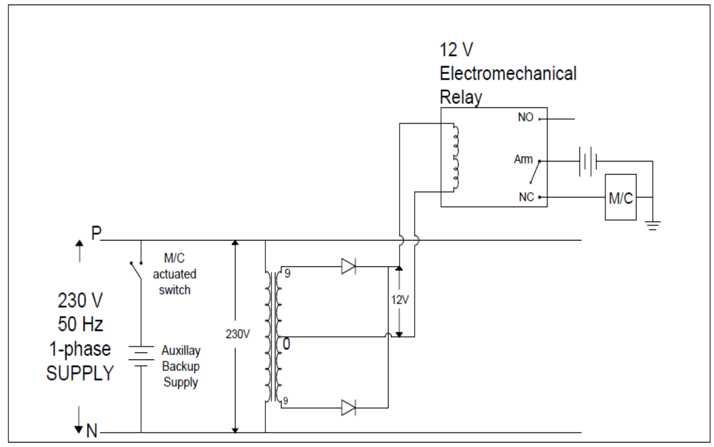

Fig 3

3 SIMULATION

Simulation of power system on distribution side of Bhatkal 33KV substation is done on Matlab simulink. The block diagram of power system is built through simscape, where power system blocks are available readily.

3.1 Modeling of the distribution system

Figure 4 shows distribution system model, with 33kv transmission line connected to substation and trunk line as three phase parallel RLC branch is used for distribution. Various spur line is dragged out with distribution transformers, measuring, controlling, transmitting data instruments.

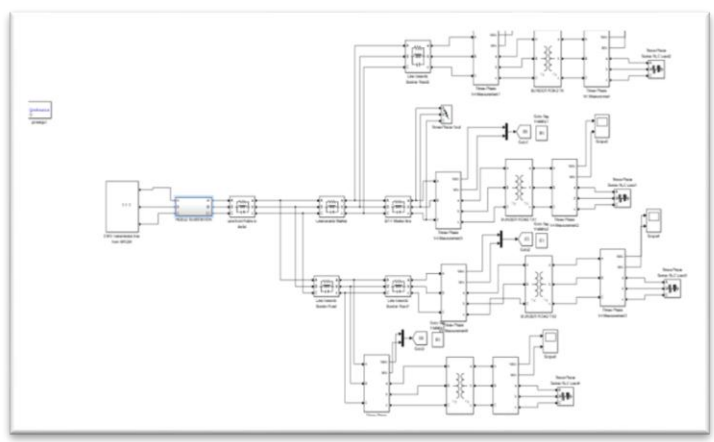

Fig 4

3.2 Substation, measuring and control

Figure 5 shows substation model equipped with three phase transformer with breakers, trips when fault occur in any distribution line. And also provided with measuring and control unit.

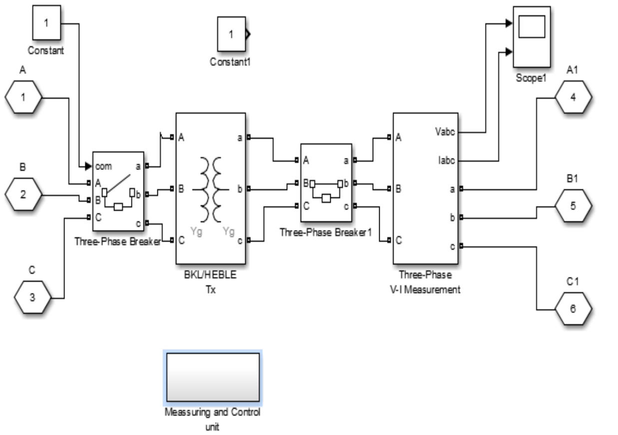

Fig5

The measuring and control unit is shown in figure 6.
When a fault occurs in any spur line, the detection kit at every spur line will detect fault and transmit the data to the substation. The data is collected in measuring and control unit and some control action is taken.

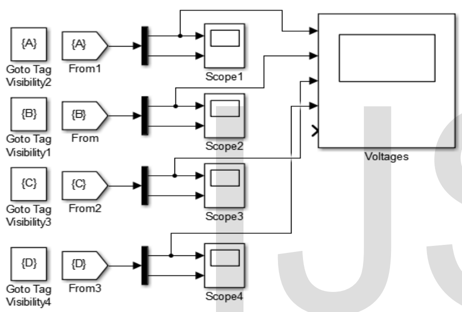

Figure 6

3.3 Simulation result:

When a fault occurs in any spur line, the detection kit at every spur line will detect fault and transmit the data to the substation. If the fault is created at any of the spur line, the measuring unit at that line will detect, collect and transmit the data to the central or substation. The voltage wave form and current wave form for fault detection is shown in figure 7(a) and 7(b).

Once the fault is declared the controller injects a fixed dc voltage in to the line. Due to the large inductance of the line the current increased linearly with respect to time and the maximum current reached by the line is limited by the line resistance. The current measured at the spur line is transmitted to the cloud based server with any of the communication methods and the data gives the measure of distance of fault that is occurring.

The current increases linearly with time. The voltage and current waveform for fault detection after dc voltage injection is shown in figure 8(a) and 8(b).

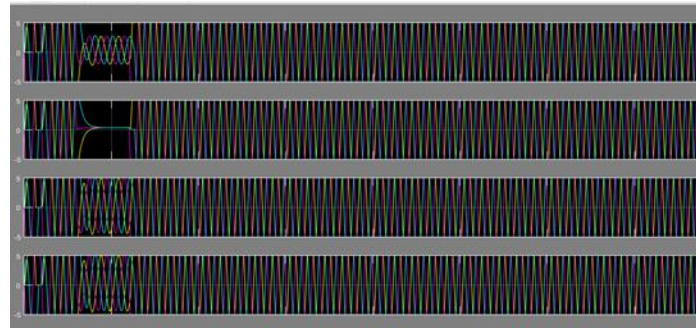

Figure 7(a)

In this current wave form shown in figure 8(b), we can see that when dc is injected to the line, during fault period, the current increase linearly due to inductance of the faulty line.

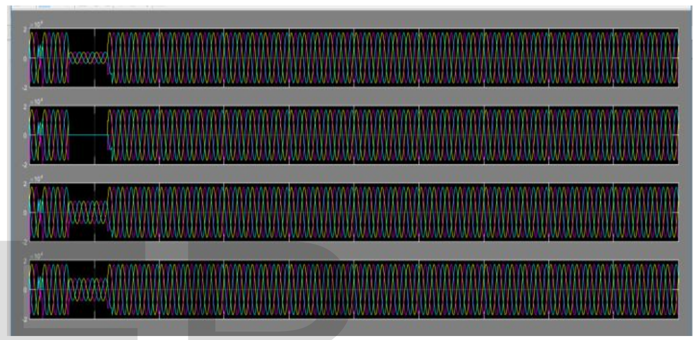

Figure 7(b)

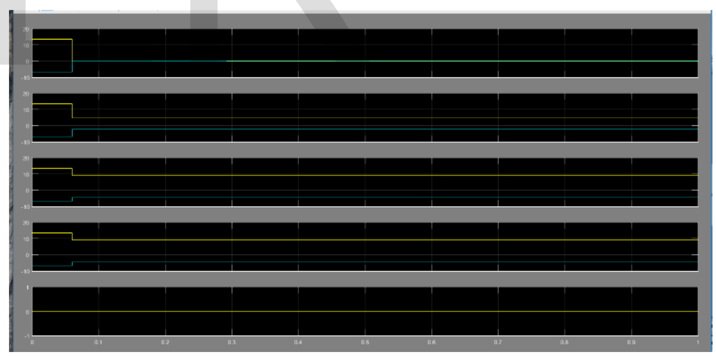

Figure 8(a)

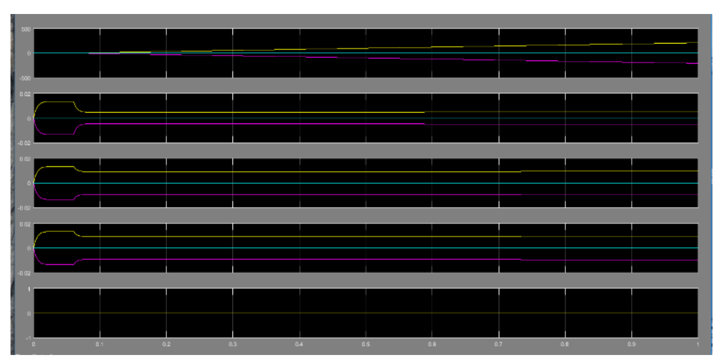

Figure 8(b)

The fault created is line to line type[AB] and here the distance of fault occurring is varied and for various locations on the same line the distance is determined by the DC injection method and is tabulated

4 Conclusion

In this paper fault identification in distribution line using DC injection method is presented. The method used simple inductive equation. The distribution system is simulated using matlab simulink to find the fault location. Results from the simulation shown that the location can be found with 1km precision from the substation end. The above method also makes use of cloud based communication where the current data of each spur line is available on cloud for analysis or observation.

Acknowledgment

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