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Fault and Theft Recognition Using Toro Dial Sensor in Programmable Current Relay for Feeder Security

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Abstract**—**Feeder protection is important in transmission and distribution side because if any fault occurs in any feeder or transformer, man power is needed to identify the problem and it will take more time. In the existing system, directional overcurrent elements with load further secured by a load encroachment function can be used to provide necessary security and sensitivity for faults on remote points in a circuit. It is validated only in renewable plant collector circuit protection applications over a wide range of operating conditions. In this method, the directional overcurrent feeder protection is developed by using monitoring of feeder section through internet. In this web based monitoring, the fault and power theft are identified by using Toro dial sensor and its information is received by SCADA (Supervisory Control and Data Acquisition) and controlled by ARM microcontroller. This web based monitoring is also used to monitor the feeder management, directional current detection, demand side management, overload fault. This monitoring system is capable of monitoring the distribution feeder over a large area depending upon the cost. It is also used to reduce the power theft, time and man power. The simulation is done by MATLAB software.

Keywords**—**Current sensor, distribution feeder protection, directional overcurrent, power theft, protective relay.

I. Introduction

FROM the producing unit, the current delivers to the feeders through the transmission line and then it will be distribute to the consumers. If any fault occurs in the transmission line in both the low voltage and high voltage side, it can be identified by using the Torodial sensor and monitor through the web based monitoring system. The faults like earth fault, ground fault, breaker failure and also it can identify the power theft by using web based monitoring system. The hardware used in this project are Tiva processor, Protective relay, Current Transformer, Torodial sensor, SCADA etc. Current transformers are nothing but the voltage transformers and potential transformers are known as instrument transformers.

Protective Relays are electrically operated switches. They are used where it is necessary to control a circuit by a low power signal with complete electrical isolation between control and controlled circuits. Torodial sensors are ideal for use in process liquids where metal electrode contact feeder would crush or become marked. It is a system for operating with coded signals over communication channels. The decision-making system may be combined with a data acquisition system by adding the use of oblique signals over message signals to acquire information about the status of the remote equipment for display or for recording functions. For simulation, the fault is manually generated and given as input to the generating unit of the Simulink design by using MATLAB.

Protective relay using a microcontroller and software based protection algorithm is used for detection of electrical or process faults [3]. Multifunction digital relay can be used to protect the generator voltage, frequency, reverse power over current, VT-fuse detection, and breaker failure protection [1]. In the existing system, fault produced in the DC microgrid can be protected and identified by using the intelligent electronic devices and probe power technique [2].

When power in a circuit is very high to apply directly for the measuring instruments, a current transformer will produce a low current accurately proportional to the current in the circuit, which can be conveniently connected to measuring and recording instruments [4]. For detection fault in the transmission line, distance relaying algorithm is used [5]. To protect the faults in the distribution feeder, software based detection algorithm is used [6]. For the DC current interruption, semiconductor based circuit breakers are used [7]-[9].

II. Existing System

In the existing system, the fault occurs in the microgrid can be detected and identified by using the intelligent electronic devices and probe power technique. It can be validated only in renewable plant collector circuit protection applications over a wide range of operating conditions.

III. Proposed System

In the presented method, the fault can be detected and identified in the AC transmission and distribution system by using web based monitoring system over a wide area. In this web based monitoring, the fault and Power theft are identified by using Toro dial sensor and its information is acquired by using SCADA and controlled by ARM microcontroller. This web based monitoring is also used to monitor the feeder management, directional current detection, demand side management, overload fault. This monitoring system is capable of monitoring the distribution feeder over a wide range of operating conditions in the wide area depends on the cost.

IV. Faults in the Transmission Line and Distribution System

Faults occurring on above and below the ground levels of

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the distribution feeders caused by various sources like:

- Line to line fault
- Line to ground fault.
- Earth fault
- Over load fault
- Breaker failure

Some stable faults can be apparatus failures or cables cut or short-circuited by excavation apparatus. This type of system can be used to affect the voltage and current characteristics during a fault. Proper fortification strategies are to make reliability an utmost condition. Basic feeder protection is well-known. Reclosing is often practical to restore service following momentary faults on transparency circuits. Safety can be maintained with the help of time and pickup synchronization between over current plan, it may operate for a specific fault event. The challenge in feeder safety is reliable.

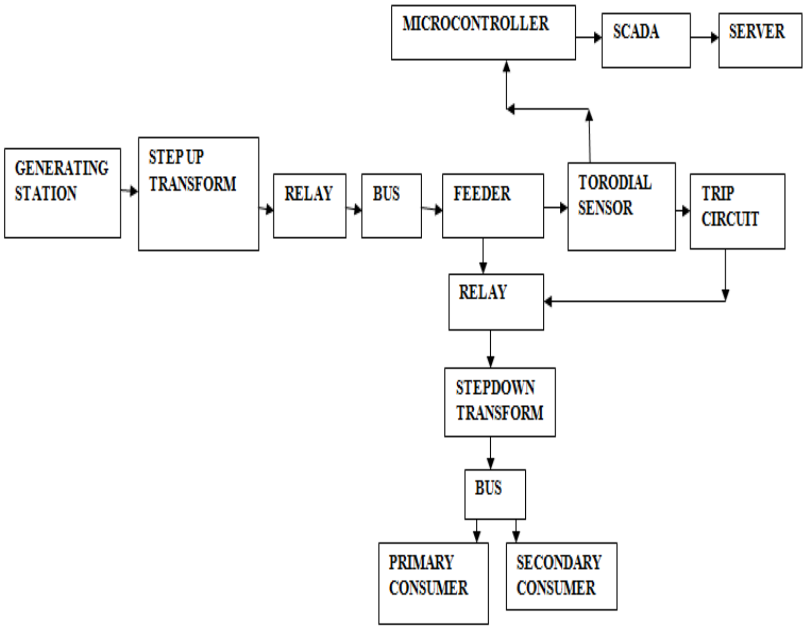

Fig. 1 Overall Block diagram

V. Description

The block diagram consists of the relays, current transformer, arm microcontroller, feeders, generating station, generating step up transformer, substation step down transformer, Toro dial sensor, SCADA system, server, trip circuit, bus.

If any fault occurs in the transmission side and distribution side, it can be identified by using the sensor and then the information will be sent to the electrical board with the help of network based monitoring system. This type of system can be also used to monitor the power theft. Fig. 1 shows the block diagram.

This type of network system can work with the help of internet, it can monitor and identify the location of the fault. If any short circuit occurs, it can be tripped by using the circuit breaker.

VI. Fault Equation

Z_1, Z_2 and Z_0 are the impedances of the system to the flow of positive, negative and zero succession electric current, respectively. For earth fault

$$Ir0 = Ir1 = Ir2\ E/Z0+Z1+Z2 \quad (1)$$

where Ir0 = Current reference r0; Ir1 = Current reference r1; Ir2 = Current reference r2; Z1, Z2, Z3 = impedances of the system.

Double phase to earth fault,

$$Ir2 = -Ir1 \quad (2)$$

$$Ir0 = 0 \quad (3)$$

The equation for the three phase breaker is

$$L_{max} = 1000V_{3\,Ø}/3^2I(R_C\cos Ø + Xc\,\mathrm{Sin}Ø) \quad (4)$$

where Lmax = max. length of the cable, $V_{3\,Ø}$ is the max. permissible three phase voltage drop, I is the nominal full, load, Rc is the AC resistances of the cable, Xc is the ac reactance of the cable, $Cos_Ø$is the load power factor. The equation of the overcurrent relay is

$$T= KxØ_1xØ_2\sin θ \quad (5)$$

where K = is a constant, $Ø_1$ and $Ø_2$ are the two fluxes, θ is the phase angle between the fluxes. The equations of ac operations are given by

$$Fe = K\, I^2 = 1/2\, KI^2_m - 1/2\, K\, I^2_m \cos 2\omega t \quad (6)$$

where Im = max. value of the operating current, K = constant.

VII. Methodology

Feeder protection scheme along with overcurrent relay are implemented. Different types of faults are implemented and that system will identify all types of faults. It provides a high speed, accurate control over various faults. Emergency system section can be used in the Simulink because if any current or voltage occurs it can be identified and detected by using web based monitoring system.

VIII. Simulation

For the simulation purpose, the Proteus software can be used. Proteus PCB design combines the ISIS schematic capture and ARES PCB layout. The simulation diagram consists of three parts; main feeder, sub feeder and by pass section as shown in Figs. 2 and 3. The simulation diagram consists of the fault section, generating section, consumers, relay section, voltage section. The Switch block passes to the second input with the help of first input or the third input. The first input and the third inputs are called as data inputs. The second input is called the control input.

If any fault occurs in the step up transformer, the circuit will immediately trip with the help of circuit breaker. With the help of sensor, the data can be sensed and then it will be stored in the SCADA block and then that data will be monitored through internet. Then, it will be given to the synchronous machine. A synchronous generator is an electrical machine producing alternating EMF (Electromotive force or voltage) of constant frequency. The Three-Phase Breaker circuit is used for opening and closing times. It can be controlled either from an external control mode or internal control mode. The three-phase breaker block can be connected between the inputs and outputs of the blocks. One can use this block in series with the help of three-phase element. Signal Conditioner is designed to convert from low voltage to high voltage or high voltage to low voltage. And the fault and fault location can be identified by using the sensor as shown in Fig. 3.

Figs. 4 and 5 show the experimental setup for both the transmitter side and the receiver side. The transmitter side consists of tiva controller, signal conditioner, load, voltage regulator, optic isolator, power supply, Toro dial sensor, Max232, step down transformer. If any fault occurs it can be sensed by using the Toro dial sensor.

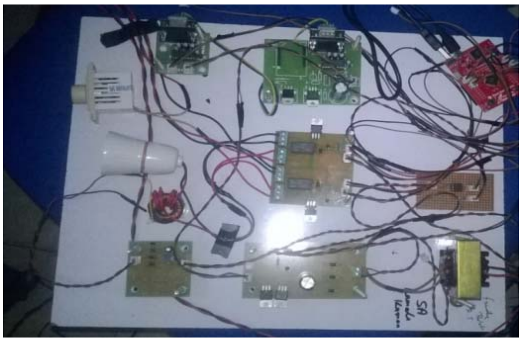

Fig. 4 Experimental setup (Transmitter Side)

Fig. 5 Experimental setup (receiver Side)

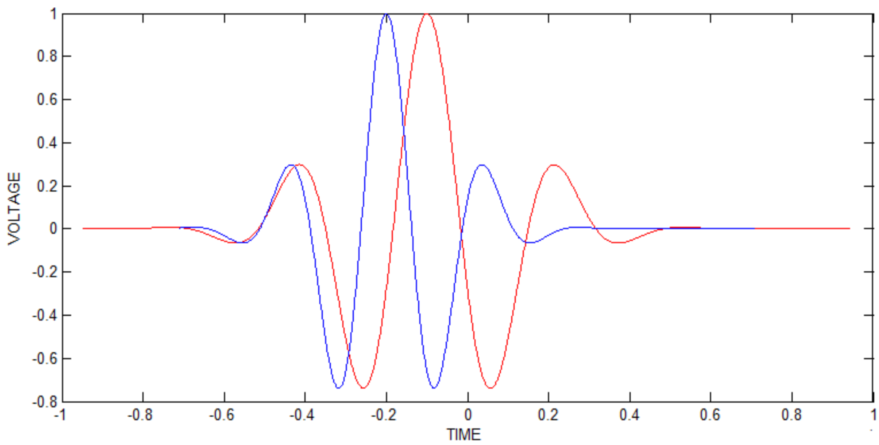

Fig. 6 Comparison waveform

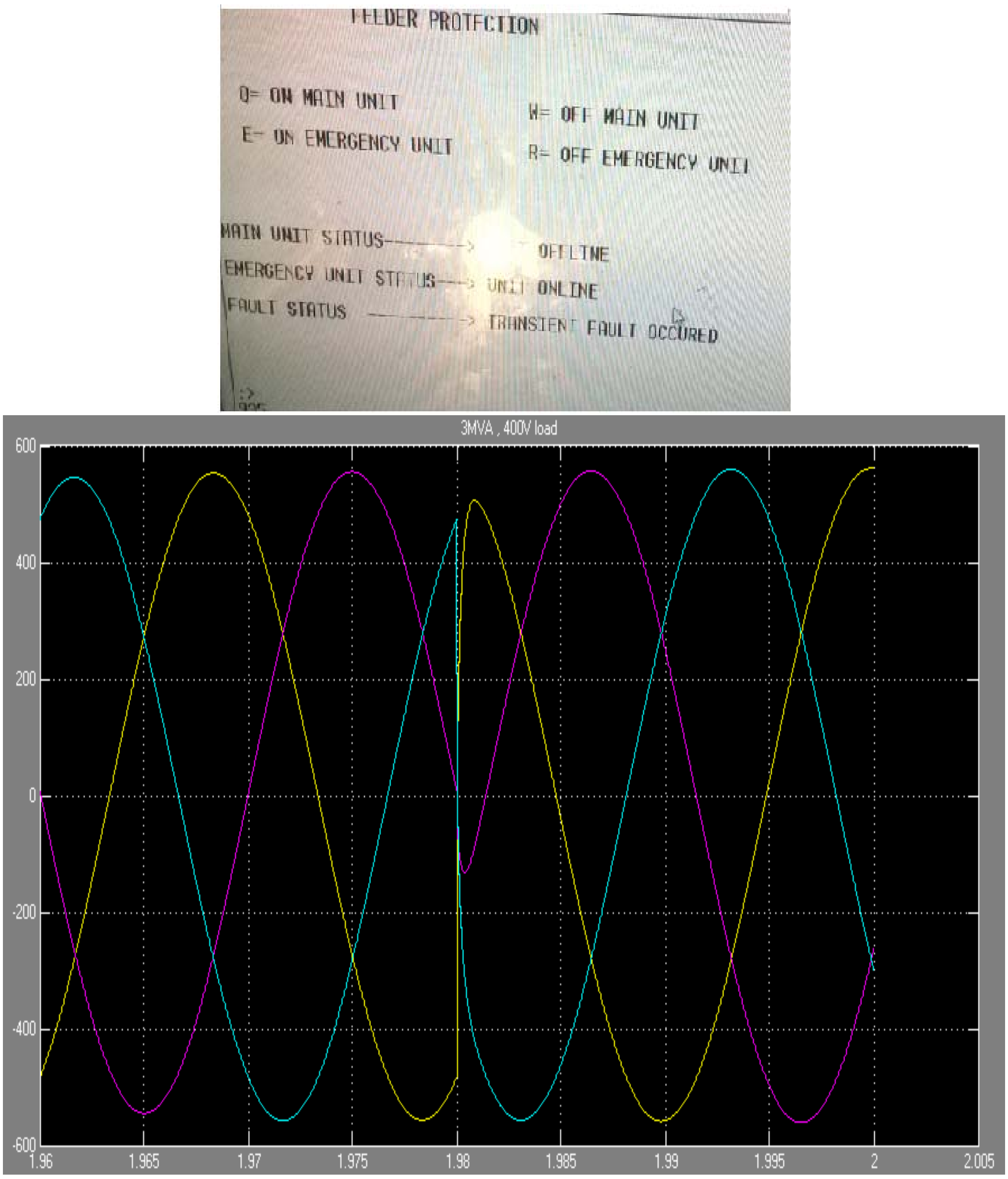

Fig. 7 Comparison of hardware and software results

Fig. 6 shows the comparison wave of the time and voltage. In this, if any sudden drop occurs in the voltage, the emergency unit will immediately go to ON condition.

Fig. 7 shows the comparison results of the software and hardware. The result of the software will be in the form of sinewave. In this software result, the faults can be created manually. But in the hardware results the faults can be generated in the circuit and that faults will be rectified and displayed on the monitor. It can be done with the help of wireless communication (Taranga Module).

IX. Conclusion

The fault protection and identification of location scheme occurs in the feeder section. The presented system is for identification of fault location by using the web based monitoring system and isolating the segment to avoid the entire system shutdown. The faults can be sensed by using the Toro dial sensor. The sensed data can be store the data in the SCADA system. Furthermore, by doing this the time, cost and man power will be reduced and then fault location can be identified easily. For simulation, the fault is manually generated and given as input to the generating unit of the Simulink design by using MATLAB.

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