Automation of Distribution Grid for Fault Detection and Isolation

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Abstract—A new approach to power system automation for the distribution feeder is to locate and isolate the fault automatically. This paper presents automatic fault detection, isolation, using Radio Frequency communication. This system incorporates two systems: a power system which consists of a distribution feeder having number of load buses and a communication network of the distributed intelligent devices in the system**.**

Keywords: Distribution System, Fault Location, Isolation Service Restoration (FLISR), Substation Protection, Feeder Protection, Self-healing.

I. INTRODUCTION

In electric power system, power distribution system is an important part in order to supply reliable, efficient and continuous power to consumer. This paper is based on the concept of self-healing, i.e. the ability of grid to detect the fault, find the location of fault then isolate that fault section and also restore the system. All this done automatically. Self-Healing is known as Automated Fault Location, Isolation. This is achieved by endowing Circuit breakers, Relays and Switches, multi-agent devices, etc.

II.RELATED WORK

The interfacing of communication network with power system is nowadays taking attention for reliable service. K. K. Agarwal presents an overview of principles for automatic fault location and isolation system to automatically isolate the faulted section in an overhead system [1]. The development of a fault management system for distribution automation system (DAS) for operating and controlling low voltage (LV) downstream of 415/240V [2]. Service restoration problem formulation and solution algorithm incorporated the load curtailment. A ranking based heuristic search algorithm is proposed which prioritizes the multi-objective service restoration distribution network, and this prevents the practicality progress of feeder automation system[5].

The Fault Location, Isolation and Service Restoration (FLISR) application can improve reliability dramatically without compromising safety and asset protection. R. W. Uluski describes the FLISR function, provides information on the major trends of the day and issues that need to be resolved, and suggests where the industry should go[6].An effective healer healing approach to accelerate the fault location function of the FLISR process is realized by optimal placement of fault indicators (FIs). A multiple objective function is formulated, and solved using multi-objective particle swarm optimization (MOPSO), to simultaneously minimize indispensable economic and technical objectives [7][11].

FLISR is one of the key automation application which reduces the outage time to the end customers and also reduces the financial penalties incurred due to outages. P. Parikh and M. Monadi proposed a fast FLISR algorithm using IEC 61850 based Generic Object Oriented Substation Event (GOOSE) technology [8][10]. The service reliability can be significantly affected if the communication system fails to operate successfully [9].

A multi agent-based distribution automation solution is proposed to be used in the distribution of self-healing grids to solve the service restoration part of the Fault Location, Isolation and Service Restoration (FLISR) task. FLISR algorithm based on the Multi-Agent System (MAS) concept is designed for active smart distribution grids by leveraging the DG-assisted service restoration functionality [12][13].

III. NATURE OF FAULTS

There are tremendous varieties and causes of faults in distribution grid. The most of the faults are occurred in distribution grid as it is nearer to the load.

1) Line to Line Faults:

These faults are occurred due to the contact between any two phases. The causes for these faults are falling of trees, birds, snakes on the line.

2) Line to ground faults:

These faults are mainly due to the contact between one phase and ground. The main cause for these faults is the falling of conductor on the ground.

3) Double line to ground faults:

These faults are occurred when any two phases comes in contact with the ground.

4) Three line to ground faults:

These faults are occurred when all the three phases come in contact with each other and the ground. The frequency of these faults is the least among the all faults.

5) Overload faults:

These faults are dependent on the nature of load. These are over current faults. The faults which are occurred in distribution grid are mainly of this type as the distribution grid is closest to the load

6) Short circuit faults:

These faults are often considered as over current faults. When the current flowing through the line is 8 to 10 times more than normal line current, then this abnormal condition is considered as short circuit.

7) Unbalanced load faults:

The uneven loading of phases produces unbalanced currents to flow in the three phases. In this case, the neutral current is not zero

IV. DISTRIBUTION GRID AND PROTECTION

We have considered radial distribution system of single distribution feeder for the automatic FLISR System. Depending upon whether the feeder is of primary or secondary distribution system, one feeder separates two buses.

Protective relays are used for the detection of an abnormal conditions in system and take appropriate action as soon as possible to regain the power system to its normal operation mode.

The feeder protection consists of a protection system on the substation side of the feeder, as well as one at every bus connected to the distribution side.

A) Substation Side protection

The substation side protection consists of the instantaneous over current relay (OCR) and Circuit Breaker (CB). When a fault current is persistent for a predetermined set of cycles, the OCR trips CB on all three phases. Depending on the measurement of current transformer (CT) on all three phases, the OCR operates. To handle the temporary faults like false

B) Feeder Protection System (FP):

The feeder protection System (FP) consists of an over current relay (OCR) and Circuit Breaker (CB). When a fault current is persistent for a predetermined set of cycles, the OCR trips CB on all three phases. Also the CB can be operated by an external control signal.

An Isolator Switch (ISW) is used to isolate the incoming bus of the feeder section from the outgoing bus of the feeder section. By the external control signal, the IS disconnects fully both the end of faulty feeder segment. If this is not done, the one end of faulty feeder segment will be live when service is restored. As shown in Fig. 1, CBij provides protection for this scheme. Where i=1. . . . .N, which denotes the feeder segment. And j=1 for the CB equipped upstream of the feeder segment, j= 2 for CB equipped downstream of feeder segment.

The communication transceivers are also equipped on the SSP's and FP's to achieve communication between them. A Radio Frequency Protocol is used for the communication.

V. HARDWARE SCHEMATIC DIAGRAM

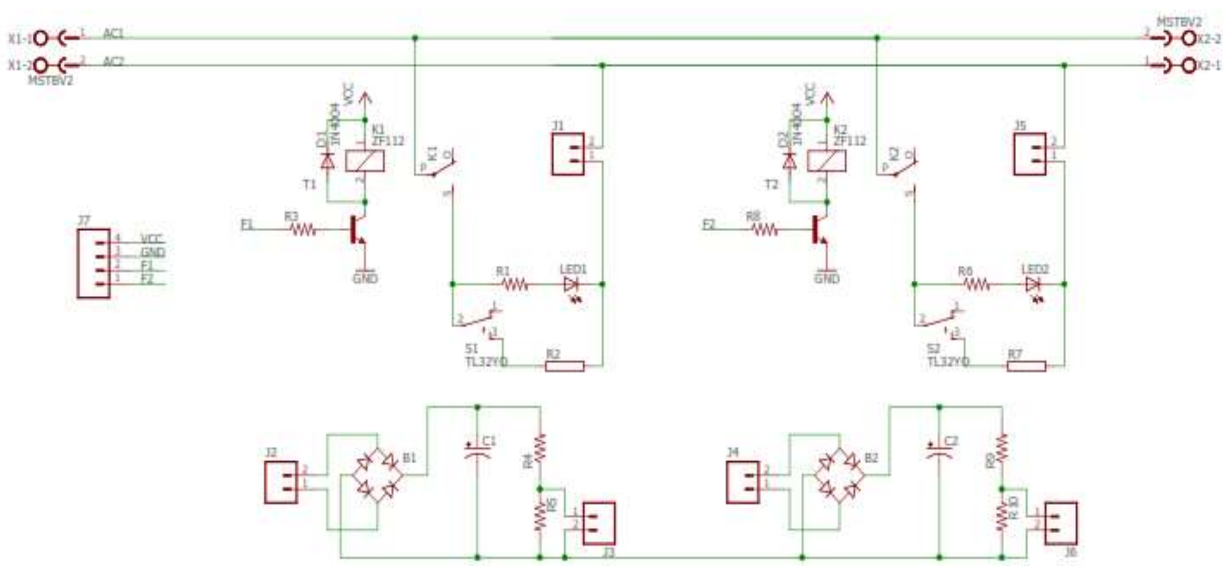

Fig 1: HARDWARE SCHEMATIC DIAGRAM

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