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SMALL SCALE GRID ARCHITECTURE FOR LINE FAULT DETECTION AND ISOLATION

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***Abstract*-One of the big challenges facing the power grids network today is the inability to produce electricity continuously on the customer side.Traditional fault isolation approaches cause the power shutdown to a wide area to keep the device safe. Localization of faults and their isolation is performed manually today. Therefore a localized recovery mechanism for fault is very necessary to preserve the integrity of the system after a fault occurs. In this paper, in a three-phase isolated micro grid scenario, we have established quick detection and isolation mechanism for single-phase to neutral line failure. Fault detection and isolation of a micro grid during the insulated mode of service is very important, because there is bidirectional power flow. The fault detection system that we have developed can identify and isolate the fault within a few milliseconds, and locate the fault in single and bi-directional power flow scenarios within a two second delay. With the assistance of the communication network built into the power grid, the proposed device is able to locate the exact failed section.**

1. INTRODUCTION

The frequency of secondary distribution grid fault incidence is considerably high compared with the main side. Some of the faults in a power system result in an immense variety in electrical parameters that will have a significant effect on the load activity. In today's distribution grid the fault should be isolated from the distribution transformer if a fault occurs in some portion of the distribution grid. In most of the grid, this condition triggers a long-term power drop.

A micro grid is a network of small scale distribution, built to provide electricity to a local community. The micro grid will work in island mode if an abnormal condition occurs in the main grid. Within the micro grid, power sharing is present during the insulated mode of operation. The power flow within the network is bidirectional, depending on the demand for electricity. The direction of power flow should also be understood in order to establish a fault detection mechanism within an island micro grid scenario.

We have proposed a three phase micro grid system in this paper. The micro grid network includes smart houses, which can serve as both a power source and a customer, as well as smart modules that are present at each distribution point. Most of the fault detection and insulation mechanisms that had previously been introduced for a micro grid network in other works were primarily in the DC network. Fault detection and isolation mechanism for micro grid network has been done in the DC network in most of the preceding work. In addition, for this DC micro grid system most works used ring type architecture. In this paper we considered the radial-architecture AC micro grid network. By considering this method, we built and implemented an automated mechanism for detecting faults, isolating them and quickly locating the faults.

The rest of the paper is arranged as follows: section 2 presents the relevant works, section 3 describes the proposed device architecture, section 4 presents the method of detection and isolation of faults, section 5 presents the method of position of faults, section 6 presents the configuration of the hardware, section 7 presents the implementation of the hardware, section 8 presents the testing and analysis and section 9 presents the latter.

2. RELATED WORK

In a DC micro grid network a fault safety and insulation scheme was proposed (Jae-Do and Jared, 2013). The authors used the current sensor in this scheme to detect and isolate the fault with the aid of a master and slave controller which is connected with every segment of the micro grid network of this loop type. But the protection schemes for the micro grid network in the island mode of operation could be somewhat different from the conventional protection scheme because there is bidirectional power flow. In the three-phase distribution system, various forms of fault were compared (Cheraghi and Goodarz, 2011). The simulation showed that in a three-phase system, the magnitude of the fault current varies widely for different types of fault. Awareness of this huge current of faults was crucial to the creation of a safety scheme for this system. A description of the current micro gird security schemes was given in (Buigues, 2013). Due to changes in the connection and disconnection of generators, load centres, storage network and other switches, the safety scheme for a micro grid should be tolerable to the complex topological transition. By evaluating the current conditions at various relay sites, a fault current detection approach was used in (Sanaye-Pasand and Khorashadi-Zadeh, 2003).

Whenever a fault occurs at the transmission line, it was subject to change in the current at each relay site. In this work, the theory of variation of the current sensor before and after the occurrence of fault was used for identification of faults and their classification. An over-current security for a micro grid network was proposed with the assist IED in (Voima, Kauhaniemi and Laaksonen, 2011). According to them, when operating isolated mode, a new over-current security scheme is required for a micro grid system as the change in operating condition from grid-connected mode to insulated mode causes a dramatic shift in distribution network parameters. Detection of a fault is achieved in this paper in accordance with IEDs, with the aid of the telecommunication network.

An approach to power grid monitoring using wireless sensor networks was provided in (Fateh, Govindarasu, and Ajjarapu, 2013). According to this paper, while bandwidth and latency were the key bottlenecks for using wireless sensor networks in a smart grid scenario, proper network design could make wireless sensor networks the best solution to control power grids. In this paper, the authors used a hierarchical wireless sensor network. In a smart grid scenario, various communication technologies and their specifications have been discussed (Fateh, Govindarasu and Ajjarapu, 2013).

In this paper, an analysis of various communication technologies provided specific communication requirements such as latency, reliability, frequency and protection. Research of the smart grid control technology wireless sensor network (Gungor and Hancke, 2010). The authors performed an experimental WSN study on different power grid scenarios and found that they could satisfy most of the connectivity criteria required for smart grid connectivity.

3. SMALL SCALE GRID ARCHITECTURE

In this work, we were considering a three-phase micro grid that operates in insulated mode. Each smart home in this network had the capacity to produce and store electricity from a renewable energy resource. The extra power produced within the system could be shared among the load centers according to the power demand in order to maintain the system's self-sustaining. This power sharing between the loads was crucial because the micro grid was not connected to the source of the normal power grid.

In this work we only considered single phase loads that were spread uniformly over three phases. We presumed that each load has a source of renewable energy, and that it would act as both a load and a generator. Also, it can store the extra power generated. The smart meter that was present at each smart home would track both home and away from home the bidirectional power flows continuously. Since a three phase distribution grid has been proposed in this work, three power lines will be available to the distribution point. We had to use three intelligent modules at each distribution pole to control the three phase lines.

If we had only one smart module to track the three phase lines, failure of this smart module could make the three phase lines non-observable. Thus, smart modules will boost device robustness for each step line. The breakers connected with an intelligent module at each distribution point. A micro grid-associated control station to monitor and take decisions based on device data.

4. FAULT DETECTION AND ISOLATION METHOD

A central aspect of the emerging micro grid network is power sharing. Faults that can occur in this three-phase micro grid may cause unbalance in the network and prevent the power sharing. Hence, a mechanism for detecting and isolating faults is very important for the system's continuous operation. In this study, this type of fault was called

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only the single line to neutral fault since 95 per cent of the fault occurs within a three-phase network.

For each phase-line, each distribution pole was fitted with three smart modules. Every smart device was connected to a current sensor, voltage sensor, circuit breaker, module of communication and micro controller unit. Those sensors were attached to the micro controller along with circuit breakers and communication modules. Figure 2 displays a block diagram of an intelligent computer. Current sensors and voltage sensors continuously monitored the state of current and voltage at each phase line. At each intelligent device the processor unit continuously verified if the current values exceeded the lower and upper threshold limits allowed. If the current sensor value exceeded the threshold limits, the circuit breaker present at that line of phase opened the circuit.

The intelligent device continuously sent the sensed current value to the intelligent device of its neighboring distribution pole after fault detection and isolation. Whenever a smart device receives a message from its neighbor it compares the value it receives to its own perceived value. After this comparison every smart device took one of the two decisions.

a. If the adjacent intelligent module's current value difference was not a high value, then there was no fault between the two poles, and the breaker status was closed condition.

b. If the neighbouring intelligent module's current value difference was a high value then a fault occurred between the two poles, and the breaker associated with that phase line was opened.

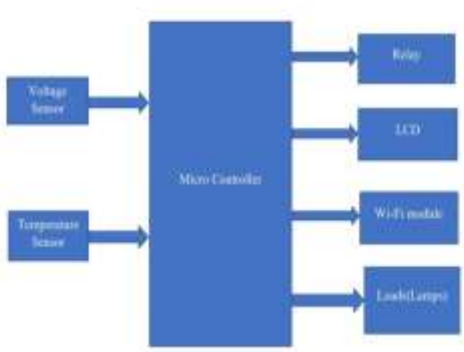

Fig. 1.1 Block Diagram of Small Scale Grid Architecture

Thus the breaker connected to the exact location of the fault opened and the other breaker stayed in the closed position. This helped to locate the fault precisely within this shielded micro grid. The key advantage of this localized isolation of fault was that it prevented shutdown of the whole network during defective condition. In addition, the other portion of the distribution grid remained in stable condition.

The intelligent module sent the details about the fault position and the new breaker state status to the control station after the fault position was localized. The identification and isolation of faults resulted in two nano girds forming. The power re-routing mechanisms could be implemented in future to shift the power required area to a power balanced area.

5.HARDWARE IMPLEMENTATION

Detection and isolation of faults played an important role in preserving the reliability of the proposed microgrid network. In our laboratory a portion of the proposed micro grid network was implemented with automatic fault detection and insulation mechanism in a single phase network. Two smart modules have been developed in this research which were to be present at each distribution point.

The current and voltage value changed every time a fault occurred. Therefore, we used certain parameters in our system to assess the state of the fault. Although the fault was detected from the current value, we were monitoring the voltage shift in our device as well. According to (Rebekah Hren Brian, 2011) for feeders the voltage drop should not exceed 2 percent and for efficient operation the voltage drop for branch circuit should not exceed 3 percent. The voltage has been continuously monitored in our system to ensure its variability in this range has been reduced.

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Fig. 1.2 Hardware Implementation of line fault detection and isolation

In that hardware, we built two smart modules. These modules were connected to a power supply line and checked under different charging conditions.

5.1 SHORT CIRCUIT CONDITION

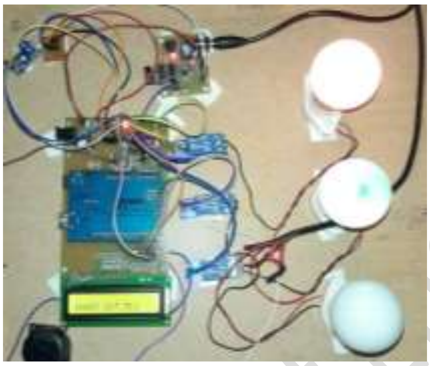

Fig. 1.3 Short circuit condition

In this short circuit condition the power will not passes through the transmission line 1. But the power passes through the remaining transmission lines as shown in Fig. 1.3.

5.2 OPEN CIRCUIT CONDITION

Fig.1.4 Open circuit condition

In this open circuit condition the power will not passes through the transmission line 2. But the power passes through the remaining transmission lines as shown in Fig. 1.4.

5.3 OVER VOLTAGE CONDITION

Fig. 1.5 Over voltage condition

In this over voltage condition the power will not passes through the transmission line 3. But the power passes through the remaining transmission lines as shown in Fig. 1.5.

6. CONCLUSION

This paper proposed three step micro grid architecture capable of automatically detecting faults and isolating mechanism. The bidirectional flow of power within the insulated micro grid made the process for detecting faults more difficult. A fault detection mechanism built in this research could detect and isolate the fault and in a balanced state make up the remaining part of the grid. The proposed system was tested under various current conditions of fault and the results showed that the proposed system could locate the fault within a delay of 2 seconds. While a single phase to neutral fault was very common in a three-phase distribution power network, other types of faults were also significant, and their occurrence. Automatic error detection and fault localization did not align the system. New approaches to power re-establishment after identification and isolation of faults may also be carried out as further research.

7. REFERENCES

Jae-Do, Park., Jared, Candelaria., 2013. Fault Detection and Isolation in Low voltage DC- Bus Micro grid System. Power delivery IEEE Transaction on 201328.2 779- 787.

Cheraghi., Goodarz., 2011. Comparison of the Effects of Phase to Ground Faults and Three Phase Faults in a Micro-turbine Generation System. International Review on Modelling & Simulations 4.2.

Buigues, G., Dysko, A., Valverde, V., Zamora, I., & Fernández, E., 2013. Microgrid Protection: Technical challenges and existing techniques. Renew Energy Power, Qual J, 11, 262.

Sanaye-Pasand, M., and H, Khorashadi-Zadeh., 2003. Transmission line fault detection & phase selection using ANN. International Conference on Power Systems Transients—IPST.

Voima., Sampo., Kimmo, Kauhaniemi., and Hannu Laaksonen., 2011. Novel protection approach for MV microgrid. 21st International Conference on Electricity Distribution.

Fateh., Benazir., Manimaran, Govindarasu., and Venkataramana, Ajjarapu., 2013. Wireless network design for transmission line monitoring in smart grid. Smart Grid, IEEE Transactions on 4.2:1076-1086.

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