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Overcurrent and Earthfault Relay Coordination for Microgrid with Numerical Relay Features

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Abstract: ***This Paper deals with the Relay Coordination for microgrids by considering the symmetrical and unsymmetrical faults. A microgrid is an active distribution system in which the renewable energy sources and loads connected to feeders operate parallel or autonomously from the main power grid. In a microgrid, Overcurrent relays can be used as the protection device. When there is changeover from grid connected to islanded mode or disconnection of DG will lead to variation in short circuit current. So, the relay may fail to operate or there will be delay in operation. Relay Coordination is done on the basis of load flow and short circuit analysis. Simulation is done using the ETAP (Electrical Transient and Analysis Program) Software by taking the 9 bus 18 node system.***

Keywords: Microgrid, Islanded mode, ETAP (Electrical Transient and Analysis Program)

I.INTRODUCTION

The Fast Depletion of fossil fuels increases the electrical power demand. Therefore, there is a prerequisite for employing the renewable energy sources in getting electrical power generation. One of the solutions for this problem is Microgrids. A microgrid is a grid that operates self-reliantly or collaboratively with other minor microgrids. A small-scale and a localized power station that has its own generation, storage capacities and definable boundaries will be considered a microgrid. A hybrid microgrid is same as the microgrid, it can be integrated with the main power grid in that area. During the heavy demand periods of power, Microgrids can be used as a supplement or provide back-up power which is supported by renewable energy sources and generators. power grid during periods of heavy demand.

During the downtime condition, the buildings with rechargeable generation capabilities through generators and solar panels provide energy and revenue. By combining together with smart grid deployments, additional energy can be sold back to local microgrids to make revenue in addition to providing resilience and capacity to local electrical grid.

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II. LITERATURE SURVEY

[1] In this Paper, they proposed the microgrid shield scheme which focuses on fault current limiters size and resetting directional overcurrent relays by using genetic algorithm. Active type of FCL used in this system. This active FCL are placed in the system incase of any fault and have insignificant impedance throughout normal operation.

[2] In General, the relay organization for microgrid is to sighted for a symmetrical fault. But the microgrid may undergo faults at phases or ground . So the aim is to deliver protection scheme for faults In this paper they had planned a safety scheme for all types of faults.

[3]This paper recommends a suitable method for determining a group of unsurpassed relay locations. This method is viable for all Distributed Generators installations. The integral function in Matlab optimization toolbox can be used as a problem solving technique for optimization problem which may only give local solutions. But in Etap it is easy to simulate all the constraints into account.

[4] Grading margin is the time difference between the maneuver of two head-to-head relays for achieving proper discrimination between both. If the grading margin is not provided correctly, then more than one relay will operate for a fault, which leads to disconnection of unnecessary circuit breaker and loss of supply to the consumers.

[5]In this Paper, they had proposed Directional Overcurrent Relays can be suitable for the reliable operation in grid allied and islanded modes of microgrid operations but the directional relay is unidirectional and it can clear fault only in one direction. If the deviation occurs in any other direction it won't consider as a fault.

[6]In this paper they implemented the hybrid genetic algorithm to maintain the transient stability of the Distribution generator. and they have compared this algorithm with Genetic algorithm, they proposed this method provides the DG maximum production of generation but the cost is high.

[7] In this paper, For Optimum Relay Coordination, Genetic Algorithm method is proposed. Artificial Intelligence is employed. To avoid mis operation of relays, combination of prime and gridlock relay is used by the graph philosophy. This is for loop distribution system.

[8] In this paper, directional overcurrent relays are used. Directional overcurrent relays will trip in one direction and it will not trip for other directions. However, the directional overcurrent relay is not fit to defend micro grid for changeable fault current magnitude rendering to different modes,

they can function as prime relay during the fault sector and it will function as a gridlock relay if the fault is in another zone.

III.PROPOSED METHODOLOGY

Micro grids have inherent capability of surviving the grid failure to ensure the availability which results in very high fault current with grid connected operation and very small fault current in islanded operation.

Most of the renewable source present in the micro grids are inverter based and hence their contribution to fault current depends on controllers.

Due to different storage devices adopted the contribution of fault current may vary for each device. So, the selected system can be analysed properly for coordination.

Load Flow analysis can be done to ensure the different direction of current and to estimate the full load current in the system. Short Circuit Analysis can be done to find the short circuit current. Based on the results for each case considered the relay settings can be given for numerical relay for proper coordination.

SINGLE LINE DIAGRAM USING ETAP

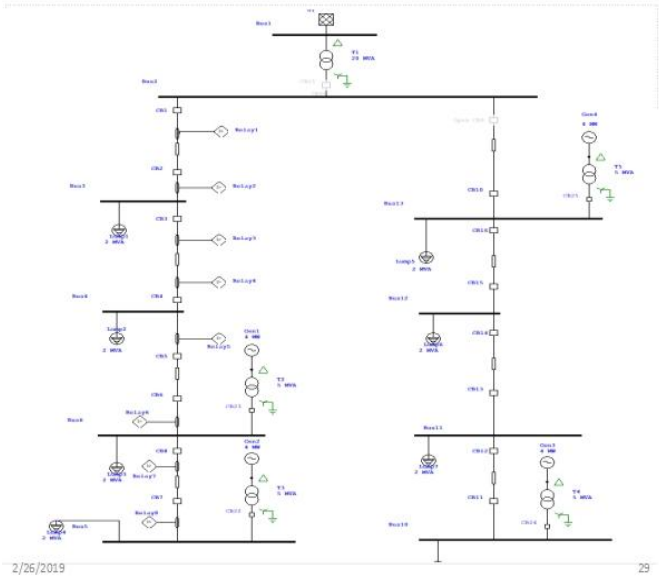


Figure 1

For the Protection of a power system, Relay co-ordination could be a important one. For such relay coordination settings are typically given throughout an accurate approach supported the previous analysis. For over current protection, the calculated pickup current is given in line with the load flow analysis. and settings have to be sent to the relay. Relay settings had been tired such a way that correct co-ordination is achieved on the various modes of operation. For the initial commissioning of power plants, because of the addition and deletion of equipment and feeders the review and checking of coordination is extremely necessary. Most of the power are typically acknowledged from the generators of confined station. Relay co-ordination is completed by the calculated value of plug setting and procure current and time multiplier setting of the relay, by considering peak fault current at the relay location. By projectile the curve characteristics the time multiplier setting value are typically adjusted. once plotting the relay coordination curves, it is to be maintained between the curves of varied protective devices for guaranteeing the proper sequence operation of inverse time over current relays. The load flow calculation values helps to determine the state of the Circuit breaker for a given load and generation distribution parameters. As the state held fixed for some time, it is represented by a steady-state condition. In general, any small change in loads, motors, and other loads, the direction of current flow and bus voltages fluctuate constantly. And this can be eliminated by measuring the steady-state effects on system requirement. Short circuit studies give the values of RMS and Peak voltage for different kinds of faults which are input for the relay setting calculations and for the design of circuit breakers.

INFERENCE FROM LOAD FLOW ANALYSIS

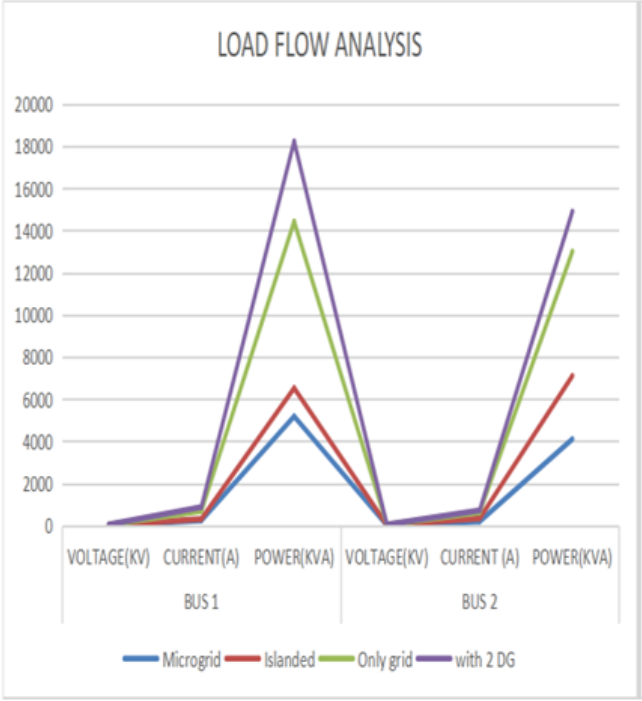


Figure 2

1: LOAD FLOW ANALYSIS DATA

	BUS1			BUS 2		
	V (KV)	I (A)	P (KVA)	V (KV)	I (A)	P (KVA)
Microgrid	12.47	245.5	5180	12.47	194.6	4104
Island	12.47	64.7	1340	12.47	144.9	3000
Only grid	12.47	384.9	7900	12.47	289	5897
with 3 DG	12.47	181.1	3800	12.47	90.7	1898

INFERENCE FROM SHORT CIRCUIT ANALYSIS

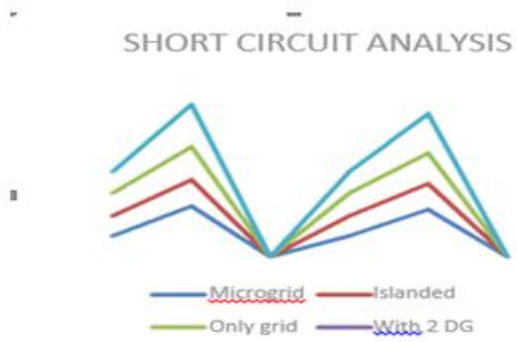


Figure 3

TABLE 2: SHORT CIRCUIT ANALYSIS DATA

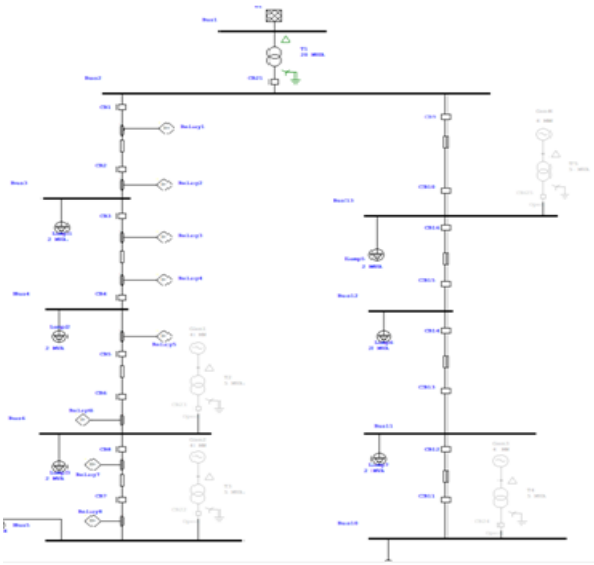
	BUS 1		BUS 2	
	V (KV)	I(A)	V(KV)	I(KA)
Microgrid	6.7	16.38	6.69	15.18
Islanded	6.54	8.42	6.56	8.44
Only Grid	7.38	10.74	7.35	9.87
With 3 DG	6.9	13.76	6.88	12.7

From load flow analysis we can see load current is flowing in different direction in all four cases considered.

From short circuit study, the current is different for 3 – phase and LG fault for all four cases. Hence for giving protection setting to relay we should give for all cases separately. With the numerical we can give group setting to relay according to different condition.

By sensing the status of circuit breaker of DG/grid (i.e whether open or close) we can conclude which mode it is operating and appropriate setting in automatically updated through communication system.

IV. SIMULATION RESULTS



CASE 1: GRID MODE

Figure 4

Figure 5

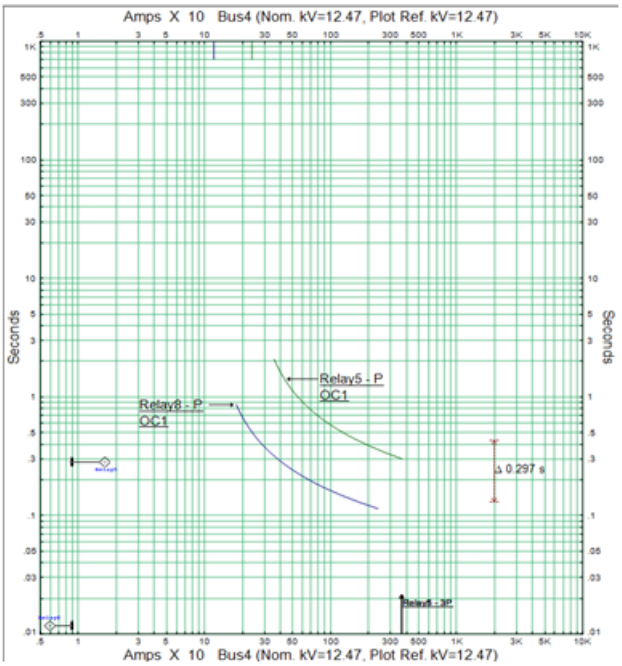
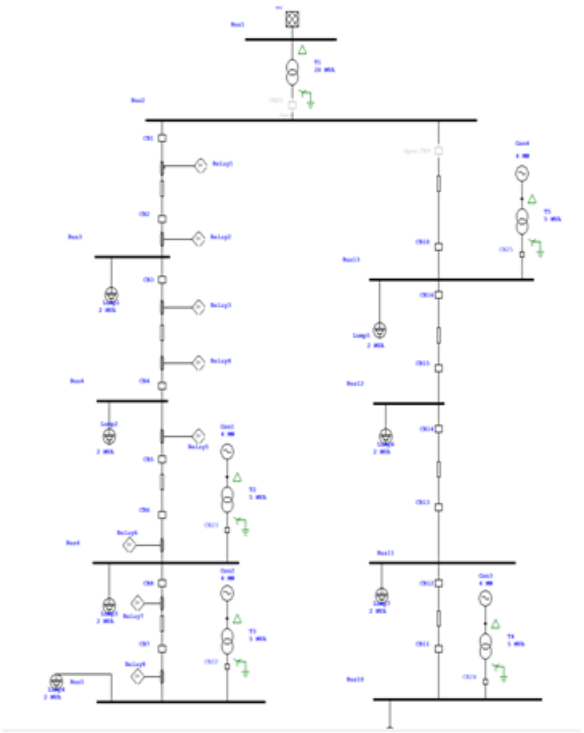


Figure 6



CASE 2: ISLANDED MODE

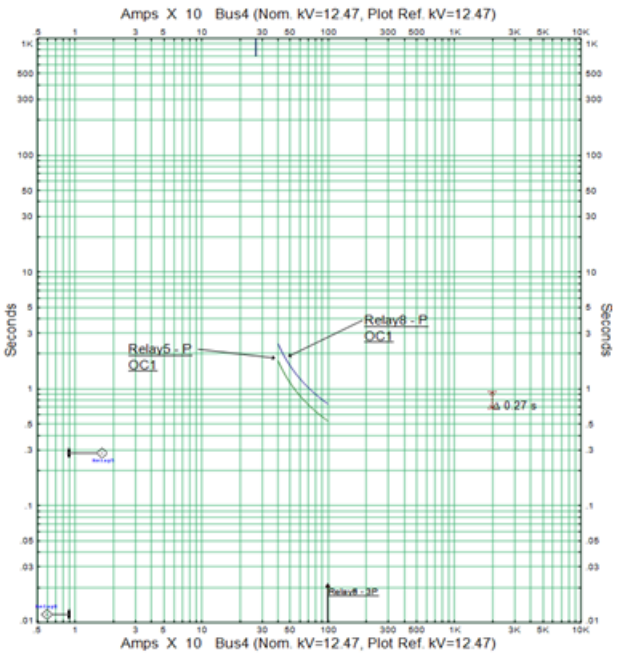


Figure 5

CASE 3: GRID WITH 4 DG MODE

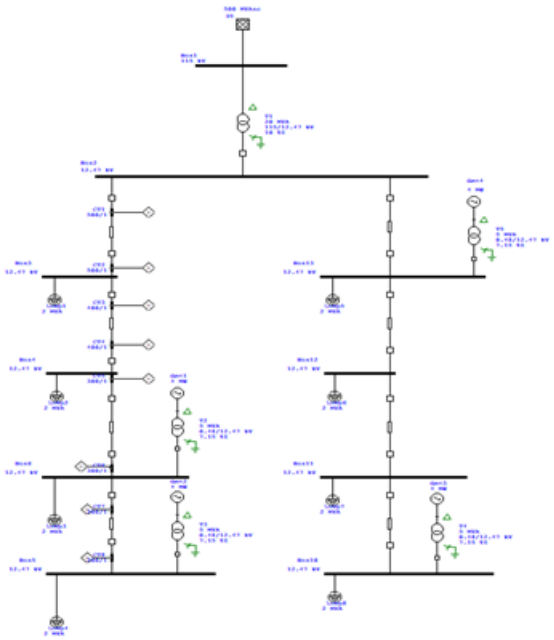


Figure 6

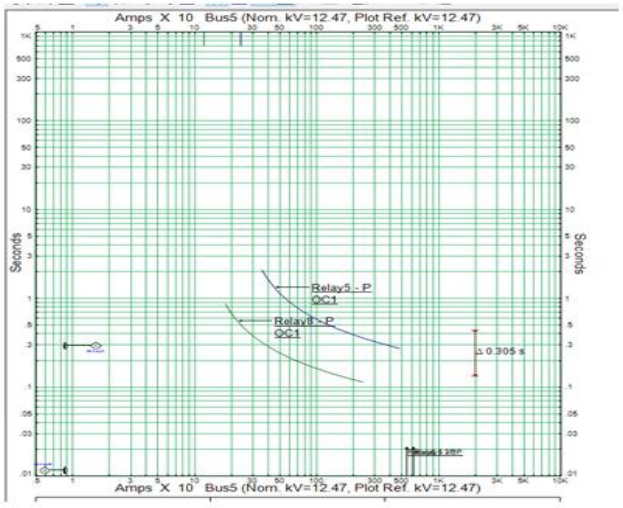


Figure 7

CASE 4: GRID WITH 3 DG MODE

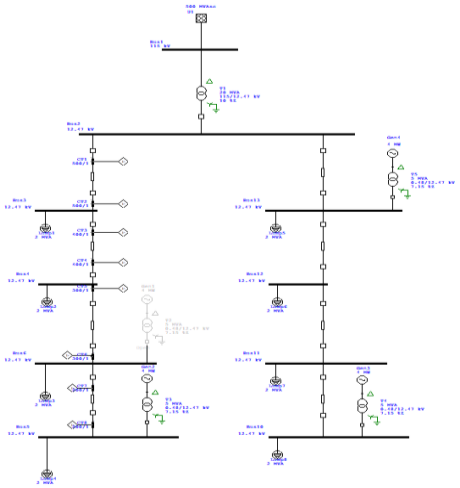


Figure 8

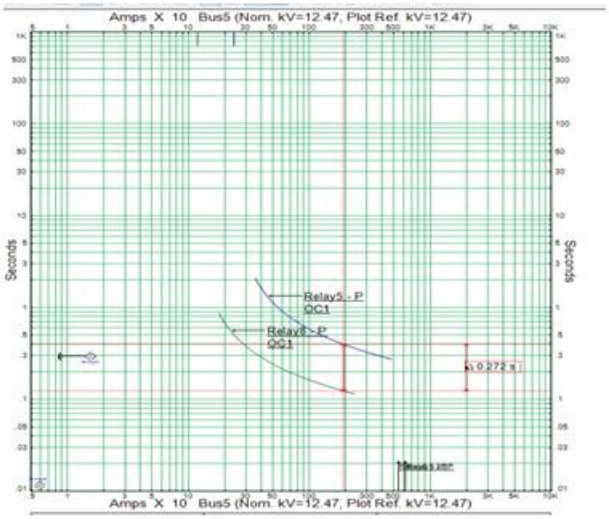


Figure 9

V.CALCULATIONS

RELAY SETTING

- Pick up/Plug setting:
  - $PS = \frac{Over\ Load\ Current}{CT\ Primary\ Current}$
  - Overload Current = $Full\ load\ current * 1.2$
- $Top = \frac{0.14\ (TMS)}{(PSM)^{0.02}-1}$

TMS - Time multiplier setting
PSM - Plug setting multiplier.

» Where $PSM = \frac{I_{relay}}{PS}$; PS = Plug Setting

VI.CONCLUSION

Hence relay setting will change for each and every configuration on system as fault current and normal current varies under different Configuration. Hence relay setting will vary on different configuration and sensing the CB status, operating modes are detected and appropriate settings are updated by communication system. By giving proper settings to each mode for the considered system the relay coordination has been achieved.

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