SIMULATION OF PROTECTION FUNCTIONS FOR CONNECTING DISTRIBUTED GENERATION RESOURCES TO DISTRIBUTION NETWORKS CONSIDERING VECTOR GROUP OF INTERFACE TRANSFORMER

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ABSTRACT

One of the biggest changes happening to the distribution system is the increased penetration levels of distributed generation (DG). The growing trend of installing DGs within distribution networks has benefits such as increased reliability of supply, reduced losses, improved voltage profile, and etc; however, integrating large number of DGs into existing distribution networks is a challenging issue. Indeed, DGs, in large numbers, could reverse the direction of the typical radial power flow; which in turn transforms a radial network to a multi-supply grid with bidirectional power flows. Therefore, the existing protection schemes designed based on the radial configuration will no longer be appropriate.in this paper we simulation of protection functions for connecting distributed generation resources to distribution networks considering vector group of interface transformers.

INTRODUCTION

introducing Distributed Generation (DG) into a distribution system designed for radial power flow creates many issues including but not limited to: harmonic concerns, system overvoltages, fault coordination, increased fault currents, insulation coordination, and islanding concerns.[1] The choice of vector group of the interface transformer plays an important role in the protection function of DG-connected distribution networks, enables a reliable and secure detection of the faulted section. Different energy sources may be used but it is the interfacing scheme used by the DG that will have the largest impact on the protection of the distribution system. All connections have advantages and disadvantages that need to be considered by the utility and distributed generation owner. The choice of connection will affect the magnitude of over-voltages following single-phase faults and also on the magnitude of the fault current supplied from the substation. There is no universally accepted "best" connection in the literature. In the full paper, to fill this research gap, a comprehensive set of simulations is carried out by using DIGSILENT software. The simulations consider different vector groups of interface transformers within a DG-connected distribution feeder. The presented analyses consider table 1 as it shows the possible choices with each connection.[1]

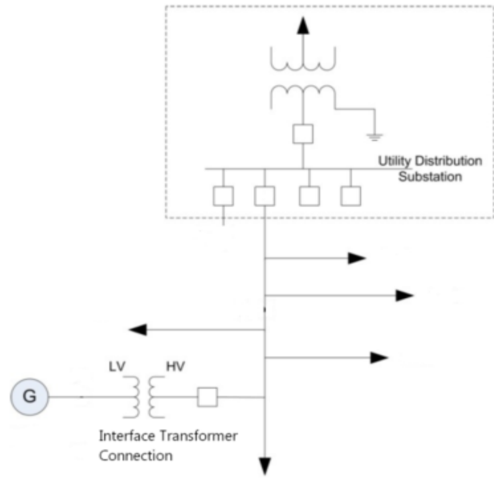

Fig. 1 typical distribution network with an interface transformer[1]

Table 1: the possible choices with each connection

Low Voltage (LV)	High Voltage (HV)	
Delta	Delta	Grid-side isolated
Gnd-Wye	Delta	Grid-side isolated
Delta	Wye	Grid-side isolated
Delta	Gnd-Wye	Grid-side grounded
Gnd-Wye	Gnd-Wye	Grid-side grounded

Eventually, this paper proposes a set of practical protection schemes based on some Simulink-based simulations which is functional from the viewpoint of the utility as well as the DG-owners.

Protection Issues with DG

Most utility systems use a traditional radial feeder system to delivery power to customer loads and implemented protection schemes only considering power flow in only one direction. The addition of DG changes energy flows which now can flow in either direction through system protection devices. The following protection issues must be considered when DG is being considered to be integrated with the utility: Short Circuit Power; Islanding; Reduced Reach of Impedance Relays; Reverse Power Flow; Voltage Profile;

Auto Re-closure; Ferro-resonance; Grounding; and Safety.[2]
In this paper,events that occurred in the network ,we grouped the flowing
1)three phase and single phase fault
2)switching
And then offer protection function for each of them

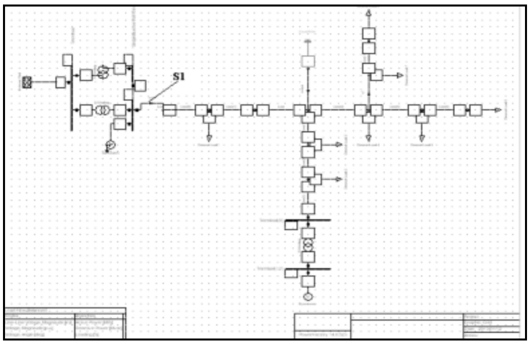

Fig2:distribution network in digsilent enviorment

A)three phase and single phase fault

Protection against three phase fault in distribution network one of the requirements .in this paper is not discussed in this section and the next section line to ground fault is discussed .

B) line-to-ground faults

One of the main effects of Distributed Generation Interconnection Transformer is detection of single line-to-ground faults. In general, the DG Interface Transformer Connections can be divided into two categories. Grid-side isolated and Grid-side grounded.

B-1): Grid-side isolated

this connections there is no source of zero sequence current to impact the utility ground relay coordination. In addition, any ground fault on the low voltage side of DG transformer will not be detected at the substation breaker(Grid) location. If substation breaker(Grid) is tripped for a single-line to ground fault, With this connections, phase faults will have two sources of fault currents. Hence,Single phase to ground fault detection by over current protection equipment is not allowed And other protective functions is required. One of the solutions for single phase to ground fault detection using 3VT method and 59N protective function.figure 4 shows simulation output for this method.

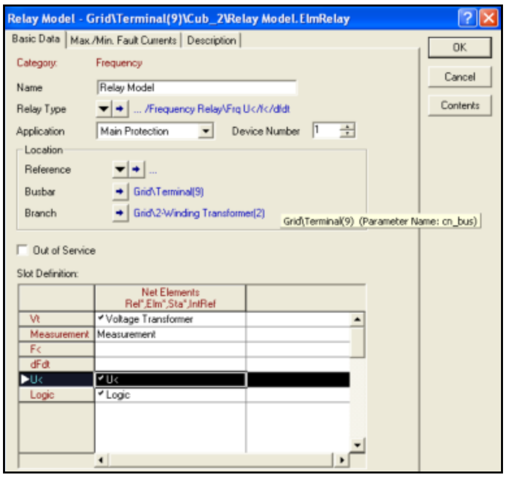

Fig3:under/over voltage relay in DIGSILENT

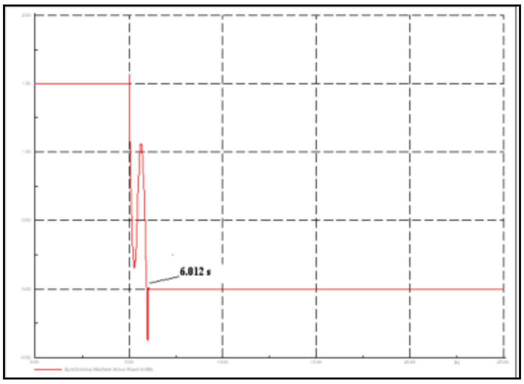

Fig4:simulated out put for 3VT method

B-2)grid side grounded

This connections establishes a zero sequence current source for ground faults on the distribution system, which could have a significant impact on the utility's ground relay coordination[3].hence,in this cases with relay settings changed single fault to ground can be detected and other protective function not required.

C)switching

For this purpose we consider the worst case. with disconnect S1,upstream network is completely disconnected. Furthermore, according to Equation 1 switching heavy loads on the generator frequency is affected ,

$$J\frac{dw}{dt} = P_m - P_e$$

P_m=mechanical input power to generator
Pe =generator out put electrical power
J=rotor inertia
W=angular speed of generator

so frequency protection function(under/over frequency and ROCOF) is required.
for this case we simulate a ROCOF relay. Consider S1 switching in t=2s and ROCOF setting B=.2HZ/s.figure5 shows simulated output for this simulation.

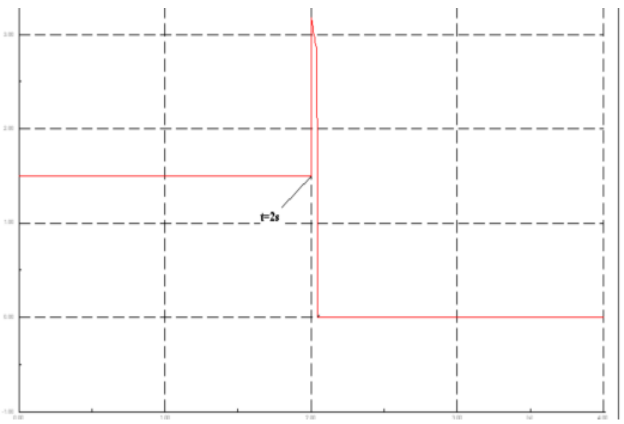

Fig5:simulated out put for ROCOF relay

From this section of paper according to network events ,the basic protection functions considered.figure 6 shows this protection function connection diagram.

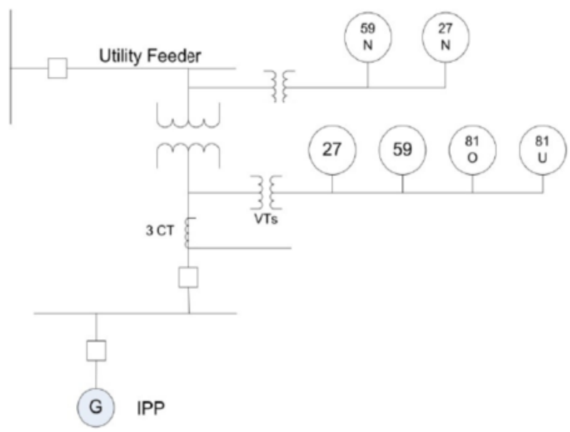

Fig6 :basic protection function connection diagram

Conclusion

in this paper simulation of protection functions for connecting distributed generation resources to distribution networks considering vector group of interface transformers discussed.according to simulation result distributed generation transformer vector group has the greatest effect on L-G fault detection. In the last section the basic protection function and connection diagram presented.

References

[١] U. o. W. Ontario, "Distributed Generation (DG) Protection Overview," 2008

[٢] R. F. Arritt and a. R. C. Dugan, "Distributed Generation Interconnection Transformer and Grounding Selection," *IEEE,* pp. 1-7, 2008.

[٣] ieee 1547 standard for interconnecting distributed resources with electrical power systems.," *IEEE,* 2003

Appendix:

DG information
S=2MVA
cos@=0.8
Xd=1.5 pu
Xq=.75 pu
X0=.1 pu
X2=.2pu