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Comparative Analysis of Over Current Relay and Counter Set Relay for Fault Protection of Distributed Solar Generation

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ABSTRACT*:*

The active network of the future will connect small and medium-sized energy sources to the needs of consumers quickly and securely. To enhance capacity, postpone maintenance in transmission and distribution networks, prevent network expenses, decrease line losses, defer the construction of large-scale generating projects and move costly power from the grid supply system, DG is often used as a backup power source. Dominion Energy's reported fault incidents are examined in this article. In order to demonstrate that the real DER fault response may vary from earlier understandings, the size, angle, and sequence components of faults are investigated. Replaced with counter set current relay, which entirely shuts off when limiting number crosses 3 times, universal reclosure over current is replaced with counter set current. A short-term transient defect will shut the over current relay, but a long-term problem will leave it open. The analysis with respect to different conditions is checked using a DER (PVA) connected to this counter set reclosure over current relay.

Keywords: DER System, over current relay, MATLAB, Simulink, Solar Power Generation Fault.

1. INTRODUCTION

Energy shortages, rolling blackouts, and rises in electricity prices have sparked a quest for alternative sources of energy in the wake of the rising demand for electricity. Small-scale power production sources near where energy is used have been developed as a result of this called Distributed Energy Resources (DERs). DERs are intended to supplement or replace the current electric power grid. [1]

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In addition to reducing emissions of dangerous chemicals, distributed power generation (DG) reduces the huge capacity and long-distance transmission line construction of the conventional grid, which reduces high voltage transmission line loss and electromagnetic pollution.

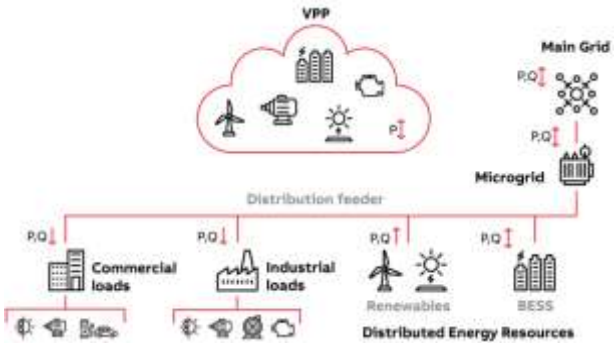

Figure 1: Diagram on Distributed energy resource

There are several issues that arise while implementing distributed generation. It is possible that the installation of a new generation source could cause source fault current to be redistributed on feeder circuits, which might result in a loss of relay coordination and a possible overvoltage. In addition, frequency and voltage levels must be taken into account, since certain DG sources may not be able to sustain the local loads, resulting in complicated applications like load-shedding, etc. [3]

2. OVER-CURRENT RELAY

In an over current relay, the actuating quantity is only current. There is only one current operated element in the relay, no voltage coil etc. are required to construct this protective relay.[4]

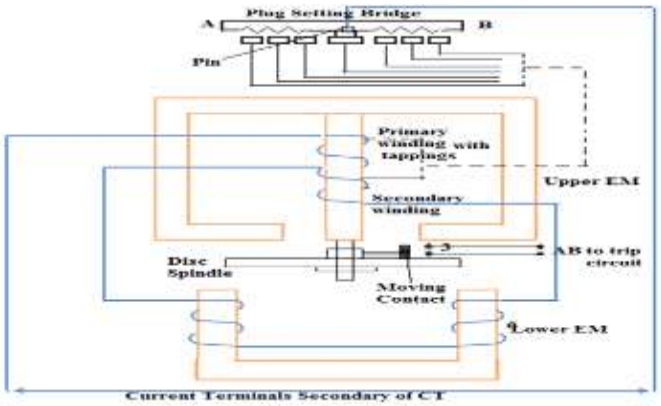

Figure 2: Over current relay

In an over current relay, there would be essentially a current coil. When normal current flows through this coil, the magnetic effect generated by the coil is not sufficient to move the moving element of the relay, as in this condition the restraining force is greater than deflecting force. [5] But the magnetic effect increases, and after a certain level of current, the deflecting force generated by the magnetic effect of the coil, crosses the restraining force. As a result, the moving element starts moving to change the contact position in the relay. Although there are different types of overcurrent relays but basic working principle of overcurrent relay is more or less same for all [6][7]Depending upon time of operation, there are various types of over current relays, such as

Instantaneous over current relay

Definite time over current relay

Inverse time over current relay

3. PROPOSED METHODOLOGY

This shows the modelling of a three-phase transmission line linked photovoltaic system that incorporates a short-circuit current management controller from PVA and the load.[8][9][10] This method is based on the rate of increase and magnitude of current in a DER based on a PV solar system. The study system model consists of a typical feeder used in it.[11] available in MATLAB Library for various methods like Windows, shifting, scaling etc.

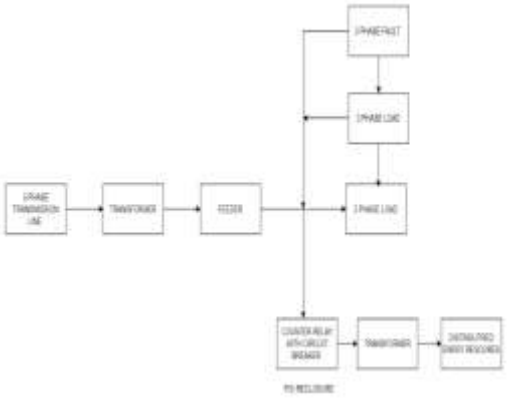

Figure 3: Proposed system of Fault Characteristic of DER System

Automatic or manual, an electrical circuit breaker is a switching mechanism used to regulate and safeguard an electrical power supply. A circuit breaker must be carefully designed to be able to properly stop the arc is formed when a circuit breaker is closed due to the large currents used in contemporary power systems. [12][13]

According different criteria there are different types of circuit breaker. According to their arc quenching media the circuit breaker can be categorized as:[14]

Oil circuit breaker.

Air circuit breaker.

SF_6 circuit breaker.

Vacuum circuit breaker

Table 1: Simulation parameters

Name	Unit and Value
Supply Voltage	132KV
Power	2500KVA
Step-up down Transformer	132KV/34.5KV
Power rating of step-up transformer	47MVA
Frequency	50Hz
Phase to phase voltage	34.5KV
Active Power	100KW
Reactive Power	50KVAR
Circuit Breaker Resistance	0.01 Ohm
Solar irradiation	1000 W/m^2
Temperature	35 Degree
Duty Cycle	0.5
Capacitor	1000 Micro Farad
Resistance	0.005 Ohm
Inductor	5Mh

4. RESULTS AND DISCUSSION

The implementation of the proposed algorithm is done over MATLAB (R2016). The signal processing toolbox helps us to use the functions

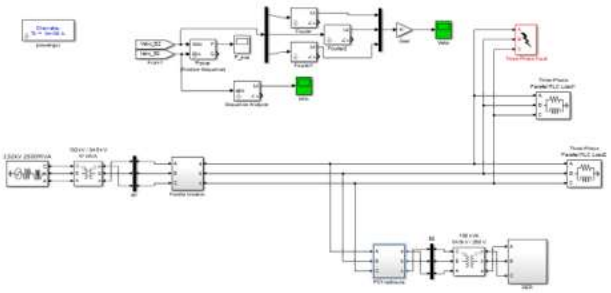

Figure 4: Simulation model without relay

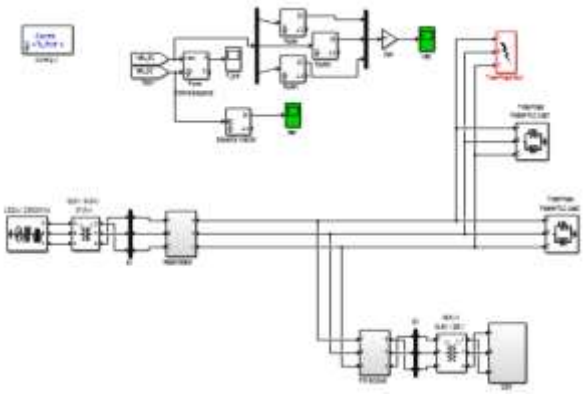

Figure 5: Simulation model with overcurrent relay

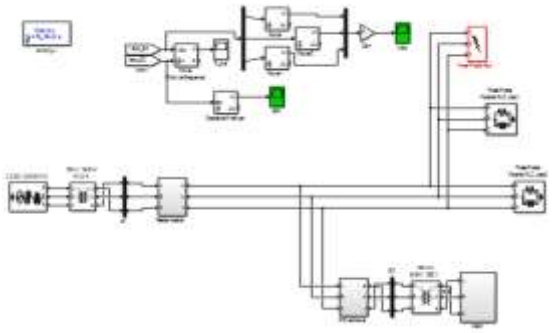

Figure 6: simulation model of counter set reclosure over current relay

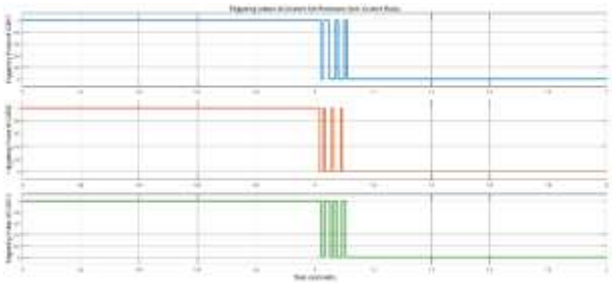

Figure 7: Triggering pulses of Counter Set Reclosure Over Current Relay

The restriking times is limited to 3, after three times the relay completely triggers OFF and eliminate the fault from DER.

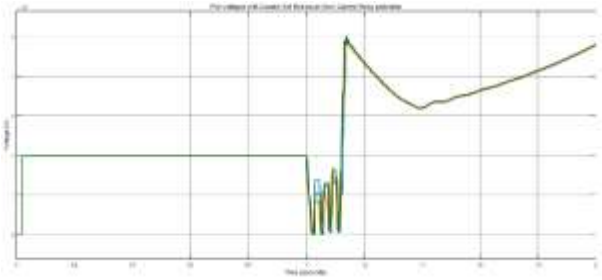

Figure 8: PVA voltages with Counter Set Reclosure Over Current Relay protection with fault from 1 to 1.3sec

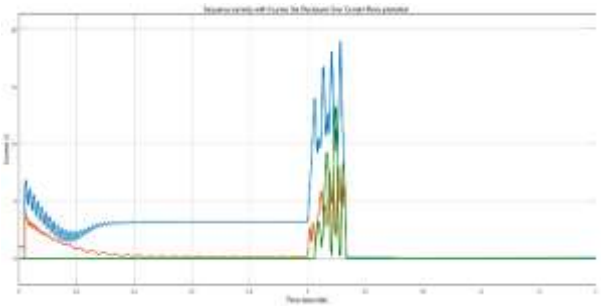

Figure 9: Sequence currents with Counter Set Reclosure Over Current Relay protection with fault from 1 to 1.3sec

Considering a permanent fault on the line the traditional over current relay trips ON and OFF continuously until the fault is removed. As it is a permanent fault where the lines are sabotaged by direct contact to each other or to ground. This continues tripping of the breaker by the relay will damage the equipment connected to the system. To avoid this damage to the system the traditional over current relay is replaced with counter set re-closure over current relay which permanently trips OFF the circuit breaker after specific number of re-closures. When the fault is removed manually, the breaker is tripped back ON.

This protects the system from temporary faults and also permanent faults. The counter set re-closure over current relay trips back ON for temporary faults and permanently trips OFF for permanent fault.

5. CONCLUSION

Compared to the over current and no relay models, the reclosure over current relay has a lower concentration of fault current at the fault point. As long as the defect is still present in the line and the modules are destroyed, the no-relay paradigm is a total failure. During the malfunction, the overcurrent relay repeatedly activates and deactivates, causing damage to the test system's modules. To ensure that the proposed system and its components are safe from damage, the reclosure over current relay is used in conjunction with a restraining mechanism.

Distribution utilities will play a much larger role going forward if DG captures a significant portion of the power market. DG will need changes in the architecture of distribution systems. A more decentralized electrical system may be prepared by conducting more research to discover the technological capabilities, the operational strategies, and the skill needs of distribution network operators.

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