# Co-ordination of relay for Microgrid using Directional overcurrent relay

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**Abstract:** During the transition between Grid mode of operation to Islanded mode of operation and Loss of generators in the Microgrid, the fault current levels will change not only the fault current level Change will happen, relay pairs also change. It will results in delay operation of the relay or relay operation failure. So we need an optimal and single protection scheme for protection of Micro grid system against over currents. Micro grid protection is one of the most important challenges due to the above said reasons. So single protection scheme must enhance the system reliability and stability of the system with various level of phase faults fault current like LLL, LL and LLG with various modes of operation in micro grid system. Protection is provided by REF 541 (Feeder management Relay).

**Keywords:** Micro grid, Grid connected mode, Phase faults, Islanded mode, Relay Co-ordination.

## 1. Introduction

Power requirement is increased due to increase in load demand and also problem in reduction of fossil fuels. Transmission and distribution systems deal with many problems such as security, loss and reliability. So, there is a need of renewable energy source for power generation such as solar, wind, biogas, etc., Micro grid gives remedial solution for controlling above said renewable energy source. When any external disturbance or fault occurs in the main grid, this connected system is isolated from main grid and micro-grid supplies required power to load demand. Micro-grid is distinguished from distributed generation in a way that implementation of control is done by micro-grid.

An essential step in the design of any power distribution system is the time-current coordination of all overcurrent protective devices mandatory for the protection of the system and the linked equipment. When there is an abnormal flow of power in the system for a particular time period, the protective devices should isolate the affected system with minimum disturbance in the remaining system. This is the objective of a well-coordinated electrical power system.

In Micro-grid system, during transition from the grid connected mode to isolated mode of operation or loss of distributed generators, the changes in the short circuit current level may cause the existing protection scheme fail to operate or delay the relay operation. This paper recommends an optimal and single protection scheme for Micro grid control system for phase faults i.e.., three phase symmetrical and un-symmetrical faults. When there is no proper relay coordination, unwanted tripping occurs in the healthy system. So, relay coordination plays major role in the protection of the system. Load flow and short circuit analysis is done as pre-analysis for relay coordination.

While introducing Diesel Generator (DG) in the multi-source or Ring Main system, if any faults or external disturbances occur it leads to change in magnitude and direction of current. The main disadvantage in the existing system is that the usage of Diesel Generator in the system, leads to improper co-ordination functions. To overcome this disadvantage, Directional Overcurrent Relay is used. It operates when the fault current occurs in the system. And the unwanted tripping of the healthy system will not occurs; only the system with fault will be tripped and makes the system more reliable.

## 2. Mathematical Model

The study of comparison and selection of operating times for the protective devices, which achieve the objectives of the protection system under abnormal conditions are known as Overcurrent Coordination. To minimize the equipment damage and to interrupt the short circuits, Overcurrent Coordination is used. They determine the characteristics, ratings, and settings of overcurrent protective devices as soon as possible. Due to this, they are applied to the fault or overload condition when the minimum portions of the power system were interrupted.

Operating Time of Relay,

$$T_{op} = \frac{0.14\ (TMS)}{(PSM)^{\alpha}-1} \qquad (1)$$

$$PSM = \frac{I_{relay}}{PS} \qquad (2)$$

$$PS = \frac{Over\ load\ current\ (I)}{C.T\ Primnary} \quad (3)$$

Where,

$\alpha = 0.02$,
TMS = Time Multiplier Setting,
PMS = Plug Multiplier Setting,
PS = Plug Setting,
I = Fault Current.

The Upper and Lower limit of the PS of a relay are represented as,

$$PSi, min \leq PSi, \leq PSi, max \quad (4)$$

The limits set for each relay of PS are Maximum = 2.5 and Minimum = 0.5 respectively.

A. OPERATING TIME OF PRIMARY AND BACKUP RELAY CONSTRAINT:

When the fault occurs in the system, within the operating time of relay (Top) the primary relay isolate the affected system from the healthy system. If the primary relay fails to operate, the backup relay act as primary relay within the particular time period to isolate the fault portion from the system.

$$Tbackup - Tprimary \geq CTI \quad (5)$$

A. TMS CONSTRAINTS

When the fault occurs in the system, the TMS controls the operating time of the relay within the particular time limitation. The limits of TMS for each relay are specified as Max = 1 and Min = 0.05 respectively.

$$TMSj, min \leq TMSj \leq TMSj, max \quad (6)$$

B. PS CONSTRAINTS

The minimum and maximum value of PS for each relay is 0.5 and 2.5 respectively. The upper and lower limits must be within the specified limits.

$$PSi,min \leq PSi \leq Psi,max \quad (7)$$

The step by step procedure for the proposed flow chart is explained as follows:

Step 1: The value of Plug setting and Time multiplier setting along with CTR are given as input to the system.

Step 2: The upper and lower limits of the Plug setting and Time multiplier setting are initialized randomly. As mentioned in section II, the plug setting value is randomly chosen between 0.5 and 2.5.

Step 3: Analysation for short circuit is done by creating Faults (3 phase, LL, LLG) in the system.

Step 4: Identification of corresponding primary and backup relay for each fault location.

Step 5: Optimization of relay setting for Plug setting and Time multiplier setting for each relay are calculated.

Step 6: Check whether the obtained relay setting gives the optimal solution to trip the faulted portion. Otherwise till optimum solution .is obtained repeat step 5.

Step 7: Finally, optimized relay setting is obtained.

In this proposed system, by considering all phase faults in both grid and islanded mode of operation an optimal protection scheme is obtained.

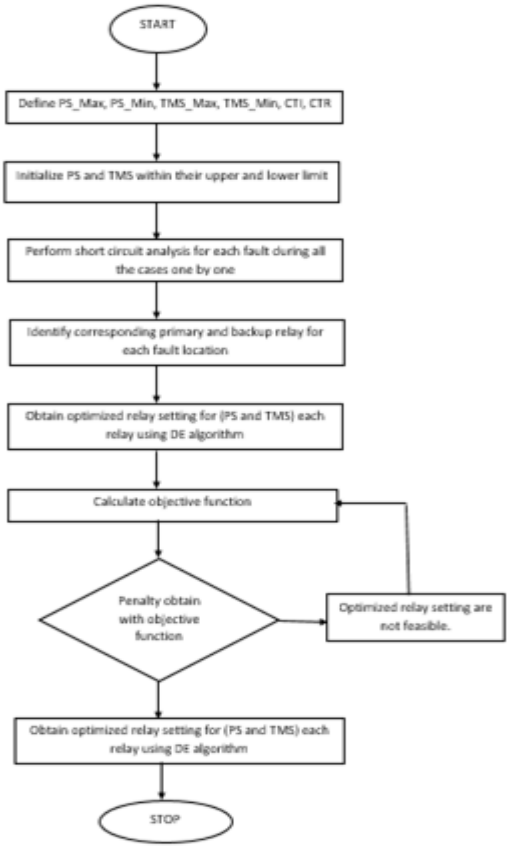


FIGURE 1: FLOW CHART FOR OPTIMIZED SETTING

**Iii. Results and Discussion**

In this paper proposes an optimal protection scheme for Micro grid by considering all phase faults along with its grid-connected and island mode of operation. In both operating mode we get desired zone of with the implementation of direction overcurrent relay in both mode of operation with the coordination interval of 0.2s with the application of numerical relay

Directional over current relay

The system fault occurs between Bus75 and Fd39.The relay numberd 30(R30) senses the fault current and gives the tripsignal to Switch Switch gear numbered 4(SG4)and the relay numberd 32(R32) senses senses the fault current and gives the tripsignal to Switch gear numbered 5(SG5) which isolates the faulted portion.

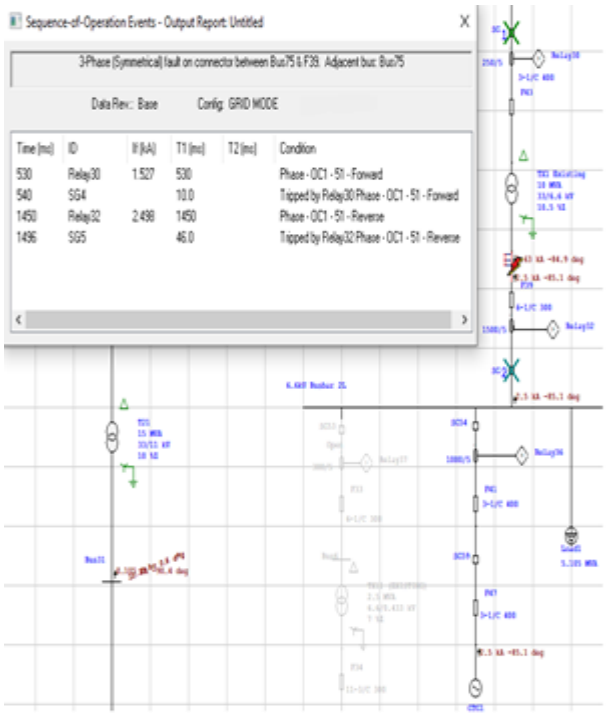


Figure 2: Simulation represents the symmetric fault occurs on conductor between Bus75 and Fd39.

Relay co-ordination for optimal protection

In this proposed system, optimal relay co-ordination is done for both grid-connected and islanded mode of operation. In both mode, symmetric and asymmetric fault are created and the operating condition of the relay is monitored.

Case Study 1: Grid-connected operating mode

Case Study 2: Islanded operating mode

Grid connected mode of operation

In the Figure 2, we shown the Relay Coordination of primary protection of LVCB and back up relay 23 which having the Coordination interval of numerical is chosen low as 0.2s, because it doesn't have over run time.

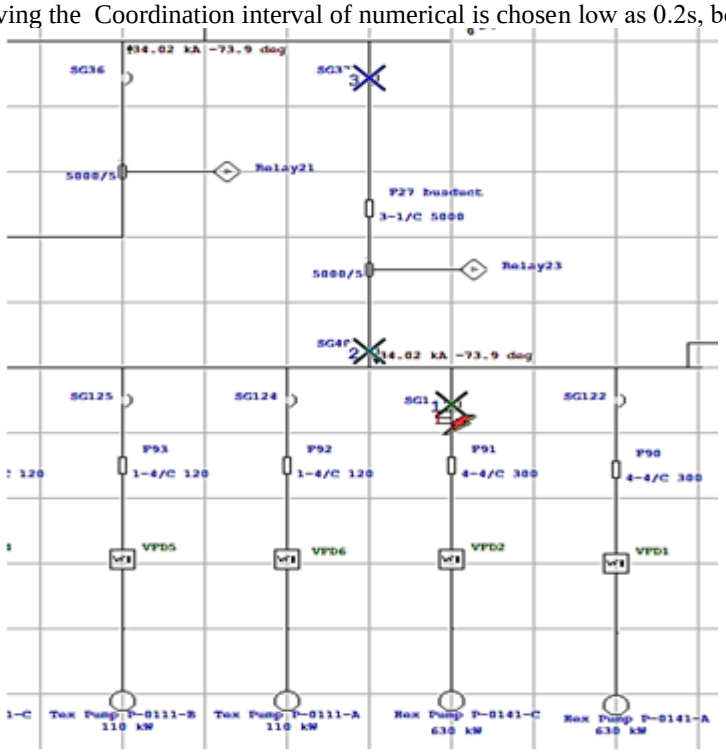


Figure 3: Simulation for Grid connected mode of operation when symmetric fault occurs.

The symmetric fault occurs between SG123 and F91.The relay numberd 21(R21) senses the fault current and gives the tripsignal to Switch gear numbered 40(SG40) which isolates the faulted portion.

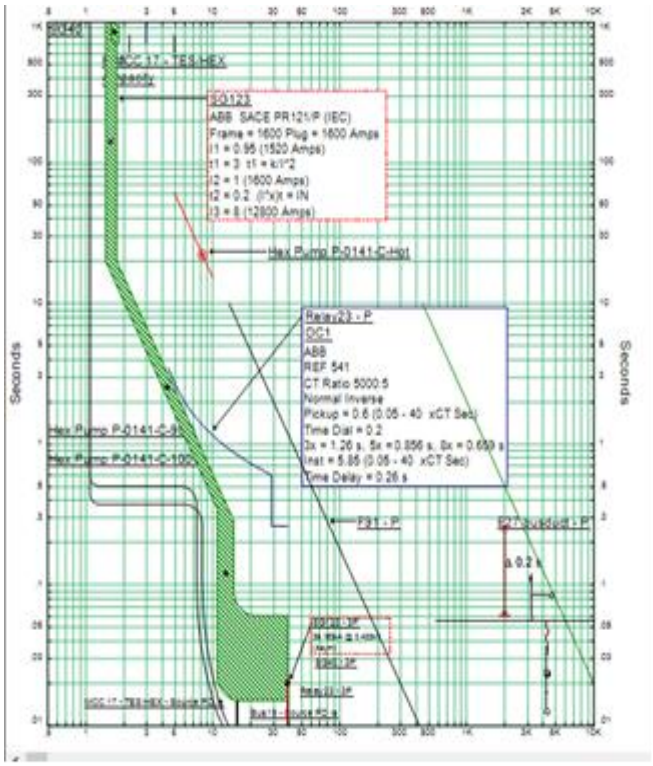


Figure 4: Sequence of operation and TCC star view Islanded mode of operation

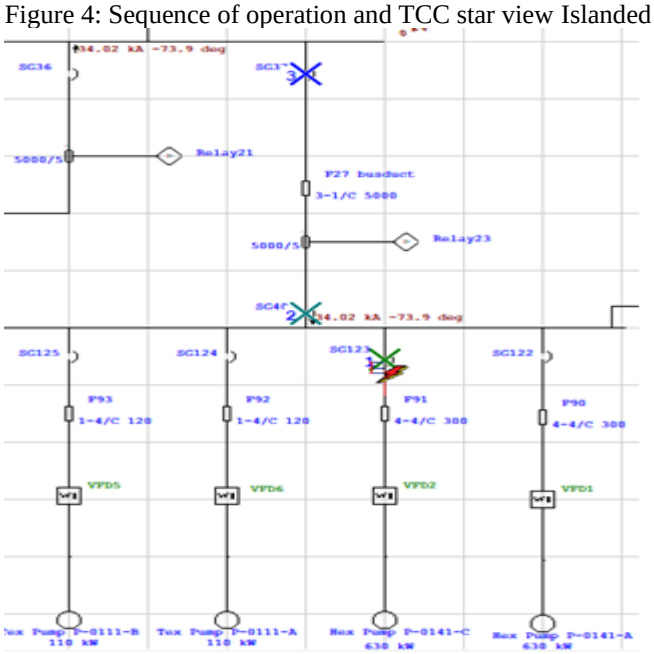


Figure 5: Simulation for islanded mode of operation when symmetric fault occurs.

The symmetric fault occurs between SG123 and F91.The relay numberd 21(R21) senses the fault current and gives the tripsignal to Switch gear numbered 40(SG40) which isolates the faulted portion.

Sequence-of-Operation Events - Output Report: Untitled

3-Phase (Symmetrical) fault on connector between SG123 & F91. Adjacent bus: MCC 17 - TES.HE

Data Rev.: Base Config: ISLANDEDMODE

| Time (ms) | ID | If (kA) | T1 (ms) | T2 (ms) | Condition |
|---|---|---|---|---|---|
| 60.0 | SG123 | 30.537 | 15.0 | 60.0 | Phase |
| 500 | Relay23 | 30.537 | 500 | | Phase - OC1 - 50 |
| 530 | SG40 | | 30.0 | | Tripped by Relay23 Phase - OC1 - 50 |

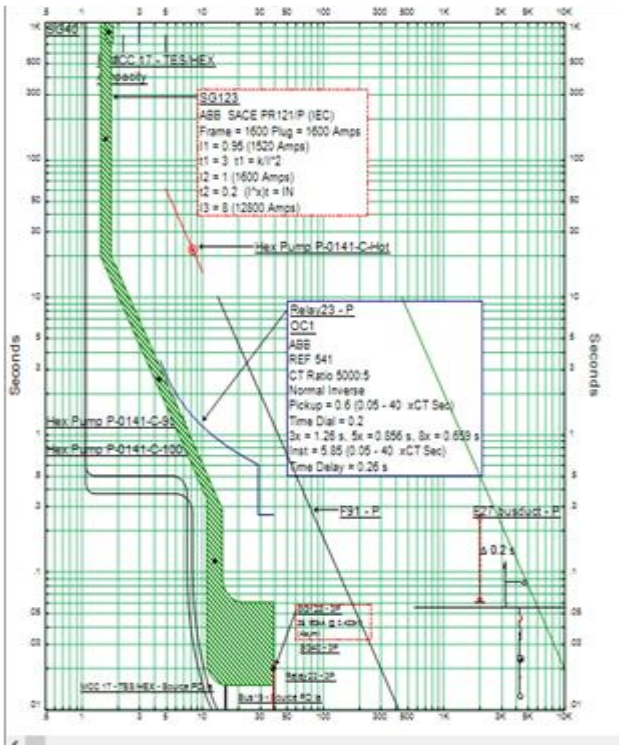


Figure 6: Sequence of operation and tcc star view

**4.Conclusion**

The simulation result of this paper determines the Characteristics curves which play an important role in clearing the fault and protection of relays. The Multi stage protection offered in numerical relays can utilize to minimize unwanted trips in the system by proper coordination. The fault can be determined by the response time of relay. Various characteristic curves are obtained to discover best promising output. With the application of Directional Relay, optimized the relay coordination with desired zone protection.

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