

Smart Protection Scheme For Radial Distribution System



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Abstract- : *In this paper, the study of optimal coordination of directional overcurrent relays along with relay communication in HV substations is proposed. The relay coordination problem is non linear. It typically consist of two groups of control variables (Time Dial Settings: TDS and Plug Settings: PS). The purpose of relay coordination is to propose the suitable settings for all releases and ensure the coordination. The differential evolution is employed to solve for solutions of optimal relay coordination. The relay coordination is mainly done to improve selectivity of the relay to particular fault. ETAP is so popular for its capability for modelling of power system networks and analyzing various studies and Real Time simulations.*

Keywords: *coordination, Overcurrent relays, differential evolution, EtAP 16.1, DigsI 4.93*

I. INTRODUCTION

In this project, considering a chiller power plant with capacity of 41000RT and the generator with the rating of 11.4 MW was added in the distribution side. So that the power taken from the grid will be reduced. We can also reduce the cost by adding new generator. Here the relay coordination is done for the newly modified power plant. The characteristics was verified using ETAP software and the communication between the relays was done with digsi software. The relay coordination studies have been carried out using the latest ETAP version 16.1. The communication between the relays was done by using RS232 cables and the communication studies have been carried out using DigsI 4.93 software. Significant advantages of the proposed technique over the usual setting method are shown by comparing the corresponding results.

II. OBJECTIVE

Relays are switches that open and close circuits electromechanically or electronically. Here the relays are coordinated in such a way that,

if a fault occurs in one location the relay nearer to the fault location will act and gives signal to next relay about the operation via cable and the characteristics will generate in the software. Here the relays are given with time duration, the relay will wait for that particular time and act accordingly and if it fails to operate the next relay corresponding to this will operate and gives trip signal to the circuit breakers and clear the fault. A strategy dependent on the interim investigation has been proposed to understand the OC transfers' ideal coordination where conceivable framework topologies have been considered. In any case, presenting any legitimate imperative to the issue because of framework topology changes may expand the base doable breaking point for time dial setting. (TDS) of the related reinforcement hand-off. This may prompt a higher TDS for the reinforcement hand-off, which builds the time delay for each blame at any topology. As the loads are spread across the plant the distribution network is divided into various switch gears and MCCs. Relay settings are also provides fault clearing time information.

III. SINGLE LINE DIAGRAM

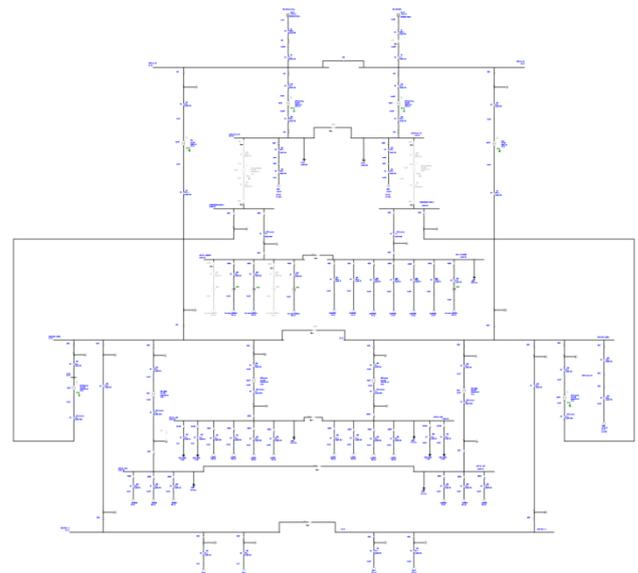


Fig.1. Single Line Diagram

From the single line diagram, consider the fault occur in the bus 9 induction motor after 0.5 seconds the relay will start operate and gives trip signal to the circuit breaker (SG96) and the circuit breaker will clear the fault. If the relay does not operate within 0.5 seconds the relay 6 will operate and will isolate the entire 11kv bus and thus will helps in clearing the fault.

Revised Manuscript Received on August 30, 2019.

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IV. RELAY CO ORDINATION

A method based on the interval analysis has been suggested to solve the OC relays’ optimal coordination where possible grid topologies have been considered. However, introducing any valid constraint to the problem due to grid topology changes may increase the minimum feasible limit for time dial setting (TDS) of the related backup relay. Any backup relay should operate with a satisfactory time delay compared to its related main relay. This is the basis for applying constraint (2) in the previous subsection. For a remote backup, this is usually to maintain the selectivity of the protection system, while for a local backup, this is due to the higher precision and reliability of the main relay.

V. ABBREVIATIONS AND ACRONYMS

- AGB - Auxiliary Gas Boiler
- AFB - Arc Flash Boundary
- BEC - Brine Electrical Centrifugal Chiller
- B/C - Bus Coupler
- CB - Circuit Breaker
- CT - Current Transformer
- CT - Cooling Tower
- CWC - Chilled Water Storage
- DFC - Direct Fired Chiller
- DT - Definite Time
- ECC - Electrical Centrifugal Chiller
- IEEE - Institute of Electrical and Electronics Engineers
- kA - Kilo Ampere
- kV - Kilo Volt
- kW - Kilo Watt
- LV - Low Voltage
- LTI - Long Time Inverse
- MDC - Malaysian Distribution Code
- MVA - Mega Volt Ampere
- MW - Mega Watt
- NI - Normal Inverse
- NR - Numerical Relay
- O/G - Outgoing
- PPE - Personal Protective Equipment

VI. SYSTEM SPECIFICATIONS

A. Specification for power system

- PJH/SUNCON/GDCP1/M&E/MCC / INT / SCH / 0001: Schematic Diagram For Main Single Line Diagram - 2ND PHASE
- PJH / SUNCON / GDCP1 / M&E / MCC / INT / SCH / 0002: Schematic Diagram For MCC 17 & MCC 18
- PJH / SUNCON / GDCP1 / M&E / MCC / INT / SCH / 0003: Schematic Diagram For MCC 11 & MCC 12
- PJH / SUNCON / GDCP1 / M&E / MCC / INT / SCH / 0004: Schematic Diagram For Mcc 15 & MCC 16
- VELLD/SUNWAY/GDC/SIT/2017/001 : Simulation Input Data
- Danfoss Harmonic Analysis Report : Variable Speed Drive data sheets

B. Standards:

- IEEE 399-1997 :Recommended practice for industrial and commercial Power System Analysis
- IEEE 242-2001 :Recommended Practice for protection NFPA 70E :2012 Edition

C. Assumptions

- The maximum grid short circuit current is considered as 20.152 kA.
- GTG impedances are considered as per IEC 60034
- Bus duct impedance are neglected.

D. System data

The details of network data provided by Sunway Construction Sdn. Bhd, which has been considered for the studies.

a) Utility Data

Two 33kV sources are received from TNB PMU’s Abu Bakar Baginda and NUNI through underground cables to incoming feeders of 33kV MV panels located inside GDC premises.

b) Generator data

The generator parameters provided by Sunway Construction Sdn. Bhd has been considered for the studies.

c) Line/cable data

Cable/ line data (Type of cable/line and length) provided by Sunway Construction Sdn. Bhd has been considered for the studies.

d) Transformer data

The transformer data (MVA rating, rated HV/LV voltage ratio, % impedance and tap details) provided by Sunway Construction Sdn. Bhd has been considered for the studies .

e) Motor Data

The motor details provided by Sunway Construction Sdn. Bhd has been considered for the studies

VII. PROTECTION PHILOSOPHY & RESULTS

A LV circuit breakers

For LV Circuit breakers that are provided with

S.No	PMU Name	Voltage (kV)	3 phase Fault current (kA)	Short circuit MVA	X/R	Freq uency (HZ)
1	Abu Bakar Baginda	33	20.152	1152	20	50
2	NUNI	33	20.258	1158	20	50

Microprocessor based electronic releases which has LSIG Functions.

Setting philosophy of these releases are described as below :

L – Long Time



Long Time Release has both pick up setting and Time band. Pickup setting is selected at 120% of the full load current of the equipment's Time band is selected to ensure the optimal coordination with the downstream.

S – Short Time

Short Time Release has both pick up setting and Time. Pickup setting is selected at 200% of the full load current of the equipment's Time band is selected to ensure the 200 ms coordination with the downstream.

I – Instantaneous Protection

Instantaneous release has only pick up setting.

Pickup setting is selected above the inrush current or through fault current to ensure the selectivity.

G – Ground Protection

Ground protection release has both pick up setting and Time. Pickup setting is selected at 20% of the full load current of the equipment's Time band is selected to ensure the 200 ms coordination with the downstream

VIII. PHASE SETTINGS

For LV Circuit breakers that are provided with Thermal Magnetic releases which has T & M functions.

Setting philosophy of these releases are described as below:

Thermal

Thermal Release has only pick up setting. Pickup setting is selected at 120% of the full load current of the equipment's.

Magnetic

Magnetic Release has only pick up setting. Pickup setting is selected above the motor starting current.

B Motors (11kV side)

A Phase over current and earth fault relays

A Phase settings:

- Phase IDMT Pick up ($I_{>}$): 110% of motor rated current.
- Phase IDMT TMS ($T_{>}$): TMS is selected such that, the IDMT characteristics should come above the starting time characteristics and below the hot run characteristics.
- Phase IDMT Curve selection: IEC NI or VI or EI (Depends on motor starting time)
- Phase DT current ($I_{>>}$): 1.2 to 1.65 times of motor starting current
- Phase DT time ($T_{>>}$): Minimal value of TMS is selected

C Earth settings:

- Earth IDMT Pick up ($I_{e>}$): 10% of motor rated current.
- Earth IDMT TMS ($I_{e>>}$): TMS is adjusted such that, for any close in fault the IDMT operating time should be 0.3sec.
- Earth IDMT Curve selection: IEC SI
- Earth DT setting ($I_{e>>>}$): Motor rated current Earth DT setting ($T_{e>>>}$): Minimal value of TMS is selected

IX. FIGURES AND TABLES

TABLE I. SETTINGS OF NEW GENERATOR

S No	SWGR	Feeder name	relay	make	CT ratio
1	11kv SWG1 (NEW)	Incomer from T/X-21	REJ 601	ABB	1250/5
2	11kv SWG1 (NEW)	Transformer-11	REJ 601	ABB	200/5
3	11kv SWG1 (NEW)	Transformer-15	REJ 601	ABB	200/5
4	11kv SWG1 (NEW)	Transformer-17	REJ 601	ABB	200/5
5	11kv SWG1 (NEW)	Outgoing to 11 kv ECC-1 SWG	REJ 601	ABB	200/5

TABLE II. OVER CURRENT RELAY SETTINGS

SNo	SWGR	$I_p >$	TDS	Curve	$I_p >>$	$T >>$
1	11kv SWG1 (NEW)	0.7	0.22	NI	3	0.5
2	11kv SWG1 (NEW)	0.75	1	EI	11	0.05
3	11kv SWG1 (NEW)	0.75	1	EI	11	0.05
4	11kv SWG1 (NEW)	0.75	1	EI	11	0.05
5	11kv SWG1 (NEW)	1	0.65	NI	6	0.25

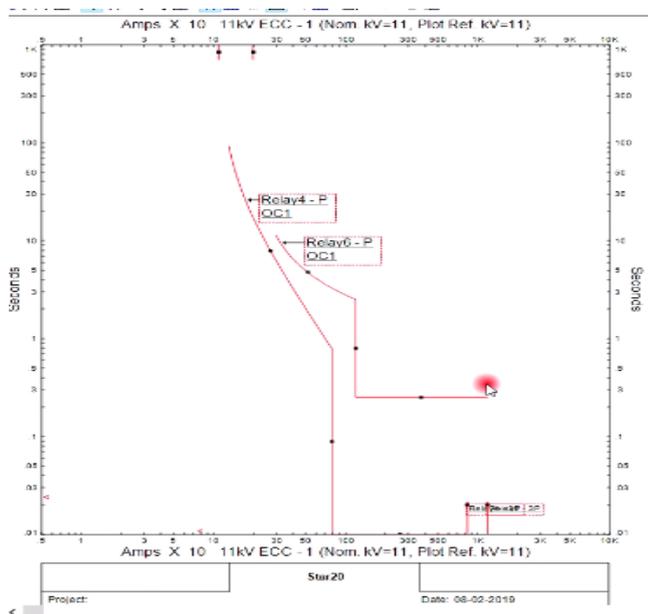


Fig.2. Co ordination of Relay 4 and Relay 6

X. SIMULATION RESULTS

The results are collected and evaluated by calculating the minimum, maximum, average and standard deviation of those results obtained from 50 trails. To access the effectiveness of the proposed method the relay co ordination is shown Fig.2.

XI CONCLUSION

In this project fast selection and reliable relay operation is achieved to isolate the faulty section from healthy section. Due to relay co ordination fault duration is minimized. The power taken from the grid is reduced because of newly added generator. Thus cost is also reduced. Relay communication holds several advantages..Information can travel long distances even if the sender and receivers are far apart. It also speeds up data transmission. Using this method, the problems in the operation of the OC relays due to the change in the topology of the grid are totally solved.

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