COORDINATING OF OVERCURRENT RELAY IN DISTRIBUTION SYSTEM USING LINEAR PROGRAMMING TECHNIQUE

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A project report submitted in partial fulfilment of the
requirements for the award of the degree of
Master of Engineering (Electrical-Power)

Faculty of Electrical Engineering
Universiti Teknologi Malaysia

JUNE 2013

To my beloved parents,

Mahmood Mohammad Zaheri, Mary Heidary

and Sisters,

Dila Mohammad Zaheri, Dorsa Mohammad Zaheri

And all my Friends

All my teachers and lecturers,

For their encouragement,

Support and motivation

Through my journey of education

ACKNOWLEDGEMENT

First of all, I would like to express my deepest sense of gratitude to my project supervisor, P*rof. Dr. Abdullah Asuhaimi bin Mohd Zin*, who offered his continuous advice and encouragement throughout the course of this project report. I thank him for the systematic guidance and great effort he put into training me in the scientific field.

I would like to express my gratitude to Professor Jafar Soltani , Dr. Majid Moazemi, from the department of electrical and computer engineering at Isfahan University of Technology, who encouraged and supported me for continuing my study in electrical power engineering

ABSTRACT

Power system includes many variety of equipment. A lot more amount of circuit breakers and relays are necessary to protect the system. The relays in the power system should be coordinated correctly so as to prevent mal-operation and therefore to avoid the unneeded outage of healthy section of the system. The overcurrent relays are usually the foremost protection product in a distribution system. Overcurrent relay is typically used as backup protection. But in a number of situations it may become the only protection supplied. A relay should get sufficient possibility to protect the area under its main protection. Just if the main protection does not clean the fault, the actual back-up Protection must start tripping, and as a result, overcurrent relay coordination in power distribution system is a important issue of protection engineer. The overcurrent relay coordination in ring fed distribution systems is a very constrained optimization trouble. The purpose is usually to discover an optimum relay setting to minimize the time of interruption of the power source and to stay away from the mal-operation of relay.

This research talks about linear programming technique for optimum coordination of overcurrent relays in a ring fed distribution system.

ABSTRAK

Sistem kuasa merangkumi pelbagai jenis peralatan. Lebih banyak pemutus litar dan geganti diperlukan untuk melindungi sistem ini. Geganti dalam sistem kuasa perlu diselaraskan dengan betul untuk mengelakkan gangguan yang tidak diperlukan dalam satu sistem yang sihat. Geganti arus lebih biasanya merupakan perlindungan utama dalam sistem pengagihan. Geganti arus lebih juga biasanya digunakan sebagai perlindungan sandaran. Tetapi dalam beberapa keadaan ia mungkin menjadi satu-satunya perlindungan yang ada. Geganti perlu memastikan ia dapat melindungi kawasan yang telah ditetapkan. Jika perlindungan utama tidak dapat mengasingkan fault, perlindungan sandaran haruslah berfungsi dan hasilnya penyelarasan geganti arus lebih dalam sistem pengagihan kuasa menjadi isu penting bagi jurutera perlindungan. The penyelarasan geganti arus lebih dalam sistem pengagihan gelang adalah satu isu yang penting.Tujuannya adalah untuk menentukan set optimum geganti untuk meminimumkan masa gangguan electric dan mengelakkan geganti dari tidak berfungsi.Kajian ini membincangkan tentang teknik pengaturcaraan linear untuk penyelarasan optimum geganti arus lebih dalam sistem pengagihan gelang.

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PROJECT REVIEW

1.1. Background of Study

The majority of obvious impact of a shunt fault is an unexpected increase current. Thus it is organic that the value of current be made use of as beneficial indication of existence of a fault. Consequently the over-current protection is the actual most widely applied form of protection. Overcurrent (OC) relay is generally employed as backup protection. But in some conditions it could be the mainly protection provided. A relay needs to get satisfactory chance to protect the sector under its prime protection. Just if the main protection does not crystal clear the failing, the back-up protection must trigger tripping(Bedekar, Bhide et al. 2009). A common power system could include a huge selection of equipment and also more protection relays to protect the equipment. Every relay inside the system requires being coordinated together with the relay protecting the adjacent equipment. If back-up protections tend to be not well coordinated, mal-operation can happen and, as a result, OC relay coordination is a main worry of power system protection. The total protection coordination is thus very complicated.

Lines are secured through overcurrent, distance, or pilot-relaying tools, based on the specifications. Overcurrent sending is the easiest and least expensive, the most hard to utilize, and the quickest to need readjustment or even substitute as a system variations. It is usually used for phase- and ground-fault protection on station-service and distribution circuits in electric power and in industrial techniques, and on some sub transmission lines where the cost of distance communicating cannot be validated. It is used for primary ground-fault protection upon most transmission lines wherever length relays are used for stage faults, and for ground back-up protection on most lines having pilot sending for major protection.

Nevertheless, length sending for ground-fault primary and back-up protection of transmission lines is slowly exchanging overcurrent relaying. Overcurrent relaying is used widely additionally at power-transformer areas for external-fault back-up protection, but here, also, there is a tendency towards exchanging overcurrent by using distance relays.

It is typically the exercise to use a set of two or three overcurrent relays for protection towards interphase faults and a individual overcurrent relay for single-phase-to-ground faults. Individual ground relays are usually preferred due to the fact they can be modified to offer faster and more sensitive protection for single-phase-to-ground faults than the phase relays can provide. On the other hand, the phase relays alone are occasionally depended on for protection towards all types of faults. Additionally, the phase relays must often be made to be inoperative on the zero-phase-sequence element of ground-fault current. These contents will be handled in more detail afterwards.

Overcurrent relaying is well matched to distribution-system protection for various reasons. Not only is overcurrent relaying essentially simple and low-cost but also these benefits are realized in the biggest degree in many distribution circuits. Very frequently, the relays do not need to be directional, and after that no a-c voltage source is needed. Additionally, two phase relays and one ground relay are allowable. And ultimately, slipping reactor or capacitor slipping (described somewhere else) may be used.

In electric-utility distribution-circuit protection, the best benefit can be taken of the inverse-time feature for the reason that the fault-current magnitude relies generally on the fault area and is virtually not affected by changes in creation or in the high-voltage transmission system. Not only may relays with incredibly inverse figure be used for this cause but also such relays supply the best selectivity with fuses and reclosers. Nevertheless, if ground-fault-current magnitude is severely limited by neutral-grounding impedance, as is often true in industrial circuits, there is little or no benefit to be acquired from the inverse feature of a ground relay. Inverse-time relaying is supplemented by instantaneous relaying anywhere possible. Speed in removing faults reduces damage and therefore makes automatic reclosing most likely to be successful.

Throughout a system where there is a supply at some more than one of the line terminals, fault and load current may flow in both way. Relays protecting the lines are, thus, subject matter to fault currents flowing in both the directions. If non-directional OC relays have been used in this sort of system, they might need to be coordinated with, not only the relays at the remote end of the line, but also with relays behind them(Badri Ram 2008). Since directional relays run exclusively when the failing current flows in the particular tripping direction, they avoid coordination with the relays right behind them. The directional OC relay coordination trouble in distribution procedure can easily be determined as linear programming problem with limitations and may be fixed using one of the linear programming techniques, namely, simplex, dual simplex, or two phase simplex technique.

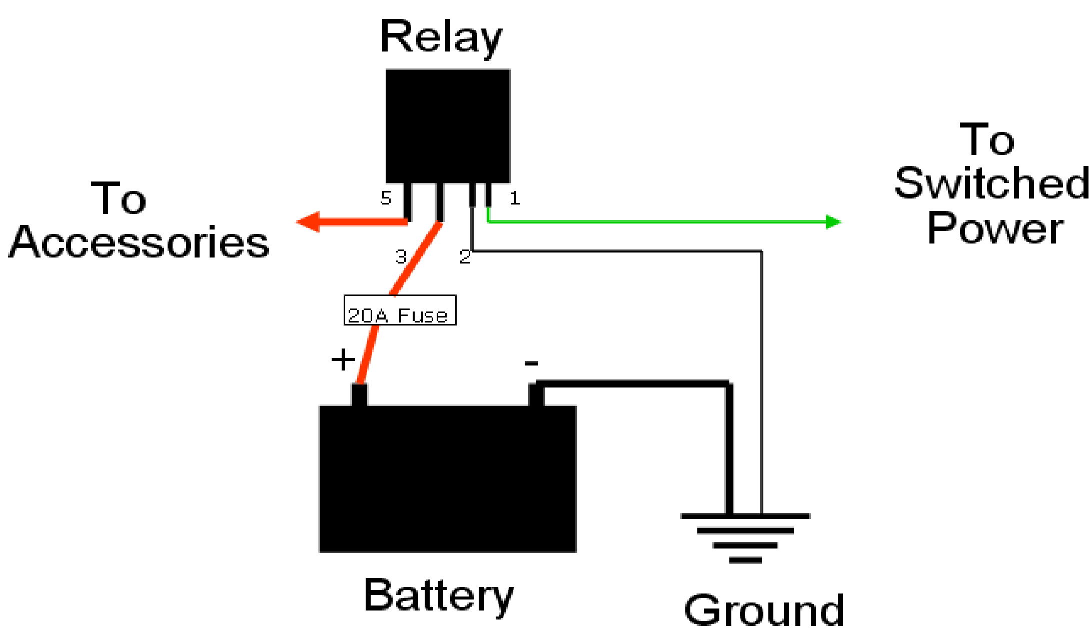

Figure 1.1 relay connections

1.2. Problem Statement

Directional OC relays include a couple of kinds of settings: time dial setting (TDS) and pickup current setting (Ipu). Directional OC relays permit for ongoing time dial setting and also discrete pickup current setting. When pickup currents are taken to become set, the problem turns into a linear programming problem and is resolved to determine the ideal TDS of the relays(M.J. Damborg 1984). The coordination of directional OC relays in any power system can be explained as comes after:

$$\min \Sigma \, WiTik \quad \ldots(1)$$

Where Tik shows the operation time of relay Ri for a fault in area k, and Wi is a coefficient and also is usually fixed to 1. Hence the coordination problem of directional OC relays in interconnected power systems may be stated as an optimization problem, where the total of the operating times of the relays of the system is reduced, under the subsequent limitations:

Coordination criteria

$$Tnk - Tik \geq •T \quad \ldots(2)$$

where Tnk is the operation time of the first backup of relay Ri for a given fault in zone k. •T is coordination time interval which is necessary for maintaining the selectivity of relays. It is taken to be 0.2 second.

Bounds on the settings

$$TDSimin \leq TDSi \leq TDSimax \quad \ldots(3)$$

$$Timin \leq Ti \leq Timax \quad \ldots(4)$$

where TDSi is the time dial setting of relay Ri and Ti is theoperating time of relay Ri .

Relay characteristics

All relays are assumed to be identical and are assumed to have normal IDMT characteristic as (Urdaneta A.J. 1996):

$$Ti = (\lambda \, . \, TDSi) \, / \, [(I/Is) \, \gamma \, - 1] \quad \ldots (5)$$

Where I is input current, and Is is setting current. For normal IDMT relay γ is 0.02 and λ is 0.14. As the pickup currents of the relays are pre-determined from the system requirements, equation (5) becomes

$$Ti = (\alpha i.\ TDSi) \ldots (6)$$

Where α is λ / [(I/Is)γ - 1].

Making substitution from equation (6) in equation (1), the objective function becomes

min Σ (αi . TDSi) …(7)

In this equation αI's are known. Values of TDSi can be determined by simplex method, which is one of the linear programming methods.

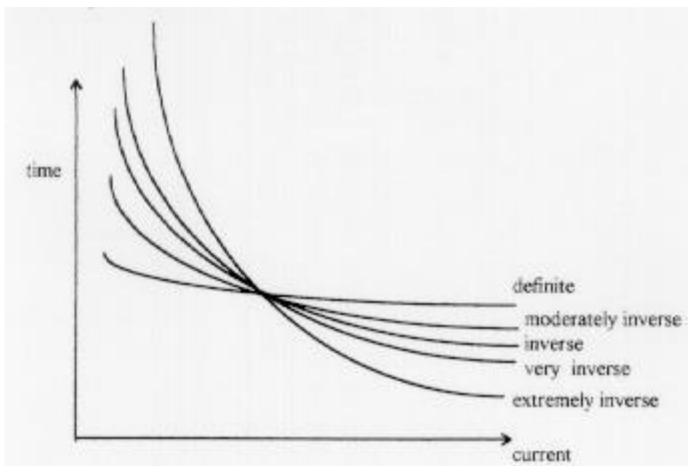

Figure 1.2 Different Relay characteristics

1.3 Purpose of Study

The actual OC relay time coordination in ring fed distribution systems is actually a highly restricted optimization problem which could be stated as a linear programming problem (LPP).The purpose is to discover and the best relay setting to reduce the time of operation of relays and at the same time, to maintain the relays effectively coordinated to prevent the mal-operation of relays.

1.4 Research Objective

We can find the following objective:

- To recognize how to minimize the operating time of relay for fault at any point.
- To use the linear programming technique for coordinating OC relays
- To compare the improved programming result with last result

1.5 Significance of Study

The issue of coordinating protecting relays is composed of choosing their appropriate configurations such that their basic protective perform is fulfilled under the requirements of sensitivity, selectivity, reliability, and speed. If backup protections are generally not well coordinated, mal-operation may happen and, as a result, OC relay coordination is actually a main concern of power system protection. Every protection relay in the power system requires being coordinated together with the relays protecting the adjacent equipment. The total protection coordination is therefore very complicated.

1.6 Scope of The Study

The linear technical optimization method has been employed for optimum coordination of OC relays. Initially a simple radial system is taken. The detailed procedure for formulation of relay coordination problem is explained for this system and the detailed solution for this problem is presented. Then a parallel experimental feeder system with five relays is taken and the optimum value of time multiplier setting (TMS) of each relay is obtained using linear protection problem (LPP) method.

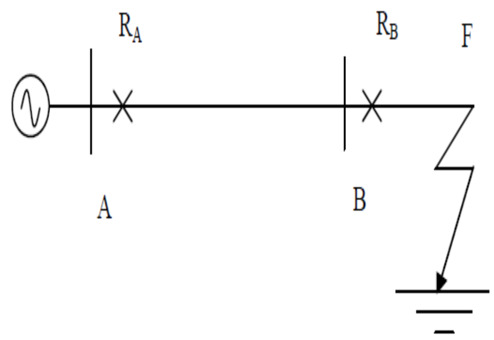

Figure 1.3 simple two buses system

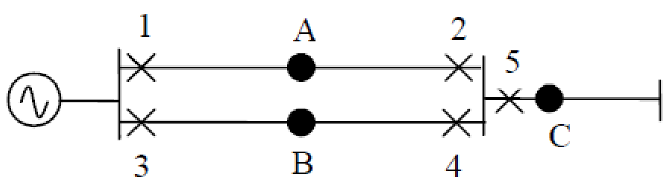

Figure 1.4 power system with parallel lines

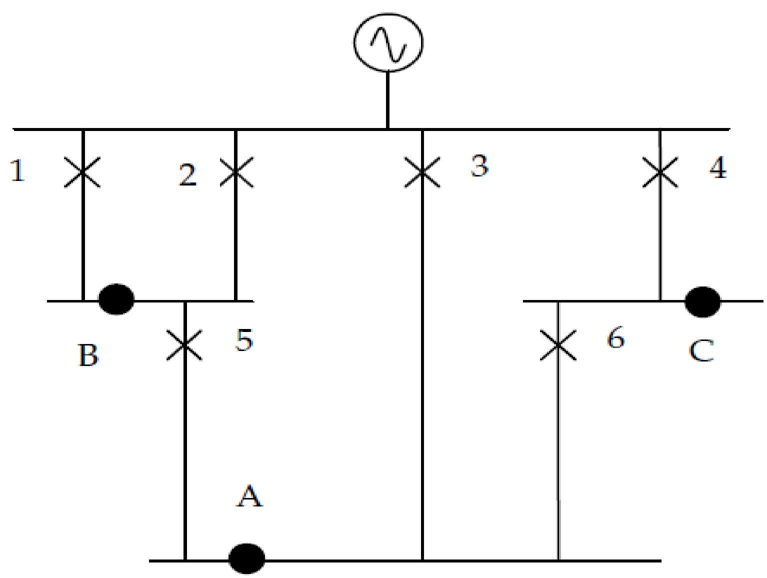

Figure 1.5 experimental four buses system

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