

母线差动保护的计算机整定计算

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【摘要】 本文简要地介绍了母线差动保护计算机整定计算的数学模型,运行方式的考虑,保护整定原则,以及基于上述方法编制的母线差动保护整定计算程序,该程序已在实际电网中应用,满足工程计算要求:

【关键词】 母线差动保护 计算机整定

引言

目前,我国发电厂、变电所的 35~500kV 母线上都装有采用差动原理构成的母线保护,主要有完全电流差动保护,不完全电流差动保护,电流相位比较式差动保护等。它们的整定计算大部分由计算人员手算完成,不但计算量大,而且重复工作多,易出错。随着微机在电力系统中应用的日益普及,采用计算机对各种保护进行整定是大势所趋。本程序是根据大连电业局、吉林热电厂等单位提出的要求及整定计算原则,结合实际电网情况,编制的母线差动保护整定计算实用程序。程序采用电网节点阻抗矩阵为数学模型,运行方式的变化及网络结构的变更采用支路追加法修正原阻抗矩阵中的部分元素,充分考虑了各种运行方式对母线差动保护整定的影响。在此基础上,程序可自动完成双母线固定连接式差动保护、双母线母联相位比较式差动保护、完全电流差动保护及不完全电流差动保护的整定计算,并已在东北等地区实际系统中应用,满足了工程计算的要求。

1 计算方法

1.1 数学模型

利用直接法形成电网节点导纳矩阵:

$$Y = \begin{bmatrix} y_{11} & \cdots & y_{1n} \\ \vdots & \ddots & \vdots \\ y_{n1} & \cdots & y_{nn} \end{bmatrix}$$

式中 $y_{ii} = \sum_{j=1}^n y_{ij}$ (i, j 直接相连)

$y_{ij} = -y_{ji}$ (i, j 之间支路阻抗倒数)

对节点导纳矩阵进行三角分解形成因子表,利用因子表法求解全网节点阻抗矩阵。

程序首先形成电网最大运行方式下的节点阻抗矩阵和最小运行方式下的节点阻抗矩阵,采用最大运行方式下的节点阻抗矩阵计算保护的動作值,采用最小运行方式下的节点阻抗矩阵进行灵敏度校验,程序中只存贮最大、最小运行方式下节点阻抗矩阵的下三角元素。

$$Z = \begin{bmatrix} Z_{11} & & \\ \vdots & \ddots & \\ Z_{n1} & \cdots & Z_{nn} \end{bmatrix}$$

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1.2 电网结构变更时节点阻抗矩阵的修正。

随着系统运行方式的变化,电网结构的变更,电网的节点阻抗矩阵也随之变化。母线差动保护的整定计算,必须在保护最大运行方式下计算定值,在保护最小运行方式下校验灵敏度。本程序利用已有的最大运行方式下的节点阻抗矩阵计算保护定值,对于最小运行方式下的节点阻抗矩阵,利用支路追加法^[1],计及母线相邻元件检修一个的情况,修正该节点阻抗矩阵中的部分元素校验保护的灵敏度,充分地考虑了系统运行方式的变化和电网结构的变更,从而使保护的整定更加合理。

1.3 短路计算

最大运行方式下三相短路的计算

短路点电流: $I_d^{(3)} = 1/Z_{dd}$

相邻元件的最小电流: $I_{d\cdot\min} = \min\{(Z_{dd} - Z_{di}) \cdot I_d^{(3)} / Z_{di}\} \quad i = 1, \dots, n$

穿越母线的最大短路电流: $I_{d\cdot\max}^{(3)} = I_d^{(3)} - I_{d\cdot\min}$

最小运行方式下两相短路的计算:

假定各元件正、负序阻抗相等,采用支路追加法^[1]对系统最小运行方式的节点阻抗矩阵在相邻元件检修一个的情况下进行修正,然后计算两相短路电流。

$$I_{d\cdot\min}^{(2)} = \frac{\sqrt{3}}{2} \cdot I_{d\cdot\min}^{(3)}$$

2 母线差动保护整定原则

2.1 双母线固定联接式差动保护

2.1.1 起动元件

(1) 躲过母线外部短路时的最大不平衡电流

$$I_{dz\cdot j} = K_K \cdot K_i \cdot I_{d\cdot\max}^{(3)} / n_{LH}$$

式中 K_i 一般取 0.1,当采用中间变流器时, $K_i = 0.1 + 0.9 \times 0.05 = 0.145$

(2) 躲过差动回路 LH 二次回路断线

$$I_{dz\cdot j} = K_K \cdot I_{fh\cdot\max} / n_{LH}$$

取大者为定值,当采用 BCH—2 型差动继电器为起动元件时, $W_{cd} \leq AW_0 / I_{dz\cdot j}$,确定实际差动线圈的整定匝数(W_{cd}),根据实际整定匝数计算定值: $I_{dz\cdot j} = AW_0 / W_{cd\cdot z}$ ($AW_0 = 60$ 安匝)

2.1.2 选择元件

躲过另一组母线三相短路时的最大不平衡电流:

$$I_{dz\cdot j} = K_K \cdot K_i \cdot I_{d\cdot\max}^{(3)} / n_{LH}$$

2.1.3 电压闭锁元件

低电压: $U_{dz} = (0.06 \sim 0.65)U_e$

负序电压: $U_{dz\cdot 2} = (0.06 \sim 0.09)U_e$

2.1.4 灵敏度校验: $K_{lm} = I_{d\cdot\min}^{(2)} / I_{dz\cdot j} \cdot n_{LH} \geq 2$

2.2 双母线母联相位比较式差动保护

整定原则同 2.1 (除无选择元件外)

2.3 完全电流差动保护

整定原则同 2.2

2.4 不完全电流差动保护

2.4.1 差动电流速断

$$I_{dz} = K_k \cdot [I_{d \cdot \max} + K_{fh} \cdot (I_{\Sigma 1} + I_{\Sigma 2})]$$

式中 $I_{\Sigma 1}$ ——未接入差动保护回路的出线总负荷电流。

$I_{\Sigma 2}$ ——切除某一段母线后,在被保护母线段未接入差动保护回路中的各出线所增加的总负荷电流。

当母线只有两段时, $I_{\Sigma 2} = I_{\Sigma 1}$

有三段式: $I_{\Sigma 2} = \frac{1}{2} I_{\Sigma 1}$

灵敏度校验: $K_{lm} = I_{d \cdot \min}^{(2)} / I_{dz} \geq 1.5$

2.4.2 差动过电流

按以下两式计算,取大者为整定值

$$I_{dz} = K_K \cdot K_{fh} \cdot (I_{\Sigma 1} + I_{\Sigma 2}) / K_h$$

$$I_{dz} = K_K \cdot (I_{\Sigma 1} + K_{2q} \cdot I_{\Sigma 2})$$

灵敏度校验: $K_{lm} = I_{d \cdot \min}^{(2)} / I_{dz} \geq$

1.2

3 程序介绍

3.1 程序的主要功能和特点

3.1.1 程序可完成下列母线差动保护的整定计算:①双母线固定连接式差动保护②双母线母联相位比较式差动保护,③完全电流差动保护,④不完全电流差动保护。

3.1.2 母线差动保护整定计算的内容包括:起动元件的动作值($I_{dz \cdot j}$, $W_{cd \cdot z}$)及灵敏度校验(K_{lm});选择元件的动作值($I_{dz \cdot j}$, $W_{cd \cdot z}$)及灵敏度校验(K_{lm});电压电流闭锁元件的定值计算等。

3.1.3 程序可根据计算人员的要求,对全网中的所有母线保护或部分母线保护进行整定计算;也可给定母线保护定值,程序自动完成灵敏度校验,若灵敏度满足要求,保留该定值,否则重新计算保护定值。

3.1.4 程序的计算结果包括:①母线差动保护整定计算的全部过程;有运行方式,整定原则,一次定值,二次定值及各元件的灵敏度;②

母线差动保护定值表,供计算和运行人员分析使用,也可作为整定计算资料存放,以备日后查

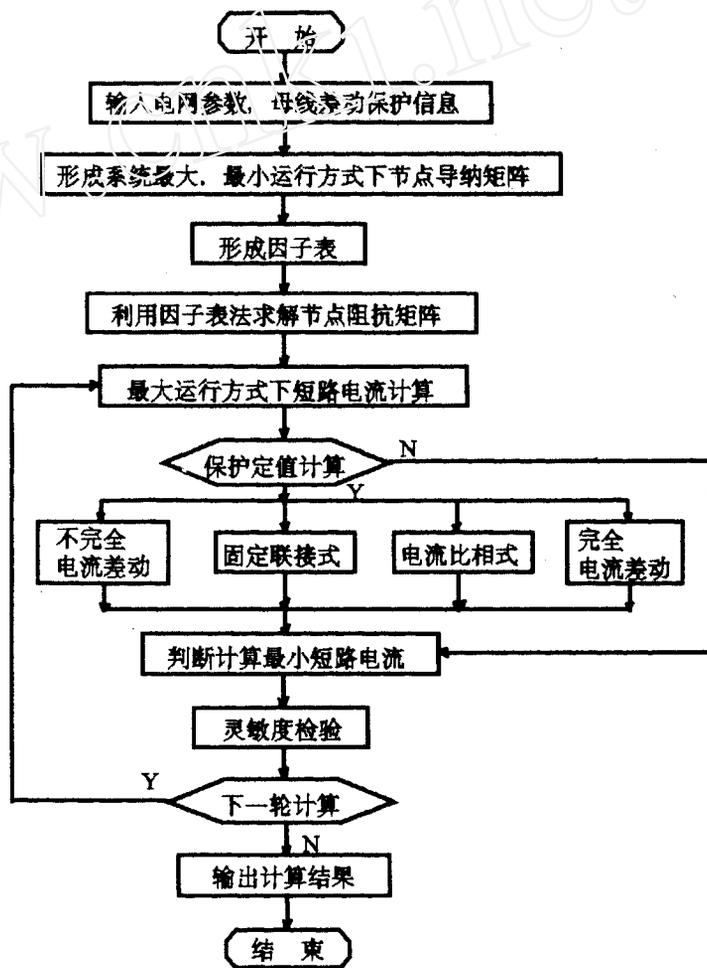


图 1

寻。

3.1.5 程序形成系统最大,最小运行方式下的节点阻抗矩阵,采用支路追加法修改最小运行方式下节点阻抗矩阵的部分元素来计及母线相邻元件检修一回的情况,充分考虑了电网结构变更,电源运行方式变化对母线差动保护的影响。

3.2 程序的主流程图

其程序主流程图如图 1 所示

4 结束语

程序以电网节点阻抗矩阵为数学模型,利用支路追加法以适应电源运行方式变化,网络结构变更时的节点阻抗矩阵,对母线各种差动保护进行计算。该程序采用 MS—FORTRAH 语言编写适用于各种微型计算机。对实际电网的母线差动保护进行计算,整定结果表明:整定值同手算一致,符合实际,已在东北等地使用,满足了实用要求,具有较高的使用价值,也可在其它地区电网中使用。

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4 结论

本文提出的方案解决了以往全电流差动保护中安全性与灵敏性之间的矛盾,理论分析和实验表明,该方案简单可靠,易于实现。该方案已编制软件,用于最近研制成功的 WXH—35 型微机光纤纵差保护装置中,即将投入现场运行。

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- 2 朱声石. 高压电网继电保护原理与技术. 电力工业出版社,1981

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CONTENTS AND ABSTRACTS (Partial)

THEORETICAL STUDY AND CALCULATION

Split-phase Current Differential Protection Using Fault Components Wu Ye'cai, et al(4)

A new scheme of utilizing phase current fault component to realize split-phase current fault component differential protection and utilizing zero-sequence currents of both ends to realize zero-sequence current differential protection is presented basing on split-phase full current differential protection. On the precondition of assuring enough preventability against fault beyond reach, the protection has very high sensitivity in high resistive fault within reach on heavy load.

Key words: fault component current differential, zero-sequence current differential, microprocessor-based line protection

The Influence of Start Methods And LF Characteristic of Pump Storage Group on Protection Yao Qinglin, et al(10)

There may be a LF zone of long term during start process of pump storage group which, as a synchronous motor, drives pump. The influence of different start methods and their LF characteristic on pump storage group protection is discussed and a valuable conclusion is yielded.

Key words: pump storage group, motor start, LF characteristic, group protection

A Digital Narrow-Band Filter for Microprocessor-Based Protection Xiong Xiaofu, et al(15)

A method of using frequency sampling to design a narrow-band digital filter for microprocessor-based protection is introduced and the method is used to design a digital filter to filter fundamental component. Comparing with Fourier full-cycle filtering method, it has more advantageous in restricting nonperiodic component. The application prospect of the method in the microprocessor-based protection is indicated.

Key words: digital filter, narrow-band, frequency sampling, microprocessor-based protection

A daptive Impedance Relay for Short Line Fan Chunju, et al(18)

According to the small setting value and the characteristics of the short line and its fault, an adaptive impedance relay for short line has been put forward in this paper on the basis of the detailed analysis of circular directional impedance relay, reactance relay and quadrilateral impedance relay. The relay posed takes full advantages of the calculating and judging capability, with the reactance relay measuring short circuit impedance, the directional impedance relay directing correctly. This relay is able to protect big transition resistance and avoid the load impedance. When used as single phase ground relay, it is easy to be made to protect transition resistance adaptively.

Key words: short line, impedance relay, protection, adaptive

Research on Microprocessor-Based Comprehensive Induction Motor Protection Device Luo Wenguang, et al(21)

For reasons of higher damage rate of domestic motor in service, a power plant desired to instal a new protective device on its large asynchronous motor. The author took part in the development of the device. The device is a microprocessor-based protection device using 8031 as CPU. The design principle and method of its software and hardware are introduced. Simulation experiment has shown that the device is better than conventional protection device (e. g. electro-magnetic, rectifier and transistor types).

Key words: microprocessor-based comprehensive protection device, thermal simulation equation, operating characteristics

Computer Setting Calculation for Bus Differential Protection Wang Xiang, et al(26)

This paper simply describes the mathematic model for computer setting calculation of bus differential protection, consideration of operation mode, protection setting principle, and setting calculation program of the bus differential protection written basing on the above method. The program has been applied in a real electric network and can meet the requirement of engineering calculation.

Key words, bus differential protection, computer calculation

Research The Algorithm of Extracting The Square Root in Electric Transducer Zhou Damin(30)

It will take a lot of time to extract the square root in the microprocessor-based electric transducer realized on electrotechnical laws. This paper firstly analyzes the shortcomings of the two algorithms of extracting square root, Newton iteration and fast table look-up, and improve them to yield two adaptive combined algorithms of extracting the square root. Thus the speed of extracting the square root increases greatly.

Key words, electric transducer, algorithm of extracting the square root

NEW PRODUCT DEVELOPMENT

General-Used High Accuracy Optic-Fibre Sensing System Zhang Peiming, et al(35)

This paper introduces a general-used high accuracy optic-fibre sensing system which is suitable for on-line measuring current.

Key words, general-used, optic-fibre sensing system, on-line detection

Developmet of Electromagnetic Relay CAD Expert System Xiu Shixin, et al(39)

The architecture, function, building method and feature of the electromagnetic relay CAD expert system are described. The system is equipped with an experience knowledge base of relay expert, which can form judgment and inference upon the expert experience knowledge and simulate the design thinking and solving way of the experts. Application of the expert system technique in CAD solves the non-numerical questions in conventional CAD system and has important significance in realizing intellectualization and automation of electric product.

Key words, electromagnetic relay, CAD, expert system

Application of Integration Development Technology in Upgrade of relaying panel CAD system Xu Tao, et al(43)

Research on KGD3 Control Power Supply of Electromagnetic Brake Xie Shuangquan, et al(48)

SERVICE EXPERIENCE

Discussion on Preventing DC Parasitic Circuit And One-Point-Earthing Zou Shenyuan(52)

Some accident examples of parasitic circuits occurring in relay device are listed. The improving method is presented by analyzing these examples and how to use the special-used terminals in The Keyoints of Anti-accident Measure in Relay and Safety Automation Device' is described. This paper also analyzes the relationship between the capacitance of dc positive and negative poles to earth and the voltage of both coil ends and the measures to be taken when the positive terminal of output auxiliary relay coil earthes.

Key words, parasitic circuit, one-point-earthing

Discussion on The Relay Protection And Secondary Circuit in Main Electric Connections of $1 \frac{1}{2}$ Circuit Breaker Used for 220kV Substation Zhang Huaqing(58)

Discussion on Selectable Recording of Fault Recorder in Guangyinge Substation Wang Bing(64)

Application Problem of Economizer Signal Lamp in Control Signal Circuit and Its Solution Chen Yuanpeng(65)

Application of ZRJ-03 Intelligent Thermotechnic Meter Calibration System Wang Dean(67)

STRUCTURE AND TECHNOLOGY

Discussion on Several Questions of CAPP Xia Chuenhou, et al(71)

Significance of Application and Dissemination of SMT Yin Xuebo, et al(74)

This paper explains the significance of application and dissemination of SMT and analyzes the process of SMT and THT. It also describes the feasibility of SMT.

Key words, SMT, SMD, SMC, SMB

Technology and Quality Control During The Trial-Production of Relay Protection Product Prototype Wang Jie(77)

Technology and quality control is closely related with the quality of prototype trial-prduction of relay protection product. In view of the speciality of prototype trial-production and the site management of trial-production, the action of technology and quality control during the trial-production of relay prototype is described.

Key words, prototype trial-production, technology, quality