Automated Systems & Technologies
25-26 May 2015 • St. Petersburg, Russia

DEVELOPMENT OF GENERALIZED SIMULATION MODEL OF OVERCURRENT PROTECTION DEVICE

Iskakov Ualikhan, Josif Breido

Karaganda State Technical University,
Department of automation of production processes
Bulvar Mira 56, main bld. 140, 100027
Karaganda, Kazakhstan, e-mail: ualikhan88@mail.ru

Abstract

Overcurrent protection devices are utilized for safe reliable and efficient operation of power systems, and also to prevent the detrimental effects of faults in power systems [1]. Errors during design of protection systems and calculation of protection device threshold can lead to malfunctions and damages of power system components, leading to considerable costs for their replacement and in longer disconnections of power supply to the customers. Therefore it is important to confirm the thresholds of protection devices and to confirm their operability before commissioning.

Modern hardware and software tools allow to analyze and to detect possible design errors, using development of detailed models of protection devices, and modeling of operation conditions. Modern microprocessor based overcurrent protection is very complex and multifunctional however existing simulation models of overcurrent protection are highly tailored and don’t have the ability to use it to validate settings of protection equipment.

There is a generalized simulation model of overcurrent protection device using SimPowerSystems (MATLAB/Simulink) is presented. The overcurrent protection has features of instantaneous, time delay protection and earth fault protection.

The presented model was done after preliminary analysis of operation principles and functional structures of microprocessor based relays of leading

foreign manufacturers such as: Siemens, MerlinGerin (SchneiderElectric), Areva, Mechanotronika.

MAIN TEXT

The analysis of the operation principles and functional structures of microprocessor based protection [2, 3, 4, 5, 6, 7] like instantaneous overcurrent protection, definite time overcurrent protection and earth fault protection revealed that all of them could be presented in one generalized functional diagram showed on figure 1.

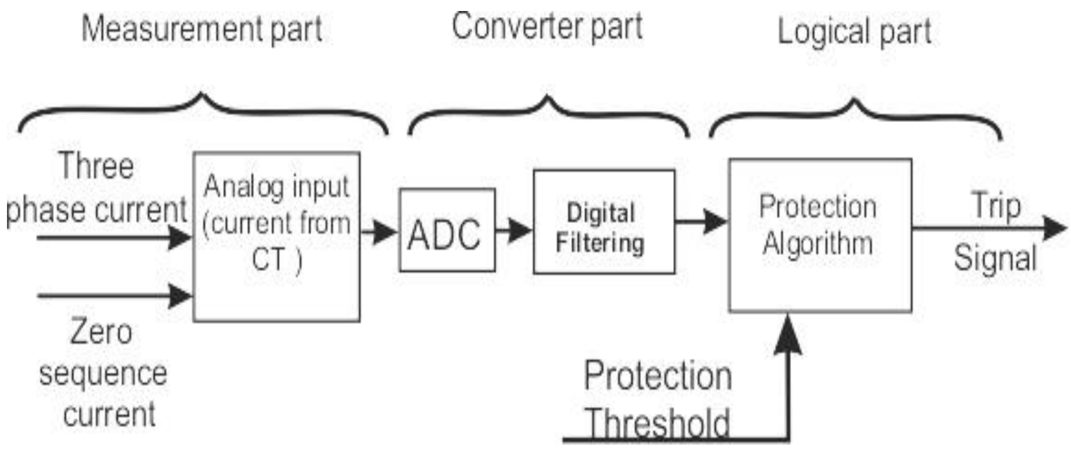

Figure 1. The generalized functional diagram of overcurrent protection.

The functional diagram showed on figure 1 consists of three main parts.

The measurement part consists of current and voltage analog inputs, which are allow receiving measurement signals from current, voltage and zero-sequence-current transformer.

The converter part consists of analog-to-digital converter and digital filter. The analog-to-digital converter is using to convert analog signals from current and voltage transformers to digital form. The digital filter is using to extract fundamental signals and also to anti-aliasing effects. The digital filter used here is a low pass digital FIR filter.

In the logical part obtained root-mean-square values of current and voltage are fed to protection algorithm block. If input current value exceeds the threshold value, relay will turn on timer, which realizes time delay. Time delay value depends on protection type. For instantaneous overcurrent protection time delay doesn’t set up, for definite time overcurrent protection time delay is setting up depending on distance to power supply from protection device place.

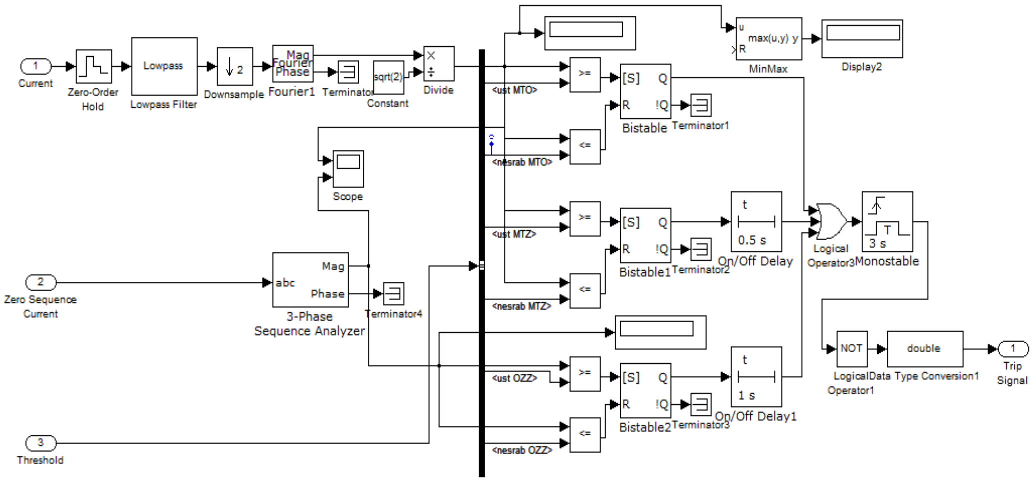

Figure 2. Simulation model of overcurrent protection device.

The simulation model of overcurrent protection including instantaneous overcurrent protection, definite time overcurrent protection and earth fault protection implemented using SimPowerSystems (MATLAB/Simulink) [8] interactive tool showed on fig.2.

To the inputs of model three-phase current value and zero sequence current value are coming up. Analog-to-digital converting realized using ZeroOrderHold block, which is available in DiscreteLibrary. To noise filtering LowpassFilter block is used. DownSample block is used in order to reduce sampling rate, it is helps avoiding anti-aliasing effects. The Fourier block is used to extract periodic component of short circuit current. The 3-PhaseSequenceAnalyzer block is used to obtain zero-sequence-current. Protection algorithm realized using comparison and Bistable trigger blocks, time delay realized using On/OffDelay block. Obtained short circuit current and zero-sequence-current values compare with threshold value, which are come from threshold setting block. The overcurrent device output is produces control signal (TripSignal) to switching device.

CONCLUSION

Developed the generalized model of overcurrent protection is allows to simulate operation and emergency conditions of power systems, and also gives possibility to control parameters, which are influence to protection device tripping.

The simulation model allows validating calculated threshold values and settings, and detecting power system conditions which lead to malfunctioning of protection devices.

REFERENCES

[1] J. Breido, U. Iskakov, The adaptive tools of power system protection and electric equipment protection. (Science and innovative developments – To the North, Mirnyi, 2014)

[2] Operating instructions. Sepam + 1000 series 40. Protection functions 3/1. MerlinGerin Schneider Electric, pp 196-197

[3] Operating instructions. Digital overcurrent protection relay with time delay and with thermal overload protection and autoreclosing SIPROTEC 7SJ602 v 3.1. Siemens AG 1999, pp 206-207 (2001)

[4] User manual (model R). MICOM P111 Universal overcurrent protection relay v 7B, pp 42-43

[5] Operating instructions. Digital protection block BMRZ-100, DIVG 648228.024UM, Mechanotronika, pp 35-36

[6] E. M. Schneerson, *Digital relay protection*, (Energoatomizdat, Moscow 2007)

[7] A. M. Fedoseev, M. A. Fedoseev, *Relay protection of power systems*, (Energoatomizdat, Moscow 1992)

[8] I. V. Chernyh, “SimPowerSystems” *Modeling of electrical device using Simulink* (Electronic edition, http://matlab.exponenta.ru/)