UDC 621.317

D. Ornatsky, doctor of science, B. Dobrzhanska, assistant, S.Koversun, assistant
(National Aviation University, Ukraine)

Relay protection system for small-based networks with reduced technical-economic indicators

The article is devoted to increase of reliability, protection against damage and improvement of metrological characteristics of the relay protection system for low-power networks with improved technical and economic indicators, due to the lack of problems inherent in standard multi-stage security systems for distribution networks, especially in bilateral power supply.

Introduction

The main problems that arise when creating selective protection, especially from the short (SG) ground fault in the networks (6-10 kV), are conflicting requirements for their sensitivity, selectivity, and performance in conditions when the currents in damaged and intact areas are not clear enough and persistent differences. This makes the task of improving the metrological characteristics (M CH) of measuring instruments of relay protection (RP) relevant [1, 2].

Widespread current protection (due to its sensitivity) with current transformers of zero sequence (TZS), which are now replaced by measuring converters current-current (with a conversion factor of 1: 1000) based on Hall sensors in the integral performance of the accuracy class 0.2 ... 0.5, which do not have low-frequency poles, and according to mass-size indicators, current transformers dominate [3].

The advantages of such converters are also in the absence of errors due to the induction of magnetization to the current transformer (CT) and with significant restrictions on load resistance [4]. However, while there are also problem problems with the disengagement from jumps of capacitive current, saturated with higher harmonics when ground faults on other lines. This needs to provide the selectivity of increasing the current to protect the workload from the permissible limits, while at the same time, in order to increase the reliability of the compensated networks, it is necessary to reduce this current, which significantly limits the application of this method.

However, in this case, the requirements for the metrological characteristics of the use of measuring transducers are substantially increased, which is complicated by the fact that such measurements must be made for basic harmonics with high speed and precision.

Analysis of research and publications

One possible solution to this contradiction is the use of a relay (power of currents of zero sequence) reactive for uncompensated radial networks and active for compensated ones. For example: microprocessor relay and relay protection devices of the series RS83 are intended for use at substation (6-10) kV of substations and distribution points.

The composition of the series is intended to perform the functions of the RIS of distribution networks without the use of additional equipment, with the base unit of the series is a multi-stage device - maximum current protection (MCP).

Devices favorably differ from domestic and foreign analogues with availability, small dimensions, low consumption, accuracy of parameter control and user-friendliness, and in terms of the functionality / cost ratio, most analogues are superior [5].

To the disadvantages of microprocessor relay protection devices include the following: high cost and low maintenance [6].

Electrolytic capacitors included in the relay protection of even the best companies in Japan after 7 years of operation in pulse power supply units lose their properties, tightness, create a flow of electrolyte, able to eat copper tracks of boards.

The PC83 series microprocessor device is based on methods and means for building current protection (MCP, current cut off (CO), the disadvantages of which are: incomplete line coverage, significant time elapses near power sources, although this requires high-speed response in a stable environment. Instability of the zone of action due to changes in the resistance in the zone of damage and the change of the regime of the system, which makes it difficult to use them in networks of 6-10kV.

In these cases, it is necessary to use security systems that ensure the failure of the damage without time-consuming throughout the entire protected line, including on lines of small length. These are so-called differential protection systems, they provide an instant disable s. l. at any point of the site protection and have selectivity at SG outside the protected area. That is, for them there is no need for consistency, besides, they do not react to fluctuations in the network.

The only drawback of this method is the high cost of the connecting cable and work on its laying.

The statement of the research problem

To prevent the aforementioned shortcomings a functional scheme of the protection system was developed, presented in Fig. 1, which will allow transmitting measurement information signals over real-time telephone communication lines with high precision. Based on the use of narrowband BPM models using non-classical PLL system and iterative integrating converters with dynamic memory devices with improved metrological characteristics . In this case, the cost of the components of the entire transmission system is equivalent to the cost of two modems for the transfer of digital information, while in an alternative version of the work on laying the cable and its cost will reach tens of thousands of U.S.

Another advantage of the proposed system is the possibility of using more accurate primary input links (without transformers) based on operational amplifiers or Hall effect transducers, due to the presence of a sceinous channel of transmission of measuring signals using BPM modulation. In addition, such a system in its architecture will refer to systems of a centralized type (with a large number of similar elements). The advantage of being economical is that the resident part of the system will consist of only primary converters and BPM modulators with a network adapter.

Presenting main material

The work of the system is based on the differential method of building relay protection and has a centralized structure. On Fig. 1a is a structural diagram of one cell of the resident part of the system, which is installed at the ends of the secured line. A feature is the use for transmitting measurement information signals using "narrowband" pulse width modulation where the signal transmitted has an asymmetric triangular shape. Such a signal is obtained in a linear pulse width modulator based on "quadratic" voltage-frequency transducers (BPM) (BPM *) and through the line transformer (TL) falls into the telephone line.

As primary currents of measuring current transducers (MTK), identical means are used that would not have low frequency (low frequency) poles in the frequency response, for example, current sensors based on the Hall effect, or current sensors in which the low-frequency pole is located in the high-frequency (HF) region , for example air transformers or shunts with galvanically isolated amplifiers, which will help reduce the aperiodic component.

On Fig. 1b shows the distribution of the bandwidth of a telephone channel between a band of useful BPM * signal, which is bundled at a frequency of 1.8 kHz and an alarm band, which uses one of the frequencies of the tone call (367 Hz).

The receiving part of the system is located at the generating station and consists of comparators of variable voltages one for each protected area of the network. The block diagram of a comparator of variable voltages (CVV) is presented in Fig. 1 in. The circuit consists of two identical channels: Channel 1 and Channel 2, each containing a serially connected transformer of the TL line, a PIM * d pulse width demodulator, a two-stage follow-on filter, the first stage of which is a two-channel filter, which is synchronized with the twenty-fourth harmonic network frequency (1200 Hz).

The synchronization signal is generated by using the direct synthesis synthesizer (DSS) from the third harmonic of the network frequency (150 Hz) by doubling its frequency by analogue quadrators, which ensures high quality of the synchronization signal. The second stage of the cut-off filter is a four-channel filter (4), which is synchronized with the twelfth harmonic of the network frequency (600 Hz). As channel filters, iterative-integrating converters with dynamic storage devices have been used to improve the metrological characteristics of the filter.

The results of the study of the AFC filter in the Electronic Workbench software environment are presented in Fig. 2. As can be seen from the data, the suppression of odd harmonics significantly exceeds 80 dB in the majority of the frequency range. The nearest pair harmonics: the second and the fourth are suppressed to a lesser degree (respectively - 27 Db and 61 DB), but due to the use of two-phase intermittent synchronous detection, their influence will be neutralized.

At the filter output, the purified signal of the main harmonic falls on phase-sensitive rectifiers (FVS): FCHB 1 and FWB 2, which determine the quadrature components of the first harmonic of the input signal. Thus, by determining the coordinates of the current vector vectors at the beginning and at the end of the protected line, it is possible to determine the phase shift between them and their modules, which will make it possible to determine the presence of any SG.

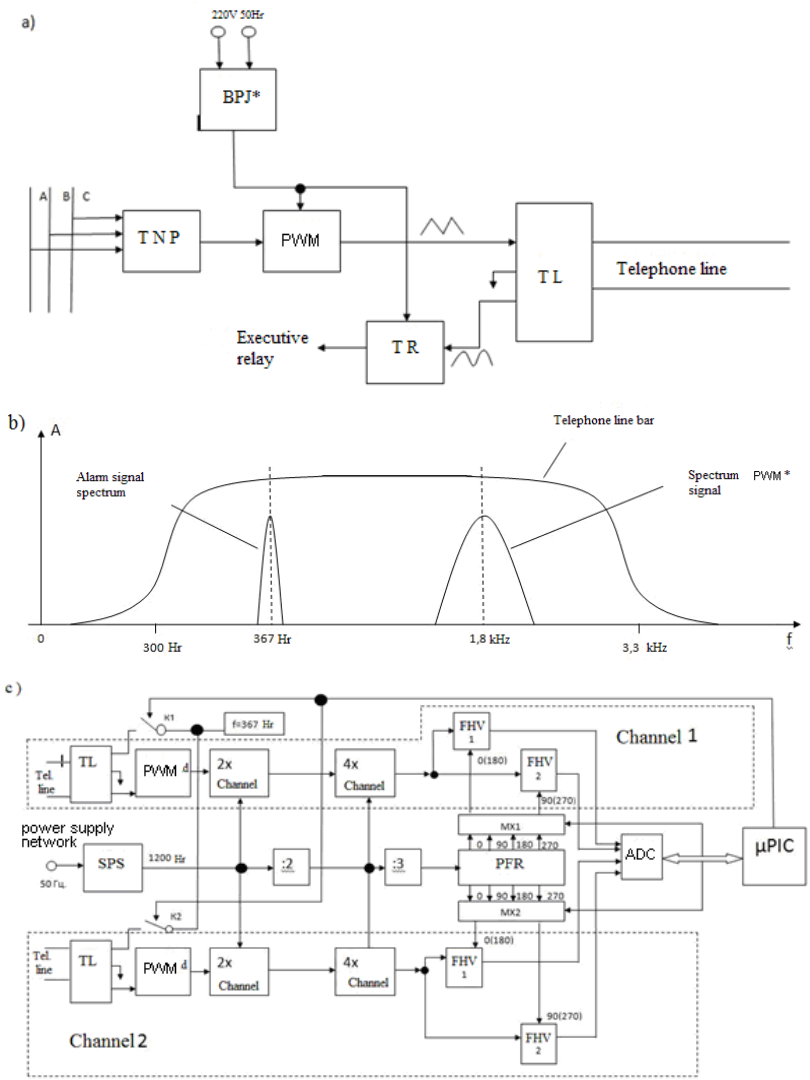

Fig. 1 - The block diagram of the protection system: a) the cell of the resident part of the system, UPS - uninterrupted power supply, ER - electronic relay, TL - line transformer b) distribution of the bandwidth of the telephone channel, c) structural scheme of the comparator of alternating voltage, DPS - divider phase separator, M CH1, M CH2 - analog differential multiplex,: 2,: 3 - frequency dividers respectively for two and three.

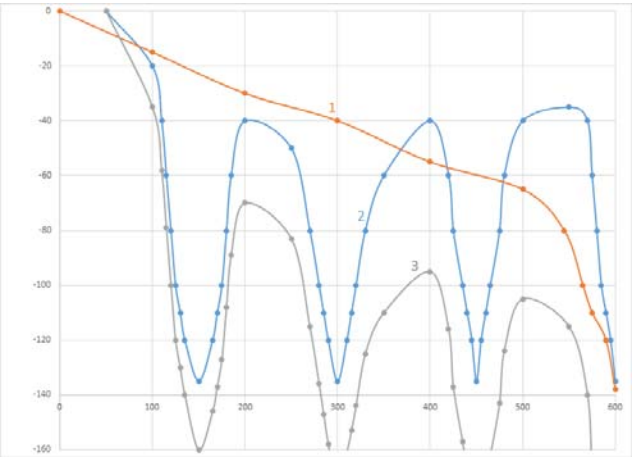

Fig. 2 - the study of the frequency response filter in the software environment Electronic Workbench: 2-X-two-channel filter, 4-X-four-channel and Σ -total.

Conclusions: Increased metrological characteristics of the system (speed, accuracy, selectivity) achieved through the use of non-trivial technical solutions of the main components with improved M CH (BPM, BPM modems, measuring amplifiers with differential-current input, scratch-tracking filters, phase-sensitive rectifiers, low-noise uninterrupted block power with a harmonious transforming signal) significantly reduce the range of means that would be needed to build a system with equal functional capabilities, while also significantly reduces the amount of necessary software. Increased reliability, immunity to the system, due to the lack of problems inherent in standard multi-stage distribution network protection systems, especially in two-way power supply.

References

1. Shneerson E.M. Digital relay protection / Э.M. Shneerson - Moscow: Energoatomizdat, 2007. - 549 p.
2. Nikitin AA Digital relay protection. Fundamentals of synthesis of measuring part of microprocessor relays: the text of lectures / A.A. Nikitin - Cheboksary: Izvestia Chuvash. Un-ta, 2014. - 240 s.
3. Electronic resource: Rs-catalog, http://ru.rsdelivers.com.
4. Chernobrovov NV, Semenov V.A. Relay Protection of Power Systems: Textbook. allowance for technical schools / N.V. Chernobrov, VA Semenov - Moscow: Energoatomizdat, 1998. - 800 p.
5. Electronic resource: Microprocessor devices RPA Series RS83; http://rzasystems.ru/56.html