



On the issue of improving the reliability of consumer protection in unbalanced modes of low-voltage networks

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ABSTRACT

Article is devoted to the research of reliability of systems of power supply. Results of introduction of the latest technical solutions realized in automatic Master pact breakers of the Schneider Electric company are given in it, for modernization of 0.4 kV of traditional devices of relay protection applied now in networks. With objective of reduction conformity to modern safety requirements under standards of International Electric-technical Commission it is offered to apply these achievements at the organization of a domestic production on release of power automatic breakers.

Keywords: *Master pact, compact, low-voltage automatic breakers*

I. INTRODUCTION

For the reason adductions in correspondence to the modern requirements to safety on standard International Electric-technical Commission (IEC) is offered use these achievements at organizations domestic production on issue of the power automatic breakers.

It agrees taken effect on January 1, 2003 (in Russia) to new requirements of Rules of device of electrical installations (RDEI)¹, concerning an electrical

security and the rules corresponding to the international norms, one of the major requirements to protective equipment in networks to 1000 V is the requirement for ensuring speed of shutdown of the damages connected with impact on the person. This time according to table 1.7.1 of RDEI, depends on value of a voltage and at the phase voltage 220 V should not exceed 0.4 sec.

At present the begun transition in abroad and in Russia to the next generation of microprocessor (digital) device of relay protection and automatics (DRPA) with integration within the limits of a uniform information complex of functions of relay protection, measurement and commercial account electric power, regulation and management of electrical installation it is directed on maintenance of increase of reliability of electrical supply of consumers and conformity to modern safety requirements on IEC².

The spectrum of arrangements DRPA for networks of the low and average voltage, offered to the consumer the domestic and foreign companies, allows executing adequate systems of protection for various objects.

and specialists of the Ministry of the Russian Federation, pp. 69, 2005.

¹ SOLOVYOV A.L. *Guidelines on choice of features and setting protection of electrical equipment with the use of microprocessor terminal to series SEPAM manufactured by Schneider Electric.* // St. Petersburg Institute of energy development of management

² ZHALILOV R.B. *Digital relays : regulatory framework application, brief description.* // Chief power engineer , pp. 14-17 , April 2007.

Digital terminals possess all standard functions of microprocessor protections: measurements, relay protection, system automatics, self-diagnostics, diagnostics of work of the breakers device and a network, digital oscillography and have communication with system of the MANAGEMENT information system on interface RS-485 c open report MODBUS. The given arrangements have a modular design and program formation of protection.

In descriptions on digital relays as well in standard IEEE, IEC time current characteristics current protection are set by mathematical formulas. For construction of these characteristics with objective of their coordination with characteristics of other protective devices (the relay and fuses) is necessary to know the basic traditional conditions of a choice maximal current protection (currents of operation, characteristics, time of operation).

The comparative analysis³ of different types independent current characteristics of digital relays and Russian analog relays PTB-I, II, III, PT-80 as well as current characteristics of the Russian fuses of type SDQCL (safety device quartz current limiting) has shown, that in the majority of cases the most suitable for Russia is "standard independent", or "normal" the characteristics and to it similar characteristics of standards IEEE (it is moderate independent) and IEC (independent). However there can be an indispensability of use and other types of characteristics.

The known electrical technical firm "Schneider Electric" lets out and delivers on the market various electric equipment and including microprocessor (digital) relays-terminals of set SEPAM⁴, as well as low-voltage automatic breakers (AB) to set Compact and Master pact. Master pact is one of the best AB on greater currents in the world⁵. Having improved base model, the company "Schneider Electric" has let out on the market breakers Master pact NT and NW under trade mark Merlin Gerin. To the basic dignity of power breakers of possibility enable, selectivity and to convenience service - the built in functions of communication and measurements have increased.



Fig. 1. Master pact NT with block of the control and management Micrologic P in cell DD -0.4 kV.

at the reduced sizes of the device (fig. 1).

The block of the control and management of Micro logic A/P/H is equipped by the liquid crystal display and simple navigating keys. The user has a direct access to necessary parameters and set point. Navigation between screens is carried out intuitively; adjustment is simplified at maximum by direct reading from with display. The text information is displayed on chosen language (from possible 6 languages).

AB Master pact is integrated into the general system of scheduling that optimizes its operational service. The architecture of system of data transmission is characterized by openness and may be adapted for any reports.

Protection functions are independent of the measurement. These functions are controlled by the electronic element of the ASIC⁶ common to all units and control that ensures immunity to immunity to interference, as well as a very high reliability.

The patented system "double regulation" system protection lets you give:

- upper threshold by means of breakers;
- more precise setting by using the keypad or remotely. Such accurate adjust set points (before 1 Ampere) and extracts the time (before 1 second) appears on the display.

Another difference is their environmental security, AB Master pact represent a potential danger to the environmental, factories producing this apparatus, do

³ Reference 2, Reference 3., Reference 5.

⁴ Reference 3.

⁵ MERLIN GERIN. *Circuit breakers and disconnectors for power transfer in low voltage networks*. 2007 catalog. Moscow. Informational support center.

⁶ Reference 4, Reference 5.

not pollute the environmental and are in accordance with ISO 14001.

Fig. 1 below shows the Master pact driver performance, AB established in cell developed by the author distributing device -DD-0.4 kV for complete transformer substation (CTS). In coordination with the Master pact (the regulation IDMTL) with protection of the average voltage or fuse is optimized by adjusting the curve of the overload protection. This regulation also provides better adapted this protection to some consumers.

In three-polar automatic breakers Master pact are neutral protection setting with keyboard or remote (with additional function communication COM) and provides 4 positions: unsecure neutral (4P 3d), partially protected neutral (4P 3d+N/2), fully protected neutral (4P 4d), double protected neutral (4P 3d+2N). Dual neutral protection applies if the neutral section is twice cross-section of phases (a strong asymmetry of load, high late of third order harmonics).

In four pole automatic breakers Master pact are neutral protection setting with keyboard realized with three-terminal section switch and has three positions : unsecure neutral (4P 3d), partially protected neutral (4P 3d+N/2), fully protected neutral (4P 4d). Neutral protection not activated, if the curve overload protection is regulated by one of the protections IDMTL.

In accordance with the current setting and time adjustable from keypad or remotely if there are additional function communication COM, blocks of Micro logic P/ H control current, voltage, power, frequency and phase rotation. If there are additional functions for each set point is exceeded COM remotely. Each exceeding the set points can be optionally unhooking (protection) or to the, alarm by additional programmable contact M2C, M6C when you unhooking the memorization is current, ten recent unhooking and emergency signals are recorded in two separate chronological reports. Three - service indicators (wear contact, number of contacts, etc.) are stored in the register.

The additional function communication COM provides:

- read data and remote parameter setting protection or emergency-preventive signaling;

- the transfer of all measurement data and calculated factors;
- the signaling of the reasons of the unhooking and emergency-preventive signaling;
- viewing chronological reports and indicator of the technical service;
- reset counters maximum values.

Some of the measured or calculated values are available only if you have additional function communication COM:

- $I_{\text{shock}} \cdot \sqrt{(I_1 + I_2 + I_3) / 3}$, $I_{\text{no balance}}$;
- load factor from I_r ;
- total power factor $\cos \varphi$. And with block Micro logic H further available:
- total value of the phase and power factor $\cos \varphi$;
- the harmonic distortion on current and voltage;
- coefficient of current K and average to K;
- intensified coefficients of current and voltage;
- all basic components of harmonics on each phase;
- phase shift the main components of the current and voltage harmonics;
- power and distortion coefficients on each phase;
- amplitude and phase shift 3 - 51 order harmonics current and voltage.

Access to all counters for the maximum and minimum values is provided if there are additional data transfer functions for COM dispatch system.

The Master pact circuit (2, 5, 6, 7- performances) to protect the mains leads are implemented: protection against overloading, triggered by the current value of the current. Thermal memory: thermal "image" before and after the trip.

- Protection against short circuits - selective circuits (MCP) and the instantaneous current cutoff. Select the state function I^2t (enabled or disabled) in setting time protection with low exposure time.

Blocks of the control and management Micro logic 6, 7th performance also include:

- protection against short-circuits- protection type "No balance" or "return of current in accordance with current earth lead" (fig.2). Select the State function I^2t (enabled or disabled) in the setting time;
- but block of the control and management Micro logic 7th performances:
- differential current protection of zero sequence (Vigi).

Currently operated by the electronic blocks (mark MECR) for automatic breakers (such as "Electron", VA-53 series, VA-55 etc.) are not protected against short -circuits and differential protection of zero sequence current, therefore do not meet the new requirements of RDEI⁷ for electrical safety. For protection against short- circuits in the currently complete transformer substation (CTS) general and special purpose, it the necessary to use additional relays, which reduces the reliability of such schemes. The modern Russian-made DRPA devices, such as the BMPRP-0.4 (STC Mechanotronics), TEMP (VNIIR), etc., the entire set of protections for network 0.4 kV CTS network leads to the complexity of such schemes and unnecessary price increases for their implementation⁸.

Short stop for the protection analysis in the three-phase mains four-wire TN-C.

For most industrial electric power supply 220/380 V in the now commonly used three-phase electric network four-wire TN-C. The main protective function assigned to a car in which to focus on building equipment should lead to his trip by using current protections.

As a result of network asymmetry in emergency mode (in short-circuits and the not fully phase circuit) on Earth is significant scatter current, not entering the coverage of current protection in phase conductors. Consumers with low resistance grounding device observed zero appearance conductor power cable power from other electric installations of the neutral terminal. Than lower resistance grounding in TN-C networks, the more the wandering currents that create additional danger of electrical traumatism.

In three-phase five-wire TN-S network N- conductors are separated by PE-conductors on the buses PEN substation and next are separated throughout the network. The Zero worker conductor is used to supply power to the electric power and connecting with receivers grounded neutral electrical installations (on the flow working currents), and zero protective PE-conductor - for connecting electrical parts with earthed neutral power source (current it appears only

in emergency mode). Protective PE- conductor connects equipment grounding electrode body.

Tires N and PE input device bus isolated one from another; N- and PE- conductors are on the plane- and separated. In such a network of asymmetry and zero sequence in normal mode does not flow through grounding devices and PE- conductor. When breakage in chain of N- wires single- phase consumers are disrupted, there is a strong bias of phases, but the conditions of electrical safety a not violated. When the N-conductor breakage and short circuit the current reaches the set point alarms equipment protection phase conductors. When breakage of PE- conductor supplying line is saved, all users in normal mode, but the equipment is grounded only on own grounding conductors.

Note the following differences 5 wires network from 4 wires :

- 4 wires system as zero conductors actually used land;
- breakage of the N -conductor supply line in the system may have 4 wires continuity of work in near-normal, it does not damage the equipment before disconnecting the mains line current protections and need immediate emergency stop;
- breakage of the N - conductor supply line single-phase short circuit on the case other if you have a large voltage touch on sells, the system is the calculation.

Developed the author of DD-0.4 kV⁹ total (protective and working) tire sections (PEN bay bus exhaust power cables), connects to the neutral transformer. At the rear bottom of each cabinet section of no. 1 and no. 2 to their chassis bolt connection supported protective grounding bus, joined with ground contour CTS. Protection against short-circuits is implemented according to the principle given in fig. 2. Thus, the proposed DD-0.4 kV is used when the current user has three-phase mains four-wire TN-C, and can be implemented when reconstructing the craft of electrical networks with switching to IEC on three-phase 5- wires recommended network TN-S.

⁷ Reference 1.

⁸ ZHALILOV R.B. *About one way of protecting consumers of electricity in the networks of 0.4kV.* // Electrical equipment, , pp. 29-35, February 2008.

⁹ Reference 5, Reference 6, Reference 7.

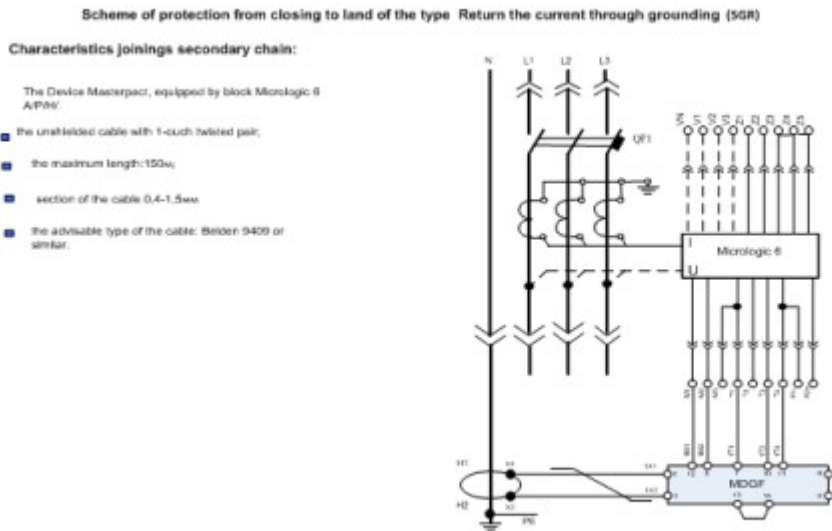


Fig.2. Scheme of protection from closing to the land of the type Return the current through (SGR), marketed with AS Masterpact.

Conclusion

1. DD-0.4 kV SUBSTATIONS, equipped with automatic circuit breakers of Schneider Electric Master pact with block of the control and management Micro logic A/P/H will implement a comprehensive protection and substation control at a modern level. Units Micro logic A/P/H provide automatic management of locally or from remote control units, control of the primary equipment, measuring, marking, recording and transmission waveform data, etc.

2. Domestic production of power circuit breakers meeting, modern requirements of IEC, IEEE for security and relevant international standards (regulations), care should be taken to apply in their design and construction of innovative technical solutions such as, "protection neutral", "four pole performance", "the measurement and calculation of indicators of the quality of electricity, "additional function communication COM", "chronological reports", "indicators of the technical service" and etc.

3. The main focus of the technical upgrading of electrical equipment of industrial enterprises should be the introduction of equipment having substantial advantages over exploited. Advisable in every company have periodically updated the list of electrical equipment and installations to be replaced by relay protection and automatics in order replacement, taking into account the duration of exploitation, the protected equipment, possible

consequences of the failure of false work, the availability of domestic microelectronic analogs etc.

4. Should be paid great attention to the problem of interaction in the "man-machine", as well as the preparation and training of maintenance and operational personnel, since the introduction of the microprocessor relay protection devices required both skills relay staff and equipping services modern automated devices to relay their maintenance.

5. When reconstructing existing, as well as designing new functional electrical networks should seek to move to the recommended IEC three-phase network 5 wires net TN-S, in line with modern safety requirements for RDEI.

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