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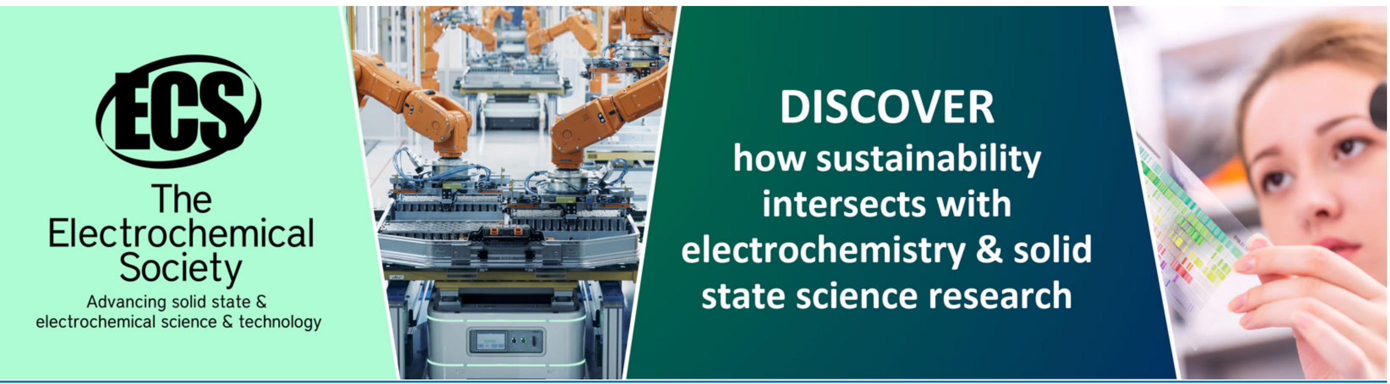

Method of reliability and speed increase of work of automatic input of a reserve on the basis of the microprocessor terminal

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Abstract. The new operation algorithm of the automatic input device of a reserve (AIR) together with the system of relay protection of power transformers of substation is offered. The increase in reliability and speed of the automatic input of a reserve is provided due to use of signs and algorithms of identification of emergencies and collaboration of a system of relay protection and automatic equipment of substation. The sign of identification of level of undervoltage on tires of the distributing device with automatic input of a reserve and also type of the relay protection which switched-off the equipment in emergency operation is entered. The formulas for calculation of parameters at which operation of AIR is provided are offered. The proof of efficiency of the offered signs and algorithms is executed on the basis of the analysis of oscillograms of parameters of emergency operation. The program realization of the offered algorithm on the basis of the microprocessor terminal of relay protection Sepam 1000+ is presented.

1. Introduction

The microprocessor devices of relay protection (MDRP) [1] became the main devices of relay protection in electrical networks of the industrial enterprises and city electrical networks.

The advantages of MDRP are rather known: these are small dimensions, wide range of protective characteristics, functions of measurement and archiving of electrical quantities at the time of protection operation. Microprocessor devices continuously carry out self-checking, there is a possibility of remote control and expeditious change of values of settings of protection [2, 3].

Except these obvious advantages of MDRP it is important to specify the following features having crucial value for operation.

1. Due to the gadgets and technologies used in activity and household clever decisions, the relay protection executed on the basis of the microprocessor becomes more convenient and intuitively clear for quick and technicians at service and operation, than devices on semiconductor and electromechanical relays [4].

2. Relay protection on the basis of the microprocessor equipment allows using signs and algorithms of identification of emergencies which were theoretically proved, but did not receive practical application [5, 6].

Therefore, the development and improvement of new means of relay protection and automatic equipment of electrical networks and power supply systems is relevant [7]. So far insufficiently effective are devices of local automatic equipment [8]. In this regard expedient is use of MDRP [9] for widespread devices of the automatic input of a reserve (AIR) and automatic repeated switch-on (ARSO).

2. Materials and methods

The standard scheme of two-transformer substation of 110 kV with distributing devices of the low voltage of 6-10 kV assumes separate work of sections (systems) of tires and the AIR installation on the section Q5 switch (fig. 1) [10, 11].

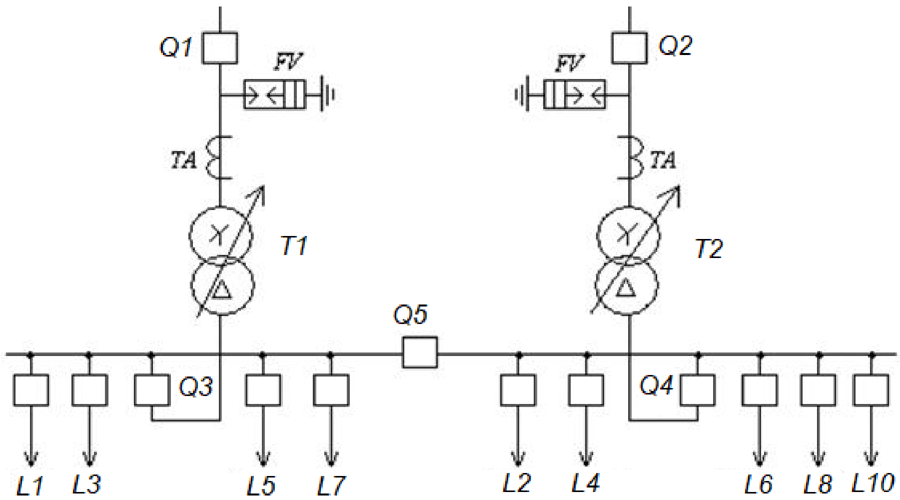

Figure 1. Scheme of two-transformer substation of 110/10 kV

For such scheme the following options of emergency operation are possible:

1. SC on the feeding transformer, shutdown of the transformer the main protection - longitudinal differential, without endurance of time.
2. SC on the feeding transformer, without shutdown of the transformer high-speed protection.
3. SC on tires – is started by MCP with endurance of time or reserve protection against external overcurrents.
4. SC on the departing lines. In this case SC has to be disconnected by the corresponding protection of the departing line, as a rule, with relative selectivity, and with endurance of time.

AIR has to fulfill in the 1st and 2nd cases, including the stand-by power supply after shutdown of the main (damaged) transformer [12, 13]. In the first emergency operation shutdown of the transformer differential protection can be a signal to operation of AIR. In this case the response time of AIR can build up with a selectivity step from the response time of high-speed protection of the transformer and be accepted approximately $t_{o.p.} = 0.3$ s. The signal of operation of high-speed protection of the transformer can be identification sign of need of turning on of the section switch (permission of operation of AIR) after confirmation signals about presence of voltage on a reserve source (the second transformer), strain monitoring of parallel inputs and inclusion of The Departing Line mode.

In the second case as criterion of existence of damage to the transformer (that is after the lead-in switch) critical undervoltage at least can serve in one of phases at simultaneous increase in current of a phase (fig. 2). Previously the setting on voltage can be set, building up from undervoltage at external SC (that is on buses or the departing lines). In practice voltage in such mode is set within $U_{min} = (0,2 – 0,4) \cdot U_{nom} = U_{C.Z.1}$. In case of SC in a transformer chain voltage on tires of secondary voltage will be lower as there will be no feed of voltage from the power source (power transformer). Therefore for an initial setting it is possible to offer formula (1):

$$U_{o.p.2} = (0,2 – 0,4) \cdot U_{nom} / K_N. \qquad (1)$$

where K_N – reliability coefficient.

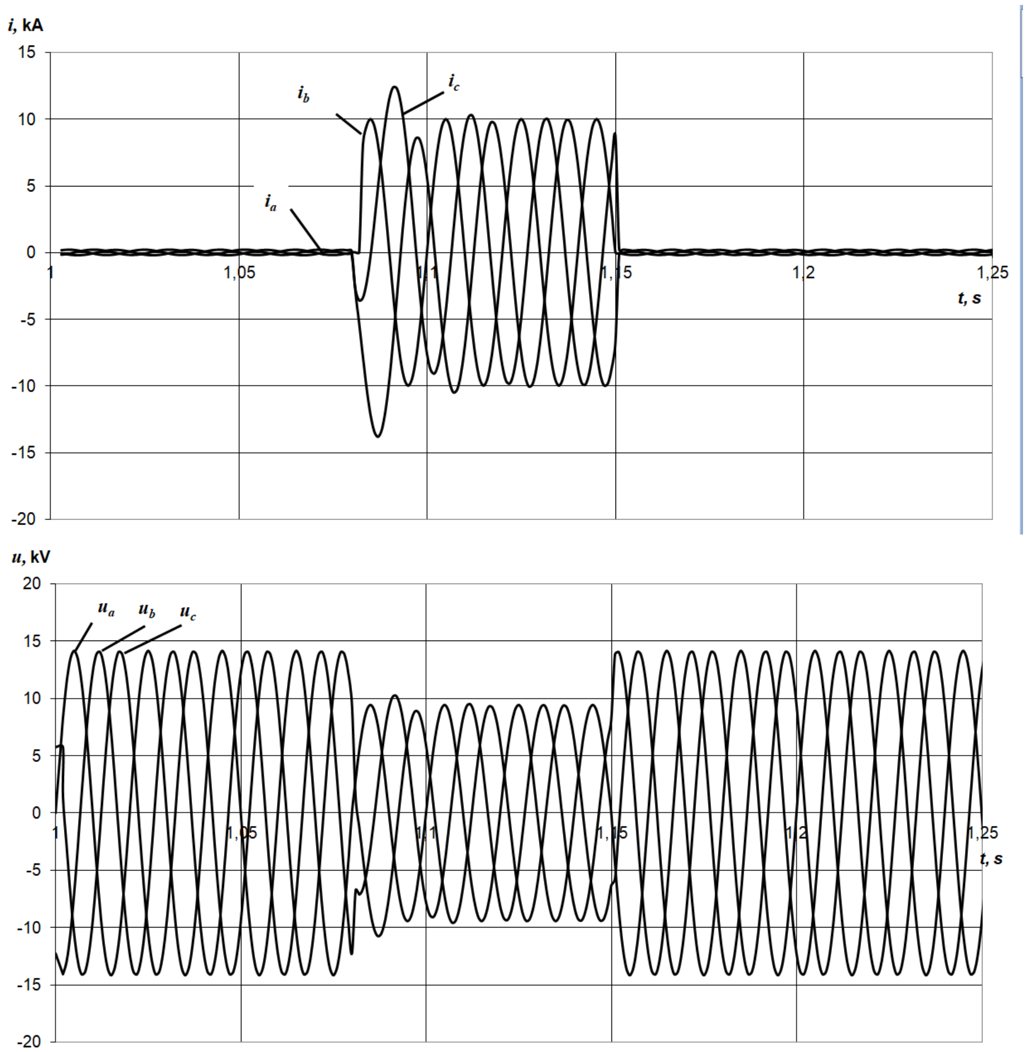

Figure 2. Two-phase SC on buses RU of 10 kV

In this case (that is to turning on of the section switch) the signal of the interlock contact of the section switch (at shutdown) can be a signal to operation of AIR. Actuation time of AIR in this case will be $t_{o.p} = t_{off}$ input off, and this time is minimum possible as inclusion on parallel operation of the damaged main source and a reserve source inadmissibly.

In the 3rd and 4th options of succession of events and operation of AIR should be blocked as at SC on buses and not disconnected SC on the main power supply departing lines is not damaged and does not demand connection of a reserve source. AIR should be prohibited even in case of shutdown of SC on accession and buses the switch on input of the transformer (main power supply). Identification criterion of such option of succession of events is smaller undervoltage in comparison with voltage of $U_{o.p.}$ as in these cases voltage is supported by the EMF of loading of 6 (10) kV, especially motive loading (fig. 2).

3. Results

The implementation of this algorithm can be considered on the example of MDRP Sepam of the second generation having flexible logic that allows setting the sequence of actions demanded for the specific protected object [9].

The described algorithm is implemented by the scheme submitted in fig. 3.

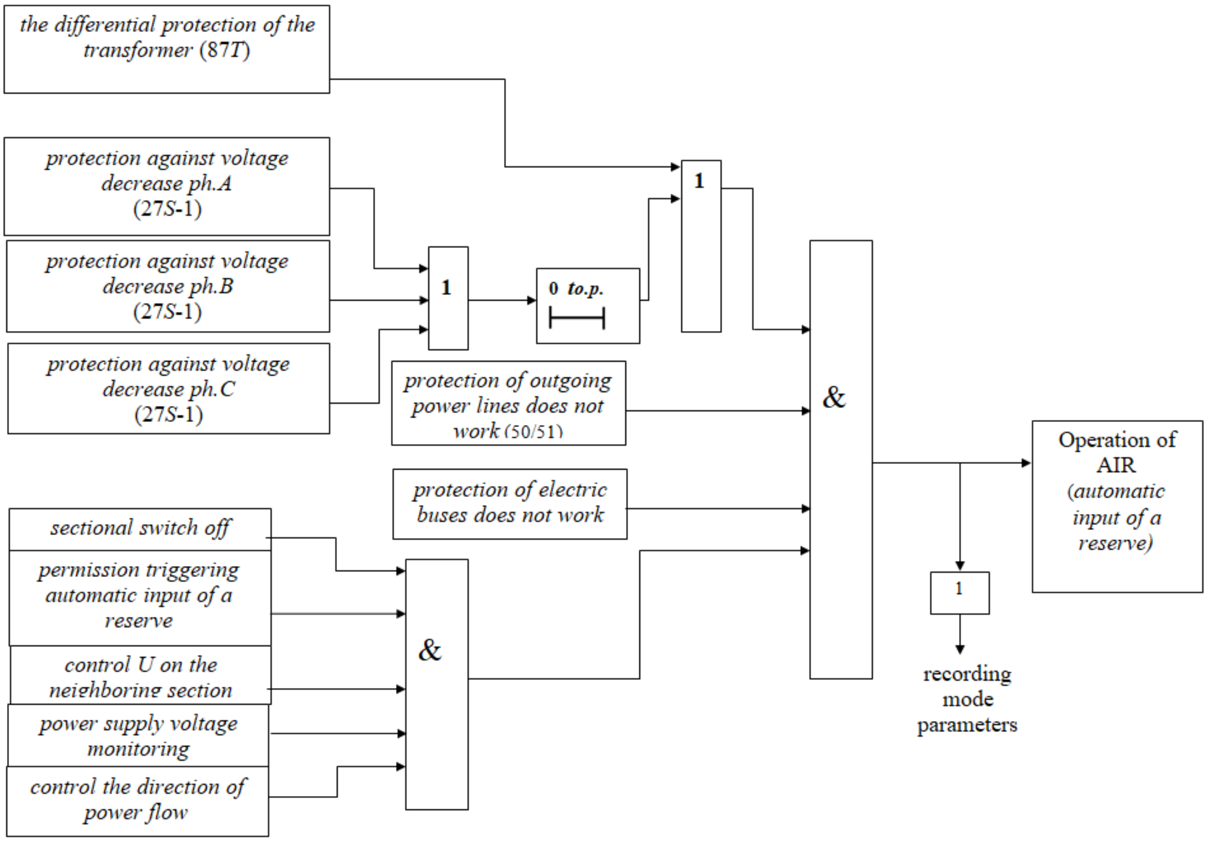

Figure 3. Developed algorithm of action of AIR

4. Conclusion

MDRP allow using difficult and multicriteria signs and algorithms of identification of faults and by that to provide the selection action of relay protection. Transition to similar algorithms will allow reducing the number of excessive operations of systems of relay protection and automatic equipment, to increase sensitivity and high-speed performance of systems of relay protection. The offered algorithm of action of AIR will allow reducing time of a break of power supply of consumers that leads to increase in reliability of power supply of consumers. Transition from simple calculations of settings of protection to accounting of interference and interaction of different types of protection and automatic equipment is the beginning of transition to the self-adaptive smart systems of the relay protection which is not demanding constant control from service staff [14, 15] and providing more reliable power supply, the minimum time of a break of supply of electricity and the maximum sensitivity and high-speed performance.

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