Choice of commutation device and development of the scheme of a universal sectionalizing point with automatic load transfer function for the 0.38 kV electric network

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Abstract. The overestimated length of rural power lines of 0.38 kV leads to the fact that it is often not possible to fulfill both the sensitivity conditions of the protective device installed at the transformer substation and protecting the line from overloads and short circuits, and the requirements of the power supply reliability of consumers. This problem can be solved by installing in-line universal sectionalizing point equipped with an automatic load transfer function. The use of these devices allows dividing a line into sections provides the necessary sensitivity of protection for each section of the line and the possibility of supplying power to undamaged areas from a backup power source. In addition, only with the use of automated switching devices installed in power lines, it is possible to create intelligent electrical networks. When developing these devices, it is necessary to take into account the electromechanical characteristics of switching devices that are planned to be used for switching lines.

1 Introduction

The universal sectionalizing point (SP) equipped with an automatic load transfer (ALT) function, microcontroller control unit of the pole-mounted version (SPALT(PM)) is a device designed to perform the functions of sectionalizing and redundancy in 0.38 kV electrical networks. This device allows dividing the 0.38 kV power line into sections and supply power to undamaged areas from a backup power source via the ATS function [1-4]. For such devices, it is important to choose the right switching device in terms of its electromechanical characteristics. First of all, this device should be controlled remotely, must provide the ability to switch short-circuit currents and perform switching at high speed, must have high switching durability.

2 Switching devices selection

Vacuum contactors and modular circuit breakers can be considered as sectionalizing devices of the sectioning point for automatic load transfer.

Shunt release devices are used to provide remote control from the operator console in ALT circuit with automatic switches. It is possible to remotely disable both single-phase and three-phase circuit breakers with their help. It is sufficient to apply a voltage pulse to its coil using a communication channel to actuate a shunt release device [5-9].

At the moment, a large range of products from both domestic and foreign manufacturers is presented in the world market. The most famous and reputable companies are: IEK, ABB and Schneider Electric [10].

Table 1 presents the main characteristics of shunt release devices above the specified companies.

Thus, it can be concluded that shunt release devices and circuit breakers manufactured by the above companies have almost similar characteristics. However, the use of the GVAS225 series shunt release device in conjunction with GV2ME or GV2P series automatic switches is the most promising.

The second version of the switching device is a vacuum contactor, for example, LSM/TEL-1-4/400 developed by the company Tavrida Electric. The LSM/TEL-1-4/400 low-voltage vacuum contactor is designed for switching electrical circuits in three-phase alternating current networks of industrial frequency with nominal voltage depending on the performance up to 1140 V. The contactor is able to turn on, conduct and disconnect the currents under normal conditions and at working overloads. It is used in the composition of complete devices as a complete product for frequent switching [14].

The advantages of this device are: large mechanical and switching resource; self-control of control circuits and temperature control unit; insensitivity to voltage dips in auxiliary circuits.

Detailed technical characteristics of the vacuum contactor can be viewed in table 2.

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Table 1. Main characteristics of the shunt release devices [11-13].

Technical specifications	IEK PH-47	ABB S2C-A	Schneider Electric GVAS225
Rated operating voltage	230 V	230 V	230 V
Operating temperature range	From -40 to +50 °C	From -40 to +50 °C	From -40 to +50 °C
Operating voltage range	161-253 V	110-415 V (AC) 110-220 V (DC)	220-240 V
Pulse power consumption	3 W	-	1.6 W
Mechanical wear resistance	> 10000 cycles	> 10000 cycles	10000 cycles with GV3P and GV3L or 30000 cycles with GV2ME and GV2P
Degree of protection	IP20	IP20	IP20
Compatibility with automatic switch	BA47-29/100	S200, M200, DS200	GV2L, GV2ME, GV2P, GV3L

Table 2. LSM / TEL-1-4 / 400-352 Specifications.

Parameter name	Value
Rated voltage, V	380
Nominal switching and breaking capacity, kA	4.0
Rated short-time current, 10 s, kA	3.2
Mechanical resource cycles	Not less than 2 000 000
Maximum number of operations per hour	600
Switching resource when rated current off, cycles	50
On time, ms	Not less than 50
Off time, ms	Not less than 80
Rated activation control voltage, V	~220
Minimum voltage perceived as an "ENABLE" command, V	176
Preparation time for switching-on: - after energizing the operating power supply, s - after the previous shutdown operation, s	Not less than 10 Not less than 5.5
Degree of protection	IP40
Service life, years	25
Weight, kg	Not more than 10

Comparison of the characteristics of automatic circuit breaker control devices and a vacuum contactor allows to conclude that it is preferable to use a vacuum contactor as the switching device in the SPALT(PM) since it has the best characteristics in terms of mechanical life, switching on and off and it is more convenient to implement control algorithms.

3 Development of the SPALT(PM) scheme

Algorithm SPALT(PM) should allow the use of the device in the modes sectionalizing point and ALT point. Accordingly, the design of the device should allow to perform these algorithms.

An electrical schematic diagram for the universal sectionalizing point with the ALT function and with the microcontroller control unit of the pole-mounted version

(SPALT(PM) has been developed. The diagram is shown in Figure 1.

In the developed scheme, QS1 and QS2 disconnectors are used for manual switching before and after the KM1 vacuum contactor. This contactor is designed for automated switching of the power circuit in all provided modes of operation. The QS3 throw-over switch serves for shunting SP when it is taken out for repair, for technical maintenance. This allows to eliminate the undersupply of electricity to consumers during the SP maintenance. The switch SA1 is used to switch the manual and remote-control mode of the device. A programmable logic controller is used as the control head unit, which receives data on the electrical parameters of the network (current, voltage, frequency and power) through the measurement module and transmits commands to the control unit of the contactor (via the analog output module). Button SB1 "Stop" is used to manually turn off the 0.38 kV SPALT(PM). It is

Fig. 1. Electrical schematic diagram of SPALT(PM).

also possible to turn off the device manually by turning off the QS 1 switch. This shutdown is possible only if there is no current flowing through the SPALT(PM). The SB2 “Start” button is designed to restore the initial state of the circuit after a manual shutdown using the SB1 “Stop” or after the device trips.

Designed SPALT(PM) can be used as one of the switching devices that are integrated into intelligent electrical networks [15-19].

4 Conclusions

1. The use of devices that allow dividing the power line into areas provides the necessary sensitivity to protect

each section of the line as well as the ability to supply power to undamaged areas from a backup power source. When developing these devices, it is necessary to take into account the electromechanical characteristics of switching devices that are planned to be used for switching lines.

2. The use of vacuum contactors makes it possible to implement the principles of 0.38 kV smart electric networks since they have high network switching speed, a large resource, the ability to switch short circuit currents in 0.38 kV networks and the creation on their basis of automated switching devices installed in power lines.

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