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Determination of changes in the parameters of reed switches in resource-saving relay protection devices of the electrical part of power plants

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Determination of changes in the parameters of reed switches in resource-saving relay protection devices of the electrical part of power plants

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Abstract. This publication is a continuation of many years of research on the development of the basis for building a unique resource-saving relay protection, which does not use current transformers to obtain information about the primary current. The authors propose to consider the possibility of building relay protection devices with the use of reed switches as sensitive elements. However, an important issue remains the study of reed switches parameters with the passage of time and the number of actuations and returns.

1. Introduction
Power installations that are designed to produce or convert, transmit, distribute or consume electrical energy are called electrical installations [1]. Faults and abnormal modes can occur in electrical installations. Relay protection devices, which continuously monitor the status of all elements of the power system, are needed to detect the faulty section and disconnect it from the power system [2]. Classically, the devices of relay protection receive information about the flowing current and voltage from measuring current and voltage transformers. However, current transformers have a number of disadvantages. They are metal-intensive, have large errors in transient modes and create a dangerous voltage when their secondary circuits are broken [3]. It is possible to avoid these disadvantages by using other primary transducers to obtain information, such as reed switches [4-9].

2. Main part
In [5] a study of the properties of reed switches in the devices of resource-saving relay protection of the electrical part of power plants is presented. In [5] the necessity of studying the change in the reed switch parameters with respect to the number of the number of times its contacts are actuated is noted. This paper presents the result of a three-month experiment on twenty new reed switches.

3. Research methods and equipment
The essence of the study is to create conditions for reliable operation of reed switch contacts, which are to create the influencing current is not less than two times higher than the operating current of reed switches. For this purpose was chosen transformer step-down transformer 220V/36V and the inductor coil, which provides the creation of appropriate magnetic flux. Figure 1 shows a schematic of the setup. After removing the initial triggering parameters and return contacts, 20 new reed switches were placed

in the center of the coil. In the diagram under number 1 is the transformer, under number 2 is the inductance coil, under number 3 is the reed switch placed in the inductance coil.

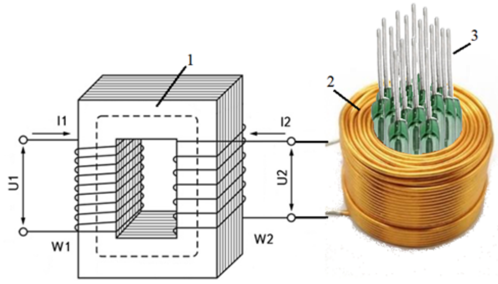

Figure 1. Schematic diagram of the reed switch test setup. 1: transformer; 2: inductor; 3: reed switches; U1: primary voltage; U2: secondary voltage; W1: number of turns of the primary winding; W2: number of turns of the secondary winding; I1: primary current; I2: secondary current.

At first the reed switches were set for 1 month of continuous operation. In one month each reed switch performed about 259.2 million actuations and returns, based on 100 actuations (50 Hz - voltage frequency) per second for 30 days. Afterwards the response and return parameters of the reed switch contacts were taken again. Then the reed switch contacts were installed in the test setup for another two months of continuous operation. In total each reed switch closed and opened its contacts 777.6 million times at a rate of 100 actuations per second (50 Hz) for 90 days.

The initial actuation and return parameters were taken as follows. After all new reed switches had been numbered, they were placed one by one in a lab inductance coil, with a constant voltage applied to the leads. The voltage was gradually increased from 0 V to 20 V. The reed switch contacts were connected to a series-connected battery and a resistor. At the moment of actuation of the reed switch contacts on the resistor the voltage drop appeared due to closing of the circuit, at the return of the reed switch contacts - the circuit was opened and the voltage dropped. The voltage drop across the resistor and the voltage applied to the laboratory inductance coil were recorded with a UNI-T UPO3254E oscilloscope. For a single reed the determination of the trigger and return voltages was determined three times. This is necessary to confirm the repeatability of the results and to avoid measurement error. The circuit for setting the parameters of the reed switches remained assembled during the whole experiment, in order to exclude the possibility of introducing additional errors. After each stage (stage 1 - 1 month of operation of the reed switches and stage 2 - 3 months of operation), the procedure of reading the parameters of actuation and return of the reed switches was repeated. The results of the readings in absolute values are presented in Table 1.

Table 1. Changes of the reed switches parameters in absolute values.

No reed switch	new reed switch		after a month of work		after 3 months of work	
	U_{cp}	U_v	U_{cp}	U_v	U_{cp}	Uv
1	837	526	842	531	832	516
2	857	476	887	516	842	491
3	832	667	842	672	812	652
4	807	461	827	466	812	451
5	807	431	812	436	787	421
6	837	556	842	566	827	546
7	807	667	827	672	812	672
8	747	556	752	566	737	556
9	887	822	892	827	867	807
10	732	456	742	451	737	451
11	777	541	812	546	797	541

No reed switch	new reed switch		after a month of work		after 3 months of work	
	U_{cp}	U_v	U_{cp}	U_v	U_{cp}	Uv
12	902	556	927	576	892	566
13	822	541	827	546	827	531
14	822	526	842	531	827	516
15	807	586	827	566	812	546
16	747	446	767	356	767	110
17	837	526	867	531	847	501
18	837	526	867	516	842	516
19	837	586	842	576	832	566
20	807	541	812	536	812	531

To determine the relative magnitude of changes in the parameters of operation and return of reed switch contacts, we used formula 1, and the results are presented in Table 2. Thus we obtained the percentage of change in the parameters.

$$\varepsilon_{Ucp/Uv} = \frac{U_{cp(new)} - U_{cp(after1m/after3m)}}{U_{cp(new)}} \cdot 100\% \quad (1)$$

Table 2. Changes of reed switch parameters in percent.

№ reed switch	after a month of work		after 3 months of work	
	εUcp	εUv	εUcp	εUv
1	-0.60	-0.95	0.60	1.90
2	-3.50	-8.40	1.75	-3.15
3	-1.20	-0.75	2.40	2.25
4	-2.48	-1.08	-0.62	2.17
5	-0.62	-1.16	2.48	2.32
6	-0.60	-1.80	1.19	1.80
7	-2.48	-0.75	-0.62	-0.75
8	-0.67	-1.80	1.34	0.00
9	-0.56	-0.61	2.25	1.82
10	-1.37	1.10	-0.68	1.10
11	-4.50	-0.92	-2.57	0.00
12	-2.77	-3.60	1.11	-1.80
13	-0.61	-0.92	-0.61	1.85
14	-2.43	-0.95	-0.61	1.90
15	-2.48	3.41	-0.62	6.83
16	-2.68	20.18	-2.68	75.34
17	-3.58	-0.95	-1.19	4.75
18	-3.58	1.90	-0.60	1.90
19	-0.60	1.71	0.60	3.41
20	-0.62	0.92	-0.62	1.85

Figure 2 graphically shows the results of taking off the parameters of operation and return of reed switch contacts in absolute values in three states - new reed switches, after one month of continuous operation, after three months of continuous operation.

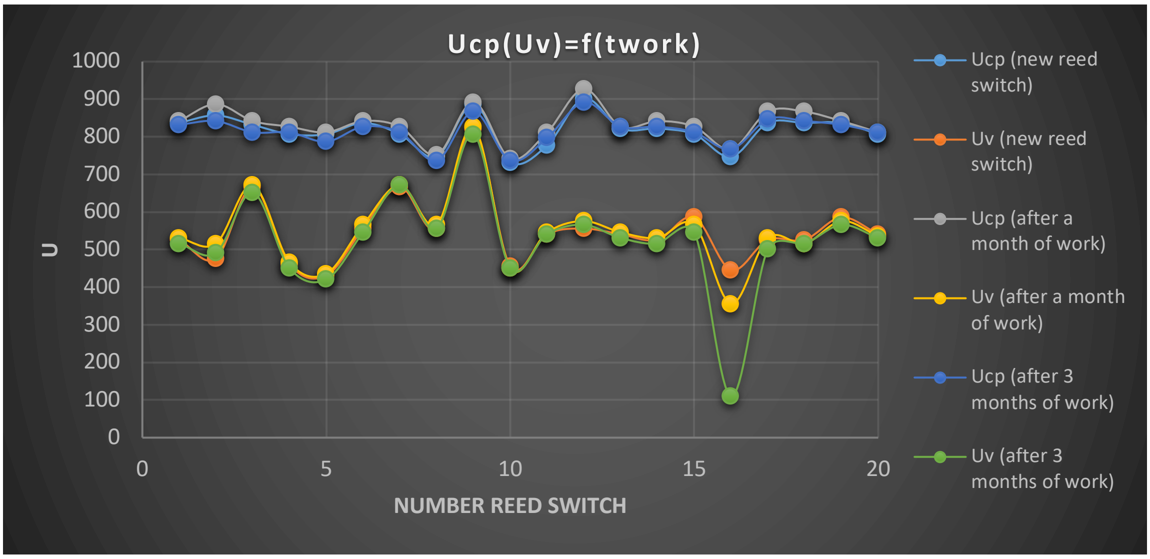

Figure 2. Changing the parameters of the reed switches.

4. Conclusions

According to the results of the study, we can conclude about the sufficient stability of the parameters of operation and return of the reed switch contacts, depending on the amount of time worked and the number of actuations. The deviation in the main mass does not exceed 3%. However, as can be seen in Figure 2, the contact return parameters of reed switch number 16 after the first month changed by 20%, and after three months by 75%. In this case, this reed must be rejected and not applicable in the future. It should be concluded that this procedure is recommended before introducing the reed to the experiments and studies, to improve the reliability and accuracy of the results.

Acknowledgements

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