

**The ED3F and ED3FL- type chokes for protecting capacitors' compensation batteries**

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The technical parameters of the products are still being adjusted to changeable operational conditions and Customers' increasing needs and requirements. This process enables the production of new types of devices. The ED3F chokes, manufactured so far by ELHAND TRANSFORMATORY, and aimed at protecting the batteries of capacitors against unfavourable impact from the current higher harmonics, have recently been technically improved.

**The ED3F and ED3FL chokes**

As a result of design work, two new types of protective and suppressing chokes have been created, i.e. ED3F and ED3FL-type, which are different from the others insofar as their technical parameters and assignment are concerned.

When starting work on a new device, the designer has to determine the optimum design assumptions that describe precisely the later operational conditions of the choke. However, it is extremely rare for a designer to receive the operational conditions of the choke from the purchaser, especially the most essential information concerning the qualitative and quantitative content of the current harmonics in the anticipated workplace of the choke.

Most frequently, the assumptions for the design are completed on the basis of the information obtained from the customer, taking into account the requirements set out in the norms in force and data gathered during the long-term manufacturing experience.

Owing to strict design assumptions (table 1), the ED3F chokes have been adjusted to the

protection of capacitors compensation batteries in extremely hard conditions, i.e. at very high content of higher harmonic in the battery current.

During the research on the ED3FL chokes, the principle of adjusting the working parameters of these chokes to similar chokes manufactured by European producers was applied, by assuming similar design guidelines. The ED3FL chokes are perfect at playing their protective role in the typical working conditions of the capacitors' compensation batteries. Together with the battery capacity, they form resonance systems, protecting the capacitors against overload with currents of higher harmonic frequencies. However, it should be noted that, on average, the ED3FL chokes are 30 – 40% lighter than ED3F chokes. This has a direct impact on the price for these devices. The basic differences between the ED3F and ED3FL chokes are shown in Table 1.

Type	Current harmonics content assumed			Magnetic linearity	Insulation temp. class
	I <sub>3</sub> 150Hz	I <sub>5</sub> 250Hz	I <sub>7</sub> 350Hz		
ED3F	7,5% I <sub>1</sub>	30% I <sub>1</sub>	15% I <sub>1</sub>	I <sub>Lin</sub> =1,3xΣI <sub>r</sub>	T40E (120°C)
ED3FL	0,5% I <sub>1</sub>	5,0% I <sub>1</sub>	0,5% I <sub>1</sub>	I <sub>Lin</sub> =1,2xΣI <sub>r</sub>	T40B (130°C)

Table 1 Selected parameters for ED3F and ED3FL chokes

Other technical parameters (i.e. rated current and voltage, induction, power range) are common for both types of chokes.

The parameter known as magnetic linearity determines the choke's maximum current I<sub>Lin</sub> for which the induction, when subject to change, does not exceed the value of L ≥ 95% L<sub>n</sub>. Thus, it defines the choke induction stability when subject to loads. It is dependant on the magnetic circuit property and selection of the choke working point at the magnetisation characteristics. The suppression (choking) ratio is determined for the choke-capacitor system as per the following dependency:

$$p\% = 100 * \frac{U_L}{U_C} = 100 * \left( \frac{f}{f_r} \right)^2$$

The most frequently manufactured chokes are those for LC systems with the suppression ratios  $P=7\%$  and  $p=5\%$ , which is compliant with the resonance frequencies,  $f_r=189\text{Hz}$  and  $f_r=223\text{Hz}$  respectively. The chokes with such suppression frequencies are widely used in compensation systems, in which the fifth and seventh harmonic reach an alarming high level. In the systems with considerable content of the third harmonic, chokes with the suppression ratio  $p=14\%$  are used, i.e. with the resonance frequency  $f_r=133\text{Hz}$ .

The market success of the wide range of chokes and transformers manufactured by ELHAND TRANSFORMATORY depends to great extent on the designers and technologists who, by selecting proper materials and determining the optimum design assumptions for respective types of devices, make it capable of meeting the ever-growing customer requirements and, at the same time, maintain a competitive edge.

### **The ED3F and ED3FL chokes structure**

ED3F and ED3FL chokes are manufactured in the three-phase version for the power range from 2,5 to 80 kVar. The inductions and rated currents powers of the suppression chokes assigned for the protection of the capacitors compensation batteries are mainly dependant on the capacity and power of the batteries with which they are going operate.

The chokes cores are made of anisotropic silicon sheets of a thickness between 0.25 and 0.5 mm. The windings are usually coiled with round winding wire and rolled formed wire. When formed in the right manner, they are placed at the core columns. Then the core is completed with a missing yoke, while maintaining suitable widths of the air gaps. The choke is then subject to vacuous impregnation and thus protected against environmental impact. Furthermore, the chokes are equipped with terminals and cable tips, as well as mechanical instrumentation, frequently necessary for transportation. The ready-

made devices are tested at the electrical testing station in order to detect possible defects in the product that may not have been noticed during the manufacturing process.

The production process is carried out on the basis of the procedure for quality assurance, compliant with norm ISO 9002, guaranteeing the highest quality of the machines and devices produced.

### **Bibliography**

- [1] *Norm IEC 60938-2:1994*
- [2] *Norm EN 61558:2000*
- [3] *Norm IEC 60289:1997*