ELECTRIC FIELD MEASUREMENT FOR LOW VOLTAGE AUTOMATIC CIRCUIT BREAKER

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Abstract: In this paper I present the measurement of the electrical field around the low voltage automatic circuit breaker in different scenarios. The measurements are taken from two axes, and will be compared with values obtained from mathematical simulations. The methods that are used are elaborated by the author in his doctoral paper work.

Keywords: electric field, automatic circuit breaker, metra hit,

1. INTRODUCTION

The experiment was making to determine the electric field intensity produced by a low voltage automatic circuit breaker. The result obtained in experiment a used to determine the area with the large value of electrical field intensity, to determine that these experimental values are bigger or small that the electric field limit, and, to compare with experimental values obtained in a simulation environment.

2. DESCRIPTION OF THE EXPERIMENTAL STAND

The experimental stand is compound from a 10 A automatic circuit breaker, an autotransformers used to modified the voltage, a unidirectional electric field meter (Metra Hit FMA1), and a multimeter (DVM345di) with RS232 port which transmit the measured value to a PC.

In figure 1 is presented the compound elements of the experimental stand.

Fig. 1: The components of experimental stand: automatic circuit breaker, Metra Hit FMA1, DVM345di multimeter.

The two scenarios for which are made the measurements are:

- For constant voltage (220 V) the distance between open contacts is modified, and the electric field intensity is measured along a two axex AB and EF, like is presented in figure 2;
- For the same distance between open contacts (maximum value), the voltage is modified, and gives the following values: 200 V, 220 V and 240 V.

In figure 2 is presented the experimental stand and the axes used to measure the electrical field intensity.

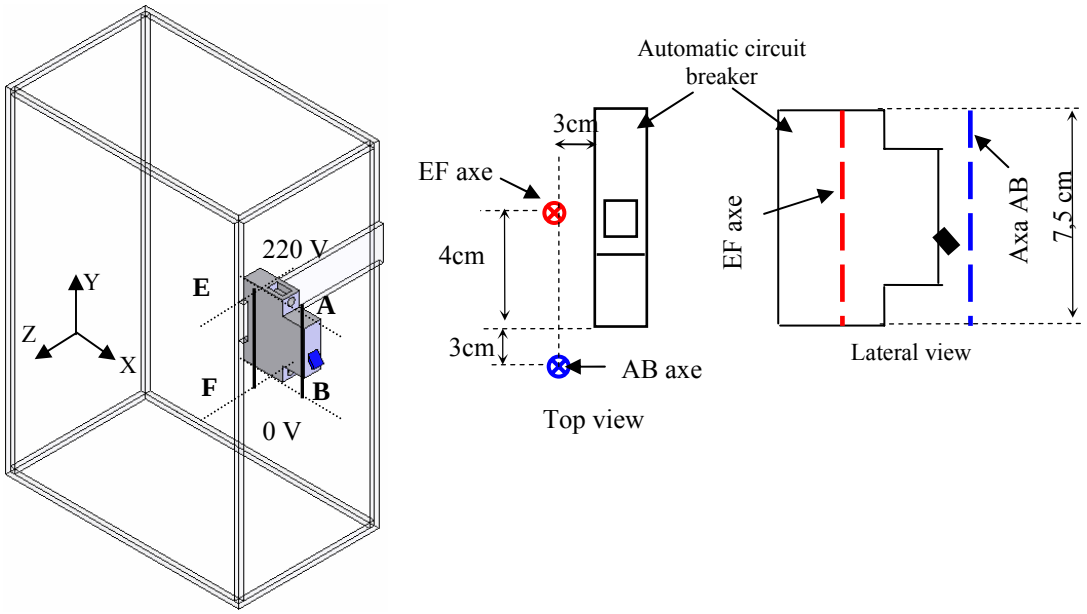

Fig. 2: The representation af axes used to measurement of electric field intensity (isometric, top and lateral view)

To obtain different distance between open contacts, the circuit breaker was opened and makes in him two gaps, one on each side of circuit breaker. These gaps are placed between mobile contact and the bearing surface of him on the circuit breaker enclosure. In this gap we introduce insulating material materials with different depth (0.8mm and 1.6mm).

The measurement was made after two axes, which are represented in figure 2, and this are:

- AB axe – which is place in front side of the automatic circuit breaker, at about 30 mm from this.
- EF axe – is placed in lateral side of the automatic circuit breaker, at about 30 mm from this. The position of this axe is in the neighbourhood of the connection slots and of the surface of contact.

The measurement was made for these two axes, over 75 mm long, which is the dimension of automatic circuit breaker. The measurement was made for the three axes X, Y and Z to compound the electric field intensity. By programming the scanning mechanism [1], we obtained 46 point of measurement, at 1.66 mm each over.

3. RESULTS

3.1. Electric field intensity variation along AB ax*e*

The resultant electric field intensity was compounded from the values measured on the three directions: X, Y and Z, as show in figure 3.

In figure 4 is presented the comparison between the resultant electric field intensity for three different distances between open contacts, respectively 5.36, 4.5 and 3.75 mm.

By analysing the values measured along AB axes for the electric field intensity we can conclude the followings:

- For all three study cases we observed that on the OY direction the effective value of electric field intensity are the greatest, and on the OZ direction are the lowest;
- On the all three directions, the variation of the electric field intensity has same rate of curve;
- The maximum value of the electric field intensity is obtained near to point A, which is the input terminal of voltage. The minimum value is greater that 100 V/m.

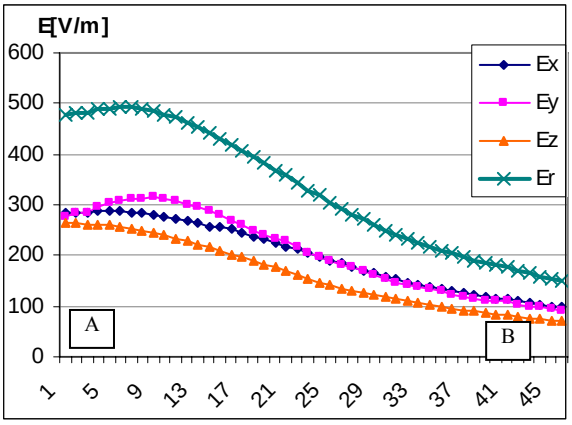

Fig. 3: The electric field intensity measured on AB axe for the three directions, and resultant, for the maximum distance between open contacts (5.36 mm) at 220 V voltages.

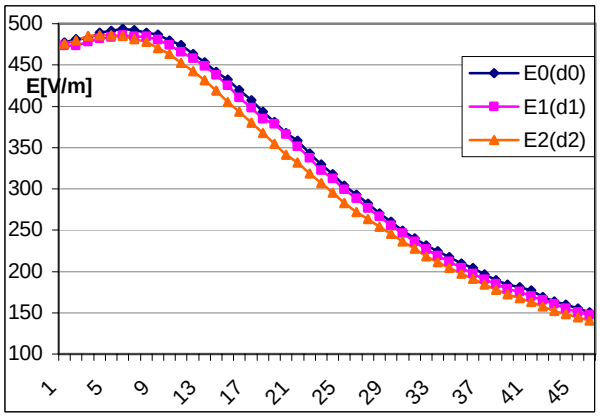

Fig. 4: The comparison of electric field intensity along AB axe, depending of distance between open contacts: d0= 5,36; d1=4,5; d2=3,75.

In the table 1, is centralised the maximum, minimum and medium values of electric field intensity measured on the AB axe for all three values of distance between opened contacts.

Table 1

The maximum, minimum and medium values of electric field intensity depending of distance between opened contacts.			
	d0 = 5,36mm	d1 = 4,5mm	d2 = 3.74mm
Emax [V/m]	**493.88**	486.26	486.01
Emin [V/m]	**150.91**	147.42	140.74
Emed [V/m]	**329.58**	324.09	314.03

We can estimate that the electric field intensity fall non-linear with the distance between contacts, heaving a more abrupt slope so as the distance between open contacts are smaller.

3.1. Electric field intensity variation along EF axe

In figure 5 is presented the variation of electric field intensity (effective values) along EF axe depending on distance between open contacts.

By analysing the values measured along EF axes for the electric field intensity we can conclude the followings:

- The maximum value for electric field intensity is obtained from the minimum distance between open contacts;
- The most significant variation of electric fiend intensity is obtained for the first 8 point of measurements (approximately 13 m from the top contact)
- The most significant growing of electric field intensity is obtained at the first decreasing of the distance between open contacts.

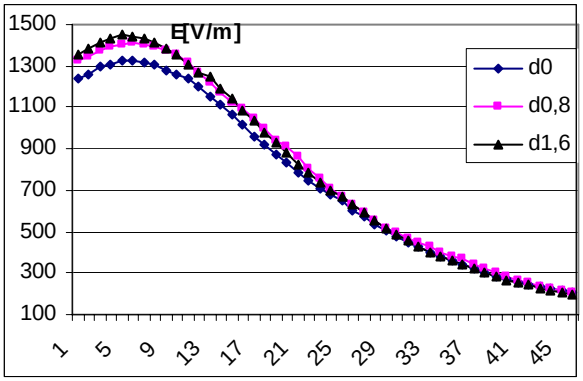

Fig. 5: The comparison of electric field intensity along EF axe, depending of distance between open contacts: d0= 5,36; d1=4,5; d2=3,75.

4. CONCLUSIONS

By studying the results of measurements of electric field intensity we can conclude:

- at modification of distance between open contacts:
  - on AB axe, if the distance between contacts decrease then the electric field intensity decrease, with 5.5V/m for the first 0.8mm and then with 10V/m for the next 0.8mm.
  - on the EF axe, if the distance between contacts decrease then the electric field intensity grows.
- At modification of the voltage applied on the automatic circuit breaker, on the both axe, AB and EF, the electric field intensity grow with the grown of the voltage.
- Only AB axe can be used to monitoring the electric field intensity to can determine the distance between open contacts or to determine the electric potential.
- The EF axe can be used only to monitoring the voltage.

5. REFERENCES

[1] Popa Sorin Eugen, Puiu Petru Gabriel, "Aspects concerning the electromagnetic print determination of the electric device"MOCM-11, Bacău, 2005, vol 4, ISSN 1224-7480;
[2] Leonte P., Baraboi A., Hnatiuc E., Adam M., Dispozitiv sesizor de câmp electric alternativ. Brevet RO 107772 61(1993).
[3] Pepe R. C., ESD Multiple Discharge, IEEE International Symposium on Electromagnetic Compatibility, 253-258,1999.
[4] ***LabView Data Acquisition VI Reference Manual for Windows, National instruments, September 1994 Edition.
[5] Kouyoumdjian A., R. Calvas and J. Delaballe, "La compatibilité électromagnétique", Institut Schneider Formation February 1996, ref. MD1CEM1F.
[6] Ioan D., Radulescu M., Ciuprina Gabriela, Fast Extraction of Static Electric Parameters with Accuracy Control, Scientific Computing in Electrical Engineering (W.H.A. Schilders et al Eds), Springer, pp.248-256, 2004.