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# Analysis of the Electric Arc in Low Voltage Circuit Breakers

A. Iturregi[1], E. Torres[2], I. Zamora[2]

[1] Department of Electrical Engineering
EUITMOP, University of the Basque Country
Colina Beurko s/n, 48901 Barakaldo (Spain)
Phone/Fax number: +34 94 601 4979/7800, e-mail: araitz.iturregi@ehu.es

[2] Department of Electrical Engineering
ETSI, University of the Basque Country
Alameda Urquijo s/n, 48001 Bilbao (Spain)
Phone/Fax number: +34 94 601 7332/4200, e-mail: esther.torresi@ehu.es, inmaculada.zamora@ehu.es

**Abstract.** Low Voltage Circuit Breakers (LVCBs) play an important role in electric power systems as they are responsible for switching on and off electric currents, as well as for safety of equipment and human beings. Their working base is the electric arc that appears between their contacts when establishing or interrupting the electric current in the circuit. This electric arc is a complex phenomenon where lots of physic interactions take place in a very short time. Therefore, the optimization of the operation of LVCBs makes necessary a deep understanding of the phenomena involved in the appearance of the electric arc. This knowledge can be achieved by means of modelization and simulation tools. This option allows us to obtain the evolution of physical magnitudes which would be difficult to measure in laboratory tests. The aim of this paper is to describe the phenomena of the electric arc in LVCBs, as well as the specification of the mathematical, physical and software needs for its modelization and simulation.

## Key words

Low Voltage Circuit Breaker (LVCB), Electric arc, Modelization, Simulation.

## 1. Introduction

A Circuit Breaker (CB) is a switching device which can open or close a circuit in a small fraction of time, being its purpose the establishment or interruption of the circulation of current through the circuit under usual or unusual working conditions.

The interruption process of the current in a CB is always carried out by an electric arc. This process begins when the movable contact starts to separate. As a consequence, the contact area between contacts decreases and current density gets larger, until the energy associated with this process causes the metal of the contacts to begin to vaporize and an arc appears. In spite of the existence of a physical separation of the switching contacts, the established arc makes possible that current continues flowing. Thus, the current interruption involves the extinction of the electric arc, which is achieved when the interrupting medium between contacts becomes again an isolating medium [1-3].

In this paper the characteristics of the electric arc are described with the aim of characterizing the interruption process in low voltage devices. In addition, an overview of the most important models and simulation methods are exposed, as well as the last trends in the development of low voltage arc simulation. Finally some examples are shown [4-6].

## 2. Electric arc phenomena in LVCB

Physically, the arc is an incandescent gas column, with an approximate straight trajectory between electrodes (anode and cathode) and temperatures over 6000 and 10000 ºC. Metallic contact surfaces are also incandescent and a reduction in the cross-section of the arc is observed near them. This way, three regions can be defined: a central zone or arc column and the anode and the cathode regions (Figure 1).

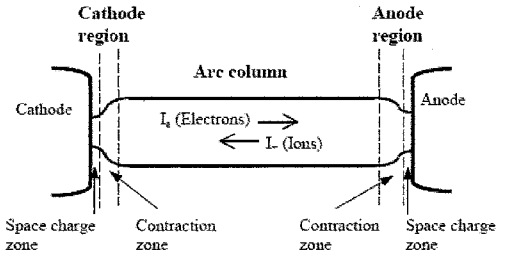


Figure 1. Electric arc structure [2]

Regarding the creation of the arc, two phenomena have to be taken into account. On one hand, conduction of electricity by gases. On the other hand, the emission of electrons by metals. Switching devices are based on the