EXPERIMENTAL RESULTS FOR INTERNAL RESISTANCE VARIABILITY OF TESTING APPARATUS FOR LOW CURRENT CIRCUITS IN EXPLOSIVE ATMOSPHERES

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ABSTRACT: *For almost 5 decades, low current equipments protected by the type of protection intrinsic safety are tested in explosive atmospheres with the help of standardized test rig. This test rig includes an apparatus that produces electrical sparks in the explosive atmosphere due to the energy supplied by the tested circuit in which it is interconnected.*
Within an interlaboratory testing program coordinated by PTB Germany, in year 2012, some reproducibility issues for the results of this test were revealed. The unexpected variability of this test results is due to an excessive sensitivity over the testing conditions.
Within IECEx, the working group WG4 of Technical Committee TC31 follows the improvement of test reproducibility by identifying some new tolerance intervals for parameters that define the testing conditions, based on experimental results.
This paper has the purpose of underlining and analyzing the internal resistance variability of testing apparatus for low current circuits in explosive atmospheres.

KEY WORDS*: intrinsic safety, low current circuits*

1. INTRODUCTION

Process of industrial field and the energetic field modernization is closely supported by a new complex infrastructure based on intelligent systems.

These intelligent systems are interconnected with technological installations which process combustible substances (gases, vapours, mists, dusts, lint, fibers) whose storage and processing involves the existence of explosion risk.

Spaces affected by the presence of dangerous concentrations of combustible substances are grouped and classified so as to be possible the typification of explosion protection.

Entirely technological equipment can represent the ignition source for such explosive atmospheres.

To reduce the risk of explosion, in the last century were conceived several types of protection, which applied to equipment (even from the design and production phase) significantly reduces the possibility of ignition of explosive atmospheres from such equipment.

A distinct category of electrical equipment is the low current equipment. This category includes all the electrical equipment systems designed for information transfer and processing.

Explosion protection of these types of equipment and systems is easily accomplished by using the type of protection intrinsic safety.

Implementation of the type of intrinsic safety protection involves limiting the stored and transited energy through circuits at non-dangerous values from the point of view of ignition possibilities for the given explosive atmospheres.

Brief description of the spark test apparatus

Low current electrical equipments are tested regarding the capacity of non-igniting the explosive atmospheres by using a device that performs electrical discharges in an explosive testing mixture.

Brought electricity is taken from the equipment under test and transferred to an assembly of mobile elements.

The elements that get into intermittent contact to produce the sparks are four tungsten wires and a cadmium disk.

In fact, from electrical point of view, this equipment makes electrical resistance variations between the closed circuit and open circuit.

Due to the complex relative movement between the wire and disc, the disc surface becomes grooved so that the mere passage of the wire will determine a variable profile of the contact resistance.

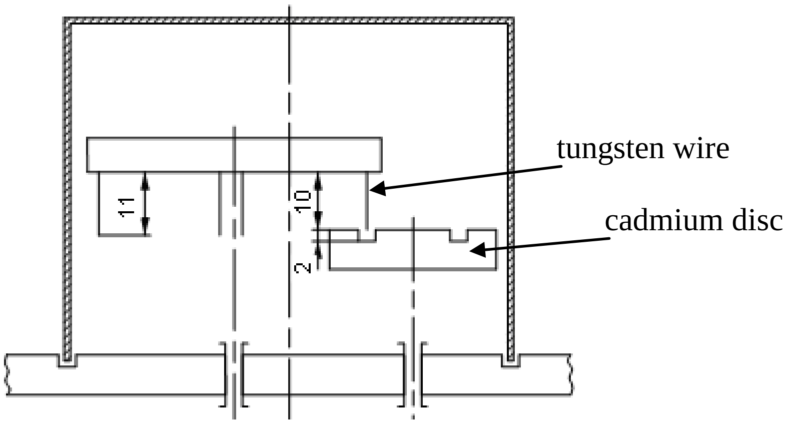

Figure 1 Schematic diagram of the spark test apparatus chamber, in vertical section [13]

Description of the experimental test rig

For acquisition of contact resistance values of the spark test apparatus were used a car battery as supply source, a limiting resistor R = 300 ohms and an oscilloscope, and the spark test apparatus was modified so that 3 of the 4 tungsten wires were gave up.

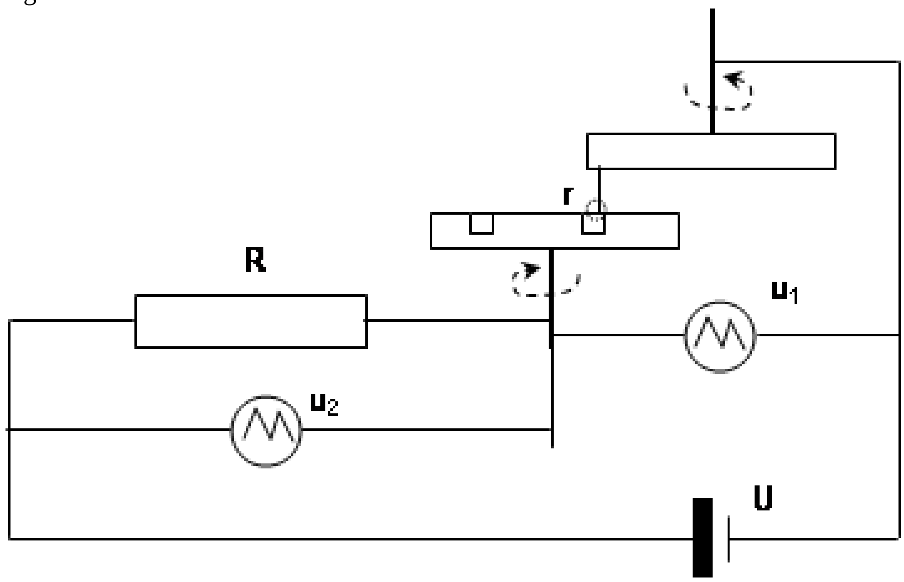

Figure 2 Experimental test rig

During the spark test apparatus operation the voltage on the spark test apparatus contacts varies between 0 and U. Variation of *u1* values measured with the oscilloscope is shown in figure 3.

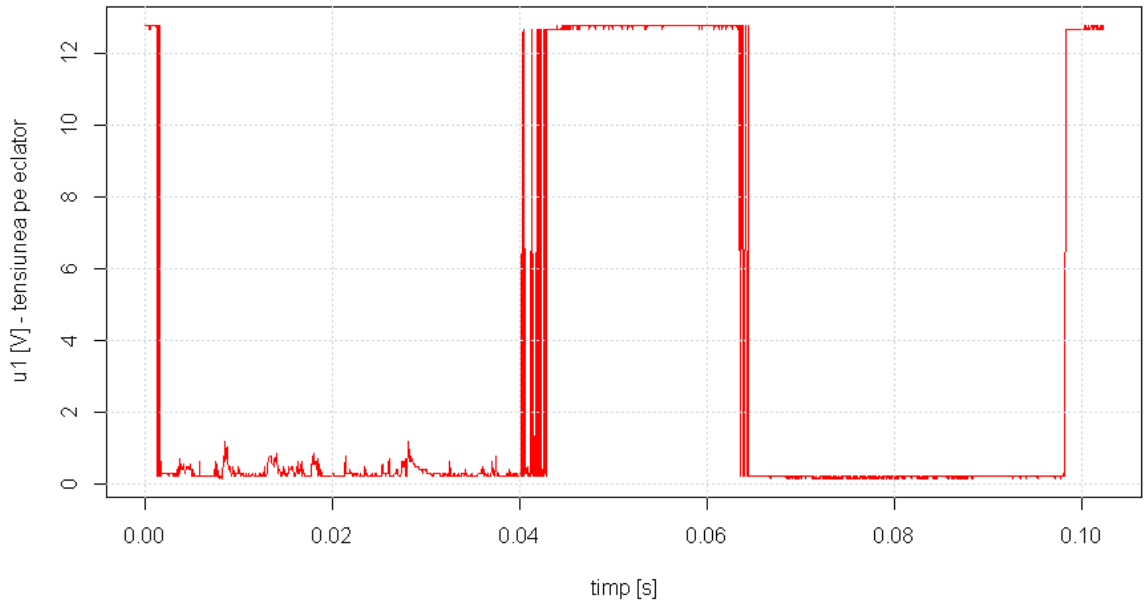

Figure 3 Voltage variation on the spark test apparatus for a window of 100 ms

In the diagram in Figure 3 is visible the voltage variation on the spark test apparatus in the range 0 ÷ U.

In order to highlight the effect on the spark test apparatus resistance due to the passage of the tungsten electrode over the scratched profile of the cadmium disk the oscilloscope trigger was set to record the voltage values from the moment when the voltage on the spark test apparatus drops below 0.05 V. The resulting voltage values are shown in the diagram in figure 4. Synchronized with the acquisition of voltage values on the spark test apparatus, on channel 2 was recorded the voltage value on the series resistor R. The resulted values are shown in the diagram in figure 5.

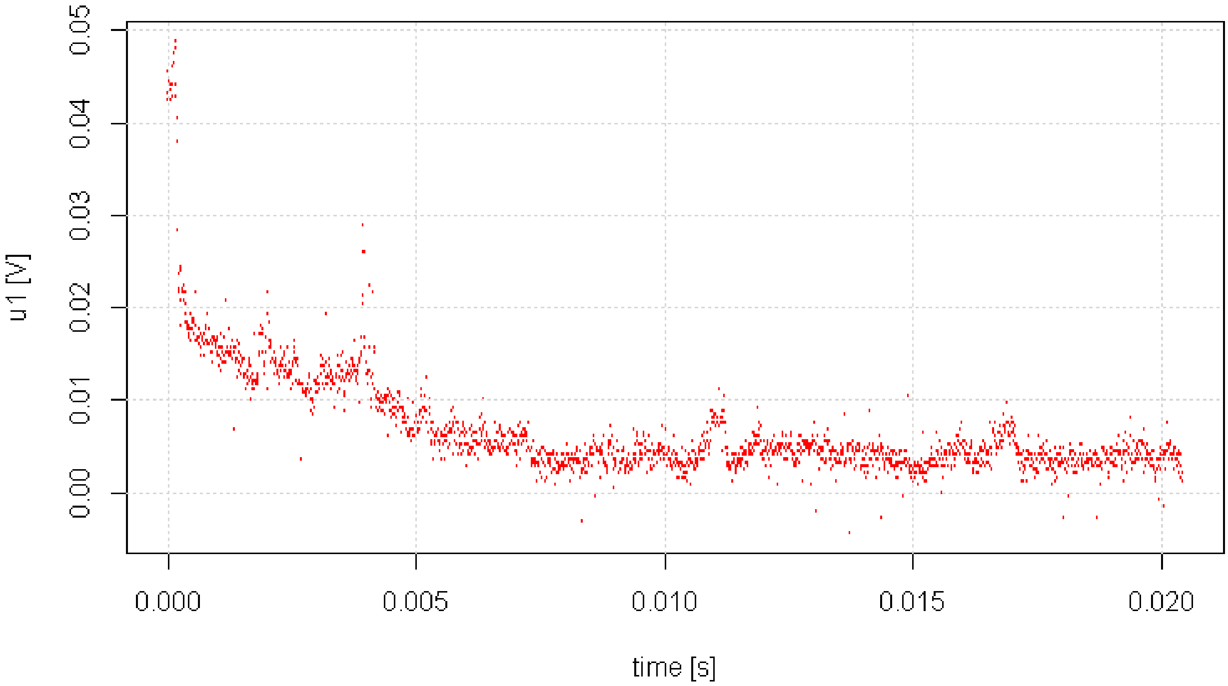

Figure 4 Voltage variation on the spark test apparatus for a window of 20 ms and 0.05 V

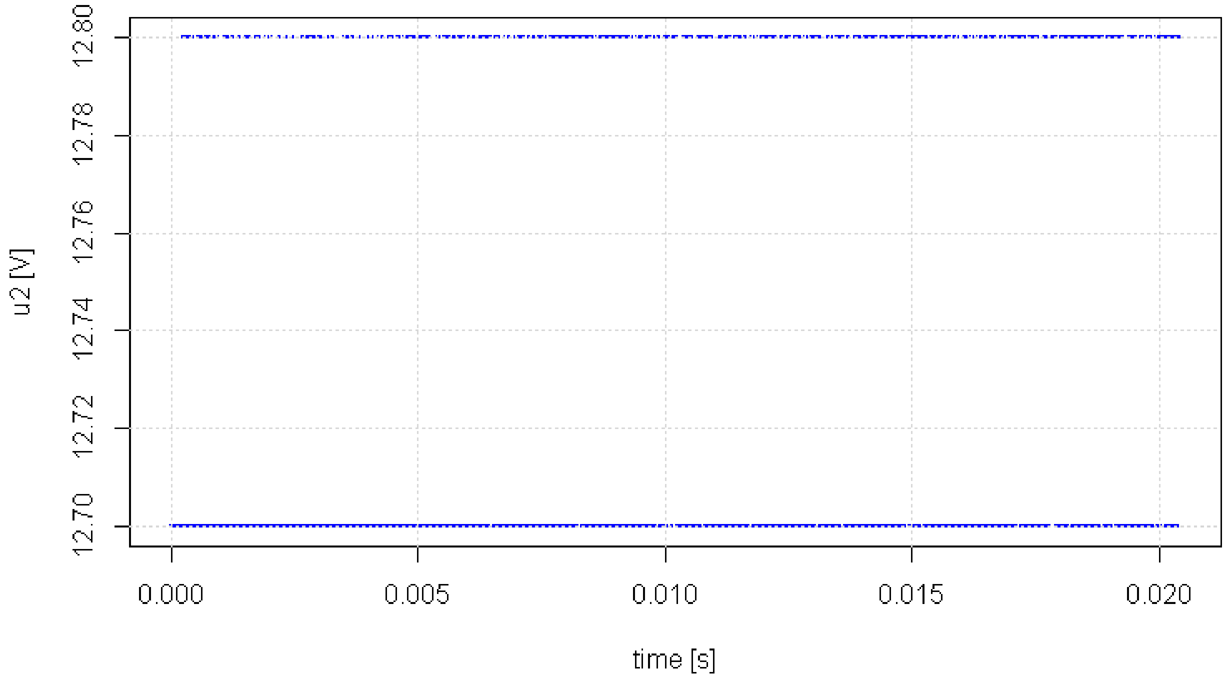

Figure 5 Voltage variation on resistor R for a window of 20 ms

Using relation (1) to calculate the equivalent resistance of the spark test apparatus have resulted the values shown in the diagram in Figure 6. Also, the distribution of the equivalent calculated resistance values of the spark test apparatus is presented in the histogram in Figure 7.

It is observed that the distribution of resistance values of the spark test apparatus is close to an exponential characteristic.

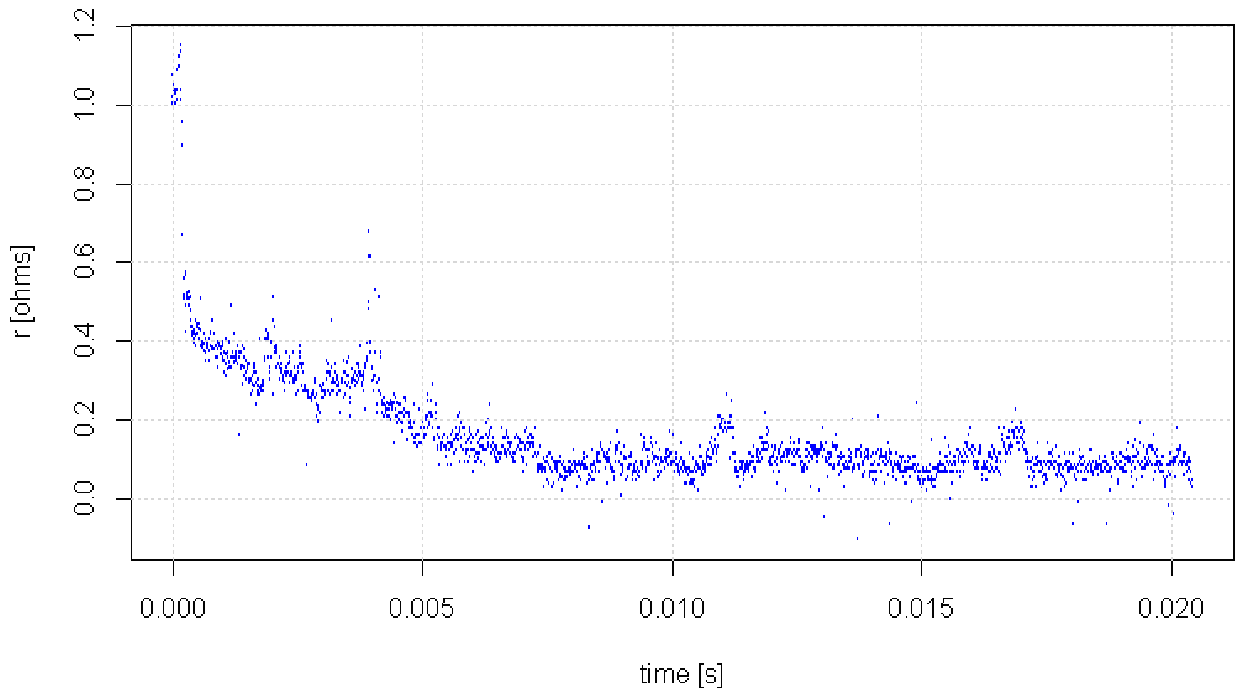

Figure 6 Resistance variation on the spark test apparatus for a window of 20 ms

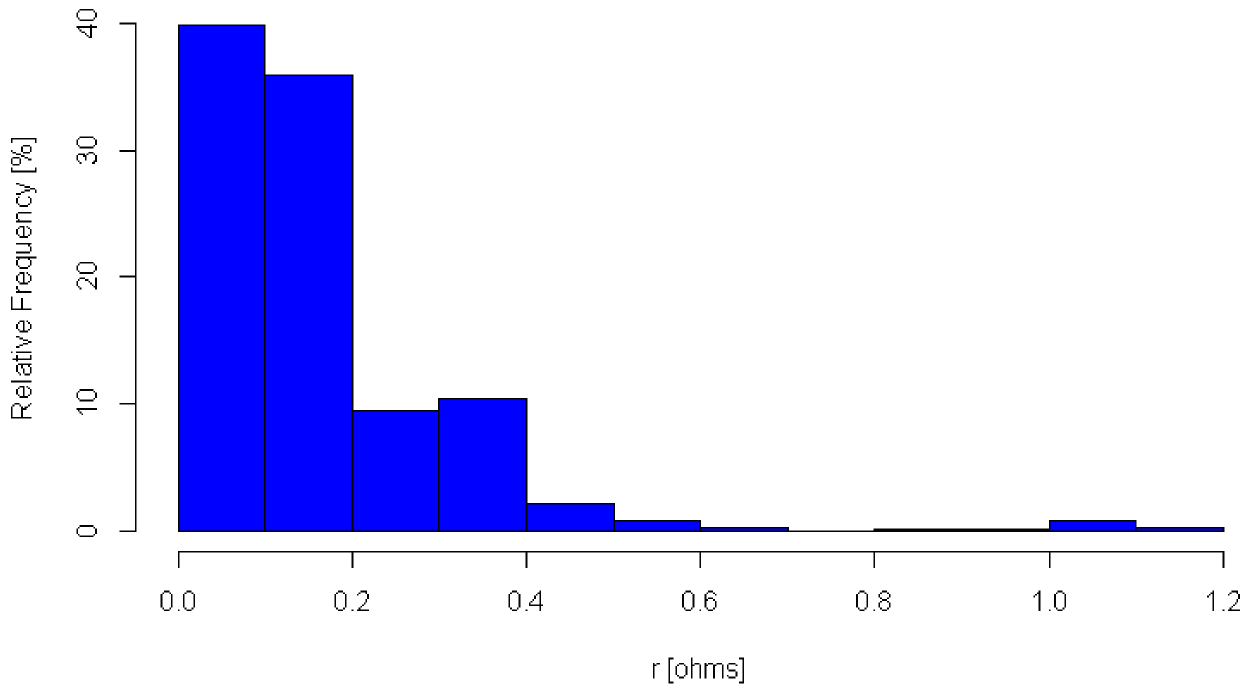

Figure 7 The distribution histogram for the resistance values of the spark test apparatus for a window of 20 ms.

To highlight the exponential character of the distribution, the spark test apparatus resistance value was logarithmated. This time the distribution became almost symmetrical and is close in aspect to the normal distribution.

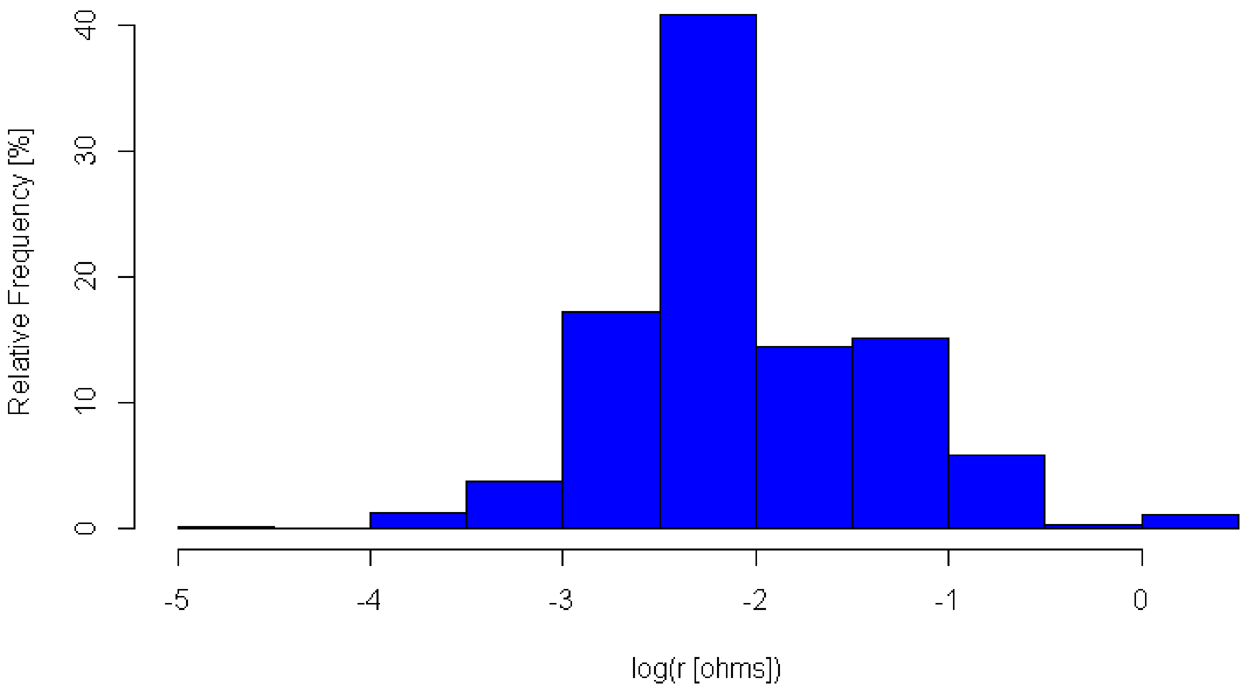

Figure 8 The histogram of distribution for the logarithm resistance values of spark test apparatus for a window of 20 ms

2. CONCLUSIONS

1) During operation the spark test apparatus varies its internal resistance between a minimum value and infinity;

2) Analysis of the distribution of values calculated for the equivalent internal resistance of the spark test apparatus (when the spark test apparatus is a "closed" circuit) showed that they follow an exponential distribution law.

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