Short circuit investigation in telecommunication equipment through the theoretical electrical engineering

Svetlin Antonov

Abstract – **This paper shows an analysis of the features of the short circuits in technics which are precondition for ignition in telecommunication equipment. Keeping an non insulated electrodes of currency source may cause to a short circuit and processes of a huge energy transfer in a moment of time. This can lead to inflaming of some materials which ate the systems built by. The currency potentials, internal resistance and an external resistance in the electrical circle and the quantity of released and consumed energy of the outer element are investigated.**

Keywords – **Short circuit, Telecommunication systems, Theoretical electrical engineering, Ignition, Fire, Resistance.**

I. INTRODUCTION

Ignition in telecommunication equipment is an everyday occurrence. Some of the reasons are chemical reactions, old currency sources [1], short circuits in the electrical section, some external influences etc. When the fire affects a telecommunication technics, this leads to a huge costs to die out the flames and then to repair or to change the equipment. If the engineers know how the short circuit let the electrical energy to flow so intensively even for a second the will be able to prevent situations of a damage.

The current in case of a short circuit means a huge amount of energy transfer throw a low resistance medium (so small resistance as it lean to a 0 ohm). This process is described as Ohm's law, which is deeply investigated in the present paper.

Solving the problem of currency source and rising flames in telecommunication equipment is an analysis problem. It can be admitted: the construction and the other parameter of the source are known, the structure of the electrical circle and the included electrical parts with their parameters are known. Then the solution of the described problem is to find the currency value and the power in shorted circle which are enough to produce too much heat and a flame in the equipment.

II. MATHEMATICAL MODEL

An ideal voltage source is shown on Fig. 1. For the purposes of this investigation we assume the realistic case of availability of an internal resistance caused by the properties of the incorporated constructive materials in the technics (Fig. 2).

Svetlin Antonov is with the Faculty of Automatics at Technical University Sofia, 8 Kl. Ohridski Blvd, Sofia 1000, Bulgaria, E-mail: svantonov@yahoo.com.

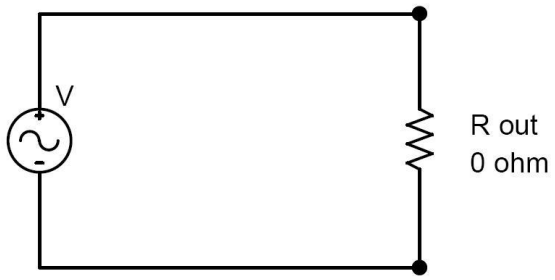

Fig. 1. Figure example

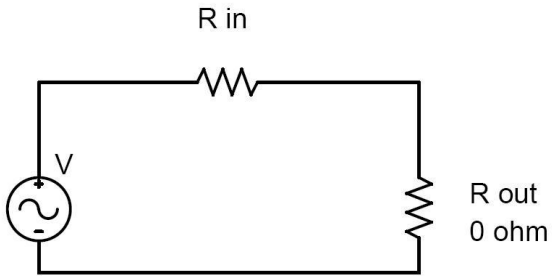

Fig. 2. Figure example

Current flowing through the circuit is determined by the voltage between the source terminals, its internal resistance and consumers (external) one. In case of short circuit current will only depend on the internal resistance Rin and the potential difference between the electrodes Eq. (1) [2]. The accuracy of calculation of the potential in the point is determined by the integration constant.

$$V_1 - V_2 = \int_1^{M_0} \vec{E}\vec{dl} - \int_2^{M_0} \vec{E}\vec{dl} \qquad (1)$$

where: V1 and V2- value of the potential in the point measured in volts; M_0- point zero potential; $\vec{E}$ - Intensity of the electric field; $\vec{dl}$ - Tangential vector at the center of the element.

After the unification of the two integral obtained Eq. (2):

$$V_1 - V_2 = \int_1^{M_0} \vec{E}\vec{dl} + \int_{M_0}^{2} \vec{E}\vec{dl} = \int_1^{2} \vec{E}\vec{dl} \qquad (2)$$

It follows that the potential difference coincides with the voltage between the two points in an electric field, i.e., between the source terminals.

When introduced in Fig. 2 internal resistance is correct to record inequality $|e(t)| \geq |u(t)|$. It becomes equality only in the absence of flowing current. If it is taken into account the internal resistance of the source:

$$u(t) = e(t) - R_{in} i(t) \tag{3}$$

The determination of the resistance of the consumer is done with assumptions as: assumed to take place a short circuit between the source terminals by conductor made of homogeneous material; electric field is evenly $\vec{E} = const$; the conductive material has a conductivity γ, the conductive medium is linear $\gamma = const$; the cross section of the connecting wire is constant $s = const$. Based on the foregoing, it can save the differential form of Ohm's law (determining the density of the current) [2]:

$$\vec{J} = \gamma \vec{E} \tag{4}$$

$$J = \frac{i}{s} = \gamma E \tag{5}$$

$$u = \int_l \vec{E}\vec{dl} = \int_l E dl = E \int_l dl = El \tag{6}$$

After substituting $E = \frac{u}{l}$ for i is prepared:

$$i = \frac{\gamma s}{l} u \tag{7}$$

If the power source is adopted as the current source, the equivalent circuit (Fig. 3) includes a parallel resistor. This changes the ratio of the currents in this part of the circuit, and then obtained the inequality $|je(t)| \geq |i(t)|$. It becomes equality if implemented short circuit as a result of which the current through the internal resistance will be zero and will run exclusively through the external circuit.

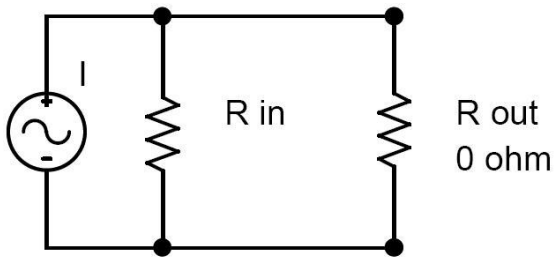

Fig. 2. Figure example

The resistance of the conductor is determined by the geometric dimensions and the specific conductivity of dependency:

$$R = \frac{l}{\gamma s} \tag{8}$$

Released power from this element to the flow of current is determined by:

$$p = Ri^2 \tag{9}$$

and power consumption is determined by:

$$p = \frac{1}{R} u^2 \tag{10}$$

The development of Eq. (10) reference goes here to determine the instantaneous power, depending on the voltage on the conductive element and the current flow:

$$p(t) = u(t) i(t) \tag{11}$$

For the purposes of the study overlooked the probability of the existence of a capacitive or inductive nature of the conducting part in the implementation of short-circuiting.

III. Conclusion

Taking into account the described parameters and their relationships a voltage/ currency source must be taken to isolate the electrodes in order to avoid short circuits. Isolation may be accomplished by any insulating, adhesive tape, it has to be tightly covered and the two electrodes of the battery and the strip are tightly glued edges. Other kind of isolation is to remove the source from the power nest in the corpus of the telecommunication equipment, which is the most secured option in the listed below.

Power consumption of the currency flow in short circuit leads to a huge power spending transformed from currency to heat. This is a precondition to ignite not so the conductor as the dialectical elements in the telecommunication equipment.

References

[1] Fire and Arson Investigator, p20-28, ISSN: 1059-7298, January, 2010.

[2] Farhi, S, S, Papazov. Theoretical electrical engineering 1, Tehnika, 1987.