Correlation theory of casual processes in electrical power problems for systems of electric transport

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***Abstract* − The method is proposed for determining the energy figures of electric transport systems, based on the correlation theory of casual processes. According to this method, the components of the total capacity and the capacity rates are expressed through the correlation functions and the mathematical expectations of the researched traction voltages and currents. Numerical calculations of active, reactive and apparent power, as well as the ratio of reactive power to the traction substation feeder are shown that the method possesses high accuracy: error less than 2%.**

***Key words:* method, correlation function, the power train, energy figures, voltage, current, power, casual process.**

I. Introduction

In the basis of the analysis of electric power processes, and thereby evaluating the energy performance, in systems of electric transport is the task of measuring instrument or analytical determination of components of the full power. Developed relatively new, electronic microprocessor meters with high accuracy measure different characteristics of power and energy. However, they work almost without mistakes only in steady-state conditions, only with sinusoidal voltages and currents, and only in symmetric systems [1]. Especially these errors increase if the voltages and currents are rapidly change values and, moreover, are casual processes, which are typical for electric transport traction networks [2].

In connection with the above, the most correct way to estimate the total power components and their losses is calculated on the basis of experimentally obtained under actual operating conditions of registograms and oscillograms changes over time in the voltage $U(t)$ and current $I(t)$ in devices (traction substations, traction networks, electric rolling stock) systems of electric vehicles.

Thus, if $U(t)$ and $I(t)$ are non-sinusoidal, but periodic, it is possible to determine the components of the total power applied to the classical Fare-analysis.

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However, the time dependence of the currents and voltages at the input and output traction substations and feeders, as well as in electric rolling stock are realizations of rapidly changing casual processes (Fig. 1), the use to which the classical spectral analysis is inappropriate [3].

In this case it is necessary to use the theory of casual processes.

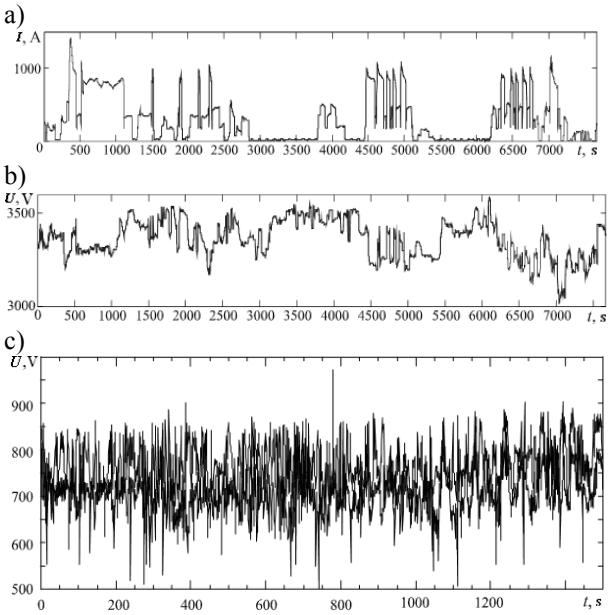

Fig. 1. The realization of electric locomotive VL8 in one of its operation modes (for one of the trips) on a plot of Prydniprovska Railways: the voltage at the pantograph (a); traction current (b); temporary realization of the voltage at the pantograph of the tram (c)

So below, in this work, to solve this problem it is proposed a method which is based on the correlation theory of casual processes.

II. The essence and the theoretical background of the method

The method of correlation functions is based on the well-known theory of stationary processes in terms of auto and mutually correlation functions [4, 6].

According to this theory, the autocorrelation function $K_U(t)$ of voltage $u(t)$ as stationary ergodic casual process, can be written as the expectation of scalar