COMPUTER CONTROL SYSTEM „SDMC" FOR URBAN ELECTRICAL TRANSPORT

Vitalie EŞANU*, Iurie RÂMBU**, Nicolae SECRIERU***
*STE „Informbusiness", **Chisinau, electrical transport department,
***Chisinau, TUM, Chisinau

Abstract **– In this paper is presented the obtained positive experience in the Chisinau electrical transport department due the trolleybuses modernization with computer control system type „SDMC", that are developed and produced by STE "Informbusiness".**

Keywords: *computer control system, urban electrical transport, trolleybus modernization, IGBT-technology.*

1. INTRODUCTION

It is known the urban electrical transport is more ecological mean of transport. Annually, about 3 trillion of passenger travels with urban transport are made, which about 50% are referred to the electrical transport [1-2], but in the some countries, such as Russia, Ukraine, Moldova, Romania and other, the most vehicles have an advanced moral and technical degradation state, the service is at the low level, functioned time is about 8-10 years, the traction motor control is usually traditional with serial starting rheostats in the rotor circuit, that leads to 25-35% damage of electrical energy. From the other hand, the traction motor protection is very primitive and the motor are defected by following causes: upload – 30%; corrosion – 19%; nominal parameters overflow – 13%; low ventilation – 10%; rotor defects – 12 %; other – 5% [1-2].

The traditional methods to control these transport units cannot to prevent the constantly increasing of electrical power and combustion prices. The implementation of computer control systems on base of new technologies, in particular, IGBT-technology, is the right way to solving these problems.

2. COMPUTER CONTROL SYSTEM ARCHITECTURE FOR URBAN ELECTRICAL TRANSPORT

Automated control of electrical transport traction motor can be effectuated, if it is solved two base problems: a) development of efficient power commutator with electronic control; b) development of intelligent algorithms for commutator control with microcontroller.

It is known, that power commutator for the direct current is realized for traction motor with capabilities of instantly commutation of necessary circuits. If this commutator is triggered periodically with any frequency , then the power on the traction motor, which is connected to the direct current source, may be controlled. In this case, it is a static converter of power of direct current, named as „chopper". A typical schema of this converter is presented in the fig. 1 – the electrical traction motor is connected as load to the direct current source with voltage U_1 by means of commutator, that can be based on, for example, GTO type thyristor with smoothing filter and protection diode ***D*** (fig. 1a) and based on IGBT-transistors (fig. 1b). The theoretical diagrams of voltage and current from this circuit are presented in the fig. 2, where it shows, that by opening/closing the commutator will be formed a series of pulses with amplitude $\boldsymbol{U_1}$ equal of source voltage, but on the traction motor it is obtained a voltage with average amplitude $\boldsymbol{U_{2med}}$. This voltage depends on source voltage $\boldsymbol{U_1}$ and duty factor :

$$U_{2av} = \lambda U_1,$$

where :

$$\lambda = T_1/(T_1+T_2) = T_1/T.$$

Afterwards, the average current similarly depends on this duty factor :

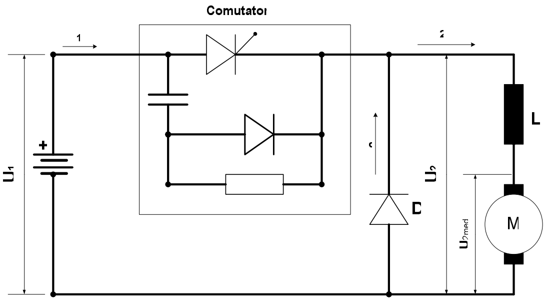
$$I_{1av} = \lambda(Id+I_2).$$

In practice, in power commutator development and engineering, it is must take in consideration a more factors: coil winding connection, parameters and characteristics of the traction motor, also power supply networks [4]. It is known, that thyristor commutator have a lot of disadvantages, such as low frequency of commutation, some voluminous additional elements, limits the other possibilities of control: low excitation of coil winding, reversing, etc.

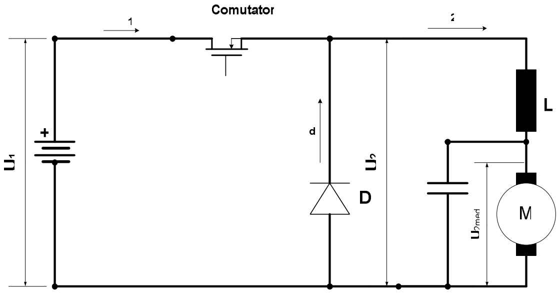
Taking in consideration the mentioned factors, it was proposed to develop the power electronic commutator on base of new technology, on base of IGBT transistors, that provides all necessary possibilities of commutations: parallel, serial and mixed of coil winding [5]. It is common knowledge that the control of commutation is very important. It is impossible to realize a control of electrical transport with a simple units having a fixed logic [3]. It is necessary more powerful microcontrollers to realize efficient and intelligent control algorithms for the electrical transport units and it must to cover not only traction motor problems, but a set of additional functions, such as protection, communication, etc.

Taking in account these considerations, the STE "Informbusiness" proposed a architecture of a computer control system for trolleybuses, that cover the following functions:

- fine control of the electrical traction motor with exact respecting of the all parameters, characteristics and diagrams, which are stored in the microcontroller ROM;
- independent and fine regulation of the magnetic flow in the parallel coil wiring, respecting characteristics and diagrams and in dependence



a)



b)

Fig. 1. A typical schema of the converter.

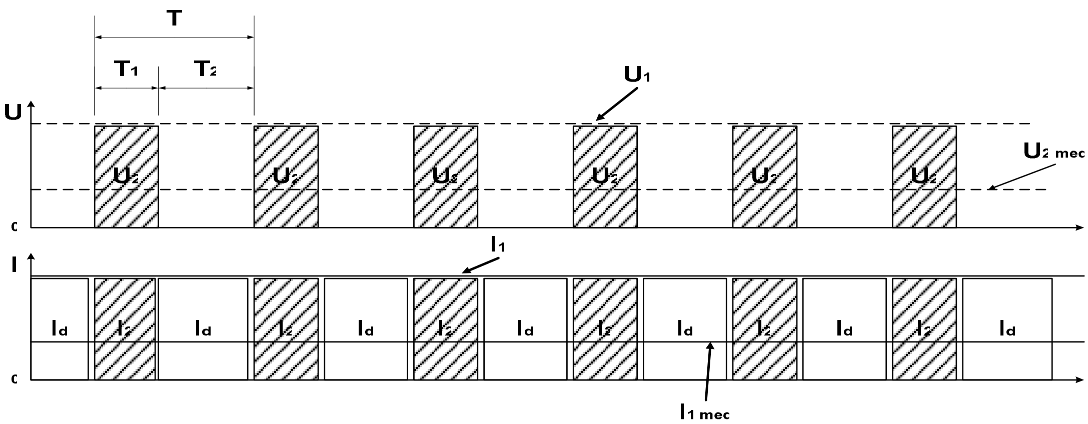


Fig. 2. Voltage and current diagrams.

of load and reference position of the acceleration pedal, using open loop, close loop and mixed modes of regulation;

- protection of the traction motor with hardware and software methods;
- self-diagnosis of the microcontroller and peripheral units, also diagnosis of other mechanism, such as acceleration and braking;
- registering and processing of the errors and operative communication about defects;
- listing of defects on the LCD indicator and its reading from the microcontroller memory;
- setting of the optimal characteristics of the traction motor in the dependence of load, climacteric and topographical conditions for minimizing of electrical power consumption;
- current limitation in the coil wiring;
- operative possibilities for editing and modernizing of the control algorithm in microcontroller memory.

Thereby the computer control system for electrical transport units must be realized on base of powerful microcontroller with flexible architecture and high reliability.

3. TECHNICAL AND ECONOMICAL RESULTS OF A SDMC-103 IMPLEMENTATION

After a most of investigations, it was developed a family of computer control system, named as SDMC-103. During investigations and developments main demands to these systems was: compact and modular construction; a large functionality and high flexibility, a high performance reliability and service ability, easy configuration and adaptation for the diverse type of trolleybuses substantially with a software means. In the results it was obtained the computer control systems with parameters and characteristics presented in the table 1.

The economical and social effects of implementation of the control systems SDMC-103 type are characterized by the following:

1. The electrical energy is reduced up to 30-35% in comparing with traditional control units;
2. It is simplified the driving process of trolleybus – the acceleration pedal operate like as in automobile ;

Technical characteristics	**Values**
Maxim input voltage (U_{in})	900 V
Maxim output current	500 A
Output voltage	5 - (U_{in})
Limit of current	up to 500 A
Control frequency	up to 8 kHz
Control levels for the error detection:	
- input voltage	up to 780 V
- output current	up to 500 A
- output voltage	out of 30 – 780 V
- voltage on board	out of 18 – 35 V
- operation temperature	out of -40 ÷ +80 ˚C
Dimensions of the control module	730x330x320 mm
Dimensions of indicator	195x142x23 mm
Weight of module	45,2 kg

Table 1. The technical characteristics of the SDMC family systems.

3. On the indicator are displayed all the necessary for the driver parameters: velocity, state of doors, energy accounting, errors and defects, problems in the supply network.
4. The acceleration and braking are very fine in comparing with traditional units and due this it is decreasing the deterioration of the transmission of trolleybus.
5. It is dismounted all the old equipment and subsequently, the trolleybus weight become lightly.
6. In any time it is possible to display and copy from microcontroller memory all the parameters: (the distance, average and maxim velocity, the codes of the defects with appearance time, etc);
7. The control systems SDMC – 103 have some distinctive proprieties in comparing with analogical systems:

a) it is on-board control system with extended set of functions for electrical transport control system;

b) very reduced weight;

c) it is installed in the driver cabin, due the small dimensions;

d) the prices of SDMC-103 type system a more less in comparing with similar systems.

4. CONCLUSIONS

The computer control system for the trolleybuses traversed a lot of checking and proofing tests during a 3 years and now are produced by STE “Informbusiness” for some models of trolleybuses. Recently, these systems are successfully explored on the new models and old models modernized trolleybuses, due the easy configuration and adaptation with software means.

The positive experience shows the high reliability, the efficiency, that permits to economize about 30-35% of electrical power and to recuperate the investments during the 10-14 months.

References

[1]. L. Cantemir, G. Chiriac. *An analysis of a public transport problematic in Romania*. – In: The 1-th International conference on Electromechanically systems. Chisinau, 16-18 October, 1997.

[2]. *Rail and Trolleybus Transit Cities*. – In: http://home.cc.umanitoba.ca/~wyatt/rail-transit-list.html.

[3]. M. Ratoi, R. Bojoi, Gh. Baluta, L Cretu. *PWM Implementation solutions using programmable logic devices*. – In: The 1-th International conference on Electromechanically systems. – Chisinau, 16-18 October, 1997.

[4]. J. Tlustý, J. Doležal, A.G. Castillo, V. Valouch. *Power Quality in Industrial Distribution Systems.* – In: Proc. of the Inter. Conf. UIE 2000, Lisboa, Portugal, November 1–4, 2000, pp. 603–612.

[5]. *Trolleybus Microcontroller command system type SDMC-103* – In: http://www.trans-electro.ru/index_rom.html.