Measuring and Monitoring System for Buses with Electric Power

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Abstract: - This article describes the measuring and monitoring system for electric buses and cars. There are described basic function blocks and measuring traction batteries principles. Monitoring system enables measuring of all values, which are necessary for calculation of running time of car with electric power supply or other devices with battery source.

Key-Words: - battery, measuring, monitoring, electric power, electric bus, electric car

1 Introduction

Lead acid batteries, NiCd batteries and other chemical cells are used in traction. For effective energy utilization the knowledge of actual operating values and history of using concrete cell is required. This monitoring system makes possible to measure and calculate these values: voltage, current, power, time, charge, temperature, speed and a supposed radius of action.

A basic block structure of monitoring system is show in Fig. 1. It composes one driving computer two master units and 23 slave units. Number of slave units depends on a number of battery cells. Slave units measure cell voltages and temperature of battery. Two of slave units measure traction battery currents.

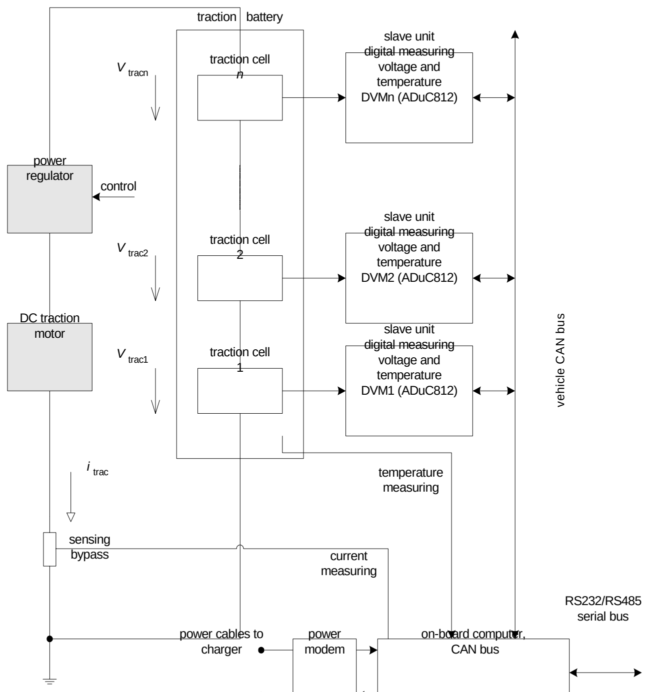

Fig. 1 Basic structure of monitoring system

2 On-board Computer

Two on-board master computers control monitoring system, communicate with other slave units and a control PC computer. All slave units are connected via a vehicle CAN bus.

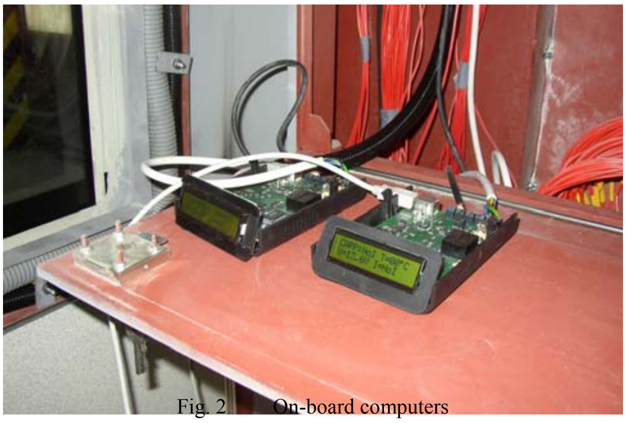

Fig. 2 On-board computers

Each master unit contains power source for bus CAN supplying. This power source is galvanically isolated from all other voltage source.

3 Control PC type computer

Control computer communicates with on-board master computers, processes all measured quantities and informs a driver, or electric device operator, about status and operation mode of device on a display. It shows information concerning battery capacity and operational time.

All measured data is stored in database server, which is part of control computer. This data could be uploaded to another database server by Internet or intranet.

Control computer contains converting and calibration constants for every slave units. These constants are sent to slave units when monitoring is started for the first time, or when calibration tests are executed. Constants can be calculated in auto-calibration mode, too. Communication between slave units and control computer is always wia on-board computers. Control computer is connected to on-board computer by USB interface.

To optimize charging process it is necessary to supply the charger with information concerning battery status. If an EPRONA [2] fast-charger with embedded intelligence is used for charging this, data is sent by Bluetooth bus. Charger obtains information of battery structure and history of previous charging. From this information it can choose optimal charging process. During charging process the monitoring system checks all values and if the limit is exceeded it sends command for charging process change or it sends a command to stop charging. If there are no problems, the operator only connects power cable and charging process is completely automatized. Via the intelligent charger the monitoring system can send to control centre stored data for their evaluation. If a classical charger is used, monitoring system only stores measured data.

4 Slave Units

The slave units measure values of battery cells voltage, and battery temperature. Each of slave units measures seven values of voltage and one value of temperature. 12-bit ADC is use to measure a voltage. Voltage range depends on applied battery and can be easily changed. The precision depends on this range, but precision better than 0.1 V is preferred. Temperature range is -40 to 80 °C with 1 °C precision. This precision is sufficient for all measurements and consequent processing.

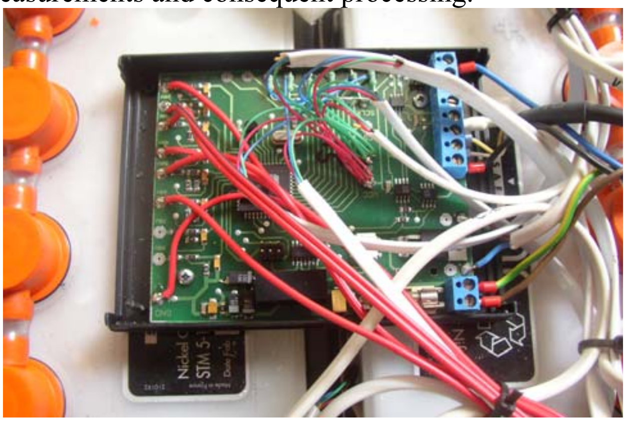

Fig. 3 Connected slave unit

Measured data is converted to digital information and sent to master unit via a CAN bus. Each of slave units has its own galvanically isolated power source. This is a necessity, because each unit works with different common voltage.

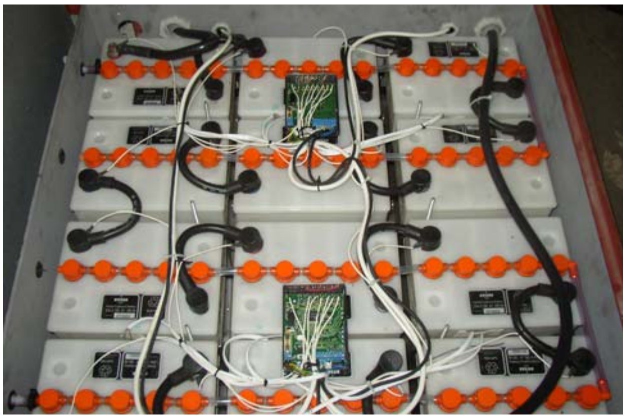

Fig. 4 Slave units on battery pack

Each slave unit is assigned by a unique address. This address is used when a slave unit communicates with the master unit. It is important for correct evaluation of battery capacity and setting-up a slave unit.

5 Slave unit for current measuring

Two of slave units are dedicated for current measuring. They are located near to sensing resistive shunt for interference rejection. Measured standard range is ± 400 A. Total precision reaches up to 0.1 A. The precision of this value is very important for battery capacity determination. Range of current depends on applied battery and a load. The range can be changed by changing external circuitry and setting new converting constants.

6 Fast-charger

Fast-charger with embedded intelligence is designed for automatic fast-charging of accumulator batteries. Its modification, enabling to communicate in a smart way with monitoring on-board computer system of electrically driven vehicle, is able to transfer digital data via power cable generally flown by high variable charging currents. Two chargers are used for bus charging process.

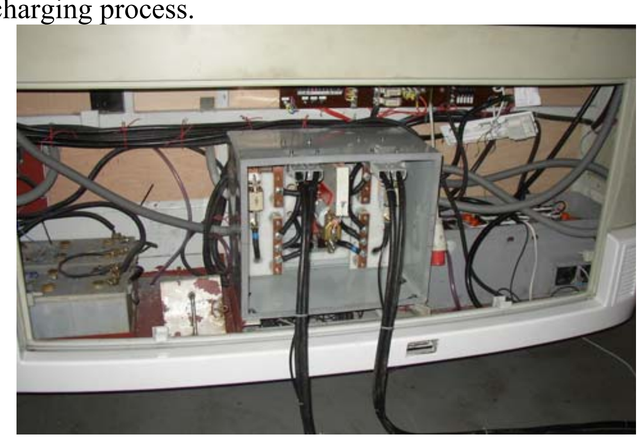

Fig. 5 Charging connectors

7 Simulator of fast-charger

Due to parallel development of both monitoring system and intelligent fast-charger on two different workplaces, it was necessary to create and develop the program simulating fast-charger external communication for its non-stop functional self-testing and for data communication between monitoring system and intelligent fast-charger.

This program simulates all interface and logical internal functions of the intelligent fast-charger and respects data communication among master unit and slave units inside the monitoring system.

Program sends communicated data to PC monitor after each data transfer procedure using standard serial interface. The simulating system enables to display all measured values sent by master and all slave units. Program contains database portion for recording all measured values. Program works under Microsoft Windows® 95/98, 2000, NT, XP operating systems.

Simulator contains the database core. All measured data can be stored when database program core is running. Data recorder contains two windows. The first window indicates data measured by master unit. The second window shows data provided by slave units. The complete system can incorporate 1 to n slave units. The number of data in the second window depends on a number of incorporated slave units. Data file contains daily data and current time stamps, too. This stamp is necessary for later interpretation of measured and recorder data values.

8 Conclusion

Monitoring system enables measuring of all values, which are necessary for calculation of running time of car with electric power supply or other devices with battery source. Because each traction battery cell is monitored, it is possible to determine wrong cell without necessity to case change all traction cells. Charger sends information about battery before charging and it supervise overstep of the limit values during charging cycle. It minimizes the necessity of a skilled device operator.

Fig. 6 Assembly of bus with electric drive and monitoring system

Described monitoring system was tested in real run. A BETA 1,3 electric car was used for tests. The first prototype was assembled in 1999 and tested for following two years. We obtained a lot of information about function and problems during car testing. These problems were processed and eliminated in the latest version of monitoring system.

Fig. 7 Bus with electric power

Last version of monitoring system is used in bus with electric power. This bus is now used in real urban traffic in Znojmo town by CAS Service Znojmo company. All parts of system have been under award and optimization and progress.

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References:

[1]. Vrba, R. a kol.: Measuring and monitoring system of electrically driven vehicle. Partial Research Rreport of MSM 262200010 Research Plan, BUT FEECS, Brno 2001 (in Czech).

[2]. Čermák, Z.: Parameter specifications. EPRONA, a.s., Rokytnice nad Jizerou 1999 (in Czech).

[3]. MSDN™ Library. Microsoft Corporation. Microsoft 1998.

[4]. MIKROSYN New brends in microelectronic systems and nanotechnologies.