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DIAGNOSTIC MEASUREMENT EMBEDDED SYSTEM

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This article deals with diagnostic measurement system based upon embedded system wich can be used to monitor automobile´s power system. The main focus is on the hardware part of the system and on setting the parameters of the system.

Key words: automated, embedded, automobile.

ВБУДОВАНА СИСТЕМА ДІАГНОСТИЧНИХ ВИМІРЮВАНЬ

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Робота присвячена діагностичній системі вимірювань, заснованій на вбудованій системі, яка може використовуватися для моніторингу силової системи автомобілів. Основну увагу приділено розробці силової частини системи та параметрів налаштувань системи.

Ключові слова: автоматизація, вбудовані системи, автомобіль.

PROBLEM STATEMENT. The goal of this article is the proposal and realization of diagnostic measurement system.

Main part of this measurement system is hardware, where the measurement system is realised. The core of this system is control unit which controls the secondary circuits which measure current and voltage directly on automobile´s battery. These measured values are then by analog-digital converter converted to digital form and stored into backup memory.

Control circuit provides the Internet connection utilising the GSM modem.

Measured values are then directly sent via Internet to expert system, where they are further processed and evaluated.

EXPERIMENTAL PART AND RESULTS OBTAINED. *Hardware part of diagnostic system.* Hardware part consists of blocks which are pictured in Fig. 1 which presents the block diagram.

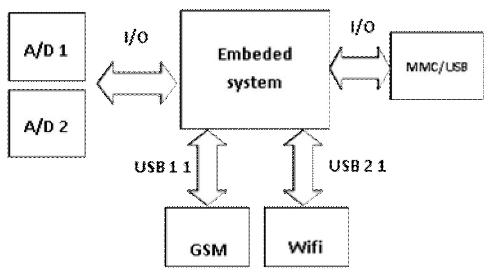

Figure 1 – Block diagram of the measurement chain

The core if the measurement system is embedded system which controls all other circuits and provides Internet connection.

Measurement is realised by pair of analog-digital converters. These converters scan the voltage and current directly on battery and transform the values to digital form. Control unit then stores the data on USB key or MMC memory card then send them via GSM modem to expert system. Wi-fi connection is used for control unit updates and settings of control unit.

Fox Board control unit. Embedded system FOX Board was used for control of the whole system. It is enclosed developer embedded system based on Linux core. The whole control unit is built on board with dimensions 66 x 72 mm and consist of 32 bit microprocessor ETRAX 100LX with operating frequency 100 MHz. Operating system is stored in 8 MB flash memory and has 32 MB of RAM memory avaiable. This embedded system has low power consumption, therefore it is suitable for such connections. The big advantage lies in number of input/output interfaces such as LAN,USB,RS-232 as well as openness of this system due to its Linux basis. Fox Board control unit is shown on Picture (Fig. 2).

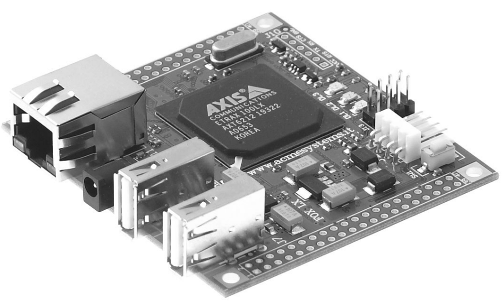

Figure 2 – FoxBoard

Another big advantage of this control unit is its pre-installed software which helps with management of this unit. WEB and FTP servers are installed for file transfer. For system management and start of the unit the TELNET is used, it also allows full control over the whole system. Following picture (Fig. 3) shows the I/O interfaces of the unit.

FOX Board uses USB 1 and USB 2 interfaces for communication purposes. GSM modem is connected to USB 1 USB Wi-fi key is connected to USB 2. I/O channels are used for data collection and connection of analog-digital converter. Because of openness of the system, access to channels is directly permitted on procesor and no special additional drivers are needed. Application which controls the measurement was programmed utilising the C language which is compatible with Linux core. 8 input lines are used for data collection.

These lines are on J7 connector. For secondary circuits, which are needed for measurement control are another 4 lines used, 3 of them are on J7 connector and one on J6 connector.

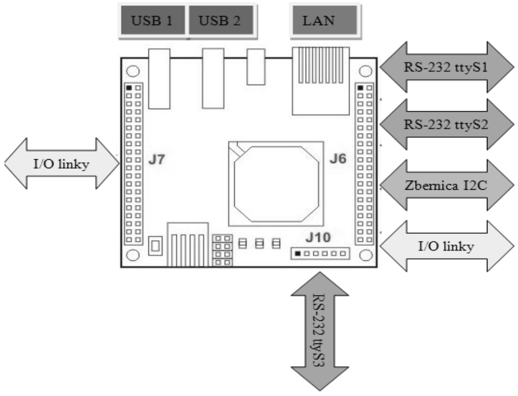

Figure 3 – FoxBoard I/O interfaces

Program which perform the measurement is stored directly on USB key. After the start of the system, the script runs which automatically connect the USB key and runs the measurement program. Measured data are written directly to USB key and are sent via Internet.

Measurement apparatus – analog digital conversion. Measurement is done by measurement apparatus, which consist of functional blocks. Block diagram of apparatus is pictured in Fig. 4.

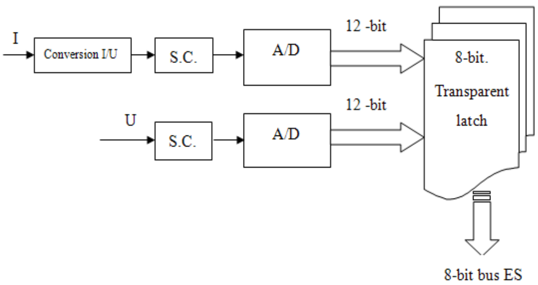

Figure 4 – FoxBoard

We need to measure two variables – electrical current and electrical voltage, so the apparatus consist of two very similar channels. The description of the apparatus begin from left side, as is the measurement and transformation of variables.

First channel which measures the current has one more functional block. This block is called C/V transfer. Basically it is pliers sensor of current wich transform current to voltage. It is needed before analog-digital converter used can process only voltage. Other blocks are same for both channels, therefore there is no need to differentiate, whether it is channel which measures current, or voltage.

Next block which follows is labelled as S.C. It is sampling circuit which serves for sampling the measurement variable to avoid their possible change during measurement. Input of this circuit is the measured variable, which after receiving the control pulse from control unit is moved to the output of this circuit. There it remains unchanged regardless of input, unless another control pulse from control unit is received.

Block labelled as A/D is 12 bits analog-digital converter. This converter converts the input voltage to digital form. Voltage is received from sampling circuit and during conversion is unchanged to avoid the errors in conversion. Converter is controlled by control unit. Conversion begins after receiving the run pulse.

8 bits latches serves for separation of interface of control unit from A/D interface, because the control unit can process only one 8 bit data. Data which are on the A/D output are however 12 bits for every channel. Therefore latches have to be used for correct separation of individual channels from bus, in order to avoid any mistakes on the bus.

In order to correctly separate the bus, we have used 4 latches, which are interconnected and control the data flow in following order. All 4 latches begin in the state of high impedance, then first latch receives control pulse from control unit. Latch is then in active state and control unit´s bus receives the first 8 bits from first channel. After the data are read, the latch is set to the state of high impedance again, and control unit brings the control pulse to second latch, which activates itself and the remaining 4 bits from first channel are driven to input of ES bus. The procedure is then repeated for second channel. This process ensures, that all the data are properly loaded without any mistakes on A/D and ES bus.

Additionally, pliers sensor of current CT 237 A transforms the analog current to analog voltage in channel 1.

It is standardised sensor which is used in measurement of high currents. It converts the direct and alternating current to direct and alternating voltage. Range of current is from 0 to 200A AC/DC. Frequency range is up to 10KHz DC. Resulting output voltages are:

– when range to 20 A, then 1 A = 10 mV;
– when range to 200 A then 1 A = 1 mV.

Fig. 5 shows the used pliers sensor of current.

Figure 5 – Pliers sensor of current CT 237 A

Following picture Fig. 6 shows one measurement cycle.

To the logical input of operational amplifier S/H the value log.H is brought. In this moment the voltage amplifier is sampling, period of recording is set to 20 µs. During that time the voltage on OA output is not changing. After that the value log L is brought to A/D converter to CP input (connector JP2 and JP4) and conversion of data begins. After bringing the log. H to CP checked data are then brought to A/D converter´s output. After that, the series of control pulses (R.I. 1 and R.I. 2) occures, during this the data are loaded by ES. The process is following: at first the 8 bit I data are loaded, then R.I 2 control pulse changes the value to Log. L and reamining 4 bits I are loaded. This process is analogic for data reading from other measurement channel which measures the voltage.

Running of measurement. After the start of ES the script is started automatically which mounts the USB key and runs the measurement program. Measured data are written to USB key to file which contains 3600 values. After the closure of file, new one is opened and the measurement continues in infinite cycle. This measurement is provided by program which runs automatically after the start of the ES. Program has several layers of protection, like resuming after restart. GSM modem is initiated after the closure of the file, which is then sent to FTP server.

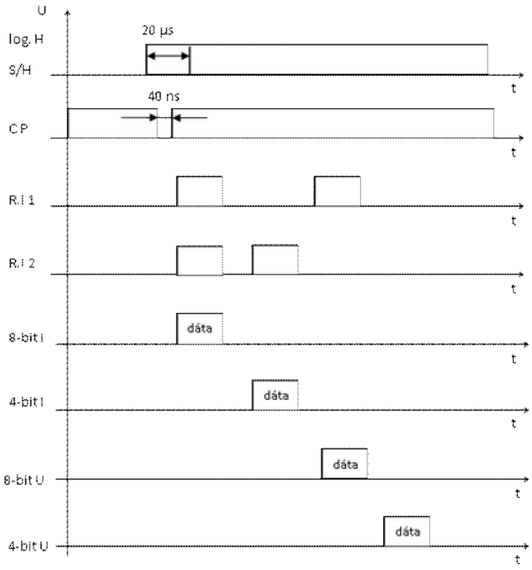

Figure 6 – Measurement cycle

CONCLUSIONS. This measurement apparatus was installed into automobile, where it collected data during its daily usage during several months. Sampling interval was set to 1 second. This means, that we have information about power system of automobile in every second which is a great and significant benefit of this measurement apparatus.

ACKNOWLEDGMENT.

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ВСТРАИВАЕМАЯ СИСТЕМА ДИАГНОСТИЧЕСКИХ ИЗМЕРЕНИЙ

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Работа посвящена диагностической системе измерений, основанной на встраиваемой системе, которая может использоваться для мониторинга силовой системы автомобилей. Основное внимание уделено разработке силовой части системы и параметров её настройки.

Ключевые слова: автоматизация, встраиваемые системы, автомобиль.

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