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UTILIZATION OF THE PORTABLE DATA ACQUISITION UNIT IN PROCESS CONTROL RELATED TASKS

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ABSTRACT
This paper describes new portable data acquisition unit which was developed at our department for all tasks related to process control and identification. The device is designed with respect to possible battery operation which in conjunction with laptop computer enables process measurement in areas where power source is not available. Communication using standard RS232 serial interface makes it fully platform independent and thus suitable for connecting with any system, not only personal computer. Implemented ASCII - based communication protocol provides very effective way to communicate with number of software environments like Matlab/Simulink or ControlWeb, for instance. In order to improve development of new software applications with this device a support program library for Matlab/Simulink and Visual C++ was created.
Keywords: data acquisition, process control, serial communication

1. INTRODUCTION
Process measurement is one of the most important tasks in the whole control system. It is determined by the fact that control accuracy is fully dependent on how preciously measuring chain works. Present-day there is available number of devices performing data acquisition tasks – standard cards for PCI or ISA bus which are suitable for personal computers and its industrial versions and modules for industrial automation usually equipped with RS485, CAN and other interfaces. Independent category is formed by smart sensors incorporating sensor, converter to unified signal and data acquisition device in one embedded system with very compact dimensions and low power consumption. They have number of advantageous features such as automatic diagnostic and calibration, high accuracy and immunity against electromagnetic interference due to short signal paths. On the other hand lower operating temperature range reduces their usage to laboratory applications, automotive and aircraft industry where compact dimensions and low weight are crucial. Quite often occurred situations when it is necessary to measure data in terrain where it is not possible to use standard computer equipped with DAQ card. In these cases laptop computer equipped with portable data acquisition device may be very advantageous and sometimes the only way how to get data about investigated system.
This contribution describes multi-channel portable data acquisition device based on low cost general-purpose 8-bit microcontroller Motorola 68HC908GP32, which was developped in our department mainly for control and monitoring educational laboratory models. In order to improve development of new software applications with this device it is very important to equip it with supporting program libraries and utilities for software environments like Matlab/Simulink and Visual C++ for instance.

2. DESCRIPTION OF THE DAQ DEVICE

2.1. Hardware design

Block schematic of the portable data acquisition device is depicted in the Figure 1. It consists of seven main parts: analog input circuits (analog multiplexer and A/D converter), microcontroller circuits, digital I/O buffers, analog output circuits (D/A converter and output amplifier), serial communications interface and finally power supply circuits.

The core of the DAQ device is 8-bit general-purpose Motorola microcontroller 68HC908GP32 with Von-Neumann architecture which is fully upward compatible with the 68HC05 family. On the chip is integrated timer interface with input capture and output compare functions, 8-channel analog-to-digital converter with 8-bit resolution, up to 33 general-purpose I/O pins, clock generator module with PLL, serial communication interface and serial peripheral interface. M68HC908GP32 has implemented several protective and security functions such as low-voltage inhibit which monitors power supply voltage, computer operates properly (COP) counter and FLASH memory protection mechanism preventing unauthorized reading of the user's program. Internal RAM memory has capacity of 512B and FLASH memory 32KB. Internal clock frequency can be 8MHz at 5V operating voltage or 4MHz at 3V operating voltage. Microcontroller supports two low-power modes: wait and stop mode [3]. Analog-to-digital conversion is performed by external 12-bit A/D converter Linear Technology LTC1298 with very low power consumption. It is equipped by 3-wire synchronous serial interface enabling fast and effective way to communicate with microcontroller [2]. Digital-to-analog circuit utilizes 12-bit D/A converter Burr-Brown DAC7611 with internal 2.435V reference and high speed rail-to-rail amplifier [1]. Output voltage is amplified to unified range 0 to 10V by general purpose operational amplifier. Digital I/O buffers protects microcontroller inputs against electrostatic discharge which may occur during handling and connecting DAQ device to the measured object and boosts output current from microcontroller pins and protect them against overload or short-circuit. Power supply circuits provide stabilized voltages for each functional block; +5V for digital circuits, +18V and -9V using DC/DC converter for analog output amplifier from one 9V single supply. Technical parameters of the portable data acquisition device are shown in the Table 1. Photograph of the first prototype unit is in the Figure 2.

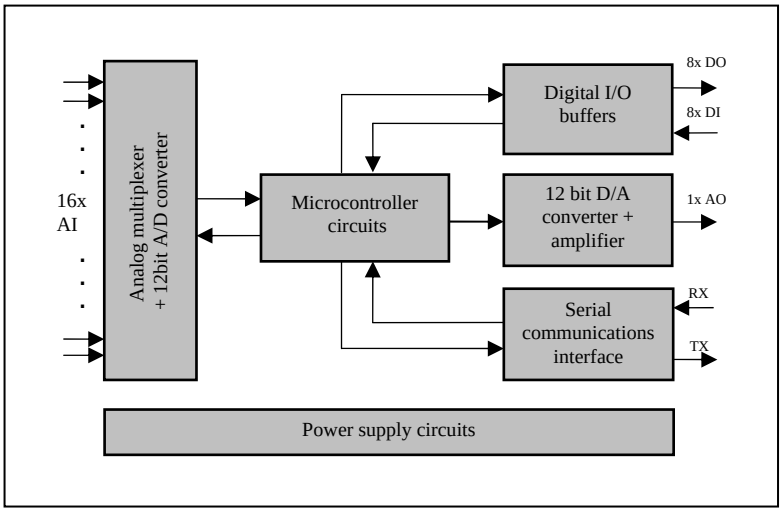

Figure 1. Block schematic of the device.

Table 1. Technical parameters of the DAQ device.

Digital inputs	8 channels, TTL compatible
Digital outputs	8 channels, TTL compatible
Analog inputs	16 channels, 12 bits resolution, unipolar input range 0-10V
Analog outputs	1 channel, 12 bits resolution, unipolar output range 0-10V
Supply voltage	6.5 to 9V DC
Communication	RS232 interface, 57600Bd, 8bit, 1 start bit, 1 stop bit

Figure 2. Photograph of the first prototype unit.

2.2. Communication protocol

Data acquisition device communicates with supervision system using standard serial interface RS232 which is fully platform independent. In order to achieve compatibility with many software platforms universal ASCII based communication protocol was choose. Very advantageous is possibility to send all implemented commands using generic terminal program that is contained in most operating systems. Each command can be divided up to five parts depending on concrete function implementation. Example of one command structure is depicted in the Figure 3. Communication starts with character "~" then must follow command name with fixed length to two characters (for example "AO" means set analog output). After it is first command parameter with length one character (channel index) next character is space followed by second parameter (value). Command must be terminated by CRLF sequence.

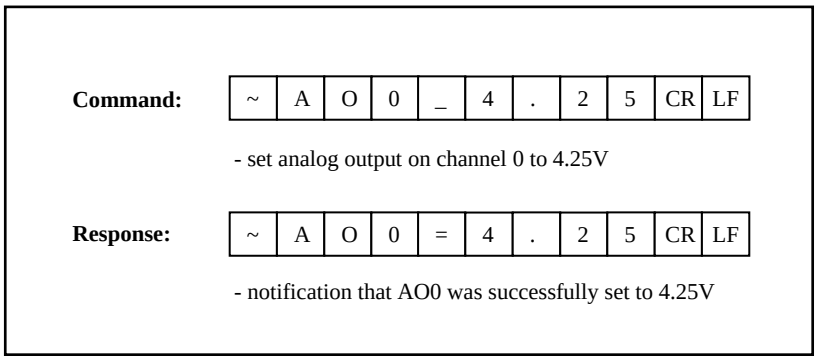

Figure 3. Communication example – command and response.

3. SOFTWARE SUPPORT

Although communication protocol is very simple and easy to understand it is more comfortable in a control application to call functions which can automatically generate commands for the data acquisition device and consequently process its response. Application developer then does not need to know exact communication protocol and do not need to program it. This simplification is resulting in faster program development and reduction of debugging time. For portable DAQ device were created supporting program libraries dedicated for Visual C++ and Matlab 6.5 software environments. They incorporate all functions implemented in device including error processing. In order to device testing and diagnosis DAQ test utility was created (Figure 4). This program can test all functions of the DAQ device and may be very helpful for testing wire connections to the monitored system. In the Table 2 are listed all implemented library functions for Visual C++. Matlab 6.5 library has implemented same functions with only one difference – in place of device handle is serial port object.

Table 2. Implemented library functions for Visual C++.

Function	Description
HANDLE **Open_device**(const char*)	Opens device connected to specified serial port ("COM1", "COM2",…) and returns device handle.
int **Close_device**(HANDLE h)	Closes device with specified handle.
int **Set_digital_out**(HANDLE handle, int output, int value)	Sets specified digital channel (0 to 7) to desired logical value (0 or 1).
int **Set_digital_out_B**(HANDLE handle, int value)	Sets digital channels to value (0 to 255). For example value 100 sets digital outputs to state 01100100.
int **Set_analog_out**(HANDLE handle, int output, float value)	Sets analog output on specified channel to desired value in volts (0 to 10V). Function accepts values in floating-point format.
int **Get_digital_in**(HANDLE handle, int input)	Function returns state of the selected digital channel.
int **Get_digital_in_B**(HANDLE handle)	Function returns state of all digital channels. For example if digital inputs state is 01100100, function returns 100.
double **Get_analog_in**(HANDLE handle, int input);	Function returns voltage (0 to 10V) on specified analog input (0 to 15).

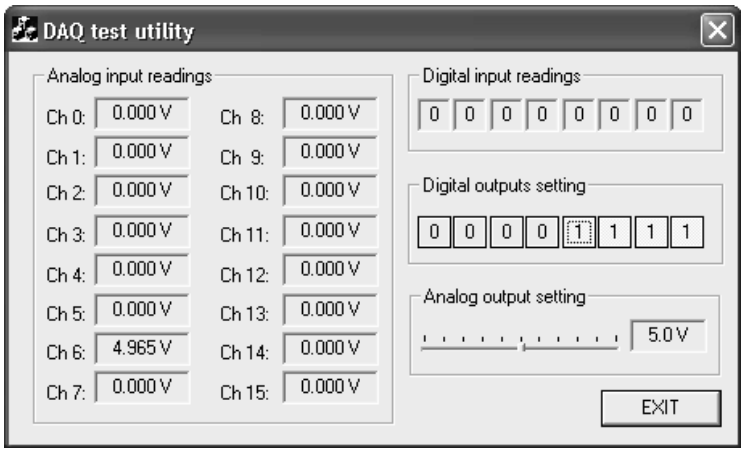

Figure 4. DAQ device test utility – main window.

4. CONCLUSION

The contribution deals with portable data acquisition unit which was developed at our department in order to control and monitoring educational models. The device is designed with respect to possible battery operation which in conjunction with laptop computer enables process measurement in areas where power source is not available. Communication with supervision system is realized by standard RS232 serial interface which makes DAQ device fully platform independent and thus suitable for connecting with any system, not only personal computer. In order to improve development of new software applications with this device a support program library for Matlab/Simulink and Visual C++ was created.

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5. REFERENCES

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