

Jan BABJAK^{*}, Petr NOVÁK^{}**

MAXON DC MOTOR CONTROL BY MF624 I/O CARD
ŘÍZENÍ DC MAXON MOTORU V/V KARTOU MF624

Abstract

The article describes principles and shows examples of driving small Maxon DC motors using the multifunction I/O card MF624 from Humusoft. For speed control, one of Pulse-Width Modulation (PWM) unit installed on this card is used. Analog input and encoder input are used for measuring of motor speed and motor position. For educational and test purpose a small board connecting all parts (driving and measure motor, user inputs and outputs) to I/O card was developed and realized. For card control we use programming tools Visual Basic .NET and the Matlab software. Examples demonstrating the basic electric motor control and regulation task were developed for both of these software environments.

Abstrakt

Článek popisuje principy a příklady řízení malého stejnosměrného motoru Maxon za použití multifunkční vstupně výstupní (V/V) karty MF624 od společnosti Humusoft. Pro řízení rychlosti motoru je použit jedna z jednotek generující pulzně-širokovou modulaci (PŠM), které jsou na kartě přítomny. Pro měření rychlosti je možno použít analogový signál – generovaný druhým motorem ve funkci tachodynamu („měřicí motor“), nebo klasického enkodéru. Pro polohové řízení je dispozici již zmiňovaný rotační enkodéru. Pro výukové a testovací účely byl navržen a realizován malý modul, který spojuje všechny komponenty (hnací a měřicí motor, uživatelské vstupy a výstupy) s V/V kartou. Pro ovládání karty používáme programovacího nástroje Visual Basic.NET a software Matlab. Pro ty to softwarová prostředí byly vytvořeny příklady demonstrující základní úlohy řízení a regulace elektromotorů.

1 INTRODUCTION

Research on the Department of robotics at VŠB-TU Ostrava is focused on mobile robots. Basic elements of locomotion subsystem of any mobile robots are motors, especially DC electric motors. For correct work of mobile robots we must know how to control the speed and position of these motors. For driving of DC motors, PWM signals magnified by H-Bridge device are used. Speed of this motor can be measured by Incremental Rotary enCoder (IRC) or by analog value of induced voltage. To compare differences between this ways of speed measure principles, we used pair of DC motors. One of these motors is powered and the other one serves only as a measuring device. To connect all of these signals to PC, we use a multifunction I/O card which offers an easy way to create programs to motor control and regulation.

2 TESTING HARDWARE

For testing and measuring of DC motor characteristics we must be able to connect all the electronics signals to the control system for further processing. For these reasons we developed a small unit which allows to connect these signals to the multifunction I/O card for standard PC with PCI bus. To drive this measuring set, we use one DC motor connected by a clutch to another DC motor which serves as a measure. This measuring motor is equipped by an encoder whit 64 Counts-Per-

^{*} Ing. BABJAK Ján, Department of Robotics, Faculty of Mechanical Engineering, VŠB-Technical University of Ostrava, 17.listopadu 15, Ostrava-Poruba, tel. (+420) 59 6995757, jan@babjak.cz

^{**} doc. Dr. Ing. NOVÁK Petr, Department of Robotics, Faculty of Mechanical Engineering, VŠB-Technical University of Ostrava, 17.listopadu 15, Ostrava-Poruba, tel. (+420) 59 6993595, petr.novak@vsb.cz

Revolution (CPR) used to exact position and speed measuring. In principle, every DC motor can be used as DC Tachometer which can provide analog information of its speed. This property is used to measure motor speed in another way which allows us to compare results of both of these measurement methods.

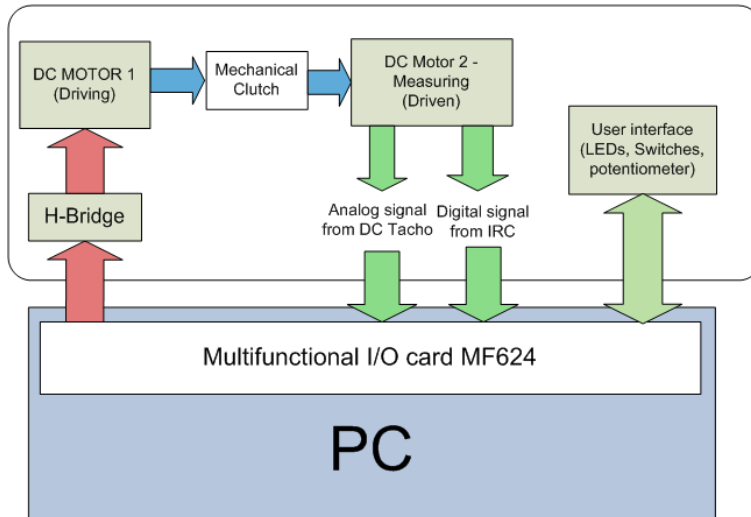


Fig. 1 Block layout of the motor control testing device

This configuration of testing hardware allows to realize various motor speed and position control task. The driving motor is powered by 12V power output directly from the I/O card. This is the reason why we need no external power source. The testing hardware is equipped with a simple user interface for basic motor control – it provides two digital inputs (red and green button), two digital outputs (red and green LED) and one analog input (potentiometer)

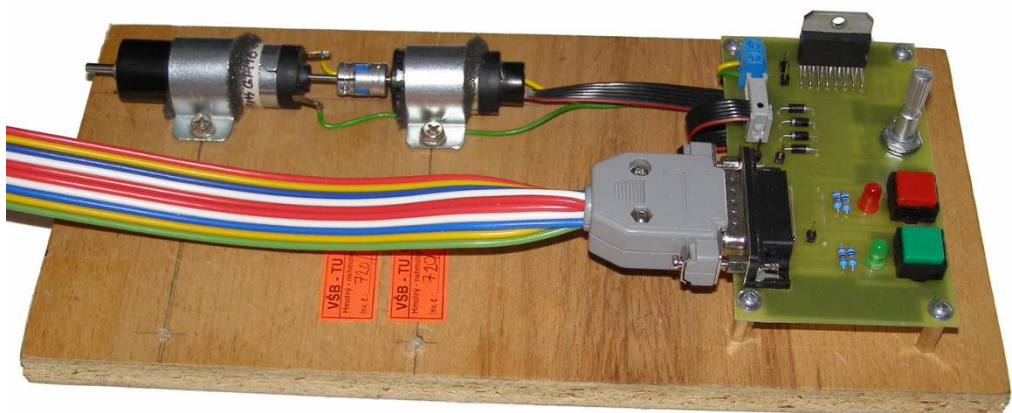


Fig. 2 Image of the measuring board

3 MEASURED TASKS

The goal of this measuring is to get a comparison between the exact digital value of speed of the driven motor taken from IRC encoder and induced analog value from the DC tachometer. The result of this measuring is described on the following graph. The blue line represents the duty factor

of Pulse-Width Modulation. At the beginning of the measuring, it is set to zero and then it is increasing to 100% and back to zero again. Value from the encoder is shown as a red line and the analog value as a green line.

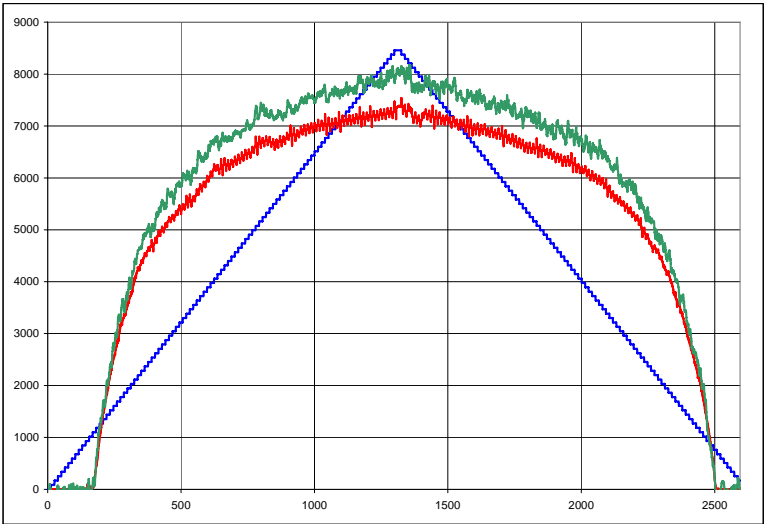


Fig. 3 – Comparison between IRC (red) and DC Tacho analog value (green), duty factor of PWM is blue (0 – 100%)

From this measuring we can say that the information about speed of a DC motor taken from IRC is almost equivalent to the information taken from a DC tachometer. The reason of the difference between the red and green lines shown on the graph is only the different scale of the data.

Another task which can be done with this hardware is measuring of electrical characteristics of any electric signal on board. For this task we need two-channel oscilloscope to show all the important signals. Typical signals are shown at the followed images.

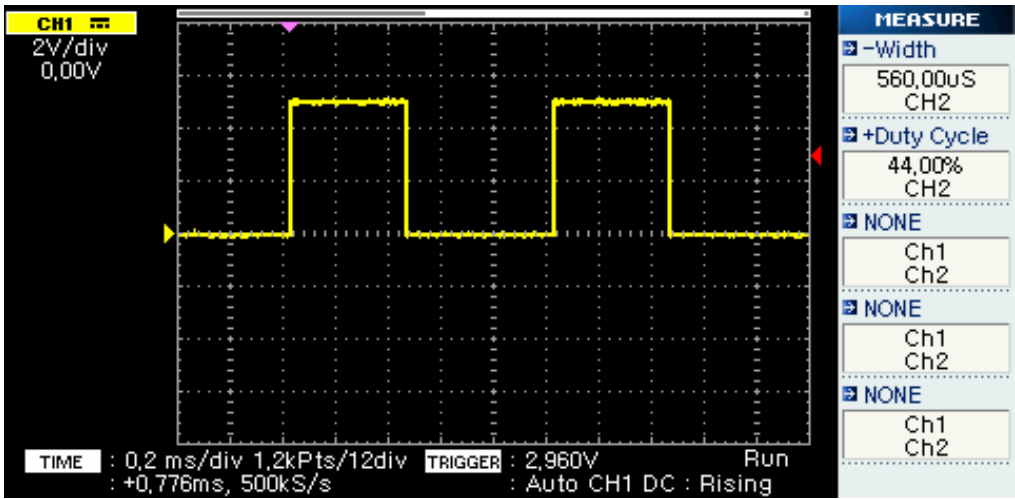


Fig. 4 – PWM waveform

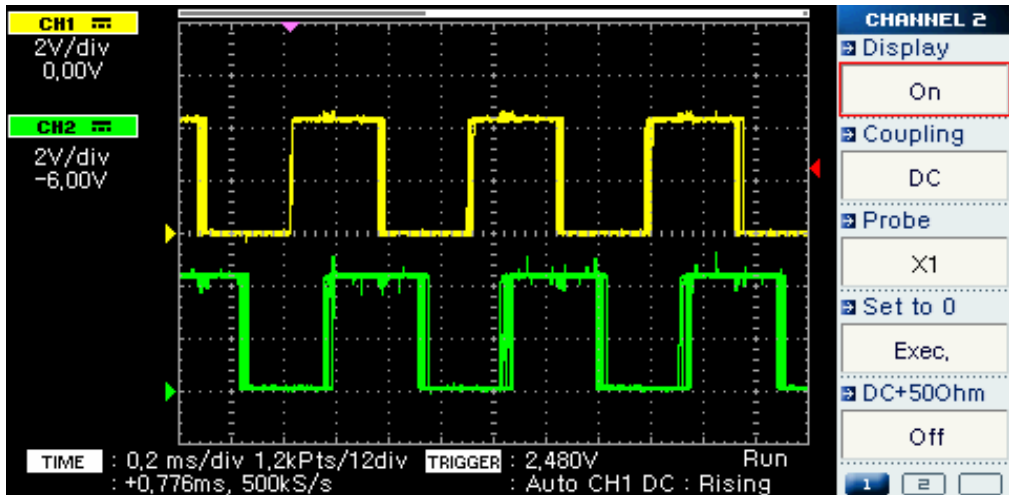


Fig. 5 – IRC waveforms (channel A, channel B)

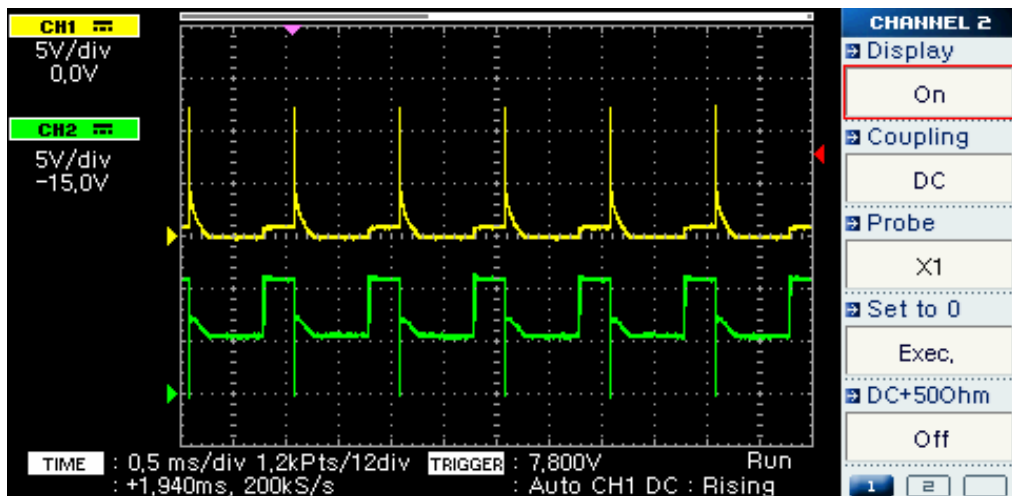


Fig. 6 – Waveform of a motor power feed

We can see a waveform of PWM signal used to control speed motor (Fig. 4), two waveforms from channel A and channel B from incremental rotary encoder (Fig. 5) and a waveform directly from the power feed of the driving motor (Fig. 6). With the digital oscilloscope's measure function, we can verify all parameters of these signals. We can check frequency, duty of PWM and other electric parameters.

Another example of use of this testing module is to realize a simple “Device in the Loop” architecture with Matlab Simulink environment and DC motors. Model of a regulator is realizing the P-Regulation function. Output of the regulator is connected to the driving DC motor and input of the regulator is acquired from DC tacho analog value. Matlab Simulink has no direct support for this multifunction I/O board so we have to use MATLAB function blockset to get direct access to the I/O ports of this card. On the next figure, we can see a simple DC motor speed regulation loop. The desired value of speed is taken from the analog value from a potentiometer installed on the user interface on this testing board.

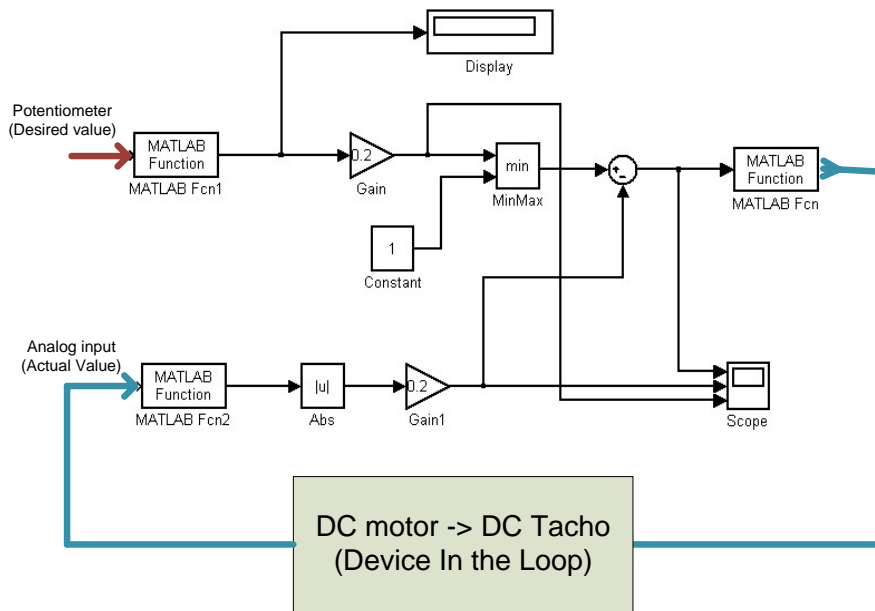


Fig. 7 Model of the P-Regulator in Matlab Simulink environment

Using Matlab or Matlab Simulink we can realize any type of regulator to control DC motor (for example motors on mobile robot). We can verify the behaviour of our regulator in a real case before we use this particular algorithm to make a program for microprocessor which can control DC motors without the PC and Matlab.

We can also control this multifunctional I/O card and testing motors from Visual Basic .NET. A screenshot from the testing application developed at this environment is at fig. 8.

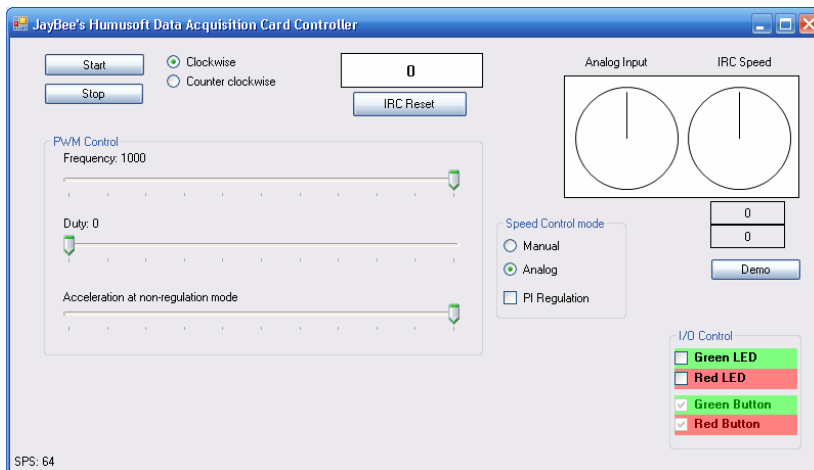


Fig. 8 – Control application written in Visual Basic .NET

With this example application we can control speed of motors. We have the information about speed of a motor from the analog input (DC Tacho) and encoder. This information is presented on the analog panel meter. We also have access to the I/O user interface (LEDs and buttons). PI regulation was implemented in this application, too. We can switch modes of operation by radiobuttons at the “Speed Control mode” section. The application is designed for testing and educational purposes.

4 CONCLUSION

With this testing board we can verify any small DC electromotor speed and position controlling algorithm before it will be implemented to an embedded control system (for example to microcontroller). This device is also useful to demonstrate the principles of DC motors control to students at laboratory lessons.

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Reviewers:

ing. Roman Dudek, ESP, Insisa, a.s., Ostrava

ing. Marcel Boščík, ABB, Robotics Division, Ostrabva-Hrabová