THRE AXIS MICROSTEP CONTROL CARD FOR EDUCATIONAL X-Y-Z MULTIPLE AXIS UNITS

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Abstract: The paper presents an original and experimental microstepping control card. The microstepping card controls thre stepper motor with such a mihigh resolution that your workpiece finish will be of exceptional quality. The unpleasant noise and resonances normally associated with stepper motors are considerably reduced. The microstepping card is designed for continuous operation.

Keywords: microstepping, stepper motor, power drivers, control axe.

1. INTRODUCTION

The PC slot-in card contains all components necessary for driving three stepper motors, including the three power end-stages (Morar, 2002b). The requirements of a variety of applications in the low- to medium power range can be met by this card, especially when used in conjunction with stepper motors. It is a major feature of the system that the motors are driven in the so-called microstepping mode.

A conscious attempt has been made to provide the customer with electronics which can support - from the points of view of price, and of the open nature of the hard- and software architecture - a variety of applications.

Stepper motors are the important connecting link in technical operations in which input information is digitally processed and results in movement and positioning runs. They are capable, because of their operating principle, to act upon this digital information directly, without any further mechanical conversions.

When a stepper motor is operated within a defined working range, feed-back signals can be dispensed with. Because of its simplicity, the stepper motor is very frequently met with in practice. Operating mode may be full- or half- or microstepping, of which full- and half-step operation are the most commonly used. This leads to the question - why then is it necessary to develop from full- and half-step to micro-stepping mode?

A weakness of full- and half-step operation appears at low speeds. Movement may be jerky. Also, because there is an obtrusive noise, it is unpleasant to be in the vicinity of such installations.

This is of special significance in laboratories. The strong tendency towards resonating is a further reason for going over to micro-stepping.

2. INTERNAL OPERATION

The microstepping card is to be used internally (inserted into ISA PC slot) and provided with external power supply (Morar, 2001). The block scheme of microstepping card is shown in figure 1.

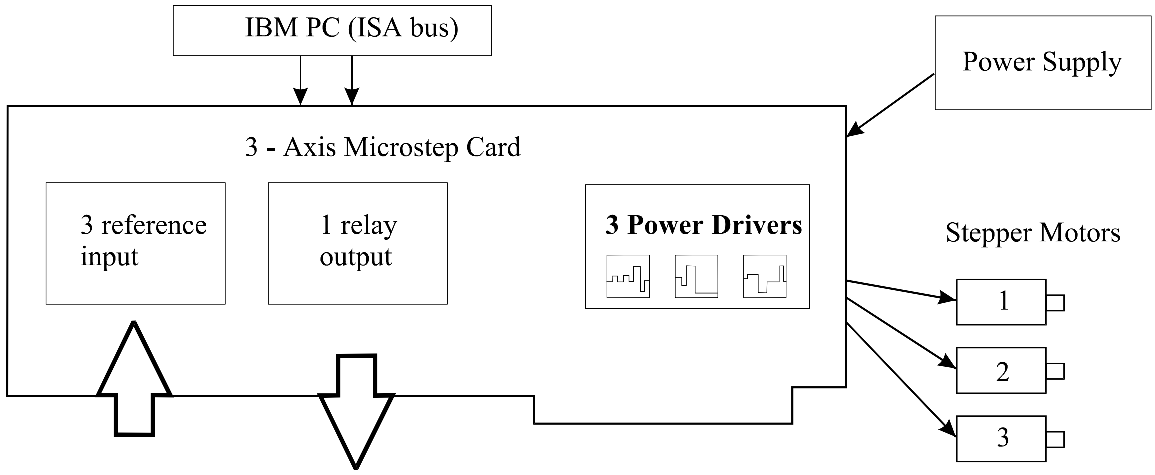
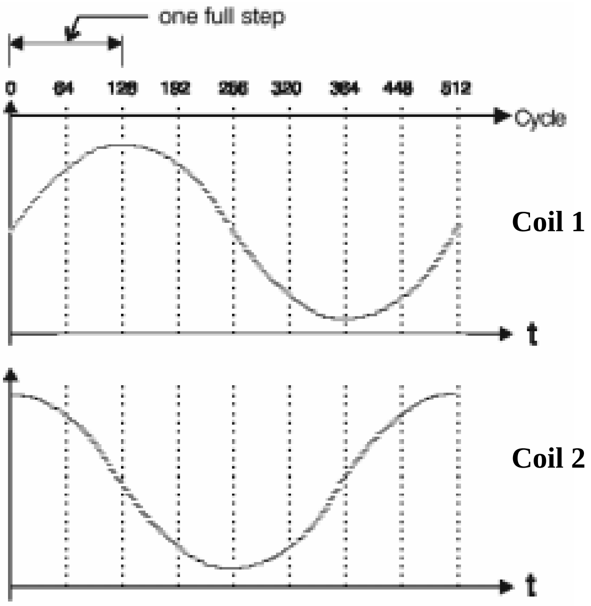


Fig.1. The block scheme of microstepping card.

Due to the principle of control employed in the microstepping card, the motor can execute up to 25,600 steps/rev (i. e. 128 microsteps * 200 steps). Switching sequence of motor windings in bipolar operation in the microstepping mode is shown in figure 2.



The basic principle is to produce, according to an 8-bit range of 0-255, two currents 90 out-of-phase with each other, for the two phases of the motor. This is as though each motor is controlled by a two-channel current amplifier, where each current value is represented by an 8-bit value. The motor is supplied with the correct values of phase current by the transmission of the 8-bit values to two defined port addresses.

The theoretically achievable speed of the microstepping card in [mm/s] depends on the resolution of the microstep setting and on the lead of the drive screw. The base address of the card can be selected by means of DIP-switches, and must end with a 0 (for example 300h, 310h, 340h). Figure 3 shown example a selected base address.

basic adjustment
base address 340 HEX

example
base address 300 HEX

example
base address 310 HEX

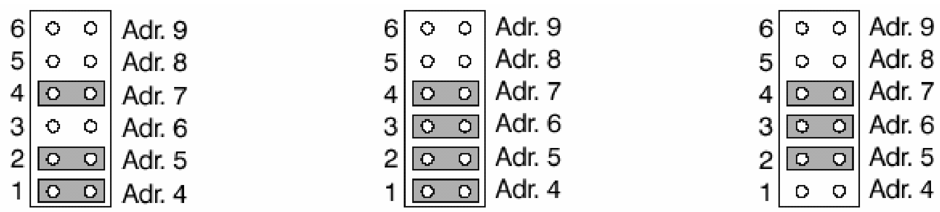


Fig.3. Base address selected.

The two phase currents of a motor are conditioned by the transmission of an 8-bit value to two defined port addresses. Allocation of port addresses for the individual motors with pre-set base address, e. g. 300h (shown in table 1). Datum switch inputs with port address 306h with pre-set base address 300h (shown in table2):

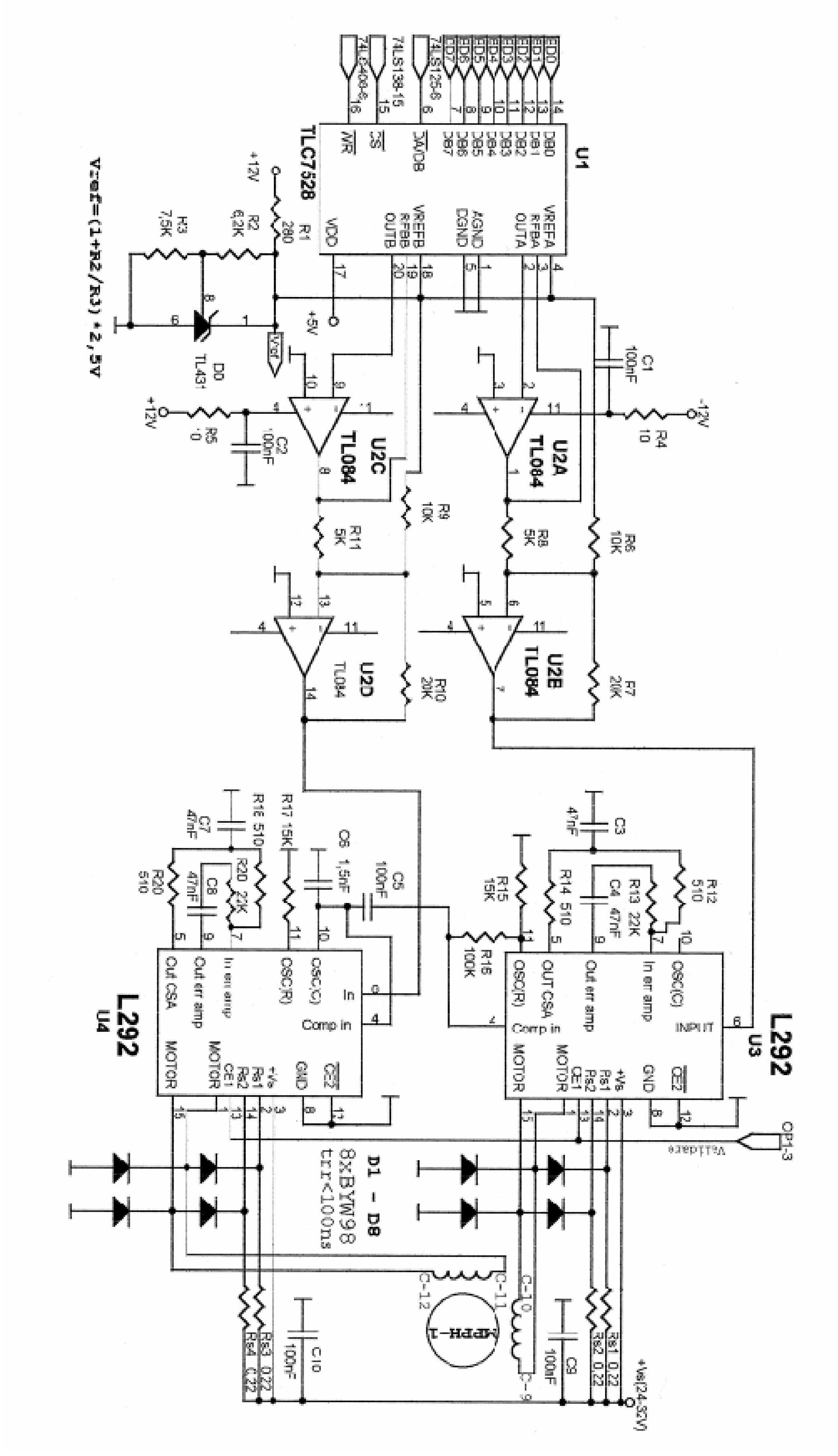


Fig.4. Electrical scheme of microstepping control card(one stepper motor)

Table 1

Motor No	Phases	Port address	value transmitted
1	A1/A2	300 HEX	0-255
1	B1/B2	301 HEX	0-255
2	A1/A2	302 HEX	0-255
2	B1/B2	303 HEX	0-255
3	A1/A2	304 HEX	0-255
3	B1/B2	305 HEX	0-255

Table 2

reference switch	pin (J101)	bit number	port address
motor 1	24	0	306 HEX
motor 2	23	1	306 HEX
motor 3	22	2	306 HEX

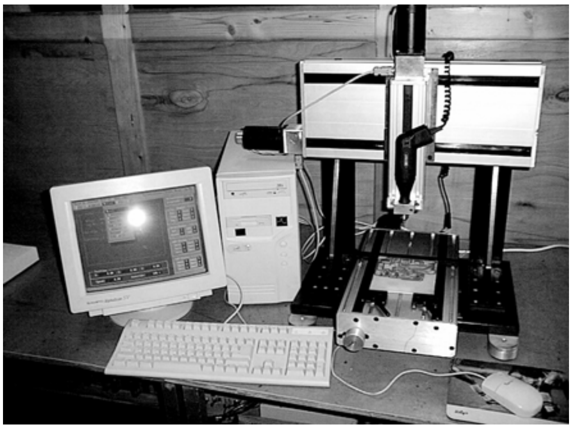


Fig.5. The general view of developed system (controller + CNC machine)

3. MICROSTEPPING CARD FEATURES

- 1 -3 axes of stepper motor control
- 1 – 3 axes of stepper motor drives included as standard feature on card
- Microstepping modes
- From 1 – 128 microsteps/full step, maximum 2A/phase
- Maximum 100VA per axis
- Line voltage from 24v to 30V
- Cooling fan provided on card
- Motor reference and line voltage with 25-pin sub-D connector
- Emergency cut-off by relay or kill-switch
- Programs can be written in BASIC, PASCAL and C
- up to thre cards per PC (DIP switches)
- 3 home reference inputs, optically isolated, 24V
- 1 relay output, 24V/1A

Adaptation of the microstepping card motor current to customized stepper motors with A phase current less than 2 Ampére! The microstepping card is designed for a phase current of 2 A. If a motor with a phase current less than 2 A is used, it is possible to adapt the hardware to the motor. According to the technical data (refer to motor driver module L292, manufacturer: SGS-Thomson), an input voltage of 9.1 V at L292 corresponds to a phase current of 2 A. At present, when transmitting OXFF HEX, the software ensures that a voltage of about 9.1 V is made available at L292 by means of appropriate analogue amplifiers. In this case the reference voltage is 4.5 V. To reduce the phase current it seems sensible to reduce the reference voltage.

The electrical schematic of the microstepping control card for command of one stepper motor is shown in figure 4 (Morar, 2002a).

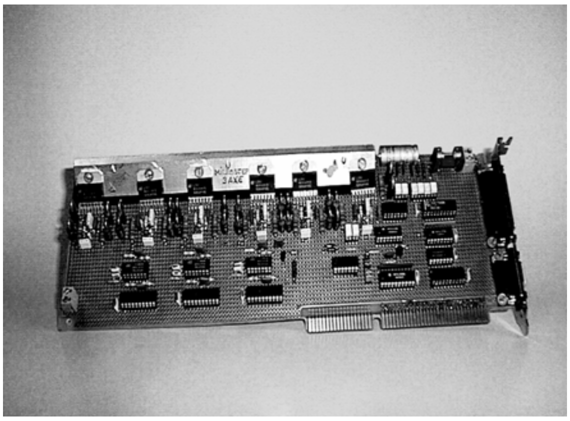


Fig.6. The general view of microstepping control card.

4. MOTION CAPABILITIES

- Liner Interpolation – true step-by-step interpolation during acceleration, deceleration, and all points in between, on 3 axes
- Circular interpolation – true step-by-step circular interpolation during acceleration, deceleration, and all points in between on any two axes.
- Continuous arcs without stopping at axis boundaries
- Incremental and absolute commands
- Programmable position, velocity and acceleration

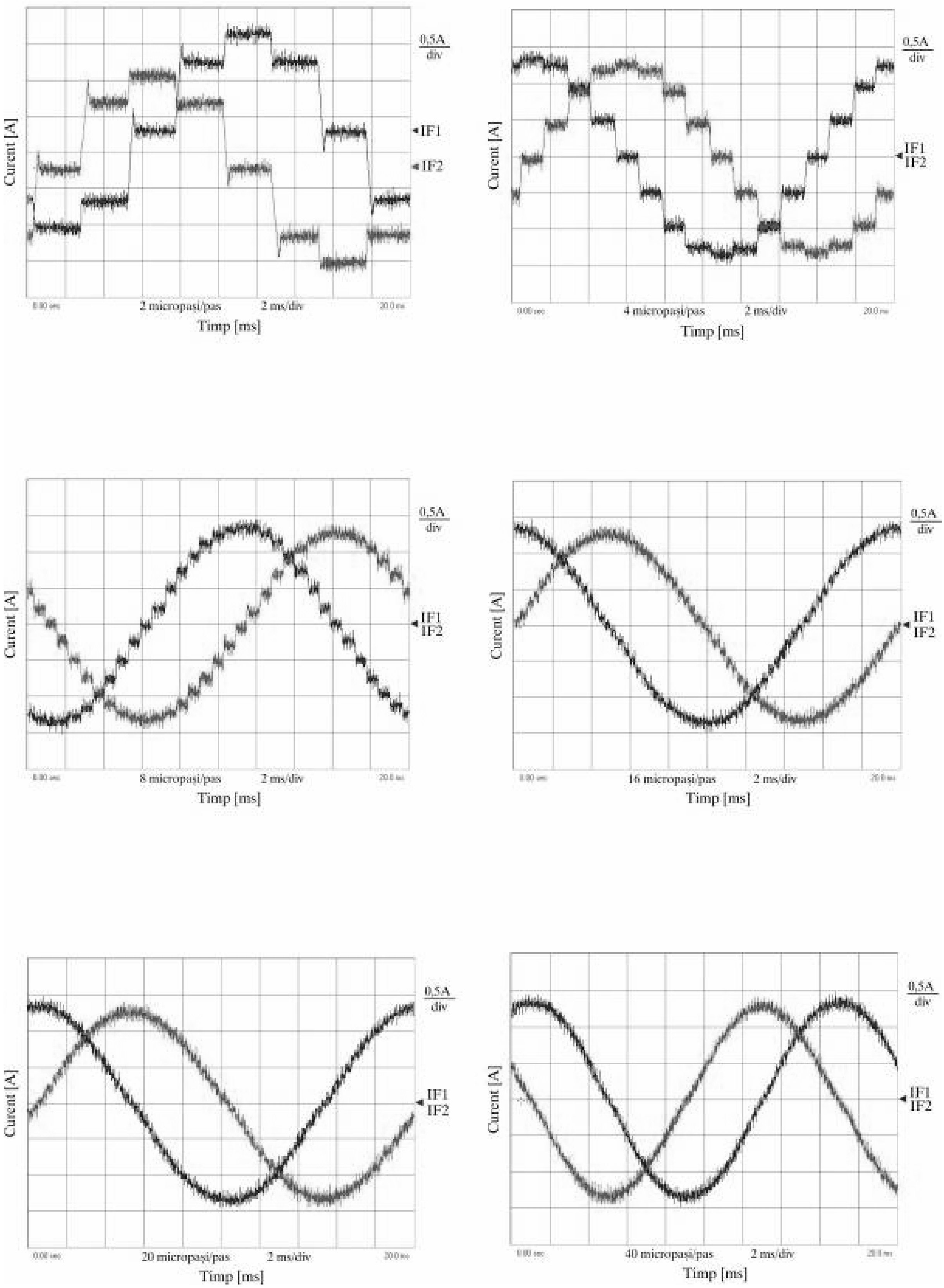


Fig.7. Experimental results.

5. EXPERIMENTAL RESULTS

Figure 5 exposes the developed system which was achieved by Electrical Drive Laboratory of the Engineering Faculty, "Petru Maior" University of Târgu-Mureş, the tests were done using a true three dimensional CNC machine (controlled by three bipolar stepper motors). The CNC prototyping machine includes application which is ideal for educational uses as well as an industrial application (Acarnely, 1992), (Morar 2001).

Figure 6 shows the general view of microstepping card. In order to measure the phase currents, two hall sensors (LEM modules – LA25NP) were used, and a data acquisition numerical system dedicated to the electric drives as in (LEM, 1992), (Thomson, 1996).

As experimental results, the phase currents of a two-phase bipolar stepper motor (2, 4, 8, 16, 20, 40 microstep/step) are shown in figure 7 (Morar, 2001).

6. CONCLUSIONS

The last progress both in control in motor drive domain impose on the researchers a continuous reorientation in order to solve the design problems with the newest technical means. In this sense the author have developed an original microstep card for the open-loop control of 3 stepper motors. Among the facilities offered by this card we mention:

- motor acts almost like a d.c. motor
- resonances are significantly reduced
- noise generation is considerably reduced
- very high step resolution
- bipolar switching operation

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