# Electronic Module for 2D Positioner Manuel Control

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*Abstract* – **Electric drives are wide used in engineering practice. Precise operation and easy control of stepper electric motors had put their application in exact position fixing. The stepper motors in combination with control can provide a flexible operation and awards an opportunity to make reliable electric drives systems. Experimental model of electronic module for 2D positioner control based on two small powerful stepper electric motors and programm-able logical matrix is presented in the report.**

*Keywords* – **magnetic fields control, stepper electric motors, programmable logical systems.**

## I. INTRODUCTION

Stepper electric motors are often used in the practice as electric drives of different machines and equipments. Special units are used for this effect which are able to control the motor poles so that can carry out needed operations.

There are electromechanical units doing manipulations as position fixing of details, reading and writing heads which fine control is unimaginable without stepper electric motor. In some cases is not necessary to do this fixing automatic but manuel. So the operator directly assigns a direction, speed and a shifting distance.

Electric motors electronic control can be made by different manners. There are such units with discrete logic, microcontrollers and programmable logical matrixes. The last give a possibility for a flexible change of the discrete logical circuits and also to have a programming of their functions with some much possibilities – operating frequency, time constants etc.[1, 2, 3].

The aim of this elaboration is to propose, fulfill and investigate an experi-mental model of electronic module for control in two directions (2D) positioner by means of two small powerful stepper motors and programmable logical matrix. The developed unit can be applied in auto-mation, electronics and engineering practice for creating of different units for position fixing in 2D plain which are controlled by voltage level. The circuitry and experimental results of the unit which determines the direction and the rotation speed of electric motors in relation to the applied input voltage are presented.

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## II. PRESENTATION

A block schematic diagram of the created experimental unit is depicted in Fig.1. It is intended for the position in 2D plain manuel control. Two small powerful stepper electric motors (SM) of the type KP39HM4-016 produced by Matsushita [4] are used. They control the motion of the metal frame in two directions. The block schematic diagram of the electronic unit is composed by three modules – set up generator-modulator (SGM), program-able logical device (PLD) and power device (PD). The control module executes double function. It assigns a motion direction of a corresponding motor (to X or to Y) and its rotation speed. SGM is created by two identical set up circuits ($SC_X$ or $SC_Y$). They produce a signal to PLD which shows the rotation direction and a signal to controlled by voltage generator UFG. The rotation direction of the corresponding motor is determined by the sliding contact of the potentiometer position (control X or control Y). The resistance change of the potentiometer makes a control signal change to controlled by voltage block generator (UFG). It is a system of two channels generator for rectangular pulses. Its frequency is controlled by voltage given from corresponding set up circuit. So by SGM are made two independent pair pulses XCLK, XDIR and YCLK, YDIR with different (independent) frequencies. They give a clock signal and the rotation direction of both motors.

The LPD is the basic module. It is made on the base of a developmental system CoollRunner II, produced by Xilinx [5]. The platform consists of CPLD programmable logical matrix XC2C256 in case TQG144 and peri-pheral modules – JTAG programmer, clock generator, display, buttons, etc [5]. The programme is written down in a this block memory. It generates a defined sequence of pulses for motors correct management. After their for-ming the ruling signals come in power module (PM). Two independent each other signal pairs $X_{1`2}$ and $Y_{1`2}$ enter to a driver block (PD) input. They control the motion to X and Y. PD supplies with needed current and voltage motors coils SM_ X and SM_Y.

The set up generator–modulator (SGM) schematic circuit diagram is depicted in Fig. 2. It consists of set up circuit $SC_X$ and controlled by voltage generator UFG. $SC_X$ defines a motor rotation direction. It is made by means of opera-tional amplifiers $IC_{1a}$, $IC_{1b}$ and $IC_{2a}$, $IC_{2b}$ and connected with them elec-tronic components – resistors $R_1 \div R_{12}$, capacitors $C_1 \div C_3$, $C_5$ and diode $D_2$, $D_3$. This circuit generates two signals. The first is used for voltage-fre-quency generator UFG control (elements $IC_{2b}$, $IC_{2c}$, $IC_{2d}$, $D_1$, $R_{13} \div R_{17}$). The second signal defines a motor rotation direction. The Y channel control is absolutely the same. The corresponding block generates signals for control of a speed and a direction (YCLK and YDIR).

This block circuit operation is defined by sliding contact voltage of a potentiometer $R_P$ and its comparing with standard defined. The sliding contact place defines the rotation direction. In its middle position the voltage is equal to a half of supplying voltage. The amplifier $IC_{2d}$ works as an integrator but $IC_{2b}$ as a comparator.

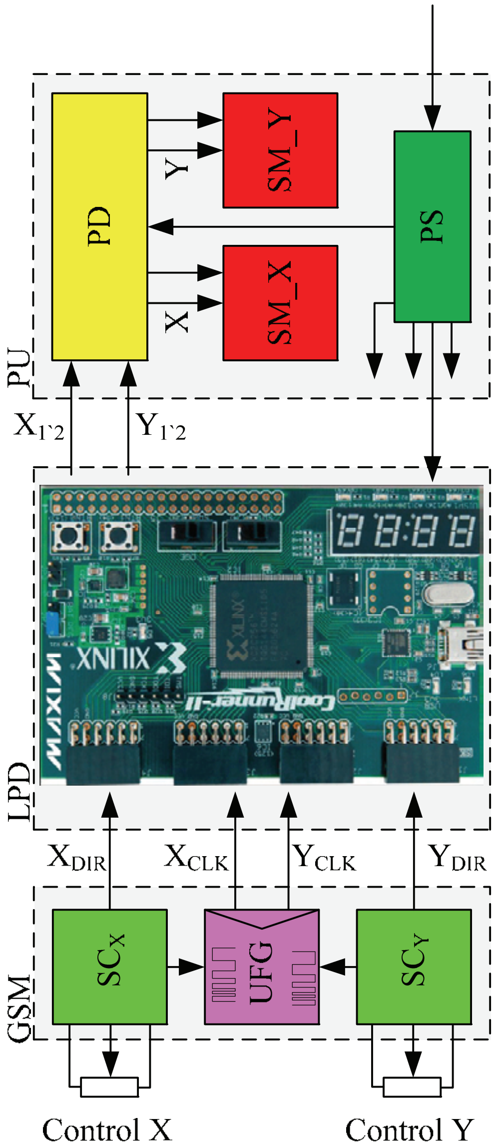


Fig. 1. Block structure of the electronic unit for 2D positioner control

They both build together a generator which is controlled by a voltage limited by $IC_{2c}$ and by a connected in its feedback $D_1$. The voltage value at which pulse generations appear is dependent on the values of resistors $R_1$=10kΩ, $R_2$=50kΩ, $R_3$=10kΩ. They are so selected and define the control voltage to be equal to a half of supply. When the potentiometer is moved to any direction from the middle position the comparator $IC_{2a}$ without delay sets up at it output a corresponding level (0 or 1) and the shifting value is determined by the voltage value at the output of $IC_{1b}$ and it starts to generate pulse XCLK. The describing operation of module SCX timing diagrams are depicted in Fig. 2.

The received from UFG signals determine motor control speed to X and Y.

The signal levels XDIR and YDIR define their rotation direction. They are given to inputs of a programmable logical device PLD.

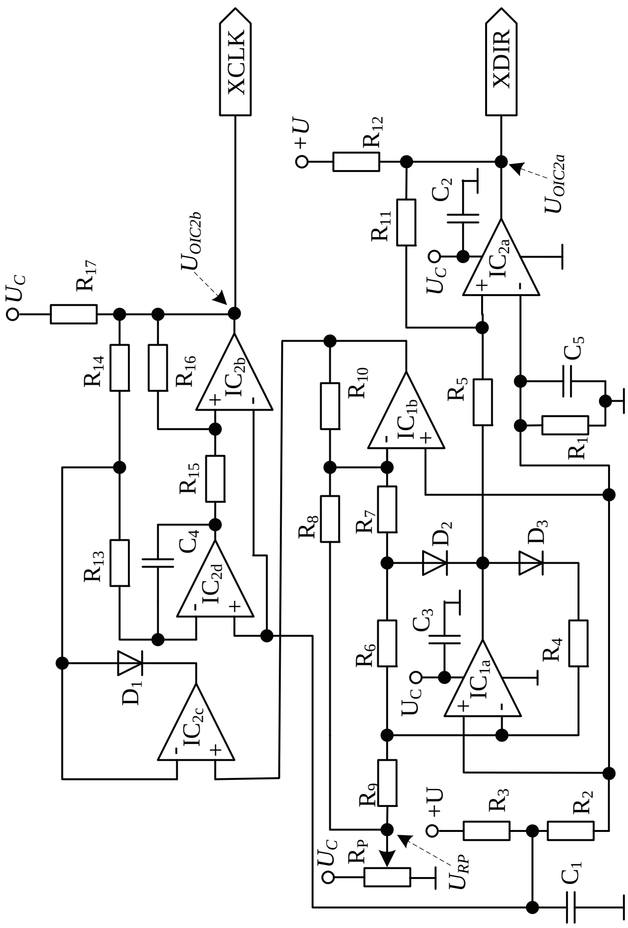


Fig. 2. Simplified schematic circuit diagram of an analog module for X channel control

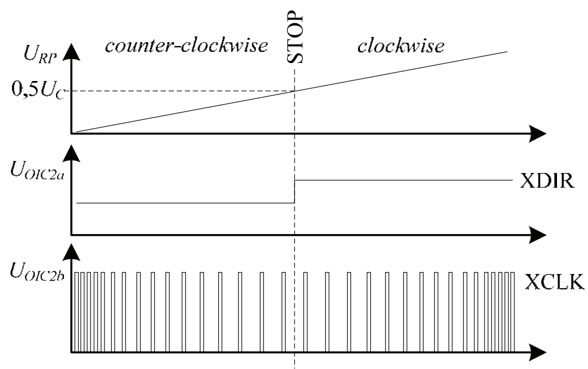


Fig. 3. Timing diagrams describing an analog module operation given a direction and speed rotation

TABLE I
THE CONFIGURATION OF A PROGRAMMABLE LOGICAL MATRIX PINS

| Type of Signal | Control by X direction<br>Name of Signal – pin number | Control by Y direction<br>Name of Signal – pin number | |
|---|---|---|---|
| INPUTS | XCLK – p124 | YCLK – p39 | CLOCK |
| | XDIR – p38 | YDIR – p38 | DIRECTION |
| OUTPUTS | CL1X – p10 | CL1Y – p143 | Control coil L1+ |
| | CL2X – p7 | CL2Y – p139 | Control coil L1- |
| | CL3X – p5 | CL3Y – p136 | Control coil L2+ |
| | CL4X – p3 | CL4Y – p134 | Control coil L2- |

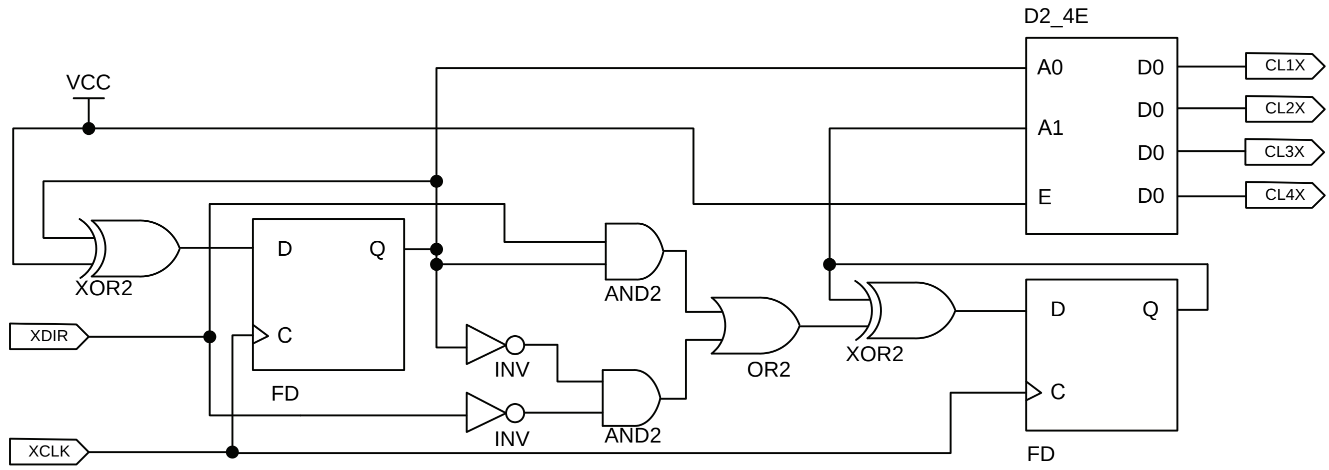


Fig. 4. Programmed in CPLD circuit for control to X only

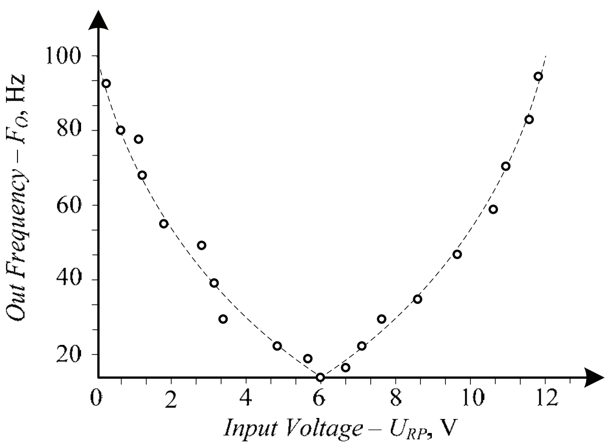


Fig. 5. Conversion characteristic of one channel in device UFG – $F_O=f(U_{RP})$

The signals from both channels are treated by PLD. For unit realization are necessary both hardware and software. The logical matrix is programmed by a software ISE Design Suit 10.1 produced by Xilinx [5]. The CPLD programming can be made by two methods.

The first is by a programme code drafting. The other used here is by a desired circuit drowing with available in section schematic prepared libraries with function-nal elements. A software conceptual electric circuit is depicted in Fig.4.

The formed in device UFG signals go to the programmable logical matrix inputs. They are configured so that the signal XCLK controls D-triggers FD (Fig. 4). A direction signal comes to logical scheme which controls the se-cond trigger so that a decimal counter has to sum up or to subtract. A  modu-le PLD generates 4 signals (CL1X, CL2X, CL3X, CL4X) used for driver control of motors. The configuration of a programmable logical matrix pins in relation to input and output signals of both channels is depicted in table1 1.

The output signals for both control channels X and Y are absolutely inde-pendent. They come to driver block PD. The conceptual electric circuit of one channel in driver block is depicted in Fig. 6. The signals from CPLD are inverted by input buffers IC3. Each pair signals CL1X, CL2X and CL3X, CL4X controls MOSFET transistors (Fig. 6) in a H-bridge. One diagonal of both bridges is connected to voltage supply.

Another is connected to electric motor coil. The bridge circuit based on transistors VT1,VT2,VT3,VT4 controls a coil L1 while a bridge with VT5,VT6, VT7, VT8 controls a coil L2 (Fig.6 and table 1).

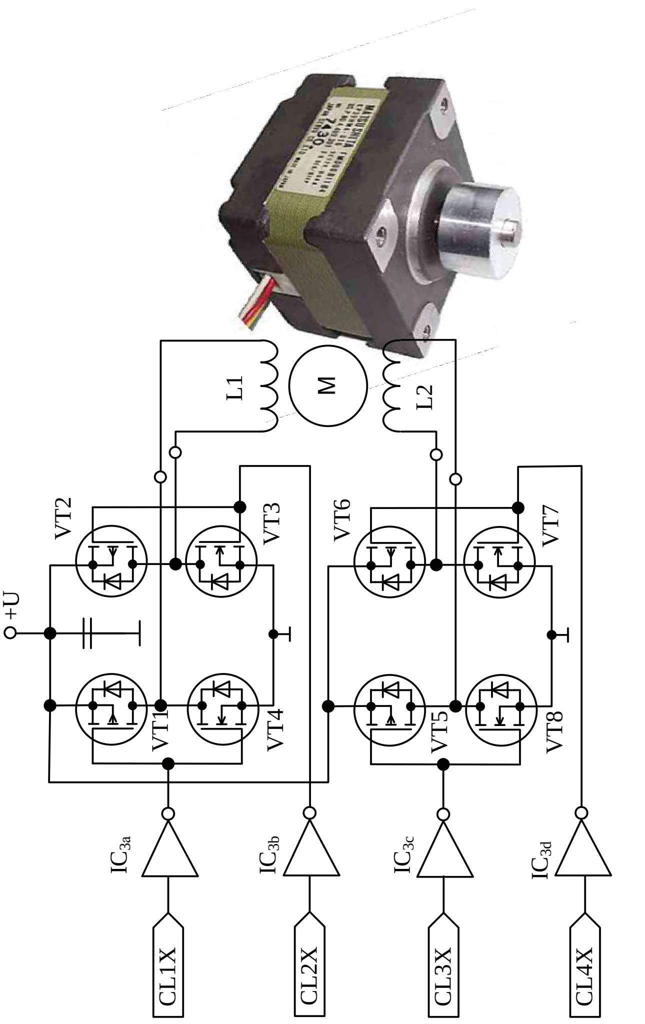


Fig. 6. Conceptual electric circuit of one channel in driver block

## III. Conclusion

An experimental unit for manuel control of 2D positioner is exploited. It is made up a block circuit describing the operation of electronic unit. A con-ceptual electric circuit composed of three basic modules – set up generator, programmable logical device and power module is realized. A software for programmable logical device is created in programme medium ISE Design Suit 10.1 produced by Xilinx. The programming is made with build in deve-lopmental platform JTAG programmer. The realized unit is experimental investigated. The results are:

1. The timing diagrams in special check points having effect upon unit operation are obtained by means of electronic oscilloscope and are depicted in Fig. 4

2. A conversion characteristics of one channel of block UFG (Fig. 5) is obtained. It shows a dependence between a generator output frequency $F_O$ change and a voltage $U_{RP}$ supplied to its output by means of potentiometer $R_P$ .The analysis shows that it is symmetrical in relation to the middle value of the stabilized voltage supply (1/2 $U_C$ = 6V). The experimental character-ristic shows that controlled by voltage generator exibits nonlinearity.

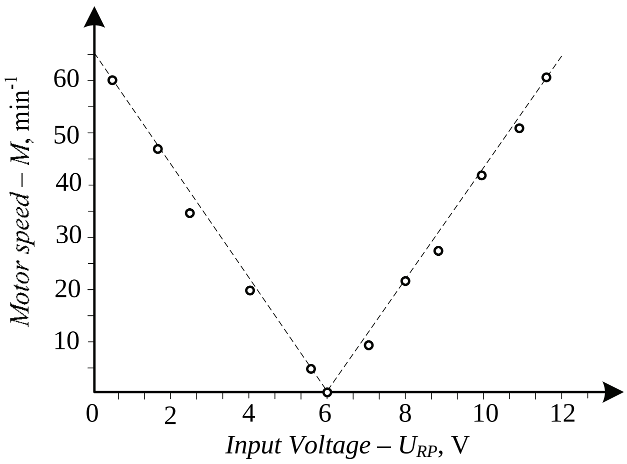


Fig.7 Experimental characteristic $M = f(U_{RP})$

3. The dependence of electric motor M rotor rotation speed on input voltage coming from potentiometer RP is investigated. The characteristic $M=f(U_{RP})$ is depicted in Fig. 7. It is symmetrical and linear. When a half of voltage is supplied the stepped motor stops. It is established the same change range of rotation sped from an input voltage $U_{RP}$ in relation to initial value $U_{RP}$= 6V. This range is symmetrical to both rotation directions – from left to right at $U_{RP}$ = 6÷12V and backwards from right to left at $U_{RP}$= 6÷0V the electric rotor rotation speed rises to $M$ = 60 min$^{-1}$.

The created unit can find a wide application in research laboratories and in engineering practice by the different positioners, machines and equipments, mechanical cutter, leth, metrology etc.

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