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DRIVE OF STEPPER MOTOR 2L110M

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***Annotation* – regulated electric drive based on stepper motor is described. Work of power driver is considered, main parameters and its characteristics are described. Features of forming of microstep working mode of motor and algorithms of power driver control are considered.**

***Keywords*– stepper motor, controller, power driver, pulses, microstep, peak current, working current, holding current.**

Formulation of the problem. Stepper drive is the electromechanical device, which converts electrical pulses in to discrete mechanical movements. These motors have long been successfully used in a variety of devices. It can be found is disk drives, printers, plotters, faxes, and also at various industrial and special equipment. At present many different types of stepper motors for all occasions are produced. But correct choosing of motor type is only half of the problem. It is equally important to choose the right driver circuit and algorithm, which is often determined by the program microcontroller.

Analysis of recent researches. Stepper motors are used in drives of machines and mechanisms, which work at start/stopping mode, and also at continuous moving drives, where control action is formed by sequence of electrical pulses [1]. In contrast to servo drives, stepper drives allow precise movement without using feedback sensors of angular position.

This type of drive consists from namely motor, power control module (driver) and external controller. When planned movement of actuator is small, motor with a long rifled shaft can be used. That gives a possibility to reduce price of stepper motor system by eliminating ball-screw or another converting device of rotational movement into linear.

Forming of aim of paper. Aim of paper is to increase efficiency of using of stepper motor control system.

Main part of research. It is to use special stepper motor drives for control by motor behavior, particularly, for hybrid motor series 23HS driver 2L110M can be used [2].

Driver consists from semiconductor convertor with inbuilt simplest interface, which provides working off of input voltage pulses. Power driver of stepper motor is a power amplifier, which converts pulses from external control system into shaft movement. In addition, each pulse causes shaft movement at 1 microstep, which allows smooth motor work with little vibration and noise level. Control by motor current is three-level, with levels of peak current at switching, working current at switching and holding current under stopping, and ensures optimal motor work in term of overheating. The value of current setpoint is defined by DIP-switches SW1-SW3 combination, and SW4 allows setting of current level at motor holding mode. For example, at strict requirements torque behavior for shaft holding, nominal current value is needed. At another cases it is possible to reduce resulting current to 50% from nominal value. In addition, power driver has protection for overvoltage, overloading by current, overheating and short circuit of power transistors.

An important and significant advantage of this driver is the ability to work at high voltage alternating current, i.e. the user does not need to install additional rectifier, the price of which sometimes exceeds even the price of driver. At the same time, a built-in high voltage source allows for higher rotational speed without reducing torque.

For power driver control the external controller, which forms one of two main types of control - PUL/DIR – «step/direction» or CW/CCW – «pulse/pulse», can be used.

At «pulse/pulse» working mode with two channel frequency input pulses comes to both frequency inputs PUL (CW) and DIR (CCW), according to needed direction of rotation. At «step/direction» working mode with one channel frequency input the direction of rotation is defined by level of the voltage at DIR input. For guaranteed signal processing by internal microcontroller, the duration of high and low pulse level should be not less than 1,5 microseconds.

Power part of driver consists from eight transistors *VT1–VT8*, which works at PWM mode with stabilization of current at windings. Pulse width is defined by difference between real value of current and value of current, which is set by DIP-switches. At most existing schemes each of power transistors is shunted by reverse

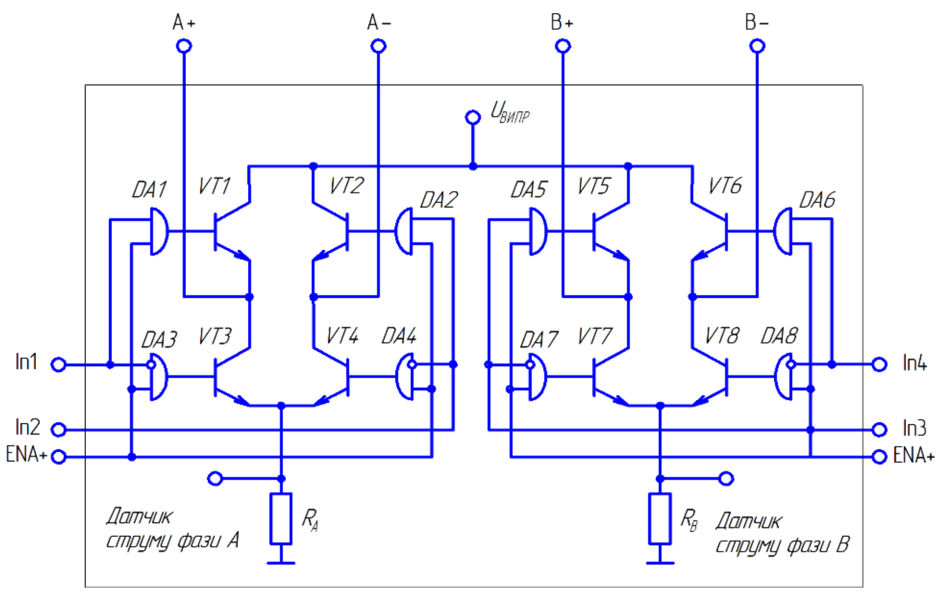

Fig. Electrical circuit of power part of drive diode for reducing of overvoltage (it is not shown at scheme). The value of current at windings is measured by current sensors at each phase of motor.

Pulses from inbuilt microcontroller come to *In1–In4* inputs. Switching frequency of *VT1–VT8* transistors is defined by pulses frequency, which come to PUL input at working mode with one channel frequency input, and PUL/DIR inputs at working mode with two channel frequency input. Pulses from microcontroller are received by operational amplifiers *DA1 – DA8*, and further into control inputs of *VT1–VT8* power switches. According to functional characteristics at this scheme amplifiers *DA3, DA4, DA7, DA8* with a function «inhibition», and *DA1, DA2,DA5, DA6* with conjunction function «AND» are used.

Signal of work permission ENA+ and ENA- is hardware enable function and ensured guaranteed disabling of power switches when signal with zero level comes. Such scheme solution is used for ensures of electrical safety requirements on electric trauma for staff.

Let consider algorithm of drive work at half-step mode. At initial moment of work in the absence of signals at In1-In4 inputs the transistors *VT3,VT4,VT7,VT8* are opened. When control pulse comes to In1, *VT3* becomes off and *VT1* becomes on. At this case rectified supply voltage of drive is applied to winding A. After this control pulse goes to In3 input, so *VT5* becomes on, and transistor *VT7* becomes on. Winding *B* obtains supply voltage and shaft of the motor rotates at half of step. Thereafter signal from In1 is removed and motor rotates same direction at half of step again, because winding *B* is still under voltage. It should be noted that at supplying of both windings at half-step mode current in each winding at the level 0.707 from nominal is stabilized.

At microstep working mode vector sum of current at *A* and *B* windings forms resulting current vector with amplitude, nominal for connected motor, and angle, which is aliquot to

$$\alpha = \frac{360^0}{p_П N},$$

where p_p – number of poles, N – number of switches of motor windings.

Multiplicity of microstep is determinated by DIP-switches also.

Conclusions. Power driver is a source of direct current. It not only controls by stepper motor work, but also provides protection from emergency operation.

Microstep mode is created by changing of ratio of current values at *A* and *B* windings. Resulting vector sum corresponds to nominal value of current, which id set by DIP-switches.

Literature.

1. Kulinichenko G.V. Ocenka xarakteristik mexatronnogo modulya na baze shagovogo dvigatelya / Kulinichenko G.V., Baguta V.A., Korobov A.G. // Visnik NTU "xpi" – xarkiv, 2013, №51(1024). – pp. 43 – 53. [In Russian]
2. Two-phase hybrid stepper motor driver. Model 2L110M. http://www.motionking.com/download/2L110M_Instruction_Rev.E.pdf