Experiment: Stepper motor driver

1. Objectives

The aim of this experiment is to familiarize students with the structure and properties of stepper motors, and the knowledge of methods of driving and control them.

2. Components and instrumentation.

Figure 1 shows how the two-phase motor power and bipolar stepper motor driver using LMD18245 [1].

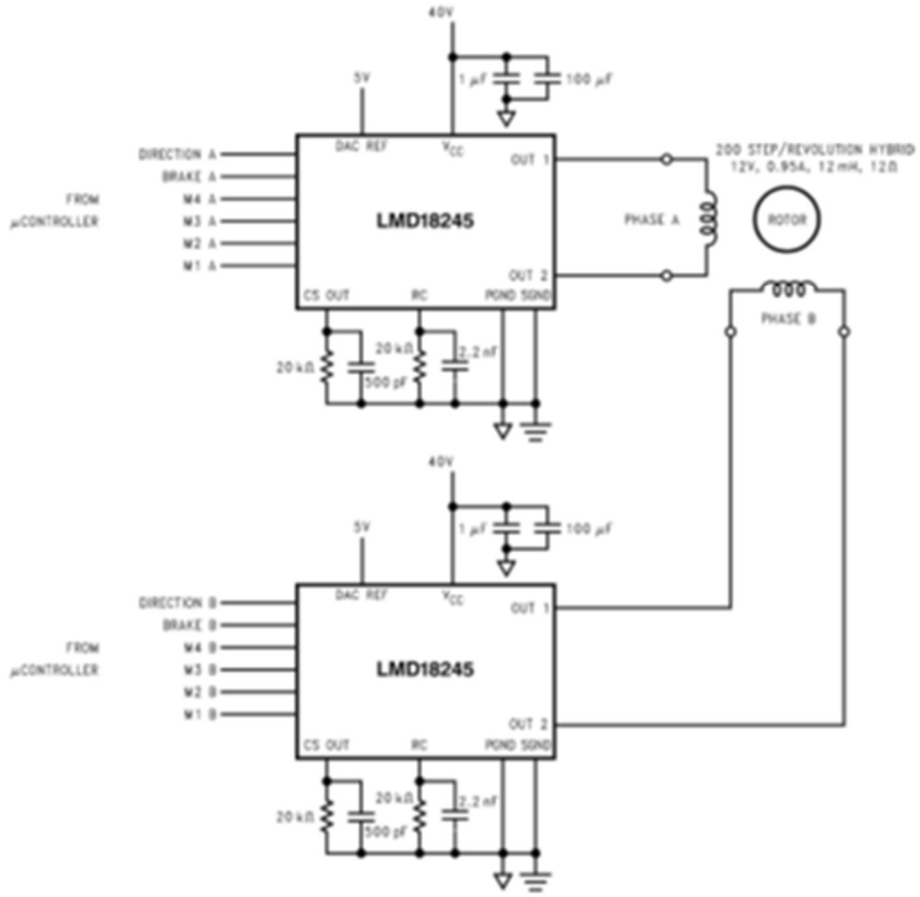

Figure 1. Typical application circuit for driving bipolar stepper motors [1]

Each integrate circuit LMD18245 has the high power DMOS H-bridge. Every bridge can delivers continuous output current up to 3 A. These circuits use an innovative current sensing method, which eliminates the power losses associated with a sense resistor in series with the motor. A four bit digital to analog converter (DAC, inputs M1 – M4, M4 is the MSB – most significant bit) provides a digital path for controlling the motor current, and easily allows to

implementation full, half and microstep stepper motor drives. Figure 2 shows function block diagram and connection diagram of LMD18245.

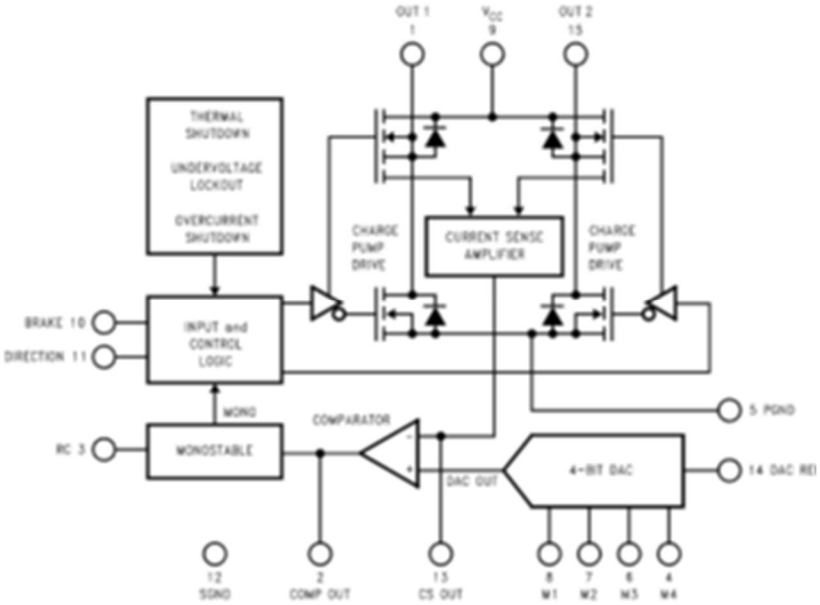

Figure 2. Functional block and connection diagram

3. Preparation.

The estimated time to prepare for classes is 3 to 6 hours.

3.1. Readings

Basic:

[1] Lecture notes (“Actuators”)
[2] LMD18245 datasheet

Optional:

[3] Takashi Kenjo, Akira Sugawara, Stepping motors and their microprocessor controls, Oxford University Press, USA , 1995
[4] J. Przepiorkowski, Electric motors in electronic practice, BTC (in Polish).
[5] T. R. Kuphaldt, Lessons In Electric Circuits, Volume II – AC, Sixth Edition, 2007

3.2. Problems

1. What is the operation principle of a stepper motor ?
2. What are the types of stepper motors?
3. What is the principle of a half-step and micro-step driving ?
4. What is a torque ?

4. Content of report

1. Observe and determine currents in motor winding:
    a) Plug in the power supply to the controller (DC = 12V);
    b) Connect oscilloscope to PCB with motor driver as shown in Figure 3;

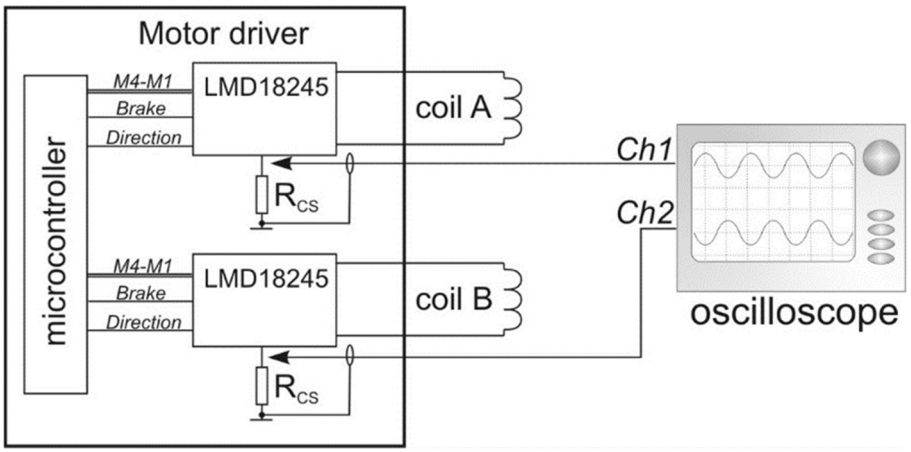

Figure 3. Measurement of stepper motor current

    c) Analyzing schematic diagram of the controller (Figure 6) determine and the data sheet of LMD18245 determine the maximum winding currents for jumpers P11- P41 (P12 – P42) – Tab. 1

2. Observe using oscilloscope and print the windings current wave shapes for full-, half- and micro-step mode; save the print screens.
    a) Analyzing schematic diagram of the controller (Figure 6) and data sheet of current transducer LTS-6-NP read the maximum current of windings from scop – Tab. 1

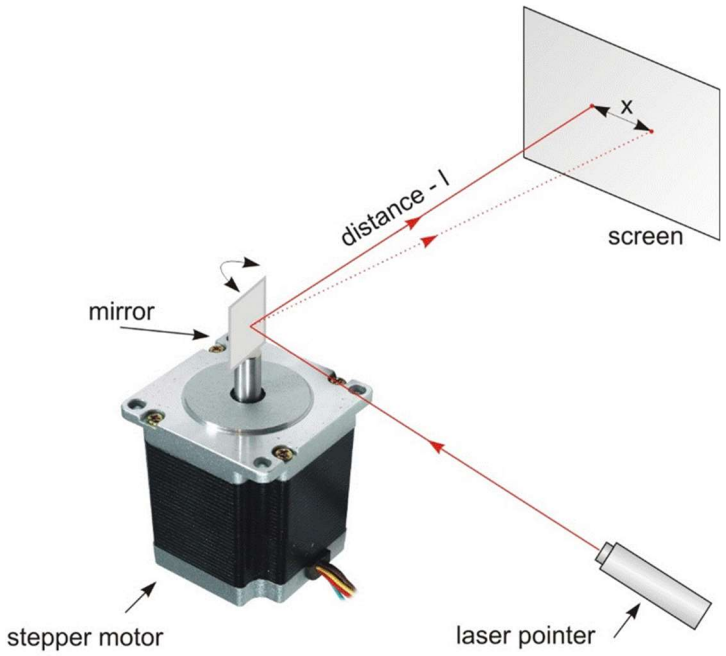

*Figure 4. Measurement setup for stepper motor resolution determination (**alternatively the laser pointer can be fixed on motor shaft**).*

3. Using above setup in Figure 4 determine maximum motor speed for different operation modes (full-, half-, micro-steps); perform 1 or 2 full rotations with small speed and observe if the laser spot return to its start position; increase speed (*decrease the delay between steps in controller*) and determine the speed when final laser spot position change (motor steps will be lost); Repeat this for all four maximum winding currents (different jumper position P1x-P2x) – Tab.2
4. Using arrangement as in Figure 5 measure of stepper motor torque as the function of maximum current and for full-, half- and micro-step modes – Tab.3; draw the Tr = f(Imax) plots for every mode;

Figure 5. Torque measurements set up..

Tab.1

jumper	Imax [A] Calculated as in 1c)	Imax [A] Observed as in 2a)
P11(P12)		
P21(P22)		
P31(P32)		
P41(P42)		

Tab.2

Mode	Max current [A] Px1-Px2	Resolution Angle/step [deg]	Max speed (Minimum Step delay no lost steps) [us]
Micro step			
Half wave			
Full wave			

Tab.3

mode	Max current [A] (Px1-Px2)	F [N]	R [mm]	Tr [Nm]
Full wave				
Half wave				
Micro-stepp				

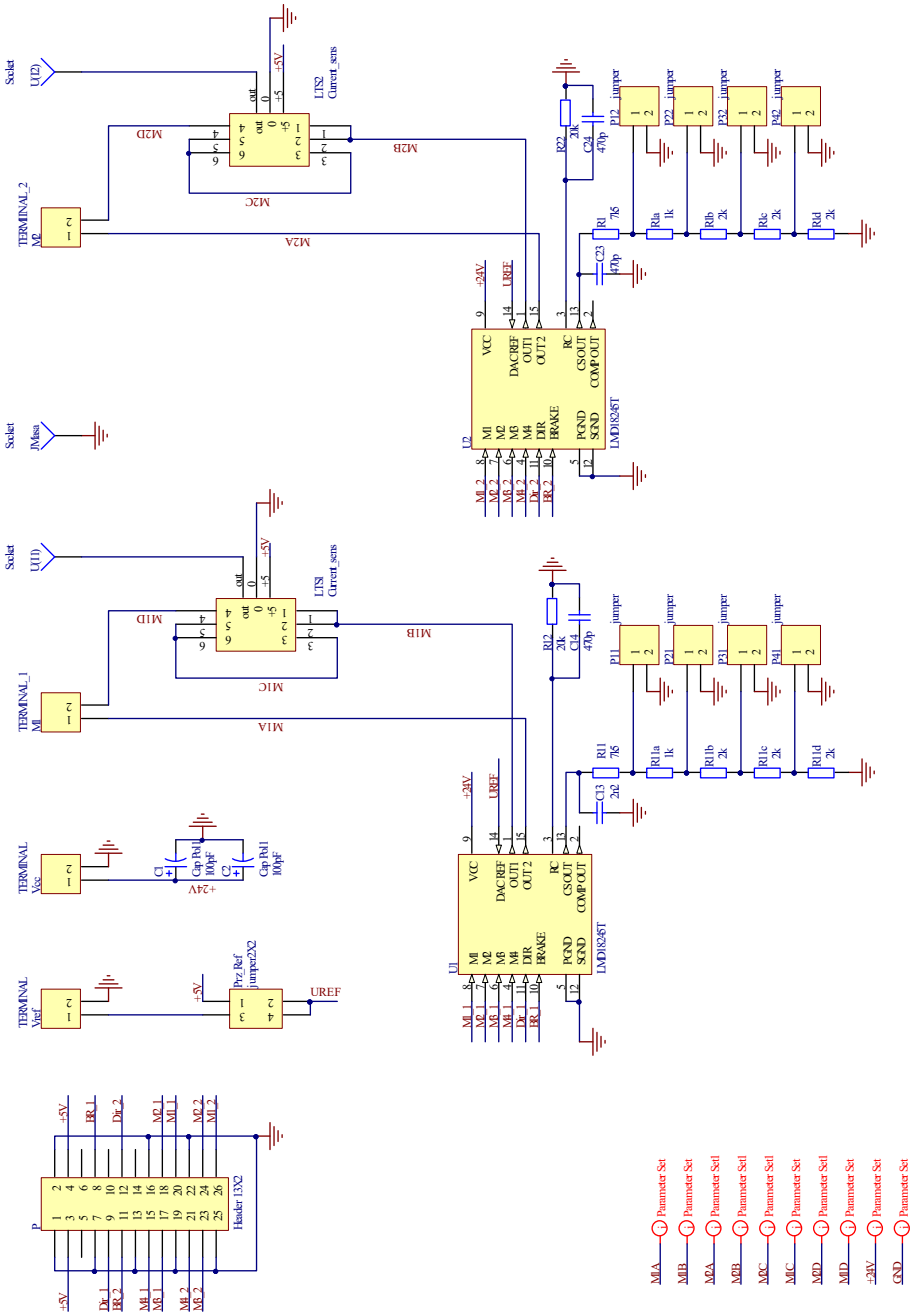

Figure 6. Schematic diagram of the controller.