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].

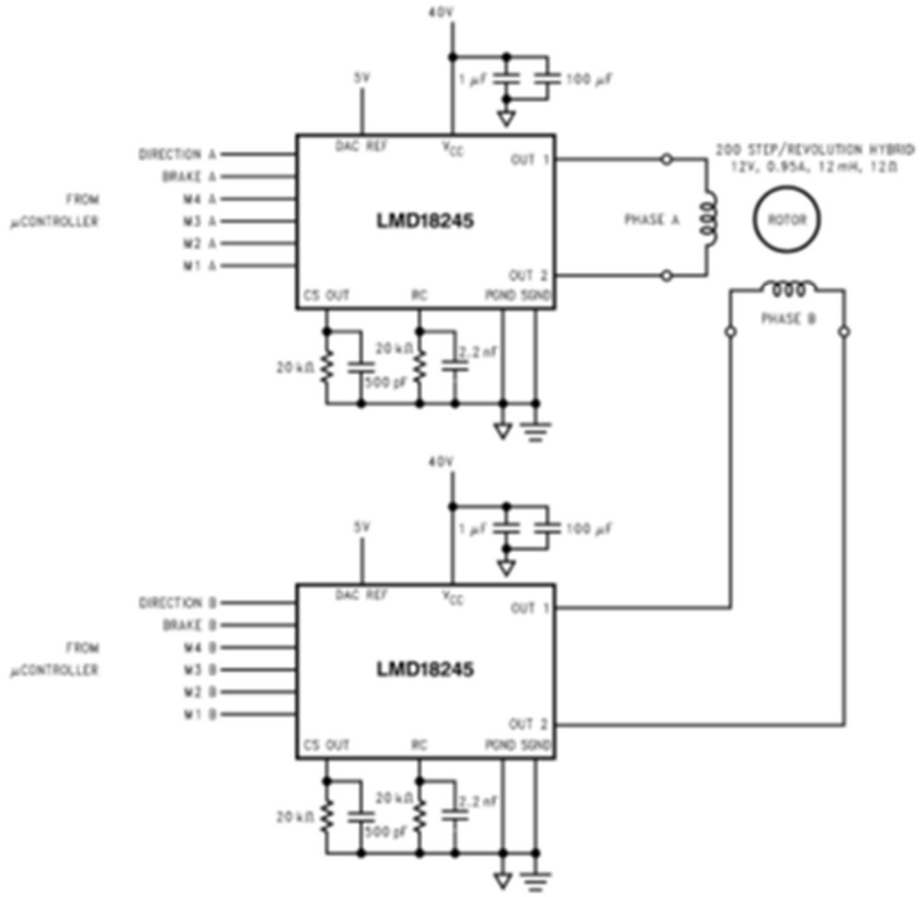

Figure 1. Typical application circuit for driving bipolar stepper motors [1]

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.

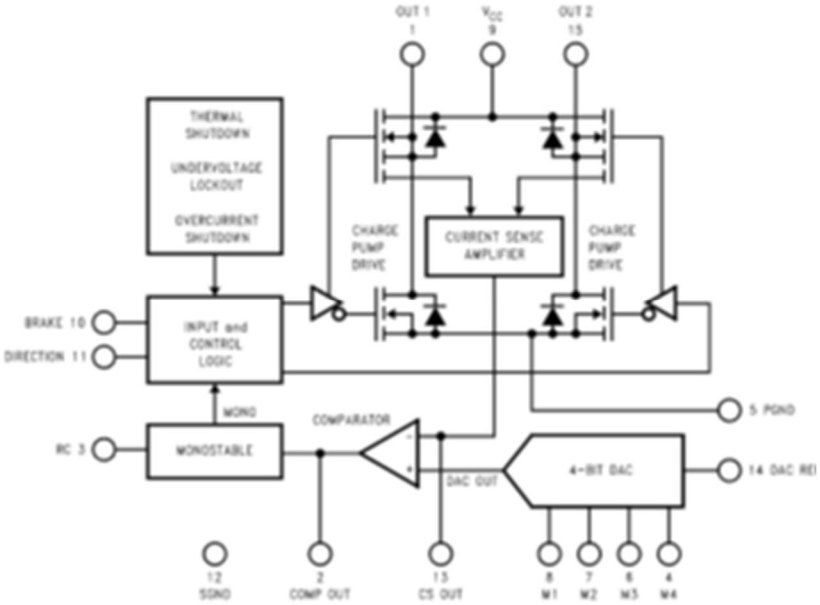

Figure 2. Functional block and connection diagram

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 ?
5. Taking data sheet of LTS-6-NP into account calculate the output voltage of current sensor for 3 different configurations (1,2,3 turns of winding) and for 1A (sensitivity in V/A).

4. Content of report

1. Start the setup:
   a) Lunch on computer STM32CubeIDE program and choose Stepper_LMD18245 project. Found the functions SetCurrents(int I1,int I2) that turn on currents in winding 1 and 2 of the value I1 and I2 respectively and delay_us(DEL) that introduce delay between steps in microseconds.
   b) Connect the computer with Nucleo module.
   c) Plug in the power supply to the controller (DC = 12V or 24V, depend of kind of motor);
   d) Connect oscilloscope to PCB with motor driver as shown in Figure 3;
   e) Start the program with default parameters (full step mode).

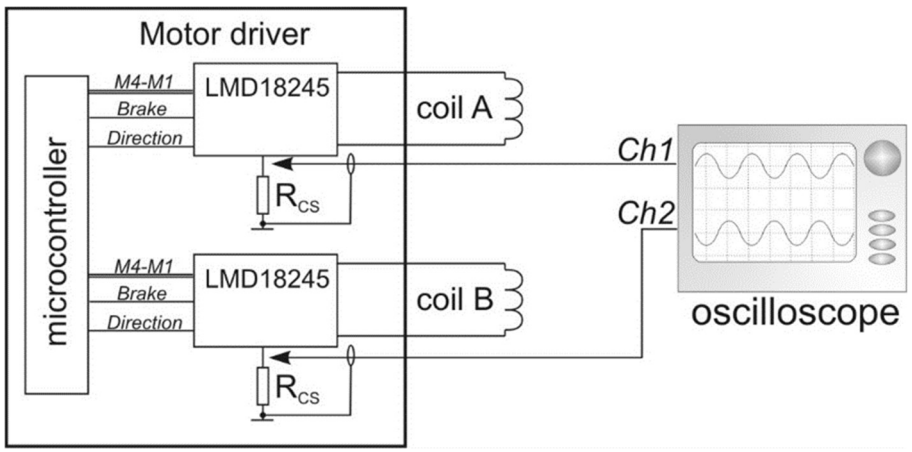

Figure 3. Measurement of stepper motor current

2. Observe on the scope winding currents and determine its amplitudes (takin results of point 5 of chapter 3.2). Save and print current wave shapes. Repeat this point for wave driving, full-, half- and micro-step (at least two different number of micro steps) modes and for four position of jumpers P1x-P2x.
3. Calculate (takin calculation results of point 5 of chapter 3.2) the observed amplitude of windings current for different jumper position P1x-P2x – Tab. 1

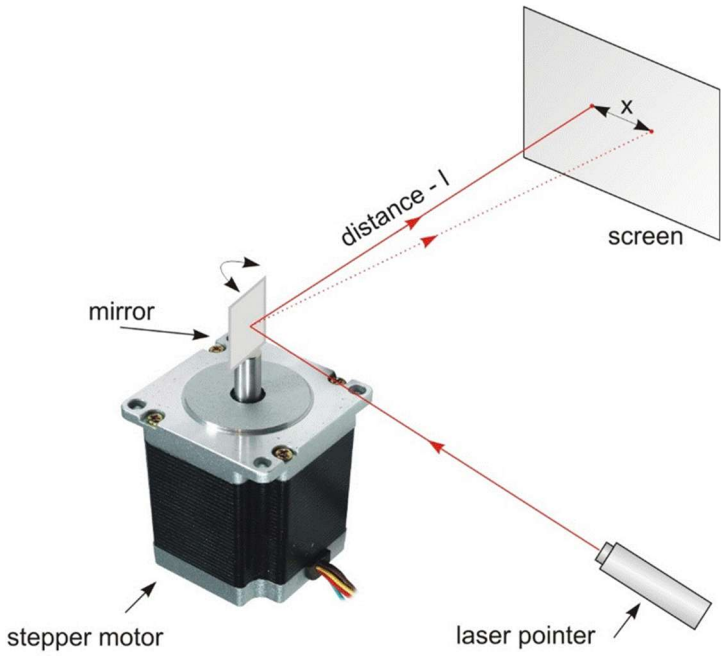

*Figure 4. Measurement setup for stepper motor resolution determination (**alternatively the laser pointer can be fixed on motor shaft**).*

4. Using above setup in Figure 4 determine maximum motor speed for different operation modes; perform a few steps forward and reverse with small speed and observe if the laser spot return to its start position; increase speed (*decrease the delay between steps*) and determine the speed when final laser spot position change (motor steps will be lost); Repeat this for current amplitudes (different jumper position P1x-P2x) – Tab.1
5. Using arrangement as in Figure 5 measure of stepper motor torque as the function of maximum current (position P1x-P2x) and for full-, wave-, half-, micro-step (at least 2 possibilities) modes – Tab.1.
6. Repeat points 2-5 for different motors available in lab

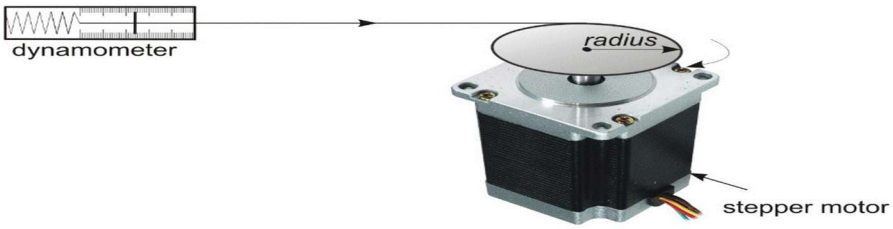

Figure 5. Torque measurements set up..

Tab.1

Mode	jumpers	Current amplitude [A]	Resolution angle/microstep [deg]	Minimum Step delay no lost steps [us]	Steps per tun	Max speed [rip/min]	Torque [Nm]
Micro step e.g.16 micro steps	P11(P12)						
	P21(P22)						
	P31(P32)						
	P41(P42)						
Micro step e.g. 4 micro steps	P11(P12)						
	P21(P22)						
	P31(P32)						
	P41(P42)						
Half step	P11(P12)						
	P21(P22)						
	P31(P32)						
	P41(P42)						
Wave driving	P11(P12)						
	P21(P22)						
	P31(P32)						
	P41(P42)						
Full step	P11(P12)						
	P21(P22)						
	P31(P32)						
	P41(P42)						

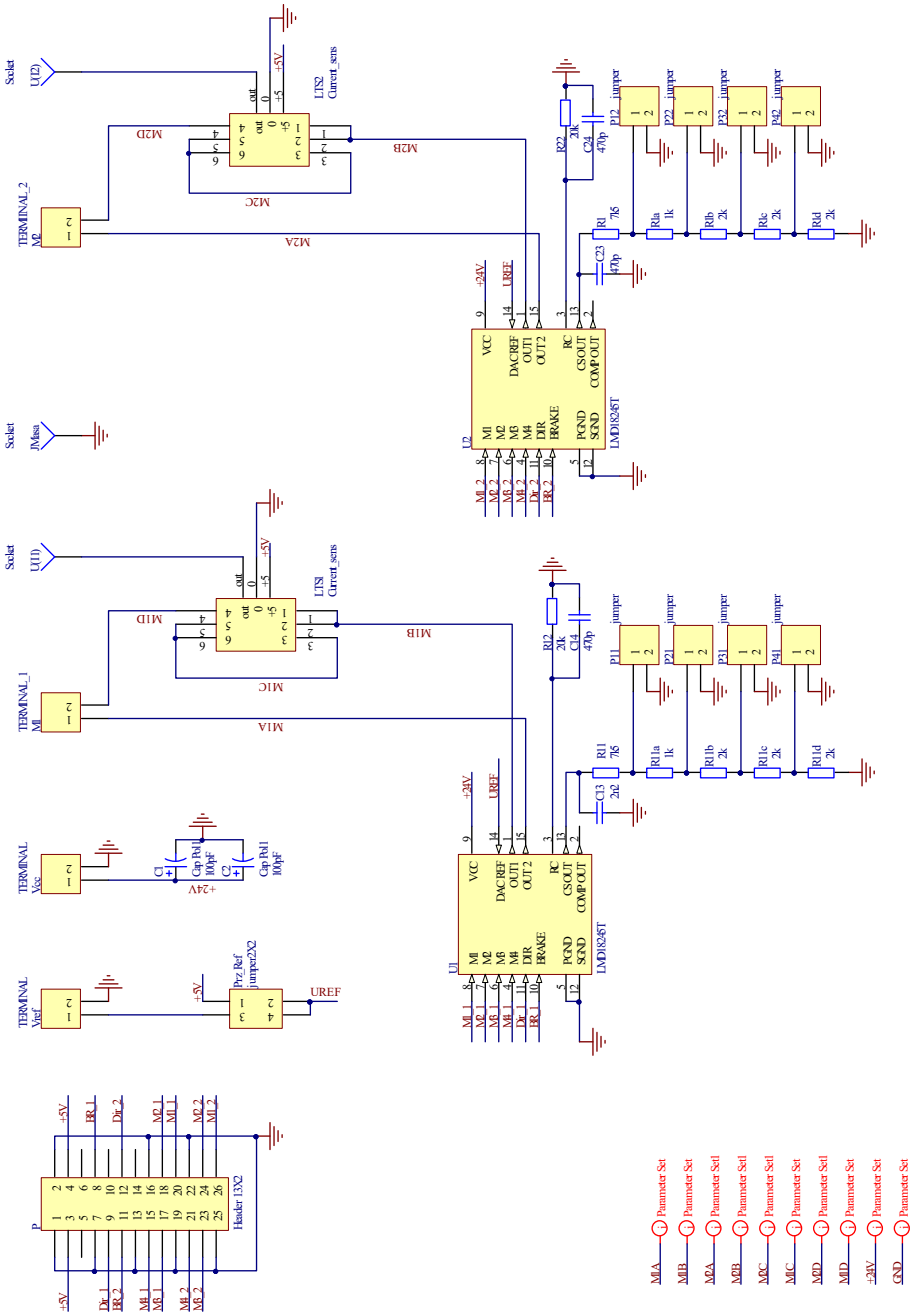

Figure 6. Schematic diagram of the controller.

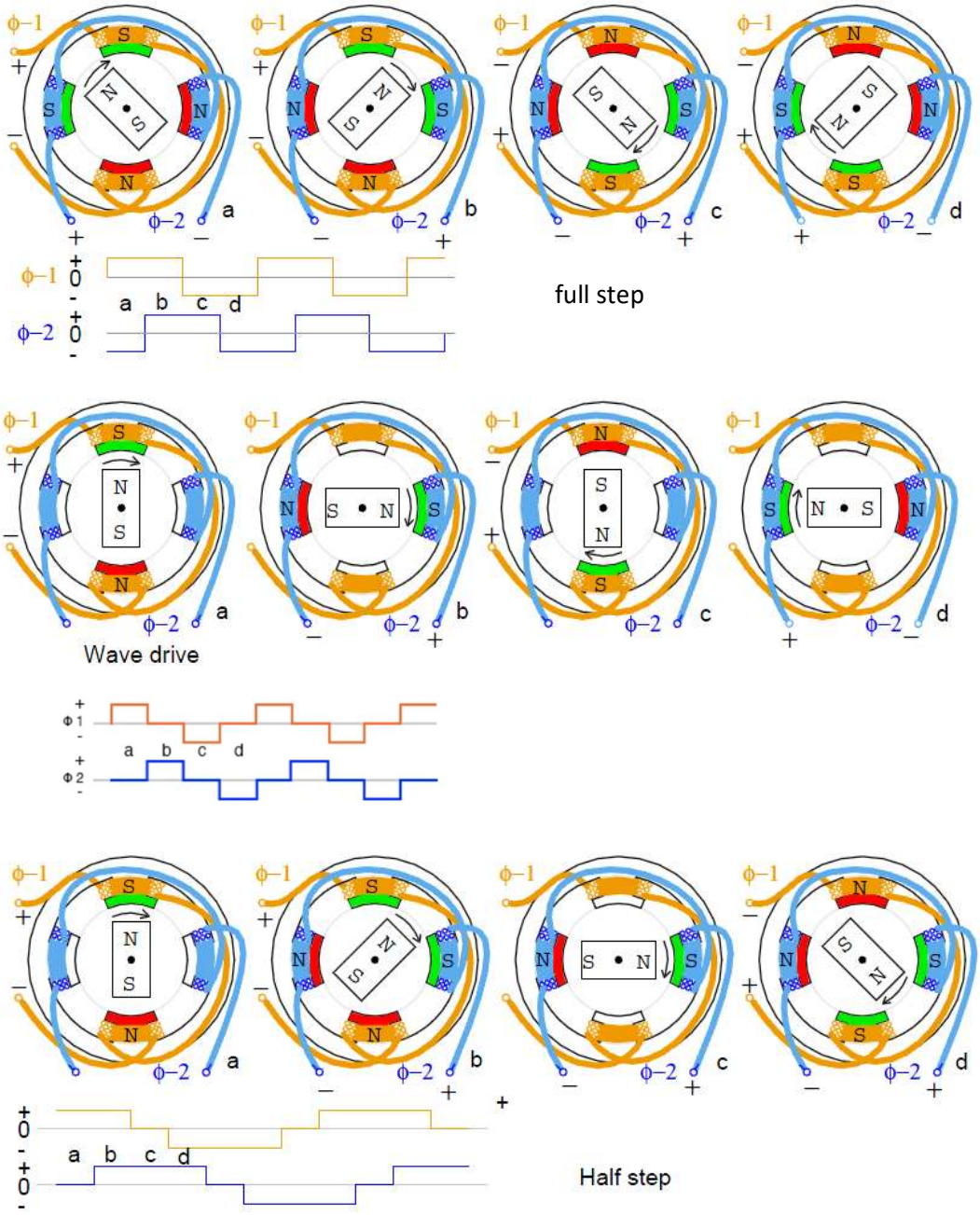

Figure 7. Main drive modes.