

Experiment: Stepper motors comparison

1. Objectives -e7KuTahP!5Zh6N

The aim of this experiment is to familiarize students with the structures 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 L6205D [1].

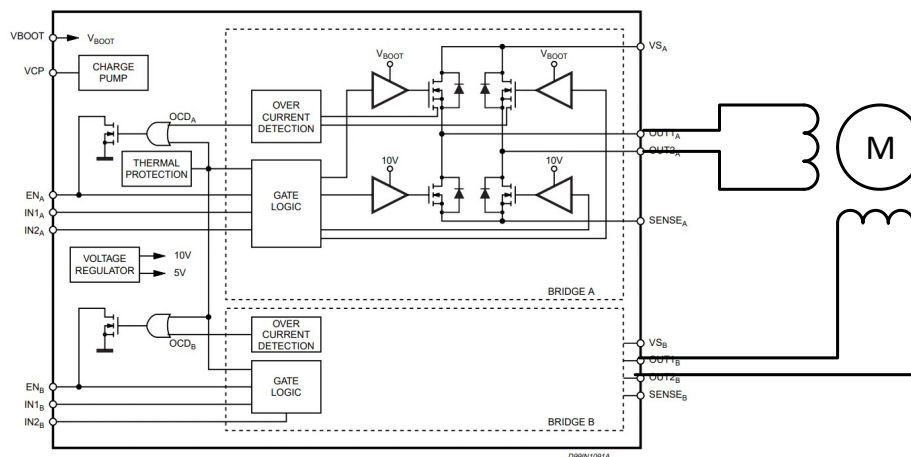


Figure 1. Typical application circuit for driving bipolar stepper motors [1]

Each integrate circuit L6205 has two high power DMOS H-bridges. Every bridge can delivers continuous output current up to 2 A. Circuit provides a digital path for controlling the motor current, and easily allows to implementation any (Two-Phase-On, One-Phase-On Drive (Wave Drive) and half step Drive) stepper motor drives. Figure 2 shows function block diagram and connection diagram of L6205.

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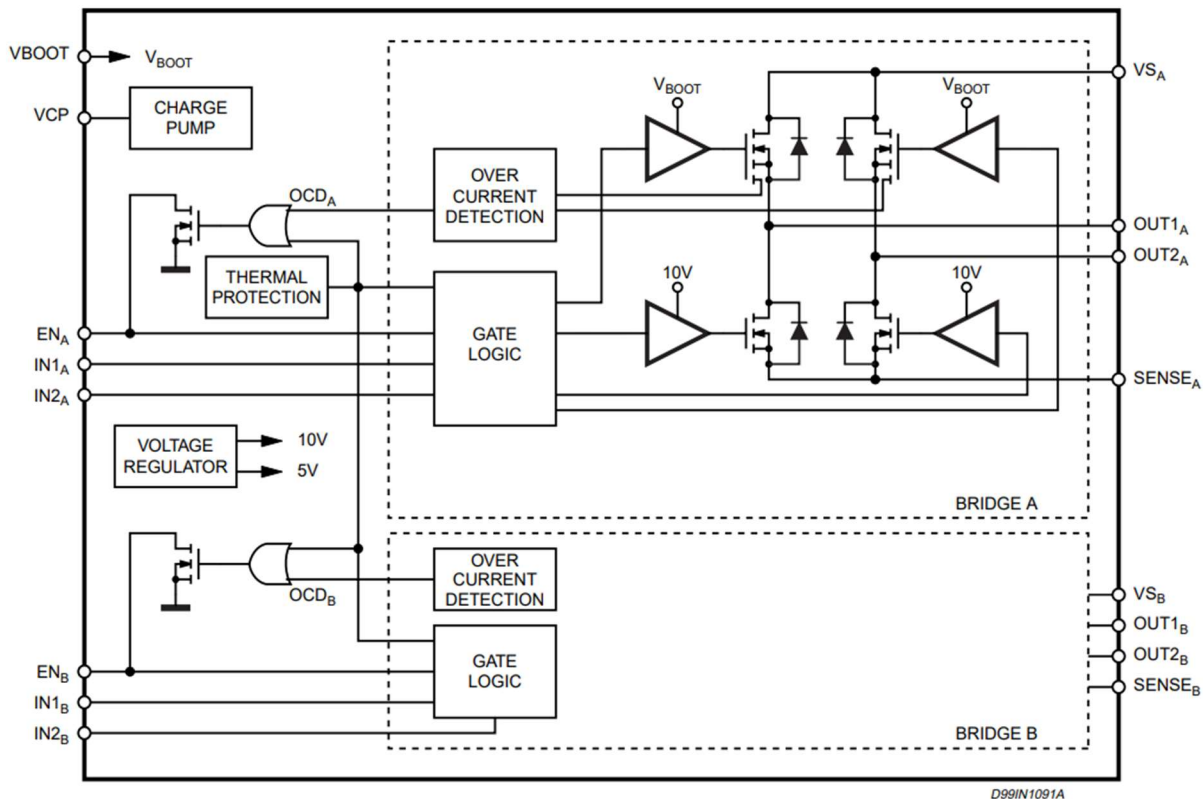


Figure 2. Functional block and connection diagram

3. Preparation.

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

3.1. Readings

Basic:

- [1] Lecture notes (“Actuators”)
- [2] L6205D datasheet

Optional:

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

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, full step and wave driving ?

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4. What is a torque ?
5. Taken 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.

4. Content of report

1. Start the motor (one of available on the stand):
 - a) Lunch on computer STM32CubeIDE program and choose PRG_ST32G071_L6205 project. Found the function SetCurrents(wind_A,wind_B) which turn positive, negative and zero current in A and B windings of motor. For adjusting step duration use function DelayUS() that introduce delay in microseconds (variable DEL).
 - b) Connect the computer with Nucleo module.
 - c) Plug in the power supply to the controller (DC = 12V);
 - d) Connect oscilloscope to PCB with motor driver as shown in Figure 3 (compare with Figure 7 and Figure 8);
 - e) Start the program with default parameters (full step mode).

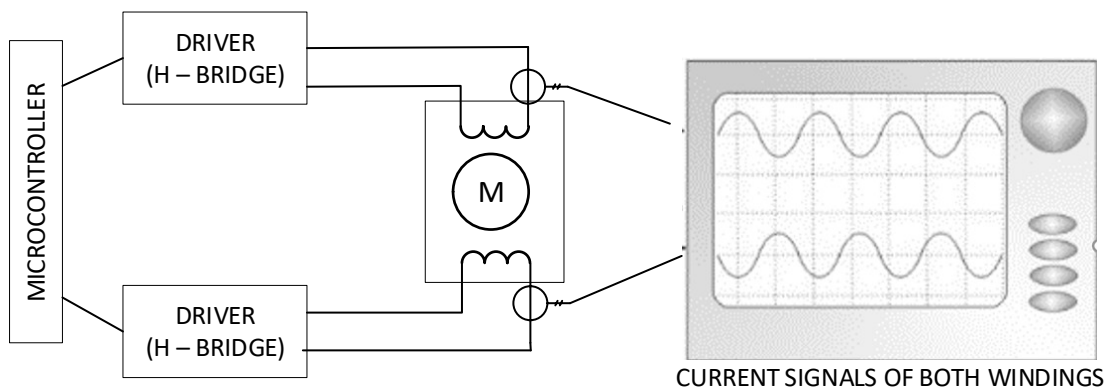


Figure 3. Measurement of stepper motor currents.

2. Observe on the scope winding currents and determine its amplitudes (taken results of point 5 of chapter 3.2). Save and print current wave shapes. Repeat this point for wave driving, full-, and half-step modes and for two supply voltages (nominal and $\frac{3}{4}$ of nominal)
3. Calculate (taking calculation results of point 5 of chapter 3.2) the observed amplitude of windings current with two supply voltages (nominal and $\frac{3}{4}$ of nominal) – Tab. 1



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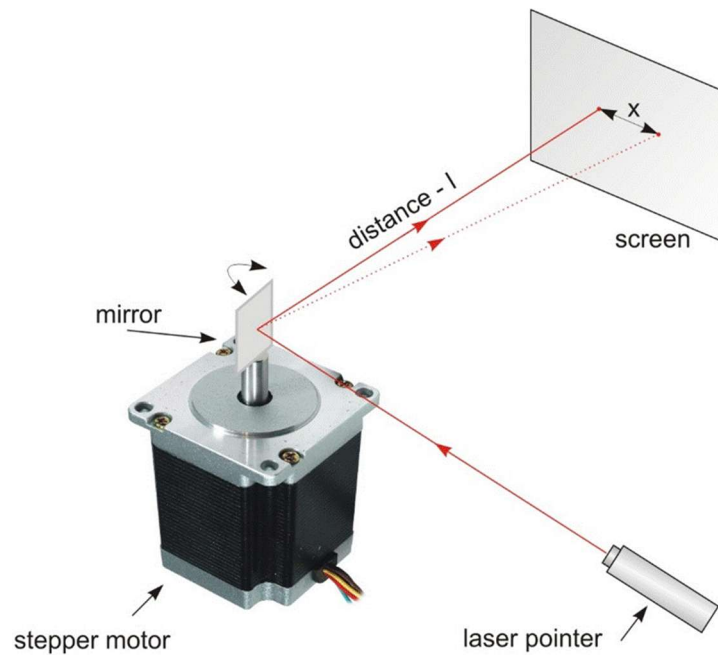


Figure 4. Measurement setup for stepper motor resolution determination (alternatively the laser pointer can be fixed on motor shaft).

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 two maximum winding currents amplitudes (change the voltage supply – the nominal and $\frac{3}{4}$ of nominal) – Tab.1
5. Using arrangement as in Figure 5 measure of stepper motor torque for two maximum current amplitudes (change the voltage supply – the nominal and $\frac{3}{4}$ of nominal) and for full-, wave- and half-step modes – Tab.1; ;
6. Repeat points 2-5 for different motors available in lab



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Figure 5. Torque measurements set up..

Tab.1 (for motor.....)

Mode	Supp. Voltage (nominal and ¾ nominal supp.) [V]	Current amplitude [A]	Resolution angle/minimu m step [deg]	Steps per tun	Minimum Step delay no lost steps [us]	Max speed for minimum step delay no lost steps [RPM]	Torque [Nm]
Full step							
Wave driving							
Half step							

Figure 6. Schematic diagram of the controller.

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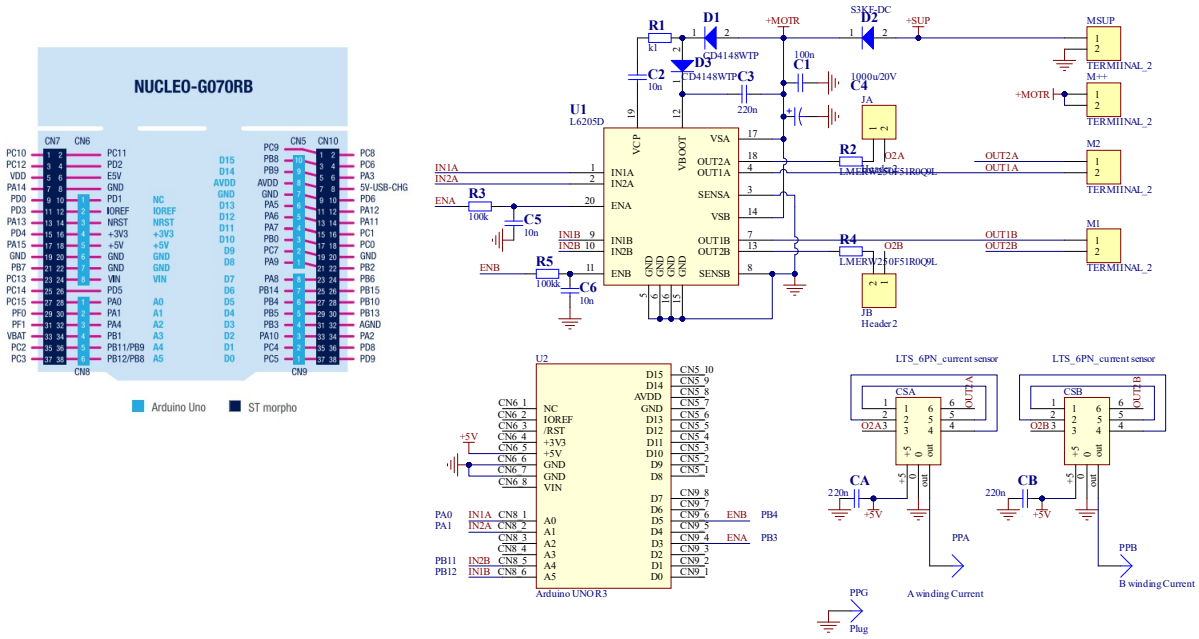


Figure 7. Schematic diagram of stepper motor driver.

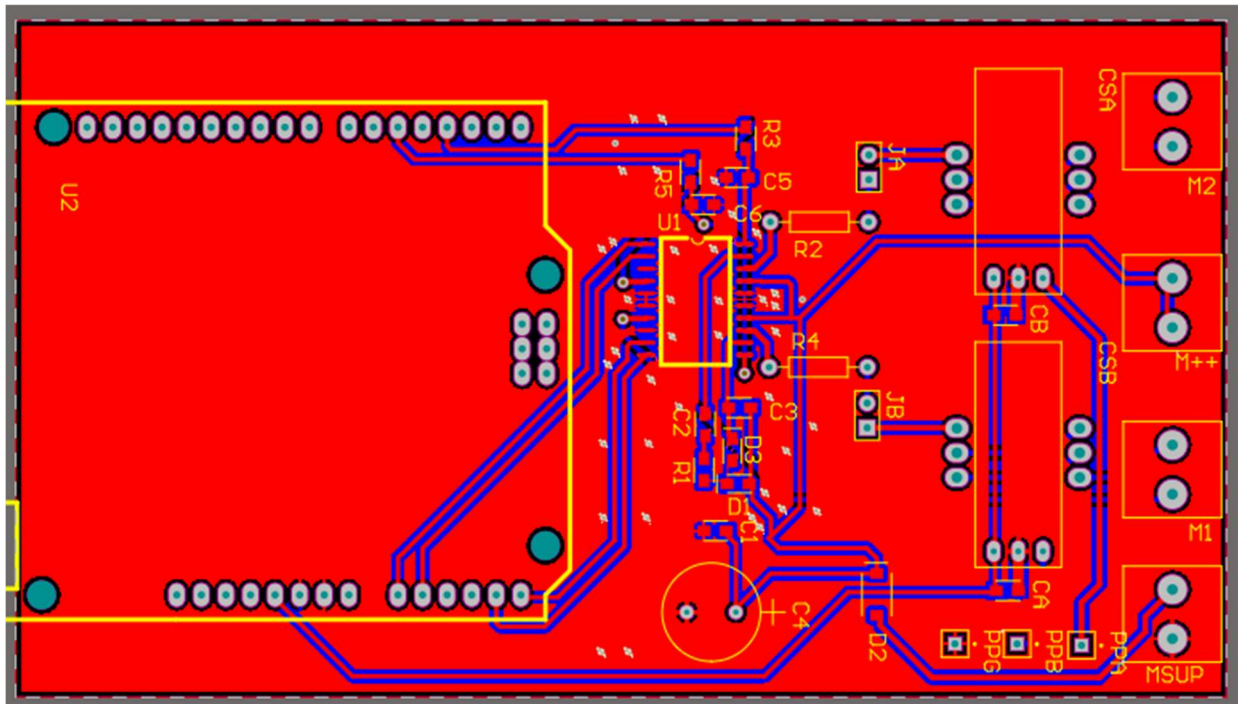


Figure 8. PCB of stepper motor driver.



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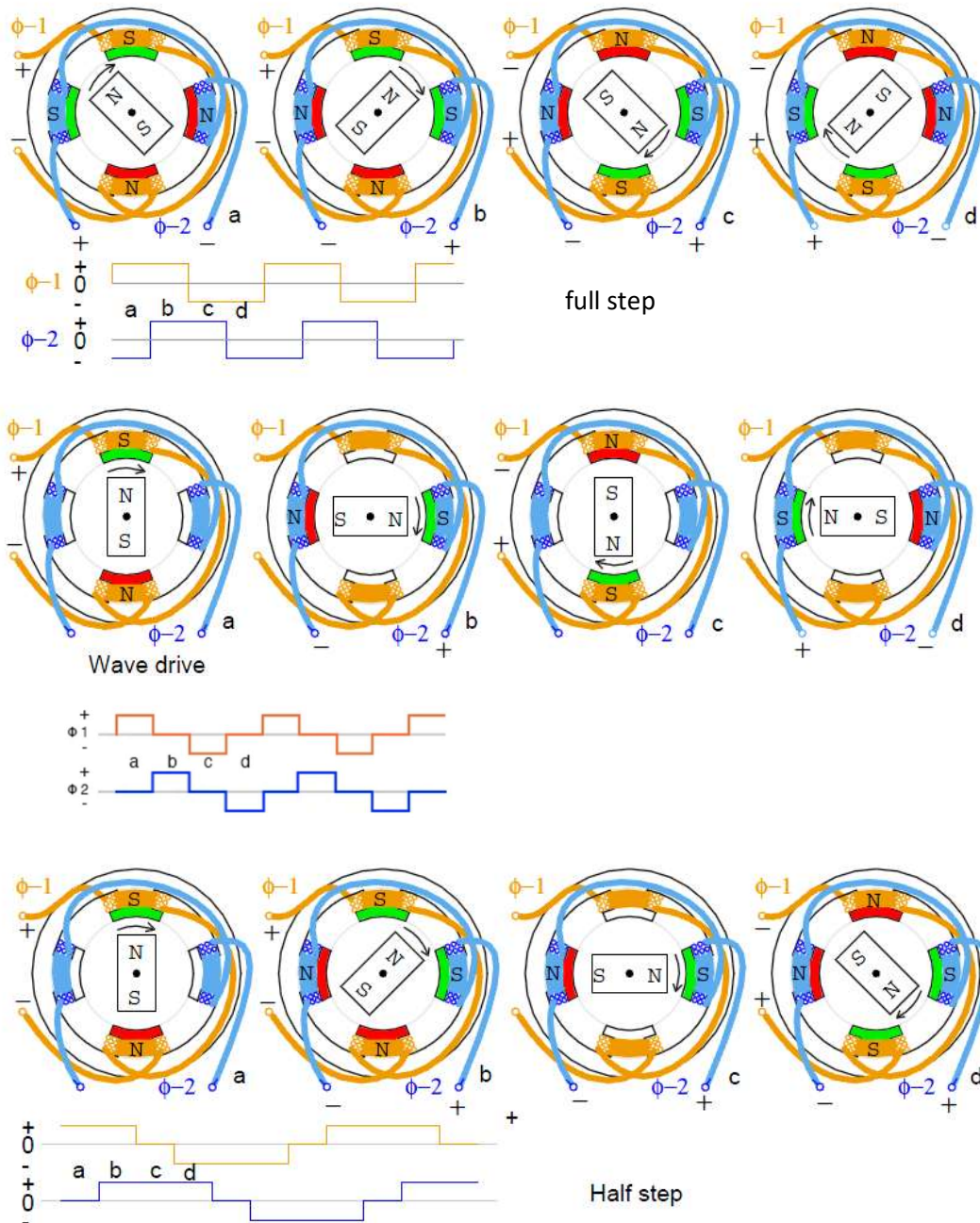


Figure 9. Main drive modes