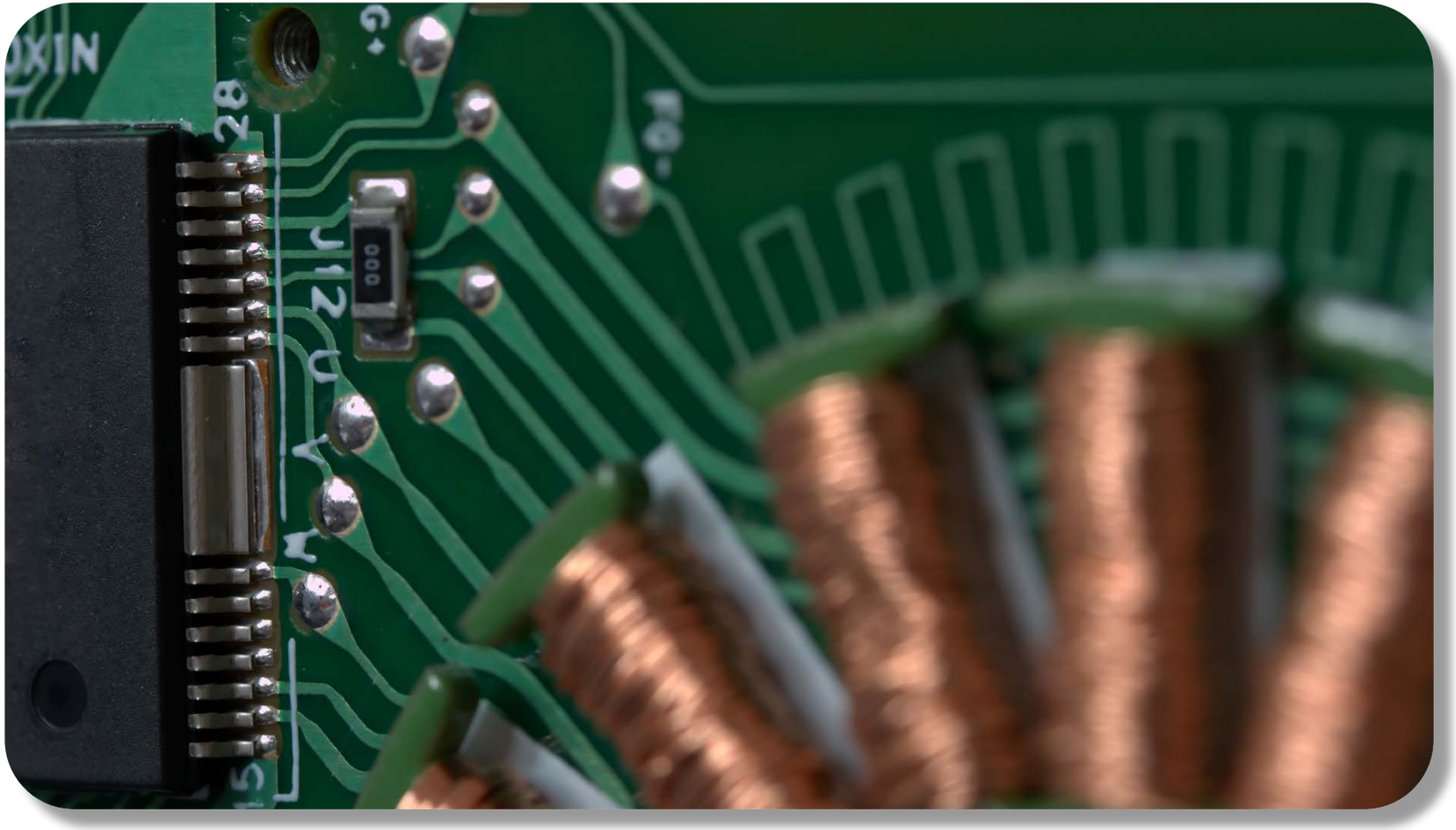
Motor Drivers



ECE230 Introduction to Embedded Systems

Motors

Learning objectives

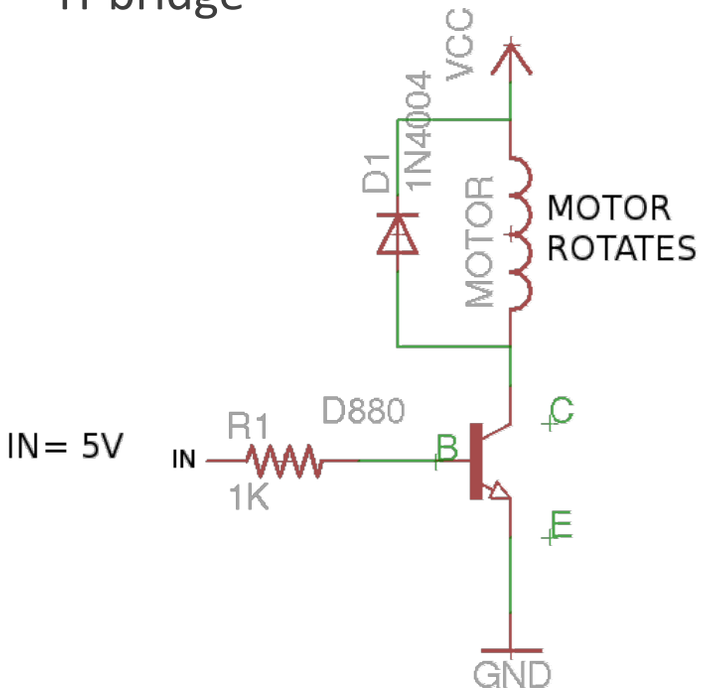
Following this lesson and related activities, students will be able to

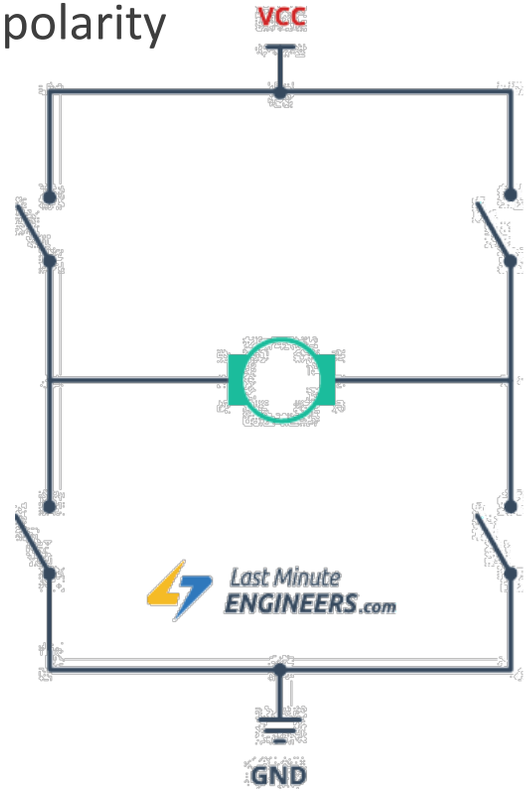
- Interface a DC motor with a microcontroller in order to drive the motor within specified power limits
- Interface a stepper motor with a microcontroller in order to drive the motor within specified power limits

DC Motor Driver

DC motors require more current than can be sourced from microcontroller

- Must use a transistor driver circuit to switch current on/off
  - Microcontroller signal connected to base/gate
- For bi-directional control, need four transistors to switch polarity
  - H-bridge

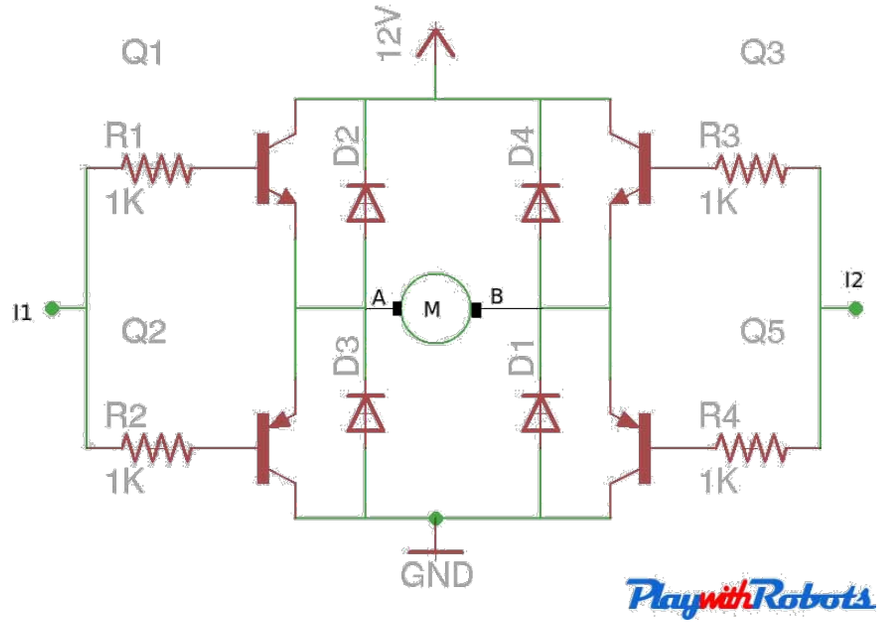


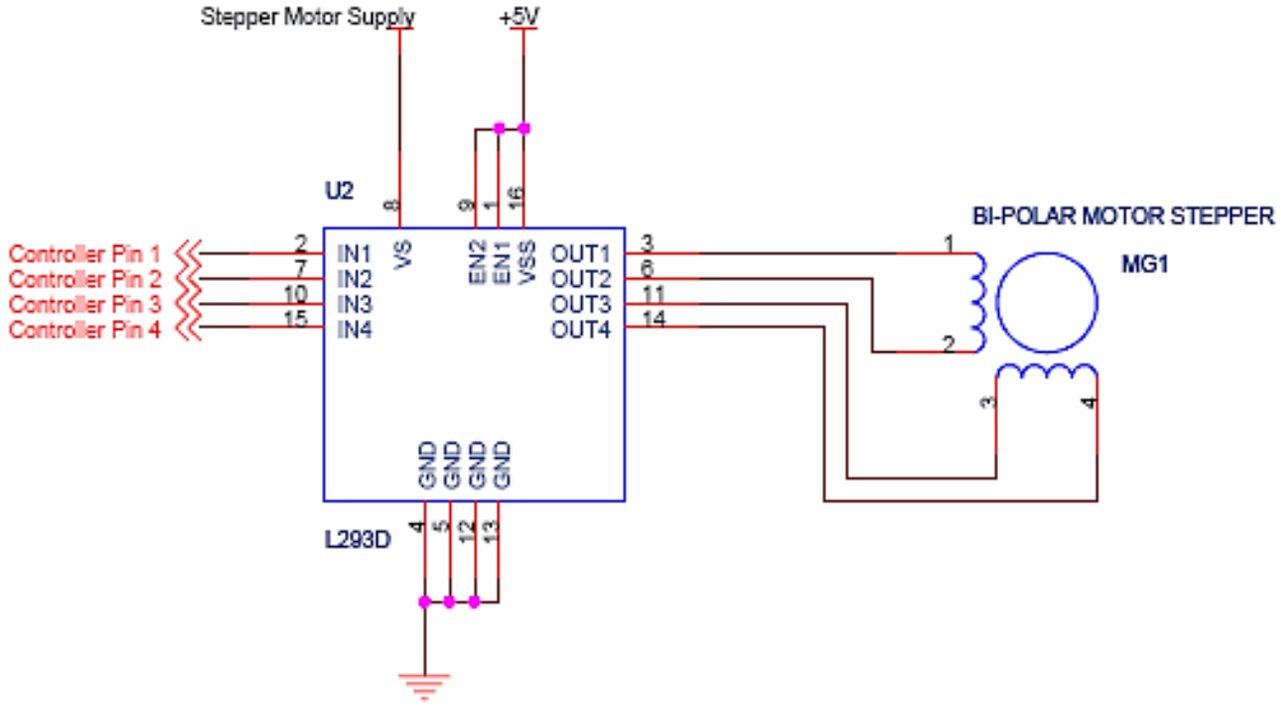


Bipolar Stepper Motor Driver (H-bridge)

Uses TTL signals from microcontroller to selectively connect motor pins to power and ground

- Transistors used to source motor directly from V_{CC}/V_{EE}
- Bipolar stepper motor requires two H-bridges
  - Bi-directional control of both coils





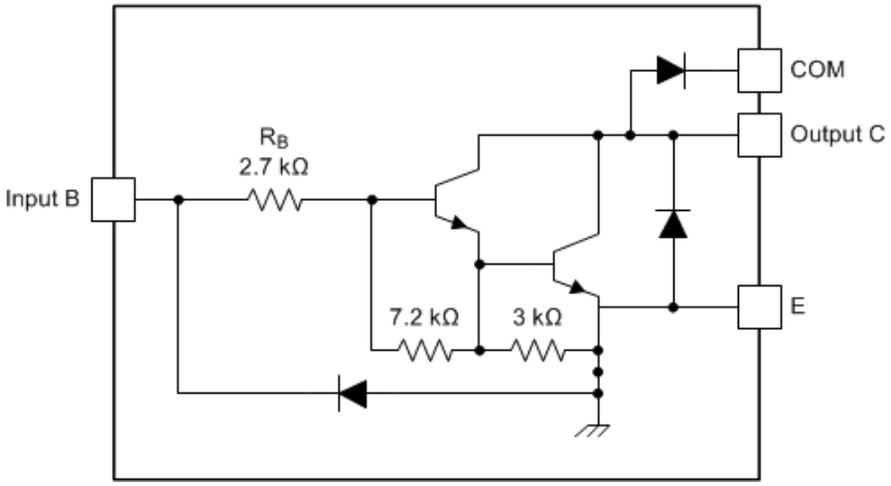
Unipolar Stepper Motor Driver Board

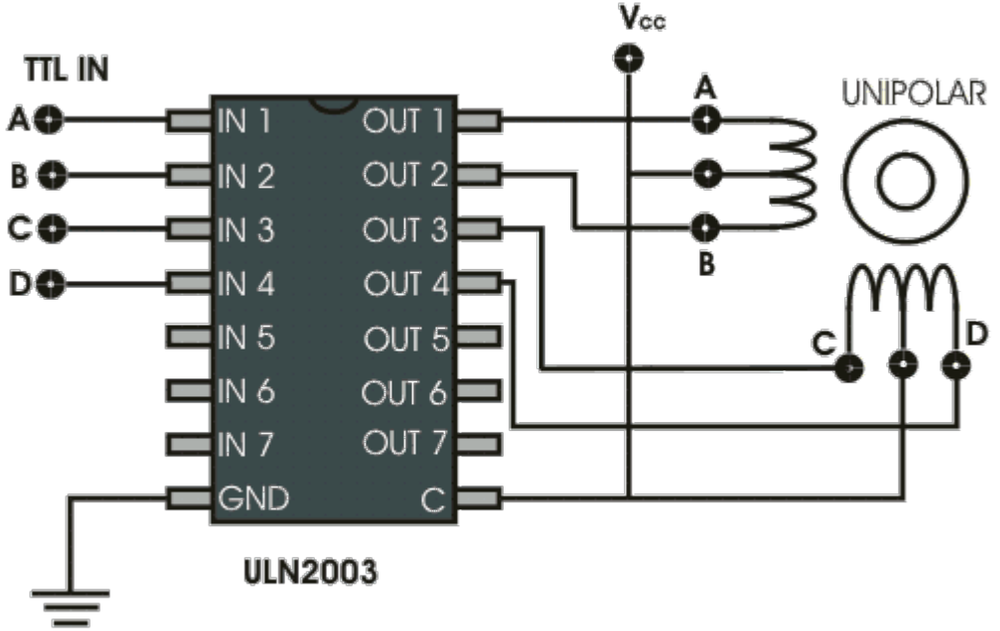
Uses TTL signals from microcontroller to selectively connect motor pins to ground

- Center-taps connected to V_{CC}
- Transistors used to source motor directly from rails, connecting coil to V_{EE}/GND

Common center-tap connection

- 5-pin connection



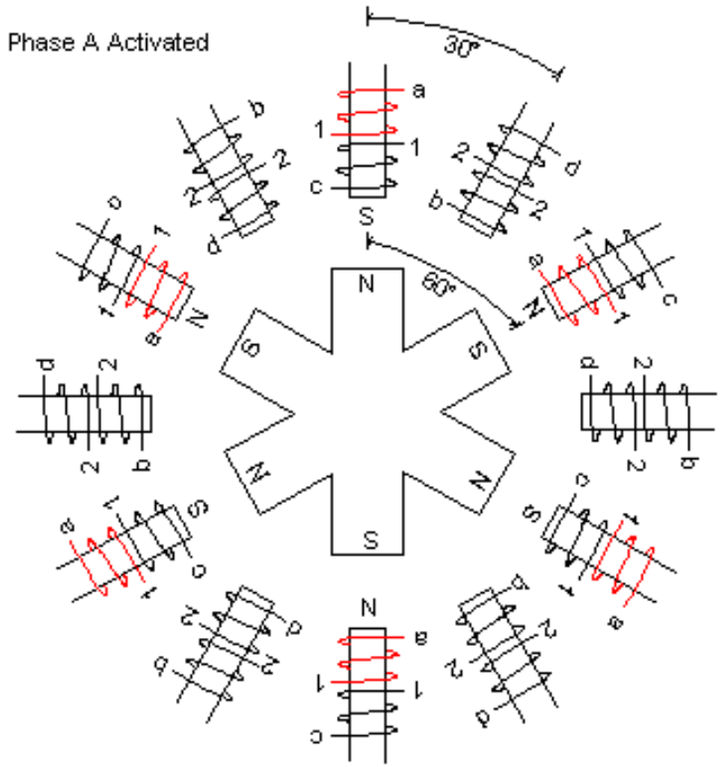


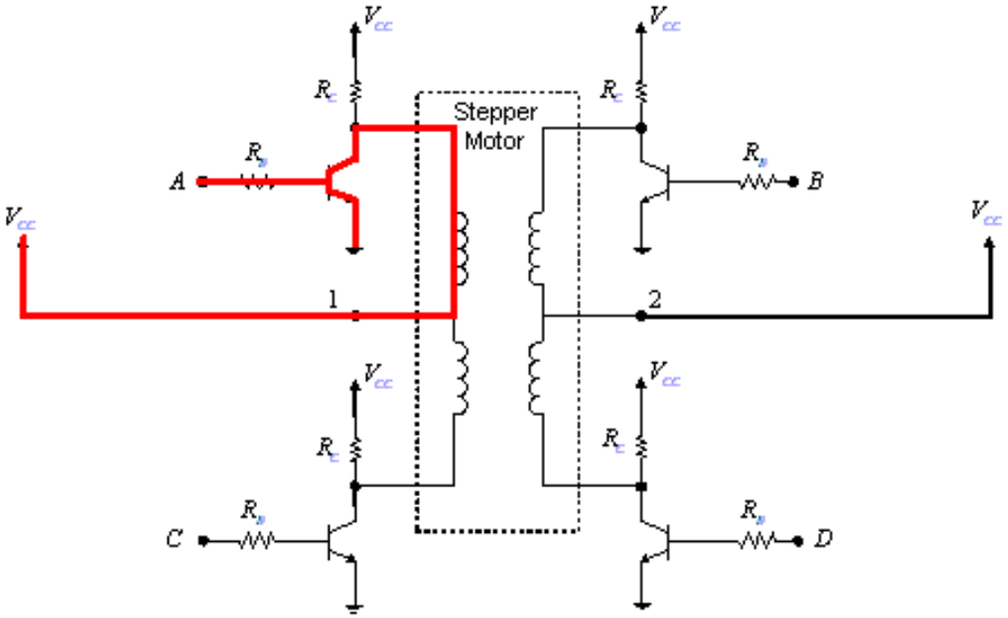
Stepper Motor Stepping Sequence

Sequence	Polarity	Name	Description
↑ 0001 → 0010 ↓ 0100 ← 1000	---+ --+- -+-- +---	Wave Drive, One-Phase	Consumes the least power. Only one phase is energized at a time. Assures positional accuracy regardless of any winding imbalance in the motor.
↗ 0011 ↘ 0110 ↙ 1100 ↖ 1001	--++ -++- ++-- +--+	Hi-Torque, Two-Phase	Hi Torque - This sequence energizes two adjacent phases, which offers an improved torque-speed product and greater holding torque.
↑ 0001 ↗ 0011 → 0010 ↘ 0110 ↓ 0100 ↙ 1100 ← 1000 ↖ 1001	---+ --++ --+- -++- -+-- ++-- +--- +--+	Half-Step	Half Step - Effectively doubles the stepping resolution of the motor, but the torque is not uniform for each step. (Since we are effectively switching between Wave Drive and Hi-Torque with each step, torque alternates each step.) Note that this sequence is 8 steps.

Unipolar Half-step Sequence Example

Alternating energizing of one or two phases (A, B, C, D)





Summary

DC motors require more current than can be sourced from microcontroller

- Must use a transistor driver circuit to switch current on/off

For bi-directional control, need four transistors to switch polarity

- H-bridge

Bipolar stepper motor requires two H-bridges

- Bi-directional control of both coils

Unipolar Stepper Motor Driver selectively connects motor pins to ground

- Common center-taps – connected to V_{CC}
- Transistors used to source motor directly from rails, connecting coil to V_{EE}/GND

References

Images

- Title
  - Adobe stock
- DC Motor Driver
- Bipolar Stepper Motor Driver (H-bridge)
  - http://playwithrobots.com/dc-motor-driver-circuits/
  - https://lastminuteengineers.com/l293d-dc-motor-arduino-tutorial/
- Unipolar Stepper Motor Driver Board
  - https://www.ti.com/product/ULN2003A
  - https://electronics.stackexchange.com/questions/15249/driving-stepper-motor-using-uln2003a-ic
  - https://forum.arduino.cc