澳門大學
UNIVERSIDADE DE MACAU
UNIVERSITY OF MACAU

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Lecture 11

MECH451 – Control and Automation

EMEB223 – Mechatronics

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Chapter 6 – Motors and Motor Control (cont'd)

Outline

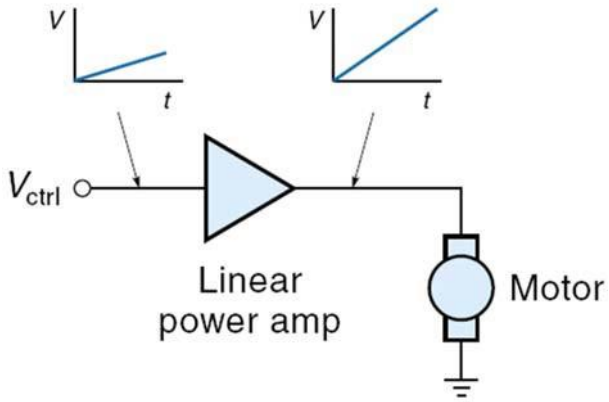
- Direct current (DC) motors
  - Theory of operation
  - Control circuits
- Stepper motors
  - PM stepper motors
  - VR stepper motors
  - Control circuits

Control circuits

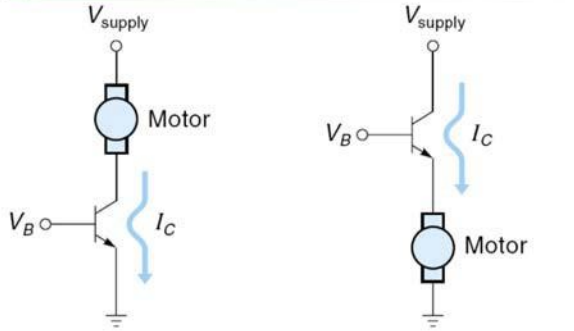
- To drive the motor, an interface circuit is required to convert the low-level motor-control signal from the controller into a signal strong enough to run the motor.
- Two methods of motor speed control
  - **Analog drive**
  - **Pulse-width modulation (PWM)**

Analog drive

- The classical way to do this is with an **analog drive**
  - A linear power amplifier amplifies the drive signal from the controller and gives the motor a “strengthened” analog voltage
  - A DAC (digital-to-analog converter) would be required if the controller is digital.

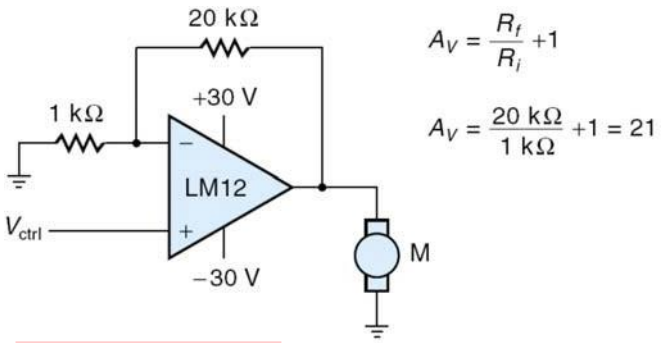


(a) Analog drive



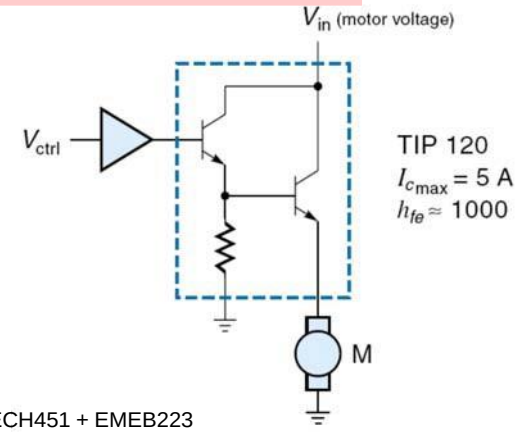
(a) Common emitter (b) Common collector

Power transistor driver

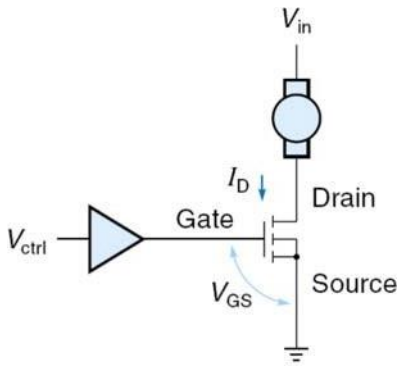


Power IC driver (LM12)

Power Darlington transistor driver



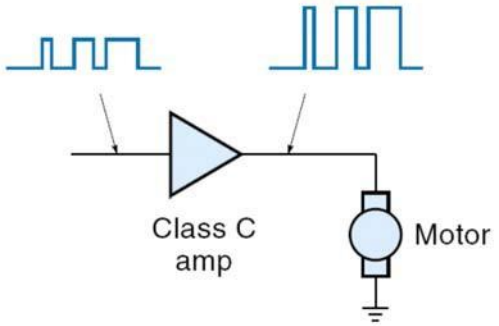
Power MOSFET driver



Pulse-width modulation (PWM)

- The other technique for controlling a DC motor is **pulse-width modulation** (PWM).
  - In this system, power is supplied to the motor in the form of DC pulses of a fixed voltage
  - The width of the pulses is varied to control the motor speed.
    - The wider the pulses, the higher the average DC voltage, so more energy is available to the motor.
  - The frequency of the pulses is high enough that the motor runs smoothly.

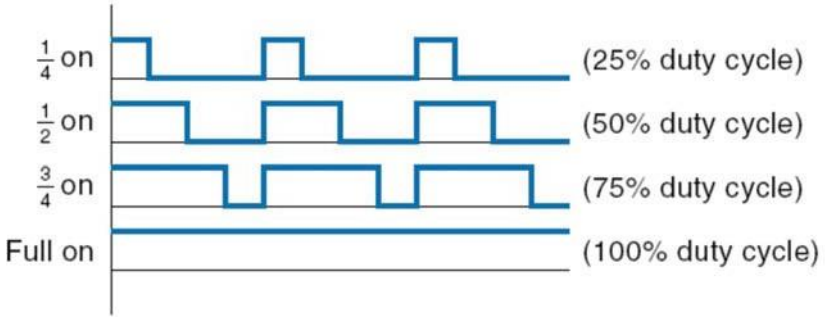
Class C operation: Full-on or full-off



(b) Pulse-width modulation (PWM) drive

PWM (cont'd)

- Power is supplied to the motor in a square wavelike signal of constant magnitude but varying pulse width or duty cycle.
- **Duty cycle** refers to the percentage of time the pulse is high (per cycle).



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