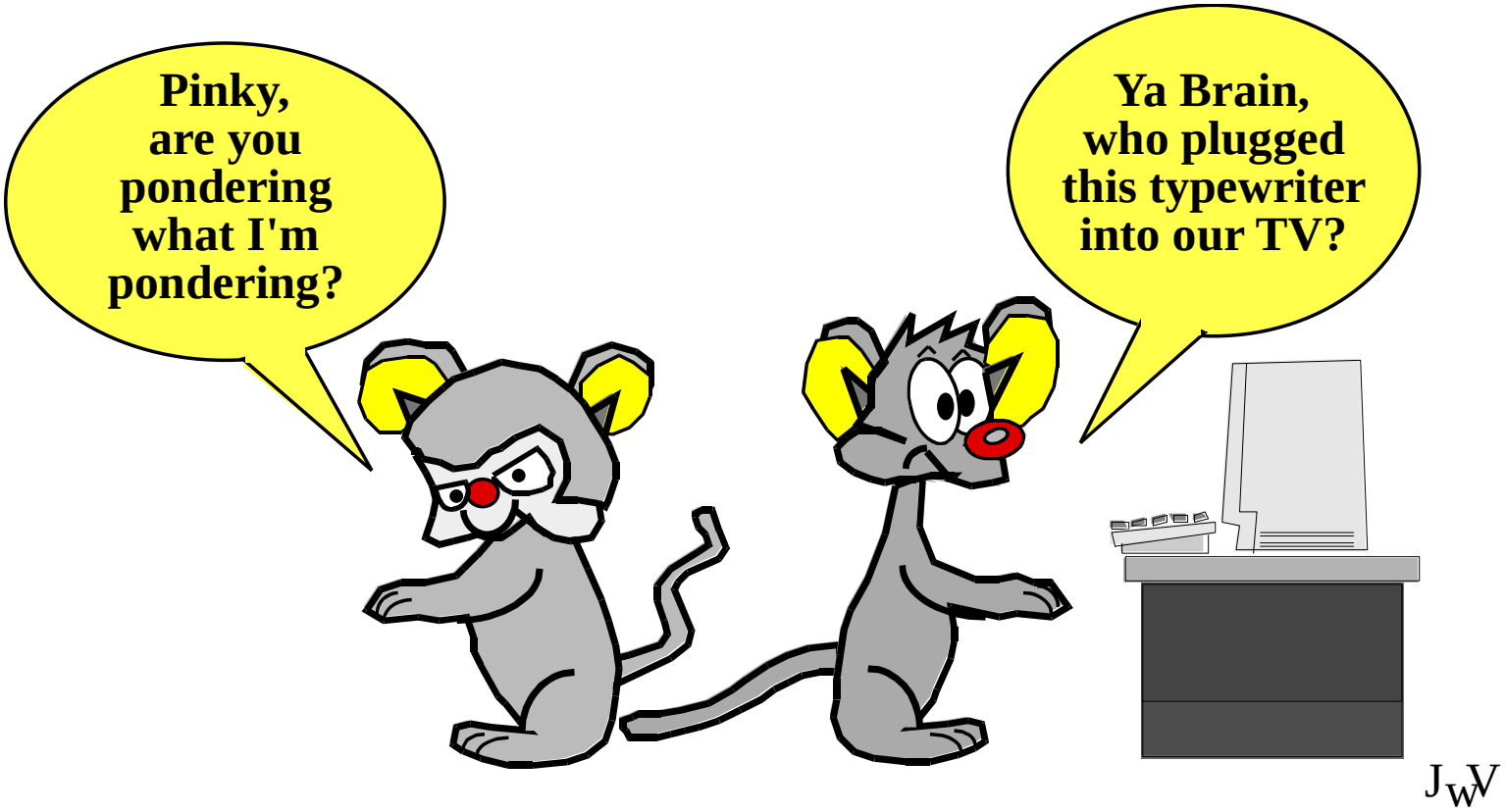
19. Motor Interfacing

- **Motor physics**
- **Transistor-level interface**



Digital Interfacing

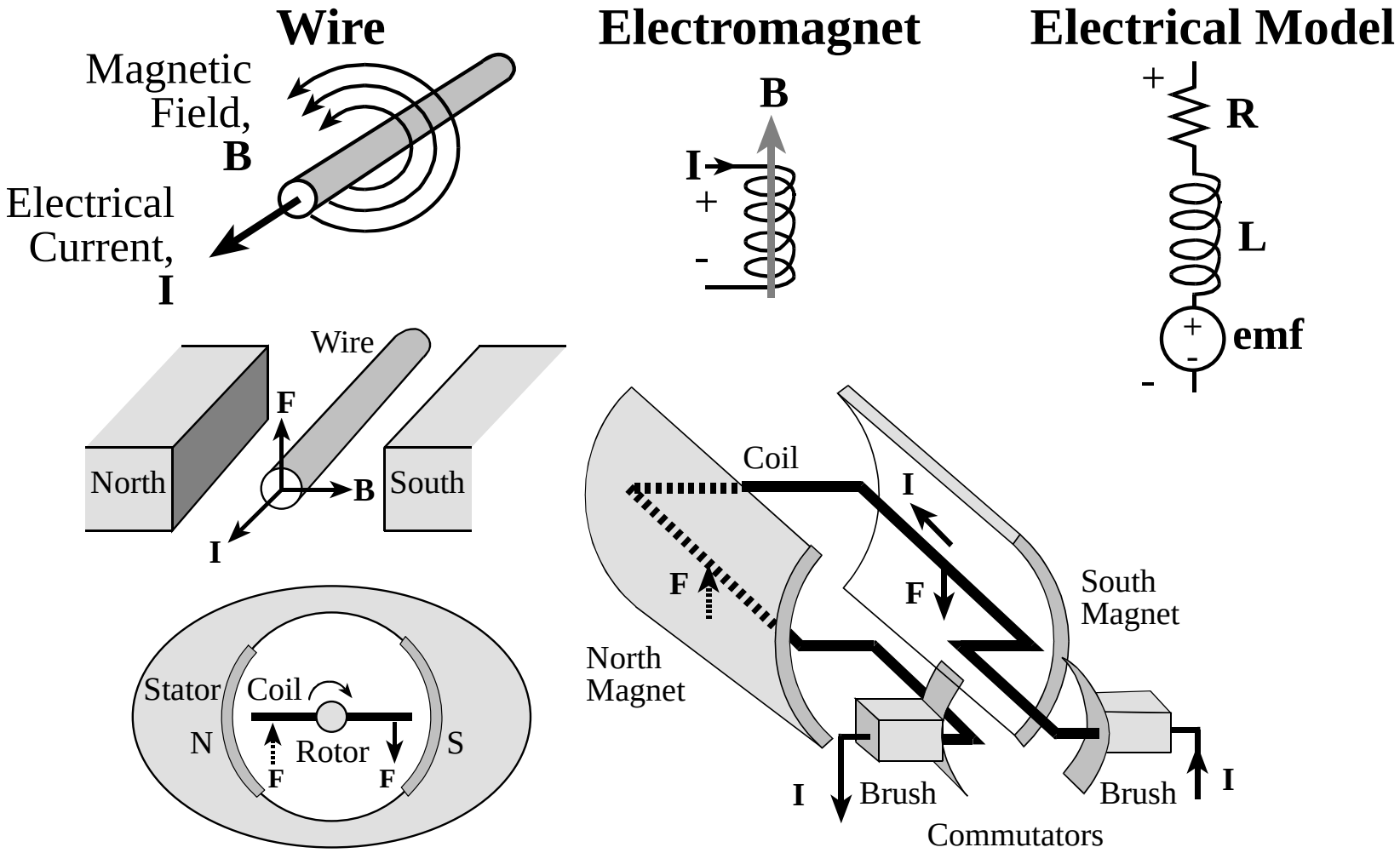
V_{OL} is defined as the voltage at maximum I_{OL}

Family	*Example*	I_{OH}	I_{OL}	I_{IH}	I_{IL}	*fan out*
Standard TTL	7404	0.4 mA	16 mA	40 µA	1.6 mA	10
Schottky TTL	74S04	1 mA	20 mA	50 µA	2 mA	10
Low Power Schottky	74LS04	0.4 mA	4 mA	20 µA	0.4 mA	10
High speed CMOS	74HC04	4 mA	4 mA	1 µA	1 µA	
LM3S/LM4F 2mA-drive	LM3S811	2 mA	2 mA	2 µA	2 µA	
LM3S/LM4F 4mA-drive	LM3S811	4 mA	4 mA	2 µA	2 µA	
LM3S/LM4F 8mA-drive	LM3S811	8 mA	8 mA	2 µA	2 µA	

Electrical specifications
- **See Chapter 24 of TM4C123**
- **5V tolerant?**
- **PD0, PD1 ⇔ PB7,PB6**

All GPIO signals are 5-V tolerant when configured as inputs except for PD4, PD5, PB0 and PB1, which are limited to 3.6 V.

Motor Physics



Darlington Transistor

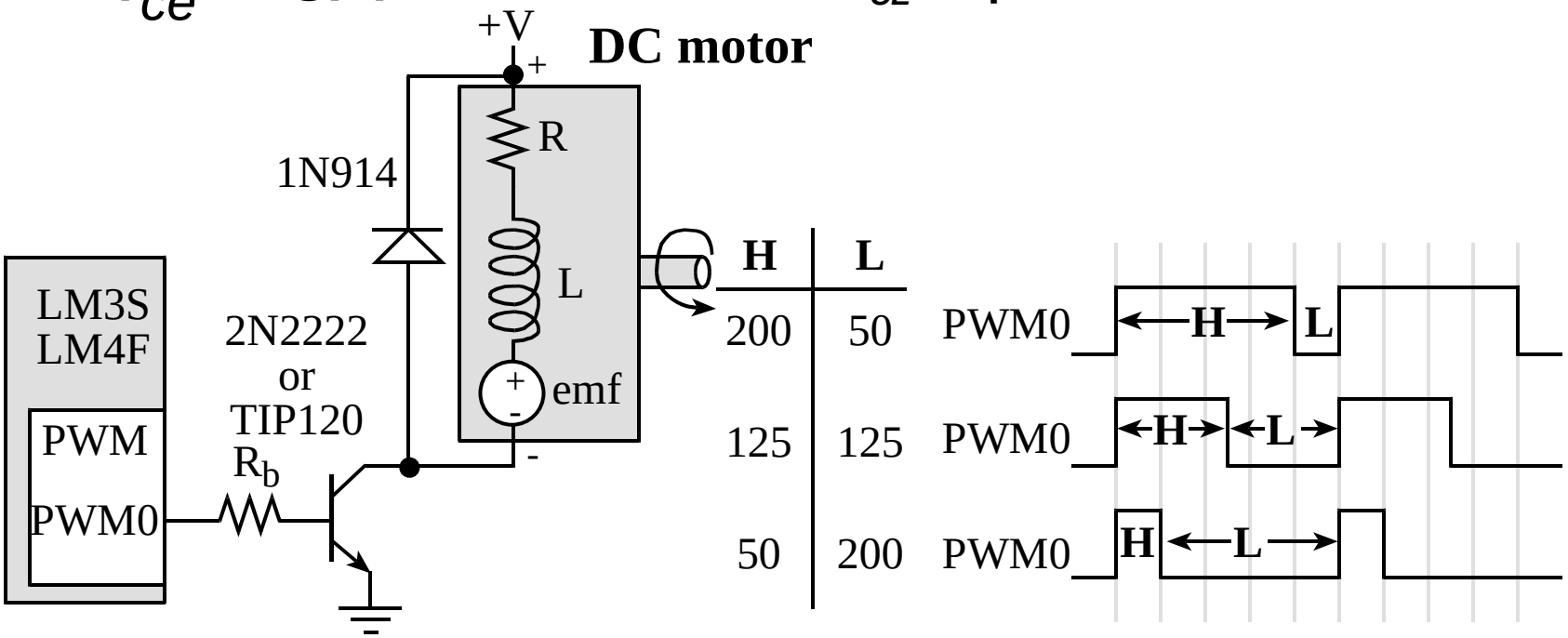
- TIP120 (NPN)
- h_{fe} = 1000
- I_{ce} = 3A

$I_b = I_{coil} / h_{fe}$ = 1A/1000 = 1mA

$R_b \le (V_{OH}-V_{be})/I_b$ = (3-2.5)/1mA = 0.5 kΩ

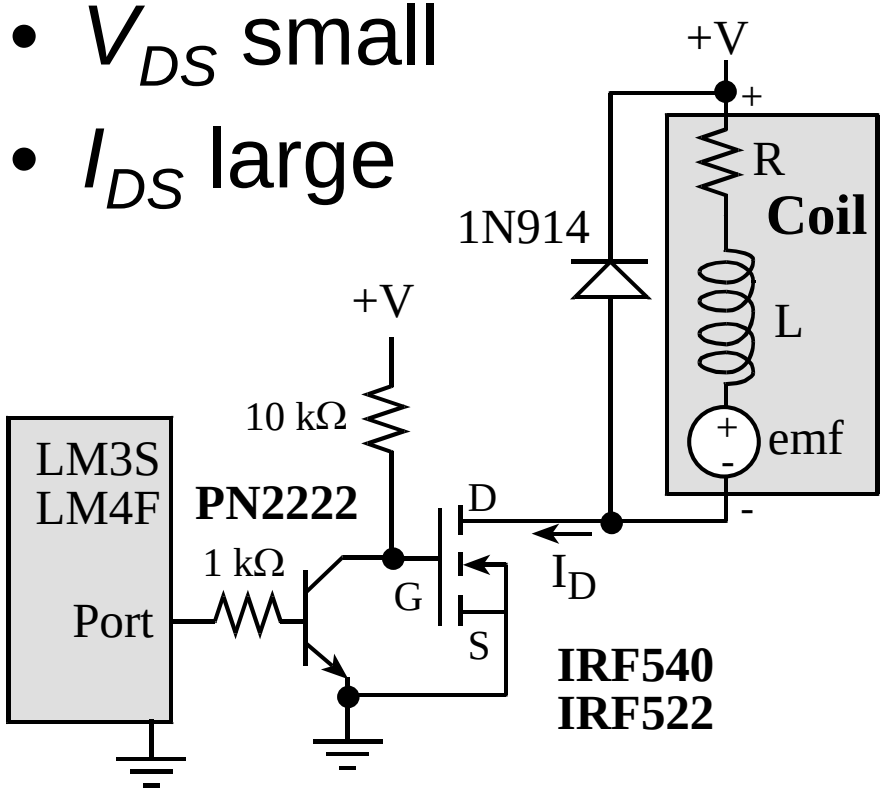
R_b = 100 Ω

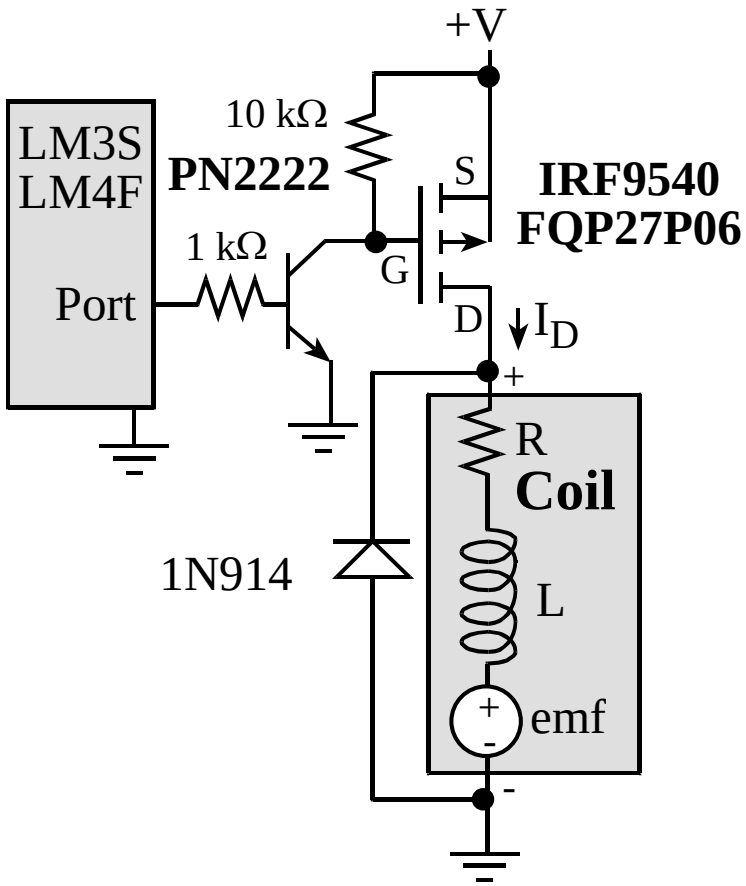
V_{CE} depends on current



MOSFET Interface

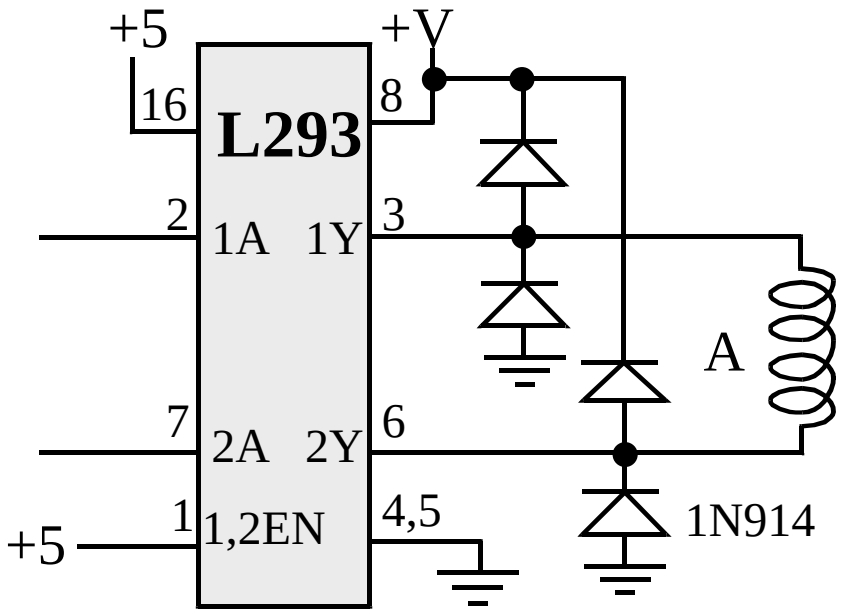
- V_{GS} turns on
- V_{DS} small
- I_{DS} large

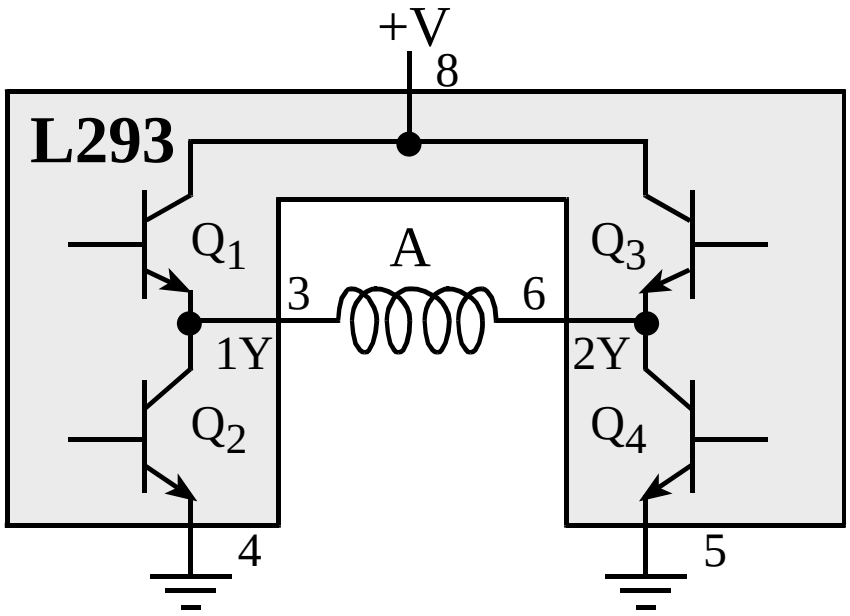




H-bridge Interface

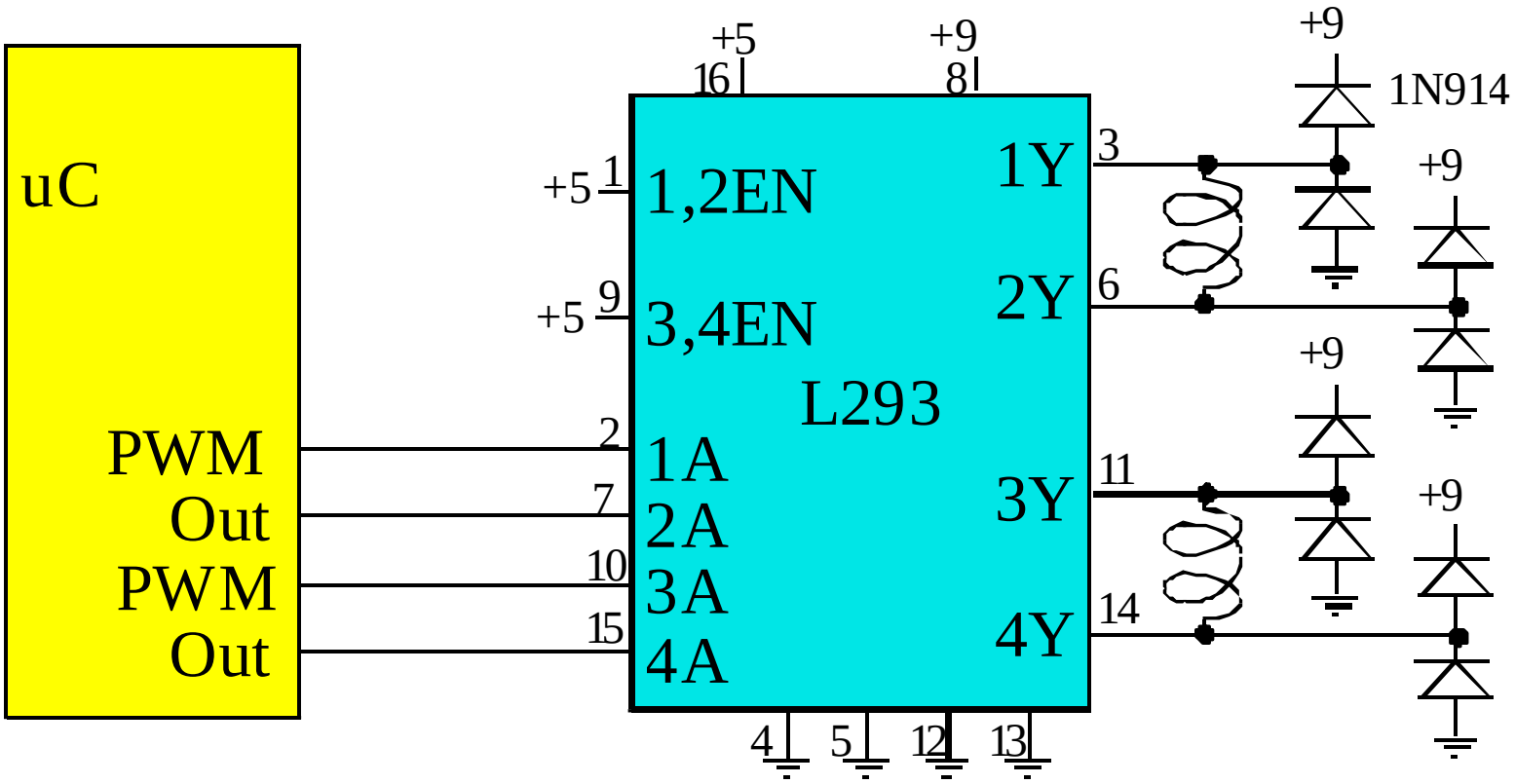
- Both directions
- V_{OH} = +V-1.4, V_{OL} = *1.2*





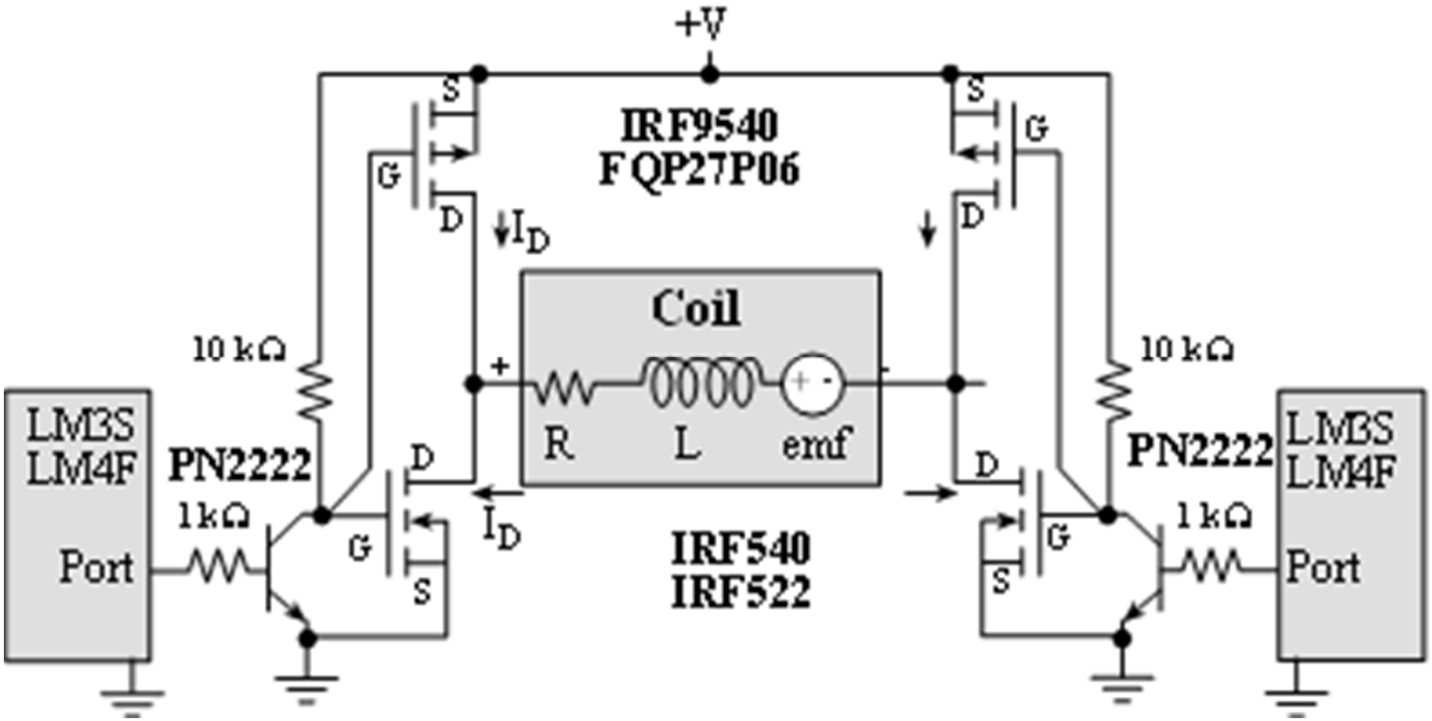
H-bridge Interface

- PWM controls power
- Out controls direction



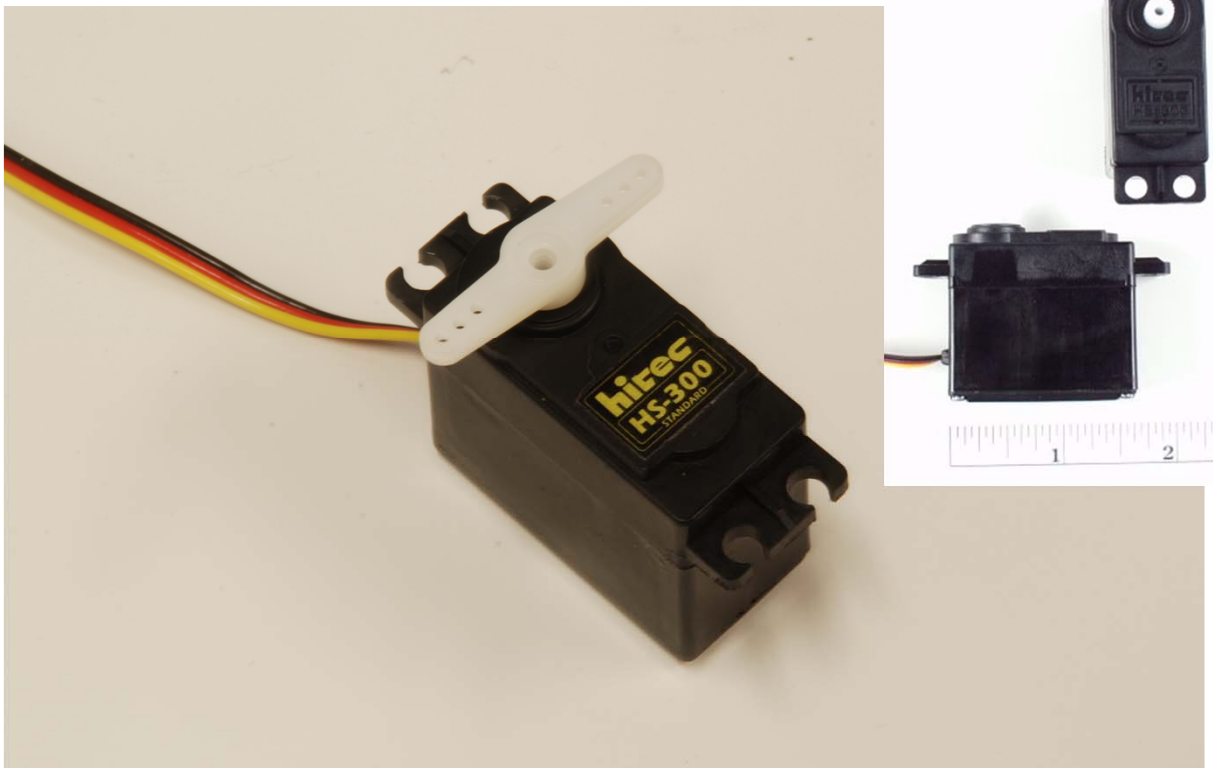
H-bridge Interface

- One Port is PWM controlling power
- Other port controls direction



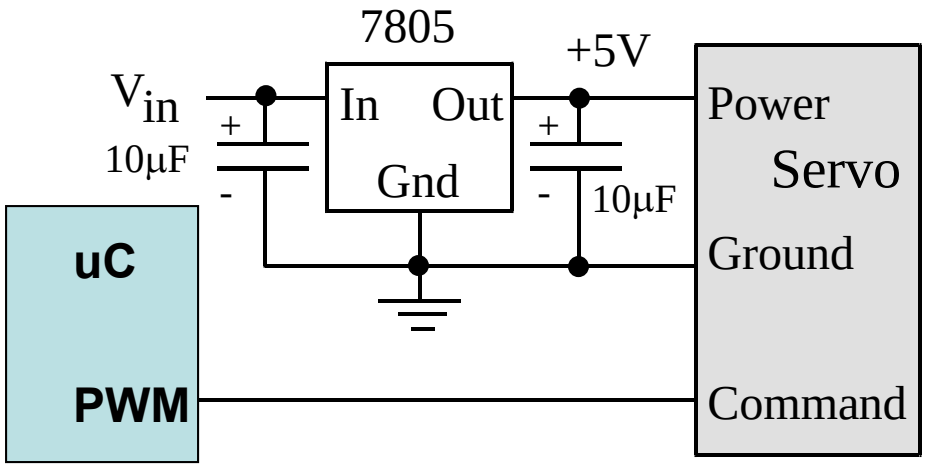
Servo Motor

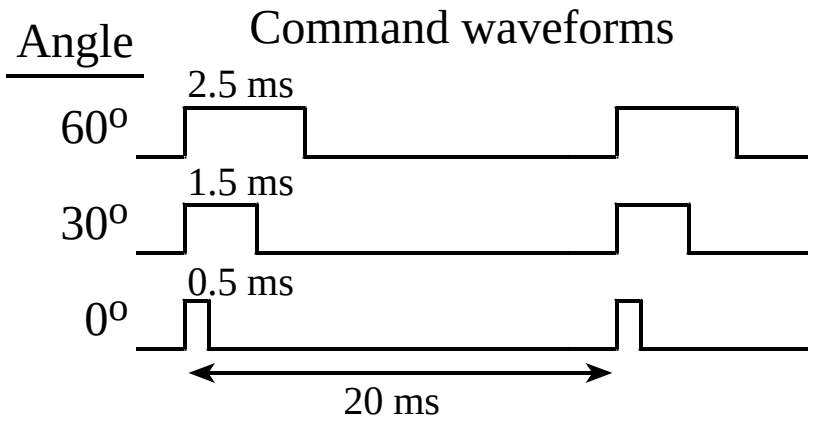
- Simple digital interface (built in controller)
- Duty cycle controls angle



Servo Interface

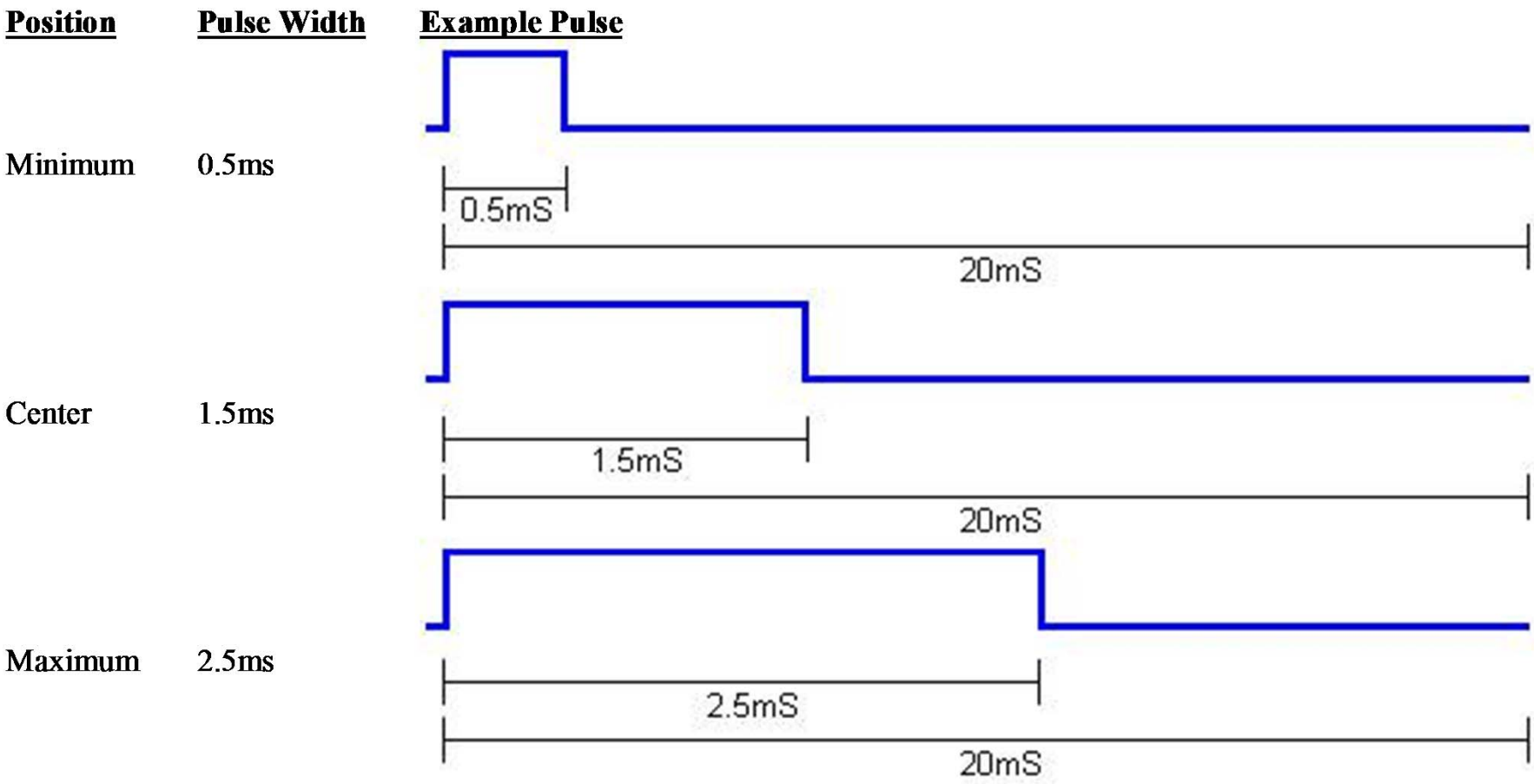
- Needs its own +5V regulator
- Duty cycle controls angle





Servo Software

- Duty cycle controls angle



Summary

- Be careful of the currents
- Sensors are noisy
- Time lag makes it unstable
- Component testing
- Visualization and control