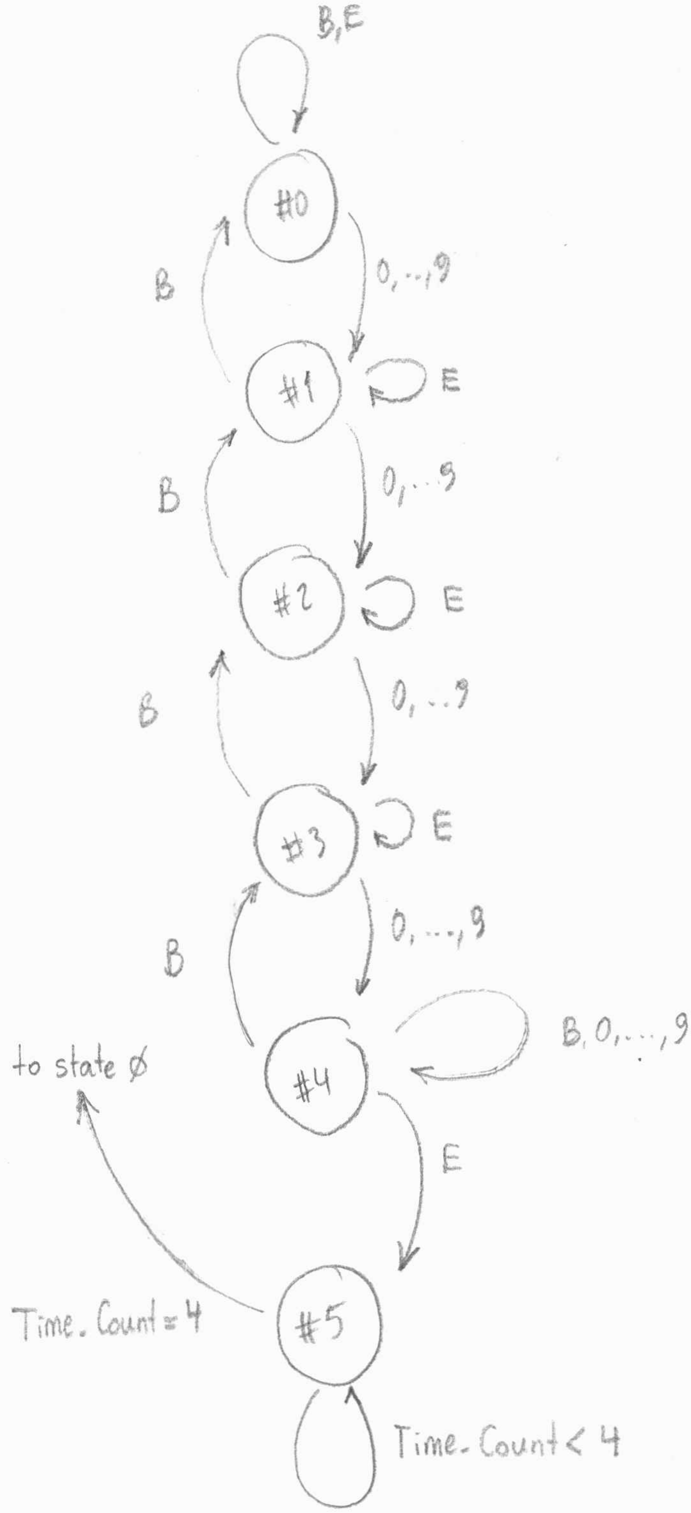
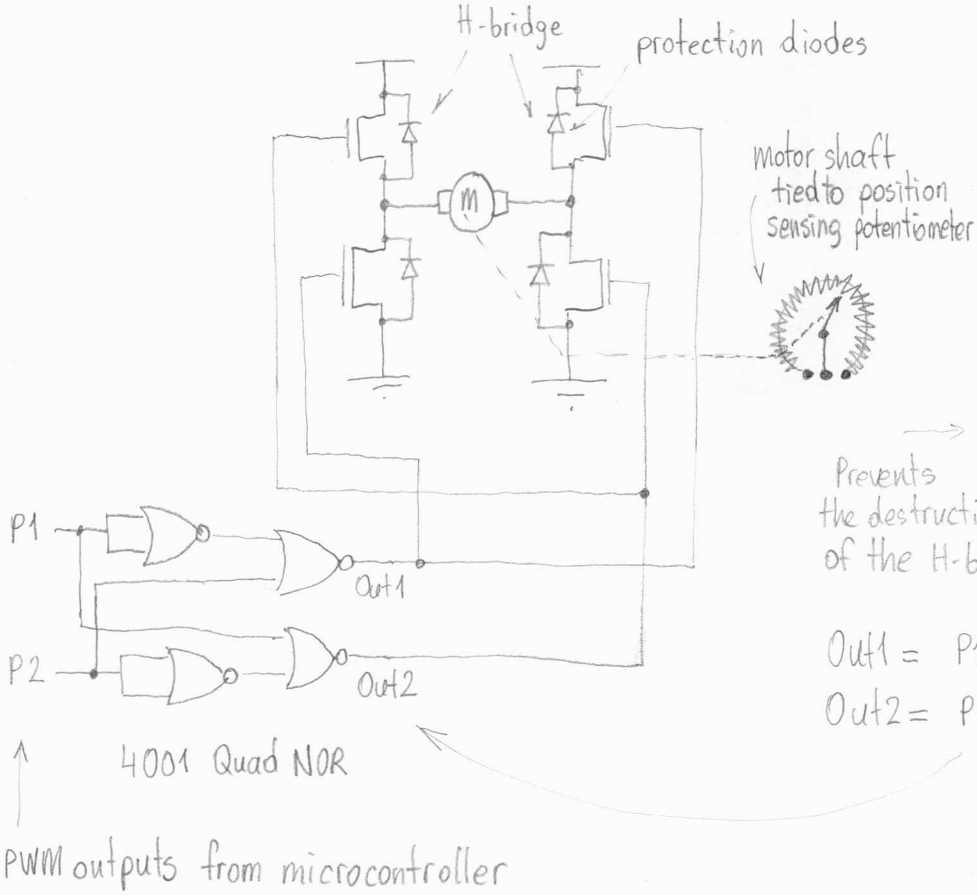
State transition diagram for the "Door Lock" program



POSITION CONTROL of a DC SERVO



Short-cct Protection

P1	P2	Out1	Out2
0	0	0	0
0	1	0	1
1	0	1	0
1	1	0	0

→ (row 1 1) Prevents the destruction of the H-bridge

$$Out1 = P1 \cdot \overline{P2} = \overline{\overline{P1} + P2}$$

$$Out2 = P2 \cdot \overline{P1} = \overline{\overline{P2} + P1}$$

PWM rate controlls the power delivered to a load.

$$\text{Average Power} = \frac{1}{T}\int_0^{T_1} \frac{V_{DD}^2}{R}\,dt = \frac{T_1}{T} \cdot \frac{V_{DD}^2}{R}$$

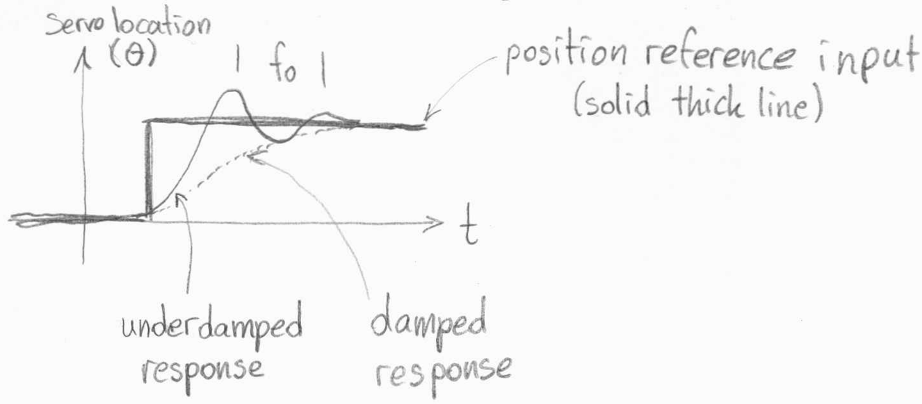
pulse duration controls average power; $\frac{T_1}{T}$: duty cycle

If the PWM frequency, $f \triangleq \frac{1}{T}$ is larger than the highest frequency of the motor response, then the motor filters the pulsed drive signal and makes a smooth rotation, even though it is driven by a pulsed signal.

A similar effect is observed when an LED is driven by a PWM circuit. If the frequency is higher than approximately 60 Hz, no flicker is observed and changing the PWM duty cycle results in a change in perceived intensity.

Step response of a DC Servo

Depending on the control scheme used and the parameters associated with the control loop, the system's response varies.

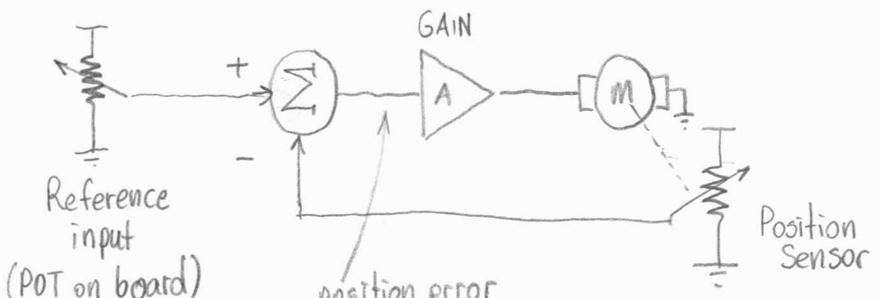


The oscillations observed for an underdamped control loop reveal the natural frequency of the DC servo.

As we are designing a "Discrete Time Sampled Controller", the control loop frequency (i.e., how frequently the position is sensed and the PWM rates are updated) should be adjusted to a much higher frequency than the mechanical system's natural frequency.

A measurement yields that $f_0 \cong 3$ Hz, so a control loop frequency of 100 Hz is quite good.

We would apply PROPORTIONAL CONTROL to the servo (*)

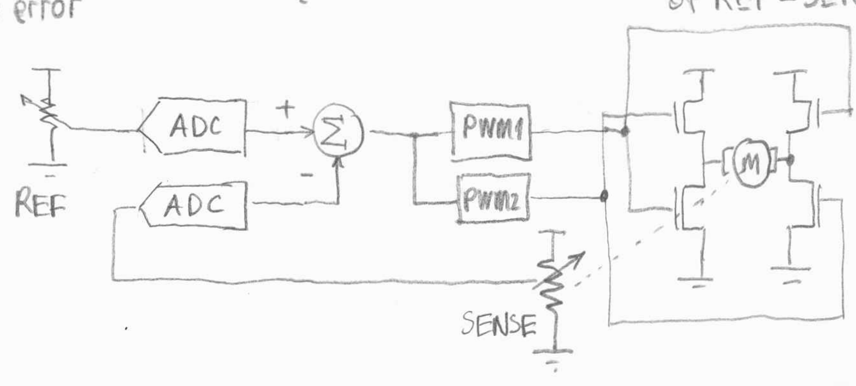


Algorithm

Every 10 msec

1. Get REF & SENSE from ADC
2. Update PWM1 & PWM2 according to sign and magnitude of REF − SENSE (the error)

In discrete time →



(*) Other options include combinations of PROPORTIONAL, DIFFERENTIAL (derivative) and INTEGRAL control