Chapter 8

Digital and Analog Interfacing Methods

Lesson 11 Part f

Interface for generating Analog Outputs for Servomotor control using Pulse Width Modulation

Pulse width modulation

1. A Pulse width modulated output obtained using a digital number x.
2. A analog output is obtained by integrating the Pulse width modulated pulses.
3. Pulse frequency is proportional to clock input frequency to a n-bit pulse accumulator
4. Pulse-width of modulated pulse is proportional to value $(2^n - x)$ when x is loaded into a modulation register.

Pulse width modulation

5. The analog output is proportional to $\pm(2^n - x)$ where value x loads into PWM register.
6. The number x generates output as if it is obtained by a DAC function.
7. Modulation % = ±Period for pulse width is '1' divided by Total period of pulse at 1 and at 0 multiplied by 100.

PWM output

- x = digital number in an n-bit PWM register
- PWM output bit = 1 for period T1
- PWM output bit = 0 for period T2
- T1 $\alpha \pm (2^{n-1} - x)$;
- T2 α (x);
- (T1 + T2) α (2^{n-1}),where
- V Output of integrator α k.(T1)/ (T1+T2)
- k is integration constant

8-bit PWM example

- When x in PWM register = all 0s = 00000000 (=0d). Let pulse-width T1= 0 ms, and T1+T2 = 128 ×5 μs = 0.64 ms
- x= 01000000 (= 64d) generate output width T1 = 0.32 ms, when register count-input pulse periods equal (0.32/64) ms = 5 μs
- x = 11111111 (= 255d) generate width T1 = 0.6325 ms.

PWM output

Analog output V α +[$(2^n - x)$] and T1 programmed between 1.0 ms to 2.0 ms

Positive

T2 T1

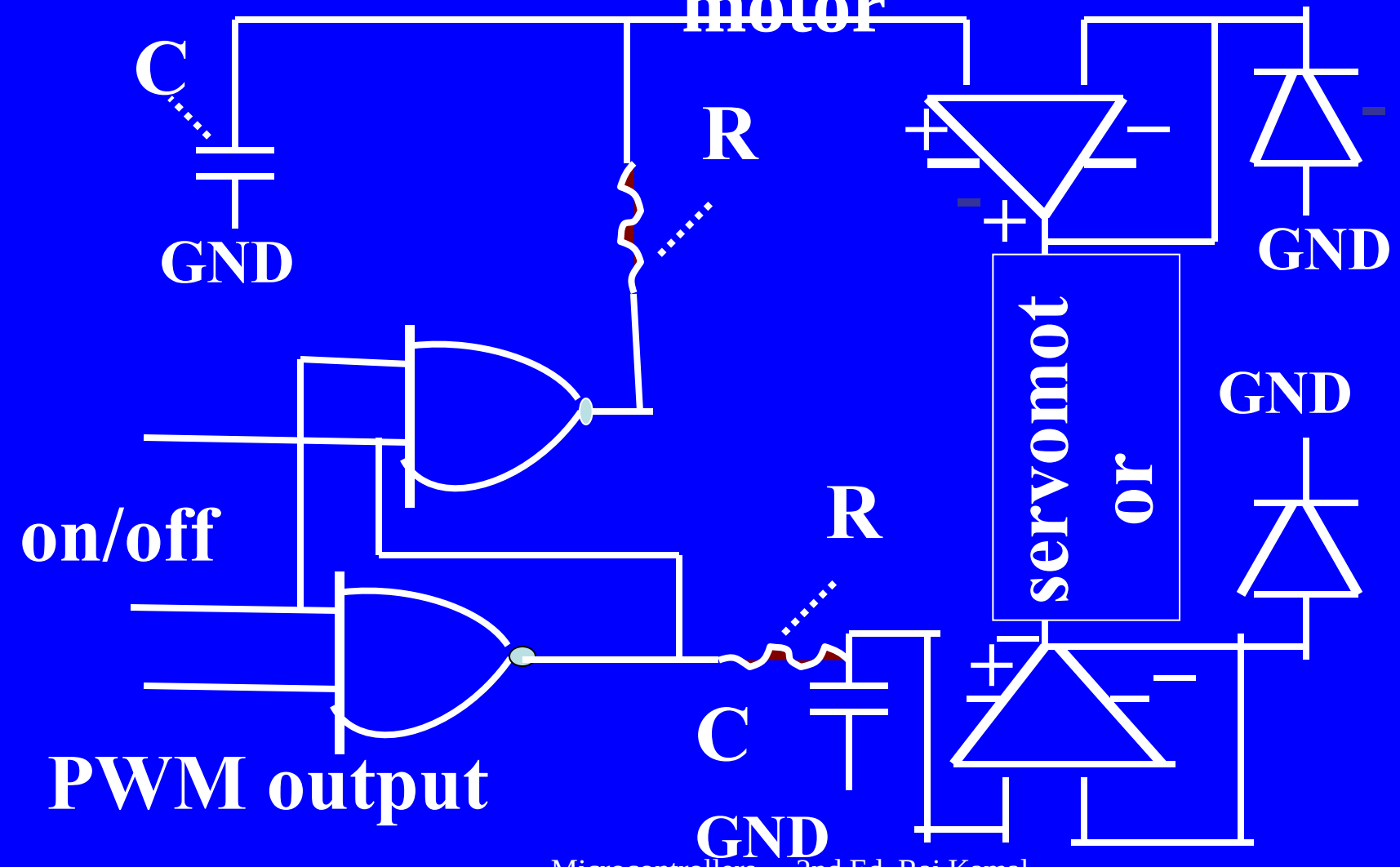
Analog Outputs Interfaces

- PWM plus Integrator
- PWM output to integrator-1 for servomotor angle control
- When x values such pulse width = 1 ms or 1.5 ms or 2 ms to coil C' with pulse period = 20 ms.

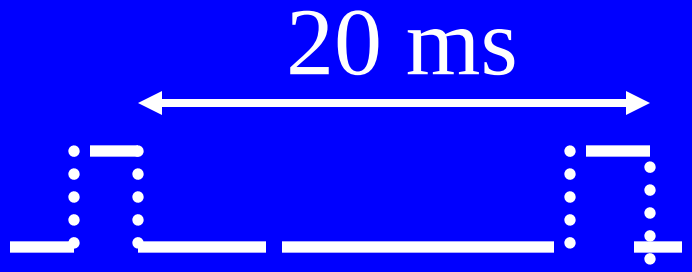
Analog Outputs Interfaces

- 0° angle change when pulse width is 0.5 ms
- – 90° angle x values such pulse width = 1 ms
- + 90° angle x values such pulse width = 2 ms
- Angle between – 90° and + 90° when pulse width is between 1 ms and 2 ms.

Integrator PWM output for current, speed and direction control of d. c. motor



Servomotor control

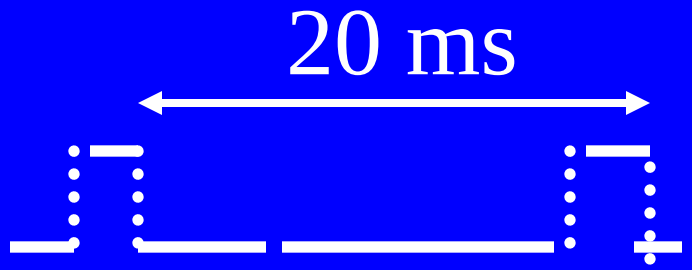


PWM output

1.5ms **1.5ms**

Servomotor at Neutral 0° position

Servomotor control

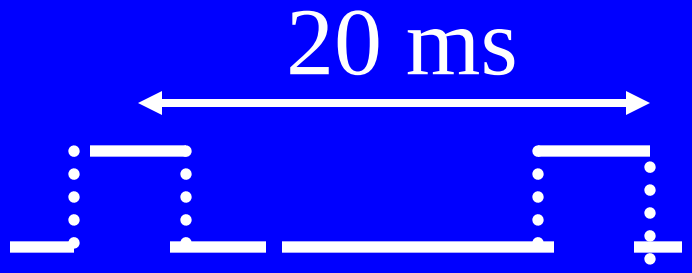


PWM output

1.0ms **1.5ms**

Servomotor at −90° reversed position

Servomotor control



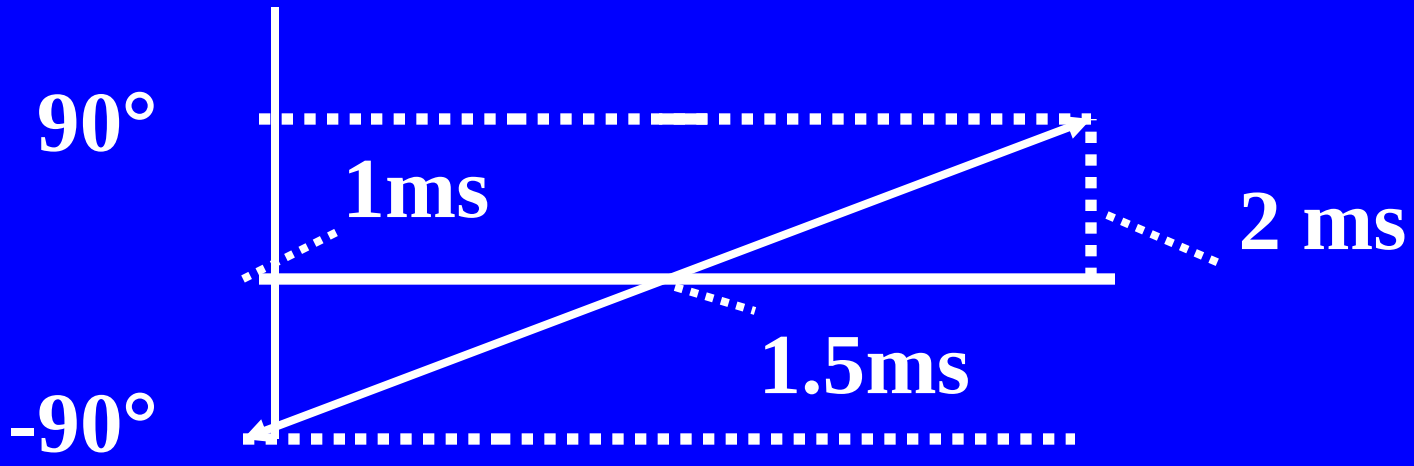
PWM output

2.0 ms **2.0 ms**

Servomotor at +90° forward position

Servomotor rotate angle

PWM outputs at 20 ms Intervals



PWM output = 1 period vs. rotated angle

Summary

We learnt

- Analog Outputs is obtained after integration of pulse width modulated output
- Pulse width of the modulated pulses is proportional to value loaded in pulse width modulation register
- Pulse frequency is proportional to clock input frequency to pulse accumulator
- x can be programmed such that analog outputs obtained as a function of x for the width period 1 ms and 2 ms for angles between $\pm 90°$

End of Lesson 11 Part f

Interface for generating Analog Outputs for Servomotor control using Pulse Width Modulation