Chapter 8

Digital and Analog Interfacing Methods

Lesson 11 Part 6

Interface for generating Analog Outputs for dc motor and speed and direction 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 $(2^{n-1} - x)$ when x is loaded into a modulation register.

Pulse width modulation

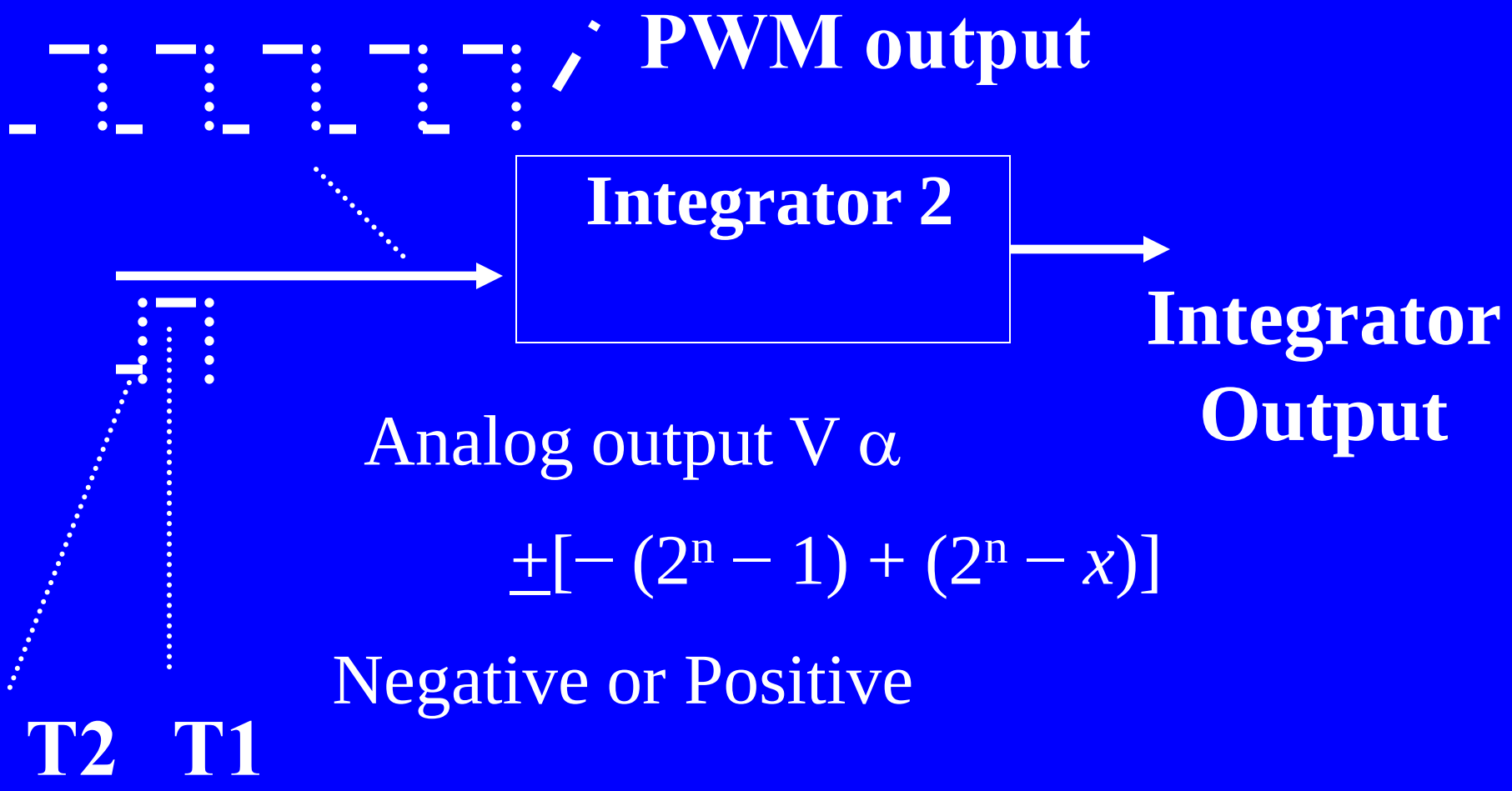
5. The analog output is proportional to $\pm(0.5 - x)$ where value x loads into PWM register.
6. The number x generates output as if it is obtained by a DAC function.
7. Modulation % = $\pm$0.5 of Period for pulse width is '1' divided by Total period of pulse at 1 and at 0 multiplied by 100.

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

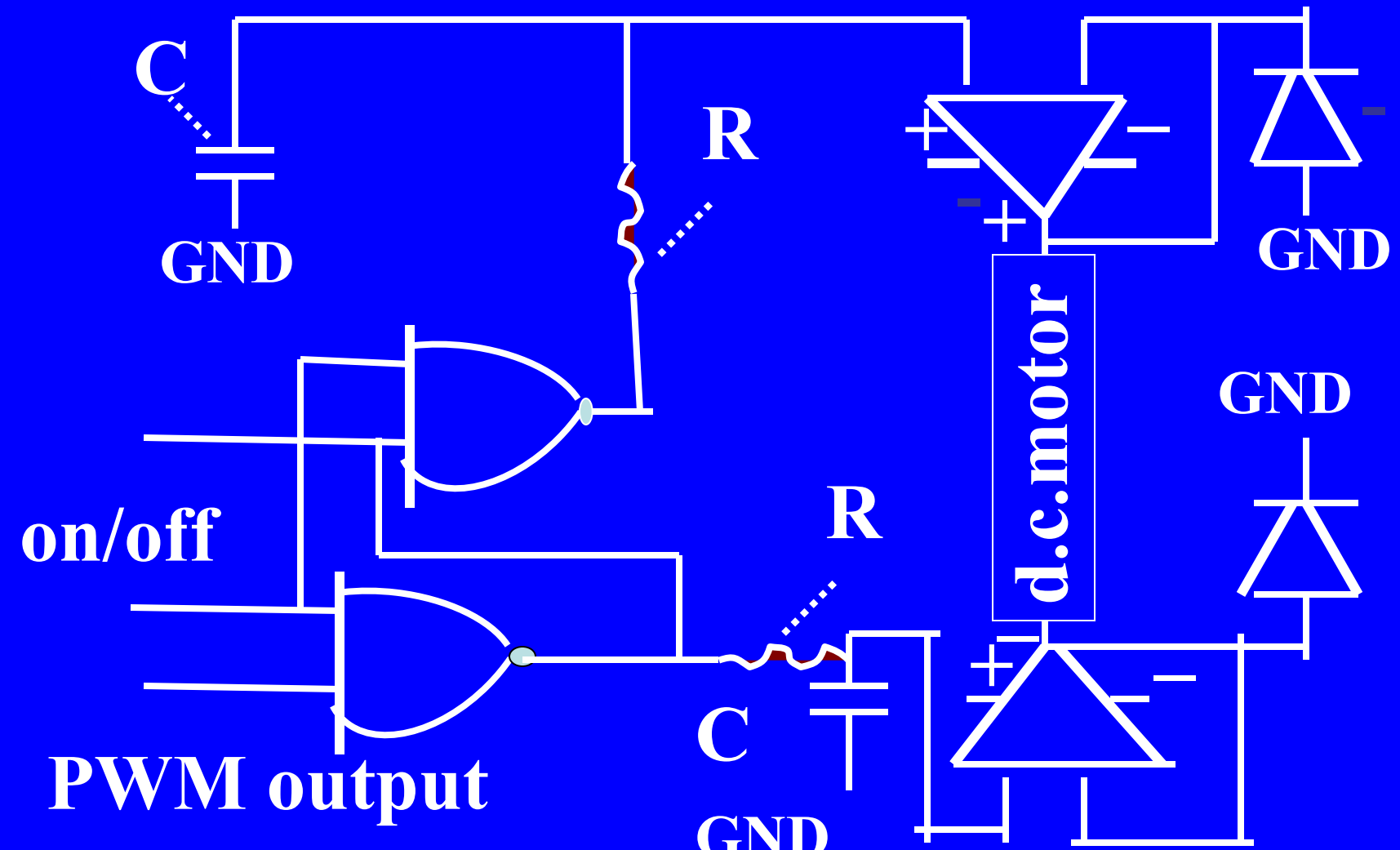
- When x in PWM register = all 0s = 00000000 (=0d). Let pulse-width T1= 0 ms, and T1+T2 = 128 ×5 μs = 0.64 ms
- x= 01000000 (= 64d) generate output width T1 = 0.32 ms, when register count-input pulse periods equal (0.32/64) ms = 5 μs
- x = 11111111 (= 255d) generate width T1 = 0.6325 ms.


PWM output
Integrator 2
Integrator Output
Analog output V α
±[− (2n − 1) + (2n − x)]
Negative or Positive
T2 T1

Analog Outputs Interfaces

- PWM plus Integrator
- PWM and inverse of PWM output to integrator-2 for d.c.motor speed and direction control
- Speed controls by $\pm(2^{n-1} - x)$
- On-Off control by two NAND gates second input
- Direction controls by $x > 2^{n-1}$ or $x < 2^{n-1}$

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



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
- Integrator can be designed such that + or − or both − and _+ analog outputs obtained as a function of x between $\pm(2^{n-1} - x)$

End of Lesson 11 Part e

Interface for generating Analog Outputs for dc motor and speed and direction control using Pulse Width Modulation