ME 311: Microprocessors and Automatic Control

Microprocessor interfacing
PWM interface

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Various interfaces

- Digital input output (I/O)
- PWM: Pulse width modulation
- Counter interface
- Analog to digital converter ADC
- Digital to analog converter DAC
- Communication interfaces: uart, RS232, etc.

Philosophy of Interfacing

- Although we saw specific digital i/o interfaces in detail with example of 8085 microprocessor and XEP 100, what you need to take away is philosophy rather than syntax
- Basic philosophy in all interfacing problems is to write specific 'words' in different registers. Control word in control register and so on.
- The syntax of these words is what is to look for in the data sheet of the respective micro-controller
- Say for example look at data sheet of XEP 100 to program the PWM interface.

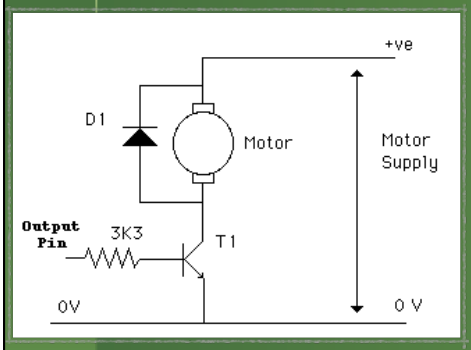
Philosophy of Interfacing: PWM

- Q: What is PWM?
- Q: Why we need PWM interface in automatic control application?
- Problem statement: Given PWM frequency say 10 Khz and duty cycle say x % develop a program to initiate different registers in XEP 100 to achieve corresponding PWM output on channel 1.

What all we need to run motor using muc?

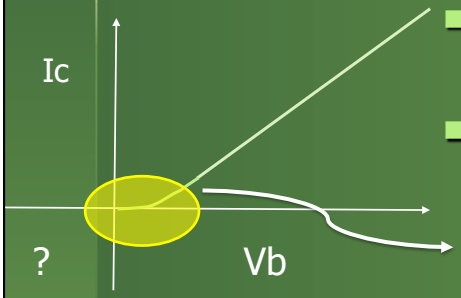
- Q: does microcontroller have large power needed to drive motors? NO ☹
- So some kind of power amplifier is needed
- What would be input to this power amplifier?
- How to regulate power/voltage given to motor and how to change the direction? Any ideas!!!

Power Amplifier



- Lets look at simple power amplifier circuit we know: power transistor
- Would this work
  - How do we vary power
  - How do we change direction?

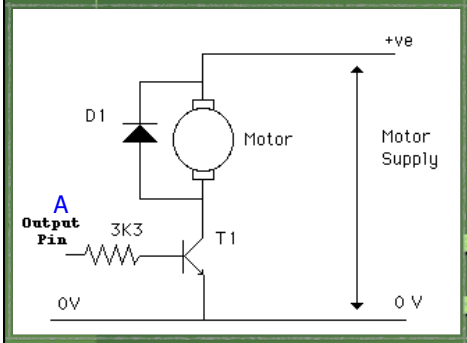
Power Amplifier



- Recall transistor characteristics
- Problems
  - Forward bias voltage is required before current can flow
  - Which input from microprocessor can vary power?
  - Analog / Digital??

- Reverse characteristics not favorable to change direction of motor

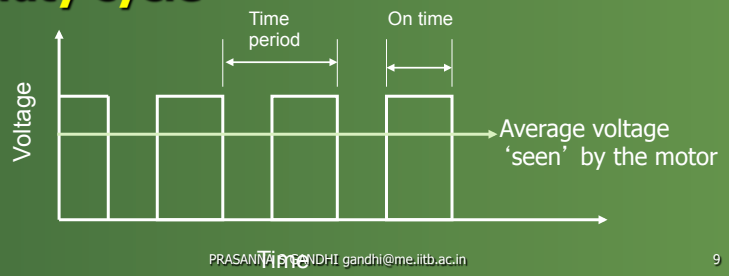
How do we get over these problems?



- Can we use digital input instead of analog input at A in smart way to deliver varying power?
- How to vary power?
- Switch on and off digital signal at A. Vary 'on time' as compared to 'off time'

What do we achieve?

- Pulse Width Modulation (PWM): Power supply regulated by varying the % of "on-time" of a digital signal also called **duty cycle**



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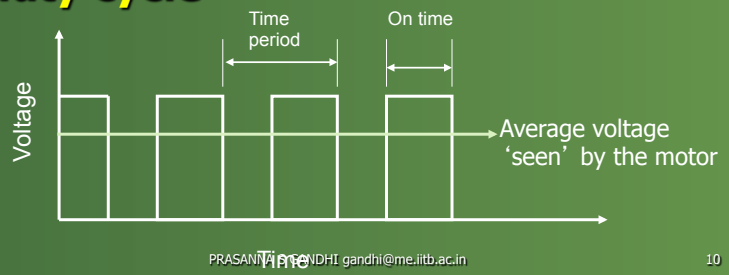
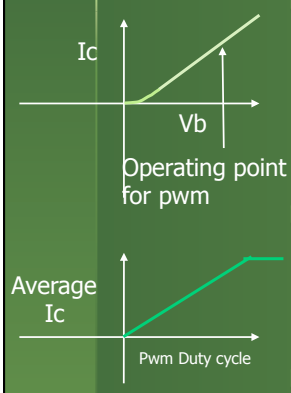


What do we achieve?



- Operating point on transistor characteristics is now fixed. Issue related to "dead zone" disappear.
- Smooth variation of average Ic in motor by varying "on time" of PWM waveform.
- IMP: PWM frequency should be high 'enough' : typically 2-10 kHz

PWM interface of XEP 100

- Identify registers and their values to be used from datasheet of XEP 100
- Specifically look at PWME, PWMCLK, PWMPOL, PWMPRCLK, PWMDTYx, PWMPERx registers in datasheet
- Use PWMPERx = 0xFF value. Think why??
- C program for generating desired PWM signal on channel 1 will finally be like setting some values into these registers

PWM interface of XEP 100

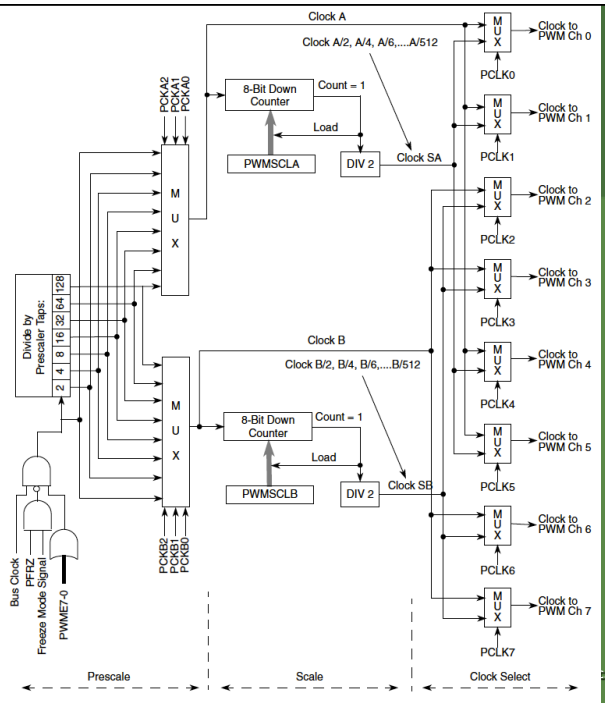


Figure 19-18. PWM Clock Select Block Diagram

Reminder: what is mux!!

Multiplexer

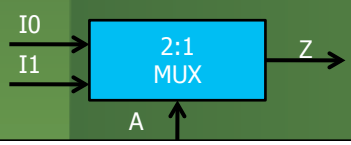
I0	I1	A	Z
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

Simplest:

- Two data inputs I0 and I1 and control input A
- Depending on A select either I0 or I1

$$Z = A' I_0 + A I_1$$

A	Z
0	I0
1	I1



PWM interface of XEP 100

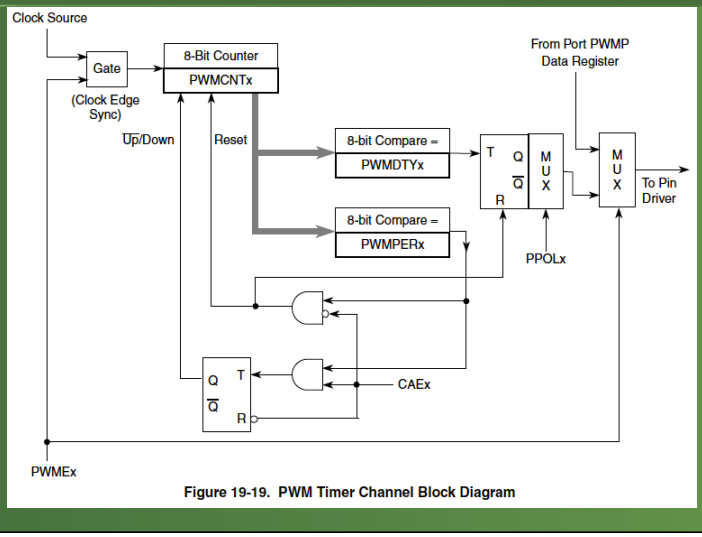


Figure 19-19. PWM Timer Channel Block Diagram

15

Calculation of duty cycle and frequency

- See datasheets

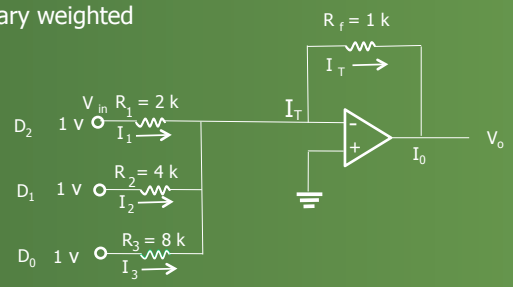
DAC: Digital to analog converter

- Given digital number how to generate voltage corresponding to the value?
- Electronic circuit to do so? Can you think of a circuit
- Use opamps to achieve this

Using Opamp for summing

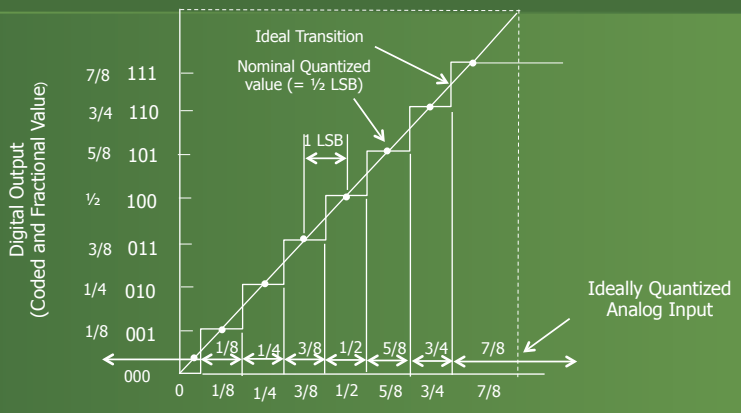
Summing amplifier with Binary weighted Input Resistors

$V_o = -R_f I_T$
$= -(1k)(0.875\ mA)$
$= -0.875\ v$
$= |7/8\ V|$



A 3-Bit A/D Converter

Quantization problem!!



(b) Analog Input vs Digital Output

Thank You