CMPE242 March 16, 22 PART II 1/

March 16 (Wed)

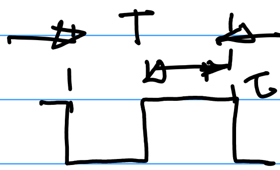
Topics: 1° PWM Architecture/Hardware Aspect — Waveforms, Timing Diagrams, SPRs

2° LSM303 Sensor I2C

Example: PWM Discussion.

$\left\{ \begin{array}{l} f_{PWM} \\ \text{Duty Cycle} \end{array} \right.$

One period



Duty Cycle $= \tau / T$ ... (1).

Square Wave: D.C. = 50%.

Architectural Aspects:

2021F-105-#0-cpu-arm11-2018S-29-...

P1106

6410X_UM

32 PWM TIMER

This chapter describes the functions and usage of PV

C. Prescaler for f_{PWM} Config

8 bit

PP1107

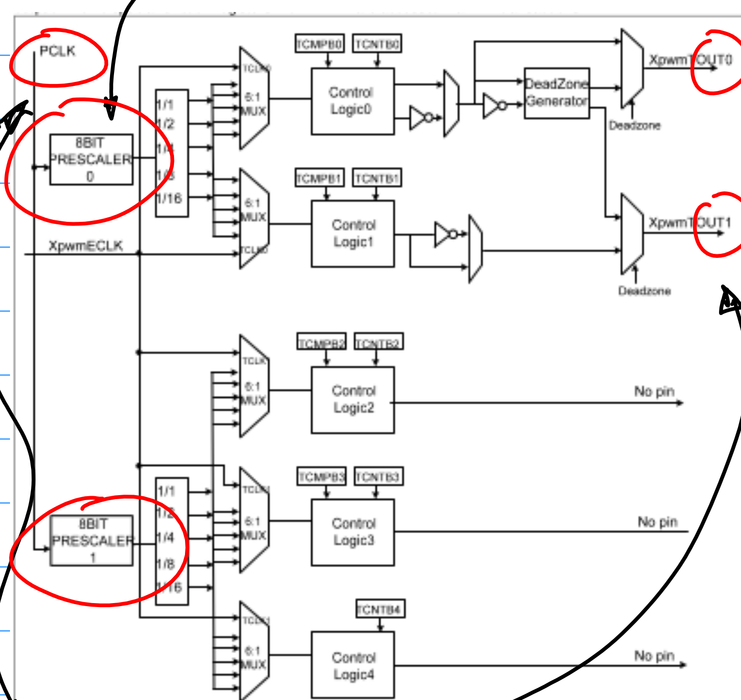


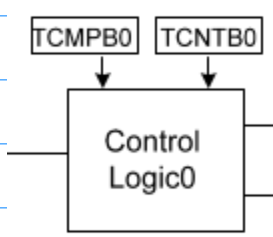
Figure 32-1. PWMTIMER Clock Tree Diagram

a. Input: PCLK peripheral clock.

1/2, 1/4, 1/8, ..., of the System Clock

b. Output (2 outputs)

d. Special Purpose Registers



CONF (Configuration Register)

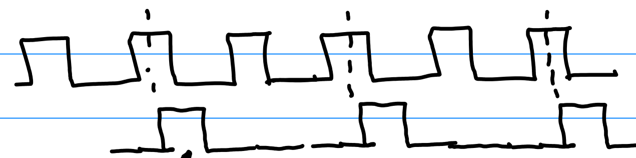
CNT (Control — "Count")

CMP (Comparision)

define f_{PWM} & Duty Cycle.

- 2022S-107e-pwm-waveform-v3-2018-3-4.jpg
- 2022S-107f-pwm-specialPurposeRegister-v3-2018-3-4.jpg
- 2022S-107g-pwm-calculation-v3-2018-3-4.pdf

Note: Background on Counters.



Count By 2

Expand this to A counter for Both integer Number & Fractional Number (in General) → f_{PWM} (for interger Only)

then, use Another Counter to get Duty Cycle.

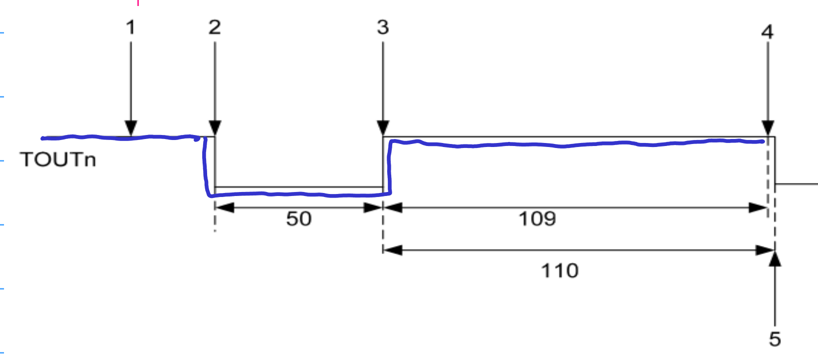
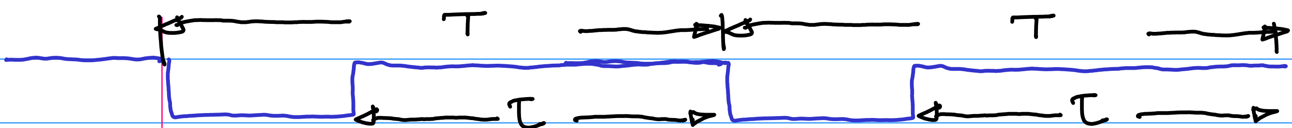


Figure 32-2. Simple Example of PWM Cycle Block Diagram



$T = 1/f_{PWM} \ \cdots (2)$, $\quad f_{PWM} = \dfrac{PCLK}{(\text{Prescaler}+1)\,DIV} \ \cdots (3)$

Frequency = PCLK / ({prescaler value + 1}) / {divider value}

Suppose $PCLK = \frac{1}{4}(\text{System Clock}) = \frac{1}{4}(800\times10^6)$

$= 200\times10^6$

Defined By Special Purpose Register.

Design Guidelines for PWM:

① CNT (TCNTB0) Define f_{PWM}

Control Count — Timer — Buffer0 for PWM0

② Cmp (TCMPB0) Defines Duty Cycle

Comparision

③ CONF Configuration Register. Defines f_{PWM}

Example: Suppose $PCLK = 500\times10^6$ (MHz), Suppose to Drive A Stepper Motor $f_{PWM} = 2KHz = 2\times10^3$

Find the Counts N for TCNTB0

$\dfrac{PCLK}{N} = f_{PWM} \ \cdots (4)$

$\frac{PCLK}{N} = f_{PWM}$, Substitute the design Requirements into it.

$\frac{500\times10^6}{N} = 2\times10^3$,

$\therefore N = \frac{500\times10^6}{2\times10^3} = 250\times10^3$

Verify if TCNTB0 Can hold up to that Number

PP1117

32.4 SPECIAL FUNCTION REGISTERS

32.4.1 REGISTER MAP

Register	Offset	R/W	Descrip
TCFG0	0x7F006000	R/W	Timer Configuration Registe two 8-bit Prescaler and Dea
TCFG1	0x7F006004	R/W	Timer Configuration Registe and DMA Mode Select Bit
TCON	0x7F006008	R/W	Timer Control Register
TCNTB0	0x7F00600C	R/W	Timer 0 Count Buffer Regis
TCMPB0	0x7F006010	R/W	Timer 0 Compare Buffer Re
TCNTO0	0x7F006014	R	Timer 0 Count Observation
TCNTB1	0x7F006018	R/W	Timer 1 Count Buffer Regis

2^{32}

32.4.1.4 TCNTB0 (Timer0 Counter Register)

Register	Offset	R/W	
TCNTB0	0x7F00600C	R/W	Timer 0 Count I

Conclusion: 5-Steps operation of PWM. Can be described as (1) Count By N with Eqn (4), PP3. And deposit N into TCNTB0; (2) Deposit Count M into TCMPB0, where $M = (D.C.) \times N$ ... (5)

(3) The Down Counting will decrement TCNTB0's count by 1 at a time, And a Comparison is made to TCMPB0, if matched, then trigger the Output to "1", Down Counting continues till the Count in TCNTB0 = 0 One period is reached. Then Repeat this process.

Feb. 21. 21.

Example: Suppose CLK = 50 MHz, Design Implementation Technique to produce $f_{PWM} = 1000$ Hz, to Drive Stepper Motor Controller, in addition, Duty Cycle is 30%.

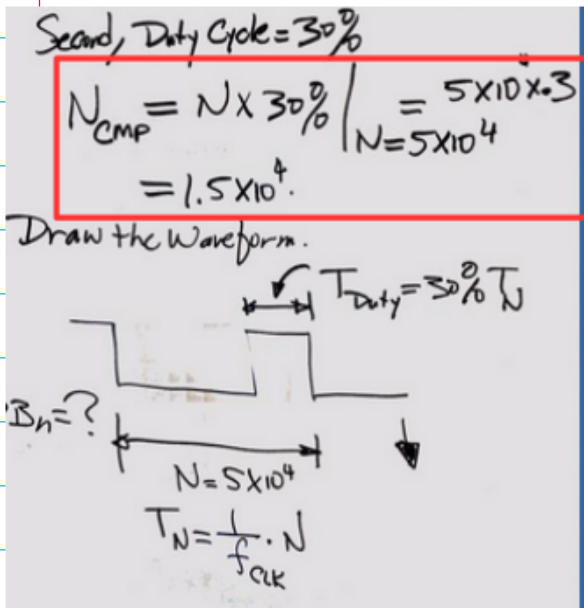
Find: (1) $TCNTB_n = ?$; (2) Find $TCMPB_n$

Sol First, find the Counts N Based on the given condition.

$\frac{50\times10^6}{N} = f_{PWM}$ ... (1) $f_{PWM} = 1000$

$N = \frac{50\times10^6}{1\times10^3} = 5\times10^4 \rightarrow$ Hex

$TCNT_n$



March 21 (Monday)

Midterm on 23rd (Wed).

1 hr. Exam, + 15 min.

Review on Midterm.

3 Questions.

1. A question on Basic Concepts.
   1. CPU Architecture
      32 Bit Architecture
   a. Memory map. Banks,
   b. GPP/IO Peripheral controller.
   c. SPRs. Naming, functions.
      GPx CON, GPxDAT
      Tech. Spec ⇄ Binary Pattern
   d. ARM11 Reference, Code
      User Space, Kernel Space
   e. Target Platform, NAND,
      Software Side { O.S. distribution. Toolchain, menu config.
   f. SPRs in Driver Code.
      GPIO user program.
      { fd = open(" $\underbrace{\quad\quad}_{\text{Path/Driver}}$ ");
        ioctl( );
      Kernel Space Program Sample
      GPECON, etc → CPU Datasheet
   g. GPIO Testing { I/P Testing, O/P testing.
      Ref: 2022S-101-notes-cmpe242-3-14.pdf
      PP. 9 CKT → Pin Selection
      gpio 79 (pin 42)
      gpio 78 (pin 40)

2. Question(s) on PID Controller Design.
   { Hardware, Software } → Motor Drive GPP/PWM
   Motor Drive Pin Connection Requirements
   Sch., Connectivity Table.

"Demo" Live Execution of your program.

i. Board is Ready. Take a photo of your Board During the exam.

ii. Stepper motor/motor Drive And the Prototype Board work together, Take a photo, Screen Capture of program execution.

Motor Operation, micro steps, Angular Displacement.

Target Platform. Hardware Configuration to access device driver, such as GPIO, PWM or I2C.

3. Theoretical Aspects of the PID Controller Design.

a. PID Block Diagram.

P~, PI~, PD, ... etc.

D(erivative Controller) Short future.

I(ntegration Controller) History

b. Computation. Forward Difference, Backward Difference, Central Difference. Kernels, Computation.

Integration Controller. History Back N Steps.

c. Sensor Interface Hardware I2C I/F.

LSM303 I2C Based Sensor.

2022S-108b-AngularSensing-i2c-LSM303- final HL 2017-3-13.pdf

Example: An Application of LSM303

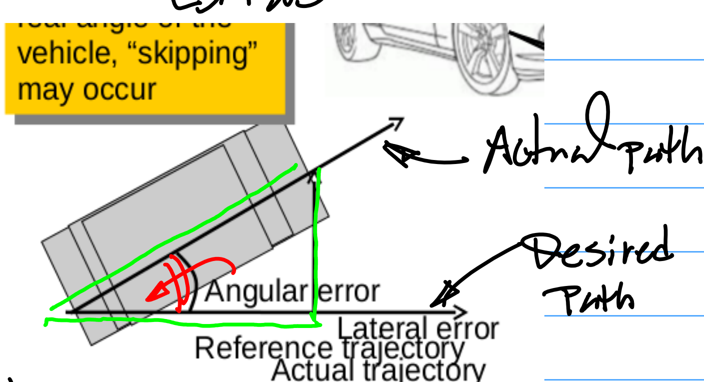


Fig 1.

α: from LSM303

$\vec{P_A}$: is measurable

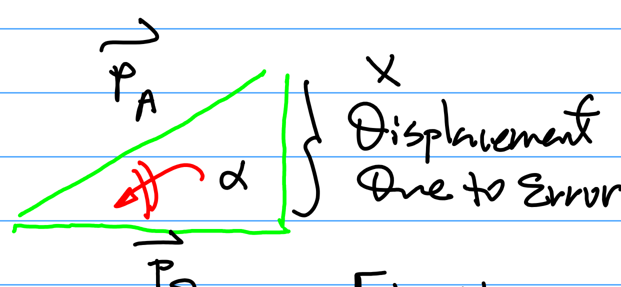


Fig. 1b

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Find $\|\vec{P_A}\|$ is defined by PWM Driven Stepper motor action.

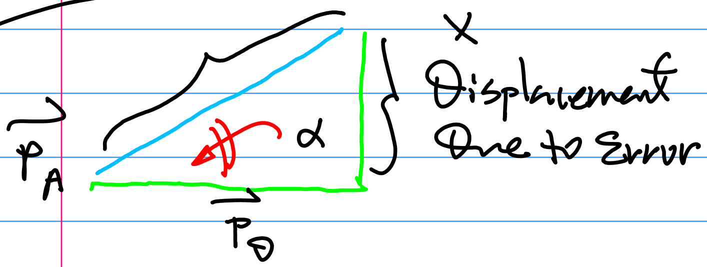


Fig. 2

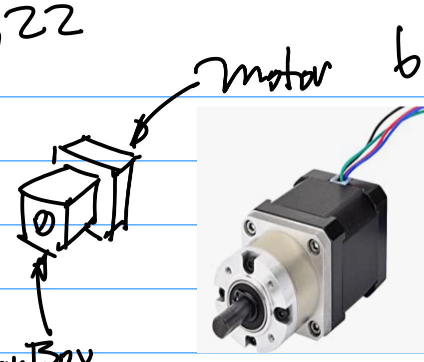
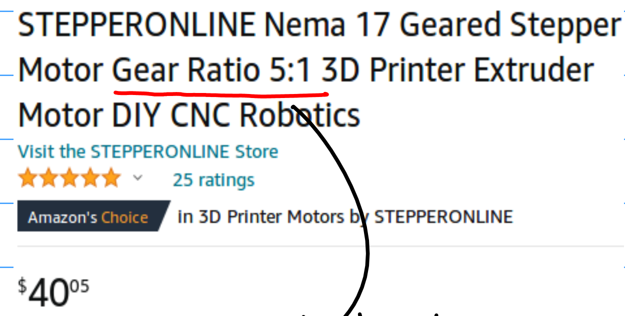


Fig. 3.



Reduction Ratio, R_R

For the purpose of increasing the Torque.

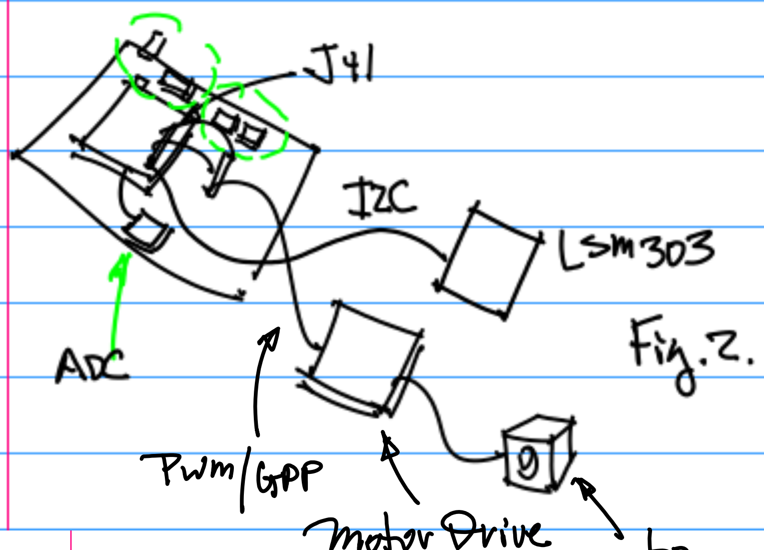


Fig. 2.

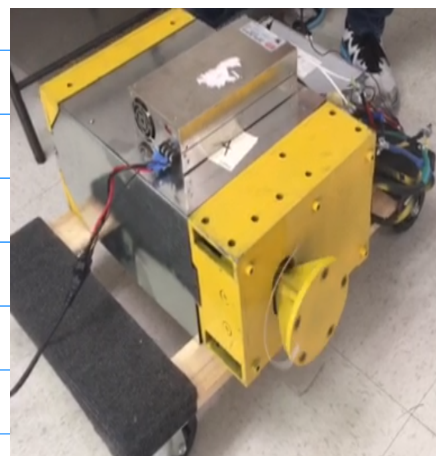
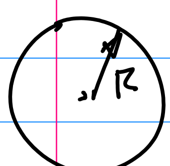


Fig. 4a, 4b With Reduction Ratio Gear Box.



the wheel of the Robot has the dimension R=100mm

Now, Let's take a look at the hard ware of the motor Combo.

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To find /Establish one-to-one mapping Between the actual path and PWM operation.