CmpE242

$\nabla^2 = \frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}$ ... (1)

March 10 (Wed)

$G(x,y) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(x^2+y^2)}{2\sigma^2}}$ ... (2)

Note $\mu_x=\mu_y=0$, $\sigma_x=\sigma_y=\sigma$

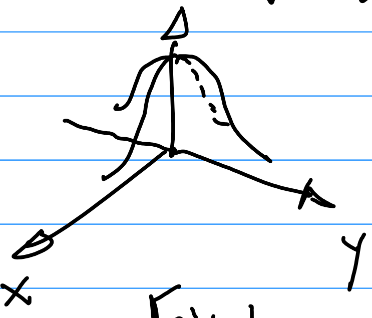
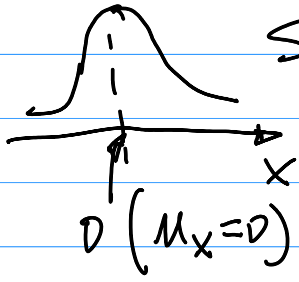


Fig 1.



From Eqn (4), Plot from the github 2018S-15-Lec6-V3 ...

Let y=0, to have one indep. Variable x.

$\nabla^2 G(x,y)\big|_{y=0} = \nabla^2 G(x,0)$ ...(3)

$$-\frac{1}{\sqrt{2\pi}\sigma^3} e^{-\frac{x^2}{2\sigma^2}} + \frac{x^2}{\sqrt{2\pi}\sigma^5} e^{-\frac{x^2}{2\sigma^2}}$$

LoG(x), or $\nabla^2 G(x,0)$

Example: (1) Use LoG(x) to Build a Convolutional Kernel(s) to Compute Derivatives of the Error

22

Note: LoG(x) is **NOT** Exactly the Computation for derivatives, But we use it, for its Low pass feature, and 2nd order derivative.

Sol.

(1) "Mapping" to a Kernel

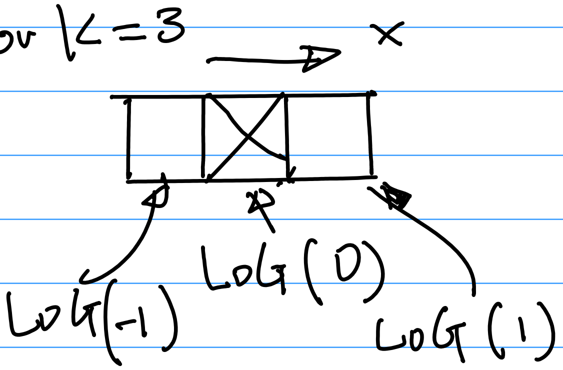
Build a kernel with "odd" Number of grids, elements

K × 1

No. of elements

One Row

for K=3



a. Identify the Center Reference

b. from LoG(x) (or $\nabla^2 G(x,0)$), map it to the Kernel

Solve for y ...

Driver Implementation. $\left\{ \begin{array}{l} f_{PWM} \\ D.C. \end{array} \right.$

2018S-10-0 ~
PWM Driver

Add Duty Cycle Function to Device Driver.

{ Theoretical Aspect
{ Implementation C Code.

SPRs { TCON ← Control Reg.
TCNT ← Counter Reg.
TCMP ← Compare Reg.
CFG0
CFG1

Root

Prefix
"T" imer

PWM Output Square Waveform

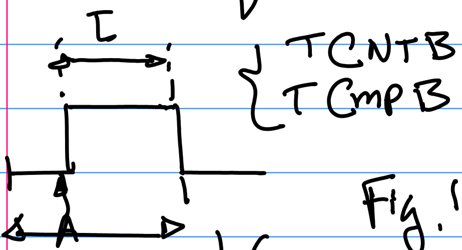


Fig. 1

$T_{PWM} = 1/f_{PWM}$

$$f_{PWM} = \frac{CLK_P}{(Prescaler+1)(divider)} \quad \ldots (3)$$

PP 1118, CPU Datasheet

Prescaler: 8 bit, [0, 255]

Divider; 1, 2, 4, 8, 16

Note CFG/CON are responsible for Setting Prescalar/Divider value.

$$f_{PWM} = \frac{50 \times 10^6}{(Pres+1) \cdot Div.} \quad \ldots (*)$$

If we need $f_{PWM} = 2 \times 10^3$

Find SPR, Set SPR. to Realize this frequency.

From CPU Datasheet CFG0 CON.

Sol

$$2 \times 10^3 = \frac{50 \times 10^6}{(Pres+1) Div}$$

$$(Pres+1) \cdot Div = \frac{50 \times 10^6}{2 \times 10^3}$$

$$(Pres+1) Div. = 25 \times 10^3$$

Let Div = 16,
Solve for Pres.

$$Pres+1 = \frac{25 \times 10^3}{16}$$

$$Pres = \frac{25 \times 10^3 - 16}{16} \simeq > 255$$

Iteration,

Change PCLK to 10MHz,
then, we have

$Pres = \frac{10\times10^6 - 16\times2\times10^3}{16\times2\times10^3}$ if it is still too big

therefore, then Low the CLK_p

try $CLK_p \simeq 2\times10^6$. please verify it!

Note: SPR Responsible for f_{PWM}

T CNT B

Timer Root Buffer

$f_{PWM} = 1\times10^3$ given.

f ~~master~~ Clock Peripherial

N Counts for CNT SPR.

$f = f_{PWM} \cdot N$ ... (4)

Given Target Unknown to be Calculated

Note: T Cmp B

Comparison Register for Duty Cycle

2nd Counts Value for "Cmp" Derived from Duty Cycle.

March17 (Wed) f_{PWM} By Setting SPR's value

Duty Cycle

Arm11, Datasheet

TCNTB ← "N" Counts ↕ f_{PWM}

TCmpB

20185-10-

$f_{PCK}/f_{PWM} = N$ ...(1)

Define ~~one~~ the Period ; CNT

Duty Cycle → % → Counts

Percentage ↓

Cmp

GPFCON PP.522

GPFCON[29:28] = 10 → PWM

GPFCON[31:30] = 10 → PWM

#define S3C64xx_GPFCON 0x7...

*.h

&= ~(0x3u<<28)

"AND" Neg. "11" "00"

|= (0x2u<<28)

"OR" "10" unsigned

Set 2 Bits

GPFCON[29:28] = 10

March 22nd (mon)
Review.

1° 3± Questions.

a Basic Concepts CPU Architecture
Block Diagram.

Memory Map. Peripherial Controllers

GPP (GPIO)
PWM
} SPRs
CON
DAT
⋮

PWM
TCNTB
TCmpB
CFGφ, 1

Architecture → Mem → SPR
Code ←

{ User Space Programming
Kernel Space Device Driver

Kconf ←
Script
Define Compilation + Build Process.

Programming Requirements, No Program Code Writing

However! 'Debug/Change the existing Code is Needed;

b Design-Related Question(s)

SCH. Design, CKT for PWM

Pin(s), f_{PWM} — GPIO

motor Drive

Pin(s), Label(s) Stepper motor I/F

GPP I/O Testing ("Hello, the World")

{ Input Testing CKT
Output Testing CKT

Resistance Value Calculation

c Theoretical Aspects

C1. PID Controller Design
Basic Concepts
Block Diagram.

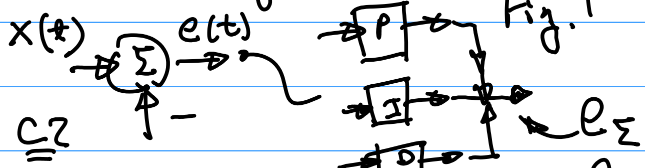


Fig. 1

C2
Kernels
F.D. 2×1 → Central D.
B.D. 2×1
$\frac{1}{2}$(F.D+B.D)

↓

With Noise Reduction 3×1
Low Pass Filter: G(x) Gaussian.

+ 2nd Order Derivation as in Computer Vision

∇^2 : Laplacian $\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2} \rightarrow$ 1D $\frac{\partial^2}{\partial x}$

LoG(x)

Note: One page formula sheet is Allowed, However No verbal Description And/OR Examples Allowed.

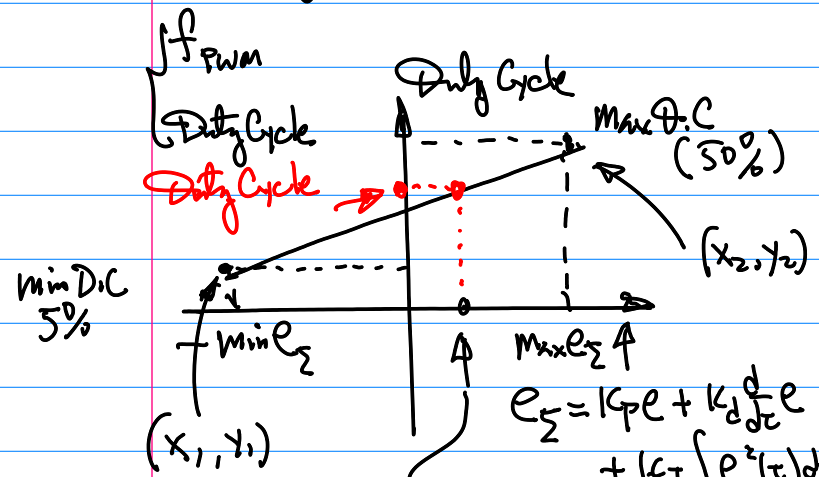
Note: Calculator Is Allowed.

Close Book, Close Notes
Datasheets if needed will be provided;

Convolution with Kernel(s)
Table of E(t), find $\frac{d}{dt}E(t)$ Convolution

$$\int K_I e^2(\tau)d\tau \approx \sum_{i=0}^{I} K_I e^2(I)$$

Mapping to Control function PWM



$$e_\Sigma = K_p e + K_d \frac{d}{dt} e + K_I \int_I e^2(\tau)d\tau$$

$e_\Sigma = 0.57$

find control Action, → D.C = ?

Implementation: Reference Platform
ARM11

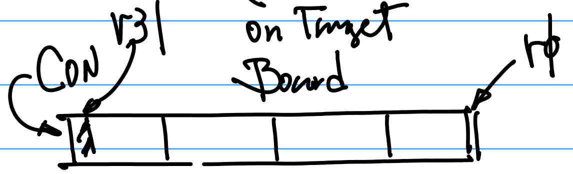
Architecture
CPU Block Diagram → Memory map.
2^{32} (4GB)
8 Equal Bank
↓ 3 Addr. Bits
$a_{31} a_{30} a_{29}$

* SPRs. ←
(Peripheral Controllers)

{PWM
{GPP

GPx CON
GPx DAT
TCNTB
TCMPB

Design Spec. → SPRs → CPU Datasheet
(Pins)
on Target Board



To perform init & Config:
1° Binary Pattern for SPR.

Read/modify user Application Programs | Kernel Space Device Driver Program.

C Code for this purpose.

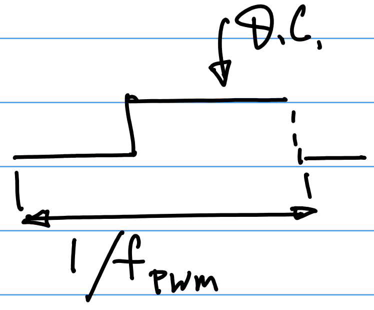
Note: PWM Waveform, e.g. Duty Cycle Calculation.

N. for CNT
N' for $_{T}\text{Cmp}_{B}$

$$f_{PCLK} / f_{PWM} = N$$

$$f_{PWM} = \frac{PCLK}{(Presl+1) * DVR}$$

$$\%(D.C) * N = N' \rightarrow \text{Cmp}$$



Pre-requisit {
1° O.S Source Distribution
2° Tool Chain Distro.
"Cross Comp"
3° Datasheet.

↓

Tool Chain Installed
Running make menuconfig

Continued → Kconf (at \drivers ~\char)

↓

Script. Add your Device Driver

↓

make menuconfig

↓

invoke your Change, Compile & Build (module Only for Simplicity Purpose)

↓

Object "KO".

↓

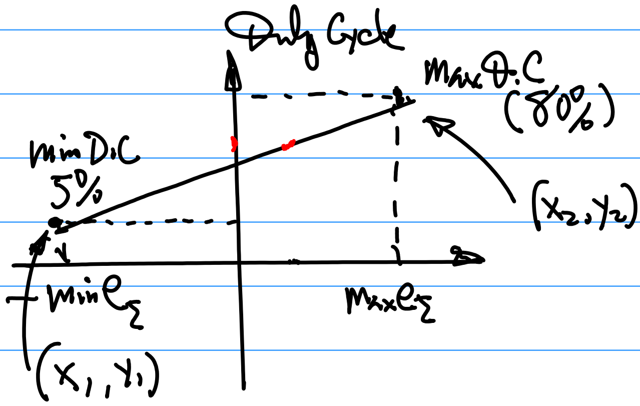
Copy "USB" upLoad by "CP" Copy Command to your target

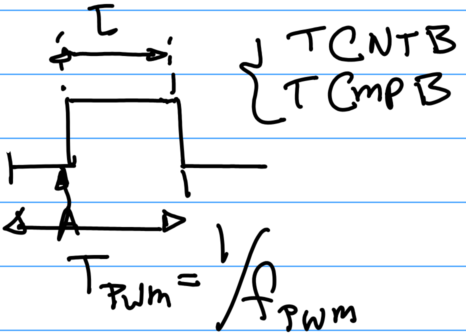
↓

"insmod" mytest.KO (To make it as a part of Kernel Image)

↓

run your user application program (By calling the module)





https://github.com/hualili/CMPE242-Embedded-Systems-/blob/master/2018S-16-AngularSensing-i2c-L8

https://github.com/hualili/CMPE242-Embedded-Systems-/blob/master/2018S-16-AngularSensing-i2c-L

CMPE/EE242

April 5th (Monday)

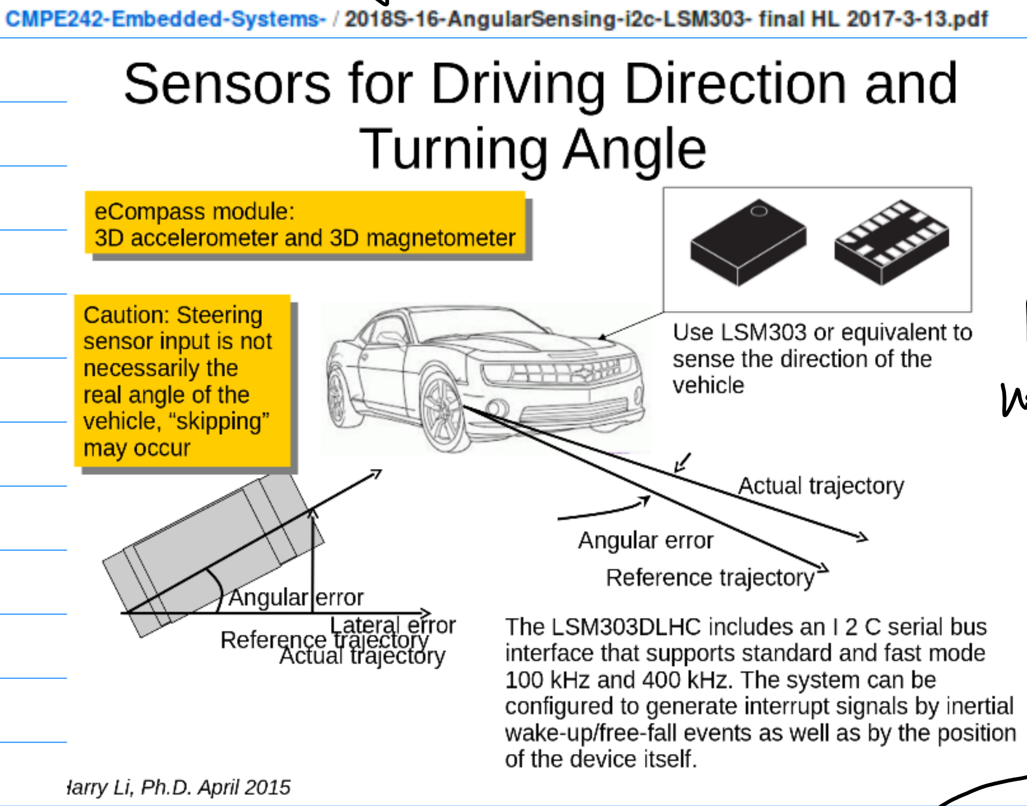
1. midterm Graded, the key was posted online, github, search under folder 2019S, "Key"

2. 2nd half of this Course. IIoT (Industrial IoT)

Sensors I/F { Digital Sensors — I2C I/F.
Analog Sensors — ADC

FFT to find / Characterize 32 Analog Sensor Data (Nyquist Theorem) Validation of Sensor Data.

OpAmps to Build Processing CKT. "SPICE" Simulation.



CMPE242-Embedded-Systems- / 2018S-16-AngularSensing-i2c-LSM303- final HL 2017-3-13.pdf

Sensors for Driving Direction and Turning Angle

eCompass module:
3D accelerometer and 3D magnetometer

Caution: Steering sensor input is not necessarily the real angle of the vehicle, "skipping" may occur

Use LSM303 or equivalent to sense the direction of the vehicle

The LSM303DLHC includes an I 2 C serial bus interface that supports standard and fast mode 100 kHz and 400 kHz. The system can be configured to generate interrupt signals by inertial wake-up/free-fall events as well as by the position of the device itself.

Harry Li, Ph.D. April 2015

Example: LSM303

Note: Next Project use LSM303.

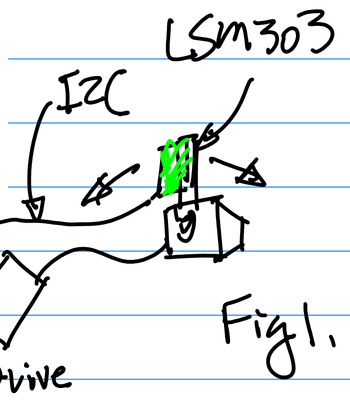
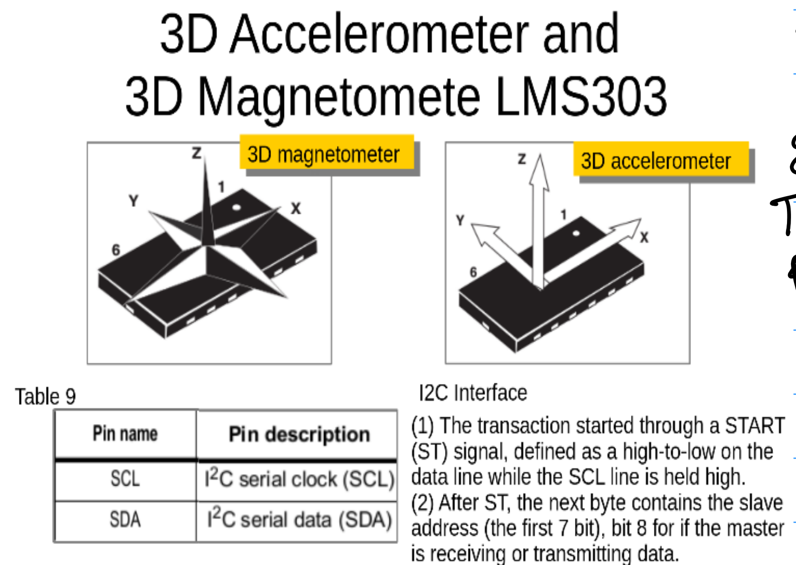


Fig1. Configuration I for PID controller



3D Accelerometer and 3D Magnetomete LMS303

Table 9

Pin name	Pin description
SCL	I²C serial clock (SCL)
SDA	I²C serial data (SDA)

I2C Interface

(1) The transaction started through a START (ST) signal, defined as a high-to-low on the data line while the SCL line is held high.
(2) After ST, the next byte contains the slave address (the first 7 bit), bit 8 for if the master is receiving or transmitting data.

Homework: Implementation I2C LSM303 Sensor I/F. Due April 16 (Fri)

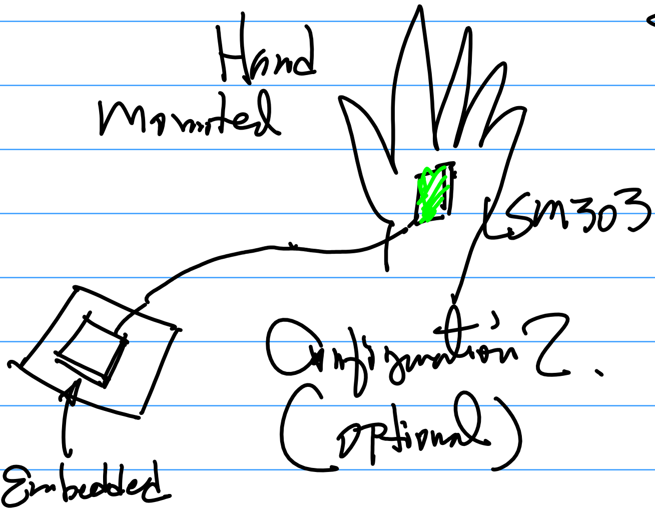


Fig2.

Submission On Canvas

Objective ① To be Able to Read Sensor Input,

② To be Able Config the Sensor.

1. Note: LSM303 for ST-micro

Sensor Supports { Acceleration X-y-z axis
Magnetometer
Temperature

2. I2C

{ SDA (Serial Data) Bidirectional Data;
SCL (Serial Clock)

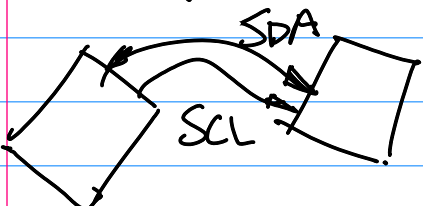


Fig4.

3. a Space-Time Diagram

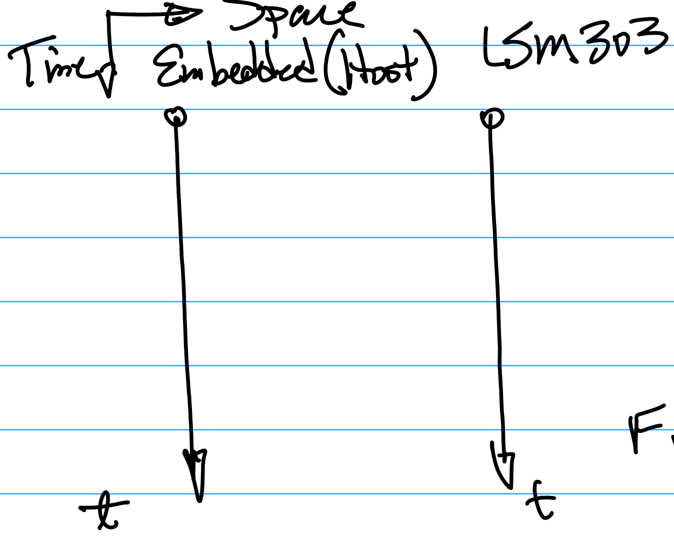


Fig3

b To Describe "Hand-Shaking"

Three Small steps.

Step 1. → Step 2 → Step 3

Host Command for the Target via Address for Init & Config

Slave "ACK"

Data Transmission will start

* Be sure read Datasheet to map the Steps of the I/F to Space-Time Diagram.

3. Datasheet Table 9 & 11.

Pp.20.

Notation:

A Frame

1° ST → SP
"Start" "Stop"

2° The Notations in Table 1
SAD, SAD+W, SUB, DATA,
SAK. etc. pp. 20

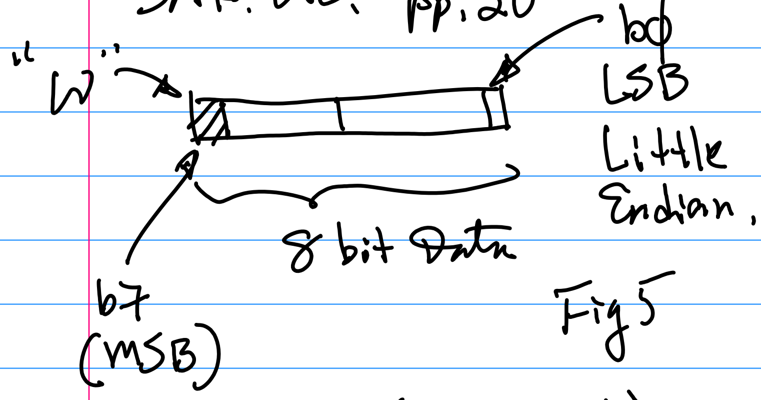


Fig 5

3° from pp. 20 (Datasheet)

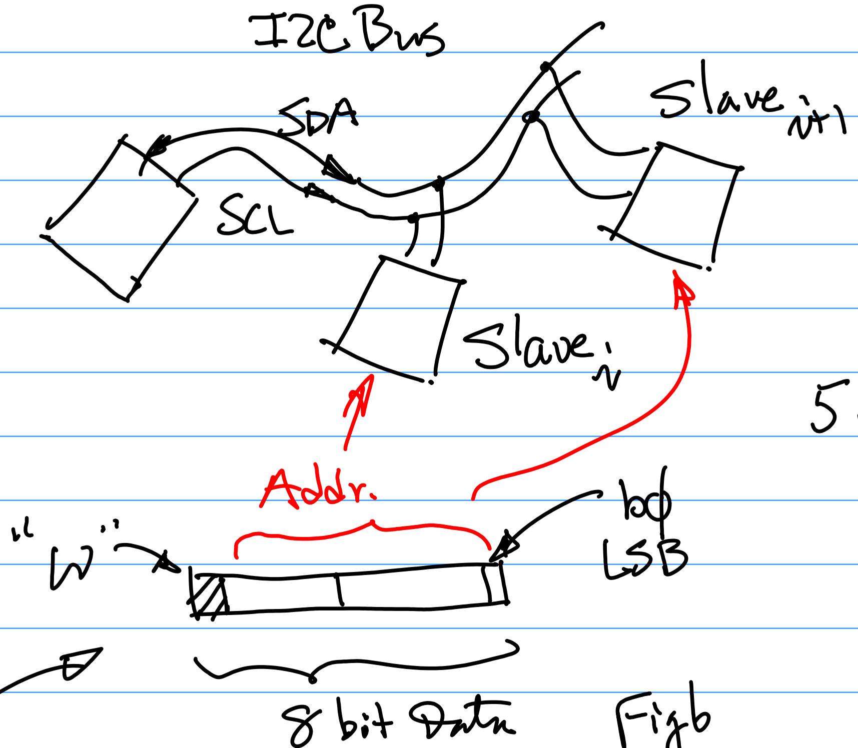
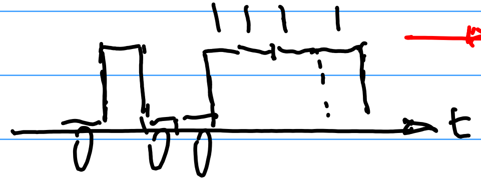


Fig6

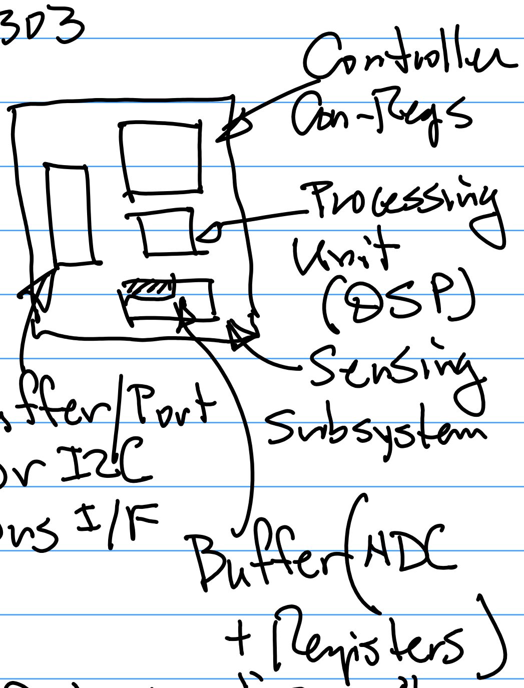
4. 1st Address (7 bits), 2nd Address SUB.
lower
All from the host (Target platform)

0xf2
1111 0010



Consider A slave device
LSM303

Fig 7



2nd Address "SUB" is for Identifying the target inside the Slave Device.

5. 127 Devices Possible (Theoretically) on I2C Bus, In Reality this has to be Checked By "FAN-IN FAN-OUT"

128 Internal Addresses
→ Special Purpose Registers.

6. Most Significant Bit is transmitted first

Example: From Datasheet (LSM303)
PP.19 Table 11, 12, 13

Homework (1pt) Due A week from Today, April 14, Due On CANVAS

1° Build I2C Bus Interface with your target platform as a host, LSM303 Slave. To be able:

a Hardware Implementation. (e.g. mount LSM303 on the Stepper motor, OR mount it to your hand)

b Read Acceleration Data X, Y, Z, Display it on your terminal.

c Read Magnetometer Data and display it on the terminal

Note: Sample code is posted "as is" basis.

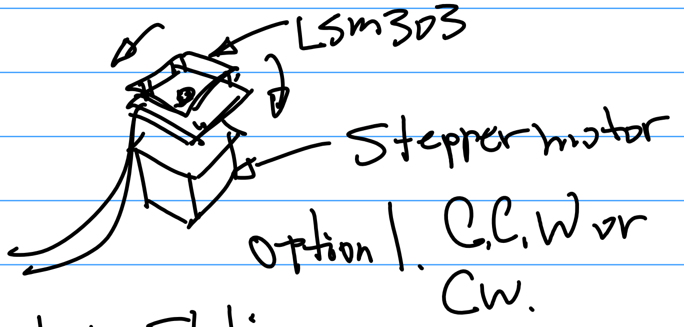
Repo: 20-2021S-10-lsm

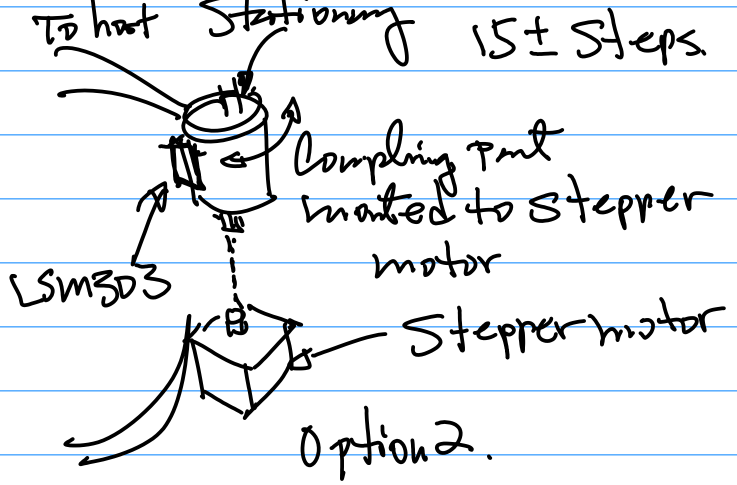
2° Submission

a Source Code, b Readme.txt

c photo(s) of your Implementation

3x photos, 1 for the entire System (with Laptop); 2nd for the Host Side, Expansion Connector is the focus; 3rd for LSM303





d 5 seconds Video Clip(s)
720P OR 1080P (1920x1280)
Compressed, mpeg4, .avi ?

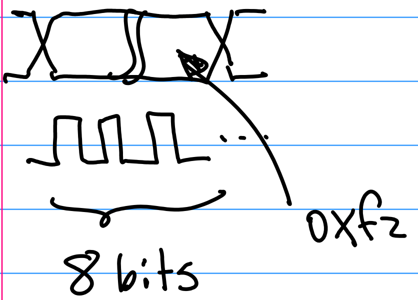
file Naming: firstName_4Digits_242.zip

Note: Table 11 & 12 (PP19)

CmpE/EE242

OneByte Writing → Multiple Bytes Writing
Host — Host

Table (Logical Behavior)
↓
Timing (Waveform)



Now, the Address for the Sensor(s) and Addresses for Registers

- Control Register — Init & Config
- Data Register

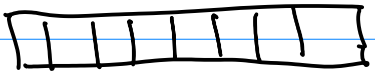
SAD[7:1] Address + SAD[0] for W/R
- =1 for W
- =0 for R

Note: Use info from Table 14 to fill in SAD+W, SAD+R in tables 11~13.

Note: Section 5.1.3 Magnetometer

Example: Table 18. Control Register A for Magnet

CTRL_REG1_A [7:∅] 8bits.



CTRL_REG1_A[7:4]=0X7
(for 400Hz)

TechSpec ⇄ Binary Pattern

TechSpec:

i. 400Hz Data Rate

ii. X-Y axis.

iii. Sensor Active (No LowPower)

CTRL_REG1_A [3]=0
CTRL_REG1_A [2]=0
CTRL_REG1_A [1]=1
CTRL_REG1_A [0]=1
→ 0X3

Hence,

CTRL_REG1_A [7:0] = 0X73 ✓

Section 7.1.8 Status Registers

Section 7.1.9~7.1.11 Data Registers.

2's Complement form
↓
1's Complement By Negation
"0" → "1"
"1" → "0"
+1