# CmpE242 Spring 2022

Jan 26 (Wed) First Day of the Class.

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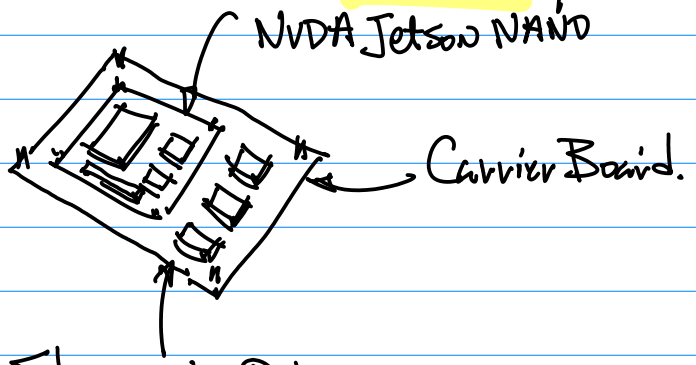
Textbooks + References:
No Textbook, however GPU Datasheets Are employed as a Base Line Reference, and serves as a textbook.
1. ARM11 GPU Datasheet, from Samsung & SoC Document for the development Board.
2. NVDA Jetson NANO Developer Kit. Reference Source for people using NANO as a target platform.
System-on-module Document. (Not used that much in this class).
Design Guide As 2nd primary Ref. for Jetson NANO.
3. Broadcom Pie. BCM2835 (CPU Datasheet).

Selection of Target platform for this Course.
a. NVDA Jetson NANO
b. Broadcom Pie
c. Samsung ARM CPU
d. Nxp i8

Note: Select your target platform from the options a–d.
(Consider Nvidia Jetson NANO).

Programming Languages: { C/C++ / python
O.S. Support: Linux.
Rich I/O I/F Support.

Requirements for the Course:
1. Design/Build A State-of-the-Art Prototype System; Each Person will have to have one individual system.




2 Form 4 person team, Work on Homework, Project, However All coding, Report etc have to be complished individually, no Code, Report, Project etc. Can be Shared.

Grading:
1. Midterm Exam, Close Book/Close Notes 30%. Prototype System will be needed to Answer Design Questions, and to execute programs. Need to take photos of the prototype.

2. Final Exam, Similar Format, 40%. Prototype System is a Part of the Exam.

3. Homework, Projects. 30%. 1st project During the 1st half of the Semester. 2nd project By Team Project, @ End of the Semester, Requires PPT Presentation & Live Demo.

Announcement in Class, in Written form Both in the Lecture Notes and ON SJSU Canvas, Late projects/Homwork 1 pt panelty.

Jan31 (Monday)

Today's Topic: Bill of Material & Prototype System.

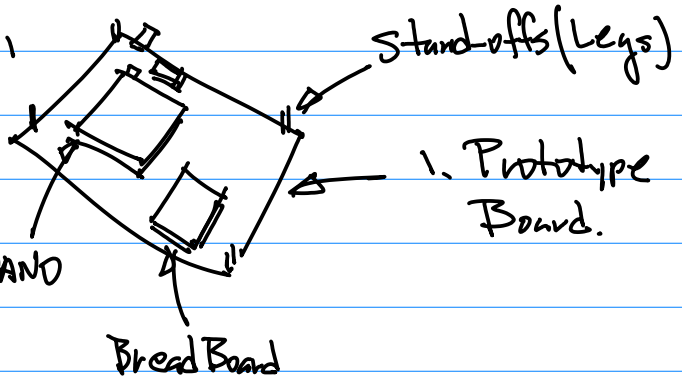
Target platform to consider for your Prototype:

- Nvidia Jetson NANO, 2GB
- Broadcom Pie. 3B+, 4.

Note: Jetson NANO is Better And more powerful with Almost the Same Cost.

Bill of Material for Prototype System

Fig1



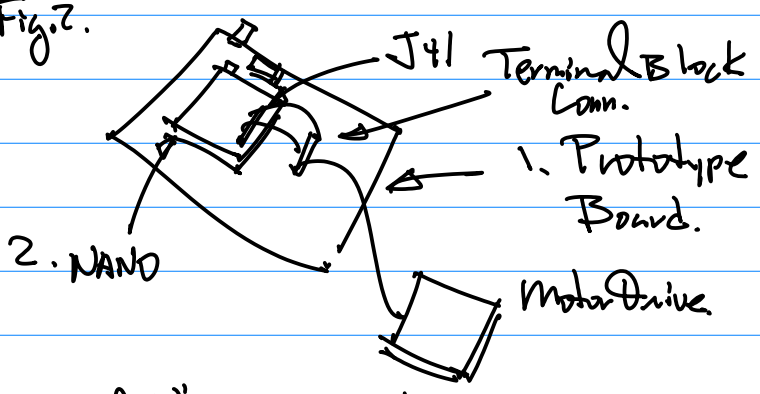

Note: a. Adequate size to host CPU-module (NVDA Jetson NANO) 16 x 11½ Cm.

b. Power Circuit.

c. Stepper motor Drive

Note: For Simple Testing Purpose, you can Choose to use Non-professional Grade Drive. Or Use professional Grade Stepper motor Drive. (Robotics, CNC, 3D Printer Additive Manufacturing), Size of the Drive can be same Size of your CPU Module

Fig.2.




Prefab "Through Holes" with Coating for Soldering.

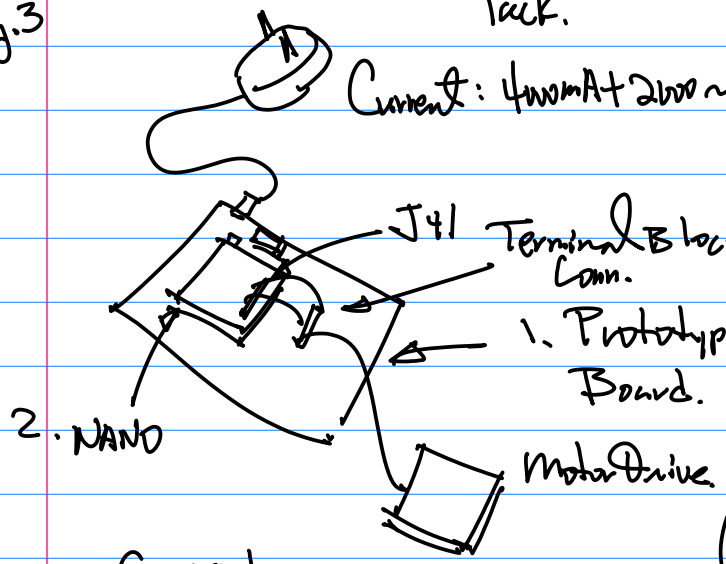
Stand-offs (legs)

Components for:

- External Power Unit
- GPIO Testing Circuit

External Power Unit (Option 1: Wall-Mount Adapter; Option 2: Battery Pack.

Fig.3




Current: 4000mA + 2000 + 4000mA

Current

Note: Adaptor To provide power Not just to the Target platform, But also to the entire Board

NAND Target Requires 4A (4000mA) Current for Peak Computing, On top of it, you will need to consider providing Adequate Current for the Logic, for Sensor I/F (LSM303), for Stepper Motor Drive. (1)

Note: IC DC Regulator is Needed.

Make sure DC Regulator IC can handle Adequate Current

Consider 7805 as an example. Only 1500mA is allowed, No good

information

-voltage integrated-circuit voltage regulators is designed for a wide range of a include on-card regulation for elimination of noise and distribution problems ass tion. Each of these regulators can deliver up to 1.5 A of output current. thermal-shutdown features of these regulators essentially make them immune

(7805 Datasheet)

Note: Some power regulator will have Output voltage Drop.

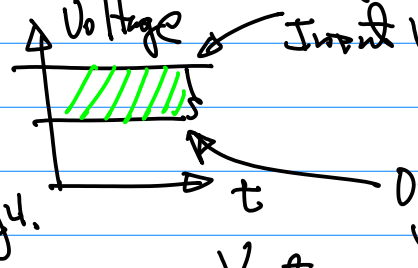
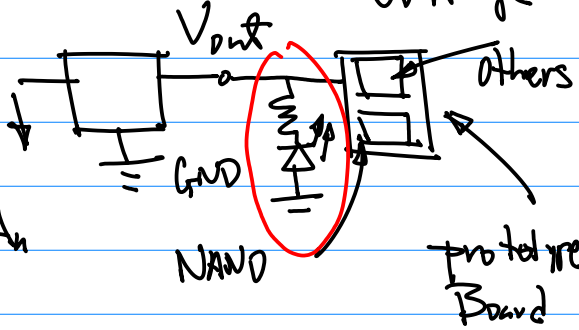



Fig4.




(To the Output of An Adaptor)

(2) Red LED, $V_{LED} \simeq 1.2V$, $I_{LED} \simeq 10mA$

(3) Assorted Resistors (A few hundred of Ohms to A few Mega Ohms)

Caps. for Noise Reduction. for IC Regulator Compensation).

(4) Right Angle DC connector.

Right Angle

Voodoo Lab 2.1mm Right Angle Barrel ...
**$1.90**
West Coast ...

CUI Devices PJ-050AH DC Power ...
**$1.14**
Mouser Elec...

Fig.5

## Anchor Electronics

Website | Directions | Save

4.6 ★★★★½ 50 Google reviews

Electronic parts supplier in Santa Clara, California

Long-running supplier of a huge range of electronic components, tools, cables & more.

**Address:** 2040 Walsh Ave, Santa Clara, CA 95050

**Hours:** Closes soon · 4PM · Opens 7:30AM Tue

GPIO Testing { Input { "0"s "1"s ; Output { "0"s "1"s

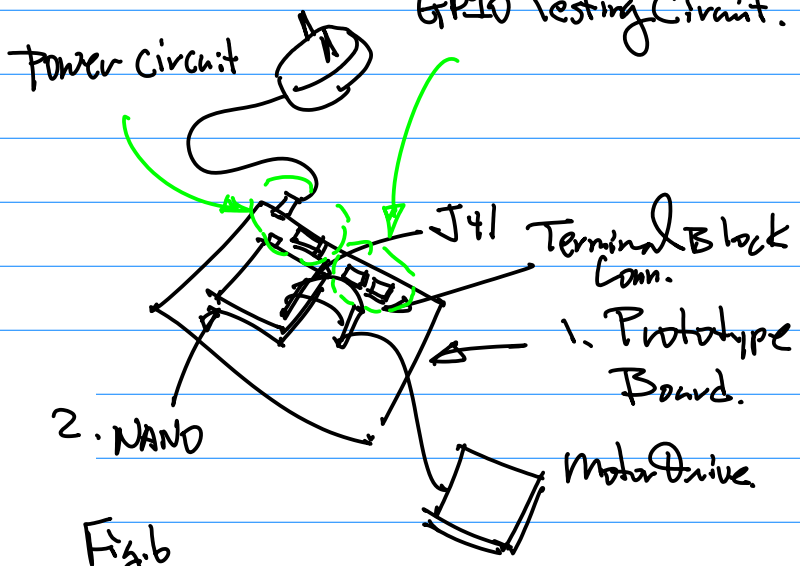
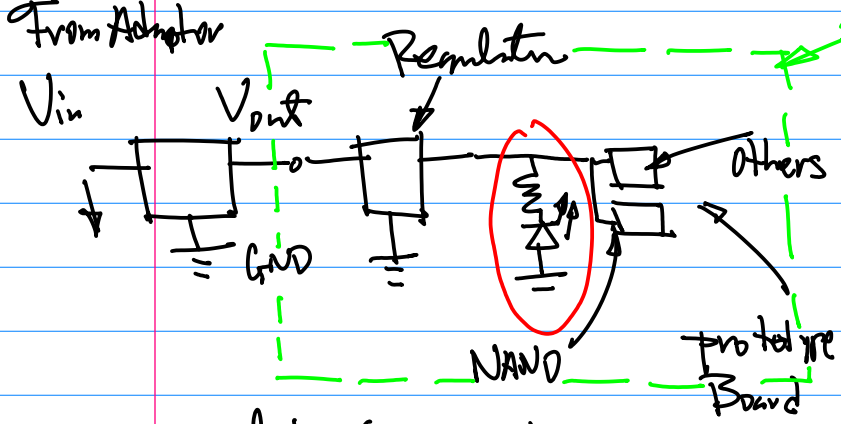



Fig.6

Input Testing:
1. Toggle s/w.
2. Assorted Resistors
(10 Ohms ~ A few Hundred Ohms)



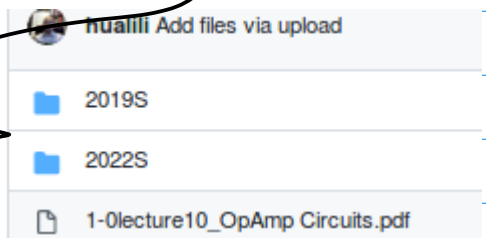

Components for GPIO Testing.

Output Testing:
1. Color LED (Red, yellow, Green)
2. Assorted Resistors.

Feb. 2nd (Wed)
Today's Topics:
1° Bill of Material (Continuation)
2° Prototype System Design.

# Cmpe242 Spring 22

Class github




Option B for the motor drive "Easy Drive" a. ~1000mA.

EasyDriver Stepper Motor Controller
$1.71
RobotShop.com

Example: Bill of material for PID controllers (Stepper motor etc).

GPIO Testing Circuit.

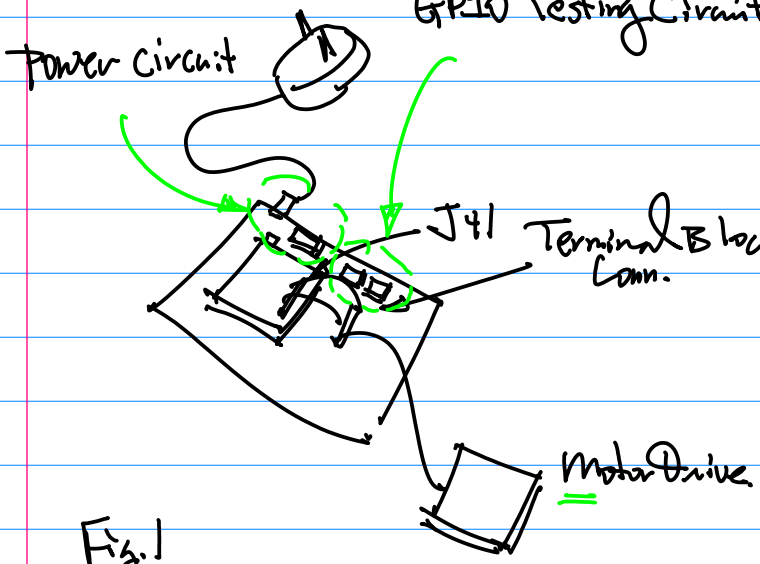
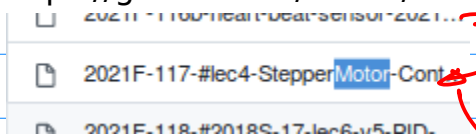



Fig.1

Ref. for Stepper motor Drive

https://github.com/hualili/CMPE244




PID Controller (P: Proportional, I: Integral, D: Derivative)

Motor Drive for Stepper motors.

For CNC, 3D printer, for self-driving Robot

Option A. Professional Drive

Option B.

InstaCNC Machining Center


Integrated Stepper
$265.00
Automation...

TB6600 4.5A CNC Single-Axis For LDR-40B

Stepper Motor Controller 1 15 USD

https://www.amazon.com/gp/product/B01DIK5IRI/ref=oh_aui_detailpage_o02_s00?ie=UTF8&psc=1

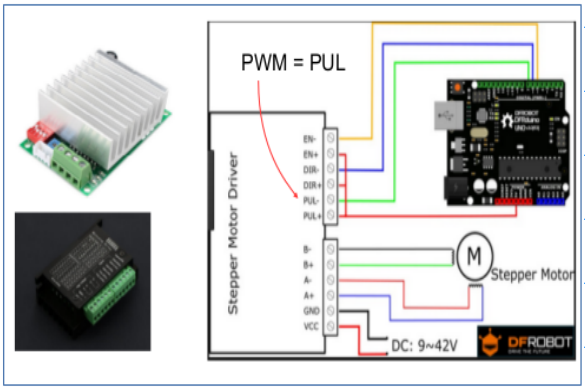



Fig.2

~$15–$40

Note: Specs for Option A: a. 4.5A. (2500mA ~3000mA for this class & Beyond) b. TB6600 (IC Chip Provides Adequate Power)

Bill of material (motor)

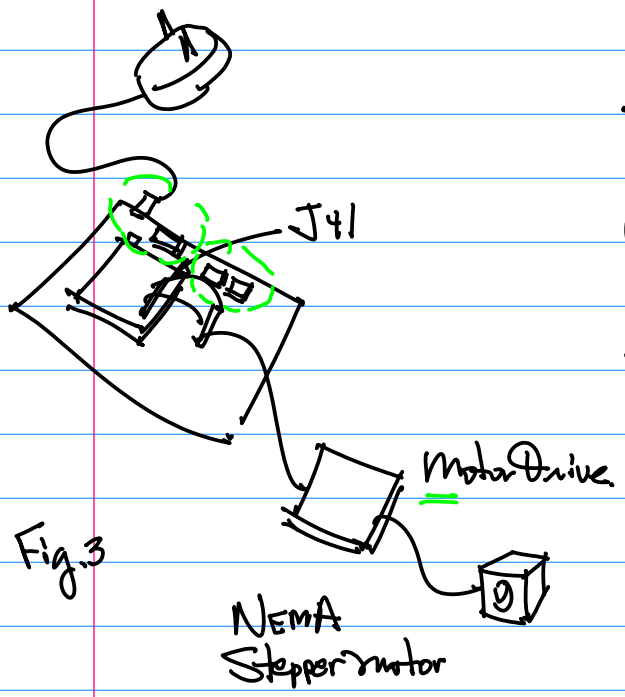



Fig.3

https://www.anaheimautomation.com/marketing/stepper/stepper-motors.php?gclid=EAIaIQobChMIqsaW3pbi9QIV-R6tBh1QBAFsEAAYAiAAEgIhx_D_BwE

Stepper motor - NEMA-17
$14.00
Adafruit Ind...

Fig.4.

Buying LSM303 module

Bill of material (IoT Applications Analog Sensor I/F)

ADC module (Analog/Digital Conversion)

I2C
SPI (Serial Peripheral Interface)


Adafruit 1018 Acceleration Sensor
$17.95
Mouser Electronics

Adafruit Industries LLC 1085 ADS1115
$14.95
Digi-Key

Adafruit Industries LLC 4648 PCF8591
$6.50
Digi-Key

ANAHEIM AUTOMATION

Selection Guideline:

1. Digital Interface Protocol (GPIO and ADC Interface);

SPI: 50+ mbps, I2C: 2.4 mbps

Bill of material (Sensors) for PID

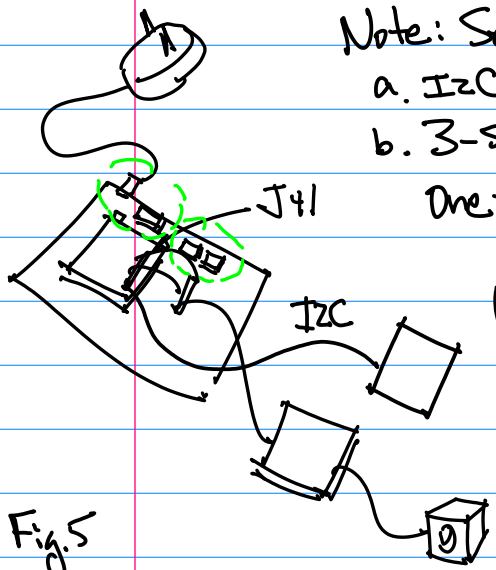
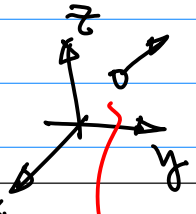



Fig.5

Note: Sensor LSM303
a. I2C Sensor Interface;
b. 3-sensing units in One package

LSM303



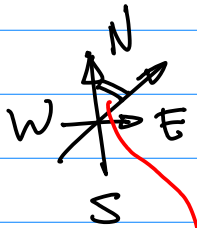




Fig.6

LSM303DLHC

Ultra-compact high-performance eCompass module: 3D accelerometer and 3D magnetometer

Datasheet - production data

(2) (1)

including Temperature Sensing (The 3rd one)

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## Selection Guideline (Continued)

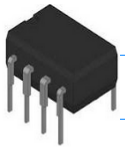
2. Sample Rate:
   500KSPS or 1 MSPS (million Samples per Second)
3. Quantization Level of ADC.
   Bits per Sample. 8 ~ 10 bit Resolution minimum;

Nyquest Sampling Theorem.

$f_{sample} \geq 2 f_{max}$ ...(1)

Note: Optional Component — OpAmp.

Operational Amplifier



Texas Instruments
LM741CN/NOPB
$0.91
Digi-Key

Single OpAmp.

Or LM358 (Quad OpAmps in One Package).

Homework: One A week from Today. (Feb. 9) 11:59 pm

1. Identify your target platform, And provide A screen Capture or photo of its Connector. with Table of pin Expansion Assignment;
2. Create A table of Bill of material Based on Lecture Discussion.
3. Submission: A pdf file with Naming: First_Last_SID_Target_242.pdf. Submission to CANVAS.

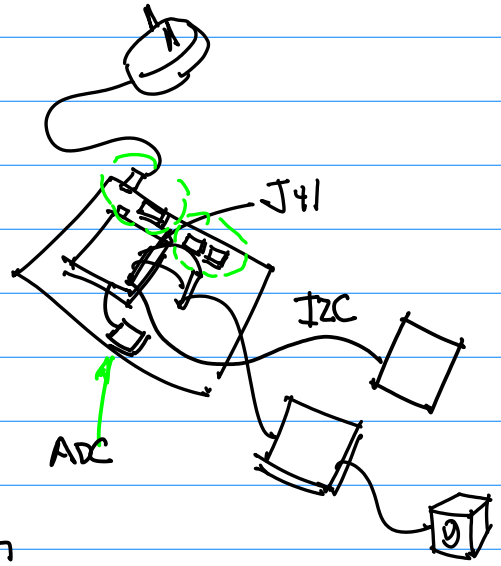



Fig.7

Bill of material for ADC.

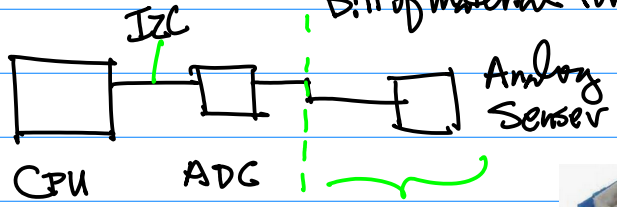
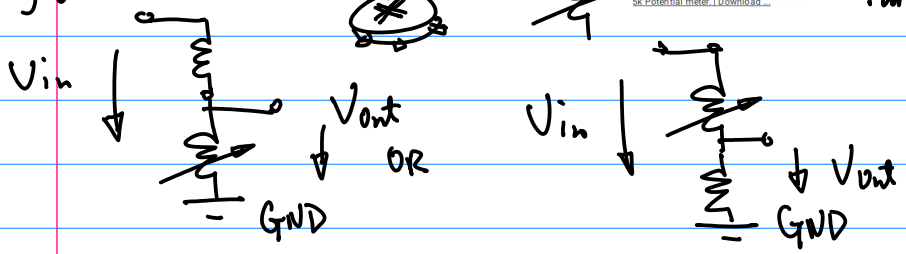



Fig.8

5k Potential meter, | Download ...




Feb 7 (Mon)

Today's Topics:

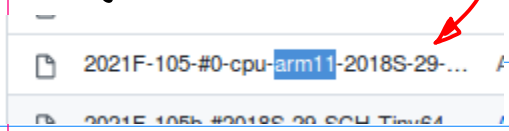
1° Bring Up the target platform.
2° GPIO Testing, e.g., "Hello, the world".

Target Platforms { a. Jetson NANO / b. Pie3B+/4.

Note: Base Line Reference Samsung ARM11.

# CMPE242 Spring22

Ref. CPU Datasheet of Samsung ARM-11 is on the Class github. (Cmpe244)




PPT for Today's Lecture

Example: Bring up The target Platform, NANO.

Note: Visit Nvidia Developer Site, And sign up As a developer

Pre-requisites:

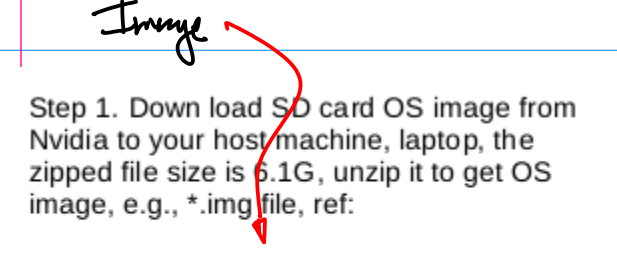
1° Developer Account;

2° Linux O.S. (Kernel Source Distribution) for Device Drive Development & Kernel Source Optimization;

3° Down Load Pre-Compiled, Pre-Built Kernel Image to SD Card And

4° Target Board, Jetson NANO 2GB OR 4GB.

Step 1. Down Load Pre-Build kernel Image




Step 2. Down Load "Ethecher" Software tool, then execute this tool to write the Down Loaded Pre-Built Kernel O.S. to your SD Card.

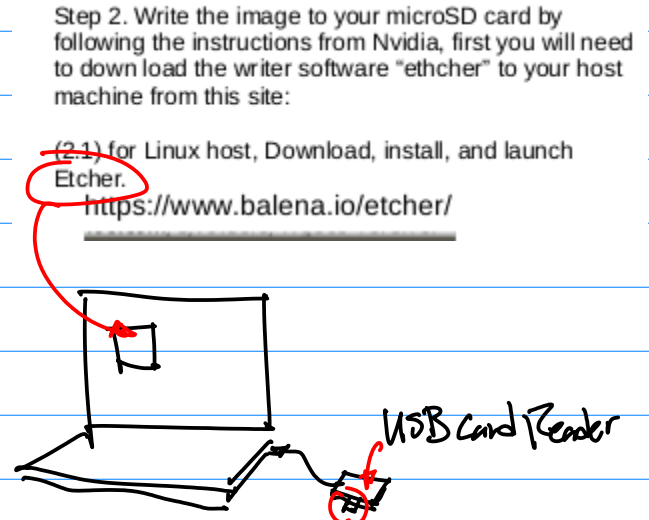



Fig 1.

Step 3. Took SD Card from the Reader, Insert the Card into the USB Slot of the target platform, then Power-ON the System. Then follow the steps during the Booting to initialize & Configure the System, such as user Name, Password, Time-Zone Setup etc.

Example: To prepare GPIO Testing. (To Be Assigned as Homework)

Hardware Aspect:

Step 1. Identify the Expansion Connector &

# CMPE242 Spring22

## Pin Assignment.

From NVDA Developer Site to find Connector Information

J41 Connector

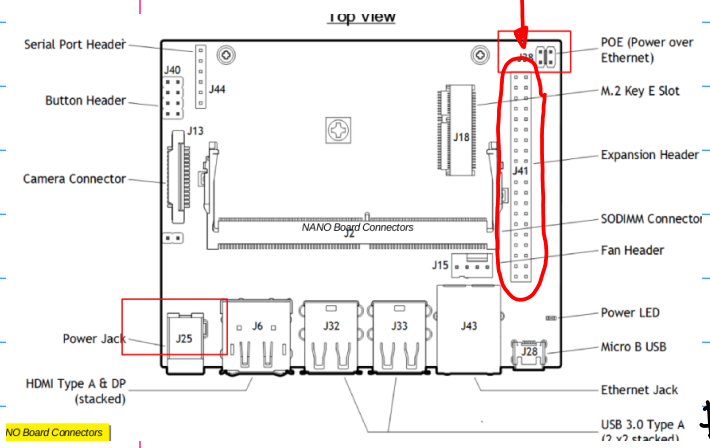



Fig.2

Table 1. Pin Assignment/Connectivity Table

| CPU/Connector Pin | Description | Note |
|---|---|---|
| GPIO79/J41-12 | GPIO Input | |
| GPIO78/J41-40 | GPIO Output | |
| GND/J41-6 | GND | |

## Step3. Design Schematics

## Step2. Establish Pin Assignment/ Connectivity Table

Pin Assignment → GND : Common GND
GPIO : GPIO79/Pin12
GPIO78/Pin40

| Sysfs GPIO | Name | Pin | Pin | Name | Sysfs GPIO |
|---|---|---|---|---|---|
| | 3.3 VDC Power | 1 | 2 | 5.0 VDC Power | |
| | I2C_2_SDA I2C Bus 1 | 3 | 4 | 5.0 VDC Power | |
| | I2C_2_SCL I2C Bus 1 | 5 | 6 | GND | |
| gpio216 | AUDIO_MCLK | 7 | 8 | UART_2_TX /dev/ttyTHS1 | |
| | GND | 9 | 10 | UART_2_RX /dev/ttyTHS1 | |
| gpio50 | UART_2_RTS | 11 | 12 | I2S_4_SCLK | gpio79 |
| gpio14 | SPI_2_SCK | 13 | 14 | GND | |
| gpio194 | LCD_TE | 15 | 16 | SPI_2_CS1 | gpio232 |
| | 3.3 VDC Power | 17 | 18 | SPI_2_CS0 | gpio15 |
| gpio16 | SPI_1_MOSI | 19 | 20 | GND | |
| gpio17 | SPI_1_MISO | 21 | 22 | SPI_2_MISO | gpio13 |
| gpio18 | SPI_1_SCK | 23 | 24 | SPI_1_CS0 | gpio19 |
| | GND | 25 | 26 | SPI_1_CS1 | gpio20 |

| | | | | | |
|---|---|---|---|---|---|
| | GND | 25 | 26 | SPI_1_CS1 | gpio20 |
| | I2C_1_SDA I2C Bus 0 | 27 | 28 | I2C_1_SCL I2C Bus 0 | |
| gpio149 | CAM_AF_EN | 29 | 30 | GND | |
| gpio200 | GPIO_PZ0 | 31 | 32 | LCD_BL_PWM | gpio168 |
| gpio38 | GPIO_PE6 | 33 | 34 | GND | |
| gpio76 | I2S_4_LRCK | 35 | 36 | UART_2_CTS | gpio51 |
| gpio12 | SPI_2_MOSI | 37 | 38 | I2S_4_SDIN | gpio77 |
| | GND | 39 | 40 | I2S_4_SDOUT | gpio78 |

Fig.3

| Sysfs GPIO | Name | Pin | Pin | Name | Sysfs GPIO |
|---|---|---|---|---|---|
| | 3.3 VDC *Power* | 1 | 2 | 5.0 VDC *Power* | |
| | I2C_2_SDA *I2C Bus 1* | 3 | 4 | 5.0 VDC *Power* | |
| | I2C_2_SCL *I2C Bus 1* | 5 | 6 | GND | |
| gpio216 | AUDIO_MCLK | 7 | 8 | UART_2_TX */dev/ttyTHS1* | |
| | GND | 9 | 10 | UART_2_RX */dev/ttyTHS1* | |
| gpio50 | UART_2_RTS | 11 | 12 | I2S_4_SCLK | gpio79 |
| gpio14 | SPI_2_SCK | 13 | 14 | GND | |
| gpio194 | LCD_TE | 15 | 16 | SPI_2_CS1 | gpio232 |
| | 3.3 VDC *Power* | 17 | 18 | SPI_2_CS0 | gpio15 |
| gpio16 | SPI_1_MOSI | 19 | 20 | GND | |
| gpio17 | SPI_1_MISO | 21 | 22 | SPI_2_MISO | gpio13 |
| gpio18 | SPI_1_SCK | 23 | 24 | SPI_1_CS0 | gpio19 |
| | GND | 25 | 26 | SPI_1_CS1 | gpio20 |
| | GND | 25 | 26 | SPI_1_CS1 | gpio20 |
| | I2C_1_SDA *I2C Bus 0* | 27 | 28 | I2C_1_SCL *I2C Bus 0* | |
| gpio149 | CAM_AF_EN | 29 | 30 | GND | |
| gpio200 | GPIO_PZ0 | 31 | 32 | LCD_BL_PWM | gpio168 |
| gpio38 | GPIO_PE6 | 33 | 34 | GND | |
| gpio76 | I2S_4_LRCK | 35 | 36 | UART_2_CTS | gpio51 |
| gpio12 | SPI_2_MOSI | 37 | 38 | I2S_4_SDIN | gpio77 |
| | GND | 39 | 40 | I2S_4_SDOUT | gpio78 |

Input Testing.

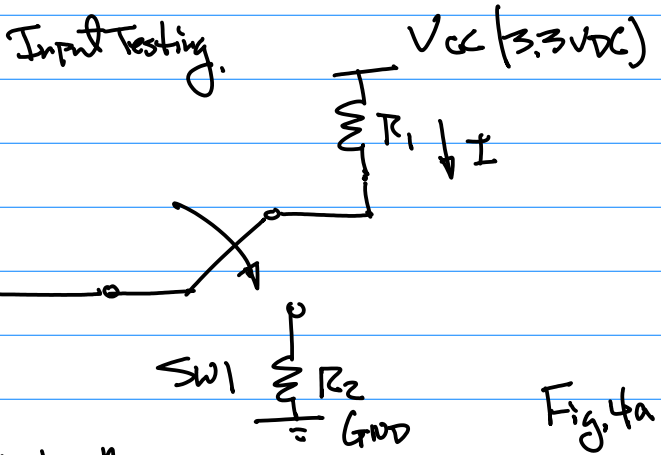
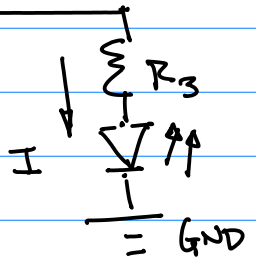



Fig. 4a

Let I = 10mA.

$R_1 = V_{CC}/I = 3.3/10KM^{-3} = 330\Omega$, $R_2 = R_1$




$I \simeq 10mA$

Note: Since NAND Output current is small, so we choose not to use $R_3$.