

Jan 26 (Wed) First Day of the Class.

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Office Hours: M.W. 4:30-5:30 PM.

Textbooks + References:

No Textbook, however GPU Datasheets Are employed as a Base Line Reference, and serves as a textbook.

1. ARM GPU Datasheet, from Samsung & SGH 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. Xip is

Note: Select your target platform from the options a-d.

(Consider Nvidia Jetson NANO).

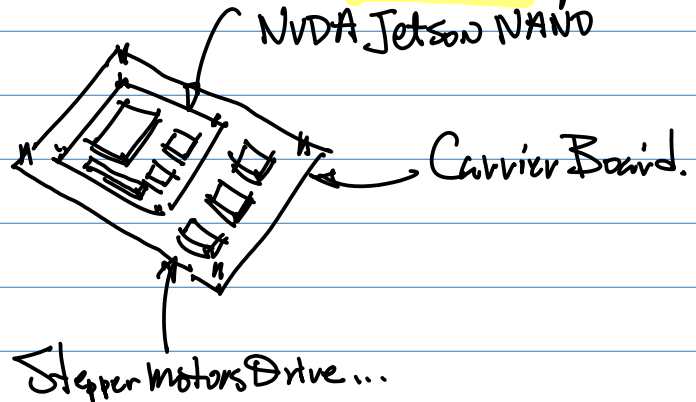
Programming Languages: { C/C++
python

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 completed 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 SSSU Canvas, Late Projects/Homework 1 pt Penalty.

Jan 31 (Monday)

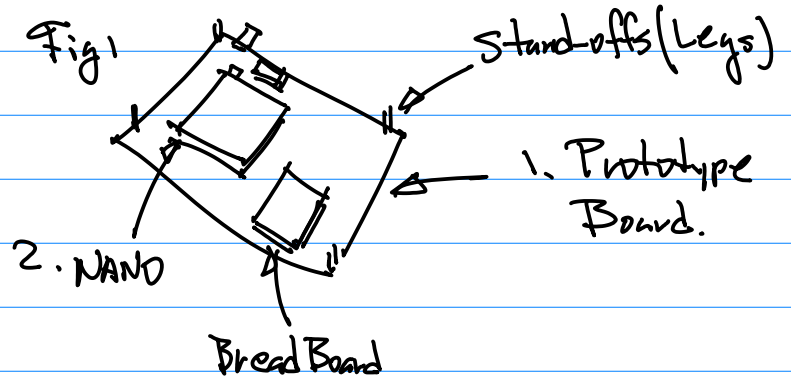
Today's Topic: Bill of Material & Prototype System.

Target platform to consider for your prototype :

- ↓ Nvidia Jetson Nano, 2GB
- ↓ Broadcom Pi. 3BT, 4.

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

Bill of Material for Prototype System



Note: a. Adequate size to host CPU module (NVIDIA Jetson Nano)

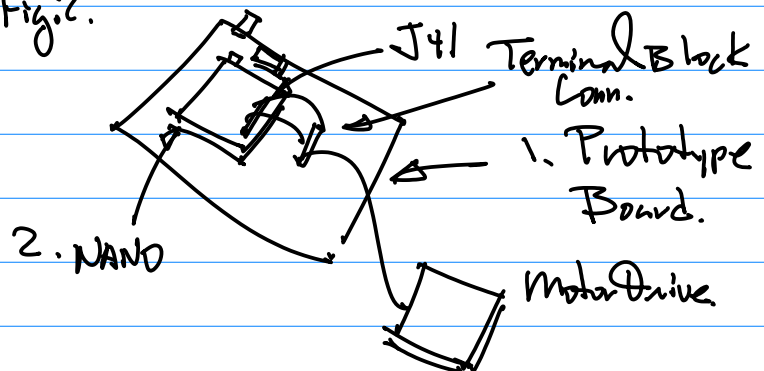
16 x 11 1/2 Cm.

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.

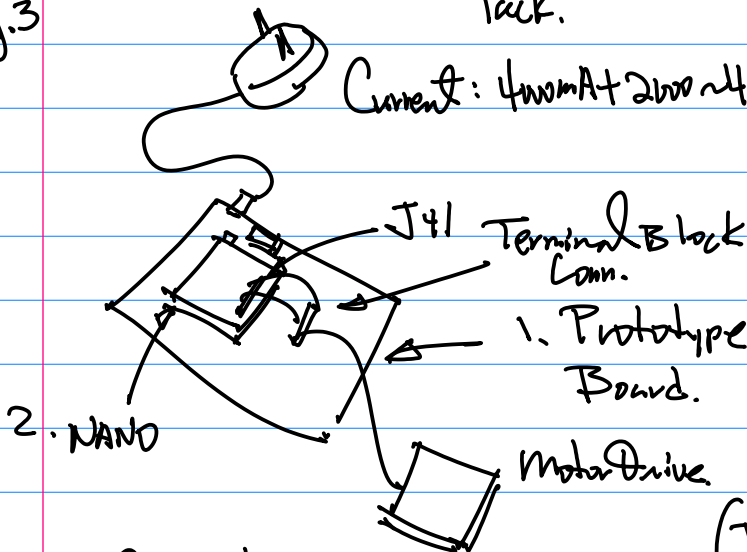
Make sure DC Regulator IC Can
Handle Adequate Current

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

voltage integrated-circuit voltage regulators is designed for a wide range of ;
include on-card regulation for elimination of noise and distribution problems as
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)

Fig.3



Current

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

NANO Target Requires 4A (4000mA)
Current for Peak Computing, On top of
it, you will need to consider providing
Adequate Current for Gpio Logic,
for Sensor I/F (LSM 303), for Stepper
Motor Drive.

Note: IC DC Regulator is Needed.

Note: Some power regulators will
have Different voltage Drop.

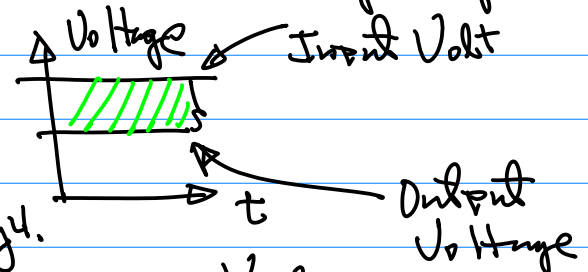
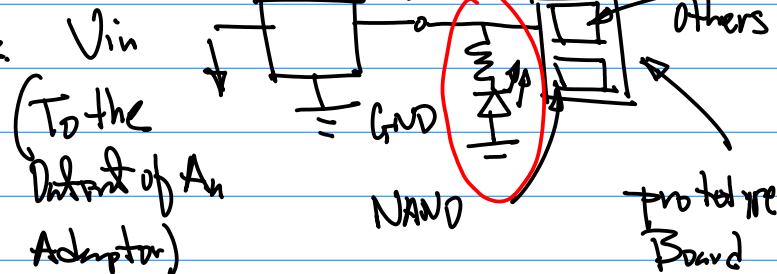


Fig.4.



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

(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

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



Fig.5

Anchor Electronics

Website Directions Save

4.6 ★★★★★ 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 ▾

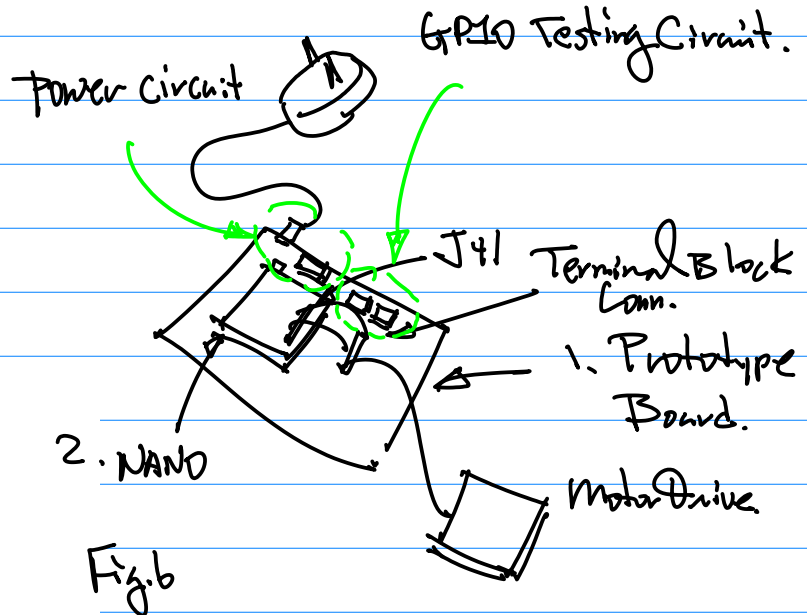


Fig.6

Input Testing:

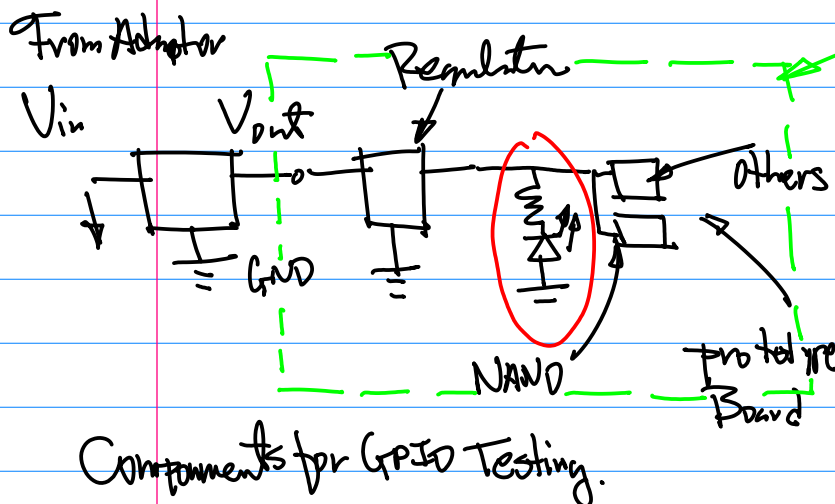
1. Toggle sw.
2. Assorted Resistors



(10 Ohms ~ A few Hundred Ohms)

Output Testing:

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



Components for GPIO Testing.

Feb. 2nd (Wed)

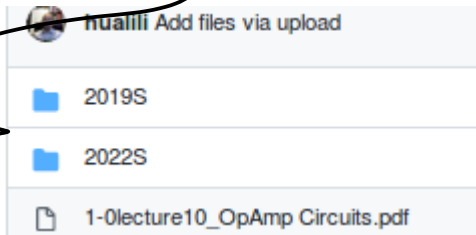
Today's Topics :

- 1° Bill of material (Continuation)
- 2° Prototype System Design.

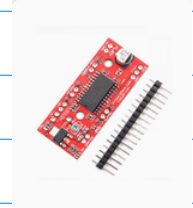
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Class github



Option B for the motor drive
"Easy Drive" a. ~100mA.



EasyDriver Stepper Motor Controller
\$1.71
RobotShop.com

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

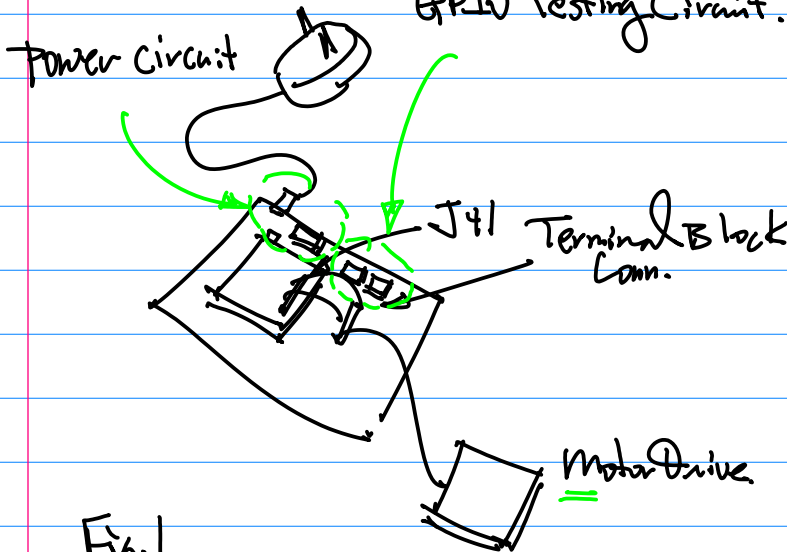
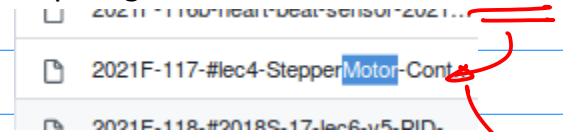


Fig.1

Ref. for Stepper motor Drive

<https://github.com/hualili/CMPE244>



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

For CNC, 3D printer, for Self-Driving Robot

Motor Drive for Stepper motors.

Option A. Professional Drive

Option B.



InstaCNC Machining Center



Free 2-day
Integrated Stepper
\$265.00
Automation...

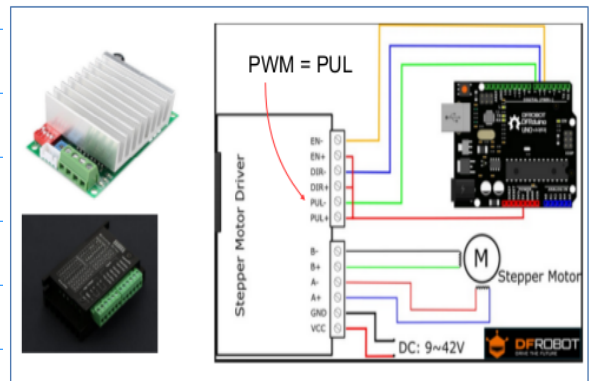


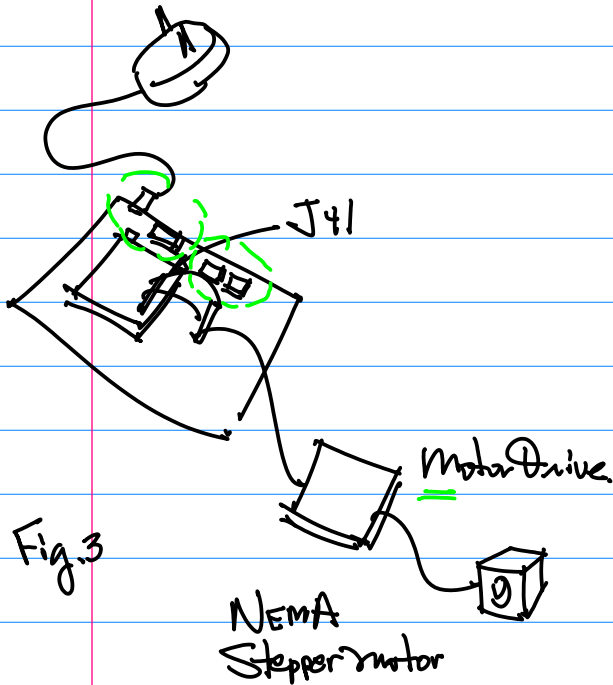
Fig.2

~\$15-\$40

Note: Specs for Option A: a.

4.5A. (2500mA ~ 3000mA for this class & Beyond) b. TB66xx (IC Chip Provides Adequate Power)

Bill of material (motor)



https://www.anaheimautomation.com/marketing/stepper/stepper-motors.php?gclid=EAlaIqobChMIqsaW3pbi9QIV-R6tBh1QBAFsEAAyAAEglhx_D_BwE



Stepper motor
- NEMA-17

\$14.00

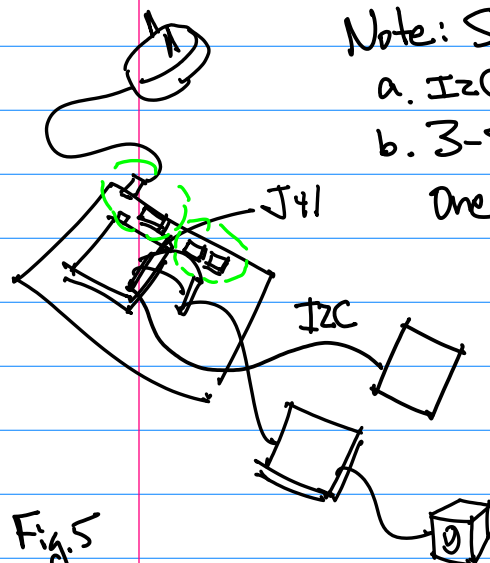
Adafruit Ind...



Fig. 4.

Bill of material (Sensors) for PID

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



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

Selection guideline:

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

SPI: 50± Mbps, I2C: 2M Mbps

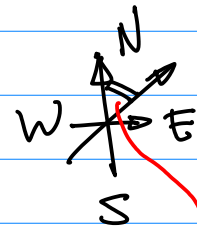


Fig. 6

LSM303



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

LSM303DLHC

Datasheet - production data

including Temperature Sensing (the 3rd one)

Selection Guideline (Continued)

2. Sample Rate:

500KSPS or 1 MSPS (million Samples per Second)

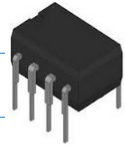
3. Quantization Level of ADC.

Bits Per Sample. 8~10 bit Resolution minimum.

Nyquist Sampling Theorem.

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

Note: Optional Component — OpAmp.
Operational Amplifier



Single OpAmp.

OpLM358
(Quad OpAmps in One Package).

Texas Instruments
LM741CN/NOPB
\$0.91
Digi-Key

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-3ID-Target-242.pdf. Submission to CANVAS.

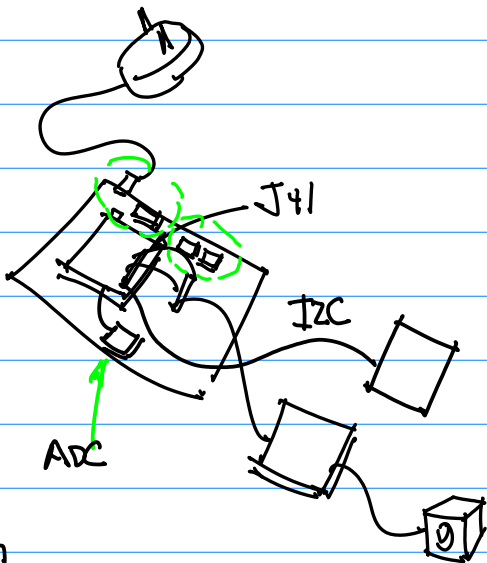
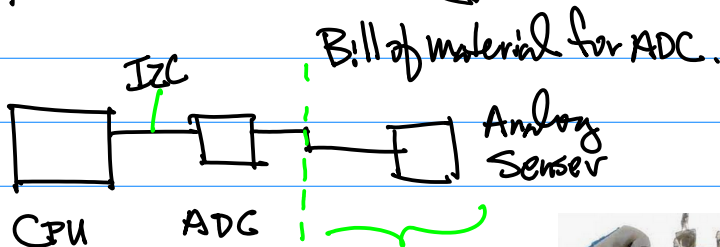


Fig. 7



Feb 7 (Mon)

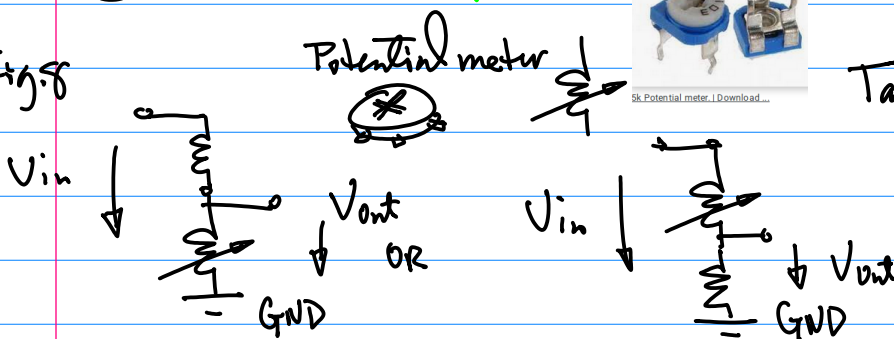
Today's Topics:

- 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.

Fig. 8



Ref. GPU Datasheet of Samsung ARM-11 is on the Class github. (CMPE242)



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 Driver 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-Built Kernel Image

Step 1. Down load SD card OS image from Nvidia to your host machine, laptop, the zipped file size is 6.1G, unzip it to get OS image, e.g., *.img file, ref:

<https://developer.nvidia.com/embedded/learn/get-started-jetson-nano-devkit#write>

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

Step 2. Write the image to your microSD card by following the instructions from Nvidia, first you will need to down load the writer software "etcher" to your host machine from this site:

(2.1) for Linux host, Download, install, and launch Etcher.

<https://www.balena.io/etcher/>

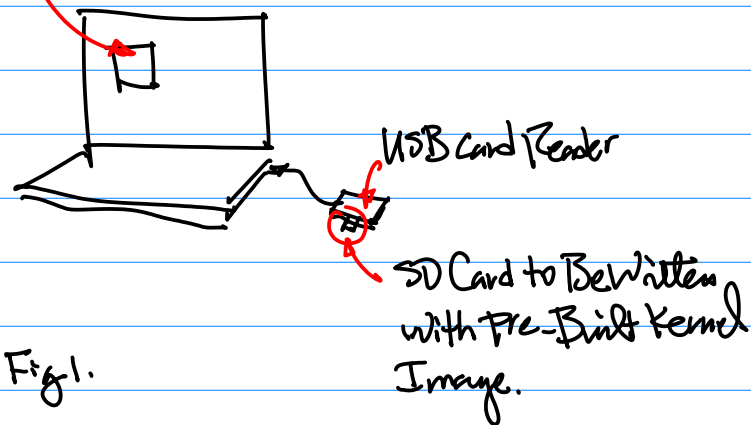


Fig 1.

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 GPSD Testing. (To Be Assigned as Homework)

Hardware Aspect:

Step 1. Identify the Expansion Connector &

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Pin Assignment.

From NXP Developer Site to find

Connector Information

J41 Connector

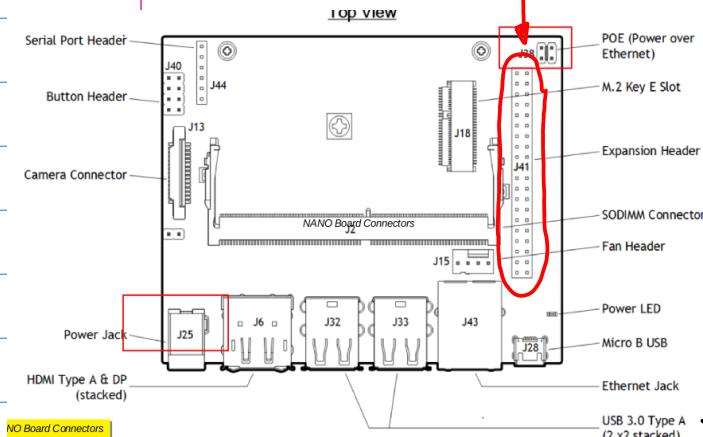


Table 1. Pin Assignment/Connectivity Table

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

Step 3.
Design Schematics

Fig. 2

Step 2. Establish Pin Assignment/
Connectivity Table

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

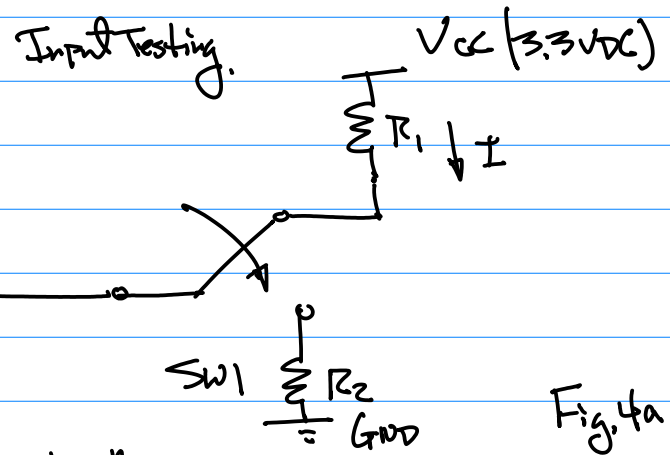
Sysfs GPIO	Name	Pin	Pin	Name	Sysfs GPIO
	3.3 VDC Power	1	2	5.0 VDC Power	
	I2C_2_SDA I2C Bus 1	3	4	5.0 VDC Power	
	I2C_2_SCL I2C Bus 1	5	6	GND	
gpio216	AUDIO_MCLK	7	8	UART_2_TX /dev/ttyTHS1	
	GND	9	10	UART_2_RX /dev/ttyTHS1	
gpio50	UART_2_RTS	11	12	I2S_4_SCLK	gpio79
gpio14	SPI_2_SCK	13	14	GND	
gpio194	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	gpio7
	GND	39	40	I2S_4_SDOUT	gpio78

i, Ph.D.

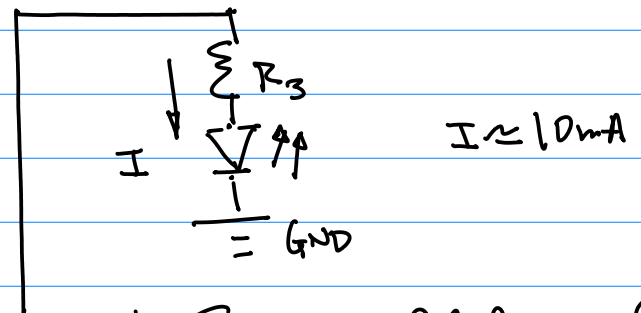
Fig. 3

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	



Let $I = 10mA$.

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



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

i, Ph.D.

Feb 9 (Wed) Topics:

- 1^o Building GPIO Testing Capability on the target platform, Jetson Nano.
- 2^o Kernel O.S. Sources plus toolchain

Example: Bring Up Your Target Board
Step 1. Build your prototype system with NAND Target Board mounted on it.

Homework (Due A week from today)
Feb 16.

1. Prototype System with A Carrier Board
4"x3" or Similar Size of your
Choice;
2. GPIO Testing Circuit for Both
Input / Output Testing (Schematics)
3. Mount your NAND on the
Carrier Board.

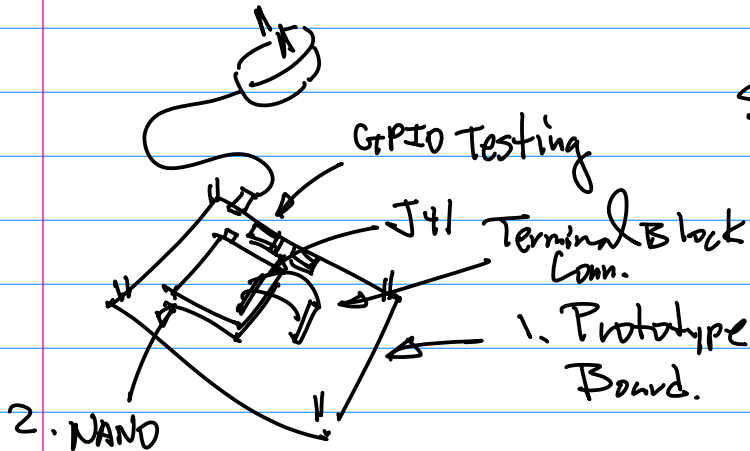
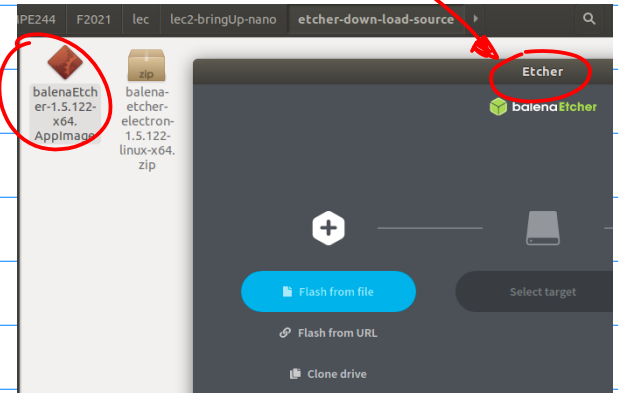


Image From NVDA Developer Site,
And together with Flash Writing
Software. "Etcher"



Step 3. Run "Etcher" program to
Upload the O.S. Kernel Image to
the target NAND Board.

Note: Target Image for my Board
is 2019.4.7 Due to my Applications
in Deep Learning. For Embedded Class,
We can use other / Latest Release

4. Take a photo of your System (with
A Root connection)

5. Screen Capture from your Root
machine, which shows NAND
is running.

6. Put Photos plus Schematic into
One PDF file, Zip it, Submit to
SJSU CANVAS.

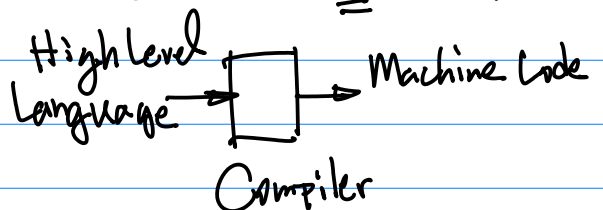
Step 2. Down Load Pre-Build Kernel

2022S-105-#106-n-Jetpack-kernel-driver-simpler-2021-2

Jetpack from NVDA consists of
a. O.S., Kernel (Device Driver), b.
GPU Packages, c. OpenCL, d. DNN

O.S. (Operating Systems)

Tool Chain: → Cross Compiler



Step 4. Take SD Card to the target NAND,
Boot (Power Up) the NAND, finish
Configuration process, then Ready to
go. (To create your Applications).

Example: O.S. Kernel Source Debugging,
Device Driver Development

{ O.S. + Toolchain for NAND
{ O.S. + Toolchain for Samsung ARM11

Step 1. Download And Install
Kernel Source, And Toolchain.

Note: Purpose is to Optimize
Kernel Image, Optimize/Develop/Debug
Device Drivers.

* make menuconfig

↑ Software Tool for Kernel O.S.
Compile + Build, And for Device
Driver Development & Debugging.