CEC Continuing Education Center

DesignNews

Understanding Sensors and Data Analysis Using the Arduino Nano 33 BLE Sense

# DAY 1 : Arduino Nano 33 BLE Sense Overview

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# Webinar Logistics

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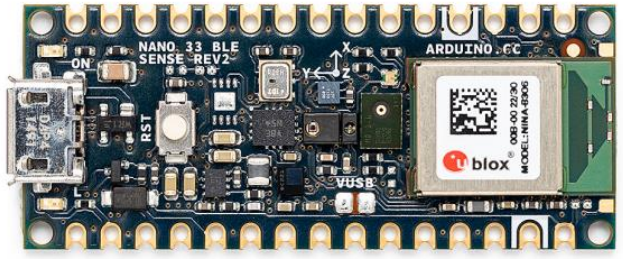
# Dr. Don Wilcher

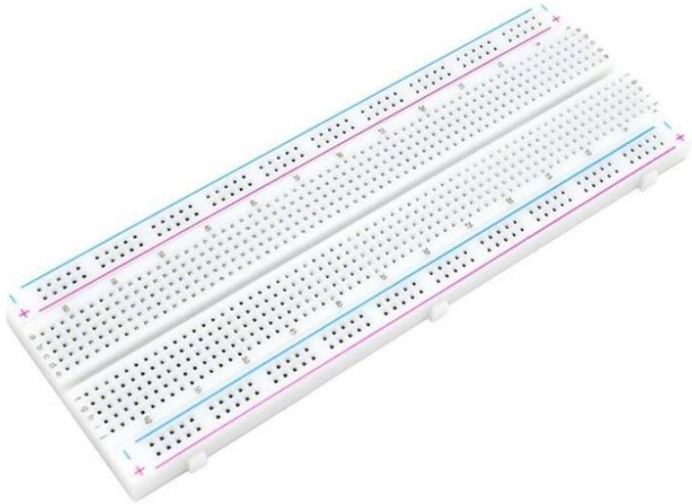
Visit ‘Lecturer Profile’ in your console for more details.

# Course Kit and Materials

## Arduino Nano 33 BLE Sense Board




## Solderless Breadboard

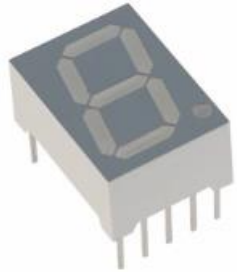


## Adafruit Parts Pal Kit

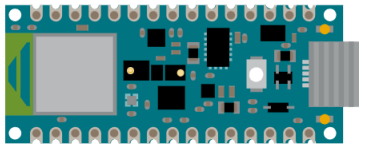
## I2C OLED Display


https://www.amazon.com/HiLetgo-Serial-128X64-Display-Color/dp/B06XRBYJR8/ref=sr_1_6?crid=1VC2UTZ2P8NWF&keywords=i2c%2Boled&qid=1700192985&sprefix=I2C%2B%2Caps%2C108&sr=8-6&th=1

## 7 Segment LED Display, Common Cathode

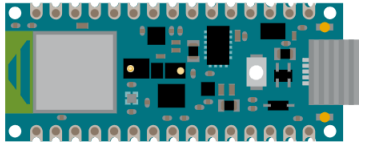


# Agenda:



- What is an Arduino Nano 33 BLE Sense?
  - a) Description
  - b) Functional Overview
- nRF52840 System on Chip (SoC)
  - a) Block Diagram
  - b) Core Components
  - c) Bluetooth Low Energy (LE)
- Setting up an Arduino Nano 33 BLE Sense Development Environment (Mini Hands-On Activity)
- Lab: Pushbutton-Alternate Blink Controller

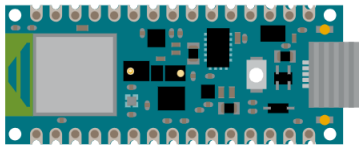
# Research Perspective



"The Internet of Things, which has been quietly building and evolving over the past decade, now impacts many aspects of society"(Chua & Storey, 2022).

# What is an Arduino Nano BLE Sense?

## Description



- An Internet of Things (IoT) platform to perform sensing and actuating in a physical environment.
- A Cortex M4F processor with an operating frequency of 64MHz.
- The Arduino Nano 33 BLE Sense board has the following items
  - a) Bluetooth Low Energy (BLE).
  - b) Eight onboard sensors
  - c) Analog and Digital port pins
- The Arduino Nano 33 BLE Sense board can be powered in 3 ways.
  - a) USB connector
  - b) Vin (header connector)
  - c) Vusb (header connector)

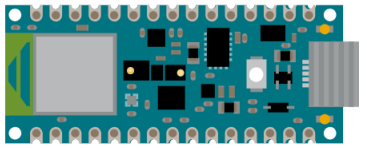
# Question 1

**The Arduino Nano 33 BLE Sense board can be powered in 4 ways.**

**a) True**

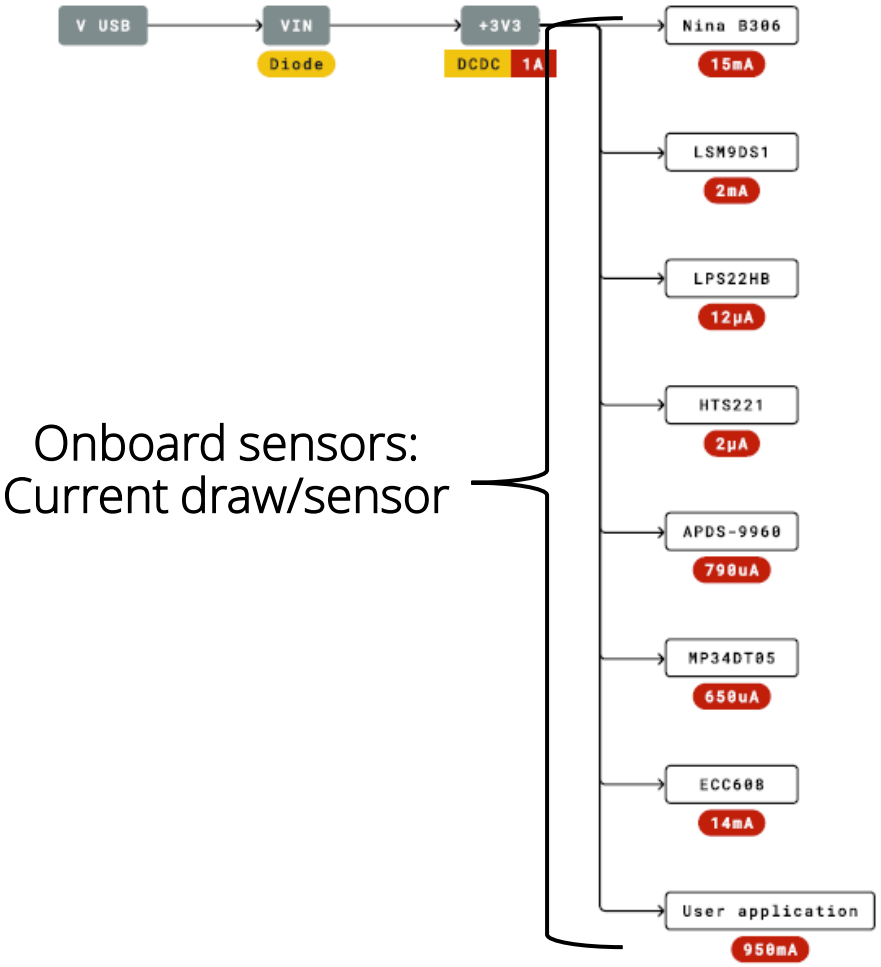
**b) False**

# What is an Arduino Nano BLE Sense? . . .

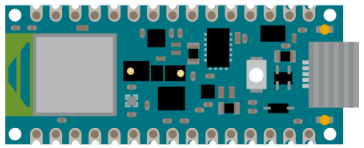


## Functional Overview

## Approaches to Powering Arduino Nano BLE Sense board



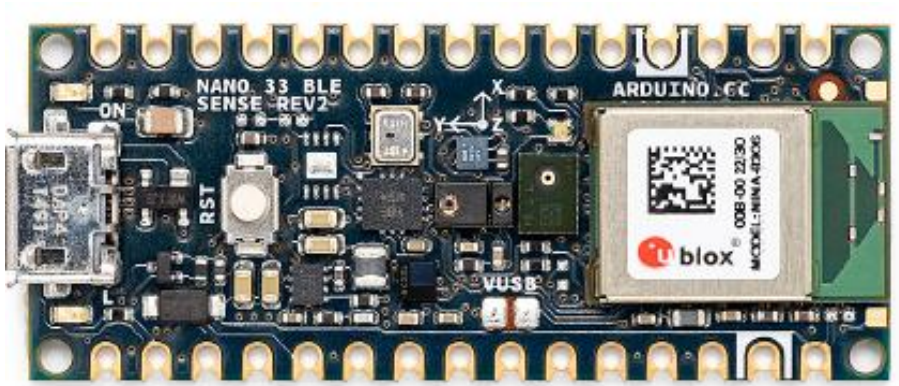
# What is an Arduino Nano BLE Sense?. . .



## Functional Overview

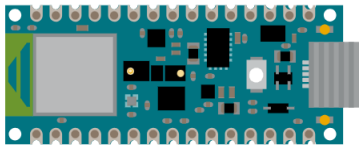
### Original Board


### Version 2




Pictures courtesy of Arduino.cc

# What is an Arduino Nano BLE Sense?. . .



## Functional Overview

## Original Board

## Top of Board

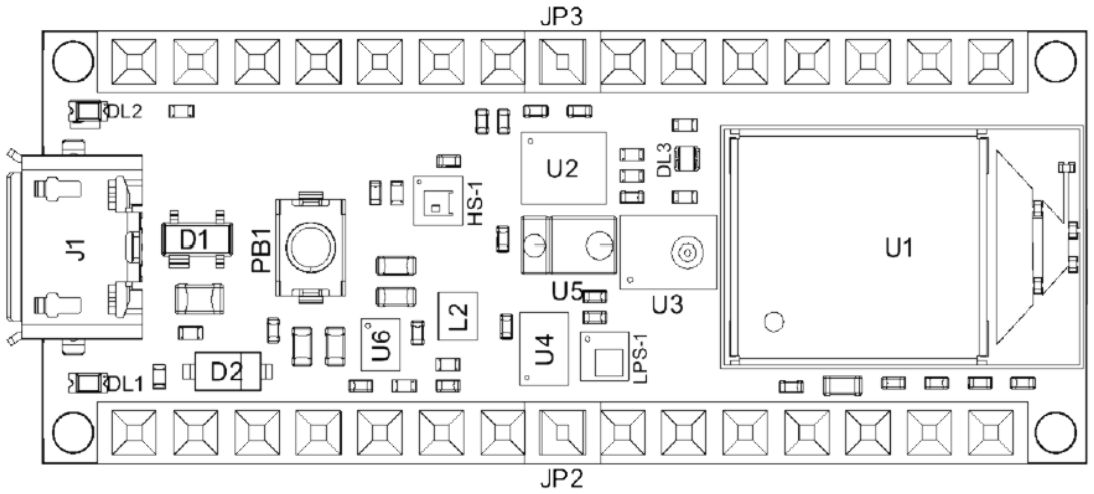
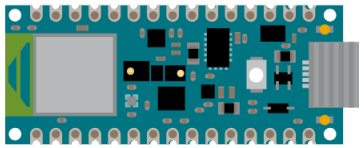



Illustration courtesy of Arduino.cc

| Ref. | Description | Ref. | Description |
|---|---|---|---|
| U1 | NINA-B306 Module Bluetooth® Low Energy 5.0 Module | U6 | MP2322GQH Step Down Converter |
| U2 | LSM9DS1TR Sensor IMU | PB1 | IT-1185AP1C-160G-GTR Push button |
| U3 | MP34DT06JTR Mems Microphone | HS-1 | HTS221 Humidity Sensor |
| U4 | ATECC608A Crypto chip | DL1 | Led L |

| Ref. | Description | Ref. | Description |
|---|---|---|---|
| U5 | APDS-9660 Ambient Module | DL2 | Led Power |

# What is an Arduino Nano BLE Sense?. . .



## Functional Overview

## Original Board

## Bottom of Board

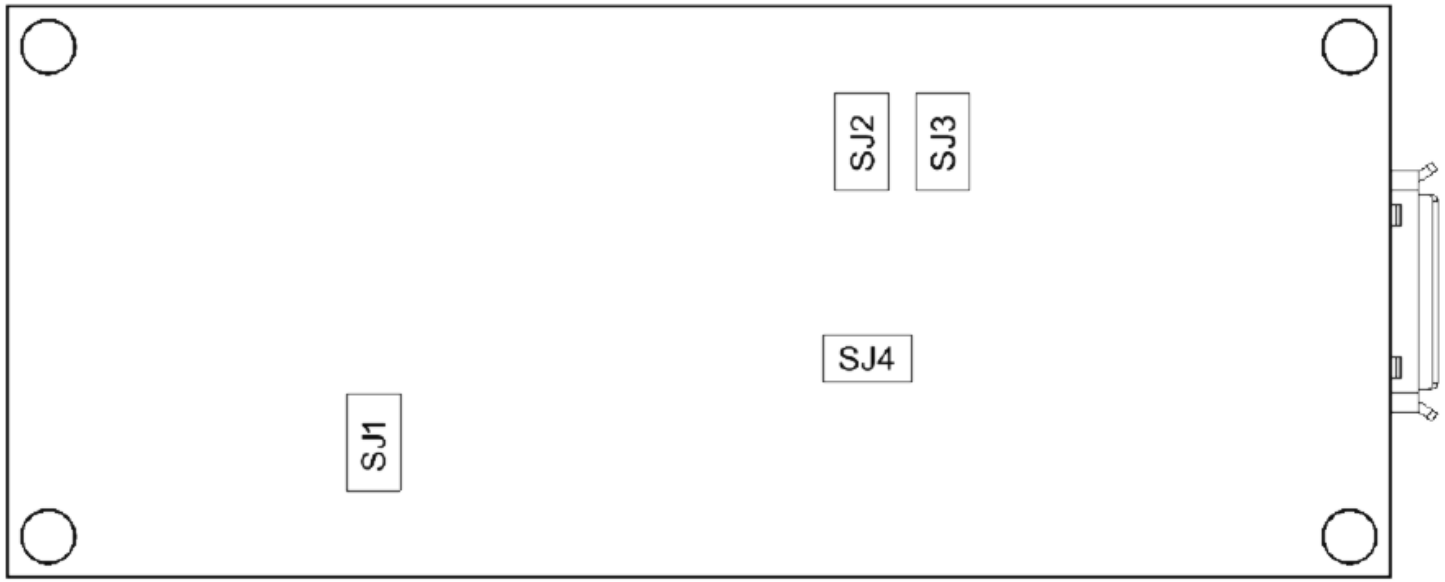



Illustration courtesy of Arduino.cc

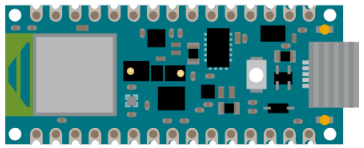
| Ref. | Description | Ref. | Description |
|---|---|---|---|
| SJ1 | VUSB Jumper | SJ2 | D7 Jumper |
| SJ3 | 3v3 Jumper | SJ4 | D8 Jumper |

# Question 2

**In reviewing slide 11, what sensor is referenced by the U3 designator?**

**a) MP39DT06JTR Mems Microphone**
**b) MP39DT60JTR Mems Microphone**
**c) MP39DT06KTR Mems Microphone**
**d) MP39DT05JTR Mems Microphone**

# What is an Arduino Nano BLE Sense?. . .



## Functional Overview

## Version 2

## Top of Board

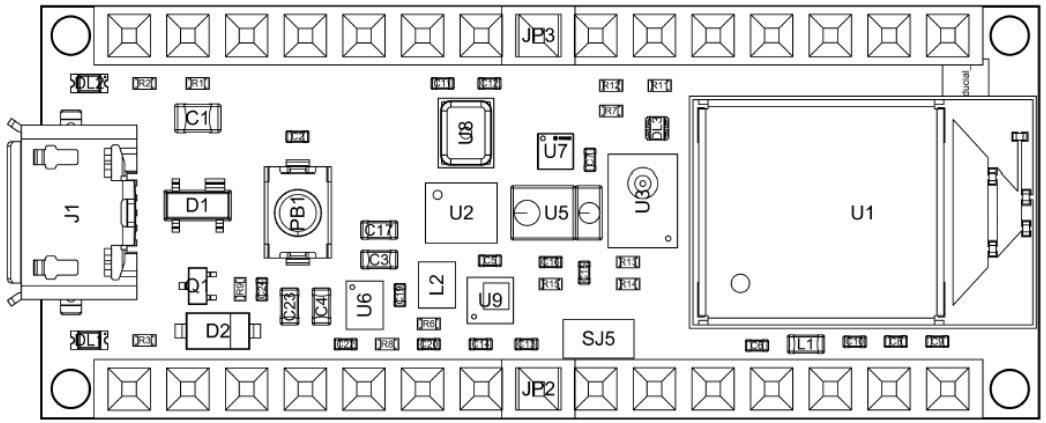
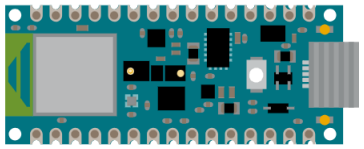



Illustration courtesy of Arduino.cc

| Ref. | Description | Ref. | Description |
|---|---|---|---|
| U1 | NINA-B306 Module Bluetooth® Low Energy 5.0 Module | U6 | MP2322GQH Step Down Converter |
| U2 | BMI270 Sensor IMU | PB1 | IT-1185AP1C-160G-GTR Push button |
| U3 | MP34DT06JTR MEMS Microphone | U8 | HS3003 Humidity Sensor |
| U7 | BMM150 Magnetometer IC | DL1 | Led L |
| U5 | APDS-9660 Ambient Module | DL2 | Led Power |
| U9 | LPS22HBTR Pressure Sensor IC | | |

# What is an Arduino Nano BLE Sense?. . .



## Functional Overview

## Version 2

## Bottom of Board

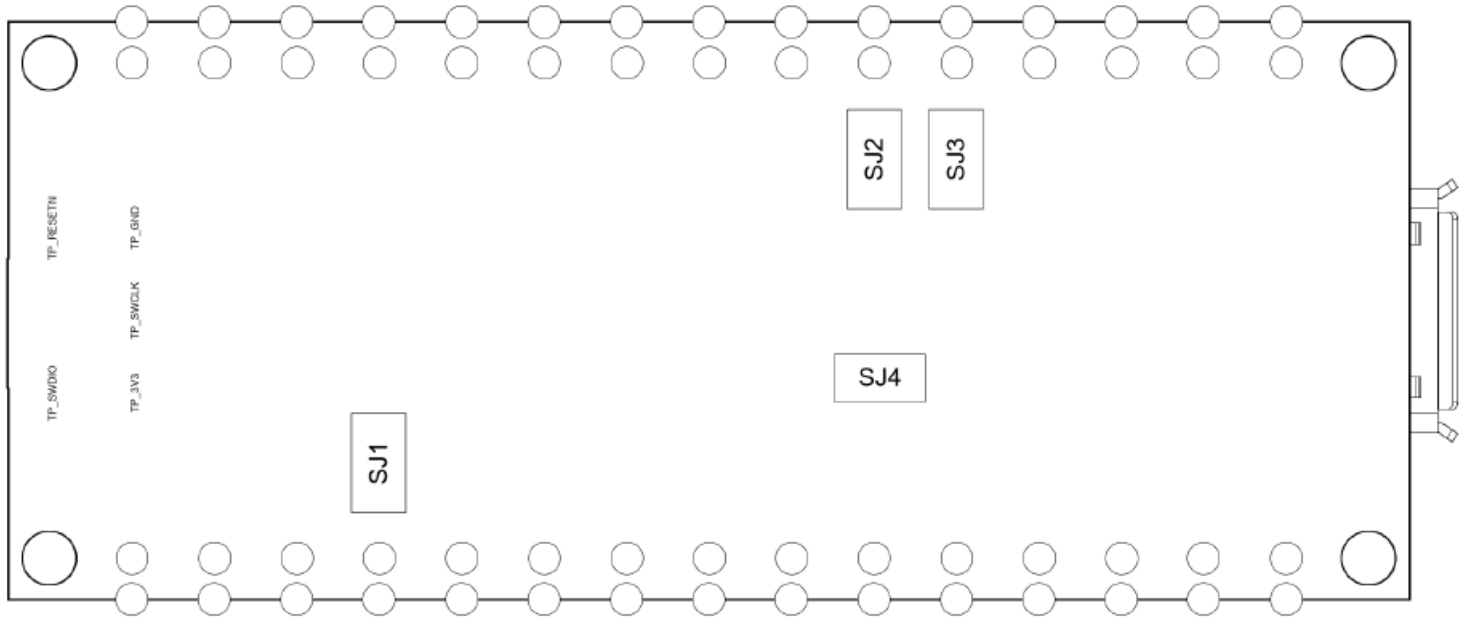
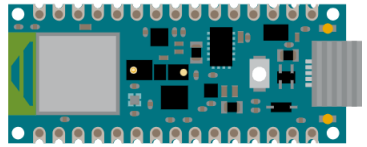



Illustration courtesy of Arduino.cc

| Ref. | Description | Ref. | Description |
|---|---|---|---|
| SJ1 | VUSB Jumper | SJ2 | D7 Jumper |
| SJ3 | 3v3 Jumper | SJ4 | D8 Jumper |

# What is an Arduino Nano BLE Sense? . . .



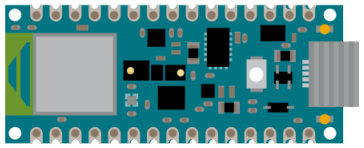
## Functional Overview

### Nano 33 BLE Sense vs Nano 33 BLE Sense Rev 2

### Comparison Table

| Feature | Arduino Nano 33 BLE Sense | Arduino Nano 33 BLE Sense Rev 2 |
|---|---|---|
| Microcontroller | nRF52840 | nRF52840 |
| CPU Core | ARM Cortex-M4 | ARM Cortex-M4 |
| Clock Speed | 64 MHz | 64 MHz |
| Flash Memory | 1 MB | 1 MB |
| SRAM | 128 KB | 128 KB |

# What is an Arduino Nano BLE Sense? . . .



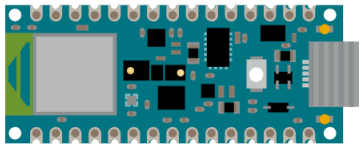
## Functional Overview

## Nano 33 BLE Sense vs Nano 33 BLE Sense Rev 2

### Comparison Table

| | | |
|---|---|---|
| Bluetooth | BLE 4.2 | BLE 5.2 |
| Sensors | Accelerometer, Gyroscope, Magnetometer, Microphone, Humidity and Temperature Sensor, Ambient Light Sensor, Pressure Sensor | Accelerometer, Gyroscope, Magnetometer, Microphone, Humidity and Temperature Sensor, Ambient Light Sensor, Pressure Sensor, Gesture Sensor |
| Form Factor | Nano | Nano |
| Pin Compatibility | Yes | Yes |

# What is an Arduino Nano BLE Sense? . . .



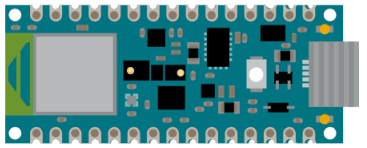
## Functional Overview

### Nano 33 BLE Sense vs Nano 33 BLE Sense Rev 2

**Comparison Table**

| | | |
|---|---|---|
| Current Consumption | 4 µA (deep sleep) | 2 µA (deep sleep) |
| Operating Temperature Range | -20°C to +85°C | -40°C to +85°C |
| Applications | Wearables, IoT devices, Machine learning | Wearables, IoT devices, Machine learning |

# What is an Arduino Nano BLE Sense? . . .



## Functional Overview

## Pinout

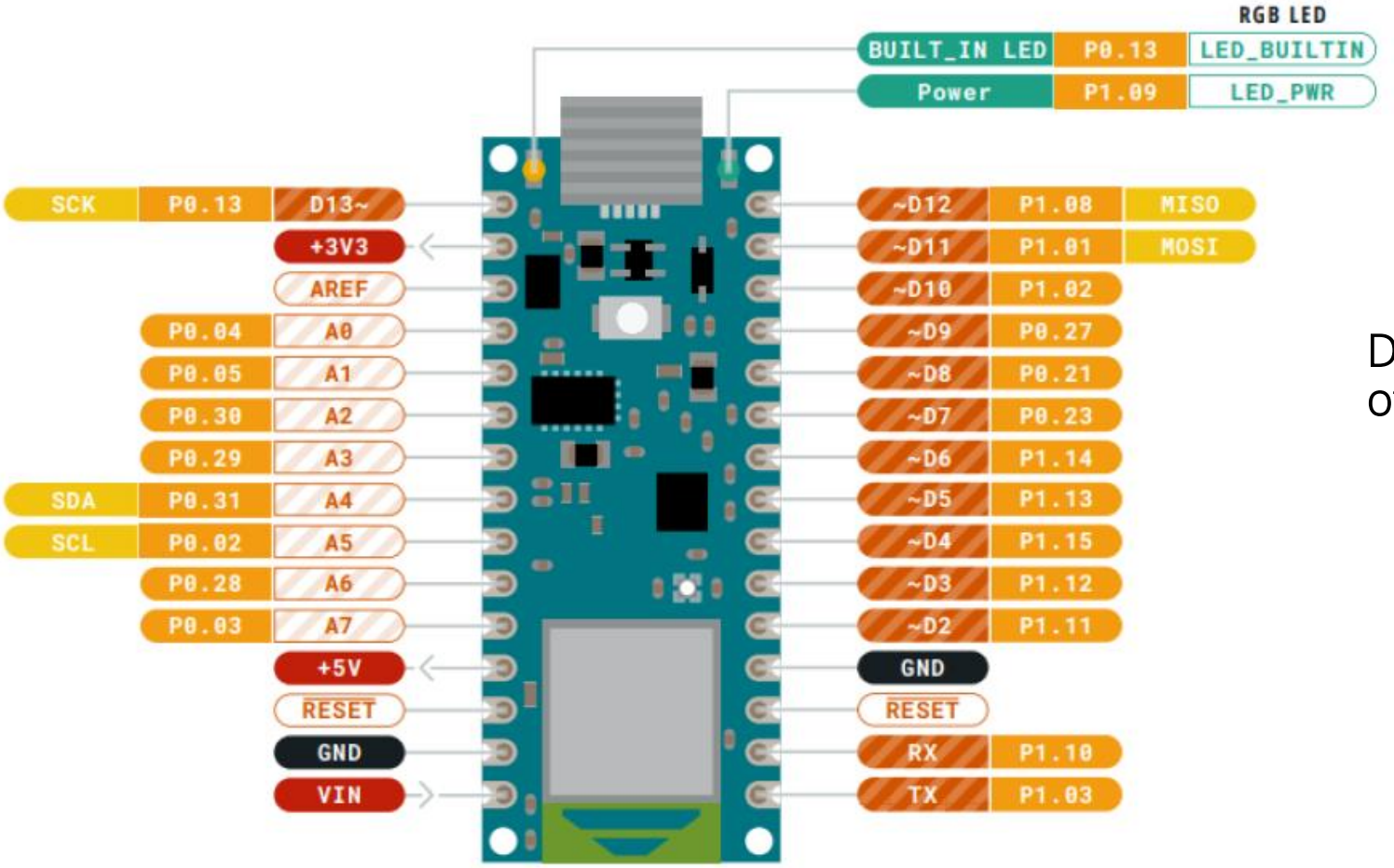
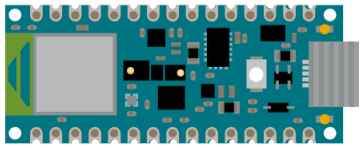


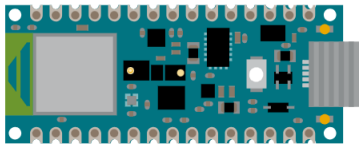

Diagram courtesy of Arduino.cc

# nRF52840 System on Chip (SoC)



- The nRF52840 is a high-performance, low-power, multi-protocol Bluetooth 5.4 SoC from Nordic Semiconductor.
- It is based on the ARM Cortex-M4 CPU with a floating-point unit (FPU) and offers a wide range of features listed next.
  a) Bluetooth 5.4 support for Bluetooth Low Energy(BLE)
     i. Bluetooth mesh
     ii. Near Field Communication (NFC)
     iii. Thread
     iv. Zigbee
- An ARM Cortex –M4 Central Processing Unit (CPU) operating at 64MHz.
- Up to 512 KB of Flash memory and 64 KB of RAM.

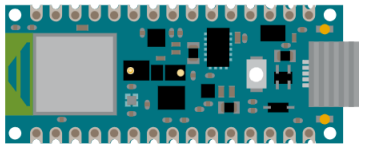
# nRF52840 System on Chip (SoC). . .



- Low power consumption, with a typical active current of 5.5 µA
- A wide supply voltage range of 1.7 to 5.0 V
- Support for a variety of development tools, including the nRF5 SDK and nRF Connect for Windows Desktop


Picture courtesy of
Nordic Semiconductor

# nRF5250 System on Chip (SoC). . .
# What is a SoC?



- A system on a chip (SoC) is an integrated circuit (IC) that integrates most or all computer or other electronic system components onto a single chip.
- A SoC includes:
  - a) the central processing unit (CPU),
  - b) memory, input/output (I/O) ports,
  - c) and other peripherals.
- SoCs are commonly used in mobile devices,
  - a)such as smartphones and tablets, as well
  - b) in other embedded systems like
    - i. wearables
    - ii. home electronics.

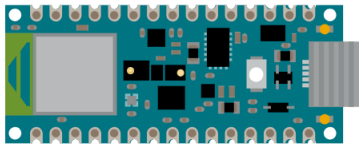
# Question 3

**The nRF52840 is a high-performance, high-power, multi-protocol Bluetooth 5.4 SoC manufactured by Texas Instruments.**

**a) True**

**b) False**

# nRF52840 System on Chip (SoC). . .



## Block Diagram: Part 1

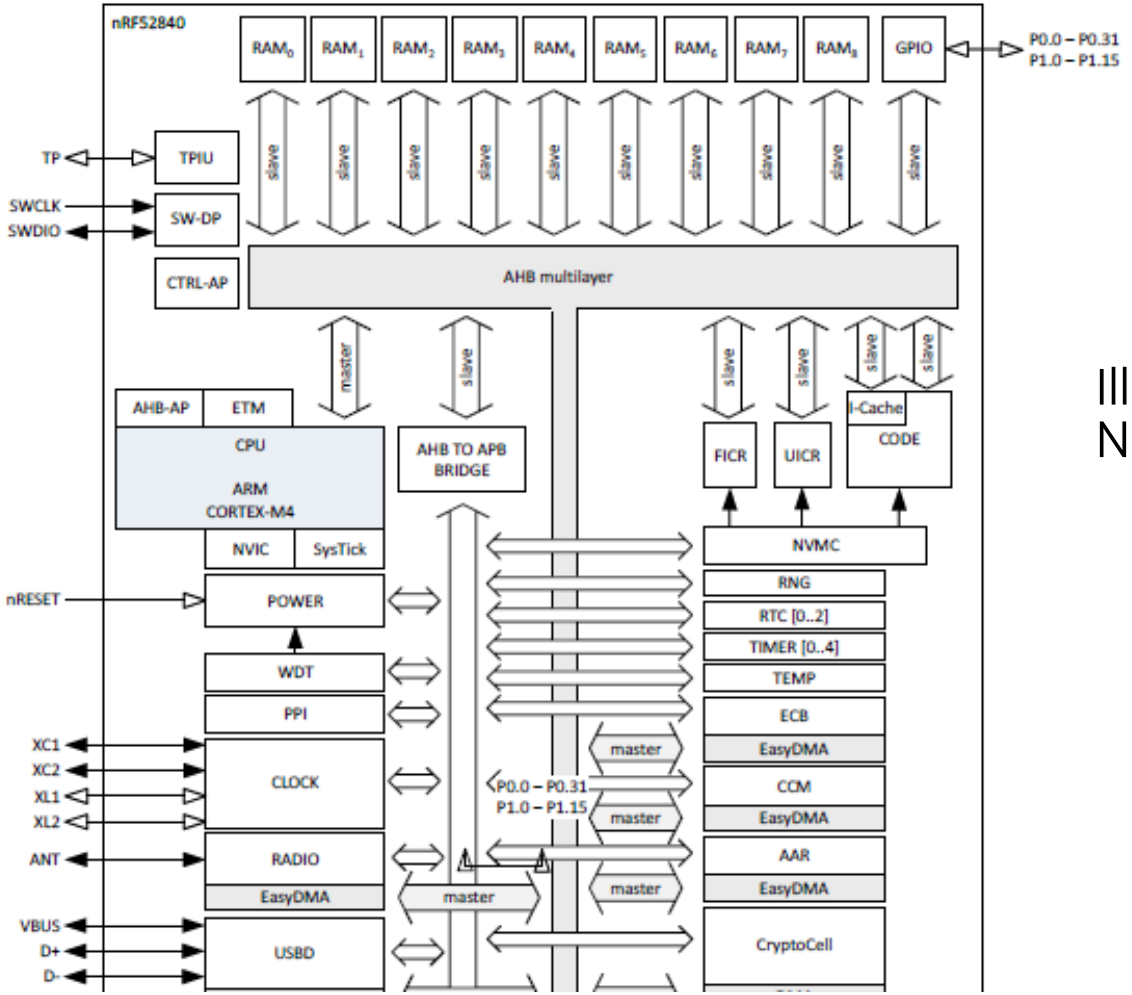
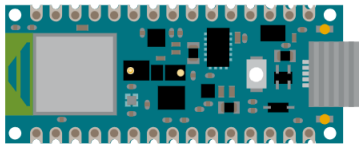


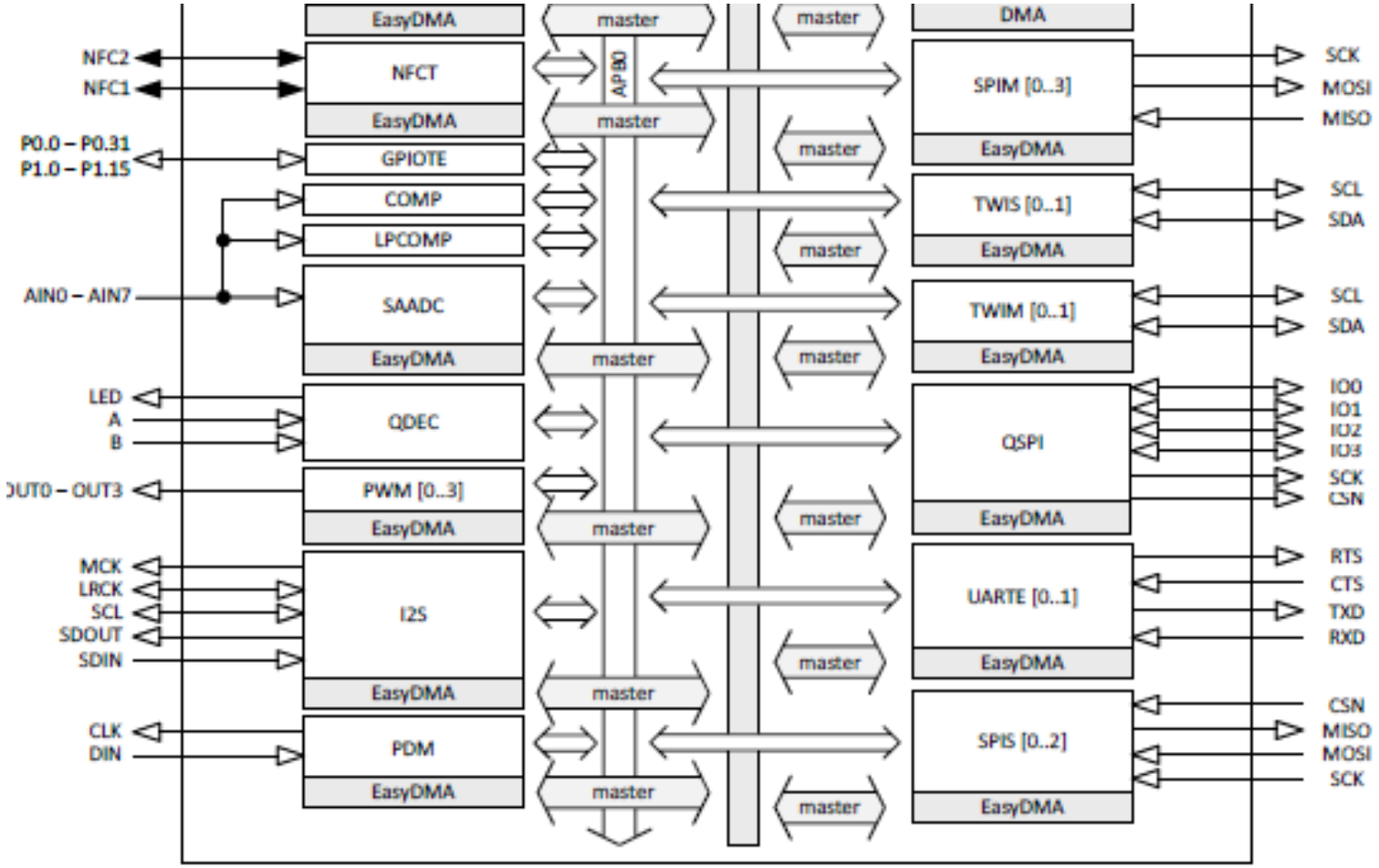

Illustration courtesy of Nordic Semiconductor

# nRF52840 System on Chip (SoC)...

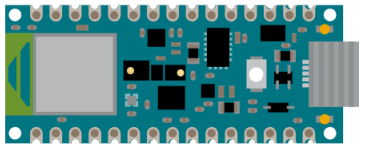


## Block Diagram: Part 2

Illustration courtesy of Nordic Semiconductor



# nRF5250 System on Chip (SoC). . . Core Components

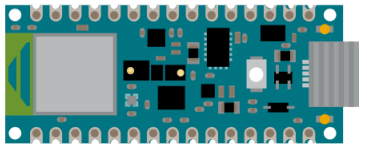


The core components of the nRF52840 are:

- ARM Cortex-M4F CPU with FPU (Floating-Point Unit)
- 1MB flash and 256kB RAM
- 48x GPIOs: GPIOs (General Purpose Input/Output).
- A rich set of peripherals and interfaces: The nRF52840 includes many peripherals and interfaces, such as SPI, QSPI, PDM, I2S, and USB.
- The nRF52840 is a very low-power SoC, with a typical active current of 5.5 µA.
- A wide supply voltage range: The nRF52840 supports a wide supply voltage range of 1.7 to 5.0 V. This makes it compatible with a wide range of power sources.

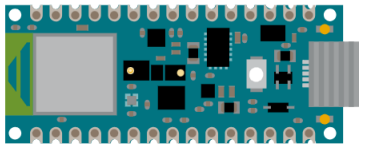
These core components make the nRF52840 a versatile and powerful SoC that is well-suited for a wide range of applications.

# nRF52840 System on Chip (SoC). . . Bluetooth Low Energy (LE)



- The Bluetooth Low Energy (LE) radio is designed for:
  a) very low power operation.
  b)Transmitting data over 40 channels in the 2.4GHz unlicensed ISM frequency band.
- The Bluetooth LE radio provides developers with tremendous flexibility to build products that meet the unique connectivity requirements of their market.
- Bluetooth LE supports multiple communication topologies like:
  a) point-to-point
  b) broadcast
  c) mesh
- Bluetooth technology can support the creation of reliable, large-scale device networks.

# nRF52840 System on Chip (SoC). . . Bluetooth Low Energy (LE)



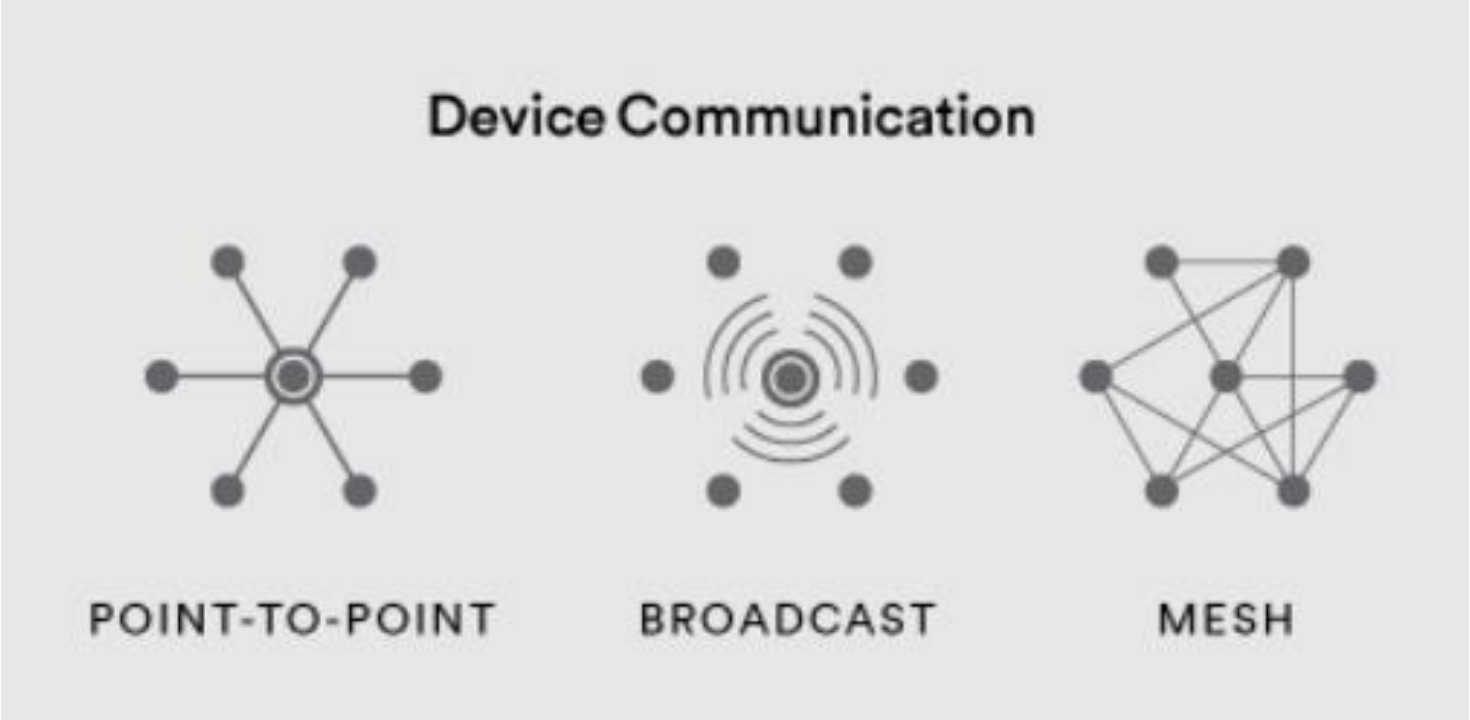
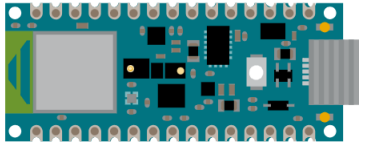
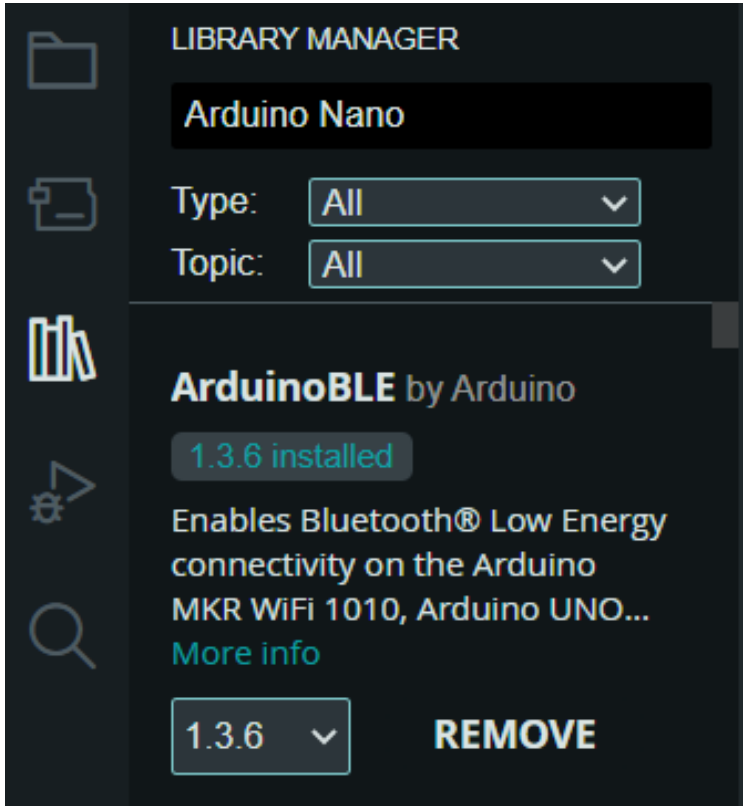



Illustration courtesy of Bluetooth.com

# Setting up an Arduino Nano 33 BLE Sense Development Environment. . .






## Mini Hands-On Activity

Reference > Libraries > Arduinoble

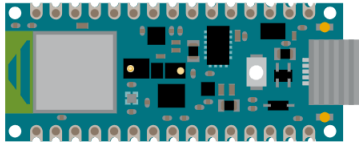
### ArduinoBLE

Communication

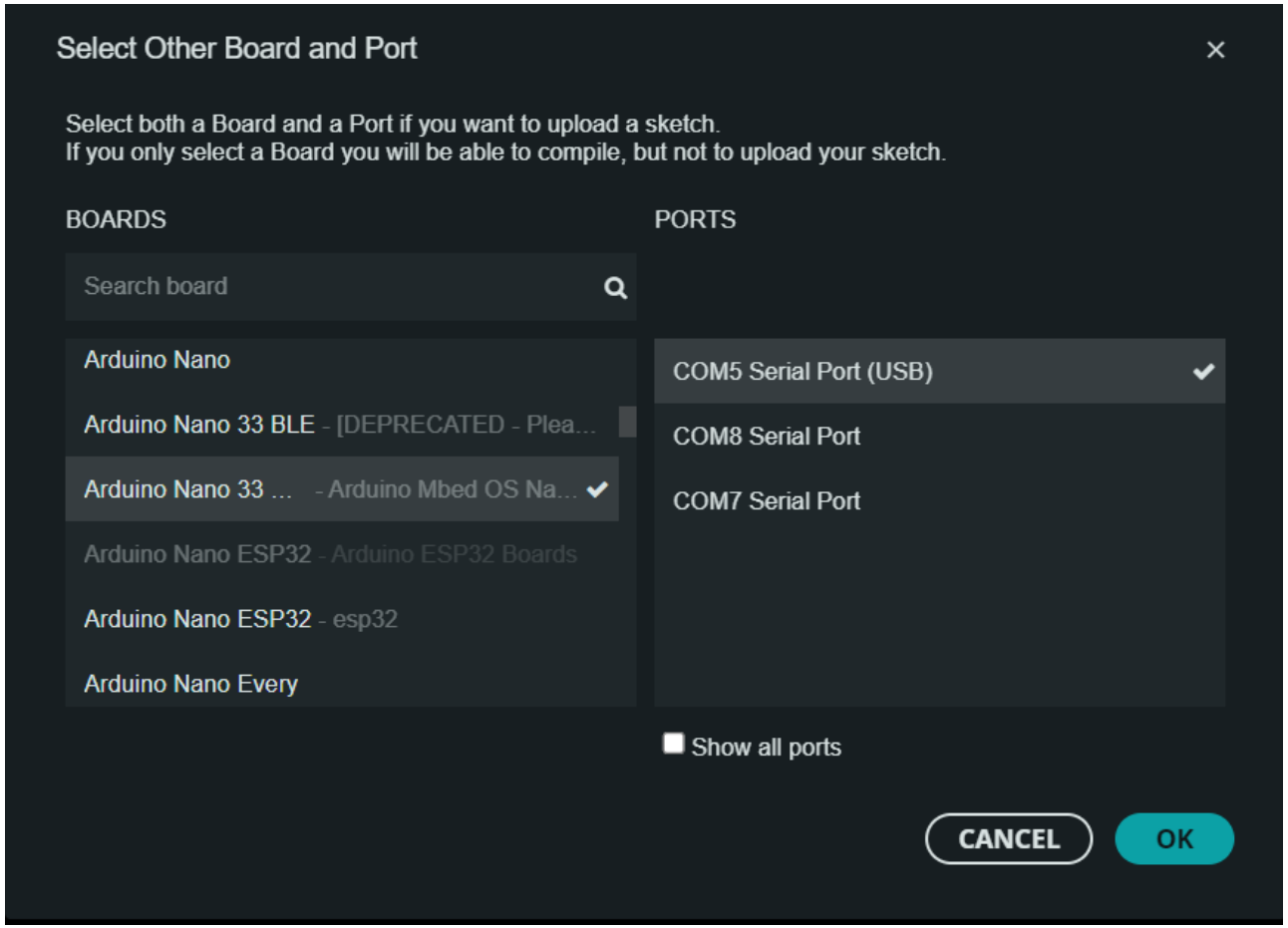
Enables Bluetooth® Low Energy connectivity on the Arduino MKR WiFi 1010, Arduino UNO WiFi Rev.2, Arduino Nano 33 IoT, Arduino Nano 33 BLE, Nicla Sense ME and UNO R4 WiFi.

This library supports creating a Bluetooth® Low Energy peripheral & central mode.

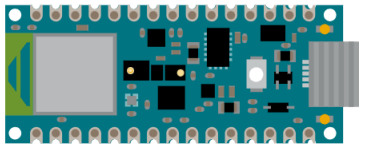
# Setting up an Arduino Nano 33 BLE Sense Development Environment. . .



Mini Hands-On Activity

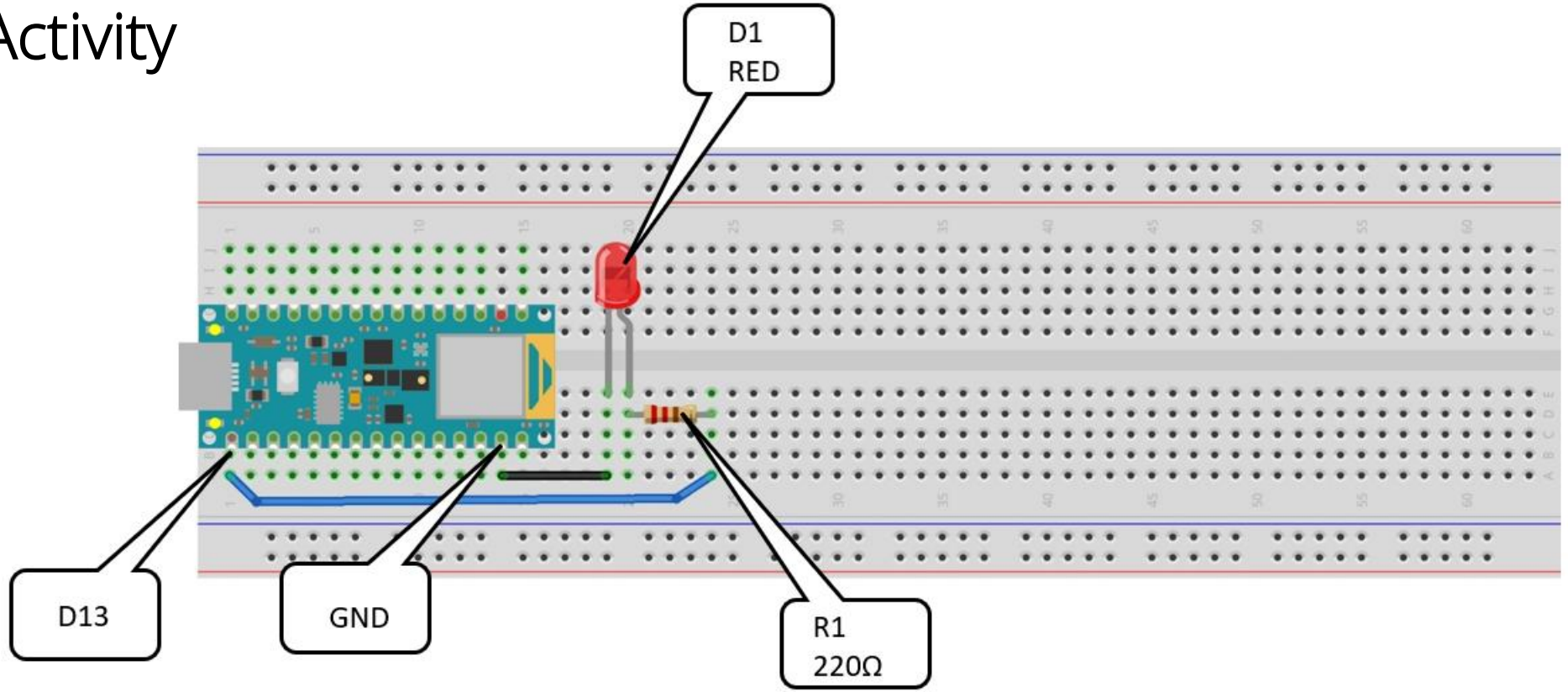


# Setting up an Arduino Nano 33 BLE Sense Development Environment. . .

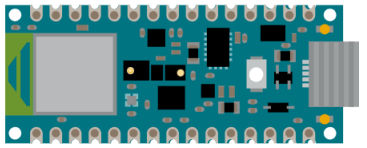


Mini Hands-On Activity

Arduino Nano 33 BLE Sense Blink Project
Electrical Wiring Diagram

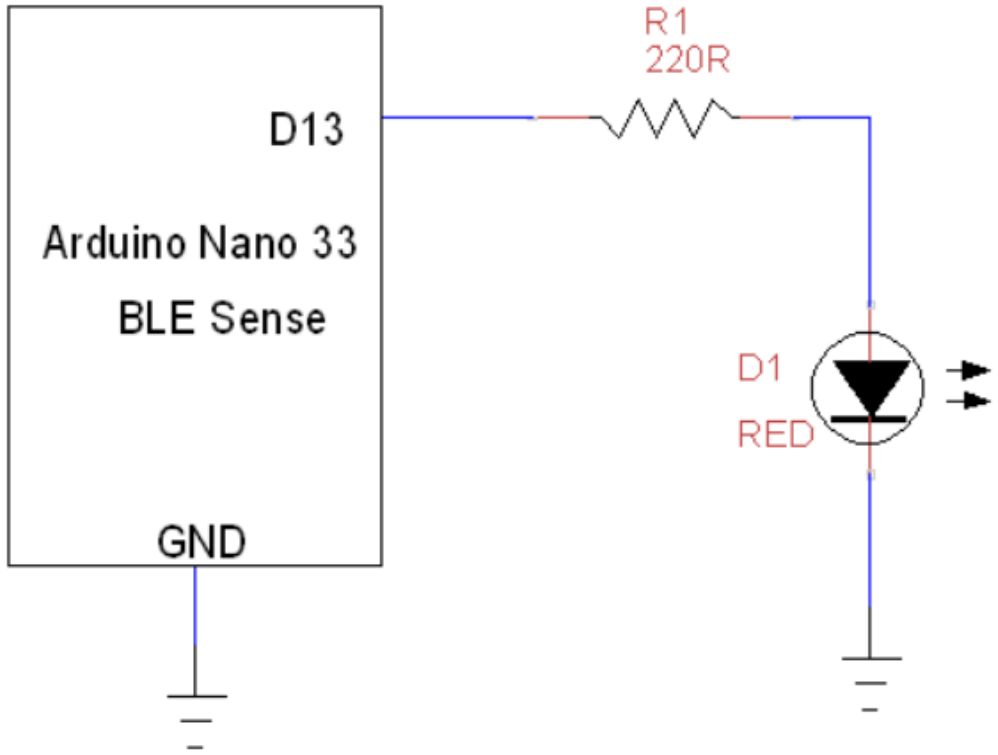


# Setting up an Arduino Nano 33 BLE Sense Development Environment. . .



Arduino Nano 33 BLE Sense Blink Project
Electronic Circuit Schematic Diagram

Mini Hands-On Activity

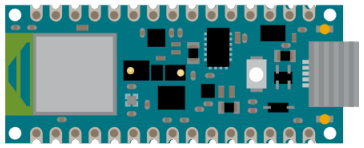


# Question 4

**In reviewing the Blink Project Electronic Circuit Schematic diagram on slide 32, D1 provides an extension for which onboard component?**

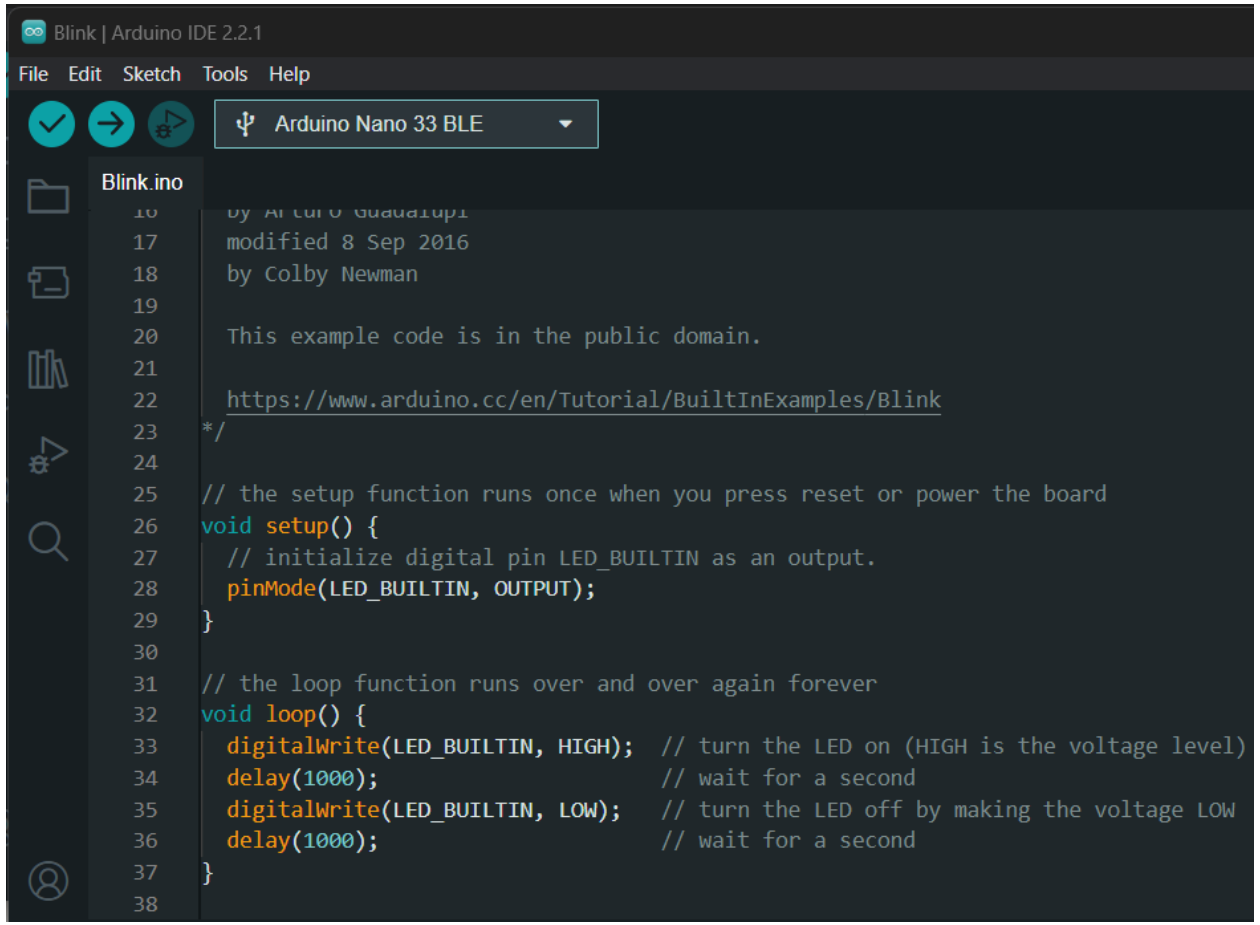
**a) HS3003 Humidity Sensor**
**b) LPS22HBTR Pressure Sensor**
**c) LED Power**
**d) LED L**

# Setting up an Arduino Nano 33 BLE Sense Development Environment. . .

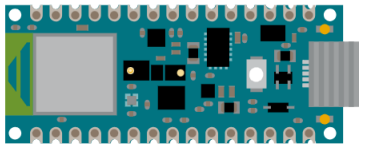


## Mini Hands-On Activity

Upload the Blink code to the Arduino Nano 33 BLE Sense

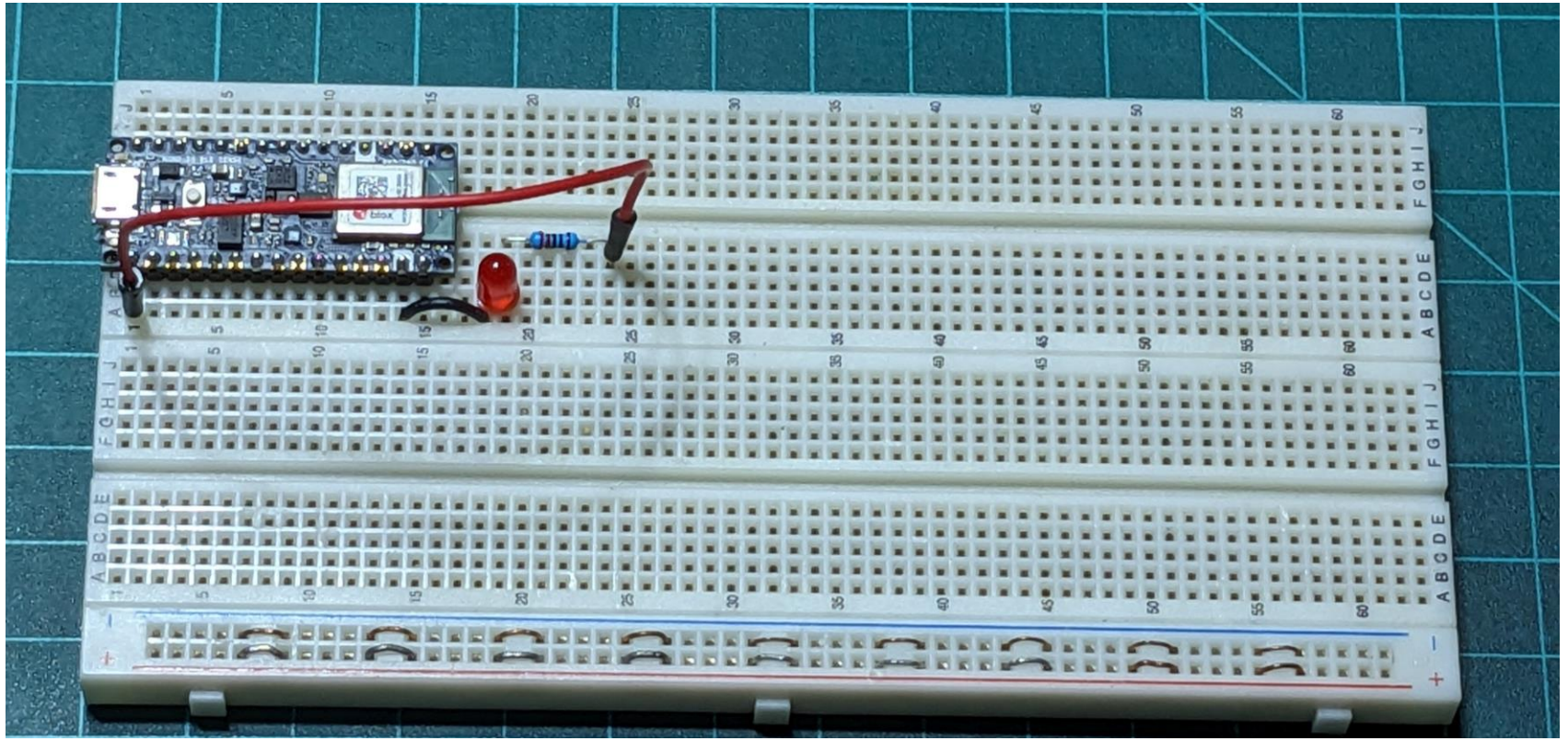


# Setting up an Arduino Nano 33 BLE Sense Development Environment. . .

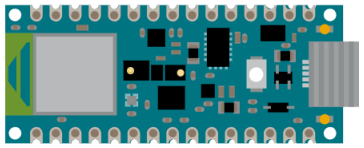


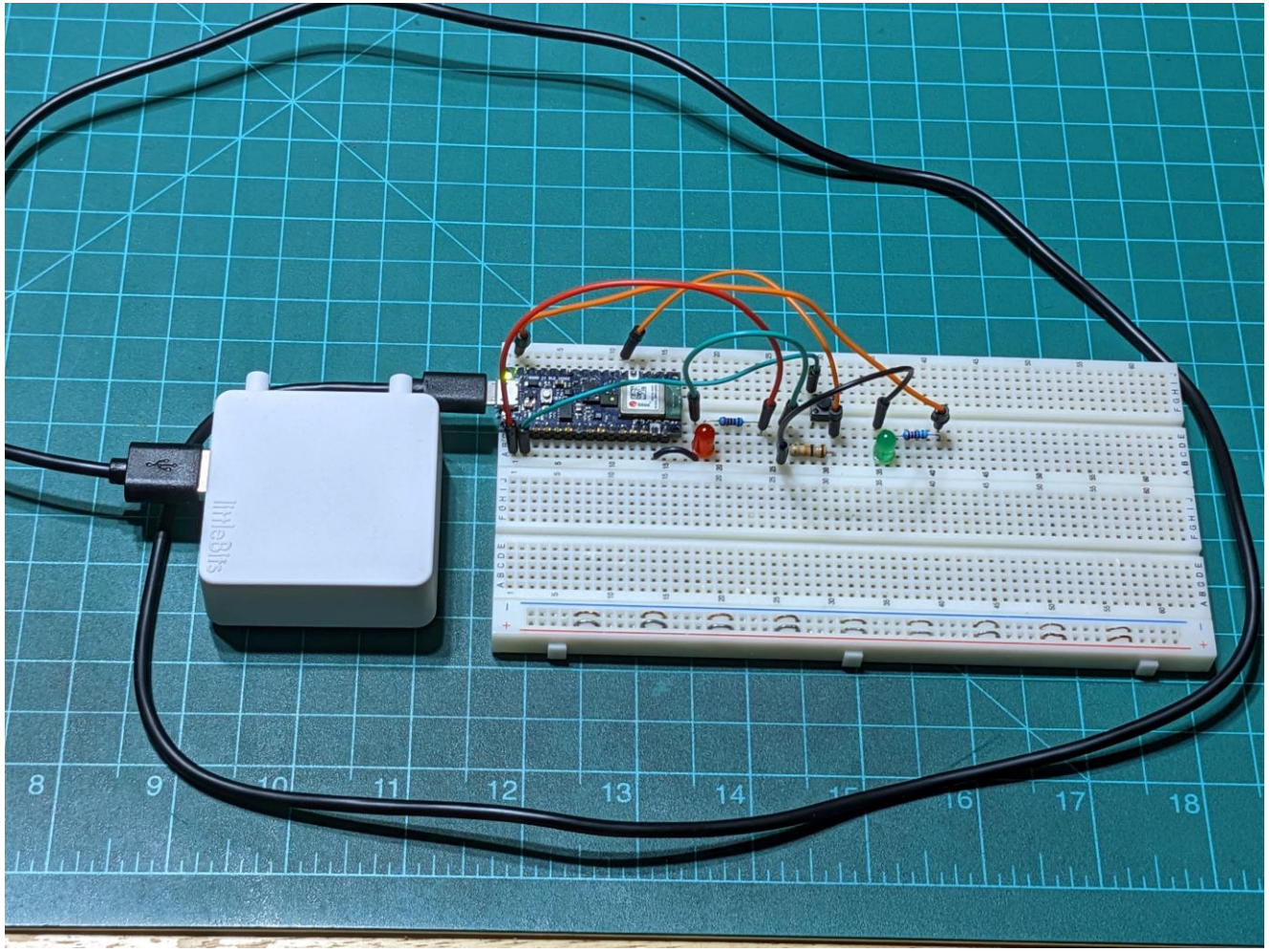
Arduino Nano 33 BLE Sense Solderless Breadboard (Blink Project)

## Mini Hands-On Activity

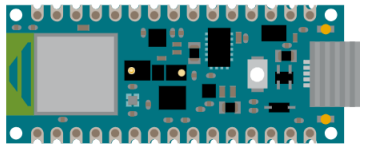


# Lab: Pushbutton-Alternate Blink Controller





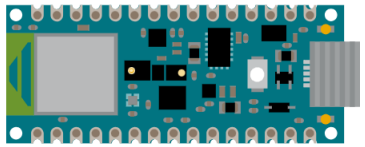
# Lab: Pushbutton-Alternate Blink Controller. . .



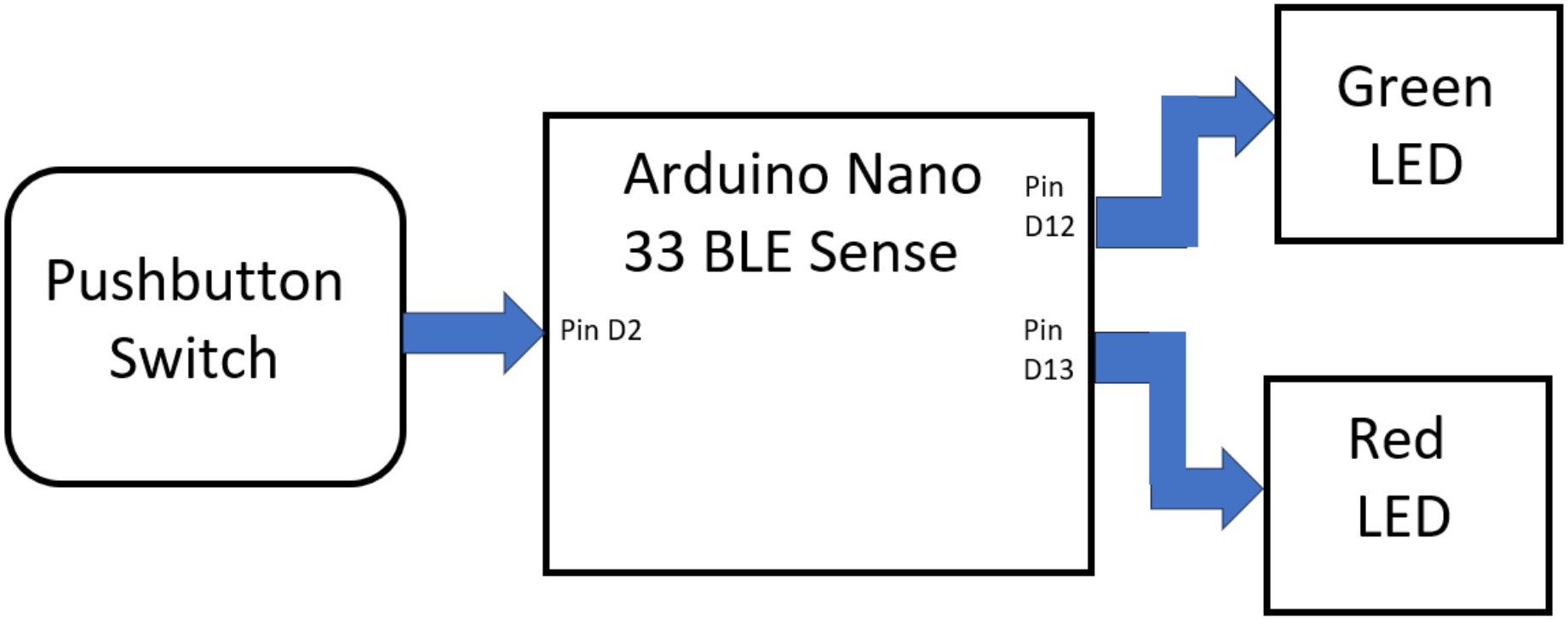
**Lab Objectives:**

- Participants will learn to wire the Arduino Nano 33 BLE Sense Pushbutton-Alternate Blink Controller.
- Participants will learn to perform an Inquiry Request to generate code using Bard AI.
- Participants will learn to program the Arduino Nano 33 BLE Sense board using the Bard AI code.
- Participants will learn how to operate the Pushbutton-Alternate Blink Controller.

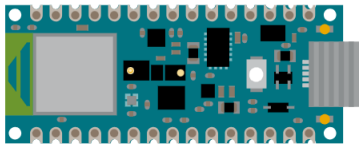
# Lab: Pushbutton-Alternate Blink Controller. . .



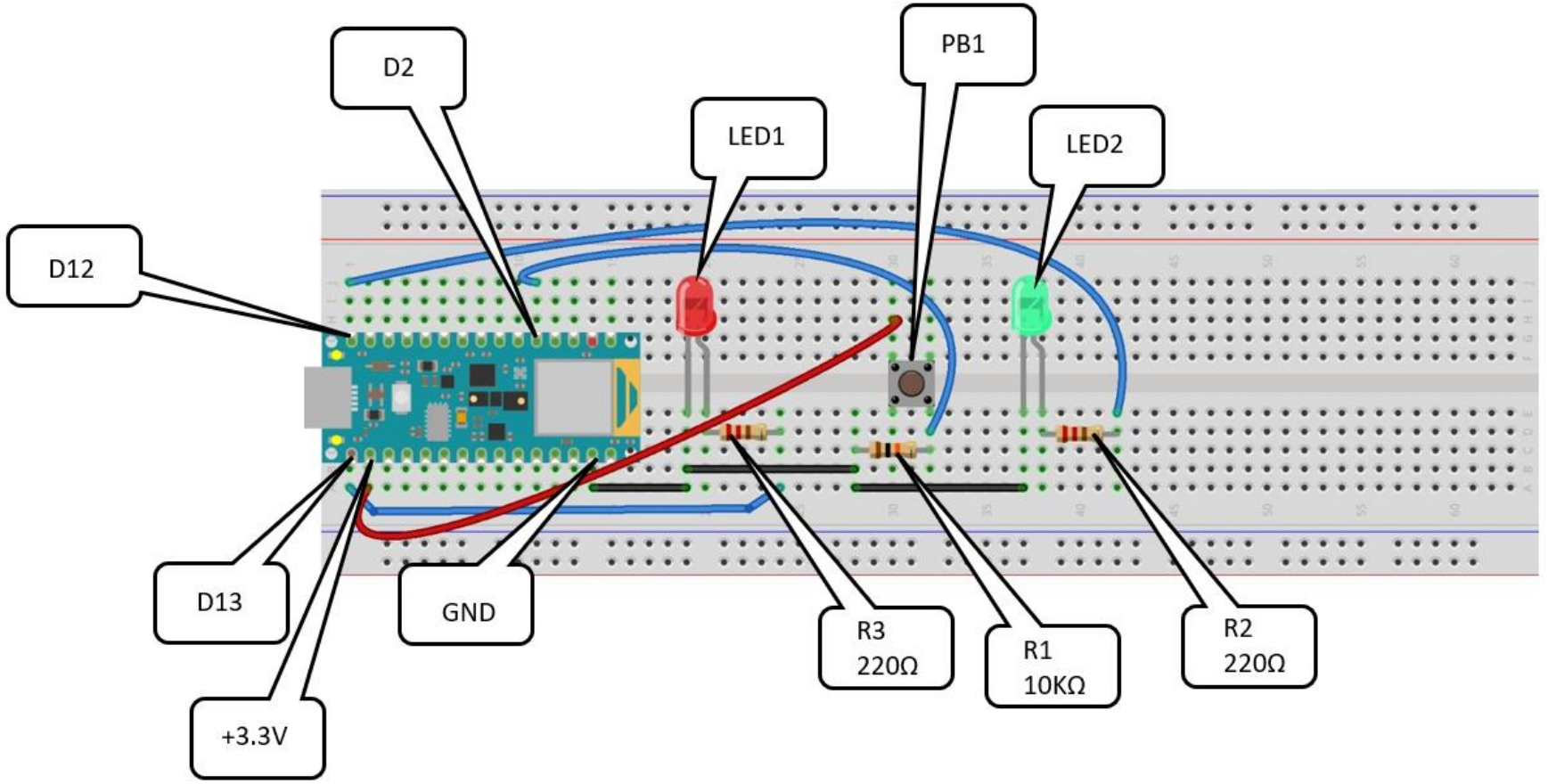
## Concept System Block Diagram



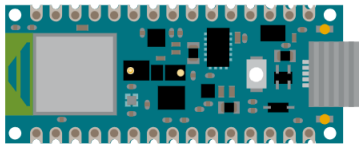
# Lab: Pushbutton-Alternate Blink Controller. . .



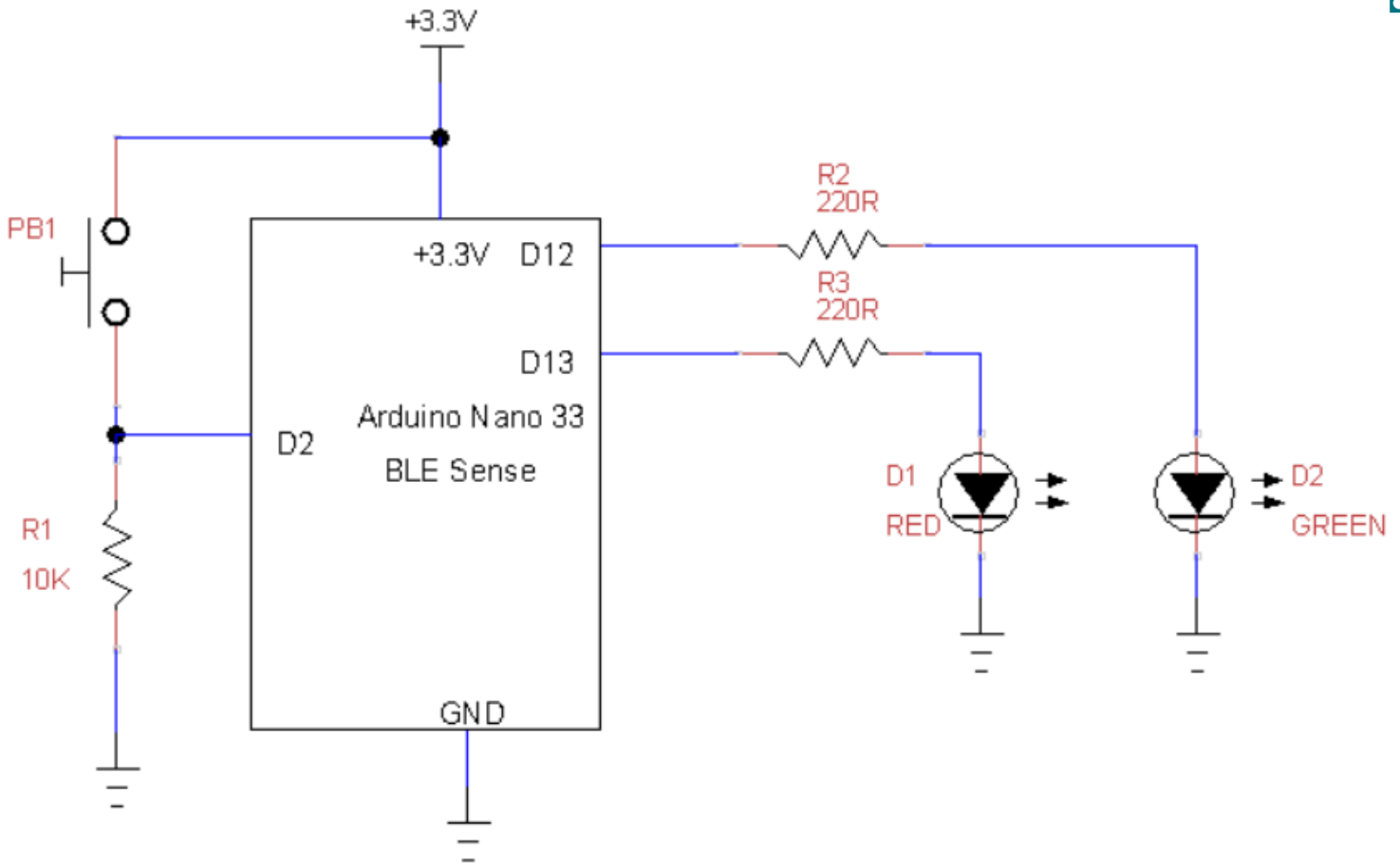
Arduino Nano 33 BLE Sense
Pushbutton-Alternate Blink Controller
Electrical Wiring Diagram



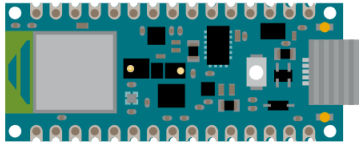
# Lab: Pushbutton-Alternate Blink Controller. . .



Arduino Nano 33 BLE Sense Pushbutton-Alternate Blink Controller Electronic Circuit Schematic Diagram



# Lab: Pushbutton-Alternate Blink Controller. . .



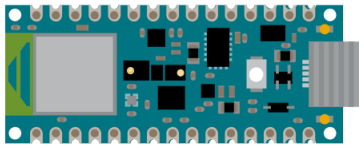
Write code where pressing a pushbutton switch (PB1) wired at digital pin 2 (D2) will blink an LED wired at digital pin 13 (D13) and digital pin 12 (D12). A 10 kilohm pulldown resistor is wired at D2. Pressing the pushbutton switch (PB1) will turn on D12 first, then turn off. D13 output will be off first, then turn on.

Bard AI Inquiry Request for Pushbutton-Alternate Blink Controller Code Generation.

C++

```
const int buttonPin = 2; // Pushbutton switch connected to digital pin 2
const int ledPin1 = 12; // LED connected to digital pin 12
const int ledPin2 = 13; // LED connected to digital pin 13

int buttonState = 0; // Variable to store the button state

void setup() {
  // Set pin modes
  pinMode(buttonPin, INPUT); // Set the button pin as an input
  pinMode(ledPin1, OUTPUT); // Set the LED pin as an output
  pinMode(ledPin2, OUTPUT); // Set the LED pin as an output
}

void loop() {
  // Read the button state
  buttonState = digitalRead(buttonPin);

  if (!buttonState) { // If the button is pressed (LOW state due to pulldown resistor)
    // Turn on LED1
    digitalWrite(ledPin1, HIGH);

    // Delay for 500 milliseconds
    delay(500);

    // Turn off LED1
    digitalWrite(ledPin1, LOW);

    // Delay for 500 milliseconds
    delay(500);

    // Turn on LED2
```

# Lab: Pushbutton-Alternate Blink Controller. . .

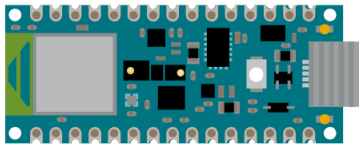


Bard AI Inquiry Request for Pushbutton-Alternate Blink Controller Code Generation. . .

Copy the code and paste it into the Arduino IDE.

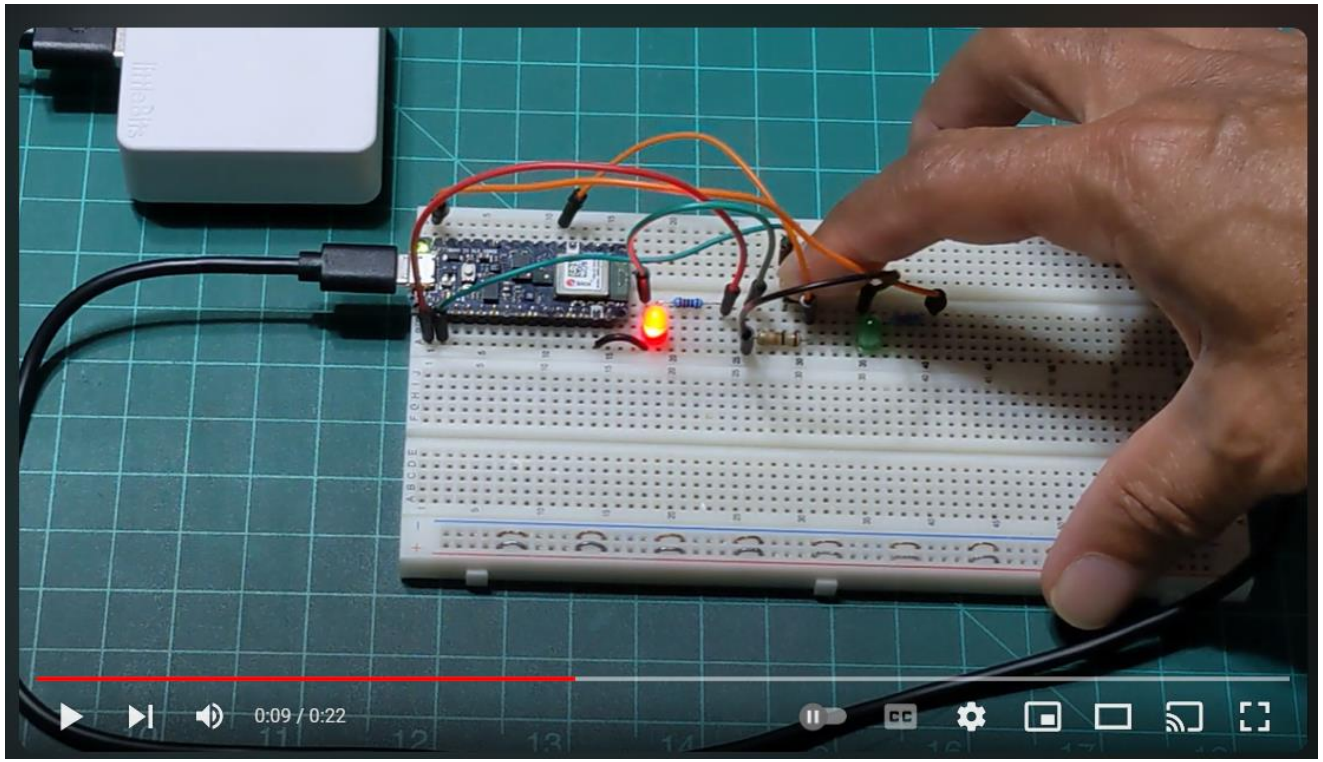
```
    // Turn on LED2
    digitalWrite(ledPin2, HIGH);

    // Delay for 500 milliseconds
    delay(500);

    // Turn off LED2
    digitalWrite(ledPin2, LOW);
  }
}
```

# Lab: Pushbutton-Alternate Blink Controller. . .



Arduino Nano 33 BLE Sense Pushbutton-Alternate Blink Controller video
Click the link below:

https://youtu.be/-CKXcvOhJDo



# Question 5

**Which AI Large Language Model (LLM) platform was used to generate the Pushbutton-Alternate Blink Controller?**

**a) Bart**
**b) Bert**
**c) ChatGPT (OpenAI)**
**d) Bard**

# Thank you for attending

Please consider the resources below:

Chua, C.E., & Storey, V.C. (2022). A tutorial on prototyping internet of things device and systems: A gentle introduction to technology that shapes our lives. *Communications of the Association for Information Systems*, *51*(34), 327-364. https://www.researchgate.net/publication/360263045_A_Tutorial_on_Prototyping_Internet_of_Things_Devices_and_Systems_A_Gentle_Introduction_to_Technology_that_Shapes_Our_Lives

Course_Lab_project_code.zip folder: Github Repository: https://github.com/DWilcher/HCI_Electronics

Kurniawan, A. (2021). *Iot projects with arduino nano 33 ble sense*. Apress. https://link.springer.com/chapter/10.1007/978-1-4842-6458-4_3

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