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A Study on New Arduino NANO Board for WSN and IoT Applications

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Abstract

In this paper, we present a new research on the new coming Arduino Nano boards for summer 2019. Arduino has expanded its family of tiny Nano boards with new offerings that deliver better specs for a lower price. Four new boards of Arduino, Nano will be on the market soon, they have integrated interesting features for attractive applications. The new boards include Wi-Fi and Bluetooth as wireless communication. Some of them include general-purpose sensors i.e. temperature, humidity, pressor and acceleration for movement detection. We have detailed the new boards, and made a comparison study. It can be concluded that these boards will improve and facilitate the design of IoT projects and applications and the wireless sensors network.

Keywords: *Arduino Nano, IoT application, BLE, Single board controller*

1. Introduction

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Arduino, which was introduced in 2005, is an open source microcontroller boards. It is a platform that provides easy and cheap for interested people to construct electronic devices that can be programmed to interact with the external environment using sensors and actuators. It has many capabilities such as: input, output, processing, receiving and sending information over the internet. Developers write C or C++ programming languages in the Arduino Integrated Development Environment (IDE) to program the Arduino development board.

Several versions of the Arduino hardware have been evolved throughout the time, starting from the basic one Arduino-Uno, then the Mega, Mini, Nano, LilyPad, and others. The smallest is the Nano as it can be seen from its name. It is not cheaper than other Arduino boards and has similar specs to the Uno board.

The Italian makers had produced other four new Arduino boards that will serve different purposes. Arduino delivered four new boards in mid of June in 2019 [4]. The new Nano boards are small and cheap and fit into small projects.

Arduino extended the processing power of the previous small 18x45mm boards reducing power consumption. These low-cost microcontrollers are suitable for those who want to build their own gadgets.

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Now the specs of the tiny Nano boards are better for a lower price. The Arduino Nano Every and the Nano 33 IoT, which adds wireless connectivity, are available without headers for a lower price. They could be wired into circuits to interact with external environment, i.e. sensors, lights, motors, microphones, buttons, and more.

The new four boards are:

a) Arduino Nano Every, for our "everyday" projects.
b) Arduino Nano 33 IoT (internet of things), for Internet of Things projects.
c) Arduino Nano 33 BLE (Bluetooth low energy), for Bluetooth connectivity
d) Arduino Nano BLE Sense, which includes many on-board sensors.

The lowest-price board in Arduino's lineup is the Nano Every. They are suitable for prototyping compact and small projects [1].

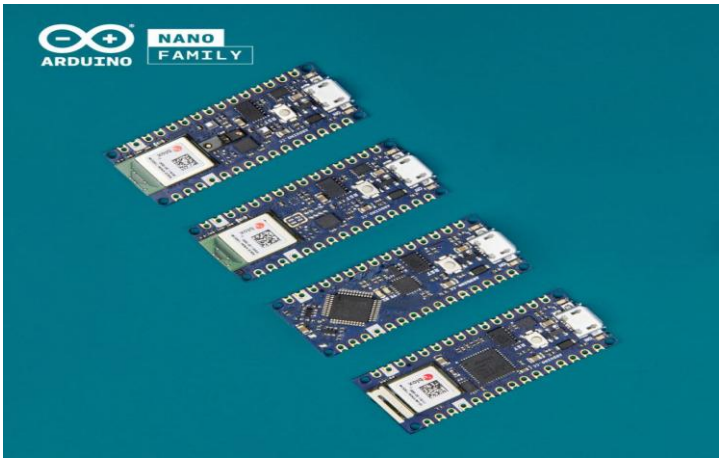

Figure 1. Illustration of the four Nano 33 Boards from Arduino

2. Description

In the next section, the new four Nano boards will be described and more details will be presented concerning the Nano 33 IoT and Nano 33 BLE sense.

2.1. The Nano Every

The Nano every board is designed based on the old Arduino Nano with little difference. It is equipped with the ATMega4809 microcontroller and an energy efficient processor called Arm's Cortex M0+. It comes with doubled flash memory size, higher clock speed and 3x the SRAM. It is suitable for everyday projects.

The Arduino Nano Every features a powerful processor, the ATMega4809. It is the first AVR device that includes Microchip's Core Independent Peripherals (CIP). The new Nano differs from the original Nano as it comes in a castellated form. It is also breadboard-compatible and it can be soldered directly onto another PCB.

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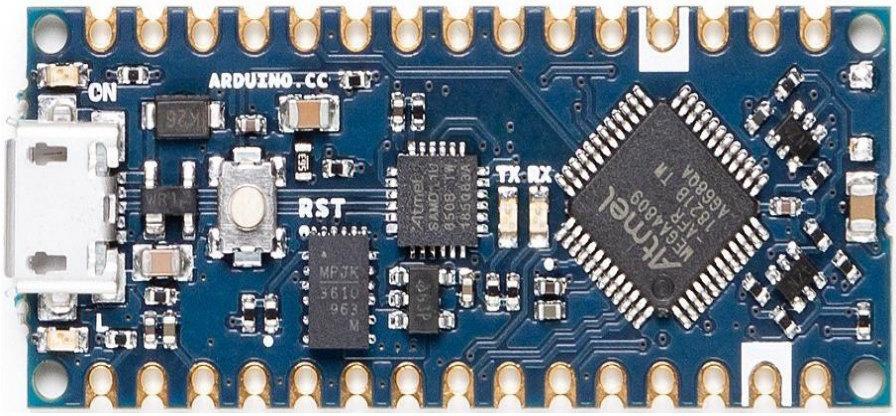

Figure 2. Arduino Every presentation

2.2 Arduino Nano 33 IoT

The Nano 33 IoT is advanced and compatible with Arduino IoT Cloud [9]. It is equipped with Arm Cortex-M0+ processor that is based on ATSAMD21 microcontroller, 802.11n Wi-Fi and Bluetooth v4.2, and Wi-Fi. To measure angular rate and force you can take advantage of the 6-axis IMU. The security issue of the IoT can be handled by the crypto chip embedded in the board.

Arduino Nano 33 IoT supports wireless based projects that allow designers to remotely control and monitor their projects because it is also compatible with Arduino IoT cloud service. Certificates and pre-shared keys are securely stored in the crypto ship. The board is used as an SMT module or in a breadboard and it is equipped with the 9-axis IMU.

2.3 Arduino Nano 33 BLE

This board should provide users with high performance due to higher processing power and lower power consumption as promised by Arduino. If users are designing projects that require IoT technologies and applications such as environmental monitoring and motion tracking then this boards is the most suitable one. It is appropriate for projects that automates motion and for wearables. It is also suitable for projects that require short-range Bluetooth and low power consumption.

2.4 Nano 33 BLE Sense

It is the same case for the Nano 33 BLE in terms of performance and power consumption. Both promise to enhance these issues. For short-range Bluetooth projects user can use this or the previous board. It is also suitable for environmental and motion automation projects and wearables. For example, there are sensors for gestures, humidity, light, color, pressure, and temperature in addition the microphone.

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3 More Details on Arduino Nano 33 IOT

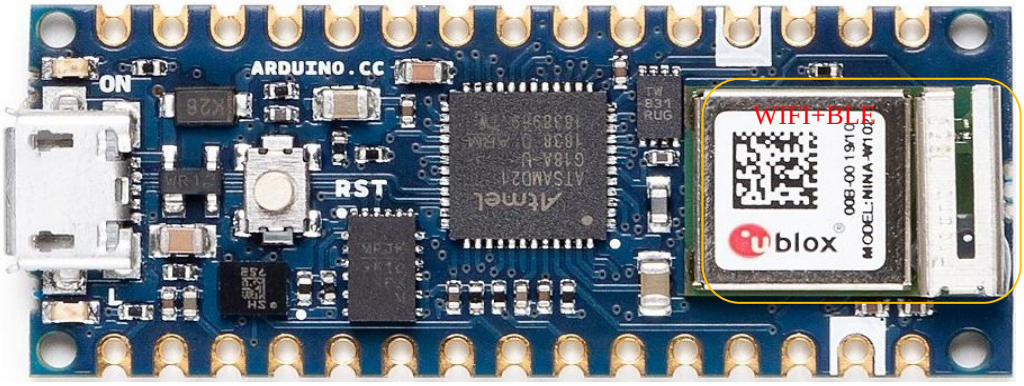

Figure 3. Nano 33 IoT board

Arduino Nano 33 IoT is based on the SAMD21G18A microcontroller. Its clock speed is up to 48MHz, with Flash 256KB and SRAM 32KB. The board supports 3.3V I/Os and does not tolerate 5V. Connecting 5V signals directly to this board will damage it. In addition, it is not like in the Arduino Nano boards that support 5V operation. the 5V pin in the Nano 33 IoT is connected to USB power input through a jumper. It does not supply any voltage. A NINA W102 ESP32 module manages the communication of the WiFi and the Bluetooth [2]. It is connected to SAMD21 microcontroller with a serial port and an SPI BUS though the following pins as presented in the following table:

Table 1. Nano 33 IoT board Pin details [1]

SAMD21 Pin	SAMD21 Acronym	NINA Pin	NINA Acronym	Description
13	PA8	19	RESET_N	Reset
39	PA27	27	GPIO0	Attention Request
41	PA28	7	GPIO33	Acknowledge
23	PA14	28 / 21	GPIO5 / GPIO19	SPI CS
24	PA15	29 / 20	GPIO18 / GPIO22	UART RTS
22	PA13	1	GPIO21	SPI MISO
21	PA12	36	GPIO12	SPI MOSI
31	PA22	23	GPIO3	Processor TX -> Nina RX
32	PA23	22	GPIO1	NINA TX -> Processor RX

There is a supporting library for the crypto chip that is used by the WiFiNINA library. The board has two 15 pins connectors, one on each side, pin to pin compatible with the original Arduino Nano.

Pins A4 and A5 are used as an I2C Bus and are not recommended for analog inputs. debug signals are arranged as 3x2 test pads with 100 mil pitch, under the communication module, on the bottom side of the board. Pin 1 is the bottom left one with the USB connector on the left and the test pads on the right.

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4 More details on Nano 33 BLE Board

The Arduino 33 BLE and BLE sense are similar in design. The new Arduino Nano 33 BLE Sense is based on the same u-blox NINA B306 module. It comes with a set of sensors such as light, gesture, temperature , pressure, humidity, and embedded microphone. More details can be found in [3].

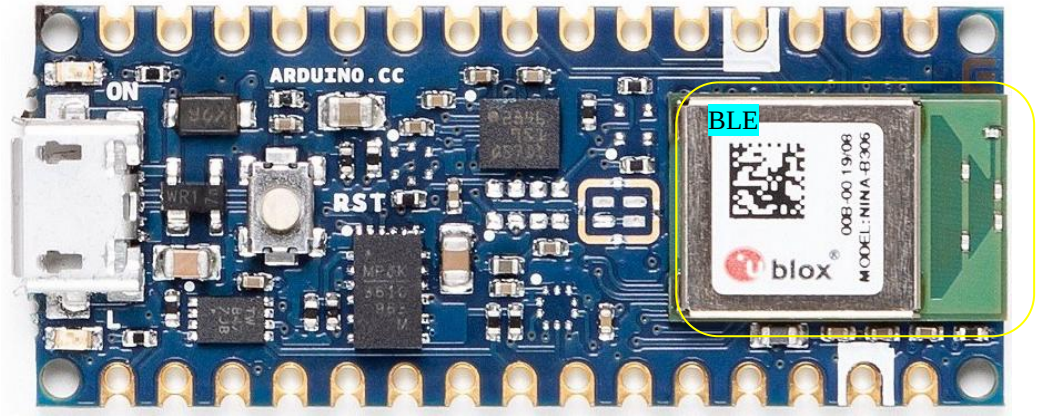

Figure 4: Nano 33 BLE board

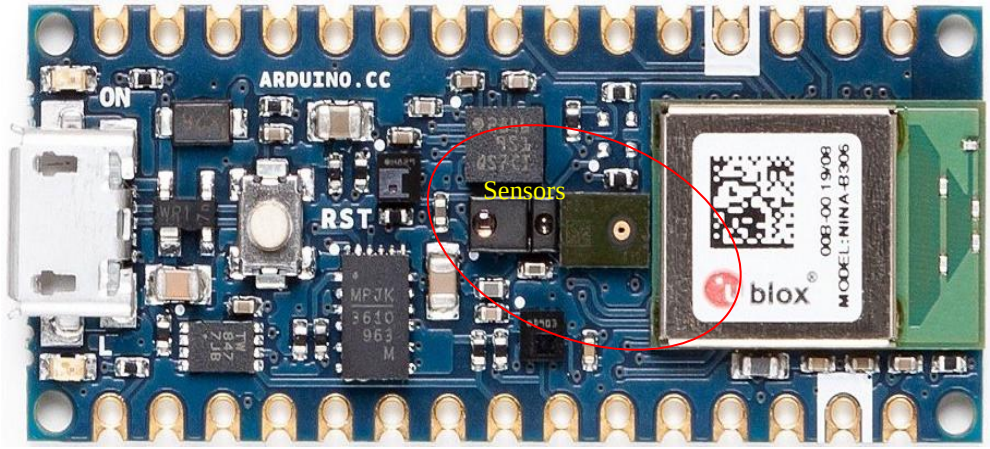

Figure5. Nano 33 BLE sensor Board "in red circle are inverted sensors"

This compact and reliable Nano board has low power consumption compared to other same size boards. It contains a powerful Cortex M4F. It has a nine axis Inertial Measurement Unit (IMU).

Arduino Nano 33 BLE is a multiprotocol; therefore, it is ideal for automation projects. This board is also suitable for designing wearable devices and movement-sensing projects that need to communicate to other devices at a close range. It is and is not 5V tolerant, it supports only 3.3V I/Os. In addition, the 5V pin is connected, through a jumper, to the USB power input. There are two 15 pins connectors on the board, one on each side, pin to pin compatible with the original Arduino Nano. Description is presented in Table 2.

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Table2. Pin description of Nano 33 BLE [1]

Pin	Function	Type	Description
1	D13	Digital	GPIO
2	+3V3	Power Out	Internally generated power output to external devices
3	AREF	Analog	Analog Reference; can be used as GPIO
4	A0/DAC0	Analog	ADC in/DAC out; can be used as GPIO
5	A1	Analog	ADC in; can be used as GPIO
6	A2	Analog	ADC in; can be used as GPIO
7	A3	Analog	ADC in; can be used as GPIO
8	A4/SDA	Analog	ADC in; I2C SDA; Can be used as GPIO (*)
9	A5/SCL	Analog	ADC in; I2C SCL; Can be used as GPIO(*)
10	A6	Analog	ADC in; can be used as GPIO
11	A7	Analog	ADC in; can be used as GPIO
12	V_{USB}	Power In/Out	Normally NC; can be connected to V_{USB} pin of the USB connector by shorting a jumper
13	RST	Digital In	Active low reset input (duplicate of pin 18)
14	GND	Power	Power Ground
15	VIN	Power In	Vin Power input
16	TX	Digital	USART TX; can be used as GPIO
17	RX	Digital	USART RX; can be used as GPIO
18	RST	Digital	Active low reset input (duplicate of pin 13)
19	GND	Power	Power Ground
20	D2	Digital	GPIO
21	D3/PWM	Digital	GPIO; can be used as PWM
22	D4	Digital	GPIO
23	D5/PWM	Digital	GPIO; can be used as PWM
24	D6/PWM	Digital	GPIO; can be used as PWM
25	D7	Digital	GPIO
26	D8	Digital	GPIO
27	D9/PWM	Digital	GPIO; can be used as PWM
28	D10/PWM	Digital	GPIO; can be used as PWM
29	D11/MOSI	Digital	SPI MOSI; can be used as GPIO
30	D12/MISO	Digital	SPI MISO; can be used as GPIO

In this board, pins A4 and A5 are used as an I2C bus and it is not recommended to use analog input. On the other hand, the 5V pin is connected to a USB power input though a jumper.

The debug signals are arranged as 3x2 test pads on the bottom side of the board, under the communication module, as shown in Table 3 with 100 mil pitch, . Pin 1 is the bottom left one with the USB connector on the left and the test pads on the right.

Table 3. Debug signal pins on Nano 33BLE and BLE+ sensor [1]

Pin	Function	Type	Description
1	+3V3	Power Out	Internally generated power output to be used as voltage reference
2	SWD	Digital	nRF52480 Single Wire Debug Data
3	SWCLK	Digital In	nRF52480 Single Wire Debug Clock
5	GND	Power	Power Ground
6	RST	Digital In	Active low reset input

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5 Comparative study between the new boards and the old one

Table 4. Results of comparative study

Type Char	Nano Every	Nano 33 IoT	Nano 33 BLE	Nano 33 BLE Sense	Old Nano
Microcontroller	ATMega4809	SAMD21G18A	nRF52480	nRF52480	
Clock Speed	20 MHz	48 MHz	64 MHz	64 MHz	16 MHz
Flash	48KB	256KB	1MB	1MB	32KB (2KB used by bootloader)
RAM	6KB	32KB	256KB	256KB	2KB
Connectivity	none	WIFI+Bluetooth Esp32	BLE	BLE short range LP	none
Sensors	none	6-axes-IMU	9-axes-IMU	9-axes-IMU, Temp, hum, Pression, Color, gesture	none
hardware Security	none	Hardware Cripto	Hardware Cripto	Hardware Cripto	none
Price	$9.90 / $11.90 with headers	$18 / $20 with headers	$19 / $21 with headers	$29.50 / $31.50 with headers	$22
Apps	Wearable, Embedded dev Ehealth Smart Device	IoT apps IoV WSN Apps Smart Devices Connected dev	IoT apps WSN Apps Smart Devices Connected dev	IoT apps WSN Apps Smart Home Motion sensors automation	Some applications, robot Automation,

Regarding the results in Table 4, we can conclude that using the new Nano 33 IoT or Nano 33 BLE or BLE Sense will reduce components on old boards. It will also be easy to integration into IoT applications, and easy to insert as gateway in wireless sensors network design. Therefore, Based on their characteristics, these boards can be used in many applications or projects.

6 Conclusion

The new boards are intended to be structured as modules. The goal behind these boards is not only for big manufacturers but also for small one who want to produce devices according to their prototypes that are based on classic or MKR boards. “The new Nanos are for those millions of makers who love using the Arduino IDE for its simplicity and open source aspect, but just want a great value, small and powerful board they can trust for their compact projects. With prices from as low as $9.90 for the Nano Every, this family fills that gap in the Arduino range, providing makers with the Arduino quality they deserve for those everyday projects” Massimo Banzi, co-founder of Arduino.

Based on this study, we can conclude that students will have more time to develop software part by including these boards in their applications or project in IoT, WSN, smart devices, connected devices, wearable devices.

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