

## Description

The Arduino® Nano 33 IoT and Arduino Nano 33 IoT with headers are a miniature sized module containing a Cortex M0+ SAMD21 processor, a Wi-Fi® + Bluetooth® module based on ESP32, a crypto chip which can securely store certificates and pre-shared keys and a 6 axis IMU. The module can either be mounted as a DIP component (when mounting pin headers), or as a SMT component, directly soldering it via the castellated pads.

## Target areas:

Maker, enhancements, basic IoT application scenarios



## Features

- **SAMD21G18A**

- **Processor**

- 256 kB Flash
    - 32 kB Flash
    - Power On Reset (POR) and Brown Out Detection (BOD)

- **Peripherals**

- 12 channel DMA
    - 12 channel event system
    - 5x 16 bit Timer/Counter
    - 3x 24 bit timer/counter with extended functions
    - 32 bit RTC
    - Watchdog Time
    - CRC-32 generator
    - Full speed Host/Device USB with 8 end points
    - 6x SERCOM (USART, I<sup>2</sup>C, SPI, LIN)
    - Two channel I<sup>2</sup>S
    - 12 bit 350ksps ADC (up to 16 bit with oversampling)
    - 10 bit 350ksps DAC
    - External Interrupt Controller (up to 16 lines)

- **Nina W102**

- **Module**

- Dual Core Tensilica LX6 CPU at up to 240MHz
    - 448 kB ROM, 520 kB SRAM, 2MB Flash

- **Wi-Fi®**

- IEEE 802.11b up to 11Mbit
    - IEEE 802.11g up to 54MBit
    - IEEE 802.11n up to 72MBit
    - 2.4 GHz, 13 channels
    - -96 dBm sensitivity

- **Bluetooth® BR/EDR**

- Max 7 peripherals
    - 2.4 GHz, 79 channels
    - Up to 3 Mbit/s
    - 8 dBm output power at 2/3 Mbit/s
    - 11 dBm EIRP at 2/3 Mbit/s
    - -88 dBm sensitivity

- **Bluetooth® Low Energy**

- Bluetooth® 4.2 dual mode
    - 2.4GHz 40 channels
    - 6 dBm output power
    - 9 dBm EIRP
    - -88 dBm sensitivity
    - Up to 1 Mbit/

- **MPM3610** (DC-DC)

- Regulates input voltage from up to 21V with a minimum of 65% efficiency @minimum load
    - More than 85% efficiency @12V

- **ATECC608A** (Crypto Chip)

- Cryptographic co-processor with secure hardware based key storage
    - Protected storage for up to 16 keys, certificates or data
    - ECDH: FIPS SP800-56A Elliptic Curve Diffie-Hellman
    - NIST standard P256 elliptic curve support
    - SHA-256 & HMAC hash including off-chip context save/restore
    - AES-128 encrypt/decrypt, galois field multiply for GCM

- **LSM6DSL** (6 axis IMU)

- Always-on 3D accelerometer and 3D gyroscope
    - Smart FIFO up to 4 KByte based
    - $\pm 2/\pm 4/\pm 8/\pm 16$  g full scale
    - $\pm 125/\pm 250/\pm 500/\pm 1000/\pm 2000$  dps full scale



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## 1 The Board

As all Nano form factor boards, Nano 33 IoT and Nano 33 IoT with headers does not have a battery charger but can be powered through USB or headers.

**NOTE:** Nano 33 IoT and Nano 33 IoT with headers only supports 3.3V I/Os and is **NOT** 5V tolerant so please make sure you are not directly connecting 5V signals to this board or it will be damaged. Also, as opposed to Arduino Nano boards that support 5V operation, the 5V pin does NOT supply voltage but is rather connected, through a jumper, to the USB power input.

### 1.1 Application Examples

**Weather station:** Using the Nano 33 IoT or Nano 33 IoT with headers together with a sensor and a OLED display, we can create a small weather station communicating temperature, humidity etc. directly to your phone.

**Air quality monitor:** Bad air quality may have serious effects on your health. By assembling the board, with a sensor and monitor you can make sure that the air quality is kept in indoor-environments. By connecting the hardware assembly to an IoT application/API, you will receive real time values.

**Air drum:** A quick and fun project is to create a small air drum. Connect your board and upload your sketch from the Arduino Cloud Editor and start creating beats with your audio workstation of your choice.

## 2 Ratings

### 2.1 Recommended Operating Conditions

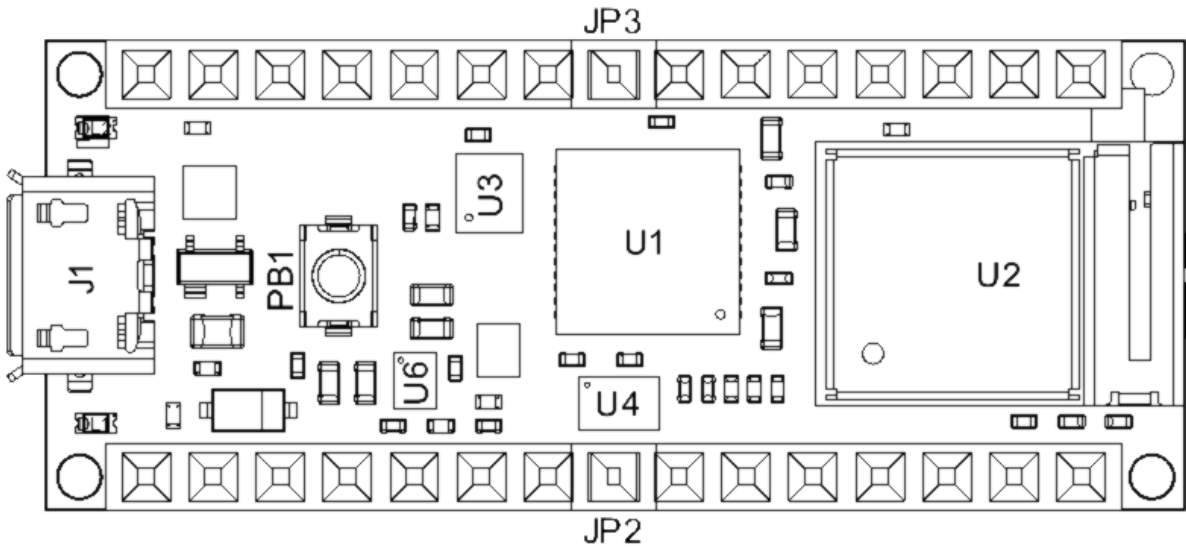
| Symbol | Description                                      | Min             | Max             |
|--------|--|-----------------|-----------------|
|        | Conservative thermal limits for the whole board: | -40 °C ( 40 °F) | 85 °C ( 185 °F) |

### 2.2 Power Consumption

| Symbol  | Description                              | Min  | Typ | Max | Unit |
|---------|--|------|-----|-----|------|
| VINMax  | Maximum input voltage from VIN pad       | -0.3 | -   | 21  | V    |
| VUSBMax | Maximum input voltage from USB connector | -0.3 | -   | 21  | V    |
| PMax    | Maximum Power Consumption                | -    | -   | TBC | mW   |

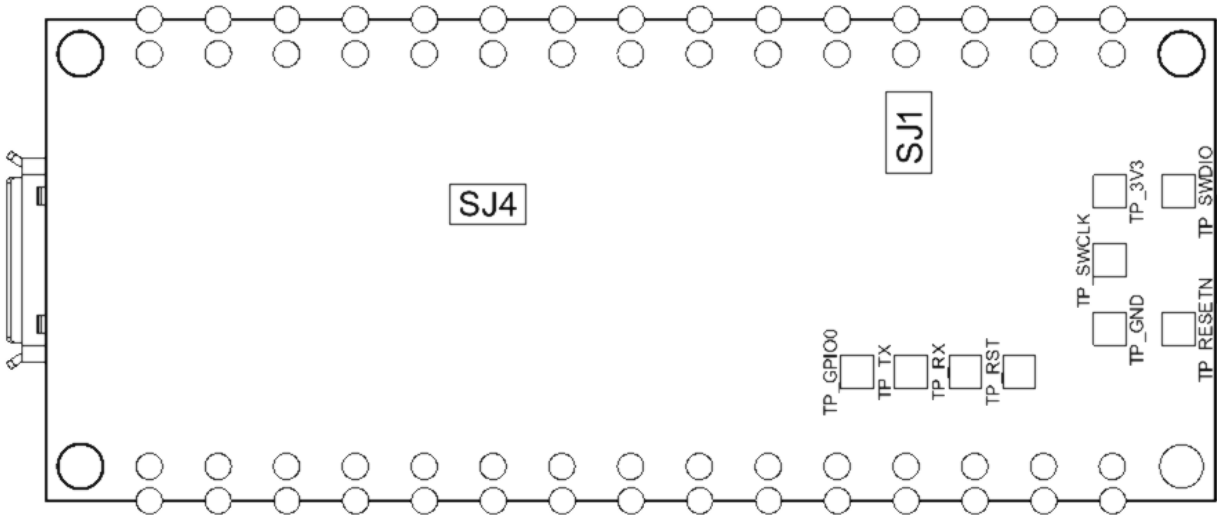
## 3 Functional Overview

### 3.1 Board Topology



Board topology top

| Ref. | Description                               | Ref. | Description                   |
|------|---|------|-------------------------------|
| U1   | ATSAMD21G18A Controller                   | U3   | LSM6DSOXTR IMU Sensor         |
| U2   | NINA-W102-00B Wi-Fi®/Bluetooth® LE Module | U4   | ATECC608A-MAHDA-T Crypto Chip |
| J1   | Micro USB Connector                       | PB1  | IT-1185-160G-GTR Push button  |



Board topology bottom

| Ref. | Description               | Ref. | Description                 |
|------|---------------------------|------|-----------------------------|
| SJ1  | Open solder bridge (VUSB) | SJ4  | Closed solder bridge (+3V3) |
| TP   | Test points               | xx   | Lorem Ipsum                 |

### 3.2 Processor

The Main Processor is a Arm® Cortex®-M0+ running at up to 48 MHz. Most of its pins are connected to the external headers, however some are reserved for internal communication with the wireless module and the on-board internal I<sup>2</sup>C peripherals (IMU and Crypto).

**NOTE:** As opposed to other Arduino Nano boards, pins A4 and A5 have an internal pull up and default to be used as an I<sup>2</sup>C Bus so usage as analog inputs is not recommended.

Communication with NINA W102 happens through a serial port and a SPI bus through the following pins.

| SAMD21 Pin | SAMD21 Acronym | NINA Pin | NINA Acronym | Description            |
|------------|----------------|----------|--------------|------------------------|
| 13         | PA08           | 19       | RESET_N      | Reset                  |
| 39         | PA27           | 27       | GPIO0        | Attention Request      |
| 41         | PA28           | 7        | GPIO33       | Acknowledge            |
| 23         | PA14           | 28       | GPIO5        | SPI CS                 |
| 21         | GPIO19         | UART RTS |              |                        |
| 24         | PA15           | 29       | GPIO18       | SPI CLK                |
| 20         | GPIO22         | UART CTS |              |                        |
| 22         | PA13           | 1        | GPIO23       | SPI MISO               |
| 21         | PA12           | 36       | GPIO12       | SPI MOSI               |
| 31         | PA22           | 23       | GPIO3        | Processor TX ↔ Nina RX |
| 32         | PA23           | 22       | GPIO1        | Processor RX ↔ Nina TX |

### 3.3 Wi-Fi®/Bluetooth® Communication Module

Nina W102 is based on ESP32 and is delivered with a pre-certified software stack from Arduino. Source code for the firmware is available [13].

**NOTE:** Reprogramming the wireless module's firmware with a custom one will invalidate compliance with radio standards as certified by Arduino, hence this is not recommended unless the application is used in private laboratories far from other electronic equipment and people. Usage of custom firmware on radio modules is the sole responsibility of the user.

Some of the module's pins are connected to the external headers and can be directly driven by ESP32 provided SAMD21's corresponding pins are aptly tri-stated. Below is a list of such signals:

| SAMD21 Pin | SAMD21 Acronym | NINA Pin | NINA Acronym | Description |
|------------|----------------|----------|--------------|-------------|
| 48         | PB03           | 8        | GPIO21       | A7          |
| 14         | PA09           | 5        | GPIO32       | A6          |
| 8          | PB09           | 31       | GPIO14       | A5/SCL      |
| 7          | PB08           | 35       | GPIO13       | A4/SDA      |

### 3.4 Crypto

The crypto chip in Arduino IoT boards is what makes the difference with other less secure boards as it provides a secure way to store secrets (such as certificates) and accelerates secure protocols while never exposing secrets in plain text.

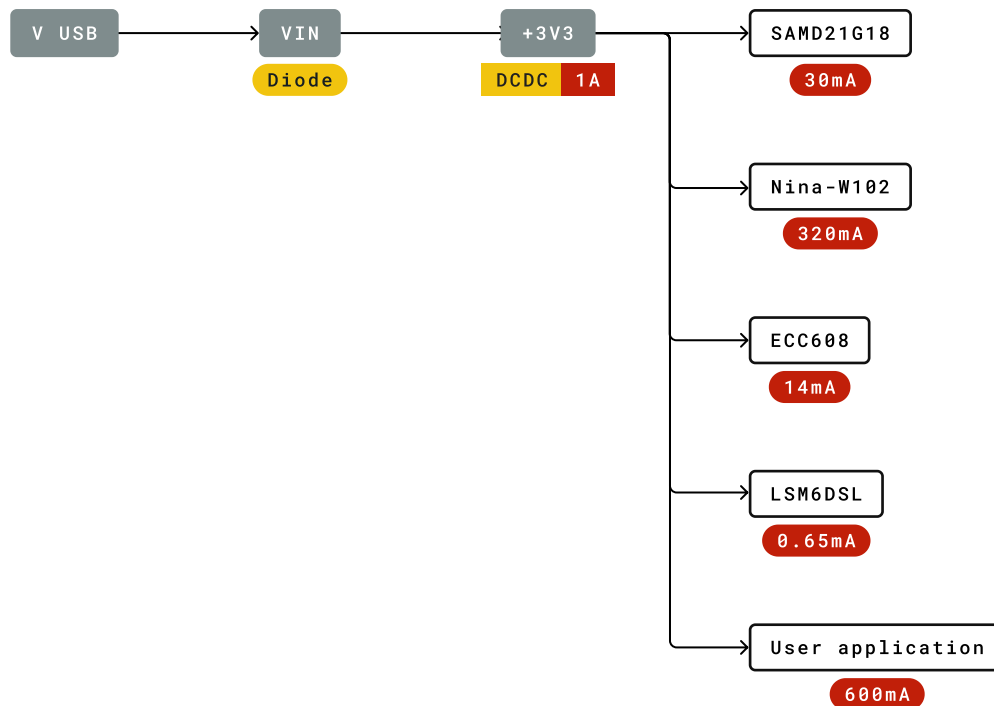
Source code for the Arduino Library that supports the Crypto is available [14]

### 3.5 IMU

The board has an embedded 6-axis IMU which can be used to measure board orientation (by checking the gravity acceleration vector orientation) or to measure shocks, vibration, acceleration and rotation speed.

Source code for the Arduino Library that supports the IMU is available [\[15\]](#)

### 3.6 Power Tree



Legend :

- Component
- Power I/O
- Conversion Type
- Max Current
- Voltage Range

Power tree





## 4 Board Operation

### 4.1 Getting Started - IDE

If you want to program your board while offline you need to install the Arduino Desktop IDE [1] To connect the Nano 33 IoT to your computer, you'll need a Micro-B USB cable. This also provides power to the board, as indicated by the LED.

### 4.2 Getting Started - Arduino Cloud Editor

All Arduino boards, including this one, work out-of-the-box on the Arduino Cloud Editor [2], by just installing a simple plugin.

The Arduino Cloud Editor is hosted online, therefore it will always be up-to-date with the latest features and support for all boards. Follow [3] to start coding on the browser and upload your sketches onto your board.

### 4.3 Getting Started - Arduino Cloud

All Arduino IoT enabled products are supported on Arduino Cloud which allows you to Log, graph and analyze sensor data, trigger events, and automate your home or business.

### 4.4 Sample Sketches

Sample sketches for the Nano 33 IoT can be found either in the "Examples" menu in the Arduino IDE or in the "Documentation" section of the Arduino Docs website [4].

### 4.5 Online Resources

Now that you have gone through the basics of what you can do with the board you can explore the endless possibilities it provides by checking exciting projects on Arduino Project Hub [5], the Arduino Library Reference [6] and the online store [7] where you will be able to complement your board with sensors, actuators and more

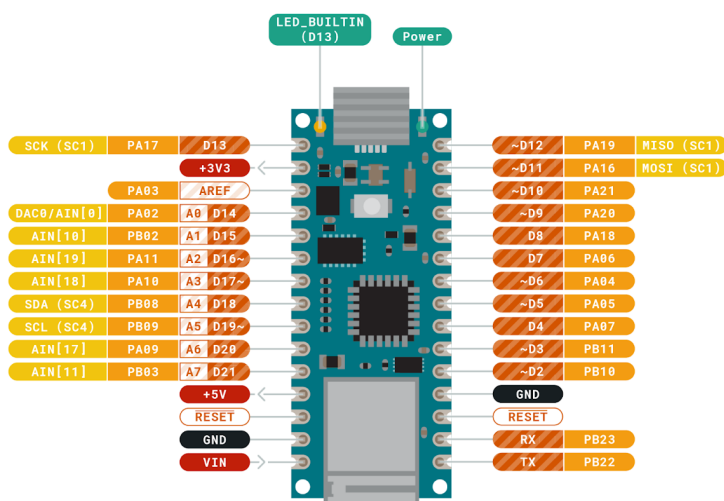
### 4.6 Board Recovery

All Arduino boards have a built-in bootloader which allows flashing the board via USB. In case a sketch locks up the processor and the board is not reachable anymore via USB it is possible to enter bootloader mode by double-tapping the reset button right after power up.

## 5 Connector Pinouts



### ARDUINO NANO 33 IoT



Pinout

### 5.1 USB

| Pin | Function | Type         | Description   |
|-----|----------|--------------|---|
| 1   | VUSB     | Power        | Power Supply Input. If board is powered via VUSB from header this is an Output <b>(1)</b> |
| 2   | D-       | Differential | USB differential data -   |
| 3   | D+       | Differential | USB differential data +   |
| 4   | ID       | Analog       | Selects Host/Device functionality   |
| 5   | GND      | Power        | Power Ground  |

1. The board can support USB host mode only if powered via the  $V_{USB}$  pin and if the jumper close to the VUSB pin is shorted.

## 5.2 Headers

The board exposes two 15 pin connectors which can either be assembled with pin headers or soldered through castellated vias.

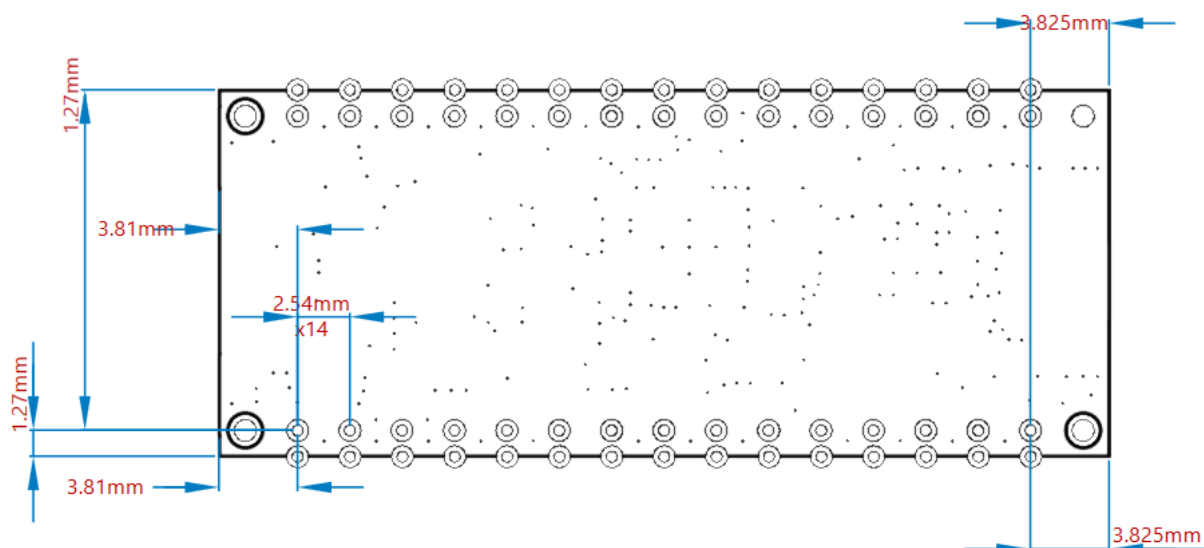
| Pin | Function | Type         | Description   |
|-----|----------|--------------|---|
| 1   | D13      | Digital      | GPIO  |
| 2   | +3V3     | Power Out    | Internally generated power output to external devices                               |
| 3   | AREF     | Analog       | Analog Reference; 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 <b>(1)</b>                                     |
| 9   | A5/SCL   | Analog       | ADC in; I2C SCL; Can be used as GPIO <b>(1)</b>                                     |
| 10  | A6       | Analog       | ADC in; can be used as GPIO   |
| 11  | A7       | Analog       | ADC in; can be used as GPIO   |
| 12  | VUSB     | Power In/Out | Normally NC; can be connected to VUSB 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   |

## 5.3 Debug

On the bottom side of the board, under the communication module, debug signals are arranged as 3x2 test pads with 100 mil pitch. Pin 1 is depicted in Figure 3 – Connector Positions

| Pin | Function | Type       | Description   |
|-----|----------|------------|---|
| 1   | +3V3     | Power Out  | Internally generated power output to be used as voltage reference |
| 2   | SWD      | Digital    | SAMD11 Single Wire Debug Data                                     |
| 3   | SWCLK    | Digital In | SAMD11 Single Wire Debug Clock                                    |
| 4   | UPDI     | Digital    | ATMega4809 update interface                                       |
| 5   | GND      | Power      | Power Ground  |
| 6   | RST      | Digital In | Active low reset input  |





Bottom side connectors

## 7 Certifications

### 7.1 Declaration of Conformity CE DoC (EU)

We declare under our sole responsibility that the products above are in conformity with the essential requirements of the following EU Directives and therefore qualify for free movement within markets comprising the European Union (EU) and European Economic Area (EEA).

### 7.2 Declaration of Conformity to EU RoHS & REACH 211 01/19/2021

Arduino boards are in compliance with RoHS 2 Directive 2011/65/EU of the European Parliament and RoHS 3 Directive 2015/863/EU of the Council of 4 June 2015 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

| Substance                              | Maximum limit (ppm) |
|--|---------------------|
| Lead (Pb)                              | 1000                |
| Cadmium (Cd)                           | 100                 |
| Mercury (Hg)                           | 1000                |
| Hexavalent Chromium (Cr6+)             | 1000                |
| Poly Brominated Biphenyls (PBB)        | 1000                |
| Poly Brominated Diphenyl ethers (PBDE) | 1000                |
| Bis(2-Ethylhexyl} phthalate (DEHP)     | 1000                |
| Benzyl butyl phthalate (BBP)           | 1000                |
| Dibutyl phthalate (DBP)                | 1000                |
| Diisobutyl phthalate (DIBP)            | 1000                |

Exemptions : No exemptions are claimed.

Arduino Boards are fully compliant with the related requirements of European Union Regulation (EC) 1907 /2006 concerning the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH). We declare none of the SVHCs (<https://echa.europa.eu/web/guest/candidate-list-table>), the Candidate List of Substances of Very High Concern for authorization currently released by ECHA, is present in all products (and also package) in quantities totaling in a concentration equal or above 0.1%. To the best of our knowledge, we also declare that our products do not contain any of the substances listed on the "Authorization List" (Annex XIV of the REACH regulations) and Substances of Very High Concern (SVHC) in any significant amounts as specified by the Annex XVII of Candidate list published by ECHA (European Chemical Agency) 1907 /2006/EC.

### 7.3 Conflict Minerals Declaration

As a global supplier of electronic and electrical components, Arduino is aware of our obligations with regards to laws and regulations regarding Conflict Minerals, specifically the Dodd-Frank Wall Street Reform and Consumer Protection Act, Section 1502. Arduino does not directly source or process conflict minerals such as Tin, Tantalum, Tungsten, or Gold. Conflict minerals are contained in our products in the form of solder, or as a component in metal alloys. As part of our reasonable due diligence Arduino has contacted component suppliers within our supply chain to verify their continued compliance with the regulations. Based on the information received thus far we declare that our products contain Conflict Minerals sourced from conflict-free areas.

## 8 FCC Caution

Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference
- (2) this device must accept any interference received, including interference that may cause undesired operation.

#### FCC RF Radiation Exposure Statement:

1. This Transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.
2. This equipment complies with RF radiation exposure limits set forth for an uncontrolled environment.
3. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

English: User manuals for license-exempt radio apparatus shall contain the following or equivalent notice in a conspicuous location in the user manual or alternatively on the device or both. This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions:

- (1) this device may not cause interference
- (2) this device must accept any interference, including interference that may cause undesired operation of the device.

French: Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

- (1) l'appareil n' doit pas produire de brouillage
- (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

#### IC SAR Warning:

English This equipment should be installed and operated with minimum distance 20 cm between the radiator and your body.

French: Lors de l' installation et de l' exploitation de ce dispositif, la distance entre le radiateur et le corps est d' au moins 20 cm.

**Important:** The operating temperature of the EUT can't exceed 85°C and shouldn't be lower than -40°C.

Hereby, Arduino S.r.l. declares that this product is in compliance with essential requirements and other relevant provisions of Directive 2014/53/EU. This product is allowed to be used in all EU member states.

| Frequency bands         | Maximum output power (EIRP) |
|-------------------------|-----------------------------|
| 2402-2480MHz(EDR)       | 6.24 dBm                    |
| 2402-2480MHz(BLE)       | 6.30 dBm                    |
| 2412-2472MHz(2.4G WiFi) | 13.61 dBm                   |



## 9 Company Information

|                     |                                  |
|---------------------|----------------------------------|
| <b>Company name</b> | <b>Arduino S.r.l</b>             |
| Company Address     | Via Andrea Appiani,2520900 MONZA |

## 10 Reference Documentation

| Reference                              | Link  |
|--|---|
| Arduino IDE (Desktop)                  | <a href="https://www.arduino.cc/en/software">https://www.arduino.cc/en/software</a>   |
| Arduino Cloud Editor                   | <a href="https://create.arduino.cc/editor">https://create.arduino.cc/editor</a>   |
| Arduino Cloud Editor - Getting Started | <a href="https://docs.arduino.cc/arduino-cloud/guides/editor/">https://docs.arduino.cc/arduino-cloud/guides/editor/</a>   |
| Arduino Documentation                  | <a href="https://docs.arduino.cc">https://docs.arduino.cc</a>   |
| Arduino Project Hub                    | <a href="https://create.arduino.cc/projecthub?by=part&amp;part_id=11332&amp;sort=trending">https://create.arduino.cc/projecthub?by=part&amp;part_id=11332&amp;sort=trending</a>   |
| Library Reference                      | <a href="https://www.arduino.cc/reference/en/">https://www.arduino.cc/reference/en/</a>   |
| Arduino Store                          | <a href="https://store.arduino.cc/">https://store.arduino.cc/</a>   |
| Forum                                  | <a href="http://forum.arduino.cc/">http://forum.arduino.cc/</a>   |
| SAMD21G18                              | <a href="https://ww1.microchip.com/downloads/aemDocuments/documents/MCU32/ProductDocuments/DataSheets/SAM-D21DA1-Family-Data-Sheet-DS40001882G.pdf">https://ww1.microchip.com/downloads/aemDocuments/documents/MCU32/ProductDocuments/DataSheets/SAM-D21DA1-Family-Data-Sheet-DS40001882G.pdf</a>   |
| NINA W102                              | <a href="https://content.u-blox.com/sites/default/files/NINA-W10_DataSheet_UBX-17065507.pdf">https://content.u-blox.com/sites/default/files/NINA-W10_DataSheet_UBX-17065507.pdf</a>   |
| ECC608                                 | <a href="https://ww1.microchip.com/downloads/aemDocuments/documents/SCBU/ProductDocuments/DataSheets/ATECC608A-CryptoAuthentication-Device-Summary-Data-Sheet-DS40001977B.pdf">https://ww1.microchip.com/downloads/aemDocuments/documents/SCBU/ProductDocuments/DataSheets/ATECC608A-CryptoAuthentication-Device-Summary-Data-Sheet-DS40001977B.pdf</a> |
| MPM3610                                | <a href="https://www.monolithicpower.com/pub/media/document/MPM3610_r1.01.pdf">https://www.monolithicpower.com/pub/media/document/MPM3610_r1.01.pdf</a>   |
| NINA Firmware                          | <a href="https://github.com/arduino/nina-fw">https://github.com/arduino/nina-fw</a>   |
| ECC608 Library                         | <a href="https://github.com/arduino-libraries/ArduinoECCX08">https://github.com/arduino-libraries/ArduinoECCX08</a>   |
| LSM6DSL Library                        | <a href="https://github.com/stm32duino/LSM6DSL">https://github.com/stm32duino/LSM6DSL</a>   |

## 11 Revision History

| Date       | Revision | Changes                               |
|------------|----------|---------------------------------------|
| 25/04/2024 | 4        | Updated link to new Cloud Editor      |
| 27/10/2023 | 3        | Correction NINA SPI pins              |
| 03/08/2022 | 2        | Reference documentation links updates |
| 15/04/2021 | 1        | General datasheet updates             |