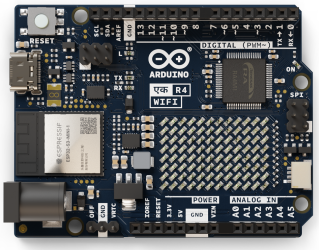
Product Reference Manual
SKU: ABX00087_IN



Description

The Arduino® UNO एक R4 WiFi is the first UNO board to feature a 32-bit microcontroller and an ESP32-S3 Wi-Fi® module (ESP32-S3-MINI-1-N8). It features a RA4M1 series microcontroller from Renesas (R7FA4M1AB3CFM#AA0), based on a 48 MHz Arm® Cortex®-M4 microprocessor. The UNO एक R4 WiFi's memory is larger than its predecessors, with 256 kB flash, 32 kB SRAM and 8 kB of EEPROM.

The RA4M1's operating voltage is fixed at 5 V, whereas the ESP32-S3 module is 3.3 V. Communication between these two MCUs is performed via a logic-level translator (TXB0108DQSR).

Target areas:

Maker, beginner, education

Features

The **R7FA4M1AB3CFM#AA0**, often referred to as RA4M1 in this datasheet, is the main MCU on the UNO एक R4 WiFi, connected to all pin headers on the board as well as all communication buses.

- **Overview**
  - 48 MHz Arm® Cortex®-M4 microprocessor with a floating point unit (FPU)
  - 5 V operating voltage
  - Real-time Clock (RTC)
  - Memory Protection Unit (MPU)
  - Digital-to-analog Converter (DAC)
- **Memory**
  - 256 kB Flash Memory
  - 32 kB SRAM
  - 8 kB Data Memory (EEPROM)
- **Peripherals**
  - Capacitive Touch Sensing Unit (CTSU)
  - USB 2.0 Full-Speed Module (USBFS)
  - 14-bit ADC
  - Up to 12-bit DAC
  - Operational Amplifier (OPAMP)
- **Power**
  - Operating voltage for RA4M1 is 5 V
  - Recommended input voltage (VIN) is 6-24 V
  - Barrel jack connected to VIN pin (6-24 V)
  - Power via USB-C® at 5 V
- **Communication**
  - 1x UART (pin D0, D1)
  - 1x SPI (pin D10-D13, ICSP header)
  - 1x I2C (pin A4, A5, SDA, SCL)
  - 1x CAN (pin D4, D5, external transceiver is required)

See the full datasheet for the R7FA4M1AB3CFM#AA0 in the link below:

- R7FA4M1AB3CFM#AA0 datasheet

The **ESP32-S3-MINI-1-N8** is the secondary MCU with a built-in antenna for Wi-Fi® & Bluetooth® connectivity. This module operates on 3.3 V and communicates with the RA4M1 using a logic-level translator (TXB0108DQSR).

- **Overview**
  - Xtensa® dual-core 32-bit LX7 microprocessor
  - 3.3 V operating voltage
  - 40 MHz crystal oscillator

- **Wi-Fi®**
  - Wi-Fi® support with 802.11 b/g/n standard (Wi-Fi® 4)
  - Bit rate at up to 150 Mbps
  - 2.4 GHz band
- **Bluetooth®**
  - Bluetooth® 5

See the full datasheet for the ESP32-S3-MINI-1-N8 in the link below:

- ESP32-S3-MINI-1-N8 datasheet

CONTENTS

1 The Board

1.1 Application Examples

The UNO एक R4 WiFi is part of the first UNO series of 32-bit development boards, being previously based on 8-bit AVR microcontrollers. There are thousands of guides, tutorials and books written about the UNO board, where the UNO एक R4 WiFi continues its legacy.

The board features 14 digital I/O ports, 6 analog channels, dedicated pins for I2C, SPI and UART connections. It has a significantly larger memory: 8 times more flash memory (256 kB) and 16 times more SRAM (32 kB). With a 48 MHz clock speed, it is also 3x faster than its predecessors.

In addition, it features an ESP32-S3 module for Wi-Fi® & Bluetooth® connectivity, as well as a built-in 12x8 LED matrix, making it one of the most visually unique Arduino boards to date. The LED matrix is fully programmable, where you can load anything from still frames to custom animations.

Entry-level projects: If this is your first project within coding and electronics, the UNO एक R4 WiFi is a good fit. It is easy to get started with, and it has a lot of online documentation.

Easy IoT applications: build projects without writing any networking code in the Arduino Cloud. Monitor your board, connect it with other boards and services, and develop cool IoT projects.

LED Matrix: the 12x8 LED matrix on the board can be used for showing animations, text scrolling, create mini-games and much more, being the perfect feature to give your project more personality.

1.2 Related Products

- UNO R3
- UNO R3 SMD
- UNO R4 Minima

Rating

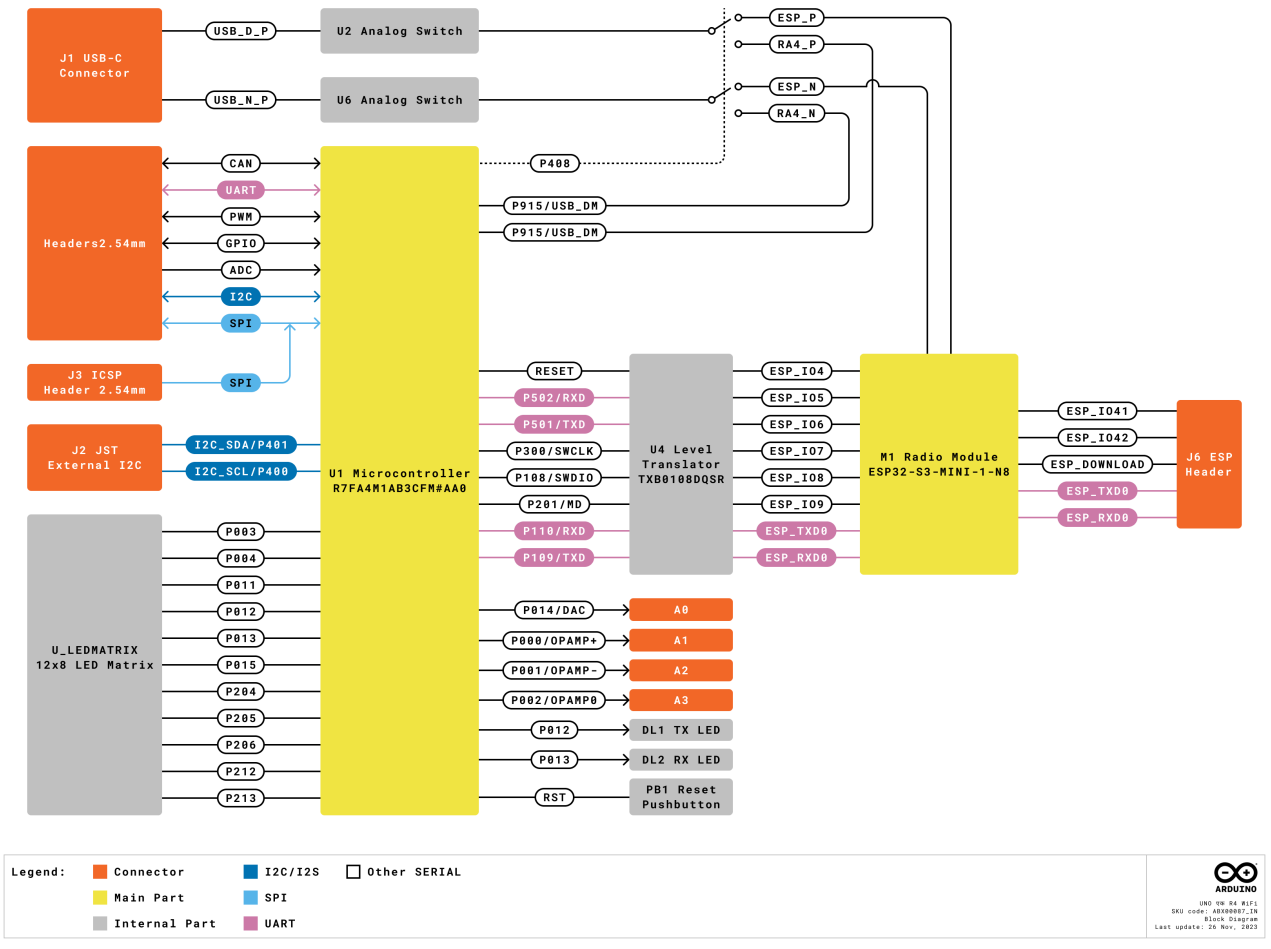
2 Recommended Operating Conditions

Symbol	Description	Min	Typ	Max	Unit
V_{IN}	Input voltage from VIN pad / DC Jack	6	7.0	24	V
V_{USB}	Input voltage from USB connector	4.8	5.0	5.5	V
T_{OP}	Operating Temperature	-40	25	85	°C

Note: V_{DD} controls the logic level and is connected to the 5V power rail. V_{AREF} is for the analog logic.

Functional Overview

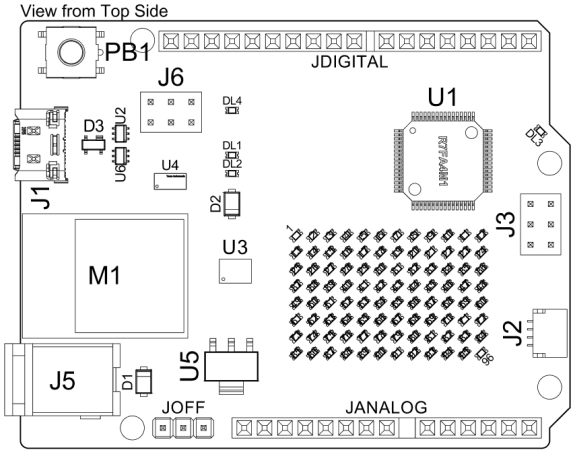
3 Block Diagram



Arduino UNO एक R4 WiFi Block Diagram

4 Board Topology

4.1 Front View



Top View of Arduino UNO एक R4 WiFi

Ref.	Description
U1	R7FA4M1AB3CFM#AA0 Microcontroller IC
U2	NLASB3157DFT2G Multiplexer
U3	ISL854102FRZ-T Buck Converter
U4	TXB0108DQSR logic level translator (5 V - 3.3 V)
U5	SGM2205-3.3XKC3G/TR 3.3 V linear regulator
U6	NLASB3157DFT2G Multiplexer
U_LEDMATRIX	12x8 LED Red Matrix
M1	ESP32-S3-MINI-1-N8
PB1	RESET Button
JANALOG	Analog input/output headers
JDIGITAL	Digital input/output headers
JOFF	OFF, VRTC header
J1	CX90B-16P USB-C® connector
J2	SM04B-SRSS-TB(LF)(SN) I2C connector
J3	ICSP header (SPI)
J5	DC Jack
J6	ESP header
DL1	LED TX (serial transmit)

Ref.	Description
DL2	LED RX (serial receive)
DL3	LED Power (green)
DL4	LED SCK (serial clock)
D1	PMEG6020AELRX Schottky Diode
D2	PMEG6020AELRX Schottky Diode
D3	PRTR5V0U2X,215 ESD Protection

5 Microcontroller (R7FA4M1AB3CFM#AA0)

The UNO एक R4 WiFi is based on the 32-bit RA4M1 series microcontroller, **R7FA4M1AB3CFM#AA0**, from Renesas, which uses a 48 MHz Arm® Cortex®-M4 microprocessor with a floating point unit (FPU).

The operating voltage for the RA4M1 is fixed at 5 V as to be hardware compatible with shields, accessories & circuits based on previous Arduino UNO boards.

The R7FA4M1AB3CFM#AA0 features:

- 256 kB flash / 32 kB SRAM / 8 kB data flash (EEPROM)
- Real-time Clock (RTC)
- 4x Direct Memory Access Controller (DMAC)
- 14-bit ADC
- Up to 12-bit DAC
- OPAMP
- CAN bus

For more technical details on this microcontroller, visit the Renesas - RA4M1 series official documentation.

6 Wi-Fi® / Bluetooth® Module (ESP32-S3-MINI-1-N8)

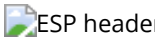
The Wi-Fi® / Bluetooth® LE module on the UNO एक R4 WiFi is from the ESP32-S3 SoCs. It features the Xtensa® dual-core 32-bit LX7 MCU, a built-in antenna and support for 2.4 GHz bands.

The ESP32-S3-MINI-1-N8 features:

- Wi-Fi® 4 - 2.4 GHz band
- Bluetooth® 5 LE support
- 3.3 V operating voltage
- 384 kB ROM
- 512 kB SRAM
- Up to 150 Mbps bit rate

This module acts as a secondary MCU on the UNO एक R4 WiFi, and communicates with the RA4M1 MCU using a logic-level translator. Note that this module operates on 3.3 V as opposed to the RA4M1's 5 V operating voltage.

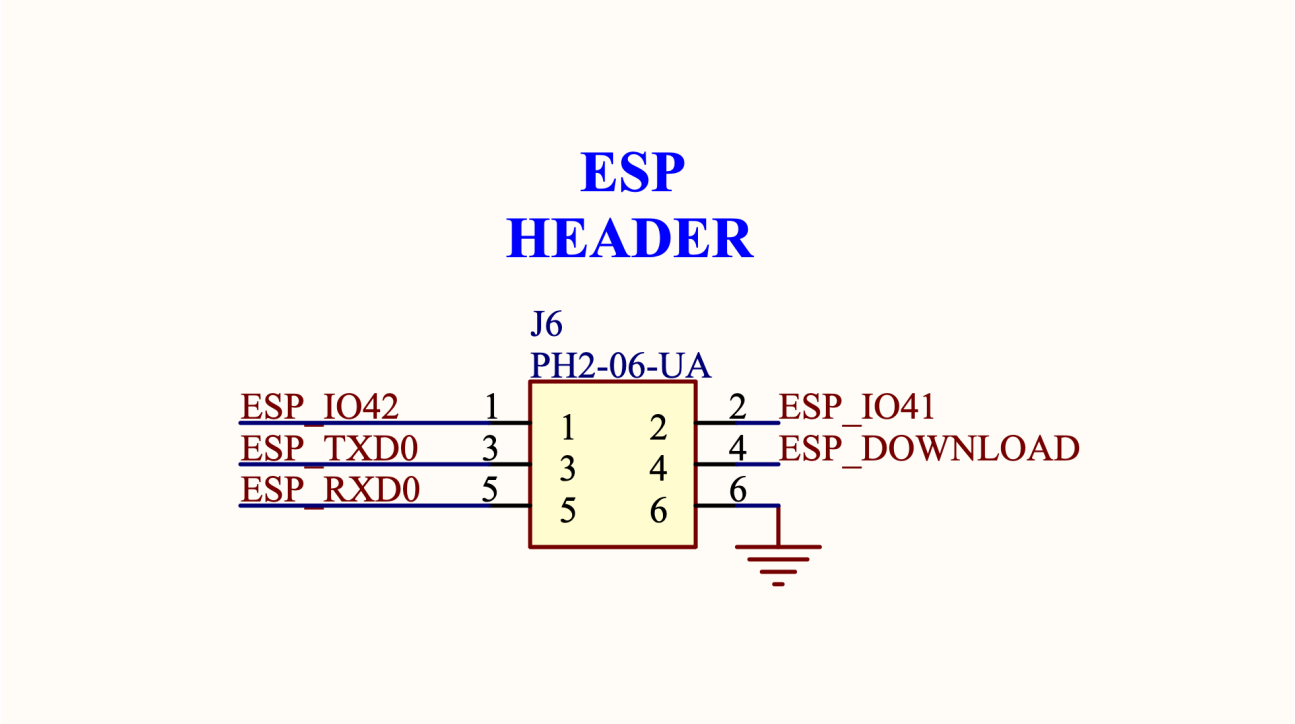
6.1 ESP Header


ESP header.

ESP header.

The header located close to the RESET button can be used to access the ESP32-S3 module directly. The pins accessible are:

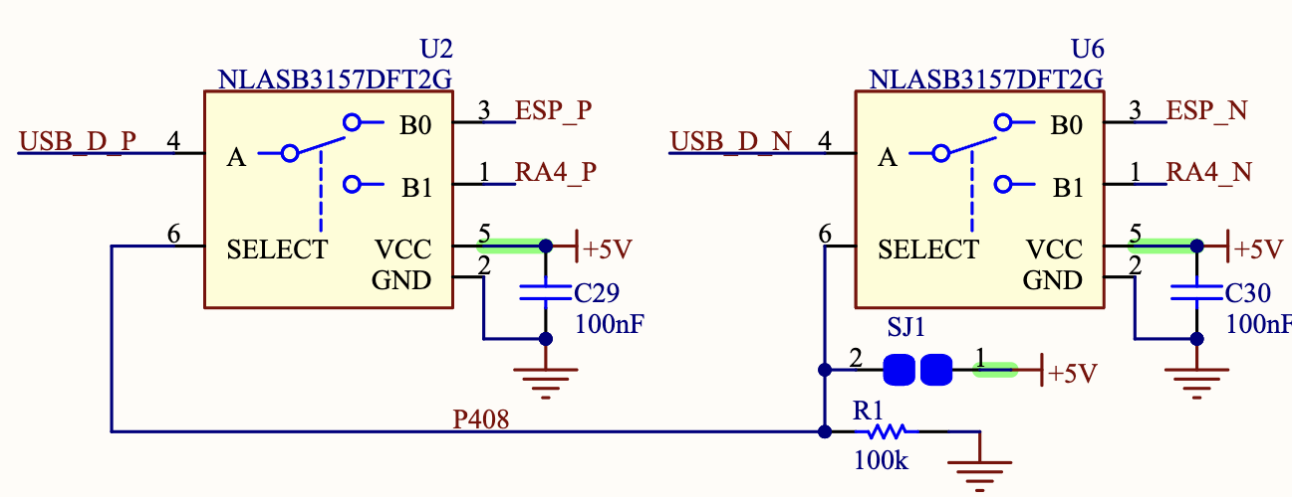
- ESP_IO42 - MTMS debugging (Pin 1)
- ESP_IO41 - MTDI debugging (Pin 2)
- ESP_TXD0 - Serial Transmit (UART) (Pin 3)
- ESP_DOWNLOAD - boot (Pin 4)
- ESP_RXD0 - Serial Receive (UART) (Pin 5)
- GND - ground (Pin 6)



ESP header (schematic)

6.2 USB Bridge

When programming the UNO एक R4 WiFi, the RA4M1 MCU is programmed via the ESP32-S3 module by default. The **U2** and **U6** switches can switch the USB communication to go directly to the RA4M1 MCU, by writing a high state to the P408 pin (D40).



Soldering together the **SJ1** pads permanently sets the USB communication directly to the RA4M1, bypassing the ESP32-S3.

7 USB Connector

The UNO एक R4 WiFi has one USB-C® port, used to power and program your board as well as sending & receiving serial communication.

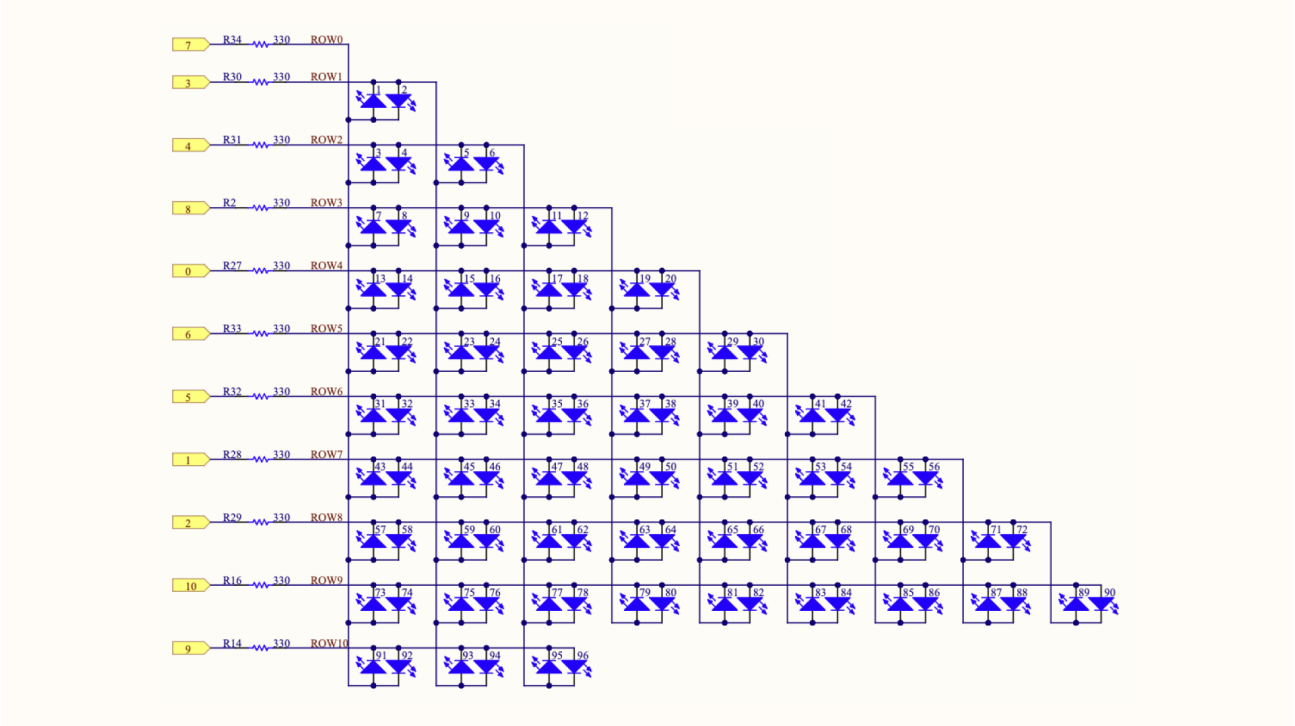
Note: The board should not be powered with more than 5 V via the USB-C® port.

8 LED Matrix

The UNO एक R4 WiFi features a 12x8 matrix of red LEDs (**U_LEDMATRIX**), connected using the technique known as charlieplexing.

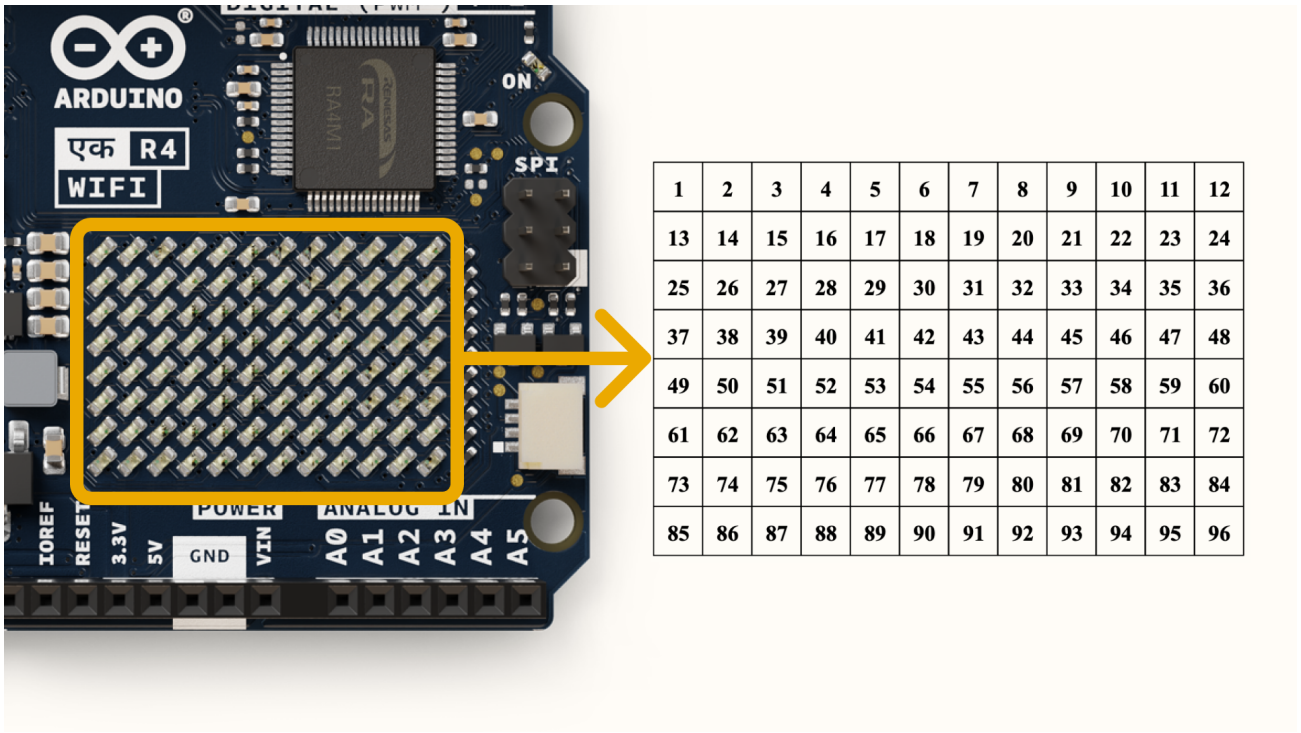
The following pins on the RA4M1 MCU are used for the matrix:

- P003
- P004
- P011
- P012
- P013
- P015
- P204
- P205
- P206
- P212
- P213



LED matrix schematics.

These LEDs can be accessed as an array, using a specific library. See the mapping below:



1	2	3	4	5	6	7	8	9	10	11	12
13	14	15	16	17	18	19	20	21	22	23	24
25	26	27	28	29	30	31	32	33	34	35	36
37	38	39	40	41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72
73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96

LED matrix number mapping.

This matrix can be used for a number of projects and prototyping purposes, and supports animation, simple game designs and scrolling text among other things.

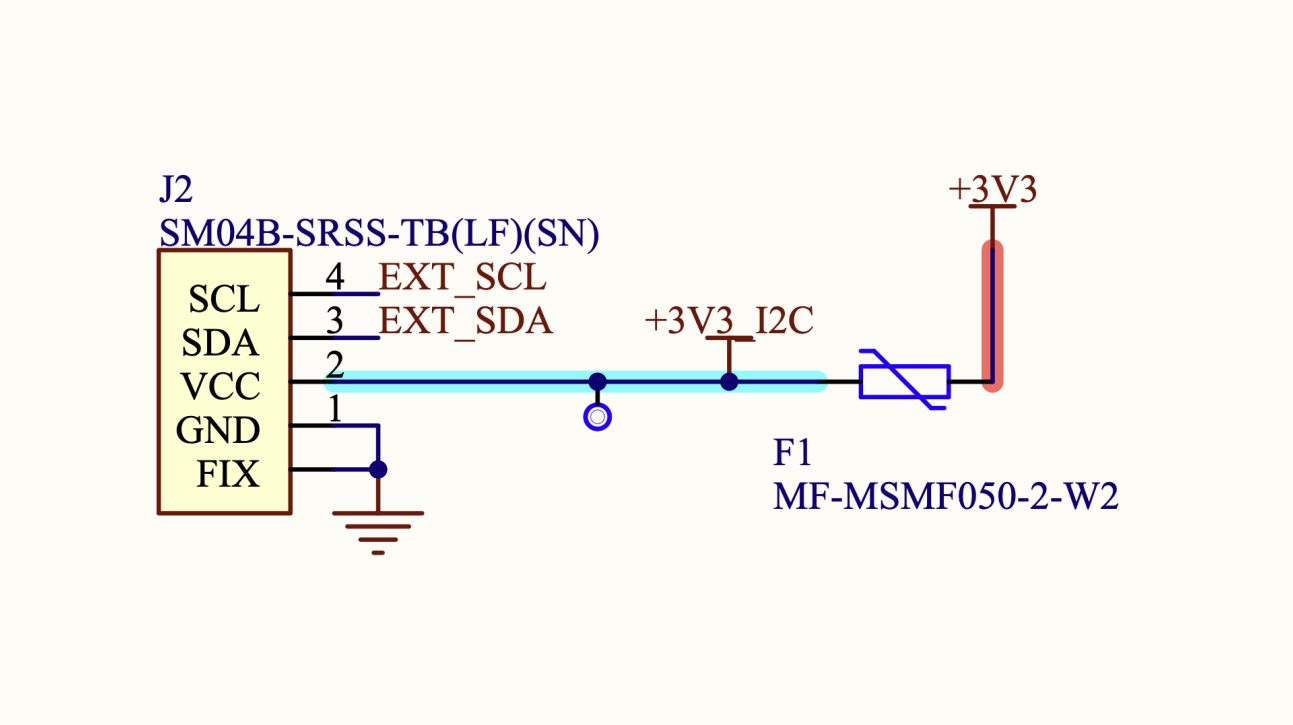
9 Digital Analog Converter (DAC)

The UNO एक R4 WiFi has a DAC with up to 12-bit resolution attached to the A0 analog pin. A DAC is used to convert a digital signal to an analog signal.

The DAC can be used for signal generation for e.g. audio applications, like generating and altering sawtooth waves.

10 I2C Connector

The I2C connector SM04B-SRSS-TB(LF)(SN) is connected to a secondary I2C bus on the board. Note that this connector is powered via 3.3 V.



I2C connector.

This connector also shares the following pin connections:

JANALOG header

- A4
- A5

JDIGITAL header

- SDA
- SCL

Note: as A4/A5 is connected to the main I2C bus, these should not be used as ADC inputs whenever the bus is in use. You can however connect I2C devices to each of these pins and connectors simultaneously.

11 Power Options

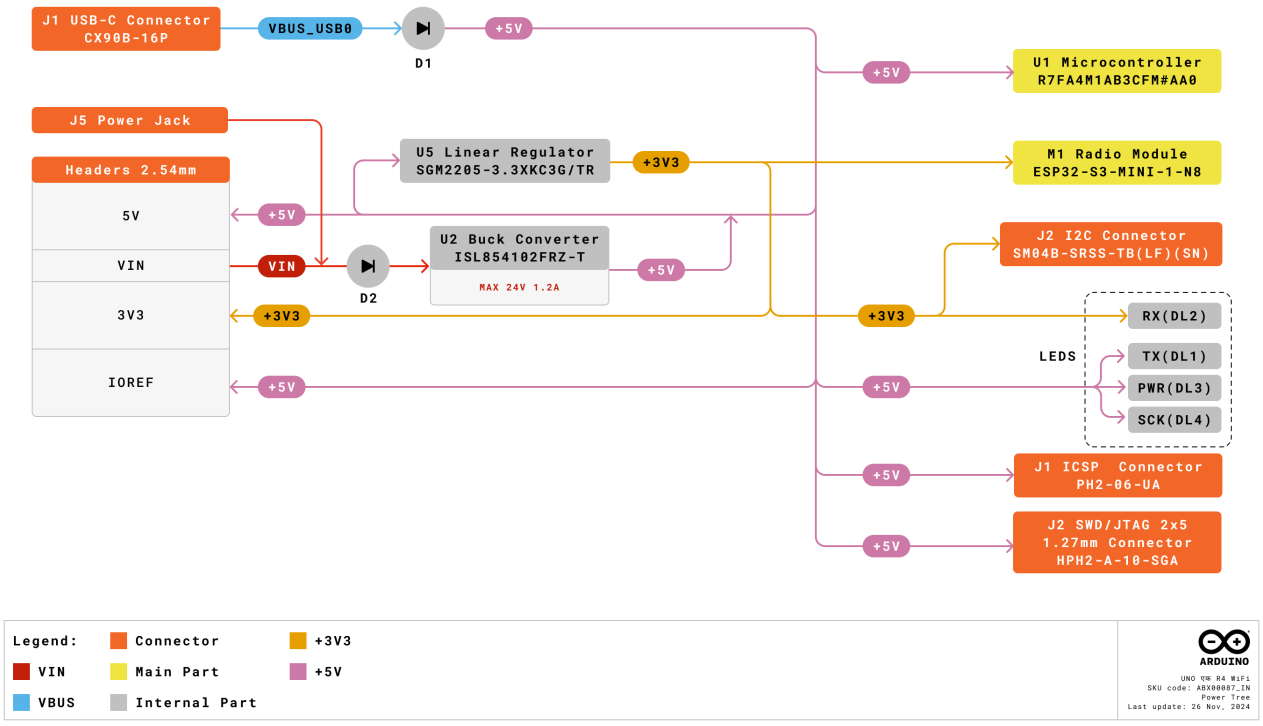
Power can either be supplied via the VIN pin, or via USB-C® connector. If power is supplied via VIN, the ISL854102FRZ buck converter steps the voltage down to 5 V.

Both VUSB and VIN pins are connected to the ISL854102FRZ buck converter, with Schottky diodes in place for reverse polarity & overvoltage protection respectively.

Power via USB supplies about ~4.7 V (due to Schottky drop) to the RA4M1 MCU.

The linear regulator (SGM2205-3.3XKC3G/TR) converts 5 V from either the buck converter or USB, and provides 3.3 V to a number of components, including the ESP32-S3 module.

11.1 Power Tree



Arduino UNO एक R4 WiFi power tree.

11.2 Pin Voltage

The general operating voltage for UNO एक R4 WiFi is 5 V, however the ESP32-S3 module's operating voltage is 3.3 V.

Note: It is **very** important that ESP32-S3's pins (3.3 V) do not come in contact with any of the RA4M1's pins (5 V), as this may damage the circuits.

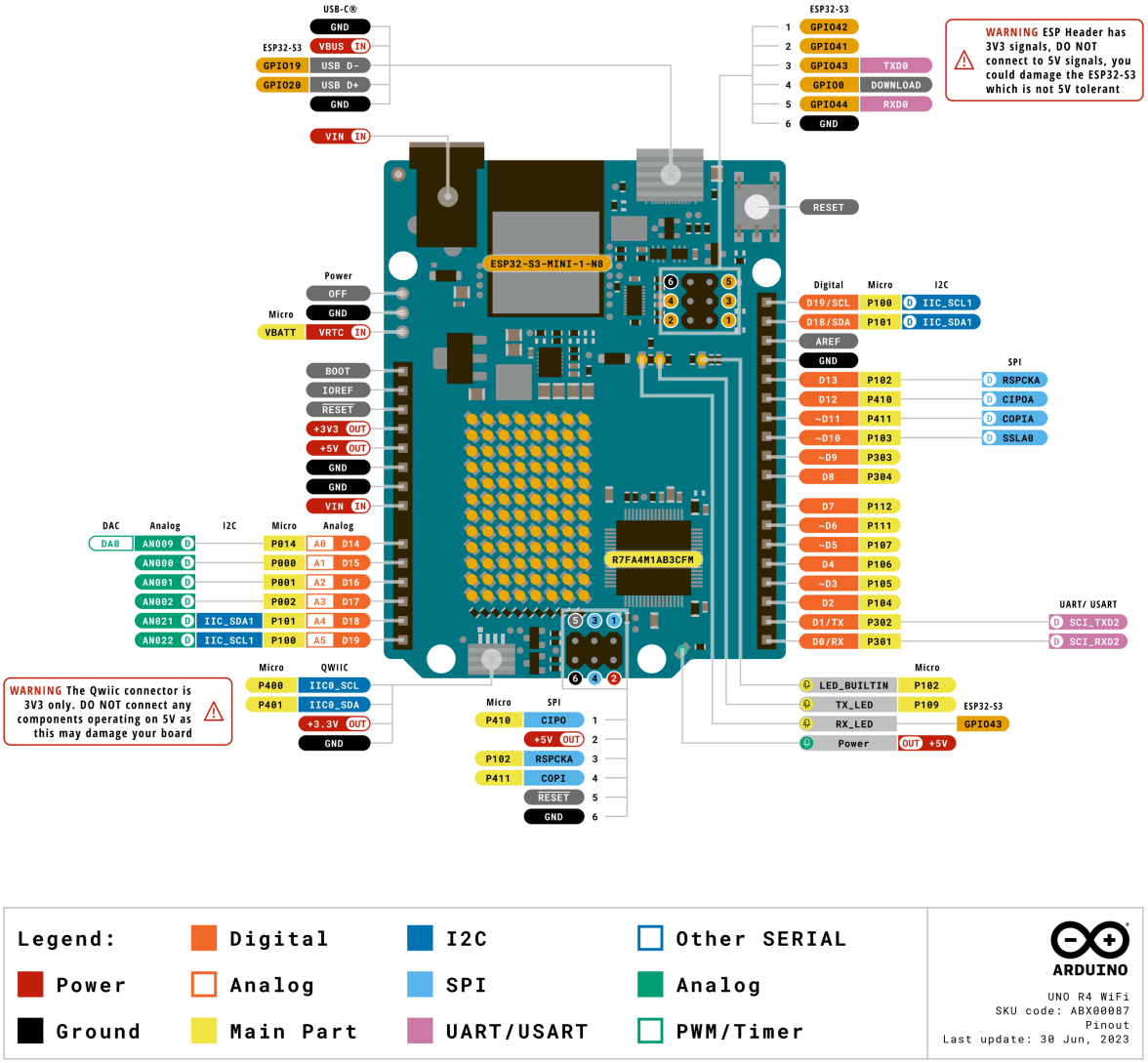
11.3 Pin Current

The GPIOs on the R7FA4M1AB3CFM#AA0 microcontroller can safely handle up to 8 mA of current. Never connect devices that draw higher current directly to a GPIO as this may damage the circuit.

For powering e.g. servo motors, always use an external power supply.

Mechanical Information

12 Pinout



Pinout for UNO एक R4 WiFi.

12.1 Analog

Pin	Function	Type	Description
1	BOOT	NC	Not Connected
2	IOREF	IOREF	Reference for digital logic V - connected to 5 V
3	Reset	Reset	Reset
4	+3V3	Power	+3V3 Power Rail
5	+5V	Power	+5V Power Rail
6	GND	Power	Ground
7	GND	Power	Ground
8	VIN	Power	Voltage Input
9	A0	Analog	Analog input 0 / DAC
10	A1	Analog	Analog input 1 / OPAMP+
11	A2	Analog	Analog input 2 / OPAMP-
12	A3	Analog	Analog input 3 / OPAMPOut
13	A4	Analog	Analog input 4 / I2C Serial Datal (SDA)
14	A5	Analog	Analog input 5 / I2C Serial Clock (SCL)

12.2 Digital

Pin	Function	Type	Description
1	SCL	Digital	I2C Serial Clock (SCL)
2	SDA	Digital	I2C Serial Datal (SDA)
3	AREF	Digital	Analog Reference Voltage
4	GND	Power	Ground
5	D13/SCK/CANRX0	Digital	GPIO 13 / SPI Clock / CAN Receiver (RX)
6	D12/CIPO	Digital	GPIO 12 / SPI Controller In Peripheral Out
7	D11/COPI	Digital	GPIO 11 (PWM) / SPI Controller Out Peripheral In
8	D10/CS/CANTX0	Digital	GPIO 10 (PWM) / SPI Chip Select / CAN Transmitter (TX)
9	D9	Digital	GPIO 9 (PWM~)
10	D8	Digital	GPIO 8
11	D7	Digital	GPIO 7
12	D6	Digital	GPIO 6 (PWM~)
13	D5	Digital	GPIO 5 (PWM~)
14	D4	Digital	GPIO 4
15	D3	Digital	GPIO 3 (PWM~) / Interrupt Pin
16	D2	Digital	GPIO 2 / Interrupt Pin
17	D1/TX0	Digital	GPIO 1 / Serial 0 Transmitter (TX)
18	D0/TX0	Digital	GPIO 0 / Serial 0 Receiver (RX)

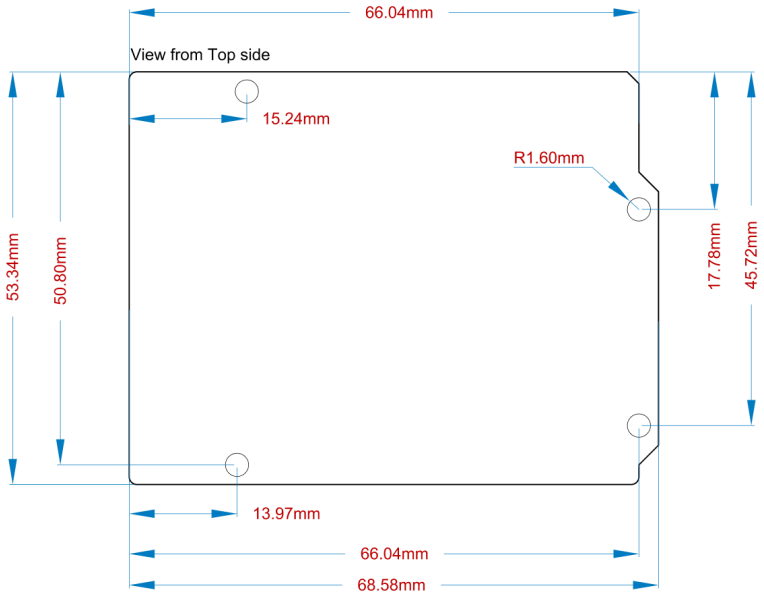
12.3 OFF

Pin	Function	Type	Description
1	OFF	Power	For controlling power supply
2	GND	Power	Ground
1	VRTC	Power	Battery connection to power RTC only

12.4 ICSP

Pin	Function	Type	Description
1	CIPO	Internal	Controller In Peripheral Out
2	+5V	Internal	Power Supply of 5 V
3	SCK	Internal	Serial Clock
4	COPI	Internal	Controller Out Peripheral In
5	RESET	Internal	Reset
6	GND	Internal	Ground

13 Mounting Holes And Board Outline



Top side Mechanical View of Arduino UNO एक R4 WiFi

14 Board Operation

14.1 Getting Started - IDE

If you want to program your UNO एक R4 WiFi while offline you need to install the Arduino® Desktop IDE **[1]**. To connect the UNO एक R4 WiFi to your computer, you will need a Type-C® USB cable, which can also provide power to the board, as indicated by the LED (DL1).

14.2 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.

14.3 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.

14.4 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 existing projects on Arduino Project Hub **[4]**, the Arduino Library Reference **[5]**, and the online store **[6]**; where you will be able to complement your board with sensors, actuators and more.

14.5 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 the power-up.

15 Company Information

Company name	Arduino SRL
Company Address	Via Andrea Appiani, 25 - 20900 MONZA（Italy)

16 Reference Documentation

Ref	Link
Arduino IDE (Desktop)	https://www.arduino.cc/en/Main/Software
Arduino IDE (Cloud)	https://create.arduino.cc/editor
Cloud IDE Getting Started	https://docs.arduino.cc/cloud/web-editor/tutorials/getting-started/getting-started-web-editor
Project Hub	https://create.arduino.cc/projecthub?by=part&part_id=11332&sort=trending
Library Reference	https://github.com/arduino-libraries/
Online Store	https://store.arduino.cc/

17 Change Log

Date	Revision	Changes
24/11/2024	1	Release IN version