

Uno R3+

1 DESCRIPTION

The PTSolns *Uno R3+* based on the ATmega328P-PU, is a popular microcontroller development board with additional unique features. The *Uno R3+* continues to be compatible with a range of shields, yet it has two extra female header pins. These pins are used to supply SDA and SCL that are shifted from the onboard logic level of 5V down to 3.3V. Along with the onboard QWIIC® connector, this shifted 3.3V I2C bus makes it convenient to connect many common sensors and modules that operate on 3.3V logic. No need for extra external components, all the logic level shifting between 5V and 3.3V on the I2C bus is done automatically onboard.



The *Uno R3+* replaces the previous bulky USB port with a modern USB-C port. Meanwhile the standard power barrel jack remains onboard. The board has a new layout of components, such as for example, the grouping of the four LEDs (Power LED, Pin 13 controlled LED, TX and RX communication LEDs). Furthermore, the *Uno R3+* allows for a larger current draw on the 3.3V pin with a rated maximum of 0.5A. This lets the user manage their project's power budget more easily by allowing a larger current draw.

This version of the *Uno R3+* contains the ATmega328P-PU as a 28-Pin through-hole component that can be removed from the board and used elsewhere, as in for example the popular entry-level project "Make Your own Uno". The *Uno R3+* comes with a pre-installed out-of-the-box ready set of tests. This gets simple projects started quickly and allows for testing the proper function of the board. A large active online community supports this microcontroller and its programming using the Arduino IDE software. Many tutorials, projects, schematics, and sketches can be easily found online in blogs, forums and the like.

This *Plus* version offers all of the features users come to learn and expect, and adds additional ones that make this board stand out.

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2 DOCUMENT REVISION HISTORY

Current document revision is Rev 0.

3 PRODUCT FEATURES

This section highlights notable features of the *Uno R3+*.

3.1 I/O Connectors & Input Power

The *Uno R3+* has three input/output (I/O) connectors as follows:

- USB-C
- Power barrel jack (2.1 mm x 5.5 mm)
- QWIIC®

These connectors are shown in Figure 1. Note that the QWIIC connector adheres to the standardization as outlined by SparkFun Electronics: <https://www.sparkfun.com/qwiic>

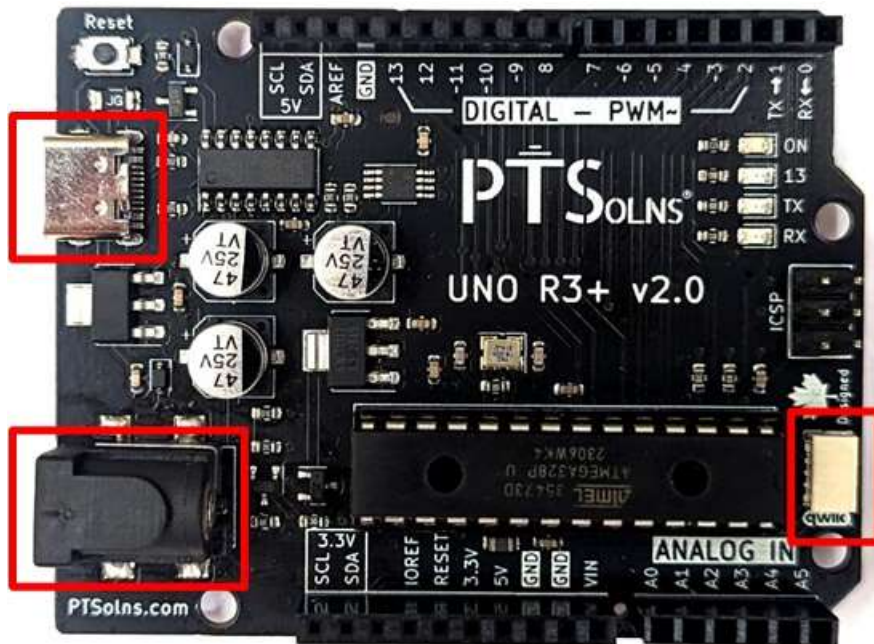


Figure 1: The three I/O connectors on the *Uno R3+*.

The *Uno R3+* can be powered in multiple ways, with the most common two methods being the USB-C port and the power barrel jack. If the user connects both at the same time, the board automatically selects the voltage from either source depending on the voltage level of the power jack. The user can also power the board using the “VIN” pin on the female header with the same voltage input ratings as for the power barrel jack (i.e. Vin = 7-12 V max).

The board can also be powered directly by supplying a clean and steady 5V DC to the “5V” pin on the female header. This bypasses the onboard 5V voltage regulator, and can be done if an external 5V source is available. **Note that the ATmega328P-PU should not exceed an input voltage of 5.5V and therefore the user needs to exercise caution when powering the *Uno R3+* from the 5V pin directly.**

3.2 I2C Bus

The *Uno R3+* offers an I2C bus on the SDA and SCL lines, inherently at the ATmega328P-PU 5V logic level. For the ATmega328P-PU the 5V SDA and SCL pins are the A4 and A5 analog pins, respectively. For convenience these pins are also available on the top-left female header breakout marked as “SCL” and “SDA” in a box with “5V”, as seen in Figure 1. This is to clearly indicate to the user that this part of the I2C bus operates on 5V logic.

The *Uno R3+* has an onboard Logic Level Shifter (LLS) that shifts the 5V I2C bus down to 3.3V. These corresponding I2C pins are available on the bottom-left female header breakout marked as “SCL” and “SDA” in a box with “3.3V”, as seen in Figure 1. This is to clearly indicate to the user that this part of the I2C bus operates on the 3.3V logic.

The I2C bus at 3.3V is also made available in the form as a QWIIC connector. This connector is available to the right of the ATmega328P-PU, marked with the trademark “QWIIC” logo, as seen in Figure 1. Note that the QWIIC connector adheres to the standardization as outlined By SparkFun Electronics: <https://www.sparkfun.com/qwiic>

The user can connect multiple peripherals to the *Uno R3+* via I2C simultaneously. It is possible to connect to the 5V I2C, shifted 3.3V I2C as well as the QWIIC connector all at once as long as the following requirements are met:

- The total number of I2C connected peripherals does not exceed 126 units.
- The power budget of the project does not exceed any current rating (See Section 5).
- Each device address is unique (alternatively an [I2C MUX](#) can be used to connect peripherals with the same address on the same I2C bus).
- There is not too much capacitance introduced by long connecting wires. The rise-time of the I2C signals as determined by the corresponding time constant must be within acceptable range (See discussion below).

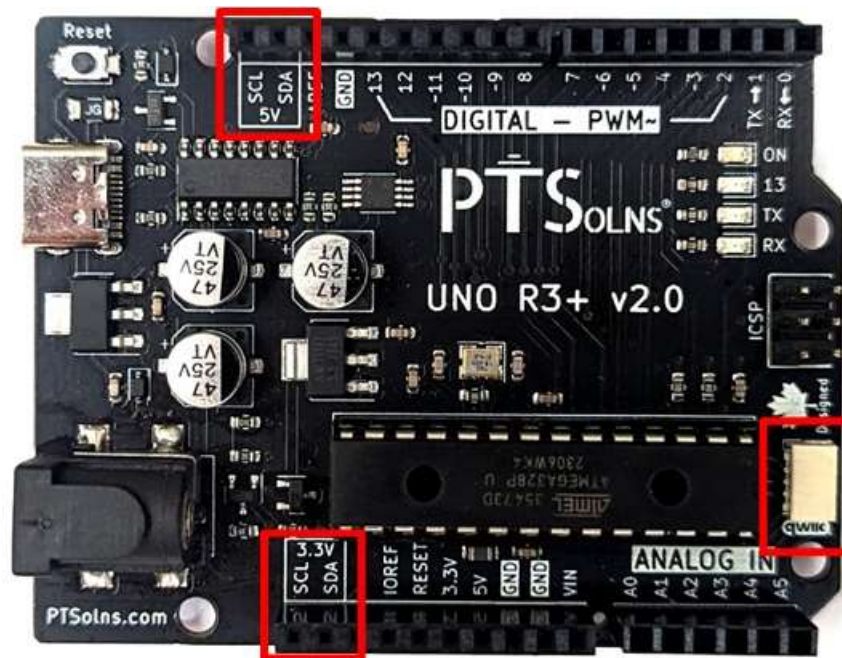


Figure 1: I2C pins at 5V and 3.3V, as well as the QWIIC connector, on the Uno R3+.

The default connection for the 3.3V SDA and SCL pins on the *Uno R3+* is such that it is enabled. This means, the *Uno R3+* out-of-the-box will have a functioning 3.3V I2C bus as seen near the bottom-left (female header pins) and middle-right (QWIIC connector) in Figure 1. However, it is possible to disconnect these pins by cutting the jumper pads labelled “3.3V SDA” and “3.3V SCL” as shown in Figure 2. When these pins are cut the 3.3V SDA and SCL pins and QWIIC connector are floating.

Furthermore, there are additional pull-up resistors on the 5V I2C bus each of 10 k Ω . These can also be disconnected by cutting the jumper pads labelled “10k Pull-up 5V SCL” and “10k Pull-up 5V SDA” as shown in Figure 2. A full schematic of the Logic Level Shifter (LLS) showing the 5V and the 3.3V sides of the I2C bus, as well as the four jumper pads, can be seen in Figure 3.

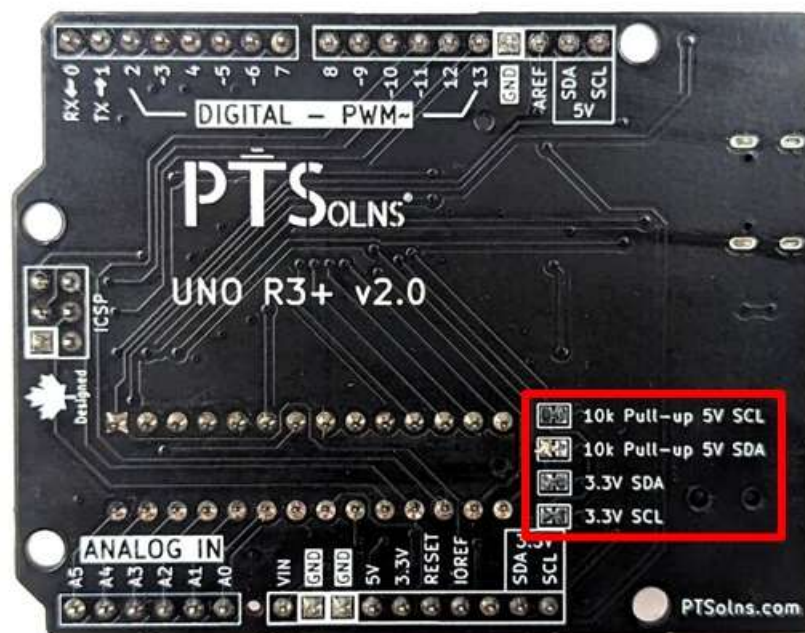


Figure 2: Jumper pads on the back of the Uno R3+ (all closed by default).

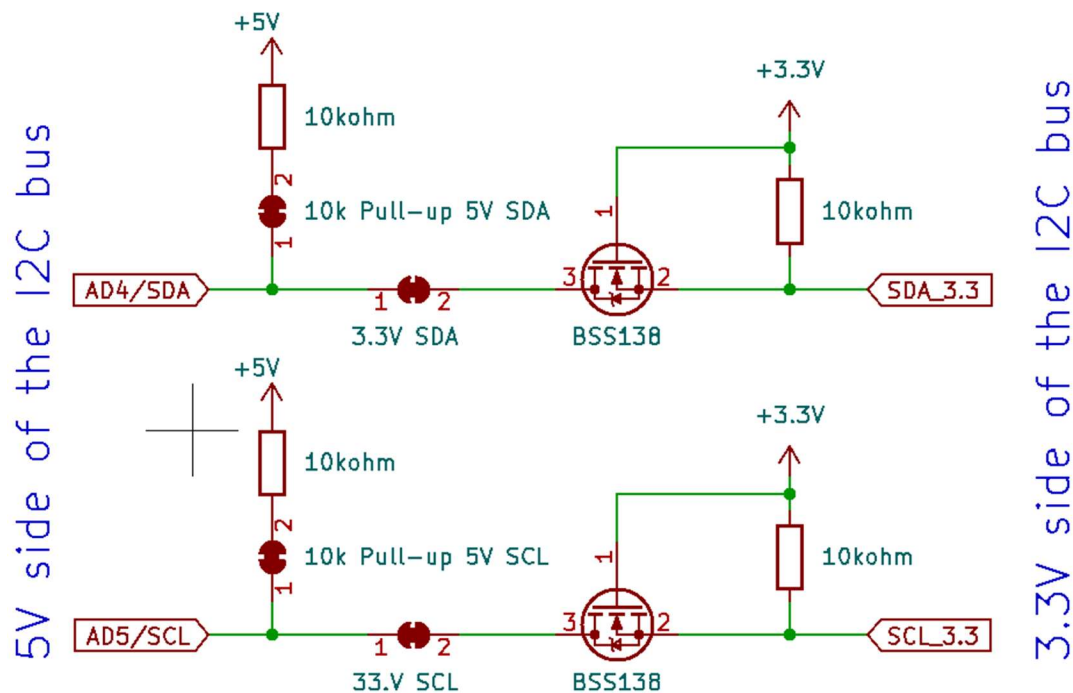


Figure 3: Logic Level Shifter (LLS) schematic on the Uno R3+ showing the 5V and the 3.3V sides of the I2C bus.

The user is made aware that if too many I2C connected peripherals are used at once, or the connecting wires are long (around 1.5m or longer), the I2C communication may start to break down. This is not a deficiency of the *Uno R3+* but rather a characteristic of I2C communication itself. When the SDA signal rise-time starts to take too long and becomes sluggish (because the time constant is too large, which is a function of resistance and capacitance on the I2C bus), then data may become corrupt. Often this will result in the microcontroller freezing and a restart may be required. This scenario is easily diagnosed with an oscilloscope. The user can try the following simple changes to improve the I2C bus quality:

- Reduce the communication wire on the SDA and SCL lines.
- Add or decrease pull-up resistors on the SDA and SCL lines. Note that many peripherals have their own pull-ups onboard, and when connecting many of such modules on the I2C bus that the total resistance acts as if in parallel, thus decreasing the overall resistance. The user may have to decrease the resistance or disable entirely. Alternatively, there may not be enough resistance and so larger resistance may need to be added.
- Reduce the clock speed of the SCL line. The slower the communication speed, the less sluggish or slow rise-time of the SDA line impacts the communication. Typically, the default SCL clock speed is 100 kHz. Although there is no theoretical lower limit for I2C, some peripherals have issues working below 10 kHz.

3.3 ICSP Breakout

The *Uno R3+* has an In-Circuit Serial Programming (ICSP) breakout section via a 2X3 Pin male header, as shown in Figure 4. The pin breakout of the ICSP is shown in the schematic in Figure 5, with the following definitions:

- CIPO: Controller In, Peripheral Our (formerly called MISO)
- SCK: Serial Clock
- COPI: Controller Out, Peripheral In (formerly called MOSI)
- Reset: Reset

For orientation of the pins, the ground “GND” pin is outlined with a white printing, best seen from the back of the board.

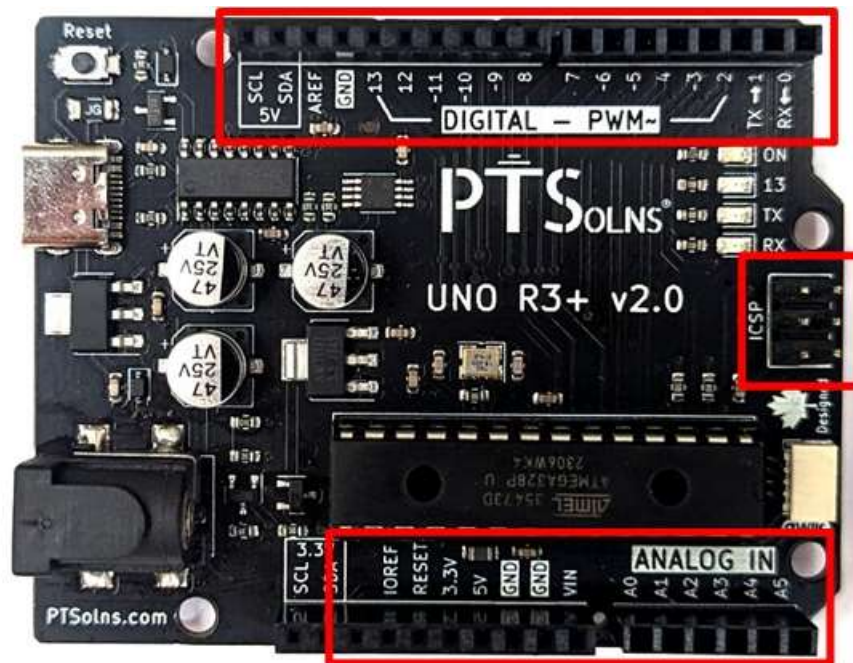


Figure 4: Breakout pins of the Uno R3+.

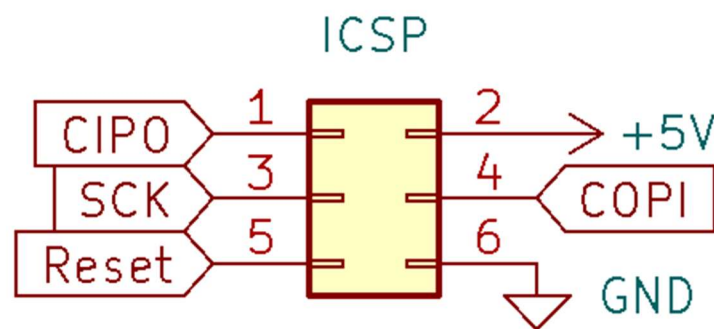


Figure 5: ICSP breakout pins.

3.4 Compatibility with Shields (Stackability)

The *Uno R3+* is fully stackable and thus compatible with a range of common shields. Therefore, all of the regular breakout pins both be the female headers as well as the male header are available, as shown in Figure 4. The *Uno R3+* does have two extra pins on the female header labelled with “SCL” and “SDA” in a box with “3.3V” (See Section 3.2). For most shields these two extra pins do not interfere with a shield stacked on top.

3.5 Component Arrangement & Pinout Diagram

The *Uno R3+* has a unique component arrangement. As an example, the four onboard LEDs (Power LED, Pin 13 controlled LED, TX and RX communication LEDs). Some notable component arrangements, including the LEDs, Reset button and the ATmega328P-PU, are shown in Figure 6.



Figure 6: Notable component arrangements of the Uno R3+.

The *Uno R3+* has 14 digital Input/Output (I/O) pins, referred to as “DIO”, of which six are PWM capable. There are six analog input pins, and various power related pins. All of the pins are shown in the pinout diagram in Figure 7.

Note the following:

- A tilde next to a DIO indicates that pin is PWM capable.
- DIO 13 also controls the onboard LED labelled “13” as shown.
- The Reset pin is connected to the push button as well as the pinout on the ICSP.

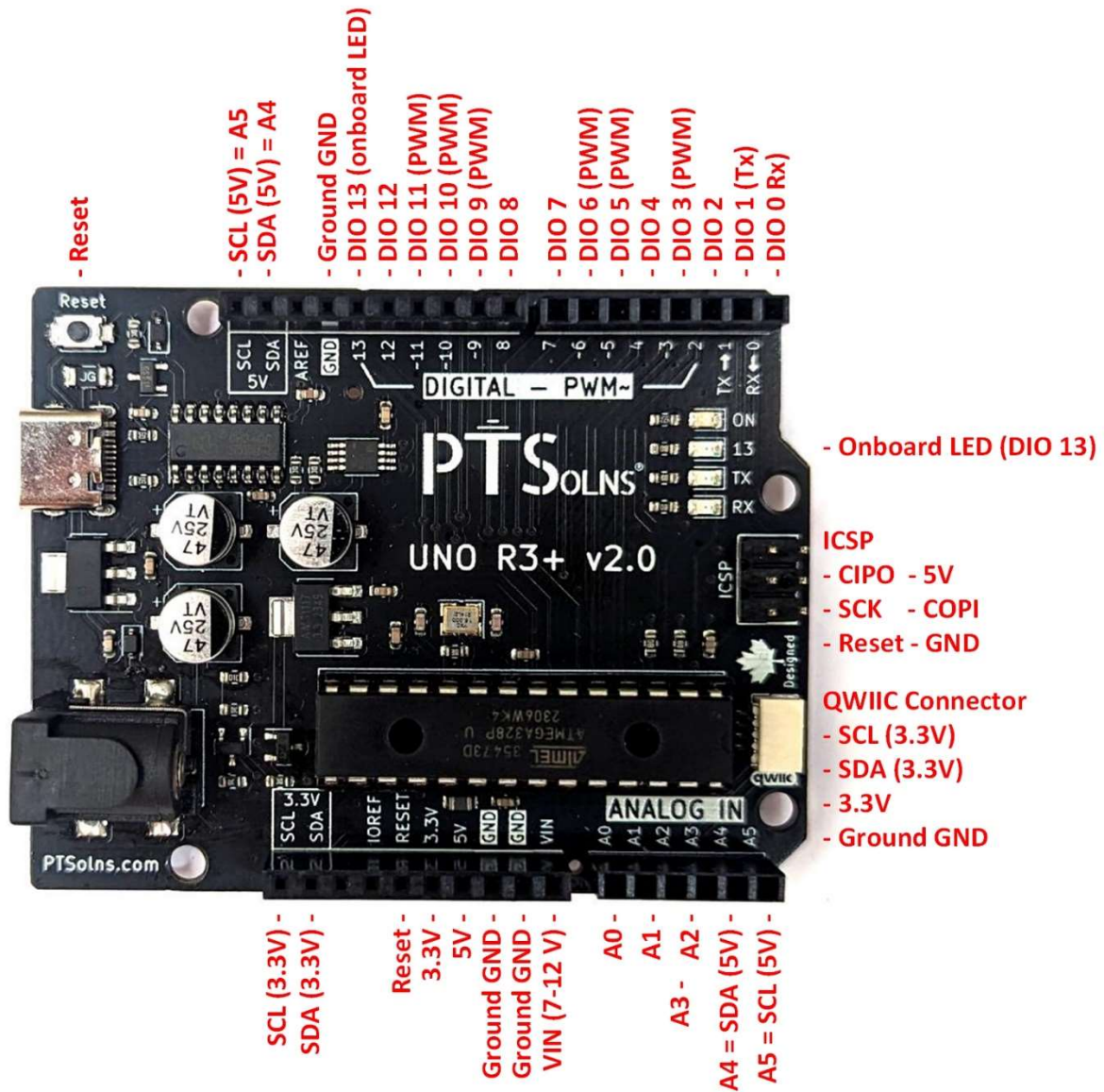


Figure 7: Pinout diagram for the Uno R3+.

3.6 Mark of Authenticity

Authentic PTSolns PCBs have a black solder mask color and are marked with the “PTSolns” logo in white silkscreen printing. The “Canadian Designed” symbol, consisting of the Canadian Maple Leaf with the word “Designed” underneath, can also be found on the PCB in white silkscreen printing. The “PTSolns” trademark and the “Canadian Designed” symbols are shown in Figure 8.



Figure 8: The “Canadian Designed” symbol found on authentic PTSolns PCBs.

4 PHYSICAL PROPERTIES

The physical properties of the *Uno R3+* are outlined in Table 1.

Table 1: Physical Properties.

	Quantity	Value	Reference
PCB	Length (longest)	68.6 mm	Figure 9
	Width (longest)	53.3 mm	Figure 9
	Thickness	1.6 mm	--
	Weight (with IC)	24 g	--
	Color	Black	--
	Silkscreen	White	--
Material	Lead free HASL-RoHS surface finish		--
	FR-4 base		--
Mounting Holes	4x each with 3.2mm diameter		Figure 10

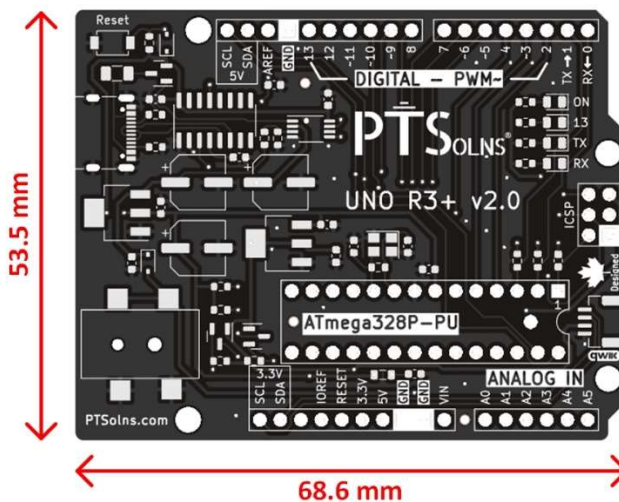


Figure 9: Dimensions of the Uno R3+.

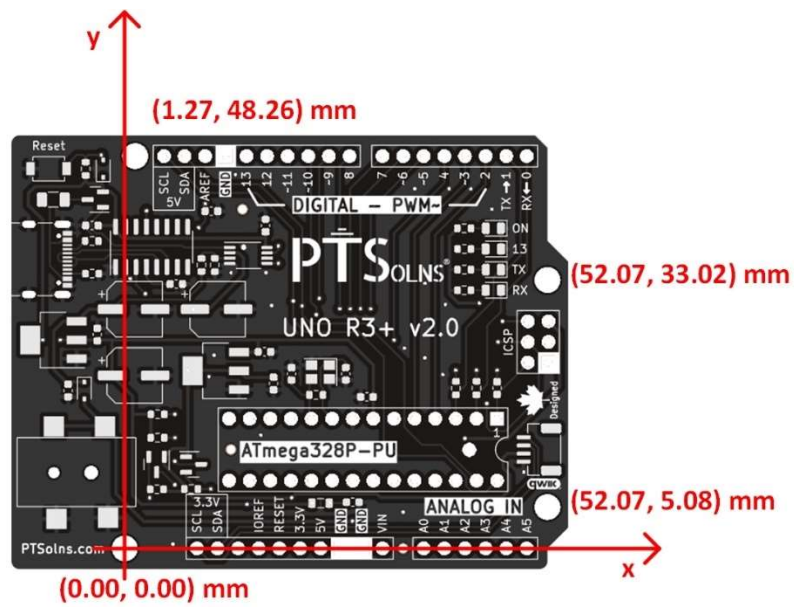


Figure 10: Positions of mounting holes. Coordinate grid zeroed on the bottom-left mounting hole.

5 ELECTRICAL PROPERTIES

The electrical ratings for the *Uno R3+* are outlined in Table 2.

Table 2: Electrical ratings for the *Uno R3+*.

Type of trace	Rating
Input voltage on USB-C	5 V
Input voltage on power barrel jack	7-12 V
Max current on any single GPIO	40 mA
Max combined current on all GPIO	200 mA
Max current draw on 5V pin	500 mA
Max current draw on 3.3V pin	500 mA

6 USAGE AND APPLICATION

This section presents important information regarding the first-time usage of the *Uno R3+*.

6.1 CH340 Driver & Programming

The *Uno R3+* uses the common CH340 IC to enable communication between what is plugged into the USB-C port (e.g. user's laptop) and the microcontroller (ATmega328P-PU). This IC is required when trying to program the *Uno R3+*. The driver for the CH340 typically must be installed the first time it is needed in any project. Many boards and modules make use of the CH340 so chances are that the driver is already installed. However, if the driver is not yet installed, the user must first install it in order to program the *Uno R3+*. This installation typically only has to be done once.

SparkFun Electronics has written a comprehensive tutorial on this topic, and the user is referred to their excellent documentation on this. Find the link here:

<https://learn.sparkfun.com/tutorials/how-to-install-ch340-drivers/all>

There are many other tutorials available online that can be found by searching “CH340 driver installation instructions” or similar.

Once the CH340 driver is installed, the *Uno R3+* can be programmed. To program the *Uno R3+* the user is encouraged to install the Arduino IDE software (free), which can be found here:

<https://www.arduino.cc/en/software>

There are several ways a microcontroller can be programmed, but the Arduino IDE is one of the easiest ways to get started quickly, with a large active online community and many tutorials and forums.

6.2 Inserting the ATmega328P-PU IC

When inserting the ATmega328P-PU IC into the corresponding 28-Pin IC socket the orientation is important. The user must take care to never insert the IC the wrong way around. The ATmega328P-PU has two markings to indicate the Pin 1 and the orientation. Figure 11 shows these two markings.

The *Uno R3+* also has two markings on and near the corresponding 28-Pin IC socket, as shown in Figure 12. The ATmega328P-PU should be inserted into the socket with all the orientation and Pin 1 markings aligned. As in the case of the image in Figure 12, the markings are all on the right side. The writing on the ATmega328P-PU should be upside down when viewing the *Uno R3+* in the same orientation as in Figure 12.

NOTE: It is recommended that the power to the *Uno R3+* be disconnected whenever inserting or removing the ATmega328P-PU IC.

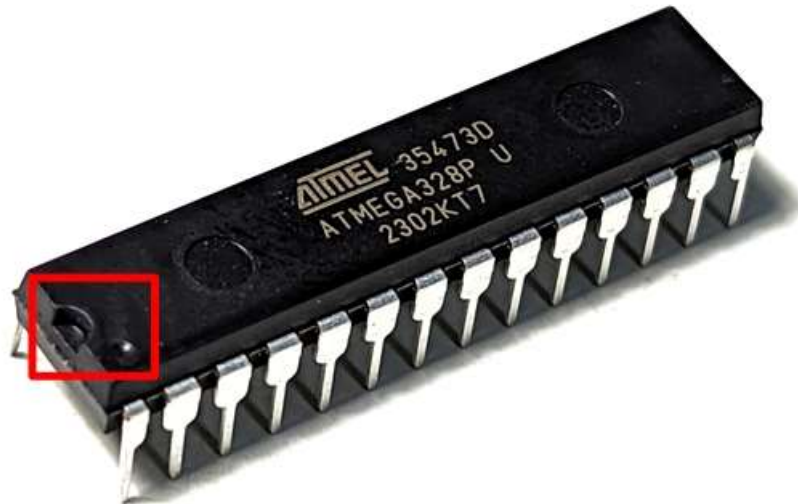


Figure 11: ATmega328P-PU Pin 1 marking (dot indent) and half-circle marking (half-circle indent).



Figure 12: Pin 1 marking (white silkscreen dot) and orientation marking (half-circle indent on IC socket) on the Uno R3+.

6.3 Out-of-the-Box Ready Examples

The *Uno R3+* comes pre-installed with a sketch that allows the user to perform several tests without any further programming. These pre-programmed tests can be used to check the working order of the *Uno R3+*, or to get started quickly making some simple examples. These out-of-the-box ready tests include:

- 1) Onboard (and Pin 13) LED blinking in unique pattern.
- 2) Reset makes onboard LED (and Pin 13) blink in fast pattern of four for one cycle.
- 3) I2C scanner searches for connected devices (5V or 3.3V I2C bus, or QWIIC connector) every 5 seconds and prints the results to Serial monitor on baud rate 9600.
- 4) Pin 9 is on a fading in and out cycle that can drive an external LED accordingly.
- 5) Analog read on Pin A0 and displayed to Serial monitor on baud rate 9600.

Each of these tests is explained in further detail below. If the user wants to restore the pre-installed testing sketch, it can be downloaded from the PTSolns documentation repository sub-domain:

https://docs.PTSolns.com/IDE_sketches/Uno_R3plus_Getting_Started.ino

6.3.1 Test 1: Onboard LED (Pin 13) Blink Unique Pattern

With the *Uno R3+* powered, the onboard LED (marked “13”) blinks in a regular unique pattern. The LED will illuminate for 100 mS and turn OFF for 200 mS. If the reset is pressed (see Test 2) the pattern changes momentarily before returning to the same pattern.

The onboard LED (marked “13”) is also connected to Pin 13, available on one of the pins of the female header (also marked “13”). As a further test, the positive terminal of a standard LED can be put into the female header Pin 13, with the negative terminal of the LED attached to a resistor (in the range of ~200 Ω to 1000 Ω , give or take). The other free end of the resistor can be plugged into one of the ground (marked “GND”) pin in a female header. The LED and resistor can either be soldered together, or a breadboard can be used to make the electrical connection.

6.3.2 Test 2: Onboard LED (Pin 13) Blink Reset Pattern

The reset button triggers a momentarily different pattern consisting of four rapid blinks of the onboard LED (marked “13”) of 50 mS ON and 50 mS OFF. This tests that the *Uno R3+* is restarting properly.

Upon reset the *Uno R3+* output several messages to the Serial monitor on baud rate 9600. To see these messages, load the Arduino IDE software and plug in the *Uno R3+* (ensure that the CH230 driver is installed – see Section 6.1). Turn on the Serial monitor (select baud rate 9600) and read the output window.

6.3.3 Test 3: I2C Scanner

Every five seconds the I2C bus is scanned for any connected peripherals. This includes the 5V and 3.3V I2C bus available on the corresponding female header pins, and the QWIIC connector (See Section 3.2 on I2C bus). The results of the scan are printed to the Serial monitor on baud rate 9600. To see these results, load the Arduino IDE software and plug in the *Uno R3+* (ensure that the CH230 driver is installed – see Section 6.1). Turn on the Serial monitor (select baud rate 9600) and read the output window.

The user can connect several I2C peripherals at once, on any or all of the three connection points (5V I2C pins, 3.3V I2C pins, QWIIC connector). All the device addresses will be displayed in the Serial monitor.

6.3.4 Test 4: Pin 9 Fade

Pin 9 available on the female header (marked “~9”) is a PWM capable pin (that’s what the tilde “~” indicates). PWM allows a pin to be driven at different duty cycles. This, among many other examples, can be used to dim, or fade, an external LED. In a similar fashion as outlined in Test 1, connect an LED plus resistor to Pin 9 and ground (marked “GND”) and observe the LED fading pattern. Ensure that the LED positive terminal is in Pin 9 and that the negative terminal goes toward GND through the resistor.

6.3.5 Test 5: Analog A0 Read

The analog pin A0 is programmed to be continuously reading any input connected to it. The read input value is displayed in the Serial monitor on baud rate 9600. To see these results, load the Arduino IDE software and plug in the *Uno R3+* (ensure that the CH230 driver is installed – see Section 6.1). Turn on the Serial monitor (select baud rate 9600) and read the output window.

The user can plug a wire directly into the female header pin A0 and the other end into:

- A0 to Ground (marked “GND”)
- A0 to 3.3V
- A0 to 5V
- A0 free floating

The output as displayed in the Serial monitor will read different values accordingly. A properly working *Uno R3+* should produce the following results:

- A0 to Ground (marked “GND”) -> Output around 0
- A0 to 3.3V -> Output around 660, plus or minor a few
- A0 to 5V -> Output around 1023, plus or minor a few
- A0 free floating -> Output ranges widely

7 REFERENCES

This section lists relevant references.

- ATmega328P-PU datasheet by Micochip Technology:
<https://www.microchip.com/en-us/product/atmega328p>
- Arduino IDE software (See Section 6.1):
<https://www.arduino.cc/en/software>
- PTSolns' Documentation Repository Sub-Domain:
<https://docs.PTSolns.com>
- PTSolns website:
<https://ptsolns.com/>
- *Uno R3+* default installed testing sketch (See Section 6.3):
https://docs.PTSolns.com/IDE_sketches/Uno_R3plus_Getting_Started.ino
- QWIIC connector standardization by SparkFun Electronics (See Sections 3.1 and 3.2):
<https://www.sparkfun.com/qwiic>
- CH340 driver installation tutorial by SparkFun Electronic (See Section 6.1):
<https://learn.sparkfun.com/tutorials/how-to-install-ch340-drivers/all>

The following lists PTSolns shields recommended for use in conjunction with the *Uno R3+*.

- Proto-Shield datasheet:
https://docs.ptsolns.com/datasheets/Datasheet_PTS-00153_Prot-Shield.pdf
- Interface-Shield datasheet:
https://docs.ptsolns.com/datasheets/Datasheet_PTS-00156_Interface-Shield_Kit.pdf
- NRF-Shield datasheet:
https://docs.ptsolns.com/datasheets/Datasheet_PTS-00154_NRF-Shield.pdf