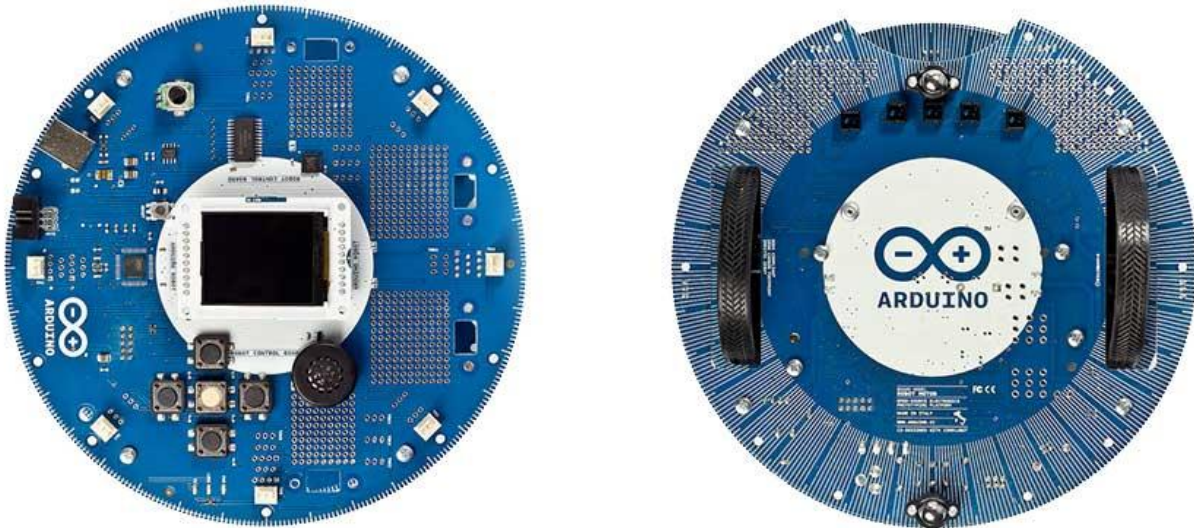




Arduino Robot



Overview

The Arduino Robot is the first official Arduino on wheels. The robot has two processors, one on each of its two boards. The *Motor Board* controls the motors, and the *Control Board* reads sensors and decides how to operate. Each of the boards is a full Arduino board programmable using the Arduino IDE.

Both Motor and Control boards are microcontroller boards based on the ATmega32u4 ([datasheet](#)). The Robot has many of its pins mapped to on-board sensors and actuators.

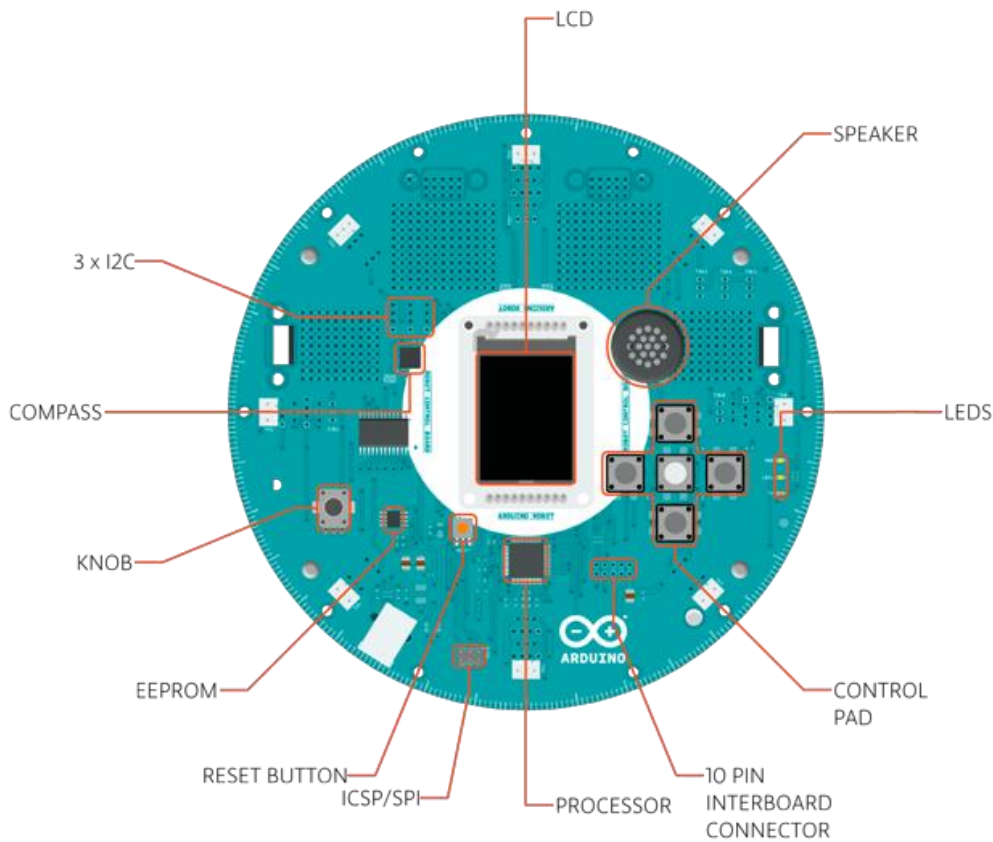
Programming the robot is similar to the process with the Arduino Leonardo. Both processors have built-in USB communication, eliminating the need for a secondary processor. This allows the Robot to appear to a connected computer as a virtual (CDC) serial / COM port.

As always with Arduino, every element of the platform – hardware, software and documentation – is freely available and open-source. This means you can learn exactly how it's made and use its design as the starting point for your own robots. The Arduino Robot is the result of the collective effort from an international team looking at how science can be made fun to learn. Arduino is now on wheels, come ride with us!

Control Board Summary

Microcontroller	ATmega32u4
Operating Voltage	5V
Input Voltage	5V through flat cable
Digital I/O Pins	5
PWM Channels	6
Analog Input Channels	4 (of the Digital I/O pins)
Analog Input Channels (multiplexed)	8
DC Current per I/O Pin	40 mA
Flash Memory	32 KB (ATmega32u4) of which 4 KB used by bootloader

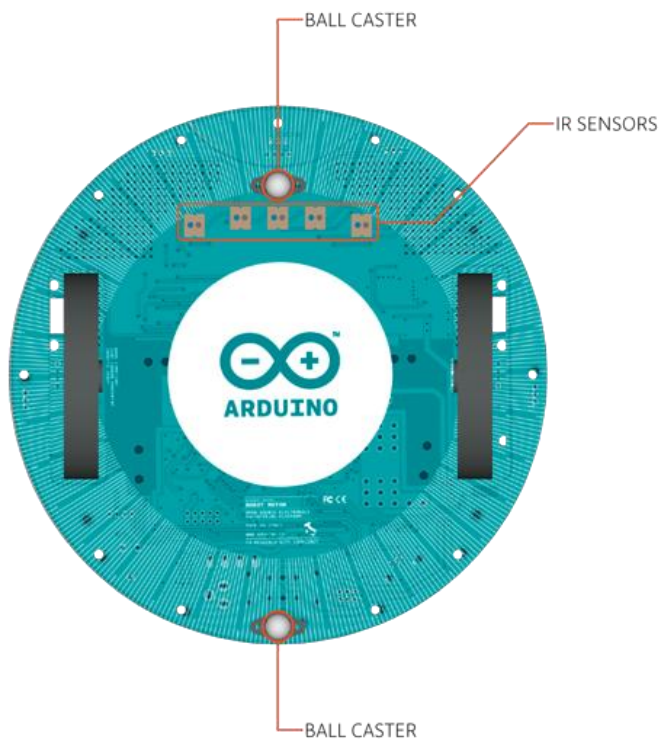
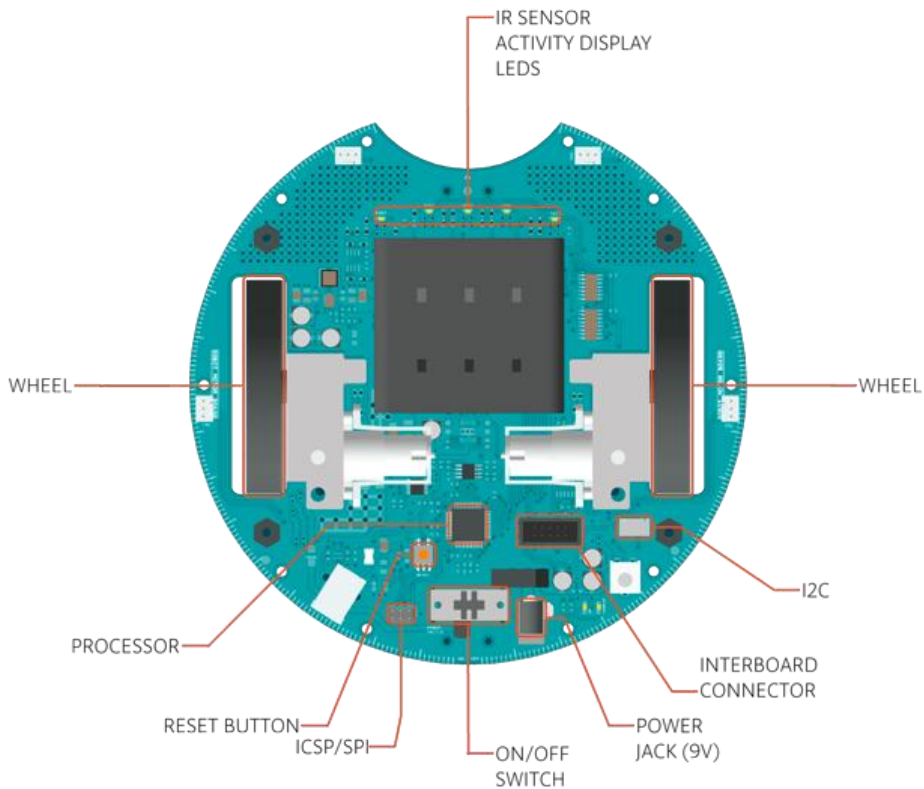
SRAM	2.5 KB (ATmega32u4)
EEPROM (internal)	1 KB (ATmega32u4)
EEPROM (external)	512 Kbit (I2C)
Clock Speed	16 MHz
Keypad	5 keys
Knob	potentiometer attached to analog pin
Full color LCD	over SPI communication
SD card reader	for FAT16 formatted cards
Speaker	8 Ohm
Digital Compass	provides deviation from the geographical north in degrees
I2C soldering ports	3
Prototyping areas	4



Motor Board Summary

Microcontroller	ATmega32u4
Operating Voltage	5V
Input Voltage	9V to battery charger
AA battery slot	4 alkaline or NiMh rechargeable batteries
Digital I/O Pins	4
PWM Channels	1
Analog Input Channles	4 (same as the Digital I/O pins)
DC Current per I/O Pin	40 mA
DC-DC converter	generates 5V to power up the whole robot
Flash Memory	32 KB (ATmega32u4) of which 4 KB used by bootloader
SRAM	2.5 KB (ATmega32u4)

EEPROM	1 KB (ATmega32u4)
Clock Speed	16 MHz
Trimmer	for movement calibration
IR line following sensors	5
I2C soldering ports	1
Prototyping areas	2



Schematic & Reference Design

EAGLE files for control and motor boards: [arduino-robot-reference-design.zip](#)

Power

The Arduino Robot can be powered via the USB connection or with 4 AA batteries. The power source is selected automatically.

The battery holder holds 4 rechargeable NiMh AA batteries.

NB : Do not use non-rechargeable batteries with the robot

For safety purposes, the motors are disabled when the robot is powered from the USB connection.

The robot has an on-board battery charger that requires 9V external power coming from an AC-to-DC adapter (wall-wart). The adapter can be connected by plugging a 2.1mm center-positive plug into the Motor Board's power jack. The charger will not operate if powered by USB.

The Control Board is powered by the power supply on the Motor Board.

Memory

The ATmega32u4 has 32 KB (with 4 KB used for the bootloader). It also has 2.5 KB of SRAM and 1 KB of EEPROM (which can be read and written with the [EEPROM library](#)).

The Control Board has an extra 512 Kbit EEPROM that can be accessed via I2C.

There is an external SD card reader attached to the GTFT screen that can be accessed by the Control Board's processor for additional storage.

Input and Output

The Robot comes with a series of pre-soldered connectors. There are a number of additional spots for you to install additional parts if needed.

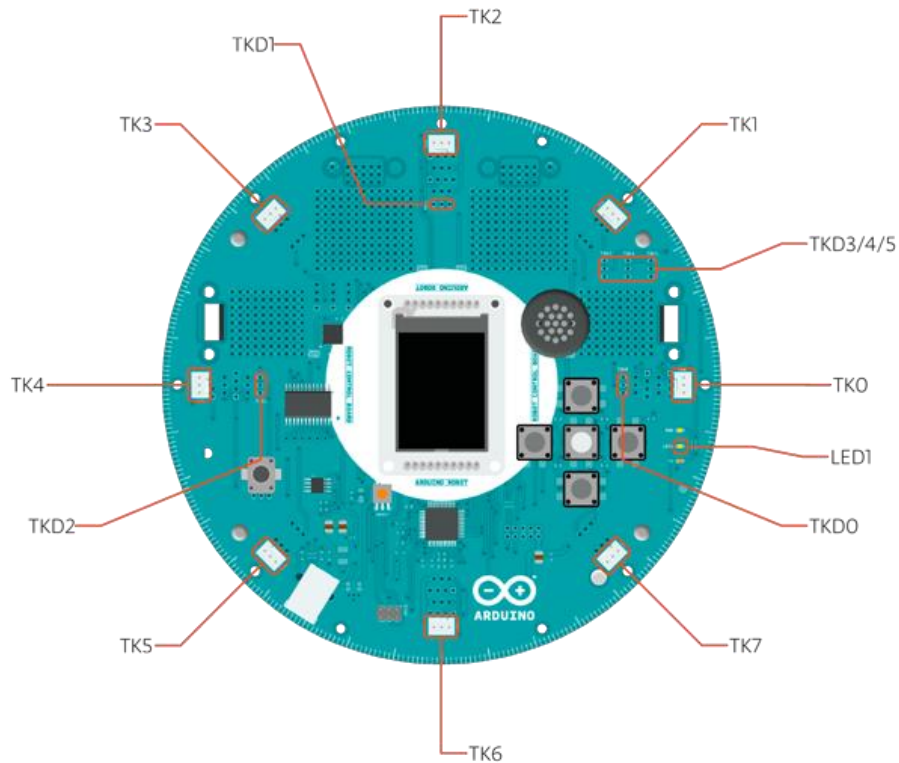
All the connectors are labelled on the boards and mapped to named ports through the [Robot library](#) allowing access to standard Arduino functions. Each pin can provide or receive a maximum of 40mA at 5V.

Some pins have specialized functions :

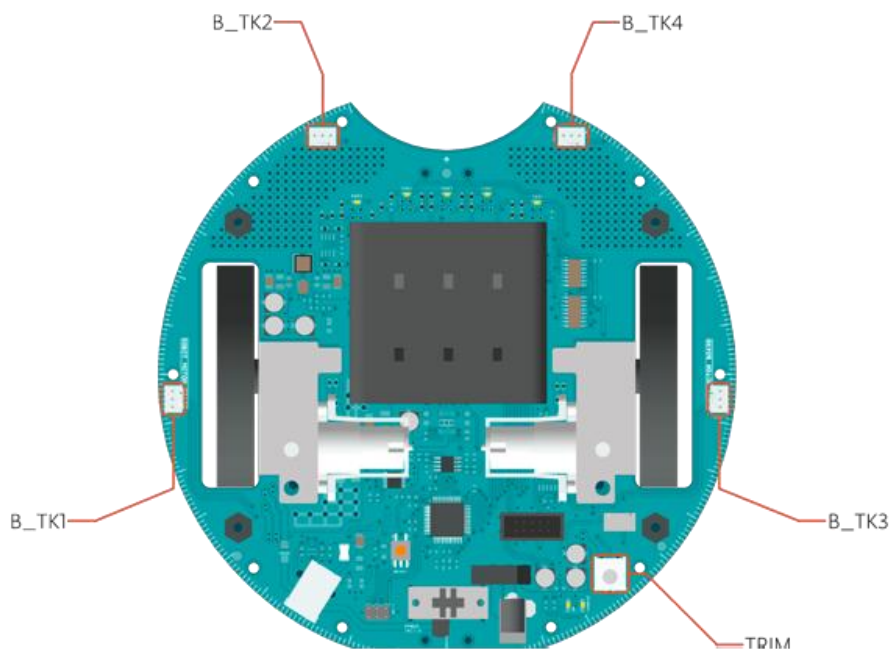
Control Board TK0 to TK7: these pins are multiplexed to a single analog pin on the Control Board's microprocessor. They can be used as analog inputs for sensors like distance sensors, analog ultrasound sensors, or mechanical switches to detect collisions.

Control Board TKDo to TKD5: these are digital I/O pins directly connected to the processor, addressed using [Robot.digitalRead\(\)](#) and [Robot.digitalWrite\(\)](#) functions. Pins **TKDo to TKD3** can also be used as analog inputs with [Robot.analogRead\(\)](#)

Note: if you have one of the first generation robots, you will see that the TKD pins are named TDK* on the Robot's silkscreen. TKD* is the proper name for them and is how we address them on the software.*



Motor Board TK1 to TK4: these pins are named in software as **B_TK1** to **B_TK4**, they can be digital or analog input pins, and support Robot.digitalRead(), Robot.digitalWrite() and Robot.analogRead().



Serial Communication: The boards communicate with each other using the processors' serial port. A 10-pin connector connects both boards carries the serial communication, as well as power and additional information like the battery's current charge.

Control Board SPI: SPI is used to control the GTFT and SD card. If you want to flash the processor using an external programmer, you need to disconnect the screen first.

Control Board LEDs: the Control Board has three on-board LEDs. One indicates the board is powered (PWR). The other two indicate communication over the USB port (LED1/RX and TX). LED1 is also accessible via software.

Both boards have **I²C** connectors available: 3 on the Control Board and 1 on the Motor Board.

Control Board Pin Mapping

ARDUINO LEONARDO	ARDUINO ROBOT CONTROL	ATMEGA 32U4	FUNCTION	REGISTER
D0	RX	PD2	RX	RXD1/INT2
D1	TX	PD3	TX	TXD1/INT3
D2	SDA	PD1	SDA	SDA/INT1
D3#	SCL	PD0	PWM8/SCL	OC0B/SCL/INT0
D4	MUX_IN A6	PD4		ADC8
D5#	BUZZ	PC6	???	OC3A/#OC4A
D6#	MUXA/TKD4 A7	PD7	FastPWM	#OC4D/ADC10
D7	RST_LCD	PE6		INT6/AIN0
D8	CARD_CS A8	PB4		ADC11/PCINT4
D9#	LCD_CS A9	PB5	PWM16	OC1A/#OC4B/ADC12/PCINT5
D10#	DC_LCD A10	PB6	PWM16	OC1B/oc4B/ADC13/PCINT6
D11#	MUXB	PB7	PWM8/16	oCoA/OC1C/#RTS/PCINT7
D12	MUXC/TKD5 A11	PD6		T1/#OC4D/ADC9
D13#	MUXD	PC7	PWM10	CLK0/OC4A
A0	KEY D18	PF7		ADC7
A1	TKD0 D19	PF6		ADC6
A2	TKD1 D20	PF5		ADC5
A3	TKD2 D21	PF4		ADC4
A4	TKD3 D22	PF1		ADC1
A5	POT D23	PF0		ADC0
MISO	MISO D14	PB3		MISO,PCINT3
SCK	SCK D15	PB1		SCK,PCINT1

MOSI	MOSI D16	PB2		MOSI,PCINT2
SS	RX_LED D17	PB0		RXLED,SS/PCINT0
TXLED	TX_LED	PD5		
HWB		PE2		HWB

Motor Board Pin Mapping

ARDUINO LEONARDO	ARDUINO ROBOT CONTROL	ATMEGA 32U4	FUNCTION	REGISTER
D0	RX	PD2	RX	RXD1/INT2
D1	TX	PD3	TX	TXD1/INT3
D2	SDA	PD1	SDA	SDA/INT1
D3#	SCL	PD0	PWM8/SCL	OC0B/SCL/INT0
D4	TK3 A6	PD4		ADC8
D5#	INA2	PC6	???	OC3A/#OC4A
D6#	INA1 A7	PD7	FastPWM	#OC4D/ADC10
D7	MUXA	PE6		INT6/AIN0
D8	MUXB A8	PB4		ADC11/PCINT4
D9#	INB2 A9	PB5	PWM16	OC1A/#OC4B/ADC12/PCINT5
D10#	INB1 A10	PB6	PWM16	OC1B/oc4B/ADC13/PCINT6
D11#	MUXC	PB7	PWM8/16	oCoA/OC1C/#RTS/PCINT7
D12	TK4 A11	PD6		T1/#OC4D/ADC9
D13#	MUXI	PC7	PWM10	CLK0/OC4A
A0	TK1 D18	PF7		ADC7
A1	TK2 D19	PF6		ADC6
A2	MUX_IN D20	PF5		ADC5
A3	TRIM D21	PF4		ADC4
A4	SENSE_A D22	PF1		ADC1
A5	SENSE_B D23	PF0		ADC0

MISO	MISO D14	PB3		MISO,PCINT3
SCK	SCK D15	PB1		SCK,PCINT1
MOSI	MOSI D16	PB2		MOSI,PCINT2
SS	RX_LED D17	PB0		RXLED,SS/PCINT0
TXLED	TX_LED	PD5		
HWB		PE2		HWB

Communication

The Robot has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega32U4 provides UART TTL (5V) serial communication, which is available on digital the 10-pin board-to-board connector. The 32U4 also allows for serial (CDC) communication over USB and appears as a virtual com port to software on the computer. The chip also acts as a full speed USB 2.0 device, using standard USB COM drivers. On Windows, a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Robot board. The RX (LED1) and TX LEDs on the board will flash when data is being transmitted via the USB connection to the computer (but not for serial communication between boards).

Each one of the boards has a separate USB product identifier and will show up as different ports on you IDE. Make sure you choose the right one when programming.

The ATmega32U4 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the [documentation](#) for details. For SPI communication, use the [SPI library](#).

Programming

The Robot can be programmed with the Arduino software ([download](#)). Select "Arduino Robot Control Board" or "Arduino Robot Motor Board" from the **Tools > Board** menu. For details, see the [getting started page](#) and [tutorials](#).

The ATmega32U4 processors on the Arduino Robot come preburned with a [bootloader](#) that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the AVR109 protocol.

You can bypass the bootloader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header; see [these instructions](#) for details.

Automatic (Software) Reset and Bootloader Initiation

Rather than requiring a physical press of the reset button before an upload, the Robot is designed in a way that allows it to be reset by software running on a connected computer. The reset is triggered when the Robot's virtual (CDC) serial / COM port is opened at 1200 baud and then closed. When this happens, the processor will reset, breaking the USB connection to the computer (meaning that the virtual serial / COM port will disappear). After the processor resets, the bootloader starts, remaining active for about 8 seconds. The bootloader can also be initiated by double-pressing the reset button on the Robot. Note that when the board first powers up, it will jump straight to the user sketch, if present, rather than initiating the bootloader.

Because of the way the Robot handles reset it's best to let the Arduino software try to initiate the reset before uploading, especially if you are in the habit of pressing the reset button before uploading on other boards. If the software can't reset the board you can always start the bootloader by double-pressing the reset button on the board. *A single press on the reset will restart the user sketch, a double press will initiate the bootloader.*

USB Overcurrent Protection

Both of the Robot boards have a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

Physical Characteristics

The Robot is 19cm in diameter. Including wheels, TFT screen and other connectors it can be up to 10cm tall.