bot'n roll
ONE
build your own robot
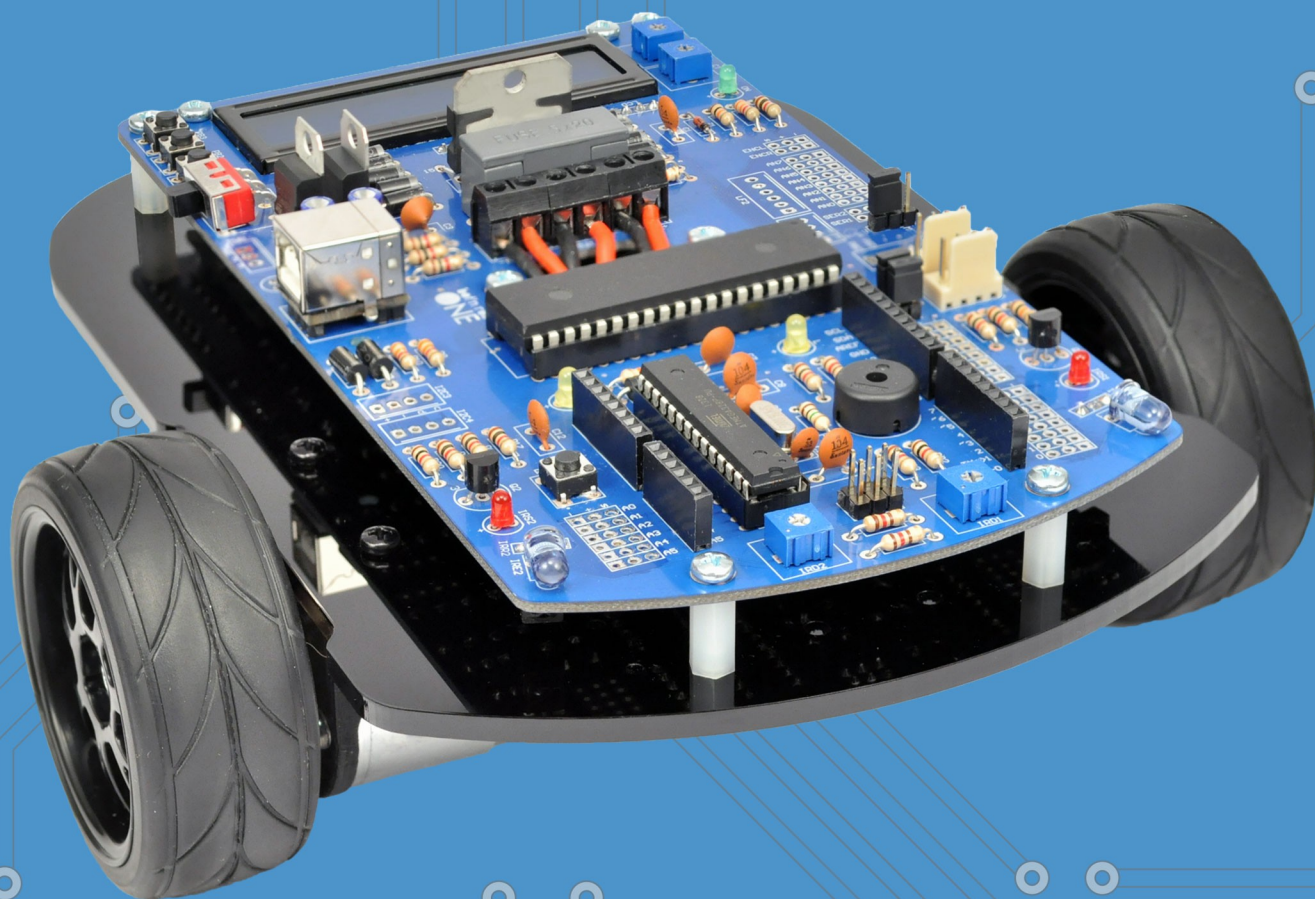
user assembling manual

www.botnroll.com

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Document Revision: May 29th, 2023

1. INTRODUCTION

1.1. BOT'N ROLL ONE A

1.1.1. BOT'N ROLL ONE A - TO WHOM IS IT FOR?

The Bot'n Roll ONE A Arduino compatible is an *Open Source* didactic product, which is intended for all those who wish to start with mobile robots despite not having much knowledge about electronics or computers. The assembly of this robot allows the first steps with some of the most common electronic components. The brief introduction to the basic components and explanation of some concepts along the assembly instructions allow a very enriching introductory approach that complements the electronic components assembling.

Those who wish to get started in robotics find in Bot'n Roll ONE A the ideal tool to assemble a robot while not having the basic knowledge on robotics.

Teachers will find the Bot'n Roll ONE A a working tool able to assist them in imparting knowledge to their students. From electronic to programming, this robot allows the study of a wide range of concepts in a very practical perspective.

The most experienced will find this robotic kit an interesting challenge. The Bot'n Roll ONE A has two microcontrollers, one ATmega328 running at 16MHz, programmable in C language with Arduino IDE (like an Arduino UNO) and one PIC18F45K22 running at 80MHz programmable in C with MPLABX Microchip (supplied with firmware developed by botnroll.com). A library for the Arduino IDE specifically developed by botnroll.com allows interaction between the two microcontrollers. This kit comes with an alphanumeric LCD display with 2 two lines and 16 characters per line.

This robot can be coupled with a wide range of Arduino compatible shields such as wireless communications, GPS, GPRS, and many other sensors and actuators to perform various tasks, which makes it suitable to participate in the major national and international robotic competitions. These competitions are always very inspiring for young people allowing them to see different solutions created by other teams, a source of motivation willing them to learn more.

For more information, you can register on www.botnroll.com to keep you abreast of news.

1.1.2. BOT'N ROLL ONE A MAIN CHARACTERISTICS

Microcontrollers: 1 ATmega328 + 1 PIC18F45K22

Supply Voltage: 7V to 15V DC

Digital I/O's: 14 (6 of which allow PWM)

Analog Inputs: 6 (ATmega328) + 8 (PIC18F45K22)

Dedicated Outputs for servo control: 2 (PIC18F45K22)

Encoders Inputs: 2 (PIC18F45K22)

I2C Connectors: 4 (ATmega328)

LCD *Display*: 2x16 Alphanumeric with contrast and light control (PIC18F45K22)

Push Buttons: 3 (PIC18F45K22)

Obstacle Sensors: 2 (PIC18F45K22)

***Buzzer*:** 1 (ATmega328)

Debugging LED´s: 2

Motors: 2 (PIC18F45K22)

- Nominal Voltage: 12V DC
- Nominal Current: 0.58A
- Rotation without load: 285rpm
- Nominal Binary: 1.16Kg.cm
- Maximum Instantaneous Binary: 1.74Kg.cm

Dimensions: 205mm x 192mm x 85mm

Weight: 800g (base kit without battery)

Battery: Ni-MH AA 12V 800mAh

Other characteristics:

- Reset Button;
- Circuit for measuring the battery voltage;
- Allows to include a voltage regulator dedicated to servo feeding;
- Microcontrollers communicate through SPI bus;
- Protection against short-circuit with a 4A slow fuse.

1.1.3. BOT'N ROLL ONE A GENERAL OVERVIEW

Obstacles Detection by Infrared

Buzzer

14 Digital I/O's

I2C bus for communication

ICSP to Program the PIC18F45K22

Two 12V DC motors and two driving wheels

Servo Control

8 Analog Inputs (Line Follower)

Encoders Input

Slow Fuse to protect against short-circuits

Battery voltage measurement circuit

LCD contrast and light adjustment

6 Analog Inputs

Reset Button

ATmega328 Microprocessor

Debugging LED

I2C communication bus

PIC18F45K22 Microprocessor

USB port to program the ATmega328

Voltage Regulators

Double H Bridge to drive the motors

ON/OFF switch

Push Buttons

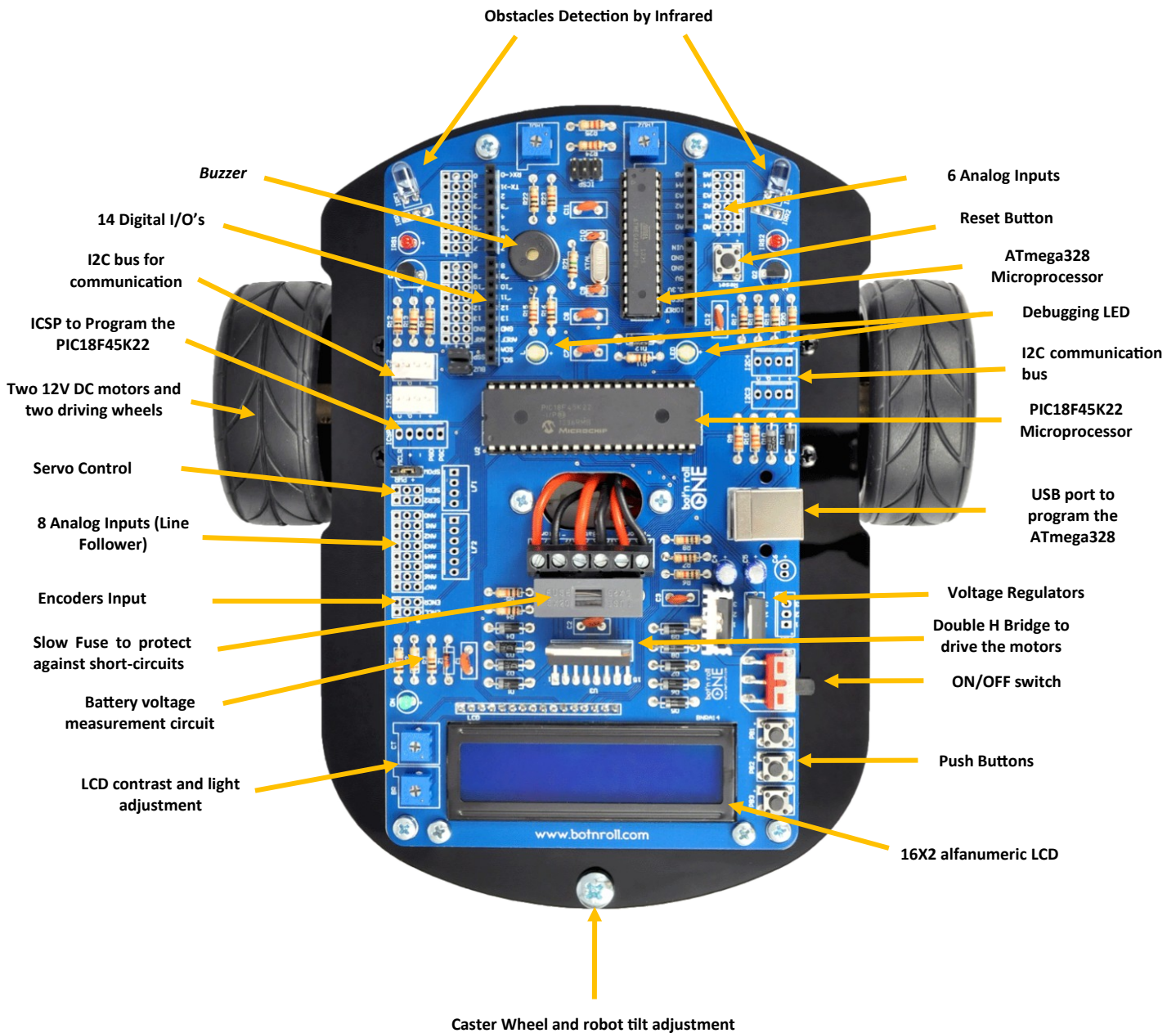16X2 alfanumeric LCD

Caster Wheel and robot tilt adjustment

Fig. 1: Bot'n Roll ONE A general overview

1.2. ROBOTICS

1.2.1. HISTORICAL INTRODUCTION

The word "robot" was first used in a theatre play "RUR" (Rossum's Universal Robots) written in 1920 by Karel Capek, a Czech playwright. In this piece, a character built several artificial men and used them to replace men work. It was the first time someone used this word to designate "artificial man". In its original language, (Czech) "Robota" means, "forced labour". Perhaps due to this secondary meaning, the robots are more associated with the industry. Even before this piece, the robots were called "Automan" by the Greeks, whose meaning is "to move automatically."
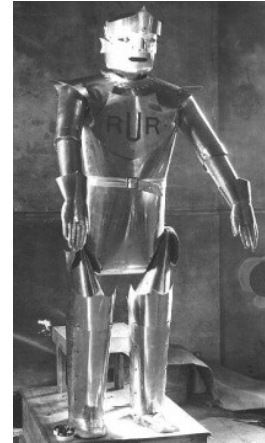

Fig. 2: *Rossum's* **Universal Robots**

1.2.2. THE THREE LAWS OF ROBOTICS

Created by the writer Isaac Asimov in his fiction book I, Robot these laws dictate the expected behaviour of robots:

1st law: *a robot may not injure a human being, or through inaction allow a human being to come to harm*.

2nd law: *a robot must obey the orders given it by human beings, except where such orders would conflict with the first law*.

3rd law: *a robot must protect its own existence as long as such protection does not conflict with the first or second law*.

According to Asimov, the main objective of these laws was to make possible the existence of intelligent robots (the laws presume enough intelligence to distinguish between good and evil) in such way they would not rebel against the human domain. Later on, Asimov introduced one more law:
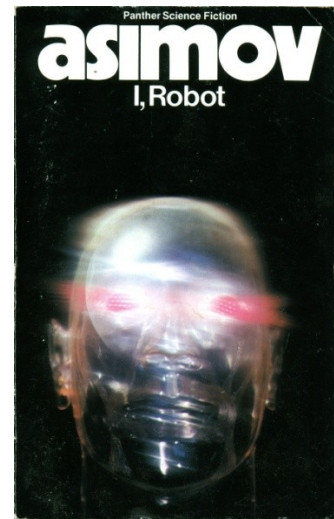
Fig. 3: Book "I Robot" by Isaac Asimov

Law Zero: *A robot may not harm humanity, or, by inaction, allow humanity to come to harm*.

However, law zero, has the serious problem of transferring the power to the robot (possibility) to assess, ace of specific situations, if the interests of humanity overlaps the individual interest. Such possibility opens a dangerous loophole for machines dictatorship, which would elect by themselves the highest good, being even able to harm a human being should they understand that it is the best for humankind.

These are not exactly laws in the real sense of the word, but just guidelines that all robotics enthusiasts and researchers implement when creating and developing robots.

1.2.3. MAIN EVENTS AND SOCIETIES RELATED WITH ROBOTICS

RoboCup® - http://www.robocup.org/

The RoboCup is a Robot World Wide initiative for research and education, whose main objective is to promote artificial intelligence and robotics in general. Having a football game as the main challenge, new technologies are developed in all areas of robotics, so that a team of robots can win the human world champions in the year 2050. Every year this event takes place in a different country.

S.P.R. - http://www.spr.ua.pt/site/

The *Sociedade Portuguesa de Robótica* (Portuguese Robotics Society also known as SPR) is a non-profitable association whose main objective is to promote and stimulate education, research and technological development, as well as industrial and servicing robotics applications.

F.N.R. - http://www.spr.ua.pt/fnr/

The *Festival Nacional de Robótica* (Portuguese Open) was first held in 2001 in *Guimarães*, and has as main objective to promote science and technology in junior and secondary schools, in the university level, as well as in the general public, through simple and entertaining robot competitions. The Portuguese Open, is held annually in a different city and it includes a symposium where national and international researchers from the robotics field gather together to present the most recent activities of their research work. This event is an initiative from the Portuguese Robotics Society and it has had an incredible growth since its beginning, both in participants and in general public.

RoboParty® – http://www.roboparty.org/

The RoboParty® is an educational event that gathers teams of 4 people, during 3 days and 2 nights (participants bring their sleeping bag) to teach how to build autonomous mobile robots in a simple and entertaining way, supported by qualified tutors. Initially, a short course is given to teach the first steps in electronics, robot programming and mechanical construction. Afterwards, a robotic kit developed by the company SAR - Soluções de Automação e Robótica and by University of Minho is supplied to be assembled by the participants (mechanics, electronics and programming), belonging to the team at the end of the event. The tutors follow closely the team's work at all stages, in order to assure that every robot works properly in the end.

In parallel, there are several leisure activities such as sports, music, Internet, games, parties, etc. Each participant brings his sleeping bag and stays overnight during the whole event.

The RoboParty® is identical to a LAN Party and it runs non-stop but with an educational and pedagogical purposes. Rules of important national and international robotic competitions are shown and explained so that youngsters can participate later on with the robot they build at RoboParty.

botnroll.com – http://www.botnroll.com/

botnroll.com develops educational products in the robotics field. The products are excellent educational helpers for all those willing to start learning about robotics. Basic and secondary teachers can find in these products the ideal tool to teach mechanics, electronics and programming in their lectures. For the most experienced, there are also high technological mobile robotic solutions.

1.3. ELECTRONICS – DEFINITIONS

The electronics is the branch of science that studies the use of circuits consisting of electrical and electronic components, with the main aim to transform, transmit process and store energy.

The electronics is the branch of physics that studies the issue and the effect of electrons and their use in electronic devices.

Electronics studies essentially the electronic flow of charges through the semiconductor (non-metallic conductors).
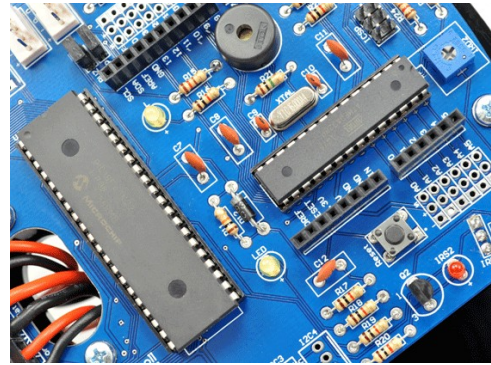
Fig. 4: Electronic Printed Circuit Board

Electronics allows manipulating energy through flow, storage, distribution or conversion. It also allows acquiring, processing, converting, filtering and storing information, through electrical signals.

Electronic Engineering consists on the application of the basic principles of electronic in technologies in order to solve practical problems.

2. BOT'N ROLL ONE A COMPONENTS

When you first open your **Bot'n Roll ONE A** kit verify that it contains the following components:
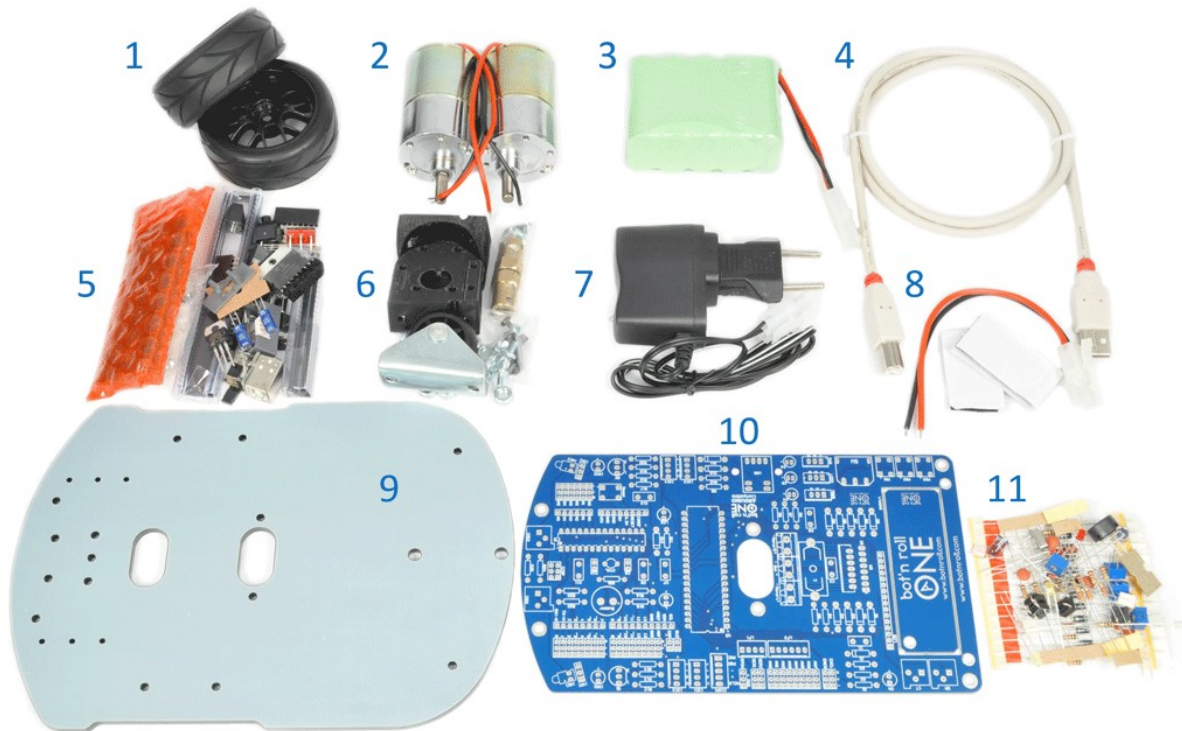
Fig. 5: Bot'n Roll ONE A electronic components

1- Two driving wheels

2- Two DC motors

3- Battery

4- USB Cable to connect the robot to the computer

5- Major electronics components

6- Mechanic components and caster wheel

7- Battery charger

8- Battery accessories for placing and connection

9- Acrylic base

10- Printed Circuit Board

11- Smaller electronics components

IMPORTANT NOTE: Should any component be missing, immediately contact the kit supplier for its replacement.

3. BATTERY

Put the battery to charge utilizing the charger included with your kit before you begin the robot assembly. This way the battery will be ready to use when you finish building your robot!

The provided battery is a Ni-MH (nickel metal hydride), 12V rated voltage and 800mAh rated current.

3.1. CHARGING THE BATTERY

Maximum Voltage: The battery is fully charged when its voltage stands between 14,5V and 15V.

Minimum Voltage: The battery is considered discharged when its voltage its lower than 10V.

Charging Current: The provided charger allows you to define the battery charging current. It's recommended a current equal or less than one-tenth of the rated current, for a battery of 800mAh the charging current must be: 800 / 10 = 80mA.

Charging Time: The charging time is determined by the battery capacity multiplied by a factor of 1.4 and divided by the charging current: 800 x 1.4 / 80 = 14 hours. The battery must be disconnected from the charger when it finishes its charging process.

Fast Charge: It's possible to charge the battery with a current higher than the one above calculated, on the other hand, this process may cause the battery to warm up and will decrease its lifetime.

Charging Cycles: You should avoid charging the battery for a few minutes or even a couple of hours, this way you are shortening its capacity and its lifetime. Respecting the charging and discharging cycles extends its longevity.

Polarity: Verify if you connect the charger with the correct polarity ("+" "-")!

3.2. HANDLING THE BATTERY

Make sure the battery cable is properly attached to the robot before you plug the battery connector! This prevents short circuits in your battery.

Never short circuit the battery terminals! This will destroy the battery and may even start a fire.

4. BOT'N ROLL ONE A ASSEMBLY

The Bot'n Roll ONE A assembly is carried out in three steps:

1 – Mechanical Assembly
2 – Electronic Assembly
3 – Electrical Wiring

TIP: Put the battery to charge when you start building up your robot, so that after assembling it is ready to use. It takes about 8 hours for a battery full charge. Do not leave the battery charging for longer than 8 hours otherwise you may damage it. Since these are Ni-MH batteries you must perform complete charges and discharges, rather than charging just a few minutes or even one or two hours. Short charges reduce the battery capacity and its lifetime.

IMPORTANT NOTE: Some tools not included on this kit might be necessary, namely multimeter, PH1 and PH2 Phillips screwdriver, flat nose pliers, soldering iron, soldering wire, de-soldering pump, cutting pliers.

4.1. MECHANICAL ASSEMBLY

For the mechanical assembly, you will need the motors, the wheels, the motors supports, hubs, screws and the acrylic base.

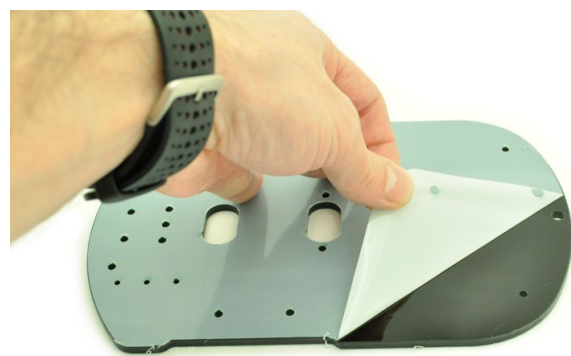Before you start assembling the robot, remove the two protective plastic layers form the acrylic base!

Fig. 6: Preparing the acrylic base

4.1.1. MOTORS

The setting of each motor is performed using a motor support with two M3 embedded nuts, three M3x6mm PH1 screws and two M3x12m PH1 screws.

You need a 1.5mm hex wrench included in the mechanical components bag and a Phillips PH1 screwdriver (not supplied).

Fig. 7: Required equipment to set the motors

Fix the motor to the support using the three smaller M3x6mm PH1 screws.

Use the Phillips PH1 screwdriver to tighten all three screws conveniently.
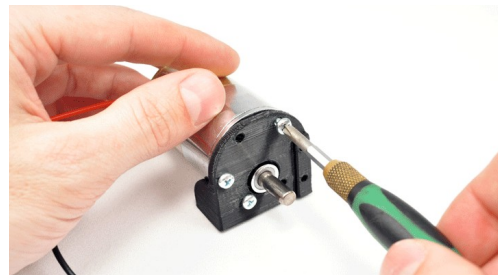
Fig. 8: Fixing the L shape motor support to the motor itself

Fix the support with the motor to the acrylic base using the two longer M3x12mm PH1 screws and M3 nuts embedded in the support.

Fig. 9: Fixing the motors to the acrylic base

The acrylic base has a hole to pass the motors wires to connect later on to the printed circuit board. Introduce the wires into the hole according to the image.

Fig. 10: Passing the motors wires through the acrylic base

4.1.2. DRIVING WHEELS

The Bot'n ONE A roll moves around using two drive wheels that are connected to the motors. They are made of plastic with a rubber coating.

In order to attach each wheel it is necessary to use an engagement "hub", a hexagon M3x3mm bolt and an M4x6mm PH2 screw.
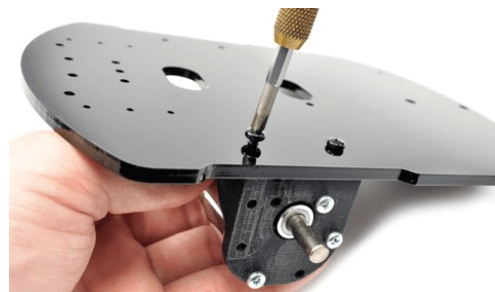

Fig. 11: Components to fix the driving wheels

The motor shaft has a surface that is not round! Use this flat area to mechanically lock the bolt hub and prevent it to rotate on the shaft. This way you assure that all energy from the motor is transmitted to the wheels!

Fit the hub on the motor shaft and the hex bolt screws against the flat area of the shaft using a 1.5mm hex wrench.

Insert the wheel on the hub, pushing it against the hexagonal tip of the hub.

Lock the wheel to the *hub* using the M4x6mm PH2 screw and tighten it conveniently!

Fig. 12: Assembling the driving wheels

IMPORTANT NOTE: Check that there are no gaps between the wheel and the motor as this will influence the robot movement!

4.1.3. CASTER WHEEL

The caster wheel is necessary to support the robot and it is used to adjust the inclination according to your needs. Therefore, you have to adjust the robot height in its rear.

To place the caster wheel, two M5x20mm PH2 screws and six M5 nuts are used.

Fig. 13: Caster wheel, bolts and nuts

Insert the screws into the acrylic base and attach two M5 nuts on each screw.

Place the caster wheel inserting the screws into the corresponding holes and tighten the last M5 nut on each screw.

Use the M5 nuts on each side of the caster wheel to adjust the inclination of the robot.

Check there are no loose nuts and that the caster wheel aligns properly with the drive wheels as it influences the movement of the robot.

Fig. 14: Assembling the caster wheel and adjusting of the robot inclination

Congratulations! You finished assembling the mechanics of your Bot'n Roll ONE A!

You can move on to the electronic assembling.

4.2. ELECTRONICS ASSEMBLY

For the electronics assembly you require the following tools (not supplied with the robot):

- Soldering iron
- Soldering wire
- De-soldering pump
- Cutting pliers

Fig. 15: Required material for electronics assembly

IMPORTANT NOTE: In this stage, all electronic components are soldered to the Printed Circuit Board. For a correct soldering process, we strongly recommend all components to be soldered sequentially as presented in this manual. Bad soldering can cause destruction of components and printed circuit board, therefore, before you start soldering you must read the "crash course on Soldering" available on Bot'n Roll ONE A supplied manuals.

4.2.1. PRINTED CIRCUIT BOARD (PCB)

The Printed Circuit Board (PCB) contains small holes to insert the electronic components.

The silk screen printing (description of components in white) identifies the position and orientation of each electronic component on the Printed Circuit Board.

The Printed Circuit Board acts as a base for the electronic components and contains all the connections between them, according to the wiring diagram of the robot.
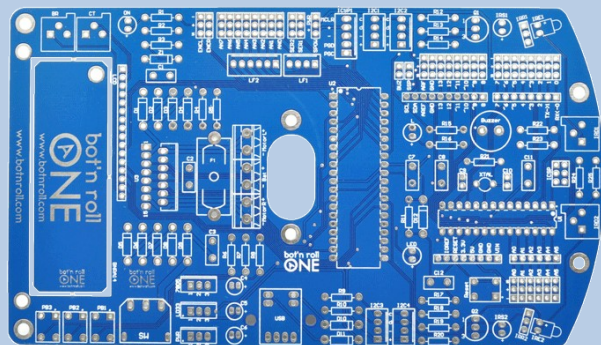

Fig. 16: Printed Circuit Board (PCB)

You must insert the components respecting the serigraphy (white letters) but solder them on the opposite side. It is not necessary to solder the components on the serigraphy side because the holes are plated and therefore they allow the passage of electric current.

4.2.2. RESISTORS

Electrical resistance is the name given to an element that opposes the passage of electric current (direct or alternating).

Usually resistance is represented by the letter R and its unit of measurement by the Ohm (Ω).
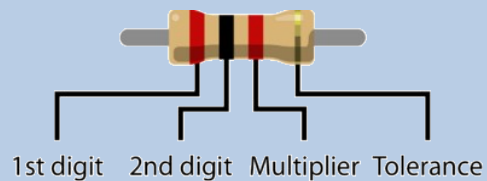

1st digit   2nd digit   Multiplier   Tolerance

Fig. 17: Resistance – lines with colour codes

The nominal value is represented by coloured bands (colour code), which satisfies the following criteria: exponent of the power of 10 that multiplies the original number, and finally the fourth colour (slightly shifted to the right) corresponds to the tolerance in percentage.

Colour	1st Band	2nd Band	3rd Band	4th Band	
	1st Figure	2nd Figure	Multiplier	Tolerance	%
Silver			0.01		+/- 10
Gold			0.1		+/- 5
Black	0	0	X 1	No colour	+/- 20
Brown	1	1	X 10	Silver	+/- 1
Red	2	2	X 100	Gold	+/- 2
Orang	3	3	X 1,000		+/- 3
Yellow	4	4	X 10,000		+/- 4
Green	5	5	X 100,000		
Blue	6	6	X 1,000,000		
Violet	7	7			
Gray	8	8	X 0.1		
White	9	9	X 0.01		

Table 1: Resistance colour codes

Example: What is the value of the resistor on the picture?

The first two colours: yellow (4) and violet (7) form the number 47. The third colour, orange (3), corresponds to the exponent of the power of ten: 10^3, or multiply by 1000, the fourth colour, silver (10%), indicates the tolerance. Thus, the electrical resistance is:

Fig. 18: Resistor example

R = 47000Ω with 10% tolerance or R = (47 000 Ω ± 4700Ω)
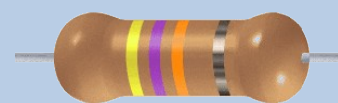
Taking as reference the following table, solder the resistors in the corresponding locations on the printed circuit board:

Solder the resistors value 1KΩ ±5%

(Colours: **Brown**, **Black**, **Red** and **Gold**) on **R1, R6, R7, R8, R13, R14, R16, R17, R18, R19, R20, R22** and **R23**;

Solder the resistors value 10KΩ ±5%

(Colours: **Brown**, **Black**, **Orange** and **Gold**) on **R3, R4, R5, R11** and **R12**;

Solder the resistors value 120Ω ±5%

(Colours: **Brown**, **Red**, **Brown** e **Gold**) on **R15, R24** and **R25**;

Solder the resistor value 1MΩ ±5%

(Colours: **Brown**, **Black**, **Green** and **Gold**) on **R21**;

Solder the resistors value 3,3KΩ ±5%

(Colours: **Orange**, **Orange**, **Red** e **Gold**) on **R2, R9** and **R10.**

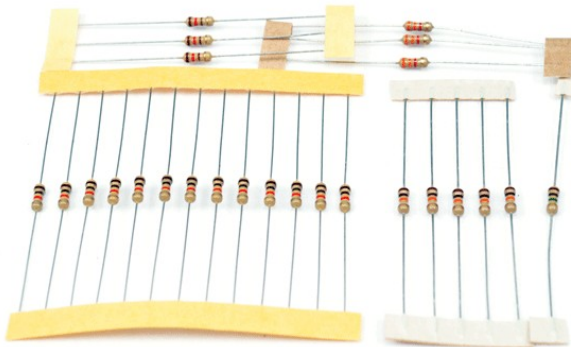| Description	Component
R1	1 KΩ
R2	3,3 KΩ
R3	10 KΩ
R4	10 KΩ
R5	10 KΩ
R6	1 KΩ
R7	1 KΩ
R8	1 KΩ
R9	3,3 KΩ
R10	3,3 KΩ
R11	10 KΩ
R12	10 KΩ
R13	1 KΩ
R14	1 KΩ
R15	120 Ω
R16	1 KΩ
R17	1 KΩ
R18	1 KΩ
R19	1 KΩ
R20	1 KΩ
R21	1 MΩ
R22	1 KΩ
R23	1 KΩ
R24	120 Ω
R25	120 Ω

Fig. 19: Bot'n Roll ONE A resistors

Tip: First, place all the resistances in the proper places slightly bending the terminals of each resistance.

Press the resistance against the desk before applying the solder process.

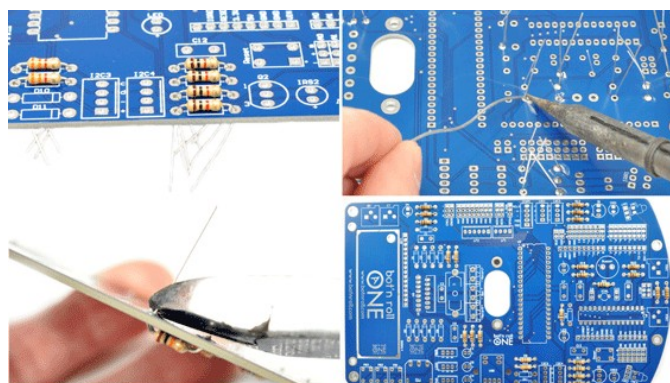After soldering cut the terminals as short as possible to avoid short-circuits.

Fig. 20: Resistors on the Printed Circuit Board

4.2.3. CRYSTAL OSCILLATOR

A crystal oscillator is an electronic component that uses the resonant properties of a piezoelectric crystal, to create an electrical signal with a very precise frequency. Bot'n Roll ONE A uses a 16MHz quartz oscillator crystal which makes the IC ATmega328 to operate at a 16MHz clock frequency. Like traditional watches, which also use a crystal, the usage of a crystal makes the Bot'n Roll ONE A a very accurate machine to measure time.

Fig. 21: Crystal Oscillator

Description	Component
XTAL	Crystal 16MHz

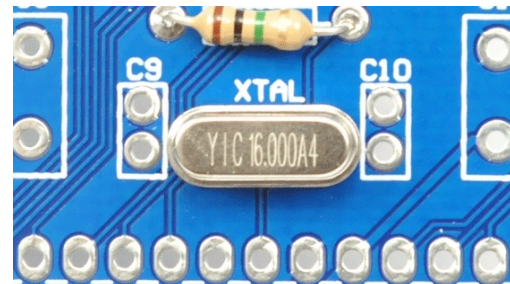On the printed circuit board serigraphy, the crystal oscillator is represented by "XTAL".

Fig. 22: Crystal Oscillator on the board

4.2.4. DIODES

The conventional diode consists of two blocks of semiconductor material, a N-type doped with negative ions (-), and a P-type doped with positive ions (+).

As main characteristic, the diode allows the electric current to flow only in one direction (left to right as shown in the picture).

To indicate the polarity, the diode has a mark that points to the corresponding edge of the cathode. The electric current flows from the anode (+) to the cathode (-) and not in reverse.

The Zener diode differs from the conventional diodes in being able to drive in both directions (direct and reverse), in controlled situations, without damaging itself. The Zener diode has an associated reverse voltage that remains constant in a situation where the current flows in the opposite direction. This allows it to be used in Bot'n Roll ONE A as a protection element in the battery measurement circuit. It works as a voltage limiter. To its terminals, voltage never rises above 5.1 V and thus the PIC18F45K22 will never be damaged in case the battery accidentally has excessively high voltages.
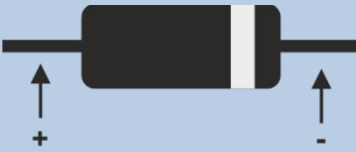
Fig. 23: Diode

Fig. 24: Zener Diode

Fig. 25: Robot Diodes

The board uses two different diodes with references:

FR203, used to drive the motors and to protect the power circuit of the robot.

Zener 5v1, used as a protection element in the battery measurement circuit.

The diodes have polarity, and therefore, must be placed with the correct orientation! Each diode has a mark that must match with the mark represented on the serigraphy of the printed circuit board (Fig. 26: Diodes location).

The diode reference is printed on the component itself.

Place the Zener diode 5V1 on **Z1.**

Place the FR203 diode on positions: **D1**, **D2, D3, D4, D5, D6, D7, D8, D9, D10, D11** and **D12.**

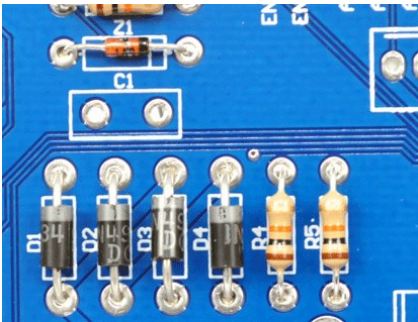| Description	Component
D1	FR203
D2	FR203
D3	FR203
D4	FR203
D5	FR203
D6	FR203
D7	FR203
D8	FR203
D9	FR203
D10	FR203
D11	FR203
D12	FR203
Z1	Zener 5v1

Fig. 26: Diodes location

4.2.5. POTENTIOMETERS

A potentiometer is a variable resistor, i.e., its value can be adjusted, and this way, one can control the intensity of the current flowing in a given circuit. In Bot'n Roll ONE A, potentiometers allow adjustment of the obstacles sensor detection distance, the contrast and brightness of the LCD display.
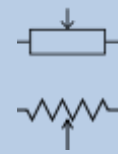
Fig. 27: Potentiometers

The printed circuit board has four 10KΩ potentiometers.

Its value is written on the side, as explained on Fig. 28: Potentiometers.

Description	Component
IRD1	Potentiometer 10KΩ
IRD2	Potentiometer 10KΩ
BR	Potentiometer 10KΩ
CT	Potentiometer 10KΩ

The inscription **P 103** corresponds to 10 000Ω, i.e., 10 KΩ.

The **IRD1** potentiometer regulates the left obstacle sensor detection distance.

The **IRD2** potentiometer regulates the right obstacle sensor detection distance.

The **BR** potentiometer regulates the LCD display brightness.

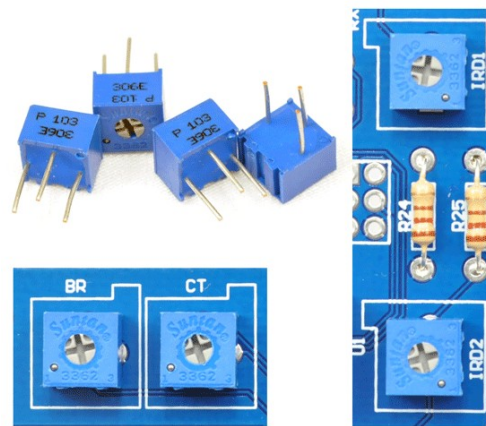The **CT** potentiometer regulates the LCD display contrast.

Fig. 28: Potentiometers

4.2.6. COLOURED LEDS

An LED – Light Emitting Diode, consists of a PN junction of a semiconductor material and two terminals, the anode (A, positive terminal) and cathode (K, negative terminal).

The colour of the light emitted by the LED depends on the semiconductor material.

Like the diode, the LED has polarity. The flat spot identifies the cathode (-) and is associated with the shorter leg.

Warning: Never look directly to the light emitted by an LED. At a short distance, the light is strong enough to injure the retina and the damage is permanent!
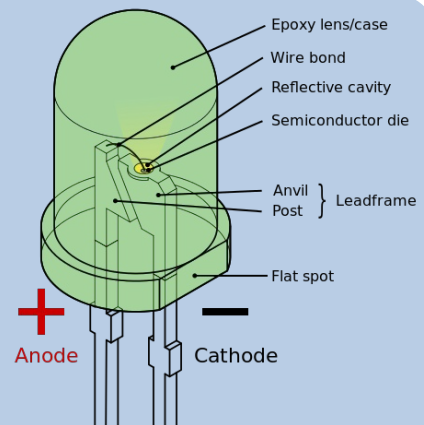

Fig. 29: LED

The Light Emitting diodes (LED's) indicate the status of your Bot'n Roll ONE A.

The green LED **ON** indicates that the robot powered.

The yellow LED's are for *"debugging"* and are controlled by your program.

Description	Component
ON	LED green
L	LED yellow
LED	LED yellow
IRS1	LED red
IRS2	LED red

The red LED's are associated to the obstacles detection circuit.

Place the green LED where **ON** is indicated in the PCB**.**

Place the yellow LED's on **L** and **LED**.
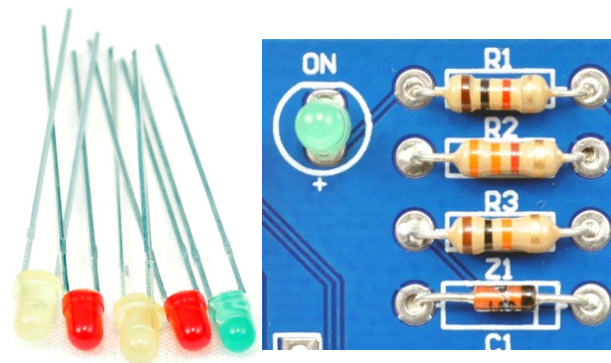
Place the red LED's on **IRS1** and **IRS2.**


Fig. 30: LED's

IMPORTANT NOTE: Do not forget that the LED's have polarity! You must insert the longest leg of each LED on the "**+**" indication on the board.

4.2.7. INTEGRATED CIRCUIT SOCKETS

The sockets for integrated circuits allow easy replacement of the integrated circuits in case they are damaged. Never solder integrated circuits directly on the PCB!

Description	Component
U1	28 pins socket
U2	40 pins socket

There are two sockets to insert the ATmega328 and PIC18F45K22 integrated circuits. These sockets have 28 and 40 pins respectively.
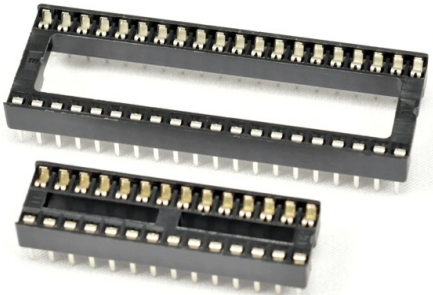
Each socket has a slot at one end that should match the serigraphy on the board. The placement of the sockets must respect these slots because they are very important in inserting the integrated circuits. The integrated circuits also have that slot. **If you insert an integrated circuit in the wrong orientation, you will damage it permanently!**

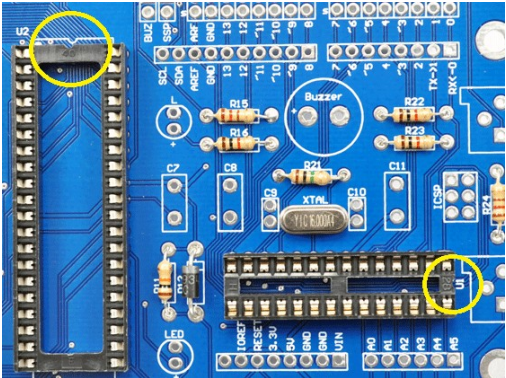The sockets must be soldered on **U1** and **U2**.

Fig. 31: Integrated circuits sockets

IMPORTANT NOTE: The ATmega328 and PIC18F45K22 integrated circuits will be inserted later in the sockets. Should only be inserted in step 3.3.4 after wiring the board.

4.2.8. INFRARED EMITTERS

Infrared emitters are LEDs that emit infrared light. This light is not visible to the human eyes, but it causes damage to the retina as in conventional LEDs!

Using a video camera, like a web cam for example, one can check whether the LEDs are working or not.

Description	Component
IRE1	Infrared emitter
IRE2	Infrared emitter

The infrared emitters are used in the obstacle detection circuit. They emit light that is reflected by the obstacles.

Place the infrared emitters on positions **IRE1** and **IRE2** facing outwards.

Fig. 32: Infrared emitters LED's

4.2.9. PUSH BUTTONS

A push button places an electrical signal on the circuit while being pressed.

Description	Component
PB1	Push button
PB2	Push button
PB3	Push button
Reset	Push button

Four push-buttons allow you to interact with the robot. You can, for instance, navigate on menus and change settings on your program quickly and without connecting your robot to the computer.

Use the push buttons **PB1**, **PB2** and **PB3** to interact with your robot and to navigate on menus displayed on the LCD.
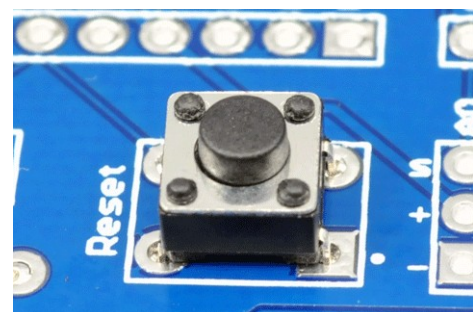
The *Reset* push button resets the Arduino.

Fig. 33: Push buttons

4.2.10. MAIN SWITCH

A switch is a device that interrupts the power supply (electric current) to the circuit.

Description	Component
SW	Main switch

The main switch allows you to power the robot ON and OFF.

It must be soldered on **SW** "*Switch*".

Bot'n Roll ONE A will be powered ON when you slide the switch to the front side of the robot. It will be OFF if you slide the switch back!
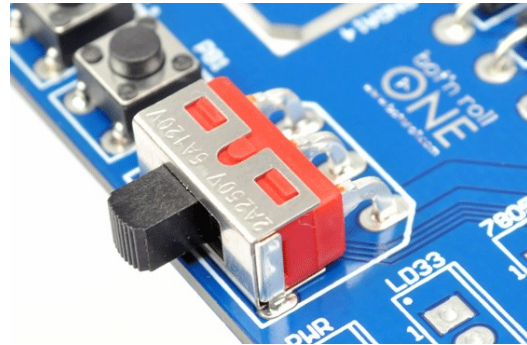

Fig. 34: Main switch

4.2.11. BUZZER

The *buzzer* is a transducer that converts electrical pulses into sound.

Description	Component
Buzzer	*Buzzer*

The buzzer can be used to create melodies or warning sounds, for example, to indicate that the battery voltage is too low.
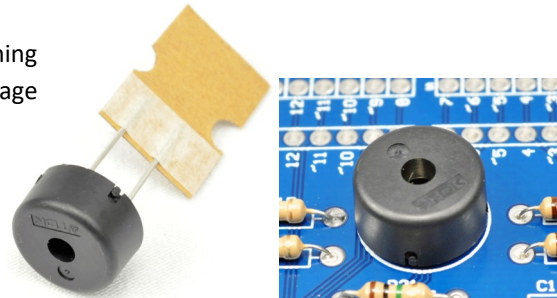

Fig. 35: *Buzzer*

4.2.12. CERAMIC CAPACITORS

The capacitor is a component that stores energy between two conducting plates ($E=1/2CV^2$). It is used to stabilize the energy on the robot circuits.

The capacitance (C) relates the stored charge with the voltage at its terminals ($C=Q/V$). The capacitor is made up of two conductive plates that are separated by an insulator or dielectric.

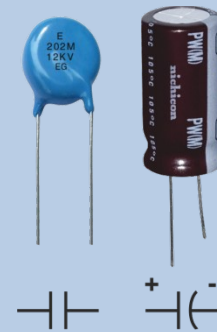There are monolithic capacitors (no polarity - left) and electrolytic (with polarity - right).

Fig. 36: Capacitor

Bot'n Roll ONE A uses ceramic capacitors with two distinct values: 22pF and 100nF.

The 22pF capacitor has the legend 22 and the 100nF capacitor has 104K written on it.

Description	Component	Inscription
C1	100nF	104K
C2	100nf	104K
C3	100nF	104K
C7	100nF	104K
C8	100nF	104K
C9	22pF	22
C10	22pF	22
C11	100nF	104K
C12	100nF	104K

Fig. 37: Ceramic capacitors

Place the 100nF capacitors on **C1**, **C2**, **C3**, **C7, C8, C11** and **C12**.

Place the 22pF capacitors on **C9** and **C10**. Note that 33pF capacitors can also be used as an alternative!
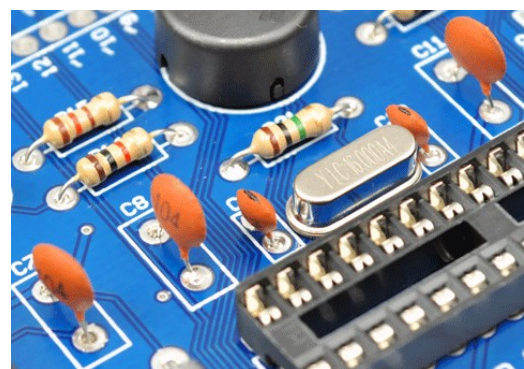

Fig. 38: Capacitors location

4.2.13. BIPOLAR TRANSISTORS

A transistor is a semiconductor device used to amplify or switch electrical signals. On Bot'n Roll ONE A it is used in the obstacles detection circuit to increase the power of the light emitted by the infrared LED's.

It consists of three layers of semiconductor material of **P** and **N** types and has three terminals: **E**mitter, **B**ase and **C**ollector. The provision of the three layers **P** and **N** set to **PNP** or **NPN** transistor.

When used as an amplifier, the current flowing between the base and emitter (input) is amplified and manifests itself between collector and emitter (output). When the transistor acts as switch, the base input signal toggles the output signal.

Depending on the transistor connection configuration, the amplified or toggled signal in the output can be inverted or not, regarding the input signal.
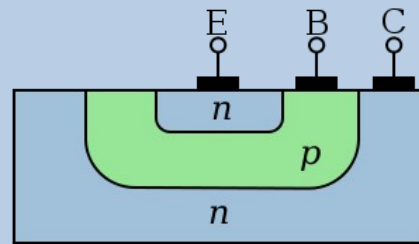
Fig. 39: NPN bipolar transistor

The two PNP BC557 transistors are placed on **Q1** and **Q2**.

Description	Component
Q1	BC557 Transistor
Q2	BC557 Transistor

These components are present in the infrared emitter circuit, working as switches, allowing the PIC18F45K22 to turn OFF and ON the infrared LED's with high power. Thus, the obstacles can be detected at great distances!

Fig. 40: BC557B PNP Transistor

Transistors have polarity! Only work properly if placed correctly in the circuit.

You must match the flat surface of the transistor with the flat line on the board´s serigraphy.

4.2.14. JUMPERS

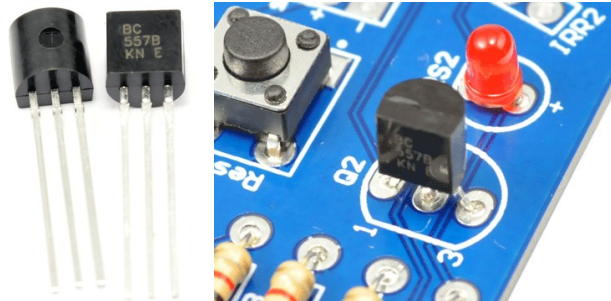A jumper is a connector that allows you to electrically configure the robot, directing the electric current to certain areas of the circuit.

Description	Component
SPOW	2-positions jumper
BUZ	1-position jumper
SSP	1-position jumper

Bot'n Roll ONE A has one 2-positions jumper and two 1-position jumpers.

The 2-positions jumper **SPOW** "*Servo Power*" allows you to select whether the servos are powered by the **7805** voltage regulator or the **PWR** voltage regulator dedicated to the servos.

The **BUZ** jumper connects the buzzer to the I/O pin **9** of Arduino.

The **SSP** jumper, when connected, allows communication between the Arduino and the PIC using the I/O pin **2** of Arduino as "*Slave Select*" of the SPI communication bus.
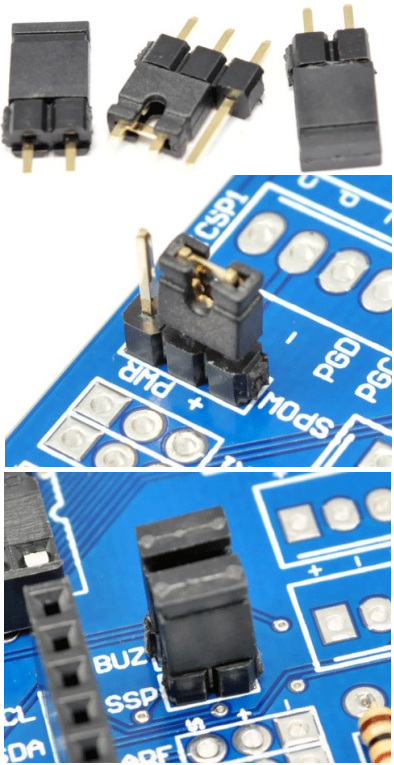

Fig. 41: *Jumpers*

4.2.15. ARDUINO CONNECTORS

The set of five connectors allows the connection of Arduino Compatible *"shields"*, like the wireless **XBee** communication shield.

Description	Component
ICSP	2x3 male connector
A0-A5	1x6 female connector
VIN-IOREF	1x8 female connector
0-7	1x8 female connector
8-SCL	1x10 female connector

Solder each of the five connectors on the rows with the same number of pins as the connector. Check that they are properly aligned and touching the printed circuit board!

Each of the five Arduino connectors has its specific function:

The **VIN-IOREF** connector is the Arduino **Power connector**. All robot circuit voltages are available here: **5V**, **3.3V**, **VIN** (battery voltage) and **GND** (0V). The **RESET** pin is connected to the Arduino *Reset* button and the **IOREF** is reserved for future shields.

On the **A0-A5** connector are located the analog inputs of the Arduino Analog to Digital Converter (**ADC**). Here you can connect analog sensors whose signal vary between 0V and 5V. With just some lines of code, you can get the corresponding digital value. Should you use **I2C** communication you cannot use the **A4** and **A5** pins as inputs for the ADC, since they are reserved for the I2C communication.

Fig. 42: Arduino connectors

Next to the **A0-A5** connector, you will find a group of triple connections that have the same **A0-A5** identification. Here you can connect analog sensors that also require voltages between 0V and 5V. On this group of connectors the "**s**" pins correspond to the analog inputs, "**-**" corresponds to the 0V and "**+**" corresponds to 5V.

On the **0-7** and **8-SCL** connectors, you have the Arduino digital inputs and outputs (I/O) and each of these pins can be configured by software as a digital input or output. On each of the **0** to **13** outputs, you can place a 0V or 5V signal that correspond to the **Low** and **High** states respectively. On the pins with the symbol "**~**", for example **~3** you can have a **PWM** output and here you can control servomotors, like the ones used on the gripper. When configured as digital inputs, to connect digital sensors for example, on each of these pins you can check whether you have 5V or 0V. The **SCL** and **SDA** pins are used for **I2C** communication and corresponds to **A4** and **A5** pins of connector **A0-A5**. The **AREF** pin should only be used in case you require an external reference voltage for the ADC conversions, but this voltage can only vary between 0V and 5V!

Next to the **0-7** and **8-SCL** connectors, you will find a group of triple connections that have the same identification **0-7** and **8-SCL**. Here you can connect digital sensors and actuators that require voltage between 0V and 5V. On this group of connectors the "**s**" pins correspond to the digital pins, the "**-**" corresponds to the 0V and the "**+**" corresponds to 5V.

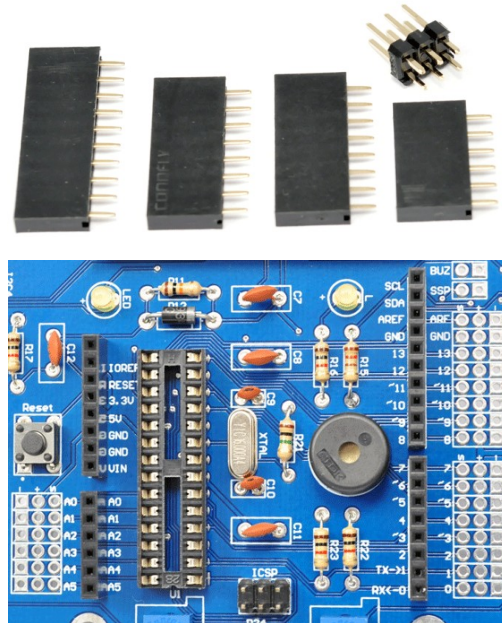The **ICSP** connector allows **SPI** communication with *shields* and the **ICSP** (*In Circuit Serial Programming*) programming of the Arduino bootloader.

4.2.16. POWER CONNECTORS

The power connectors allow you to connect the battery and motors to the PCB. Screws secure the wires.

Description	Component
MotorL	Left motor connector
Bat	Battery connector
MotorR	Right motor connector

Join the connectors using the slots so that you have a six links unique connector.

Fit it and solder all terminals on the PCB.

On **MotorL** you connect the left motor, on **MotorR** you connect the right motor and on **Bat** you connect the battery.
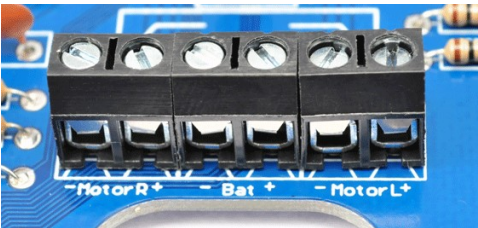

**Fig. 43: Power connectors location**

4.2.17. FUSE AND FUSE HOLDER

A fuse is a protective device comprising a metallic conductor that melts as soon as the electric current flowing through it exceeds the specified value.

Description	Component
F1	Fuse support

To protect against short circuits a 4A fuse with a fuse-holder is used. If the electric current supplied by the battery exceeds 4A, the fuse will burn.

Place the 4A slow blow fuse on the fuse support cover.
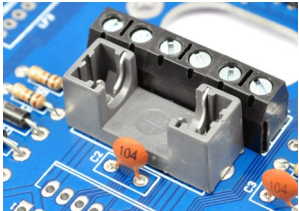
The fuse holder must be inserted in the printed circuit board on "**F1".**
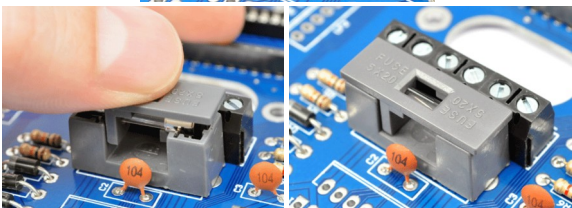
Insert the fuse cover with the fuse on it.

Fig. 44: Placing the fuse in the circuit

4.2.18. ELECTROLYTIC CAPACITORS

Electrolytic capacitors have polarized terminals! As such, when placed on the printed circuit board, you have to respect their polarity.

Description	Component
C4	100µF
C5	100µF

They should be placed on **C4** and **C5** with the longest terminal inserted into the location identified by the symbol "**+**" on the serigraphy.

The capacitors value is 100µF.

Fig. 45: Electrolytic capacitors

4.2.19. I2C CONNECTORS

These connectors allow you to plug devices that use I2C communication protocol like compasses, accelerometers, sonar, temperature and humidity sensors, etc.

Description	Component
I2C1	KK 1x4 male connector
I2C2	KK 1x4 male connector

Place the connectors on **I2C1** and **I2C2**. Note that the mark in the serigraphy represents the vertical plastic of the connector.
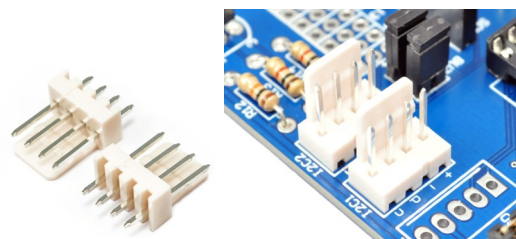

Fig. 46: I2C connectors

4.2.20. USB - SERIAL CONVERTER

The USB – Serial (RS232) converter is the device which allows programming the robot through a computer USB port.

Description	Component
USB	USB converter

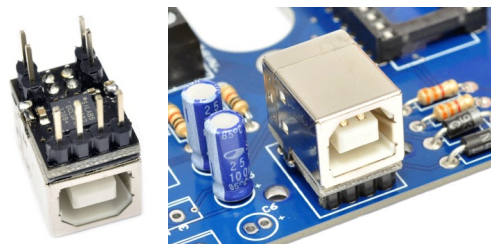This device is placed on the "**USB**" mark of the serigraphy.

Fig. 47: USB converter

4.2.21. HEAT SINK

A heat sink is a metallic object that reduces the working temperature of a component. It avoids the component to be damaged due to excessive temperature and increases its lifetime.

Description	Component
7805	LM7805
LD33	LD33CV

Attach the LM7805 to the heatsink using the bolt and nut provided. Put together the smooth inner surface of the heatsink sink, and the metallic surface of the LM7805!
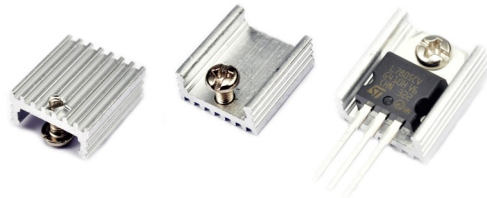

Fig. 48: Heat sink

4.2.22. VOLTAGE REGULATORS

The LM7805 and LD33CV components are linear voltage regulators to supply specific voltages for powering the circuit.

The 7805 serves as a power source for devices that work at 5 volts while the LD33 power devices that work at 3.3 Volts.

Description	Component
7805	LM7805
LD33	LD33CV
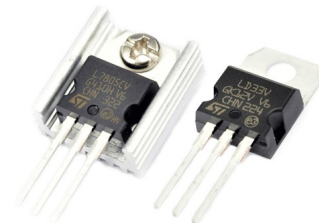
According to the serigraphy, place the LM33CV where indicated "**LD33**" and the LM7805 where indicated "**7805**".

You must solder the LM7805 with the heat sink already placed!

Components orientation must be respected. Note that the double line on the serigraphy corresponds to the metallic heat sink of the component.

Fig. 49: LD33 and 7805 Voltage regulators

4.2.23. L298 H BRIDGE

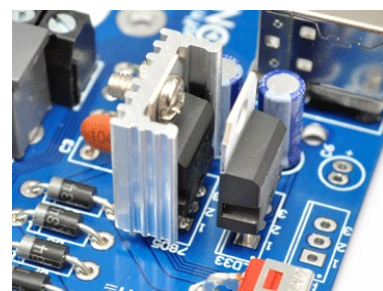The L298N component corresponds to a double H bridge to drive, independently, each motor of the robot, allowing control of speed and direction.

This component allows a maximum current of 2A on each H Bridge for continuous operation. For short moments (up to 100 us), it enables a 3A debit for each motor.

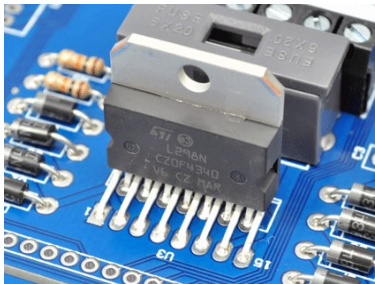| Description	Component
U3	L298N

Place the L298N on "**U3**".
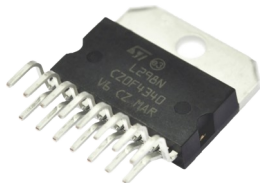
Fig. 50: L298N integrated circuit

4.2.24. INFRARED RECEIVERS

The infrared receivers are sensors that detect infrared light reflected by obstacles. This light is emitted by the infrared LEDs as a 56 KHz modulated signal, i.e. each LED turns on and off 56,000 times per second! If the LEDs do not emit at this frequency the infrared receiver sensors will not detect obstacles.

Description	Component
IRR1	VISHAY TSSP4056
IRR2	VISHAY TSSP4056

Two infrared receivers are placed at the **bottom** of the printed circuit board, unlike all the components already soldered.

Insert the VISHAY TSSP4056 receivers under the PCB on **IRR1** "*Infra-Red Receiver1*" and **IRR2**, with the sensors facing outwards as illustrated on figure 49.

These receivers must be soldered on the top side of the PCB, opposite to what you have done so far.

Fig. 51 Infrared receivers

4.2.25. LCD

The LCD is a device that enables the robot to interact with the user through written messages, for example, states of the program or the value of variables.
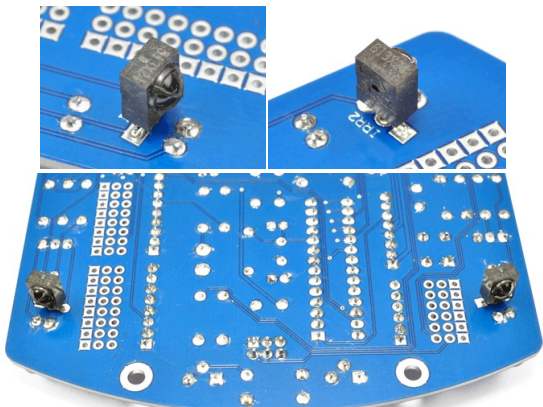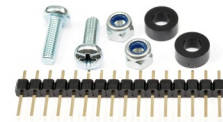
The Bot'n Roll ONE A LCD is alphanumeric, has 2 lines with 16 characters each. It has adjustable contrast and brightness.

Description	Component
LCD	1x16 connector

To hold the LCD a 16 pins header connector, two M3x10 PH1 screws, two nylon spacers and two M3 nuts are provided.

To attach the LCD you have to remove the piece of plate that fills the output hopper. Use a file/sandpaper to smooth the output hopper, if necessary, so that the LCD enters effortlessly.

The LCD enters from the bottom of Bot'n Roll ONE A PCB. Before inserting it, place the 16-pin header connector between the LCD and the board with the longer pins facing down.

Insert the LCD on the board and place the two screw assemblies, nylon spacer and nut, as indicated in the figure and attaching the LCD to the printed circuit board by tightening the screws.

Check that the 16-pin header connector has been "sandwiched" between the LCD and the Bot'n Roll ONE A PCB, with the pins inside the holes of the "LCD" link on the robot board.

Confirm that the LCD is horizontally aligned and solder the 16-pin header connector to Bot'n Roll ONE A PCB. Afterwards solder the 16 pins underneath on the LCD.

The removed piece of PCB board is designed to be used as a unique and distinctive keyring!

Fig. 52: Placing the LCD

4.2.26. USB-SERIAL CONVERTER PROTECTION CASING

The USB-Serial converter is a component that is subject to constant physical stresses resulting from the introduction and removal of the USB cable. A 3D printed PLA plastic casing was developed to "embrace" and protect the USB-Serial converter. It allows maintaining the integrity of its structure.
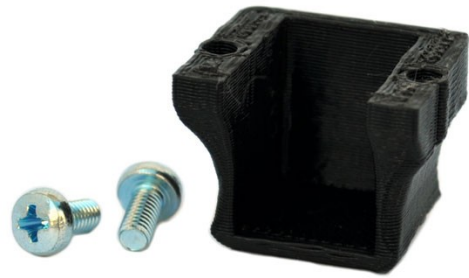
Place the plastic protection on the USB-Serial converter so the USB connection for the cable is visible. Verify that the two holes on the bottom of the protection casing are aligned with the holes on the robot´s PCB.
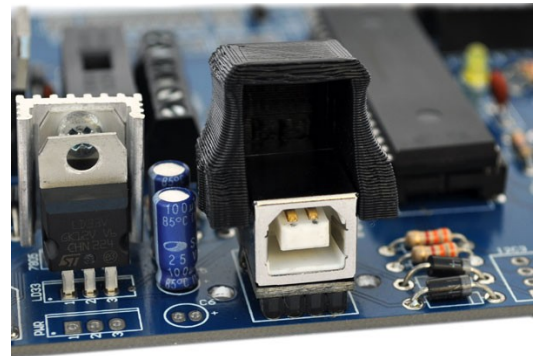
Insert the two M3x6mm screws into the holes and tighten them using a PH1 screwdriver, threading them into the plastic protection. Thread the screws until the bottom of the plastic casing touches the robot's PCB, but not tighten too much because you can grind the plastic material!
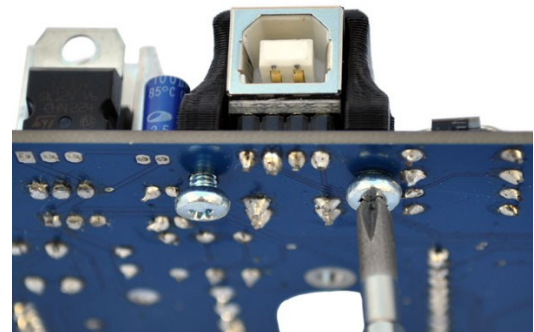
Verify that the screws are not in contact with the welds, it may cause short-cicuits!

The USB-Serial converter is now physically protected, with a lot of robustness, for everyday use!

Fig. 53: Placing the USB-Serial protection plastic casing

4.3.   WIRING AND TESTING

4.3.1. CONNECTING THE BATTERY

VERY IMPORTANT NOTE:

Short-Circuiting the battery might initiate a fire!

Never connect the battery to the robot before finishing all connections!

Before unscrewing the battery cable from the "**Bat**" connector, ensure that the battery is **NOT connected** to the cable!
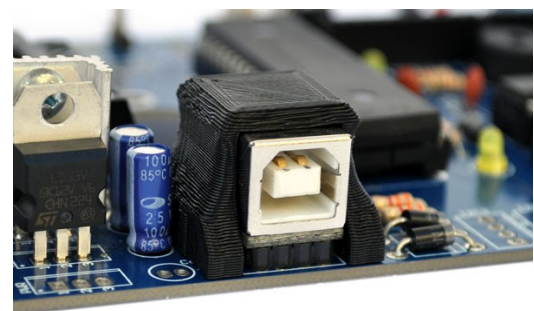

The battery connector is plugged in "**Bat**". The red wire must be connected to the "**+**" mark on the serigraphy and the black wire to the"**−**". **In this case, the Polarity is EXTREMELY important!**

The wires passage from the lower part of the robot to the printed circuit board is through the central hole on the acrylic base.
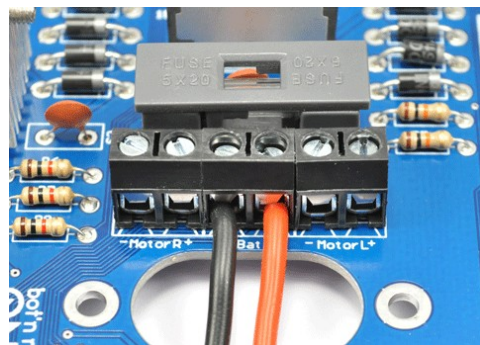
Fig. 54: Plugging the battery wires

4.3.2. ASSEMBLY ELECTRICAL CHECK

Now, connect the charged battery to the robot and verify that the **ON** LED turns on and off when you use the main switch.

Check with a voltmeter that the 5V, 3.3V and VIN (battery voltage) voltages are present in the **Arduino Power Connector** (**VIN-IOREF**). You should always measure with respect to GND that corresponds to 0V.

If any of the above does not happen, it means that there were problems during the assembling. You should fix it before going to the next step. In the table below we present some tips to help you solving the problem:

Fig.55: LED ON

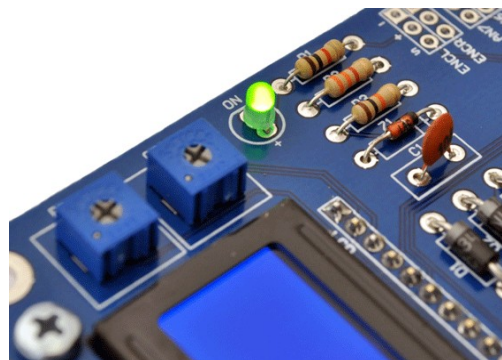| Possible cause / Inspection	Solution
The battery is not properly inserted on the connector.	Insert the battery correctly and check that the connector tab is latched.
The battery wires are not properly connected to the Bot'n Roll ONE A printed circuit board.	Check whether the wires are securely fastened to the "**Bat**" connector and perform a continuity test with a multimeter.
The fuse is not inserted in the circuit.	Insert the fuse as indicated on section 3.2.17 of this manual.
The fuse blew.	Most likely, there is a short circuit on the board. Check solders, identify and remove the short circuit before inserting a new fuse.
The fuse is not blown but the green LED **ON** does not light up or the voltages are not all present on the Arduino connector.	In this case, there might still be a short circuit but the electric current is not enough to blow the fuse. Check the temperature of the voltage regulators **7805** and **LD33**.
One or both voltage regulators are too hot.	There is great probability of a short circuit. Check solders, identify and remove the short circuit. There is still a small chance of a component being damaged.
The voltage regulators do not warm up, the **ON** LED does not light up or the power connector voltages of the Arduino are not present.	It is likely that there are bad solders and contact between the components and the board is faulty. Identify cold solders, in which the solder wire does not shine and apply the soldering iron again until you see the solder melt completely. Add more solder wire if necessary.
The voltage regulators did not warm up, the **Power** connector voltages are present but the Power **ON** LED does not light. The Arduino connector's voltage are present but the **ON** LED does not light up.	You should confirm that the LED **ON** is soldered according to the polarity, where the + corresponds to the longest leg. Check the polarity of the **ON** LED with a multimeter.
After checking all the above possibilities, the problem still exists.	Contact the help service on *botnroll.com*.

4.3.3. INTEGRATED CIRCUITS PLACEMENT

An integrated circuit is a miniaturized electronic circuit consisting mainly of semiconductor devices such as transistors. The number of transistors on integrated circuits can vary from a couple of transistors to tens of millions of transistors.

Description	Component
U1	ATmega328
U2	PIC18F45K22

On the robot, two DIP format integrated circuits are used:

PIC18F45K22: 40 pins processing unit (PIC).

ATmega328: 28 pins processing unit (Arduino).

NOTE: Before inserting the integrated circuits ensure that the Bot'n Roll ONE A is powered OFF.

It may be necessary to align the pins of integrated circuits before inserting them on the sockets. Do this carefully because the pins are fragile and can break if not done properly or bended several times, becoming irreparably damaged.

IMPORTANT NOTE: The integrated circuits have a unique inserting position. In one of the edges, a cavity corresponds to the printed mark on the PCB serigraphy.
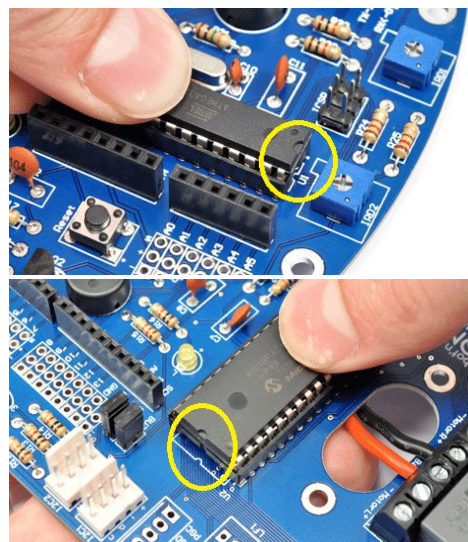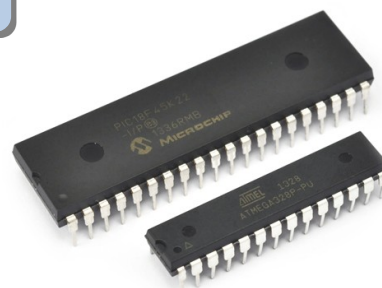Insert the ATmega328 on **U1** and the PIC18F45K22 on **U2**.

Fig. 56 Integrated circuits insertion

4.3.4. FIXING THE PCB ON THE ACRYLIC BASE

Fixing the robot board to the acrylic base is carried out by using 6 sets of one 12mm nylon spacer, one M3x8 PH1 screw and one M3x4 PH1 screw.

Fig. 57: Required parts to hold the PCB on the acrylic base

Insert each M3x8 PH1 screw on the acrylic base from bottom to top and screw a nylon spacer until it is tightened.

Repeat for each of the six spacers.

Place the electronic board passing the motors wires by the centre hole and attach it using the M3x4 PH1 screws thru the nylon spacers.
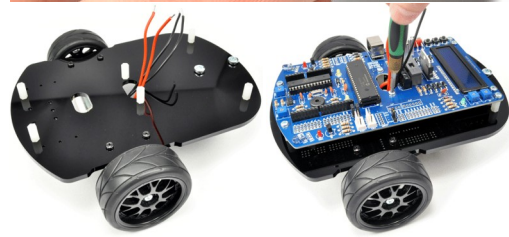
Tighten the screws with a Phillips screwdriver so that there are no gaps between the PCB, the nylon spacers and the acrylic base.
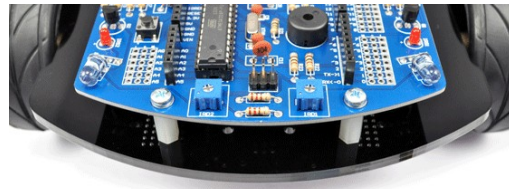
Fig. 58: Assembling the PCB on the acrylic base

4.3.5. CONNECTING THE MOTORS

The connection of the motors is carried out on the **MotorL** and **MotorR** connectors. The left motor connects to **MotorL** and the right one to **MotorR**.

IMPORTANT NOTE: The motors wires have black and red colours. Correctly connecting these wires is very important because polarity determines the motor direction of rotation and the robot may not move as expected!

The red wire must be plugged on the "**+**" and the black wire on "**−**".
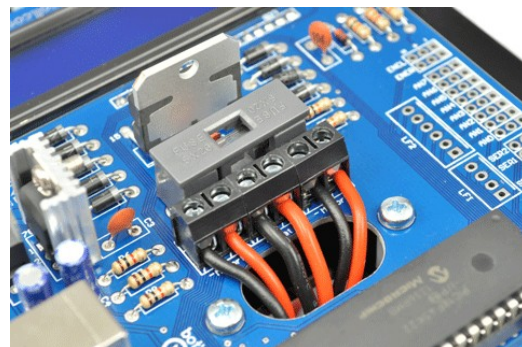
Fig. 59: Motors connection

4.3.6. BATTERY PLACEMENT

The battery is placed on the bottom part of the acrylic base using three Velcro strips.

Before attaching the Velcro strips check that the area is not sticking dirty, or greasy!

If necessary, use a glass-cleaning product to clean the surfaces and let them dry properly!

Glue the two velcro strips to the battery pressing hard for proper attachment. Afterwards, remove the stickers protection to place the battery on the robot.

Put the battery on the Bot'n Roll ONE A pressing again for a good grip. Attention not to damage the components on the robot board!

After the battery is secured with Velcro and fully charged, attach the connector and Bot'n Roll ONE A is ready to be programmed!

Well done!

Fig. 60: Battery placement

5. INSTALLING THE USB-SERIAL (RS232) CONVERTER VCP DRIVER

The driver allows your computer operating system to communicate with the Bot'n Roll ONE A.

To install the driver visit the Bot'n Roll ONE A support web page http://botnroll.com/onea/ and download the "**VCP Driver - Windows**" or "**VCP Driver - Mac OS X**" by clicking on the correct link according to your operating system. After download, decompress the ".*zip*" file and run the application.

Every time you connect your robot to your computer using the USB cable a virtual COM port (VCP) is created, through which the communication between your Bot'n Roll ONE A and your PC is carried out. The programming application environment uses the port to communicate with Bot'n Roll ONE A and therefore transfer your programs to the robot.

The USB-Serial converter used by Bot'n Roll ONE A is a **PoUSB12** product from *PoLabs* and uses the *Bridge* **CP2102** device from *Silicon Labs*.

6. ARDUINO PROGRAMMING ENVIRONMENT

The *software* used to program the robot is Arduino IDE. This application is necessary to edit the programs in C language. It is also used to transfer your programs to Bot'n Roll ONE A.

6.1. ARDUINO IDE INSTALLATION

To install the Arduino IDE, visit Bot'n Roll ONE A support web page http://botnroll.com/onea/ and click on the essentials "**Arduino IDE - Windows**" or "**Arduino IDE - Mac OS X**" to download it according to your operating system.

After downloading, decompress the .zip file and copy it to a folder of your choice on your computer.

This folder contains several sub-folders and files, amongst them, the "**arduino**" application**,** the executable that starts the Arduino IDE. The sub-folder "*libraries*" is also very important and contains all the Arduino libraries. The libraries are your programming working tools.

6.2. INSTALLING THE BNRONEA LIBRARY ON ARDUINO

The **BnrOneA** library developed by **botnroll.com** for the Arduino IDE contains all the required commands to control the robot. This library must be installed on Arduino IDE.

On the Bot'n Roll ONE A support web page http://botnroll.com/onea/, download the **Arduino Library** file by clicking on "**BnrOneA.zip**".

Decompress the file and place the extracted folder "**BnrOneA**" inside the "*libraries*" directory that was described on the previous section. Now you have all the required tools to successfully program your **Bot'n Roll ONE A!**

6.3. CONFIGURING COMMUNICATION WITH THE ROBOT

Before proceeding with this step, ensure you have installed the VCP driver correctly. Connect the Bot'n Roll ONE A to your computer using the supplied USB cable. At this time, a COM port to communicate with the robot is automatically assigned.

Open the Arduino IDE, press the "**Tools -> Board**" option, and select the "**Arduino Uno**" board. **Bot´n Roll ONE A** will be programmed as if it is an Arduino Uno.
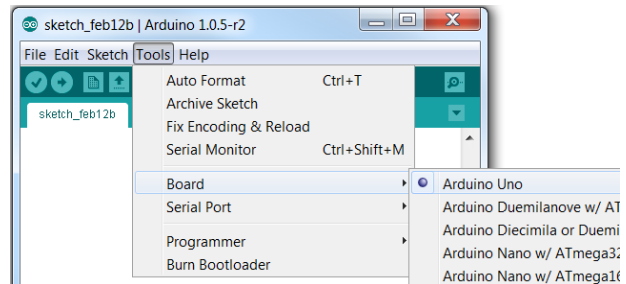
Fig. 61: Selecting the board to program

On the "**Tools -> Serial Port**" option, select the correct COM port given to **Bot'n Roll ONE A**.
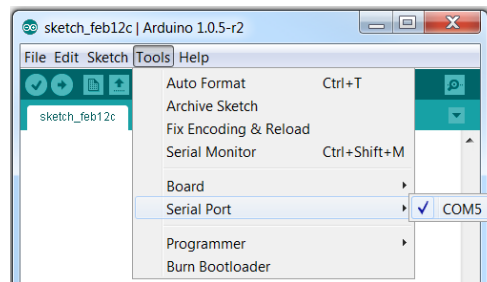
Fig. 62: Selecting the Serial port

Should no COM port be available, you probably did not install the USB-Serial converter VCP driver correctly.

Open the Windows device manager and search for the item "Ports (COM and LPT)". Expand the item, you will see all COM ports available.

"**Silicon Labs CP210x USB to UART Bridge**" is the designation which identifies the COM port that "talks" to Bot'n Roll ONE A (on this figure example **COM5** port has been assigned).

Should the item "**Silicon Labs CP210x USB to UART Bridge**" not show up on the list, you have to install the VCP driver correctly.

Fig. 63 COM ports on the device manager

6.4. LOADING A PROGRAM TO BOT'N ROLL ONE A

On the Arduino IDE application, you will find several example programs that you can load to your robot.

Click on "***File -> Examples -> 01.Basics -> Blink***" and a new window with the code of this example will show up.
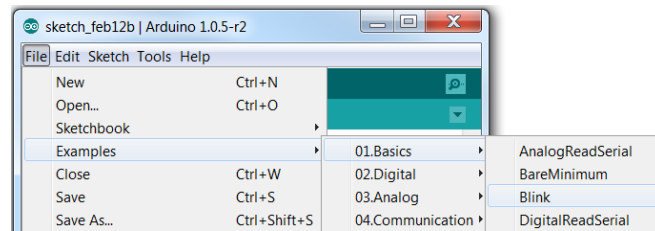
Fig. 64: Loading an example program

Click on "***File -> Upload***" or press the "arrow pointing right" icon to send the program to the robot. As soon as the upload finishes, you must see the yellow L LED flashing each second!

Fig. 65: Sending a program to the robot
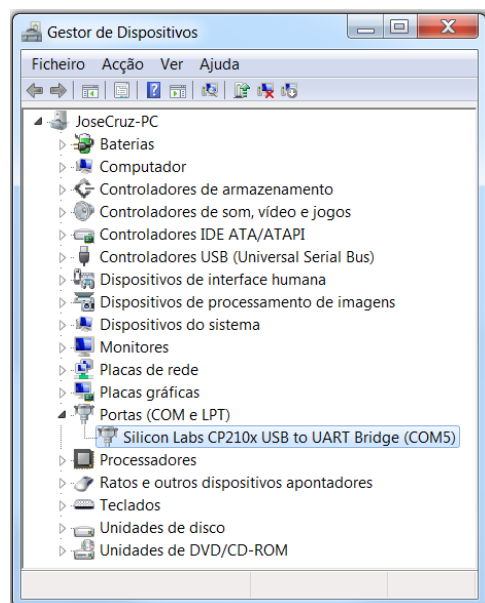
Clicking on "***File -> Examples -> BnrOneA-> ...***" you will find all the programs developed by botnroll.com specifically for Bot'n Roll ONE A.

On "***File -> Examples -> BnrOneA-> Basic -> ...***" you can find the simplest programs whose main purpose is to test all your robot hardware. You must study and understand well all these small programs!

On "***File -> Examples -> BnrOneA-> Advanced -> ...***" are available some more advanced programs which you might understand only after the basic ones.

On "***File -> Examples -> BnrOneA-> Extra -> ...***" you can find programs related with the Bot'n Roll ONE A extras, which will make your robot more versatile.

Fig. 66: Programs from the BnrOneA library

7. BOT'N ROLL ONE A HARDWARE TEST

After your robot have successfully passed the electrical test (section 3.3.2 of this manual), it is necessary to test all Bot'n Roll ONE A devices individually and verify they are operating correctly. You will have to program the robot with the corresponding sample codes and perform the test described on each of the following points listed, in the presented order!
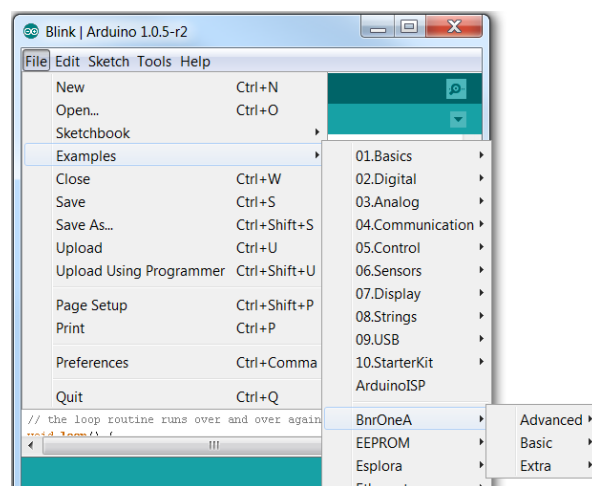
7.1. "L" LED

Using the Arduino IDE open the example program "*Blink*" located on "*File -> Examples -> 01.Basics -> Blink*" and program the robot clicking on "*Upload*". When the upload ends, you must see the **L** LED blinking every second.

If the **L** LED does not lights up check if there is any short-circuit or bad solders on:
- **L** LED;
- **R16** resistor;
- Pin **13** of the Arduino **8-SCL** connector;
- ATmega328 **integrated circuit socket**.

Assure that you have soldered the **L** LED respecting its polarity. You can verify that using a multimeter or comparing the internal connections of the LED with an identical one.

7.2. BUZZER

Load the "*Buzzer*" program located on "*File -> Examples -> BnrOneA -> Basic -> Buzzer*" to the robot. When the upload ends, you should listen a melody emitted by the buzzer. This indicates that the buzzer is working properly.

Should the buzzer not play the melody, check if the **BUZZ** jumper is placed correctly and if there is any short-circuit or bad solders on:
- *Buzzer*;
- **R15** resistor;
- **BUZZ** jumper;
- ATmega328 **integrated circuit socket**.

7.3. DEBUG "LED"

Load the program "*LED*" located on "*File -> Examples -> BnrOneA -> Basic -> LED*" to the robot. When the upload ends, you should see the LED blinking each second.

Should the **LED** not emit any light you must check for short-circuits or bad solders on:
- **LED** LED;
- **R18** resistor;
- Pin **13** of the Arduino **8-SCL** connector;
- **SSP** jumper;
- PIC18F45K22 **integrated circuit socket**.
- ATmega328 **integrated circuit socket**.

Assure that you have soldered the **LED** LED respecting its polarity. You can check that using a multimeter or comparing the LED internal connections with an identical one.

7.4. LCD

Load the "*LCD*" program located on "*File -> Examples -> BnrOneA -> Basic -> LCD*" to the robot. When the upload ends, you should see the "*LCD Test OK**!!**"* message on the LCD.

Should you not see the message, check that:
- The robot main switch is ON;
- You correctly adjusted the LCD brightness using the **BR** potentiometer;
- You correctly adjusted the LCD contrast using the **CT** potentiometer;

If you still cannot see the message on the LCD verify that there are no short-circuits or bad solders on:
- LCD **16 pins connector**;
- **BR** potentiometer**;**
- **CT** potentiometer**;**
- **SSP** jumper;
- PIC18F45K22 **integrated circuit socket**.
- ATmega328 **integrated circuit socket**.

7.5. PUSH-BUTTONS

Load the "***Push-buttons***" program located on "***File -> Examples -> BnrOneA-> Basic -> PushButtons***" to the robot. When the upload ends, you can see on the LCD the button number you are pressing:
- **0** if **no** button is being pressed
- **1** if **PB1** button is pressed
- **2** if **PB2** button is pressed
- **3** if **PB3** button is pressed

If any button does not work properly check that there are no short-circuits or bad solders on:
- **PB1** switch;
- **PB2** switch;
- **PB3** switch;
- **R6** resistor;
- **R7** resistor;
- **R8** resistor;
- **SSP** jumper;
- PIC18F45K22 **integrated circuit socket**.
- ATmega328 **integrated circuit socket**.

7.6. BATTERY

Load the "**Battery**" program located on "***File -> Examples -> BnrOneA -> Basic -> Battery***" to the robot. When the upload ends, you should see the battery voltage value on the LCD.

If the voltage value is not between 9.0V and 14.0V, check that:
- The robot main switch is ON;
- The battery is charged;
- The resistor on **R2** is 3.3KΩ;
- The resistor on **R3** is 10KΩ;
- Placed the *Zener* diode **Z1** with the correct orientation.

If the problem continues verify that there are no short-circuits or bad solders on:
- **C1** capacitor;
- **R2** resistor;
- **R3** resistor;
- **Z1** diode;
- **SSP** jumper;
- PIC18F45K22 **integrated circuit socket**.
- ATmega328 **integrated circuit socket**.

7.7. MOTORS

Load the "**Motors**" program located on "*File -> Examples -> BnrOneA -> Basic -> Motors*" to the robot. When the upload ends, the motors might start moving and a message is shown on the LCD describing the movement being carried out.

Should some motor not move check:
- The robot main switch is ON;
- The battery is charged;
- The **MotorL** connector is tightened;
- The **MotorR** connector is tightened;
- The *hubs* are properly placed on the motors;
- The robot **wheels** are properly tightened to the hubs.

If the problem continues verify that there are no short-circuits or bad solders on:
- **C2** capacitor;
- **D2**, **D3**, **D4**, **D5**, **D6**, **D7**, **D8** and **D9** diodes;
- **MotorL** connector;
- **MotorR** connector;
- **U3** (L298N) integrated circuit;
- **SSP** jumper;
- PIC18F45K22 **integrated circuit socket**.
- ATmega328 **integrated circuit socket**.

7.8. INFRARED LED'S

Load the "*_01_EmittersOnOff*" program located on "*File -> Examples -> BnrOneA-> ObstaclesSensor -> _01_EmittersOnOff*" to the robot. When the upload ends, the infrared LED's will commute each second with its respective status information shown on the LCD.

Use a mobile phone camera (without infrared filters) to check that LED's are blinking, since human eyes cannot see this type of light.

If some of the infrared LED's do not emit any light, adjust the corresponding potentiometer (**IRD1** for **IRE1** and **IRD2** for **IRE2**) until you see light being emitted by the LED.

If the problem continues verify that there are no short-circuits or bad solders on:
- **IRE1** LED;
- **Q1** transistor;
- **IRD1** potentiometer;
- **R13** and **R24** resistors;
- **IRE2** LED;
- **Q2** transistor;
- **IRD2** potentiometer;
- **R19** and **R25** resistors;
- **SSP** Jumper;
- PIC18F45K22 **integrated circuit socket**.
- ATmega328 **integrated circuit socket**.

7.9.   OBSTACLE SENSORS

Load the "**_02_ObstaclesRead**" program located on "***File -> Examples -> BnrOneA-> ObstaclesSensor -> _02_ObstaclesRead***" to the robot. When the upload ends, the infrared LED's will emit infrared light which when reflected by an obstacle will make the **IRS1** and **IRS2** LED's blinking.

On the LCD, a message with the obstacle proximity indication is written and the values vary from 0 to 25:
- **0** the sensors do not detect any obstacle;
- **25** the obstacle is very close to the robot.

Put your hand in front of the infrared LED´s to simulate an obstacle and check that the **IRS1** and **IRS2** LED's blink and at the same time the respective message is presented on the LCD.

If some of the **IRS1** or **IRS2** LED's do not flash, verify there are no short-circuits or bad solders on:
- **IRS1** LED;
- **IRR1** sensor;
- **R14** resistor;
- **IRS2** LED;
- **IRR2** sensor;
- **R20** resistor;
- **SSP** Jumper;
- PIC18F45K22 **integrated circuit socket**.
- ATmega328 **integrated circuit socket**.

Assure that you soldered the **IRS1** or **IRS2** LED's respecting its polarity. You can check this using a multimeter or comparing the LED's internal connections with identical ones.

Place the robot against an obstacle, like wall or a white paper sheet, and adjust the desired distance using the **IRD1** and **IRD2** potentiometers and a screwdriver.

7.10.   MOTORS CALIBRATION

Load the "***MotorsCalibrate***" program located on "***File -> Examples -> BnrOneA-> Advanced -> MotorsCalibrate***" to the robot. When the upload ends you are going to configure the necessary power to move the motors.

Calibrating the motors must be done with the robot placed on a **flat surface** and using a **fully charged battery**. The goal of this process is to register the necessary power for the robot to initiate movement and the battery voltage in that precise moment. The robot will use these calibrating values to improve motion with very low speeds and to maintain a constant velocity as battery voltage drops while discharging.

The LCD presents the power (PWM from 0 to 100) applied to the motors. Using the push-button **PB1** you will increase the power until the robot starts moving forward. In that precise moment you lift the robot and press the **PB3** push-button to save the values in the robot´s memory. The LCD will present a message stating the data was saved.

This calibrating process must be done whenever you switch the battery for another with a different nominal voltage or the motors for others with different nominal rotation or gear ratio.

Your **Bot'n Roll ONE A** is now complete and functional! Use your imagination and explore the fantastic world of Robotics… Congratulations!

8. EXTRAS

A wide range of components can be integrated in your Bot'n Roll ONE A and thus increasing its functionalities. Arduino compatible shields as wireless XBee, Bluetooth, RF, GPS, GPRS and sensors like line follower, sonar, compass, encoders and any I2C device can be added to your Bot'n Roll ONE A and imagination is the limit!

On the extras user manual you will find a detailed description of some of these components. Visit the Bot'n Roll ONE A support web page http://botnroll.com/onea/ to get the respective user manual.

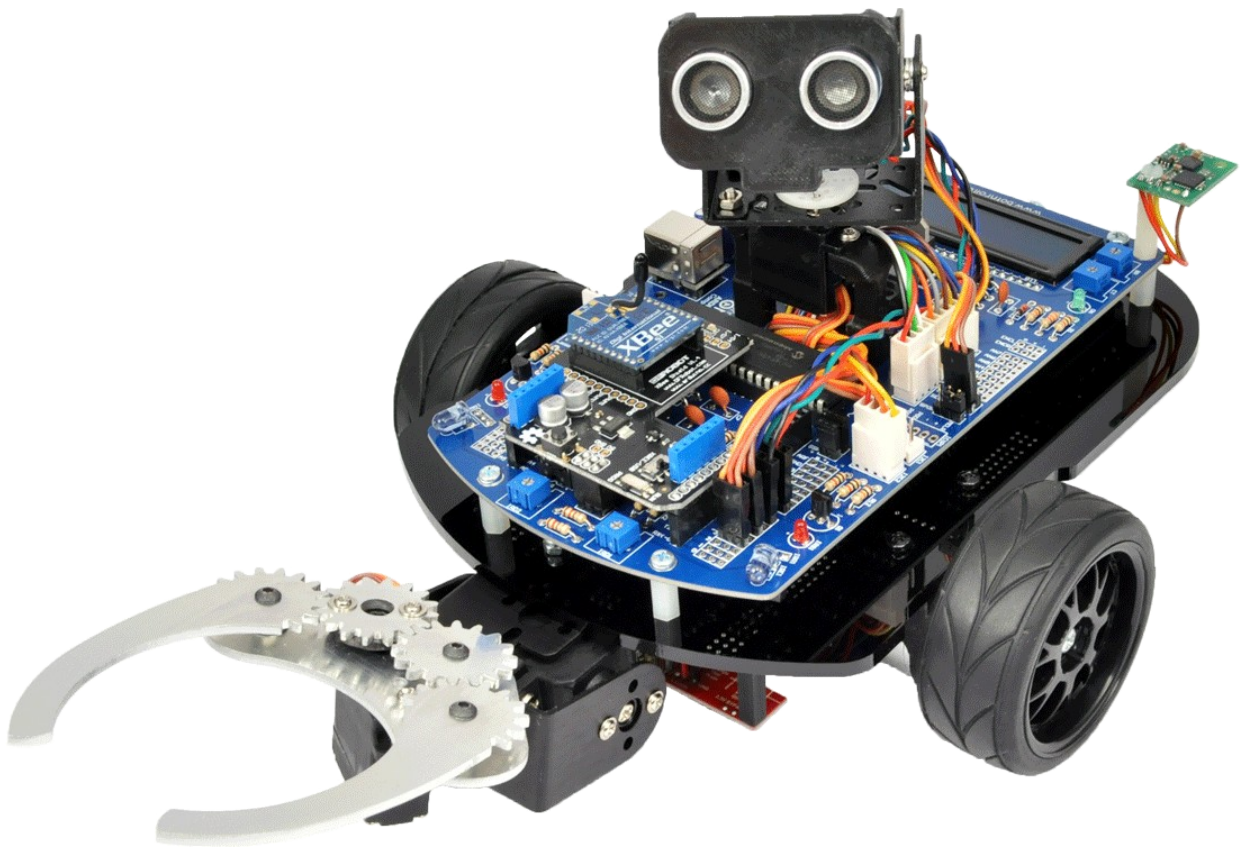You can also visit the www.botnroll.com *website* for more information.

Fig.67 Extras on Bot'n Roll ONE A

9. ANEX

9.1. BOT'N ROLL ONE A ELECTRONIC BOARD COMPONENTS LIST

Qt	Description	Qt	Description
3	120 Ohm resistor	1	LM7805CT IC
13	1K Ohm resistor	1	LD33CV IC
3	3,3K Ohm resistor	1	28 pins IC socket
5	10K Ohm resistor	1	40 pins IC socket
1	1M Ohm resistor	2	Infrared LED
4	10K potentiometer	2	IR VISHAY TSSP4056 receiver
1	3mm green LED	1	POUSB12 USB-Serial converter
2	3mm red LED	2	PNP BC557 transistor
2	3mm yellow LED	1	*Buzzer* – Magnetic transducer
2	22pF capacitor	1	16x2 LCD display
7	100nF capacitor	1	16 pins header connector
2	100uF 25V capacitor	4	Push buttons
1	16MHz crystal	1	Main switch
12	FR203 diode	1	10 pins female connector
1	5V1 Zener diode	2	8 pins female connector
1	3A 20x5mm slow fuse	1	6 pins female connector
1	Fuse support base	1	3x2 connector
1	Fuse support cover	2	KK 4 pins male KK connector
1	Atmega328 IC	3	2 pins connector with screw
1	PIC18F45K22 IC	2	2 pins jumper connector
1	L298N IC	1	3 pins jumper connector

9.2. ELECTRIC SCHEMATICS