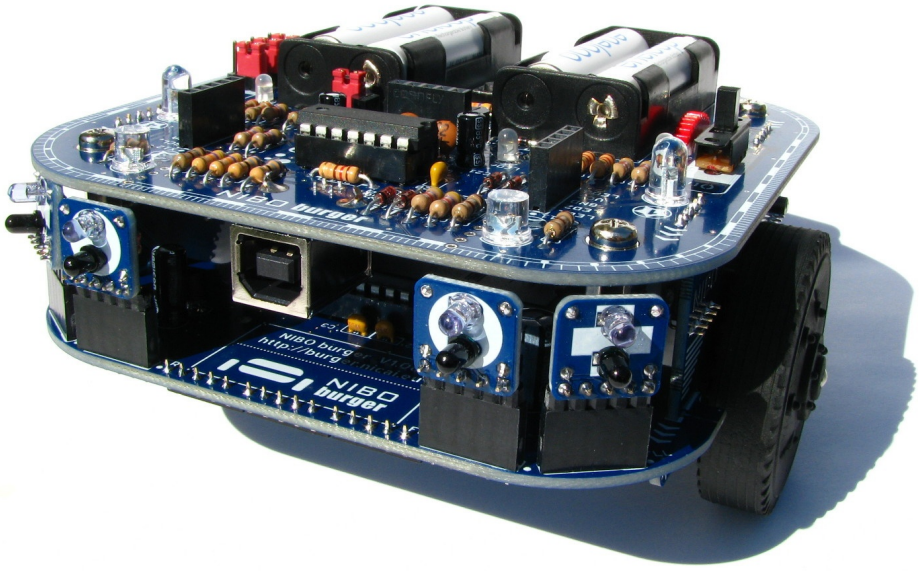
NIBO burger – Robot Kit

Construction manual



nicai systems

version 2015/09/08

Safety instructions

For construction and operation of the robot please consider the following safety instructions:

- The robot kit **NIBO burger** is designed for learning, teaching and experimental purposes only. The company does not accept any liability for other uses of the programming adapter. Any other use is at the users own risk.
- No machines must be attached to the robot. In particular the operation with devices on main voltage is forbidden.
- The robot must not be operated without supervision. When not in use the robot is to be separated from the power supply.
- The robot must be operated with stabilized DC voltage by 4,8 V. In particular the robot must be operated **with rechargeable batteries (1,2V) only** and never with normal batteries (1,5V).
- We take no responsibility for data loss of an attached computer.
- The robot must be used indoors only. In particular the usage of the robot is expressly forbidden on public roadways!
- For a usage deviating from these guidelines no warranty and no accountability are assumed, the operation is at your own risk!

For soldering please consider following points:

- Always work with extreme caution with the soldering iron!
- Inappropriate operation can lead to severe burns or cause fires.
- Never place the hot soldering iron on the table or on other surfaces.
- Never leave the soldering iron switched on unsupervised.
- Please consider the possible emission of poisonous fumes when soldering. Ensure there is sufficient ventilation and wash your hands thoroughly after work.
- Keep the soldering iron away from children!
- Please consider the safety instructions of the soldering iron manufacturer!
- Pay attention to a correct soldering tip temperature: High temperatures (400°C) may damage the tip, but also allow a short soldering time. Low temperatures (320°C) will increase the soldering time. This may damage the electronic components.

Table of contents

1 Introduction and overview

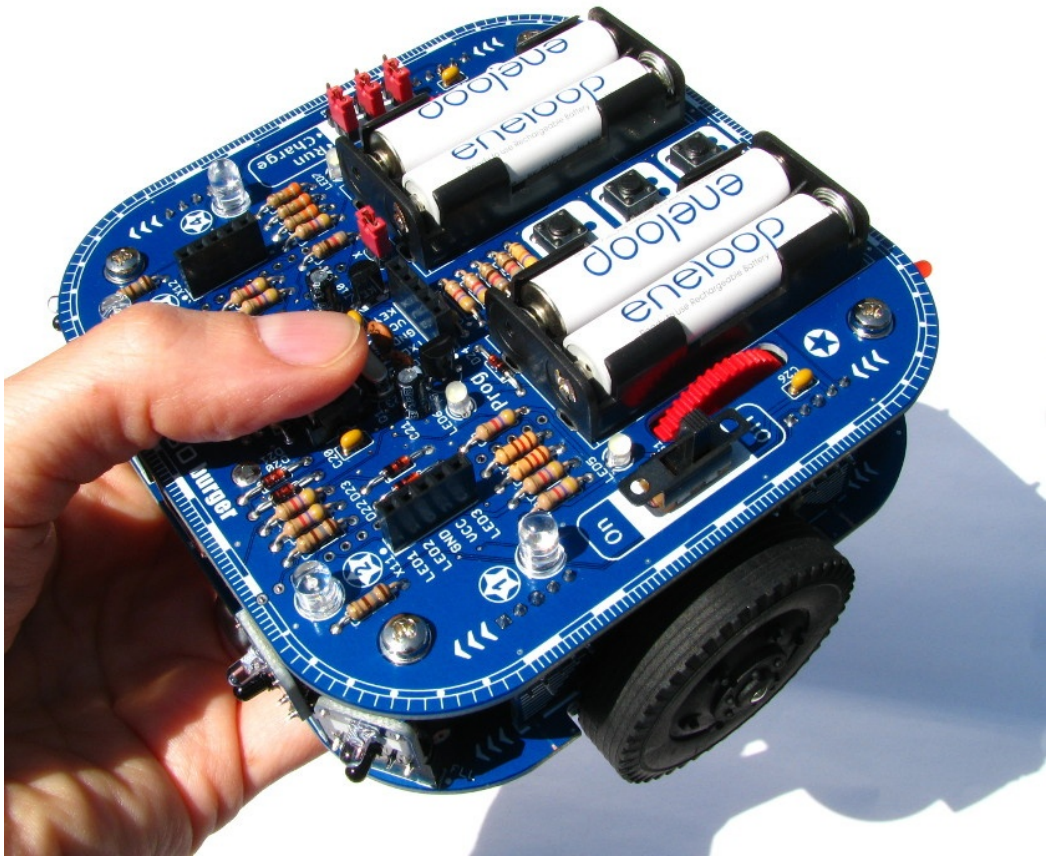
The **NIBO burger** robot kit is a free programmable autonomous robot with **9 sensors**. He is able to react stand-alone on his environment.

NIBO burger has an Atmel ATmega16 AVR main controller and several sensors to percept his surroundings. An integrated USB programmer also acts as charger for the rechargeable batteries.

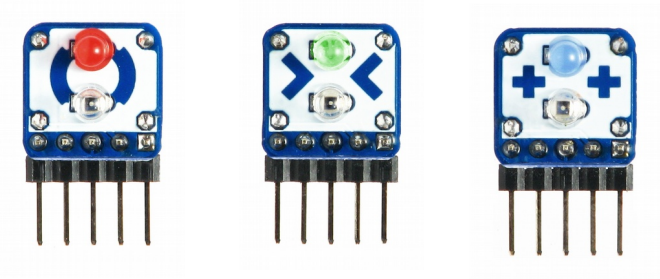
On the upper board there is an integrated slot for **ARDUINO shields**.

The **variable sensor system** contains ***7 sensor bricks***, which can be plugged into ***10 sensor slots***. **3 colour sensor bricks** enable the robot to detect different colours. With **4 IR sensor bricks** it is possible to detect different objects contact-free.

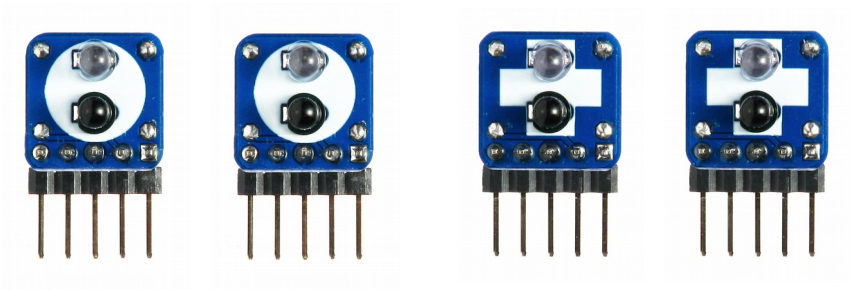
There are two possible versions to assemble the **transmission unit**: the **25:1** gear transmission ratio allows high speed driving, the **125:1** gear transmission ratio allows precise driving.



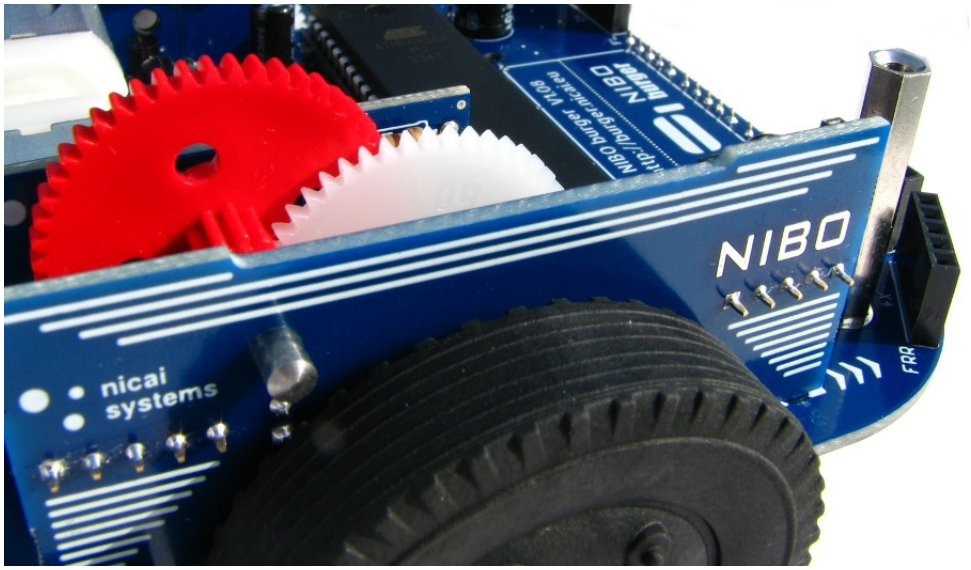
Colour sensor bricks:



IR sensor bricks:

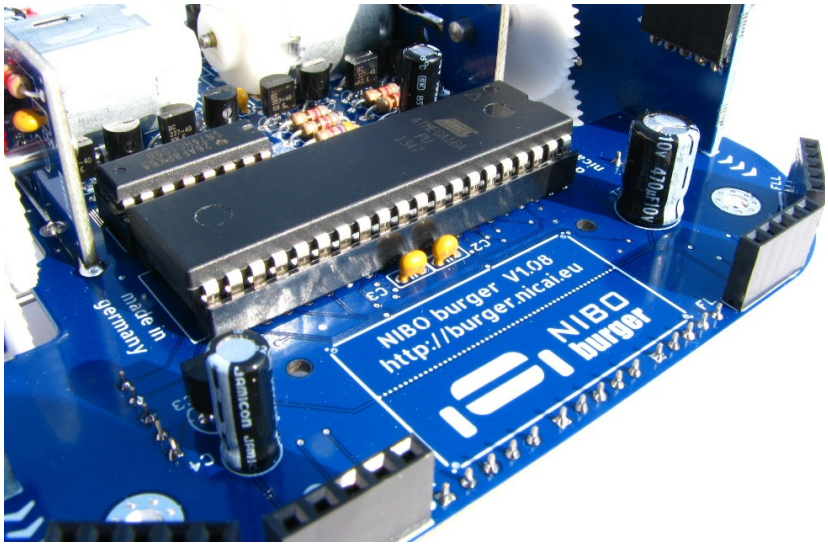


A construction manual with many illustrations explains the assembly and the necessary soldering step by step. In order to enable a quick and motivating introduction to the fields robotics, programming and control engineering the sensors are comfortable to program and to control.

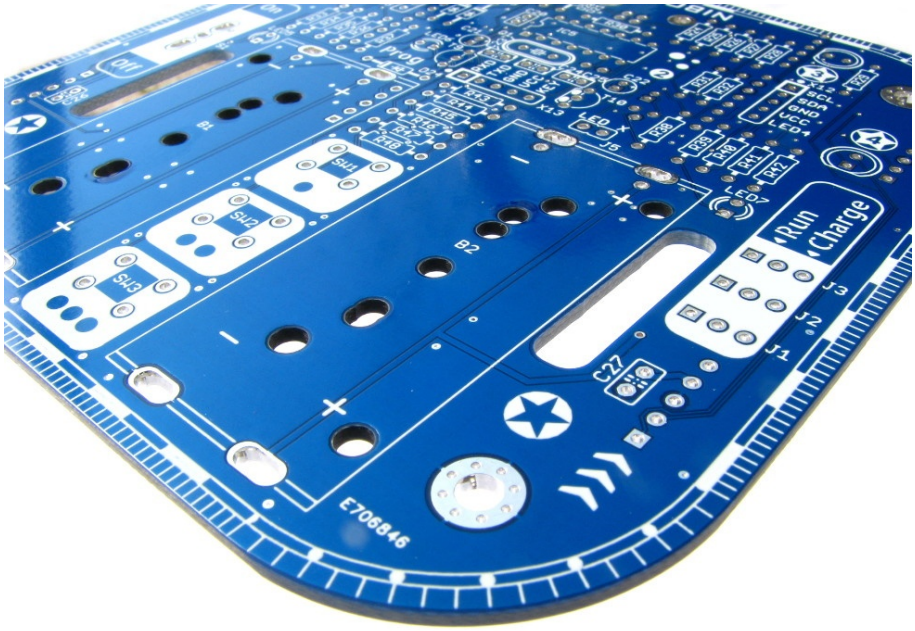


The whole thing is completed by the **NiboRoboLib** which provides all important basic functions and a programming tutorial in C for the first steps.

After assembling you can directly start with own programming.



All electronic parts are placed amply dimensioned on the circuit board and so the robot is quite easy to solder.



1.1 Features

Technical data:

- Dimensions: (L x W x H) 108 x 126 x 58 mm
- Weight: 295g (with rechargeable batteries)
- Power supply: 4 AAA Micro rechargeable batteries with 1,2 V each
- Voltages: 4,8 V and 3,3V (stabilised)
- Dimensions of main circuit board: 108 x 108 mm

Equipment:

- ATmega16 (16 kB Flash, 1 kB SRAM, 15 MHz)
- ATtiny44 to control the integrated USB-programmer
- USB-programmer which also provides as battery charger for the rechargeable batteries
- 4 coding LEDs for own functions
- 3 status LEDs
- 3 colour sensor bricks
- 4 IR-sensor bricks
- 10 sensor slots for the sensor bricks
- 3 free programmable push buttons
- 2 odometry sensors
- Powered by two motors with 125:1 transmission (convertible to 25:1)
- Jumper to deactivate motor control – Anti move function
- 3 extension ports, each with 3 bits (I^2C, UART) for own ideas/experiments
- Open source library
- Footprint for ARDUINO shields

Applications:

- Following lines
- Controlled proceed tangent route
- Contact-free detection of obstacles
- Autonomous performance
- Determination of different flooring
- Colour detection
- Barcode detection
- Following walls

Features:

- Main CPU with 16 kByte flash-memory
- Programmable in C, C++ and Java (GNU gcc and nanoVM)

1.2 Motors

The robot is driven by two motors with 125:1 transmission (respectively 25:1 transmission). The motors are driven by a H-bridge with a 14,7 kHz PWM-signal. The PWM-signal can be regulated by odometry-sensors, thus it is possible to drive with constant speed.

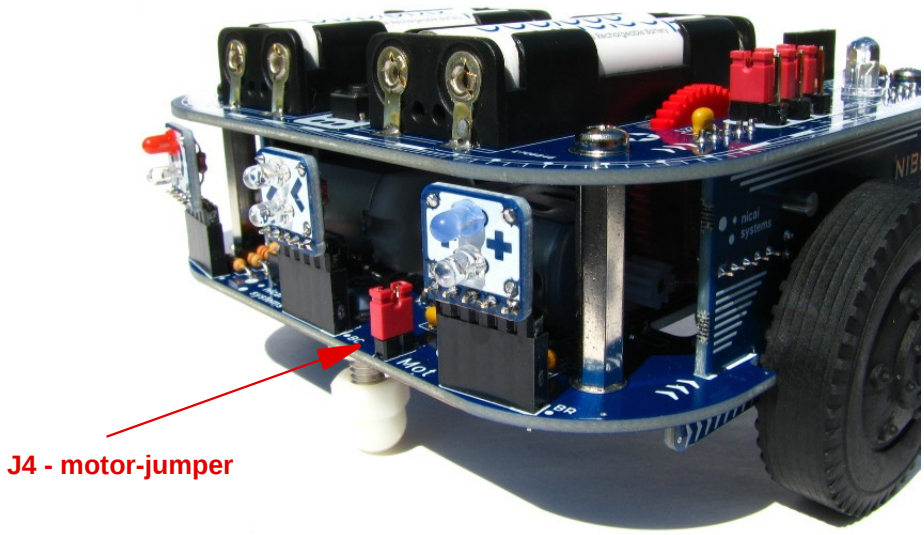
1.2.1 Odometry

The direction of rotation and the speed of the wheels is measured by two photo-transistors and two IR-LEDs on the red gearwheels of the transmission. The speed is directly proportional to the frequency of the signal.

1.2.2 Motor bridge

The motor bridge is needed for current amplification and for voltage regulation of the microcontroller signals. The motor is controlled by one of three possible signal-combinations from the H-bridge: high/low (forward), low/high (backwards), high/high (short-circuit). The short-circuit operating (freewheel) is for better utilization of energy with PWM-control, since electricity does not have to flow against the supply voltage in this case. Additionally the freewheel stabilizes the torque for lower values.

It is possible to **deactivate** the **motor bridge** by **removing** the **jumper J4 (Mot)** for test cases.



1.3 Sensors

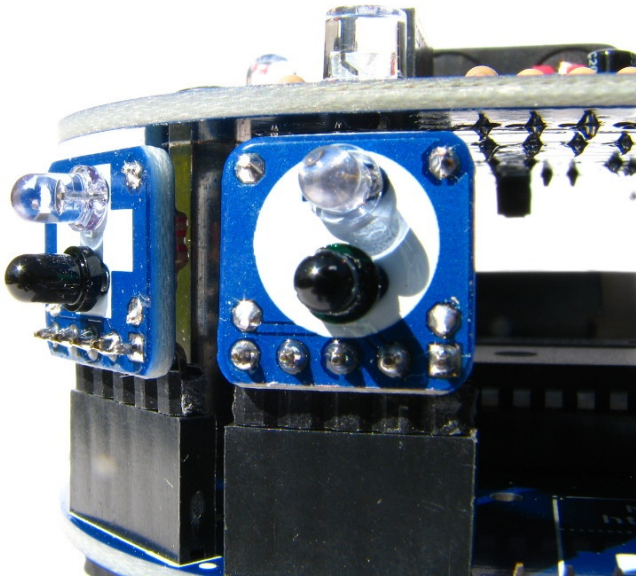
The robot is able to learn and to react on environmental conditions by its sensors. The following subsections describe the sensors in detail:

1.3.1 IR sensor bricks

The robot has four IR sensor bricks to detect objects / obstacles contact-free. Each sensor brick consists one IR phototransistor and one IR led. So the **reflection factor** can be measured and interpreted. To avoid the influence of

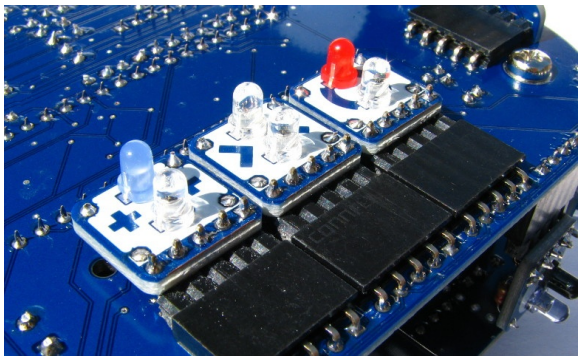
diffused light it is necessary to use a **modulation method**. This method is already implemented in the **NiboRoboLib**.

With the variable sensor system with **10 sensor slots** you can test **different setups**: For example it is possible to plug all 4 sensors into the front slots, or you can place 2 sensors on the front and 2 sensors on the back. Another possibility is to use 3 sensors for analysing the floor.



1.3.2 Colour sensor bricks

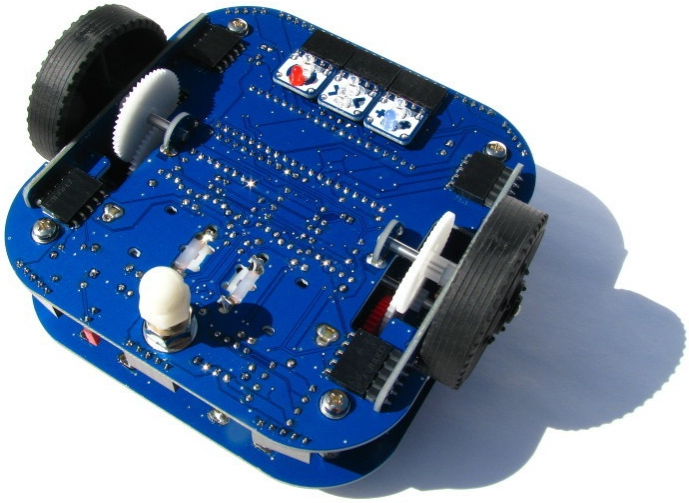
NIBO burger has 3 colour sensor bricks (blue, green, red):



These sensors can also be plugged into the 10 sensor slots:

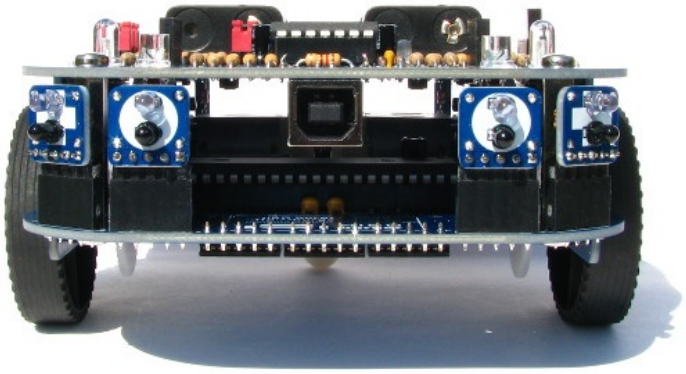
For example they can be plugged into the three slots on the back to detect and to analyse coloured objects:

You can also plug the 3 sensors into the slots at the bottom side of the robot to analyse coloured floors. This setup is also well suited for following lines.



1.4 USB interface

The robot can be connected to a computer by the USB interface. It is possible to upload new software by this interface. Additionally the rechargeable batteries can be charged by this interface.



1.5 Interfaces / Extension ports

The **NIBO burger** has 3 extension ports. Each of these ports has five contacts: plus, minus and 3 signal bits.

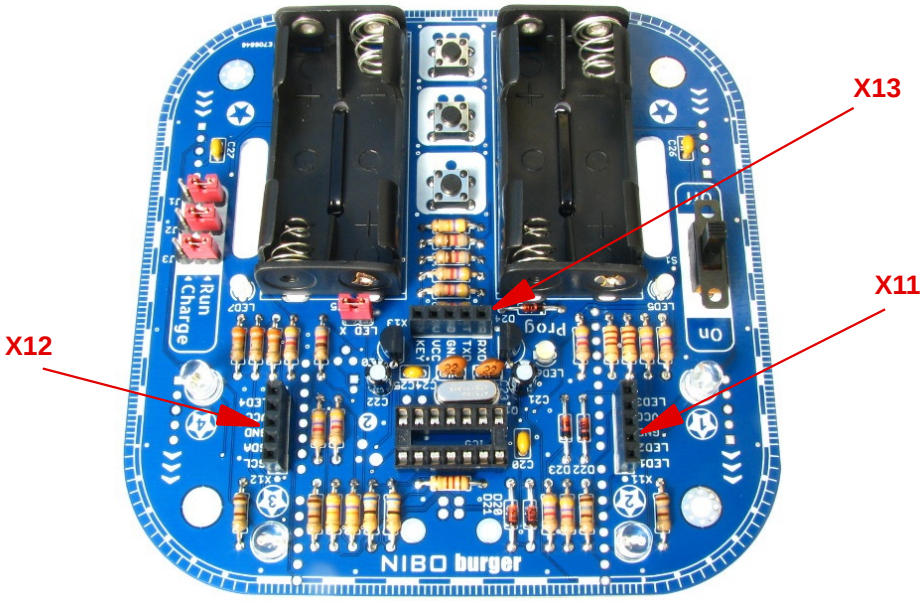
All ports have additional functions:

Port	*Signal 1*	*Signal 2*	*Signal 3*	*Information*
X11	LED1	LED2	LED3	Digital interface
X12	SCL	SDA	LED4	I²C-interface
X13	RXD	TXD	KEY	Serial interface

You can connect own extensions at the port **X12** by an I²C-interface. Extensions with a serial interface can be connected to the port **X13**.

The signals **LED1** – **LED4** can be used for own ideas by removing jumper J5 (**LED_X**).

It is possible to use the **KEY** signal as an analog input, if none of the buttons SW1 – SW3 is being pushed.



1.6 Other hardware components

1.6.1 Free programmable Coding-LEDs

The two red LEDs (***LED 1*** and ***LED 4***) and the two blue LEDs (***LED 2*** and ***LED 3***) are coding LEDs. They can be controlled by own programming.

1.6.2 Function LEDs

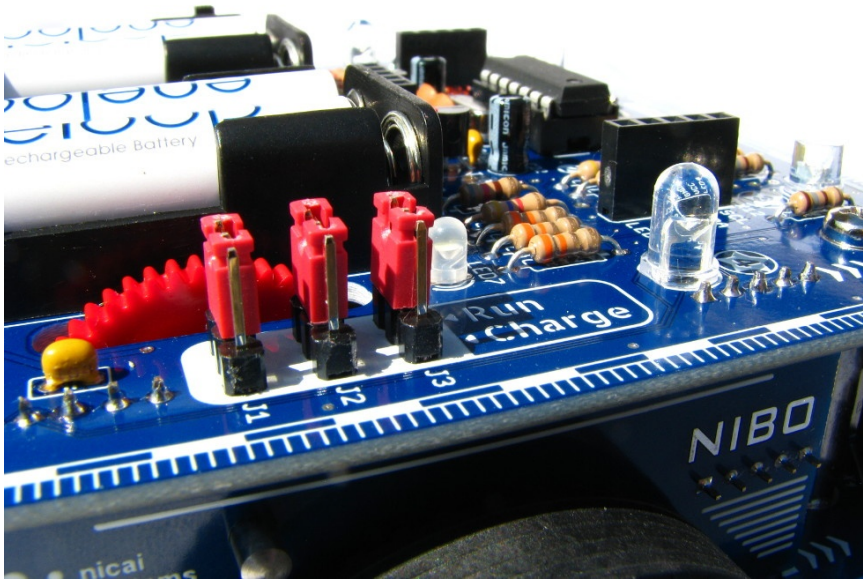
The small white LEDs show the following functions:

LED 5	***Operating mode information***: flashes during the robot is online
LED 6	***Programming***: flashes during the programming process
LED 7	***Charging information***: flashes during the charging process

1.6.3 Voltage switch / Charging

The voltage switch **S1** separates the battery voltage from the circuit and provides the possibility to charge the rechargeable batteries in combination with the jumpers J1, J2 and J3 (see chapter 3.7).

Normal operation (RUN):



2 Assembling of the robot

Please read the following chapter completely before you begin with the assembly!

2.1 Necessary tools

You need the following tools for the assembly:

Soldering iron with sponge & electronic solder wire

Electronic cutting pliers

Small recessed head screwdriver

Universal pliers

Small hammer

If there occur problems after the assembly, you can use the following tools:

Soldering remover

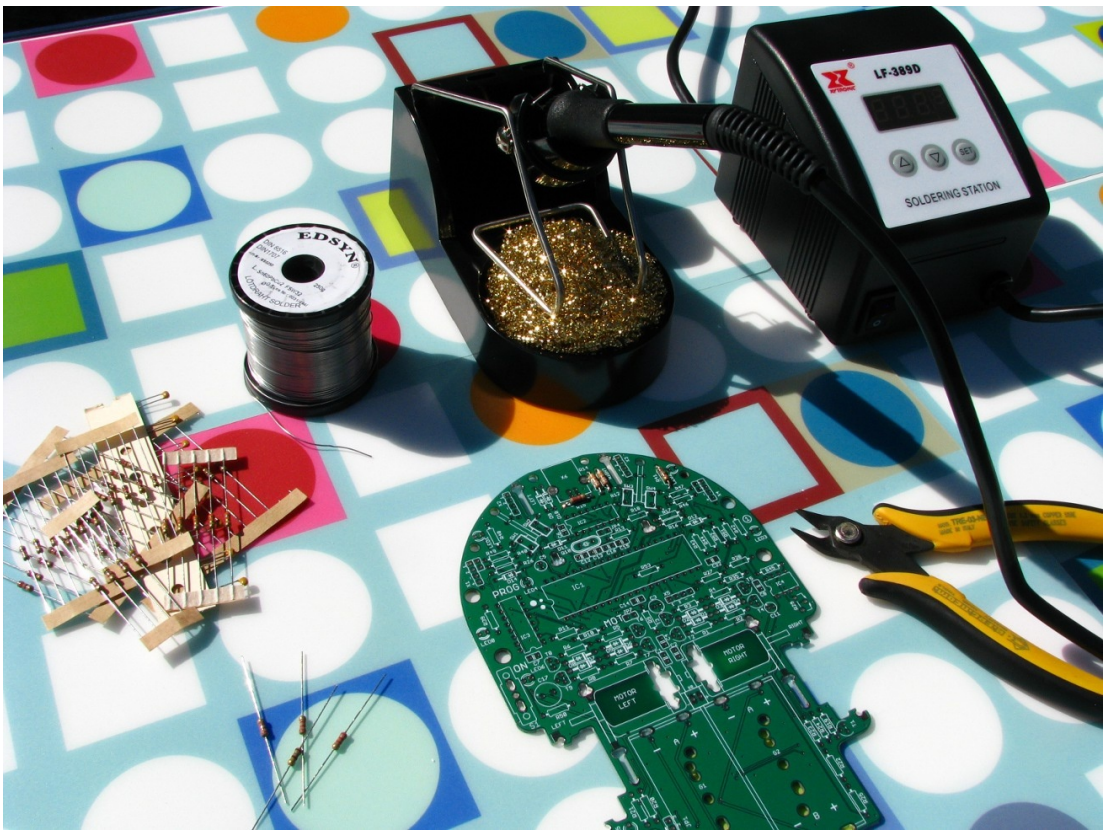
Multimeter (with continuity tester)

2.2 Soldering

For soldering you should use a **regulated** soldering station with **at least 50 W** and a fine tip.

Tip: The manual of the soldering station should definitely contain the word “regulated”. A regulated soldering station means, that it “knows” exactly the temperature of its tip. So it is able to readjust the temperature if its necessary. It is very helpful to have no temperature drop during soldering!

You should select a temperature of about 370 °C, depending on the soldering station the temperature can drift up to 400 °C. The best thing is to test it. You should use flux cored solder wire with a diameter of 0.5 mm. The best for beginners is to start with lead-containing solder wire (**SN60PB40**).



Soldering should work like this:

Video „Soldering in 30 seconds“ http://www.nicai.eu/soldering

If it doesn't work as seen in the video, it can be useful
to check the own soldering equipment and/or get someones help.

The soldering time should be limited to a few seconds (not minutes!) for each pad. Most electrical components react sensitively to high temperature.

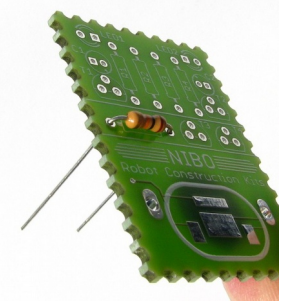
For **very** sensitively components you can do the following:

First you solder 3-5 seconds, if the soldering point isn't good enough yet, you let the component cool down and afterwards you solder again for 3-5 seconds.

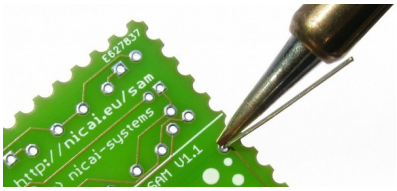
The optical components (LEDs, IR-LEDs and phototransistors) are very sensitively components.

Procedure:

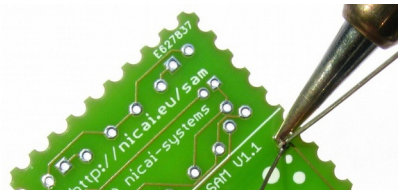
First of all you have to insert the legs of the electronic part into the soldering pads of the circuit board. On some parts you have to **pay attention** to the **polarity**. That means that it is quite important which leg has to be connected to which pad!



Now you have to heat the **soldering pad** and the **leg simultaneously** with the soldering iron at the bottom side of the board:



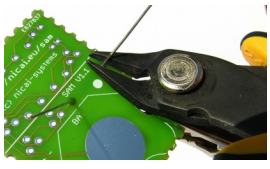
Then the **tin-solder** has to be attached **additionally**. If everything is well heated, the tin-solder is melting and the leg of the electronic part gets connected to the soldering pad:



The finished soldering point should look like this:

The leg of the electronic part has to be fixed at the soldering pad. If it is not yet fixed, you have to solder again!

Now you can remove the remaining legs with an electronic cutting pliers. The cutting pliers has to be positioned **parallel** to the circuit board for not cutting through some traces:



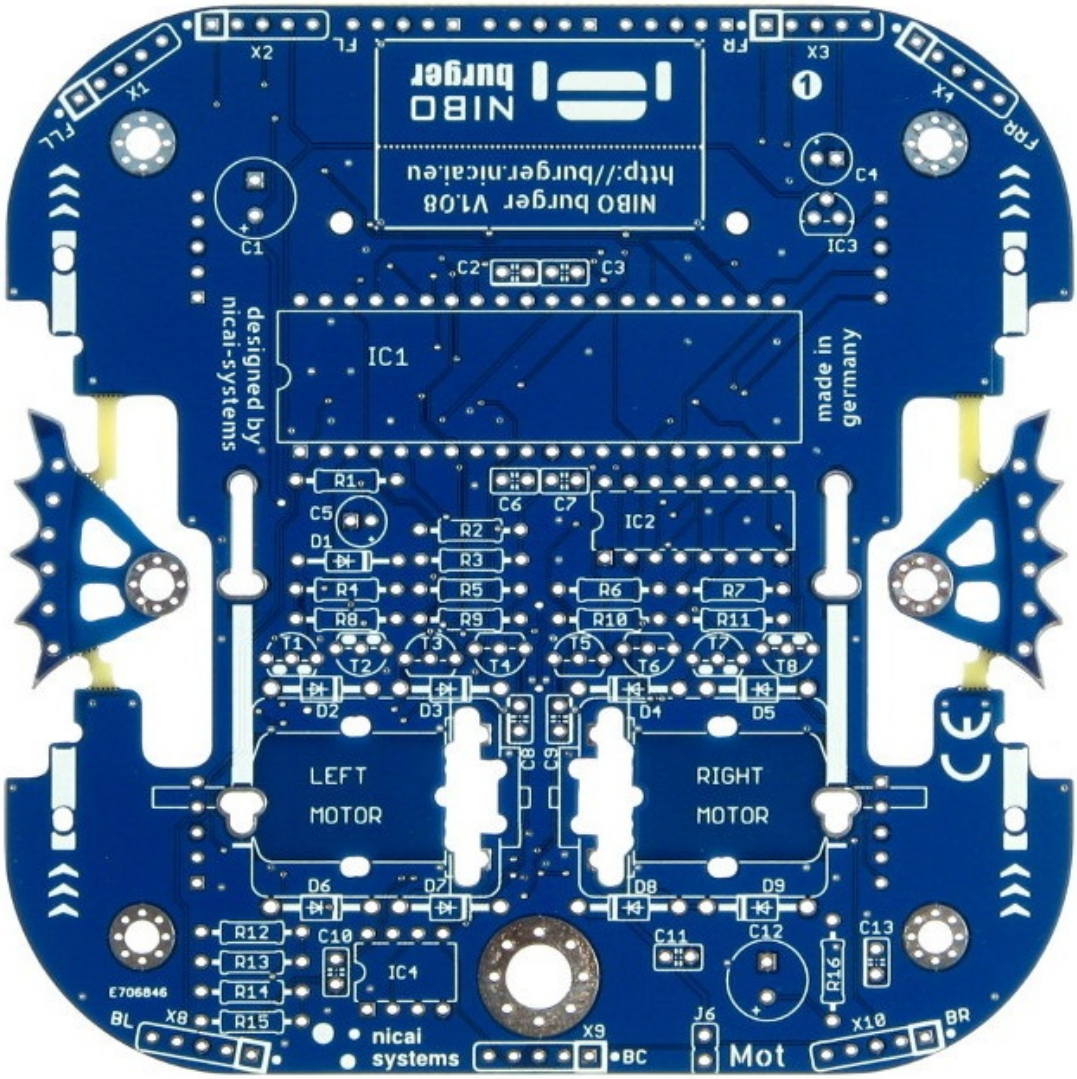
Finished soldering point:

Hint: *Don't breath in the solder smoke and wash your hands after soldering!*

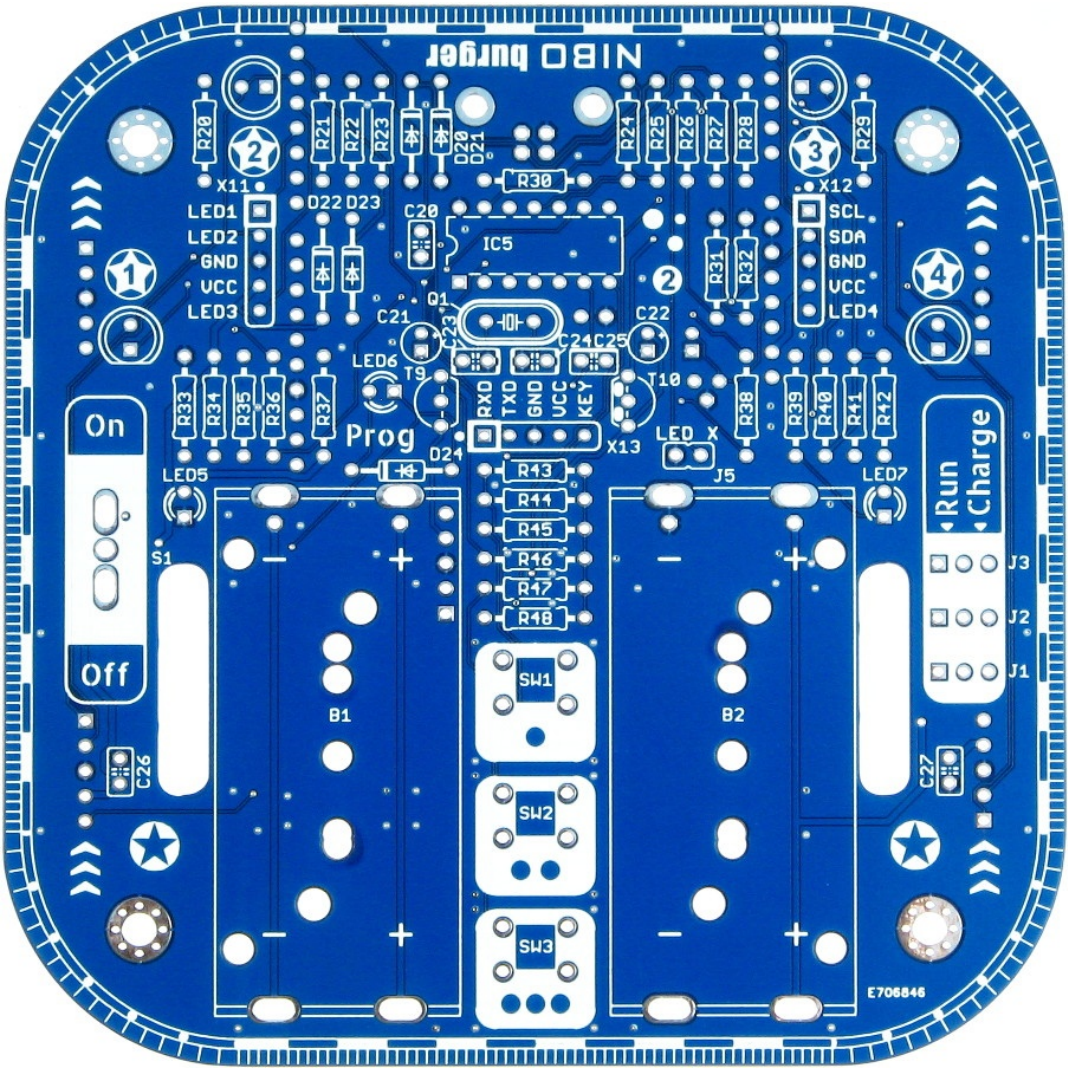
2.3 Placing components onto the circuit boards

This section describes how to place the electrical components onto the circuit boards. First of all an overview of the plain boards:

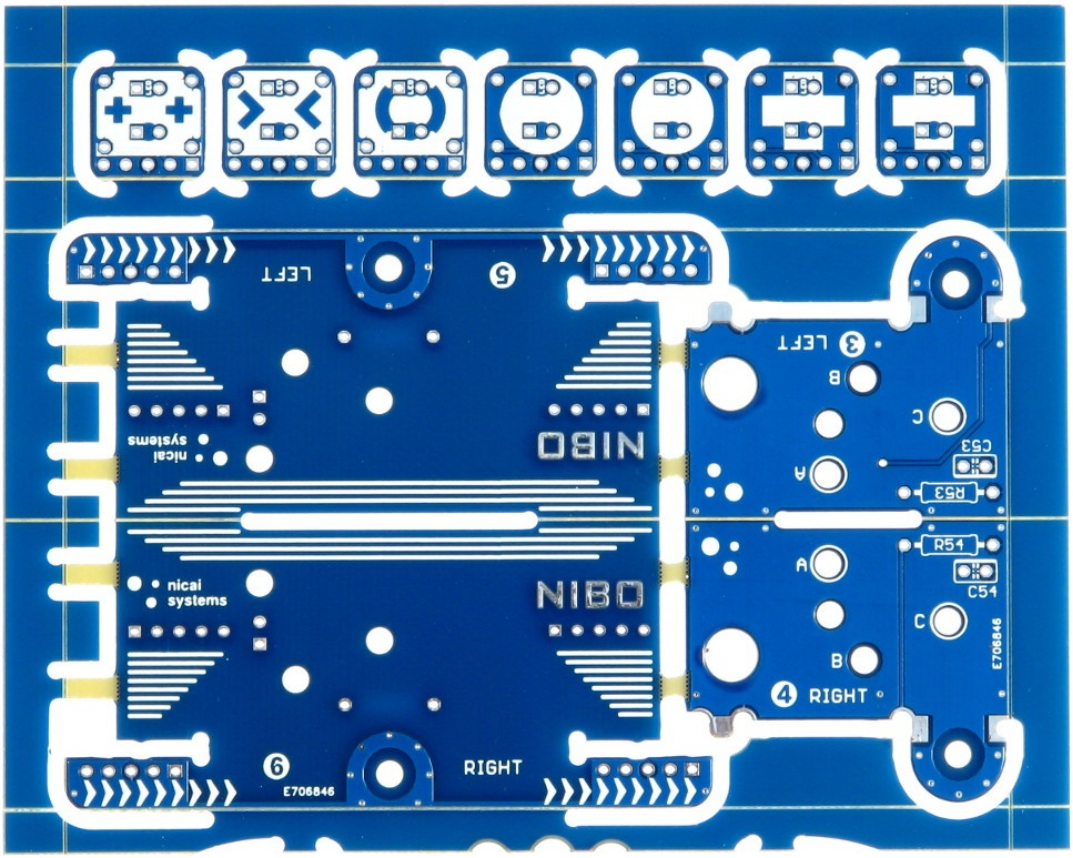
Board ① - first level:



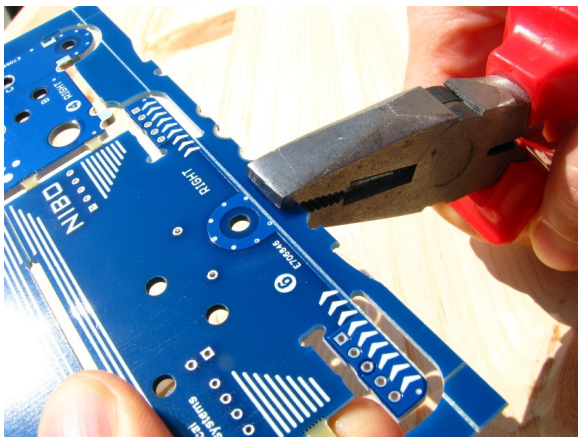
Board ② - second level:



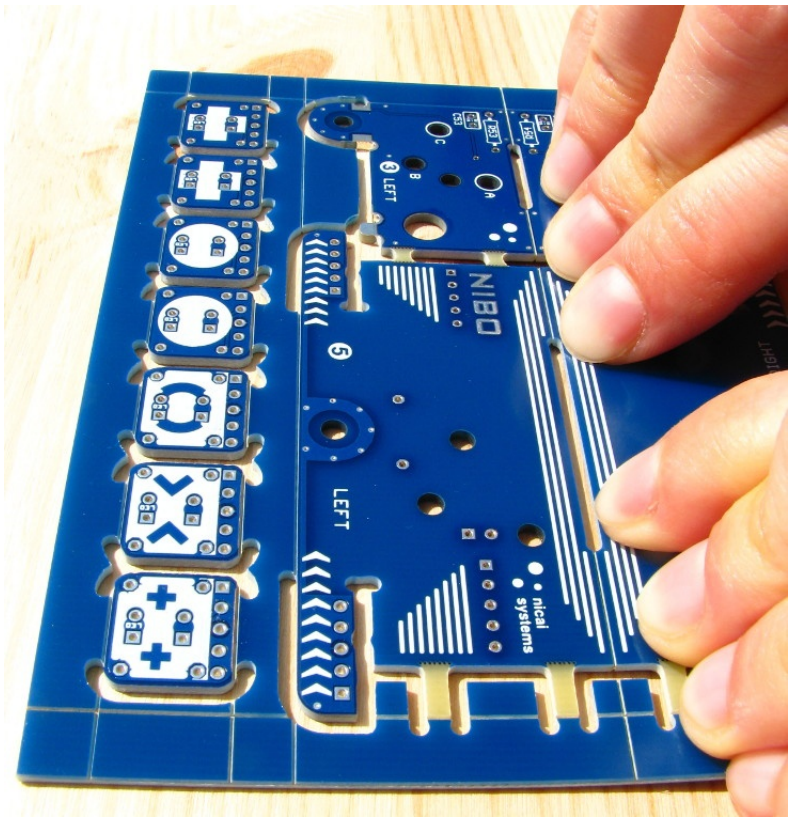
Boards ③, ④, ⑤, ⑥ and the sensor bricks:



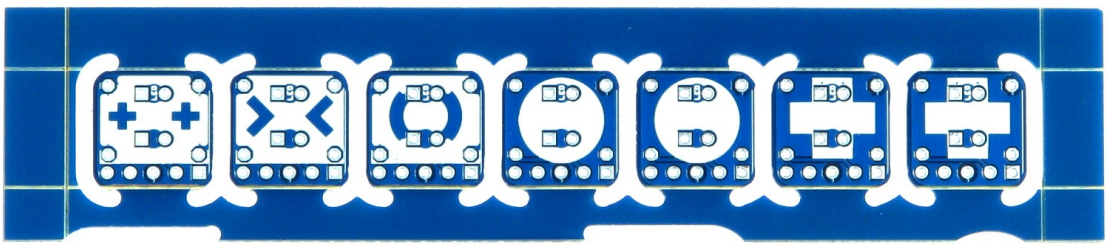
At first the boards ③ - ⑥ (**NOT the sensor bricks!**) must be separated from the frame e.g. by an universal pliers:



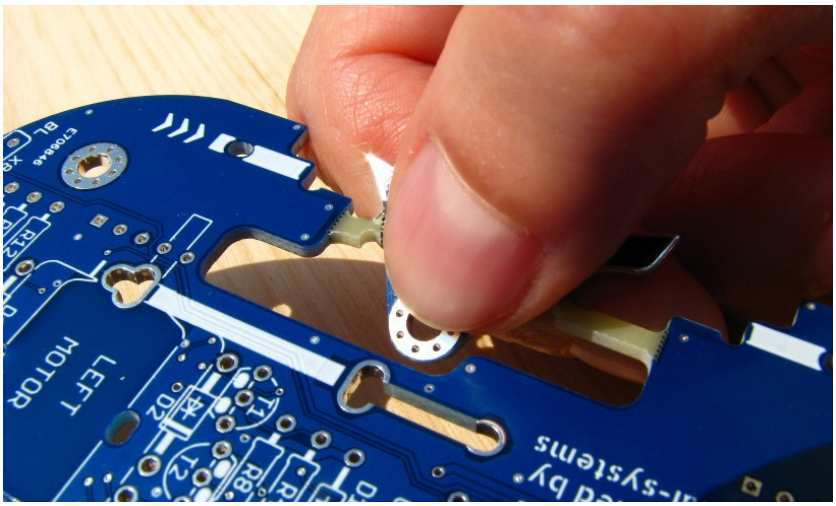
In order not to damage the single boards with the pliers, you can do the middle separation without it on a flat surface:

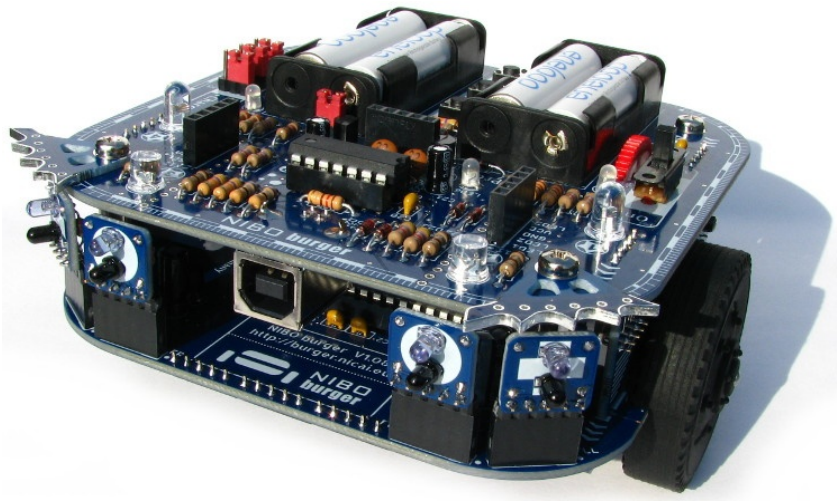


Tip: If you first **don't** separate the sensor brick boards, it is much easier to solder the electronic parts:

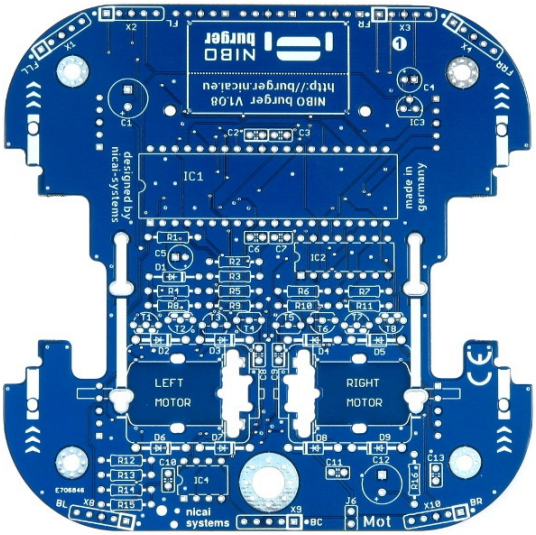


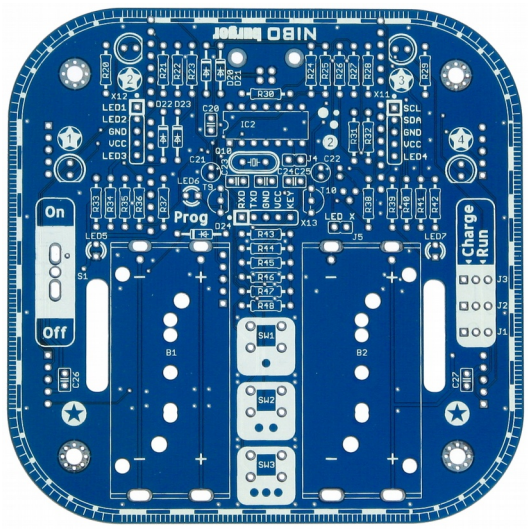
The “wings“ are for decoration and they protect the front sensors. They can be separeted by slight turning from board ①:

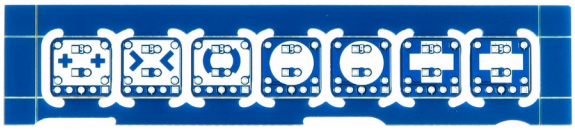


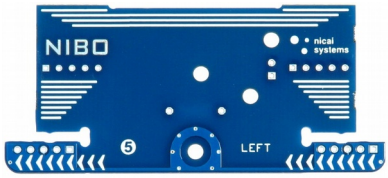


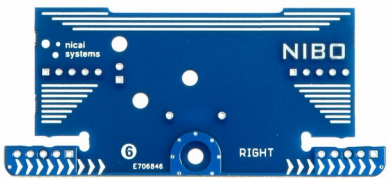
All in all you get this circuit boards:

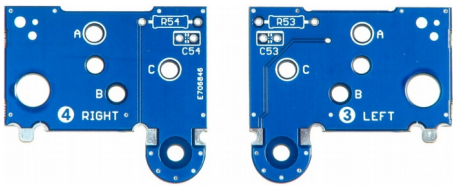








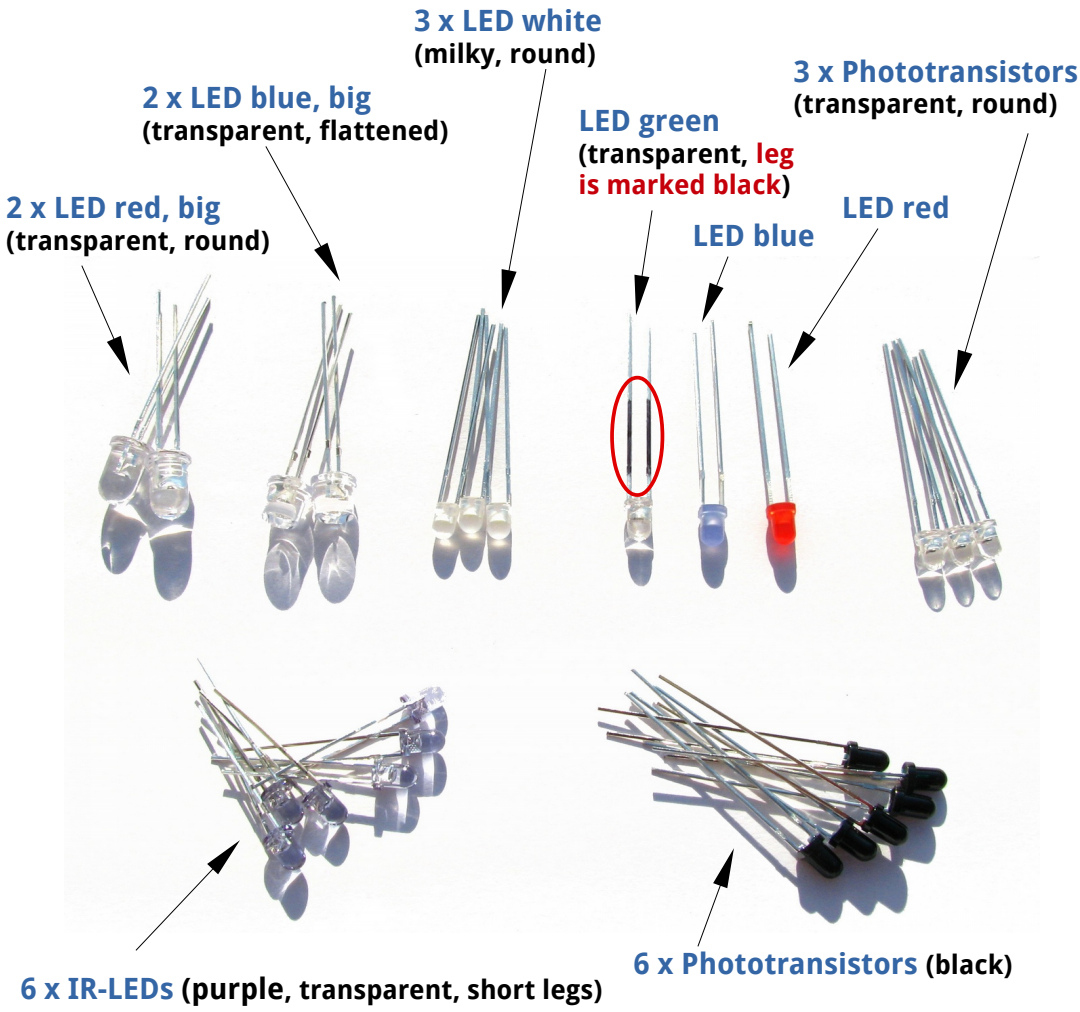




2.3.1 Preparing operations

2.3.1.1 Overview of the optoelectronic parts

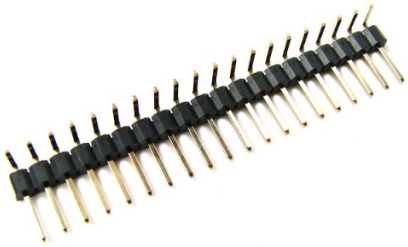
For some of the optoelectronic parts **looks very similar** it is advisable to **sort** them:



2.3.1.2 Seperation of pin header strips

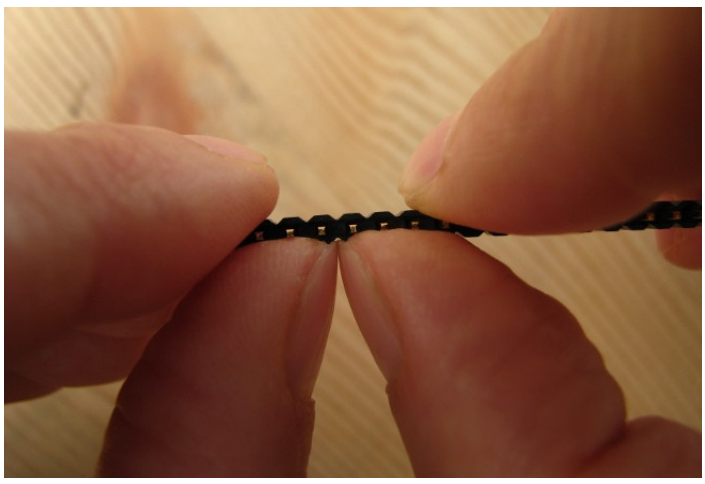
The kit contains **two sorts** of pin header strips. All of them must be seperated to 5 pin headers before assembly.

Typ A: **right angle** headers:



Typ B: **straight** headers:

Because all headers must be **seperated** to **5-pin** configuration, you have to count 5 contacts and break the strip with the thumbnails at the right position:

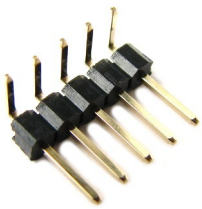


Tip: To count correctly it can be helpful to place a 5-pole socket onto the header before breaking.

The header is easy to break:

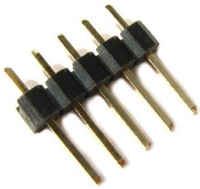
We need at large:

7 right angle 5-pin headers



7 x

and **8 straight** 5-pin headers

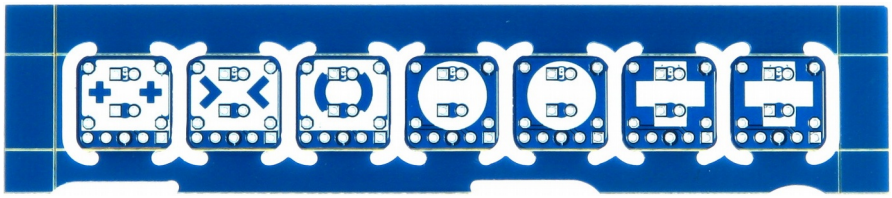


8 x

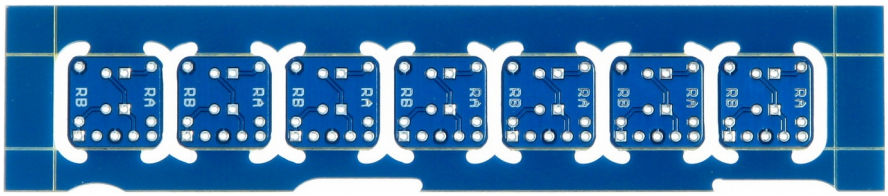
2.3.2 Assembly of the sensor bricks

First of all we place resistors and optoelectronic parts onto the circuit boards of the bricks.

Top sides of the boards:



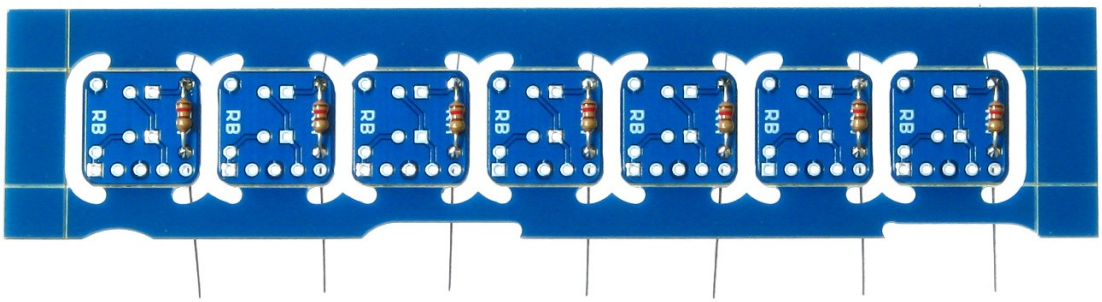
Bottom sides of the boards:



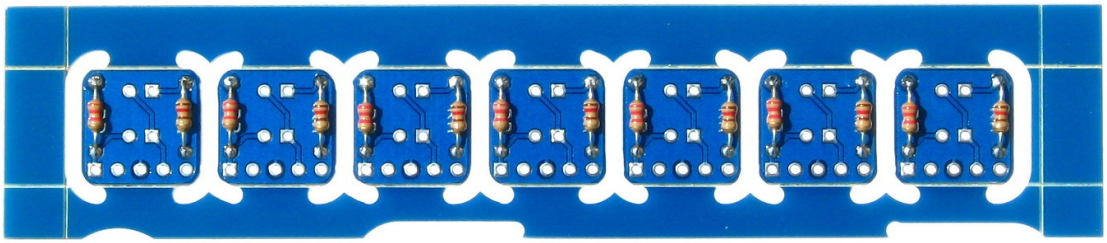
2.3.2.1 Placing components onto the bottom sides

The little **mini!!** resistors with the value 120 Ω
(*code*: brown-red-brown- (gold))
have to be placed to the soldering pads **RA**:

ATTENTION: 120 Ω resistors exist also in big!!!



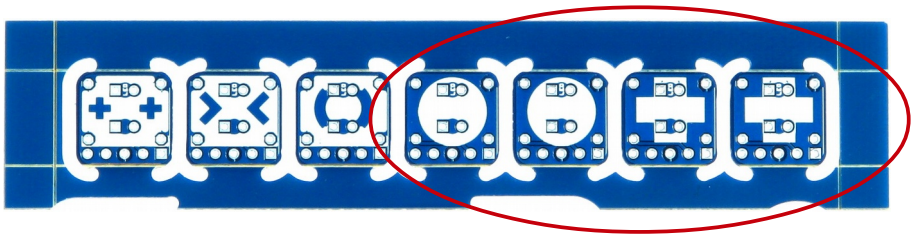
The little **mini!!** resistors with the value 2,2 kΩ
(*code*: red-red-red- (gold))
have to be placed to the soldering pads **RB**:



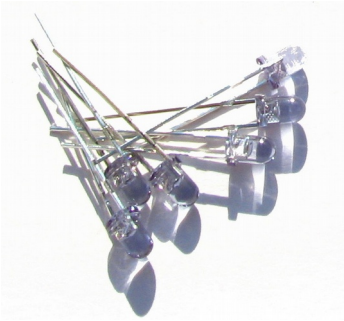
2.3.2.2 Placing components onto the top sides

Part 1: IR sensor bricks

We start with the **top sides** of the IR sensor bricks:



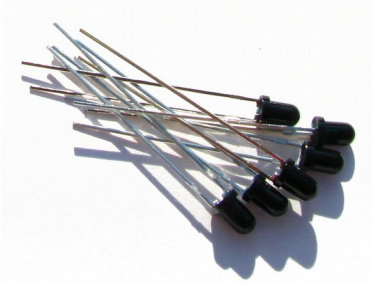
IR sensor bricks



Place four IR leds into the **upper** soldering pads (marked with **LED**).

You have to pay attention to the **polarity**:

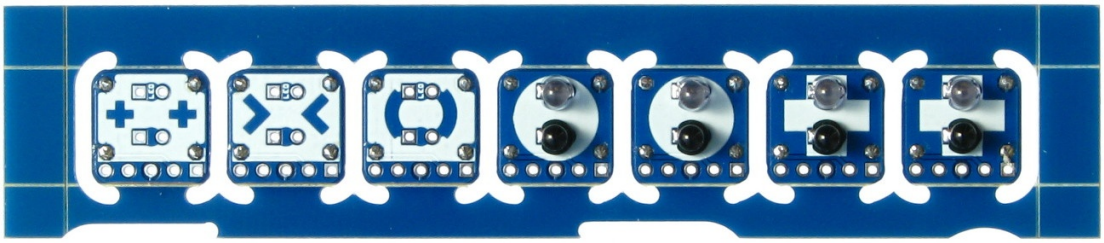
The **short leg** must be placed into the **rectangular soldering pad**!



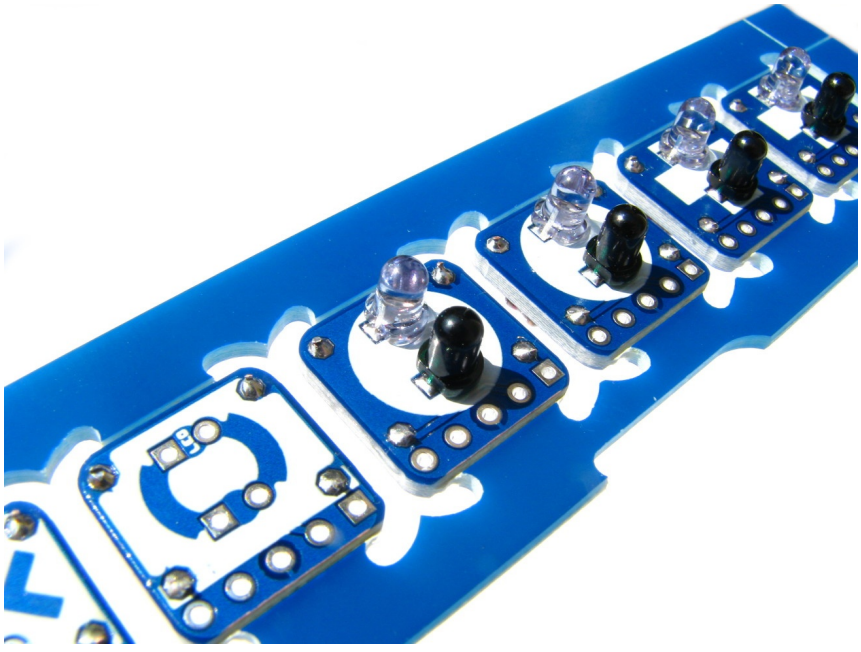
Place four black phototransistors into the **lower** soldering pads.

You have to pay attention to the **polarity**:

The **short leg** must be placed into the **rectangular soldering pad**!

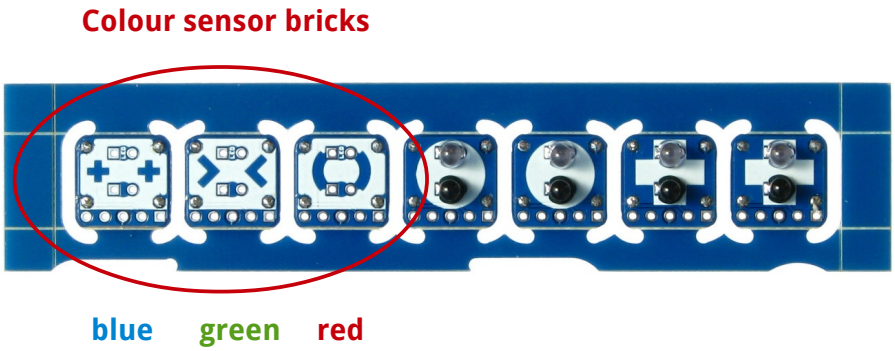


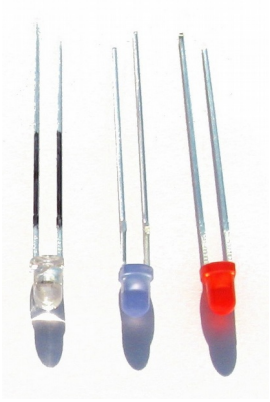
The result should look like this:



Part 2: Colour sensor bricks

We start with the **top sides** of the colour sensor bricks:





Place the blue, the green and the red led into the **upper** soldering pads (marked with **LED**).

You have to pay attention to the **polarity**:

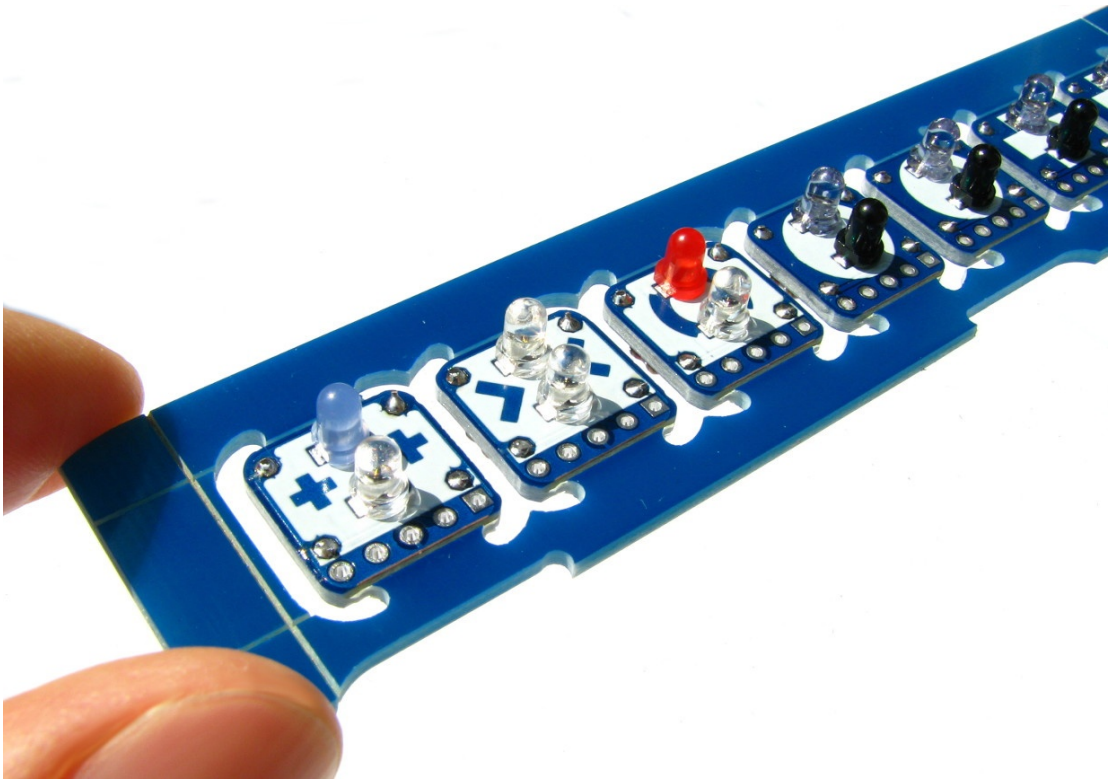
The **short leg** must be placed into the **rectangular soldering pad**!

Place three **transparent** phototransistors into the **lower** soldering pads.

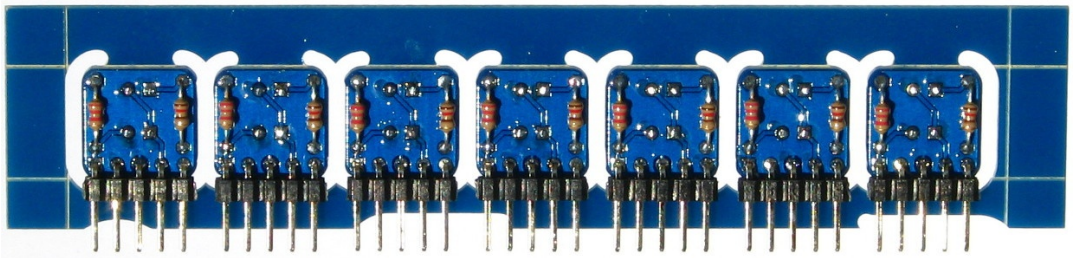
You have to pay attention to the **polarity**:

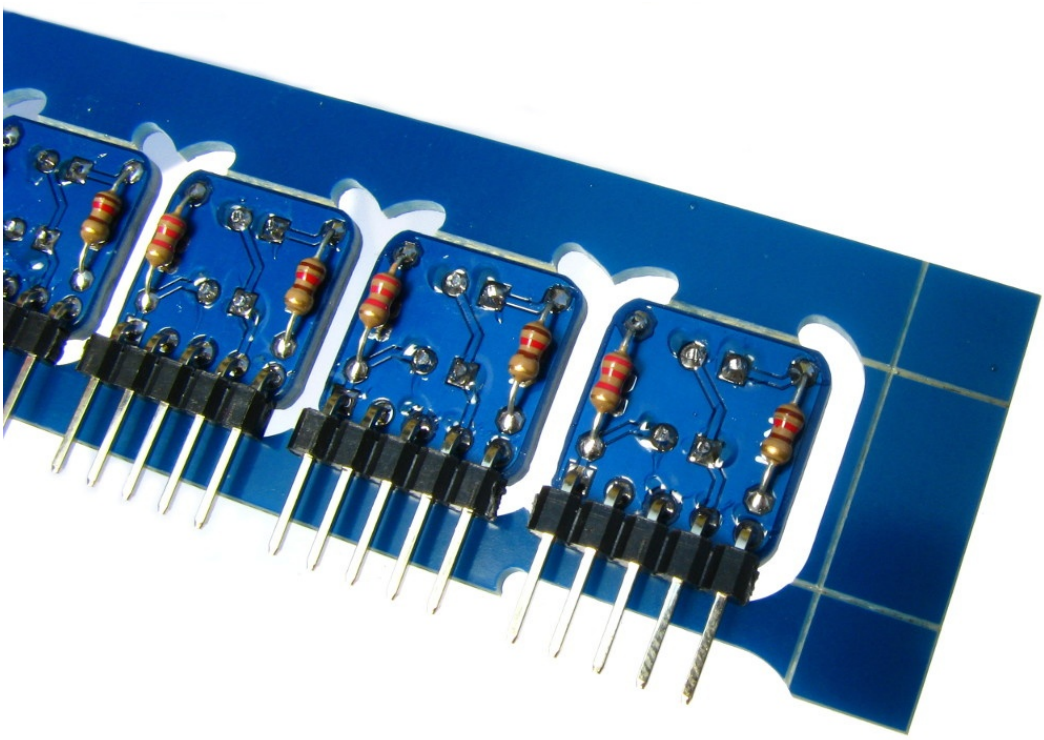
The **short leg** must be placed into the **rectangular soldering pad**!

The result should look like this:



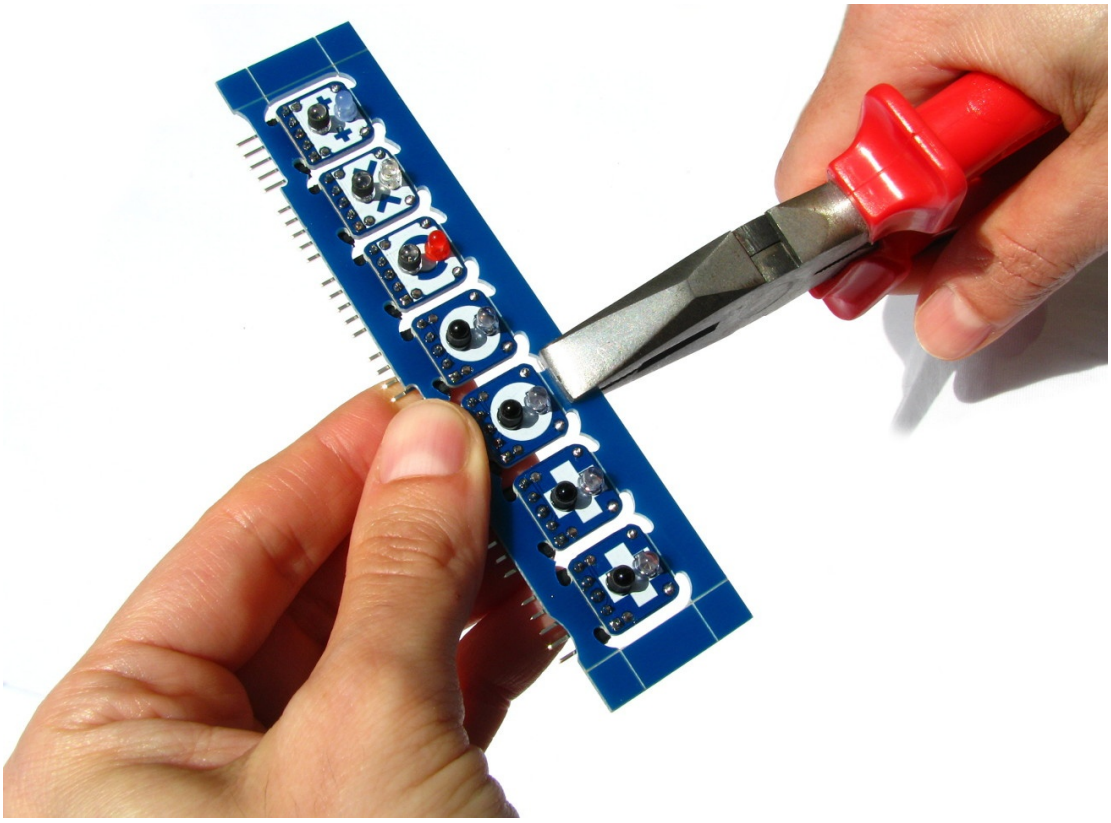
Now the right angle 5-pin headers have to be soldered onto the **bottom** sides of all sensor boards:

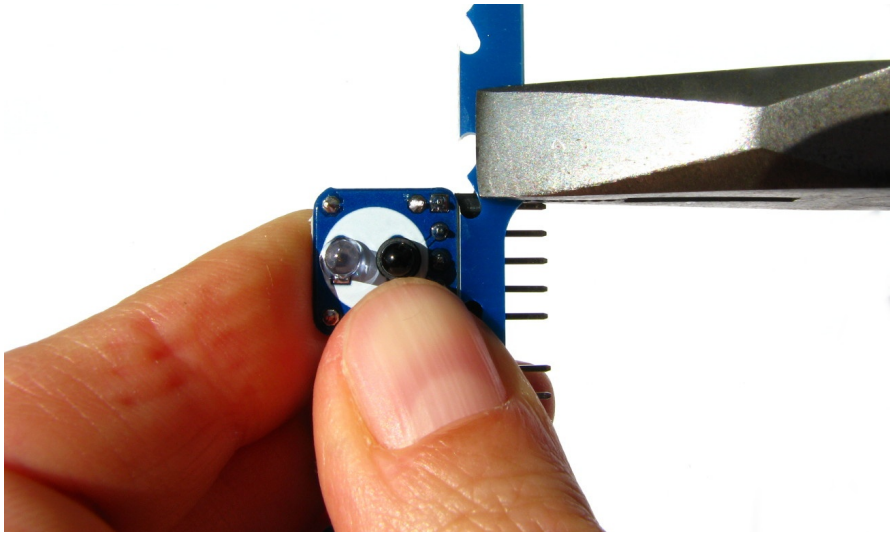




To get best sensor values it is advisable to shield **all phototransistors** with 3 mm long pieces of heat-shrinkable tubing:

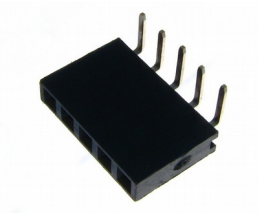
Now you can separate the individual sensor bricks from the frame:



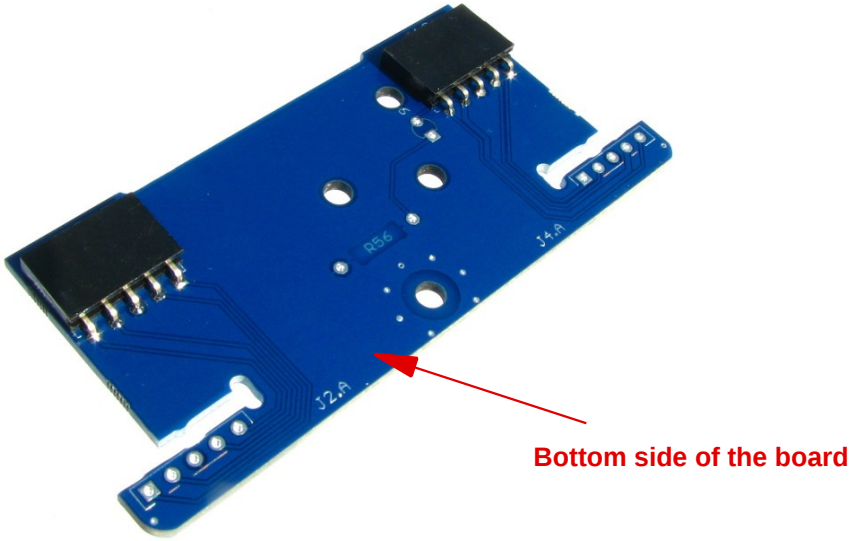


2.3.3 Component placement of boards ⑤ and ⑥

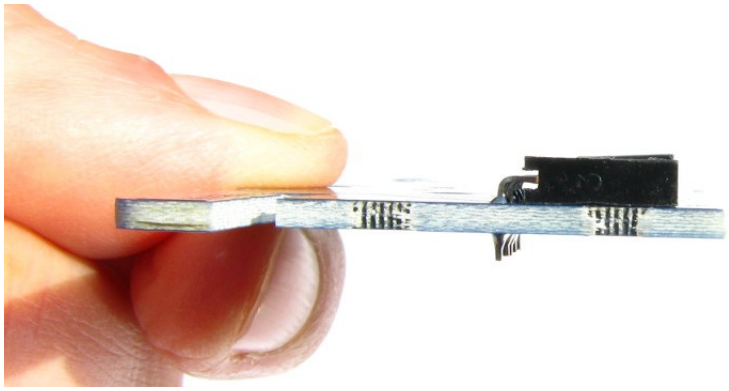
In this section we place components onto the both side plates of **NIBO burger**. **All** components have to be placed on the **bottom sides** of the circuit boards:



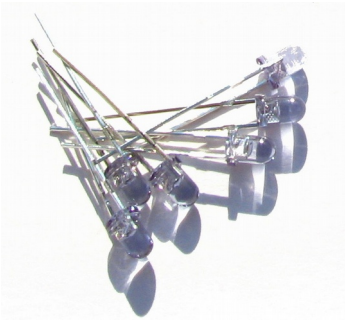
Four 5-pin right angle sockets have to be placed onto the **bottom sides** of the boards into the soldering pads **J1.B**, **J2.B**, **J3.B** und **J4.B**.
They are soldered from the top side.



The sockets should be planar onto the boards as possible:



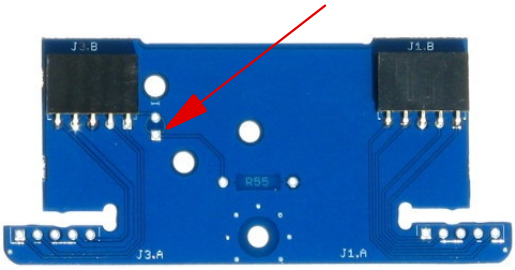
The resistors with the value **180 Ω**
(*code*: brown-grey-brown- (gold))
have to be placed to the soldering pads **R55** and **R56** on the **bottom sides** of the boards.

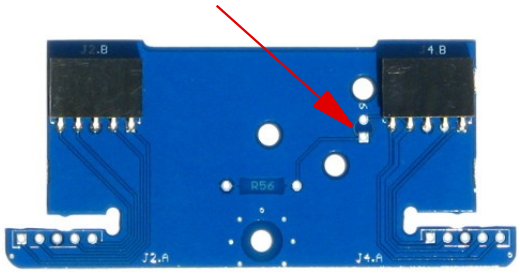


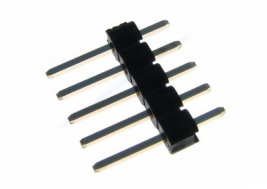
Each board gets one IR led. They have to be placed into the marked soldering pads (see the photos).

You have to pay attention to the **polarity**:

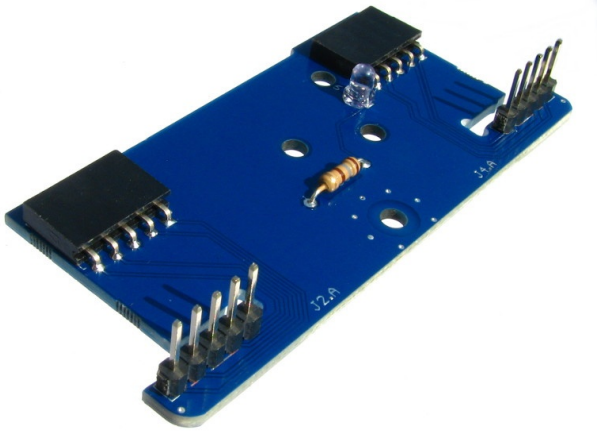
The **short leg** must be placed into the **rectangular soldering pad**!



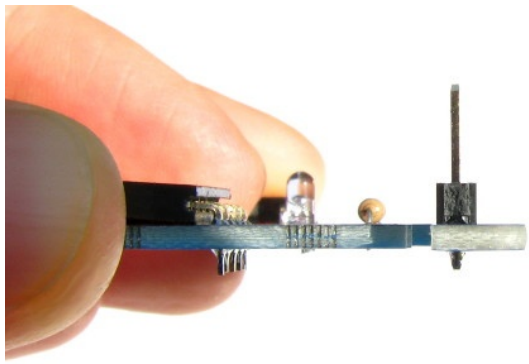




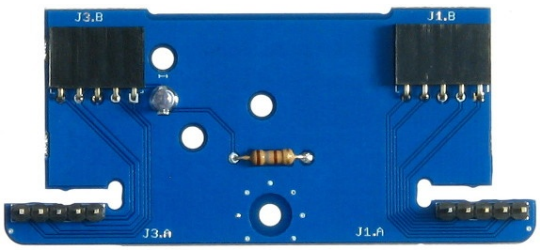
Finally four 5-pin straight headers are placed into the soldering pads **J1.A**, **J2.A**, **J3.A** and **J4.A** from the **bottom** sides of the boards and are soldered from the top sides.

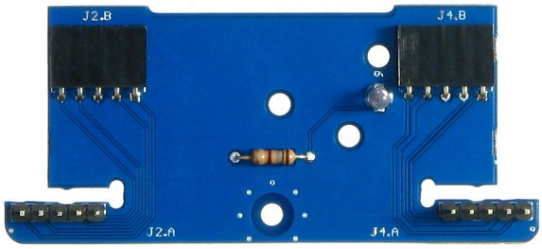


Later on the side plates have to be plugged with other plates. Therefore it is important to solder the headers at **right angle** onto the boards:

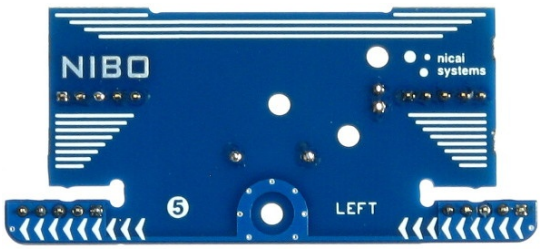


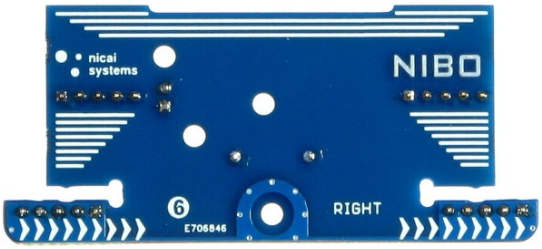
Finished **bottom** sides of the boards:





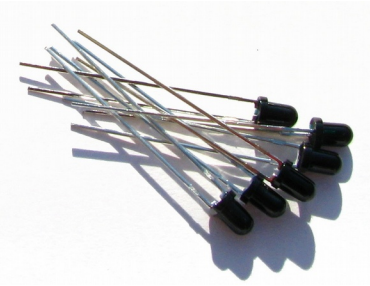
Finished **top** sides of the boards:





2.3.4 Component placement of boards ③ and ④

The boards ③ and ④ have to be placed on their bottom sides **and** on their top sides. We start with the **bottom sides** of the boards:



The black phototransistors are soldered into the soldering pads **PT53** and **PT54**.

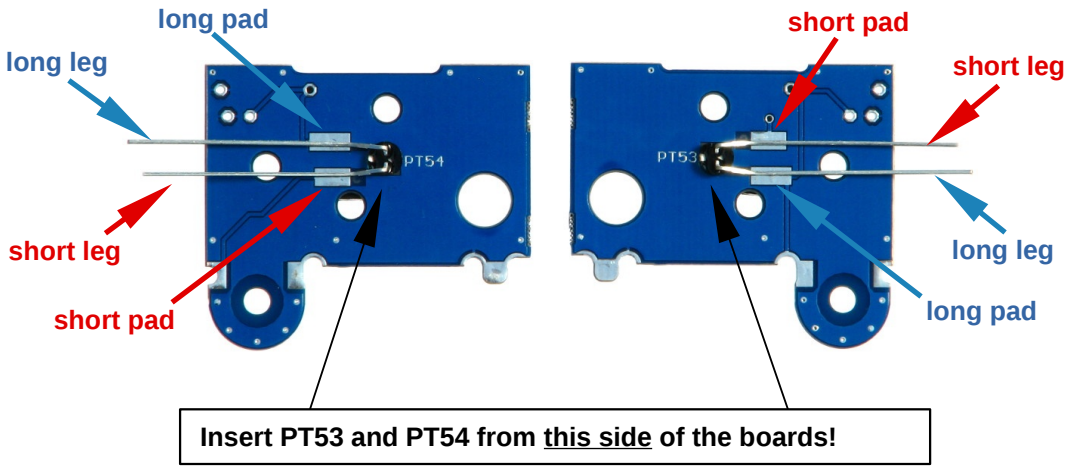
You have to pay attention to the **polarity**:

The **short leg** must be placed into the **rectangular soldering pad**!

PT53 and **PT54** are for measuring the motor rotation speed. The phototransistors have to be put through the hole **from the BOTTOM side** so that the **shorter** leg can be soldered onto the **shorter** soldering pad.

(**If** the phototransistors don't fit through the hole you can expand the hole with a 3 mm drill for some hundredth mm).

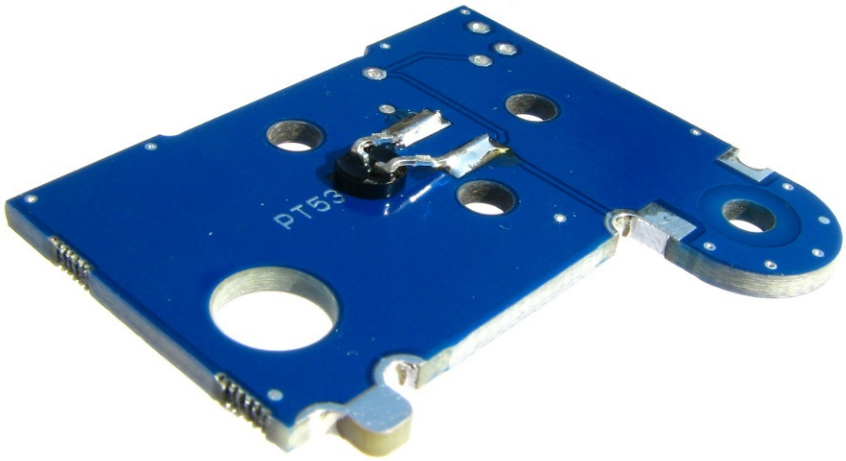
Afterwards the legs must be bend over towards the soldering pads:



After bending, the legs must be **trimmed**:

Now the legs are **soldered**:

The result should look like this:



Now **turn** the circuit boards!

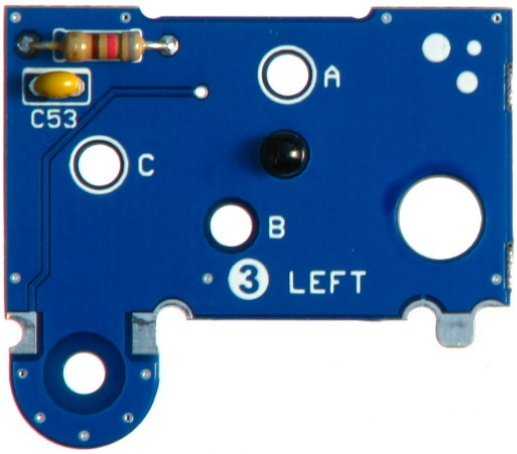
The resistors with the value **820 Ω**
(*code*: grey-red-brown- (gold))
have to be placed into the soldering pads **R53** and **R54** on the **top sides** of the boards.

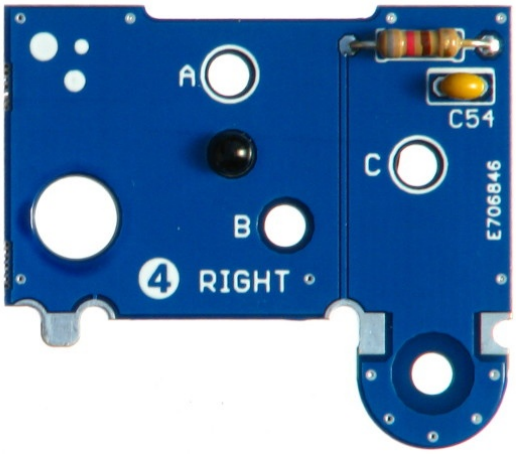
The **10 nF** ceramic multilayer capacitors
(imprint: **103**) have to be placed into the soldering pads **C53** and **C54** on the **top sides** of the boards.

You don't have to pay attention to the polarity.

> ***Tip:*** The resistors and the capacitors have to be flush mounted onto the circuit boards ③ and ④. Otherwise they get in conflict with the gearing!

Finished **top sides** of the boards:





2.3.5 Component placement of boards ① and ②

Now we place components onto the both main circuit boards:

> ***Note:*** The sequence of placement depends on the height of the components to make all soldering pads well accessible. The following subsections are sorted according to this criterion.

2.3.5.1 Resistors

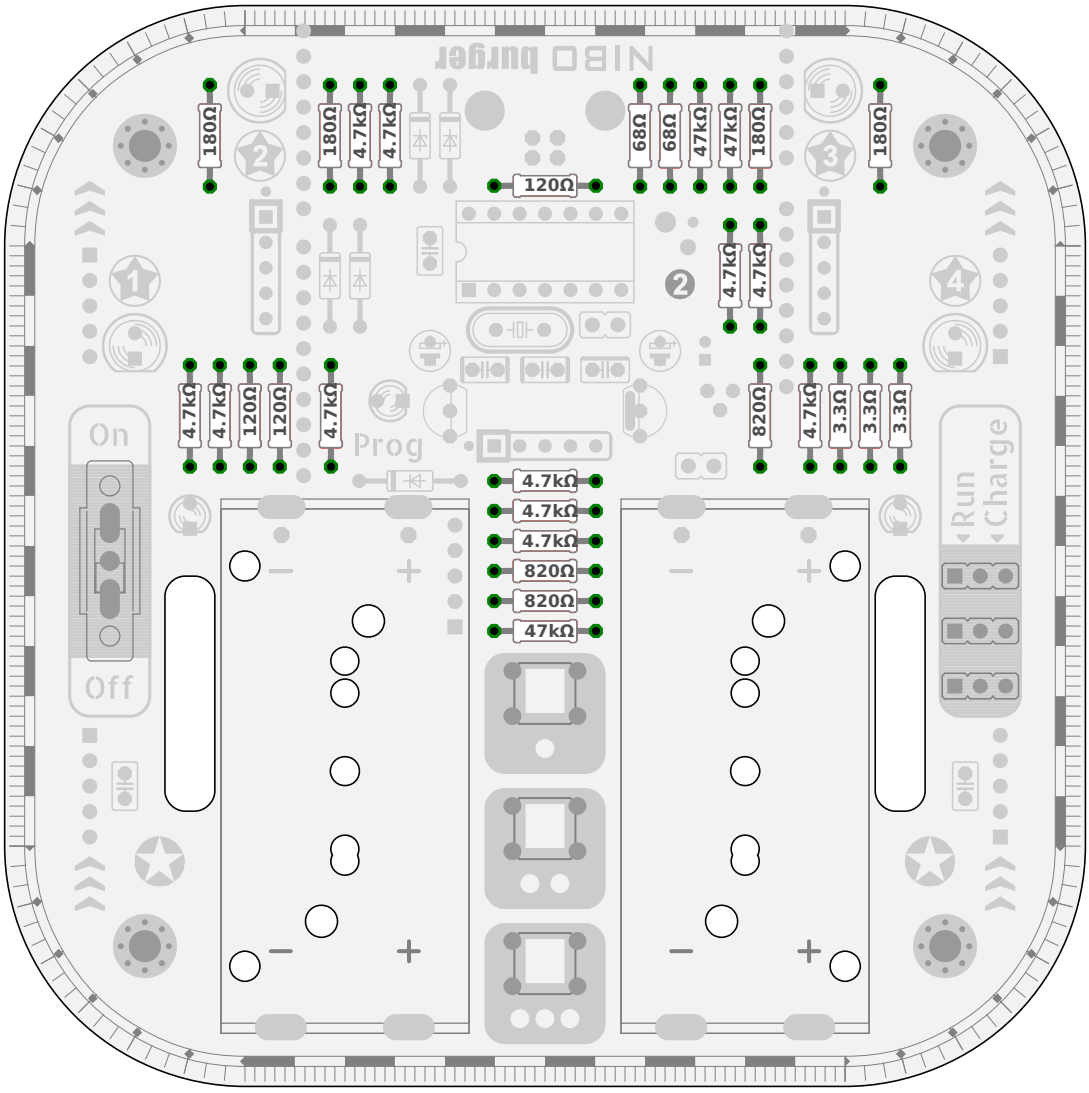
The resistors are soldered horizontal onto the boards. The legs must be bent over, as shown in the illustration.
You don't have to pay attention to the polarity.
The value of the resistors is indicated by a four band colour code on the resistor, which is explained in the appendix.

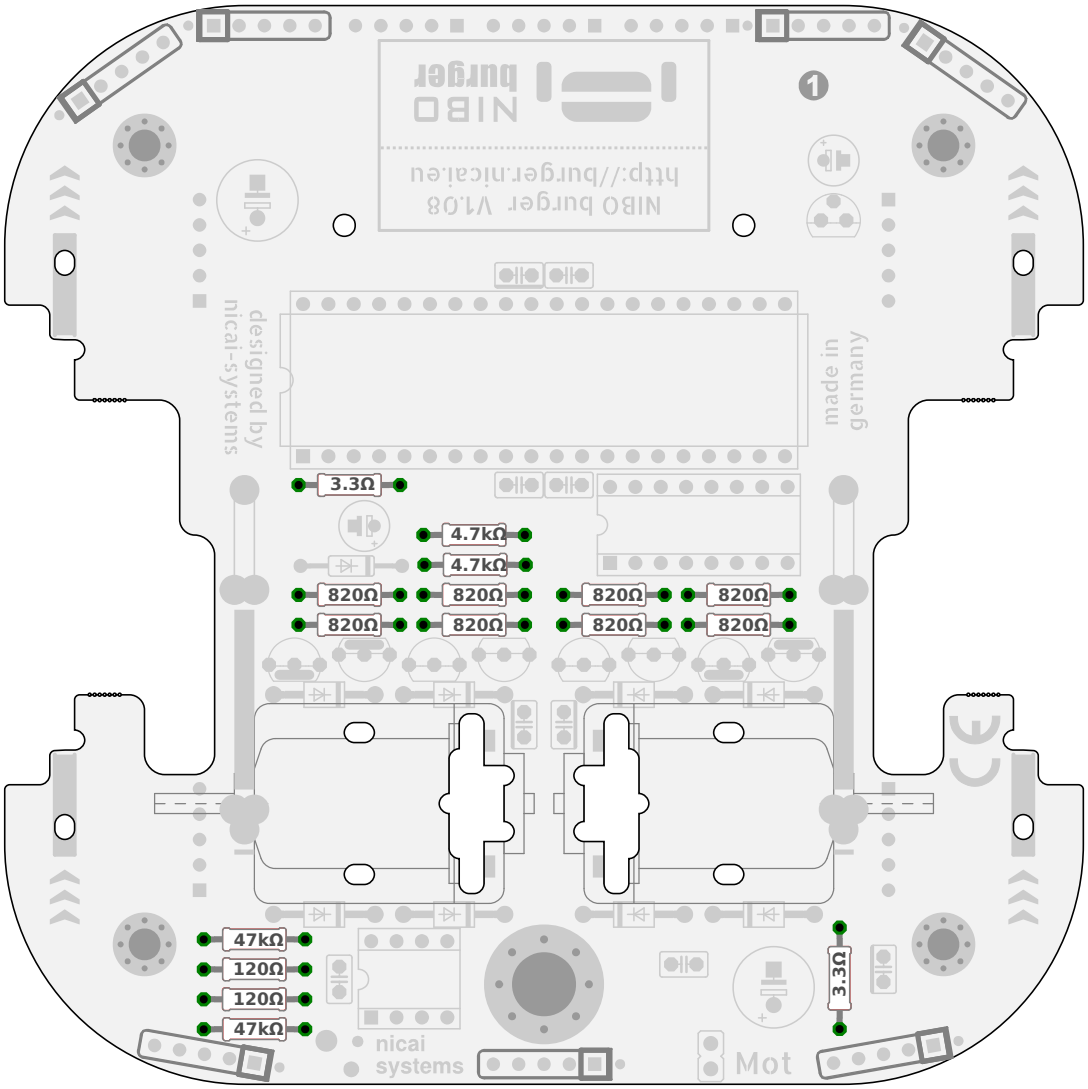
> **R1 – R16** are on board ①, **R20 – R48** are on board ②

Value	Parts	Colour code
3,3 Ω	R1, R16, R40, R41, R42	orange – orange – gold - (gold)
68 Ω	R24, R25	blue – grey – black - (gold)
120 Ω	R13, R14, R30, R35, R36	brown – red – brown – (gold)
180 Ω	R20, R21, R28, R29	brown – grey – brown – (gold)
820 Ω	R4, R5, R6, R7, R8, R9, R10, R11, R38, R46, R47	grey – red – brown – (gold)
4,7 kΩ	R2, R3, R22, R23, R31, R32, R33, R34, R37, R39, R43, R44, R45	yellow – violet – red – (gold)
47 kΩ	R12, R15, R26, R27, R48	yellow – violet – orange – (gold)

Tip: There is an overview of the placement on the next pages!

The following overview diagram shows the placement of the resistors on the main circuit boards:



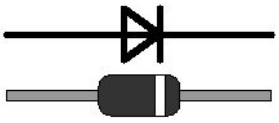

NIBO burger
http://burger.nicai.eu
NIBO burger V1.08
designed by nicai-systems
made in germany
3.3Ω
4.7kΩ
4.7kΩ
820Ω
820Ω
820Ω
820Ω
820Ω
820Ω
820Ω
820Ω
47kΩ
120Ω
120Ω
47kΩ
3.3Ω
nicai systems
Mot

2.3.5.2 Zener-/Schottky-Diodes

The Zener diodes **D20** and **D21** of type BZX83V003.6 (respectively 55C3V6) and the Schottky diodes **D1, D22**, **D23** and **D24** of type BAT85 must be bend like the resistors before placement.

Type	*Part*
BZX83 V003.6	D20 D21
BAT85	D1 D22 D23 D24

You have to pay attention to the polarity!!
The cathode is indicated by the ring on the diode and must be soldered at the white line, respectively the symbol of the diode, marked on the circuit board.



The figure shows the symbol of the diode and below it shows the diode as electrical part. Before soldering you have to pay attention that the ring on the diode is soldered at the side of the vertical line of the symbol.

Tip: The Schottky diodes are labeled with ***BAT85*** in small letters.
They are packed as group of **four**.
D1 is to find on board ①, all others are to find on board ②

2.3.5.3 Silizium-Diodes

Also the Silizium diodes **D2-D9** of type **1N4007** must be bend like the resistors before placement.

You have to pay attention to the polarity!!

Type	*Part*
1N4007	D2 D3 D4 D5 D6 D7 D8 D9

The white line on the board print, respectively the printed symbol of the diode, marks the position where the cathode (indicated by the ring on the diode) has to be soldered.

2.3.6 Ceramic multilayer capacitors

There are 13 ceramic multilayer capacitors to be placed onto the board.

The capacitors C2, C8, C9, C13 and C25 have a value of **10 nF** (imprint: 103).

Value	*Part*
10 nF	C2 C8 C9 C13 C25

The other capacitors C3, C6, C7, C10, C11, C20, C26 and C27 have a value of **100 nF** (imprint: **104**).
You don't have to pay attention to the polarity.

100 nF	C3 C6 C7 C10 C11 C20 C26 C27

Info: The imprint 104 means 10*10^4 pF, or generally: the imprint *xyz* means a capacity of *xy*10^*z* pF.

C20 - C27 are to find on board ②, all others are on board ①

2.3.7 Ceramic plate capacitors

The both ceramic plate capacitors **C23** and **C24** have a capacity of 22 pF (imprint: 22).

You don't have to pay attention to the polarity.
They are placed on board ②.

Value	*Part*
22 pF	C23 C24

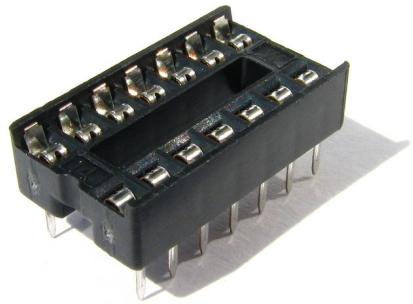
2.3.8 Crystal

The crystal **Q1** has a frequency of 15,000MHz and must be placed on board ②. After positioning the body should not be in contact with the board (Optimal distance to the board: 1mm).
You don't have to pay attention to the polarity.

Value	*Part*
15 MHz	Q1

Tip: It helps to put a 1mm thick piece of cardboard between plate and crystal before soldering. After the crystal is soldered the cardboard can be carefully removed.

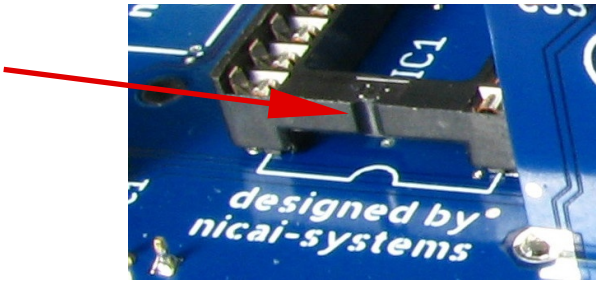
2.3.8.1 IC-Sockets



There are **four** IC-sockets to be soldered onto the boards. The 40 pin socket is for the main controller ATmega16, the **14 pin** socket is for the ATtiny44, the **16 pin** socket is for the demultiplexer 74HC139 and the 8 pin one is for the operational amplifier LM358.

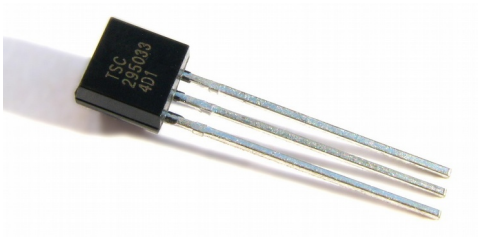
Type	*Part*
40-pol	IC1
16-pol	IC2
14-pol	IC5
8-pol	IC4

The notch in the socket must point in the same direction as the mark on the board!!



The **ICs** will be **inserted later!**

2.3.8.2 Voltage controller IC

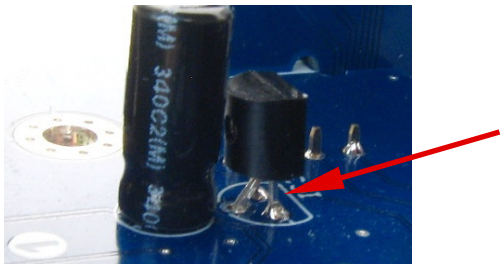


Type	*Part*
TSC 295033	IC3

The 3,3 V voltage controller IC must be placed onto board ① into the soldering pad **IC3**.
Therefore the middle leg of the component has to be bent a little bit.

***Note*:** The component is **NOT** to be flush mounted onto the board. It should stick out circa 2 mm:

During placement you have to **pay attention to the polarity!** The **flat side** of the component is marked on the circuit board.



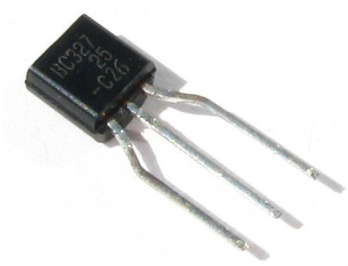
2.3.9 NPN Bipolar-transistors

The five NPN bipolar-transistors **T3**, **T4**, **T5**, **T6** and **T9** are of the type **BC337 !!**.
During placement you have to **pay attention to the polarity!**
The **flat side** of the transistor is marked on the circuit board.

Type	*Part*
BC337	T3
	T4
	T5
	T6
	T9

T9 is to find on board ②, T3 - T6 are to find on board ①

2.3.9.1 PNP Bipolar-transistors



The five PNP bipolar-transistors **T1, T2**, **T7**, **T8** and **T10** are of the type **BC327 !!**.
During placement you have to **pay attention to the polarity!**
The **flat side** of the transistor is marked on the circuit board.

Type	*Part*
BC327	T1
	T2
	T7
	T8
	T10

T10 is to find on board ②, the others are to find on board ①

!! Important !! The robot must never be switched on **without inserted IC2** (74HC139), otherwise the **transistors will be destroyed**!

2.3.9.2 White leds

The LEDs **LED5 - LED7** have got two legs, a short one (cathode) and a long one (anode). They are placed on board ②.

Type	*Part*
Led white	LED5
	LED6
	LED7

You have to pay attention to the **polarity**:

The **short leg** has to be soldered into the **rectangular soldering pad**!

2.3.9.3 Red leds

Type	*Part*
Led red	LED1 LED4

The leds **LED1** and **LED4** also have two legs: a short one (cathode) and a long one (anode).
They are placed on board ②:

You have to pay attention to the **polarity**:

The **short leg** has to be soldered into the **rectangular soldering pad**!

2.3.9.4 Blue leds

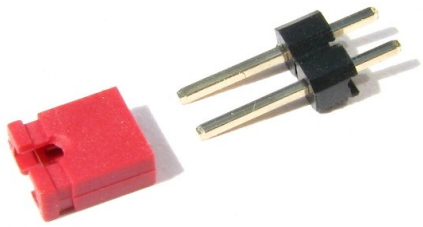
Type	*Part*
Led blue	LED2 LED3

The leds **LED2** and **LED3** also have two legs: a short one (cathode) and a long one (anode). The body of these components is flattened.
They are placed on board ②:

You have to pay attention to the **polarity**:

The **short leg** has to be soldered into the **rectangular soldering pad**!

2.3.9.5 Jumper 2-pole



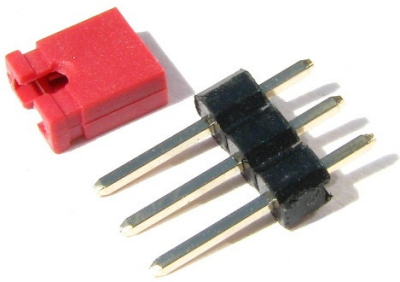
Type	*Part*
Jumper	J5 J6

The best way to place the jumper **J5** and **J6** onto the board is to solder them complete (connector and bridge). You should pay attention to a short soldering time so that the plastic does not melt.

J6 is to find on board ①, it's the **motor jumper**. The motor function is only active with connected J6. Therefore we **take off** the bridge after soldering to **deactivate** the **motor function**!

J5 is to find on board ②, it's the **LED jumper**. If J5 is not connected, the leds LED1-LED4 are **deactivated**. Than you are free to use the port bits of these leds at X11 and X12.
After soldering we connect J5 with the bridge!

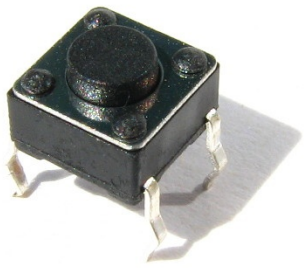
2.3.9.6 Jumper 3-pole



type	*part*
Type	*Part*
Jumper	J1 J2 J3

The 3-pole jumpers **J1**, **J2**, and **J3** have to be soldered analog to the 2-pole ones. After soldering the jumpers must be connected at the **RUN** position.

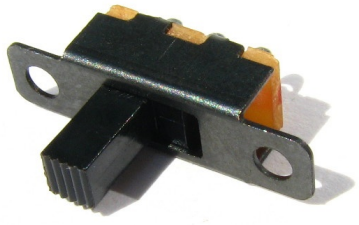
2.3.9.7 Button



Type	*Part*
Button	SW1 SW2 SW3

The placement of the buttons **SW1 - SW3** is protected against polarity reversal. You have to place it onto the board with soft pressure till it snaps in.
You don't have to pay attention to the polarity.

2.3.9.8 Switch



The toggle switch **S1** may be soldered onto the board in both possible orientations, the functionality stays the same.

Type	*Part*
Switch	S1

2.3.10 Electrolytic capacitors

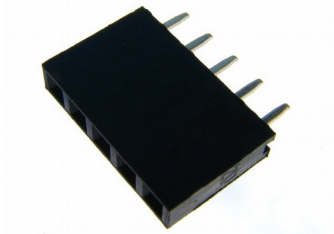
During placement of the 470µF electrolytic capacitors (**C1, C12**), the 100µF electrolytic capacitors (**C4, C5**) and the two 4,7µF electrolytic capacitors (**C21** und **C22**) onto the board **you have to pay attention to the polarity!**

The **short leg** must be placed into the **rectangular pad!**

Value	*Part*
470 µF	C1 C12
100 µF	C4 C5
4,7 µF	C21 C22

The **positive** connections are marked with “+” sign on the board. The positive pin of the electrolytic capacitor is the **long leg** and the negative one is the **short leg**. The negative connections are implemented as rectangular pads. You can find a “-” symbol on the housing of the capacitor.

2.3.10.1 Straight sockets – 5 contacts



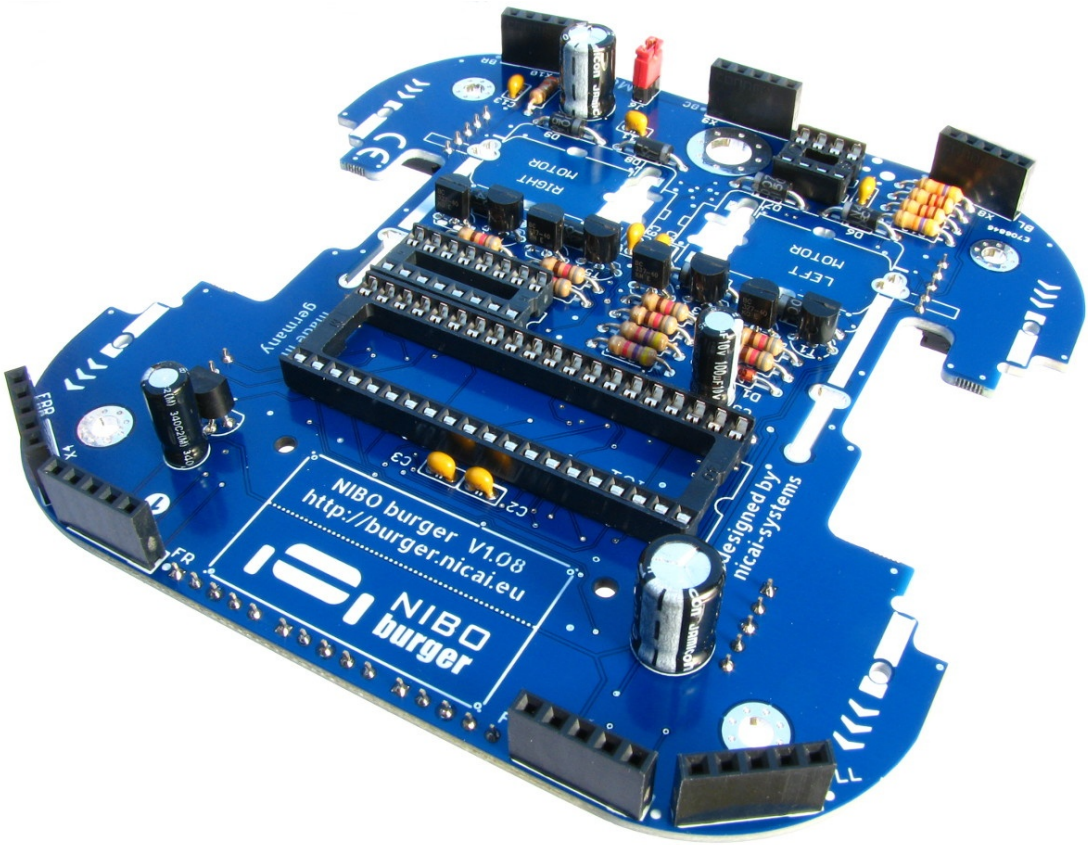
The **10** straight sockets with 5 contacts have to be soldered into the pads **X1-X4**, **X8-X10** and **X11-X13**.

You don't have to pay attention to the polarity.

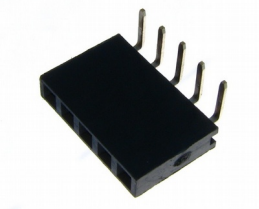
Type	*Part*
Straight socket 5 contacts	X1 X2 X3 X4 X8 X9 X10 X11 X12 X13

X11-X13 are on board ②, all other sockets are to find on board ①

The sockets have to be soldered right-angled, because later on the sensor bricks will be inserted (board ①):



2.3.10.2 Right-angle sockets – 5 contacts



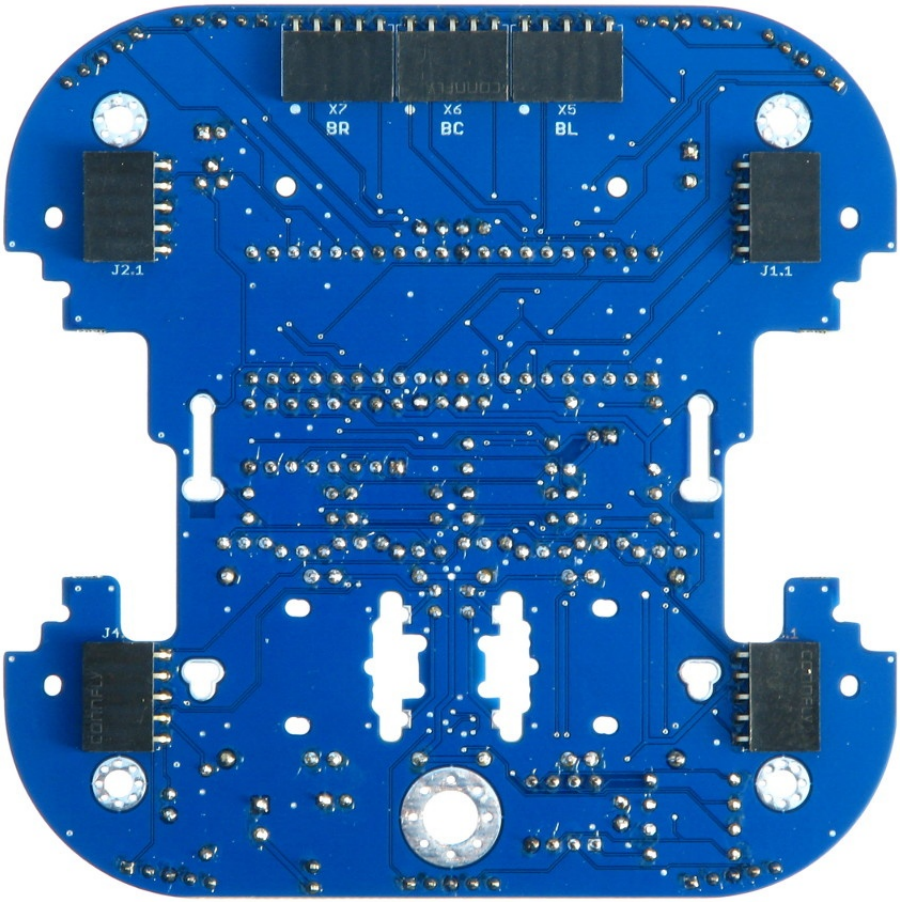
The **7** right-angle sockets with 5 contacts have to be soldered into the pads **X5-X7** and **J1.1-J4.1**.

You don't have to pay attention to the polarity.

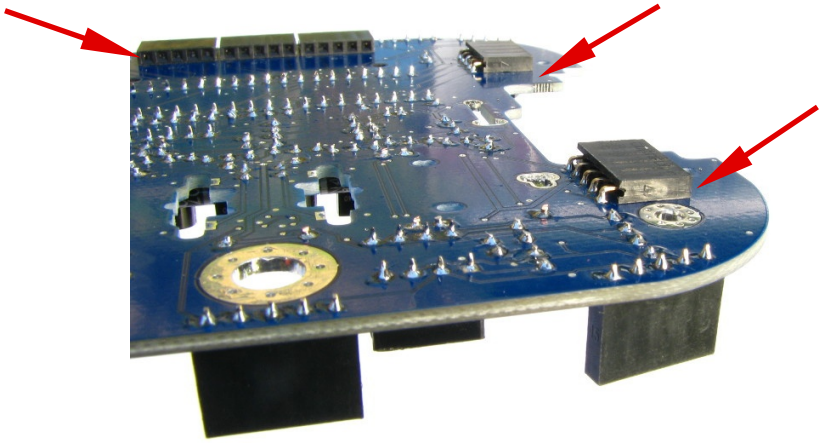
Type	*Part*
Right-angle socket 5 contacts	X5 X6 X7 J1.1 J2.1 J3.1 J4.1

All sockets have to be soldered on the bottom side of board ①

The result should look like this:



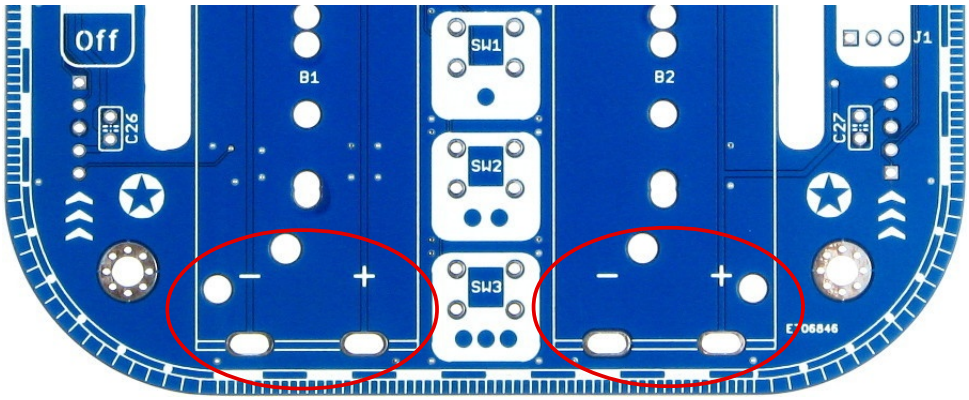
The sockets should be planar onto the boards as possible:



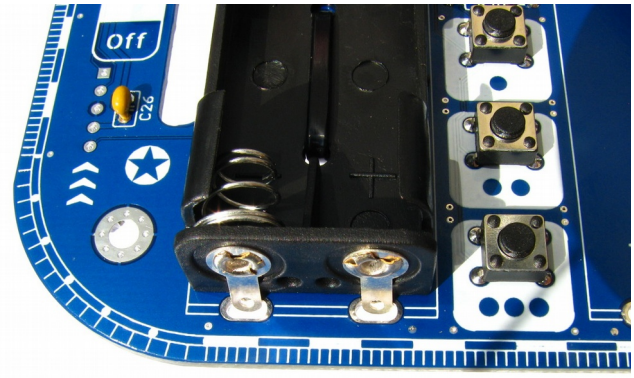
2.3.11 Battery packs

Now the two battery packs will be attached to board ②.
Before soldering they must be fixed each with one small cable strap.

Before assembling the packs you have to pay attention to the **"+/-" labels** on the circuit board and to the "+/-" labels of the respective battery pack (the important side is the **side with the soldering contacts**: the outside contact plates):

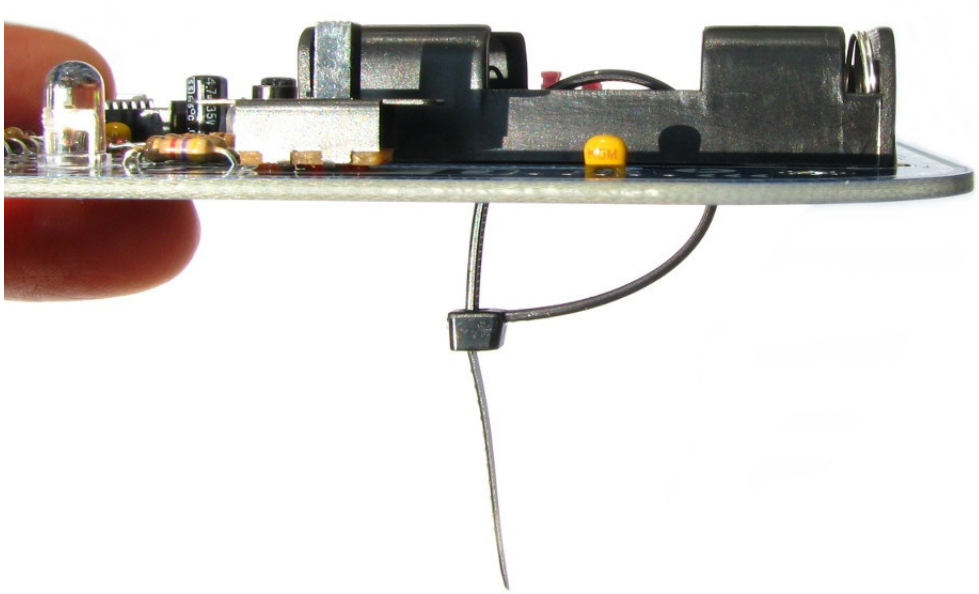


The "+/-" labels of the board and of the pack **only** has to suit at the **side with the soldering contacts**.
According to this the battery packs are put on the board with the soldering contacts (outside contact plates) pointing to the **edge of the board**:

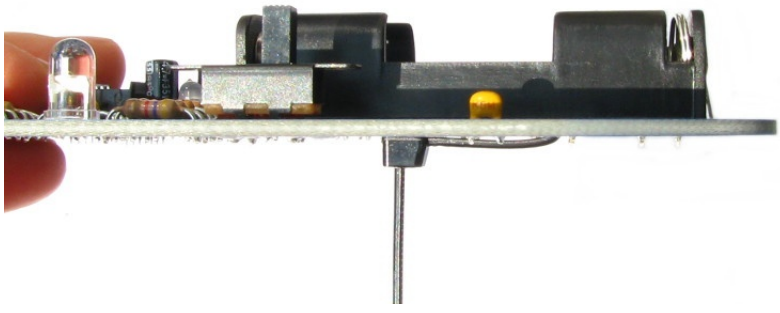


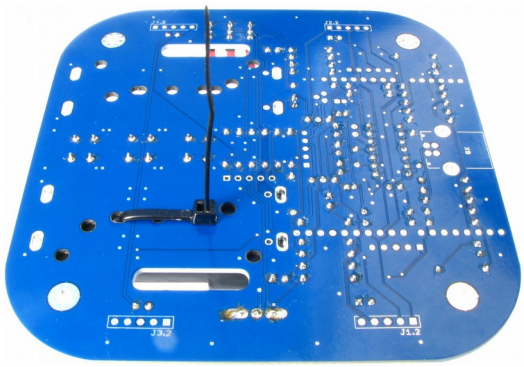
Before soldering the battery packs must be fixed with the small cable straps at the circuit board.

The cable strap has to put through the two holes of the board:



Then the cable strap is to be fastened (e.g. with an universal pliers):

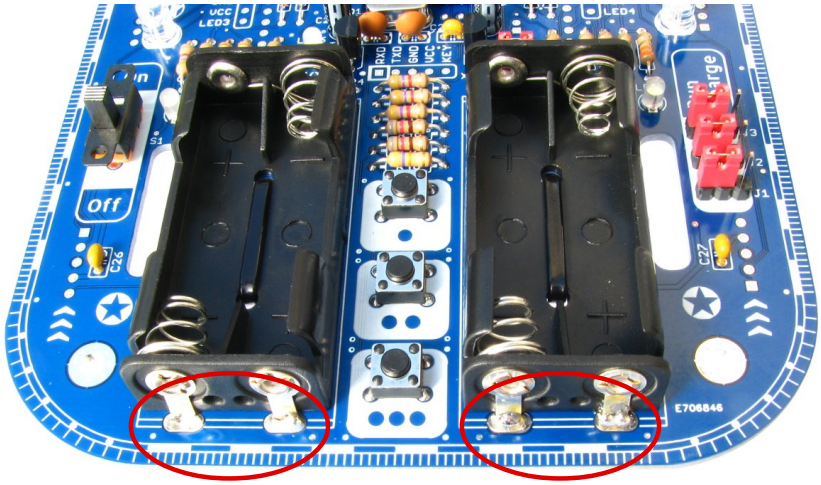




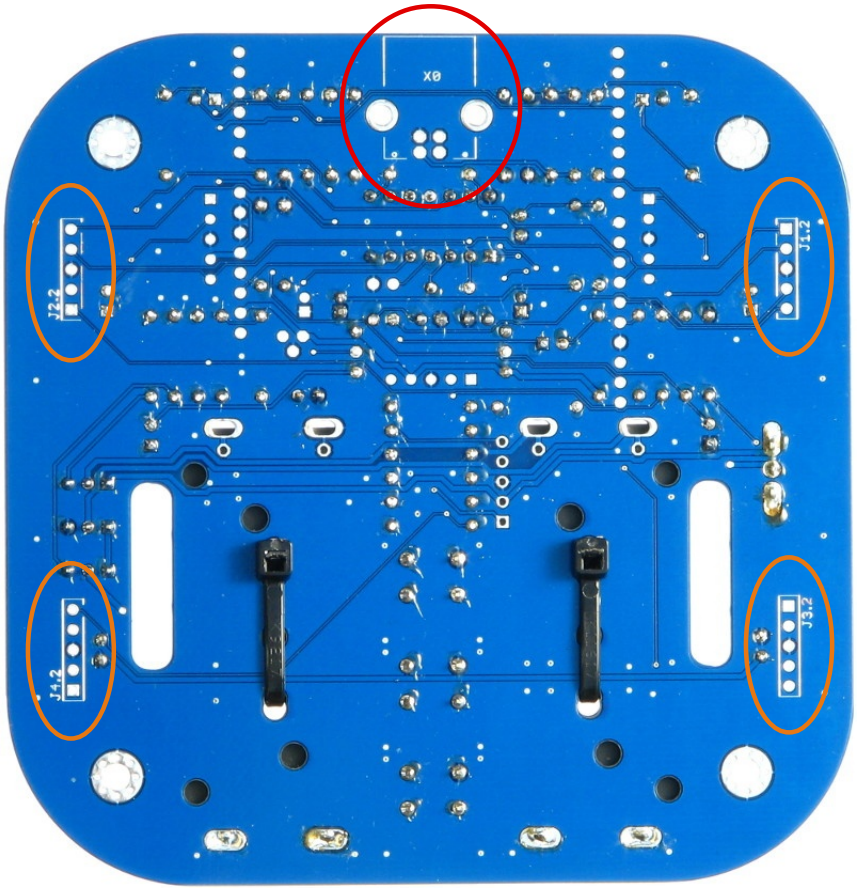
The cable strap has to be **cut shortly** with an electronic cutting pliers.

The other battery pack has to be fixed in the same way.

Finally the packs must be **soldered** (each at two contacts) at the top side of the circuit board:

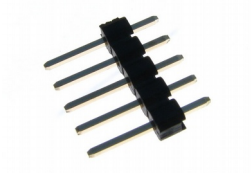


Now the board has to be **turned**:



The straight 5-pin headers J1.2, J2.2, J3.2, J4.2 and the USB socket X0 have to be placed at this side of the board!

2.3.11.1 Straight 5-pin headers



Soldering the straight 5-pin headers **J1.2**, **J2.2**, **J3.2** and **J4.2** you have to pay attention that they are **aligned at right angle** to the board.
Later on they will be contacted with the side plates.

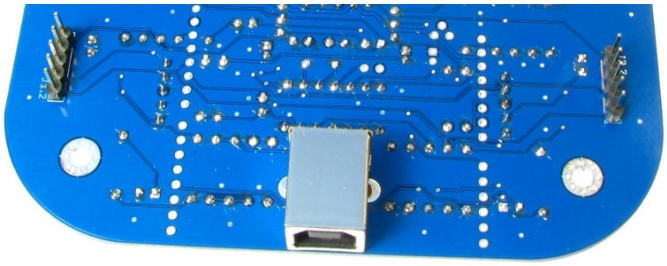
Type	*Part*
Straight 5-pin headers	J1.2 J2.2 J3.2 J4.2

2.3.11.2 USB socket

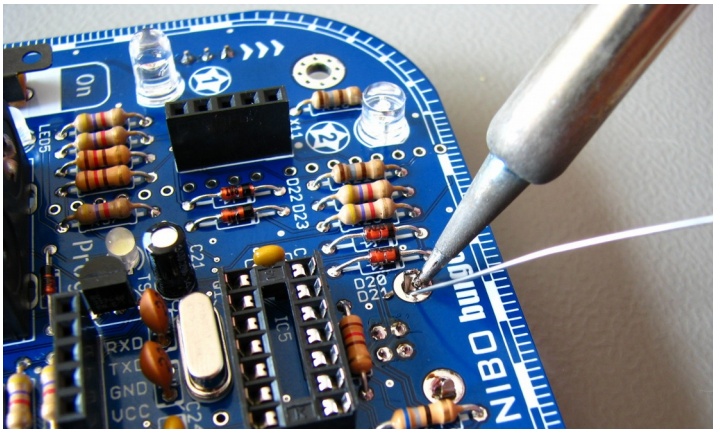
During installation of the USB socket **X0** you should pay attention that the smaller pins are not bent. The part is polarity safe. The USB socket is soldered at large at **6 soldering pads**.

Type	*Part*
USB socket	X0

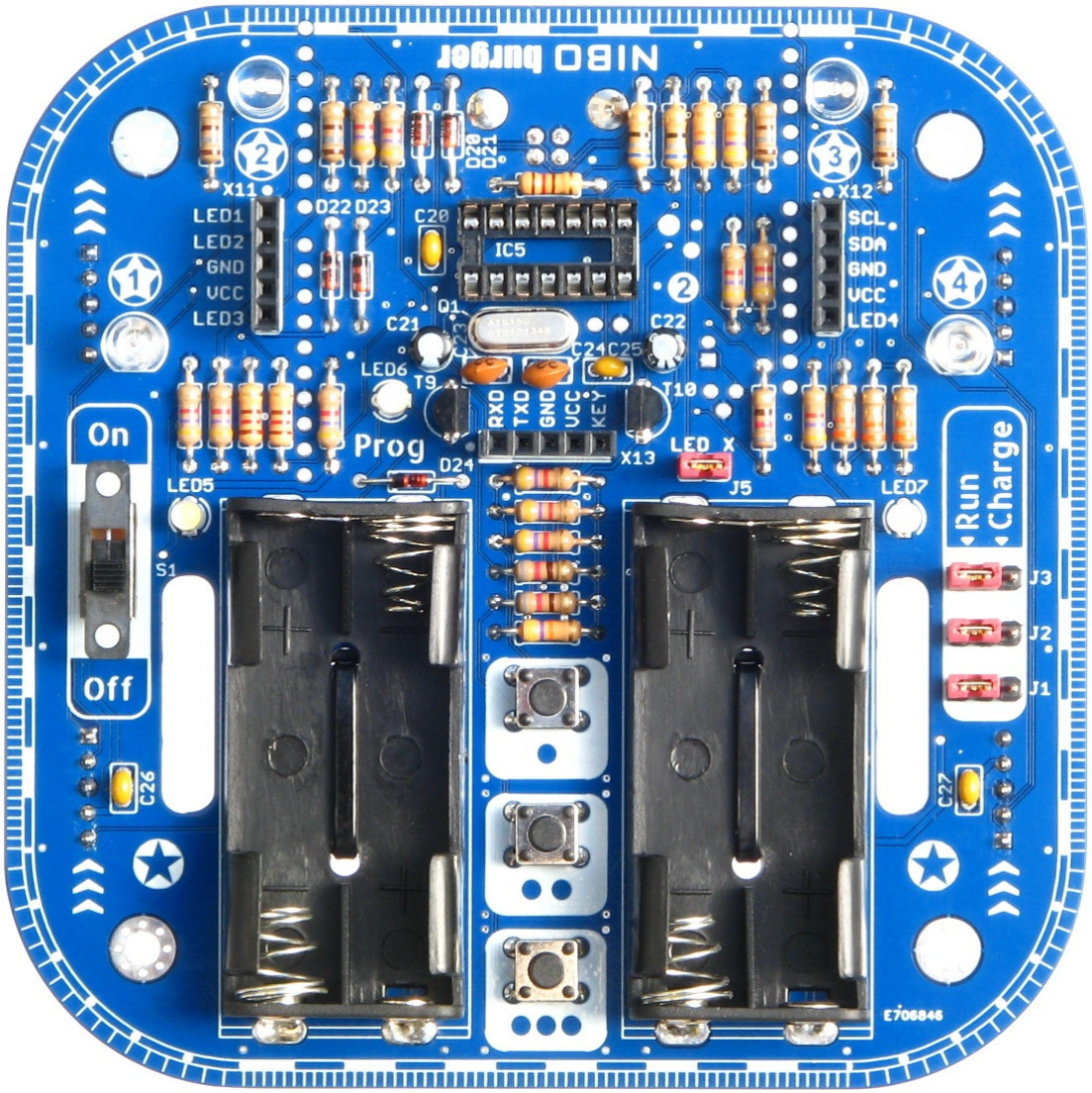
Place the USB socket at the **bottom side** of the board...



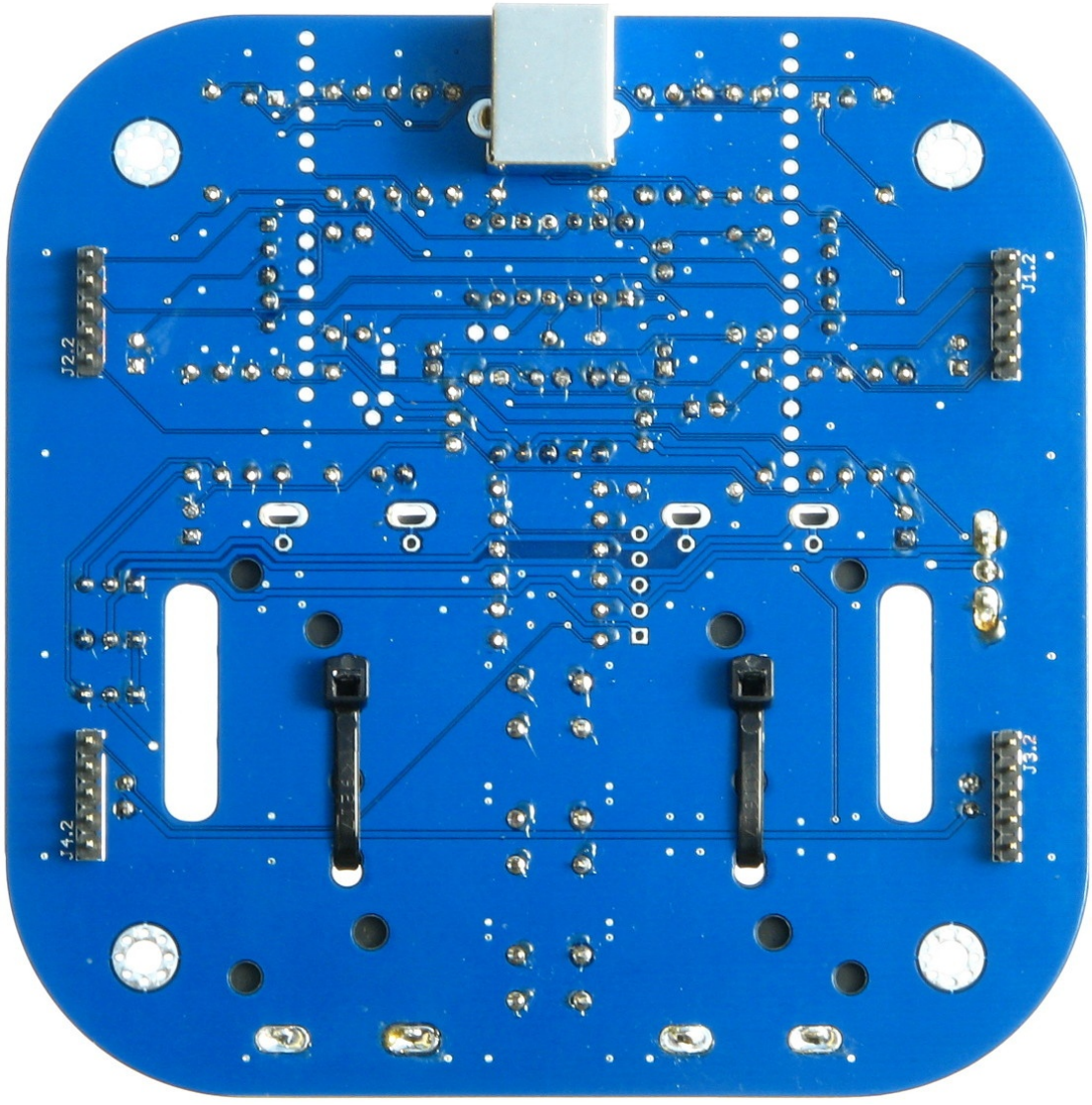
…and solder it at the **top side** of the board at **6 soldering pads,** the two holders of the housing have to be completely filled with tin solder:



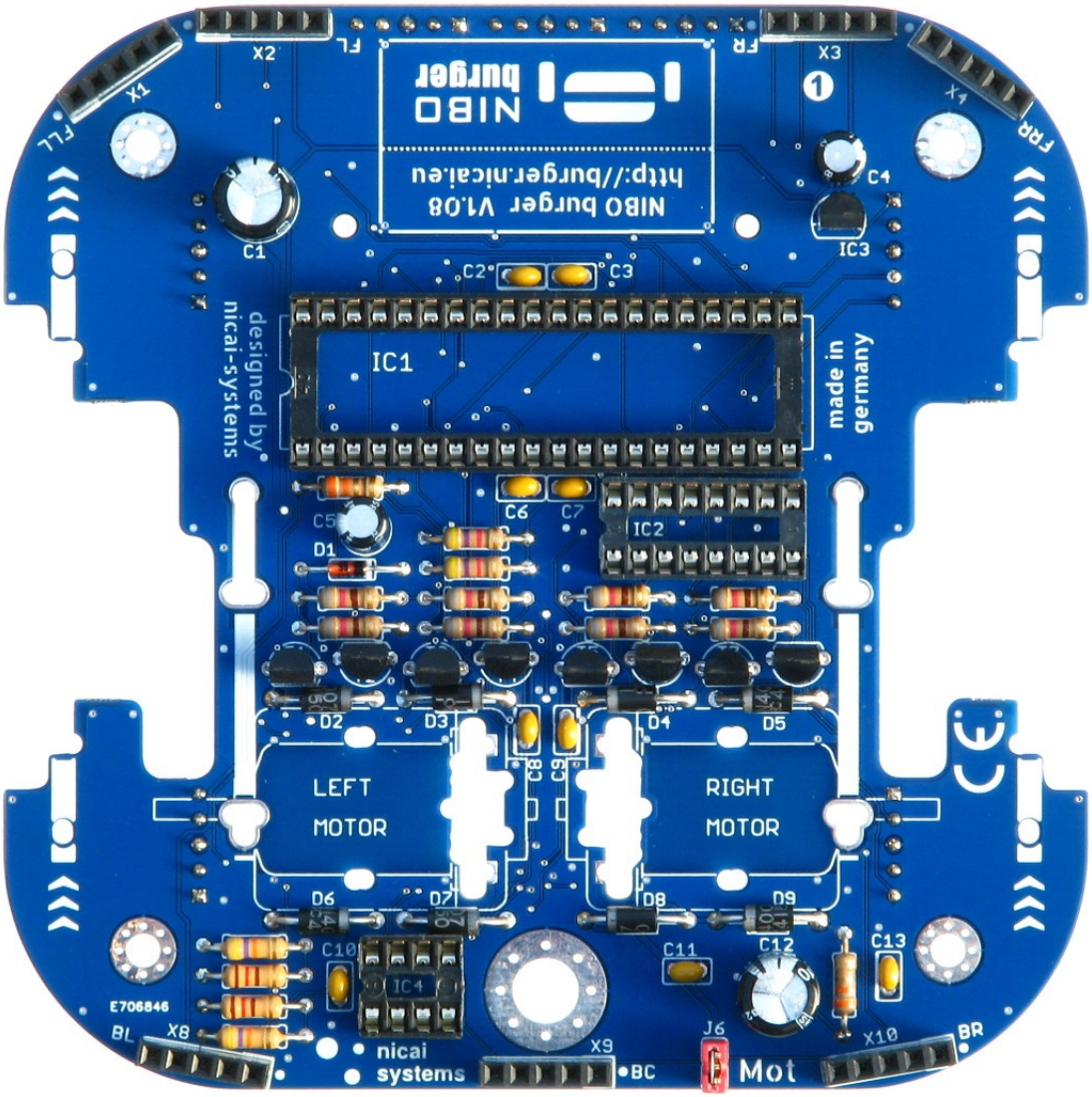
Finished top side of board ②:



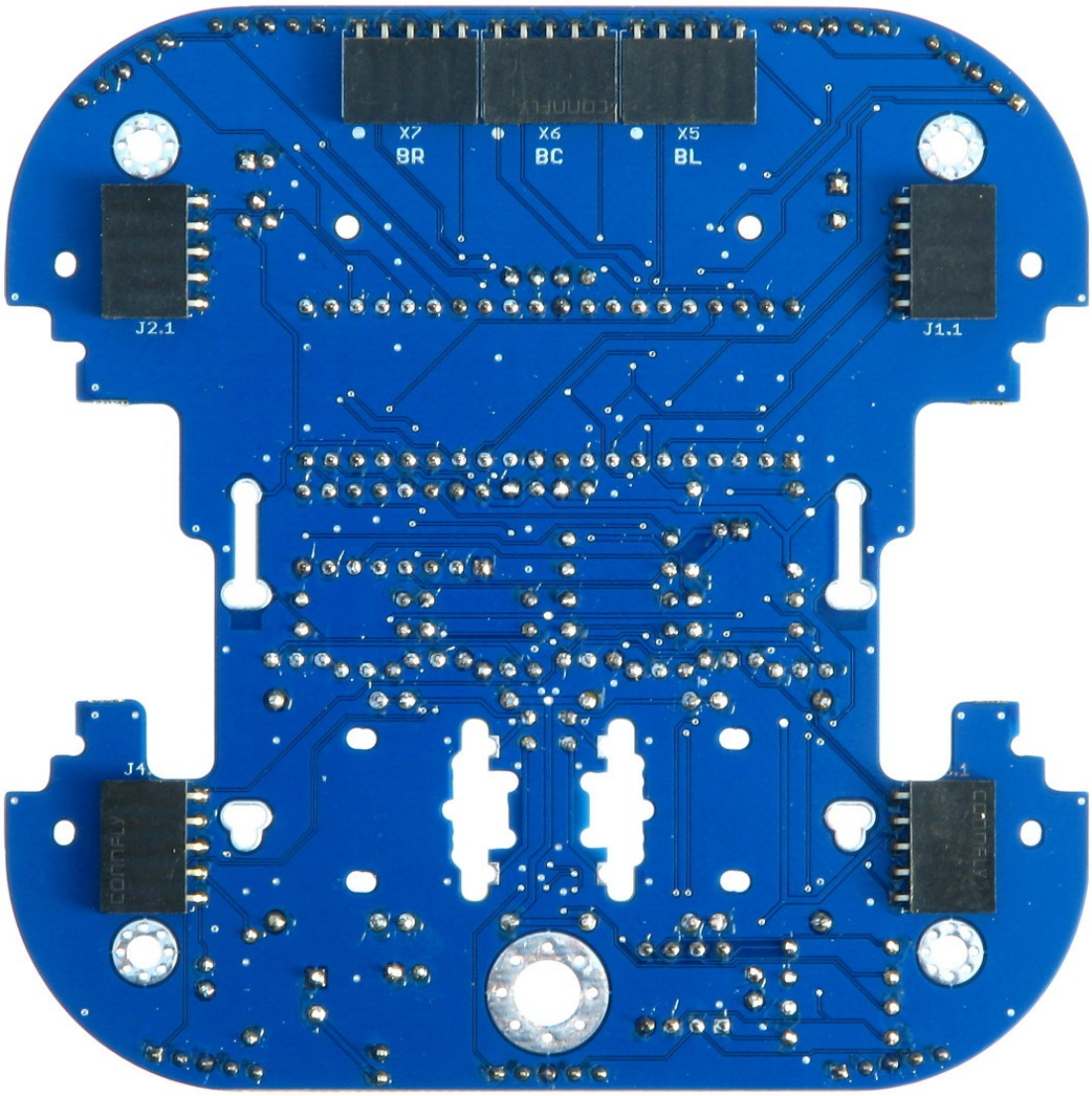
Finished bottom side of board ②:



Finished top side of board ①:



Finished bottom side of board ①:



2.4 Visual inspection of the circuit board

Before the board is attached for the first time to a power supply, all electrical components must be checked for the correct assembly. Therefore you have to check all values.

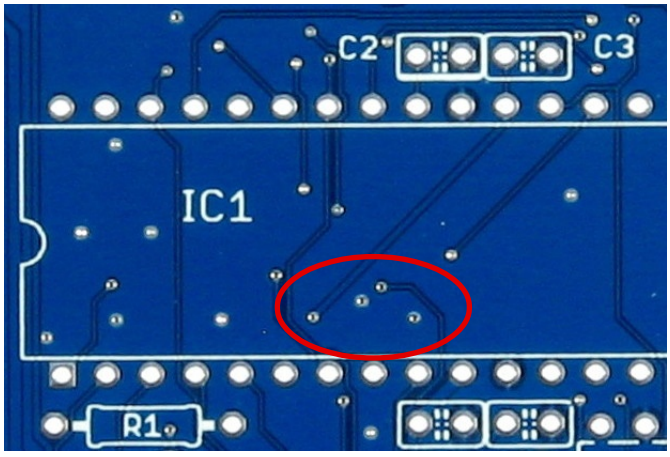
Afterwards you have to pay attention to the polarity and the correct installation respectively.

Finally check the board for short circuits and make sure that neither on the top side nor on the bottom side of the board remains any solder or wire.

!! Important !!

The robot must never be switched on **without inserted IC2** (74HC139), otherwise the **transistors** for the motor-control **will be destroyed**!

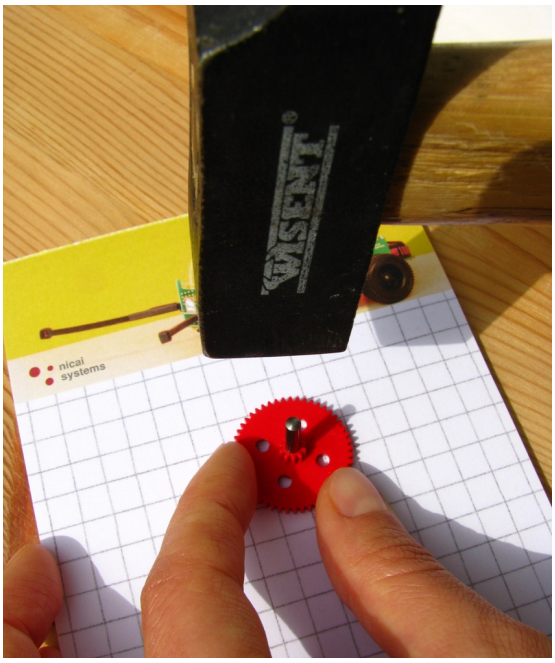
Information:
Particularly the via's (v*ertical interconnect access*), the picture shows four of them for example, should not be connected together with solder spots!



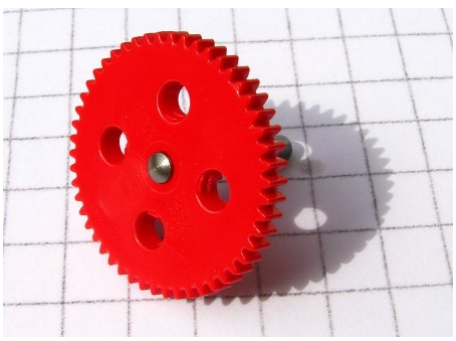
2.5 Assembling of the modules

2.5.1 Preparation operations

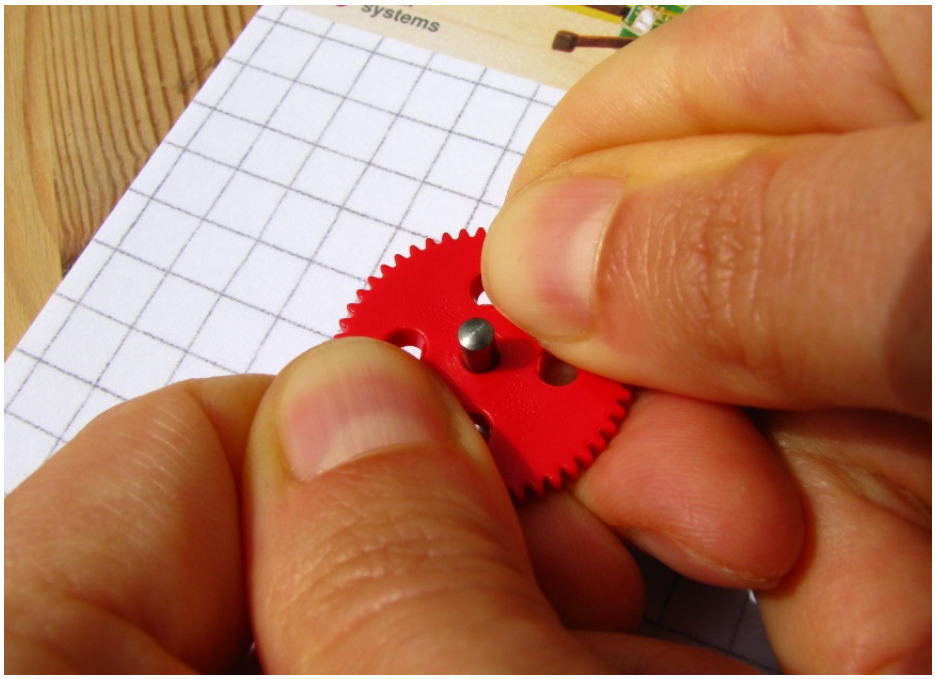
The two **red** double gearwheels must be pressed onto the two **short** steel axes (3 x 24 mm). Therefore you have to press the axis with the help of a hammer into the side of the gearwheel with the **smaller** gear (please use e.g. a paper pad so that nothing gets destroyed):



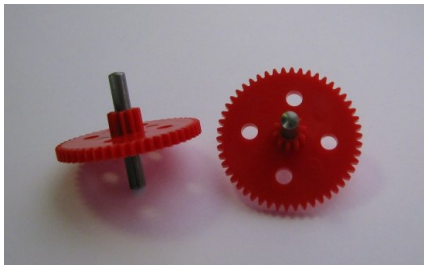
The axis must be pressed through with the hammer until it looks like this:



Then you have to press the axis **carefully** through the gearwheel. For not getting injured, the **thumbnails** must have some **distance** to the axis:



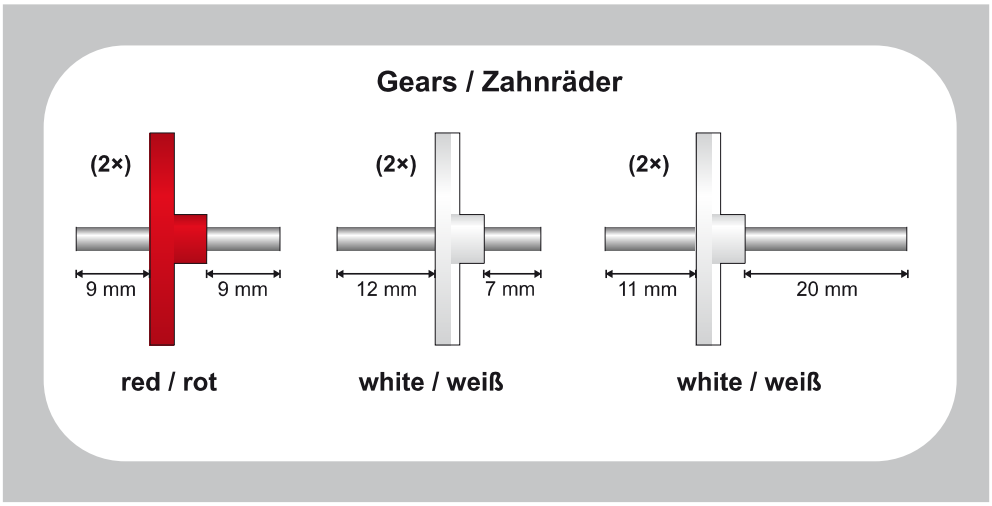
Afterwards the gearwheels should be in the middle of the axis:



Now the both **white** double gearwheels have to be pressed onto the two **short** steel axes (3 x 24 mm). The procedure is analog to the red gearwheels. Pay attention to the different distances / positions (see the picture / stencil).

Now the last both **white** double gearwheels have to be pressed onto the two **long** steel axes (3 x 37 mm). The procedure is analog to the red gearwheels. Pay attention to the different distances / positions (see the picture / stencil).

With the help of the stencil inside the package you can easily proof the distances:



2.5.2 Assembling of the engine section / transmission unit

Now the two **motors** and the circuit boards ③ and ④ have to be fixed to the circuit board ①.

First of all put the motor axis through the boards as shown below.

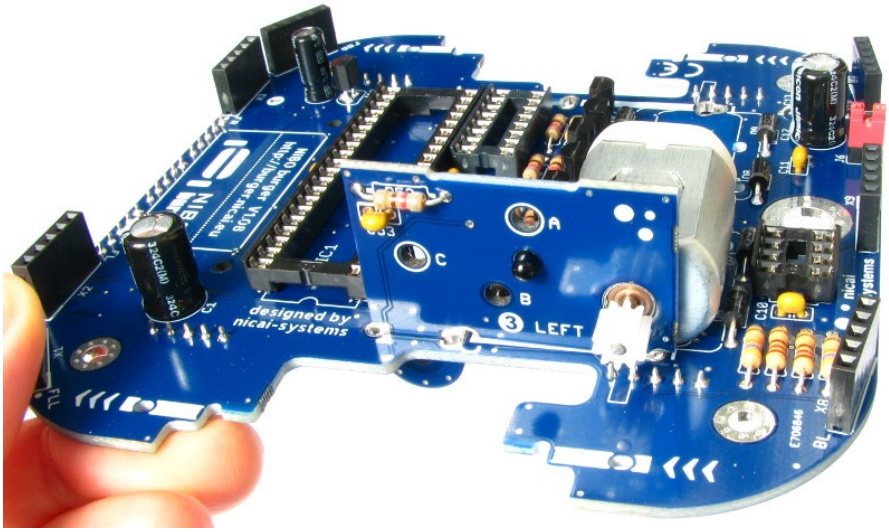
The soldering contacts of the motors must face downwards!!

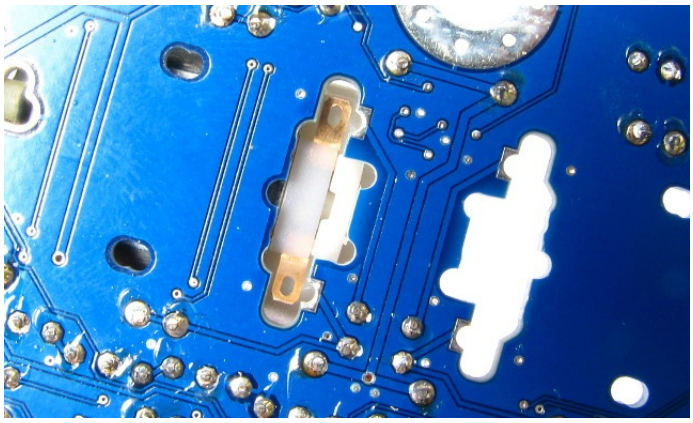
In case of one motor does not fit correctly into the hole, the hole can be carefully widened with a 6mm drill bit.

We start with the **left side** (driving direction):

Put the board ③ through the fitting slots of the circuit board ① so that the motor will be planar onto the "**MOTOR LEFT**" field.

The soldering contacts of the motor have to fit exactly into the recess of board ①.



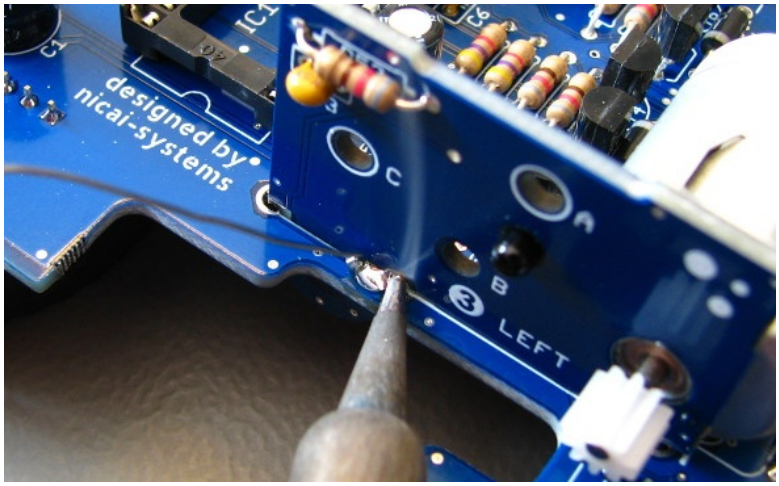


For an easier soldering of the motor contacts and board ① you can bent up the motor contacts a little bit.

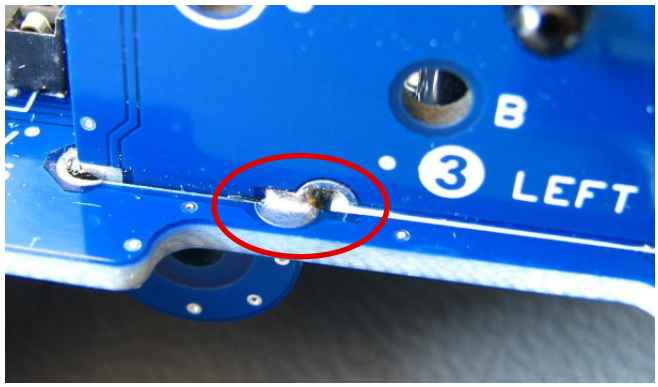
When the motor fits correctly, board ③ is soldered to board ① beginning with the middle soldering contact (see pictures).

These soldering joints work with the help of **capillary action**: you tin the respective point **sparse** with tin-solder and heat the point afterwards about **10 seconds** with the soldering iron. Because of the capillary action the tin-solder will be pulled inwards and the boards will be fixed together. So you get an electric and a mechanic contact.

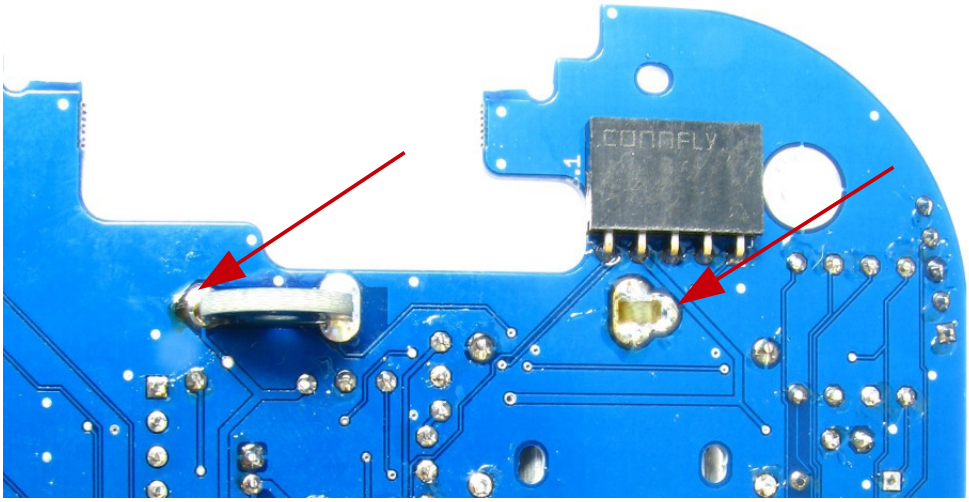
Tip: While soldering the transmission unit you have to pay attention that the several circuit boards are **orthogonal adjusted**. It is not easy to disassemble the unit afterwards.



The result should look like this:



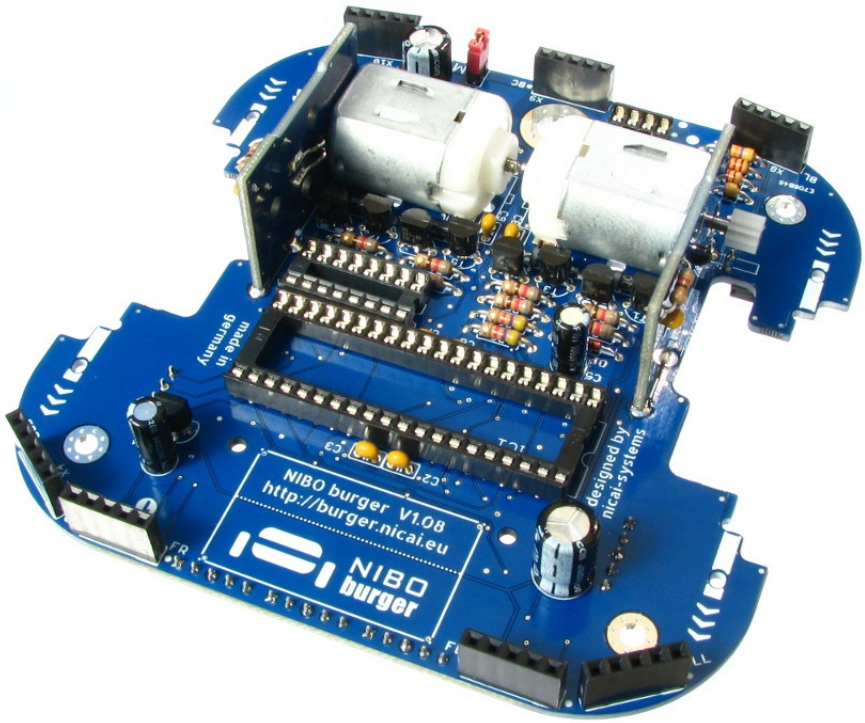
Now the both remaining connections (red arrows) must be soldered from the **bottom side** of the main circuit board.



Then the motor contacts have to be soldered to the board:

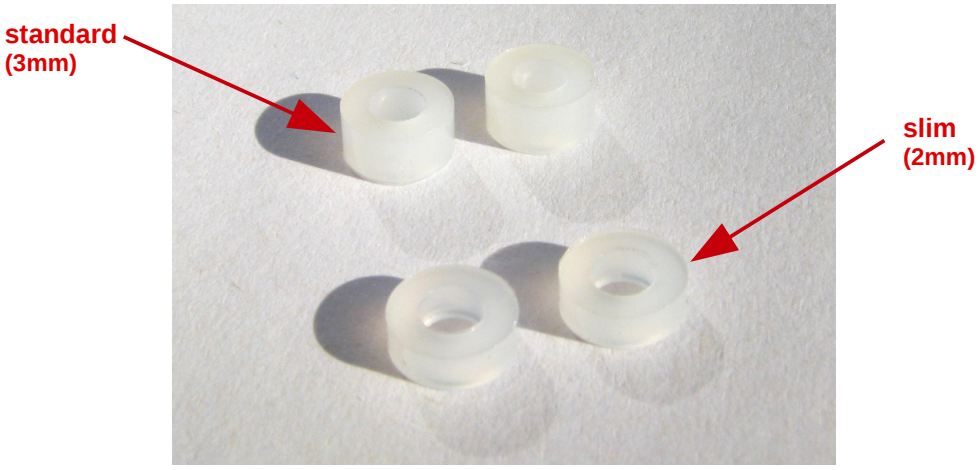
Now the **right side** has to be assembled analog.

The result should look like this:



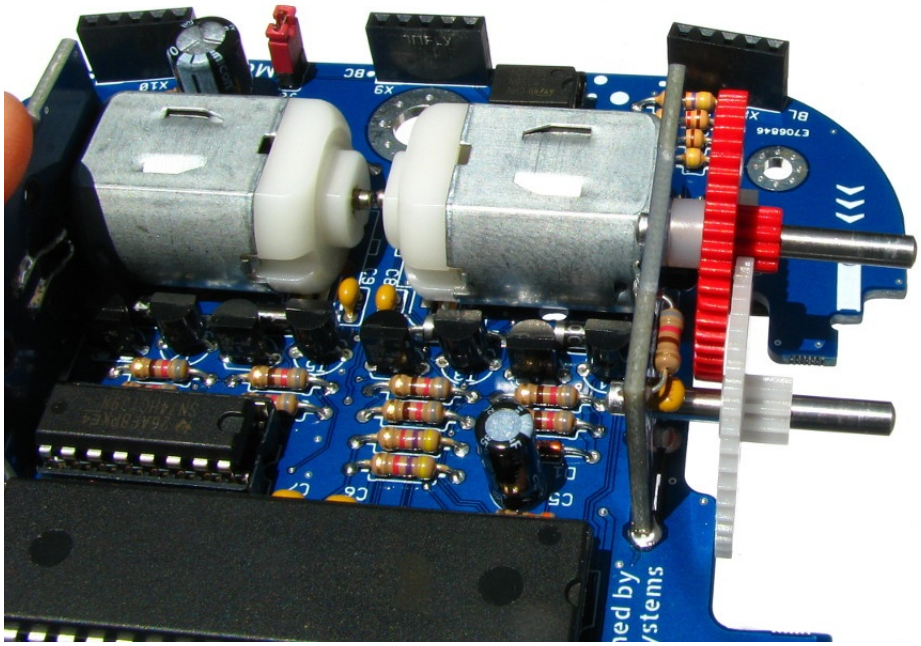
Now the **left transmission unit** (transmission ratio 125:1) will be assembled:

The kit contains two sorts of plastic distance rings:



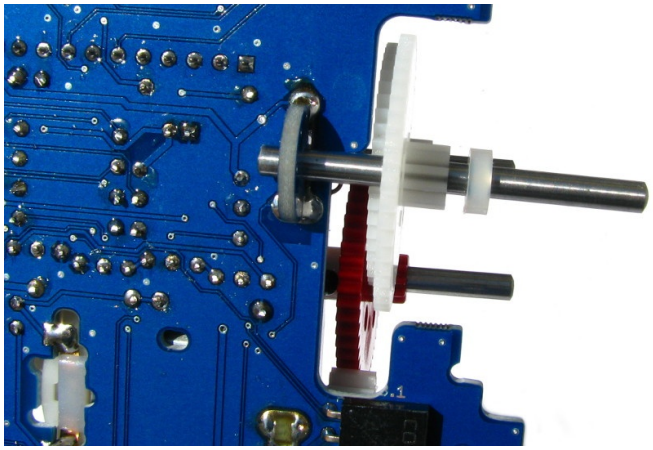
Put the white **standard (3 mm)** plastic distance ring to the short axis with the **red gearwheel** (to the opposite side of the little gearwheel). Then the axis must be put (with the distance ring ahead) into the **borehole A**.

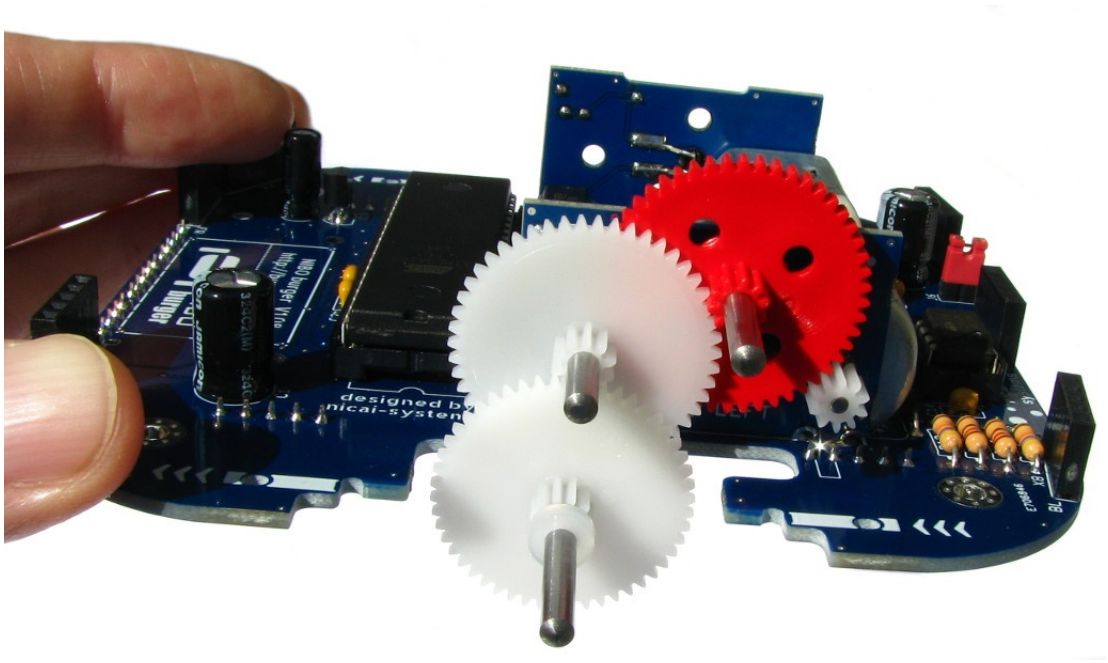
Afterwards you have to put the **short axis** with the **white** gearwheel (the little gearwheel outwards) into the **borehole C**:



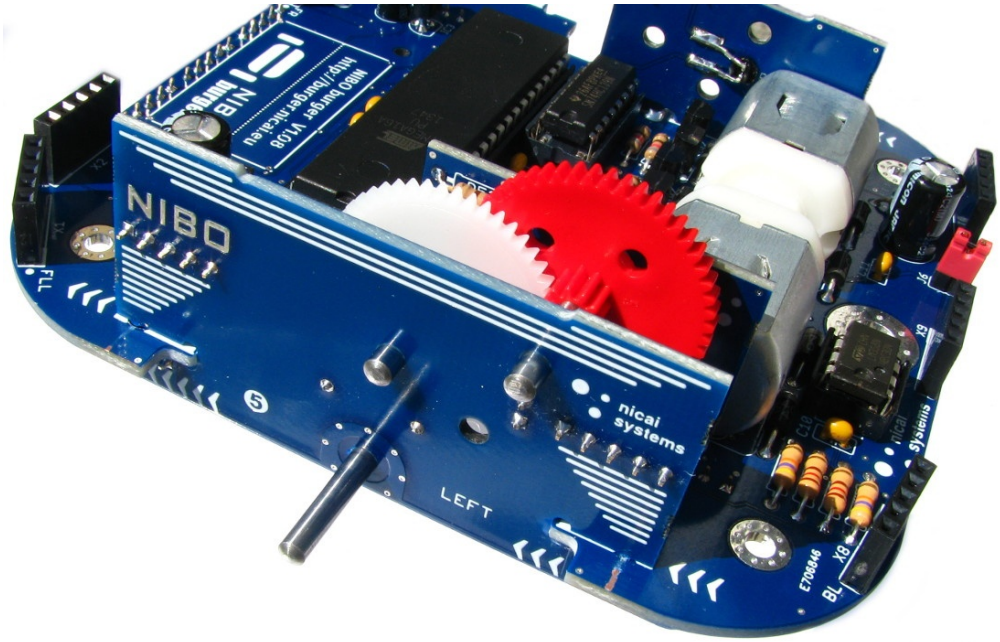
Then the **long axis** with the **white** gearwheel (the little gearwheel outwards) must be put into the **lowermost borehole**:

You have to put a **slim (2 mm)** distance ring to this axis:

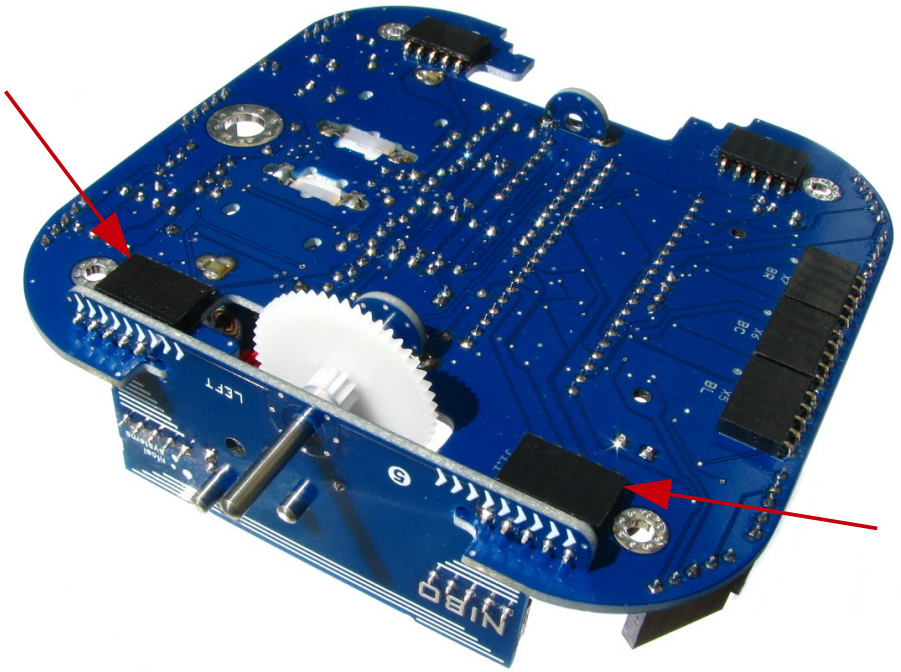




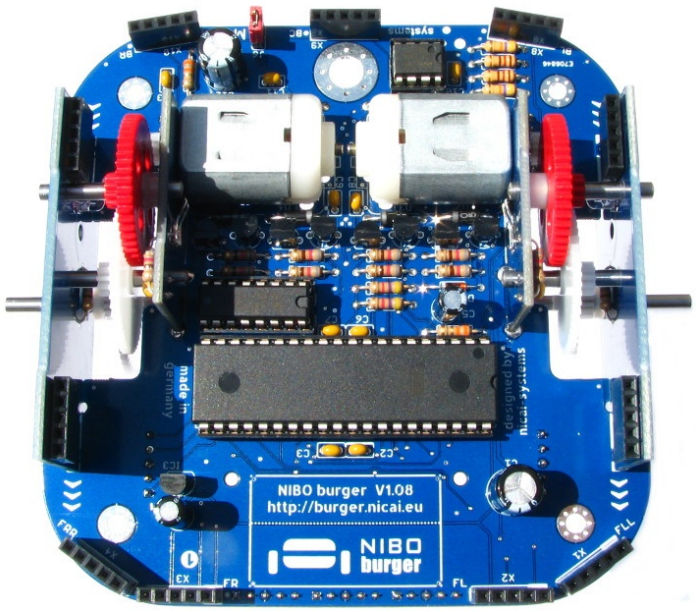
The transmission is fixed by board ⑤ (the electronic parts of board ⑤ point inwards):



The 5-pin headers must be connected to the 5-pin sockets of board ①:



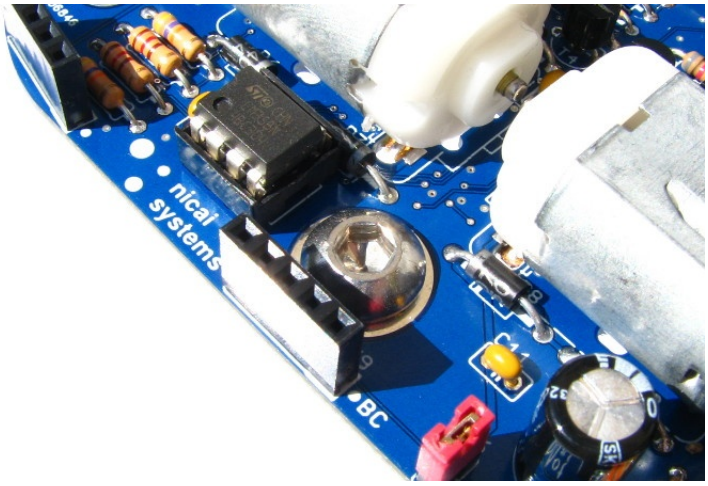
Now the left transmission unit is completed. The **right unit** has to be assembled analog:



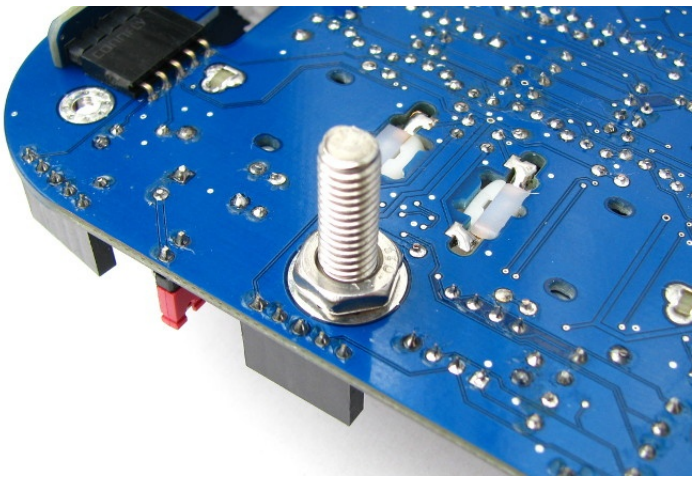
> ***Tip:*** You can reduce the operating noise by careful greasing the transmission (see also page 82).

2.5.3 Mounting the polyamid pin

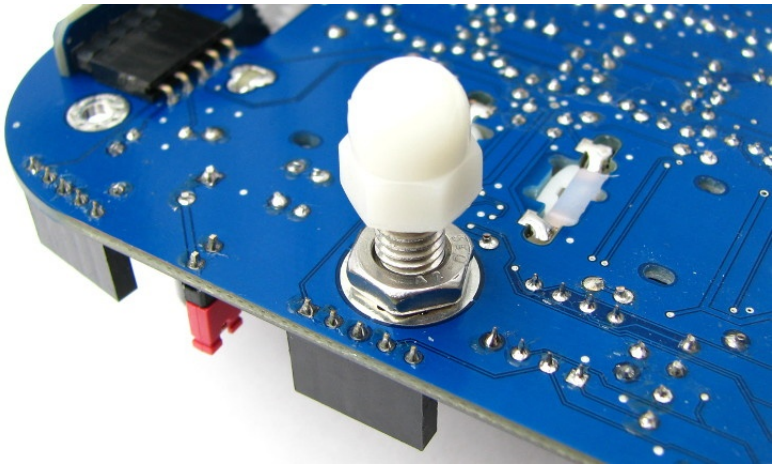
First we put the large screw from the top side through board ①:



Then the screw is fixed from the bottom side with a hex nut:

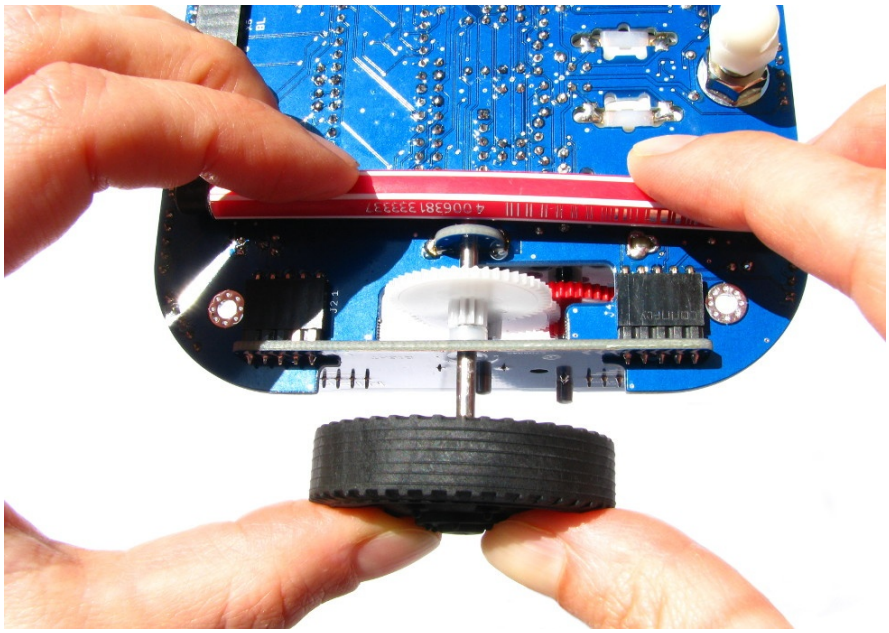


Finally the white polyamid pin must be screwed on:



2.5.4 Attaching the wheels

The both wheels have to be put onto the drive shafts so that they are performing well. To avoid damaging the transmission you shall press (e.g. with an edged crayon) against the opposite side of the axis:



2.5.5 Insertion of the ICs

The robot must never be switched on **without inserted IC2** (74HC139), otherwise the **transistors** for the motor-control **will be destroyed**!

The four ICs must be put with careful pressure into the sockets.

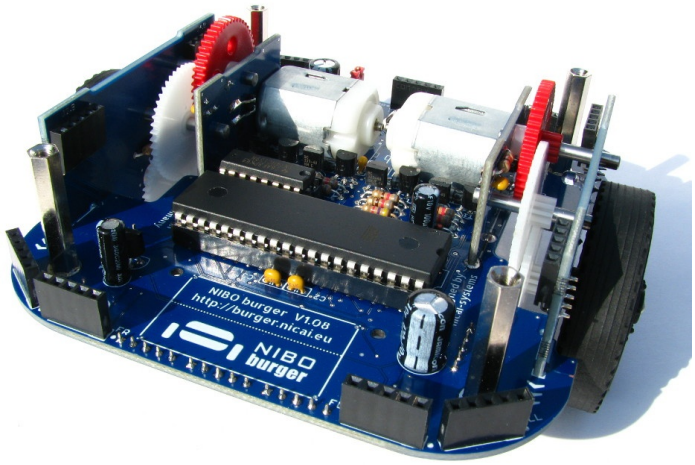
The notches on the ICs have to point in the same direction as the marks on the board!!

IC1: ATmega16

IC2: 74HC139

IC4: LM358

IC5: ATtiny44



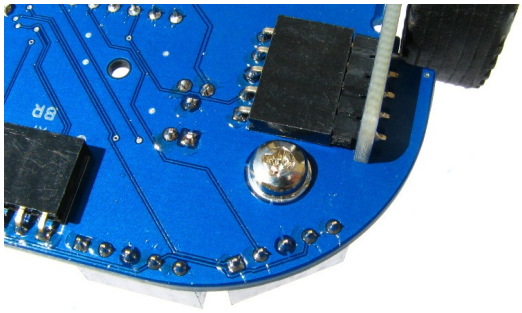
ICs are sensitive to electrostatic damage!

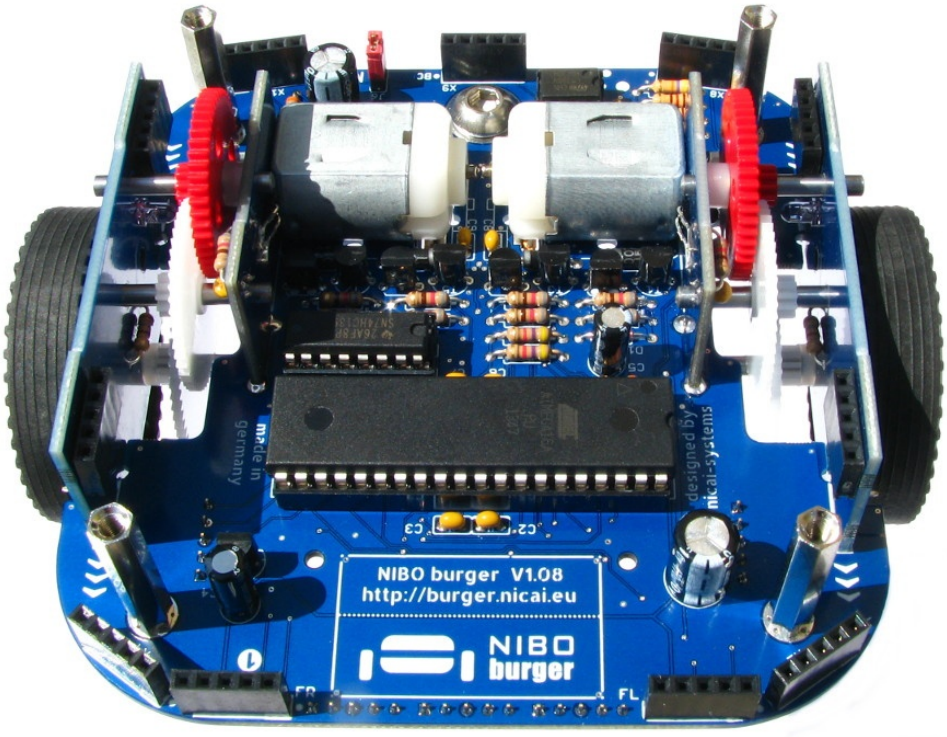
Electrostatic sensitivity means that these electronic parts can be destroyed only by being touched by an electrically charged person. A person can get electrically charged e.g. by wearing clothes of fleece material, or by walking on a carpet. By touching grounded metal the person can easily get discharged.

2.5.6 Assembling of the second layer

Now the second layer will be assembled:

First we fix the four bolts with four lenshead screws on board ①:

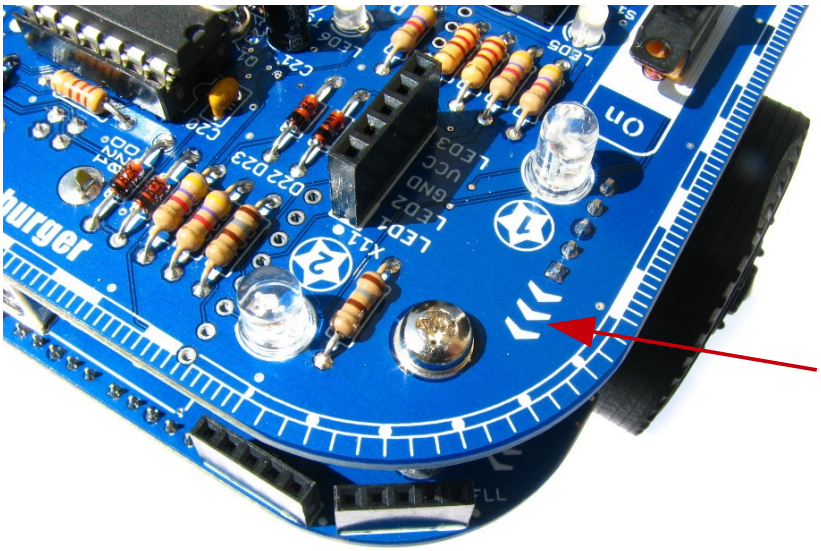




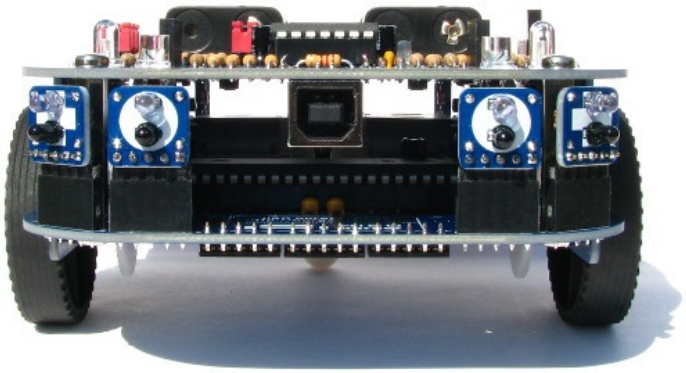
Now we connect board ② with the side boards in the **right orientation!!** and fix it with four screws.

All plug-in contacts must be **connected**!

Note: The arrow sysmbols on the boards show the driving direction:



Now the robot is ready for takeoff ;-)



3 Preparation for operation

After finishing the preparations the **NIBO burger** can now be activated step by step for the first time.

!! Important !!

The **NIBO burger** must never be switched on **without inserted IC2** (74HC139), otherwise the **transistors** for the motor-control **will be destroyed**!

1. **Switch off** the robot
2. **Remove** all **sensor bricks**
3. **Take off** the motor jumper **J6**
4. Insert 4 x Micro AAA 1,2V rechargeable batteries

Now the **NIBO burger** has to be **switched on**, then the white **LED 5** near to the switch **must** flash.

3.1 Part I – Coding-LEDs & buttons

About 5 seconds after switching on the leds **LED 1 – LED 4** should flash one after another for a short time.

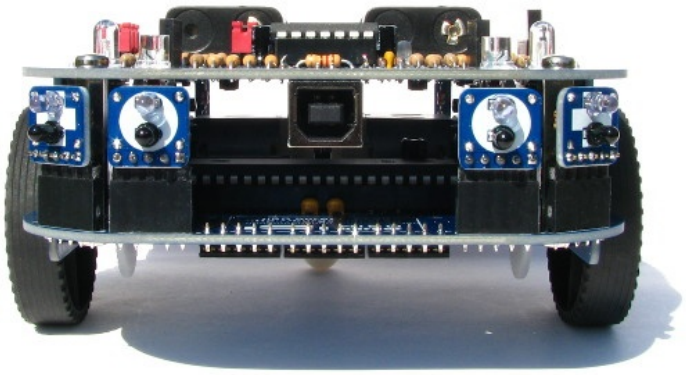
Now press **button 1**, then **LED 1** must glow.
If **button 2** is pressed, **LED 2** has to glow.
While **button 3** is pressed, **LED 3** must glow.

All coding leds and buttons are now checked and we **switch off** the **NIBO burger**.

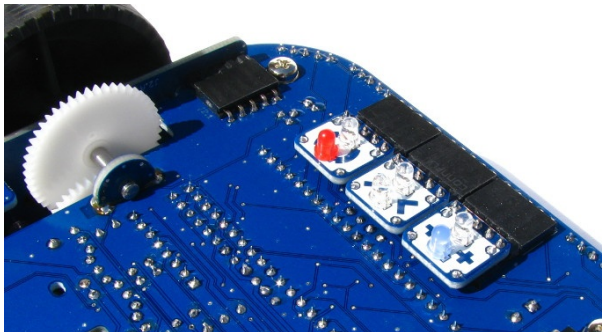
3.2 Part II – Sensor bricks

We build the following setup to test the sensor bricks:

Put the four **IR sensor bricks** into the front slots (**FLL** – **FRR**):



The **colour sensor bricks** must be put into the bottom slots in the **following order** (BR - red, BC - green, BL - blue):



Now **press and hold button 1** and **switch on** the robot.

Then LED 1 must flash. Now loose the button! LED 1 flashes shortly and the test program has been started.

We start with the test of the **IR sensor bricks**:

If you place your finger in about 3 cm distance in front of a sensor, the respective led will glow (e.g. LED 1 if sensor FLL is touched).

Try this with all IR sensor bricks.

Note: If the leds glow **permanently**, you may have forgotten to shrink the phototransistors with heat-shrinkable tubing (see page 34)!

Now we test the functionality of the **floor sensors / colour sensor bricks**. Press once **button 1**:

Raise the robot and test the sensors analog to the IR sensor test.

LED 1 should glow for the **blue** sensor brick, **LED 2** and **LED 3** should glow for the **green** sensor brick and **LED 4** should glow for the **red** sensor brick.

Now **switch off** the robot.

3.3 Part III – Motors & odometry sensors

Now **press and hold button 2** and **switch on** the robot.

Then LED 2 must flash. Now loose the button! LED 2 flashes shortly and the test program has been started.

We start with testing the **odometry sensors**. We want to verify that the phototransistors are able to detect the **turns of the wheels**.

Now turn carefully (from the top side) the **left red gear**. While doing this **LED 1** and **LED 2** must flash alternate. If the photoelectric barrier is blocked by the gear the red led flashes. If it is not blocked then the blue led flashes.

The right side has to be tested analog.

Now we test the motors. Press once button 2:

First we must connect jumper **J6**. Now the robot is able to drive!

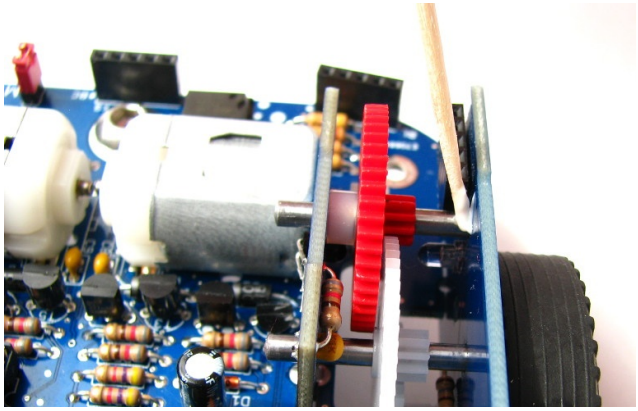
- Press button 1 → the robot drives forward
- Press button 2 → the robot stops
- Press button 3 → the robot drives backward

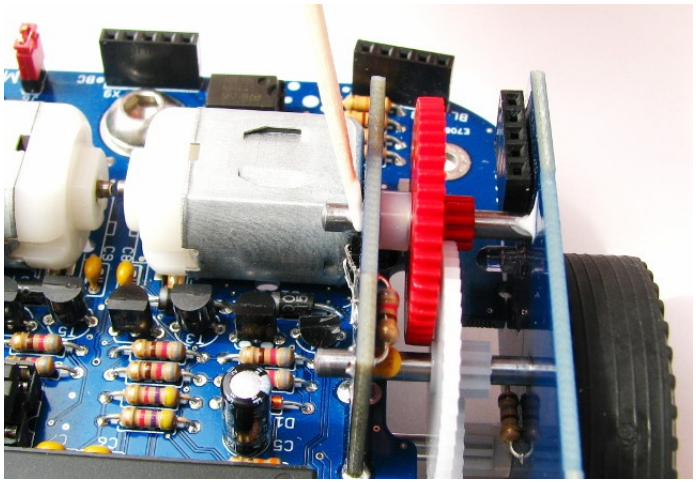
It's possible that **NIBO burger** will not drive in a straight line. That doesn't matter for it is an unregulated drive!

Now the robot has to be **switched off**.

Tip: You can reduce the operating noise by greasing the transmission for example with a greasy ointment and a toothpick.

Grease both sides of the axes at the contact points of axes and circuit boards:





Additional the other axes can be greased.

3.4 Part IV – Calibration of the sensors

To calibrate the sensors we use the included cards „**Calibration**“ and „**Colour Card**“.

Now **press and hold button 3** and **switch on** the robot.

Place the robot at **position 1** of the card „**Calibration**“ (the three colour sensors must be above the black area).
Now push button 1. Then LED 1 must flash.

Then place the robot at **position 2** of the card „**Calibration**“ (the three colour sensors must be above the white area).
Now push button 2. Then LED 2 must flash.

The calibration is now finished and stored!

With the **Colour Card** we can check if the sensors are able to detect correct colours:

Therefore you have to place the three colour sensors above an coloured area:

- **blue** area → LED 2 and LED 3 flashes
- **red** area → LED 1 and LED 4 flashes
- **green** area → LED 1 and LED 2 flashes
- **yellow** area → LED 3 and LED 4 flashes

Now the testing is finished and you can start with programming your robot!

3.5 Installation of the NiboRoboLib

Now the NiboRoboLib has to be installed. The **latest** version and an **installation manual** (.pdf) are to find here:

http://www.roboter.cc/niboRoboLib

All files are also available on the enclosed CD.

The **NiboRoboLib** contains:

- All necessary **drivers** for NIBO 2
- All necessary **drivers** for NIBO bee
- All necessary **drivers** for NIBO burger
- **RoboDude** (transmission programm for **.hex**- and **.xhex**-files)
- **C-library** and **test programms** for NIBO 2
- **C-library** and **test programms** for NIBO bee
- **C-library** and **test programms** for NIBO burger
- **Calibrating programms** for the sensors
- **ARDUINO**-library for NIBO 2
- **ARDUINO**-library for NIBO bee
- **ARDUINO**-library for NIBO burger

During installation it is possible to choose the desired packages.

After the installation the **NIBO burger** is ready to use!

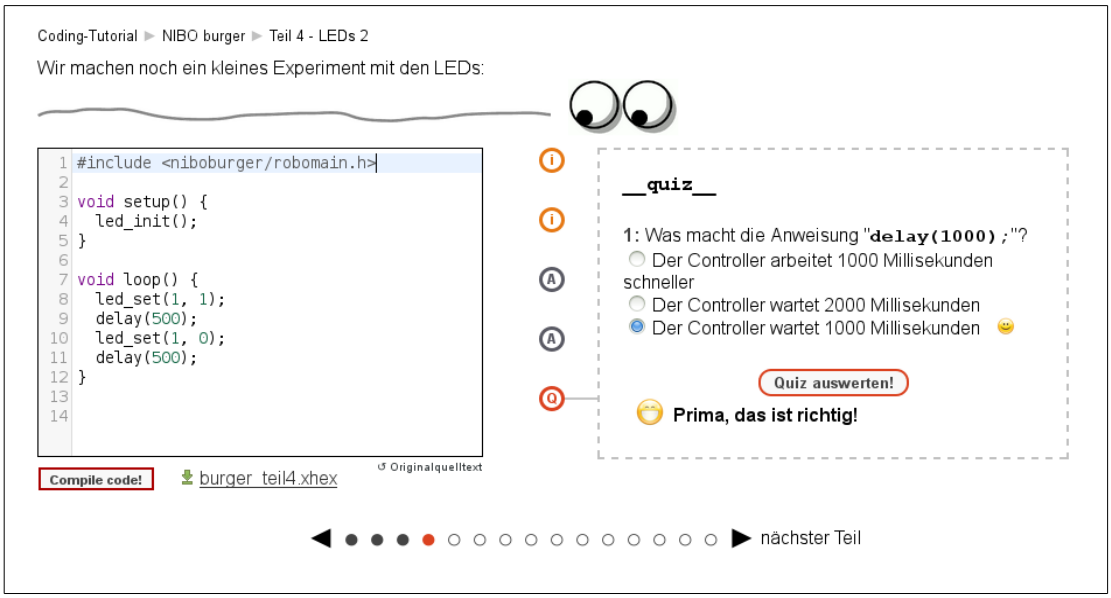
3.6 Programming

There are different possibilities / programming environments for **NIBO burger**:

3.6.1 NIBO burger Coding Tutorial

Possibility 1:

You can easily start programming with the interactive *NIBO burger Coding Tutorial*. It guides you through all functions of the robot and simultaneously you learn programming:

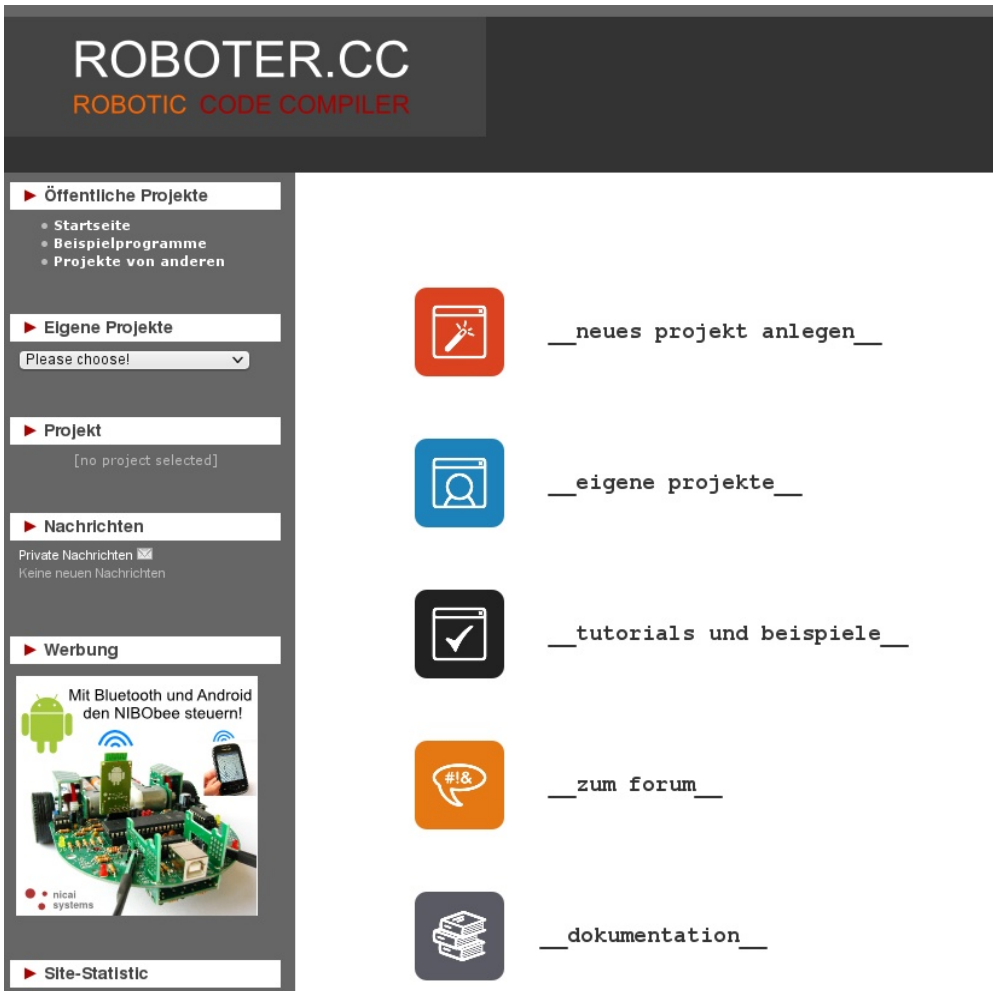


http://www.roboter.cc/codingTutorial/niboburger

3.6.2 Online-Compiler – Roboter.CC

Possibility 2:

Additionally you have the possibility to program the **NIBO burger** online at the Roboter.CC platform:



Roboter.CC is an open-source platform. You can create own robotic projects, manage and compile them at the platform.

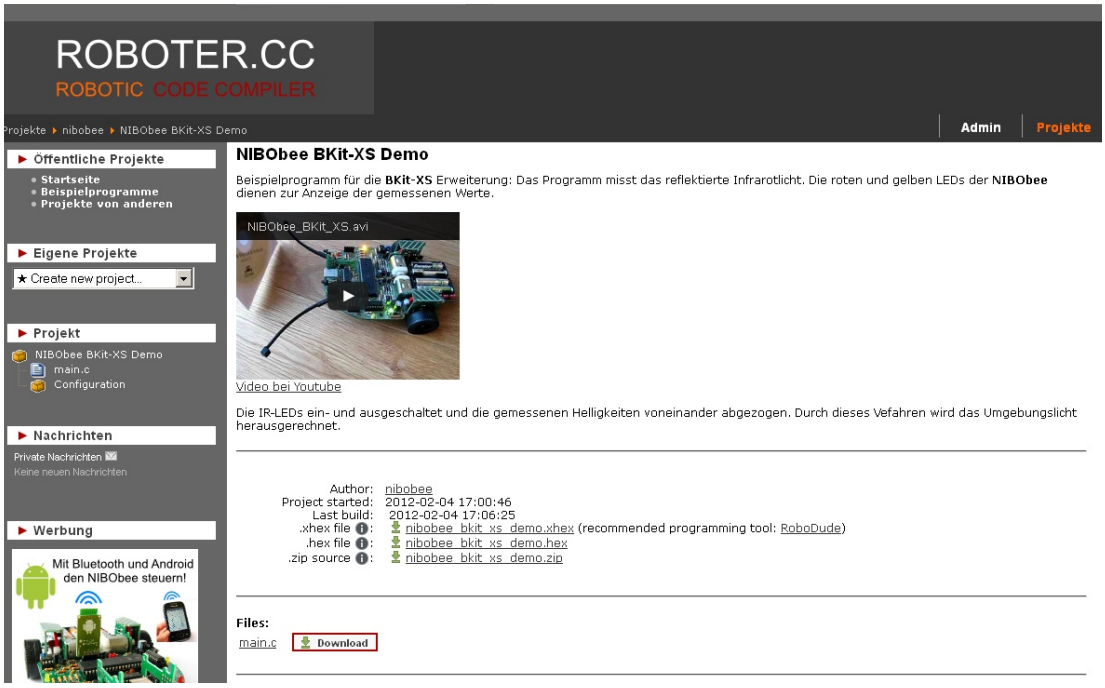
You can also easily test existing program examples. All projects are compiled online at **Roboter.CC** – it is not necessary to install a local programming environment – the library links are working automatically.

Easily:

1. Choose robot type and programming language
2. Write the program code
3. Transfer the resulting XHEX-file with *RoboDude* to the robot

Or:

1. Choose an already existing XHEX-file
2. Transfer the XHEX-file with *RoboDude* to the robot



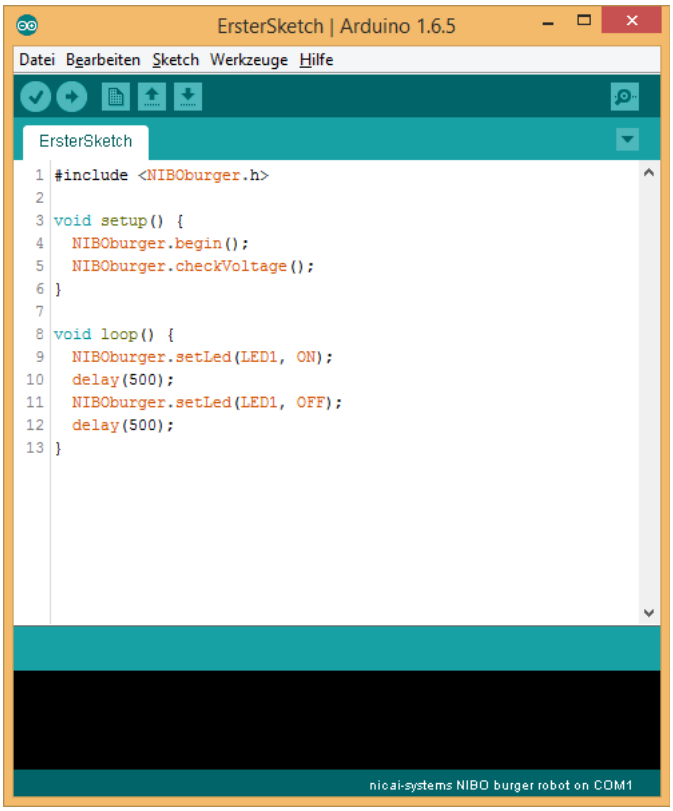
There is also a user forum (german) with lots of additional information, ideas, questions and answers!

http://www.roboter.cc

3.6.3 NIBO burger ARDUINO Tutorial

Possibility 3:

It is also possible to program the **NIBO burger** in **ARDUINO**:



A german **programming tutorial** inclusive **installation manual** with lots of examples and explanations is to find here:

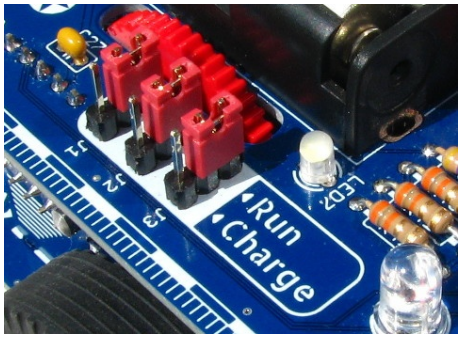
http://www.nicai-systems.com/de/nibo-burger-programmierung

3.7 Charging the rechargeable batteries by USB

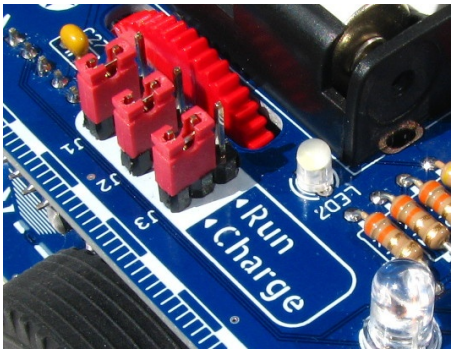
The rechargeable batteries of the **NIBO burger** can be charged as follows:

1. The robot is **switched off** and
2. It is **connected** over USB with the **computer** and
3. The position of the jumpers **J1**, **J2** and **J3** is changed into the „**CHARGE** position" (see photos):

Normal operation (**RUN**):



Charging mode (**CHARGE**):



The **white LED 7** (shown on the photos) indicates the **state of charge**:

LED7	***meaning***
off	no charging
on, with quick interrupts	charging
flashes every 2 seconds	finished charging
flashes 2 times a second	error
½ second on ½ second off	no rechargeable batteries / jumper position error

The charging mode terminates automatically after 7 hours.

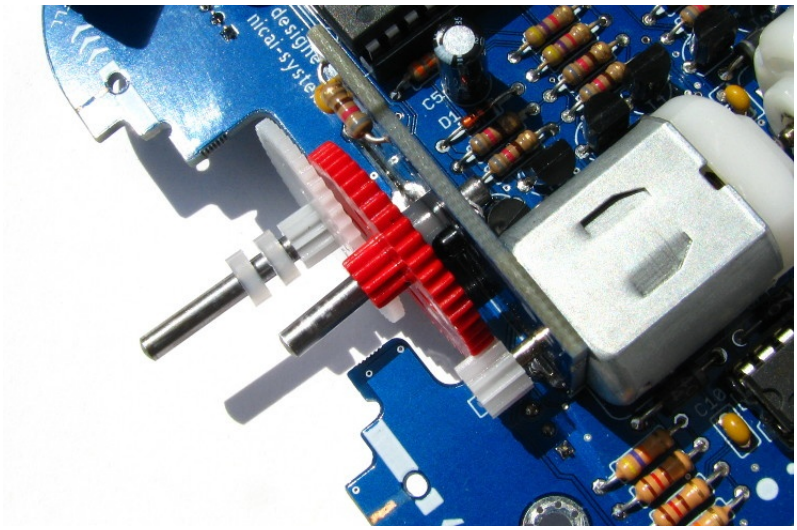
3.8 25:1 transmission ratio setting

The **NIBO burger** transmission unit can be assembled in two different settings: The previous setting allows precise driving with a 125:1 transmission ratio. The alternative setting with a 25:1 transmission ratio allows high speed driving.

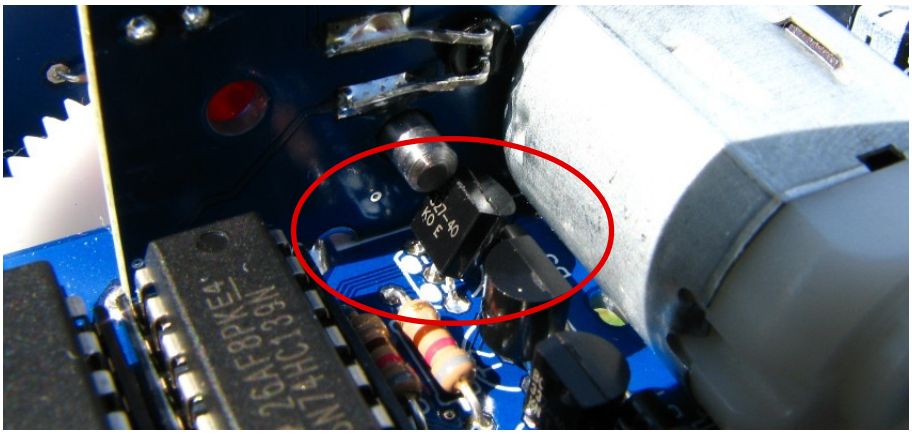
For the reconstruction to the **25:1** transmission ratio you have to disassemble the robot: take the second layer off, pull the wheels off and take the both side boards ⑤ and ⑥ off. Then you also have to take the axes off (all gears stay at the same position on the respective axis!).

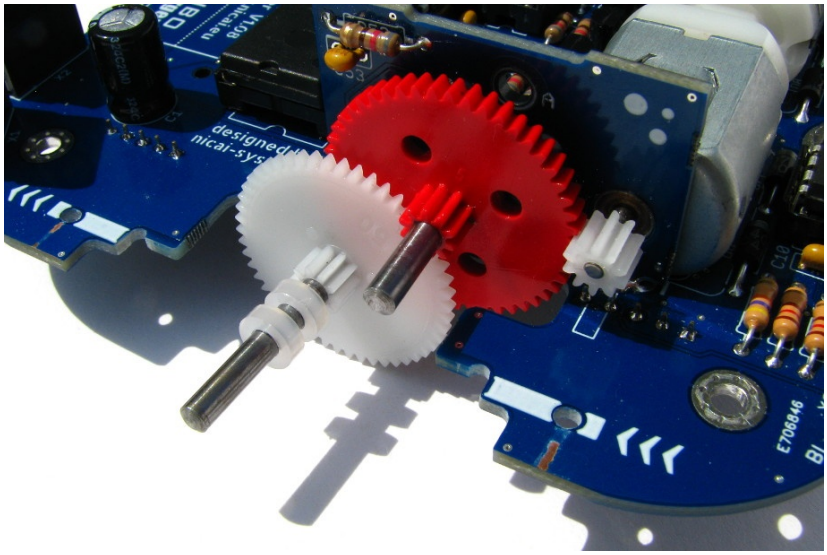
Now the transmission unit has to be assembled in a new setting:

The **red gear** with the standard (3 mm) distance ring has to be put into **borehole B**. The long axis with the white gear has to be put into the lowermost borehole and gets a **second** slim (2 mm) distance ring (the short axis with the white gear is **not** used in this setting):



Note: For this transmission unit setting it is necessary to bend the both transistors nearby the short axes a little bit:





Now the both side boards have to be connected and the robot can be completed as shown before. Then **NIBO burger** is ready to use!

ATTENTION! Forwards and backwards are now inverted!

3.9 Additional information

The *NIBO-Wiki* provides additional information like **FAQ's**, service links for replacement parts, technical details and much more:

http://www.nibo-roboter.de

4 Appendix

4.1 Resistor colour codes

The values of the resistors are indicated by a four band colour code:

colour	band 1	band 2	band 3 (factor)	band 4 (tolerance)
silver	—	—	$1 \cdot 10^{-2}$ = 10 mΩ	±10 %
gold	—	—	$1 \cdot 10^{-1}$ = 100 mΩ	±5 %
black	—	0	$1 \cdot 10^{0}$ = 1 Ω	—
brown	1	1	$1 \cdot 10^{1}$ = 10 Ω	±1 %
red	2	2	$1 \cdot 10^{2}$ = 100 Ω	±2 %
orange	3	3	$1 \cdot 10^{3}$ = 1 kΩ	—
yellow	4	4	$1 \cdot 10^{4}$ = 10 kΩ	—
green	5	5	$1 \cdot 10^{5}$ = 100 kΩ	±0,5 %
blue	6	6	$1 \cdot 10^{6}$ = 1 MΩ	±0,25 %
violet	7	7	$1 \cdot 10^{7}$ = 10 MΩ	±0,1 %
grey	8	8	$1 \cdot 10^{8}$ = 100 MΩ	—
white	9	9	$1 \cdot 10^{9}$ = 1 GΩ	—

4.2 THT parts list

Count	Value	Device	Part
2		BATTERYHOLDER	B1, B2
2	470 µF	CPOL-EUE3.5-8	C1, C12
7	10 nF	C-EU025-025X050	C2, C8, C9, C13, C25, C53, C54
2	4.7 µF	CPOL-EUE1.8-4	C21, C22
2	22 pF	C-EU025-025X050	C23, C24
8	100 nF	C-EU025-025X050	C3, C6, C7, C10, C11, C20, C26, C27
2	100 µF	CPOL-EUE2-5	C4, C5
4	BAT85	BAT85	D1, D22, D23, D24
8	1N4007	1N4007	D2, D3, D4, D5, D6, D7, D8, D9
2		BZX83V003.6	D20, D21
1		ATMEGA16A-PU	IC1
1		74HC139N	IC2
1		TS2950CT33	IC3
1		LM358N	IC4
1		ATTINY44A-PU	IC5
2	IR	LED3MM	IR55, IR56, IR1X, IR2X, IR3X, IR4X
3		STL3G	J1, J2, J3
8		BL5W	J1.1, J2.1, J3.1, J4.1, J1.B, J2.B, J3.B, J4.B
8		STL5G	J1.2, J2.2, J3.2, J4.2, J1.A, J2.A, J3.A, J4.A
7		STL5W	J1X, J2X, J3X, J4X, J5X, J6X, J7X
2		STL2G	J5, J6
2	red	LED5MM	LED1, LED4
2	blue	LED5MM	LED2, LED3
3	white	LED3MM	LED5, LED6, LED7
1	red	LED3MM	LED5X
1	green	LED3MM	LED6X
1	blue	LED3MM	LED7X
6	IR	PT-3mm	PT53, PT54, PT1X, PT2X, PT3X, PT4X
3	VIS	PT-3mm	PT5X, PT6X, PT7X
1	15 MHz	CRYSTALHC49S	Q1
5	3.3 Ω	R-EU_0207/10	R1, R16, R40, R41, R42
5	47 kΩ	R-EU_0207/10	R12, R15, R26, R27, R48
5	120 Ω	R-EU_0207/10	R13, R14, R30, R35, R36
13	4.7 kΩ	R-EU_0207/10	R2, R3, R22, R23, R31, R32, R33, R34, R37, R39, R43, R44, R45

6	180 Ω	R-EU_0207/10	R20, R21, R28, R29, R55, R56
2	68 Ω	R-EU_0207/10	R24, R25
13	820 Ω	R-EU_0207/10	R4, R5, R6, R7, R8, R9, R10, R11, R38, R46, R47, R53, R54
7	120 Ω	R-EU_0204/7	RA1X, RA2X, RA3X, RA4X, RA5X, RA6X, RA7X
7	2.2 kΩ	R-EU_0204/7	RB1X, RB2X, RB3X, RB4X, RB5X, RB6X, RB7X
1		M9040P	S1
3		10-XX	SW1, SW2, SW3
5	BC327-40	BC327	T1, T2, T7, T8, T10
5	BC337-40	BC337	T3, T4, T5, T6, T9
1		CON_USB_B	X0
10		BL5G	X1, X2, X3, X4, X8, X9, X10, X11, X12, X13

5 Links

In this subsection you can find a selection of links to web pages with related topics.

Development environments:

Atmel: http://www.atmel.com
Web page of the microcontroller manufacturer.
There are data sheets, application notes and the development environment AVRStudio.

WinAVR: http://winavr.sourceforge.net/
AVR-GCC compiler for Windows with many add ons, especially for AVRStudio.

AVRDude: http://savannah.nongnu.org/projects/avrdude/
free programmer software (suits for NIBO robots).

Roboter.CC: http://www.roboter.cc
Online code compiler & robotic online community, especially for robotic projects with lots of examples and user forum.

Further informations:

- **Nibo mainpage**: http://nibo.nicai-systems.de
  NIBO manufacturers web page. Provides technical information, the construction manual and additional links.
- **Nibo Wiki**: http://www.nibo-roboter.de
  provides all information about the NIBO robot kits.
- **Mikrocontroller**: http://www.mikrocontroller.net
  information about microcontroller and their coding.
- **AVRFreaks**: http://www.avrfreaks.net
  information about the AVR.