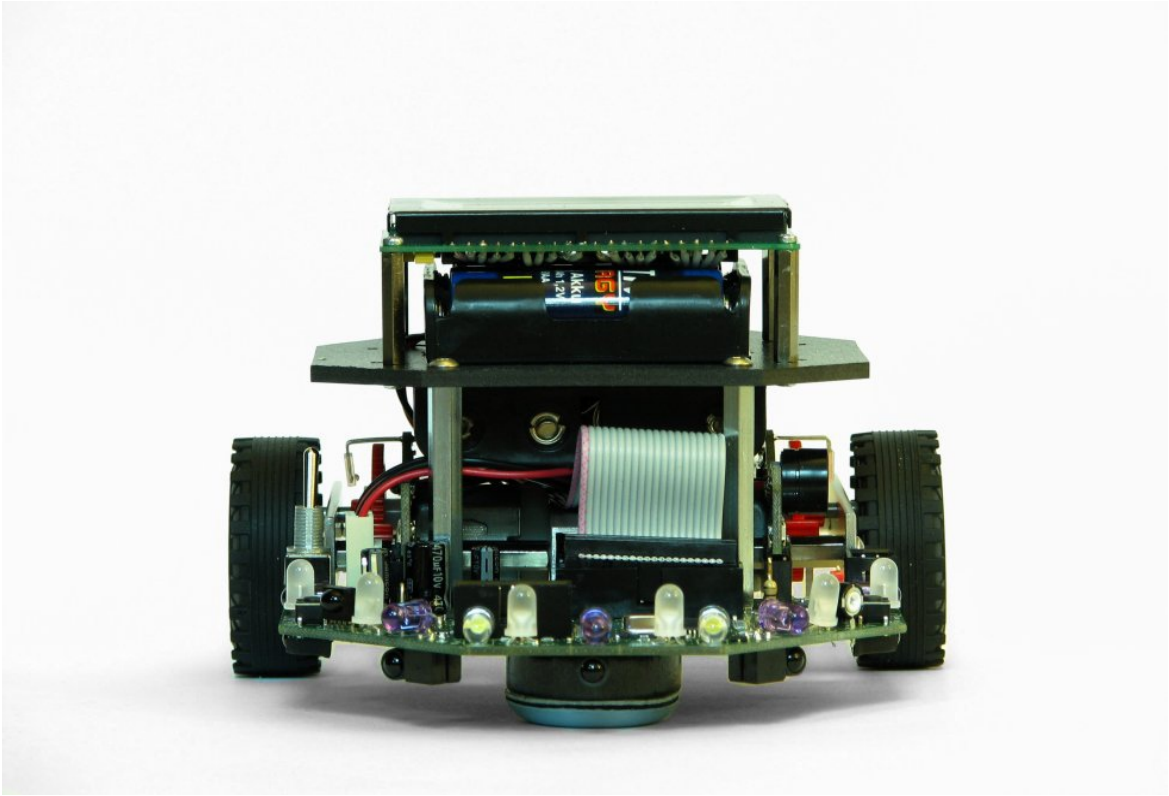
Robot kit Nibo2

Construction manual



nicai
systems

Safety instructions

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

- The robot kit Nibo2 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 mains 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 9.6 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 robot kit **Nibo2** is a programmable mobile robot which was developed by the company nicai-systems. As an autonomous robot it is able to drive independently into any direction. By its multiple sensors Nibo2 can avoid obstacles and follow lines on the floor.

The kit was designed to impart technical knowledge to young people. Particularly they can get experience in the fields robotics, microcontroller programming and measuring and control engineering. In order not to make life too much difficult for beginners the microcontrollers are sufficiently dimensioned. Thus there is much space for programming.

The robot is controlled by two microcontrollers: an Atmel ATmega128 as main controller and an Atmel ATmega88 controller. It can be programmed with every usual Atmel programming adapter. In particular the programming adapter UCOM-IR2 by nicai-systems is suitable for Nibo2.

The complex and time-critical modules motor-control and distance measuring are completely implemented on the ATmega88 microcontroller. The firmware for this controller is provided by nicai-systems, it can however be customized to the respective requirements of the user. Therefore the programmer does not need special knowledge in measuring and control engineering. There is no need for the user to think about time-critical program sections himself.

The purpose of development was to design a robot kit which is affordable for pupils and students without restrictions on important system components. The use of several distance sensors was a priority, in order to give the robot „a feeling“ for its environment.

The circuit boards are delivered with placed SMD (surface mounted devices) components, so that the customer only has to solder the THT (through hole technology) components. This allows **persons with fundamental soldering knowledge** to finish the boards.

1.1 Features

Technical data:

- Dimensions: (L x W x H) 136 x 131 x 78 mm
- Weight: 544g (with rechargeable batteries and display)
- Power supply: 8 AA Mignon rechargeable batteries with 1,2 V each
- Voltages: 5 V (stabilized) and 9,6 V
- Dimensions of main circuit board: 110 x 80 mm

Equipment:

- 5 IR-reflex sensors for distance measuring
- ATmega128 (16 MHz) as main CPU
- ATmega88 (16 MHz) for motor-control and distance measuring
- 8 multicolour LEDs for status display
- 2 bright, white LEDs for lighting
- 2 floor sensors to avoid fall
- 2 sensors to follow lines
- IR-receiver unit
- 4 wheel encoder sensors for exact detection of wheel rotation
- Solid aluminum structure for motor section
- Powered by two motors with 25:1 transmission
- Miniature speaker for acoustic signals
- ISP-interface (In-System-Programming)

Applications:

- Following lines
- Detection and avoidance of obstacles
- Autonomous cruising in rooms
- Following walls

- Detection of precipices
- Determination of different flooring
- Tracing objects
- Remote control of TV-sets and HiFi-equipment

Features:

- Main CPU with 128 kByte flash-memory
- Programmable in C, C++ and Java (GNU gcc and nanoVM)
- Separate controller for motor-control (wheel-encoder-analysis and PID controller) and for obstacle detection (modulated IR-light, 5 channels, up to 100 cm distance)

1.2 Motors

The robot is driven by two motors with 25:1 transmission. The motors are driven by a H-bridge with 31 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 speed of the wheels is measured with four photo-transistors and two IR-LEDs on the middle gearwheel of transmission. The components are on two odometry-sensor boards. The direction of rotation can be determined by phase shift of both IR-signals. 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 gets one of three possible signal-combinations from H-bridge: plus/minus (forward), minus/plus (backwards), plus/plus (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 a jumper for test cases.

1.2.3 Motor controller

The ATmega88 is used to regulate the motor speed. The main processor gives a reference speed, then the ATmega88 determines the actual speed with the help of the odometry-sensors and computes an optimal pulse/break rate for the PWM-signal of the motors.

The motor controller is implemented as PID-controller with modifications by Takahashi and „anti-windup“.

Typical values for the constants KI, KD and KP are given in EEPROM of ATmega88. The optimization of the values is carried out by the programmer.

1.3 Sensors

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

1.3.1 Distance measuring

For a rough estimation of the distances of obstacles Nibo2 emits modulated IR-light. The reflection factor is determined from the received signals. The reflection factor not only depends on the distance of obstacles but also of their *colour* in IR-range. Therefore just a rough estimation of distances is possible, which however is good enough to drive round obstacles. Under good conditions it is possible to locate objects up to a distance of one meter.

1.3.2 Floor- and line-following sensors

To measure the reflection factor of the floor under the robot there are four CNY70 photoelectric reflex-sensors. So it is possible to detect sheers and to follow lines. Additionally different floorings can be differentiated, if their IR-reflection factors are different. To avoid the influences of scattered light it is advisable to use a modulated signal.

1.4 Communication

The largest part of the communication is carried out by the IR-interface. One part of the communication is the reception and transmission of IR-remote-control commands. The other part is the communication with the separately available programming adapter UCOM-IR2.

1.4.1 IR-receiver

The IR receiver component SFH5110-36 is adjusted to a modulation frequency of 36 kHz and is able to receive RC5 and RC6 compatible remote control commands. The programming adapter UCOM-IR2 is able to communicate in these modulation frequencies too.

1.4.2 IR-transmitter

In addition to distance measuring the IR-LEDs are used to transmit light pulses. The IR-signals are modulated with a frequency of 36 kHz, which is coordinated to the IR-receiver component.

1.4.3 ISP interface

The robot can be programmed by a standard 6-pin Atmel ISP programming adapter. So the user has a wide choice of programming devices. The programming adapter UCOM-IR2 provides a 6-pin Atmel interface.

1.4.4 Extension port

The extension port provides the connection for future extensions.

1.5 Other hardware components

1.5.1 Status LEDs

The eight duo-LEDs show the actual status of the robot. They can be illuminated in the colours red, green and orange.

1.5.2 Lighting

With the two very bright white LEDs it is possible to light up dark areas. This may support for example the working with a camera.

1.5.3 Configuration jumper and function button

It is possible to call own functions as reaction to jumper and button events.

1.5.4 Reset button and voltage switch

The reset button provides the reset of the microcontrollers. The voltage switch separates the battery voltage from the circuit and provides to charge the batteries by the charging plug.

1.5.5 Display

Additionally the robot can be upgraded with a display which makes detailed information available to the programmer.

There are two displays connectable: a text display with two lines each with 16 characters, and a graphic display with 64*128 pixel (approx. eight lines each with 18 characters).

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:

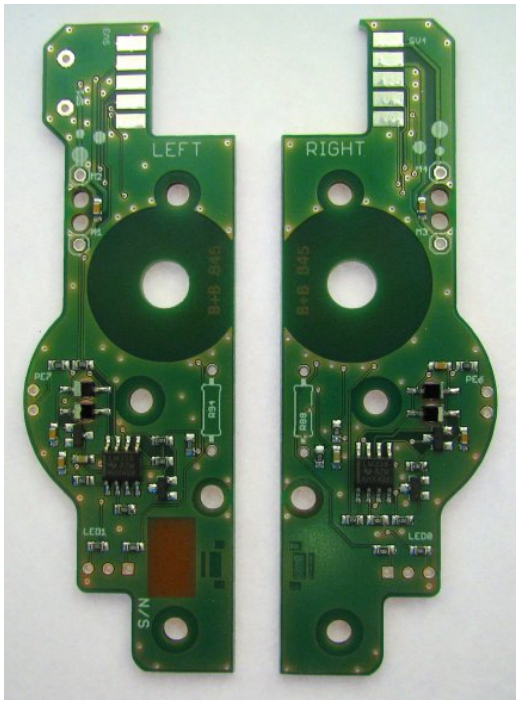
- Soldering iron with sponge
- Electronic solder wire
- Soldering remover
- Multimeter (with continuity tester)
- Electronic cutting pliers
- Long-nose pliers / pincer
- Universal pliers
- Small recessed head screwdriver
- 2 mm hexagon socket wrench (included in delivery)
- Small hammer
- Fine file

2.2 Soldering

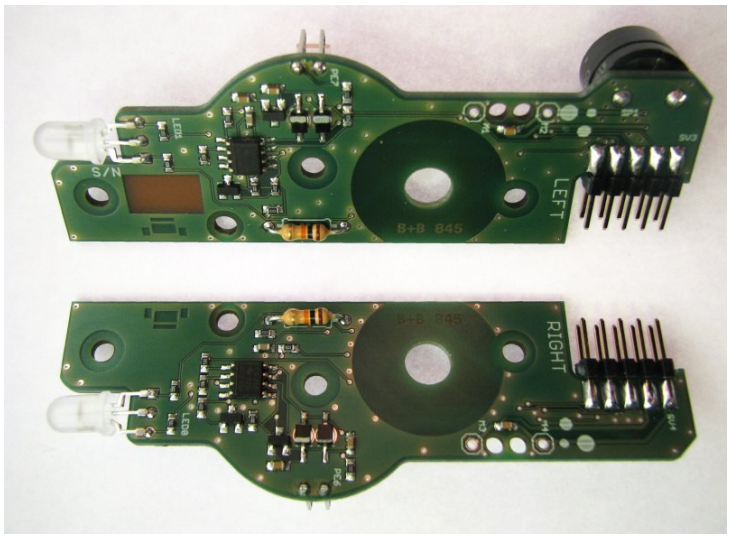
For soldering you should use a soldering iron or a soldering station with 50 W and a fine tip. If you are using an adjustable soldering station you should select a high temperature of 370 °C since the board is lead free like all circuit boards today. You should use flux cored solder wire with a diameter of 0.5 mm. The soldering time should be limited to a few seconds for each pad. Most electrical components react sensitively to high temperature.

2.3 Odometry sensor boards

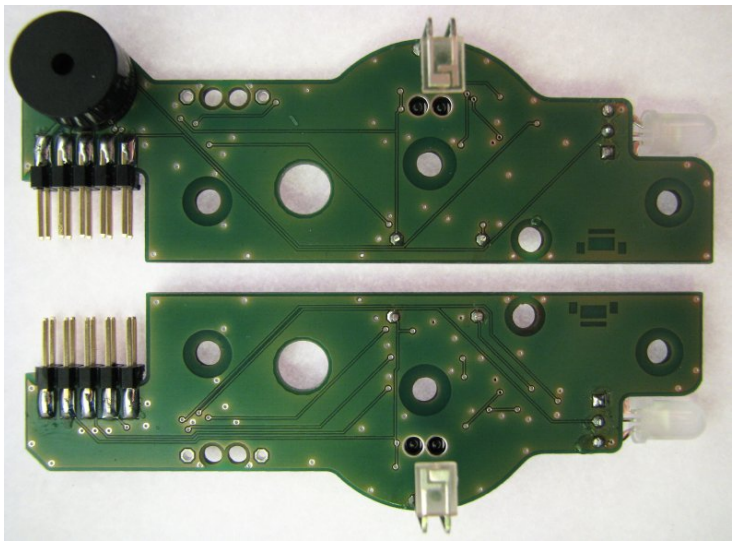
First the odometry sensor boards (OMS-boards) have to be soldered (the photo shows the components side):



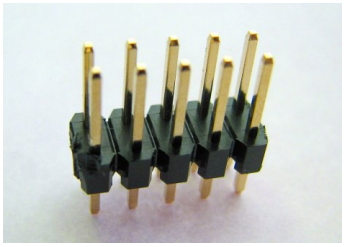
The finished component side (top side) of the boards should look like this:

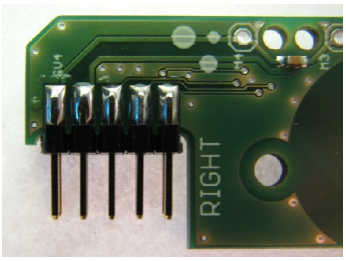


The finished bottom side of the boards should look like this:



2.3.1 10-way headers

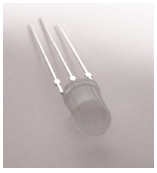




The 10-way headers are soldered with their shorter pins onto the OMS-boards (see the photo left side).
You don't have to pay attention to the polarity.

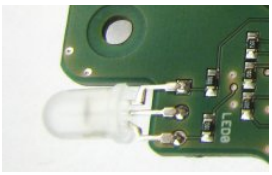
It is important to solder the headers in-line with the boards (see the photo right side)!

2.3.2 Multi colour LEDs



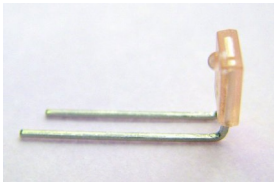
The multi colour LEDs **LED0** and **LED1** have got three legs, a short one (green anode), a long one (common cathode) and a medium one (red anode). The leg with **medium length** must be placed into the **rectangular** soldering pad.

value	*part*
LED (multi colour)	LED0 LED1



The LEDs are soldered to the component side of the OMS-boards. After soldering they have to be bent over backwards (see the photo).

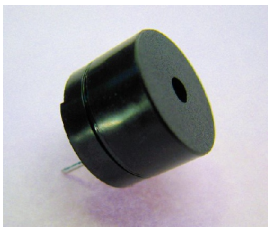
2.3.3 IR-LEDs



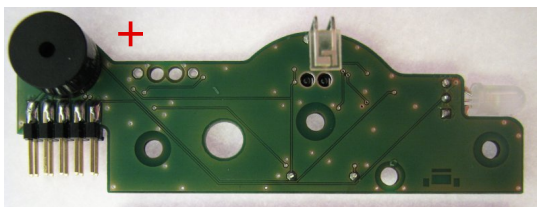
The two IR-LEDs (IRL80A) **PE6** and **PE7** have to be bent with pliers so that the lens face the bent legs. The section from the plastic body to the bend has to be 2 mm long. They have to be soldered onto the bottom side of the OMS-boards. The distance from the bent to the OMS-board has to be **8 mm** (see the photo of the finished OMS-boards).

value	*part*
IR-LED (IRL80A)	PE6 PE7

2.3.4 Miniature speaker



The speaker **SP1** has to be soldered onto the bottom side of the left OMS-board (marking: LEFT). You have to **pay attention to the polarity**: positive- and negative pole are marked on the component board. The polarity of the board is shown here:



2.3.5 Resistors

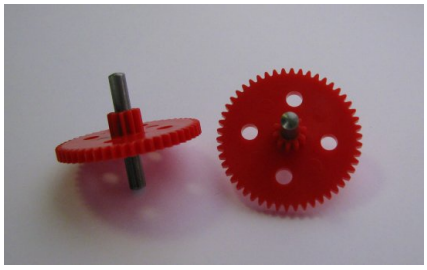
The both resistors **R88** and **R94** will be soldered horizontal onto the board. Therefore the legs must be bent over at both sides, as shown in the illustration.
The value of the resistors is indicated by a four band colour code on the resistor, which is explained in the appendix.

The following table shows the colour code of the used resistors:

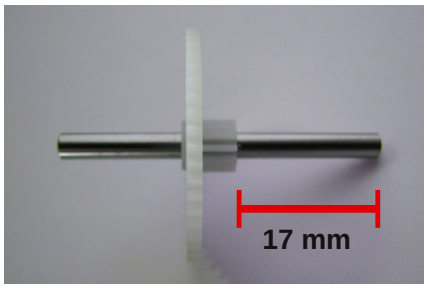
value	parts	colour code
10 kΩ	R88, R94	brown – black – orange – (gold)

2.4 Assembling of the engine section

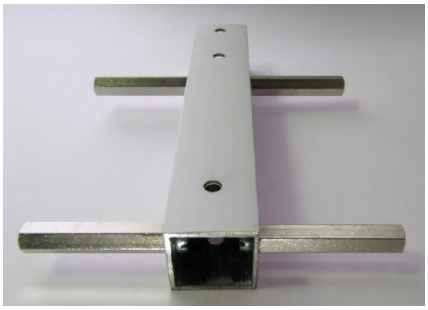
As preparation the two red double gearwheels must be pressed onto the two short steel axes (3x20 mm). Therefore you have to press the axis into the side of the gearwheel with the smaller gear. You must press the axis carefully with force (maybe with the help of a small hammer) through the gear. Afterwards the gearwheel should be in the middle of the axis:



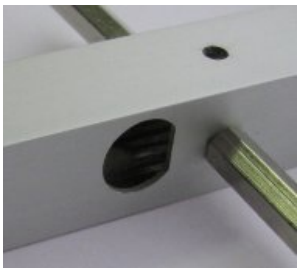
Now the both white double gearwheels have to be pressed onto the two long steel axes (3x37 mm). The distance from the smaller gear to the end of the axis should be 17 mm:



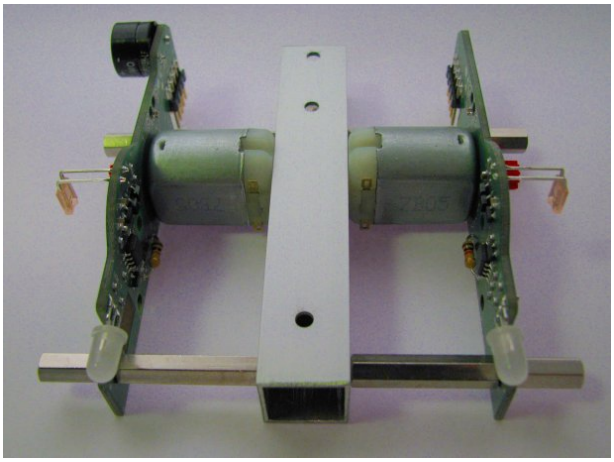
We begin with the central beam which is an aluminium square-profile. With the help of a long-nose pliers you have to put the four slotted screws (M3x7) from the inside through the respective holes and screw them from the outside with four 25 mm bolts:



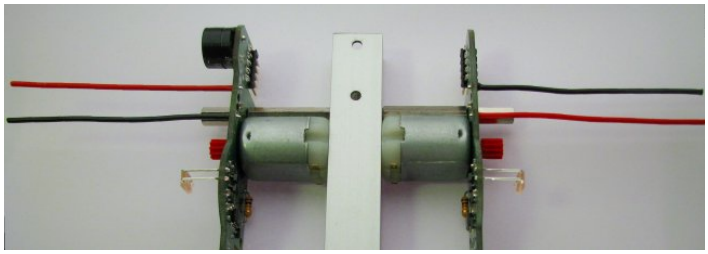
The next step is to mount the OMS-boards to both sides. Therefore you have to place the square-profile as shown in the image (page 16). The top side of the square-profile can be easily identified: the large boreholes for the motors are closer to the top side of the profile.



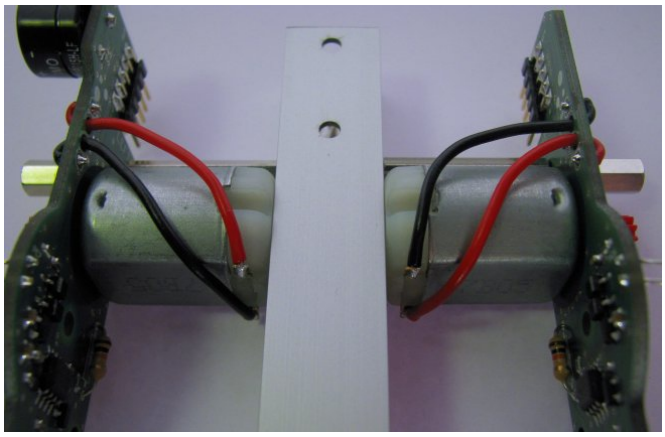
Now place the motors accurately fitting between the OMS-boards and the square-profile. Afterwards the OMS-boards must be screwed with the 12 mm bolts:



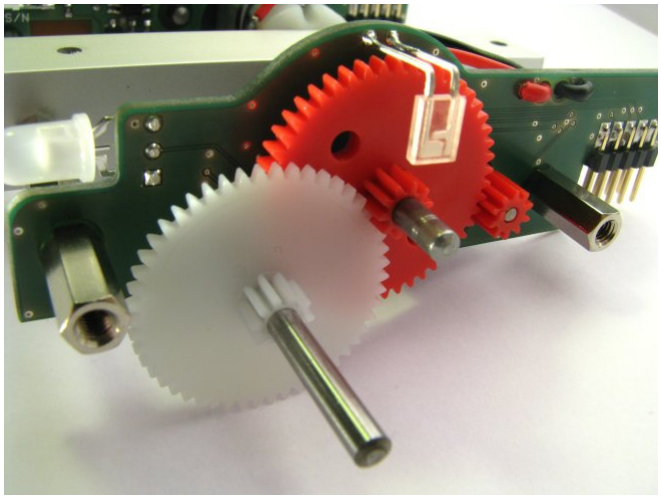
The red and the black cable must be cut into halves. The four pieces must be isolated 0,5 cm on one side. Afterwards they can be soldered from the outside to the OMS-boards:



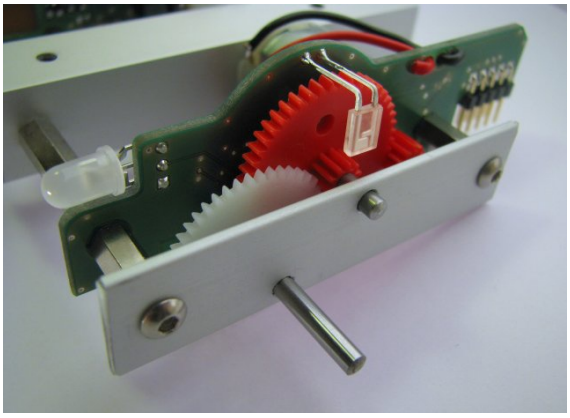
Now the cables must be put inwards through the holes and soldered to the motors (see the photo). Therefore you have to shorten and isolate them.



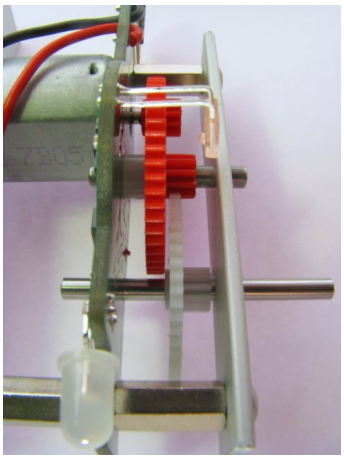
Now the transmissions must be mounted on both sides. Put the white plastic distance ring to the short axis with the red gearwheel (to the opposite side of the little gearwheel). Then the axis must be put (with the distance ring ahead) into the borehole below the IR-LED (IRL80A). Afterwards you have to put the long axis with the white gearwheel (the little gearwheel outwards) into the borehole next to the Nibo logo:



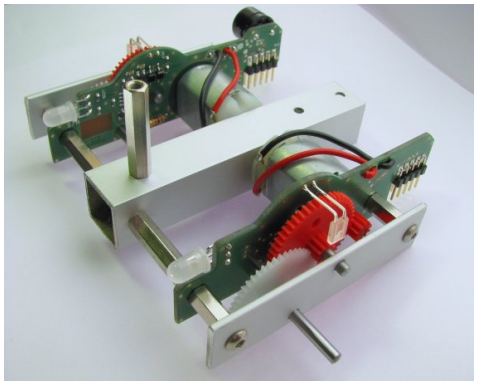
Now the transmission is fixed with one aluminum cover panel and two hexagon socket screws. The same procedure applies to the other side.



Detailed view of the gearwheels placement:

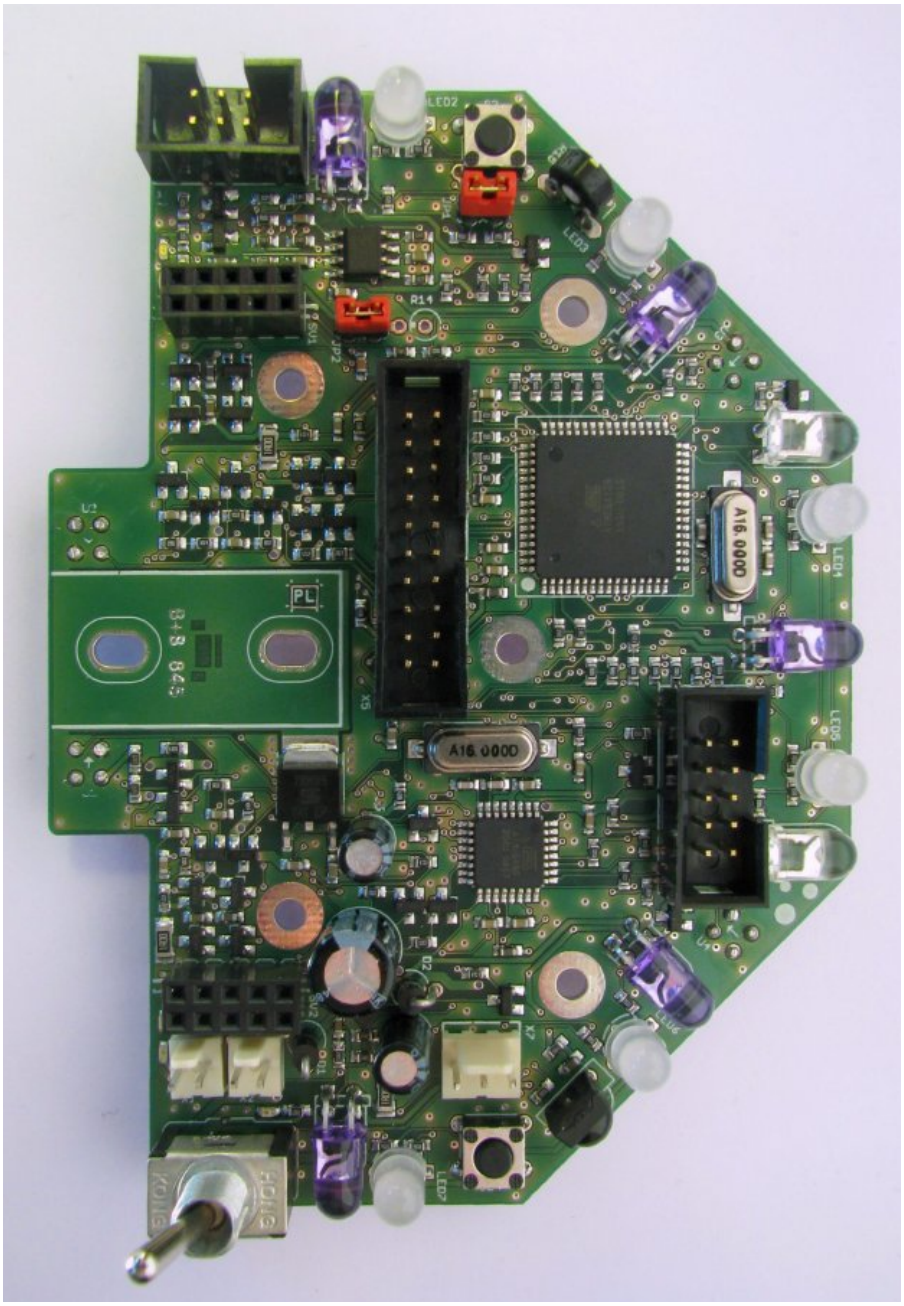


Finally a 25 mm bolt is fixed with a hexagon socket screw to the top side of the square-profile:

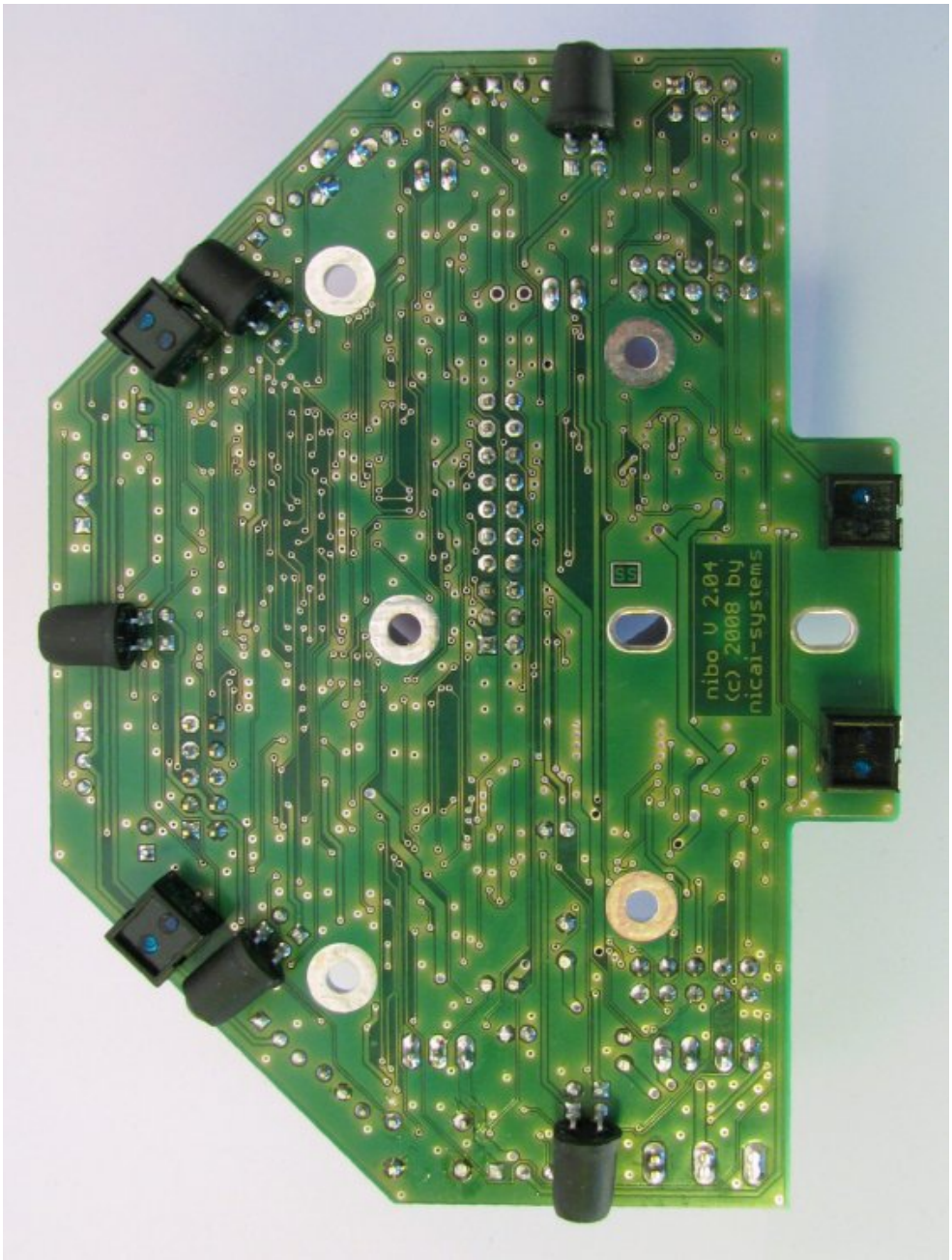


2.5 Placing components onto the main board

This section describes how to place the electrical components onto the main circuit board.
The finished top side of the board should look like this:



The finished bottom side of the board should look like this:



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

2.5.1 Resistor

The resistor **R14** only has to be soldered onto the board if the robot will be equipped with a **display**!
The resistor will be soldered upright onto the board. Therefore one leg must be bent over, as shown in the illustration. The body of the resistor must be soldered into the marked soldering pad.

The value of the resistors is indicated by a four band colour code on the resistor, which is explained in the appendix.

The **display set** contains the resistor **R14**. Depending on the type of the used display R14 has a different value: you have to solder a **100 Ω** resistor for the graphic display and a **47 Ω** resistor for the text display.

value	part	colour code
100 Ω	R14	brown – black – brown – (gold)
47 Ω	R14	yellow – violet – black – (gold)

2.5.2 Diodes

The diodes **D1** and **D2** of type SB140 must be bend like the resistor before placement. **You have to pay attention to the polarity:** the cathode is indicated by the ring on the diode and must have the straight leg. The leg of the anode has to be bent. Similar to the resistor the body of the diode must be soldered into the marked soldering pad.

type	*part*
SB140	D1 D2

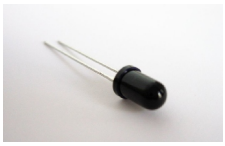
2.5.3 Photoelectric reflex-sensors

type	part
CNY70	U1 U2 U3 U4

The four photoelectric reflex-sensors **U1**-**U4** of type CNY70 will be soldered from the **bottom side** of the board (two inwards and two near the boarder of the board). The photoelectric reflex-sensors consist of an IR-LED (the blue window) and an IR-phototransistor (the dark window faced to the imprint).

You have to pay attention to the polarity! The IR-LEDs (the blue windows) of the two sensors **U3** and **U4** have to point to the direction of the edge of the board, that means the imprints (the dark window) have to face the center of the board.
The imprints (the dark windows) of the two sensors **U1** and **U2** have to be placed side by side, that means the IR-LEDs (the blue windows) also have to face the edge of the board (**see the image at the beginning of the section!**).
Additionally there are little marking arrows at the top of the board: the arrowhead points to the dark window.
Please notice: These parts are heat-sensitive!

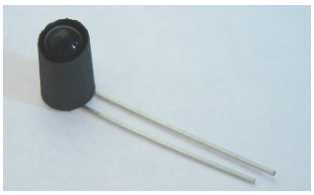
2.5.4 IR-photo-transistors



type	part
photo-transis-tor	PT1 PT2 PT3 PT4 PT5

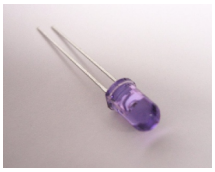
The photo-transistors **PT1**-**PT5** are for measuring the reflected IR-emission. In order to avoid disturbing influences they are soldered onto the **bottom side** of the board.

The legs have to be bent over near to the bottom of the phototransistor. **You have to pay attention to the polarity**: the **short leg** must be placed into the **rectangular** soldering pad. They must be soldered into the pair of soldering pads which is nearer to the edge of the board.



Additionally the photo-transistors must be shielded by 8 mm long pieces of heat-shrinkable tubing. Therefore each piece has to overlap the bottom of the transistor approx. 1 mm. Shrink the piece with heat (at best with hot air, if necessary with the soldering iron from approximately 2 mm distance to the piece!). The photo shows a photo-transistor with heat-shrinkable tubing before shrinking.

2.5.5 IR-LEDs



type	*part*
IR-LED	PE1 PE2 PE3 PE4 PE5

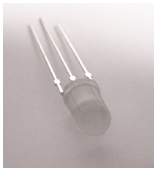
The IR-LEDs **PE1**-**PE5** provide the IR-emission. They will be soldered on the **top side** of the board.
The legs must be bent over approx. 2 mm from the bottom of the IR-LED (**opposite direction as the black phototransistors!**). For this purpose you may put some 2 mm thick material in between (screwdriver or something like that). **You have to pay attention to the polarity**: the **long leg** must be placed into the **rectangular** soldering pad.
Please notice: These parts are heat-sensitive!

2.5.6 White LEDs

type	*part*
LED (white)	LED8 LED9

The both white LEDs **LED8** and **LED9** must be bent over near to the bottom of the LED. **You have to pay attention to the polarity**: the **short leg** must be placed into the **rectangular** soldering pad.
Please notice: These parts are heat-sensitive!

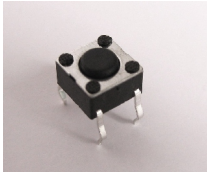
2.5.7 Multi colour LEDs



type	*part*
LED (multi-colour)	LED2 LED3 LED4 LED5 LED6 LED7

The multi colour LEDs **LED2**-**LED7** have got three legs, a short one (green anode), a long one (common cathode) and a medium one (red anode). The leg with **medium length** must be placed into the **rectangular** soldering pad. As additional identification the housing is flattened towards the leg with the medium length. This is also marked on the circuit board.
Please notice: These parts are heat-sensitive!

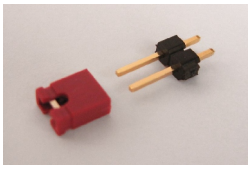
2.5.8 Button



type	*part*
button	S2 S3

The placement of the buttons **S2** (reset button) and **S3** (function button) is protected against polarity reversal. You have to place it onto the board with soft pressure till it snaps in. The pinout is **not** square and therefore only **two** of four orientations are possible.

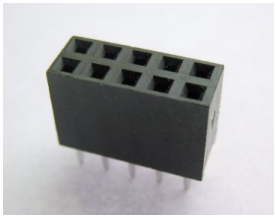
2.5.9 Jumper



The best way to place the jumpers **JP1** and **JP2** onto the board is to solder them complete (connector and bridge). You should pay attention to a short soldering time so that the plastics do not melt.

type	*part*
jumper	JP1 JP2

2.5.10 10-way sockets

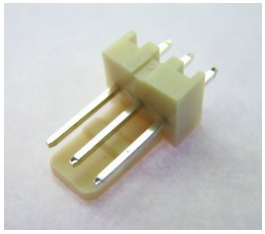


You don't have to pay attention to the polarity while soldering the two 10-way sockets **SV1** and **SV2**.

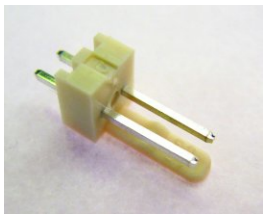
They should be carefully aligned, because the OMS-boards are attached to them later!

type	*part*
10-way socket	SV1 SV2

2.5.11 Connectors



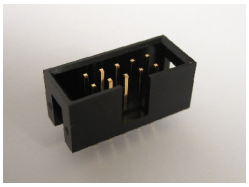
The 3-pin power connector **X7** and the both 2-pin battery pack connectors **X1** and **X2** have to be soldered onto the board with regard to the **correct polarity**. The noses of the connectors are marked on the circuit board.



The noses of all connectors have to point to the center of the board.

type	*part*
power connector	X7
battery pack connector	X1 X2

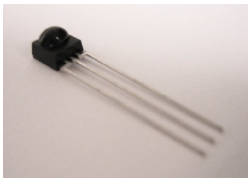
2.5.12 Box headers



The three box headers **X4**, **X5** and **X6** must be placed in **correct orientation** onto the board. The white printing on the circuit board shows the gap of the box header.
The 6-pin box header **X4** provides the programming interface of the robot. The 10-pin box header **X6** is the extension port. The 20-pin box header **X5** is for the connection to an LC-display.

type	*part*
box header (6-pin)	X4
box header (10-pin)	X6
box header (20-pin)	X5

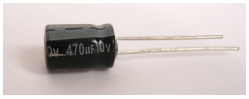
2.5.13 IR-receiver-IC



Placing the IR-receiver-IC **U5** you have to **pay attention to the polarity**: the knob of the IC has to be oriented towards the edge of the board.

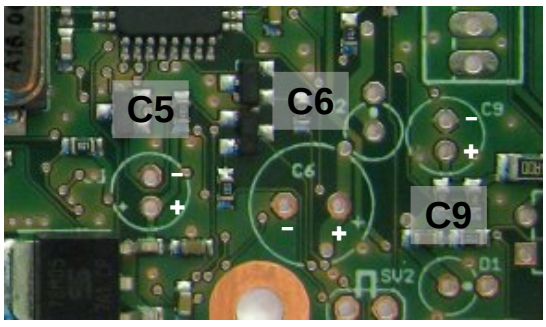
type	*part*
IR-receiver-IC	U5

2.5.14 Electrolytic capacitors



During placement of the 470µF electrolytic capacitor (**C6**) and the two 100µF electrolytic capacitors (**C5** and **C9**) onto the board **you have to pay attention to the polarity**: the **positive** connections are marked with a “+” 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 by thermal vias. You can find a “-” symbol on the housing of the capacitor.

value	*part*
470 µF	C6
100 µF	C5 C9

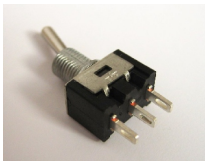


2.5.15 Potentiometer

Placing the potentiometer **R15** you have to **pay attention to the polarity**: there is only one possible orientation. The potentiometer is to adjust the contrast of the display.

type	*part*
potentio-meter	R15

2.5.16 Switch



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

type	*part*
toggle switch	S4

2.6 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.

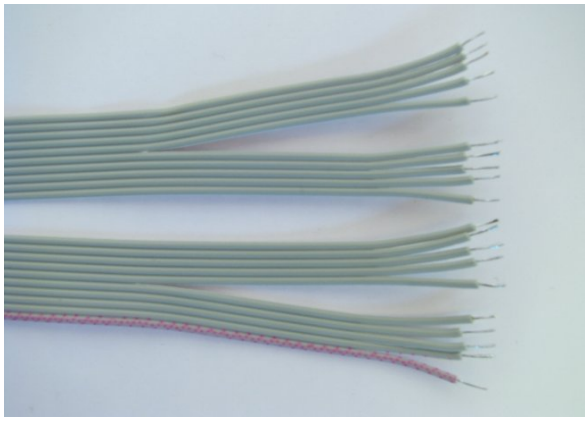
Finally check the board for short circuits and make sure that neither on the top side nor on the bottom side of the board remains any solder or wire.

2.7 Assembling of the graphic-display (optional)

First the 20-pin connector has to be pressed on the ribbon cable. You have to make sure that the **colour** marked conductor is connected to the **first** pin of the connector.

The residual conductors have to be soldered to the display. Therefore some preparations are necessary:
The cable must be divided for 12 cm into two groups (10 conductors in each group). Now each group has to be divided for 5 cm into two new groups (5 conductors in each group):

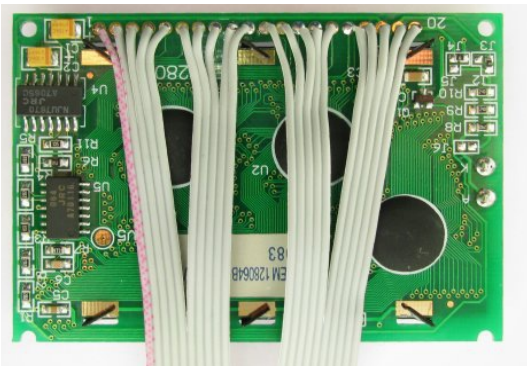
Now each conductor needs to be separated (approx. 2 cm), isolated (approx. 5 mm) and tinned. Afterwards you may solder five conductors in each step.



The conductors must be soldered in the numeric order to their corresponding pads on the display-board:

connector	display	function
1	1	+5V
2	2	0V
3	3	contrast
4	4	D0
5	5	D1
6	6	D2
7	7	D3
8	8	D4
9	9	D5
10	10	D6
11	11	D7
12	12	CS1
13	13	CS2
14	14	reset
15	15	RW
16	16	RS
17	17	EN
18	18	VD / +5V
19	19	VLED+
20	20	VLED-

The result should look like this:



2.8 Assembling of the text-display (optional)

First the 20-pin connector has to be pressed on the ribbon cable. You have to make sure that the **colour** marked conductor is connected to the **first** pin of the connector. Now the residual conductors must be soldered in the given order (**see table**) onto the display-board.

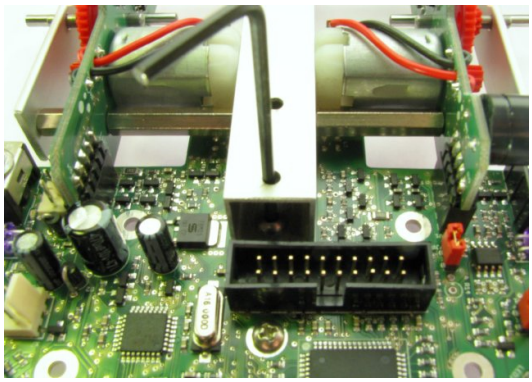
connector	display	function
1	2	+5V
2	1	0V
3	3	contrast
4	7	D0
5	8	D1
6	9	D2
7	10	D3
8	11	D4
9	12	D5
10	13	D6
11	14	D7
12	n.c.	CS1
13	n.c.	CS2
14	n.c.	reset
15	5	RW
16	4	RS
17	6	EN
18	2	VD / +5V
19	L+	VLED+
20	L-	VLED-

Conductor **1** and conductor **18** are both soldered to the **display contact 2**.

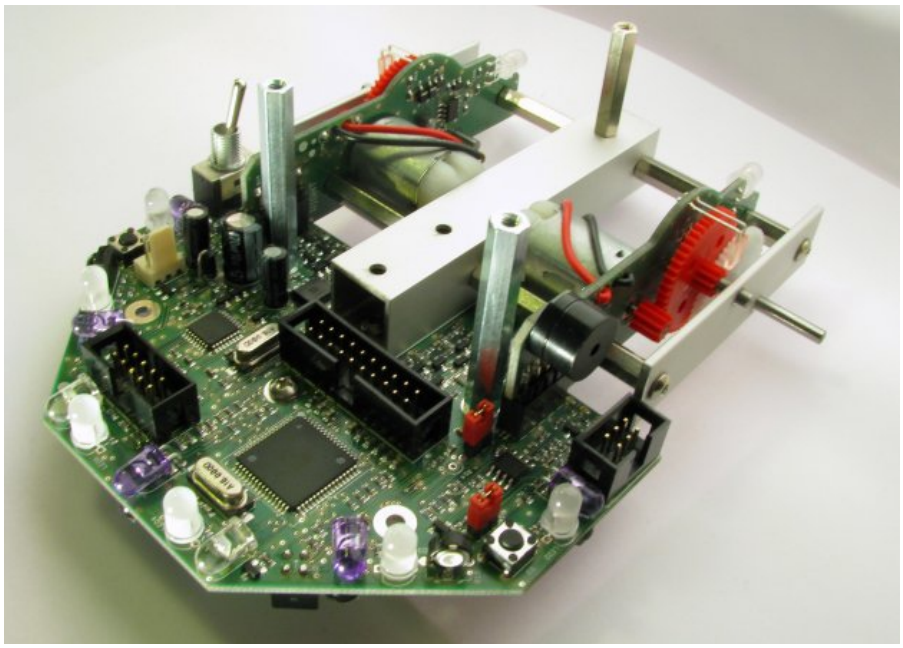
2.9 Assembling of the modules

First you have to glue the teflon pad onto the black wood-slice. Then the slice has to be mounted centered to the bottom side of the circuit board with the wood screw.

Now the engine section must be fixed to the board. You need a long-nose pliers/pincer and little bit of patience. First put two hexagon socket screws with a pincer from inside through the both front bore holes of the square-profile. Now the engine section is fixed with the two 10-way headers of the OMS-boards to the main circuit board. Pay attention that the both hexagon socket screws inserted before, are put through the board after the assembly. These two screws are now fixed from the bottom side of the board each with a plastic grommet (for not to damage the board) and a nut. Using the enclosed hexagon socket wrench the screws can be fixed through the upper bore holes of the square-profile.



Finally the two 40 mm distance-bolts have to be screwed (next to the 10-way headers) with hexagon socket screws from the bottom side to the board.

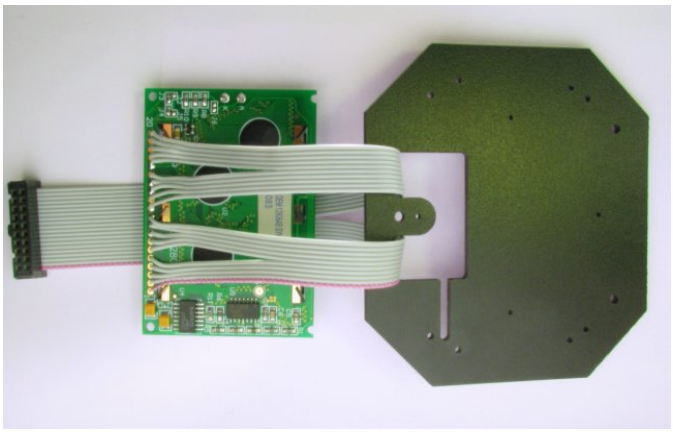


Now the 2nd floor is to be mounted:

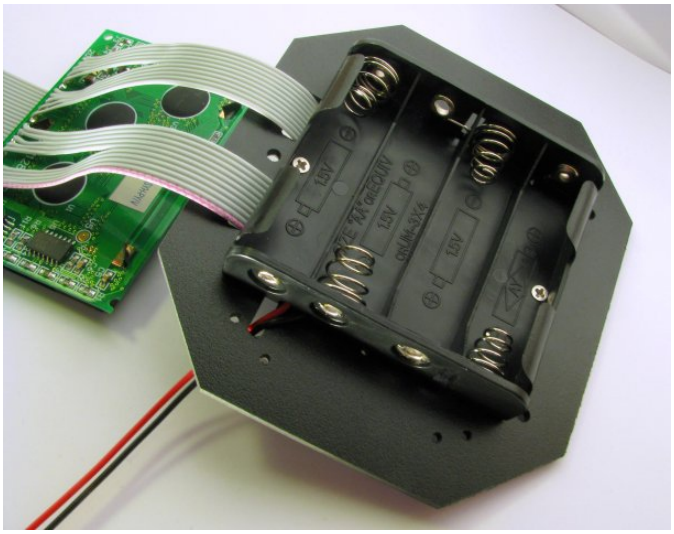
First the two battery packs must be screwed onto the plastic plate.

►You find a detailed illustration of the plate on page 35.

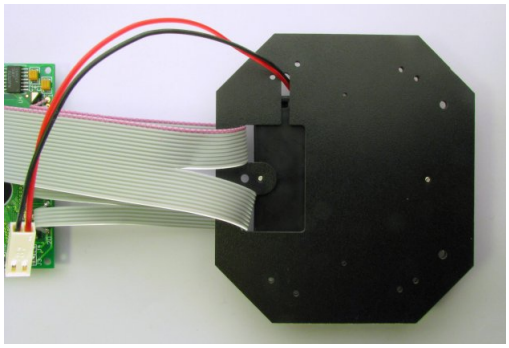
If the robot shall be equipped with a **graphic display**, you have to put the connector of the display cable through the cable cut-out of the plate first:



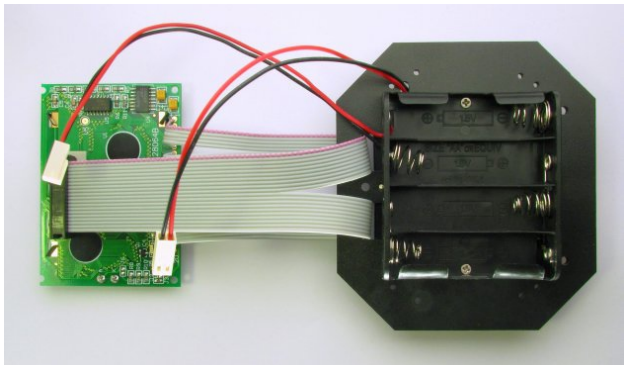
Before the upper battery pack is screwed at the boreholes (**2**) with the 5 mm recessed head screws (M2x5) the connector must be put through the cable cut-out.



Bottom side view:

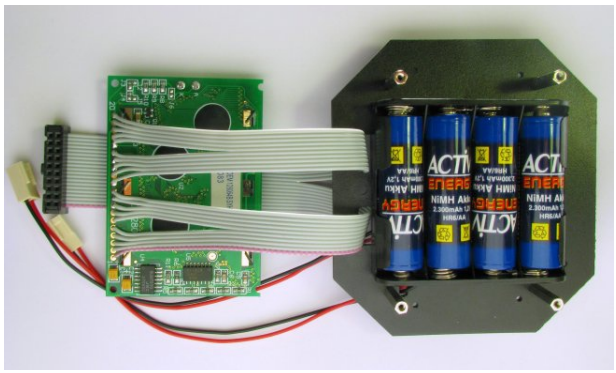


The second battery pack has to be screwed from the **bottom side** of the plate at the boreholes (**3**).



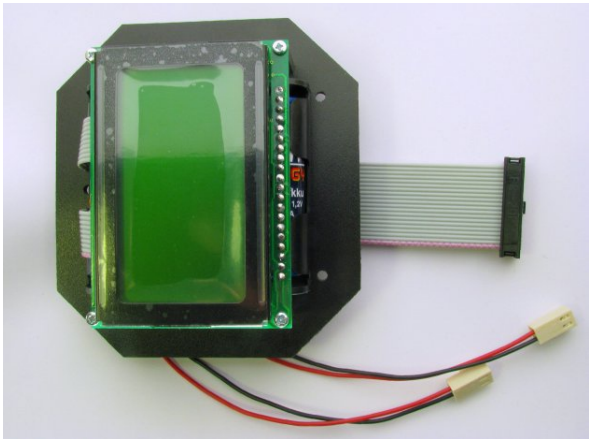
For the construction with graphic display: You have to screw four 20 mm bolts with the filister head screws (M2x6) at the bore holes (**4**).

Afterwards the Mignon rechargeable batteries are put into the battery packs.

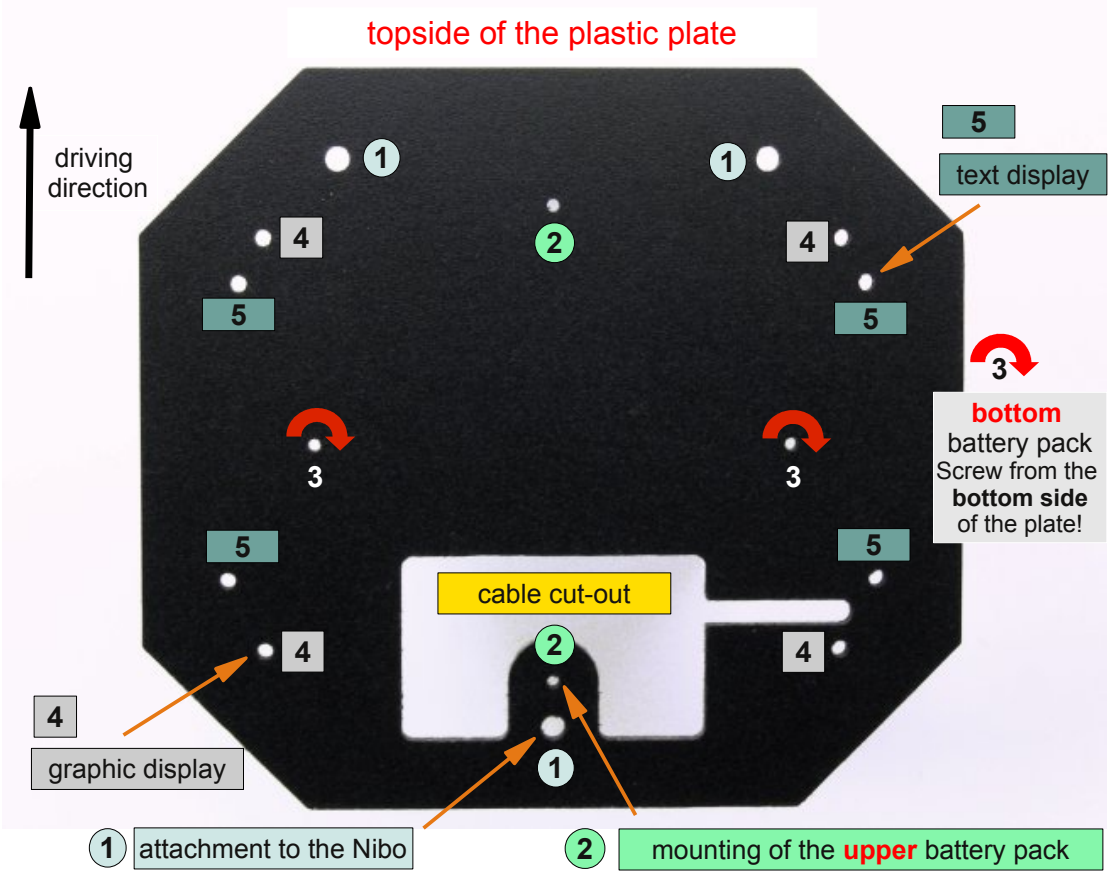


If required the batteries of the bottom side can be fixed by the enclosed cable ties. Therefore the two cable ties have to be spanned through the four remaining boreholes around both battery packs.

Now the display is screwed with four filister head screws (M2x6) to the bolts. The soldering points of the display finally have to point into the driving direction.

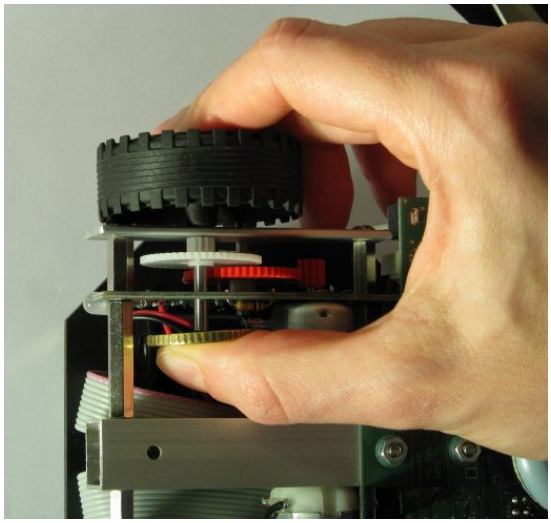


Overview of the plastic plate:

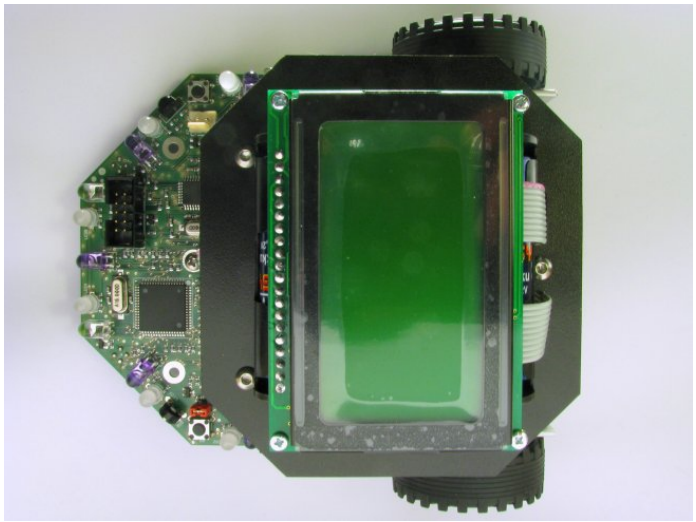


Now the complete 2nd floor has to be screwed onto the distance bolts of the engine section at the boreholes (**1**) with three hexagon socket screws. Before it is advisable to **switch-off the robot** (toggle switch backward), to put all connectors into the corresponding sockets and to place the cables optimal.

Finally both wheels have to be put onto the drive shafts. To avoid damaging the transmission you shall use therefore a piece of metal (such as a coin) to press it against the opposite side of the axis:



Now the Nibo is ready to operate (chapter 3).



3 Preparation for operation

After finishing the preparations the Nibo can now be activated step by step for the first time.

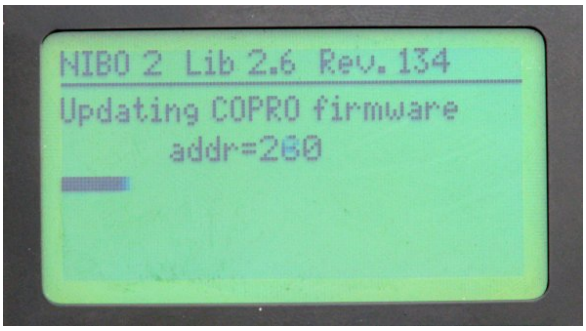
3.1 LED test

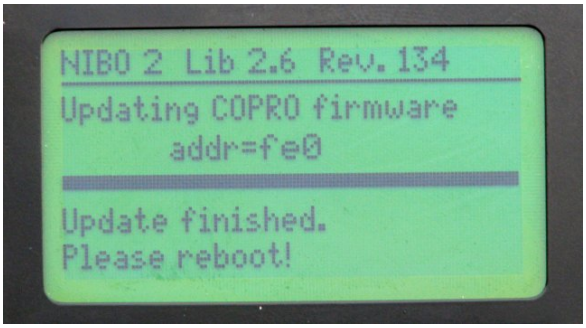
First you have to remove the jumpers **JP1** and **JP2**. Then switch on the robot (toggle switch forward). Now each status LED should glow red for a second and then it should glow green for a second in sequence (starting with the right rear light). Afterwards the both white LEDs should glow up at the same time and then the display light should be switched on (possibly you have to adjust the contrast of the display with a small recessed head screwdriver at the potentiometer). Finally all LEDs are glowing simultaneously and the procedure starts again.

3.2 Programming the co-controller

Next the ATmega88 co-controller (COPRO) can be programmed. The Nibo must be **switched off**, the jumper **JP1** (nearby the function button S3) must be **placed** and the jumper **JP2** (in front of the left OMS-board) still has to be **removed**.

Now switch on the robot and press the function button **S3** for 3 seconds simultaneously (the status LEDs indicate the status of the boot event). After 3 seconds the status LEDs on the left side should glow red. The firmware is now automatically transferred to the controller:

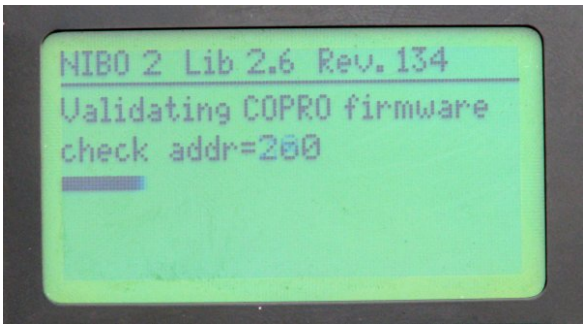




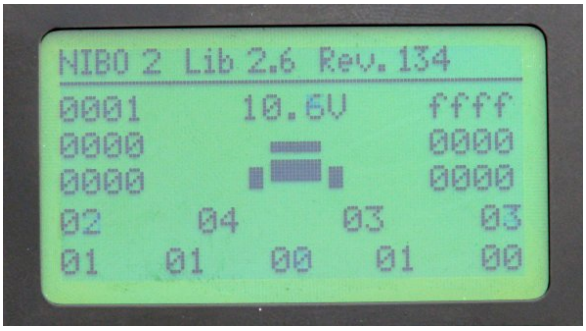
After successful programming all status LEDs are blinking green. If a new programming was not necessary, or in case of a problem, all status LEDs are blinking red.

3.3 Sensor test

Now push the reset button **S2** to start the test program. At first the firmware of the co-controller will be automatically checked:



After successful verification the following values are shown on the graphic display:




```
 NIBO2  Library version  revision

Odometry_R     Voltage    Odometry_L
Speed_R                     Speed _L
Current_R                  Current _L
Floor_R    Line_R   Line_L   Floor_L
Dist_R Dist_FR Dist_F Dist_FL Dist_L
```

`Odometry_R/L:`	counter for wheel rotation (ticks)
`Speed_R/L:`	speed of the wheel (ticks / second)
`Current_R/L:`	power consumption of the motor
`Floor/Line_R/L:`	floor sensors
`Dist_*:`	distance sensors

One chapter of the programming-tutorial explains how to **calibrate the floor sensors**.

3.4 Motor control test

After the sensor test the robot has to be **switched off** and **both jumpers** have to be **placed**. After switching on again the robot should wait 10 seconds, then drive a short distance forward, wait a moment and drive the short distance backward.

3.5 Fuse-Bits

The default values for the fuse-bits of the ATmega128 are: EXTENDED=0xFF, HIGH=0xC1, LOW=0xFF. These values **must not be changed**. Otherwise you are **locked out of the controller!!!**

If all tests were successful as far as now, you can start with own programs, **have fun!**

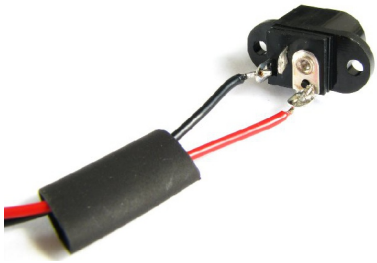
Additional information (german): http://www.nibo-roboter.de

Tip: At http://www.roboter.cc you can easily test ready programming examples or write some own code. All projects can be compiled online at **Roboter.CC** – the installation of a local development environment is not necessary. The libraries are linked automatically.

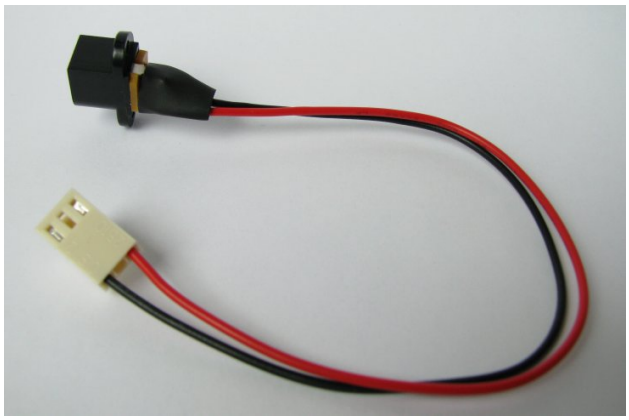
3.6 Adapter cable for battery chargers

The kit contains the required components for an adapter cable for battery chargers: One female connector for 2.1mm barrel connectors, one cable with 3-pin connector and a piece of heat-shrinkable tubing (the remaining piece of the IR-phototransistors).

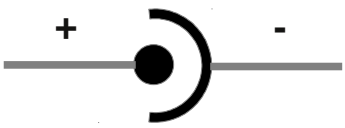
The red cable has to be soldered to the middle pin of the female connector, the black one must be soldered to the outer connection. **Before** soldering you have to put the cables through the heat-shrinkable tubing!



Afterwards you have to isolate the connections with the heat-shrinkable tubing:



If Nibo is switched off, the voltage of the battery pack is applied to the female connector as follows:



We recommend the usage of a battery charger with automatic switchoff for 8 battery cells.

4 Appendix

4.1 Resistor colour codes

The values of resistors are indicated by a four coloured band 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

Name	Type	Value	Package
C5, C9	electrolytic capacitor	100µF	E2-5
C6	electrolytic capacitor	470µF	E3,5-8
D1, D2	diode	SB140	RAD2,5
JP1, JP2	jumper		JP1
LED0, LED1, LED2, LED3, LED4, LED5, LED6, LED7	LED	red/green	DUOLED5MM
LED8, LED9	LED	white	LED5MM0S
PE1, PE2, PE3, PE4, PE5	IR-LED	SFH485	LED5MM0S
PE6, PE7	IR-LED	IRL80A	LED3MM
PT1, PT2, PT3, PT4, PT5	IR-phototransistor	SFH300	LED5MM0S
R14	resistor		0309V
R15	potentiometer	5k	CA6H
R88, R94	resistor	10k	0207/10
S2, S3	button		B3F-10XX
S4	toggle switch		M9040P
SP1	speaker	KSS1201	KSS1201
SV1, SV2	10-way socket	10pol	MA05-2
SV3, SV4	10-way header	10pol	MA05-2-SIDE
U1, U2, U3, U4	photoelectric reflex sensors	CNY70	CNY70
U5	IR-receiver-IC	SFH5110	SFH5110
X1, X2	connector	2pol	22-23-2021
X4	box header	6pol	MA03-2
X5	box header	20pol	MA10-2
X6	box header	10pol	MA05-2
X7	connector	3pol	22-23-2031

4.3 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 (downloader, suits for the Nibo!).

Further Information:

- Main web page for the Nibo robot: http://nibo.nicai-systems.com The Nibo manufacturers web page. Provides technical information, the construction manual and additional links.
- Nibo wiki: http://www.nibo-roboter.de provides all information about Nibo and the programming adapter UCOM-IR.
- Nibo Shop: http://shop.nicai-systems.de the robot can be purchased at the nicai-systems online-shop.
- Microcontroller: http://www.mikrocontroller.net information about microcontroller and their coding.
- AVRFreaks: http://www.avrfreaks.net information about the AVR.
- Roboter.CC: http://www.roboter.cc robotic online code compiler.