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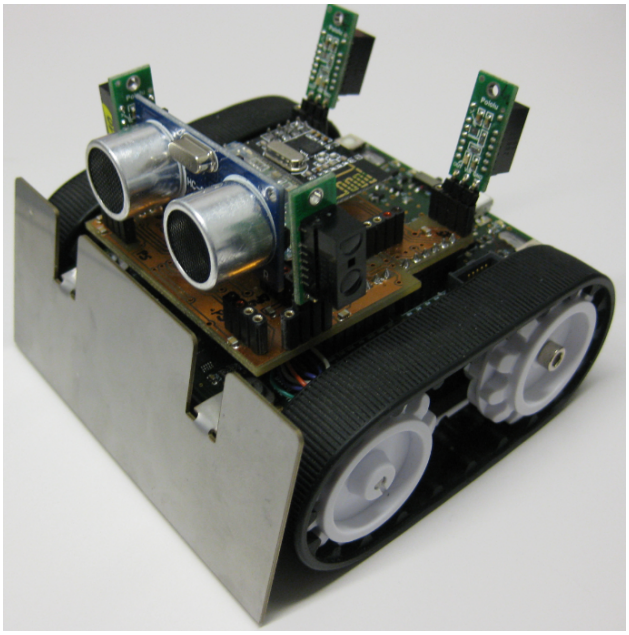
INTRO Sumo Robot

Hardware & Assembly Guide



Author:
Erich Styger, CC Electronics
erich.styger@hslu.ch

October 27, 2014

Revision History

Revision	Date	Author(s)	Description
0.01	24-Sep-13	EST	Initial version with LaTeX.
0.02	25-Sep-13	EST	Added schematic information.
0.03	26-Sep-13	EST	FRDM assembly instructions.
0.04	27-Sep-13	EST, AAL	References and Zumo Base Board assembly.
0.05	04-Oct-13	AAL	Added chassis assembly instructions.
0.06	05-Oct-13	EST	Added slide information.
0.07	13-Feb-13	EST	Completed improvement areas. Need to document new encoders.
0.08	26-Feb-14	AAL	Added description for new encoders.
0.08	17-Okt-14	AAL	Removed description part of old version, added description of encoders for the new one.
0.09	23-Okt-14	EST	Fixed motor connections.

Andreas Albisser (AAL), Erich Styger (EST)

Contents

1 Robot Assembly

This section describes how to assemble the Robot.

1.1 Material

Following parts are needed:

- Zumo Robot Chassis Kit (Pololu order number 1418)
- 2 Micro Metal Gearmotor with extended motor shaft (Pololu order number 2215)
- Optical encoder pair kit (Pololu order number 2591)
- Basic Sumo Blade for Zumo Chassis (Pololu order number 1410)
- Zumo Reflectance Sensor Array (Pololu order number 1419)
- Arduino stackable headers (Pololu order number #1035)
- 2x12pin SDM board connector for the Reflectance Sensor (2 headers, 2x6), Mouser P/N 649.89898-306ALF.
- A fully equipped Base Board with a Freescale K22 (ARM Cortex-M4F running up to 120 MHz)
- One 100mm Micromatch connection cable (Farnell order number 1056210)

You also need access to an workshop where you have access to tools, screws and glue and the possibility to solder (for example the electronic workshop, room number C301).

1.2 Arduino Headers

The robot features Arduino compatible headers so extension boards can be easily added. Any standard headers can be populated, and we are using headers from Pololu (#1035, Figure 1).

Figure 1: Pololu Stackable Headers

To make it easier to align the headers properly, use an existing Arduino shield. If you don't have one, then just be extra careful to properly align the headers.

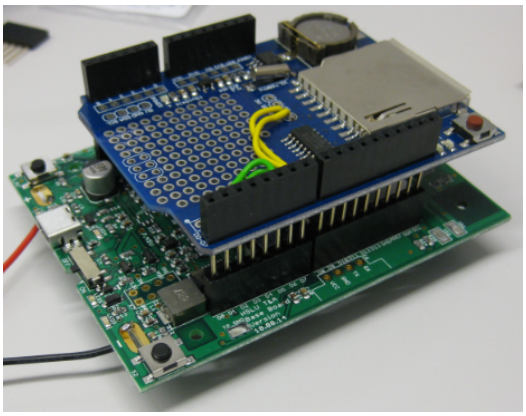


Figure 2: Arduino Shield to Help Align Headers

Because the PCB should be flat on the robot chassis as much as possible, clip the pins before soldering. Clip the pin about above the PCB, so the pin is still a little bit or about 0.2 mm above the PCB (Figure 3).

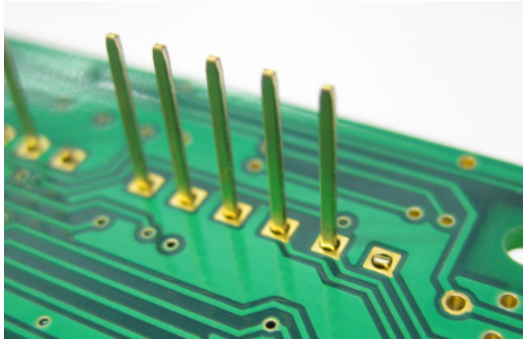


Figure 3: Clipped Arduino Header Pin

If you do not have an Arduino Shield availble, then clip and solder one header pin first (Figure 4). That way the header is already secured, and you can easily clip the other pins. If the headers are not properly aligned, you can easily fix it as only one pin is soldered.

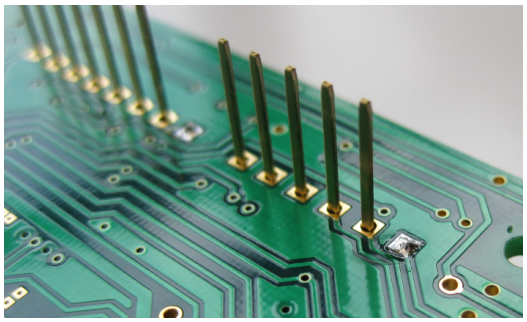


Figure 4: Clipped and Soldered Header Pin

Have all the four headers soldered to the board (Figure 5 and Figure).

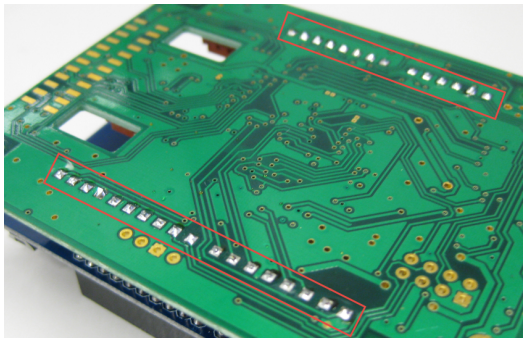


Figure 5: Four Arduino Headers Soldered to Board (Bottom)

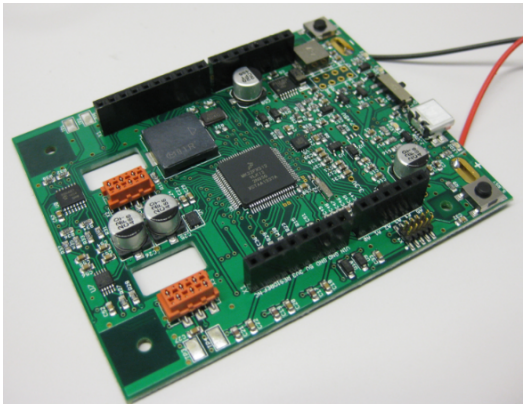


Figure 6: Four Arduino Headers Soldered to Board (Top)

1.3 Optical Wheel Encoders and Motors

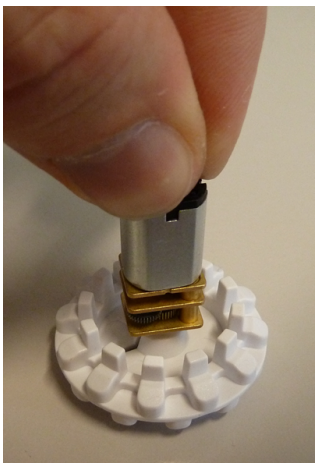
This section shows how the motors and the wheels get together, and how the optical motor shaft encoders get assembled. You need one set of Optical Encoder Pair Kit for Micro Metal Gearmotors (3.3V), Pololu Item #2591, two 75:1 Micro Metal Gearmotor HP with Extended Motor Shaft #2215 and one Micromatch 6-pin cable (Farnell Part Number 1056210) (Figure 7).

Figure 7: Motors, Encoders and Cable

From the Chassis Kit (#1418) we need the two wheels matching the motor shaft. Because some pressure is needed to put them together properly, the best way is to use your thumbs on the motor back part and to press gently the motor into the wheel (see Figure 8a). Because the shaft might not fit easily into the wheel, a few tips:

1. Use a file tool to round/cut the edge of the shaft, so it can fit easily.
2. Use a little bit machine oil or soap to reduce the frictional force while inserting.

Take care that the shaft does not need to absorb too much transverse force, because this could easily damage the gearing mechanism. The motor and the wheel are put together properly when the shaft of the motor reaches the outer side of the motor (Figure 8b).



(a) Exert only vertical pressure

(b) The shaft should reach the outer side of the wheel

Figure 8: How the motors and the wheels should be composed

From the Encoder Kit, we are using the 3-tooth wheels (Figure 9).

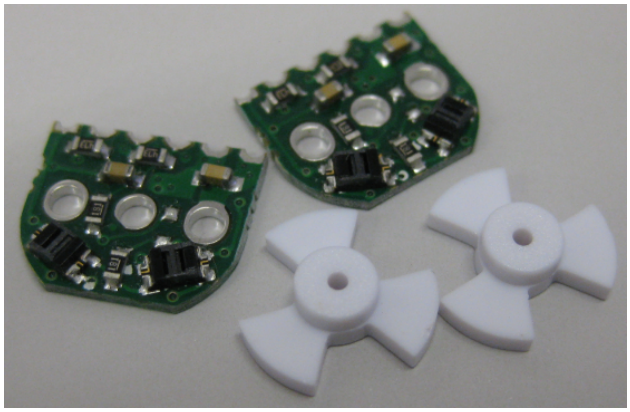
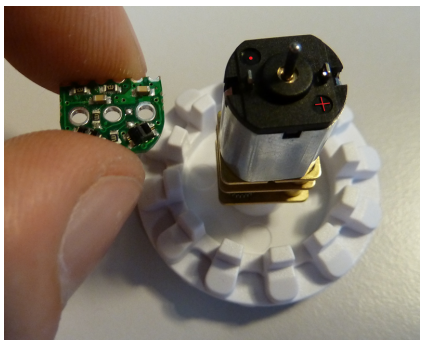
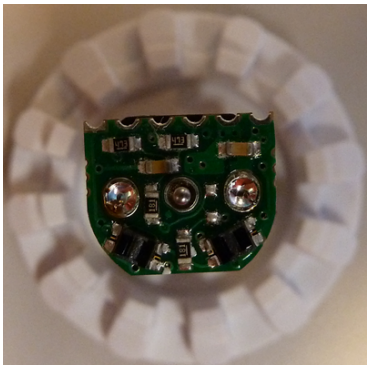


Figure 9: Optical Encoder with 3-Tooth Wheels

After that, the encoder should be soldered on the back side of the motor. In order to make sure that everybody uses the same polarity on the motors, take care the point sign of the motor is on the connection side of the encoder PCB and the plus side of the motor where the optical sensors on the PCB are, see Figure 10a, where the marking on the motors are highlighted in red. When soldering the encoder PCB on the motor, it is important that the PCB is lying straight on the motor and the shaft in the middle is in the middle of the hole of the encoder PCB (see Figure 10b).



(a) Put together of motor and encoder PCB



(b) The encoder PCB soldered

Figure 10: How to soldering the encoder PCB on the motor

The next step is to solder the Micromatch connection cables to the encoders. In order to do this, you need to cut your Micromatch connection cable (Farnell order number 1056210) in two pieces 11). Use a length of **2cm** for each cable (cable end to beginning of connector) (Figure 12).

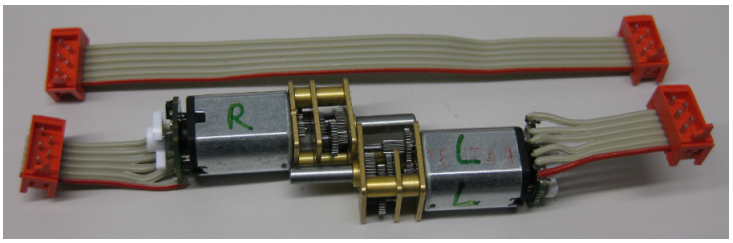


Figure 11: Micromatch Cable with Motors

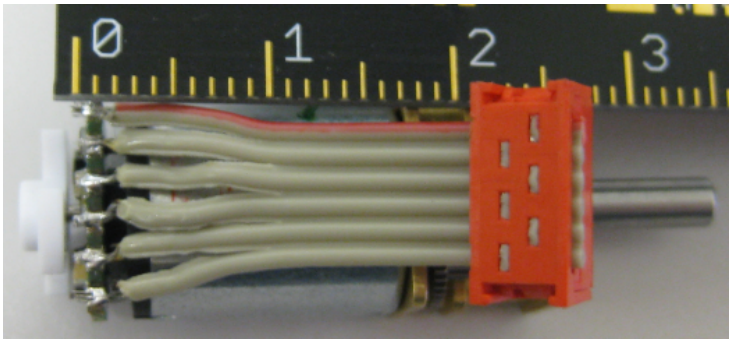


Figure 12: Micromatch Cable Length

Take care about the orientation of cables and connectors (Figure 13): the

red wire is connected to the GND of the optical encoder. Failing to match the proper orientation will destroy the encoder!

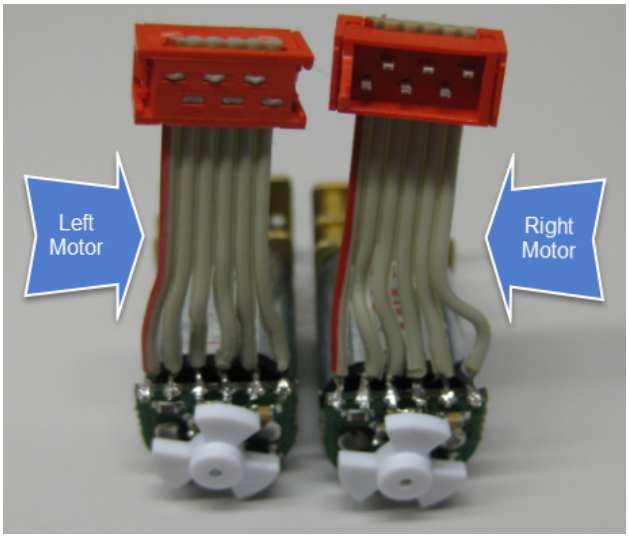


Figure 13: Motors with Encoder and Cable

This way, the two plugs facing in different directions, which is the way how it is meant to be mounted on the robot chassis (Figure 14).

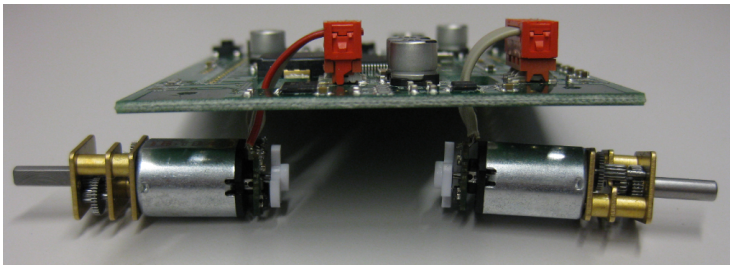


Figure 14: Left and Right Motors with Chassis

Take care when mounting the encoder wheels to put them close to the optical sensors on the one hand but not too close, because they must not touch anything - for example the encoder PCB itself or one of the wires. The encoder wheels should be easy rotatable and should not touch the wires (Figure 15).

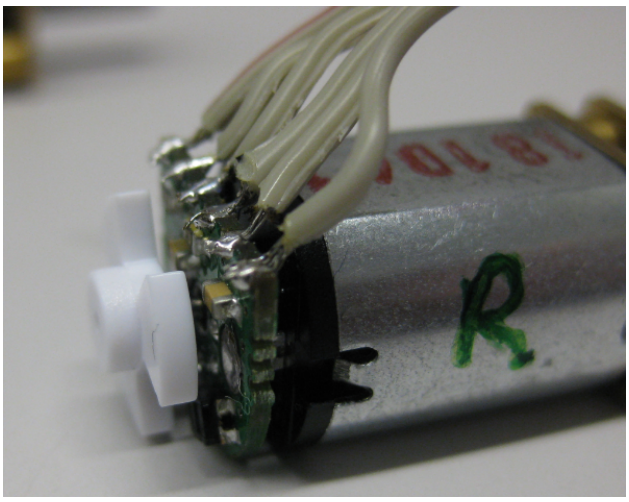


Figure 15: Encoder Wheel Freely Rotating

1.4 Reflectance Sensor Array

This section explains how the optical reflectance sensor gets assembled. The sensor array is used as line detection sensor in the robot.

You need one Zumo Reflectance Sensor Array (#1419) (Figure 16).

Figure 16: Zumo Reflectance Sensor Array Kit

You will need the sensor PCB, the male connector, the jumper and the right-angle 3-pin jumper array. Return the remaining material so it can be used for other projects (Figure 17).

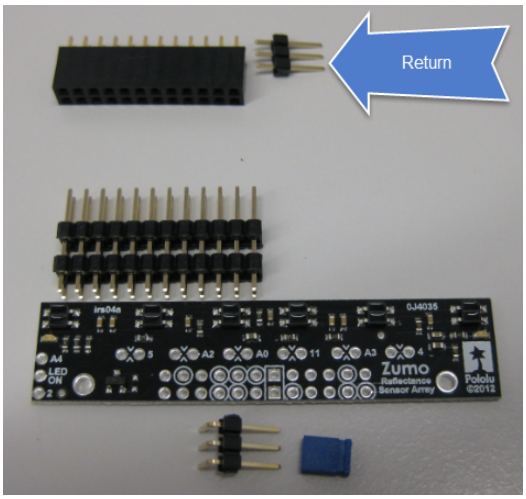


Figure 17: Zumo Reflectance Sensor Array Material

Solder the header (long side up) and the jumper pins to the board (Figure 18 and 19).

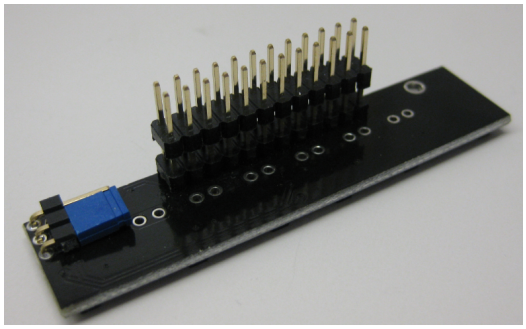


Figure 18: Assembled Sensor Array PCB

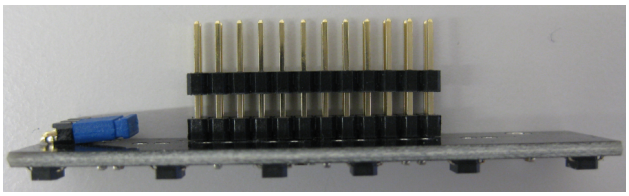


Figure 19: Reflectance Sensor Array with Headers

The connector on the robo PCB is an SMD one, in two parts (Figure).

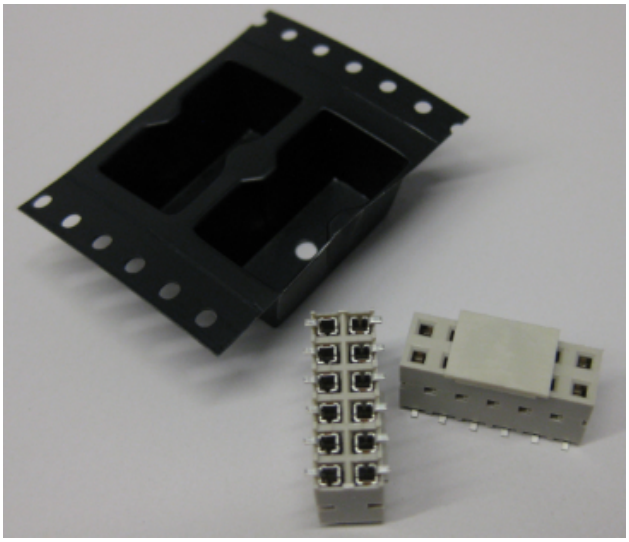


Figure 20: SMD Refelectance Sensor Header

To solder the connector to the PCB, apply a bit solder on one of the pads:

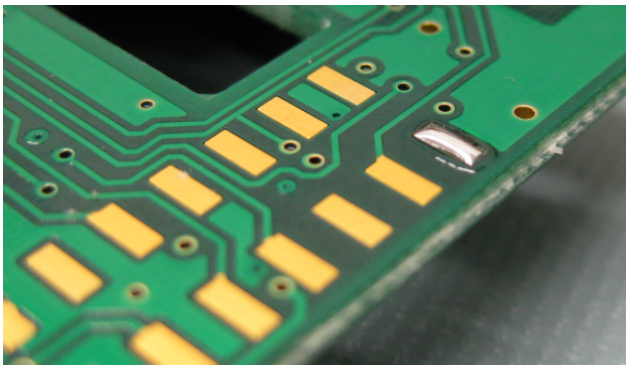


Figure 21: Solder on one of the Reflectance Header Pad

Use a pin row to align and keep the two header together. Then solder the one pad with the solder on it first (A), and then solder another pad (B) (Figure).

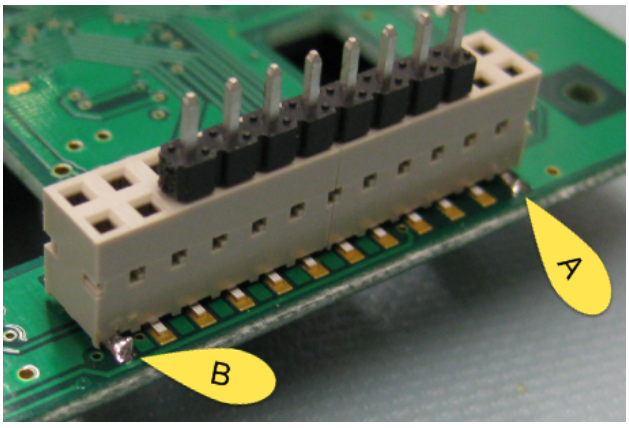


Figure 22: Solder two Header Pads

Properly align and center the header (Figure 23). If needed heat the soldered pads to realign. Then solder all the remaining pads (Figure 24).

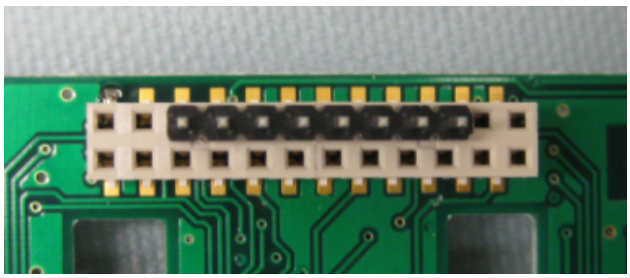


Figure 23: Aligned Headers with Pads

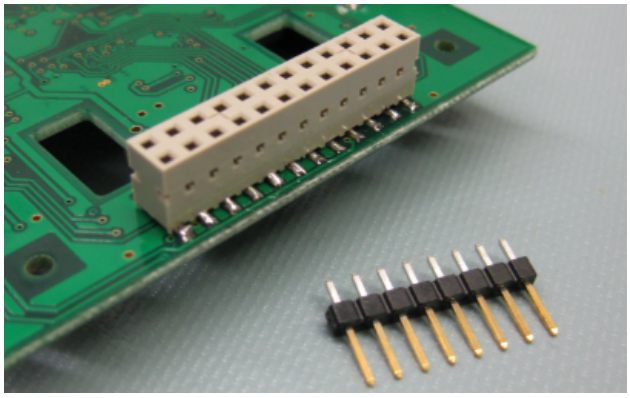


Figure 24: Soldered Reflectance Header on PCB

The sensor gets mounted behind the front blade of the robot, see Figure 25 and 26. Make sure you plug in the sensor array with the infrared sensors near the blade.

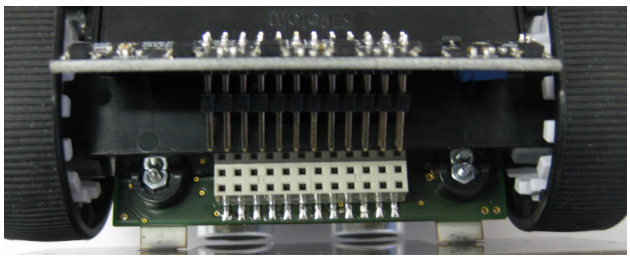


Figure 25: Reflectance Sensor Connector

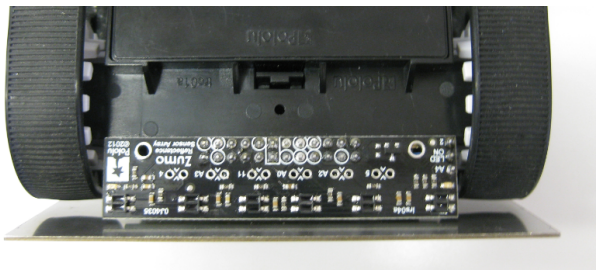


Figure 26: Reflectance Sensor Mounted behind the blade

1.5 Bluetooth Header

The robot base board features a 4-pin Bluetooth module header. There is as well a Bluetooth header available on the sensor shield for the robot. Locate the Bluetooth module connector on your board (on the right side) with Vcc 5V, GND, TX and RX (Figure 27).

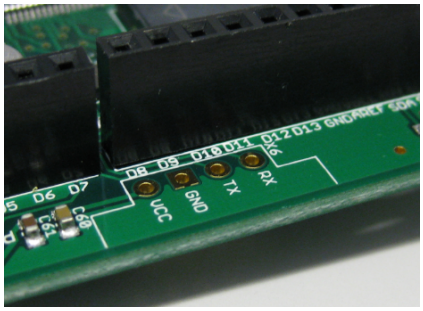


Figure 27: Bluetooth Header Location

Solder a 4-pin header to the board. A tip is to mark Vcc and GND with a felt tip pen to avoid wrong Bluetooth module orientation (Figure 28).

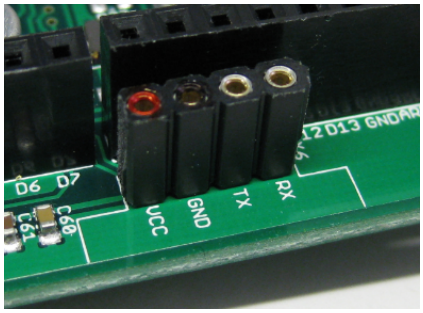


Figure 28: Bluetooth Header Soldered

On the bottom side of the board, make sure the pins are cut to a minimum (Figure 29).

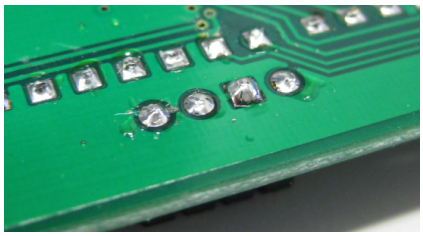


Figure 29: Bluetooth Header Board Bottom Side

Figure 30 shows the Bluetooth module inserted into the socket:

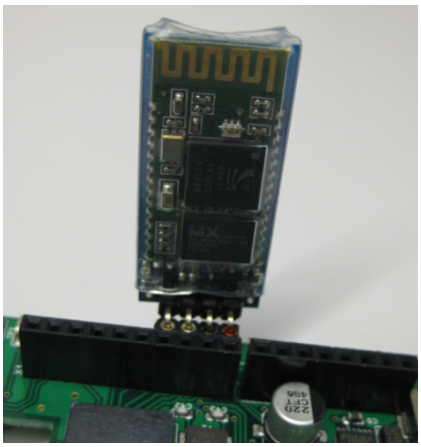


Figure 30: Bluetooth Module Inserted

1.6 Chassis

The chassis used is the Zumo robot chassis from Pololu (#1418).

Figure 31: Pololu Zumo Chassis Kit

Place the M3 nut (A) into each of the two side slots on the back side of the chassis. Insert the bolts (B) through the wheels, with placing an idler sprocket on it (C) (Figure 33). Use a 3 mm hex key (Allen wrench) to tighten the bolts, but be careful not to over-tighten it.

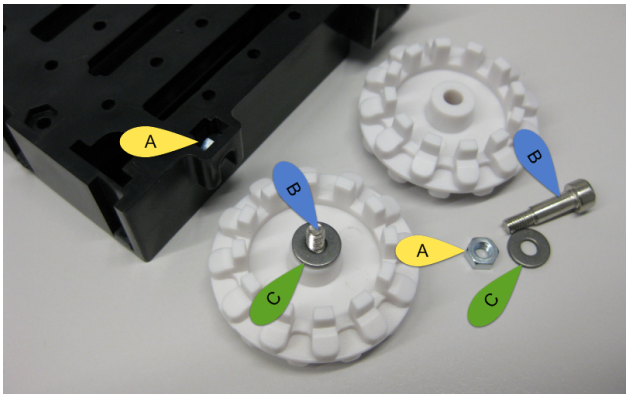


Figure 32: Mounting Back Wheels

Mount both back wheels the chassis (Figure 33).

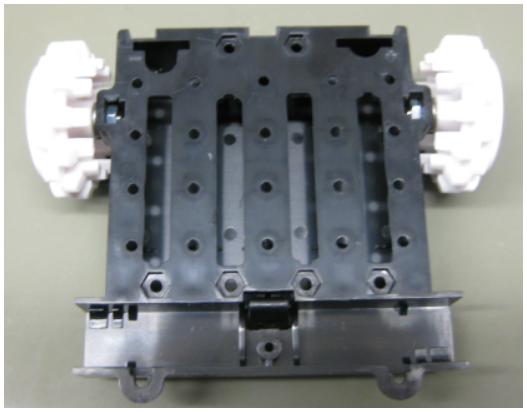


Figure 33: Back Wheels Mounted

Figure 34 shows the placement of the battery connectors. The top left and right connectors will be soldered into the robot PCB. Notice that there is larger hole for the minus connector having the spring contact.

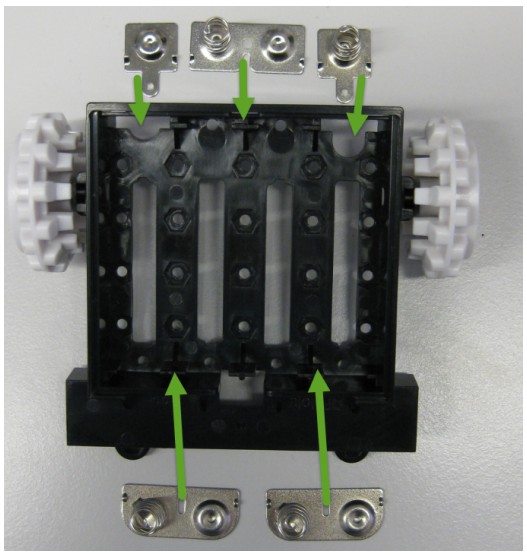


Figure 34: Placement of Battery Connectors

Figure 35 shows the five battery connectors mounted inside the chassis.

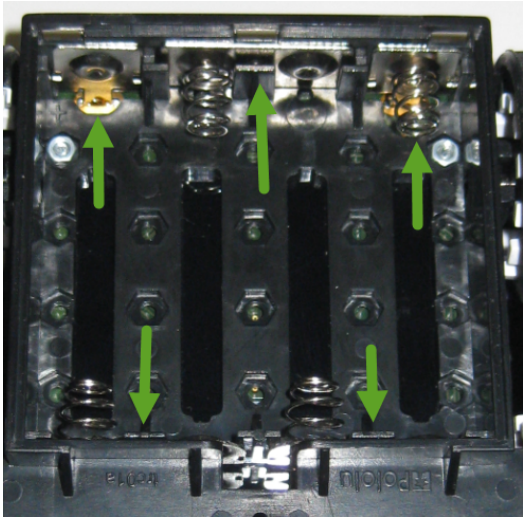


Figure 35: Battery Connectors Mounted inside Chassis

There are marks inside the chassis to fit the motor and to keep it tight (Figure 36).

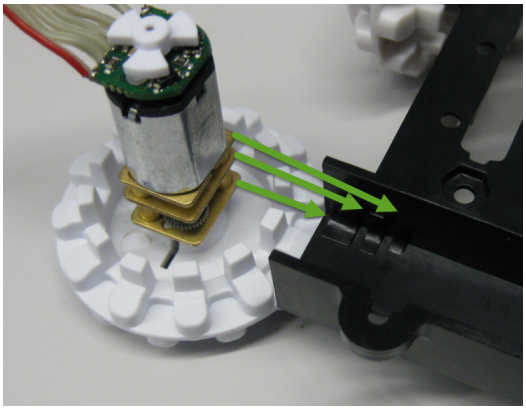


Figure 36: Motor to Match Marks in Chassis

Insert the motors into the chassis (Figure 37).

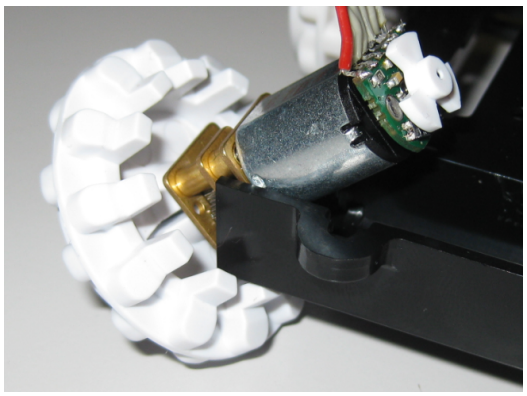


Figure 37: Inserting the Motors into Chassis

The motor needs to be aligned with the outside border of the chassis (Figure).

Figure 38: Motors Inserted and Aligned with Chassis

The cover plate of the chassis has a protective sleeve on it which should be removed (Figure 39):

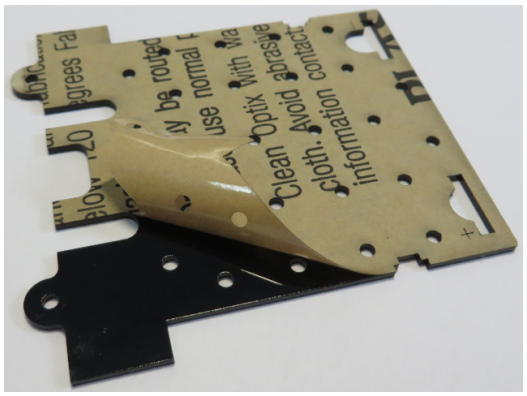


Figure 39: Removing Protective Sleeve

Place the cover plate on the chassis. Make sure that the battery connector holes are matching (Figure 40).

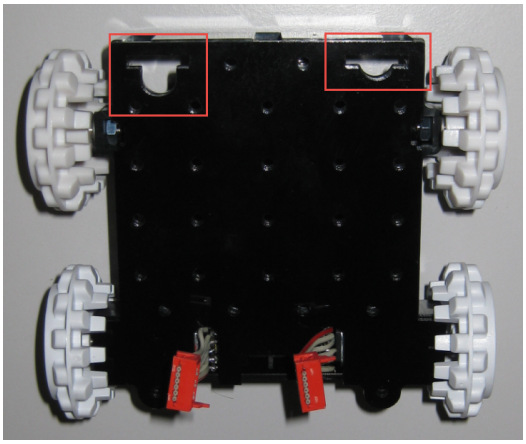


Figure 40: Cover Placed on Chassis

Place for plastic distance holder (about 0.5 mm height) onto the cover plate to compensate for the soldering connector distance. We want to avoid that there is too much stress and bending of the PCB (Figure 41).

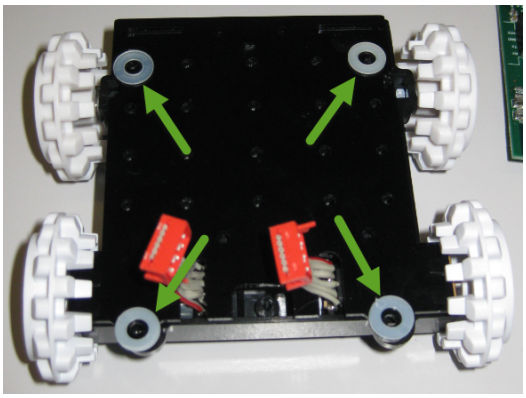


Figure 41: Placed Distance Holder

Place the board on top of the cover plate (Figure 42) and apply nuts and bolts for the two rear parts, but do not make it tight yet.

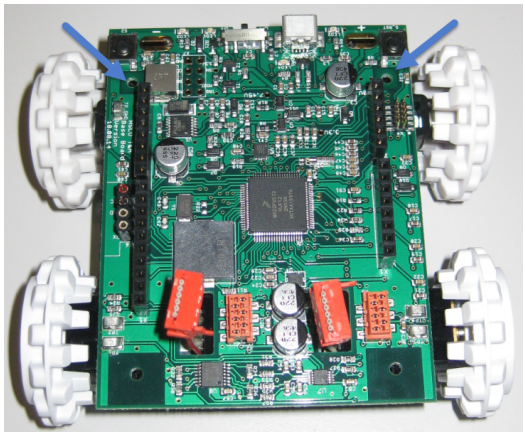


Figure 42: PCB placed on Cover Plate

As a trick, use a tape to hold the nut in place (Figure 43).

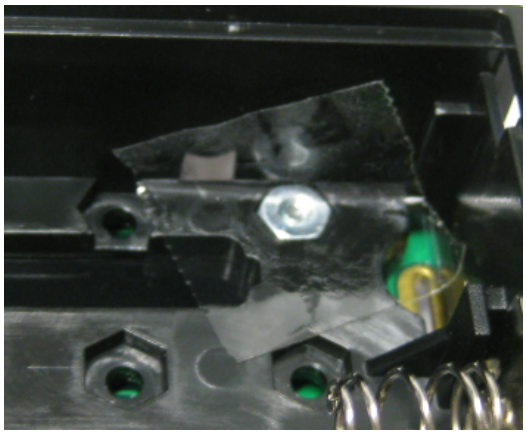


Figure 43: Tape to hold Nut in Place

The front of the robot has a blade to push the opponent robot (1410, Figure 44).

Figure 44: Zumo Blade

Cut the sharp edges of the Blade do it does not damage the board. Bend the two blade tabs to an angle that it fits the Sumo. Do **not** bend the tabs after the blade has been mounted, or do not bend them multiple times as they will break. Use an appropriate tool to bend the tabs.

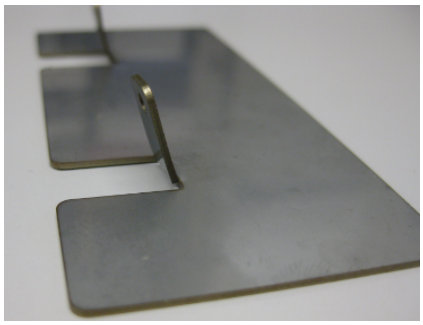


Figure 45: Zumo Blade with Bended Tabs

Because the Pololu Zumo nuts and bolts are not long enough, use 2mm x 10mm nuts. Mounte the blade to the front of the robot (Figure 46 and 47).

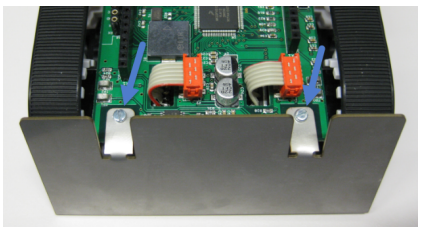


Figure 46: Front Blade Mounted

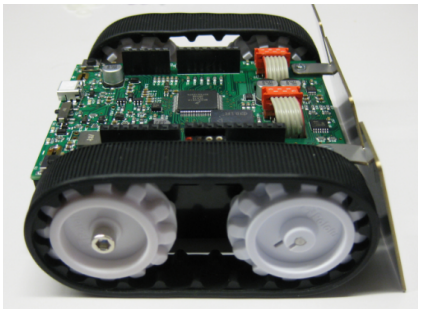


Figure 47: Front Blade Mounted

To solder the battery connectors to the board, first keep them in plate e.g. with a tape. Make sure you are using the correct tab for each place!

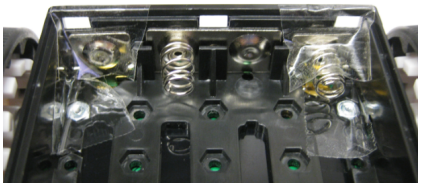


Figure 48: Battery Connectors kept in Place with Tape

The battery connector should go a bit above the PCB top side (Figure 49).

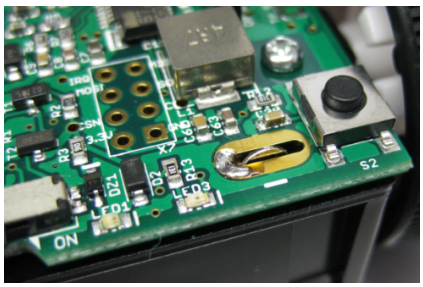


Figure 49: Battery Connector and PCB

Then solder the connectors to the board (Figure 50).

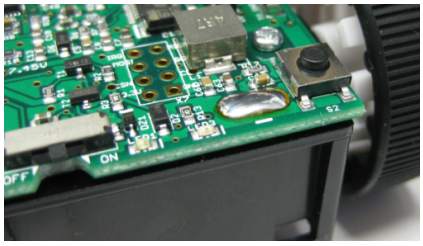


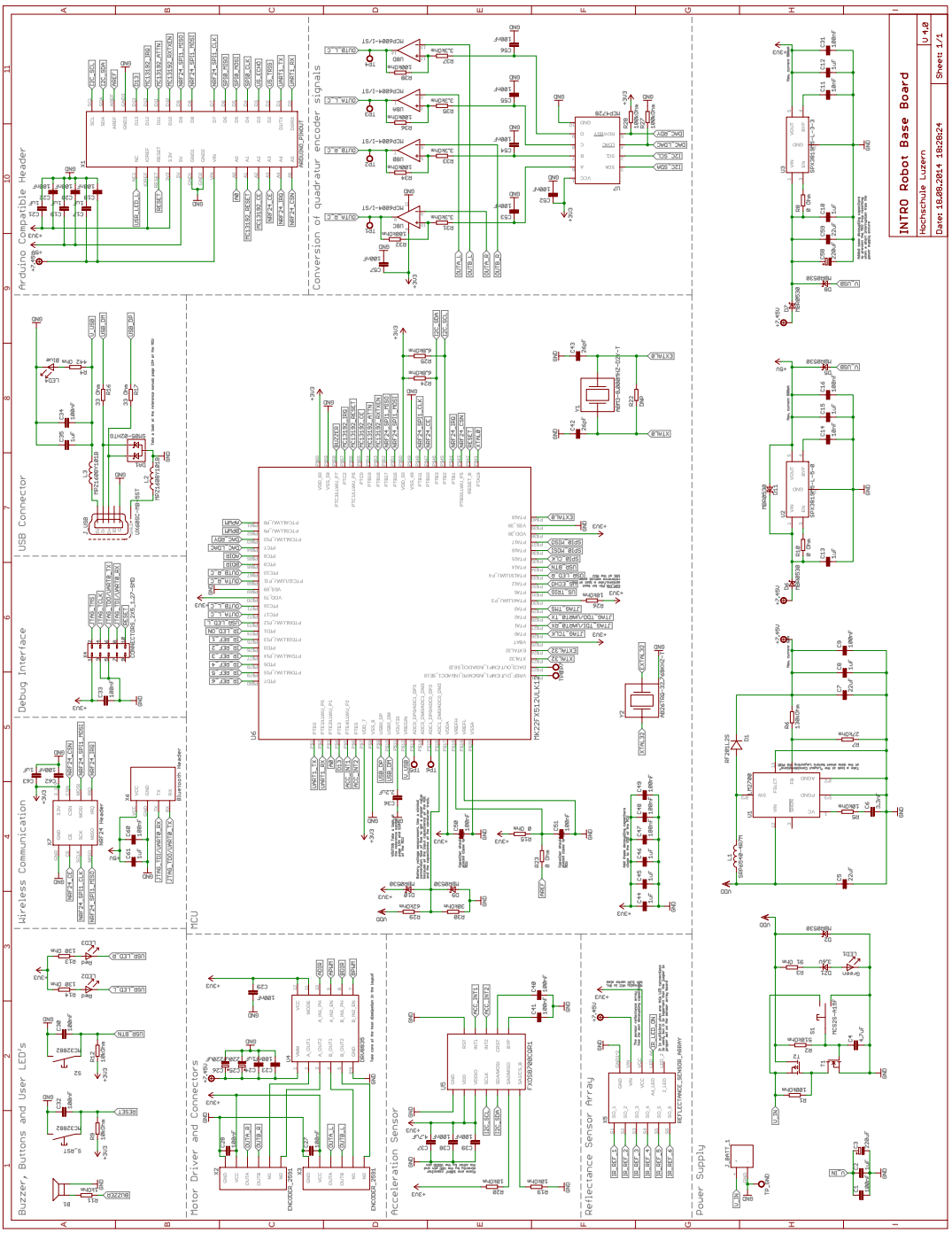
Figure 50: Soldered Battery Connector

Inside the battery compartment 4 AA batteries are placed (Figure 51).

Figure 51: Battery Compartment

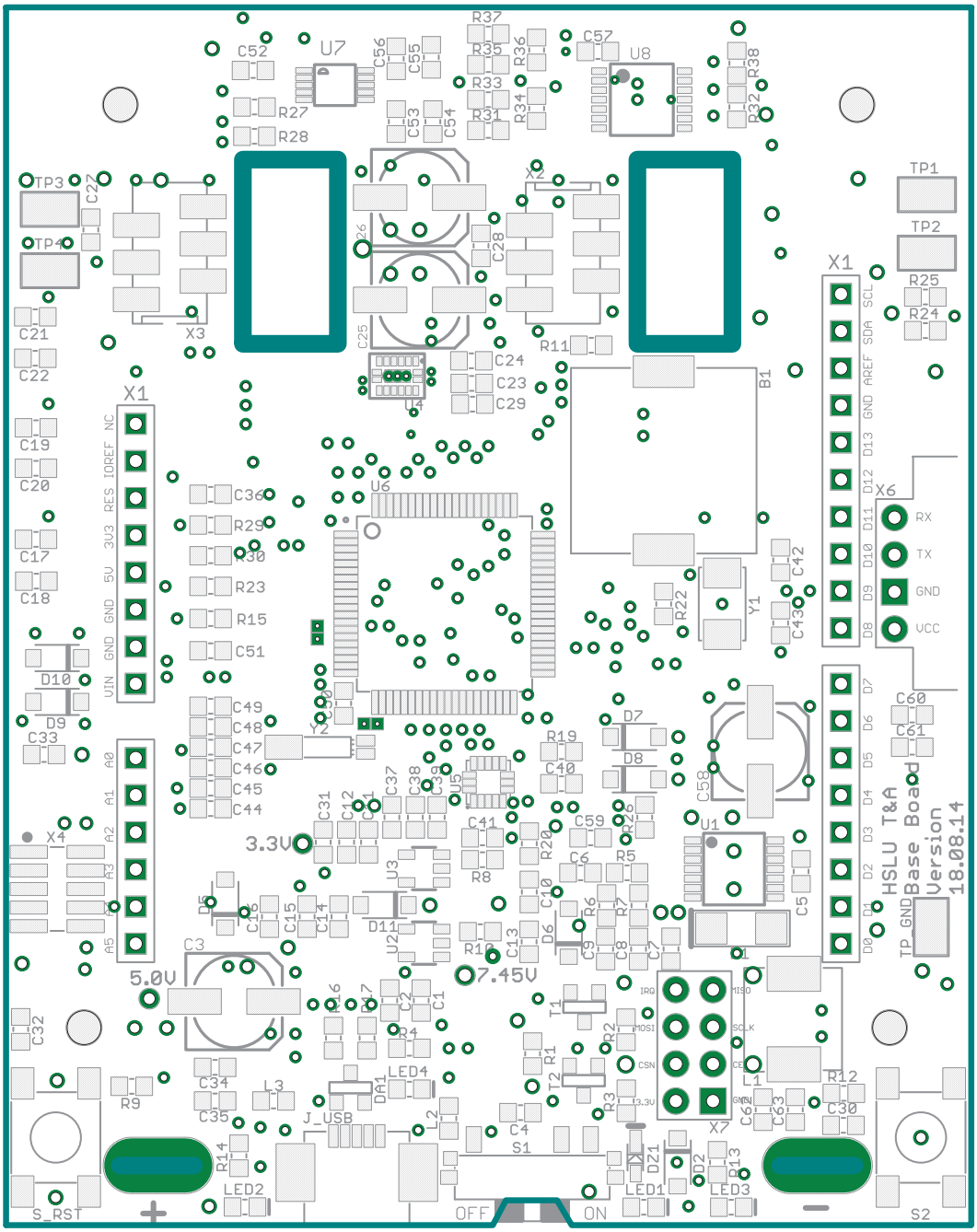
2 Appendix

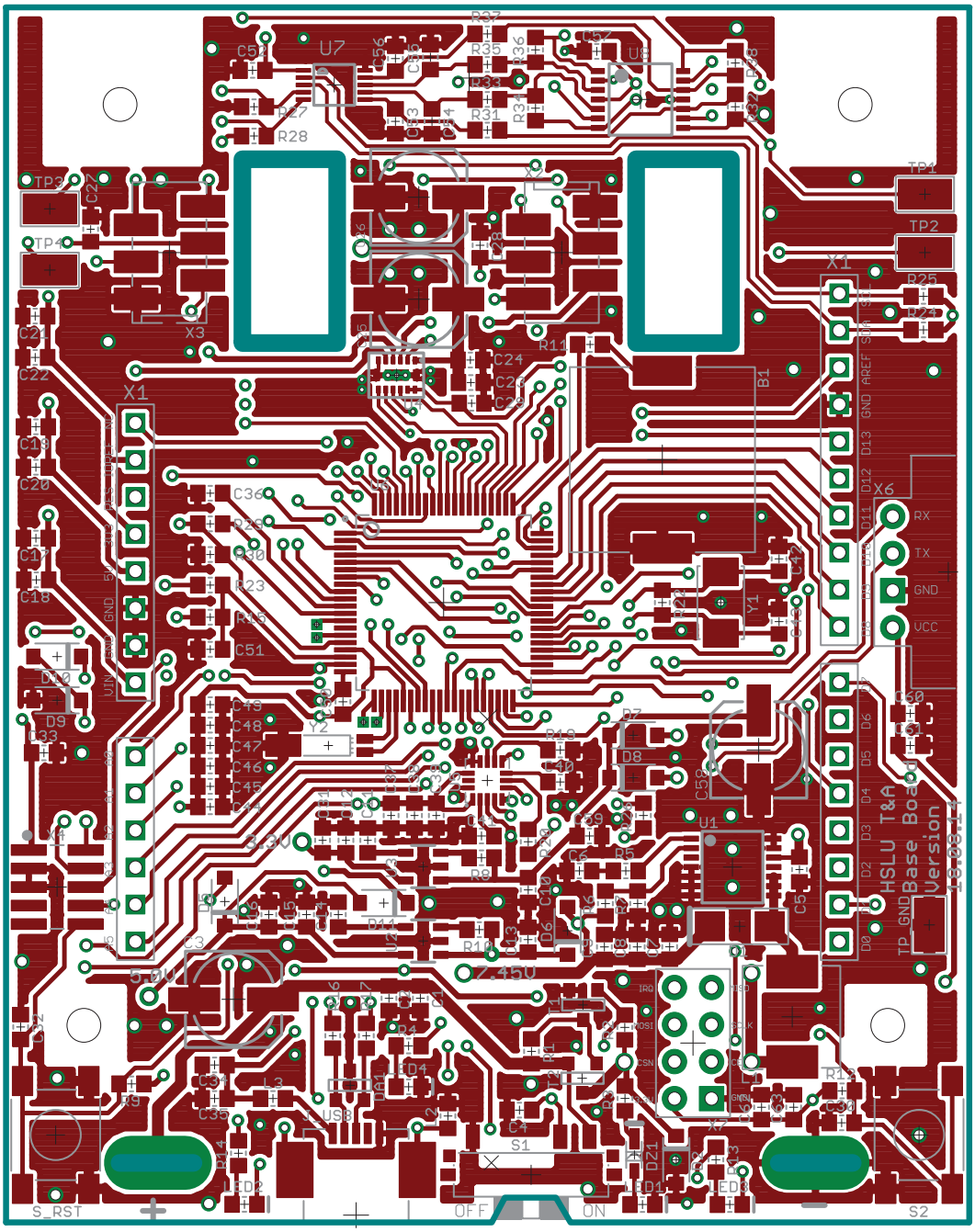
2.1 INTRO Robo Base Board Schematics

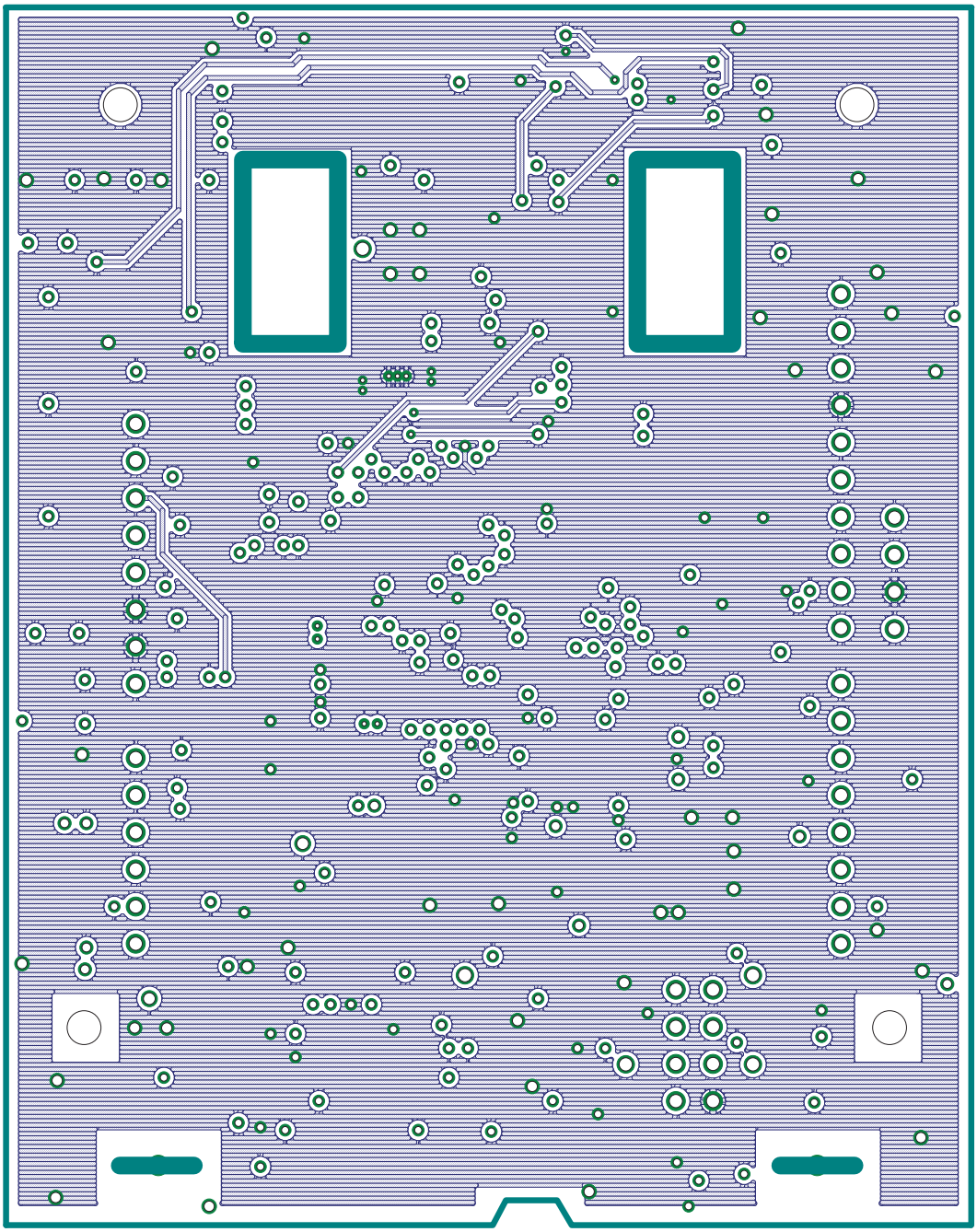

INTRO Robot Base Board
Hochschule Luzern
Date: 18.06.2014 18:28:24
V1.0
Sheet: 1/1
Arduino Compatible Header
Conversion of quadratur encoder signals
USB Connector
Debug Interface
Wireless Communication
MCU
Buzzer, Buttons and User LED's
Motor Driver and Connectors
Acceleration Sensor
Reflectance Sensor Array
Power Supply

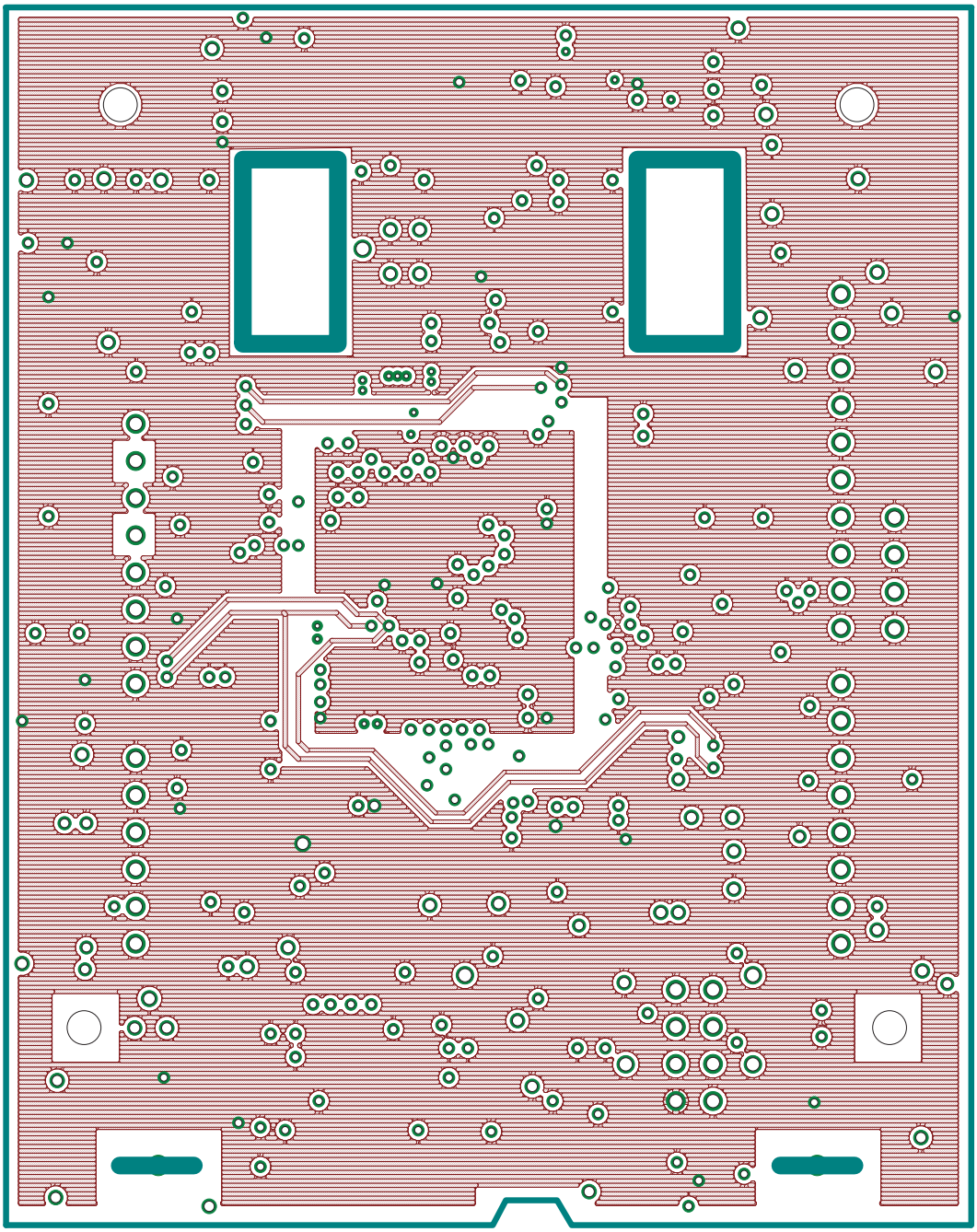
2.2 INTRO Zumo Base Board Layout

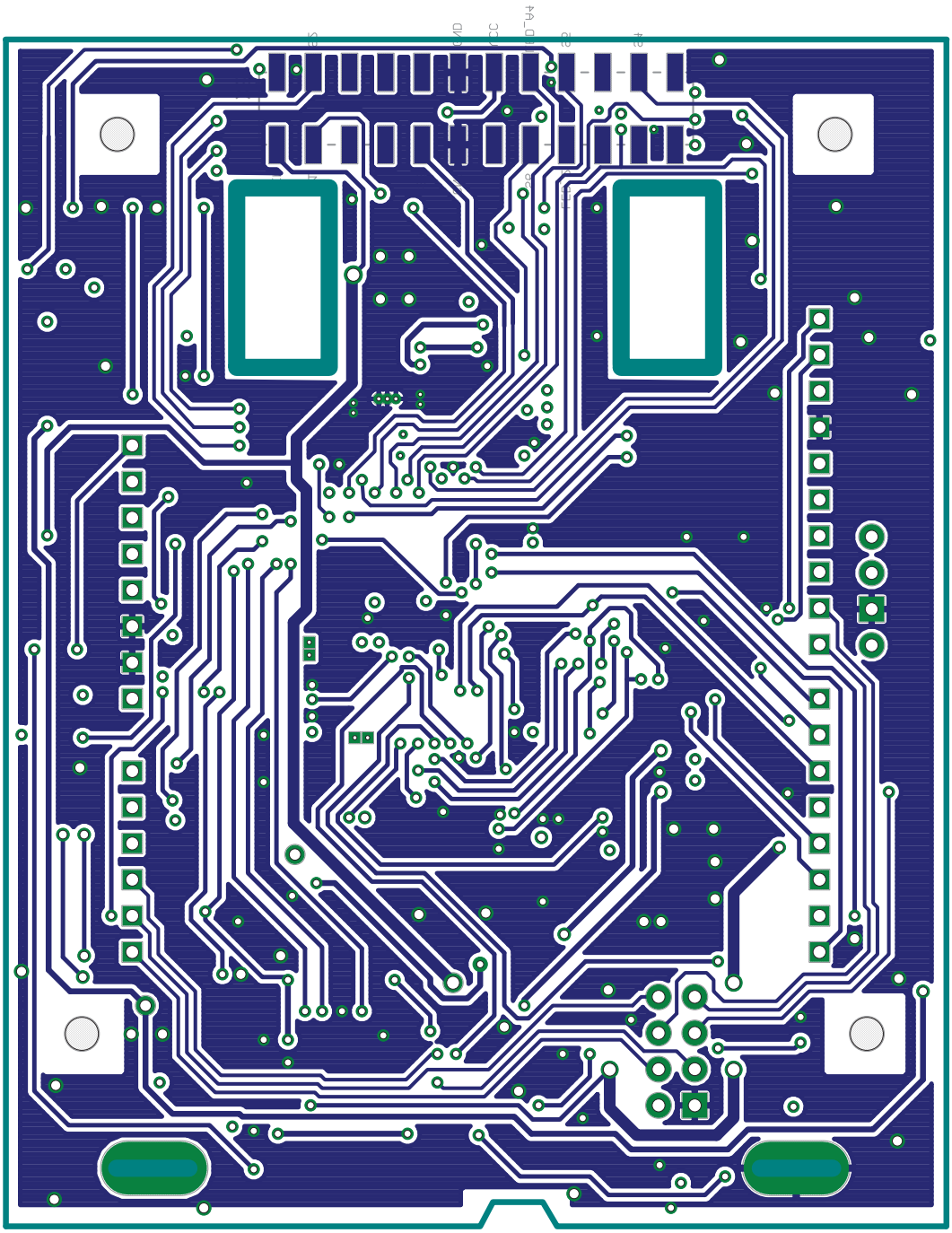
1. Silk screen and solder mask on top side
2. Top Layer (Signal Layer)
3. 2nd Layer (GND Layer)
4. 3rd Layer (VCC Layer)
5. Bottom Layer (Signal Layer)


HSLU T&A
Base Board
Version
18.08.14
3.3V
5.0V
7.45V
OFF
ON
S_RST
S1
S2
J_USB
LED1
LED2
LED3
LED4
TP1
TP2
TP3
TP4
X1
X2
X3
X4
X6
U1
U2
U3
U4
U5
U6
U7
U8
B1
Y1
Y2
RX
TX
GND
VCC


HSLU T&A
Base Board
Version 1.0.0.3
TP1
TP2
TP3
TP4
X1
X3
X6
RX
TX
GND
VCC
S_RST
OFF
ON
S1
S2
3.3V
5.0V
7.450







2.3 Pin Mapping

The following pages show the pin assignment as reported by Processor Expert:

```
================================================================================
THIS FILE WAS GENERATED BY "Processor Expert version 10.4 for Freescale Microcontrollers".
Project "INTRO_K22_Robo", 2014-10-23, 09:11, # CodeGen: 41
DO NOT MODIFY IT.
================================================================================


================================================================================
 SIGNAL LIST
--------------------------------------------------------------------------------
SIGNAL-NAME [DIR]          => PIN-NAME [PIN-NUMBER]
--------------------------------------------------------------------------------
A1 [Input]                 => ADC0_SE15/PTC1/LLWU_P6/SPI0_PCS3/UART1_RTS_b/FTM0_CH0/FB_AD13/
    I2S0_TXD0 [56]
A2 [Input]                 => ADC0_SE14/PTC0/SPI0_PCS4/PDB0_EXTRG/FB_AD14/I2S0_TXD1 [55]
AccelInt [Input]           => PTE4/LLWU_P2/SPI1_PCS0/UART3_TX/SDHC0_D3/TRACE_D0 [5]
ADC_1                      => ADC0_DP2/ADC1_SE6a/PTE2/LLWU_P1/SPI1_SCK/UART1_CTS_b/SDHC0_DCLK/
    TRACE_D2 [3]
ADC_Battery                => ADC1_DM0/ADC0_DM3 [16]
BT_RX_J1_5 [Input]         => ADC1_SE5a/PTE1/LLWU_P0/SPI1_SOUT/UART1_RX/SDHC0_D0/TRACE_D3/I2C1_SCL/
    SPI1_SIN [2]
BT_TX_J1_7 [Output]        => ADC1_SE4a/PTE0/SPI1_PCS1/UART1_TX/SDHC0_D1/TRACE_CLKOUT/I2C1_SDA/
    RTC_CLKOUT [1]
BUTTON [Input]             => PTA14/SPI0_PCS0/UART0_TX/I2C2_SCL/I2S0_RX_BCLK/I2S0_TXD1 [34]
BUZZER [Output]            => CMP1_IN1/PTC3/LLWU_P7/SPI0_PCS1/UART1_RX/FTM0_CH2/CLKOUT/I2S0_TX_BCLK
    [58]
D10 [Input]                => PTB18/CAN0_TX/FTM2_CH0/I2S0_TX_BCLK/FB_AD15/FTM2_QD_PHA [53]
D11 [Input]                => PTB19/CAN0_RX/FTM2_CH1/I2S0_TX_FS/FB_OE_b/FTM2_QD_PHB [54]
D12 [Input]                => ADC0_SE4b/CMP1_IN0/PTC2/SPI0_PCS2/UART1_CTS_b/FTM0_CH1/FB_AD12/
    I2S0_TX_FS [57]
```

```
D13 [Input]                  => ADC0_DM2/ADC1_SE7a/PTE3/SPI1_SIN/UART1_RTS_b/SDHC0_CMD/TRACE_D1/
    SPI1_SOUT [4]
D5 [Input]                   => PTA16/SPI0_SOUT/UART0_CTS_b/UART0_COL_b/I2S0_RX_FS/I2S0_RXD1 [36]
D6 [Input]                   => ADC1_SE17/PTA17/SPI0_SIN/UART0_RTS_b/I2S0_MCLK [37]
DIR_LEFT_J10_05 [Output]     => ADC1_SE5b/CMP0_IN3/PTC9/FTM3_CH5/I2S0_RX_BCLK/FB_AD6/FTM2_FLT0 [66]
DIR_RIGHT_J10_07 [Output]  => ADC1_SE4b/CMP0_IN2/PTC8/FTM3_CH4/I2S0_MCLK/FB_AD7 [65]
IR_1 [I/O]                   => PTD2/LLWU_P13/SPI0_SOUT/UART2_RX/FTM3_CH2/FB_AD4/I2C0_SCL [75]
IR_2 [I/O]                   => PTD3/SPI0_SIN/UART2_TX/FTM3_CH3/FB_AD3/I2C0_SDA [76]
IR_3 [I/O]                   => PTD4/LLWU_P14/SPI0_PCS1/UART0_RTS_b/FTM0_CH4/FB_AD2/EWM_IN [77]
IR_4 [I/O]                   => ADC0_SE6b/PTD5/SPI0_PCS2/UART0_CTS_b/UART0_COL_b/FTM0_CH5/FB_AD1/
    EWM_OUT_b [78]
IR_5 [I/O]                   => ADC0_SE7b/PTD6/LLWU_P15/SPI0_PCS3/UART0_RX/FTM0_CH6/FB_AD0/FTM0_FLT0
    [79]
IR_6 [I/O]                   => PTD7/CMT_IRO/UART0_TX/FTM0_CH7/FTM0_FLT1 [80]
LDAC [Output]                => CMP0_IN1/PTC7/SPI0_SIN/USB_SOF_OUT/I2S0_RX_FS/FB_AD8 [64]
LED_USER_Left [Output]       => PTD0/LLWU_P12/SPI0_PCS0/UART2_RTS_b/FTM3_CH0/FB_ALE/FB_CS1_b/FB_TS_b
    [73]
LED_USER [Output]            => CMP2_IN1/PTA13/LLWU_P4/CAN0_RX/FTM1_CH1/I2C2_SDA/I2S0_TX_FS/
    FTM1_QD_PHB [33]
Left_A_J9_09 [Input]         => PTC17/UART3_TX/FB_CS4_b/FB_TSIZ0/FB_BE31_24_BLS7_0_b [72]
Left_B_J9_11 [Input]         => PTC16/UART3_RX/FB_CS5_b/FB_TSIZ1/FB_BE23_16_BLS15_8_b [71]
MagnetometerInt [Input]      => PTE5/SPI1_PCS2/UART3_RX/SDHC0_D2/FTM3_CH0 [6]
MPC4728_RDY [Input]          => CMP0_IN0/PTC6/LLWU_P10/SPI0_SOUT/PDB0_EXTRG/I2S0_RX_BCLK/FB_AD9/
    I2S0_MCLK [63]
PWM_LEFT_J10_01 [Output]     => PTC4/LLWU_P8/SPI0_PCS0/UART1_TX/FTM0_CH3/FB_AD11/CMP1_OUT [61]
PWM_LEFT_J10_01 [Output]     => PTC4/LLWU_P8/SPI0_PCS0/UART1_TX/FTM0_CH3/FB_AD11/CMP1_OUT [61]
PWM_RIGHT_J10_03 [Output]  => PTC5/LLWU_P9/SPI0_SCK/LPTMR0_ALT2/I2S0_RXD0/FB_AD10/CMP0_OUT/FTM0_CH2
    [62]
PWM_RIGHT_J10_03 [Output]  => PTC5/LLWU_P9/SPI0_SCK/LPTMR0_ALT2/I2S0_RXD0/FB_AD10/CMP0_OUT/FTM0_CH2
    [62]
RF_CE [Output]               => ADC1_SE14/PTB10/SPI1_PCS0/UART3_RX/FB_AD19/FTM0_FLT1 [47]
RF_CSN [Output]              => ADC0_SE8/ADC1_SE8/PTB0/LLWU_P5/I2C0_SCL/FTM1_CH0/FTM1_QD_PHA [43]
```

```
RF_IRQ [Input]             => ADC0_SE9/ADC1_SE9/PTB1/I2C0_SDA/FTM1_CH1/FTM1_QD_PHB [44]
Right_A_J9_15 [Input]      => ADC1_SE6b/PTC10/I2C1_SCL/FTM3_CH6/I2S0_RX_FS/FB_AD5 [67]
Right_B_J9_13 [Input]      => ADC1_SE7b/PTC11/LLWU_P11/I2C1_SDA/FTM3_CH7/I2S0_RXD1/FB_RW_b [68]
SCL                        => ADC0_SE12/PTB2/I2C0_SCL/UART0_RTS_b/FTM0_FLT3 [45]
SDA                        => ADC0_SE13/PTB3/I2C0_SDA/UART0_CTS_b/UART0_COL_b/FTM0_FLT0 [46]
SPI_CLK_nRF [Output]       => ADC1_SE15/PTB11/SPI1_SCK/UART3_TX/FB_AD18/FTM0_FLT2 [48]
SPI_MISO_nRF [Input]       => PTB17/SPI1_SIN/UART0_TX/FTM_CLKIN1/FB_AD16/EWM_OUT_b [52]
SPI_MOSI_nRF [Output]      => PTB16/SPI1_SOUT/UART0_RX/FTM_CLKIN0/FB_AD17/EWM_IN [51]
US_Echo [Input]            => CMP2_IN0/PTA12/CAN0_TX/FTM1_CH0/I2C2_SCL/I2S0_TXD0/FTM1_QD_PHA [32]
US_Trig [Output]           => PTA5/USB_CLKIN/FTM0_CH2/CMP2_OUT/I2S0_TX_BCLK/JTAG_TRST_b [31]
========================================================================================



========================================================================================
 PIN LIST
----------------------------------------------------------------------------------------
PIN-NAME [PIN-NUM]         => SIGNAL-NAME [DIRECTION]
----------------------------------------------------------------------------------------
ADC0_DM2/ADC1_SE7a/PTE3/SPI1_SIN/UART1_RTS_b/SDHC0_CMD/TRACE_D1/SPI1_SOUT [4] => D13 [Input]
ADC0_DP2/ADC1_SE6a/PTE2/LLWU_P1/SPI1_SCK/UART1_CTS_b/SDHC0_DCLK/TRACE_D2 [3] => ADC_1
ADC0_SE12/PTB2/I2C0_SCL/UART0_RTS_b/FTM0_FLT3 [45] => SCL
ADC0_SE13/PTB3/I2C0_SDA/UART0_CTS_b/UART0_COL_b/FTM0_FLT0 [46] => SDA
ADC0_SE14/PTC0/SPI0_PCS4/PDB0_EXTRG/FB_AD14/I2S0_TXD1 [55] => A2 [Input]
ADC0_SE15/PTC1/LLWU_P6/SPI0_PCS3/UART1_RTS_b/FTM0_CH0/FB_AD13/I2S0_TXD0 [56] => A1 [Input]
ADC0_SE4b/CMP1_IN0/PTC2/SPI0_PCS2/UART1_CTS_b/FTM0_CH1/FB_AD12/I2S0_TX_FS [57] => D12 [Input]
ADC0_SE6b/PTD5/SPI0_PCS2/UART0_CTS_b/UART0_COL_b/FTM0_CH5/FB_AD1/EWM_OUT_b [78] => IR_4 [I/O]
ADC0_SE7b/PTD6/LLWU_P15/SPI0_PCS3/UART0_RX/FTM0_CH6/FB_AD0/FTM0_FLT0 [79] => IR_5 [I/O]
ADC0_SE8/ADC1_SE8/PTB0/LLWU_P5/I2C0_SCL/FTM1_CH0/FTM1_QD_PHA [43] => RF_CSN [Output]
ADC0_SE9/ADC1_SE9/PTB1/I2C0_SDA/FTM1_CH1/FTM1_QD_PHB [44] => RF_IRQ [Input]
ADC1_DM0/ADC0_DM3 [16]     => ADC_Battery
ADC1_SE14/PTB10/SPI1_PCS0/UART3_RX/FB_AD19/FTM0_FLT1 [47] => RF_CE [Output]
ADC1_SE15/PTB11/SPI1_SCK/UART3_TX/FB_AD18/FTM0_FLT2 [48] => SPI_CLK_nRF [Output]
```

```
ADC1_SE17/PTA17/SPI0_SIN/UART0_RTS_b/I2S0_MCLK [37] => D6 [Input]
ADC1_SE4a/PTE0/SPI1_PCS1/UART1_TX/SDHC0_D1/TRACE_CLKOUT/I2C1_SDA/RTC_CLKOUT [1] => BT_TX_J1_7 [
    Output]
ADC1_SE4b/CMP0_IN2/PTC8/FTM3_CH4/I2S0_MCLK/FB_AD7 [65] => DIR_RIGHT_J10_07 [Output]
ADC1_SE5a/PTE1/LLWU_P0/SPI1_SOUT/UART1_RX/SDHC0_D0/TRACE_D3/I2C1_SCL/SPI1_SIN [2] => BT_RX_J1_5 [
    Input]
ADC1_SE5b/CMP0_IN3/PTC9/FTM3_CH5/I2S0_RX_BCLK/FB_AD6/FTM2_FLT0 [66] => DIR_LEFT_J10_05 [Output]
ADC1_SE6b/PTC10/I2C1_SCL/FTM3_CH6/I2S0_RX_FS/FB_AD5 [67] => Right_A_J9_15 [Input]
ADC1_SE7b/PTC11/LLWU_P11/I2C1_SDA/FTM3_CH7/I2S0_RXD1/FB_RW_b [68] => Right_B_J9_13 [Input]
CMP0_IN0/PTC6/LLWU_P10/SPI0_SOUT/PDB0_EXTRG/I2S0_RX_BCLK/FB_AD9/I2S0_MCLK [63] => MPC4728_RDY [
    Input]
CMP0_IN1/PTC7/SPI0_SIN/USB_SOF_OUT/I2S0_RX_FS/FB_AD8 [64] => LDAC [Output]
CMP1_IN1/PTC3/LLWU_P7/SPI0_PCS1/UART1_RX/FTM0_CH2/CLKOUT/I2S0_TX_BCLK [58] => BUZZER [Output]
CMP2_IN0/PTA12/CAN0_TX/FTM1_CH0/I2C2_SCL/I2S0_TXD0/FTM1_QD_PHA [32] => US_Echo [Input]
CMP2_IN1/PTA13/LLWU_P4/CAN0_RX/FTM1_CH1/I2C2_SDA/I2S0_TX_FS/FTM1_QD_PHB [33] => LED_USER [Output]
PTA14/SPI0_PCS0/UART0_TX/I2C2_SCL/I2S0_RX_BCLK/I2S0_TXD1 [34] => BUTTON [Input]
PTA16/SPI0_SOUT/UART0_CTS_b/UART0_COL_b/I2S0_RX_FS/I2S0_RXD1 [36] => D5 [Input]
PTA5/USB_CLKIN/FTM0_CH2/CMP2_OUT/I2S0_TX_BCLK/JTAG_TRST_b [31] => US_Trig [Output]
PTB16/SPI1_SOUT/UART0_RX/FTM_CLKIN0/FB_AD17/EWM_IN [51] => SPI_MOSI_nRF [Output]
PTB17/SPI1_SIN/UART0_TX/FTM_CLKIN1/FB_AD16/EWM_OUT_b [52] => SPI_MISO_nRF [Input]
PTB18/CAN0_TX/FTM2_CH0/I2S0_TX_BCLK/FB_AD15/FTM2_QD_PHA [53] => D10 [Input]
PTB19/CAN0_RX/FTM2_CH1/I2S0_TX_FS/FB_OE_b/FTM2_QD_PHB [54] => D11 [Input]
PTC16/UART3_RX/FB_CS5_b/FB_TSIZ1/FB_BE23_16_BLS15_8_b [71] => Left_B_J9_11 [Input]
PTC17/UART3_TX/FB_CS4_b/FB_TSIZ0/FB_BE31_24_BLS7_0_b [72] => Left_A_J9_09 [Input]
PTC4/LLWU_P8/SPI0_PCS0/UART1_TX/FTM0_CH3/FB_AD11/CMP1_OUT [61] => PWM_LEFT_J10_01 [Output]
PTC4/LLWU_P8/SPI0_PCS0/UART1_TX/FTM0_CH3/FB_AD11/CMP1_OUT [61] => PWM_LEFT_J10_01 [Output]
PTC5/LLWU_P9/SPI0_SCK/LPTMR0_ALT2/I2S0_RXD0/FB_AD10/CMP0_OUT/FTM0_CH2 [62] => PWM_RIGHT_J10_03 [
    Output]
PTC5/LLWU_P9/SPI0_SCK/LPTMR0_ALT2/I2S0_RXD0/FB_AD10/CMP0_OUT/FTM0_CH2 [62] => PWM_RIGHT_J10_03 [
    Output]
PTD0/LLWU_P12/SPI0_PCS0/UART2_RTS_b/FTM3_CH0/FB_ALE/FB_CS1_b/FB_TS_b [73] => LED_USER_Left [Output
    ]
```

```
PTD2/LLWU_P13/SPI0_SOUT/UART2_RX/FTM3_CH2/FB_AD4/I2C0_SCL  [75]  =>  IR_1  [I/O]
PTD3/SPI0_SIN/UART2_TX/FTM3_CH3/FB_AD3/I2C0_SDA  [76]  =>  IR_2  [I/O]
PTD4/LLWU_P14/SPI0_PCS1/UART0_RTS_b/FTM0_CH4/FB_AD2/EWM_IN  [77]  =>  IR_3  [I/O]
PTD7/CMT_IRO/UART0_TX/FTM0_CH7/FTM0_FLT1  [80]  =>  IR_6  [I/O]
PTE4/LLWU_P2/SPI1_PCS0/UART3_TX/SDHC0_D3/TRACE_D0  [5]  =>  AccelInt  [Input]
PTE5/SPI1_PCS2/UART3_RX/SDHC0_D2/FTM3_CH0  [6]  =>  MagnetometerInt  [Input]
=================================================================
```

./pdf/ProcessorExpert_SIGNALS.txt

2.4 Improvement Ideas

This section lists ideas and findings for a new revision of the robot, with a priority (High, Medium, Low):

1. Green VBAT LED is too faint: increase current.
2. Blue USB LED is under nRF24L01+ module: move position

References

[1] Pololu Robotics & Electronics.
Altimu-10 gyro, accelerometer, compass, and altimeter.
Pololu #1269, Oct 2013.

[2] Pololu Robotics & Electronics.
Pololu 38 khz ir proximity sensor, fixed gain, high brightness.
Pololu #2460, Sep 2013.

[3] Pololu Robotics & Electronics.
Pololu 38 khz ir proximity sensor, fixed gain, low brightness.
Pololu #2461, Sep 2013.

[4] Pololu Robotics & Electronics.
Pololu 5v dc/dc converter.
Pololu #2119, Sep 2013.

[5] Pololu Robotics & Electronics.
Pololu 9v dc/dc converter.
Pololu #2116, Sep 2013.

[6] Pololu Robotics & Electronics.
Pololu carrier with sharp gp2y0d805z0f digital distance sensor 5cm.
Pololu #1132, Sep 2013.

[7] Pololu Robotics & Electronics.
Pololu carrier with sharp gp2y0d810z0f digital distance sensor 10cm.
Pololu #1134, Sep 2013.

[8] Pololu Robotics & Electronics.
Pololu motor drv8835 module.
Pololu #2135, Sep 2013.

[9] Pololu Robotics & Electronics.
Pololu zumo blade.
Pololu #1410, Sep 2013.

[10] Pololu Robotics & Electronics.
Pololu zumo chassis kit.
Pololu #1418, Sep 2013.

[11] Pololu Robotics & Electronics.
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