# AGH University of Science and Technology

**The NXP Cup Technical Report**

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# KNE::Fideltronik


*(AGH Electronics scientific club)*

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Cracow, 2017

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## Content

## 1. Mechanical design

Mechanical design is based on parts from TNC-KIT, which includes car chassis with two DC brush motors, gear, dumper, servo and wheels. There is also custom control board containing motors driver, MCU, power supply system and interfaces for sensors, servo and lighting. Board is mounted in the middle of the car, next to the stand for camera and lighting – there is a custom board containing three power LEDs with elliptic lens. We have also used thrust bearings to stiffen front wheels.

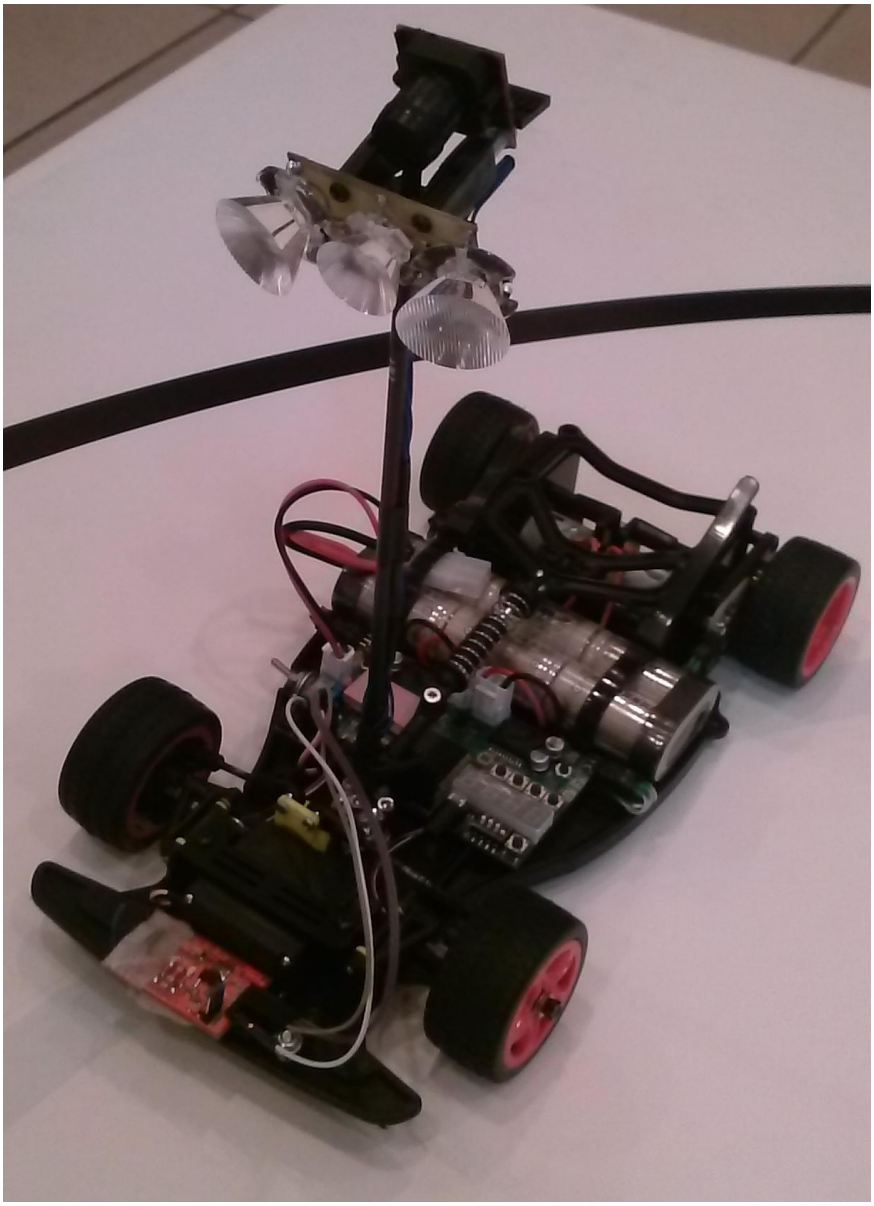


**Figure 1 Manufactured car**

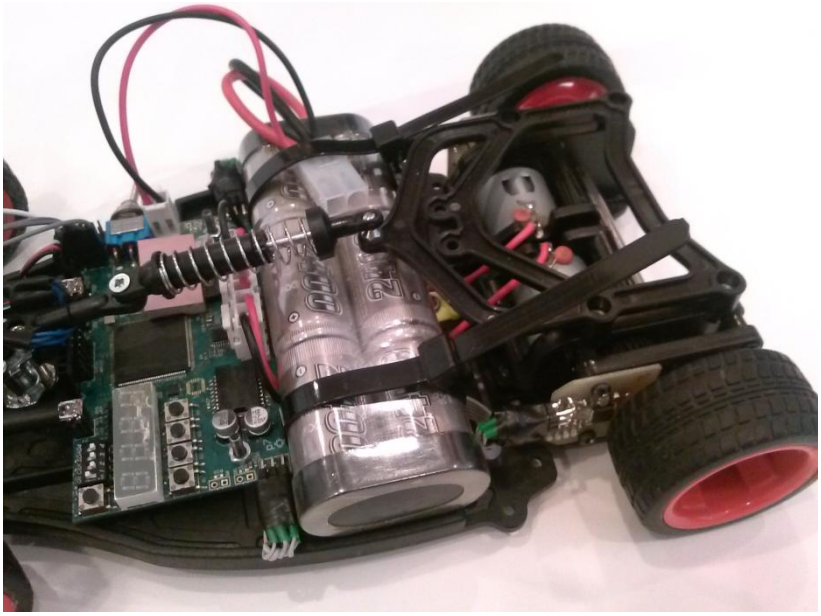


**Figure 2 Back side of car - battery mounting and motors.**

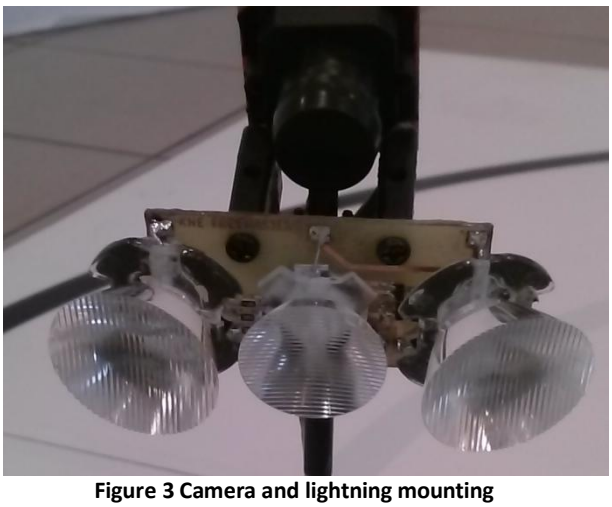


**Figure 3 Camera and lightning mounting**

## 2. Control circuit and electronics design

Control circuit is based on microcontroller K60F and motor drivers MC33887. Custom control board was developed to better fit into car chassis. It also helps to connect new sensors, such as encoders, gyro, transoptors and accelerometer.

Below we present diagram showing connections between parts of the manufactured car.

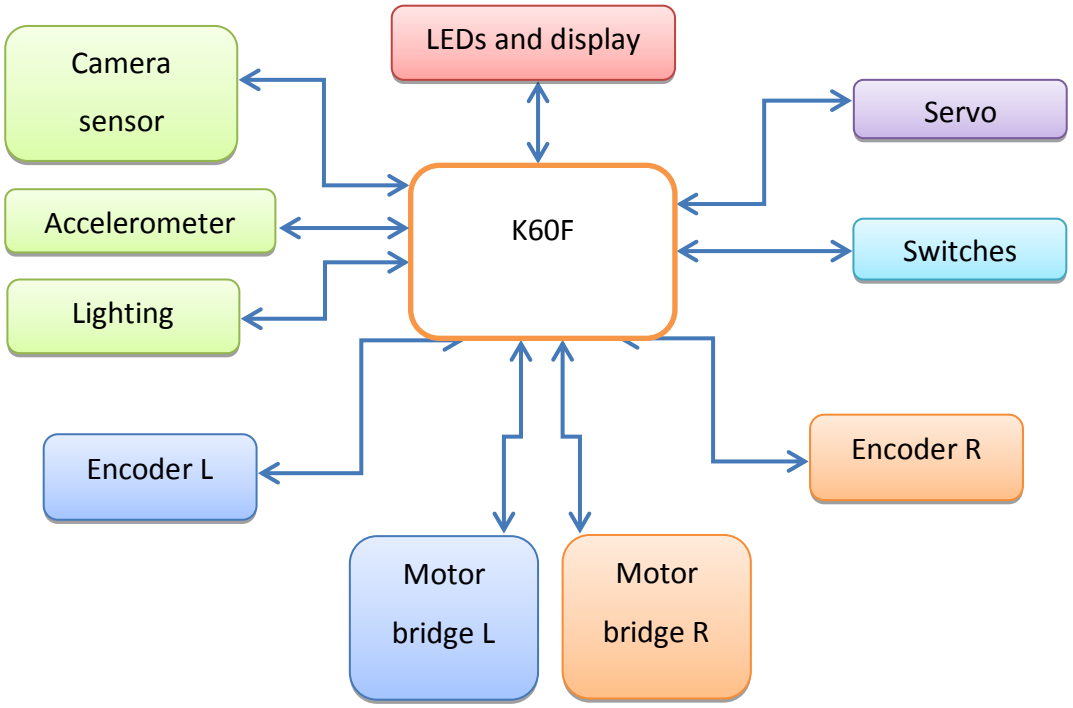



**Figure 4 Control circuit diagram**

Components of car control board:

- MCU – K60F - main control unit,
- Camera sensor – used to look at the track and follow the lines,
- Lightning – additional LEDs with lens to highlight trace,
- Accelerometer - FXLS8471Q,
- Motor bridges – based on MC33887,
- Encoders – magnetic rotary sensor – AS5040, mounted next to the motor's gear where magnet is installed,
- Switches – micro switches and dip switched for car controlling,
- Set of LEDs on board and 4 digit, 7 segment display for development purposes.

There is also place for gyro, but it is not mounted.

Schematic for control board is included at the end of document - enclosure 1.

## 3. Control software design

Software was created using CodeWarrior Development Tools and C programming language.

Control loop is based on consecutives tasks:

- Read data from camera
- Calculate center of the track
- Check if start sign is present
- Using PID regulator, calculate steering for servo
- Using data from encoders and actual steering angle on front wheels there is calculated control signal for motors.

This loop is repeated until start is detected.

There are also display, LEDs and switches on the board – they are used to set car parameters manually and control algorithm execution.

For testing, we have added Bluetooth module to communicate with the car to be able to change algorithm parameters during driving, perform manual steering and present data read from the line camera – there is dedicated application working on PC with Bluetooth module.

## 4. Total weight and dimensions

Total weight: 0.95kg

Dimensions: 280 mm (length) x 250 mm (width) x 290 mm (height)

## 5. Power consumption

Total power consumption is equal to 7W.

## 6. Sensors used

- line scan camera, from the TNC –KIT,
- AS5040 – magnetic sensor x2 - AMS sensors were used because we could not find any NXP contactless magnetic rotary encoder with quadrature output signal,
- FXLS8471Q – 3-Axis Linear Accelerometer.

## 7. Number of servo motors besides the existing driving motors and rudder motors of the vehicle model

None, the only servo used is the one provided with the TNC -KIT.

## 8. Bibliography


[1] NXP Cup Tutorial, https://community.nxp.com/docs/DOC-1095

[2] K60 Sub-Family Reference Manual http://cache.freescale.com/files/32bit/doc/ref_manual/K60P144M100SF2V2RM.pdf

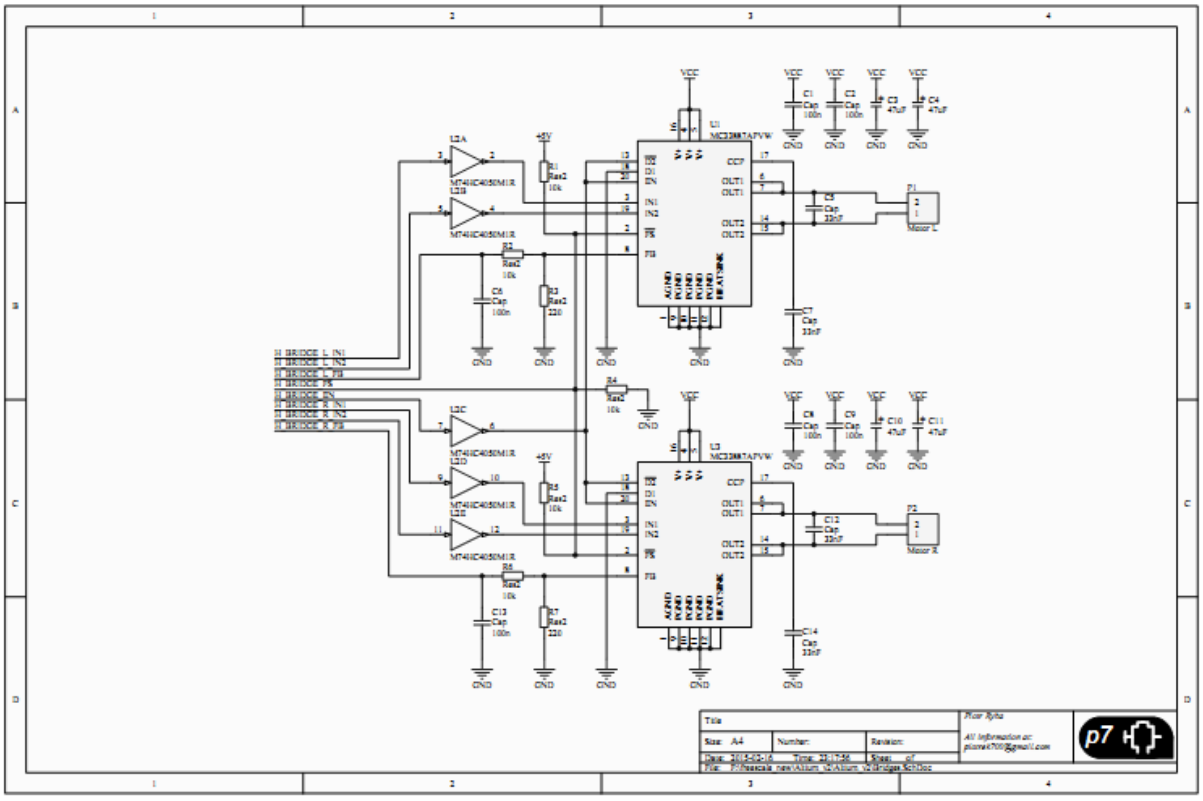
[3] 5.0 A Throttle Control H-bridge, http://www.freescale.com/files/analog/doc/data_sheet/MC33887.pdf

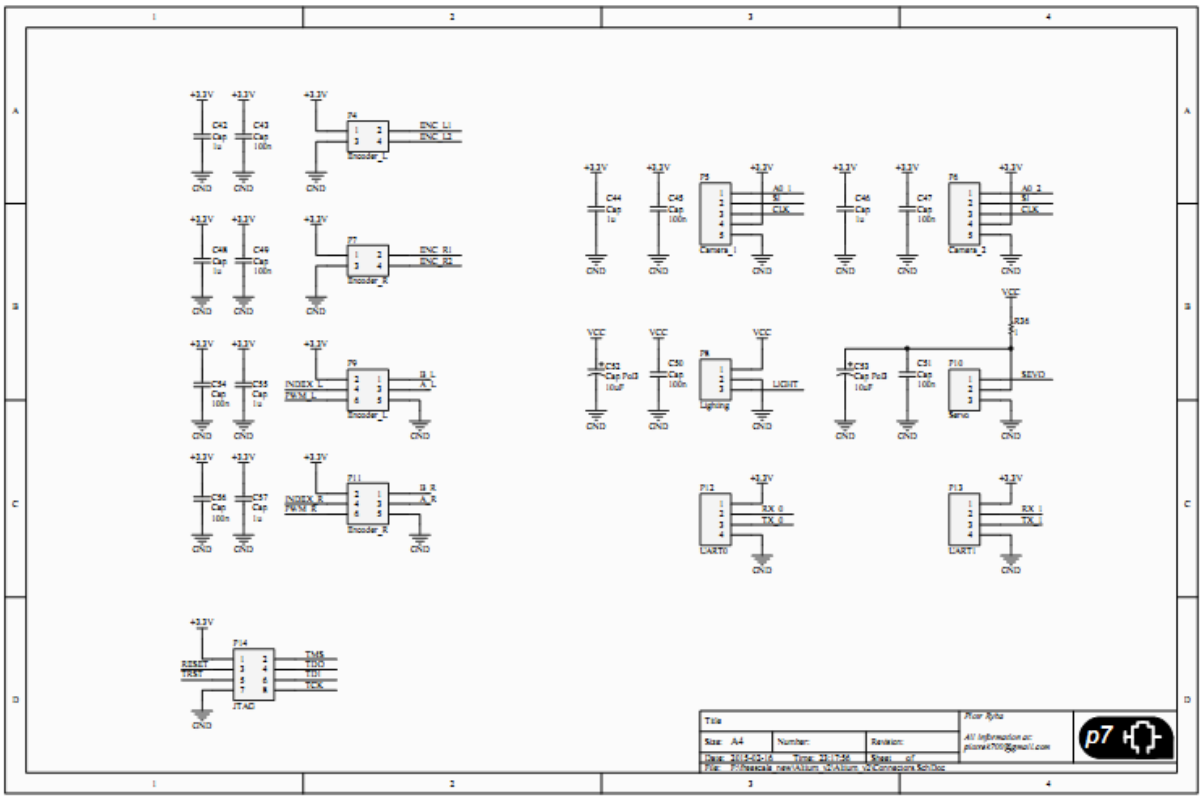
[4] TSL1401CL128 × 1 Linear Sensor Array With Hold http://www.ams.com/eng/content/download/250163/975677/file/TSL1401CL.pdf

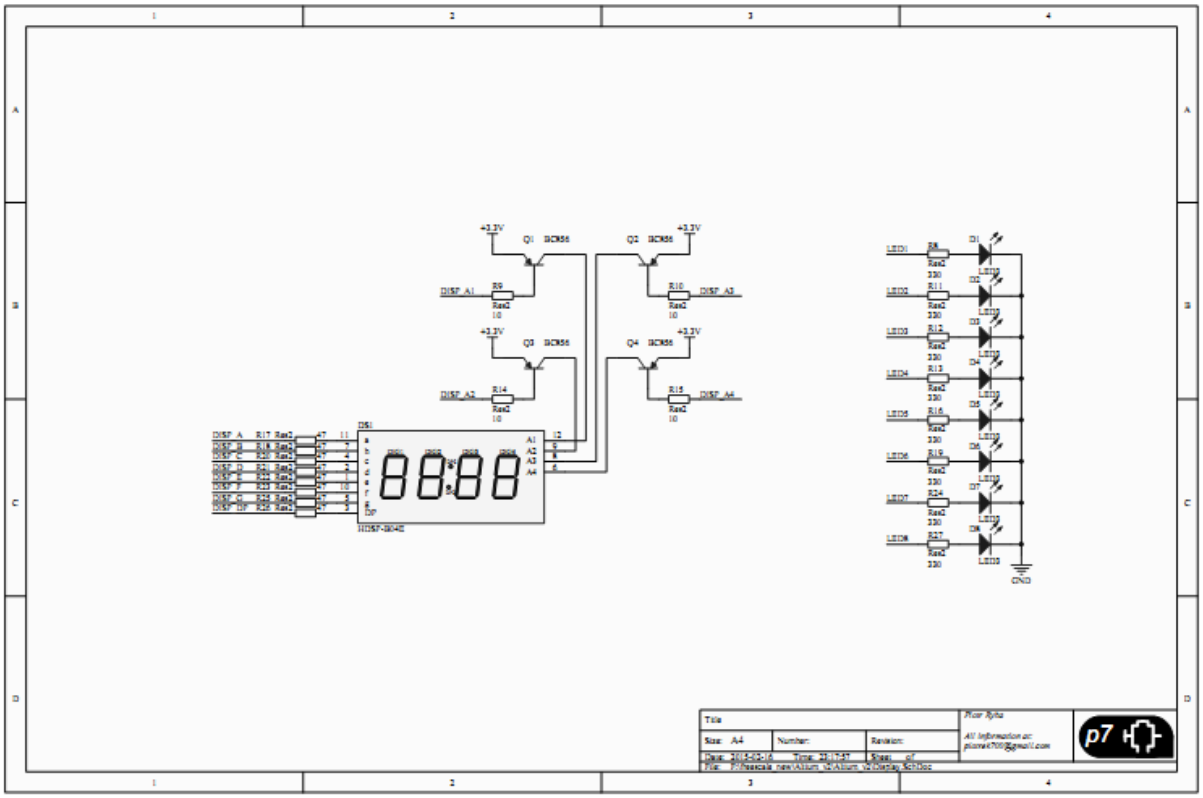
[5] PID for Line Following, http://www.chibots.org/index.php?q=node/339

[6] AS5040 Rotary Sensor http://ams.com/eng/Products/Position-Sensors/Magnetic-Rotary-Position-Sensors/AS5040

## Enclosure 1






+3.3V
Q1 BCR56
Q2 BCR56
Q3 BCR56
Q4 BCR56
DISP_A1
DISP_A2
DISP_A3
DISP_A4
R9
R10
R14
R15
Res2
10
DS1
HDSP-B04E
LED1
LED2
LED3
LED4
LED5
LED6
LED7
LED8
D1
D2
D3
D4
D5
D6
D7
D8
R8
R11
R12
R13
R16
R19
R24
R27
LED10
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GND
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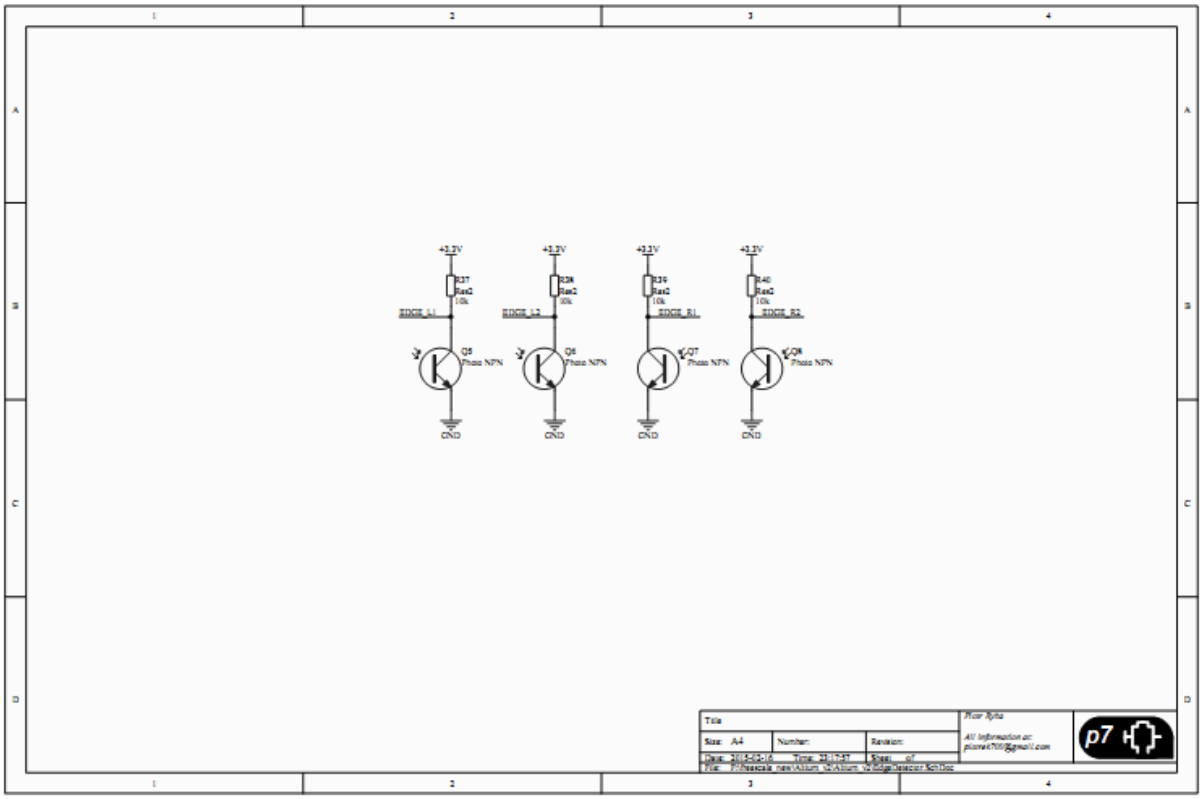
Revision:
Piotr Rytz
All information at:
piotrek7000@gmail.com
p7


+3.3V
R37
R38
R39
R40
Res2
10k
EDGE_L1
EDGE_L2
EDGE_R1
EDGE_R2
Q5
Q6
Q7
Q8
Photo NPN
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Piotr Rytz
All information at:
piotrek7000@gmail.com
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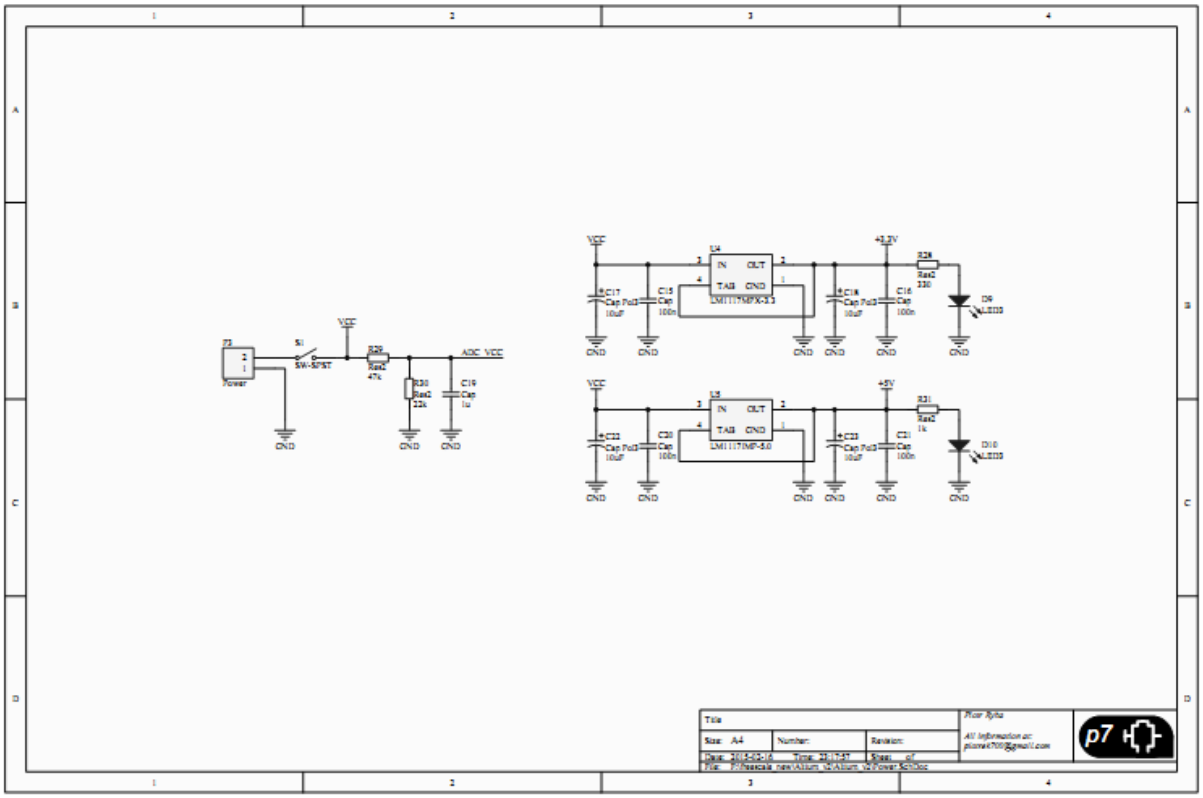
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OUT
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R28
Res2
330
D9
LED3
C17
Cap Pol2
10uF
C15
Cap
100n
C18
Cap Pol2
10uF
C16
Cap
100n
U5
LM1117MP-5.0
+5V
R31
Res2
1k
D10
LED3
C22
Cap Pol2
10uF
C20
Cap
100n
C23
Cap Pol2
10uF
C21
Cap
100n
J3
Power
S1
SW-SPST
R29
Res2
47k
R30
Res2
22k
C19
Cap
1u
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GND
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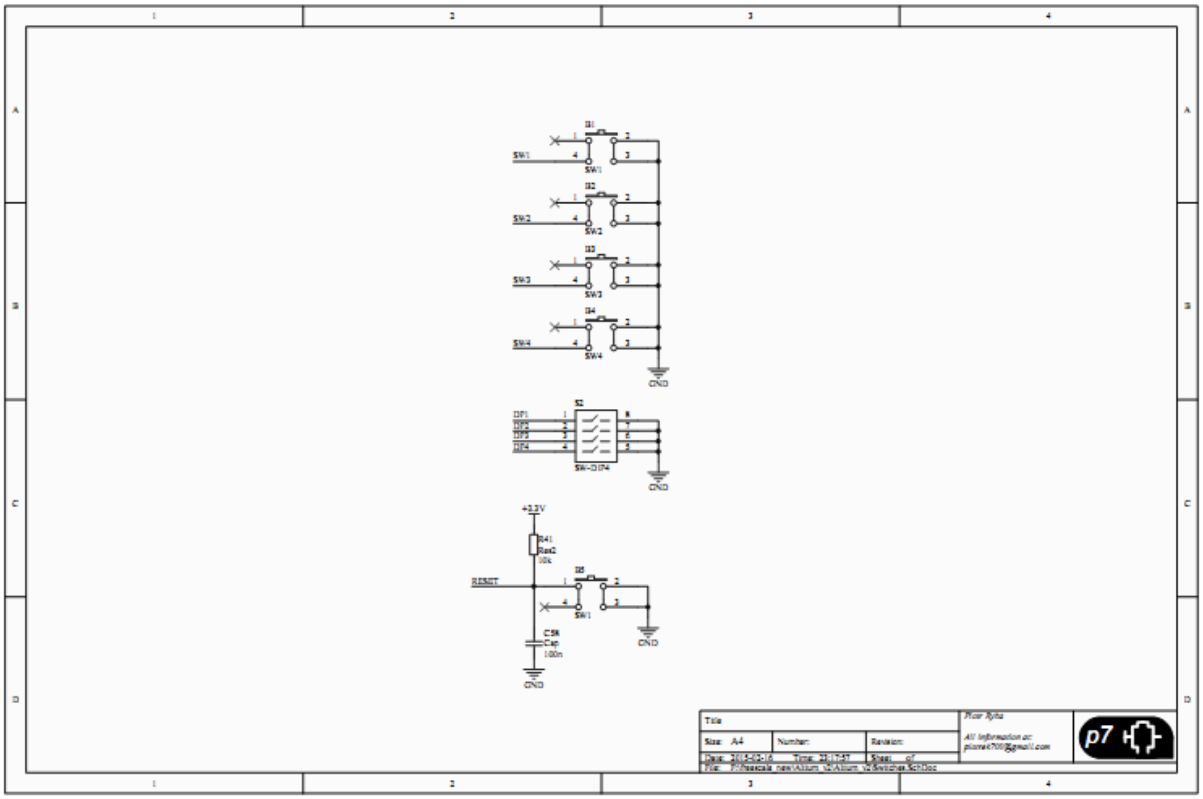
Piotr Rytz
All information at:
piotrek7000@gmail.com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SW2
SW3
SW4
S2
SW-DIP4
+3.3V
R41
Res2
10k
RESET
C58
Cap
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GND
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