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Current measurement unit for motor torque control

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Abstract:
This report presents a description of electronic hardware designed to measure current floating through DC motor using integrated magnetic sensor. Such sensor provides almost power lossless measurement, while providing decent accuracy.

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1 Introduction

Many robotics control algorithms assumes that robot actuators have input in form of torque. In reality often only regulation of dc motor supply voltage is available. In order to control torque of electric actuator, current measurement floating through motor is required. This report describes electronic module in form of Arduino shield equipped with integrated magnetic current sensor.

2 Goals to accomplish

The goal of this project was to design electrical circuit that is capable of measuring current that is powering DC motor. Such circuit has to have following properties:

- generate as small as possible power losses
- be resilient to electrical noise
- high sampling rate

3 Hardware design

Hardware design consist of three main parts:

3.1 Current sensor

As current sensor acs712 was used. It is **Fully Integrated, Hall Effect-Based Linear Current Sensor IC**. This type of sensor has huge advantage in very small power loss and simplicity of use. Most important features of this IC in this design:

- 1.2 $m\Omega$ internal conductor resistance
- 2.1 kVRMS minimum isolation voltage from input to output
- 5.0 V single supply operation
- 185 $\frac{mV}{A}$ output sensitivity
- **Factory-trimmed for accuracy**

3.2 Power supply

As power supply two low drop linear voltage regulators are used: LM1117 in 5V and 3.3V versions. The main advantage of this power supplies are:

- Ease of use
- Popularity
- Low price
- Low noise

3.3 Microcontroller development board

As a microcontroller development board NUCLEO-F411RE is used. The most important features of this board are:

- Powerful microcontroller (STM32F411RE - Arm Cortex-M4 with FPU)
- Low price
- Popularity in students environment
- Arduino compatibility

4 Used tools

- As PCB design software opensource Kicad was used
- STM32CubeMX was used as initialization code generator
- System Workbench for STM32 was used as IDE
- STM-STUDIO-STM32 as results visualization

5 Resources

This problem of this project is also described in this document: `http://ecetutorials.com/power-plant/closed-loop-speed-contorl-of-dc-motor/`

6 Results

Idea electrical schematic is presented of figure 6.5. Pcb layout and 3D model is presented on figures 6.1,6.2 and 6.3. Assembled circuit is showed on figure 6.4.

At this moment whole project is cable of measuring current floating through the motor and displaying it in STM-STUDIO. On the PCB there is installed motor controller (TB6612FNG), what makes it perfect platform for experimenting with torque control in electric motors.

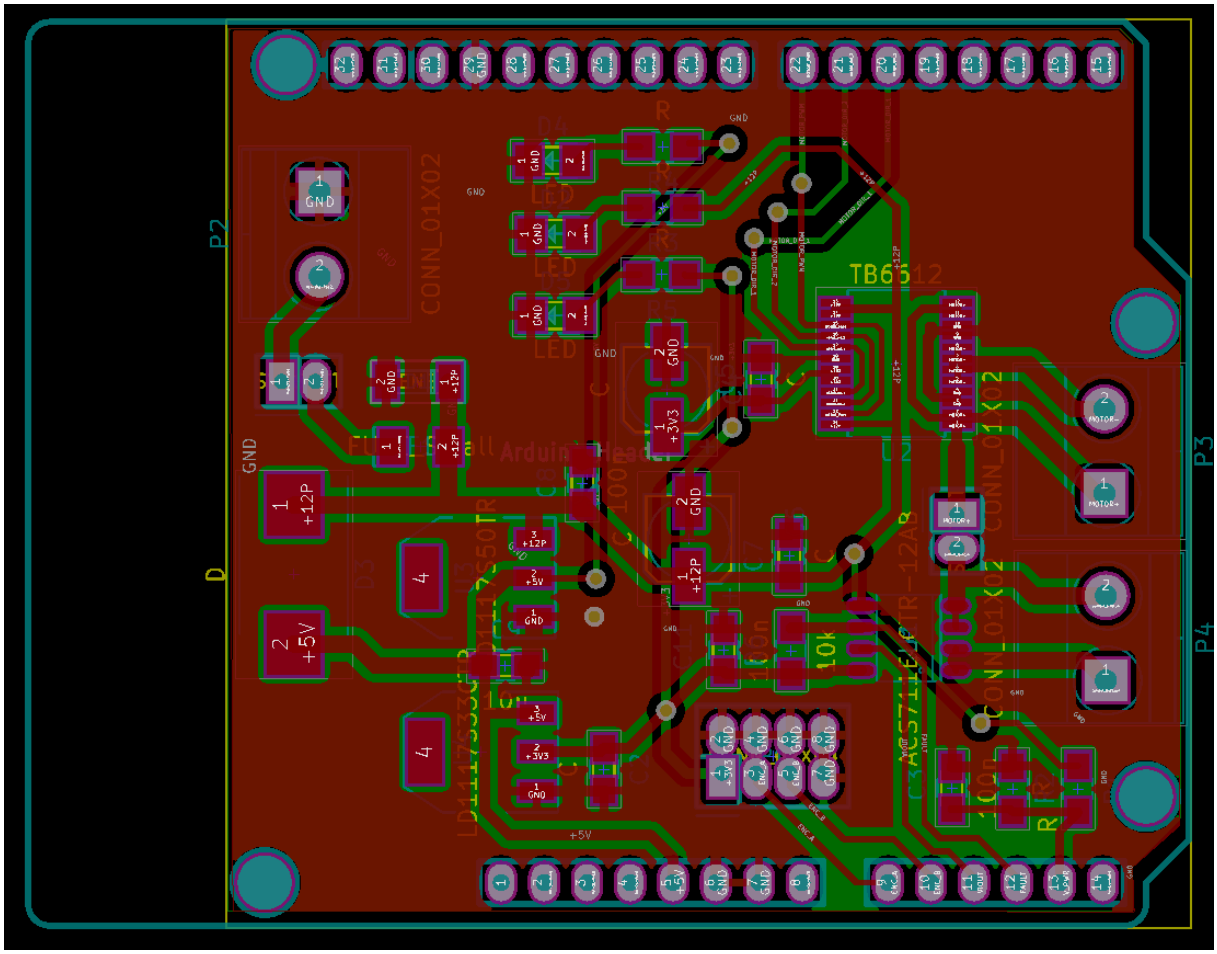

Figure 6.1: PCB top component placement

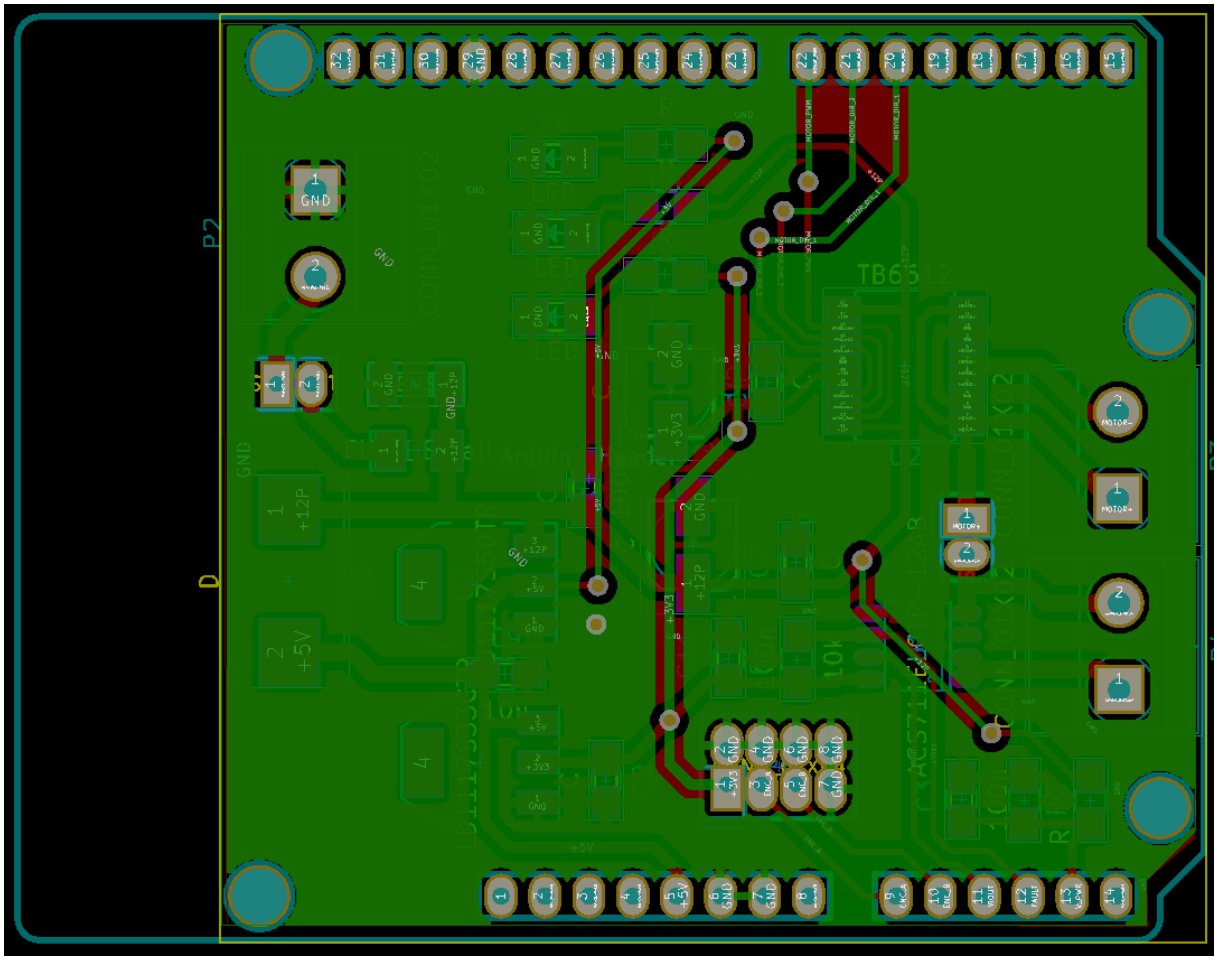

Figure 6.2: PCB bottom component placement

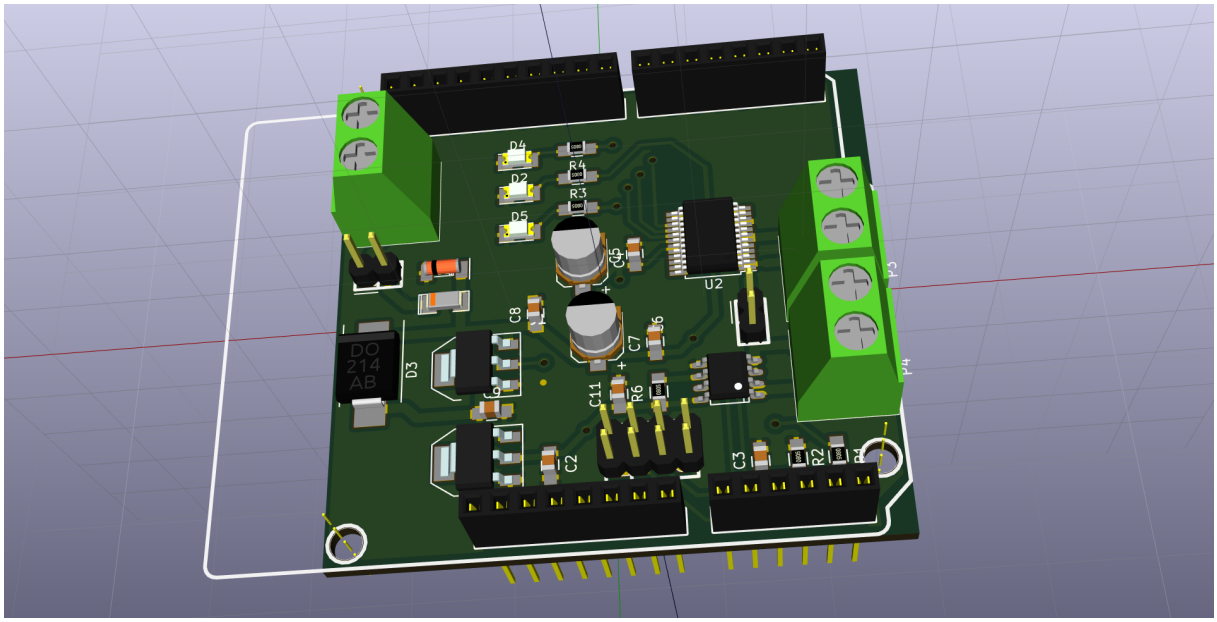

Figure 6.3: 3D view of board

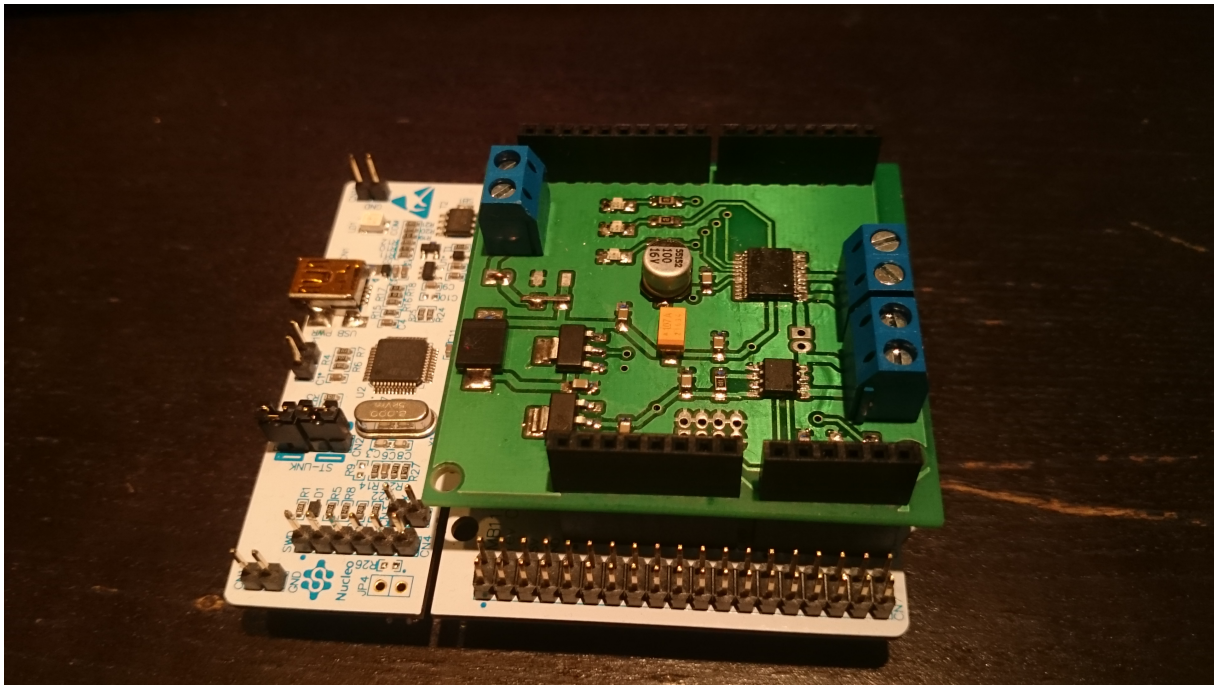

Figure 6.4: Photo of assembled circuit

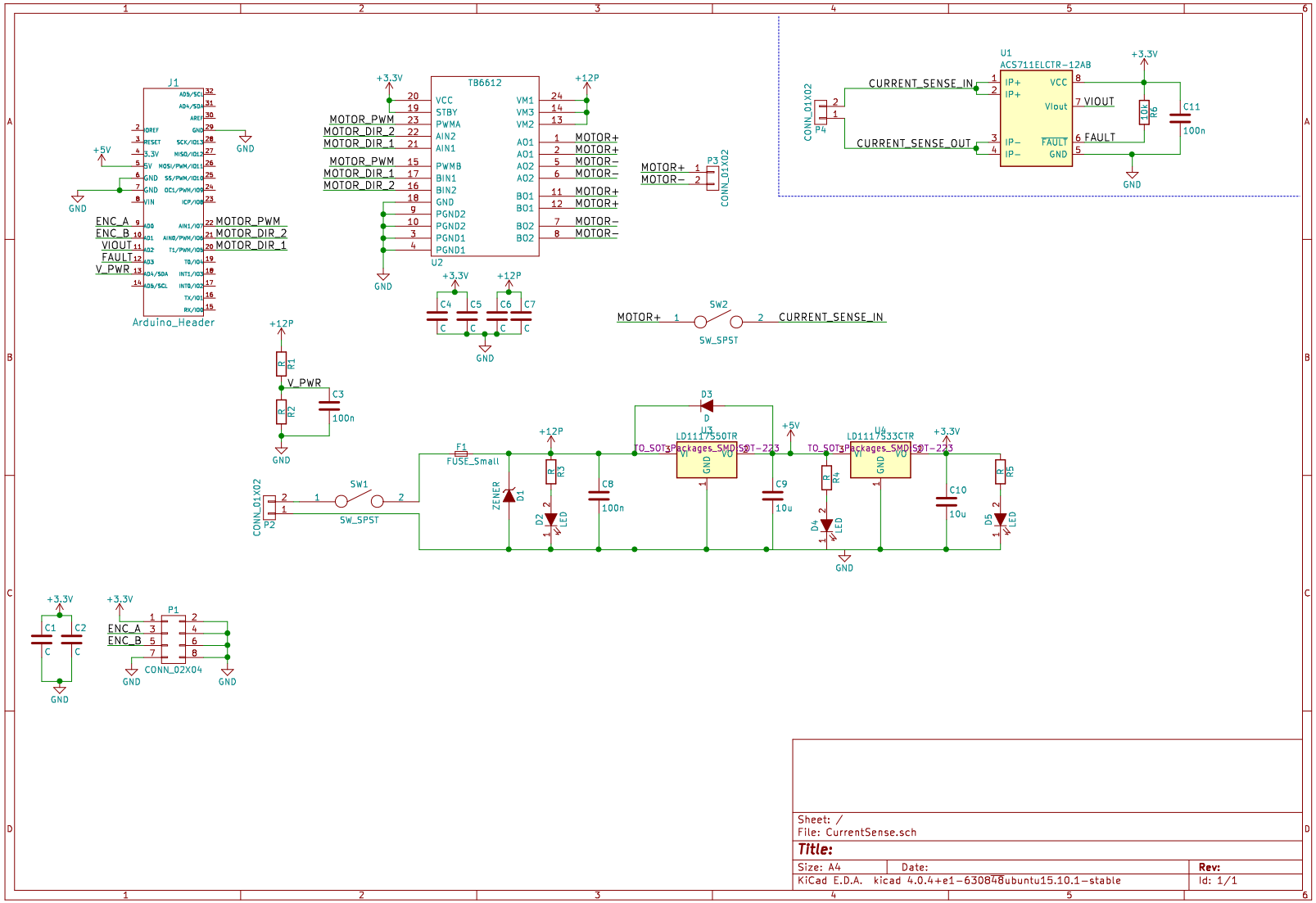

Figure 6.5: Idea electrical schematic