Magnetic Field Sensor Amplification Circuit

A Rough Overview

The board consists of five parts (see fig. 1). The INA itself, the Digipoti which sets the gain and the DAC which sets the offset. The DAC and the Digipoti can be controlled with an Arduino which is electronically decoupled with an optocoupler. Additional there is optional filter circuit. Further adjustments can be taken through the jumpers JP1 to JP5 (see fig. 2) as follows.

JP1 At left position (Pin 3,2) the DAC is unused and the Digipoti is used while in right position (Pin 2,1) DAC and Digipoti are used

JP2 Includes the filter circuit

JP3 Includes the Digipoti, without the Jumper the gain should be 1

JP4, JP5 Connecting the in and out signal ground with the power ground

Arduino Communication

The Arduino and the board communicate over the Serial Peripheral Interface (SPI).

The hardware reserved pins for the SPI are given for the different Arduino types in the following table (fig. 3[1]). The pins can also be set by the arduino software. The arduino programme uses the shared hardware pins (MOSI, SCK) and sets at the beginning the single pins (SS). Each board has two SS connections one for the DAC and one for the DigiPoti (fig. 4).

[1] `https://www.arduino.cc/en/Reference/SPI`

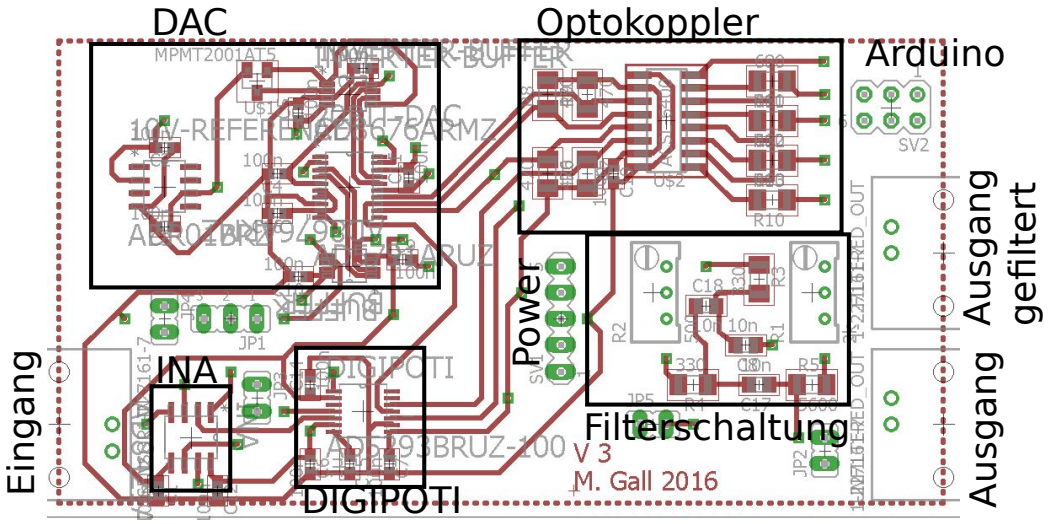

Abbildung 1: Board overview

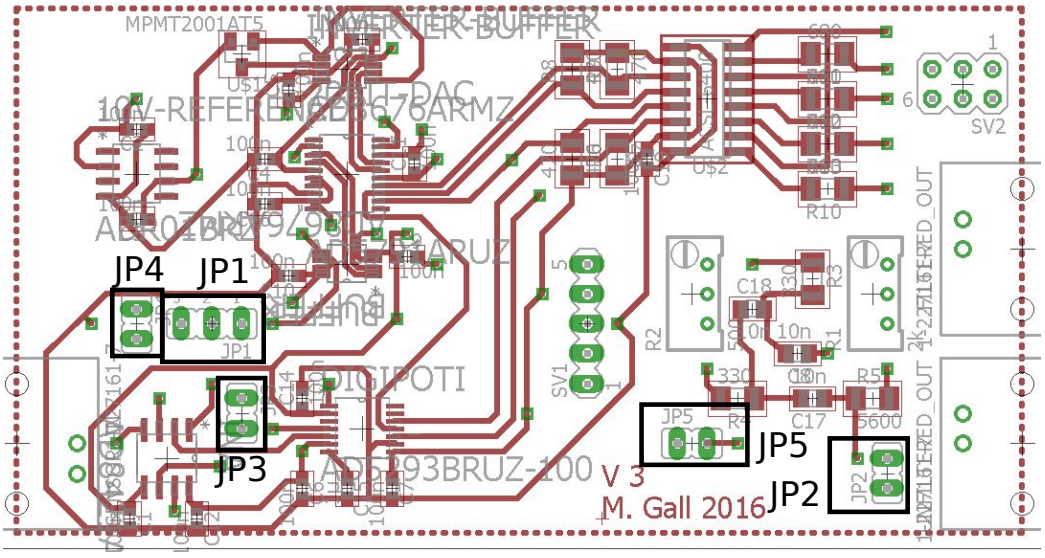

Abbildung 2: Jumper overview

Arduino / Genuino Board	MOSI	MISO	SCK	SS (slave)	SS (master)	Level
Uno or Duemilanove	11 or ICSP-4	12 or ICSP-1	13 or ICSP-3	10	-	5V
Mega1280 or Mega2560	51 or ICSP-4	50 or ICSP-1	52 or ICSP-3	53	-	5V
Leonardo	ICSP-4	ICSP-1	ICSP-3	-	-	5V
Due	ICSP-4	ICSP-1	ICSP-3	-	4, 10, 52	3,3V
Zero	ICSP-4	ICSP-1	ICSP-3	-	-	3,3V
101	11 or ICSP-4	12 or ICSP-1	13 or ICSP-3	10	10	3,3V
MKR1000	8	10	9	-	-	3,3V

Note that MISO, MOSI, and SCK are available in a consistent physical location on the ICSP header; this is useful, for example, in designing a shield that works on every board.

Abbildung 3: Arduino SPI pins

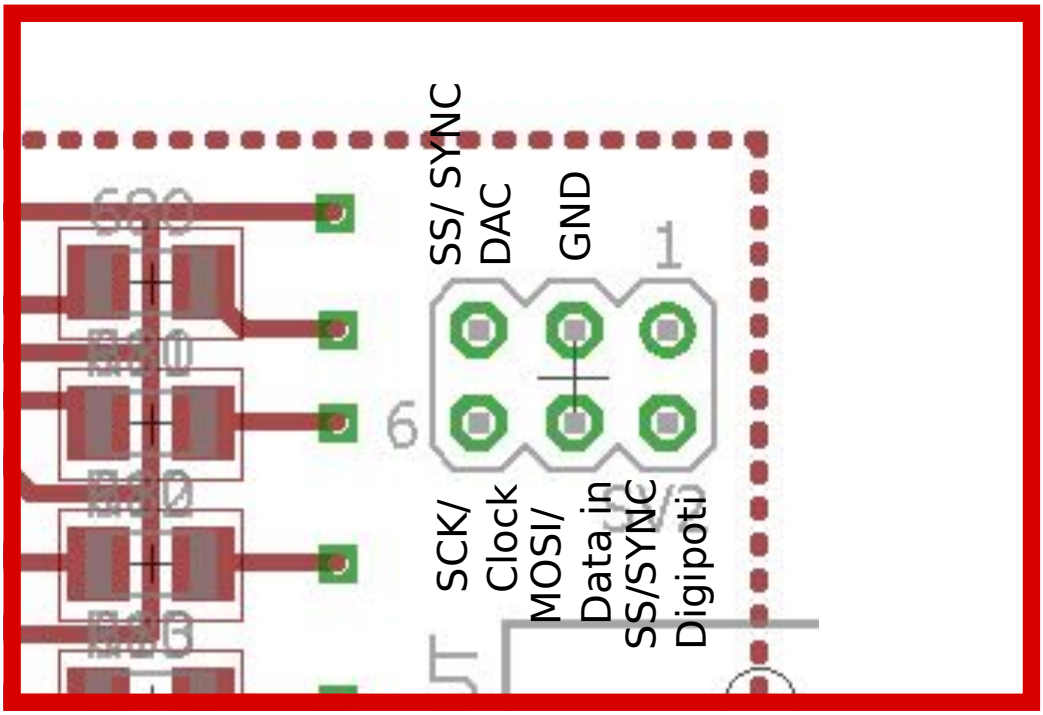

Abbildung 4: Arduino SPI pins on the board

Controlling the DAC, DigiPoti

Each board is controlled by the same Arduino. The Arduino sequence for setting the values is constructed the following way:
First define which board is addressed (A, B or C) then the component, which is either the DAC (D) or the Digipoti (P) and followed by the new value. A typical sequence looks like: *AP200*. With this sequence the value of the Digipoti on board A is set to 200.

The initial values correspond to the maximum resistor value for the digipoti and an offset of zero for the DAC. Is the value set higher than the initial value the offset is negative if it is smaller it is positive. The exact values can be found in the programme.

Power Supply

The Power supply for the magnetic field sensor and the amplification board must be separated. One way to separate them is to use a DC/DC converter, which is galvanic separated. The circuit for the separation of the powers is shown in figure 5. It could be that the voltage reference LM7815 is not

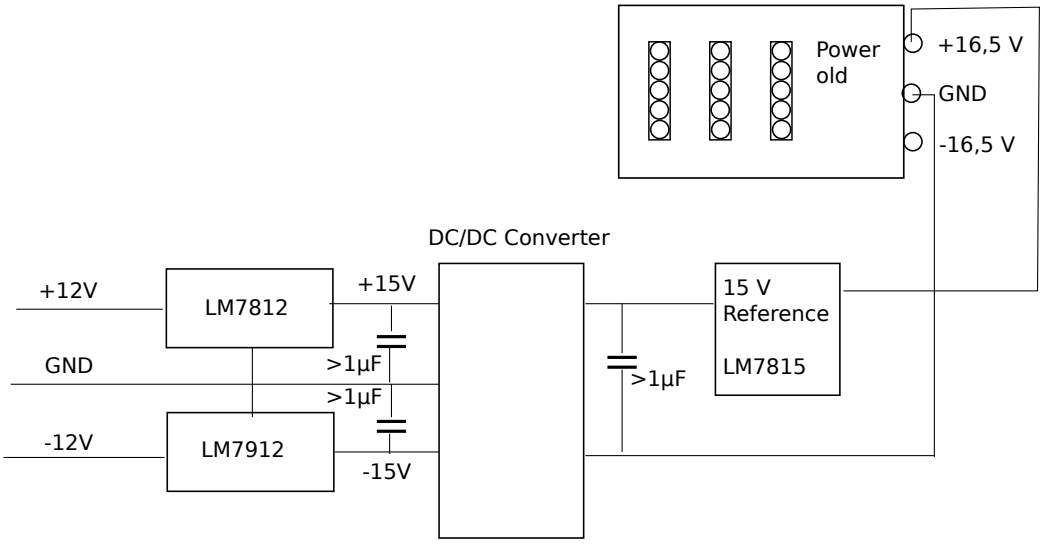

Abbildung 5: Spererated power circuit with use of one power supply.

necessary and a 47 μF capacity could be sufficient (see fig. 6).

The DC/DC converter works with a certain frequency (probably around 300 kHz), which will lead to a noisy signal since the voltage references can not compensate this. However the shown circuits are not yet tested. A better and more stable solution would be the use of two power supplies.

Magnetic Field Sensor

There exists a special wire for the readout of the magnetic field sensor. One connector is non-magnetic, which belongs to the magnetic field sensor. The pins of the readout side are shown in figure 7, note that these differ from the input configuration.

Noticeable Problems

On the bottom side of the board is a loop which belongs to GND. If this has any effects is unclear but it is possible to open the loop with a cut (see fig. 8).

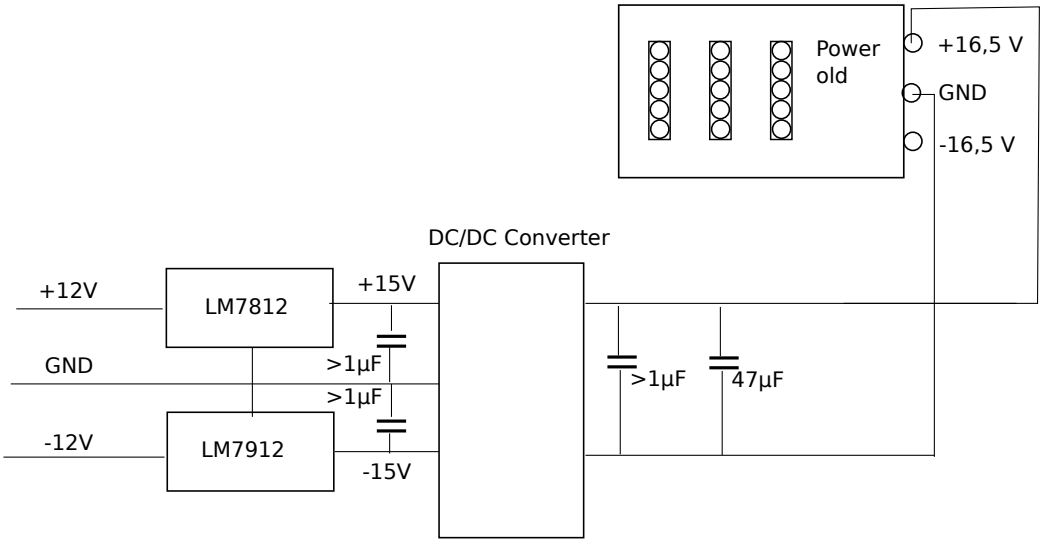

Abbildung 6: Alternative power circuit without LM7815.

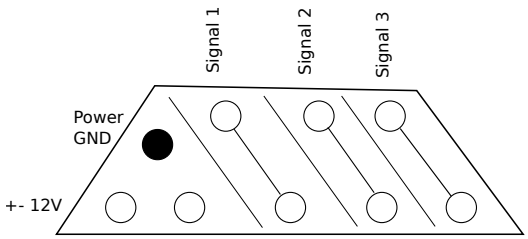

Abbildung 7: Magnetic field sensor readout pin configuration

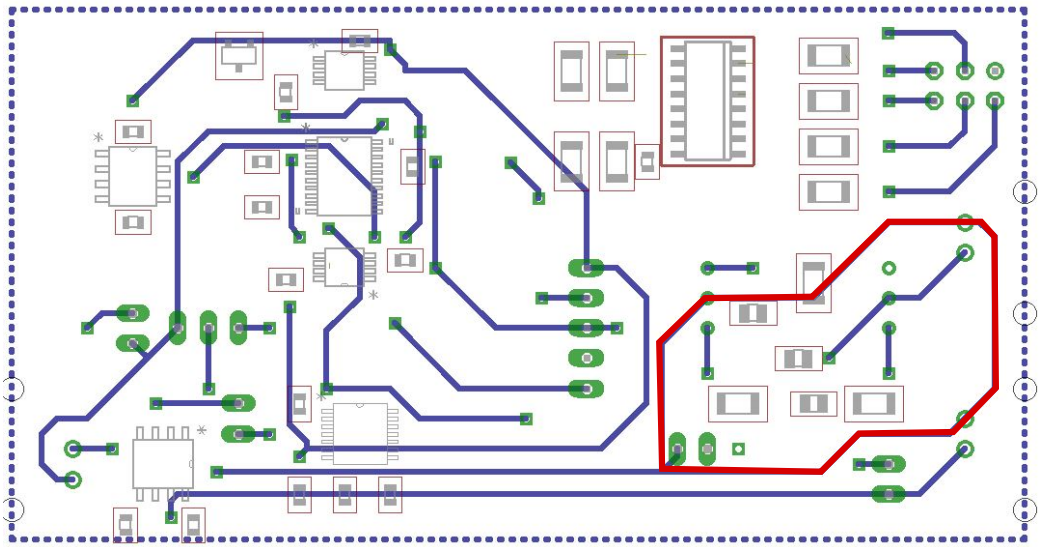

Abbildung 8: Possible GND loop (red)

Milling Tips

1. In many cases not all pads were separated properly from each other. This seems to be a common mistake, which should be checked before the components are implemented.

2. For easier soldering a conductor path isolation of 0.5 mm is recommended.

Soldering Tips

Since the board is more complex, it is useful to solder it step by step and check each step for errors.

1. Solder the vias.

2. Solder the INA and the relevant capacities. The functionality of the INA can be easily checked by a test setup. The output signal should equal the input signal.

3. Now soldering the Digipoti and the Optokoppler. Check if it is possible to change the gain with the Arduino.

4. Same with the DAC part.

5. Solder the filter circuit.

The SMD components can be soldered with a microscope. It is useful to start with a little bit solder on one pad. While heating it up again place the component there.

Sometimes the solder does not flow well therefore use some solder flux, which is available as a white permanent marker (Edding) looking pen.

Debugging Tips

Unsoldering: SMD components are easily unsoldered with solder-tweezers.

Loose short-circuit: Responsible can be copper shavings. Search for it with a microscope and/or use compressed air to clean the board.