Controller Network

Part 1

For the calculation of the minimal response time we use the Baudrate from the lecture of Modbus RTU which is 115200 bits per second. For the message we use 8 Bytes per message. Well need a request and a response until we can update so the formula is:

$$ \frac{1}{115200\frac{bits}{s}}\cdot (8 \cdot 8 \cdot 2) bits = 0.00006944 s \approx 0.00007 s = 70 us $$ We round to 70 us for having time for the bus idle. The sensor works as follows: A piece of paper spins around at a certain spot on the wheel everytime the wheel spins one time it will darken a lightsensitive Resistor. An Analog pin measures the voltage difference which appears when the resistor has no light an from that we can determine the spinning speed. The test task is to compare the both sensore values the one of the sensor built into the motor and the lightsensitive sensor.

Messages

Messages are built up as follows:

- 1 Byte: ID of the Responder: 01 (Motor) or 02 (Sensor)
- 2 Byte: ID of the Task: 03 (read) or 06 (write)
- 3 & 4 Byte: Address
- 5 & 6 Byte: Message
- 7 & 8 Byte: CRC

Address:

- Motor: Control state: 0001, RPM 0005, Set Speed 0009
- Sensor: Read Value: 0006

Message: Data
CRC: Calculated

Error codes are directly taken from the modbus RTU protocol:
illegal_func = 0x01
illegal_addr = 0x02
illegal_data = 0x03
device_fail = 0x04

Protocol difference

For transmitting errors, the protocol does not comply with the official modbus protocol. For simplicity it was decided to only use 8 byte messages.

The developed protocol is transmitting the error code in the message field, and it also sets the highes bit in the task id byte. The address field will be not changed and the crc is calculated as usual for the transmitted values. Examples screenshots from the oscilloscope can be seen in Part 3.

Part 2

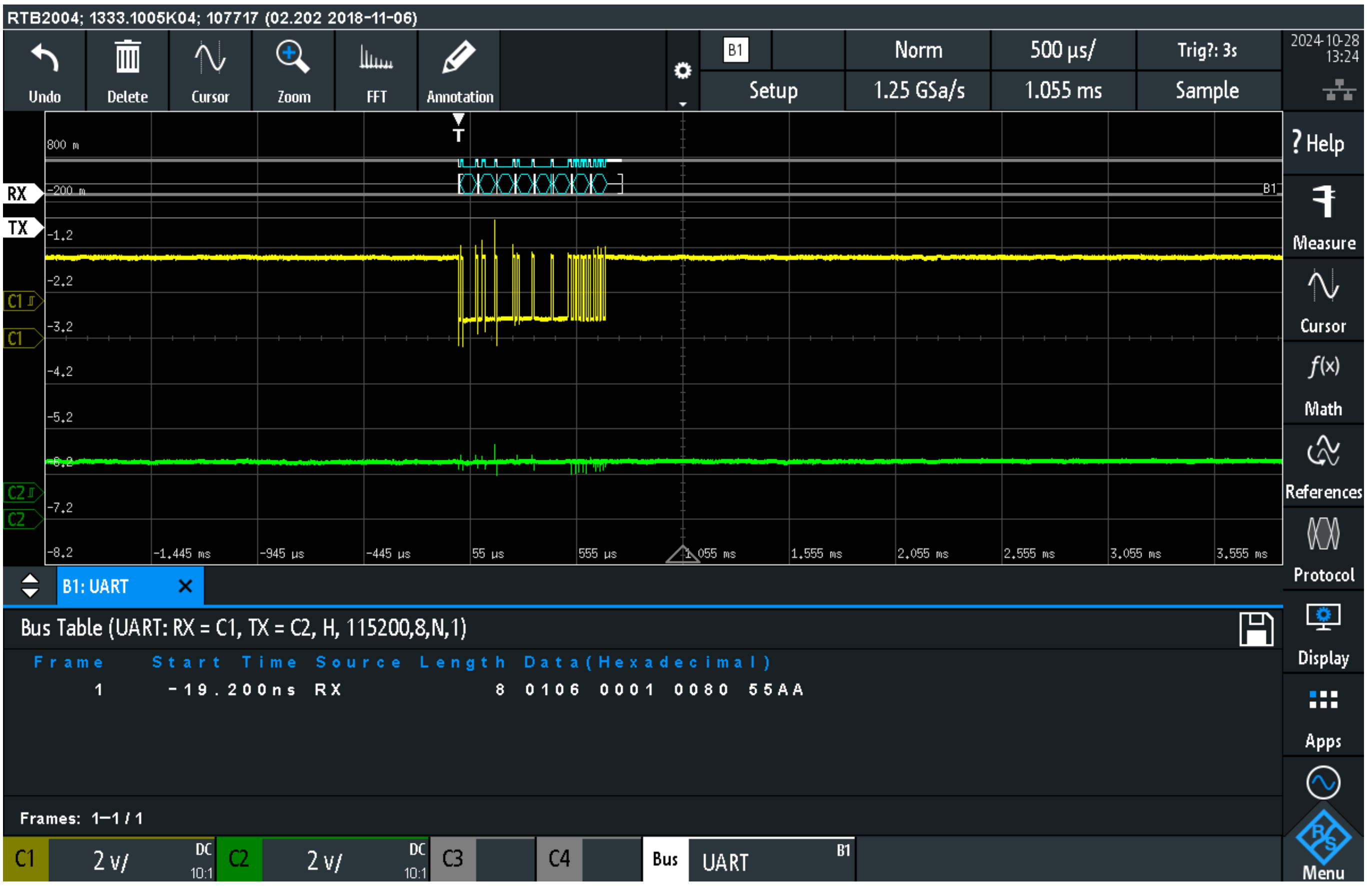
Testing

For testing the serial communication, the code from Assignment 5.2 was used.

simulating crc error

RPi is sending wrong crc value

Message is ignored from Arduino



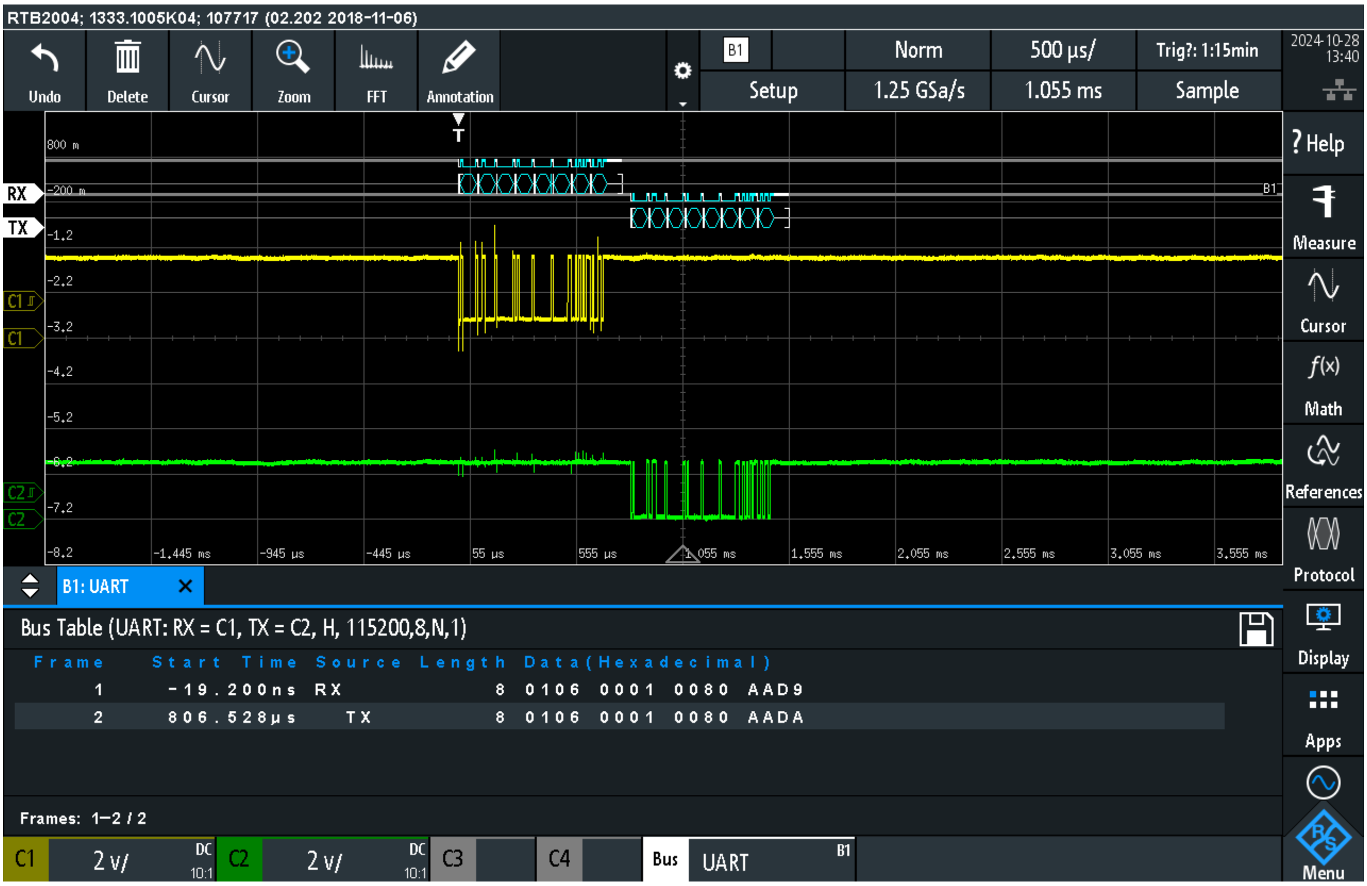
Bus Table (UART: RX = C1, TX = C2, H, 115200,8,N,1)

Frame	Start Time	Source	Length	Data(Hexadecimal)
1	-19.200ns	RX	8	0106 0001 0080 55AA

Frames: 1–1 / 1

CH1: RX line Arduino
CH2: TX line Arduino
Bus table: request was sent to write value 128 at address 1; Arduino does not respond to this valid message, because the CRC value is wrong

Arduino is sending a wrong crc in the answer



Bus Table (UART: RX = C1, TX = C2, H, 115200,8,N,1)

Frame	Start Time	Source	Length	Data(Hexadecimal)
1	-19.200ns	RX	8	0106 0001 0080 AAD9
2	806.528µs	TX	8	0106 0001 0080 AADA

Frames: 1–2 / 2

CH1: RX line Arduino
CH2: TX line Arduino
Bus table: request was sent to write value 128 at address 1; Arduino responds with a wrong crc value

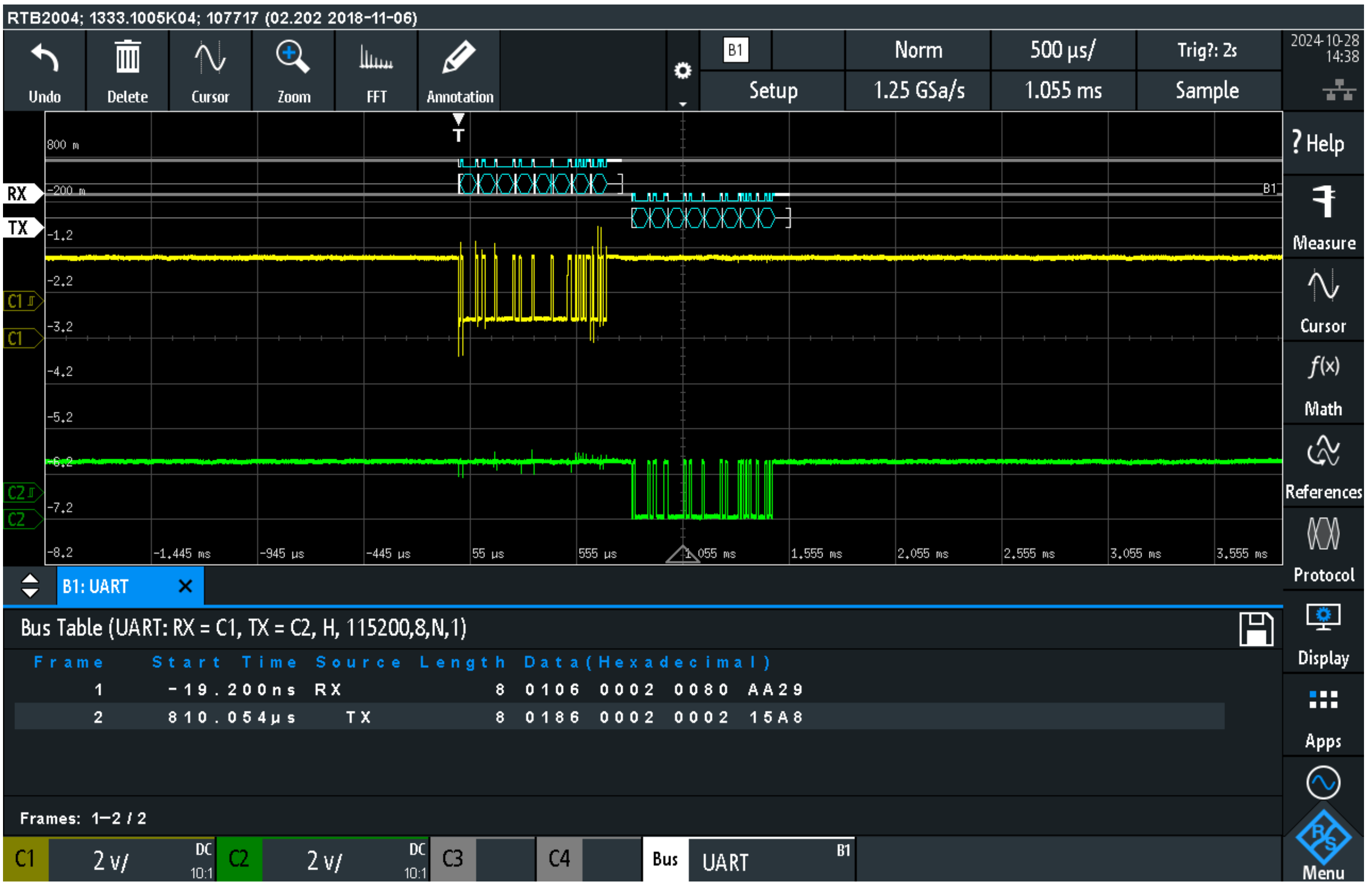
Print from linux terminal:

```
pi@rpi-matthiasr24:~/Controller_network/Master_Rpi $ ./modbus 1 6 1 128
Sent request: 01 06 0001 0080 aad9
CRC Error, will not use message. Received: 0xaada Calculated: 0xaad9
```

Part 3

Exceptions

Illegal Data Address

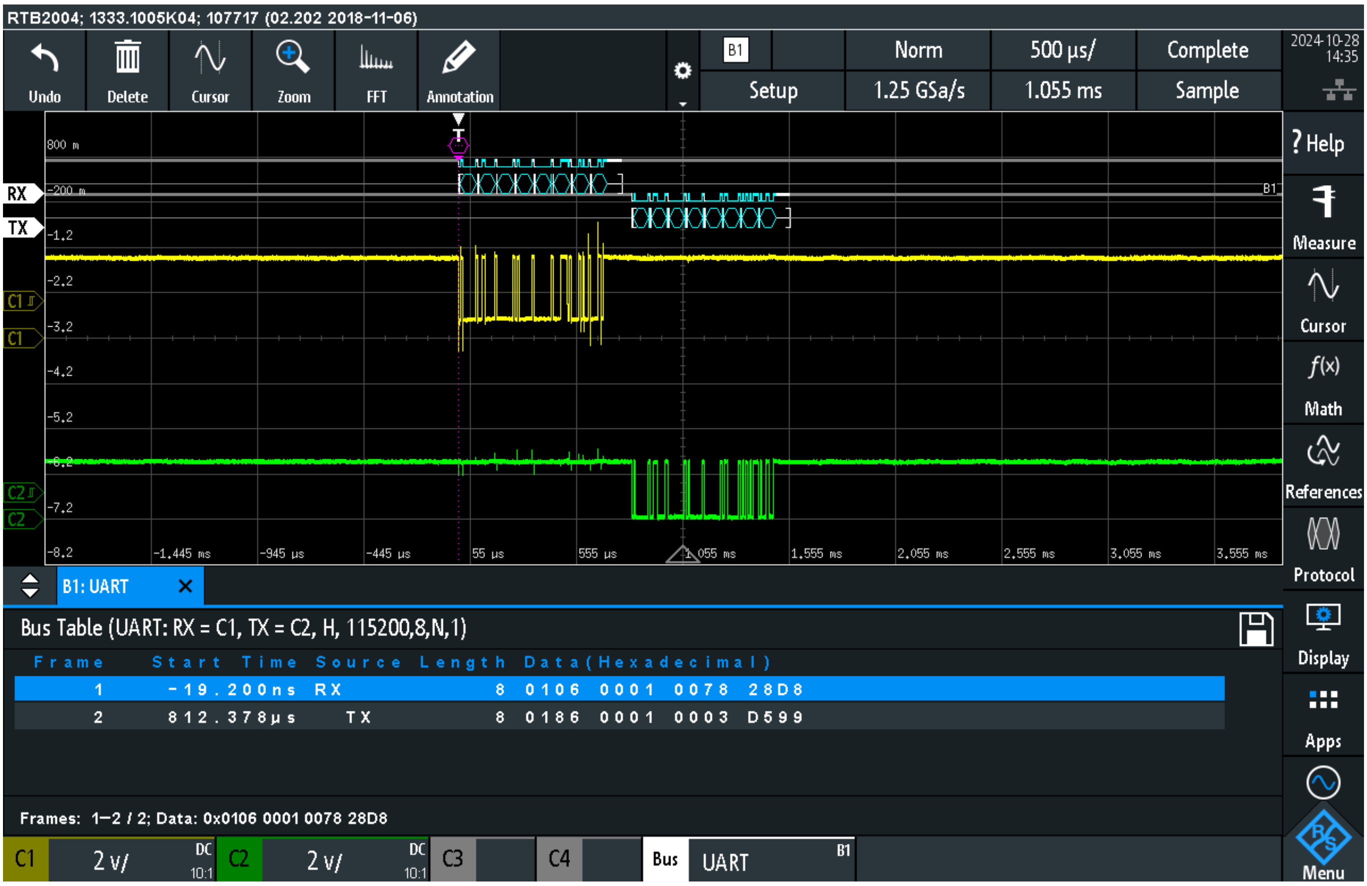


Bus Table (UART: RX = C1, TX = C2, H, 115200,8,N,1)

Frame	Start Time	Source	Length	Data(Hexadecimal)
1	-19.200ns	RX	8	0106 0002 0080 AA29
2	810.054µs	TX	8	0186 0002 0002 15A8

CH1: RX line Arduino
CH2: TX line Arduino
Bus table: request was sent to write value 120 at address 1, Arduino responds with illegal data response message in the data field

Illegal Data Value



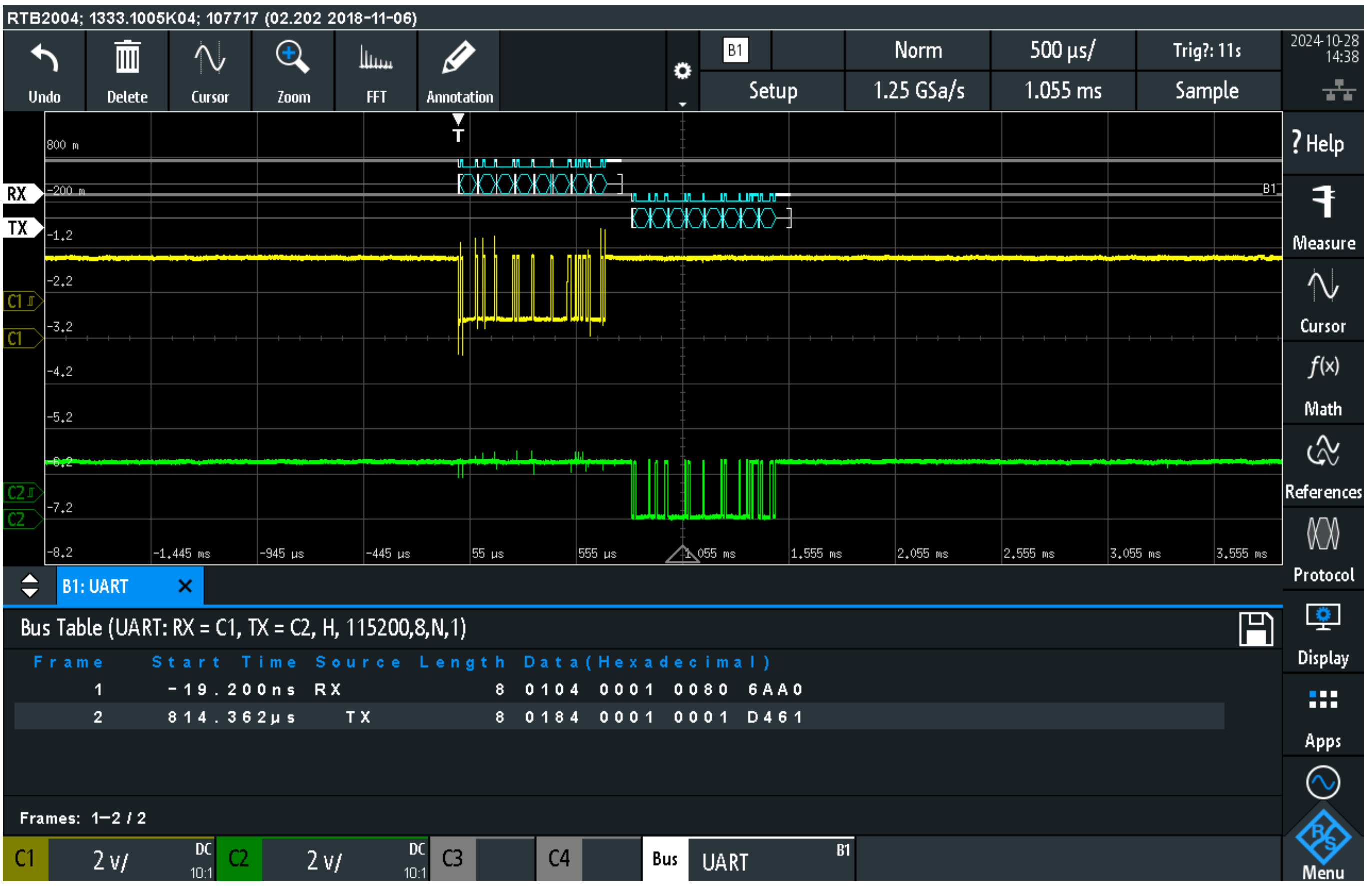
Bus Table (UART: RX = C1, TX = C2, H, 115200,8,N,1)

Frame	Start Time	Source	Length	Data(Hexadecimal)
1	-19.200ns	RX	8	0106 0001 0078 28D8
2	812.378µs	TX	8	0186 0001 0003 D599

Frames: 1–2 / 2; Data: 0x0106 0001 0078 28D8

CH1: RX line Arduino
CH2: TX line Arduino
Bus table: request was sent to write value 120 at address 1, Arduino responds with illegal data response message in the data field

Illegal Function



Bus Table (UART: RX = C1, TX = C2, H, 115200,8,N,1)

Frame	Start Time	Source	Length	Data(Hexadecimal)
1	-19.200ns	RX	8	0104 0001 0080 6AA0
2	814.362µs	TX	8	0184 0001 0001 D461

Frames: 1–2 / 2

CH1: RX line Arduino
CH2: TX line Arduino
Bus table: request was sent for function 4, Arduino responds with illegal function response message in the data field.

systemd

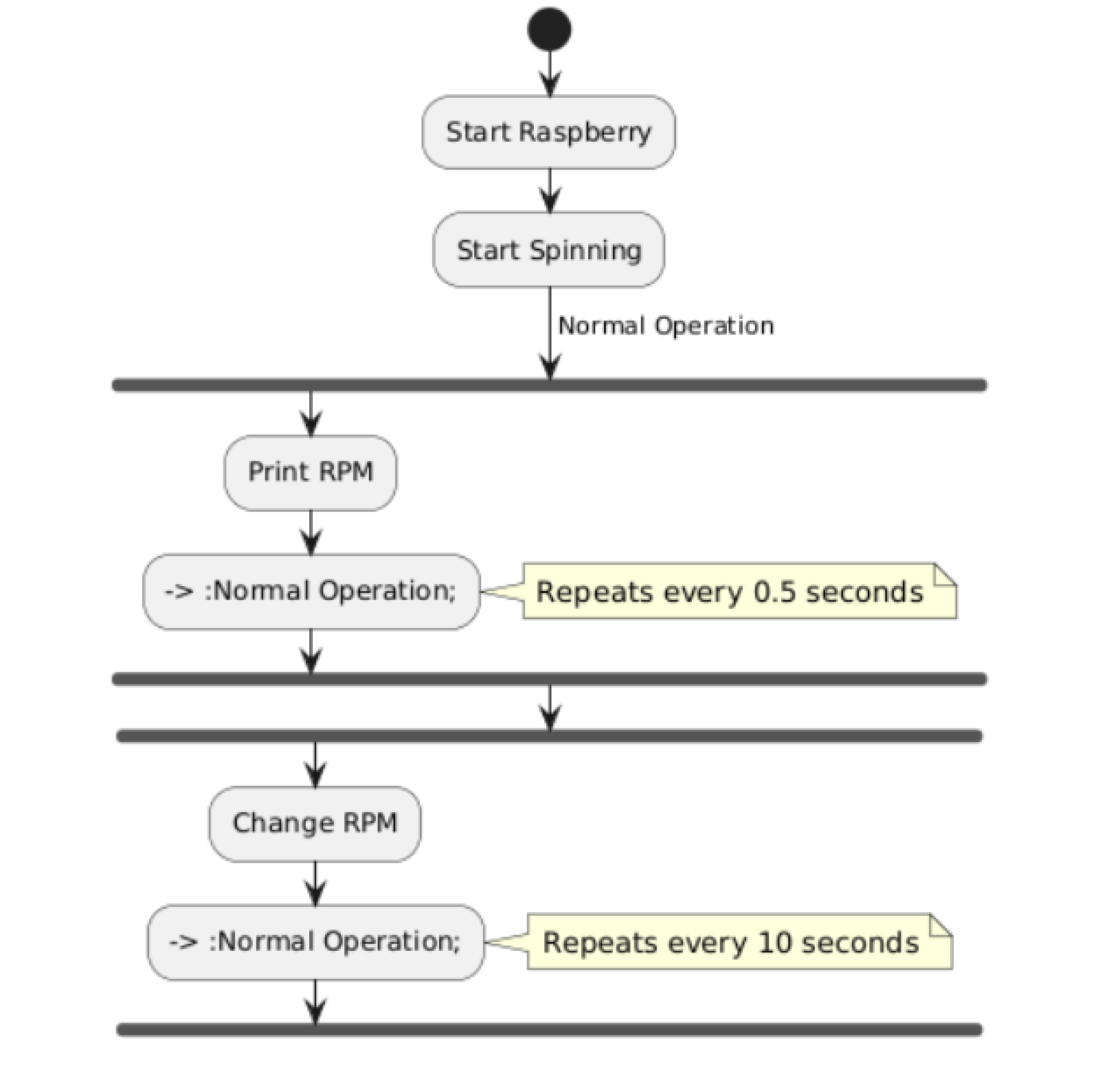
With the systemd file controller.service the programm main.cpp starts automatically when the raspberry is booting.

print

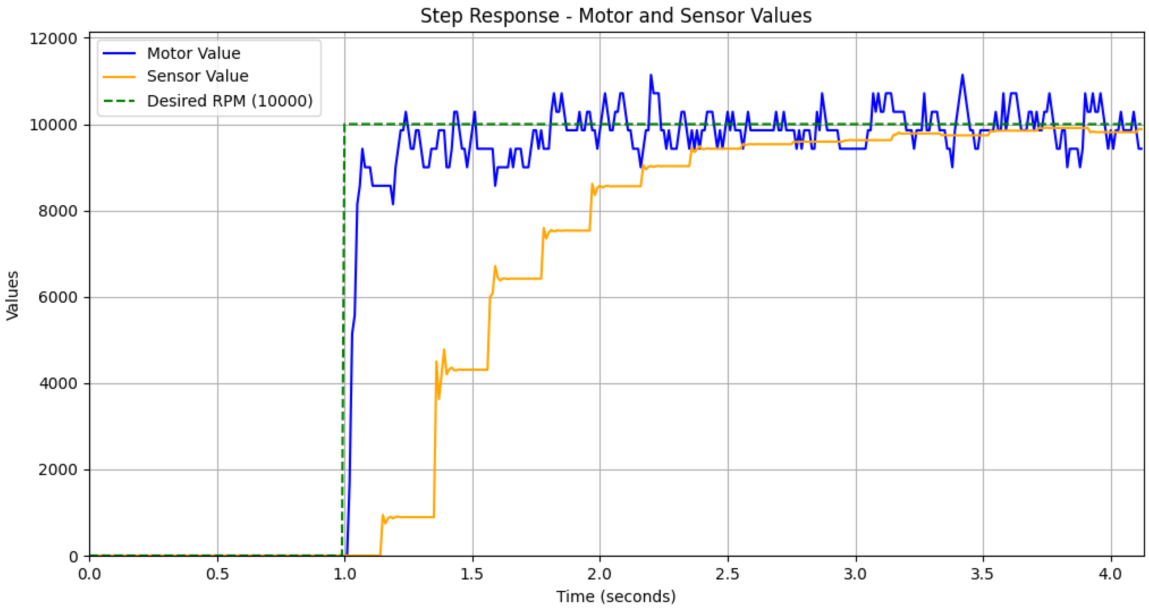
In the printOut.txt is a sample output of the programm. It shows the status change of the motor in the beginning and prints the calculated RPM of the Motor and the Sensor value.

Part 4

The following Diagram shows the programm:



On the following figure the Step response is shown with both sensors displaying the RPM:



YouTube: https://youtu.be/4T9cs9V0CYY?si=DkrCI6loCEgpb1c4

GitHub: https://github.com/UniRoi/Controller_network