ID S3

Function and characterization of a temperature and humidity sensor with 1-wire interface and a gas sensor with I2C interface

Required Knowledge:

- 1-wire Interface
- Environmental Measurements: Temperature, Humidity, VOC's
- Arduino Programming
- Python Programming (Anaconda/Spyder)
- Datasheet DHT-11 (https://components101.com/sites/default/files/component_datasheet/DHT11-Temperature-Sensor.pdf or https://www.mouser.com/datasheet/2/758/DHT11-Technical-Data-Sheet-Translated-Version-1143054.pdf)
- Datasheet CCS811 (e.g. https://cdn.sparkfun.com/assets/learn_tutorials/1/4/3/CCS811_Datasheet-DS000459.pdf)

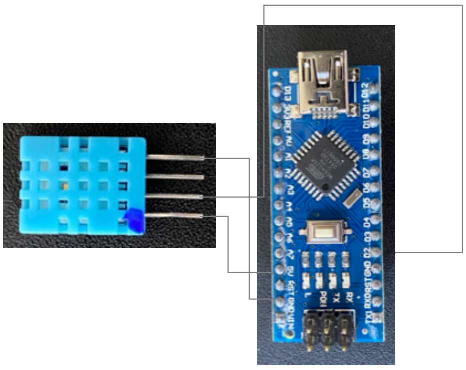
Material:

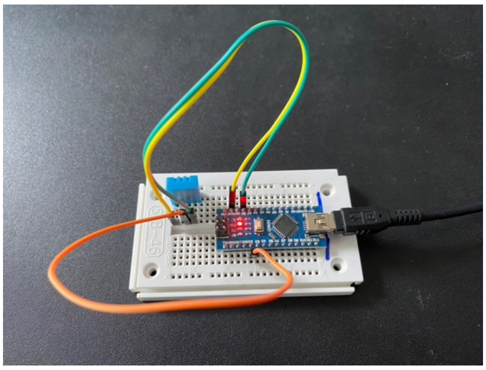
- Arduino Nano
- Temperature and Humidity Sensor DHT11
- Breakout Board CCS811
- Breadboard
- USB-Mini Cabel
- 3 Male-Male Connectore (1-wire)
- 5 Male-Female Connectors (CCS811 / I2C)
- Laptop, Arduino-IDE, Python-IDE (z.B. Anaconda), simple terminal software (z.B. HTerm)

Duration: approx. 4h

Setup:

Hardware:





Please note: According to the specification, a 10kOhm resistor should also be used as a pull-up between signal line and 5V. The sensor then pulls the line to ground with low resistance for communication.

WARNING: Reverse polarity (5V/GND) will destroy the sensor (a hole will appear on the back). Thus, make sure, the sensor is connected correctly BEFORE turning the power on!

Software:

- Arduino IDE with the libraries „DHT sensor library" and „Adafruit Unified Sensor"
- Anaconda/Spyder
- Prepared programmes from the Teams site (Arduino, Python)

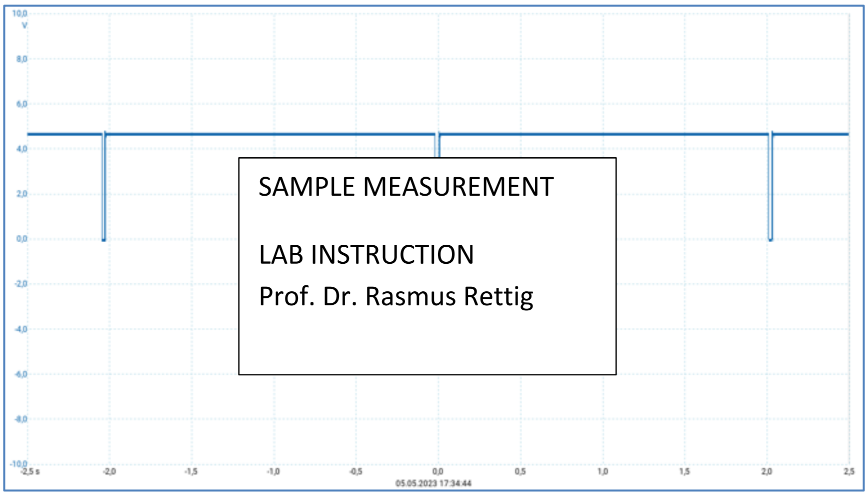
Part 1 - Setup

- Setup the Arduino and the DHT11 on the breadboard
- Three connections are required: 5V, GND, 1-wire pin (in code: Arduino / D2); **MAKE SURE, THE DHT11 IS CONNECTED CORRECTLY BEFORE POWERING ON (NO REVERSE POLARITY)**

- Download the program "Basisprogramm_DHT11_Arduino" from the teams site, compile it and transfer it to the Arduino
- Check the transmitted times with "Tools/Serial Monitor" or "Tools/Serial Plotter"; make sure that the transmission parameters (COM port and baud rate) are set correctly
- Download the "Basisprogramm_ReadUSB_DHT11" program and load it into your editor under Anaconda/Spyder
- Start the program there and check the output values. You may have to install the "pyserial", "numpy" and "matplotlib" libraries in the Anaconda Navigator beforehand
- Make sure that the COM port and baud rate are also set correctly in the program
- Analyze both programs: Which measurement data is recorded and how does the measurement data get onto the laptop, include a brief explanation and flow chart for the data flow

Part 2 – Analysis of the physical layer of the 1-wire interface with an oscilloscope

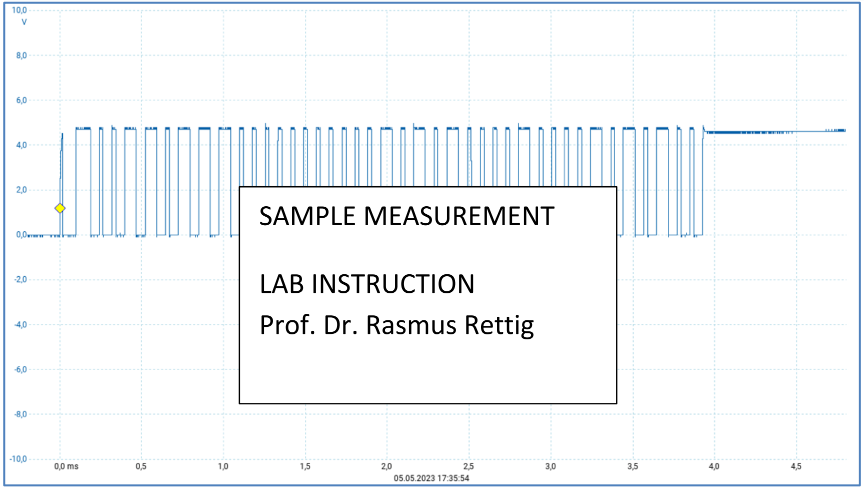
- Connect the oscilloscope to your measurement setup. Measure the voltage between the 1-wire line and GND with a probe (please adjust the square-wave signal beforehand!).
- Examine the 1-wire protocol: How does a telegram look like?
  How often are messages sent per second?
- Decode your device ID based on your measurement. Document the result in your lab report!



SAMPLE MEASUREMENT

LAB INSTRUCTION

Prof. Dr. Rasmus Rettig



SAMPLE MEASUREMENT

LAB INSTRUCTION

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Part 3 – Sensor time constants

- Set up the sensor and let it run until the values for temperature and humidity no longer change (typically a few minutes).
- Start the measurement data acquisition in Python

- Breathe briefly on the sensor, watch the temperature and humidity rise and then fall again. Save and plot your measurement result RH(t) and T(t). Plot with the y-axis both linearly and logarithmically scaled.
- Fit an exponential function to the decreasing curves of both quantities. To do this, select a suitable area of the measurement curves. Which time constants τ do you observe?
- Confirm your results by plotting both the measured data and the exponential function into the same graph.

Part 4 – Automatic fan control

- Modify the Arduino program so that the built-in LED (pin 13) turns on when the temperature exceeds a threshold. If the threshold value is not reached again, the LED should be switched off again. This function could also be used to switch on a fan via a relay or power transistor.

Part 5 – Integration of CCS811

- Figure out how to integrate the CCS811 into the system (hardware, software), document your approach and implement it
- In each run of the program, in addition to the measurement data from the DFT11, also transfer the data from the CCS811 and store and save them together
- Carry out a measurement over about 5 minutes and record the following five measured values in parallel: DHT11: temperature, relative humidity; CCS811: Temperature (please measure and correct the offset beforehand), TVOC, CO2
- Compare all measurement data graphically with Python and describe/discuss the relationships (5 coordinate systems with a common time axis)