Features

- Measures all important indoor air quality values: T, RH, light intensity
- Communicates via Modbus RTU (RS-485)
- Wide input voltage range 5 - 30V
- Easy to setup using Raspberry Pi and open-source Veles Sensors python library
- Temperature range -40 - 125 °C
- Relative humidity range 0 - 100 %
- Light intensity from 0.01 to 64k lux
- Fully opensource

Description

RHT01 is a wired indoor air quality sensor measuring temperature, relative humidity and light intensity. Communication over RS-485 using Modbus RTU protocol makes it easy to interface with the sensor using PLC or any PC with RS-485 to USB converter. Open-source Python libraries are available to ease sensor configuration and readout using PC and embedded computers (e.g. Raspberry Pi).

A wide input voltage range makes it possible to integrate the sensor with many different systems, ranging from house-wide 12V bus to 5V USB connected to a local computer.

Fully open-source ecosystem: sensor hardware, case, firmware, and connected Python libraries are open-sourced under permissive licensing.

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1 Specifications

1.1 Electrical Specifications

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input voltage	V_{DD}	5	12	24	V
Average supply current	I_{DD}			50	mA
RS485 Single-Ended Output High	V_{OH}	2.2			V
RS485 Single-Ended Output Low	V_{OL}			0.8	V
RS485 Differential Output	V_{OD}	2.0			V
RS485 Receiver Differential Threshold Voltage	V_{TH}	-200	-105	-10	mV

Table 1: Electrical Specifications

1.2 Sensing Specifications

Parameter	Conditions	Value
T measurement range	-	–40 ÷ +125 °C
T measurement accuracy	Typical	±0.2 °C
T measurement repeatability	Typical	±0.2 °C
RH measurement range	-	0 ÷ 100 %RH
RH measurement accuracy	Typical	±1.8 %RH
RH measurement repeatability	-	±0.08 %RH
RH measurement repeatability	ADC Ticks	0 ÷ 65535

Table 2: Sensing Specifications

1.3 Interface Specifications

Parameter	Value
Used Protocol	Modbus RTU
Default Baudrate	19200 Baud
Usable Baudrates	4800, 9600, 14400, 19200, 28800, 38400, 57600, 76800, 119200 Baud
Data Bytes	8
Parity	Even
Stop Bits	1

Table 3: Sensing Specifications

1.4 Connectors Pinout

1.4.1 Main Connector Pinout

The main connector is the Sullins Connector Solutions SWR204-NRTN-D02-RA-GA connector. The matching connector for the cable is SWH204-NULN-D02-UU-WH with SWT204-UPTN-S01-UU-UU crimping pins.
The pinout can be seen in figure 1 and table 4.

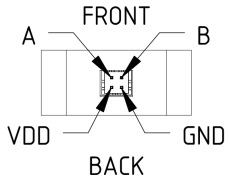


Figure 1: Main Connector Pinout

Pin	Name	Description
1	VDD	Supply Voltage
2	A	RS485 A+
3	B	RS485 B-
4	GND	Ground

Table 4: Main Connector Pinout

1.4.2 Programming Connector Pinout

The sensor can be programmed through the Serial Wire Debug (SWD) interface using an ST-Link. ST-Link can be connected to the sensor using pads for spring-loaded pins in the bottom layer of the PCB. The pinout can be seen in table 5. The first pin of the connector is marked with a square pad.

Pin	Name	Description
1	3V3	3.3V Sensing
2	GND	Ground
3	SWDIO	SWD Data
4	SWCLK	SWD Clock
5	NRST	MCU Reset

Table 5: Programming Connector Pinout

2 Communication Specification

For the physical layer, RS-485 is used. This allows the communication to be robust and resistant to EMI (electro-magnetic interference). On top of the physical layer, Modbus RTU is used as a data link layer. This protocol is widely supported by the number of PLCs and other devices. To interface with a PC (or any computer with a USB port), a USB to RS485 converter may be used in conjunction with the Veles Sensors python library.

2.1 Physical Layer - RS485

RS-485 is a full-duplex serial bus, ideally suited for low-speed, noise-resistant communication over long distances (up to 1200 m - more if repeaters are used). Linear bus topology is preferable over star or ring configurations. To prevent signal reflections, each sensor is equipped with a 120 Ω termination resistor. Therefore, the optimal cable for connecting sensors to each other and to the master node is a twisted pair cable with 120 Ω characteristic impedance.

2.2 Data Link Layer - Modbus RTU

Modbus is a well-tested, openly-published, and royalty-free data communications protocol. Developed for industrial applications, it aims to be simple and robust. It is a client/server (master/slave) type protocol. The maximum number of client nodes on a Modbus bus is 247.

A limitation of Modbus-based buses is that there is no arbitration in case of address conflict. This means that nodes should be either added one by one or node addresses should be configured beforehand.

Address 0 can be used as a broadcast message (e.g. instructing all sensors to turn off LED). No slave response is generated.

2.2.1 Modbus register space

Modbus supports four types of registers:

Object type	Access	Size	Address space
Coil	read / write	1 bit	00001 - 09999
Discrete input	read	1 bit	10001 - 19999
Input register	read	16 bits	30001 - 39999
Holding register	read / write	16-bits	40001 - 49999

Table 6: Modbus register space

2.3 RHT01 Modbus registers

2.3.1 Input registers

Input registers contain measured values. They are read-only and 16-bit in size.

Register name	Register address	Unit	Note
Serial Number HI	30001	-	
Serial Number LO	30002	-	
Temperature	30003	°C	
Temperature	30004	°F	
Relative humidity	30005	%	
CO_2 concentration	30006	ppm	
Light Intensity CH0	30007	ticks	
Light Intensity CH1	30008	ticks	
Temperature Error	30009	-	see Note 1
Relative Humidity Error	300010	-	see Note 1
Light Intensity Error	300011	-	see Note 2

Table 7: Modbus input registers for RHT01

Note 1 The error codes are described in table 8.

Error Code	Error Description
0	OK
-1	Communication with the sensor failed
-2	Data CRC Check failed

Table 8: Error codes of measured Temperature and Relative Humidity values

Note 2 The error codes are described in table 9.

Error Code	Error Description
0	OK
-1	Communication with the sensor failed

Table 9: Error codes of measured Light Intensity values

2.3.2 Holding registers

The holding registers can be written to by the master node. Sensor RHT01 offers the following configuration registers:

Register name	Address	Note
Device Modbus address	40001	see Note 4
Modbus baudrate	40002	see Note 5
Light Sensor Gain	40003	see Note 1
Light Sensor Measurement Rate	40004	see Note 2
Light Sensor Integration Time	40005	see Note 3
Reset device	49999	see Note 6

Table 10: Modbus holding registers for RHT01

Note 1 The gain can be set to following values:

Gain	Value [lux]
1X	1 ÷ 64k
2X	0.5 ÷ 32k
4X	0.25 ÷ 16k
8X	0.125 ÷ 8k
48X	0.02 ÷ 1.3k
96X	0.01 ÷ 600

Table 11: Gain values of LTR-329ALS-01

Note 2 The measurement rate can be set to following values: 50, 100, 200, 500, 1000 and 2000 ms. Insert these values as an integer in milliseconds.

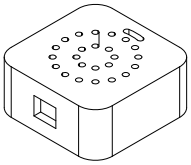
Note 3 The integration time can be set to following values: 50, 100, 150, 200, 250, 300, 350 and 400 ms. Insert these values as an integer in milliseconds.

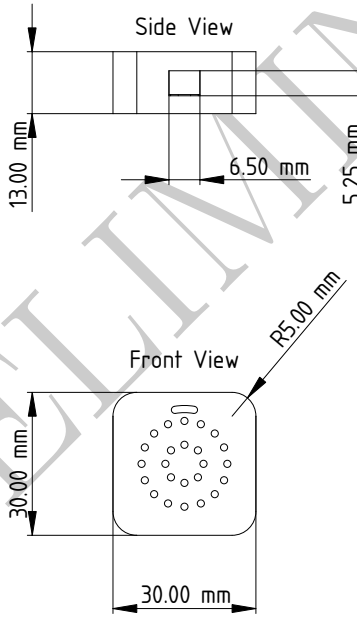
Note 4 Device Modbus address may be changed by writing to this register. The allowed values are in the range of 1 to 247. The device will start using a new address immediately and cease to respond at the previous address. Reset is not needed. It is the responsibility of the user to prevent address collisions on a bus.

Note 5 Modbus baudrate in bits/s. May be one of: 4800, 9600, 14400, 19200, 28800, 38400, 57600, 76800, 115200. Please be aware that lower baudrates are more reliable for long distance communication.

Note 6 Writing the magic constant 0xABCD to this device will instruct the device to soft-reset.

3 Mechanical Dimesions





4 Schematic