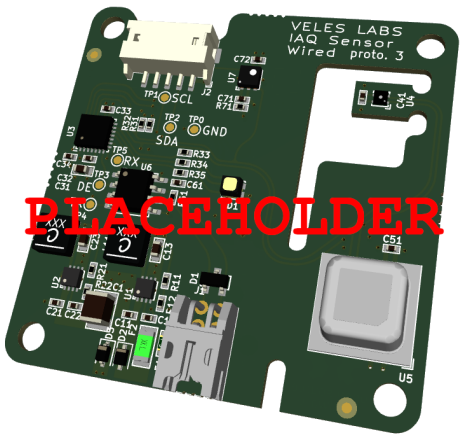

Features

- Measures all important indoor air quality values: CO_2, T, RH, VOC
- Communicates via Modbus RTU (RS-485)
- Wide input voltage range 5 - 30V
- Indicates CO_2 (carbon dioxide) level using LED for quick air quality assesment
- Easy to setup using Raspberry Pi and open-source Veles Sensors python library
- Carbon dioxide measurement range 0 - 40000 ppm
- Temperature range -40 - 125 °C
- Relative humidity range 0 - 100 %
- VOC (volatile organic compounds) index range 1 - 500 VOC index points
- Fully opensource

Description

IAQSW-01 is a wired indoor air quality sensor measuring temperature, relative humidity, carbon dioxide and volatile organic compounds. 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).

On-board RGB LED enables user to quickly assess air quality with single glance. Two quality-to-color schemes are available: continuous color change and tri-state (semaphore) mode. Thresholds for color change are user-configurable.

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

Extended version of this sensor IAQSW-01-PM adds particulate matter (dust) measurement option.

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

Application

- IAQ measurement for home and office spaces, ventilation control

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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
CO_2 measurement range	-	0 ÷ 40000 ppm
CO_2 measurement accuracy	400 ppm – 2000 ppm	(±50 ppm + 5% of reading)
CO_2 measurement repeatability	Typical	±10 ppm
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

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

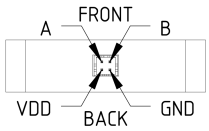

Figure 1: Main Connector Pinout

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

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 physical layer RS-485 is used. This enables communication to be robust and resistant to EMI (electro-magnetic interference). On top of physical layer Modbus RTU is used as a data link layer. This protocol is widely supported by number of PLCs and other devices. To interface with PC (or any computer with USB port) USB to RS485 converter may be used in conjunction with 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 120 Ω termination resistor, therefore optimal cable for connecting sensors to each other and to master node is twisted pair cable with 120 Ω characteristic impedance.

2.2 Data Link Layer - Modbus RTU

Modbus is 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. Maximum number of client nodes on a Modbus bus is 247.

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.

(TODO note: random address assignment command?)

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 IAQSW-01 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	Dimension	Note
Temperature	30010	°C	
Temperature	30011	°F	
Relative humidity	30012	%	
CO_2 concentration	30013	ppm	
VOC index	30014	VOC index	see Note 1
VOC ticks	30015	raw VOC ticks	Raw value from VOC sensor
Temperature from CO_2 sensor	30028	°C	
Temperature from CO_2 sensor	30029	°F	
RH from CO_2 sensor	30030	%	

Table 7: Modbus input registers for IAQSW-01

Note 1 VOC index has range 1-500 with 100 being the average. After sensor start-up VOC index is 0 until sufficient amount of data has been measured.

2.3.2 Holding registers

Holding registers can be written to by master node. Sensor IAQSW-01 offers following configuration registers:

Register name	Address	Note
LED on	40001	set to 0 to turn off LED; set to 1 to turn LED on
LED brightness	40002	range from 0 (off) to 100 (full intensity)
LED smooth	40003	see Note 1
CO_2 alert limit 1	40004	see Note 2
CO_2 alert limit 2	40005	see Note 2
CO_2 temperature offset	40006	see Note 3
Device Modbus address	40007	see Note 4
Modbus baudrate	40008	see Note 5
Reset device	40100	see Note 6

Table 8: Modbus holding registers for IAQSW-01

Note 1 Setting LED smooth register to 1 will turn on LED color interpolation, meaning LED will have color in continuous spectrum from green to red according to CO_2 level. Setting this register to 0 will turn off interpolation and set LED to semaphore (tri-state) mode. Depending on CO_2 level LED color will then be either green, yellow or red.

Note 2 Registers CO_2 alert limit 1 and 2 set threshold for LED color change (see Note 1). Limit 1 is threshold between green and yellow color, limit 2 is threshold betweek yellow and red color.

Note 3 SCD41 is CO_2 sensing device used in IAQSW-01 sensor. It is also able to measure temperature, however it may be subject to offset due to internal heating of SCD41. This register allows user to compensate this offset.

Note 4 Device Modbus address may be changed by writing to this register. Allowed values are in range from 1 to 247. Device will start using new address immediately and cease to respond at previous address. Reset is not needed. It is the responsibility of a 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 magical constant 0xABCD to this device will instruct device to soft-reset.

3 Mechanical Dimesions