RRHxxx

All-in-one environmental and air quality sensor

The RRHxxx is an integrated sensor module for the measurement of critical air quality parameters. Sensors for particulate matter (PM), total volatile organic compounds (TVOC), estimation of carbon dioxide (eCO_2) optional nitrogen dioxide (NO_2), optional ozone (O_3), humidity (RH), and temperature (T), are combined in a single package.

The RRHxxx provides digital outputs for each sensor, which can be measuring parameters simultaneously. Output correction algorithms use the correlation between sensors to improve the accuracy of each measurement and identify detectable substances. In addition, control and arithmetic processing is done within the module, freeing resources on the host MCU and simplifying the implementation on the customer side.

The RRHxxx can be configured with selectable UART or the I^2C interface, and operating mode depending on response time and accuracy needed.

The sensors are placed within the module housing, which protects against malfunctions from dust accumulation. A 6-pin connector provides an easy plug and play interface.

Applications

- Home appliances / air purifiers
- Air quality monitors
- HVAC / Industrial automation
- IoT devices

Features

- Simultaneous multi-sensor measurements of all relevant air quality parameters
- Up to nine sensor outputs:
  - Detection of particle sizes from 0.3µm to 10.0µm
  - Output mass concentration bins for PM1, PM2.5, and PM10
  - Temperature and humidity
  - Measurement of total organic compounds (TVOC) concentrations and indoor air quality (IAQ) index according to UBA
  - Estimates carbon dioxide level (eCO2)
  - Selective measurement of nitrogen dioxide (NO_2) and ozone (O_3) for outdoor air quality index (AQI) calculation according to EPA (optional)
- Operating temperature range up to 60°C
- Operating humidity range up to 90% RH
- Temperature sensor accuracy: ±0.2°C
- Targeted JEDEC JESD47 qualification
- Siloxane resistant
- UART and I^2C interfaces
- Outline dimensions 46.6 × 34.8 × 12 mm

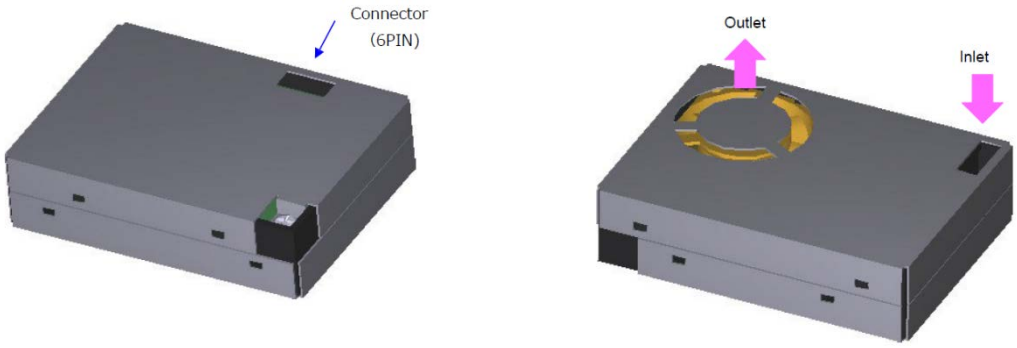
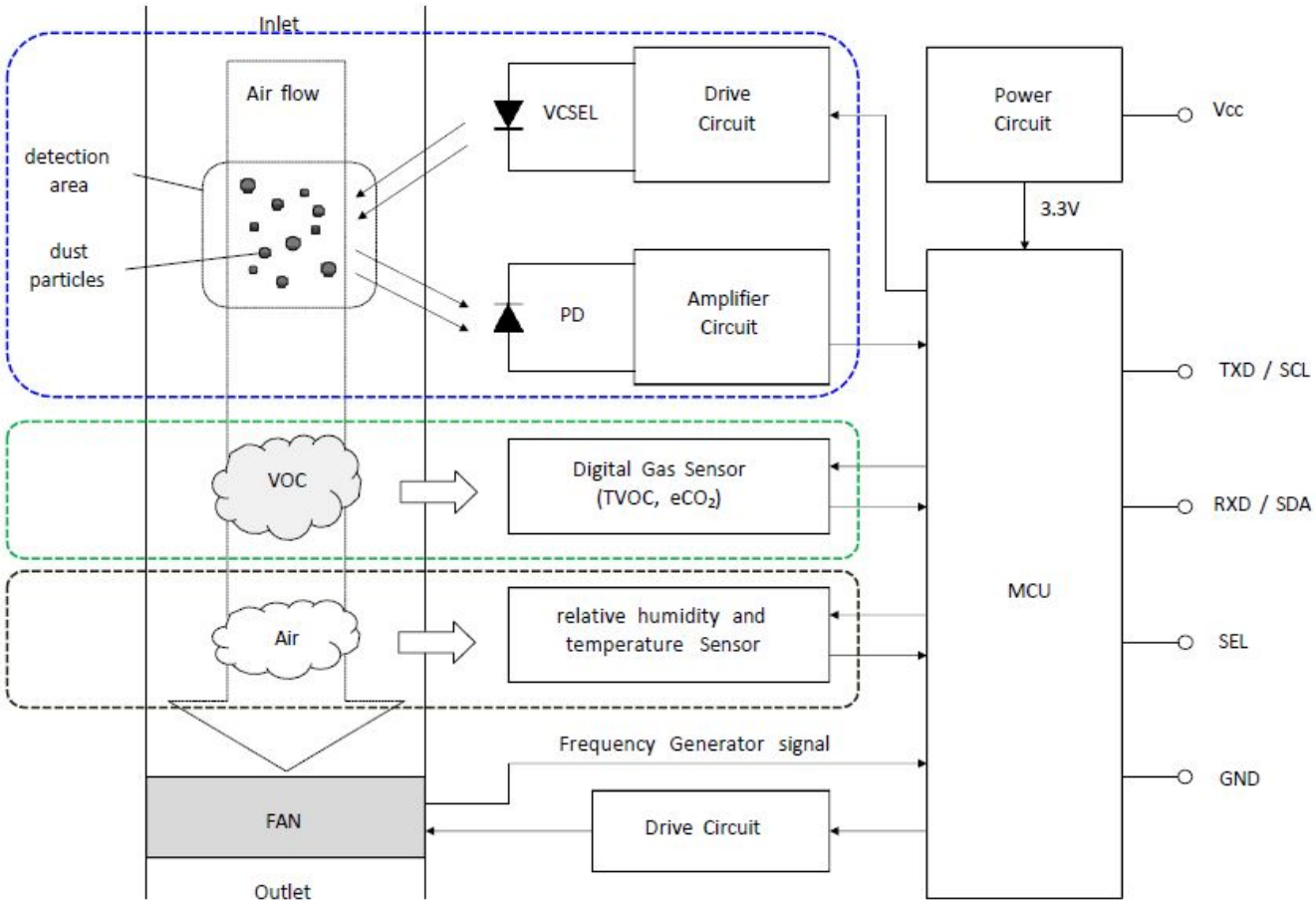


Figure 1. Sensor Module

Contents

1 Overview

1.1 Block Diagram



*NO_2 and O_3 are optional

Figure 2. Block Diagram

1.2 Product Family Overview and Ordering Information

Part Number	Sensor Outputs
TBD	Particulate Matter Relative Humidity /Temperature TVOC / eCO_2
TBD	Particulate Matter Relative Humidity /Temperature TVOC / eCO_2 NO_2 / O_3

2 Pin Information

2.1 Pin Assignments

TBD.

2.2 Pin Descriptions

Pin Number	Pin Name	Description	Notes
1	VCC	Supply voltage	5V ±10%
2	GND	Ground	
3	TXD	UART: Transmitting pin	3.3V Logic
	SDA	I2C: Serial data	
4	RXD	UART: Receiving pin	3.3V Logic
	SCL	I2C: Serial clock	
5	SEL	Interface select	UART: Floating or 3.3V I2C: Low level (GND)
6	NC	Do not connect	

3 Specifications

3.1 Absolute Maximum Ratings

CAUTION: Do not operate at or near the maximum ratings listed for extended periods of time. Exposure to such conditions can adversely impact product reliability and result in failures not covered by warranty.

Table 1. Absolute Maximum Ratings

Parameter	Minimum	Maximum	Unit
Supply voltage (VDD)	-0.3	6.0	V
Interface select (SEL)	-0.3	3.6	V
I/O pins (RXD/SCL, TXD/SDA)	-0.3	3.6	V
Max. current on any I/O pin		±25	mA
Operating temperature	-10	60	C
Storage temperature	-40	75	C
Humidity range (non-condensing)	5	90	%RH

3.2 Electrical Specifications

Table 2. Electrical Specifications

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply Voltage	VCC		4.5	5.0	5.5	V
Active Current	ICC	PM Sensor		50	65	mA
		Humidity/Temp Sensor (14-bit)	0.55	0.62	0.69	µA
		TVOC + eCO_2		5.2	10.3	mA
		NO_2 & O_3		8	10	mA
		MCU		5.2		mA
Sleep Current		PM Sensor		35	50	µA
		Humidity/Temp Sensor (-40 to 125°C)			2.5	µA
		TVOC + eCO_2		450		nA
		NO_2 + O_3		450		nA
		MCU		2.7		mA
Input high level voltage	V_{IH}		2.31			V
Input low level voltage	V_{IL}				0.99	V
Output high level voltage	V_{OH}	I_{OH} = 4mA	2.70			V
Output low level voltage	V_{OL}	I_{OL} = 3mA			0.40	V

4 Sensor Specifications

4.1 Particulate Matter Specifications

Table 3. Particulate Matter Specifications

Parameter	Conditions	Value	Unit
Particle size range		0.3 - 10.0	µm
Mass concentration consistency (PMX_1) [1][3]	0 - 100 µg/m^3	±30	µg/m^3
	100 - 500 µg/m^3	±30	%
Mass concentration consistency (PMX_2) [2][3]	0 - 100 µg/m^3	±10	µg/m^3
	100 - 500 µg/m^3	±10	%
Mass concentration range		0 - 1,000	µg/m^3
Mass concentration resolution		1	µg/m^3
Mass concentration size range	PM1	0.3 - 1.0	µm
	PM2.5	0.3 - 2.5	µm
	PM10	0.3 - 10	µm
Number concentration range		0 - 3,000	1/cm^3
Number concentration size range	NC_0.3	0.3 - 10.0	µm
	NC_0.5	0.5 - 10.0	µm
	NC_1	1.0 - 10.0	µm
	NC_2.5	2.5 - 10.0	µm
	NC_4	4.0 - 10.0	µm
Sampling interval		1	s
Response time		≤ 8	s
Lifetime (reference) [4]	Ta = 25°C, 15-65% RH	50,000	hours
Acoustic noise	0.3m	≤ 28	dB(A)

1. PMX_1 represents the mass concentration of particle size 0.3µm - Xµm. Reference with standard particles (KCl particles).
2. PMX_2 represents the mass concentration of particle size 0.3µm - Xµm. Reference with cigarette smoke.
3. The fan speed setting value is 100% (default setting).
4. Lifetime is a reference value, and not a guaranteed value.

4.2 Humidity and Temperature Sensor Specifications

Table 4. Humidity and Temperature Sensor Specification, T_A = +25°C, V_{DD} = 1.71V to 3.6V

Parameter	Condition	Minimum	Typical	Maximum	Unit
Humidity Sensor					
Range		0		100	%RH
Accuracy [1]	10% to 90% RH		±1.5	±1.8	%RH
Resolution	14-bit		0.04	0.05	%RH
Hysteresis				±1.0	%RH
Non-linearity from Response Curve	10% to 90% RH		±0.15	±0.25	%RH
Long-Term Stability			±0.1	±0.25	%RH/Yr
Response Time Constant [2] (τ_H)	20% to 80% RH Still Air	3.0	4.0	6.0	s
Temperature Sensor					
Range		-40		125	°C
Accuracy	-10°C to 80°C		±0.2	±0.3	°C
Resolution	14-bit		0.01	0.02	°C
Response Time Constant [3] (τ_T)			>2.0		s
Long-Term Stability				0.03	°C/Yr
Supply Voltage Dependency [4]			0.03	0.1	°C/V

1. Monotonic increases from 10 to 90% RH after sensor has been stabilized at 50% RH.
2. Initial value to 63% of total variation. Response time depends on system airflow.
3. Initial value to 63% of total variation. Response time depends on system thermal mass and air flow.
4. Temperature accuracy can be optimized for specified supply voltages upon request.

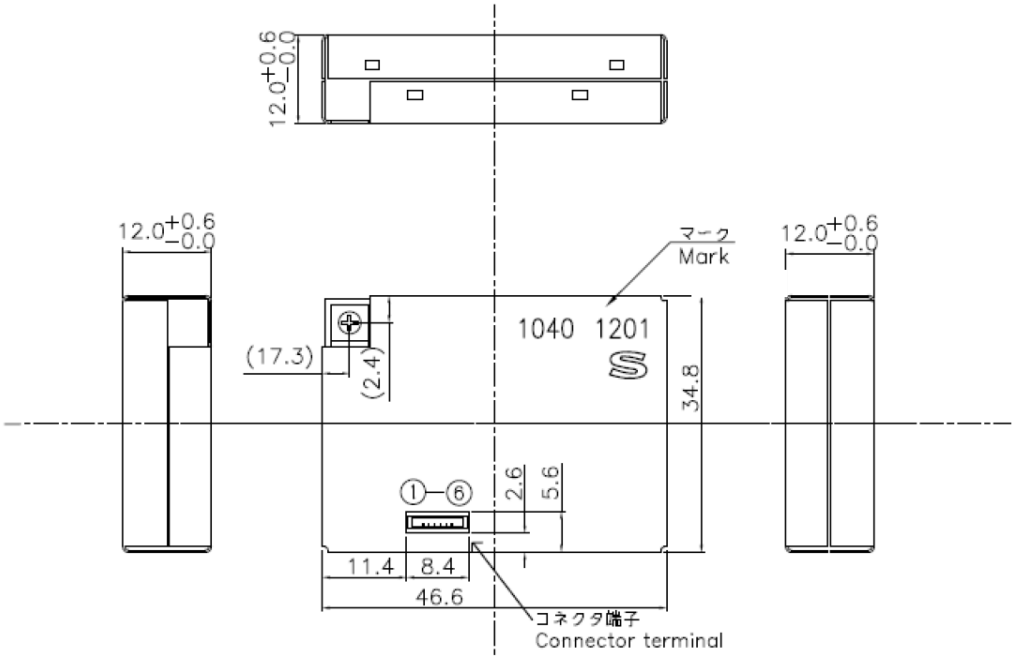
4.3 Gas Sensor Specifications

Table 5. Gas Sensor Module Specifications during Operation

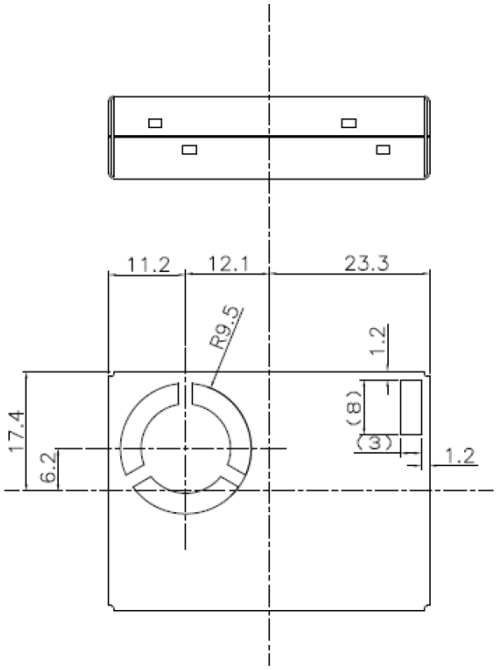
Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Unit
TVOC + eCO_2						
	IAQ Specified Measurement Range [1]	Ethanol in air	160		10000	ppb
	eCO_2 Range	Estimated CO_2	400		5000	ppm
	Humidity Range	Non-condensing	0		90	%RH
	Sample Rate			3		s
NO2 and O3						
AQI	Air Quality Index	Rating according to EPA for ozone and nitrogen dioxide	0		500	
	Measurement Range	Ozone	20		500	ppb
		Nitrogen dioxide	20		500	ppb
RH	Humidity Range	Non-condensing	5		90	%RH
T	Temperature Range	Typical outdoor environment	-20		50	°C
		Extended range	-40		65	°C
	Sample Rate			10		s

1. Source: Umweltbundesamt, Beurteilung von Innenraumluftkontaminationen mittels Referenz- und Richtwerten, (Bundesgesundheitsblatt - Gesundheitsforschung - Gesundheitsschutz, 2007).
2. Response times depend on TVOC gas and concentration.

5 Package Outline Drawings



All dimensions in mm. Unspecified tolerance should be ±0.3mm.



6 Revision History

Revision	Date	Description
0.01	Sep 23, 2022	Initial release.

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