SPECIFICATION

Product Name: Integrated Air Quality Sensor Module

Item No.: AM1008W

Version: V0.3

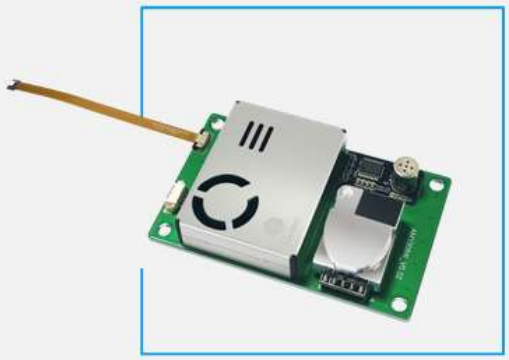
Date: June 10, 2020

Revision

No.	Version	Content	Date
1	V0.2	The information of the Mating Female Connector and the Connection cable is updated.	2018.12.29
2	V0.2	The particle measurement accuracy is updated.	2018.12.29
3	V0.3	Update communication protocol and command.	2020.06.10

Integrated Air Quality Sensor Module

AM1008W



Applications

- Air purifier
- Air quality monitor
- Air conditioner
- Ventilation system
- Consumer electronic products
- Environmental monitoring

Description

AM1008W is an indoor air quality sensor module with highly integrated ultra-thin laser particle sensor, NDIR CO_2 sensor, semiconductor VOC sensor, temperature and humidity sensor, which can real-time output digital measurement data. It is with stable performance, compact structure design, multi-function and optional connection ways, which can be widely used for IAQ monitor, air purifier, ventilation system, air conditioner, etc.

Features

- Highly integrated with sensors including: laser particle, NDIR CO_2, VOC, temperature, humidity for option
- The NDIR CO_2 sensor is with high low power consumption, auto-calibration
- Ultra-thin (height is only 12mm) laser particle sensor with four working mode
- Easy to install and debugging simply
- With voltage regulator design and EMC compliant, strong anti-static ability

Working Principle

- The PM sensor integrated adopts laser scattering technology to detect PM2.5 mass concentration
- The CO_2 sensor integrated adopts NDIR technology to detect indoor CO_2 concentration
- The VOC sensor is based on semiconductor principle
- The RH&T sensor integrated adopts capacitance resistance materials to detect indoor RH&T

Specifications

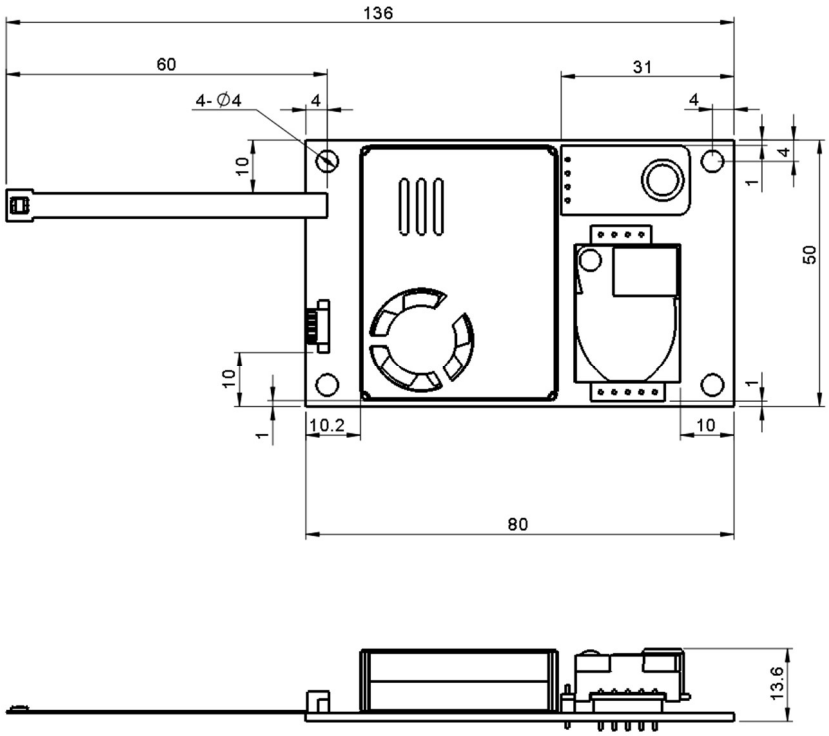
Integrated Indoor Air Quality Sensor Specification	
Operating principle	CO_2: NDIR technology PM: laser scattering technology VOC: semiconductor
Measurement range	PM: 0~1000μg/m³ CO_2: 0~5000ppm VOC: 0~3 level Temperature: -20℃~70℃ RH: 0-95%RH
Measurement accuracy for PM2.5	0~35μg/m³, ±5μg/m³ >35μg/m³, ±15% of reading Condition: 0℃~40℃, 50±10%RH Reference instrument: TSI Dust Source: Cigarette + Arizona A1
CO_2 measurement accuracy	±(50ppm+5% of reading) @-10℃~50℃, 50±10%RH (Note 1 and 2)
Temperature accuracy	±1℃@0℃~40℃, 50±10%RH
Relative humidity accuracy	±5%RH
PM preheating time	≤8s
CO_2 preheating time	≤30s
VOC preheating time	≤180s
Data refresh rate	1s
Working condition	-10~50℃, 0-95%RH (non condensing)
Storage condition	-30~70℃, 0-95%RH (non condensing)
Working voltage	DC 5V±0.1V, ripple wave < 50mV
Average working current	≤300mA
Signal output	UART_TTL(3.3V TTL)
Dimension	W80*H50*D13.6 mm
Life span	MTTF of PM sensor=37,297 hours (continuous turn on) CO2≥10 years VOC≥10 years

Note 1: In normal IAQ applications, accuracy is defined after minimum three (3) ABC periods of continuous operation with ABC on. Some industrial applications do require maintenance. Contact Cubic for further information.

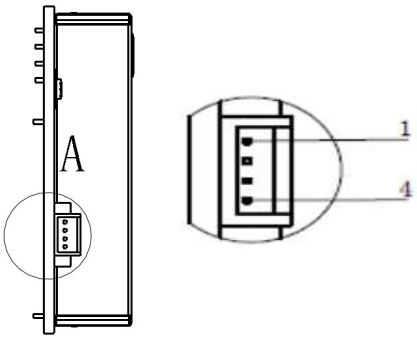
Note 2: Specification is referenced to certified calibration mixtures. Uncertainty of calibration gas mixtures (±2% currently) is to be added to the specified accuracy for absolute measurement.

Dimensions and Connector

1. Dimensions (Unit mm, tolerance ±0.2 mm)



2. I/O Connector Pinout



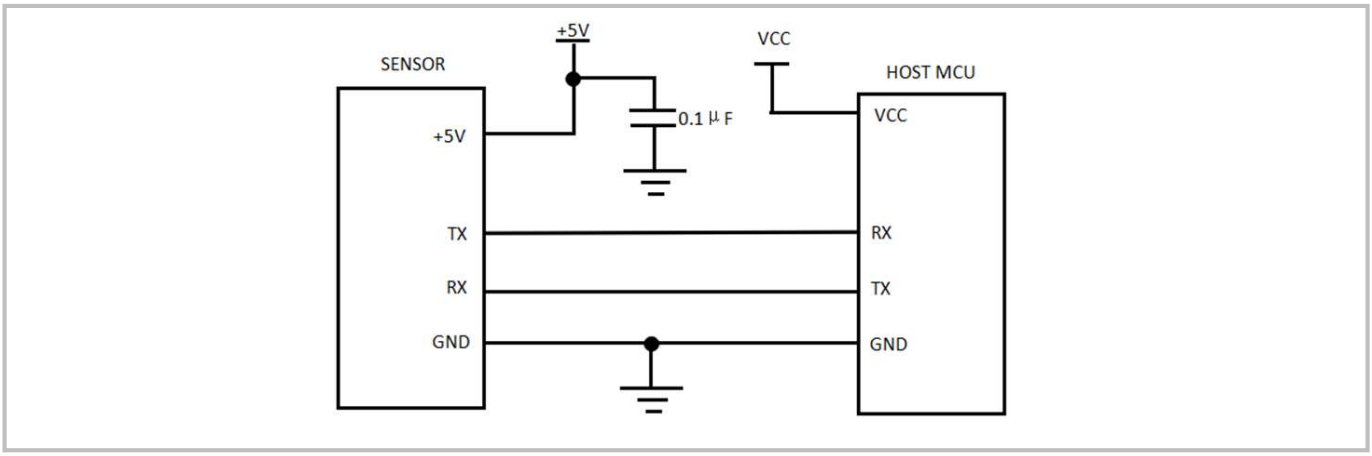
No.	Pin	Description
1	GND	Power supply input (GND)
2	RX	UART-RX input (TTL@3.3V)
3	TX	UART-TX output (TTL @3.3V)
4	+5V	Power supply input (+5V)

The interface connector is located at the side of the sensor. Corresponding female plug part number is A1251WR-S-4P from CJT. The pitch is 1.25mm.

The connection cable with female connector at both ends can also be customized.

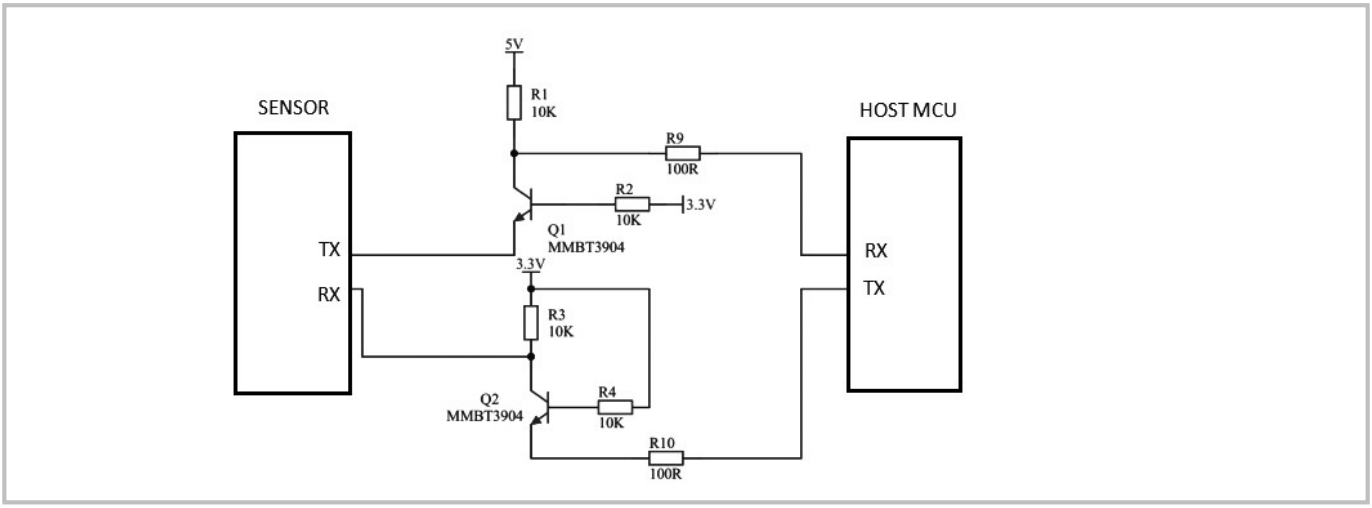
Application Circuit

UART TTL 3.3V UART output



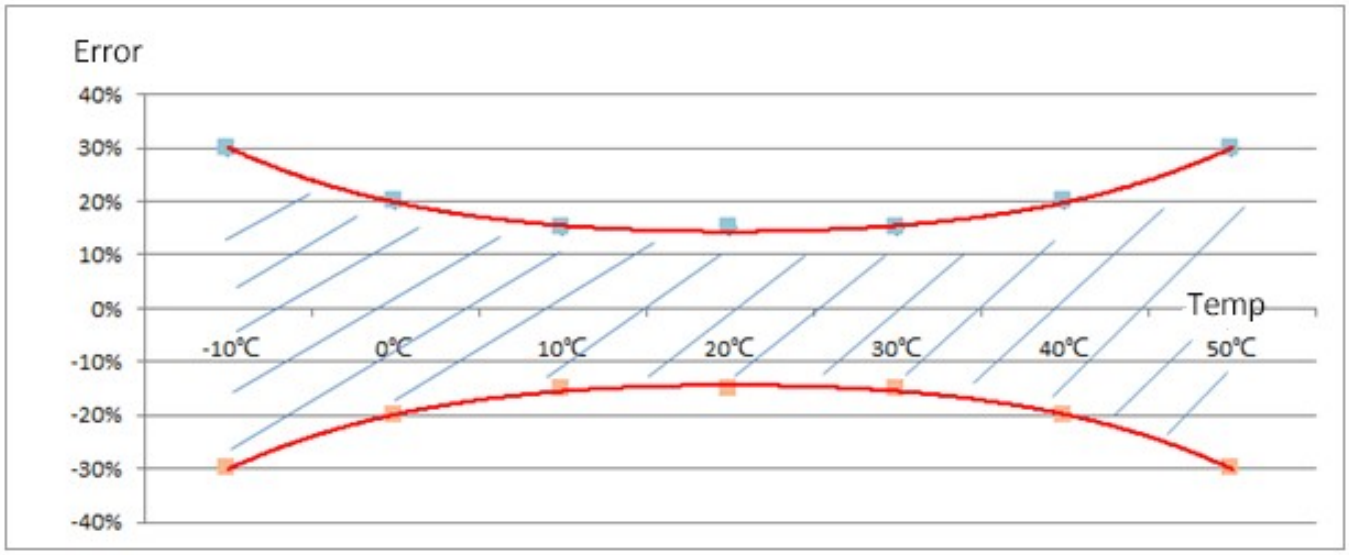
Test scenarios 3: 3.3V-5V switching circuit diagram

If host MCU is 5V, it need to add the chip and circuit at the communication port (RX, TX) to make 5V transfer to 3.3V.



Temperature Influence Curve

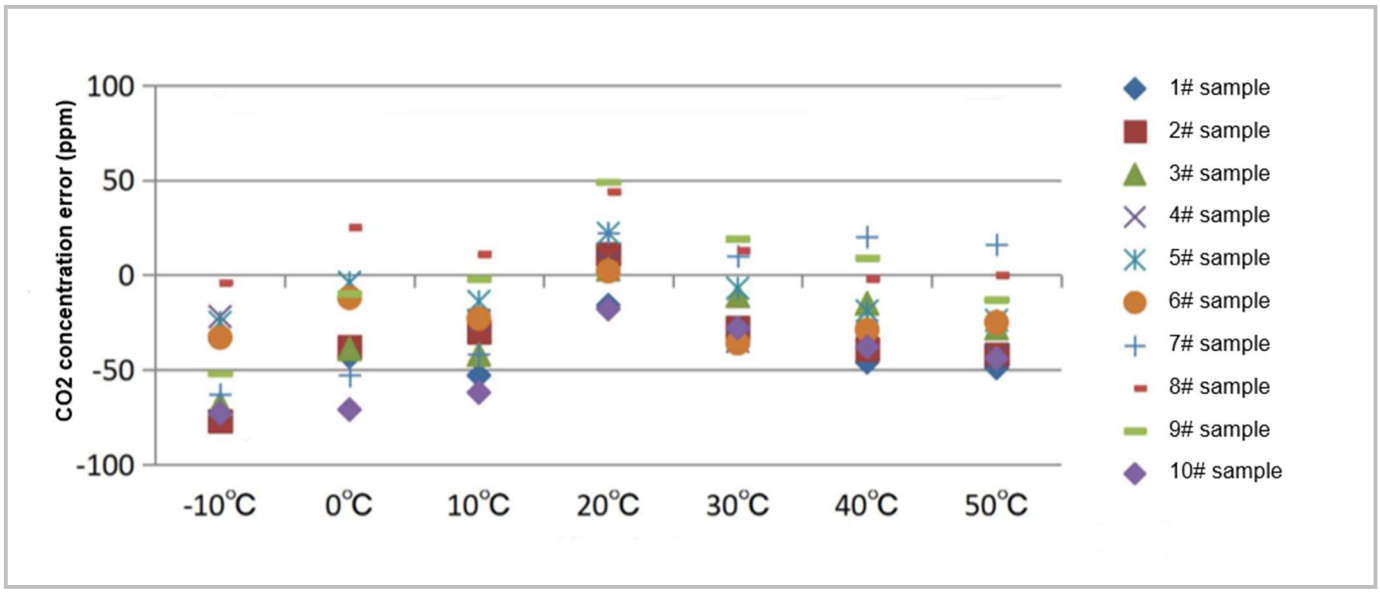
PM Temperature Influence Curve



Measured error: under 25℃±2℃, 50±10%RH, 0~1000μg/m³, consistency and accuracy of PM2.5 is ±15% reading or ±15μg/m³, whichever is larger.

Temperature influence coefficient: 0.5%/℃~1%/℃ or 0.5μg/m³/℃~ 1μg/m³/℃, whichever is larger.

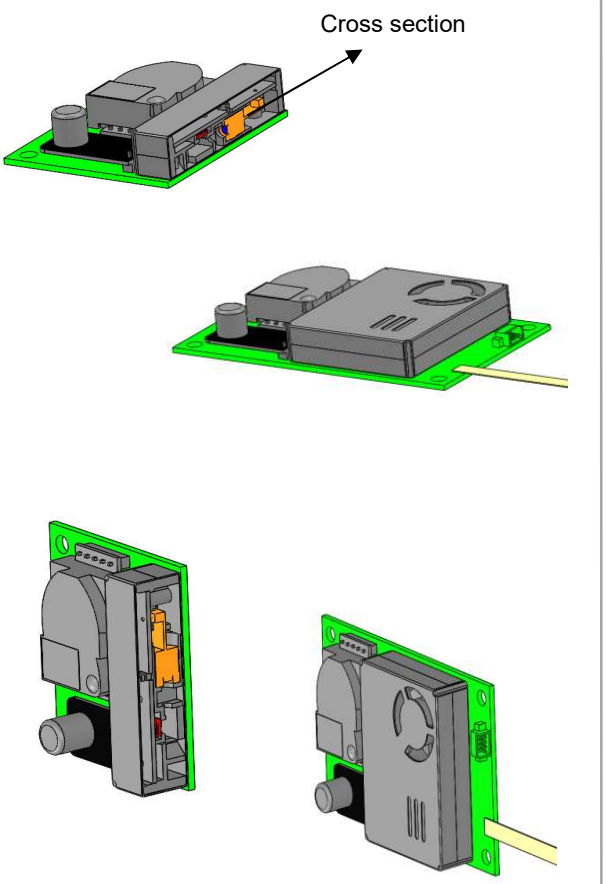
Temperature Influence Curve of CO2 sensor



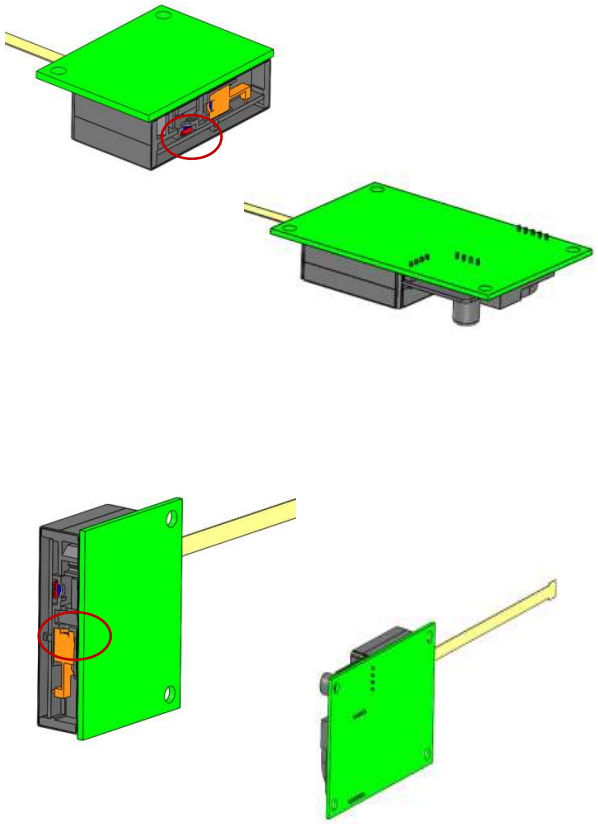
Product Installation

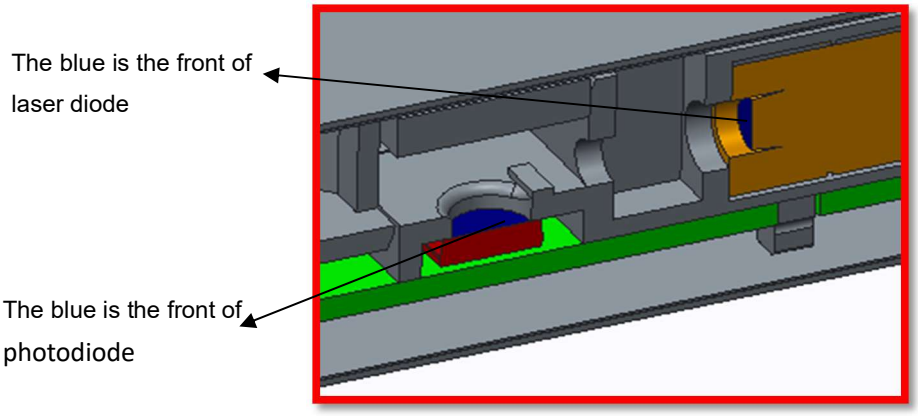
- When install AM1008W module in your system or equipment, please make sure of unobstructed air-inlet and air-outlet. And there is no huge airflow faced to air-inlet and air-outlet.
- In order to avoid dust deposition on the surface of sensitive component (laser diode and photosensitive diode), which may affect the measurement accuracy of the sensor, the appropriate installation ways are recommended as below.

Recommended Installation



Non Recommended Installation





User Attention

▪AM1008W sensor module is for household electronics products. For application of medical, mining, disaster preparedness, which needs high security and high dependence, this sensor is not suitable.

▪The laser dust sensor adopts non-static adsorption materials such as metal, please avoid to working under the high particle concentration environment.

▪When you use the laser dust sensor, please make sure of unobstructed air-inlet and air-outlet. The CO_2, VOC using diffusion for sampling, the gas diffusion hole should be reserved.

▪This sensor module should avoid working outdoors or in the heavy dust environment. Protection against sandstorm, rain, snow and willow floccus should be completed by the user equipment.

▪When use the laser dust sensor, it's recommended to add 50~60 mesh protective filters to the air inlet position, so as to prevent the pollution of large particles of dust, floccules, hair etc on the detection data.

▪When the sensor module is applied to air purifier or detection equipment, the sensor should be installed more than 20cm above the ground, to avoid the fan couldn't work normally due to the pollution of large dust and floccus.

UART Communication Protocol

1. General Statement

1). The data in this protocol are all hexadecimal data. Such as "46 for decimal [70]"

2). [xx] for single-byte data (unsigned, 0-255); high byte of double byte data is in the front, the low byte in the back

3). Baud rate: 9600, data bits: 8, stopbits:1, parity: No.

2. Format of Serial Communication Protocol

Sending format of software:

Start Symbol	Length	Command	Data 1	……	Data n.	Check Sum
HEAD	LEN	CMD	DATA1	……	DATAn	CS
11H	XXH	XXH	XXH	……	XXH	XXH

Detail description on protocol format:

Protocol Format	Description
Start	Command sending fixed [11H], the module respond fixed [16H]
Length	Frame bytes length = data length +1 (including CMD+DATA)
Command	Command
Data	Data of writing or reading, unfixed length
Check sum	Cumulative sum of data = 256 - (HEAD+LEN+CMD+DATA)

3. Command Table of Serial Protocol

Item No.	Function Description	Command
1	Read measurement result	0x01
2	CO_2 calibration	0x03
3	Open/close particle measurement	0x0C
4	Set up and read particle measurement time	0x0D
5	Set up and read timing measurement mode	0x05
6	Set up and read dynamic working mode	0x06
7	Set up and read particle calibrated coefficient	0x07
8	Read software version	0x1E
9	Read serial number	0x1F

4. Protocol Description

4.1 Read Measurement Result

Send: 11 02 01 01 EB

Response: 16 16 01 DF1 DF2 DF3 DF4 DF5 DF6 DF7 DF8 DF9 DF10 DF11 DF12 DF13 DF14 DF15 DF16 DF17 DF18 DF19 DF20 DF21 [CS]

Function: to read CO_2, VOC, RH, Temp, (GRIMM) PM1.0, PM2.5, PM10, (TSI) PM1.0, PM2.5, PM10 state CS

Statement:

Response data bit:

16 16 01	02 C2	00 01	02 48	02 F9	00 00	00 00	00 00	00 00	00 28	00 00	00	XX
	CO_2	VOC	RH	Temp	$PM_{1.0}$	$PM_{2.5}$	PM_{10}	$PM_{1.0}$	$PM_{2.5}$	PM_{10}	state	CS
					(GRIMM)			(TSI)				

Item	Data Bit	Decimal Effective Value Range	Corresponding Value	Multiple
CO_2	[DF1] [DF2]	0 ~ 5,000	0 ~ 5,000 ppm	1
VOC	[DF3] [DF4]	0 ~ 3	0 ~ 3 level	1
Related humidity	[DF5] [DF6]	50 ~ 990	5 ~ 99.0 %	10
Temperature	[DF7] [DF8]	300 ~ 1,200	-20 ~ 70℃	10
PM1.0 (GRIMM)	[DF9] [DF10]	0 ~ 1,000	0 ~ 1,000μg/m³	1
PM2.5 (GRIMM)	[DF11] [DF12]	0 ~ 1,000	0 ~ 1,000μg/m³	1
PM10 (GRIMM)	[DF13] [DF14]	0 ~ 1,000	0 ~ 1,000μg/m³	1
PM1.0 (TSI)	[DF15] [DF16]	0 ~ 1,000	0 ~ 1,000μg/m³	1
PM2.5 (TSI)	[DF17] [DF18]	0 ~ 1,000	0 ~ 1,000μg/m³	1
PM10 (TSI)	[DF19] [DF20]	0 ~ 1,000	0 ~ 1,000μg/m³	1

1. For particle concentration measurement, the sensor only outputs PM2.5 (TSI), so value of PM1.0 (TSI), PM10 (TSI), PM1.0 (GRIMM), PM2.5 (GRIMM), and PM10 (GRIMM) will always be 0.

2. Temperature data is added 500 upon practical measurement result.

For example, -20℃ is corresponding to value 300. Temperature value = (DF7 * 256 + DF8 - 500)/10.

3. The measurement result comes out with two data bits, high bit is on the head, and the low bit is after then.

Measurement result= $DF_n * 256 + DF_{n+1}$

4. Status bit: status alarming. (When the working temperature and fan speed of PM2008 is abnormal)

Bit	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Alarming	Reserved	Reserved	Reserved	Reserved	1: Working temperature is low	1: Working temperature is high	1: Fan at low revolving speed	1: Fan at high revolving speed

4.2 CO_2 Calibration

Send: 11 03 03 DF1 DF2 [CS]

Response: 16 01 03 E6

Function: CO_2 calibration
Statement:
Format statement:

Item	Data Bit	Decimal Effective Value Range	Corresponding Value	Multiple
Calibration target value	[DF1] [DF2]	400 ~ 1,500	400 ~ 1,500 ppm	1

1. Calibration target value = DF1*256+DF2
2. Before CO_2 calibration, make sure that the current ambient CO_2 value is the target value you want to calibrate and that the stable time is at least 2 minutes.

4.3 Open and Close Particle Measurement

Send: 11 03 0C DF1 1E CS
Response: 16 02 0C DF1 CS
Function: open and close particle measurement
Statement:
1. When send command, DF1=02 is measurement open; DF1=01 is measurement close;
2. When respond command, DF1=02 is measurement open; DF1=01 is measurement close;
3. When the sensor receives command for measurement open, it will go into continuous measuring mode;
If send: 11 03 0C 02 1E C0 // open particle measurement
Response: 16 02 0C 02 DA // the sensor module is under measurement open status

If send: 11 03 0C 01 1E C1 // close particle measurement
Response: 16 02 0C 01 DB // the sensor module is under measurement close status

4.4 Set up and Read Particle Measuring Time

Send: 11 03 0D DF1 DF2 [CS] // set up particle measuring time
Send: 11 01 0D E1 // read particle measuring time
Response: 16 03 0D DF1 DF2 [CS]
Function: Read particle measuring time
Note:
1. Particle measuring time = DF1*256+DF2, unit is second. Minimum measuring time is 36 seconds. Time range is 36-65,530 seconds. After setting up xx seconds particle measuring time, the sensor will stop working first, then you can send “Open/command” to start single xx seconds measuring.
2. When measuring time is ≥ 65,531, it means module will be in continuous measuring mode once powered on. It will not stop until “stop" command is sent.

Example:
Send: 11 03 0D 00 24 BB // set up single measuring mode; measuring time is 36sec
Response: 16 03 0D 00 24 B6 // measuring time is set up successfully

Send: 11 03 0D FF FF E1 // set up continuously measuring mode (Repowering on means to start measuring status)
Response: 16 03 0D FF FF DC // continuously measuring mode is set up successfully

Send: 11 01 0D E1 // read particle measuring time
Response: 16 03 0D FF FF DC // read successfully

4.5 Set up Timing Measuring Mode

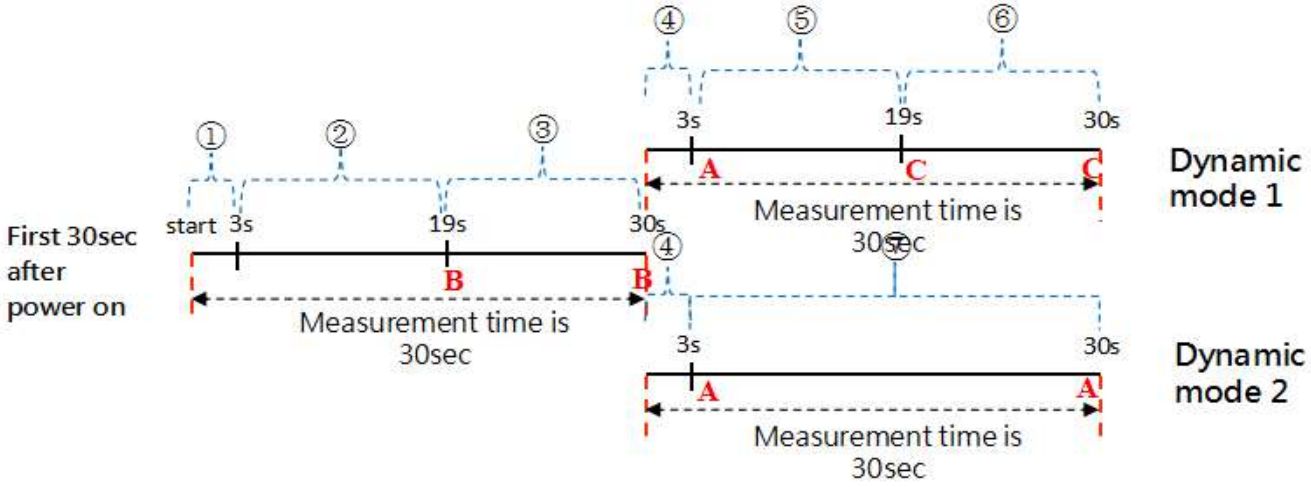
Send: 11 03 05 DF1 DF2 [CS] // set up particle measuring mode
Send: 11 01 05 E9 // read particle measuring mode
Response: 16 03 05 DF1 DF2 [CS]
Function: Read particle measuring time
Note:
1. Particle measuring mode value X = DF1*256+DF2, unit is second;
2. When X >=60, it means module is under timing measuring mode. Measurement timing cycle is X seconds. The sensor module will start measurement every X seconds. Default measuring time is 36 seconds.
3. Range for X, minimum timing period is 1 minute
Send: 11 03 05 02 05 E0 // Set up as timing measuring mode, and timing cycle is 517 seconds.
Response: 16 03 05 02 05 DB // Set up successfully

4.6 Set up Dynamic Measuring Mode

Send: 11 02 06 DF1 [CS] // Set up dynamic particle measuring mode
Send: 11 01 06 E8 // Read dynamic particle measuring mode
Response: 16 02 06 DF1 [CS]
Function: Read / set up particle dynamic measuring mode

Note:
1. Particle dynamic measuring mode result DF1.
2. When DF1=0, close dynamic measuring mode. When DF1=1, start dynamic measuring mode.

Dynamic Working Mode:



After sensors are in dynamic working mode, start measuring every 30s. The sensor starts the measurement for the first 3 seconds.
After 3 seconds of measurement, the sensor starts measuring again continuously for 16 seconds and outputs the B value.

The laser diode turns off for 11 seconds, enters the standby state, and outputs the B value.
After the first 30 second period, the sensor starts a new 3 second measurement and outputs the A value.
① If | A-B |> 10 μg / m³ or | A-B | / B> 10%, the sensor selects Dynamic mode 1. The sensor measures continuously for 16 seconds and outputs the C value.
The laser diode turns off for 11 seconds, enters the standby state, and outputs the C value.
② If | A-B | <10 μg / m³ or | A-B | / B <10%, the sensor selects Dynamic mode 2 and stores A value, then enters standby state for 27 seconds and outputs A value.

Regardless of the dynamic mode A or B, the sensor starts a new 30 second measurement cycle by starting the initial 3 second measurement. Compare the measured value with the previously stored value for the initial 3 seconds and select Dynamic mode 1 or 2 again.

Send: 11 02 06 01 E6 // Set up opening dynamic particle measuring mode
Response: 16 02 06 01 E1 // Set up successfully

Send: 11 02 06 00 E7 // Set up closing dynamic particle measuring mode
Response: 16 02 06 00 E2 // Set up successfully

The module can support 4 kinds of working mode (Single + Continuous + Timing + Dynamic).
It can be switched between these 4 kinds of working mode.
It is continuous working mode by default after leaving factory.
These 4 kinds of working mode can be switched by sending commands, as following:

1. Send: 11 03 0D 00 24 BB // Single measuring mode, time is 36sec
2. Send: 11 03 0D FF FF E1 // Continuously measuring mode
3. Send: 11 03 05 02 05 E0 // Timing measuring mode, interval time is 517 seconds
4. Send: 11 02 06 01 E6 // Dynamic measuring mode

4.7 Set up and Read Particle Calibrated Coefficient

Send: 11 02 07 DF1 [CS] // Set up particle calibrated coefficient. DF1 means calibrated coefficient
Send: 11 01 07 E7 // Read particle calibrated coefficient
Response: 16 02 06 DF1 [CS]
Function: Read/set up particle calibrated coefficient

Note: Range 70~150 μg/㎥. Corresponding coefficient: 0.7~1.5
Description:
1. When there is difference between standard device, calibrated coefficient can be set to correct the final value.
2. When calibrated coefficient is set, the value of PM2.5 will be corrected by this coefficient.

4.8 Read Software Version Number

Send: 11 01 1E D0
Response: 16 09 1E DF1 ~ DF8 [CS]
Function: Read software version
Note:

Software version= “DF1 ~ DF8”
Should change the HEX code to ASCII code.

Example:
HEX code: 16 0E 1E 50 4D 20 56 31 2E 32 36 2E 35 2E 32 38 E9
ASCII code: PM V1.26.5.28

4.9 Read Serial Number

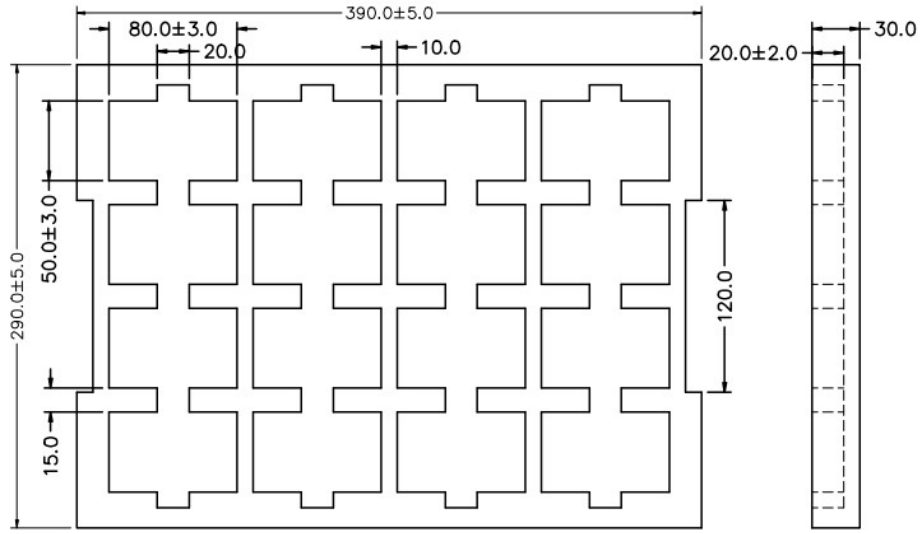
Send: 11 01 1F CF
Response: 16 11 DF1…DF10 [CS]
Function: Read serial number

Note: Serial number= DF1…DF10

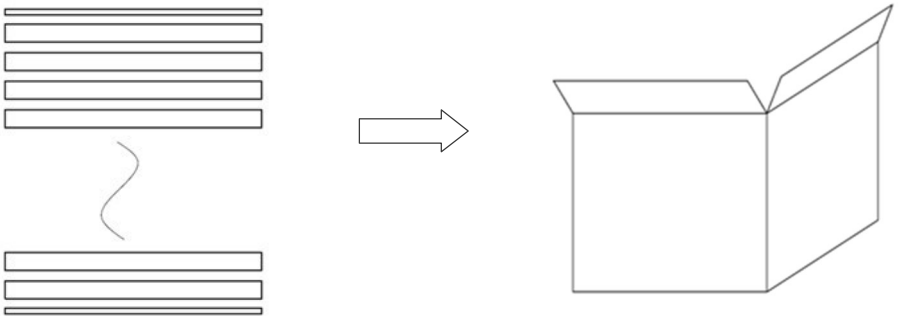
Example:
Response: 16 0B 1F 00 00 00 7E 09 07 07 0E 0D 72 9E
Serial number: 126 2311 1806 3442

Packing Information

Tray Size



Tray Qty 10



Carton

Sensor per Tray	Tray Qty	Sensor per Carton	Carton Dimensions	Packing Material
16 pcs	10 layers	160pcs	395*310*330mm	Red anti-static EPE

After-Sales Services and Consultancy

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