SPECIFICATION

Product Name: Laser Particle Sensor Module

Item No.: PM2016

Version: V0.2

Date: June 25, 2021

Revision

No.	Version	Content	Date
1	V0.1	The first version	2019.03.01
2	V0.2	Update specification and protocol	2021.06.25

Laser Particle Sensor Module

PM2016

Applications

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

Description

PM2016 is a laser particle sensor module which uses light scattering principle. It measures and calculates the suspending particle number which is within unit volume on the air exactly and output particle mass concentration μg/m^3 directly via mathematical algorithm and scientific calibration.

Features

- The smallest size of available measurement: 0.3μm
- Real-time output particle mass concentration in μg/m^3 is available
- VOC, temperature and humidity measuring function is reserved
- High accuracy, high sensitive and quick response (≤8s)
- Small size, compact structure, easy to install

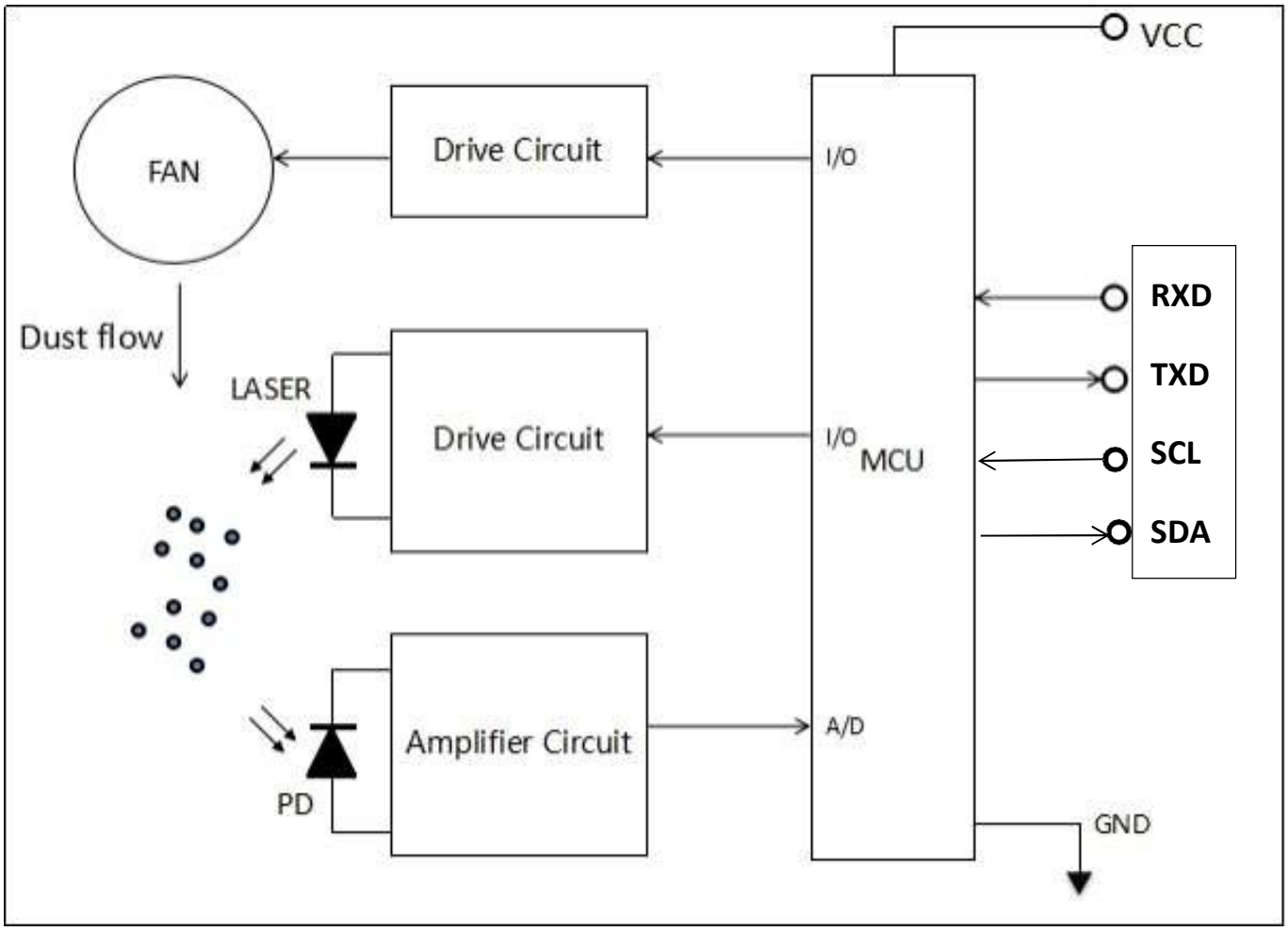
Working Principle

Sampling by the internal pressure which occurs by fan, when sampling particles pass through light beam (laser), there will be light scattering phenomenon. Scattered light will be converted into electrical signal (pulse) via photoelectric transformer. The bigger particles will obtain stronger pulse signal (peak value). Through peak value and pulse value quantity concentration of particles in each size can be calculate. Thus, real-time measured data is obtained through measuring quantity and strength of scattered light.

PM2016 Specifications

Laser Particle Sensor Specification	
Operating principle	Laser scattering
Measured particle range	0.3μm~10μm
Measurement range	0~5,000μg/m³
Resolution	1μg/m³
Working condition	-10°C ~ 60°C, 0-95%RH (non-condensing)
Storage condition	-40°C ~ 70°C, 0-95%RH (non-condensing)
Measurement accuracy[1]	Mass concentration PM1.0/PM2.5: 0~100μg/m³, ±10μg/m³ 101~500μg/m³, ±10% reading PM10: 0~100μg/m³, ±25μg/m³ 101~500μg/m³, ±25% reading(GRIMM 11-A, 25±2°C , 50 ±10%RH）
Response time	1second
Time to first reliable reading	≤ 8 seconds
Power supply	DC 5V±0.1V, ripple wave＜100mV
Working current	≤80mA
Dimensions	W40.7*H40.7*D12.2 mm
Weight	26.5g
Digital output	UART/IIC: 3.3V
MTTF	128,000 hrs (continuous turn on)

Internal Architecture Description

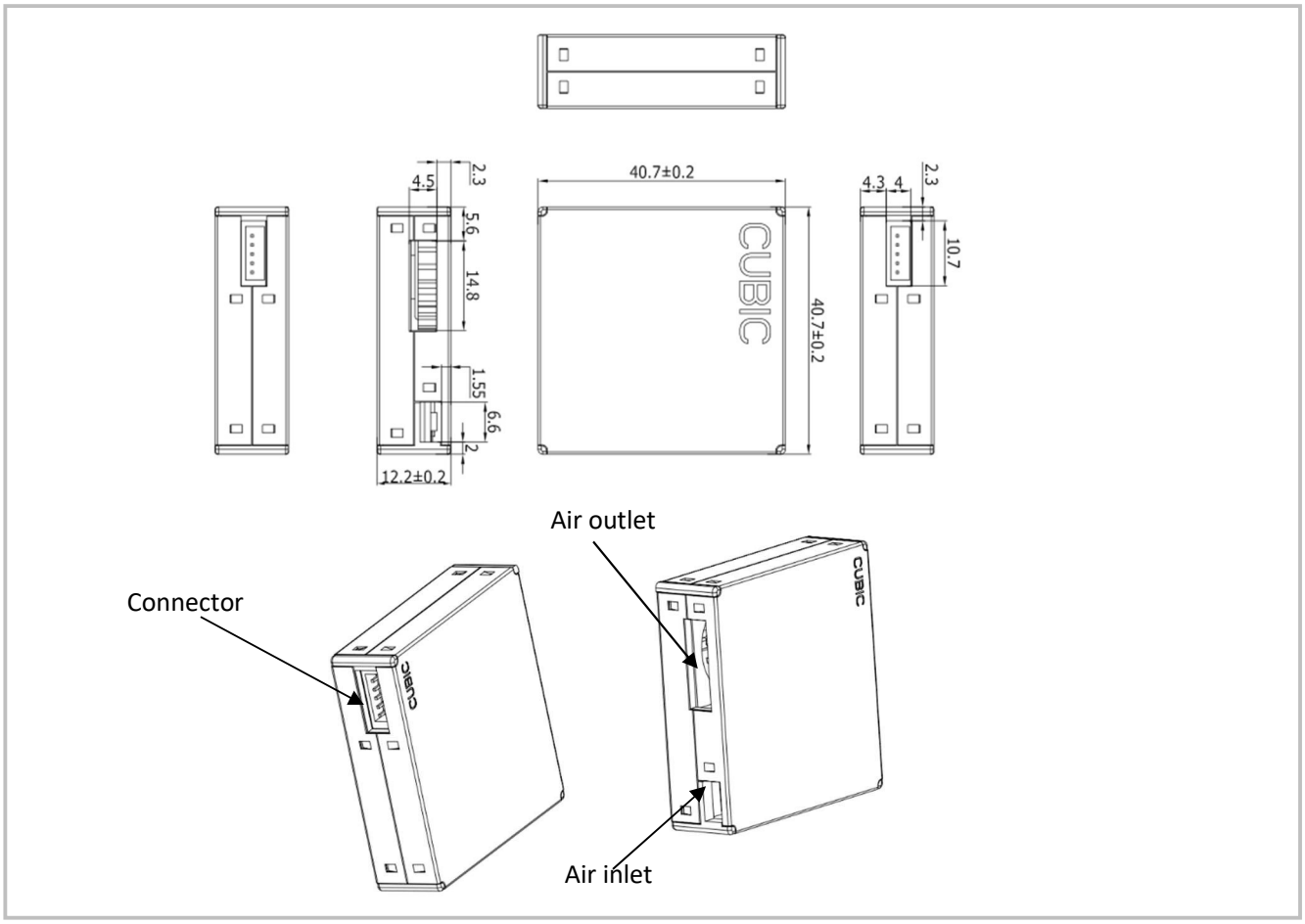


According to the above figure, the light source part of PM2016 is composed of a laser tube and a driving circuit. The detection part of the sensor is composed of light sensitive part which receives reflected light and amplifying circuit. Data processing and communication output are completed by microprocessor.

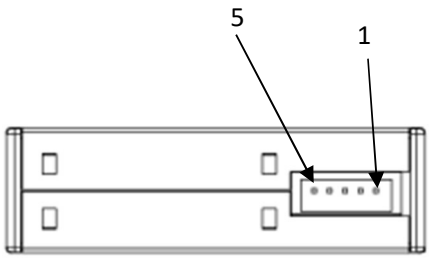
The gas flows into the module through the fan, when sampling particles pass through light beam (laser), there will be light scattering phenomenon, and scattered light will be converted into electrical signal (pulse) via light sensitive part. Electrical signal will be transformed into digital signals after amplifying circuit, smoothing and MCU processed.

Dimensions and Connector

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



2. I/O Connector Pin out

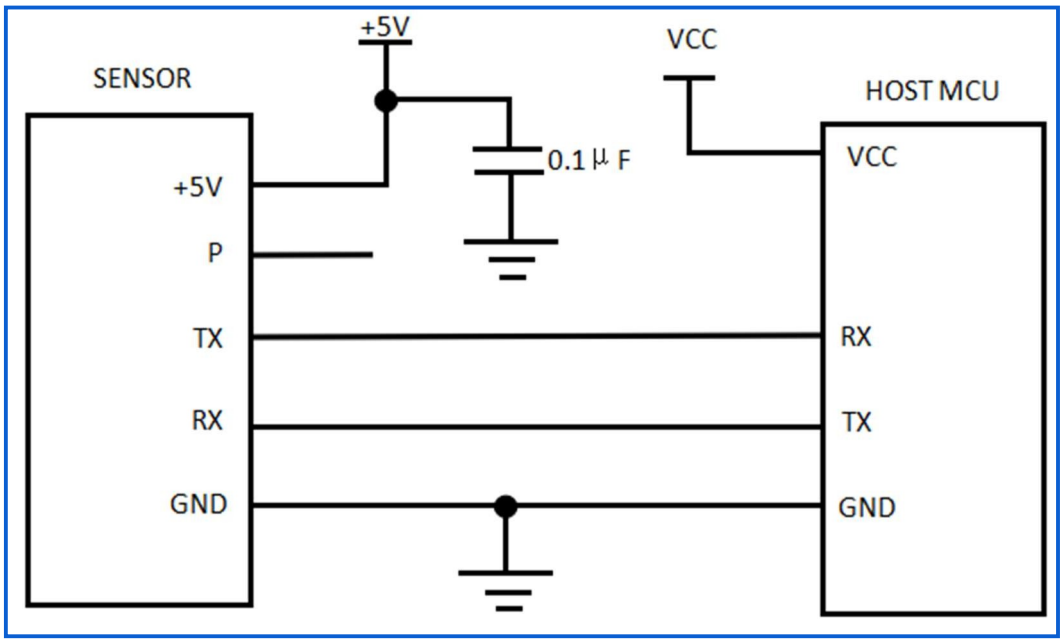


No.	Pin	Description
1	VCC	Power input (+5V)
2	RX/SDA	UART receiving/IIC data
3	TX/SCL	UART sending/IIC clock
4	P	Output mode exchange TTL level @3.3V High level or floating is UART communication mode, low level is IIC communication mode
5	GND	Power input (ground terminal)

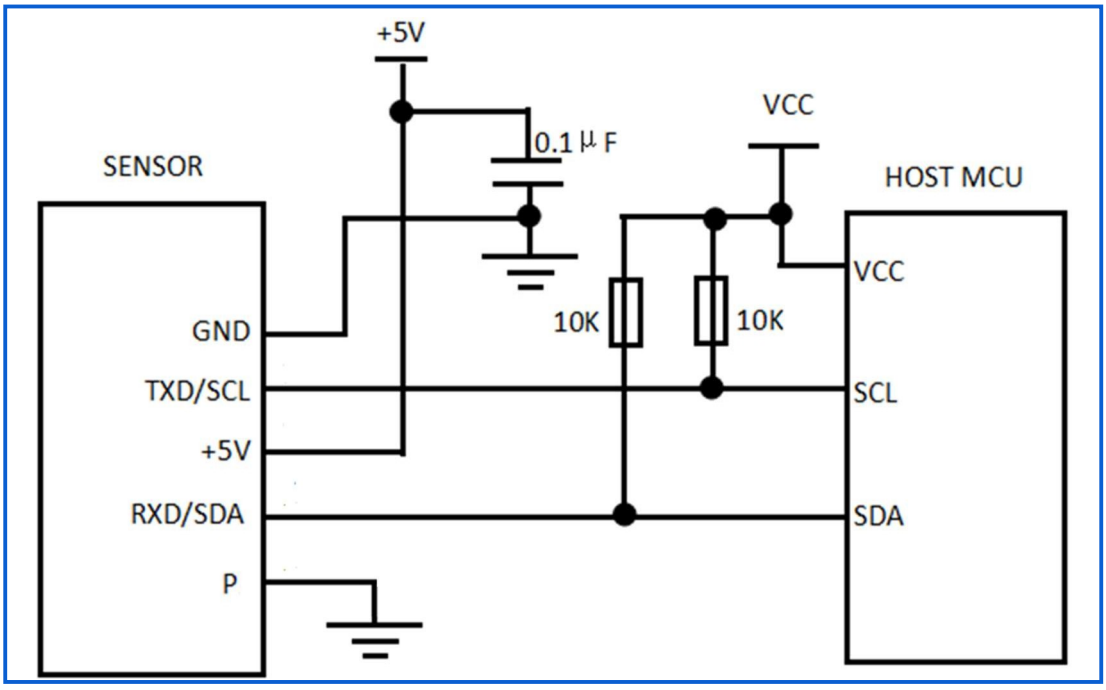
Item	Part Number	Pitch
Connector	CJT A1501WR-S-5P	1.5 mm

Typical Application Circuit

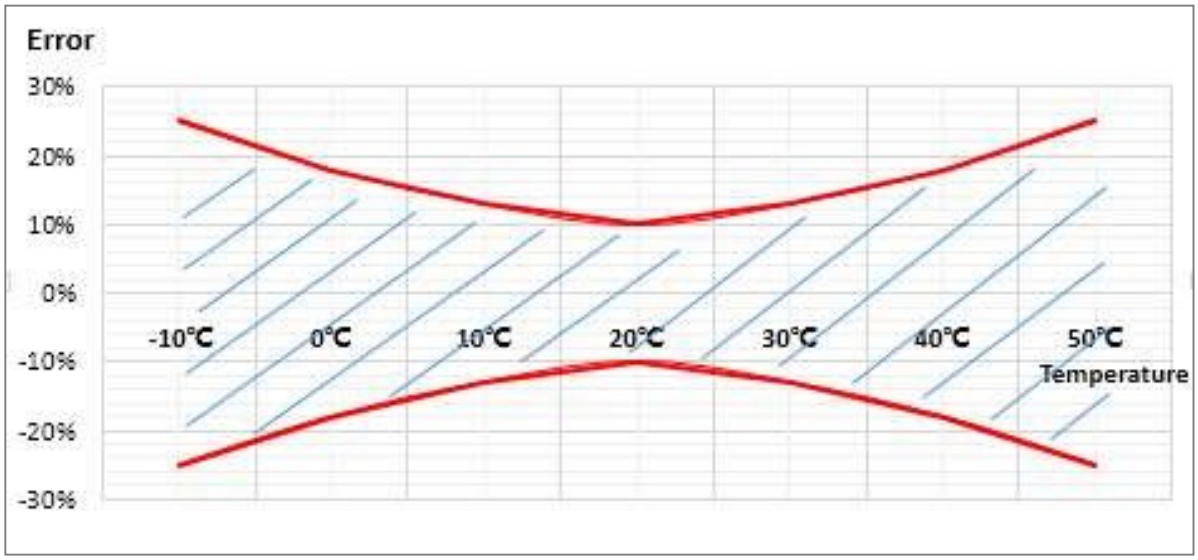
Case 1. UART Application



Case 2. IIC Application



Temperature Influence



Particle measured error: under 25±2℃, 50±10%RH, 0~500μg/m³, consistency and accuracy of PM1.0/PM2.5 is ±10% reading or ±10μg/m³, whichever is larger (GRIMM 11-A, Cigarette+A1 Dust).

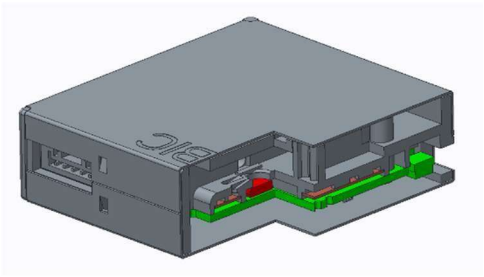
User Attention

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

▪ Please do not use it in bad dusty environment and close sampling port.

▪ Avoid using the sensor under situation with strong magnetic, such as situation close to stereo speaker, microwave oven, induction cooking.

▪When installing to system, make sure the inlet and outlet is unobstructed, and cannot be touched against by large air stream. There are two sides cannot be put downwards (As below pictures), In case of dust deposition on the surface of sensitive device, dust deposition will affect accuracy of sensor.



Inner crossing section drawn

Recommend installation

▪The metal case of sensor connects with the DC ground of inner circuit directly, which will cause safety problem if touching with DC ground. To avoid this problem, Sensor should be internally installed and no permit for touching sensor before power off.

▪There is no high pressure transient protection circuit of the sensor. The power supply of the sensor should be stable 5V and low noise. Please refer to the working current in specification table.

▪The sensor itself is safe to use. What the user should be cautious is the safety of power supply and structure design onthe sensor.

▪This product is defined as 3R laser product according to 《GB7247.1-2012 laser product safety》 with laser radiation inside. Please avoid direct illumination on the eye. The warning label is as below.

UART Communication Protocol

1. General Statement

1) The data in this protocol is all hexadecimal data. For example,“46” for decimal [70].
2) [xx] is for single-byte data (unsigned, 0-255); for double data, high byte is in front of low byte.
3) Baud rate: 9600; Data Bits: 8; Stop Bits: 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 symbol	Sending by software is fixed as [11H], module respond is fixed as [16H]
Length	Length of frame bytes= data length +1 (including CMD+DATA)
Command	Command
Data	Data of writing or reading, length is not fixed
Check sum	Cumulative sum of data = 256- (HEAD+LEN+CMD+DATA)

3. Command Table of Serial Protocol

Item No.	Function Description	Command
1	Read particle measurement result	0x0B
2	Open/close particle measurement	0x0C
3	Set up and read particle calibrated coefficient	0x07
4	Read software version number	0x1E
5	Read serial number	0x1F

4. Detail Description of UART Protocol

3.1 Read Particle Measurement Result

Send: 11 02 0B 07 DB

Response: 16 35 0B DF1- DF52 [CS]

Function: Read concentration of particle

Note: Read particle concentration (ug/m3)

PM1.0 = DF1*256^3 + DF2*256^2 + DF3*256^1 + DF4

PM2.5 = DF5*256^3 + DF6*256^2 + DF7*256^1 + DF8

PM10 = DF9*256^3 + DF10*256^2 + DF11*256^1 +DF12

DF13~DF48: Reserved

DF49:

Alarm of sensor module working condition:

Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Alarm definition	1: Laser diode short circuit		1: Laser diode open circuit	1: dust accumulation	1: low working temperature	1: high working temperature	1: Fan at low revolving speed	1: Fan at high revolving speed

DF50, DF51, DF52: Reserved

Note: Part of reserved bytes is used for Cubic internal testing and not related to function.

3.2 Open/Close Particle Measurement

Send: 11 03 0C DF1 1E CS

Response: 16 02 0C DF1 CS

Function: Open/close measurement

Note:

1. When sending command, DF1=02 means opening measurement, DF1=01 means closing measurement;
2. When receiving response, DF1=02 means measuring opened, DF1=01 means measuring closed;

3.3 Set up and Read Particle Calibrated Coefficient

Send: 11 02 07 DF1 [CS] // Set up particle calibrated coefficient

Send: 11 01 07 E7 // Read particle calibrated coefficient

Response: 16 02 07 DF1 [CS]

Function: Read/set up particle calibrated coefficient

Note:

1. Range 70~150, 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 PM1.0, PM2.5, and PM10 will be all corrected by this coefficient.

3.4 Read Software Version Number

Send: 11 01 1E D0

Response: 16 0E 1E DF1~DF13 [CS]

Function: Read software version

Note:

Software version="DF1~DF13", 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

3.5 Read Serial Number

Send: 11 01 1F CF

Response: 16 0B 1F DF1 DF2 DF3 DF4 DF5 DF6 DF7 DF8 DF9 DF10 CS

Function: Read serial number

Note:

Serial number = (DF1*256+DF2), (DF3*256+DF4), (DF5*256+DF6), (DF7*256+DF8), (DF9*256+DF10)

Example:

Response: 16 0B 1F 00 00 00 7E 09 07 07 0E 0D 72 9E

Serial number: 0000 0126 2311 1806 3442

IIC Communication Protocol

1. Brief Introduction

a. This is an IIC protocol for PM2016. The sensor module is lower computer, which is not able to initiate communication automatically. Communication is initiated via main controlled board, which reads data and sends control commands.
b. Communication clock frequency <=100Khz

2. Communication Common Command

START: start signal, send by main controlled board;
STOP: stop signal, send by main controlled board;
ACK: acknowledge signal, send by the sensor module if in bold; otherwise, send by main controlled board;
NACK: non-acknowledge signal, send by the sensor module if in bold; otherwise, send by main controlled board;
Px: receive and send data; send by the sensor module if in bold; otherwise, send by main controlled board.

3. Protocol Detailed Description

3.1 Send Command Data

Send by main controlled board:
START+WRITE+ACK+P1+ACK+P2+ACK…… +P7+ACK+STOP

Data	Byte content	Description
Device address	Sensor address and writing bit	This byte is 0x50 when write data
P1	0x16	Frame header
P2	Frame length	Number of byte, not including length of device address (From P1 to P7, 7 bytes in total)
P3	Data 1	Control command of the sensor as: Close measurement: 1 Open measurement: 2 Set up calibration coefficient:6
P4	Data 2, high byte	Calibration coefficient:(Range: 70~150, Corresponding: 0.7~1.5）
P5	Data 2, low byte	
P6	Data 3	Reserved
P7	Data check code	Check code= (P1^P2^……^P6)

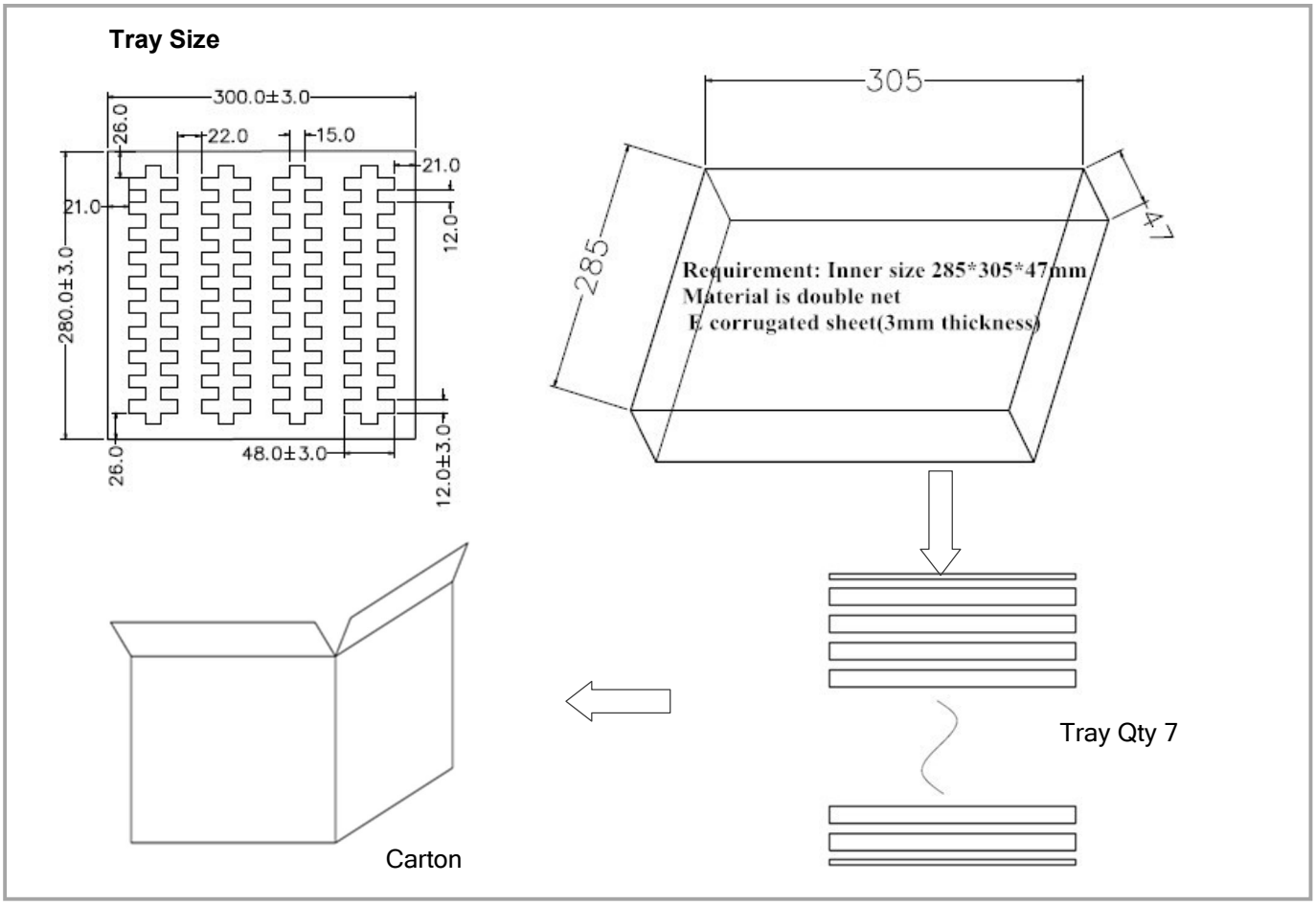
3.2 Read Data Command

Send by main controlled board:
START+READ+ACK+P1+ACK+P2+ACK+……+P32+NACK+STOP

Data	Byte content	Description
Device address	Sensor address and reading bit	This byte is 0x51 when read data
P1	0x16	Frame header
P2	Frame length	Number of byte, not including length of device address (from P1 to P32, 32 bytes in total)
P3	Sensor status	Close: 01; Alarm: 07, means the temperature is too high or too low, or fan speed is too high or too low.; Measuring: 02; Other data is invalid.
P4	Data 1, high byte	Reserved

P5	Data 1, low byte	
P6	Data 2, high byte	Calibration coefficient: (Range: 70~150, Corresponding: 0.7~1.5)
P7	Data 2, low byte	
P8	Data 3, high byte	PM1.0, unit: μg/m³
P9	Data 3, low byte	
P10	Data 4, high byte	PM2.5, unit: μg/m³
P11	Data 4, low byte	
P12	Data 5, high byte	PM10, unit: μg/m³
P13	Data 5, low byte	
P14	Data 6, high byte	Reserved
P15	Data 6, low byte	
P16	Data 7, high byte	
P17	Data 7, low byte	
P18	Data 8, high byte	
P19	Data 8, low byte	
P20	Data 9, high byte	
P21	Data 9, low byte	
P22	Data 10, high byte	
P23	Data 10, low byte	
P24	Data 11, high byte	
P25	Data 11, low byte	
P26	Data 12, high byte	
P27	Data12, low byte	
P28	Data 13, high byte	
P29	Data 13, low byte	
P30	Data 14, high byte	
P31	Data 14, low byte	
P32	Data check code	Check code = (P1^P2^……^P31)

Package Information



Sensor per Tray	Tray Qty	Sensor per	Carton Dimensions	Packing Material
40 pcs	7 layers	280 pcs	395*310*330 mm	Red anti-static EPE

After-Sales Services and Consultancy

Cubic Sensor and Instrument Co.,Ltd.
Tel: +86 (0)27 81628827 Fax: +86 (0)27 81628821
Add: Fenghuang No.3 Road, Fenghuang Industrial Park, Eastlake Hi-tech Development Zone, Wuhan 430205, China
E-mail: info@gassensor.com.cn