SPECIFICATION

Product Name: Dual Beam NDIR CO_2 Sensor Module

Item No.: CM1107H

Version: V0.1

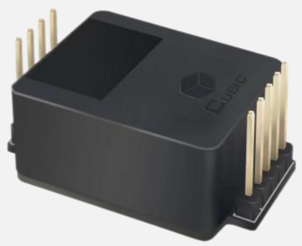
Date: March, 1st,2022

Revision

No.	Version	Content	Date
1	V0.1	First Version Issue	2022.3.01

Dual Beam NDIR CO_2 Sensor Module

CM1107H



Applications:

- Fruit and vegetable storage
- Carbonate beverage storage
- Microbial cultivation
- Wine or beer cellar

Description

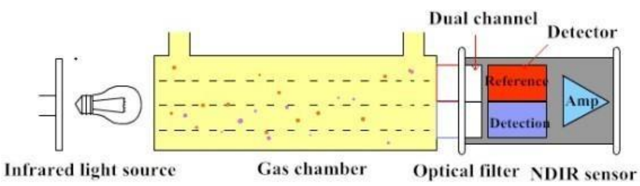
CM1107H is a dual beam (single light source, dual channel) NDIR CO_2 sensor, based on non-dispersive infrared (NDIR) technology, which can detect CO_2 concentration of indoor air. With higher accuracy, superior long term stability, it is widely used for ventilation system, air purifier, air conditioner, intelligent agriculture, storage and cold-chain, etc.

Features

- NDIR technology with independent intellectual property
- Dual beam detection for superior stability and better accuracy
- High accuracy, long term stability, long life (>10years)
- Temperature calibration within whole measurement range
- Signal output UART/I^2C/PWM
- Small size and compact structure, easy to install

Working Principle

The main components of an NDIR CO_2 sensor are an infrared source, a sample chamber, a filter and two detectors. The infrared light is directed by the infrared source passing through the gas chamber towards the detector.



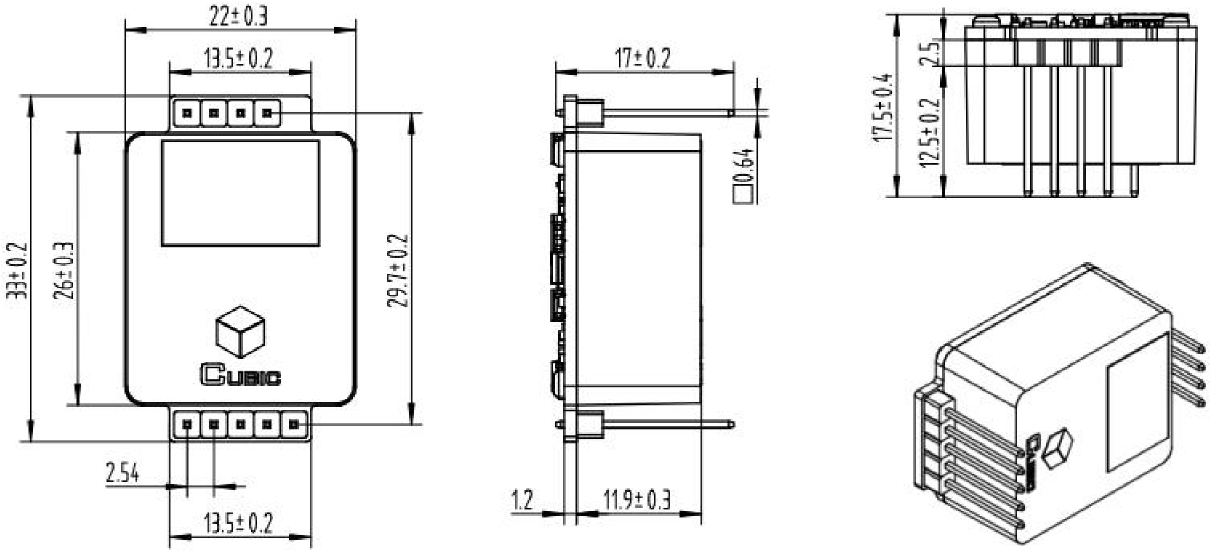
CO2 molecules inside the gas chamber will only absorb a specific wavelength of the light. The filter allows only the specific wavelength corresponded to pass through it. One detector measures the intensity of infrared light that is related to the intensity of CO2 and can be described through the Lambert-Beer's Law. The other detector is as for reference. The change in sensor signal reflects the change in gas concentration.

Specifications

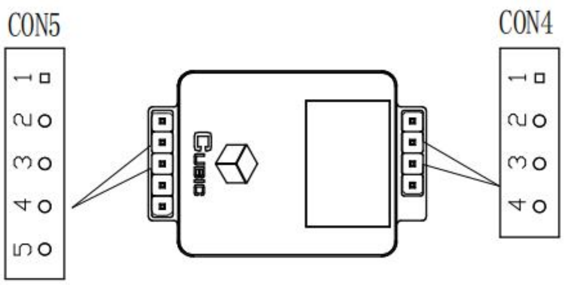
Dual Beam NDIR CO_2 Sensor Specification	
Target gas	Carbon Dioxide (CO_2)
Operating principle	Non-dispersive infrared (NDIR)
Measurement range	0-5.000% Vol
Resolution	0.001% Vol
Working temperature	-10°C ~ 50°C
Working humidity	0-95%RH (non-condensing)
Storage temperature	-30°C ~ 70°C
Storage humidity	0-95%RH (non-condensing)
Accuracy	0-0.2% Vol: ± 0.02% vol (200ppm); 0.2% Vol-5% Vol:10% of reading
Sampling frequency	1s
Preheating time	30s
Power supply	DC 4.5V~5.5V
Working current	<50mA
Dimensions	W33 * H22 * D13.1mm（without pin）
Weight	7g
Signal output	UART_TTL (3.3V) I^2C (3.3V)
PWM output	Output high level minimum duration: 2ms (0% Vol)
	Output high level maximum duration: 1002ms (5.00% Vol)
Alarm output	Reserved
Life span	≥10 years

Dimensions and Connector

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



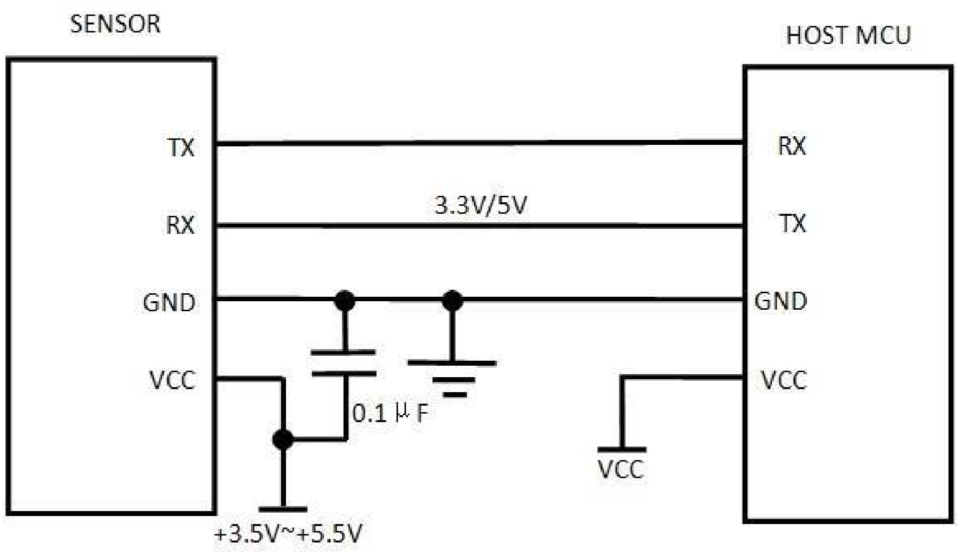
2. I/O Connector Pinout



CON5			CON4		
Pin	Name	Description	Pin	Name	Description
1	+3.3V	Power supply output (+3.3V/100mA)	1	+5V	Power supply input voltage,
2	RX/SDA	UART-RX (Receiving)/I²C data, compatible with 3.3V and 5V communication	2	GND	Power supply input (GND)
3	TX/SCL	UART-TX (Sending)/I²C clock, 3.3V communication	3	A	Alarming
4	R/T	UART/I²C Switch (Output mode exchange TTL level @3.3V High level or floating is UART communication mode, low level is I²C communication mode)	4	PWM	PWM output
5	CA	Manual calibration			

Typical Application Circuit

Application scene: UART_TTL 3.3V serial port output



Description of Calibration

1. Auto calibration (Closed by default, if open please refer to the protocol)

Rough installing and influence of transportation might result in reducing of sensor measuring accuracy and baseline drift, sensor will correct the drift by the built-in self-correcting logic. Powering on the sensor for 7 days continuously, it will record the lowest CO2 concentration measurement value during the 7 days, which will be regarded as baseline (400ppm) when sensor implements auto calibration after the 7 days working. In order to ensure correct auto calibration, please make sure working environment of the sensor can reach to outdoor fresh air level (400ppm) during the 7 days auto baseline correction cycle.

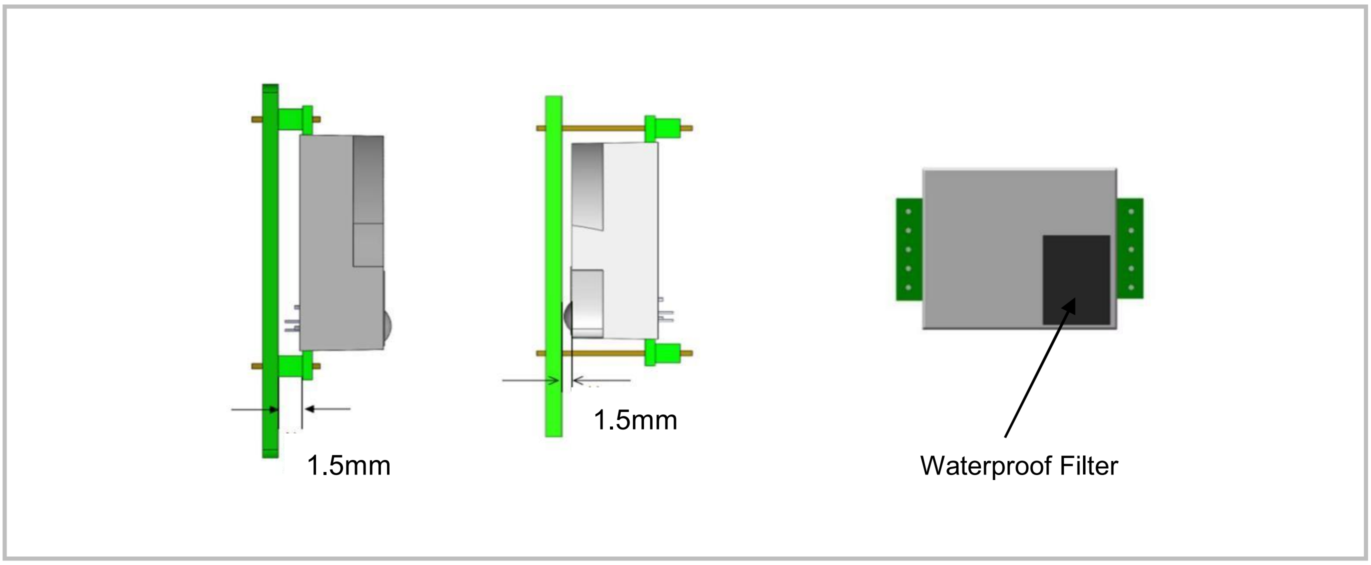
Note: For more detailed information on sensor auto-calibration, please contact Cubic

2. Manual calibration:

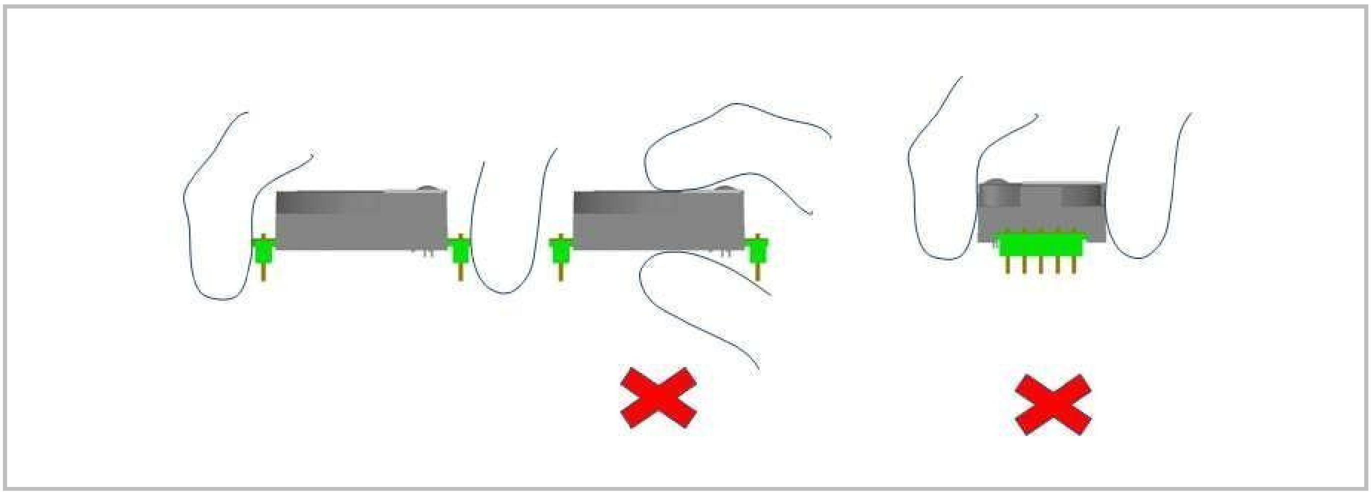
Rough installing and influence of transportation might result in a reducing of sensor reading accuracy and baseline drift. If need to recover accuracy quickly after installing, users can do manual calibration. Please place the sensor in an environment where outdoor atmospheric CO2 levels can reach 400 ppm and ensure the CO2 concentration in this environment is stable before calibration. The CA pin of sensor should be well connected at least 2 seconds when doing the manual calibration. Sensor will activate the calibration program after 6 seconds. In addition, sensor also can do manual calibration by sending command, please refer to the communication protocol for more details.

Product Installation

1. In order to ensure airflow diffusion into the sensor inner, make sure the minimum distance between the area of waterproof filter and the other components is 1.5 mm, otherwise, quick response time of the sensor will be affected. Reference as below:



2 .To avoid the influence of stress on sensor, please soldering by hand as much as possible when mounting the sensor to the PCB. Reference 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). Baud rate: 9600, Data Bits: 8, Stop Bits: 1, Parity: No, Flow control: No.

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

2. Format of Serial Communication Protocol

Sending format of upper computer:

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 upper computer 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)%256

3. Command Table of Serial Protocol

Item No.	Function Name	Command
1	Read measured result of CO_2	0x01
2	Open/ Close ABC and set ABC parameter	0x10
3	Calibrate concentration value of CO_2	0x03
4	Read software version	0x1E
5	Read the serial number of the sensor	0x1F

4. Detail Description of Protocol

4.1 Read Measured Result of CO_2

Send: 11 01 01 ED

Response: 16 05 01 DF1- DF4 [CS]

Function: Read measured result of CO_2 (Unit: 0.001% Vol)

Note:

CO_2 measured result = DF1*256+DF2; The output is 550ppm during 30s (preheating time) after power on.

DF3 is status bit, definition as below, DF4 is reserved

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Reserved	1: Drift 0: Normal	1: Light Aging 0: Normal	1: Non-calibrated 0: Calibrated	1: Less than Measurement Range 0: Normal	1: Over Measurement Range 0: Normal	1: Sensor Error 0: Operating normal	1: Preheating 0: Preheat complete

Example:

Response: 16 05 01 00 60 00 00 84

Explanation:

Hex is converted to decimal: 60 is 96

CO_2 concentration= 0.096% Vol

4.2 Open/Close ABC and Set ABC Parameter

Send: 11 07 10 DF1 DF2 DF3 DF4 DF5 DF6 CS

Response: 16 01 10 D9

Explanation:

DF1: Reserved, default 100 (0x64)

DF2: Open/close auto calibration (0: open; 2: close, default close)

DF3: Calibration cycle (1-30 days optional, default is 7 days) DF4:

High base value (2 bytes)

DF5: Low base value (2 bytes)

DF6: Reserved, default is 100 (0x64)

Note:

The default value of DF4 and DF5 is 400, that is DF4: 01; DF5: 90

4.2.1 Open ABC and Set Calibration Cycle

When ABC function is closed and if want to re-open ABC function, then set the DF2=0.

Example: Send below command to open ABC function and set the calibration cycle

Send: 11 07 10 64 00 07 01 90 64 78

Response: 16 01 10 D9

4.2.2 Close ABC

The ABC function is default closed. If want to close the ABC function after open it, then set the DF2=2.

Send: 11 07 10 64 02 07 01 90 64 76

Response: 16 01 10 D9

4.2.3 Change the Calibration Cycle

If want to change the calibration cycle to 10 days, then set the DF3=0A.

Send: 11 07 10 64 00 0A 01 90 64 75

Response: 16 01 10 D9

4.2.4 Check ABC Status and ABC Cycle

To check the ABC status, then check the DF2, 0 means open; 2 means close
To check the ABC cycle, then check the DF3 (DF3 range can be 1-30 days, default is 7 days)

Send: 11 01 0F DF
Response: [ACK] 07 0F [DF1][DF2][DF3][DF4][DF5][DF6][CS]

4.3 Calibration of CO_2 Concentration

Send: 11 03 03 DF1 DF2 CS

Response: 16 01 03 E6

Function: Calibration of CO2 concentration

Note:

1. Calibration target value = DF1*256+DF2 Unit: 0.01% Vol
2. Before calibration, please make sure CO_2 concentration in current ambient is calibration target value. Keeping this CO_2 concentration for at least one minute, then began calibration.

Example:

When you need to calibrate CO_2 concentration of the sensor to 4.00% Vol, send command:

Send: 11 03 03 01 90 58

Hex is converted to decimal: 01 is 01; 90 is 144, CO_2 concentration =01*256+144 = 4.00% Vol

4.4 Read Software Version

Send: 11 01 1E D0

Response: 16 0C 1E DF1-DF11 CS

Function: Read software version

Note:DF1-DF10: stand for ASCII code of software version, DF11 is reserved.

Example:

When the sensor version is CM V0.0.20, respond data as follows:

Hexadecimal converted to ASCII code:

Note: when 20 converted to ASCII code, it equals to blank space.

16 0C 1E **43 4D 20 56 30 2E 30 2E 32 30**

↓

CM V0.0.20

4.5 Read the Serial Number of the Sensor

Send: 11 01 1F CF

Response: 16 0B 1F (SN1) (SN2) (SN3) (SN4) (SN5) [CS]

Function: Read the serial number of the sensor

Note: Read the serial number of the sensor. SN: 0~9999, 5 integer form 20-digit number

I²C Communication Protocol

1. Timing Diagram Introduction

1.1 Common Description

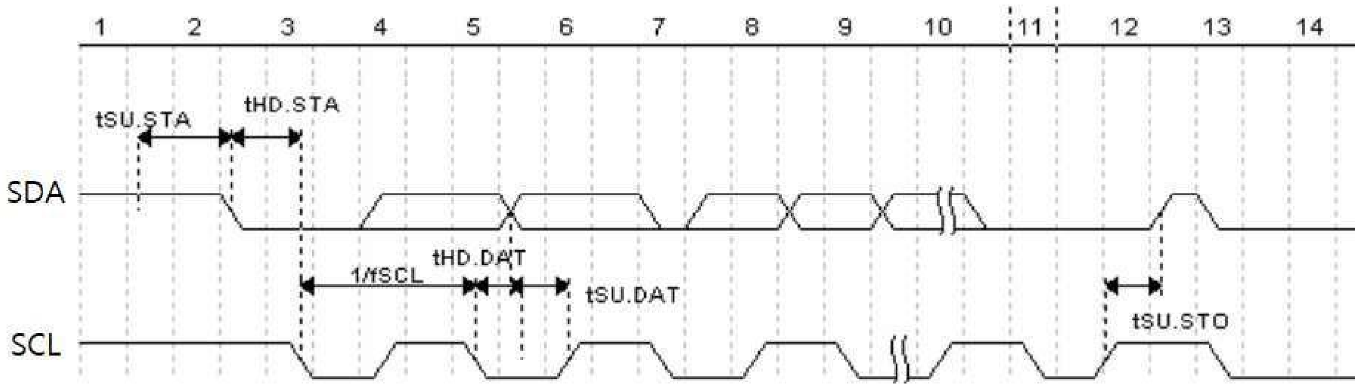
a. This protocol is based on standard I²C timing sequence, the clock frequency is 10kHz～400kHz.

b. Use big-endian format, the most significant bit to be sent first.

1.2 I²C Sequence Diagram Introduction

Item	Parameter			Unit
	Min	Typical	Max	
fSCL (SCL clock frequency)	10		400	KHz
tHD.STA (hold time of the starting bit)		0.6		us
tSU.STA (setup time of the starting		0.6		us
tHD.DAT (hold time of the data)		0		ns
tSU.DAT (setup time of the data)		250		ns
tSU.STO (setup time of the stop bit)		4		us

Note: SCL clock frequency is generated by the master device with the range 10khz～400khz.



Picture 1: I²C clock introduction

1.3 Basic Data Transmission Formats

S	SA	W	A	D	A	D	…	D	A/~A	P

Picture 2: The general data format sends from the master device to the slave

S	SA	R	A	D	A	D	…	D	A/~A	P

Picture 3: The general data format received from the slave device to the master device

The meaning of the symbol in picture 1.2 and picture 1.3:

S: start condition

SA: slave address

W: write bit

R: read bit

A: acknowledge bit

~A: not acknowledge bit

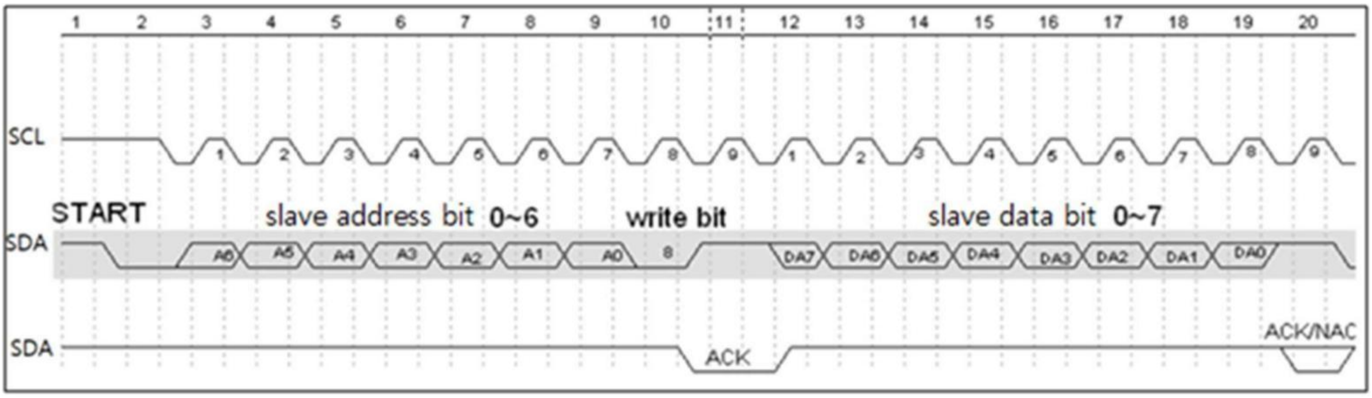
D: data, each data is 8bit

P: stop condition

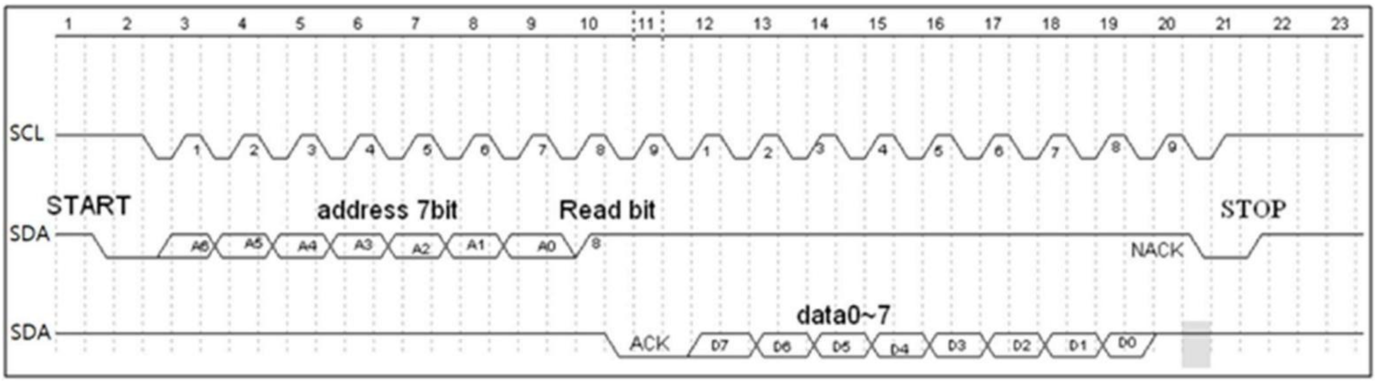
Shadow: The signal generated from the master device

No Shadow: The signal generated from the slave device

1.4 Timing Diagram



Picture 4: The address byte send from the master device



Picture 5: The master device read a byte from the slave device

1.5 Notes

The performance of the MCU which is used in the sensor is not very high. If you use I/O port to simulate IIC master device, it is suggested to reserve a period before and after ACK signal (such as 100 us), after sending every byte (8 bit) to leave enough time for the SCM to process the data. Within requirements of speed, it is recommended to lower the reading speed as much as possible.

2. Measuring Function

Format of Command

Format of Sending: [CMD][DF0]……[DFn]

[CMD] Command number, for distinguishing different command.

[DF0] … [DFn] The command with parameter item and optional items

Format of Response: [CMD][DF0]……[DFn]［CS］

[CMD] Command number

[DF0]… [DFn] Effective data

[CS] Data check bit = -([CMD]+ [DF0]+……[DFn]) Only use the lowest bit

2.1 Statement of Measuring Command

The slave address is 0x31, the data command of the slave device is as below:

No.	Function Name	CMD	Function Description
1	Measure result	0x01	Read measuring result
2	Calibration	0x03	Manual calibration to target concentration
3	Read the serial number of the sensor	0x1F	Read the serial number of the sensor
4	Check software version	0x1E	Read software version

2.2 Measuring Result

The master device should send command of measuring result.

Send: 0x01

Response: [0x01][DF0][DF1] [DF2][CS]

Note:

1. Sensor starts measuring result status once receiving the command 0x01. After this, all the data which I^2C read will be such status format data, until the sensor receives new command or re-powering on.

2. Data format, master device receives DF0 first, and then receives CS at last.

Remark	Status Bite	Decimal Effective Reading Value Range	Relative Value	Multiple
CO_2 measuring result	[DF0] [DF1]	0 ~ 5.000% Vol	0 ~ 5000	0.001

CO_2 measuring result: DF0 *256+DF1, unit is 0.001% Vol

Example:

The master device reads some data: Read 3 bit.

0x01 0x00 0x20 0x00 0xDF

CO_2 measuring result = (0x00 0x20) $_{hexadecimal}$ = (32) $_{decimal}$ = 0.032% Vol

The reading will be 0.04% Vol during 30s after power on.

DF2 is status bit, definition as below:

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Reserved	1: Drift 0: Normal	1: Light Aging 0: Normal	1: Non-calibrated 0: Calibrated	1: Less than Measurement Range 0: Normal	1: Over Measurement Range 0: Normal	1: Sensor Error 0: Operating normal	1: Preheating 0: Preheat complete

2.3 Calibration

The master device should send command of zero setting.

Send: 0x03 [DF0] [DF1]

Response: [0x03] [DF0] [DF1] [CS]

Note:

1. Sensor starts setting status once receiving command 0x03. After this, all the data which I²C read will be such status format data, until the sensor receives new command or re-powering on.

2. Data format, master device receives DF0 first, and then receives CS at last. The result is calculated by high bit in front: [DF0] * 256 + [DF1], the unit is 0.01% Vol.

2.4 Read the Serial Number of the Sensor

Send: 0x1F

Response: [0x1F] [DF0] [DF1] [DF2] [DF3] [DF4] [DF5] [DF6] [DF7] [DF8] [DF9] [CS]

Note:

1. Sensor starts device code output status once receiving the command 0x1F. After this, all the data which I²C read will be such status format data, until the sensor receives new command or re-powering on.
2. Data format, the master device receives [DF0] first, and then receives [CS] at last. The result is calculated by hig h bit in front.

Remark	Data Bit	Decimal Effective Reading Value Range	Relative Value	Multiple
Integer type 1	[DF0] [DF1]	0 ~ 9999	0 ~ 9999	1
Integer type 2	[DF2] [DF3]	0 ~ 9999	0 ~ 9999	1
Integer type 3	[DF4] [DF5]	0 ~ 9999	0 ~ 9999	1
Integer type 4	[DF6] [DF7]	0 ~ 9999	0 ~ 9999	1
Integer type 5	[DF8] [DF9]	0 ~ 9999	0 ~ 9999	1

3. The five-integer type makes 20 codes.

2.5 Read Software Version

Send: 0x1E

Response: [0x1E] [DF0] [DF1] [DF2] [DF3] [DF4] [DF5] [DF6] [DF7] [DF8] [DF9] [CS]

Note: 1. Sensor starts software version output status once receiving the command 0x1E. After this, all the data which I²C read will be such status format data, until the sensor receives new command or re-powering on.
2. Data format, the master device receives DF_0 first, and then receives CS at last. [DF_0] …… [DF_9] is ASCII.

3. Communication Diagram

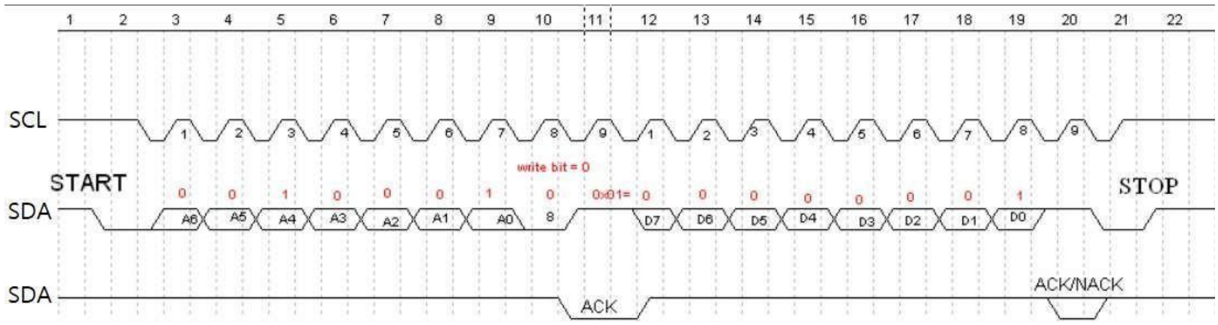
Diagram 1: The master device read two bytes continuously from the slave device.

The slave machine address: 0x31 = 0110001 (the machine address is 7 bit) + read/write bit（1bit）

The slave data address: 0x01 = 00000001

Step 1: The master device sends the address of the slave device+ write bit: 0110001+0 → 01100010 (0x62); at this time, the master device is in sending status.

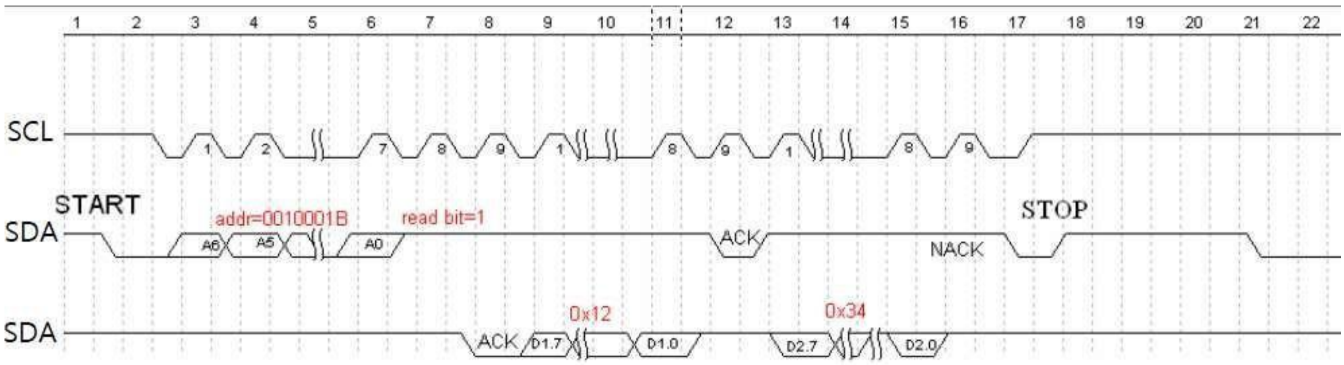
Step 2: The master device sends the slave data address: 0x01



Picture 6: The timing diagram send from the master device

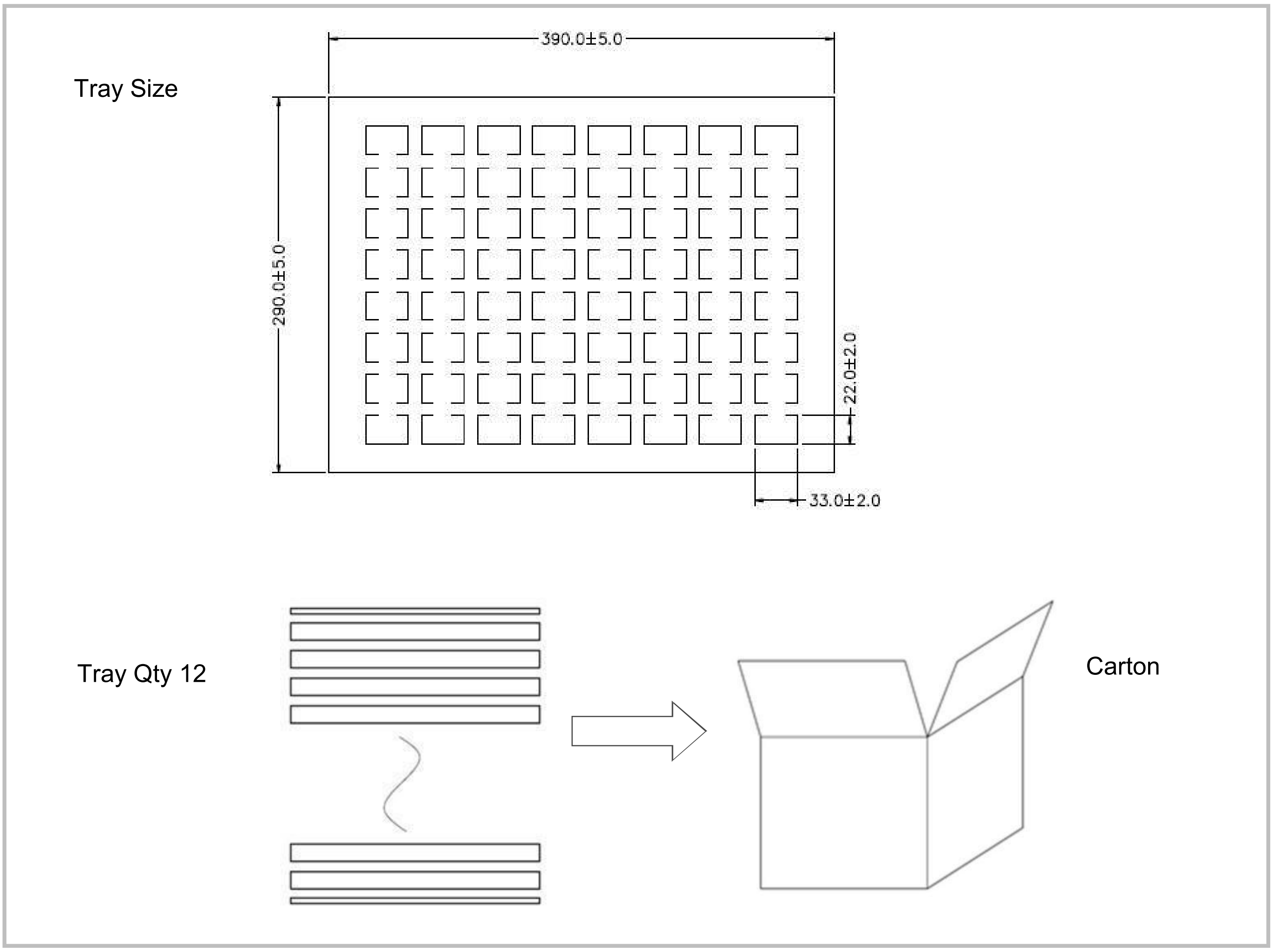
Step 3: The master device send the slave machine address+ read bit: 0110001+1 → 01100011 (0x63); at this time, the master device is in receiving status.

Step 4: The master device sends the answer bit after receiving a one-bit data and the slave continuously sends the next data. If the master device sends the no-answer bit after receiving a one-bit data, then the communication will stop.



Picture 7: The master device receives the data from the slave device

Packing Information



Sensor per Tray	Tray Qty	Sensor per Carton	Carton Dimensions	Packing Material
64 pcs	12 layers	768 pcs	W400 * L300 * H320 mm	Red anti-static EPE

After-Sales Services and Consultancy

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