DATASHEET & MANUAL

Product Name: Super Low Power CO_2 Sensor Module

Item No.: CM1106SL-N

Version: V0.9

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Revision

No.	Version	Content	Date
1	V0.1	First Edition	2019.09.11
2	V0.2	1.Update power consumption chart 2.Update working sequential chart	2019.10.25
3	V0.3	1.Update working current 2.Revise explanation about working sequential chart	2020.01.06
4	V0.4	Update description of ABC	2020.03.12
5	V0.5	Update description of working model and accuracy	2020.05.15
6	V0.6	Update description of working mode	2020.08.06
7	V0.7	Update description of single measurement working mode	2020.10.12
8	V0.8	Update description of specification	2021.01.13
9	V0.9	Change continuous mode B power set string	2021.05.20

Super Low Power NDIR CO$_2$ Sensor Module

CM1106SL-N

Applications

- HVAC industry
- Detecting units with battery operation
- Portable instruments

Description

CM1106SL-N is super low power consumption, high performance NDIR battery-powered CO$_2$ sensor, which can be used to detect CO$_2$ concentration of indoor air by adopting advanced non-dispersive infrared (NDIR) technology. It is ideally suited for HVAC industry, detecting units with battery operation, portable instruments, etc.

Features

- NDIR technology with independent intellectual property
- Super low power consumption
- High accuracy, long-term stability, long life (>15 years)
- Temperature calibration within whole measurement range
- Auto-calibration, no need of maintenance
- Small size and compact structure, easy to install
- Wide supply voltage range enables variety of battery options.
- Adjustable measurement cycle by host
- ABC setting by host

Working Principle

The main components of an NDIR CO$_2$ sensor are an infrared source, a sample chamber, a filter and an infrared detector. The infrared light is directed by the infrared source passing through the gas chamber towards the detector.
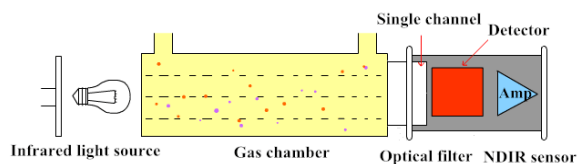
CO$_2$ molecules inside the gas chamber will only absorb a specific wavelength of the light. The filter allows only the specific wavelength corresponded to pass through it. The detector measures the intensity of infrared light that is related to the intensity of CO$_2$ and can be described through the Lambert-Beer's Law. The change in sensor signal reflects the change in gas concentration.

Super Low Power NDIR CO_2 Sensor Specification	
Target gas	Carbon dioxide (CO_2)
Operating principle	Non-dispersive infrared (NDIR)
Measurement range	0-5000pm (Note 1)
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	± (50ppm+5% of reading) (Note 2) ± (50ppm+3% of reading) (Note 3)
Power supply	DC 3.3V-5.5V
Average working current	60uA (1 minute as measurement cycle) 30uA (2 minutes as measurement cycle) 12uA (5 minutes as measurement cycle)(Note 4)
Measurement Setting	Default: single measurement mode (working mode A), reading output is without moving average(Adjustable by host)(Note 5)
Dimensions	33x19.7x8.9mm (pin is not included)
Weight	5g
Signal output	UART_TTL
Life span	≥15 years

Specifications

Note 1：Sensor is designed to measure in the range 0~5000ppm. Nevertheless, exposure to concentrations below 400ppm may result in incorrect operation of ABC algorithm and shall be avoided for model with ABC ON.

Note 2: In normal IAQ applications, accuracy is defined with 10°C-35°C, 0-85%RH. ±(50ppm+5% of reading) could achieved under continuous power supply mode, with 4s as working cycle and moving average based on 24 data.

Note 3: In normal IAQ applications, accuracy is defined with 10°C-35°C, 0-85%RH. When the sensor is under single measurement mode (controlled power supply by host), the sensor reading output is without moving average. The defined accuracy ±(50ppm+3% of reading) is based on data moving average≥5 and range of 400~2000ppm.

Note 4:   See Figure 4 Average Current for more information under different working cycle.

Note 5:   See more details in Sensor Working Mode. There are two working modes, working mode A and working mode B. Working mode A is single measurement mode (controlled power supply by host), while working mode B is continuous measurement mode. Default is working mode A. Command to set working A or B is defined in UART protocol.

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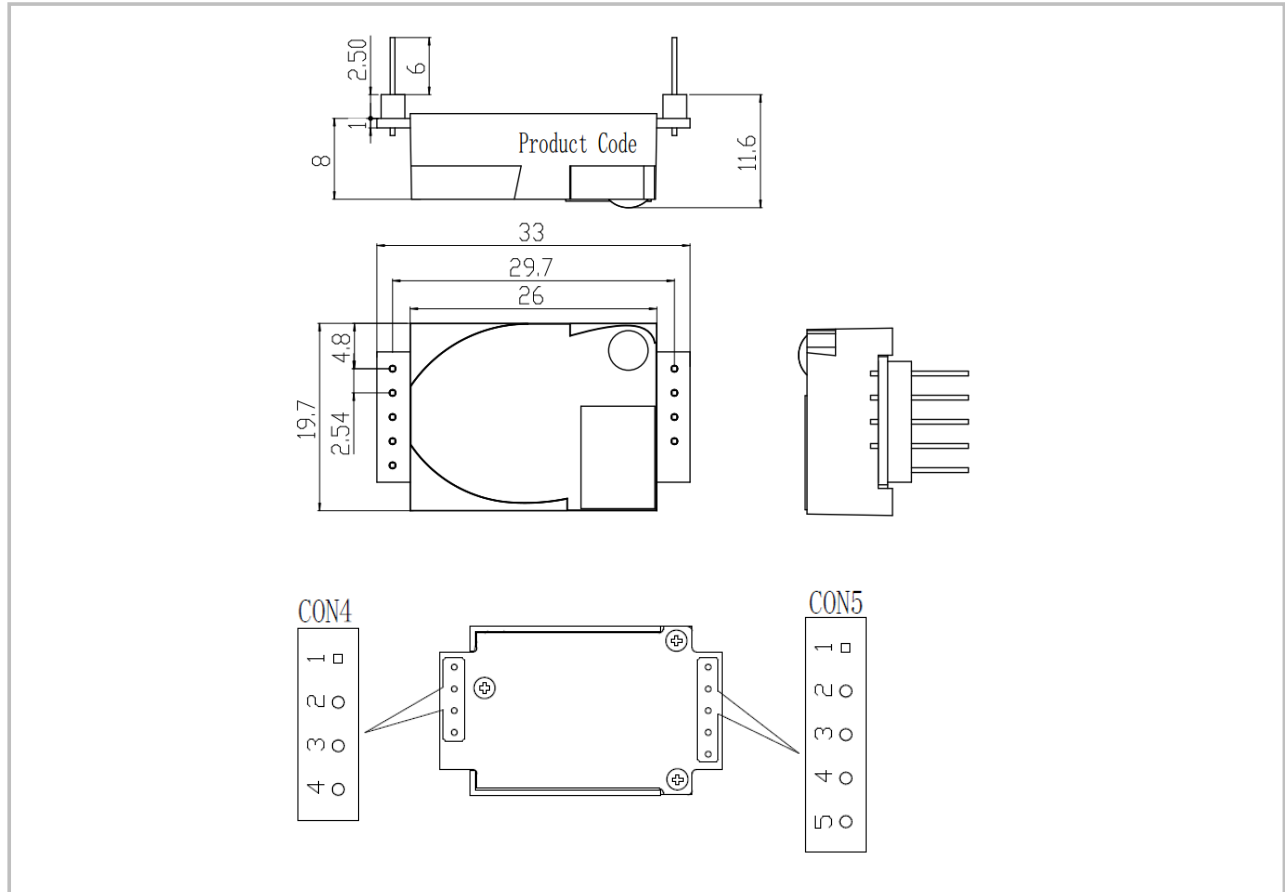
1. Dimensions (Unit mm, tolerance ±0.2 mm)

Figure 1

2. I/O Connector Pin out

CON5			CON4		
Pin	Name	Description	Pin	Name	Description
1	GND	Power supply input (GND)	1	EN	Power input enable (normal power supply at high power level, power off at low power level)
2	VBB	MCU power supply input (3.3-5.5V)	2	DVCC	Power supply output (2.8V)
3	VDDIO	RDY external pull-up power interface	3	RDY	To indicate the sensor data is ready, and the host could communicate.
4	RX	UART-RX (Receiving) data, Compatible with 2.8V communication.	4	COMSEL	Communication swift (Reserved)
5	TX	UART-TX (Sending), Compatible with 2.8V communication.			

3. The Function of PIN

Pin	Function
VBB	Sensor power supply pin (3.3-5.5V)
EN	Sensor power supply switch pin（3.3-5.5V）

4. The explanation of Pin working

VBB Status	EN Status	Sensor Status
0	L	No Working
3.3-5.5V	L	No Working
0	H	No Working
3.3-5.5V	H	Working

Reference Circuit

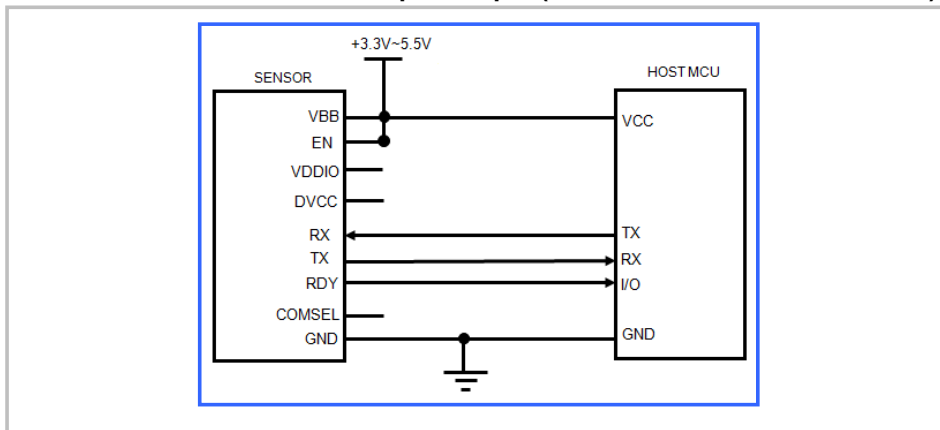**Application scene 1: UART_TTL 2.8V serial port output (Continuous Measurement Mode)**

Figure 2

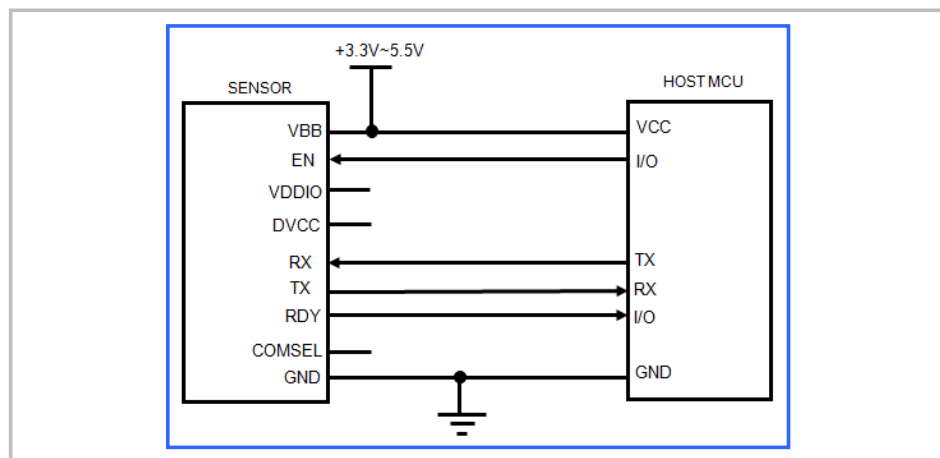**Application scene 2: UART_TTL 2.8V serial port output (Single Measurement Mode)**

Figure 3

Power Consumption Chart

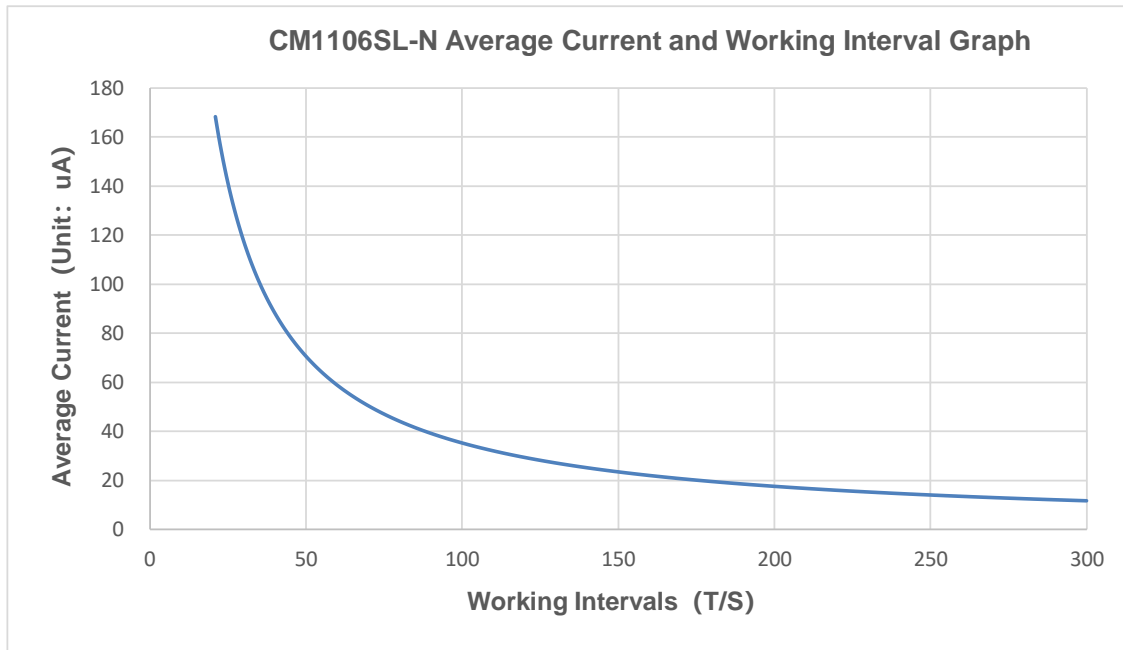**CM1106SL-N Average Current and Working Interval Graph**

Figure 4

Blue Curve: light source work once in setting working intervals (T), every time work for 100ms.

The Graph shows the average current of CM1106SL-N under single measurement mode (Working Mode A).
To get lower working current under the same scenario, Cubic could offer sensor type with 100ms working mode for light source. Under this mode, the average working current is 30uA @ two minutes' working interval.
For more information, please contact Cubic.
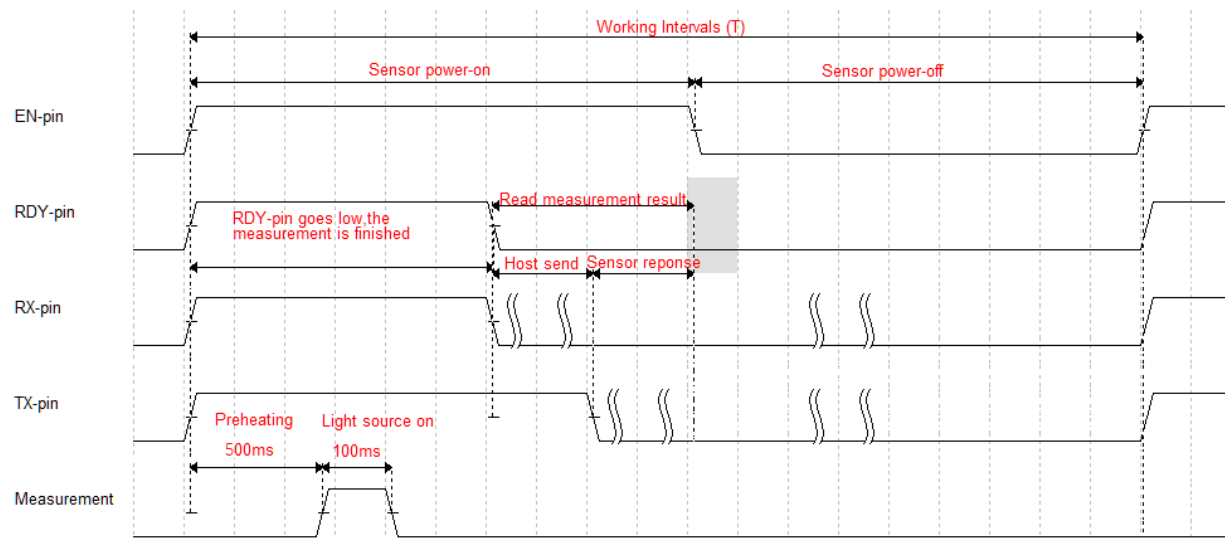
Working Sequential Chart (working mode A)

Figure 5

1. Explanation of working sequential chart

The working mode of CM1106SL-N is host-slave mode: CM1106SL-N is a slave and it begins to work after getting EN_VBB pin high level and getting power from the host. After powering on for 500ms, the light source flashes for 100ms, and then MCU of CM1106SL-N starts a calculation on measured CO2 concentration, and the calculation take 100ms, so in total one circle working time is 700ms. Then the host could communicate with CM1106SL-N when the RDY pin goes low level. After communication, the host will put EN_VBB pin to low level and the CM1106SL-N is powered off and stops working.

After power off, TX-pin and RX-pin level are followed by the host, and they need to be kept at low level during power off period, otherwise the sensor may not work normally.

If the host keeps the EN_VBB pin high to keep the sensor active all the time, the sensor will work in every 2 minutes cycle as default.

Note: 1. The light source flashing 100ms, the working cycle is 2 minutes by default (It can change by protocol).

2. Explanation of working mode

Cubic Super Low Power NDIR CO2 Sensor CM1106SL-N supports two working modes for measurement of CO2 concentration: single measurement mode (working mode A) and continuous measurement mode (working mode B).

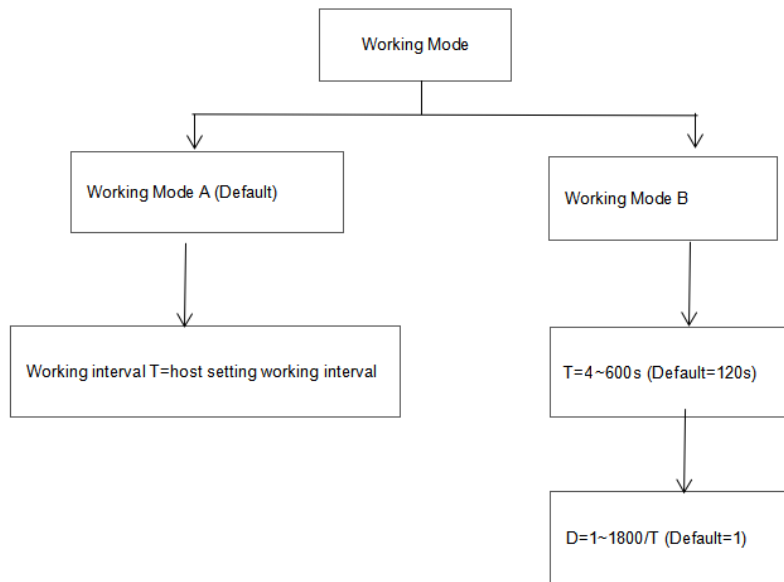**Working mode A, single measurement mode**

When in single measurement mode, the sensor works by waiting for the hosts command to measure. The host need to send a command sequence to trigger each measurement. After each measurement, besides EN pin, both RX and

TX pins are also need to be set to low power level, to avoid reverse current flow, which may influence working time series defined by host. The reading output from the sensor is without moving average. The host could make moving average to get higher stability and accuracy.

Working mode B, continuous measurement mode

When in continuous measurement mode, the sensor works at regular intervals (default setting 2 minutes). The host can read measurement after each measurement and does not need to send any command to trigger measurements. The host could set working intervals and set moving average to get better stability.

```
                        ┌──────────────────┐
                        │  Working Mode    │
                        └──────────────────┘
                           │            │
                  ┌────────┘            └────────┐
                  ▼                              ▼
      ┌──────────────────────────┐    ┌──────────────────────┐
      │ Working Mode A (Default) │    │   Working Mode B     │
      └──────────────────────────┘    └──────────────────────┘
                  │                              │
                  ▼                              ▼
 ┌─────────────────────────────────┐  ┌──────────────────────┐
 │ Working interval T=host setting │  │ T=4~600s (Default=120s)│
 │ working interval                │  └──────────────────────┘
 └─────────────────────────────────┘             │
                                                 ▼
                                      ┌──────────────────────┐
                                      │ D=1~1800/T (Default=1)│
                                      └──────────────────────┘
```

1. CM1106SL-N is with default single measurement mode (working mode A).

-Under this working mode, the working interval T = host setting working interval, the sensor works only one time during a working interval. There is no data moving average (the moving average data D=1).

-If the host supply continuous power to the sensor, the sensor will work in 2-minute working interval, no data moving average. Working Interval [T] * and Data Moving Average [D] * cannot be set by command.

2. When host send command to activate working mode B, the sensor will enter continuous measurement mode. The host could set Working Interval [T] * and Data Moving Average [D] *. Setting command is in UART protocol. The default working interval is 2 minutes.

[T] = Working Interval
[D] = Data Moving Average [D], maximum value is 120.

Description of Calibration

CM1106SL-N can support auto baseline calibration function (Auto Calibration is closed by default), the user could open the Auto Calibration function by command in protocol.

Auto Calibration:
Rough installing and influence of transportation might result in a reducing of sensor reading accuracy and baseline drift, sensor will correct the drift by the built-in self-correcting logic.

1. Continuous Measurement Mode

When the host sends command to activate working mode B, the sensor will enter continuous measurement mode. Powering on the sensor for 7 days (7 days by default) continuously, it will record the lowest CO_2 concentration measurement value during the 7 days, which will be regarded as baseline (400ppm) when sensor do auto calibration after the 7 days working.

Remark: The sensor is with Auto Calibration closed by default.

2. Single Measurement Mode

When the host sends command to activate working mode A, the sensor will enter single measurement mode and power supply interval will be controlled by the host under mode A.

-If the power supply interval is longer than 30mins, after each time measuring, the host need to send a measuring data back to the sensor to make the sensor store this data as Auto Calibration database.

-if the power supply interval is less than 30mins, then during every 30mins working period, only the last measuring data need to be sent from the host to the sensor as an ABC calibration

(About how the host sends the data back to sensor, please refer to the communication protocol 4.9).

When the storing data reaches to calibration cycle*48 times (default of calibration cycle is 7 days, so in single measurement mode the sensor will calibrate after 7*48=336 times measuring), it will invoke the lowest CO_2 concentration measurement from the storing data, which will be regarded as baseline (400ppm) by the sensor and implement auto calibration.

Note:
1. If the sensor works in continuous measurement mode, please ensure the sensor is powered on during the complete one ABC working cycle, otherwise it cannot trigger the calibration.

2. In single measurement mode,CM1106SL-N supports power-off storage, even if the power is off, the stored data is still retained, when the storing data reaches to calibration cycle*48 times, the sensor will implement auto calibration.

3. In order to ensure the reading accuracy after auto calibration, please make sure the working environment of sensor can reach the outdoor fresh air level, that is to say, the CO_2 concentration of sensor can reduce to the outdoor air level (400ppm) during the 7 days.

4. Please contact with Cubic for more detailed auto calibration strategy.

5. If auto calibration environment cannot be ensured, then regular manual calibration is recommended, please refer to the communication protocol 4.2, implement calibration and set the CO2 concentration as 400ppm under fresh air environment.

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 effected.

Reference as below:

2.5mm

1mm

1.5mm

1.5mm

Waterproof Filter
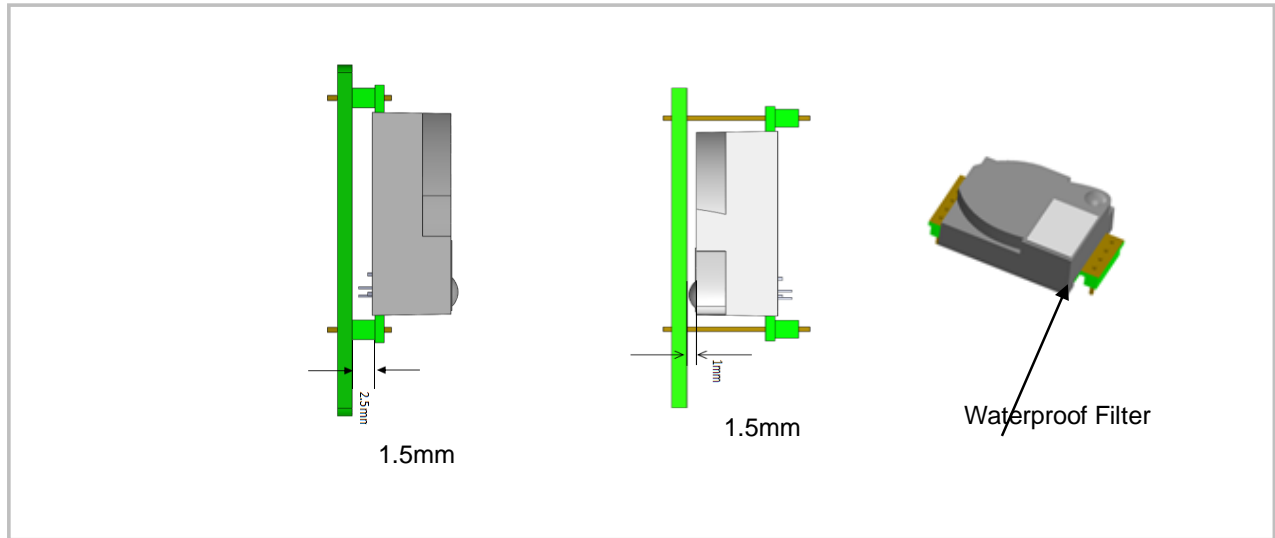
2. To avoid the influence of stress on sensor, please soldering by hand as much as possible when mounting the sensor to the PCB.

Reference as below:
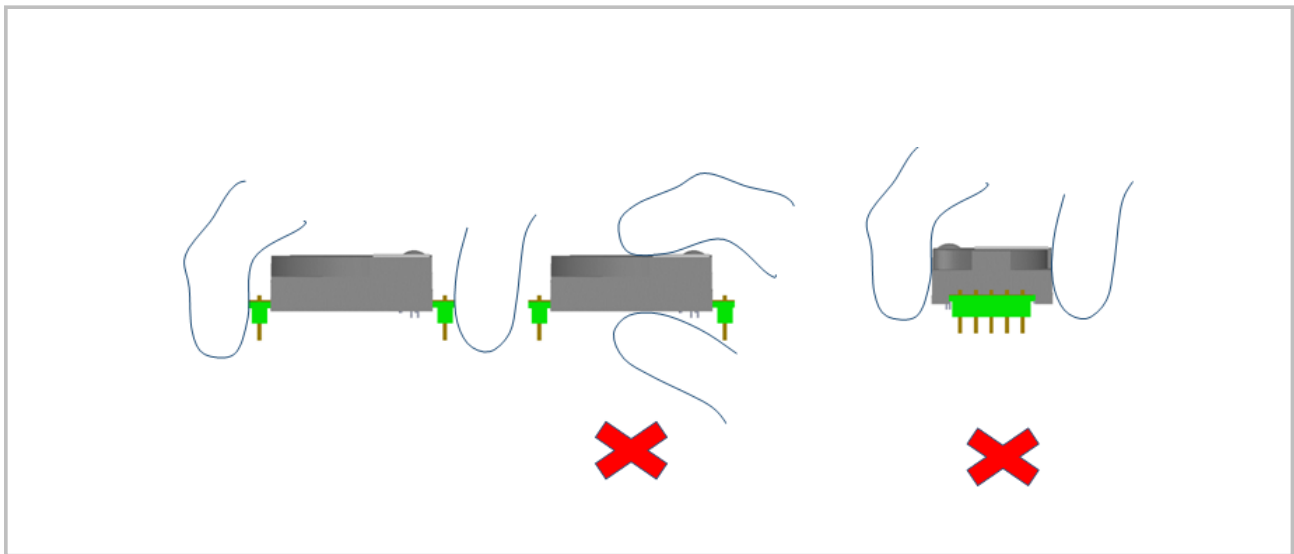
UART Communication Protocol

1. CM1106SL-N only supports UART communication protocol.

2. To meet the requirements from more designers, CM1106SL-N is with two sets of UART communication protocol.

Below information is one of the UART communication protocol (Protocol Version 1). If it is not suitable for designer

to integrate, please contact info@gassensor.com.cn to request the other UART communication protocol.

3. Customized communication protocol is also available, for more details, please contact Cubic by

info@gassensor.com.cn.

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). [x x] for single-byte data (unsigned, 0-255); [x x] for double data (signed,-32768~+32767), high byte is in front of low byte. It is remark after "——".
4). All data is an integer and may have a (100, 10, 1)-fold correspondence with the actual display data (related to the specific instrument).
5). Sensor operation remains after power off

2. Format of Serial Communication Protocol

Sending format of test software:

Start Symbol	Length	Command	Data1	…	Data n.	Check Sum
HEAD	LEN	CMD	DATA1	…	Data	CS
11H	XXH	XXH	XXH	…	XXH	XXH

Detail description on protocol format:

Protocol Format	Description
Start Symbol	Sending by test software is fixed as [11H], module response 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	Calibration of CO_2 concentration	0x03
3	ABC parameter check	0x0F
4	ABC parameter set	0x10
5	Read software version	0x1E
6	Read the serial number of the sensor	0x1F
7	Set /check sensor measurement period and number of smoothing data	0x50
8	Set / check sensor working status	0x51
9	Sensor ABC calibration data store	0x11

4. Detail Description of RS232 Protocol

4.1 Read Measured Result of CO_2

Send: 11 01 01 ED

Response: [ACK] 05 01 DF1- DF4 [CS]

Function: Read measured result of CO_2 (Unit: ppm)

Note:

CO_2 measured result = DF1*256+DF2

DF3, DF4 is reserved

Example:

Response: 16 05 01 02 58 00 00 8A

Explanation:

Hex is converted to decimal: 02 is 02; 58 is 88

CO_2 concentration =02*256+88 = 600ppm

4.2 Calibration of CO_2 Concentration

Send: 11 03 03 [DF0] [DF1] [CS]

Response: [ACK] 01 03 [CS]

Function: Calibration of CO_2 concentration

Note:

1. Calibration target value = DF1*256+DF2 Unit: PPM, range (400-1500ppm)

2. Before calibration, please make sure CO_2 concentration in current ambient is calibration target value. Keeping this CO_2 concentration for two 2 minutes, and then began calibration.

Example:

When need to calibrate CO_2 concentration of the sensor to 600ppm, send command:11 03 03 02 58 8F

Hex is converted to decimal: 02 is 02; 58 is 88

CO_2 concentration =02*256+88 = 600ppm

4.3 ABC Parameter Check

Send: 11 01 0F DF

Response: [ACK] 07 0F [DF1] [DF2] [DF3] [DF4] [DF5] [DF6] [CS]

Function: Sensor ABC parameter check

Example:

Send: 11 01 0F DF

Response: 16 07 0F 64 02 07 01 90 64 72

4.4 Open/Close ABC and Set ABC Parameter

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

Response: 16 01 10 D9

Function: Sensor ABC parameter set

Explanation:

DF1: reserved, default 100 (0x64)

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

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

DF4 and DF5: The high and low baseline of calibration. (2 bytes), baseline of calibration=DF4*256+DF5

DF6: reserved, default is 100 (0x64)

Note: The default baseline of calibration is 400ppm, hex is converted to decimal: 01 is 01 and 90 is 144, so DF4=01 and DF5=90 by default.

4.4.1 Open ABC and Set Calibration Cycle

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

Response: 16 01 10 D9

4.4.2 Close ABC

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

Response: 16 01 10 D9

4.5 Read Software Version

Send: 11 01 1E D0

Response: [ACK] 0C 1E [CH1]......[CH11] [CS]

Function: Read software version

Note: Input software version number: [CHx] stand for software version by ASCII code.

Example:

When the sensor version is V0.04SL-N2, response data as follows:

16 0C 1E 56 30 2E 30 34 53 4C 2D 4E 32 00 5C

Note: When hexadecimal 20 is converted to ASCII code, the ASCII code is the blank space.

4.6 Read the Serial Number of the Sensor

Send: 11 01 1F CF

Respond: [ACK] 0B 1F（SN1）（SN2）（SN3）（SN4）（SN5）[CS]

Function: Read the serial number of the sensor

Note: Output the serial number of the sensor. SNn is from 0 to 9999. The 20 bit number is formed by five integers.
Example:
Send: 11 01 1F CF
Response: 16 0B 1F 00 00 02 11 03 8C 0A D3 00 08 39
Sensor serial number: 00000529090827710008

4.7 Set / Check Measurement Period and Number of Smoothed Data
Set:
Send: 11 04 50 [DF1] [DF2] [DF3] [CS]
Response**:** 16 01 50 [CS]
Check:
Send: 11 01 50 [CS]
Response: 16 04 50 [DF1] [DF2] [DF3] [CS]
Description:
Measurement period (s) period = DF1 * 256 + DF2, unit s (range: 1s ~ 10min)
Number of smoothed data = DF3

Example 1:
Set the sensor working intervals as 2 min and the number of smooth data as 15
Send: 11 04 50 00 78 0F 14
Note: The smoothing time is no longer than 30min. If the sensor measurement period is set to 2min, the maximum smoothed data number is 30(min) / 2(min) =15

Example 2:
Set the sensor working intervals as 2 seconds and the number of smooth data as 2 (used in GasLab).
Send: 11 04 50 00 02 02 97

4.8 Set / Check Working Status
Set:
Send: 11 02 51 [DF1] [CS]
Response**:** 16 01 51 [CS]
Check:
Send: 11 01 51 [CS]
Response: 16 02 51 [DF1] [CS]
Description:
DF1 = 0 single measurement mode default (command A)
DF1 = 1 continuous measurement mode (command B)

Example:
Set to continuous power mode
Send: 11 02 51 01 9B

4.9 Sensor ABC Calibration Storing Data
Send: 11 01 11 [CS]
Response: 16 01 11 [CS]
Description: When the sensor is in the single measurement mode, the host will send an ABC calibration storing data command to the sensor every 30min(if power supply interval is less than 30min), or after each time measurement (if the power supply interval is longer than 30min).

Support

The quickest way to obtain technical support is via email. Please include a clear, concise definition of the problem and any relevant troubleshooting information or steps taken so far, so we can duplicate the problem and quickly respond to your inquiry.

Warranty

The sensor comes with a 90 day warranty starting from the date it was shipped to the buyer. For more information visit our website:
https://www.gaslab.com/pages/terms-conditions

Contact Us

If the troubleshooting guide above does not help you solving your problem or for more information, please contact us using the information below.

Support@GasLab.com
(386) 872-7668 (M-F 9:00am–5:00pm EST)

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131 Business Center Drive
Ormond Beach, FL 32174
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