MFrontier NDIR CO2 Sensor Module Instruction Manual

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MFrontier

MFrontier NDIR CO2 Sensor Module

MTP80-A is a dual channel carbon dioxide sensor based on the principle of Non Spectral Infrared (NDIR) technology. It can detect the concentration of carbon dioxide in the air in real time and output the concentration value through UART, IIC, and PWM methods. It has strong anti-interference ability, high sensitivity, strong stability, long lifespan, low power consumption, and supports two calibration methods: self calibration and manual calibration, with minimal data accuracy error. Suitable for industries such as air monitoring, fresh air systems, smart homes, and in car air purification.

Advantage

- Long term stability advantage – The stability of NDIR sensors mainly depends on the light source, and under the condition of no abnormalities in the light source, the long-term stability of NDIR is extremely excellent compared to other types of gas sensors .
- The working principle of an NDIR sensor for measuring concentration is to detect the infrared energy of the characteristic infrared absorption band of the measured gas. The signal characteristic is that when there is no measured gas, the signal strength is maximum, and the higher the concentration, the smaller the signal. The measured concentration can reach 10000PPM.

Features

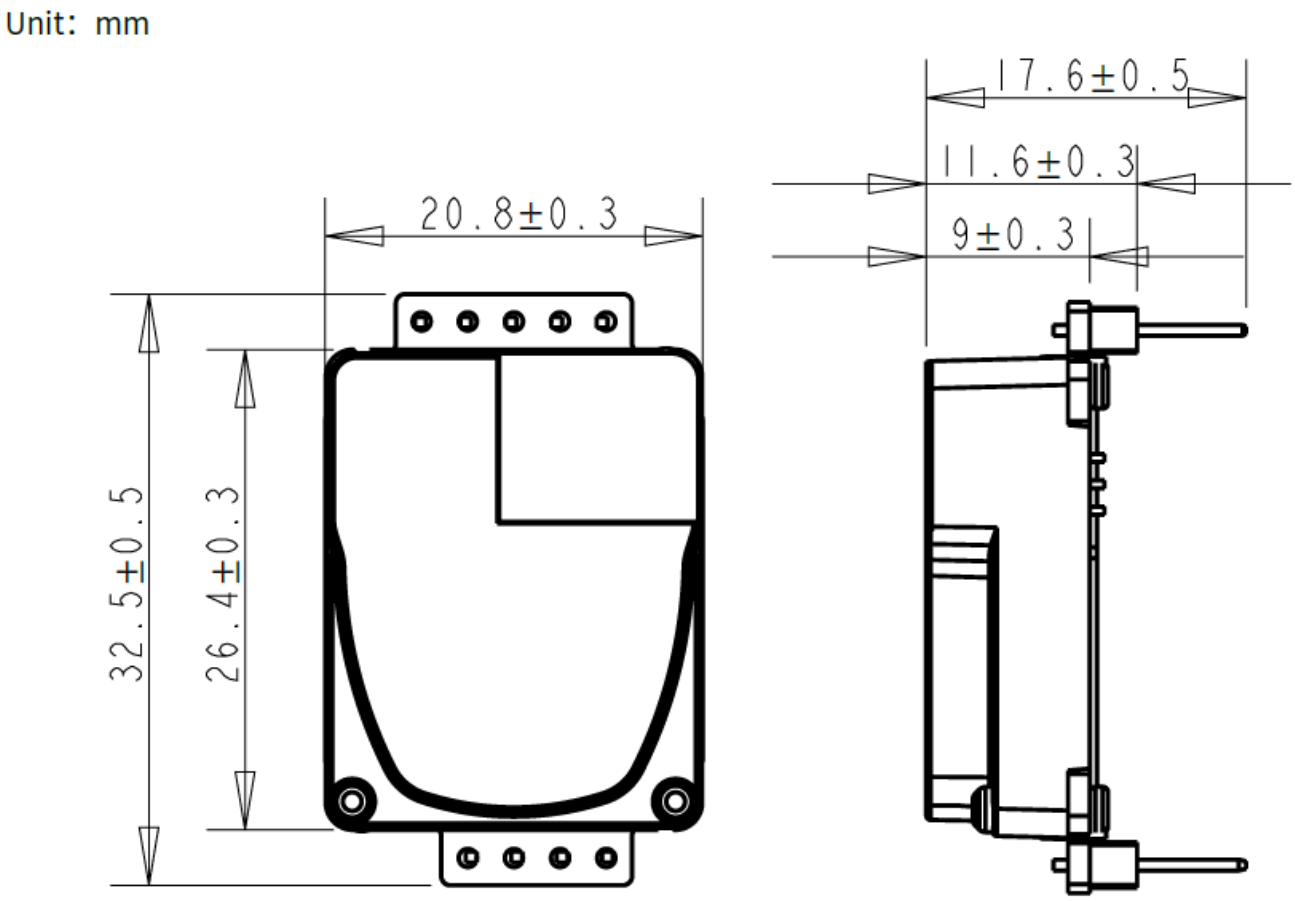
- NDIR detection principle
- Short preheating time
- Temperature compensation and automatic calibration algorithms
- High sensitivity and precision
- Anti interference and strong stability

Applications

- Air quality monitoring equipment
- Fresh air system

- Car air purification
- Air purification equipment
- HAVC system
- Smart Home

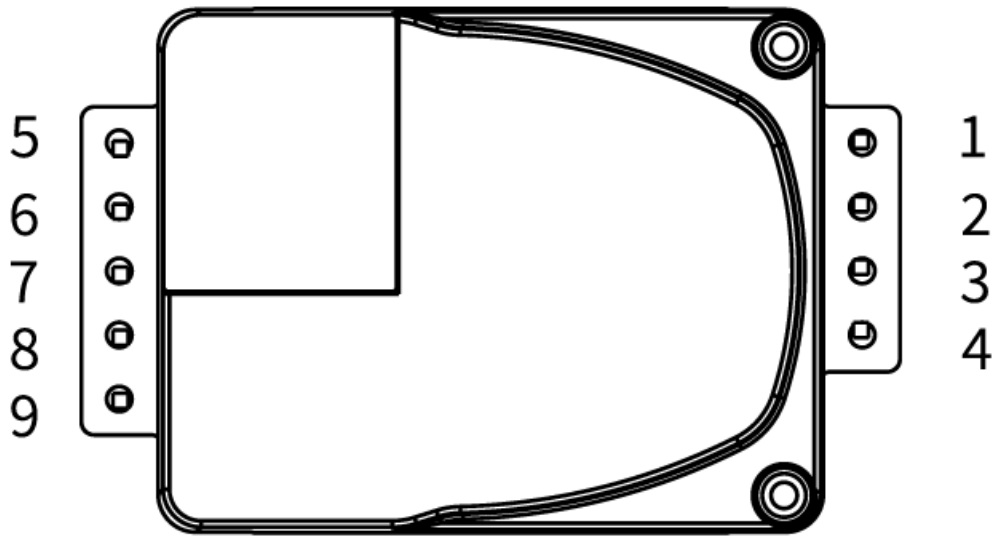
Size



Parameters

parameters	index
Measure gas type	CO_2
measuring principle	NDIR
Measurement concentration range	400ppm~5000ppm（The range can be customized to 10000ppm）
Measurement interval	2 S
Measurement accuracy	±(40ppm + 4% of reading)，25°C +2°C，50%±10%RH enviroment
Response time	T90 time is 90 seconds
Operating temperature range	0-50° C
Operating humidity range	0-90% RH (non-condensing)
Storage temperature range	-20° C~60° C
Size	32.5x20.8x11.6mm（max dimensions）
Power supply requirements	4.2V~5.5V
Current consumption	250mA peak current, 5mA valley current, 20mA average working current
Life	10+ years
Communication interface	Uart /IIC
PWM Output	Period：1004ms，Pulse：2ms~1002ms（0~5000ppm）
Alarm Output	Output 1 with concentration>1000ppm, output 0 with concentration<800ppm, pin in open drain output mode, unable to draw current
Self calibration cycle	The default self calibration cycle is 7 days

Pin diagram



Pin Definition

Pin number	Pin name	Pin Function Description	Pin electrical characteristics

1	VIN	Positive end of power supply	Equipped with anti reverse connection protection and input v oltage range 4.2V-5.5V
2	GND	Power supply negative terminal	
3	Alarm-OC	Alarm function, pin in open drain output mode. When the measured concentration is greater than 1000ppm, the output of this pin is high. When the concentration is less than 800ppm, the output of this pin is low	The pin is in open drain output mo de, and an external pull-up resisto r is required for use.
4	PWM	PWM function, used to output CO2 concentration.	The pin is in push-pull output mod e, and the output PWM cycle is 1004ms.
5	VCC-O ut	The internal LDO output of the sensor is usually 3V ± 2% . Generally used for serial communication level conversion.	Output voltage: 3.3V ± 2%, maximum without overcurrent prot ection Output current: 6mA
6	Host-T X /IIC-SD A	The TX pin of the UART in the main system is usually th e TX of the customer MCU or the SDA of the IIC function .	The usual communication level is 3.3V. When used for IIC function, t he pin configuration is open drain mode, and an external pull-up resi stor is required for use.
7	Host-R X /IIC-SC L	The RX pin of the UART in the main system is usually th e RX of the customer MCU or the SCL of the IIC function .	The usual communication level is 3.3V. When used for IIC function, t he pin configuration is open drain mode, and an external pull-up resi stor is required for use.
8	R/T	This pin has two functions: 1. As an RS485 directional control pin. This pin is in ope n drain output mode and can be directly connected to th e direction enable pin of the RS485 chip, requiring an ext ernal pull-up resistor. At this time, modules Pin6 and Pin 7 are UART functions. 2. UART/IIC function selection pin. This pin is grounded before power on (grounding after power on is invalid), an d Pin6 and Pin7 of the module are IIC functions. When t he pin is powered on, it is in pull-up input mode and can be suspended or grounded . As an RS485 direction enable pin, it is in open drain out put mode and requires an external pull-up resistor.	When the pin is po w ered on, it is in pull- up input mode and can be suspended or grounded. As an R S485 direction enable pin, it is in open drain output mode and requi res an external pull-up resistor.

9	bCAL-in	Manual calibration of control pins	When the pin is powered on, it is in input mode with pull-up resistance

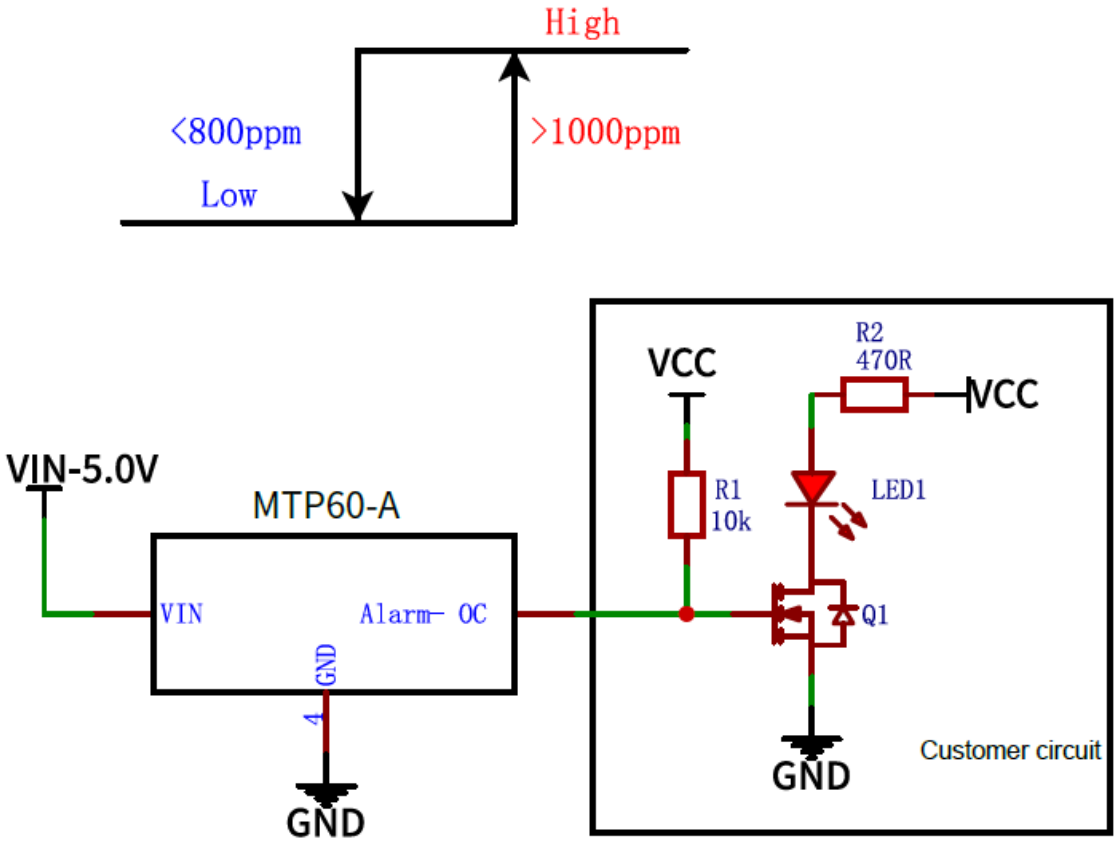
Calibration function

The MTP80 module is a precision optical module. After leaving the factory, due to various reasons such as transportation, installation, welding, etc., the measurement of the module may experience certain drift, resulting in a decrease in accuracy. The module is equipped with a set of self calibration algorithms that can periodically and automatically correct measurement errors, ensuring that the module maintains good measurement accuracy. The default self calibration cycle of the module is 7 days (168 hours), which can be adjusted by command (24 hours to 720 hours).

To ensure the measurement accuracy of the calibrated sensor, please ensure that the concentration of CO2 in its working environment can approach outdoor atmospheric levels for at least a few hours within 7 days of power on.

Alarm function

The MTP80 module supports alarm output function and outputs through the Alarm OC pin. When the measured CO2 concentration value is greater than 1000ppm, the Alarm OC pin outputs a high level. When the measured CO2 concentration value is less than 800PPM, the Alarm OC pin outputs a low level. Note that the Alarm OC pin is configured in open drain output mode and requires an external pull-up resistor to be used. If an error occurs in the module, the Alarm OC pin will remain high.
The reference usage method is shown in the figure on the right.



Communication protocol

serial communication
The baud rate for serial communication is 9600bps, and the serial communication packet is defined as follows:

Protocol format
Frame format description:

Field	Length	Explain
Frame header	2	Fixed to 0x42,0x4D
Instruction byte	1	Command definition or sensor type definition
Command Bytes	2	Specific command words
Data length	2	Big end
data	n	Big end
Checksum	2	The sum of all bytes from the frame header to the last byte of the data

The following protocol description applies to the gas sensor series, with instruction byte 0xA0.
Command Byte Description

Command word	Explain
0x0001	Set air pressure parameters (internal default air pressure is 1013.0hPa)
0x0002	Read the current set air pressure value
0x0003	Reading gas concentration values
0x0004	Single point correction function (with reference concentration)
0x0005	Single point correction reading status
0x0006	Prohibit or enable self calibration
0x0007	Read self calibration status
0x0008	Read self calibration cycle (hours)
0x0009	Set self calibration cycle (hours)

Basic Control Protocol

Function Name		Frame header	Instruction byte	Command Bytes	Data length	Data	Check sum
Setting air pressure parameters	MCU sends	0x42 0x4d	0xA0	0x0001	0x00 0x02	The atmospheric pressure value range is 700–1100 (16-bit integer)	Check sum
	Module return	s 0x42 0x4d	0xA0	0x0001	0x00 0x00		Check sum

Read the current air pressure value	MCU sends	0x42 0x4d	0xA0	0x0002	0x00 0x00		Check sum
	Module return	s 0x42 0x4d	0xA0	0x0002	0x00 0x02	Atmospheric pressure value (16-bit integer)	Check sum
Read the current concentration value	MCU sends	0x42 0x4d	0xA0	0x0003	0x00 0x00		Check sum
	Module return	s 0x42 0x4d	0xA0	0x0003	0x00 0x05	Gas concentration value (32-bit integer) and data validity flag (8-bit) 0x00: valid; 0xFF: data unavailable;	Check sum
Single point correction function (with reference concentration)	MCU sends	0x42 0x4d	0xA0	0x0004	0x00 0x04	The reference concentration range is 400~5000 (32-bit integer)	Check sum
	Module return	s 0x42 0x4d	0xA0	0x0004	0x00 0x01	0x01: indicates calibration start; 0xf: indicates calibration error	Check sum
Read single point correction status	MCU sends	0x42 0x4d	0xA0	0x0005	0x00 0x00		Check sum
	Module return	s 0x42 0x4d	0xA0	0x0005	0x00 0x01	0x00: indicates calibration completed; 0x01: indicates calibration still in progress	Check sum
Enable or disable self-calibration	MCU sends	0x42 0x4d	0xA0	0x0006	0x00 0x01	0x00: enables self-calibration; 0xf: disables self-calibration	Check sum

	Module return	s 0x42 0x4d	0xA0	0x0006	0x00 0x00		Checksum
Read self-calibration status	MCU sends	0x42 0x4d	0xA0	0x0007	0x00 0x00		Checksum
	Module return	s 0x42 0x4d	0xA0	0x0007	0x00 0x01	0x00: Enable self-calibration 0xf: Disable self- calibration	Checksum
Read Self-calibration cycle	MCU sends	0x42 0x4d	0xA0	0x0008	0x00 0x00		Checksum
	Module return	s 0x42 0x4d	0xA0	0x0008	0x00 0x02	Self-calibration cycle range: 24–720h	Checksum
Setting the self-calibration period	MCU sends	0x42 0x4d	0xA0	0x0009	0x00 0x02	Self-calibration cycle range: 24–720h	Checksum
	Module return	s 0x42 0x4d	0xA0	0x0009	0x00 0x01	00: Correct operation; 01: The input data is less than 24 hours and will not be accepted; 02: The input data is greater than 720 hours and will not be accepted	Checksum

Application Examples

①Set air pressure parameters

Send：0x42 0x4D 0xA0 0x00 0x01 0x00 0x02 0x03 0xF5 0x02 0x2A

Device	Phase	Data	Description	Cmd.Phase.Ofs(rep)
43	OUT	42 4d a0 00 01 00 02 03 f5 02 2a	BM.....*	1.1.0
43	IN	42 4d a0 00 01 00 00 01 30	BM.....0	2.1.0

0x03F5 is the hexadecimal value of 1013;

②Read the current air pressure

Send：0x42 0x4D 0xA0 0x00 0x02 0x00 0x00 0x01 0x31

Device	Phase	Data	Description	Cmd.Phase.Ofs(rep)
43	OUT	42 4d a0 00 02 00 00 01 31	BM.....1	1.1.0
43	IN	42 4d a0 00 02 00 02 03 f5 02 2b	BM.....+	2.1.0

③Read gas concentration value

Send：0x42 0x4D 0xA0 0x00 0x03 0x00 0x00 0x01 0x32

The data valid bit is 0xf, the data is not available：

Device	Phase	Data	Description	Cmd.Phase.Ofs(rep)
43	OUT	42 4d a0 00 03 00 00 01 32	BM.....2	1.1.0
43	IN	42 4d a0 00 03 00 05 00 00 00 00 ff 02 36	BM.....6	2.1.0

IIC instruction analysis

The module works in IIC slave mode and can be connected to an external MCU. The module contains a pull-up resistor.
The module device slave address is: 0x32 (7-bit address)
The module write operation address is: 0x64
The module read operation address is: 0x65

Host sending sequence:

1. Send start signal
2. Send address write (slave address + R/W = 0x64) and check response
3. Send read command (0x03) and check response
4. Send stop signal
5. Send start signal
6. Send address read (slave address + R/W (1) = 0x65) and check response
7. Read 3 bytes from the module and send response
8. Send stop signal

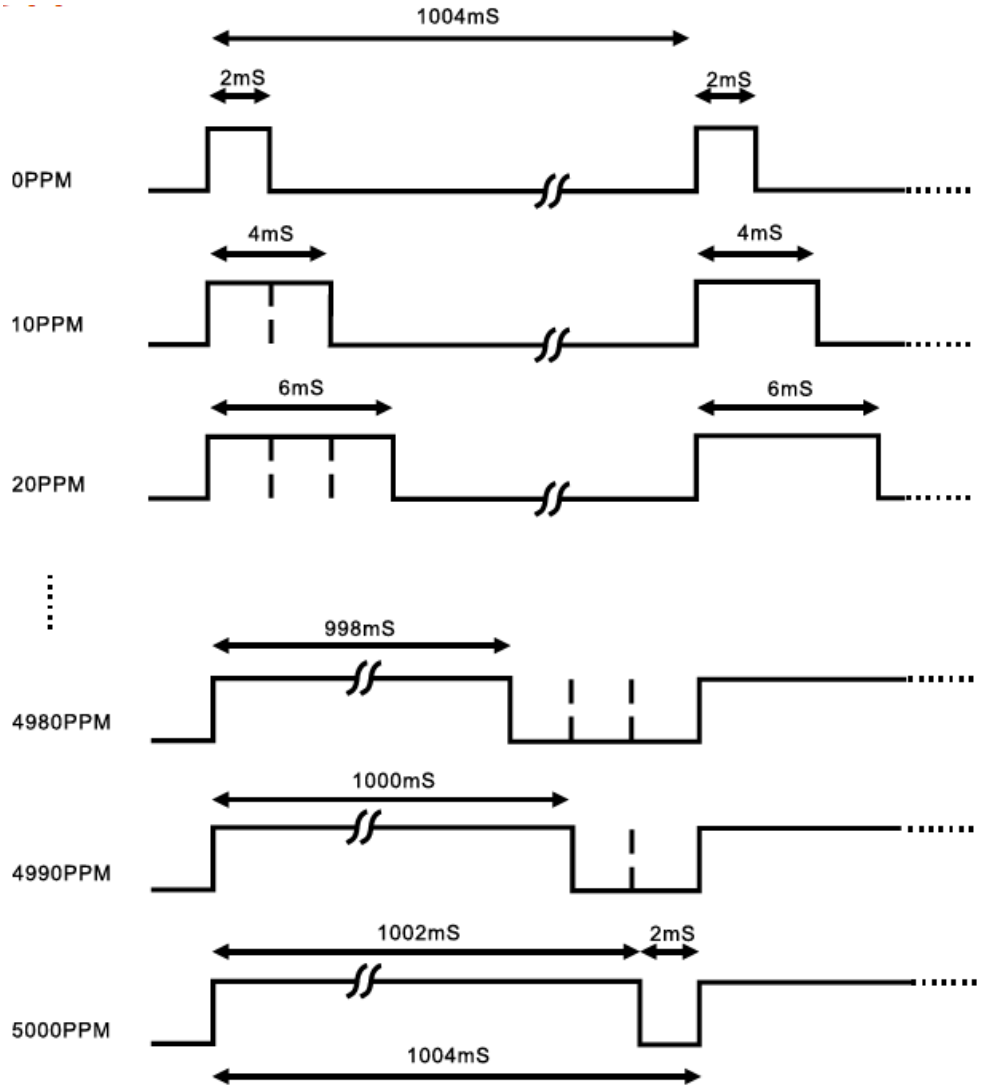
The received 3 bytes data are described as follows:

CO2 concentration		**Data valid bytes**
Concentration high byte	Concentration low byte	0x00/0xFF

Note:
CO2 concentration = high byte of CO2 concentration * 256 + low concentration byte
Data valid byte, 0x00 means valid data, 0xf means invalid data

PWM function detailed explanation

- The PWM cycle is 1004ms
- The high level output is 2ms in the starting stage
- The middle cycle is 1000ms
- The low level output is 2ms in the ending stage
- The calculation formula for obtaining the current CO2 concentration value through PWM is:
- Cppm = 5000*(TH-2ms)/(TH+TL-4ms)
- Cppm is the calculated CO2 concentration value, in ppm
- TH is the time when the output is high level in an output cycle
- TL is the time when the output is low level in an output cycle



Reliability Test

Test items	Experimental conditions	Acceptance conditions	Number of verifications n Number of failures c
High temperature storage	60±2, store without power on for 48h	After 2 hours of recovery in normal temperature environment, the sensor accuracy meets the specification standard	n=8 c=0
Low temperature storage	-20±2, store without power on for 48h	After 2 hours of recovery in normal temperature environment, the sensor accuracy meets the specification standard	n=8 c=0
High temperature and high humidity storage	40℃ ±2℃ 85%RH±5%RH 48h storage without power supply	After 2 hours of recovery in normal temperature environment, the sensor accuracy meets the specification standard	n=8 c=0
High temperature operation	At 50±2℃, the product will run for 48 hours with power on	After 2 hours of recovery in normal temperature environment, the sensor accuracy meets the specification standard	n=8 c=0
Low temperature operation	At 0±2℃, the product will run for 48 hours with power on	After 2 hours of recovery in normal temperature environment, the sensor accuracy meets the specification standard	n=8 c=0
High and low temperature shock	After keeping at – 20 for 60 minutes, switch to 60 within 10s and keep for another 60 minutes as one cycle, a total of 10 cycles, the sample is not powered on during the test	After 2 hours of recovery in normal temperature environment, the sensor accuracy meets the specification standard	n=8 c=0
Simulating transport vibration	Six-sided vibration, 30 minutes per side, vibration frequency 240rpm	After 2 hours of recovery in normal temperature environment, the sensor accuracy meets the specification standard	n=8 c=0
Package falling	Drop height: set according to the weight-to-height ratio specified in GB/T4857.18. Test according to GB/T4857.5 drop test method for packaging and transport packages. The drop test sequence is one corner, three edges and six faces (if the customer has special requirements, it can be done according to the customer’s requirements).	After the package drop test, the sensor appearance should not be obviously defective, no components should fall off, the sensor should be able to work normally, and the sensor accuracy should meet the specifications.	n=1 box c=0

Revision History

Date	Version	change
2022.6.2	1.0	Initial version

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Documents / Resources

	MFrontier NDIR CO2 Sensor Module [pdf] Instruction Manual NDIR CO2 Sensor Module, NDIR CO2, Sensor Module, Module

References

- MF MFrontier-MEMS sensor, infrared thermopile sensor, infrared pyroelectric sensor, infrared thermopile array sensor, temperature sensor, gas sensor, PM sensor, pressure sensor, infrared filter
- User Manual