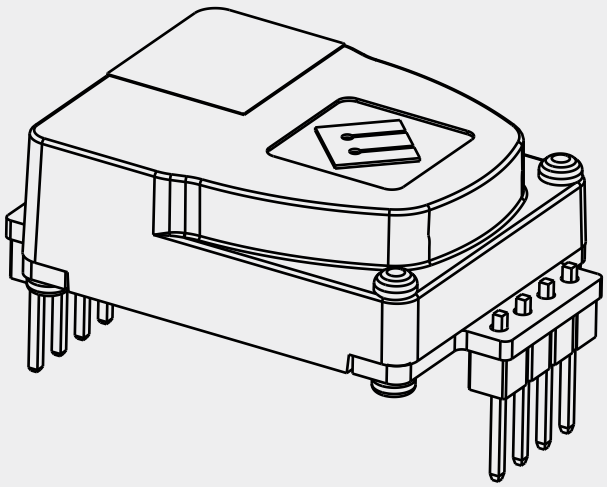
MEMSFRONTIER
美思先端

MTP60-A

NDIR CO2 Gas Single Channel Sensor Module



SPECIFICATION

Shenzhen MemsFrontier Electronics Co., Ltd.

Product description

MTP60-A is a single-channel carbon dioxide sensor based on the principle of non-dispersive infrared technology (NDIR). It can detect the concentration of carbon dioxide in the air in real time and output the concentration value through U A R T, I IC and PWM. It has strong anti-interference ability , high sensitivity, strong stability, long life, low power consumption, etc., supports two calibration methods, self-calibration and manual calibration, and the data accuracy error is extremely small. It is suitable for industries such as air monitoring, fresh air system, smart home, and car air purification.

Differentiation advantage

- Advantages of long-term stability——The stability of NDIR sensors basically depends on the light source. When the light source is normal, the long-term stability of NDIR is extremely superior to other types of gas sensors.
- Wide measurement concentration range - the working principle of the NDIR sensor is to detect the infrared energy in the characteristic infrared absorption band of the measured gas, and its signal characteristics are: when there is no measured gas, the signal strength is the largest, and the higher the concentration, the smaller the signal. The measurement concentration can reach 10000PPM.

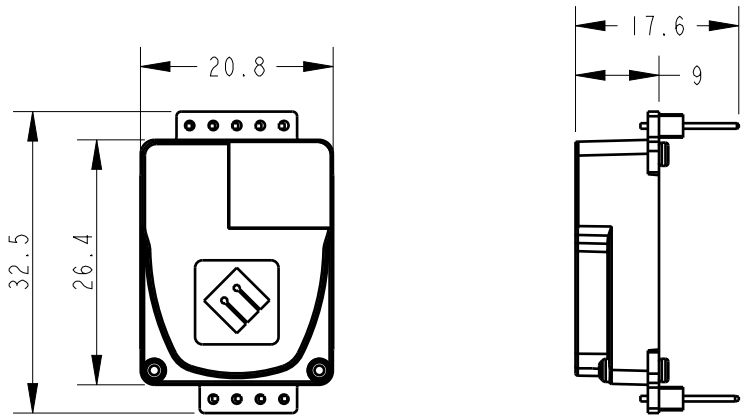
Features

- NDIR detection principle
- High sensitivity, high precision
- Short warm-up time
- Anti-interference, strong stability
- Temperature Compensation and Auto-Calibration Algorithms

Application Scenario

- Air Quality Monitoring Equipment
- Air purification equipment
- Fresh air system
- HAVC system
- In-car air purification
- Smart home

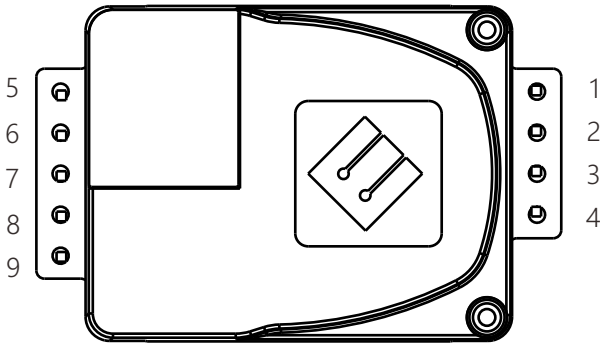
Product size



Product parameters

MTP60-A	
Target Gas	CO_2
Operating Principle	NDIR
Measurement Range	400ppm---5000ppm (range can be customized to 50000ppm)
Measurement Interval	2s
Accuracy	± (50ppm + 5% of reading)
Response Time	T90 time is 90s
Operating Temperature	0-50°C
Operating Humidity	0-90% RH non condensed
Storage Temperature	-20°C---60°C
Dimensions	32.5X20.8X17.6mm (max dimensions)
Power Supply	4.2V---5.5V
Power Consumption	250mA peak current, 5mA valley current, 20mA average working current
Life Expectancy	10+ years
Serial Communication	Uart/IIC
PWM Output	Period: 1004ms, Pulse: 2ms-1002ms (0---5000ppm)
Alarm Output	Concentration>1000ppm output 1, concentration<800ppm output 0, the pin is open-drain output mode, can not sink current
Self Calibration Cycle	The self-calibration cycle defaults to 7 days

Pin Diagram



Pin definition

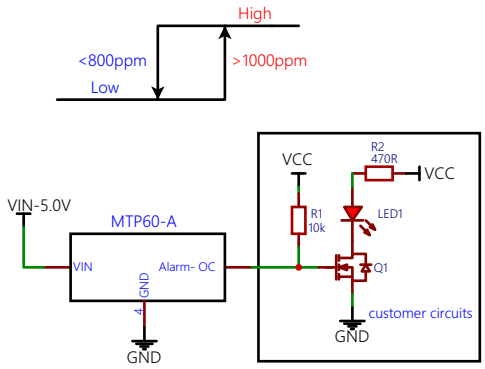
Pin number	Pin name	Pin function description	Pin Electrical Characteristics
1	VIN	Positive power supply	With anti-reverse protection, input voltage range: 4.2V-5.5V
2	GND	Negative terminal of power supply	
3	Alarm-OC	Alarm function, the pin is open-drain output mode. When the measured concentration > 1000ppm, the output of this pin is high, when the concentration is < 800ppm, the output of this pin is low.	The pin is an open-drain output mode, and an external pull-up resistor is required for use.
4	PWM	PWM function for outputting CO2 concentration.	The pin is in push-pull output mode, and the output PWM period is 1004ms.
5	VCC-Out	Sensor internal LDO output, typically 3 V ± 2%. Generally used for serial communication level conversion.	Output voltage: 3.3V±2%, no over-current protection Maximum output current: 6mA
6	Host-TX /IIC-SDA	The TX pin of the UART of the host system is usually the TX of the client MCU, or the SDA of the IIC function.	Usually the communication level is 3.3V. When used as an IIC function, the pin is configured as an open-drain mode, and an external pull-up resistor is required for use.
7	Host-RX /IIC-SCL	The RX pin of the UART of the host system is usually the RX of the client MCU, or the SCL of the IIC function.	Usually the communication level is 3.3V. When used as an IIC function, the pin is configured as an open-drain mode, and an external pull-up resistor is required for use.
8	R/T	This pin has two functions: 1. As an RS485 direction control pin. This pin is an open-drain output mode, which can be directly connected to the direction enable pin of the RS485 chip, and an external pull-up resistor is required. At this time, Pin6 and Pin7 of the module are UART functions. 2. UART/IIC function selection pin. This pin is grounded before power-on (grounding after power-on is invalid). Pin6 and Pin7 of the module are IIC functions. When the pin is powered on, it is an input mode with pull-up, which can be suspended or grounded. When used as the RS485 direction enable pin, it is in open-drain output mode, and an external pull-up resistor is required.	When the pin is powered on, it is an input mode with pull-up, which can be suspended or grounded. When used as the RS485 direction enable pin, it is an open-drain output mode, and an external pull-up resistor is required.
9	bCAL-in	Manual Calibration Control Pins	When the pin is powered on, it is an input mode with a pull-up resistor

Calibration function

The MTP60-A module is a precision optical module. After leaving the factory, due to various reasons such as transportation, installation, and welding, it will cause a certain drift in the measurement of the module, resulting in poor accuracy. The module has a built-in self-calibration algorithm, which can automatically correct the measurement error periodically, so that the module can always maintain a relatively good measurement accuracy. The module self-calibration period defaults to 7 days (168 hours), which can be adjusted by command (24 hours to 720 hours). In order to ensure the measurement accuracy of the sensor after calibration, please ensure that the concentration of CO2 in the working environment of the sensor can be close to the outdoor atmospheric level for at least several hours within 7 days of continuous operation after power-on.

Alarm function

The MTP60-A module supports the alarm output function, which is output through the Alarm-OC pin. When the measured CO2 concentration value > 1000PPM, the Alarm-OC pin outputs a high level. When the measured CO2 concentration value is <800PPM, the Alarm-OC pin outputs a low level. Note: The Alarm-OC pin is configured as an open-drain output mode, and an external pull-up resistor is required for use. If an error occurs in the module, the Alarm-OC pin will remain high. Refer to the figure on the right for the usage method.



Protocol

Serial communication

The baud rate of the serial communication is 9600bps, and the serial communication package is defined as follows:

1. Protocol format

3.Frame Format Description

field	length	explanation
frame header	2	Fixed to 0x42, 0x4D
command byte	1	command definition or sensor type definition
command byte	2	specific command word
Data length	2	big endian
data	n	big endian
checksum	2	Sum of all bytes from the frame header to the last byte of data

The following protocol description is applicable to the gas sensor series, the instruction byte is: 0xA0.

4. Command Byte Description

Command word	explanation
0x0001	Set air pressure parameters (internal default air pressure is 1013.0hPa)
0x0002	Read the current barometric pressure value
0x0003	Read gas concentration value
0x0004	Single point correction function (with reference concentration)
0x0005	Single point correction read status
0x0006	Disable or enable self-calibration
0x0007	Read self-calibration status
0x0008	Read self-calibration period (hours)
0x0009	Set self-calibration period (hours)

2. Basic Control Protocol

5. Basic Control Protocol

function name		frame header	command byte	command byte	data length	data	checksum
Set barometric parameters	MCU sends	0x42 0x4d	0xA0	0x0001	0x00 0x02	Atmospheric pressure value range is 700--1100 (16bit integer)	checksum
	Module return	0x42 0x4d	0xA0	0x0001	0x00 0x00		checksum
Read current air pressure value	MCU sends	0x42 0x4d	0xA0	0x0002	0x00 0x00		checksum
	Module return	0x42 0x4d	0xA0	0x0002	0x00 0x02	Atmospheric pressure value (16bit integer)	checksum
Read current concentration value	MCU sends	0x42 0x4d	0xA0	0x0003	0x00 0x00		checksum
	Module return	0x42 0x4d	0xA0	0x0003	0x00 0x05	Gas concentration value (32bit integer) and data valid identification (8bit) 0x00: valid; 0xFF: data unavailable;	checksum
Single point correction function (with reference concentration)	MCU sends	0x42 0x4d	0xA0	0x0004	0x00 0x04	The range of reference concentration is 400---5000 (32bit integer)	checksum
	Module return	0x42 0x4d	0xA0	0x0004	0x00 0x01	0x01: Indicates that calibration starts 0xFF: Indicates calibration error	checksum
Read single point correction status	MCU sends	0x42 0x4d	0xA0	0x0005	0x00 0x00		checksum
	Module return	0x42 0x4d	0xA0	0x0005	0x00 0x01	0x00: Indicates that the calibration is completed 0x01: Indicates that the calibration is still in progress	checksum
Enable or disable self-calibration	MCU sends	0x42 0x4d	0xA0	0x0006	0x00 0x01	0x00: enable self-calibration 0xff: disable self-calibration	checksum
	Module return	0x42 0x4d	0xA0	0x0006	0x00 0x00		checksum
Read self-calibration status	MCU sends	0x42 0x4d	0xA0	0x0007	0x00 0x00		checksum
	Module return	0x42 0x4d	0xA0	0x0007	0x00 0x01	0x00: enable self-calibration 0xff: disable self-calibration	checksum
Read self-calibration period	MCU sends	0x42 0x4d	0xA0	0x0008	0x00 0x00		checksum
	Module return	0x42 0x4d	0xA0	0x0008	0x00 0x02	Self-calibration cycle range: 24--720h	checksum
Set self-calibration period	MCU sends	0x42 0x4d	0xA0	0x0009	0x00 0x02	Self-calibration cycle range: 24--720h	checksum
	Module return	0x42 0x4d	0xA0	0x0009	0x00 0x01	00: correct operation; 01: the input data is less than 24h, not acceptable; 02: the input data is greater than 720h, not acceptable	checksum

3. Application example

①Set air pressure parameters

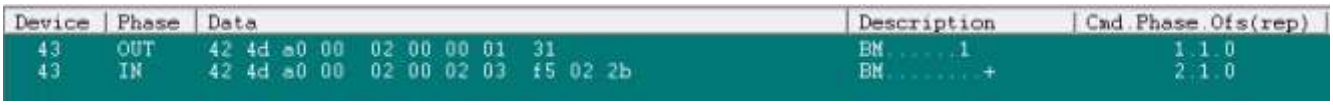
Send: 0x42 0x4D 0xA0 0x00 0x01 0x00 0x02 0x03 0xF5 0x02 0x2A

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 of 1013;

②Read the current air pressure value

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 the gas concentration value

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

The data significant bit is 0xFF, the data is unavailable:

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 inside.
The slave address of the module device is: 0x32 (7-bit address)
The write operation address of the module is: 0x64
The read operation address of the module is: 0x65

Host sending timing:

1. Send start signal
2. Send address write (slave address + R/W = 0x64) and check response
3. Send a read command (0x03) and check the response
4. Send a 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 the response
8. Send a stop signal

The received 3-byte data is described as follows:

Co2 concentration		data valid byte
concentration high byte	concentration low byte	0x00/0xFF

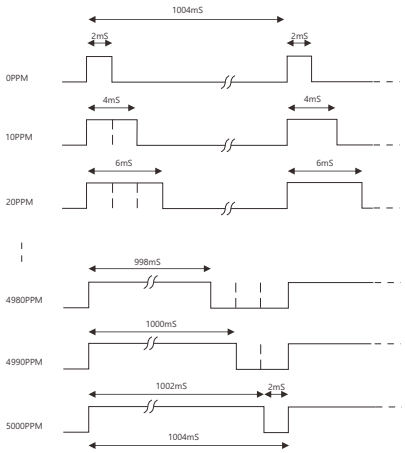
Notice:
Co2 concentration = high byte in CO2 concentration * 256 + low concentration byte
Data valid byte, 0x00 means the data is valid, 0xFF means the data is invalid

◆ Detailed explanation of PWM function

The period of PWM is 1004ms
High level output for 2ms in the initial stage
Middle cycle 1000ms
Low level output for 2ms at the end stage
The calculation formula for obtaining the current CO2 concentration value through PWM:

Cppm = 5000* (TH-2ms) / (TH+TL-4ms)

Cppm is the calculated CO2 concentration value, the unit is ppm



therein:

TH is the time when the output is high in one output cycle

TL is the time when the output is low in one output cycle

◆ Reliability test

Test items	Experimental conditions	Acceptance conditions	Number of verifications n. Number of failures c
high temperature storage	60℃±2℃, store for 48h without power on	After recovering at room temperature for 2 hours, the accuracy of the sensor meets the specification standard	n=8 c=0
cryogenic storage	-20℃±2℃, store for 48h without power on	After recovering at room temperature for 2 hours, the accuracy of the sensor meets the specification standard	n=8 c=0
High temperature and high humidity storage	40℃±2℃, 85%RH±5%RH, store for 48h without power on	After recovering at room temperature for 2 hours, the accuracy of the sensor meets the specification standard	n=8 c=0
high temperature operation	At 50℃±2℃, the product will run for 48 hours with electricity	After recovering at room temperature for 2 hours, the accuracy of the sensor meets the specification standard	n=8 c=0
low temperature operation	At 0℃ ± 2℃, the product runs for 48 hours with electricity	After recovering at room temperature for 2 hours, the accuracy of the sensor 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 60 minutes as a cycle, a total of 10 cycles, no power on during the sample test	After recovering at room temperature for 2 hours, the accuracy of the sensor meets the specification standard	n=8 c=0
Simulate transport vibration	Vibration on six sides, 30min on each side, vibration frequency 240rpm	After recovering at room temperature for 2 hours, the accuracy of the sensor meets the specification standard	n=8 c=0
package drop	Drop height: set according to the height corresponding to the weight specified in GB/T 4857.18. Test according to GB/T4857.5 drop test method for packaging and transportation packages. The drop test sequence is one corner, three sides and six sides (if the customer has special requirements, it can be according to the customer's requirements).	After the package drop test, the appearance of the sensor should have no obvious defects, no components have fallen off, the sensor should be able to work normally, and the accuracy of the sensor should meet the standards in the specification	n=1 box c=0