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ANCHIP

CO Detector Digital Sensor

BM22S3221-1

Revision: V1.00 Date: July 01, 2022

Table of Contents

Features

- Operating voltage: 2.5V~5.0V
- Operating current: < 10μA @ 3.0V
- Detection range: 3ppm~1000ppm
- Interfaces: UART (TX/RX)/STATUS
- Communication mode: UART communication
- Communication interface baud rate: 9600bps
- Sensor service life: 10 years
- Default alarm threshold: 180ppm
- Factory calibration, default preheating time:120s

General Description

The BM22S3221-1 is a CO detector digital sensor which includes an integrated MCU as the master device with a serial communication interface and which can offer widespread, flexible and convenient use. The sensor has a linear output function to perform concentration conversion and directly output the real-time methane CO concentration value. The sensor's small size advantage offers easy integration into product applications. Additional advantages include long service life, easy operation, no external drive circuit, low cost, etc. In summarising, this is a digital sensor especially designed for CO detection applications and suitable for use in CO leakage alarms, smart homes, etc.

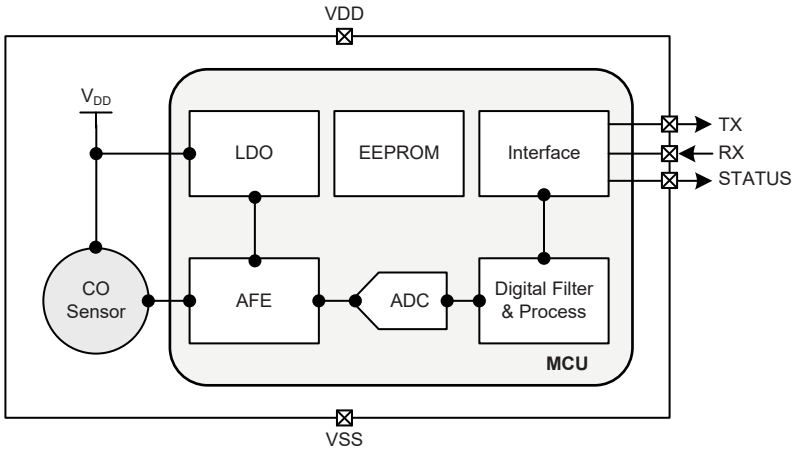
Applications

- CO leakage alarm
- Smart home
- IoT devices

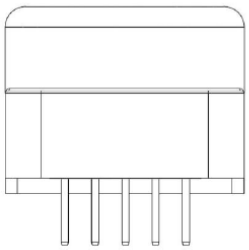
Selection Table

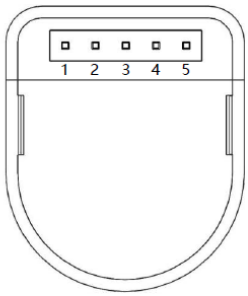
Part Number	Gas Type	Detection Range	Interface
BM22S3221-1	CO	3ppm~1000ppm	UART (TX/RX)/STATUS

Block Diagram



Pin Assignment





Pin Description

Pin Number	Pin Name	Type	Description
1	VDD	PWR	Sensor module power input
2	VSS	PWR	Ground
3	RX	ST	UART RX serial data input – baud rate 9600bps
4	TX	CMOS	UART TX serial data output – baud rate 9600bps
5	STATUS	O	Alarm level output – default output low in non-alarm status

Legend: O: Digital output; ST: Schmitt Trigger input;
PWR: Power; CMOS: CMOS output

Absolute Maximum Ratings

Supply Voltage ..... V_{SS}-0.1V to V_{SS}+5.5V

Input Voltage ..... V_{SS}-0.1V to V_{DD}+0.1V

Storage Temperature..... -15°C to 60°C

Operating Temperature..... -10°C to 55°C

Total Power Dissipation 3mW

Note: These are stress ratings only. Stresses exceeding the range specified under "Absolute Maximum Ratings" may cause substantial damage to the sensor. Functional operation of the sensor at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect sensor reliability.

D.C. Electrical Characteristics

Ta=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
V_{DD}	Operating Voltage	—	—	2.5	3.0	5.0	V
I_{DD}	Operating Current	3.0V	—	—	10	20	μA

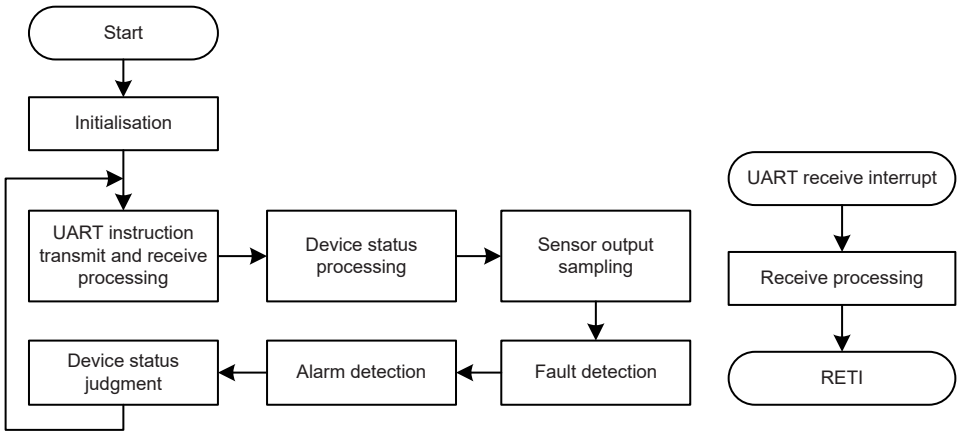
Functional Description

Solution Introduction

The BM22S3221-1 CO detector digital sensor includes a high accuracy linear CO sensor and an integrated MCU as the master device. The concentration can be converted by calibrating the concentration conversion reference value when there is a certain concentration of CO in the environment where the sensor is located. The sensor will process the CO concentration signal and then transmit the processed data to an external MCU. The sensor can output an AD value or directly output the CO concentration value. The sensor module has two output modes. The first output mode is the level output mode. Under normal conditions, the STATUS pin defaults to output low. When the CO concentration is detected to have reached the alarm threshold, the pin will change to a high level. The second output mode is the serial interface mode, which is subdivided into a serial interface automatic output mode and a serial interface communication mode. In the serial interface automatic output mode, when the sensor operates normally, it will output the current sensor status every sampling period (about 1s) using the TX pin (baud rate 9600bps). The serial interface communication mode is implemented using the TX/RX pins using the UART communication instructions. In this way, the detailed sensor module status can be read using the TX pin and the sensor parameters such as the preheating time and alarm value can be modified using the RX pin. These two modes have their own special characteristics and can be chosen according to the users' requirements, the detailed usage of which can be obtained from the relevant interface section.

Operation Flow

After the system is powered on, the BM22S3221-1 is initialised and preheated. The default preheating time is 120s. After the preheating is complete, the sensor enters the normal operation mode. In the normal operation mode, the sensor performs device status processing, sensor output sampling, fault detection and alarm detection in turn. The CO sensor AD value can be obtained every sensor output sampling period, which is about every 1s. This CO concentration data will be automatically output using the serial interface along with other data such as the device status and the real-time CO calibrated alarm value. When the UART receives a falling edge on the RX pin, the sensor is woken up and will enter the UART receive interrupt routine and execute UART instruction transmit and receive operations.

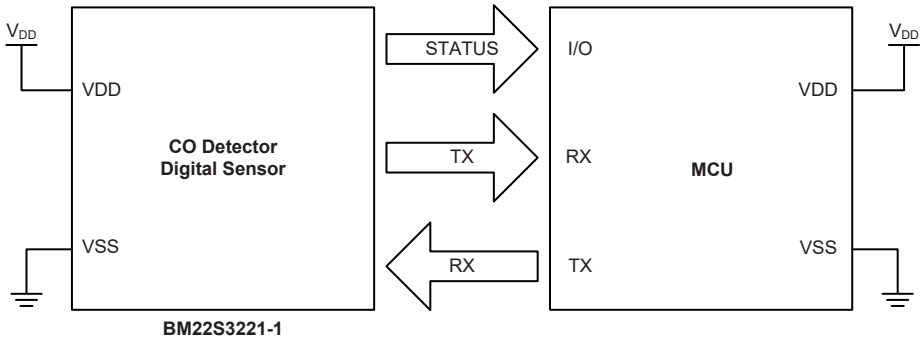


Operation Flowchart

CO Sensor Characteristics

The electrochemical sensor reacts with the measured gas and generates an electrical signal proportional to the gas concentration, which is converted into a voltage signal output. This will result in an output voltage change in direct proportion to the CO concentration. Using this characteristic, the output can be converted by an AD and data can be converted into output signals corresponding to the gas concentration level after being processed by an AFE, the calibration concentration conversion reference point and software algorithms.

Application Circuits



BM22S3221-1

Interface Description

Alarm Status Level Output Interface: STATUS

Under normal conditions, the pin 5 STATUS pin, defaults to a low value. When the sensor detects that the CO concentration in the environment has exceeded the preset alarm value and remains there for at least 5s, the sensor will enter the alarm status and the pin will change from low to high. When the CO concentration reduces to the exit alarm value and remains there for 5s, the pin will reset back to a low value.

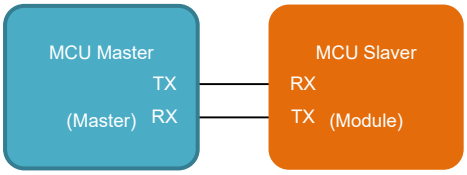
UART Serial Communication Interface: TX/RX

TX pin automatic output data: Under normal conditions, for every sampling period of about every 1s, the TX pin will automatically output the sensor current operating status, real-time gas concentration AD value, gas concentration value and other data.

TX/RX pin serial interface communication: The external MCU can configure the sensor or obtain sensor data using the UART serial communication port TX/RX. This could be obtaining or setting the current alarm point, obtaining or modifying the calibration value and preheating time, etc.

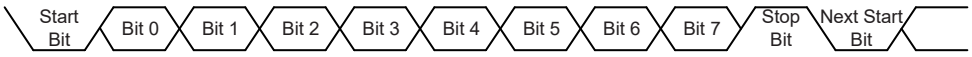
UART Serial Communication

The sensor RX pin will be at a high level under normal conditions. The external MCU sends data using the UART transmit and receive data format using the TX pin. The start bit of the data is low. A falling edge on the RX pin will wake up the MCU for UART communication processing.



UART Transmit and Receive Data Format

The UART transmit and receive data format is composed of a start bit, data bits and a stop bit. The sensor uses a baud rate of 9600bps for data transmission. The following diagram shows the waveform for UART data transmission and reception.



TX Pin Serial Interface Automatic Output Data Format

When the module operates normally, for every sampling period of about 1s, a frame of data will be output at a baud rate of 9600bps. Each data frame contains 32 bytes as shown in the following table. The data content is the same as the U03 instruction returned during UART communication.

Data Number	Data Content	Description	Data Number	Data Content	Description
1	0xAA	Fixed data	17	XX	Calibration data high byte(7)
2	0x20	Fixed data	18	XX	Calibration data low byte(7)
3	0x21	Fixed data	19	XX	Calibration zero point high byte(8)
4	0x01	Fixed data	20	XX	Calibration zero point low byte(8)
5	0xAC	Fixed data	21	XX	Check code(9)
6	XX	CO real-time AD value high byte	22	XX	Alarm threshold high byte(10)

Data Number	Data Content	Description	Data Number	Data Content	Description
7	XX	CO real-time AD value low byte	23	XX	Alarm threshold low byte(10)
8	XX	Power-on reference AD value high byte(1)	24	XX	Exit alarm value(11)
9	XX	Power-on reference AD value low byte(1)	25	XX	Reserved
10	XX	Real-time gas concentration high byte(2)	26	XX	Reserved
11	XX	Real-time gas concentration low byte(2)	27	XX	Production data: year(12)
12	XX	Reserved	28	XX	Production data: month(12)
13	XX	Run flag(3)	29	XX	Production data: day(12)
14	XX	CO sensor status flag(4)	30	XX	Software version number high byte(13)
15	XX	Preheating timing(5)	31	XX	Software version number low byte(13)
16	XX	Gas calibration countdown(6)	32	XX	Check code(14)

Note: 1. Record the OPA AD value (12-bit) after power-on.

2. Current ambient concentration value, the acceptable value is 3~1000ppm.

3. Each run flag is defined as follows (Bit 1 ~ Bit 7 are reserved):
   If Bit 0 is 1, this indicates that preheating has completed; if Bit 0 is 0, this indicates that preheating is in progress.

4. Each device status data bit is defined as follows - Bit 1 and Bit 2 are reserved:
   If Bit 0 is 1, this indicates that the calibration is in progress;
   If Bit 3 is 1, this indicates that the calibration has completed;
   If Bit 4 is 1, this indicates that the zero point calibration has completed;
   If Bit 5 is 1, this indicates that the gas calibration has completed;
   If Bit 6 is 1, this indicates that the sensor is in a fault condition;
   If Bit 7 is 1, this indicates an alarm status;

5. Power-on preheating countdown, the units are seconds, the default preheating time is 120s.

6. Gas calibration countdown, the units are seconds, the default gas calibration time is 120s.

7. Calibration data, each 128ppm change amount under the calibrated concentration.

8. Calibration zero point, calibrate and record the zero point.

9. Check code: If the output is 0xAC, this means that the calibration has been completed; if other values are output, this means that there is a calibration error.

10. Alarm threshold, when the real-time CO concentration value exceeds this value, an alarm will be triggered.

11. Exit alarm value, when the real-time CO concentration value is lower than this value, the alarm will be released

12&13. The production date and software version number are in 8421 BCD format.

14. Check code calculation method: Take the lower 8 bits of the sum of the first 31 bytes, complement them and increment by one.

Example: If a frame of data received by the master using the serial interface is AA 20 21 01 AC 00 EE 00 DD 00 00 8C 03 32 00 00 00 28 01 2D AC 00 B4 37 05 DC 20 11 02 01 24 B6, this indicates that the device preheating has completed, the zero point calibration and gas calibration have completed. The calibrated concentration is 128ppm. The AD change amount corresponding to every 128ppm gas concentration is 40. The current real-time AD value is 238. The concentration value is 0, the alarm threshold is 180ppm, the exit alarm value is 55ppm, the production date is November 02, 2020, and the software version number is V1.24.

UART Data Transmission Format

Master sent data format: The data frame sent by the master device consists of 4 bytes (fixed length), which are instruction, address, data and check code respectively. The related instruction definitions are different depending upon the slave device but fall into three categories, general instruction, special query instruction and special modification instruction. The general instructions are supported by all slave devices and mainly used to implement functions such as MCU reset, software version query, production date query, calibration triggered, overall device status query and factory reset etc. The special query and modification instructions are customised according to different device types. Each device has its own UART data instruction definitions, the details of which can be found in the relevant protocol.

Check code: Take the lower 8 bits of the sum of all data, complement them and increment by one. The calculated result will then be known as the check code. For example if the instruction is 0xE0 0x1A 0x15, its check code is 0xF1.

Instruction	Address	Data	Check Code
8-bit	8-bit	8-bit	8-bit

Slave returned data format: The data returned from the slave device has a variable length and is composed of instruction header, data length, device type, protocol version, return instruction, return address, data 0 ~ data N and check code. The instruction header is fixed at 0xAA, the data length is the length from the instruction header to the check code, which is the length of all data. The device type is used to indicate what the current slave type is. The protocol version refers to the version of the UART communication protocol used by the current slave and the return instruction corresponds to the instruction sent by the master. Data 0 ~ Data N is the returned data for different instructions, the check code calculation method is the same as the master.

Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data 0	…	Data N	Check Code
8-bit	8-bit	8-bit	8-bit	8-bit	8-bit	8-bit	…	8-bit	8-bit

UART Communication Instruction Set Summary

Instruction type: The CO detector digital sensor BM22S3221-1 UART communication protocol contains three instruction types, general instruction, special query instruction and special modification instruction. There are 22 instructions in total, including 5 general instructions, 12 special query instructions and 5 special modification instructions. For their detailed contents and definitions, refer to the corresponding instruction description sections.

The general instruction number and function are as follows:

Instruction Type	Instruction Number	Instruction	Address	Instruction Function
General Instruction	U00	AF	00	Device reset
	U01	AD	00	Query the production date and software version
	U02	AB	XX	Trigger the calibration function
	U03	AC	00	Query all current device status and data
	U04	A0	00	Factory reset

The special query instruction number and function are as follows:

Instruction Type	Instruction Number	Instruction	Address	Instruction Function
Special Query Instruction	R01	D0	1B	Query whether the current device serial interface data output is enabled
	R02	D0	1C	Query the device alarm output level
	R03	D2	88	Query current device status
	R04	D2	80	Query the CO current AD value high byte
	R05	D2	81	Query the CO current AD value low byte
	R06	D2	82	Query the power-on reference value high byte
	R07	D2	83	Query the power-on reference value low byte
	R08	D2	84	Query the gas concentration value high byte
	R09	D2	85	Query the gas concentration value low byte
	R10	D0	0C	Query alarm value high byte
	R11	D0	0D	Query alarm value low byte
	R12	D0	0E	Query exit alarmvalue (the setting range is 1~255)

The special modification instruction number and function are as follows:

Instruction Type	Instruction Number	Instruction	Address	Instruction Function
Special Modification Instruction	W01	E0	1B	Modify the device serial interface data output enable control
	W02	E0	1C	Modify the device alarm output level
	W03	E0	0C	Modify the alarm value high byte
	W04	E0	0D	Modify the alarm value low byte
	W05	E0	0E	Modify the exit alarmvalue (the setting range is 1~255)

General Instruction Description (U00~U04)

Instruction U00

Master	Instruction	Address	Data					Check Code
	AF	00	00					51
Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
	AA	08	21	01	AF	00	00	7D

Description: Reset the sensor module.
Example: A frame of data send by the master is AF 00 00 51 and the slave device returns AA 08 21 01 AF 00 00 7D.

Instruction U01

Master	Instruction Header	Address	Data					Check Code
	AD	00	00					53
Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Software Version	
	AA	0C	21	01	AD	00	XX	XX
	Production Date			Check Code				
	XX	XX	XX	XX				

Description: Query the software version and production date. The software version number and production date are in 8421 BCD format.
Example: A frame of data send by the master is AD 00 00 53, the slave device returns AA 0C 21 01 AD 00 01 24 20 11 02 23.
This indicates the software version: V1.24, production date: November 02, 2020

Instruction U02

Master	Instruction	Address	Data					Check Code
	AB	XX	00					XX
Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
	AA	08	21	01	AB	00	00	81

Description: Trigger the calibration function to determine which calibration mode to use according to the address sent by the master.
Gas calibration: Address B1 will trigger the gas calibration mode which should be implemented in standard concentration gas environments. (e.g. calibrated at 128ppm CO concentration.)
Examples: A frame of data send by the master is AB B1 00 A4, the slave device returns AA 08 21 01 AB 00 00 81. This indicates that the sensor triggers the gas calibration which should be implemented in standard concentration gas environments.

Instruction U03

Master	Instruction	Address	Data					Check Code
	AC	00	00					54
Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	CO Real-time AD Value		
	AA	20	21	01	AC	XX	XX	
	Power-on Reference Value		Concentration Value		Reserved	Run Flag	CO Status	Preheating Timing
	XX	XX	XX	XX	XX	XX	XX	XX
	Calibration Countdown	Calibration Data		Calibration Zero Point		Check Code	Alarm Value	
	XX	XX	XX	XX	XX	XX	XX	XX
	Exit Alarm Value	Reserved		Production Date		Software Version		
	XX	XX	XX	XX	XX	XX	XX	XX
	Check Code							
	XX							

Description: Query the current device status and data, the slave will return 32 bytes of data.
Byte 0 ~ Byte 4: Fixed Data Header
Byte 5 ~ Byte 6: CO Real-time AD Value: OPA output real-time AD value using 12-bit AD sampling.
Byte 7 ~ Byte 8: Power-on Reference Value: Record the OPA AD output value (12-bit) after power-on.
Byte 9 ~ Byte 10: Concentration Value: The current ambient concentration value, the acceptable value is 3~1000ppm.
Byte 11: Reserved: For pre-production debugging, this is don't care in actual applications
Byte 12: Run Flag (Bit 1 ~ Bit 7 are reserved)
If Bit 0 is 1, this indicates preheating has completed; if Bit 0 is 0, it indicates preheating is in progress.
Byte 13: CO Status:
If Bit 0 is 1, this indicates that the calibration is in progress.
Bit 1 is reserved.
Bit 2 is reserved.
If Bit 3 is 1, this indicates that the calibration has completed.
If Bit 4 is 1, this indicates that the zero point calibration has completed.
If Bit 5 is 1, this indicates that the gas calibration has completed.
If Bit 6 is 1, this indicates that the sensor is in a fault condition.
If Bit 7 is 1, this indicates an alarm status.
Byte 14: Preheating Timing: Power-on preheating countdown, the units are seconds, the default preheating time is 120s.
Byte 15: Calibration Countdown: The units are seconds, the default calibration time is 120s.
Byte 16 ~ Byte 17: Calibration Data: The AD change amount corresponding to each 128ppm gas concentration under the calibrated concentration.
Byte 18 ~ 19: Calibration Zero Point: Calibrate and record the AD value output when the device is normal;
Byte 20: Check Code: If the output is 0xAC, this means that the calibration has completed; if other values are output, this means that there is a calibration error.
Byte 21 ~ 22: Alarm Value: When the CO real-time AD value exceeds this value, an alarm will be triggered.
Byte 23: Exit Alarm Value: When the CO real-time AD value is lower than this value, the alarm will be released.
Byte 24~25: Reserved: For pre-production debugging, this is don't care in actual applications.
Byte 26~30: Production Date and Software Version Number are in 8421 BCD format.
Byte 31 Check code calculation method: Take the lower 8 bits of the sum of the first 31 bytes, complement them and increment by one.
Example: The master sends AC 00 00 54 and the slave returns AA 20 21 01 AC 00 EE 00 DD 00 00 8C 03 32 00 00 00 28 01 2D AC 00 B4 37 05 DC 20 11 02 01 24 B6.
This indicates that the device preheating has completed, the zero point calibration and gas calibration have been completed. The calibrated concentration is 128ppm, the AD change amount corresponding to every 128ppm gas concentration is 40. The current real-time AD value is 238, the concentration value is 0, the alarm threshold is180ppm, the exit alarm value is 55ppm, the production date is November 02, 2020, and the software version number is V1.24.

Instruction U04									
	Master	Instruction	Address	Data					Check Code
		A0	00	00					60
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	21	01	A0	00	00	8C

Description: Factory reset. After this instruction is sent, reset all parameter configurations to their factory settings.
Factory setting data description:
1. Alarm Value: 180ppm
2. Exit Alarm Value: 55ppm
3. Calibration Zero Point
4. Calibration Data
5. Factory reset

Example: The master sends A0 00 00 60 and the slave returns AA 08 21 01 A0 00 00 8C.
Perform a factory reset operation, the sensor reloads the factory calibration data.

Special Query Instruction Description (R01~R12)

Instruction R01	Master	Instruction	Address	Data					Check Code
		D0	1B	00					15
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	21	01	D0	1B	XX	XX

Description: Query whether the current device serial interface data output is enabled, if the data is 08H, it indicates that the serial interface output has been enabled and the serial interface will automatically output data once every detection period. If the data is 00H, it indicates that the serial interface output is not enabled, the serial interface will not output data.

Examples: 1. The master sends D0 1B 00 15 and the slave returns AA 08 21 01 D0 1B 00 41.
This indicates that the device serial interface output is not enabled, the serial interface will not output data.

2. The master sends D0 1B 00 15 and the slave returns AA 08 21 01 D0 1B 08 39.
This indicates that the serial interface output is enabled, the serial interface will automatically output data once every detection period.

Instruction R02	Master	Instruction	Address	Data					Check Code
		D0	1C	00					14
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	21	01	D0	1C	XX	XX

Description: Query the current device alarm output level. If the data is 08H, it indicates that the STATUS pin outputs high under an alarm condition and low under normal conditions. 00H is the opposite.

Example: The master sends D0 1C 00 14 and the slave returns AA 08 21 01 D0 1C 08 38.
This indicates that the STATUS pin outputs a high under an alarm condition and low under normal conditions.

Instruction R03	Master	Instruction	Address	Data					Check Code
		D2	88	00					A6
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	21	01	D2	88	XX	XX

Description: Query the current device status.

Device Status

If Bit 0 is 1, this indicates that the calibration is in progress.
Bit 1 is reserved.
Bit 2 is reserved.
If Bit 3 is 1, this indicates that the calibration has completed.
If Bit 4 is 1, this indicates that the zero point calibration has completed.
If Bit 5 is 1, this indicates that the gas calibration has completed.
If Bit 6 is 1, this indicates that the sensor is in a fault condition.
If Bit 7 is 1, this indicates an alarm status;

Example: The master sends D2 88 00 A6 and the slave returns AA 08 21 01 D2 88 32 A0.
This indicates that the equipment is in a normal state, the zero point and gas calibrations have completed.

Instruction R04	Master	Instruction	Address	Data					Check Code
		D2	80	00					AE
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	21	01	D2	80	XX	XX

Description: Query the CO AD high byte value.

Example: The master sends D2 80 00 AE and the slave returns AA 08 21 01 D2 80 01 D9.
This indicates that the current CO AD high byte value is 01H.

Instruction R05	Master	Instruction	Address	Data					Check Code
		D2	81	00					AD
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	21	01	D2	81	XX	XX

Description: Query the CO AD low byte value
Example: The master sends D2 81 00 AD and the slave returns AA 08 21 01 D2 81 1D BC.
This indicates that the current CO AD low byte value is 1DH.
Combined with the CO AD value high byte that is read by the R04 instruction, the current CO AD value can be obtained which is 0x011D=285.

Instruction R06	Master	Instruction	Address	Data					Check Code
		D2	82	00					AC
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	21	01	D2	82	XX	XX

Description: Query the power-on reference value high byte
Example: The master sends D2 82 00 AC and the slave returns AA 08 21 01 D2 82 01 D7.
This indicates that the power-on reference value high byte is 01H.

Instruction R07	Master	Instruction	Address	Data					Check Code
		D2	83	00					AB
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	21	01	D2	83	XX	XX

Description: Query the power-on reference value low byte
Example: The master sends D2 83 00 AB and the slave returns AA 08 21 01 D2 83 29 AE.
This indicates that the power-on reference value low byte is 29H;
Combined with the power-on reference value high byte that is read by the R06 instruction, the current power-on reference can be obtained which is 0x0129=297.

Instruction R08	Master	Instruction	Address	Data					Check Code
		D2	84	00					AA
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	21	01	D2	84	XX	XX

Description: Query the concentration value high byte
Example: The master sends D2 84 00 AA and the slave returns AA 08 21 01 D2 84 00 D6.
This indicates that the current concentration value high byte is 00H.

Instruction R09	Master	Instruction	Address	Data					Check Code
		D2	85	00					A9
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	21	01	D2	85	XX	XX

Description: Query the concentration value low byte
Example: The master sends D2 85 00 A9 and the slave returns AA 08 21 01 D2 85 09 CC.
This indicates that the current concentration value low byte is 09H.
Combined with the concentration value high byte that is read by the R08 instruction, the current concentration value can be obtained which is 0x0009=9ppm.

Instruction R10	Master	Instruction	Address	Data					Check Code
		D0	0C	00					24
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	21	01	D0	0C	XX	XX

Description: Query the alarm value high byte, the default alarm value is 180ppm.
Example: The master sends D0 0C 00 24 and the slave returns AA 08 21 01 D0 0C 00 50.
This indicates that the alarm value high byte is 00H.

Instruction R11	Master	Instruction	Address	Data					Check Code
		D0	0D	00					23
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	21	01	D0	0D	XX	XX

Description: Query the alarm value low byte, the default alarm value is 180ppm.
Example: The master sends D0 0D 00 23 and the slave returns AA 08 21 01 D0 0D B4 9B.
This indicates that the alarm value low byte is B4H.
Combined with the alarm value high byte that is read by the R10 instruction, the alarm value can be obtained which is 0x00B4=180ppm.

Instruction R12	Master	Instruction	Address	Data					Check Code
		D0	0E	00					22
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	21	01	D0	0E	XX	XX

Description: Query the exit alarm value, the default exit alarm value is 55ppm, the setting range of which is 1~255.
Example: The master sends D0 0E 00 22 and the slave returns AA 08 21 01 D0 0E 37 17.
This indicates that the exit alarm value is 37H.
The exit alarm value can be obtained which is 0x037=55ppm.

Special Modification Instruction Description (W01~W05)

Instruction W01	Master	Instruction	Address	Data					Check Code
		E0	1B	XX					XX
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	21	01	E0	1B	XX	XX

Description: Modify the device serial interface data output enable control. If the data is 08H, this indicates that the serial interface output has been enabled and the serial interface will automatically output data once every period. If the data is 00H, the serial interface will not output data.
Examples: 1. The master sends E0 1B 00 05 and the slave returns AA 08 21 01 E0 1B 00 31.
This indicates that the device serial interface output is not enabled, the serial interface will not output data.
2. The master sends E0 1B 08 FD and the slave returns AA 08 21 01 E0 1B 08 29.
This indicates that the serial interface output is enabled, the serial interface will automatically output data once every detection period.

Instruction W02	Master	Instruction	Address	Data					Check Code
		E0	1C	XX					XX
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	21	01	E0	1C	XX	XX

Description: Modify the device alarm output level. If the data is 08H, the STATUS pin outputs high under an alarm condition and low under normal conditions. 00H is the opposite.

Examples: 1. The master sends E0 1C 08 FC and the slave returns AA 08 21 01 E0 1C 08 28.
This indicates that the STATUS pin outputs high under an alarm condition and low under normal conditions.
2. The master sends E0 1C 00 04 and the slave returns AA 08 21 01 E0 1C 00 30.
This indicates that the STATUS pin outputs low under an alarm condition and high under normal conditions.

Instruction W03	Master	Instruction	Address	Data					Check Code
		E0	0C	XX					XX
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	21	01	E0	0C	XX	XX

Description: Modify the alarm threshold high byte
Note: this instruction will take effect immediately after execution.

Example: If the alarm threshold is modified to 300ppm=0x012C, the alarm threshold high byte should be modified to 01H.
The master sends E0 0C 01 13 and the slave returns AA 08 21 01 E0 0C 01 3F.
This indicates that the alarm threshold high byte has been successfully modified to 01H.

Instruction W04	Master	Instruction	Address	Data					Check Code
		E0	0D	XX					XX
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	21	01	E0	0D	XX	XX

Description: Modify the alarm threshold low byte
Note: this instruction will take effect immediately after execution.

Example: If the alarm threshold is modified to 300ppm=0x012C, the alarm threshold low byte should be modified to 2CH.
The master sends E0 0D 2C E7 and the slave returns AA 08 21 01 E0 0D 2C 13.
This indicates that the alarm threshold low byte has been successfully modified to 2CH.

Instruction W05	Master	Instruction	Address	Data					Check Code
		E0	0E	XX					XX
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	21	01	E0	0E	XX	XX

Description: Modify the exit alarm value
Note: This instruction will take effect immediately after execution. The exit alarm value should be less than the alarm threshold value.

Example: The default exit alarm value is 55ppm=0x037, the setting range of which is 1~255.
The master sends E0 0E 37 DB and the slave returns AA 08 21 01 E0 0E 37 07.
This indicates that the exit alarm value has been successfully modified to 37H.

Note: 1. In this document, all slave devices refer to CO detector digital sensors, unless otherwise specified.
2. The last byte of the 4-byte instruction sent by the master is the check code. Ensure that the check code is correct otherwise the slave will consider that the received data is incorrect and ignore it. Refer to the UART data format description section for the check code calculation method.
3. If any illegal instruction other than those aforementioned is used, the slave will return the original data sent by the master.
4. Data transmission and reception is in hexadecimal format unless otherwise specified.
5. When the sensor is in the preheating or calibrating status, do not execute other instructions otherwise the sensor operating status will not be guaranteed.

Considerations

1. The sensor aging time must be at least 48 hours before use.
2. Do not unwrap the sensor at will.
3. Avoid contact with organic solvents (including silicone rubber and other adhesives), coatings, chemicals, fuel oils and high gas concentrations.
4. All the electrochemical sensors cannot be completely encapsulated with resin materials, nor can they be immersed in an oxygen-free environment for a long time, otherwise the sensor performance will be damaged.
5. All the electrochemical sensors cannot be used in the environments of containing corrosive gases for a long time, which will damage the sensor.
6. Gas zero point calibration must be carried out in a clean atmosphere.
7. When the sensor is testing and applying, vertical intake air must be avoided on the front.
8. The sensor air intake hole should not be blocked or contaminated.
9. The sensor must not be subjected to excessive impact or vibration.
10. Do not use if the sensor outer shell is damaged or deformed.
11. The sensor is slow to return to the initial state after prolonged use in high concentration gas environments.
12. The sensor is forbidden to be encapsulated with hot melt adhesive or sealant with a curing temperature higher than 80°C.
13. The sensor is forbidden to be stored and used in high alkaline gas concentrations for a long time.

Dimensions