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ANCHIP

Gas Detector Digital Sensor

BM22S3021-1

Revision: V1.01 Date: October 21, 2020

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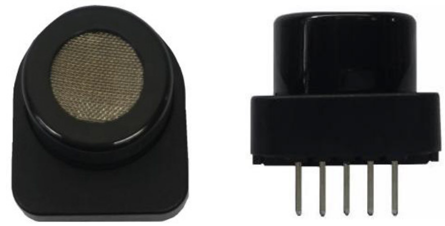
Features



- Operating voltage: 5V
- Operating current: <250mA
- Detection range: 300ppm~10000ppm
- Interfaces: UART (TX / RX) / STATUS
- Communication mode: UART communication
- Communication interface baud rate: 9600BPS
- Sensor service life: 5 years
- Alarm point factory calibration, default 9%LEL (CH4)
- Users can recalibrate alarm point

General Description

The BM22S3021-1 is a semiconductor gas detector digital sensor, which includes an integrated MCU as the master device with a serial communication mode, which can offer widespread and convenient use. The sensor has the advantages of small size, convenience of integration into product applications, long service life, easy operation, no external drive circuit, low cost, etc. To summarise, it is a low-cost digital sensor specially designed for gas detection applications and suitable for use in gas leakage alarms, smart homes, etc.

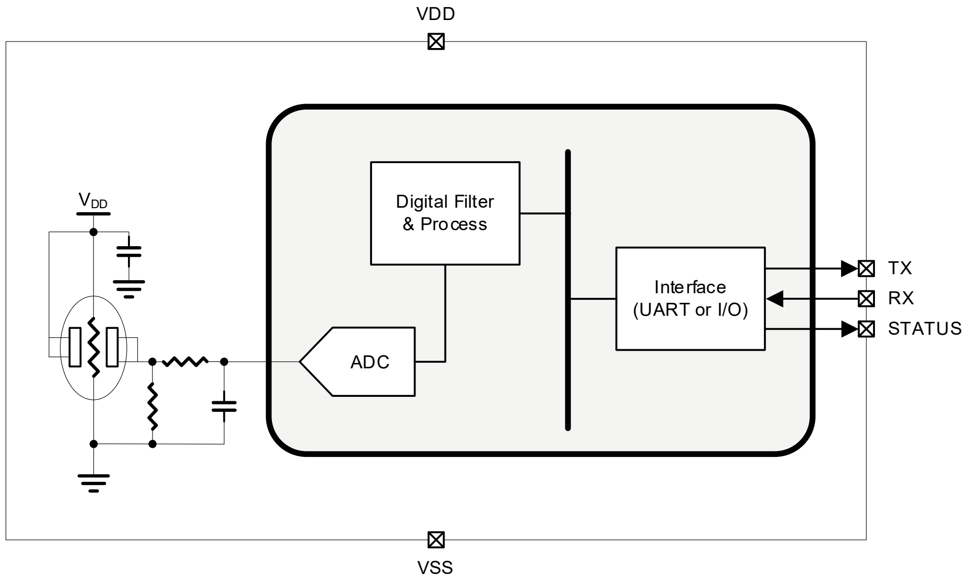
Applications

- Gas leakage alarms
- Smart gas stoves
- Gas water heaters
- Smart homes
- IoT devices

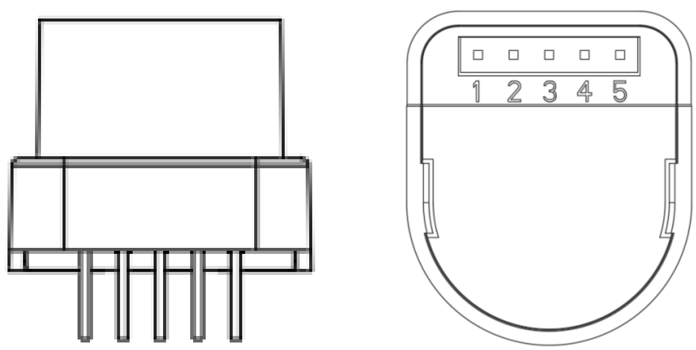
Selection Table

Part Number	Gas Type	Detection Range	Interface
BM22S3021-1	Methane	300ppm~10000ppm	UART (TX / RX) / STATUS

Block Diagram



Pin Assignment



Pin Description

Pin Number	Pin Name	Type	Description
1	VDD	PWR	Sensor module power input (5V)
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~V_{SS}+5.0V

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

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

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

Total Power Dissipation 1275mW

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	—	—	4.9	5.0	5.1	V
I_{DD}	Operating Current	5V	—	—	160	250	mA

Functional Description

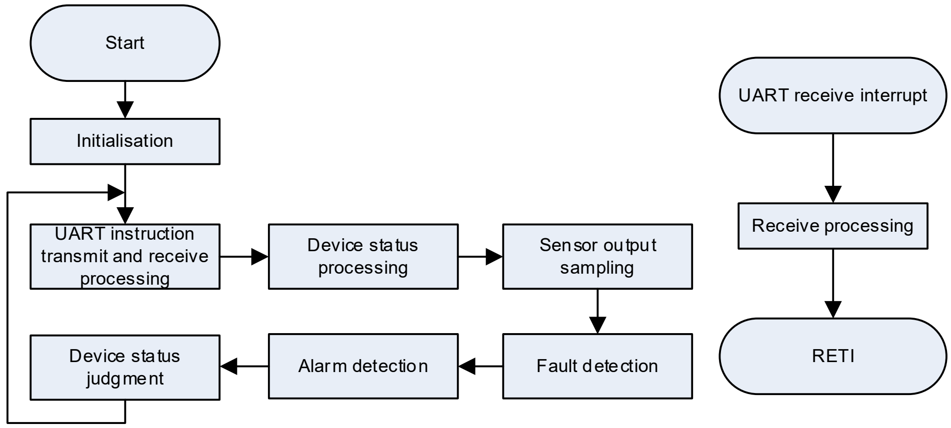
Solution Introduction

The BM22S3021-1 gas detector digital sensor includes an integrated MCU as the master device. As it uses a high accuracy combustible gas sensor, when there is a certain concentration of gas in the environment where the sensor is located, the sensor will process the gas concentration signal and then transmit the processed data to an external MCU. The sensor module has two output modes. The first is the level output mode. Under normal conditions, the STATUS pin defaults to output low. When the gas concentration is detected to have reached the alarm point, the pin will change to a high level. The second is the serial interface mode, which is subdivided into serial interface automatic output mode and 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 preheating time and alarm value can be modified using the RX pin. These two modes have their own special characteristics and can be chosen flexibly according to users' requirements, the detailed usage of which can be obtained from the relevant interface section.

Operation Flow

After the system is powered on, the BM22S3021-1 is initialised and preheated. The default preheating time is 180s. 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. Every sensor output sampling period (about 1s) the A/D value of the combustible gas sensor can be obtained, which will be automatically output using the serial interface along with the data such as device status and gas calibrated alarm value.

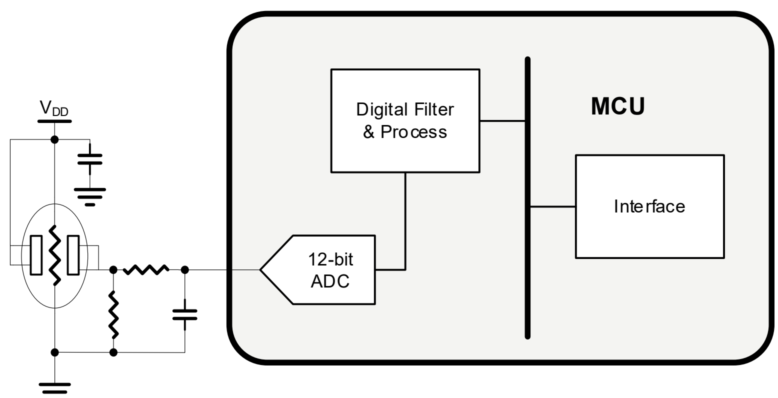
When the UART receives a falling edge on the RX pin, the sensor is woken up to enter the UART receive interrupt and perform UART instruction transmit and receive processing.



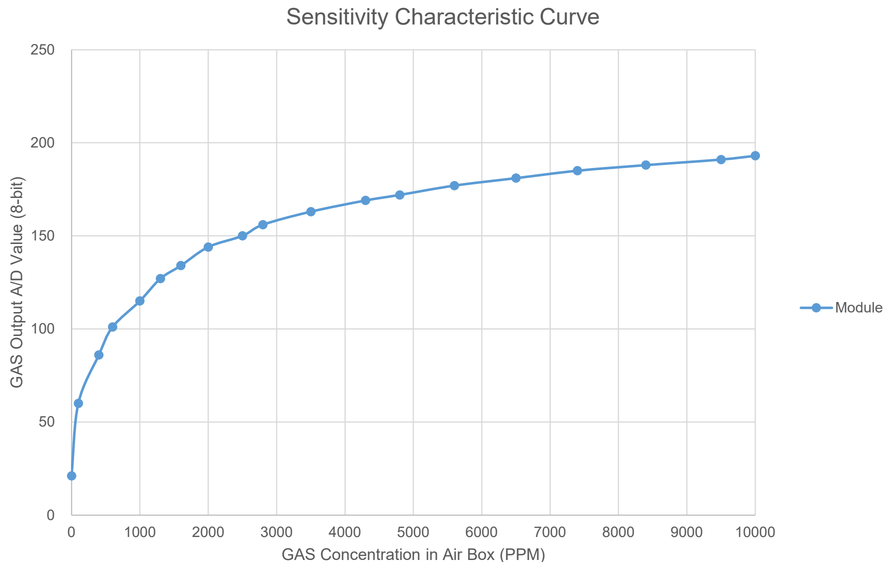
BM22S3021-1 Operation Flowchart

Combustible Gas Sensor Characteristics

The gas-sensitive material used in the combustible gas sensor is stannic dioxide (SnO_2), a material which has lower conductivity in clean air. When a combustible gas exists in the air, the sensor conductivity will increase according to the combustible gas concentration increment. With this characteristic, a simple circuit is required to convert the conductivity change into output signals corresponding to the gas concentration through an A/D converter and a filter circuit.

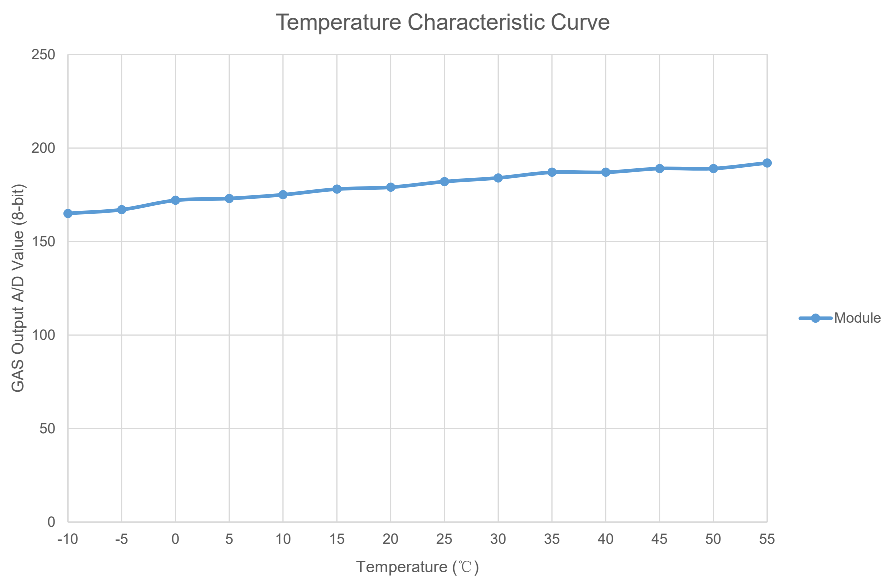


Gas Detector Sensor Circuit



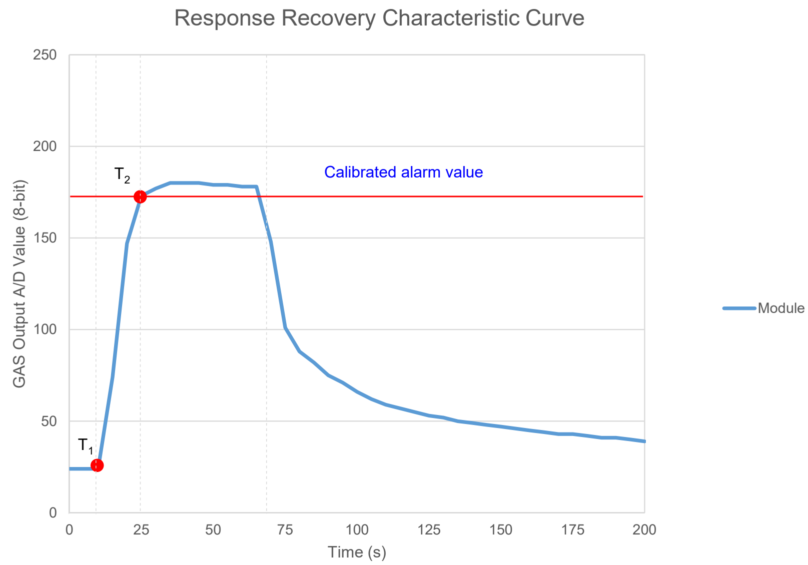
Sensitivity Characteristic Curve

In the diagram, the abscissa represents the gas concentration (PPM) in the air box and the ordinate represents the A/D conversion value of the gas sensor output signal. Due to differences between the internal sensor gas-sensitive components, the measured results for different sensors may be different from the curve parameters shown below. Refer to the actual test results.



Temperature Characteristic Curve

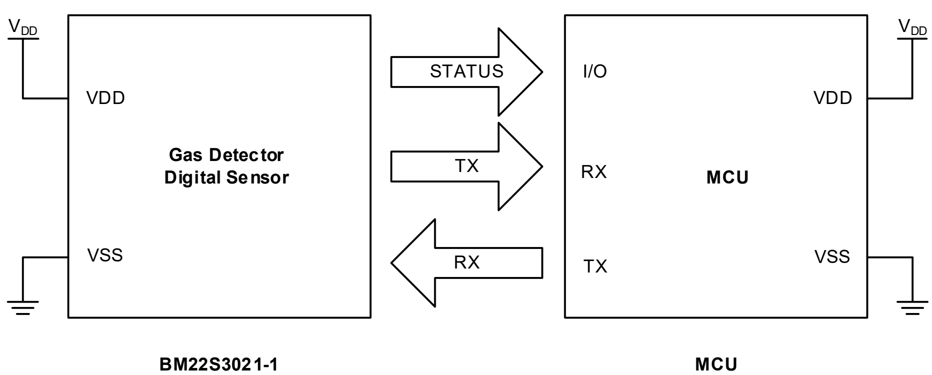
In the diagram, the abscissa represents the temperature change and the ordinate represents the A/D conversion value of the gas sensor output signal with a concentration of 5000PPM. Due to the differences between different internal sensor gas-sensitive components, the measured results for different sensors may be different from the curve parameters shown below. Refer to the actual test results.



Response Recovery Characteristic Curve

In the diagram, the abscissa represents the time change and the ordinate represents the A/D conversion value of the gas sensor output signal. The time from 0 to T1 represents that the sensor is in normal environments. After time T1, place the sensor in a test gas with a concentration of 1.6 times (14.4%LEL) the alarm value and start timing. When the sensor output A/D value reaches the calibrated alarm value, record the current time as T2. The sensor response time is (T2-T1). After the sensor output is stable for a period of time, remove the sensor from the test gas. Due to the differences between different internal sensor gas-sensitive components, the measured results for different sensors may be different from the curve parameters shown below. Refer to the actual test results.

Application Circuits



Interface Description

Alarm Status Level Output Interface

Under normal conditions, Pin 5, STATUS, defaults to low. When the sensor detects that the gas 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 gas concentration reduces to half the preset alarm value and remains there for 5s, the pin will reset back to low.

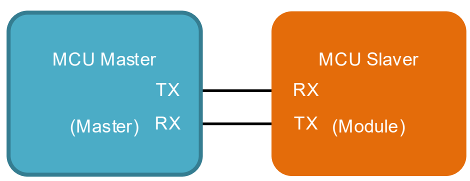
UART Serial Communication Interface

TX pin automatic output data: Under normal conditions, the TX pin will automatically output the sensor current operating status, real-time gas concentration A/D value, calibration value and other data every sampling period (about 1s).

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

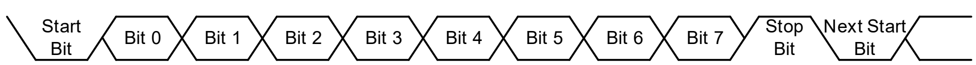
UART Serial Communication

The sensor RX pin will be at a high level under normal conditions. The external MCU sends data in the following format (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, every sampling period (about 1s) a frame of data will be output at a baud rate of 9600BPS. Each data frame contains 18 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	10	XX	Calibration timing
2	0x12	Fixed data	11	XX	V_{BG} real-time A/D value high byte (2)
3	0x02	Fixed data	12	XX	V_{BG} real-time A/D value low byte (2)
4	0x01	Fixed data	13	XX	Production data: year (3)
5	0xAC	Fixed data	14	XX	Production data: month (3)
6	XX	Device status (1)	15	XX	Production data: day (3)
7	XX	Gas real-time A/D value	16	XX	Software version number high byte (3)
8	XX	Gas calibrated alarm value	17	XX	Software version number low byte (3)
9	XX	Preheating countdown	18	XX	Check code (4)

Note: 1. Each device status data bit is defined as follows (Bit 1 and Bit 7 are reserved):
Bit 0: Preheating; Bit 2: Alarm status; Bit 3: Sensor fault;
Bit 4: Being calibrated; Bit 5: Uncalibrated or calibration fault; Bit 6: Normal standby
2. V_{BG} real-time A/D value: Collect the A/D value of the internal V_{BG} voltage (1.04V) using V_{DD} as the A/D converter reference voltage.
12-bit A/D conversion data result with right alignment. For example, if the read results are D11=0x03 and D12=0xB8, then obtain $3B8_{16}=952_{10}$. According to the calculation formula $1.04V/V_{DD}\times4096=952$, therefore $V_{DD}\approx4.47V$.
3. The software version number and production date is in 8421 BCD format.
4. Check code calculation method: Take the lower 8 bits of the sum of the first 17 bytes, complement and increment by one.

Example: If a frame of data received by the master using the serial interface is AA 12 02 01 AC 01 16 A0 3A 00 03 B8 19 07 23 01 00 A5, it indicates that the device is preheating and has been calibrated. The calibrated alarm value is 160, the current real-time A/D value is 22, the remaining preheating time is 58 seconds and the A/D value of the current V_{BG} voltage is 952 (using this V_{BG} voltage value the current V_{DD} voltage can be calculated as 4.47V).

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 and overall device status query. 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 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 variable length and mainly composed of instruction header, data length, device type, protocol version, return instruction, 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 (i.e., 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 under different instructions, the check code calculation method is the same as the master.

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

UART Communication Instruction Set Summary

Instruction type: The gas detector sensor BM22S3021-1 UART communication protocol contains three instruction types, general instruction, special query instruction and special modification instruction. There are 26 instructions in total, including 5 general instructions, 11 special query instructions and 10 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	R00	D2	50	Query the current device status
	R01	D2	51	Query the current preheating remaining time
	R02	D2	40	Query the gas real-time A/D value
	R03	D2	41	Query the gas calibrated alarm point
	R04	D2	42	Query the gas calibration remaining time
	R05	D0	01	Query the current preset power-on preheating time
	R06	D0	02	Query the current preset calibration time
	R07	D0	03	Query the current preset minimum calibration limit
	R08	D0	04	Query the current preset maximum calibration limit
	R09	D0	1B	Query whether the current device serial interface data output is enabled
	R10	D0	1C	Query the current device alarm output level

The special modification instruction number and function are as follows:

Instruction Type	Instruction Number	Instruction	Address	Instruction Function
Special Modification Instruction	W00	E2	51	Modify the current preheating remaining time
	W01	E2	42	Modify the current calibration remaining time
	W02	E0	01	Modify the power-on preheating setting time
	W03	E0	02	Modify the calibration setting time
	W04	E0	03	Modify the minimum calibration limit
	W05	E0	04	Modify the maximum calibration limit
	W06	E2	41	Modify the current alarm point
	W07	E0	12	Modify the calibrated alarm point
	W08	E0	1B	Modify the device serial interface data output enable control
	W09	E0	1C	Modify the device alarm output level

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	02	01	AF	00	00	9C

Description: Reset the sensor module.

Instruction U01	Master	Instruction	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	02	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: If the slave device returns AA 0C 02 01 AD 00 01 00 19 07 23 56, this indicates the software version: V1.00, production date: July 23, 2019

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	02	01	AB	XX	00	XX

Description: Trigger the calibration function to determine which calibration mode to use according to the address sent by the master.
Air calibration: Address B0 will trigger the air calibration mode, at which point the device will set a default alarm value without the requirement for standard concentration gas environments.
(The air calibration mode only sets an alarm change, but cannot determine the concentration value at the time of alarm)
Gas calibration: Address B1 will trigger the gas calibration mode, which should be implemented in standard concentration gas environments. (e.g. calibrated at 9%LEL gas concentration.)

Instruction U03	Master	Instruction	Address	Data			Check Code
		AC	00	00			54
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Device Status	GAS Real-time A/D Value
		AA	12	02	01	AC	XX	XX
		GAS Calibrated Alarm Value		Preheating Timing	Calibration Timing	V_{BG} Real-time A/D Value		
		XX		XX	XX	XX	XX	
		Production Date			Software Version		Check Code	
		XX	XX	XX	XX	XX	XX	

Description: Query the current device status and data, the slave will return 18 bytes of data.
1. Device status:
   Bit 0: Preheating; Bit 2: Alarm status; Bit 3: Sensor fault;
   Bit 4: Being calibrated; Bit 5: Uncalibrated or calibration fault; Bit 6: Normal standby
2. Gas real-time A/D value: sensor output real-time A/D value using 8-bit A/D sampling.
3. Gas calibrated alarm value: A/D value with gas calibration. When the gas real-time A/D value exceeds this value, an alarm will be triggered.
4. Preheating timing: power-on preheating countdown in seconds
5. Calibration timing: calibration countdown in seconds
6. V_{BG}: Collect the A/D value of the internal V_{BG} voltage (1.04V) using V_{DD} as the A/D converter reference voltage.
   V_{BG} data format: right-aligned 12-bit A/D value.

Example:
1. If the slave device returns AA 12 02 01 AC 01 16 A0 3A 00 03 B8 19 07 23 01 00 A5, this indicates that the device is preheating and has been calibrated. The calibrated alarm value is 160, the current real-time A/D value is 22, the remaining preheating time is 58 seconds and the A/D value of the current V_{BG} voltage is 952 (using this value the current V_{DD} voltage can be calculated as 4.47V).
2. If the slave device returns AA 12 02 01 AC 60 18 00 00 00 05 8B 19 07 23 01 00 49, this indicates that the device has preheated and is in a standby condition without calibration. The current real-time A/D value is 24 and the A/D value of the current V_{BG} voltage is 1419 (using this value the current V_{DD} voltage can be calculated as 3.00V).

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	02	01	A0	00	00	AB

Description: Factory reset. After this instruction is sent, reset all parameter configurations to their factory settings.

Factory setting data description:
1. Calibrated alarm value: 9%LEL A/D value
   (Due to the internal gas-sensitive components, the alarm A/D values calibrated by different sensors may be different)
2. Power-on preheating time: 180s
3. Calibration time: 150s
4. Serial interface output: enable
5. Alarm output level: The STATUS pin outputs high when alarming and low under normal conditions
6. Minimum calibration limit: 77 A/D values
7. Maximum calibration limit: 205 A/D values

Special Query Instruction Description (R00~R10)

Instruction R00	Master	Instruction	Address	Data					Check Code
		D2	50	00					DE
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	02	01	D2	50	XX	XX

Description: Query the current device status.
Device status:
Bit 0: Preheating; Bit 2: Alarm status; Bit 3: Sensor fault;
Bit 4: Implementing calibration; Bit 5: Uncalibrated or calibration fault; Bit 6: Normal standby
Example:
1. If the master sends D2 50 00 DE and the slave returns AA 08 02 01 D2 50 01 28, this indicates that the device is preheating and has been calibrated.
2. If the master sends D2 50 00 DE and the slave returns AA 08 02 01 D2 50 61 C8, this indicates that the device is preheating and has not been calibrated.

Instruction R01	Master	Instruction	Address	Data					Check Code
		D2	51	00					DD
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	02	01	D2	51	XX	XX

Description: Query the current preheating remaining time.
Example: If the master sends D2 51 00 DD and the slave returns AA 08 02 01 D2 51 1E 0A, this indicates that the current preheating remaining time is 30 seconds.

Instruction R02	Master	Instruction	Address	Data					Check Code
		D2	40	00					EE
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	02	01	D2	40	XX	XX

Description: Query the GAS real-time A/D value, using 8-bit A/D sampling.
Example: If the master sends D2 40 00 EE and the slave returns AA 08 02 01 D2 40 12 27, this indicates that the current GAS real-time A/D value is 18.

Instruction R03	Master	Instruction	Address	Data					Check Code
		D2	41	00					ED
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	02	01	D2	41	XX	XX

Description: Query the GAS calibrated alarm point, with 8-bit A/D value.
Example: If the master sends D2 41 00 ED and the slave returns AA 08 02 01 D2 41 90 A8, this indicates that the current GAS calibrated alarm point is 144.

Instruction R04	Master	Instruction	Address	Data					Check Code
		D2	42	00					EC
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	02	01	D2	42	XX	XX

Description: Query the GAS calibration remaining time, only available when calibrating.
Example: If the master sends D2 42 00 EC and the slave returns AA 08 02 01 D2 42 64 D3, this indicates that the current GAS calibration remaining time is 100 seconds.

Instruction R05	Master	Instruction	Address	Data					Check Code
		D0	01	00					2F
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	02	01	D0	01	XX	XX

Description: Query the current preset power-on preheating time.
Example: If the master sends D0 01 00 2F and the slave returns AA 08 02 01 D0 01 78 02, this indicates that the current preset power-on preheating time is 120 seconds.

Instruction R06	Master	Instruction	Address	Data					Check Code
		D0	02	00					2E
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	02	01	D0	02	XX	XX

Description: Query the current preset calibration time.
Example: If the master sends D0 02 00 2E and the slave returns AA 08 02 01 D0 02 96 E3, this indicates that the current preset calibration time is 150 seconds.

Instruction R07	Master	Instruction	Address	Data					Check Code
		D0	03	00					2D
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	02	01	D0	03	XX	XX

Description: Query the current preset minimum calibration limit. To calibrate normally, the GAS real-time A/D value should greater than this value.
Example: If the master sends D0 03 00 2D and the slave returns AA 08 02 01 D0 03 4D 2B, this indicates that the current preset minimum calibration limit is 77.

Instruction R08	Master	Instruction	Address	Data					Check Code
		D0	04	00					2C
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	02	01	D0	04	XX	XX

Description: Query the current preset maximum calibration limit. To calibrate normally, the GAS real-time A/D value should less than this value.
Example: If the master D0 04 00 2C sends and the slave returns AA 08 02 01 D0 04 CD AA, this indicates that the current preset maximum calibration limit is 205.

Instruction R09	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	02	01	D0	1B	XX	XX

Description: Query whether the current device serial interface data output is enabled. 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 detection period. If the data is 00H, it indicates that serial interface output is not enabled.

Instruction R10	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	02	01	D0	1C	XX	XX

Description: Query the current device alarm output level. If the data is 08H, the STATUS port outputs high when alarming and low under normal conditions. 00H is the opposite.

Special Modification Instruction Description (W00~W09)

Instruction W00	Master	Instruction	Address	Data					Check Code
		E2	51	XX					XX
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	02	01	E2	51	XX	XX

Description: Modify the current preheating remaining time, which is effective for this time. The setting value should be reloaded after the next power on or reset.
Example: If the master sends E2 51 05 C8 and the slave returns AA 08 02 01 E2 51 05 13, this indicates that the current preheating remaining time has been successfully modified to 5 seconds.

Instruction W01	Master	Instruction	Address	Data					Check Code
		E2	42	XX					XX
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	02	01	E2	42	XX	XX

Description: Modify the current calibration remaining time, which is effective for this time. The setting value should be reloaded after the next power on or reset.
Example: If the master sends E2 42 0A D2 and the slave returns AA 08 02 01 E2 42 0A 1D, this indicates that the current calibration remaining time has been successfully modified to 10 seconds.

Instruction W02	Master	Instruction	Address	Data					Check Code
		E0	01	XX					XX
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	02	01	E0	01	XX	XX

Description: Modify the power-on preheating setting time. The default is 180 seconds. The setting range is 1~256 seconds. It will not take effect until the next power on or reset occurs.
Example: If the master sends E0 01 5A C5 and the slave returns AA 08 02 01 E0 01 5A 10, this indicates that the power-on preheating setting time has been successfully modified to 90 seconds.

Instruction W03	Master	Instruction	Address	Data					Check Code
		E0	02	XX					XX
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	02	01	E0	02	XX	XX

Description: Modify the calibration setting time, which will take effect in the next calibration.
Example: If the master sends E0 02 3C E2 and the slave returns AA 08 02 01 E0 02 3C 2D, this indicates that the calibration setting time has been successfully modified to 60 seconds.

Instruction W04	Master	Instruction	Address	Data					Check Code
		E0	03	XX					XX
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	02	01	E0	03	XX	XX

Description: Modify the minimum calibration limit, which will take effect in the next calibration.
Example: If the master sends E0 03 50 CD and the slave returns AA 08 02 01 E0 03 3C 2C, this indicates that the minimum calibration limit has been successfully modified to 80. To calibrate normally, the gas real-time A/D value should exceed this value.

Instruction W05	Master	Instruction	Address	Data					Check Code
		E0	04	XX					XX
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	02	01	E0	04	XX	XX

Description: Modify the maximum calibration limit, which will take effect in the next calibration.
Example: If the master sends E0 04 B4 68 and the slave returns AA 08 02 01 E0 04 B4 B3, this indicates that the maximum calibration limit has been successfully modified to 180. To calibrate normally, the gas real-time A/D value should less than this value.

Instruction W06	Master	Instruction	Address	Data					Check Code
		E2	41	XX					XX
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	02	01	E2	41	XX	XX

Description: Modify the current alarm point, which is effective for this time. The setting value should be reloaded after the next power on or reset.
Note: The modification will not take effect until the device is calibrated, otherwise it will be in an uncalibrated status.
Example: If the master sends E2 41 8C 51and the slave returns AA 08 02 01 E2 41 8C 9C, this indicates that the current alarm point has been successfully modified to 180.

Instruction W07	Master	Instruction	Address	Data					Check Code
		E0	12	XX					XX
	Slave	Instruction Header	Data Length	Device Type	Protocol Version	Return Instruction	Return Address	Data	Check Code
		AA	08	02	01	E0	12	XX	XX

Description: Modify the alarm threshold (modify the calibrated alarm point), effective immediately.
Example: If the master sends E0 12 56 B8 and the slave returns AA 08 02 01 E0 12 56 03, this indicates that the alarm threshold has been modified to 86.

Instruction W08	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	02	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.

Instruction W09	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	02	01	E0	1C	XX	XX

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

Note: 1. In this document, all slave devices refer to gas detector digital sensors, unless otherwise specified.
2. The last byte of the 4-byte instruction sent by the master is the check code. Ensure the check code is correct otherwise the slave will consider 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

Situations that Must Be Avoided

1. Supply power to the sensor strictly according to its supply voltage.

   A voltage exceeding 5V may cause irreversible damage to the sensor. Even if the sensor is not physically damaged or destroyed, the sensor sensitivity will be reduced. If the voltage is too low, the sensor will not operate normally.

2. During the normal operation of the sensor, the temperature of the wire mesh on the sensor surface will reach above 80°C, therefore be aware of the risk of burning injuries. If other objects such as hands touch the wire mesh on the sensor surface, the sensor output data may be affected.

3. Exposure to volatile silicon compound gases

   The sensor should avoid exposure to silicon adhesives, hair gels, silicone rubber, putty or other volatile silicon compounds. If the sensor surface absorbs volatile silicon compounds, the sensor sensitive material will be covered in silicon dioxide formed by the decomposition of silicon compounds. This will inhibit the sensor sensitivity and cannot be reversed.

4. Highly corrosive environment

   If the sensor is exposed to high concentrations of corrosive gases (such as H2S, SOX, Cl2, HCl, etc.), it will not only cause corrosion or damage to heating materials and sensor leads but also cause irreversible deterioration of the sensitive material performance.

5. Pollution of alkali, alkali metal salts and halogens

   If the sensor is contaminated with alkali metals, especially brine sprays or exposed to halogens such as Freon, it will also cause performance deterioration.

6. Contact with water

   Being splashed or immersed in water can cause the sensor sensitivity to decrease.

7. Freezing

   If water freezes on the sensor sensitive material surface, the sensitive layer will break and will lose its sensitivity.

Situations that Should Be Avoided

1. High gas concentrations

   No matter whether the sensor is powered on or not, prolonged placement in high gas concentration situations will affect the sensor characteristics. If the sensor is sprayed directly with lighter gas, it will cause serious damage to the sensor.

2. Drastic temperature changes

   No matter whether the sensor is powered on or not, extreme environmental temperature changes will have a certain effect on the sensor.

3. Prolonged storage

   If the sensor is stored for a long time without being powered on, its resistance will experience a reversible drift, which is related to the storage environment. The sensor should be stored in a sealed bag free of volatile silicon compounds. When storing the sensor for longer periods, a longer period of time is required after power on for stabilisation before use. The storage time and corresponding recommended aging time are shown in the following table.

Storage Time	Recommended Aging Time
Less than 1 month	Not less than 48 hours
1~6 months	Not less than 72 hours
More than 6 months	Not less than 168 hours

4. Prolonged exposure to extreme environments

   No matter whether the sensor is powered on or not, prolonged exposure to extreme environments, such as high humidity, high temperature or high pollution, will seriously affect the sensor performance.

5. Vibrations

   Frequent and excessive vibrations, which may occur in transit or when using tools or ultrasonic welders on assembly line, may cause the internal sensor leads to resonate and break.

6. Impact

   If the sensor is subjected to a strong impact or drop, its leads can break.

Dimensions