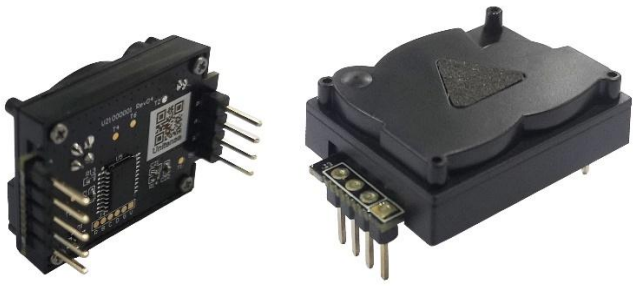
产 品 规 格 书

PRODUCT SPECIFICATION

双通道二氧化碳气体传感器

Dual Beam NDIR CO_2 Sensor

U9102 Series Rev. A1



版本 Version	修订记录 Revision Record	发行日期 Issue Date
A0	初次发放 Initial Release	2022-10-21
A1	勘误通信协议细节，统一术语与排版规范 Correct communication protocol details, unify terminology and formatting standards	2026-08-21

1. 产品介绍 Product Introduction

1.1 产品概述 Product Description

U9102系列是一款双通道光学二氧化碳传感器，本产品利用非色散红外（NDIR）原理探测空气中的CO_2浓度，它采用优化的光学设计、电路设计、数字信号处理算法和补偿算法，相较于市场同类型产品，其具有信噪比高、重复性好、响应快的特点。得益于其额外的参考通道，它具有更好的稳定性。此外，通过稳健性设计，产品通过了多项严苛的环境测试和寿命测试，具有优越的可靠性。U9102 Series is a dual beam optical carbon dioxide (CO_2) sensor that utilizes the principle of non-dispersive infrared (NDIR) to detect CO_2 concentration in the air. Due to its additional reference channel, it has better stability compared with a single-beam sensor. This product applies optimized optical design, circuit design, digital signal processing algorithm, and compensation algorithm. Compared with similar products on the market, it has the characteristics of a high signal-to-noise ratio, good repeatability, and fast response. In addition, through its robust design, the product has passed several environmental and life tests that guarantee superior reliability.

1.2 产品特性 Product Features

- ✧ 多温度点/全量程校准 Full-measurement-range calibration at multi-points temperature
- ✧ 参考通道以确保读数的长期稳定 Reference channel to ensure long-term stability
- ✧ RMS噪声小于1 ppm RMS noise less than 1.0 ppm
- ✧ 使用寿命大于15年 Work-life more than 15 years
- ✧ 结构紧凑、便于安装 Compact mechanical structure for easy installation
- ✧ 提供自动校准模式和手动校准模式 Auto-calibration and Manual-calibration available
- ✧ 信号输出 PWM/UART/I^2C Output signal PWM/UART/I^2C

1.3 应用领域 Application Field

- ✧ 室内空气监测 Indoor air quality monitoring
- ✧ 暖通空调、新风系统 HVAC system and fresh air system
- ✧ 车内空气监测 Cabin air quality control in automotive application
- ✧ 农业温室监控 Agriculture monitor and control systems such as green-house planting

1.4 使用注意事项 Application Notes

a. 在传感器的焊接、安装、使用等过程中，应避免光学气室承受任何方向的压力；在操作时应采用防静电措施。During soldering, installation, and use, protect the optical chamber from physical pressure in any direction; take ESD precautions during handling.

b. 锡焊焊接时，温度设置须低于380 ℃，尽量保证焊接时间小于3秒。选择性波峰焊可能导致热应力和光学气室形变，在工艺开发时应做充分验证。When performing tin soldering, set the temperature below 380 ℃, and the soldering time shall be less than 3 seconds as far as possible. Selective wave soldering may cause thermal stress and optical chamber deformation, which should be carefully qualified when conducting process development.

c. 确保传感器通风良好，勿遮挡气体扩散孔（防水透气膜）。如在风道中，避免气流直吹气体扩散孔。传感器应避免阳光直射和热辐射。Ensure that the sensor is well ventilated and the air diffusion holes (particle filter) are not blocked. For example, avoid blowing direct airflow at the air diffusion hole when placing the sensor in the air duct. Protect the sensor from direct sunlight and thermal radiation.

d. 应避免接触腐蚀性气体，以免传感器性能和可靠性退化。Avoid exposure to corrosive gases as it would lead to sensor performance and reliability degradation.

e. 传感器出厂默认开启自校准功能，默认校准周期是72小时。如传感器工作在长期不通风的环境中，请通过指令关闭自校准功能。The auto-calibration function is enabled by default, and the default calibration period is 72 hours. If the sensor works in an unventilated environment, turn off the self-calibration function by sending a command.

f. 通过引脚或校准命令进行手动校准时，传感器须在稳定的气体环境（例如400 ppm）下连续工作2分钟以上。When performing manual calibration with the pin or the calibration command, the sensor shall operate continuously for more than 2 minutes in a stable gas environment (e.g., 400 ppm).

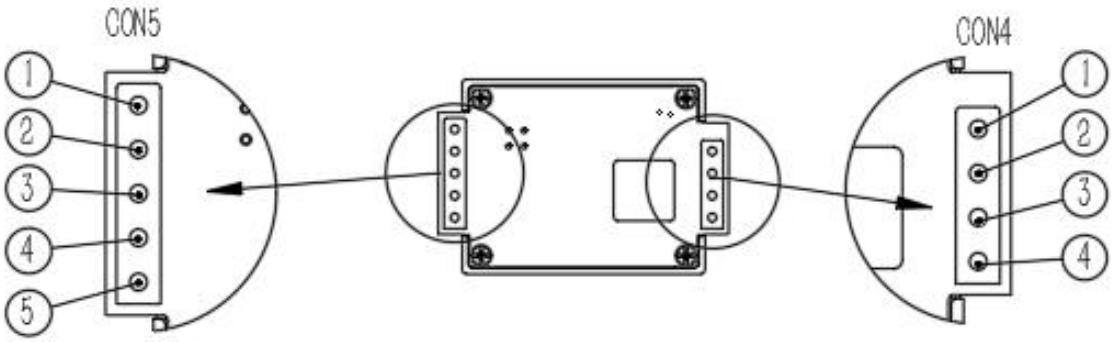
2. 产品特性 Product Characteristics

2.1 技术指标 Technical Specification

产品型号 Product Number	U91020001	U91020003	U91020002
检测气体 Target Gas	Carbon Dioxide (CO_2)		
检测范围 Measurement Range	400 to 5,000 ppm	400 to 2,000 ppm	400 to 10,000 ppm
检测精度 Accuracy (1, 2)	± (30 ppm + 3% reading)		± (50 ppm + 5% reading)
响应时间 Response Time	< 40 seconds		
工作条件 Operation Conditions	-20～60 ℃; 0～95% RH (Non-condensing)		
存储条件 Storage Conditions	-40 ℃～70 ℃		
供电电压 Power Supply	DC 4.5 V～5.5 V，Ripple voltage < 50 mV		
平均工作电流 Average Current	~27 mA		
峰值电流 Peak Current	< 250 mA		
通讯接口 Communication Interface	1) UART TTL (3.3 V) 2) PWM (upon request) (3) 3) I^2C (upon request) (3)		
产品寿命 Life Expectancy	15 years		
长期稳定性 Long-term Stability	≤ 2% F.S.		
重量 Weight	5.8 grams		

(1) 规格参考认证的标准混合标气(±2 % 不确定度）
(Specification is referenced to certified calibration gas mixture (±2% uncertainty).)
(2) 经过三个自动校准周期后满足精度要求。
(Accuracy satisfied after three auto-calibration periods.)
(3) 定制需求请联系万悟。
(Contact Unitense for customized requests.)

2.2 引脚定义 Pin Definition



Bottom view from PCBA surface

序号 Pin-out		描述 Description
CON5	1	Manual calibration
	2	Output change from UART to I²C (upon request)
	3	UART_TX
	4	UART_RX
	5	DC +3.3 V output (100 mA)
CON4	1	PWM output (upon request)
	2	Alarm output (upon request)
	3	GND
	4	DC + 5 V power supply

2.3 数据传输 Data Communication

2.3.1 串口通信 Serial Port (UART) Communication

波特率Baud rate: 9600，数据位Data bits: 8，停止位Stop bits: 1，校验位Parity: None，流量控制Flow control: None

2.3.2 通讯协议格式 Format of Communication Protocol

发送－ Send						
帧头	长度	命令	数据$_1$	...	数据$_n$	校验和
Header	Length	CMD	$DATA_1$	...	$DATA_n$	CS
0x10	0xXX	0xXX	0xXX	...	0xXX	0xXX
返回－ Response						
帧头	长度	命令	数据$_1$	...	数据$_n$	校验和
Header	Length	CMD	$DATA_1$	...	$DATA_n$	CS
0x20	0xXX	0xXX	0xXX	...	0xXX	0xXX

2.3.3 通讯协议格式说明 Introduction about Format of Communication Protocol

项目 Items	描述 Description	字节数 Bytes
帧头 (Header)	发送是0x10，返回是0x20。 Send 0x10 or Response 0x20.	1
长度 (Length)	帧数据字节长度，等于CMD~$DATA_n$的字节数。 Count of bytes from CMD to $DATA_n$.	1
命令 (CMD)	详见命令列表。 See Command List.	1
数据 ($DATA_x$)	$DATA_1$~$DATA_n$.	1Byte per $DATA_x$
校验和 (CS)	CS = 0x100 -(Header+Length+CMD+$DATA_1$+...+$DATA_n$)%0x100	1

2.3.4 命令列表 Command List

命令列表 Command List	
0x01	读取软件版本号 Get software version
0x02	查询产品序列号 Get product serial number (SN)
0x03	读取气体浓度值 Read gas concentration of CO_2 in ppm
0x04	手动校准 Manual calibration of reading
0x05	设置自动校准参数 Setting parameters of automatic calibration

2.3.5 指令格式 Command Format

0x01 - 读取软件版本号 Get software version

发送命令 Send

Byte0	**Byte1**	**Byte2**	**Byte3**
Header	Length	CMD	CS
0x10	0x01	0x01	0xEE

返回值 Response

Byte0	**Byte1**	**Byte2**	**Byte3**	...	**Byte(n+2)**	**Byte(n+3)**
Header	Length	CMD	$DATA_1$	...	$DATA_n$	CS
0x20	0xXX	0x01	0xXX	...	0xXX	0xXX

$DATA_1$~$DATA_n$为软件版本号，内容和长度会随着软件版本的升级而改变。
$DATA_1$~$DATA_n$ is software version. It will be changed with the software update.

0x02 - 查询产品序列号 Get product serial number (SN)

发送命令 Send

Byte0	Byte1	Byte2	Byte3
Header	Length	CMD	CS
0x10	0x01	0x02	0xED

返回值 Response

Byte0	Byte1	Byte2	Byte3	...	Byte(n+2)	Byte(n+3)
Header	Length	CMD	$DATA_1$	...	$DATA_n$	CS
0x20	0xXX	0x02	0xXX	...	0xXX	0xXX

$DATA_1$~$DATA_n$ 表示产品序列号，具体长度因型号而异：

- **U91020001 / U91020003:** 长度为 15 个字节 n = 15，此时 Length = 0x10。
- **U91020002**: 长度为 19 个字节 19，此时 Length = 0 x 14。

$DATA_1$~$DATA_n$ is SN, the length varies by model:

- **U91020001 / U91020003**: 15 bytes n = 15, Length = 0 x 10.
- **U91020002**: 19 bytes n = 19, Length = 0 x 14.

0x03 - 读取气体浓度值 Read gas concentration of CO_2 in ppm

发送命令 Send

Byte0	Byte1	Byte2	Byte3
Header	Length	CMD	CS
0x10	0x01	0x03	0xEC

返回值 Response

Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
Header	Length	CMD	$DATA_1$	$DATA_2$	$DATA_3$	$DATA_4$	CS
0x20	0x05	0x03	0xXX	0xXX	0xXX	0xXX	0xXX

浓度读数 Concentration reading = $DATA_1$*0x100+$DATA_2$.
$DATA_3$ and $DATA_4$ are reserved.

0x04 - 手动校准 Manual calibration of reading

发送命令 Send

Byte0	Byte1	Byte2	Byte3	Byte4	Byte5
Header	Length	CMD	$DATA_1$	$DATA_2$	CS
0x10	0x03	0x04	0xXX	0xXX	0xXX

返回值 Response

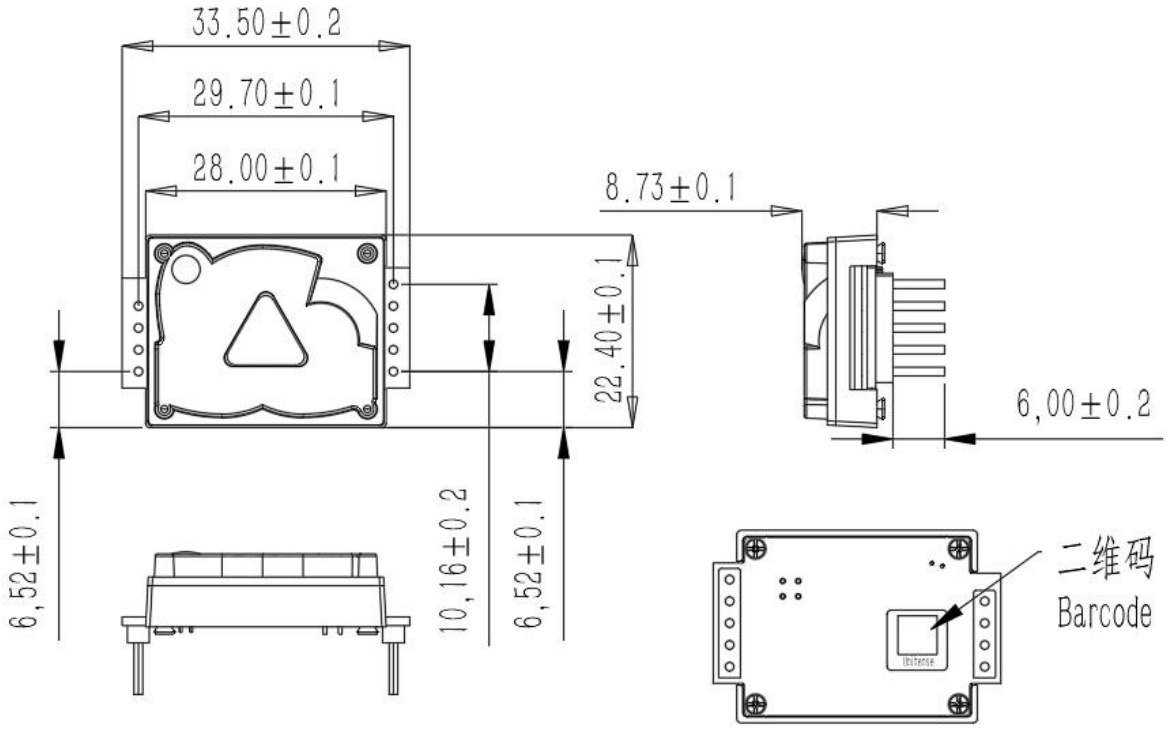
Byte0	Byte1	Byte2	Byte3
Header	Length	CMD	CS
0x20	0x01	0x04	0xDB

校准目标值 Calibration target value = $DATA_1$*0x100+$DATA_2$.

0x05 - 设置自动校准参数 Setting parameter of automatic calibration								
发送命令 Send								
Byte0	**Byte1**	**Byte2**	**Byte3**	**Byte4**	**Byte5**	**Byte6**	**Byte7**	**Byte8**
Header	Length	CMD	$DATA_1$	$DATA_2$	$DATA_3$	$DATA_4$	$DATA_5$	CS
0x10	0x06	0x05	0xXX	0xXX	0xXX	0xXX	0xXX	0xXX
返回值 Response								
Byte0		**Byte1**		**Byte2**		**Byte3**		
Header		Length		CMD		CS		
0x20		0x01		0x05		0xDA		

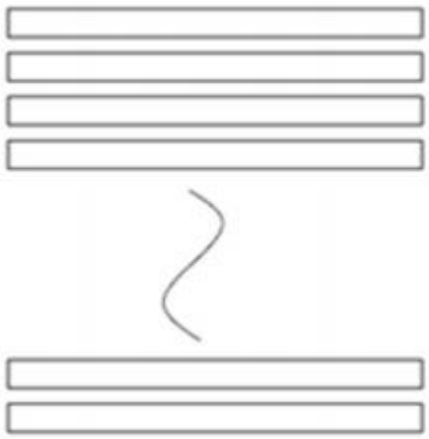
$DATA_1$：自动校准使能 Auto Calibration Function Enable, 1 - Enable, 0 - Disable.
$DATA_2$ and $DATA_3$：自动校准周期 Auto Calibration Period (hours) = $DATA_2$*0x100+$DATA_3$.
This value will be set to 24H if it is less than 24H.
$DATA_4$ and $DATA_5$：自动校准目标值 Auto Calibration target value (ppm) = $DATA_4$*0x100+$DATA_5$.

3. 外形尺寸 Product Outlines (unit: mm)

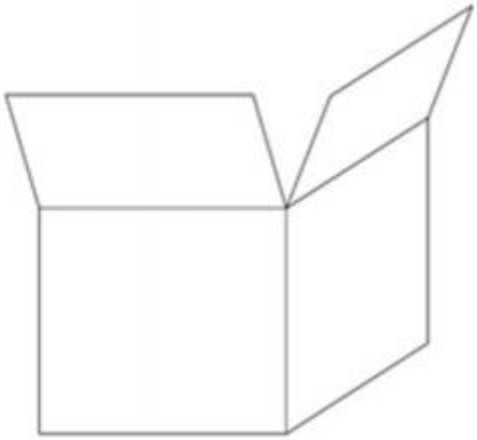


4. 包装规格 Packaging Specification

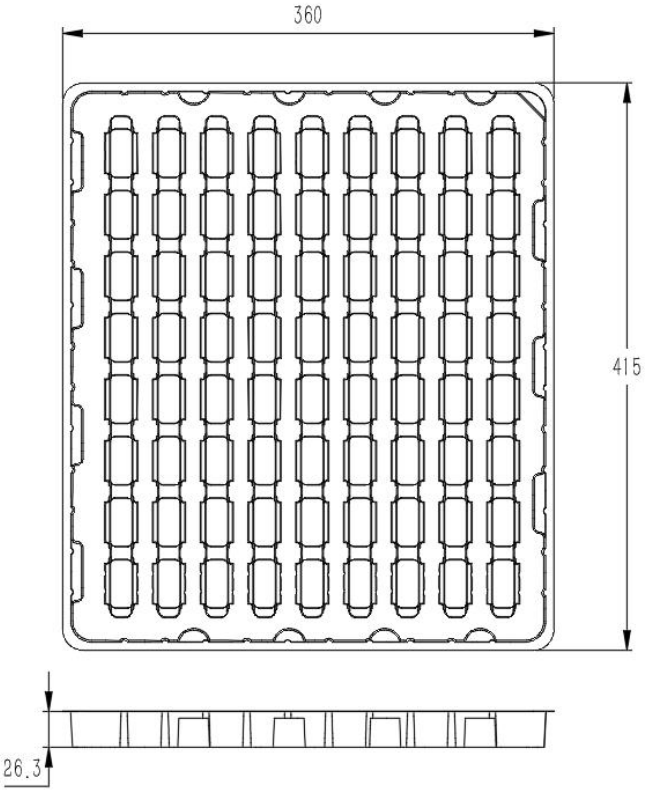
包装箱尺寸 Carton Size (W*L*H)			产品托盘数 Tray Qty.	每托盘产品数 Qty. per Tray	总数 Total Qty.	重量 Gross Weight
415 mm	355 mm	215 mm	8 pcs	72 pcs	576 pcs	Max.10.0 kg



防静电吸塑托盘 Anti-static blister tray
数量 Qty.：9 pcs



包装箱 Carton
1 pc



防静电吸塑托盘 Anti-static blister tray

注意：
顶部放置1pc空置的防静电吸塑托盘充当盖板

Note:
1pc empty anti-static blister tray serves as the cover on the top