产 品 规 格 书

PRODUCT SPECIFICATION

冷媒（制冷剂）泄漏监测系统

Refrigerant Leakage Detection System

U960410 Series Rev. 06

版本 Version	修订记录 Revision Record	发行日期 Issue Date
05	预发放 Preliminary Release	2025.2.12
06	修正了关于命令“查询产品序列号”返回值中的SN长度. Update the SN length in the response for command "Get product serial number".	2025.02.14

1. 产品介绍 Product Introduction

1.1 产品概述 Product Description

U960401 Series是一款光学冷媒（制冷剂）泄漏监测传感器系统，其利用非色散红外（NDIR）原理探测空气中的制冷剂气体浓度。本产品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。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，具有优越的稳定性和可靠性。U960401 series is a range of optical-based refrigerant detection systems (RDS) that utilize the principle of non-dispersive infrared (NDIR) to detect refrigerant gas concentrations in the air. The product series feature patented optical design, circuit design, digital signal processing algorithm, and compensation algorithm. Compared to similar products on the market, it offers a high signal-to-noise ratio, excellent repeatability, and rapid response time. Furthermore, thanks to its robust design, the product has successfully passed numerous environmental tests, ensuring superior stability and 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
- ✧ 零点噪声有效值约10 ppm; RMS noise ~10 ppm @ zero
- ✧ 使用寿命大于15年 Work-life more than 15 years
- ✧ 集成继电器用于风机/压缩机控制 Integerated relay for fan/compressor control
- ✧ LED闪烁代码指示操作状态 LED blink code to indicate opearation status
- ✧ 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 RS485; Output signal RS485

1.3 应用领域 Application Field

- ✧ 暖通空调系统的冷媒泄露监测 Refrigerant leakage monitoring of HVAC system
- ✧ 冰箱和制冷系统的冷媒泄露监测 Refrigerant leakage monitoring of refrigeration system

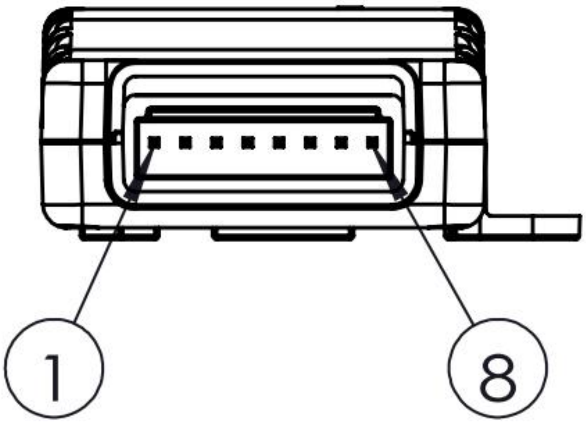
2. 产品特性 Product Characteristics

2.1 技术指标 Technical Specification

产品型号 Product Number	U96041001	U96041002	U96041003	U96041004	U96041031
检测气体 Target Gas	R32	R454B	R454A	R454C	R290
检测范围 Measurement Range[1]	0~50% LFL (extended range to 100% LFL upon request (3))				
检测精度 Accuracy	±2.5% LFL for standard range ±5% LFL for extended range (2)				
响应时间 Response Time	< 30 s (4)				
工作条件 Operation Conditions	-40 to 85 ℃, 0 to 95% RH (Non-condensing)				
存储条件 Storage Conditions	-40 ℃ to 85 ℃				
供电电压 Power Supply	AC/DC 10 V ~ 28 V，Ripple voltage < 100 mV				
平均工作电流 Average Current	< 50 mA @ 24V DC supply voltage				
控制输出 Control Output	Dual relay output				
通讯 Communication	RS485				
产品寿命 Life Expectancy	15 years				
长期稳定性 Long-term Stability	≤ 2% LFL				
符合性 Compliance	IEC 60335-2-40, UL 60335-2-40				
重量 Weight	< 65 grams				

(1) Contact Unitense for monitoring of other refrigerant belongs to A2L, A3 safety group.
(2) Standard range: 0 to 25% LFL and -20 to 60 °C; Extended range: 25 to 50% LFL and -40 to 85 °C.
(3) Contact Unitense for customized request.
(4) Directly exposed to the refrigerant gas with concentration 25% LFL and Detection Threshold Limit Value set to 10% of LFL.

2.2 引脚定义 Pin Definition



Front view to connector side

序号 Pin-out	描述 Description
1	Power Input
2	GND
3	Relay_1 Normal Open
4	Relay_1 Normal Closed
5	Relay_2 Common
6	Relay_2 Normal Open
7	RS485_B
8	RS485_A

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: no，流量控制Flow control: no

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
Head	Length	CMD	DATA1	...	DATAn	CS
0x10	xx	xx	xx	...	xx	xx
返回- Respone						
帧头	长度	命令	数据1	...	数据n	校验和
Head	Length	CMD	DATA1	...	DATAn	CS
0x20	xx	xx	xx	...	xx	xx

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 (Head)	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~DATAn的字节数。 Count of bytes from CMD to DATAn.	1
命令 (CMD)	详见命令列表。 See Command List.	1
数据 (DATAx)	DATA1~DATAn.	1Byte per DATAx
校验和 (CS)	Checksum (CS) = 0x100 - (Head+Length+CMD+DATA1+...+DATAn)%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
0x04	手动校准 Manual calibration
0x05	设置自动校准参数 Setting parameter 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**
Head	Length	CMD	CS
0x10	0x01	0x01	0xEE

返回值 Response						
Byte0	**Byte1**	**Byte2**	**Byte3**	...	**Byten+2**	**Byten+3**
Head	Length	CMD	DATA1	...	DATAn	CS
0x20	xx	0x01	xx	...	xx	xx
DATA1~DATAn为软件版本号，内容和长度会随着软件版本的升级而改变。 DATA1~DATAn 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**
Head	Length	CMD	CS
0x10	0x01	0x02	0xED

返回值 Response

Byte0	**Byte1**	**Byte2**	**Byte3**	...	**Byte21**	**Byte22**
Head	Length	CMD	DATA1	...	DATA19	CS
0x20	0x14	0x02	xx	...	xx	xx

DATA1~DATA19表示产品序列号,长度为19个字节。
DATA1~DATA19 is SN, 19 bytes.

0x03 - 读取气体浓度值 Read gas concentration in ppm			
发送命令 Send			
Byte0	**Byte1**	**Byte2**	**Byte3**
Head	Length	CMD	CS
0x10	0x01	0x03	0xEC

返回值 Response

Byte0	**Byte1**	**Byte2**	**Byte3**	**Byte4**	**Byte5**	**Byte6**	**Byte7**
Head	Length	CMD	DATA1	DATA2	DATA3	DATA4	CS
0x20	0x05	0x03	xx	xx	xx	xx	xx

浓度读数 Concentration reading = (DATA1*0x100+DATA2)*0x0A (ppm)
DATA3 and DATA4 are reserved.

0x04 - 手动校准 Manual calibration of reading					
发送命令 Send					
Byte0	**Byte1**	**Byte2**	**Byte3**	**Byte4**	**Byte5**
Head	Length	CMD	DATA1	DATA2	CS
0x10	0x03	0x04	xx	xx	xx

返回值 Response

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

校准目标值 Calibration target value = (DATA1*0x100+DATA2)*0x0A (ppm)

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
Head	Length	CMD	DATA1	DATA2	DATA3	DATA4	DATA5	CS
0x10	0x06	0x05	xx	xx	xx	xx	xx	xx

返回值 Response

Byte0	Byte1	Byte2	Byte3
Head	Length	CMD	CS
0x20	0x01	0x05	0xDA

DATA1：自动校准使能 Auto Calibration Function Enable, 1 - Enable, 0 - Disable.
DATA2 and DATA3：自动校准周期 Auto Calibration Function Period (hours) = DATA2*0x100+DATA3.
This value will be set to 24H if it is less than 24H.
DATA4 and DATA5：自动校准目标值 Auto Calibration target value
= (DATA4*0x100+DATA5)*0x0A (ppm)

For example：
Enable Auto Calibration Function and set Auto Calibration Function Period to be 72H, set Auto Calibration target value to 0 ppm，so:
DATA1 = 0x01,DATA2 = 0x00,DATA3 = 0x48,DATA4 = 0x00,DATA5 = 0x00,Checksum = 0x9C.

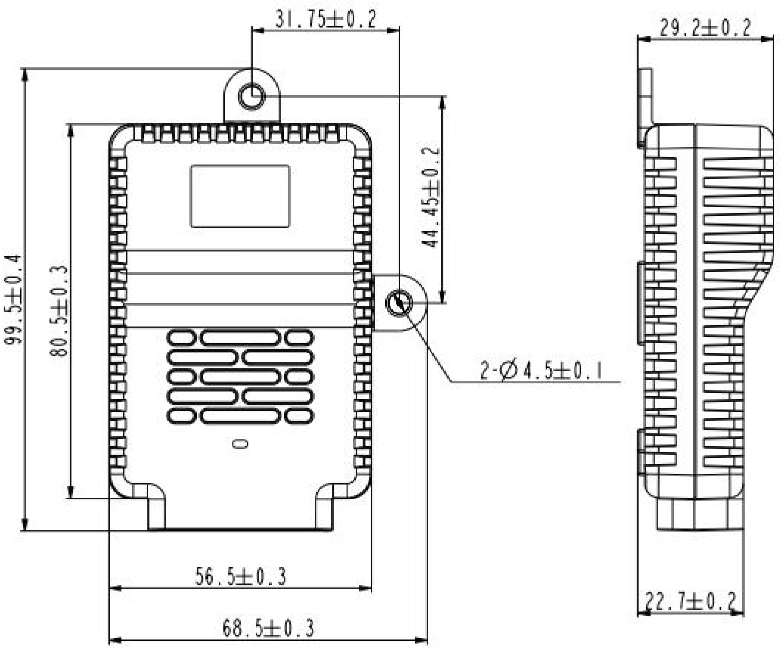
When disable Auto Calibration Function,please use the command as following:
0x10 0x06,0x05,0x00, 0x00,0x48,0x00,0x00,0x9D

2.4 LED闪烁代码 LED Blink Code

闪烁代码 Blink Code	描述 Description
Steady_on	Normal operation
1	Time delay after an event
2	Sensor starting to fail
3	To be determined
4	Mitigation mode
5	End of life

The operation state of the RDS is indicated using an LED blink code. During each LED blink cycle, the number of blinks corresponds to the value of the blink code, with a 200-millisecond interval between each blink. After each cycle, there is a 2-second pause before the next blink cycle begins. If the LED remains steadily lit, it indicates that the RDS is functioning normally.

3. 外形尺寸 Product Outlines (unit: mm)



4. 接线图 Wiring Diagram