SPECIFICATION

Product Name: AM4203-DR Series NDIR Refrigerant Sensor

Item No.: AM4203-DR Series

Version: V0.5

Date: July 1st, 2024

Revision

No.	Version	Content	Date
1	V0.1	Preliminary version	2024.01.26
2	V0.2	1. SPST relay contact type changed from normally closed (N.C.) to normally open (N.O.). 2. Relay working logic changed from positive to negative to address sensor fault or unpowered conditions. 3. Added reference load connection diagram in a heat pump system.	2024.02.23
3	V0.3	1. Update product picture,installation instruction picture, appearance size and pin definition. 2. Update technical specifications:startup time is increased from 3s to 10s;update response time is T60≤30s;update dimensions and peak current. 3. Two SPDT are used to accommodate a SPST plus a SPDT switch. 4. Added the content of response when an error request is sent in the communication protocol.	2024.04.09
4	V0.4	1. Update product pictures, size pictures and installation instructions pictures. 2. Update technical specifications:dimensions.	2024.05.28
5	V0.5	1. Add certification instructions to the specification.	2024.07.01

AM4203-DR Series NDIR Refrigerant Sensor

Application

- Residential and commercial cooling
- Industry cooling and cold chain
- Residential and commercial heat pump
- Air conditioning system

Product Introduction

AM4203-DR Refrigerant Sensor is based on NDIR (Non-Dispersive Infrared) technology with high accuracy and longer lifespan. This sensor has been developed with standard gas and is efficiently calibrated in the factory by Cubic own gas sensor calibration technology. The sensing solutions can be easily integrated in safety and alarming devices.

Main Features

- NDIR (non-dispersive infrared) technology
- Matrix calibration to ensure accuracy
- Fast response (T60≤30 seconds)
- High selectivity, immune to poisoning gases
- Double relay output for HVAC control purpose
- Automatic heating mechanism for anti-condensation
- Maintenance free installation – reference channel and self-compensation, long-term stability, no false positives
- Long lifespan, 15+ years lifetime
- CE, RoHS, Reach, UL 60335-2-40 4th edition and IEC 60335-2-40 7th edition standard compliance

Principle of Measurement

Non-Dispersive Infrared (NDIR) Principle

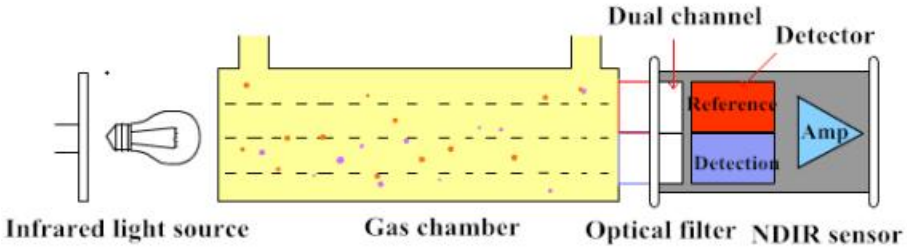
Molecule like CH2F2 (R32) and other hydrocarbon components have specified absorption spectrum in infrared range. When light wave corresponded to certain gas with absorption spectrum passes through measured gas, the intensity of light wave will be significantly weakened. The intensity attenuation is related to concentration of measured gas. This relation follows Lambert-Beer's Law.

I stands for light transmissivity, $I = I_0 e^{-kpl}$

i stands for light absorption intensity, $i = I_0 - I = I_0 (1 - e^{-kpl})$

I_0**:** incident light intensity
l: thickness of gaseous medium
p: gas concentration
k: absorption coefficient

AM4203-DR series NDIR refrigerant sensor is a dual-channel type with very high accuracy and good long-term stability. The basic principle of a dual-channel NDIR sensor is shown in the figure below:



The infrared light source radiates infrared light which passes through the measured gas in the optical path and narrow band filters, then reaches the infrared detector. By measuring the intensity of the infrared light arriving at the infrared detector, the concentration of the measured gas can be calculated.

Technical Specifications

AM4203-DR Refrigerant Sensor Technical Specifications		
Basic performance	**AM4203-DR**	**AM4203H-DR**
Detecting principle	NDIR (non-dispersive infrared) technology	
Measurement gas [1)]	R32/R454A/R454B/R454C/R290	
Measurement range [2)]	0~100% LFL	
Accuracy [3)]	±2.5% LFL (@15%~25%LFL,-30~60℃)	
Resolution	0.1% LFL	
Sampling frequency	1Hz	
Startup Time [4)]	≤10s	
Response time [5)]	T60≤30s	
Anti-condensation with heater [6)]	No	Yes
Protection level	IP54	
Output	RS485 + Relay Output [7)]	
Dimensions	100.4mm *74mm *27.3mm (pin is not included)	
Lifetime	>15years, fault alarm before EOL will report	
Certification	Certified by IEC 60335-2-40:2022 Ed.7 and UL 60335-2-40:2022 Ed. 4.	
Environmental conditions		
Working temperature	-30～70℃	
Storage temperature	-40～85℃	
Working humidity	0-95%RH (non-condensing)	0-100%RH
Electrical specifications		
Power supply	12~36V DC, ripple wave≤100mV; 18~36V AC / 47~63Hz	
Average Working Current [8)]	≤70mA @ 24V DC ≤100mA @ 24V AC, 50Hz	≤120mA @ 24V DC ≤170mA @ 24V AC, 50Hz
Peak Current [8)]	≤250mA @ 24V DC ≤850mA @ 24V AC, 50Hz	≤400mA @ 24V DC ≤950mA @ 24V AC, 50Hz

Remark:

1) For measurement of other refrigerant gases (R1234yf, R1234ze) please contact Cubic.

2) 100%LFL or 100%LEL at 25℃ for each measurement gas (%Vol):

Unit / Gas	R32	R454A	R454B	R454C	R290
LFL	14.4%	8.79%	11.49%	7.9%	/
LEL	/	/	/	/	2.1%

3) For range 0~14.9%LFL, the maximum error is ±3.7LFL%, for range 25.1%LFL to 50%LFL, the maximum error is ±15% of reading.

4) The sensor output is zero during 10s startup time.

5) At 25%LFL measurement gas environment.

6) A heater is used for anti-condensation function. (The test method is to move the sensor from 5℃ (95%RH) environment to 35℃ within 1 minute (condensing occurs). Under this condition, the heater is default on, and the sensor can keep stable and accurate measurement without influence of condensation.)

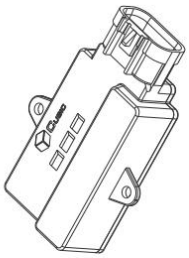
7) Two single-pole double-throw (SPDT) relays with normally open contacts (N.O.) and one normally closed contact (N.C.) are integrated into the sensor. (One of the SPDT's immovable end is used as a reserve.)Both relays will be de-energized during *Alarm State* (sensor unpowered or

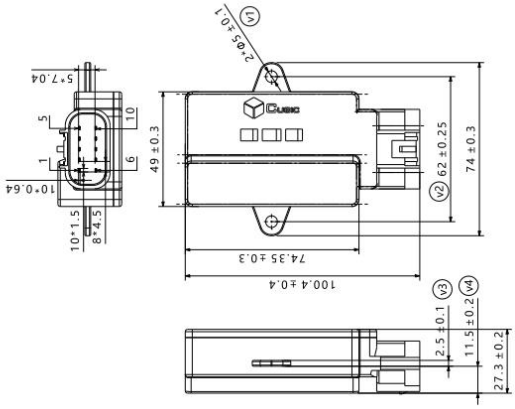
sensor fault or detected leak >= DTLV) and energized during *Non-Alarm State* (sensor powered and working normally and detected leak < DTLV).

8) The current is measured at room temperature condition, and it may also change on different devices or under high and low temperature conditions.

Appearance Size & Pin Definition

1. Appearance Size

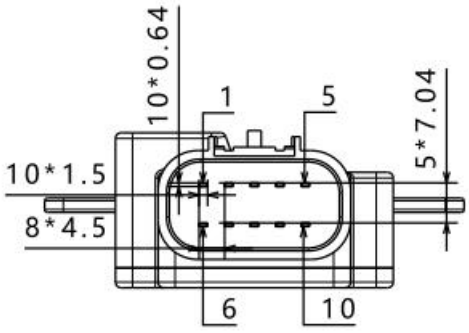




Notes:

1. *All dimensions in millimeters; dimensions without limits are nominal.*
2. *Body dimensional tolerances ±0.2 mm.*

2. Pin Definitions



Pin	Name	Description
1	VIN	Power supply port
2	NO-2	NO-2 relay normally open interface
3	COM-2	NO-2 relay com interface
4	NC-2	NO-2 relay normally closed interface
5	B	RS485-B
6	GND	Power ground
7	NO-1	NO-1 relay normally open interface
8	COM-1	NO-1 relay com interface
9	NC-1	NO-1 relay normally closed interface
10	A	RS485-A

Pin pitch	Pin size	Available mating connector
4.5mm	1.5mm	Sensor end: Delphi 15326847 Matching end connector model:Delphi 15326842

Note:

1. The user may also use other connectors based on the detailed dimension of sensor pin, as the figure above.
2. Cubic can provide mating connector with cable; the cable length is 200mm.

Precautions for Use

1. Rated working temperature: - 30℃ ~70℃, for temperature out of this range please contact Cubic.
2. Connecting cables shall be shielded ones with insulating sheath with shielding layer grounded.
3. Users should not replace the components of this product without the professional guidance to avoid any irreversible damage. If need any technical supports, please contact Cubic.
4. Power supply voltage to the sensor should be within the rated value. A power supply lower than the rated voltage may cause the sensor to malfunction, while higher may cause permanent damage to the sensor.
5. Voltage and current on the contacts should not exceed the rated value, otherwise it may cause damage to the relay or sensor.

Communication Protocol

1. Protocol Overview

The communication protocol uses the standard Modbus protocol in Modbus-RTU transmission mode. During the communication process, the sensor is always as a slave, responding to the master command sent by the host. The master communicates with the slave through RS-485 interfaces. The sensor can be communicated 3 seconds after powered on.

2. Serial Port Settings

Baud rate	Data Bit	Stop Bit	Parity	Flow Control
38400	8	1	None	None

3 Message Frame Format

Slave Device Address	Function Code	Data	CRC-16/MODEBUS
1 byte	1 byte	N bytes	2 bytes

3.1 Function Code

No.	Function Code	Operation	Description
1	0x03	Read holding registers	1 register includes 2 bytes
2	0x06	Write single register	1 register includes 2 bytes

3.2 Read Holding Registers(0x03)

Request		Response	
Field Name	**HEX**	**Field Name**	**HEX**
Slave Device Address	0x20~0x50	Slave Device Address	0x20~0x50
Function Code	0x03	Function Code	0x03
Starting Register Address High Byte	0x00~0xFF	Number of Data Bytes	0x00~0xFF
Starting Register Address Low Byte	0x00~0xFF	First Register Value High Byte	0x00~0xFF
Number of Registers High Byte	0x00~0xFF	First Register Value Low Byte	0x00~0xFF
Number of Registers Low Byte	0x00~0xFF	…	…
CRC Check Low Byte	0x00~0xFF	Last Register Value High Byte	0x00~0xFF
CRC Check High Byte	0x00~0xFF	Last Register Value Low Byte	0x00~0xFF
		CRC Check Low Byte	0x00~0xFF
		CRC Check High Byte	0x00~0xFF

3.3 Write Single Register(0x06)

Request		Response	
Field Name	**HEX**	**Description**	**HEX**
Slave Device Address	0x20~0x50	Slave Device Address	0x20~0x50
Function Code	0x06	Function Code	0x06
Register Address High Byte	0x00~0xFF	Register Address High Byte	0x00~0xFF
Register Address Low Byte	0x00~0xFF	Register Address Low Byte	0x00~0xFF
Register Value High Byte	0x00~0xFF	Register Value High Byte	0x00~0xFF
Register Value Low Byte	0x00~0xFF	Register Value Low Byte	0x00~0xFF
CRC Check Low Byte	0x00~0xFF	CRC Check Low Byte	0x00~0xFF
CRC Check High Byte	0x00~0xFF	CRC Check High Byte	0x00~0xFF

3.4 Detailed Register List

Register	*Units/Value = Description*	*Read/Write*	*Register size*	*Data Type*	*Data Format*	*Register Address (Hex)*
Percent LFL	% LFL (Multiplied by 100 to remove decimal)	READ ONLY	2 Bytes	Signed	Hex	0x00
Temperature	℃ (Multiplied by 100 to remove decimal)	READ ONLY	2 Bytes	Signed	Hex	0x01
Gas Type	R32: 0x01 R454B: 0x02 R454A: 0x03 R454C: 0x04 R290: 0x05	READ ONLY	2 Bytes	Unsigned	Hex	0x02
Slave Address	default: 0x20 Range: 0x20-0x50	READ/WRITE	2 Bytes	Unsigned	Hex	0x03
Alarm Value	default: 15%LFL Range :1-100	READ/WRITE	2 Bytes	Unsigned	Hex	0x04
Error Status	*See table of error status*	READ ONLY	2 Bytes	Unsigned	Hex	0x05
Software Version	ASCII code of software version	READ ONLY	6 Bytes	Unsigned	Hex	0x06 - 0x08
Serial Number	ASCII code of serial number	READ ONLY	16 Bytes	Unsigned	Hex	0x09 - 0x10
ABC Cycle	Default: 7, unit: days Range: 0-240 0 means ABC is off	READ/WRITE	2 Bytes	Unsigned	Hex	0x11
Operation Hours	Range:0x0-0xFFFFFFFF Unit: hours	READ ONLY	4 Bytes	Unsigned	Hex	0x12 - 0x13
Heater Switch	0x00: OFF 0x01: ON Default: 0x01 (ON)	READ/WRITE	2 Bytes	Unsigned	Hex	0x14

Table of error status:

Status byte	Definition	Note
0x00	Working normally	The sensor is working normally
0x01	Power supply abnormal	Power supply >36V DC or <12V DC, or > 36V AC or < 18V AC
0x02	Working temperature abnormal	Working temperature >70℃ or <-30℃
0x04	Preheating	The sensor is in preheating process (10s after power on)
0x08	Light source fault	The light source is not working normally
0x10	Original signal abnormal	Abnormal sensor measurement signal
0x20	Out of measurement range	Measured concentration is higher than 100% LEL
0x40	Heating function abnormal	Heating function is not available
0x80	Sensor life expiration	The sensor needs to be replaced

Note:

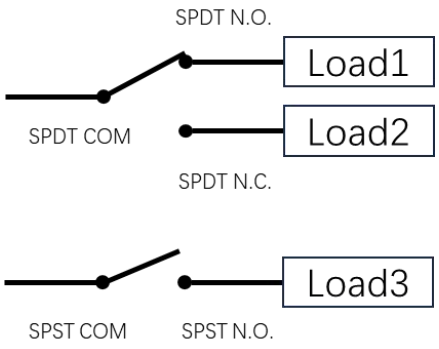
1. If a error format or nonexistent request is sent, the response is 208302.

4. Relay Information and Working Logic

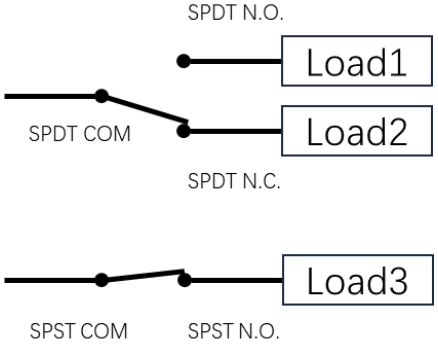
Type	Contact Rating	Electrical Endurance
Single-Pole Double-Throw	3A 250VAC / 3A 30VDC	10,000 operations
Single-Pole Single-Throw	3A 250VAC / 3A 30VDC	10,000 operations

Both relays will be de-energized during *Alarm State* (sensor unpowered or sensor fault or detected leak >= DTLV) and energized during *Non-Alarm State* (sensor powered and working normally and detected leak < DTLV).

Note: DTLV stands for "Detection Threshold Limit Value" and refers to "Alarm Value".

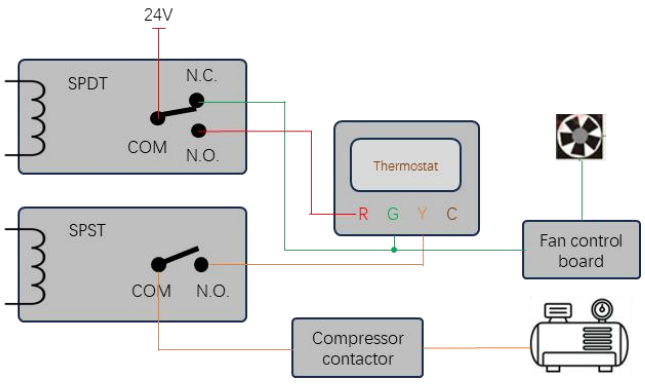


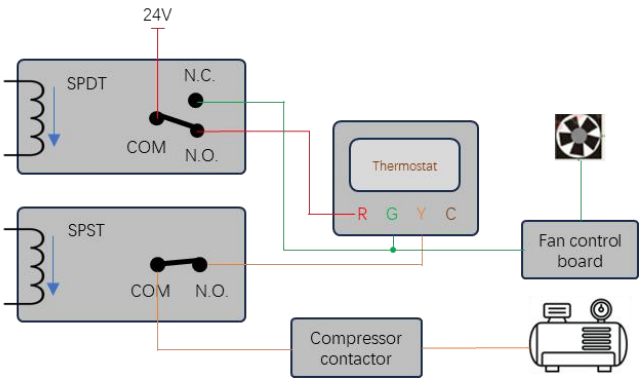
Relay de-energized during alarm state



Relay energized during non-alarm state

5. Reference Load Connection in a Heat Pump System





Alarm State

- SPDT relay and SPST relay are de-energized

SPDT Contact Actions

- SPDT N.C. close to energize G, fan starts operating
- SPDT N.O. open to cut-off 24V power supply to Thermostat

SPST Contact Actions

- SPST N.O. open to cut-off Y signal, compressor stops operating

Alarm Trigger Conditions

- Sensor unpowered, or
- Sensor fault, or
- Sensor detected leak >= DTLV (threshold value)

Non-Alarm State

- SPDT relay and SPST relay are energized

SPDT Contact Actions

- SPDT N.C. open to de-energize G, fan stops operating
- SPDT N.O. close to give 24V power supply to Thermostat

SPST Contact Actions

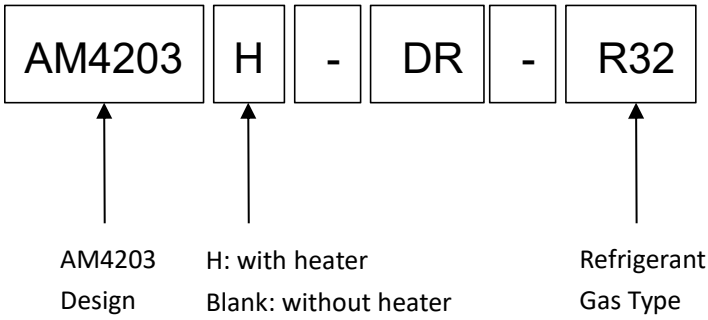
- SPST N.O. close to energize Y signal, compressor starts operating

Non-Alarm Trigger Conditions

- Sensor powered, and
- Sensor working normally, and
- Sensor detected leak < DTLV (threshold value)

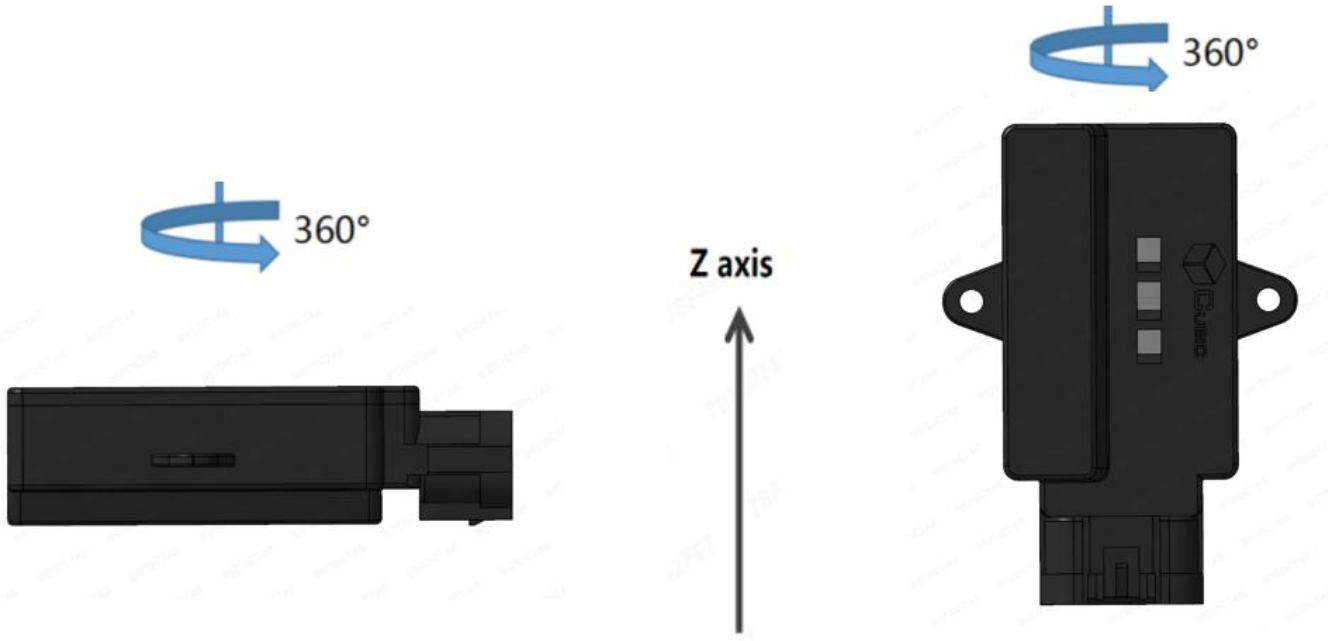
Note:
1.The current use of two SPDT can be compatible with the above scheme and one switch can be reserved for later use.

Product Code Instruction



Sensor Installation Instruction

The recommended installation method is shown in the figure below. The terminal connector facing down and the design of shutter can prevent the sensor from dust accumulation, greatly reduce the influence of the sensor measurement by dust accumulation, and prolong the service life of the sensor.



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