Flow Sensor

FR15

Version：1.2

Issue Date：2023-11-05

Zhengzhou Winsen Electronic Technology Co., Ltd

Statement

Thanks for purchasing our product. In order to let customers use it better and reduce the faults caused by misuse, please read the manual carefully and operate it correctly in accordance with the instructions. If users disobey the terms or remove, disassemble, change the components inside of the sensor, we shall not be responsible for the loss.

The specific such as color, appearance, sizes &etc, please in kind prevail.

We are devoting ourselves to products development and technical innovation, so we reserve the right to improve the products without notice. Please confirm it is the valid version before using this manual. At the same time, users' comments on optimized using way are welcome.

Please keep the manual properly, in order to get help if you have questions during the usage in the future.

Zhengzhou Winsen Electronics Technology CO., LTD

1.Profile：

The FR15 gas flow sensor is specially developed for the medical field. It uses the MEMS thermal principle to flow the vascular gas medium and is suitable for critical ventilators/transport ventilators, etc. The product integrates two types of MEMS flow and temperature sensitive components, and is equipped with gas medium mass flow and medium temperature measurement functions.

Reference Standards:

JJF1234-2018《Ventilator Calibration Specification》

YY9706.102-2021 《Medical electrical equipment》

GB/T 14710-2009《Environmental requirements and test methods for medical appliances》

ISO18562-2017《Biocompatibility assessment of respiratory airways in the medical field》

2. Features：

- ✧ High sensitivity, very low start-up flows;
- ✧ High response time;
- ✧ High accuracy and measurement repeatability;
- ✧ Wide range;
- ✧ Biocompatible gas connection material

3. Technical specifications

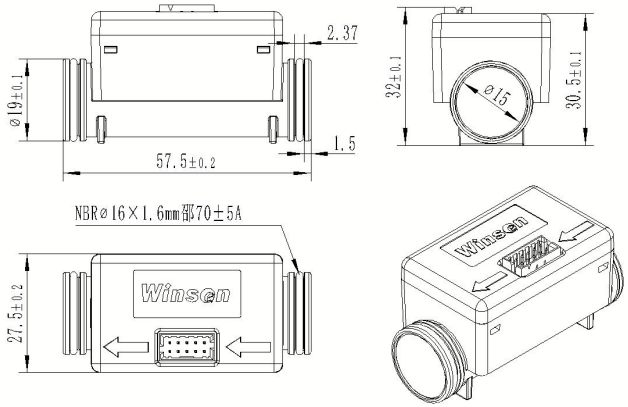
3.1 Technical parameters

Model No.		FR15
D		⌀15mm
Flow measurement	Maximum flow rate	240L/min @20℃ 101.325kPa
	Measurement accuracy	9L/min ~ 240L/min ±2.5% 0 ~ 9L/min ±0.5%FS
	Repeatability	0.5%
	Working temperature	70kPa ~ 107kPa
	Burst pressure	≥0.7MPa
	Working temperature	5℃ ~ 55℃
Temperature measurement	Measurement range	- 20℃ ~ + 80℃
	Measurement accuracy	0℃ ~ 80℃ ±2.5℃
		- 20℃ ~ 0℃ ±4℃
Output signal	Output method	Digital IIC and linear analogue voltage
	IIC communication rate	400kHz
	Digital Signal Refresh Time	≤1ms
	Analogue flow	linearity 0.25V ~ 2V
	Analogue temperature	linearity 0.25V ~ 2V
	Signal Response Time T_{10} ~ T_{90}	≤3ms
Electrical parameters	Working voltage	5 V ~ 14V
	Rated power	< 0.3W
	Electrical interface	Sensor: Molex 87831-1041 Lead wire: Molex 87832-1010
Others	Storage temperature	-20℃ ~ 80℃
	Pressure losses	< 1800Pa @200L/min 101.325kPa
	Measuring medium	Dry, clean, non-corrosive gases
	Weight	22g±1g

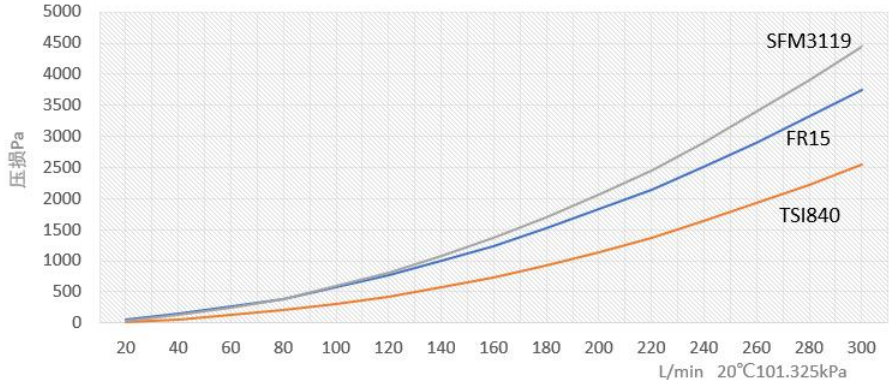
* The default flow sensor of our company adopts 20℃ 101.325kPa, air calibration, and the production conditions are temperature 22 ± 2 ℃, purified, (30%~35%) RH environment. If the user has special requirements, it will be calibrated according to the customer's requirements.

*- %FS refers to full scale accuracy, % is reading accuracy.

3.2 Structural parameters

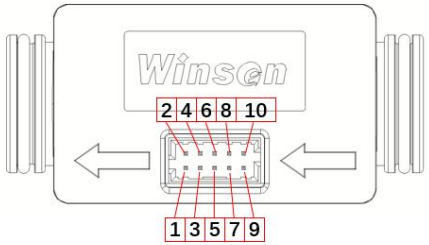


3.3Flow and pressure loss curves



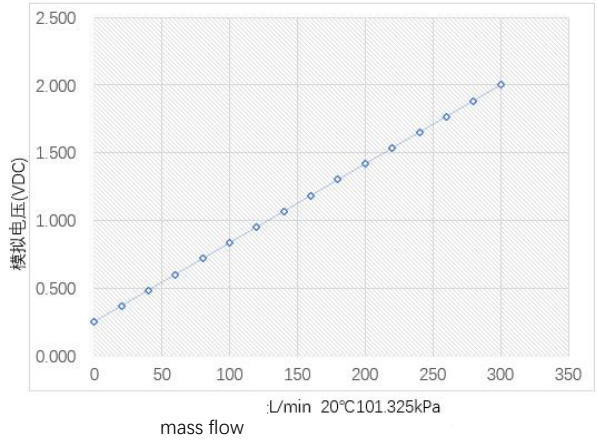
3.4 Interface definition

The built-in connector of the sensor is Molex 87831-1041, and the specific signals are defined in the table below:



PIN1	V(Flow)	PIN2	GND
PIN3	V(Temp)	PIN4	GND
PIN5	IIC_SCL	PIN6	IIC_SDA
PIN7	NC	PIN8	VCC
PIN9	GND	PIN10	NC

3.5Analogue signal output and calculation



4 IIC Communications

4.1 IIC Connections

This sensor adopts the standard IIC communication protocol, using the serial data bus (SDA) and serial time bus (SCL). The recommended pull-up resistor is 4.7kΩ.

4.2 IIC address

The default address is 0x40, followed by 1 bit of read (1) or write (0) data bit.

4.3 IIC communications

Transmission start signal (S) - When the clock line SCL is high, the data line SDA has a falling edge from high to low.

Transmission stop signal (P) - When the clock line SCL is high, the data line SDA has a rising edge from low to high.

Acknowledge (ACK) - SCL sends a positive pulse while SDA is low.

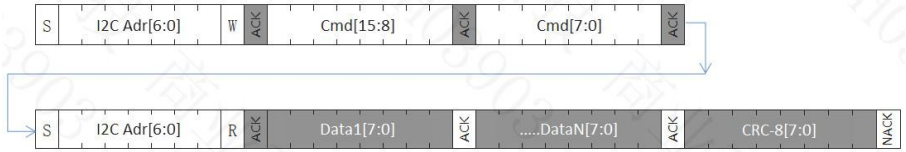
Non-Acknowledge (NACK) - SCL sends a positive pulse while SDA is high.

4.4 Command set and data transfer sequence

Command code	Return/Write Number of bytes (bytes)	Command description	Remark
0x1000	5	traffic collection	read instantaneous flow value

4.5 Communication timing

4.5.1 Flow rate collection



Datasheets:

Data1	Current flow rate Measured value	HEX, High byte first
Data2		
Data3	Current temperature Measured value	HEX, High byte first
Data4		
Data5	CRC-8	Calibration value

Conversion factor table:

Medium Type	Conversion factor	Offset
Air	140	20000
Oxidation	142	20000
Other gas		

4.5.2Digital Flow Calculation:

$$\text{Flow rate(L/min)} = \frac{\text{Flow measurement value} - \text{offset}}{Conversion\ factor}$$

4.5.3Digital temperature calculation:

T(℃)= ((Data3*256+Data4)-500) /10

4.6 CRC check

CRC check uses CRC-8, the initial value is 0x00, The polynomial is0x131(x8 + x5 + x4 + 1), The sample code is as follows:

```
//*************************************
//function name: Calc_CRC8
//functionality : CRC8 calculate, initial value: 0x00, polynomial: 0x131(x8 + x5 + x4 + 1)
//parametric : unsigned char *data: CRC Checking array pointers
//           unsigned char num: CRC Check Data Length
//return : crc: calculated CRC8 value
unsigned char Calc_CRC8(unsigned char *data, unsigned char num)
{
  unsigned char bit,byte,crc = 0x00;
    for(byte = 0; byte < num; byte++)
  {
    crc ^= data[byte];
    for(bit = 8; bit > 0; --bit)
    {
      if(crc & 0x80)
          crc = (crc << 1)^0x131;
        else
          crc = (crc << 1);
}
```

```
        }
        return crc;
    }
```

5. Install and use

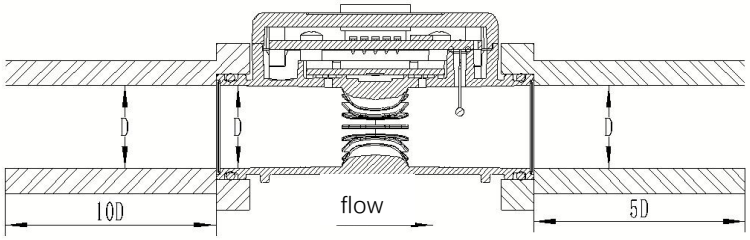
Due to the low pressure drop across the sensor, the flow is not fully regulated by the sensor itself. The piping leading to the sensor will also affect the airflow distribution through the sensor, and the measurement results will be affected accordingly. In order to obtain the best measurement performance, it is recommended to configure laminar flow as much as possible. Details as follows:

5.1 The gas used must be purified to avoid dust, liquid, and oil. If necessary, a filter device can be installed in the air inlet end of the gas path.

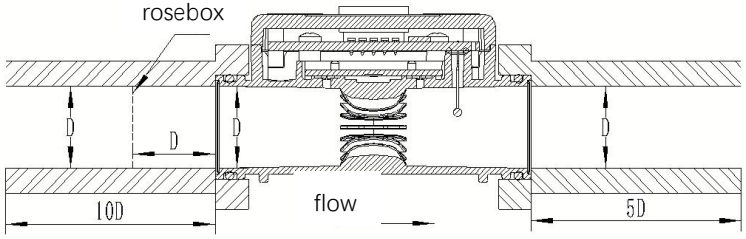
5.2 The operating pressure of the medium should not exceed 2 times the maximum operating pressure of the product.

5.3 In order to ensure the measurement accuracy of the sensor in the application scenario, it is recommended to install it as follows.

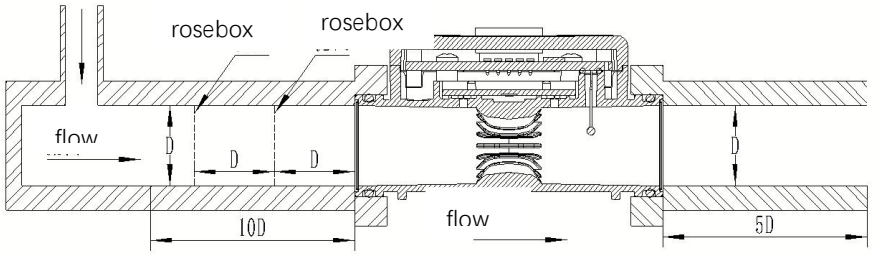
5.3.1 For silicone hose connections: For silicone hoses with an internal diameter of ⌀ 15, it is recommended that the inlet end be connected to a rigid adapter tube as shown in the diagram



5.3.2 For occasions where the installation space is insufficient, rectification measures or filters can be added inside the rigid piping at the inlet end as shown in the diagram to adjust the airflow distribution, applicable to fan-driven pipe network



5.3.3 For ventilators and other compact space occasions, the structure of the airway at the inlet end can be adjusted as shown in the diagram to adjust the airflow distribution



6.Fault Diagnosis

6.1 Preliminary inspection

6.1.1 Check the opening of air source and inlet.

6.1.2 Ensure the correct connection of communication lines.

6.1.3 Check whether the medium pressure and ambient temperature meet the product technical indicators.

6.2Troubleshooting

No	Fault phenomenon	Possible reasons	processing method
1	No signal output or non-zero fixed output when not ventilated	Sensor damage	Repair
		Wire sequence error	Check that the terminals are plugged in correctly
2	No signal change during ventilation	Sensors reversed	Replacement of mounting direction
		Wire sequence error	Check that the terminals are plugged in correctly
		Sensor damage	Repair
3	The sensor responds normally during aeration, but shows a specific pattern of deviation from the reference meter.	Inconsistent reference standards	Troubleshooting and converting units of measure used by reference instruments and sensors
	The sensor reacts normally during aeration, the signal has a large irregular beat, but the average value of the sampled signal is close to that of the reference instrument over a period of time.	Turbulence in installation piping	Increase the signal integration time Or refer to 5.3 Optimising pipework
	Sensor responds normally during aeration, but with large negative deviations	Jet stream in line to sensor	Refer to 5.3.3 Optimisation of pipework Or ask the manufacturer to analyse the solution together
	The sensor reacts normally during aeration, the signal jumps in a specific pattern, but the average value of the sampled signal is close to that of the reference instrument over a period of time	Periodic pulsation in airflow	Increase the signal integration time Or refer to 5.3 to adjust the rectification (e.g. increase the number of screen layers or mesh)

7.Disclaimer

Our company is not responsible for the damage caused by the following circumstances:

- Natural disasters.
- Misoperation or unreasonable use.
- Operate or store in unsuitable or harsh environment.
- Unauthorized modification or disassembly of products.
- Violent means lead to product damage.