# **AS200 Datasheet**

# **Gas Mass Flow Controller**

- Support digital signals, 1~5V analog signals, and 4~20mA analog signals
- Use a single power supply  $(+15 \sim +24 \text{VDC})$
- Support automatic alarm, multi-gas multi-range and other functions

# **Product Summary**

AS200 series gas mass flow controller is suitable for a variety of conventional gases, improving the accuracy and reliability of gas mass flow control measurement results. The repeatability is as high as  $\pm 0.2\%$ F.S.; the low leakage rate of 1×10-10 Pa·m3/sec He and good air tightness ensure production safety; it can support a variety of signal outputs, including digital signals, 1~5V analog signals and 4~20mA analog signal, can use a single power supply (+15~+24 VDC), suitable for different working scenarios; the standard open communication protocol facilitates customers to develop their own control and acquisition software; at the same time, the product also provides powerful Free client PC software to facilitate user debugging operations.

AS200 series products are developed by Aosong Electronic using advanced MEMS technology. Aosong adopts unique technologies in many aspects such as sensor driving, zero-point drift control and valve control, ensuring the high performance, high quality and high reliability. AS200 is a highquality instrument with good stability, high precision, low leakage rate and high pressure resistance.

# Applications

AS200 series gas mass flow controller (MFC) is mainly used for precise control and measurement of gas mass flow. It has important application in scientific research and production in various fields such as semiconductor integrated circuit technology, special materials, chemical industry, petroleum industry, medicine, environmental protection and vacuum. Its typical applications include: integrated circuit process equipment, such as epitaxy, diffusion, plasma etching, sputtering, ion implantation and various CVD equipment; other industry equipment, such as optical fiber melting, micro-reactors, gas mixing and distribution systems , gas sampling devices, capillary measuring instruments, gas chromatographs and other analytical instruments, etc.



Figure 1. AS200 mass flow controller

# **1. Product Description**

#### 1.1 Statement

This manual has been carefully reviewed, but there is no guarantee that it does not contain errors or omissions. The manufacturer does not assume any responsibility for errors or omissions, nor does it assume any responsibility for losses caused by the use of the information in this manual.

#### **1.2 Instructions for use**

This manual describes in detail the necessary matters for the correct and safe use of this series of products.

Product users please read this manual carefully and understand it before use. During use, please pay attention to the text with the mark and all contents contained in the precautions.  $\triangle \bigcirc$ 

The company reserves the right not to assume liability for property damage or personal injury caused by failure to follow the user manual. This manual is essential for your installation, maintenance and troubleshooting. Please keep it properly.

#### **1.3 Safety precautions**

Please read the following precautions in conjunction with the user manual. Our company will not be responsible for any consequences arising from failure to operate in accordance with the precautions.

a) Please do not replace or modify products and parts

Do not substitute any part of the product or make any unauthorized modifications to the product. The safety label must be kept intact when returning it to the factory for re-calibration or repair.

b) Please contact professional staff to serve you

Do not replace parts without authorization during use. Any technical support must be provided by professional technicians authorized by our company.

c) Please pay special attention when using dangerous gases

If hazardous gases are used, please take precautions and flush the product completely if conditions permit. If the hazardous gas is moist, make sure that the moist hazardous gas does not react chemically with the product and sealing materials.

d) Pay special attention when purging the product

Before removing the product from the gas line and after installing the product, the entire system must be purged, and dry gas must be used to purge the remaining gas residue in the channel.

e) Please follow the appropriate steps for purging

The product must be purged under a ventilation hood and the operator must wear gloves for protection.

f) Do not use this product in explosive environments

To avoid an explosion, do not use this product in explosive environments unless the product has valid certification.

g) Please use appropriate connectors and operate in accordance with relevant tightening procedures The external connectors connected to the product must match the connectors used in the product. When tightening the connectors, please follow the operating instructions in the product manual.

h) Please check whether there is air leakage at the product jointPlease carefully check all component connections to ensure there are no air leaks after installation.

i) Please make the product work under safe inlet pressure

Do not allow the inlet pressure of the product to exceed the maximum working pressure (see maximum working pressure in the product instructions)

j) Please keep the entire system away from contamination

Do not use gas containing pollutants while the system is running. For example, the gas contains dust, dirt, fibers, glass fragments or iron filings.

k) Please preheat the product before use

Please preheat before use, especially dangerous gases, you should pay more attention to it. Please use an absolutely closed valve to ensure there is no false flow during preheating.

Model	AS200A		
Valve type	Normally closed		
Measure range (N <sub>2</sub> )	(100, 200)SCCM (0 ~ 3, 5, 10, 20, 30, 50)SLM		
Accuracy	±1.0% S.P.(≥35%F.S.) ±0.35% F.S.(<35% F.S.)		
Linearity	±0.5% F.S.		
Repeat accuracy	±0.2% F.S.		
Response time	lsec		
Working pressure difference range	0.05 ~ 0.35MPa (0 < flow range≤10SLM) 0.1 ~ 0.35MPa (10 < flow range≤30SLM) 0.2 ~ 0.45MPa (30 < flow range≤50SLM)		
Max work pressure	0.45MPa		
Temperature Coefficient	Zero: ≤±0.05% F.S./°C ; Span: ≤±0.1% F.S./°C Flow range ≤30SLM Span: ≤±0.2% F.S./°C Flow range >30SLM		
Compressive strength	3MPa		
Leak rate	$1 \times 10^{-10} \text{ Pa} \cdot \text{m}^3/\text{sec He}$		
Sealing material	fluororubber		
Working temperature	5 ~ 45°C		
Input signal	Digital: RS485 or EtherCAT Analog:1 ~ 5 VDC or 4 ~ 20 mA		
Output signal	Digital: RS485 or EtherCAT Analog:1 ~ 5 VDC or 4 ~ 20 mA		

#### **1.4 Technical Parameter**

Zero drift	< 0.6%F.S. per year without autozero			
Power supply	+15 ~ +24VDC (unipolar)			
Surface chemical composition	Normal			
Surface roughness	25Ra			
Standard connector	Double ferrule $\varphi$ ; Double ferrule 1/4"; Double ferrule 3/8"; VCR1/4" male connector; Double ferrule $\varphi$ 3; Double ferrule 1/8"; VCR1/4"; $\varphi$ 6 (inner) x1 hose connector; $\varphi$ 5 (inner) x1.5 hose connector; $\varphi$ 4 (inner) x1 hose connector; double ferrule $\varphi$ 10mm; A-type sealing joint;			
Power connector	9 pin male sub-D, EtherCAT			
Weight	around 0.95Kg			

Note:

MFC is usually calibrated with nitrogen (N2) before leaving the factory. The unit of mass flow rate is specified as: SCCM (standard ml/min); SLM (Standard Liter/Min); The standard status is specified as: Temperature - 273.15K (0°C); Air pressure—101325Pa (760mm Hg) The unit SCCM is the same as "mL/min, 0°C, 1atm", and the unit SLM is the same as "L/min, 0°C, 1atm". F. S.(Full Scale): Full scale value; S.P.(Set Point): Set point value

#### **1.5** Calibration

AS200 series can be calibrated according to user requirements. If the user does not explain the working conditions and other information, it will be calibrated according to the standard conditions.

#### **1.5.1 Standard status**

Outlet pressure: atmospheric pressure

Gas mass flow is usually expressed as volume flow under standard conditions, and the mass flow units are SCCM and SLM.

Under the standard state, the density of the gas is a constant. The density multiplied by the volume under the standard state is the mass number, so the volume flow rate under the standard state is equal to the mass flow rate.

The standard installation position of MFC is horizontal installation. To ensure the highest measurement accuracy, users should indicate the installation method of the equipment when purchasing.

### 1.5.2 Accuracy adjustment

After the AS200 manufactured, it must be copied on the corresponding calibration bench for 24 hours, and then accurately calibrated. Indicators such as accuracy, dynamic response, and stability of pressure changes must be inspected twice and must be passed before leaving the factory.

#### 2. Installation

#### 2.1 Overview

WARNING: Toxic, corrosive or flammable or explosive gases must be handled with extreme caution. After the MFC is installed, the entire gas circuit should be thoroughly inspected to ensure there are no gas leaks. Before introducing corrosive gas, dry inert gas should be passed for one hour to clean the MFC.

IMPORTANT NOTE: When installing the MFC, make sure the arrows shown on the product channels are in the same direction as the gas flow through the product.

#### 2.2 Unpacking

AS200 series products are packed in clean vacuum bags. The outer plastic bag should be removed before entering the clean room. In order to reduce pollution, the inner clean bag should be removed in a clean environment.

# 2.3 Mechanical installation

#### 2.3.1 Overview

In most applications, it is necessary to install a shut-off valve in the gas line. The trapped pressurized gas between the stop valve and MFC will produce a cleaning effect. The user should decide the installation position of the stop valve (upstream or downstream) according to the situation. To prevent contamination, it is recommended that you install a filter in the pipeline upstream of the product.

The installation position of AS200 series products should be consistent with the installation position you requested when ordering. The air should be dry and clean. External impact or vibration should be avoided during installation. The product appearance is shown in Figure 2-1. Figures 2-2 and 2-3 show the dimensions of different connectors (double ferrule 1/4"; VCR 1/4" male connector). Before installation, do not remove the protective caps on the connectors at both ends until you actually

#### install the MFC.



Figure 2-1. AS200 photo



Figure 2-2. 2- 1/4" product dimensions



Figure 2-3. VCR1/4" male connector version dimension

#### Note<sup>(1)</sup>:

The height of 115mm in Figure 2-2 is the height without the cable plug. After adding the plug, the height will increase by about 50mm.

#### **2.3.2 Installation**

Correctly connect the MFC to the pipeline according to the direction of air inlet and outlet. The connectors for the following installation methods need to be purchased by the user.

#### 2.3.2.1 1/4" VCR connector installation method

There are two types of VCR washers: non-positioning VCR washers and positioning VCR washers. The installation of the 1/4" VCR connector is shown in Figure 2-4 and Figure 2-5. When using a non-positioning VCR washer, put the washer into the female nut; when using a positioning VCR washer, fix the washer in The raised joint. First tighten the nut and joint by hand, then use double wrenches. Use one wrench to hold the joint still, and use the other wrench to rotate the nut. It is required to use the wrench to rotate 1/8 to 1/4. lock up.



Figure 2-4. Installation of VCR connector without positioning VCR gasket



Figure 2-5 VCR connector installation with VCR gasket positioned

#### 2.3.2.2 Two ferrule installation

The installation method of the double ferrule is shown in Figure 2-6. After installing the front ferrule, rear ferrule and nut, first tighten the nut and the joint by hand, and then tighten with a wrench (double ferrule joints imported from abroad require Turn the wrench 1.25 turns to tighten) to ensure no air leakage. Note that double wrenches should be used. Use one wrench to hold the joint stationary, and use the other wrench to rotate the nut. Especially when disassembling the nozzle, double wrenches must be used, otherwise the joint will loosen and affect the seal.



Figure 2-6 Two ferrule installation

# **2.4 Electrical installation**

#### 2.4.1 Overview

AS200 series products adopt switching power supply mode and can support dual power supply ( $\pm$  15VDC) or single power supply ( $\pm$ 15~ $\pm$ 24VDC). Customers can choose according to their needs.

The electrical connectors of AS200 series products use D-type male connectors and EtherCAT connectors. The D-type connector has 9 pins. The 9-pin connector is a SEMI standard type and only supports 1~5V analog voltage setting and 1~5V analog voltage output. Customers choose according to their needs when purchasing products.

AS200 series products support RS485 serial communication and EtherCAT protocol. Users can use RS485 cables or corresponding adapters to connect to computers.

#### 2.4.2 Connection

Figure 2-7, Figure 2-8, and Figure 2-9 show the connection diagram of the 9-pin D-type male connector, RS485 port, and EtherCAT product communication interface of the AS200 MFC.





1, TX+ 2, TX- 3, RX+ 6, RX-

Figure 2-9. EtherCAT product RJ45 connector connection

#### **3. Product function introduction**

#### 3.1 Overview

AS200 series products are products developed by Aosong Electronic using the most advanced MEMS technology. Unique technologies are used in many aspects such as sensor driving, zero-point drift control and valve control, ensuring the high performance, high quality and high reliability of the product.

#### **3.2 Control method**

AS200 series products are compatible with digital analog control methods. Customers can choose the control signal method according to their needs. The products support digital control, 1~5V voltage control and 4~20mA or 0~20mA current control. When the customer selects one of the control signals, the other two control signals will be automatically blocked by the system. The flow detection signal is digitally sent out with 1~5V voltage and 4~20mA or 0~20mA current without affecting each other.

### 3.3 Zero adjustment

Customers can correct the zero drift of the flow meter through zero adjustment. Before zeroing, the customer needs to first confirm that no gas passes through the product, and then perform the zeroing operation through software commands or the zeroing button. If the zeroing button is used, confirm that the zeroing button is pressed for more than 5 seconds until the green LED indicator light flashes. , to release. After the zeroing process is completed, the green LED indicator light will stop flashing.

#### 3.4 Valve control

AS200 series products support direct closing or opening of the MFC's solenoid regulating valve through digital communication or analog voltage. For more details, please refer to the official website: <u>www.aosong.com.</u>

#### 3.5 Valve types

AS200 series MFC solenoid control valve normally closed valve type. When the normally closed MFC is not powered on, the solenoid valve is closed.

#### **3.6 Accumulated traffic**

AS200 series products can record and output the accumulated value of gas flow through MFC. The units of cumulative values are standard milliliters (SCC). For example, if the cumulative value reads 3000, it means that the gas passing through the MFC has accumulated to 3000 standard milliliters (SCC).

#### 4. Product Maintenance

#### 4.1 Overview

There is no need for daily maintenance of the MFC, only occasional cleaning and recalibration. If the controller is supplied with ultra-clean and non-corrosive gas, it should be cleaned and recalibrated after 3 or 4 years. If the controller is supplied with low cleanliness gas or a corrosive gas, it should be cleaned and recalibrated after 1 or 2 years.

#### 4.2 Precautions<sup>▲</sup>

#### 4.2.1 Media usage requirements

The gas used must be purified, and dust, liquid and oil must be avoided. If necessary, a filter, etc. must be installed in the gas line. If the flow controller outlet is connected to a liquid source, a one-way valve should be installed at the flow controller outlet to prevent liquid backflow from damaging the product.

#### Warning:

For products that use corrosive or toxic or flammable gases, the airtightness of installation and connections should be strictly ensured and tested before use. If it needs to be removed from the system, dry human body fluids should be used before disconnecting the gas line. Use harmless conventional gases (such as nitrogen, air) or inert gases to thoroughly clean the product. Failure to clean may cause fire, explosion, poisoning and other accidents, resulting in casualties.

#### 4.2.2 Valve sealing problem

The solenoid valve of MFC is a regulating valve, not a stop valve, and cannot be used as a stop valve. If necessary, the user should install a separate stop valve. Especially if users use dangerous gases, they should usually add a stop valve to the MFC's air inlet and outlet to ensure work safety. The internal air leakage rate of the MFC valve port is within 1% F.S., which is normal.

### 5. Malfunction check

#### 5.1 Initial inspection

- Check whether the air source and the air path to the MFC are open.
- Ensure that power and control signals are properly routed to the electrical connectors on the circuit board.
- Check whether the communication cable is connected correctly.

NO.	Malfunction	Possible reasons	Measures	
	When there is no ventilation, the displayed value is not	still have flow	Check whether the stop valve is closed	
1		Zero drift	Use the autozero function	
	zero.	Others	Pls contact manufacturer	
		The air connection is incorrect	Check whether the MFC is correctly connected to the gas line	
		The pressure difference is not within the required range	Check pressure	
		MFC work in other mode	Use software to check and change control modes	
		Power problem	Check whether the power supply and power connection are correct	
2	Flow can't be controlled	The setting signal is incorrect	Check the set voltage or current signal	
		MFC is polluted	Pls contact manufacturer	
		sensor issue	Pls contact manufacturer	
		PCB issue	Pls contact manufacturer	
		Value issue	Pls contact manufacturer	
3 No	No communication	Power issue	Check whether the power supply and power connection are correct	
		Communication issue	Check whether the communication cable is connected correctly	
		Address conflict	Check whether the MFC's address conflicts with other MFCs	
		The baud rate setting is incorrect	Check the baud rate setting of the MFC	
		PCB issue	Pls contact manufacturer	

#### Appendix I Product serial number description





-[TT]φ4(inner)x1 soft tube connector(type A, full scale≤30SLM) -[XX] special connector ref to [d] [s] - Seal material -[V] fluororubber [m] - installation -[H] Horizontal -[E] Lay flat -[U] Install the air inlet upward vertically -[D] The air inlet is installed vertically downward
[d] – Others -[] Factory default: cover and label text: English Work differential pressure range: $(0.05 \sim 0.35)$ MPa $(7.3 \sim 50.8 \text{ psid})$ (FLOW≤10SLM) $(0.1 \sim 0.35)$ MPa $(14.5 \sim 50.8 \text{ psid})$ (0.1 ~ 0.35) MPa $(14.5 \sim 50.8 \text{ psid})$ $(0.2 \sim 0.45)$ MPa $(29.0 \sim 65.3 \text{ psid})$ (30SLM < FLOW) AS200-AXXN : < 0.02MPa (2.9psid) Compressive strength:3MPa (435. 1psig) Calibration temperature: $(22 \pm 3)$ °C Valve control signal: Valve control mode is 2 Power supply: +24V single power supply Control mode: DeviceNet products default to digital mode; ProfiBus products default to ProfiBus mode; the rest are analog voltage modes
<ul> <li>-[S] special requirements:</li> <li>For example: input and output signals: 4 ~ 20mA;</li> <li>Please indicate the proportion of mixed gas: N2 (60%) +CO2 (40%)</li> <li>Working pressure difference range: (0.3 ~ 0.5) MPa</li> <li>Calibration temperature: 40°C</li> <li>Cover and label text: Chinese</li> <li>Valve control signal: Valve control mode is 0</li> <li>Power supply: ± 15V power supply</li> <li>Control mode: ProfiBus product analog voltage mode</li> <li>Other special requirements.</li> <li>For example:</li> <li>AS200 A 013 C 500C D GG V H S</li> </ul>
Type: AS200 Model: Rubber seal Gas: N <sub>2</sub> Valve:Normally closed valve Full scale Range: 500SCCM Communication:DB15 pin Air inlet and outlet interface: Two ferrules $\varphi$ 6mm Sealing: fluorine rubber Installation: horizontal Special requirements: such as Chinese, working pressure difference (0.05~0.3)MPa, special joints (with drawings)Fill in the special calibration temperature 40°C, current setting and other requirements.

Gas		Gas code (SEMIE52-0302)	Specific heat (cal/g°C)	Density (g/L 0°C)	Conversion factor
Air	Air	8	0.24	1.293	1.001
Ar	Argon	4	0.125	1.784	1.42
AsH <sub>3</sub>	Arsane	35	0.117	3.478	0.673
BBr <sub>3</sub>	Boron tribromide	79	0.065	11.18	0.378
BCl <sub>3</sub>	Boron trichloride	70	0.122	5.227	0.45
BF <sub>3</sub>	Boron trifluoride	48	0.178	3.025	0.508
B <sub>2</sub> H <sub>6</sub>	Borane	58	0.502	1.235	0.441
CCl <sub>4</sub>	carbon tetrachloride	101	0.13	6.86	0.306
CF4	Carbon tetrafluoride	63	0.166	3.964	0.42
CH <sub>4</sub>	Methane	28	0.532	0.715	0.722
C <sub>2</sub> H <sub>2</sub>	acetylene	42	0.405	1.162	0.596
C <sub>2</sub> H <sub>4</sub>	Ethylene	38	0.366	1.251	0.597
C <sub>2</sub> H <sub>6</sub>	Ethane	54	0.424	1.342	0.482
C <sub>3</sub> H <sub>4</sub>	propyne	68	0.363	1.787	0.421
C <sub>3</sub> H <sub>6</sub>	Acrylic	69	0.366	1.877	0.411
C <sub>3</sub> H <sub>8</sub>	propane	89	0.399	1.967	0.358
C <sub>4</sub> H <sub>6</sub>	Butyne	93	0.352	2.413	0.322
C <sub>4</sub> H <sub>8</sub>	Butene	104	0.372	2.503	0.299
C4H10	Butane	117	0.404	2.65	0.261
C <sub>5</sub> H <sub>12</sub>	Pentane	240	0.392	3.219	0.217
CH <sub>3</sub> OH	Methanol	176	0.328	1.43	0.584
C <sub>2</sub> H <sub>6</sub> O	ethanol	136	0.34	2.055	0.392
C <sub>2</sub> H <sub>3</sub> Cl 3	Trichloroethan e	112	0.165	5.95	0.278
СО	carbon monoxide	9	0.249	1.25	1
CO <sub>2</sub>	carbon dioxide	25	0.202	1.964	0.739
$C_2N_2$	Cyanide gas	59	0.261	2.322	0.451
Cl <sub>2</sub>	Chlorine	19	0.115	3.163	0.858
D <sub>2</sub>	Deuterium	14	1.733	0.18	0.997
F <sub>2</sub>	Fluorine gas	18	0.197	1.695	0.931
GeC <sub>14</sub>	Germanium tetrachloride	113	0.107	9.565	0.267

# **Appendix II Common Gas Conversion Coefficients**

Gas		Gas code (SEMIE52-0302)	Specific heat (cal/g°C)	Density (g/L 0°C)	Conversion factor
GeH <sub>4</sub>	germane	43	0.141	3.418	0.57
H <sub>2</sub>	hydrogen	7	3.422	0.09	1.01
HBr	hydrogen bromide	10	0.086	3.61	0.999
HCl	hydrogen chloride	11	0.191	1.627	0.988
HF	hydrogen fluoride	12	0.348	0.893	1.001
HI	hydrogen iodide	17	0.055	5.707	1
H <sub>2</sub> S	hydrogen sulfide	22	0.228	1.52	0.802
Не	Helium	1	1.242	0.179	1.42
Kr	krypton gas	5	0.059	3.739	1.431
N2	Nitrogen	13	0.249	1.25	1
Ne	Neon	2	0.246	0.9	1.431
NH <sub>3</sub>	Ammonia	29	0.501	0.76	0.719
NO	Nitric oxide	16	0.238	1.339	0.978
NO2	nitrogen dioxide	26	0.192	2.052	0.737
N2O	nitrous oxide	27	0.21	1.964	0.71
O <sub>2</sub>	oxygen	15	0.22	1.427	0.981
PCl <sub>3</sub>	Phosphorus trichloride	193	0.125	6.127	0.358
PH3	Phosphane	31	0.261	1.517	0.69
PF5	Phosphorus pentafluorid e	143	0.161	5.62	0.302
POCl <sub>3</sub>	Phosphorus oxychloride	102	0.132	6.845	0.302
SiCl <sub>4</sub>	Silicon tetrachlorid e	108	0.127	7.585	0.284
SiF4	silicon tetrafluoride	88	0.169	4.643	0.348
SiH4	Silane	39	0.319	1.433	0.6
SiH <sub>2</sub> Cl <sub>2</sub>	Dichlorosila ne	67	0.147	4.506	0.416
SiHCl <sub>3</sub>	Trichlorosil ane	147	0.133	6.043	0.34
SF <sub>6</sub>	Sulfur hexafluorid e	110	0.159	6.516	0.258
$SO_2$	sulfur dioxide	32	0.149	2.858	0.687

TiCl <sub>4</sub>	Titanium tetrachlorid e	114	0.157	8.465	0.206
WF <sub>6</sub>	Tungsten hexafluorid e	121	0.096	13.29	0.217
Xe	xenon	6	0.038	5.858	1.431

Note: Instructions for using conversion coefficients

MFC is generally calibrated with N2 when it leaves the factory. If it is other gases in actual use, the reading can be corrected if necessary by multiplying the flow rate displayed by the flow indicator by the flow conversion coefficient. If it is a single-component gas, its conversion coefficient can be found in our product technical specifications; if it is a multi-component gas (assumed to be composed of n gases), please calculate its conversion coefficient C according to the following formula:

Basic formula: C=0.3106 N /  $\rho$  (Cp)

Among them:  $\rho$  ——the density of gas under standard state

CP——the constant pressure specific heat of the gas

N----- the gas molecule composition coefficient (related to the components of the gas molecule, see the

table below)

Gas molecule composition coefficient table:

Gas molecules	Example		N value
single atomic molecule	Ar	He	1.01
diatomic molecule	СО	$N_2$	1.00
triatomic molecule	CO <sub>2</sub>	NO <sub>2</sub>	0.94
polyatomic molecules	NH <sub>3</sub>	$C_4H_8$	0.88

Mix gas:  $N = N_1(\omega_1/\omega_T) + N_2(\omega_2/\omega_T) + \dots + N_n(\omega_n/\omega_T)$ 

Formula:

$$C = \frac{0.3106 \left[N_1 \left(\omega_1 / \omega_T\right) + N_2 \left(\omega_2 / \omega_T\right) + \dots + Nn \left(\omega_n / \omega_T\right)\right]}{\rho_1 C p_1 \left(\omega_1 / \omega_T\right) + \rho_2 C p_2 \left(\omega_2 / \omega_T\right) + \dots + \rho_n C p_n \left(\omega_n / \omega_T\right)}$$

 $\omega 1...\omega n$ —the flow rate of the corresponding gas

 $\omega$ T——the flow rate of mixed gas

 $\rho$ 1... $\rho$ n - the density of the corresponding gas under standard conditions (see the gas conversion coefficient table for values)

CP1...CPn—— the constant pressure specific heat of the corresponding gas (see the gas conversion coefficient table for values)

N1...Nn——the molecular composition coefficient of the corresponding gas. For the value, see the gas molecular composition coefficient table.

### Warning and personal injury

Do not use this product in safety protection devices or emergency stop equipment, or in any other application where the failure of the product may cause personal injury, unless there is a specific purpose or authorization for use. Refer to the product data sheet and instructions before installing, handling, using or maintaining this product. Failure to follow recommendations may result in death or serious personal injury. The company will not be liable for any compensation for personal injury or death resulting therefrom, and is exempt from any claims that may arise against the company's managers and employees, as well as affiliated agents, distributors, etc., including: various costs, claims Fees, attorney fees, etc.

#### **Quality Assurance**

Guangzhou Aosong Electronic Co., Ltd. provides direct purchasers of its products with a quality guarantee as shown in the following table (calculated from the date of shipment), with the technical specifications stated in the Aosong Electronic product manual. If the product is proven to be defective during the warranty period, the company will provide free repair or replacement services.

Product	Warranty
AS200 MFC	12 months

Our company is only responsible for products that are defective when used in situations that meet the technical conditions of the product. The company does not make any guarantees regarding the application of the product in non-recommended special scenarios. The company does not make any commitment to the reliability of its products when used in other non-company supporting products or circuits.

This manual is subject to change without prior notice.

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