RPG400

Pirani-Piezo Combination Vacuum Gauge

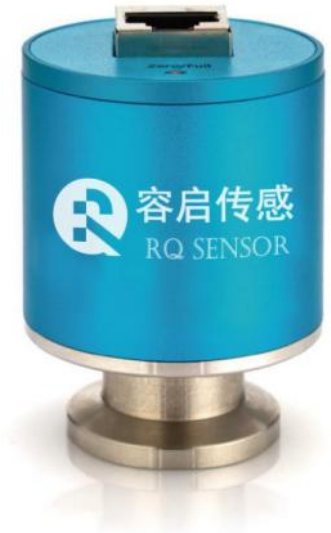
Introduction

The Series RPG400 Pirani-Piezo Combination Vacuum Gauge is designed specifically for wide-range pressure measurement applications, combining MEMS Pirani and MEMS Piezo sensor technologies. Compared to traditional Pirani vacuum gauges, the RPG400 offers higher accuracy, stability, repeatability and faster response time.

The RPG400 gauge integrates measurement data from MEMS Pirani sensor and Piezo sensors. It is designed for vacuum measurement of gases in the pressure range of 1×10^{-5}…1500 Torr. The Pirani and Piezo sensor chips are fabricated using advanced microfabrication processes, resulting in excellent accuracy and consistency.

The RPG400 gauge has analog signal output and RS485 digital communication interface . It can compatible with vacuum gauges from other manufacturers, allowing for plug-and-play without system adjustments or hardware interface changes. As a result, the previously accustomed output curves can be directly obtained.

The RPG400 gauge can also output other standard industrial signals according to the customer application requirements.



Features

- Range from $1x10^{-5}$Torr to 1500Torr
- Gas-independent absolute pressure measurement range from 10Torr to 1000 Torr
- Analog and RS485 digital output
- Adjustable output curve
- Resistant to air impact or vibration damage
- With temperature compensation

Applications

- Semiconductor manufacturing
- Vacuum coating
- Leak detection
- Freeze dryer
- Vacuum packaging machine
- Propulsion device

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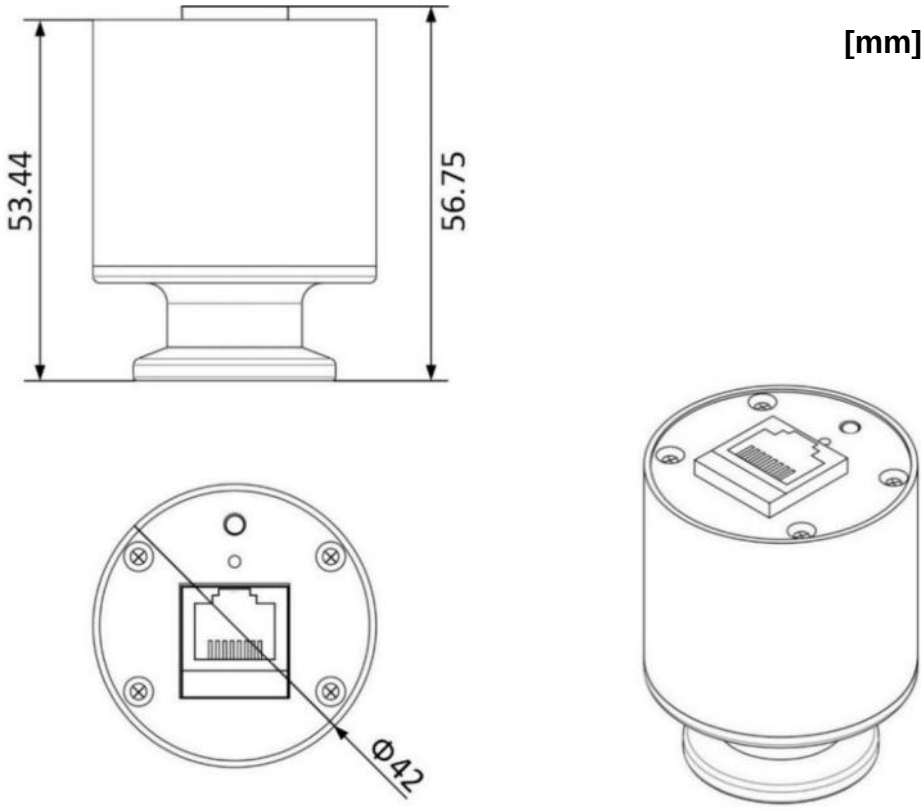
1. Specifications

(Accuracy and repeatability are typical values measured with N_2 gas at ambient temperature after zero adjustment)

Parameter	Min.	Typ.	Max.	Units	Conditions
Sensor Type		MicroPirani + MEMS Piezo			-
Measurement range	$1x10^{-5}$		1500	Torr	N_2/Air
Output voltage	1		9.2	V	Standard model or Factory settings
Output curve		Logarithmic curve			
Accuracy		±10%		Torr	$5x10^{-4}$ ~ $1x10^{-3}$
		±15%		Torr	$1x10^{-3}$ ~ 10
		±0.75%		Torr	10 ~ 1000
Resolution		16		bit	
Repeatability		±8%		Reading	$5x10^{-4}$ ~ $1x10^{-3}$ Torr
		±2%		Reading	$1x10^{-3}$ ~ 10 Torr
		±0.2%		Reading	10 ~ 1000 Torr
Response time		0.1		s	
Supply voltage	9	24	30	V	
Operating current		30		mA	
Identification		71.5		KΩ	Factory settings
Operating temperature	0		40	℃	
Storage temperature	-20		65	℃	
Overpressure limit			6	bar	
Probe material		304 stainless steel			Factory settings

2. Dimensions

[mm]

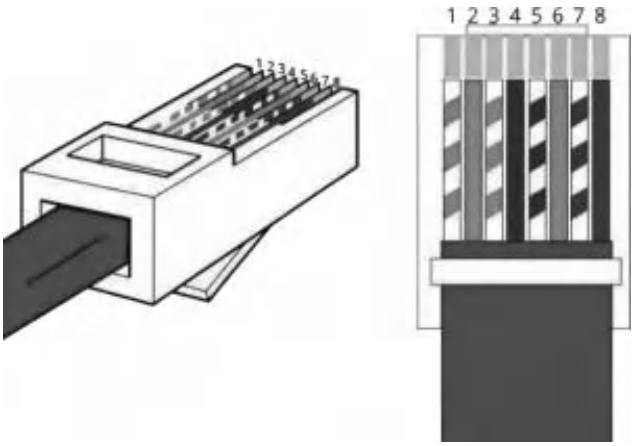


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3. Pin assignment

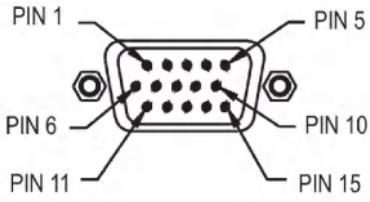
3.1. RJ45 8-pin

Pin1	Power + (9~30VDC)
Pin2	Power GND
Pin3	Analog Signal Output
Pin4	27KΩ identification
Pin5	Analog Signal GND
Pin6	NC
Pin7	RS485, DATA-
Pin8	RS485, DATA+



3.2. D-Sub15-pin

Pin1	RS485, DATA-	**Pin9**	Relay #1 NC
Pin2	RS485, DATA+	**Pin10**	Relay #2 NC
Pin3	Power + (9~30VDC)	**Pin11**	Relay #2 Common
Pin4	Power GND	**Pin12**	Relay #2 NO
Pin5	Analog Signal Output	**Pin13**	Relay #3 NC
Pin6	Analog Signal GND	**Pin14**	Relay #3 Common
Pin7	Relay #1 NO	**Pin15**	Relay #3 NO
Pin8	Relay #1 Common	——	——



4. Digital Signal Output

The product adopts the standard Modbus RTU protocol. The default communication parameters are as follows:

- Default address: 255 (0xFF)
- Baud Rate: 9600
- Data Bits: 8
- Stop Bits: 1
- Parity: None

4.1. Register Types

The series uses the holding register in Modbus RTU to read the air pressure value and set the Modbus address of the sensor. The default Modbus address bit for sensor is 255.

4.2. Holding Register Function Definitions

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Holding register (read/write) Code: 03		
Modbus address	Description	Data Type
0x0000	1. Stores air pressure value, unit Pa. To convert to actual air pressure value, divide by 1000. 2. Big-endian storage (high-order byte stored at low-order address, low-order byte stored at high-order address) 3. Example: If the read value is 0x05F5E100, the converted air pressure value is 100000Pa	32-bit integer
0x0001		
0x0005	1. Store sensor manufacturing year and month information 2. Example: If the read value is 0x1904, the sensor was manufactured in April 2025	16-bit unsigned integer
0x0006	1. Stores sensor production batch and Modbus address information. 2. Example: If the read value is 0x0104, the sensor was produced in the first batch in April 2025, and the factory-set Modbus address information address is 04 3. The sensor's default Modbus address is 0xFF, i.e., 255.	16-bit unsigned integer

4.3. Communication Examples

1. Write sensor address (use function code 10 to change address, function code 06 is not supported)

Instruction	Slave address	Function code	Register start address high eight bits	Register start address low eight bits	Number of registers high eight bits	Number of registers low eight bits	Number of bytes	Data4	Data3	Data2	Data1	CRCL	CRCH
Example	0XFF	0X10	0X00	0X05	0X00	0X02	0X04	0X00	0X00	0X00	0X01	0XC5	0XBB

Note: Data1 is the device's Modbus bus address.

Slave response:

Instruction format	Slave address	Function code	Register start address high eight bits	Register start address low eight bits	Number of registers high eight bits	Number of registers low eight bits	CRCL	CRCH
Example	0XFF	0X10	0X00	0X00	0X00	0X02	0X54	0X16

Note: No information to be parsed in the slave response

2. Reading Air Pressure Value (Using Function Code 03)

Master Sends Command:

Instruction format	Slave address	Function code	Register start address high eight bits	Register start address low eight bits	Number of registers high eight bits	Number of registers low eight bits	CRCL	CRCH
Example	0XFF	0X03	0X00	0X00	0X00	0X02	0XD1	0XD5

Note: 0xFF is the device's general address. If the device's Modbus bus address is known, it can be used directly.

Slave response:

Instruction format	Slave address	Function code	Return Number of bytes	Data4	Data3	Data2	Data1	CRCL	CRCH
Example	0XFF	0X03	0X04	0X00	0X01	0X00	0X05	0XC1	0XD7

Where 00 01 00 05 is the air pressure data, with the most significant byte first and the least significant byte last. 00 01 00 05H is 65541 in decimal. Actual air pressure value = 65541 * 0.001 = 65.541 (Pa).

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5. Analog Signal Output

The analog signal output can be remotely transmitted to external devices such as PLCs, DCS systems, and recorders. The voltage output range is adjustable. The typical vacuum degree and analog signal correspondence are shown below.

5.1. Output Voltage and Formula 1

$$P = 10^{\frac{U-c}{1.286}}$$

Where:
U——Voltage output
P——Different vacuum degree units
c——Constant used for different vacuum degree units, as shown in the table below:

U	*P*	*c*
V	mbar	6.143
V	Torr	6.304
V	mTorr/micron	2.448
V	Pa	3.572

5.2. Output Voltage and Formula 2

$$P = 10^{U-c}$$

Where:
U——Voltage output
P——Different vacuum degree units
c——Constant used for different vacuum degree units, as shown in the table below:

U	*P*	*c*
V	mbar	6
V	Torr	6.125
V	mTorr/micron	3.125
V	Pa	4

5.3. Output Voltage and Formula 3

$$P = 10^{U-c}$$

Where:
U——Voltage output
P——Different vacuum degree units
c——Constant used for different vacuum degree units, as shown in the table below:

U	*P*	*c*
V	mbar	5.5
V	Torr	5.625
V	mTorr/micron	2.625
V	Pa	3.5

5.4. Output Voltage and Formula 4

$$P = 10^{U-c}$$

Where:
U——Voltage output
P——Different vacuum degree units
c——Constant used for different vacuum degree units, as shown in the table below:

U	*P*	*c*
V	mbar	5
V	Torr	5.125
V	mTorr/micron	2.125
V	Pa	3

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5.5. Output Voltage and Formula 5

$$P = 10^{U-c}$$

Where:
U——Voltage output
P——Different vacuum degree units
c——Constant used for different vacuum degree units, as shown in the table below:

U	*P*	*c*
V	mbar	5.875
V	Torr	6
V	mTorr/micron	3
V	Pa	3.875

6. Calibration

The vacuum gauge is calibrated at the factory, but due to vibration during transportation or contamination during long-term operation, the vacuum gauge may drift. If a large deviation in the vacuum gauge measurement value is found, zero-point and full-scale calibration can be performed. In addition, the thermal conductivity of gas under medium and high vacuum is related to the type of gas. Different types of gases have different thermal conductivity coefficients for the sensor. The vacuum gauge is calibrated with standard nitrogen at the factory. Therefore, when measuring the vacuum of gases other than air or nitrogen, the sensor needs to be calibrated by the original manufacturer.

6.1. Zero-Point Calibration

Install the vacuum gauge on the vacuum system, preferably in the same environment as the vacuum gauge. Power on the vacuum gauge to preheat it and run it continuously. At the same time, evacuate the vacuum system to below 0.0001Pa and wait for 5 minutes. When the vacuum gauge reaches thermal equilibrium, zero-point calibration can be performed. The specific operation is as follows.

a) Insert a pin into the zeroing and full-scale adjustment holes, press and hold the button until the red light illuminates, then release the button;
b) Press the button briefly once. The red light will flash 3 times and then turn off;
c) The indicator light will automatically return to a solid green state. At this point, the vacuum gauge zeroing operation is complete and it is ready for normal operation.

6.2. Full-scale calibration

Power on the vacuum gauge under atmospheric pressure to preheat it. It is best to do this under the same environment as the vacuum gauge is used in, and wait 5 minutes until the vacuum gauge reaches thermal equilibrium. Then, the full-scale calibration operation can be performed. The specific operation is as follows:

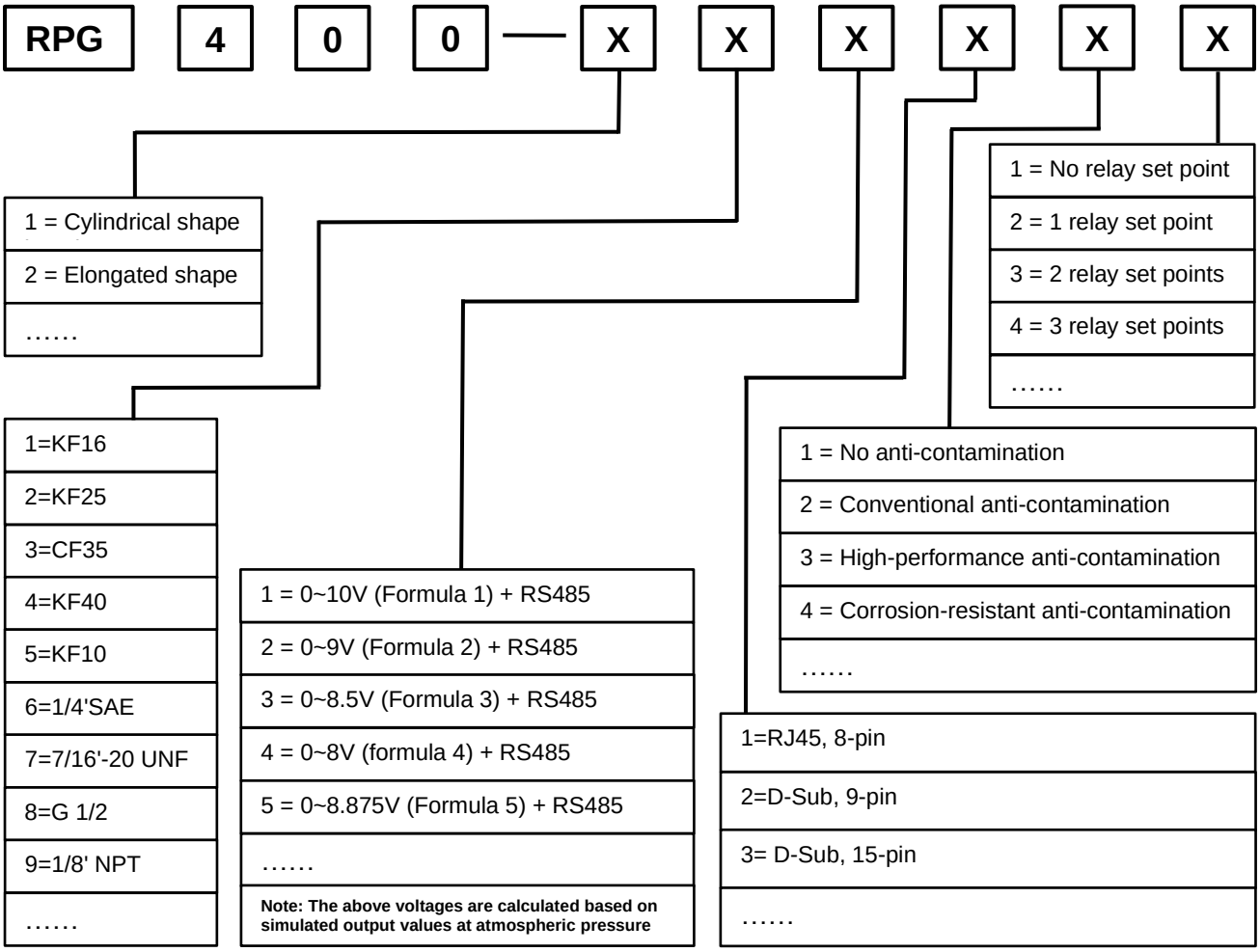
a) Insert a pin into the zeroing and full-scale adjustment holes, press and hold the button until the red light illuminates. Continue pressing the button until the green light illuminates, then release the button;
b) Press the button briefly once. The green light will flash 3 times and then turn off;
c) The indicator light will automatically return to a solid green state. At this point, the vacuum gauge full-scale calibration operation is complete and it is ready for normal operation.

7. Indicator Light Status Description

Solid green light – Vacuum gauge is in normal working condition.
Red light is always on—the vacuum gauge is malfunctioning, and the processing circuit MCU has not entered normal working state.
Indicator light off – Vacuum gauge power supply abnormal.
Red light flashes 3 times – Vacuum gauge completes zero-point calibration.
Green light flashes 3 times – Vacuum gauge completes full-scale calibration.

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8. Ordering Information



The standard model of this series of Pirani vacuum gauges is RPG400-115121. If there are other non-standard models, please consult with RQ for definition.

9. Revision History

Product Datasheet Version Control (RPG400)			
Version	Modification Time	Modification Content	Modifier
V1.0	2024.08	Initial Version	YSC
V2.0	2026.02	Optimized performance parameters, simulated output status, etc.	YSC

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