nAPG200 Active Pirani Gauge

INSTRUCTION MANUAL

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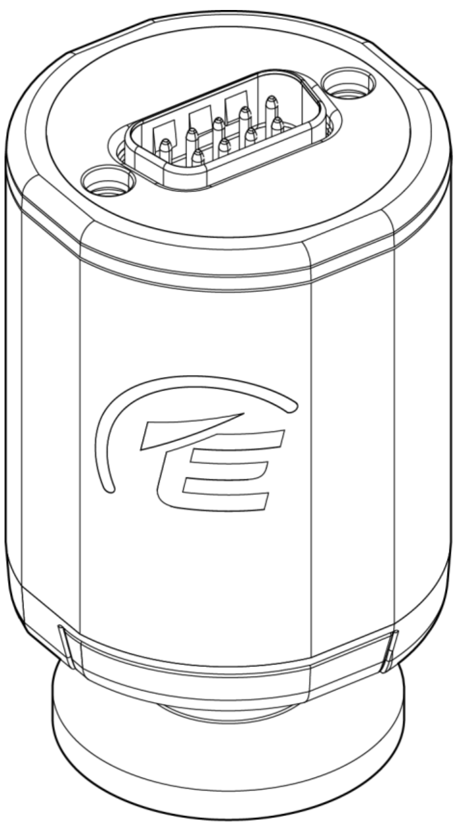

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Original instructions

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You must use this product as described in this manual. Read the manual before you install, operate, or maintain the product.

Numbering matrix

n	APG200	–				–		–		–		–	

D	1	G						

Contents

List of Figures

1. Safety and compliance

For safe operation from the start, read these instructions carefully before you install or commission the equipment and keep them safe for future use. Read all the safety instructions in this section and the rest of this manual carefully and make sure that you obey these instructions.

1.1 Definition of Warnings and Cautions

Important safety information is highlighted as warning and caution instructions which are defined as follows. Different symbols are used according to the type of hazard.

WARNING:

If you do not obey a warning, there is a risk of injury or death.

CAUTION:

If you do not obey a caution, there is a risk of minor injury, damage to equipment, related equipment or process.

NOTICE:

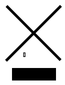
Information about properties or instructions for an action which, if ignored, will cause damage to the equipment.

We reserve the right to change the design and the stated data. The illustrations are not binding.

1.2 Safety symbols

The safety symbols on the products show the areas where care and attention is necessary.

The safety symbols that we use on the product or in the product documentation have the following meanings:

	Warning/Caution An appropriate safety instruction must be followed or caution to a potential hazard exists.
	WEEE symbol The equipment must be discarded carefully. Obey local and national regulations for disposal of this equipment.

2. Introduction

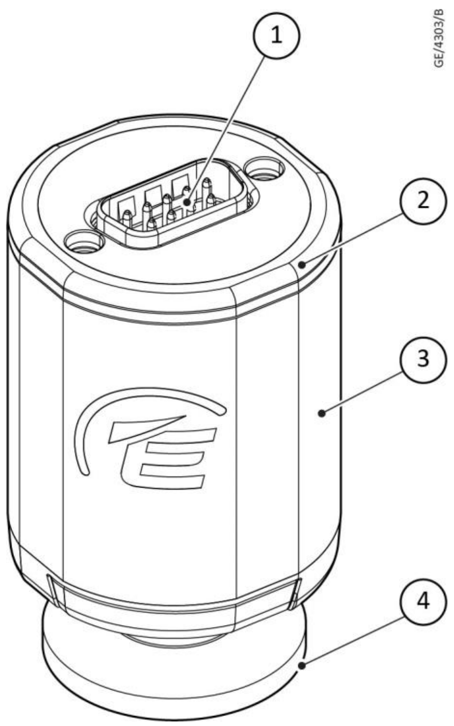
2.1 Description

The nAPG200 pirani gauge operates on the principle of thermal conductivity in which the rate of heat loss from a heated filament is dependent on the pressure of the gas (around filament). Refer to *Figure: General view*.

The nAPG200 is a digital gauge. All gauge calibration and control functions are carried out over serial communications. Use RS232 for point to point systems and RS485 for point to point or multi-drop systems.

1. The gauge has a detachable tube that allows the replacement of the tube or electronics in the event of failure.
2. An LED indicator surrounding the circumference of the top of the gauge provides status indication.
3. The gauge is available with different vacuum flanges to integrate with the customer process.
4.

Figure 1 General view



1. *Electrical connector*
2. *LED indicator*
3. *Electronics housing*
4. *Vacuum flange*

2.1.1 Item number and description matrix

The range of the pirani gauge is highly configurable. The characteristics of a particular product are defined through the product item number or description. The characteristics in the table that follows can be selected at the point of purchase.

Table 1 Options

Characteristic	Description
Filament/Pressure range	Different filament materials which have been selected for their ability to measure low pressures and/or their resistance to corrosion
Setpoint	Transistor setpoint or 1 solid state relay
Flange	Different vacuum flanges are available
Communications proto-col	Gauges are available with RS232 or RS485 communication protocols
Other	Gauges can be ordered with calibration certificates

Figure 2 Item number matrix

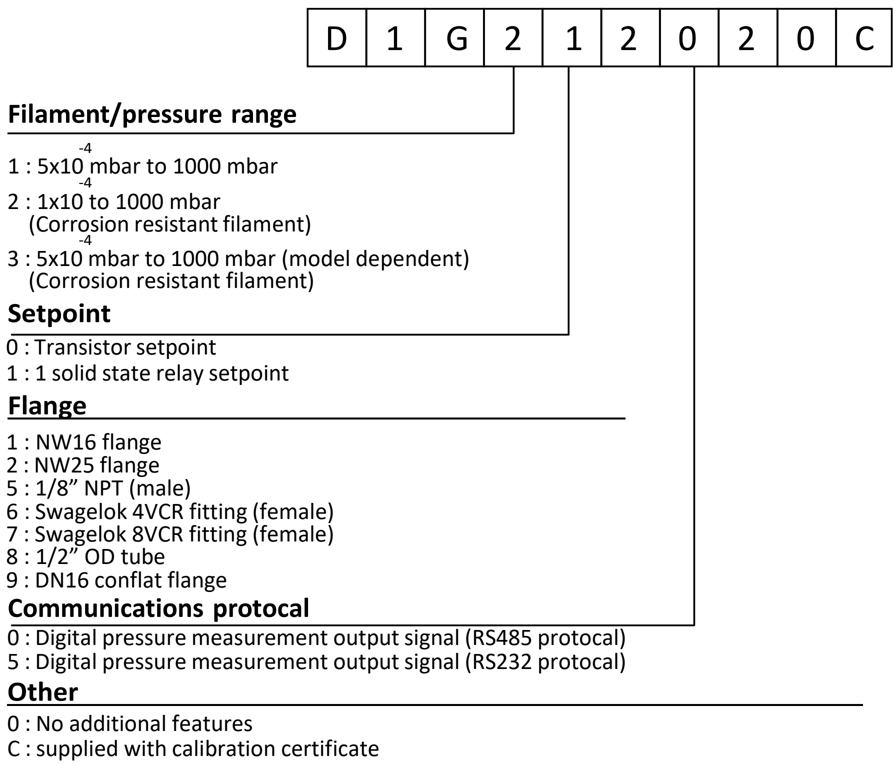


Figure 3 Item description matrix

n	APG200	X	LC	S	RS485	NW25	9 PIN DSUB	CAL

Filament/pressure range

M : Standard filament
$5x10^{-4}$ mbar to 1000 mbar
LC : Corrosion resistant filament
$1x10^{-4}$ to 1000 mbar
MP : Corrosion resistant filament
$5x10^{-4}$ mbar to 1000 mbar
(model dependent)

Setpoint

[Blank] : Transistor setpoint
S : 1 solid state relay setpoint

Communicational protocal

RS232 : Digital pressure measurement output signal (RS232 protocal)
RS485 : Digital pressure measurement output signal (RS485 protocal)

Flange

NW16 : NW16 flange
NW25 : NW25 flange
1/8” NPT : 1/8” NPT (male)
4VCR : Swagelok 4VCR fitting (female)
8VCR : Swagelok 8VCR fitting (female)
Bare tube : 1/2” OD tube
DN16CF : DN16 conflat flange

Other

[Blank] : No additional features
CAL : supplied with calibration certificate

The complete range of available options can be found in the *Item number and description matrix* on page 8.

3. Technical data

3.1 Operating and storage conditions

Table 2 Operating and storage conditions

Parameter	Value
Ambient operating temperature range	+5 °C to +60 °C
Ambient storage temperature range	-30 °C to +70 °C
Bakeout temperature	150 °C (with electronics housing removed)
Humidity	80% RH up to 31 °C decreases linearly to 50% RH at 40 °C and above
Maximum altitude	3000 m
Maximum internal pressure	10 bar absolute (9 bar gauge)
Pollution degree	2
Filament temperature	Approximately 100 °C

Table 3 Materials exposed to vacuum

Filament characteristic*	Materials exposed to vacuum		
Where used	**M**	**MP**	**LC**
Filament Material	Tungsten/Rhenium (standard)	Platinum/Rhodium (corrosion resistant)	Platinum/Iridium (corrosion resistant)
Tube	Stainless Steel 316L and 304L		
Filter	Stainless Steel 316L		
Other	Glass, Ni, NiFe,	Stainless Steel 302S26	Glass, Ni, NiFe, PTFE

** Refer to Figure: Item description matrix for characteristics.*

3.2 Performance data

Table 4 Performance data

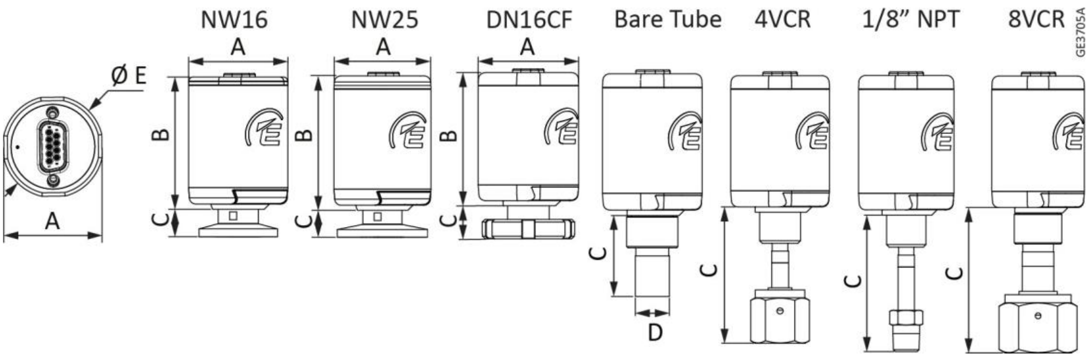
Characteristics / Filament	Pressure range	Typical accuracy
"M" or "MP"	100 mbar to 1000 mbar	±50% reading
	1×10^{-3} mbar to 100 mbar	±15% reading
	5×10^{-4} mbar to 1×10^{-3} mbar	±50% reading
"LC"	10 mbar to 100 mbar	±50% reading
	1×10^{-3} mbar to 10 mbar	±15% reading
	1×10^{-4} mbar to 1×10^{-3} mbar	±50% reading

3.3 Mechanical data

Table 5 Mechanical data

Characteristic		Value	Units
Dimensions		Refer to *Figure: Dimensions (mm)*	mm
Enclosure rating		IP40	-
Mass		≤ 200	g
Internal volume of tube			
Flange	NW16	3.3	cm^3
	NW25	3.3	
	1/8" NPT	3.8	
	4VCR	3.6	
	8VCR	5.5	
	Bare tube	4.8	
	DN16CF	3.3	

Figure 4 Dimensions (mm)



Characteristics	Dimension (mm)				
Filament/Pressure range	**A**	**B**	**C**	**D**	**E**
NW16	37	52	11	-	38
NW25	37	52	11	40	
DN16CF	37	52	13	-	
Bare Tube	37	52	30	12.7	
4VCR	37	52	38	-	
1/8" NPT	37	52	51	-	
8VCR	37	52	39	-	

3.4 Electrical data

Table 6 Electrical data

Parameter	Data
Electrical supply voltage	▪ 15 to 48 V d.c. nominal ± 10% ▪ Limited-energy circuit/source in accordance with IEC 61010-1
Maximum power consumption	1.5 W
Maximum inrush current	150 mA
Electrical connector	9 way D-sub male
ID resistor	10 kΩ

Note:

National Electrical Code (NEC) Class 2 or Limited Power Source (LPS) are also accepted.

3.5 Setpoint

Table 7 Transistor setpoint variants ([blank] characteristic)

Parameter	Data
Open collector transistor	1 (Quantity)
Maximum external load rating	48 V d.c. maximum, 100 mA
Back EMF suppression diode*	Minimum surge rating 1 A, minimum reverse voltage rating 100 V

* Recommended when external DC relay is connected, refer to *Figure: 9 way D-sub connector with setpoint transistor*.

Table 8 Solid state relay variants ("S" characteristic)

Parameter	Data
Solid state relay	1 (Quantity)
Form	Single Pole Single Throw (SPST), Normally Open (N.O.)
Rating	48 V d.c. maximum, 500 mA
Relay on series resistance	Typical 0.2 Ω, maximum 0.3 Ω

3.6 Serial communications

Table 9 Serial communications

Parameter	Value
RS232 transmit	
▪ Mark ▪ Space	▪ < -8 V (I_{out} maximum: -8 mA) ▪ > +8 V (I_{out} maximum: +8 mA)
RS232 receive	

Parameter	Value
▪ Mark ▪ Space ▪ Maximum input	▪ < +1 V (I_{in} maximum: -2 mA) ▪ > +2 V (I_{in} maximum: +2 mA) ▪ ±12 V
RS485	
▪ Output differential ▪ Input differential threshold ▪ Maximum input ▪ Bus load	▪ > 1.5 V (I_{out} maximum: ±25 mA) > ±0.2 V (I_{in} maximum: ±1 mA) ▪ -7 V to +12 V ▪ The gauge applies one unit load to the RS485 bus.
Default setup	9600 baud, 8 bits, 1 stop bit, no parity
Maximum baud rate	38400 baud

4. Installation

4.1 Unpack and inspect

1. Remove the packing materials and protective covers.
2. Examine the gauge.
3. If the gauge is damaged, tell the supplier and carrier in writing in three days. Give:
    - item number of the gauge
    - order number
    - supplier invoice number of the gauge.
4. Keep the packing materials for inspection.
5. Do not use the product if it is damaged.
6. If the system is not used immediately, put the protective cover and packing materials on the gauge.
7. Store the gauge in applicable conditions. Refer to *Table: Operating and storage conditions*.

Check that your package contains the following items:

Table 10 Checklist of items

Quantity	Description	Check
1	nAPG200 gauge	❑
1	Test report	❑
1	Instruction manual	❑

4.2 Install the gauge

⚠ **WARNING: HIGH PRESSURE**

Risk of damage to equipment. Use a co-seal or trapped O-ring carrier to connect the gauge to a vacuum system. If the pressure is more than the atmospheric pressure, the standard centring rings are not applicable.

⚠ **WARNING: CRITICAL APPLICATION**

Risk of damage to equipment. Do not use the gauge for safety critical applications. The gauge is not intended to be fail-safe.

To install the gauge, do the procedure as follows:

1. You can install the gauge in any direction.
2. In factory, the gauge is installed vertically and calibrated for nitrogen.
3. For the correct pressure indication at the direction of installed gauge, calibrate the gauge again at atmospheric pressure.
4. Mount the gauge tube in vertical direction to minimise the build up of process particulates and condensable vapours within the gauge.

5. For precision, we recommend that the atmosphere and vacuum adjustment must be done before use. Refer to *Maintenance* on page 31.

4.3 Connect the gauge

4.3.1 Connect to the vacuum system

To connect the gauge to the vacuum system:

- Use an O-ring or a centring-ring or a co-seal to connect the gauge with NW16 or NW25 flange to a similar flange on the vacuum system. The gauge is not compatible with centering ring adaptors.
- Use a new copper gasket to connect the gauge with a DN16CF flange and a new face seal metal gasket to connect the gauge with a 8VCR or 4VCR flange to a similar flange on the vacuum system.
- Apply 2 to 3 turns of 6 mm or 1/4” wide PTFE tape to a gauge with an 1/8” NPT flange. Begin at the start of the thread and wrap in the direction of the threads to make sure that the seal is leak tight.
- Make sure that the vacuum system has a correct earth (ground) connection.
- Connect the tube of the gauge to the vacuum system.

4.3.2 Connect to the electrical equipment

CAUTION: GAUGE MALFUNCTION

Risk of damage to equipment. Do not make connections to the gauge identification pin. Failure to do so can cause the gauge to malfunction.

Refer to *Recommended electrical connections* on page 17 for schematic diagram of the electrical connections to the gauge. Use the pins on the electrical connector as shown in *Table: Pins on the gauge electrical connector*.

Refer to *Technical data* on page 11 for more specifications.

Figure 5 Electrical connectors

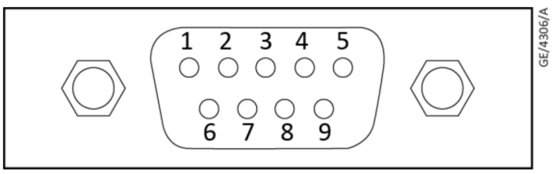


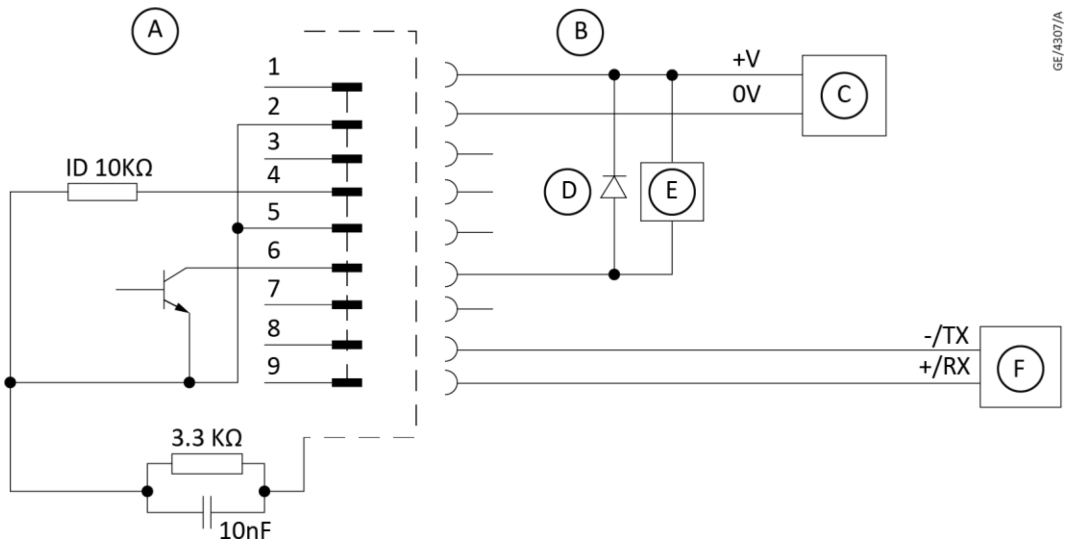
Table 11 Pins on the gauge electrical connector

Recommended electrical connection	Setpoint transistor	Solid state relay
Pin	**Refer to *Figure: Electrical connectors***	
1	Electrical supply positive	
2	Electrical supply ground (0 V)	
3	Not connected	

Recommended electrical connection	Setpoint transistor	Solid state relay
Pin	**Refer to *Figure: Electrical connectors***	
4	ID resistor	
5	RS485/RS232 common	
6	Setpoint output signal	Relay 1 closing contact
7	Not connected	Relay 1 common
8	RS485 negative/RS232 transmit	
9	RS485 positive/RS232 receive	

Recommended electrical connections

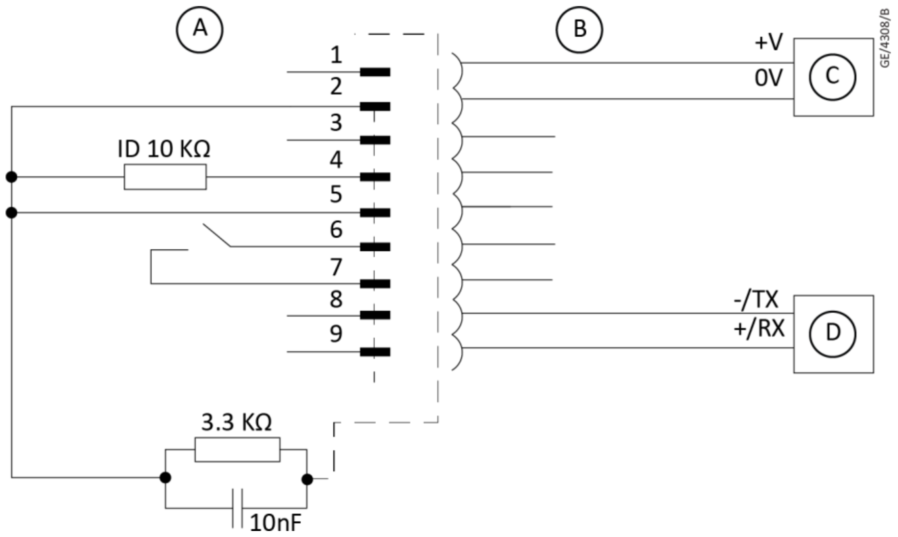
Figure 6 9 way D-sub connector with setpoint transistor



A. Gauge
B. Connector
C. Electrical supply
D. Back EMF suppression diode (optional)
E. DC relay (optional)
F. RS485/R232 serial communication

Refer to *Table: Pins on the gauge electrical connector* for addition information concerning pins.

Figure 7 9 way D-sub connector with solid state relay



A. Gauge *B. Connector*
C. Electrical supply *D. RS485/R232 serial communication*

Note:

For setpoint transistor variants only, The setpoint output is an active low open-collector transistor capable of operating a d.c. relay or control logic. If you connect an external relay, use a suppression diode to protect the gauge from transient voltages generated when the relay is set to off.

Refer to *Table: Pins on the gauge electrical connector* for addition information concerning pins.

4.4 Maximum cable length

The maximum cable length is dependent on the conductor cross-section and the supply voltage used.

Table 12 Maximum cable length

Electrical supply voltage	Maximum cable length (24 AWG)
15 V	100 m
48 V	1000 m

4.5 Connect the serial interface

CAUTION: VOLTAGE DIFFERENCE

Risk of damage to equipment. All of the ground connections are tied together. If differences exist in the local ground voltage, damage could occur. If the gauges being connected experiences different ground potentials, a suitable RS485 isolator must be connected between them.

The gauge has one of 2 serial interfaces built in, RS232 or RS485. Either interface can be used for point to point communication with a single gauge from the digital gauge range.

The RS485 interface can be used for multi-drop communication with multiple gauges from the digital gauge range.

Connect the RS232

The RS232 interface uses two lines for data transfers and an additional line as a signal common. Hardware handshaking is not implemented. The connector pin out is not compatible with standard serial leads and these must not be used.

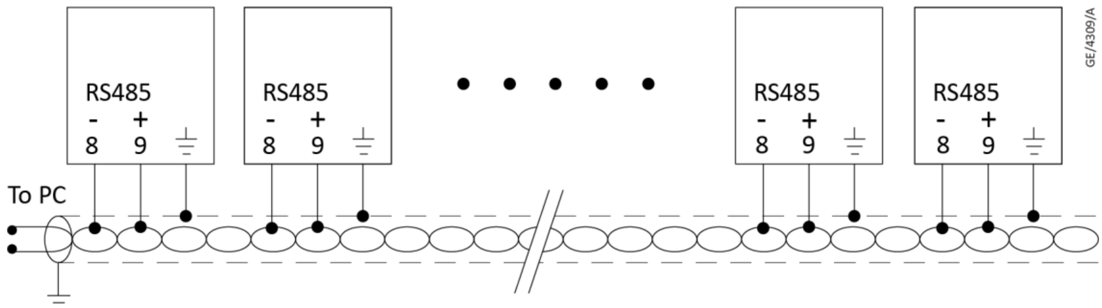
It is recommended that shielded cable be used for the interface to reduce interference problems and the length of the RS232 link should be less than 10 metres. For longer links, either install line drivers or use RS485.

Connect the RS485

The RS485 interface uses two lines for differential data transfers. Multiple gauges from the digital gauge range, and other RS485 compatible manufacturers products, can be connected to the same serial bus.

It is recommended to use the shielded twisted pair cable for the interface to reduce interference problems and the length of the RS485 link should be less than 1000 metres. Long links may require the addition of 120 Ω terminating resistors at each end of the link to improve communication reliability.

Figure 8 RS485 connection



5. Operation

WARNING: HIGH FILAMENT TEMPERATURE

Risk of injury or damage to equipment. Do not use the gauge to measure the pressure of explosive or flammable gases or mixtures. The gauge has a heated filament which operates approximately at 100 °C. The temperature of the filament can be higher in fault conditions.

WARNING: OVER-PRESSURISE

Risk of injury or damage to equipment. When you measure the pressure of gases of high molecular weight, the pressure indicated can be below the true pressure. Make sure that the gauge is not over-pressurised when using heavy gases.

Refer to the Digital gauge range serial communications manual (D1G0001880) for details of the serial command protocol and message format and summary of serial query/ commands in *Serial command quick reference guide* on page 36.

5.1 LED indicator

When the gauge is connected to a power supply the LED indicator will illuminate and flash red for approximately 5 seconds while the gauge is initialising. The LED indicator indicates the gauge status:

- green if the gauge is operating normally
- red if an error is detected. Refer to *Fault finding* on page 32.

Normal operation

During normal operation, the LED indicator pulses to provide an approximate indication of the measured pressure.

Pressure band	LED pattern		
	Colour	Change rate	
		High intensity (s)	Low intensity (s)
Pressure ≤ 1 mbar	Green	Continuous	n/a
1 mbar < Pressure ≤ 50 mbar		0.75	0.75
Pressure > 50 mbar		1.5	1.5

The pulsing operation (low intensity/high intensity) is switched on by default but can be disabled (refer to *Pulsed LED indicator on/off* on page 28). If pulsing is disabled, the LED will be green continuously during normal operation.

Note:

The pulsing function enabled/disabled is unaffected by power cycling the gauge.

Error indication

If an error occurs within the gauge, the LED indicator will illuminate red and flash. Refer to *Fault finding* on page 32.

5.2 Serial communications

The communications to the digital gauge range are ASCII based text and work on the client/server principle. The digital gauge is the server and will only transmit a message in response to one sent to it. The client, a PC for example, must always start the conversation.

5.2.1 Message basics

A conversation consists of a message to the digital gauge and its response. Having sent a message to the digital gauge, the reply must be received before continuing.

There are two types of message sent to the digital gauge:

- Commands sending information to the gauge (!)
- Query requesting information from the gauge (?)

All messages end with a carriage return. In multi-drop mode, the ? and ! are preceded by the addressing information (#). The characters which are not enclosed by start (# and / or !?) and end (cr) characters will be ignored. Incomplete messages will be ignored if a new start character is received.

Commands

Commands send information to the digital gauge. These can be literal commands such as 'turn gauge on' or setups to be stored by the digital gauge. Setups hold information about how the digital gauge must behave such as the pressure measurement units under or at the setpoint thresholds.

Queries

Queries request information from the digital gauge. These can be direct queries of the value of a parameter such as gauge pressure or reading a setup value currently in the digital gauge.

Responses

Responses from the digital gauge contain either the data requested (=) or the status of the command (*). Note that for commands such as pirani tube calibration on the gauge, the action will continue after the response has been received and the gauge status will need to be monitored to determine when the command has completed.

Detailed parameter checking is performed by the digital gauge so a good response guarantees that the message and parameter have been accepted by the serial communications. Correct command behaviour must be checked by querying the appropriate attribute. For example write a setup, read it back and check the updates are as requested. Refer to *Response error codes* on page 23 for details of the response error codes.

Objects and configurations

Each parameter or function within the digital gauge has an object number that is used to reference it. Some objects have more than one configuration associated with them, for these objects the configuration type is sent and returned as the first parameter in the data field.

5.2.2 Protocol message format

Throughout this manual, messages will be displayed using the following formats:

Object IDs consist of 1-3 ASCII digits representing a number between 0 - 999, as shown below:

n	n	n

Data fields contain command codes or parameter values and will vary in length and format according to the message type. If there is more than one item in the data field, each item is separated by a semi colon(;).

n	or	n	n	or	Data	or	Data 1	;	Data 2	;	Data 3

Returned response codes consist of 2 characters representing a number between 0-99. A code of '00' always means 'OK'. Other codes are used to indicate error conditions:

r	r

In multi-drop mode, a multi-drop header is prefixed to each message. It is composed of a '#', followed by a 2 character Destination ID, a colon, and a 2 character Source ID:

#	d	d	:	s	s

Space and carriage returns are shown as:

sp	or	cr

Control command

Command format:

!	*C*	*n*	*n*	*n*	*sp*	*n*	*cr*

Normal or error response

*	*C*	*n*	*n*	*n*	*sp*	*r*	*r*	*cr*

Setup command

Command format:

!	*S*	*n*	*n*	*n*	*sp*	*Data*	*cr*

Normal or error response

*	*S*	*n*	*n*	*n*	*sp*	*r*	*r*	*cr*

Setup query

Query format:

?	*S*	*n*	*n*	*n*	*cr*

Normal response

=	*S*	*n*	*n*	*n*	*sp*	*Data*	*cr*

Error response

***	*S*	*n*	*n*	*n*	*sp*	*r*	*r*	*cr*

Value query

Query format:

?	*V*	*n*	*n*	*n*	*cr*

Normal response

=	*V*	*n*	*n*	*n*	*sp*	*Data*	*cr*

Error response

***	*V*	*n*	*n*	*n*	*sp*	*r*	*r*	*cr*

Multi-drop prefix

Command or Query prefix format

#	*d*	*d*	*:*	*s*	*s*	*?*	*V*	*n*	*n*	*n*	*cr*

Response prefix format

#	*s*	*s*	*:*	*d*	*d*	*=*	*V*	*n*	*n*	*n*	*sp*	*Data*	*cr*

5.2.3 Response error codes

The error codes returned in the case of command or query failure are consistent across all our products that support serial communications:

Table 13 Response error codes

Error code	Meaning
0	Acknowledge - no error
1	Invalid command for object ID
2	Invalid query / command
3	Missing parameter
4	Parameter out of range
5	Invalid command in current state
6	Data checksum error
7	EEPROM read or write error
8	Operation timeout
9	Invalid config ID

Refer to the Digital gauge range serial communications manual (publication number D1G0001880) for full details of the serial command protocol and message format. This includes further information on command error codes.

5.2.4 Communications timings

Because of the complexity of the product, precise message timings are not defined, the following values are provided for guidance. Latency estimates are comms query and reply flight time. Processor latency may add up to 3.5 ms.

Table 14 Communications timings

Command examples vs Baud rate:		9600 (ms)	19200 (ms)	38400 (ms)
Gauge type	?S751<cr> =S751 NNNxxx-NN_N_RSxxx; DnnnnnnnnX;nnnn<cr>	48.0	24.0	12.0
+ Multidrop	#dd:ss #ss:dd	+12.5	+6.3	+3.1
+ µP Latency	-	+3.5	+3.5	+3.5
Estimated latency - slowest		~64.0	~33.8	~18.6
Read Pressure	?V752<cr> =V752 n.nnE±nn;nnnn<cr>	27.1	13.5	6.8
+ µP Latency	-	+3.5	+3.5	+3.5
Estimated latency - fastest		~30.6	~17	~10.3

When a command (!) is sent to the gauge, make sure that there is a delay of > 25 ms after receiving the reply before sending another command (!) or query (?) as the gauge may not receive the message.

5.2.5 Gauge status bits

The gauge status is returned with every pressure reading as 16 bits of ASCII encoded HEX:

"F"				"F"				"F"				"F"			
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Table 15 Gauge status bits

BIT	Status flag	Meaning
0	Gauge Err	Gauge specific error active*
1	-	Not applicable to this gauge
2	SPOP ON	Setpoint On or Off
3	Gauge LK	Gauge parameters locked
4 5	Pressure units	Gauge pressure units: 1=mbar, 2=Pa (Default), 3=Torr
6	FlashEE Err	All stored parameters and calibrations defaulted
7	Calibrating	Calibration in progress - pressure reading invalid
8	-	Not applicable to this gauge
9	-	Not applicable to this gauge
10	Pir Fil Err	Pirani filament failure
11	-	Not applicable to this gauge

BIT	Status flag	Meaning
12	Gas type	Gauge Gas type: 0 = Nitrogen, 1 = Argon, 2 = Helium, 3 = CO_2, 4 = Neon, 5 = Krypton, 6 = Xenon
13		
14		
15	-	Not applicable to this gauge

** Gauge specific errors are bits 6 to 11 inclusive.*

5.3 Gauge operation under serial control

When you operate the gauge, refer to the summary of serial query/commands in *Serial command quick reference guide* on page 36 and refer to Digital gauge range serial communications manual (publication number D1G0001880) for the implementation of each serial command.

5.3.1 Gauge identification

All serial gauges are identified by a single value of ID resistor and this is 10 kΩ. All further gauge identification is carried out over serial communications.

Query/command	Description
?S0	Read wildcard identification
?S751	Read gauge identification
!S751	Set gauge name
?S790	Read gauge serial number

5.3.2 Pressure measurement

Read the measured pressure in the selected gas type and pressure units along with the gauge status. Refer to *Communications timings* on page 24 for the gauge status bits.

Query/command	Description
?V752	Read gauge pressure and status
!S752	Acknowledge gauge errors
!S755	Set pressure units

5.3.3 Gas dependency

The gauge is calibrated for the use in nitrogen and will read correctly with dry air, oxygen and carbon monoxide. For the other gases a conversion is necessary to get the correct pressure reading.

The *Figure: Gas dependency* shows equivalent readings for 7 common gases Nitrogen, Argon, Helium, Carbon dioxide, Neon, Krypton and Xenon. The gas conversion is carried out by the gauge at the time of measurement and the pressure reading is returned in the selected gas type.

Query/command	Description
!S756 n	Set gas type (n is value of gas)

Figure 9 Gas dependency of APG200 with M, MP filament/pressure characteristic

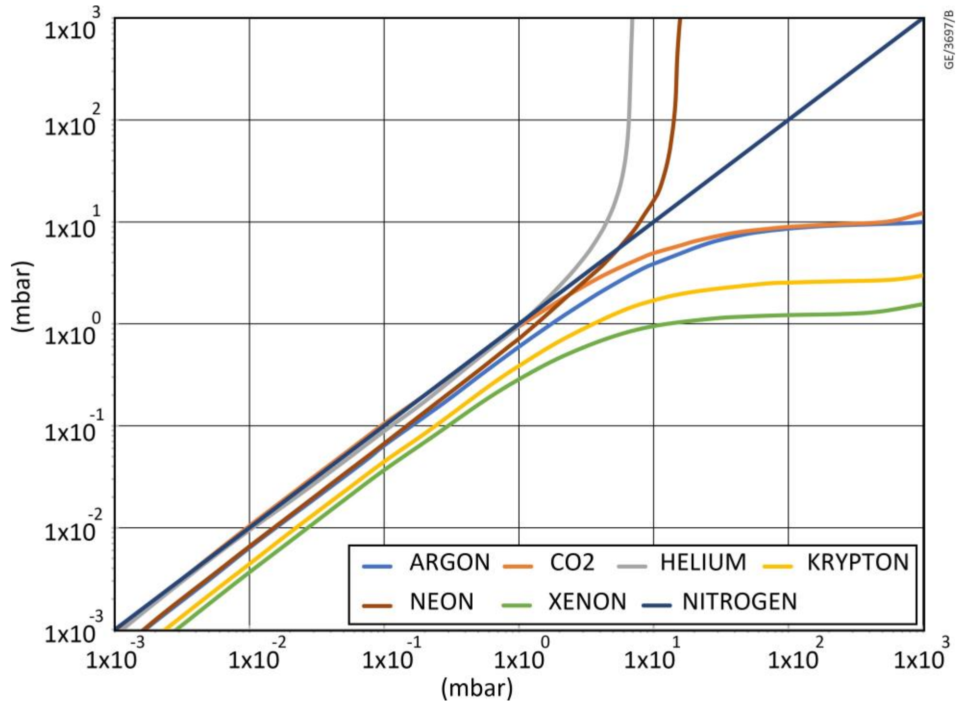
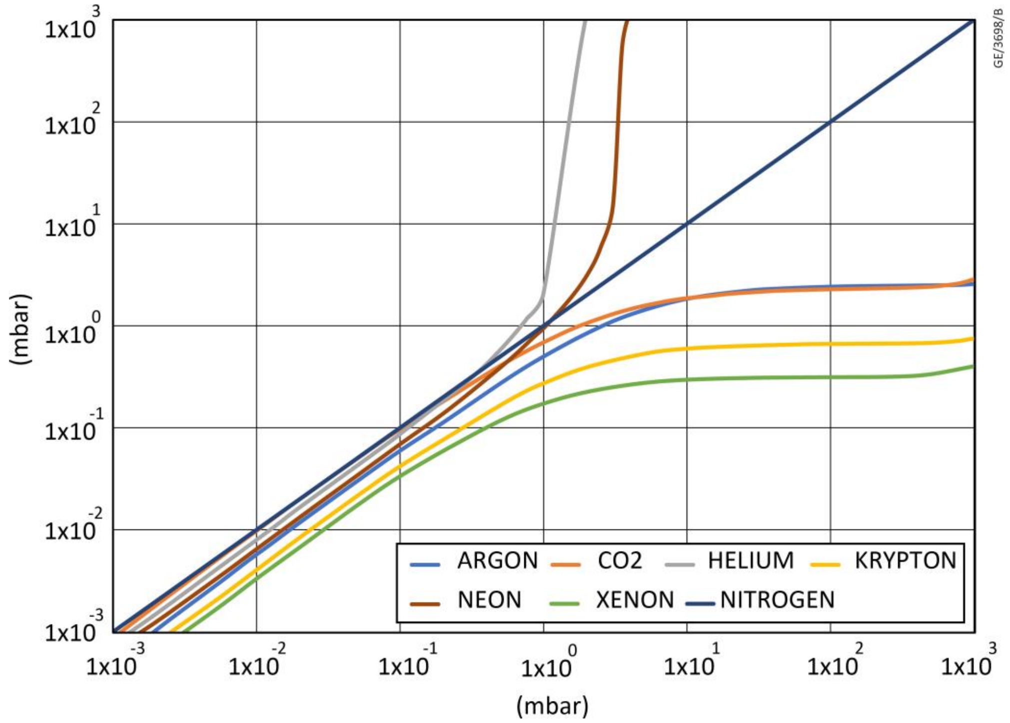


Figure 10 Gas dependency of APG200 with LC filament/pressure characteristic



Note:

X-axis - True pressure

Y-axis - Indicated pressure

5.3.4 Gauge adjustments

For optimum accuracy it is recommended that both atmosphere and vacuum adjustments are carried out before use. The gauge can be adjusted for atmosphere and vacuum when set to a gas type of nitrogen. Gauge adjustments are not supported for other gas types.

Atmosphere adjustment

1. Supply power to the gauge, make sure that the LED indicator is green and allow the gauge to warm up at atmospheric pressure in nitrogen or air for at least 10 minutes.
2. Initiate the atmosphere adjustment by sending the calibrate command to the gauge.
3. The LED indicator will flash cyan to indicate the operation is being performed.
4. After 3 seconds, the LED indicator stops flashing and the atmosphere adjustment parameters are stored in the gauge.
5. The status of the gauge during this adjustment is displayed in the gauge status that is returned when the gauge pressure is read. The calibration in process bit will be cleared when the adjustment is complete.
6. The output of the gauge will automatically be adjusted to read atmosphere.

Vacuum adjustment

1. Switch on the power supply to the gauge and allow it to operate for at least 10 minutes.
2. Reduce the pressure to 1×10^{-5} mbar (or less).
3. Initiate the vacuum adjustment by sending the calibrate command to the gauge.
4. The LED indicator will flash cyan to indicate the operation is being performed.
5. After 3 seconds, the LED indicator stops flashing and the vacuum adjustment parameters are stored in the gauge.
6. The status of the gauge during this adjustment is displayed in the gauge status that is returned when the gauge pressure is read. The calibration in process bit will be cleared when the adjustment is complete.
7. The output of the gauge will automatically be adjusted to read vacuum.

Tube adjustment

If a replacement tube is installed to the gauge it is necessary to adjust the gauge to match the characteristics of the new tube.

1. Make sure that the gauge is at atmospheric pressure in nitrogen or air. Supply power to the gauge, make sure that the LED indicator is green.
2. Initiate the vacuum adjustment by sending the tube calibration command to the gauge.
3. The LED indicator will flash orange for approximately 5 minutes while the adjustment is performed. When the gauge stops blinking, the adjustment is complete.

4. The status of the gauge during this adjustment is displayed in the gauge status that is returned when the gauge pressure is read. The calibration in process bit will be cleared when the adjustment is complete.
5. Do the atmosphere and vacuum adjustments after the optimum accuracy.

Query/command	Description
!S761 1;1	Atmosphere adjustment
	Vacuum adjustment
!S760 1	Clear calibration
!S761 0;1234	Adjustment for new tube (1234 is password)

5.3.5 Setpoint

The setpoint output is an open collector output transistor or solid-state relay depending on the model. The magnitude of the setpoint thresholds can be set between 1.0 x 10^{-10} to 9.9 x 10^{6} and are set and read in the gauge gas type and pressure units. When pressure units are changed, the setpoint thresholds are automatically updated. The magnitude of the setpoint thresholds are unaffected by changes in gas type and the value for the new gas type will be identical to that of the previous gas type.

The setpoint output is set to off (open) when the gauge pressure reading is above the high threshold and set to on (closed) when below the low threshold. The high and low thresholds allow for programmable hysteresis. No additional hysteresis is added by the gauge.

If the low threshold is set higher than the high threshold, the high threshold is updated at the same time to the same value. Equally, if the high threshold is set lower than the low threshold, then the low threshold is updated at the same time to the same value.

When both thresholds are set below the operating range of the gauge, then setpoint operation will be disabled.

Query/command	Description
!S754 0;n.nE±nn !S754 1;n.nE±nn	1 setpoint low threshold, 0 setpoint high threshold
?S754 0 ?S754 1	Read setpoint thresholds 1 is low, 0 is high Response "=S754 1;n.nE±nn" or "=S754 0;n.nE±nn"

Note:

- By ensuring the set-point is set to permanently ON, the setpoint can be used to indicate that the gauge is operating correctly.

- The gauge setpoint output state is also be returned in the gauge status and can be read when the gauge pressure query is sent.

5.3.6 Pulsed LED indicator on/off

The LED status indicator can be switched on or off by using the commands below.

Query/command	Description
!S791 n	Set Pulsed LED status indicator n=0 Pulsed LED disabled, n=1 Pulsed LED enabled
?S791	Read Pulsed LED status indicator status reply "=S791 n" n=0 Pulsed LED disabled n=1 Pulsed LED enabled

5.3.7 Parameter control

Gauge commands can be locked to prevent accidental adjustment by sending the command lock to the gauge. When the command lock is set, changes to gauge parameters are prohibited and attempts to adjust will return a gauge state error. The gauge pressure units, gas type and setpoint thresholds can be reset to gauge defaults by sending the return to defaults command.

The following parameters are cleared when returned to default:

- gas type to Nitrogen
- pressure units to Pa
- setpoints to minimum (1 x 10^{-10})
- blinking on
- ATM, VAC, Tube cal all remain unaffected.

Query/command	Description
!S753 n	Set gauge command lock n: 0=unlock 1=lock
!S757 1	Return to default settings

5.3.8 Gauge run parameters

A counter is provided to monitor the run hours of the gauge and this information can be used to aid in determining the best service interval for the gauge tube based on the specific process environment. The run counter can be read and the counter can be reset to zero by sending the reset run hours command to the gauge.

It is possible to read the internal temperature of the microprocessor within the gauge.

Query/command	Description
?V759	Read internal temperature
?V769	Read run hours
!C769 nnnn	Reset run hours nnnn=1234 password

5.3.9 Operation errors

If a gauge error occurs during operation, then the LED indicator illuminates red signifying an error. Refer to *Fault finding* on page 32 for details of how to remedy the situation.

Table 16 Error indication

LED indication			Meaning	Cause
Colour	Change rate			
	On (s)	Off (s)		
Red	0.25	0.25	Tube error	Filament broken, tube not fully inserted, temperature compensator broken
	0.7	0.7	Calibration error	Calibration could not be ach-ieved

If the gauge enters an error state, the condition will latch until the issue is rectified and the error is subsequently acknowledged.

Query/command	Description
!S752 1	Acknowledge error

Note:

When the gauge enters an error state, the relays are switched off, status bits indicate error, pressure indicates zero. Error condition for example calibration error, filament error.

5.4 Bakeout

In some UHV applications it is desirable to bake the vacuum system components to achieve a lower base pressure. The tube of the gauge can be baked to 150 °C but the electronics housing must be removed.

- Refer to *Figure: Replace the gauge tube*, remove the electronics housing.
- Bake the tube on your vacuum system. Do not exceed 150 °C.
- Allow the tube to cool before refitting the electronics housing.

6. Maintenance

6.1 Replace the gauge tube

You must install a replacement tube to the gauge if:

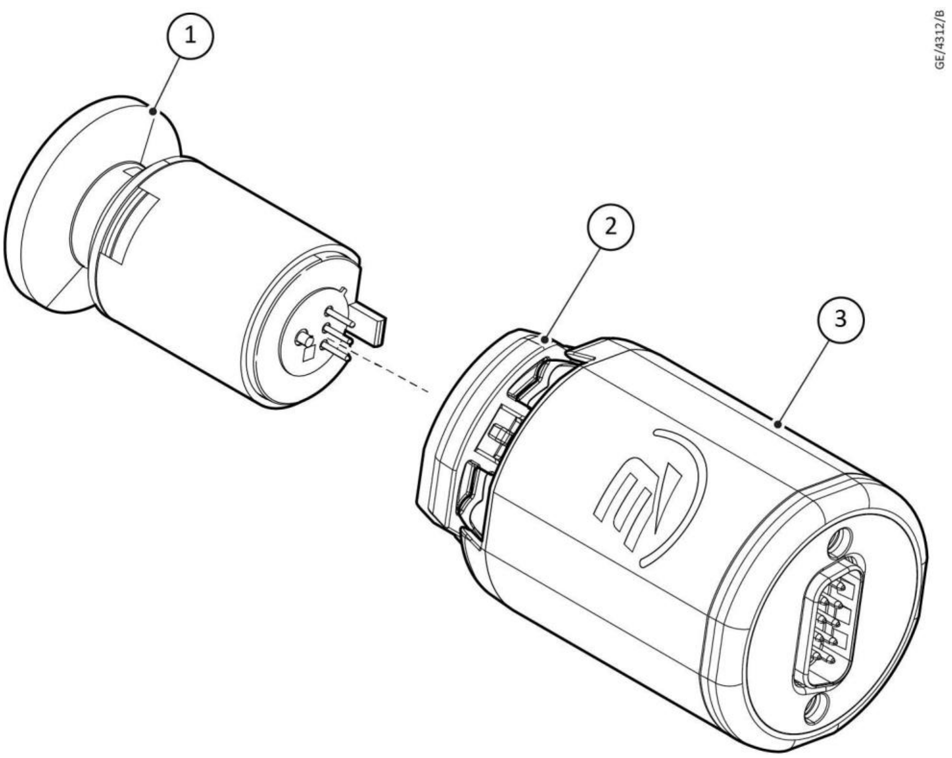
- The gauge tube is contaminated.
- The atmosphere or vacuum adjustment cannot be achieved.
- The filament is broken.

Refer to *Figure: Replace the gauge tube*. To replace the gauge tube:

1. Unplug the electrical cable, vent the vacuum system to atmospheric pressure and remove the gauge from the vacuum system.
2. Pull the retaining clip from side of gauge.
3. Pull the tube from the electronics housing.
4. Install the replacement tube into electronics housing with correct alignment.
5. Install the retaining clip again.

Whenever a new tube is installed it is necessary to adjust the gauge to match the new tube. Refer to *Gauge adjustments* on page 27.

Figure 11 Replace the gauge tube



1. Gauge tube *2. Retaining clip*
3. Electronics housing

7. Fault finding

Table 17 Faults

Fault

Fault	LED not lit
Cause	**Incorrect electrical supply voltage. Supply polarity reversed.**
Remedy	Check the electrical supply and connections.

Fault	Pressure reading incorrect
Cause	**Vacuum leak**
Remedy	Do the leak check of the vacuum system.
Cause	**Tube has drifted and requires adjustment**
Remedy	Do the atmosphere and vacuum adjustments.
Cause	**Tube is contaminated**
Remedy	Replace the tube.
Cause	**Gauge is measuring gas with different thermal conductivity to Nitrogen or Air.**
Remedy	Refer to *Gas dependency* on page 25.
Cause	**Adjustment done at an incorrect pressure**
Remedy	Repeat the adjustment but make sure the pressure is at atmosphere or vacuum.

Fault	Gauge shows calibration error
Cause	**Adjustment done at an incorrect pressure.**
Remedy	Repeat the adjustment but make sure that the pressure is at atmosphere or vacuum.
Cause	**Wrong type of tube is installed.**
Remedy	Check that the correct type of tube is installed (M, MP, or LC).
Cause	**New tube has been installed.**
Remedy	Make the adjustments as given in *Gauge adjustments* on page 27.
Cause	**Tube has drifted outside permissible limits and can not be adjusted.**
Remedy	Replace the tube.

Fault	Gauge shows broken filament
Cause	**Tube is missing.**
Remedy	Install the tube. Remove the electrical connector and insert back.
Cause	**Wrong type of tube is installed.**
Remedy	Check that the correct type of tube is installed (M, MP or LC).
Cause	**Filament is broken.**
Remedy	Replace the tube.

8. Disposal

- Dispose of the gauge, components and accessories safely as per all local and national safety and environmental requirements.
- You can recycle the gauge and cables. Contact us or the supplier for more information.
- The gauge and cables are in the scope of the European Directive on Waste Electrical and Electronic Equipment, 2012/19/EU.
- For European customers we offer a recycling service for the gauge and cables at the end of the product’s life.
- Be careful if the gauge is contaminated with dangerous process substances.

9. Spares

Order the spare parts and accessories from our nearest company or distributor. When you order, give:

- Model and item number of your equipment
- Serial number (if any)
- Item number and description of the part.

Figure 12 Replacement tube spares

Z	D	1	G		A		A	A	A	A

Filament/pressure range

1 : 1x10^{-3} or 5x10^{-4} mbar to 1000 mbar (model dependent)
2 : 1x10^{-4} or 5x10^{-4} mbar to 1000 mbar (model dependent)
(Corrosion resistant filament)
3 : 1x10^{-3} or 5x10^{-4} mbar to 1000 mbar (model dependent)
(Corrosion resistant filament)

Flange

1 : NW16 flange
2 : NW25 flange
5 : 1/8” NPT (male)
6 : Swagelok 4VCR fitting (female)
7 : Swagelok 8VCR fitting (female)
8 : 1/2” OD tube
9 : DN16 conflat flange

Figure 13 Replacement electronics housing

Z	D	1	G			A	1			A

Filament/pressure range

1 : 1x10^{-3} or 5x10^{-4} mbar to 1000 mbar (model dependent)
2 : 1x10^{-4} or 5x10^{-4} to 1000 mbar (model dependent)
(Corrosion resistant filament)
3 : 1 x10^{-3} or 5x10^{-4} mbar to 1000 mbar (model dependent)
(Corrosion resistant filament)

Setpoint

0 : Transistor setpoint
2 : 2 solid state relay setpoint

Connector

1 : RJ45 connector
2 : 9 pin D - subminiature (male)

Voltage output

0 : 2.0 V to 9.0 V log linear with pressure
2 : 1.9 V to 10.0 V log linear with pressure
3 : 2.2 V to 8.5 V log linear with pressure
4 : 1.875 V to 8.875 V log linear with pressure
5 : 2.0 to 10.0 V non linear with pressure

10. Serial command quick reference guide

Table 18 Serial command quick reference guide

ID	Object	Operations and Config ID	Parameter	Notes	Lockable
0	Wildcard gauge type	?S0		Read gauge identity: Hardware version, Software version, Name	
750	Node address (RS485 build only)	!S750	nn	Set Node Address: 00 = Multi-drop disabled (default) 01-98 = Multi-drop enabled	✓
		?S750		Read Node Address	
751	Gauge type	!S751	nnnn	Set gauge name: 0000 to 9999	✓
		?S751		Read gauge identity: Hardware version, Software version, Name	
752	Gauge control	!S752	n	Acknowledge gauge errors: 1 = Acknowl-edge	
		?V752		Read gauge pressure: pressure, status bits	
753	Gauge command lock	!S753	n	Set gauge command lock: 0 = editable 1 = locked	

ID	Object	Operations and Config ID	Parameter	Notes	Lockable
754	Setpoint	!S754 0;	n.nE±nn	Set high setpoint threshold: 1.0×10^{-10} to 9.9×10^{6} must be ≥ Low threshold	✓
		?S754 0		Read high setpoint threshold	
		!S754 1;	n.nE±nn	Set low setpoint threshold: 1.0×10^{-10} to 9.9×10^{6} must be ≤ High threshold	✓
		?S754 1		Read low setpoint threshold	
755	Pressure units	!S755	n	Set pressure units: 1 = mbar 2 = Pascal (default) 3 = Torr	✓
756	Gas type	!S756	n	Set gas type: 0 = Nitrogen / Air (Default) 1 = Argon 2 = Helium 3 = Carbon Dioxide 4 = Neon 5 = Krypton 6 = Xenon	✓
757	Return to defaults	!S757	n	Reset all user settings to default: 1 = reset pressure units, gas type, LED pulsing and setpoint thresholds	✓
759	Internal temperature	?V759		Read internal temperature	

ID	Object	Operations and Config ID	Parameter	Notes	Lockable
760	Clear calibration	!S760	n	Clear atmosphere and vacuum calibration, reset LED pulsing: 1 = set calibrations to de-fault values	✓
761	Pirani calibration	!S761 0;	nnnn	Trigger Tube Calibration 1234 = password protection	✓
		!S761 1;	n	Calibrate atmosphere and vacuum: 1 = calibrate at current pressure	✓
769	Run hours	!C769	nnnn	Clear all Run hours counters 1234 = pass-word protection	✓
		?V769		Read gauge run hours: Run hours	
780	Baud rate	!C780	n	Set baud rate: 1 = 38400 2 = 19200 4 = 9600 (default) 5 = 115200 6 = 230400	✓
781	Auto-enumerate (RS485 build only)	!C781	n	Auto-enumerate node address: 0 = Off - replies enabled 1 = On - replies disabled 2 = Auto - replies disabled and node address randomised	✓
790	Serial number	?S790	-	Read gauge serial number	-
791	LED Pulsing	!S791	n	Set LED pulsing status: 0 = LED pulsing disable 1 = LED pulsing enable	-
		?S791	-	Read LED pulsing status	

11. Service

11.1 Return the equipment or components for service

Before you send your equipment to us for service or for any other reason, you must send us a completed Declaration of Contamination of Vacuum Equipment and Components – Form HS2. The HS2 form tells us if any substances found in the equipment are hazardous, which is important for the safety of our employees and all other people involved in the service of your equipment. The hazard information also lets us select the correct procedures to service your equipment.

We provide instructions for completing the form in the Declaration of Contamination of Vacuum equipment and Components – Procedure HS1.

Download the latest documents from *edwardsvacuum.com/HSForms/*, follow the procedure in HS1, fill in the electronic HS2 form, print it, sign it, and return the signed copy to us.

NOTICE:

If we do not receive a completed HS2 form, your equipment cannot be serviced.

P20010450B

EU Declaration of Conformity

This declaration of conformity is issued under the sole responsibility of the manufacturer:

Edwards Ltd
Innovation Drive
Burgess Hill
West Sussex
RH15 9TW
UK

Documentation Officer
Jana Sigmunda 300
Lutín , 78349
Czech Republic
T: +42(0) 580 582 728
documentation@edwardsvacuum.com

APG200 Active Pirani Gauge
nAPG200 Active Pirani Gauge

Is in conformity with the relevant Union harmonisation legislation:

2014/30/EU	Electromagnetic compatibility (EMC) directive Class B Emissions, Industrial Immunity
2011/65/EU	Restriction of certain hazardous substances (RoHS) directive as amended by Delegated Directive (EU) 2015/863

Based on the requirements of relevant harmonised standards and technical documentation:

EN 61326-1:2013	Electrical equipment for measurement, control and laboratory use. EMC requirements. General requirements
EN IEC 63000:2018	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

This declaration, based on the requirements of the listed Directives and EN ISO/IEC 17050-1, covers all product serial numbers from this date on: *2022-06-21*

You must retain the signed legal declaration for future reference
This declaration becomes invalid if modifications are made to the product without prior agreement.

Nick Barratt - Engineering Manager, Eastbourne

Ed Neuss – General Manager, Eastbourne

This product has been manufactured under a quality management system certified to ISO 9001:2015

P20010450B

Declaration of Conformity

Edwards Ltd
Innovation Drive
Burgess Hill
West Sussex
RH15 9TW
UK

Documentation Officer
documentation@edwardsvacuum.com

This declaration of conformity is issued under the sole responsibility of the manufacturer.

APG200 Active Pirani Gauge
nAPG200 Active Pirani Gauge

The object of the declaration described above is in conformity with relevant statutory requirements:

Electromagnetic Compatibility Regulations 2016
Class B Emissions, Industrial Immunity

Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012

Relevant designated standards or technical specifications are as follows:

EN 61326-1:2013	Electrical equipment for measurement, control and laboratory use. EMC requirements. General requirements
EN IEC 63000:2018	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

This declaration, based on the requirements of the listed Statutory Instruments and EN ISO/IEC 17050-1, covers all product serial numbers from this date on: *2022-06-21*

You must retain the signed legal declaration for future reference
This declaration becomes invalid if modifications are made to the product without prior agreement.

Signed for and on behalf of Edwards Ltd

Nick Barratt - Engineering Manager, Eastbourne

Ed Neuss – General Manager, Eastbourne

This product has been manufactured under a quality management system certified to ISO 9001:2015

ADDITIONAL LEGISLATION AND COMPLIANCE INFORMATION

RoHS (EU, UK): Material Exemption Information
This product is compliant with the following Exemptions
Annex III:

- 6(b) **Lead** as an alloying element in aluminium containing up to 0.4% by weight
- 6(c) Copper alloy containing up to 4% **lead** by weight
- 7(a) **Lead** in in high melting temperature type solder (i.e. lead based alloys containing 85% by weight or more lead)
- 7(c) I Electrical and electronic components containing **lead** in a glass or ceramic other than dielectric ceramic in capacitors, e.g. piezoelectronic devices, or in a glass or ceramic matrix compound

REACH (EU, UK)
This product is a complex article which is not designed for intentional substance release. To the best of our knowledge the materials used comply with the requirements of REACH. The product manual provides information and instruction to ensure the safe storage, use, maintenance and disposal of the product including any substance based requirements.

Article 33.1 Declaration (EU, UK)
This product contains Candidate List Substances of Very High Concern above 0.1%ww by article as clarified under the 2015 European Court of Justice ruling in case C-106/14.

- Lead (Pb)
  This substance is present in certain aluminium / brass / electrical or electronic components.

Additional Applicable Requirements

The product is in scope for and complies with the requirements of the following:

2012/19/EU	Directive on waste electrical and electronic equipment (WEEE)
Product is certified to CSA-C22.2 No.61010-1-12	Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements TÜV Rheinland certificate no. CU72225965
Product is certified to UL61010-1 3rd Edition	Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements TÜV Rheinland certificate no. CU72225965

材料成分声明
China Material Content Declaration

	有害物质 Hazardous Substances					
部件名称 Part name	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr VI)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
铸铝及铝合金制品 Aluminium alloys	X	O	O	O	O	O
印刷电路组件 (PCA) Printed Circuit Assembly (PCA)	X	O	O	O	O	O

O: 表示该有害物质在该部件的所有均质材料中的含量低于 GB/T 26572 标准规定的限量要求。
O: Indicates that the hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in GB/T 26572.

X: 表示该有害物质在该部件的至少一种均质材料中的含量超出 GB/T26572 标准规定的限量要求。
X: Indicates that the hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement of GB/T26572.

This product has been manufactured under a quality management system certified to ISO 9001:2015