Leybold

Digital Penningvac Transmitter

PTR225RN

PTR90RN

Operating instructions 301106082_002_C1

Original instructions

Copyright notice

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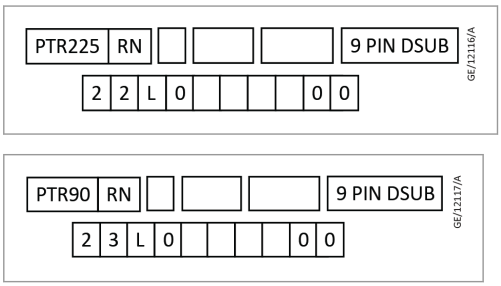
We accept no liability for loss of profit, loss of market or any other indirect or consequential loss whatsoever.

Product warranty and limit of liability are dealt with in our standard terms and conditions of sale or negotiated contract under which this document is supplied.

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

Numbering matrix



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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.

The instruction manual is an important safety document that we often deliver digitally. It is your responsibility to keep the instruction manual available and visible while working with the equipment. Please download the digital version of the instruction manual for use on your device or print it if a device will not be available.

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 Trained personnel

For the operation of this equipment “trained personnel” are:

- skilled workers with knowledge in the fields of mechanics, electrical engineering, pollution abatement and vacuum technology and
- personnel specially trained for the operation of vacuum pumps

Safety and compliance

1.3 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** Risk of injury and/or damage to equipment. An appropriate safety instruction must be followed or a potential hazard exists.
	**Warning - Dangerous voltage** Risk of injury. Identifies possible sources of hazardous electrical shock.
	**Warning - High magnetic field** Risk of injury or damage to equipment. Identifies a possible source of a magnetic field capable of disrupting equipment including pacemakers.
	**Warning - Risk of explosion** Risk of injury or damage to equipment. Identifies a situation that could result in an explosion.
	Warning - Overpressure Risk of increased pressure beyond permissible limit.
	WEEE symbol The equipment must be discarded carefully. Obey local and national regulations for disposal of this equipment.
	Warning - Magnetic field High magnetic fields may be present. Pacemakers or other similar implanted devices may be affected.

2 Introduction

2.1 Description

The PTR225RN and PTR90RN are inverted magnetron vacuum gauges. The pressure is measured indirectly as a function of the current which flows in a crossed field Townsend discharge generated within the magnetron cell.

The PTR225RN and PTR90RN are digital gauges. 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.

The PTR90RN is considered a wide range gauge as it additionally incorporates a Pirani filament. Using the principle of thermal conductivity in which the rate of heat loss from a heated filament is dependent on the pressure of the gas surrounding the filament, it is possible to indirectly measure up to atmospheric pressure. The Pirani reading at vacuum is adjusted automatically.

The PTR90RN also incorporates a unique striking mechanism consisting of a small incandescent filament mounted adjacent to the magnetron cell. This filament is automatically ignited, providing enough emission electrons to initiate the discharge.

The gauges incorporate microprocessor control of various features:

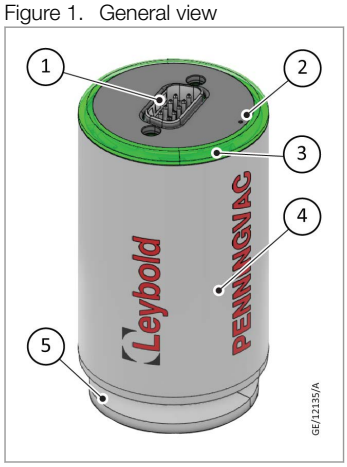
- Automatic control of the discharge voltage in the magnetron cell during the ignition of the gauge.
- Reduction of the discharge voltage in the magnetron cell after ignition in order to enhance the lifetime of the gauge.
- Error monitoring to help identify the exact cause of failure.
- Simple adjustment of setpoint trip level.

Referring to *Figure: General view*:

- The gauge has a detachable tube that allows the replacement of the tube or electronics housing in the event of failure.
- An LED indicator surrounding the circumference of the top of the gauge provides a status indication and aids the adjustment of the gauge when you navigate through the menus.
- The gauge is available with different vacuum flanges to integrate with the customer process.

Introduction

Figure 1. General view



1. *Electrical connector*
2. *(Not used on digital gauges)*
3. *LED indicator*
4. *Electronics housing*
5. *Vacuum flange*

2.2 Item number and description matrix

The range of PTR225RN and PTR90RN 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
Setpoint	Transistor setpoint or solid state relay
Flange	Different vacuum flanges are available
Communications protocol	Gauges are available with RS232 or RS485 protocols

Figure 2. Item description matrix

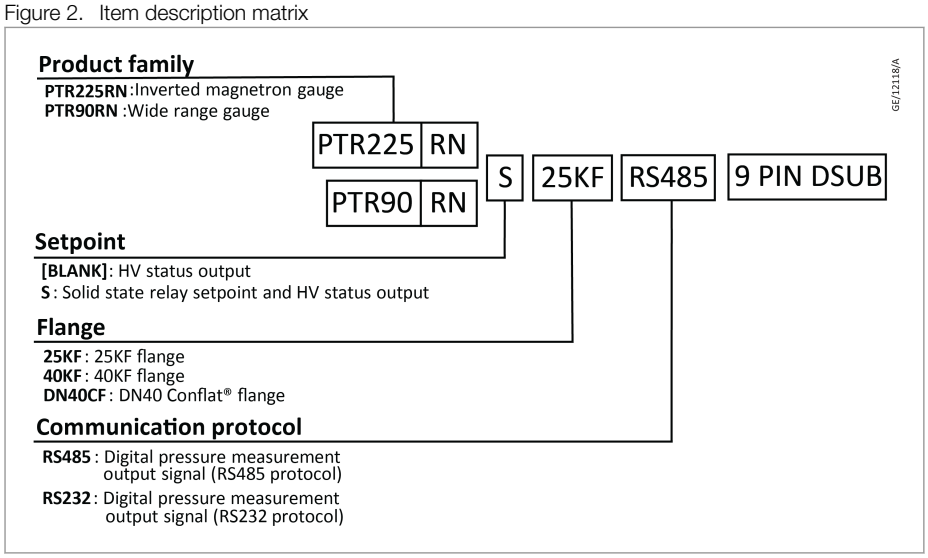
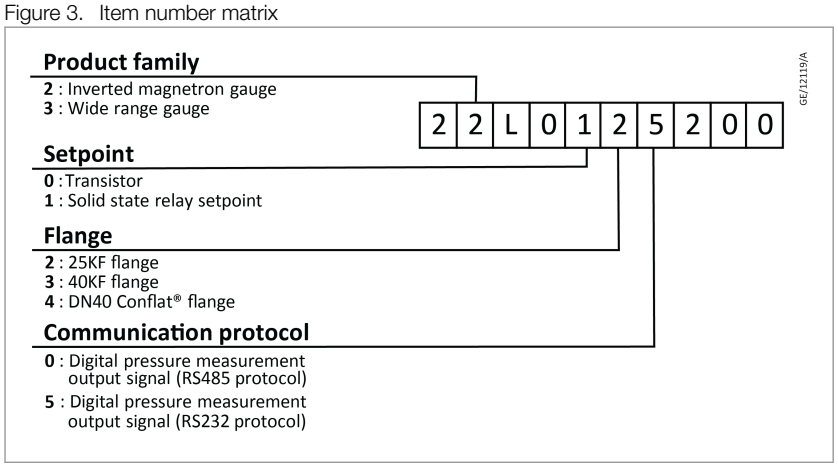


Figure 3. Item number matrix



3 Technical data

3.1 Operating and storage conditions

Table 2. Operating and storage conditions

Parameter	Value	
	PTR225RN	PTR90RN
Ambient operating temperature range	+5 °C to +60 °C Indoor use only	
Ambient storage temperature range	-30 °C to +70 °C	
Bakeout temperature	150 °C with electronics removed	
Humidity	80% RH up to 31 °C decreasing 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	
Pirani filament temperature	N/A	≈95 °C
Striking aid temperature	N/A	≈1500 °C

3.2 Manufacturing materials

Table 3. Materials exposed to vacuum

Where used	Material exposed to vacuum	
	PTR225RN	PTR90RN
Tube	Stainless steel 316L, 304L	
Magnetron cell	Stainless steel 304, 430	
Feedthrough	Stainless steel 304, Mo, Ni-Fe, glass	
Pirani filament	N/A	W
Striking aid	N/A	W

3.3 Performance data

Table 4. Performance data PTR225RN and PTR90RN

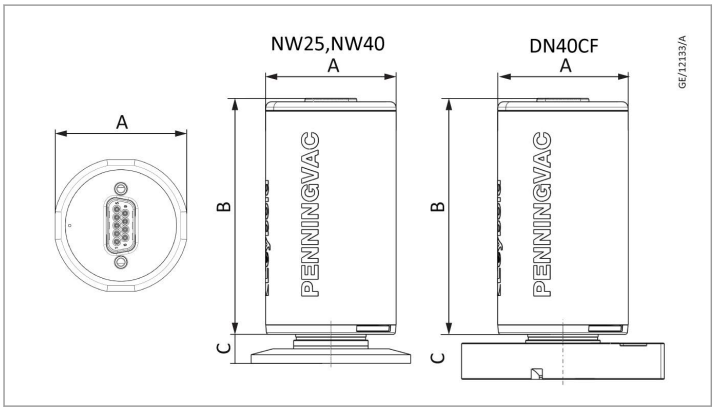
	Pressure range	Typical accuracy N_2
PTR225RN	1×10^{-9} – 1×10^{-2} mbar	±30 % reading
PTR90RN	1×10^{-9} – 1×10^{3} mbar	±30 % reading up to 1×10^{-3} mbar, ±15 % reading to 10 mbar

3.4 Mechanical data

Table 5. Mechanical data

Characteristic		Value	Units
Dimensions		Refer to *Dimension drawing* on page 13	mm
Enclosure rating		IP40	-
Mass	NW25	350	g
	NW40	380	
	DN40CF	630	
Internal volume of tube			
Flange	NW25	≈20	cm^3
	NW40		
	DN40CF		

3.5 Dimension drawing



	Dimension (mm)		
Flange	**A**	**B**	**C**
NW25	45	82	10
NW40	45	81.5*	10
DN40CF	45	81.5*	15.5

3.6 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	
PTR225RN	4 W
PTR90RN	
Maximum inrush current	
PTR225RN	220 mA
PTR90RN	270 mA

Parameter	Data
Electrical connector	9 pin D-SUB male
ID resistor	10 kΩ

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

3.7 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 d.c. relay is connected, refer to *Figure: PTR225RN and PTR90RN 9 pin 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

3.8 Serial communications

Table 9. Serial communications

Parameter	Value
RS232 transmit	
▪ Mark ▪ Space	▪ < -8 V (I_{in} maximum: -8 mA) ▪ > +8 V (I_{out} maximum: +8 mA)
RS232 Receive	
▪ 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	230400 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, inform the supplier and carrier in writing in three days. Provide the below:
   - item number of the gauge
   - order number
   - supplier invoice number of the gauge.
4. Keep packing materials for inspection.
5. Do not use the product if it is damaged.
6. If the system is not to be used immediately, put the protective cover and packing materials on the gauge.
7. Store the gauge in applicable conditions. Refer to *Operating and storage conditions* on page 12.

Check that your package contains the following items:

Table 10. Checklist of items

Quantity	Description	Check
1	Vacuum gauge	❑
1	Test report	❑
1	Instruction manual	❑
1	Electronics housing removal tool	❑

4.2 Install the gauge

WARNING: HIGH PRESSURE

Risk of damage to equipment. Use an O-ring with and an outer centring ring 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 the factory, the gauge is mounted horizontally and calibrated for nitrogen.
3. Mount the gauge tube in vertical direction to minimise the build up of process particulates and condensable vapours within the gauge.
4. PTR225RN only: For the correct pressure indication at the direction of the installed gauge, calibrate the gauge again at atmospheric pressure.

5. PTR90RN only: For precision, we recommend that the atmosphere and vacuum adjustment must be done before use. Refer to *PTR90RN adjustment* on page 27.

4.3 Gauge connections

4.3.1 Connect the gauge to vacuum system

To connect the gauge to the vacuum system:

1. Use an O-ring with an outer centring ring to connect the gauge with an NW25 or NW40 flange to a similar flange on the vacuum system.
2. Use a new copper gasket to connect the gauge with a DN40CF flange to a similar flange on the vacuum system.
3. Make sure that the vacuum system has a correct earth (ground) connection.
4. Connect the tube of the gauge to the vacuum system.

4.3.2 Connect the gauge to electrical system

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 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 PTR225RN and PTR90RN electrical connector*.

Refer to *Technical data* on page 12 for more specifications.

Figure 4. Electrical connector

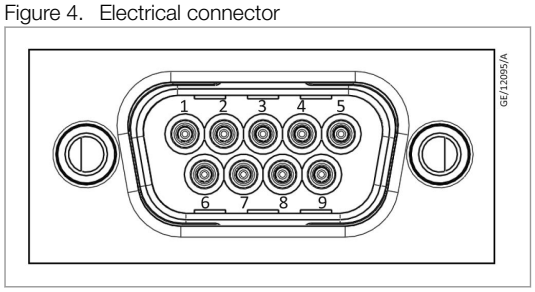
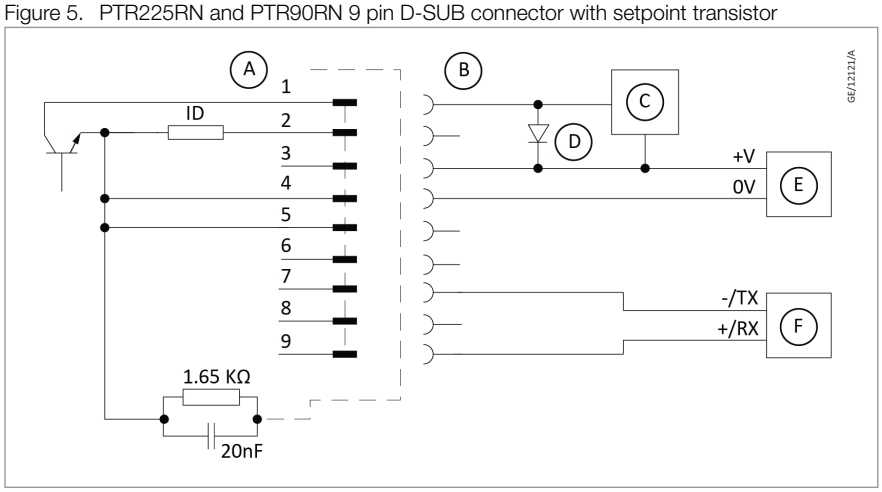


Table 11. Pins on the PTR225RN and PTR90RN electrical connector

Recommended electrical connection	Setpoint transistor	Solid state relay
Pin	**Refer to** *Figure: Electrical connector*.	
1	Setpoint output signal	Relay closing contact
2	ID resistor	
3	Electrical supply positive	
4	Electrical supply ground (0V)	
5	RS485/RS232 common	
6	Not connected	Relay common
7	RS485 negative/RS232 transmit	
8	No connection	
9	RS485 positive/RS232 receive	

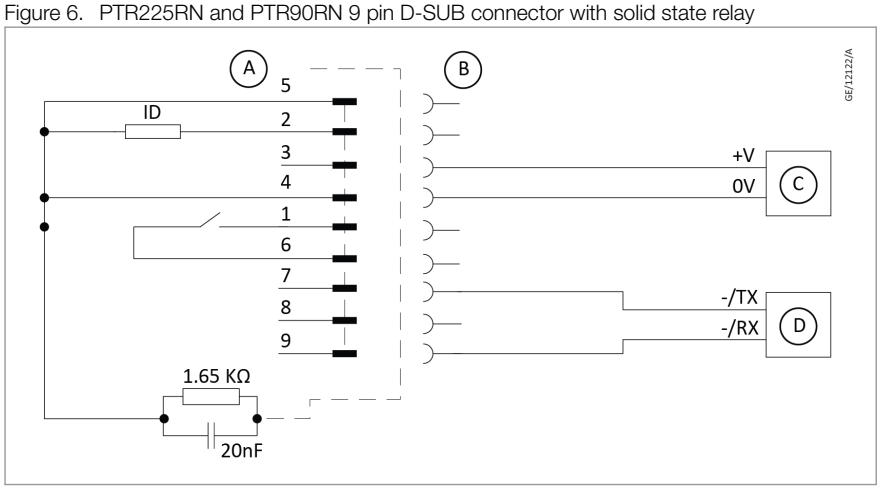
Recommended electrical connections

Figure 5. PTR225RN and PTR90RN 9 pin D-SUB connector with setpoint transistor



A. Gauge
B. Connector
C. DC relay (optional)
D. Back EMF suppression diode (optional)
E. Electrical supply
F. RS485/RS232 serial communication

Figure 6. PTR225RN and PTR90RN 9 pin D-SUB connector with solid state relay



A. Gauge
B. Connector
C. Electrical supply
D. RS485/RS232 serial communication

Note:
For setpoint transistor variants only, the setpoint output is an active low open-collector transistor capable of operating 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 turned off.
Refer to *Table: Pins on the PTR225RN and PTR90RN electrical connector* for additional 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 (24AWG)
15 V	100 m
48 V	1000 m

4.5 Connect the serial interface

CAUTION: VOLTAGE DIFFERENCE

Risk of damage to equipment, if voltage differences exist in the local ground voltage as all the ground connection are tied together. If the gauges being connected experience 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.

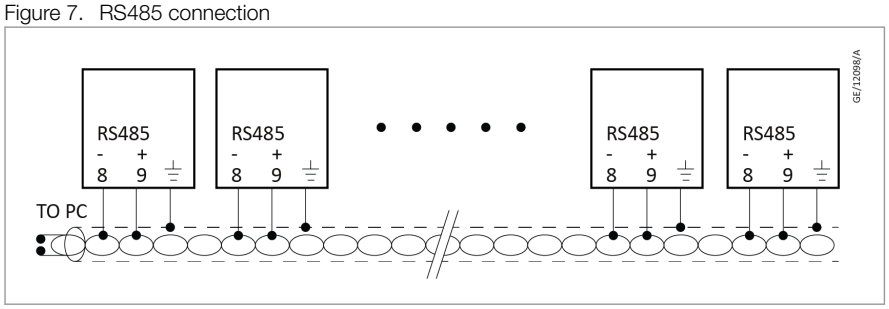
It is recommended that shielded cable be used for the interface to reduce interference problems and the length of the RS232 link should be less than 10 m. For longer links, either install line drivers or use RS485.

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 m. Long links may require the addition of 120 Ω terminating resistors at each end of the link to improve communication reliability.

Figure 7. RS485 connection



5 Operation

WARNING: MAGNETIC FIELD

Risk of injury. Magnetic field may interfere with pacemakers. Maintain a distance of minimum 10 cm between the gauge and the heart pacemaker. Use anti-magnetic shields to prevent the influence of the strong magnetic field.

WARNING: MAGNETIC FIELD

Risk of injury or damage to equipment. The gauge incorporates magnets. Keep away from heart pacemakers, computers, credit cards and any other magnetically sensitive devices.

WARNING: EXPLOSION HAZARD

Risk of injury or damage to equipment. Do not use the gauge to measure explosive or flammable gases or mixtures.

WARNING: ELECTRICAL HAZARD

Risk of electric shock. Do not disconnect the electronics and magnet housing from the body tube when the body tube is connected to the vacuum system. If there is a plasma discharge in the vacuum system near the body tube, the body tube can become electrically charged.

PTR225RN:

WARNING: ELECTRICAL HAZARD

Risk of injury or damage to equipment. Never operate the PTR225RN when is it disconnected from the vacuum system or when there are explosive or flammable gases in the surrounding atmosphere or the vacuum system. High voltages (up to 4.5 kV) are generated inside the body tube of the PTR225RN; these could cause injury to people or could be a source of ignition.

CAUTION: GAUGE MALFUNCTION

Risk of damage to equipment. Do not operate the gauge at pressures above 1 x 10^{-2} mbar. If the gauge is operated at pressures greater than 1 x 10^{-2} mbar it may fail prematurely.

PTR90RN:

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.

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 and a striker filament which operates approximately at 1500 °C. The temperature of the filaments can be higher in fault conditions.

Refer to the digital gauge range serial communications manual (300980367) for details of the serial command protocol and message format and summary of serial query/ commands in *Serial command quick reference guide* on page 40.

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:

PTR225RN:

- Blue - gauge is disabled
- Flashing yellow - gauge initiating discharge in the magnetron cell (striking)
- Green - gauge is operating correctly
- Red - an error is detected. Refer to *Fault finding* on page 34.

PTR90RN:

- Green - gauge is operating correctly
- Red - an error is detected. Refer to *Fault finding* on page 34.

Normal operation

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

Table 13 LED pattern PTR225RN

Pressure band	LED Pattern PTR225RN		
	Colour	Change Rate	
		High intensity (s)	Low intensity (s)
Pressure ≤ 1 x 10^{-6} mbar	Green	Continuous	N/A
1 x 10^{-6} < Pressure ≤ 1 x 10^{-4} mbar		0.5	0.5
Pressure > 1 x 10^{-4} mbar		1	1

Table 14 LED pattern PTR90RN

Pressure band	LED Pattern PTR90RN		
	Colour	Change Rate	
		High intensity (s)	Low intensity (s)
Pressure ≤ 1 x 10^{-4} mbar	Green	Continuous	N/A
1 x 10^{-4} < Pressure ≤ 1 x 10^{-1} mbar		0.5	0.5
Pressure > 1 x 10^{-1} mbar		1	1

The pulsing operation (low intensity/high intensity) is switched on by default but can be disabled (refer to Pulsed LED indicator on/off). 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 34.

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 ! 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 or 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 24 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 formats

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 15. Response error codes

Error code	Meaning
00	Acknowledge – no error
01	Invalid command for object ID
02	Invalid query / command
03	Missing parameter
04	Parameter out of range
05	Invalid command in current state
06	Data checksum error
07	EEPROM read or write error
08	Operation timeout
09	Invalid config ID

Note:
Refer to the digital gauge range serial communications manual (300980367) for full details of the serial command protocol and message format. This includes further information on command error codes.

5.2.4 Communication 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 16. Communication timings

Command examples vs Baud rate:		**9600 (ms)**	**19200 (ms)**	**38400 (ms)**
Gauge type	?S751<cr>	48.0	24.0	12.0
	=S751 NNNxxx-NN_N_RSxxx; DnnnnnnnnX;nnnn<cr>			
+ 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>	27.1	13.5	6.8
	=V752 n.nnE±nn;nnnn<cr>			
+ µP Latency	-	+3.5	+3.5	+3.5
Estimated latency - fastest		≈30.6	≈17	≈10.3

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 17. Gauge status bits

BIT	Status flag	Meaning	PTR225RN	PTR90RN
0	Gauge Err	Gauge specific error active*	✓	✓
1	Mag ON	Gauge magnetron on or off	✓	✓
2	SPOP ON	Setpoint on or off	✓	✓
3	Gauge LK	Gauge parameters locked	✓	✓
4	Pressure units	Gauge pressure units: 1=mbar, 2=Pa (Default), 3=Torr	✓	✓
5				
6	FlashEE Err	All stored parameters and calibrations defaulted	✓	✓
7	Calibrating	Calibration in progress - pressure reading invalid	✓	✓
8	Mag Str	Magnetron striking	✓	✓
9	Mag Str Fail	Magnetron striking failure (Not Struck)	✓	✓
10	Pir Fil Err	Pirani failure	×	✓
11	Str Fil Err	Striker filament failure	×	✓
12	Gas type	Gauge gas type: 0 = nitrogen 1 = argon 2 = helium 3 = carbon dioxide 4 = neon 5 = krypton 6 = xenon	✓	✓
13				
14				
15	Mag Exposure	Magnetron exposure threshold exceeded†	✓	✓

* Gauge specific errors are bits 6 to 11 inclusive.

† Gauge status flag with user settable magnetron exposure threshold.

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 40 and refer to digital gauge range serial communications manual (300980367) 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 *Gauge status bits* on page 26 for details of the gauge status bit status.

Note:
In order to measure pressure, the PTR225RN must first be enabled to allow the gauge to strike. The PTR90RN gauge is enabled automatically.

Query/command	Description
?V752	Read gauge pressure and status
!S752	Acknowledge gauge errors
!C752	Set gauge strike control
?C752	Read gauge strike control*
!S755	Set pressure units

* Not applicable to PTR225RN.

5.3.3 Gas dependency

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

The correct gas type must be first be selected from 7 common gases: nitrogen, argon, helium, carbon dioxide, neon 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.

5.3.4 PTR90RN adjustment

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 dry 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 progress 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 x 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 progress 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 dry air. Supply power to the gauge, make sure that the LED indicator is green.
2. Initiate the tube 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 progress bit will be cleared when the adjustment is complete.
5. After performing tube adjustment, atmosphere and vacuum adjustment is recommended.

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 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})
- Pulsed LED to on
- PTR90RN only: 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, the number of hours the magnetron has been operating and the cumulative magnetron pressure exposure in pressure x hours. 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
!S769	Set magnetron exposure threshold
?S769	Read magnetron exposure threshold

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 34 for details of how to remedy the situation.

Table 18. Error indication

LED indication			Meaning	Cause
Colour	Change rate			
	On (s)	Off (s)		
Red	0.5	0.5	EEPROM error	Gauge memory corrupted
			Pirani filament error	Calibration could not be achieved, calibration performed at incorrect pressure, filament broken, temperature compensator broken, tube not fully inserted
			Striker filament error	Striker filament broken
			Striking error	Inverted magnetron did not strike within 15 minutes of being enabled

If the gauge enters an error state, the condition will be held 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 *Replace the gauge tube*.
- 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:

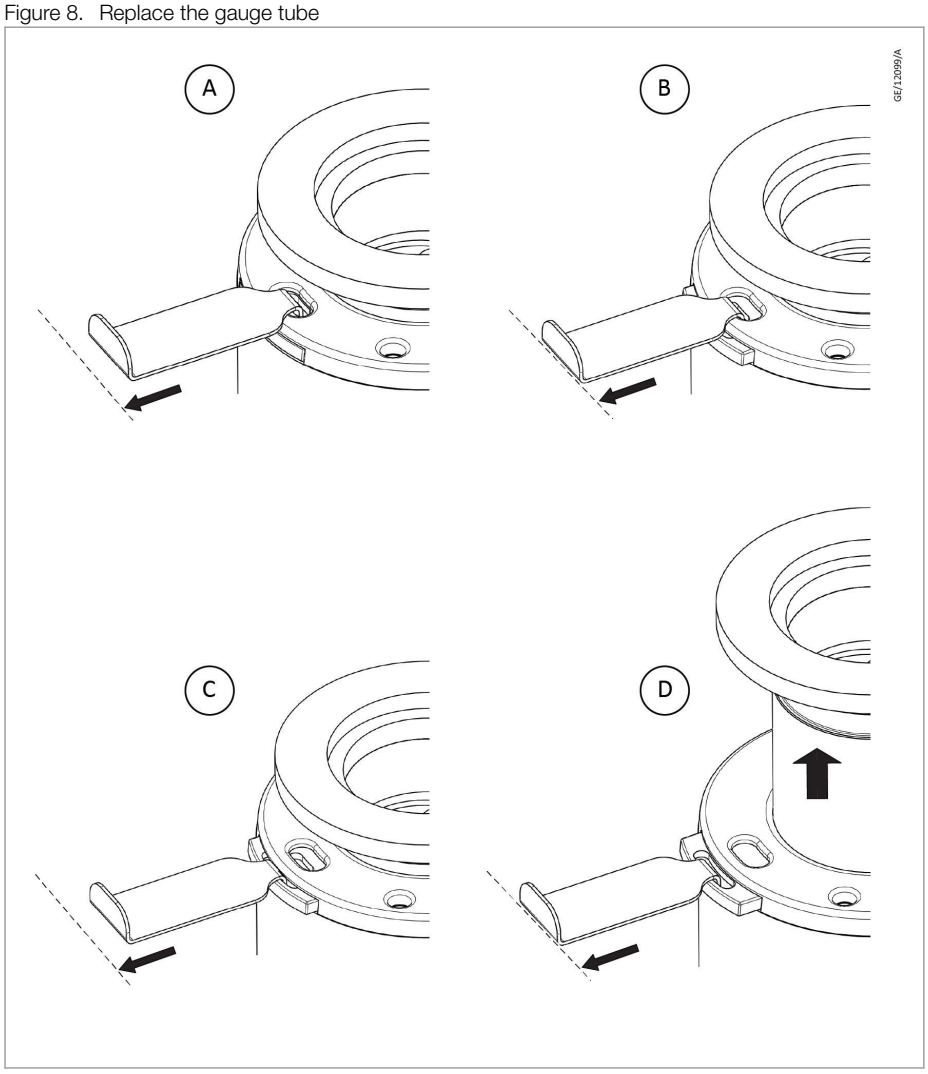
- the gauge tube is contaminated
- (PTR90RN only) the atmosphere or vacuum adjustment cannot be achieved
- (PTR90RN only) the filament is broken.

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. Referring to images A and B, using the electronics housing removal tool supplied with the product, insert the tool into the underside of the electronics housing and partially pull out the retaining clip from the side of the gauge.
3. Referring to image C and D, place the housing removal tool directly into the retaining clip and gently release the clip.
4. Pull the tube from the electronics housing.
5. Install the replacement tube into the electronics housing with the correct alignment ensuring that the tube is pressed fully home.
6. Lock the tube in place by pressing the retaining clip fully home. The clip should appear as in image A.

Whenever a new PTR90RN tube is installed it is necessary to adjust the gauge to match the new tube. Refer to *PTR90RN adjustment* on page 27.

Figure 8. Replace the gauge tube



7 Fault finding

Table 19. Faults

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

Fault	No reply to communication
Cause	**Incorrect electrical supply voltage. Supply polarity reversed**
Remedy	Check the electrical supply and connections.
Cause	**Incorrect communications interface or serial comms connections reversed**
Remedy	Check communications interface and connections.
Cause	**Incorrect baud rate selected**
Remedy	Check all supported baud rates.
Cause	**Incorrect multi-drop address selected**
Remedy	Check gauge node address setting by using the wildcard node address on a point-to-point communications connection.
Cause	**Communications collisions due to multiple gauges connected on a point-to-point system, or a duplicate node address on a multi-drop system**
Remedy	Check gauge node address setting by using the wildcard node address on a point-to-point communications connection.
Cause	**Replies disabled during auto-enumeration**
Remedy	Make sure replies are enabled.

Fault	Pressure reading incorrect
Cause	**Vacuum leak**
Remedy	Leak check vacuum system.
Cause	**Incorrect pressure units selected**
Remedy	Check pressure units setting.

Cause	**New tube has been installed***
Remedy	Perform Adjustment for new tube.
Cause	**Pirani filament 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 properties to that of nitrogen or dry air**
Remedy	Refer to *Gas dependency* on page 27.
Cause	**Adjustment undertaken at incorrect pressure***
Remedy	Repeat the adjustment but make sure the pressure is at atmosphere or vacuum.

* Not applicable to PTR225RN.

Fault	**Gauge shows Pirani error***
Cause	**Pirani filament broken**
Remedy	Replace the tube.
Cause	**Adjustment done at incorrect pressure**
Remedy	Repeat the adjustment but make sure the pressure is at atmosphere or vacuum.
Cause	**Tube has drifted outside permissible limits and can no longer be adjusted**
Remedy	Replace the tube.
Cause	**New tube has been installed**
Remedy	Perform Adjustment for new tube.
Cause	**Tube has not been correctly fitted into electronics housing**
Remedy	Ensure that the tube has been fully pushed home and the retaining clip correctly fitted in place.
Cause	**Temperature compensator open circuit**
Remedy	Replace the tube.

* Not applicable to PTR225RN.

Fault	**Gauge shows striker filament error***
Cause	**Striker filament is broken**
Remedy	Replace the tube.

* Not applicable to PTR225RN.

Fault	**Gauge shows striking error**
Cause	**The gauge is contaminated and has not struck within 30 minutes**
Remedy	Replace the gauge tube.

Fault finding

Cause	**The gauge has been switched on at too low a pressure**
Remedy	Raise the pressure to > 1 x 10^{-9} mbar and switch on the gauge.

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 equipment
- serial number (if any)
- item number and description of the part.

Figure 9. Replacement tube spares

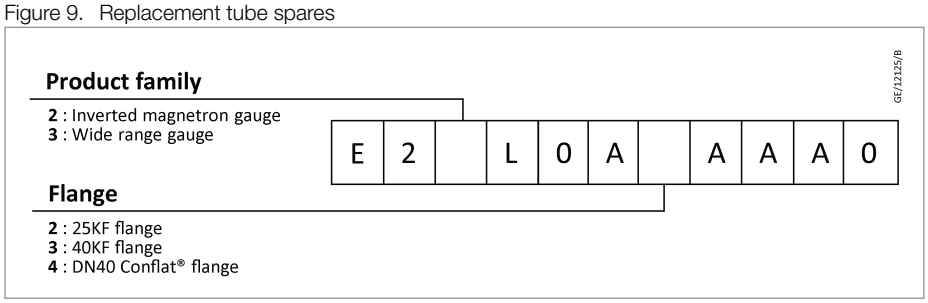
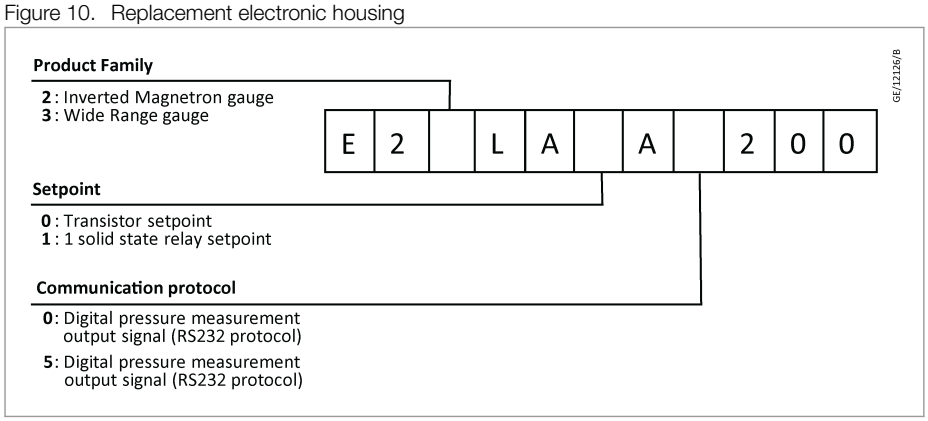


Figure 10. Replacement electronic housing



10 Accessories

Table 20. Active gauge cable - type H

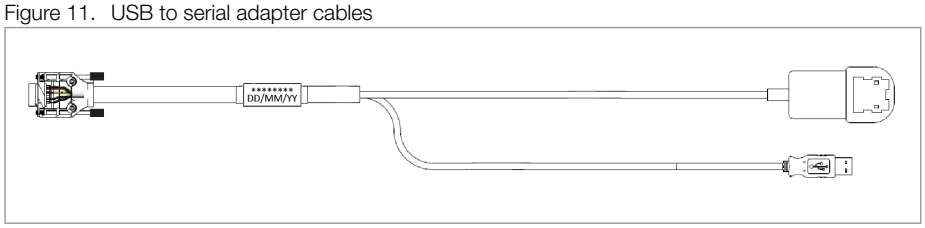
Cable length	Item number
H "RN" 5 m (15 feet)	230560V01
H "RN" 10 m (30 feet)	230561V01
H "RN" 20 m (60 feet)	230563V01

Table 21. USB to serial adapter cables

Description	Item number
USB PWR/SER adapter RS232 D-SUB LEY	230566V01
USB PWR/SER adapter RS485 D-SUB LEY	230562V01

These cables include a 24 V power supply and provide a complete solution for configuring a digital gauge.

Figure 11. USB to serial adapter cables



11 Serial command quick reference guide

Table 22 Serial command quick reference guide

ID	Object	Operations and Config ID	Parameter	Notes	Lockable	PTR225RN	PTR90RN
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	!C752	n	Set gauge strike control 0 = Off 1 = On		✓	✓
				2 = Auto		×	✓
		?C752		Read gauge control		×	✓
		!S752	n	Acknowledge gauge errors: 1 = Acknowledge		✓	✓
		?V752		Read gauge pressure: pressure, status bits		✓	✓

Serial command quick reference guide

ID	Object	Operations and Config ID	Parameter	Notes	Lockable	PTR225RN	PTR90RN
753	Gauge command lock	!S753	n	Set gauge command lock: 0 = editable 1 = locked		✓	✓
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	n.nE±nn	Read high setpoint threshold		✓	✓
		!S754 1;		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	✓	✓	✓

Serial command quick reference guide

ID	Object	Operations and Config ID	Parameter	Notes	Lockable	PTR225RN	PTR90RN
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		×	✓
760	Clear calibration	!S760	n	Clear atmosphere and vacuum calibration, reset LED pulsing: 1 = set calibrations to default 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 = password protection	✓	✓	✓
		?V769		Read gauge run hours: Run hours		×	×
				Read gauge run hours: Run hours; magnetron hours; magnetron exposure		✓	✓
		!S769	n.nE±nn	Set exposure threshold 0.0E±00 Pa/Hrs (default = Off)	✓	✓	✓
		?S769		Read exposure threshold		✓	✓
780	Baud rate	!C780	n	Set baud rate: 1 = 38400 2 = 19200 4 = 9600 (default) 5 = 115200 6 = 230400	✓	✓	✓

Serial command quick reference guide

ID	Object	Operations and Config ID	Parameter	Notes	Lockable	PTR225RN	PTR90RN
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		✓	✓

12 Service

12.1 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 *leybold.com/en/downloads/download-documents/declaration-of-contamination/*, 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.

P20010533A

EU Declaration of Conformity

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

Leybold GmbH
Bonner Strasse 498
D-50968 Köln
Germany

Documentation Officer
T: +49(0) 221 347 0
documentation@leybold.com

PTR225RN Penningvac Transmitter
PTR90RN Penningvac Transmitter

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: *2023-02-28*

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

P20010533A

Declaration of Conformity

Leybold GmbH
Bonner Strasse 498
D-50968 Köln
Germany

Documentation Officer
Innovation Drive
Burgess Hill
West Sussex
RH15 9TW
documentation@leybold.com

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

PTR225RN Penningvac Transmitter
PTR90RN Penningvac Transmitter

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: *2023-02-28*

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 Leybold GmbH

Nick Barratt - Engineering Manager, Eastbourne

Ed Neuss – General Manager, Eastbourne

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)

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.

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Leybold

Pioneering products. Passionately applied.

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