Instruction Manual

Digital Wide Range Gauge (nWRG)

Description	Item Number
nWRG RS485 NW25	D147-90-010
nWRG RS485 DN40 CF	D147-90-020
nWRG RS232 NW25	D147-90-510
nWRG RS232 DN40 CF	D147-90-520
nWRG-L RS485 NW25	D147-91-010
nWRG-L RS485 DN40 CF	D147-91-020
nWRG-L RS232 NW25	D147-91-510
nWRG-L RS232 DN40 CF	D147-91-520

Original Instructions

EDWARDS

www.edwardsvacuum.com

Declaration of Conformity

We, Edwards,
Innovation Drive,
Burgess Hill,
West Sussex,
RH15 9TW, UK

declare under our sole responsibility, as manufacturer and person within the EU authorised to assemble the technical file, that the product(s)

Digital Active Pirani Gauge (nAPG)	D026-9X-XXX
Digital Active Inverted Magnetron Gauge (nAIM)	D146-9X-XXX
Digital Wide Range Gauge (nWRG)	D147-9X-XXX

to which this declaration relates is in conformity with the following standard(s) or other normative document(s)

EN61326-2-3: 2013	Electrical equipment for measurement, control and laboratory Use. EMC requirements. Particular requirements. Test configuration, operational conditions and performance criteria for transducers with integrated or remote signal conditioning
CAN/CSA-C22.2 No.61010-1-12	Safety requirements for electrical equipment for measurement, Control and laboratory use – Part 1: General requirements
UL61010-1, 3rd Edition	Safety requirements for electrical equipment for measurement, Control and laboratory use – Part 1: General requirements

and fulfils all the relevant provisions of

2014/30/EU	Electromagnetic Compatibility (EMC) Directive
2012/19/EU	Waste from Electrical and Electronic Equipment (WEEE) Directive
2011/65/EU	Restriction of Certain Hazardous Substances (RoHS) Directive

Note: This declaration covers all product serial numbers from the date this Declaration was signed onwards.

L G Marini

Mr Larry Marini – Senior Technical Manager

28.02.2017, Eastbourne

Date and Place

This product has been manufactured under a quality management system certified to ISO 9001:2008

P200-10-104
Issue A

Material Declaration

In accordance with the requirements of the Chinese regulatory requirement on the Management Methods for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products Order No. 32 (also known as 'China RoHS2') and SJ/T 11364 Marking for the Restricted Use of Hazardous Substances in Electronic and Electrical Products:

Product		Product Label	Meaning
nWRG RS485 NW25	D14790010		*This product contains hazardous substances in at least one of the homogeneous materials used which are above the limit requirement in GB/T 26572 as detailed in the declaration table below.* *These parts can safely be used for the environmental protection use period as indicated.*
nWRG RS485 DN40 CF	D14790020		
nWRG RS232 NW25	D14790510		
nWRG RS232 DN40 CF	D14790520		
nWRG-L RS485 NW25	D14791010		
nWRG-L RS485 DN40 CF	D14791020		
nWRG-L RS232 NW25	D14791510		
nWRG-L RS232 DN40 CF	D14791520		

材料成分声明
Materials Content Declaration

部件名称 Part name	有害物质 Hazardous Substances					
	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)
印刷电路组件 (PCA) Printed Circuit Assembly (PCA)	X	O	X	O	O	O
电缆/电线/连接器 Cable/wire/connector	X	O	O	O	O	O
机械部件 Mechanical Components	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.

These products are EU RoHS complaint, the following Exemptions apply:
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)
(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
7(c) II **Lead** in dielectric ceramic in capacitors for a rated voltage of 125 V AC or 250 V DC or higher
8(b) **Cadmium** and its compounds in electrical contacts
15 **Lead** in solders to complete a viable electrical connection between semiconductor die and carrier within integrated circuit flip chip packages
34 **Lead** in cermet-based trimmer potentiometer elements

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For return of equipment, complete the HS Forms at the end of this manual.

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Trademark credits

Scotchbrite™ is a trademark of 3M Global Trading, Inc.

Contents

1 Introduction

1.1 Scope and definitions

This manual provides installation, operation and maintenance instructions for the Edwards Digital Wide Range Gauge (nWRG). The nWRG must be used as specified in this manual. Read this manual before installing and operating the nWRG.

Important safety information is highlighted as WARNING and CAUTION instructions; these instructions must be obeyed. The use of WARNINGS and CAUTIONS is defined below.

WARNING

Warnings are given where failure to observe the instruction could result in injury or death to people.

CAUTION

Cautions are given where failure to observe the instruction could result in damage to the equipment, associated equipment or process.

The units used throughout this manual conform to the SI international system of units of measurement.

The following symbol is on the wide range gauge:

Edwards offer European customers a recycling service.

1.2 Description

The nWRG, shown in Figure 1, is a combined inverted magnetron and Pirani gauge in a single compact unit.

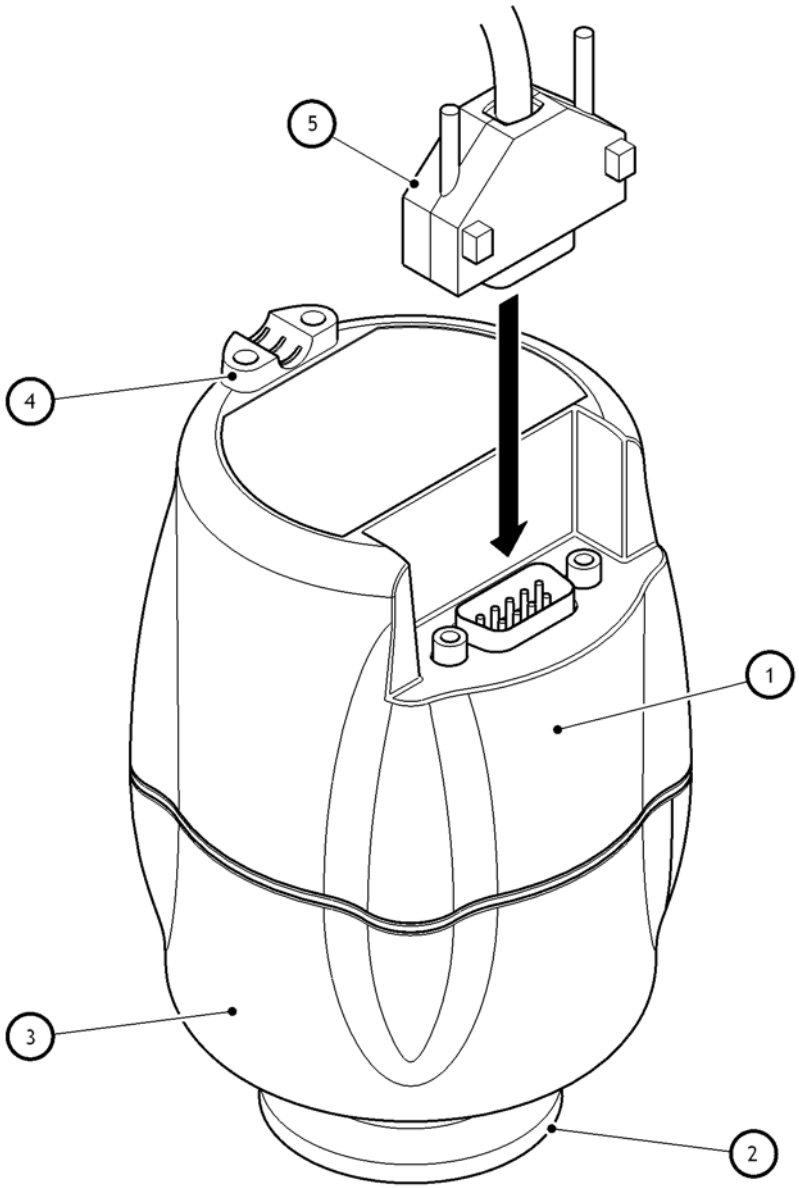
The nWRG incorporates a unique striking mechanism consisting of a small incandescent filament mounted inside the magnetron tube. This filament is automatically ignited, providing enough emission electrons to initiate the discharge. The nWRG incorporates an intelligent, microprocessor-based control system that is used to control various features, including:

- Automatic control of the magnetron HT voltage during the ignition of the gauge.
- Reduction of the HT voltage after ignition to enhance the life time of the gauge.
- Automatic adjustment of the Pirani vacuum reading.
- Provision of an error monitoring feature which will help identify the exact cause of failure.
- Simple adjustment of the nWRG settings including measurement units and setpoint trip levels.

The nWRG is available in a number of variants based on Magnet, Tube, Flange and Serial communications interface. Magnets are available in Standard and Low-field which have a very low external magnetic field and are suitable for use with sensitive analytical instruments. Flanges are available in NW25 and DN40 CF.

All gauge calibration and control functions are carried out over serial communications. The serial communications interface is available in two versions: RS232 for point-to-point systems; RS485 for either point-to-point or multi-drop systems.

Figure 1 - General view of the nWRG



1. Electronics housing
2. Vacuum flange
3. Magnet housing
4. Cable strain relief
5. Cable connector plug

2 Technical data

2.1 Mechanical data

Table 1 - Mechanical data

Parameter	Value
Dimensions	Refer to Figures 2 and 3
Mass	
NW25	750 g
Low Field and NW25	800 g
DN40 CF	1000 g
Low Field & DN40 CF	1050 g
Internal volume of tube	26 cm^3
Enclosure rating	IP42 (vertical, with the vacuum flange at the bottom) IP40 (all other orientations)

2.2 Performance, operating and storage conditions

Table 2 - Performance, operating and storage conditions

Parameter	Value
Measurement range	10^{-9} to 1 x 1000 mbar
Accuracy	± 15 % at < 100 mbar
	± 30 % at < 10^{-3} mbar
Maximum over-pressure	6 bar absolute (5 bar gauge)
Ambient temperature	
Operating	5 to 60 °C
Storage	-30 to +70 °C
Filament temperature	~100 °C above ambient
Humidity	80 % RH up to 31 ºC decreasing linearly to 50 % RH at 40 ºC and above
Maximum altitude	3000 m (indoor use only)
Pollution degree	2

2.3 Electrical data

Table 3 - Electrical data

Parameter	Value
Electrical supply voltage	
Nominal	+15 to +48 V d.c.
Minimum	+14.5 V d.c.
Maximum	+52.8 V d.c.
Max voltage ripple	1 V peak-to-peak
Max source resistance	50 Ω
Maximum power consumption	2 W
Electrical connector	9 way D-type male
Setpoint output	Open collector transistor
Rating	48 V d.c., 100 mA max
Back EMF suppression diode *	
Min. surge rating	1 A
Min. reverse voltage rating	100 V
Gauge identification resistance	
All digital gauges	10 kΩ ± 2 %

* *Required when using an external d.c. relay connected to the setpoint output.*

2.4 Serial communication

Table 4 - Serial communication

Parameter	Value
RS232 transmit	
Mark	< -8 V (I_{out} max: -8 mA)
Space	> +8 V (I_{out} max: +8 mA)
RS232 receive	
Mark	< +1 V (I_{in} max: -2 mA)
Space	> +2 V (I_{in} max: +2 mA)
Maximum input	± 12 V
RS485	
Output differential	> 1.5 V (I_{out} max: ± 25 mA)
Input differential threshold	> ± 0.2 V (I_{in} max: ± 1 mA)
Maximum input	-7 V to +12 V
Bus load	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

2.5 Materials exposed to vacuum

Table 5 - Materials exposed to vacuum

Parameter	Value
Filaments	Tungsten
Tube Assembly	Stainless Steel Nickel Nickel plated NiFe Glass Fluoroelastomer

Figure 2 - Dimensions (mm) of the nWRG-NW25

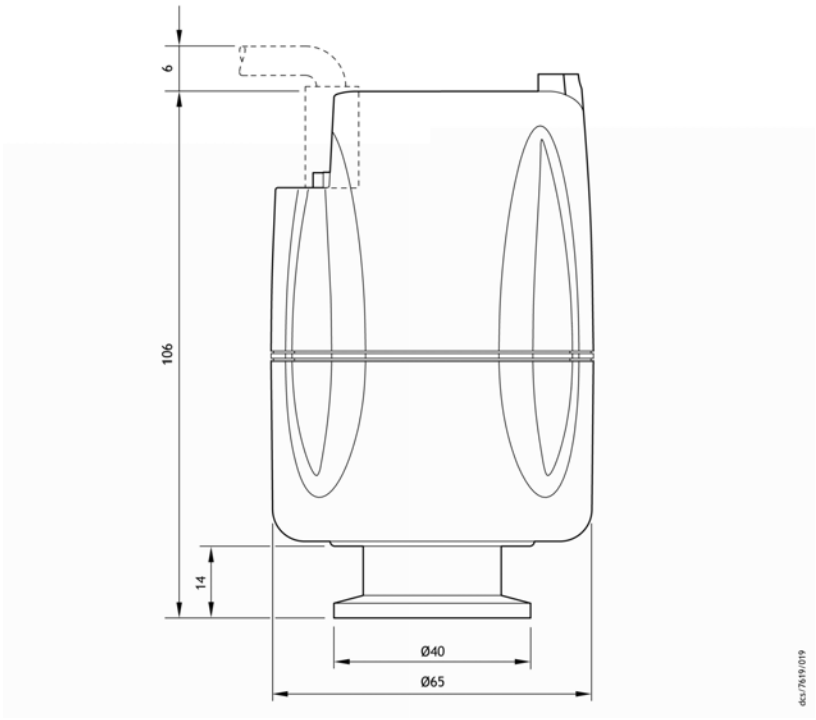
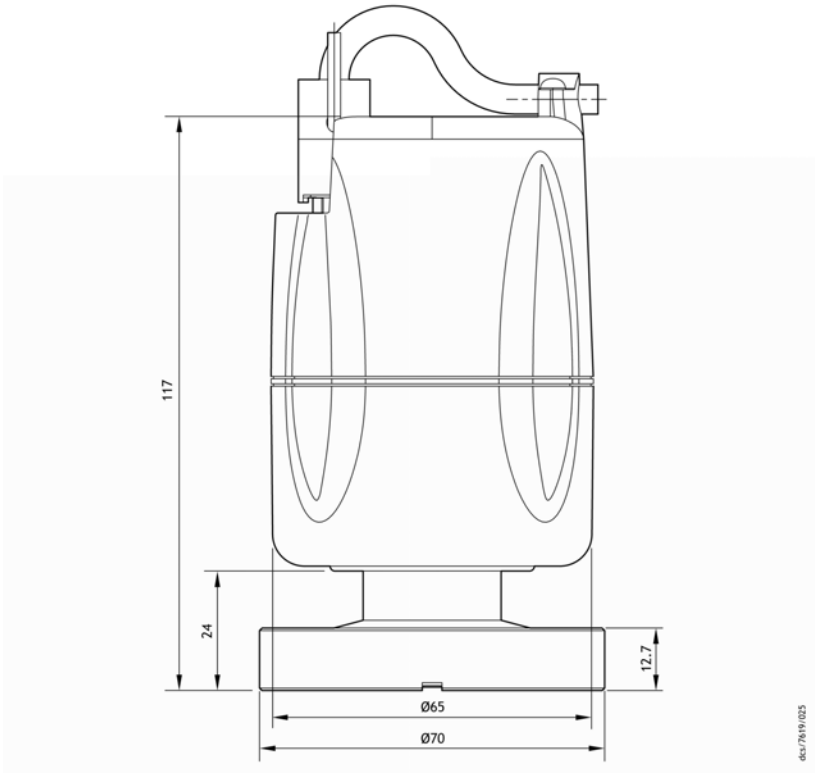


Figure 3 - Dimensions (mm) of the nWRG-DN40 CF



3 Installation

3.1 Unpack and inspect

WARNING

The nWRG incorporates magnets. Keep away from heart pacemakers, computers, credit cards and any other magnetically sensitive devices.

Remove all packing materials and protective covers and check the nWRG.

If the nWRG is damaged, notify the supplier and the carrier in writing within three days. State the Item Number of the nWRG together with the order number and the supplier's invoice number. Retain all packing materials for inspection. Do not use the nWRG if it is damaged.

If the nWRG is not to be used immediately, replace the protective covers. Store the nWRG in suitable conditions as described in Section 6.

3.2 Fit the nWRG to the vacuum system

CAUTION

Where protection against fluid ingress is required, ensure that the gauge is installed vertically, with the vacuum flange at the bottom. For all other mounting orientations the gauge has no protection against fluid ingress and should be installed where fluids cannot enter the gauge.

The nWRG can be mounted in any orientation. To avoid the build-up of debris or condensable material in the body tube of the nWRG (which will probably cause pressure measurement errors), it is recommended that the nWRG is installed vertically as shown in Figures 2 and 3.

Use an O-ring / centring ring or co-seal and clamp to connect the NW25 flange of the nWRG to a similar flange on the vacuum system.

Use a copper gasket and screws to connect the DN40 CF flange of the nWRG to a similar flange on the vacuum system.

In accordance with good practice, it is recommended that the vacuum system has a secure Earth (ground) connection, and that the tube of the nWRG is electrically connected to the vacuum system.

3.3 Electrical connections

WARNING

Ensure that the gauge is installed in accordance with all national and local safety regulations. Ensure that all wiring is safely secured to eliminate trip hazards.

WARNING

If the nWRG malfunctions, the nWRG pressure output may be incorrect. If such a failure could cause injury to people or damage equipment, install a suitable control system to indicate the failure and, if necessary, to close down the process system.

3.3.1 Connect to customer supply and control equipment

A schematic diagram of the recommended electrical connections to the nWRG is shown in Figure 5.

The pins on the nWRG electrical connection socket are used as shown in Table 6. The specification of the electrical supply, d.c. relay and back EMF suppression diode are given in Section 2.

Figure 4 - D-type 9-way male connector

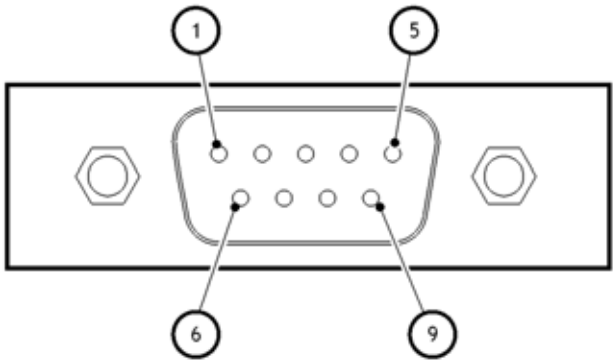


Table 6 - Pin identification

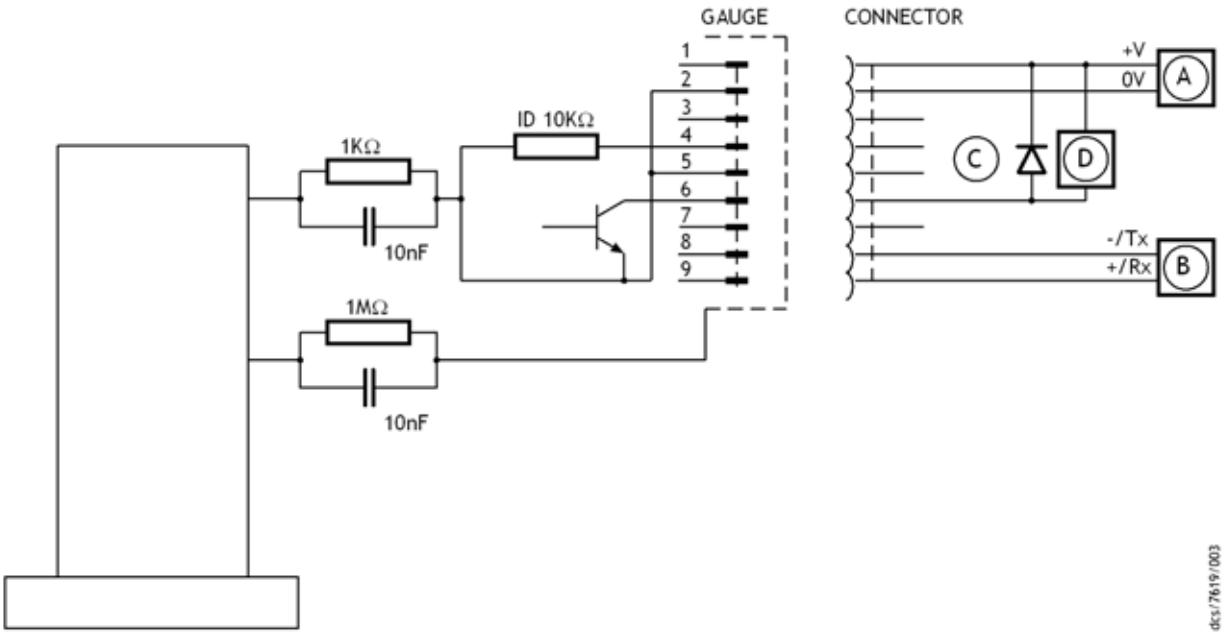
Pin number	Connection
1	Supply positive
2	Supply common
3	Not connected
4	ID resistor
5	RS485 / RS232 common
6	Setpoint output
7	Not connected
8	RS485 Negative / RS232 Transmit
9	RS485 Positive / RS232 Receive

Connections to pins 4 and 6 are optional.

The value of the ID resistor is determined by measuring the resistance between pins 4 and 5. All serial gauges are identified by a 10 kΩ resistor as full gauge identification is carried out over serial communications.

The setpoint output on pin 6 is an active low open-collector transistor suitable for driving a d.c. relay or control logic. If connecting a relay a suppression diode must be used to protect the gauge from transient voltages generated when the relay is switched off, as shown in Figure 5.

Figure 5 - nWRG electrical connections



A. Electrical supply
B. RS485 / RS232 serial communication
C. Back EMF suppression diode (optional)
D. d.c. relay (optional)

3.3.2 Connecting the serial interface

The nWRG has one of two serial communications protocols built in, RS232 or RS485. Either interface can be used to 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.

3.3.2.1 Connecting 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 computer 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.

3.3.2.2 Connecting RS485

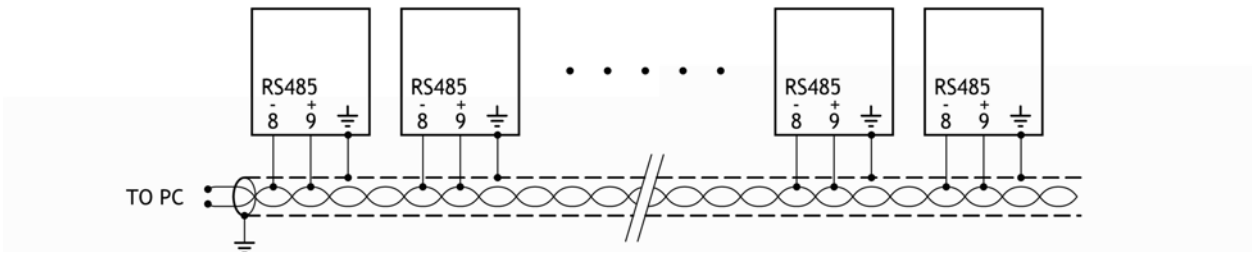
The RS485 interface uses two lines for differential data transfers. Multiple gauges from the digital gauge range, and other RS485 compatible Edwards products, can be connected to the same serial bus.

CAUTION

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

It is recommended that shielded twisted pair cable be used 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 communications reliability.

Figure 6 - RS485 and ground connections between multiple gauges



4 Operation

4.1 Safety

WARNING

Do not use the nWRG to measure the pressure of explosive or flammable gases or mixtures.

WARNING

Never operate the nWRG when it is 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 3 kV) are generated inside the body tube of the gauge; these could cause injury to people or could be a source of ignition.

WARNING

Do not disconnect the nWRG 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.

WARNING

When the pressure of gases of high molecular weight are measured, the pressure indicated can be below the true pressure. Ensure that the nWRG is not over-pressurised when using heavy gases.

WARNING

Use the gauge only for its intended purpose as described in this instruction manual.

WARNING

The nWRG incorporates magnets. Keep away from heart pacemakers, computers, credit cards and any other magnetically sensitive devices.

Note: *The nWRG has a magnet that may affect devices that are sensitive to high magnetic fields. The effect is reduced on the Low Field version.*

4.2 Serial communications

The nWRG is a digital gauge. All gauge controls and pressure measurements are carried out over serial communications.

The communications to the gauge operate on a master / slave principle. The gauge is the slave and will only transmit a message in response to one sent to it. The master, a PC for example, must always start the conversation.

A conversation consists of a message to the gauge and its response back. Having sent a message to the gauge, wait for the reply before continuing.

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

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

All messages end with a carriage return.

Refer to the digital gauge range Serial communications manual (D026-91-880) for full details of the serial command protocol and message format.

Refer to Section 8 for a quick reference guide to serial commands supported by this gauge.

4.2.1 Set baud rate - !C780

The gauge baud rate can be set to 9600, 19200 or 38400. The command reply is returned at the current baud rate before the gauge baud rate setting is updated.

The default gauge set up is 9600 baud.

This command can be locked to prevent accidental adjustment.

4.2.2 Multi-drop mode

Multi-drop mode is only supported by RS485 gauges and is enabled when a node address is assigned to a gauge. In multi-drop mode, commands and queries are only responded to when prefixed by a multi-drop header with a valid destination address. Replies are returned to the source address. Node addresses "00" and "99" have special meaning and should be used as described below:

Wildcard "99" addressed messages should only be used with a single gauge in multi-drop mode where its node address is unknown. Use with multiple gauges will result in comms collisions and no valid reply will be received.

Broadcast "00" addressed messages can be used with multiple gauges in multi-drop mode where all gauges require the same command to be performed - e.g. Baud rate setting. No reply will be sent and no alternate message confirmation will be provided.

Refer to the digital gauge range Serial communications manual (D026-91-880) for full details of the serial command protocol and message format. This includes further information on multi-drop mode and gauge responses.

4.2.2.1 Set node address - !750

The gauge node can be set to a value between 00 and 98. It can be read back with the read node address query. Assigning a node address of 00 disables multi-drop mode, and assigning a node address between 01 and 98 enables multi-drop mode. The command reply is returned from the current node address before the gauge node address setting is updated.

The default gauge set up is node address 00 - multi-drop disabled.

This command can be locked to prevent accidental adjustment.

4.2.2.2 Read node address - ?750

The read gauge node address query returns the gauge multi-drop node address. This query can be used with the multi-drop wildcard "99" node address prefix, on a point-to-point serial connection, when the actual gauge node address setting is unknown.

4.2.2.3 Auto-enumerate - !C781

The gauge node can be automatically set to a value between 01 and 98. This command disables all comms replies and uses the gauge setpoint output as a message receipt flag. The gauge comms replies can be re-enabled when the validity of the assigned node address is confirmed.

Refer to the digital gauge range Serial communications manual (D026-91-880) for full details of the auto enumeration process.

This command can be locked to prevent accidental adjustment.

4.3 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.

4.3.1 Read wildcard identification - ?S0

The read wildcard identification query is consistent across all Edwards products that support serial communications and returns the hardware version, software version and user programmable gauge name.

4.3.2 Read gauge identification - ?S751

The read gauge identification query returns the returns the hardware version, software version and user programmable gauge name.

4.3.3 Set gauge name - !S751

The gauge name can be set to a value between 0000 and 9999. It is read back as part of the gauge identification query.

This command can be locked to prevent accidental adjustment.

4.3.4 Read gauge serial number - ?S790

The read gauge serial number query returns the gauge serial number.

4.4 Pressure measurement

For optimum accuracy it is recommended that atmosphere adjustment is carried out before use. Refer to Section 4.6.1 for atmosphere adjustment.

4.4.1 Read gauge pressure - ?V752

The read gauge pressure query returns the measured pressure in the selected gas type and pressure units and the gauge status. Refer to Section 4.11 for details of the gauge status bits.

The default gauge set-up is Nitrogen / Air and Pascal.

4.4.2 Acknowledge gauge errors - !S752

Gauge errors are acknowledged and are cleared by sending the Acknowledge gauge errors command to the gauge. Gauge errors that are still active cannot be cleared and will remain active until the cause of the error state is removed. Digital gauge errors are returned in the gauge status and can be read when the gauge pressure is queried. Refer to Section 4.11 for details of the gauge status bits.

4.4.3 Set gauge strike control - !C752

The nWRG magnetron is set up to strike automatically when pressure falls below 7×10^{-3} mbar, as measured by the Pirani, and to turn off again when the pressure rises above 1×10^{-2} mbar. If delayed striking is required, then the nWRG strike can be manually controlled when the pressure is below 1×10^{-2} mbar.

Gauge striking can be enabled and disabled, or set to Automatic striking (Default). The status of the gauge during striking is displayed in the gauge status and can be read when the gauge pressure is queried.

4.4.4 Read gauge strike control - ?C752

The read gauge strike control query returns the current gauge strike control setting.

4.4.5 Set Pressure units - !S755

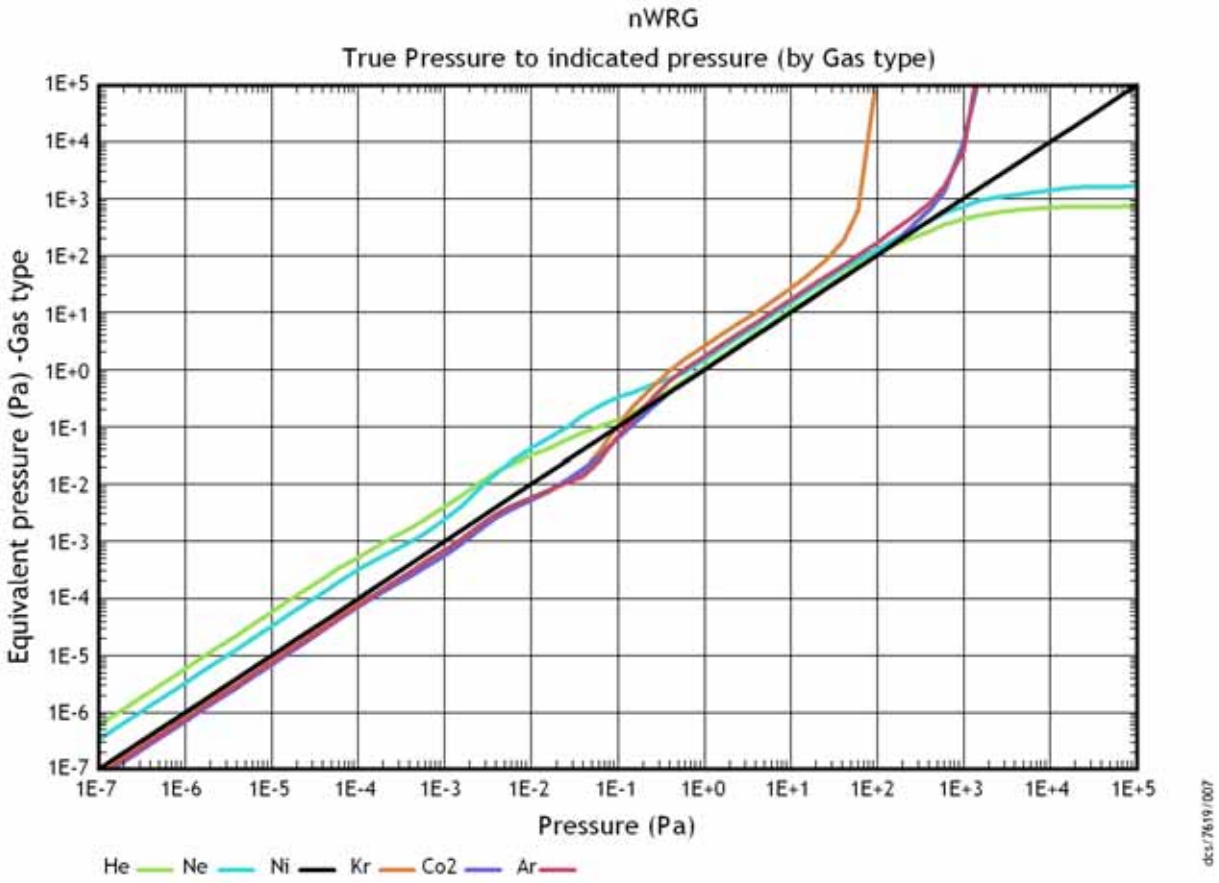
Gauge pressure units can be set to mbar, Pascal or Torr. The selected gauge pressure units are returned in the gauge status that is displayed when the gauge pressure is read.

This command can be locked to prevent accidental adjustment.

4.5 Gas dependency

The nWRG is calibrated for use in nitrogen, and will read correctly with dry air, oxygen and carbon monoxide. For any other gas type an internal conversion is applied in order to indicate the correct pressure reading. Figure 7 shows the equivalent pressure readings for six common gases: nitrogen, argon, helium, carbon dioxide, neon and krypton. 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.

Figure 7 - Equivalent pressure readings for six common gases



4.5.1 Set gas type - !S756

Gauge gas type can be set to nitrogen, argon, helium, carbon dioxide, neon or krypton. The selected gauge gas type is returned in the gauge status and can be read when the gauge pressure is queried.

This command can be locked to prevent accidental adjustment.

4.6 Gauge adjustments

The nWRG is can be adjusted for atmosphere when set to a gas type of nitrogen. Gauge adjustments are not supported in other gas types.

4.6.1 Atmosphere adjustment - !S761

For optimum accuracy it is recommended that atmosphere adjustment is carried out before use.

- Switch on the power supply to the nWRG and allow it to operate at atmospheric pressure for at least 10 minutes
- Trigger the atmosphere adjustment by sending the calibrate command to the gauge
- The output of the gauge will be automatically adjusted to read atmosphere.

This command can be locked to prevent accidental adjustment.

4.6.2 Clear calibration - !S760

The atmosphere adjustment can be cleared by sending the clear calibration command to the gauge. The atmosphere adjustment on the gauge will be returned to factory default.

This command can be locked to prevent accidental adjustment.

4.7 Setpoint

The setpoint output is an open collector transistor that is activated based on the gauge pressure reading. The setpoint thresholds are set and read in the gauge gas type and pressure units. When the gauge gas type or pressure units are changed, the setpoint thresholds are automatically updated.

The setpoint output is turned OFF (open) when the gauge pressure reading is above the high threshold and turned 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, then 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.

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

4.7.1 Set setpoint thresholds - !S754

The gauge setpoint thresholds can be set to pressure values between 1.0×10^{-10} and 9.9×10^{-6} and these will be in the gauge gas type and pressure units. If the gas type or pressure units are changed, then the setpoint thresholds will be automatically updated for the new settings. The gauge setpoint thresholds can be read back with the read gauge setpoint threshold query.

This command can be locked to prevent accidental adjustment.

4.7.2 Read setpoint thresholds - ?S754

The read gauge setpoint threshold query returns the setpoint threshold pressure in the gauge gas type and pressure units.

4.8 Gauge parameter control

4.8.1 Set gauge command lock - !S753

Gauge commands can be locked to prevent accidental adjustment by sending the command lock command to the gauge. When the gauge command lock is set, changes to gauge parameters are prohibited and attempts to adjust them will return a gauge state error.

4.8.2 Return to default settings - !S757

The gauge pressure units, gas type and setpoint thresholds can be reset to gauge defaults by sending the return to defaults command to the gauge.

This command can be locked to prevent accidental adjustment.

4.9 Gauge run parameters

A number of counters are provided to monitor the run hours of the gauge, the operational hours of the magnetron element and the pressure exposure of the magnetron element. This information can be used to aid in determining the best service interval for the gauge tube based upon the specific process environment.

The gauge run hours counter is the time that the gauge has been operating.

The magnetron run hours counter is the time that the magnetron has been operating.

The magnetron exposure counter is the cumulative gauge pressure over the time that the magnetron has been operating.

A threshold value for the magnetron exposure can be set to trigger a status flag that indicates that a tube service is advised. This threshold is defaulted to OFF and can be set by the user to an appropriate value based upon the user's specific process, setup and experience. Refer to Section 4.11 for details of the gauge status bits.

The value of the magnetron exposure counter is dependent on the gas type selected. For consistent results the gas type setting should not be changed.

4.9.1 Read internal temperature - ?V759

The read internal temperature query returns the internal temperature of the gauge processor in degrees Celsius.

4.9.2 Read run hours - ?V769

The read run hours query returns the number of hours the gauge has been operating, the number of hours the magnetron has been operating, and the cumulative magnetron pressure exposure in pressure hours.

4.9.3 Reset run hours - !C769

The gauge run hours counters can be reset to zero by sending the reset run hours command to the gauge.

This command can be locked to prevent accidental adjustment.

4.9.4 Set magnetron exposure threshold - !S769

The magnetron exposure threshold can be set to an exposure value between 1.0×10^{-7} and 5.0×10^{5} and this will be in the gauge pressure unit hours. A value of 0.0E±00 will disable the magnetron exposure status flag. If the gauge pressure units are changed, the magnetron exposure threshold will be automatically updated for the new setting.

The magnetron exposure threshold can be read back with the read magnetron exposure threshold query. This command can be locked to prevent accidental adjustment.

4.9.5 Read magnetron exposure threshold - ?S769

The magnetron exposure threshold query returns the magnetron exposure threshold value in the gauge pressure unit hours. A value of 0.0E±00 indicates that the magnetron exposure status flag is disabled.

4.10 Response error codes

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

Table 7 - 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 (D026-91-880) for full details of the serial command protocol and message format. This includes further information on command error codes.

4.11 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 8 - Gauge status bits

BIT	Status flag	Meaning
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 filament failure
11	Str Fil Err	Striker filament failure
12	Gas type	Gauge Gas type: 0=N2 (default), 1=Ar, 2=He, 3=CO2, 4=H, 5=Ne, 6=Kr
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*

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5 Maintenance

The internal components of the nWRG gauge are shown in Figure 9. The nWRG gauge is designed so that the components can be replaced using the spares listed in Section 7.3. Refer to the following sections for details of maintenance procedures that should be performed when necessary.

5.1 Introduction

WARNING

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 pins of the anode assembly can become electrically charged.

WARNING

Disconnect the cable from the nWRG before removing the nWRG from the vacuum system. High voltages are generated inside the nWRG.

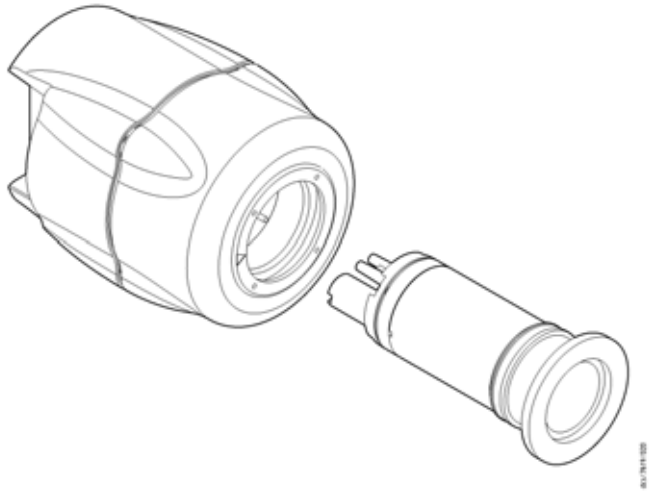
The internal components of the nWRG are shown in Figure 9. The nWRG is designed so that the components can be cleaned or replaced using the spares listed in Section 7.3. Refer to the following sections for details of maintenance procedures that should be performed when necessary.

5.2 Replace the body tube

Refer to Figure 8 and follow this procedure to replace the gauge body tube.

1. Unplug the electrical cable, vent the vacuum system to atmospheric pressure and remove the gauge from the vacuum system.
2. Hold the magnet housing firmly and pull the body tube assembly to remove.
3. Fit the replacement tube assembly into the magnet housing and then rotate it while maintaining gentle pressure until the tube assembly locates. Push fully home until the locking spring snaps into position.
4. Refit the gauge to the vacuum system as described in Section 3.2 and reconnect the electrical cable.

Figure 8 - Refitting the body tube assembly



5.3 Replace the electrode assemblies

Refer to Figure 9 and the following procedure.

1. Remove the nWRG from the vacuum system and the body tube assembly from the nWRG as described in Section 5.2.
2. Use a suitable screwdriver to unscrew the four screws (1) on the top of the body tube and remove the Pirani tube housing (2), pirani tube (4), viton gasket (5), anode assembly (6) and the viton O-ring (7) from the body tube (9).
3. Use circlip pliers to remove the circlip (12) from the vacuum flange end of the body tube (9), then remove the cathode tube (11) and the cathode plate (10).
4. Fit the new cathode plate (10) and cathode tube (11) into the body tube (9) and secure with the circlip (12).
5. Fit the new O-ring (7) and anode assembly (6) onto the body tube (9). Ensure that the orientation of the anode assembly (6) is correct. Take care not to damage the striker filament (13).
6. Fit the Pirani tube (4) inside the plastic Pirani tube housing (2). Place the viton gasket (5) onto the Pirani tube housing (2) and press with your thumb to locate it in the Pirani tube housing (2).
7. Place the combination of the Pirani tube housing (2), Pirani tube (4) and the viton gasket (5) onto the anode assembly (6). Ensure that the three pins are located correctly.
8. Gently rotate the anode assembly together with the Pirani assembly until the arrow (3) on the plastic Pirani tube housing (2) is aligned with the groove (8) in the body tube (9). Take care not to damage the striker filament (13).
9. Refit the four M2 screws (1) with their washers into the four holes in the plastic Pirani tube housing (2) and tighten evenly to a torque of 0.2 Nm.
10. Refit the body tube (9) to the magnet housing, as described in Section 5.2 and nWRG to the vacuum system as described in Section 3.2.

5.4 Replace the electronics and magnet housing

The magnet housing and end-cap contain the nWRG control electronics. Replace the complete unit as described below.

1. Remove the nWRG from the vacuum system and the body tube assembly as described in Section 5.2.
2. Dispose of the old electronics and magnet housing. Refer to Section 6.2.
3. Fit the body tube to the new electronics and magnet housing as described in Section 5.2.
4. Refit the nWRG to the vacuum system as described in Section 3.2.

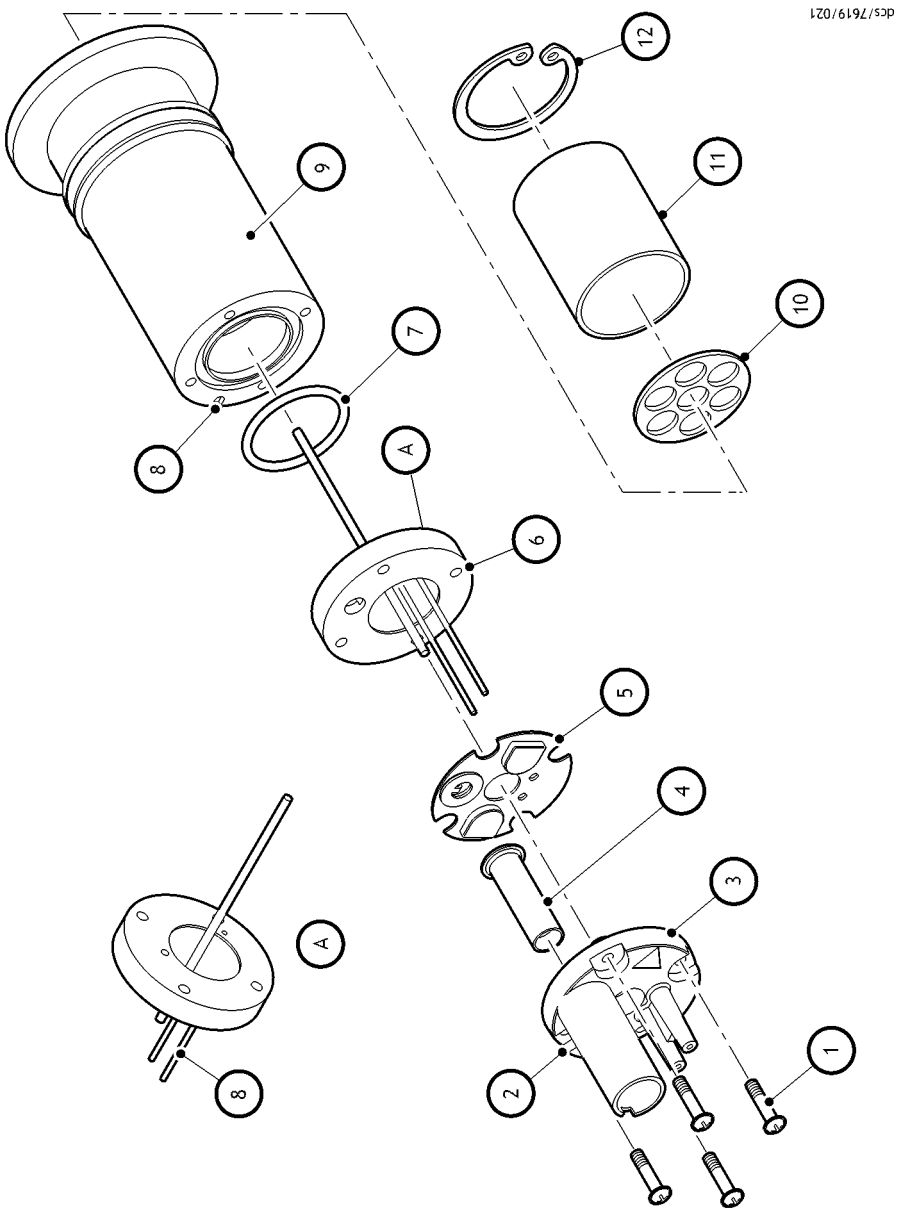
5.5 Clean the internal components

Refer to Figure 9 and the following procedure.

1. Remove the internal components from the magnet housing as described in Section 5.3.
2. Clean the Pirani tube (4) in alcohol for about 5 minutes (using an ultrasonic tank if available). Place the Pirani tube (4) with the opening end facing downward on a piece of clean tissue and leave it to dry.
3. Use an abrasive material (e.g. Scotchbrite™) to clean the anode assembly (6). Extra care is required when cleaning the area around the striker filament (13).
4. Degrease the cathode plate (10), cathode tube (11) and body tube (9) and anode assembly (6) in a suitable degreasing agent (using an ultrasonic tank if available). Thoroughly soak them in a suitable laboratory detergent. Rinse in clean water to remove the detergent and then in methanol to remove all of the water, then thoroughly dry the components.

5. Refit the components in the electronics and magnet housing as described in Section 5.3.

Figure 9 - Exploded view of the body tube assembly



A. View on rear of anode
1. M2 screws and washers
2. Pirani tube housing
3. Alignment arrow
4. Pirani tube
5. Viton Gasket
6. Anode assembly
7. O-ring
8. Alignment groove
9. Body tube
10. Cathode plate
11. Cathode tube
12. Circlip

5.6 Fault finding

Table 9 - Fault finding

Symptoms	Possible cause	Remedy
No Reply to communications	Incorrect electrical supply voltage or supply polarity reversed.	Check electrical supply and connections.
	Incorrect communications interface or serial comms connections reversed.	Check communications interface and connections.
	Incorrect baud rate selected.	Check all supported baud rates.
	Incorrect multi-drop address selected.	Check gauge node address setting by using the wildcard node address on a point-to-point communications connection.
	Communications collisions due to multiple gauges connected on a point-to-point system, or duplicate node address on a multi-drop system.	Check each gauge node address setting by using the wildcard node address on a point-to-point communications connection.
	Replies disabled during auto-enumeration.	Ensure replies enabled.
Pressure reading incorrect	Vacuum leak.	Leak check vacuum system.
	Incorrect pressure units selected.	Check pressure units setting.
	Incorrect gas type selected.	Check gas type setting.
	Tube contaminated.	Clean the tube or replace the tube.
Gauge indicates calibration error	Tube has drifted outside permissible limits and can no longer be adjusted.	Replace the tube.
Gauge indicates broken filament	Tube is missing.	Fit the tube.
	Filament is broken.	Replace the tube.
Gauge indicates strike failure	Vacuum below operating range of the gauge.	Command strike within operating range of the gauge.
	Tube contaminated.	Clean the tube or replace the tube.
Gauge indicates FlashEE error	Gauge parameters and factory calibration have been defaulted.	Contact the supplier.

5.7 Calibration service

A calibration service is available for all Edwards gauges. Calibration is by comparison with reference gauges, traceable to National Standards. Contact Edwards for details.

6 Storage and disposal

6.1 Storage

Return the nWRG to its protective packaging and store the nWRG in clean dry conditions until required for use. Do not exceed the storage temperature conditions specified in Section 2.2.

When required for use, prepare and install the nWRG as described in Section 3.

6.2 Disposal

Dispose of the nWRG and any components safely in accordance with all local and national safety and environmental requirements.

Alternatively, it may be possible to recycle the nWRG and / or cables: contact Edwards or supplier for advice (also see below).

The nWRG and associated cables are within the scope of the European Directive on Waste Electrical and Electronic Equipment, 2002/96/EC. Edwards offers European customers a recycling service for the nWRG / cables /associated gauge heads at the end of the nWRG's life. Contact Edwards for advice on how to return the nWRG and /or cables for recycling.

Particular care must be taken if the nWRG has been contaminated with dangerous process substances or has been overheated or has been in a fire. Fluoroelastomers are used in the nWRG; these are safe in normal use, but can decompose into dangerous breakdown products if heated to 260 °C and above.

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7 Service and spares

7.1 Introduction

Edwards products and spares are available from Edwards companies in Belgium, Brazil, China, France, Germany, Israel, Italy, Japan, Korea, Singapore, United Kingdom, U.S.A and a world-wide network of distributors. The majority of these centres employ Service Engineers who have undergone comprehensive Edwards training courses.

When maintaining the nWRG, Edwards recommends using only Edwards maintenance and service kits.

Order spare parts from the nearest Edwards company or distributor. When ordering, please state for each part required:

- Model and Item Number of the equipment
- Serial number
- Item Number and description of the part.

7.2 Service

Edwards products are supported by a world-wide network of Edwards Service Centres. Each Service Centre offers a wide range of options including: equipment decontamination; service exchange; repair; rebuild and testing to factory specifications. Equipment which has been serviced, repaired or built is returned with a full warranty.

Local Service Centres can also provide Edwards engineers to support on-site maintenance, service or repair of equipment.

For more information about service options, contact the nearest Service Centre or other Edwards company.

7.3 Spares

Table 10 - Spares

Spares	Item number
Electronics and magnet housing	
nWRG RS232	D147-90-800
nWRG RS485	D147-90-801
nWRG-L RS232	D147-91-800
nWRG-L RS485	D147-91-801
Replacement tube	
nWRG NW25	D147-01-801
nWRG DN40 CF	D147-03-801
Electrode assembly kit*	D147-01-802
Pirani tube replacement kit†	D147-01-803
Full body tube service kit‡	D147-01-804

* *The electrode assembly kit contains one each of the following components: cathode plate, cathode tube, anode assembly, O-ring, plastic Pirani housing, circlip, gasket and 4 screws and washers.*

† *The Pirani tube replacement kit contains one each of the following components: Pirani tube assembly, Pirani housing, gasket and 4 screws and washers.*

‡ *The full body tube service kit contains one each of the following components: cathode plate, cathode tube, anode assembly, O-ring, Pirani tube assembly, plastic Pirani housing, circlip, gasket and 4 screws and washers.*

8 Serial command quick reference guide

Table 11 - Serial command quick reference guide

ID	Object	Operations & 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 controls	!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	
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: 1.0e-10 to 9.9e+06 must be >= Low threshold	✓
		?S754 0		Read high setpoint threshold	
		!S754 1;	n.nE±nn	Set low setpoint threshold: 1.0e-10 to 9.9e+06 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 types	!S756	n	Set gas type: 0 = Nitrogen / Air (Default) 1 = Argon 2 = Helium 3 = Carbon Dioxide 4 = Neon 5 = Krypton	✓

Table 11 - Serial command quick reference guide (continued)

ID	Object	Operations & config ID	Parameter	Notes	Lockable
757	Return to defaults	!S757	n	Reset all user settings to default: 1 = reset set points, gas type and pressure units	✓
759	Internal temperature	?V759		Read internal temperature	
769	Run hours	!C769	nnnn	Clear all Run hours counters 1234 = password protection	✓
		?V769		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: 4 = 9600 (default) 2 = 19200 1 = 38400	✓
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	

Please refer to the digital gauge range Serial communications manual (D026-91-880) for full details of the serial command protocol and message format.