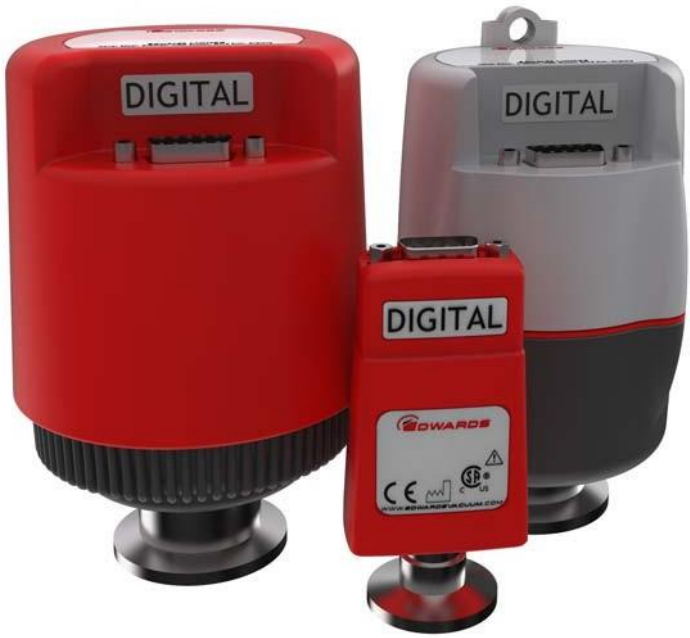
D026-91-880
Issue A

Instruction Manual

Digital Gauge Range Serial Communications



Description	Item Number
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

Original Instructions

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Declaration of Conformity

We, Edwards Limited,
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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
EN50581:2012	Technical Documentation for the Assessment of Electrical and Electronic Products with respect to the Restriction of Hazardous Substances

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

02.11.2015, Eastbourne

Date and Place

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

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dcs/7619/06/15

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Tables

Table Page

1 Introduction

1.1 Scope and definitions

This manual provides operation instructions for serial interface communications to the Edwards digital gauge range, part numbers:

Description	Item Number	Product Manual
Digital Active Pirani Gauge (nAPG)	*D026-9X-XXX*	*D026-90-880*
Digital Active Inverted Magnetron Gauge (nAIM)	*D146-9X-XXX*	*D146-90-880*
Digital Wide Range Gauge (nWRG)	*D147-9X-XXX*	*D147-90-880*

CAUTION

Before using these instructions, ensure that a good understanding is had about the operation of the digital gauge that is being communicated with by referring to the digital gauge product manual.

1.2 Message basics

The communications to the digital gauge range are ASCII text based and work on a master / slave principle. The digital 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 digital gauge and its response back. Having sent a message to the digital gauge, the reply must be received before continuing.

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

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

All messages end with a carriage return.

In multi-drop mode, the ? and ! are preceded by the addressing information (#).

Characters not enclosed by start (# and / or !?) and end (cr) characters will be ignored. Incomplete messages will be ignored if a new start character is received.

1.2.1 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 should behave such as the pressure measurement units under or at the setpoint thresholds.

1.2.2 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.

1.2.3 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 nAPG, 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 Section 4 for details of the Response error codes.

1.2.4 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 config type is sent and returned as the first parameter in the data field.

1.3 Serial protocol message format

1.3.1 Definitions

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	*Data1*	;	*Data2*	;	*Data3*

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*

1.3.2 Control command

Command format	!	C	n	n	n	sp	n	cr

Normal, or error, response	*	C	n	n	n	sp	r	r	cr

1.3.3 Setup command

Command format	!	S	n	n	n	sp	Data	cr

Normal, or error, response	*	S	n	n	n	sp	r	r	cr

1.3.4 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

1.3.5 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

1.3.6 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

1.4 Communications timings

Because of the complexity of the product precise message timings are not defined, however, the following are provided for guidance. Latency estimates below are comms query and reply flight time. Processor latency may add up to 3.5 ms. Analogue measurements are updated every 10 ms as per existing gauges.

Table 1 - Communications timings (gauge type)

Command examples vs Baud rate		9600	19200	38400
Gauge Type	?S751<cr> =S751 nNNN-nn_RSxxx;DnnnnnnnnX;nnnn<cr>	43.8 ms	21.9 ms	10.9 ms
+Multi-drop:	#dd:ss #ss:dd	+12.5 ms	+6.3 ms	+3.1 ms
+µP Latency		+3.5 ms	+3.5 ms	+3.5 ms
Estimated latency - slowest		~59.8 ms	~31.7 ms	~17.5 ms

Table 2 - Communications timings (read pressure)

Command examples vs Baud rate		9600	19200	38400
Read Pressure	?v751<cr> =v751 n.nnE±nn;nnnn<cr>	27.1ms	13.5 ms	6.8 ms
+µP Latency		+3.5 ms	+3.5 ms	+3.5 ms
Estimated latency - fastest		~30.6 ms	~17 ms	~10.3 ms

2 Serial command summary

Table 3 - Serial command summary

ID	Object	Operations & config ID	Parameter	Notes	Lockable	nAPG	nAIM	nWRG
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		☐	☐	☐
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	☐	☐	☐	☐

Table 3 - Serial command summary (continued)

ID	Object	Operations & config ID	Parameter	Notes	Lockable	nAPG	nAIM	nWRG
756	Gas type	!S756	n	Set gas type: 0 = Nitrogen / Air (Default) 1 = Argon 2 = Helium 3 = Carbon Dioxide 4 = Neon 5 = Krypton	☐	☐	☐	☐
757	Return to defaults	!S757	n	Reset all user settings to default: 1 = reset setpoints, gas type and pressure units	☐	☐	☐	☐
759	Internal temperature	?V759		Read internal temperature		☐	☐	☐
760	Clear calibration	!S760	n	Clear Atm and Vac calibration: 1 = reset to factory default	☐	☐	☐	☐
761	Pirani calibration	!S761 0;	nnnn	Trigger Tube Calibration 1234 = password protection	☐	☐	☐	☐
		!S761 1:	n	Calibrate Atm or Vac: 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: 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		☐	☐	☐

3 Serial command specifics

3.1 Object 0 - Wildcard gauge type

3.1.1 Read gauge type

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.

Query Format	?	S	0	cr								
Normal response	=	S	0	sp	*Hardware*	;	*Software*	;	*Gauge Name*	cr		
Error response	*	S	0	sp	r	r	cr					

The hardware version is alpha-numeric and consists of between 10 and 13 characters in the format "nNNN-vv_RSxxx" or "nNNN_RSxxx"; where "nNNN" is the gauge type, "-vv" is the gauge version, and "_RSxxx" is the communications build.

The software version is alpha-numeric and consists of 10 characters in the format "DxxxxxxxxN"; where "Dxxxxxxxx" is the software number and "N" is the issue.

The user programmable gauge name is numeric and consists of 4 digits in the format "nnnn". This can be programmed by the user to aid identification of the gauge on the vacuum system.

3.2 Object 750 - Node address

Multi-drop mode is only supported by RS485 gauges.

3.2.1 Set node address

The gauge node can be set to a value between 00 and 98. 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. Refer to Section 6 for details of Multi-drop mode.

The default gauge set up is node address 00.

Command format	!	S	7	5	0	sp	n	n	cr
Normal response	*	S	7	5	0	sp	0	0	cr
Error response	*	S	7	5	0	sp	r	r	cr

Where "nn":

- 00 = Multi-drop disabled
- 01 to 98 = Multi-drop enabled

This command can be locked to prevent accidental adjustment.

3.2.2 Read node address

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.

Query Format	?	S	7	5	0	cr			
Normal response	=	S	7	5	0	sp	n	n	cr
Error response	*	S	7	5	0	sp	r	r	cr
Wildcard query	#	9	9	:	s	s	?	S	7	5	0	cr
Wildcard response	#	s	s	:	9	9	=	S	7	5	0	sp	n	n	cr

Where "nn" is the gauge node address and "ss" is the source node address for the multi-drop wildcard query.

3.3 Object 751 - Gauge type

3.3.1 Set gauge name

The gauge name can be set to a value between 0000 and 9999.

Command format	!	S	7	5	1	sp	n	n	n	n	cr
Normal response	*	S	7	5	1	sp	0	0	cr		
Error response	*	S	7	5	1	sp	r	r	cr		

Where "nnnn" is the gauge name.

This command is only supported by RS485 gauges.

This command can be locked to prevent accidental adjustment.

3.3.2 Read gauge identity

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

Query Format	?	S	7	5	1	cr						
Normal response	=	S	7	5	1	sp	Hardware	;	Software	;	Gauge Name	cr
Error response	*	S	7	5	1	sp	r	r	cr			

The hardware version is alpha-numeric and consists of between 10 and 13 characters in the format: "nNNN-vv_RSxxx" or "nNNN_RSxxx"; where "nNNN" is the gauge type, "-vv" is the gauge version, and "RSxxx" is the communications build.

The software version is alpha-numeric and consists of 10 characters in the format "DxxxxxxxxN"; where "Dxxxxxxxx" is the software number and "N" is the issue.

The user programmable gauge name is numeric and consists of 4 digits in the format "nnnn". This can be programmed by the user to aid identification of the gauge on the vacuum system.

3.4 Object 752 - Gauge control

3.4.1 Set gauge strike control

Gauge striking can be enabled and disabled, or set to automatic strike control, depending on the gauge type. The status of the gauge during striking is displayed in the gauge status and can be read when the gauge pressure is queried.

Command format	!	C	7	5	2	sp	n	cr
Normal response	*	C	7	5	2	sp	0	0	cr
Error response	*	C	7	5	2	sp	r	r	cr

Where "n":

0 = strike disabled

1 = strike enabled

2 = automatic strike control (where supported)

This command can be locked to prevent accidental adjustment.

3.4.2 Read gauge control

The read gauge strike control query returns the gauge strike control setting on gauges that support automatic and manual strike control.

Query Format	?	C	7	5	2	cr		
Normal response	=	C	7	5	2	sp	n	cr
Error response	*	C	7	5	2	sp	r	r	cr

Where "n" is the strike control setting.

3.4.3 Acknowledge gauge errors

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 5 for details of the gauge status bits.

Command format	!	S	7	5	2	sp	1	cr
Normal response	*	S	7	5	2	sp	0	0	cr
Error response	*	S	7	5	2	sp	r	r	cr

Where:

1 = Acknowledge gauge errors.

3.4.4 Read gauge pressure

The read gauge pressure query returns the measured pressure, in the selected gas type and pressure units, and the gauge status. The default gauge set-up is Nitrogen / Air and Pascal.

Query Format	?	V	7	5	2	cr			
Normal response	=	V	7	5	2	sp	Pressure	;	Status	cr
Error response	*	V	7	5	2	sp	r	r	cr

The measured pressure consists of 8 characters in exponential format: "n.nnE±nn"

The gauge status consists of 4 characters as 16 bits of ASCII encoded HEX in the format "nnnn". Refer to Section 5 for details of the gauge status bits.

3.5 Object 753 - Gauge command lock

3.5.1 Set gauge command lock

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. The gauge command lock setting is returned in the gauge status and can be read when the gauge pressure is queried. Refer to Section 5 for details of the gauge status bits.

Command format	!	S	7	5	3	sp	n	cr

Normal response	*	S	7	5	3	sp	0	0	cr

Error response	*	S	7	5	3	sp	r	r	cr

Where "n":

0 = gauge parameters editable

1 = gauge parameters locked

3.6 Object 754 - Setpoint

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 setpoint threshold pressure consists of 7 characters in exponential format: "n.nE±nn"

The high setpoint threshold is config "0" of the setpoint object.

The low setpoint threshold is config "1" of the setpoint object.

3.6.1 Set high setpoint threshold

If the high setpoint threshold is set lower than the low setpoint threshold, then the low setpoint threshold will be updated at the same time to the same pressure value.

Command format	!	S	7	5	4	sp	0	;	Pressure	cr

Normal response	*	S	7	5	0	sp	0	;	0	0	cr

Error response	*	S	7	5	0	sp	0	;	r	r	cr

This command can be locked to prevent accidental adjustment.

3.6.2 Read high setpoint threshold

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

Query Format	?	S	7	5	2	sp	0	cr		
Normal response	=	S	7	5	2	sp	0	;	Pressure	cr
Error response	*	S	7	5	2	sp	0	;	r	r	cr

3.6.3 Set low setpoint threshold

If the low setpoint threshold is set higher than the high setpoint threshold, then the high setpoint threshold will be updated at the same time to the same pressure value.

Command format	!	S	7	5	4	sp	1	;	Pressure	cr
Normal response	*	S	7	5	0	sp	1	;	0	0	cr
Error response	*	S	7	5	0	sp	1	;	r	r	cr

This command can be locked to prevent accidental adjustment.

3.6.4 Read low setpoint threshold

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

Query Format	?	S	7	5	2	sp	1	cr		
Normal response	=	S	7	5	2	sp	1	;	Pressure	cr
Error response	*	S	7	5	2	sp	1	;	r	r	cr

3.7 Object 755 - Pressure units

3.7.1 Set pressure units

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.

Command format	!	S	7	5	5	sp	n	cr
Normal response	*	S	7	5	5	sp	0	0	cr
Error response	*	S	7	5	5	sp	r	r	cr

Where "n":

1 = mbar

2 = Pascal (default)

3 = Torr

This command can be locked to prevent accidental adjustment.

3.8 Object 756 - Gas type

3.8.1 Set gas type

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.

Command format	!	S	7	5	6	sp	n	cr
Normal response	*	S	7	5	6	sp	0	0	cr
Error response	*	S	7	5	6	sp	r	r	cr

Where "n":

0 = Nitrogen / Air (Default)

1 = Argon

2 = Helium

3 = Carbon Dioxide

4 = Neon

5 = Krypton

This command can be locked to prevent accidental adjustment.

3.9 Object 757 - Return to defaults

3.9.1 Return to default settings

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.

Command format	!	S	7	5	7	sp	1	cr
Normal response	*	S	7	5	7	sp	0	0	cr
Error response	*	S	7	5	7	sp	r	r	cr

Where:

1 = reset pressure units, gas type and setpoints

This command can be locked to prevent accidental adjustment.

3.10 Object 759 - Internal temperature

3.10.1 Read internal temperature

The read internal temperature query returns the internal temperature of the gauge processor in degrees Celsius to 1 decimal place.

Query Format	?	V	7	5	9	cr		
Normal response	=	V	7	5	9	sp	*Temperature*	cr
Error response	*	V	7	5	9	sp	r	r	cr

The measured temperature consists of between of between 3 and 5 characters in the format "nnn.n". Leading zeros are not returned.

3.11 Object 760 - Clear calibration

3.11.1 Clear Pirani calibration

The atmosphere and vacuum adjustments can be cleared, depending on the gauge type, by sending the clear calibration command to the gauge. Gauge adjustments can only be modified when the gauge is set to a gas type of Nitrogen and are not supported in other gas types. The atmosphere and vacuum adjustments on the gauge will be returned to factory default.

Command format	!	S	7	6	0	sp	1	cr
Normal response	*	S	7	6	0	sp	0	0	cr
Error response	*	S	7	6	0	sp	r	r	cr

Where:

1 = reset to factory default (where supported)

This command can be locked to prevent accidental adjustment.

3.12 Object 761 - Pirani calibration

Gauges that contain a Pirani measurement filament can be adjusted for atmosphere and vacuum, depending on the gauge type.

New tube calibration is config "0" of the Pirani calibration object.

Atmosphere or vacuum calibration is config "1" of the Pirani calibration object.

3.12.1 Trigger tube calibration

If a replacement tube is fitted to the gauge it will be necessary to adjust the gauge to match the new tube. Note that this is only required when a new tube is fitted and can only be carried out at atmosphere. Gauge adjustments can only be carried out when the gauge is set to a gas type of nitrogen, and are not supported in other gas types. Refer to dedicated gauge manual for full calibration procedure.

Command format	!	S	7	6	1	sp	1	2	3	4	cr
Normal response	*	S	7	6	1	sp	0	;	0	0	cr
Error response	*	S	7	6	1	sp	0	;	r	r	cr

Where:

1234 = password protection for Tube calibration (where supported)

This command can be locked to prevent accidental adjustment.

3.12.2 Calibrate atmosphere or vacuum

For optimum accuracy it is recommended that atmosphere and vacuum adjustments are carried out before use, depending on the gauge type. The calibration carried out depends on the gauge pressure when the calibration is triggered. Note that this can only be carried out at atmosphere or vacuum. Gauge adjustments can only be carried out when the gauge is set to a gas type of nitrogen, and are not supported in other gas types. Refer to dedicated gauge manual for full calibration procedure.

Command format	!	S	7	6	1	sp	1	;	1	cr
Normal response	*	S	7	6	1	sp	1	;	0	0	cr
Error response	*	S	7	6	1	sp	1	;	r	r	cr

Where:

1 = calibrate at current pressure (where supported)

This command can be locked to prevent accidental adjustment.

3.13 Object 769 - Run hours

The number of operating hours is recorded by the gauge and can be accessed via the Run hours object. Gauges that contain a magnetron also record the number of hours that the magnetron has been operating and the pressure exposure of the magnetron element. The magnetron exposure threshold can be set to trigger a status flag that indicates that a tube service is advised. Refer to Section 5 for details of the gauge status bits.

3.13.1 Clear run hours counters

The gauge run hours counters can be reset to zero by sending the reset run hours command to the gauge. Note that this is generally only required when a new tube is fitted or the tube has been serviced.

Command format	!	C	7	6	9	sp	1	2	3	4	cr
Normal response	*	C	7	6	9	sp	0	0	cr
Error response	*	C	7	6	9	sp	r	r	cr

Where:

1234 = password protection

This command can be locked to prevent accidental adjustment.

3.13.2 Read gauge run hours:

The read run hours query returns the number of hours the gauge has been operating and, depending on the gauge type, the operational hours of the magnetron element and the pressure exposure of the magnetron element.

Query Format	?	V	7	6	9	cr						
Normal response	=	V	7	6	9	sp	Run Hours	cr				
Normal response	=	V	7	6	9	sp	Run Hours	;	Mag Hours*	;	Exposure*	cr
Error response	*	V	7	6	9	sp	r	r	cr			

* where supported

The hours count consists of 7 digits in the format "nnnnnnn" which represent the total number of hours the gauge has been operating and that the Magnetron has been operating. The exposure pressure consists of 7 characters in exponential format: "n.nE±nn" in pressure hours.

3.13.3 Set magnetron exposure threshold

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.

Command Format	!	S	7	6	9	sp	Exposure	cr	
Normal response	*	S	7	6	9	sp	0	0	cr
Error response	*	S	7	6	9	sp	r	r	cr

The exposure pressure consists of 7 characters in exponential format: "n.nE±nn" in pressure hours.

This command can be locked to prevent accidental adjustment.

3.13.4 Read magnetron exposure threshold

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.

Query Format	?	S	7	6	9	cr		
Normal response	=	S	7	6	9	sp	Exposure	cr
Error response	*	S	7	6	9	sp	r	r	cr

3.14 Object 780 - baud rate

3.14.1 Set baud rate

The gauge baud rate can be set to 9600, 19200 or 38400.

The default gauge set up is 9600 baud.

Command format	!	C	7	8	0	sp	n	cr
Normal response	*	C	7	8	0	sp	0	0	cr
Error response	*	C	7	8	0	sp	r	r	cr

Where "n":

4 = 9600 (default)

2 = 19200

1 = 38400

The command response is returned at the current baud rate before the gauge baud rate setting is updated. The master baud rate can be adjusted on receipt of a normal response. Where an error response is returned, the baud rate will not be updated and the master baud rate must not be changed.

This command can be locked to prevent accidental adjustment.

3.15 Object 781 - Auto-enumerate

Multi-drop mode is only supported by RS485 gauges.

3.15.1 Auto-enumerate node address:

CAUTION

Incorrect use of this command may result in the gauge being left in a state where it is unresponsive to serial communication. Only use this command in accordance with the auto-enumeration procedure.

CAUTION

This command's alternate use of the setpoint output may result in erratic vacuum system operation if left connected during configuration. Only use this command in accordance with the auto-enumeration procedure.

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 Section 7 for full details of the auto-enumeration procedure.

Command format	!	C	7	8	1	sp	n	cr

*Normal response**	*	C	7	8	0	sp	0	0	cr

*Error response**	*	C	7	8	0	sp	r	r	cr

* responses only returned when serial communications replies are enabled.

Where "n":

0 = Auto-enumeration mode Off - serial replies enabled

1 = Auto-enumeration mode On - serial replies disabled

2 = Auto-enumerate - serial replies disabled and node address randomised

Where an error response is returned, auto-enumeration mode will not be enabled, and the auto-enumeration procedure must be restarted when the source of the error has been resolved.

When auto-enumeration mode is enabled, all serial replies are disabled and receipt of a valid serial message is indicated by activation of the setpoint output signal.

This command can be locked to prevent accidental adjustment.

3.16 Object 790 - Serial number

3.16.1 Read gauge serial number

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

Query Format	?	S	7	9	0	cr		
Normal response	=	S	7	9	0	sp	*Serial No.*	cr
Error response	*	S	7	9	0	sp	r	r	cr

The gauge serial number consists of 9 digital in the format "nnnnnnnnn" which is the used to identify the unique gauge.

4 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 4 - 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

4.1 00 - Acknowledge - no error

This indicates that the command and any associated parameters have been accepted by the gauge and the requested action triggered.

4.2 01 - Invalid command for object ID

This indicates that the command or query type is not supported for the selected object ID. For example commanding the internal temperature object, or reading the clear calibration object. Refer to Section 2 - Serial command summary, for commands and queries supported by each object ID.

4.3 02 - Invalid query / command

This indicates that the command or query type is not supported by the currently connected gauge. For example, commanding Pirani calibration on a nAIM gauge, or setting a node address on an RS232 gauge. Refer to Section 2 - Serial command summary, for commands and queries supported by each gauge type.

4.4 03 - Missing parameter

This indicates that the command is missing an expected parameter, or that the parameter provided is incomplete. Refer to Section 3 - Serial command specifics, for parameters and formats supported by each command type.

4.5 04 - Parameter out of range

This indicates that the command parameter provided is incorrect, out of range, or too long. Refer to Section 3 - Serial command specifics, for parameters and formats supported by each command type.

4.6 05 - Invalid command in current state

This indicates that the command is not supported with the gauge in the current state. For example, updating the pressure units with the gauge parameters locked, or requesting a Pirani calibration in a gas other than Nitrogen. Refer to Section 2 - Serial command summary, for commands that can be locked to prevent accidental adjustment and confirm the gauge lock status. Refer to Section 3 - Serial command specifics, for specific limitations of each command type

4.7 06 - Data checksum error

This error response is not required by the digital gauge range.

4.8 07 - EEPROM read or write error

This error response is not required by the digital gauge range.

4.9 08 - Operation timeout

This indicates that the command buffer has overflowed and commands have been overwritten and not actioned. For example, two commands sent in very quick succession without time for the gauge to respond. In this case neither command would have been actioned.

4.10 09 - Invalid config ID

This indicates that the configuration ID is not supported for the selected object ID. Refer to Section 2 - Serial command summary, for the configuration IDs supported by each object ID.

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 5 - Gauge status bits

BIT	Status flag	Meaning	nAPG	nAIM	nWRG
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*

6 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, messages are responded to when prefixed by a multi-drop header with a valid destination address:

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

Where "dd" is the destination address and "ss" is the source address. Valid Node addresses are 01-98. 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.

Expected gauge responses are:

- If a message is in multi-drop mode and the digital gauge is not in multi-drop mode, then the message **will not** be acted upon and a reply **will not** be returned.
- If a message is in multi-drop mode and the message is not addressed to the digital gauge's node address, then the message **will not** be acted upon and a reply **will not** be returned.
- If a message is in multi-drop mode and the message is addressed to the digital gauge's node address, then the message **will** be acted upon and a reply **will** be returned.
- If a message is in multi-drop mode and the Broadcast "00" address is used, then the message **will** be acted upon and a reply **will not** be returned. Only write (!) commands are supported.
- If a message is in multi-drop mode and the Wildcard "99" address is used, then the message **will** be acted upon and a reply **will** be returned. All commands are supported.

7 Auto-enumeration

Node addresses can be randomly assigned to supported gauges by using the auto-enumerate command. In order to prevent comms collisions on systems with multiple gauges, gauge replies are disabled and the gauge setpoint output is used to flag receipt of a valid message. Because of this, it is essential that all gauge setpoint outputs can be monitored and that they are not connected to the vacuum system in any way that might cause erratic system behaviour.

7.1 Multiple gauges on a multi-drop system

Multiple multi-drop gauges, on a multi-drop system, can be simultaneously randomly assigned a node address using the Broadcast "00" node address. Multiple single point gauges, on a multi-drop system, will all respond to a single point command.

After auto-enumeration is triggered, each node address must be queried and all the gauge setpoint outputs monitored for a response. Once all gauges and their node addresses have been correctly identified, then the gauge replies can be re-enabled. Depending on the number of gauges on the system, multiple cycles may be required to ensure unique node address allocation.

!C781 2	All single point gauges **OR**
#00:ss!C781 2	All multi-drop gauges: replies disabled and node address assigned
↓	
#01:ss?S0	Query each node address from 01 to 98 and monitor gauge setpoint outputs
<no SP>	No response detected - No gauge at that node address
↓	
#42:ss?S0	Repeat query for all node addresses
<SP active>	Single valid message response detected - single gauge at that node address
↓	
#84:ss?S0	Query node address
<2 x SP active>	multiple message responses detected - multiple gauges at node address
#84:ss!C781 2	Re-auto-enumerate gauges at the identified node address
↓	
#01:ss?S0	Re-start node address queries
↓	
#98:ss?S0	Repeat until all node addresses queried and no clashes detected
↓	
#42:ss!C781 0	Gauge replies can be enabled at identified node addresses
#ss:42*C781 0	Reply returned

7.2 Individual gauge on a point-to-point system

Individual gauges, on a point-to-point system, can be randomly assigned a node address using the Wildcard "99" node address:

!C781 2	All single point gauges **OR**
#99:ss!C781 2	All multi-drop gauges: replies disabled and node address assigned
↓	
#99:ss!C781 0	Any gauge enable replies
#ss:99*C781 0	Reply returned
#99:ss?S750	Any gauge query Node address
#ss:99=S750 63	Node address returned

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.

If you are returning a vacuum pump, note the following:

- If a pump is configured to suit the application, make a record of the configuration before returning the pump. All replacement pumps will be supplied with default factory settings.
- Do not return a pump with accessories fitted. Remove all accessories and retain them for future use.
- The instruction in the returns procedure to drain all fluids does not apply to the lubricant in pump oil reservoirs.

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

Note: *If we do not receive a completed HS2 form, we will not accept the return of the equipment.*