nEXT Turbomolecular Pumps
nEXT240, nEXT300 and nEXT400

INSTRUCTION MANUAL

edwardsvacuum.com

Copyright notice

Trademark credit

Disclaimer

The content of this manual may change from time to time without notice. We accept no liability for any errors that may appear in this manual nor do we make any expressed or implied warranties regarding the content. As far as practical we have ensured that the products have been designed and constructed to be safe and without risks when properly installed and used in accordance with their operating instructions.

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.

P20003600G

CE Declaration of Conformity

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

The following product

B812 XXXXX	nEXT 240D
B813 XXXXX	nEXT 240T
B822 XXXXX	nEXT 300D
B823 XXXXX	nEXT 300T
B832 XXXXX	nEXT 400D
B833 XXXXX	nEXT 400T

Is in conformity with the relevant requirements of European CE legislation:

2006/42/EC	Machinery directive
2014/35/EU	Low voltage directive (LVD) as applicable to electrical sub-assemblies
2014/30/EU	Electromagnetic compatibility (EMC) directive
2011/65/EU	Restriction of certain hazardous substances (RoHS) directive as amended by Delegated Directive (EU) 2015/863

Based on the relevant requirements of harmonised standards:

EN 1012-2:1996 +A1:2009	Compressors and vacuum pumps. Safety requirements. Vacuum pumps
EN 61010-1:2010	Safety requirements for electrical equipment for measurement, control and laboratory use. General requirements
EN 61326-1:2013	Electrical equipment for measurement, control and laboratory use. EMC requirements. General requirements Class B Emissions, Industrial Immunity

Documentation Officer: Jelena Havelkova, Spielberk Office Centre, Holandska 10, Brno, 63900 Czech Republic,
✆: +42(0) 734 418 896, ✉: documentation@edwardsvacuum.com

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: 11th November 2019

Petr Smerek – Engineering Manager
Scientific Vacuum Division
Lutin

Ian Keech – General Manager
Lutin

Additional Legislation and Compliance Information

EU EMC Directive: Class A/B equipment

Caution: This equipment is not intended for use in residential environments and may not provide adequate protection to radio reception in such environments.

EU RoHS Directive: Material Exemption Information

This product is compliant with the following Annex III Exemptions:

- 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
- 8(b) **Cadmium** and its compounds in electrical contacts

EU REACH Regulation Compliance

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

This product does not knowingly or intentionally contain 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.

- Cadmium (Cd) added to the Candidate List June 2013

As indicated by the applied RoHS exemption above, this substance is present in electronic componentry

- Lead (Pb) added to the Candidate List June 2018

As indicated by the applied RoHS exemption(s) above this substance is present in certain aluminium/brass components.

ADDITIONAL INFORMATION

The products listed are also in scope for and comply with the requirements of the following:

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

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
铜管管件 Brass pipe fitting	X	O	O	O	O	O
铜接头 Brass connectors	X	O	O	O	O	O
印刷电路组件 (PCA) Printed Circuit Assembly (PCA)	X	O	X	O	O	O

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

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

This page has been intentionally left blank.

Contents

List of Figures

This page has been intentionally left blank.

1. Safety and compliance

1.1 Definition of Warnings and Cautions

NOTICE:

This manual meets our obligation to provide you with information. For safe operation from the start, read these instructions carefully before you install or commission the equipment.

Read all the safety instructions in this section and the rest of this manual carefully and make sure that you obey these instructions. The equipment must only be operated and maintained by trained personnel in the proper condition and as described in this instruction manual.

Obey local and state requirements and regulations. If you have any questions about safety, operation or maintenance of the device, please contact our nearest subsidiary.

Important safety information is highlighted as warning and caution instructions. Obey these instructions.

WARNING:

If you do not obey a warning, there is a risk of injury or death. Different symbols are used according to the type of hazard.

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 pump or the system.

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

Keep the instructions for future use.

1.2 Safety symbols

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

The safety symbols that follow are used on the product or in the product documentation.

	Warning/Caution A safety instruction which must be followed.
	Warning - Heavy object Identifies a possible hazard from a heavy object.
	Warning - Dangerous voltage Identifies possible hazards from dangerous voltages.
	Warning - Hot surfaces Identifies a potential hazard from a hot surface.
	Warning - Protective earth (ground) The equipment must be grounded.
	Warning - Use protective equipment Use appropriate protective equipment.
	Warning - Maximum angle of paired slings An indication that the maximum angle of the paired slings must not be more than 45°.
	Warning - Moving parts present An indication that there are parts that move. You must let the parts that turn stop and then remove the electrical power.
	Warning - Pressurised An indication that the equipment contains pressurised gases/liquids.
	Warning - Risk of explosion An indication that there is a risk of explosion when you do the task.
	Warning - RF earth An indication that there are radio frequencies in the area of this task.

1.3 Trained personnel

“Trained personnel” for the operation of this pump are

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

2. Introduction

The units used in the manual conform to the SI international system of units of measurement where applicable US equivalent units of measurement are given. When flow rates are specified, the abbreviation ‘sccm’ is used to mean standard cubic centimetres per minute. This is a flow of 1 cm^3 min^{-1} at an ambient temperature of 0 °C and a pressure of 1013 mbar (1.013 x 10^5 Pa).

2.1 Overview

WARNING: SAFE EQUIPMENT USE

Risk of injury or damage to equipment. Improper use of the equipment can cause damage to it or injury to people. The user is responsible for the safe operation, installation and monitoring of the system.

WARNING: ELECTROLYTIC CAPACITORS

Risk of asphyxiation. The drive contains electrolytic capacitors and, under certain fault conditions, may emit dangerous fumes. Ensure that the drive is operated in a well-ventilated area.

CAUTION: ELECTRICAL CONNECTIONS

Risk of damage to equipment. Do not attempt to separate the controller from the pump since this will cause damage to the electrical connections.

A nEXT pump has a turbomolecular pump with a permanently attached controller which have drive electronics.

The controller controls the electrical supply to the pump with the exception of standby speed control. The controller has no manual controls and can be operated through the logic interface only. To operate the nEXT pump, connect it to the customer control equipment and power supply or use the manufacturer's TIC Turbo Instrument Controller or TIC Turbo Controller.

The controller drives the brush-less d.c. motor in the pump. Three variants of the nEXT pump are:

- The 'S' or 'Simplex' variant which has turbomolecular blades.
- The 'D' or 'Duplex' variant which has turbomolecular blades and a drag mechanism that allows operation at higher backing pressures than the pure turbomolecular pumps.
- The 'T' or 'Triplex' variant which has turbomolecular blades, a drag mechanism and a regenerative mechanism. The regenerative stage gives the option to utilise 'boost' mode.

An 'iD' or 'iT' interstage variant gives an interstage port between the turbomolecular blades and drag mechanism. For SEM and TEM applications, an 'L' variant is available which offers lower vibration and stray magnetic field emissions.

The nEXT pump is supplied with an inlet screen. The inlet screen is installed in the centering O-ring for ISO version pumps and in the envelope for CF version pumps. The nEXT pumps with an NW25 interstage port are supplied with an inlet strainer. The inlet strainer is installed in the interstage port. The inlet screen and inlet strainer prevent the damage to the pump caused by debris entering the pump.

The nEXT pump has a vent port for venting the pump and vacuum system to the atmospheric pressure. The pump has a manual vent valve which can be replaced with a TAV5 or TAV6 solenoid-operated vent valve (available as an accessory, refer to *Accessories on page 97*). The on-board motor controller can control the TAV valve.

The nEXT pump has a purge port through which an inert purge gas can be introduced to protect the bearing and motor from corrosion. You can install an optional vent port adapter and purge restrictor to the purge port to control the flow rate of the purge gas and to filter the gas supply. Refer to *Accessories on page 97*.

Air coolers and a water-cooling block are available as an optional accessory to cool the nEXT pumps. Refer to *Accessories on page 97*.

2.2 Pump controller

The pump controller has the drive electronics that control the pump operation and the TAV vent valve. The connector socket is given at the side of the controller where the TAV vent valve can be plugged in. Refer to *Controller connector socket on page 33*.

The controller has three indicator LED's which signal the general status, operation and the service status of the pump. The LEDs can be used for fault finding if a problem occurs. Refer to *Indicator LED's on page 34*.

The drive electronics system has a number of built-in safety features to prevent the pump from damage during sustained high pressure or temperature.

- The electronics constantly monitors the temperature in the controller and the temperature of the motor in the pump. If the controller or the motor gets too hot, the controller decreases the power supplied to the pump motor and the pump speed decreases. If the rotational speed of the pump decreases below 50% of the full speed, the electronics can trip into a fail condition, depending on the system configuration. Refer to *Timer on page 13*.
- If the inlet pressure of the pump increases, the power supplied to the pump motor increases to counteract the gas frictional load. When the built-in maximum power limit is reached, the speed of the pump starts to decrease. If the rotational speed of the pump decreases below 50% of the full speed, the electronics can trip into fail condition, depending on how the system has been configured. Refer to *Timer on page 13*.
- If the electrical supply fails, the controller uses the motor in the pump as a generator. This means the pump has its own regenerative supply and a separate battery for an emergency power backup is not necessary. The regenerated energy maintains the electrical supply to the controller, the vent valve or the fan attached to the controller connector until the pump speed decreases below 50% of the full rotational speed to make sure that the vent valve stay shut until below 50% of the full rotational speed and prevent the pump from venting at a full speed. It makes sure that the serial link and signals on the parallel interface stays active until the pump speed decreases below 50%.

2.3 Operational features

The nEXT pumps have the basic start and stop commands and some other features that allows the pump operation to be modified for an applicable application. Refer to *Table: Logic interface technical data on page 30* for factory default settings of the parameters given in the sections that follows.

OEM supplied pumps can have drive parameters and default user-selectable settings. The drive parameters and default user-selectable settings can be different from the parameters given in the instruction manual to suit specified process requirements. Contact OEM for more information and advice.

2.3.1 Power limit setting

Select the maximum power that will be drawn by the pump. If more power is supplied, the pump will accelerate quickly to reach full speed.

If fast cycling or higher gas loads are necessary for the application, set the power limit to the maximum value. If ramp time is not important in the application, use the lower power limit, down to a minimum value (refer to *Table: Power limit setting on page 61*). Make sure that sufficient cooling is available for the application.

Make sure that the power supply can supply sufficient power to the pump. If a lower power limit setting is selected, a smaller power supply can be used. Refer to *Electrical data on page 28* for more information.

2.3.2 Power limit setting

Select the maximum power that will be drawn by the pump. The more power supplied, the quicker the pump will accelerate to reach full speed.

If the application requires fast cycling or higher gas loads, set the power limit to the maximum value. If ramp time is not important in the application, use a lower power limit, down to a minimum value (refer to *Table: Power limit setting on page 61*). Also ensure there is sufficient cooling for the application.

Ensure that the power supply is capable of delivering sufficient power to the nEXT pump. By choosing a lower power limit setting, a smaller power supply may be used. For more information, refer to *Electrical data on page 28*.

Table 1 Power limits

Pump	Standard default setting	Maximum value setting	Minimum value setting
nEXT240, nEXT300 and nEXT400	160 W	200 W	50 W

2.3.3 Standby speed

In standby mode, the pump rotational speed is lower than the full rotational speed. The default setting for standby speed is 70% of the full speed.

To operate the pump at standby speed, it must be in the start condition.

If operating the pump at maximum speed at all times is not necessary for the application, use the standby speed feature rather than setting the pump to off. You can

use the standby speed feature for tuning the vacuum system or as a power saving option for the system.

The standby speed is a user-selectable value. Refer to *Standby speed setting on page 63*.

2.3.4 Timer

When the pump is started, an internal timer is starts automatically in the drive electronics. The default timer setting is 8 minutes.

If the pump fails to reach 50% of full rotational speed in the timeout period, the motor controller will signal a fail and decelerate the pump to rest. This feature prevents the motor controller from driving the pump at maximum power for a long time. The pump can fail to reach 50% speed if the gas load is too high (for example if there is a leak in the system), if the backing pump fails or if the pump is too hot.

The timeout period is user-selectable (refer to *Timer setting and options on page 64*). If slow ramp-up of the pump is necessary for the application, extend the timeout period. The timer is permanently enabled for ramp-up.

If the rotational speed of the pump decreases below 50% of the full speed, the pump time can be set to recover rather than trigger a fail condition. The timer starts immediately when the rotational speed of the pump decreases below 50% of the full speed. If the rotational speed of the pump increases above 50% during the timeout period, the timer will reset. If the rotational speed of the pump does not recover by the end of the timeout period, the motor controller will trigger a fail condition and decelerate the pump to rest.

The timer function is enabled when the pump is shipped. You can disable the timer function. If the timer function is disabled, the pump will fail and decelerate to rest immediately when the rotational speed of the pump decreases below 50%.

2.3.5 Analogue output

The pump controller produces an analogue output for monitoring four different system parameters:

- Measured pump rotational speed (default condition)
- Measured motor power
- Measured motor temperature
- Measured controller temperature.

The range of the analogue output signal is from 0 to 10 V and is directly proportional to the system parameter. Refer to *Logic interface connector on page 30*.

Connect the analogue output to an applicable meter or indicator to display the applicable system parameter or connect it to the customer control equipment (for example, to operate other components in the pumping system at set values).

The analogue output can monitor only one system parameter at a time. You can configure the controller to monitor different system parameter. Refer to *Analogue signal options on page 65*.

2.3.6 Automatic vent options

The manufacturer's TAV vent valve can be connected to the nEXT pump's controller. The controller can give number of different venting options.

The drive electronics can control the rate of venting. Using this feature, the pump can be vented from the full rotational speed in a controlled manner that will not damage the pump bearings. When the rotational speed of the pump decreases below 50% of the maximum speed, it is safe to do a hard vent (open the vent valve fully).

Many venting options are available, that includes:

- Hard vent when the rotational speed decreases below 50%
- Controlled vent when the rotational speed is above 50% speed and hard vent is below 50% speed
- Hard vent immediately through an applicable restrictor.

Controlled venting gives a quicker ramp down time by controlling the vent rate through a single large orifice across the speed range of the pump. List of the venting options is given in *Vent options, vent valve connection and control on page 56*.

A feature is given that allows a delayed start of the nEXT pump. With this feature, the vent valve can be closed before starting the nEXT pump. This allows the backing pump to decrease the pressure in the vacuum system before starting the nEXT pump.

If the controller is not used to control a TAV vent valve, it can be used to operate a fan. You can configure the controller to permanently enable the fan.

2.3.7 Normal speed setting

The normal speed is a user-selectable parameter which can be set from 50% to 100% of full rotational speed.

When the pump gets to normal speed, a signal is available on the normal pin of the logic interface connector. The signal can be used to control the application as it shows that the vacuum performance (pump speed) is at a set level. The default setting is 80% of the full rotational speed. Refer to *Normal speed setting on page 63* for instructions to change the normal speed setting.

2.4 Logic interface

The pump controller can be operated only through the logic interface. The signals on the logic interface are of three types:

- Control inputs: Switch-type signals that are used to control the pump
- Status outputs: To identify the status of the system
- Analogue output: Gives a 0 - 10 V output for a number of pump parameters.

The logic interface supports the serial control and the parallel control to monitor and control through one connector. For serial control, RS232 (default) or RS485 can be selected using the RS485 / RS232 slide switch which is given on the motor controller. Refer to *Connection for serial control and monitoring on page 46*.

You can plug the logic interface into the manufacturer's TIC Turbo Controller or TIC Turbo Instrument Controller and then use the given functionality. The logic interface can be connected to the customer control system as an alternative.

Refer to *Logic interface connector on page 30* for more information about the logic interface.

2.4.1 Parallel control and monitoring

The simple parallel interface is a quick and easy way to control the pump. Same interface is used on the 24 V manufacturer's Turbo Pumps. The start and standby controls are available to use. You can monitor the system status using the normal, fail and analogue output signals.

Note:

The serial enable switch must be open (no connection) and the slide switch must be in the RS232 position. Refer to Connect the parallel control and monitoring on page 45.

Refer to *Connect the parallel control and monitoring on page 45* for more instructions about how to use the parallel interface.

A system that is in operation with a parallel connection only is not capable to adjust the configuration settings stored in the controller (for example, power limit setting or controlled venting options). In this case, all these features will be at factory default settings. You can manually adjust the standby speed if standby mode is selected, but the controller must be configured separately before the installation of the nEXT pump to the system. Refer to *Controller configuration (serial configuration) on page 16* for more information.

2.4.2 Serial control and monitoring

The serial communications link gives complete control and monitoring by using three signal lines.

The serial data lines have the same connector pins as the parallel signals standby and fail. The serial data lines can be configured to give an RS485 compliant or RS232 compatible interface by setting the position of the RS485 / RS232 slide switch. Refer to *Connection for serial control and monitoring on page 46*.

The serial enable signal must be linked to 0 V for the system to accept commands from the serial link. This is a safety feature which operates as an interlock. For pure serial control, the parallel start signal will be left unconnected.

The motor controller will continue to give normal and analogue signals on the logic interface connector even when operating under serial control. You can get the status of the normal signal and the value of the system parameter on the analogue output by interrogating the system status through the serial link.

Refer to *Connection for serial control and monitoring on page 46* for more information about the serial interface.

2.4.3 Serial control with parallel monitoring

Normal and analogue signals stay available when using serial control. You can control the pump through the serial link while monitoring the normal and analogue signals in the parallel interface.

The serial link uses the same connector pins as the parallel signals standby and fail so these parallel control and monitoring signals are not available. The serial enable signal must be linked to 0 V and the parallel start signal will be left unconnected.

2.4.4 Parallel control with serial monitoring or serial configuration

Use this configuration to operate the pump in parallel control mode, with the option to:

- adjust the configuration settings stored in the motor controller or
- monitor operational status of the pump through the serial link

The serial enable signal must be linked to 0 V for serial communications to take place. While operating under parallel control with the serial link active, the parallel start control signal is available (as given in *Parallel control and monitoring on page 15*) but the standby control line will not be available as it is used as a serial data line.

If the serial enable line is deactivated while the RS485 / RS232 slide switch is in the RS232 position, the serial link must be disconnected. We recommend you to make a special cable for the serial communications that includes a link between serial enable and 0 V. This way, the serial enable is automatically activated when the cable is connected and deactivate when the cable is removed.

2.4.5 Controller configuration (serial configuration)

All configuration settings stored in the motor controller are kept when the power to the pump is removed so that it is possible to use another system to configure the motor controller before the installation of the pump at the application. You can configure the operation of the pump as per the application and the pump can be operated using a simple parallel interface system.

To configure the pump, use a customer simple serial system or use the manufacturer's TIC Turbo Controller or Turbo Instrument Controller. The TICs allows the storage of a pump's configuration. You can download the configuration to another pump. This is useful when you configure a number of pumps with the same settings before they are installed at a system.

Note:

The RS485 / RS232 slide switch must be in the RS232 (default) position if the TIC is to be used to configure the pump. Refer to *Connect the serial interface to the customer control equipment on page 46**.*

The TIC is supplied with a Windows™ based PC program which allows the pump to be configured from a single PC. The program has a simple user interface and it is not necessary to use the ASCII message protocol given in *Connection for serial control and monitoring on page 46*. The TIC PC program can save number of pump configurations which can be downloaded to the other pumps.

3. Technical data

3.1 General technical data

Table 2 General data

General items	Reference data
Performance	Refer to *Table: nEXT 240 pumps technical data on page 17*, *Table: nEXT 300 pumps technical data on page 18* and *Table: nEXT 400 pumps technical data on page 19*, *Figure: nEXT240 performance curve on page 21*, *Figure: nEXT300 performance curve on page 22* and *Figure: nEXT400 performance curve on page 22*.
Dimensions	Refer to *Figure: nEXT 240 dimensions (mm) on page 23*, *Figure: nEXT 300 dimensions (mm) on page 24* and *Figure: nEXT 400 dimensions (mm) on page 25*.
Maximum inlet flange temperature nEXT240 nEXT300 nEXT400	 75 °C 80 °C 70 °C
Maximum permitted external magnetic field	5 mT Radial*
Pollution degree	EN61010 Pollution degree 2
Equipment type	Fixed equipment, for indoor use only
Enclosure protection (installed)	IP40

* *Reduce gas load when operating in magnetic the field.*

Table 3 nEXT 240 pumps technical data

Parameter	nEXT240D ISO100	nEXT240D CF100	nEXT240T ISO100	nEXT240T CF100
Mass	5.7 kg	8.7 kg	6.0 kg	9.0 kg
Inlet flange	DN100ISO-K	DN100CF	DN100ISO-K	DN100CF
Outlet flange	DN25NW	DN25NW	DN25NW	DN25NW
Vent port	⅛ inch BSPP	⅛ inch BSPP	⅛ inch BSPP	⅛ inch BSPP
Purge port	⅛ inch BSPP	⅛ inch BSPP	⅛ inch BSPP	⅛ inch BSPP
Interstage port	DN25NW	DN25NW	DN25NW	DN25NW
Booster port	DN25NW	DN25NW	DN25NW	DN25NW

Parameter	nEXT240D ISO100	nEXT240D CF100	nEXT240T ISO100	nEXT240T CF100
Inlet pumping speed N_2 He H_2	 240 l/s 230 l/s 165 l/s	 240 l/s 230 l/s 165 l/s	 240 l/s 230 l/s 165 l/s	 240 l/s 230 l/s 165 l/s
Inlet compression ratio N_2 He H_2	 >1 x 10^{11} 3 x 10^5 1 x 10^4	 >1 x 10^{11} 3 x 10^5 1 x 10^4	 >1 x 10^{11} 1 x 10^6 1.5 x 10^4	 >1 x 10^{11} 1 x 10^6 1.5 x 10^4
Interstage pumping speed N_2 He H_2	 13 l/s 13 l/s 11 l/s	 13 l/s 13 l/s 11 l/s	 13 l/s 13 l/s 11 l/s	 13 l/s 13 l/s 11 l/s
Peak booster pumping speed (nitrogen) RV12 backing pump XDS10 backing pump	-	-	 26 m^3h^{-1} 24 m^3h^{-1}	 26 m^3h^{-1} 24 m^3h^{-1}
Ultimate pressure*	<6 x 10^{-8} mbar	<5 x 10^{-10} mbar	<6 x 10^{-8} mbar	<5 x 10^{-10} mbar

** Ultimate pressure 48 hours after bakeout for CF version and without bakeout for ISO version with 2-stage rotary vane backing pump.*

Note:

Pumping speeds given are without an inlet screen.

Table 4 nEXT 300 pumps technical data

Parameter	nEXT300D ISO100	nEXT300D CF100	nEXT300T ISO100	nEXT300T CF100
Mass	5.8 kg	8.5 kg	6.1 kg	8.8 kg
Inlet flange	DN100ISO-K	DN100CF	DN100ISO-K	DN100CF
Outlet flange	DN25NW	DN25NW	DN25NW	DN25NW
Vent port	⅛ inch BSPP	⅛ inch BSPP	⅛ inch BSPP	⅛ inch BSPP
Purge port	⅛ inch BSPP	⅛ inch BSPP	⅛ inch BSPP	⅛ inch BSPP
Interstage port	DN25NW	DN25NW	DN25NW	DN25NW
Booster port	DN25NW	DN25NW	DN25NW	DN25NW
Inlet pumping speed N_2 He H_2	 300 l/s 340 l/s 280 l/s	 300 l/s 340 l/s 280 l/s	 300 l/s 340 l/s 280 l/s	 300 l/s 340 l/s 280 l/s

Parameter	nEXT300D ISO100	nEXT300D CF100	nEXT300T ISO100	nEXT300T CF100
Inlet compression ratio N_2 He H_2	 $>1 \times 10^{11}$ 1×10^{6} 5×10^{4}	 $>1 \times 10^{11}$ 1×10^{6} 5×10^{4}	 $>1 \times 10^{11}$ 3×10^{6} 1×10^{5}	 $>1 \times 10^{11}$ 3×10^{6} 1×10^{5}
Interstage pumping speed N_2 He H_2	 13 l/s 13 l/s 11 l/s	 13 l/s 13 l/s 11 l/s	 13 l/s 13 l/s 11 l/s	 13 l/s 13 l/s 11 l/s
Peak booster Pumping speed (nitrogen) RV12 backing pump XDS10 backing pump	-	-	 $26\ m^3h^{-1}$ $24\ m^3h^{-1}$	 $26\ m^3h^{-1}$ $24\ m^3h^{-1}$
Ultimate pressure*	$<6 \times 10^{-8}$ mbar	$<5 \times 10^{-10}$ mbar	$<6 \times 10^{-8}$ mbar	$<5 \times 10^{-10}$ mbar

** Ultimate pressure 48 hours after bakeout for CF version and without bakeout for ISO version with 2-stage rotary vane backing pump.*

Note:

Pumping speeds given are without an inlet screen.

Table 5 nEXT 400 pumps technical data

Parameter	nEXT400D ISO160	nEXT400D CF160	nEXT400T ISO160	nEXT400T CF160
Mass	6.2 kg	10.0 kg	6.5 kg	10.3 kg
Inlet flange	DN160ISO-K	DN160CF	DN160ISO-K	DN160CF
Outlet flange	DN25NW	DN25NW	DN25NW	DN25NW
Vent port	⅛ inch BSPP	⅛ inch BSPP	⅛ inch BSPP	⅛ inch BSPP
Purge port	⅛ inch BSPP	⅛ inch BSPP	⅛ inch BSPP	⅛ inch BSPP
Interstage port	DN25NW	DN25NW	DN25NW	DN25NW
Booster port	DN25NW	DN25NW	DN25NW	DN25NW
Inlet pumping speed N_2 He H_2	 400 l/s 390 l/s 325 l/s	 400 l/s 390 l/s 325 l/s	 400 l/s 390 l/s 325 l/s	 400 l/s 390 l/s 325 l/s
Inlet compression ratio N_2 He H_2	 $>1 \times 10^{11}$ 1×10^{8} 5×10^{5}	 $>1 \times 10^{11}$ 1×10^{8} 5×10^{5}	 $>1 \times 10^{11}$ $>1 \times 10^{8}$ 1×10^{6}	 $>1 \times 10^{11}$ $>1 \times 10^{8}$ 1×10^{6}

Parameter	nEXT400D ISO160	nEXT400D CF160	nEXT400T ISO160	nEXT400T CF160
Interstage pumping speed N_2 He H_2	 13 l/s 13 l/s 11 l/s	 13 l/s 13 l/s 11 l/s	 13 l/s 13 l/s 11 l/s	 13 l/s 13 l/s 11 l/s
Peak booster Pumping speed (nitrogen) RV12 backing pump XDS10 backing pump	-	-	 26 m^3h^{-1} 24 m^3h^{-1}	 26 m^3h^{-1} 24 m^3h^{-1}
Ultimate pressure*	<1 x 10^{-8} mbar	<1 x 10^{-10} mbar	<1 x 10^{-8} mbar	<2 x 10^{-10} mbar

** Ultimate pressure 48 hours after bakeout for CF version and without bakeout for ISO version with 2-stage rotary vane backing pump.*

Note:

Pumping speeds given are without an inlet screen.

Table 6 nEXT pumps technical data

Parameter	nEXT240D	nEXT240T	nEXT300D	nEXT300T	nEXT400D	nEXT400T
Critical backing pressure N_2	9.5 mbar	20 mbar	9.5 mbar	20 mbar	10 mbar	20 mbar
Critical backing pressure He	7 mbar	8.5 mbar	7.5 mbar	8.5 mbar	8.5 mbar	8.5 mbar
Critical backing pressure H_2	2.5 mbar	3 mbar	2.9 mbar	3 mbar	3 mbar	3 mbar
Maximum continuous inlet flow (at ultimate backing pressure)*						
Nitrogen:						
Water cooling (40 °C Ambient)†	45 sccm	55 sccm	95 sccm	65 sccm	105 sccm	50 sccm
Force air cooling (35 °C Ambient)	30 sccm	50 sccm	115 sccm	100 sccm	90 sccm	105 sccm
Natural convection (30 °C Ambient)	10 sccm	10 sccm	35 sccm	25 sccm	45 sccm	25 sccm
Argon:						
Water cooling (40 °C Ambient)	35 sccm	35 sccm	63 sccm	42 sccm	70 sccm	49 sccm
Force air cooling (35 °C Ambient)	20 sccm	28 sccm	76 sccm	70 sccm	70 sccm	77 sccm
Natural convection (30 °C Ambient)	7 sccm	7 sccm	20 sccm	20 sccm	28 sccm	20 sccm
Maximum continuous backing pressure (at ultimate inlet pressure)*						
Nitrogen:						
Water cooling (40 °C Ambient)†	6 mbar	2.75 mbar	6.75 mbar	4.75 mbar	7.5 mbar	4 mbar
Force air cooling (35 °C Ambient)	4.75 mbar	2.75 mbar	7 mbar	8 mbar	7.5 mbar	9 mbar
Natural convection (30 °C Ambient)	1 mbar	0.4 mbar	2.75 mbar	1 mbar	4 mbar	1.25 mbar

Parameter	nEXT240D	nEXT240T	nEXT300D	nEXT300T	nEXT400D	nEXT400T
Argon:						
Water cooling (40 °C Ambient)	4.75 mbar	2.75 mbar	6 mbar	3.75 mbar	6.5 mbar	4 mbar
Force air cooling (35 °C Ambient)	3 mbar	1.5 mbar	6.5 mbar	7 mbar	6.5 mbar	8 mbar
Natural convection (30 °C Ambient)	0.5 mbar	0.2 mbar	2 mbar	0.75 mbar	3 mbar	1.2 mbar
Recommended backing pump	RV12/XDS10					
Operation attitude	Vertical and upright to horizontal ± 2 °					
	Vertical only for 'nL' variant pumps					
Normal rotational speed	60,000 revolutions per minute					
Starting Time to 90% Speed (160 W)	115 sec	140 sec	155 sec	175 sec	175 sec	200 sec
Starting Time to 90% Speed (200 W)	95 sec	120 sec	135 sec	150 sec	150 sec	170 sec
Sound pressure level (1 metre away)	<45 dB(A) ± 3dB(A) Declared dual number noise emission values in accordance with ISO4871					

** Values for the maximum continuous inlet pressure taken using a RV12 backing pump at sea level in negligible magnetic field. Values for the maximum continuous backing pressure taken under no flow conditions at sea level in negligible magnetic field. Refer to* *Vent options, vent valve connection and control on page 56* *for cooling conditions. At pressures above these, the rotational speed decreases below nominal.*

† Cooling water temperature 15 °C at a flow rate of 30 l hr^{-1}.

Figure 1 nEXT240 performance curve

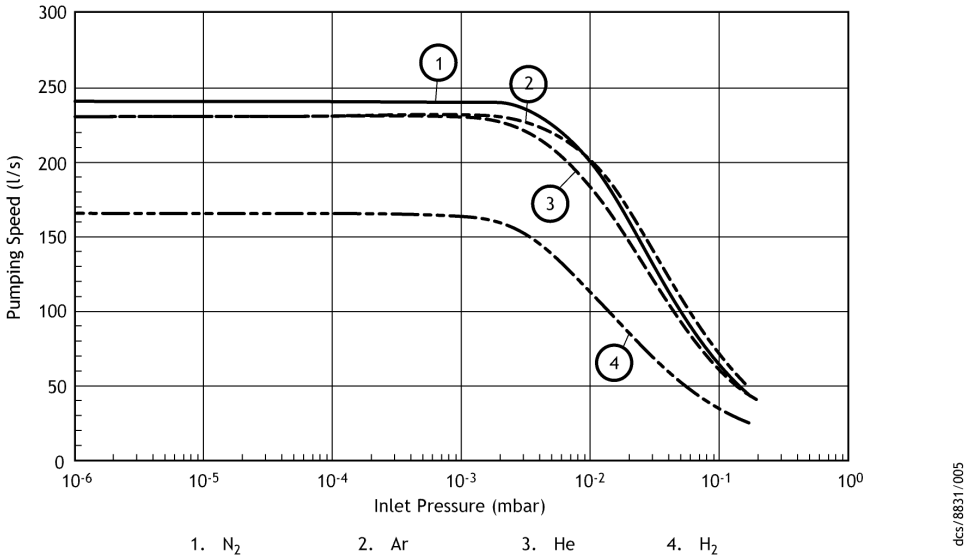
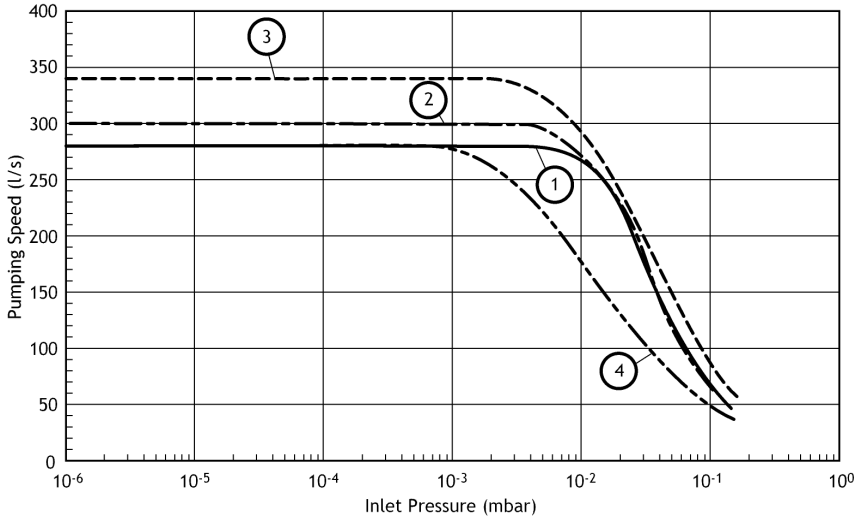


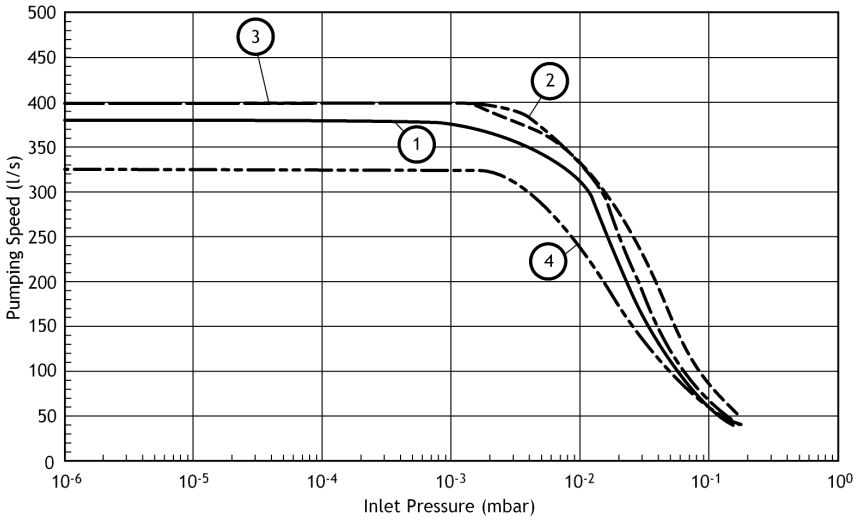
Figure 2 nEXT300 performance curve



1. N_2 2. Ar 3. He 4. H_2

dcs/8831/006

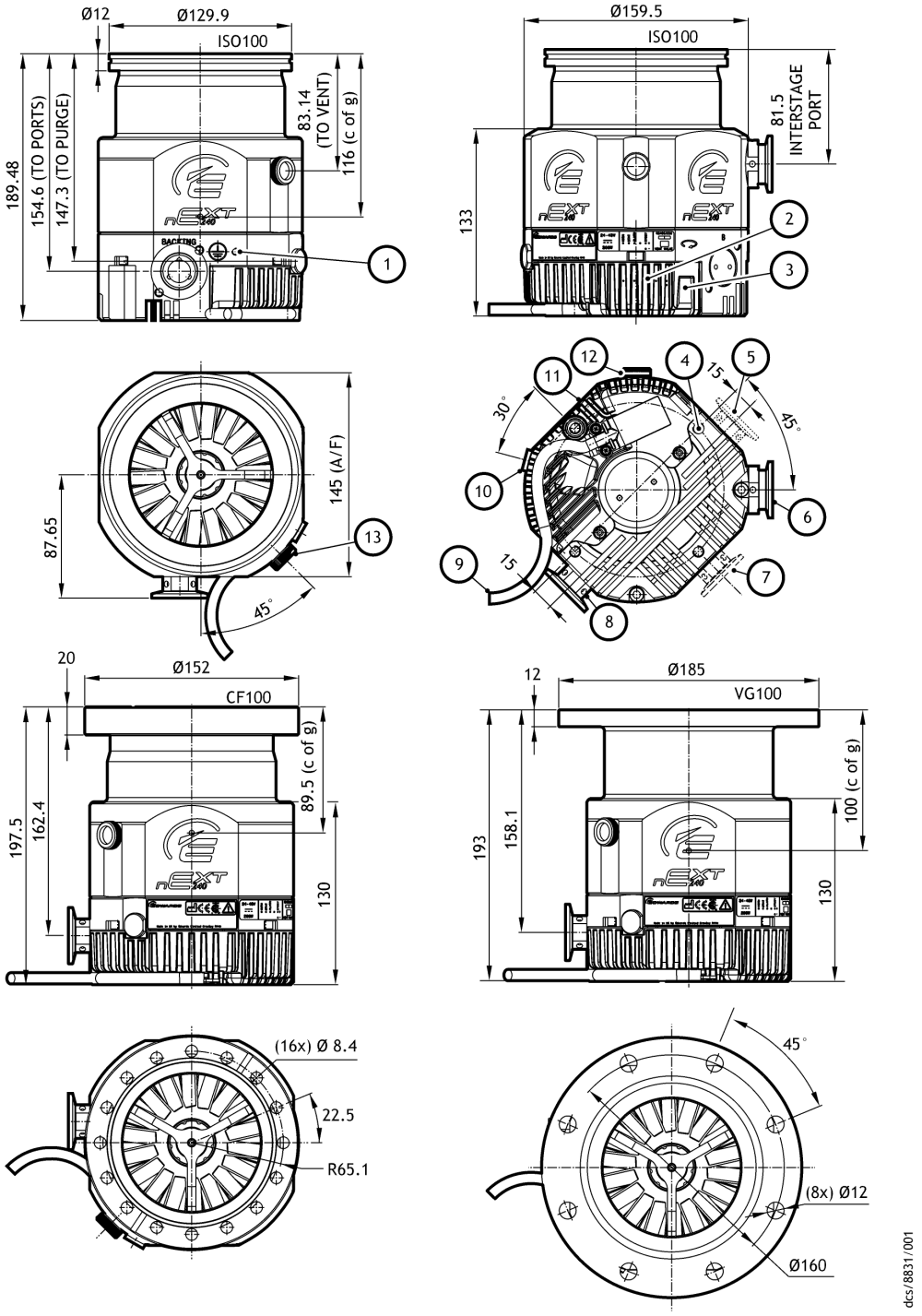
Figure 3 nEXT400 performance curve



1. N_2 2. Ar 3. He 4. H_2

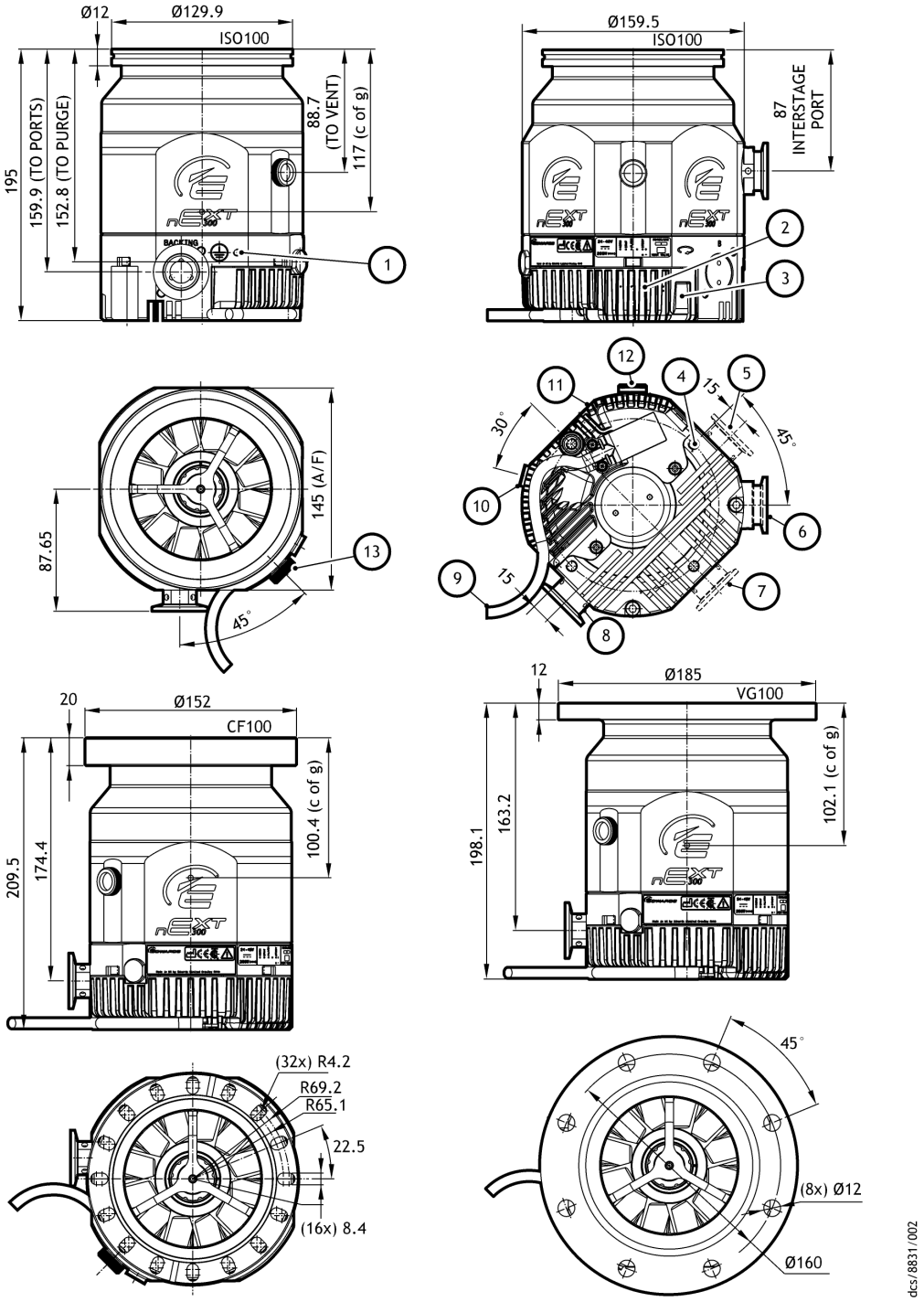
dcs/8831/007

Figure 4 nEXT 240 dimensions (mm)



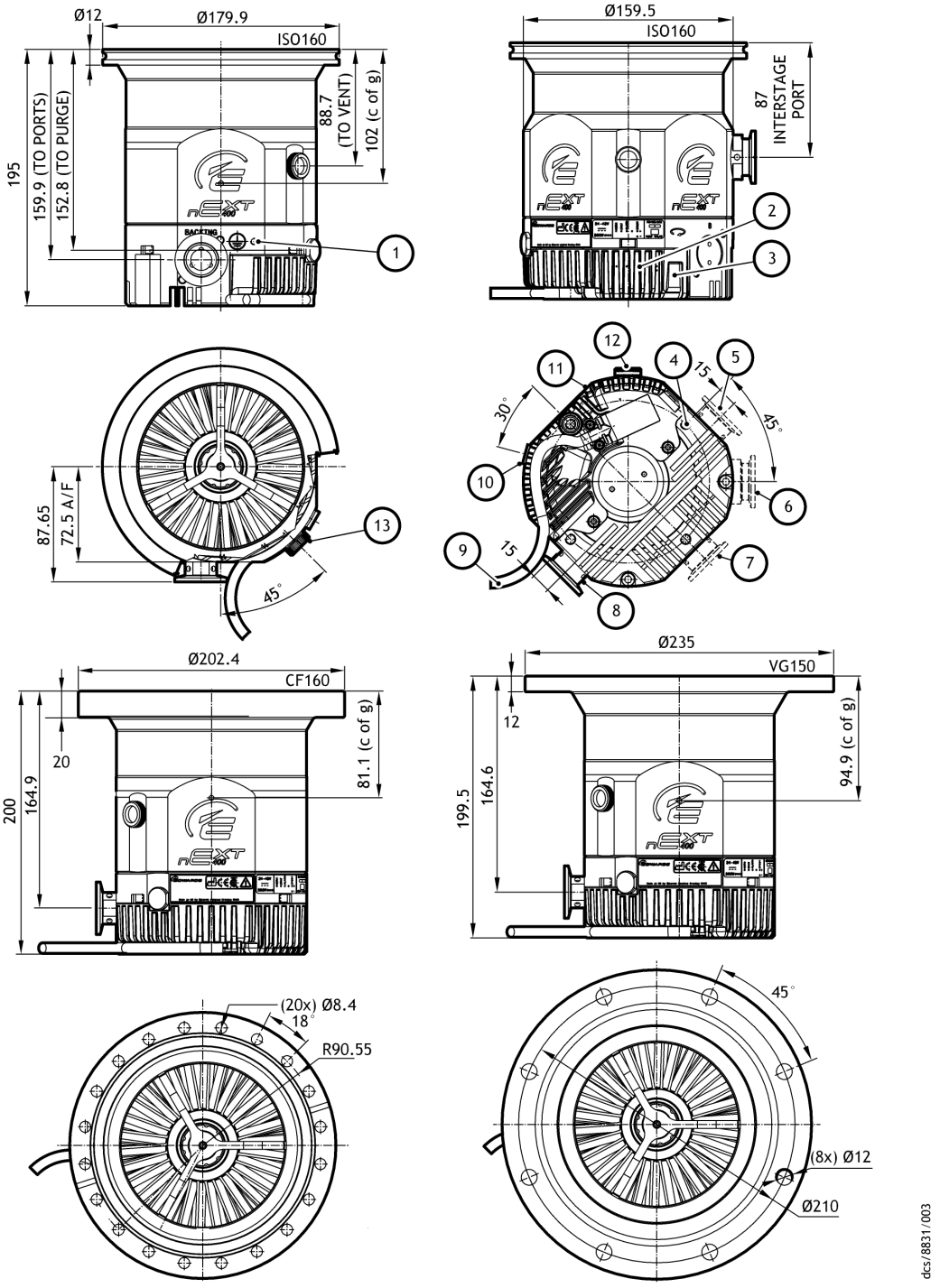
1. Earth point
2. LED indicators on drive unit
3. Removable cap RS485/RS232 switch vent valve socket
4. Base mounting holes and fan mountings
5. Booster port B
6. Interstage port
7. Booster port A
8. Backing port
9. 24/48 V supply
10. Body purge port
11. Electrical drive unit
12. Envelope vent port ⅛ inch BSP
13. Envelope vent

Figure 5 nEXT 300 dimensions (mm)



1. Earth point
2. LED indicators on drive unit
3. Removable cap RS485/RS232 switch vent valve socket
4. Base mounting holes and fan mountings
5. Booster port B
6. Interstage port
7. Booster port A
8. Backing port
9. 24/48 V supply
10. Body purge port
11. Electrical drive unit
12. Envelope vent port ⅛ inch BSP
13. Envelope vent

Figure 6 nEXT 400 dimensions (mm)



1. Earth point
2. LED indicators on drive unit
3. Removable cap RS485/RS232 switch vent valve socket
4. Base mounting holes and fan mountings
5. Booster port B
6. Interstage port
7. Booster port A
8. Backing port
9. 24/48 V supply
10. Body purge port
11. Electrical drive unit
12. Envelope vent port ⅛ inch BSP
13. Envelope vent

3.2 Operation and storage environment

Table 7 Operation and storage environment

Range	Data
Ambient operating temperature range	5 °C to 35 °C
Ambient operating humidity range	10 to 90% RH (non-condensing)
Maximum operating altitude	3000 m
Ambient storage temperature range	-30 °C to 70 °C

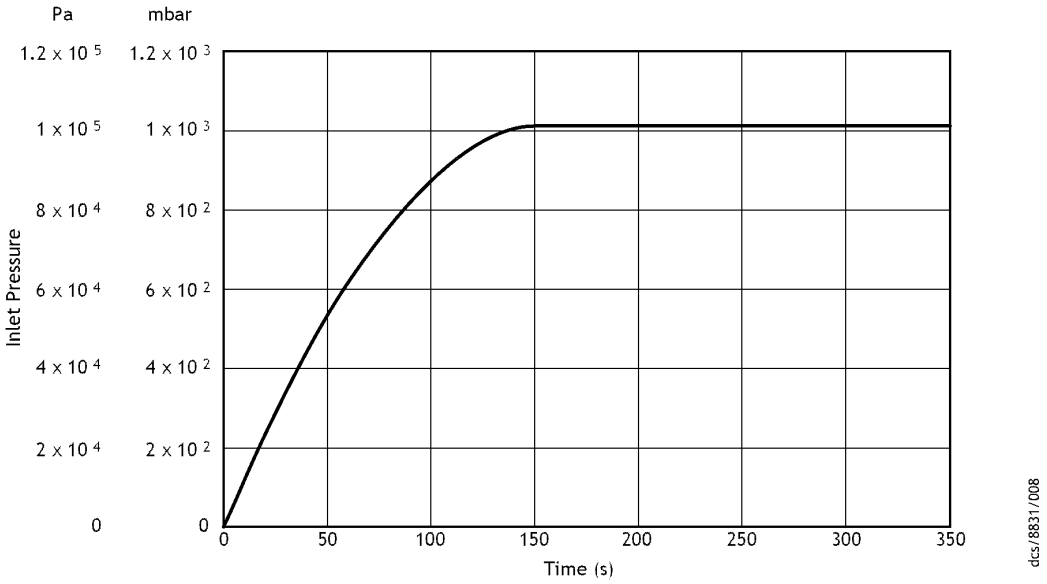
3.3 Vent gas specification and vent control data

The pump can be vented to atmosphere, but the high relative humidity of the air can increase the subsequent pump-down time. To decrease the pump-down times, vent with dry and clean gases. Refer to *Vent options, vent valve connection and control on page 56* for the vent options and the vent valve connection. Refer to *Controlled venting options on page 62* for configuring the venting options.

Table 8 Vent gas specification and vent control

Vent gas specification and control	Reference data
Vent gas	Dry air, nitrogen, argon or other inert gases
Maximum dew point at an atmospheric pressure	-22 °C
Maximum size of particulates	1 µm
Maximum concentration of oil	0.1 parts per million
Recommended time for the rotational speed to reach 50%	> 15 seconds
Maximum permitted rate of increase of pressure	Refer to *Figure: Maximum allowed rate of increase in pressure during venting: pressure against time (pump initially at full speed) on page 27*.

Figure 7 Max allowed rate of pressure rise during venting: pressure against time (pump initially at full speed)



3.4 Purge gas specification

Table 9 Purge gas specification

Purge gas specification	Reference data
Purge gas	Dry air, nitrogen, argon or other inert gases
Maximum dew point at an atmospheric pressure	-22 °C
Maximum size of particulates	1 µm
Maximum concentration of oil	0.1 parts per million
Permitted purge gas flow (when necessary)	20 to 50 sccm (0.33 to 0.84 mbar l s^{-1} or 33 to 84 Pa l s^{-1})
Recommended purge gas flow	25 sccm (0.42 mbar l s^{-1}, 42 Pa l s^{-1})
Maximum permitted supply pressure of the purge gas	1 bar (gauge), 14.5 psig, 2 x 10^5 Pa

3.5 Cooling water

Refer to *Table: Cooling water specification on page 28* for the cooling water specification. The cooling water supply must be a high-quality drinking water specification. Check with the water supply authority if there is doubt about the quality of the supply.

Table 10 Cooling water specification

Cooling water specification	Reference data
Quality	Mechanically clean and optically clear with no deposits or turbidity
pH value	6.0 to 8.0
Maximum calcium carbonate concentration	75 parts per million
Maximum chloride concentration	100 parts per million
Minimum oxygen concentration	4 parts per million
Minimum cooling water flow rate (at 15 °C)	15 l hr^{-1}
Water temperature	10 to 20 °C
Maximum water pressure	5 bar (gauge), 73.5 psig, 6 x 10^5 Pa
Materials exposed to the cooling water	Nickel plated brass

3.6 Electrical data

The pumps can be operated by the customers system or by the manufacturer's TIC Turbo Instrument Controller or TIC Turbo Controller.

If using the customer system, the size of the power supply depends on the application. The rate of increase in the pump speed is dependent on the power limit setting. The power limit setting overrides the necessary power supply setting. If the serial communications or an access to the manufacturer's TIC is available, the power limit setting of the pump can be selected. Refer to *Table: Logic interface technical data on page 30* for the maximum power limit settings for the pumps. If the rapid cycling of the pump is necessary for an application, you can get the faster rate of increase in the pump speed if the power supply supplies higher current, up to a maximum in accordance with *Table: Logic interface technical data on page 30*.

If the power limit setting is not adjustable, use a power supply capable to supply sufficient current to meet manufacturer's factory default power limit setting shown in *Table: Logic interface technical data on page 30*.

The manufacturer's TIC has variants. If the pump is operated using the manufacturer's TIC, contact us to select the applicable variant for the application.

3.7 Pumping media

WARNING: DANGEROUS GASES

Risk of asphyxiation. Release the dangerous gases and gas mixtures safely. Do not expose people to the gases. If hazardous gases or vapour must pump, obey the safety recommendations of the supplier of the gas or vapour.

WARNING: PYROPHORIC OR EXPLOSIVE GASES

Risk of explosion. Do not use the nEXT pump to pump pyrophoric or explosive gas mixtures as the pump is not applicable for this purpose. The pump and its connections are not designed to contain an explosion.

WARNING: DANGEROUS GASES

Risk of damage to equipment. In the interstage and booster versions of the nEXT pumps, gas pumped through the interstage port will mix with gas pumped through the pump inlet. Make sure that the gases do not react or combine to form dangerous gases and substances.

WARNING: HIGH OPERATING PRESSURE

Risk of damage to equipment. Do not exceed the maximum continuous operating pressure. Failure to do so can cause dangerous rotor temperatures and will decrease the life of the pump.

WARNING: VACUUM EXPOSURE

Risk of injury. Do not expose the part of the human body to the vacuum.

WARNING: MERCURY VAPOUR

Risk of damage to equipment. Do not use a nEXT pump to pump mercury vapour. Do not allow mercury (for example, from a McLeod gauge) to come in contact with the pump. If mercury vapour is pumped, the pump rotor can corrode and fail.

Note:

Concentrations of gases can be changed by the compression of the pump.

The pumps are designed to pump the residual gases used in high-vacuum systems are:

- Air
- Methane
- Propane
- Butane
- Carbon monoxide
- Nitrogen
- Hydrogen
- Carbon dioxide
- Neon
- Krypton
- Helium
- Ethane
- Argon

To pump a gas that is not listed, contact the supplier for an advice. Failure to contact the supplier can invalidate the warranty of the pump. The pump is not applicable for pumping aggressive or corrosive gases.

The pump can be used to pump the oxygen and water vapour, with the conditions that follows:

- Oxygen - when the pump is purged by an inert gas, oxygen can be pumped at a concentration above 20% by volume. Refer to *Purge gas specification on page 27* for purge gas specification. If the pump is not purged, the oxygen concentration must be less than 20% by volume.
- Water vapour - Make sure that the vapour does not condense in the pump. Refer to *Water cooling on page 59*.

3.8 Materials exposed to gases pumped

The materials and component types that are exposed to the gases pumped are:

- Aluminium alloys
- Stainless steels
- Fluoroelastomer and nitrile O-rings
- Hydrocarbon lubricant
- Rare earth magnets
- Silicon nitride
- Carbon fibre reinforced epoxy resin
- Fire retardant polypropylene
- Polyamide
- PVC
- Titanium
- Silicon
- Torlon
- Ceramic

3.9 Logic interface connector

The pump has 15-way logic interface connector at the end of the logic interface cable. You can plug the logic interface connector into the manufacturer's TIC Turbo Instrument Controller or TIC Turbo Controller. Use applicable connector mating half (not supplied) to connect the pump to the customer equipment. Refer to *Table: Logic interface technical data on page 30* for the connector mating half type, *Table: Logic interface connector pins on page 32* for the logic interface connector pins for the electrical connections and *Figure: Interface circuits for nEXT turbo pump controllers on page 33* for the circuit diagrams of the connector interface.

Table 11 Logic interface technical data

Logic interface item	
Connector*	15-way D-type male
nEXT pumps electrical supply:	

Logic interface item	
Permitted voltage range (with ripple)	24 - 48 V d.c. +5%, -10% (21.6 to 50.4 V d.c.)
Maximum voltage ripple	0.5 V r.m.s.
Fuse rating	10 A for 24 V d.c. supply 5 A to 10 A for 48 V d.c. supply Type 'T' IEC approved or Time delay fuse UL/CSA approved
Limit of the power supply:	
Factory default setting	160 W
Maximum setting	200 W
Minimum setting	50 W
Precision of power regulation	± 10 W
Start and serial enable control inputs:	
Enabled control voltage: low (close)	0 to 0.8 V d.c. (I_{out} = 0.55 mA nominal)
Disabled control voltage: high (open)	4 to 26.4 V d.c. (Internal pull up to 6.4 V nominal)
Standby control input	
Enabled control voltage: low (close)	0 to 0.8 V d.c. (I_{out} = 0.29 mA nominal)
Disabled control voltage: high (open)	4 to 26.4 V d.c. (Internal pull up to 3.2 V nominal)
Analogue output	
Output voltage	0 to 10 V d.c. (directly proportional to the measured parameter) Motor speed: 0 - 1000 Hz (0-100%) Input power: 0 - 200 W Motor temperature: 0 - 100 °C Controller temperature: 0 - 100 °C
Voltage precision	± 0.2 V
Output current	≤ 5 mA for specified precision
Normal status output:	
Type	Open collector transistor plus pull up resistor. Refer to *Figure: Interface circuits for nEXT turbo pump controllers on page 33*.
< Normal speed (default 80%)	Off (2.2 kΩ internal pull up to 12 V d.c.)
≥ Normal speed	On (< 0.8 V d.c. sinking 20 mA)
Current rating	20 mA to 0 V
Voltage rating	28.8 V d.c. maximum external pull up voltage
Fail status output:	
Type	Open collector transistor plus pull up resistor. Refer to *Figure: Interface circuits for nEXT turbo pump controllers on page 33*.

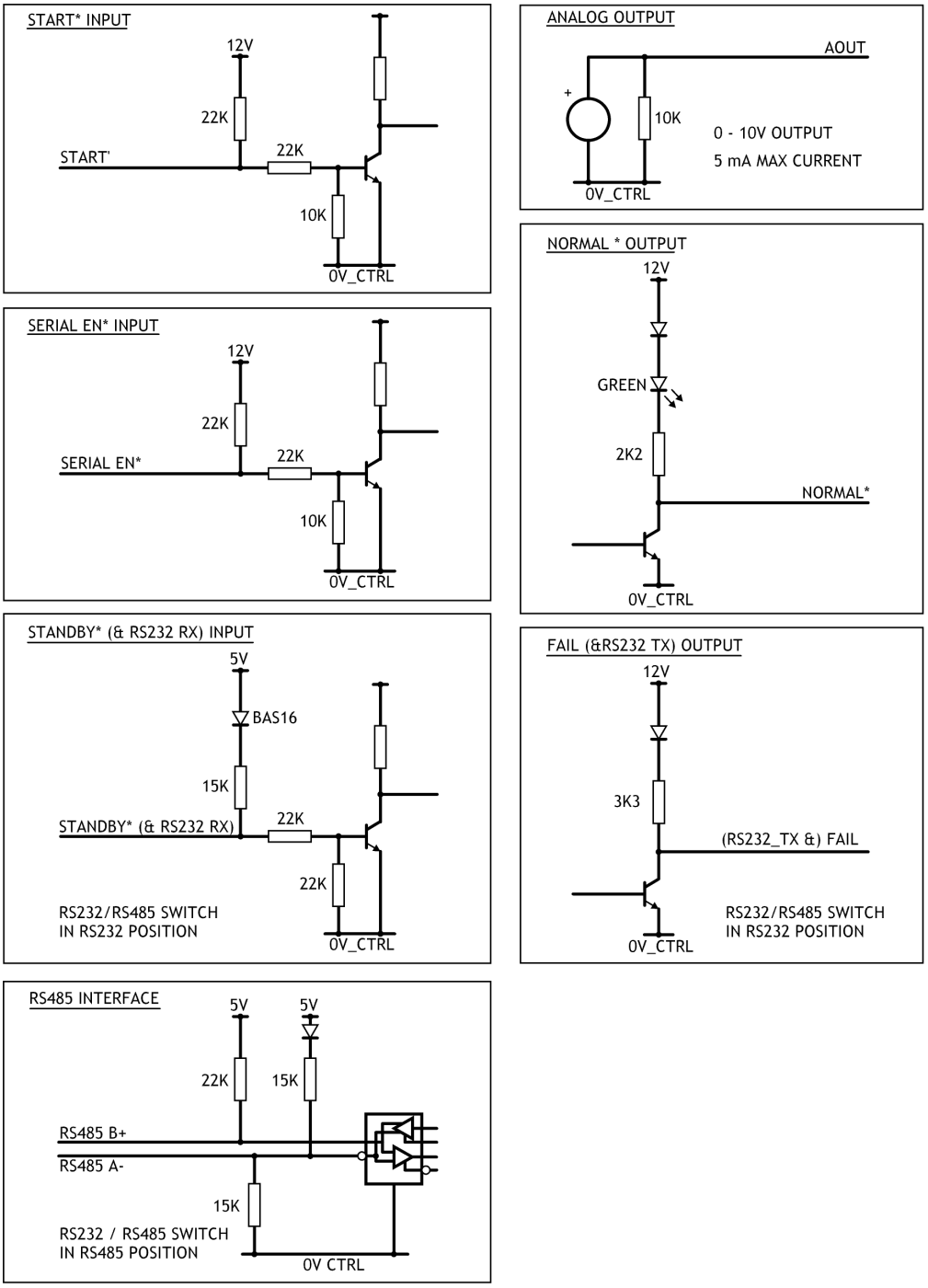
Logic interface item	
Fail	Off (3.3 kΩ pull up to 12 V d.c.)
OK	On (< 0.1 V d.c. sinking 1.7 mA, < 0.8 V d.c. sinking 20 mA)
Current rating	20 mA to 0 V
Voltage rating	28.8 V d.c. maximum external pull up voltage

** Mating half of connector not supplied.*

Table 12 Logic interface connector pins

Pin Number	Signal	Polarity	Use
2	0 V Control reference	-	0 V reference for all control and status signals below.
3	START / STOP control input	-	Connect to Pin 2 to start pump
4	STANDBY control input / Serial RX / RS485 A-	-	Connect to Pin 2 to enable standby speed when serial enable is inactive and RS485 / RS232 switch is in the RS232 position.
5	Serial enable	-	Connect to Pin 2 to enable the serial link
7	FAIL / Serial TX / RS485 B +	-	Logic high when fail condition exists and serial enable is inactive and RS485 / RS232 switch is in the RS232 position.
9	Analogue output	Positive	0 - 10 V output proportional to measured output
10	Chassis / Screen	-	Screen
12	Chassis / Screen	-	-
15	NORMAL status output	-	Logic low when the rotational speed of the pump is at normal speed or above the normal speed
8, 13, 14	Electrical supply: 0 V	-	-
1, 6, 11	Electrical supply: 24 V - 48 V d.c.	Positive	-

Figure 8 Interface circuits for nEXT turbo pump controllers



3.10 Controller connector socket

The pump has a 3-way controller connector socket at the side of the controller. When the pump is shipped, the 3-way controller connector is concealed with a black protective cover. Before you use the 3-way controller connector, remove the black protective cover with the help of a screwdriver. The mating plug for the 3-way controller connector is supplied with the pump.

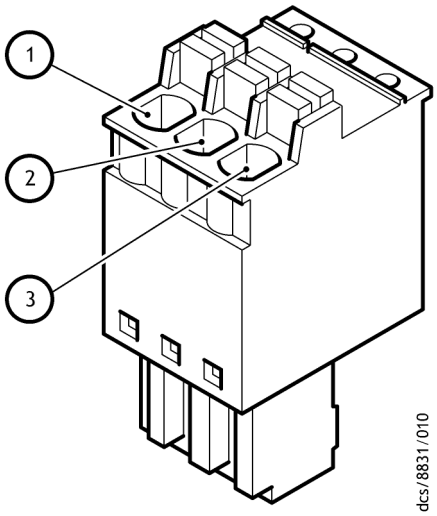
The connector supplies the power to the vent valve or fan connected to the 3-pins. The connector mating plug is shown in *Figure: Controller connector showing pin numbers on page 34*, with the polarity of the pins marked, when the vent valve or fan is set to on.

The 24 V d.c. output on the controller connector is protected from the overload or short circuit to 0 V d.c. / 24 V d.c. Rtn / chassis. The output supplies the current given in *Table: Controller technical data on page 34*. For higher currents, the output voltage will decrease and can set to off to limit the current.

Table 13 Controller technical data

Description	Data
Connector plug	Phoenix part number FK-MC1881338
Voltage output	24 V d.c. -25%, +10% (18 V d.c. to 26.4 V d.c.)
Current output	500 mA

Figure 9 Controller connector showing pin numbers



Pin number	Signal	Polarity
1	24 V d.c. Out	+
2	Chassis	
3	24 V d.c. Rtn	-

3.11 Indicator LED's

The pump has three indicator LED's, shown in *Figure: Controller status information on page 46*.

Table 14 Indicator LED's

LED	Description
Normal LED	The green LED stays when the rotational speed of the pump is more than the normal speed setting, irrespective of the acceleration or deceleration of the pump.

LED	Description
Status LED	The yellow LED flashes with a 50% duty cycle at the rotational frequency of the pump motor. At high speeds it is continuously on. The LED sets to off when the rotational speed is very low or stopped. If the next service is available, the LED flashes in a sequence to show which service operation is necessary. Refer to *Fault finding on page 80*.
Alarm LED	The red LED flashes in a sequence to show an error code if a fail condition prevents the operation of the pump. The error codes can be used for the fault finding as given in *Fault finding on page 80*.

Note:

If an external electrical load is connected to the normal output line, the Normal LED can come on.

4. Installation

4.1 Unpack and inspect

WARNING: HEAVY OBJECT

Risk of injury and damage to equipment. Use applicable lifting equipment to move the pump. Failure to do so can cause injury to people and damage to the equipment. Refer to *Pumping media on page 28* for the mass of the pump.

Do not use the controller cable as a lifting device. Do not use the cable to lift or support the pump.

WARNING: FINGER GUARD

Risk of injury. The inlet screen is a coarse filter for debris. Do not use the inlet screen as a finger guard.

1. Store the pump in its sealed bag until it is installed.
2. Be careful when you unpack the pump to prevent the excessive shocks. The excessive shocks can damage the bearings and decrease the life of the pump. The pump is supplied with sealed inlets and outlets to prevent the entry of dust and vapour.
3. Do not remove the seals until the pump is installed on the vacuum system.
4. Remove the packing materials from the pump.
5. Check the pump.
6. Keep all the packing materials for use in inspection and in case the pump is returned for the service.
7. If the pump is damaged, notify your supplier and the carrier immediately. Give the supplier and the carrier the information that follows:
   - part number of the pump
   - serial number of the pump
   - order number
   - supplier's invoice number
8. Do not use the pump if the pump is damaged.
9. Check that the package has the items given in *Table: Checklist of components on page 36*. If the items are missing, notify the supplier in writing in three days.
10. If the pump is not to be used immediately, store the pump in conditions as given in *Storage on page 91*.

Table 15 Checklist of components

Quantity	Description	Check (✓)
1	nEXT pump with inlet screen fitted (installed to CF pumps only)	❒

Quantity	Description	Check (✓)
1	Inlet seal (trapped O-ring with integral inlet screen, Co-seal or copper compression gasket applicable for the inlet flange type)	❒
1	Connector (24 V) - for driving accessories from the controller socket	❒
1	Inlet strainer (installed in the NW25 interstage and booster port only)	❒

4.2 Typical installation

A typical pumping system with a nEXT pump is shown in *Figure: Typical pumping system with a nEXT pump on page 38*.

The accessories available for the nEXT pumps are given in *Accessories on page 97*, the accessories are shown in *Figure: nEXT exploded accessories view on page 97* and *Figure: nEXT exploded accessories view on page 98*.

4.3 Connect to the vacuum system

WARNING: TRIP HAZARD

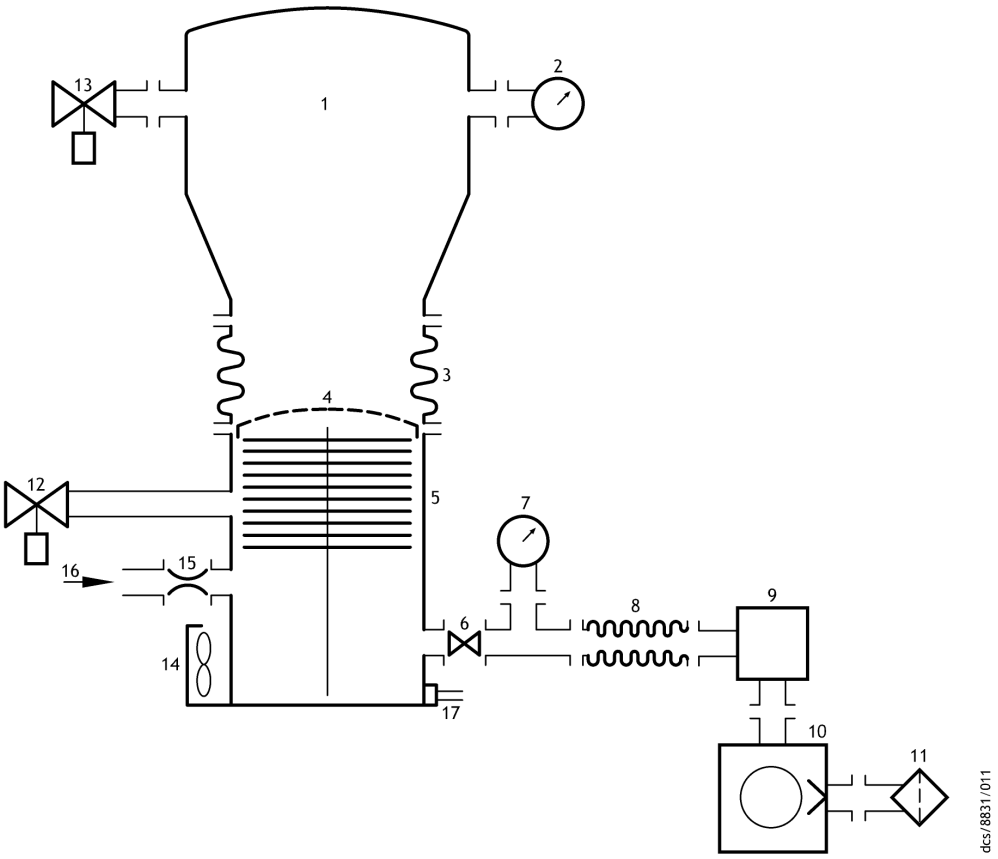
Risk of injury and damage to equipment. Make sure that the cable and pipe work attached to the pump are carefully routed. Failure to do so can cause a slip or trip hazard and damage to the cable.

WARNING: INSTALLATION SEQUENCE

Risk of injury. Install the pump in the vacuum system before you connect the logic interface cable to the control equipment and to the electrical supply so the pump cannot operate. Failure to do so can cause injury to people while installation.

We recommend you to do a leak test of the system after the installation is completed.

Figure 10 Typical pumping system with a nEXT pump



1. Vacuum system
2. High-vacuum gauge
3. Vibration damper
4. Inlet screen
5. nEXT pump
6. Backing valve
7. Vacuum gauge
8. Flexible bellows
9. Foreline trap
10. Rotary backing pump
11. Mist filter
12. Vent valve
13. Alternative position for vent valve
14. Air cooler
15. PRX purge restrictor
16. Regulated purge gas supply
17. WCX water cooler and connections

4.3.1 Inlet screen (installed on CF only)

WARNING: SHARP EDGES

Risk of injury. Removal of the inlet screen will expose the risk of injury from sharp edges.

CAUTION: INLET SCREEN

Risk of damage to equipment. The inlet screen prevents the contamination of the pump. Do not remove the inlet screen until the pump is prepared to be mounted onto the system.

1. Remove the inlet screen only if the debris can not fall into the pump. If the inlet screen is removed, the pumping speed will increase by maximum 10% for course and 20% for fine inlet screens.
2. To remove an inlet screen, put it centrally over the CF inlet flange.
3. Apply equal pressure with the fingers around the edge of the screen and push the inlet screen down.

If the inlet screen is not in a installed position, the tangs must be snapped into the locating groove in the inlet flange using a applicable tool to press them into position.

For ISO flanged pumps, we supplies a combination inlet screen / trapped O-ring.

4.3.2 Mechanical fixing

WARNING: PUMP SEIZURE

Risk of injury and damage to equipment. Do not operate the pump until it is correctly installed. If the pump seizes, the stored energy of the rotor can cause fast movement of the pump, which can cause damage and injury to people.

WARNING: INLET SCREEN

Risk of injury. The inlet screen is a coarse filter for debris. Do not use the inlet screen as a finger guard.

WARNING: EJECTED PARTS FROM PUMP

Risk of injury and damage to equipment. Position the system view-ports and vulnerable components away from the pump inlet. Failure to do so can cause damage from the ejected parts if the pump rotor fails.

Obey one of the methods that follows to install the pumps:

- Install the pump through its inlet flange to a rigid, firmly fixed vacuum system. Refer to *Inlet connection and orientation on page 39*.
- If installation of the pump is not possible because of the nature of the vacuum system, install the base of the pump at a firm support. Refer to *Base mounting on page 40* for instructions on base mounting the pump.

4.3.3 Inlet connection and orientation

The pump can be installed at the vacuum system through the inlet flange. You can mount the pump in vertical and upright through to horizontal (± 2°). If the pump is mounted horizontally and used with a rotary vane backing pump, make sure that a foreline trap is installed to prevent the condensed oil in the backing line from entering in the turbo pump. If installation of the foreline trap is not possible, install the pump with the backing port that points vertically down (± 45°).

Make sure that the pump inlet and the components installed to the pump inlet are clean and dust-free. Failure to do so can increase the pump-down time.

The inlet connections for the pump are CF flange, ISO flange and VG flange.

- If the pump has a CF flange, use the copper compression gasket supplied with the pump. Use all supplied bolts to connect the inlet flange of the pump to the vacuum system.
- If the pump has an ISO flange, use the manufacturer's combination inlet screen / trapped O-ring supplied with the pump. Use minimum four claw clamps (each torqued to 30 Nm) to connect the inlet flange of the pump to the vacuum system.
  You can also use a rotatable collar and the combination inlet screen and trapped O-ring supplied with the pump to connect the inlet flange of the pump to the vacuum system. Use all supplied bolts with the rotatable collar.
- If the pump has a VG flange, use all supplied bolts of 8 x M10 and washers to connect the pump to the vacuum system. Flange installation bolts must have minimum 700 MPa tensile strength and equally tightened in a cross-pattern in 3 tightening stages to a final torque of 30 Nm to make sure equal compression of the O-ring and clamping of the flanges.

Tighten all inlet flange bolts again when the system is under vacuum. Make sure that torques or other forces are not transmitted to the pump from the vacuum system or the related pipelines. If necessary, install an inlet vibration damper between the pump inlet and the vacuum system and install the base of the pump to a rigid support, as given in *Base mounting on page 40*.

4.3.4 Base mounting

The base of the pump can be installed to a rigid support using the tapped fixing holes. Refer to *Figure: nEXT 240 dimensions (mm) on page 23*, *Figure: nEXT 300 dimensions (mm) on page 24* and *Figure: nEXT 400 dimensions (mm) on page 25* for the installation hole details.

Note:

Remove the four rubber feet from the four tapped fixing holes before you base mount the pump.

Obey the requirements that follows to make sure that the pump stay secured if the pump seize:

Support must withstand a destructive torque of:	6 KNm
Installation screws:	4quantity of M8 to ISO898-1 strength class 12.9 (nominal tensile strength 1200 MPa)
Screw engagement length:	6 mm minimum
Fastening torque:	15 Nm (1.53 kgf.m)

Use this method for installation if the pump supports the weight of the vacuum system. Make sure that the weight of the vacuum system is not more than 20 kg.

4.3.5 Backing port connection

WARNING: PUMP OVER-PRESSURE

Risk of damage to equipment. To prevent over-pressure in the pump, do not limit the exhaust line when you vent from a positive pressure gas supply.

CAUTION: BEARING LIFE

Risk of damage to equipment. Do not use the pump with a backing pressure less than 5 x 10^{-4} mbar (5 x 10^{-2} Pa). Lower backing pressures increases the evaporation rate of the lubrication oil and can decrease the life of the bearings.

Note:

Make sure that the ducting is done at the backing line if oil mist or hazardous substances are available.

Use applicable vacuum tubing and connectors to connect the NW flange of the backing port to the backing pump. If necessary, use flexible pipe or bellows to decrease the transmission of vibration from the backing pump to the pump.

We recommend you to use our EM, RV or XDS Scroll backing pump. The recommended size of backing pump is given in *Table: nEXT pumps technical data on page 20*. A larger or smaller backing pump can be used, depending upon the application it is intended for.

The pumps are applicable to use with diaphragm backing pumps but the effect of higher backing pressure on the pump's performance and cooling requirements must be noted. Refer to *Table: nEXT pumps technical data on page 20* and *General technical data on page 17*.

4.3.6 Interstage connection (variants only)

Use applicable vacuum tube and connectors to connect the interstage port to the vacuum system or to the outlet flange of the other turbo or compound turbomolecular pump (if using an 'i' nEXT pump to back other pump). Keep the inlet strainer in the interstage port only if you are sure that debris cannot enter the interstage port.

4.4 Purge gas connection

4.4.1 Recommended purge gas flow

The recommended purge gas flow for typical applications is 25 sccm (0.42 mbar l s^{-1}, 42 Pa l s^{-1}). The flow protects the pump when you pump the oxygen in concentrations more than 20% by volume.

The flow rate of the purge gas must be in a range given in *Purge gas specification on page 27*. To limit the flow rate, use a flow controller or a pressure regulator and calibrated flow restrictor. The PRX10 purge restrictor accessory is applicable for the purpose. Refer to *Accessories on page 97*.

4.4.2 Connect the purge gas

Note:

The purge gas must comply with the specification given in Purge gas specification on page 27.

1. To supply the purge gas to the pump, remove the plug installed in the purge port.
2. To install a vent port adaptor, refer to *Accessories on page 97*.
3. Connect the purge gas supply to the vent port adaptor.

4.5 Electrical installation

WARNING: ELECTRICAL INSTALLATION

Make sure that the electrical installation of the pump is in accordance with the regional and local codes and conforms to local and national safety requirements. The pump must be connected to an applicable power supply unit with an applicable earth (ground) point.

Make sure that the qualified person does the electrical installation. Do the electrical connections of the pump after the pump is installed on the vacuum system. Disconnect all electrical connections from the pump before you remove it from the vacuum system.

Do the grounding of the pump using the given connection. Refer to *Ground the connections on page 42*.

You can operate the pump using the manufacturer's TIC Turbo Instrument Controller, TIC Turbo Controller (refer to *Connect the logic interface to the TIC on page 42*) or using the customer system. Refer to *Connect the logic interface to the customer control equipment on page 43* for information about control. Refer to *Connect the electrical supply on page 43* for instructions on how to connect the electrical supply.

4.5.1 Ground the connections

We recommend you to install a separate ground conductor to ground the pump. Use the braided wire that is not insulated or a separate insulated green / yellow connector with a minimum 10 AWG (5.3 mm^2) conductor (to comply with US and Canadian installation codes), M5 x 10 screw and shake proof washer supplied (installed to the ground hole of the pump) to inatall the ground conductor to the pump. The impedance between the pump body and the earth connection point must be < 0. Ω.

4.5.2 Connect the logic interface to the TIC

If the manufacturer's TIC Turbo Instrument Controller or a TIC Turbo Controller is used to power and control the pump, connect the pump logic interface cable into the back of the TIC. Refer to the TIC Instruction Manual for more information.

If the TIC is to be used to control the pump, make sure that the RS485 / RS232 slide switch is in RS232 position. Refer to *Connect the serial interface to the customer control equipment on page 46*. If the switch is in the RS485 position:

- the TIC will connect to the pump in parallel mode (that shows the pump type as nEXTp)
- the serial connection is disabled
- start and stop is possible.

4.5.3 Connect the logic interface to the customer control equipment

If you operate the pump with the customer control system, use an applicable connector mating half (not supplied) to connect the control equipment to the connector on the logic interface cable (refer to *Table: Logic interface technical data on page 30*). Refer to *Table: Logic interface connector pins on page 32* for full details of the logic interface connector pins when you do the electrical connections to the pump given in the sections that follows.

You can control the pump with a hardware parallel control interface or through the commands sent over a serial interface.

If you control the pump with the hardware parallel interface, refer to *Connect the parallel control and monitoring on page 45* for more information. If the serial interface is used, refer to *Connection for serial control and monitoring on page 46*. The logic interface gives the facility to work with a mixture of parallel and serial control. Refer to *Connection for mixed parallel and serial operation on page 54*.

4.5.4 Connect the electrical supply

WARNING: POWER SUPPLY

Risk of damage to equipment. A separate power supply (not included) is necessary for the product. The power supply must be protected against a hazardous live condition (for example, a short circuit).

WARNING: ELECTRICAL ISOLATION DEVICE

Risk of damage to equipment. Install an applicable isolation device in the electrical supply. Make sure that the switch is easy to access and marked as disconnecting device for the pump. Failure to do so can cause failure to set the pump to off in an emergency.

WARNING: HOT SURFACE

Risk of injury or damage to equipment. Install an applicable fuse (as given in *Logic interface connector on page 30*), in the 24 - 48 V supply line to the pump. To protect the pump in the fault condition, use an applicable rated fuse (refer to *Table: Logic interface technical data on page 30*). The power supply must have a current rating capable of blowing the fuse. Failure to do so can cause the hazardous surface temperature of the pump or risk of a fire hazard.

WARNING: SUPPLY VOLTAGE

Risk of damage to equipment. Make sure that the maximum supply voltage is not more than necessary voltage. Failure to do so can cause permanent damage to the control electronics and can cause mechanical hazard in failure conditions.

WARNING: HOT SURFACE

Risk of injury or damage to equipment. When you connect the pump to the power supply, make sure that all 3 pins for the 24 - 48 V connection and all 3 pins for the 0 V connection on the customer connector mating half are connected to the power supply. Failure to do so can cause the overheating of the connectors.

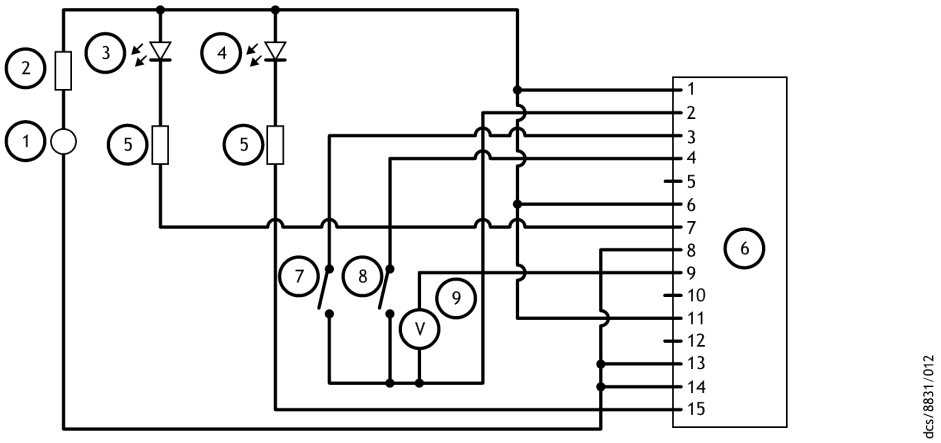
Refer to *Figure: Logic interface connections - parallel control on page 44* for a schematic diagram of the logic interface connections.

The electrical supply for the pump must meet the requirements of BS EN 61010-1/ C22.2 1010-1. Make sure that the hazardous voltages given in EN61010 are not available on the electrical interface to the pump.

The pump 0 V is not referenced to ground. Make sure that there is only one path between 0 V and ground. Do not make multiple connections between 0V and ground to prevent the offset voltages on control and status signals and problems with serial communications. If there is no connection available between 0 V and ground, make the connection at the power supply. Other electrical equipment connected to the system can make a connection between 0 V and ground, for example a personal computer or a measuring equipment.

Refer to *Table: Logic interface connector pins on page 32* when you connect the electrical supply to the customer connector mating half.

Figure 11 Logic interface connections - parallel control



1. 24 V d.c. electrical supply
2. Fuse
3. Optional LED indicator - system OK
4. Optional LED indicator - normal speed
5. Current limit resistor for LED
6. nEXT pump logic interface
7. Start switch
8. Optional standby switch
9. Optional voltmeter to monitor analogue output

Note:

The voltage supply to the pump controller can be more than 24 V. But the circuits connected to the normal and fail line must have maximum external pull-up voltage rating as given in Table: Logic interface technical data on page 30.

4.6 Connect the parallel control and monitoring

To make the connections for the parallel control and monitoring, use an applicable mating half (not supplied).

CAUTION: BACK EMF SUPPRESSION DIODE

Risk of damage to equipment. If the normal and fail lines are used to drive the coils of the d.c. relays, install a back EMF suppression diode in parallel with each relay coil to protect the pump.

Connect the customer control equipment to the control input pins of the customer logic interface mating half. Refer to *Table: Logic interface connector pins on page 32* to identify the connector pins of the logic interface.
The control inputs are:

- Start
- Standby speed

To activate one of the control inputs, connect the control input pin to the 0 V control reference. To start the pump, connect the pin 3 (Start / Stop) to the pin 2 (0 V reference). To stop the pump, remove the connection between the pin 3 and pin 2. To put the pump in standby, connect the pin 4 (Standby) and pin 3 (Start / Stop) to pin 2 (0 V reference).

Note:

Serial enable is also a control input, it is not necessary in a system that operates under parallel control. Make sure that there is no connection to the serial enable (pin 5).

Note:

To use the standby or fail parallel interface signals, make sure that the RS485 / RS232 slide switch is in the RS232 (default) position. Refer to Connect the serial interface to the customer control equipment on page 46.

1. To monitor an analogue output, connect the customer control equipment to the pump analogue output (pin 9) and to the pin 2 of the customer logic interface mating half.
   When the pump is shipped, the analogue output is configured to monitor the rotational speed of the pump. To monitor other parameters, configure the pump again using the commands over the serial interface. Refer to *Connection for serial control and monitoring on page 46* for more information.
2. To monitor the normal status output, connect the customer control equipment to the normal status output (pin 15) and to the pin 2 of the customer logic interface mating half.
   You can use the output to control other devices in the pumping system. The output can operate a low power relay of up to 24 V d.c. coil rating (up to 20 mA).

3. To monitor the fail status output, connect the customer control equipment to the fail output (pin 7) and to the pin 2 of the customer logic interface mating half. You can use the output to control other devices in the pumping system. The output can operate a low power relay of up to 24 V d.c. coil rating (up to 20 mA).

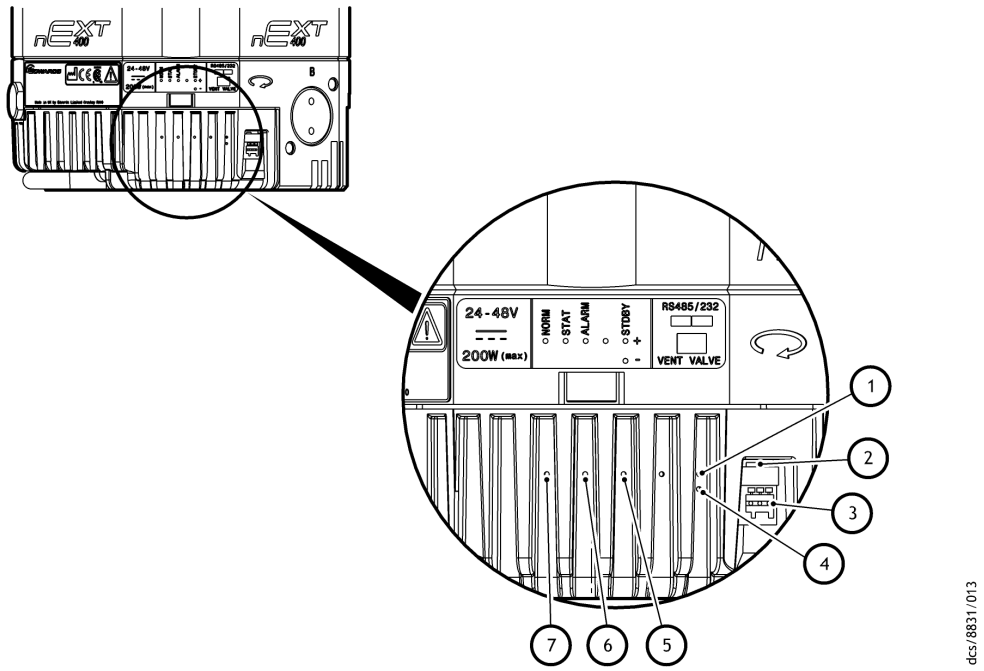
4.7 Connection for serial control and monitoring

In the serial interface, the pump is controlled through a number of serial commands or the nST PC software. You can also check the operational status in the serial interface. In the multi-drop mode, connection of more than one pump to a single serial port on the control system is possible.

4.7.1 Connect the serial interface to the customer control equipment

The serial interface is available in RS485 or RS232 options. Use the slide switch (given above the controller connector) to select the serial interface (refer to *Figure: Controller status information on page 46*). To adjust the slide switch, remove the plastic connector cover of the controller and use a small tool to toggle the slide switch. Move the switch to the right to enable RS232 serial interface. Move the switch to the left to enable RS485 serial interface. The default setting of the motor controller is RS232 serial interface.

Figure 12 Controller status information



1. Standby speed increase button
2. RS485 / RS232 switch
3. Controller connector socket
4. Standby speed reduce button
5. Alarm LED
6. Status LED
7. Normal LED

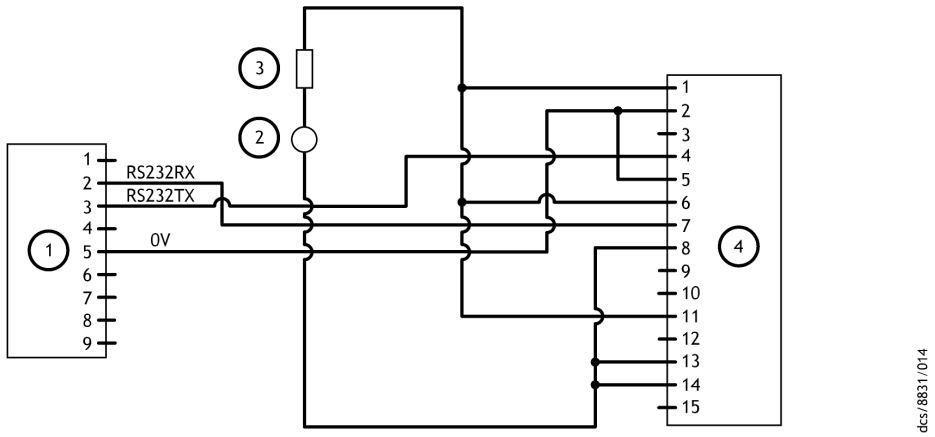
CAUTION: PUMP GROUND CONNECTION

Risk of damage to equipment. When you connect the pump to a PC, the 0 V pin on the RS232 connector can be connected to the ground through the PC. Make sure that the 0 V rail of the 24 - 48 V d.c. supply is not connected to the ground at other point (example, at the power supply). If the 0 V rail of the 24 - 48 V d.c. supply will not be connected to the ground at the PC, use an opto-isolated interface to the PC.

The pump can connect to the RS485 or RS232 serial input on the control equipment or a PC as shown in *Figure: Logic interface connections - RS232 serial control on page 47* and *Figure: Logic interface connections - RS485 serial control on page 48*. In given configuration, the PC is the serial link master and the pump is the slave. The distance over which the serial link will work is dependent on the difference in voltage between the 0 V at the sending and receiving end. If the 0 V reference at the receiving end is in 0.3 V of the 0 V control reference pin on the pump control connector, then the serial link has to be capable of to operate at a distance up to 6 m. For longer distance, an interface circuit external to the pump can be necessary.

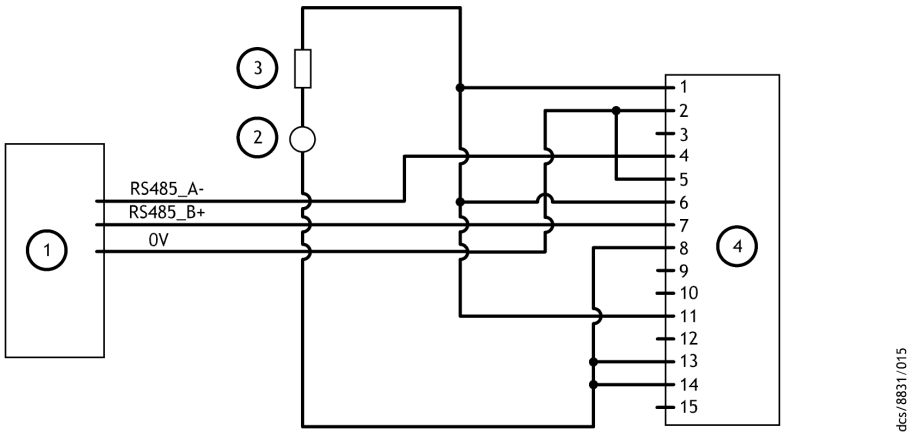
The software in the pump can operate with the other pumps connected to a single serial link master. This is a multi-drop mode. The RS485 option is recommended for the multi-drop mode. When the RS232 option is selected, more hardware is necessary to link number of pump units to a single serial link master. A concept drawing of one possible arrangement is shown in *Figure: Conceptual diagram for multi-drop connection using RS232 interface on page 49*. When the RS485 option is selected, it is easy to connect number of pumps to a single master. Refer to *Figure: RS485 multi-drop connection on page 50*.

Figure 13 Logic interface connections - RS232 serial control



1. RS232 interface on control equipment
2. 24 - 48 V d.c. electrical supply
3. Fuse
4. nEXT pump logic interface

Figure 14 Logic interface connections - RS485 serial control



1. RS485 interface on control equipment
2. 24 - 48 V d.c. electrical supply
3. Fuse
4. nEXT pump logic interface

4.7.2 Serial enable

To send a serial message over the serial link, activate the serial enable. To activate the serial enable, link the serial enable input signal (pin 5) to pin 2 of the customer logic interface mating half.

We recommend you to incorporate this link into the serial communications cable so that the serial enable is activated only when the serial cable is connected. When the cable is removed, serial enable will become inactive.

Serial enable operates as an interlock for the start commands sent over the serial interface. If the pump operates in serial control mode (having been sent a serial start command) and the serial enable becomes inactive, the pump will trigger a fail condition and will decelerate and stops. To clear the fail condition, activate the serial enable again and send a serial stop command.

4.7.3 Serial protocol

The serial interface link is set to 9600 Baud, 8 bits, 1 stop, no parity with no handshaking. The commands are made up from printable ASCII characters. The maximum message size that can be sent is 80 characters, that includes start and end characters.

Note:

All alphabetical characters must be sent in upper case format. Response can have lower case characters.

Every complete command message sent will receive a response that follows:

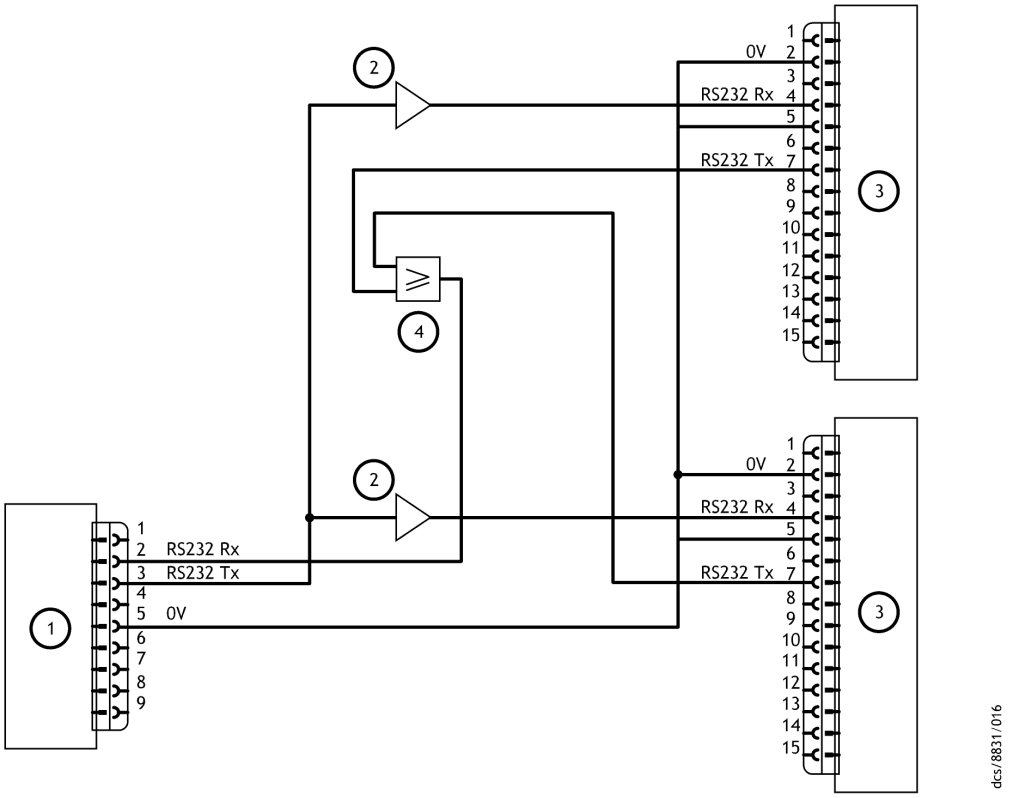
- status code or
- data return

The pump accepts one message at a time. The pump will only accept a new message when the response to the previous message has returned.

If the pump ignores the characters that are not framed in the start and stop characters. Messages that does not have the stop character missing will be discarded with no response when a new start character is received. If the pump receives an unrecognisable message between the start and stop characters, it will reply an applicable error message.

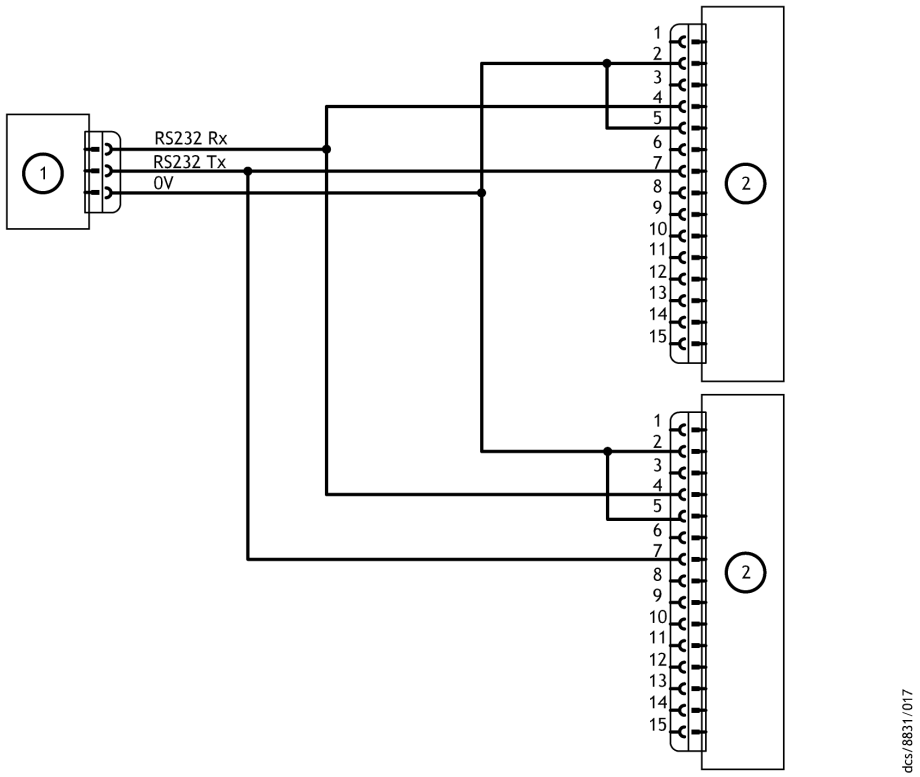
Refer to *Multi-drop operation on page 54* for more information about how to operate the pumps in the multi-drop mode.

Figure 15 Conceptual diagram for multi-drop connection using RS232 interface



1. RS232 interface on control equipment
2. Buffer
3. pump
4. OR gate

Figure 16 RS485 multi-drop connection



1. RS485 interface on control equipment
2. pump logic interface

4.7.4 Message structure

The message structure and command set are the same for RS485 and RS232 options. To communicate a message to the pump, send the characters in a specific order. If the message is not in a correct structure, the message will be ignored and the pump will not send the reply.

The correct structure of the message is as follows:

- a valid start character:
  - '!' character for a store operation or
  - '?' character for a query operation followed by
- a command: an upper case alphabetical character, followed by
- an object number: has three decimal digits, followed by
- a data field (only for some commands): has a sequence of characters separated from the object number by a space, followed by
- a terminating carriage return.

The message protocol in multi-drop mode is different. Refer to *Multi-drop operation on page 54*.

4.7.5 Command set

Refer to *Table: Summary of commands that can be sent to the nEXT pump on page 51* for the summary of the full set of commands available to control and monitor the pump.

Refer to *Table: Command abbreviations on page 53* for the abbreviations used to specify the commands in the sections that follows.
Refer to *Table: Error codes on page 53* for the error codes that can be returned.

Table 16 Summary of commands that can be sent to the pump

Object name	Command	Parameter range	Factory setting	Data type	Units	Comments
Node	!S850 ?S850	0.99	-	decimal	address	multi-drop address 0 = disable multi-drop address 99 = wildcard
Pump type	?S851	7 10 4	-	string string string	chars chars chars	Pump type DSP software version number (D396496XXX for nEXT) Full speed RPS (1000 for nEXT)
Pump control	!C852	0 1	-	decimal	-	Stop the pump Start the pump
	?V852	0.1800 32-bits	-	decimal hex	RPS flags	Measured motor speed System status word
Vent options	!S853 ?S853	0	0	decimal		Hard vent only when < 50% speed
		1				Controlled vent if > 50% speed or hard vent if < 50% speed
		2				Hard vent if stop or hard vent if fail and < 50% speed
		3				Hard vent if stop or controlled vent if fail and > 50% speed or hard vent if fail and < 50% speed
		4				Hard vent if fail or hard vent if stop and < 50% speed
		5				Hard vent if fail or controlled vent if stop and > 50% speed or hard vent if stop and < 50% speed
		6				Hard vent if stop or fail
		7				Same as option 6
		8				Vent = Permanently enabled (Fan)
Timer setting	!S854 ?S854	1.30	8	decimal	minutes	Timeout period for both initial ramp up and if speed drops below 50%
Power limit setting	!S855 ?S855	50.200	160	decimal	Watts	Link power maximum
Normal speed setting	!S856 ?S856	50.100	80	decimal	%	Normal speed as a percentage of full speed

Object name	Command	Parameter range	Factory setting	Data type	Units	Comments
Standby speed setting	!S857 ?S857	55.100	70	decimal	%	Standby speed as a percentage of full speed
Temperature readings	?V859	0.100 0.100	-	decimal decimal	°C °C	Measured motor temperature Measured controller temperature
Link parameter readings	?V860	0.500 0.300 0.15000	-	decimal decimal decimal	0.1 Volts 0.1 Amps 0.1 Watts	Measured link voltage Measured link current Measured link power
Factory settings	!S867	1	-	-	-	Reset all configuration options and parameters to the factory settings
PIC software version	?S868	10	-	string	chars	Boot loader software version number (D374796XXX)
Speed control	!C869	0 1	-	decimal	-	Set target speed to full speed Set target speed to standby speed
Timer options	!S870 ?S870	0 1	1	decimal	-	Timer = disabled Timer = enabled Note that the timer is permanently enabled on ramp-up.
Analogue signal options	!S871 ?S871	0 1 2 3	0	decimal	-	Analogue output = measured speed Analogue output = measured power Analogue output = measured motor temp. Analogue output = measured control temp.
Close vent valve	!C875	1	-	decimal	-	Closes the vent valve for delayed start and overrides the current vent option. There is no open vent valve command but the stop command (!C852 0) will clear the override.
Service status	?V881	32 bits	-	hex	flags	Service status word
Controller run time	?V882	0..999999	-	decimal	hours	Hours run by controller
		0..999999		decimal	hours	Hours until controller service due
Pump run time	?V883	0..999999	-	decimal	hours	Hours run by pump
		0..999999		decimal	hours	Hours until pump service due

Object name	Command	Parameter range	Factory setting	Data type	Units	Comments
Pump cycles	?V884	0..65535	-	decimal	cycles	Cycles run by pump
		0..65535		decimal	cycles	Cycles until pump service due
Bearing run time	?V885	0..999999	-	decimal	hours	Hours run by bearing
		0..999999		decimal	hours	Hours until bearing service due
Oil cartridge run time	?V886	0..999999	-	decimal	hours	Hours run by oil cartridge
		0..999999		decimal	hours	Hours until oil cartridge service due

Table 17 Command abbreviations

Abbreviation	Meaning
cr	carriage return character
chars	characters
d	decimal ASCII character
h	hexadecimal ASCII character
r	Returned error code. Refer to *Table: Summary of commands that can be sent to the nEXT pump on page 51*.
sp	space character
string	can have several ASCII characters
X	multi-drop decimal ASCII character

Note:

Fields that have multiple 'd' characters shows the typical length. All data fields have a maximum of 5 decimal characters (prefixed by a minus number for negative numbers).

Fields that have multiple 'X' characters shows the maximum length and does not show the fixed length.

Table 18 Error codes

Returned error code	Meaning
0	No error
1	Invalid command for object ID
2	Invalid Query or Command
3	Missing parameter
4	Parameter out of range
5	Invalid command in current state - Example: serial command to start or stop when in parallel control mode

4.7.6 Multi-drop operation

With multi-drop mode, a single computer system can communicate with more than one pump. Each pump must be assigned its own individual address before it can be installed in a multi-drop system. The command to assign the multi-drop address is sent in standard nEXT message format. Refer to *Assigning a multi-drop address on page 65*.

The message protocol in the multi-drop mode is different than the protocol given for the serial messages in the single pump systems. The differences in the multi-drop message protocol are:

- All multi-drop commands, queries or replies have the first character as #.
- All commands, queries and replies have a header that has:
  - the address of the node that the message is to
  - the address of the node that the message is from
- Delimiter character: (colon) which separates the two multi-drop addresses in the header
- The remaining message (command, query or reply) obeys the same protocol as given for the single pump systems.
- The wild card address 99 is useful which means 'any' node.

After a pump has been assigned a multi-drop address, it will ignore the messages in the format for the single pumps. An individual pump will ignore all the command messages unless the multi-drop address matches its own address.

4.8 Connection for mixed parallel and serial operation

You can use the parallel interface control inputs to control the pump. At the same time, you can use the serial interface or the USB service port (using the manufacturer's nST PC software) to monitor different pump parameters.
Alternatively, you can use the commands sent over the serial interface to control the pump. At the same time, you can monitor the normal signal and analogue output over the parallel interface.

Refer to *Figure: Logic interface connection - mixed parallel and serial operation on page 55* for the schematic diagram of a system that demonstrates how to do this. The connection is a combination of the parallel and serial connection, given in *Connect the parallel control and monitoring on page 45* and *Connection for serial control and monitoring on page 46*. Options given in the sections are available in a mixed parallel and serial operation.

Note:

While serial enable is active to enable the serial link, the parallel standby and fail signals are not available.

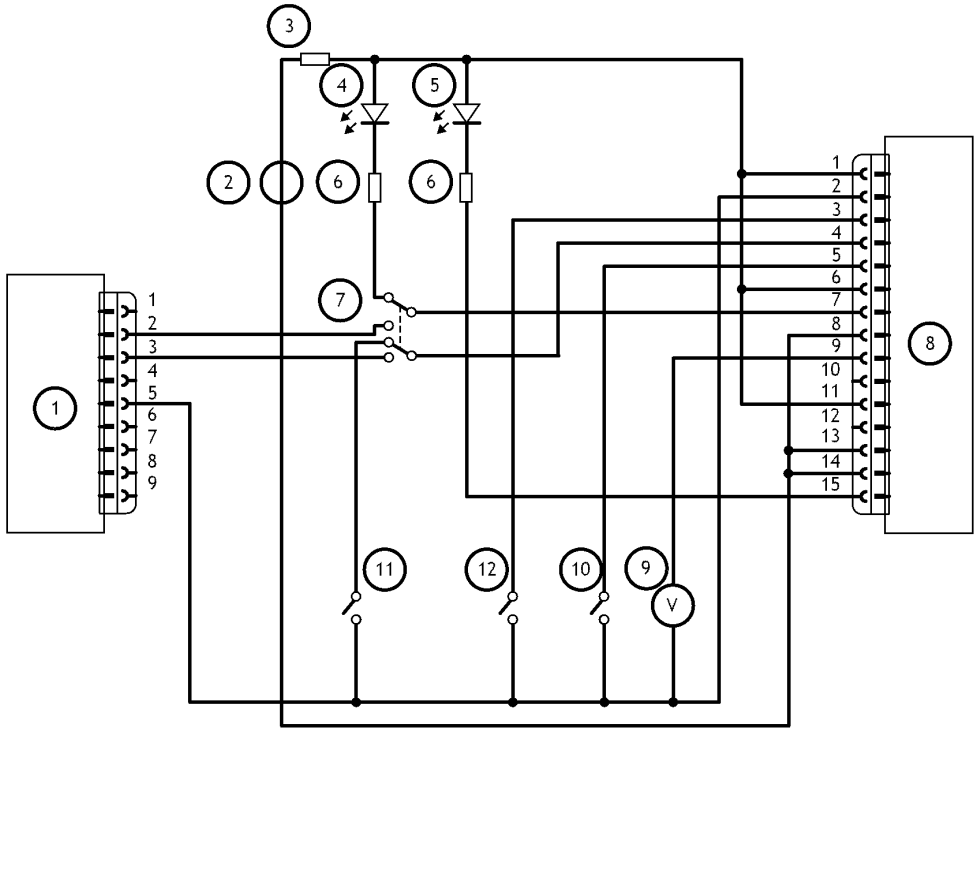
The multi-drop connection is shown in *Connection for serial control and monitoring on page 46*. You can use the multi-drop connection with mixed parallel and serial operation. You can use the multi-drop connection with mixed parallel and serial operation.

You cannot use the parallel interfaces and serial interfaces at the same time to control the pump. For example, if you start the pump by sending a start command over the serial interface, you cannot stop the pump by using the start or stop switch on the parallel interface. To stop the pump, send a serial stop command. Only when the serial

stop command has been received by the pump can any commands sent through the parallel interface be acted on.

If you use the start switch on the parallel interface to start the pump, you cannot stop the pump by sending a stop command over the serial interface. To stop the pump, use the parallel stop switch. The serial interface accepts the start or stop commands only when you use the parallel interface switch to stop the pump.

Figure 17 Logic interface connection - mixed parallel and serial operation



1. RS232 interface on control equipment
2. 24 V d.c. electrical supply
3. Fuse
4. Optional LED indicator - system OK
5. Optional LED indicator - normal speed
6. Current limit resistor for LED
7. Optional serial link selector
8. pump
9. Optional voltmeter
10. Optional serial enable switch
11. Optional standby switch
12. Start switch

Note:

The voltage supply to the pump controller can be more than 24 V. But the circuits connected to the normal and fail line must have maximum external pull-up voltage rating as given in Table: Logic interface technical data on page 30.

4.9 Vent options, vent valve connection and control

CAUTION: RATE OF INCREASE IN PRESSURE

Risk of damage to equipment. If you vent the pump when it is at full rotational speed and the rate of increase in pressure is too high, the pump can get damaged and its life can decrease. We recommend to limit the rate of increase in pressure (refer to *Figure: Maximum allowed rate of increase in pressure during venting: pressure against time (pump initially at full speed) on page 27*) or open the vent valve only after the pump speed has decreased to 50% of the full rotational speed.

To keep the cleanliness of the vacuum system, we recommend you to vent the pump before you set the pump (or vacuum system) to off, when the speed of the pump is between full rotational speed and 50% of the full rotational speed. Between this speed, the rotor spins sufficiently fast to suppress the back-streaming of hydrocarbon oil from the backing pump.

Do not connect the vent valve to the backing pipeline to prevent the contamination. Connect the inlet of the vent valve to the vent gas supply. Refer to *Vent gas specification and vent control data on page 26* for the vent gas specification.

To do vent, obey one of the methods given in *Manual vent valve on page 56* to *Alternative valve connected to the vacuum system on page 58*.

4.9.1 Manual vent valve

A manual vent valve is supplied with the pump. Do not open the manual vent valve too quickly, as it is not possible to precisely control the rate of increase in pressure using the manual vent valve. We recommend you to open the manual vent valve only after the speed of the pump decreases to 50% of the full rotational speed.

4.9.2 TAV5 or TAV6 solenoid vent valve

The TAV5 and TAV6 solenoid valves are available as an accessory. Refer to *Accessories on page 97*. You can use the solenoid valves as follows:

- Use a TAV5 or TAV6 solenoid valve in the place of the manual vent valve on the pump
- Use a TAV5 or TAV6 solenoid valve connected to a convenient flange on the vacuum system

If the vent valve is connected to the vacuum system, select a point upstream of the pump to prevent the back-streaming of oil from the backing pump.

If you use the TAV5 vent valve, you can hard-vent the pump only when it is at full speed (if the vacuum system has a volume of five litres or more).
If you use the TAV6 vent valve, you can hard-vent the pump only when it is at full speed (if the vacuum system has a volume of 10 litres or more).

Install an applicable vent restrictor and vent the pump when it is at full speed or use the controlled venting option when:

- the volume of the vacuum system is less than 5 litres (when using a TAV5 vent valve) or

- the volume of the vacuum system is less than 10 litres (when using a TAV6 vent valve).

Refer to *Table: Vent restrictor orifice diameter (with atmospheric pressure at the inlet of the vent valve) on page 58* for an applicable orifice size to be installed to the vent valve for the given vacuum system volumes to limit the rate of increase in pressure. Refer to *Figure: Maximum allowed rate of increase in pressure during venting: pressure against time (pump initially at full speed) on page 27*.

Note:

If a vent restrictor is used, the time necessary to vent the vacuum system can be long. Use a vent valve without a vent restrictor to decrease the time. Before you open the vent valve, wait until the speed of the pump decreases to 50% of the full rotational speed.

4.9.3 Vent valve control

You can use controller electronics to control the TAV5 solenoid valve or TAV6 solenoid valve.

To control the solenoid valve:

1. Install the electrical connector supplied with the pump at the lead of the TAV5 solenoid valve or TAV6 solenoid valve.
2. Make sure that the cable cores and screen are wired correctly. Follow the electrical connection instructions given in the Accessories Manual (supplied with the TAV valve) and refer to *Figure: Controller connector showing pin numbers on page 34*.
3. Connect the connector into the socket at the side of the controller. Refer to *Figure: Controller status information on page 46*.

Refer to *Table: Vent options on page 57* for details on different vent options.

Table 19 Vent options

Option number	Description of the vent function
0	Vent valve opens fully below 50% full rotational speed for the stop command or fail. This is the factory default setting.
1	Controlled venting from 100% to 50% full rotational speed, vent valve opens fully below 50% for the stop command or fail.
2	Vent valve fully opens immediately if the stop command is received, vent valve opens fully below 50% full rotational speed if fail.
3	Vent valve fully opens immediately if stop command is received, controlled venting from 100% to 50% full rotational speed if fail then vent valve opens fully below 50 %.
4	Vent valve fully opens immediately if fail, vent valve opens fully below 50% full rotational speed if stop.
5	Vent valve fully opens immediately if Fail, controlled venting from 100% to 50% full rotational speed if Stop command received then vent valve opens fully below 50%.

Option number	Description of the vent function
6.7	Vent valve fully opens immediately for the Stop command or Fail.

When the pump is shipped, the controller is set to the factory default vent option 0, refer to *Table: Vent options on page 57*. You can configure the controller to one of the other vent options. Commands can be sent through the serial interface or the manufacturer's TIC Turbo and Instrument Controller or Turbo Controller.

The controller only operates (shuts) the TAV solenoid valve when it receives a start command. Before the controller operates (shuts) the TAV solenoid valve, the valve will be in the 'open' vent state. If the vacuum system is a large system, let backing pump decrease the pressure in the system to an acceptable level before you start the pump. Send a command through the serial interface to close the vent valve before you send a start command. This is known as a delayed start.

If you control the pump with the manufacturer's TIC Turbo and Instrument Controller or TIC Turbo Controller, the TAV solenoid valve can be operated from the TIC. Refer to the TIC Instruction Manuals for more information.

4.9.4 Alternative valve connected to the vacuum system

If you use different vent valve, make sure that the applicable vent restrictor is installed in the vacuum system to limit the rate of increase in pressure. Refer to *Table: Vent restrictor orifice diameter (with atmospheric pressure at the inlet of the vent valve) on page 58* for information about the sizes of vent restrictor. If the applicable vent restrictor is not installed, open the vent valve only when the speed of the pump decreases to 50% of the full rotational speed.

Table 20 Vent restrictor orifice diameter (with atmospheric pressure at the inlet of the vent valve)

Vacuum system volume (litres)	Orifice diameter (mm)
< 20	≤ 1.0
< 10	≤ 0.7
< 5	≤ 0.5
< 2	≤ 0.35

4.10 Cooling

4.10.1 Introduction

CAUTION: PUMP COOLING

Risk of damage to equipment. Make sure that the pump is sufficiently cooled to prevent the damage to the rotor and bearing.

When you use an alternative configuration (other than the manufacturer's standard cooling accessories) to cool the pump, make sure that the cooling is not directed or ducted onto the pump controller.

CAUTION: VENTILATION FOR PUMP

Risk of damage to equipment. If the pump is in an enclosure, make sure that sufficient ventilation is available. The ambient temperature around the pump must not be more than 40 °C.

- Natural convection cooling: For the light pumping duties, with an ambient air temperature less than 30 °C, natural convection cooling can be sufficient to cool the pump.
- Forced air cooling: The ambient air temperature must be 5 °C to 35 °C when you use the forced air cooling. make sure that there is sufficient supply of cooling air to the pump.
- Water cooling: Use water cooling when the ambient air temperature greater than 35 °C or when you use a bakeout band (CF variants only). When you use the water cooling, ambient air temperature must be less than 40 °C and the water temperature must be between 10 °C and 20 °C.

We recommend to cool the pump by forced air cooling or water cooling, when possible. Refer to *Table: nEXT pumps technical data on page 20* for more information on the performance.

4.10.2 Forced air cooling

You can configure the customer controller to operate the air cooler only if the commands can be sent through the serial interface or a manufacturer's TIC Turbo and Instrument Controller or Turbo Controller.

Air cooling accessories are available for the pump (refer to *Accessories on page 97*). Install the air cooler as given in the instruction manual supplied with it. If you use an alternative fan for air cooling, make sure that the flow rate is more than 100 m^3h^{-1} (60 cfm).

You can supply the power to the air cooler by a customer external power supply, the manufacturer's TIC Turbo and Instrument Controller, the TIC Turbo Controller or the Controller. If a TAV solenoid valve is connected to the controller, you cannot supply the power to the air cooler by the controller. Obey the electrical connection instructions in the air cooler manual to wire the lead of the air cooler into the controller connector supplied with the pump (refer to *Figure: Controller connector showing pin numbers on page 34*). Connect the connector into the socket at the side of the controller (refer to *Figure: Controller status information on page 46*).

4.10.3 Water cooling

CAUTION: CONDENSATION IN PUMP

Risk of damage to equipment. To prevent the condensation in the pump and controller, stop the cooling water supply when the pump is set to off.

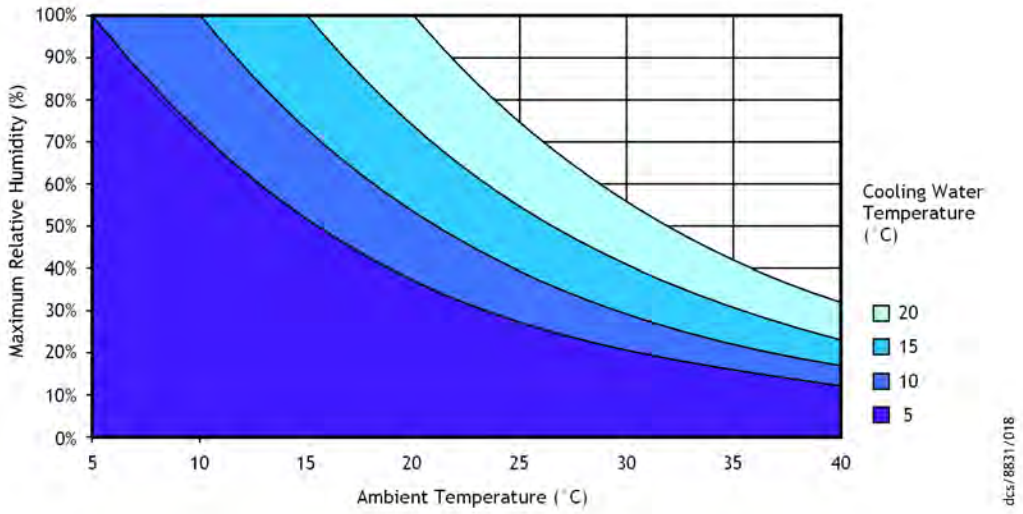
Condensation can occur if you use a water cooling block in a high humidity environments. Protect the pump and other equipment by considered design of the installation. Refer to *Figure: RS485 multi-drop connection on page 50* for recommendations.

A WCX water cooler accessory is available for the pump (refer to *Accessories on page 97*). Install the WCX water cooler accessory as given in the instruction manual supplied with it. The cooling water supply must be as per the specification given in *Cooling water on page 27*. Pipes in the water cooling circuit can get blocked if the cooling water has too much calcium carbonate or large particles. Corrosion of the water cooling circuit can occur if the cooling water has too less quantity of calcium carbonate and oxygen. A drinking water of a good quality is applicable. If in doubt, check the quality of the cooling water supply. If necessary, do the treatment and filtration.

1. Connect the cooling water supply to the water cooler at the pump. Use one of the two push-fit connectors on the water cooler for the water supply or return connections.
2. Push the nylon hose (approximately 10 mm outer diameter) into the ends of the hose connectors of the water cooler at the pump. You can also remove the hose connectors from the water cooler to make a connection to the 1/8 inch BSP female threaded installed on the water cooler.

To prevent the breaking of the cooling water circuit when you remove the pump for the maintenance, remove the two M6 screws. Remove the water cooler from the pump.

Figure 18 Maximum relative humidity to avoid condensation with water cooling



5. Configuration

WARNING: CONNECTION TO THE VACUUM SYSTEM

Risk of injury and damage to equipment. Do not operate the pump if it is not connected to the vacuum system. The pump rotor rotates at high speeds and the rotating blades are not visible. If the pump is operated without connection, the pump rotor can cause injury.

Before you operate the pump, configure the motor controller settings that are applicable for the application.

If the system is designed to operate with parallel control and monitoring, you cannot change the motor controller settings when the pump is installed on the system. The pump is supplied with the settings at factory default values, as shown in *Table: Summary of commands that can be sent to the nEXT pump on page 51*. If you want to change the motor controller settings, change the settings before you install the pump on the system.

To configure the pump, use one of the methods that follows:

- Use the customer serial system. Refer to *Configure the pump using serial commands on page 61* for the necessary commands to configure the motor controller.
- Use manufacturer's TIC Turbo and Instrument Controller or TIC Turbo Controller. Refer to *Configuring the nEXT pump using a TIC on page 66* for more information.

Note:

Use the button on the controller to adjust the standby speed. Refer to Standby speed setting on page 63.

If the pump is operated with parallel control and monitoring and the controller settings will not be reconfigured, refer to *Before starting the pump on page 68*.

5.1 Configure the pump using serial commands

Refer to *Table: Summary of commands that can be sent to the pump on page 51* for the summary of the serial commands, parameter ranges and factory defaults for each setting. Refer to the sections that follows for more information about settings.

5.1.1 Power limit setting

Table: Power limit setting on page 61 shows the power limit setting options for the pumps. The pump is supplied with a default power limit as shown. If this limit is not suitable for the application, change it to value between the maximum and minimum shown.

Table 21 Power limit setting

Maximum value setting	Minimum value setting	Default power setting
200 W	50 W	160 W

Send the command as follows (the 'd' characters shows the value in Watts that will be set. For example, to set the limit to 90 W, type 90).

Command	*!*	*S*	*8*	*5*	*5*	*sp*	*d*	*d*	*d*	*cr*

The reply is as follows:

Reply	***	*S*	*8*	*5*	*5*	*sp*	*r*	*cr*

The power limit setting is now stored in memory of the pump.

To check what power limit is set, send a query as follows:

Command	*?*	*S*	*8*	*5*	*5*	*cr*

The reply is as follows:

Reply	*=*	*S*	*8*	*5*	*5*	*sp*	*d*	*d*	*d*	*cr*

5.1.2 Power supply to the fan from the controller

If the controller is not used to control a vent valve, the controller can supply the power to the fan.

To enable the fan, send the command:

Command	*!*	*S*	*8*	*5*	*3*	*sp*	*8*	*cr*

The reply is as follows:

Reply	***	*S*	*8*	*5*	*3*	*sp*	*r*	*cr*

The permanently enabled fan setting is now stored in the memory of the pump.

When the pump is shipped, it is set up to operate a vent valve. Send a query that follows to find the setting:

Command	*?*	*S*	*8*	*5*	*3*	*cr*

The reply as follows:

Reply	*=*	*S*	*8*	*5*	*3*	*sp*	*d*	*cr*

If the character 'd' is 8, the fan is enabled. If the character 'd' is other than 8, configure the motor controller to operate the fan.

5.1.3 Controlled venting options

Number of vent options are available if you use the motor controller to automatically control a vent valve. Refer to *Table: Vent options on page 57*.

To set a vent option, send the command that follows, (character 'd' refers to the option number shown in *Table: Vent options on page 57*):

Command	*!*	*S*	*8*	*5*	*3*	*sp*	*d*	*cr*

The reply as follows:

Reply	***	*S*	*8*	*5*	*3*	*sp*	*r*	*cr*

The venting option is now stored in the memory of the pump.

To check the venting option that is set, send a query as follows:

Command	*?*	*S*	*8*	*5*	*3*	*cr*

The reply is as follows:

Reply	*=*	*S*	*8*	*5*	*3*	*sp*	*d*	*cr*

5.1.4 Standby speed setting

You can operate the pump at a standby speed rather than full rotational speed. The standby speed is a user-configurable option and can be set to the value between 55% and 100% full rotational speed. When the pump is shipped, it is configured with a standby speed of 70% full rotational speed.

To change the standby speed setting, use one of the methods that follows:

- Use the STDBY+ and STDBY- push buttons (given on the controller). Each push of the button adjusts the speed by 10 Hz (1%) Refer to *Figure: Controller status information on page 46*.
- Use a serial command

To change the standby speed setting using a serial command, send the command that follows (characters 'd' shows the value as a percentage of full rotational speed):

Command	*!*	*S*	*8*	*5*	*7*	*sp*	*d*	*d*	*d*	*cr*

The reply is as follows:

Reply	***	*S*	*8*	*5*	*7*	*sp*	*r*	*cr*

The standby speed is now stored in memory of the pump.

To check what standby speed is set, send a query as follows:

Command	*?*	*S*	*8*	*5*	*7*	*cr*

The reply is as follows:

Reply	*=*	*S*	*8*	*5*	*7*	*sp*	*d*	*d*	*d*	*cr*

5.1.5 Normal speed setting

The normal speed is a user-configurable setting and can be set to the value between 50% and 100% full rotational speed. When the pump is shipped, it is configured with a normal speed of 80% full rotational speed.

To change the normal speed setting, send the command that follows (characters 'd' shows the value as a percentage of full rotational speed):

Command	*!*	*S*	*8*	*5*	*6*	*sp*	*d*	*d*	*d*	*cr*

The reply is as follows:

Reply	***	*S*	*8*	*5*	*6*	*sp*	*r*	*cr*

The normal speed is now stored in the memory of the pump.

To check what normal speed is set, send a query as follows:

Command	*?*	*S*	*8*	*5*	*6*	*cr*

The reply is as follows:

Reply	*=*	*S*	*8*	*5*	*6*	*sp*	*d*	*d*	*d*	*cr*

5.1.6 Timer setting and options

Refer to *Timer on page 13* for a full description of timer functionality.

The timeout period is a user-configurable option and can be set to a value from 1 to 30 minutes. When the pump is shipped, it is configured with a default timeout period of 8 minutes.

To change the timer setting, send the command that follows (where the characters 'd' represent the timeout period in minutes):

Command	*!*	*S*	*8*	*5*	*4*	*sp*	*d*	*d*	*cr*

The reply will be as follows:

Reply		***	*S*	*8*	*5*	*4*	*sp*	*r*	*cr*

The timer setting is now stored in memory of the pump.

To check what timeout period is set, send a query as follows:

Command	*?*	*S*	*8*	*5*	*4*	*cr*

The reply will be as follows:

Reply	*=*	*S*	*8*	*5*	*4*	*sp*	*d*	*d*	*cr*

The timer is permanently enabled during ramp-up. It is optional to have the timer enabled at other times. When the pump is shipped, the timer is enabled by default.

To disable the timer, send the serial command that follows:

Command	*!*	*S*	*8*	*7*	*0*	*sp*	*0*	*cr*

The reply will be as follows:

Reply	***	*S*	*8*	*7*	*0*	*sp*	*r*	*cr*

The state of the timer option is stored in memory of the pump.

To enable the timer again, send the serial command that follows:

Command	*!*	*S*	*8*	*7*	*0*	*sp*	*1*	*cr*

The reply will be as follows:

Reply	***	*S*	*8*	*7*	*0*	*sp*	*r*	*cr*

To check if the timer is enabled or disabled, send the query that follows:

Command	*?*	*S*	*8*	*7*	*0*	*cr*

The reply will be as follows (where d=0 means disabled and d=1 means enabled):

Reply	=	S	8	7	0	sp	d	cr

5.1.7 Analogue signal options

The analogue output can be used to monitor one of the four different parameters. Refer to *Table: Analogue signal options on page 65*.

Table 22 Analogue signal options

Option number	Description of analogue output number
0	Measured pump rotational speed. This is the factory default setting.
1	Measured system power
2	Measured motor temperature
3	Measured controller temperature

To configure the analogue output, send the command that follows (where, the character 'd' shows the option number given in *Table: Analogue signal options on page 65*):

Command	!	S	8	7	1	sp	d	cr

The reply is as follows:

Reply	*	S	8	7	1	sp	d	cr

The analogue output signal setting is now stored in memory of the pump.

To check which analogue output signal setting is enabled, send a query as follows:

Command	?	S	8	7	1	cr

The reply will be as follows:

Reply	=	S	8	7	1	sp	d	cr

5.1.8 Factory settings

The pump can be configured again to its original factory settings with one serial command.

To reset the controller to factory settings, send the command that follows:

Command	!	S	8	6	7	sp	1	cr

The reply will be as follows:

Reply	*	S	8	6	7	sp	r	cr

The factory settings are restored in the memory of the pump.

5.1.9 Assigning a multi-drop address

Each individual pump must be programmed with its own multi-drop address through a point-to-point connection before introduction into a multi-drop network.

When the pump is shipped, multi-drop mode is disabled by default.

To assign a multi-drop address, send the command that follows (where the 'd' characters represent the address):

Command	*!*	*S*	*8*	*5*	*0*	*sp*	*d*	*d*	*cr*

Note:

The address can be a decimal number from 1 to 98. The address number 0 is used to disable multi-drop mode. The address number 99 is reserved as a wild card and is used in the query set up detailed later.

The reply will be as follows:

Reply	***	*S*	*8*	*5*	*0*	*sp*	*r*	*cr*

The multi-drop address is stored in the pump.

To check if the pump has a multi-drop address, send the command that follows:

Reply	*?*	*S*	*8*	*5*	*0*	*cr*

If the reply is as follows, the pump has multi-drop mode disabled:

Reply	*=*	*S*	*8*	*5*	*0*	*sp*	*0*	*cr*

If the pump has a multi-drop address, there will be no reply. Communicate with the pump in multi-drop message protocol. Refer to *Multi-drop operation on page 54* for more information about multi-drop mode and multi-drop message protocol.

To check the multi-drop address of the pump, send the query as follows (using wild card address 99 which means 'any' node):

Command	*#*	*9*	*9*	*:*	*9*	*9*	*?*	*S*	*8*	*5*	*0*	*cr*

The reply will be as follows, where dd shows the multi-drop address of the pump:

Reply	*#*	*9*	*9*	*:*	*9*	*9*	*=*	*S*	*8*	*5*	*0*	*sp*	*d*	*d*	*cr*

Multi-drop mode can be disabled by assigning the pump an address 0. To do this, send the command that follows (where dd shows the multi-drop address of the pump and xx shows the address of the node that is sending the command):

Command	*#*	*d*	*d*	*:*	*x*	*x*	*!*	*S*	*8*	*5*	*0*	*sp*	*0*	*cr*

The reply will be as follows:

Reply	*#*	*x*	*x*	*:*	*d*	*d*	***	*S*	*8*	*5*	*0*	*sp*	*0*	*cr*

When the multi-drop mode is disabled, the pump will not respond to multi-drop commands.

5.2 Configuring the nEXT pump using a TIC

The pump can be configured using the manufacturer's TIC Turbo and Instrument Controller or TIC Turbo Controller. Refer to *Connect the logic interface to the TIC on page 42*.

The parameters of the pump that can be set using the TIC are:

- Power limit setting

- Controlled venting options, including operating a fan from the controller
- Standby speed setting
- Normal speed setting
- Timer settings: to enable and disable the timer, setting the timeout period
- Electronic braking options
- Factory default settings

Refer to the TIC Turbo and Instrument Controller or TIC Turbo Controller Instruction Manuals for information on how to do the settings.

Note:

You cannot configure the Analogue Output Options using the TIC. You cannot assign a multi-drop address to the pump with TIC.

Option is available to connect the TIC to a PC and using the TIC PC program to configure the pump. The TIC PC program allows:

- configuration of all settings given in the above list
- configuration of the analogue output options
- assignment of a multi-drop address.

Refer to the TIC PC program Instruction Manual for more information.

6. Operation

6.1 Before starting the pump

Before you start the pump, obey the steps that follows.

6.1.1 Close the vent valve

- If you use a manual vent valve, turn it clockwise to close the vent valve.
- If you use the customer control system to drive a vent valve, make sure that the vent valve is closed.
- If you operate a TAV solenoid valve from the controller, the TAV valve will be closed automatically when the pump is started.
- If you use the TIC to operate the vent valve, refer to *Operation with a TIC on page 73*.

Note:

The backing pump and nEXT pump can be started at the same time. The nEXT pump will not get damaged and can operate as an effective baffle. If the vacuum system is large (100 litres or larger) it will be more efficient to allow the backing pump to decrease the system pressure to 10 mbar before you start the nEXT pump. Close the vent valve before you start the backing pump.

When you use the controller to control a TAV solenoid valve and operate with parallel control and monitoring, you cannot close the valve before you start the nEXT pump (the facility to send the applicable serial command is not available). If the facility to send serial commands is available, a delayed start can be done. Refer to *Delayed start on page 69*.

6.1.2 Pre-start Sequence

Note:

If the motor controller has been configured to operate a fan, the fan will start automatically when the power is supplied to the nEXT pump.

1. Turn on the applicable cooling device (fan or cooling water supply).
2. Start the backing pump.
3. Switch on the power supply to the pump.
4. Check that the three LEDs (normal, status and alarm LEDs) on the motor controller illuminate for approximately 0.5 seconds and then extinguish.

Refer to *Fault finding on page 80* if:

- LEDs does not illuminate
- Red or yellow LEDs flashes in a repeated sequence
- Red LED is illuminated.

6.2 Operation with parallel control and monitoring

6.2.1 Start the pump

To start the pump, link the start/stop control input to the 0 V control reference on the logic interface connector. The pump will accelerate to full operating speed.

The green indicator on the controller will illuminate when the pump reaches to normal speed. This is 80% of full rotational speed by default, but a different value can be selected to suit the application.

6.2.2 Running at standby speed

If the pump operates at less than or more than the standby speed it will accelerate or decelerate until standby speed is reached.

1. To operate the pump at standby speed, link the standby control input to the 0 V control reference on the logic interface connector.
2. To return the pump to the full speed, disconnect the standby control input from the 0 V control reference on the logic interface connector.

6.2.3 Stop the pump

To stop the pump, disconnect the start/stop control input from the 0 V control reference on the logic interface connector. The pump rotor will decelerate and stop.

6.2.4 Parallel monitoring

The parameters that follows can be monitored:

- Analogue output
- Normal signal
- Fail signal

Refer to *Connect the parallel control and monitoring on page 45* for instructions on how to monitor the signals. Refer to *Table: Logic interface technical data on page 30* for the analogue output.

6.3 Operation with serial control and monitoring

6.3.1 Delayed start

If using a TAV solenoid valve controlled by the controller, it can be necessary to close it before you start the pump. This allows the backing pump to decrease the pressure in the vacuum system.

To close the vent valve, send the command that follows:

Command	*!*	*C*	*8*	*7*	*5*	*sp*	*1*	*cr*

The reply is as follows:

Reply	*	*C*	*8*	*7*	*5*	*sp*	*r*	*cr*

Note:

This command overrides the current vent option and closes the vent valve. There is no command to open the vent valve but, when a stop command is sent to the pump, the override will be cleared.

6.3.2 Start the pump

To start the pump, send the command (over the serial communications link) that follows:

Command	*!*	*C*	*8*	*5*	*2*	*sp*	*1*	*cr*

The reply is as follows:

Reply	*	*C*	*8*	*5*	*2*	*sp*	*1*	*cr*

The pump will accelerate to full operating speed. The green indicator LED illuminates when the pump reaches normal speed. This is 80% of the full rotational speed by default, but a different value can be selected to suit the application.

6.3.3 Standby speed

If the pump operates at less than or more than the standby speed it will accelerate or decelerate until standby speed is reached.

To operate the pump at standby speed, send the command (over the serial communications link) that follows:

Command	*!*	*C*	*8*	*6*	*9*	*sp*	*1*	*cr*

The reply is as follows:

Reply	*	*C*	*8*	*6*	*9*	*sp*	*r*	*cr*

To return the pump to full speed, send the command that follows:

Command	*!*	*C*	*8*	*6*	*9*	*sp*	*0*	*cr*

The reply is as follows:

Reply	*	*C*	*8*	*6*	*9*	*sp*	*r*	*cr*

6.3.4 Stop the pump

When the stop command is received, the pump rotor will decelerate and stop.

To stop the pump, send the command (over the serial communications link) that follows:

Command	*!*	*C*	*8*	*5*	*2*	*sp*	*0*	*cr*

The reply is as follows:

Reply	*	*C*	*8*	*5*	*2*	*sp*	*r*	*cr*

6.3.5 Temperature readings

The temperatures of the pump motor and the internal electronics of the pump can be monitored. Send the query that follows:

Command	*?*	*V*	*8*	*5*	*9*	*cr*

The reply is as follows:

Reply	*=*	*V*	*8*	*5*	*9*	*sp*	*d*	*d*	*d*	*;*	*d*	*d*	*d*	*cr*

Here:

- first number is the motor temperature
- second number the internal controller temperature, all measured in °C.

6.3.6 Link parameter readings

The parameters that follows can be monitored:

- internal voltage
- current and motor power of the pump.

Send the query that follows:

Command	*?*	*V*	*8*	*6*	*0*	*cr*

The reply is as follows:

Reply	*=*	*V*	*8*	*6*	*0*	*sp*	*d*	*d*	*d*	*;*	*d*	*d*	*d*	*;*	*d*	*d*	*d*	*d*	*d*	*cr*

Here:

- first number shows the voltage (measured in 0.1 Volts - i.e. divide the number by 10 to get the answer in Volts)
- second number shows the current (measured in 0.1 Amps)
- third number shows the motor power (measured in 0.1 Watts).

6.3.7 Measured motor speed

The measured rotational speed of the motor in the pump can be monitored.

Send the query that follows:

Command	*?*	*V*	*8*	*5*	*2*	*cr*

The reply as as follows (where first returned number shows the motor rotational speed in revolutions per second (Hz)):

Reply	*=*	*V*	*8*	*5*	*2*	*sp*	*d*	*d*	*d*	*d*	*;*	*h*	*h*	*h*	*h*	*h*	*h*	*h*	*h*	*cr*

Note:

The second return number is a 32-bit system status word (set of 8 hexadecimal characters) which is useful for fault finding. Refer to Decoding system status words on page 87 to decode the system status word.

6.4 Mixed parallel and serial operation

In mixed parallel and serial operation, the pump can receive commands from serial and parallel interfaces. Refer to *Figure: Serial and parallel control flowchart on page 73* to understand how the commands controls the pump. The pump will power up with 'None in Control'. From this state a parallel start signal or a serial start command can receive, which can move the pump to parallel control mode or serial control mode. Serial start commands can receive only if the serial enable line is active.

The state of the serial enable line can be switched between active and inactive while in mixed parallel and serial operation. The primary function of the serial enable line is to enable the serial link. It has no direct effect on the control mode. The pump will receive and respond to serial commands whenever the serial enable line is active. The pump will not receive or respond to serial commands when the serial enable line is inactive.

Availability of the parallel standby and fail signals depends on the state of the serial enable line and the position of the RS485/RS232 switch as given in *Table: Serial enable matrix on page 72*.

Table 23 Serial enable matrix

RS485/ RS232 switch	Serial enable	
	Active	**Inactive**
RS232	Standby and fail lines are used for RS232 data.	Standby and fail lines are used for parallel Standby control and fail indication.
	Parallel standby control and fail indication are disabled.	Serial communications are disabled.
RS485	Standby and fail lines are used for RS485 data.	Standby and fail lines are in (RS485) high impedance state.*
	Parallel standby control and fail indication are disabled.	Serial communications are disabled.

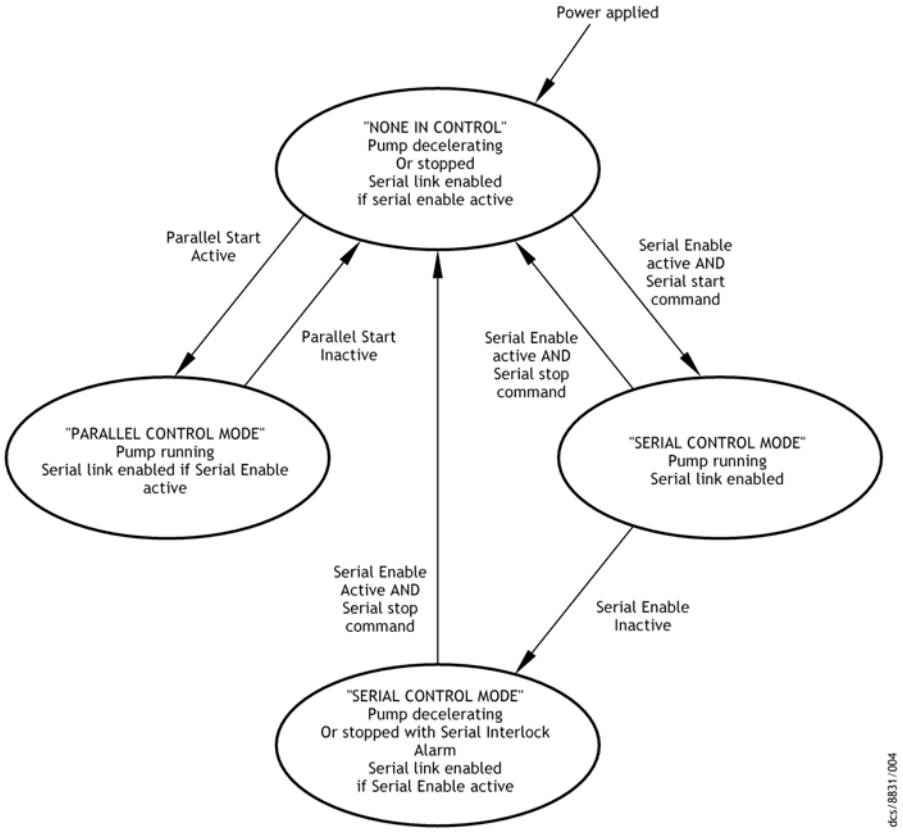
** The pump target speed will change between run speed and standby speed in response to data driven onto the RS485 bus by other devices connected to the bus. Do not activate the parallel start line when the RS485/232 switch is in RS485 position and serial enable line is inactive. Do not deactivate the serial enable line when the pump is in operation after a start from the parallel start line and the RS485/232 switch is in the RS485 position.*

In parallel control mode, the pump does not accept serial stop commands but will accept all other serial commands. When serial enable is active, the pump will operate at standby speed if the serial standby command is given. When Serial Enable is inactive and the RS485/RS232 switch is in RS232 position, the pump will operate at standby speed when the parallel standby line is active.

In serial control mode, the state of the parallel Start line will be ignored but the serial enable line gives an interlock function as shown in *Figure: Serial and parallel control flowchart on page 73*. This interlock function only operates with serial start commands and in serial control mode only. In serial control mode, the pump cannot be commanded to standby speed by the standby line, instead a serial standby command must be used.

The parallel normal and analogue output signals gives valid pump status information at all times under mixed parallel and serial operation. The analogue output voltages are given in *Table: Logic interface technical data on page 30*.

Figure 19 Serial and parallel control flowchart



6.5 Operation with a TIC

For operation with the manufacturer's Turbo Instrument Controller or TIC Turbo Controller, the pump can be connected to this type of unit, which gives the power necessary to drive the pump. Instructions on the setup and operation with the TIC or TIC Turbo Controller can be found on CD ROM part number D39700879 which is supplied with the TIC or TIC Turbo Controller.

6.6 Decelerating and venting

Switch off the backing pump immediately after applying the stop command (by the parallel or serial interface or by the TIC). The system can be vented in accordance with the advice given in *Vent options, vent valve connection and control on page 56*.

CAUTION: RATE OF INCREASE IN PRESSURE

Risk of damage to equipment. Do not open a manual vent valve until the pump rotational speed decreases below 50%, otherwise the rate of increase in pressure can be too high, which can damage the pump. In an emergency, open the vent valve quickly to decelerate the pump rotor in the shortest possible time.

If you use the controller to control a TAV solenoid valve, there is a 2-second delay between receiving a stop command (or detecting a fault condition) and opening the vent valve. The delay allows time for gauges, valves and other equipment to be switched off before venting occurs.

The green indicator LED on the controller will extinguish as rotational speed drops below normal speed. At very low speeds, the yellow indicator LED flashes. The yellow indicator LED extinguishes when the pump has stopped.

6.7 Operation at extreme conditions

6.7.1 Operation with high inlet pressure

If the pump inlet pressure increases, the power supplied to the pump motor will increase to counteract the gas frictional load.

The pump rotational speed will stay constant until the peak power level is reached. After the peak power level, the speed of the pump will start to decrease.

If the pump speed decreases below 50% of full rotational speed, the timer will start (if it is enabled). If the speed does not recover to more than 50% speed before the timeout period expires, the pump will stop and display a fail signal. If the timer is disabled, the pump will stop immediately and display a fail signal if the speed decreases below 50% of the full rotational speed. Refer to *Electrical data on page 28* for the maximum power delivered to the pump. Refer to *Table: nEXT pumps technical data on page 20* for maximum permitted inlet pressure.

6.7.2 Operation at high temperatures

Temperature sensors in the pump mechanism and electronics are monitored by an internal system. If the system detects that internal temperatures are too high, the power supplied to the pump motor is reduced, the pump can possibly not be able to maintain full rotational speed if it is too hot.

If the pump speed decreases below 50% of the full rotational speed, the timer will start (if it is enabled). If the speed does not recover to more than 50% speed before the timeout period expires, the pump will stop and display a fail signal. If the timer is disabled, the pump will stop immediately and display a fail signal if the speed decreases below 50% of the full rotational speed. Refer to *Operation and storage environment on page 26* for pump operating ranges. Refer to *Cooling on page 58* for advice on pump cooling.

6.7.3 Protection against over-speed

Control software in the motor controller control the pump rotational speed and prevents the operation of the pump more than its normal full rotational speed.

If the control software fails, the motor controller has a built-in safety circuit that checks if the pump is operating at over-speed. If an over-speed condition is detected, the motor controller automatically stops the power to the pump motor, slows the pump and stop. The motor controller signals a fail condition if over-speed is detected.

If the pump is operating at over-speed, set the pump to off and contact us or the supplier.

6.7.4 Electrical supply failure

WARNING: POWER SUPPLY FAILURE

Risk of injury. If the power supply fails when the pump is in operation, the rotor can spin for approximately 30 minutes. The control circuit can possibly not give indication that the rotor is spinning.

WARNING: AUTOMATIC RESTART

Risk of injury. If the parallel start control signal on the logic interface connector is set to start, the pump can automatically restart when the electrical supply is restored after an electrical supply failure. Make sure that people does get injured by the rotating blades of the pump.

If the electrical supply to the pump fails when the pump is rotating, the motor of the pump is used as a generator.

The regenerated power is used to:

- keep the output signals on the logic interface (such as the normal signal and serial communications)
- to power the three indicator LEDs on the motor controller
- to keep the power at the motor controller outputs (to control the vent valve, if installed).

As the rotational speed of the pump decreases, the power generated from the motor also decreases until it is no longer able to keep power to the logic interface or LEDs. This will occur at speeds less than 50% full rotational speed. There will be no indication of pump rotational speed, but the impeller can possibly continue to operate.

When the power is restored after a power failure, the behavior of the pump depends on the control mode at the time of failure (parallel or serial) and the duration of time the pump was without power. Refer to *Table: Behaviour of a pump when the power is re-instated after an electrical supply failure on page 76* for number of scenarios.

6.8 Bakeout

WARNING: HOT SURFACE

Risk of burn. Do not touch the bakeout band or adjacent surfaces during the bakeout process as they will be hot.

CAUTION: BAKEOUT PROCESS

Risk of damage to equipment. Pumps with ISO flanges are not applicable for bakeout. Use the pumps with CF flanges for bakeout. When baking the pump to more than 70 °C at the inlet flange, the pump must be water cooled to prevent the damage to the bearing lubricant.

If the pump (and the vacuum system) are heated, the degassing process will speed up and the pump can reach the ultimate vacuum in the shortest possible time. Heating the pump will also prevent condensation of vapours in the pump.

The manufacturer's BX bakeout band can be used to heat the pump. Refer to *Accessories on page 97*. Install correct band around the pump, just below the CF inlet flange. When baking the pump or the system, make sure that the temperature of the inlet flange is not more than the values given in *Table: General data on page 17*.

When baking the vacuum system, if the temperature of the system is more than 200 °C, put a radiation shield between the system and the pump. The radiation shield decreases the heat radiated onto the pump rotor.

A bakeout of four hours is long enough to remove water condensation from the pump. The bakeout time depends on the amount of condensation in the pump and the vacuum system, and the ultimate pressure necessary.

Table 24 Behaviour of a pump when the power is re-instated after an electrical supply failure

Length of power failure	Control mode	Behaviour of pump
Power is restored before the rotational speed of the pump decreases below 50%	Parallel or serial control mode	Regenerative power keeps all output signals active during the power failure. The pump will speed up to designated speed after the power has been restored.

Length of power failure	Control mode	Behaviour of pump
Power is restored after the rotational speed of the pump decreases below 50% but before regenerative power stops	Parallel or serial control mode, timer disabled	Regenerative power keeps all output signals active during the power failure. As the timer is disabled, the controller will go into fail condition when the speed decreases below 50% and will display flashing error code 0. When the power is restored, the pump will not speed up until the error is cleared. To clear the error, send a stop command (parallel or serial, depend on the control mode), send a start command to speed up the pump to the designated speed.
	Parallel or serial control mode, timer enabled	Regenerative power keeps all output signals active during the power failure. If power is restored before the timer period expires, the pump will speed up to designated speed. If the timer period expires, the controller will go into fail condition and will display flashing error code 3. As above, when the power is restored, the pump will not speed up until the error is cleared. To clear the error, send a stop command (parallel or serial, depend on the control mode), send a start command to speed up the pump to the designated speed.
Power is restored after the rotational speed of the pump decreases below 50% and the regenerative power stops	Parallel or serial control mode	Regenerative power stops and fails to keep output signals. When power is restored, the pump with parallel control will automatically restart if the start control on the logic interface is set to start. The pump with serial control requires a new start command to speed up the pump to the designated speed. The fail signals caused during the regenerative power period are lost when the power is restored.

7. Maintenance

WARNING: PERSONAL PROTECTIVE EQUIPMENTS

Risk of injury. When you remove the pump, make sure to use the personal protective equipment to prevent the damage from failed components and possible accumulation of hazardous material. Check that the pump is vented to atmosphere at a safe temperature. Be careful from possible spillages, sharp edges and debris. Removal of the pump inlet screen will expose the risk of injury from sharp edges.

WARNING: MAINTENANCE SAFETY

Allow the pump rotor to stop before you disconnect the logic interface cable from the power supply. Isolate other power sources. Remove the pump from the vacuum system for maintenance or fault finding procedures.

7.1 Introduction

Instructions for bearing maintenance and surface cleaning for the turbomolecular vacuum pump are given in the sections that follows. The inlet screens, inlet strainer and inlet flange seals are available as spares. Refer to *Spares on page 95*.

7.2 Bearing and oil cartridge maintenance

Replace the oil cartridge and oil-lubricated bearing when its service life ends. This is approximately more than 17,500 hours for the oil cartridge and 35,000 hours for the bearing.

When the oil cartridge or bearing are necessary to replace, we recommend to:

- send the pump to our Service Centre for a bearing or oil cartridge replacement.
- purchase an oil cartridge or bearing service kit and replace the bearing or oil cartridge on-site.

Refer to *Service on page 93*.

7.3 Rotor life

The fatigue life of turbomolecular pump rotors is approximately 40,000 to 50,000 cycles. As a precautionary measure, we recommend you to return the pumps for a major service (rotor replacement) after 20,000 cycles of acceleration to full speed and back to a stop, or after ten years of use, whichever occurs first.

7.4 Clean the external surfaces of the pump

CAUTION: CLEANING SOLUTIONS

Risk of damage to equipment. Clean the external surfaces of the pump in a well-ventilated location. When using cleaning solutions and solvents to clean the pump, obey the precautions given by the manufacturer. Do not inhale particulates which can be in the pump.

Do not clean the parts of the pump other than external surfaces. Use of organic solvents can damage the internal pump components. Do not use abrasive materials to clean the pump parts.

If the inner side of the pump is contaminated, it cannot be possible to get the necessary ultimate vacuum performance or the pump-down times can increase. In this case, return the pump to our Service Centre for cleaning.

You can use the organic solvent to clean the external surface of the pump. We recommend you to use non-CFC solvents such as isopropanol or ethanol. Only small amount of a cleaning solution is necessary to clean the pump surface.

For environmental reasons, keep wastage of cleaning solutions and solvents to a minimum.

8. Fault finding

CAUTION: CONTROLLER SAFETY

Risk of damage to equipment. Do not remove the controller from the pump as the controller may be damaged.

Refer to *Table: Fault finding on page 80* for the possible causes of faults and the recommended actions to rectify faults.

Table 25 Fault finding

Symptom
The controller LEDs do not flash for 0.5 seconds when the system is set to on on page 80
The pump does not rotate after a parallel start command is sent on page 80
The pump does not rotate after a serial start command is sent on page 81
The pump does not respond in multi- drop mode on page 81
The green Normal LED does not light or the pump does not rotate at full speed or the pump fails while in operation on page 81
Ultimate pressure cannot be reached on page 81
The pump is very noisy or there is excessive vibration or both on page 82
No serial comms on page 82
Fail signal or standby signal not working on page 83
Yellow service LED is flashing a repeated sequence on page 83
The red alarm LED is on on page 83
The red alarm LED is flashing on page 83
Other problems on page 83

Fault	**The controller LEDs do not flash for 0.5 seconds when the system is set to on**
Cause	**The electrical supply has failed.**
Remedy	Make sure that the electrical supply is set to on and the fuses (and current limiting devices) are not tripped.
Cause	**The pump rotor is rotating.**
Remedy	The LEDs can possibly not flash if the pump is in operation.

Fault	**The pump does not rotate after a parallel start command is sent**
Cause	**Check that the electricity supply is on. Check if the fail output is active.**
Remedy	If there is a fail signal, check if the red alarm LED is flashing. If yes, refer to *Flashing error codes on page 86*. If the power is supplied and fail signal is not given, but the rotor does not rotate, the fault is in the pump.

Fault	The pump does not rotate after a serial start command is sent
Cause	**Check if the pump returns a reply to the start command.**
Remedy	If there is no reply, do the checks given in *No serial comms on page 82* or do the checks given in *The pump does not rotate after a parallel start command is sent on page 80*.

Fault	The pump does not respond in multi- drop mode
Cause	**The multi-drop is disabled.**
Remedy	Make sure the pump has a multi-drop address. Make sure that the commands are sent using the multi-drop protocol.

Fault	The green Normal LED does not light or the pump does not rotate at full speed or the pump fails while in operation
Cause	**The inlet pressure is too high.**
Remedy	Reduce the pumping load or check for a gross leak into the system.
Cause	**The pump is too hot when in operation.**
Remedy	• Increase the cooling to the pump. Change from air cooling to water cooling (refer to *Technical data on page 17* for maximum inlet pressure and cooling requirements). • Increase cooling water flow or decrease the water temperature or do both. • Check that external heat sources (such as system bakeout heaters) are not excessive.
Cause	**The rotor does not rotate freely.**
Remedy	The pump bearings may be damaged. Contact supplier or us.

Fault	Ultimate pressure cannot be reached
Cause	**Pressure is limited by water vapour.**
Remedy	Bake the system and pump.
Cause	**The vacuum gauges are contaminated.**
Remedy	Clean or replace the vacuum gauges.
Cause	**Pumping speed is not sufficient (because of poor conductance between the pump and the gauge or the chamber is too large).**
Remedy	Increase the conductance or decrease the volume.
Cause	**Inlet pressure is more than 0.5 mbar (50 Pa).**
Remedy	If the interstage inlet pressure is too high, the inlet pressure at the turbomolecular inlet is increased. Make sure that the interstage inlet pressure is less than 0.5 mbar (50 Pa).
Cause	**The backing pressure is more than 10 mbar ($1x10^3$ Pa).**
Remedy	The backing pressure can be too high. Check for backing pipeline leaks. If the throughput is high, a larger backing pump can be necessary.
Cause	**The high vacuum area of the system is contaminated.**

Remedy	Clean the high vacuum system.
Cause	**Check the system for leaks and contamination.**
Remedy	If a leak is found, repair it and clean the contamination.
Cause	**The inlet pressure is less.**
Remedy	• Remove the pump from the system and test the ultimate pressure of the pump only. • Check the pump for contamination. Do the leak test of the pump. If the leak rate more than $1x10^{-7}$ mbar l s^{-1} ($1x10^{-5}$ Pa l s^{-1}), contact us or the supplier.
Fault	**The pump is very noisy or there is excessive vibration or both**
Cause	**The rotational speed of the pump is same as the resonant frequency of the attached system.**
Remedy	Change the natural frequency of the system or isolate the pump using flexible bellows.
Cause	**The vibration is transmitting from the rotary backing pump.**
Remedy	Install a flexible bellows or a vibration isolator in the backing line.
Cause	**The noise is irregular and increasing.**
Remedy	A defective bearing. Contact us or the supplier.
Cause	**The pump makes a constant high pitched noise.**
Remedy	The rotor is out of balance. Contact us or the supplier.
Fault	**No serial comms**
Cause	**No electrical supply, loss of serial link.**
Remedy	Check that: • the electrical supply is on. • the serial link is connected. • the serial enable line is active.
Cause	**Slide switch is not in the correct position for RS232 or RS485.**
Remedy	Check that: • the electrical supply is on. • the serial link is connected. • the serial enable line is active. • Left for RS485, right for RS232. • Right for parallel control and monitoring.
Cause	**Incorrect baud rate and node address.**
Remedy	Check baud rate and, if operating in multi-drop mode, the node address matches those of the pump.
Cause	**Check that the red light is not on or flashing.**
Remedy	If LED is on, check the red alarm LED symptoms.

Fault	Fail signal or standby signal not working
Cause	**The serial enable line is not active.**
Remedy	Must be disconnected or driven high for use of standby and fail lines.
Cause	**Slide switch is not in the correct position for RS232 or RS485.**
Remedy	Left for RS485, right for RS232. Right for parallel control and monitoring.
Fault	**Yellow service LED is flashing a repeated sequence**
Cause	**A service is necessary.**
Remedy	Refer to *Flashing service codes on page 83*.
Fault	**The red alarm LED is on**
Cause	**The red alarm LED is on is normal during the software upgrade process.** **At other times, if the red alarm LED is on it shows a problem is detected in the FLASH memory.**
Remedy	If software is upgrading, complete the upgrade process. If the red alarm LED is on at other times: • restart the system • upgrade the software (if restarting the system does not correct the fault) .
Fault	**The red alarm LED is flashing**
Cause	**A fail condition has activated.**
Remedy	Note the position of the long flashes in the series of 6 flashes to find the error code. Refer to *Flashing error codes on page 86* and obey the instructions.
Fault	**Other problems**
Cause	**Fault conditions other than previously mentioned.**
Remedy	Contact us or the supplier.

8.1 Flashing service codes

When a service is necessary, the standard once per revolution flash on the yellow status LED is changed to a service flash code. Refer to *Table: Flashing service codes on page 83* for the service flash codes.

Table 26 Flashing service codes

Service flash code	Comments	Actions
LED on 1sec LED off 1sec	Oil cartridge service recommended	We recommend you to replace the oil cartridge. Refer to *Service on page 93*.

Service flash code	Comments	Actions
LED on 3sec LED off 1sec	Bearing and oil cartridge service recommended	We recommend you to replace the bearing and oil cartridge. Refer to *Service on page 93*.
LED on 3sec LED off 3sec	Pump service necessary	The turbo impeller or controller has reached its expected life. We recommend you to return the pump to our service centre for service. Refer to *Service on page 93*.

8.2 Decoding service status words

The service status can be accessed through the serial link. This method of accessing service status will give the most complete information of current and future service requirements and preventative maintenance activities can be scheduled.

A summary of the current pending service status is given in response to the service status command that follows:

Command	*?*	*V*	*8*	*8*	*1*	*cr*

The reply is as follows:

Reply	*=*	*V*	*8*	*8*	*1*	*sp*	*h*	*h*	*h*	*h*	*h*	*h*	*h*	*h*	*cr*

The service status word is made up of 8 hexidecimal digits. To decode this word, convert each digit into a 4-digit binary number as described in *Decoding system status words on page 87*.

Each binary digit (bit) represents a flag that is active (state 1) or not active (state 0). To help decode the service status word, each bit is numbered (starting with 0 for the least significant to 31 for the most significant) as shown in *Controller run time on page 85*. The meaning of each bit in the service status word is given in *Table: Service flags on page 84*.

Table 27 Service flags

Bit number	Status flag	Active flag means
0	Oil cartridge service due	Set when hours until oil cartridge service due = 0
1	Bearing service due	Set when hours until bearing service due = 0
2	Pump service due	Set when hours until pump service due = 0 or cycles until pump service due = 0
3	Controller service due	Set when hours until controller service due = 0
4	Reserved	-
5	Reserved	-
6	Reserved	-

Bit number	Status flag	Active flag means
7	Service due	Service is due. Specific operation necessary should be determined by checking the bits above
8 - 31	Reserved	-

8.3 Controller run time

The run hours and recommended service time of the controller on the pump can be monitored.

Send the query that follows:

Command	*?*	*V*	*8*	*8*	*1*	*cr*

The reply is as follows (where, first number is the hours run by the controller and second is the number of hours until the service is recommended):

Reply	*=*	*V*	*8*	*8*	*2*	*sp*	*d*	*d*	*d*	*d*	*d*	*d*	*;*	*d*	*d*	*d*	*d*	*d*	*d*	*cr*

Note:

The number of hours until the next service is due is estimated by the controller based on the operating conditions of the pump and they can decrease at more or less than 1 hour per hour. Decreased pump temperature is the primary factor in extending the controller life.

8.4 Pump run time

The run hours and recommended service time of the impeller in the pump can be monitored.

Send the query that follows:

Command	*?*	*V*	*8*	*8*	*3*	*cr*

The reply will be as follows (where, first number is the hours run by the impeller and second is the number of hours until service is recommended):

Reply	*=*	*V*	*8*	*8*	*3*	*sp*	*d*	*d*	*d*	*d*	*d*	*d*	*;*	*d*	*d*	*d*	*d*	*d*	*d*	*cr*

8.5 Pump cycles

The number of start-stop cycles completed and the number remaining until the next service is due can be monitored.

Send the query that follows:

Command	*?*	*V*	*8*	*8*	*4*	*cr*

The reply is as follows (where, first number is the start-stop cycles completed by the pump and second is the number of start-stop cycles until service is recommended):

Reply	*=*	*V*	*8*	*8*	*4*	*sp*	*d*	*d*	*d*	*d*	*d*	*d*	*;*	*d*	*d*	*d*	*d*	*d*	*d*	*cr*

8.6 Bearing run time

The run hours and recommended service time of the bearing in the pump can be monitored.

Send the query that follows:

Command	*?*	*V*	*8*	*8*	*5*	*cr*

The reply is as follows (where, first number is the hours run by the bearing and second is the number of hours until service is recommended):

Reply	*=*	*V*	*8*	*8*	*5*	*sp*	*d*	*d*	*d*	*d*	*d*	*d*	*;*	*d*	*d*	*d*	*d*	*d*	*d*	*cr*

8.7 Oil cartridge run time

The run hours and recommended service time of the oil cartridge in the pump can be monitored.

Send the query that follows:

Command	*?*	*V*	*8*	*8*	*6*	*cr*

The reply is as follows (where, first number is the hours run by the oil cartridge and second is the number of hours until service is recommended):

Reply	*=*	*V*	*8*	*8*	*6*	*sp*	*d*	*d*	*d*	*d*	*d*	*d*	*;*	*d*	*d*	*d*	*d*	*d*	*d*	*cr*

8.8 Flashing error codes

When a fail condition becomes active, the red alarm lights continuously or shows a flashing sequence.

If the error light is on continuously, this shows a problem with the embedded software. Restart the system. If restarting the system does not clear the fault, a software download is necessary. Contact us or the supplier. If the alarm LED is flashing, identify the error flash code and refer to *Table: Flashing error codes on page 86*.

Sufficient off period is there between each subsequent cycle repetition to mark the start of a new flash sequence. The duration of a long flash (L) is equal to 3 times the duration of a short flash (0.5 s).

Table 28 Flashing error codes

Error flash position	Error flash code	Comments	Actions
0	ssssss	The speed decreases below 50% of the full rotational speed with the Timer disabled.	Check if the pump is too hot or if the inlet pressure is too high.
1	Lssssss	Controller internal software mismatch	Restart the system. If the error code is not cleared, contact us or the supplier.

Error flash position	Error flash code	Comments	Actions
2	sLssss	Controller failed internal configuration and calibration operation	Restart the system. If the error code is not cleared, contact us or the supplier.
3	ssLsss	Failure to reach or maintain half full speed in the timer setting value	Check if the pump is too hot or if the inlet pressure is too high.
4	sssLss	Overspeed or overcurrent trip is activated, or other hardware fault	Restart the system. If the error code is not cleared, contact us or the supplier.
5	ssssLs	Pump internal measurement system is disconnected or damaged	Restart the system. If the error code is not cleared, contact us or the supplier.
6	sssssL	Serial enable becomes inactive after a serial start command	Activate the Serial Enable again and send a Serial Stop command to clear the error code.

Note:

The alarm LED error flash sequence can signal multiple fail conditions. For example, error flash code sLssLs signifies error 2 (controller failed internal configuration and calibration operation) and error 5 (pump internal measurement system disconnected or damaged).

8.9 Decoding system status words

When you use the serial communications link, additional information that can be useful for the fault finding can accessed. When sending a query to monitor measured motor speed, the pump also returns a System Status Word.

The send command that follows:

Command	*?*	*V*	*8*	*5*	*2*	*cr*

The reply is as follows (where, first returned number refers to motor rotational speed in revolutions per second (Hz)):

Reply	*=*	*V*	*8*	*5*	*2*	*sp*	*d*	*d*	*d*	*d*	*;*	*h*	*h*	*h*	*h*	*h*	*h*	*h*	*h*	*cr*

The system status word returned is made up of 8 hexadecimal digits. To decode this word, convert each digit into a 4-digit binary number. Example:

2	2	8	3	0	0	2	2
↓	↓	↓	↓	↓	↓	↓	↓
0 0 1 0	0 0 1 0	1 0 0 0	0 0 1 1	0 0 0 0	0 0 0 0	0 0 1 0	0 0 1 0

Refer to *Table: Hexadecimal conversion table on page 87* for more information.

Table 29 Hexadecimal conversion table

Hexadecimal	Binary	Decimal
0	0000	0

Hexadecimal	Binary	Decimal
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
A	1010	10
B	1011	11
C	1100	12
D	1101	13
E	1110	14
F	1111	15

Each binary digit (bit) represents a flag that is either active (state 1) or not active (state 0). To help decode the system status word, each bit is numbered (starting with 0 for the least significant to 31 for the most significant) as shown below.

Refer to *Table: Status flag on page 88* for the list of the lower 16 status flags that are useful for fault finding. The upper 16 status flags are reserved by us.

Binary digits

0	0	1	0	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit numbers

Table 30 Status flag

Bit number	Status flag	Active flags means
0	Fail	Fail status condition active
1	Stopped speed	Below stopped speed
2	Normal speed	Above normal speed
3	Vent valve closed	Vent valve energised
4	Start	Start command active
5	Serial enable	Serial enable active
6	Standby	Standby active
7	Half full speed	Above 50% full rotational speed
8	Parallel control mode	Exclusive control mode selection
9	Serial control mode	Exclusive control mode selection

Bit number	Status flag	Active flags means
10	Invalid Controller software	Controller internal software mismatch
11	Controller upload incomplete	Controller failed internal configuration and calibration operation
12	Timer expired	Failure to reach or maintain half full speed in the timer setting value
13	Hardware trip	Overspeed or Overcurrent trip activated
14	Thermistor error	Pump internal temperature measurement system disconnected or damaged
15	Serial control mode interlock	Serial enable has become inactive following a serial Start command.

The system status word used in the example above was taken when the pump is not in operation. Decode the word for more information about the state of the pump. Refer to *Table: Example decoding of system status words on page 89*.

Table 31 Example decoding of system status words

Bit number	Status of bit (in example)	Indication
0	0	The pump has not failed
1	1	The pump is at rest
2	0	Speed is below normal speed
3	0	The vent valve is open
4	0	There is no active start command
5	1	Serial enable is active
6	0	Standby is not active
7	0	Speed is below 50% of full rotational speed
8	0	The pump is not in parallel control mode
9	0	The pump is not serial control mode
10	0	There is no controller internal software mismatch
11	0	Controller passed internal configuration and calibration operation
12	0	The timer has not timed out
13	0	Overspeed and overcurrent trip not activated
14	0	Pump internal temperature measurement system is fine
15	0	Serial enable has not become inactive during serial control

8.10 Useful service information

If you use the serial communications link, additional information about the pump (such as pump type and internal controller software versions) can be accessed. This information is useful for the service personnel to select the model of the pump.

Send the query that follows to find out the pump type:

Command	*?*	S	*8*	*5*	1	*cr*

The reply is as follows (where string 1 is the pump type, string 2 is the DSP software version number and string 3 is the designated full speed of the pump (in revolutions per second)):

Reply	*=*	S	*8*	*5*	1	*sp*	String 1	*;*	String 2	;	String 3	;	*cr*

Send the query that follows to find out the boot loader software version:

Command	*?*	S	*8*	6	8	*cr*

The reply is as follows (where, string 1 is the boot loader software version number):

Reply	*=*	S	*8*	6	8	*sp*	String 1	*cr*

9. Storage

If possible, do not store the pump for long-term. When long-term storage is necessary, the pump should be set up and operated for minimum eight hours every six months.

To store the pump:

1. Put protective covers over the inlet, outlet, interstage (for the 'i' nEXT only), purge, booster (for the 'T' nEXT only) and vent ports.
2. Put the pump in its packing materials. Seal the pump in a plastic bag with a applicable desiccant for fastest pump-down when the pump is put back into service.
3. Store the pump in cool, dry conditions until necessary for use. Refer to *Table: Operation and storage environment on page 26* for recommended storage environment.
4. When necessary, prepare and install the pump as given in *Installation on page 36*.
5. Always keep the pump upright to prevent the drainage of oil from the bearing reservoir.

10. Disposal

WARNING: PERSONAL PROTECTIVE EQUIPMENTS

Risk of exposure to harmful substances. If the pump rotor fails, there can be some dust created from the rotary components in the pump touching each other. Use correct personal protective equipment when handling and disposing the pump. Make sure that all pump inlets and outlets are capped off before disposal.

Dispose of the pump, components and accessories safely and in accordance with all local and national safety and environmental requirements.

Be careful from the components that have been contaminated with dangerous process substances.

Do not the inhale the particulates which can be in the pump.

Do not incinerate the pump. The pump contains phenolic and fluorosilicone materials that can decompose to very dangerous substances when heated to high temperatures.

11. Service

Our products, spares and accessories are available from our 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 our comprehensive training courses.

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

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

Our products are supported by a world-wide network of our service centres. Each service centre offers a wide range of options that includes: equipment decontamination, service exchange, repair, rebuild and testing to factory specifications. Equipment which has been serviced, repaired or rebuilt is returned with a full warranty.

The local service centres can also give our engineers to support on-site maintenance, service or repair of equipment. For more information about service options, contact our nearest service centre or the company.

11.1 Return the equipment or components for service

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

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

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 us.

NOTICE:

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

11.2 Bearing and oil cartridge on-site maintenance

The oil cartridge and bearing of the pump can be serviced on-site by service engineer trained by us.

The service tool kits that follows and service parts are available.

Table 32 Service tool kits

Service tool kit	Item number
Oil cartridge tool kit	B80000812
Bearing tool kit	B80000805

Table 33 Service kits

Service kit	Item number
Oil cartridge	B80000811
Bearing and oil cartridge	B80000810

Note:

The oil cartridge and bearing tool kits are necessary when changing a pump bearing.

12. Spares

CAUTION: SUPPLIED SPARES

Risk of damage to equipment. If you use spares that are not supplied by us, it will decrease the reliability and performance of the pump. This will also invalidate the product warranty.

12.1 ISX inlet screen

An inlet screen is installed to the CF pump as supplied to prevent damage from the entry of debris into the pump. The Item Numbers of replacement inlet screens are as follows. Select the inlet screen as per the inlet flange size of the pump. The inlet screen on a pump cannot be replaced with an NW inlet flange.

Table 34 Inlet screens

Flange Size	Inlet Screen	Item Number
DN100CF	Coarse inlet screen	B80000821
DN100CF	Fine inlet screen	B80000822
DN160CF	Coarse inlet screen	B80000823
DN160CF	Fine inlet screen	B80000824

12.2 Inlet strainer

The interstage pumps are supplied with an inlet strainer for the interstage port. The Item Number for a replacement inlet strainer is as follows.

Table 35 Inlet strainers

Flange Size	Inlet Screen
DN25ISO-K	B70610817

12.3 Inlet-flange seals and integrated inlet screens

The pumps are supplied with an inlet seal. The Item Numbers of replacement seals are given in *Table: Inlet flange seals and integrated inlet screens on page 95*.

Table 36 Inlet flange seals and integrated inlet screens

Flange size	Inlet flange seal	Item number
DN100ISO-K	ISO100 trapped O-ring with integrated coarse inlet screen	B81000808
DN100ISO-K	ISO100 trapped O-ring with integrated fine inlet screen	B81000809
DN160ISO-K	ISO160 trapped O-ring with integrated coarse inlet screen	B80000825

Flange size	Inlet flange seal	Item number
DN160ISO-K	ISO160 trapped O-ring with integrated fine inlet screen	B80000826
DN100ISO-K	ISO100 trapped O-ring	C10523001
DN160ISO-K	ISO160 trapped O-ring	C10524001
DN100CF	100CF copper compression gasket (pack of 5)	C08200003
DN160CF	160CF copper compression gasket (pack of 5)	C08300003

12.4 NW16 and NW25 Ports

The pumps are supplied with NW25 exhaust and booster ports. The item numbers of replacement ports are as follows.

Table 37 NW16 and NW25 ports

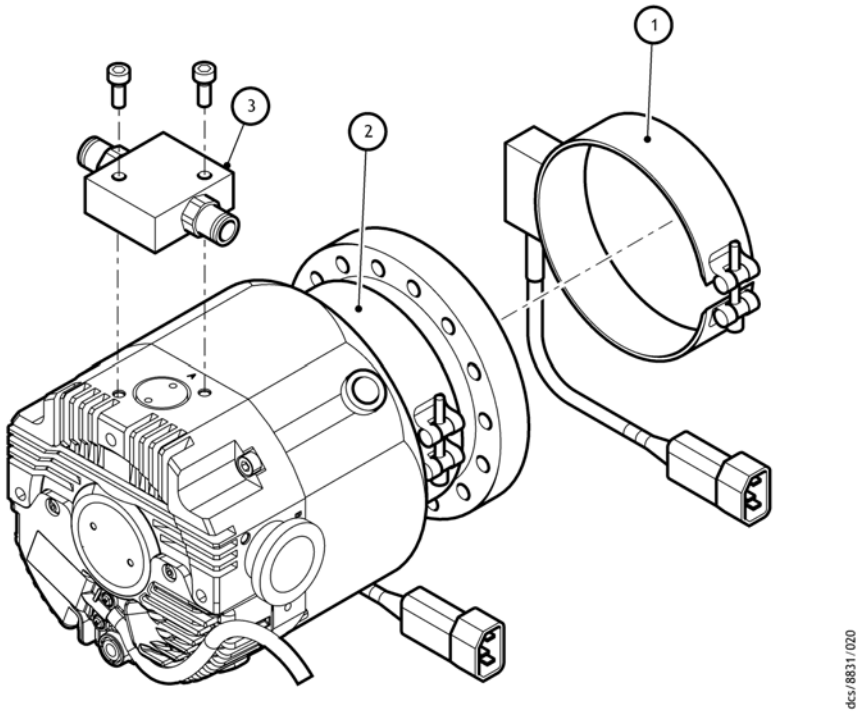
Port	Item Number
NW25	B80000809
NW16	B80000806

13. Accessories

13.1 Installation

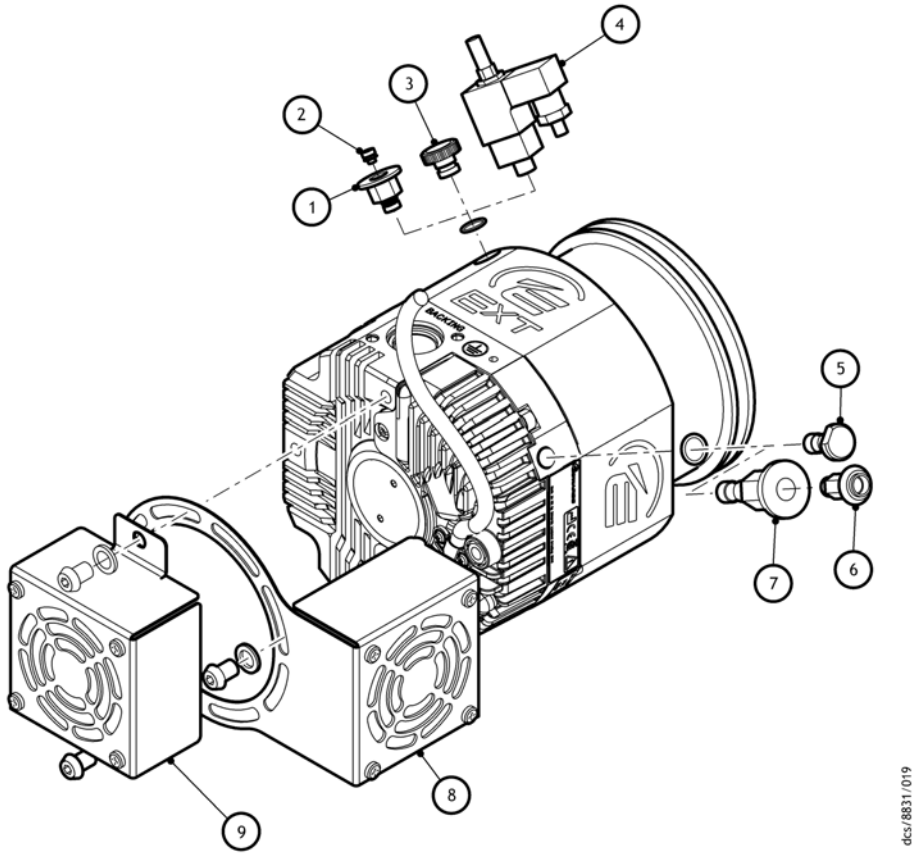
The accessories available for use with the pumps are described in the sections that follows. *Figure: nEXT exploded accessories view on page 97* and *Figure: nEXT exploded accessories view on page 98* shows how the accessories are installed to the pump.

Figure 20 nEXT exploded accessories view



1. BX 250 bake out band (DN100CF envelope shown)
2. BX 250 bake out band position
3. WCX water cooling accessory

Figure 21 nEXT exploded accessories view



1. DN10NW adaptor
2. VRX vent restrictor
3. Manual vent valve (fitted)
4. TAV solenoid vent valve
5. Purge plug (fitted)
6. PRX purge restrictor
7. DN10NW adaptor
8. ACX nEXT air cooler (radial)
9. ACX nEXT air cooler (axial)

13.2 ACX air cooler

An ACX air cooler can be installed to the pump. Refer to *Cooling on page 58* to check the correct air cooling in a particular application.

Table 38 ACX air cooler

Air Cooler	Current draw	Item number
ACX nEXT radial fan	135 mA	B58053175
ACX nEXT axial fan	135 mA	B58053185
ACX nEXT radial fan (with Phoenix connector)	135 mA	B58053170
ACX nEXT axial fan (with Phoenix connector)	135 mA	B58053180

13.3 WCX water cooler

A water cooler can be installed to the pump. Refer to *Cooling water on page 27* to check the applicable cooling water supply.

Table 39 WCX water cooler

Water Cooler	Item Number
WCX nEXT water cooling kit	B80000815

13.4 BX bakeout band

A BX bakeout band increases the degassing of the pump to enable it to achieve lower pressures. It can be also used to protect the pump from condensation of contaminants. The bakeout bands are available in 110 - 120 V or 220 - 240 V versions.

Note:

Use the flange heater only with CF variants.

Table 40 BX bakeout band

Bakeout Band	Item Number	For use with
BX250 (110 V)	B58052041	nEXT240
BX250 (240 V)	B58052061	nEXT240
BX300 (110 V)	B80000814	nEXT300
BX300 (240 V)	B80000816	nEXT300
BX450 (110 V)	B58052043	nEXT400
BX450 (240 V)	B58052063	nEXT400

13.5 TAV vent valve and vent port adaptor

Two solenoid-operated vent valves are available for system venting. The valves are 24 V d.c., normally open and can be driven by the controller. The solenoid valve is installed in place of the manual valve or can be installed with an adaptor (supplied with the valve). Use the valves with applicable NW10 flanged port on the vacuum system.

TAV5 is applicable for smaller vacuum systems. TAV6 has a higher conductance and is applicable for larger vacuum systems (with volume more than 10 litres).

Table 41 TAV vent valve and vent port adaptor

Product	Orifice Diameter	Item Number
TAV5 vent valve	0.5 mm	B58066010
TAV6 vent valve	1.0 mm	B58066020

13.6 VRX vent restrictor

Use a VRX installed orifice vent restrictor to restrict flow of vent gas into the pump. A VRX vent restrictor can be installed to the inlet of a TAV5 or TAV6 vent valve or to a PRX10 purge restrictor. Refer to *Table: Vent restrictor orifice diameter (with atmospheric*

pressure at the inlet of the vent valve) on page 58 for information on the selection of the correct VRX vent restrictor. Refer to *Table: Vent restrictors on page 100* for the item numbers of the vent restrictors available.

Table 42 Vent restrictors

Vent restrictor	Orifice diameter (mm)	Item number
VRX10	0.1	B58066021
VRX20	0.2	B58066022
VRX30	0.3	B58066023
VRX50	0.5	B58066024
VRX70	0.7	B58066025

13.7 Vent port adaptor

The vent port adaptor has a 1/8 inch BSP male thread that can be screwed in the vent port and purge port which makes them applicable for NW10 fittings.

Table 43 Vent port adaptor

Vent port adaptor	Item Number
Vent port adaptor NW10 - 1/8 inch BSP male	B58066011

13.8 PRX purge restrictor

The PRX10 is a modified DN10NW centring ring that filters the purge gas and restricts its flow rate to the recommended flow of 25 sccm. Install a vent port adaptor to the purge port to connect a purge restrictor to the pump.

Table 44 PRX purge restrictor

Item	Item Number
PRX10 purge restrictor	B58065001

13.9 C-clamp adaptor kit

The NW25 exhaust and booster port of the pump can be removed and replaced with a C-clamp connection.

The tool kit and parts that follows are available.

Table 45 C-clamp adaptor tool kit

Tool kit	Item Number
Port removal and insertion tool	B80000807

Table 46 C-clamp adaptor port kit

Port kit	Item Number
C-clamp and NW25 flange adaptor	B80000813

13.10 Interface cable

An interface cable connects the pump to a PC. Serial commands are used to control and monitor the pump.

Table 47 Interface cable

Item	Item Number
nEXT Interface cable	B80000808

13.11 TIC PC program

The TIC PC program is a PC-based software that can be used to retrieve and set the user configurable parameters in the pump. TIC PC program enables monitoring and data logging of the pumping system.

This page has been intentionally left blank.