



# E2M28 and E2M30 Rotary Vacuum Pumps

INSTRUCTION MANUAL

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| Publication title                      | Publication number | Link  |
|--|--------------------|---|
| Vacuum pump and vacuum system safety   | P40040100          | <a href="https://4vac.io/6db8w9">https://4vac.io/6db8w9</a> |
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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.

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# 1. Safety and compliance

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

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

## 1.1 Definition of Warnings and Cautions

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

### **WARNING:**

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

### **CAUTION:**

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

### **NOTICE:**



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

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


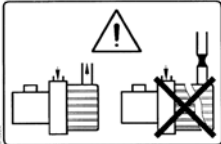

## 1.2 Safety symbols

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

The following warning labels may be present on the pump and used throughout the product documentation:

|   |  |
|---|--|
|  | Warning - refer to accompanying documentation. |
|  | Warning - risk of electric shock.              |



|   |   |
|---|---|
|  | Warning - hot surfaces.   |
|  | Warning - do not block the pump outlet  |
|  | Warning - use protective equipment. Indicates that protective equipment must be used. |

## 2. Introduction

### 2.1 Scope and definitions

This manual provides installation, operation and maintenance instructions for our rotary vacuum pumps. The pump must be used as specified in this manual.

Read this manual before installing and operating the pump.

### 2.2 Hazardous location implications



This equipment is intended to be installed in a safe non-hazardous area and its design meets the requirements of Group II Category 3 equipment in accordance with EU and UK Legislations concerning equipment and protective systems intended for use in potentially explosive atmospheres.

The ATEX Category 3 applies in respect of potential ignition sources internal to the equipment. An ATEX Category has not been assigned in respect of potential ignition sources on the outside of the equipment as the equipment has not been designed for use where there is an external potentially explosive atmosphere. There is no potential source of ignition within the pump during normal operation but there may be potential sources of ignition under conditions of predictable and rare malfunction as defined in the Directive.

There is no potential source of ignition within the pump during normal operation but there may be potential sources of ignition under conditions of predictable and rare malfunction as defined in the Directive. Accordingly, although the pump is designed to pump flammable materials and mixtures, operating procedures should ensure that under all normal and reasonably predictable conditions, these materials and mixtures are not within explosive limits. Category 3 is considered appropriate for the avoidance of ignition in the case of a rare malfunction which allows flammable materials or mixtures to pass through the pump while within their explosive limits.

When flammable or pyrophoric materials are present within the equipment:

- Do not allow air to enter the equipment.
- Ensure that the system is leak tight.

For further information, please contact us: refer to our website [www.edwardsvacuum.com](http://www.edwardsvacuum.com) for details of your nearest company.

### 2.3 Description

The pumps are two-stage, direct drive, sliding vane pumps. The pump is oil-sealed and designed for reliable, long-term operation in both laboratory and industrial

environments. The pump is a free-standing unit. The drive is provided through a flexible coupling by a single-phase or three-phase (four pole) motor.

The motors are totally enclosed and are cooled by the motor-cooling fan which directs air along the motor fins.

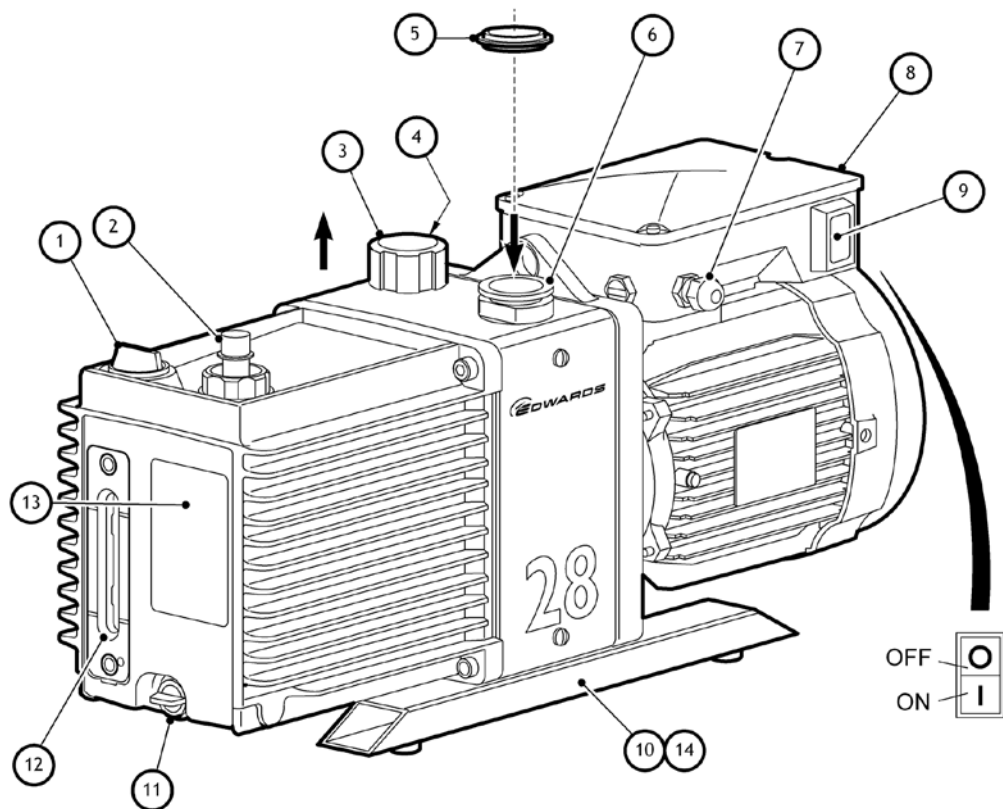
The single-phase motors have a thermal overload device. When the motor is too hot, the thermal overload device switches off the pump. The thermal overload device has an automatic reset; when the motor cools down, the device resets and the motor will restart. The single phase motors have an on/off switch.

An oil pressure system lubricates the pump shaft bearing surfaces and rotor sealing faces. The pump has an oil distribution valve which prevents discharge of oil to the pump interior (suckback) after the pump stops. The pumping chambers are air-tight, so this arrangement prevents air suckback unless the gas-ballast valve is open. For protection in this case, refer to [Gas-ballast](#) on page 12.

The level and condition of oil in the oil box reservoir can be inspected through the oil sight-glass (12). An oil filler-plug (1) is fitted to the top of the oil box. The pump has an oil drain-plug (11) to allow gravity oil drain.

The pump has an inlet-port (6), outlet nozzle (2) and gas-ballast control (3). The pump is mounted on two mild steel box section skids (10) on rubber pads. Details of suitable vibration isolators and other recommended accessories are given in [Accessories](#) on page 46.

Figure 1 General view of the pump



dcs/8832/050

- |  |                                |
|--|--------------------------------|
| 1. Oil filler                              | 2. Outlet nozzle               |
| 3. Gas-ballast control                     | 4. Gas-ballast inlet           |
| 5. Centring-ring and O-ring (supplied)     | 6. Inlet-port (adaptor flange) |
| 7. Cable-gland/Amphenol connector position | 8. Motor terminal box          |
| 9. On/Off switch                           | 10. Box section skids          |
| 11. Oil drain-plug (gravity drain)         | 12. Oil sight-glass            |
| 13. Pump identification label              | 14. Oil drip tray              |

**Note:**

A pump with a single-phase motor is shown in this figure. The motor shown in this figure is not representative of the motor used on the E2M28 (Amphenol) pump with item number A37317984. On this pump, cable-gland/amphenol connector position and on/off switch are transposed, with cable-gland/amphenol connector position being an IEC60320 16-20 Amp socket.

## 2.4 Gas-ballast

To pump high vapour loads, gas-ballast is delivered into the pump to prevent condensation of the vapour carried by the pumped gases.

Air (or another gas) can be introduced into the low vacuum stage through the gas-ballast control. The gas-ballast control is a multi-turn valve which can be adjusted, as required, between closed and fully open.

## 3. Technical data

### 3.1 Operating and storage conditions

 **Note:**

To comply with EN 61010 and CSA standards, the pump must be installed and used indoors and within the operating conditions specified in [Table: Operating and storage conditions](#).

**Table 1 Operating and storage conditions**

| Parameter                                    | Reference data      |
|--|---------------------|
| Ambient temperature range (operation)        | 13 to 40 °C         |
| Ambient temperature range (storage)          | - 30 to 70 °C       |
| Normal surface temperature of the pump-body* | 45 to 65 °C         |
| Maximum humidity (operation)                 | 90% RH              |
| Maximum altitude (operation)                 | 2000 m              |
| Pollution degree                             | 2                   |
| Installation category                        | II                  |
| Noise level at 1 metre                       | 57 dB(A) (at 50 Hz) |
| Vibration severity†                          | Class 1C            |

\* At ultimate vacuum, with ambient temperature of 20 °C.

† Measured at the inlet port to ISO 2372 (1974).

### 3.2 Performance

 **Note:**

Where total pressures are shown in [Figure: Dimensions \(mm\)](#) below, measurements were taken using an untrapped total pressure capacitance diaphragm gauge on a header, as specified by Pneurop standards.

**Table 2 Performance data**

| Parameter                       | E2M28                               | E2M30    |
|---------------------------------|-------------------------------------|----------|
| 50 Hz electrical supply         | 32.2 m <sup>3</sup> h <sup>-1</sup> | 19 cfm   |
| 60 Hz electrical supply         | 38.9 m <sup>3</sup> h <sup>-1</sup> | 23 cfm   |
| Maximum pumping speed - Pneurop |                                     |          |
| 50 Hz electrical supply         | 27.5 m <sup>3</sup> h <sup>-1</sup> | 16.2 cfm |
| 60 Hz electrical supply         | 33.0 m <sup>3</sup> h <sup>-1</sup> | 19.4 cfm |
| Motor rotational speed          |                                     |          |

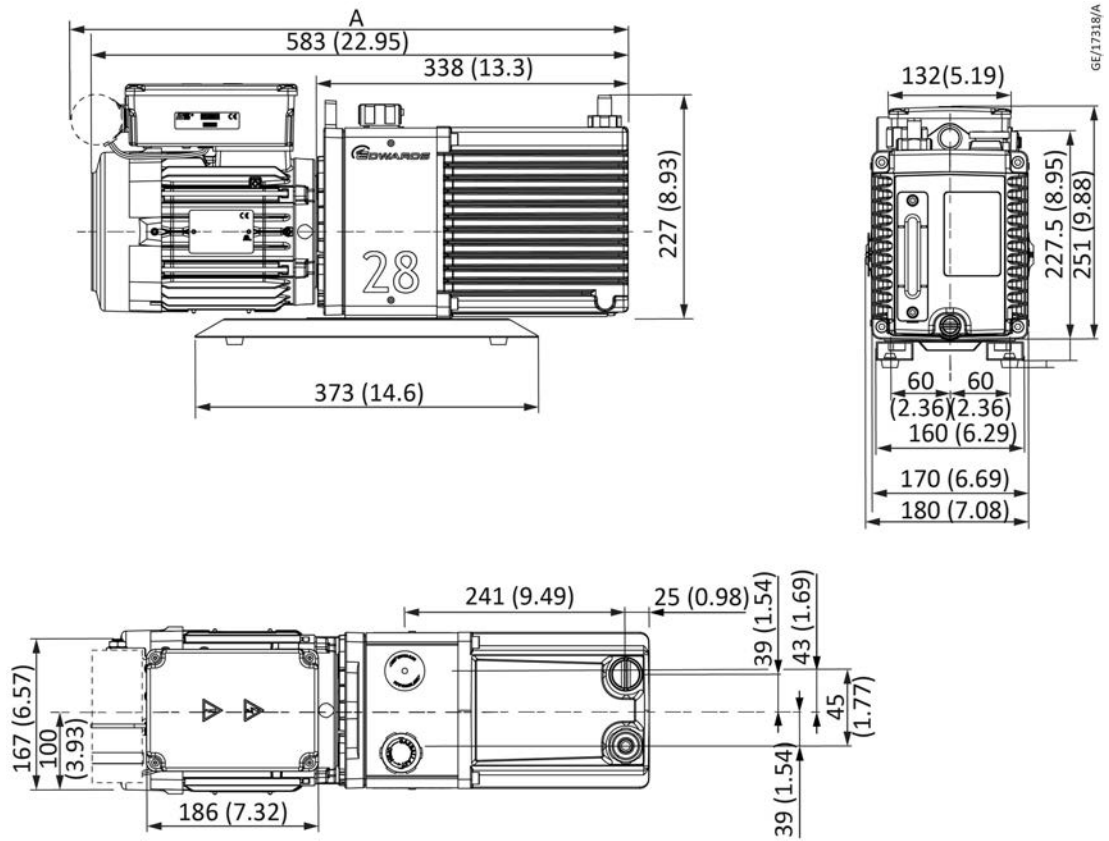
| Parameter  | E2M28   | E2M30   |
|--|---|---|
| 50 Hz electrical supply                                      | 1440 r min <sup>-1</sup>                                      | 1440 r min <sup>-1</sup>                                      |
| 60 Hz electrical supply                                      | 1720 r min <sup>-1</sup>                                      | 1720 r min <sup>-1</sup>                                      |
| Ultimate vacuum  |   |   |
| without gas-ballast (partial pressure)                       | 1 x 10 <sup>-4</sup> mbar<br>1 x 10 <sup>-2</sup> Pa          | 7 x 10 <sup>-5</sup> torr                                     |
| without gas-ballast (total pressure)                         | 1 x 10 <sup>-3</sup> mbar<br>1 x 10 <sup>-1</sup> Pa          | 7 x 10 <sup>-4</sup> torr                                     |
| with full gas-ballast (partial pressure)                     | 2 x 10 <sup>-1</sup> mbar<br>2 x 10 <sup>1</sup> Pa           | 1.5 x 10 <sup>-1</sup> torr                                   |
| Maximum water vapour inlet pressure                          | 30 mbar<br>3 x 10 <sup>3</sup> Pa                             | 22.5 torr   |
| Maximum water vapour pumping rate                            | 0.7 kg h <sup>-1</sup>  | 0.7 kg h <sup>-1</sup>  |
| Maximum permitted outlet pressure (for full pump throughput) | 0.5 bar gauge<br>1.5 bar absolute<br>1.5 x 10 <sup>5</sup> Pa | 0.5 bar gauge<br>1.5 bar absolute<br>1.5 x 10 <sup>5</sup> Pa |

### 3.3 Mechanical data

*Table 3 Mechanical data*

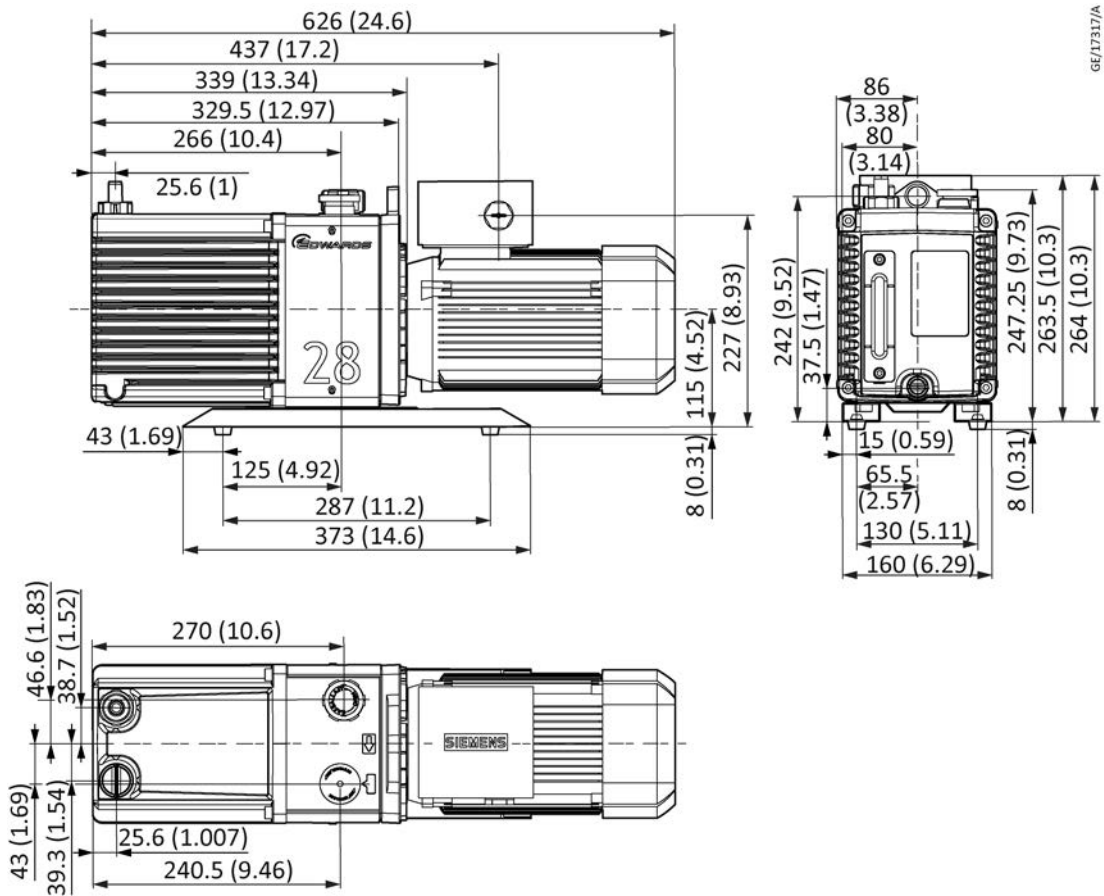
| Parameter             | Data   |
|-----------------------|--|
| Approximate pump mass | 44 kg  |
| Dimensions            | Refer to <a href="#">Figure: Dimensions (mm)</a>   |
| Degree of protection  |  |
| Single-phase motors   | IP44   |
| Three-phase motors    | IP54   |
| Pump inlet port       | NW25 (the flange can be removed from the 1 inch BSP threaded hole)                             |
| Pump outlet port      | 15 mm external diameter nozzle (the nozzle can be removed from the 3/4 inch BSP threaded hole) |

Figure 2 Single-phase motors: Dimensions mm (Inches)



| Pump part number ending | Frequency (Hz) | Dimensions (mm) |
|-------------------------|----------------|-----------------|
|                         |                | A               |
| 903, 930                | 50/60          | -               |
| 904, 984                |                | 611             |

**Figure 3** Three-phase motors: Dimensions mm (Inches)



### 3.4 Lubrication data

**Note:**

Manufacturers Material Safety Data Sheets for the oils specified below are available upon request.

**Table 4** Lubrication data

| Hydrocarbon pumps:        |                             |
|---------------------------|-----------------------------|
| Recommended oil*          | Ultragrade 19               |
| Maximum oil capacity      | 1.32 litres                 |
| PFPE - prepared EM pumps: |                             |
| Recommended oil*          | Krytox 1506 or Fomblin O6/6 |
| Maximum oil capacity      | 1.32 litres                 |

\* To operate the pump when the ambient temperature is outside the range specified in [Operating and storage conditions](#) on page 13, or to optimise pump performance when processing condensable vapours, a different oil may be used.



### 3.5 Electrical data

Refer to [Table: Electrical data: three-phase motors](#) and [Table: Electrical data: single-phase motors](#). For motor current information please refer to the motor rating plate. The motor start-up current is drawn for less than one second, so time-lag fuses must be used to prevent unnecessary fuse failure when the pump starts. Fuses should be to EN60269. If using the pump at temperatures lower than 13 °C, the start-up current will be drawn for longer; this may cause the motor thermal overload device to open.

**Table 5 Electrical data: single-phase motors**

| Pump part number ending | Nominal supply (V) | Frequency (Hz) | Mechanical power (W) | Full load current (A) | Recommended supply protection (A) |
|-------------------------|--------------------|----------------|----------------------|-----------------------|-----------------------------------|
| 903, 930                | 200                | 50             | 750                  | 5                     | 32                                |
|                         | 230                | 50             | 750                  | 4.5                   | 32                                |
|                         | 230                | 60             | 900                  | 5.5                   | 32                                |
|                         | 240                | 60             | 900                  | 5                     | 32                                |
| 904                     | 100                | 50             | 750                  | 9.7                   | 40                                |
|                         | 200                | 50             | 750                  | 4.9                   | 32                                |
|                         | 100                | 60             | 900                  | 11.4                  | 40                                |
|                         | 200                | 60             | 900                  | 5.7                   | 32                                |
| 984                     | 100                | 50             | 750                  | 9.7                   | 40                                |
|                         | 200                | 50             | 750                  | 4.9                   | 32                                |
|                         | 220                | 50             | 750                  | 4.5                   | 32                                |
|                         | 230                | 50             | 750                  | 4.4                   | 32                                |
|                         | 100                | 60             | 900                  | 11.4                  | 40                                |
|                         | 110                | 60             | 900                  | 10.2                  | 40                                |
|                         | 120                | 60             | 900                  | 9.2                   | 40                                |
|                         | 200                | 60             | 900                  | 5.7                   | 32                                |
|                         | 220                | 60             | 900                  | 5.1                   | 32                                |
|                         | 240                | 60             | 900                  | 4.7                   | 32                                |

**Table 6 Electrical data: three-phase motors**

| Pump part number ending | Nominal supply (V) | Frequency (Hz) | Mechanical power (W) | Full load current (A) | Recommended supply protection (A) |
|-------------------------|--------------------|----------------|----------------------|-----------------------|-----------------------------------|
| 934                     | 200                | 50             | 750                  | 3.9                   | 6                                 |
|                         | 200                | 60             | 900                  | 3.9                   | 6                                 |
|                         | 380                | 60             | 900                  | 2.2                   | 4                                 |
| 940                     | 380                | 50             | 750                  | 1.8                   | 2                                 |
|                         | 400                | 50             | 750                  | 1.77                  | 2                                 |

| Pump part number ending | Nominal supply (V) | Frequency (Hz) | Mechanical power (W) | Full load current (A) | Recommended supply protection (A) |
|-------------------------|--------------------|----------------|----------------------|-----------------------|-----------------------------------|
|                         | 230                | 60             | 900                  | 3.5                   | 6                                 |
|                         | 460                | 60             | 900                  | 1.76                  | 2                                 |

*Table 7 Recommended cord sets for -984 pump variants and cable specifications*

| Description                                 | Rating   | Coupler type       | Item number |
|---|--|--------------------|-------------|
| Cord set assembly, UK                       | Cable style = H05VV-F, 3 x 1.5 mm <sup>2</sup> , 300 V, 70 °C, maximum length of 2.5 metres<br>Plug type = BS1363 UK plug<br>Appliance coupler = IEC60320 style C19<br>Fuse type = BS1363 10 Amp fuse, to an IEC60320 style    | Straight entry     | A50505003   |
|   |  | Right angled entry | A50505006   |
| Cord set assembly, Europe                   | Cable style = H05VV-F, 3 x 1.5 mm <sup>2</sup> , 300 V, 70 °C, maximum length of 2.5 metres<br>Plug type = European Schuko VDE approved, 16 A 250 V rated with dual earthing contact<br>Appliance coupler = IEC60320 style C19 | Straight entry     | A50506003   |
|   |  | Right angled entry | A50506006   |
| Cord set assembly, USA/Canada (200 - 230 V) | Cable style = SJT, 3 x 14 AWG, 300 V, 90 °C, VW-1 maximum length of 3.0 metres<br>Plug type = NEMA, 6-15P plug<br>Appliance coupler = IEC60320 style C19   |                    | N/A         |

## 4. Installation

### 4.1 Safety



**WARNING:**

Ensure that the installation technician is familiar with the safety procedures which relate to the pump oil and the products handled by the pumping system.



**WARNING:**

If a hydrocarbon oil is used in this pump, do not use the pump to process oxygen in concentrations greater than 25% in volume. If the oxygen concentration is greater than 25%, There is a risk of fire or explosion in the oil-box of the pump.



**WARNING:**

Do not use the pumps to pump hazardous substances.



**WARNING:**

Obey the safety instructions listed below and take note of appropriate precautions. Failure to do so can cause injury to people and damage to equipment. Prevent any part of the human body from coming into contact with the vacuum.

- Wear the appropriate safety clothing when coming into contact with contaminated components is anticipated. Dismantle and clean contaminated components inside a fume cupboard.
- Vent and purge the vacuum system before installation work is started.
- Take suitable precautions to avoid the inhalation of oil mist and excessive skin contact with pump oil, as prolonged exposure can be harmful.
- Disconnect the other components in the pumping system from the electrical supply so that they cannot be operated accidentally.
- Safely route any electrical supply cables so that they cannot accidentally trip people.
- Ensure that the pump is suitable for the application. If in doubt as to the suitability of the pump for the application, refer to our guidelines on vacuum pump and vacuum system safety (refer to the Associated Publication at the end of the contents list at the front of this manual) or contact us for advice.

### 4.2 System design

Consider the following points when designing the pumping system:

- We recommend the use of a foreline vacuum isolation valve to allow the pump to warm up before pumping condensable vapours or if a vacuum needs to be maintained when the pump is not running.

- Avoid high levels of heat input to the pump from the process gases, otherwise the pump may overheat and seize, and cause the motor thermal overload device to open.
- If using the pump in a high ambient temperature with a high gas throughput, the temperature of the pump body may exceed 70 °C. We recommend the use of additional guarding to prevent contact with hot surfaces under these conditions.
- Make sure that the exhaust pipeline cannot become blocked. If an outlet-isolation valve is fitted, make sure the pump cannot be operated with the valve closed.
- Provide for a purge of inert gas when the pumping system is shut down, to dilute dangerous gases to safe concentrations. A suitable gas-ballast control valve for introduction of purge gas into the pump is available as an accessory (refer to [Gas ballast valve](#) on page 49).

Contact our application team for further advice on dilution requirements if required.

### 4.3 Unpack and inspect

1. Remove all packing materials and protective covers and check the pump. If the pump is damaged, notify the supplier and the carrier in writing within three days; state the item number of the pump together with the order number and the supplier's invoice number. Retain all packing materials for inspection. Do not use the pump if it is damaged.
2. Check that the package contains the items listed. If any of these items are missing, notify the supplier within three days.

If the pump is not to be used immediately, replace the protective covers. Store the pump in suitable conditions, as described in [Storage](#) on page 43.

**Table 8 Checklist of items**

| Quantity | Description                            | Check (✓)                |
|----------|--|--------------------------|
| 1        | Rotary vacuum pump                     | <input type="checkbox"/> |
| (1)      | Fitting pack containing the following: |                          |
| 1        | NW25 centring-ring                     | <input type="checkbox"/> |
| 1        | O-ring for centring-ring               | <input type="checkbox"/> |
| 1        | Receptacle connectors*                 | <input type="checkbox"/> |

\* Various sizes: supplied with single-phase motors except for pumps with item numbers A37316903, A37317984 and A37325984.

### 4.4 Locate the pump



#### **WARNING:**

Attach mechanical lifting equipment to the eye on the pump. Failure to do so can result in injury to people or damage to the pump. Refer to [Mechanical data](#) on page 14 for the mass of the pump.

The pump can be either free-standing on its box section skids, or be fixed by bolts through the four fixing holes in the box section skids, or be used with vibration isolators.

For the locations of the fixing holes in the box section skids refer to [Figure: Dimensions \(mm\)](#).

Provide a firm, level platform for the pump. Locate the pump so that the oil-level sight-glass is visible and the oil filler-plug, oil drain-plugs and gas -ballast control are accessible.

If the pump will be located inside an enclosure, make sure that there is adequate ventilation at both ends of the pump, so that the ambient temperature around the pump does not exceed 40 °C. There must be a minimum space of 25 mm between the pump and the enclosure walls.

## 4.5 Fill the pump with oil

Fill the pump with oil as described below. Refer to [Figure: General view of the pump](#) for the item numbers.

1. Remove the oil filler-plug.
2. Pour oil into the pump until the oil-level reaches the MAX mark on the bezel at the top of the oil sight-glass. If the oil-level goes above the MAX mark, remove the oil drain-plug and drain the excess oil from the pump.
3. After a few minutes, recheck the oil-level. If the oil-level is now below the MAX mark, pour more oil into the pump.
4. Refit the oil filler-plug. Tighten the plug firmly by hand. Do not overtighten.

## 4.6 Electrical installation: single-phase motors



### WARNING:

Ensure that the electrical installation of the pump conforms with the local and national safety requirements. The pump must be connected to a suitably fused and protected electrical supply with a suitable earth (ground) point, for recommended cord sets refer to [Lubrication data](#) on page 16.



### CAUTION:

Ensure that the motor is correctly configured for the electrical supply voltage and frequency. If not, damage to the motor can occur.

### Note:

*The pump will restart automatically when the electrical supply is restored after an interruption and when the pump cools after it has overheated. If the pump is not required to restart automatically, use electrical control equipment which must be reset manually.*

Ensure that the electrical supply voltage corresponds with the voltage specified on the motor data plate.

We recommend that connecting the electrical supply to the motor through a starter or circuit breaker that has thermal over-current protection and can be adjusted to suit the full-load current ratings shown on the motor rating plate. The fuse ratings must be calculated by a qualified electrician. The supplier of the thermal over-current protection

device may specify fuse ratings to ensure correct operation of the over-current protection device. Ensure that the fuse used is suitable for the starting currents given on the motor rating plate.

The diameter of the outer sheath of the electrical supply cable must be within the range 7 mm to 10.5 mm. The cable must conform in size and colour coding with the local and national electrical installation regulations. The temperature rating of the cable must be 70 °C or greater.

**Table 9 Motor connection details**

| Pump part number ending | Voltage (V)             | Frequency (Hz) | Connection details: refer to Figure  |
|-------------------------|-------------------------|----------------|--|
| 903, 930                | 200/230                 | 50             | <i>Figure: Single-phase motors: 200/230 V, 50 Hz and 230/240 V, 60 Hz on page 23</i>   |
|                         | 230/240                 | 60             |  |
| 904                     | 100                     | 50/60          | <i>Figure: Single-phase motors: 100 V, 50/60 Hz on page 24</i>   |
|                         | 200                     | 50/60          | <i>Figure: Single-phase motors: 200 V, 50/60 Hz on page 25</i>   |
| 984                     | 100/200/220/230         | 50             | <i>Figure: Motor voltage selection: single-phase motors, 100/200/220/230 V, 50 Hz or 100/110/120/200/220/240 V, 60 Hz on page 26</i> |
|                         | 100/110/120/200/220/240 | 60             |  |

#### 4.6.1 Standard single-phase motors with pump part number ending 903, 904 and 930

1. Remove the cover from the motor terminal box (*Figure: General view of the pump*).
2. Remove the cable-gland from the inside of the terminal-box and fit the cable-gland to the cable leadthrough hole in the side of the terminal-box. Using a tool, tighten to a torque of 5 Nm.
3. Pass the electrical supply cable through the gland.
4. Remove the receptacle connectors from the fitting pack.
5. Fit a ring connector to the earth (ground) wire.
6. Select the correct size of receptacle connectors for the cable wires:
  - Use the red connectors for wire sizes 0.75 to 1.5 mm<sup>2</sup>.
  - Use the blue connectors for wire sizes 1.5 to 2.5 mm<sup>2</sup>.
7. Attach the appropriate connector to the live and neutral wires.
8. Connect the electrical supply cable to the appropriate terminals as shown in:
  - *Figure: Single-phase motors: 200/230 V, 50 Hz and 230/240 V, 60 Hz on page 23*
  - *Figure: Single-phase motors: 100 V, 50/60 Hz on page 24*
  - *Figure: Single-phase motors: 200 V, 50/60 Hz on page 25*
9. Tighten the earth (ground) terminal connection to a torque of 2.13 to 2.87 Nm.
10. Tighten the dome shaped nut on the cable-gland until the outer sheath of the cable is firmly gripped. Using a tool, tighten to a torque of 4 Nm. Do not overtighten.

11. Check that the cable connections are correct, then refit the cover on the motor terminal-box.

#### 4.6.2 Single-phase motors with IEC C20 connector, pump part number ending 984

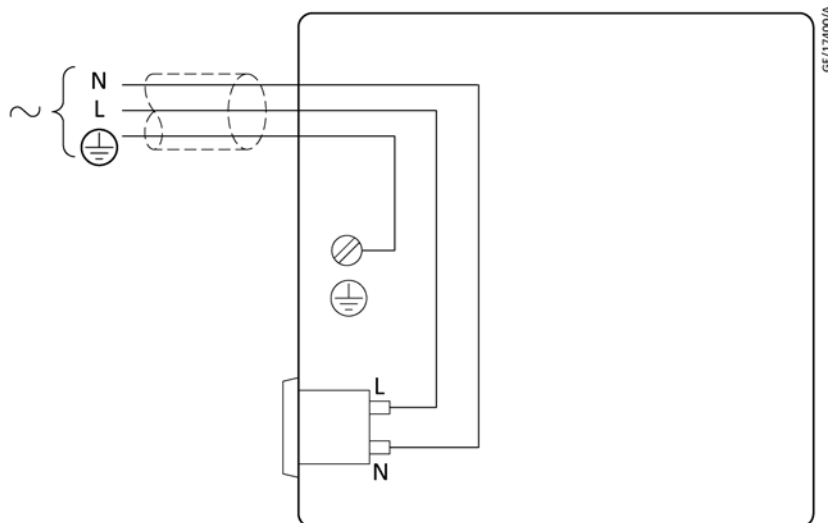
The motor is designed for a single-phase electrical supply and is suitable for 50 Hz and 60 Hz operation. The motor can be manually switched between nominal supply voltages of 110-120 V and 200-240 V.

Use the following procedure to check that the voltage selector switch is correctly positioned for the electrical supply voltage:

1. Refer to [Figure: Motor voltage selection: single-phase motors, 100/200/220/230 V, 50 Hz or 100/110/120/200/220/240 V, 60 Hz](#) on page 26. Undo the four screws securing the terminal box cover and remove the cover.
2. Check the position of the voltage selector switch. If the switch is in the correct position, continue at step 3. If the voltage selector switch is in the wrong position, press the switch to select the alternative position.
3. Refit the terminal box cover and secure with the three screws.

When selecting the mating half of the connector, please ensure that it is compatible (IEC60320 C19 female).

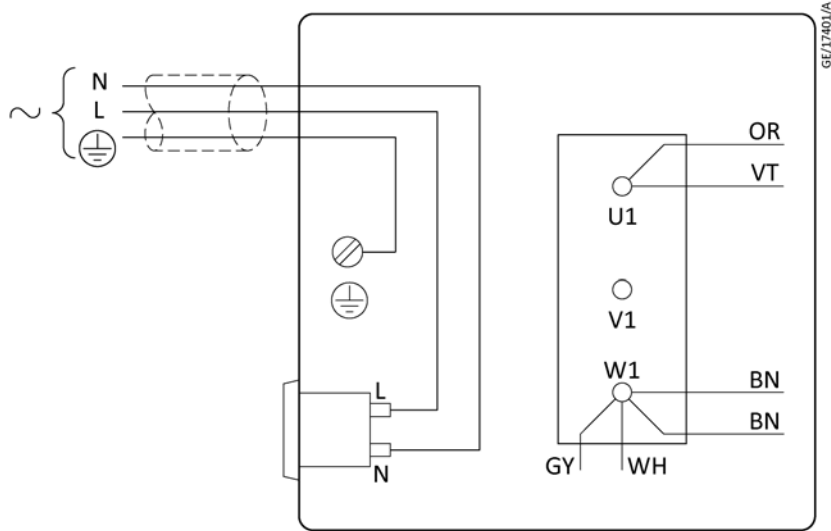
**Figure 4** Single-phase motors: 200/230 V, 50 Hz and 230/240 V, 60 Hz



**Note:**

*For pump part number ending 903, 930.*

**Figure 5** Single-phase motors: 100 V, 50/60 Hz



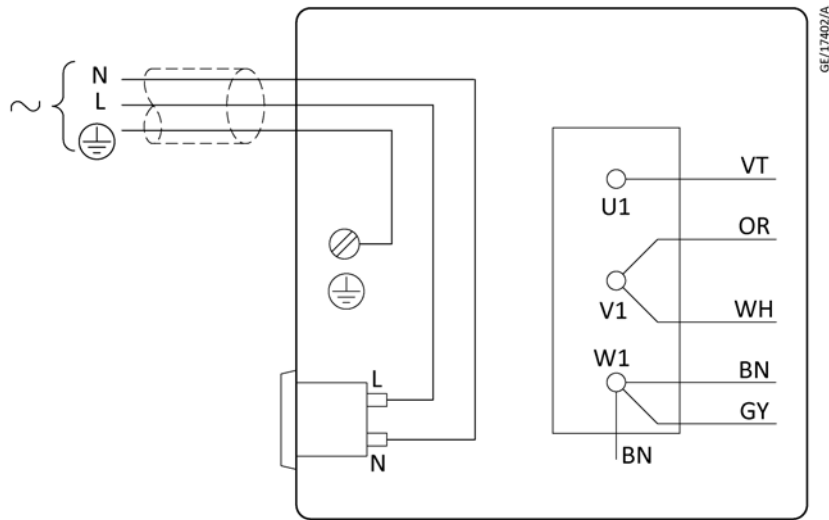
| Wire colour codes: |        |    |        |
|--------------------|--------|----|--------|
| BN                 | Brown  | VT | Violet |
| GY                 | Grey   | WH | White  |
| OR                 | Orange |    |        |

**Note:**

*For pump part number ending 904, low-volt connection.*



**Figure 6** Single-phase motors: 200 V, 50/60 Hz

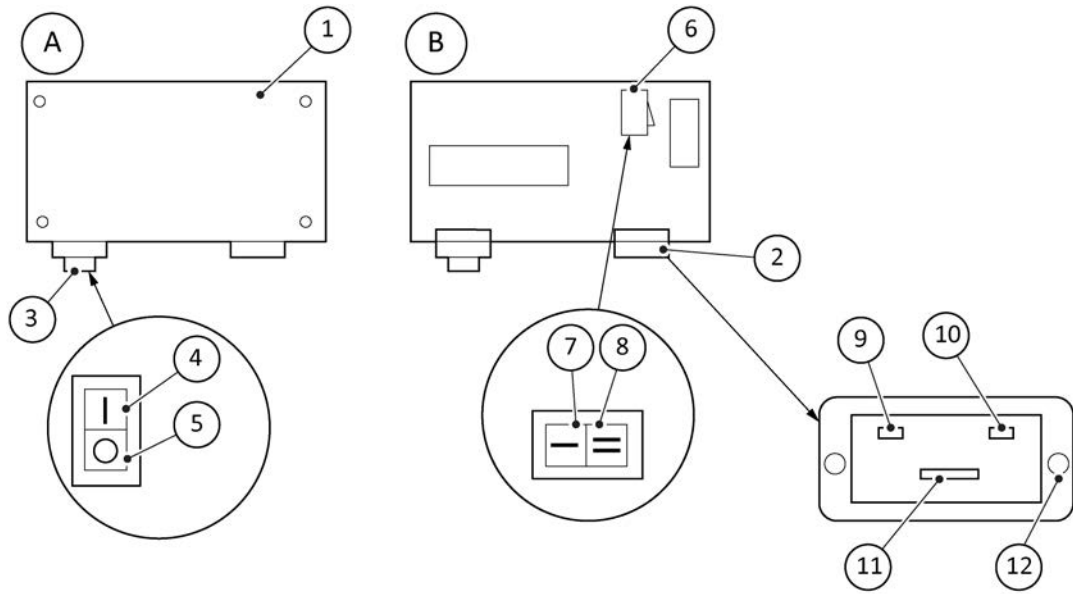


| Wire colour codes: |        |    |        |
|--------------------|--------|----|--------|
| BN                 | Brown  | VT | Violet |
| GY                 | Grey   | WH | White  |
| OR                 | Orange |    |        |

**Note:**

*For pump part number ending 904, high-volt connection.*

**Figure 7** Motor voltage selection: single-phase motors, 100/200/220/230 V, 50 Hz or 100/110/120/200/220/240 V, 60 Hz



GE/17392/A

A. Top view of terminal box

B. Top view of components inside terminal box

| No.                  | Description                                    |
|----------------------|--|
| 1                    | Terminal box cover                             |
| 2                    | IEC 60320 C20 connector                        |
| 3                    | On/Off switch                                  |
| 4                    | Position 'I' (on)                              |
| 5                    | Position 'O' (off)                             |
| 6                    | Voltage selector switch                        |
| 7                    | Position 'I' (low voltage setting 100-120 V)   |
| 8                    | Position 'II' (high voltage setting 200-240 V) |
| 12                   | 2 Torx screws                                  |
| <b>Pin numbering</b> |  |
| 9                    | Live   |
| 10                   | Neutral  |
| 11                   | Earth (Ground)                                 |

**Note:**

For pump part number ending 984.

## 4.7 Electrical installation: three-phase motors

### 4.7.1 Connect the electrical supply to the motor



#### **WARNING:**

Ensure that the electrical installation of your pump-motor conforms with your local and national safety requirements. It must be connected to a suitably fused and protected electrical supply and a suitable earth point.



#### **CAUTION:**

If your pump-motor can be used with more than one voltage range, you must ensure that the motor is configured for your electrical supply voltage. If you do not, you may damage the motor.

#### **Note:**

*The pump will restart automatically when the electrical supply is restored after an interruption. If you do not want the pump to restart automatically, use electrical control equipment which must be reset manually.*

We recommends connecting the electrical supply to the motor through a starter or circuit breaker that has thermal over-current protection and can be adjusted to suit the full-load current ratings shown on the motor rating plate. The fuse ratings must be calculated by a qualified person. The supplier of the thermal over-current protection device may specify fuse ratings to ensure correct operation of the over-current protection device. Ensure that the fuse used is suitable for the starting currents given on the motor rating plate.

The diameter of the outer sheath of the electrical cable must be in the range 10-14 mm. The cable must conform in size and colour coding with local and national electrical installation regulations. The temperature rating of the cable must be 70 °C or greater.

1. Remove the cover from the motor terminal-box.
2. Remove the cable-gland from the inside of the terminal-box and fit the cable-gland to the cable leadthrough hole in the side of the terminal-box. Using a tool, tighten to a torque of 3.75 Nm.
3. For motor wiring information refer to the wiring diagram supplied in the motor terminal box. The dual voltage motors can be configured to operate with either the high range or low range electrical supply.
4. Pass the electrical supply cable through the cable-gland and connect to the appropriate terminals. Tighten the earth (ground) terminal connection to a torque of 2.13 to 2.87 Nm.
5. Tighten the dome shaped nut on the cable gland until the outer sheath of the cable is firmly gripped. Using a tool, tighten to a torque of 2.5 Nm. Do not overtighten.
6. Ensure that the gasket seal for the terminal box cover is correctly positioned, then refit the cover to the terminal-box and secure with the screws.

## 4.7.2 Check the direction of rotation



### CAUTION:

Ensure that the pump-motor rotates in the correct direction. If it does not, the pump and your vacuum system can become pressurised.

1. With the pump inlet unconnected, watch the motor cooling-fan through the motor fan-cover.
2. Switch on the electrical supply to the motor for a few seconds, then switch off the electrical supply again.
3. Check that the motor cooling-fan rotates in the correct direction shown by the arrow on the motor mounting plate. If the direction of rotation is incorrect:
  - a. Switch off the electrical supply immediately.
  - b. Isolate the pump from the electrical supply.
  - c. Remove the terminal-box cover and swap wires L1 and L3: refer to the wiring diagram supplied in the motor terminal box.
  - d. Refit the cover to the terminal-box.

## 4.8 Connect the pump inlet

Take note of the following information when connecting the pump to the vacuum system. Refer to [Accessories](#) on page 46 for details of the accessories mentioned below.

- For optimum pumping speeds, ensure that the pipeline connected to the inlet-port is as short as possible and has an internal diameter not less than the inlet-port diameter.
- Support the vacuum pipelines to prevent loading of the coupling-joints.
- If necessary, incorporate flexible bellows in the system pipelines to reduce the transmission of vibration and to prevent loading of coupling-joints. If you are using flexible bellows, ensure that bellows are used which have a maximum pressure rating which is greater than the highest pressure that can be generated in the system. It is recommended that manufacturers flexible bellows are used.
- Use a suitable inlet catchpot if pumping condensible vapours or if using the pump for very dusty applications.
- Ensure that sealing surfaces are clean and scratch-free.

Connect the vacuum system to the inlet-port (*Figure: General view of the pump*). To make this connection:

- Connect to the NW25 flange supplied: use the NW25 centring-ring and O-ring supplied.
- Remove the NW25 flange and connect to the 1 inch BSP threaded hole.
- Use an NW25 to 28 mm bore tube adaptor available as an optional accessory, refer to [Pump inlet adaptor](#) on page 49.

## 4.9 Connect the pump outlet



### WARNING:

Connect the pump outlet to a suitable treatment plant to prevent the discharge of dangerous gases and vapours to the surrounding atmosphere. Use a catchpot to prevent the drainage of contaminated condensate back into the pump.

The exhaust system must be configured so that the maximum pressure at the pump outlet does not exceed 0.5 bar gauge (1.5 bar absolute,  $1.5 \times 10^5$  Pa) at full pump throughput.

We recommend fitting an oil mist filter to the pump outlet in the following circumstances:

- When using the pump with the gas-ballast control open.
- When operating the pump with an inlet pressure greater than 10 mbar for extended periods.
- When frequently pumping down from atmospheric pressure.

The mist filter will trap the oil exhausted from the pump: the oil can be reused if it is not contaminated.

To connect the pump to the outlet accessories or to the exhaust treatment plant:

- Connect 15 mm internal diameter vacuum or plastic hose to the outlet nozzle (*Figure: General view of the pump*).
- Remove the outlet nozzle and connect to the 3/4 inch BSP threaded hole.
- Remove the outlet nozzle and replace it with an NW25 flange adaptor (available as an optional accessory, refer to *Pump outlet adaptor* on page 49) and then connect to the NW25 flange.

## 4.10 Gas-ballast inlet connection

The position of the gas-ballast inlet is shown in *Figure: General view of the pump*. The gas-ballast inlet has several filters (shown in *Figure: Remove/replace the gas-ballast filter*) to trap any dust and debris if air is used as the gas-ballast supply.

If using a different gas for the gas-ballast supply or to connect a valve to the gas-ballast inlet:

1. Remove the filters (as described in *Clean the gas-ballast filter* on page 38).
2. Connect the gas supply or valve to the 1/4 inch BSP threaded hole.

## 4.11 Leak-test the system

Leak-test the system and seal any leaks found after you have installed the pump, to prevent leakage of substances out of the system and leakage of air into the system.

## 5. Operation



### **WARNING:**

**Do not expose any part of the human body to vacuum. Failure to obey this warning could result in injury.**

#### Note:

*If the pump is PFPE-prepared, refer to [PFPE-prepared EM pumps](#) on page 50.*

### 5.1 ATEX directive implications

This equipment is designed to meet the requirements of Group II Category 3 equipment in accordance with Directive 2014/34/EU of the European Parliament and the Council of 26th February 2014 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres. (The ATEX Directive)

The ATEX Category 3 applies in respect of potential ignition sources internal to the equipment. An ATEX Category has not been assigned in respect of potential ignition sources on the outside of the equipment as the equipment has not been designed for use where there is an external potentially explosive atmosphere.

There is no potential source of ignition within the pump during normal operation but there may be potential sources of ignition under conditions of predictable and rare malfunction as defined in the Directive. Accordingly, although the pump is designed to pump flammable materials and mixtures, operating procedures should ensure that under all normal and reasonably predictable conditions, these materials and mixtures are not within explosive limits. Category 3 is considered appropriate for the avoidance of ignition in the case of a rare malfunction which allows flammable materials or mixtures to pass through the pump whilst within their explosive limits.

#### 5.1.1 Flammable materials



### **WARNING: FLAMMABLE MATERIALS**

**Risk of injury and damage to the equipment. Obey the instructions and take note of the precautions given below to ensure that pumped gases do not enter their flammable ranges.**

When flammable materials are present within the equipment:

- Do not allow air to enter the equipment.
- Ensure that the system is leak tight.
- Use an inert gas purge (for example, a nitrogen purge) to dilute any flammable gases or vapours entering the pump inlet, and/or use an inert gas purge to reduce the concentration of flammable gases or vapours in the pump and in the exhaust pipeline to less than one quarter of the gases' published Lower Explosive Limits (LEL).

- Use an inert gas purge into the pump gas ballast connection to prevent the condensation of flammable vapours within the pump mechanism and exhaust pipeline.

### 5.1.2 Gas purges



#### **WARNING: INERT GAS SUPPLY**

Risk of injury. If using inert gas purges to dilute dangerous gases to a safe level, ensure that the pump is shut down if an inert gas supply fails.



#### **WARNING: FLAMMABLE GAS RANGE**

Risk of injury and damage to the equipment. Obey the instructions and take note of any precautions given below to make sure that pumped gases do not enter their flammable ranges.

Switch on the inert gas purge to remove air from the pump and the exhaust pipeline before the process starts. Switch off the purge flow at the end of the process only after any remaining flammable gases or vapours have been purged from the pump and exhaust pipeline.

If liquids that produce flammable vapours could be present in the pump foreline, then the inert gas purge to the pump should be left on all the time this liquid is present. Flammable liquids could be present in the foreline as a result of condensation or may be carried over from the process.

When calculating the flow rate of inert gas required for dilution, consider the maximum flow rate for the flammable gases/vapours that could occur. For example, if a mass flow controller is used to supply flammable gases to the process, assume a flow rate for flammable gases that could arise if the mass flow controller is fully open.

Continually measure the inert gas purge flow rate: if the flow rate falls below that required, stop the flow of flammable gases or vapours into the pump.

#### **Note:**

*We recommend obtaining and reading the Vacuum Pump and Vacuum System Safety manual (publication number P40040100), available from us or the supplier.*

## 5.2 Gas-ballast control

Use the gas-ballast control (refer to [Figure: General view of the pump](#)) to change the flow of gas-ballast into the low vacuum stage of the pump, and to provide an additional oil-feed to the pump mechanism.

Use the gas-ballast control closed:

- To achieve ultimate vacuum.
- To pump dry gases.

Turn the gas-ballast control six turns anti-clockwise to open it fully. Use the gas-ballast control open:

- To pump high concentrations of condensable vapour.

- To decontaminate the oil.

When operating the pump with the gas-ballast control open, there will be an increased rate of oil loss from the pump. Ideally, a mist filter and oil return kit should be used on clean applications.

## 5.3 Start-up



### **WARNING:**

**Do not block the pump outlet or allow the outlet pressure to rise above 1.5 bar absolute. The oil box may fracture and may cause injury to people nearby.**

If the oil is contaminated, or if the pump temperature is below 13 °C, or if the electrical supply voltage is more than 10% below the lowest voltage specified for the pump, the pump may operate at a reduced speed for a few minutes. On single-phase pumps, if the pump continues to operate at reduced speed, the motor thermal overload device will open and stop the pump. When the motor has cooled, the thermal overload device will reset automatically and the pump will restart.

1. Check that the pump oil-level is between the MAX and MIN marks on the bezel of the oil-level sight-glass; if it is not, refer to [Check the oil level](#) on page 36.
2. Turn the gas-ballast control to the required position (refer to [Gas-ballast control](#) on page 31).
3. Switch on the electrical supply to the pump.
4. Check that the oil-level in the sight-glass drops slightly (by 3 to 5 mm) after start-up. This shows that the pump has primed with oil.
5. If the pump fails to prime, operate the pump with the inlet open to atmosphere for approximately 30 seconds. Then isolate the inlet and check that the oil-level drops by 3 to 5 mm.
6. To achieve ultimate vacuum, pump condensable vapours or decontaminate the pump oil, refer to the procedures in [To achieve ultimate vacuum](#) on page 32, [To pump condensable vapours](#) on page 33 and [To decontaminate the oil](#) on page 33 respectively. Otherwise, open the vacuum system isolation-valve.

## 5.4 To achieve ultimate vacuum

If the pump does not achieve the performance specified in Performance, make sure that this is not due to the system design before you contact supplier or us for advice, In particular, the vapour pressure of all materials used in the vacuum system (including pump oil) must be much lower than the specified ultimate vacuum of the pump.

Refer to [The pump fails to achieve specified performance \(failure to reach ultimate vacuum\)](#) on page 41 for a list of possible causes for failure to achieve the specified performance, note however that the most common causes are:

- Pressure measurement technique or gauge head is unsuitable or the gauge head is faulty.
- Use of an oil other than the recommended oil and the vapour pressure of the oil is higher than the specified ultimate vacuum of the pump.

Use the following procedure to achieve ultimate vacuum:



1. Mechanically isolate the pump from the vacuum system.
2. Turn the gas-ballast control fully anti-clockwise (fully open) and operate the pump for at least 1 hour (or overnight) to thoroughly purge the oil of contaminants.
3. Close the gas-ballast control.
4. Open the vacuum system isolation-valve and pump down to ultimate vacuum.

## 5.5 To pump condensable vapours

Use gas-ballast (open the gas-ballast control) when there is a high proportion of condensable vapours in the process gases:

1. Close the vacuum system isolation-valve.
2. Turn the gas-ballast control anti-clockwise to fully open and operate the pump for 30 minutes to warm the oil, this will help to prevent vapour condensation in the pump.
3. Open the vacuum system isolation-valve and continue to operate the pump with the gas-ballast control open.

After pumping condensable vapours, decontaminate the oil (if necessary), use the procedure in [To decontaminate the oil](#) on page 33.

## 5.6 To decontaminate the oil

The oil in the pump should be clear. If the oil is cloudy or discoloured, it is contaminated with process vapours.

1. Look at the condition of the oil in the oil sight-glass ([Figure: General view of the pump](#)). If the oil is cloudy or discoloured, continue with the procedure at step 2 below.
2. Close the vacuum system isolation-valve.
3. Turn the gas-ballast control fully anti-clockwise.
4. Operate the pump until the oil is clear.

## 5.7 Unattended operation

The pump is designed for unattended operation under the normal operating conditions specified in [Operating and storage conditions](#) on page 13. However, we recommend checking the pump at a regular interval of not more than 14 days; check the pump more frequently if pumping high volumes of gas or if operating the pump with the gas-ballast control open.

Single-phase motors are cooled by internal fans. These motors have a thermal overload device. When the motor is too hot, the thermal overload device switches off the pump. The thermal overload device has an automatic reset; when the motor cools down, the device resets and the motor will restart.

When checking the pump, make sure that the pump is not going through a repetitive cycle of thermal overload failures and automatic resets. If necessary, reduce the thermal load from the pumped gases to prevent overheating of the pump.

## 5.8 Shut-down

 **Note:**

*If the gas-ballast control is open and the motor is switched off for any reason, the pump drive shaft may rotate in the reverse direction, causing a system pressure rise. To prevent this, use a gas-ballast control valve (refer to [Gas ballast valve](#) on page 49).*

We recommend, as described in the procedure below, decontaminating the oil before shutting down the pump; this will prevent damage to the pump by the contaminants in the oil.

1. Refer to [To decontaminate the oil](#) on page 33 and decontaminate the oil, as required.
2. Close the vacuum system isolation-valve (if not already closed).
3. Close gas-ballast (that is, turn the gas-ballast control clockwise).
4. Switch off the electrical supply to the pump.

## 6. Maintenance

### 6.1 Safety information



**WARNING:**

Allow the pump to cool (so that it is at a safe temperature for skin contact) before starting maintenance work. Make sure the pump is switched off in case the thermal overload device restarts the pump.



**WARNING:**

Obey the safety instructions given below and take note of appropriate precautions. Failure to do so can cause injury to people and damage to equipment.



**CAUTION:**

Never use hydrocarbon lubricants in a PFPE-prepared pump.

 **Note:**

*If the pump is PFPE-prepared, refer to [PFPE-prepared EM pumps](#) on page 50.*

- A suitably trained and supervised technician must maintain the pump.
- Ensure that the maintenance technician is familiar with the safety procedures which relate to the pump-oil and the products processed by the pumping-system.
- Isolate the pump and other components in the pumping system from the electrical supply so that they cannot be operated accidentally.
- After maintenance is completed, recheck the pump rotation direction if the electrical supply has been disconnected.
- Do not reuse O-rings and seals if they are damaged.
- The pump and its oil will be contaminated with the process chemicals that have been pumped during operation. Ensure that the pump is decontaminated before maintenance and that adequate precautions are taken to protect people from the effects of dangerous substances if contamination has occurred.
- Leak-test the system after maintenance work is complete if connecting or disconnecting any vacuum or exhaust joints; seal any leaks found.
- Do not touch or inhale the thermal breakdown products of fluorinated materials which may be present if the pump has been heated to 260 °C and above. These breakdown products are very dangerous. Fluorinated materials in the pump may include oils, greases and seals. The pump may have overheated if it was misused, if it malfunctioned or if it was in a fire. Manufacturers Material Safety Data sheets for fluorinated materials used in the pump are available on request: contact supplier or us.

## 6.2 Maintenance plan

The plan shown in [Table: Maintenance plan](#) details the routine maintenance operations necessary to maintain the pump in normal use. Instructions for each operation are given in the section shown.

More frequent maintenance may be required if the pump is used to process corrosive or abrasive gases and vapours, in these circumstances, we recommend you to replace the pump seals every year. If necessary, adjust the maintenance plan according to experience.

When carrying out maintenance on the pump, use our spares and maintenance kits, these contain all the components necessary to complete maintenance operations successfully. The item numbers of the spares and kits are given in [Spares](#) on page 45.

Examine the condition of any external accessory, filters or traps (if fitted) when carrying out maintenance on the pump. Refer to the instructions supplied with these accessories for the necessary maintenance procedures.

**Table 10 Maintenance plan**

| Operation   | Frequency                              | Refer to section  |
|---|--|---|
| Check the oil level   | As required; at least monthly          | <a href="#">Check the oil level</a> on page 36                          |
| Replace the oil   | 3 to 6 months depending on application | <a href="#">Replace the oil</a> on page 37                              |
| Inspect and clean the inlet filter                              | Every oil change                       | <a href="#">Inspect and clean the inlet-filter</a> on page 37           |
| Clean or replace the gas-ballast filter                         | Yearly                                 | <a href="#">Clean the gas-ballast filter</a> on page 38                 |
| Clean the motor fan-cover and enclosure                         | Yearly                                 | <a href="#">Clean the motor fan-cover and enclosure</a> on page 39      |
| Clean and overhaul the pump and replace the blades as necessary | 3 to 4 years depending on application  | <a href="#">Clean and overhaul the pump</a> on page 39                  |
| Replace the run capacitor                                       | Every 4 years                          | <a href="#">Replace the run capacitor and test the motor</a> on page 39 |
| Test the motor condition  | Every 4 years                          | <a href="#">Replace the run capacitor and test the motor</a> on page 39 |
| Fit new blades  | Every 30000 hours of operation         | <a href="#">Fit new blades</a> on page 40                               |

## 6.3 Check the oil level

 **Note:**

1. If required, it is possible to check the oil-level while the pump is operating, however the pump must be switched off. Isolate the pump and other components in the pumping system from the electrical supply before pouring oil into the pump.

2. Do not mix hydrocarbon lubricants with PFPE or vice versa. If the oil is mixed, drain and refill with clean oil as described in [Replace the oil](#) on page 37.

Refer to *Figure: General view of the pump* for the items in brackets.

1. Check that the oil-level in the oil sight-glass is between the MAX and MIN level marks on the bezel of the oil sight-glass.
2. If the oil-level is near to or below the MIN level mark, remove the oil filler-plug and pour more oil into the reservoir until the oil reaches the MAX level mark. If the oil-level goes above the MAX mark, remove the oil drain-plug and drain the excess oil from the pump. Refit the oil drain-plug. Refit the oil filler-plug.
3. If the oil is contaminated, drain and refill the pump with clean oil as described in *Replace the oil* on page 37.

## 6.4 Replace the oil

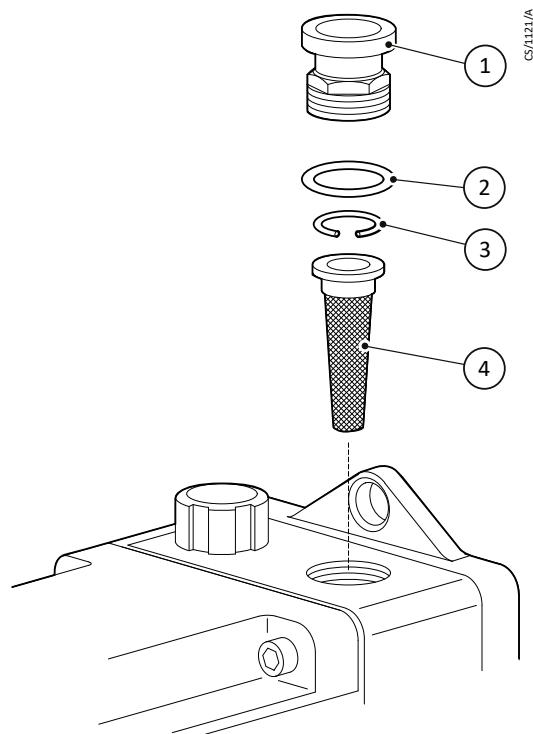
Refer to *Figure: General view of the pump* for the items in brackets.

1. Operate the pump for approximately ten minutes to warm the oil, then switch off the pump. (This lowers the viscosity of the oil and allows the oil to be drained from the pump more easily).
2. Isolate the pump from the electrical supply and disconnect it from the vacuum system.
3. Remove the oil filler-plug.
4. Place a suitable block under the pump-motor to tilt the pump and place a suitable container under the oil drain-plug (gravity drain). Remove the oil drain-plug and allow the oil to drain into the container.
5. If the oil is dirty or contaminated:
  - Refit the oil drain-plug and pour clean oil into the pump.
  - Reconnect the pump to the electrical supply and operate the pump for about 5 to 10 minutes.
  - Disconnect the pump from the electrical supply, remove the oil drain-plug and allow the oil to drain out of the pump.
  - Repeat this step until the oil reservoir is clean.
6. Refit the oil drain-plug, remove the block and reconnect the pump to the vacuum system.
7. Fill a suitable container with clean oil and pour the oil into the filler hole until the oil-level reaches the MAX level mark on the bezel of the oil sight-glass.
8. Allow a few minutes for the oil to drain into the pump. If necessary, add more oil. Refit the oil filler-plug.

## 6.5 Inspect and clean the inlet-filter

Refer to *Figure: Remove/replace the inlet filter*.

1. Unscrew the inlet adaptor and remove the O-ring, circlip and inlet-filter.
2. Wash the filter in a suitable cleaning solution. Allow the filter to dry.
3. Refit the inlet-filter, circlip, O-ring and inlet adaptor.

**Figure 8** Remove/replace the inlet filter

1. Inlet adaptor
3. Circlip

2. O-ring
4. Inlet-filter

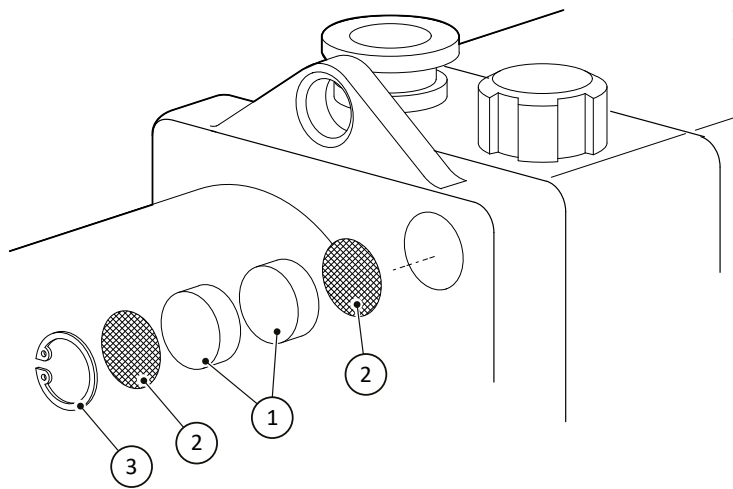
## 6.6 Clean the gas-ballast filter

### Note:

*The gas-ballast filter may have been removed to connect a gas supply or valve to the gas-ballast inlet.*

Refer to [Figure: Remove/replace the gas-ballast filter](#).

1. Remove the retainer circlip.
2. Remove the protective wire mesh and filter elements.
3. Wash the wire mesh and filter in a suitable cleaning solution. Allow the wire mesh and filter to dry before replacing them in the pump.
4. Refit the wire mesh and filter element in the adaptor plate housing and retain with the retainer circlip.

**Figure 9** Remove/replace the gas-ballast filter

1. Filter element
3. Retainer circlip

2. Wire mesh

## 6.7 Clean the motor fan-cover and enclosure

If the motor fan-cover and enclosure are not kept clean, the air flow over the motor can be restricted and the pump may overheat.

1. Switch off the pump and disconnect it from the electrical supply.
2. Use a dry cloth and a brush to remove dirt and deposits from the fan-cover and enclosure.

## 6.8 Clean and overhaul the pump

Clean and overhaul the pump as described in the instructions supplied with the clean and overhaul kit (see [Spares and accessories](#) on page 45).

## 6.9 Replace the run capacitor and test the motor



### **WARNING:**

**Change the run capacitor as per the maintenance plan.**

Replace the run capacitor as described in the instructions supplied with the capacitor kit. Refer to [Table: Capacitor kits, Spares](#) on page 45.

Test the earth (ground) continuity and the insulation resistance of the pump-motor, in accordance with local regulations for periodic testing of electrical equipment. We recommends that:

- The earth (ground) continuity is less than 0.1  $\Omega$ .
- Insulation resistance is greater than 10 M $\Omega$ .

If the motor fails these tests, replace the motor.

## 6.10 Fit new blades

Fit new blades to the pump as described in the instructions supplied with the blade kit (see *Spares and accessories* on page 45).



## 7. Fault finding

A list of fault conditions and their possible causes is provided in the following sections to assist in basic fault-finding. If unable to rectify a fault when using this guide, call the supplier or our nearest service centre for advice.

### 7.1 The pump has failed to start

- The electrical supply fuse has failed.
- The motor is incorrectly wired.
- The operating voltage does not match that of the motor.
- The exhaust filter or exhaust line is blocked.
- The oil temperature is below 13 °C.
- The oil is too viscous.
- The oil is contaminated.
- The pump is seized after long storage or has been left to stand after pumping contaminants.
- The motor is faulty.

### 7.2 The pump fails to achieve specified performance (failure to reach ultimate vacuum)

- The measuring technique or gauge is unsuitable.
- There is a leak in the external vacuum system.
- The gas-ballast control is open.
- The oil level is too low.
- The pump has been filled with the wrong type of oil.
- The oil is contaminated.
- The pump has not primed.
- The vacuum fittings are dirty.
- The inlet-filter is blocked.
- The pump has not warmed up.
- The motor shaft rotates in the wrong direction.

### 7.3 The pump is noisy

- The motor fan-cover is damaged.
- The coupling and fan assembly are poorly adjusted.
- The motor coupling is loose.
- The motor bearings are worn.
- The oil is contaminated with solid particles.
- One of the pump blades is sticking.

## **7.4 The pump surface temperature is above 100 °C**

- The ambient temperature is too high.
- The cooling-air supply is insufficient or is too hot.
- The cooling-air supply is blocked.
- The electrical supply voltage is too high.
- The exhaust filter or exhaust line is blocked.
- The oil level is too low.
- The pump is filled with the wrong type of oil.
- The oil is contaminated.
- The process gas is too hot or the throughput is too high.

## **7.5 The vacuum is not maintained after the pump is switched off**

- The gas-ballast control is open.
- O-ring(s) are damaged or missing.
- The shaft seals have deteriorated.

## **7.6 The pumping speed is poor**

- The connecting pipelines are too small in diameter.
- The connecting pipelines are too long.
- The inlet-filter is blocked.

## **7.7 There is an external oil leak**

- The oil pump shaft seal is worn or damaged.
- The oil box gasket has deteriorated.
- There is an oil leak from gas-ballast control.
- There is an oil-leak from the drain-plug.

## 8. Storage



### CAUTION: STORAGE SAFETY

Risk of pump damage. Observe the storage temperature limits stated in *Technical data* on page 13. Storage below - 30 °C will permanently damage the pump seals.

#### Note:

*If you will store a new pump in conditions of high humidity, remove the pump from its cardboard packaging box, dispose of the box (refer to *Disposal* on page 44).*

Use the following procedure to store the pump:

1. Ensure that the pump has been shut-down as described in Operation.
2. Isolate the pump from the electrical supply.
3. Purge your vacuum system and the pump with dry nitrogen and disconnect the pump from your vacuum system.
4. Replace the oil as described in *Replace the oil* on page 37.
5. Place and secure protective covers over the inlet and outlet-ports.
6. Store the pump in cool, dry conditions until required for use.
7. When required, prepare and install the pump as described in Installation. If the pump has been stored for more than a year, before you install the pump you must clean and overhaul it as described in the instruction supplied with the clean and overhaul kit.

## 9. Disposal

Dispose of the pump, the oil and any components removed from the pump safely in accordance with all local and national safety and environmental requirements.

Particular care must be taken with components and waste oil which have been contaminated with dangerous process substances.

Do not incinerate fluoroelastomer seals and O-rings.

## 10. Spares and accessories

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 comprehensive our training courses.

Order spare parts and accessories from our nearest company or distributor. When ordering, state for each part required:

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

### 10.1 Spares

The maintenance kits listed in contains all the parts required to maintain the pump. The maintenance kits also include instructions for the use of the kits.

Use the clean and overhaul kit for routine maintenance operations. Use the blade kit together with the clean and overhaul kit when renewing the blade assembly in the rotary pump.

*Table 11 Spares item numbers*

| Spare                                | Item number |
|--------------------------------------|-------------|
| Clean and Overhaul kit (Hydrocarbon) | A37301131   |
| Clean and Overhaul kit (PFPE filled) | A37301136   |
| Blade kit                            | A37301135   |
| Ultragrade 19 Oil (4 litres)         | H11025013   |
| Fomblin Grade 06/6 Oil               | H11301016   |

*Table 12 Capacitor kits*

| Motor part number | Capacitance | Colour | Item number |
|-------------------|-------------|--------|-------------|
| A07110028         | 20 $\mu$ F  | White  | A50591813   |
| A07110032         | 80 $\mu$ F  | Silver | A50591800   |
| A07110033         | 80 $\mu$ F  | Silver | A50591800   |
| A07110036         | 20 $\mu$ F  | White  | A50591813   |
| A07110037         | 20 $\mu$ F  | White  | A50591813   |
| A07110039         | 30 $\mu$ F  | White  | A50591814   |
| A07110040         | 80 $\mu$ F  | Silver | A50591800   |

### 10.2 Capacitor selection table

The following table can be used to select the correct capacitor kit if motor and/or pump part numbers are known.

**Table 13 Capacitor kit selection table**

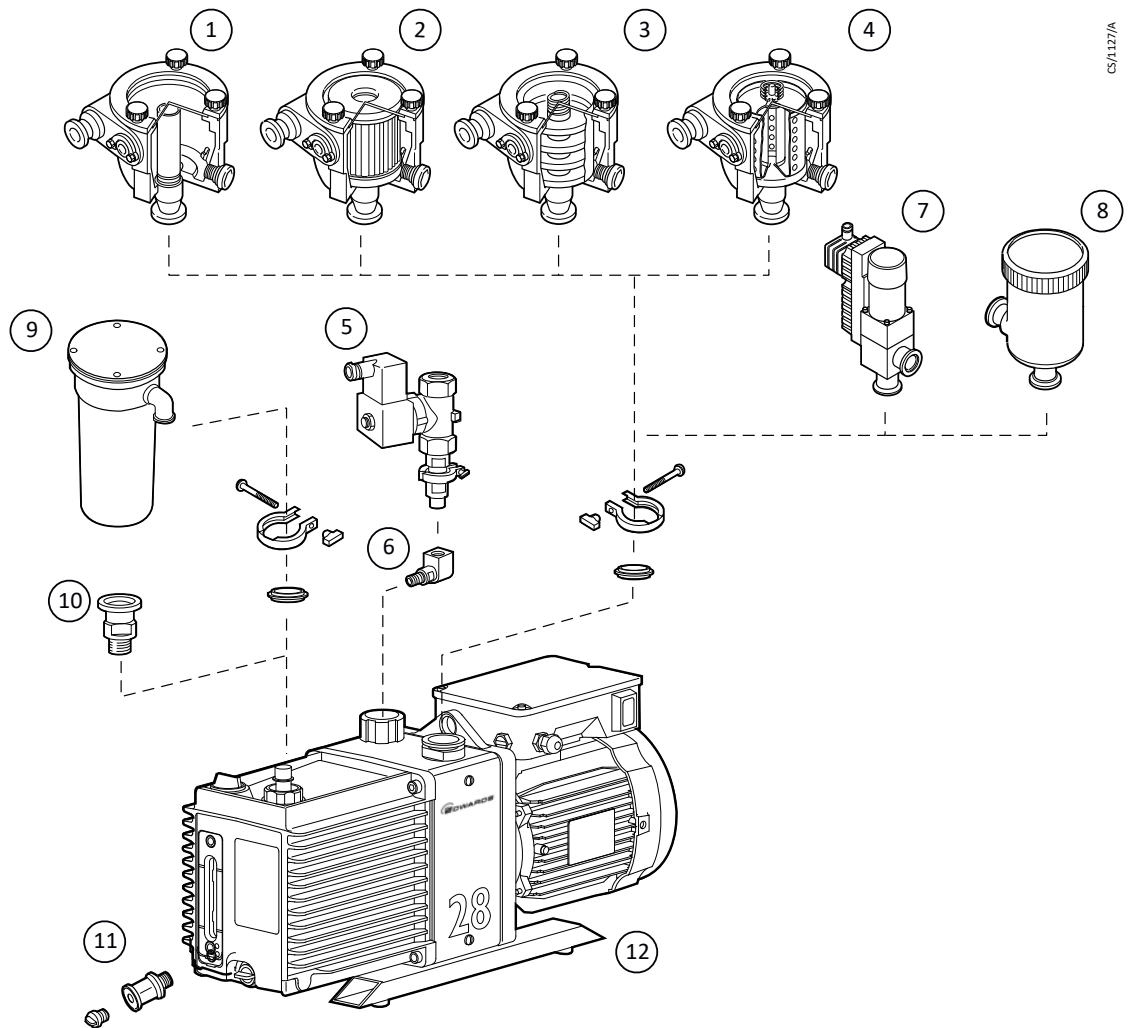
| Pump type | Pump part number | Motor part number | Capacitor kit |
|-----------|------------------|-------------------|---------------|
| E2M28     | A37315903        | A07110028         | A50591813     |
|           | A37315904        | A07110033         | A50591800     |
|           | A37315981        | A07110032         | A50591800     |
|           | A37316903        | A07110036         | A50591813     |
|           | A37317984        | A07110039         | A50591814     |
|           | A37319903        | A07110037         | A50591813     |
|           | A37324904        | A07110040         | A50591800     |
|           | A37324930        | A07110028         | A50591813     |
|           | A37325903        | A07110028         | A50591813     |
|           | A37325984        | A07110039         | A50591813     |
| E2M30     | A37415903        | A07110028         | A50591813     |
|           | A37415904        | A07110033         | A50591800     |
|           | A37415981        | A07110032         | A50591800     |
|           | A37435903        | A07110028         | A50591813     |
|           | N04091000        | A07110028         | A50591813     |

### 10.3 Accessories

A range of accessories is available for the pumps, as shown in [Figure: Accessories](#).

The accessories are briefly described in the following sections. Refer to [Table: Accessory item numbers](#) for the item numbers of these accessories.

Figure 10 Accessories



- |                                     |                         |
|-------------------------------------|-------------------------|
| 1. Inlet catchpot                   | 2. Inlet dust filter    |
| 3. Inlet desiccant trap             | 4. Inlet chemical trap  |
| 5. Gas ballast valve                | 6. Banjo/elbow assembly |
| 7. Solenoid operated pipeline valve | 8. Foreline trap        |
| 9. Outlet mist filter               | 10. NW25 adaptor        |
| 11. Vibration isolators             | 12. Oil drain extension |

Table 14 Accessory item numbers

| Accessory                                  | Item number |
|--|-------------|
| ITO20K Inlet catchpot                      | A44110000   |
| ITF20K Inlet dust filter                   | A44215000   |
| ITD20K Inlet desiccant trap                | A44510000   |
| ITC20K Inlet chemical trap                 | A44410000   |
| EMF30 Outlet mist filter                   | A46233000   |
| PV25EK Valve: 200/240 V, 1-phase, 50/60 Hz | C41301000   |

| Accessory                                  | Item number |
|--|-------------|
| PV25EK Valve: 110/127 V, 1-phase, 50/60 Hz | C41303000   |
| FL20K foreline trap                        | A13305000   |
| Vibration isolators (pack of four)         | A24801412   |
| ODE 1/4 Oil drain extension                | A50503000   |
| Pump inlet adaptor                         | C10520201   |
| Flexible bellows                           | C10511670   |
| Pump outlet adaptor                        | C10501414   |
| Gas ballast banjo elbow assembly           | A50006003   |
| Gas ballast valve: 110 V, 50/60 Hz         | A50006984   |
| Gas ballast valve: 240 V, 50/60 Hz         | A50006930   |

### 10.3.1 Inlet catchpot

The inlet catchpot traps any liquid droplets and prevents their entry into the pump.

### 10.3.2 Inlet dust filter

The inlet dust filter protects the pump against abrasive dust.

### 10.3.3 Inlet desiccant trap

Use a desiccant trap when pumping limited quantities of water vapour at high pumping speeds to a low vapour pressure.

### 10.3.4 Inlet chemical trap

The inlet chemical trap protects the pump against chemically active gases.

### 10.3.5 Outlet mist filter

The outlet mist filter separates and traps oil droplets in the pump outlet to prevent oil mist discharge. The mist filter is supplied with an adaptor to connect it to the pump outlet.

### 10.3.6 Solenoid operated pipeline valve

Fit the pipeline valve between the vacuum system and the pump inlet to provide additional system protection when the pump is switched off.

### 10.3.7 Foreline trap

Use a foreline trap on a clean pumping system to prevent back-migration of rotary pump oil vapour into the vacuum system.



### **10.3.8 Vibration isolators**

The vibration isolators reduce transmission vibration and noise when the pump is floor or frame mounted and help to reduce strain when the mounting area is uneven.

### **10.3.9 Oil drain extension**

Fit the oil drain extension between the oil drain port on the pump and the oil drain-plug to make the drainage of oil from the pump easier.

### **10.3.10 Pump inlet adaptor**

This is a NW25 to 28 mm bore tube adaptor, supplied with connection hardware. Attach this adaptor to the NW25 pump-inlet to connect 28 mm bore plastic or rubber tube.

### **10.3.11 Flexible bellows**

Use flexible bellows to connect the pump-inlet to the vacuum system. We recommend the use of bellows when using vibration isolators.

### **10.3.12 Pump outlet adaptor**

This is a 3/4 inch BSP to NW25 adaptor. Use this adaptor when removing the hose adaptor supplied fitted to the pump outlet to adapt the 3/4 inch BSP thread to NW25 pump inlet.

### **10.3.13 Gas ballast banjo/elbow assembly**

Use this 3/4 inch BSP assembly when a remote ballast supply or gas ballast valve is fitted.

### **10.3.14 Gas ballast valve**

Use this to control the gas-ballast remotely. The gas ballast banjo/elbow assembly will also be required (refer to [Gas ballast banjo/elbow assembly](#) on page 49) when fitting this accessory.

## 11. PFPE-prepared EM pumps

If a PFPE-prepared EM pump has been ordered, the pump will be supplied prepared for use with the manufacturers PFPE mechanical pump oils, such as Fomblin YVAC 06/6 and Krytox 1506.

PFPE-prepared EM pumps are suitable for pumping high concentrations of oxygen.

We recommend referring to publication P40040100 (Vacuum pump and Vacuum System Safety) before installing and using a PFPE-prepared EM pump.

### 11.1 Installation



#### CAUTION:

**Never use hydrocarbon lubricants in a PFPE-prepared pump.**

Installation of a PFPE-prepared EM pump is as specified in [Installation](#) on page 19, but take note of the caution above.

### 11.2 Operation



#### WARNING:

**PFPE-prepared EM pumps are suitable for pumping high concentrations of oxygen, but We recommend that a PFPE-prepared EM pump is not used for the pumping of hazardous materials.**

Operation of a PFPE-prepared EM pump is as specified in [Operation](#) on page 30, but take note of the warning above.

### 11.3 Maintenance



#### WARNING:

**Obey the safety instructions given below and take note of appropriate precautions. Failure to do so can cause injury to people.**

- Take additional care if it is suspected that the pump (and hence the PFPE oil) has overheated.
- Do not touch or inhale the thermal breakdown products of PFPE oil, which may be present, if the pump has been heated to 260 °C and above. PFPE oils are safe in normal use but can decompose into very dangerous substances if they are heated to 260 °C and above. The pump may have overheated if it was misused, if it malfunctioned or if it was in a fire. Safety Data Sheets for PFPE oils used in the pump are available on request: contact us or the supplier.

Fomblin oil has different properties from other pump oils, therefore:

## A37310880\_W - PFPE-prepared EM pumps

- When filling the PFPE-prepared EM pump with Fomblin oil, we recommend regular checks for oil leaks, particularly around the shaft seals.
- If an oil leak is detected, contact us or the supplier for advice.

## 12. Service

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

The local service centre can also provide our engineers to support on-site maintenance, service or repair of the equipment.

For more information about service options, contact the nearest service centre or our other company.

### 12.1 Return the equipment or components for service

Before you send your equipment to us for service or for any other reason, you must complete a Declaration of Contamination Form. The 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.

If you are returning equipment note the following:

- If the equipment is configured to suit the application, make a record of the configuration before returning it. All replacement equipment will be supplied with default factory settings.
- Do not return equipment 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 [edwardsvacuum.com/HSForms/](http://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 form, your equipment cannot be serviced.**



## EU Declaration of Conformity

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

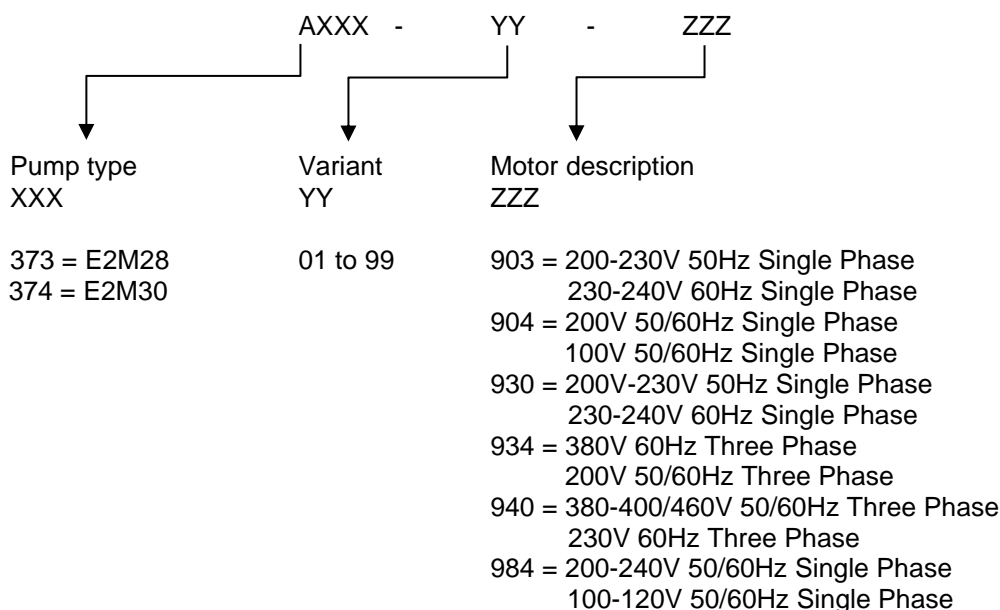
### Edwards Ltd

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West Sussex  
RH15 9TW  
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### Documentation Officer

Jana Sigmunda 300  
Lutín , 78349  
Czech Republic  
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[documentation@edwardsvacuum.com](mailto:documentation@edwardsvacuum.com)

The product specified and listed below



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

- 2006/42/EC      Machinery directive  
*Note: The safety objectives of the Low Voltage Directive 2014/35/EU were complied with in accordance with Annex 1 No. 1.5.1 of this directive.*
  
- 2014/34/EU      ATEX directive on use in potentially explosive atmospheres  
 II 3 G Ex h IIB T4 Gc  
 INTERNAL ATMOSPHERES ONLY  
 TCF 218  
 Only the internal pumping mechanism is classified as ATEX category 3, external parts and motor are not in scope.
  
- 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:

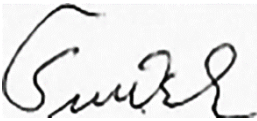
- EN 1012-2:1996 +A1:2009      Compressors and vacuum pumps. Safety requirements. Vacuum pumps
- EN 60034-30:2009              Rotating electrical machines -- Part 30: Efficiency classes of single-speed, three-phase, cage-induction motors (IE-code)

- EN ISO 80079-36:2016 Explosive atmospheres – Part 36: Non-electrical equipment for explosive atmospheres.  
Basic method and requirements
- EN ISO 80079-37:2016 Explosive atmospheres - Part 37: Non-electrical equipment for explosive atmospheres --  
Non-electrical type of protection constructional safety "c", control of ignition sources "b",  
liquid immersion "k"

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: *2024-11-08*

You must retain the signed legal declaration for future reference

This declaration becomes invalid if modifications are made to the product without prior agreement.



*Petr Šmerek – Engineering Manager  
Scientific Vacuum Division, Lutín*



*Jan Večeřa – General Manager  
Lutín, CZ*



## Declaration of Conformity

**Edwards Ltd**

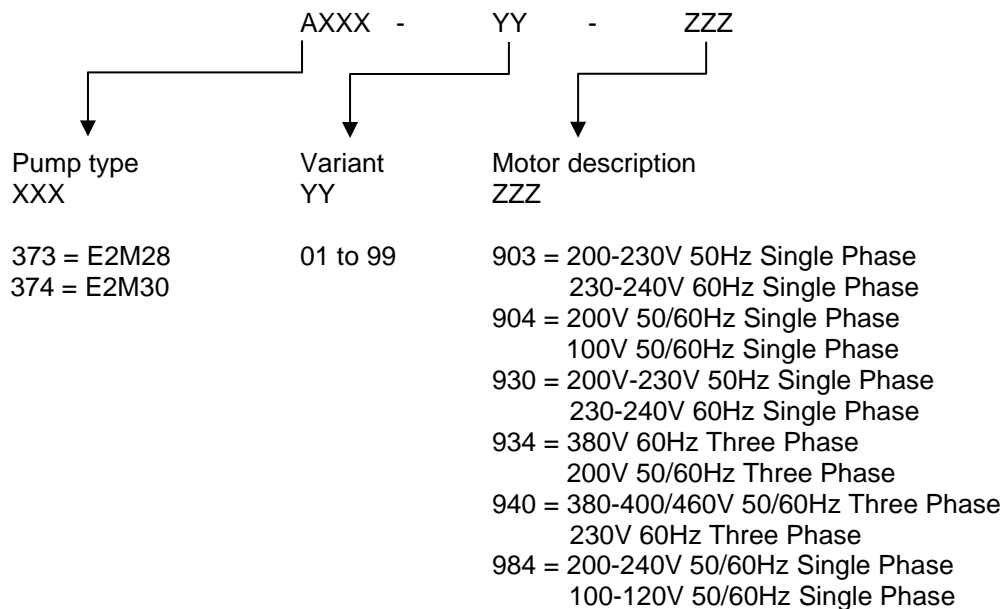
Innovation Drive  
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RH15 9TW  
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**Documentation Officer**

[documentation@edwardsvacuum.com](mailto:documentation@edwardsvacuum.com)

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

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



Supply of Machinery (Safety) Regulations 2008

*The objectives of the Electrical Equipment (Safety) Regulations 2016 are governed by Annex 1 1.5.1 of this regulation.*

Equipment and Protective Systems Intended for use in Potentially Explosive Atmospheres Regulations 2016



II 3 G Ex h IIB T4 Gc

INTERNAL ATMOSPHERES ONLY

TCF 218

Only the internal pumping mechanism is classified as ATEX category 3, external parts and motor are not in scope.

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

Relevant designated standards or technical specifications are as follows:

EN 1012-2:1996 +A1:2009 Compressors and vacuum pumps. Safety requirements. Vacuum pumps

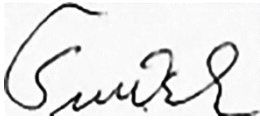
EN 60034-30:2009 Rotating electrical machines -- Part 30: Efficiency classes of single-speed, three-phase, cage-induction motors (IE-code)

|                      |   |
|----------------------|---|
| EN ISO 80079-36:2016 | Explosive atmospheres – Part 36: Non-electrical equipment for explosive atmospheres. Basic method and requirements  |
| EN ISO 80079-37:2016 | Explosive atmospheres - Part 37: Non-electrical equipment for explosive atmospheres -- Non-electrical type of protection constructional safety "c", control of ignition sources "b", liquid immersion "k" |

This declaration, based on the requirements of the listed Statutory Instruments and EN ISO/IEC 17050-1, covers all product serial numbers from this date on: *2024-11-08*

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

**Signed for and on behalf of Edwards Ltd**



*Petr Šmerek – Engineering Manager  
Scientific Vacuum Division, Lutín*



*Jan Večeřa – General Manager  
Lutín, CZ*



## ADDITIONAL LEGISLATION AND COMPLIANCE INFORMATION

### RoHS (EU, UK): Material Exemption Information

This product is compliant with the following Exemptions

Annex III:

- 6(b) **Lead** as an alloying element in aluminium containing up to 0.4% by weight
- 6(c) Copper alloy containing up to 4% **lead** by weight

### REACH (EU, UK)

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

### Article 33.1 Declaration (EU, UK)

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

- Lead (Pb)  
This substance is present in certain aluminium and brass components.

### WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT (EU,UK)


This product must be disposed of in accordance with the requirements of the WEEE Directive.

## Additional Applicable Requirements

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

|  |   |
|--|---|
| CSA-C22.2 No.77-2014   | Motors with inherent overheating protection   |
| CSA-C22.2 No.100-2014  | Motors and generators<br><i>Canadian Standards Authority and Underwriters Laboratory</i>  |
| Product is certified to<br>CSA-C22.2 No.61010-1-12           | Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements<br>CU 72405500, CU 72405499   |
| Product is certified to<br>UL61010-1 3 <sup>rd</sup> Edition | Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements<br>CU 72405500, CU 72405499   |
| IEC 61010-1:2010/AMD1:2016                                   | Safety requirements for electrical equipment for measurement, control and laboratory use Part1: General requirements  |
| EN 61010-1:2010 + A1:2019                                    | Safety requirements for electrical equipment for measurement, control and laboratory use. General requirements<br><i>The pumps comply with EN 61010-1 when installed in accordance with the instruction manual supplied with the pumps.</i> |

材料成分声明  
China Material Content Declaration

| 部件名称<br>Part name<br>  | 有害物质<br>Hazardous Substances |                      |                      |  |  |  |
|---|------------------------------|----------------------|----------------------|--|--|--|
|   | 铅<br>Lead<br>(Pb)            | 汞<br>Mercury<br>(Hg) | 镉<br>Cadmium<br>(Cd) | 六价铬<br>Hexavalent<br>Chromium<br>(Cr VI) | 多溴联苯<br>Polybrominated<br>biphenyls<br>(PBB) | 多溴二苯醚<br>Polybrominated<br>diphenyl ethers<br>(PBDE) |
| 铸铝及铝合金制品<br>Aluminium alloys  | x                            | o                    | o                    | o  | o  | o  |
| 铜接头<br>Brass connectors   | x                            | o                    | o                    | o  | o  | o  |
| <p>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。<br/>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.</p> <p>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。<br/>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.</p> |                              |                      |                      |  |  |  |

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