

**oerlikon**  
leybold vacuum

# **RUVAC**

Roots Vacuum Pumps

Single-Stage

250 - 13 000 m<sup>3</sup> x h<sup>-1</sup> (147 - 7657 cfm)

173.01.02

Excerpt from the Oerlikon Leybold Vacuum Full Line Catalog

Product Section C07

Edition 2010

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# General

## Applications and Accessories

Roots Vacuum Pumps	WA/WAU	WS/WSU	WS/WSU(W) PFPE	WH 700/702	WH/WHU 4400/7000	WSLF	RA
<b>Applications</b>							
Semiconductor production			■	■			
Vacuum coating	■			■	■		■
Large scale research		■			■		■
Chemistry/Pharmaceutical	■						■
Metallurgy/Furnaces	■	■		■	■		■
Lamps and tubes manufacture		■					
Laser engineering						■	
Packaging	■						
Central vacuum supply systems	■	■		■	■		■
Freeze drying	■	■		■			
Leak testing systems		■		■	■		
Electrical engineering	■	■		■	■		■
High purity gases/closed refrigerant cycles		■		■	■		
Mechanical engineering	■	■	■	■	■		■
Automotive industry	■	■	■	■	■		■
<b>Accessories</b>							
	Page						
Frequency converters	C07.09	■	■	■	■	■	■
Pressure switches	C07.42	■	■	■	■	■	■
Temperature sensor PT 100	C07.42	■ <sup>1)</sup>					

<sup>1)</sup> For ATEX pumps only

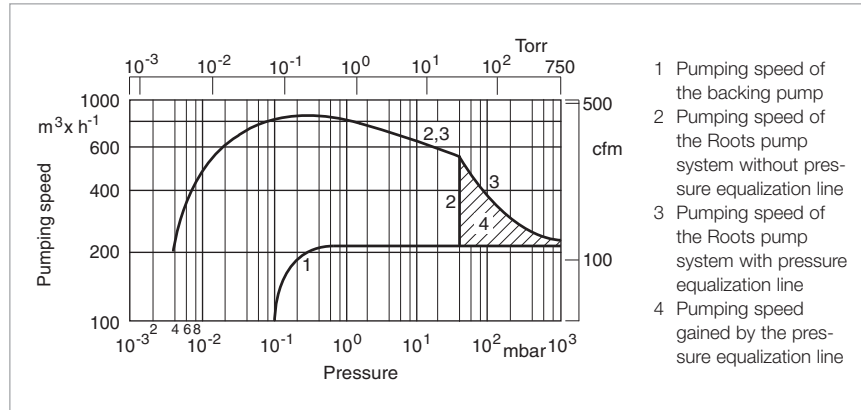
# General Information on Roots Vacuum Pumps

## Applications

For many years now Roots vacuum pumps have been well established in the area of vacuum technology. In combination with backing pumps, which compress against the atmosphere, these pumps offer the following advantages:

### Shifting the Operating Pressure into the High Vacuum Range

As a rule of the thumb one may say that Roots vacuum pumps are capable of improving the attainable ultimate pressure of a pump system by a factor of 10. With two Roots vacuum pump stages and a corresponding backing pump it is possible to attain pressures in the range down to  $10^{-5}$  mbar ( $0.75 \times 10^{-5}$  Torr). Under certain circumstances this will make the use of additional high vacuum pumps (turbo-molecular pumps or diffusion pumps) unnecessary.

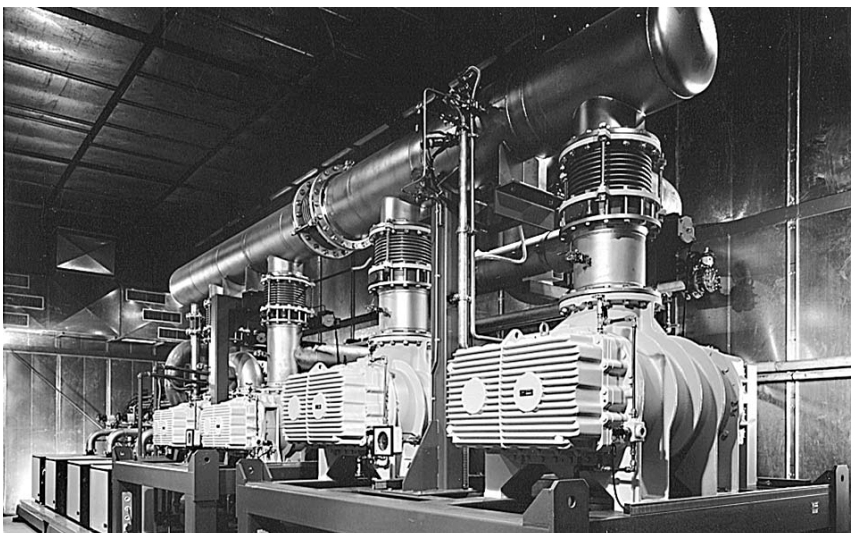


Comparison of pumping speed characteristics with and without pressure equalization line

### Multiplied Pumping Speed

Due to the non-contact rotation of the impellers, Roots vacuum pumps are able to run at higher speeds. Thus a high pumping speed is obtained with a relatively small size pump. Pumping speeds in excess of  $1000 \text{ m}^3/\text{h}$  ( $589 \text{ cfm}$ ) can only be attained with Roots vacuum pumps.

When selecting the right kind of backing pump (sizing) it will be possible to pump large quantities of gas in connection with smaller backing pumps. Energy consumption of such a pump system is much less compared to a single backing pump offering the same pumping speed.



Pump system with RA Roots vacuum pumps

The use of Roots vacuum pumps in the area of vacuum technology has resulted in further specializations and improvements:

- Through an integrated bypass (pressure equalization line) it is also possible to utilize the pumping speed of the Roots vacuum pump at high pressures and large quantities of gas at an early stage. This reduces the pumpdown time especially for cyclic operation (see figure "Comparison of pumping speed characteristics with and without pressure equalization line").
- High-purity gases or hazardous gases impose strict requirements on the leak-tightness of the system. Canned motors are hermetically sealed. There are no seals in

contact with the atmosphere which might be subject to wear. This prevents leaks and failures due to oil leaks. A service life of over 20000 hours without maintenance is quite common.

- Tolerances and the quality of the balancing combined with forced lubricated bearings and toothed gears permit high speeds and the use of frequency converters. Thus it is possible to attain a high pumping speed while the process is in progress and to reduce the speed when the process has been stopped or while changing the batch. This results in a lower consumption of energy and a longer service life with uncompromised reliability.

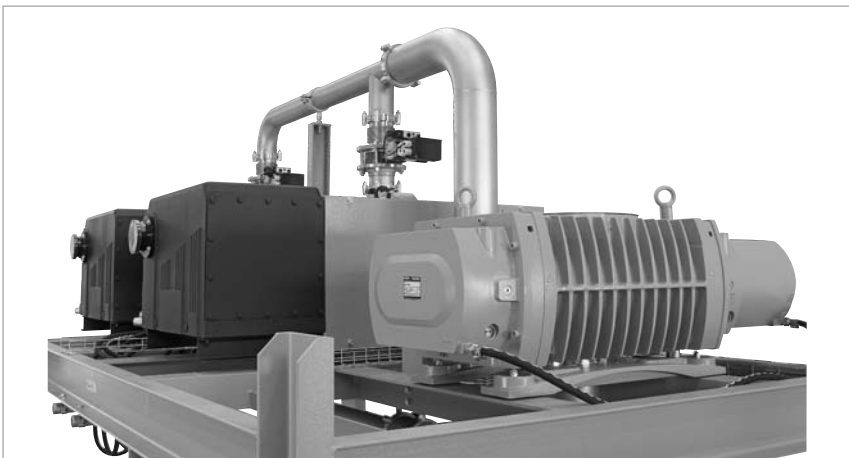
- Conversion from vertical to horizontal flow is easily implemented and can be performed at the place where the pump has been installed. Thus the pump can be adapted more closely to the operating conditions of your system.

Lately, a further characteristic is gaining prominence: Roots vacuum pumps are capable of compressing the media in the pump chamber without the presence of any further media. This mostly avoids interaction between different media in the pump itself and also in the connected vacuum chamber. Therefore

- the medium which is pumped is not contaminated with lubricants or sealants; complex accessories (exhaust filters, separators, etc.) are not needed;
- the lubricant in the side chambers is hardly affected, so that service life is not reduced;
- backstreaming of oil from the backing pump into the connected vacuum chamber is prevented.

The effective air cooling arrangement reduces operating costs to a minimum. Cooling water is not required.

These characteristics make the Roots vacuum pump attractive for almost all rough and medium vacuum applications.



Pump system with RA Roots vacuum pump and SOGEVAC rotary vane vacuum pump

## Semiconductor Technology

In the area of semiconductor technology, Roots vacuum pumps are found in etching processes among others, and in use with dry compressing vacuum pumps.

The pumping speed of the combination of backing pumps amounts to 200 to 500 m<sup>3</sup>/h (118 to 295 cfm) and it ensures a cut-in pressure of 10<sup>-1</sup> mbar (0.75 x 10<sup>-1</sup> Torr) for the turbomolecular pump. In the case of dry compression, corrosive gases which also have a high particulate content must be pumped.

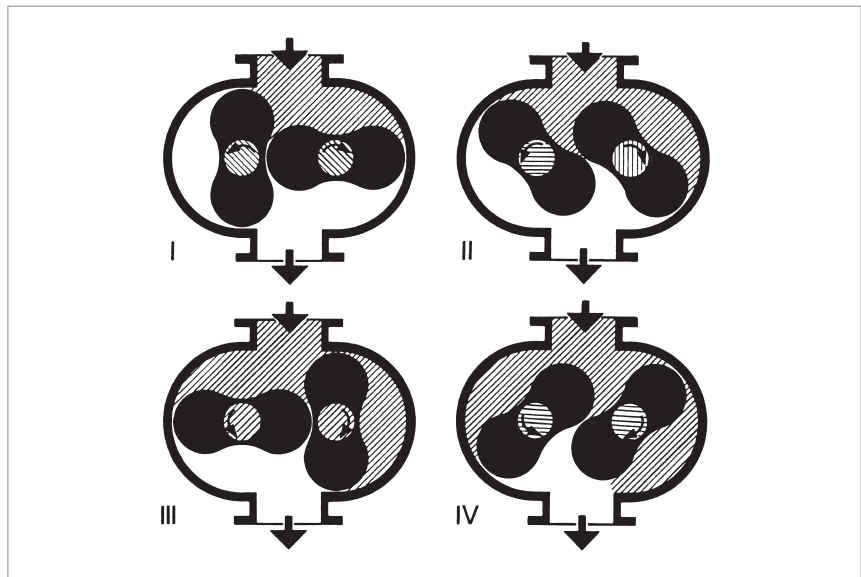
Canned motors and PFPE fluids provide a good seal against the outside and allow long periods between servicing, high reliability and thus very low operating costs (WS PFPE types).

Specific suitable for this processes and use in clean rooms are Roots vacuum pumps filled with PFPE and water-cooled motors.

These kind of motor has only a little heat dissipation.

## Central Vacuum Supply Systems

Large Roots vacuum pumps, usually in connection with single-stage rotary vane vacuum pumps serve several consumers of vacuum (packaging machines, for example) at the same time.



Operational diagram of a single-stage Roots vacuum pump (with vertical pumping action)

Due to the uncontrolled influx of gas, a high of pumping speed must be attained quickly, in order to keep the vacuum (1 to 30 mbar (0.75 to 22.5 Torr)) permanently available to all consumers. This in particular, is implemented by Roots vacuum pumps having a pressure equalization line (WAU types).

## Chemistry

Replacement of vapor jet or gas jet pumps on liquid ring pumps in drying and distillation plants is necessary for attaining the required operating pressure of about 1 mbar (0.75 Torr). Reduction of operating costs by entirely eliminating vapor or gas quantities includes separation of these on the pressure side (WA and RA types).

## Laser Systems

Continuous circulation of the gas in order to remove heat from a closed cycle in which pressure differentials of up to 100 mbar (75 Torr) must be maintained. The tough requirements regarding purity necessitate a total absence of contamination by oil and dust. This is ensured by reducing the pressure level in the oil chambers as well as by coating the pump chamber. The pumps are assembled and tested under clean room conditions.

The canned motor ensures a high degree of leak-tightness to the outside and permits operation in connection with a frequency converter (WSLF types).

## Operating Principle

Roots vacuum pumps, which are also called Roots blowers, are rotary plunger type pumps where two symmetrically shaped impellers rotate in opposite directions inside the pump housing.

The figure-of-eight rotors are synchronized by a gear which ensures that the impellers are counter-rotating in such a way, that they are near to one another and to the housing without actual contacting.

In rotor positions I and II (see figure "Operational diagram of a single-stage Roots vacuum pump (with vertical pumping action)") the volume of the intake is increased. As the rotors turn further to position III a part of the volume is cut off from the intake side.

In position IV this volume is opened to the exhaust side and gas under fore-vacuum pressure (higher than the intake pressure) flows in. This gas compresses the gas coming from the intake. As the rotors turn further the compressed gas is ejected through the exhaust flange.

This process repeats itself twice for each rotor per full turn.

As the rotors do not come into contact with the pump's housing Roots vacuum pumps may be operated at high speeds. Thus a high pumping speed is obtained from comparably small pumps.

The pressure difference and the compression ratio between intake and exhaust is limited in Roots vacuum pumps.

In practice the maximum attainable pressure difference is of significance only in the rough vacuum range ( $p > 10 \text{ mbar}$  ( $p > 7.5 \text{ Torr}$ )) whereas in the medium vacuum range ( $p < 1 \text{ mbar}$  ( $p < 0.75 \text{ Torr}$ )) the attainable compression ratio is of importance.

Roots vacuum pumps from Oerlikon Leybold Vacuum have been designed to specially meet the requirements of the fine vacuum range. They are normally used in connection with backing pumps (exception RAV) or in closed gas cycles (WSLF series).

## Design

The pump chamber of Roots vacuum pumps is free of any sealing agents or lubricants. Only the toothed wheels of the synchronous gear are lubricated with oil. Toothed gear wheels and bearings of the RUVAC are placed in two side chambers which also contain the oil reservoir. These two side chambers are separated from the pump chamber by piston ring seals.

Suitably designed oil supply systems in both chambers ensure that a sufficient quantity of oil is supplied to the gear wheels and bearings at all permissible speeds.

Almost all RUVAC Roots vacuum pumps are designed for a horizontal and vertical pumping action.



Pump system consisting of RUVAC WAU 1001 and SOGEVAC SV 200



# Types

Various types of Roots vacuum pumps have been developed to ensure optimum adaptation to the widely varying applications for this type of pump.

## - Flange mounted motor

The drive shaft of the pump is directly connected to an electric motor via a flexible coupling. The required seal of the drive shaft against atmospheric pressure is obtained by oiled shaft seals.

## - Canned motor

In the canned motor, rotor and stator pack are separated by a vacuum-tight can made of a non-magnetic material. The rotor operates on the drive shaft of the pump in the vacuum, so that a shaft seal which would be subject to wear is not required.

## - Hermetically sealed motor

The hermetically sealed motor is the latest technology step for Roots vacuum pumps. It integrates the complete motor assembly into the vacuum reaching the same efficiency as a standard flange mounted motor without the need of a shaft seal. The hermetically sealed motor is the most compact, efficient and reliable motor technology available for roots pumps.

## - Pressure equalization line

The integrated pressure equalization line connects the exhaust flange to the intake flange through a differential pressure valve.

This valve opens at a high pressure differential between the flanges. Part of the gas then flows through this line back to the intake flange. This is why the Roots vacuum pump may be switched on at atmospheric pressure together with the backing pump. This also increases the pumping speed of the pump combination at high intake pressures.

## - Special ACE vibration absorber

These pumps are best used in applications involving frequent pump-down cycles. The vibration absorber is of an oil sealed or filled design where minute amounts of oil may enter the vacuum system via the piston of the vibration attenuator.

## RUVAC WA/WAU, WS/WSU

The series WA/WAU Roots vacuum pumps are provided with directly flange-mounted air-cooled standard three-phase motors. The oiled radial sealing rings of the RUVAC WA/WAU for sealing the shaft against the atmosphere are made of FPM (FKM) (fluor polymer).

The WH/WHU series pumps have a water cooled hermetically sealed motor.

Roots vacuum pumps of the series WAU/WSU/WHU are provided with an additional integrated pressure equalization line and a differential pressure valve.

Pumps from these series are supplied with a vertical pumping action as standard.

## Using the RUVAC WS and RUVAC WH in combination with a frequency converter

### Simulation of a pressure equalization line

The available frequency converters have been matched to the pump so that the possibility of mechanically overloading it is excluded. In the case of a pressure difference which is too high, the rotational speed of the pump is automatically reduced until its load drops in to the permissible range.

### Operation at any rotational speeds

The frequency converter can be used to adjust the pumping speed of the Roots pump during operation. This allows maximum flexibility to find the right setup for any application.

## Increasing the pumping speed

The pumps are prepared to handle a maximum rotational speed of 4200 rpm - 7200 rpm depending on the pump size.

Therefore the use of a frequency converter permits an increase in the nominal pumping speed of up to 140%.

## Note

Please enquire about possibly existing usage limits (process dependent).

## RUVAC WSLF

The pumps of these series are especially adapted Roots vacuum pumps from the RUVAC WS series which are intended for operation with gas lasers.

They are driven by a canned motor so that a shaft seal for sealing against atmospheric pressure is not required.

Air-cooled series with nominal pumping speeds of  $1000 \text{ m}^3 \times \text{h}^{-1}$  (589 cfm) are available.

The RUVAC WSLF series with increased motor ratings is intended for operation in connection with frequency converters.

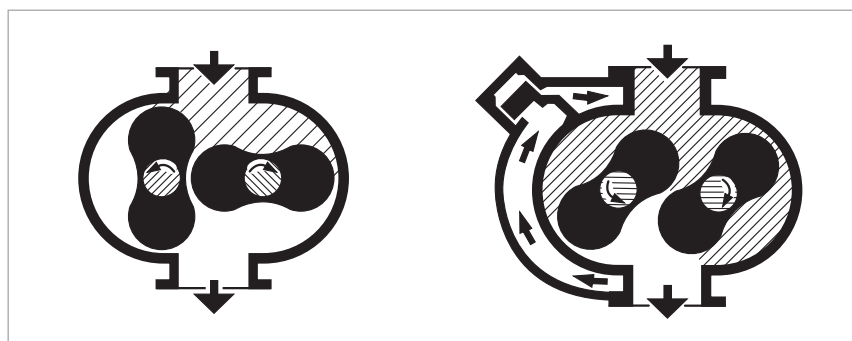
These pumps are available with nickel-plated or plasma-nitrated surface as standard.

All pumps of these series are supplied with a horizontal pumping action.

Vertical pumping action is available upon request.

## RUVAC RA

RA series Roots vacuum pumps are equipped with a directly flange-mounted three-phase motor (RA 13000 via V-belt drive).



Schematic section through a RUVAC WA/WS (left) and a RUVAC WAU/WSU (right)



## Backing Pumps

The backing pumps from Oerlikon Leybold Vacuum listed in the following are recommended for connection to the RUVAC Roots vacuum pumps:

- Rotary vane vacuum pumps
  - TRIVAC B with pumping speeds between 16 and 65 m<sup>3</sup> x h<sup>-1</sup> (9.4 and 38.3 cfm)
  - SOGEVAC with pumping speeds between 16 and 1200 m<sup>3</sup> x h<sup>-1</sup> (9.4 and 707 cfm)
- Dry compressing piston vacuum pumps
  - ECODRY M with pumping speeds between 38 and 48 m<sup>3</sup> x h<sup>-1</sup> (22 and 28 cfm)
- Dry compressing screw vacuum pumps
  - SCREWLINE SP250 and SP630 with pumping speed of 250 and 630 m<sup>3</sup> x h<sup>-1</sup> (147 and 371 cfm)
- Rotary piston vacuum pumps
  - E and DK with pumping speeds between 200 and 250 m<sup>3</sup> x h<sup>-1</sup> (117.8 and 147.3 cfm)
- Roots vacuum pumps with pre-inlet cooling
  - RUVAC RAV G with pumping speeds between 250 and 8100 m<sup>3</sup> x h<sup>-1</sup> (147.3 and 4770.9 cfm)
- Liquid ring vacuum pumps upon request

## Accessories

### Frequency Converter V1000

This frequency converter is specially designed for the new RUVAC WH series. For this frequency converter much equipment is available.

For more information see Technical Data at "RUVAC WH Roots Vacuum Pumps with Water-Cooled Hermetically Sealed Motors".

For each Roots vacuum pump size, a matching frequency converter is available.

## Frequency Converter RUVATRONIC RT 5

The electronic frequency converters RUVATRONIC RT 5/251 to 5/16 000 have been designed specially for use in connection with Oerlikon Leybold Vacuum Roots pumps of the RUVAC WA and WS series.

### The main characteristics of the RUVATRONIC RT 5 are:

#### Simulation of a pressure equalisation line

The software of the frequency converters is adapted to each pump and ensures that the risk of mechanically overloading the pump can be excluded. In the case of too high pressure differences, the rotational speed will be decreased automatically until the load is reduced to within the pump's limits. RUVAC Roots vacuum pumps of the types WA, WS and RA (without pressure equalisation line) can be switched on together with the forepump at atmospheric pressure. Through this, the pumpdown time can be reduced drastically. The minimum pumping speed of the backing pump needs to be considered in this case.

In connection with this kind of operation, the minimum pumping speed of the backing pump needs to be observed.

Pump	Required pumping speed for the backing pump
WA/WS 251	50 m <sup>3</sup> /h ( 29 cfm)
WA/WS 501	100 m <sup>3</sup> /h ( 59 cfm)
WA/WS 1001	200 m <sup>3</sup> /h ( 118 cfm)
WA/WS 2001	410 m <sup>3</sup> /h ( 241 cfm)
WH 700/702	140 m <sup>3</sup> /h ( 82 cfm)
WH/WHU 4400	880 m <sup>3</sup> /h ( 518 cfm)
WH/WHU 7000	1400 m <sup>3</sup> /h ( 824 cfm)
RA 3001	650 m <sup>3</sup> /h ( 383 cfm)
RA 5001	930 m <sup>3</sup> /h ( 547 cfm)
RA 7001	1250 m <sup>3</sup> /h ( 736 cfm)
RA 9001	3240 m <sup>3</sup> /h (1907 cfm)

## Operation at up to 3 predefined speeds

Via floating contacts, the pump can be operated at one of the 3 predefined speeds. Switching over to another predefined speed is possible during operation.

### Operation at any rotational speed

With a 0 to 10 V signal, any speed can be predefined to operate the pump between the minimum and maximum rotational speed. The software reliably ensures that the rotational speed cannot drop below the minimum speed or exceed the maximum speed.

### Increase in the pumping speed

By operating the Roots vacuum pumps at frequencies over 50 Hz, the nominal pumping speed of the pumps can be increased. Depending on the type of pump, an increase between 20 and 100% is possible.

### Note

Please enquire about possible application limitations (process dependent).

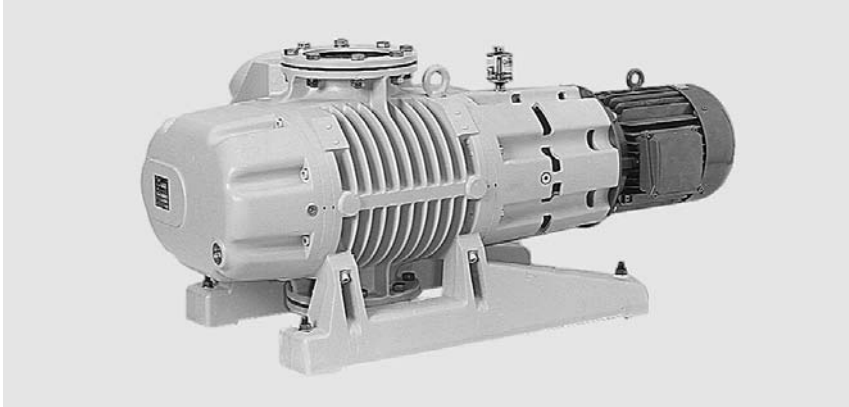
## Dust Separators and Dust Filters

Vacuum processes with a high particle count or involving significant quantities of dust require special measures for protecting the vacuum pumps.

Dust separators and dust filters can be found in chapter "Accessories" of Product Section C08.

# Products

## RUVAC WA/WAU Roots Vacuum Pumps with Air-Cooled Flange-Mounted Motors



RUVAC WAU 2001 single-stage Roots vacuum pump, depicted with a DN 160 ISO-K collar flange

### Advantages to the User

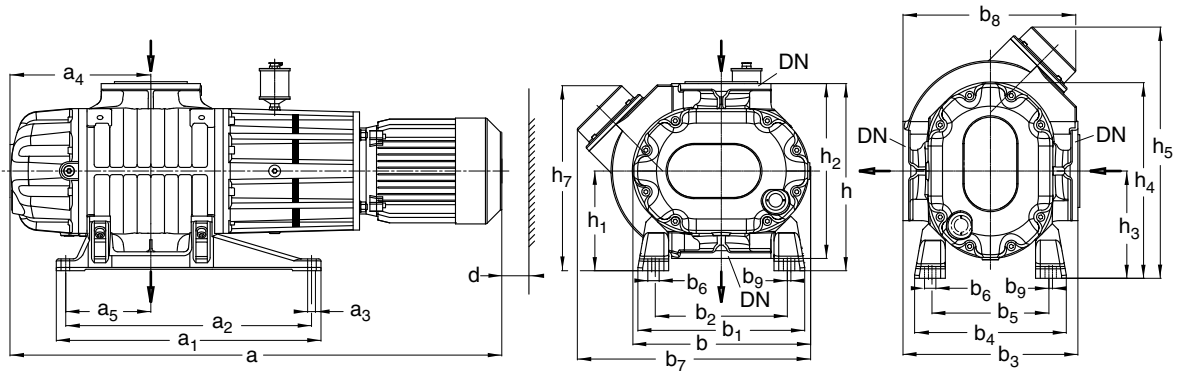
- Two air-cooled series, each with four models
- Reliable and trouble-free
- Sealing rings with their housing can be readily replaced
- Shaft seals and elastomer seals made of FPM (FKM)/Viton
- Air-cooled standard motors in accordance with IEC dimensions eg. NEMA dimensions
- Easy to exchange with custom motors
- Integrated pressure equalization line for protection against overloading at high pressures on WAU models
- Pumping direction may be changed as required
- ATEX versions compliant to 94/9/EC possible

### Typical Applications

- For oil-free compression of gases and vapors in combination with a backing pump
- Short cycle pumping processes also in the presence of large quantities of gas and vapor

### Supplied Equipment

- RUVAC WA/WAU are supplied as standard for a vertical pumping action, horizontal pumping action upon request
- Mineral oil N 62 is used as standard
- Gasket in the intake flange with dirt sieve
- The required oil filling is included in separate bottles



Type		DN/DN <sub>1</sub>	a <sup>1)</sup>	a <sup>2)</sup>	a <sub>1</sub>	a <sub>2</sub>	a <sub>3</sub>	a <sub>4</sub>	a <sub>5</sub>	a <sub>6</sub>
WA/WAU 251	mm	63 ISO-K	732	790	405	365	14	209	120	194
	in.		28.82	31.10	15.94	14.37	0.55	8.23	4.72	7.64
WA/WAU 501	mm	63 ISO-K	830	918	486	450	14	237	155	218
	in.		32.68	36.14	19.13	17.72	0.55	9.33	6.10	8.58
WA/WAU 501H	mm	63 ISO-K	830	918	486	450	14	237	155	218
	in.		32.88	36.14	19.13	17.72	0.55	9.33	6.10	8.58
WA/WAU 1001	mm	100 ISO-K	1054	1085	560	520	16.5	298	180	262
	in.		41.50	42.72	22.05	20.47	0.65	11.73	6.10	10.31
WA/WAU 1001H	mm	100 ISO-K	1054	1085	560	520	16.5	298	180	262
	in.		41.50	42.72	22.05	20.47	0.65	11.73	6.10	10.31
WA/WAU 2001	mm	160 ISO-K	1275	1283	800	740	18	367	220	310
	in.		50.20	50.51	31.50	29.13	0.71	14.45	8.66	12.20
WA/WAU 2001H	mm	160 ISO-K	1275	1283	800	740	18	367	220	310
	in.		50.20	50.51	31.50	29.13	0.71	14.45	8.66	12.20

		b	b <sub>1</sub>	b <sub>2</sub>	b <sub>3</sub>	b <sub>4</sub>	b <sub>5</sub>	b <sub>6</sub>	b <sub>7</sub> <sup>3)</sup>	b <sub>8</sub>	b <sub>9</sub>
WA/WAU 251	mm	250	270	210	280	230	170	24	305	285	7.5
	in.	9.84	10.63	8.27	11.02	9.06	6.69	0.94	12.01	11.22	0.30
WA/WAU 501	mm	310	299	229	320	271	201	24	390	313	7.5
	in.	12.20	11.77	9.02	12.60	10.67	7.91	0.94	15.35	12.32	0.30
WA/WAU 501H	mm	310	299	229	320	271	201	24	414	330	7.5
	in.	12.20	11.77	9.02	12.60	10.67	7.91	0.94	16.30	12.99	0.30
WA/WAU 1001	mm	376	352	278	370	320	246	24	494	366	7.5
	in.	14.80	13.86	10.94	14.57	12.60	7.91	0.94	19.45	14.41	0.30
WA/WAU 1001H	mm	376	352	278	370	320	246	24	524	398	7.5
	in.	14.80	13.86	10.94	14.57	12.60	7.91	0.94	20.63	15.67	0.30
WA/WAU 2001	mm	463	518	388	460	422	292	24	638	456	7.5
	in.	18.23	20.39	15.28	18.11	16.61	11.50	0.94	25.12	17.95	0.30
WA/WAU 2001H	mm	463	518	388	460	422	292	24	642	460	7.5
	in.	18.23	20.39	15.28	18.11	16.61	11.50	0.94	25.28	18.11	0.30

		d	h	h <sub>1</sub>	h <sub>2</sub>	h <sub>3</sub>	h <sub>4</sub>	h <sub>5</sub> <sup>2)</sup>	h <sub>6</sub>	h <sub>7</sub>
WA/WAU 251	mm	50	300	160	280	180	306	360	330	307
	in.	2.00	11.81	6.30	11.02	7.09	12.05	14.17	12.99	12.09
WA/WAU 501	mm	50	340	180	320	194	348	430	370	332
	in.	2.00	13.39	7.09	12.60	7.48	13.70	16.93	14.57	13.07
WA/WAU 501H	mm	50	340	180	320	194	348	450	370	350
	in.	2.00	13.39	7.09	12.60	7.48	13.70	17.72	14.57	13.78
WA/WAU 1001	mm	50	396	211	370	227	414	532	425	392
	in.	2.00	15.59	8.31	14.57	8.94	16.30	20.94	425	15.43
WA/WAU 1001H	mm	50	396	211	370	227	414	564	425	424
	in.	2.00	15.59	8.31	14.57	8.94	16.30	22.20	425	16.69
WA/WAU 2001	mm	50	530	300	460	351	578	753	541	523
	in.	2.00	20.87	11.81	18.11	13.82	22.76	29.65	21.3	20.59
WA/WAU 2001H	mm	50	530	300	460	351	578	760	541	530
	in.	2.00	20.87	11.81	18.11	13.82	22.76	29.92	21.3	20.87

<sup>1)</sup> This dimension "a" relates to pumps with the IEC motor used as standard by Oerlikon Leybold Vacuum

<sup>2)</sup> This dimension "a" relates to pumps with the NEMA motor used as standard by Oerlikon Leybold Vacuum

<sup>3)</sup> For RUVAC WAU only

DN = ND 6 pump flange in accordance with DIN 2501

DN<sub>1</sub> = Collar flange with gasket for connecting ISO-K standard components

Outside dimensions ± 3 mm (0.12 in.)

Dimensional drawing for the RUVAC WA/WAU pumps

## Technical Data

### WA/WAU 251

### WA/WAU(H) 501

		50 Hz	60 Hz	50 Hz	60 Hz
Nominal pumping speed <sup>1)</sup>	m <sup>3</sup> x h <sup>-1</sup> (cfm)	253.0 (149.0)	304.0 (179.0)	505.0 (297.4)	606.0 (357.0)
Max. pumping speed with backing pump	m <sup>3</sup> x h <sup>-1</sup> (cfm)	210.0 (123.7)	251.0 (148.0)	410.0 (241.0)	530.0 (312.0)
	TRIVAC	D 65 B	D 65 B	–	–
	SOGEVAC	–	–	SV 200	SV 200
Ultimate partial pressure <sup>2)</sup>	mbar (Torr)	< 2 x 10 <sup>-5</sup> (< 1.5 x 10 <sup>-5</sup> )	< 2 x 10 <sup>-5</sup> (< 1.5 x 10 <sup>-5</sup> )	< 8 x 10 <sup>-3</sup> (< 6 x 10 <sup>-3</sup> )	< 8 x 10 <sup>-3</sup> (< 6 x 10 <sup>-3</sup> )
Ultimate total pressure <sup>2)</sup>	mbar (Torr)	< 8 x 10 <sup>-4</sup> (< 6 x 10 <sup>-4</sup> )	< 8 x 10 <sup>-4</sup> (< 6 x 10 <sup>-4</sup> )	< 4 x 10 <sup>-2</sup> (< 3 x 10 <sup>-2</sup> )	< 4 x 10 <sup>-2</sup> (< 3 x 10 <sup>-2</sup> )
Permissible cut-in pressure <sup>2)</sup>					
RUVAC WA	mbar (Torr)	90.0 (67.5)	60.0 (45.0)	100.0 (75.0)	80.0 (60.0)
Max. permissible pressure difference during continuous operation <sup>3)</sup>	mbar (Torr)	80.0 (60.0)	80.0 (60.0)	80.0 (60.0)	80.0 (60.0)
Leak rate, integral	mbar x l x s <sup>-1</sup>	< 1 x 10 <sup>-2</sup>	< 1 x 10 <sup>-2</sup>	< 1 x 10 <sup>-2</sup>	< 1 x 10 <sup>-2</sup>
Main supply					
IEC motor (ATB) <sup>4)</sup>	Δ / Y V	220-240 / 380-420	220-277 / 380-480	220-240 / 380-420	220-277 / 380-480
NEMA motor (US version) <sup>4)</sup>	Δ / Y V	230 / 400	200-230 / 460	230 / 400	200-230 / 460
Thermal class		F	F	F	F
Motor power	kW (hp)	1.1 (1.5)	1.1 (1.5)	2.2 (3.0)	2.2 (3.0)
Nominal speed, approx. (50/60 Hz)	rpm	3000/3600	3000/3600	3000/3600	3000/3600
Max. permissible speed	rpm	3600	3600	3600	3600
Type of protection	IP	55	55	55	55
Oil filling for the bearing chamber <sup>5)</sup>		1. Filling <sup>6)</sup> / 2. Filling	1. Filling <sup>6)</sup> / 2. Filling	1. Filling <sup>6)</sup> / 2. Filling	1. Filling <sup>6)</sup> / 2. Filling
vertical pumping action, approx.	I (qt)	0.65 (0.69) / 0.6 (0.63)	0.65 (0.69) / 0.6 (0.63)	0.9 (0.95) / 0.8 (0.85)	0.9 (0.95) / 0.8 (0.85)
horizontal pumping action, approx.	I (qt)	0.5 (0.53) / 0.45 (0.48)	0.5 (0.53) / 0.45 (0.48)	0.75 (0.79) / 0.7 (0.74)	0.75 (0.79) / 0.7 (0.74)
Oil filling of the shaft sealing ring housing	I (qt)	0.6 (0.63)	0.6 (0.63)	1.0 (1.06)	1.0 (1.06)
Connection flanges <sup>7)</sup>	DN	63 ISO-K	63 ISO-K	63 ISO-K	63 ISO-K
	DN	3" ANSI	3" ANSI	3" ANSI	3" ANSI
Materials (materials in contact with the gas)		C steel, CrNi steel, grey cast iron, FPM (FKM)	C steel, CrNi steel, grey cast iron, FPM (FKM)	C steel, CrNi steel, grey cast iron, FPM (FKM)	C steel, CrNi steel, grey cast iron, FPM (FKM)
Weight WA / WAU	kg (lbs)	85.0 / 89.0 (187.4 / 196.2)	85.0 / 89.0 (187.4 / 196.2)	128.0 / 133.0 (282.2 / 293.3)	128.0 / 133.0 (282.2 / 293.3)
Noise level <sup>8)</sup>	dB(A)	< 64	< 64	< 67	< 67

<sup>1)</sup> To DIN 28 400 and subsequent numbers

<sup>2)</sup> With double-stage rotary vane vacuum pump TRIVAC, resp. single-stage rotary vane vacuum pump SOGEVAC (Type of backing pump look at max. pumping speed).

When using 2-stage backing pumps the ultimate pressures will be correspondingly lower

<sup>3)</sup> Applicable for ratio up to 1 : 10 between backing pump and Roots vacuum pump at 3000 rpm

<sup>4)</sup> Motor voltage and current may deviate depending on the type of motor.

Please always note the information on the nameplate

<sup>5)</sup> Authoritative, however, is the oil level at the oil-level glass

<sup>6)</sup> After a complete disassembly

<sup>7)</sup> US models ANSI flanges

<sup>8)</sup> At an operating pressure below < 10<sup>-1</sup> mbar (< 0.75 x 10<sup>-1</sup> Torr)

## Technical Data

		WA/WAU (H) 1001		WA/WAU(H) 2001	
		50 Hz	60 Hz	50 Hz	60 Hz
Nominal pumping speed <sup>1)</sup>	m <sup>3</sup> x h <sup>-1</sup> (cfm)	1000 (589)	1200 (707)	2050 (1207.5)	2460 (1449)
Max. pumping speed with backing pump	m <sup>3</sup> x h <sup>-1</sup> (cfm) SOGEVAC	800 (470) SV 300	1000 (588) SV 300	1850 (1089) SV 630 F	2100 (1236) SV 630 F
Ultimate partial pressure <sup>2)</sup>	mbar (Torr)	< 8 x 10 <sup>-3</sup> (< 6 x 10 <sup>-3</sup> )	< 8 x 10 <sup>-3</sup> (< 6 x 10 <sup>-3</sup> )	< 8 x 10 <sup>-3</sup> (< 6 x 10 <sup>-3</sup> )	< 8 x 10 <sup>-3</sup> (< 6 x 10 <sup>-3</sup> )
Ultimate total pressure <sup>2)</sup>	mbar (Torr)	< 4 x 10 <sup>-2</sup> (< 3 x 10 <sup>-2</sup> )	< 4 x 10 <sup>-2</sup> (< 3 x 10 <sup>-2</sup> )	< 4 x 10 <sup>-2</sup> (< 3 x 10 <sup>-2</sup> )	< 4 x 10 <sup>-2</sup> (< 3 x 10 <sup>-2</sup> )
Permissible cut-in pressure <sup>2)</sup> RUVAC WA	mbar (Torr)	60.0 (45.0)	45.0 (33.5)	30.0 (22.5)	25.0 (18.5)
Max. permissible pressure difference during continuous operation <sup>3)</sup>	mbar (Torr)	80.0 (60.0)	80.0 (60.0)	50.0 (37.5)	50.0 (37.5)
Leak rate, integral	mbar x l x s <sup>-1</sup>	< 1 x 10 <sup>-2</sup>	< 1 x 10 <sup>-2</sup>	< 1 x 10 <sup>-2</sup>	< 1 x 10 <sup>-2</sup>
Main supply IEC motor (ATB) <sup>4)</sup>	Δ / Y V	220-240 / 380-420	220-277 / 380-480	- / 380-420	- / 380-480
NEMA motor (US version) <sup>4)</sup>	Δ / Y V	230 / 400	200-230 / 460	400 / -	460 / -
Thermal class		F	F	F	F
Motor power	kW (hp)	4.0 (5.4)	4.0 (5.4)	7.5 (10.0)	7.5 (10.0)
Nominal speed, approx. (50/60 Hz)	rpm	3000/3600	3000/3600	3000/3600	3000/3600
Max. permissible speed	rpm	3600	3600	3600	3600
Type of protection	IP	55	55	55	55
Oil filling for the bearing chamber <sup>5)</sup> vertical pumping action, approx.	I (qt)	1. Filling <sup>6)</sup> / 2. Filling	1. Filling <sup>6)</sup> / 2. Filling	1. Filling <sup>6)</sup> / 2. Filling	1. Filling <sup>6)</sup> / 2. Filling
	I (qt)	2.0 (2.11) / 1.8 (1.90)	2.0 (2.11) / 1.8 (1.90)	3.85 (4.07) / 3.6 (3.81)	3.85 (4.07) / 3.6 (3.81)
horizontal pumping action, approx.	I (qt)	1.2 (1.27) / 1.1 (1.16)	1.2 (1.27) / 1.1 (1.16)	2.65 (2.75) / 2.4 (2.54)	2.65 (2.75) / 2.4 (2.54)
Oil filling of the shaft sealing ring housing	I (qt)	1.3 (1.37)	1.3 (1.37)	1.6 (1.69)	1.6 (1.69)
Connection flanges <sup>7)</sup>	DN	100 ISO-K	100 ISO-K	160 ISO-K	160 ISO-K
	DN	4" ANSI	4" ANSI	6" ANSI	6" ANSI
Materials (materials in contact with the gas)		C steel, CrNi steel, grey cast iron, FPM (FKM)	C steel, CrNi steel, grey cast iron, FPM (FKM)	C steel, CrNi steel, grey cast iron, FPM (FKM)	C steel, CrNi steel, grey cast iron, FPM (FKM)
Weight WA / WAU	kg (lbs)	220.0 / 225.0 (485.1 / 496.1)	220.0 / 225.0 (485.1 / 496.1)	400.0 / 406.0 (882.0 / 895.2)	400.0 / 406.0 (882.0 / 895.2)
Noise level <sup>8)</sup>	dB(A)	< 75	< 75	< 80	< 80

<sup>1)</sup> To DIN 28 400 and subsequent numbers

<sup>2)</sup> With single-stage rotary vane vacuum pump SOGEVAC (Type of backing pump look at max. pumping speed).  
When using 2-stage backing pumps the ultimate pressures will be correspondingly lower

<sup>3)</sup> Applicable for ratio up to 1 : 10 between backing pump and Roots vacuum pump at 3000 rpm

<sup>4)</sup> Motor voltage and current may deviate depending on the type of motor.

Please always note the information on the nameplate

<sup>5)</sup> Authoritative, however, is the oil level at the oil-level glass

<sup>6)</sup> After a complete disassembly

<sup>7)</sup> US models ANSI flanges

<sup>8)</sup> At an operating pressure below < 10<sup>-1</sup> mbar (< 0.75 x 10<sup>-1</sup> Torr)

## Ordering Information

**WA/WAU**

**WA/WAU(H)**

**WA/WAU(H)**

**WA/WAU(H)**

**251**

**501**

**1001**

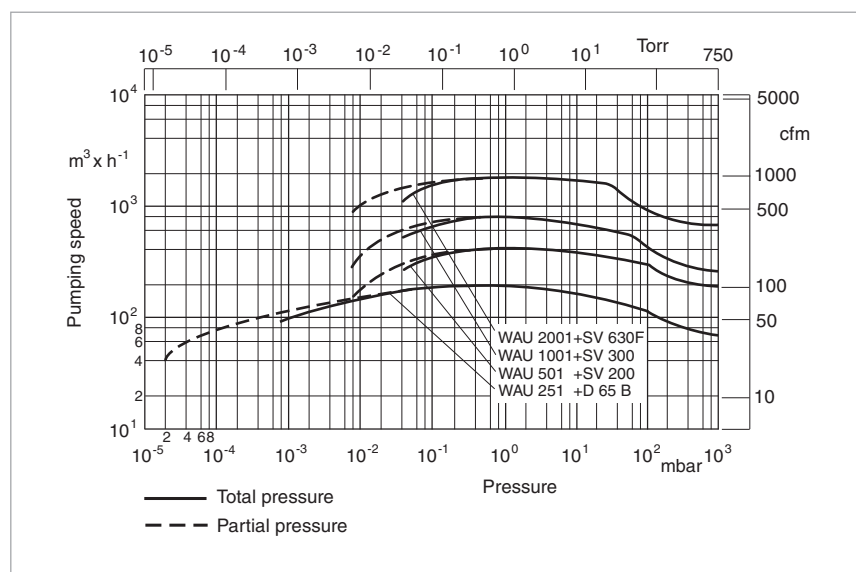
**2001**

Roots vacuum pump				
RUVAC WA (IEC motor)	<b>Part No. 117 20</b>	<b>Part No. 117 30</b>	<b>Part No. 117 40</b>	<b>Part No. 117 50</b>
RUVAC WA (NEMA motor, US version)	<b>Part No. 917 20</b>	<b>Part No. 917 30</b>	<b>Part No. 917 40</b>	<b>Part No. 917 50</b>
RUVAC WAU (IEC motor)	<b>Part No. 117 21</b>	<b>Part No. 117 31</b>	<b>Part No. 117 41</b>	<b>Part No. 117 51</b>
RUVAC WAU (NEMA motor, US version)	<b>Part No. 917 21</b>	<b>Part No. 917 31</b>	<b>Part No. 917 41</b>	<b>Part No. 917 51</b>
RUVAC WA, without motor	<b>Part No. 117 24</b>	<b>Part No. 117 34</b>	<b>Part No. 117 44</b>	<b>Part No. 112 54</b>
RUVAC WAU, without motor	-	<b>Part No. 155 008</b>	<b>Part No. 112 17</b>	<b>Part No. 113 22</b>
RUVAC WAU(H) (IEC motor), with special ACE vibration absorber	-	<b>Part No. 118 31</b>	<b>Part No. 118 41</b>	<b>Part No. 118 51</b>
RUVAC WS/WSU(H) seal kit	<b>Part No. 194 60</b>	<b>Part No. 194 64</b>	<b>Part No. 194 68</b>	<b>Part No. 194 72</b>
Flange adapter set, consisting of Flange adapter with screws, bolts, washers and nuts for ANSI flange	<b>(3" ANSI)</b>	<b>(3" ANSI)</b>	<b>(4" ANSI)</b>	<b>(6" ANSI)</b>
WA/WS pump	<b>Part No. 200 03 179</b>	<b>Part No. 200 03 179</b>	<b>Part No. 200 03 180</b>	<b>Part No. 200 03 181</b>
WAU/WSU pump	<b>Part No. 200 03 179</b>	<b>Part No. 200 03 179</b>	<b>Part No. 200 03 180</b>	<b>Part No. 200 03 182</b>
Frequency converter RUVATRONIC (see description in Section "General", paragraph "Accessories")	<b>RT 5/251</b> <b>Part No.</b> <b>500 001 381</b>	<b>RT 5/501</b> <b>Part No.</b> <b>500 001 382</b>	<b>RT 5/1001</b> <b>Part No.</b> <b>500 001 383</b>	<b>RT 5/2001</b> <b>Part No.</b> <b>500 001 384</b>

## Accessories

Shaft sealing ring replacement kit WA/WAU	<b>Part No.</b> <b>EK 110 002 661</b>	<b>Part No.</b> <b>EK 110 002 661</b>	<b>Part No.</b> <b>EK 110 002 662</b>	<b>Part No.</b> <b>EK 110 002 662</b>
Large maintenance kit WA	<b>Part No.</b> <b>EK 110 002 663</b>	<b>Part No.</b> <b>EK 110 002 664</b>	<b>Part No.</b> <b>EK 110 002 667</b>	<b>Part No.</b> <b>EK 110 002 669</b>
WAU	<b>EK 110 002 665</b>	<b>EK 110 002 666</b>	<b>EK 110 002 668</b>	<b>EK 110 002 670</b>

<sup>1)</sup> Certified in accordance with ATEX Directive 94/9/EG, Category 3 (inside)



Pumping speed of the RUVAC WA/WAU, 50 Hz

## Ordering Information

## WA/WAU (ATEX-Pumps for 50 Hz-Operation)

**251                      501                      1001                      2001**

Roots vacuum pump RUVAC WAU ATEX Category 3 (inside) T3/T4	<b>Part No. 155 021</b>	<b>Part No. 155 031</b>	<b>Part No. 155 041</b>	<b>Part No. 155 051</b>
RUVAC WAU ATEX Category 3 (inside) T3/T4 and (outside) T3	<b>Part No. 155 027</b>	<b>Part No. 155 037</b>	<b>Part No. 155 047</b>	<b>Part No. 155 057</b>
RUVAC WAU ATEX Category 3 (inside) T3/T4 and (outside) T4	<b>Part No. 155 029</b>	<b>Part No. 155 039</b>	<b>Part No. 155 049</b>	<b>Part No. 155 059</b>
RUVAC WA ATEX Category 2 (innen) T3/T4 und (außen) T4	<b>Part No. 155 080</b>	<b>Part No. 155 082</b>	<b>Part No. 155 084</b>	<b>Part No. 155 086</b>
RUVAC WA, ohne Motor ATEX Category 2 (innen) T3/T4 und (außen) T4	<b>Part No. 155 081</b>	<b>Part No. 155 083</b>	<b>Part No. 155 085</b>	<b>Part No. 155 087</b>
RUVAC WA ATEX Category 3 (inside) T3/T4 and (outside) T3	<b>Part No. 155 026</b>	<b>Part No. 155 036</b>	<b>Part No. 155 046</b>	<b>Part No. 155 056</b>
RUVAC WA ATEX Category 3 (inside) T3/T4 and (outside) T4	<b>Part No. 155 028</b>	<b>Part No. 155 038</b>	<b>Part No. 155 048</b>	<b>Part No. 155 058</b>

### Accessories for ATEX

Category 3 (inside) and 3 (outside)

Shaft sealing ring replacement kit WA/WAU	<b>Part No. EK 110 002 661</b>	<b>Part No. EK 110 002 661</b>	<b>Part No. EK 110 002 662</b>	<b>Part No. EK 110 002 662</b>
Large maintenance kit WA	<b>Part No. EK 110 002 663</b>	<b>Part No. EK 110 002 664</b>	<b>Part No. EK 110 002 667</b>	<b>Part No. EK 110 002 669</b>
WAU	<b>Part No. EK 110 002 665</b>	<b>Part No. EK 110 002 666</b>	<b>Part No. EK 110 002 668</b>	<b>Part No. EK 110 002 670</b>

### Accessories for ATEX

Category 2 (inside) and 2 (outside)

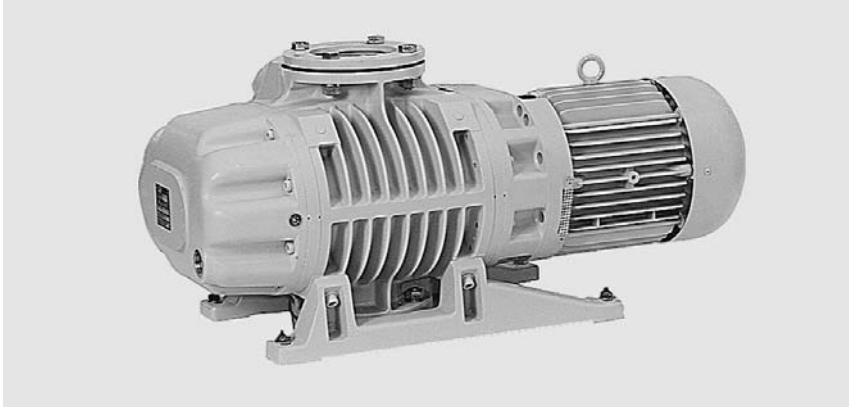
Large maintenance kit WA	<b>Part No. EK 110 002 800</b>	<b>Part No. EK 110 002 801</b>	<b>Part No. EK 110 002 802</b>	<b>Part No. EK 110 002 803</b>
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**Note:** EEx de IIC T4 and EEx e T3 compliant motors

For all enquiries and orders relating to category 2 and 3 ATEX products please exclusively use our ATEX questionnaire. You can find this questionnaire at the end of the full-line catalog together with the fax forms or in the Internet under "[www.oerlikon.com/leyboldvacuum](http://www.oerlikon.com/leyboldvacuum)" under Download Documents in the area Documentation.



# RUVAC WS/WSU Roots Vacuum Pumps with Air-Cooled Canned Motors



Single-stage Roots vacuum pump RUVAC WSU 1001 shown with ISO-K 100 rotatable flanges

## Advantages to the User

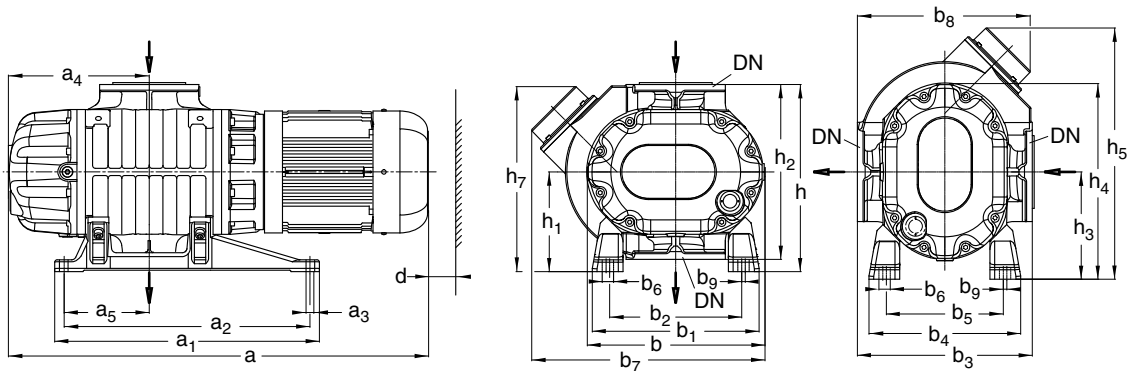
- Two series, each with four models
- Highly leak-tight air-cooled pumps driven by a air-cooled canned motor
- Lubricated with mineral oil. RUVAC WS/WSU PFPE with per-fluoropolyether (PFPE)
- WS and WSU PFPE pumps are identical except for the lubricant and the shipping package
- No thermal problems due to the speed independent cooling arrangement using a separately connected fan, thus no thermal problems at low speeds
- Over-temperature switch in the stator coil of the motor
- All elastomer seals made of FPM (FKM)/Viton
- Integrated pressure equalization line with differential pressure valve prevents overloading on WSU model
- RUVAC WS 251 to 2001 may be operated over a wide frequency range using a frequency converter
- No shaft feedthrough to the atmosphere, thus particularly leak-tight
- Pumping direction may be changed as required

## Typical Applications

- For applications which require a high pumping speed at pressures between  $10^{-2}$  and  $10^{-4}$  mbar ( $0.75 \times 10^{-2}$  and  $0.75 \times 10^{-4}$  Torr)
- Used where the possibility of contamination due air ingress or pumped media leakage must be avoided
- Suction or pumping of high-purity or radioactive gases
- Is used in clean rooms where the air must not be recirculated by the motor's fan

## Supplied Equipment

- The required oil or PFPE filling is included in separate bottle
- If no other type of oil is stated, then mineral oil N 62 is used as standard
- Purged with nitrogen for corrosion protection
- Gasket in the intake flange with integrated dirt sieve



Type		DN/DN1	DN <sub>1</sub>	a	a <sub>1</sub>	a <sub>2</sub>	a <sub>3</sub>	a <sub>4</sub>	a <sub>5</sub>
WS/WSU 251	mm	65	63 ISO-K	694	405	365	14	212	120
	in.			27.32	15.94	14.37	0.55	8.35	4.72
WS/WSU 501	mm	65	63 ISO-K	752	486	450	14	237	155
	in.			29.61	19.13	17.72	0.55	9.33	6.10
WS/WSU 501H	mm	65	63 ISO-K	752	486	450	14	237	155
	in.			29.61	19.13	17.72	0.55	9.33	6.10
WS/WSU 1001	mm	100	100 ISO-K	885	560	520	16,5	298	180
	in.			34.84	22.05	20.47	0.65	11.73	7.09
WS/WSU 1001H	mm	100	100 ISO-K	885	560	520	16,5	298	180
	in.			34.84	22.05	20.47	0.65	11.73	7.09
WS/WSU 2001	mm	150	160 ISO-K	1042	800	740	18	367	220
	in.			41.02	31.50	29.13	0.71	14.45	8.66
WS/WSU 2001H	mm	150	160 ISO-K	1042	800	740	18	367	220
	in.			41.02	31.50	29.13	0.71	14.45	8.66

		b	b <sub>1</sub>	b <sub>2</sub>	b <sub>3</sub>	b <sub>4</sub>	b <sub>5</sub>	b <sub>6</sub>	b <sub>7</sub> <sup>1)</sup>	b <sub>8</sub>
WS/WSU 251	mm	250	270	210	280	230	170	24	305	285
	in.	9.84	10.63	8.27	11.02	9.06	6.69	0.94	12.01	11.22
WS/WSU 501	mm	310	299	229	320	271	201	24	390	313
	in.	12.20	11.77	9.02	12.60	10.67	7.91	0.94	15.35	12.32
WS/WSU 501H	mm	310	299	229	320	271	201	24	414	330
	in.	12.20	11.77	9.02	12.60	10.67	7.91	0.94	16.30	12.99
WS/WSU 1001	mm	376	352	278	370	320	246	24	494	366
	in.	14.80	13.86	10.94	14.57	12.60	9.69	0.94	19.45	14.41
WS/WSU 1001H	mm	376	352	278	370	320	246	24	524	398
	in.	14.80	13.86	10.94	14.57	12.60	9.69	0.94	20.63	15.67
WS/WSU 2001	mm	463	518	388	460	422	292	24	638	456
	in.	18.23	20.39	15.28	18.11	16.61	11.50	0.94	25.12	17.95
WS/WSU 2001H	mm	463	518	388	460	422	292	24	642	460
	in.	18.23	20.39	15.28	18.11	16.61	11.50	0.94	25.28	18.11

		b <sub>9</sub>	d	h	h <sub>1</sub>	h <sub>2</sub>	h <sub>3</sub>	h <sub>4</sub>	h <sub>5</sub> <sup>1)</sup>	h <sub>6</sub>
WS/WSU 251	mm	7.5	50	300	160	280	180	306	360	307
	in.	0.30	2.00	11.81	6.3	11.02	7.09	12.05	14.17	12.09
WS/WSU 501	mm	7.5	50	340	180	320	194	348	430	332
	in.	0.30	2.00	13.39	7.09	12.60	7.48	13.70	16.93	13.07
WS/WSU 501H	mm	7.5	50	340	180	320	194	348	450	350
	in.	0.30	2.00	13.39	7.09	12.60	7.48	13.70	17.72	13.78
WS/WSU 1001	mm	7.5	50	396	211	370	227	414	532	392
	in.	0.30	2.00	15.59	8.31	14.57	8.94	16.30	20.94	15.43
WS/WSU 1001H	mm	7.5	50	396	211	370	227	414	564	424
	in.	0.30	2.00	15.59	8.31	14.57	8.94	16.30	22.20	16.69
WS/WSU 2001	mm	7.5	50	530	300	460	351	578	760	523
	in.	0.30	2.00	20.87	11.81	18.11	13.82	22.76	29.92	20.59
WS/WSU 2001H	mm	7.5	50	530	300	460	351	578	753	530
	in.	0.30	2.00	20.87	11.81	18.11	13.82	22.76	29.65	20.87

<sup>1)</sup> For RUVAC WSU only

Outside dimensions ± 3 mm (0.12 in.)

DN = ND 6 pump flange in accordance with DIN 2501

DN<sub>1</sub> = Collar flange with gasket for connecting ISO-K standard components

Dimensional drawing for the RUVAC WS/WSU pumps

## Technical Data

### WS/WSU 251

### WS/WSU(H) 501

		50 Hz	60 Hz	50 Hz	60 Hz
Nominal pumping speed <sup>1)</sup>	m <sup>3</sup> x h <sup>-1</sup> (cfm)	253 (149)	304 (179)	505 (297.4)	606 (357)
Max. pumping speed with backing pump	m <sup>3</sup> x h <sup>-1</sup> (cfm)	210.0 (123.7)	251.0 (148.0)	410.0 (241.0)	530.0 (312.0)
	TRIVAC	D 65 B	D 65 B	–	–
	SOGEVAC	–	–	SV 200	SV 200
Ultimate partial pressure <sup>2)</sup>	mbar (Torr)	< 2 x 10 <sup>-5</sup> (< 1.5 x 10 <sup>-5</sup> )	< 2 x 10 <sup>-5</sup> (< 1.5 x 10 <sup>-5</sup> )	< 8 x 10 <sup>-3</sup> (< 6 x 10 <sup>-3</sup> )	< 8 x 10 <sup>-3</sup> (< 6 x 10 <sup>-3</sup> )
Ultimate total pressure <sup>2)</sup>	mbar (Torr)	< 8 x 10 <sup>-4</sup> (< 6 x 10 <sup>-4</sup> )	< 8 x 10 <sup>-4</sup> (< 6 x 10 <sup>-4</sup> )	< 4 x 10 <sup>-2</sup> (< 3 x 10 <sup>-2</sup> )	< 4 x 10 <sup>-2</sup> (< 3 x 10 <sup>-2</sup> )
Permissible cut-in pressure <sup>2)</sup>					
RUVAC WS	mbar (Torr)	90.0 (67.5)	60.0 (45.0)	100.0 (75.0)	80.0 (60.0)
Max. permissible pressure difference during continuous operation <sup>3)</sup>	mbar (Torr)	80.0 (60.0)	80.0 (60.0)	80.0 (60.0)	80.0 (60.0)
Leak rate, integral	mbar x l x s <sup>-1</sup>	< 1 x 10 <sup>-4</sup>	< 1 x 10 <sup>-4</sup>	< 1 x 10 <sup>-4</sup>	< 1 x 10 <sup>-4</sup>
Main supply					
Δ / Y	V	200 / –	200-208 / –	200 / –	200-208 / –
Δ / Y	V	230 / 400	265 / 460	208-265 / 460	265 / 460
Thermal class		F	F	F	F
Motor power, 50/60 Hz	kW (hp)	1.1 (1.5) / 1.4 (1.9)	1.1 (1.5) / 1.4 (1.9)	2.2 (3.0) / 2.4 (3.3)	2.2 (3.0) / 2.4 (3.3)
Nominal speed, approx. (50/60 Hz)	rpm	3000/3600	3000/3600	3000/3600	3000/3600
Max. permissible speed	rpm	6000	6000	6000	6000
Type of protection	IP	20	20	20	20
Oil filling for the bearing chamber <sup>4)</sup>		1. Filling <sup>5)</sup> / 2. Filling	1. Filling <sup>5)</sup> / 2. Filling	1. Filling <sup>5)</sup> / 2. Filling	1. Filling <sup>5)</sup> / 2. Filling
PFPE					
vertical pumping action, approx.	I (qt)	0.6 (0.63) / 0.55 (0.58)	0.6 (0.63) / 0.55 (0.58)	0.85 (0.9) / 0.75 (0.79)	0.85 (0.9) / 0.75 (0.79)
horizontal pumping action, approx.	I (qt)	0.5 (0.53) / 0.45 (0.48)	0.5 (0.53) / 0.45 (0.48)	0.75 (0.79) / 0.7 (0.74)	0.75 (0.79) / 0.7 (0.74)
other oils					
vertical pumping action, approx.	I (qt)	0.65 (0.69) / 0.6 (0.63)	0.65 (0.69) / 0.6 (0.63)	0.9 (0.95) / 0.8 (0.85)	0.9 (0.95) / 0.8 (0.85)
horizontal pumping action, approx.	I (qt)	0.5 (0.53) / 0.45 (0.48)	0.5 (0.53) / 0.45 (0.48)	0.75 (0.79) / 0.7 (0.74)	0.75 (0.79) / 0.7 (0.74)
Connection flanges	DN	63 ISO-K	63 ISO-K	63 ISO-K	63 ISO-K
Weight WS / WSU	kg (lbs)	90.0 / 95.0 (198.5 / 209.5)	90.0 / 95.0 (198.5 / 209.5)	130.0 / 135.0 (286.7 / 297.7)	130.0 / 135.0 (286.7 / 297.7)
Noise level <sup>6)</sup>	dB(A)	< 63	< 63	< 63	< 63

<sup>1)</sup> To DIN 28 400 and subsequent numbers

<sup>2)</sup> With double-stage rotary vane vacuum pump TRIVAC or single-stage rotary vane vacuum pump SOGEVAC  
(Type of backing pump look at max. pumping speed)

When using 2-stage backing pumps the ultimate pressures will be correspondingly lower

<sup>3)</sup> Applicable for ratio up to 1 : 10 between backing pump and Roots vacuum pump at 3000 rpm

<sup>4)</sup> Authoritative, however, is the oil level at the oil-level glass

<sup>5)</sup> After a complete disassembly

<sup>6)</sup> At an operating pressure < 10<sup>-1</sup> mbar (< 0.75 x 10<sup>-1</sup> Torr)

## Technical Data

### WS/WSU(H) 1001

### WS/WSU(H) 2001

		50 Hz	60 Hz	50 Hz	60 Hz
Nominal pumping speed <sup>1)</sup>	m <sup>3</sup> x h <sup>-1</sup> (cfm)	1000 (589)	1200 (707)	2050 (1207.5)	2460 (1449)
Max. pumping speed with backing pump	m <sup>3</sup> x h <sup>-1</sup> (cfm) SOGEVAC	800 (470) SV 300	1000 (588) SV 300	1850 (1089) SV 630 F	2100 (1236) SV 630 F
Ultimate partial pressure <sup>2)</sup>	mbar (Torr)	< 8 x 10 <sup>-3</sup> (< 6 x 10 <sup>-3</sup> )	< 8 x 10 <sup>-3</sup> (< 6 x 10 <sup>-3</sup> )	< 8 x 10 <sup>-3</sup> (< 6 x 10 <sup>-3</sup> )	< 8 x 10 <sup>-3</sup> (< 6 x 10 <sup>-3</sup> )
Ultimate total pressure <sup>2)</sup>	mbar (Torr)	< 4 x 10 <sup>-2</sup> (< 3 x 10 <sup>-2</sup> )	< 4 x 10 <sup>-2</sup> (< 3 x 10 <sup>-2</sup> )	< 4 x 10 <sup>-2</sup> (< 3 x 10 <sup>-2</sup> )	< 4 x 10 <sup>-2</sup> (< 3 x 10 <sup>-2</sup> )
Possible cut-in pressure <sup>2)</sup> RUVAC WS	mbar (Torr)	60.0 (45.0)	45.0 (33.5)	30.0 (22.5)	25.0 (18.5)
Max. permissible pressure difference during continuous operation <sup>3)</sup>	mbar (Torr)	80.0 (60.0)	80.0 (60.0)	50.0 (37.5)	50.0 (37.5)
Leak rate, integral	mbar x l x s <sup>-1</sup>	< 1 x 10 <sup>-4</sup>	< 1 x 10 <sup>-4</sup>	< 1 x 10 <sup>-4</sup>	< 1 x 10 <sup>-4</sup>
Main supply					
Δ / Y	V	200 / –	200-208 / –	200 / –	200-208 / –
Δ / Y	V	230 / 400	265 / 460	230 / 400	265 / 460
Thermal class		F	F	F	F
Motor power, 50/60 Hz	kW (hp)	4.0/4.4 (5.4/6.0)	4.0/4.4 (5.4/6.0)	7.5 / 8.5 (10.0/11.6)	7.5/8.5 (10.0/11.6)
Nominal speed, approx. (50/60 Hz)	rpm	3000/3600	3000/3600	3000/3600	3000/3600
Max. permissible speed	rpm	6000	6000	4200 <sup>6)</sup>	4200 <sup>6)</sup>
Type of protection to EN 60 529	IP	20	20	20	20
Oil filling for the bearing chamber <sup>5)</sup> PFPE vertical pumping action, approx.		1. Filling <sup>6)</sup> / 2. Filling	1. Filling <sup>6)</sup> / 2. Filling	1. Filling <sup>6)</sup> / 2. Filling	1. Filling <sup>6)</sup> / 2. Filling
	l (qt)	1.95 / 1.75 (2.06 / 1.85)	1.95 / 1.75 (2.06 / 1.85)	3.0 / 2.7 (3.17 / 2.85)	3.0 / 2.7 (3.17 / 2.85)
horizontal pumping action, approx.			1.2 / 1.1		
	l (qt)	1.2 / 1.1 (1.27 / 1.16)	1.2 / 1.1 (1.27 / 1.16)	2.1 / 1.9 (2.22 / 2.00)	2.1 / 1.9 (2.22 / 2.00)
other oils vertical pumping action, approx.					
	l (qt)	2.0 / 1.8 2.11 / 1.90	2.0 / 1.8 2.11 / 1.90	3.85 / 3.6 (4.07 / 3.81)	3.85 / 3.6 (4.07 / 3.81)
horizontal pumping action, approx.					
	l (qt)	1.2 / 1.1 (1.27 / 1.16)	1.2 / 1.1 (1.27 / 1.16)	2.6 / 2.4 (2.75 / 2.54)	2.6 / 2.4 (2.75 / 2.54)
Connection flanges	DN	100 ISO-K	100 ISO-K	160 ISO-K	160 ISO-K
Weight WS / WSU	kg (lbs)	228.0 / 233.0 (502.7 / 513.8)	228.0 / 233.0 (502.7 / 513.8)	458.0 / 465.0 (1009.9 / 1025.3)	458.0 / 465.0 (1009.9 / 1025.3)
Noise level <sup>7)</sup>	dB(A)	< 68	< 68	< 72	< 72

<sup>1)</sup> To DIN 28 400 and subsequent numbers

<sup>2)</sup> With single-stage rotary vane vacuum pump SOGEVAC or dry compressing vacuum pump SCREWLINE  
(Type of backing pump look at max. pumping speed)

When using 2-stage backing pumps the ultimate pressures will be correspondingly lower

<sup>3)</sup> Applicable for ratio up to 1 : 10 between backing pump and Roots vacuum pump at 3000 rpm

<sup>4)</sup> Also 6000 rpm upon order

<sup>5)</sup> Authoritative, however, is the oil level at the oil-level glass

<sup>6)</sup> After a complete disassembly

<sup>7)</sup> At an operating pressure < 10<sup>-1</sup> mbar (< 0.75 x 10<sup>-1</sup> Torr)

## Ordering Information

**WS/WSU**

**WS/WSU(H)**

**WS/WSU(H)**

**WS/WSU(H)**

**251**

**501**

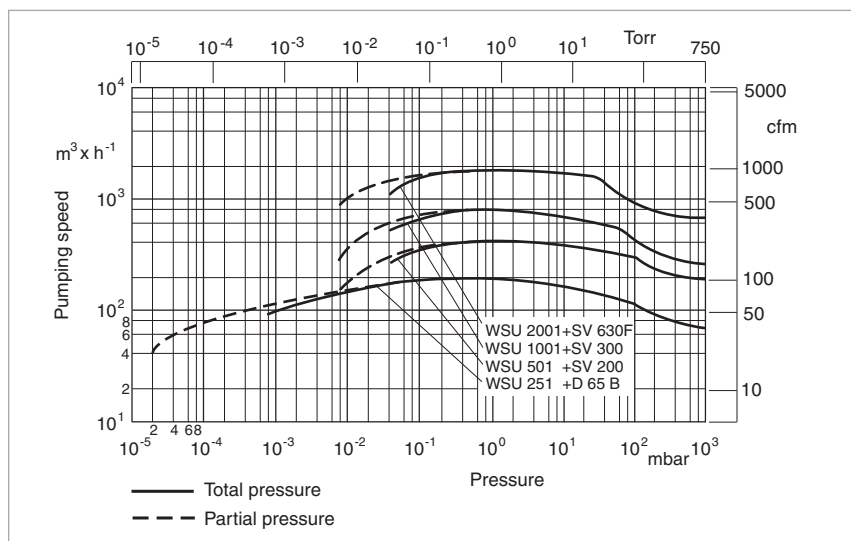
**1001**

**2001**

Roots vacuum pump				
RUVAC WS	<b>Part No.</b> 117 22	<b>Part No.</b> 117 32	<b>Part No.</b> 117 42	<b>Part No.</b> 117 52
RUVAC WSU	<b>Part No.</b> 117 23	<b>Part No.</b> 117 33	<b>Part No.</b> 117 43	<b>Part No.</b> 117 53
RUVAC WS PFPE	<b>Part No.</b> 117 27	<b>Part No.</b> 117 37	<b>Part No.</b> 117 47	<b>Part No.</b> 117 57
RUVAC WSU PFPE	<b>Part No.</b> 117 28	<b>Part No.</b> 117 38	-	<b>Part No.</b> 200 03 123
RUVAC WSU PFPE (US version)	-	-	<b>Part No.</b> 917 48	-
RUVAC WS 2001, GS 555 (max. 100 Hz)	-	-	-	<b>Part No.</b> 167 007
RUVAC WS 2001, PFPE (max. 100 Hz)	-	-	-	<b>Part No.</b> 150 95
RUVAC WSU 2001, GS 555 (max. 100 Hz)	-	-	-	<b>Part No.</b> 150 96
RUVAC WSU H	-	<b>Part No.</b>	<b>Part No.</b>	<b>Part No.</b>
with special ACE vibration absorber	-	118 33	118 43	118 53
RUVAC WSU H, PFPE	-	-	<b>Part No.</b>	-
with special ACE vibration absorber	-	-	150 47	-
RUVAC WS/WSU(H) seal kit	<b>Part No.</b> 194 62	<b>Kat.-Nr</b> 194 66	<b>Part No.</b> 194 70	<b>Part No.</b> 194 74
Flange adapter set, consisting of flange adapter with screws, bolts, washers and nuts for ANSI flange				
	<b>(3" ANSI)</b>	<b>(3" ANSI)</b>	<b>(4" ANSI)</b>	<b>(6" ANSI)</b>
WA/WS pump	<b>Part No.</b> 200 03 179	<b>Part No.</b> 200 03 179	<b>Part No.</b> 200 03 180	<b>Part No.</b> 200 03 181
WU/WSU pump	<b>Part No.</b> 200 03 179	<b>Part No.</b> 200 03 179	<b>Part No.</b> 200 03 180	<b>Part No.</b> 200 03 182
Frequency converter RUVATRONIC (see description in Section "General", paragraph "Accessories")	<b>RT 5/251</b> <b>Part No.</b> 500 001 381	<b>RT 5/501</b> <b>Part No.</b> 500 001 382	<b>RT 5/1001</b> <b>Part No.</b> 500 001 383	<b>RT 5/2001</b> <b>Part No.</b> 500 001 384

## Accessories

Large maintenance kit	<b>Part No.</b>	<b>Part No.</b>	<b>Part No.</b>	<b>Part No.</b>
WS	EK 110 002 671	EK 110 002 672	EK 110 002 673	EK 110 002 674
WSU	EK 110 002 675	EK 110 002 676	EK 110 002 677	EK 110 002 678



Pumping speed of the RUVAC WS/WSU, 50 Hz



# RUVAC WS/WSU (W) PFPE Roots Vacuum Pumps with Water-Cooled Canned Motors



Single-stage Roots vacuum pump RUVAC WS 501 W shown with ISO-K 63 rotatable flanges

## Advantages to the User

- Two series
- Highly leak-tight air-cooled pumps driven by a water-cooled canned motor
- RUVAC WS/WSU(W) PFPE lubricated with perfluoropolyether (PFPE)
- WS and WSU PFPE pumps are identical except for the lubricant and the shipping package
- Over-temperature switch in the stator coil of the motor
- All elastomer seals made of FPM (FKM)/Viton
- Integrated pressure equalization line with differential pressure valve prevents overloading on WSU model
- RUVAC WS 501 bis 2001 may be operated over a wide frequency range using a frequency converter
- No shaft feedthrough to the atmosphere, thus particularly leaktight
- Pumping direction may be changed as required

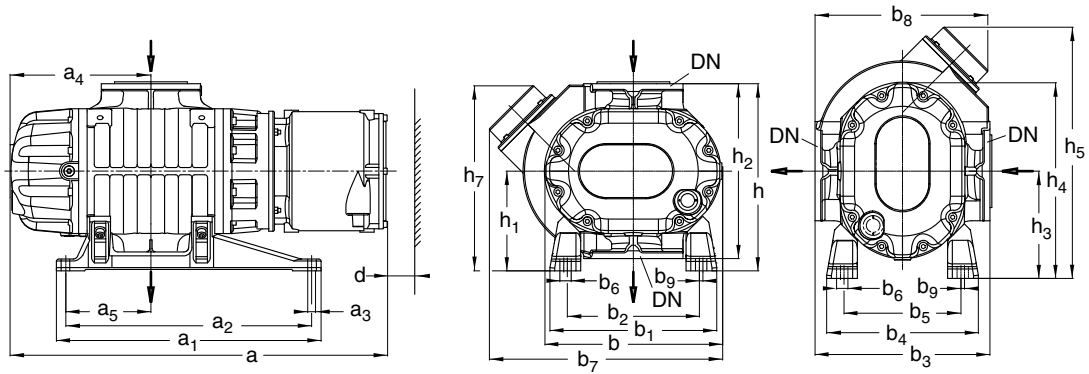
## Typical Applications

- For applications which require a high pumping speed at pressures between  $10^{-2}$  and  $10^{-4}$  mbar ( $0.75 \times 10^{-2}$  and  $0.75 \times 10^{-4}$  Torr)
- Used where the possibility of contamination due air ingress or pumped media leakage must be avoided
- Suction or pumping of high-purity or radioactive gases
- Is used in clean rooms where the air must not be recirculated by the motor's fan

## Supplied Equipment

- The required oil or PFPE filling is included in separate bottle (exceptions are marked)
- PFPE is used as standard
- Purged with nitrogen for corrosion protection
- Gasket in the intake flange with integrated dirt sieve





Type		DN	DN <sub>1</sub>	a	a <sub>1</sub>	a <sub>2</sub>	a <sub>3</sub>	a <sub>4</sub>	a <sub>5</sub>	
WS 501 W	mm	63 ISO-K	63 ISO-K	738	496	450	14	237	155	
	in.			29.06	19.53	17.72	0.55	9.33	6.10	
WS/WSU 1001 W	mm	100 ISO-K	100 ISO-K	793	560	520	16,5	298	180	
	in.			31.22	22.05	20.47	0.65	11.73	7.09	
WS/WSU 2001 W	mm	160 ISO-K	160 ISO-K	958	800	740	18	367	220	
	in.			437.72	31.50	29.13	0.71	14.45	8.66	
<hr/>										
		b	b <sub>1</sub>	b <sub>2</sub>	b <sub>3</sub>	b <sub>4</sub>	b <sub>5</sub>	b <sub>6</sub>	b <sub>7</sub> <sup>1)</sup>	b <sub>8</sub>
WS 501 W	mm	310	299	229	305	271	201	24	–	–
	in.	12.20	11.77	9.02	12.01	10.67	7.91	0.94	–	–
WS/WSU 1001 W	mm	372	352	278	370	320	246	24	494	366
	in.	14.65	13.86	10.94	14.57	12.60	9.69	0.94	19.45	14.41
WS/WSU 2001 W	mm	457	518	388	460	422	292	24	638	456
	in.	17.99	20.39	15.28	18.11	16.61	11.50	0.94	25.12	17.95
<hr/>										
		b <sub>9</sub>	d	h	h <sub>1</sub>	h <sub>2</sub>	h <sub>3</sub>	h <sub>4</sub>	h <sub>5</sub> <sup>1)</sup>	h <sub>6</sub>
WS 501 W	mm	7.5	50	331	180	305	194	348	–	–
	in.	0.30	2.00	13.03	7.09	12.01	7.64	13.70	–	–
WS/WSU 1001 W	mm	7.5	50	396	211	370	227	414	532	392
	in.	0.30	2.00	15.59	8.31	14.57	8.94	16.30	20.94	15.43
WS/WSU 2001 W	mm	7.5	50	530	300	460	351	578	760	523
	in.	0.30	2.00	20.87	11.81	18.11	13.82	22.76	29.92	20.59

<sup>1)</sup> For RUVAC WSU ... W only

Outside dimensions ± 3 mm (0.12 in.)

DN = ND 6 pump flange in accordance with DIN 2501

DN<sub>1</sub> = Collar flange with gasket for connecting ISO-K standard components

Dimensional drawing for the RUVAC WS/WSU(W) PFPE pumps

## Technical Data

## WS 501 W

		50 Hz	60 Hz
Nominal pumping speed <sup>1)</sup>	m <sup>3</sup> x h <sup>-1</sup> (cfm)	505.0 (297.4)	606.0 (357.0)
Max. pumping speed with backing pump	m <sup>3</sup> x h <sup>-1</sup> (cfm) SOGEVAC	410 (241) SV 200	530 (312) SV 200
Ultimate partial pressure <sup>2)</sup>	mbar (Torr)	< 8 x 10 <sup>-3</sup> (< 6 x 10 <sup>-3</sup> )	< 8 x 10 <sup>-3</sup> (< 6 x 10 <sup>-3</sup> )
Ultimate total pressure <sup>2)</sup>	mbar (Torr)	< 4 x 10 <sup>-2</sup> (< 3 x 10 <sup>-2</sup> )	< 4 x 10 <sup>-2</sup> (< 3 x 10 <sup>-2</sup> )
Permissible cut-in pressure <sup>2)</sup> RUVAC WS	mbar (Torr)	100 (75)	80 (60)
Max. permissible pressure difference during continuous operation <sup>3)</sup>	mbar (Torr)	80 (60)	80 (60)
Leak rate, integral	mbar x l x s <sup>-1</sup>	< 1 x 10 <sup>-4</sup>	< 1 x 10 <sup>-4</sup>
Main supply			
Δ / Y	V	200 / -	200-208 / -
Δ / Y	V	230 / 400	265 / 460
Thermal class		F	F
Motor power, 50/60 Hz	kW (hp)	2.2 (3.0)/2.4 (3.3)	2.2 (3.0)/2.4 (3.3)
Nominal speed, approx. (50/60 Hz)	rpm	3000/3600	3000/3600
Max. permissible speed	rpm	6000	6000
Type of protection	IP	40	40
Cooling water connection with inside thread		1/4" 18 NPT	1/4" 18 NPT
Cooling water consumption, min. at inlet temperature, max. 25 °C (77 °F)	l x h <sup>-1</sup>	200	200
Max. permissible cooling water pressure	bar	6	6
Oil filling for the bearing chamber <sup>4)</sup> PFPE vertical pumping action, approx.	l (qt)	0.85 (0.9) / 0.75 (0.79)	0.85 (0.9) / 0.75 (0.79)
horizontal pumping action, approx.	l (qt)	0.75 (0.79) / 0.7 (0.74)	0.75 (0.79) / 0.7 (0.74)
Connection flanges	DN	63 ISO-K	63 ISO-K
Weight	kg (lbs)	130.0 (286.7)	130.0 (286.7)
Noise level <sup>6)</sup>	dB(A)	< 63	< 63

<sup>1)</sup> To DIN 28 400 and subsequent numbers

<sup>2)</sup> With single-stage rotary vane vacuum pump SOGEVAC  
(Type of backing pump look at max. pumping speed).

When using 2-stage backing pumps the ultimate pressures will be correspondingly lower

<sup>3)</sup> Applicable for ratio up to 1 : 10 between backing pump and Roots vacuum pump at 3000 rpm

<sup>4)</sup> Authoritative, however, is the oil level at the oil-level glass

<sup>5)</sup> After a complete disassembly

<sup>6)</sup> At an operating pressure < 10<sup>-1</sup> mbar (< 0.75 x 10<sup>-1</sup> Torr)

## Technical Data

### WS/WSU 1001 W

### WS/WSU 2001 W

		50 Hz	60 Hz	50 Hz	60 Hz
Nominal pumping speed <sup>1)</sup>	m <sup>3</sup> x h <sup>-1</sup> (cfm)	1000 (589)	1200 (707)	2050 (1207.5)	2460 (1449)
Max. pumping speed with backing pump	m <sup>3</sup> x h <sup>-1</sup> (cfm) SCREWLINE	830 (489) SP250	1000 (588) SP250	1780 (1044) SP630	2080 (1224) SP630
Ultimate total pressure <sup>2)</sup>	mbar (Torr)	< 1 x 10 <sup>-3</sup> (< 7.5 x 10 <sup>-4</sup> )	< 1 x 10 <sup>-3</sup> (< 7.5 x 10 <sup>-4</sup> )	< 1 x 10 <sup>-3</sup> (< 7.5 x 10 <sup>-4</sup> )	< 1 x 10 <sup>-3</sup> (< 7.5 x 10 <sup>-4</sup> )
Permissible cut-in pressure <sup>2)</sup>					
RUVAC WS	mbar (Torr)	50.0 (37.5)	20.0 (15.0)	23.0 (17.25)	18.0 (13.5)
Max. permissible pressure difference during continuous operation <sup>3)</sup>	mbar (Torr)	80.0 (60.0)	50.0 (37.5)	50.0 (37.5)	50.0 (37.5)
Leak rate, integral	mbar x l x s <sup>-1</sup>	< 1 x 10 <sup>-4</sup>	< 1 x 10 <sup>-4</sup>	< 1 x 10 <sup>-4</sup>	< 1 x 10 <sup>-4</sup>
Main supply					
Δ / Y	V	200 / –	200-208 / –	200 / –	200-208 / –
Δ / Y	V	230 / 400	265 / 460	230 / 400	265 / 460
Thermal class		F	F	F	F
Motor power, 50/60 Hz	kW (hp)	4.0/4.4 (5.4/6.0)	4.0/4.4 (5.4/6.0)	7.5 /8.5 (10.2/11.6)	7.5/8.5 (10.2/11.6)
Nominal speed, approx. (50/60 Hz)	rpm	3000/3600	3000/3600	3000/3600	3000/3600
Max. permissible speed	rpm	6000	6000	4200 <sup>4)</sup>	4200 <sup>4)</sup>
Type of protection	IP	54	54	54	54
Cooling water connection with inside thread		2x G 3/8"	2x G 3/8"	2x G 1/2"	2x G 1/2"
Cooling water consumption, min. at inlet temperature, max. 25 °C (77 °F)	l x h <sup>-1</sup>	90	90	150	150
Max. permissible cooling water pressure	bar	7	7	7	7
Oil filling for the bearing chamber <sup>5)</sup>		1. Filling <sup>6)</sup> / 2. Filling	1. Filling <sup>6)</sup> / 2. Filling	1. Filling <sup>6)</sup> / 2. Filling	1. Filling <sup>6)</sup> / 2. Filling
PFPE vertical pumping action, approx.	l (qt)	1.95 / 1.75 (2.06 / 1.85)	1.95 / 1.75 (2.06 / 1.85)	3.0 / 2.7 (3.17 / 2.85)	3.0 / 2.7 (3.17 / 2.85)
horizontal pumping action, approx.	l (qt)	1.2 / 1.1 (1.27 / 1.16)	1.2 / 1.1 (1.27 / 1.16)	2.1 / 1.9 (2.22 / 2.00)	2.1 / 1.9 (2.22 / 2.00)
Connection flanges	DN	100 ISO-K	100 ISO-K	160 ISO-K	160 ISO-K
Weight WS / WSU	kg (lbs)	228.0 / 233.0 (502.7 / 513.8)	228.0 / 233.0 (502.7 / 513.8)	458.0 / 465.0 (1009.9 / 1025.3)	458.0 / 465.0 (1009.9 / 1025.3)
Noise level <sup>7)</sup>	dB(A)	< 68	< 68	< 72	< 72

<sup>1)</sup> To DIN 28 400 and subsequent numbers

<sup>2)</sup> With dry compressing vacuum pump SCREWLINE  
(Type of backing pump look at max. pumping speed).

When using 2-stage backing pumps the ultimate pressures will be correspondingly lower

<sup>3)</sup> Applicable for ratio up to 1 : 10 between backing pump and Roots vacuum pump at 3000 rpm

<sup>4)</sup> Also 6000 rpm upon order

<sup>5)</sup> Authoritative, however, is the oil level at the oil-level glass

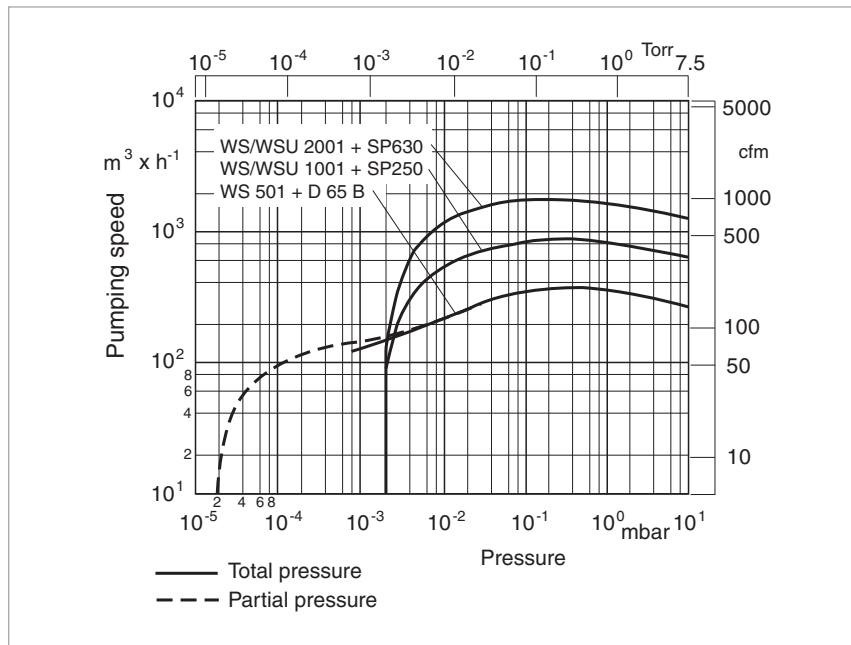
<sup>6)</sup> After a complete disassembly

<sup>7)</sup> At an operating pressure < 10<sup>-1</sup> mbar (< 0.75 x 10<sup>-1</sup> Torr)

## Ordering Information

	<b>WS</b> <b>501 W</b>	<b>WS/WSU</b> <b>1001 W</b>	<b>WS/WSU</b> <b>2001 W</b>
Roots vacuum pump RUVAC WS PFPE RUVAC WSU PFPE	<b>Part No. 128 60</b> -	<b>Part No. 155 042 <sup>1)</sup></b> <b>Part No. 155 043 <sup>1)</sup></b>	<b>Part No. 155 052 <sup>1)</sup></b> <b>Part No. 155 053 <sup>1)</sup></b>
RUVAC WS/WSU(H) seal kit	<b>Part No. 194 66</b>	<b>Part No. 194 70</b>	<b>Part No. 194 74</b>
Flange adapter set, consisting of flange adapter with screws, bolts, washers and nuts for ANSI flange	<b>(3" ANSI)</b> <b>Part No.</b>	<b>(4" ANSI)</b> <b>Part No.</b>	<b>(6" ANSI)</b> <b>Part No.</b>
WA/WS pump	<b>200 03 179</b>	<b>200 03 180</b>	<b>200 03 181</b>
WAU/WSU pump	-	<b>200 03 180</b>	<b>200 03 182</b>
Frequency converter RUVATRONIC (see description in Section "General", paragraph "Accessories")	<b>RT 5/501</b> <b>Part No.</b> <b>500 001 382</b>	<b>RT 5/1001</b> <b>Part No.</b> <b>500 001 383</b>	<b>RT 5/2001</b> <b>Part No.</b> <b>500 001 384</b>

<sup>1)</sup> Prepared for operation with PFPE, without PFPE filling



Pumping speed of the RUVAC WS/WSU (W) PFPE, 50 Hz



# RUVAC WH 700/702 Roots Vacuum Pumps with Water-Cooled Hermetically Sealed Motors for PFPE, Anderol and Mineral Oil



RUVAC WH 700 single-stage Roots vacuum pump

## Advantages to the User

- Lower energy costs through innovative motor technology (efficiency class 1)
- Minimized space requirements due to an extremely compact design and the possible direct adaptation to backing pumps
- Easy system integration
- Optimum price-to-performance ratio; high pumping speed (1730 m<sup>3</sup>/h at 120 Hz with optional frequency converter)
- Integrated water cooling system for installation within closed systems
- Parts in contact with the cooling water are made of stainless steel (corrosion-free)
- Trouble-free operation with toxic or corrosive media owing to the hermetically sealed motor and the purge gas option
- No shaft seals towards atmosphere, therefore high reliability, long service intervals and no oil leaks

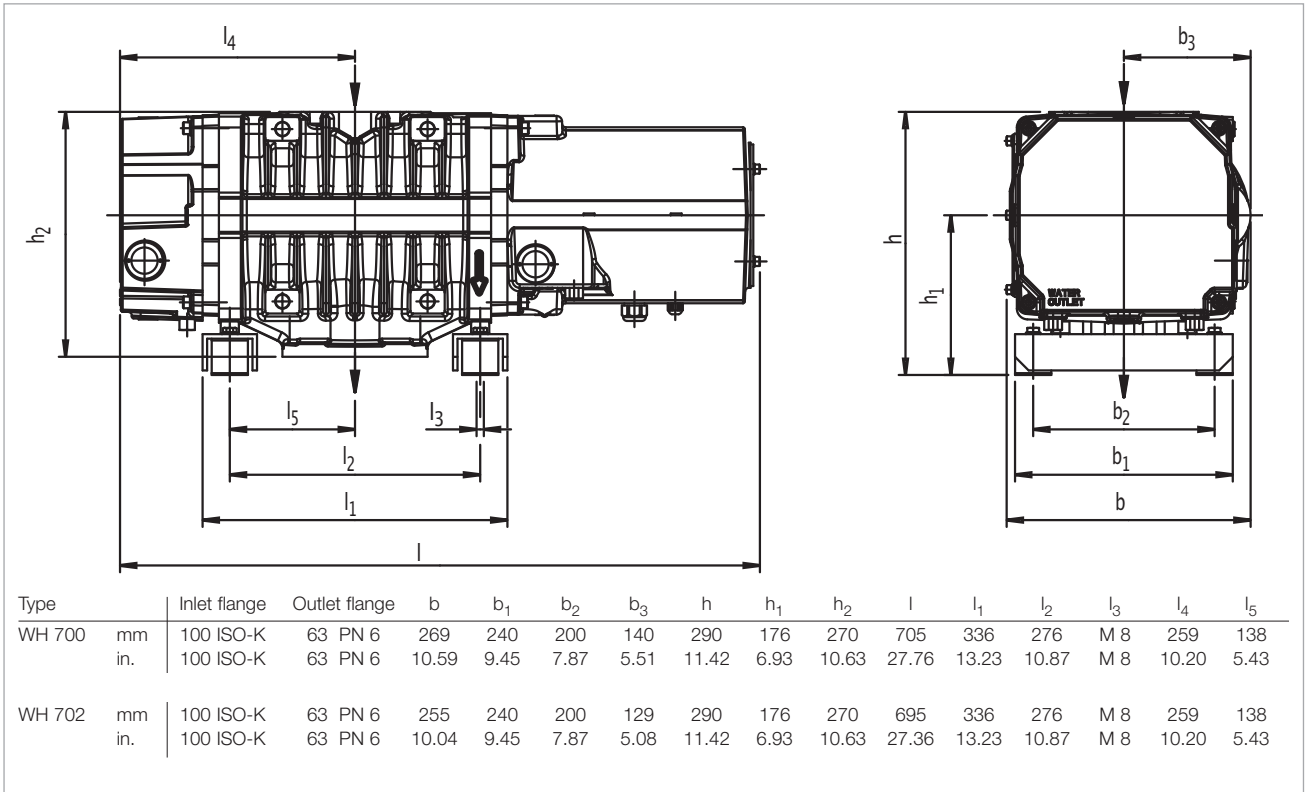
## Typical Applications

The Roots pumps of the WH series were developed for deployment in all applications with high requirements regarding operating pressure, cycle times and system uptime.

- Solar industry
- Furnace construction
- Industrial coating processes
- Research
- Space simulation

## Supplied Equipment

- RUVAC WA/WAU are supplied as standard for a vertical pumping action, no horizontal pumping action available
- Synthetic oil GS 555 is used as standard
- Gasket in the intake flange with dirt sieve
- The required oil filling is included in separate bottles



Dimensional drawing for the RUVAC WH 700 and WH 702



## Technical Data

## WH 700

		40 Hz <sup>1)</sup>	50 Hz	60 Hz	80 Hz <sup>1)</sup>	120 Hz <sup>1)</sup>
Nominal pumping speed <sup>2)</sup>	m <sup>3</sup> x h <sup>-1</sup> (cfm)	570 (336)	710 (418)	860 (507)	1150 (677)	1730 (1019)
Max. effective pumping speed at a pumping speed of the backing pump of 100 m <sup>3</sup> x h <sup>-1</sup> (58.9 cfm)	m <sup>3</sup> x h <sup>-1</sup> (cfm)	360 (212)	460 (271)	550 (324)	730 (430)	1100 (648)
Max. permissible pressure difference during continuous operation <sup>3), 4)</sup>	mbar (Torr)	85.0 (63.75)	75.0 (56.25)	65.0 (48.75)	50.0 (37.50)	30.0 (22.50)
Nominal speed	rpm	2400	3000	3600	4800	7200
Max. permissible speed	rpm	7200	7200	7200	7200	7200
Min. permissible speed	rpm	1200 <sup>5)</sup>	1200 <sup>5)</sup>	1200 <sup>5)</sup>	1200 <sup>5)</sup>	1200 <sup>5)</sup>
Ultimate partial pressure with DURADRY pumps	mbar (Torr)	< 8 <sup>-3</sup> (< 6 <sup>-3</sup> )	< 8 <sup>-3</sup> (< 6 <sup>-3</sup> )	< 8 <sup>-3</sup> (< 6 <sup>-3</sup> )	< 8 <sup>-3</sup> (< 6 <sup>-3</sup> )	< 8 <sup>-3</sup> (< 6 <sup>-3</sup> )
Ultimate total pressure with DURADRY pumps	mbar (Torr)	< 4 <sup>-2</sup> (< 3 <sup>-2</sup> )	< 4 <sup>-2</sup> (< 3 <sup>-2</sup> )	< 4 <sup>-2</sup> (< 3 <sup>-2</sup> )	< 4 <sup>-2</sup> (< 3 <sup>-2</sup> )	< 4 <sup>-2</sup> (< 3 <sup>-2</sup> )
Leak rate, integral	mbar x l x s <sup>-1</sup>	< 1 x 10 <sup>-4</sup>	< 1 x 10 <sup>-4</sup>	< 1 x 10 <sup>-4</sup>	< 1 x 10 <sup>-4</sup>	< 1 x 10 <sup>-4</sup>
Permissible ambient temperatures	°C (°F)	+12 to +45 (+54 to +113)	+12 to +45 (+54 to +113)	+12 to +45 (+54 to +113)	+12 to +45 (+54 to +113)	+12 to +45 (+54 to +113)
Type of protection	IP	54	54	54	54	54
Water connection (4 pcs.)	G	1/4", female	1/4", female	1/4", female	1/4", female	1/4", female
Cooling water quantity	l/h	300 <sup>6)</sup>	300 <sup>6)</sup>	300 <sup>6)</sup>	300 <sup>6)</sup>	300 <sup>6)</sup>
Cooling water admission temperature	°C (°F)	+15 to +30 (+59 to +86)	+15 to +30 (+59 to +86)	+15 to +30 (+59 to +86)	+15 to +30 (+59 to +86)	+15 to +30 (+59 to +86)
Max. permissible cooling water pressure	bar	7	7	7	7	7
Lubricant filling (PFPE)						
Gear side	l (qt)	0.6 (0.63)	0.6 (0.63)	0.6 (0.63)	0.6 (0.63)	0.6 (0.63)
Motor side	l (qt)	0.3 (0.31)	0.3 (0.31)	0.3 (0.31)	0.3 (0.31)	0.3 (0.31)
Connection flange (DIN 2501, ND 6)						
Inlet	ISO-K	100	100	100	100	100
Outlet	ISO-K	65	65	65	65	65
Weight	kg (lbs)	125 (276)	125 (276)	125 (276)	125 (276)	125 (276)
Dimension (W x B x H)	mm (in.)	709 x 265 x 270 (27.91x10.43x10.63)	709 x 265 x 270 (27.91x10.43x10.63)	709 x 265 x 270 (27.91x10.43x10.63)	709 x 265 x 270 (27.91x10.43x10.63)	709 x 265 x 270 (27.91x10.43x10.63)
Noise level according to DIN 45635, Part 13	dB(A)	< 65	< 65	< 65	< 65	< 65
Permissible shipping and storage temperature	°C (°F)	-10 to +75 (+14 to +167)	-10 to +75 (+14 to +167)	-10 to +75 (+14 to +167)	-10 to +75 (+14 to +167)	-10 to +75 (+14 to +167)

<sup>1)</sup> Only possible with frequency converter motor and external frequency converter

<sup>2)</sup> To DIN 28 426 and subsequent numbers

<sup>3)</sup> Higher pressure differences are possible

<sup>4)</sup> Gas temperatures over 40 °C (104 °C) can result in a reduction of the pressure difference values; please consult Oerlikon Leybold Vacuum on this

<sup>5)</sup> system for the bearings and the gear, and must be taken into account as soon as the speed is constant for over five minutes. When operating the pump below the minimum permissible speed for a period of time exceeding five minutes, such operation can damage the pump due to insufficient lubrication

<sup>6)</sup> The cooling water quantity can be reduced provided the temperature of the discharged water does not exceed 45 °C (113 °C)

<sup>7)</sup> Please note that the WH 700 W PFPE is equipped with two independent oil reservoir chambers. Both chambers must be filled separately, respectively emptied separately. Moreover, the oil levels must be checked separately during operation

<sup>8)</sup> The typical operating frequency of the frequency converter is 8 kHz. The total harmonic distortion for the motor current amounts to 12% approx

## Ordering Information

## WH 700

## WH 702

Roots vacuum pump RUVAC WH vertical flow direction 2.2 kW internal FC and PFPE filling internal FC and GS 555 filling 2.2 / 2.6 kW for direct inline operation 50/60 Hz 200 / 220 V	- - <b>Part No. 155 202</b>	<b>Part No. 155 100</b> <b>Part No. 155 105</b> -
400 / 460 V	<b>Part No. 155 203</b>	-
3.5 kW for FC operation 200 V	<b>Part No. 155 204V</b>	-
400 V	<b>Part No. 155 205V</b>	-
Frequency converter 200 / 240 V motor power 4 kW (for Part. No. 155 204V)	<b>Part No. 155 210V</b>	-
400 / 480 V motor power 4 kW (for Part. No. 155 205V)	<b>Part No. 155 211V</b>	-
Mains filter 200 to 240 V (for Part. No. 155 204V)	<b>Part No. 155 215V</b>	-
400 to 480 V (for Part. No. 155 205V)	<b>Part No. 155 216V</b>	-
LCD display (for Part. No. 155 210V and 155 211V)	<b>Part No. 155 213V</b>	-
Interface cable (for Part. No. 155 210V and 155 211V)	<b>Part No. 155 214V</b>	-
Profibus DP module <sup>1)</sup> (for Part. No. 155 210V and 155 211V)	<b>Part No. 155 212V</b>	-
Oil drain facility (M 16 x 1.5) with 90° drain coupling	<b>Part No. 200 14 271</b>	<b>Part No. 200 14 271</b>
Reducer DN 100/63 ISO-K	<b>Part No. 267 47</b>	<b>Part No. 267 47</b>
Major maintenance kit	-	<b>Part No. EK 110 002 691</b>

<sup>1)</sup> For further bus options please contact Oerlikon Leybold Vacuum Sales

# RUVAC WH/WHU Roots Vacuum Pumps with Water-Cooled Hermetically Sealed Motors with Mineral Oil, Synthetic Oil or PFPE filling



RUVAC WH 4400 single-stage Roots vacuum pump with hermetically sealed motor

## Advantages to the User

- Lower energy costs through innovative motor technology (efficiency class 1)
- Minimized space requirements due to an extremely compact design
- Easy system integration
- Optimum price-to-performance ratio; high pumping speed (9800 m<sup>3</sup>/h @ 70 Hz with optional frequency converter)
- Integrated water cooling system for installation within closed systems
- Parts in contact with the cooling water are made of stainless steel (corrosion-free)
- Trouble-free operation with toxic or corrosive media owing to the hermetically sealed motor and the purge gas option
- No shaft seals towards atmosphere, therefore high reliability, long service intervals and no oil leaks
- Flexible installation; selectable vertical or horizontal gas flow
- Secure operation and faster pump down in short cycle operation with optional bypass-line

## RUVAC WHU with bypass line

- Maximum efficiency in short cycle operation for the WHU types with bypass line and newly developed control flap
- Reduced pumpdown time
- Pump start-up at atmospheric pressure possible
- Optimized cycle time for the control flap (patent pending); delivers an even faster response compared to operation with frequency converter
- Extreme contamination resistance of the control flap

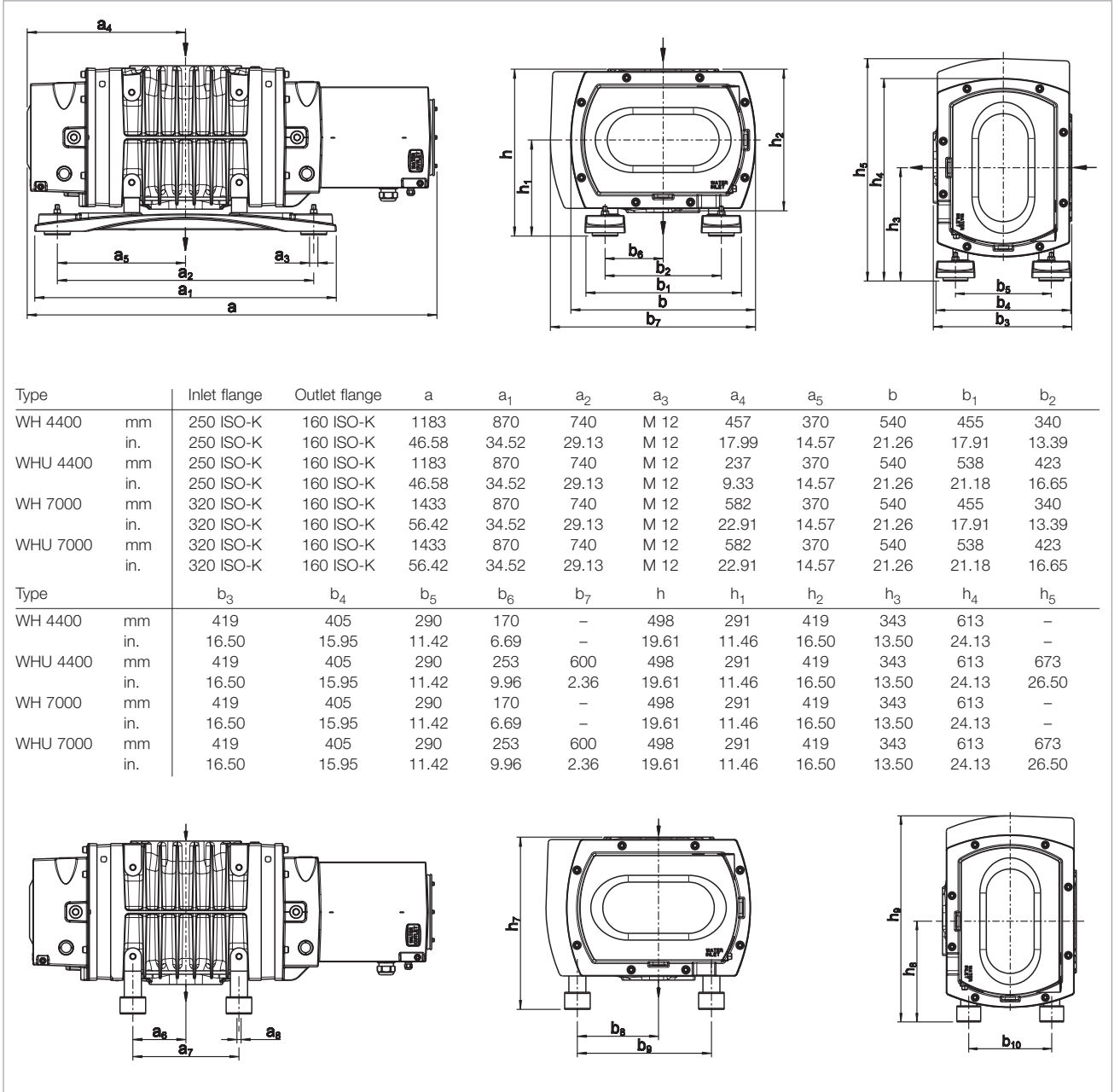
## Typical Applications

The Roots pumps of the WH series were developed for deployment in all applications with high requirements regarding operating pressure, cycle times and system uptime.

- Solar industry
- Furnace construction
- Industrial coating processes
- Research
- Space simulation

## Supplied Equipment

- Pump will be delivered with standard shock absorbers
- Synthetic oil GS 555 is used as standard
- Gasket in the intake flange with dirt sieve
- The required oil filling is included in separate bottles



Dimensional drawing for the RUVAC WH/WHU pumps; above with pump feet

## Technical Data

### WH/WHU 4400

### WH/WHU 7000

		50 Hz	60 Hz	80 Hz	50 Hz	60 Hz	70 Hz
Nominal pumping speed <sup>1)</sup>	m <sup>3</sup> x h <sup>-1</sup> (cfm)	4400 (2592)	5280 (8964)	7040 (4147)	7000 (4123)	8400 (4948)	9800 (5772)
Max. effective pumping speed with backing pump							
SCREWLINE SP630	m <sup>3</sup> x h <sup>-1</sup> (cfm)	3300 (1944)	3900 (2297)	4800 (2827)	4700 (2768)	5300 (3122)	5800 (3416)
and RUVAC WS 2001	m <sup>3</sup> x h <sup>-1</sup> (cfm)	3700 (2179)	4400 (2592)	5800 (3416)	5700 (3357)	6800 (4005)	7800 (4594)
Max. permissible pressure difference during continuous operation	mbar (Torr)	30 to 45 <sup>2)</sup> (22.5 to 33.75) <sup>2)</sup>	20 to 30 <sup>2)</sup> (15.0 to 22.5) <sup>2)</sup>	8 to 12 <sup>2)</sup> (6.0 to 9.0) <sup>2)</sup>	20 to 30 <sup>2)</sup> (15.0 to 22.5) <sup>2)</sup>	14 to 21 <sup>2)</sup> (10.5 to 15.75) <sup>2)</sup>	11 to 14 <sup>2)</sup> (8.25 to 10.5) <sup>2)</sup>
Leak rate, integral	mbar x l x s <sup>-1</sup>	1 x 10 <sup>-4</sup>	1 x 10 <sup>-4</sup>	1 x 10 <sup>-4</sup>	1 x 10 <sup>-4</sup>	1 x 10 <sup>-4</sup>	1 x 10 <sup>-4</sup>
Permissible ambient temperatures	°C (°F)	+12 to +40 <sup>3)</sup> (+54 to +104) <sup>3)</sup>	+12 to +40 <sup>3)</sup> (+54 to +104) <sup>3)</sup>	+12 to +40 <sup>3)</sup> (+54 to +104) <sup>3)</sup>	+12 to +40 <sup>3)</sup> (+54 to +104) <sup>3)</sup>	+12 to +40 <sup>3)</sup> (+54 to +104) <sup>3)</sup>	+12 to +40 <sup>3)</sup> (+54 to +104) <sup>3)</sup>
Mains voltage	V	400 (200) <sup>4)</sup>	460 (200) <sup>4)</sup>	FC	400 (200) <sup>4)</sup>	460 (200) <sup>4)</sup>	FC
Nominal power consumption	kW (hp)	11.0 / 18.5 14.75 / 24.81	11.0 / 18.5 14.75 / 24.81	11.0 / 18.5 14.75 / 24.81	11.0 / 18.5 14.75 / 24.81	11.0 / 18.5 14.75 / 24.81	11.0 / 18.5 14.75 / 24.81
Idle mode power consumption	kW (hp)	1.2 (1.6)	1.4 (1.9)	2.0 (2.7)	1.2 (1.6)	1.4 (1.9)	2.0 (2.7)
Nominal speed	rpm	3000	3600	4800	3000	3600	4200
Max. permissible speed	rpm	4800 <sup>5)</sup>	4800 <sup>5)</sup>	4800 <sup>5)</sup>	4200 <sup>5)</sup>	4200 <sup>5)</sup>	4200 <sup>5)</sup>
Type of protection	IP	54	54	54	54	54	54
Water connection (4 pcs.)	G	1/4", female	1/4", female	1/4", female	1/4", female	1/4", female	1/4", female
Cooling water quantity	l/h	180 to 360	180 to 360	180 to 360	180 to 360	180 to 360	180 to 360
Max. permissible cooling water pressure bar		6	6	6	6	6	6
Lubricant filling	l (qt)	4.75 (5.0)	4.75 (5.0)	4.75 (5.0)	4.75 (5.0)	4.75 (5.0)	4.75 (5.0)
Connection flange (DIN 2501, ND 6)							
Inlet	ISO-K	250	250	250	320	320	320
Outlet	ISO-K	160	160	160	160	160	160
Weight WH / WHU	kg (lbs)	590 (1301)	590 (1301)	590 (1301)	650 (1433)	650 (1433)	650 (1433)
Noise level <sup>6)</sup> according to DIN EN ISO 2151	dB(A)	< 63	< 63	< 63	< 63	< 63	< 63

<sup>1)</sup> To DIN 28 400 and subsequent numbers

<sup>2)</sup> Permissible pressure difference are dependent on various factors. Please see manual for further details

<sup>3)</sup> Higher ambient temperatures are possible with reduced operating limits. Please consult Oerlikon Leybold Vacuum for details

<sup>4)</sup> Low voltage available as option for the 11 kW (14.75 hp) motor

<sup>5)</sup> Min. permissible speed: 1200 rpm if run for more than 2 minutes

<sup>6)</sup> Valid for 50 Hz operation under ultimate pressure conditions.

Higher rotational speeds and especially pressure levels about 10 mbar (7.5 Torr) will result in higher noise levels

## Ordering Information

## WH/WHU

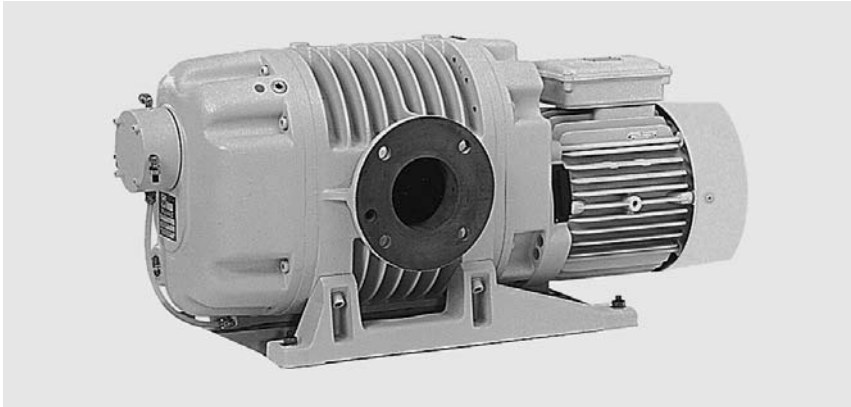
**4400**

**7000**

Roots vacuum pump		
RUVAC WH GS 555, 11 kW	<b>Part No. 155 150</b>	<b>Part No. 155 160</b>
RUVAC WH GS 555, 18 kW	-	<b>Part No. 155 167</b>
RUVAC WH PFPE, 11 kW		
400 V	<b>Part No. 155 155</b>	<b>Part No. 155 165</b>
200 V	<b>Part No. 155 156</b>	-
RUVAC WHU GS 555, 18 kW		
bypass valve	-	<b>Part No. 155 162</b>
Frequency converter		
11.0 kW short cycle operation	<b>Part No. 155 190V</b>	<b>Part No. 155 190V</b>
11.0 kW continuous operation	<b>Part No. 155 191V</b>	<b>Part No. 155 191V</b>
18.5 kW short cycle operation	<b>Part No. 155 193V</b>	<b>Part No. 155 193V</b>
Line filter for frequency converter	<b>Part No. 155 195V</b>	<b>Part No. 155 195V</b>
LCD display (for Part. No. 155 190V, 155 191V and 155 193V)	<b>Part No. 155 213V</b>	<b>Part No. 155 213V</b>
Interface cable (for Part. No. 155 190V, 155 191V and 155 193V)	<b>Part No. 155 214V</b>	<b>Part No. 155 214V</b>
Profibus DP module <sup>1)</sup> (for Part. No. 155 190V, 155 191V and 155 193V)	<b>Part No. 155 212V</b>	<b>Part No. 155 212V</b>
Pump feet (set)	<b>Part No. 155 180</b>	<b>Part No. 155 180</b>
Major maintenance kit	<b>Part No. EK 110 002 828</b>	<b>Part No. EK 110 002 828</b>
Spare motor		
11.0 kW	<b>Part No. E 110 000 406</b>	<b>Part No. EK 110 000 406</b>
18.5 kW	<b>Part No. E 110 000 405</b>	<b>Part No. EK 110 000 405</b>

<sup>1)</sup> For further bus options please contact Oerlikon Leybold Vacuum Sales

# RUVAC WSLF Roots Vacuum Pumps for Laser Gas Systems



RUVAC WSLF 1001 LF Roots vacuum pump

Roots vacuum pumps driven by canned motors are available for gas laser systems.

## Advantages to the User

- A gas mixture of helium, nitrogen and carbon monoxide is continuously circulated at a reduced system pressure
- High pumping speed from a small, quiet running pump
- Operation with a frequency converter is possible
- Nickel-plated pump chamber surfaces
- Through an additional vacuum pump the bearing chambers may be evacuated to a pressure lower than the pressure within the pumping chamber of the RUVAC
- Water-cooled oil separating system
- Integrated oil separating system for extended maintenance intervals

## Typical Applications

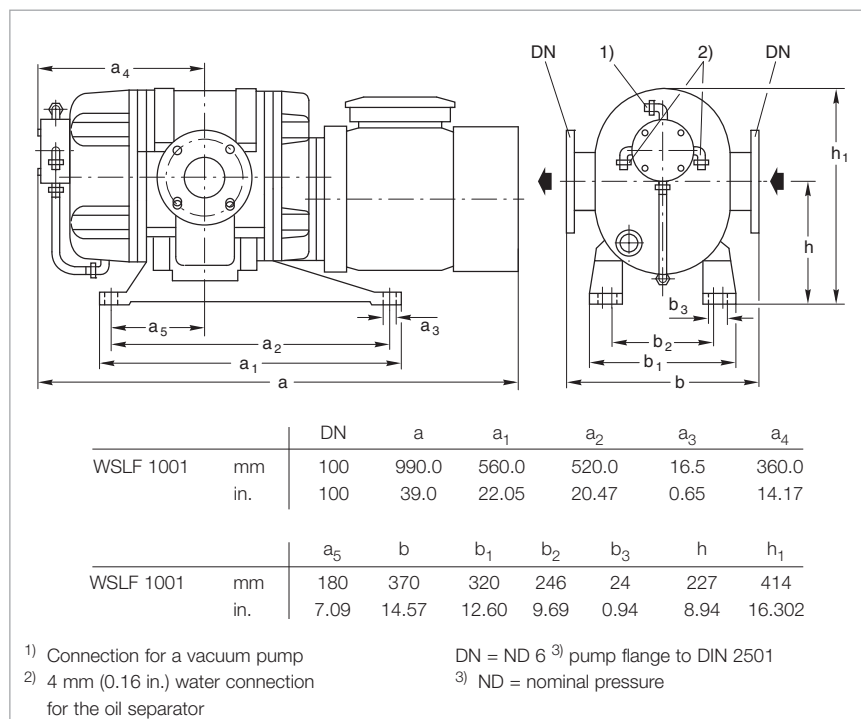
- Processing of ferrous and non-ferrous materials like welding, cutting and surface refinement

## Technical Note

- The gas circulation system must be very clean and entirely free of hydrocarbons

## Supplied Equipment

- Horizontal pumping action as standard
- With oil pressure switch and oil drain facility
- The required oil filling is included separately (special oil ANDEROL 2100 HTCL)
- Purged with nitrogen for corrosion protection



Dimensional drawing for the RUVAC WSLF pumps

**Technical Data****WSLF 1001**

		<b>50 Hz</b>	<b>60 Hz</b>
Nominal pumping speed <sup>1)</sup>	m <sup>3</sup> x h <sup>-1</sup> (cfm)	1000 (589)	1200 (707)
Max. permissible pressure difference during continuous operation	mbar (Torr)	80 (60)	80 (60)
Main supply Δ / Y	V	200-230 / 400	200-265 / 460
Motor power	kW (hp)	7.5 (10.2)	8.5 (11.6)
Nominal speed	rpm	3000	3600
Max. permissible speed	rpm	6000	6000
Type of protection	IP	20	20
Oil filling of the bearing chambers	l (qt)	1.2 (1.27)	1.2 (1.27)
Connection flange DIN 2501	DN	100	100
Weight	kg (lbs)	275 (606.4)	275 (606.4)
Cooling water pressure	bar (psi)	1 to 5 (14.5 to 72.5)	1 to 5 (14.5 to 72.5)
Cooling water throughput	l x h <sup>-1</sup> (cfm)	200.0 (0.9)	200.0 (0.9)
Hose connection for hose		6 x 1	6 x 1

**Ordering Information****WSLF 1001**

RUVAC WSLF Roots vacuum pump RUVAC WSLF 1001	<b>Part No. 117 94</b>
RUVAC WSLF seal kit	<b>Part No. 194 70</b>

<sup>1)</sup> To DIN 28 400 and subsequent numbers



# RUVAC RA Roots Vacuum Pumps with Flange-Mounted Air-Cooled Motors



RUVAC RA 5001 single-stage Roots vacuum pump

Roots vacuum pumps offering a high pumping speed.

## Advantages to the User

- Oil immersed radial shaft seals made of FPM (FKM) for sealing against the atmosphere
- Use of universal IEC motors (50/60 Hz)
- The motors fulfil in Europe (50 Hz) the efficiency requirements in accordance with EFF1
- In the USA (60 Hz) the motors are UL approved and fulfil the efficiency requirements in accordance with EPAC
- If required with external pressure equalisation line and differential pressure valve so that the pump may be switched on jointly with the backing pump at atmospheric pressure
- Motors can easily be exchanged for special voltage motors. Explosion protected motors and motors for special main frequencies upon request
- Over-temperature switch in the stator coil of the motor
- Rugged dry compressing vacuum pump
- Most reliable even under rough operating conditions
- ATEX versions compliant to 94/9/EC possible

## Typical Applications

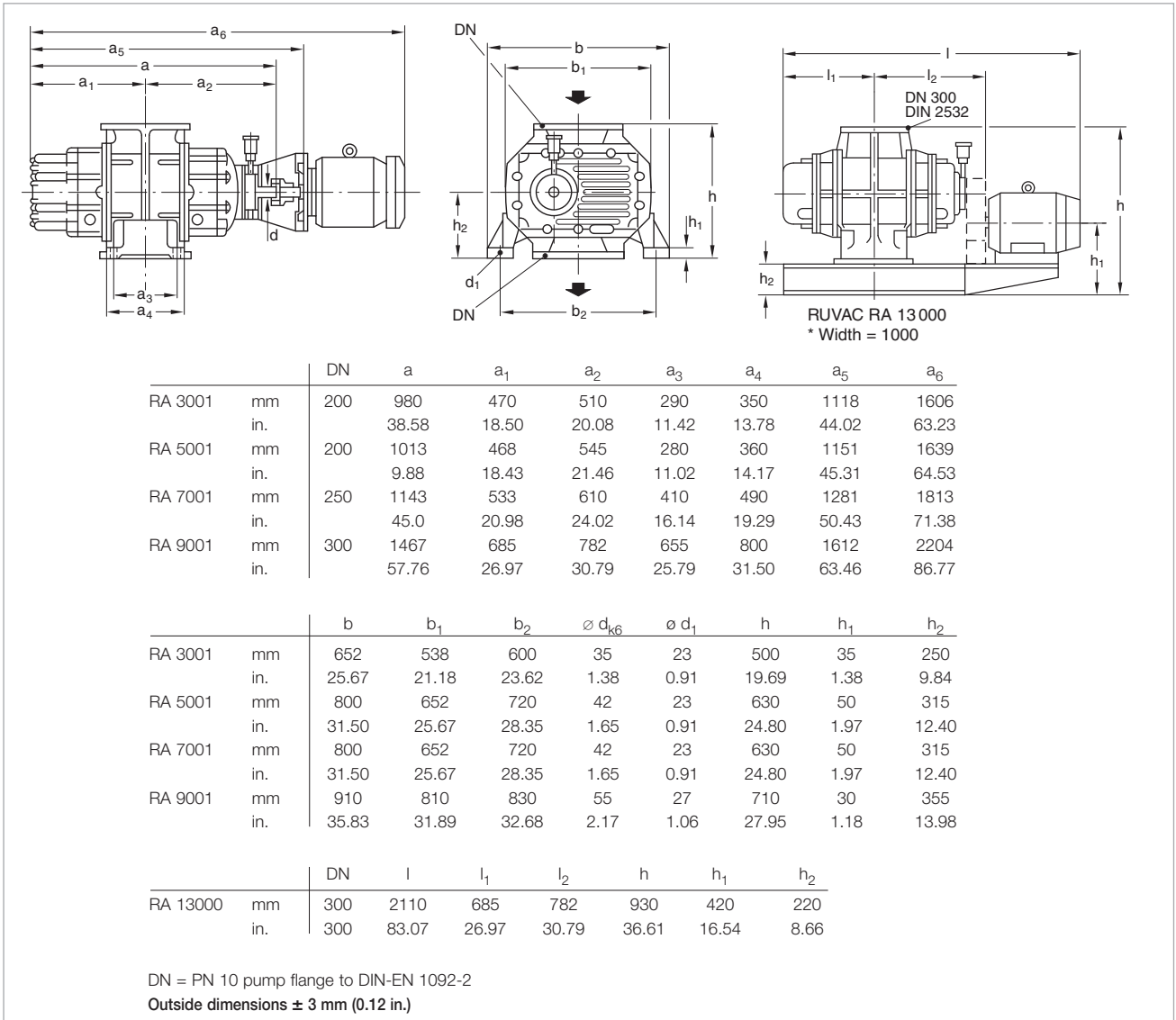
- Large vacuum systems like sintering and annealing furnaces which require multi-stage pumpsets
- In large vacuum rectification systems Roots vacuum pumps with postcondensers for compressing of vapors

## Custom Pumps

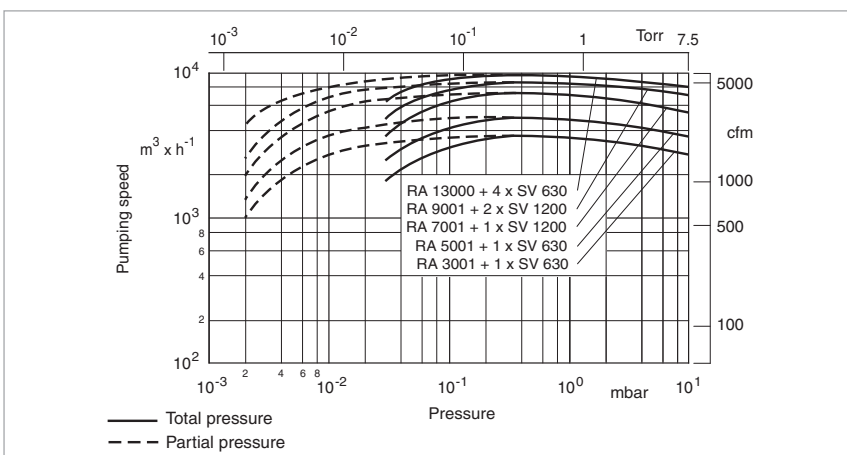
- If required the RA pumps are also available as C versions (chemical versions)
- Pumps made of special materials may be specified as well as pressure burst resistant pumps
- Custom designed pumps for pumping speeds of 250 m<sup>3</sup>/h to 2000 m<sup>3</sup>/h (147.3 to 1178 cfm)

## Technical Note

For operation ordering of oil is necessary (see section "Miscellaneous")



Dimensional drawing for the RUVAC RA pumps



Pumping speed curves for the RUVAC RA, 50 Hz

## Technical Data

### RA 3001

### RA 5001

		50 Hz	60 Hz	50 Hz	60 Hz
Nominal pumping speed <sup>1)</sup>	m <sup>3</sup> x h <sup>-1</sup> (cfm)	3845 (2264)	4625 (2724)	5450 (3210)	6560 (3864)
Max. pumping speed with backing pump	m <sup>3</sup> x h <sup>-1</sup> (cfm) SOGEVAC	3200 (1883) SV 630 F	3850 (2266) SV 630 F	4300 (2531) SV 630 F	5200 (3061) SV 630 F
Ultimate partial pressure <sup>2)</sup>	mbar (Torr)	< 8 x 10 <sup>-3</sup> (< 6 x 10 <sup>-3</sup> )	< 8 x 10 <sup>-3</sup> (< 6 x 10 <sup>-3</sup> )	< 8 x 10 <sup>-3</sup> (< 6 x 10 <sup>-3</sup> )	< 8 x 10 <sup>-3</sup> (< 6 x 10 <sup>-3</sup> )
Ultimate total pressure <sup>2)</sup>	mbar (Torr)	< 4 x 10 <sup>-2</sup> (< 3 x 10 <sup>-2</sup> )	< 4 x 10 <sup>-2</sup> (< 3 x 10 <sup>-2</sup> )	< 4 x 10 <sup>-2</sup> (< 3 x 10 <sup>-2</sup> )	< 4 x 10 <sup>-2</sup> (< 3 x 10 <sup>-2</sup> )
Max. permissible pressure difference during continuous operation <sup>3)</sup>					
	mbar (Torr)	53.0 (39.8)	53.0 (39.8)	53.0 (39.8)	53.0 (39.8)
for < 3 min.	mbar (Torr)	93.0 (69.8)	93.0 (69.8)	93.0 (69.8)	93.0 (69.8)
Main supply	Δ / Y	V			
	Δ / Y	V	380 / 660	440 / -	380 / 660
	Δ / Y	V	400 / 690	460 / -	400 / 690
	Δ / Y	V	415 / -	-	415 / -
Thermal class		F	F	F	F
Motor power	kW (hp)	11.0 (15.0)	12.5 (17.0)	15.0 (20.4)	17.0 (23.1)
Nominal speed, 50 Hz	rpm	3000/3600	3000/3600	3000/3600	3000/3600
Max. permissible speed	rpm	3600	3600	3600	3600
Type of protection	IP	55	55	55	55
Oil filling, approx.					
vertical pumping action	l (qt)	7.0 (7.4)	7.0 (7.4)	12.0 (12.7)	12.0 (12.7)
horizontal pumping action	l (qt)	3.5 (3.7)	3.5 (3.7)	5.4 (5.7)	5.4 (5.7)
Connection flange					
suction side <sup>4, 5)</sup>	DN	200	200	200	200
pressure side <sup>4, 5)</sup>	DN	200	200	200	200
Adapter flange package					
suction side	DN	250 ISO-K	250 ISO-K	250 ISO-K	250 ISO-K
pressure side	DN	160 ISO-K	160 ISO-K	160 ISO-K	160 ISO-K
Weight complete, approx.	kg (lbs)	580.0 (1278.9)	580.0 (1278.9)	770.0 (1697.9)	770.0 (1697.9)

## Ordering Information

### RA 3001

### RA 5001

#### 50 / 60 Hz

#### 50 / 60 Hz

Roots vacuum pump RUVAC RA with motor, coupling and lantern <sup>6)</sup> RUVAC RA, ATEX version	<b>Part No. 119 50 upon request</b>	<b>Part No. 119 53 upon request</b>
Adapter flange package for suction and pressure side, including centering ring with integrated dirt sieve in the intake flange	<b>Part No. 200 14 472</b>	<b>Part No. 200 14 472</b>
Frequency converter RUVATRONIC (see description in Section "General", paragraph "Accessories")	<b>RT 5/3001 Part No. 500 001 385</b>	<b>RT 5/5001 Part No. 500 001 386</b>

<sup>1)</sup> To DIN 28 400 and subsequent numbers

<sup>2)</sup> With single-stage rotary vane vacuum pumps SOGEVAC

<sup>3)</sup> Valid for a ratio of 1 : 5 between backing pump and Roots vacuum pump

<sup>4)</sup> According to DIN 2532

<sup>5)</sup> Without adapter flange to ISO-K flange

<sup>6)</sup> Without oil filling

## Technical Data

		RA 7001		RA 9001		RA 13000	
		50 Hz	60 Hz	50 Hz	60 Hz	50 Hz	
Nominal pumping speed <sup>1)</sup>	m <sup>3</sup> x h <sup>-1</sup> (cfm)	7337 (4321)	8819 (5194)	9567 (5635)	11484 (6762)	13000 (7657)	
Max. pumping speed with backing pump or	m <sup>3</sup> x h <sup>-1</sup> (cfm)	6100 (3590)	7200 (4238)	7500 (4414)	8900 (5239)	10000 (5890)	
	SOGEVAC	SV 1200	SV 1200	2 x SV 1200	2 x SV 1200	-	
	m <sup>3</sup> x h <sup>-1</sup> (cfm)	-	-	-	-	2500 (1473)	
Ultimate partial pressure <sup>2)</sup>	mbar (Torr)	< 8 x 10 <sup>-3</sup> (< 6 x 10 <sup>-3</sup> )	< 8 x 10 <sup>-3</sup> (< 6 x 10 <sup>-3</sup> )	< 1 x 10 <sup>-2</sup> (< 7.5 x 10 <sup>-3</sup> )	< 1 x 10 <sup>-2</sup> (< 7.5 x 10 <sup>-3</sup> )	< 1 x 10 <sup>-2</sup> (< 7.5 x 10 <sup>-3</sup> )	
Ultimate total pressure <sup>2)</sup>	mbar (Torr)	< 4 x 10 <sup>-2</sup> (< 3 x 10 <sup>-2</sup> )	< 4 x 10 <sup>-2</sup> (< 3 x 10 <sup>-2</sup> )	< 5 x 10 <sup>-2</sup> (< 3.8 x 10 <sup>-2</sup> )	< 5 x 10 <sup>-2</sup> (< 3.8 x 10 <sup>-2</sup> )	< 5 x 10 <sup>-2</sup> (< 3.8 x 10 <sup>-2</sup> )	
Max. permissible pressure difference during continuous operation <sup>3)</sup>							
	mbar (Torr)	53.0 (39.8)	53.0 (39.8)	66.0 (49.5)	66.0 (49.5)	53.0 (39.8)	
for < 3 min.	mbar (Torr)	93.0 (69.8)	93.0 (69.8)	133.0 (99.8)	133.0 (99.8)	93.0 (69.8)	
Main supply	Δ / Y	V	380 / 660	440 / -	380 / 660	440 / -	380 / 660
		V	400 / 690	460 / -	400 / 690	460 / -	400 / 690
		V	415 / -	-	415 / -	-	415 / -
Thermal class		F	F	F	F	F	
Motor power	kW (hp)	18.5 (25.1)	21.0 (28.6)	22.0 (30.0)	25.0 (34.0)	30.0 (40.8)	
Nominal speed, 50 Hz	rpm	3000/3600	3000/3600	1500/1800	1500/1800	2000	
Max. permissible speed	rpm	3600	3600	1800	1800	2000	
Type of protection	IP	55	55	55	55	55	
Oil filling, approx.							
vertical pumping action	l (qt)	12.0 (12.7)	12.0 (12.7)	11.0 (11.6)	11.0 (11.6)	11.0 (11.6)	
horizontal pumping action	l (qt)	5.4 (5.7)	5.4 (5.7)	7.6 (8.0)	7.6 (8.0)	7.6 (8.0)	
Connection flange							
	suction side <sup>4, 5)</sup>	DN	250	250	300	300	300
	pressure side <sup>4, 5)</sup>	DN	250	250	300	300	300
Adapter flange package							
	suction side	DN	250 ISO-K	250 ISO-K	320 ISO-K	320 ISO-K	320 ISO-K
	pressure side	DN	250 ISO-K	250 ISO-K	250 ISO-K	250 ISO-K	
Weight complete, approx.	kg (lbs)	840 (1852.2)	840 (1852.2)	1400 (3087.0)	1400 (3087.0)	upon request	

## Ordering Information

	RA 7001		RA 9001		RA 13000
	50 / 60 Hz		50 / 60 Hz		50 Hz
Roots vacuum pump RUVAC RA with motor, coupling and lantern <sup>6)</sup> RUVAC RA, ATEX version	<b>Part No. 119 60</b> upon request		<b>Part No. 119 63</b> upon request		upon request -
Adapter flange package for suction and pressure side, including centering ring with integrated dirt sieve in the intake flange	<b>Part No. 200 14 473</b>		<b>Part No. 200 14 474</b>		-
Frequency converter RUVATRONIC (see description in Section "General", paragraph "Accessories")	<b>RT 5/7001</b> <b>Part No. 500 001 387</b>		<b>RT 5/9001</b> <b>Part No. 500 001 388</b>		<b>RT 5/13000</b> <b>Part No. 500 001 389</b>

<sup>1)</sup> To DIN 28 400 and subsequent numbers

<sup>2)</sup> With single-stage rotary vane vacuum pumps SOGEVAC

<sup>3)</sup> Valid for a ratio of 1 : 5 between backing pump and Roots vacuum pump

<sup>4)</sup> According to DIN 2532

<sup>5)</sup> Without adapter flange to ISO-K flange

<sup>6)</sup> Without oil filling

# Accessories

## Pressure Switches

The RUVAC vacuum pumps may be switched on and off automatically through a pressure switch driven by a SV 110 switching amplifier and a contactor.

The pressure switch may be installed in the intake of the RUVAC using a screw-in adaptor, an elbow and two centering and two clamping rings.

Upon request the pressure switch may be set by Oerlikon Leybold Vacuum to a fixed value. Please state this pressure value in your order.

### Ordering Information

### Pressure Switches

Pressure switch PS 115, adjustable setting Pressure switch setting	<b>Part No. 160 04</b> <b>Part No. 160 05</b>
Accessories for fitting the PS 115 pressure switch Screw-in adaptor DN 16 ISO-KF, M 16 x 1.5 mm (0.06 in.) Elbow DN 16 KF Centering ring DN 16 KF (2 are required) Clamping ring DN 16 KF (2 are required)	<b>Part No. 168 40</b> <b>Part No. 184 36</b> <b>Part No. 183 26</b> <b>Part No. 183 41</b>
SV 110 switching amplifier (for PS 114/115)	<b>Part No. 160 78</b>
Oil pressure switch for RUVAC WSLF 1001 and WS-PFPE	<b>Part No. 194 82</b>

## Temperature Sensor PT 100

The temperature sensor measures the gas temperature at the centre of the RUVAC delivery flange.

Depending on the size of the RUVAC pump, respectively its flange size, the PT 100 sensor is fitted at different positions.

### Ordering Information

### Temperature Sensor

Temperature sensor PT 100	<b>Part No. 155 010</b>
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## Vacuum Pump Oils

Lubricating oils for rotary vanevacuum pumps need to fulfil demanding requirements. Their vapor pressure must be low at high temperatures and the water content and water uptake must be minimal. Their viscosity characteristics need to be flat, lubricating properties need to be excellent and resistant against thermal decomposition and increased mechanical stress.

All the vacuum pump oils listed in the following have been subjected in our factory laboratories to very comprehensive tests closely resembling the conditions encountered in practice by the pumps from the RUVAC series.

Under vacuum engineering conditions, lubricating oils may react very differently compared to what is being expected of them.

In order to ensure the best possible performance of the Oerlikon Leybold Vacuum pumps, the use of vacuum pump oils qualified by Oerlikon Leybold Vacuum is required.

When using not suitably qualified third party oils, the oil change intervals and the performance of the vacuum pump may be reduced. Also unwanted deposits may occur which may even cause severe damage to the vacuum pump.

Our oils are subjected to an involved qualification process with respect to their technical suitability in our vacuum pumps.

Our warranty commitment is dependent on the usage of lubricating oils which are qualified by us.

No liability will be assumed for any kind of damage caused through the usage of types of oil which have not been qualified or which are unsuitable.

In order to adapt the pumps to the different applications of our customers, different types of oil are used in the RUVAC pumps.

Please note that owing to differing properties not all types of oil may be used in all pumps of the RUVAC series.

If you can not find the combination of pump and oil you require by way of a Part. No., please ask us for a quotation.

### Lubricant Types

#### Mineral Oils

Mineral oils are products distilled and refined from crude oil. These do not consist of precisely defined compounds but rather consist of a complex mixture. The way in which the mineral oil is pre-treated and its composition are decisive as to the applications it will be suited for. Depending on the distribution of the hydrocarbons and the dominance of certain properties, mineral oils are grouped according to paraffin-base, naphthenic and aromatic. For the purpose of attaining especially low ultimate pressures, mineral oils must be selected on the basis of a core fraction.

The thermal and chemical resistance of mineral oils has been found to be adequate in the majority of applications. They offer a high degree of compatibility with elastomers and resistance to hydrolysis.

## Synthetic Oils

Synthetic oils are produced by a chemical reaction. The group of synthetic oils includes liquids differing widely as to their chemical structure and composition. Correspondingly their physical and chemical properties differ considerably. Synthetic oils are used in those cases where special properties of the oil are required which can not be fulfilled by mineral oils.

The oils given in the following belong to the group of synthetic oils:

## Ester Oils

Ester oils are organic compounds which excel especially through their high thermal resistance to cracking compared to mineral oils. Chemical resistance is generally quite good, but will depend on the type of ester oil. Elastomer compatibility and resistance against hydrolysis are not so good compared to mineral oils.

## Perfluorinated polyether (PFPE)

These are oils which are only composed of carbon (C), fluorine (F) and oxygen atoms (O). The existing C-O and C-F bonds are highly stable. For this reason PFPE oils are practically inert against all chemical and oxidising influences.

Perfluorinated polyether will not polymerise under the influence of high energy radiation.

PFPE is non-flammable. Oerlikon Leybold Vacuum NC 1/14 has the approval of BAM (Federal Institute for Materials Research and Testing) for pumping of pure oxygen.

Perfluorinated polyether are used when pumping strongly reactive substances like oxygen (O<sub>2</sub>), fluorine (F<sub>2</sub>) and uranium hexafluoride (UF<sub>6</sub>). Regarding Lewis acids (for example, boron trifluoride (BF<sub>3</sub>), aluminum trichloride (AlCl<sub>3</sub>)) they are not completely inert. Here reactions may take place at temperatures over 100 °C (212 °F).

Perfluorinated polyether are thermally highly stable. Thermal decomposition may only take place at temperatures of over 290 °C (554 °F).

**Caution:** Perfluorinated polyether will – when decomposed – release toxic and corrosive gases: hydrogen fluoride (HF), carbonyl difluoride (COF<sub>2</sub>). For this reason open fires must be avoided in the workspace where PFPE is being used. Do not smoke in the workspace where PFPE is being used.

Only suitably prepared pumps must be used in connection with perfluorinated polyether, since it is essential that the pumps be free of hydrocarbons.

Changing from one basic type of oil to PFPE must be left exclusively to authorised Service Centers. The pump will have to be fully disassembled and carefully cleaned. Gaskets and filters will have to be exchanged and suitable greases will have to be used.

Safety data sheets are available to professional users from:

E.mail “documentation.vacuum@oerlikon.com” or Internet “www.oerlikon.com/leyboldvacuum”.

# Overview Oils

## Application Data

### N 62

### GS 555

Type of oil	Paraffin-base mineral oil, core fraction, free of additives	Diester oil
Examples of areas of application and process media	Standard oil For pumping air, chemically inert permanent gases (noble gases, for example), water vapor	Used at elevated temperatures. Pumping of air, chemically inert permanent gases (noble gases, for example), carbon dioxide CO <sub>2</sub> , carbon monoxide CO, aliphatic compounds (for example, methane CH <sub>4</sub> , propane C <sub>3</sub> H <sub>8</sub> , ethylene C <sub>2</sub> H <sub>4</sub> ), organic solvent vapors
Remarks	The ultimate pressures stated in our catalogs are based on operation of the pump with N 62 (except for the PFPE pumps)	
Elastomer compatibility FPM (FKM) (Viton) NBR (Perbunan) <sup>1)</sup> EPDM	Suited Conditionally suited Not suited	Suited Conditionally suited Not suited

## Technical Data

### N 62

### GS 555

Viscosity			
at 40 °C (104 °F)	mm <sup>2</sup> /s	90	94
at 100 °C (212 °F)	mm <sup>2</sup> /s	10	9
Flash point	°C (°F)	> 255 (491)	250 (482)
Vapor pressure			
at 20 °C ( 68 °F)	mbar (Torr)	< 1 x 10 <sup>-5</sup> (< 0.75 x 10 <sup>-5</sup> )	7 x 10 <sup>-5</sup> (5.3 x 10 <sup>-5</sup> )
at 100 °C (212 °F)	mbar (Torr)	< 3 x 10 <sup>-3</sup> (< 2.3 x 10 <sup>-3</sup> )	1.5 x 10 <sup>-3</sup> (1.1 x 10 <sup>-3</sup> )
Density at 15 °C (59 °F)	g/ml	0.88 <sup>2)</sup>	0.96
Pour point	°C (°F)	< -9 (< +16)	-42 (-44)
Middle molecular weight	g/mol	550	530

## Ordering Information

### N 62

### GS 555

1 liter (1.06 qt)	<b>Part No. 177 01</b>	<b>Part No. 200 10 272</b>
5 liters (5.29 qt)	<b>Part No. 177 02</b>	<b>Part No. 200 10 891</b>
20 liters (21.14 qt)	<b>Part No. 177 03</b>	<b>Part No. 200 00 193</b>
180 kg (397.35 lbs)	<b>Part No. 177 05</b>	-

Please note that the technical data stated are only typical data. Slight variations from batch to batch must be expected.

The technical data stated here can not be taken as assured properties.

<sup>1)</sup> Resistance to decomposing is very much dependent on the share of acrylonitrile in the NBR

<sup>2)</sup> at 20 °C (68 °F)



**Application Data****ANDEROL 2100 HTCL****NC 1/14**

Type of oil	Polyolester	Perfluorinated polyether PFPE
Examples of areas of application and process media	Used in the RUVAC WSLF for operation in connection with gas lasers	For pumping strong oxidants like oxygen, O <sub>2</sub> , ozone O <sub>3</sub> , nitrogen oxides NO <sub>x</sub> and sulphur oxides (SO <sub>2</sub> , SO <sub>3</sub> ) as well as reactive substances like halogens (for example fluorine F <sub>2</sub> , chlorine Cl <sub>2</sub> ), hydrogen halides (for example hydrogen chloride HCl, hydrogen bromide HBr), uranium hexafluoride UF <sub>6</sub> and conditionally Lewis acids (for example, boron trichloride BCl <sub>3</sub> )
Remarks		Use only PFPE modified pumps. For operation with PFPE we recommend the exclusive use of such pump types which are equipped with a split-pole motor  Mixing with other types of oil must be absolutely avoided
Elastomer compatibility FPM (FKM) (Viton) NBR (Perbunan) <sup>1)</sup> EPDM	Suited Conditionally suited Not suited	Suited Conditionally suited Not suited

**Technical Data****ANDEROL 2100 HTCL****NC 1/14**

Viscosity			
at 40 °C (104 °F)	mm <sup>2</sup> /s	94	47
at 100 °C (212 °F)	mm <sup>2</sup> /s	13	5
Flash point	°C (°F)	265 (509)	- <sup>2)</sup>
Vapor pressure			
at 20 °C ( 68 °F)	mbar (Torr)	5.0 x 10 <sup>-5</sup> (3.8 x 10 <sup>-5</sup> )	3.0 x 10 <sup>-7</sup> (2.3 x 10 <sup>-7</sup> )
at 100 °C (212 °F)	mbar (Torr)	8.5 x 10 <sup>-4</sup> (6.4 x 10 <sup>-4</sup> )	6.0 x 10 <sup>-4</sup> (4.5 x 10 <sup>-4</sup> )
Density at 15 °C (59 °F)	g/ml	0.92	1,89 <sup>3)</sup>
Pour point	°C (°F)	-35 (-31)	-40 (-40)
Middle molecular weight	g/mol	No known	2500

**Ordering Information****ANDEROL 2100 HTCL****NC 1/14**

1 liter (1.06 qt)	<b>Part No. 200 14 333</b>	<b>Part No. 177 38</b>
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Please note that the technical data stated are only typical data. Slight variations from batch to batch must be expected.

The technical data stated here can not be taken as assured properties

<sup>1)</sup> Resistance to decomposing is very much dependent on the share of acrylonitrile in the NBR

<sup>2)</sup> **Caution:** Perfluorinated polyether will, when being decomposed at temperatures over 290 °C (554 °F), release toxic and corrosive gases

For this reason open fires must be avoided in the workspace where PFPE is being used. Do not smoke in the workspace where PFPE is being used

<sup>3)</sup> at 20 °C (68 °F)

# Only available for purchase in North and South America

## Application Data

### HE-200

### HE-1600

Type of oil	Paraffin-base mineral oil, core fraction, free of additives	Perfluorinated polyether PFPE
Examples of areas of application and process media	Standard oil for Oerlikon Leybold Vacuum USA For pumping air, chemically inert permanent gases (noble gases, for example), water vapor, solvent vapors in the case of laboratory pumps operated with cold traps	For pumping strong oxidants like oxygen, O <sub>2</sub> , ozone O <sub>3</sub> , nitrogen oxides NO <sub>x</sub> and sulphur oxides (SO <sub>2</sub> , SO <sub>3</sub> ) as well as reactive substances like halogens (for example fluorine F <sub>2</sub> , chlorine Cl <sub>2</sub> ), hydrogen halides (for example hydrogen chloride HCl, hydrogen bromide HBr), uranium hexafluoride UF <sub>6</sub> and conditionally Lewis acids (for example, boron trichloride BCl <sub>3</sub> )
Remarks	The ultimate pressures stated in operation of the pump with HE-200 (except for the PFPE pumps) Service life may be extended through the use of an oil filter	Use only correspondingly modified pumps. For operation with PFPE we recommend the exclusive use of such pump types which are equipped with a split-pole motor Mixing with other types of oil must be absolutely avoided
Elastomer compatibility FPM (FKM) (Viton) NBR (Perbunan) <sup>1)</sup> EPDM	Suited Conditionally suited Not suited	Suited Suited Suited

## Technical Data

### HE-200

### HE-1600

Viscosity at 40 °C (104 °F)	mm <sup>2</sup> /s	58	–
Viscosity at 20 °C ( 68 °F)	mm <sup>2</sup> /s	–	140
Viscosity at 100 °C (212 °F)	mm <sup>2</sup> /s	9	
Viscosity at 99 °C (210 °F)	mm <sup>2</sup> /s	–	7
Flash point	°C (°F)	224 (435)	Not known <sup>2)</sup>
Vapor pressure at 100 °C (212 °F)	mbar (Torr)	3.9 x 10 <sup>-4</sup> (2.9 x 10 <sup>-4</sup> )	2.7 x 10 <sup>-4</sup> (2.0 x 10 <sup>-4</sup> )
Pour point	°C (°F)	-10 (14)	-40 (-40)
Middle molecular weight	g/mol	480	3000

## Ordering Information

### HE-200

### HE-1600

1.0 liter (1 quart)	<b>Part No. 98 198 006</b>	–
3.8 liters (1 gal)	<b>Part No. 98 198 007</b>	–
18.9 liters (5 gal)	<b>Part No. 98 198 008</b>	–
208 liters (55 gal)	<b>Part No. 98 198 010</b>	–
0.9 kg (2 lbs)	–	<b>Part No. E 190 999 051</b>
1.8 kg (4 lbs)	–	<b>Part No. 898 564-2</b>
7.2 kg (16 lbs)	–	<b>Part No. E 190 999 052</b>

Please note that the technical data stated are only typical data. Slight variations from batch to batch must be expected.

The technical data stated here can not be taken as assured properties

<sup>1)</sup> Resistance to decomposing is very much dependent on the share of acrylonitrile in the NBR

<sup>2)</sup> **Caution:** Perfluorinated polyether will, when being decomposed at temperatures over 290 °C (554 °F), release toxic and corrosive gases

For this reason open fires must be avoided in the workspace where PFPE is being used. Do not smoke in the workspace where PFPE is being used

# Services

## On-site Replacement of the Dynamic Seals (with oil N 62) \*)

The on-site replacement of the dynamic seals includes the following:

Oil change (standard oil N 62), partial disassembly of the pump, replacement of the complete shaft seal, visual inspection of the subassemblies, electrical safety test, test run including check of the attained ultimate pressure levels (depending on the installation situation)

### Ordering Information

### On-site Replacement of the Dynamic Seals (with oil N 62) \*)

<b>For pump</b> WA/WAU 151/251 WA/WAU 501 WA/WAU 1001 WA/WAU 2001	<b>Part No. AS 1181 F</b> <b>Part No. AS 1182 F</b> <b>Part No. AS 1183 F</b> <b>Part No. AS 1184 F</b>
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## Small On-site Maintenance (with oil N 62) \*)

The small on-site maintenance includes the following:

Oil change (standard oil N 62), visual inspection of the subassemblies, electrical safety test, test run including check of the attained ultimate pressure levels (depending on the installation situation)

### Ordering Information

### Small On-site Maintenance (with oil N 62) \*)

<b>For pump</b> WA/WS 151/251 WA/WS 501 WA/WS 1001 WA/WS 2001	<b>Part No. AS 1185 F</b> <b>Part No. AS 1186 F</b> <b>Part No. AS 1187 F</b> <b>Part No. AS 1188 F</b>
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## \*) Notes on our on-site after sales service

The listed services include the costs for material and working hours on site for standard RUVAC pumps. Services for pump variants upon request.

Transportation and travelling expenses are invoiced at cost. All services refer to the repair of freely accessible and not contaminated vacuum components.

### Complete Refurbishing at the Service Centre (with oil N 62)

Complete refurbishing at the service centre includes the following:

Disassembly of the pump, cleaning of all individual components including visual inspection, machined reworking of the housing sections; if required rebalancing of the pair of impellers, replacement of the wearing parts, assembly of the pump including new seals and standard oil N 62, electrical safety test, test run including check of the attained ultimate pressure levels.

#### Ordering Information

#### Complete Refurbishing at the Service Centre (with oil N 62)

For pump	Part No.
WA 151/251	AS 1189
WA 501	AS 1190
WA 1001	AS 1191
WA 2001	AS 1192
WS 151/251	AS 1193
WS 501	AS 1194
WS 1001	AS 1195
WS 2001	AS 1196
WAU 151/251	AS 1197
WAU 501	AS 1198
WAU 1001	AS 1199
WAU 2001	AS 1200
WSU 151/251	AS 1201
WSU 501	AS 1202
WSU 1001	AS 1203
WSU 2001	AS 1204

### Complete Refurbishing with Decontamination at the Service Centre (with oil N 62)

Complete refurbishing with decontamination at the service centre includes the following:

Disassembly of the pump, cleaning and decontamination of all individual components, visual inspection of all components, machined reworking of the housing sections; if required rebalancing of the pair of impellers, replacement of the wearing parts, assembly of the pump including new seals and standard oil N 62, electrical safety test, test run including check of the attained ultimate pressure levels.

#### Ordering Information

#### Complete Refurbishing with Decontamination at the Service Centre (with oil N 62)

For pump	Part No.
WA 151/251	AS 1189 D
WA 501	AS 1190 D
WA 1001	AS 1191 D
WA 2001	AS 1192 D
WS 151/251	AS 1193 D
WS 501	AS 1194 D
WS 1001	AS 1195 D
WS 2001	AS 1196 D
WAU 151/251	AS 1197 D
WAU 501	AS 1198 D
WAU 1001	AS 1199 D
WAU 2001	AS 1200 D
WSU 151/251	AS 1201 D
WSU 501	AS 1202 D
WSU 1001	AS 1203 D
WSU 2001	AS 1204 D

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