

Instruction Manual

TORRI

Multi-Stage Rotary Lobe Vacuum Pump
BD 0100, 0300, 0600 A



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Safety Notes

This operation manual provides the installation, operation, basic maintenance and service information for all the BD types of Busch vacuum pumps.

Before using this pump, the user should read the contents listed below carefully.

Anyone operated this pump should have the knowledge about the vacuum systems and be able to identify and avoid any potential danger related to the pump. Improper operation may cause damage and a serious accident. Before installation and operating the pump, the user should understand well the pump's construction, operating procedure and the hazards. If there is any problem about the operation, safety and maintenance of the pump, please contact Busch.

Related important notice will be remarked with the sign "**DANGER!**", "**WARNING!**", and "**CAUTION!**", please refer to the following definition :



DANGER!

The sign defines an imminently hazardous situation will occur, and cause death or serious injury, if violating the rules.



WARNING!

The sign defines a potential hazard will occur, and might cause death or serious injury, if violating the rules.



CAUTION!

The sign defines an imminently hazardous situation will occur, and might cause minor or moderate injury, if violating the rules.

Important Precautions



DANGER!

Only the qualified personnel are allowed to unload and lift the pump. When elevating the pump, no personnel should be under the object.



DANGER!

Please add noble gases during process which contains 21% oxygen to prevent fire or explosion.



WARNING!

Only a qualified electrician should perform electrical work. Before beginning wiring or maintenance work, make sure to cut and lock out the electrical power.



WARNING!

Before removing and cleaning the vacuum or exhaust pipes, please use N₂ gas to dilute the flammable or toxic material in the piping and keep the toxic material away from the personnel.



WARNING!

After installing the piping, please perform a leak check to prevent leaks of the flammable, dangerous or toxic gases, and to avoid air getting into the pump.
It will cause improper chemical reactions if gases get into the pump



WARNING!

Before the application of different processes, the pump is requested for overhaul to avoid the interaction of the residuals in the pump.



WARNING!

When the temperature is below 0°C, the cooling water might damage the pipe due to freezing and expansion. So please remove the cooling water from pipe during shutdown, stock, and delivery.

**WARNING!**

Vacuum pump motor with electromagnetic waves, a person fitted with pacemaker is prohibited to nearing.

**CAUTION!**

Do not modify the pump or any of its parts without BUSCH's approval. BUSCH will stop the warranty or compensation, if the damage to the pump or to the vacuum system is caused by any private modification or replacement.

**CAUTION!**

All the wastes, including vacuum oil, vacuum grease and PC boards, should be properly treated according to the local and national environmental regulations.

**CAUTION!**

As far as temperature is concerned, the pump is suitable for evacuation of a 300 liters tank. The pump is not suitable for continuous duty at a pressure more or equal than 60 mbar. However, the pump wouldn't be failed in 300 liters tank with duty at 1013 mbar under any cycle time.

The pump is able to handle Argon gas capacity up to 10 slm.

The following safety warning label appears on the housing of the pump:

Electric shock caution



Inspection and Transportation

1. Checking for the pump specification

Please check the specification on the nameplate of the pump and confirm that pump supplied agree with your purchase.

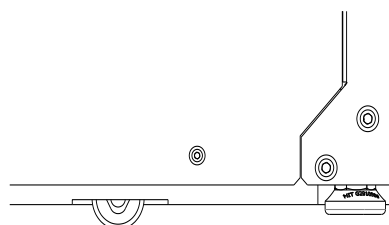
2. Checking for the accessories

Please check if all the parts attached are complete. When there is any damage or when components are missing, please contact us immediately. All the Busch vacuum pumps are attached with:

- (1) Instruction Manual, one copy
- (2) One electric power connector (Female)
- (3) One centering ring for inlet (KF50)
- (4) One set of quick-connect couplers for cooling water (RC 1/4")

3. Attention for moving the pump

For a convenient installation, four mobile support units, each consisting of a caster and a height-adjustment foot (shown in the drawing at the right), are attached at the frame of the pump. Before moving the pump, make sure to check the four adjustment feet are already at their highest positions.



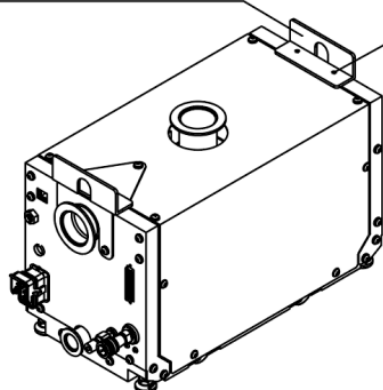
4. Instructions for lifting the pump

The appropriate way to lift the pump is with a hoist. There is a silencer on the bottom of the pump that will be damaged if the pump is lifted from underneath by a forklift truck or other methods that rely on the silencer to support the weight of the pump. (The lifting brackets are included in pump package)

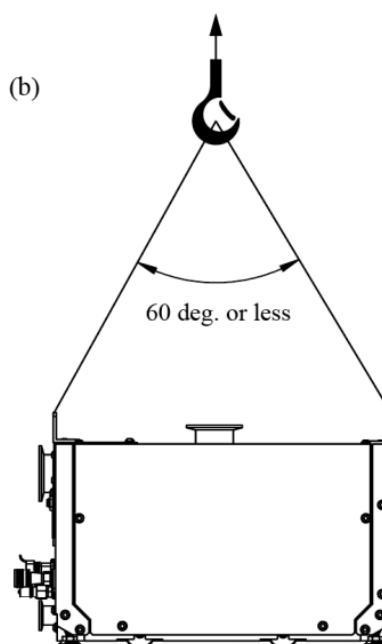
(a)

Make sure the direction of installation is correct.

Hex Bolts (M6x12)
& Washers



(b)



Quick Installation

[Installation]

- (1) Verify that the main supply voltage is correct and that the capacity of the No Fuse Breaker (NFB) and wires in the power supply cabinet meet the requirements in the table below:

Voltage Model	200~220V		380~415V	
	NFB Note1	Cable Size (Temperature 105°C)	NFB Note1	Cable Size (Temperature 105°C)
TORRI BD 0100 A	15A	14AWG	10A	14AWG
TORRI BD 0300 A	30A	14AWG	20A	14AWG
TORRI BD 0600 A	30A	14AWG	20A	14AWG

- (2) Lower the adjustable foot on the pump frame until the movable wheels are 3 ~ 5 mm above the floor, then tighten the M16 nuts to secure the adjustable foot.
- (3) Check the oil level of the gear box in screw pump and booster pump (if any), the level should be required at 1/2 to 2/3 of the oil sight glass.
- (4) Connect the vacuum system with the pump.
- (5) Connect the exhaust system.
- (6) Connect the cooling water supply.
- (7) To avoid shock or accidental starting, make sure the NFB in the power supply cabinet is turned off or that the emergency stop button is depressed. Using a power supply cable that conforms with the wire diameter and temperature requirements in the table above, connect the pump to the power supply cabinet.
- (8) If remote operation via SEMI regulation is planned, please set the control mode in the LCD controller to "SEMI" and refer to Section 3.5.2 for input and output signal connections on the Tool Interface Connector, which is item 25 in Figure 1.1 in Section 1.1

[Start]

- (9) Turn on the cooling water and check piping for water leaks.
- (10) Turn on the power switch in the pump controller or release the emergency stop button.
- (11) Ensure the cooling water flow is proper. Higher than minimum 1 L/Min (15°C - 28°C) for TORRI BD 0100 A and minimum 2 L/Min (15°C - 28°C) for TORRI BD 0300 A & BD 0600 A.
- (12) When the control mode of the pump is LOCAL, push "START" button to start the pump; and push "STOP" button to stop the pump.
- (13) Check if operating current is normal or not.
- (14) After the pump has run for 4 hours, check the temperature of the motor and pump casing is normal or not.

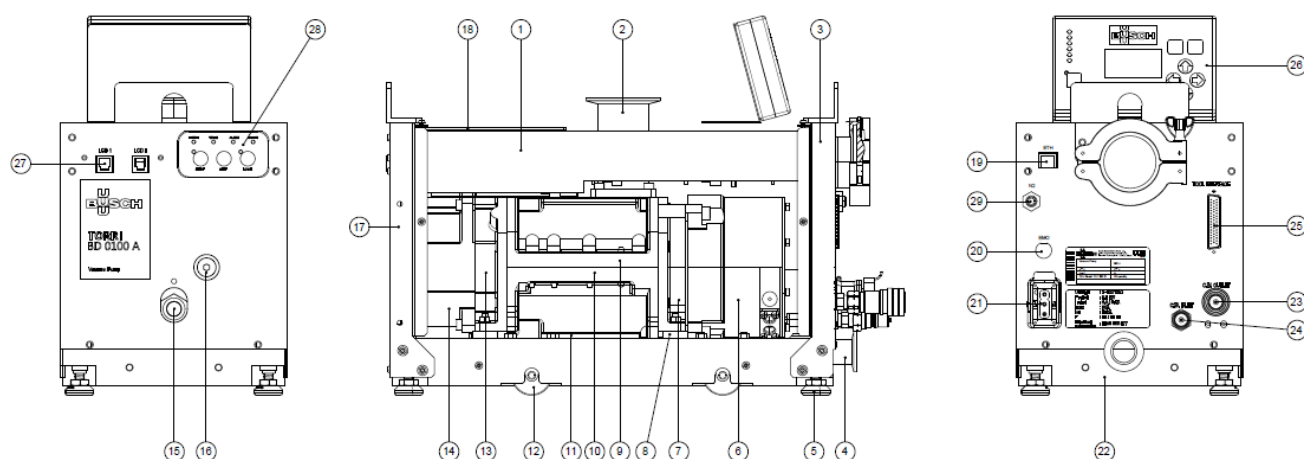
1. Introduction

1.1 Pump Module

Busch Multi-Roots Vacuum Pump is Dry Pump. They all belong to positive- displacement rotary pumps. During operating, the pump rotors do not contact each other; therefore, there is no need of grease for lubricating or for sealing, and thus no concerns for the oil gas back-permeating issue for the pump.

Rotor : 5 stages & 2 lobes simple structure bring low power consumption and users can save power consumption costs at the end.

TORRI BD 0100 A configuration diagram and description of each component



1. Electrical unit
2. Inlet (NW50)
3. Pump frame
4. Exhaust (NW25)
5. Height-adjustment foot
6. Motor (3HP)
7. A-side endplate
8. Shock-absorb pad
9. Casing (upper)
10. Casing (lower)

11. Silencer
12. Caster
13. B-side endplate
14. Gear Box
15. Oil sight glass
16. Oil filling plug
17. Pump frame
18. Inverter
19. Ethernet Port
20. Emergency stop switch (planned)

21. Power Supply Receptacle
22. Base frame
23. Cooling water outlet
24. Cooling water inlet
25. Tool Interface
26. LCD Controller
27. LCD Controller Port
28. Simple Control Panel
29. N2 Port

TORRI BD 0300 / 0600 A configuration diagram and description of each component.

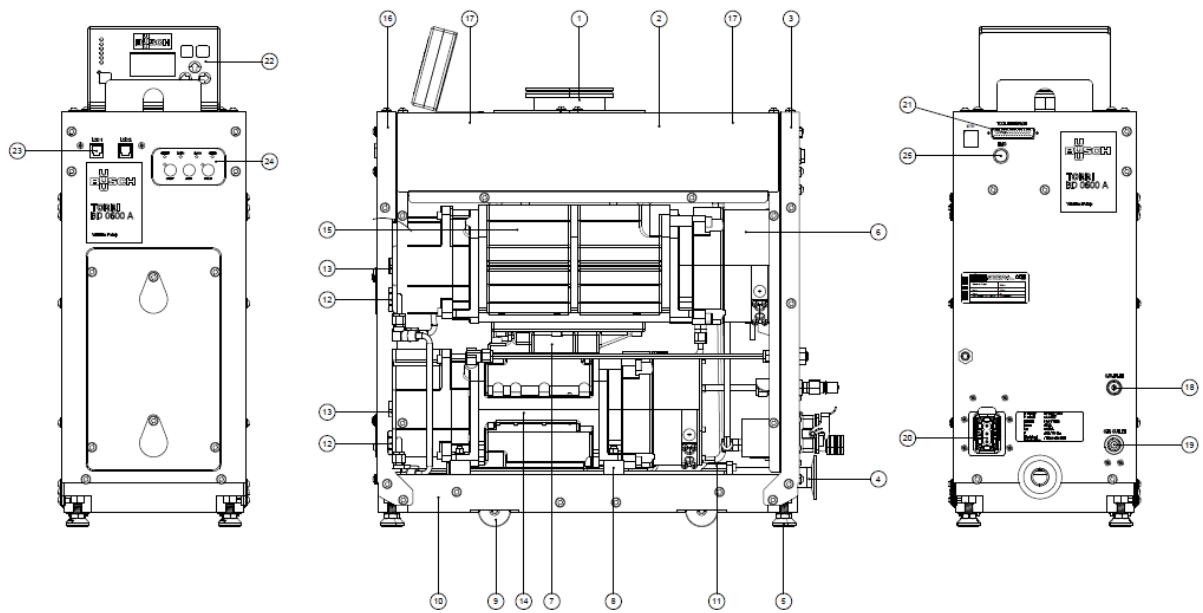
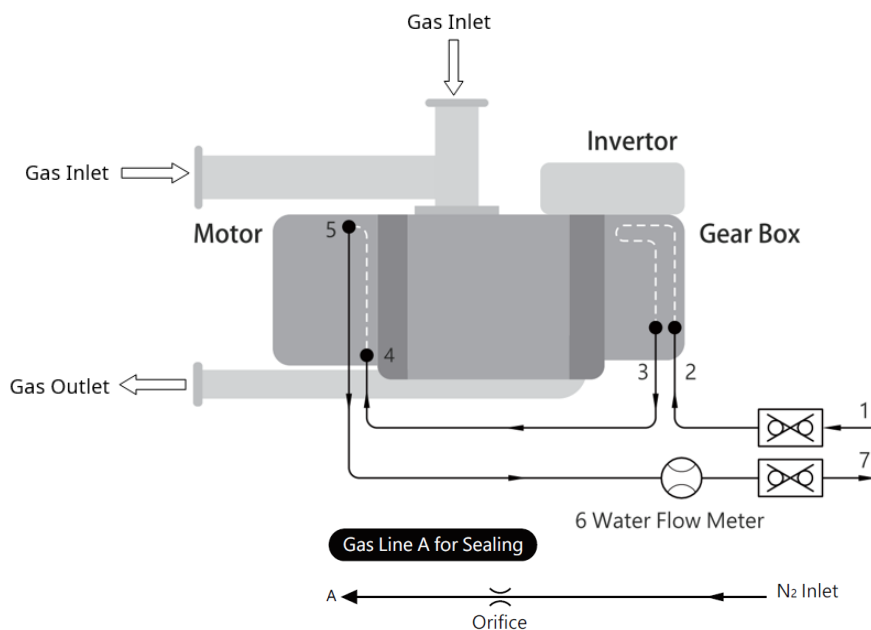


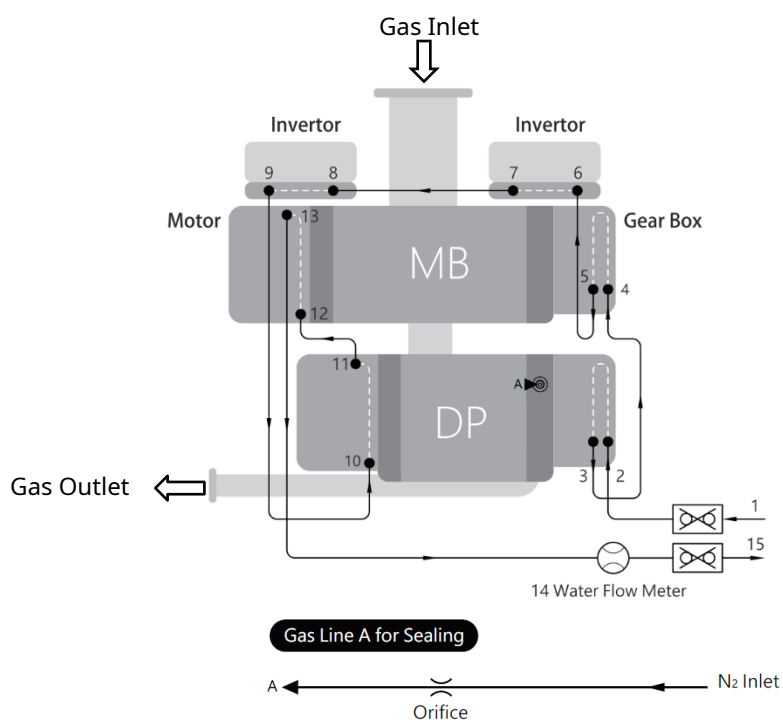
Figure 1.1.1 TORRI BD 0300 / 0600 Pump Configuration

- | | | |
|---------------------------|-----------------------------|--------------------------------|
| 1. Electrical unit | 11. Silencer | 21. Semi Port |
| 2. Inlet (ISO80) | 12. Oil level indicator | 22. LCD Controller |
| 3. Pump frame | 13. Plug | 23. LCD Controller Port |
| 4. Exhaust (NW40) | 14. DP (BD 0100) | 24. Simple Control Panel |
| 5. Height-adjustment foot | 15. MB (PRF 0600) | 25. Emergency stop switch Port |
| 6. Motor (3HP) | 16. Pump frame | |
| 7. Connector | 17. Inverter | |
| 8. Shock-absorbing pad | 18. Cooling water inlet | |
| 9. Caster | 19. Cooling water outlet | |
| 10. Base frame | 20. Power Supply Receptacle | |

1.2 Cooling Water Piping System



- | | |
|-------------------------------------|----------------------------------|
| 1. Cooling water inlet | 5. Cooling water outlet of Motor |
| 2. Cooling water inlet of Gear Box | 6. Waterflow meter |
| 3. Cooling water outlet of Gear Box | 7. Cooling water outlet |
| 4. Cooling water inlet of Motor | |



- | | | |
|--|--|--|
| 1. Cooling Water Inlet | 6. Cooling Water Inlet of Inverter (DP) | 11. Cooling Water Outlet of Motor (DP) |
| 2. Cooling Water Inlet of Gear Box (DP) | 7. Cooling Water Outlet of Inverter (DP) | 12. Cooling Water Outlet of Motor (MB) |
| 3. Cooling Water Outlet of Gear Box (DP) | 8. Cooling Water Inlet of Inverter (MB) | 13. Cooling Water Outlet of Motor (MB) |
| 4. Cooling Water Inlet of Gear Box (MB) | 9. Cooling Water Outlet of Inverter (MB) | 14. Water flow meter |
| 5. Cooling Water Outlet of Gear Box (MB) | 10. Cooling Water Inlet of Motor (DP) | 15. Cooling Water Outlet |

TORRI BD 0100 A cooling water path as below:

From cooling water inlet (1) Gear box & inverter (2 3) cooling water motor (4 5) water flow meter (6) cooling water outlet (7).

TORRI BD 0300 / 0600 A cooling water path as below:

From Cooling water inlet (1) to Gear Box of DP & MB (2 3 4 5) to inverter (6 7 8 9) to Motor (10 11 12 13) to Water flow meter (14) to cooling water outlet (15).

Piping and quick connector both are stainless steel, so there is no cooling water pollution issue.

The system will send a warning action or alarm action with insufficient water flow.

In order to avoid contamination causes flow meter to have wrong action,

when the pump casing or motor temperature is normal, the system will send a warning message with insufficient water flow.

When the pump casing or motor temperature is higher than default setting value, the alarm action of insufficient water flow will be generated.

When the cooling water flow is insufficient, but the pump temperature is normal, choose direct protection action by parameter setting. (Please see Figure 4.3 Control Panel)

If the cooling water valve is equipped, please refer to the 「Other Setup Cooling Water Delay Time」 of Figure 4.4. When the pump is turned off for some time, close the water valve.

When the ambient temperature is below 0°C and pump is shutdown, in order to avoid cooling water pipe freeze caused pipe burst. Please remove the quick connector and apply high-pressure air into the pipe to remove the residual water.

Default setting protection action parameter:

Issue		Water Flow		
		Normal	Warning	Alarm
(Motor or Casing) Tempt.	Normal	Pump Running	Pump Running	STOP
	Warning	Pump Running	Pump Running	STOP
	Alarm	STOP	STOP	STOP

1.3 Control System

The control system for Busch Multi-Roots vacuum pump consists of frequency inverter and controller. It also can monitor and record the operating status of the pump. It has a LCD controller (option), Modbus TCP network port and Ethernet port. The protection provided by the control system has two levels: Warning and Alarm.

When a warning message appears, the pump will not shut down. When an alarm message appears, the pump will shut down immediately. With the monitoring of the control system, the user can know the pump operating status, can do the maintenance in advance of a real breakdown, and can prevent a sudden out-of-service of the pump from suffering with other losses. The record message of "Warning" and "Alarm" could be available for the user to do a trace checking and to judge the problem of the shutdown.

The LCD controller (option) can provide with the parameter setting, indication of operating status, the warning and alarm messages, starting or stopping the pump. The Ethernet port could provide the remote operation with external signals and could start or stop the pump. In addition, the Modbus TCP network port is also available for a monitoring by a PC.

2. Technical Data

2.1 Technical Specification List

Model		Unit	BD0100A
Pumping speed		L/min	1667
		m ³ /hr	100
		cfm	59
Ultimate Pressure		Torr	7.5×10^{-3}
		mbar	1×10^{-2}
		Pa	1
Canned Motor	Frequency	Hz	183.3
	Voltage	V	220 +/- 10% 380 +/- 10%
	Rated Power	kW	2.2
	Rated Current	A	11A (220V) / 6.3A (380V)
Connection	Inlet		NW50
	Outlet		NW25
Cooling Water	Max. Pressure	kg/cm ² (PSI)	4.0 (57)
	Pressure Dif.	kg/cm ² (PSI)	1.0 (14)
	Min. Flow	l/min	Higher than 1.0
	Temp.	°C (F)	15 - 28 (59 - 82,4)
	Connection		RC 1/4"
Dimension	L×W×H	mm (in)	450 x 230 x 275 (18 x 9 x 11)
Weight		Kg (lbs.)	60 (132)
Noise Note1		dB(A)	<60
System Max. Leak-rate		mbar · l/s	1×10^{-5}
Operation Temp.		°C (F)	5 ~ 40 (41 ~ 104)
Operation Moisture		RH	90%
Lubrication Oil	Type		BUSCH YLC 250 B
	Quantity Note2	liter	0.1

Note1 : The noise varies depend on the installation occasion. When there are walls or objects that may reflect noise, the noise may be higher than the standard.

Note2 : The amount of oil is based on the oil level of the oil indicator 1/2 to 2/3.

Model		Unit	BD 0300 A	BD 0600 A
Pumping speed		L/min	5000	10000
		m ³ /hr	300	600
		cfm	177	353
Ultimate Pressure		Torr	7.5×10^{-4}	7.5×10^{-4}
		mbar	1×10^{-3}	1×10^{-3}
		Pa	0.1	0.1
Canned Motor	Frequency	Hz	Booster pump: 110.0 Backing pump: 183.3	Booster pump: 233.3 Backing pump: 183.3
	Voltage	V	220 +/- 10% 380 +/- 10%	220 +/- 10% 380 +/- 10%
	Rated Power	kW	Booster pump: 2.2 Backing pump: 2.2	Booster pump: 2.2 Backing pump: 2.2
	Rated Current	A	Booster : 11/ 6.3 A Backing : 11/ 6.3 A	Booster : 11/ 6.3 A Backing : 11/ 6.3 A
Connection	Inlet		ISO80	ISO80
	Outlet		NW40	NW40
Cooling Water	Max. Pressure	kg/cm ² (PSI)	4.0 (57)	4.0 (57)
	Pressure Dif.	kg/cm ² (PSI)	1.0 (14)	1.0 (14)
	Min. Flow	l/min	Higher than 2.0	Higher than 2.0
	Temp.	°C (F)	15 - 28 (59 - 82,4)	15 - 28 (59 - 82,4)
	Connection		RC 1/4"	RC 1/4"
Dimension	L×W×H	mm (in)	530 x 230 x 520 (20 x 9 x 20)	530 x 230 x 520 (20 x 9 x 20)
Weight		Kg (lbs.)	60 (132)	60 (132)
Noise ^{Note1}		dB(A)	<60	<60
SystemMax.Leak-rate		mbar · l/s	1×10^{-5}	1×10^{-5}
Operation Temp.		°C (F)	5 ~ 40 (41 ~ 104)	5 ~ 40 (41 ~ 104)
Operation Moisture		RH	90%	90%
Lubrication Oil	Type		BUSCH YLC 250 B	BUSCH YLC 250 B
	Quantity ^{Note2}	liter	0.1	0.1

Note1 : The noise varies depend on the installation occasion. When there are walls or objects that may reflect noise, the noise may be higher than the standard.

Note2 : The amount of oil is based on the oil level of the oil indicator 1/2 to 2/3.

2.2 Dimension

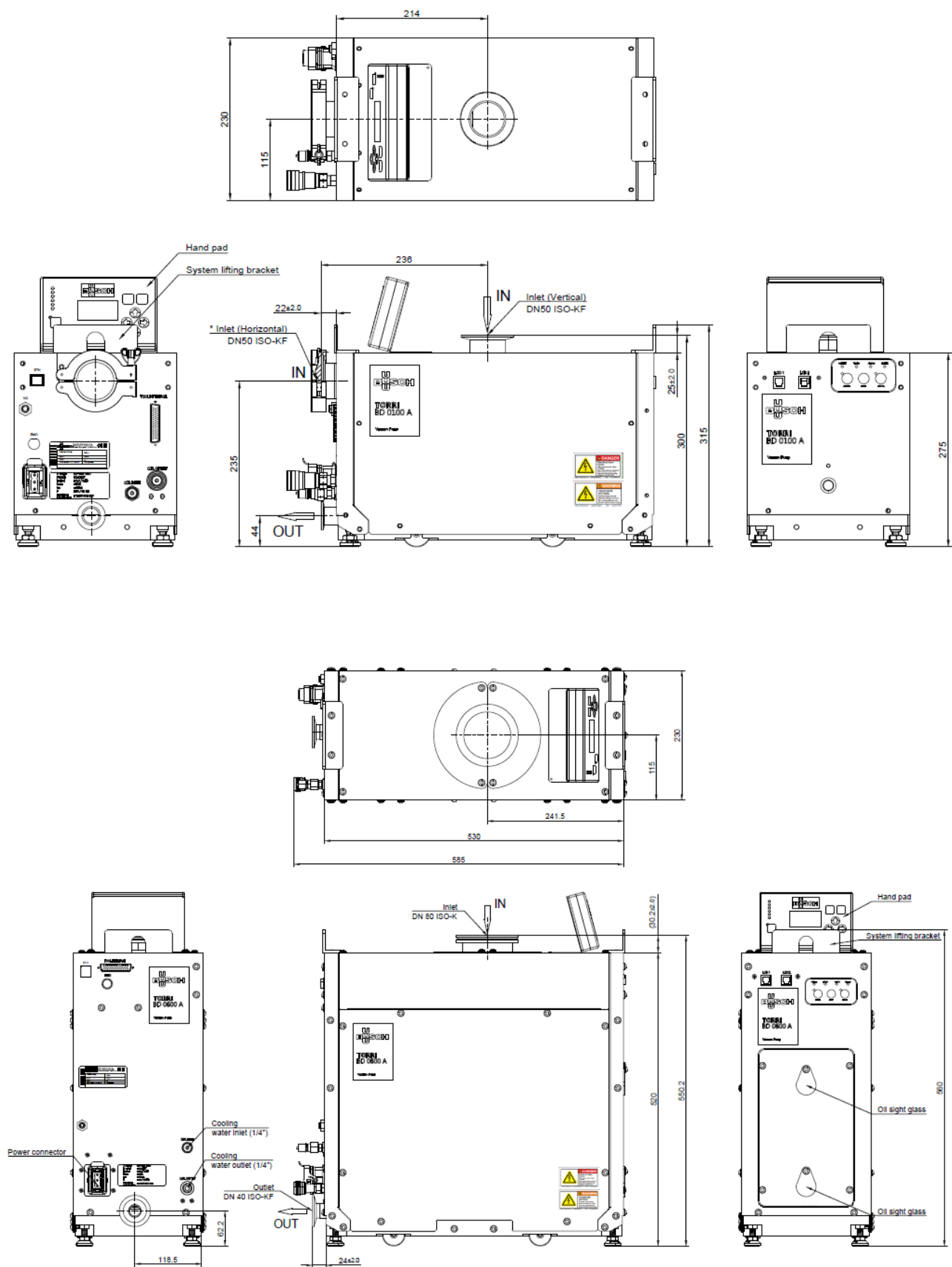
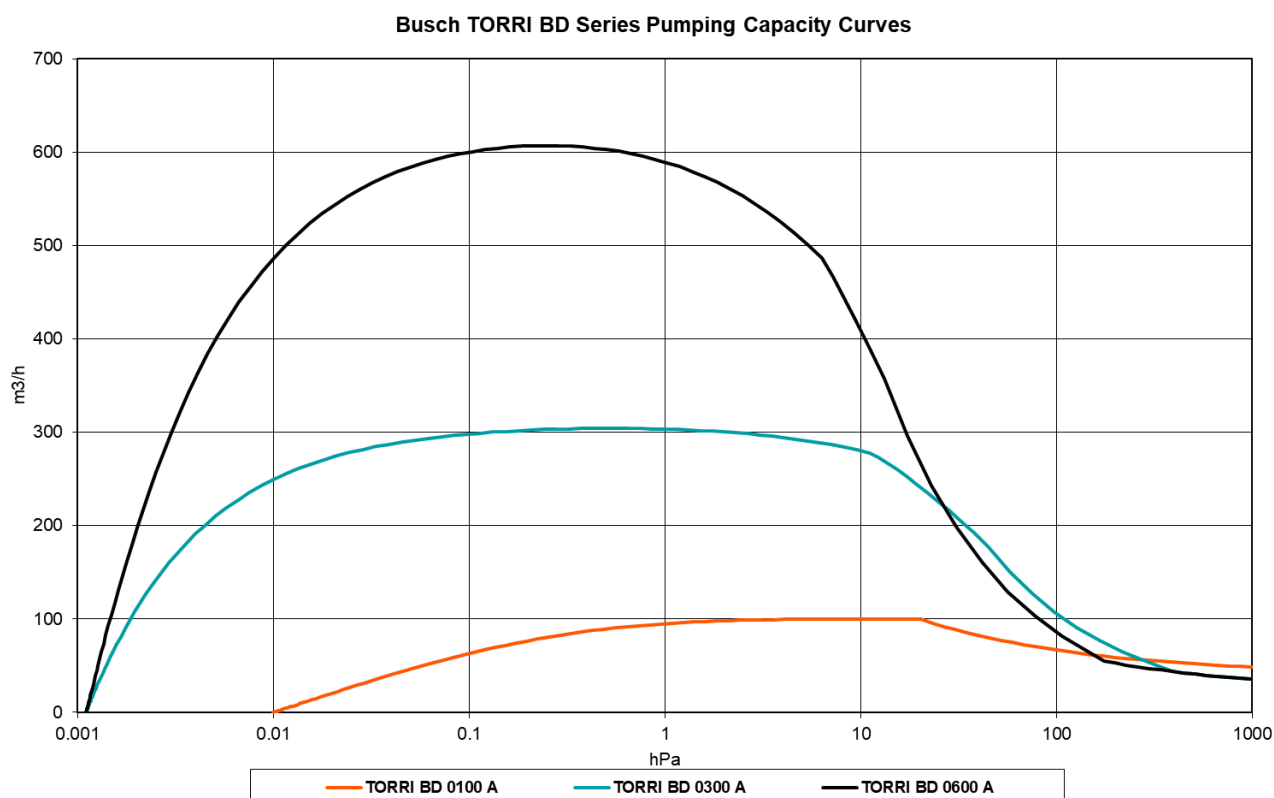


Figure 2.1 TORRI BD 0100 / 0300 / 0600 A Dimension (Unit : mm)

2.3 Pumping Speed Curve



3. Installation

3.1 Notes



WARNING!

Before installing and using this pump, please read this manual carefully and operate according to the explanation in the content, in order to prevent a hazard and damage to the pump.



CAUTION!

Be careful not to overturn the pump when pushing or pulling the pump sideways.

[Attention for Electrical Safety]

- (1) User must make sure that the grounding wire is connected, and the grounding function meets the electric rules.
- (2) Every pump should be connected to the power supply with a power cable and the connector provided with the pump respectively. The wire size should be matched to the power consumption of the pump.
- (3) Check the voltage of the power supply is correct; and the rated current of the NFB in user's facility meets the Table listed below.

Table 3.1 Recommended rated current of the NFB

Voltage Model	200~220V		380~415V	
	NFB Note1	Cable Size (Temperature 105°C)	NFB Note1	Cable Size (Temperature 105°C)
TORRI BD 0100 A	15A	14 AWG	10A	14 AWG
TORRI BD 0300 A	30A	14 AWG	20A	14 AWG
TORRI BD 0600 A	30A	14 AWG	20A	14 AWG

3.2 Environment and Location

[Environment Requirements]

- (1) The vacuum pump should be installed indoors, with a good ventilation and sufficient illumination; it should not be installed in a place which is highly-polluted, very humid, full of corrosive gases, metal dust, with a direct sun shining and getting soaked easily by the rain.
- (2) The temperature of the environment for installing the pump should not exceed 40 °C, and the installing site should stay away far enough from the boiler and any other equipment that would be heat-transpiring.
- (3) The space on top and around the pump should be kept for over 900 mm, at least, for a maintenance purpose.
- (4) The pump installed indoors should prevent a hot-gas short circulation, or inter-effected by the heat-exhausting from the equipment's, therefore the location for the vacuum pump should be considered cautiously.
- (5) Luminance must be higher than 300 lux.

[Location Requirements]

- (6) The pump should be installed on the floor which can stand the weight of the pump. A shock-absorbing pad should be used between the frame of the pump and the floor for a better ground holding and less impact of the floor vibration.

[Adjusting Height of Pump]

- (7) Adjust the adjustment foot on the pump frame until the moveable wheels are 3-5 mm away from the ground; then tighten the M16 nuts to fix the pump.

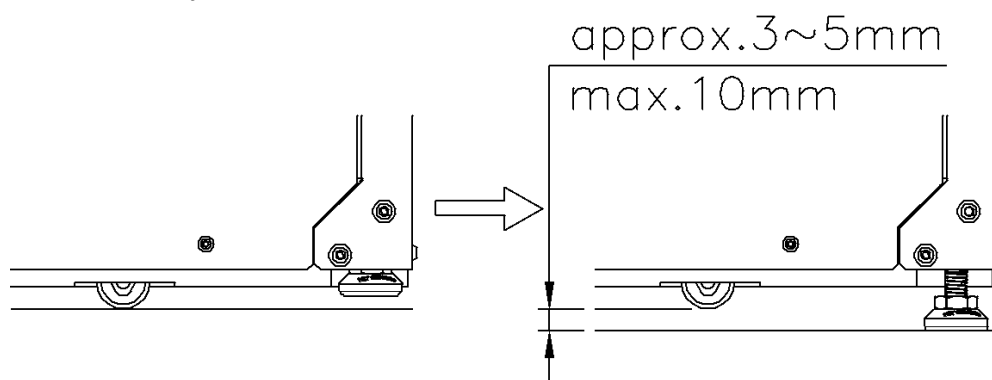


Figure 3.1 The adjustment foot and caster

3.3 Oil Level Inspection



CAUTION!

The oil level should be checked monthly at least; the vacuum oil should be regularly changed every year or half a year, subject to the situation of the process application. When filling the vacuum oil, make sure the pump has stopped completely.

The oil level in the gear box of the vacuum pump should be higher than $1/2 \sim 2/3$ of the oil indicator, refer to Fig. 3.2 below. If under $1/2$ of the oil indicator, new vacuum oil should be re-supplied. Please refer to chapter 6 maintenance.

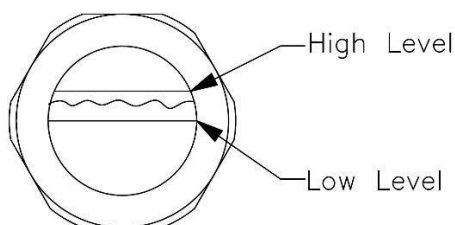


Figure 3.2 Oil Indicator

3.4 Piping

3.4.1 Vacuum and Exhaust Piping



WARNING!

Check for leaks after installing the pump. A leak may cause to the dangerous discharge of hazardous substances or to unpredictable reactions with air admitted into the pump.

**WARNING!**

The exhaust pipes of the pump should be connected properly with exhaust gas treatment equipment to avoid the leakage of the toxic or dangerous gas.

**CAUTION!**

Open the valve on the exhaust piping before starting the pump. If the system has an exhaust gas scrubber, open its inlet and outlet valves. Operating pump with these valves closed will pressurize the exhaust and overload the pump.

[Connection for Vacuum System]

Pay attention to the following rules when connecting the vacuum pump and the vacuum system:

- (1) For the deepest vacuum and best pumping speed, use the shortest possible pipe, the fewest elbows. Select pipe diameters that are sufficient large to minimize conductance losses in the pressure range of your process without unnecessarily increasing pumped volume for systems like load lock that cycle. A bellows between the foreline and the pump inlet is recommended to reduce stress and vibration in the pipe work.
- (2) The supports should be, as much as possible, installed under the vacuum pipe lines; to avoid shear strength at the joints of the pipe lines, and a leakage thus caused.

[Connection for Exhaust System]

Attentions for connecting pump and the exhaust system are listed as follows :

- (1) When there is high pressure from the exhaust system, please check if the silencer of the vacuum pump and the exhaust pipes for the facilities are blocked or not.
- (2) A bellows or braided bellows should be installed between the exhaust connection of the pump and the exhaust pipe line to reduce vibration and stress in the pipe work. Centering rings with a second metal ring outside the O-ring are strongly recommended for all exhaust line and pump exhaust connections. This metal ring captures the O-ring to prevent it from deforming and letting gas escape if the pressure in the exhaust line rises.
- (3) When using explosive, corrosive or toxic gas for the process, the pump exhaust system must not contact the atmosphere.

A leak check will surely be performed after the installation of the vacuum pump or when finding any leakage. When proceeding with the leak check for the vacuum pump or the vacuum system, please pay attention to check any emission of gas (moisture, residual of organic solvent) which will cause virtual leaks of the vacuum system. The recommended maximum leak rate value for a Helium leakage test or other ways of test is 1×10^{-5} mbar·l/s

3.4.2 Cooling Water Piping



CAUTION!

Never stop supplying the cooling water during the pump operation, otherwise, the components of the pump will be over-heating and then will be broke down.

After the pump is stopped, please keep cooling down the pump with the cooling water for more than ten minutes; after that, cease to supply the cooling water.



WARNING!

After the power supply switch is turned on, do not pull off the cooling pipe lines inside the pump; otherwise the cooling water will spill out and cause a circuit short and an electrical fatality accident of personnel.

The water ports are quick-connect couplers (RC1/4"), and the maximum endurable pressure is 4 kg/cm² (57 PSI). The water flow meter is installed inside the pump for a monitoring and protection purpose. Please refer to chapter 4 for settings. The operating steps are as follows.

- (1) According to the directions of water inlet and outlet from the pump, connect the male and female quick joints to the rear panel.
- (2) Supply the cooling water and check any leakage from the joints and the pipe lines.
- (3) Check, with the LCD controller, if the water flow is over the minimum flow rate required. If not, please increase the flow.
- (4) Do not connect pump cooling water loops in series. Select piping to ensure sufficient flow through each pump.
- (5) If cooling water valve is equipped, please setting the delay time to close the valve in control panel.

3.5 Electrical Connection

- (1) According to the electrical regulations, the proper specification for the wire and NFB to ensure the safety of electricity usage.
- (2) The voltage for the power supply should be kept within $\pm 10\%$ of the rating voltage.
- (3) The voltage unbalance should be kept within 10%.
- (4) The input power frequency should be kept within $\pm 5\%$ of the rating frequency.
- (5) The system passed the SEMI F47-0812R. It will be keep running when the input voltage in accordance with standard. The system can automatic recovery run within 1 second of voltage interruption.
- (6) The inverter and power supply of the system passed the harmonic test according to the IEC 61000-3-2 Class A standard.

3.5.1 Power Supply Connection



WARNING!

Vacuum pump power supply wiring must follow the instructions below, otherwise it will cause the pump unit and the motor parts of the major damage.

Description	Mating connector description/external supply rating
Mains connection	Han® C module : 40A ; 2.5 - 8 mm ²

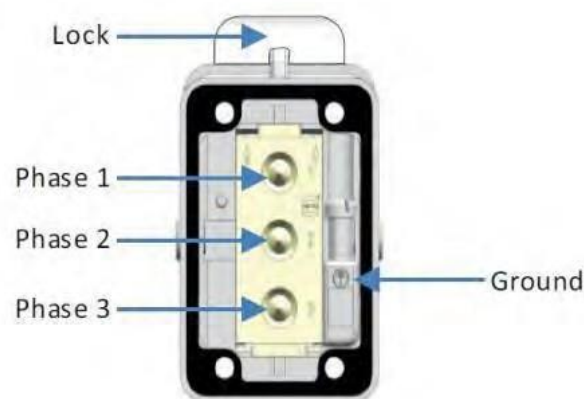


Figure 3.3 Power connector pin assignments (supply socket)

3.5.2 Interface Connection

According to the semiconductor industrial standard E73-0299, the vacuum pump has one set of 50-Pin Female D-sub connector for connecting with the process equipment (see Fig. 3.4). The functions and pin assignments are shown in the Table 3.2 below. Please refer to Fig. 3.5 for sequence and Fig. 3.6 for wiring.

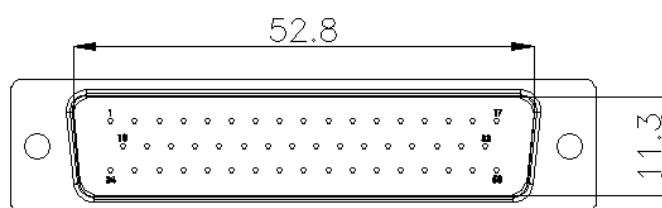


Figure 3.4 Interface connector

Table 3.2 Pin assignment for Interface connector

Pin no	Purpose	Sign in	Signal Type
1	Alarm status	OUT (type D)	Open (when Alarm)
2	Alarm status		
3	Warning status	OUT (type D)	Open (when Warning)
4	Warning status		
5	DP start/stop status	OUT (type D)	Close (when DP starts)
6	DP start/stop status		
7	MB start/stop status	OUT (type D)	Close (when MB starts)
8	MB start/stop status		
9	Pump ready status	OUT (type D)	Close (when pump ready)
10	Pump ready status		
13	MB full speed reached	OUT (type D)	Close (when reached)
14	MB full speed reached		
15	Remote/Local Status (+)	OUT (type C)	Close (when Remote)
16	Remote/Local Status (-)		
17	Remote Start Pump (+)	IN (type B)	Close (DP will start)
18	Remote Start Pump (-)		
21	Process ON (+)	IN (type B)	Close (Pump will full speed)
22	Process ON (-)		
37	Remote Start Pump	IN (type A)	Close (DP will start)
38	Remote Start Pump		
39	EMO	OUT	Open (When triggered EMO)
40	EMO		
41	Process ON	IN (type A)	Close (Pump will full speed)
42	Process ON		

For output signal: There are 5 sets of dry contact. Refer to Fig 3.7. Please pay attention to the contact rating when using it.

For input signal: Pin 37 and Pin 38 are connected by dry contact or open collector to control pump start or stop.

Pin 41 and Pin 42 are connected by dry contact or open collector, which can control process on signal to pump start.

As shown as Fig 3.6. T is the time delay and wait for the pressure switch to actuate.

Note: The control mode of the pump must be in the SEMI mode. Please check the setting in the LCD controller.

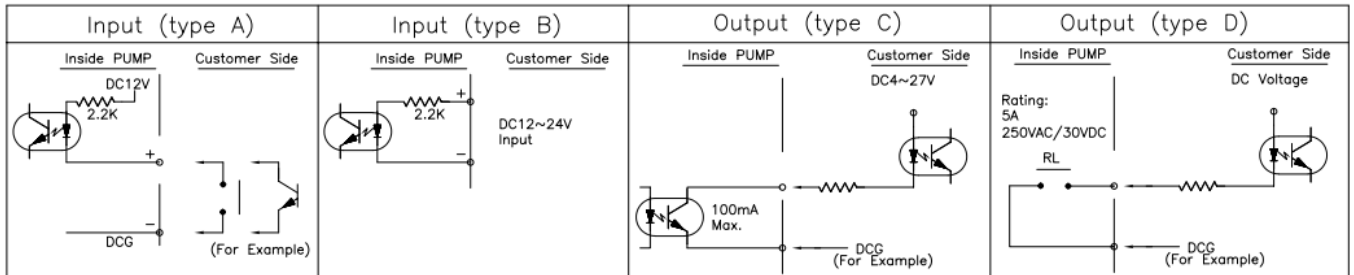


Figure3.5: Signal Type

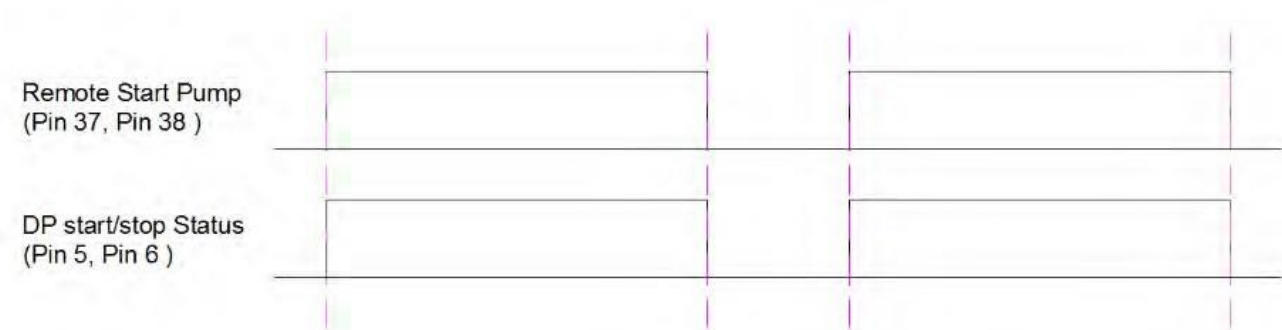


Figure 3.6: Pump start & stop sequence

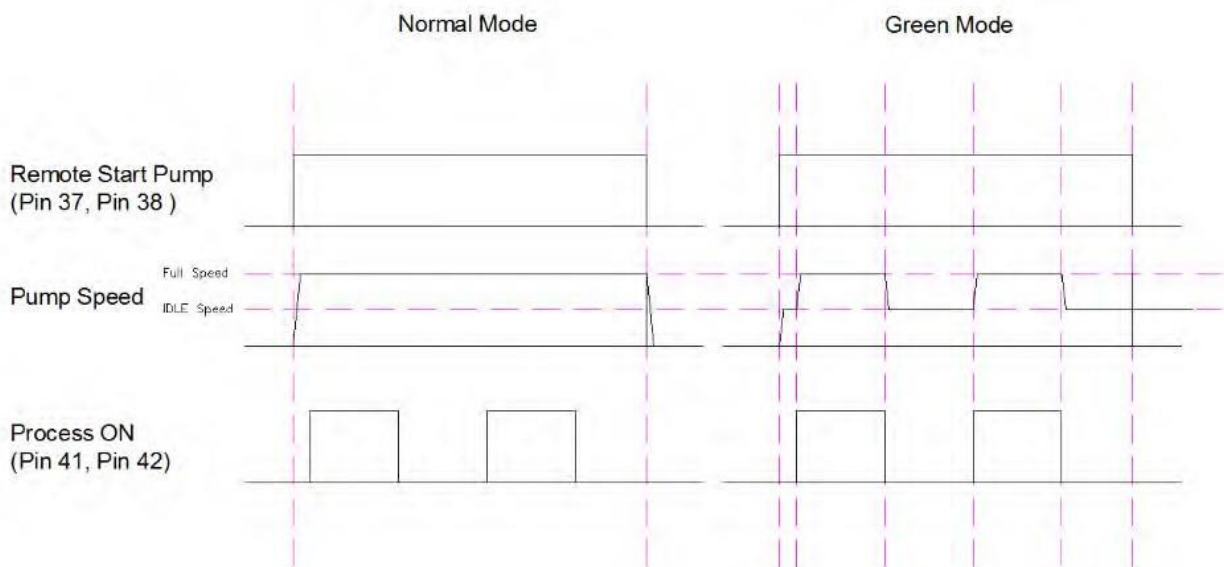
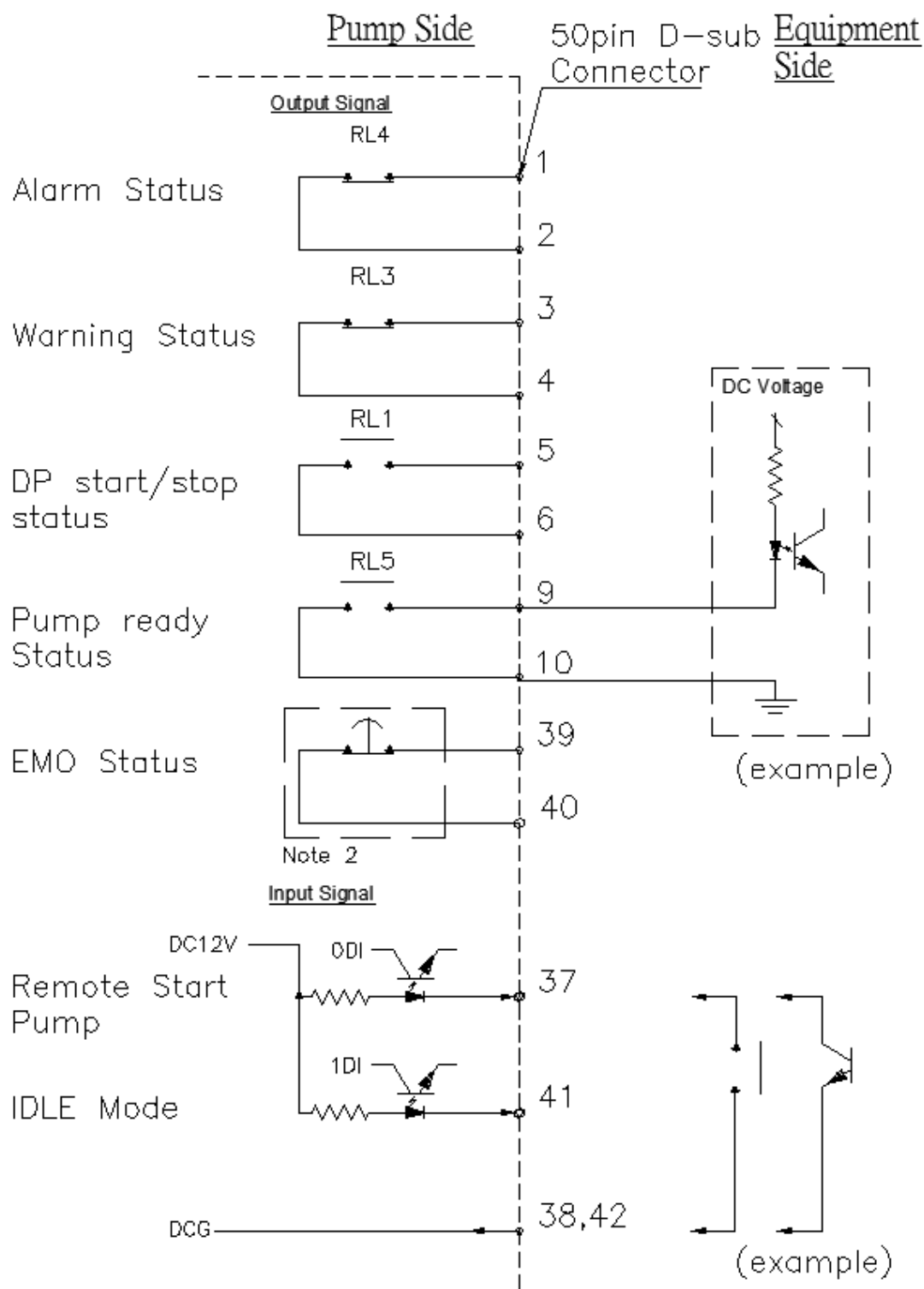


Figure 3.7: Process on signal sequence

Interface signal



Note 1: The rating of the relay contacts RL1 ~ RL5 is 5A 250VAC / 30VDC

Note 2: EMO Status (pin 39,40) will be functioned when the pump equips with :SEMI S2 BO " (Planned)

Figure 3.7 Interface circuit diagram and connection method

3.5.3 Modbus TCP Interface Port

Pump can provide Modbus TCP communication interface, it connects to the equipment through the Ethernet port to read the operating status of the pump. The port is the standard RJ45 connector. Please contact Busch company for the communication protocol.

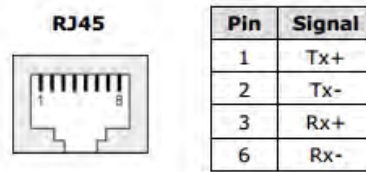


Figure 3.8 RJ45 Interface Port

4.Operation

4.1 Simple Control Panel

The pump front frame is equipped with a control panel, it provides simple operation and display of the pump status. The buttons and LED functions are described as follows:

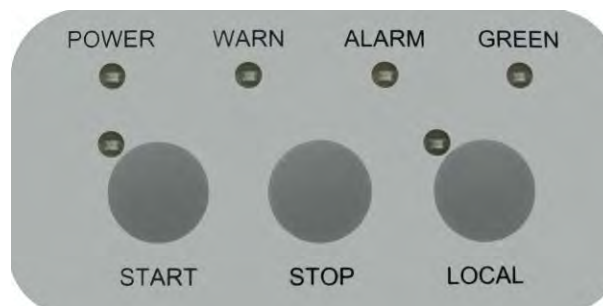


Figure 4.1 Simple Control Panel

[LED Indicator]

- POWER (Green) : Lighting when system is powered.
- ALARM (Red) : Flashing when pump is in Alarm status.
- WARNING (Orange) : Flashing when pump is in Warning status.
- GREEN (Green) : Lighting when the IDLE model is start.

[Button]

- START (Green) : Start pump will light after pump starting.
- STOP : Stop pump.
- LOCAL (Green) : Press about 5 sec, light goes on. Gained the control right.

The START and STOP buttons are valid.

Press about 5 sec again, the light goes off, the START and STOP buttons have no effect, which can prevent people from touching the buttons by mistake.

4.2 MMIControllerPort

When MMI controller plugged into the port (RJ45), it will load the parameter setting of pump, shown as Fig 4.2.

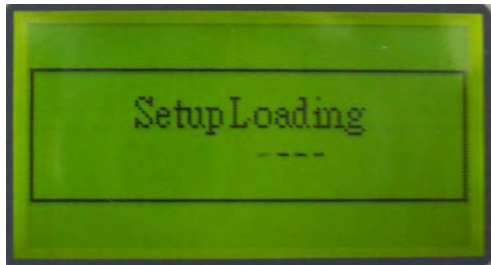


Figure 4.2 MMI parameter loading screen

4.3 LCD Control Panel

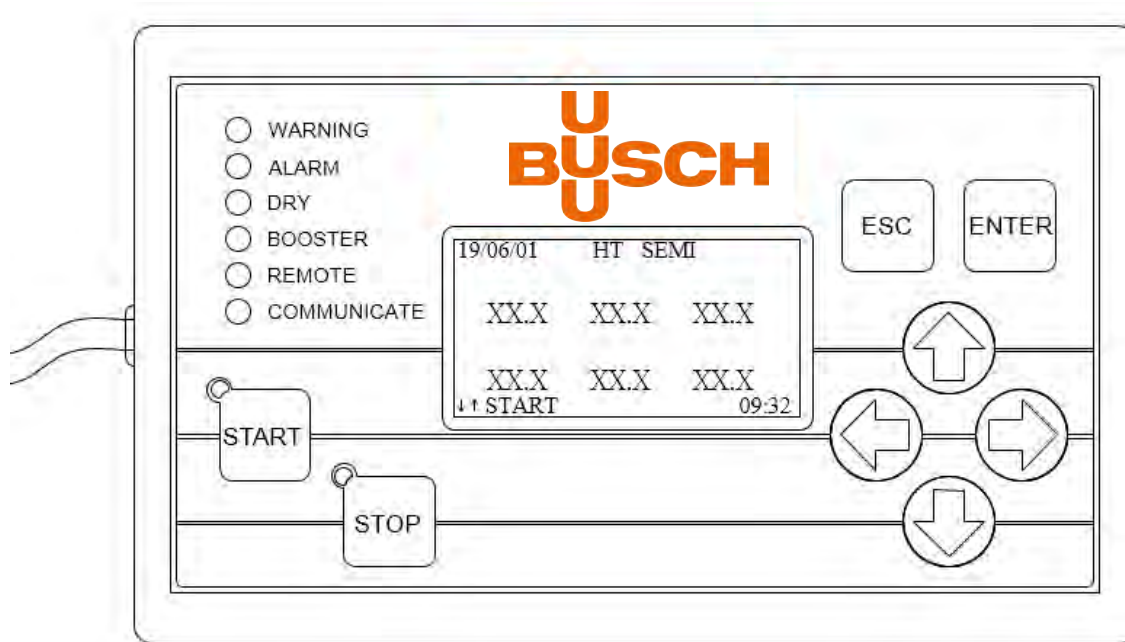


Figure 4.3 Control Panel

[LED Indicator]

- | | | |
|-------------------------|---|--|
| ● WARNING (Orange) | : | Flashing when pump is in Warning status. |
| ● ALARM (Red) | : | Flashing when pump is in Alarm status. |
| ● DRY (Green) | : | Lighting when the Dry pump is running. |
| ● BOOSTER (Green) | : | Lighting when the Booster pump is running. |
| ● REMOTE (Green) | : | Flashing when pump is in Remote mode. |
| ● COMMUNICATE (Green) | : | Flashing when data is in communicated. |

[Button]

- START (Green) : Start pump , will light after pump starting.
- STOP (Red) : Stop pump , will light after pump stopping. Stop the Buzzer.
- ESC : Back to last page, Cancel Warning and Alarm status.
- ENTER : Confirm 、 Next page.
- Arrow Keys : Scroll page.

[LCD Display]

- 「 19/06/01 」 : Date (Y/M/D).
- 「 HT 」 : N2 heater is operating.
- 「 SEMI 」 : Pump is in remote controlling mode.
- 「 BP 」 : Pump will run with booster pump, flashing when booster pump is running.
- 「 IDL 」 : Pump is running under IDLE mode.
- 「 ↓ ↑ START 」 : Help information for Key board.
- 「 09 : 32 」 : Time.

4.4 Control Panel Operating Introduction (See Fig.4.4)

The pump control function could be divided into four layers. The first layer indicates the status of the pump including pump currents, motor temperature, casing temperature, water flow, N2 mass flow, exhaust pressure, etc.

The second layer could check the warning, alarm records and the lasting hours before maintenance. The UP and DOWN key could be used to scroll the display to show more information.

- "12.1.18", user can select °C or °F for temperature unit display
- "12.1.19", user can select "Torr, mbar, kPa, psi, kgf/cm2" for pressure unit. (Note: "kgf/cm2" is displayed in "kgf")

The controller provides two modes to control the pump operation. For "local" mode, the START and STOP buttons on the LCD control panel are used to start/stop the pump. For "SEMI" mode can control pump start/stop by the external signal.

The third layer “12.1 User Setup” provides user to change the system setting which includes

- Setting for language at “12.1.1”
- Settings for MB at “12.1.3, 12.1.4, 12.1.5, 12.1.6, 12.1.7”
- Settings for N2 flow meter at “12.1.8, 12.1.9, 12.1.10”
- Settings for connecting with PC at “12.1.12, 12.1.13, 12.1.14, 12.1.15”
- Setting for temperature unit at “12.1.18”
- Setting for pressure unit at “12.1.19”, "12.1.11"

“12.2 Factory Setting” provides warning and alarm value setting during pump operation. Normal users do not need to change the parameters of this part. If there is special demand, please contact Busch.

When "Water flow protection (without temperature) "is setup at 0 at "12.2.4.12 DI setting" , if water flow is lower than the alarm but the motor temperature or the casing temperature is normal, then the message "W06 Cooling water flow too low" will be generated. This message will not stop pump immediately; until the temperature of the motor or casing exceeds the warning setting, the message "A06 Cooling water flow too low" will be generated and stop pump.

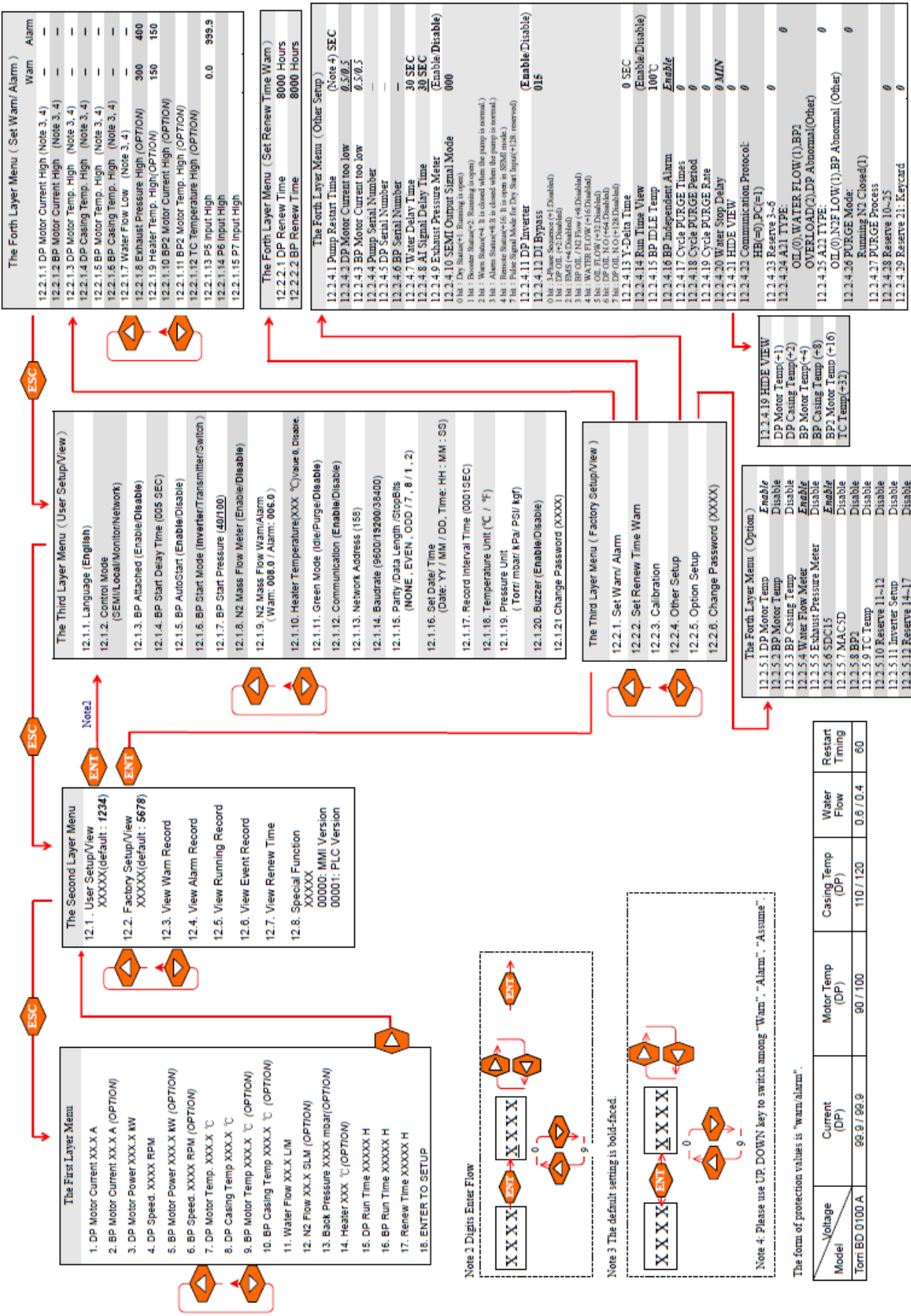


Figure 4.4 Control Panel Operating Flowchart

4.5 Start/Stop the Pump

4.5.1 Before Starting

Please proceed with the following items before connecting the vacuum pump with the power cable.

- (1) Check if the vacuum pump is in its position and the adjustment foot are fixed or not.
- (2) Turn on the cooling water and check if the pipe is connected and pipe is leaking or not.



CAUTION!

If any valve on the exhaust piping is closed, the pump will be shut down because of overloading.

- (3) Check the exhaust piping. If there is any valve closed on the exhaust piping, please open it.
- (4) Check if the inlet port of the pump and the vacuum system are connected properly.



CAUTION!

If the water flow is too low, the temperatures of the pump body and the motor will rise and may cause rotor contact and other problems.

- (5) Check if the cooling water supply of the pump is sufficient. Higher than 1 L/Min (15°C -28° C) for TORRI BD 0100 A and 2 L/Min (15°C - 28°C) for TORRI BD 0300 A & BD 0600 A.
- (6) If there is any other abnormal message on the LCD controller, please refer to chapter 5 and solve it. Then press ESC to clear the warning or alarm message before the pump could be started.

4.5.2 Start or Stop Pump



WARNING!

In order to prevent a scald accident, it is strictly forbidden to touch the pump body, the exhaust piping and the hot N2 piping before they are cold down completely.

Keep the pump body and the exhaust piping away from contact with personnel and flammable substances

Keep cool the pump with the cooling water for at least ten minutes; after that, stop to supply of the cooling water.

**CAUTION!**

In order to prevent any corrosive gases or byproducts inside the pump, do not stop the pump until after at least 30 minutes after stopping the flow of process gases.

[Local Mode Start/Stop]

When the setting “12.1.2 control mode” is 「 LOCAL 」, press the START key to start the pump and the STOP key to stop the pump.

[Remote Mode Start/Stop]

When the setting “12.1.2 control mode” is 「 SEMI 」, REMOTE lights goes on, user can control the pump by the external signal. The START and STOP buttons have no effect.

5.Troubleshooting

Message Code	Cause	Action
W01(A01) DP Current High	Exhaust pressure rises	Check exhaust piping and silencer
	Pump with noise, and rotors are in contact.	Replace or overhaul pump
	Power supply failure	Check power supply
W02(A02) BP Current High	Pump start pressure is too high	Check vacuum pressure switch setting
	Pump with noise, and rotors are in contact.	Replace or overhaul pump
	Power supply failure	Check power supply
W03(A03) DP Motor Temp. Hi	Insufficient cooling	Check water flow and temperature
	Motor failure	Replace the motor
W04(A04) DP Casing Temp. Hi	Insufficient cooling	Check water flow and temperature
	Insufficient coolant in the water jacket	Refill the coolant
	Byproduct is clogged	Replace or overhaul pump
W06(A06) Water Flow Low	Water piping leaks	Check the fittings
	Differential pressure is too small	Check the inlet and outlet pressure of water piping
	Water piping is clogged	Clean or replace piping
	Outlet/inlet is reverse.	Connect correctly
	Flow meter failure	Replace flow meter
W09 DP Renew Time	DP needs to be maintained.	Check the setting. Overhaul the DP.
W10 BP Renew Time	BP needs to be maintained.	Check the setting. Overhaul the BP.
W21 PLC Version Update	-	Update PLC Version
W23 Comm. Error	The PLC/VFD is failed.	Replace the PLC/VFD in electrical box.
W31(A31) BP Motor Temp. Hi	Water Flow is too few	Check water flow and temperature
	Insufficient cooling	Check water flow and temperature
W32(A32) BP Casing Temp. Hi	Water Flow is too few	Check water flow and temperature
	High gas loading	Reduce the flow and temp. of process gas
	Long term pumping	Reduce the pumping time
A16 DP Motor Fail (Lose Speed)	The VFD control of the motor is abnormal and the restart is continuously disabled.	Power off and restart. Replace or overhaul pump.
A17 BP Motor Fail (Lose Speed)	The VFD control of the motor is abnormal and the restart is continuously disabled.	Power off and restart. Replace or overhaul pump.
A19 DP Motor Overload	Exhaust pressure rises	Check the exhaust piping and silencer
	Byproduct or object clog	Replace or overhaul pump
A20 BP Motor Overload	Operating pressure is too high	Check vacuum pressure switch setting ^{*2}
	Byproduct or object clog	Replace or overhaul pump
	Rotors are in contact.	Replace or overhaul pump

6. Maintenance

6.1 Notes

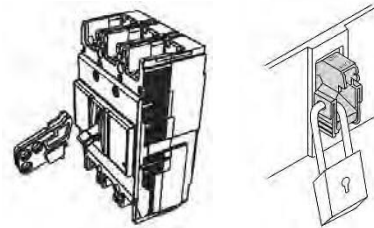


WARNING!

Follow the safety notes listed below. Improper operation may cause dangerous accidents and serious injuries.

1. Any maintenance work must be performed by the qualified personnel. The personnel must be familiar with the safety rules related to the pump and can use the suitable tools to dismantle and clean the contaminated parts. Protective equipment is necessary.
2. When start maintenance process, please use personal protective equipment, such as activated carbon mask, Silicone gloves.
3. In order to prevent any danger, don't move or disassemble the pump before it has stopped completely; switch off the power supply to the pump before you start maintenance work.
4. Lock the breaker (lockout) and show the notification before connecting power, service or trouble shooting as following :

- a. Turn off power supply, remove power connector.
- b. Turn off the breaker and set Lockout Device.
- c. Install the Lockout device
- d. Hang up the sign and install the lock.
- e. After the maintenance is completed, please remove the sign & lockout device in order.
- f. Reconnect and restart the power supply. (If safety circuit external enclosure is installed, press the reset button after power transmission)
- g. Restart pump by LCD control panel or simple control panel.

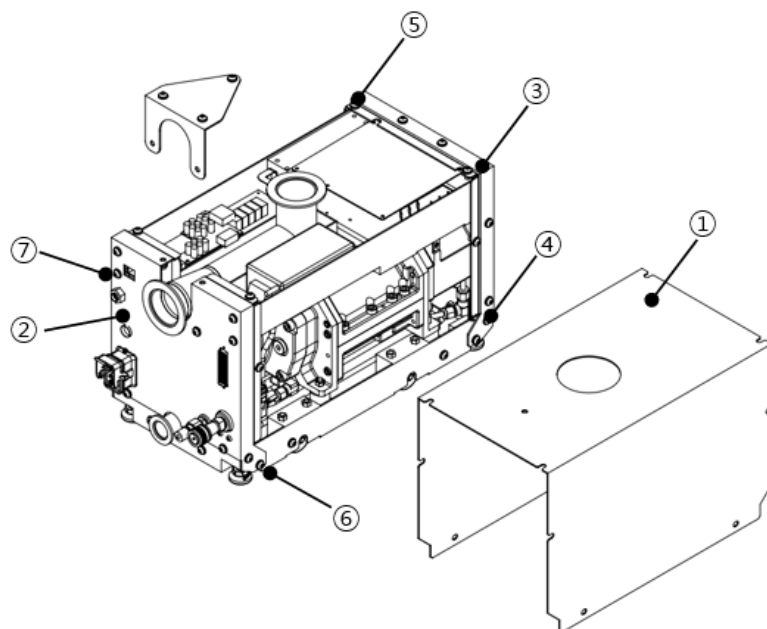


5. The pump casing, the exhaust piping and the heating piping are extremely hot during operation and remain hot for some time after stopping. Keep the personnel and flammable substances away from the hot area.
6. Close cooling water and N₂ purge gas supply before remove the piping line and fit the plug in the inlet/outlet port.
7. There might be toxic gases or materials remain in the pump, check that there is nothing remaining before the disassembly.
8. After removing the pump and exhaust piping, seal all inlet/outlet port with blind plate.
9. Don't reuse any O-ring. Be careful to cleaning all flange surfaces and check they are undamaged. Check for gas leaks after installing and maintaining the piping.
10. Do not touch or inhale the thermal breakdown products of fluorinated materials which may be present if the pump has been overheated to 260 °C and above. These breakdown products are very dangerous. Fluorinated materials in the pump may include oils, greases and seals. The pump may have overheated if it was misused, if it malfunctioned or if it was in a fire.

11. Disposal of process byproducts, lubricating oil, vacuum grease and other wastes must be in strict accord with all local and national environmental and safety regulations.

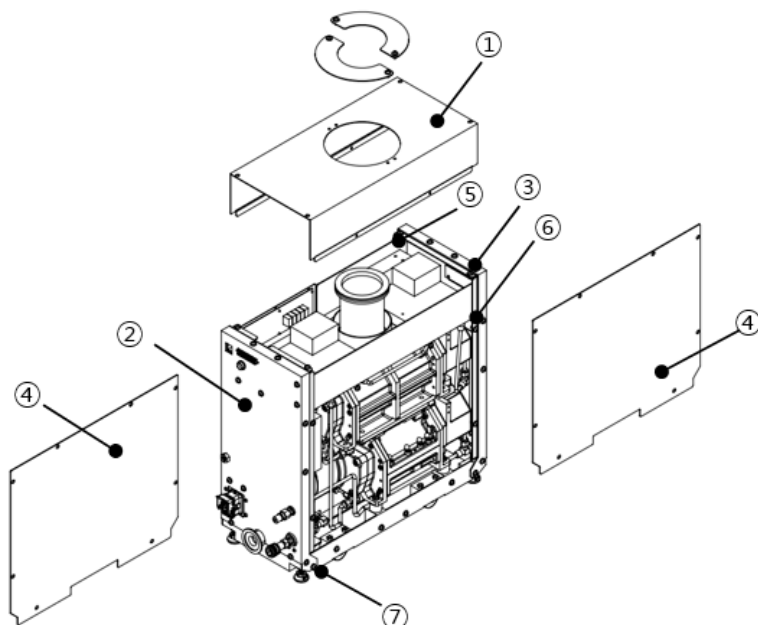
6.2 Dismantle/Assemble Pump Plates

BD 0100 A



1. Top Plate
2. Front Plate
3. Rear Plate
4. Hex Socket Screws M6*12
5. Hex Socket Screws M6*12
6. Hex Socket Screws M6*12
7. Hex Socket Screws M6*12

BD 0300 A / 0600 A



1. Top Plate
2. Front Plate
3. Rear Plate
4. Side Plate
5. Hex Socket Screws M6*8
6. Hex Socket Screws M6*8
7. Hex Socket Screws M6*8

6.3 Lubricating Oil



WARNING!

There might be toxic process gas and material inside the gear box, please be careful to avoid the contact with your eyes or skin.



CAUTION!

The lubricating oil should be used according to Busch's suggestion. BUSCH will not be responsible for any damage of the vacuum pump or vacuum system



CAUTION!

Do not start filling oil until the pump interior reaches atmospheric pressure. During pump operation, the chamber containing the oil is under vacuum. Removing the oil fill plug while the pump is running will damage the pump.

The waste oil must be disposed by the professional and qualified waste disposal dealer.

The lubricating oil for the vacuum pump is Fluorinated lubricant oil. Another kind of oil cannot be used or replaced; otherwise, it will cause a major damage of the vacuum pump.

When replacing the oil, the used oil inside the pump must be drained out completely, otherwise, it will reduce life time of the new oil. The procedures to replace the oil are listed as follows.

1. Dismantle the oil fill plug at the oil inlet hole.
2. Dismantle the drain plug at the oil outlet hole; purge all the used oil out of the oil box or making use of a proper pump to draw out the used oil.
3. Replace all the O-rings. Check all plugs are tightened. The O-rings can be found from BUSCH PM kit package.
4. Use BUSCH authorized vacuum oil and re-supply the oil to a proper level.

6.4 Piping Connector

A regular leakage check should be performed over all the connecting parts of the piping. It should be included of checking any crack on the hoses. Washers, O-rings and hoses should be replaced according their condition. All parts should be tightened again or re-sealing if necessary.

6.5 Pump Inlet Flange

Dismantle the pump inlet flange regularly for cleaning the dirt on the mesh and change with a new O-ring.

6.6 Cooling Water Piping

After operating for a period of time, the cooling water piping might encounter the problem of a poor cooling effect because of the dirt adhering to the piping. It will cause the pump casing temperature to rise. A regular cleaning job is necessary, and the clean frequency is dependent on the quality of the water. The cooling tower and the filter should also be cleaned often. If the piping has already been adhered with the dirt, the piping should be cleaned with a cleaner or be replaced.

6.7 Decontamination procedures

In order to avoid pump internal corrosion or producing by products, pump can be shut down after production process has stopped for at least 30 minutes.

Note: Pump is only for load lock, it does not require special decontamination procedures.

6.8 Scrap Procedure

Depending on the damage of the motor, rotor, housing, terminal box and gearbox, whether or not it can be reused is determined. The remaining valve parts, bearings, and circuit boards are regarded as waste, and are disposed of in accordance with environmental regulations.

6.9 Maintenance Plan

The plan shown as below details the maintenance operations we recommend to maintain the pump in normal operation. To perform the maintenance periodically and effectively will keep the pump in a normal working condition and will not suffer with the loss causing from the breakdown and failure of the pump. The frequency of the maintenance is dependent on your process. In clean processes, you can decrease the frequency of the maintenance; in harsh processes, you may have to increase the frequency of the maintenance.

Table 6.1 Maintenance plan

Item	Content	Weekly	Monthly	Yearly	2 year
			500hr	8000hr	24000hr
LCD controller	Check if there is any abnormal	○			
Motor temperature	Check if it is warning	○			
Casing temperature	Check if it is warning	○			
Motor current	Check if it is warning	○			
Cooling water flow	Check if it is warning	○			
Cooling water piping	Clean			○	
Piping connector	Check		○		
Lubricating oil level and color	Check		○		
Lubricating oil	Replace oil			●	
Emergency switch	Function test			○	
N2 pressure regulator	Function test			○	
Pump inlet flange	Check/Clean			○	
Silencer	Check/Clean			○	
N2 flow regulator(option)	Check/Clean			○	
Bearing	Complete overhaul				●
O-ring	Complete overhaul				●

Recommend replace : ● Recommend

check/clean : ○ Recommend complete

overhaul : ●

7. Option

In order to comply with the SEMI S2 standard, a "Safety Circuit External Enclosure" shall be installed. This accessory provides a complete EMO function and includes a leakage circuit breaker and an electromagnetic contactor for the safety protection of the circuit. When this accessory is installed, press the "power reset button" the pump power will be restart.

The relevant system configuration and dimensions are described in Figure 5.1 and Figure 5.2. The circuit is described in "Figure 5.3."

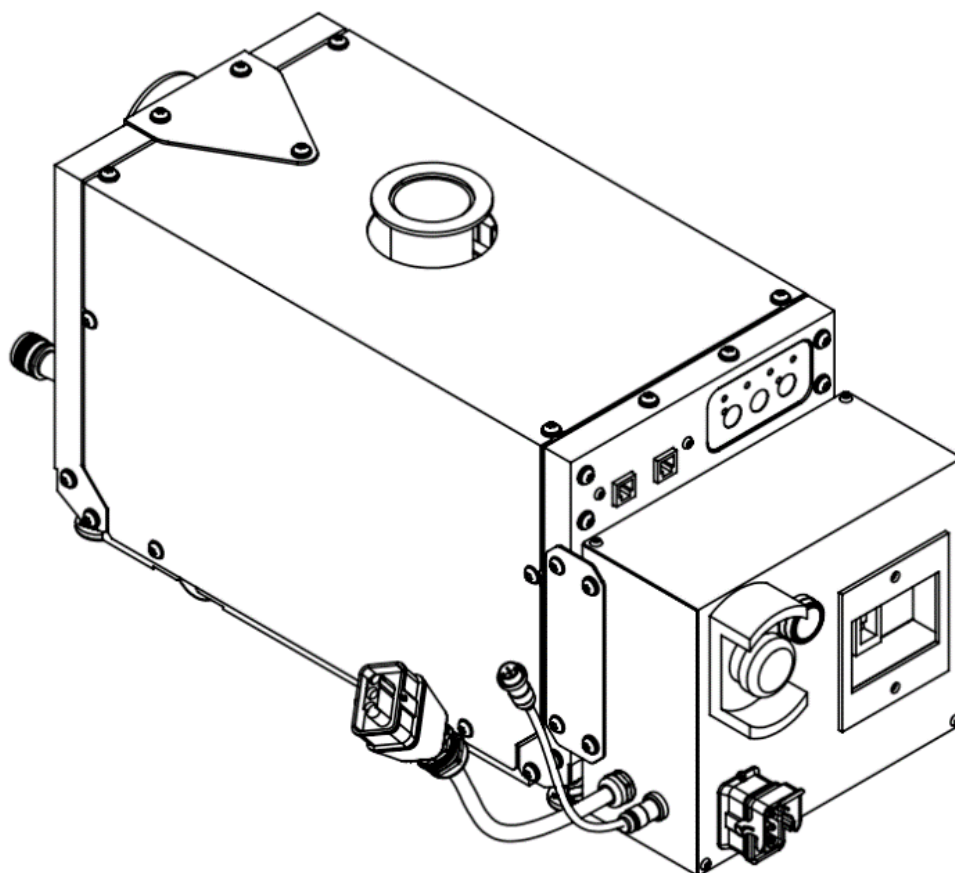


Figure 5.1 Series External Circuit Protection Enclosure System Configuration Diagram

- | | |
|-------------------------------|--------------------------------|
| 1. Power Outgoing | 5. Power Reset Button |
| 2. Power Incoming | 6. Electricity Leakage Breaker |
| 3. EMO Signal connection port | 7. Magnetic Contactor |
| 4. Emergency stop button | |

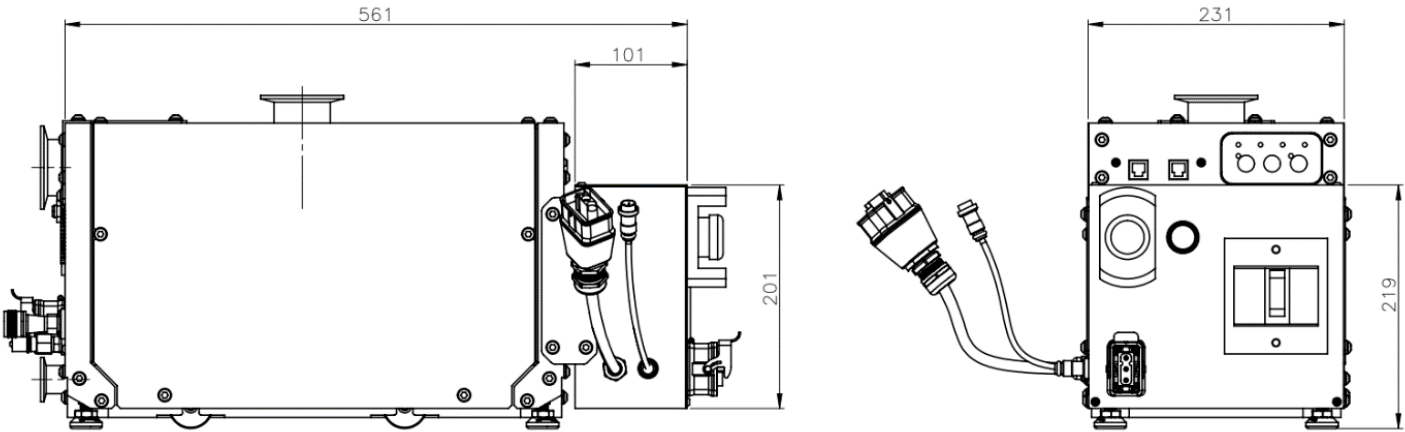


Figure 5.2 Safety Circuit External Enclosure” Dimension

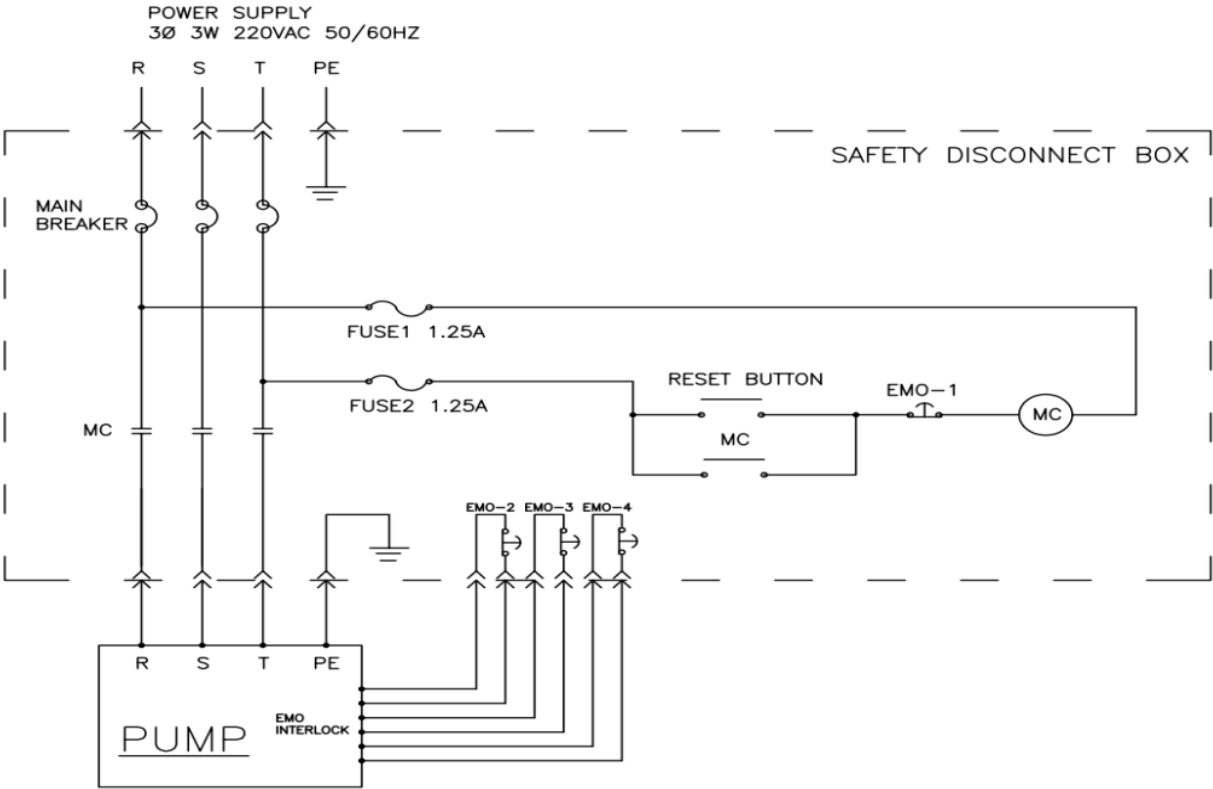


Figure 5.3 Circuit diagram

8 EU Declaration of Conformity

This Declaration of Conformity and the CE-markings affixed to the nameplate are valid for the machine within the scope of delivery. This Declaration of Conformity is issued under the sole responsibility of the manufacturer.

When this machine is integrated into a superordinate machinery the manufacturer of the superordinate machinery (this can be the operating company, too) must conduct the conformity assessment process for the superordinate machine or plant, issue the Declaration of Conformity for it and affix the CE-marking.

The manufacturer

Busch Manufacturing Korea, Ltd.
189-51, Soicheon-ro, Majang-myun
Icheon-si, Gyunggi-do, 467-813
Republic of Korea

declares that the machine: TORRI BD 0100 A; TORRI BD 0300 A; TORRI BD 0600 A

fulfill(s) all the relevant provisions from EU directives:

- 'Machinery' 2006/42/EC
- 'Electromagnetic Compatibility' (EMC) 2014/30/EU
- 'RoHS' 2011/65/EU Restriction of the use of certain hazardous substances in electrical and electronic equipment (incl. all related applicable amendments)

and comply(-ies) with the following harmonized standards that have been used to fulfill those provisions:

Standard	Title of the Standard
EN ISO 12100 : 2010	Safety of machinery - Basic concepts, general principles of design
EN 1012-2 : 1996 + A1 : 2009	Vacuum pumps - Safety requirements - Part 2
EN 60204-1 : 2018	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
EN ISO 13857 : 2019	Safety of machinery - Safety distances to prevent hazard zones being reached by the upper and lower limbs
EN ISO 2151 : 2008	Acoustics - Noise test code for compressors and vacuum pumps - Engineering method (grade 2)
EN IEC 61000-6-2 : 2019	Electromagnetic compatibility (EMC) - Generic standards. Immunity for industrial environments
EN IEC 61000-6-4 : 2019	Electromagnetic compatibility (EMC) - Generic standards. Emission standard for industrial environments

Legal person authorized to compile the technical file and authorized representative in the EU (if the manufacturer is not located in the EU):

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Icheon-si, 19.12.2023



Jeihong Kim

General Manager

Busch Manufacturing Korea, Ltd

9 UK Declaration of Conformity

This Declaration of Conformity and the UKCA-markings affixed to the nameplate are valid for the machine within the scope of delivery. This Declaration of Conformity is issued under the sole responsibility of the manufacturer.

When this machine is integrated into a superordinate machinery the manufacturer of the superordinate machinery (this can be the operating company, too) must conduct the conformity assessment process for the superordinate machine or plant, issue the Declaration of Conformity for it and affix the UKCA-marking.

The manufacturer

Busch Manufacturing Korea, Ltd.
189-51, Soicheon-ro, Majang-myun
Icheon-si, Gyunggi-do, 467-813
Republic of Korea

declares that the machine: TORRI BD 0100 A; TORRI BD 0300 A; TORRI BD 0600 A

fulfill(s) all the relevant provisions from UK legislations:

- Supply of Machinery (Safety) Regulations 2008
- Electromagnetic Compatibility Regulations 2016
- Restriction of the use of certain hazardous substances in Electrical and Electronic Equipment Regulations 2012

and comply(-ies) with the following designated standards that have been used to fulfill those provisions:

Standard	Title of the Standard
EN ISO 12100 : 2010	Safety of machinery - Basic concepts, general principles of design
EN 1012-2 : 1996 + A1 : 2009	Vacuum pumps - Safety requirements - Part 2
EN 60204-1 : 2018	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
EN ISO 13857 : 2019	Safety of machinery - Safety distances to prevent hazard zones being reached by the upper and lower limbs
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EN IEC 61000-6-2 : 2019	Electromagnetic compatibility (EMC) - Generic standards. Immunity for industrial environments
EN IEC 61000-6-4 : 2019	Electromagnetic compatibility (EMC) - Generic standards. Emission standard for industrial environments

Legal person authorized to compile the technical file and importer in the UK (if the manufacturer is not located in the UK):

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30 Hortonwood
Telford - UK

Icheon-si, 19.12.2023



Jeihong Kim

General Manager

Busch Manufacturing Korea, Ltd





BUSCH GROUP

The Busch Group is one of the world's largest manufacturers of vacuum pumps, vacuum systems, blowers, compressors and gas abatement systems. Under its umbrella, the group houses three well-known brands: Busch Vacuum Solutions, Pfeiffer Vacuum and centrotherm clean solutions. Together, they offer solutions to a wide range of industries. A global network of highly competent local teams in 44 countries ensures that expert, tailor-made support is always available near you. Wherever you are. Whatever your business.



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