Instruction Manual

STP Series Turbomolecular Pumps
STP-iXA4507 Series

Read through the Safety Precautions and each section of this Manual carefully before using the STP pump.

Keep this Manual in a place where you can quickly access it at any time.

EDWARDS

2024.09

Declaration of Conformity

CE

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

Edwards Japan Limited
1078-1, Yoshihashi,
Yachiyo-shi
Chiba, 276-8523
Japan

Documentation Officer
Jana Sigmunda 300
Lutín , 78349
Czech Republic
T: +42(0) 580 582 728
documentation@edwardsvacuum.com

Product Name:	Turbomolecular pump
Model Number:	STP-iXA4507 series

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

2006/42/EC	Machinery directive *Note: The safety objectives of the Low Voltage Directive 2014/35/EU were complied with in accordance with Annex 1 No. 1.5.1 of this directive.*
2014/30/EU	Electromagnetic compatibility (EMC) directive Class A Emissions, Industrial Immunity
2011/65/EU	Restriction of certain hazardous substances (RoHS) directive as amended by Delegated Directive (EU) 2015/863

Based on the relevant requirements of harmonised standards:

EN ISO 12100:2010	Safety of machinery. General principles for design. Risk assessment and risk reduction
EN 1012-2:1996 +A1:2009	Compressors and vacuum pumps. Safety requirements. Vacuum pumps
EN 60204-1:2018	Safety of machinery. Electrical equipment of machines. General requirements
EN 61326-1:2013	Electrical equipment for measurement, control and laboratory use. EMC requirements. General requirements

This declaration, based on the requirements of the listed Directives and EN ISO/IEC 17050-1, covers all product serial numbers from this date on: 2023-08-01.

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

Tanya Palmer
Vice President, Engineering, Semiconductor Chamber Solutions
Chelmsford

Petr Tochacek
General Manager, PC Yachiyo
Yachiyo

This product has been manufactured under a quality management system certified to ISO9001:2015.
This declaration is based on the requirements of ENISO17050-1 and the relevant directives.

材料成分声明
China Material Content Declaration

	有害物质 Hazardous Substances					
部件名称 Part name 	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr VI)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
铸铝及铝合金制品 Aluminium alloys	×	○	○	○	○	○
铜管管件 Brass pipe fitting	×	○	○	○	○	○
电缆/电线/连接器 Cable/wire/connector	×	○	○	○	○	○
印刷电路组件 (PCA) Printed Circuit Assembly (PCA)	×	○	○	○	○	○
电子元件和控件 Electronics and Controls	×	○	○	○	○	○

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

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

This product has been manufactured under a quality management system certified to ISO9001:2015.
This declaration is based on the requirements of ENISO17050-1 and the relevant directives.

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1 INTRODUCTION

1.1 Scope and definitions

This manual provides installation, operation and maintenance instructions for the Edwards Turbomolecular Pump (abbreviated to "STP pump" throughout this manual). You must use the STP pump as specified in this manual otherwise the protection provided by the equipment may be impaired.

Important safety information is highlighted as WARNING and CAUTION instructions; these instructions are mandatory. The use of WARNINGS and CAUTIONS is defined below:

WARNING

Warnings are given where failure to observe the instruction could result in serious injury or death to people.

CAUTION

Cautions are given where failure to observe the instruction could result minor personal injury in damage to the equipment, associated equipment and/or process.

Note: Items you must follow during operation and maintenance.

Throughout this manual, page, figure and table numbers are sequential.

The units used throughout this manual conform to the SI international system of units of measurement; US equivalent units of measurement are also given.

The following IEC warning labels/symbols appear on the STP-iXA4507 series Turbomolecular Pump and this Instruction Manual:

Warning - This symbol denotes general warning
Refer to accompanying documentation and instruction manual.

Warning - Hazardous Voltage
This symbol denotes the risk of electrical shock.

Warning - Heavy object
This symbol denotes the risk of low back pain and fall.

Warning - Hot surface
This symbol denotes the risk of burns.

1.2 Electromagnetic compatibility

- This product is a Class A product according to EN61326-1 (Group 1, Class A product according to EN55011) and intended to be used in an industrial electromagnetic environment defined by EN61326-1.
  This means that this product does not generate and/or use intentionally radio-frequency energy, in the form of electromagnetic radiation, inductive and/or capacitive coupling, for the treatment of material or inspection / analysis purpose and that it is suitable for use in all establishments other than domestic and those directly connected to a low voltage power supply network which supplies buildings used for domestic purposes.
- This product may have potential difficulties in ensuring electromagnetic compatibility in other than industrial environments, due to conducted as well as radiated disturbances.
- This product must not be used in residential areas because it may cause interference if used in residential areas.

1.3 Limited warranty

This WARRANTY applies to the customer to whom Edwards has delivered this product.

The warranty period is stated in the Edwards Terms and Condition of Supply of Goods and Services, or during the period specified in the agreement made by and between the customer and Edwards.

1.3.1 Item warranted

1. This warranty applies only to the product delivered from Edwards to the customer.
2. If any defect is found during this period, Edwards will, at its option, repair or recondition the product free of charge. The costs for repair or replacement of the product after the warranty period has passed will be at your own charge.

1.3.2 Disclaimer

Edwards makes no warranty with respect to any damage occurred due to any of the following during the warranty period:

1. Handling, operation or maintenance other than that specified herein.
2. Failure to follow any of the warnings or cautions enumerated in this manual.
3. Installation, operation or maintenance using parts which are not specified by Edwards.
4. Maintenance personnel other than those authorized by Edwards or Service office have disassembled, reconditioned, or tampered the product.
5. Defect resulting from the not-specified use of the product.
6. When the product is used under special conditions without obtaining the written consent of Edwards (particular gases, strong magnetic field and the radiation are added to the product).
7. Defect resulting from deposit.
8. Water cooling system defect resulting from water quality used.
9. Defect resulting from the installation of the product (exclude the installation by authorized personnel).
10. Deterioration in the external because of use (discoloration, scratches and so forth).
11. Product damage occurred during transport or other factors not attributable to Edwards.
12. Product breakage or damage due to natural disasters, fire or other external factors.
13. Deterioration in the basic performance due to the use of the product beyond limits of the use.
14. Any direct, incidental or consequential damage resulting from the use of the product.
15. When continuously operated without overhaul after the "STATUS" LED on the control unit being in the warning detection state (see Section 4.7) or "WARNING" message being displayed on the LCD of the display unit iDT-002.
16. Overhaul and replacement of maintenance parts.

1.3.3 Spare parts

- Touch down bearing.
- Air-cooling fan

Touch down bearing and air-cooling fan should be replaced at Edwards, contact Edwards.

1.4 Precautions for safe operation of the STP pump

1.4.1 Usable gases

1. Chlorine or fluorine system gases can be used in corrosion resistant pumps. When you use the following gases, contact Edwards.
   - Gases including alkaline metals except Li gas.
   - Gases including Ga, Hg, In, or Sn.
   - HBr gas.
2. Non-corrosion resistant pump cannot use the above gases including chlorine and fluorine system gases.

WARNING

Confirm the characteristics of gases to be used to prevent an accident. Refer to the Safety Data Sheet (SDS) obtained from the gas supplier. Keep SDS and follow safety advice from the gas suppliers.

WARNING

Warn of the danger of the gas with the warning label when the use gas is hazardous chemical material.

WARNING

Secure safety by wearing personal protective equipment when using the gas which might influence damage health. In addition, take appropriate measure for depending upon the properties of the gas to be used.

CAUTION

NEVER use any gas that is not specified as usable in this Manual. The use of such gas may corrode the STP pump and damage it.

CAUTION

Introduce a dry N_2 gas (purge gas) to protect the inside of the STP pump when using reactive or corrosive gas, gas including hydrogen. The use of these gases may result in product damage.

CAUTION

Cool the STP pump to prevent the STP pump from overheating when pumping gases.

1.5 Maintenance and inspection precautions

Perform any maintenance or inspection of the STP pump under the condition that no power is applied to the STP pump (refer to SEMI S2 Section 13.2 - type 1), following Section 8, "MAINTENANCE AND INSPECTION".

1.6 Labels

The following labels are affixed to the STP pump. Read the contents of the labels before operation.

1. Warning label of STP pump installation and Caution label for heavy product

   “Warning label of STP pump” installation describes a warning during installation of the STP pump. Install the STP pump according to Section 3, “INSTALLATION OF THE STP PUMP”.

   “Caution label for heavy product” is affixed to products with a weight of 18 kg or more. Comply with Section 3.2, “Unpacking" not to cause an accident during handling.

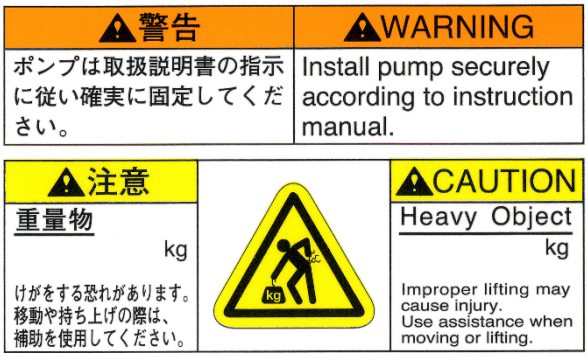


Figure 1 - Warning label of STP pump installation and Caution label for Heavy product

2. Caution label of Heater removing prohibition and Warning label for hot surface

The pump has TMS heater, which is mentioned in section 3.9.2, “TMS heater”. That is not removable. Therefore, do not remove that as “Caution label of Heater removing prohibition” mentioning.

“Warning label for hot surface” instructs operators not to touch the hot surface of the STP pump. The pump and control unit will become high temperature while the STP pump is in operation. This label is for warning operators not to get burned their hands.

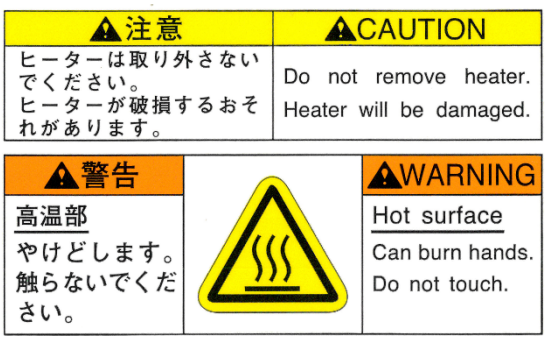


Figure 2 - Caution label of Heater removing prohibition and Warning label for hot surface

3. Caution label for the high voltage devices

The pump and the control unit are equipped with the high voltage devices. This label is for warning operators to pay attention to the high voltage devices during an inspection.

Figure 3 - Caution label for the high voltage devices

4. Label for the rotational direction

This label describes the rotational direction of the STP pump. The STP pump rotates in this direction.

Figure 4 - Label for the rotational direction

5. Notice label urging to use the water-cooling

As this label mentions, while driving the pump, always run the water-cooling unit. If the pump is used without that, it may stop running to avoid overheat. For more information such as the way to connect the water-cooling unit, see section 3.9, “TMS unit”.

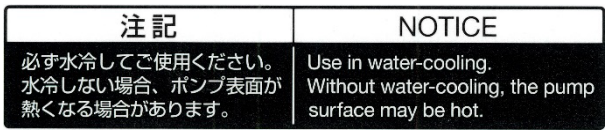


Figure 5 - Notice label urging to use water-cooling

6. Label related to connecting the water-cooling lines

As this label mentions, refer to this manual section 3.9, “TMS unit”, when connecting the water-cooling lines.

Figure 6 - Label related to connecting the water-cooling lines

7. Warning label of urging overhaul the pump

The pump needs regular overhauls. Otherwise, it causes some breakdowns. For details such as overhaul intervals, see section 8.4, “Maintenance”.

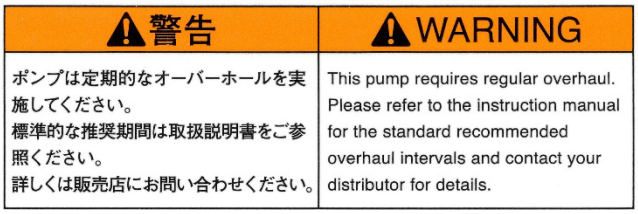
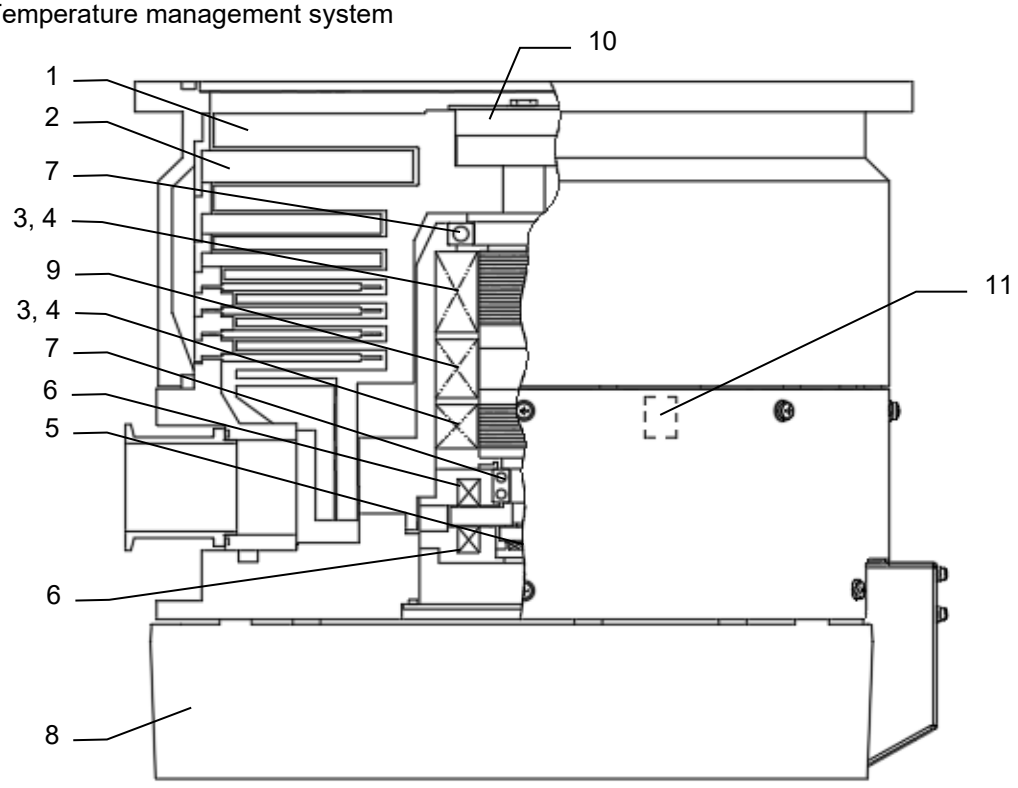


Figure 7 - Warning label of urging overhaul the pump

1.7 Operation principle of the STP pump

Turbomolecular pump (abbreviated to "STP pump" throughout this manual) is used for high vacuum pumping. It is principally used for manufacturing and inspection equipment of semiconductors, flat panels, and solar batteries.
The STP pump (Figure 8) is configured, so that rotor blade (1) and stator blade (2) are aligned alternately in the axial direction. Gas molecules are pumped from the inlet port to the outlet port by the high-speed rotation of the rotor.
The STP-iXA4507 series pump are magnetically-levitated turbomolecular pumps, each with the following features:

1. Oil-free
2. Low vibration
3. High reliability
4. Compact size (Integrated control unit)
5. Temperature management system



1.	Rotor blade	5.	Axial sensor	9.	Motor
2.	Stator blade	6.	Axial electromagnet	10.	Rotor cup cover (option)
3.	Radial sensor	7.	Touch down bearing	11.	Rotor blade temperature warning sensor *1 (option)
4.	Radial electromagnet	8.	Control unit		

*1 The rotor blade temperature warning sensor function can be added when ordering the product. Please contact us for details.

Figure 8 - Cross sectional view of the STP pump

1. Oil-free

Rotor blade (1) is supported by the magnetic bearing without any mechanical contact. Therefore, the STP pump requires no lubrication oil, unlike conventional turbomolecular pumps using ball bearings.

2. Low vibration

The magnetic bearing consists of 5 pairs of active magnetic bearings. The rotor is supported in the radial direction by 4 pairs of active magnetic bearings that consist of a radial sensor (3) and a radial electromagnet (4). A pair of active magnetic bearings in the axial direction consists of an axial sensor (5) and an axial electromagnet (6) to support the rotor in the axial direction. Because the rotor is supported without any mechanical contact, it can rotate with low vibration.

3. High reliability

Unlike conventional turbomolecular pumps using ball bearings, the magnetic bearings do not require replacement because there is no friction. To be safe when the magnetic bearings are broken, touch down bearings (7) have been installed. They do not contact the rotor during the regular operation. The rotor and magnetic bearing status are continuously monitored via the circuits detecting rotor displacement, rotational speed, and pump temperature. If an abnormality/error occurs, the rotor will stop.

4. Compact size (Integrated control unit)

For saving space, the STP pump has the mounted control unit (8), which includes the power supply that converts the alternating current input to direct current output. In addition, the following circuits are integrated into the control unit; the magnetic bearing control circuit, the motor drive circuit driving the rotor blade, the supervisor circuit monitoring pump operation status and operating the pump in remote operation mode.

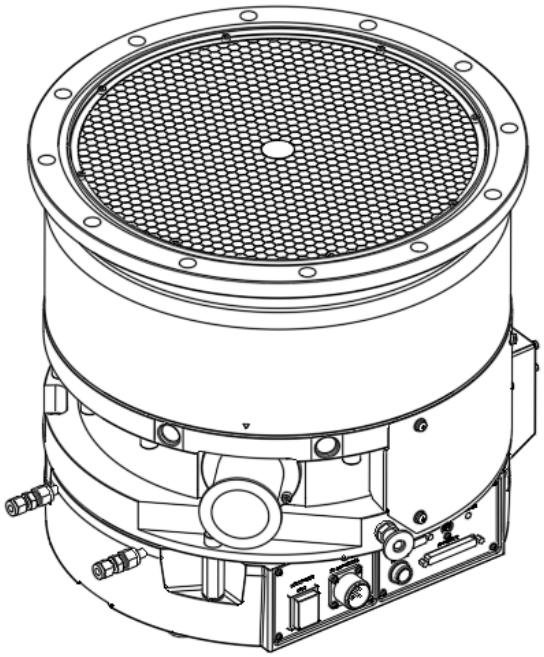
5. Temperature management system

The Temperature Management System (TMS) maintains the temperature of the turbomolecular pump by monitoring the temperature with a thermistor in the base part of the STP pump and operating the TMS valve and TMS heater ON/OFF to maintain a constant temperature of the STP pump.

1.8 STP pump specification

The external appearances, installation and unpacking ways are different depending on the STP pump model. Refer to the following:

External appearance of the STP pump



STP-iXA4507C / STP-iXA4507CV / STP-iXA4507CV3
STP-iXA4507B / STP-iXA4507BV / STP-iXA4507BV3

Naming convention:

- "C" following a pump model name indicates a corrosion resistant*1 type.
  (e.g. STP-iXA4507C)
- "B" following a pump model name indicates corrosion resistant*1 and high-emissivity coating*2 type.
  (e.g. STP-iXA4507B)
- "V" indicates a TMS*3 unit.
  (e.g. STP-iXA4507CV)
- “(n)” of the trailing number indicates TMS temperature *4

  (e.g. STP-iXA4507CV3)

*1 Corrosion-resistant: STP pump with anti-corrosive treatment.

*2 High-emissivity coating: STP pump with rotor covered with high-emissivity coating.

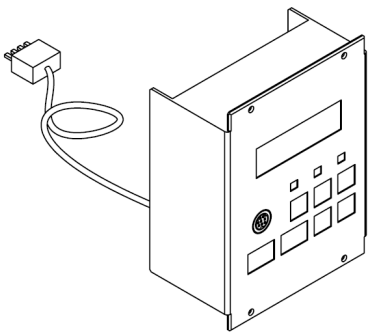
*3 Temperature Management System: TMS maintains the temperature of the turbomolecular pump with the thermistor in the base of the turbomolecular pump and operates the TMS heater ON/OFF control to maintain a constant temperature of the STP pump.

*4 Refer to Section 2.2 for TMS temperature.

The display unit iDT-002 is available as an optional accessory with STP-iXA4507 series.

The display unit operates the STP pump, confirms the pump status or sets various settings. (refer to Section 6.2, “Display unit” and the Instruction Manual of the "Display Unit iDT-002".)

Display unit iDT-002



2 TECHNICAL DATA

2.1 STP pump specifications

The values shown below are typical. They are not guaranteed.

Item			STP-iXA4507C/CV/CV3/B/BV/BV3			
Flange size	Inlet port flange		VG300	ISO320F	VG350	VG400
	Outlet port		Flange: KF50, Pipe: 52.2mm (ID)			
	Purge port		KF10			
Pumping speed*1	N_2	L/s	3,900	4,100	4,600	
	Ar	L/s	3,400	3,600	4,000	
	H_2	L/s	1,800	1,800	1,800	
Compression ratio*1	N_2, Ar		$>10^8$			
	H_2		1.0×10^3			
Ultimate pressure *1		Pa (Torr)	10^{-7} (10^{-9}) [after baking]			
Maximum backing pressure *1,2		Pa (Torr)	266 (2.0)			
Critical operating backing pressure *1,*3		Pa (Torr)	320 (2.4)			
Flow rate of purge gas <N_2> *4,5		Pa·m³/s(SCCM)	$8.4\times10^{-2}\pm1.7\times10^{-2}$ (50±10)			
Rated speed		rpm	24,240			
Backup rotational speed *6		rpm	Approximately 5,000			
Starting time		min	≦11			
Stopping time		min	≦16			
Noise		dB	<55 (at 24,240 rpm)			
Temperature Management System (TMS)			Available			
Baking temperature		°C	<120 (Do not use baking heater with TMS unit)			
Rotor blade temperature warning sensor *7	Accuracy *8	°C	±3			
	Safety feature *9		Can be enabled when option is applied			
Lubricating oil			Not necessary			
Installation position			Free			
Cooling method			Water cooling			
Mass *10		kg	111	111	104	111
Ambient temperature range		°C	0 to 40			
Storage temperature range		°C	-25 to 55			

*1 Pumping speed, compression ratio, ultimate pressure and backing pressures are measured by Edwards Japan method. (Ultimate pressure is a value after baking.)

*2 Maximum backing pressure is the pressure when the working pressure rises suddenly without flowing gas.

*3 Critical operating backing pressure is the pressure that allows continuous operation without flowing gas.

*4 If the purge gas flow rate is out of specification, the rotor blade temperature warning sensor may not function properly.

*5 Always introduce purge gas when process gas is present inside the pump to prevent product deposition on the magnetic bearing components. Adhesion of reactive products to the stator column can scratch or lock the rotor. Be sure to introduce the N_2 purge gas at the specified flow rate.

*6 A backup rotational speed is the lowest rotational speed to which the magnetic bearing can be backed up at a power failure.

*7 Rotor blade temperature warning sensor is optional. The function of the rotor blade temperature warning sensor can be added when ordering the product. Please contact us for details.

*8 The accuracy of the rotor blade temperature warning sensor is the accuracy at the rated speed.

*9 The safety function is activated at rotational speeds above 21,780 rpm. For the safety function of the rotor blade temperature warning sensor, please refer to "7.1.10 Safety feature of the rotor blade temperature warning sensor (Option)".

*10 Mass is a value of state that the only standard accessory was installed (except the optional accessory).

2.2 Maximum gas flow-rate

2.2.1 STP-iXA4507C/CV/CV3

Gas	Cooling water condition	Purge gas N_2 flow rate	Maximum gas flow-rate*1		Backing pressure [Pa(Torr)]	Backing pump [L/min]	TMS [℃]
			[Pa·m³/s]	[SCCM]			
Ar	Temperature: 15 to 25 ºC Flow rate: 2.8 to 3.2 L/min Pressure: Max 0.3 MPa (Max 3 kgf/cm²)	8.4×10^{-2} $\pm1.7\times10^{-2}$ Pa•m³/s (50±10 SCCM)	4.90	2,900	292 (2.187)	>1,300	N/A (No heater)
			6.59	3,900	140 (1.052)	>10,000	
N_2			5.07	3,000	289 (2.167)	>1,300	
			8.45	5,000	148 (1.108)	>10,000	

Table 1 - Maximum gas flow-rate (STP-iXA4507C)

Gas	Cooling water condition	Purge gas N_2 flow rate	Maximum gas flow-rate*1		Backing pressure [Pa(Torr)]	Backing pump [L/min]	TMS [℃]
			[Pa·m³/s]	[SCCM]			
Ar	Temperature: 15 to 25 ºC Flow rate: 2.8 to 3.2 L/min Pressure: Max 0.3 MPa (Max 3 kgf/cm²)	8.4×10^{-2} $\pm1.7\times10^{-2}$ Pa•m³/s (50±10 SCCM)	3.04	1,800	187 (1.406)	>1,300	70
			3.21	1,900	82 (0.614)	>10,000	
N_2			4.90	2,900	280 (2.098)	>1,300	
			7.60	4,500	135 (1.016)	>10,000	

Table 2 - Maximum gas flow-rate (STP-iXA4507CV)

Gas	Cooling water condition	Purge gas N_2 flow rate	Maximum gas flow-rate*1		Backing pressure [Pa(Torr)]	Backing pump [L/min]	TMS [℃]
			[Pa·m³/s]	[SCCM]			
Ar	Temperature: 15 to 25 ºC Flow rate: 2.8 to 3.2 L/min Pressure: Max 0.3 MPa (Max 3 kgf/cm²)	8.4×10^{-2} $\pm1.7\times10^{-2}$ Pa•m³/s (50±10 SCCM)	1.52	900	105 (0.785)	>1,300	85
			1.52	900	49 (0.371)	>10,000	
N_2			2.70	1,600	161 (1.211)	>1,300	
			3.38	2,000	73 (0.548)	>10,000	

Table 3 - Maximum gas flow-rate (STP-iXA4507CV3)

*1 The maximum gas flow-rate is applicable under conditions that N_2 or Ar gas is exhausted continuously.

2.2.2 STP-iXA4507B/BV/BV3

Gas	Cooling water condition	Purge gas N_2 flow rate	Maximum gas flow-rate*1		Backing pressure [Pa(Torr)]	Backing pump [L/min]	TMS [℃]
			[Pa·m³/s]	[SCCM]			
Ar	Temperature: 15 to 25 ºC Flow rate: 2.8 to 3.2 L/min Pressure: Max 0.3 MPa (Max 3 kgf/cm²)	8.4×10^{-2} $\pm1.7\times10^{-2}$ Pa•m³/s (50±10 SCCM)	4.90	2,900	292 (2.187)	>1,300	N/A (No heater)
			6.59	3,900	140 (1.052)	>10,000	
N_2			5.07	3,000	289 (2.167)	>1,300	
			8.45	5,000	148 (1.108)	>10,000	

Table 4 - Maximum gas flow-rate (STP-iXA4507B)

Gas	Cooling water condition	Purge gas N_2 flow rate	Maximum gas flow-rate*1		Backing pressure [Pa(Torr)]	Backing pump [L/min]	TMS [℃]
			[Pa·m³/s]	[SCCM]			
Ar	Temperature: 15 to 25 ºC Flow rate: 2.8 to 3.2 L/min Pressure: Max 0.3 MPa (Max 3 kgf/cm²)	8.4×10^{-2} $\pm1.7\times10^{-2}$ Pa•m³/s (50±10 SCCM)	4.05	2,400	244 (1.831)	>1,300	70
			4.73	2,800	109 (0.815)	>10,000	
N_2			4.90	2,900	280 (2.098)	>1,300	
			7.60	4,500	135 (1.016)	>10,000	

Table 5 - Maximum gas flow-rate (STP-iXA4507BV)

Gas	Cooling water condition	Purge gas N_2 flow rate	Maximum gas flow-rate*1		Backing pressure [Pa(Torr)]	Backing pump [L/min]	TMS [℃]
			[Pa·m³/s]	[SCCM]			
Ar	Temperature: 15 to 25 ºC Flow rate: 2.8 to 3.2 L/min Pressure: Max 0.3 MPa (Max 3 kgf/cm²)	8.4×10^{-2} $\pm1.7\times10^{-2}$ Pa•m³/s (50±10 SCCM)	2.53	1,500	160 (1.202)	>1,300	85
			2.87	1,700	76 (0.567)	>10,000	
N_2			2.87	1,700	170 (1.276)	>1,300	
			3.55	2,100	76 (0.568)	>10,000	

Table 6 - Maximum gas flow-rate (STP-iXA4507BV3)

*1 The maximum gas flow-rate is applicable under conditions that N_2 or Ar gas is exhausted continuously.

2.2.3 Water cooling use condition

Use cooling water that fulfills the following conditions.

Item		Specification	
Port type		Pump unit	9/16-18UNF
		Control unit	1/4”Tube fitting (Swagelok)
Flow rate	L/min	2.8 to 3.2	
Water temperature	°C	15 to 25 *1	
Water pressure	MPa (kgf/cm^2)	Max 0.3 (Max 3)	
Maximum grain size	mm^2	0.03	
pH		6.5 to 8.0	
Water hardness	mg/L	100	
Resistivity	kΩ·cm	4 to 1,000	
Turbidity	FNU	<30	

*1 Maximum gas flow rate differs according to the cooling water temperature.
Refer to section 2.2.

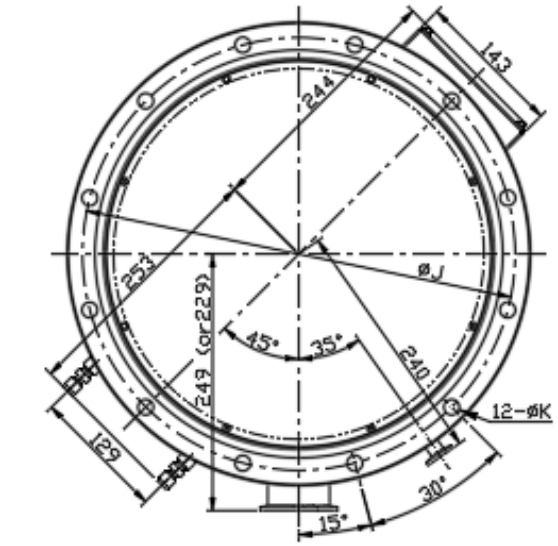
2.3 Control unit

The values shown below are typical. They are not guaranteed.

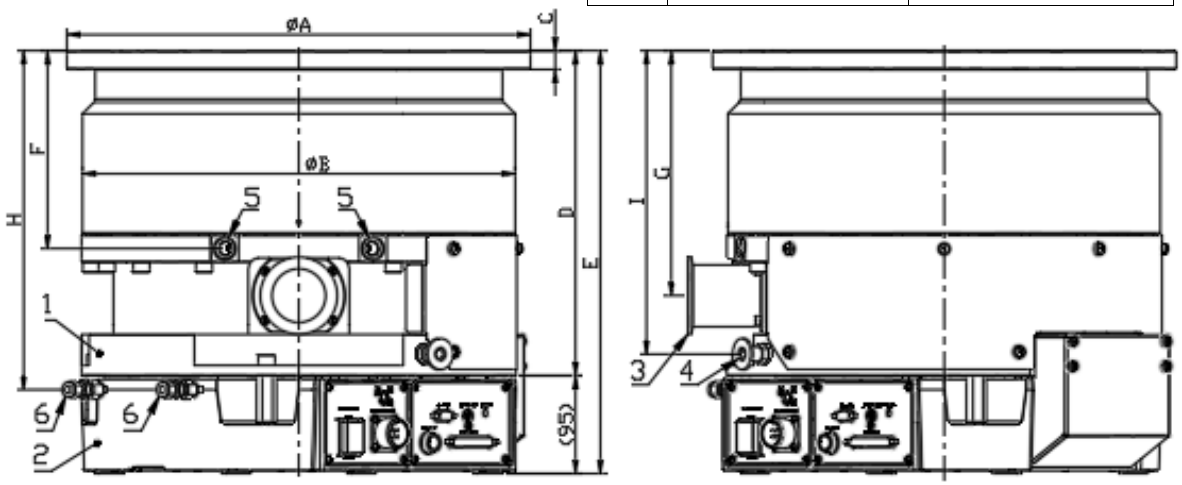
Item		STP-iXA4507C/B	STP-iXA4507CV/CV3/BV/BV3
Input voltage	ACV	200 to 240	
Allowable input voltage fluctuation	%	±10	
Input power	VA	1,600 max (without TMS unit)	2,000 max (with TMS unit)
Input frequency	Hz	50/60 ± 2	
Leakage current	mA	3.5 maximum	
Input phase		Single phase	
Main fuse specification	A	20	
Current Ampere Interrupting Capacity (AIC)	A	400 (AC240V)	
Pollution degree		2	
Installation category		Ⅱ	
Motor driving system		3-phase d.c. brushless motor driver	
Output frequency under normal operation	Hz	404 maximum	
Panel indication LED		STATUS (Green/Red/Orange LED) For other indication LEDs, refer to the separate communication interface instruction manual.	
Input/Output connector		AC POWER X1 (4 pins) COM2 X2 (9 pins) VALVE X3 (2 pins) STP-LINK X5 (8 pins) For the communication interface, refer to the separate instruction manual.	

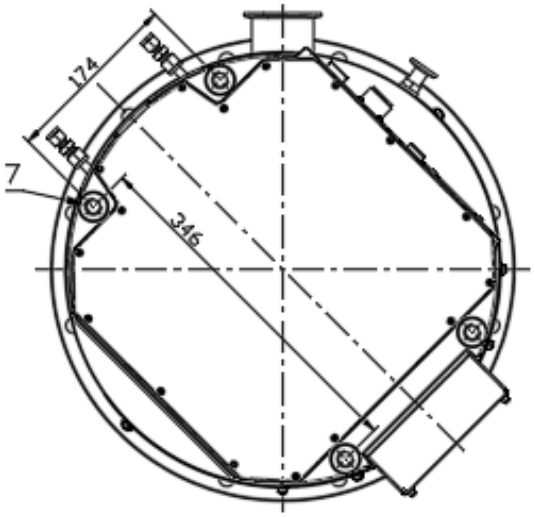
Item	STP-iXA4507 series
Safety function	Electromagnetic bearing failure detection STP pump overheat detection Motor driver overload detection Power failure detection STP pump overspeed detection Control unit overheat detection Other failure detection

2.4 External appearance of the STP pump



No.	Item	Description
1	PU: Pump unit	
2	CU: Control unit	AC220V
3	Outlet port flange	KF50
	Outlet port pipe	52.2mm (ID)
4	Purge port	KF10
5	Water cooling port of the PU	9/16-18UNF
6	Water cooling port of the CU	Tube fitting 1/4”
7	Screw hole for securing the base	4-M16 depth 25



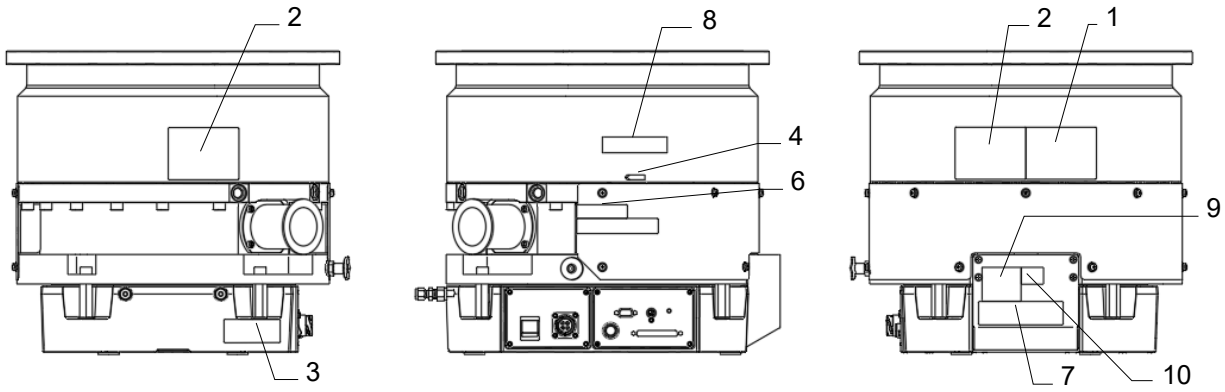


	VG300	ISO320F	VG350	VG400
ϕA	400	425	450	520
ϕB	420	420	420	420
C	18	20	24.5	20
D	370	360.5	325	315
E	465	455.5	420	410
F	247	237.5	202	192
G	292.5	283	247.5	237.5
H	383.5	374	338.5	328.5
I	349	339.5	304	294
ϕJ	370	395	420	480
ϕK	15	14	15	19

Figure 9 - External appearance of STP-iXA4507 series

2.5 Label affixing positions

Refer to Section 1.6, "Labels" for the details of the labels 1 to 7.



1	Warning label of STP pump installation and Caution label for Heavy product
2	Caution label of Heater removing prohibition and Warning label for hot surface (2 pcs)
3	Caution label for the high voltage devices
4	Label for the rotational direction
5	Notice label urging to use the water-cooling
6	Label related to connecting the water-cooling lines
7	Warning label of urging overhaul the pump
8	Company logo
9	Name plate
10	Barcode label

Figure 10 - Label affixing positions

3 INSTALLATION OF THE STP PUMP

3.1 Precautions before installation

Installation, operation, and maintenance must only be executed by people who read through this manual carefully and have the specific skills to install, operate, and maintain the STP pump.

3.1.1 Operating environment

WARNING

Confirm the characteristics of gases to be used to prevent an accident. Refer to the Safety Data Sheet (SDS) obtained from the gas supplier. Keep SDS and follow safety advice from the gas suppliers.

WARNING

Take measures according to SDS to prevent an accident when using toxic, reactive, or combustible gases. Dilute the gas to be used with the inert gas controlled if necessary. And take measures according to SDS to prevent an accident caused by exhaust gas.

CAUTION

Chlorine or fluorine system gases can be used in the corrosion-resistant pumps. When you use the following gases, contact Edwards:

- Gases including alkaline metals except for Li gas.
- Gases including Ga, Hg, In, or Sn.
- HBr gas.

The non-corrosion-resistant pumps cannot use with the above gases, including chlorine and fluorine system gases.

The STP pump should be installed in an area that meets the following requirements:

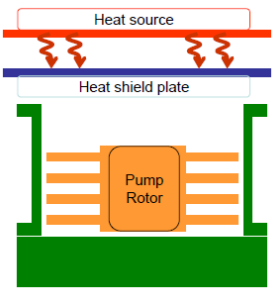
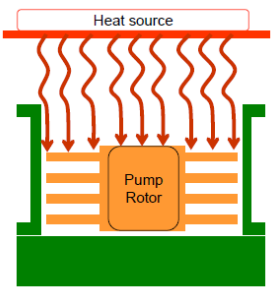
Ambient temperature	0 to 40 °C (32 to 104 °F)
Ambient relative humidity	30 to 95% (no dew condensing)
Environment	• An area that is free of externally applied mechanical shock. • A place that is free of a heat source (Keep clear from the heat source or attach a thermal shield plate). • A place that is free of a strong magnetic field (Range: up to 15 mT (150 G) in the axial direction, and up to 3 mT (30 G) in the radial direction). • A place that is free of a strong electric field. • A place that is free of radiation exposure. • No high voltage discharge (more than 500 V) (If more than 500 V is discharged, contact Edwards). • A place at an altitude of 2,000 m or less. • A place indoors. • Others: An area that is free of exposure to direct sunlight, high humidity, dust, salty air, dripping water, explosive or flammable gas, corrosive gas, excessive vibration, and sources of electric noise.
STP pump installation equipment conditions	Avoid a situation where foreign materials can fall into the STP pump (Ex. Si wafers or samples positioned above the STP pump). (Place a shield plate to prevent foreign materials from falling into the STP pump, and use the shield plate with good conductance).
	Install the STP pump so that the inlet flange of the STP pump not to be exposed to heat sources. (Install the heat shield plate to avoid getting radiation heat) Good example: Heat shield plate  Bad example: None 

Table 7 - Environmental requirements for installation

3.1.2 Installation area

Leave enough space for the following reasons in addition to the room for the STP pump: (see Figure 11)

- Space for maintenance and inspection.
- Space for connecting cables.

CAUTION
DO NOT bend the cables excessively, and beware of any obstacles when installing the STP pump. In addition, leave enough space to install other cables without bending them excessively.

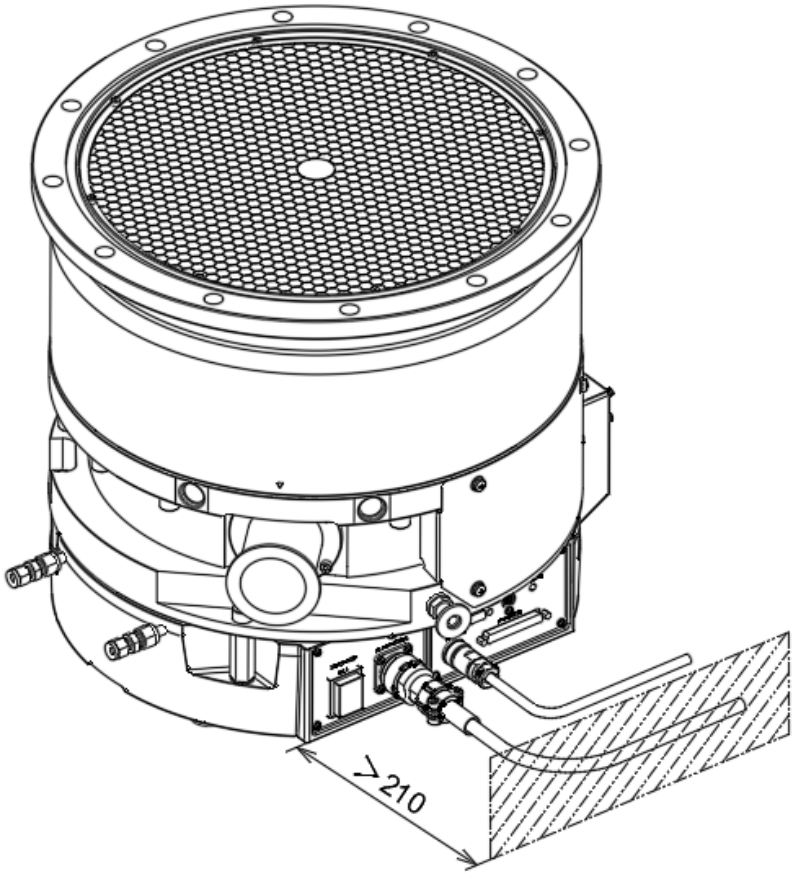


Figure 11 - Space around the STP pump *1

*1 Secure this space in consideration of the bending radius and so on.

3.1.3 Bench

A bench must be prepared by the customer to secure the STP pump. The shape and size of the bench differ depending on the equipment to install the STP pump.

WARNING

Obey the safety instructions given below and take note of appropriate precautions. If you do not, you can cause injury to people and damage to equipment.

WARNING

The STP pump is provided with a high-speed rotor. Any internal abnormality/error may result in a jump in rotational torque leading to personal injury or peripheral equipment damage.

WARNING

Design and secure the bench for the STP pump to withstand the maximum torque generated due to the occurrence of an abnormality/error. Refer to Section 3.4.3, "Secure the STP pump" for abnormal torque.

CAUTION

Secure the customer-prepared bench and the vacuum equipment on the floor or the equipment to install the STP pump. NEVER move them while the STP pump is in operation.

Confirm the dimensions of the external appearance of the STP pump when designing the bench.

The bolt may not be able to be inserted from the lower side of the inlet port according to the shape of the inlet port flange.

Note: When the external appearance of the STP pump is not in the manual, contact Edwards.

3.1.4 Insulation test

DO NOT perform an insulation test on the control unit. When performing the insulation test on your equipment, ensure that you disconnect the control unit from your equipment. Ensure that the test voltage will be not applied to the control unit.

3.2 Unpacking

3.2.1 Unpacking the STP pump

Check no damage on the outer package and no difference between the things delivered and the purchase order. If the STP pump is damaged, contact Edwards or their distributor.

Note: Keeping the packaging materials, such as the corrugated fiberboard container and cushioning material for possible reuse, is recommended.

WARNING

The STP pumps are heavy products. When lifting the STP pump, obey national laws/regulations, safety standards, and manufacturers' instructions.
Lifting devices must be used when lifting or moving the STP pump.

The STP pumps are heavy products (Refer to Section 2, "TECHNICAL DATA" for the mass of the STP pump). Therefore, use a crane or other appropriate means to withstand the load when lifting the STP pump of 18 kg or more.

Lift the STP pump with eyebolts, eye nuts, or a similar tool attached to the holes for the inlet port flange. When lifting the pump, use 2 or more ropes. (see Figure 12)
A crane, eyebolts, and eye nuts to lift the STP pump must withstand a load of five times or more the weight of the STP pump and rope must withstand a load of seven times or more. Use eyebolts or eye nuts that adapt to ISO 3266.

Lift the STP pump in stable places that are free of excessive shock or vibration to prevent it from shaking or dropping.

Be careful not to scratch the flange of the STP pump. Before installing the STP pump, check that there are no scratches on the surface.

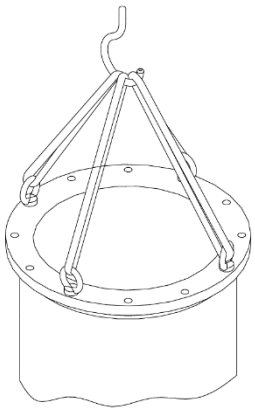


Figure 12 - Example of lifting the STP pump

Eye nut size Eye bolt size	Flange type
M12	ISO320F, VG300, VG350
M16	VG400

Table 8 - Eye nut / Eye bolt size

Use lifting devices when installing the STP pump on the equipment. A device to jack up the STP pump must withstand a load of five times or more than the weight of the STP pump.

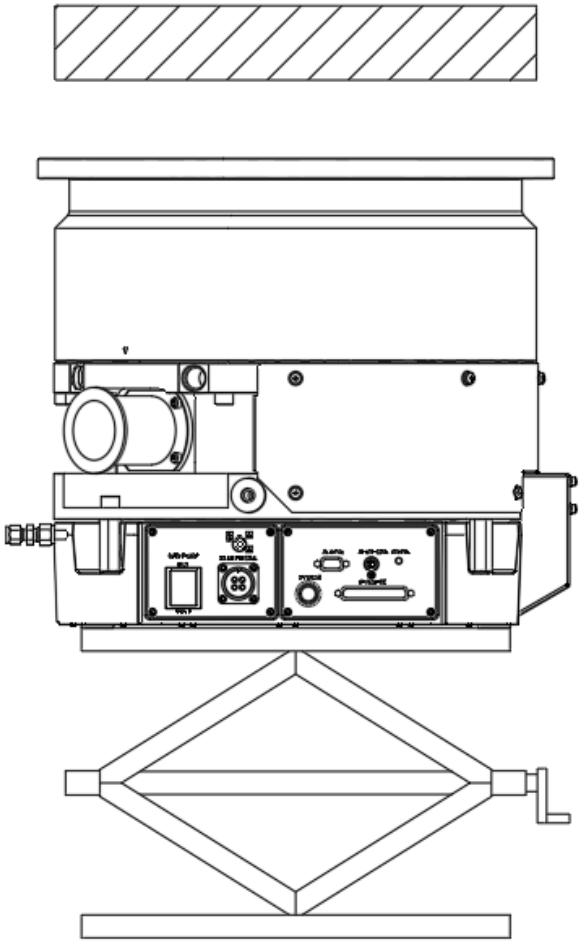
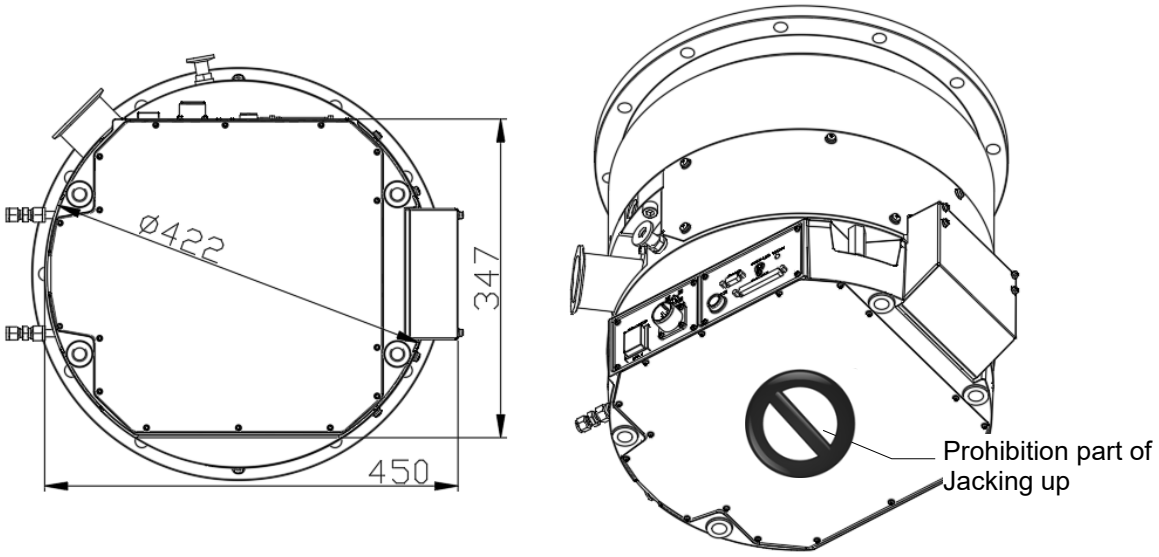


Figure 13 - Jacking up the STP pump

When jacking up the bottom of the control unit, place the STP pump on a larger table than the base size [Figure 14 (A)]. Jacking up the bottom plate [Figure 14 (B)] may deform the plate and break the internal parts. A device to jack up the STP pump should withstand a load of five times or more than the weight of the STP pump.



(A) Base size (B) Prohibition part of Jacking up

Figure 14 - Control unit bottom face

3.3 Name and function of each part

3.3.1 Name and function of the pump

The STP pump in Figure 15 is a typical pump model. Refer to Section 2, "TECHNICAL DATA".

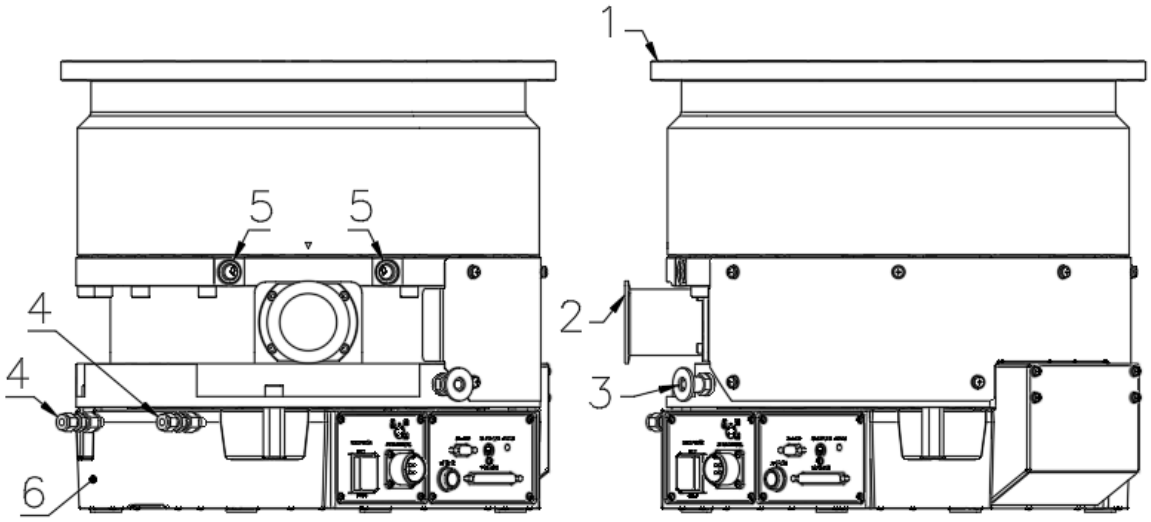


Figure 15 - Configuration of the STP pump

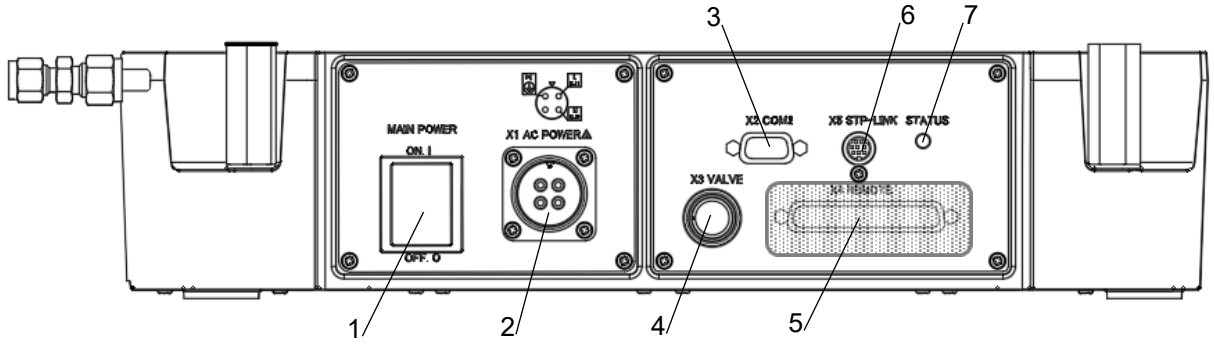
Item	Description	Function
1	Inlet port flange	Connect to the vacuum equipment (at the high vacuum side).
2	Outlet port flange	Connect to the inlet port side of the backing pump.
3	Purge port	It is a port for introducing a purge gas. Introduce a purge gas from this port to protect the inside of the STP pump when pumping reactive or corrosive gas, including hydrogen.
4	Cooling water port (control unit side)	Connect to the STP pump cooling water pipe.
5	Cooling water port (pump side)	Connect to the STP pump cooling water pipe.
6	Control unit	The electronics circuits are embedded to control the pump. Refer to Section 3.3.2, "Name and function of the control unit, for details.

Table 9 - Pump functions

3.3.2 Name and function of the control unit

	WARNING A hazardous live voltage may exist at the connectors that are marked with the warning sign ⚠. DO NOT touch the connecter because it may result in electric shock. When connecting or disconnecting the connector, the primary power must be off (switch the MAIN POWER to "OFF") and isolate (Lockout/Tagout) the electrical energy source, water, gas, and other energy sources from the vacuum equipment.

Figure 16 shows the front panel of the control unit.



1	"MAIN POWER" switch
2	"X1 AC POWER" connector
3	"X2 COM2" connector
4	"X3 VALVE" connector
5	Communication interface
6	“X5 STP-LINK” connector
7	“STATUS” LED

Figure 16 - Control unit (Front panel)

Note: Refer to Table 10 for front panel functions.

Item	Description	Function
1	"MAIN POWER" switch	Input power switch: NEVER stop the power supply to the STP pump while the STP pump is in rotation.
2	"X1 AC POWER" connector	AC input inlet: For the AC power cable The input voltage range is between 200 to 240Va.c (50/60Hz)
3	"X2 COM2" connector	RS232/RS485 (shared) serial communication connector (X2: D-Sub 9-pin): The user application can be connected. See Section 5, "SERIAL COMMUNICATION PROTOCOL".
4	" X3 VALVE" connector	For an optional unit (optional accessory) (X3: 2-pin). TMS valve can be connected.
5	Communication interface	I/O Remote or STP EtherCAT®: Refer to the instruction manual of the communication interface mounted on the STP pump ordered.
6	"X5 STP-LINK " connector	A connector (X5: STP-LINK) for the communication cable of the STP-Link (optional accessory) or the display unit iDT-002 (optional accessory). These optional accessories can operate the STP pump, confirm the operation state, or change various settings.
7	"STATUS" LED	The STP pump operation status is indicated by the color and flashing pattern of the "STATUS" LED. Refer to Section 4.7, ""STATUS" LED".

Table 10 - Control unit front panel functions

3.4 How to install the STP pump

Install the STP pump to the inside of the vacuum equipment, as shown in Figure 17.

WARNING

An appropriate enclosure or a barrier that cannot be removed without using a tool should be provided to prevent operators from accessing the connection cables between the STP pump and its connectors.

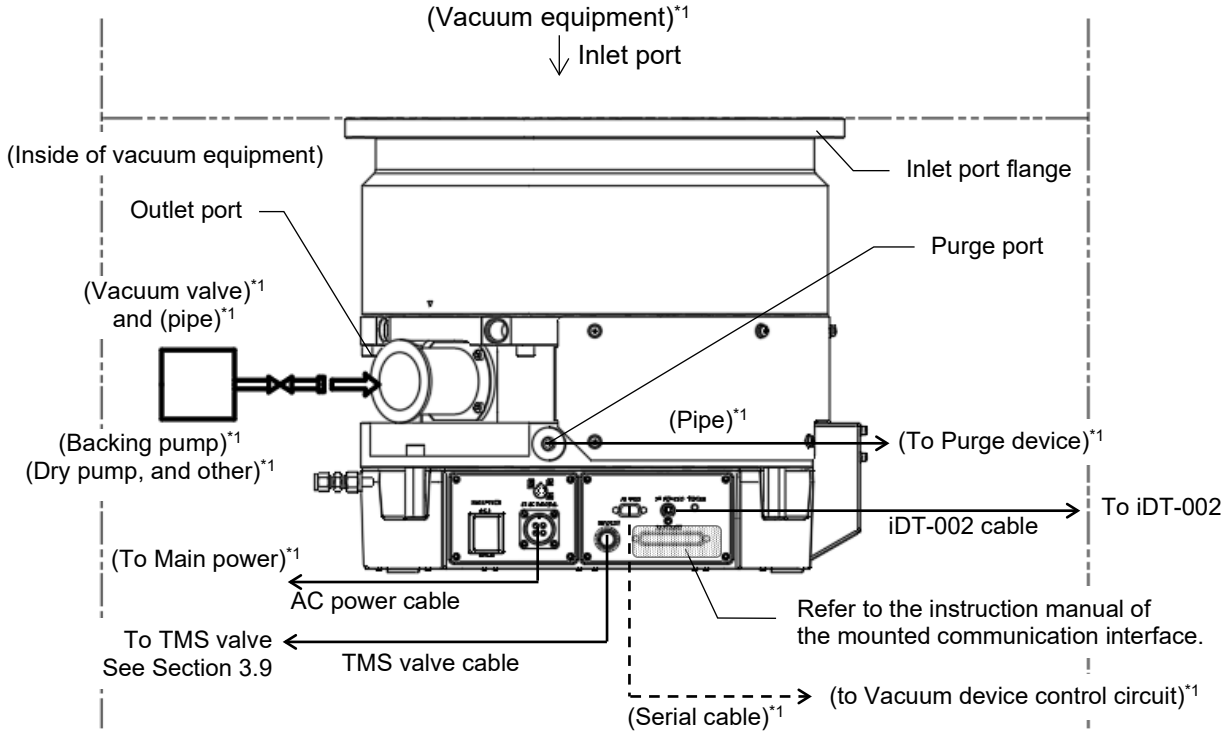
WARNING

Follow the below when installing the STP pump, or connecting or disconnecting cables. The primary power must be off (switch the MAIN POWER "OFF"). And isolate (Lockout/Tagout) the vacuum equipment from the electrical energy source, water, gas, and other energy sources. If you do not follow the above, it can cause an accidental rotation of the STP pump, resulting in an accident, an electric shock, or damage to equipment. Moreover, an accident caused by water leaks or gas leaks can occur.

CAUTION

Use a supportive device such as a lifter when installing the STP pump to the vacuum equipment. If you do not follow the above, it can hurt your back or cause injuries due to an accident such as the STP pump falling.

A supportive device such as a lifter should withstand a load of five times or more than the weight of the STP pump when installing the STP pump.



*1 The equipment and part within the parentheses must be prepared by the customer.

Figure 17 - Installation of the STP pump to the vacuum equipment

3.4.1 Cleaning the seal

WARNING

The wipes used to clean the flange of the pump might become hazardous waste depending upon the solvent (such as alcohol). Dispose of the contaminated wipes appropriately according to the regulations of each national and/or local government.

WARNING

Follow the safety instructions and take appropriate precautions when disposing of hazardous waste. If you do not follow the above, it can cause injury to people and damage to equipment.

CAUTION

A splinter shield is attached to the inlet port flange to prevent foreign materials fall into the STP pump. Always leave the splinter shield attached during operation.

CAUTION

ALWAYS install the STP pump under the condition that foreign materials cannot fall into it. Foreign materials falling into the STP pump through the splinter shield may damage the product.

Check no dirt or oil spots on the inlet and outlet port flange seals before installing the STP pump to the vacuum equipment.

Take the following measures for cleaning the seals:

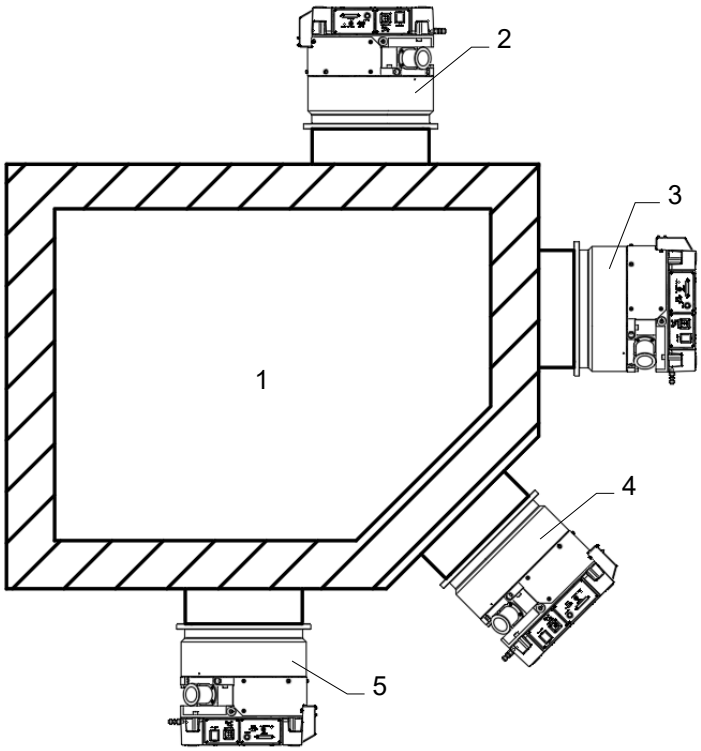
- Clean off with pure gas.
- Wipe with proper solvent (such as alcohol).

The splinter shield cannot prevent foreign materials fall into the STP pump perfectly.
ALWAYS install the STP pump under the condition that foreign materials such as Si wafers or samples are positioned above the STP pump cannot fall into it. It may result in product damage. If it is not possible, always attach a shield plate with sufficient conductance above the STP pump.

Take care not to scratch the flange of the STP pump.
Check the flange for no scratches on the surface before installing the STP pump. If unsatisfactory, contact Edwards.

3.4.2 STP pump installation positions

The STP pump can be installed vertically, horizontally, upside-down and/or slanted.



1. Vacuum equipment
2. Upside-down
3. Horizontal
4. Slanted
5. Vertical

Figure 18 - STP pump installation positions

When installing the STP pump in a horizontal or slanted position, it is recommended to install the outlet port at 135 ° or 45 ° to the direction of gravity. It can reduce the magnetic bearing load and the heat generated by the STP pump.

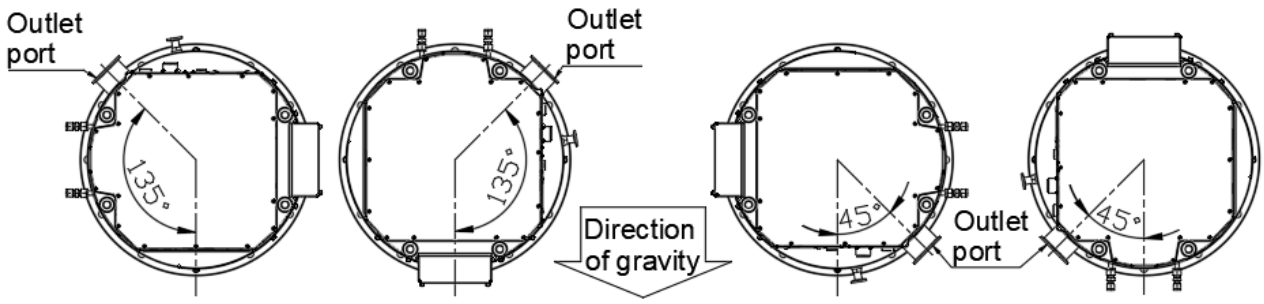


Figure 19 - Positions of the outlet port on the horizontally or slanted installed STP pump (view from bottom)

3.4.3 Secure the STP pump

WARNING

The STP pump's rotor spins at high speed. Therefore, any internal abnormality/error can lead to personal injury or peripheral equipment damage by rotational torque jumping.

The way to secure the STP pump will depend on the STP pump model and its usage. Secure the STP pump to the vacuum equipment according to the procedure specified in this manual.

The STP pump is a component system when installed on semiconductor equipment. Check the following when the STP pump is installed on semiconductor equipment.

- Confirm that the electric resistance value between the STP pump and vacuum equipment is set to 0.1 Ω or less after securing the STP pump to the vacuum equipment.

The generated torque during a pump failure is called "Destructive torque". Design and secure the vacuum equipment mounting the STP pump to withstand the destructive torque. Refer to Table 12 for destructive torque and recommended securing bolt.

Refer to Table 11 for torque tightening the bolts.

Bolt size	Q'ty	Tightening torque (Nm)
M12	12	42
M16	12	76

Table 11 - Tightening torque of the bolt

Note: When using any securing method other than that specified in this manual, contact Edwards.

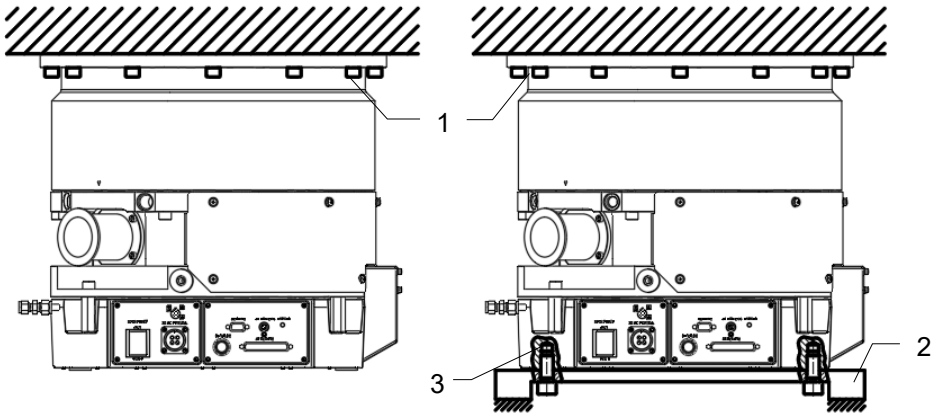
Pump model		STP-iXA4507 series			
Flange type		VG300		VG400	
Destructive Torque [kNm]		79.3		79.3	
Base securing (4 positions)		No	Yes	No	Yes
Recommended securing bolt for inlet port flange	Shape	Standard	Standard	Standard	Standard
	Size	M12	M12	M16	M16
	Q'ty	12	12	12	12
	Material*1	Carbon steel /Alloyed steel	Carbon steel /Alloyed steel	Stainless steel	Stainless steel
	Strength*1	12.9 or more	12.9 or more	70 or more	70 or more

Pump model		STP-iXA4507 series			
Flange type		VG350		ISO320F	
Destructive Torque [kNm]		79.3		79.3	
Base securing (4 positions)		No	Yes	No	Yes
Recommended securing bolt for inlet port flange	Shape	Standard	Standard	Standard	Standard
	Size	M12	M12	M12	M12
	Q'ty	12	12	12	12
	Material*1	Carbon steel /Alloyed steel	Carbon steel /Alloyed steel	Carbon steel /Alloyed steel	Carbon steel /Alloyed steel
	Strength*1	12.9 or more	12.9 or more	12.9 or more	12.9 or more

*1 Refer to ISO 898-1 (JIS B 1051), ISO 3506 (JIS B 1054).

Table 12 - Destructive torque and recommended securing bolt for inlet port flange

There are two installation methods for the pump to secure the inlet port flange, as shown in Figure 20 (i), and to secure the inlet port flange and base, as shown in Figure 20 (ii). Make sure to secure the inlet port flange of the pump with the recommended bolts, as described in Table 12, according to the installation method used. When securing the base of the control unit, refer to Section 3.4.4 “Screw holes for securing the base of the control unit”.



(i) When the base is not secured (ii) When the base is secured

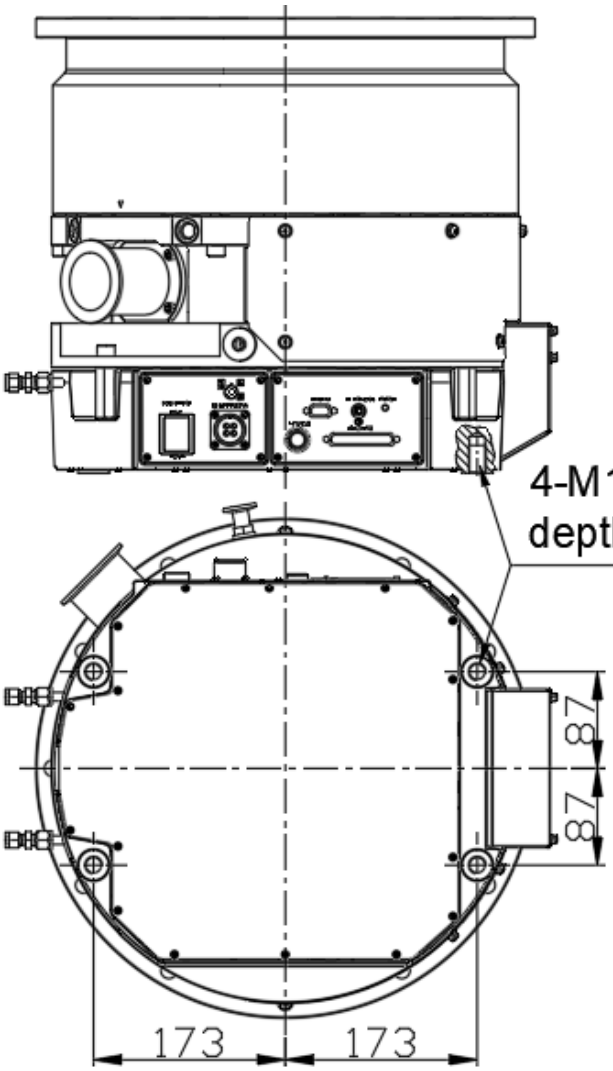
1. Recommended securing bolt for inlet port flange
2. Base
3. Bolt to secure the base

Figure 20 - Methods of securing the STP pump

3.4.4 Screw holes for securing the base of the control unit

CAUTION
Use stainless steel bolts with a 70 or more tensile strength class when securing the base of the control unit.

Figure 21 shows the position of the four screw holes for securing the base of the control unit. The fixing parts [Figure 20 (2,3)] must be prepared by the customer.



(A) Screw holes for securing the control unit base

(B) Position of the screw holes for securing the control unit base

Figure 21 - Screw holes for securing the control unit base

3.4.5 Power cables

WARNING

Ensure that the electrical supply cable is suitably protected against earth (ground) faults and that the earth (ground) and "X1 AC POWER" are correctly connected.

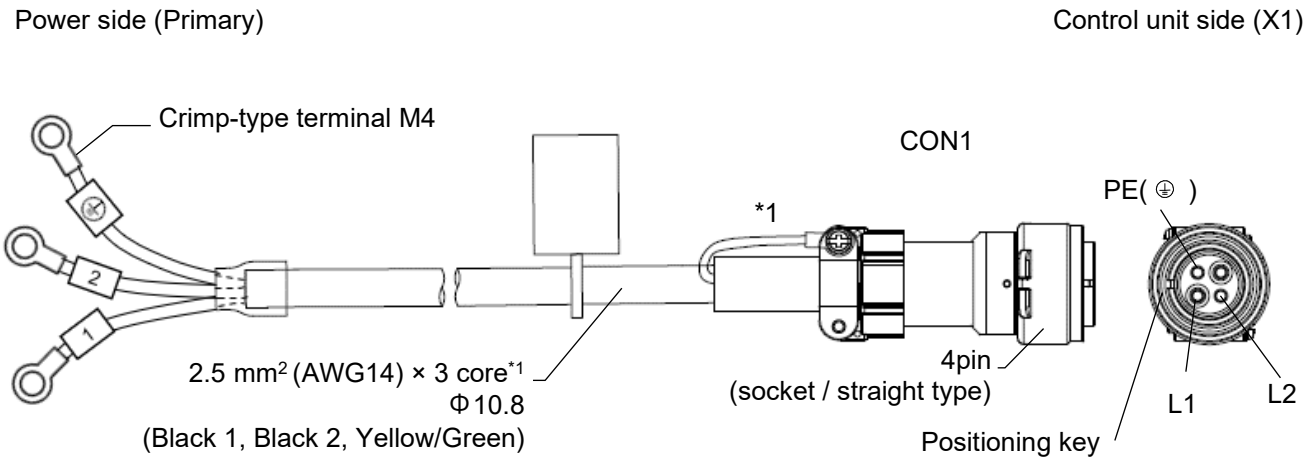
CAUTION

The power cable is designed specifically for the STP pump. DO NOT use the power cable with other products. Connect the power cable securely and not connect it in the wrong ways. And DO NOT apply voltages exceeding 1 kV to the input line.

Connect the power cable to the "X1 AC POWER" on the control unit front panel by following Table 13.

Connect the power cable to the main power of the vacuum equipment via a circuit breaker (Rated current 15 A).
Connect the primary power to the UL-recognized terminal block of the vacuum equipment. Secure the terminals with M4-bolts, and cover the terminal block with an appropriate cover. (Refer to Figure 23)

Note: The primary power cable is not included. Contact the distributor to purchase.



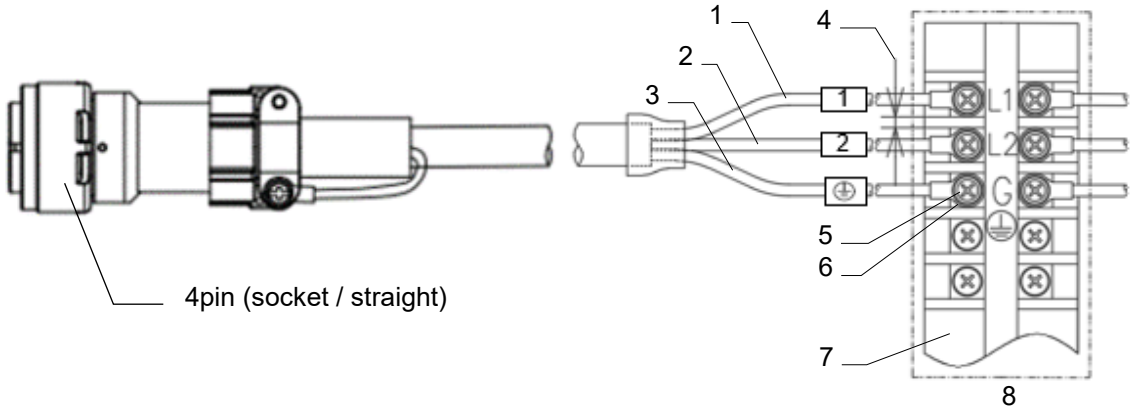
*1 Use shielded power cable. And crimp the shield wire with the Earth (PE) shield terminal on the CON1 side.

Figure 22 - Power cable (straight type connector)

CON1 pin	Cable Colour	Remarks
L1	Black 1	Single-phase 200 to 240 VAC. 50/60 Hz
L2	Black 2	
PE (⏚)	Yellow / Green	Earth (ground)

Table 13 - Power cable

Control unit side Power side (Primary)



1	Black 1	5	M4-bolt (fixing screw)
2	Black 2	6	Crimp-type terminal (M4)
3	Yellow / Green	7	Cover *1
4	Clearance min. 1.5 mm	8	Terminal block *2

*1 Use material flammability: UL 94V-0

*2 Use the UL-recognized terminal block satisfied the following conditions;

a) Clearance (between each terminal): 1.5 mm or more

b) Material flammability: UL 94V-0

c) The installation category Ⅱ

Figure 23 - Connecting method of the power cable

3.4.6 How to connect the power cable

WARNING

Follow the below when installing the STP pump, or connecting or disconnecting cables. The primary power must be off (switch the MAIN POWER "OFF"). And isolate (Lockout/Tagout) the vacuum equipment from the electrical energy source, water, gas, and other energy sources. If you do not follow the above, it can cause an accidental rotation of the STP pump, resulting in an accident, an electric shock, or damage to equipment. Moreover, an accident caused by water leaks or gas leaks can occur.

CAUTION

Connect the power cable securely and not connect it in the wrong ways.

CAUTION

Connect each cable securely and carefully, avoiding any obstacles.
DO NOT place heavy objects on the cables or bend them excessively. The STP pump cannot normally work if any problem occurs in cables, connectors, or terminals.
DO NOT apply voltage to each connector pin. And DO NOT short each pin.
Install cables with avoiding risks such as tripping or falling.

CAUTION

Insert connector vertically on each connector by aligning the position of the guide key of the connectors to prevent vending the pins. If any pins are bent, the connector cannot function normally, and it can cause an accident. Lock and tighten each connector and screw securely.

CAUTION

DO NOT apply surge voltage exceeding 1 kV to the input power line. Always ground the power cable to prevent electric shock.

CAUTION

Support each cable to not apply any direct force to the connectors or terminals. The STP pump can not function normally if any problem occurs in the cables, connectors, or terminals.

Connect the power cable to the "X1 AC POWER" on the control unit front panel.

3.5 Precautions for vacuum piping

CAUTION
DO NOT open the flange to atmospheric air while the STP pump runs. The STP pump cannot normally work if atmospheric air flows into it.

Install valves to shut off (Lockout / Tagout) purge gas N_2 and cooling water.

When stopping the backing pump, atmospheric air can flow reversely into the STP pump, depending on the backing pump.

Attach a vacuum valve to the pipe between the STP pump outlet port flange and the backing pump. Close the vacuum valve when stopping the backing pump.

Note: Some noise or detecting "Disturbance error" can happen on the STP pump when vacuuming with the backing pump. Because the rotor in the STP pump is sucked by the backing pump, depending on the backing pump's speed, chamber capacity, and pipe length between the STP pump and the backing pump. When the failure is detected, perform the RESET operation.

Follow the below to let the STP pump work on its original performance:

1. Be careful not to scratch the flange of the STP pump and the vacuum equipment. Before installing the STP pump, check them for no scratches on the surface.
2. Use a low gas loss tube such as made of steel or aluminium tubes to connect the vacuum equipment and the STP pump.
3. Leaks should be minimised as possible. It is also necessary to degrease the tubes to keep gas losses as low as possible.
4. For a recommended backing pump's speed, refer to Section 2.1, "STP pump specifications". However, the pressure at the inlet and outlet ports varies with the gas flow rate, the vacuum equipment's capacity, length and material of the piping.
   Select a backing pump by its capacity and starting method (such as simultaneous starting or starting after generating roughing vacuum) suitable for the vacuum equipment.
5. Depending on the type of backing pump, oil vapour can contaminate the inside of the STP pump. The viscosity of some kind of oil can cause a malfunction when the reverse flow of oil is strong. Take the following measures to ensure the correct flow of oil:
   - Attach a vacuum valve to the pipe between the STP pump outlet port flange and the backing pump.
   - Attach an adsorption trap next to the vacuum valve.

3.5.1 Vacuum piping method

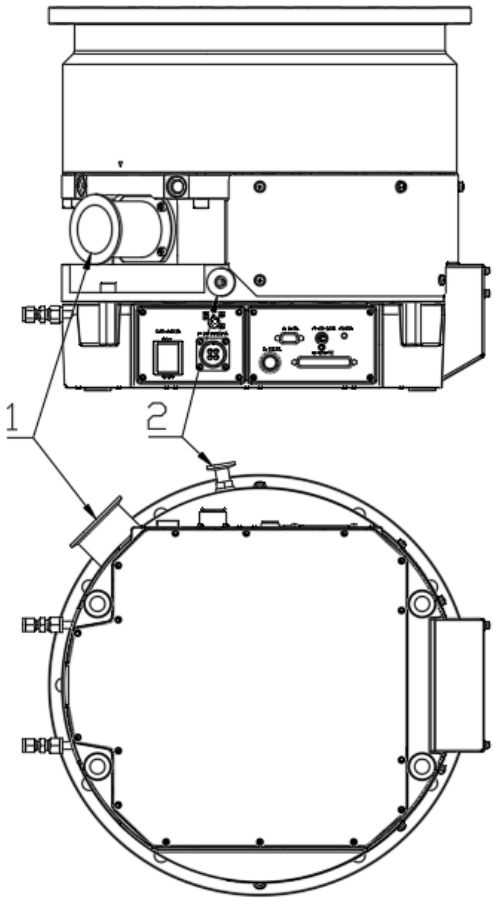
1. Attach the inlet port to the high vacuum side.
   (Refer to Section 2.1, "STP pump specifications" for maximum working pressure).
2. Attach the outlet port to the inlet port flange of the backing pump (primary side pump).
   (Refer to Section 2.1, "STP pump specifications" for allowable backing pressure).

3.6 Connecting the purge port

When pumping reactive or corrosive gas, including hydrogen, introduce a dry N_2 gas or other gas into the STP pump to protect the inside of the STP pump. Introduce a dry N_2 gas through the electromagnetic valve, needle valve, or similar valve (must be prepared by the customer) from the purge port to isolate (Lockout/Tagout) the purge gas N_2.

For instructions on how to introduce the purge gas, see Section 4.1.2.

Notre : Close the purge port with the blank flange when not introducing the purge gas.



1 Outlet port flange 2 Purge port (Dry N_2 gas or other)

Figure 24 - Connecting the purge port

3.7 Connecting the water cooling pipes

Secure the water cooling pipes to prevent water leakage and use cooling water under the conditions provided in Section 2.2.3, "Water cooling use condition". It is recommended to connect the water cooling pipes according to the direction (IN side / OUT side) in Figure 25. Install a container for leaking water or a water leak detector where cooling water may leak (e.g. cooling water ports). Figure 25 shows the position of the cooling water ports.

Install the valve to isolate (Lockout / Tagout) cooling water at your company.

Note: Secure the connection pipe, and cool the STP pump.
Insufficient cooling of the pump can cause the surface of the pump to be hot. Running the pump continuously without cooling can cause a failure and stop.

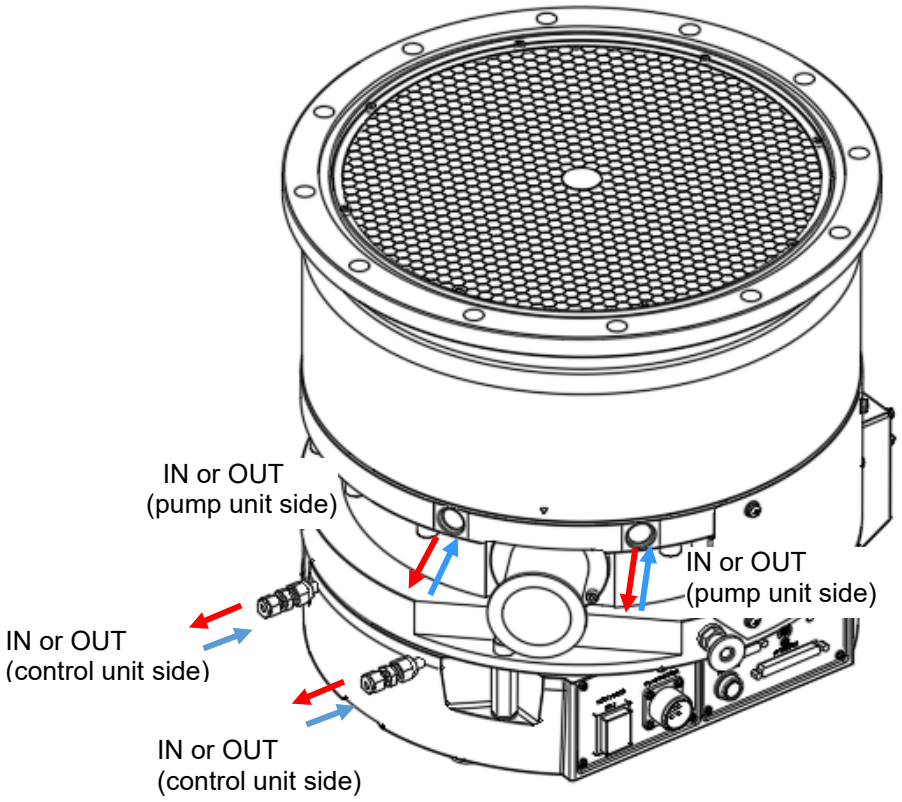


Figure 25 - Positions of the cooling water port

3.8 Attaching a baking heater

WARNING

The surfaces of the STP pump and its peripheral equipment will become extremely hot when baking. NEVER touch them with bare hands.

CAUTION

Check the rated voltage of the baking heater (optional accessory)
This working voltage range is within ±10% of the rated voltage.

CAUTION

DO NOT apply excessive force to the cable of the baking heater.

CAUTION

Attach the baking heater around the surface of the STP pump tightly. The loose parts will overheat if the baking heater is not attached tightly.

Baking heater and protective devices for baking heater (e.g. earth leakage breaker, fuses, etc.) must be provided by your company.

When attaching the baking heater at your company, refer to the external appearance (see Section 2.4) before purchasing it.

Install the baking heater near the inlet port flange of the envelope. (see Figure 26)

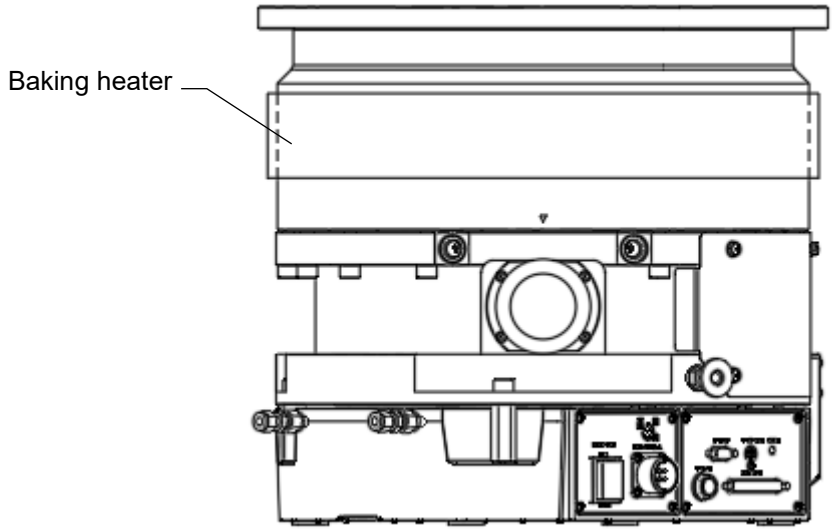


Figure 26 - Baking heater installation position

3.9 TMS unit

WARNING

The STP pump runs at high temperatures while the Temperature Management System (TMS) unit works. NEVER touch or remove the heater cover. It causes electric shock or burns. NEVER touch the STP pump and its peripheral equipment while TMS unit is in operation. The operators can burn their hands.

The Temperature Management System (TMS) maintains the temperature of the STP pump constantly by monitoring the temperature with the temperature sensor in the base part of the STP pump and performing the TMS valve and TMS heater ON/OFF control.

The control unit is always water-cooled. Connect the pump and TMS valve according to Figure 28.

CAUTION

DO NOT install the TMS unit in places with high temperature, humidity, noise, vibration, or unstable environment.

CAUTION

DO NOT apply force to the cables during installation, and DO NOT place heavy objects on the cables or bend them excessively.

3.9.1 TMS unit specification

Item	Specification
Temperature control method	Control ON/OFF of the TMS heater and cooling water
Pre-set temperature *1 °C	CV / BV: 66 CV3 / BV3: 81
Failure output	Failures are output from the STP control unit
TMS valve voltage DCV	24

*1 The pre-set temperature of the TMS unit and the TMS temperature described in 2.2.1 to 2.2.2 are different. The TMS temperatures listed in 2.2.1 to 2.2.2 are representative values for the pump flow path.

Table 14 - TMS unit specification

3.9.2 TMS heater

The TMS heater heats the base of the STP pump. The TMS heater is attached to the STP pump at our factory (with the cover).

3.9.3 Connecting the TMS heater cable

The TMS heater cable is attached to the STP pump at our factory. A fuse is set in the TMS heater cable of the STP-iXA4507 series.

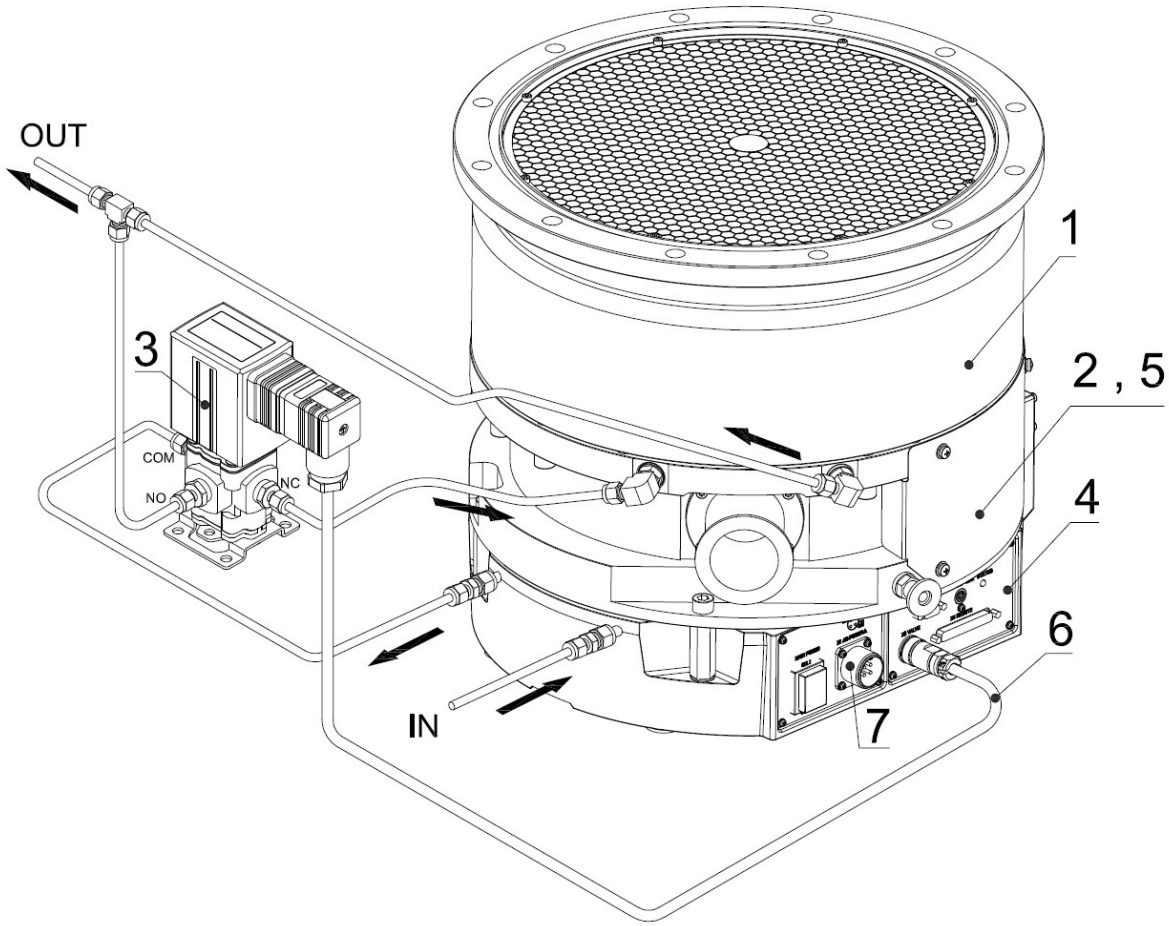
3.9.4 TMS valve

The TMS valve controls the cooling water to maintain a constant temperature inside the STP pump.

Note: The maximum flow of cooling water and the usage condition of TMS unit are listed in Section 2.2.3, "Water cooling use condition" and Section 3.9, “TMS unit”.

3.9.5 Configuration of the STP pump with the TMS

Figure 27 shows the wiring and piping of the three-way valve type.

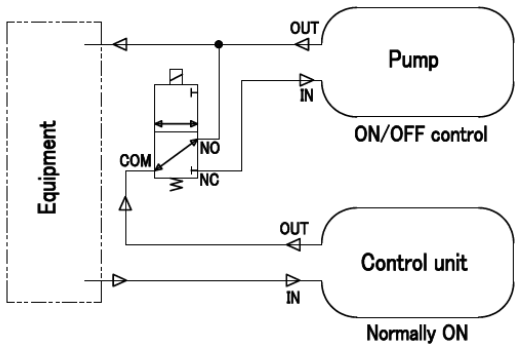


1. STP pump
2. TMS heater (with cover)
3. TMS valve
4. Control unit
5. TMS heater cable (with cover)
6. TMS valve cable
7. X1 AC POWER connector

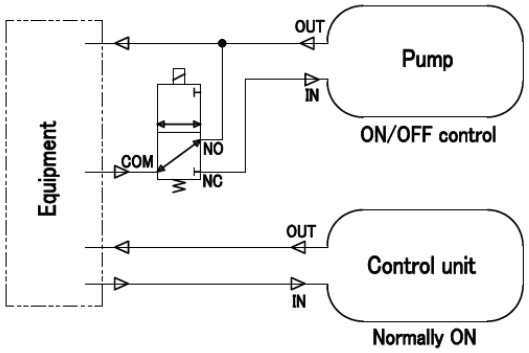
Figure 27 - Configuration of the STP pump with the TMS

3.9.6 Connecting the pump and TMS valve

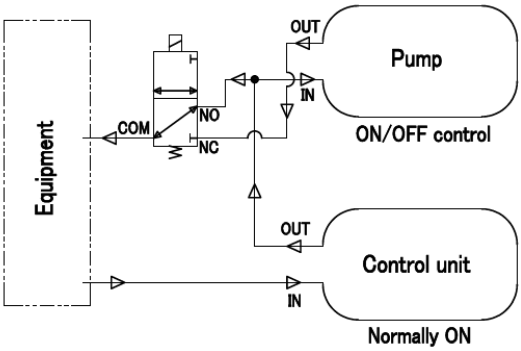
The control unit is always water-cooled. For Three-way valve type [A-2], [B-2] and Two-way valve type [C] in Figure 28, two water supply lines are required.
Connect the pump and TMS valve according to Figure 28.



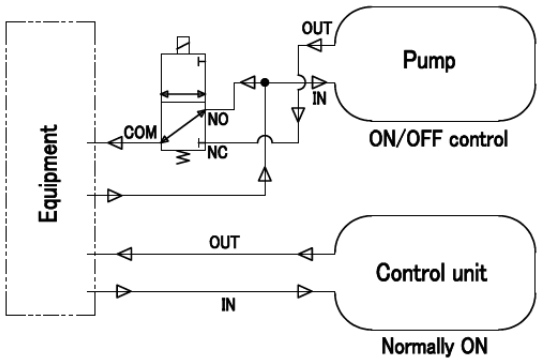
[A-1] Three-way valve A type
(One supplying system)



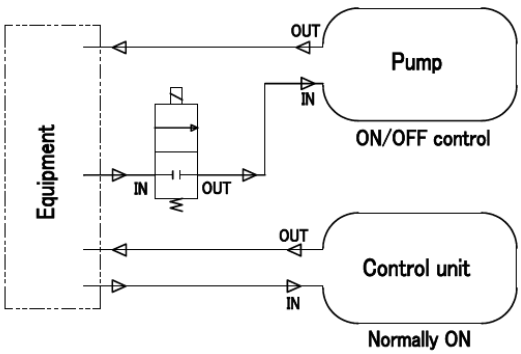
[A-2] Three-way valve A type
(Two supplying system)



[B-1] Three-way valve B type
(One supplying system)



[B-2] Three-way valve B type
(Two supplying system)



[C] Two-way valve type

Figure 28 - TMS valve connection

Use cooling water that fulfils the conditions in Section 2.2.3, “Water cooling use condition”.

Note: The cooling water pipes are not included in the pump, so prepare and connect it with the electromagnetic cooling water valve by yourself.

3.10 Connecting to semiconductor equipment

The STP pump becomes a component system when installed on semiconductor equipment. Consider the following when designing semiconductor equipment.

3.10.1 Connecting to power

The STP pump must be connected to the main power of the semiconductor equipment electrical distribution system with a circuit breaker (Rated current 15 A).

Electrical energy isolation (Lockout/Tagout) must be made by the semiconductor equipment's main disconnect device or circuit breaker.

Provide the equipment with the main disconnect devices or circuit breaker with more than 10,000 Arms symmetrical amperes interrupting capacity (AIC).

3.10.2 Emergency off circuit (EMO circuit)

Ensure the power of the STP pump will be shut off by EMO circuit of the equipment.

When the power is shut off, the STP pump performs the same as a power failure. (After backup operation during a power failure, the rotor lands on the touch down bearing)

Consider the following when designing the EMO circuit.

CAUTION
Ensure the atmosphere does not flow into the pump when the EMO circuit works (example: shut the valve). The touch down bearing can be damaged, and the STP pump does not work properly if the atmosphere flows into the STP pump.

CAUTION
The STP pump rotates for a while after the EMO circuit shuts off the power. Therefore, do a recovery operation after the STP pump has stopped completely.

CAUTION
Stop the STP pump to prevent damage to the touch down bearing before the operation check of the EMO circuit with regular maintenance.

Note: Prepare the main disconnect device and the EMO circuit by yourself.
Use the main disconnect device, which is lockable only in the de-energised position.
Locate the main disconnect device and the EMO button in a place where personnel are readily accessible and are not exposed to any hazards during the operation.

4 OPERATION

4.1 Gas pumping, cooling and baking of the STP pump

The work in this manual must be done by personnel who understand its contents well.

4.1.1 Gas pumping

WARNING

Confirm the characteristics of gases to be used to prevent an accident. Refer to the Safety Data Sheet (SDS) obtained from the gas supplier. Keep SDS and follow safety advice from the gas suppliers.

WARNING

When using pyrophoric gas, keep SDS and the safety advice from the gas suppliers.

WARNING

When pumping gases, they may remain in the STP pump. Introduce a purge gas and then exhaust all gases. Residual gases can cause an accident if/when the pump is removed. Take measures according to SDS to prevent an accident when using toxic, reactive, or combustible gases.

CAUTION

Chlorine or fluorine system gases can be used in the corrosion-resistant pumps. When you use the following gases, contact Edwards:

- Gases including alkaline metals except for Li gas.
- Gases including Ga, Hg, In, or Sn.
- HBr gas.

The non-corrosion resistant pumps cannot use the above gases, including chlorine and fluorine system gases.

CAUTION

Cool the STP pump to prevent the STP pump from overheating when pumping gases. Install the cables so that personnel are not exposed to the risk of tripping or falling.

4.1.2 How to introduce a purge gas

CAUTION
When pumping reactive or corrosive gas, including hydrogen, introduce a purge gas to protect the inside of the STP pump. Otherwise, it may result in product damage.

Connect a needle valve or a similar part to the purge port and introduce dry N_2 gas or other gas to purge the gas (see Section 3.6, "Connecting the purge port").

CAUTION
Refer to Section 2.1, “STP pump specifications”, for the proper amount of the gas purge to introduce.

High pressure at the inlet port may result in noise. However, it is not an abnormality or error.

4.2 Cooling the STP pump

When pumping gases or performing baking, always cool the STP pump. If the TMS unit is used, cool the STP pump with the method specified for the TMS unit.

4.2.1 Water-cooling method

Follow the below instructions:

- Connect the hoses properly to prevent water leaks. Refer to Section 2, "TECHNICAL DATA", for the TMS unit condition.
- Use clean water as much as possible. Cooling water containing foreign materials can corrode or clog the cooling water pipe. When the cooling system is clogged with foreign materials, clogs may be removed by flowing cooling water in reverse.
- When the STP pump is not to be used for a long time or be moved after use, introduce compressed air from one side of the cooling water port not to remain water inside.
- When the STP pump is overheated due to a shortage or suspension of water, the protective function detects the overheated condition in the STP pump and stops the STP pump.
  For safety, attach a flow switch to the cooling water exit to stop the STP pump if abnormal cooling water flow occurs (A flow switch is available on the market).
- The joint for the water-cooling unit is made of stainless steel. To prevent corrosion, connect the stainless steel joint.

Note: Refer to Section 2.2.3, "Water cooling use condition", for the water-cooling unit.

4.3 Baking the STP pump

WARNING

The surfaces of the STP pump and its peripheral equipment will become extremely hot. Never touch them with bare hands.

CAUTION

The TMS unit and the baking heater cannot be used together simultaneously.

Bake the vacuum equipment and STP pump to attain much less pressure and reduce the exhaust time.

When baking them, always cool the STP pump to prevent overheating. Start baking after cooling is started.

Set the temperature of the baking heater to 120 °C (248 °F) or less.

(The baking heater of the optional accessory is set to 110°C (230 °F) or less)

DO NOT introduce gases during baking to prevent overheating.

Run the STP pump during baking to exhaust the gas discharged from the vacuum equipment and the inner wall of the STP pump.

4.4 Before starting the STP pump

CAUTION

NEVER connect or disconnect any cables while the power is ON. NEVER turn the primary power OFF (turn the MAIN POWER "OFF") during normal shutdown operations while the STP pump is in rotation. DO NOT release the inlet port flange or outlet port flange into the atmosphere while the STP pump rotates.

CAUTION

Connect each cable securely and carefully, avoiding any obstacles.
DO NOT place heavy objects on the cables or bend them excessively. The STP pump cannot normally work if any problem occurs in cables, connectors, or terminals.
DO NOT apply voltage to each connector pin. And DO NOT short each pin.
Install cables with avoiding risks such as tripping or falling.

CAUTION

DO NOT bind a communication line with a protective earth line or a power line.
Moreover, keep away a communication line from the apparatus that can be a noise source as much as possible.

CAUTION

Locate and secure the cables.
It may be difficult to measure the reproducibility of the communication failure without securing the cables.

CAUTION

Avoid installing a power line and a communication line in the same metallic duct.
When it is unavoidable, separate the lines with a metal separator and connect the duct, including the metal separator, to GND. Or install a communication line into conductive pipes, such as metal.

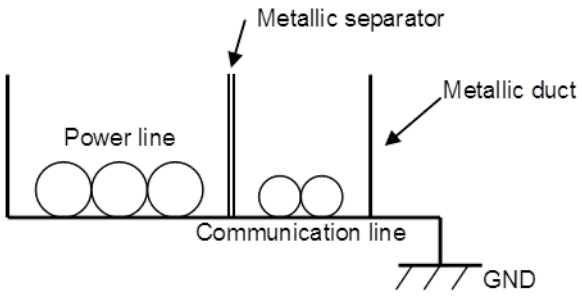


Figure 29 - Example of cable installation in metallic duct

4.4.1 Confirmation before starting

After completing the installation, piping, leakage test of the STP pump, and wiring of the power cables, the STP pump is ready to start. Confirm the below before the STP pump starts.

1. Ensure the STP pump is installed correctly (refer to Section 3).
2. Ensure the correct supply voltage is applied.
3. Ensure all cables are securely connected and locked.

4.4.2 Confirmation of vacuum system

1. Starting backing pump

Start the backing pump before or simultaneously with the start of the STP pump. Open the vacuum valve at the outlet port flange side after starting the backing pump.

Note: DO NOT open the vacuum valve without operating the backing pump. It may cause a reverse flow of oil, which can contaminate the inside of the STP pump, depending upon the backing pump's type.

Note: DO NOT frequently start/stop operations. Otherwise, it can cause the STP pump to overheat.

2. Stop backing pump

CAUTION
DO NOT stop the backing pump without closing the vacuum valve. It can cause a reverse flow of atmospheric air into the STP pump, resulting in a malfunction depending upon the backing pump's type.

Close the vacuum valve at the outlet port flange side just before or after stopping the STP pump. After closing the valve, then stop the backing pump.

Note: DO NOT stop the backing pump without closing the vacuum valve. It may cause a reverse flow of oil, which can contaminate the inside of the pump, depending upon the backing pump's type.

4.5 Powering ON/OFF

4.5.1 Powering ON

Turn "ON" the "MAIN POWER" switch on the control unit. If there is no error, the magnetic bearings work, and the rotor levitates (POWER ON state). The "STATUS" LED flashes green in 1.6 second period (Levitation state).

4.5.2 Powering OFF

Turn "OFF" the "MAIN POWER" switch when the STP pump stops (during the status is "Levitation": the "STATUS" LED flashes green in 1.6 second period).
The magnetic bearing stops, the rotor lands, and then the "STATUS" LED is off (POWER OFF state).

4.6 Pump operation

4.6.1 Input operation port setting

The STP pump needs to set the hardware which operates the STP pump before the operation.
The STP pump is equipped with the serial port COM2 (X2 COM2 connector) and the parallel port (X4 REMOTE connector) or EtherCAT® (IN, OUT connector) as standard operating hardware.
The STP-Link (optional accessory) or the display unit iDT-002 (optional accessory) can also operate the STP pump via the serial port (X5 STP-LINK connector).

Regarding how to set the input port, refer to 5.2.4, "Input operation port setting".

When operating the STP pump via serial communication, refer to Section 5, "SERIAL COMMUNICATION PROTOCOL".
When operating the STP pump via the STP-Link (optional accessory) or the display unit iDT-002 (optional accessory), refer to each Instruction Manual.

4.6.2 X5 STP-LINK socket

Connects the communication cable for the STP-Link (optional accessory) or the Display unit iDT-002 (optional accessory). These optional accessories can operate the STP pump, confirm the operational state, or change various settings.

See the "STP-Link" or the “Display unit iDT-002” Instruction Manual for the detailed specification and operating method.

4.7 "STATUS" LED

The STP pump operation status is indicated by the colors and flashing patterns of the "STATUS" LED. If the flashing pattern is different from any pattern shown in Figure 30, there is a possibility of failure. Contact our Service office.

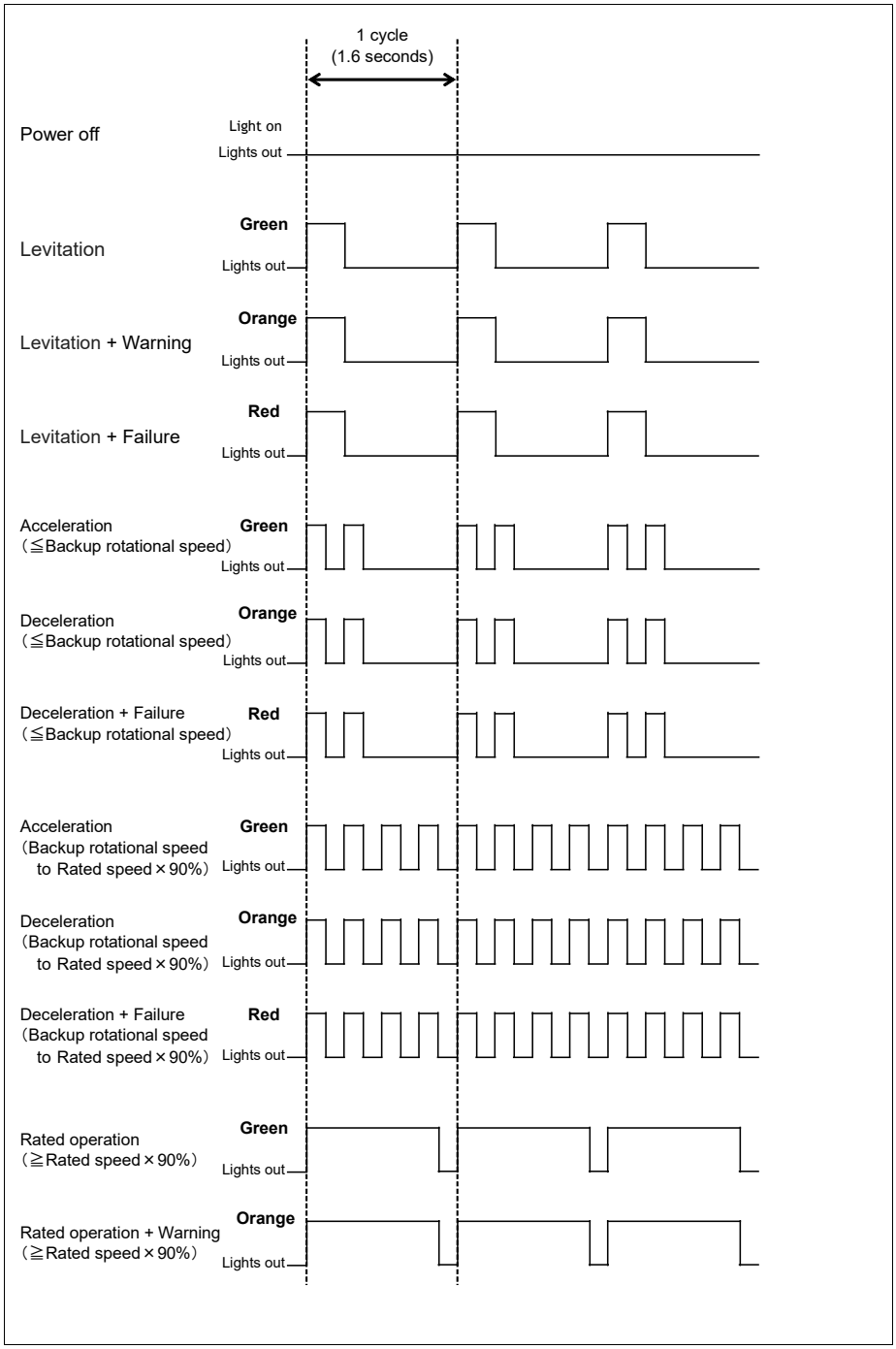


Figure 30 - The flash patterns of STATUS

4.8 Second speed option

When the second speed option is enabled, the second rating speed can be set independently of the normal rating speed setting. Either the second or normal rating speed can be selected by I/O remote input or serial communication port.
The second speed setting can be changed from serial communication port, or STP-Link. (see Section 5.4, "Command specifications")

Table 15 shows the STP pump actions when switching the speeds.

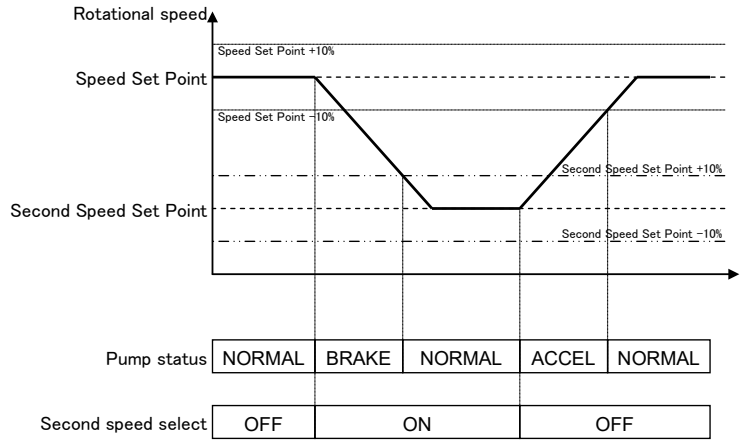
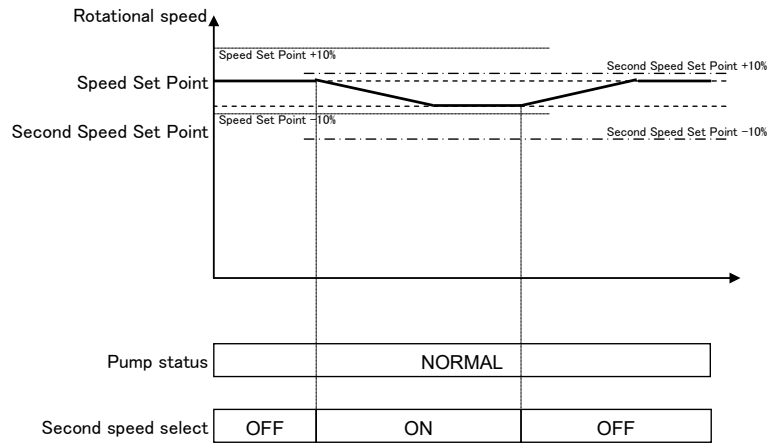
	Pump status
The difference between the Normal Speed and the Second Speed Setting is more than approximately 10%	When the rotational speed becomes lower, the STP pump enters the BRAKE mode and decelerates. When the rotational speed becomes higher, the STP pump enters the ACCEL mode and accelerates. The STP pump will enter the normal mode when the rotational speed is within +10% of the speed setting. 
The difference between the Normal Speed and the Second Speed Setting is approximately 10% or less	The rotational speed changes remaining in the normal mode. 

Table 15 - Second speed function

4.9 Operating the TMS unit (for use with the TMS unit)

4.9.1 Before starting

Check the following items before starting:

1. Check that the TMS valve cable is securely connected to the "X3 VALVE" connector on the control unit.
2. Check that the TMS valve and the cooling water pipe are securely connected.

4.9.2 Starting/Stopping

Power on the STP pump, and the TMS function starts automatically.
Power off the STP pump, and the TMS function stops automatically.
While the STP pump is in a power ON state, the TMS function operates regardless of the status of the STP pump. When some errors occur, the TMS function is stopped.

4.9.3 Setting the TMS unit function

When an STP pump base temperature is lower than the set value, the TMS heater is turned "ON", and the TMS valve is turned "OFF" to heat the STP pump.
When an STP pump base temperature is higher than the set value, the TMS heater is turned "OFF", and the TMS valve is turned "ON" to cool the STP pump.

5 SERIAL COMMUNICATION PROTOCOL

5.1 Introduction

STP-iXA4507 series has a serial RS232/RS485 compliant interface. It can make operating the STP pump and checking information of the STP pump, such as a running state with software.

The STP pump has the serial ports for connecting the user application, STP-Link (optional accessory), or the display unit iDT-002 (optional accessory). (see Figure 31)

The STP pump is equipped with 2 serial ports: COM2 and STP-LINK.

Hereafter, the STP pump's serial port is called a serial interface module (abbreviated to SIM). And the equipment that can communicate with the STP pump via RS232/RS485 is called a PC.

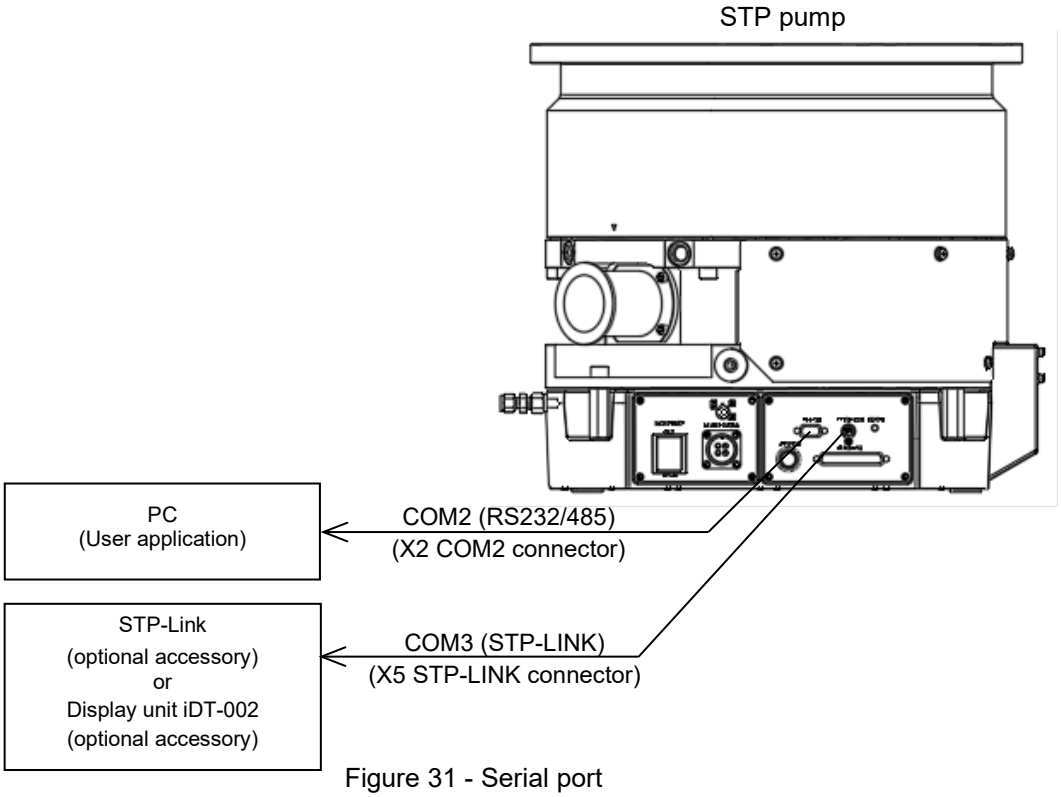


Figure 31 - Serial port

5.2 Connection and setting up

5.2.1 Signal connection

1. Serial Port COM2 (X2 COM2 connector)

The serial port COM2 is available for serial communication using RS232 or RS485 protocol. When using a user application, connect it to this port.

Connect the connector X2 (D-Sub 9-pin, socket type) to a PC according to Table 16. Connect only TxD / RxD / GND in the RS232 and D+ / D- in the RS485. DO NOT connect other pins which are reserved for optional use. DO NOT use a commercially available straight cable to which all lines are connected.

	X2 (D-Sub 9-pin, socket)
RS232	2 (TxD)
	3 (RxD)
	5 (GND)
RS485	7 (D-)
	8 (D+)
Reserved	1, 4, 6 *1, 9

*1 Pin 6 of the connector X2 outputs 5 VDC for option units. DO NOT connect pin 6. It may damage peripheral equipment, such as PC.

Table 16 - X2 pin assign

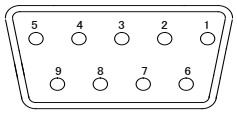


Figure 32 - X2 connector (D-Sub 9-pin)

Note: The screws for locking a cable to the connector X2 are M2.6 screws.

The RS232 and RS485 on the X2 COM2 port cannot use simultaneously.

When connecting RS232, the length of a communication cable should be 15 m or less. When connecting RS485, refer to Section 5.2.2.

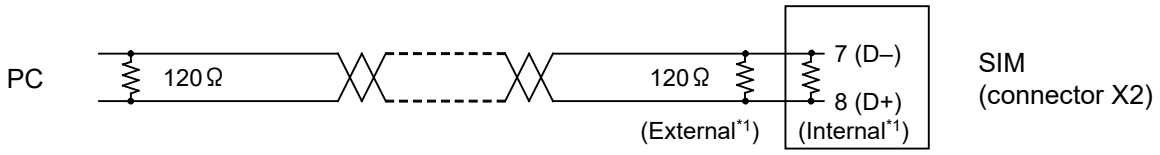
2. STP-LINK (X5 connector)

The STP-Link (optional accessory) or the display unit iDT-002 (optional accessory) can be connected to the X5 connector.

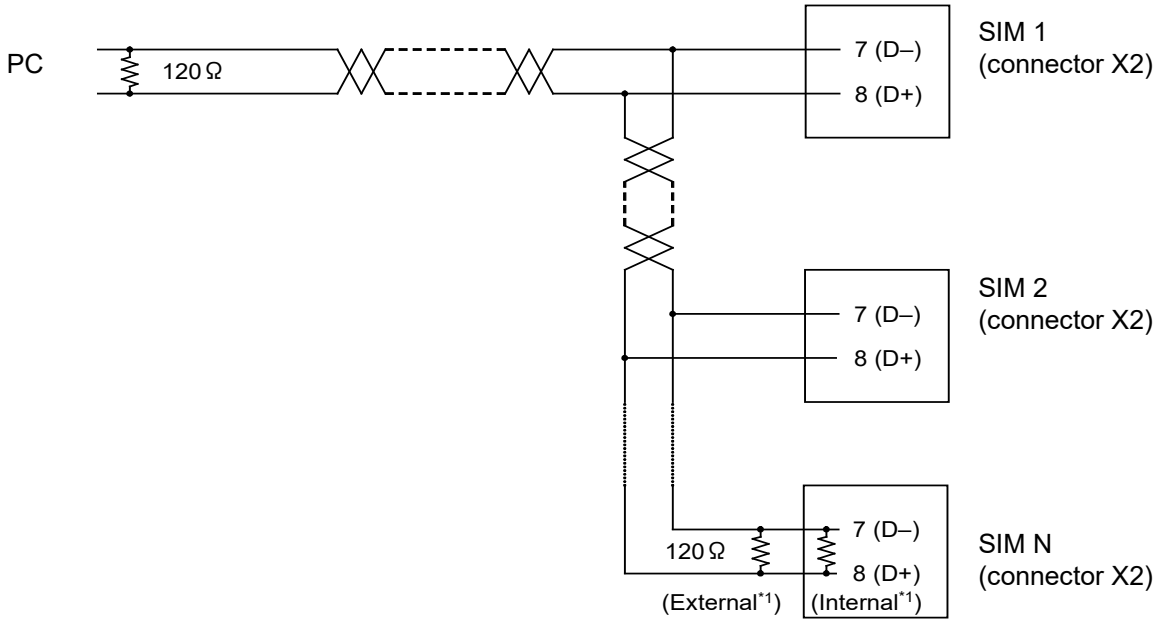
5.2.2 Connecting the RS485

Make sure the following when using the serial port COM2 with RS485.

- A connection condition is 1 on 1 (single point connection) or 1 on N (multi-point connection). Up to 32 SIMs can be connected with the multi-point connection.
- After receiving commands, SIM will return a response 5 msec later at the shortest. Connect a PC that switching time between transmitting and receiving is 5 msec or less.
- Use twisted-pair wires for communication cables. The sum length of the communication cables should be 1.2 km or less.
- Connect the terminators to the communication devices at both transmission line ends. Use 120 Ω, 0.25 W resistors for the external terminator.
- The internal terminator of the STP side is available. When using it, set it by STP-Link (optional accessory) or display unit iDT-002 (optional accessory). Do not use an internal and an external terminator simultaneously. It can cause some communication failures.



a) RS485 single point connection



b) RS485 multi-point connection

*1 Either internal or external

Figure 33 - RS485 connections

5.2.3 Communication parameter setting

The factory setting of COM2 is shown in Table 17. Use the STP-Link (optional accessory) or the display unit iDT-002 (optional accessory) to set communication parameters.

Communication parameter	Factory setting	PC setting example
Baud rate	9,600 bps	1,200 to 56,000 bps
Bit length	8 bit	7, 8 bit
Stop bit	1 bit	1, 2 bit
Parity	None	None, Even, Odd
Driver type	RS232/RS485 single	RS232/RS485 single, RS485 multi
RS485ID *1	1	1 to 127
Terminator *2	Not use	Not use, Use

*1 It is used in RS485 Multi.

*2 Internal terminator

Table 17 - Communication parameters

5.2.4 Input operation port setting

Set the input operation port to the serial port when operating the STP pump via the serial port. Set the parameter of the “Input operation port” to the serial port which operates the STP pump, following Section 5.4.16 "ReadOptionFunc".

The parameter value of the factory setting is “I/O REMOTE” (parallel port) or “EtherCAT®”.
The "Input Operation Port" can also be changed with the STP-Link (optional accessory) or the display unit iDT-002 (optional accessory).

	Input operation port	Remark
Parallel port	I/O Remote	X4 REMOTE connector
—	EtherCAT®	RJ45 connector (COM1)
Serial port	COM2	X2 COM2 connector
	STP-LINK	X5 STP-LINK connector

Table 18 - Input operation port

Note: Any commands other than STP pump operation are effective in every port regardless of the input operation port setting.

5.2.5 Serial communication timeout setting

If the signal on the input operation port is interrupted for a certain period during acceleration or normal operation, the STP pump detects a failure and stops. The time setting of the failure detection is user-definable. When the setting value is 0, the function is disabled. This value will be common to all serial ports, and the factory setting is 1 minute.

The setting value can be changed using serial communication (see 5.4.17, “SetOptionFunc”), the STP-Link (optional accessory) or the display unit iDT-002 (optional accessory).
Design the user application so that a PC communicates with the STP pump at fixed, regular intervals within the setting time, except when the function is disabled (the value is 0).

	Default	Setting Range	Remark
Serial communication time out setting	1 minute	0 to 500 minutes (1 minute step)	The function is disabled when the value is set to 0.

Table 19 - Serial communication time out setting

Note: When the communication time out is disabled, the STP pump may not stop when the serial communication does not work correctly due to a disconnection of the communication cable. In this case, interrupt the power supply for 2 seconds or more to stop the STP pump by power failure detection. Supply the power to the STP pump immediately after power failure detection.

5.2.6 Recommended items about communication cable installation

Noise generated by many factors such as types or lengths of cables, communication speed, and other communication devices may cause communication failure with a serial port. It is very difficult to prevent a communication failure completely. However, the followings are valid methods for countermeasure noise for the communication cable.

- Use a shielded communication cable and an EMI countermeasure communication connector hood. Choose the suitable grounding method according to the operating environment.

[Both ends grounding (Electromagnetic shielding)]

It is a grounding method for reducing an inductive voltage in the communication line produced by the magnetic field emitting from a power supply line. Ground both ends of all the cables connecting communication devices. Clamp the STP pump side shield on a connector hood. A ground loop will be made up through both ends grounding. Connect between the STP pump's GND and a PC's GND with low impedance to prevent potential ground difference.

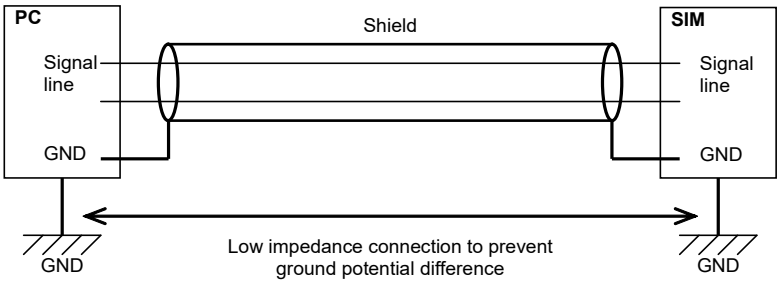


Figure 34 - Grounding example (Both ends grounding)

[Single point grounding (Electrostatic shield)]

It is the grounding method for reducing an electrostatic induction in the communication line produced by the noise from electrostatic inductions or unnecessary radiations. Ground the communication cable shield by a single point to the PC side. DO NOT ground on the STP pump side. When a ground potential difference is high, the single point grounding may be more effective than both ends grounding for reducing noise.

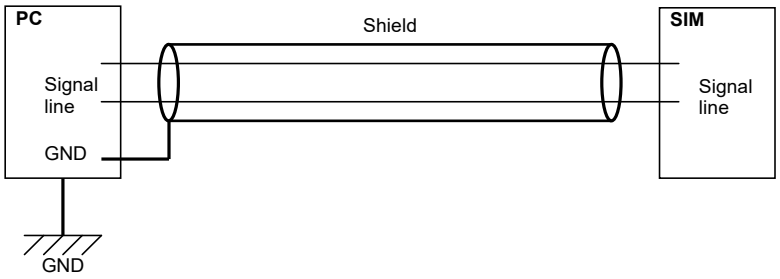


Figure 35 - Grounding example (single-point grounding)

- DO NOT bundle a communication line with a protective earth line or a power line. Moreover, keep away a communication line from a noise source as much as possible.

- To prevent radio frequency noise, place a ferrite core on both ends of the communication cable. Electromagnetic interference caused by radiofrequency noise (150 kHz to 1 GHz) affects communication. In that case, attaching some ring ferrites to the cables can reduce communication failure.

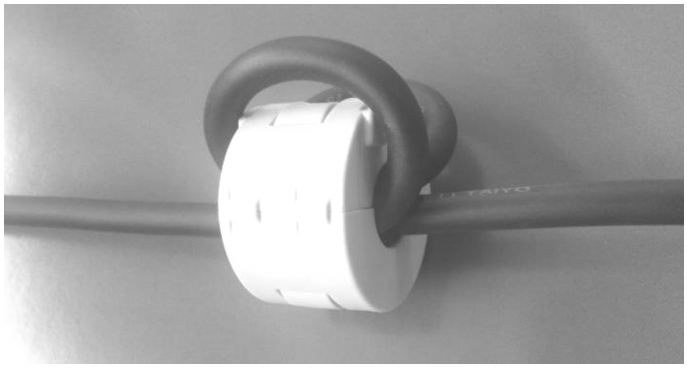


Figure 36 - Example of ring ferrite core installation

- Decide the arrangement of the cables and secure the cables.
  It may be difficult to take a countermeasure of communication failure without securing the cables because the condition that the communication failure occurs cannot recreate.

- Avoid installing a power line and a communication line in the same metallic duct.
  When unavoidable, separate a line with a metallic separator and connect the duct containing a metallic separator to GND. Or install a communication line into conductive pipes.

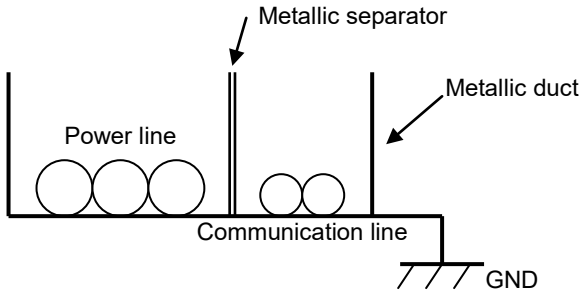
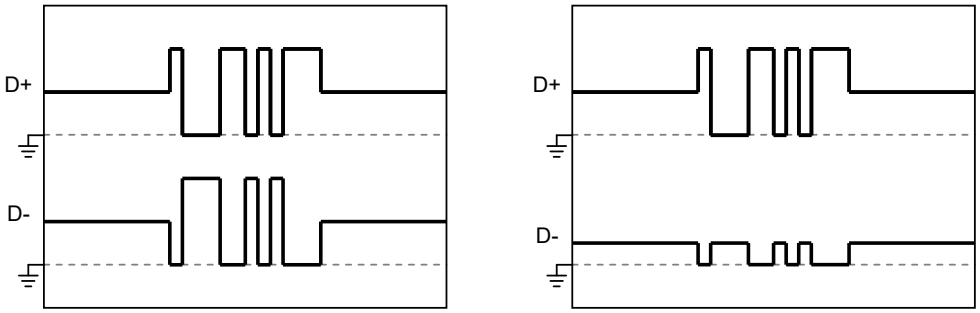


Figure 37 - Example of cable installation in metallic duct

- DO NOT insert or remove a communication cable during a communication device or the STP pump's power is turned ON.
  If the communication line is applied by surge voltage from a potential difference between communication interfaces or static electricity, communication interface circuits may break down.

  Communication failure frequently occurs if the communication interface circuit is broken.
  If the communication interface circuits are broken, RS485 may still work according to the environment. However, it is easy to get some communication errors. Therefore, check that the differential signal waveform is normal with an oscilloscope if the circuits are suspected to be broken.



a) Normal

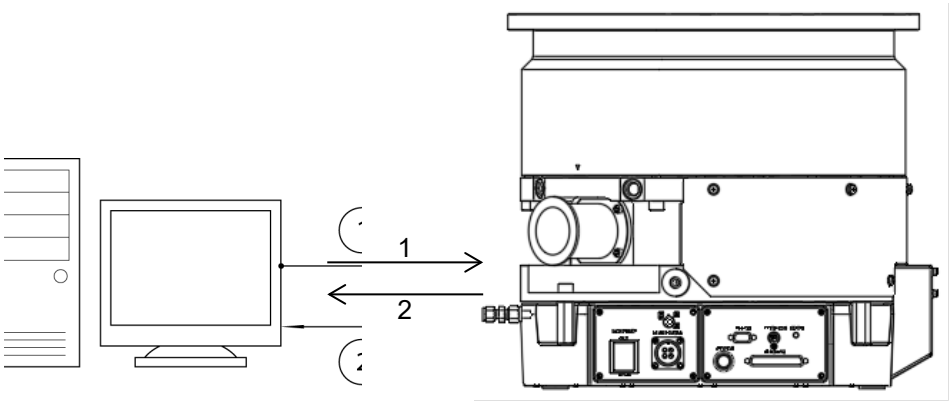
b) Abnormal
(abnormal voltage amplitude)

Figure 38 - Example of a differential signal waveform

5.3 Protocol specifications

5.3.1 General description

In the STP serial communication protocol, a SIM(s) receives communication commands transmitted from a PC (Figure 39-1), and sends a response following the communication commands (Figure 39-2). The communication commands from a PC transmit a text message (ASCII text) assigned to each function. The communication commands include the control commands (the STP pump operation commands) and the query commands (read-out of the STP pump operation modes).



1. Communication command 2. Response

Figure 39 - PC to SIM communication

Table 20 shows ASCII characters used in the transmission procedures, error procedures, and handshake in the application layer.

	ASCII character	HEX code	Function
Transmission layer	Stx	02	Transmission block start character
	Etx	03	Transmission frame end character
	Etb	17	Transmission block end character
	Ack	06	Acknowledgment response
	Nak	15	Non-acknowledgment response
	@	40	Network frame ID character
Application layer	#	23	Acknowledgment response
	!	21	Non-acknowledgment response

Table 20 - Transmission control characters

5.3.2 Standard transmission frame

The transmission frame has a single block or multiple transmission blocks. The transmission block consists of a start control character, data block Numbers (3 digits), a message (up to 255 characters), an end control character, and a checksum (LRC). The following table shows the transmission frame if the message transmission character string is C_n.

Transmission frame when a message is below 255 characters (n<=255):

	1	2	3	4	5		5+n	5+n+1	5+n+2
ASCII	Stx	0	0	1	C_1		C_n	Etx	LRC

"Stx" and "Etx" are used as the transmission frame's start and end characters, respectively.

Transmission frame when a message exceeds 255 characters
(n = 255, m<=255, k = the number of transmission blocks):

		1	2	3	4	5		5+n	5+n+1	5+n+2
First Block	ASCII	Stx	0	0	1	$C1_1$		$C1_n$	Etb	LRC
Second Block	ASCII	Stx	0	0	2	$C2_1$		$C2_n$	Etb	LRC
Final Block	ASCII	Stx	k			Ck_1		Ck_m	Etx	LRC

"Stx" is used as a start character of each transmission block. "Etb" is used as an end character of the transmission block with a message of 255 characters. "Etx" is used as an end character of the final transmission block (the end character of the transmission frame).

5.3.3 Control command (in the RS232/RS485 single point connection)

A control command is used to transmit pump operation commands and change setting commands to the SIM. The first character of the control command is "Sp" (a space character, HEX code "20"), and the subsequent characters are ASCII characters corresponding to the respective function code and parameter.

Sp	CHR	C_1	C_2					C_n

CHR: Function code character, C_1 to C_n: Parameter.

The parameter (C1 to Cn) is a 16 bit signed hexadecimal value coded ASCII text. When a message (the space character, the function code, and the parameter) exceeds 255 characters, input "Sp" and CHR to only the top of the transmission blocks (the first transmission block of the transmission frame). It is unnecessary to input them into the second and the subsequent transmission blocks.

The SIM returns the acknowledgement response character "#" when correctly processing the query command. If not, the SIM returns the non-acknowledgement response character "!" and 3 characters of the non-acknowledgement code are added to "!".

Transmission frame when data is transmitted with one block (a message is less than 256 characters):

Designate the control command on a PC first.

<- Less than 256 chr. ->

PC->SIM	Stx	0	0	1	Sp	CHR	C_1		C_n	Etx	LRC
SIM->PC											Ack or Nak

Parameter characters are less than 254 characters (n< 254) when a message is less than 256 characters.

Then the preceding SIM->PC character is "Ack", the instructed control command is executed, and the SIM returns the following response.

PC->SIM							Ack or Nak
SIM->PC	Stx	0	0	1	# or !	Etx	LRC

The PC transmits "Ack" or "Nak"; then transmits the next command if necessary.

Transmission frame when data is transmitted to two blocks (message is more than 256 characters and less than 512 characters):

Designate the control command (the 1st block) on a PC first.

PC->SIM	Stx	0	0	1	Sp	CHR	C_1		C_{253}	Etb	LRC
SIM->PC											Ack or Nak

Next, when the preceding SIM->PC character is "Ack", the PC continues instructing the following control command (the 2nd block).

PC->SIM	Stx	0	0	2	C_{254}		C_n	Etx	LRC
SIM->PC									Ack or Nak

The parameter characters are less than 510 characters (n< 510) when a message is less than 512 characters.

Then if the preceding SIM->PC character is "Ack", the instructed control command is executed, and the SIM returns the following response.

PC->SIM							Ack or Nak
SIM->PC	Stx	0	0	1	# or !	Etx	LRC

The PC transmits "Ack" or "Nak"; then transmits the next command if necessary.

5.3.4 Query command (in the RS232/RS485 single point connection)

A query command is used to read the pump operation state and setting values. The first character of the query command in the RS232/RS485 single point connection is "?" (HEX code "3F"), and the subsequent characters are ASCII characters corresponding to the respective function code and parameter.

?	CHR	C_1	C_2					C_n

CHR: Function code character, C_1 to C_n: Parameter

The parameter (C_1 to C_n) is a 16 bit signed hexadecimal value coded ASCII text. When a message (the space character, the function code, and the parameter) exceeds 255 characters, input "?" and CHR to only the top of the transmission blocks (the first transmission block of the transmission frame). It is unnecessary to input them into the 2nd and the subsequent transmission blocks.

The SIM returns the acknowledgement response character "#" when correctly processing the query command. If not, the SIM returns the non-acknowledgement response character "!" and 3 characters of the non-acknowledgement code are added to "!".

Transmission frame when data is transmitted with one block and returned with two blocks:

Designate the query command on a PC first.

<- Less than 256 chr. ->

PC->SIM	Stx	0	0	1	?	CHR	C_1		C_n	Etx	LRC	
SIM->PC												Ack or Nak

The parameter characters are less than 254 characters (n< 254) when the message is less than 256 characters.

Then if the preceding SIM->PC character is "Ack", the instructed query command is executed, and the SIM returns the following response (1st block).

PC->SIM												Ack or Nak
SIM->PC	Stx	0	0	1	Sp	CHR	C_1		C_{253}	Etb	LRC	

And then, if "Ack" is sent by the PC->SIM character as a response (1st block) to the SIM, the SIM returns the following response (2nd block).

PC->SIM										Ack or Nak
SIM->PC	Stx	0	0	2	C_{254}		C_n	Etx	LRC	

The PC transmits "Ack" or "Nak"; then transmits the next command if necessary.

5.3.5 Transmission data format

The data value is 16 bit signed hexadecimal value coded ASCII text.

Example: 12090 on decimal equals 2F3A on hexadecimal.

5.3.6 Frame control (checksum)

The transmission frame is controlled by the odd number parity check. First, LRC is initialized to FF_{hex}. Next, LRC is calculated by EXCLUSIVE-OR (XOR) of all the frame bytes containing "Stx", "Etb", "Etx" and LRC and transmitted as LRC.

Examples:

A character string for calculation before the calculating LRC:

ASCII	Stx	0	0	1	#	Etx	LRC
HEX	02	30	30	31	23	03	FF

The calculation of LRC:

02_{hex} XOR 30_{hex} XOR 30_{hex} XOR 31_{hex} XOR 23_{hex} XOR 03_{hex} XOR FF_{hex} = EC_{hex}

The character string for transmission after the calculating LRC:

ASCII	Stx	0	0	1	#	Etx	LRC
HEX	02	30	30	31	23	03	EC

However, LRC is set to $6C_{hex}$ if the data length is 7 bits in the above example since the MSB (most significant bit) is always 0.

5.3.7 Error control

- Transmit the transmission frame repeatedly from a PC when a SIM transmits "Nak" (parity check error). On the other hand, when a SIM receives "Nak" from a PC, the transmission frame is transmitted again. This operation is repeated up to 5 times.
- A SIM transmits "Ack" or "Nak" to a PC after receiving a communication command. When the PC cannot receive "Ack" or "NaK" after 2 seconds, retransmit the transmission frame from the PC.

When these communication errors repeatedly occur, display an error message or start the error routine on the PC.

5.3.8 Transmission frame in RS485 multi-point connection

In an RS485 multi-point connection, a network frame ID character, "@", and 3 characters as a network frame number are added to a transmission frame to recognize a network frame and have compatibility for the standard transmission frame of RS485.

The network frame number is specified as 1 to 127 by 16 bit signed hexadecimal value coded ASCII to identify the SIM.

Examples: A Network frame ID character and number in the multi-point connection

ASCII	@	0	1	Network frame No "1"
HEX	40	30	31	

ASCII	@	6	4	Network frame No "100"
HEX	40	36	34	

ASCII	@	7	F	Network frame No "127"
HEX	40	37	46	

The transmission frame has a single block or multiple transmission blocks. Each transmission block consists of a network frame ID character, a network frame number, a start control character, a data block number (3 digits), a message (up to 255 characters), an end control character, and a checksum (LRC). The following shows a transmission frame when the message transmission character string is C_n.

Transmission frame when a message is below 255 characters (n<=255):

	1	2	3	4	5	6	7	8		8+n	8+n+1	8+n+2
ASCII	@	F_1	F_2	Stx	0	0	1	C_1		C_n	Etx	LRC

"@" is used as a network frame ID character.

"Stx" and "Etx" are used as the transmission frame's start and end characters, respectively.

Transmission frame when a message exceeds 255 characters (n = 255, m<=255, k = the number of transmission blocks)

First		1	2	3	4	5	6	7	8		8+n	8+n+1	8+n+2
Block	ASCII	@	F_1	F_2	Stx	0	0	1	$C1_1$		$C1_n$	Etb	LRC
Second		1	2	3	4	5	6	7	8		8+n	8+n+1	8+n+2
Block	ASCII	@	F_1	F_2	Stx	0	0	2	$C2_1$		$C2_n$	Etb	LRC
Final		1	2	3	4	5	6	7	8		8+m	8+m+1	8+m+2
Block	ASCII	@	F_1	F_2	Stx	k			Ck_1		Ck_m	Etx	LRC

"@" is used as a network frame ID character.

"Stx" is the start character of each transmission block, and "Etb" is the end character of the transmission block of a message of 255 characters.
"Etx" is the end character of the final transmission block (end character of the transmission frame).

5.3.9 Control command in RS485 multi-point connection

The control command to a SIM for a pump operation or a setting change transmitted is specified below. The first character is "Sp" (space character, HEX code "20"). And the next ASCII characters correspond to the function code and parameter.

Sp	CHR	C_1	C_2					C_n

CHR: Function code character, C_1 to C_n: Parameter

The parameter (C_1 to C_n) is 16 bit signed hexadecimal value coded ASCII text. When a message (the space character, the function code, and the parameter) exceeds 255 characters, input "Sp" and CHR to only the top of the transmission blocks (the first transmission block of the transmission frame). It is unnecessary to input them into the second and succeeding transmission blocks.

The SIM returns the acknowledgement response character "#" when the control command is processed correctly. If not, the SIM returns the non-acknowledgement response character "!" and 3 characters of the non-acknowledgement code are added to "!".

Transmission frame when data is transmitted to one block (a message is less than 256 characters):

Designate the control command on a PC first.

<- Less than 256 chr.->

PC->SIM	@	F_1	F_2	Stx	0	0	1	Sp	CHR	C_1		C_n	Etx	LRC	
SIM->PC															Ack or Nak	F_1	F_2

Parameter characters are less than 254 characters (n< 254) when a message is less than 256 characters.

Then the preceding SIM->PC character is "Ack", the instructed control command is executed, and the SIM returns the following response.

PC->SIM														Ack or Nak	F_1	F_2
SIM->PC	@	F_1	F_2	Stx	0	0	1	# or !			Etx	LRC				

The PC transmits "Ack" or "Nak"; then transmits the next command if necessary.

Transmission frame when data is transmitted to two blocks (message is more than 256 characters and less than 512 characters):

Designate the control command (the 1st block) on a PC first.

PC->SIM	@	F_1	F_2	Stx	0	0	1	Sp	CHR	C_1		C_{253}	Etb	LRC		
SIM->PC															Ack or Nak	F_1	F_2

Next, when the preceding SIM->PC character is "Ack", the PC continues instructing the following control command (the 2nd block).

PC->SIM	@	F_1	F_2	Stx	0	0	2	C_{254}		C_n	Etx	LRC	
SIM->PC													Ack or Nak	F_1	F_2

The parameter characters are less than 510 characters (n< 510) when a message is less than 512 characters.

Then the preceding SIM->PC character is "Ack", the instructed control command is executed, and the SIM returns the following response.

PC->SIM												Ack or Nak	F_1	F_2
SIM->PC	@	F_1	F_2	Stx	0	0	1	# or !	Etx	LRC			

The PC transmits "Ack" or "Nak", then transmits the next command if necessary.

5.3.10 Query command in RS485 multi-point connection

The control command to a SIM for a pump operation or a setting change transmitted is specified below. The first character is "?" (HEX code "3F"). And the next ASCII characters correspond to the function code and parameter.

?	CHR	C_1	C_2				C_n

CHR: Function code character, C_1 to C_n: Parameter.

The parameter (C1 to Cn) is 16 bit signed hexadecimal value coded ASCII text. When a message (the space character, the function code, and the parameter) exceeds 255 characters, input "?" and CHR to only the top transmission block (the first transmission block of the transmission frame). It is unnecessary to input them into the second and succeeding transmission blocks.

The SIM returns the acknowledgement response character "#" when the query command is processed correctly. If not, the SIM returns the non-acknowledgement response character "!" and 3 characters of the non-acknowledgement code are added to "!".

Transmission frame when data is transmitted with one block and returned with two blocks:

Designate the query command on a PC first.

<- Less than 256 chr.->

PC->SIM	@	F_1	F_2	Stx	0	0	1	?	CHR	C_1		C_n	Etx	LRC	
SIM->PC														Ack or Nak	F_1	F_2

The parameter characters are less than 254 characters (n< 254) when the message is less than 256 characters.

Then if the preceding SIM->PC character is "Ack", the instructed query command is executed, and the SIM returns the following response (1st block).

PC->SIM													Ack or Nak	F_1	F_2
SIM->PC	@	F_1	F_2	Stx	0	0	1	Sp	CHR	C_1		C_{253}	Etb	LRC	

And then, if "Ack" is sent by the PC->SIM character as a response (1st block) to the SIM, the SIM returns the following response (2nd block).

PC->SIM												Ack or Nak	F_1	F_2
SIM->PC	@	F_1	F_2	Stx	0	0	2	C_{254}		C_n	Etx	LRC		

The PC transmits "Ack" or "Nak"; then transmits the next command if necessary.

5.3.11 Broadcasting command in RS485 multi-point connection

The START or STOP of STP pump operation command can be concurrently instructed to all the multi-connected SIMs. Always assign 0 (HEX code "30", "30") to network frame number. Note that there is no response from the respective SIM.

PC->SIM	@	0	0	Stx	0	0	1	Sp	E	Parameter 1	Etx	LRC
SIM->PC											No response	

Parameter	Item	Data Format	Remark
1	Pump operation command	8-bits hexadecimal coded ASCII	Refer to Table 21

Pump operation command	Value
START	1
STOP	2

Table 21 - Pump operation commands

5.3.12 Application note

Noise generated by many factors such as the type or length of cable, communication speed, and different communication devices may cause communication failure with a serial port. It is very difficult to prevent a communication failure completely. The followings are the methods to create tool applications with redundancy to noise.

- Be sure to communicate according to the protocol. If it communicates by different procedures described by this manual, communication failure might cause.
  Figure 40 shows the block diagram of the valid communication process from sending a command to receiving answer data.
  Moreover, examples of the communication procedures are shown in Figure 44, Figure 45, and Figure 46.

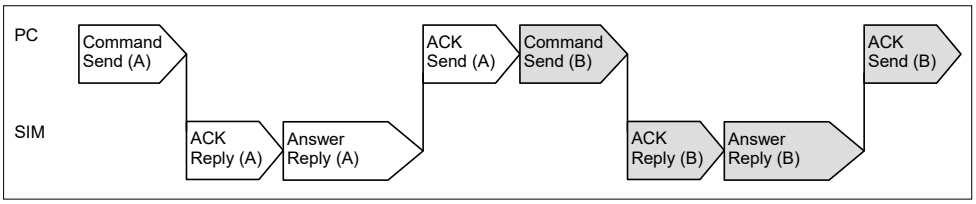


Figure 40 - Block diagram of communication process example

- A SIM will reply "ACK" or "NAK" within approximately 2 seconds after receiving a command.
  If there is no reply, the SIM may not have received the command. In this case, resend the command from an equipment application before regarding it as a communication failure. If the problem cannot solve after resending it several times, make a process of communication failure on the equipment application.
- Monitor the character "Etx" in the process of finishing receiving data.
  The receiving process is completed by receiving the "LRC" (checksum) data after getting "Etx". This process can reduce the task of modifying an equipment application if receiving commands with different answer data sizes according to the pump mode.

  However, when judging the completion of the answer receiving process by the number of received characters, check that "Etx" has been received, and the LRC checksum is correct.
- After sending the command, release the elapsed time process due to communication timeout when receiving answer data. When receiving many answer data, the answer receiving process of an equipment application may regard time out, and all data may not be able to obtain.

- Always check the LRC checksum of answer data. When the LRC checksum is incorrect, do not use the data. When incorrect data caused by noise is accepted, parameters might be set with unexpected values. In this case, the processing of an equipment application may judge that it is a communication failure. When the LRC checksum is incorrect, receive the answer data again with the following methods.
  - Resend the answer data again from SIM by sending "NAK" within 1500 msec after receiving the answer data. However, when using RS485, send "NAK" at least 1 msec has passed after receiving the answer data.
  - Stop the communication process once, and try the communication process again.

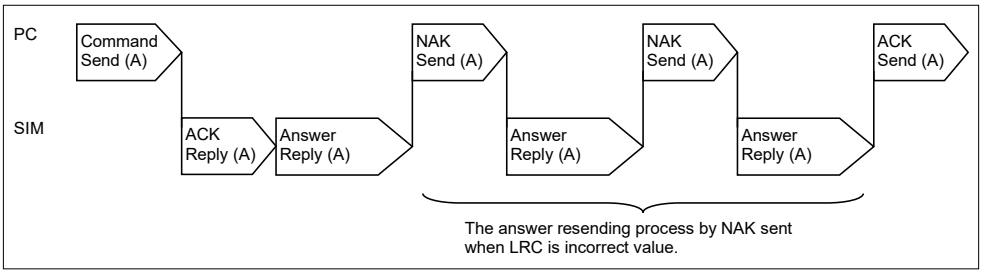


Figure 41 - Example of answer resending process

- If the next command is sent before receiving the answer data from the SIM, the contents of the answer data and the sent command from the SIM will not match.
  In this case, stop the communication for approximately 5 seconds to clear all the receiving buffer of an equipment application, and then start the communication again.

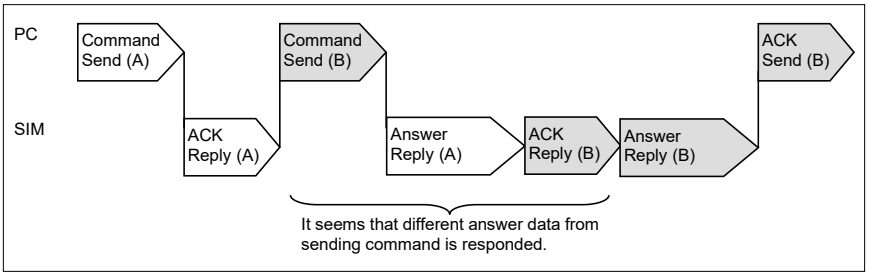


Figure 42 - Example of response when the command is sent continuously

In addition, when using RS485, do not send commands while the answer data is sent from the SIM. Crosstalk between sending and receiving data will occur, and it causes communication failure such as a flaming error.

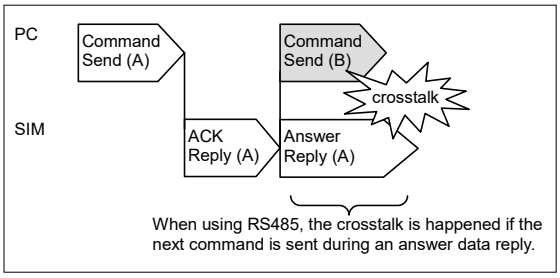


Figure 43 - Example of command sending during answer data reply

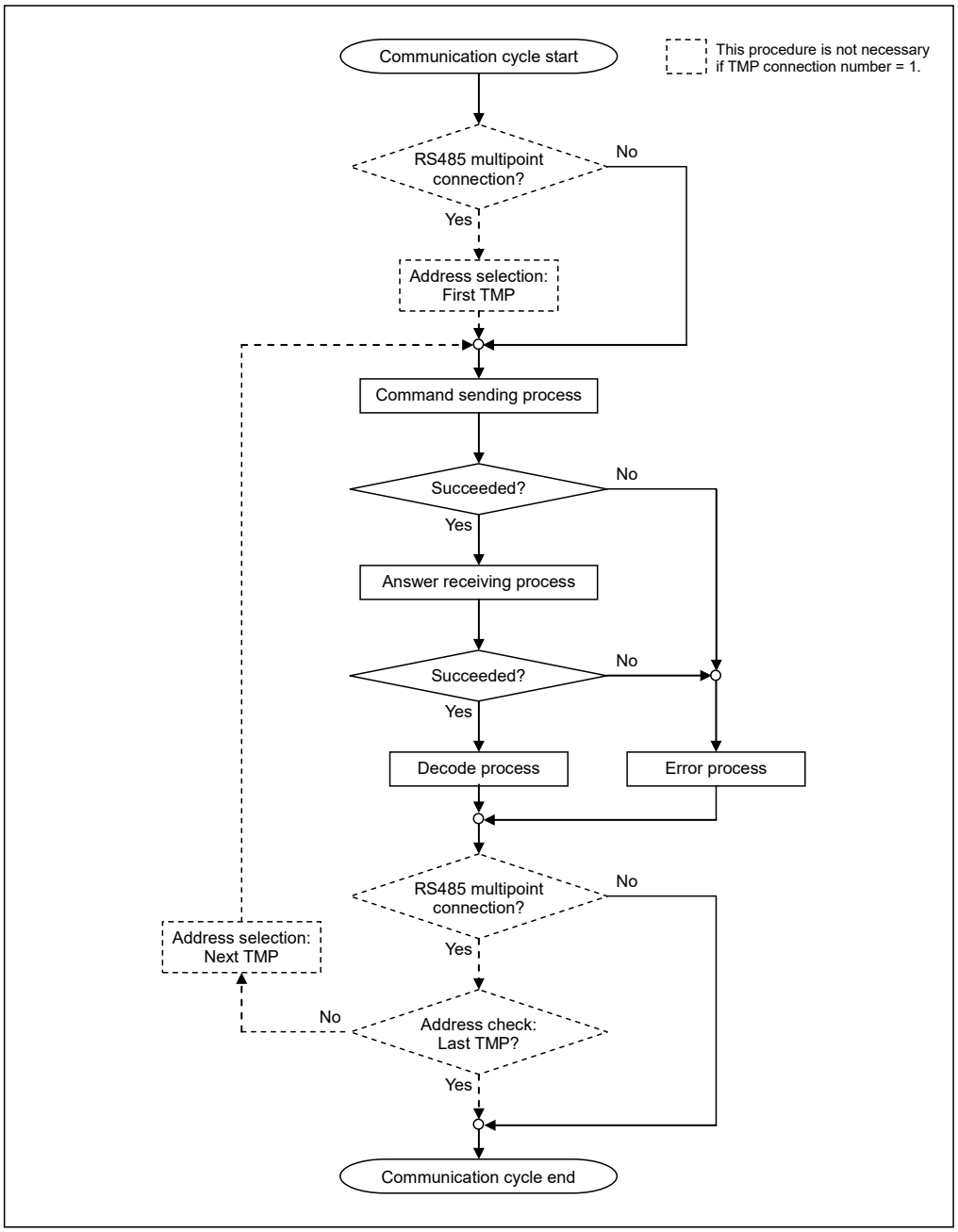


Figure 44 - Example of the communication cycle process

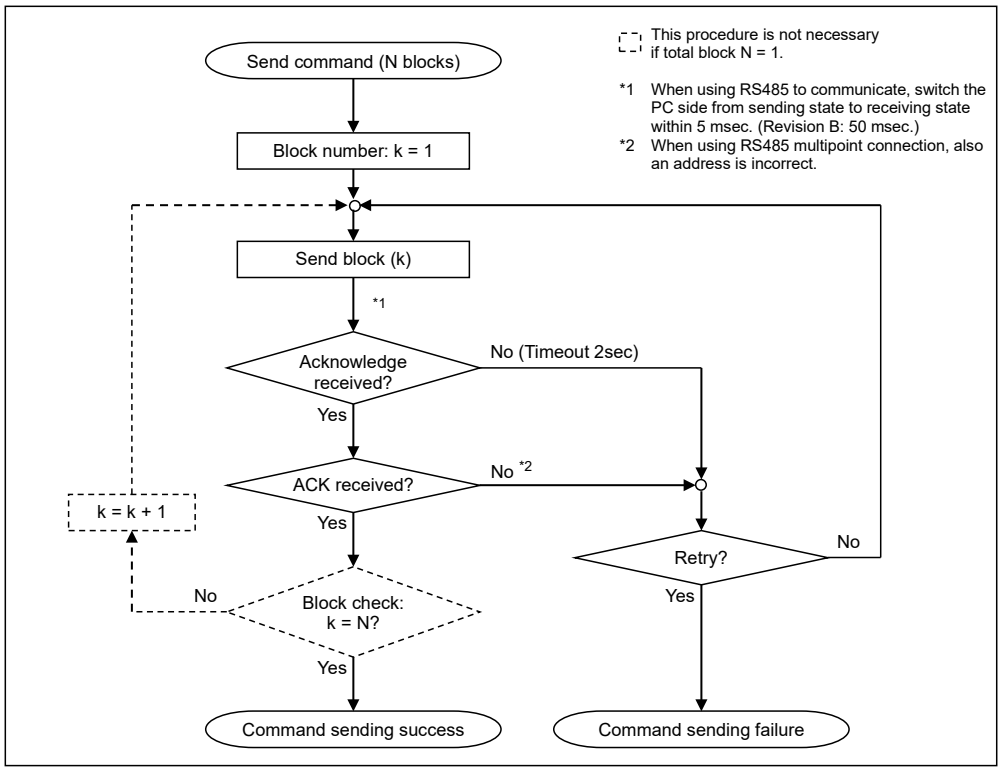


Figure 45 - Example of the command sending process

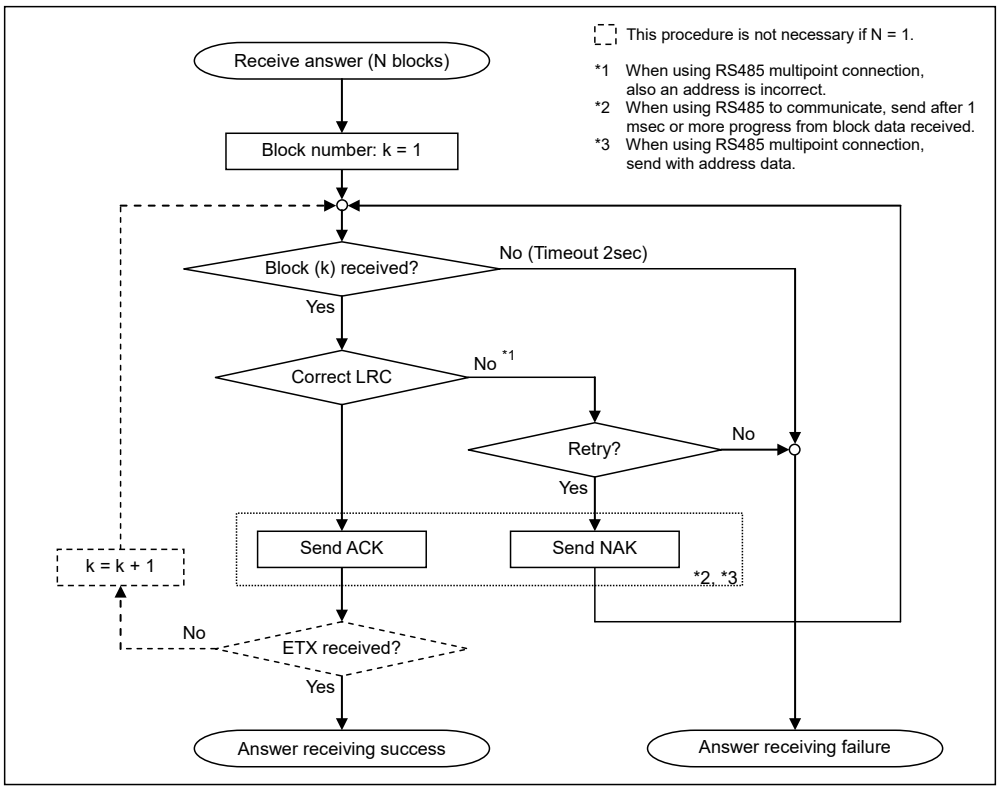


Figure 46 - Example of the answer receiving process

5.4 Command specifications

5.4.1 Command list

Function code		Command/Query Name	Function
?	D	ReadMeas	Reading the measured rotational speed
Sp	E	Command	Sending commands of START, STOP, RESET (These commands are valid only when it is sent to the serial port set as the input operation port.)
?	F	ReadFailMess	Reading the errors being detected
?	M	ReadModFonct	Reading the pump operation mode and the errors being detected
?	V	ReadVersion	Reading the software version
?	c	ReadCounters	Reading serial number, running time, and number of launch times
?	d	ReadSetPoint	Reading the setting values of the speed set point and the TMS temperature
?	e	ReadMotorTemp	Reading the measured motor temperature
?	f	ReadStatus	Reading the various settings (Remote mode, TMS function, and emergency vent valve).
?	g	ReadEvents	Reading the error records
Sp	h	SetSpeedSetPoint	Changing the speed set point *1
?	h	ReadSpeedSetPoint	Reading the speed set point
?	m	ReadModFonctWithWarning	Reading the pump operation mode, the errors, and the warnings being detected
?	[	ReadMeasValue	Reading the TMS temperature, motor temperature, motor current, measured rotational speed, and control unit temperature
?	=	ReadOptionFunc	Reading each setting value of items
Sp	=	SetOptionFunc	Changing each setting value of items *1
?	{	ReadCondition	Reading pump model and damage point
?	}	ReadEventsWithTime	Reading the error record with detection time
Sp	0	SetOptions	Changing the optional function (Second speed option) *1
?	0	ReadOptions	Reading optional function (Second speed option, TMS temperature)

Table 22 - Command list

*1 There is an endurance limit of setting changes (no more than 24 times per day for about ten years). If this limit is exceeded, it not only may become impossible to change the setting but can also cause pump failure. Do not make setting changes in excess of this endurance limit.

5.4.2 ReadMeas

Function: Reading the measured rotational speed.

Transmission frame:

PC->SIM	Stx	0	0	1	?	D	Etx	LRC
SIM->PC								Ack

PC->SIM									Ack
SIM->PC	Stx	0	0	1	Sp	D	Parameter 1 to 2	Etx	LRC

Parameter	Item	Data format	Remarks
1	[System reservation]	56-bits hexadecimal coded ASCII	
2	Measured rotational speed (Unit: Hz)	16-bits hexadecimal coded ASCII	

Example:
Measured rotational speed: 0190_{hex} = 400 Hz = 24,000 rpm

Parameter	1													2			
ASCII	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	0	1	9	0
HEX															30	31	39	30

*1 System reservation

5.4.3 Command

Function: Sending commands of START, STOP, RESET; these commands are valid only when it is sent to the serial port set as the input operation port. Refer to Section 5.4.17, "SetOptionFunc" for the setting method of the input operation port.

Transmission frame:

PC->SIM	Stx	0	0	1	Sp	E	Parameter 1	Etx	LRC
SIM->PC									Ack

PC->SIM								Ack
SIM->PC	Stx	0	0	1	#	Etx	LRC	

Parameter	Item	Data format	Remark
1	Pump operation command	8-bits hexadecimal coded ASCII	Refer to Table 23

Pump operation command	Value
START	1
STOP	2
RESET	4

Table 23 - Pump operation commands

Example:
Pump operation command: RESET operation = 4 = 04_{hex}

Parameter	1	
ASCII	0	4
HEX	30	34

5.4.4 ReadFailMess

Function: Reading the errors being detected; this data is the same data as that of "ReadModFonct" parameter 2 to 82.

Transmission frame:

PC->SIM	Stx	0	0	1	?	F	Etx	LRC
SIM->PC								Ack

PC->SIM										Ack
SIM->PC	Stx	0	0	1	Sp	F	Parameter 1 to 81*1		Etx	LRC

Parameter	Item	Data format	Remarks
1	The number of errors	8-bits hexadecimal coded ASCII	Up to 80 errors *1
2 to 81 *1	Error 1	8-bits hexadecimal coded ASCII	*2
	…	…	
	Error 80 *1	8-bits hexadecimal coded ASCII	

*1 The maximum number of errors may differ depending upon the software version of the STP pump. It is recommended that an application be designed as variable-length data.

*2 The values corresponding to the error message are transmitted (refer to Table 24 and Table 25). The larger parameter number means the more recent errors. When the number of errors being detected is under the maximum number, the parameter value larger than the number of errors being detected is set to 0.

Example:

The number of errors: 02_{hex} = 2 errors
Error 1: $0D_{hex}$ = 13 = Disturbance Xh
Error 2: $0F_{hex}$ = 15 = Disturbance Xb
Error 3 to 80: 00_{hex} = No error detected

Parameter	1		2		3		4		5		6		7		8		9		10	
ASCII	0	2	0	D	0	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HEX	30	32	30	44	30	46	30	30	30	30	30	30	30	30	30	30	30	30	30	30

Parameter	11		12		13	
ASCII	0	0	0	0	0	0
HEX	30	30	30	30	30	30

[Omitted]

68		69		70		71		72		73	
0	0	0	0	0	0	0	0	0	0	0	0
30	30	30	30	30	30	30	30	30	30	30	30

Parameter	74		75		76		77		78		79		80		81	
ASCII	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HEX	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30

Error message	Value
[System reservation]	0
[System reservation]	1
TMS Higher Temp	2
[System reservation]	3
[System reservation]	4
Power Failure	5
Power Supply Fail	6
Overspeed 1	7
DRV Overvoltage	8
[System reservation]	9
CNT Overheat 1	10
DRV Overcurrent	11
DRV Overload	12
Disturbance X_H	13
Disturbance Y_H	14
Disturbance X_B	15
Disturbance Y_B	16
Disturbance Z	17
MOTOR Overheat	18
[System reservation]	19
CNT Overheat 2	20
[System reservation]	21
[System reservation]	22
[System reservation]	23
DRV Com. Failure	24
WARNING: 1st Damage Limit	25 *1
2nd Damage Limit	26
[System reservation]	27
Speed Pulse Lost	28
Overspeed 2	29
Overspeed 3	30
M_Temp Lost	31
TMS Lower Temp	32

Error message	Value
AMB Com. Failure	33
[System reservation]	34
TMS Sensor Lost	35
[System reservation]	36
[System reservation]	37
[System reservation]	38
[System reservation]	39
[System reservation]	40
[System reservation]	41
[System reservation]	42
WARNING: Imbalance X_H	43 *1
WARNING: Imbalance X_B	44 *1
WARNING: Imbalance Z	45 *1
[System reservation]	46
[System reservation]	47
[System reservation]	48
[System reservation]	49
Driver Failure	50
[System reservation]	51
[System reservation]	52
[System reservation]	53
[System reservation]	54
[System reservation]	55
[System reservation]	56
[System reservation]	57
[System reservation]	58
Acc Malfunction	59
[System reservation]	60
Record Failure	61
[System reservation]	62
[System reservation]	63
[System reservation]	64
[System reservation]	65

Table 24 - Error message values

Error message	Value
[System reservation]	64
[System reservation]	65
[System reservation]	66
[System reservation]	67
[System reservation]	68
[System reservation]	69
[System reservation]	70
[System reservation]	71
Aberrant Brake	72
Aberrant Accel	73
[System reservation]	74
[System reservation]	75
Inordinate Current	76
[System reservation]	77
Serial Com. Fail	78 *2
[System reservation]	79
[System reservation]	80
[System reservation]	81
[System reservation]	82
[System reservation]	83
[System reservation]	84
[System reservation]	85
[System reservation]	86
[System reservation]	87

Error message	Value
Overspeed 4	88
[System reservation]	89 *1
[System reservation]	90
WARNING: Pump Run Time Over	91 *1
WARNING: Pump Overload	92 *1
[System reservation]	93 *1
Other Warning 1 (C/U Restart)	94 *1
Other Warning 2 (FAN Warning)	95 *1
Other Warning 3 (RTMP Higher)	96
Other Warning 4 (RTMP Lost)	97
[System reservation]	98 *1
Other Warning 6 (FAN Lifetime Over)	99 *1
[System reservation]	100 *1
...	...
[System reservation]	111 *1
[System reservation]	112
Other Failure 1 (RTMP Overheat)	113
Other Failure 2 (AMB Ctrl Lost)	114
[System reservation]	115
[System reservation]	116
...	...
[System reservation]	127

Table 25 - Error message values (continued)

*1 CAUTION or WARNING message. It is not a state of failure. Refer to Section 7 for details. The STP pump will continue to operate after one of these messages is displayed. It is recommended that an application be designed with this in consideration.

*2 When the setting value of serial communication timeout is 0, the error 78 is disabled (not detected).

5.4.5 ReadModFonct

Function: Reading the pump operation mode and the errors being detected; the data of errors being detected reads the same data as that of "ReadFailMess".

Transmission frame:

PC->SIM	Stx	0	0	1	?	M	Etx	LRC
SIM->PC								Ack

PC->SIM									Ack
SIM->PC	Stx	0	0	1	Sp	M	Parameter 1 to 82*1	Etx	LRC

Parameter	Item	Data format	Remarks
1	Pump operation mode	8-bits hexadecimal coded ASCII	Refer to Table 26
2	The number of errors	8-bits hexadecimal coded ASCII	Up to 80 errors *1
3 to 82*1	Error 1	8-bits hexadecimal coded ASCII	*2
	…	…	
	Error 80*1	8-bits hexadecimal coded ASCII	

*1 The maximum number of errors may differ depending upon the software version of the STP pump. It is recommended that an application be designed as variable-length data.

*2 The values corresponding to the error message are transmitted (refer to Table 24 and Table 25). The larger parameter number means the more recent errors. When the number of errors being detected is under the maximum number, the parameter value larger than the number of errors being detected is set to 0.

Pump operation mode	Value
Levitation	1
No Levitation	2
Acceleration	3
Normal	4
Deceleration (Brake)	5
Autotest	6
Tuning	7
Tuning Complete	8
[System Reservation]	9, 10, 11

Table 26 - Pump operation mode

Example:

Pump operation mode: 01_{hex} = 1 = Levitation
The number of errors: 02_{hex} = 2 errors
Error 1: $0D_{hex}$ = 13 = Disturbance Xh
Error 2: $0F_{hex}$ = 15 = Disturbance Xb
Error 3 to 80: 00_{hex} = No error detected

Parameter	1		2		3		4		5		6		7		8		9		10		11	
ASCII	0	1	0	2	0	D	0	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HEX	30	31	30	32	30	44	30	46	30	30	30	30	30	30	30	30	30	30	30	30	30	30

Parameter	12		13	
ASCII	0	0	0	0
HEX	30	30	30	30

[Omitted]

68		69		70		71		72		73		74		75	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30

Parameter	76		77		78		79		80		81		82	
ASCII	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HEX	30	30	30	30	30	30	30	30	30	30	30	30	30	30

5.4.6 ReadVersion

Function: Reading the software version

Transmission frame:

PC->SIM	Stx	0	0	1	?	V	Etx	LRC
SIM->PC								Ack

PC->SIM									Ack
SIM->PC	Stx	0	0	1	Sp	V	Parameter 1 to 24	Etx	LRC

Parameter	Item	Data format	Remarks
1 to 16	Control unit software version	8-bits hexadecimal coded ASCII	
17 to 20	Motor driver software version	ASCII character	Ver.1.2 = 0120
21 to 24	AMB software version	ASCII character	Ver.3.4 = 0340

Example:
Control unit software version: $39315F4120312E302020202020202020_{hex}$ = 91_A 1.0
Motor driver software version: 0120_{hex} = 1.2
DSP software version: 0340_{hex} = 3.4

Parameter	1		2		3		4		5		6		7		8		9		10	
	"9"		"1"		"_"		"A"		" "		"1"		"."		"0"		" "		" "	
ASCII	3	9	3	1	5	F	4	1	2	0	3	1	2	E	3	0	2	0	2	0
HEX	33	39	33	31	35	46	35	34	32	30	33	31	32	45	33	30	32	30	32	30

Parameter	11		12		13		14		15		16		17	18	19	20	21	22	23	24
	" "		" "		" "		" "		" "		" "									
ASCII	2	0	2	0	2	0	2	0	2	0	2	0	0	1	2	0	0	3	4	0
HEX	32	30	32	30	32	30	32	30	32	30	32	30	30	31	32	30	30	33	34	30

5.4.7 ReadCounters

Function: Reading serial number, running time, and number of launch times

Transmission frame:

PC->SIM	Stx	0	0	1	?	c	Etx	LRC
SIM->PC								Ack

PC->SIM										Ack
SIM->PC	Stx	0	0	1	Sp	c	Parameter 1 to 23		Etx	LRC

Parameter	Item	Data format	Remarks
1 to 10	Control unit serial number	ASCII character	
11 to 20	Pump serial number	ASCII character	
21	Pump running time (Unit: minute)	32-bits hexadecimal coded ASCII	
22	Control unit running time (Unit: minute)	32-bits hexadecimal coded ASCII	
23	Start counter	32-bits hexadecimal coded ASCII	

Example:

Control unit serial number: 12345
Pump serial number: 6789A
Pump running time: 000003C$_{hex}$ = 60 minutes = 1 hour
Control unit running time: 0000028C$_{hex}$ = 652 minutes =10 hours and 52 minutes
Start counter: 00000064$_{hex}$ = 100 times

Parameter	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
ASCII	1	2	3	4	5						6	7	8	9	A					
HEX	31	32	33	34	35	20	20	20	20	20	36	37	38	39	41	20	20	20	20	20

Parameter	21								22								23							
ASCII	0	0	0	0	0	0	3	C	0	0	0	0	0	2	8	C	0	0	0	0	0	0	6	4
HEX	30	30	30	30	30	30	33	43	30	30	30	30	30	32	38	43	30	30	30	30	30	30	36	34

5.4.8 ReadSetPoint

Function: Reading the setting values of the speed set point and the TMS temperature; the "Speed Set Point" data is the same data as that of "ReadSpeedSetPoint".

Transmission frame:

PC->SIM	Stx	0	0	1	?	d	Etx	LRC
SIM->PC								Ack

PC->SIM									Ack
SIM->PC	Stx	0	0	1	Sp	d	Parameter 1 to 2	Etx	LRC

Parameter	Item	Data format	Remarks
1	Speed Set Point (Unit: Hz)	16-bits hexadecimal coded ASCII	
2*1	TMS temperature setting (Unit: ºC)	16-bits hexadecimal coded ASCII	

*1 Valid only with TMS specification

Example:
Speed Set Point: 0190_{hex} = 400 Hz = 24,000 rpm
TMS temperature setting: 0046_{hex} = 70 ºC (158°F)

Parameter	1				2			
ASCII	0	1	9	0	0	0	4	6
HEX	30	31	39	30	30	30	34	36

5.4.9 ReadMotorTemp

Function: Reading the measured motor temperature

Transmission frame:

PC->SIM	Stx	0	0	1	?	e	Etx	LRC
SIM->PC								Ack

PC->SIM									Ack
SIM->PC	Stx	0	0	1	Sp	e	Parameter 1	Etx	LRC

Parameter	Item	Data format	Remark
1	Motor temperature (Unit: ºC)	16-bits hexadecimal coded ASCII	

Example:
Motor temperature: 0014hex = 20 ºC (68 ºF)

Parameter	1			
ASCII	0	0	1	4
HEX	30	30	31	34

5.4.10 ReadStatus

Function: Reading various settings; Remote mode, TMS function

Transmission frame:

PC->SIM	Stx	0	0	1	?	f	Etx	LRC
SIM->PC								Ack

PC->SIM										Ack
SIM->PC	Stx	0	0	1	Sp	f	Parameter 1 to 3		Etx	LRC

Parameter	Item	Data format	Remarks
1	Remote mode setting	8-bits hexadecimal coded ASCII	Refer to Table 27
2[*1]	TMS function setting	8-bits hexadecimal coded ASCII	00_{hex}: ENABLE Excluding 00_{hex}: DISABLE
3	[System reservation]	16-bits hexadecimal coded ASCII	

*1 Valid only with TMS specification. When it is not TMS specification, do not set it to "ENABLE".

Remote mode	Value
I/ O Remote (X4)	1
COM1 (EtherCAT®)	2
COM2 (X2)	5
COM3 (X5 STP-LINK)	6
[System reservation]	3, 4

Table 27 - Remote mode

Example:
Remote mode setting: 01_{hex} = I/O Remote
TMS function setting: 00_{hex} = ENABLE

Parameter	1		2		3			
ASCII	0	1	0	0	*1	*1	*1	*1
HEX	30	31	30	30				

*1 System reservation

5.4.11 ReadEvents

Function: Reading the "Error Record"; it gets the most recent 10 errors that have been detected.

Transmission frame:

PC->SIM	Stx	0	0	1	?	g	Etx	LRC
SIM->PC								Ack

PC->SIM									Ack
SIM->PC	Stx	0	0	1	Sp	g	Parameter 1 to 11	Etx	LRC

Parameter	Item	Data format	Remarks
1	The number of "Error Record"	8-bits hexadecimal coded ASCII	Up to 10 errors
2 to 11	Error Record 1 to Error Record 10	8-bits hexadecimal coded ASCII	*1

*1 The values corresponding to the error message are transmitted (refer to Table 24 and Table 25). The larger parameter number means the more recent errors. When the number of errors being detected is under the maximum number, the parameter value larger than the number of errors being detected is set to 0.

Example:
When 3 errors have been detected in the past;

The number of "Error Record": 03_{hex} = 3 errors
Error Record 1: $0F_{hex}$ = 15 = Disturbance Xb
Error Record 2: $0D_{hex}$ = 13 = Disturbance Xh
Error Record 3: 12_{hex} = 18 = T.Cable Disconnected
Error Record 4 to 10: 00_{hex} = No error recorded

Parameter	1		2		3		4		5		6		7		8		9		10		11	
ASCII	0	3	0	F	0	D	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HEX	30	33	30	46	30	44	31	32	30	30	30	30	30	30	30	30	30	30	30	30	30	30

5.4.12 SetSpeedSetPoint

Function: Changing the "Speed Set Point" value; this value can be changed from 12,120 to 24,240 rpm (202 to 404Hz). The threshold value of the illumination pattern of the "STATUS" LED is fixed. It is not changed even if the setting value of the rotational speed is changed.

CAUTION
There is an endurance limit of setting changes (no more than 24 times per day for about ten years). If this limit is exceeded, it not only may become impossible to change the setting but can also cause pump failure. Do not make setting changes in excess of this endurance limit.

Transmission frame:

PC->SIM	Stx	0	0	1	Sp	h	Parameter 1	Etx	LRC	
SIM->PC										Ack

PC->SIM							Ack
SIM->PC	Stx	0	0	1	#	Etx	LRC

Parameter	Items	Data format	Remark
1	Speed Set Point (Unit: Hz)	16-bits hexadecimal coded ASCII	*1

*1 When the value set to the parameter is larger than the upper limit, it is automatically set to the upper limit. When the value set to the parameter is smaller than the lower limit, it is automatically set to the lower limit.

Example:
Speed Set Point: 0190_{hex} = 400 Hz = 24,000 rpm

Parameter	1			
ASCII	0	1	9	0
HEX	30	31	39	30

5.4.13 ReadSpeedSetPoint

Function: Reading the "Speed Set Point" value; this value is the same as "ReadSetPoint" parameter 1 (Speed Set Point).

Transmission frame:

PC->SIM	Stx	0	0	1	?	h	Etx	LRC
SIM->PC								Ack

PC->SIM									Ack
SIM->PC	Stx	0	0	1	Sp	h	Parameter 1	Etx	LRC

Parameter	Item	Data format	Remark
1	Speed Set Point (Unit: Hz)	16-bits hexadecimal coded ASCII	

Example:
Speed Set Point: $012C_{hex}$ = 300 Hz = 18,000 rpm

Parameter	1			
ASCII	0	1	2	C
HEX	30	31	32	43

5.4.14 ReadModFonctWithWarning

Function: Reading the pump operation mode, errors and warnings being detected.

Transmission Frame:

PC→SIM	Stx	0	0	1	?	m	Etx	LRC
SIM→PC								Ack

PC→SIM									Ack
SIM→PC	Stx	0	0	1	Sp	m	Parameter 1 to 82*1	Etx	LRC

Parameter	Item	Data format	Remark
1	Pump operation mode	8-bits hexadecimal coded ASCII	See Table 25
2	WARNING being detected	16-bits hexadecimal coded ASCII	See Table 28
3	The number of errors detected	8-bits hexadecimal coded ASCII	Up to 80 errors *1
4 to 83 *1	Error 1	8-bits hexadecimal coded ASCII	*2
	…		
	Error 80 *1	8-bits hexadecimal coded ASCII	

*1 The maximum number of errors may differ depending upon the software version of the STP pump. It is recommended that an application be designed as variable-length data.

*2 The values corresponding to the error message are transmitted (refer to Table 24 and Table 25). The larger parameter number means the more recent errors. When the number of errors being detected is under the maximum number, the parameter value larger than the number of errors being detected is set to 0.

Bit	Warning message	16-bits hex value
0	[System reservation]	0001
1	WARNING: Second Damage Limit	0002
2	WARNING: First Damage Limit	0004
3	WARNING: Imbalance X_H	0008
4	WARNING: Imbalance X_B	0010
5	WARNING: Imbalance Z	0020
6	WARNING: Pump Run Time Over	0040
7	WARNING: Pump Overload	0080
8	[System reservation]	0100
9	[System reservation]	0200
10	[System reservation]	0400
11	[System reservation]	0800
12	[System reservation]	1000
13	[System reservation]	2000
14	WARNING: Other Warning *1	4000
15	[System reservation]	8000
*1 FAN Warning, C/U Restart, FAN Lifetime Over, RTMP Higher or RTMP Lost.		

Table 28 - Warning value bit assign

Example:

Pump operation mode: 01_{hex} = 1 = Levitation

WARNING being detected: $000C_{hex}$ = 0004_{hex} OR 0080_{hex} =
"WARNING: First Damage Limit" and "WARNING: Imbalance X_H"

The number of errors: 02_{hex} = 2 errors

Error 1: $0D_{hex}$ = 13 = Disturbance Xh

Error 2: $0F_{hex}$ = 15 = Disturbance Xb

Error 3 to 79: 00_{hex} = No error detected

Parameter	1		2				3		4		5		6		7		8		9		10	
ASCII	0	1	0	0	0	C	0	2	0	D	0	F	0	0	0	0	0	0	0	0	0	0
HEX	30	31	30	30	30	43	30	32	30	44	30	46	30	30	30	30	30	30	30	30	30	30

Parameter	11		12		13		14		15	
ASCII	0	0	0	0	0	0	0	0	0	0
HEX	30	30	30	30	30	30	30	30	30	30

[Omitted]

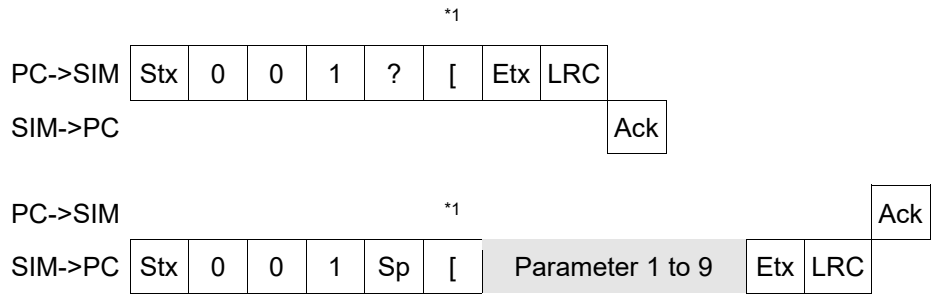
70		71		72		73		74	
0	0	0	0	0	0	0	0	0	0
30	30	30	30	30	30	30	30	30	30

Parameter	75		76		77		78		79		80		81		82	
ASCII	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HEX	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30

5.4.15 ReadMeasValue

Function: Reading the TMS temperature, motor temperature, motor current, measured rotational speed, and control unit temperature; the motor temperature value is the same temperature as "ReadMotorTemp", and the measured rotational speed value is the same as "ReadMeas" parameter 2 (Measured rotational speed).

Transmission frame:



*1 The HEX code of ASCII character '[' is "5B".

Parameter	Item	Data format	Remark
1	[System reservation]	120-bits hexadecimal coded ASCII	
2*1	TMS temperature (Unit ºC)	16-bits hexadecimal coded ASCII	
3	Motor temperature (Unit ºC)	16-bits hexadecimal coded ASCII	
4	[System reservation]	8-bits hexadecimal coded ASCII	
5	Motor current (Unit: 0.1 A)	8-bits hexadecimal coded ASCII	
6	[System reservation]	24-bits hexadecimal coded ASCII	
7	Measured rotational speed (Unit: Hz)	16-bits hexadecimal coded ASCII	
8	[System reservation]	48-bits hexadecimal coded ASCII	
9	Control unit temperature (Unit: °C)	16-bits hexadecimal coded ASCII	

*1 Valid only with TMS specification

Example:

TMS temperature: 0046_{hex} = 70 ºC (158ºF)

Motor temperature: 0014_{hex} = 20 ºC (68ºF)

Motor current: 19_{hex} = 2.5A

Measured rotational speed: $017C_{hex}$ = 380 Hz = 22,800 rpm

Control unit temperature: 0032_{hex} = 50 °C

Parameter	1																	
ASCII	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1
HEX																		

Parameter	1												2			
ASCII	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	0	0	4	6
HEX													30	30	34	36

Parameter	3				4		5		6						7			
ASCII	0	0	1	4	*1	*1	1	9	*1	*1	*1	*1	*1	*1	0	1	7	C
HEX	30	30	31	34			31	39							30	31	37	43

Parameter	8												9			
ASCII	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	0	0	3	2
HEX													30	30	33	32

*1 System reservation

5.4.16 ReadOptionFunc

Function: Reading the setting value of the input operation port, TMS option, warning function, serial communication time out, and PROG OUT/PROG IN.

Transmission frame:

					*1				
PC→SIM	Stx	0	0	1	?	=	Etx	LRC	
SIM→PC									Ack

					*1				Ack
PC→SIM									
SIM→PC	Stx	0	0	1	Sp	=	Parameter 1 to 15	Etx	LRC

*1 The HEX code of ASCII character ' = ' is "3D".

Parameter	Item	Data format	Remarks
1	Input operation port setting	8-bits hexadecimal coded ASCII	
2*1	TMS Option Enable/Disable setting	8-bits hexadecimal coded ASCII	
3	[System reservation]	48-bits hexadecimal coded ASCII	
4	Second Damage Limit Option Enable/Disable setting	8-bits hexadecimal coded ASCII	
5	First Damage Limit Warning Enable/Disable setting	8-bits hexadecimal coded ASCII	
6	Pump Runtime Over Warning Enable/Disable setting	8-bits hexadecimal coded ASCII	
7	Pump Runtime Over Warning Hours setting (×100 hours)	32-bits hexadecimal coded ASCII	
8	Imbalance Warning Enable/Disable setting	8-bits hexadecimal coded ASCII	
9	Pump Overload Warning Enable/Disable setting	8-bits hexadecimal coded ASCII	
10	Pump Overload Warning Motor current setting	16-bits hexadecimal coded ASCII	0.1 % step
11	Pump Overload Warning Rotational speed setting	16-bits hexadecimal coded ASCII	0.1 % step

*1 Valid only with TMS specification

Parameter	Item	Data format	Remarks
12	Serial communication time out setting (Unit: sec.)	16-bits hexadecimal coded ASCII	60 sec. step
13	PROG OUT pin setting	8-bits hexadecimal coded ASCII	
14	PROG IN pin setting	8-bits hexadecimal coded ASCII	
15	[System reservation]	72-bits hexadecimal coded ASCII	

Parameter	Item	Setting range
1	Input operation port setting	I/O REMOTE (X4): 01_{hex} COM1 (EtherCAT®): 02_{hex} COM2 (X2): 05_{hex} STP-LINK (X5 STP-LINK): 06_{hex}
2*1	TMS Option Enable/Disable setting	00_{hex}: ENABLE FF_{hex} :DISABLE
4	Second Damage Limit Option Enable/Disable setting	00_{hex}: ENABLE FF_{hex} :DISABLE
5	First Damage Limit Warning Enable/Disable setting	00_{hex}: ENABLE FF_{hex} :DISABLE
6	Pump Runtime Over Warning Enable/Disable setting	00_{hex}: ENABLE FF_{hex} :DISABLE
7	Pump Runtime Over Warning Hours setting	0 to 1,000×100 hours (00000000_{hex} to $000003E8_{hex}$)
8	Imbalance Warning Enable/Disable setting	00_{hex}: ENABLE FF_{hex} :DISABLE
9	Pump Overload Warning Enable/Disable setting	00_{hex}: ENABLE FF_{hex} :DISABLE
10	Pump Overload Warning Motor current setting	0 to 1,000×0.1 % (0000_{hex} to $03E8_{hex}$)
11	Pump Overload Warning Rotational speed setting	0 to 1,000×0.1 % (0000_{hex} to $03E8_{hex}$)
12	Serial communication time out setting	0 to 30,000sec. (0000_{hex} to 7530_{hex}) Round down to the 60 seconds Set to 0 to disable function

*1 Valid only with TMS specification

Parameter	Item	Setting range
13	PROG OUT pin setting	Type A (ROTATION): 01_{hex} Type B (ACCELERATION): 02_{hex} Type C (BRAKE): 03_{hex} Type D (FAIL N.O.): 04_{hex} Type E (WARNING): 05_{hex} Type F (not ROTATION): 06_{hex} Type G (ACCEL./BRAKE): 07_{hex}
14	PROG IN pin setting	Type A (RESET): 01_{hex} Type B (RESET/2nd SPEED EN): 02_{hex}

Table 29 - Parameter setting value

Example:

1. Input operation port: 01_{hex} = I/O Remote (X4)
2. TMS Option: FF_{hex} = DISABLE
4. Second Damage Limit Option: 00_{hex} = ENABLE
5. First Damage Limit Warning: 00_{hex} = ENABLE
6. Pump Runtime Over Warning: FF_{hex} = DISABLE
7. Pump Runtime Over Warning hours: $000003E8_{hex}$ = 1,000 (×100 hours)
8. Imbalance Warning: 00_{hex} = ENABLE
9. Pump Overload Warning: FF_{hex} = DISABLE
10. Pump Overload Warning Motor current: $03E8_{hex}$ = 1,000 (×0.1%)
11. Pump Overload Warning Rotational speed: 0000_{hex} = 0 (×0.1%)
12. Serial communication time out: $003C_{hex}$ = 60 sec.
13. PROG OUT pin: 05_{hex} = WARNING
14. PROG IN pin: 02_{hex} = RESET/2nd SPEED EN

Parameter	1		2		3												4		5	
ASCII	0	1	F	F	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	0	0	0	0
HEX	30	31	46	46													30	30	30	30

Parameter	6		7								8	
ASCII	F	F	0	0	0	0	0	3	E	8	0	0
HEX	46	46	30	30	30	30	30	33	45	38	30	30

Parameter	9		10				11				12				13		14	
ASCII	F	F	0	3	E	8	0	0	0	0	0	0	3	C	0	5	0	2
HEX	46	46	30	33	45	38	30	30	30	30	30	30	33	43	30	35	30	32

Parameter	15																	
ASCII	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1
HEX																		

*1 System reservation.

5.4.17 SetOptionFunc

Function: Changing the setting value of the input operation port, TMS option, warning function, serial communication time out, and PROG OUT/PROG IN.

CAUTION
There is an endurance limit of setting changes (no more than 24 times per day for about ten years). If this limit is exceeded, it not only may become impossible to change the setting but can also cause pump failure. Do not make setting changes in excess of this endurance limit.

Transmission frame:

						*1			
PC->SIM	Stx	0	0	1	Sp	=	Parameter 1 to 15	Etx	LRC
SIM->PC									Ack

PC->SIM								Ack
SIM->PC	Stx	0	0	1	#	Etx	LRC	

*1 The HEX code of ASCII character ' = ' is "3D".

Parameter	Item	Data format	Remarks
1*1	Input operation port setting	8-bits hexadecimal coded ASCII	Default 01_{hex} (I/O Remote)
			Default 02_{hex} (EtherCAT®)
2*2	TMS Option Enable/Disable setting	8-bits hexadecimal coded ASCII	Default FF_{hex} (DISABLE)
3	[System reservation]	48-bits hexadecimal coded ASCII	*3
4	Second Damage Limit Option Enable/Disable setting	8-bits hexadecimal coded ASCII	Default 00_{hex} (ENABLE)
5	First Damage Limit Warning Enable/Disable setting	8-bits hexadecimal coded ASCII	Default 00_{hex} (ENABLE)
6	Pump Runtime Over Warning Enable/Disable setting	8-bits hexadecimal coded ASCII	Default FF_{hex} (DISABLE)
7	Pump Runtime Over Warning Hours setting (×100 hours)	32-bits hexadecimal coded ASCII	Default 00000000_{hex}
8	Imbalance Warning Enable/Disable setting	8-bits hexadecimal coded ASCII	Default 00_{hex} (ENABLE)
9	Pump Overload Warning Enable/Disable setting	8-bits hexadecimal coded ASCII	Default FF_{hex} (DISABLE)

Parameter	Item	Data format	Remarks
10	Pump Overload Warning Motor current setting	16-bits hexadecimal coded ASCII	Default $03E8_{hex}$ (100.0%)
11	Pump Overload Warning Rotational speed setting	16-bits hexadecimal coded ASCII	Default 0000_{hex} (0.0%)
12	Serial communication time out setting (Unit: sec.)	16-bits hexadecimal coded ASCII	Default $003C_{hex}$ (60 sec.)
13	PROG OUT pin setting	8-bits hexadecimal coded ASCII	Default 05_{hex} (WARNING)
14	PROG IN pin setting	8-bits hexadecimal coded ASCII	Default 02_{hex} (RESET/2nd SPEED EN)
15	[System reservation]	72-bits hexadecimal coded ASCII	*4

*1 The default value depends on the communication interface mounted on the STP pump ordered.

*2 Valid only with TMS specification.

*3 Assign the parameter value the reading data of ReadOptionFunc (?=) or $FFFF32003CFF_{hex}$.

*4 Assign the parameter value the reading data of ReadOptionFunc (?=) or F_{hex}.

Refer to Table 29 for each parameter set value.
The value is not reflected when a parameter is out of a set range.

Example:

1. Input operation port: 01_{hex} = I/O Remote (X4)
2. TMS Option: FF_{hex} = DISABLE
4. Second Damage Limit Option: 00_{hex} = ENABLE
5. First Damage Limit Warning: 00_{hex} = ENABLE
6. Pump Runtime Over Warning: FF_{hex} = DISABLE
7. Pump Runtime Over Warning hours: $000003E8_{hex}$ = 1,000 (×100 hours)
8. Imbalance Warning: 00_{hex} = ENABLE
9. Pump Overload Warning: FF_{hex} = DISABLE
10. Pump Overload Warning Motor current: $03E8_{hex}$ = 1,000 (×0.1%)
11. Pump Overload Warning Rotational speed: 0000_{hex} = 0 (×0.1%)
12. Serial communication time out: $003C_{hex}$ = 60 sec.
13. PROG OUT pin: 05_{hex} = WARNING
14. PROG IN pin: 02_{hex} = RESET/2nd SPEED EN

Parameter	1		2		3											4		5	
ASCII	0	1	F	F	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	0	0	0	0
HEX	30	31	46	46												30	30	30	30

Parameter	6		7								8	
ASCII	F	F	0	0	0	0	0	3	E	8	0	0
HEX	46	46	30	30	30	30	30	33	45	38	30	30

Parameter	9		10				11				12				13		14	
ASCII	F	F	0	3	E	8	0	0	0	0	0	0	3	C	0	5	0	2
HEX	46	46	30	33	45	38	30	30	30	30	30	30	33	43	30	35	30	32

Parameter	15																	
ASCII	*2	*2	*2	*2	*2	*2	*2	*2	*2	*2	*2	*2	*2	*2	*2	*2	*2	*2
HEX																		

*1 Assign the parameter value the reading data of ReadOptionFunc (?=) or $FFFF32003CFF_{hex}$.

*2 Assign the parameter value the reading data of ReadOptionFunc (?=) or F_{hex}.

5.4.18 ReadCondition

Function: Reading the pump model and damage point.

Transmission frame:

*1

PC→SIM	Stx	0	0	1	?	{	Etx	LRC	
SIM→PC									Ack

PC→SIM						*1				Ack
SIM→PC	Stx	0	0	1	Sp	{	Parameter 1 to 4	Etx	LRC	

*1 The HEX code of ASCII character ' { ' is "7B".

Parameter	Item	Data format	Remarks
1	Pump model	160-bits hexadecimal coded ASCII	
2	[System reservation]	32-bits hexadecimal coded ASCII	
3	Damage point	16-bits hexadecimal coded ASCII	
4	[System reservation]	64-bits hexadecimal coded ASCII	

Example:

1. Pump model: 5354502D6958413435303720202020202020202020$_{hex}$
   = STP-iXA4507
3. Damage point: 32$_{hex}$ = 50

Parameter	1																			
	"S"		"T"		"P"		"–"		"i"		"X"		"A"		"4"		"5"		"0"	
ASCII	5	3	5	4	5	0	2	D	6	9	5	8	4	1	3	4	3	5	3	0
HEX	35	33	35	34	35	30	32	44	36	39	35	38	34	31	33	34	33	35	33	30

Parameter	1																			
	"7"		" "		" "		" "		" "		" "		" "		" "		" "		" "	
ASCII	3	7	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0
HEX	35	34	32	30	32	30	32	30	32	30	32	30	32	30	32	30	32	30	32	30

Parameter	2								3				4							
ASCII	*1	*1	*1	*1	*1	*1	*1	*1	0	0	3	2	*1	*1	*1	*1	*1	*1	*1	*1
HEX									30	30	33	32								

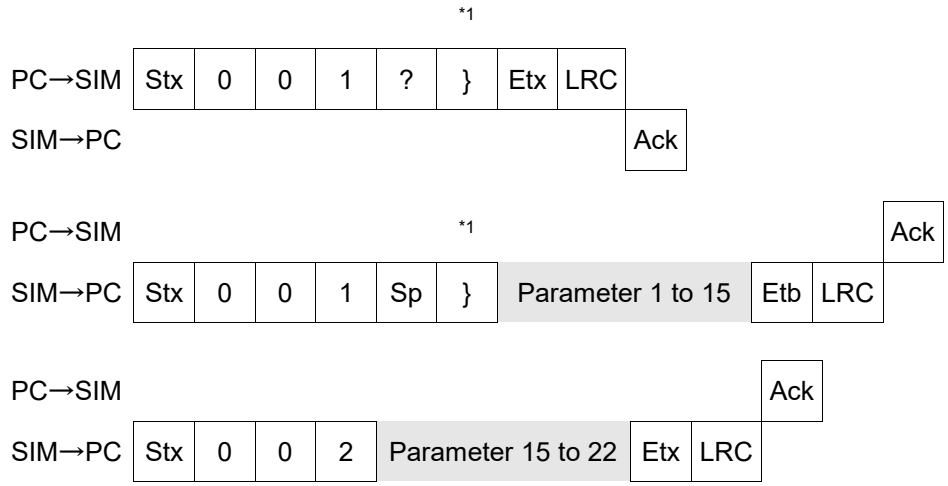
Parameter	4							
ASCII	*1	*1	*1	*1	*1	*1	*1	*1
HEX								

*1 System reservation

5.4.19 ReadEventsWithTime

Function: Reading the "Error Record" with detection time.

Transmission frame:



*1 The HEX code of ASCII character ' } ' is "7D".

Parameter	Item	Data format	Remarks
1	The number of "Error Record"	8-bits hexadecimal coded ASCII	
2	The maximum number of "Error Record"	8-bits hexadecimal coded ASCII	Up to 20 for STP-iXA4507
3 to 22	Error Record 1 to Error Record 20	80-bits hexadecimal coded ASCII (See "Error Record Format")	*1

*1 The recent error has the smallest parameter number.

Error record format:

The time information of error history has two formats that depend on the pump model.

- Total running time of the STP pump and control unit
- Real-time data by a built-in clock

Time information is identified with a time flag.

1. In the case of time flag = 0

Parameter	Item	Data format	Remarks
a	Error Code	8-bits hexadecimal coded ASCII	*1
b	Time flag	8-bits hexadecimal coded ASCII	
c	Pump running time	32-bits hexadecimal coded ASCII	Unit: minute
d	Control unit running time	32-bits hexadecimal coded ASCII	Unit: minute

*1 The values corresponding to the error message are transmitted (refer to Table 24, Table 25). When the number of detected errors is under the maximum number, the parameter value larger than the number of detected errors is set to FF_{hex}.

Example:
In the case of Disturbance X_H detection at
Pump running time = 5,000 minutes, control unit running time = 6,000 minutes

Parameter	a		b		c								d							
ASCII	0	D	0	0	0	0	0	0	1	3	8	8	0	0	0	0	1	7	7	0
HEX	30	44	30	30	30	30	30	30	31	33	38	38	30	30	30	30	31	37	37	30

2. In the case of time flag = 1

Parameter	Item	Data format	Remarks
a	Error Code	8-bits hexadecimal coded ASCII	*1
b	Time flag	8-bits hexadecimal coded ASCII	
c	Error detection time (Format : yymmddhhnn) yy: The last two digits of the year mm: Month dd: Day hh: Hour (24-hour display) nn: Minute	40-bits hexadecimal coded ASCII	*2
d	[System reservation]	24-bits hexadecimal coded ASCII	

*1 The values corresponding to the error are transmitted (refer to Table 24, Table 25). When the number of detected errors is under the maximum number, the parameter value larger than the number of detected errors is set to FF_{hex}.

*2 Each value of time is transmitted as BCD format character string.

Example:
In the case of Disturbance X_H detection on September 13, 2007, 12: 34

Parameter	a		b		c								d							
ASCII	0	D	0	1	0	7	0	9	1	3	1	2	3	4	*3	*3	*3	*3	*3	*3
HEX	30	44	30	31	30	37	30	39	31	33	31	32	33	34						

*3 System reservation

Example (in the case of time flag = 0):
When 3 errors have been detected in the past;

The number of "Error Record" :	03_{hex} = 3 errors
The maximum number of "Error Record" :	14_{hex} = 20 errors
Error Record 1 :	Error Code: $0F_{hex}$ = 15 = Disturbance Xb Time flag: 00_{hex} = Detection time is total running time Pump running time = 5,000 hrs = 300,000 minutes Control unit running time = 6,000 hrs = 360,000 minutes
Error Record 2 :	Error Code: $0D_{hex}$ = 13 = Disturbance Xh Time flag: 00_{hex} = Detection time is total running time Pump running time = 700 hrs = 42,000 minutes Control unit running time = 800 hrs = 48,000 minutes
Error Record 3 :	Error Code: 12_{hex} = 18 = MOTOR Overheat Time flag: 00_{hex} = Detection time is total running time Pump running time = 20 hrs = 1,200 minutes Control unit running time = 30 hrs = 1,800 minutes
Error Record 4 to 20 :	No error recorded

Parameter	1		2	
ASCII	0	3	1	4
HEX	30	33	31	34

Parameter	3a		3b		3c								3d					
ASCII	0	F	0	0	0	0	0	4	9	3	E	0	0	0	0	5	7	E	4	0
HEX	30	46	30	30	30	30	30	34	39	33	45	30	30	30	30	35	37	45	34	30

Parameter	4a		4b		4c								4d					
ASCII	0	D	0	0	0	0	0	0	A	4	1	0	0	0	0	0	B	B	8	0
HEX	30	44	30	30	30	30	30	30	41	34	31	30	30	30	30	30	42	42	38	30

Parameter	5a		5b		5c										5d					
ASCII	1	2	0	0	0	0	0	0	0	4	B	0	0	0	0	0	0	7	0	8
HEX	31	32	30	30	30	30	30	30	30	34	42	30	30	30	30	30	30	37	30	38

Parameter	6a		6b		6c										6d					
ASCII	F	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HEX	46	46	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30

Parameter	7a		7b				[Omitted]			21d						
ASCII	F	F	0	0				0	0	0	0	0	0	0	0	0
HEX	46	46	30	30				30	30	30	30	30	30	30	30	30

Parameter	22a		22b		22c										22d					
ASCII	F	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HEX	46	46	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30

Example (in the case of time flag = 1):
When 3 errors have been detected in the past;

The number of "Error Record" :	03_{hex} = 3 errors
The maximum number of "Error Record" :	14_{hex} = 20 errors
Error Record 1 :	Error Code: $0F_{hex}$ = 15 = Disturbance Xb
	Time flag: 01_{hex} = Detection time is built-in clock time
	Error detection time: 0709131234_{hex} = Sep. 13, 2007 at 12:34
Error Record 2 :	Error Code: $0D_{hex}$ = 13 = Disturbance Xh
	Time flag: 01_{hex} = Detection time is built-in clock time
	Error detection time: 0704300659_{hex} = Apr. 30, 2007 at 06:59
Error Record 3 :	Error Code: 12_{hex} = 18 = MOTOR Overheat
	Time flag: 01_{hex} = Detection time is built-in clock time
	Error detection time: 0612011508_{hex} = Dec. 1, 2006 at 15:08
Error Record 4 to 20 :	No error recorded

Parameter	1		2	
ASCII	0	3	1	4
HEX	30	33	31	34

Parameter	3a		3b		3c										3d					
ASCII	0	F	0	0	0	7	0	9	1	3	1	2	3	4	*1	*1	*1	*1	*1	*1
HEX	30	46	30	30	30	37	30	39	31	33	31	32	33	34						

Parameter	4a		4b		4c									4d					
ASCII	0	D	0	1	0	7	0	4	3	0	0	6	5	9	*1	*1	*1	*1	*1	*1
HEX	30	44	30	31	30	37	30	34	33	30	30	36	35	39						

Parameter	5a		5b		5c									5d					
ASCII	1	2	0	1	0	6	1	2	0	1	1	5	0	8	*1	*1	*1	*1	*1	*1
HEX	31	32	30	31	30	36	31	32	30	31	31	35	30	38						

Parameter	6a		6b		6c									6d					
ASCII	F	F	0	1	0	0	0	0	0	0	0	0	0	0	*1	*1	*1	*1	*1	*1
HEX	46	46	30	31	30	30	30	30	30	30	30	30	30	30						

Parameter	7a		7b			[Omitted]		21d					
ASCII	F	F	0	1				*1	*1	*1	*1	*1	*1
HEX	46	46	30	31									

Parameter	22a		22b		22c									22d					
ASCII	F	F	0	1	0	0	0	0	0	0	0	0	0	0	*1	*1	*1	*1	*1	*1
HEX	46	46	30	31	30	30	30	30	30	30	30	30	30	30						

*1 System reservation

5.4.20 SetOptions

Function: Changing the setting value of the optional function; the parameter n depends on the optional function.

Transmission frame:

PC->SIM	Stx	0	0	1	Sp	0	Parameter 1 to n	Etx	LRC
SIM->PC									Ack

PC->SIM							Ack
SIM->PC	Stx	0	0	1	#	Etx	LRC

Parameter	Item	Data format	Remark
1	Optional function number	16-bits hexadecimal coded ASCII	see Table 30
2 to n	Function item		

Optional function number	Value	Total parameter n	Remark
Second speed option setting	0014	3	see 5.4.20.1
Second speed selection	0015	2	see 5.4.20.2

Table 30 - Option function number and parameter list

5.4.20.1 Second speed function setting

Settings for second speed can be changed.

CAUTION

There is an endurance limit of setting changes (no more than 24 times per day for about ten years). If this limit is exceeded, it not only may become impossible to change the setting but can also cause pump failure. Do not make setting changes in excess of this endurance limit.

Parameter	Item	Data format	Remark
1	Optional function number	16-bits hexadecimal coded ASCII	0014_{hex}
2	Second speed setting (Unit: Hz)	16-bits hexadecimal coded ASCII	*1
3	Second speed option setting	16-bits hexadecimal coded ASCII	0000_{hex} : DISABLE $00FF_{hex}$: ENABLE

*1 This value can be changed from half of the rated rotational speed to the rated rotational speed. When the parameter value is larger than the rated rotational speed, it is automatically set to the rated rotational speed. When the parameter value is smaller than half of the rated rotational speed, it is automatically set to half of the rated rotational speed.

Example:

Second speed setting : $00E7_{hex}$ = 231 Hz = 13,860 rpm

Second speed option setting : 0000_{hex} = DISABLE

Parameter	1				2				3			
ASCII	0	0	1	4	0	0	E	7	0	0	0	0
HEX	30	30	31	34	30	30	45	37	30	30	30	30

5.4.20.2 Second speed selection

The normal or second rating speed setting can be selected as the NORMAL state.

Set the second speed option to the "ENABLE" when using this function.

Parameter	Item	Data format	Remark
1	Optional function number	16-bits hexadecimal coded ASCII	0015_{hex}
2	Second speed selection	16-bits hexadecimal coded ASCII	0000_{hex}: Normal rating speed setting 0001_{hex}: Second rating speed setting

Example:

Second speed selection : 0000_{hex} = Normal rating speed setting

Parameter	1				2			
ASCII	0	0	1	5	0	0	0	0
HEX	30	30	31	35	30	30	30	30

5.4.21 ReadOptions

Function: Reading the setting value of the optional function; the parameter n depends on the optional function.

Transmission frame:

PC->SIM	Stx	0	0	1	?	0	Parameter 1	Etx	LRC	
SIM->PC										Ack
PC→SIM										Ack
SIM→PC	Stx	0	0	1	Sp	0	Parameter 1 to n	Etx	LRC	

Parameter	Item	Data format	Remark
1	Optional function number (receive/return)	16-bits hexadecimal coded ASCII	see Table 31
2 to n	Function items (return)		

Optional function number	Value	Total response parameter n	Remark
Second speed option setting	0014	4	see 5.4.21.1
Second speed selection	0015	2	see 5.4.21.2
TMS temperature*1	001B	14	see 5.4.21.3

*1 Valid only with TMS specification

Table 31 - Option function number and parameter list

5.4.21.1 Second speed function setting

Settings for second speed can be changed.

Parameter	Item	Data format	Remark
1	Optional function number	16-bits hexadecimal coded ASCII	0014_{hex}
2	Second speed setting (Unit: Hz)	16-bits hexadecimal coded ASCII	
3	Second speed option setting	16-bits hexadecimal coded ASCII	0000_{hex}: DISABLE $00FF_{hex}$: ENABLE
4	Selected speed value (Unit: Hz)	16-bits hexadecimal coded ASCII	

Example:

Second speed setting : $00CA_{hex}$ = 202 Hz = 12,120 rpm

Second speed option setting : 0000_{hex} = DISABLE

Selected speed value : 0194_{hex} = 404 Hz = 24,240 rpm (Normal rating speed setting)

Parameter	1				2				3				4			
ASCII	0	0	1	4	0	0	C	A	0	0	0	0	0	1	9	4
HEX	30	30	31	34	30	30	43	41	30	30	30	30	30	31	39	34

5.4.21.2 Second speed selection

The speed setting set as rotational speed in the normal state can be read.

Parameter	Item	Data format	Remark
1	Option function number	16-bits hexadecimal coded ASCII	0015_{hex}
2	Second speed selection	16-bits hexadecimal coded ASCII	0000_{hex}: Normal rating speed setting 0001_{hex}: Second rating speed setting

Example:

Second speed selection: 0000_{hex} = Normal rating speed setting

Parameter	1				2			
ASCII	0	0	1	5	0	0	0	0
HEX	30	30	31	35	30	30	30	30

5.4.21.3 TMS temperature

Temperatures of input sensors and the heater/water valve output conditions of TMS can be read. And also, motor temperature and measured rotational speed can be read.

Note: Valid only with TMS specification

Parameter	Item	Data format	Remark
1	Option function number	16-bits hexadecimal coded ASCII	$001B_{hex}$
2	Measured temperature 1 (Unit: ºC)	8-bits hexadecimal coded ASCII	Value shows from -32 ºC (-26 ºF) to 223 ºC (433 ºF) DF_{hex} = +223 ºC (433 ºF) DE_{hex} = +222 ºC (432 ºF) : 01_{hex} = +1 ºC (34 ºF) 00_{hex} = +/-0 ºC (32 ºF) FF_{hex} = -1 ºC (30 ºF) : $E1_{hex}$ = -31 ºC (-24 ºF) $E0_{hex}$ = -32 ºC (-26 ºF)
3	Measured temperature 2 (Unit: ºC)	8-bits hexadecimal coded ASCII	
4	Measured temperature 3 (Unit: ºC)	8-bits hexadecimal coded ASCII	
5	Measured temperature 4 (Unit: ºC)	8-bits hexadecimal coded ASCII	
6	Output device 1 condition	8-bits hexadecimal coded ASCII	00_{hex} : Heater OFF/Valve Close Others : Heater ON/Valve Open
7	Output device 2 condition	8-bits hexadecimal coded ASCII	
8	Output device 3 condition	8-bits hexadecimal coded ASCII	
9	Output device 4 condition	8-bits hexadecimal coded ASCII	
10	Motor temperature (Unit: ºC)	16-bits hexadecimal coded ASCII	
11	[System reservation]	8-bits hexadecimal coded ASCII	
12	Motor current (Unit: 0.1 A)	8-bits hexadecimal coded ASCII	Value shows from 0.0 A to 25.5 A
13	[System reservation]	24-bits hexadecimal coded ASCII	
14	Measured rotational speed (Unit: Hz)	16-bits hexadecimal coded ASCII	

Example:

Measured temperature 1: $6E_{hex}$ = 110 ºC (230 ºF)
Measured temperature 2: $5F_{hex}$ = 95 ºC (203 ºF)
Measured temperature 3: $4C_{hex}$ = 76 ºC (169 ºF)
Measured temperature 4: 47_{hex} = 71 ºC (160 ºF)
Output device 1 condition: 01_{hex} = Heater ON/Water valve Open
Output device 2 condition: 01_{hex} = Heater ON/Water valve Open
Output device 3 condition: 00_{hex} = Heater OFF/Water valve Close
Output device 4 condition: 00_{hex} = Heater OFF/Water valve Close
Motor temperature: 0014_{hex} = 20 ºC (68 ºF)
Motor current: 19_{hex} = 2.5 A
Measured rotational speed: 0194_{hex} = 404 Hz (24,240 rpm)

Parameter	1				2		3		4		5		6	
ASCII	0	0	1	B	6	E	5	F	4	C	4	7	0	1
HEX	30	30	31	42	36	45	35	46	34	43	34	37	30	31

Parameter	7		8		9		10				11		12	
ASCII	0	1	0	0	0	0	0	0	1	4	*1	*1	1	9
HEX	30	30	30	30	30	30	30	30	31	34			31	39

Parameter	13						14			
ASCII	*1	*1	*1	*1	*1	*1	0	1	9	4
HEX							30	31	39	34

*1 System reservation

6 STP-LINK AND DISPLAY UNIT

The STP-Link (optional accessory) and the display unit iDT-002 (optional accessory) are available with the STP pump.

6.1 STP-Link

The "STP-Link" is a Windows application for operating the STP pump, confirming the pump status or setting various settings. Table 32 shows the principal functions.

See the help file of the "STP-Link" for the detailed specification and operating method.

Item	Functions
Operating function	Start, stop, and failure reset operation of STP pump
Confirmation function	Operational state of STP pump
	Software version
	Serial number
	STP pump model
	Operation hours
	Number of starts
	Bearing damage integrated value
	Error history
Option setting function	Remote operation mode setting
	Serial port setting
	Rotational speed setting
	TMS setting *1
	Warning function setting

*1 Valid only with TMS function

Table 32 - Functions of STP-Link

6.2 Display unit

The "display unit" operates the STP pump, confirms the pump status or sets various settings. The display unit iDT-002 is equipped with an LCD and flat panel switches.

See the "Display unit iDT-002" Instruction Manual for the detailed specification and operating methods.

7 SAFETY FUNCTIONS

The STP pump has safety functions for various abnormities/errors.
When abnormities/errors are detected, the "STATUS" LED flashes in red or orange (except during deceleration). If an abnormality/error is found when using the STP pump, check it and take measures in accordance with the following procedures. If there are no relevant trouble cases, or if the system does not work correctly even after the measures have been taken, see Section 8.5.

7.1 Safety functions

7.1.1 Power Failure

When the power voltage drops below 160 V due to a power failure, the rotation with the magnetic bearing is maintained using the regenerative energy of the rotor if the rotational speed is high. (backup operation during a power failure)

The lowest rotational speed to which the magnetic bearing can operate at a power failure is called a backup rotational speed.

1. When the rotational speed is about 5,000 rpm or more at a power failure:

   If the STP pump detects any power failure of 2 seconds or more, it decelerates. At this time, the "STATUS" LED flashes in red. In the case of the I/O Remote interface, a failure signal also simultaneously outputs from FAILURE OUT pins (14)-(33) and (15)-(33) of the "X4 REMOTE" connector.
   When the rotational speed goes down to about 5,000 rpm, the rotor lands on the touch down bearing and stops. Then "STATUS" LED is extinguished.
   If the STP pump does not detect a power failure of fewer than 2 seconds, the STP pump will continue to rotate.
   Moreover, the STP pump does not detect a power failure during decelerating.

2. When the rotational speed is less than about 5,000 rpm at a power failure:

   The STP pump does not detect the power failure. The rotor lands on the touch down bearing and stops.

Table 33 shows the states of LED output and the "X4 REMOTE" output signals at a power failure.

<table>
<tr><td rowspan="3">Rotational speed</td><td rowspan="3">Duration of power failure</td><td rowspan="3">STATUS LED</td><td colspan="2">REMOTE output signal (X4 REMOTE)</td></tr>
<tr><td colspan="2">ALARM</td></tr>
<tr><td>N.O.</td><td>N.C.</td></tr>
<tr><td rowspan="2">5,000 rpm or more</td><td>Approx. 2 sec. or longer</td><td>Flash in red</td><td>Close</td><td>Open</td></tr>
<tr><td>Shorter than approx. 2 sec.</td><td colspan="3">Continues as before</td></tr>
<tr><td>Less than 5,000 rpm</td><td></td><td>Extinguish</td><td>Open</td><td>Close</td></tr>
</table>

Table 33 - STATUS LED and X4 REMOTE output signals at power failure

7.1.2 Operation after a power recovery

1. The STP pump continues decelerating, and power failure detection is reset automatically.

   At this time, the "STATUS" LED will change from red flash to orange flash.
   In the case of the I/O Remote interface, a failure signal is also simultaneously reset on FAILURE OUT pins, (14)-(33) and (15)-(33) of the "X4 REMOTE" connector.

2. When the START signal is input after a power recovery, the STP pump reaccelerates even while it is in BRAKE state.

   However, the control unit may detect excessive vibration when power is recovered after the rotor lands on the touch down bearing (see 7.1.4). In this case, the STP pump once stops and cannot reaccelerate until the RESET operation is completed.

Note: It is recommended to make a sequential control system to supply the power to the STP pump immediately after a power recovery.

7.1.3 Abnormal state of magnetic bearing (Disturbance)

CAUTION
Check the STP pump when an abnormality or error occurs in the magnetic bearing. If "FAILURE" cannot be released after reset operation, contact our Service office.

When the magnetic bearing does not function normally due to a breakage of the STP connection cable, disconnection of connectors or any abnormality/error of the STP control circuit, the rotor lands on the touch down bearing and stops, and the "STATUS" LED flashes in red.

In the case of the I/O Remote interface, a failure signal also simultaneously outputs from the "X4 REMOTE" connector.

7.1.4 Excessive vibration (Disturbance)

The STP pump decelerates and stops when the rotor contacts with the touch down bearing for a certain period of time due to external vibration/impact, intrusion of the atmosphere, some contaminations into the STP pump, or rotor imbalance, and the "STATUS" LED flashes in red.

In the case of the I/O Remote interface, a failure signal also simultaneously outputs from the "X4 REMOTE" connector.

Note: When the rotor contacts the touch down bearing, contact noise and rotational noise of the touch down bearing are generated from the STP pump.

7.1.5 Motor driver overload (DRV Overload)

The STP pump decelerates and stops when the STP pump does not attain the rated speed within about 30 minutes after starting, or the ACCELERATION state remains during operation for about 30 minutes, and the "STATUS" LED flashes in red.

In the case of the I/O Remote interface, a failure signal also simultaneously outputs from the "X4 REMOTE" connector.

7.1.6 Overheating inside the STP pump (MOTOR Overheat)

The STP pump decelerates and stops when the motor's temperature inside the STP pump is overheated due to an overload, and the "STATUS" LED flashes in red.

In the case of the I/O Remote interface, a failure signal also simultaneously outputs from the "X4 REMOTE" connector.

7.1.7 Overheating inside the control unit (CNT Overheat)

The STP pump decelerates and stops when the temperature inside the control unit rises due to a lack of cooling water flow, high water temperature, an external heat source, or failure of an air-cooling fan, and the "STATUS" LED flashes in red.

In the case of the I/O Remote interface, a failure signal also simultaneously outputs from the "X4 REMOTE" connector.

7.1.8 Overspeed

When the rotational speed of the STP pump exceeds 25,680 rpm due to a failure in the motor driver, the STP pump changes into free-running and stops, and the "STATUS" LED flashes in red.

In the case of the I/O Remote interface, a failure signal also simultaneously outputs from the "X4 REMOTE" connector.

7.1.9 Abnormality/Error in the TMS unit (for use with the TMS unit)

The "STATUS" LED flashes in red if the temperature of the STP pump base unit is over 10 ºC (18 ºF) higher than the set value due to a TMS heater failure or other faults. And the heater is switched OFF, and the cooling water unit works. Then, the STP pump decelerates and stops. Continue to operate the cooling water unit until the temperature of the pump base is dropped to the set value after the pump stops.

In the case of the I/O Remote interface, a failure signal also simultaneously outputs from the "X4 REMOTE" connector.

The "STATUS" LED flashes in red if the temperature of the STP pump base unit is under 10 ºC (18 ºF) lower than the set value due to a TMS heater failure or other faults. And The heater and the cooling water valve are switched off. Then, The STP pump decelerates and stops.

In the case of the I/O Remote interface, a failure signal also simultaneously outputs from the "X4 REMOTE" connector.

Note: "TMS Lower Temp" is not detected for a certain time when the STP pump starts.

The STP pump decelerates and stops when a TMS sensor cable fails. In this case, the heater and the cooling water unit are switched OFF, and the "STATUS" LED flashes in red.

In the case of the I/O Remote interface, a failure signal also simultaneously outputs from the "X4 REMOTE" connector.

7.1.10 Safety feature of the rotor blade temperature warning sensor (Option)

CAUTION

If you continue to use the pump while RTMP Overheat occurs or RTMP Higher occurs frequently, it may lead to serious failure such as rotor blade damage. This may be the cause of overloading the pump, accumulation of products in the pump, deterioration or damage of parts, etc. Therefore, please review the operating conditions of the pump or overhaul it as soon as possible.
In order for the rotor blade temperature warning sensor to function properly, be sure to observe the purge gas flow rate described in "2.1 STP pump specifications".

Models equipped with a rotor blade temperature warning sensor and with an effective safety function will detect a warning (RTMP Higher) or a failure (RTMP Overheat) when the rotor blade temperature exceeds the set temperature, and will operate as follows.

	RTMP Higher (Warning)	**RTMP Overheat (Failure)**
Pump operation	Continuous operation possible	Decelerate and Stop
"STATUS" LED	Flashing orange when the pump is in levitation or rated operation	Flashing red regardless of pump status.
"X4 REMOTE" connector	For Type E (warning output, factory setting), the PROG OUT signal is output. The PROG OUT signal does not function as a warning output except for Type E.	A FAILURE signal is output.
Warning/failure reset	The warning will be cancelled when the rotor blade temp falls below the automatic cancellation temp.	After the pump is stopped, if the temp of the rotor is below the temp that can be released, it can be released by reset signal input.

7.2 "WARNING" function

7.2.1 "WARNING" function

The STP pump has a WARNING function that is shown in Table 34. It notifies the timing that the STP pump needs to overhaul by doing a self-test. The "STATUS" LED flashes in orange only in the NORMAL and LEVITATION state when a warning is detected.

In the case of the I/O Remote interface, a warning signal also simultaneously outputs from the "X4 REMOTE" connector.

It can confirm the warning messages and change the settings using the serial communication, the STP-Link (optional accessory), or the display unit iDT-002 (optional accessory).
Refer to Section 5, "SERIAL COMMUNICATION PROTOCOL", the STP-Link or the display unit iDT-002 Instruction Manual of the optional accessories for details.

No	Warning
1	First Damage Limit Second Damage Limit (Touch down bearing warning function)
2	Pump Run Time Over (Pump runtime warning function)
3	Pump Overload (Pump overload warning function)
4	Imbalance (Excessive imbalance warning function)
5	Other Warning (Other warnings)

Table 34 - WARNING function

Note: The WARNING detection cannot be reset by the "RESET" operation.
See Section 7.4, "WARNING function setting", for releasing the WARNING detection.
The STP pump can operate even when the WARNING is detected.
Overhaul the STP pump when WARNING detection is indicated.

7.3 Contents of WARNING function

7.3.1 First Damage limit

Impact of the STP pump rotor onto the touch down bearing, such as an unexpected in-rush of air from outside or power failure, can damage the touch down bearing. The STP pump monitors these impacts and adds damage points when "Disturbance" or "Power Failure" occurs. When the accumulated damage point attains certain points, the "First Damage Limit" is detected.

"First Damage Limit" warning can be released by setting the warning function to disable after it is detected. Serial communication, the STP-Link (optional accessory) or the display unit iDT-002 (optional accessory) can confirm the accumulated damage points and change the settings.

7.3.2 Second Damage Limit

"Second Damage Limit" is detected when continuing to operate the STP pump after "First Damage Limit" is detected, and the accumulation of the damage point attains the set value by further "Disturbance" and "Power Failure".
"Second Damage Limit" warning detects "START NOT ALLOWED" failure at the same time.
Overhaul the STP pump because the STP pump cannot perform the rotational operation when the "Second Damage Limit" is detected.

If it needs to operate the STP pump after the "Second Damage Limit" is detected, disable the "Second Damage Limit". The "WARNING" is still detected, but the STP pump can rotate.
The setting can be changed via serial communication, the STP-Link (optional accessory) or the display unit iDT-002 (optional accessory). The settings can be changed using the serial communication, the STP-Link (optional accessory), or the display unit iDT-002 (optional accessory).

7.3.3 Pump Run Time Over

There is a run-time counter that tracks the total running hours of the pump. When the run-time counter attains the set value, the "Pump Run Time Over" is detected. When deposition accumulates inside the STP pump, this function can be used to consider the time of the overhaul.
The setting value is user-definable.

It can confirm the total running hours of the pump and change the setting value using the serial communication, the STP-Link (optional accessory), or the display unit iDT-002 (optional accessory).

7.3.4 Pump Overload

"Pump Overload" is detected when the motor current exceeds the setting value until a certain period of time or the STP pump rotational speed drops below the set value until a certain period of time. The motor current and the rotational speed are monitored only in the NORMAL state.

When a way of use that depositions accumulate in the STP pump, the load may gradually grow in the NORMAL state with the operating time. This "WARNING" function can be used when considering the overhaul timing.

The electric current setting value and rotational speed setting value are user-definable. "Pump Overload" warning can be released by setting the warning function to disable after it is detected. The setting can be changed using serial communication, the STP-Link (optional accessory) or the display unit iDT-002 (optional accessory).

7.3.5 Imbalance

The STP pump continuously monitors its rotor balance. The "Imbalance" is detected when an imbalance of the synchronized rotor with the rotational speed exceeds the setting value.

When a way of use that depositions accumulate in the STP pump, the rotor balance is lost, and an imbalance increases gradually with the STP pump operation hours. An increase in the amount of deposition may lead to a malfunction of the STP pump. Overhaul the pump as soon as possible.

The setting value of the imbalance is fixed, and the user cannot set it.

After detecting the "Imbalance X_H", "Imbalance X_B" or "Imbalance Z", it can be released by setting the "WARNING" function to disable. The setting can be changed via serial communication, the STP-Link (optional accessory) or the display unit iDT-002 (optional accessory).

7.3.6 Other Warning

Occurrence condition	Pump operation	Countermeasures
Air-cooling fan failure (FAN Warning)	Continuing operation. When operating continuously, the STP pump may overheat and detect overheating abnormality.	Contact our Service office.
The operation of the air-cooling fan has exceeded the expected life (FAN Lifetime Over)	Continuing operation. When operating continuously, the air-cooling fan may break down.	It is recommended to replace the fan. Contact our Service office.
An unexpected restart of the control unit during the pump rotation (C/U Restart)	Each interface signal re-outputs the current status after initialization. At warning detection, if the pump is in the normal operation or acceleration, the pump accelerates again and operates continuously.	An influence of external noise may be assumed. Check the settings of the STP pump, and take measures to reduce the influence of external noise.
Disconnection/Short circuit of rotor blade temperature warning sensor (RTMP Lost)	Maintain rotation	Contact our Service office.
High temperature of rotor blade (RTMP Higher)	Maintain rotation (Warning messages are erased automatically as temperature drops, but notification history is held.)	1. Overload Check the conditions of the pump. 2. Excess product deposition Plan for STP pump overhaul. 3. Inappropriate purge gas flow rate Apply the flow rate described in the STP pump specifications.

7.4 WARNING function setting

The WARNING functions can be set to Enable or Disable. Set to "ENABLE" when using the WARNING function. Set to "DISABLE" to release each WARNING function after the WARNING is detected.

The setting values of the "Pump Run Time Over" and "Pump Overload" are adjustable. "Pump Run Time Over" can be released by setting the value larger than a pump running hours. "Pump Overload" can be released by powering off the pump.

See Table 35 and Table 36 for the default setting. The setting can be changed via serial communication, the STP-Link (optional accessory) or the display unit iDT-002 (optional accessory).

WARNING function	Default setting	User setting	User setting change (threshold)
Second Damage Limit	Enable	Disable	Disable
First Damage Limit	Enable	Enable	Disable
Pump Run Time Over	Disable	Enable	Enable
Pump Overload	Disable	Enable	Enable
Imbalance	Enable	Enable	Disable
Other Warning	Enable	Disable	Disable

Table 35 - Default setting of WARNING function

WARNING function	Factory setting (threshold)		Variable range	User setting change (threshold)
Pump Run Time Over	0 hour		0 to 100,000 hours	It can be set in units of 100 hours. 0 is not counted.
Pump Overload	Motor current	100.0 %	0 to 100.0 %	It is the rate (%) to the rated current value. A smaller value is a high possibility of detecting a "WARNING".
	Rotational speed	0.0 %	0 to 100.0 %	It is the rate (%) to the rated speed value. A larger value is a high possibility of detecting a "WARNING".

Table 36 - Factory Setting and Variable Range

Note: Refer to Section 5, "SERIAL COMMUNICATION PROTOCOL", STP-Link, or the display unit iDT-002 Instruction Manuals for the setting methods.

7.5 Troubleshooting immediately after failure occurs

The STP pump has safety functions for various abnormities/errors.
When abnormities/errors are detected, the "STATUS" LED flashes in red. In the case of the I/O Remote interface, a failure signal also simultaneously outputs from the "X4 REMOTE" connector.
If an abnormality/error is found when using the STP pump, check it and take measures in accordance with the following procedures. If there are no relevant trouble cases, or if the system does not work correctly even after the measures have been taken, see Section 8.5.

7.5.1 After power failure

It is recommended to make a sequential control system to supply the power to the STP pump immediately after a power recovery.

7.5.2 After other abnormality/error

WARNING

When disconnecting cables from the STP pump to troubleshoot and take the necessary action, confirm that the STP pump has stopped, turn off the primary power (switch the MAIN POWER to "OFF") and isolate (Lockout/Tagout) the electrical energy source, water, gas and other energy sources from the vacuum equipment. If you do not follow the above, it can cause an accidental rotation of the STP pump, resulting in an accident, an electric shock, or damage to equipment. Moreover, an accident caused by water leaks or gas leaks can occur.

CAUTION

If the "STATUS" LED does not change to green flash even though do RESET, confirm that the STP pump has stopped, and turn OFF the primary power (Switch the switch "OFF"). Then turn ON the primary power again (Switch the switch "ON").

1. After confirming the "STATUS" LED has one flash and the STP pump has stopped, remove the probable cause of the abnormality.
   When the "STATUS" LED flashes in red, follow the recommended actions given in Table 37 to Table 43.
2. Perform the RESET operation to change the "STATUS" LED flashes in green.
3. Perform the START operation. Check if the STP pump operates correctly.

7.6 Troubleshooting

7.6.1 Indication of "STATUS" LED (red flash)

A safety function operates, and the "STATUS" LED flashes in red when an abnormality/error occurs while the STP pump is in operation. In the case of the I/O Remote interface, a failure signal also simultaneously outputs from the "X4 REMOTE" connector.
If an abnormality/error is found, take measures in accordance with Table 37 to Table 43. DO NOT perform operations not mentioned in Table 37 to Table 43.

Note: The STP-Link (optional accessory) or the display unit iDT-002 (optional accessory) display an error as a message. Also, the errors being detected can be read via serial communication.

Message	Pump operation	Occurrence condition	Probable causes	Countermeasures	Referred Section
Aberrant Accel	Free run *1	Rotational speed increases in brake or Levitation state	Atmospheric air flows into the STP pump.	Check the vacuum piping system for leakage. Check the exhaust sequence. Turn "OFF" the switch to stop the pump, and then turn "ON" the switch again to recover.	3.5 4.4.2
Aberrant Brake	Free run, or decelerate and stop	The rotation does not stop after 20 min. into brake state	Failure of the control unit.	Contact our Service office.	
Acc Malfunction	Decelerate and stop	Accelerate up to 2,000 rpm or less	1. Malfunction by external noise. 2. Failure of the control unit.	1. Perform a re-start operation after resetting. 2. Contact our Service office.	
AMB Com. Failure	Decelerate and stop	Communication failure in the control unit	Failure of the control unit.	Contact our Service office.	
AMB Ctrl Lost	Decelerate and stop	Rotor control signal disconnection	1. Failure of the STP pump. 2. Failure of the control unit.	Contact our Service office.	
CNT Overheat 1	Decelerate and stop	Overheating inside the control unit	1. Overheating during baking. 2. Insufficient cooling. 3. Leakage of the vacuum piping system. 4. Repetitive start/stop operations. 5. Failure of the air-cooling fan.	1. Set the temperature of the baking heater to 120 °C or less. 2. At the time of baking or gas pumping, always cool the STP pump. 3. Check the piping system for leakage. 4. Repetitious start/stop operations may cause the STP pump to overheat. 5. Replace the air-cooling fan. Contact our Service office.	4.3 4.1.1 4.3 4.4

*1 The driver output stops and the rotor continue rotating by inertia. It may take several hours to stop.
To stop the STP pump quickly, close the vacuum valve at the outlet port flange and introduce gas from the purge port into the STP pump.

Table 37 - Error List

Message	Pump operation	Occurrence condition	Probable causes	Countermeasures	Referred Section
Disturbance X_H Disturbance Y_H Disturbance X_B Disturbance Y_B Disturbance Z	Decelerate and stop	Excessive imbalance	Excessive vibration applied externally to the STP pump: 1. External vibration/impact. 2. Atmospheric air flows into the STP pump. 3. Foreign materials fall into the STP pump. 4. Sudden pressure change at the start of roughing vacuum by backing-pump.	1. Remove external vibration so as not to transmit it to the STP pump. 2. Check the vacuum piping. 3. Install the STP pump in a way that no foreign materials fall into the STP pump. 4. Perform roughing vacuum through bypass root.	3.1.1 3.4 3.5 3.4
			Abnormal magnetic bearing: 1. Control circuit error. 2. Disconnection of the internal wiring.	Contact our Service office.	
DRV Com. Failure	Decelerate and stop	Communication failure with the motor control board	Failure of the control unit.	Contact our Service office.	
Driver Failure	Decelerate and stop	Communication failure with the motor control board	1. Malfunction by external noise . 2. Failure of the control unit.	1. Perform a re-start operation after resetting. 2. Contact our Service office.	
DRV Overcurrent	Free run *1	Motor driver over current	1. Short-circuit or ground fault in the motor winding. 2. Failure of the control unit.	Contact our Service office.	

*1 The driver output stops and the rotor continue rotating by inertia. It may take several hours to stop.
To stop the STP pump quickly, close the vacuum valve at the outlet port flange and introduce gas from the purge port into the STP pump.

Table 38 - Error List (continued)

Message	Pump operation	Occurrence condition	Probable causes	Countermeasures	Referred Section
DRV Overload	Decelerate and stop	Acceleration state continues for approx. 30 minutes	1. High pressure at the inlet port.	1. Use the maximum working pressure or less.	2.1
			2. High pressure at the outlet port.	2. Use the allowable backing pressure or less.	2.1
			3. Leakage of the piping system.	3. Check the vacuum piping system for leakage.	4.4.2
			4. Failure of the backing-pump.	4. Check the backing-pump for its capacity and START state. (use a backing-pump with the recommended capacity or more)	2.1
DRV Overvoltage	Free run *1	Motor driver over	Failure of the control unit.	Contact our Service office.	
Inordinate Current	Touch down. *2	Excessive magnetic bearing electric current continues for 30 sec.	1. Failure of the STP pump. 2. Failure of the control unit.	Contact our Service office.	
M_Temp Lost	Decelerate and stop	Abnormal motor temperature detection	Disconnection of the motor temperature sensor.	Contact our Service office.	

*1 The driver output stops and the rotor continue rotating by inertia. It may take several hours to stop.
To stop the STP pump quickly, close the vacuum valve at the outlet port flange and introduce gas from the purge port into the STP pump.

*2 The magnetic bearing output stops and the rotor is descended on the touch down bearing.

Table 39 - Error List (continued)

Message	Pump operation	Occurrence condition	Probable causes	Countermeasures	Referred Section
MOTOR Overheat	Decelerate and stop	Overheating inside the STP pump	1. Overheating during baking.	1. Set the temperature of the baking heater to 120 °C (248 °F) or less.	4.3
			2. Insufficient cooling.	2. At the time of baking or gas pumping, always cool the STP pump.	4.1.1 4.3
			3. Leakage of the vacuum piping system.	3. Check the piping system for leakage.	4.4.2
			4. Repetitive start/stop operations.	4. Repetitious start/stop operations may cause the STP pump to overheat.	4.4
			5. Failure of the air-cooling fan.	5. Replace the air-cooling fan. Contact our Service office.	
Overspeed 1, 2, 3, 4	Decelerate and stop	Rotational speed exceeds rated speed	Failure of the control unit.	Contact our Service office.	

Table 40 - Error List (continued)

Message	Pump operation	Occurrence condition	Probable causes	Countermeasures	Referred Section
Power Failure	Decelerate and stop	Insufficient power supply	1. Power failure.	1. Check whether or not a power failure has occurred.	7.1.1
			2. Incorrect connection of the power cable.	2. Connect the power cable correctly.	3.4.5 3.4.6
			3. Failure of the power cable.	3. Replace the power cable.	3.4.5 3.4.6
			4. Failure of the power supply voltage.	4. Set the rated voltage ± 10 %.	2.1
		Overheat inside the control unit.	1. Insufficient cooling of the control unit.	1. Check the volume of water and water temperature with water cooling unit. In order to recover, turn off the power (switch "OFF"), and then switch "ON" after sufficient cooling of the control unit. (Isolate input power supply 3 minutes or more.)	2.2.3
			2. Failure of the control unit.	2. Contact our Service office.	

Table 41 - Error List (continued)

Message	Pump operation	Occurrence condition	Probable causes	Countermeasures	Referred Section
Power Supply Fail	Decelerate and stop	Power supply circuit failure in control unit	Failure of the control unit.	Contact our Service office.	
Record Failure	Decelerate and stop	Failure of record in memory	Failure of the control unit.	Contact our Service office.	
RTMP Overheat	Rotor blade overheating	Decelerate and stop	1. Overload 2. Excess product deposition 3. Inappropriate purge gas flow rate	1. Check the conditions of the pump. 2. Plan for STP pump overhaul. 3. Apply the flow rate described in the STP pump specifications.	7.1.10
Serial Com. Fail	Decelerate and stop	Communication failure of the input operation port during acceleration and normal operation	1. Insufficient user application setting. 2. Disconnection or break of the communication cable. 3. Failure of the control unit.	1. Send a communication command periodically at intervals of less than setting value. 2. Check the communication cable. 3. Contact our Service office.	5.2
Speed Pulse Lost	Decelerate and stop	Abnormal rotational speed detection	Failure of the control unit.	Contact our Service office.	
Start Not Allowed	Decelerate and stop	Damage point exceeds the setting value	Frequency of "Disturbance" or "Power Failure" error.	Overhaul is needed. Contact our Service office.	
TMS Higher Temp	Decelerate and stop	TMS temperature control error (when the TMS unit detection temperature becomes higher than the setting value by 10°C (18 ºF) or more.)	1. Cooling failure of TMS unit. 2. Failure of the TMS unit.	1. Connect the electromagnetic cooling water valve correctly. Check the volume of water and water temperature. 2. Contact our Service office.	2.2.3 3.9.6

Table 42 - Error List (continued)

Message	Pump operation	Occurrence condition	Probable causes	Countermeasures	Referred Section
TMS Lower Temp	Decelerate and stop	TMS temperature control error (when the TMS unit detection temperature becomes lower than the setting value by 10 °C (18 °F) or more. Error is not detected for a certain time after the STP pump starts.)	1. Cooling failure of TMS unit.. 2. Failure of the TMS unit.	1. Connect the electromagnetic cooling water valve correctly. Check the volume of water and water temperature. 2. Contact our Service office.	2.2.3 3.9.6
TMS Sensor Lost	Decelerate and stop	TMS sensor is not connected when the state "TMS Option" is "ENABLE".	1. Disconnection of the TMS sensor. 2. Disconnection of the external TMS connection cable. 3. Failure of the external TMS connection cable. 4. Incorrect setting of the TMS function.	1. Contact our Service office. 2. Connect the cable securely. 3. Contact our Service office. 4. When the TMS function is not in use, set the "TMS Option" to "DISABLE" with display unit iDT-002 or STP-Link.	

Table 43 - Error List (continued)

7.6.2 Indication of "STATUS" LED (green and red alternately)

If an abnormality/error is detected by self-test during the power ON operation, the "STATUS" LED flashes in green and red alternately. This is the indication of the STP pump or control unit failure. Contact our Service Office.

7.6.3 No Indication of the "STATUS" LED (red)

No.	Symptom	Probable cause	Countermeasures	Referred Section
1	"STATUS" LED does not illuminate.	Incorrect connection of power cable	Connect the power cable correctly.	3.4.5 3.4.6
		Abnormal power voltage	Set the input voltage to the rated voltage ±10 %.	2.3
		Power failure	Check whether or not a power failure has occurred.	7.1.1
2	Green flashing pattern of the "STATUS" LED does not change after performing the start operation.	Failure of the "Input Operation Port" setting.	Set the input operation port correctly.	4.7 5.2.4
3	Insufficient ultimate pressure.	Failure of the backing-pump.	Check the capacity and starting state (use a backing-pump having more capacity that we specified).	2.1 4.4
		Leakage of the piping system.	Check the piping system for leakage.	3.5
		Residual molecules.	If the main composition is H_2 or H_2O, perform baking; if it is other gases, clean the inside of the vacuum equipment (If gases remain inside the STP pump, contact our Service office when it is needed to be cleaned).	3.8 4.3
4	Abnormal noise is generated while the pump is rotating	External vibration or impact	Remove external vibration so as not to transmit it to the STP pump.	3.1.1

Table 44 - Troubleshooting with no indication of the "STATUS" LED

8 MAINTENANCE AND INSPECTION

Installation, operation, and maintenance must only be executed by personnel who read through this Manual carefully and have the specific skills to perform the STP pump installation, operation, and maintenance. Confirm that no power is applied to the STP pump (refer to SEMI S2 Section 13.2 - type 1).

8.1 Maintenance and inspection

WARNING

When performing maintenance and inspections of the STP pump, exhaust gases inside the STP pump thoroughly. Residual gases may cause an accident when removing the STP pump. To prevent an accident, confirm the characteristics of gases to be used. Refer to the Safety Data Sheet (SDS) you obtain from the gas supplier. Wear personal protective clothing if necessary.

WARNING

Before carrying out any maintenance or inspections on the STP pump, confirm that the STP pump has stopped, power off the primary power (switch the MAIN POWER to "OFF") and isolate (Lockout/Tagout) the electrical energy source, water, gas, and other energy sources from the vacuum equipment. Otherwise, it may result in an inadvertent rotation of the STP pump, resulting in an accident, an electric shock, or damage to equipment. Moreover, an accident caused by water or gas leaks may occur.

WARNING

The wipes used for cleaning and decontamination might become hazardous waste depending upon the solvent (such as alcohol). Dispose of the contaminated wipes appropriately according to the regulations of each national and/or local government.

CAUTION

DO NOT touch any place other than those specified when performing maintenance or inspecting the pump. And NEVER open any panel because it could cause shock, malfunction, or short circuit.

Power OFF the peripheral equipment before performing maintenance and inspections.

Only Edwards will repair, overhaul, and replace the maintenance parts. Contact our Service office.

8.2 Cleaning

The method for cleaning the STP pump is as follows:

- Clean the outside of the STP pump with proper solvent as required. An alcohol solvent can be used.
- Clean off with pure gas when the dust has accumulated in the connector.
- Clean the outside of the control unit with a dry wipe as required.
- When the dust has accumulated in the ventilation port, wipe it off or vacuum it with the cleaner. Ensure that the dust must not enter the control unit.
- If the label of the STP pump has been damaged, contact Edwards.

The decontamination (overhaul) in the STP pump is executed in our Service office. When an overhaul is needed, contact our Service office.

8.3 Inspecting the deposit

WARNING

Deposit may have accumulated inside the TMP depending upon the type of process tool and process gases. If periodic overhauls are not conducted, the deposit inside the TMP is excessively built up. It may cause a malfunction or the following failure modes:

- Rotor breakage due to contact of the rotor with the deposit
- Damage to the process chamber and valve due to rotor debris
- Damage to the cooling water lines due to shock from rotor breakage

In specific processes, the rotor contact with the deposit can lead to a chemical reaction between the deposit and aluminium powder generated from the rotor. This may result in abnormal combustion and sudden pressure increase.

It may damage not only the TMP but also the vacuum equipment where the TMP is installed and the surroundings.

For devices in which deposit accumulates, conduct daily inspection and periodical overhaul.
Leaving the STP pump without removing the deposit may cause the STP pump to be corroded beyond it cannot be repaired. After removing the pump, contact our service office and send the pump to the service office immediately.

Note: As stated in the Disclaimer, the costs of troubleshooting problems resulting from deposition will be at your own charge even during the warranty period.

In a periodic inspection, inspect the inside of the outlet port and the pump interior for deposition adhesion. Although the STP pump needs to inspect more often depending on the use conditions, conduct a periodic inspection once every three to six months under normal conditions. If a deposit has accumulated to some extent, an overhaul (cleaning) is required. Contact our Service office.

Opening the STP pump to the atmosphere may cause a chemical reaction in the deposit. Therefore, seal the inlet port, outlet port, and purge port so as to prevent the deposit from being exposed to the atmosphere as much as possible.

For the transport method, see Section 8.5, "Transporting for repair or overhaul".

8.4 Maintenance

8.4.1 Recommended overhaul intervals

If the STP pump has been used for a long time, accumulation of a deposit and deterioration/failure of the parts may cause the pump to stop running or fail.

To efficiently and safely use the STP pump, periodically conduct an overhaul.

By referring to the overhaul intervals based on the pump conditions of use as shown in the table below, develop an overhaul plan.

Pump use condition	Recommended overhaul interval	Remarks
When a deposit has accumulated	1 year	Processes making many depositions in the pump will require a more frequent overhaul.
When no deposit has accumulated, but corrosive gas has been used	2 years	The overhaul interval needs to be individually set if the parts are severely deteriorated due to corrosive gas.
When no deposit has accumulated and no corrosive gas has been used	5 years	

Note: When "First Damage Limit" warning or "Second Damage Limit" warning is detected, it is essential to replace the touch down bearings regardless of the recommended overhaul intervals. Warning detection is indicated by flashing of "STATUS" LED (3 flashes in orange), a message on the display unit iDT-002 (optional accessory) or the STP-Link (optional accessory).

8.4.2 Standard replacement parts

When overhauling the STP pump, upper and lower touch down bearings and O-rings will be replaced as standard replacement parts.

Note: When the STP pump and STP control unit detects a warning, it is essential to have the touch down bearings replaced regardless of the recommended overhaul intervals. Refer to the Instruction Manual for each model for details of warning detection.

8.4.3 Recommended maintenance intervals for main parts

Internal components of the STP pump will be damaged from a gas load, heat, and corrosion when used long-term. Deterioration or abrasion of the internal parts of the STP pump will cause unexpected failures. When overhauling the STP pump, replacement of main parts is recommended. Refer to the following list as recommended maintenance intervals for the main parts.

Main part name		Recommended maintenance intervals *1	
		When using corrosive gas	When not using corrosive gas
Rotor blades		3 years	5 years
Rotor blades (High radiation coating specification)		3 years	5 years
Rotor shaft		3 years	5 years
Motor, Magnetic bearing unit		5 years	7 years
Vacuum connector		5 years	7 years
Temperature sensor (vacuum side)		3 years	5 years
Air-cooling fan		5 years	
PCBA in the control unit		7 years	
Accessories	TMS valve	3 years	
	TMS heater Outlet port heater	3 years	
	Connection cable	5 years	

*1 Maintenance intervals of any parts may be shortened depending on the condition of use.

The costs of replacing parts that need to be replaced will charge to the customer if observed deterioration or abrasion, even though a period is not exceeding the recommended maintenance intervals.

When an overhaul of the STP pump is needed, contact our Service office.

8.5 Transporting for repair or overhaul

WARNING

To prevent an accident, confirm the characteristics of gases to be used, referring to the Safety Data Sheet (SDS) you obtain from the gas supplier. Wear personal protective clothing if necessary.

WARNING

When returning the STP pump that has used any kind of gases to our Service office, ensure the "Return Declaration" form has been completed by filling the type of gas(es) used and the precautions taken.

WARNING

To prevent an accident during transportation, follow the "Return Procedure" instructions.

CAUTION

When returning the STP pump to Edwards, be sure to pack it well to prevent external damage. If the "Return Procedure" has not been satisfied, Edwards will not be responsible for any troubles.

Always contact our Service office before returning the STP pump for repairs, overhaul, or other purposes.

To avoid any accident by gases or corrosion inside the STP pump and electrical parts, particularly when corrosive, reactive or flammable gases have been used:

- Vacuum and hermetically seal the STP pump before transport.
- Specify the type of gases used and handling precautions in the "Return Declaration".
- When returning the STP pump to Edwards, be sure to pack it well to prevent external damage. Use similar or superior packaging material as originally supplied.

"Return Procedure(HS1)" and the "Return Declaration(HS2)" may be found at our website https://www.edwardsvacuum.com/ja-jp/health-and-safety/health-and-safety-forms. If there is difficulty accessing this file, contact Edwards for assistance.

Note: The costs of cleaning and overhauling the STP pump will be at the customer's charge.

Note: When returning the STP pump to Edwards, fill in the necessary items in the "Return Declaration" and fax it to the Service office.

9 STORAGE AND DISPOSAL

9.1 Storage of the STP pump

When planning not to use the STP pump over a long period (more than a few months), follow the precautions below:

1. Store the STP pump in a vertical position.
2. Close the inlet port of the STP pump and vacuum it using a backing pump.
3. Introduce dry N_2 gas or dry air from the outlet port or the purge port.
4. Close the outlet port and purge port.
5. If the STP pump has used water cooling, introduce compressed air from one side of the cooling water port so that no water remains in the STP pump.
6. DO NOT store the STP pump in the following areas:
   - Areas of high humidity (if it must be stored in a high humidity place, insulate it from outside and use a dehumidifier.)
   - Areas are prone to temperature extremes; high temperatures of more than 55 °C (131 °F) and low temperatures of less than -25 °C (-13 °F).
   - Areas where corrosive gases may exist
   - Areas subjected to water/dampness
   - Areas subjected to excessive dust
   - Areas with insufficient ventilation
   - Areas subjected to strong magnetic and electric fields or radiation
   - Areas which will be subjected to direct sunlight
   - Areas subjected to mist
   - Areas subjected to electric noise and vibration

9.2 Disposal

WARNING

When disposing of the STP pump, exhaust gases inside the STP pump thoroughly. Residual gases may result in an accident when disposing of the STP pump. If the STP pump has been used with reactive or corrosive gasses, always clean thoroughly before disposing of it to avoid any injury. Confirm the characteristics of gas to be used, referring to the Safety Data Sheet (SDS) you obtain from the gas supplier.

Dispose of the STP pump as industrial waste in accordance with all local and national safety and environmental standards.

Note: Edwards will not be responsible for problems during or after disposal.

10 SERVICE, SPARES AND ACCESSORIES

10.1 Introduction

Edwards products, spares and accessories are available from Edwards companies and a network of distributors. A majority of these centres employ Service Engineers who have undergone comprehensive Edwards training courses. Order spare parts and accessories from your nearest Edwards company or distributor. When you order, state for each part required:

- Model and parts number of your STP pump
- Serial number (if any)
- Item number and description of part

10.2 Service

Edwards products are supported by a world-wide network of Edwards Service offices. Each Service office offers a wide range of options, including equipment decontamination, service exchange, repair, rebuilding and testing. Equipment that has been serviced, repaired, or rebuilt is returned with a full warranty.

Your local Service office can also provide Edwards engineers to support on-site maintenance, service or repair of your equipment.

For more information about service options, contact your nearest Service office or Edwards.

10.3 Spares

Touch down bearing: When exchanging, contact our Service office. Touch down bearing should be replaced in our Service office.

Air-cooling fan: When exchanging, contact our Service Office. Air-cooling fan should be replaced in our Service office.

The possession periods of maintenance parts are at least 7 years after the products are discontinued.

Contact our Service office, when replacement is required.

10.4 Attachment components

If you require any of the items listed below, please contact Edwards.

Items	Application purpose	Remarks
Instruction Manual	STP Pump Instruction Manual	

10.5 Accessories

The following is a list of accessories that can be purchased by contacting Edwards.

Items	Application purpose	Remarks
Power cable	Primary input power	Standard cable length is 5 m. Contact Edwards for further information.
TMS unit	Control the STP pump temperature	TMS heater and TMS valve are included
STP-Link	Windows application for operating or monitoring the STP pump, or setting various settings	Dedicated communication cable is included (3m)
Display unit (iDT-002)	Unit for operating or monitoring the STP pump, or setting various settings	Dedicated communication cable is included (3m)

For more information, contact the nearest Service Office.
(http://www.edwardsvacuum.com/)

Manufacturer:

Edwards Japan Limited

1078-1, Yoshihashi, Yachiyo-shi, Chiba 276-8523 JAPAN

Telephone:	Domestic	047-458-8836
	International	+81-47-458-8836
Facsimile:	Domestic	047-458-8835
	International	+81-47-458-8835
