INTELLIGENT PUMP

AI-12 Series

Instruction Manual

Ver . 1

ATTENTION:

Before using the unit, please carefully read this instruction manual for the correct operating procedure.
After reading, be sure to store it in a safe place for future reference.
The Warranty Certificate for the unit is attached to the back page of this manual.

FLOM

Table of Contents

<Introduction>

Thank you for purchasing this intelligent pump.

- This instruction manual was prepared so that you may know how to safely and correctly use the high pressure constant flow LC pump (AI-12 series), and in order to prevent personal injury or damage to the unit during operation or maintenance.

- In order to maintain safety, this manual should be carefully read and the contents understood before installation, wiring, tubing and operation.

- All of the precautions presented in this manual are important and related to safety, thus should always be followed.

- In order that this instruction manual may be used for a long time, it should be stored in a location where it can be readily accessed as needed as a reference for operation.

The items listed below are given for your safety.

[1] The ranking of safety precautions are classified and displayed as 'Danger,' 'Warning' and 'Caution.'
Details are given on the following page in the section [1. Safety Precautions]. It is requested that you make sure to read and understand the contents before operating the unit.

[2] We are not liable for the following items.
(1) Accidents resulting from usage that is not explained in this instruction manual.
(2) Accidents resulting from the use of maintenance parts that are not genuine FLOM parts (see the List of Supplied Parts) or parts specified by us.
(3) Accidents due to usage outside of the contracted specifications.

[3] When modifications must be made to the unit, be sure to contact us beforehand.

[4] When performing maintenance or periodic inspection, be sure to follow the instructions given in this instruction manual.

[5] When installing the unit, do not place the unit in a location described in [7-2 Location for Installation and Storage]. Do not place the unit in any other location that could be dangerous. Doing so could result in fire, injury or other unforeseeable accident, so make sure the unit is placed in a safe location.

[6] The Warranty Certificate is attached to the last page of this instruction manual. Be careful that it is not damaged or lost.
In the case that the Warranty Certificate is lost, please contact us with the model type, production number and specifications (only in the case of special specifications). We will send a new instruction manual, however, there is a possibility that the warranty will become invalid. Make sure to store the instruction manual in a safe place.

1. Safety Precautions

In order that this unit may be used correctly, be sure to carefully read this instruction manual before use (installation, operation, maintenance, or inspection). Only use the unit after obtaining a good understanding of the unit and all of the safety precautions. After reading the manual, be sure to store it in a safe place where it is readily available to any user for reference.

<Definition of Symbols Indicating Precautions>

In this instruction manual, the ⚠ mark has the following meaning.

⚠ mark: This mark is shown when attention is needed before starting operation. The word put beside this mark, DANGER, WARNING, or CAUITON, gives the reason why precaution is required. These are important safety matters that must be observed.

⇒The degree of hazard and damage that may be caused by inappropriate handling is explained by the classification as follows:

⚠**DANGER**: This mark indicates "an imminently hazardous situation which, if not avoided, is likely to result in death or serious personal injury."

⚠**WARNING**: This mark indicates "a potentially hazardous situation which, if not avoided, could result in death or serious personal injury."

⚠**CAUTION**: This mark indicates "a potentially hazardous situation which, if not avoided, could result in minor or moderate personal injury, or property damage only."

* NOTE: This indicates reference information

2. List of Supplied Parts

After opening the package, make sure that all of the following parts are included.

No.	Name	Grade	Qty.	Remarks
Common Parts of the Series				
1	Power cord	７A　１２５V	1	
2	3P connector	１５A　１２５V	1	
3	Fuse	２A	2	
4	Wrench	８×１０	1	
5	Hexagonal wrench	２．５mm	1	
6	PEEK tubing	AI-12-01 : 1/16×0.25×1m AI-12-13 : 1/16×0.50×1m AI-12-33 : 1/16×0.75×1m	1	The inner diameter differs depending on the model.
7	EASY FITT	＃９００１	1	
8	STOP FITT	＃９００４	1	
9	Teflon tube	３φ×２φ×１m	1	**There are 2 tubes for AI-12-33.**
10	Suction filter	Polypropylene #8800	1	**There are 2 filters for AI-12-33.**
11	Suction needle		1	
Parts Exclusive to AI-12-01 and AI-12-13				
12	3-way inlet tee	＃９１０８	1	Already mounted in the unit.
13	No. 12 tubing	Tefzel 1/16×1.0×90mm	A set of 2	Already mounted in the unit.
14	No. 12 tee clip	＃２３０３	1	Already mounted in the unit.
15	1/8 flat seal nut	＃９７１１	1	
16	3φ flat seal ferrule	＃９７０１	1	
Parts Exclusive to AI-12-33				
17	1/8 double-lock nut	＃９３０５	2	
18	3φ double-lock ferrule	＃９４０５	2	

*: In the case that any parts are missing or damaged, contact your distributor or FLOM.

*: Many of the components of this unit are made of plastic. Tools can be used or cannot be used depending on the location of each component. Be sure to refer to this instruction manual before using any tools.

*: Be aware that trouble that occurs due to connecting similar parts is not covered by the product warranty and is out of the scope of our liability.

3. Name and Function of Each Part

3-1. <Front Panel--Explanation of Part Names>

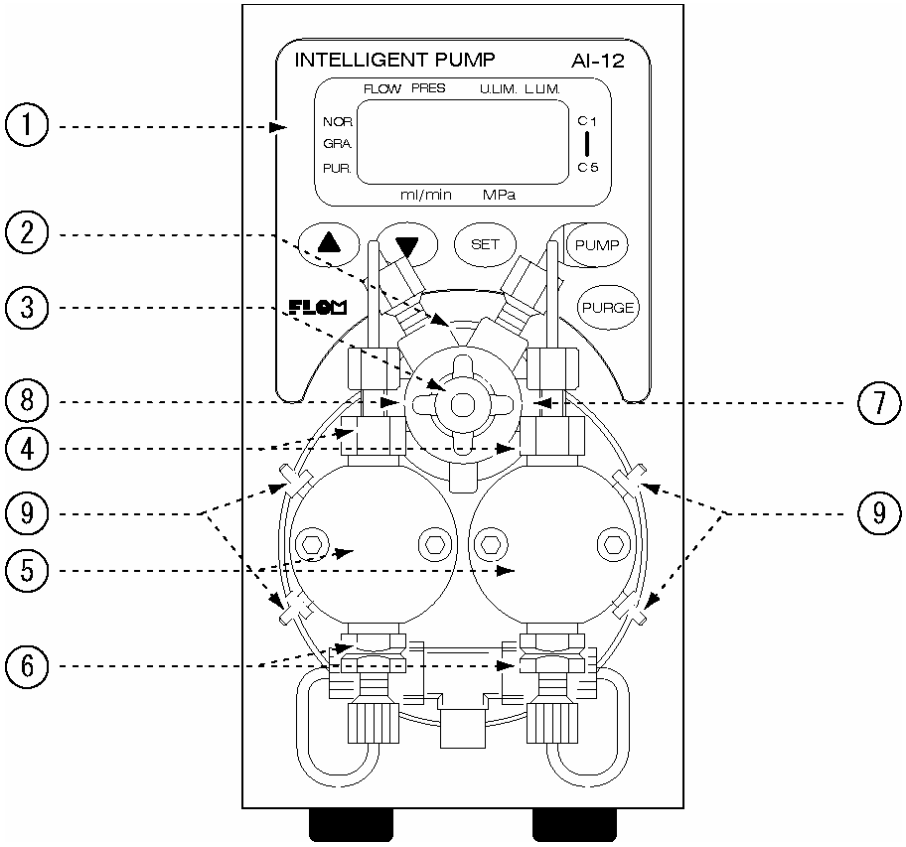


Fig. 3-1 Front Panel

No.	Name	Function
1	Control panel	Refer to [3-2. Control Panel--Explanation of Part Names]
2	Drain valve	The connection port on the right side (7) is connected to the flow system. The connection port on the left side is connected to the drain (waste liquid container)
3	Drain valve open/close plug	The drain is closed when the plug is turned to the right, and liquid flows only in the flow system. When replacing solvent, or removing air bubbles, turn the plug to the left to open the drain and draw out the liquid from the left connection port with a syringe
4	Outlet check valve	(Note that in the case where the valve holder is made of PEEK, the MAX withstand pressure is 25 MPa.)
5	Pump head	
6	Inlet check valve	
7	Outlet port	Connects to the instruments on outlet side.
8	Drain port	Refer to the explanation of functions (2) and (3).
9	Cleaning port	Connect a 2 x 3φ Teflon tube or silicon tube.

3-2. <Control Panel--Explanation of Part Names>

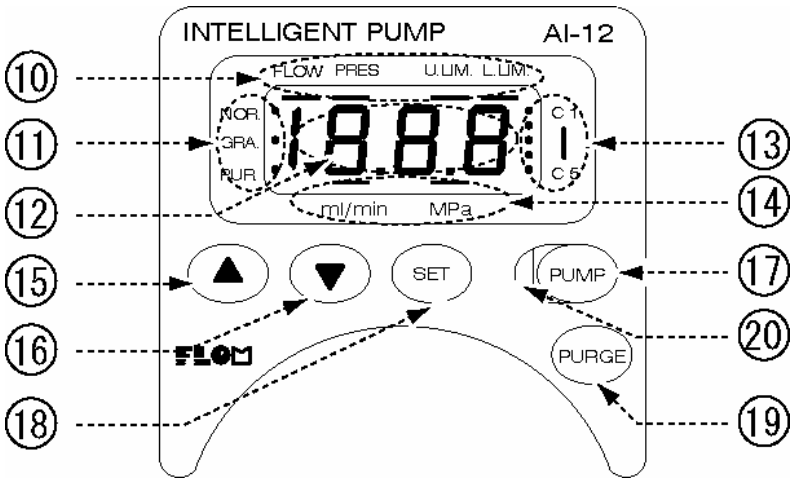


Fig. 3-2. Control Panel

No.	Name	Function
１０	Display item indicator	A bar display lights up underneath the item currently being displayed. [When FLOW is lit up → Flow setting value is being displayed] [When PRES is lit up → Pressure monitor value is being displayed] [When U.LIM is lit up → Upper pressure limit value is being displayed] [When L.LIM is lit up → Lower pressure limit value is being displayed]
１１	Flow mode indicator	A pointer display lights up at the current flow mode. [When NOR. is lit up → Normal flow mode] [When GRA. is lit up → Gradient flow mode] [When PUR. is lit up → Purge flow in progress] For details refer to [6-1. Flow Mode Settings].
１２	Numerical display area	Displays the flow setting value, pressure monitor, upper pressure limit setting, or lower pressure limit setting.
１３	5-point learned display indicator	Used when changing the preset learned data.
１４	Unit indicator	A bar display lights up above the unit of the currently displayed numerical value.
１５	UP key	Increases (UP) the currently displayed numerical value setting. The numerical value changes rapidly when continually pressed
１６	DOWN key	Decreases (DOWN) the currently displayed numerical value setting. The numerical value changes rapidly when continually pressed.
１７	PUMP key	Starts or stops the pump. When stopping the pump, the pump makes an emergency stop if the key is pressed twice (emergency stop) (except for AI-12-33).
１８	SET key	Changes the displayed item.
１９	PURGE key	Used to perform a purge flow.
２０	Status display LED	Lights up GREEN when the pump is feeding liquid, and lights up RED when an error occurs. Also, flashes GREEN when liquid is flowing in purge mode.

3-3. <Rear Panel--Explanation of Part Names>

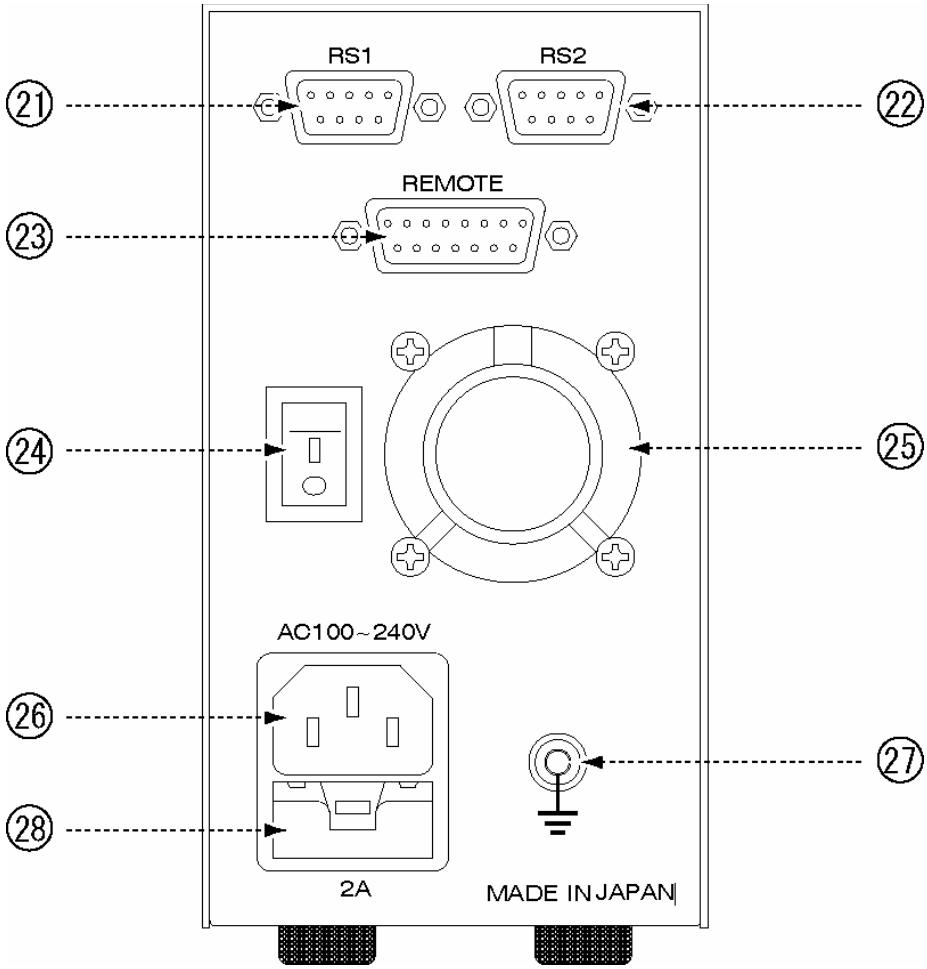


Fig. 3-3 Rear Panel

No.	Name	Function
21	RS1 terminal	RS232C (IN) 9P connector (male) Connects to a gradient controller Model 601.
22	RS2 terminal	RS232C (OUT) 9P connector (male) Connects to the RS1 terminal of a subordinate AI-12 series pump
23	REMOTE terminal	D-SUB 15-pin connector (female) For details refer to [10-1. Explanation of the Remote Connector].
24	Power-supply switch	Seesaw switch
25	Cooling fan	DC fan (blow type)
26	AC inlet	Integrated with the fuse holder.
27	Ground terminal	
28	Fuse holder	Midget type, 2A, two fuses

4. Installation

4-1. <Checking Supplied Parts>

After opening the package make sure all of the supplied parts have been included. (Refer to [2. List of Supplied Parts].)

* Note: In the case that there are missing or damaged parts, contact your distributor. Trouble that occurs due to connecting similar parts is not covered by the product warranty and is out of the scope of our liability.

4-2. <Wiring>

⚠WARNING

Be sure to hold the plug section of the power cord when plugging it into the outlet. Do not plug in the power cord with wet hands. Doing so could result in electric shock.

⚠CAUTION

In the case where large equipment that would apply a voltage shock to this unit is installed on the same power-supply line, be sure to maintain a separate power supply.

Connect the supplied power cord to the power-supply connector on the rear surface of the unit, and plug the power cord into the indoor outlet. The power supply should be 100V to 240V AC, and the frequency of the power supply should be 50/60Hz.

The power cord that is supplied with the unit is a three-prong ground type. In the case of a 2-prong outlet, use the 2-prong adapter that is supplied. Be sure to ground as shown in the figure below.

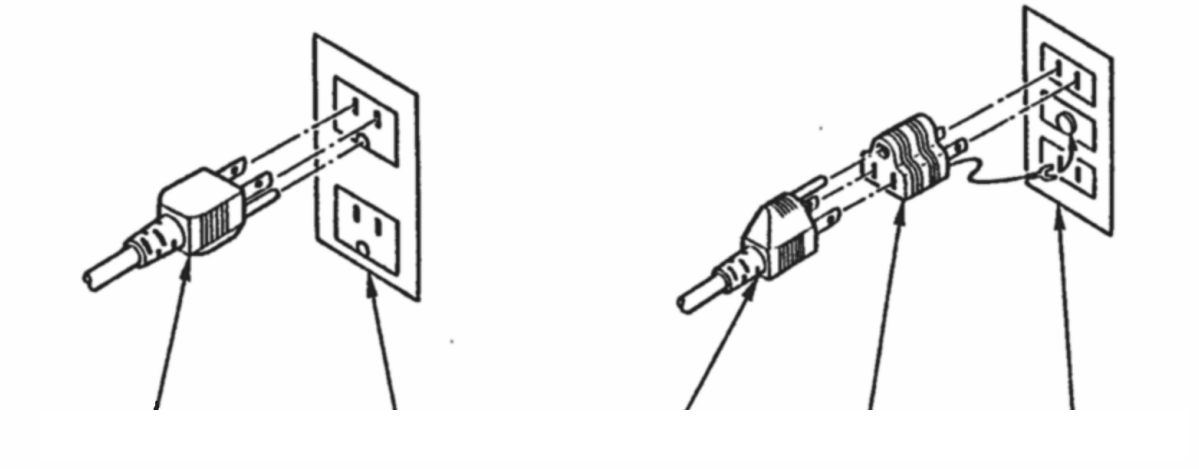


Fig. 4-2 Wiring

4-3. <Suction Tubing>

AI-12-01 and AI-12-13

Connect the supplied Teflon tube to the 3-way tee that is installed at the bottom of the inlet check valve.

AI-12-33

Connect the supplied Teflon tube directly to the inlet check valve.

*Attach the supplied solvent filter.

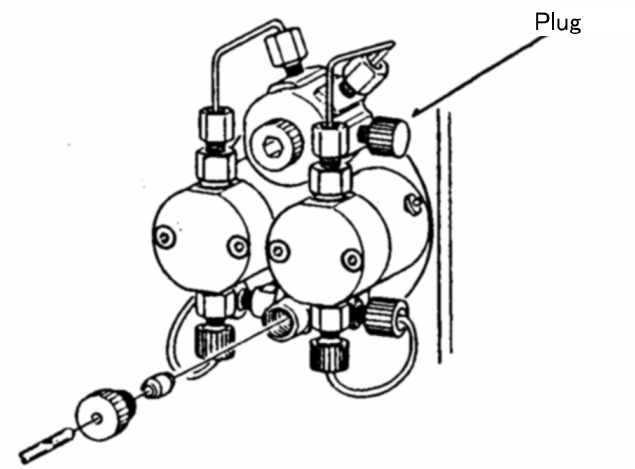


Fig. 4-3 Inlet tubing

4-4. <Connecting the Suction Needle>

Connect the supplied suction needle to the drain port of the left connection port of the drain valve.

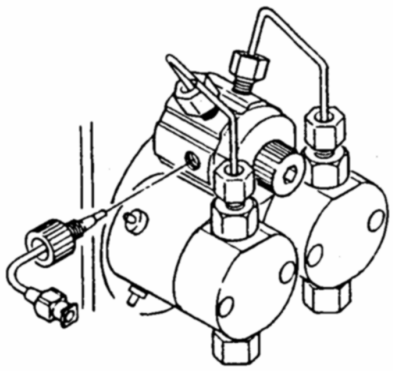


Fig. 4-4 Connecting the Suction Needle

4-5. <Air Removal Procedure>

Open the drain valve (turn to the left), attach a syringe to the suction needle and draw in a sufficient amount of solvent. This can be performed more smoothly while the pump is operating.

*** Note**: Do NOT use tools when opening or closing the drain valve. Always use a degasser for AI-12-01 and AI-12-13. The solvent bottle should be set at a location higher than the position of the pump head.

4-6. <Outlet Tubing>

Remove the stop screw that is set in the flow system port of the right connection port of the drain valve, and connect tubing to the flow system including the injector and auto sampler.

4-7. <Purge Flow>

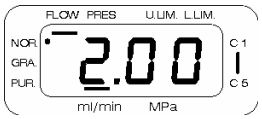
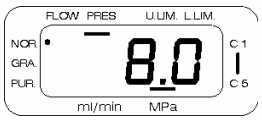
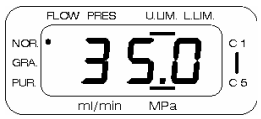
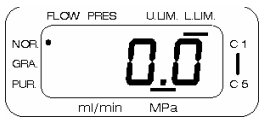
Immediately after purchasing the unit, or after the pump has not been used for a long period of time, the feeding of liquid may not become stable. In that case, perform purge flow [refer to 5-3. Purge Mode]. When feeding the liquid, be sure to close the drain valve (turn to the right).

5. Basic Operation

5-1. <Changing the Display Item>

Each time the SET key is pressed, the bar display of the display indicator lights up and the display item changes in the order of Flow Rate setting Value → Pressure Monitor Value → Upper Pressure Limit Value → Lower Pressure Limit Value.

5-2. <Flow Parameter Settings>

Flow Rate Setting	**[When the Display Indicator FLOW Bar is Lit Up]**
	Set the flow rate to an arbitrary value using the UP/DOWN keys. When a key is pressed continuously, the value will change rapidly. It is possible to change the flow rate value even when the pump is operating.
Pressure Monitor	**[When the Display Indicator PRES Bar is Lit Up]**
	When the pump is operating the current pressure is displayed in the numeric display area.
Upper Pressure Limit Value	**[When the Display Indicator U.LIM Bar is Lit Up]**
	The upper pressure limit value is set in the same way as the flow rate setting. When the pressure becomes higher than the set value, a buzzer will sound, the pump will stop and an error message will be displayed on the display unit. Refer to [9-1. Error Displays and Countermeasures].
Lower Pressure Limit Value	**[When the Display Indicator L.LIM Bar is Lit Up]**
	The lower pressure limit value is set in the same way as the flow rate setting. When the pressure becomes lower than the set value, a buzzer will sound, the pump will stop and an error message will be displayed on the display unit. Refer to [9-1. Error Displays and Countermeasures]. An error does not occur when the value is set to 0.0MPa.

5-3. <Purge Mode>

 The purge mode is used in order to smoothly replace solvent or force out air from inside the pump head.

When the PURGE key is pressed while the pump is stopped, the flow mode indicator PUR. lights up and the purge flow begins.

During the purge flow, the status display LED will flash green.

When the PURGE key is pressed again or when the PUMP key is pressed, the purge flow stops.

The flow rate setting that is changed during the purge flow is cleared when the pump stops and automatically returns to the flow that was set before the start of the purge flow.

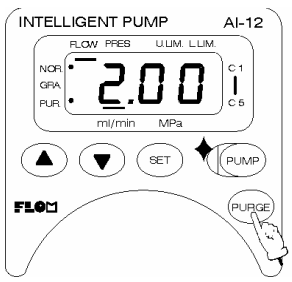


Fig. 5-3 Purge flow

*** Note**：The flow rate setting that is used when the purge flow is executed while the drain valve is open can be the maximum. However, when the purge flow is executed while the valve is closed with the unit connected to a column or the like, the flow rate should be carefully set so that there is no pressure spike.

5-4. <Liquid Flow>

When the PUMP key is pressed while the pump is stopped, the flow will begin in a preset flow mode. The current flow mode may be confirmed when the flow mode indicator lights up. For details, refer to [6-1. Flow Mode Setting]. When the PUMP key is pressed again, the pump stops. When the PUMP key is pressed twice, the pump instantly stops (except for AI-12-33).

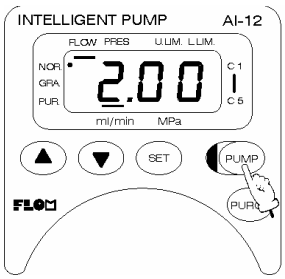


Fig. 5-4 Liquid Flow

*** Note:** When the active-learning flow is executed with air bubbles remaining in the pump head, it may become impossible to continue active learning. As a result [Er3] is displayed and the pump will stop. In that case, perform the purge flow with a pressure of 1.0 MPa or more to completely remove the air bubbles from inside the pump head.

6. Special Operation

Special operations are operations for setting conditions for the pump to allow the following:

(1) Flow mode setting (learning-mode setting)
(2) Flow correction setting
(3) Pump number setting
(4) Pressure 0-point adjustment (automatic)
(5) Changing the preset learned data

6-1. <Setup Mode>

When the power is turned ON while pressing the SET key, the pump is set to the setup mode. In the special-parameter setting mode, it is possible to perform the settings (1) to (4) above. The setting items shift in the order of (1) Flow Mode Setting → (2) Flow Correction Setting → (3) Pump Number Setting → (4) Pressure 0-point Adjustment. Enter each setting value using the UP/DOWN keys. When the SET key is pressed, the setting item shifts to the next item and the setting value is set. After completing (4) Pressure 0-point Adjustment, the operating mode automatically changes to the normal flow mode.

Flow Mode Setting (Learning Mode Setting)	**[When the Display Indicator FLOW Bar is Lit Up]**

Setting value [1]--Mode in which learned data is saved

Active learning begins when liquid begins flowing, and when the pump is stopped arbitrarily in the process, the learned data up to the point when the pump was stopped is stored in memory. After restarting the pump, liquid flow begins according to the stored learned contents. When the learned data when the pump is stopped again has a smaller pulsating flow width than the previous time, the learned contents are updated. This setting is effective when the backpressure is somewhat constant. When operation is set to this mode, NOR. is displayed by the flow mode indicator.

Setting value [2]--Mode in which the learned contents are fixed and no further learning is performed

The learned contents are fixed so that they are no longer updated. When there is no stored learned data, pulsating flow correction is not performed. This is also used when you want to protect against other users updating the learned contents. When operation is set to this mode, NOR. is displayed by the flow mode indicator.

Setting value [3]--Mode in which learned data is not saved

Learning begins when the flow starts, however the learned contents at the point when the pump is stopped are all cleared, so time for learning is required for every operation. This setting is effective when the backpressure is not constant (when a column or the like is complexly replaced). When operation is set to this mode, NOR. is displayed by the flow mode indicator.

Setting value [4]--Mode in which preset learned contents are used and further learning is performed

The liquid starts flowing according to learned contents that are stored in the pump beforehand, and active learning is further performed so that the pulsating width becomes smaller. However, the learned contents are not updated when the pump is stopped. This is the initial setting value that is set at the factory before shipping. When operation is set to this mode, NOR. is displayed by the flow mode indicator.

Setting value [5]--Gradient mode (Mode in which preset learned contents are used and no further learning is performed.)

The flow starts according to the learned contents that are stored in the pump beforehand. Further active learning is not performed. This mode should be set when performing gradient flow. When operation is set to this mode, GRA is displayed by the flow mode indicator.

Flow Rate Correction Setting	**[When the PRES bar display indicator is lit up]**

A correction value within the range -9.9 to +9.9 (%) may be input. When the actual amount of flow rate is large, a minus value should be input, and when the actual amount of flow rate is small, a plus value should be input.

Pump Number Setting	**[When the U.LIM bar display indicator is lit up]**

A value within the range 1 to 9 may be input. This is only used when performing control by communication. Normally, the number should be set to ‘1’

Pressure 0-point Adjustment (automatic)	**[There is no display by the display indicator.]**
Automatically sets the 0-point for the pressure sensor. Open the drain valve beforehand so that there is no pressure. After pressure 0-point adjustment is complete, operation will automatically change to the normal flow mode.	

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6-2. <Changing the Preset Learned Data>

The preset learned contents that are used in flow modes No. 4 and No. 5 are normally data that is adjusted at the factory. Learning your pulsating flow correction patterns for use as the preset data is also possible. For details, refer to the separate materials [AI-12 Series--Method for Setting 5-Point Learning].

7. Precautions

7.1 <Precautions for Use>

⚠WARNING: The following items are 'Warnings' and should always be adhered to.

 Do not apply organic solvent or aqueous solution to the panel cover. If applied by mistake, turn OFF the power and unplug the power cord from the outlet, then quickly wipe and remove any solvent or solution. Do not operate the unit until it is completely dry. Doing so may result in fire, short circuiting, electric shock or unit failure. If it is suspected that a large amount of solvent has entered inside the unit, contact your distributor.

 Do not insert objects such as stainless tubing or metal pieces inside the unit from the cover air vent. Doing so may result in short circuiting, electric shock, unit failure or injury.

 When unit failure is suspected, do not attempt to repair, disassemble or alter the unit youractive. Doing so may result in fire, electric shock or injury.

 When replacing the seal to the pump head and head guide, be sure to turn OFF the power on the rear panel and unplug the power cord from the AC inlet. Do not unplug or plug in the power cord with wet hands. Except for replacing the seal, do not attempt to disassemble the unit. Doing so may result in electric shock or injury. (Refer to [8-2. Plunger Seal Replacement Procedure].)

⚠CAUTION: The following items are "cautions," and should always be followed.

 For this unit, only a 100V to 240V AC (50/60Hz) power supply can be used. Using another power supply could result in fire, electric shock or unit failure.

 When trouble or errors occur, immediately stop operation and contact us with a clear description of the trouble. Continuing to use the unit as is could result in fire, electric shock or injury.

 Do not excessively bend, work on, pinch, tie, or bundle the power cord, or place heavy objects on it. Doing so may result in fire, overheating, or electric shock.

 Do not cover the air vent on the side or the exhaust vent on the rear with paper, tape or the like. Doing so may result in fire, overheating, or failure of the unit.

 The PEEK hexagonal compression screws that are connected to the discharge side of the pump head and the drain valve do not need to be tightened with a strong force. Tighten the screws by hand until they stop, then use a wrench to turn them another 60 degrees. Tightening the screws too much will result in trouble.

 In the case of feeding a buffer solution, input distilled water or the like from the cleaning port and replace the solvent approximately once a week. Performing this work will prevent liquid leakage due to wear of the plunger seal and plunger, and to improve durability of the unit. For details, refer to [8-1. Plunger Cleaning Method]. (A cleaning kit is available as an

option.)

7-2. < Location of Installation and Storage >

⚠**DANGER**: The following items are related to 'Danger,' so the instructions given shall absolutely be followed.

 This unit is not explosion proof, so do not use it in an explosive atmosphere. Doing so may result in death, injury or fire.

 The unit is light and compact, however do not place the unit above the head of the workers or in a place where it could fall. Doing so may result in death, injury or damage to the unit.

⚠**CAUTION**: The following are not appropriate locations for installing the unit. Installation in such locations could result in short circuiting or damage to the unit, so always adhere to the instructions given below.

 Avoid using or storing the unit outdoors.

 Avoid using or storing the unit near corrosive gasses.

 The CPU could malfunction due to the effects of strong electromagnetic waves. Avoid using the unit near devices that generate high-frequency waves.

 Avoid using or installing the unit in a location where there is excessive vibration or that is unstable.

 Do not install the unit in a location where it will be in direct sunlight or near heating equipment.

 Avoid using or storing the unit in locations where there is excessive humidity or dust.

 This unit is intended for use and storage at room temperature. Avoid using or storing the unit in extreme temperature conditions. (The unit should be used within a temperature range of 4^{o}C to 45 ^{o}C, with no condensation.)

 When the unit is not to be used for a long period of time, replace the liquid inside the pump head and cleaning port with distilled water or alcohol. Particularly after using a buffer solution, always replace the solution with distilled water.

* Note: Place the solvent bottle at the same height or higher than the pump head.

8. Maintenance

8-1. <Plunger Cleaning Method>

⚠CAUTION : The contents described below will result in failure of the drive unit, so be sure to adhere to the instructions given.

When a buffer solution or the like is used as an eluent, salt could precipitate out and damage the plunger, or cause the plunger seal to undergo severe wear. Cconnect a silicon tube to the cleaning port of the head unit (refer to [3-1. Front Panel--Explanation of Parts Name]) and inject distilled water using a syringe to clean the plunger and prevent the precipitation of salt.

The cleaning mechanism is not automatic, so replace the distilled water with new distilled water once every 3 days to a week. A silicon tube kit for cleaning is available as an option, however it is possible to connect and use any silicon tube.

The figure below shows the method for connecting the tubing to the cleaning side. The tube for injecting the distilled water is connected at the top. Set a container such as a beaker on the opposite side for the waste liquid.

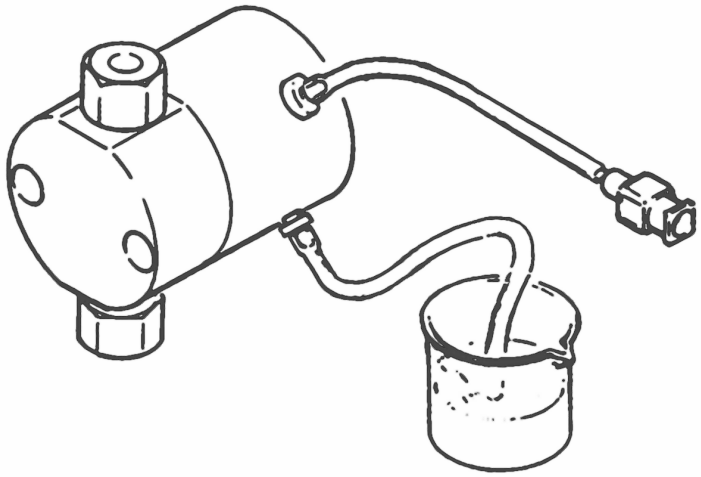


Fig. 8-1 Cleaning the Plunger

8-2. Plunger Seal Replacement Procedure

The plunger seal is a consumable part. Replace the plunger seal periodically. Normally, replace just the plunger seal that is fitted inside the pump head. When the cleaning port is used, replace the plunger seal in the pump head guide at the same time. Replace the seal according to the following procedure.

(1) Disconnect the tubing for the suction and outlet check valves using the supplied wrench.

(2) Remove the pump head set screws. Use the supplied hexagonal L wrench.

(3) Pull the pump head out from the main unit.

(4) Remove the worn seal from the head.

Attach a stopper to the outlet check valve of the head, then attach a suction needle to the inlet check valve and input water with the syringe until it flows over from the head. Insert the side of the seal insert tool (optional) having the long round rod with no ridge as far as it will go. The seal will float up on the tool due to internal pressure, and by repeatedly adding water the seal can be removed attached to the tool. If the O-ring remains inside, be sure to remove it. Refer to the figure below (Method of Removing the Seal).

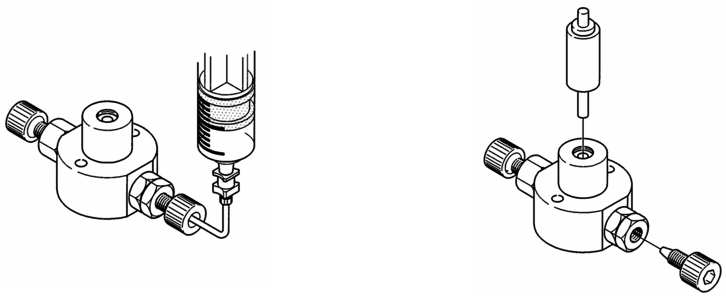


Fig. 8-2a Method of Removing the Seal

(5) Insert the seal into the head.

Set the new seal onto the end of the seal insert tool (optional) that has a ridge, making sure that the O-ring is on the outside. When doing this, the seal will be damaged if the O-ring and the seal are inserted separately, so always make sure that the O-ring is attached to the seal.

The seal can be inserted into the head as is. Gently make a circular movement for insertion. If the seal is inserted too fast, the O-ring may be damaged and result in liquid leakage, so care should be taken. Insert the seal until the pump head and the seal insert tool overlap. Remove the seal insert tool and set the pump head to complete the procedure. Refer to the figure below (Seal Insertion Method).

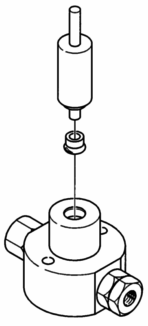


Fig. 82b Seal Insertion Method

(6) Mount the head inside the main unit and fasten with the set screws, then set the tubing in place. The seal replacement method described above should be performed after referencing [8-3. Drive Unit Construction].

8-3. <Drive Unit Construction>

- AI-12-13 and AI-12-33

1	Pump head
2	Plunger seal
3	Backup ring
4	O-ring
5	Head guide
6	Cleaning seal
7	Plunger guide
8	Spring
9	Plunger adapter
10	Plunger
11	Stainless ball
12	Spacer

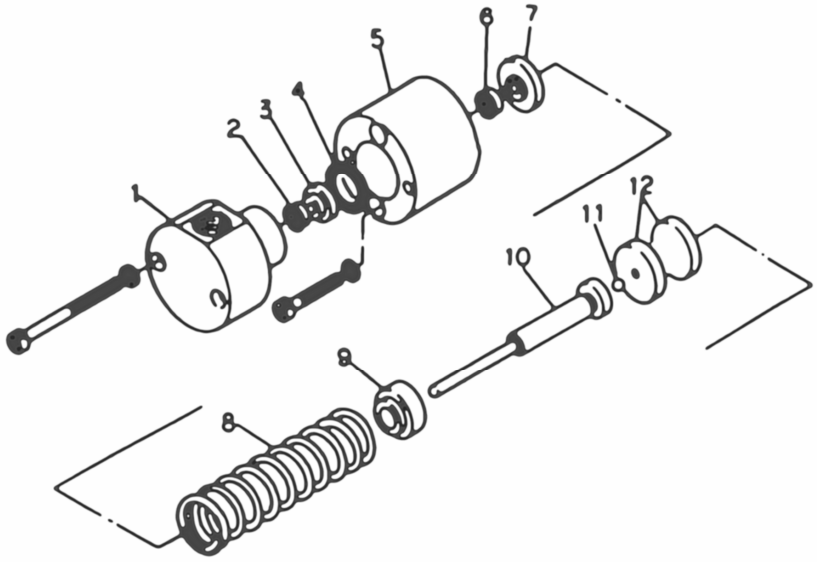


Fig. 8-3a Standard Drive Unit

-AI-12-01

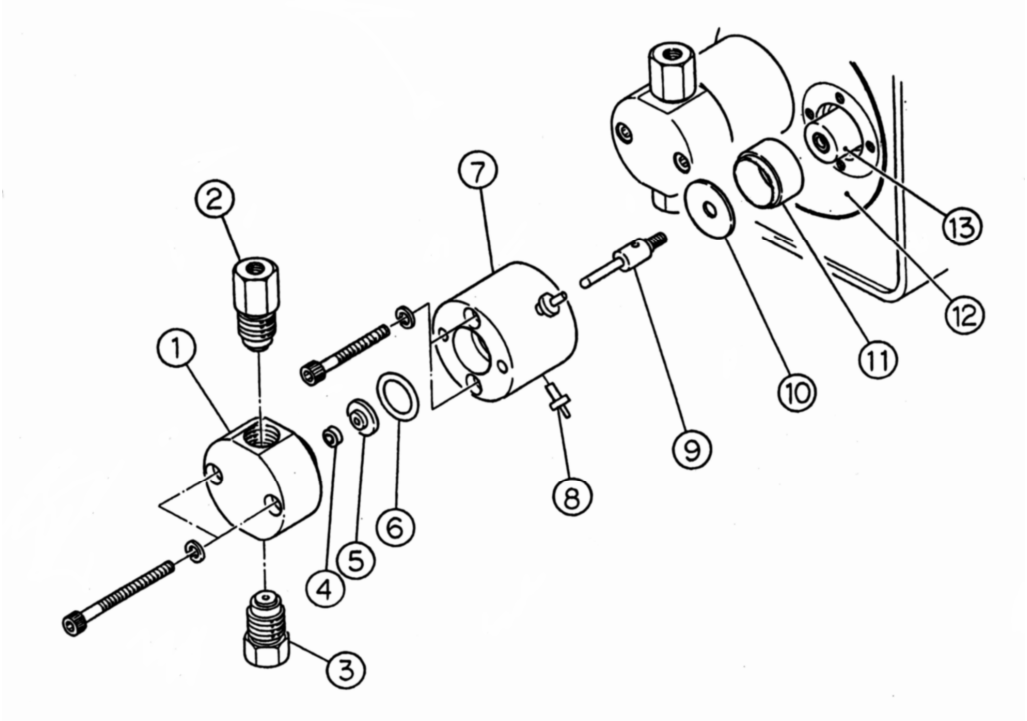


Fig. 8-3b Micro Drive Unit

1	Pump head	2	Outlet check valve	3	Inlet check valve
4	Plunder seal	5	Backup ring	6	O-ring
7	Head guide	8	Cleaning port	9	Plunger
10	Seal packing for cleaning	11	Center guide	12	Pump base
13	Rod				

8-4. <Check Valve Cleaning Method>

Inadequate liquid flow is due mostly to poor operation of the check valves, which occurs when there are air bubbles, dirt or other foreign matter between the ball and the valve seat, or when the valve is dry and the ball sticks to the valve seat. When there is poor operation of the check valves due to air bubbles, refer to [4-5. Air Removal Procedure].

When proper liquid flow does not return after removal of the air, there may be some dirt or something in between the ball and the valve seat. Clean the check valves according to the procedure described below.

(1) Remove the tubing to the inlet and outlet check valves. Remove the tubing on the discharge side using the supplied wrench (8 mm).

(2) Remove the inlet and outlet check valves from the pump head using the supplied wrench (10 mm).

(3) Place the check valves in a beaker or other container, and fill it with alcohol or distilled water (use distilled water in the case where a buffer solution is used in the mobile phase), and clean the check valves for 10 to 20 minutes using ultrasonic cleaning.

(4) After cleaning, attach the check valves to the pump head, being careful that the inlet check valve and outlet check valve are not attached to the wrong sides.

After the check valves have been attached to the pump head and tightened by hand, tighten them further approximately 90 degrees with a wrench.

* Note: Be careful not to damage the check valves by excessively tightening them with the wrench.

(5) Attach the tubing to the inlet and outlet check valves.

When attaching the tubing on the outlet side, tighten the tubing by hand as in the case of the check valves, then tighten further approximately 60 degrees with a wrench.

* Note: Be careful not to damage the check valve by excessively tightening the tubing with the wrench.

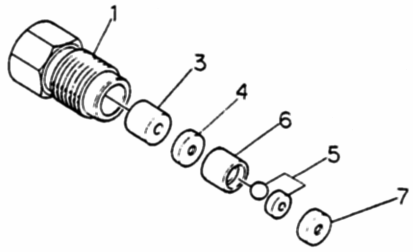
(6) After the tubing has been attached, draw out some solvent to remove the air. Refer to [4-5. Air Removal Procedure].

With the method described above, most dirt or other matter between the ball and valve seat, or sticking of the ball to valve seat should be eliminated and the valves will operate properly. However, if the check valves still operate improperly, they will have to be disassembled and cleaned. When disassembling the check valves, first remove the check valve that is suspected to be malfunctioning, and insert the supplied STOP FITT into the joint section and turn by hand. By doing so, the inside of the check valve will gradually come out from the valve cartridge. For details on the inside of the check valve, refer to the following page.

<Precautions When Assembling the Check Valve>

(1) The side of the valve seat with the mirror surface is the ball side.
(2) Use tweezers when setting the ball and valve seat inside the valve seat case.
(3) Seal A is thinner than seal B, and is located in the center section of the valve cartridge.
(4) After setting the ball and valve seat inside the valve case in (2) above, set the valve case inside the valve cartridge as shown in the figure below.
(5) Press seal B so it is parallel to the other parts. (Seal B is a consumable part, so it is recommended that it be replaced at this time.)

■ AI-1



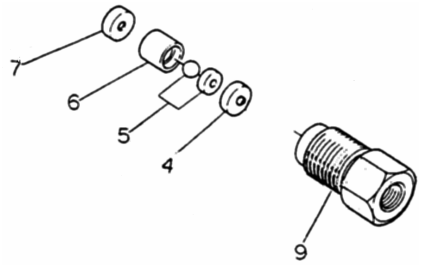


Fig. 8-4a Outlet check valve

Fig. 8-4b Inlet check valve

INDEX No.	Part number	Part name	Grade
1	# 2115	1/16” valve cartridge	No.10-32UNF PEEK
9	# 2114	1/4-28 valve cartridge	1/4-28 UNF PEEK
3	# 2005	Tapered spacer	PEEK
4	# 2006	Seal A	1.5 mm PCTFE
5	# 2008	Ball and valve seat	Ruby and sapphire
6	# 2009	Valve seat case	PEEK
7	# 2007	Seal B	2.0 mm PCTFE

■ AI-12-01

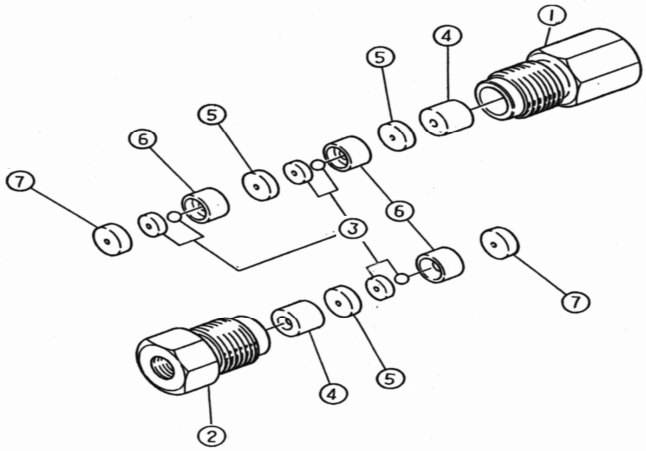


Fig. 8-4c Micro Check Valve

INDEX No.	Part number	Part name	Grade
1	# 2515	Valve cartridge (outlet)	No.10-32UNF PEEK
2	# 2510	Valve cartridge (inlet)	No.10-32UNF PEEK
3	# 2514	Ball and valve seat (micro type)	Ruby and sapphire
4	# 2005	Tapered spacer	PEEK
5	# 2511	Seal A (micro type)	1.5 mm PCTFE
6	# 2512	Valve seat case	PEEK
7	# 2513	Seal B (micro type)	2.0 mm PCTFE

9. Troubleshooting

9-1. <Error Displays and Countermeasures>

Er 1	**Upper pressure limit error**
Cause	A pressure load greater than the upper pressure limit setting occurred during the liquid flow.
Countermeasure	□ Check the tubing and column. When checking the tubing, start inspecting from the joint section that is most distant from the pump. □ Reset the upper pressure limit setting.
Er 2	**Lower pressure limit error**
Cause	A pressure load less than the lower pressure limit setting occurred during the liquid flow.
Countermeasure	Countermeasures: □ Check the tubing and joints for any occurrence of liquid leakage. □ Reset the lower pressure limit setting. *: No error will occur after the liquid flow is started until the pressure load exceeds the set value.
Er 3	**Check valve error**
Cause	There is poor liquid flow due to air, foreign matters, etc.
Countermeasure	□ Refer to [4-5. Air Removal Procedure] to remove all air. If proper liquid flow is not obtained after removing the air, clean the check valve using ultrasonic cleaning, and by disassembling the check valve and cleaning.
Er 4	**Motor rotation error**
Cause	Operation is not possible due to an abnormal load or irregular rotation.
Countermeasure	□ Do not continue to operate the pump as is with poor liquid flow (check valve). □ Liquid does not flow when a sudden pressure load occurs during the flow. □ The internal sensor is unable to detect due to dust, so liquid does not flow. In this case, request for a service.
Er 5	**Memory error**
Cause	An abnormal value was written in the internal memory, or was cleared.
Countermeasure	□ Do not use the pump near devices that generate high-frequency waves.
Er 8	**Pressure 0-point auto adjustment range over error**
Cause	Adjustment did not end within the specified values during pressure 0-point auto adjustment.
Countermeasure	□ Check whether the drain valve is open and there is a pressure load, then perform adjustment again.

9-2. <Inspection of Other Trouble>

■ The power does not turn ON.

□ Inspect the main power supply (breaker), outlet/socket.
□ Check the fuse.
□ Check the AC voltage. (Operating range: 100 to 240V AC)
When the voltage is 250V AC or greater, the internal switching power supply fails, and requires a service call.

■ There is an abnormal noise.

□ Is the pump head coming in contact with the front panel?
There should be a little play in the tubing from the flow system port to the column.
□ Is the pump in contact with any other devices?
There is an air intake port on the side of the pump, so there should always be space (2cm or greater) between the pump and other devices.
□ Is wiring coming in contact with the blower fan on the rear panel?

■ Flow rate is not stable

□ Check the AC voltage. (Operating range: 100 to 240V AC)
When the voltage is 90V AC or less, the motor will not function properly due to insufficient motor torque.

■ There is an abnormal smell.

□ Turn OFF the power supply and immediately request for a service.
When making the service call, please give a clear description of the problem.

10. External Control

10-1 <Explanation of the Remote Connector>

The D-SUB 15-pin (female) connector on the rear panel is the remote connector that enables the following remote control of the pump.

(1) Pressure signal output monitor (analog signal)
(2) Pump start input
(3) Gradient start input
(4) Pump end output
(5) Gradient step end output

(I) Wiring Diagram

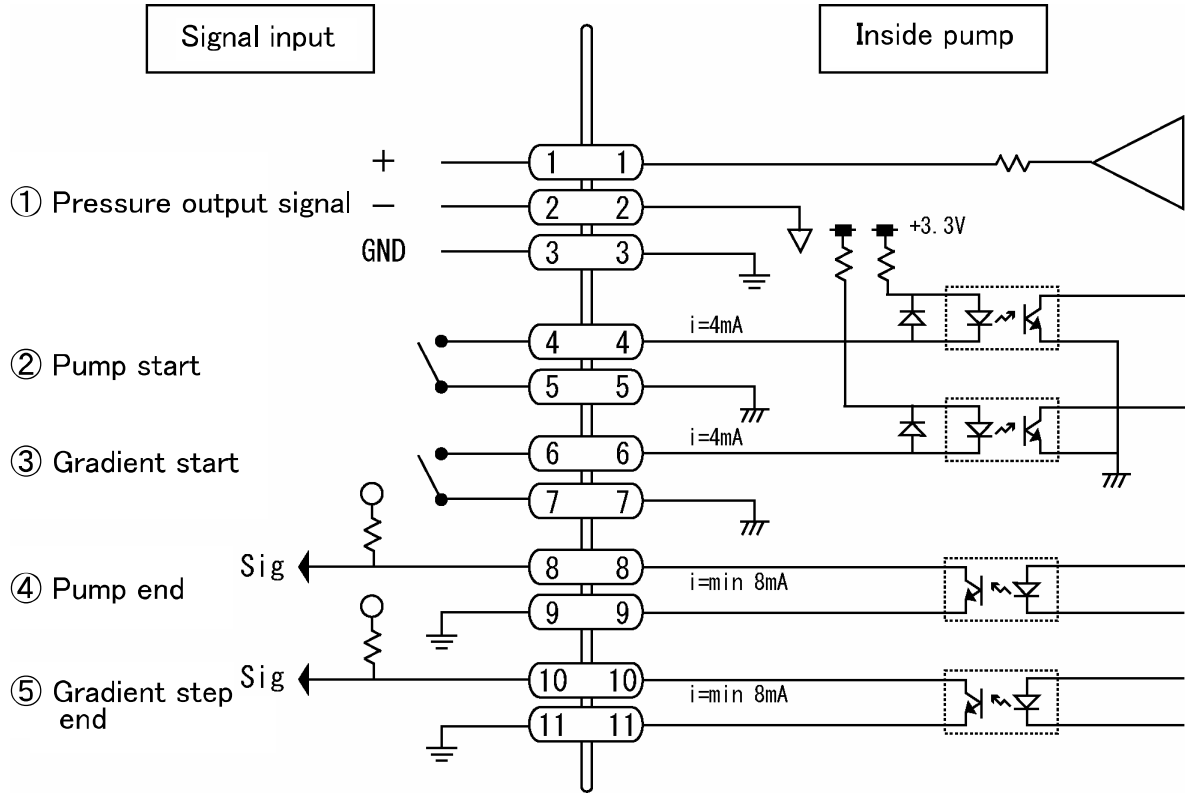


Fig. 10-1 Remote Connector Wiring Diagram

(II) Description

(1) Pressure signal output (analog signal)
The pressure load during the liquid flow is output using 0.1V/10MPa.
(2) Pump start
This is a remote pump ON/OFF signal. The pump feeds liquid only when the 4 and 5 pins are shorted.
(3) Gradient start
After settings for the gradient flow by RS232C communication commands are done, when performing the program initial liquid flow, input for 1-second-or-more pulse will start a gradient flow.
(4) Pump end
When the pump stops, the photocoupler goes ON for approximately 1 second. The operation involves the following: I. Driving the pump is stopped by a switch on the front panel. II. The pump is stopped due to error. III. Gradient flow ends.
(5) Gradient step end
When performing the gradient flow, as each step of the liquid flow program ends, the photocoupler goes ON for approximately 1 second. This does not pertain to standalone pump feed where the gradient flow is not performed.

10-2. <RS232C Communication>

For AI-12 series pumps, pump protocol through RS232C communication is possible. Up to a maximum of 9 pumps that are connected in a daisy chain can be controlled. When performing the gradient flow, it is necessary to perform various settings by transmitting commands using RS232C communication.

For details about RS232C communication, refer to the separate [RS232C Communication Manual].

11. List of Optional Parts

Part Number	Part Name	Grade	Qty.	Remarks
Optional Parts Common to the Series				
＃２３１５	Cleaning kit	Silicon	1 set	
＃２５６１	Pump ON/OFF Remote connector	D-SUB 15-pin connector	1	
Optional Parts Exclusive to AI-12-01				
＃２５００	Micro check valve ASSY (discharge)	No. 10-32UNF screw	1	
＃２５０１	Micro check valve ASSY (suction)	No. 10-32UNF screw	1	
＃２５４０	Plunger seal	2φ inorganic specifications	2	
＃２５２５	Cleaning seal	2φ	2	
＃２５４５	Seal insert tool	For 2φ	1	
Optional Parts Exclusive to AI-12-13				
＃２１００	1/16 check valve ASSY (discharge)	No. 10-32UNF screw	1	Common with AI-12-33
＃２１０１	1/16 check valve ASSY (suction)	No. 10-32UNF screw	1	
＃２２０４	Plunger seal	3.2φ inorganic specification	2	
＃２２０６	Plunger seal	3.2φ solvent containing salt spec.	2	
＃２２２７	Plunger seal	3.2φ organic specification	2	
＃２２０５	Cleaning seal	3.2φ	2	
＃２２０９	Seal insert tool	For 3.2φ	1	
Optional Parts Exclusive to AI-12-33				
＃２１００	1/16 check valve ASSY (discharge)	No. 10-32UNF screw	1	Common with the AI-12-13
＃２１０２	1/8 check valve ASSY (suction)	M8 x 1 screw	1	
＃２２０７	Plunger seal	7φ inorganic specifications	2	
＃２２２７	Plunger seal	7φ solvent containing salt spec.	2	
＃２２０８	Plunger seal	7φ organic specifications	2	
＃２２２６	Cleaning seal	7φ	2	
＃２２２８	Seal insert tool	For 7φ	1	

*: The check valve ASSYs are internal built-in type.
When an internal part is required, refer to the list of parts in [8-4. Check Valve Cleaning Method] to check the part number and part name before contacting your distributor or FLOM.

*: When there are missing or damaged parts at the time of delivery, contact your distributor. Trouble caused due to connection of similar parts is not covered by the product warranty and is out of the scope of our liability.

12. Specifications

Model	AI-12-01	AI-12-13	AI-12-33
Liquid Feeding Method	Double-plunger reciprocating method		
Maximum discharge pressure	35MPa (25MPa: For a PEEK check-valve holder)		5MPa
Range of flow rate setting	1 ～ 999 μl/min	0.01 ～ 9.99 ml/min	0.1 ～ 50.0 ml/min
Method of flow rate setting	Set using the UP/DOWN keys. 7-segment, 3-digit display		
Method of pressure setting	Set using the UP/DOWN keys. 7-segment, 3-digit display		
Pressure limiter upper limit	0 ～ 35MPa		0 ～ 10MPa
Precision of flow rate setting (Room temperature: 25 °C, water feed)	±2% (1 ～ 999 μl/min)	±2% (0.1 ～ 9.99ml/min)	±2% (1.0 ～ 50.0ml/min)
Flow rate stability	±0.3% (1 ～ 500 μl/min)	±0.3% (0.01 ～ 5.00ml/min)	±0.3% (0.1 ～ 20.0ml/min)
Pulsating flow control mechanism	(1) Active-learning control through pressure feedback (2) Pattern control using preset data (5-point learning)		
Precision of pressure display	±5%		
Special function	Instantaneous stop by pressing the PUMP key two times		————
Wetted materials	PEEK, ruby, sapphire, Teflon, PCTFE		
Power supply	100V to 240V AC (50/60 Hz)		
External dimensions	80(W) x 285(D) x 145(H) mm (excluding protruding parts)		
Weight	Approximately 4.5kg		

*: The maximum discharge pressure is the maximum instantaneous pressure, and does not mean the normal maximum discharge pressure.

*: Active-learning control cannot be used during the gradient flow. When performing the gradient flow, set the flow mode to No. 5 according to [6-1. Setup Mode].

*: Due to improvements, the specifications and external appearance of the unit may change without prior notice.

*: Be aware that due to product improvements, the illustrations used in the instruction manual may differ for some products.

13. Product Warranty

Warranty Certificate

Thank you for purchasing the Intelligent Pump.
FLOM Co., Ltd. provides this equipment with one-year product warranty. Should a failure occur to the product within the warranty period and is covered by the warranty, we will repair or replace parts free of charge, provided, however, that the failures due to the following causes and the like will not be covered by our warranty.

1) Failure caused by not adhering to the instructions given in "7: Precautions" of this instruction manual.
2) Failure caused by improper use.
3) Failure caused by repair or remodeling not performed by us.
4) Failure caused by earthquake, disaster, or other natural calamities.
5) Failure caused by a cause attributable to equipment other than this equipment.
6) Failure caused by using the equipment in a severe environment involving high temperature, high humidity, extremely low temperature, or corrosive gas, or at a constantly vibrating location.
7) Replacement of consumable parts, or parts corresponding to this classification.

* Note: Be sure to fill in the following information. The warranty will not be valid unless the information is provided.

Product model: _____

Serial number: _____

Date of delivery: _____

Name of distributor: _____

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