tissin

Smart Valve Positioner

TS900 Series

Instruction Manual

Ver. PM-TS900EN-4/2018

Table of Contents

1 Introduction

1.1 General information for the user

This instruction includes installation, operation, maintenance, and parts information for Tissin TS900 Valve Positioner. Keep these instructions in a location which is easily accessible to every user and make these instructions available to every new owner of the device.

- Installation, commissioning and maintenance of the product can only be performed by trained specialist personnel who have been authorized by the plant operator to do so.
- To avoid possible injury to the personnel or damage to valve parts, WARNING, CAUTION and NOTICE must be strictly followed.
- Before installing or commissioning, be sure to read and thoroughly understand the product manual and operate the product properly.
- Operators must strictly observe the applicable national regulations with regards to installation, function tests, repairs, and maintenance of electrical products.
- For additional information or if specific problems occur that are not explained in these instructions, contact the manufacturer.

The manual can be altered or revised due to hardware of software upgrades without any prior notice. Please visit our website (http://www.tissin.co.kr) and check the latest documentation.

Manual version	PM-TS900EN-4/2018
Software version	V.1.39

1.2 Requirements for safety

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. These safety instructions are intended to prevent hazardous situations and/or equipment damage. For the safety, it is important to follow the instructions in the manual.

⚠ WARNING

Failure to observe the warning may result in serious injuries or death.

⚠ CAUTION

Failure to observe this warning may result in damage to the device or personal injury.

⚠ NOTICE

Failure to observe the warning may result in damage to the device or may degrade performance.

Safety notes

⚠ CAUTION

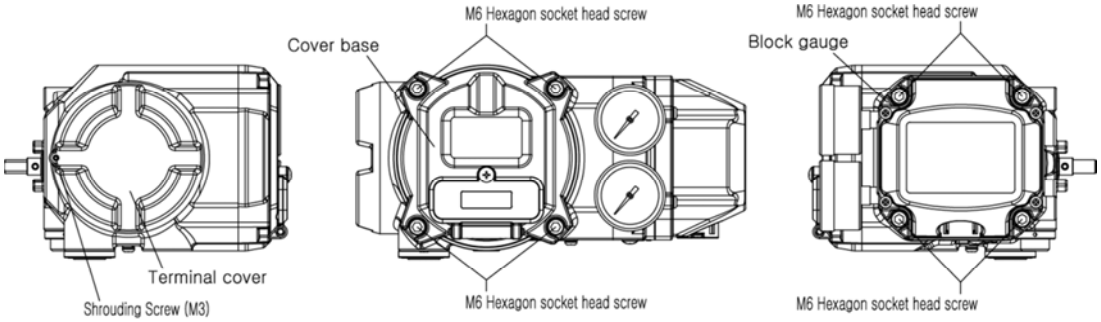
- Only trained and authorized person should operate the machinery and the equipment.
- Do not use this positioner out of the range of its specifications as this can cause failure.
- Do not service or attempt to remove product and machinery/equipment until safety is confirmed.
- Never handle mechanical equipment or disassemble the device until safety is confirmed.
- Before loosening the pneumatic lines and valves, turn off the pressure and vent the pneumatic lines.
- Before reaching into the device or the equipment, switch off the power supply and secure to prevent reactivation.
- Observe applicable accident prevention and the safety regulations for electrical equipment.

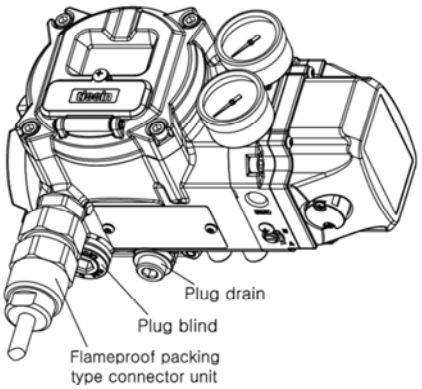
1.3 Basic safety instructions for use in the Ex area

To prevent the risk of explosion, observe not only the basic safety instructions in the respective operating instructions for operation in the Ex area, but also the following.

⚠ WARNING

- Make sure that the device is suitable for the area of use. Available in Zones 1 and Zone2.
- Check the positioner's certified and permitted explosion proof range.
- Close all unnecessary cable glands with lock screws approved for the explosions area.
- Do not remove terminal cover in a hazardous location while the power is on.
- Covers for the terminal and body should be in place while operating.
- Install cables and conduit connections must accordance with IEC60079-14.
- Ring terminal with surface area of more than 0.195mm^2 with M4 spring washer should be used when connect the power.
- For external ground terminal, ring terminal with surface area of more than 5.5 mm^2 should be used.
- The external control unit should be installed a fuse with a rated short-circuit of current of less than 62mA.
- Do not disassemble the bolts and parts shown below when the power is connected.





2 Description of products

2.1 Function

Smart valve positioner TS900 series controls the valve stroke in response to an input signal of 4~20mA DC from the control panel, DCS or calibrator.

2.2 Features

- LCD and 4 button local control
- Quick and easy calibration
- PST and alarm function
- Auto / Manual switch included
- Built-in self-diagnostic function
- Modularization of the internal parts
- IP66 / NEMA4X
- Improvement of valve control speed by applying large flow pilot valve
- Strong vibration resistance and impact resistance

2.3 Options

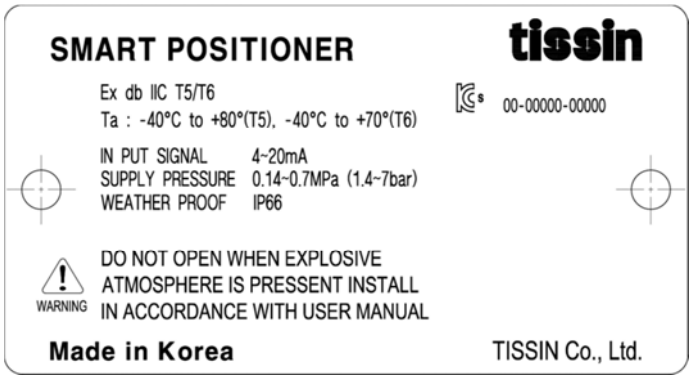
- Position transmitter (4~20mA DC Feedback signal)
- HART communication (Ver. HART 7)
- Alarm sensor

2.4 Applications

The TS900 is mounted on a pneumatic control valves and is used for fluid control of industrial parts.

- Oil and gas
- Chemicals
- Power plant
- Paper
- Water treatment
- Pharmaceutical
- Printing and dyeing processing
- Food and beverage
- Other

2.5 Name plates



<Body label>

<Cover label>

Label	Item	Description
Body label	**Ex db IIC T5/T6**	Indicates the certified explosion proof grade.
	Ta : -40℃ to +80℃(T5) **-40℃ to +70℃(T6)**	Indicates the ambient temperature range for the explosion proof. This temperature range must be observed when using in explosion-proof areas.
	INPUT SIGNAL	Indicates input current signal range.
	SUPPLY PRESSURE	Indicates the allowable input supply pressure range.
	WEATHER PROOF	Indicates the enclosure grade.
Cover label	**Model No.**	Indicates the model number.
	Serial No.	Indicates the serial number.
	Operating Temp.	Indicates the allowable operating temperature.

2.6 Products number

		TS900							
Model	Standard type	**TS900**							
	Stainless steel	**TS905**							
Acting type	Linear type		L						
	Rotary type		R						
Explosion proof type	Ex db IIC T5/T6			C					
Connection type	Conduit entry	Air connection							
	G(PF)1/2	PT1/4			1				
	G(PF)1/2	NPT1/4			2				
	NPT1/2	NPT1/4			3				
	M20	NPT1/4			4				
Lever type (Linear)	10~80mm					1			
	70~150mm					2			
	Adapter type(70mm)					3			
Lever type (Rotary)	M6 x 34L (Fork lever type)					1			
	NAMUR					5			
Ambient Temp.	-30℃~80℃ (Standard type)						S		
	-40℃~80℃ (Low temperature type)						L		
Communication*	None							0	
	Position transmitter(4~20mA DC)							1	
	HART							2	
	HART and Position transmitter (4~20mA DC)							3	
Alarm switch	None								0
	Included								A

2.7 Specifications

Model		TS900	TS905
Input signal		4~20mA DC	
Impedance		500Ω (20mA DC)	
Supply pressure		0.14~0.7MPa	
Stroke		Linear type:10~150mm, Rotary type:0~90^0	
Air connection		PT1/4, NPT1/4	
Gauge connection		PT1/8, NPT1/8	
Conduit		G(PF)1/2, NPT1/2	
Explosion proof type		Ex db IIC T5/T6	
Degree of protection		IP66	
Ambient Temp.	Acting Temp.	-30℃～85℃(Standard type), -40℃～85℃(Low temp type)	
	Explosion Temp.	-40℃~60℃(T5) / -40℃~40℃(T6)	
Linearity		±0.5% F.S.	
Sensitivity		±0.2% F.S	
Hysteresis		±0.5% F.S	
Repeatability		±0.3% F.S	
Air consumption		Below 2.3LPM (Sup.=0.14MPa)	
Required air quality		Class 3 (ISO 8573-1)	
Flow capacity		Over 100LPM (Sup.=0.14MPa)	
Material		Aluminum die cast	Stainless steel 316
Weight		3.5kg	7kg

Option specifications

Options	Item	Specification
HART	HART version	HART 7
Position transmitter	Wire connection type	2Wire
	Supply voltage	9~30V DC
Alarm switch	Supply voltage	9~30V DC

Note: Please contact our sales department for other specifications.

2.8 Structure

2.8.1 External structure

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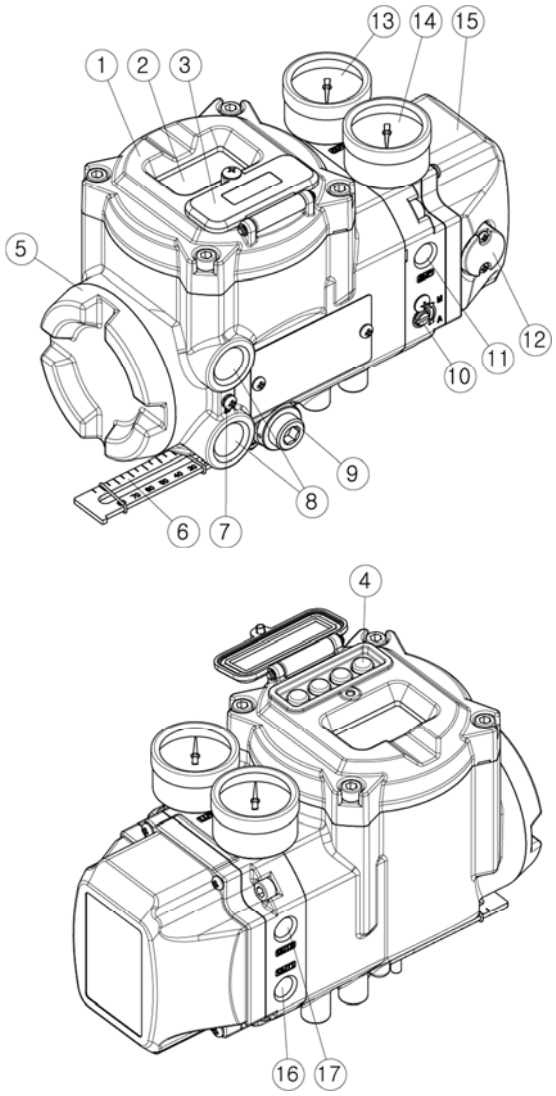
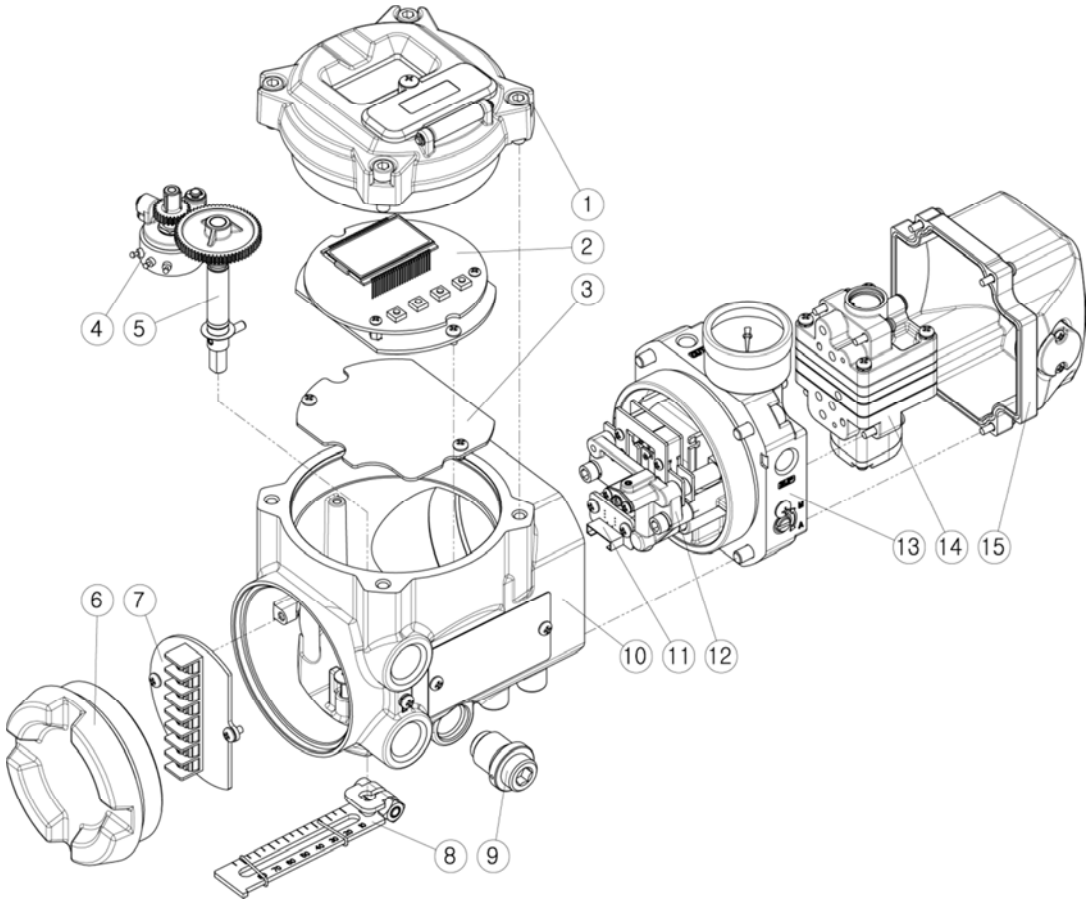


① Body cover
② LCD window
③ Button cover
④ Buttons
⑤ Junction box cover
⑥ Feedback lever
⑦ Ground bolt
⑧ Conduit
⑨ Water vent hole
⑩ Auto/Manual switch
⑪ Air supply port
⑫ Air vent hole cover
⑬ OUT2 gauge
⑭ OUT1 gauge
⑮ Pilot valve cover
⑯ Out1 port
⑰ Out2 port

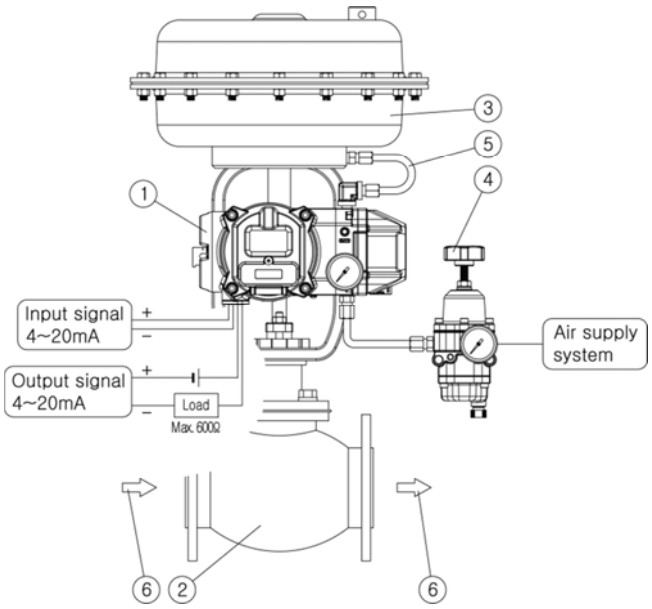
2.8.2 Internal structure



① Body cover	⑨ Water vent cover
② Main PCB	⑩ Body
③ PCB support	⑪ Pressure sensor (Option)
④ Potentiometer	⑫ Torque motor
⑤ Main shaft	⑬ Pneumatic piping block
⑥ Junction box cover	⑭ Pilot valve
⑦ Terminal block	⑮ Pilot valve cover
⑧ Feedback lever	

2.9 System configuration

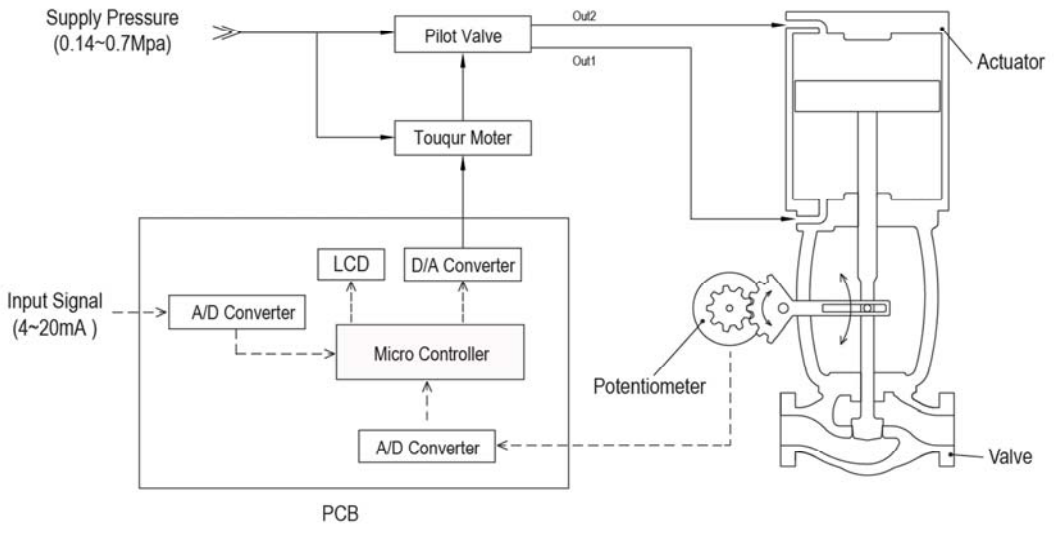
Basically, the control valve system consists of a positioner for controlling the pneumatic pressure of the actuator, an actuator for controlling the opening of the valve, and a valve for controlling the flow of the fluid.



① Positioner (TS900)
② Valve
③ Actuator
④ Regulator
⑤ Out1 vent line
⑥ Fluid

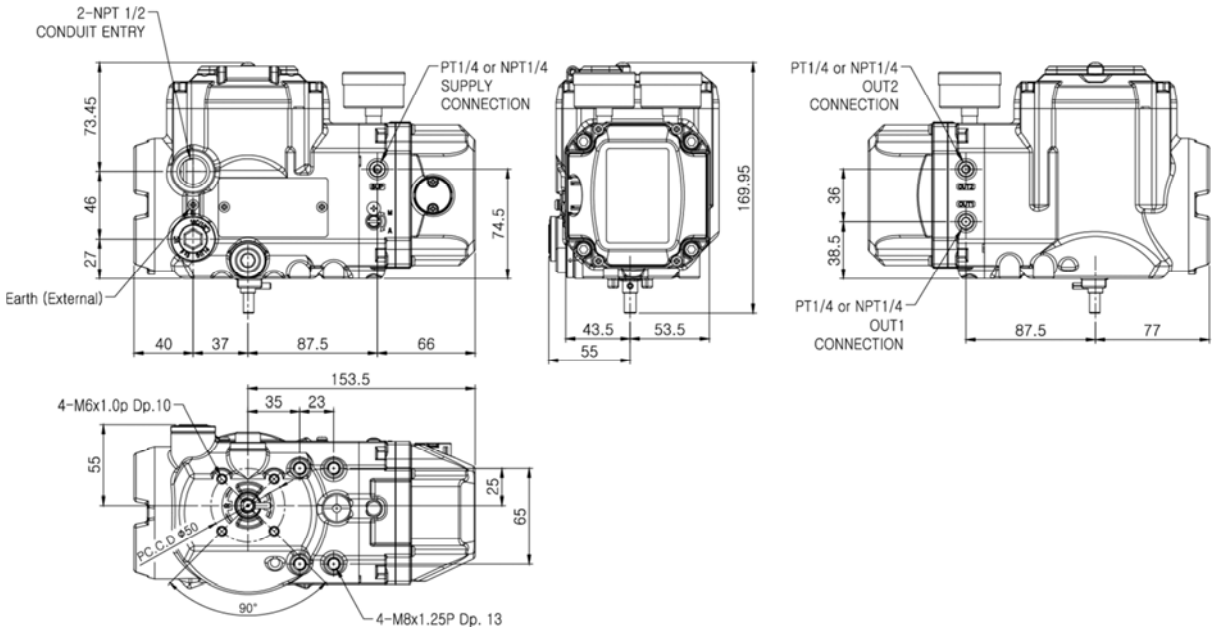
2.10 Principle of operation

TS900 receives the 4-20mA input signal of the control room, the micro-processor (CPU) compares input signal with position feedback through the potentiometer and sends control signal to the I/P conversion module torque motor, torque motor converts it to a pneumatic signal to control the pilot valve to control the opening of the control valve by converting the output pressure of OUT1 and OUT2.

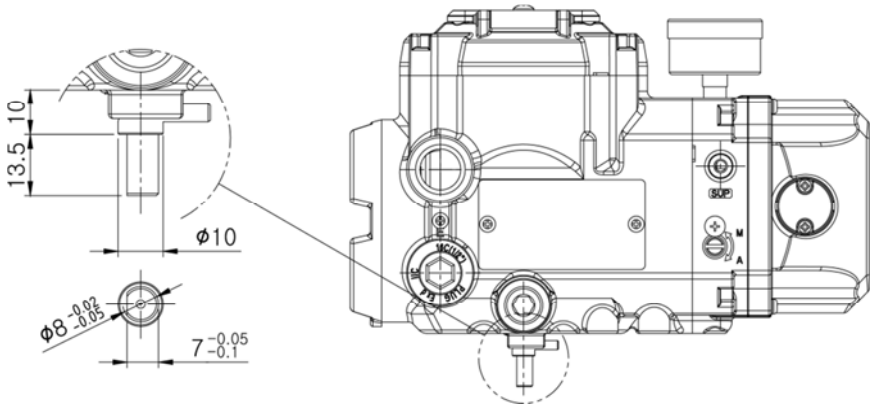


2.11 Dimension drawings

2.11.1 Dimension



2.11.2 Feedback shaft connection



3 Installation

3.1 Before installation

⚠ WARING

- Make sure if TS900 is appropriate to the valve and actuator installation conditions and the site requirements specifications before installation.
- If the installation state is not correct, TS900 control characteristics may be degraded.

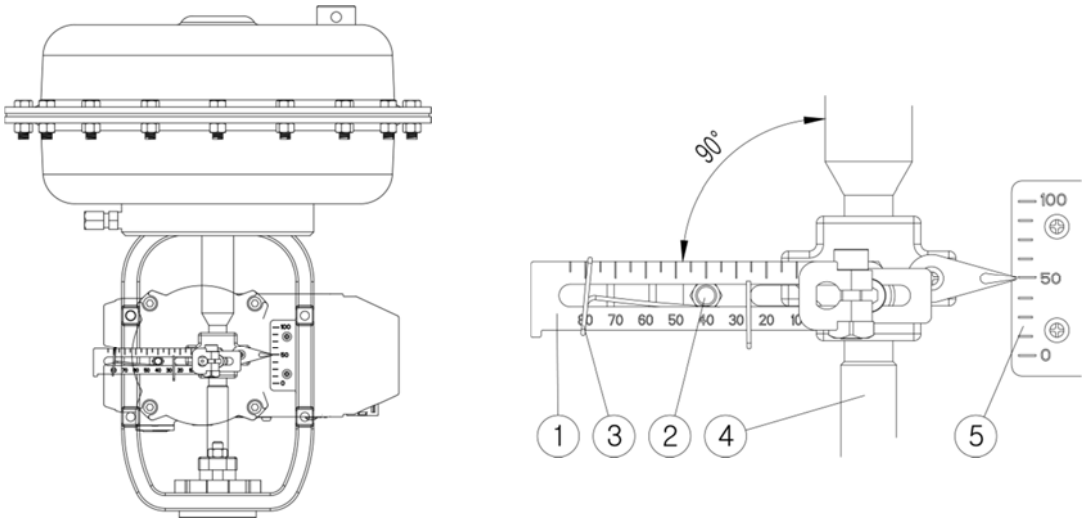
3.2 TS900L installation

3.2.1 Notes on installation

When make the mounting bracket and connecting the lever to the stem connection pin, be sure to observe the following two points.
If not compliance will affect the product performance such as linearity.

⚠ NOTICE

① When the valve stroke is 50%, the feedback lever should be horizontal.
② When the valve stroke is 50%, the stem connection pin must be located at the numeric position marked on the feedback lever that is corresponding to the valve stroke.



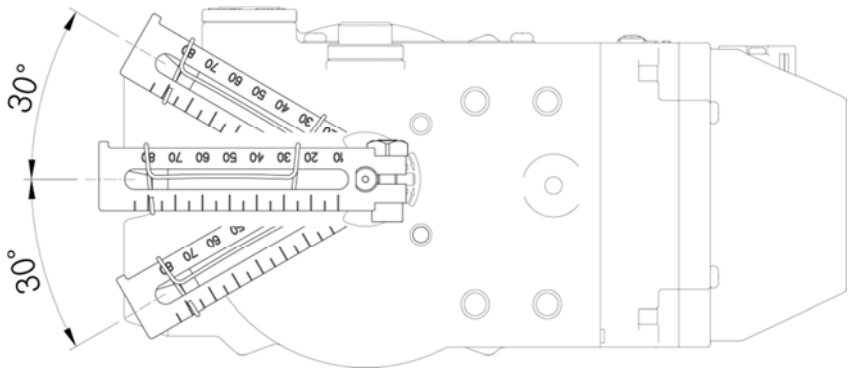
① Feedback lever
② Stem connection pin
③ Pin fixing spring
④ Actuator stem
⑤ Valve opening indicator

3.2.2 Effective rotation angle range of the feedback lever

The effective rotation angle of TS900L lever is respectively 30° upward and downward that is based on horizon.
Follow 3.2.1notes, effective rotation angle can be maintained to achieve the best performance.

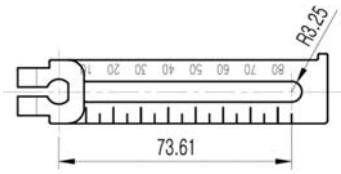
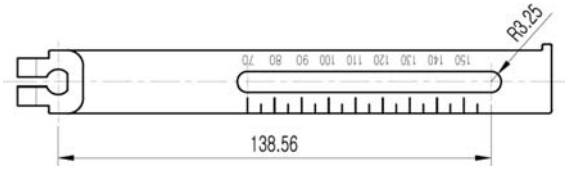
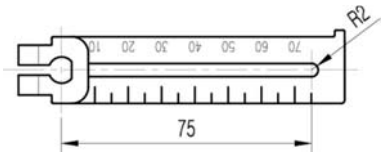
⚠ NOTICE

- If the rotation angle range is too small during operation, the performance of products such as linearity may be degradation.
- If the rotation angle range is too big during operation, may damage the product or cause malfunctions.



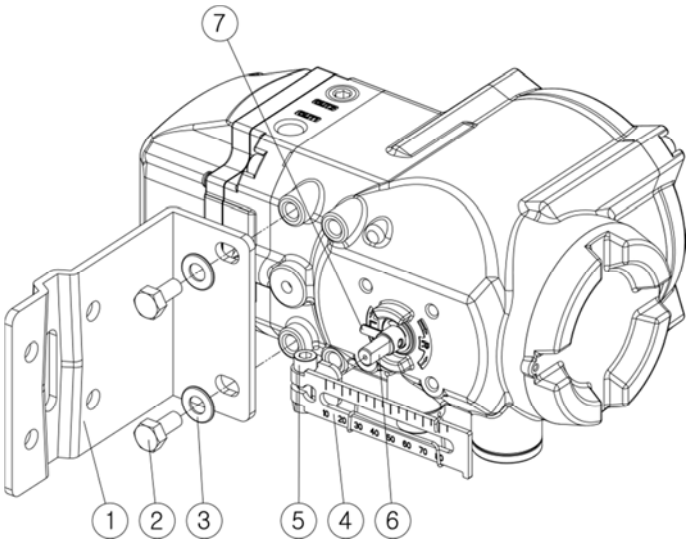
3.2.3 Lever type and dimensions

The numeric position marked on the feedback lever correspond to the valve stroke, and the stem connection pin must be connected to the corresponding marked location

Lever No.	Valve stroke	Dimensions
No.1	10~80mm	
No.2	70~150mm	
No.3	10~70mm	

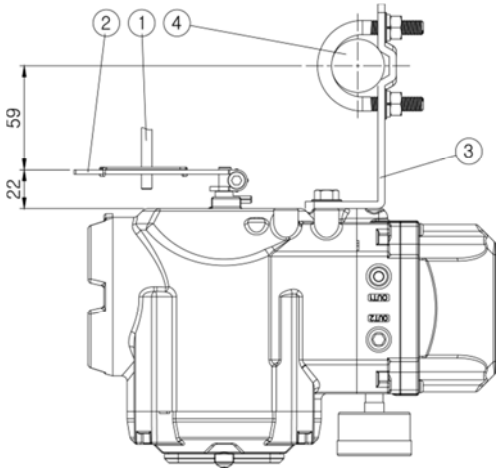
3.2.4 Bracket Installation

Refer to the TS900L drawing (refer to 2.11.1) and actuator drawing, and make appropriate bracket and install the positioner on the actuator.

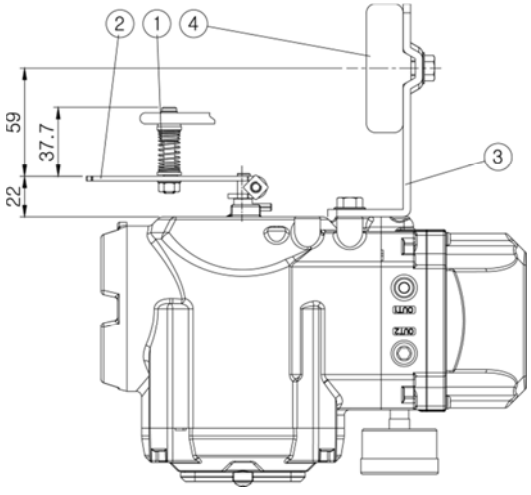


① Bracket
② Bolt (M8)
③ Washer
④ Feedback lever
⑤ Lever fixing bolt
⑥ Main shaft
⑦ Shaft fixing pin

3.3.3 Dimension after installation



<When the lever is No.1 or 2 >

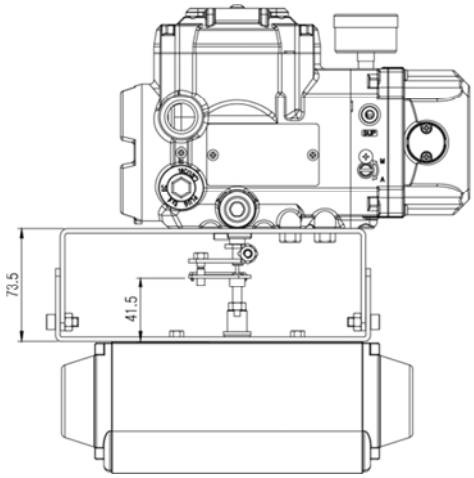


<When the lever is No.3>

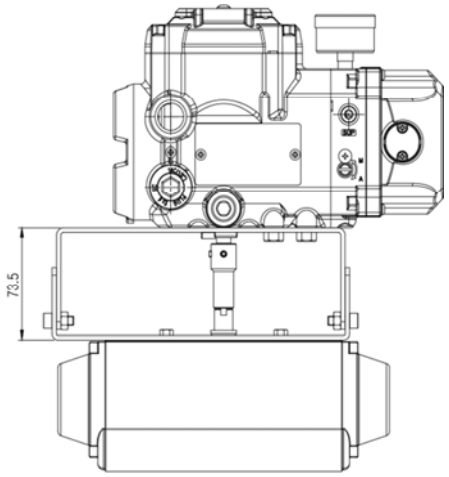
① Stem connection pin
② Feedback lever
③ Bracket
④ Actuator york

3.3 TS900R installation

3.3.1 TS900R installation examples



<Fork lever type>

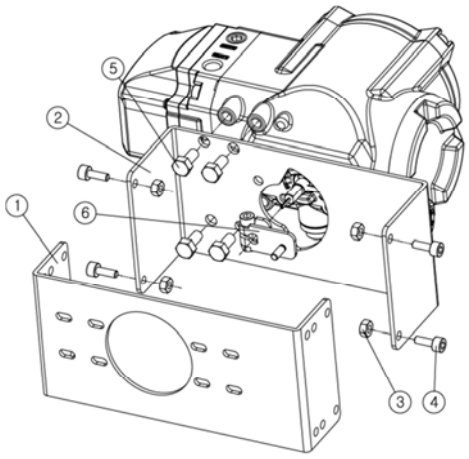


<NAMUR type>

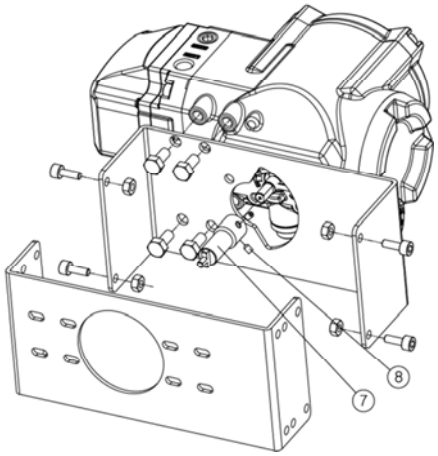
3.3.2 TS900R list of supplied installation parts

When shipped form the factory, parts 1~8 are provided as standard.

The brackets support the NAMUR mounting standard (VDI/VDE3835, IEC60534-6-2).



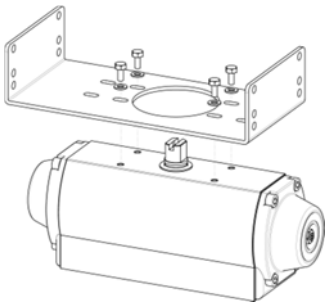
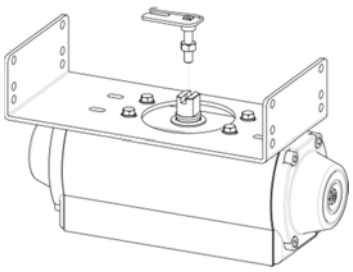
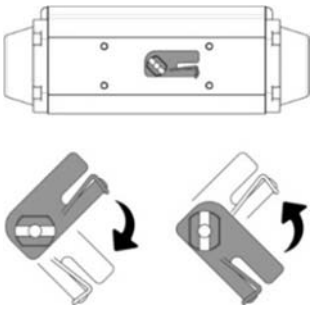
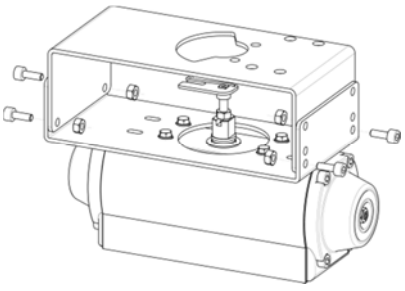
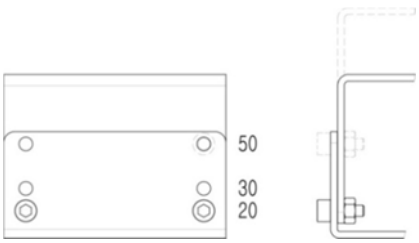
<Fork lever type>

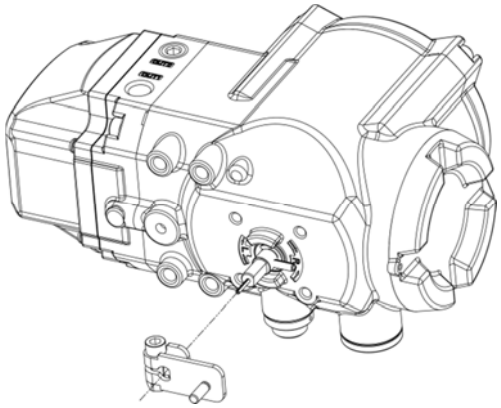
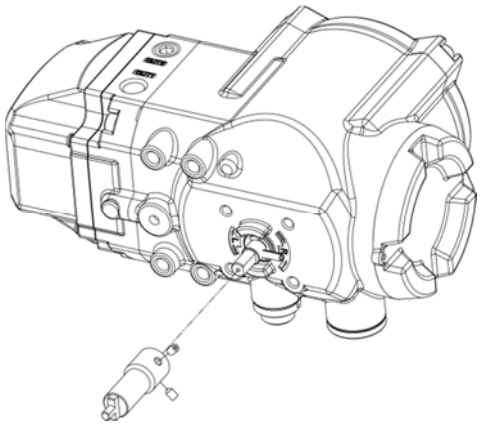
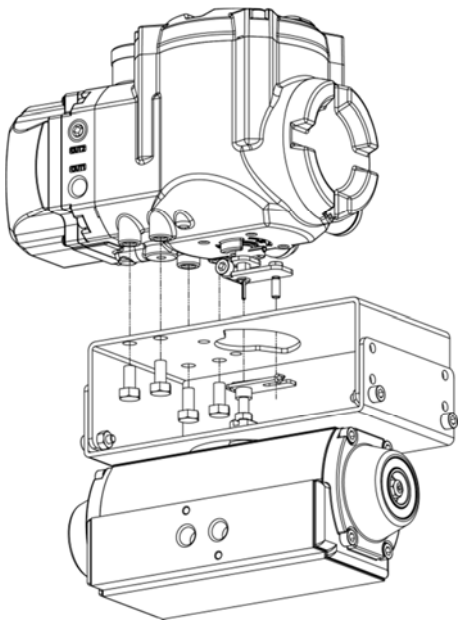


<NAMUR type>

① Lower bracket(1)
② Upper bracket(1)
③ Nuts(4)
④ Screws (M6x4)
⑤ Screws (M8x4)
⑥ Fork lever(1)
⑦ NAMUR adapter (1)
⑧ Adapter fixing pin(2)

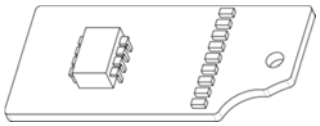
3.3.3 TS900R installation steps

1	**Lower bracket installation** Attach the lower bracket to the actuator and secure it with the screw.	
2	**Fork lever installation** Insert the fork lever into the actuator stem and tighten with the fixing bolt.	
	Position the start point of the fork lever according to the direction of rotation of the actuator stem.	
3	**Tighten upper and lower brackets** Connect the upper bracket to the lower bracket attached to the actuator and fasten with the screw.	
	Tighten the bolts to the corresponding holes of 20.30 and 50 depending on the actuator stem height.	

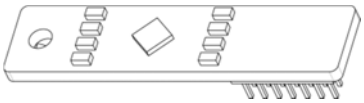
4	**Shaft lever installation** **Fork lever type** Insert the shaft lever into the main shaft and tighten with the fixing bolt.	
	NAMR type Insert the NAMUR shaft adapter into main shaft and fix it with two fixing pins.	
5	**Attach the positioner to the upper bracket and fix it with screw.** At this time, insert the lever pin at the bottom of the fork lever into the hole of the fork lever attached to the actuator and then align the center.	

3.4 Installation of option modules

According to the site requirements，the following modules can be purchased separately and installed. The corresponding function can be realized by installing modules, and the modules do not affect each other.



<Position feedback module>



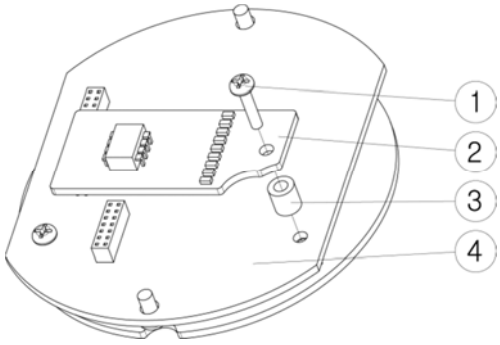
<HART communication module>

3.4.1 Installation of position feedback module

Open the body cover and remove the PCB from the body, and install the position feedback module to the main PCB as figure below.

⚠ NOTICE

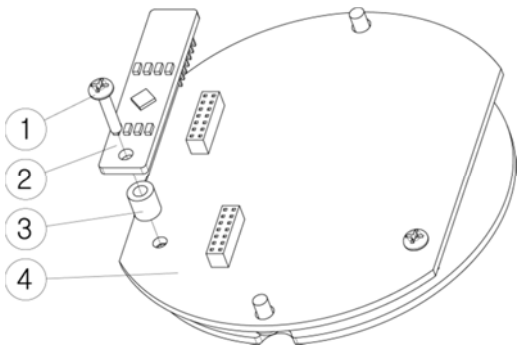
Be sure to have the feedback zero point setting and end point setting once when you after installing the feedback module. Please refer to page 38 OUT ZERO and OUT END setting method.



① Fixing bolt
② Feedback module
③ Module spacer
④ Main PCB

3.4.2 Installation of HART communication module

Open the body cover and remove the PCB from the body, and install the HART communication module to the main PCB as figure below.

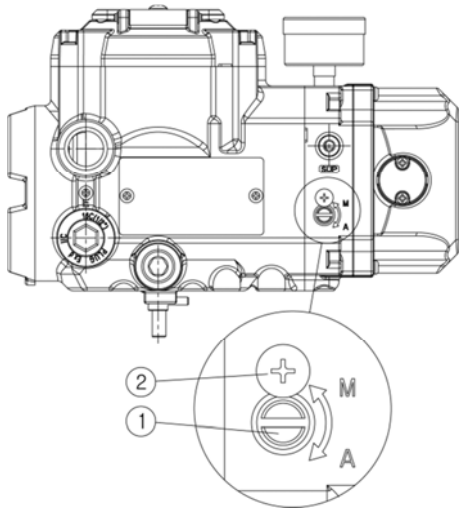


① Fixing bolt
② HART module
③ Module spacer
④ Main PCB

3.5 How to adjust Auto/Manual switch

⚠ WARNING

- Be careful that the valve moves when the Auto/Manual switch is operated.
- Do not exceed the permissible air pressure range since the input air pressure is directly transmitted to the actuator when switching to manual mode.

	① Auto/Manual switch ② Lock screw

Description	The Auto/Manual switch acts as a bypass valve. • If set the Auto, control valve opening by positioner. • If set to Manual, the supply pressure input from the regulator is transmitted directly to the actuator regardless of the signal from the positioner
Purpose	• When the control valve fails, set to Manual mode and adjust the output pressure of the regulator, if the valve moves with the pressure change, there is a high possibility of the problem of the positioner, if the valve does not move, there is a high probability that the valve has failed. • You can adjust the valve opening with the regulator by switching to Manual mode in case of product installation or field emergency
Adjustment method	• Turning the Auto/Manual switch fully clockwise with a slotted screwdriver sets the Auto mode, will control the valve with the positioner • Turning the Auto/Manual switch counterclockwise several times with a slotted screwdriver sets the Manual mode, and the regulator's air pressure is transmitted directly to the actuator.
Notes	• The product is set to Auto mode at the factory. • Auto/Manual switch works only with single type model.

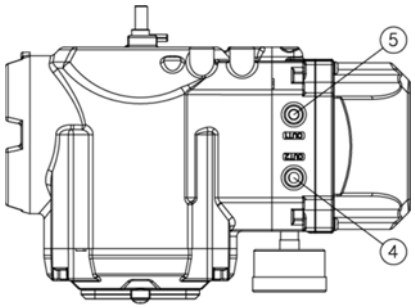
4 Pneumatic connection

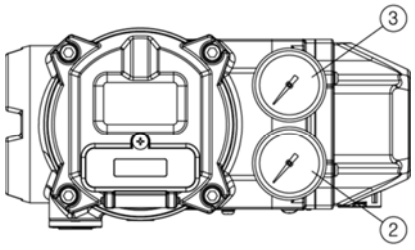
4.1 Conditions of supply air

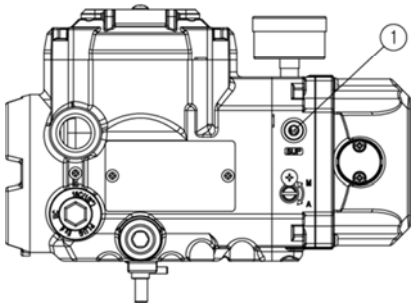
⚠ NOTICE

- Use only dehumidified and dust extracted compressed clean air.
- The air pressure input must be equipped with a regulator to supply a constant air pressure.

4.2 Description of air ports







① Supply port

② OUT1 port

③ OUT2 port

④ Out1 gauge

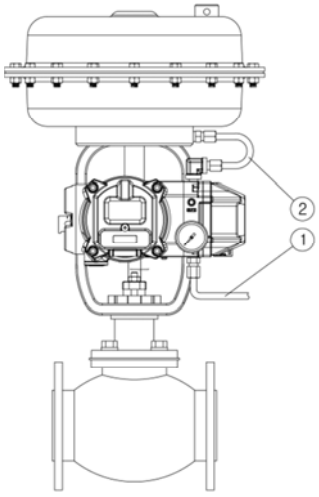
⑤ Out2 gauge

4.3 Air connections

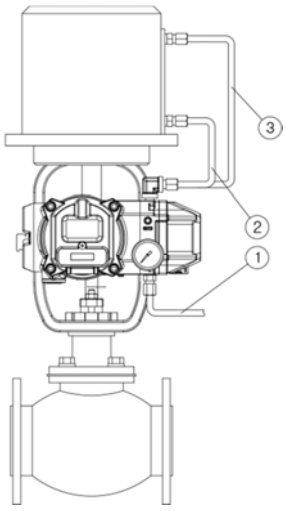
NOTICE

- This product is designed to increase the air pressure of out1 as the 4 ~ 20mA current input signal increases.

4.3.1 TS900L air connections



< Piping with single actuator>



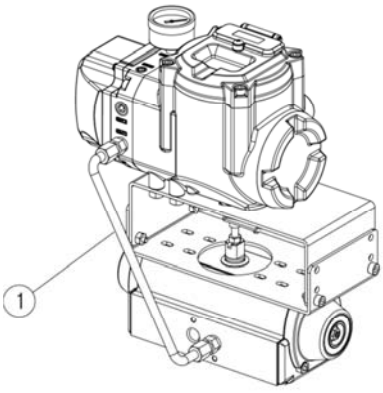
<Piping with double actuator>

① Air supply

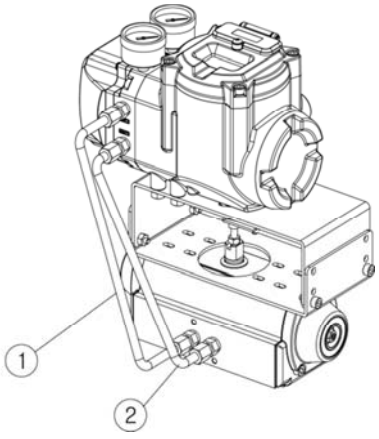
② Out1

③ Out2

4.3.2 TS900R air connections



< Piping with single actuator >



<Piping with double actuator>

① Air supply

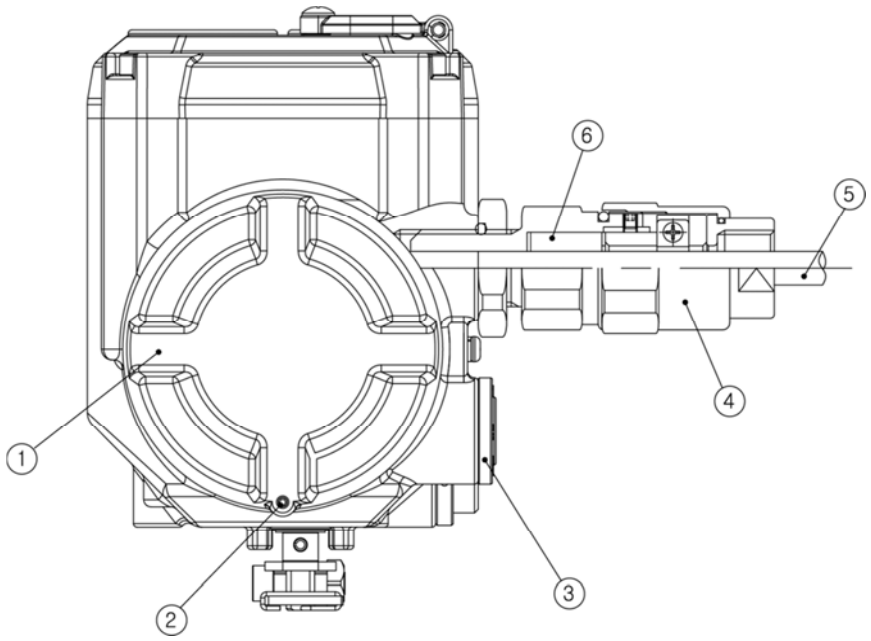
② Out1

③ Out2

5 Electrical connections

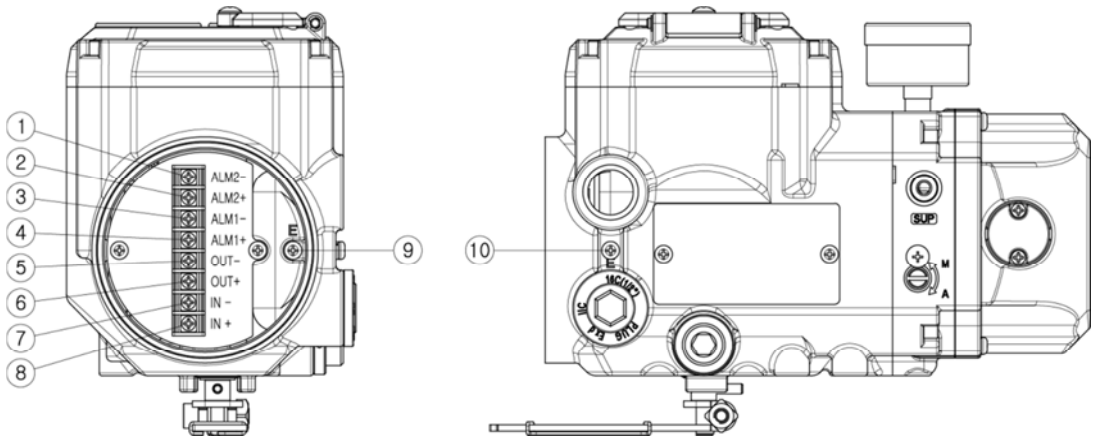
⚠ WARNING

- Be sure to check always that the electrical load is within the stated range on the nameplate. Exceeding the rating might cause a malfunction to circuit boards or burn out electrical components.
- When opening the terminal cover, be sure to shut off the power first.
- Close all unnecessary cable glands with lock screws approved for the explosions area.



① Terminal cover	④ Explosion proof cable joint
② Lock screw	⑤ Cable
③ Conduit plug	⑥ Seal diaphragm

5.1 Terminal description

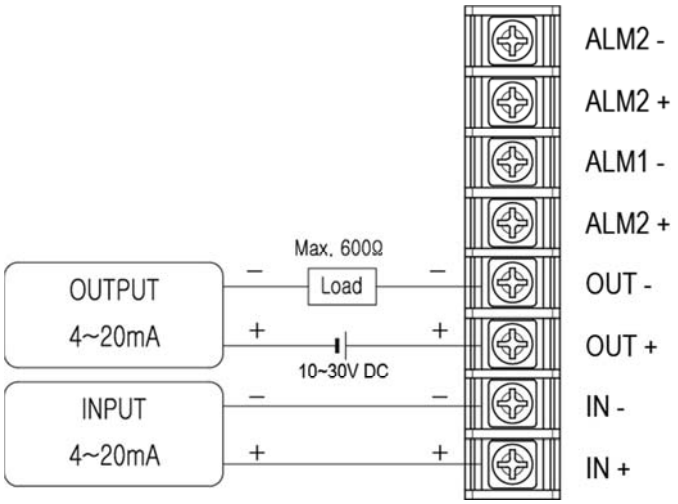


① Alarm2 signal (-)	⑥ Feedback signal (+)
② Alarm2 signal (+)	⑦ Input signal (-)
③ Alarm1 signal (-)	⑧ Input signal (+)
④ Alarm1 signal (+)	⑨ Internal ground
⑤ Feedback signal (-)	⑩ External ground

5.2 Power and feedback signal connection

⚠ WARNING

- Make sure that the input current does not exceed the specification range of the product. Exceeding the specification range may cause malfunction.
- Check polarity of + and – exactly and connect wires.
- Make sure input signal and feedback wiring lines correctly. Incorrect connection of the Feedback line to the power input can damage the components on the PCB.



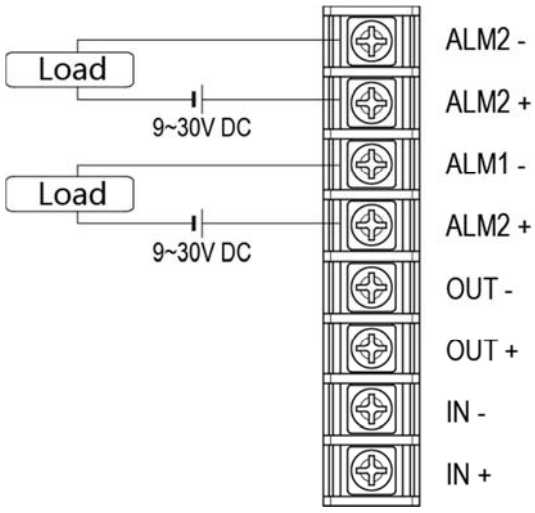
5.3 Alarm switch connection

The alarm module is built in to all products. According to the requirements of the site, you can get the feedback from the emergency alarm signal by wiring as follow.

The alarm circuit is OFF when the system is operating normally.
The alarm circuit turns ON according to the set values as below.

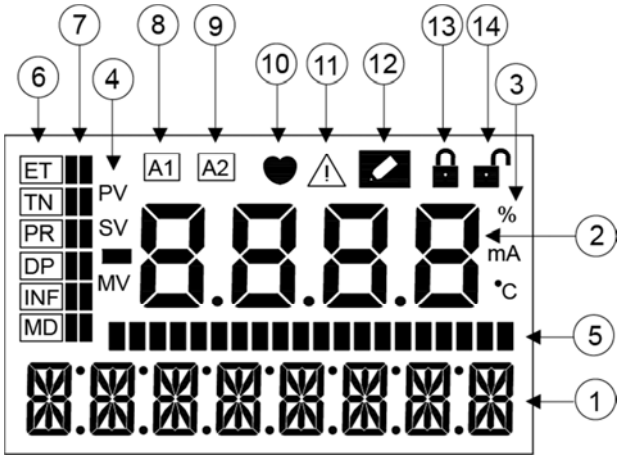
- When the product has seriously problems
- When there is a potential problem
- When the valve is fully open
- When the valve is fully close

For the setting method refer to < **AL1 URGT**> and< **AL2 URGT**> of page 44.



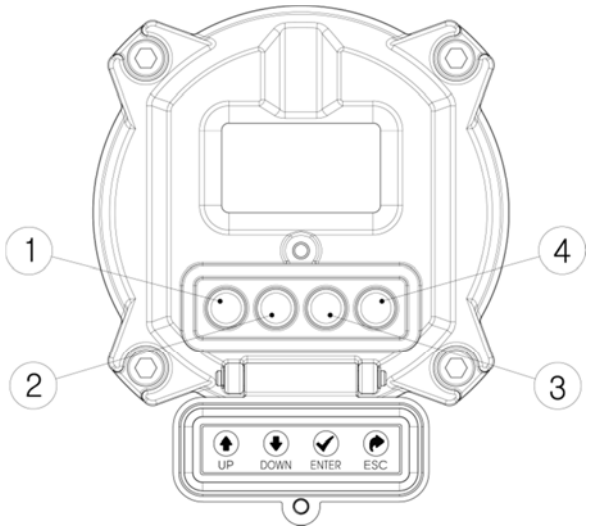
6 Calibration

6.1 Description of Display



No.	Displayed contents	Description	
①	Manu information	Displays the running menu. (Main menu, Main parameter, Sub parameter)	
②	Manu's value	Displays the currently parameter value of the menu.	
③	Manu's value unit	Displays the currently menu's value unit.	
④	Menu's value separator	**PV**	Progress value
		SV	Signal value
		MV	Motor control value
⑤	Progress bar	Displays the progress of the processor in bar form.	
⑥	Main parameter	Displays the selected main parameter currently.	
⑦	Parameter bar	Displays the position of the selected main parameter.	
⑧	Alarm 1	The icon is displayed, when the set value of alarm 1 is satisfied.	
⑨	Alarm 2	The icon is displayed, when the set value of alarm 2 is satisfied.	
⑩	HART communication	The icon is displayed, when HART communication is in progress.	
⑪	Error code	The icon is displayed If there is an error during calibration or operation.	
⑫	Modifying	The icon is displayed, when changing the internal setting values such as parameter modification.	
⑬	LOCK	The icon is displayed, when the program is locked.	
⑭	UNLOCK	The icon is displayed, when the program is unlocked.	

6.2 Description of Buttons



① UP button
② DOWN button
③ ENTER button
④ ESC button

Button	Descriptions
ENTER	• Execute the functions of the selected menu. • Saving the modified parameter values.
ESC	• Moving from the current menu go back to the upper level menu. • Cancel current command.
UP	• Moving between menus of the same level such as main menu, main parameter, sub parameter. • Change to the larger value of the set value of the selected parameter.
DOWN	• Moving between menus of the same level such as main menu, main parameter, sub parameter. • Change to the smaller value of the set value of the selected parameter.

6.3 How to perform the fast auto calibration

Open the cover of the product follow below steps to perform the quick auto calibration.

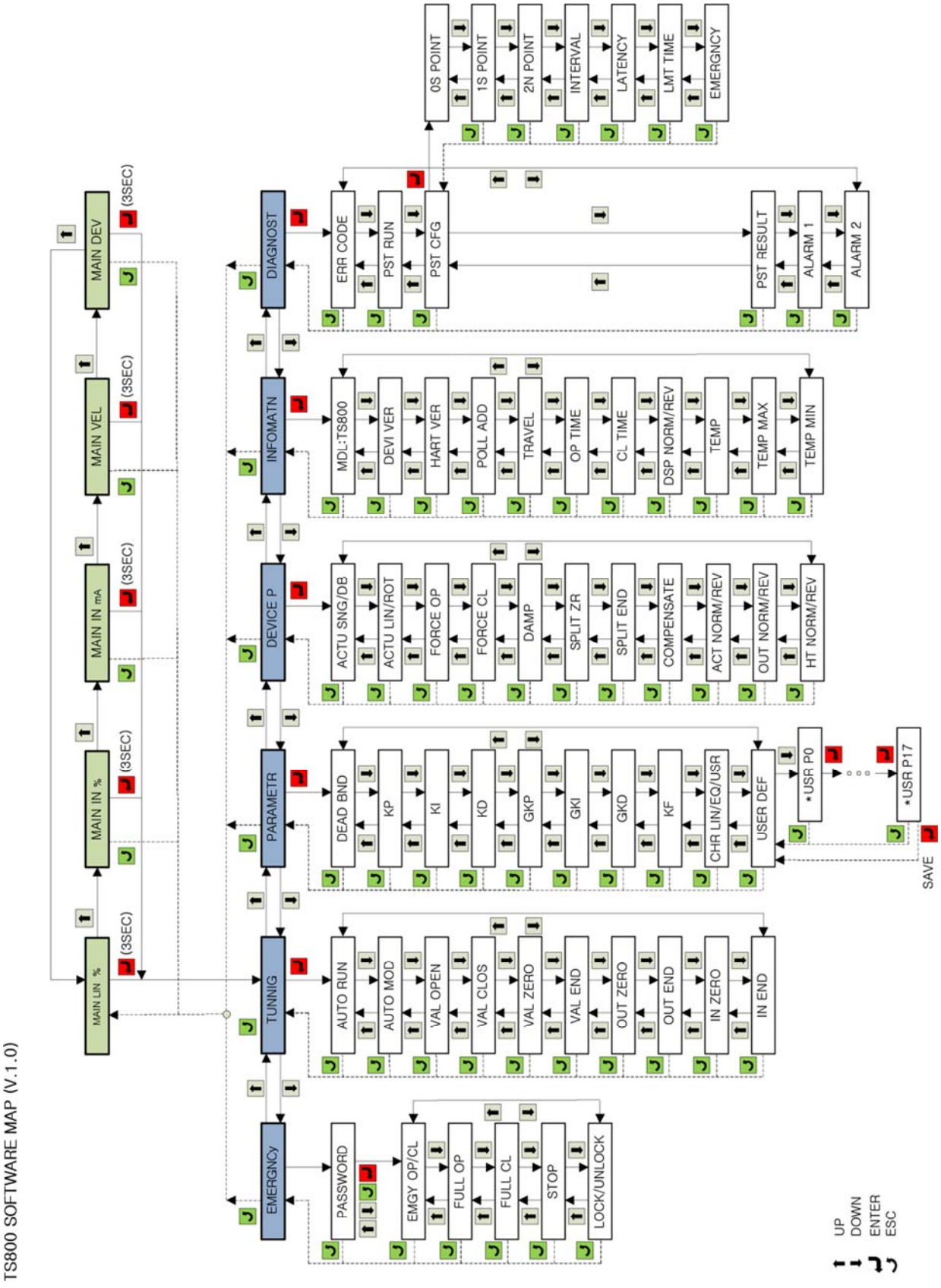
① Input **4~20mA** of current signal, pressing the <**ENTER**> button for 3seconds.
② When "**TUNNIG**" is displayed, press the <**ENTER**> button once.
③ When "**AUTO RUN**" is displayed, press the<**ENTER**> button once, and then starts the auto calibration.
④ The calibration process may take 1 ~ 3 minutes depending on the valve size.

6.3.1 Steps of auto calibration

When auto calibration is progress, it will proceed automatically in the following steps.

Steps	Check point
STEP0	Check the zero point of the valve speed. checked at the reference point of valve stops.
STEP1	Finding a zero point of the valve stroke.
STEP2	Finding a end point of the valve stroke.
STEP3	Measure the time of valve fully open. Measure the time of the valve takes from full close to full open.
STEP4	Measure the time of valve fully close. Measure the time of the valve takes from full open to full close.
STEP5	Measure of the Low BIAS Measure the motor signal reference value, when the position of valve at the 25%.
STEP6	Measure of the High BIAS Measure the motor signal reference value, when the position of valve at the 75%.

6.4 Software map



6.5 Description of Main menus

When the product is booted, **<MAIN LIN>** is displayed, which shows the current opening of the valve. Press **<UP>** or **<DOWN>** button to move to the following menu and check the corresponding information.

In the main menu, information such as the valve opening and the magnitude of the input current signal can be checked and the execution of the command or the modification of the parameter value cannot be performed.

<table>
<tr><th>Main menus</th><th colspan="2">Description</th></tr>
<tr><td rowspan="7">MAIN LIN</td><td colspan="2">Displayed percentage of current valve opening value
Depending on the set value of the flow characteristics, one of the following 5 is displayed.</td></tr>
<tr><td>LCD display value</td><td>Set flow characteristics</td></tr>
<tr><td>MAIN LIN</td><td>Linear</td></tr>
<tr><td>MAIN EQ1</td><td>EQ1 (1/25)</td></tr>
<tr><td>MAIN EQ2</td><td>EQ2 (1/50)</td></tr>
<tr><td>MAIN QO</td><td>Quick Open</td></tr>
<tr><td>MAIN USR</td><td>User defined 17 points</td></tr>
<tr><td>MAIN IN %</td><td colspan="2">Displayed the magnitude of input signal that the positioner recognizes as percentage.
• If the size of the input signal recognized by the positioner differs from output signal of the DCS or calibrator, check the voltage of the power supply.
• If the supply current is normal, please reset the <IN ZERO> and <IN END> values in the <TUNNING> of main parameter.</td></tr>
<tr><td>MAIN IN mA</td><td colspan="2">Displayed the magnitude of input signal that the positioner recognizes as mA.
• If the size of the input signal recognized by the positioner differs from output signal of the DCS or calibrator, check the voltage of the power supply.
• If the supply current is normal, please reset the <IN ZERO> and <IN END> values in the <TUNNING> of main parameter.</td></tr>
<tr><td>MAIN VEL</td><td colspan="2">Displayed currently operating speed of the valve as numbers.
• The numbers between -2047 to +2048 and negative numbers indicate speed at close, and positive numbers indicate speed at open.
• 0 means stop and the larger the absolute value, the faster the speed.</td></tr>
<tr><td>MAIN DEV %</td><td colspan="2">Displayed current input signal and valve opening value as percentage.
• Display percentage of error between the current input signal and valve opening value.
• The larger the error, the lower the control characteristic.</td></tr>
</table>

6.6 Description of Main parameters

The main parameter menu corresponds to the main menu in which various parameters are classified by function.

- When the product is booted, press and hold the **<ENTER>** button for 3 seconds to enter the main menus.
- Main menu is classified as below and can be moved by pressing **<UP>** or **<DOWN>** buttons.
- Press the **<ENTER>** button in the corresponding main menu to enter the sub parameter menus.

Main menus	Main functions of Submenu
TUNNING	• Auto calibration. • Change position of valve zero and span manually. • Change the zero and span of feedback signal manually.
PARAMETR	• Setting the Dead band. • Change PID values. • Change the flow characteristics.
DEVICE P	• Setting the Single and Double, according to the actuator types. • Setting the Linear and Rotary, according to the actuator types. • Setting the signal point of Force Open/Close. • Setting the acting type of Direct action/ Reverse action. • Change the valve acting speed.
INFOMATN	• Display the model of product. • Display the versions of device and HART. • Display the accumulated time of Open/Close. • Display the current ambient temperature, the recorded maximum ambient temperature, and the recorded minimum ambient temperature.
DIAGNOST	• Display the error code. • Setting the PST function. • Setting the Alarm function.
EMERGNCy	• In case of emergency, set to forcibly open the valve, or close valve, or maintain current position of the function. • Setting the Lock and Unlock function.

6.7 Description of Submenus

The following is detailed description about the corresponding submenu of the main menu.

- Press <**ENTER**> button in the main menu to enter the submenus.
- Use <**UP**> and <**DOWN**> buttons to move between submenus.

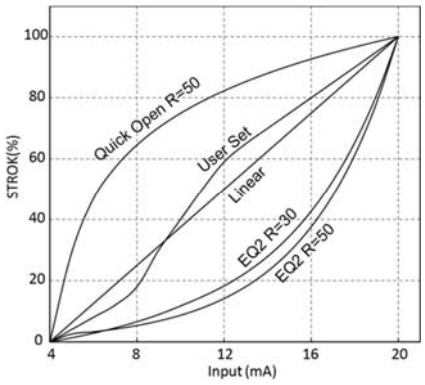
6.7.1 Submenus of TUNNING

<table>
<tr><th>Submenus</th><th colspan="2">Description of function</th></tr>
<tr><td>AUTO RUN</td><td colspan="2">Perform auto calibration
• Executable from any input signal between 4 and 20 mA.
• It takes 1~3minutes, depending on the valve size.</td></tr>
<tr><td rowspan="6">AUTO MOD</td><td colspan="2">Selects the auto calibration mode.
It is set to normal mode at the factory.</td></tr>
<tr><td>Selectable value</td><td>Description</td></tr>
<tr><td>AM FULL</td><td>Set all parameter values again.</td></tr>
<tr><td>AM BIAS</td><td>Only reset the motor reference value, but the other parameter values are not modified.</td></tr>
<tr><td>AM PIDb</td><td>Only reset PID value, but the other parameter values are not modified.</td></tr>
<tr><td>AM ZEb R</td><td>Only reset End point and Zero point of the valve, but the other parameter values are not modified.</td></tr>
<tr><td>Factory setting</td><td>AM FULL</td></tr>
<tr><td>VAL OP/CL</td><td colspan="2">Regardless of the current signal, it performs the function of opening and closing the valve with the <UP> or <DOWN> buttons manually.</td></tr>
<tr><td>VAL ZERO</td><td colspan="2">Reset the ZERO point of the valve manually.
Input 4mA current, press the <UP> and <DOWN> button to change the valve position, and press the <ENTER>button to save the current valve position, then the positioner recognizes the current position as the valve ZERO point.</td></tr>
<tr><td>VAL END</td><td colspan="2">Reset the END point of the valve manually.
Input 20mA current, press the <UP> and <DOWN> button to change the valve position, and press the <ENTER>button to save the current valve position, then the positioner recognizes the current position as the valve END point.</td></tr>
</table>

OUT ZERO	Reset the ZERO point of the feedback signal manually. Input **4mA** current signal, valve reaches zero position, after press the <**UP**> or <**DOWN**> button to adjust the value, until the 4mA feedback signal is output, and then press the <**ENTER**>button to save.
	⚠ **NOTICE**
	OUT ZERO setting must be done once after installing feedback module
OUT END	Reset the END point of the feedback signal manually. Input **20mA** current signal, valve reaches end position, after press the <**UP**> or <**DOWN**> button to adjust the value, until the 20mA feedback signal is output, and then press the <**ENTER**>button to save.
	⚠ **NOTICE**
	OUT END setting must be done once after installing feedback module
IN ZERO	Reset the ZERO value of input signal manually.. If <**MAIN IN%**> and <**MAIN mA**> appear in the main menu differ from the actual input signal, execute the commands in this menu. Input 4mA current from this menu and press <**ENTER**> button to save.
	⚠ **NOTICE**
	After replacing the main board or After program initialization, you must set the **IN ZERO** setting once.
IN END	Reset the END value of input signal manually. If <**MAIN IN%>** and <**MAIN mA**> that appear in the main menu differ from the actual input signal, execute the commands of this menu. Input **20mA** current from this menu and press <**ENTER**> button to save.
	⚠ **NOTICE**
	After replacing the main board or After program initialization, you must set the **IN END** setting once.
BIAS25	The reference value of the motor whose valve stroke is 25% It is set automatically at auto-calibration, please do not modify this parameter value manually.
BIAS75	The reference value of the motor whose valve stroke is 75% It is set automatically at auto-calibration, please do not modify this parameter value manually.

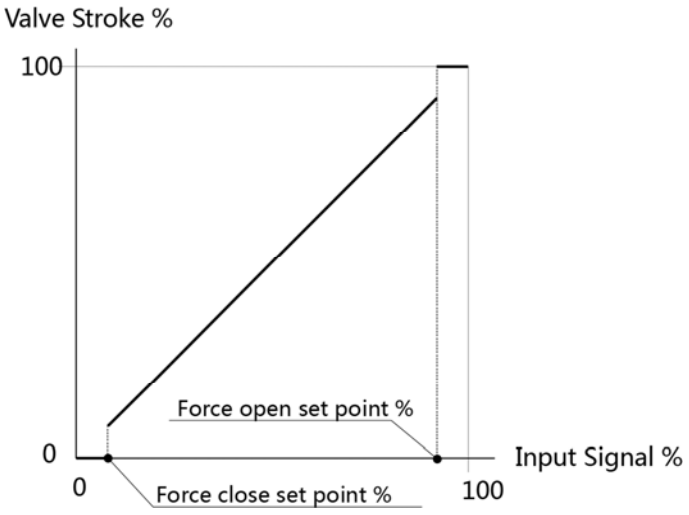
6.7.2 Submenus of PARAMETR

Submenus	Description	
DEAD bND	Dead band range, the range of allowable control error. • If hunting or oscillation occurs due to high packing friction of the valve, the problem can be solved by increasing the value within the range allowed by the field. • If the value is set too high, the accuracy may be reduced.	
	Range of settable value	0~100%
	Factory setting	0.3%
KP	P control value, the proportionality constant value of the control signal in the process of reaching the target point • If the setting value increase, the positioner finds the target point quickly but it is more likely to have hunting. • If the setting value decrease, the stability of the positioner is higher, but positioner finds the target point slowly.	
	Range of settable value	0~500.0
KI	I control value, the integral value that adds the correction signal according to the error percentage to the existing correction signal. • If the setting value is too high, the time to reach the target point is accelerated, but the oscillation phenomenon is easy to occur. • If the setting value is too low, it will slow down the search for the target point.	
	Range of settable value	0~500.0
KD	D control value, indicates the derivative value of the compensation signal based on the percentage of error allowance. • If the setting value is too high, it will slow down the search for the target point. • If the setting is too low, the oscillation is likely to occur.	
	Range of settable value	0~500.0
GKP	P control value, the proportionality constant value of the control signal in the process of reaching the target point • The function is the same as the KP control value but falls within the ± 1% error range of the target value, the GKP value is applied instead of the KP value.	
	Range of settable value	0~500.0
GKI	I control value, the integral value that adds the correction signal according to the error percentage to the existing correction signal. • The function is the same as the KI control value but falls within the ± 1% error range of the target value, the GKI value is applied instead of the KI value.	
	Range of settable value	0~500.0
GKD	D control value, indicates the derivative value of the compensation signal based on the percentage of error allowance. • The function is the same as the KD control value but falls within the ± 1% error range of the target value, the GKD value is applied instead of the KD value.	
	Range of settable value	0~500.0

<table>
<tr><td rowspan="3">KF</td><td colspan="3">Control value to overcome valve friction.
• Increasing the KF value can improve hunting that is caused by valve friction.</td></tr>
<tr><td colspan="2">Range of settable value</td><td>0~500.0</td></tr>
<tr><td colspan="2">Factory setting</td><td>0</td></tr>
<tr><td rowspan="6">CHAR</td><td colspan="3">Set the characteristics of the valve control.
 

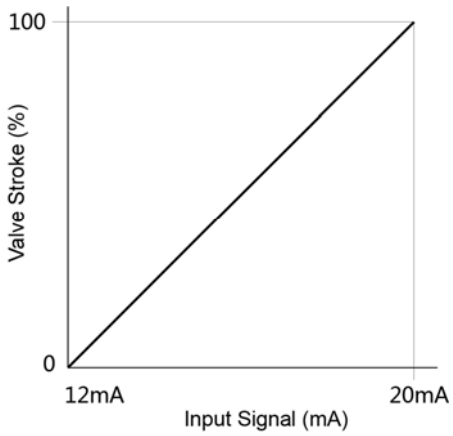
<table>
<tr><th>Input (mA)</th><th>Linear (%)</th><th>EQ1 (%)</th><th>EQ2 (%)</th><th>QO (%)</th><th>USER (%)</th></tr>
<tr><td>4</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>5</td><td>6.25</td><td>2.55</td><td>1.31</td><td>29.13</td><td>4</td></tr>
<tr><td>6</td><td>12.5</td><td>3.26</td><td>2.81</td><td>46.84</td><td>8</td></tr>
<tr><td>7</td><td>18.75</td><td>4.16</td><td>4.54</td><td>57.21</td><td>12</td></tr>
<tr><td>8</td><td>25</td><td>5.32</td><td>6.55</td><td>64.56</td><td>18</td></tr>
<tr><td>9</td><td>31.25</td><td>6.79</td><td>8.92</td><td>70.27</td><td>30</td></tr>
<tr><td>10</td><td>37.5</td><td>8.67</td><td>11.73</td><td>74.93</td><td>40</td></tr>
<tr><td>11</td><td>43.75</td><td>11.07</td><td>14.76</td><td>78.87</td><td>50</td></tr>
<tr><td>12</td><td>50</td><td>14.14</td><td>18.26</td><td>82.28</td><td>59</td></tr>
<tr><td>13</td><td>56.25</td><td>18.06</td><td>22.58</td><td>85.29</td><td>65</td></tr>
<tr><td>14</td><td>62.5</td><td>23.06</td><td>27.93</td><td>87.99</td><td>70</td></tr>
<tr><td>15</td><td>68.75</td><td>29.45</td><td>34.55</td><td>90.42</td><td>75</td></tr>
<tr><td>16</td><td>75</td><td>37.61</td><td>42.73</td><td>92.65</td><td>80</td></tr>
<tr><td>17</td><td>81.25</td><td>48.02</td><td>52.85</td><td>94.69</td><td>85</td></tr>
<tr><td>18</td><td>87.5</td><td>61.32</td><td>65.37</td><td>96.59</td><td>90</td></tr>
<tr><td>19</td><td>93.75</td><td>78.31</td><td>80.85</td><td>98.35</td><td>95</td></tr>
<tr><td>20</td><td>100</td><td>100</td><td>100</td><td>100</td><td>100</td></tr>
</table></td></tr>
<tr><td rowspan="5">Possible values</td><td>CHAR LIN</td><td>Linear</td></tr>
<tr><td>CHAR EQ1</td><td>Equal percentage (1/25)</td></tr>
<tr><td>CHAR EQ2</td><td>Equal percentage (1/50)</td></tr>
<tr><td>CHAR QUI</td><td>Quick Open</td></tr>
<tr><td>CHAR USR</td><td>User defined17poins</td></tr>
<tr><td>Factory setting</td><td colspan="2">CHAR LIN</td></tr>
<tr><td rowspan="6">USER DEF</td><td colspan="3">Realize the special flow curve by user-defined 17 points.
• In addition to the above Linear, Equal percentage, Quick open and other typical flow characteristics, the user can set the 4~20mA corresponding valve stroke position to achieve special flow curve control.
• To execute this function, <CHAR USR> must be set from the <CHAR> menus above.</td></tr>
<tr><td>Setting steps</td><td colspan="2">Set the valve position according to the signal.</td></tr>
<tr><td>*USR P0</td><td colspan="2">Set the valve position when the input signal is 4 mA.</td></tr>
<tr><td>*USE P1</td><td colspan="2">Set the valve position when the input signal is 5 mA.</td></tr>
<tr><td>*USR P2</td><td colspan="2">Set the valve position when the input signal is 6 mA.</td></tr>
<tr><td>*USR P3~16</td><td colspan="2">Follow above steps for setting the valve position when the input signal is 7~19mA .</td></tr>
<tr><td>*USR P17</td><td colspan="2">Set the valve position when the input signal is 20 mA.</td></tr>
</table>

6.7.3 Submenus of DEVICE P

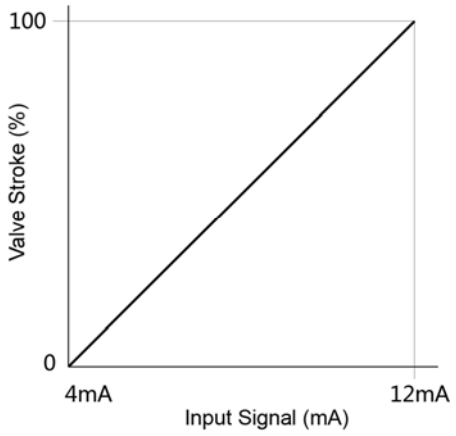
<table>
<tr><th>Submenus</th><th colspan="3">Description</th></tr>
<tr><td rowspan="6">ACTU SNG</td><td colspan="3">Depending on the actuator type, it must be set to Single or Double manually.</td></tr>
<tr><td colspan="3">⚠ NOTICE</td></tr>
<tr><td colspan="3">If the set value differs from the actuator type, the control characteristic may be degraded.</td></tr>
<tr><td rowspan="2">Possible settings</td><td>ACTU SNG</td><td>Single type</td></tr>
<tr><td>ACTU DbL</td><td>Double type</td></tr>
<tr><td rowspan="2">Factory setting</td><td>TS900L</td><td>ACTU SNG</td></tr>
<tr><td>TS900R</td><td>ACTU DbL</td></tr>
<tr><td rowspan="6">ACTU LIN</td><td colspan="3">Depending on the actuator type, it must be set to Single or Double manually.</td></tr>
<tr><td colspan="3">⚠ NOTICE</td></tr>
<tr><td colspan="3">If the set value differs from the actuator type, the control characteristic may be degraded.</td></tr>
<tr><td rowspan="2">Possible settings</td><td>ACTU LIN</td><td>Linear type</td></tr>
<tr><td>ACTU ROT</td><td>Rotary type</td></tr>
<tr><td rowspan="2">Factory setting</td><td>TS900L</td><td>ACTU LIN</td></tr>
<tr><td>TS900R</td><td>ACTU ROT</td></tr>
<tr><td rowspan="4">FORCE OP</td><td colspan="3">When the input signal is higher than the set value, the valve is forced to open. This parameter is used to move the valve into its seat with the maximum force of the actuator.
 
</td></tr>
<tr><td>Range of settable values</td><td colspan="2">0~100%</td></tr>
<tr><td>Factory setting</td><td colspan="2">100%</td></tr>
<tr><td>Note</td><td colspan="2">When the value set to 100%, this function is not applied.</td></tr>
</table>

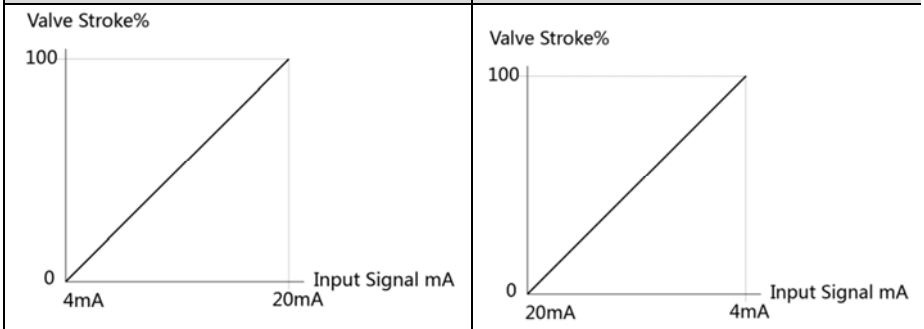
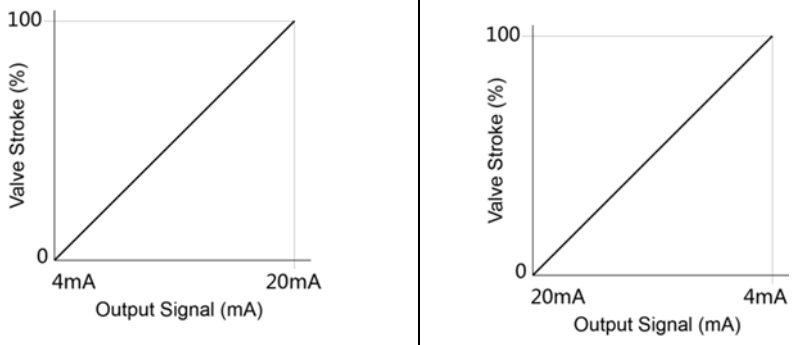
<table>
<tr><td rowspan="4">FORCE CL</td><td colspan="2">When the input current signal is lower than the set value, the valve is forced to close.
• When the valve is closed, residual pressure in the actuator chamber can be completely released.</td></tr>
<tr><td>Range of settable values</td><td>0~100%</td></tr>
<tr><td>Factory setting</td><td>0.3%</td></tr>
<tr><td>Note</td><td>When the value set to 0%, this function is not applied.</td></tr>
<tr><td rowspan="4">DAMP</td><td colspan="2">This function controls the operating speed of the valve.
• The higher the set value, the slower the operating speed of the valve.
• With this function, hunting phenomenon of small actuator can be solved.</td></tr>
<tr><td>Range of settable values</td><td>0~100%</td></tr>
<tr><td>Factory setting</td><td>0%</td></tr>
<tr><td>Note</td><td>When the value set to 0%, this function is not applied.</td></tr>
<tr><td rowspan="3">SPLIT ZR</td><td colspan="2">Set the zero point of the signal value during the split range control.

For example, if the set value is 50%, 12mA corresponds to 0% of the valve opening as shown in the right figure .

 
</td></tr>
<tr><td>Range of settable values</td><td>0~100%</td></tr>
<tr><td>Factory setting :</td><td>0%</td></tr>
<tr><td rowspan="3">SPLIT END</td><td colspan="2">Set the end point of the signal value during the split range control.

For example, if the set value is 50%, 12mA corresponds to 100% of the valve opening as shown in the right figure .

 
</td></tr>
<tr><td>Range of settable values</td><td>0~100%</td></tr>
<tr><td>Factory setting :</td><td>0%</td></tr>
</table>

<table>
<tr><td rowspan="4">COMPENSA</td><td colspan="3">This parameter corrects the error between LCD value and actual valve opening.</td></tr>
<tr><td colspan="3">⚠ NOTICE</td></tr>
<tr><td colspan="3">This function should only be used with Linear type products and rotary products must be set to 0%.</td></tr>
<tr><td>Range of setting values</td><td colspan="2">0~100%</td></tr>
<tr><td rowspan="2">Factory setting</td><td>TS900L(Linear type)</td><td>2%</td></tr>
<tr><td>TS900R(Rotary type)</td><td>0%</td></tr>
<tr><td rowspan="4">ACT NORM</td><td colspan="3">Change the action type of the valve.</td></tr>
<tr><td colspan="3">Reverse Action Direct Action
 
</td></tr>
<tr><td rowspan="2">Possible settings</td><td>ACT NORM</td><td>Reverse Action</td></tr>
<tr><td>ACT REVE</td><td>Direct Action</td></tr>
<tr><td>Factory setting</td><td colspan="2">ACT NORM</td></tr>
<tr><td rowspan="4">OUT NORM</td><td colspan="3">Set the feedback signal from the positioner can be output at the same percentage as the valve stroke, or the opposite percentage.</td></tr>
<tr><td colspan="3">Normal Reverse
 
</td></tr>
<tr><td rowspan="2">Possible settings</td><td>OUT NORM</td><td>Normal action</td></tr>
<tr><td>OUR REVE</td><td>Reverse action</td></tr>
<tr><td>Factory setting</td><td colspan="2">OUT NORM</td></tr>
<tr><td rowspan="3">HT NORM</td><td colspan="3">Adjusts the valve opening in the forward reverse or direction of the HART communication signal.</td></tr>
<tr><td rowspan="2">Possible settings</td><td>HT NORM</td><td>Direct action</td></tr>
<tr><td>HT REVE</td><td>Reverse action</td></tr>
<tr><td>Factory setting</td><td colspan="2">HT NORM</td></tr>
</table>

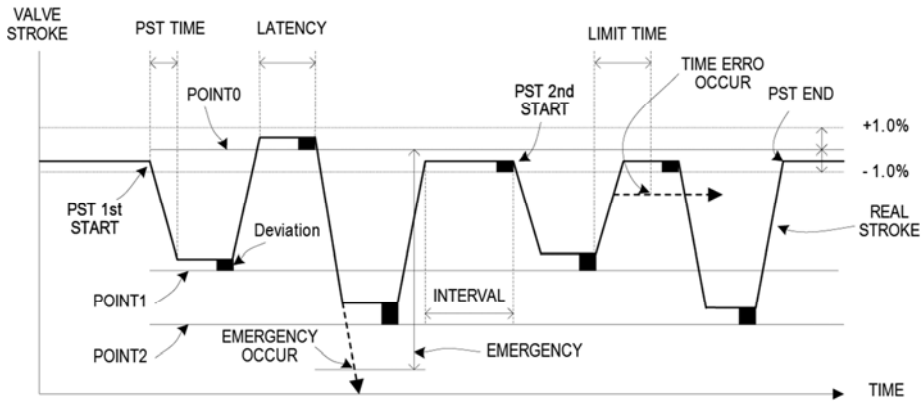
6.7.4 Submenus of INFOMATN

You can find the following information through the submenus.

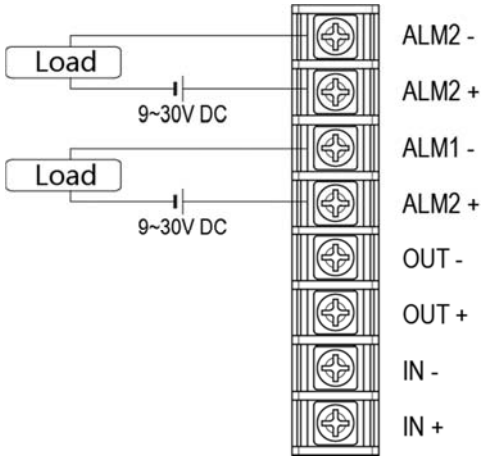
<table>
<tr><th>Submenus</th><th colspan="3">Description</th></tr>
<tr><td>MDL</td><td colspan="3">Displays the model of the product.</td></tr>
<tr><td>DEVI VER</td><td colspan="3">Displays the version of device.</td></tr>
<tr><td>HART VER</td><td colspan="3">Displays the version of HART communication.</td></tr>
<tr><td>POLL ADD</td><td colspan="3">Displays the polling address of the device in HART communication.</td></tr>
<tr><td>TRAVEL</td><td colspan="3">Displays the accumulated total travel distance of the valve after the positioner has been used. (Unit: K%)

One full travel distance from full close to full open means 100% = 0.001K% For example, if the travel value is 1K%, this means that the valve has moved 1000 stroke percentages.</td></tr>
<tr><td>OP TIME</td><td colspan="3">Displays the total accumulated time when the valve is fully open.
Unit : Second</td></tr>
<tr><td>CL TIME</td><td colspan="3">Displays the total accumulated time when the valve is fully close.
Unit : Second</td></tr>
<tr><td rowspan="4">DSP NORM</td><td colspan="3">Display the valve opening value on the LCD in reverse direction.</td></tr>
<tr><td rowspan="2">Possible settings</td><td>DSP NORM</td><td>When the valve position is 0%, 0% is displayed on the LCD. When the valve position is 100%, 100% is displayed on the LCD.</td></tr>
<tr><td>DSP REVE</td><td>When the valve position is 0%, 100% is displayed on the LCD. When the valve position is 100%, 0% is displayed on the LCD.</td></tr>
<tr><td>Factory setting</td><td colspan="2">DSP NORM</td></tr>
<tr><td>TEMPERAT</td><td colspan="3">Check the current ambient temperature of the positioner through the built-in temperature sensor.</td></tr>
<tr><td>TEMP MAX</td><td colspan="3">Displays the recorded lowest ambient temperature value after using the product.</td></tr>
<tr><td>TEMP MIN</td><td colspan="3">Displays the recorded lowest ambient temperature value after using the product.</td></tr>
</table>

6.7.5 Submenus of DIAGNOST

<table>
<tr><th>Submenus</th><th colspan="3">Description</th></tr>
<tr><td>ERR CODE</td><td colspan="3">Displays the error code of the product.
You can check the error code to resolve the problem.
For details, refer to the explanation of error codes.(Page 49)</td></tr>
<tr><td rowspan="5">PST RUN</td><td colspan="3">Set whether to execute the PST function.</td></tr>
<tr><td>What is PST</td><td colspan="2">Partial stroke testing (or PST), within the range of not affecting to the flow process, PST prevents the valve stem from sticking by moving the valve finely according to the set value and the period. In case of emergency, it can make the valve operate normally.</td></tr>
<tr><td rowspan="2">Possible settings</td><td>PST RUN</td><td>Execute the PST function</td></tr>
<tr><td>PST OFF</td><td>Do not execute PST function</td></tr>
<tr><td>Factory setting</td><td colspan="2">PST OFF</td></tr>
<tr><td rowspan="6">PST CFG</td><td colspan="3">Set the necessary items to execute the PST function.
The submenu of PST CFG is as below.
 
</td></tr>
<tr><td>Submenu</td><td colspan="2">Description</td></tr>
<tr><td rowspan="3">OP POINT</td><td colspan="2">Sets start position when PST is supposed to start.
Valve initial position must be within ±1% from "0S POINT". If not, wait until this condition is satisfied.</td></tr>
<tr><td>Default value</td><td>100%</td></tr>
<tr><td>Range of values</td><td>0~100%</td></tr>
<tr><td rowspan="3">1S POINT</td><td colspan="2">Sets 1st target position of PST.</td></tr>
<tr><td>Default value</td><td>90%</td></tr>
<tr><td>Range of values</td><td>0~100%</td></tr>
</table>

	2N POINT	Sets 2nd target position of PST.	
		Default value	80%
		Range of values	0~100%
	INTERVAL	Set the waiting time after the first PST is performed and the second PST start.	
		Default value	20 (Seconds)
		Range of values	1~100 (Seconds)
	LATENCY	Set the waiting time from "**1S POINT**" to "**2N POINT**" start. After reaching the first target point "**1S POINT**", return to the initial position, wait for the "**LATENCY**" time specified by the user, and then move to the second "**2S POINT**" target point again.	
		Default value	10 (Seconds)
		Range of values	1~100 (Seconds)
	LMT TIME	Set the time allowed to reach the target point. If the time to reach the target value during the PST execution exceeds the "**LMT TIME**" time or there is no movement, the PST is considered to have failed and the PST is immediately interrupted.	
		Default value	5 (Seconds)
		Range of values	0~100 (Seconds)
	EMERGNCY	In the PST process, if the valve position exceeds the "**EMERGNCY**" set value, the PST function is stopped	
		Default value	15%
		Range of values	0~100%
PST REDy	Check the PST function execution result value. The LCD screen displays the following information based on the set values and the execution results. See the table below to confirm the PST execution result information.		
	Result value	**PST REDy**	Ready to run PST.
		PST SUCS	PST succeed.
		PST TOUT	"LMT TIME" failed to reach the target value within the set time value range.
		PST FIXD	Valve has no action.
		PST DOUT	Exceed the target value by more than 1%.
		PST EMRG	Exceeding the allowable valve position error range, beyond the "EMERGNCY" setting value.

<table>
<tr><td rowspan="7">AL1 URGT</td><td colspan="3">Setting Alarm 1
According to the set value, If the following conditions are satisfied, the alarm circuit is turned “ON”, and LCD displayed A1 simbol.
It remains “OFF” during normal operation.
 
</td></tr>
<tr><td rowspan="5">Possible settings</td><td>AL1 URGT</td><td>When the product has a serious problem
When the priority value is 0 in the error code. (Refer to page 48)</td></tr>
<tr><td>AL1 PRI 1</td><td>When there is a potential problem
When the product has a serious problem
When the priority value is 1 in the error code. (Refer to page 48)</td></tr>
<tr><td>AL1 F_CL</td><td>When the valve is fully closed.</td></tr>
<tr><td>AL1 F_OP</td><td>When the valve is fully opened.</td></tr>
<tr><td>AL1 NONE</td><td>Disable this alarm function</td></tr>
<tr><td>Factory setting</td><td colspan="2">AL1 NONE</td></tr>
<tr><td rowspan="3">AL2 URGT</td><td colspan="3">Setting Alarm 2
According to the set value, If the following conditions are satisfied, the alarm circuit is turned “ON”, and LCD displayed A2 simbol.
It remains “OFF” during normal operation.</td></tr>
<tr><td>Possible settings</td><td colspan="2">Same as AL1 URGT of above</td></tr>
<tr><td>Factory setting</td><td colspan="2">AL2 NONE</td></tr>
</table>

6.7.6 Submenus of EMERGNCy

Submenus	Description		
PASSWORD	Must enter a password to enter this menu. The password is set at the factory and cannot be changed by the user.		
	Factory setting	Press **UP > ENTER > DOWN > UP** button sequentially. (Press the 1321 buttons from left to right)	
EMGY OP	The position of the valve to be moved can be determined when an abnormality of the positioner is detected.		
	Possible settings	**EMGy None**	Do not take any action.
		EMGy Open	Open the valve fully.
		EMGy Close	Close the valve fully.
		EMGy Stop	Stop the valve operation.
	Factory setting	**EMGy None**	
FULL OP	Open the valve fully by manual regardless of the input signal.		
FULL CL	Close the valve fully by manual regardless of the input signal.		
STOP	Maintains the current valve position regardless of the input signal.		
LOCK or UNLOCK	It locks to prevent changing all parameter values. When set to "**LOCK**", all commands such as auto-calibration, PID change, and set parameter values cannot be changed.		
	Passible setting	**LOCK**	Lock the program
		UNLOCK	Unlock the program
	Factory setting	**UNLOCK**	

7 Error code and Troubleshooting

- If there is a problem when installing or using the product, the ⚠ symbol appears on the top of the LCD.
- If you enter the "**ERR CODE**" which is submenu of "**DIAGNOST**", an error code appears.
- Check the error code and refer to the table below to solve the problem.

No	Code	priority	Cause	Resolution
1	**L**	1	Valve End point is set too high	• Check whether the positioner is installed too high or low. • Check whether the positioner is installed too far from the actuator. (Check the angle of use) • Check the potentiometer gear and main gear are out of position. (The cause of the problem is strong vibration or external shock).
2	**K**	1	Valve Zero point is set too low	• Check whether the positioner is installed too high or low. • Check whether the positioner is installed too far from the actuator. (Check the angle of use) • Check the potentiometer gear and main gear are out of position. (The cause of the problem is strong vibration or external shock).
3	**J**	1	Valve End and Zero points are set too close. (Use angle is too small)	• Increase the angle of use by repositioning the positioner closer to the actuator.
4	**I**	1	Input current is below 3.8mA	• Check input current signal
5	**H**	1	Input current is over 22mA	• Check input current signal
6	**G**	1	BIAS value exceeds limit	• Run Auto-Calibration again (Accuracy is significantly reduced when used without auto-calibration)
7	**F**	1	Ambient temperature too high	• Check ambient temperature
8	**E**	1	Ambient temperature too low	• Check ambient temperature
9	**D**	1	Used over 100,000 cycles	• Check positioner regularly
10	**C**	0	Used over 500,000 cycles	• Check positioner regularly
11	**B**	0	Used over 1million cycles	• Replace positioner
12	**A**	0	EEPROM damaged	• Replace main PCB

8 Limited warranty and disclaimer

- This product has been fully inspected and shipped through a thorough quality inspection procedure. The manufacturer warranty period of the product is 18 months after the product is shipped from Tissin in Korea.

- For any failure or damage reported within the warranty period which is clearly our responsibility, a replacement product or necessary parts will be provided. This limited warranty applies only to our product independently, and not to any other damage incurred due to the failure of the product.

- Using the device in a manner that does not fall within the scope of its intended use, disregarding this manual, using under qualified personnel, or making unauthorized alterations releases the manufacturer from liability for any resulting damage. This renders the manufacturer's warranty null and void.

tissin

Solutions for Control Valve System

Tissin Co.,Ltd.

201-1105, No 397, Seokcheon-ro,Ojeong-gu,

Bucheon-Si,Gyeonggi-do, Korea 14449

Tel : +82-32-624-4573,

Fax : +82-32-624-4574

www.tissin.co.kr