

SERVO-TOP II ELECTRONIC ACTUATOR
(linear type)

MODEL **PSN1/PSN3**

BEFORE USE

Thank you for choosing us. Before use, please check contents of the package you received as outlined below. If you have any problems or questions with the product, please contact our sales office or representatives.

■ SAFETY PRECAUTIONS

Before use, please read all the following precautions carefully to ensure the safety. These safety precautions, classified into "WARNING" and "CAUTION" according to the degree of damage that each item could cause, are imperative to prevent an accident. After reading, be sure to keep this manual always in a visible and accessible place for the user.

△ WARNING Suggesting that failure to observe the precautions could result in death or serious personal injury.

△ CAUTION Suggesting that failure to observe the precautions could result in personal injury or damage to the property.

△ WARNING

Be sure to replace the terminal box cover which houses the power input terminals on before turning on the power supply. It could cause electric shock.

Power fuse: A glass tube power fuse (5.2 dia × 20 mm) of the rating as shown below is incorporated for safety. Be sure to remove the power supply before replacing it. Replacing the fuse without turning off the power supply could cause electric shock.

- AC power (common): 3A 250V (Medium time lag)
- DC power (PSN1): 6A 125V (Medium time lag)
- (PSN3): 4A 125V (Medium time lag)

Remove power supply to the actuator before wiring to it. It could cause electric shock.

DO NOT loosen the set screw fixing the lever of angle sensor. Loosening it may cause a malfunction. It could cause electric shock, burn, and injuries.

DO NOT step onto the actuator. DO NOT rest a heavy object on or against it. It could cause injury.

When installing the PSN outdoor or where it is exposed to rain or water drops, adequate precaution must be done for preventing water from entering inside through wiring conduits. It could cause electric shock.

DO NOT mount the PSN in such direction that the output stem is at the top of the actuator. It could cause electric shock.

Be surer that the power supply is removed. Hand or arm could be caught and cause injury.

When the operation is completed, be sure to remove the spanner and cover the stem with a rubber cap. Hand or arm could be caught and cause injury.

△ CAUTION

Inside the cover, the metal plate mounting printed wiring boards located above the motor is also installed for heat dissipation. The motor and the plate may become extremely hot during operation. DO NOT touch them with bare hands. It could cause burn injury.

The adjustments which are paint locked are for factory use only and should be changed only by qualified our personnel. We are not liable for any malfunction or inconvenience caused by unauthorized change of them by the user. Otherwise it could cause breakdown.

■ PACKAGE INCLUDES:

- SERVO-TOP II body(1)
- Indicator (when the stem button is selected; attached to the actuator body with a Scotch tape)(1)
- Note: Yoke and other components necessary to attach the PSN to a valve are to be provided by the customer.

■ MODEL NO.

Confirm Model No. marking on the product to be exactly what you ordered.

■ INSTRUCTION MANUAL

This manual describes necessary points of caution when you use this product, including installation and connection, hardware setting, and basic maintenance procedures.

With the emergency shutdown option selected, please also refer to PSN1/PSN3 Instruction Manual for this option (EM-4857-A).

When you need to change software settings, please refer to the Operation Manual for Model PU-2x (EM-9255), Section B. This unit is factory adjusted and calibrated according to the Ordering Information included in the product package. If you do not need to change the pre-adjusted setting, you can skip the sections on PU-2x programming in this manual and the Operation Manual for Model PU-2x.

POINTS OF CAUTION

■ CONFORMITY WITH EU DIRECTIVES

- This equipment is suitable for Pollution Degree 2 and Installation Category II (transient voltage 2500V). Reinforced insulation (Signal or metallic housing or seq. signals or battery status (with failsafe function only) to power: 300V) is maintained. Prior to installation, check that the insulation class of this unit satisfies the system requirements.
- Altitude up to 2000 meters.
- The equipment must be installed such that appropriate clearance and creepage distances are maintained to conform to CE requirements. Failure to observe these requirements may invalidate the CE conformance.
- Install lightning surge protectors for those wires connected to remote location. Refer to "LIGHTNING SURGE PROTECTION" section below.

■ POWER INPUT RATING & OPERATIONAL RANGE

- Locate the power input rating marked on the product and confirm its operational range as indicated below:
 - 100 – 120V AC rating: 90 – 132V, 47 – 66 Hz, approx. 240VA (200VA for PSN3)
 - 200 – 240V AC rating: 180 – 264V, 47 – 66 Hz, approx. 240VA (200VA for PSN3)
 - 24V DC rating: 24V ±10% approx. 3.7A (approx. 3A for PSN3)

■ GENERAL PRECAUTIONS

- DO NOT install signal wires and power supply wires together in one duct because it may cause a malfunction due to inductive noises. If they must be installed together, use shielded cables.
- If input signals are to be turned on/off with power supplied to the actuator, be sure to set the abnormal low input operation mode.

■ ENVIRONMENT

- Inside building. If outside, keep away from direct sunlight.
- Operating temperature -25 to +55°C (-13 to +131°F) for PSN1; -15 to +55°C (5 to 131°F) for PSN3.
- Operating humidity 30 to 85% RH (non-condensing)
- Vibration 2 G (19.6 m/s²) max.
- The actuator must be installed in a place where maintenance and inspection can be conducted. Observe at least 15 cm (5.9 in.) of open space at the top of its cover for maintenance and inspection.
- Keep away from hazardous atmosphere such like explosive or corrosive gases.

■ SOUND ACCOMPANYING MOTOR ROTATION

- The PSN's stepping motor inherently generates whistling sound during normal operation according to its rotating frequency, larger with lower frequencies. DO NOT be alarmed.

■ PID CONTROL SIGNAL

- Choose PID parameters carefully so that the MV remains as stable as possible. Unstable control shortens the life of actuator and valve.

■ GASKET

- Be sure to return the gasket when you close the cover after wiring or adjustments.

■ SCREW TORQUE

- The torque for tightening screws for the cover is between 2.4 – 3.1 N·m (1.8 – 2.3 ft·lb).

■ DESIGNING YOKE

- When a foreign object is caught in the valve, a thrust as great as 7500 N (1686 lb) could be applied to the yoke. Observe enough strength when designing mechanical components such like the yoke.
- When the PSN is used on a steam stream in temperature control, its temperature may rise beyond ambient temperature caused by a heat conducted or radiated from piping. Use a longer yoke for effective heat dissipation and apply insulation material.

■ OPERATING CONDITION

- Depending on operating condition, internal temperature may rise extremely high.
- When operating continuously with such a condition, it causes short life span or damage and may impair expected performance.
- Operate with an enough margin such as shortening the operational duty time ratio.

COMPONENT IDENTIFICATION

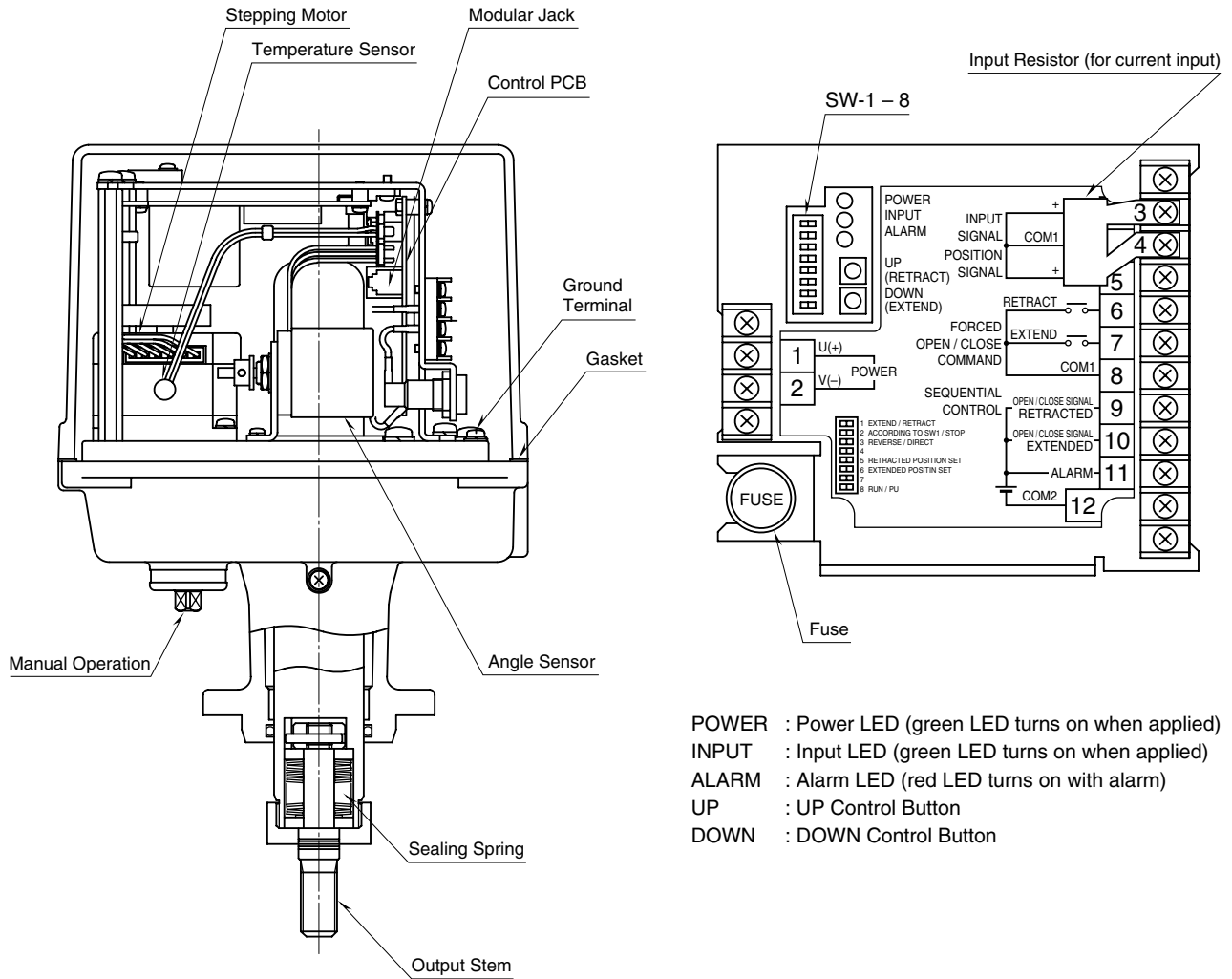


Figure 1. Component Identification

OUTPUT STROKE & ADJUSTABLE RANGE

The servo-control PCB compares input signal (position set-point signal) and actual position signal from the position sensor, and drives the motor to reduce the deviation. When a full-close signal is provided, the output stem is pressed onto the sealing spring after the valve is fully closed, until the sealing pressure reaches a preset value.

MODEL	L (mm)	L (inch)
PSN1-4x1	66 to 106	2.60 to 4.17
PSN1-4x2	52 to 92	2.05 to 3.62
PSN3-6x1	66 to 126	2.60 to 4.96
PSN3-6x2	52 to 112	2.05 to 4.41

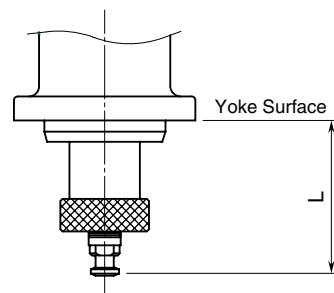


Figure 2. Operational Range of the Output Stem

INSTALLATION

Valve, yoke and other components necessary to connect the PSN to the valve are provided by the customer.

DO NOT CHANGE the ex-factory settings of the PSN. The following procedure should be done with the power supply removed, except when otherwise specified.

(General Procedure)

- 1) Apply power input and 0% input signal (100% for direct action) in order to expose the output stem to the maximum degree.
- 2) Set the valve stem at the lowest position.
- 3) Connect the PSN to the yoke.
- 4) Screw the valve stem into the output stem until there is little opening between them.

For applying a sealing pressure, refer to flexure values in Table 3 (e.g. 1 mm for applying 1500 N for PSN1-x1) and screw it until the opening equals the value.

- 5) Fix both stems with a lock nut.
- 6) Apply power input and approx. 50% input signal and check that there is no opening between the yoke and valve bonnet.

Fix the yoke and the valve.

- 7) Connect the indicator and other components if necessary.

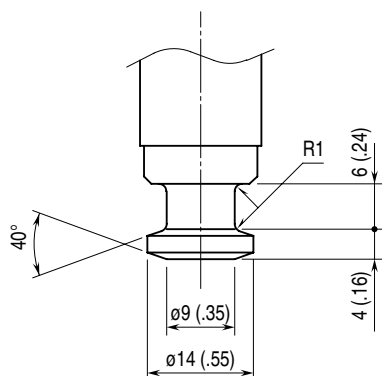


Figure 3. Stem Details

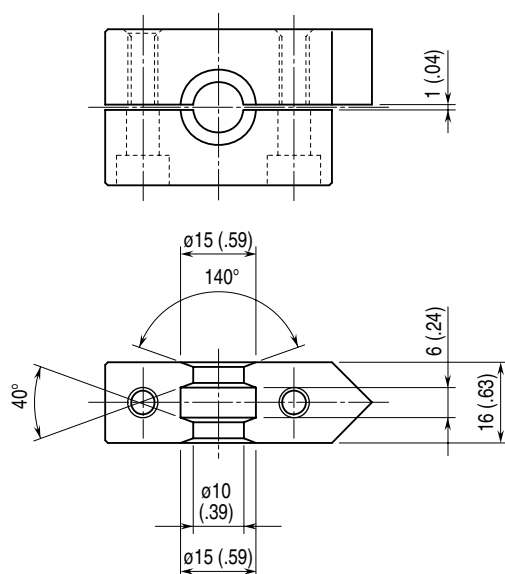


Figure 4. Indicator Details

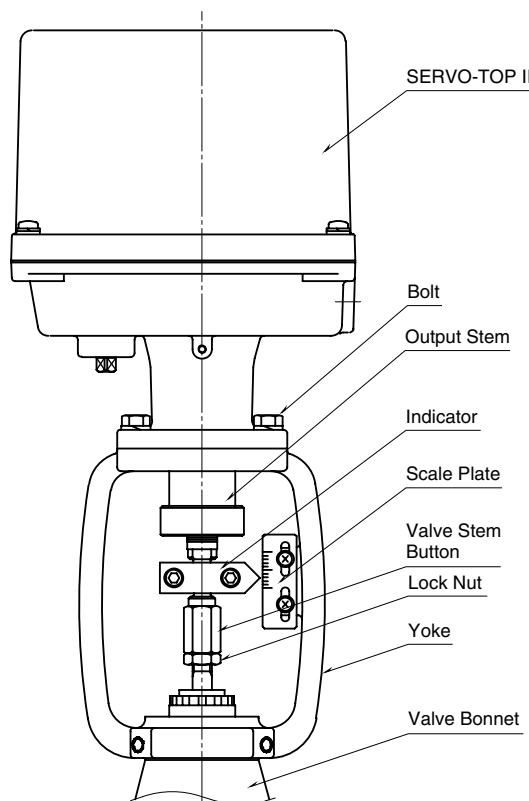
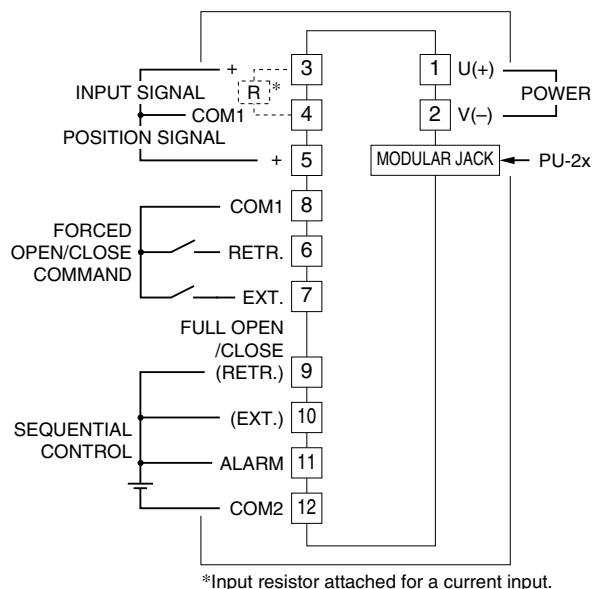


Figure 5. Connecting the PSN with a Valve, Example

ELECTRICAL CONNECTIONS

Remove the cover of the PSN body and wire to the terminal block according to Figure 6.

The PSN requires the power input (1 – 2) and input signal (3 – 4) connections for operating.



APPLICABLE SOLDERLESS TERMINAL

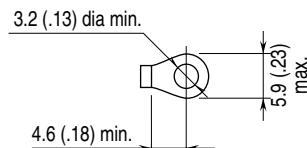


Figure 6. Connection Diagram

ADJUSTMENT PROCEDURE

Open the PSN body cover and adjust the full-open and -closed positions referring to Figure 1. Other adjustments can be also conducted as explained below: switching actuator action, safety operation at abnormally low input, and positions for the open/close limiters and for the full-open/close signal, and restart limiting timer.

For adjusting positions for the open/close limiters and for the full-open/close signal, and restart limiting timer, the PU-2x is required.

■ OPERATION AT ABNORMALLY LOW INPUT (SW-1, SW-2)

When the input goes down to $0.37 \pm 0.1V$ DC or below, the PSN goes to the abnormal low input operation. It is set to stop the actuator at the factory. Refer to Table 1.

Table 1. Abnormal low input operation & switch positions

MODE	SW-1	SW-2
Stop	*1	ON
Fully Extend	OFF	OFF
Fully Retract	ON	OFF

*1. SW-1 position is disregarded in STOP mode.

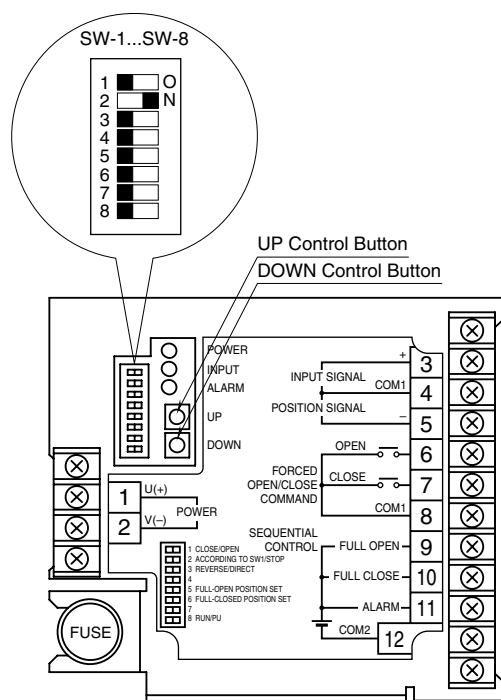


Figure 7. Adjustments, Details

■ ACTUATOR ACTION (SW-3)

Use SW-3 for switching the actuator action. It is set to “REVERSE” at the factory. Refer to Table 2.

Table 2. Actuator action

MODE	SW-3	ACTION
Direct	ON	Output stem retracted with decreasing input. (Valve stem pulled out.)
Reverse	OFF	Output stem extended with decreasing input. (Valve stem pushed in.)

In DIRECT action, the input signal 0 – 100% corresponds to the position output signal 20 – 4mA DC.

■ FULL-OPEN/CLOSED POSITIONS

- 1) Turn ON the SW-8 in order to put the PSN in the local calibration mode, and the input signal is disregarded.
- 2) Turn ON the SW-5 and adjust the fully retracted end pressing UP/DOWN control buttons.
- 3) When the output stem reaches a desired position, turn OFF the SW-5. The position is memorized as the fully retracted end.
- 4) Turn ON the SW-6 and adjust the fully extended end pressing UP/DOWN control buttons.
- 5) When the output stem reaches a desired position, turn OFF the SW-6. The position is memorized as the fully extended end.
- 6) Turn OFF the SW-8 in order to put the PSN in the operating mode. Apply input signals and confirm the full-open/closed positions.

■ SEALING SPRING

For applying a sealing pressure when the valve is fully closed, adjust flexure of the sealing spring when calibrating the fully opened/closed positions.

For applying a sealing pressure at the both ends, such like the case of a three-way valve, adjust flexure of the sealing spring at the both ends.

Excessive flexure may shorten life of the actuator and spring. Observe the maximum flexure at the maximum pressure.

The output stem is provided with scales by millimeters.

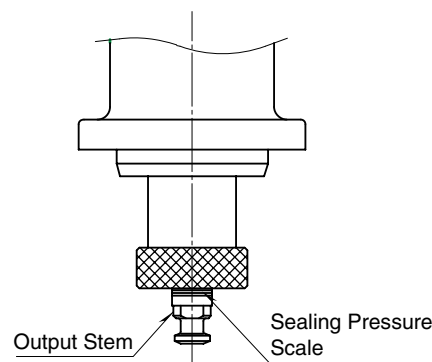


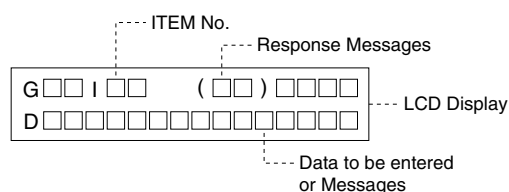
Figure 8. Sealing Spring

TYPE	MAXIMUM PRESSURE (N)	FLEXURE AT MAXIMUM PRESS. (mm)	SET PRESS. (N)	RATED SPRING (N/mm)
1500 N use	1500	1	1170	330
3000 N use	3000	1	2410	590
5000 N use	5000	0.5	3980	2040
	(lb)	(inch)	(lb)	(lb/in.)
1500 N use	337	0.04	263	1880
3000 N use	674	0.04	542	3370
5000 N use	1124	0.02	895	11600

Note: The seal spring starts flexing when a pressure exceeding the set pressure is applied. Control pressure within 80% of the set pressure except when the valve is fully closed. If excessive pressure is applied within the control range, flexure of the spring may jeopardize the linearity.

PU-2x ADJUSTMENTS

■ DISPLAY



• Response Messages

- NG: No good
The PU-2x may not be securely connected.
Check connection of the modular jack.
- ER: Communication error
Turn the SW-8 ON.

• Data Indicator

- OK: OK
- DATA-ERR: Invalid data input
- NON-ITEM: ITEM No. not applicable

■ PROGRAMMABLE ITEMS

Table 4. Programmable items () for PSN3

ITEM No.	ITEM	USABLE RANGE	MINIMUM INCREMENT	DEFAULT
10	Full-open/-closed position (retracted)	8 – 100	0.1	100
11	Full-open/-closed position (extended)	0 – 92	0.1	0
12	Retracted side limit	75 – 105	0.1	100
13	Extended side limit	-5 – 25	0.1	0
14	Full-open/-closed output (retracted)	75 – 100	0.1	98
15	Full-open/-closed output (extended)	0 – 25	0.1	2
16	Split ON/OFF	0 or 1		0
17	Split type LO/HI	0 or 1		0
18	Split point	30 – 70	0.1	50
19	Opening/closing speed limit	1 – 50	1	16 (24)
20	Deadband	0.1 – 5	0.1	0.5
21	Restart limiting timer	0 – 30 ^{*2}	0.1 ^{*2}	2
22	Speed in shutdown ^{*3}	1 – 50	1	16 (24)
23	Position in shutdown ^{*3}	0 – 100	0.1	0

*2. ROM version 1.05 or later

*3. Settings are enabled with 'Failsafe' option.

■ ROM VERSION INDICATION

Press ITEM 99 in the local calibration mode in order to display the ROM version of the PSN.

■ HOW TO PROGRAM THE PSN

- 1) Apply power supply voltage to the PSN.
- 2) Turn ON the SW-8 in order to put the PSN in the local calibration mode, and the input signal is disregarded.
- 3) Connect the modular jack cord of the PU-2x to the PSN.
ITEM display is blank.
- 4) Indicating Current Setting
Key in the ITEM No. that you want to check. (N = 0 to 9)
Press [ITEM] [N] [N].

5) Indicating New ITEM No.

Press [ITEM] [N] [N] or press [UP] or [DOWN].

6) Modifying Current Setting

Display the ITEM No. that you want to change, and press [DATA], new setting, and [ENTER].

If an irrelevant setting is entered, the PU-2x indicates "DATA-ERR" on its message display. Key in an appropriate setting again.

7) Remove the modular jack cord of the PU-2x.

8) Turn OFF the SW-8 in order to return the PSN in the operating mode. Apply input signals and confirm every setting.

Note 1: DO NOT remove power to the PSN with the PU-2x connected to it.

Note 2: Be sure to remove the PU-2x before driving the motor (in the operating mode).

■ EXPLANATIONS ABOUT THE PROGRAMMABLE ITEMS

1) Full-Open/-Closed Positions (ITEM No.10, 11)

Key in a percentage value within 0% for the extended end, and 100% for the retracted end.

[Extended End] > [Retracted End]

2) Extended/Retracted Limits (ITEM No.12, 13)

The adjustable ranges shown in Table 4 are applicable against the stroke determined by the full-open/-closed positions as 100%.

3) Full-Open/-Closed Outputs (ITEM No.14, 15)

The adjustable ranges shown in Table 4 are applicable against the stroke determined by the full-open/-closed positions as 100%.

4) Split Range (ITEM No.16 to 18)

Refer to Figure 9 and determine the type and point of split range.

When the split range is set to OFF (ITEM No.16), the split range type and point (ITEM No.17, 18) are invalid.

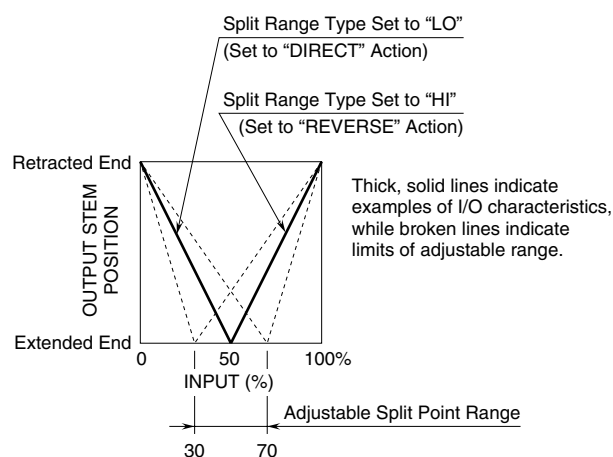


Figure 9. Split Range

5) Opening/Closing Speed Limit (ITEM No.19)

Opening/closing speed affects the thrust. Refer to Tables 5 – 6 and Figures 10 – 11 for checking required thrust and attainable speed.

Acceleration or deceleration is not included in the speed. Acceleration or deceleration respectively requires approx. 0 to 2 sec.; takes longer with faster speed.

Table 5. PSN1 opening/closing speed limit

SPEED SCALE [A]	SPEED [V] (mm/s)	OPERATION TIME (s/20 mm)	THRUST	
			N	lb
1	0.30	66.0	3000	674
2	0.54	37.3	3000	674
16	2.03	9.9	3000	674
35	4.05	4.9	2500	562
44	5.01	4.0	2000	450
50	5.65	3.5	1600	360

Speed [V] achieved by Speed Scales [A] other than mentioned above can be approximately calculated by the following equation:

$$\text{Speed [V]} = 0.106 \times \text{Speed Scale [A]} + 0.323, \text{ where } 2 \leq A \leq 50$$

Table 6. PSN3 opening/closing speed limit

SPEED SCALE [A]	SPEED [V] (mm/s)	OPERATION TIME (s/20 mm)	THRUST	
			N	lb
1	0.22	92.6	5000	1124
2	0.38	52.3	5000	1124
10	0.99	20.2	5000	1124
13	1.22	16.4	4500	1012
16	1.44	13.8	4000	899
20	1.75	11.4	3500	787
24	2.05	9.7	3000	674
28	2.35	8.5	2500	562
33	2.73	7.3	2000	450
36	2.96	6.8	1500	337
41	3.34	6.0	1000	225
48	3.87	5.2	500	112
50	4.02	5.0	350	79

Speed [V] achieved by Speed Scales [A] other than mentioned above can be approximately calculated by the following equation:

$$\text{Speed [V]} = 0.076 \times \text{Speed Scale [A]} + 0.231, \text{ where } 2 \leq A \leq 50$$

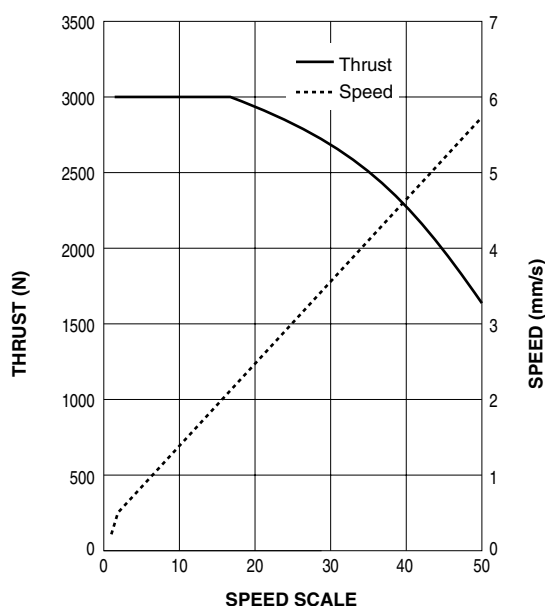


Figure 10. PSN1 Speed v.s. Thrust

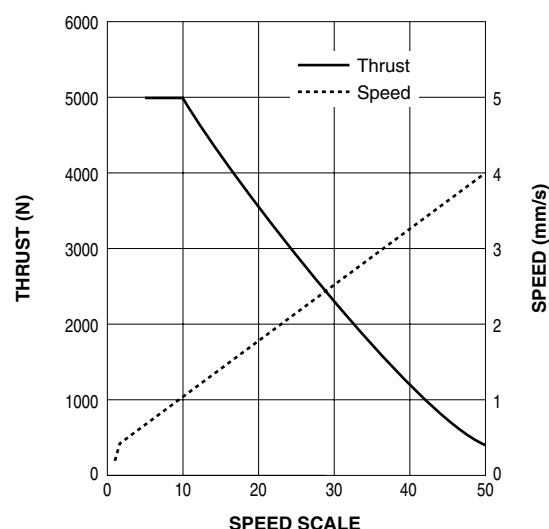


Figure 11. PSN3 Speed v.s. Thrust

6) Deadband (ITEM No.20)

Deadband is adjustable as % of the maximum stroke within 0.1 to 5%.

7) Restart Limiting Timer (ITEM No.21)

The timer is provided to protect the motor from overheating, preventing it from restarting for a certain interval once the motor has been stopped within deadband.

When the high temperature protection is activated in a high temperature ambient, adjust the timer to a longer interval.

Adjustable range is within 0 to 30 sec.

MANUAL OPERATION

■ WHEN POWER IS AVAILABLE TO SUPPLY TO PSN

- 1) Turn on the power supply.
- 2) Turn on the SW-8 to put the PSN into the local calibration mode.
- 3) Use UP/DOWN buttons to manually operate the PSN.
- 4) Turn off the SW-8 after turning off the power supply.

■ USING THE MANUAL OPERATION STEM

- 1) Be sure that the power supply is removed.
- 2) The output stem is designed to go up when the manual operation stem turns clockwise (seen from the operation stem side). Turn the spanner with a torque under 1 N·m or 0.74 ft·lb (1.5 N·m or 1.48 ft·lb for PSN3) in checking the stem position with the indicator.
- 3) The output stem moves by 10 mm per approx. 24 turns (approx. 25 turns for PSN3) of the manual operation stem.
- 4) When the operation is completed, be sure to remove the spanner and cover the stem with a rubber cap.
- 5) Be sure that the spanner is not attached before turning on the power supply.

PROTECTIVE FUNCTIONS

■ ERROR DETECTION

- When the position signal is deviated from the input signal but the output stem is stuck due to overload or certain malfunction, the PSN repeats starting the motor at the maximum torque for several items. If the stem is still stuck after that, the PSN outputs an alarm signal (LED turned ON) and stops power supply to the motor.
- In order to reset the PSN, apply several times 0% and 100% input signals in turn, or turn off and on the power supply.
- In case the alarm is off frequently, check for foreign obstacles in the valve, inappropriate adjustments, or re-tightened gland packing or other possible causes of the overload.
- Be sure to remove the cause of alarm in order to ensure appropriate life span.

■ ABNORMAL TEMPERATURE INCREASE PROTECTION

- When the incorporated temperature sensor detects an abnormal temperature increase in the motor, the PSN outputs an alarm signal (LED blinks in 0.5-sec. ON – 0.5-sec. OFF sequence) and stops power supply to the motor until the temperature decreases to an acceptable level.
- The PSN is designed to automatically recover power supply to the motor. It takes longer to recover normal operation when ambient temperature is higher.

■ PROTECTIVE FUSE

- A fuse is incorporated for protection against overcurrent in the control PCB and motor.
- If the power LED does not turn on with the power supplied to the actuator, check the fuse status.
- If a replaced fuse is blown quickly, it is possible that the control PCB and/or motor are damaged. Consult us or our representative.

■ MOTOR PREHEAT FUNCTION

When the PSN detects a temperature lower than 0°C or 32°F (approximate) on the surface of its motor, the PSN supplies current to the motor in order to warm up and maintain its surface temperature at 5°C or 41°F (approximate).

Maintain the power supply ON when the PSN is used in the ambient temperature below 0°C or 32°F.

MAINTENANCE

For effective use and longer life of the PSN, regular checking appropriate for its operating conditions are recommended. Refer to the following table.

ITEM	CHECKING POINT	HOW TO PROCEED
Functioning	Apply input 0%, 50%, 100%, then back to 50%, 0%. Check the actuator operations and positions at each input value.	Repair or calibration If the alarm indicator LED is on, check that the valve operates lightly and smoothly.
Abnormal sound	No abnormal sound is heard during operation.	Repair or calibration
Connector Leadwire	The connector is firmly connected. No breakdown of leadwires. The insulation covers are not torn, not bruised.	Repair or calibration
Inside humidity, rust	No condensation. No rust. If there is water inside, check the packing.	Remove water, dry the case and inside parts. Replace rusted parts. Calibration. If the packing is damaged, replace it.
Screws	Check that screws and bolts are securely fastened.	Re-tighten them.
Nut	Check that the nut at the valve stem is not loose.	Re-tighten it and calibrate.

For repair or parts replacement, contact us or representatives.

■ LUBRICATION

There is no need of oiling the PSN in normal operating conditions.

■ REGULAR TEST RUNNING

If the valve is not frequently operated, run a test operation regularly (once a week, for example) to check proper functions.

TROUBLESHOOTING

TROUBLE		POSSIBLE CAUSE	HOW TO PROCEED
Not functioning	Power and/or input indicator OFF	Power and/or input signal is not supplied.	Check power and input signals, remove the causes of malfunction and secure the signals.
		Wiring error.	Check the wiring.
		Bad contact.	Check the connector and other connecting sections.
		Fuse melted.	Replace it with a new one.
	Power and input indicator ON	The actuator is in local calibration mode (SW-8 ON).	Turn SW-8 OFF.
		Improper adjustments of full-open/-closed positions.	Adjust the full-open/-closed positions.
		Control PCB damaged.	Repair and calibration.
Unstable functioning		Motor damaged.	Repair and calibration.
		Abnormality in power voltage or input signal.	Remove the causes of malfunction and secure the signals.
		Operating speed is too fast.	Secure the required thrust by slowing.
		Power voltage is too low or fluctuating.	Secure the required level of voltage.
Alarm indicator ON		Input is unstable.	Check the controller and cables. Eliminate noise.
		Angle sensor is damaged.	Repair and calibration.
Alarm indicator blinking		Overload caused by a foreign object caught in the valve.	Remove the causes of overload.
		Actuator mechanism damaged.	Repair and calibration.
Alarm indicator blinking		Motor temperature is abnormally high.	Use the restart limiting timer. Review MV value from the controller.
		Wiring of the temperature sensor is broken or the connector is detached.	Check the connector and leadwires.

For repair or parts replacement, contact us or representatives.

LIGHTNING SURGE PROTECTION

We offer a series of lightning surge protectors for protection against induced lightning surges. Please contact us to choose appropriate models.