*INSTRUCTION MANUAL* ▮

| MINI-TOP ELECTRONIC ACTUATOR<br>(linear type; CC-Link) | MODEL | MSP4C/MSP5C<br>/MSP6C |

## CONTENTS

# 1. 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.

## ■ PACKAGE INCLUDES:

Mini-Top ...............................................................................(1)
The Mini-Top is not provided with a yoke or other components required for mounting it to a valve. They are to be provided by the user.

## ■ MODEL NO.

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

## ■ 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 may be caused by improper use of the product, 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 |
|---|
| Remove power supply to the actuator before wiring to the unit. It could cause electric shock. |
| Do not disassemble or modify the unit in any way. It could cause electric shock, burn, or injury. |
| DO NOT step onto the actuator unit. DO NOT rest a heavy object on or against the unit. It could cause personal injury. |
| When installing the actuator unit outdoor or where it is exposed to rain or water drops, adequate precautions must be taken for preventing water from entering inside through wiring conduits. It could cause electric shock. |

| ⚠ CAUTION |
|---|
| DO NOT remove the cover of the actuator. It may cause electric shock or injury. |
| The adjusters which are paint-sealed are for factory use only and should be changed only by qualified our personnel. Otherwise it could cause breakdown. We are not liable for any malfunction or inconvenience caused by unauthorized changes made by the user. |

# 2. POINTS OF CAUTION

## ■ POWER INPUT RATING & OPERATIONAL RANGE

• Locate the power input rating marked on the product and confirm its operational range as indicated below:
  24V DC: 24V rating ±10%, approx. 0.5A

## ■ GENERAL PRECAUTIONS

• Remove the power supply to the actuator before wiring to it.

## ■ INSTALLATION

• Indoor, or outdoor where the MSPxC is NOT exposed to direct sunlight
• Ambient temperature: -5 to +55°C (23 to 131°F)
• Operating humidity: 30 to 85% RH (non-condensing)
• Vibration: 0.5 G (4.9 m/s$^2$) max.
• Install the MSPxC where you can reach for maintenance. Observe at the minimum of 15 centimeters (6 inches) above the cover.

## ■ ELECTRICAL CONNECTION

• Separate the cables (power supply and communications) from other cables to prevent surge or inductive interference.
• Do not bind these cables together with mains supply cables or high-voltage cables. Do not install them in the same duct.

## ■ OUTDOOR USE

• When installing the MSPxC outdoor or where it is exposed to rain or water drops, be sure to fasten the cable connector tightly and leave a slack of the cable.
• Do not mount the MSPxC in such direction that the output stem is at the top of the Mini-Top unit.

## ■ O-RING, GASKET

• When replacing the actuator cover after adjustments, check that the O-ring is securely placed in the groove.
• When replacing the communication box cover, check that the gasket is in place.

## ■ YOKE DESIGN

• When a foreign object is caught in the valve, a torque four times greater than the maximum rating could be generated. Leave enough strength for mechanical components such like the yoke and stem.
• If the MSPxC is used on a steam line in temperature control, it is possible that the MSPxC temperature rises higher than the ambient temperature due to transmission or radiation via the steam piping, even when the ambient temperature is within allowable range.
  Use a longer yoke to increase heat dissipation and apply insulating material.

## ■ AND ....

• DO NOT loosen the screw fixing the potentiometer stem. Loosening it could cause a malfunction.
• DO NOT step onto the actuator. DO NOT rest a heavy object on or against it.
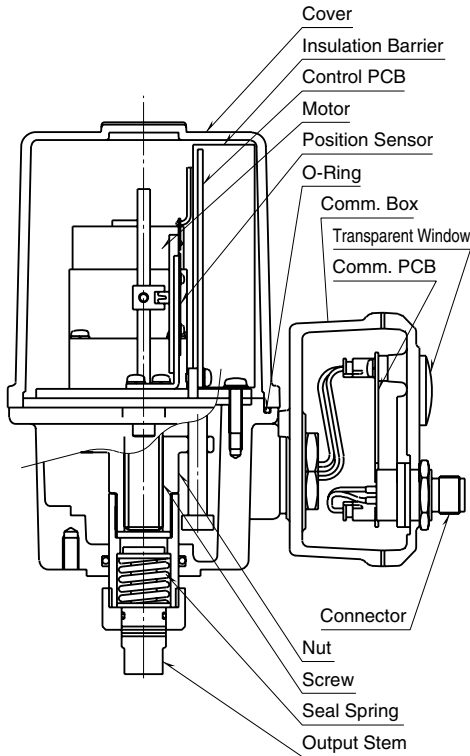
# 3. COMPONENT IDENTIFICATION



**Figure 1. Component identification, MSP4C, MSP5C**

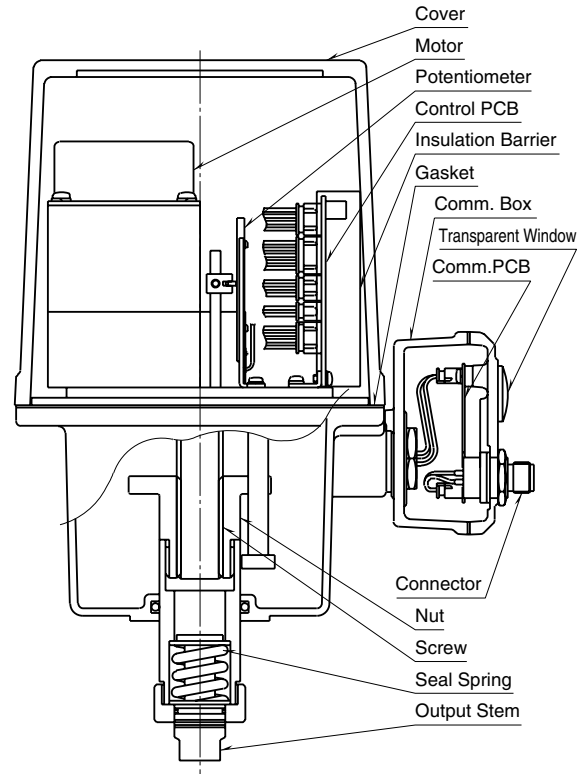Note: Construction of the MSP4C is partly different from the above figure.



**Figure 2. Component identification, MSP6C**

### ■ CC-Link CONNECTOR:

5-core micro-style connector, male

| PIN ASSIGNMENT | |
|---|---|
| 1 | SL-D |
| 2 | DB |
| 3 | DG |
| 4 | DA |
| 5 | Not used |

### ■ POWER INPUT CONNECTOR:

XS2M-D424-2 (OMRON)

| PIN ASSIGNMENT | |
|---|---|
| 1 | 24 V |
| 2 | Not used |
| 3 | GND |
| 4 | Not used |

### ■ COMMUNICATION MONITOR INDICATOR LED

| ID | STATUS | MEANING |
|---|---|---|
| L RUN | ON | Communicating |
| | Blink | ---- |
| | OFF | Not entering the network yet Timeout |
| L ERR | ON | CRC error Switch configuration error detected when the power was turned on. |
| | Blink | Switch configuration has been altered after the power was turned on. |
| | OFF | Normal |

### ■ STATUS INDICATOR LED

Normal status: Blinks with 0.5 Hz frequency (1 second ON; 1 second OFF)

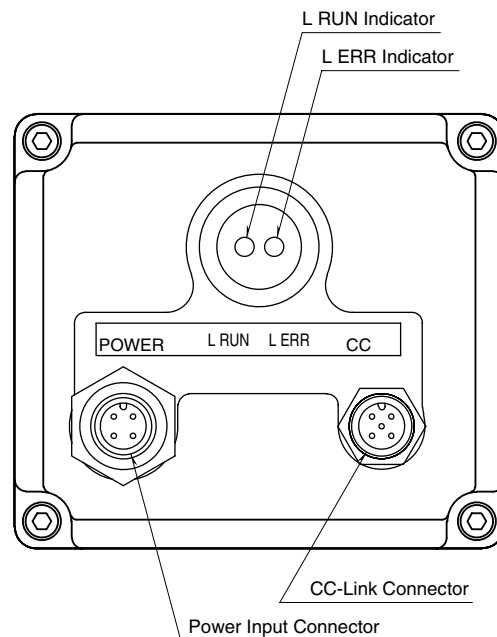Motor deadlock: Blinks with 2 Hz frequency



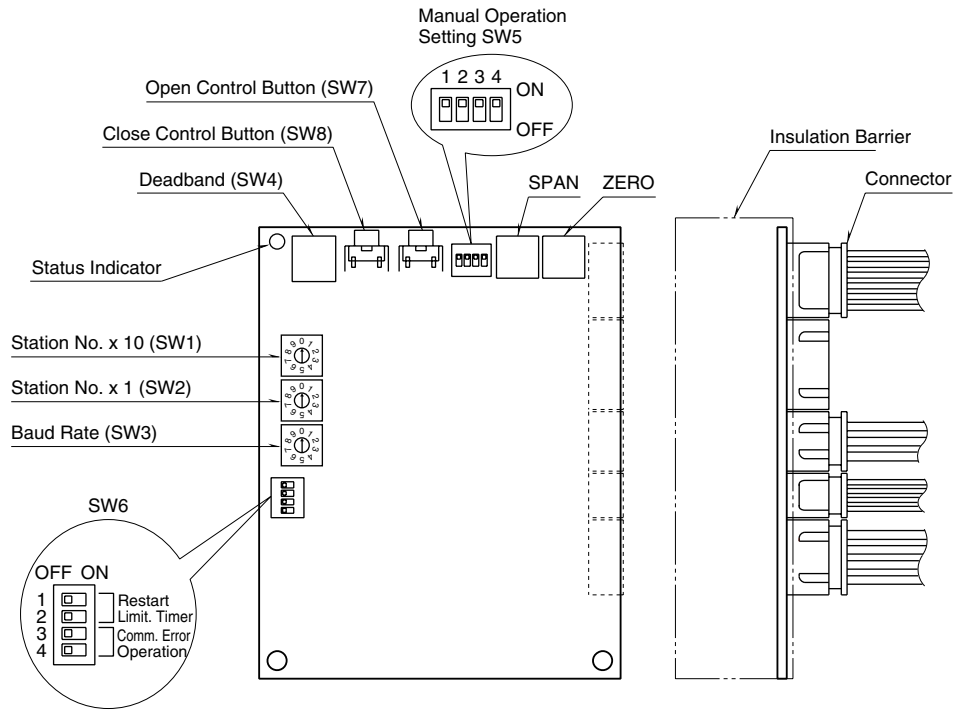**Figure 3. Component identification, Communication Box**

**Figure 4. Component identification, Control PCB**

Note 1: Applying excessive torque on potentiometers and switches may destroy the stoppers of these adjustments. Turn them gently and stop immediately where the controls hit the stopper.

# 4. OUTPUT SPAN ADJUSTABILITY

The servo-control circuit compares and amplifies "Input as Target" (position setpoint) signal and the feedback signal from the potentiometer, and drives the motor to such direction to minimize difference of the two signals.
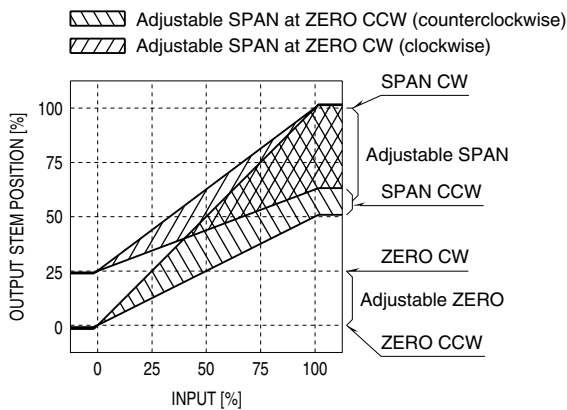


The Span, with the Zero turned fully counterclockwise, is adjustable from 50% to 100%. With the Zero turned gradually clockwise, the Span's adjustable range become narrower, down to 62.5 – 100%. The Span is adjustable to 50 – 100% of the remaining total stroke after the Zero adjustment.

**Figure 5. I/O characteristics (adjustable range)**
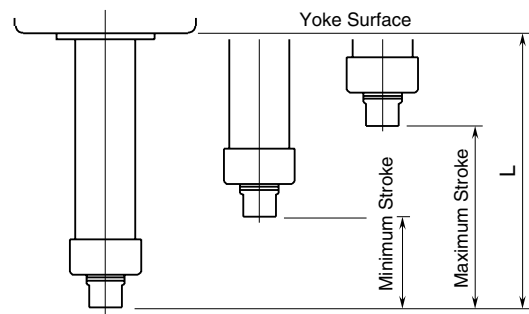


**Figure 6. Definition of the minimum and maximum strokes**

**Table 1. Available Stroke Range for Each Model**

| MODEL | L | MIN. STROKE | MAX. STROKE |
|---|---|---|---|
| MSP4C-1 | 29* | 5 | 10 |
| MSP4C-2 | 34* | 8 | 15 |
| MSP5C-1 | 40 | 5 | 10 |
| MSP5C-3 | 50 | 10 | 20 |
| MSP6C-3 | 58 | 10 | 20 |
| MSP6C-4 | 78 | 20 | 40 |

*Add 3.5 mm for stem button type.

# 5. INSTALLATION

The following is a general procedure for mounting the MSPxC to a valve with a yoke and coupling.

Be sure NOT TO CHANGE factory adjusted setting of the MSPxC.

Remove power supply during the procedure unless otherwise specified.

1) Supply power to the actuator and manually control the actuator stem to the longest position.

2) Push in the valve stem at the lowest position.

3) Set the yoke to the actuator.

4) Push the valve stem into the actuator stem until there is no gap between them.

   If you need to seal the valve, leave a spring contraction shown in Table 3 (for example, 0.5 mm for MSP4C-x3).

5) Fix the actuator stem and valve stem with a lock nut.

6) Supply power to the actuator again and raise (retract) the actuator stem by several millimeters. Check that the opening between the yoke and valve bonnet is closed. Fix the yoke and valve.

7) Attach the position indicator if required.
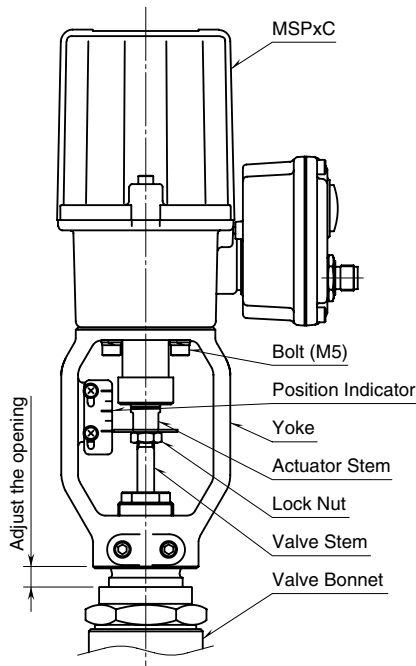


**Figure 7. MSP×C mounted onto a valve (example)**

■ **STEM BUTTON**
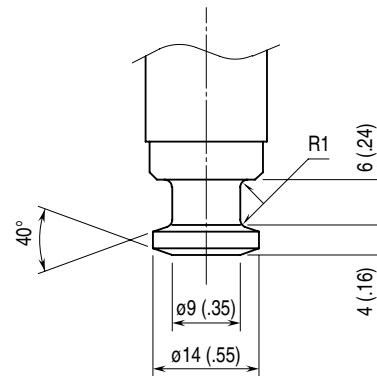


**Figure 8. Stem Details**
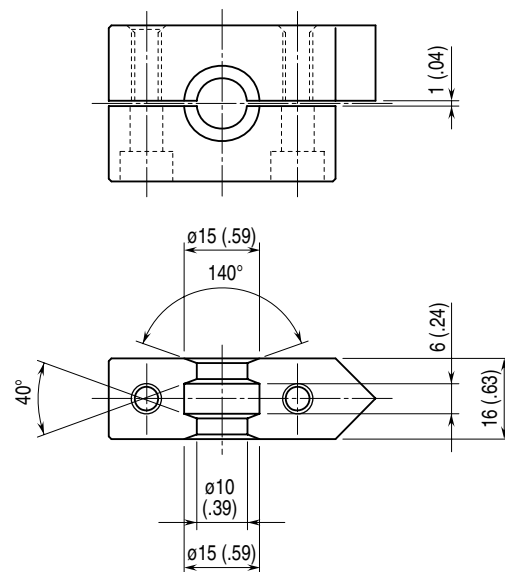


**Figure 9. Indicator Details**

# 6. WIRING CONNECTION

■ **CC-Link CONNECTOR**

Use a cable with connector approved for CC-Link.
(TE Connectivity TAA545 or Phoenix Contact SAC-4P)

■ **POWER INPUT CONNECTOR**

Use a 4-core micro-style connector, female (e.g. OMRON XS2F or XS2WD42).
Recommended T-shape adaptor, if necessary, is OMRON XR2R-D427-5.

■ **TERMINATING RESISTOR**

Recommended terminating resistor (connector) is SAC-4P-M12MS-CCL TR (Phoenix Contact).

# 7. ADJUSTMENT PROCEDURE

## 7.1. MANUAL OPERATION

The MSPxC can be manually controlled regardless of the communications status. Turn the SW5-1 ON to enable the manual operation mode. The SW8 and SW7 are used for control.

**Table 2. SW5 setting, manual operation**

| SW5 | OFF | ON |
|---|---|---|
| 1 | Control via communications | Manual operation |
| 2 | Invalid | 0% manual control command |
| 3 | Invalid | 100% manual control command |
| 4 | Unused | |

Turning both SW5-2 and -3 is invalid. The actuator operation stops.

SW8: The stem moved toward 0% position while pressing this switch.

SW7: The stem moved toward 100% position while pressing this switch.

### 7.1.1. GENERAL PROCEDURE

After installing the valve and actuator, go to adjustments in order of Zero, Span, and the seal-spring.

### 7.1.2. ZERO & SPAN

1) Zero Adjustment: Turn the power supply on and set the SW5-1 and -2 ON (OFF for the others on the SW5). This turns the actuator into the manual operation mode and automatically controls the stem toward the 0% position.

Once the stem reaches the position, adjust either the actuator with the Zero potentiometer or the mechanical position of the valve stem connection so that the actuator's extended position (valve's retracted position) is adequate.

If extra sealing pressure by the seal-spring is required, push in the actuator stem referring to Table 3.

2) Span Adjustment: Turn the power supply on and set the SW5-1 and -3 ON (OFF for the others on the SW5). This turns the actuator into the manual operation mode and automatically controls the stem toward the 100% position.

Once the stem reaches the position, adjust either the actuator with the Span potentiometer or the mechanical position of the valve stem connection so that the actuator's retracted position (valve's extended position) is adequate.

For three-way valves, the sealing pressure can be adjusted to be applied in the direction where the output stem is fully retracted (not available for the MSP4C). Adjustment procedure is the same for Zero.

3) With 0% input again, check that the Mini-Top is at the fully extended position. If the position is shifted, go through the above procedure again.

Note 1: There is only minimal effect of span adjustment to zero point, thus the stem position shifts very little at the extended side when the span potentiometer is turned.

Note 2: With the stroke narrower, hunting (the motor repeats changing direction) can happen more often. Adjust Deadband in such cases.
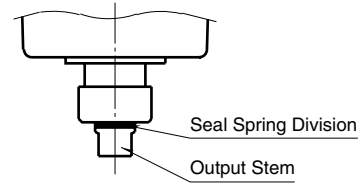


**Figure 10. Seal-spring**

**Table 3. Seal-spring pressure**

| MODEL | SPRING CONTRACTION (mm) | CONTACT* PRESSURE (N / lbs) | SEALING PRESSURE (N / lbs) |
|---|---|---|---|
| MSP4C-x3 | 0.5 | 147/33 | 98/22 |
| MSP4C-x4 | 1.0 | 300/67 | 250/56 |
| MSP4C-x7 | 1.0 | 686/154 | 294/66 |
| MSP5C-x3 | 0.5 | 150/34 | 110/25 |
| MSP5C-x4 | 1.0 | 294/66 | 216/49 |
| MSP5C-x7 | 1.0 | 686/154 | 294/66 |
| MSP6C-x3 | 1.0 | 588/132 | 441/99 |
| MSP6C-x4 | 1.0 | 1170/263 | 882/198 |
| MSP6C-x6 | 1.5 | 2350/529 | 1170/263 |

\* The minimum pressure required to contract the spring.

Note: Graduations by 1 millimeter increments are marked on the stem. For example, with MSP4C-x7, the sealing pressure reaches approx. 490 N at 0.5 mm, 686 N at 1 mm.

### 7.1.3. DEADBAND

'Deadband' is provided in 0.2% increments from 0.1%, 0.3%, 0.5%, .... with the fractions dropped.

| SW4 | DEADBAND (%) |
|---|---|
| 0 | 0.1 |
| 1 | 0.3 |
| 2 | 0.5 |
| 3 | 0.7 |
| 4 | 0.9 |
| 5 | 1.1 |
| 6 | 1.3 |
| 7 | 1.5 |
| 8 | 1.7 |
| 9 | 1.9 |

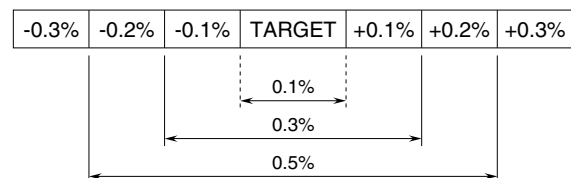| -0.3% | -0.2% | -0.1% | TARGET | +0.1% | +0.2% | +0.3% |
|---|---|---|---|---|---|---|

0.1%
0.3%
0.5%

**Figure 11. Deadband**

### 7.1.4. RESTART LIMITING TIME

Set the restart limiting time as follows:

| SW6-1 | SW6-2 | RESTART LIMITING TIME (sec.) |
|---|---|---|
| OFF | OFF | 0 |
| ON | OFF | 1.5 |
| OFF | ON | 5 |
| ON | ON | 10 |

### 7.1.5. COMMUNICATION ERROR OPERATION

The actuator operation in case of a communication error once normal communication is established after the power is turned on is defined as follows:

| SW6-3 | SW6-4 | COMM. ERROR OPERATION |
|-------|-------|-----------------------|
| OFF | OFF | Stop |
| ON | OFF | 0% position |
| OFF | ON | 100% position |
| ON | ON | Stop |

### 7.2. CC-Link

### 7.2.1. STATION NO.

Set the upper digit (x10) with SW1 and the lower digit (x1) with SW2.
This device occupies one station.

### 7.2.2. BAUD RATE

The baud rate is selected with the SW3.

| SW3 | BAUD RATE |
|-----|-----------|
| 0 | 156 kbps |
| 1 | 625 kbps |
| 2 | 2.5 Mbps |
| 3 | 5 Mbps |
| 4 | 10 Mbps |

All other settings are invalid.

### 7.2.3. COMMUNICATIONS

#### ■ MASTER to SLAVE

| DATA TYPE | ADDRESS | FUNCTION | DETAIL |
|-----------|---------|----------|--------|
| Bit | RY0 | Forced Closed Position Input [*1] | 0 : Disable    1 : Position = 0% |
| | RY1 | Forced Open Position Input [*1] | 0 : Disable    1 : Position = 100% |
| | RY2 | | |
| | RY3 | | |
| | RY4 | | |
| | RY5 | | |
| | RY6 | | |
| | RY7 | | |
| | RY8 | Enable Target Position Input | 0 : Disable    1 : Enable |
| | RY9 | | |
| | RYA | Reset Motor Deadlock Alarm | Motor deadlock alarm is canceled when '1' is set. |
| | RYB | Clear Motor Starting Counter | Motor starting counter is reset to 0 when '1' is set. |
| | RYC | Clear Motor Reversing Counter | Motor reversing counter is reset to 0 when '1' is set. |
| | RYD | Clear Accumulated Running Distance | Accumulated running distance is reset to 0 when '1' is set. |
| | RYE | | |
| | RYF | | |
| Word | RWw0 | Target Position Input | Signed, 0.01% increments (e.g. 100 = 1.00%)<br>Valid only when Enable Target Position Input is enabled. |
| | RWw1 | | |
| | RWw2 | | |
| | RWw3 | | |

*1. Valid regardless of the RY8 (Enable Target Position Input) status.  Stopped when '1' is set both at RY0 and RY1.

■ **SLAVE to MASTER**

| DATA TYPE | ADDRESS | FUNCTION | DETAIL |
|---|---|---|---|
| Bit | RX0 | | |
| | RX1 | | |
| | RX2 | | |
| | RX3 | | |
| | RX4 | | |
| | RX5 | | |
| | RX6 | | |
| | RX7 | | |
| | RX8 | Motor Deadlock Alarm | 0 : Normal    1 : Overload or other deadlock alarm |
| | RX9 | Target Position Input Error | 0 : Normal    1 : Out of range from -0.5 to +100.5% |
| | RXA | System Error | 0 : Normal    1 : Memory or other system error |
| | RXB | Control Status | 0 : Remote (CC-Link)    1 : Manual |
| | RXC | | |
| | RXD | | |
| | RXE | | |
| | RXF | | |
| Word | RWr0 | Position Output | Signed, 0.01% increments (e.g. 100 = 1.00%) |
| | RWr1 | Motor Starting Counter *2 | 1 count per every 100 starting actions |
| | RWr2 | Motor Reversing Counter *2 | 1 count per every 100 reversing actions |
| | RWr3 | Accumulated Running Distance (%) *2 | 1 count per running 100% distance every time |

*2. When the count reaches 65535, the value is held until it is reset.

### 7.2.4. BASIC OPERATING PROCEDURE

**(1) Normal Operation**

Once the communication is established, the actuator can be operated only by setting 'Enable Target Position Input' (RY8) to '1' and providing 'Target Position Input' value (RWw0).

Target Position Input data is described by signed 16-bit data, representing 0.01% by 1 LSB.

```
┌──────────────────────────────────────────┐
│ Set 'Enable Target Position Input' to '1.' │
└──────────────────────────────────────────┘
        │
    ┌───────────────────────────────┐
    │ Set 'Target Position Input.'   │
    └───────────────────────────────┘
```
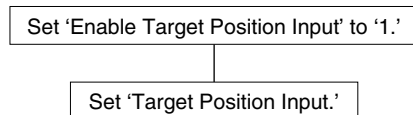
For example, set '5000' in binary for 50% setpoint. Set '-50' for -0.5%. Binary must be 2's complement.

'Position Output' (RWr0) data is in the same format.

**(2) Motor Deadlock Alarm**

When the motor is overloaded or stuck with a foreign object, the actuator sets '1' to 'Motor Deadlock Alarm' (RX8) and stops.

When '1' is set to 'Reset Motor Deadlock Alarm' (RYA), the actuator restarts.

Be sure to confirm that the Motor Deadlock Alarm is reset to '0' before returning Reset Motor Deadlock Alarm to '0.'

**(3) Operation Report**

The following data can be read out for maintenance purposes: Motor Starting Counter, Motor Reversing Counter and Accumulated Running Distance.

These data are stored in the nonvolatile memory every 10 minutes and are not deleted even when the power is removed.

In order to reset these data to 0, set '1' to the respective reset commands (RYB to RYD).

Return the reset signals to '0' after the data resetting has been confirmed.

# 8. MAINTENANCE

For effective use and longer life of the Mini-Top, 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 |
| 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. 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 Mini-Top 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.

# 9. TROUBLESHOOTING

| TROUBLE | L RUN | L ERR | POSSIBLE CAUSE | HOW TO PROCEED |
|---|---|---|---|---|
| No Func-tion | ON | OFF | Normal communication? | Confirm that the manual operation is possible. |
| | ON | Blink | Baud rate has been changed after the power supply has been turned on. | Turn the power supply off and on. |
| | OFF | OFF | Power source is turned off or cable broken. | Check the power source and the cables. |
| | — | ON | Station No. and/or Baud rate error detected when the power supply has been turned on. Communication error | Correct the Station No. and/or Baud rate setting. Check noise possibilities. Check the terminating resistor. |
| Unstable functioning | | | Power voltage is low or fluctuating. | Check the power supply. |
| | | | Position sensor damaged. | Replace the position sensor. |
| Stopped in the middle of stroke Slows down in the middle of stroke | | | Actuator mechanism is damaged. | Repair. |
| | | | Overload cause by a foreign object caught in stroke the valve. | Check the valve. |

# 10. LIGHTNING SURGE PROTECTION

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