User Manual for KH15 Waterproof Pressure Transmitter

KH15-J□□/K□□
Thank you for purchasing the KH15 waterproof pressure transmitter. To use this product safely and properly, read this user manual carefully. This is a pressure transmitter that can support a wide range of cases where components such as liquid or gas are used. Incorrect use of it causes failures, which may result in damage including faults or accidents. Keep this manual safely after reading it so that you can always reference it.

### Definition of Safety Terms
Safety precautions in this manual are categorized based on the following definition:

<table>
<thead>
<tr>
<th>△ DANGER</th>
<th>Indicates the risk that users may suffer from damage including death or serious injury, and extremely high urgency at the time of occurrence of risk.</th>
</tr>
</thead>
<tbody>
<tr>
<td>△ WARNING</td>
<td>Indicates the risk that users may suffer from damage including death or serious injury.</td>
</tr>
<tr>
<td>△ CAUTION</td>
<td>Indicates the risk that users may suffer from minor injury and the risk that only property damage may be caused.</td>
</tr>
</tbody>
</table>

### Description of Graphic Symbols

<table>
<thead>
<tr>
<th>Graphic symbols</th>
<th>Meaning</th>
</tr>
</thead>
</table>
| ✖️               | ● Generally prohibited activities  
                  Indicates prohibited activities in handling the product. |
| ☢️               | ● General instructions  
                  Indicates activities based on instructions that users are forced to conduct. |
| 🟢               | ● Other information  
                  Indicates precautions, special operating methods, and other important information. |
# Precautions for Handling Product

## WARNING

- Do not give excessive load, vibration or shock. Damage to the product and release of a measured object may be caused, which results in injury or damage to the surrounding environment.

- Repeated applied pressure shall be within the rated pressure range and shall not exceed the maximum allowable pressure. Damage to pressure elements may be caused, which results in injury or damage to the surrounding environment.

- Do not use this product for measured objects corrosive to wetted materials and gas contact parts.

- This product does not have an explosion-proof structure. Do not use the product in dangerous places with combustible gas or liquid which may cause ignition or explosion.

- Do not use non-designated batteries and power supply. Use of them causes failures, fires, or electric shocks.

- If failures or malfunctions of this product may threaten human life directly or cause harm to human bodies, do not use the product.

- Do not modify the product. Disassembly or modification of the product, or modification to add new functions may cause harm to human bodies.

- Use the product within the operating temperature range. Otherwise, the product fails or is damaged, which causes injury or damage to the surrounding environment.

- Conduct wiring correctly according to the wiring label or the wiring procedure described in the user manual. Incorrect wiring may cause failures or fires.

- When the measuring fluid is oxygen, use a degreased product. Oil may remain within general products. Oil reacts to oxygen, which causes the risk of ignition or explosion.

## CAUTION

- Install the product according to the installation procedure described in the user manual.

- Contact us for repair. Disassembly or modification of the product on your own may cause failures.

* These precautions are selected from our common safety precautions for all products that correspond to this product. KH15-specific precautions are further described in detail in the following sections.
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<tr>
<td>14. OTHERS</td>
<td>22</td>
</tr>
</tbody>
</table>
1. INTRODUCTION

Check the specifications of the delivered model. Incorrect pressure range, power supply or output will cause an accident. Make sure to use a model of the designated specifications in a location that meets your use conditions and that it is properly wired and installed.

2. PRODUCT OVERVIEW

This chapter describes the overview, characteristics, and operating principle of the product.

2.1 Overview

This is a compact, robust and waterproof pressure transmitter that uses a semiconductor strain gauge in a pressure detection part. Standard output is 4 to 20 mA DC, 0 to 5 V DC, and 1 to 5 V DC. It has a terminal box provided with a circuit, which allows you to adjust a zero point and span by removing the lid of the box.

2.2 Operating Principle

With a pressure receiving part used as a diaphragm, the product converts pressure into strain and detects the amount of strain with the semiconductor strain gauge. The detection circuit is a full-bridge type in which all four sides of the bridge consist of semiconductor strain gauges. The bridge circuit gives an electric signal proportional to the strain, which is then transmitted as direct current or voltage by signal conversion at the next circuit stage.

2.2.1 Block Diagram
2.2.2 Configuration example of above (4 to 20 mA DC output)

![Diagram of configuration example]

< Figure.2-2 >

3. MODEL NUMBER CONFIGURATION

This chapter describes the model number configuration.

KH15 - □ □ □

<table>
<thead>
<tr>
<th>Type</th>
<th>Seal system</th>
</tr>
</thead>
<tbody>
<tr>
<td>J: Small</td>
<td>3: O-ring</td>
</tr>
<tr>
<td></td>
<td>4: All-welded (SUS630 (17-4PH))</td>
</tr>
<tr>
<td></td>
<td>6: All-welded (Co-Ni alloy)</td>
</tr>
<tr>
<td>K: Large</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Internal access to adjustment</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Thread:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2: G1/4B</td>
</tr>
<tr>
<td>3: G3/8B</td>
</tr>
<tr>
<td>4: G1/2B</td>
</tr>
<tr>
<td>6: R1/8</td>
</tr>
<tr>
<td>7: R1/4</td>
</tr>
<tr>
<td>8: R3/8</td>
</tr>
<tr>
<td>9: R1/2</td>
</tr>
</tbody>
</table>
## 4. SPECIFICATIONS

### 4.1 Product Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model number</td>
<td>KH15-□□3, KH15-□□4, □□6</td>
</tr>
<tr>
<td>Pressure sensor seal system</td>
<td>O-ring type, Weld type</td>
</tr>
<tr>
<td>Pressure range*1</td>
<td>0 to 0.1, 0 to 0.3, -0.1 to 0 MPa, 0 to 0.5 =&gt; 0 to 120 MPa</td>
</tr>
<tr>
<td>Maximum allowable pressure*2</td>
<td>200% of pressure range</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>24 V DC +/-10% or 12 V DC +/-10%, 15 V DC +/-10% (only voltage output is selectable).</td>
</tr>
<tr>
<td>Output type</td>
<td>4 to 20 mA DC (load resistance 500 Ω max.), 1 to 5 V DC (load resistance 10 kΩ min.), 0 to 5 V DC (load resistance 10 kΩ min.)</td>
</tr>
<tr>
<td>Accuracy (including linearity, hysteresis and repeatability)</td>
<td>+/-1.0%F.S. (however, the pressure range is 3.5 to 20 MPa).</td>
</tr>
<tr>
<td>Operating temp. range</td>
<td>-20 to 70 °C (non-freezing, non-condensing)*4</td>
</tr>
<tr>
<td>Storage temp. range</td>
<td>-30 to 80 °C (non-freezing, non-condensing)</td>
</tr>
<tr>
<td>Temperature characteristics</td>
<td>+/-0.25%F.S. /°C with +/-0.25%F.S. accuracy (both zero/ span).</td>
</tr>
<tr>
<td>Responsiveness</td>
<td>1 ms or less</td>
</tr>
<tr>
<td>Wetted materials</td>
<td>Diaphragm: SUS630 (17-4PH), Fitting: SUS316, O-ring: NBR (standard), EPDM, Fluorine, Chloroprene</td>
</tr>
<tr>
<td>Thread size</td>
<td>G1/4B, G3/8B, G1/2B, R1/8, R1/4, R3/8, R1/2, 1/4 NPT, 3/8NPT, 1/2 NPT (R and NPT threads: for the pressure range of 50 MPa or less).</td>
</tr>
<tr>
<td>Weight</td>
<td>KH15-J□□ (small terminal box): approx. 220 g, KH15-K□□ (large terminal box): approx. 360 g</td>
</tr>
<tr>
<td>Case structure*5</td>
<td>Equivalent to IP67 (based on JIS C 0920)</td>
</tr>
</tbody>
</table>

---

*1 Pressure range is applicable for 50 MPa or less. Above 50 MPa, please consult with YAMAHA TONE LTD. 
*2 Maximum allowable pressure is applicable for 50 MPa or less. Above 50 MPa, please consult with YAMAHA TONE LTD. 
*3 Accuracy for 3.5 to 20 MPa. 
*4 Temperature characteristics are applicable for 50 MPa or less. Above 50 MPa, please consult with YAMAHA TONE LTD. 
*5 Case structure is equivalent to IP67. 
*6 CE marking is applicable for 50 MPa or less. Above 50 MPa, please consult with YAMAHA TONE LTD.
1. Do not seal the cable end with taping or adhesive during wiring as it will block atmospheric pressure introduced via the cable. Avoid using a cable with poor ventilation (no clearance within the cable).

2. Max. allowable pressure is the upper limit of pressure value which may safely be applied to the product and remain in specification once pressure is returned to the rated range with a couple of times overpressurization for about 10 minutes. Effects of continuous overpressure are not guaranteed.

3. Accuracy of +/-0.25%F.S. cannot be guaranteed for the model KH15-□□6 and 0 to 5V DC output.

4. It will be 0 to 70°C for the pressure range of 0.1 MPa or less. For the wetted part exceeding a temperature of 70°C such as steam or hot water, be sure to install a pipe siphon or similar device to keep it below 70°C. Also, when measuring low-temperature fluid such as cold water, please employ preventative measures against condensation.

5. IP67 waterproof case does not cover the waterproofing of the wiring opening (cable gland (JIS F 8801)).

6. Indoor power distribution network to connect the product shall not be affected by lightning surge voltage and the switching transients of the power system.

7. Pressure range of 120 MPa is guaranteed only when Co-Ni alloy materials and the G1/2B fitting are combined.

5. DIMENSIONS

■ 5.1 KH15-□□ (small terminal box) (Unit: mm)
5.2 KH15-K□□ (large terminal box)
6. TRANSPORTATION AND UNPACKING

■ 6.1 Precautions for Transportation

(1) Do not apply vibration as much as possible in transporting the product, as is the case with other electric meters.
(2) Never hit or drop the product.

■ 6.2 Precautions for Unpacking

(1) Check the appearance of the carton before unpacking.
(2) Be careful not to roughly handle the package during unpacking.
(3) After unpacking, remove the product from the package in a sufficiently wide area to avoid the product from being accidentally dropped.
(4) Check the product surface to see if there is any damage and the product label to see if the model number and the range are exactly what you ordered.
(5) In case of any anomaly, contact sales agent or our sales office.

7. INSTALLATION AND REMOVAL

■ 7.1 Installation

(1) Do not tighten the case main unit with a pipe wrench in connecting to a pressure line. Be sure to use the hex parts of the threads for installation of the product.
(2) Do not install the product in the pressure line with piping filled with liquid. As liquid is incompressible, tightening the threads produces high pressure, which causes equipment to fail. When installing the transmitter to the existing pressure line or replacing it with a new one, remove liquid on the piping connection side, leave an air of approximately 15 to 20 mm, and tuck the thread.
(3) The product is excellent in vibration resistance. However, avoid violent vibration as it is a measuring instrument.
(4) The product can be installed in a vertical or horizontal position in forward/backward and right/left directions.
(5) This product is in a protection class equivalent to IP 65 (JIS C 0920). To ensure a longer life, the installation location should not be exposed to direct sunlight, moisture, dust, oil or water.

⚠️ CAUTION

- Do not give excessive shock to the product during piping such as hitting or dropping.
- Do not insert a wire into the pressure inlet. The diaphragm is damaged, causing incorrect behavior.
### 7.2 Precautions for Possible Water Sprinkling

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Install the product so that the gland part (cable outlet) faces downward to prevent water from entering through there as shown in the figure below (recommended installation direction). Tighten the gland securely to prevent the intrusion of water (See “8.1 Wiring”).</td>
</tr>
<tr>
<td>● When installing the cable, move it down to the bottom first as shown in the following figure, bend it in a circular pattern a few times and then install it upward so that water hardly enters or accumulates inside the cable (move the cable down to the bottom first before installation regardless of the mounting orientation).</td>
</tr>
<tr>
<td>● For installation of conduit, do the same to prevent water from entering.</td>
</tr>
</tbody>
</table>
Atmospheric pressure is introduced into an instrument via the cable. If the cable is pressed due to a clamp, bush, or extreme bend in the middle of the cable, or if the cable is long, the exhaustion of pressure takes time. In this case, an output error may be caused because of pressure within the case or a change in temperature. Conduct wiring not to seal the cable end with tape or adhesive.

Be sure to select and use a transmission cable with an appropriate outer diameter according to the size of the gland.

Waterproof performance (equivalent to IPX7* (watertight)) is ensured by using a cable conforming to the gland. Waterproof performance is also affected by how you tighten the terminal box lid and install a wire inlet.

Be sure to check the waterproof performance when using commercially available glands or cable conduits instead of the supplied gland parts.

Waterproof performance equivalent to IPX7 is guaranteed only when the components are properly assembled. So, please check it carefully.

* IPX7 (provision of protecting temporary immersion into water): Submerge the main unit in a tank with a depth of 1 m for 30 minutes to check that the unit is not flooded (the amount of water causing harmful effects is not intruded).

< Figure 7-1 Installation direction recommended for possible water sprinkling >
8. Wiring and Connection

8.1 Wiring

1) Refer to the table below to obtain a suitable shielded cable.

<table>
<thead>
<tr>
<th>Model number</th>
<th>Terminal opening size</th>
<th>Gasket inner dia. (mm)</th>
<th>Suitable cable dia. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KH15-J-□□</td>
<td>G3/8</td>
<td>φ7</td>
<td>φ6 to 7</td>
</tr>
<tr>
<td>terminal box (small)</td>
<td></td>
<td>10a (standard)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>10b</td>
<td>φ7 to 8</td>
</tr>
<tr>
<td>KH15-K-□□</td>
<td>G1/2</td>
<td>φ9</td>
<td>φ8 to 9</td>
</tr>
<tr>
<td>terminal box (large)</td>
<td></td>
<td>15a</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>15b (standard)</td>
<td>φ10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15c</td>
<td>φ10 to 11</td>
</tr>
</tbody>
</table>

2) Process the end of the cable in accordance with Figure 8-1 and 8-2 below for each model number.

<KH15-J□□ (small terminal box)>
Strip 60 mm of the cable sheath and 7 to 9 mm of the core coat. Provide shielding at the bottom end of the sheath. Cable that fits the terminal block is AWG24 to 12 (0.2 to 3.3 mm²).

<Figure 8-1>

<KH15-K□□ (large terminal box)>
Strip 80 mm of the cable sheath, and then strip the core coat to fit the length of the M3 crimp terminal to be used. Mount the crimp terminal to the wiring terminal. Provide shielding at the bottom end of the sheath.

<Figure 8-2>
### CAUTION

- Use a dedicated tool to peel the coating to avoid damage to the cable core.

- Be careful if the shielded wires do not extend the sheath end face.

- Atmospheric pressure is introduced into an instrument via the cable. If the cable is pressed due to a clamp, bush, or extreme bend in the middle of the cable, or if the cable is long, the exhaustion of pressure takes time. In this case, an output error may be caused because of pressure within the case or a change in temperature. Conduct wiring not to seal the cable end with tape or adhesive. Avoid using the cable with poor ventilation performance (no clearance within the cable).

- Always attach a crimp terminal that fits with the core wire.

3) Open the terminal box lid and insert the cable from the terminal opening deep into the gasket (See Figure 8-3 below).

4) Tighten the gland and seal the terminal opening. (See Figure 8-3 below).

### CAUTION

- Pass the cable through the gasket and tighten it with the gland to prevent the intrusion of water.
5) Secure the wire to the terminal block.
   The recommended tightening torque for KH15-J□□ terminal block: 0.4 N·m
   The recommended tightening torque for KH15-K□□ terminal block: 0.5 N·m

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Never connect the wires with moisture adhering to the product. Penetration of moisture or other substances inside the product will cause malfunction.</td>
</tr>
<tr>
<td>• When using a bare crimp terminal, use an insulation tube to keep necessary insulation distance to avoid the live part exposure for possible electric shock or short circuit. (see the figure below).</td>
</tr>
<tr>
<td>• Be careful not to lose each component during wire connection.</td>
</tr>
</tbody>
</table>

6) Seal the terminal box by tightening the box lid.

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Tighten the terminal box lid securely to prevent the intrusion of water.</td>
</tr>
</tbody>
</table>

8.2 Waterproofness of Wire Inlet

Waterproof performance of this product is secured by using the cable with a suitable outer diameter according to the gland size. Pay enough attention to those actions affecting waterproof performance such as the tightening of the terminal box lid and installation of the wire inlet. Be sure to check the waterproof performance when using commercially available glands or cable conduits instead of the supplied gland parts.

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Protection class equivalent to IP67 is guaranteed only when the components are properly assembled.</td>
</tr>
</tbody>
</table>
8.3 Wiring Diagram and External Connection

(1) Wiring diagram

<table>
<thead>
<tr>
<th></th>
<th>2-wire system</th>
<th>3-wire system</th>
</tr>
</thead>
<tbody>
<tr>
<td>KH15-K</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terminal block</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AWG24 to 12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

KH15-K          |               |               |
| Terminal block  |               |               |
| M3              |               |               |

< Figure 8-4 >

(2) Examples of external connection

< 2-wire system (4 to 20 mA DC) >

KH15

Power supply
+24V
0V

< Figure 8-5 >

< 3-wire system (1 to 5V DC, 0 to 5V DC) >

KH15

Power supply
+24V
0V

< Figure 8-6 >

Ammeter to monitor output

4 to 20 mA DC

Load resistance

< Figure 8-5 >
When using the same power supply to connect equipment that causes surge or other phenomena, a varistor or the like should be connected to protect the transmitter.

**CAUTION**

- Before installation, check the rated value specified for this product to determine the rated value of the power supply to use. Internal resistance of equipment to be connected should be within the rated load resistance of the product.

### 9. OPERATION (ENERGIZATION)

Before powering on, make sure once again that the correct connections are established and that the rated voltage/current of the power supply as well as the internal resistance of the externally connected equipment are within the rated range of the load resistance applied to the product. Then, power on and wait at least 5 minutes for warm-up before starting a production run.

**CAUTION**

Observe the following precautions during operation:

- Avoid applying pressure equal to or higher than the rated pressure shown on the product label.
- Do not conduct wiring in the power-on state. Failures or electric shocks may be caused in the product. Follow the wiring diagram to install the cables.
- Before installation, check the rated value specified for this product to determine the rated value of the power supply to use. Internal resistance of equipment to be connected should be within the rated load resistance of the product.

### 10. MEASURES AGAINST NOISE

#### 10.1 Effects of Noise

If intermittent changes in measurement values or output are found, or if pressure values different from actual ones are indicated, they may be affected by noise. Generally, sources of noise include power supply, an output cable, peripheral equipment, and wiring. Values may be subject to effects of noise depending on the installation place or position of the product. When you identify the source and take the measures below, you can reduce effects of noise.

**Radiation noise**

- Keep the product away from the source.
- Change the direction of the product toward the source to change an incidence angle to a board.
- Install an electromagnetic shield in the source or the product.
Induction noise
- Keep the product away from the wiring carrying high current.
- Keep the product away from electrically charged machines or objects.

Conductive noise
- Use the stable power supply that is difficult to generate noise.
- Install power supply or output measurement equipment in an environment that is impervious to being affected by noise.
- Use a ferrite core to filter cables.
- Use high-noise-resistant cables such as a shield one for connection to connect the shield to the ground.

11. STORAGE

11.1 Precautions for Storage

⚠ CAUTION

Do not store the product in the places listed below. If you do not observe this instruction, the product will fail or get damaged.
- Locations that are prone to condensation with high humidity
- Locations that may be adversely affected by atmospheric pressure, temperature, humidity, ventilation, sunlight, dust, salt, sulfur-containing air or other factors
- Locations subject to inclination, vibration or shock (including those during transportation)
- Locations where chemicals are stored or gases are generated.
- Locations exposed to direct sunlight or in high-temperature cars

12. MAINTENANCE

12.1 Periodical Inspection

A periodical maintenance once a half year will be needed due to possible aging under different operating conditions. Also, perform calibration as needed. Calibration should be performed in a specified manner or at a designated calibration laboratory.

Refer to the following checklist for periodic inspections.

< Periodic Inspection Checklist >
- Appearance (flaws, cracks, deformation, and corrosion)
- Corrosion state of the pressure inlet
- Insulation resistance between the case and all terminals tied (100 MΩ or more at 50V DC)
- Leak check and retightening of the threads
- Output check with a reference pressure gauge and a measuring instrument
- Waterproof check and retightening of the cable, gland, and terminal box
Current output can be checked with a check terminal (+CH) without removing any wiring. Use an ammeter with an internal resistance of 10Ω or less during checking.

⚠️ CAUTION

- Avoid electrostatic charge.

- To clean the appearance of the product, use a water-soaked soft cloth. Do not use thinner and benzine that cause degradation or failures.

### 12.2 Adjustment

Remove the terminal box lid to adjust the output of this product. When removing the lid, you will see the plate as shown in Figure 8-7 below. The characters “Z” and “S” printed on the plate are trimmers for zero and span adjustment respectively.

- Do not perform an adjustment when the surface of the product is wet. Moisture getting inside the product will cause a failure.

- Never cause short circuits with a driver (be sure to use a resin or ceramic driver).

- After powering on, wait at least 5 minutes for warm-up in an energizing state before performing an adjustment.

- Care should be taken to prevent excessive load on trimmers. Otherwise, trimmers (circuit parts) may be damaged.

- For adjustment, use the reference pressure gauge and measuring instrument with traceability ensured.
12.2.1 Zero adjustment

Turn the zero trimmer with a slotted screwdriver to perform zeroing. A positive pressure range and compound range are adjusted differently as shown below.

< Positive pressure range >
Adjust output in a vented (unpressurized) state to 4 mA DC for the current output product, and to 1V DC or 0V DC for the voltage output product.

< Compound range >
Calculate the output value in the vented state based on the formula below.

- Current output product (4 to 20 mA DC)
  
  \[
  \text{(output in a vented state (mA))} = \left( \frac{16 \text{ mA}}{[\text{upper limit pressure range (MPa)}] - [-0.1 \text{ MPa}]} \right) \times 0.1 + 4 \text{ mA}
  \]

  \(< \text{Example} > 0.5 \text{ MPa compound range: 6.67 mA, 1.0 MPa compound range: 5.45 mA}\)

- Voltage output product (1 to 5V DC)
  
  \[
  \text{(output in a vented state (V))} = \left( \frac{4 \text{ V}}{[\text{upper limit pressure range (MPa)}] - [-0.1 \text{ MPa}]} \right) \times 0.1 + 1\text{V}
  \]

  \(< \text{Example} > 0.5 \text{ MPa compound range: 1.667 V, 1.0 MPa compound range: 1.364 V}\)

- Voltage output product (0 to 5V DC)
  
  \[
  \text{(output in a vented state (V))} = \left( \frac{5 \text{ V}}{[\text{upper limit pressure range (MPa)}] - [-0.1 \text{ MPa}]} \right) \times 0.1 + 0\text{V}
  \]

  \(< \text{Example} > 0.5 \text{ MPa compound range: 0.833 V, 1.0 MPa compound range: 0.454 V}\)

Ensure that the pressure is released to the atmosphere (no pressure) and adjust the output under this condition to the above calculated value.

⚠️ CAUTION

- Be careful not to turn the span trimmer "S" during zeroing.

12.2.2 Span adjustment

Ask us for span adjustment unless there are exceptional circumstances. Do not perform span adjustment if you do not have a reference pressure gauge.

To perform span adjustment using the reference pressure gauge, follow the procedures below. Please also note that the output value of a reverse output is different from that of the compound pressure gauge.

1) Perform zeroing as described in "12.2.1 Zero adjustment".
2) Apply an upper limit pressure range correctly, and use the span trimmer to adjust the output to 20 mA DC for the current output product and to 5V DC (or the span value) for the voltage output product.
3) Repeat steps 1) and 2) alternately to adjust the zero point and span.
Turning the span trimmer "S" will also change the zero point.

Avoid applying pressure equal to or higher than the rated pressure shown on the product label.

Be careful not to turn the span trimmer "S" during zeroing.

13. PRODUCT WARRANTY/EXPORT ADMINISTRATION REGULATIONS

13.1 Product Warranty

If the delivered product within the warranty period (one (1) year from the delivered date) is judged as a nonconforming product according to "Defect due to the design or manufacturing by Nagano Keiki Co., Ltd.", they are repaired or replaced with conforming products free of charge.

However, note that the following cases are excluded.

- Customer or any third party other than us disassemble or modify the delivered product, replace parts, or add functions;
- The information described in the User Manual or catalog is not observed;
- Non-conformance is caused by deterioration due to use, natural disaster, fire or other force majeure events; and
- Any secondary damage caused by nonconforming product including the above.

Please note that, regardless of whether the customer recognizes the handling deficiency, any obvious evidence of deformation, wear or burnout found on parts will be excluded from the warranty scope and be subject to paid service.

13.2 Export Administration Regulations

To export the product, check Foreign Exchange and Foreign Trade Law as well as laws and regulations regarding United States export administration, and then proceed with the necessary process of export.

14. OTHERS

This user manual does not cover details or all variants of equipment. It is not intended to support all events involved that you encounter in installing and maintaining the product. Therefore, when you need further detailed information, or when the manual does not provide enough information suited for your intent, contact us.