CE

User's Guide

OMEGA®
An OMEGA Technologies Company

http://www.omega.com
e-mail: info@omega.com

FMG-400's
Electromagnetic Flowmeters
(Flange type)

OMEGA

omega.com™
OMEGA®

OMEGAnetSM On-Line Service	Internet e-mail
http://www.omega.com	info@omega.com

.Servicing North America:

USA: One Omega Drive, Box 4047
ISO 9001 Certified Stamford, CT 06907-0047
Tel: (203) 359-1660 FAX: (203) 359-7700
e-mail: info@omega.com

Canada: 976 Bergar
Laval (Quebec) H7L 5A1
Tel: (514) 856-6928 FAX: (514) 856-6886
e-mail: canada@omage.com

For immediate technical or application assistance:

USA and Canada: Sales Service: 1-800-826-6342 / 1-800-TC-OMEGA℠
Customer Service: 1-800-622-2378 / 1-800-622-BEST℠
Engineering Service: 1-800-872-9436 / 1-800-USA-WHEN℠
TELEX: 996404 EASYLINK: 62968934 CABLE: OMEGA

Mexico and Latin America: Tel: (95) 800-TC-OMEGASM FAX: (95) 203-359-7807
En Espanol: (203) 359-7803 e-mail: espanol@omega.com

Servicing Europe:

Benelux: Postbus 8034, 1180 LA Amstelveen, The Netherlands
Tel: (31) 20 6418405 FAX: (31) 20 6434643
Toll Free in Benelux: 06 0993344
e-mail: nl@omega.com

Czech Republic: ul. Rude armady 1868, 733 01 Karvina-Hranice, Czech Republic
Tel: 420 (69) 6311627 FAX: 420 (69) 6311114
e-mail: czech@omega.com

France: 9, rue Denis Papin, 78190 Trappes
Tel: (33) 130-621-400 FAX: (33) 130-699-120
Toll Free in France: 0800-4-06342
e-mail: france@omega.com

Germany/Austria: Daimlerstrasse 26, D-75392 Deckenpfronn, Germany
Tel: 49 (07056) 3017 FAX: 49 (07056) 8540
Toll Free in Germany: 0130 11 21 66
e-mail: germany@omega.com

United Kingdom: 25 Swannington Road, P.O. Box 7, Omega Drive,
ISO 9002 Certified Broughton Astley, Leicestershire, Irlam, Manchester,
LE9 6TU, England M44 5EX, England
Tel: 44 (1455) 285520 Tel: 44 (161) 777-6611
FAX: 44 (1455) 283912 FAX: 44 (161) 777-6622
Toll Free in England: 0800-488-488
e-mail: uk@omega.com

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SAFETY PRECAUTIONS

Safety signs and labels affixed to the product and/or described in this manual give important information for using the product safely. They help prevent damage to property and obviate hazards for persons using the product.
Make yourself familiar with signal words and symbols used for safety signs and labels. Then read the safety precautions that follow to prevent an accident involving personal injury, death or damage to property.

Explanation of signal words

The signal word or words are used to designate a degree or level of hazard seriousness.
The signal words used for the product described in this manual are WARNING and CAUTION.

⚠WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠CAUTION	Indicates a potentially hazardous situation which, if not avoided, may result in minor to moderate injuries or in property damage.

Safety symbols

The following symbols are used in safety signs and labels affixed to a product and/or in the manual for giving safety instructions.

	Indicates an action that is prohibited. Simply DON'T do this action. The prohibited action is indicated by a picture or text inside or next to the circle
	Indicates an action that is mandatory. DO this action. The mandatory action is indicated by a picture or text inside or next to the circle.
	Indicates a potential hazard. The potentially hazardous situation is indicated by a picture or text inside or next to the triangle.

SAFETY PRECAUTIONS (continued)

Safety Precautions for Installation and Wiring

⚠ WARNING
■ Do not use the FMG400 Series in an **explosive atmosphere**.  DON'T Using this product in an explosive atmosphere can cause **explosion**.

⚠ CAUTION	
■ **Turn off main power** before working on pipes.  DO Working on pipes while power is applied can cause **electric shock**.	■ Use an **appropriate device** to carry and install the FMG400 Series.  DO If this product **falls to the ground**, injury, or malfunction of or damage to the product, can be caused.
■ **Install a switch and fuse** to isolate the FMG400 Series from main power.  DO Power supply from main power can cause **electric shock** or **circuit breakdown**.	■ **Do not modify or disassemble** the FMG400 Series unnecessarily.  DON'T Modifying or disassembling this product can cause **electric shock**, **malfunction of or damage to this product**.
■ **Turn off main power** before conducting wiring work.  DO Wiring while power is applied can cause **electric shock**.	■ **Ground** the FMG400 Series **independently from power equipment.**  DO Operating this product without grounding can cause **electric shock** or **malfunction**.
■ Do not conduct wiring work **with bare hands.**  DON'T **Remaining electric charge** even if power is turned off can still cause **electric shock.**	■ Use **crimped terminal lugs** for the terminal board and GND terminal.  DO Loose connections can cause **electric shock**, **fire from excessive current or system malfunction**.
■ Do not work on piping and wiring **with wet hands**.  DON'T Wet hands may result in **electric shock**.	 The label shown left is placed near the terminal board for power input. (A black border and symbol on yellow triangle) Be alert to **electric shock**

SAFETY PRECAUTIONS (continued)

Safety Precautions for Maintenance and Inspection

<table>
<tr><th colspan="2">⚠ CAUTION</th></tr>
<tr><td>■ Do not touch the FMG400 Series main body when high temperature fluid is being measured.
 
DON'T
The fluid raises the main body temperature and can cause burns when touched.</td><td>■ Do not conduct wiring work when power is applied.
 
DON'T
Wiring while power is applied can cause electric shock.</td></tr>
<tr><td>■ Do not conduct wiring work with wet hands.
 
DON'T
Wet hands may result in electric shock.</td><td> 
The label shown left is placed near the terminal board for power input.
(A black border and symbol on yellow triangle)
Be alert to electric shock.</td></tr>
<tr><td>■ Do not use a fuse other than the one specified.
 
DON'T
Using a fuse other than the one specified can cause system failure, damage or malfunction.</td><td>Use a rated fuse as follows depending on the power specifications.
• Fuse rating:
1A/250V for 100 to 240 V ac
• Dimensions:
Diameter 5.2 mm × 20 mm</td></tr>
</table>

Disclaimer

OMEGA does not accept liability for any damage or loss, material or personal, caused as a direct or indirect result of the operation of this product in connection with, or due to, the occurrence of any event of force majeure (including fire or earthquake) or the misuse of this product, whether intentional or accidental.

Handling Precautions

■ To obtain the optimum performance from the FMG400 Series flowmeter for years of continuous operation, observe the following precautions.

(1) Do not store or install the flowmeter in:
- places where there is direct sunlight. If this is unavoidable, use an appropriate sunshade.
- places where excessive vibration or mechanical shock occurs.
- places where high temperature or high humidity conditions obtain.
- places where corrosive atmospheres obtain.
- places submerged under water.

To put the flowmeter temporarily on the floor, place it carefully with something to support it so that the flowmeter will not topple over.

(2) Execute wiring securely and correctly.

(3) Seal the cable thoroughly at the cable gland so that the cable is kept airtight.

(4) Ground the flowmeter with 100 ohm or less ground resistance. Avoid a common ground used with other equipment where earth current may flow. An independent ground is preferable.

(5) The converter housing covers and the cable glands are tightened securely at the time of shipment. Do not remove these covers or glands unless it is necessary to wire new cables or replace old ones. Otherwise, gradual deterioration of circuit isolation or damage to this product can be caused. Tighten the covers or cable glands securely again if they have been removed.

(6) Make sure the fluid to be measured will not freeze in the detector pipe. This can cause damage to the detector pipe.

(7) Select appropriate wetted materials suited for the process fluid to be measured. Otherwise, fluid leakage due to corrosion can be caused.

(8) Observe the following precautions when you open the converter housing cover:
- Do not open the cover in the open air unprotected against rain or wind. This can cause electric shock or cause damage to the flowmeter electronics.
- Do not open the cover under high ambient temperature or high humidity conditions or in corrosive atmospheres. This can cause deterioration of system accuracy or cause damage to the flowmeter electronics.

(9) This product may cause interference to radio and television sets if they are used near the installation site. Use metal conduits etc. for cables to prevent this interference.

Handling Precautions (continued)

(10) Radio transmitters such as transceivers or cellular phones may cause interference to the flowmeter if they are used near the installation site. Observe the following precautions when using them:

- Do not use a transceiver whose output power is more than 5 W.
- Move the antenna of a transceiver or a cellular phone at least 50 cm away from the flowmeter and signal cables when using it. Do not use a radio transmitter or a cellular phone near the flowmeter while it is operating online. The transmitter or cellular phone's output impulse noise may interfere with the flowmeter.
- Do not install a radio transmitter antenna near the flowmeter and signal cables.

(11) For reasons of flowmeter failure, inappropriate parameters, unsuitable cable connections or poor installation conditions, the flowmeter may not operate properly. To prevent any of these problems causing a system failure, it is recommended that you have preventive measures designed and installed on the flowmeter signal receiving side.

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Table of Contents

1. Product Inspection and Storage

Upon arrival of the product package, open the package and check the items contained inside. If you do not intend to install the product soon after opening the package, store the product and other related items in a place such as described in 1.2 below.

1.1 Product Inspection

The FMG400 Series flange type electromagnetic flowmeter is shipped in a cardboard container filled with shock-absorbing materials. Open the package carefully and check as follows:

- Make sure the following items are included in the package.

  (1) Model FMG400 Series falnge type Electromagnetic Flowmeter..... 1
  (2) Instruction Manual 1
  (3) Operation Guide 1

- Inspect the flowmeter for indications of damage that may have occurred during shipment.
- Make sure the type and specifications of the flowmeter are in accordance with the ordered specifications.

If you cannot find the items listed above or any problem exists, contact OMEGA.

1.2 Storage

To store the FMG400 Series flowmeter after opening the package, select a storing place as follows and keep it under the conditions described below:

(1) Avoid places where there is direct sunlight, rain or wind.
(2) Store the product in a well-ventilated place. Avoid places of extremely high humidity or extremely high or low temperature. The following environment is recommended:
   - **Humidity range: 10 to 90% RH (no condensation)**
   - **Storage temperature: –15 to +65° C**
(3) Avoid places where vibrations or mechanical shock occurs.
(4) Do not leave the converter housing cover open . Open the cover only when you actually start wiring cables. Leaving the cover open can cause gradual deterioration of circuit isolation.
(5) To put the flowmeter temporarily on the floor, place it carefully with something to support it so that the flowmeter will not topple over.

2. Overview

The FMG400 Series electromagnetic flowmeter measures the volumetric flow rates of electrically conductive materials on the basis of Faraday's Law of Electromagnetic induction. The device consists of two units: the detector, through which the fluid to be measured flows, and the converter, which receives the electromotive force signals from the detector, then converts the signals into the 4–20 mA dc signal. These two units for the FMG400 Series are integrally mounted.

Features

Every type of electromagnetic flowmeter has the following features:

- Fluid flow is not obstructed and pressure loss is negligible.
- The process fluid's temperature, pressure, density or flow conditions have no effect on the accuracy of the flowmeter.
- The flowmeter output is directly proportional to the process flow rate, thus it is easy to read its output.

The FMG400 Series electromagnetic flowmeter has the following additional features:

(1) High accuracy, ±0.5% of rate is possible for 0.3–10 m/s velocity range.

(2) The flowmeter can be used to measure fluids with solids (such as sludge or slurries) for the reasons stated below:
   - The original noise-suppression circuit with signal processing capabilities ensures a stable output.

(3) The flowmeter has various flow measurement output and control functions as standard specifications and the LCD display for convenient parameter settings.
   - These functions can be selected with control keys on the panel.

(4) An easy-to-read LCD display (2-line × 16-character display)
The backlit LCD display can be read even under poor lighting conditions.

3. Names of Parts

The outline drawing of the FMG400 Series flange type flowmeter is shown in Figure 3.1 and the internal views of the converter are shown in Figures 3.2 and 3.3.

■ **Outline Drawing**

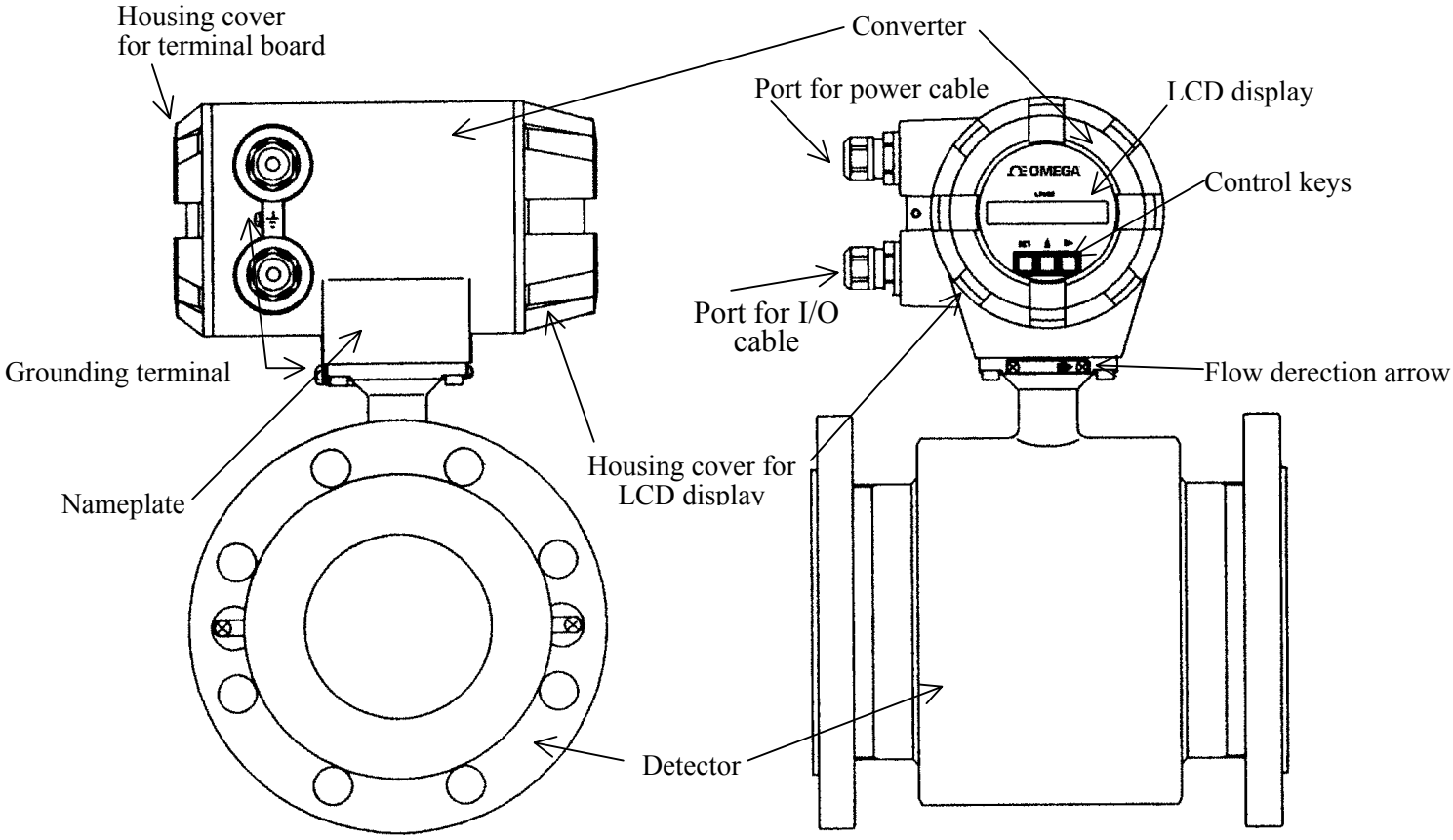
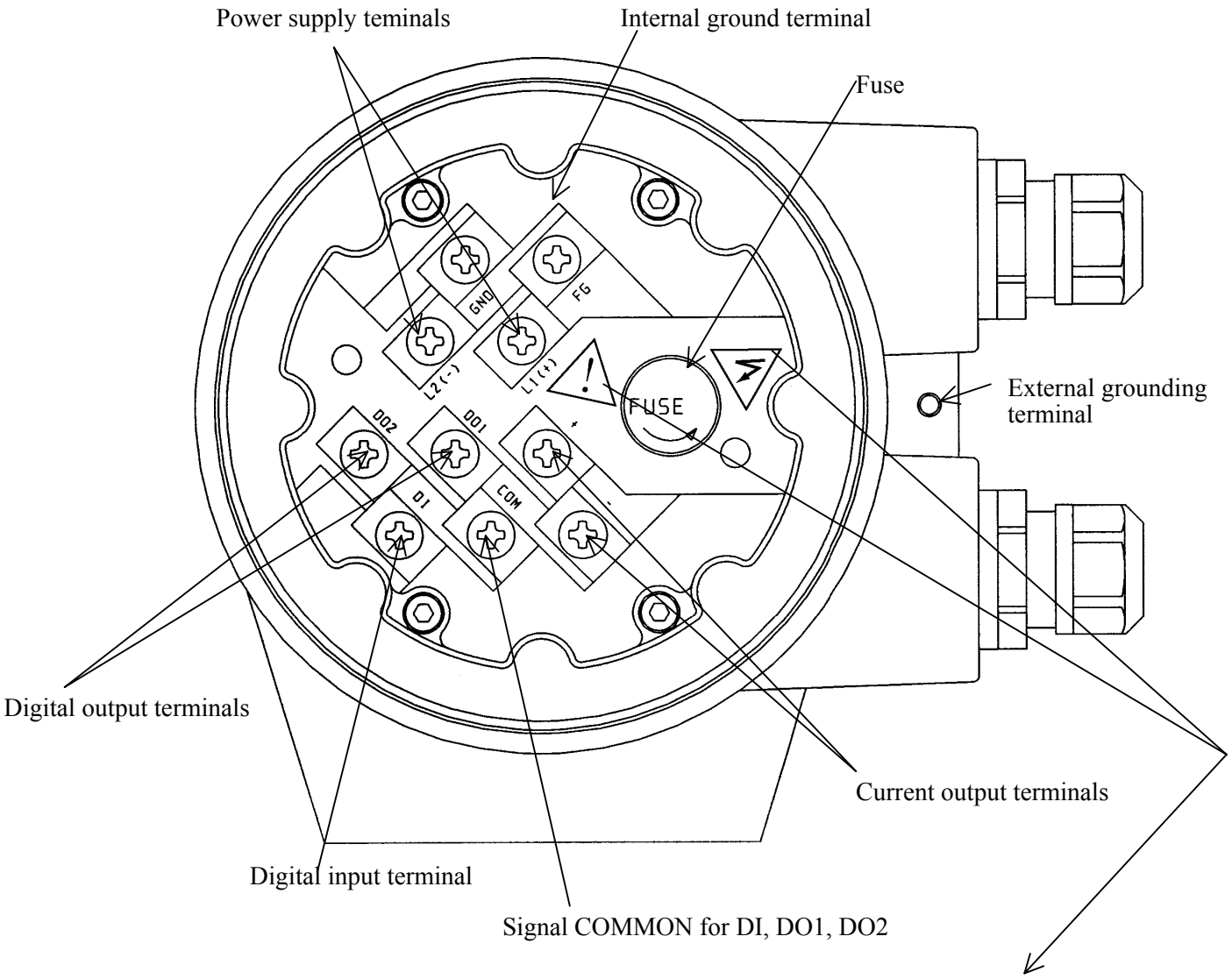


Figure 3.1 Outline drawing of FMG400 Series flange type Flowmeter

■ **Terminal Board of Converter**



宜しくお願い致します。 **CAUTION**

The seal shown in the left figure is attached to near the power supply wiring terminals. Be careful not to get electric shock.

Figure 3.2 Terminal Board of Converter

■ **Control switch or keys of Converter**

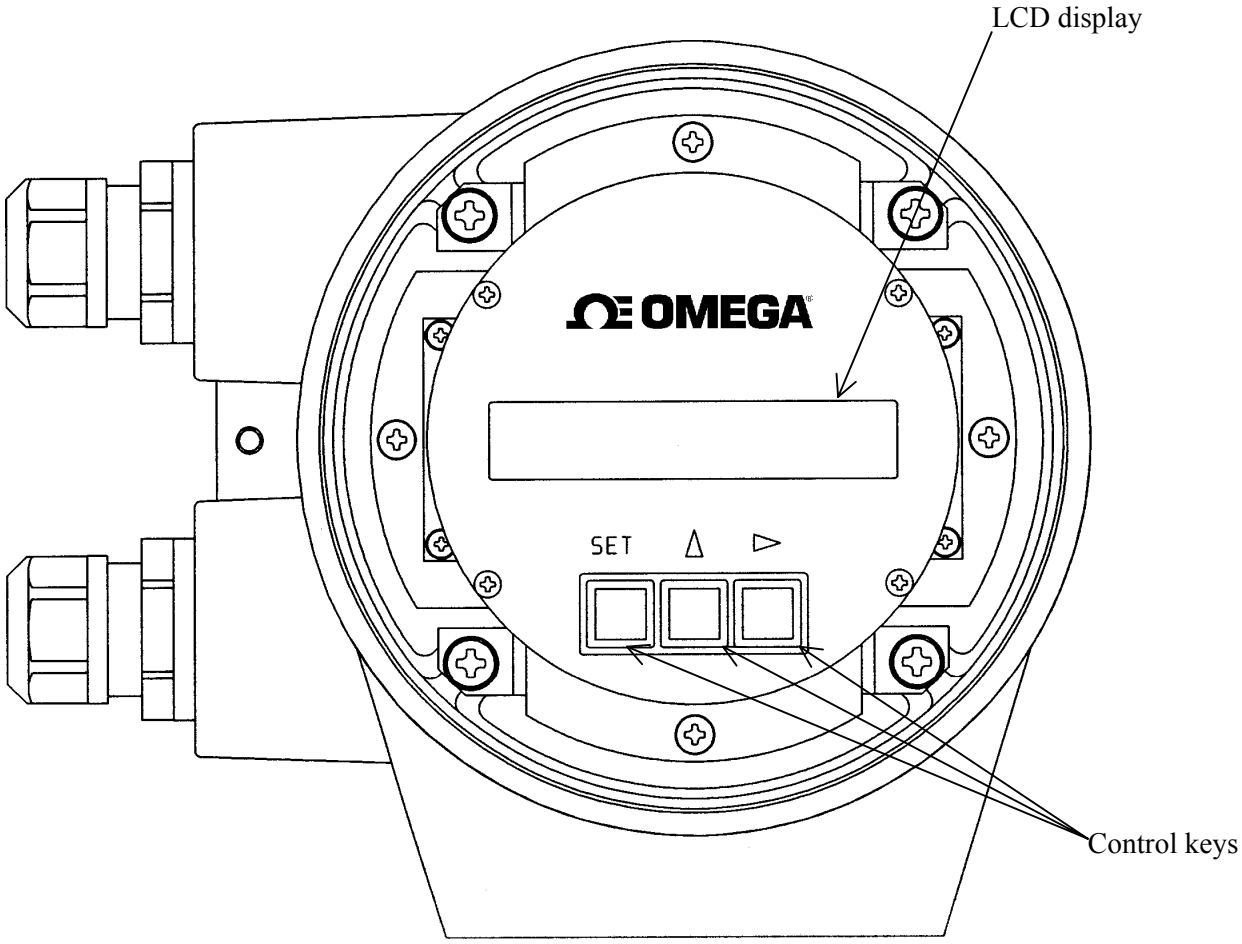


Figure 3.3 Control switch or keys of Converter

4. Installation

Safety Precautions for Installation

⚠WARNING
■ Do not use the FMG400 Series in an **explosive atmosphere**.  DON'T Using this product in an explosive atmosphere can cause **explosion**.

⚠CAUTION	
■ **Install a switch and fuse** to isolate the FMG400 Series from main power.  DO Power supply from main power can cause **electric shock** or **circuit breakdown.**	■ Use an **appropriate device** to carry and install the FMG400 Series.  DO If his product **falls to the ground**, injury, or malfunction of or damage to the product, can be caused.
■ **Do not modify or disassemble** the FMG400 Series unnecessarily.  DON'T Modifying or disassembling this product can cause **electric shock**, **malfunction or damage to this product.**	■ **Ground** the FMG400 Series **independently from power equipment.**  DO Operating this product without grounding can cause **electric shock** or **malfunction**.
■ Do not work on piping and wiring **with wet hands**.  DON'T Wet hands may result in **electric shock**	 The label shown left is placed near the terminal board for power input. (A black border and symbol on yellow triangle) Be alert to **electric shock**.

4.1 Location

To select the installation site, follow the precautions described below:

- Avoid places where fluid runs in a pulsating form.
- Avoid places within the immediate proximity of equipment producing electrical interference (such as motors, transformers, radio transmitters, electrolytic cells, or other equipment causing electromagnetic or electrostatic interference).

- Avoid places where excessive pipe vibration occurs.
- Avoid places where there is direct sunlight. If this is unavoidable, use an appropriate shade
- Avoid places where corrosive atmospheres or high humidity conditions obtain.
- Avoid places of too great an elevation or constricted areas where clearance for installation or maintenance work is not provided.
- Design piping so that the detector pipe is always filled with fluid, whether the fluid is flowing or not.
- The detector has no adjustable piping mechanism. Install an adjustable short pipe where needed.
- Chemical injections should be conducted on the downstream side of the flowmeter.

* For cautions on piping work such as the installation positions of piping and lengths of straight pipes, see Section 4.3.

4.2 Mounting

⚠CAUTION	
■ Use an **appropriate device** to carry and install the FMG400 Series.  DO If his product **falls to the ground**, injury, of malfunction of or damage to the product, can be caused.	■ **Turn off main power** before working on pipes.  DON'T Working on pipes while power is applied can cause **electric shock**.

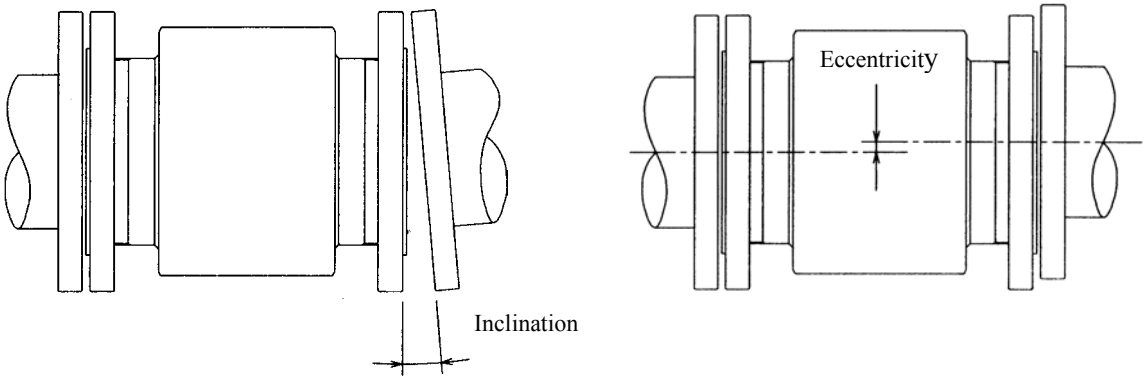
IMPORTANT

When high-temperature fluid is being measured, radiant heat from the detector pipe surface and adjoining pipes may cause the ambient temperature of the converter to go above 60 °C. If the ambient temperature goes above 60° C, try to lower the temperature by measures such as wrapping heat-insulating materials over the detector pipe and adjoining pipes.

4.2.1 Piping Inspection

Before installing the pipes, make sure that there is no inclination of pipes or tube axial displacement (eccentricity) as shown in Figure 4.1. Forced installation of the flowmeter in inclined pipes may cause destruction of the detector or leakage of the fluid. Installing the flowmeter in pipes with the presence of eccentricity may cause local friction of the lining or earth ring and measurement errors depending on the properties of the fluid.

Before installing the pipes, flush the pipe interior to remove foreign matters in the pipes.



(a) Inclination of pipe

(b) Tube axial displacement (eccentricity)

Figure 4.1 Bad Examples with Inclination of Pipe and Tube Axial Displacement (Eccentricity)

4.2.2 Cautions on Carrying Equipment

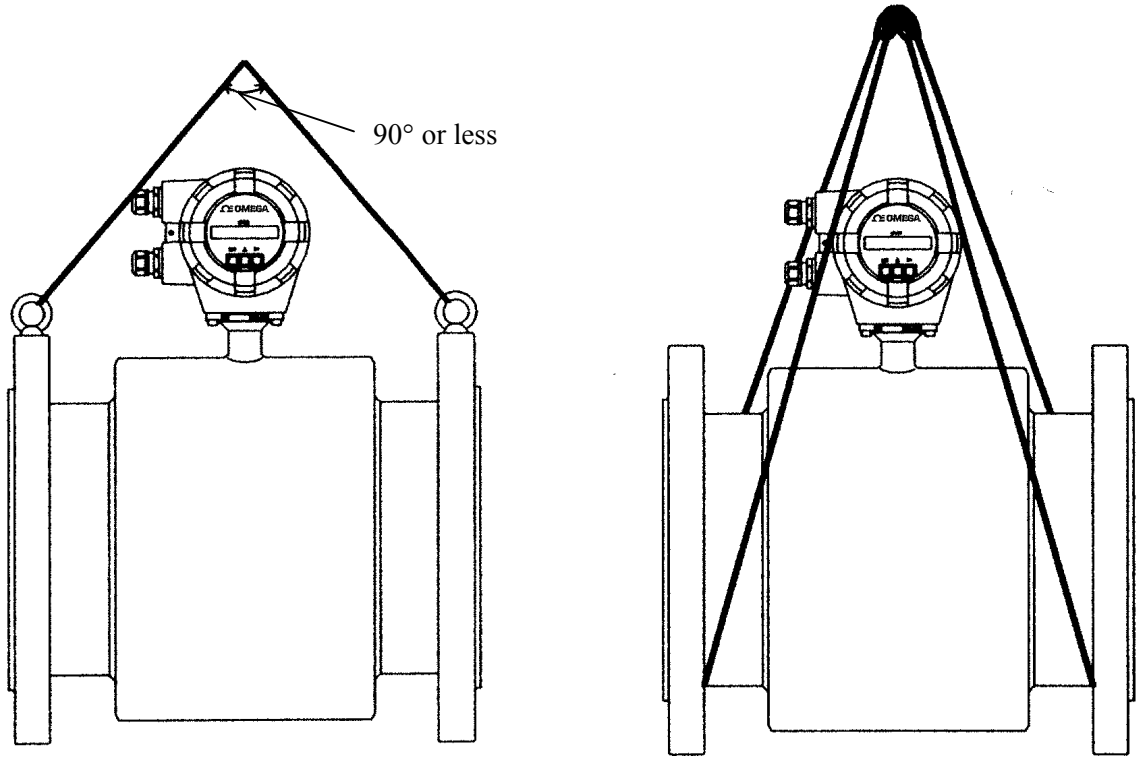
In order to prevent damages to the equipment, carry it packed as was at the time of delivery to the installation location and unpack it there.

As the detector whose nominal diameter is 200 mm comes with eyebolts, lift the equipment as shown in Figure 4.2 (a).

As the detector whose nominal diameter does not exceed 150 mm comes with no lifting means, lift the equipment as shown in Figure 4.2 (b). The weights of the detectors with different nominal diameters are described in Chapter 15 "Outline Dimensions."

Lifting the detector of any nominal diameter by pressing a bar into the detector pipe may damage the lining, preventing stable measurement. Never do this under any circumstances.

* Lifting should be performed under instructions of qualified personnel of crane or slinging work.



(a) With nominal diameter of 200 mm

(b) With nominal diameter of 150 mm or less

Figure 4.2 Lifting Method

4.2.3 Mounting Procedure

To mount the FMG400 Series flange type, place it between the upstream and downstream pipe flanges and tighten it with flange bolts and nuts. See Figure 4.3 and follow the procedure below:

1. Insert two lower mounting bolts through the clearance holes in the upstream (or downstream) pipe flange.
2. Install a packing next to the upstream (or downstream) flange face and the other packing next to the downstream (or upstream) pipe flange. The two mounting bolts can now be guided through the clearance holes in the downstream packing and flange.
3. Place the FMG400 Series flowmeter between the two flange packings, with the flowmeter detector body above the two bolts. The flowmeter must be oriented in accordance with the flow direction arrow.
4. Install the two upper mounting bolts through the clearance holes in the upstream and downstream packings and flanges. Then install the remaining mounting bolts depending on the flange pattern used.
5. Thread nuts on both ends of the 4 (or more) mounting bolts, finger tight.

6. While centering the flowmeter with the longitudinal axis of the pipeline, tighten the nuts with a wrench diagonally across in even increments.

Note that the flowmeter detector pipe axis must be aligned with the pipeline axis on both upstream and downstream sides. This is essential to have stable characteristics of flow measurement (especially for flowmeters with meter sizes of 50 mm or less).

* In the case of a detector using teflon PFA lining, bolts may get loose with time because of plastic deformation of teflon. Tighten them periodically.

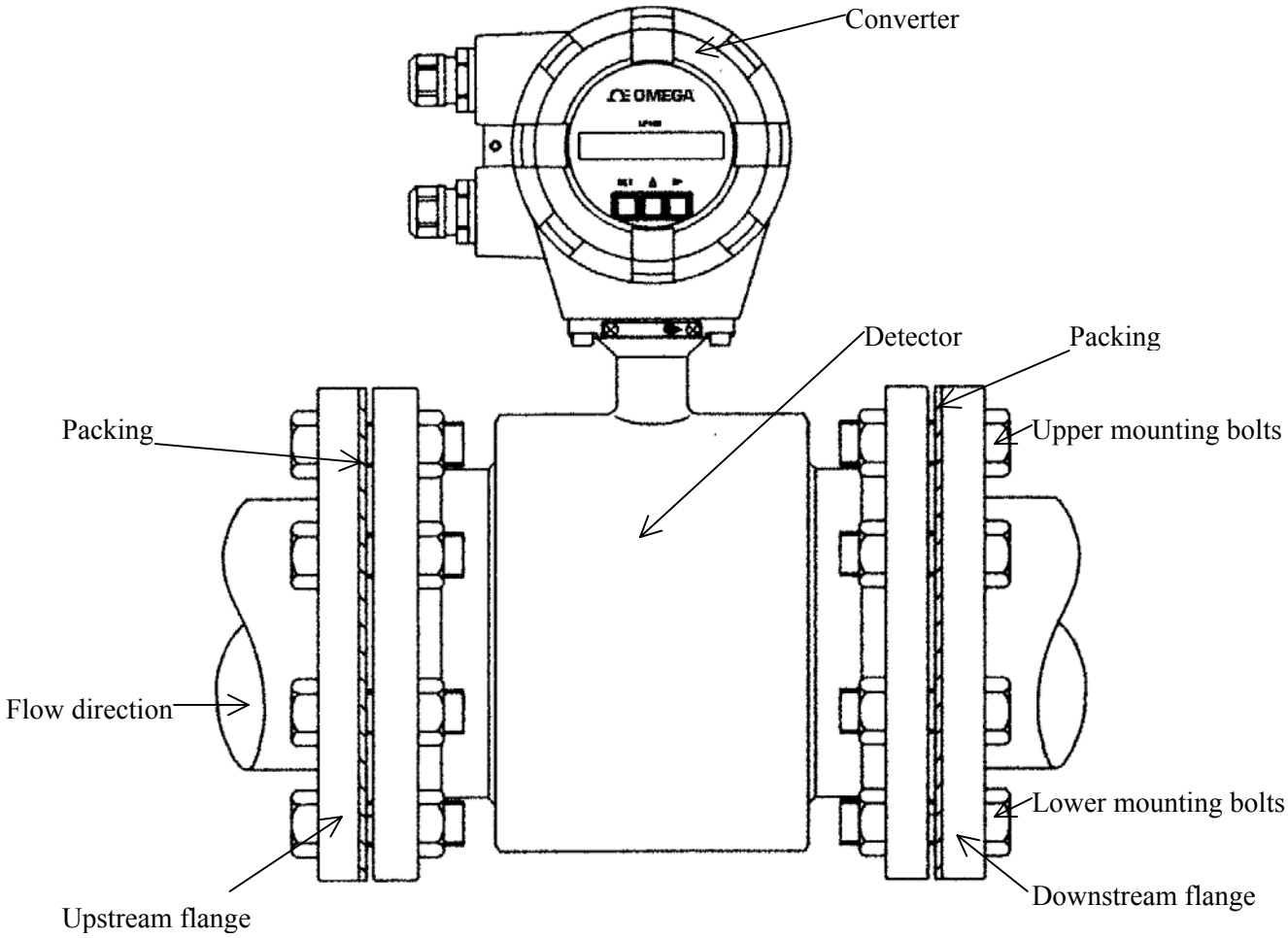


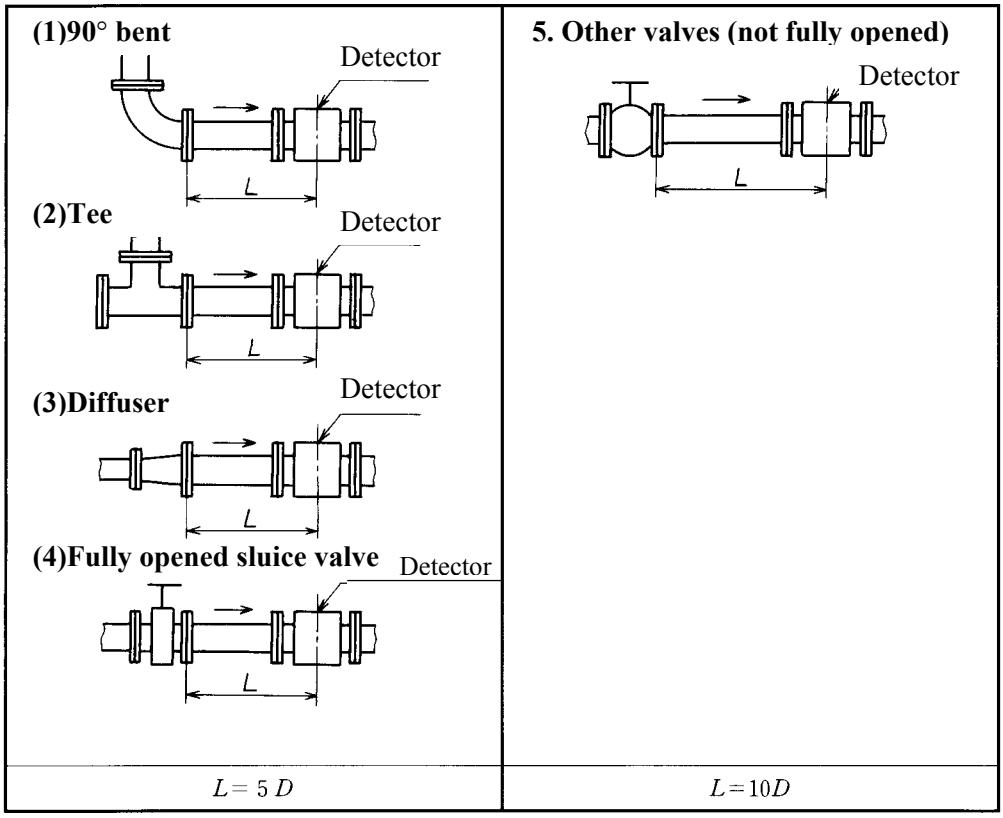
Figure 4.3 FMG400 Series flange type flowmeter-piping connections

4.3 Piping Connections

(1) Required Pipe Length

If various joints are used upstream of the detector outlet, the straight pipe length as shown in Table 4.2 is required.

Table 4.2 Required straight pipe length on the upstream side



L: Required straight pipe length—straight pipe length plus half-length of the detector.

D: Nominal bore size (diameter)

NOTES

1. The length of a reducer, if connected, can be counted as a part of the straight pipe length.
2. No straight pipe length is needed on the downstream side. If a butterfly valve is installed downstream of the detector, do not let the valve plate protrude into the pipe of the detector.

(2) Pipe Orientation

The detector may be installed in horizontal, vertical or sloping pipe runs as shown in Figure 4.4. However, except for horizontal installation, fluid should flow from lower to upper directions. See Figure 4.4.

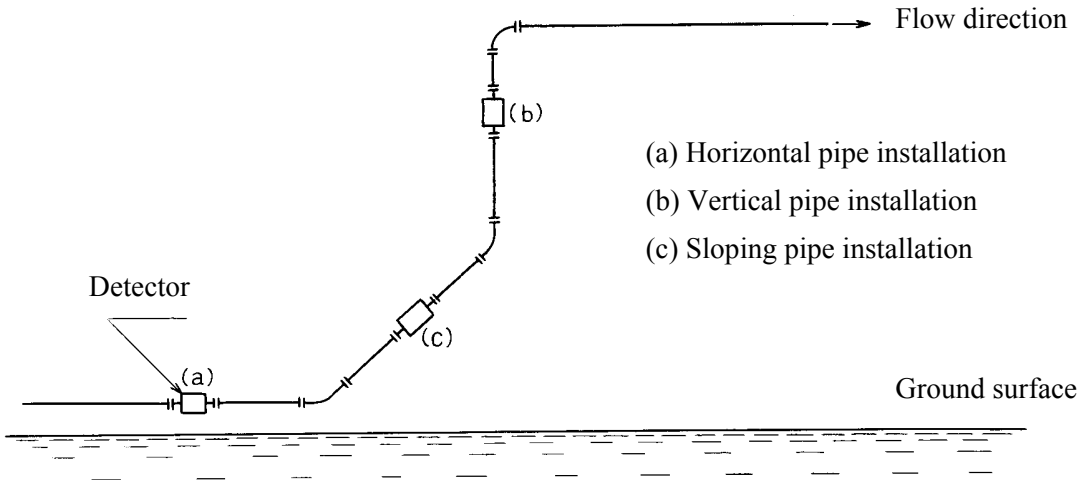


Figure 4.4 Detector Piping Orientation

The electrodes should be positioned horizontally against the ground surface in any piping installation. See Figure 4.5.

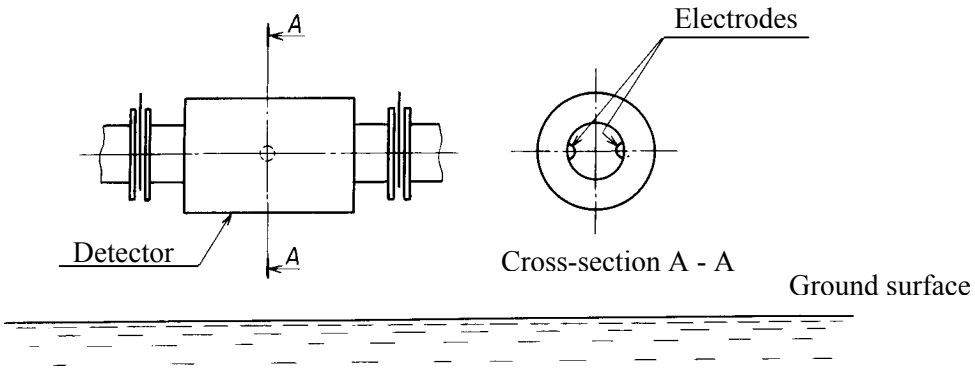


Figure 4.5 Installation position of the detector

(3) Flow Direction

Install the detector in accordance with the flow direction arrow on the detector. See Figure 4.6. If the actual flow runs opposite to the specified flow direction, the following display and output appears. (For bi-directional multi-range measurement, see 10.3, "Multi-range Functions.").

- **LCD display :** Instantaneous flow rate—indicates negative values,
  Totalized flow—no counts added.
- **Output:** Current output— 4.0 mA output; Pulse output—No pulses

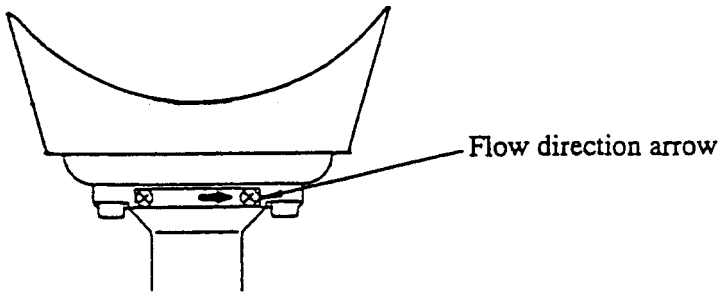


Figure 4.6 Flow direction arrow on the detector

(4) Preventing an Empty Pipe Condition

Design an upright pipe run (Figure 4.7) or sufficient head pressure (Fig. 4.8) at the downstream detector outlet if there is a possibility of the detector pipe becoming emptied.

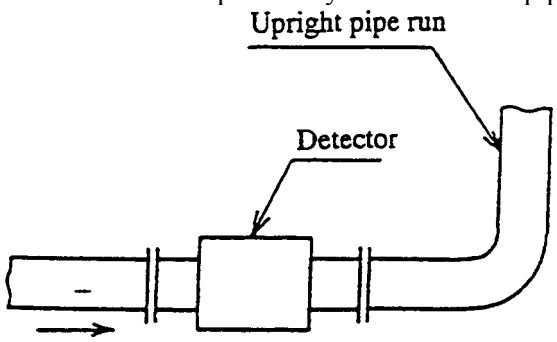


Figure 4.7 Detector with an upright pipe run at downstream outlet

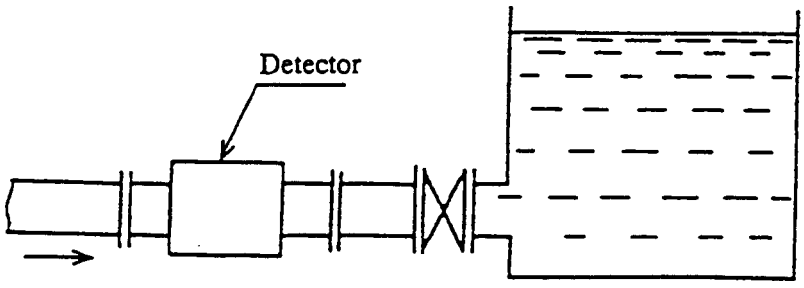


Figure 4.8 Detector with sufficient head pressure at downstream outlet

(5) The pipes on both sides of the installation location of the detector should be fixed by attaching support fittings, etc. Supporting the pipes will not only reduce piping vibration but also prevent damages to the piping due to dead weight of the electromagnetic flowmeter and weight of the fluid. (See Figure 4.9 and Figure 4.10.)

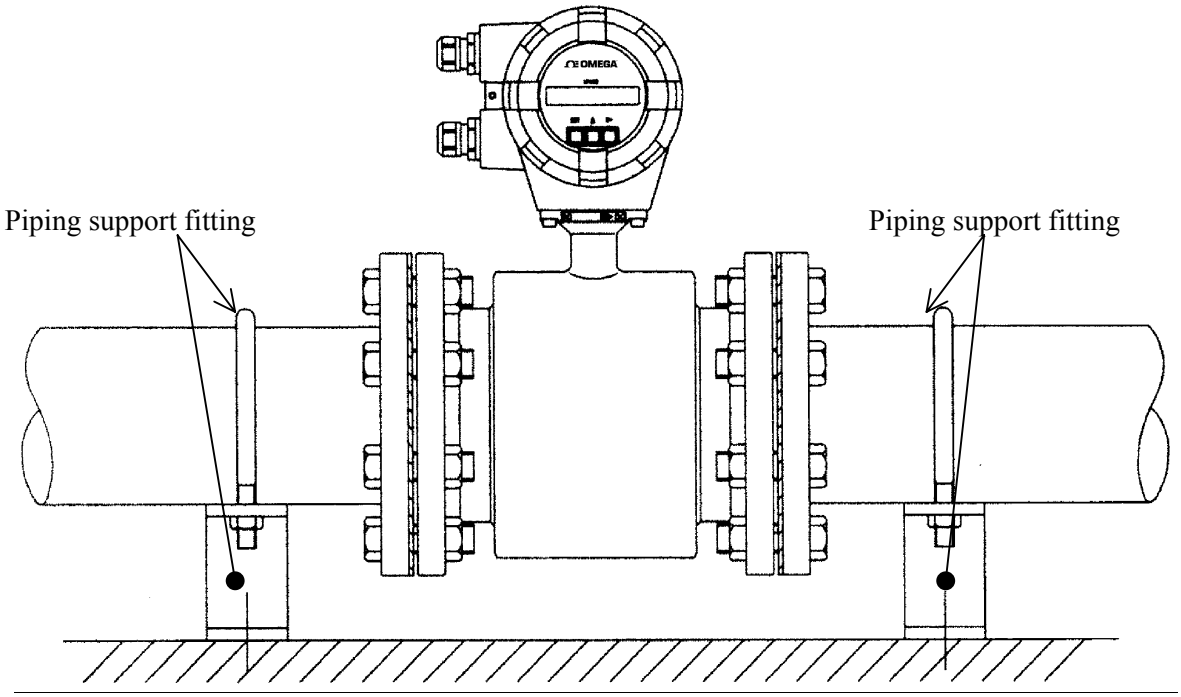


Figure 4.9 Example of Pipe Fixing Method

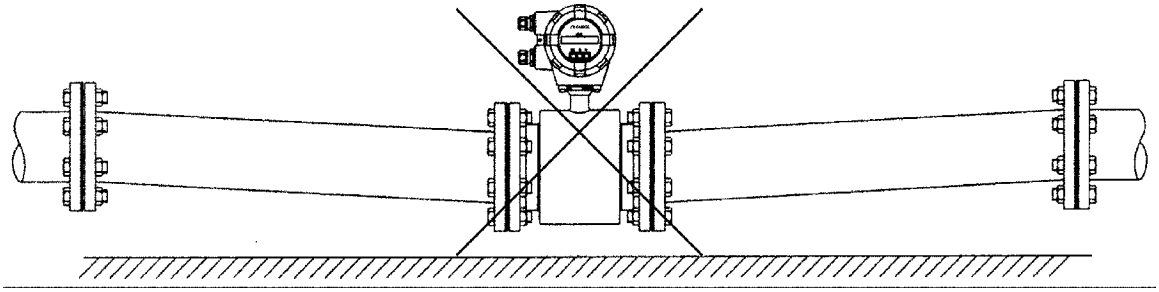


Figure 4.10 Unsupported Piping Model

5. Wiring

<table>
<tr><th colspan="2">⚠ CAUTION</th></tr>
<tr><td>Do not work on piping and wiring with wet hands.
 
DON'T
Wet hands can cause system failure.</td><td>■ Ground the FMG400 Series properly.
 
DO
Operating this product without a grounding can cause system malfunction</td></tr>
<tr><td>■ Do not modify or disassemble the FMG400 Series unnecessarily.
 
DON'T
Modifying or disassembling this product can cause electric shock, malfunction of or damage to this product.</td><td> 
The label shown left is placed near the terminal board for power input.
Be alert to electric shock.</td></tr>
</table>

Flowmeter accuracy may be affected by the way wiring is executed. Proceed with wiring taking the following precautions:

(1) Select the cable runs away from electrical equipment (motors, transformers, or radio transmitters) which causes electromagnetic or electrostatic interference.

(2) Deterioration of flowmeter circuit insulation occurs if the converter interior or cable ends get wet or humidified. This in turn causes malfunction of the flowmeter or noise problems. Avoid a rainy day if the flowmeter is to be installed outdoors. Even indoors, prevent water from splashing over the flowmeter. Try to finish the wiring as quickly as possible.

(3) The converter has a surge-absorbing barrier installed inside. Therefore, do not conduct a withstand voltage test for the converter. To check the insulation of the converter, use a voltage of 250 V dc or less.

5.1 Cables

Use the kind of cables shown in Table 5.1 to wire the converter.

Table 5.1 Cables

Name	Cable type	Nominal cross-sectional area	Overall diameter
Power cable	Three-wire sheathed cable **(Note)**	2 mm²	11 to 13 mm
I/O cable	The number of wires for the output cable depends on the system specifications. Use a shielded cable with nominal cross-sectional area of 1.25 mm² and overall diameter of 11 to 13 mm.		

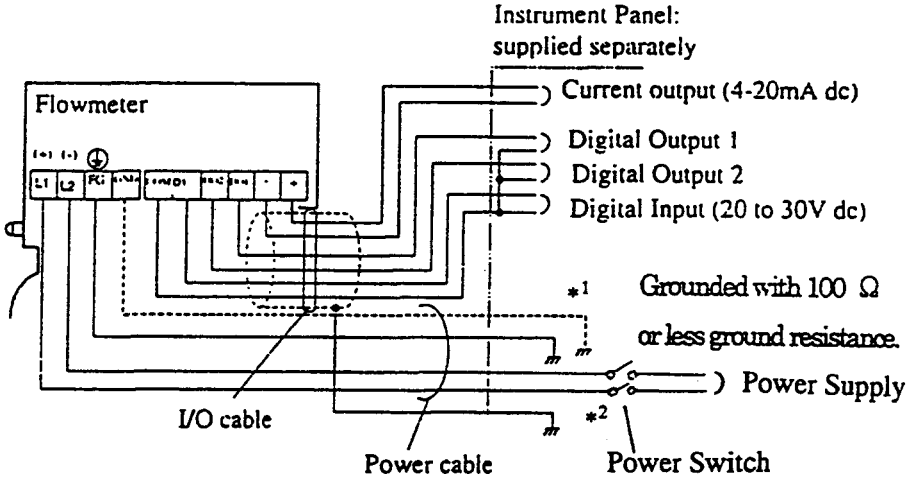
Note: Use a four-wire cable if the arresters are to be used. See Figure 5.1 below.

5.2 External Device Connections and Grounding

The terminal board connections of the FMG400 Series flowmeter are shown in Figure 5.1.

Proceed with wiring as described in Section 5.4, "Wiring Procedure."

If power supply is specified as DC, use L1 as positive (+) and L2 as negative (–) terminals.



*1 To use the arresters, ground the GND terminal using a wire shown in broken line.
*2 Locate an external double-pole power switch on the power line near the flowmeter and within easy operation.
Mark on the switch as the disconnecting device for the flowmeter.
Use the proper switch as follows.

Recommended switch rating; Rating AC250V 6A or more
Inrush current 15A or more

Figure 5.1 Terminal Board Connections

IMPORTANT

(1) The grounding terminal of the FMG400 Series flowmeter should be grounded with 100 ohm or less ground resistance. Use a heavy copper braid or wire (cross-sectional area 5.5 mm^2 minimum) to ground the terminal and make it as short as possible. The terminal is M4 size and an M4-size crimped ring lug should be used to connect the wire to the terminal. Avoid a common ground where earth current may flow. An independent ground is preferable. See Figure 5.2. for a conductive pipeline grounding and non-conductive pipeline grounding procedures.

(2) To prevent a two-point grounding, ground the shielded cable on the receiving instrument side.

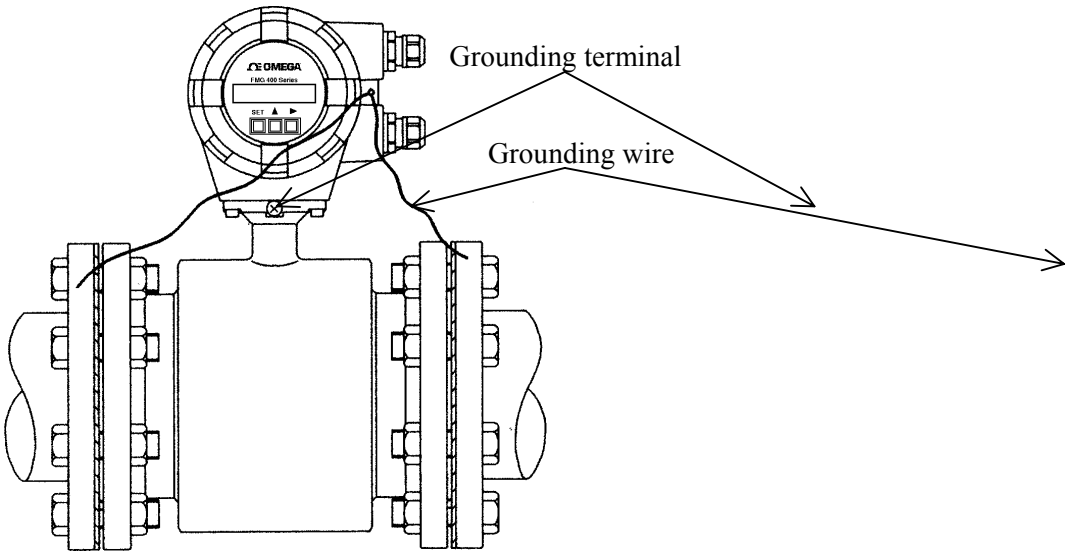
■ **If connection pipe is conductive:**

(1) Connect between the grounding terminal and both ends of the mating flanges with a heavy copper braid or wire (cross sectional area 5.5 mm^2 minimum).

(2) If the conductive pipe is not grounded to a good earth ground, use the same type of copper braid or wire to ground the terminal with 100 ohm or less ground resistance.

■ **If connection pipe is non-conductive:**

(1) Use a heavy copper braid or wire (cross sectional area 5.5 mm^2 minimum) to ground he terminal with 100 ohm or less ground resistance.



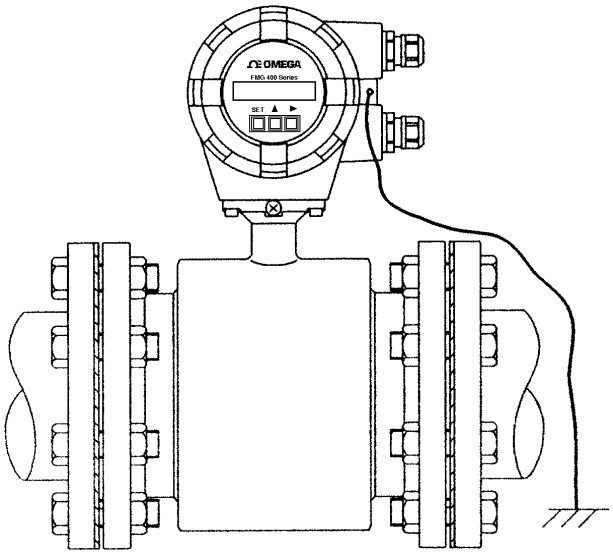


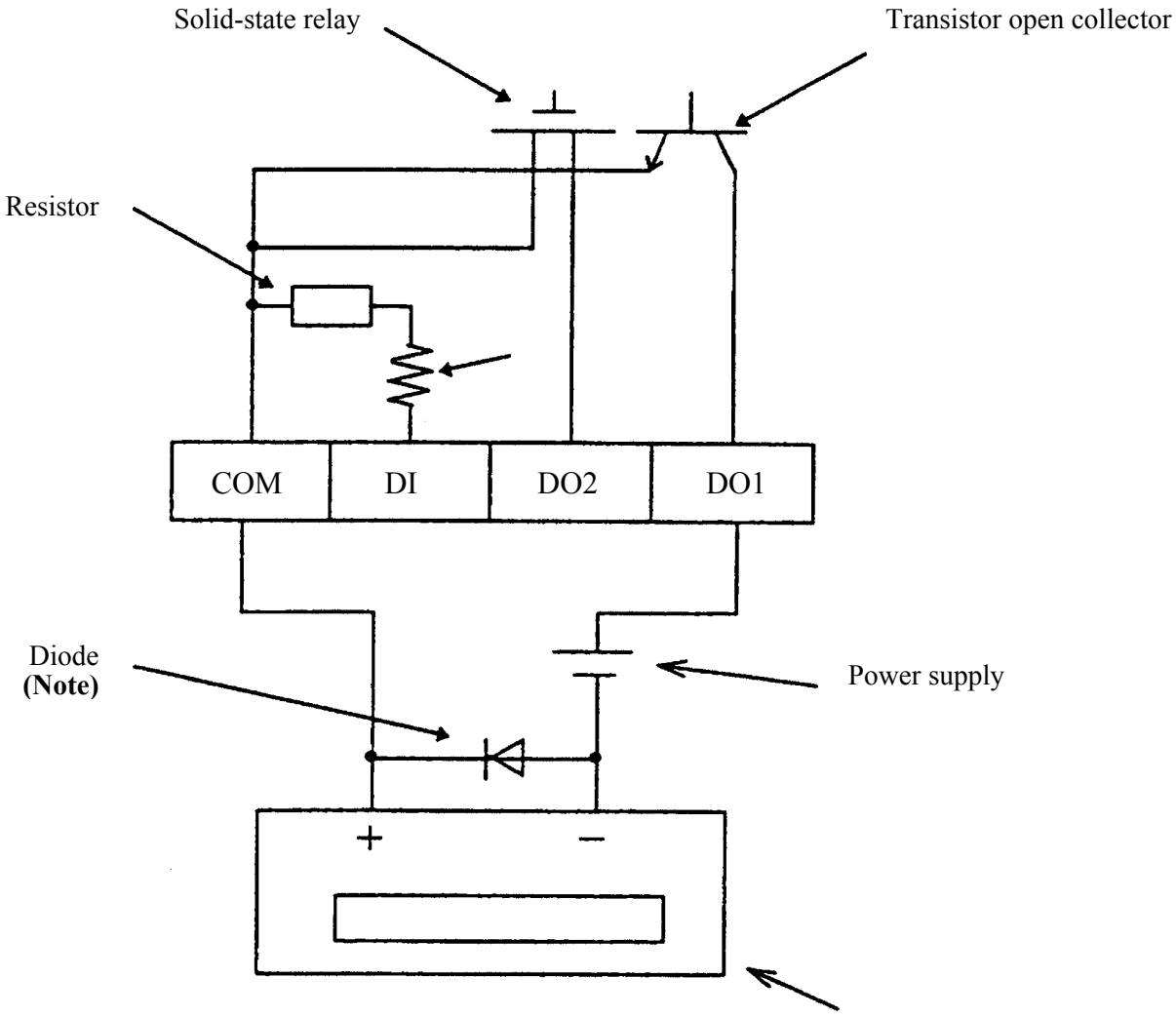
Figure 5.2 Grounding Procedure

5.3 Digital I/O Connections

Digital I/O terminals consist of contact output terminals, voltage signal input terminal (DI), and signal common terminal (COM). Each terminal (DO1, DO2 and DI) is isolated from internal circuits. Terminal (COM) is the signal common for the other three terminals (DO1, DO2 and DI).

Functions can be assigned for each terminal with the LCD control keys. See Chapter 10, "Digital I/O Functions."

To connect an electromagnetic relay or counter to the contact output terminal (DO1 or DO2), put a surge-absorbing diode into the input circuit of the relay or counter. See Figure 5.3 for an example of electromagnetic counter connection.



*** Note**. Be sure to use a surge absorption diode with a rated current of 1 A and rated withstand voltage of 200 V Min.

Figure 5.3 Electromagnetic Counter Connection Example

5.4 Wiring Procedure

Cable termination and cable connections are described below.

5.4.1 Cable Termination

⚠CAUTION	
■ Do not conduct wiring work when **power is applied.**  DON'T Wiring while power is applied can cause **electric shock**.	■ Do not work on piping and wiring **with wet hands**.  DON'T Wet hands may result in **electric shock**.

Use cables as specified in Table 5.1. Remove about 30 mm of the end of cable sheath to expose the two coated wires and then strip the wires about 10 mm. Then attach an M4-size crimped ring-lug to the end of each wire using a compression tool. The crimped ring-lug should be of the kinds with insulated sleeve to prevent shorts between adjacent terminals. The overall length of the wire with the M4-size ring-lug attached should be about 35 mm. See Figure 5.4.

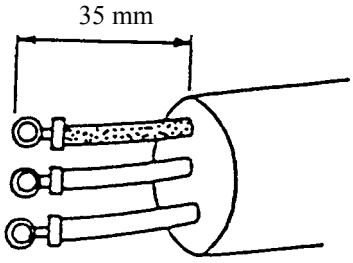


Figure 5.4 Termination of cables

5.4.2 Cable Connections

Connect the terminated cable wires to the terminal board as described below.

IMPORTANT

Connect the wires securely to the terminal board. A loose connection may result in unsatisfactory flowmeter performance. Make sure the wires are securely connected.

（1）Remove the cap nut from the cable gland and put the terminated cable through the cap nut, seal ring, and packing as shown in Figure 5.5 on the right. The blank plate inside the cable gland used when shipped is not needed once the cable is wired.

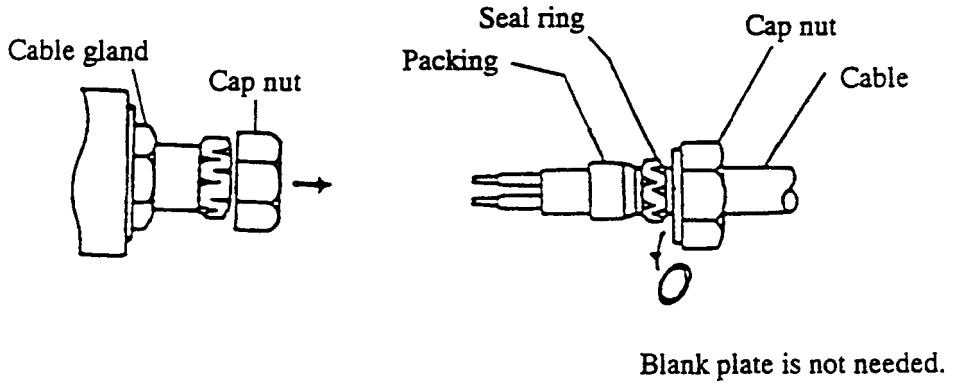


Figure 5.5 Cable connections

(2) Remove the housing cover for the terminal board shown in Figure 3.1. The terminal board is located inside the converter as shown in Figure 3.2. Connect the crimped terminal of each wire to the specified pin of the terminal board. See Figure 5.1 for the terminal board configuration. Tighten each crimped terminal to the terminal board with a screw using a Phillips screwdriver as shown in Figure 5.6. Loose connection may result in unsatisfactory flowmeter performance. Make sure the wire is securely connected.

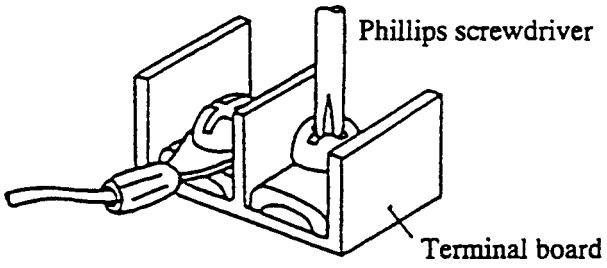


Figure 5.6 Terminal board connections

NOTE
The appropriate torque for tightening the terminal board screws is 1.2 Nm (12 kgf·cm).

(3) After the terminal board connection, pull the cable a little so that the cable runs straight from the terminal board without unnecessary winding.

However, if the sheath-removed part goes as far as where the packing is located, air may leave through there and the airtight structure may not function. See the incorrect example in Figure 5.7. Then tighten the cap nut with a wrench.

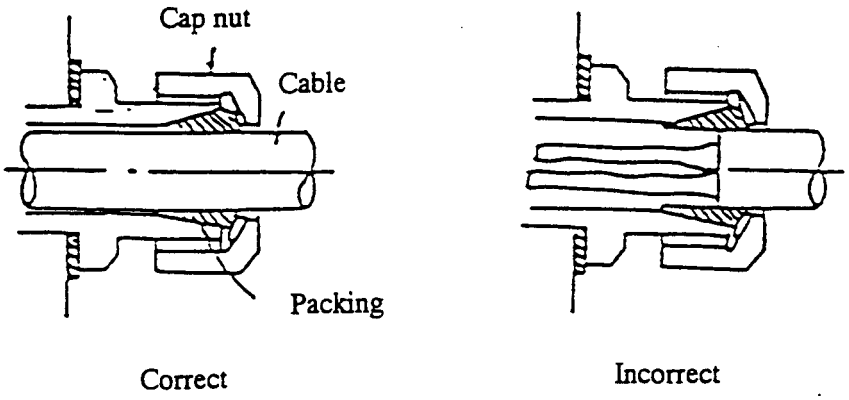


Figure 5.7 Cabling Procedure

(4) Attach the terminal cover and screw the housing cover for the terminal board. To keep the housing seal, tighten the cover securely, using a tool fitting with the groove on the cover.

6. Operation

⚠ CAUTION

- Do not touch the FMG400 Series main body when **high temperature fluid** is being measured.

The fluid raises the main body temperature and can cause **burns** when touched.

6.1 Preparatory check

Follow the procedure described below to prepare before starting the flow measurement.

System Check

- Check the wiring between the converter and related instruments.
- Make sure all the bolts of connection flanges on which the flowmeter is mounted securely tightened.
- Make sure the direction of flow arrow is in accordance with actual flow.
- Make sure the flowmeter is grounded with 100 ohm or less ground resistance.
- Make sure the converter housing covers are securely tightened.

Placing System On-Stream

- Let the fluid go through the detector pipe. When the detector is filled with the fluid, stop the fluid and keep it still in the detector pipe.

Supplying Electric Power

- Make sure the power supply is as specified.

Checking Converter Parameters

- Check the configuration parameter settings. Refer to Chapter 7, "LCD Display and Controls," along with Chapter 8, "Configuration Parameter Setting".

Zero Adjustment

- Wait for 30 minutes to warm up the flowmeter. Then making sure the fluid holds still in the detector pipe, starts the zero adjustment. Refer to 6.2, "Zero Adjustment."

On-line measurement

- After checking the items and conducting the zero adjustment as listed above, let the fluid go through the detector pipe. Output (4–20 mA dc) directly proportional to the flow rate can be obtained.

6.2 Zero Adjustment

To conduct zero adjustment of the flowmeter, the fluid in the detector pipe must be held still. To start the zero adjustment is pressing a combination of control keys for the model with LCD display (see 8.2.8, “Zero Adjustment”).

- Press the zero adjustment switch for more than 3 seconds.

(Note that once the zero adjustment is started, there is no way to cancel the zero adjustment sequence.)

- An LED lamp is ON during zero point adjustment.
- Then the LED indicator lights and the zero adjustment sequence will start. The zero adjustment sequence lasts about 3 to 6 seconds. (Zero adjustment duration depends on the excitation current frequency. It takes about 3 seconds for 24 Hz setting and about 6 seconds for 12 Hz and 6 Hz settings.)

  When the zero adjustment sequence ends, the LED indicator goes off.

To conduct the zero adjustment, it is necessary to open the converter housing cover and press the switch. Observe the following precautions when you open the housing cover:

(1) Do not open the cover in the open air unprotected against rain or wind.
If you adjust the flowmeter in the rain, this can cause electric shock or damage to the flowmeter electronics. If wind blows against the internal circuitry of the converter, output may fluctuate and fail to indicate correct measuring values.

(2) Do not conduct the zero adjustment when the ambient humidity is high. By opening the cover in high humidity conditions, the measuring accuracy may be reduced or damage caused to the flowmeter electronics.

7. LCD Display and Controls

You can select the operation mode, change the configuration parameters or execute operation-specific functions using the control keys on the panel. How to operate these keys is described in this chapter.

7.1 Outline

The Converter has a LCD display. The LCD display can be used to set and indicate various configuration parameters. Figure 7.1 shows the front view of LCD display.

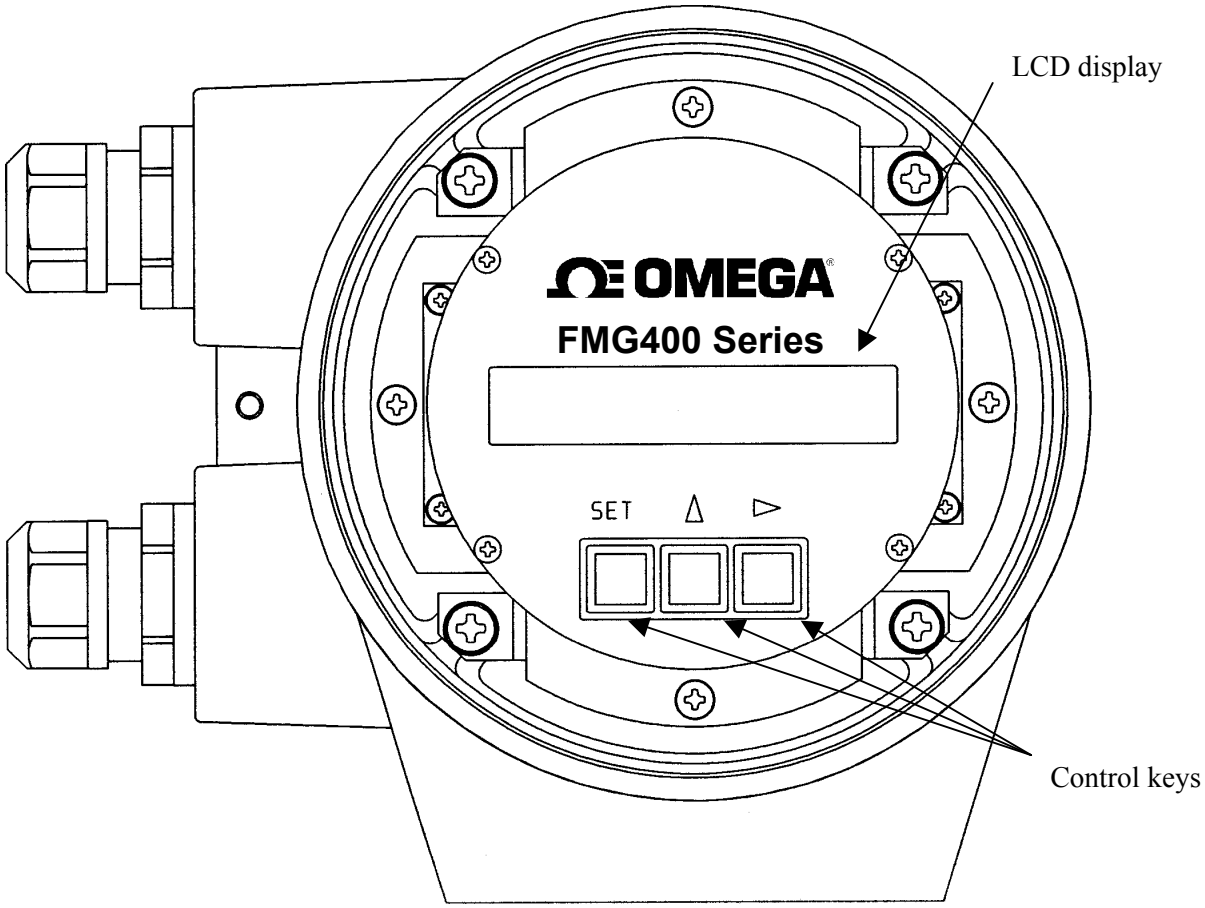


Figure 7.1 Converter with LCD display

■ **LCD display** (2-line × 16-character)

The backlit display enables an easy-to-read indication even under poor lighting conditions. Instantaneous flow rates or totalized flow in the measurement mode, or configuration parameters in the setting mode can be displayed.

■ **Control Keys**

Changing the operation mode, checking or changing parameters can be done with these keys. To operate these keys, you have to open the converter housing cover. Observe the following precautions when you open the housing cover:

(1) Do not open the housing cover in the open air unprotected against rain or wind. If you open the housing cover in the rain, it can cause electric shock or damage to the flowmeter electronics. If wind blows against the internal circuitry of the converter, output may fluctuate and fails to indicate correct measuring values.

(2) Do not open the housing cover when the ambient humidity is high. By opening the cover in high humidity conditions, the measuring accuracy may be reduced or damage caused to the flowmeter electronics.

Functions of each control key when pressed are shown in the table below.

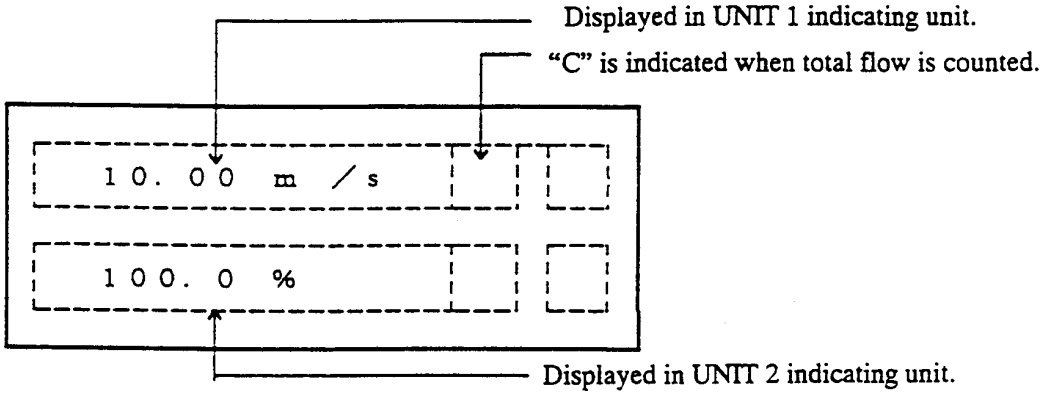
Control keys	Basic functions of control keys
SET	■ Goes into the item selection sequence.
	■ Goes into the detailed-item specifying sequence for each selected item in measurement, setting or calibration modes.
	■ Stores the selected data in the setting mode.
▲	■ Changes items (alphabet letter and number) in the items selection sequence, and changes parameters (numbers and/or units) in the detailed-item specifying sequence in measurement, setting or calibration modes.
	■ Starts and stops the totalizer in the measurement mode. **(Note)**
▶	■ Changes digits (alphabet letter and number) in the items selection sequence, and starts the detailed-item specifying sequence by indicating the left-most digit with the cursor.
	■ Moves the cursor from left to right (from the right end reverts to the left end) in the above sequence.
	■ Resets the totalizer in the measurement mode. **(Note)**

Note: To operate the totalizer, it is preferable to set the indicating unit (UNIT 1 and/or UNIT 2) to one of the units appropriate for totalization just to make sure it is operating correctly. See 10.2, "Totalizer and Pulse Output."

7.2 Display Format

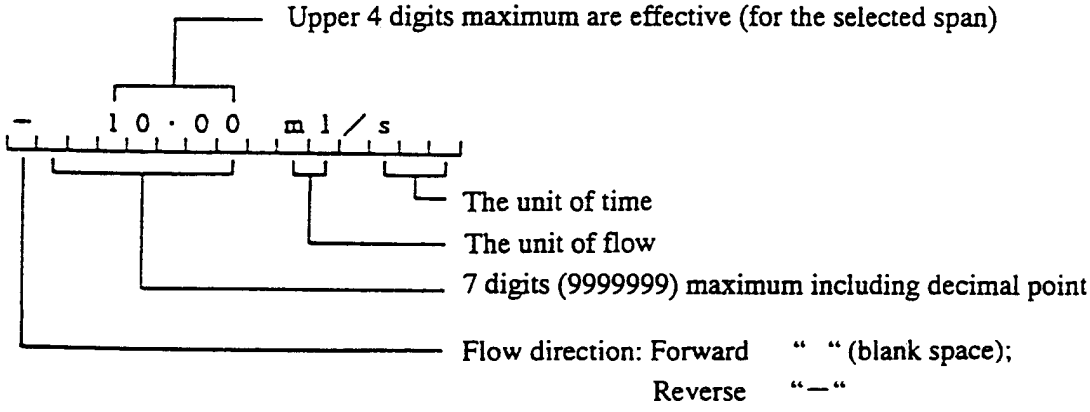
In the measurement mode, measured data are displayed in UNIT 1 (primary indicating unit) and UNIT 2 (secondary indicating unit). As to indicating units, see 8.2.4, "Indicating Unit."

Display Format

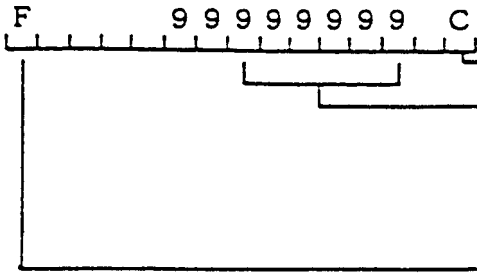


■ **Measured Value Display Format**

(1) Flow rate

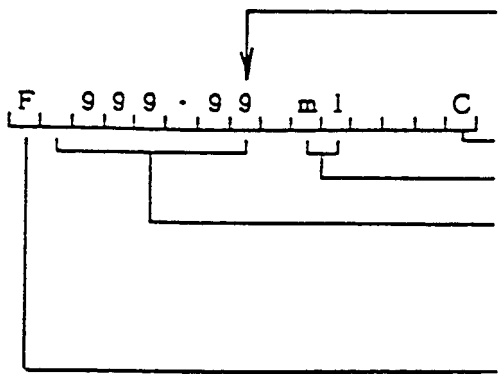


(2) Totalizer



"C" is indicated when totalized flow is counted.
Increments per counting rate. Refer to 8.2.10, "Counting Rate."
Wraps around after 99999999.
"F" for forward and "R" for reverse direction flow will be displayed

(3) Volumetric flow

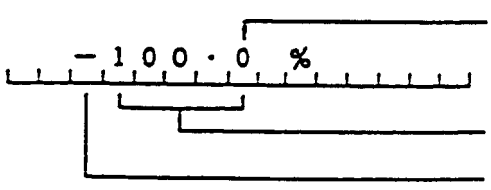


Displays down to the smallest digit of

"C" is indicated when volumetric flow is counted.
The unit of flow
8 digits (99999999) maximum including decimal point
If the flow count exceeds 99999999, wraps around.

"F" for forward and "R" for reverse direction flow will not displayed.

(4) % display



Displayed down to 0.1 %.

Displays up to 125.0 %.
Flow direction: Forward " " (blank space);
Reverse "-"

7.3 Basic operations

Flow measurement in the measurement mode, checking or changing configuration parameters in the setting mode and a converter unit check in the calibration mode are the basic operations of the converter.

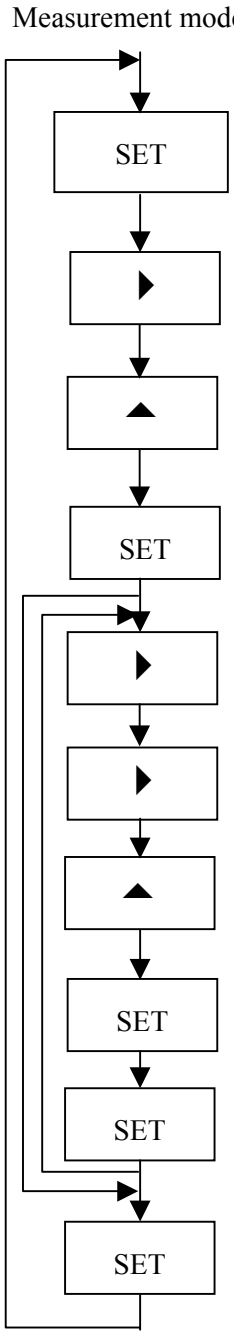
7.3.1 Mode Change

The converter has three operation modes: measurement, setting and calibration. The system stays in the measurement mode after the power is turned on. To change the mode to the setting or calibration mode, press [SET] and select the desired item using [▸] and [▴] keys. To return to the measurement mode, select "0" (MEASURE MODE) for the number column of configuration items (such as A0 or B0) . See 7.4, "Configuration Items Selection Table."

- **Measurement mode:** measures the process flow and displays and outputs the measured process values. The flowmeter can measure the flow velocity, flow rates, or totalized flow. The flowmeter first goes into this mode when power is turned on.
- **Setting mode:** used to check or change various configuration parameters used in the measurement mode. These parameter values are displayed while checking or changing these values but the flowmeter outputs the measured process values as in the measurement mode. See 7.4, "Configuration Items Selection Table" and 8.2, "Checking or Changing Parameters" for details. Configuration items are from A1, A2, A3 to M1.
- **Calibration mode:** used to check the converter internal circuits. The internally generated simulation signal is used to check the measuring span and excitation current value. The current output of the flowmeter changes in accordance with the simulation signal. The status of each digital output is held to the value just before the system moved into the calibration mode. See 7.4, "Configuration Items Selection Table" and Chapter 9, "Calibration" for details. Configuration items are from N1 to N4.

7.3.2 Configuration Parameter Selection in Setting and Calibration Modes

Follow the procedure described below to select configuration items in the setting and calibration modes. The key on the left should be pressed to start each sequence described on the right.



Goes into the item selection sequence. In this sequence, each item is indicated by a combination of an alphabet letter and a number.

Selects the desired item (indicated by an alphabet letter and a number) first by selecting the digit (alphabet or number) with [▶] and then changing the value with [▲]

Displays the parameter for the selected item. **(Note 1)**

Goes into the parameter changing sequence. The digit indicated by the cursor can be changed.

Changes the value and/or unit first by selecting the digit (with the cursor) using [▶] and then changing the value or unit with [▲].

Flickers the selected value and/or unit to confirm changes made for the selected item. **(Note 2)**

Stores the indicated value and/or unit and stops flickering of the data.

Returns to the items selection sequence.

Notes

1. To return to the measurement mode, select “0” (MEASURE MODE) for the number column of any items (such as A0 or B0).
2. To return to the parameter changing sequence, press [▲].

7.4 Configuration Items Selection Table

In the setting and calibration modes, configuration items can be selected as shown below. For example, the excitation current can be selected by the item A1. To change the parameters for the selected items, see the following chapters. To return to the measurement mode, select "0" for the number (such as A0 or B0).

Setting mode items (A1, A2, A3 to M1): See Chapter 8, "Configuration Parameter Setting."

Calibration mode item (N1 to N4): See Chapter 9, "Calibration."

	0	1	2	3	4	5	6
A	*	Excitation Current	Meter Size	Excitation Frequency			
B	*	Indicating Unit 1	Indicating Unit 2				
C	*	Range Type	Range 1	Range 2	Range 3	Range 4	Range Hysteresis
D	*	Damping Constant	Low Cutoff				
E	*	Zero Adjustment					
F	*	DO1 Function	DO2 Function	DI Function			
G	*	Counting Rate	Pulse Width				
H	*	Preset Count					
I	*	High Alarm Set	High Alarm Value	Low Alarm Set	Low Alarm Value		
J	*	Empty Pipe Alarm					
K	*	Rate-of-change Limit	Control Limit Time				
L	*	Fixed-value Output	Fixed-current Output	Fixed-pulse Output			
M	*	Zero Offset Adjustment					
N	*	Flow Rate Cal 0%	Flow Rate Cal 50%	Flow Rate Cal 100%			

* Returns to the measurement mode.

8. Configuration Parameter Setting

8.1 Configuration Items

To check or change parameters, first select the desired configuration item as described in 7.3.2.

The configuration items are listed below. See each section for detailed procedure.

The default set value in each configuration item is shown in Appendix 2.

Section	Configuration item	Display example		Page
8.2.1	Excitation Current	A1: EX. CURR.	0.2100 A	40
8.2.2	Meter Size	A2: METER SIZE	50 mm	41
8.2.3	Excitation Frequency	A3: EX. FREQ.	24 Hz	42
8.2.4	Indicating unit	B1: UNIT 1	m/s	44
8.2.5	Range Type Span (range) Hysteresis	C1: RANGE TYPE C2: RANGE 1 C3: RANGE HYST	1:SINGLE 01.000 m/s 05.0 %	46
8.2.6	Damping Constant	D1: DAMPING	05.0 SEC	51
8.2.7	Low Cutoff	D2: LOW CUT	05.0 %	52
8.2.8	Zero Adjustment	E1: ZERO ADJUST	00.1 %	53
8.2.9	Digital I/O	F1: DO1 FUNC.	1: H ALM	54
8.2.10	Counting Rate Pulse Width	G1: COUNT RATE G2: PLS. EIDTH	6.00E-11 020 m/s	56
8.2.11	Preset Count	H1: PRESET	009000	58
8.2.12	High/Low Alarm Alarm Limit Value	I1: H. ALARM SET I2: H. ALARM VAL	ON +100.0 %	59
8.2.13	Empty Pipe Alarm	J1: EMPTY ALM	ON	62
8.2.14	Rate-of-change Limit Control Limit Time	K1: LIMIT RATE K2: LIMIT TIME	05.5 % 01 SEC	63
8.2.15	Fixed-value Output	L1: FIXED OUT	OFF	65
8.2.16	Zero Offset Adjustment	M1: MANUAL ZERO	-000.1 %	68

8.2 Checking or Changing Parameters

8.2.1 Excitation Current

Proceed as follows to check or change the excitation current setting value.

■ **To check the exciting current setting value:**

Key operation	Display example	Description
SET	A1: EX. CURR. 0.2100A	Press [SET] first to start the item selection sequence and select **A1: EX. CURR.** from among the configuration items using [▲] and [▶] keys. Then press [SET] again to display the exciting current setting value.
SET	A1: EX. CURR.	Pressing [SET], the system returns to the items selection sequence.

■ **To change the excitation current setting value:**

IMPORTANT
The exciting current value is factory set when shipped. Do not change the value unless the value differs from that written on the nameplate of the flowmeter.

The following example shows how to change the excitation current setting value from 0.1900A to 0.2150A.

Key operation	Display example	Description
SET	A1: EX. CURR. 0.1900A	Press [SET] first to start the item selection sequence and select **A1: EX. CURR** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the excitation current setting value (0.1900 A in this example).
▶	A1: EX. CURR. 0.1900A	Pressing [▶], the cursor appears. Then press [▶] as many times as necessary to move the cursor to the digit to be changed.
▲	A1: EX. CURR. 0.2900A 0.2100A 0.2150A	Change the value by pressing [▲]. Then move the cursor to another digit by pressing [▶] and change the value. In this example repeat this process until the display shows "0.2150A." **(Note)**
SET	A1: EX. CURR. 0.2150A	Pressing [SET], the cursor disappears and the changed display flickers. Press [SET] again to save the value.
SET	A1: EX. CURR.	Pressing [SET], the system returns to the items selection sequence.

Note: The valid range is from 0.0500A to 0.2300A. If you try to set the value above 0.2300A, the error message * H. OVER SPEC appears. Set the value within the valid range.

8.2.2 Meter Size

Proceed as follows to check or change the meter size of the detector.

■ **To check the meter size:**

Key operation	Display example	Description
SET	A2: METER SIZE 50 mm	Press [SET] first to start the items selection sequence and select **A2: METER SIZE** from among the configuration items using [▶] and [▲] keys Then press [SET] again to display the current meter size.
SET	A2: METER SIZE	Pressing [SET], the system returns to the items selection sequence.

■ **To change the meter size:**

IMPORTANT
Meter size is factory set when shipped. Do not change the meter size unless it differs from the specified value.

The following example shows how to change the meter size from 50 mm to 100 mm.

Key operation	Display example	Description
SET	A2: METER SIZE 50 mm	Press [SET] first to start the items selection sequence and select **A2: METER SIZE** from among the configuration items using [▶] and [▲] keys. Press [SET] again to display the current meter size (50 mm in this example).
▶	A2: METER SIZE 5̲0 mm	Pressing [▶] the cursor appears.
▲	A2: METER SIZE 10̲0 mm	Select “100 mm” by pressing [▲] as many times as necessary. **(Note)**
SET	A2: METER SIZE 100 mm	Pressing [SET], the cursor disappears and the changed display flickers. Press [SET] again to save the value.
SET	A2: METER SIZE	Pressing [SET], the system returns to the items selection sequence.

Note: The meter size is changed as shown below by pressing [▲]. However, select a size in the range between 15 mm (0.5 in) and 100 mm (4in).

▶ 2.5 mm ▶15 mm ▶100 mm ▶400 mm ▶0.1 in ▶0.5 in ▶ 4 in ▶16 in

If the meter size has been changed, other setting values (such as span and counting rate) will be affected depending on the measuring unit used. Therefore, check those setting values if you have changed the meter size.

8.2.3 Excitation Frequency

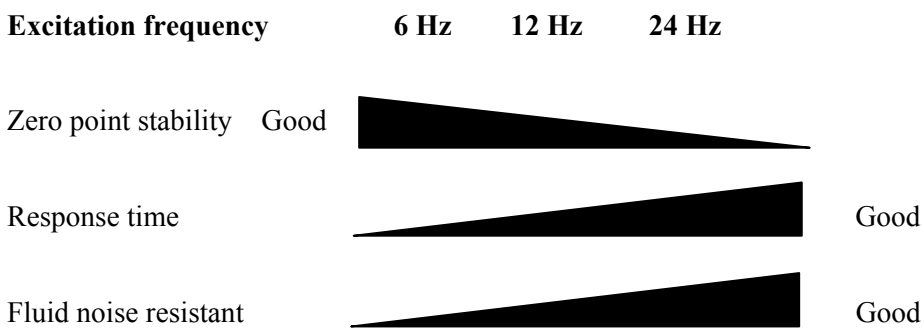
Proceed as follows to check or change the excitation frequency.

■ **To check the excitation frequency:**

Key operation	Display example	Description
SET	A3: EX. FREQ. 24 Hz	Press [SET] first to start the item selection sequence and select **A3: EX. FREQ.** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the current excitation frequency.
SET	A3: EX. FREQ.	Pressing [SET], the system returns to the items selection sequence.

■ **To change the excitation frequency:**

The excitation frequency can be selected from 6 , 12 and 24 Hz. The characteristics of the flowmeter change in accordance with the selected frequency as shown below. 24 Hz is the default setting when shipped from the factory.



The following example shows how to change the excitation frequency from 24 Hz to 12 Hz.

Key operation	Display example	Description
SET	A3: EX. FREQ. 24 Hz	Press [SET] first to start the item selection sequence and select **A3: EX. FREQ.** from among the configuration items using [▶] and [▲] keys. Press [SET] again to display the current excitation frequency (24 Hz in this example).
▶	A3: EX. FREQ. 24 Hz	Pressing [▶], the cursor appears.
▲	A3: EX. FREQ. 12 Hz	Select "12 Hz" by pressing [▲] twice. The excitation frequency changes as follows: →6 Hz→12 Hz→24 Hz→
SET	A3: EX. FREQ. 12 Hz	Pressing [SET], the cursor disappears and the changed display flickers. Press [SET] again to save the value.
SET	A3: EX. FREQ.	Pressing [SET], the system returns to the items selection sequence.

8.2.4 Indicating Unit

You can select one of the 16 engineering units listed below as an indicating unit.

- **Flow velocity:** m/s, (ft/s)
- **Flow rate:** m^3/s, m^3/min, m^3/h
  l/s, l/min, l/h
  ml/s, ml/min, ml/h
  (gal/s), (gal/min), (gal/h)
- **Volumetric flow (totalized flow):** m^3, l, ml, (gal)
- **Other units:** %, COUNT (totalized flow without a unit), RANGE (1 to 4)

Notes

1. Units in parentheses, such as "gal" and "ft" are shown only when the meter size is selected in inches. They are not shown when the meter size is selected in mm.
2. If COUNT or RANGE is selected, the display is shown as follows:
   COUNT: displays totalized flow counts (8 digits) without a unit.
   RANGE: displays the range number (1 to 4).

Two indicating units (primary unit: UNIT 1, secondary unit: UNIT 2) can be selected.

Proceed as follows to check or change these two indicating units.

■ **To check the indicating units:**

Key operation	Display example	Description
SET	B1: UNIT 1 %	Press [SET] first to start the items selection sequence and select **B1: UNIT 1** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the current primary indicating unit.
SET	B1: UNIT 1	Pressing [SET], the system returns to the items selection sequence.

Primary indicating unit and secondary indicating unit can be selected by the following configuration items:

B1: UNIT 1 primary indicating unit

B2: UNIT 2 secondary indicating unit

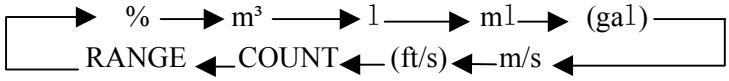
■ **To change the indicating unit:**

The following example shows how to change the primary indicating unit from % to ml/s.

Key operation	Display example	Description
SET	B1: UNIT 1 %	Press [SET] first to start the items selection sequence to select **B1: UNIT 1** from among the configuration items using [▶] and [▲] keys Then press [SET] again to display the current primary indicating unit (% in this example).
▶	B1: UNIT 1 %	Pressing [▶], the cursor appears.
▲	B1: UNIT 1 ml	Select "ml" as the first unit of primary indicating unit by pressing [▲] as many times as necessary. **(Note1)**
▶	B1: UNIT 1 ml _	Pressing [▶], the cursor moves to the second unit (time unit) of primary indicating unit.
▲	B1: UNIT 1 ml/s	Select "s" as the second unit (time unit) of primary indicating unit by pressing [▲] as many times as necessary. **(Note 2)**
SET	B1: UNIT 1 ml/s	Pressing [SET], the cursor disappears and the changed display flickers. Press [SET] again to save the unit.
SET	B1: UNIT 1	Pressing [SET], the system returns to the item selection sequence.

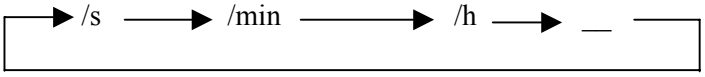
Notes

1. The first unit (volumetric units etc.) changes as shown below:



   Units in parentheses, such as "gal" and "ft" are shown only when the meter size is selected in inches. They are not shown when the meter size is selected in mm.

2. The second unit (time unit) changes as shown below:



8.2.5 Span (range)

You can set the following constants in this setting item:

1. Range type
2. Span
3. Unit of span (can be changed only in range 1)
4. Hysteresis

(1) Range type

You can select a single range or multiple ranges. Select one from five types shown below:

Range type	Description
1. SINGLE	Single range
2. 4F-0R	Unidirectional flow, automatic selection of multiple ranges
3. 2F-2R	Bi-directional flows, automatic selection of multiple ranges
4. EXT.2F-0R	Unidirectional flow, multiple ranges selected by external signal
5. EXT.2F-2R	Bi-directional flows, multiple ranges selected by external signal

(2) Span (range)

- Span can be set and displayed as follows for flow velocity and flow rates:
  - Flow velocity: 01.000 m/s (three digits after the decimal point)
  - Flow rates: 2.83E+3 m^3/H (three digits and exponential)
- Valid range of span is 0.1 m/s to 10 m/s in terms of flow velocity.
  If you try to set the span outside of this range, one of the following messages appears:
  * H. OVER SPEC. (if the set value exceeds 10 m/s)
  * L. OVER SPEC. (if the set value is less than 0.1 m/s)

  Try again to set the span within the specified range.
- When multiple ranges are used, the following must be observed:
  - Range 1 > Range 2 > Range 3 > Range 4 (unidirectional flow, multiple ranges)
  - Range 1 > Range 2, Range 3 > Range 4 (bi-directional flows, multiple ranges)

  If you try to set the ranges not conforming to the above, the following message appears:
  * MULTI RNG ERR

  Try again to set the ranges as specified above.
- Totalization counting rate
  If you have changed the span while the counting rate is set for totalization, the counting rate for 100% output may have exceeded the maximum counting capacity.
  In this kind of event, the following message appears and the system goes to the counting rate setting sequence.
  * H. OVER C RATE or L. OVER C RATE

  Set the counting rate for the newly set span.

(3) Unit of span

You can select one of the following 10 engineering units as a unit for the span. The unit is set for the range 1 and the same unit applies automatically to other ranges—range 2, range 3 and range 4.

- **Flow velocity:** m/s, (ft/s)
- **Flow rate:** m^3/s, m^3/min, m^3/h
  l/s, l/min, l/h
  ml/s, ml/min, ml/h
  (gal/s), (gal/min), (gal/h)

Units in parentheses, such as "gal" and "ft" are shown only when the meter size is selected in inches. They are not shown when the meter size is selected in mm.

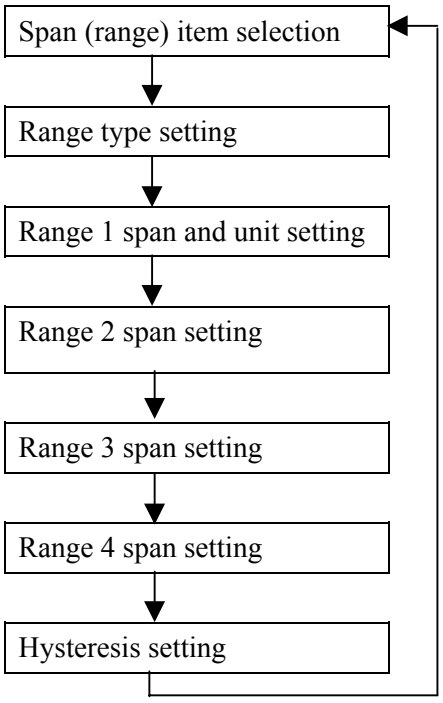
If you change the unit, the new span based on the newly set unit will be automatically displayed.

(4) Hysteresis

The hysteresis is the dead band used when multiple ranges are switched. The hysteresis can be set from 0 to 25% in increments of 0.1%. The hysteresis setting is needed only when automatic selection of multiple ranges is used.

[The setting sequence]

The following is the setting sequence of span (range).



If a single range is selected, range 2 to range 4 and hysteresis settings will be bypassed.

Proceed as follows to check or change each constant.

■ **To check each constant:**

Key operation	Display example	Description
SET	C2: RANGE 1 02.000 m/s	Press [SET] first to start the items selection sequence and select **C2: RANGE 1** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the current span for Range 1.
SET	C2: RANGE 1	Pressing [SET], the system returns to the items selection sequence.

Range type, Span. Hysteresis can be selected by the configuration items as follows:

Range type	C1: RANGE TYPE
Span of Range 1	C2: RANGE 1
Span of Range 2	C3: RANGE 2
Span of Range 3	C4: RANGE 3
Span of Range 4	C5: RANGE 4
Hysteresis	C6: RANGE HYST

■ **To change the range type:**

Range type should be changed before changing the span.

The following example shows how to change the range type from 1 to 3.

Key operation	Display example	Description
SET	C1: RANGE TYPE 1:SINGLE	Press [SET] first to start the items selection sequence and select **C1: RANGE TYPE** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the current range type.
▶	C1: RANGE TYPE 1: SINGLE	Pressing [▶], the cursor appears.
▲	C1: RANGE TYPE 3:2F-2R	Select Range type 3 (3: 2F-2R) by pressing [▲] twice.
SET	C1: RANGE TYPE 3:2F-2R	Pressing [SET], the cursor disappears and the changed display flickers. Press [SET] again to store the changed type.
SET	C1: RANGE TYPE	Pressing [SET], the system returns to the items selection sequence.

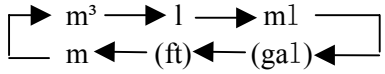
■ **To change the span (range):**

The following example shows how to change the span of Range 1 from 2.0 m/s to 100 l/min.

Key operation	Display example	Description
SET	C2: RANGE 1 02.000 m/s	Press [SET] first to start the items selection sequence and select **C2: RANGE 1** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the current span of Range 1 (2.0 m/s in this example).
▶	C2: RANGE 1 02.000 m/s	Pressing [▶], the cursor appears. Then press [▶] as many times as necessary to move the cursor to the position for the measuring unit.
▲	C2: RANGE 1 3.93E+0 l/s ↓ 2.36E+2 l/min	Select "l" as the first unit of the measuring unit by pressing [▲] as many times as necessary. **(Note1)** Similarly, pressing [▶] to move the cursor to the second unit (time unit), select "min." **(Note 2)** (The displayed span automatically changes in accordance with the newly selected unit.)
▶	C2: RANGE 1 2.36E+2 l/min	Press [▶] as many times as necessary to move the cursor to the digit of span to be changed.
▲	C2: RANGE 1 1.36E+2 l/min ↓ 1.00E+2 l/min	Change the value by pressing [▲] Then move the cursor to another digit by pressing [▶] and change the value. In this example repeat this process until the display shows "1.00E+2"(=100) l/m.
SET	C2: RANGE 1 1.00E+2 l/min	Pressing [SET], the cursor disappears and the changed display flickers. Press [SET] again to store the changed span and unit.
SET	C2: RANGE 1	Pressing [SET], the system returns to the items selection sequence.

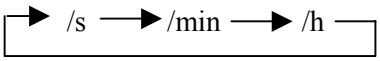
Notes

1. The first unit of the measuring unit changes as shown below:



Units in parentheses (ft and gal) are shown only when the meter size is selected in inches.

2. The second unit of the measuring unit changes as shown below:



However, the following first and second unit combinations cannot be selected:
m/min, m/h, ft/min, ft/h.

■ **To change the hysteresis:**

The hysteresis is set at 3% (default) when shipped from the factory.

The following example shows how to change the hysteresis from 3% to 5%.

Key operation	Display example	Description
SET	C6: RANGE HYST 03.0 %	Press [SET] first to start the items selection sequence and select **C6: RANGE HYST** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the current hysteresis (3.0% in this example).
▶	C6: RANGE HYST 03.0 %	Pressing [▶] the cursor appears.
▶	C6: RANGE HYST 03.0 %	Press [▶] to move the cursor to the desired digit to change.
▲	C6: RANGE HYST 05.0 %	Change the value to "5" by pressing [▲] twice. (if necessary, move the cursor to another digit and change the value).**(Note)**
SET	C6: RANGE HYST 05.0 %	Pressing [SET], the cursor disappears and the changed display flickers. Press [SET] again to store the changed hysteresis.
SET	C6: RANGE HYST	Pressing [SET], the system returns to the item selection sequence.

Note: If you try to set the hysteresis above 25.0 %, an error message "∗ H. OVER SPEC." appears. Try again to set the value within the specified range.

8.2.6 Damping Constant

The damping constant is used to moderate output fluctuations. (The larger the damping constant, the more the output is averaged. But the response to an input change will be slower.)

The damping constant can be set as follows:

0.0 sec, 0.5 sec and 1 to 60 sec (in increments of 1 second)

Note: 0.0 sec setting will work as equal to 0.1 sec damping constant.
Setting value exceeding 60 sec will be automatically set to 60 sec.

Proceed as follows to check or change the damping constant.

■ **To check the damping constant:**

Key operation	Display example	Description
SET	D1: DAMPING 02.0 S	Press [SET] first to start the items selection sequence and select **D1: DAMPING** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the current damping constant.
SET	D1: DAMPING	Pressing [SET], the system returns to the items selection sequence.

■ **To change the damping constant:**

The following example shows how to change the damping constant from 0.5 sec to 10 sec.

Key operation	Display example	Description
SET	D1: DAMPING 00.5 S	Press [SET] first to start the items selection sequence and select **D1: DAMPING** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the current damping constant (0.5 S.)
▶	D1: DAMPING 00.5 S	Pressing [▶], the cursor appears. (If necessary, press [▶] to move the cursor to the digit to be changed.)
▲	D1: DAMPING 10.5 S ↓ 10.0 S	Change the value to "1" by pressing [▲]. Then move the cursor to another digit by pressing [▶] and change the value. In this example repeat this process until the display shows "10.0 S." **(Note)**
SET	D1: DAMPING 10.0 S	Pressing [SET], the cursor disappears and the changed display flickers. Press [SET] again to store this data..
SET	D1: DAMPING	Pressing [SET], the system returns to the items selection sequence.

8.2.7 Low Cutoff

The low cutoff is the value set just above 0% flow rate. Flow rates below this level are treated as 0% and subsequent outputs as 0% current output. The low cutoff can be set from 0 to 10% of the span and in increments of 0.1%.

Proceed as follows to check or change the low cutoff value.

■ **To check the low cutoff value:**

Key operation	Display example	Description
SET	D2: LOW CUT 01.0 %	Press [SET] first to start the items selection sequence to select **D2: LOW CUT** from among the configuration items using [▶] and [▲] keys. Press [SET] again to display the current low cutoff value.
SET	D2: LOW CUT	Pressing [SET], the system returns to the items selection sequence.

■ **To change the low cutoff value:**

The following example shows how to change the low cutoff value from 1.0 % to 3.0 %.

Key operation	Display example	Description
SET	D2: LOW CUT 01.0 %	Press [SET] first to start the items selection sequence and select **D2: LOW CUT** from among the configuration items using [▶] and [▲] keys. Press [SET] again to display the current low cutoff value (1.0% in this example).
▶	D2: LOW CUT 01.0 %	Pressing [▶] the cursor appears. Then press [▶] to move the cursor to the digit to be changed.
▲	D2: LOW CUT 03.0 %	Change the value to "3" by pressing [▲] twice. **(Note)** (If necessary, move the cursor to another digit by pressing [▶] and change the value.)
SET	D2: LOW CUT 03.0 %	Pressing [SET], the cursor disappears and the changed display flickers. Press [SET] again to store the value.
SET	D2: LOW CUT	Pressing [SET], the system returns to the items selection sequence.

Note: If you try to set the low cutoff value above 10 % of the span, an error message

∗ H. OVER SPEC appears. Set the value within the specified range.

8.2.8 Zero Adjustment

To conduct the zero adjustment of the flowmeter, the fluid in the detector pipe must be held still. (If the fluid cannot be stilled by any means, see 8.2.16, "Zero Offset Adjustment.")

To start the zero adjustment, follow the procedure described below.

Key operation	Display example	Description
SET	E1: ZERO ADJUST 01.0 %	Press [SET] first to start the items selection sequence and select **E1: ZERO ADJUST** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the current flow rate (1.0% in this example).
▶	ADJUST READY 01.1 %	Pressing [▶], "**ADJUST READY**" appears as shown left and the system is ready for zero adjustment. **(Note 1)**
SET	* ZERO ADJUST	Pressing [SET], "*** ZERO ADJUST**" appears as shown left and the system starts the zero adjustment. The zero adjustment takes about 3 to 6 seconds. **(Note 2)**
———	E1: ZERO ADJUST 00.0 %	Newly adjusted zero point appears.
SET	E1: ZERO ADJUST	Pressing [SET], the system returns to the items selection sequence.

Notes

1. To cancel the zero adjustment, press [▲]. The system returns to the point where zero point is displayed.
2. Zero adjustment duration depends on the excitation frequency (24 Hz: 3 sec, 12 Hz and 6 Hz: 6 sec).

8.2.9 Digital I/O

You can select the various digital I/O functions shown below. See Chapter 10 ,"Digital I/O Functions." for details.

■ **Digital Output Functions**

DO1, DO2 items	Digital output functions
0: NO USE	Not used
1: H ALM	High limit alarm output
2: L ALM	Low limit alarm output
3: EMPTY ALM	Empty pipe alarm output
4: RNG SIG 1	Multi-range output No. 1
5: RNG SIG 2	Multi-range output No. 2
6: PRESET	Preset point output
7: CONV. ALM	Converter failure alarm output
8: PULSE OUT	Pulse output **(Note)**

Note: Pulse output can be chosen only for DO1.

■ **Digital Input Function**

DI function	Digital input function
0: NO USE	Not used
1: C STA/STP	Totalizer Start/Stop
2: C RES/STA	Totalizer Reset/Start
3: RANGE SW	Remote selection of multi-range
4: ZERO ADJ.	Zero adjustment start
5: FIXED OUT	Fixed-value output control

Proceed as follows to check or change the digital I/O functions.

■ **To check the digital I/O functions:**

Key operation	Display example	Description
SET	F1: DO1 FUNCT. 1:H ALM	Press [SET] first to start the items selection sequence and select **F1: DO1 FUNCT.** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the current DO1 function.
SET	F1: DO1 FUNCT.	Pressing [SET], the system returns to the items selection sequence.

Digital output 1 (DO1), digital output 2 (DO2) and digital input (DI) can be selected by the configuration items as follows:

Digital output 1 (DO1) F1: DO1 FUNCT.
Digital output 2 (DO2) F2: DO2 FUNCT.
Digital input (DI) F3: DI FUNCT.

■ **To change the digital I/O functions:**

The following example shows how to change the DO1 function from No. 1 to No. 3.

Key operation	Display example	Description
SET	F1: DO1 FUNCT. 1:H ALM	Press [SET] first to start the items selection sequence and select **F1: DO1 FUNCT.** From among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the current DO1 function (1: H ALM in this example).
▶	F1: DO1 FUNCT. 1:H ALM	Pressing [▶], the cursor appears.
▲	F1: DO1 FUNCT. 3:EMPTY ALM	Change the value to "3" by pressing [▲] twice.
SET	F1: DO1 FUNCT. 3:EMPTY ALM	Pressing [SET], the cursor disappears and the new DO1 function display flickers. Press [SET] again to save the new function.
SET	F1: DO1 FUNCT.	Pressing [SET], the system returns to the items selection sequence.

8.2.10 Counting Rate (pulse rate)

When the totalizer is used for total flow measurement, per-count (pulse) value is the counting rate. Pulse output is also available for external totalization. In this item, the counting rate and the pulse width for pulse output can be checked or changed. The counting rate is set using three digits and exponential quotient.

For example, 0.123 m^3 → 1.23E–1 m^3
(1.23×10^{-1} m^3)

The integration count output is not affected by the display unit, but it is recommended to set the integration unit as the display unit to check the operating status.

Proceed as follows to check or change the counting rate.

■ **To check the counting rate and pulse width:**

Key operation	Display example	Description
SET	G1: COUNT RATE 1.00E–2m^3	Press [SET] first to start the items selection sequench and select **G1: COUNT RATE** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the current counting rate.
SET	G1: COUNT RATE	Pressing [SET], the system returns to the items selection sequence.

Counting rate and pulse width can be selected by the configuration items as follows:

Counting rate G1: COUNT RATE

Pulse width G2: PLS. WIDTH

NOTES

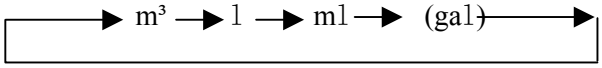
1. The counting rate should be set so that its rate for 100% flow rate output is within the range from 3.6 to 3600000 pulses/h. If you try to set the counting rate outside of this range, an error message * H. OVER SPEC or * L. OVER SPEC appears.
   Set the counting rate within the specified range.
2. The pulse width should be set to 0.5 ms to 100 ms. If the pulse width is set to a value greater than 100 ms, it will be forcibly set to 100 ms.
3. The pulse width should be set to less than half of the pulse rate for 100% flow rate output. If the pulse width is set exceeding that limit, the same error message as above appears. If the pulse width is set to 0 (zero), it will automatically be set to half of the pulse rate for 100% flow rate output.
4. To operate the totalizer, it is preferable to set the indicating unit (UNIT1 and/or UNIT 2) to one of the units appropriate for totalization just to make sure it is operating correctly.

■ **To change the counting rate:**

The following example shows how to change the counting rate from 0.01 m³ to 0.9 l.

Key operation	Display example	Description
SET	G1: COUNT RATE 1.00E–2m³	Press [SET] first to start the items selection sequence and select **G1: COUNT RATE** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the current counting rate (1.00E–2m³ = 0.01 m³).
▶	G1: COUNT RATE 1.00E–2m³	Pressing [▶], the cursor appears. Then press [▶] as many times as necessary to move the cursor to of measuring unit.
▲	G1: COUNT RATE 1.00E–2l ↓ 9.00E–1l	Select "l" as the measuring unit by pressing [▲]. **(Note)** Then move the cursor to the desired digit by pressing [▶] and change the value. In this example repeat this process until the display shows "9.00E–11."
SET	G1: COUNT RATE 9.00E–11	Pressing [SET], the cursor disappears and the new counting rate display flickers. Press [SET] again to store the new counting rate.
SET	G1: COUNT RATE	Pressing [SET], the system returns to the items selection sequence.

Note: The unit changes as shown below by pressing [▲].



The unit in parentheses (gal) is shown only when the meter size is selected in inches. However, if the unit of the count rate is set to "gal" and then the nominal diameter is changed from inch unit to mm unit, the unit of the count rate will not be changed.

8.2.11 Preset Count Value

The preset count value is used to preset the totalizer. The preset count value can be set from 0 to 99999999.

NOTE

Totalizer counting is effective only for the specified direction flow.

To operate the totalizer, it is preferable to set the indicating unit (UNIT 1 and/or UNIT 2) to one of the units appropriate for totalization just to make sure it is operating correctly.

Proceed as follows to check or change the preset count value.

■ **To check the preset count value:**

Key operation	Display example	Description
SET	H1: PRESET 00000300	Press [SET] first to start the items selection sequence and select **H1: PRESET** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the preset count value.
SET	H1: PRESET	Pressing [SET], the system returns to the items selection sequence.

■ **To change the preset count value:**

The following example shows how to change the preset count value from 500 to 1000.

Key operation	Display example	Description
SET	H1: PRESET 00000500	Press [SET] first to start the items selection sequence and select **H1: PRESET** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the preset count value (500 in this example).
▶	H1: PRESET 00000500	Pressing [▶], the cursor appears. Then press [▶] as many times as necessary to move the cursor to the desired digit to be changed.
▲	H1: PRESET 00001500 00001000	Change the value by pressing [▲]. Then move the cursor to another digit by pressing [▶] and change the value. In this example repeat this process until the display shows "1000."
SET	H1: PRESET 00001000	Pressing [SET], the cursor disappears and the new preset count value display flickers. Press [SET] again to save the new preset count value.
SET	H1: PRESET	Pressing [SET], the system returns to the items selection sequence.

8.2.12 High and Low Limit Alarms

The high and low limit alarms can be set to output an alarm signal when the flow rate exceeds the high or low limit set value. When this alarm occurs, H. ALARM or L. ALARM message appears. This high and low limit alarm function can each be enabled or disabled in this item. The high and low limit values can be set from –10% to 109.5% of the span of the range (Range 1) in increments of 0.5%.

Proceed as follows to check or change the high and low limit values.

■ **To check the high and low limit values:**

Key operation	Display example	Description
SET	I1: H. ALARM SET ON	Press [SET] first to start the items selection sequence and select **I1: H ALARM SET** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the high limit alarm enable/disable status.
SET	I1: H. ALARM SET	Pressing [SET], the system returns to the items selection sequence.

High/low limit alarm enable/disable status and high/low limit value can be selected by the configuration items as follows:

High limit alarm enable/disable status	I1: H. ALARM SET
High limit value	I2: H. ALARM VAL
Low limit alarm enable/disable status	I3: L. ALARM SET
Low limit value	I4: L. ALARM VAL

■ **To change the high/low limit alarm status and its alarm limit value:**

The following example shows how to change the high limit alarm enable/disable status from OFF to ON and change the high limit value from +100 % to +105 %.

Key operation	Display example	Description
SET	I1: H. ALARM SET OFF	Press [SET] first to start the items selection sequence and select **I1: H. ALARM SET** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the high limit alarm enable/disable status (OFF at this point).
SET	I1: H. ALARM SET OFF	Pressing [▶], the cursor appears.
▲	I1: H. ALARM SET ON	Change the status by pressing [▲]. **(Note 1)**
SET	I2: H. ALARM VAL +100.0%	Pressing [SET], the cursor disappears and the changed status flickers. Press [SET] again to save the status. Then the system goes to the item **I2: H. ALARM VAL**, and displays the current high limit value (+100.0%).
▶	I2: H. ALARM VAL +100.0%	Move the cursor to the digit to be changed.
▲	I2: H. ALARM VAL +105.0%	Change the value to "5" by pressing [▲] five times. **(Note 2)** (If necessary, move the cursor to another digit by pressing [▶] and change the value.)
SET	I2: H. ALARM VAL +105.0%	Pressing [SET], the cursor disappears and the changed high limit value display flickers. Press [SET] again to save the value.
SET	I2: H. ALARM VAL	Pressing [SET], the system returns to the items selection sequence.

Notes:

1. If the high limit alarm enable/disable status is set to OFF, the subsequent high limit value setting sequence will not come out.
2. If you try to set the value above +110% or below –10% of the span, the error messages ∗H. OVER SPEC or ∗L. OVER SPEC, respectively, appear. Set the high or low limit value within the specified range.

■ **To change the high/low limit value:**

The following example shows how to change the high limit value from +105 % to +103 %.

Key operation	Display example	Description
SET	I2: H. ALARM VAL +105.0%	Press [SET] first to start the items selection sequence and select **I2: H. ALARM VAL** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the current high limit value (+105.0% in this example).
▶	I2: H. ALARM VAL +105.0%	Pressing [▶], the cursor appears. Then press [▶] as many times as necessary to move the cursor to the digit to be changed.
▲	I2: H. ALARM VAL +103.0%	Change the value to "3" by pressing [▲] as many times as necessary. **(Note)** (If necessary, move the cursor to another digit by pressing [▶] and change the value.)
SET	I2: H. ALARM VAL +103.0%	Pressing [SET], the cursor disappears and the changed high limit value display flickers. Press [SET] again to save the value.
SET	I2: H. ALARM VAL	Pressing [SET], the system returns to the items selection sequence.

Note: If you try to set the value above +110% or below –10% of the span, the error messages ∗H. OVER SPEC or ∗L. OVER SPEC, respectively appear. Set the high limit value within the specified range.

8.2.13 Empty Pipe Alarm

The empty pipe alarm is used to notify that the detector pipe is not filled with fluid. If an empty pipe condition occurs, a message * EMPTY appears. You can enable or disable this function here.

Proceed as follows to check or change the empty pipe alarm enable/disable status.

■ **To check the empty pipe alarm enable/disable status:**

Key operation	Display example	Description
SET	J1: EMPTY ALM ON	Press [SET] first to start the items selection sequence and select **J1: EMPTY ALM** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the current empty pipe alarm enable/disable status.
SET	JI: EMPTY ALM	Pressing [SET], the system returns to the items selection sequence.

■ **To change the empty pipe alarm enable/disable status:**

The following example shows how to disable the empty pipe alarm enable status.

Key operation	Display example	Description
SET	J1: EMPTY ALM ON	Press [SET] first to start the items selection sequence and select **J1: EMPTY ALM** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the current empty pipe alarm enable/disable status. (In this example ON will be displayed.)
▶	J1: EMPTY ALM ON	Pressing [▶], the cursor appears.
▲	J1: EMPTY ALM OFF	Select “OFF” by pressing [▲].
SET	J1: EMPTY ALM OFF	Pressing [SET], the cursor disappears and the selected status display flickers. Press [SET] again to save the status.
SET	J1: EMPTY ALM	Pressing [SET], the system returns to the items selection sequence.

8.2.14 Rate-Of-Change Limit

The rate-of-change limit is used to eliminate high electrical noise contained in the process flow signal. To check electrical noise, two parameters are defined: rate-of-change limit (set in percent value of the span) and control limit time (set in units of seconds). Normally the flowmeter produces the analog output signal by sampling the flow rate signal at 1/24 (or 1/12) of a second sampling rate. If the sampled value exceeds the set rate-of-change limit value based on the averaged flow rate value up until the sampled time, the system will reject that sampled value and instead the averaged value including the rate-of-change limit value in place of the rejected sampled value will be output. However, if the limit-exceeding sampled value continues for the same flow direction for more than the preset control limit time, that data will be used as the output signal. The setting ranges for these two parameters are as follows:

- **Rate-of-change limit**

  0 to 30 %/sampling rate (in increments of 0.5 %)

  where the sampling rate is either 1/24, 1/12 or 1/6 of a second depending on the excitation frequency as shown below:

Excitation frequency	Sampling rate
24 Hz	1/24 sec
12 Hz or 6 Hz	1/12 sec

- **Control limit time:** 0 to 20 sec (in increments of 1 second)

NOTE

If "0" is set in either of these parameters, the rate-of-change limit function is disabled.

Proceed as follows to check or change the rate-of-change limit value and the control limit time.

■ **To check the rate-of-change limit value and the control limit time:**

Key operation	Display example	Description
SET	K1: LIMIT RATE 05.0 %	Press [SET] first to start the items selection sequence and select **K1: LIMIT RATE** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the current rate-of-change limit time.
SET	K1: LIMIT RATE	Pressing [SET], the system returns to the items selection sequence.

Rate-of-change limit value and control limit time can be selected by the configuration items as follows:

Rate-of-change limit value	K1: H. LIMIT RATE
Control limit time	K1: H. LIMIT TIME

■ **To change the rate-of-change limit value:**

The following example shows how to change the rate-of-change limit value from 10.0 % to 15.0 %.

Key operation	Display example	Description
SET	K1: LIMIT RATE 10.0 %	Press [SET] first to start the items selection sequence and select **K1: LIMIT RATE** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the current rate-of-change limit value (10.0 % in this example).
▶	K1: LIMIT RATE 10.0 %	Pressing [▶], the cursor appears. Then press [▶] as many times as necessary to move the cursor to the digit to be changed.
▲	K1: LIMIT RATE 15.0 %	Change the value to "5" by pressing [▲] five times. **(Note)** (If necessary, move the cursor to the next digit to be changed by pressing [▶], and change the value.).
SET	K1: LIMIT RATE 15.0 %	Pressing [SET], the cursor disappears and changed rate-of-change limit value display flickers. Press [SET] again to save the value.
SET	K1: LIMIT RATE	Pressing [SET], the system returns to the items selection sequence.

Note: If you try to set the value outside the valid range, an error message * H. OVER SPEC appears. Set the value within the specified range.

To change the control limit time, select the item K2: LIMIT TIME.

8.2.15 Fixed-Value Output

The fixed-value output is used to output a fixed current and a fixed pulse output independent of the flow rate signal. (The fixed pulse output is available only when DO1 is used for PULSE OUT function.) The fixed-value output can be set in the ranges described below. (Current output and pulse output can be set and output at the same time.)

- **Fixed current output:** 3 to 24 mA (in increments of 0.1 mA)
- **Fixed pulse output:** 0 to 1000 pps (in increments of 1 pps)

If you have disabled this function (set to OFF), you do not have to set the subsequent current and pulse output values.

When this function is enabled (set to ON), the measured data is displayed with the primary indicating unit only on the first line of the display and the fixed current output is displayed on the second line of the display. Other data output and display conditions are as follows:

- **Current output:** User-set current output
- **Pulse output:** Pulse output with a user-set counting rate
- **Digital output(s):** Previous status is retained (excluding pulse output).
- **Data Display:** Instantaneous flow rates and flow velocity (no totalization)

Display example: 1.000 m/s ← Primary indicating unit
* FIX.OUT 20.0 mA

This fixed-value output function does not work in the calibration mode.

Proceed as follows to check or change the enable/disable status of the fixed-value output and its output values.

■ **To check the enable/disable status of the fixed-value output and its output values:**

Key operation	Display example	Description
SET	L1: FIXED OUT ON	Press [SET] first to start the items selection sequence and select **L1: FIXED OUT** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the fixed-value output enable/disable status.
SET	L1: FIXED OUT	Pressing [SET], the system returns to the items selection sequence.

Fixed-value output enable/disable status, fixed current output and fixed pulse output can be selected by the configuration items as follows:

Fixed-value enable/disable status	L1: FIXED OUT
Fixed current output	L2: FIX. CURR.
Fixed pulse output	L3: FIX. PULSE

■ **To change the enable/disable status of the fixed-value output and its output values:**

The following example shows how to enable the fixed-value output function and to set its fixed current output to 20 mA DC.

Key operation	Display example	Description
SET	L1: FIXED OUT OFF	Press [SET] first to start the items selection sequence and select **L1: FIXED OUT** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the current fixed-output enable/disable status (OFF in this example).
▶	L1: FIXED OUT OFF	Pressing [▶], the cursor appears
▲	L1: FIXED OUT ON	Select "ON" by pressing [▲].
SET	L2: FIX. CURR. 10.0 mA	Pressing [SET], the selected status (ON) flickers. Press [SET] again to save the status. Then the system goes to the fixed current value setting sequence.
▶	L2: FIX. CURR. 10.0 mA	Move the cursor to the digit to be changed.
▲	L2: FIX. CURR. 20.0 mA	Change the value to "2" by pressing [▲] twice. (If necessary, move the cursor to another digit by pressing [▶] and change the value.) **(Note 1)**
SET	L3: FIX. PULSE 100 PPS	Pressing [SET], the cursor disappears and the changed value display flickers. Press [SET] again to save the value. Then the system goes to the fixed pulse output setting sequence. **(Note 2)**
SET	L3: FIX. PULSE 100 PPS	Pressing [SET], the cursor disappears and the fixed pulse output value flickers. Press [SET] again to save the value.
SET	L3: FIX. PULSE	Pressing [SET], the system returns to the items selection sequence.

Notes:

1. If you try to set the fixed-value output above the allowable range, an error message ＊H. OVER SPEC appears. Try to set the value within the specified range.
2. If PULSE OUT is not selected for digital output, the subsequent pulse output setting sequence will not be displayed.

■ **To change the fixed pulse output value:**

The following example shows how to change the fixed pulse output value from 50 pps to 100 pps.

Key operation	Display example	Description
SET	L3: FIX. PULSE 050 PPS	Press [SET] first to start the items selection sequence and select **L3: FIX. PULSE** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the current fixed pulse output value (50 pps in this example).
▶	L3: FIX. PULSE 050 PPS	Pressing [▶], the cursor appears. (if necessary, move the cursor by pressing [▶] to the digit to be changed.)
▲	L3: FIX. PULSE 150 PPS 100 PPS	Change the value to "1" by pressing [▲]. Then move the cursor to another digit to change and change the value. In this example repeat this process until the display shows "100 pps."
SET	L3: FIX. PULSE 100 PPS	Pressing [SET], the cursor disappears and the changed value display flickers. Press [SET] again to save the value.
SET	L3: FIX. PULSE	Pressing [SET], the system returns to the items selection sequence.

Fixed current output value can be changed by selecting the configuration item L2: FIX. CURR.

8.2.16 Zero Offset Adjustment

Zero offset can be applied to make the flowmeter outputs comparable to process values measured by other instruments. If the zero adjustment described in 6.2 requiring a zero flow rate condition can be performed, this zero offset adjustment is not needed. When the zero adjustment is completed, zero offset will be automatically cleared to zero. Zero offset can be set in the range described below:

Zero offset: ±0.125 m/s (±1.25 % of 10 m/s—maximum range) maximum

Proceed as follows to check or change the zero offset value.

■ **To check the zero offset value:**

Key operation	Display example	Description
SET	M1: MANUAL ZERO +002.5 %	Press [SET] first to start the items selection sequence and select **M1: MANUAL ZERO** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the current zero offset value
SET	M1: MANUAL ZERO	Pressing [SET], the system returns to the items selection sequence.

■ **To change the zero offset value:**

Calculate the zero offset value with the following equation:

Zero offset value (%) = {(actual flow rate) – (FMG400 Series measured value)}

The zero offset value should be calculated in percent value for Range 1. See the following example.

(Example)

Measured condition	Flow rate	% in measuring span
Actual flow rate obtained from other instrument.	10.0 m³/min	50 %
FMG400 Series measured value	10.5 m³/min	52.5 %
Zero offset	————	–2.5 %

If zero offset is set to –2.5 %, the converter will output 50.0 % flow rate instead of 52.5%.

The following example shows how to change the zero offset value from +1.0% to –2.5%.

Key operation	Display example	Description
SET	M1: MANUAL ZERO +001.0%	Press [SET] first to start the items selection sequence and select **M1: MANUAL ZERO** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the current zero offset value.
▶	M1: MANUAL ZERO +001.0%	Pressing [▶], the cursor appears. (If necessary, press [▶] as many times as necessary to move the cursor to the desired digit to change.)
▲	M1: MANUAL ZERO −001.0% ↓ −002.0% ↓ −002.5%	Change the sign code ("+" to "–") by pressing [▲]. Then move the cursor to another digit by pressing [▶], and change the value. In this example repeat this process until the display shows "–002.5 %." **(Note)**
SET	M1: MANUAL ZERO −002.5%	Pressing [SET], the cursor disappears and the changed value display flickers. Press [SET] again to save the value.
SET	M1: MANUAL ZERO	Pressing [SET], the system returns to the setting items selection sequence.

Note: If you try to set the value above +0.125 m/s or below –0.125 m/s, the error messages ∗ H. OVER SPEC or ∗ L. OVER SPEC, respectively, appears. Set the value within ±0.125 m/s.

9. Calibration

9.1 Calibration Items

You can conduct the following in the calibration mode:

- Checks or calibrates the zero and span of the converter by using a simulation signal.
- Checks of the excitation current.

To change the mode to the calibration mode, see 7.3.1, “Mode Change.”

IMPORTANT
To check or change the zero and span of the converter, follow the procedure described below. However, these are already checked and calibrated when shipped from the factory. Do not change these settings unless it is necessary to calibrate in the field.

Calibration items are listed below. See each section for detailed procedure.

Section	Configuration item	Display example		Page
9.2.1	0 % flow rate calibration	N1:FLOW CAL 0%	0.0 %	71
9.2.2	50 % flow rate calibration	N2:FLOW SIG.50%	50.0 %	72
9.2.3	100 % flow rate calibration	N3:FLOW CAL100%	100.0 %	73
9.2.4	Excitation current	N4:EX. CURR.DSP.	0.2100 A	74

9.2 Calibration Using Converter Signal Source

9.2.1 0 % Flow Rate Calibration

■ **To check the zero point of flow measurement:**

Key operation	Display example	Description
SET	N1:FLOW CAL 0% 0.0 %	Press [SET] first to start the items selection sequence and select **N1: FLOW CAL 0%** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to go into the calibration mode and calculate and display zero point using a simulation signal.
SET	N1:FLOW CAL 0%	Pressing [SET], the system returns to the items selection sequence.

■ **To change the zero and span of the converter:**

Key operation	Display example	Description
SET	N1:FLOW CAL 0% 0.1 %	Press [SET] first to start the items selection sequence and select **N1: FLOW CAL 0%** from among the setting items using [▶] and [▲] keys. Then press [SET] again to go into the calibration mode and calculate and display zero point using a simulation signal.
▶	ADJUST READY 0.1 %	Pressing [▶], "**ADJUST READY"** appears as shown left and the system goes into a calibration-ready condition. **(Note 1)**
SET	N1:FLOW CAL 0% * CAL.0% ADJ.	Pressing [SET], "*** CAL. 0% ADJ.**" appears as shown left and the system starts the zero calibration. The zero calibration takes about 3 to 6 seconds. **(Note 2)**
————	N1:FLOW CAL 0% 0.0 %	Newly calibrated zero point appears.
SET	N1:FLOW CAL 0%	Pressing [SET], the system returns to the items selection sequence.

Notes:

1. To cancel zero calibration, press [▲]. The system returns to the point where the zero point display appears.
2. Calibration time depends on the excitation frequency (24 Hz: 3 sec, 12 Hz and 6 Hz: 6 sec).

9.2.2 50 % Flow Rate Calibration

Using the converter's internal calibration circuit, the system can calibrate the 50% flow rate point. The 50% flow rate point calibration must be executed after conducting the 100% flow rate (span) calibration. The 50% flow rate calibration may differ depending on the 100% flow rate calibration result.

■ **To check the 50% flow rate point of flow measurement:**

Key operation	Display example	Description
SET	N2:FLOW CAL 50% 50.1 %	Press [SET] first to start the items selection sequence and select **N2: FLOW CAL 50%** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to go into the calibration mode and calculate and display 50% flow rate point using a simulation signal.
SET	N2:FLOW CAL 50%	Pressing [SET], the system returns to the items selection sequence.

■ **To change the 50% flow rate point of the converter:**

Key operation	Display example	Description
SET	N2:FLOW CAL 50% 50.1 %	Press [SET] first to start the items selection sequence and select **N2: FLOW CAL 50%** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to go into the calibration mode and calculate and display 50% flow rate point using a simulation signal.
SET	ADJUST READY 50.1 %	Pressing [▶], "**ADJUST READY"** appears as shown left and the system goes into a calibration-ready condition. **(Note 1)**
SET	N2:FLOW CAL 50% * CAL. 50% ADJ.	Pressing [SET], "*** CAL. 50% ADJ.**" appears as shown left and the system starts the 50% calibration. The zero calibration takes about 3 to 6 seconds. **(Note 2)**
———	N2:FLOW CAL 50% 50.0 %	Newly calibrated 50% flow rate point appears.
SET	N2:FLOW CAL 50%	Pressing [SET], the system returns to the items selection sequence.

Notes:

1. To cancel 50% flow rate calibration, press [▲]. The system returns to the point where 50% flow rate is displayed.
2. Calibration time depends on the excitation frequency (24 Hz: 3 sec, 12 Hz and 6 Hz: 6 sec).

9.2.3 100 % Flow Rate (Span) Calibration

Using the converter's internal calibration circuit, the system can calibrate the 100% flow rate point (hereafter called span).

■ **To check the span of the converter:**

Key operation	Display example	Description
SET	N3:FLOW CAL100% 100.1 %	Press [SET] first to start the items selection sequence and select **N3: FLOW CAL 100%** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to go into the calibration mode and calculate and display the span using a simulation signal.
SET	N3:FLOW CAL100%	Pressing [SET], the system returns to the items selection sequence.

■ **To change the span of the converter:**

Key operation	Display example	Description
SET	N3:FLOW CAL100% 100.1 %	Press [SET] first to start the items selection sequence and select **N3: FLOW CAL100%** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to go into the calibration mode and calculate and display 100% flow rate point using a simulation signal.
▶	ADJUST READY 100.1 %	Pressing [▶], "**ADJUST READY"** appears as shown left and the system goes into a calibration-ready condition. **(Note 1)**
SET	N3:FLOW CAL100% * CAL. 100% ADJ.	Pressing [SET], "*** CAL. 100% ADJ.**" appears as shown left and the system starts the 100% calibration. The zero calibration takes about 3 to 6 seconds. **(Note 2)**
————	N3:FLOW CAL100% 100.0 %	Newly calibrated 100% flow rate point appears.
SET	N3:FLOW CAL100%	Pressing [SET], the system returns to the items selection sequence.

Notes:

1. To cancel the span calibration, press [▲]. The system returns to the point where 100% flow rate is displayed.
2. Calibration time depends on the excitation frequency (24 Hz: 3 sec, 12 Hz and 6 Hz: 6 sec).

9.2.4 Checking the Excitation Current Value

You can monitor the exciting current value. The excitation current value is factory adjusted when shipped. Contact OMEGA if any change is necessary.

■ **To check the exciting current value:**

Key operation	Display example	Description
SET	N4:EX. CURR.DSP. 0.2100 mA	Press [SET] first to start the items selection sequence and select **N4: EX. CURR. DSP.** from among the configuration items using [▶] and [▲] keys. Then press [SET] again to display the excitation current value.
SET	N4:EX. CURR.DSP.	Pressing [SET], the system returns to the items selection sequence.

10. Digital I/O Functions

The converter has two digital output (DO1 and DO2) terminals along with one digital input (DI) terminal. These terminals can be used in various ways, such as a pulse output, or an alarm output terminal.

Digital I/O functions described below can be assigned for DO1, DO2 and DI.

Functions	Description
Totalization	■ The converter totalizes volumetric flow values. ■ The totalized flow can be output as a pulse signal (DO1 only) scaled by a user-specified factor (counting rate). ■ The totalizer and pulse signal (DO1 only) can be controlled (starts, stops and resets) by an external signal (DI).
Multiple Ranges	■ Multiple measuring ranges can be switched according to the process flow rates either automatically or by an external signal (DI).
Forward and Reverse flow measurements	■ Forward and reverse flows can be measured. The forward and reverse flow measurements can be used together with multiple range switching function.
High and Low Limit Alarms	■ Outputs an alarm signal (DO1 or DO2) when the process signal exceeds or stays below the limit values.
Empty Pipe Alarm	■ The detector pipe must be filled with fluid all the time. When it is not filled with fluid, the converter outputs an alarm signal (DO1 or DO2).
Totalizer Preset Point	■ When the totalized flow reaches its preset count value, the converter outputs a contact output signal (DO1 or DO2).
Remote Zero Adjustment	■ Zero adjustment (on-stream at zero flow rate) can be started by an external signal (DI).
Fixed-value Output	Fixed current output and fixed pulse output can be used to check a process loop circuit. An external signal (DI) can also be used to control this fixed-value output.
Converter Failure Alarm	■ The converter outputs an alarm signal (DO1 or DO2) if an error such as memory error or excitation circuit error occurs.

10.1 Digital I/O Specifications

Digital I/O specifications for the converter are described below:

■ **Digital Output 1(DO1)**

Output type: Transistor open collector

Number of outputs: One point

Capacity: 30 V dc, 200 mA maximum

■ **Digital Output 2(DO2)**

Output type: Solid-state relay (no polarity)

Number of outputs: One point

Capacity: 50 V dc, 150 mA maximum;

■ **Digital Input (DI)**

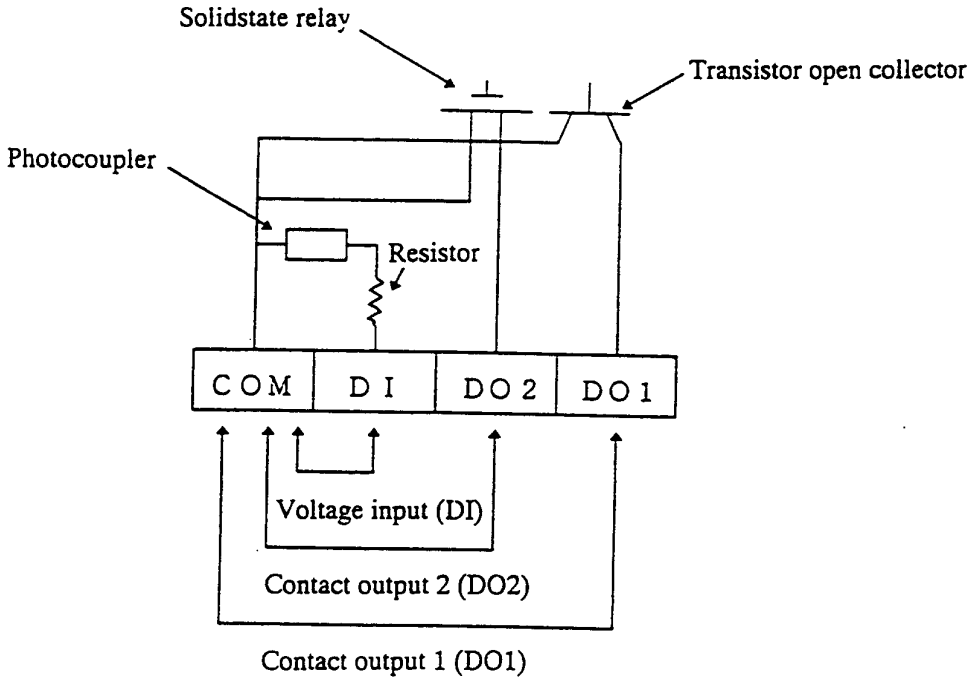
Input signal: 20 to 30 V dc voltage signal

- High input level—20 to 30 V dc
- Low input level—2 V dc maximum

Input resistance: Approximately 2.7 kΩ

Number of inputs: One point

- Each I/O terminal can be used as a specified function terminal when selected.
- Terminal COM is the signal COMMON for the other three terminals (DO1, DO2 and DI).
- Each terminal is isolated from the internal circuits. (The output terminals are not isolated from each other.)
- In the case of the standard specification (specification without digital input/output), no semiconductor contact, photocoupler or resistor is incorporated. Leave DO2 and DI open.



10.2 Totalizer and Pulse Output

To use the totalizer and pulse output for external use, proceed as follows.

Counting Rate and Pulse Width Settings

- Set the counting rate (flow volume per count) and the pulse width. Refer to 8.2.10, "Counting Rate." Set the pulse width in accordance with response time of receiving instruments. If the pulse output is not used, pulse width setting is not needed.

DO function setting

- Set DO1 as a pulse output contact signal. Refer to 8.2.9, "Digital I/O Functions." This is not needed if the pulse output is not used.

DI function setting (Note 1)

- Set one of the DI functions. Refer to 8.2.9, "Digital I/O Functions."

Indicating Unit Setting

- Select an indicating unit for UNIT 1 and/or UNIT 2 among units for totalization (m^3, l ,ml or COUNT). **(Note 1)**

Measurement Mode

- Set the operation mode of the system to the measurement mode.

Refer to 7.3.1, "Mode Change."

Clear (reset) the totalizer.

- Clear (reset) the totalizer by pressing [▶] key.
  If you have changed the counting rate, clear (reset) the totalizer before you start the totalizer.

Start the totalizer.

Start the totalizer by pressing [▲] key and make sure "C" is shown on the display. **(Note 2)**

Notes:

1. It is preferable to set the indicating unit (UNIT 1 and/or UNIT 2) to one of the units appropriate for totalization just to make sure it is operating correctly.
2. If the indicating unit (UNIT 1 and/or UNIT 2) is not the one for totalization, "C" does not appear on the display.

Totalizer Operation

■ Using control keys on the panel

To start, stop or clear (reset) the totalizer, follow the procedure described below:

Key operation	Display example	Description
▲	F 1 C 1.2300 m/s	Starts the totalizer (and pulse output). "C" for counting will be displayed and either "F" for forward or "R" for reverse flow direction will also be displayed.
▲	F 123 1.23000 m/s	Stops the totalizer (and pulse output). C" shown on the display disappears.
▶	F 0 1.23000 m/s	Clears (resets) the totalizer (and pulse output)

NOTES

1. When a bi-directional (forward and reverse) multi-range is selected, the display shows either forward or reverse flow counts depending on the selected flow direction range. When [▶] is pressed, the flow counts for both directions will be cleared to zero.
   When a unidirectional flow (forward or reverse) is selected, the totalizer does not count the opposite direction flow counts.
2. Non-volatile memory is used to store the totalizer counter value. Therefore, the value will be retained in the memory even if the power is cut off.

■ Using the DI signal

Remote operations for the totalizer and pulse output can be conducted using the DI signal. The following functions in the table can be performed. See 8.2.9, "Digital I/O" to select these functions.

Digital input (DI) Functions	DI voltage level	Totalizer and pulse output
Totalizer Start/Stop	L	Stops the totalizer and the pulse output.
	H	Starts the totalizer and the pulse output.
Totalizer Reset/Start	H	Stops and clears (resets) the totalizer.
	L	Starts the totalizer and the pulse output.

10.3 Multi-range Functions

Multi-range functions can be set under the configuration item “RANGE TYPE.” Refer to 8.2.5, “Span (Range).” Four types of multi-range configurations are available as shown below:

(1) Automatic selection of unidirectional flow multi-range
(2) Automatic selection of bi-directional flows multi-range
(3) Remote selection of unidirectional flow multi-range with an external signal
(4) Remote selection of bi-directional flows multi-range with an external signal

Proceed as follows to use the multi-range functions.

Range setting

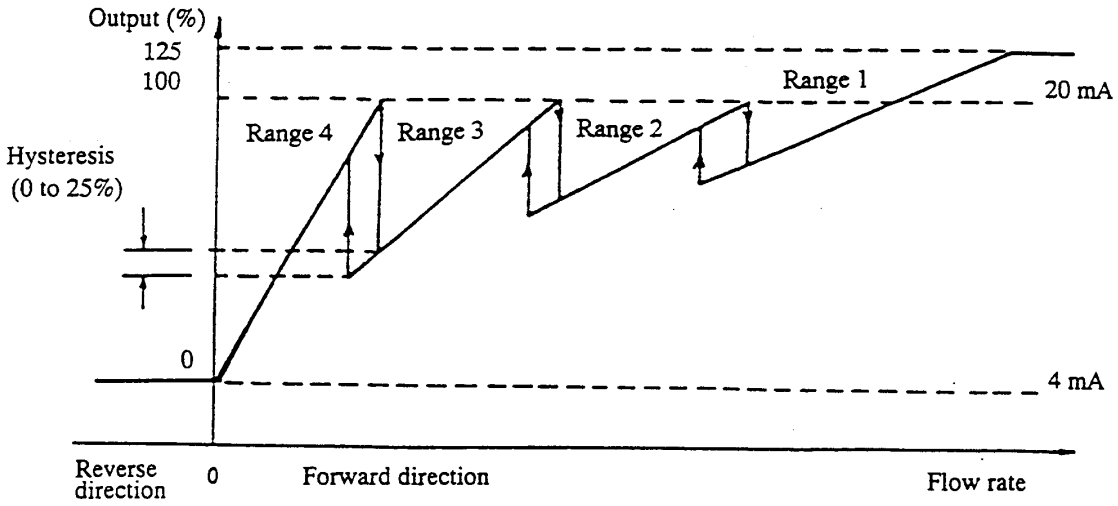
- Set as follows referring to 8.2.5, “Span (Range),”
  1. Select “RANGE TYPE.”
  2. Set the span for ranges 1 to 4.
  3. Set the hysteresis value.

DO/DI function setting

- Set DO1 and/or DO2 to use them as range outputs.
  Refer to 8.2.9, “Digital I/O Functions.”
- To select ranges with a remote signal, use DI as a remote signal.
  Refer to 8.2.9, “Digital I/O Functions.”

■ **Output performance of multi-range functions**

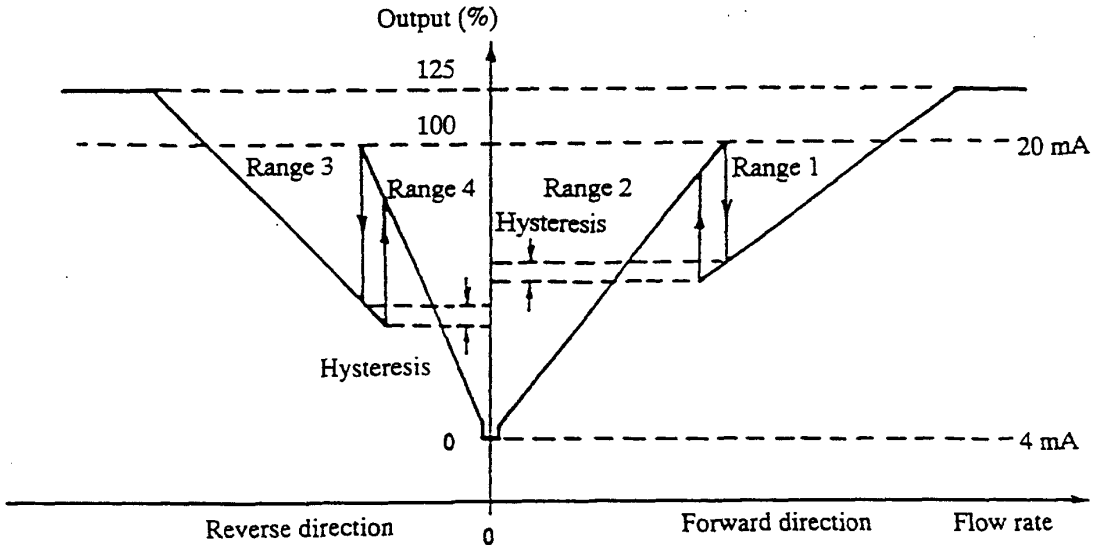
(1) **Automatic selection of unidirectional flow multi-range**



Range output	Output status			
No. 1	ON	OFF	ON	OFF
No. 2	ON	ON	OFF	OFF

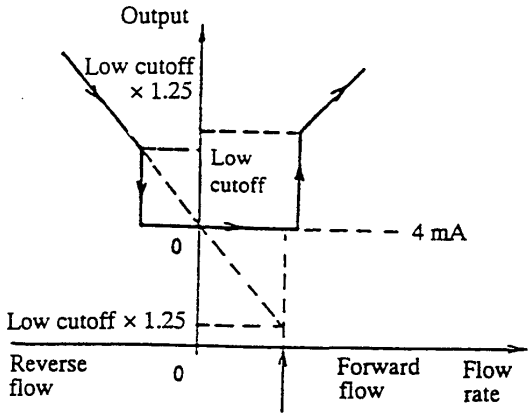
Note: The current output for opposite direction flow is 4 mA.

(2) Automatic selection of bi-directional flows multi-range

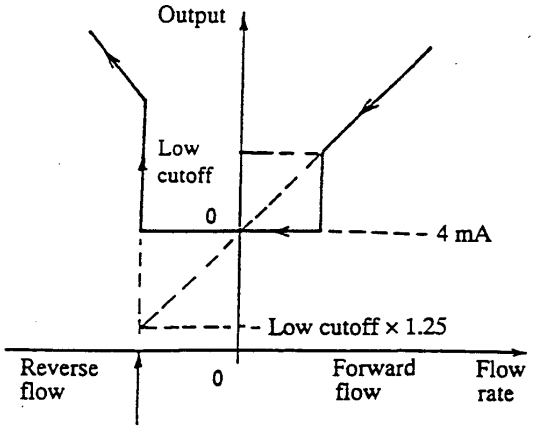


Range output	Output status	
No. 1	OFF ╲ ON	ON ╱ OFF
No. 2	ON	OFF

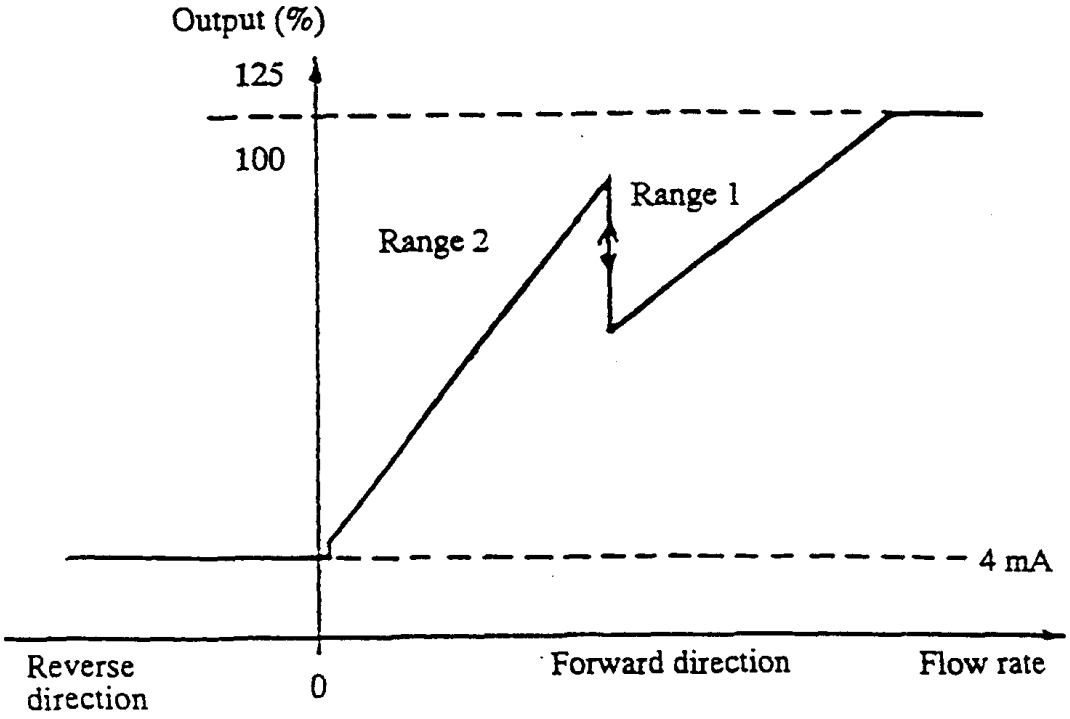
■ **Reverse to Forward direction change**



Forward to Reverse direction change



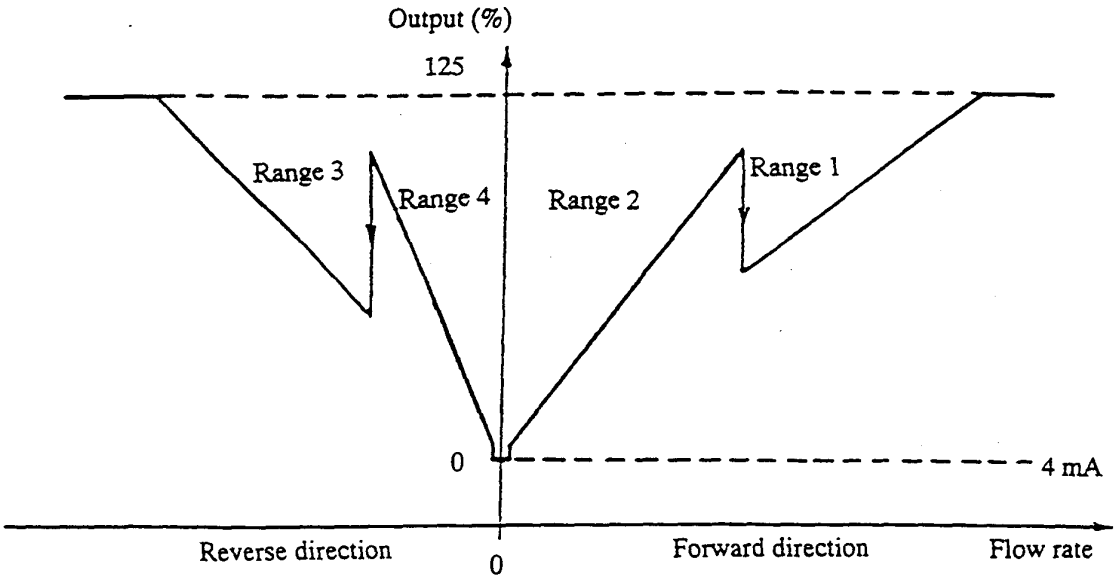
(3) Remote selection of unidirectional flows multi-range with an external signal



External signal	H level input	L level input
Range output No. 1	ON	OFF

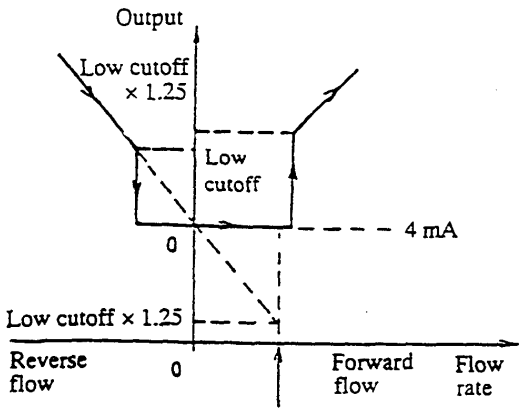
Note: The current output for opposite direction flow is 4 mA.

(4) Remote selection of bi-directional flows multi-range with an external signal

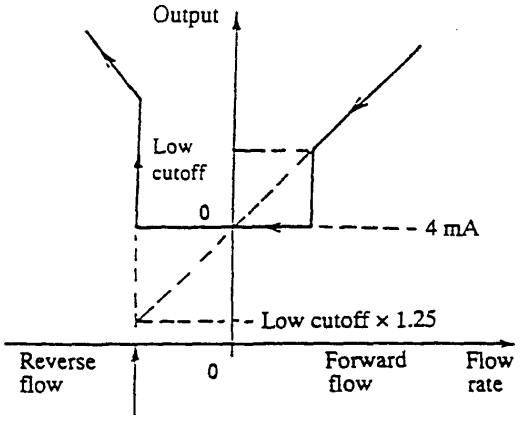


External signal	L level	H level	H level	L level
Range output No. 1	OFF	ON	ON	OFF
Range output No. 2	ON		OFF	

■ **Reverse to Forward direction change**



Forward to Reverse direction change



10.4 High and Low Limit Alarms

Proceed as follows to use the high and low limit alarms:

High and Low limit value setting

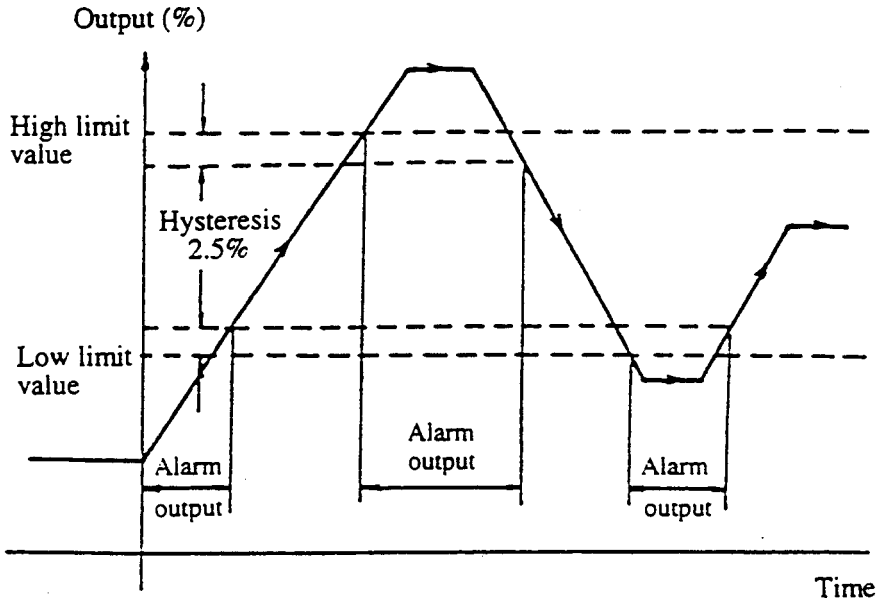
- Set the high and/or low limit alarm enable/disable status to ON and set the limit value for high and/or low alarm. See 8.2.12, “High and Low Limit Alarms.” To disable the high or low limit alarm, set its enable/disable status to OFF.

DO function setting

- Set DO1 and/or DO2 as high and/or low limit alarm outputs. See 8.2.9, “Digital I/O Functions.”

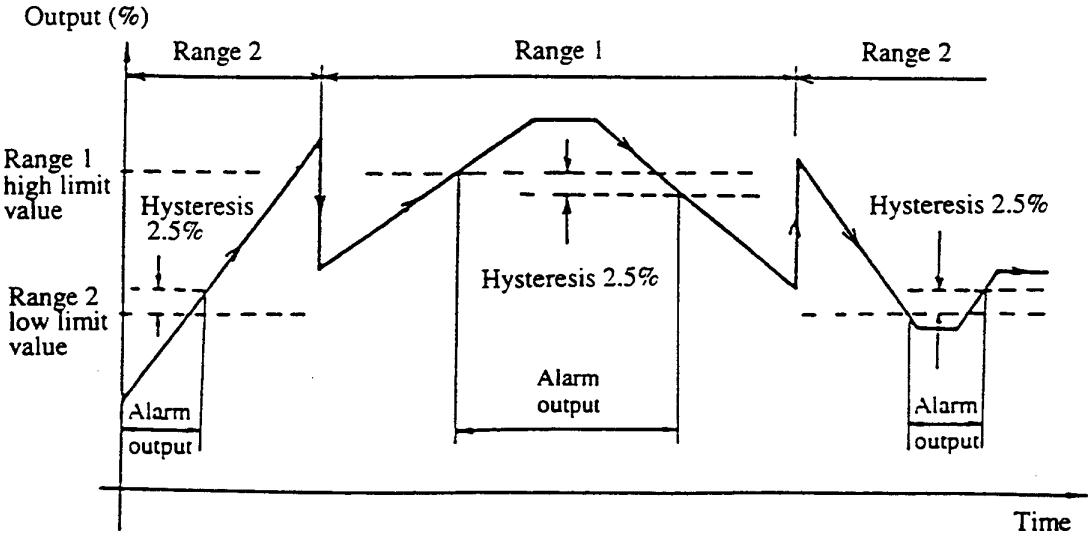
■ **High and Low Limit Alarm Output Performance**

(1) Single range performance



(2) Multi-range performance

In an example shown below, a low limit alarm is set for the Range 2 and a high limit alarm is set for the Range 1.



Note: Alarm output is an ON signal (contact closed) when an alarm occurs.

10.5 Empty Pipe Alarm

Proceed as follows to use the empty pipe alarm output.

Alarm output setting

- Set the empty alarm enable/disable status to ON. See 8.2.13, “Empty Pipe Alarm.”

DO function setting

- Set DO1 or DO2 as the empty pipe alarm output. See 8.2.9, “Digital I/O Functions.” If you use the empty pipe alarm function but not an external output, this setting is not needed.

■ **Output conditions when an empty pipe alarm occurs:**

- 4–20 mA output: 4 mA
- Totalizer and pulse output: Totalizer and pulse output are stopped.
- Measured data display: Zero is indicated for instantaneous flow rate.
- Alarm output: ON (for DO1 and contact closed for DO2)

See Chapter 11, “Self-Diagnostics and Alarms.” to use the empty pipe alarm function.

10.6 Preset Point Output

Using this preset point output function, you can output a contact signal when the totalized flow reaches its preset value. Proceed as follows to use this function.

Totalizer setting

- Set necessary parameters and selections to use the totalizer.
  See 10.2, "Totalizer and Pulse Output."

Preset value setting

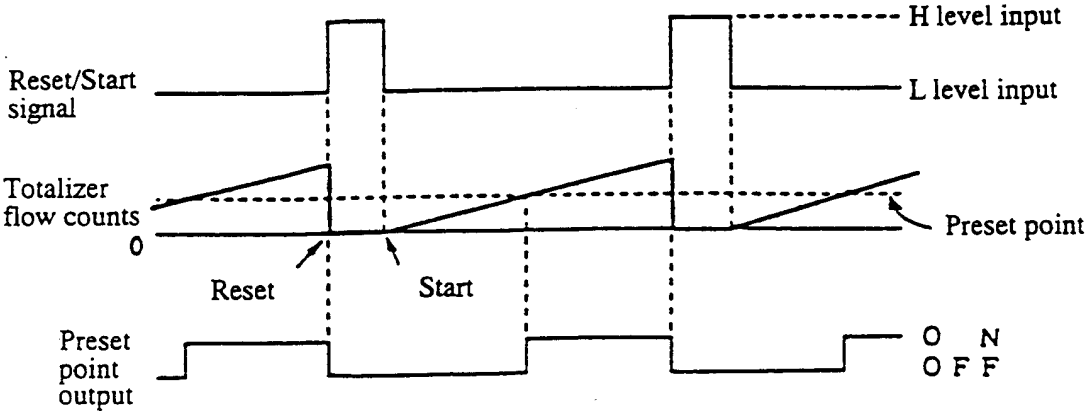
- Set the desired preset value. See 8.2.11, "Preset Count Value."

DO/DI function setting

- Set DO1 or DO2 for use as a preset point output.
  See 8.2.9, "Digital I/O Functions."
- To clear (reset) the totalizer with an external signal, set DI as a Reset/Start signal. If you use the control keys on the panel to clear (reset) the totalizer, this setting is not needed.

■ **Preset point output performance**

The following is an example in which the totalizer is reset with an external signal.



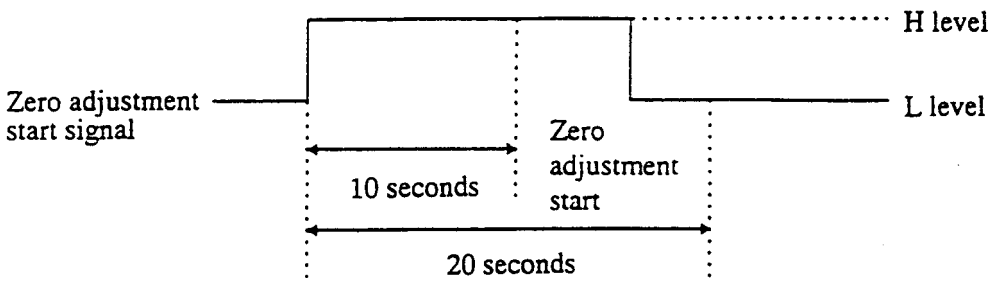
Input/Output signal time chart

- When the Reset/Start signal is in H level, the totalizer is reset to zero and stops counting.
- When the Reset/Start signal goes to L level, the totalizer starts counting.
- The preset point output goes ON when the totalizer counts reaches the preset point and the output goes OFF when the totalizer is reset to zero.

10.7 Remote Zero Adjustment

On-stream zero adjustment in a zero flow rate condition can be started with an external signal. To do this, set DI as a zero adjustment start signal. See 8.2.9, "Digital I/O Functions."

■ **Start signal requirements:**



The start signal must be set to H level first, then it must go to L level after the passage of more than 10 seconds but not more than 20 seconds, as shown above. (If the signal does not go to L level within this specified period, it will be ignored.) As soon as the signal goes to L level, zero adjustment sequence starts.

10.8 Remote Selection of Fixed Value Output

A user-specified current output and pulse output can be selected with a DI signal.

Proceed as follows to use this function:

Fixed-value setting

- Set the fixed-value for current output and for pulse output. See 8.2.15, "Fixed-Value Output." Set the fixed-value output enable/disable status to "OFF."

  If the pulse output is not used, fixed-value setting for pulse output is not needed.

DI function setting

- Set DI to use as a fixed-value output control signal. See 8.2.9, "Digital I/O Functions."

Control signal input conditions:

Control signal input level	4 –20 mA and pulse output
L level	Outputs the measured value.
H level	Outputs the fixed-value.

10.9 Converter Failure Alarm

When one or more of the following converter errors occur in a self-diagnostics sequence, an alarm signal can be output. To use this function, set DO1 or DO2 to use as an alarm output signal. See Chapter 11, “Self-Diagnostics and Alarms” for details of each alarm status.

■ **Self-diagnostics errors**

Self-diagnostics error (LCD display)	Error contents
ROM ERROR	ROM error
RAM ERROR	RAM error
PARAMETER FAIL	System parameter error
EX. CURR. OPEN	Excitation circuit open
EX. CURR ERROR	Excitation current error
ADC. ERROR	ADC error
INVALID TOTAL	Invalid totalizer counts

■ **Output conditions**

- Turns ON (contact closed) when an error occurs.
- Turns OFF (contact open) when power is cut off.

11. Self-Diagnostics and Alarms

Self-diagnostic items and their error or alarm messages are described below.

11.1 Self-diagnostics

The converter has a self-diagnostics function to detect such problems as setting error, I/O error or converter hardware failure and shows the resulting error or alarm messages on the LCD display. The error or alarm messages and their corrective actions are described below.

■ **Setting error**

If you try to set the value or measuring unit out of the range specified for each item, one of the following error messages appears.

Error message	Description	Corrective action
* H. OVER SPEC.	Setting value exceeds the allowable high limit.	Try to set the value within the specified range.
* L. OVER SPEC.	Setting value goes below the allowable low limit.	
* H. OVER C RATE	Counting rate exceeds the allowable high limit.	
* L. OVER C RATE	Counting rate goes below the allowable low limit.	
* MULTI RNG ERR	Span is not appropriate for multi-range configuration.	Try to set the span as specified.

■ **High and low limit alarms**

If the flow rate reading goes out of the set range, one of the following messages appears. If the high or low limit alarm enable/disable status is set to OFF, its alarm function (high or low) is disabled. See 8.2.12, “High and Low Limit Alarms.”

Alarm message	Description	Corrective action
H. ALARM	Flow rate reading exceeds the high limit.	Arrange so that the reading stays below the high limit.
L. ALARM	Flow rate reading goes below the low limit.	Arrange so that the reading stays above the low limit.

■ **Empty pipe alarm**

If the detector pipe is not filled with fluid, the following message appears.

Design piping so that the detector pipe is always filled with the fluid to be measured. If the empty alarm enable/disable status is set to OFF, this function is disabled. See 8.2.13, "Empty Pipe Alarms."

Alarm message	Description	Corrective action
EMPTY	Detector pipe is not filled with fluid.	Arrange piping so that the detector pipe is always filled with fluid.

Precautionary notes on using the empty pipe alarm

(1) The flowmeter detects an empty pipe condition by monitoring the impedance and signal level between the flow signal lines connected to a pair of electrodes. Therefore, the following factors may trigger an erroneous empty pipe alarm:
- Opening or loose connection of flow signal lines
- The fluid to be measured is carrying a lot of bubbles
- Contamination of the electrode with non-conductive deposits

(2) If the flowmeter is not grounded properly or if it is in an environment where high electrical noise exists, the empty pipe alarm may not function properly. Under these conditions, the reliability of flowmeter accuracy itself is not high. Try to ground the flowmeter securely to an independent good ground and relocate the cable runs to prevent noise from entering into the flowmeter circuit.

(3) If the fluid still remains in the detector pipe or the internal wall of the detector pipe is contaminated with electrically conductive deposits, the impedance between the signal lines will not go high and the empty pipe alarm may not work. In this kind of event, try to use other means to detect an empty pipe condition (such as a pump stop signal or a signal from a valve).

■ **Converter hardware failure**

The system checks the internal circuitry at the time of power-up for all error items and checks continuously for the specified items as described below. If an error is detected, one of the messages shown in the table below will be displayed.

If multiple errors occur, their messages will be displayed cyclically. The diagnostics items concerning the excitation cable and excitation circuit are detected using the ADC circuit. Thus, if the ADC fails, No. 4 (excitation cable) and No. 5 (excitation circuit) errors cannot be detected correctly. Further, this entire checking system is based on the CPU in the flowmeter. Therefore, if the CPU fails, no accurate diagnostics or error message display can be obtained.

No.	Error message	Description	Corrective action
1	* ROM ERROR *	ROM error	Internal components or printed-circuit board must be repaired or replaced. Contact OMEGA.
2	* RAM ERROR *	RAM error	
3	PARAMETER FAIL	System parameter error	
4	EX. CURR. OPEN	Excitation cables are not connected.	Connect the excitation cables correctly.
5	EX. CURR. ERROR	An error occurred in the excitation circuit.	Internal components or printed-circuit board must be repaired or replaced. Contact OMEGA.
6	ADC. ERROR	ADC error	
7	INVALID TOTAL	Totalizer data was destroyed due to external noise. (No message appears if totalization is not used.)	The error message disappears if you press the reset key.

NOTES

1. Errors No. 1 to No. 3 can be detected only at the time of power-up. The flowmeter does not start measurement if any one of these errors is detected. If these errors occur after power-up, the flowmeter cannot detect these errors, and thus may indicate and output incorrect data.
2. Errors No. 4 to No. 6 may not be detected even if the errors result in incorrect flowmeter accuracy, because of characteristic differences in components used to detect these errors.
3. CPU error cannot be detected. If the CPU stops, the watchdog timer resets the internal circuits and the flowmeter starts again from the initial power-up condition. Depending on CPU condition, the flowmeter may not indicate and output correct data.

11.2 Output Status for Errors and Alarms

The flowmeter data display, current and pulse outputs will become as follows if an error or alarm occurs.

Error or alarm message	Data display	Current output (4–20 mA)	Totalizer and pulse output	Remarks
ROM ERROR **(Note 1)**	———	4 mA	Stopped	After power-up, no measurement starts.
RAM ERROR	———	4 mA	Stopped	
PARAMETER FAIL	Zero	4 mA **(Note 2)**	Stopped	———
EX. CURR OPEN	Zero	4 mA	Stopped	Zero adjustment (on-stream at zero flow rate) cannot be conducted.
EX. CURR ERROR	Measured data	Measured data	Measured data	———
ADC. ERROR	Zero	4 mA	Stopped	———
INVALID TOTAL	Measured data	Measured data	Measured data	The error message disappears if you clear (reset) the totalizer.
EMPTY	Zero	4 mA	Stopped	Zero adjustment (on-stream at zero flow rate) cannot be conducted.

Notes

1. The display and output may not be as indicated depending on the nature of the ROM error.
2. If parameters related to the current output are defective, the current output may not be exactly 4 mA.

12. Maintenance and Troubleshooting

⚠CAUTION	
■ Do not conduct wiring work when **power is applied**.  DON'T Wiring while power is applied can cause **electric shock**.	Do not touch the FMG400 Series main body when **high temperature fluid** is being measured.  DON'T The fluid raises the main body temperature and can cause **burns.**

12.1 Maintenance

■ **Calibration**

The converter has a reference signal generating circuit. This reference signal can be used to check the zero and span of the converter for the purpose of instrumentation maintenance or periodical inspection. See Chapter 9, "Calibration."

■ **Fuse**

The fuse can be taken out by unscrewing the cap of the fuse holder. Check that the fuse is not damaged. The fuse has to be replaced periodically. The recommended replacement period is 3 years.

Type of fuse used: Glass tube fuse 1 piece
Rating: Power supply rating AC 100 to 240 V
1 AM/250 V
Dimensions: Diameter 5.2 mm × 20 mm

■ **LCD display**

If the characters displayed on the LCD are dimmed or blurred, the LCD display should be replaced. To extend the life of the flowmeter, replace the LCD early. To check and replace the LCD display, contact OMEGA.

■ **Power supply unit**

Electronic components deteriorate faster when the ambient temperature is high. The life of the power supply unit in the converter is 9 to 10 years if the ambient temperature is 40° C, and 5 to 6 years if it is 50° C. To extend the life of the flowmeter, we recommend you replace the power supply unit early. Contact OMEGA for a flowmeter inspection or unit replacement.

IMPORTANT
(1) It is recommended that the detector pipe be cleaned once a year.
(2) Use always new packing when mounting the flowmeter detector in the pipeline.

■ **Cleaning the inside of the detector**

If the fluid to be measured contains a high concentration of electrically conductive solids, the solids may accumulate as deposits on the internal wall of the detector pipe. The deposits cause a reduction of flowmeter measuring output. If the measuring output is lower than the actual process value, check for deposits on the internal wall of the detector pipe. If found, remove the deposits using a soft brush. Clean the inside of the detector periodically if measuring this kind of fluid.

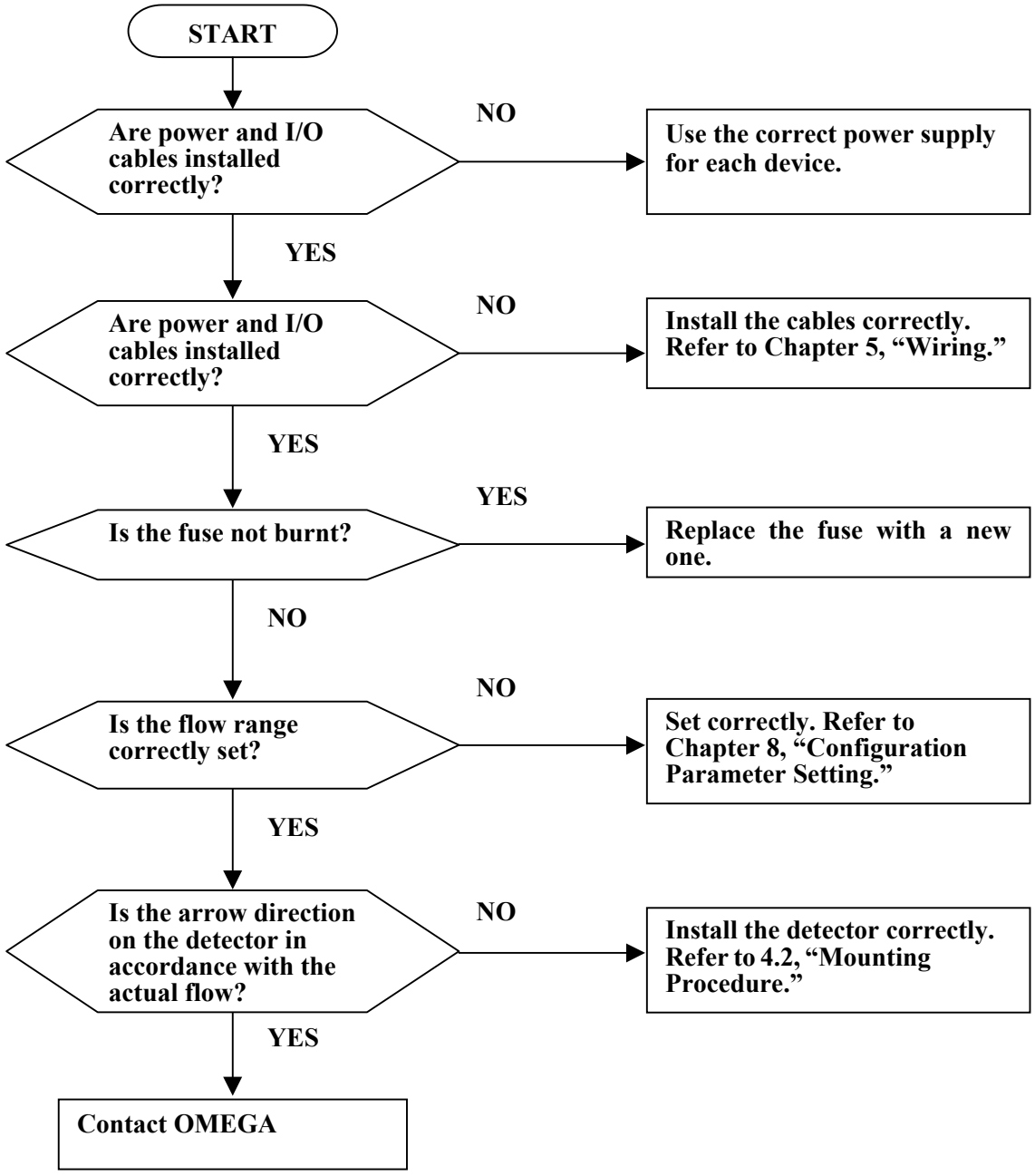
■ **Operative life**

The operative life of this flowmeter is 10 years from the date of shipment. The life of the flowmeter differs depending on the environmental conditions and the way it was used. To extend the life of the flowmeter, inspect the flowmeter periodically and clean or replace components if necessary.

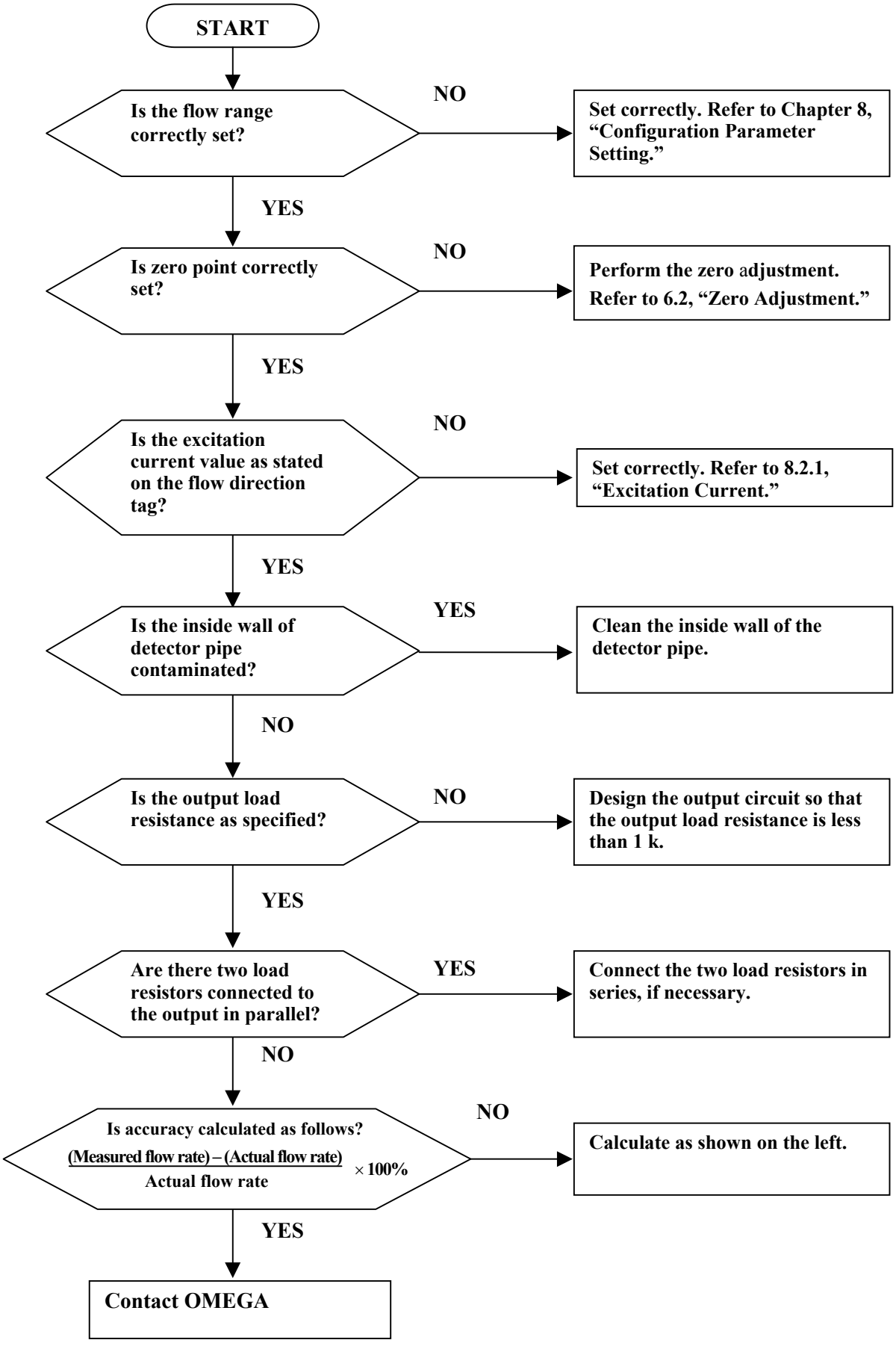
12.2 Troubleshooting

If a problem occurs while using the FMG400 Series, follow the flowcharts described below. You may find a way to solve the problem. The flowcharts are based on three symptoms (1) to (3). If you cannot solve the problem, contact OMEGA.

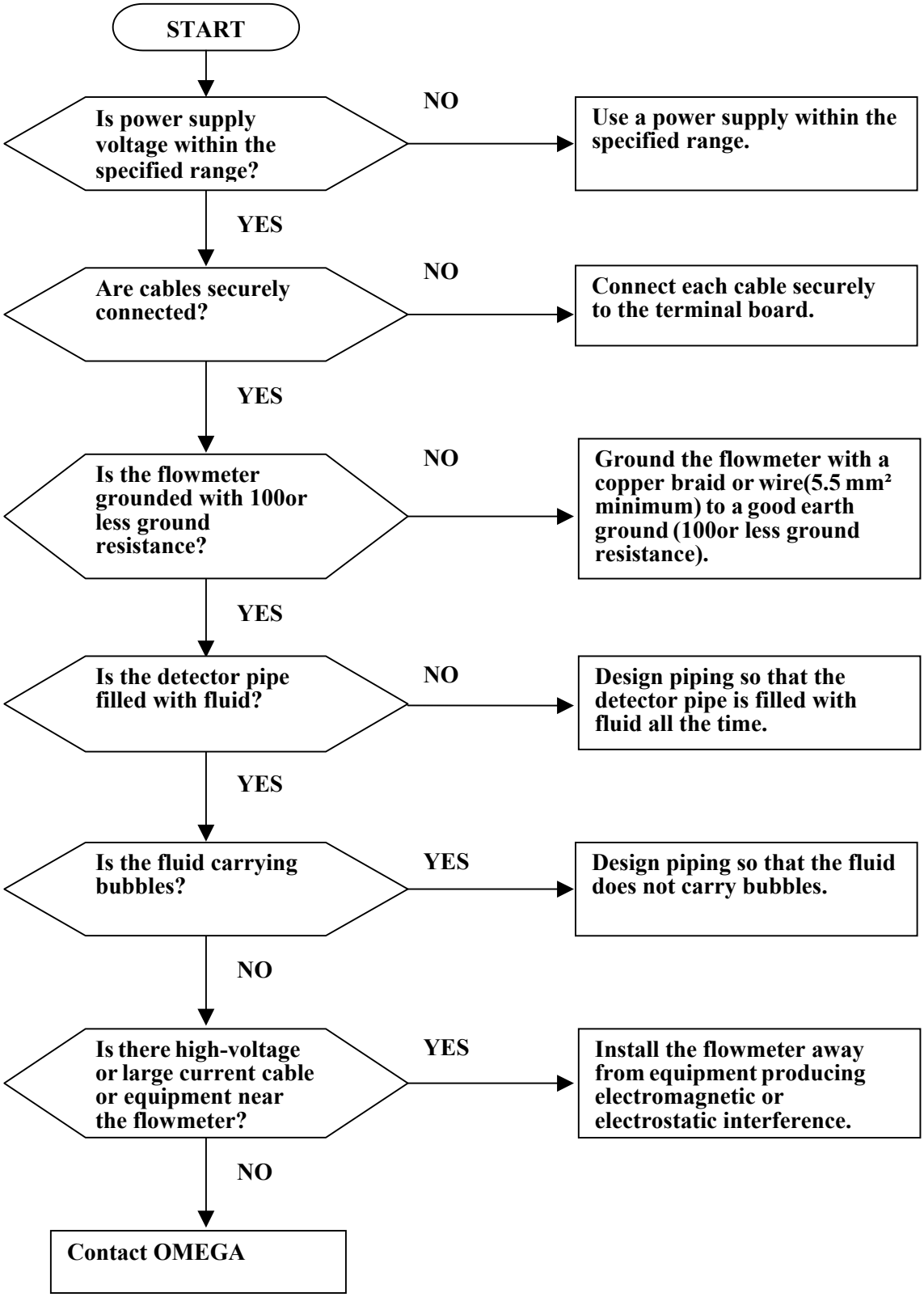
(1) Flow rate is not indicated.



(2) Flow rate indication is not correct.



(3) Flow rate indication is not stable.



13. Principle of Operation

The operating principle of the electromagnetic flowmeter is based on Faraday's Law of electromagnetic induction and it is designed to measure the volumetric flow rate of fluid. An insulated pipe of diameter D is placed vertically to the direction of a magnetic field with flux density B (see Figure 13.1). When an electrically conductive fluid flows in the pipe, an electrode voltage E is induced between a pair of electrodes placed at right angles to the direction of magnetic field. The electrode voltage E is directly proportional to the average fluid velocity V.

The following expression is applicable to the voltage.

$$E = K \times B \times D \times V \text{ [V]} \quad \text{..... (Eq. 13.1)}$$

E = induced electrode voltage [V]
K = constant
B = magnetic flux density [T]
D = meter pipe diameter [M]
V = fluid velocity [m/s]

Volumetric flow rate Q [m^3/s] is:

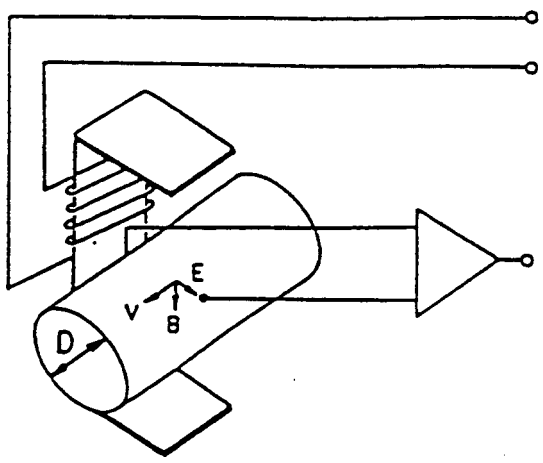
$$Q = \frac{\pi \times D^2}{4} \times V \quad \text{.....(Eq. 13.2)}$$

Using the Equation 13.1 and 13.2

$$E = K \times B \times D \times \frac{4}{\pi \times D^2} \times Q$$

$$E = \frac{4 \times K \times B}{\pi \times D} \times Q \quad \text{.....(Eq. 13.3)}$$

Therefore, volumetric flow rate is directly proportional to the induced voltage.



Square-Wave Excitation

Figure 13.1 Principle of Operation

The FMG400 Series electromagnetic flowmeter uses the square-wave excitation method, which provides long-term stable operation. With square-wave excitation, the FMG400 Series offers reliable measurement without being affected by electrostatic or electromagnetic interference, or electrochemical polarization between the electrodes and the fluid to be measured.

14. Specifications

The flowmeter specifications and the type specification code used when ordering the flowmeter are described in this chapter.

14.1 Flowmeter Specifications

■ Overall Specifications

Measurement range in terms of flow velocity:

0–0.3 m/s to 0–10 m/s

System accuracy: See the following table.

Table 14.1 System accuracy

Flow rate as a percentage of range	Accuracy	
	0.3 – 1.0 m/s	**1.0–10 m/s**
0 to 20%	————	±0.1% FS
20 to 100%	————	±0.5% of rate
0 to 50%	±0.25% of FS	————
50 to 100%	±0.5% of rate	————

Note: The accuracy above is measured under standard operating conditions OMEGA 's calibration facility.

Fluid conductivity: 5 μS/cm minimum

Fluid temperature: -10 to +120 °C (in the case of teflon PFA lining)
-10 to +80 °C (in the case of EPDM rubber lining)

Ambient temperature: –10 to +60 °C

Dimensions and Mass: See Chapter 15, “Outline Dimensions.”

■ FMG400 Series flange type Detector

Meter size: 15, 25, 40, 50, 80, 100, 150, and 400mm

Fluid pressure: –0.1 MPa {–1 kgf/cm^2} to the 2 MPa {20kgf/cm^2}

Connection flange standard: See the Specification Code table.

Principal materials

Case—Carbon steel

Lining—Teflon PFA

Electrodes—316L stainless steel (standard) and Hastelloy C (option)

Grounding rings—316 stainless steel.

Structure: IP67 (NEMA 4) Watertight

Coating: Phthalic acid resin coating, pearl-gray colored

■ FMG400 Series Converter

Input signal

Digital input DI

Signal type: 20 to 30 V dc voltage signal

Input resistance: 2.7 kΩ

Number of inputs: One point

Output signals

Current output: 4 to 20 mA dc (load resistance 0 to 1 kΩ)

Digital outputs — Tow points.

Digital output DO1:

Output type: Transistor open collector

Number of outputs: One point

Output capacity: 30 V dc, 200 mA maximum

Digital output DO2:

Output type: Solid-state relay

Number of outputs: One point

Output capacity: 50 V dc, 150 mA maximum

DI function — One of the following functions can be assigned for the DI signal.

Range switching — Selects one of two ranges in the 2-range setting or selects either the higher or lower range in the bi-directional 2-range setting.

Totalizer control — Starts and stops the totalizer.

Fixed-value outputs — Outputs fixed-values for current output and pulse output.

Zero adjustment — Starts zero adjustment (on-stream at zero flow rate).

DO1 and DO2 functions — One of the following functions can be assigned for DO1 and/or DO2.

- **Pulse output (available only for DO1)**

  Pulse rate: 3.6 to 3600000 pulses/hour
  Pulse width: 0.5 to 100 ms (but less than half of the period for 100% flow rate)

- **Multi-range selection outputs**

  One output used: (1) 2-range switching for unidirectional flow
  (DO1 or DO2) (2) Forward/Reverse flow range switching

  Two outputs used: (1) 4-range switching for unidirectional flow
  (DO1 and DO2) (2) 2-range switching for Forward and Reverse flows

- **High and/or low limit alarms outputs** — Outputs an alarm signal if the process flow rate goes above or below the set limits.

  Setting range: –10 to 109.5% of the span (range)
  Output status: Contact ON (closed)

- **Empty pipe alarm output** — Outputs an alarm signal when the detector pipe is not filled with fluid.

  Output status: Contact ON (closed)

- **Preset point output** — Outputs a signal when the totalized flow reaches the preset value.

  Setting range: 1 to 99999999 counts
  Output status: Contact ON (closed)

- **Converter failure alarm**—Outputs a signal if an error occurs when self-diagnostics is conducted.

  Output status: Contact ON (closed)

Damping: 0.5 to 60 seconds (selectable in increments of 1 second)

Parameter setting:

LCD display: Three control keys are provided to set configuration parameters.

Zero and span calibration:

Built-in calibration signal source allows converter unit check.

Zero adjustment:

Zero point adjustment can be started by pressing the switch in the converter.

Conditions when power fails:

The outputs and display will become as follows when power fails. Parameter setting values are stored in non-volatile memory and the values will be restored when the power returns to normal condition.

Current output: 0 mA dc

Digital output: OFF

LCD display: No display

Power supply

80 to 264 Vac, 50/60 Hz

Arrester: Arresters are installed in the power supply and current signal output circuit.

Housing: Aluminum alloy

Coating: Acrylic resin-baked coating, pearl-gray colored

Structure: IP67 (NEMA 4) Watertight

Cable connection port — Cable gland with a cap nut is provided.

Applicable cable diameter: 11 to 13 mm

Cable gland material: Nylon 66

Port holes in the converter: G(PF) 1/2 thread

Vibration resistance

No resonance to the following levels of vibration:

- 10 to 60 Hz, amplitude 0.07 mm;
- 60 to 150 Hz with acceleration of 9.8 m/s^2.

No problem occurs after application of 30 Hz, 29.4 m/s vibration in any axis for four 4 hours.

Note: Avoid using the flowmeter in an environment with constant vibration.

14.2 Specification Code table

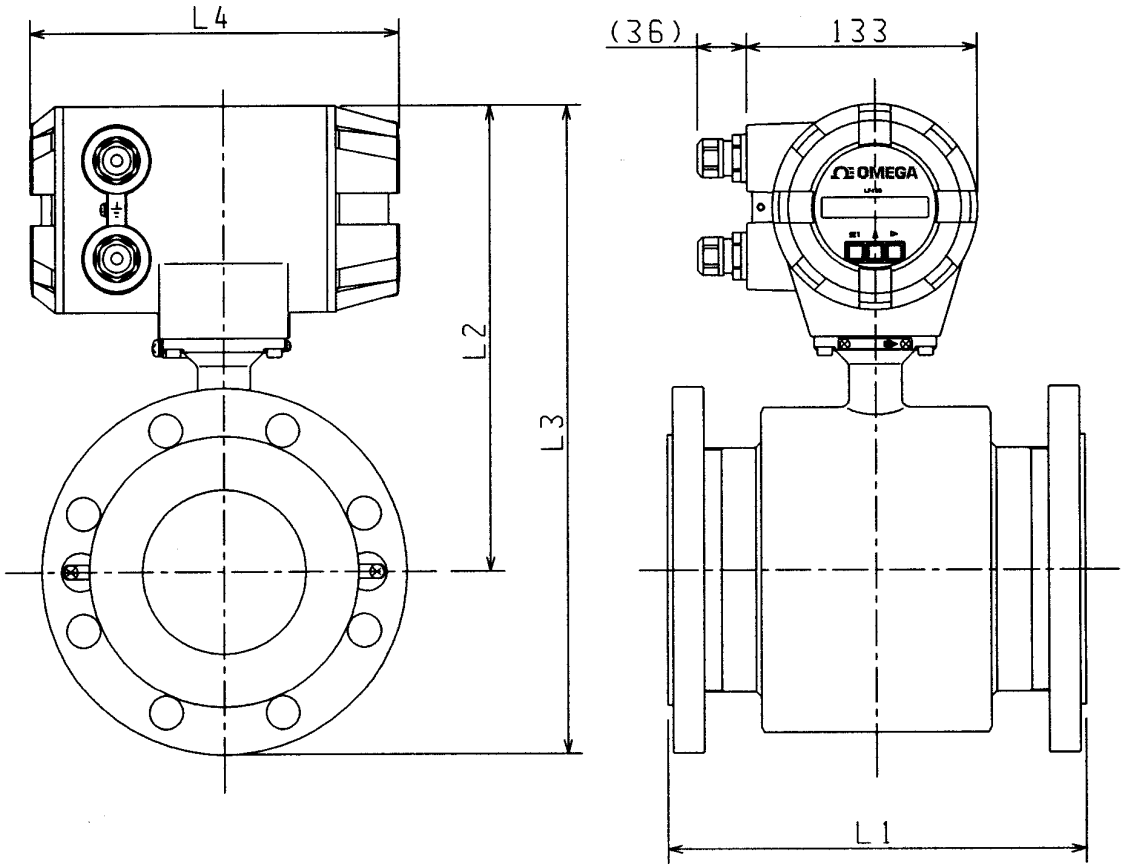
FMG400 Series flange type

Model No.	Pipe size	Main Specification
FMG-421	15mm (1/2”)	Pipe Connection: ANSI50 flange Mounting Style: Combined Type Lining: Teflon PFA Electrode: 316L Stainless Steel Grounding Ring: 316 Stainless Steel LCD (2 raw, 16 character) provided Digital Input and Digital Output provided
FMG-422	25mm (1”)	
FMG-423	40mm (1-1/2”)	
FMG-424	50mm (2”)	
FMG-425	80mm (3”)	
FMG-426	100mm (4”)	
FMG-427	150mm (6”)	
FMG-428	200mm (8”)	
FMG-429	250mm (10”)	
FMG-430	300mm (12”)	
FMG-431	350mm (14”)	
FMG-432	400mm (16”)	

15. Outline Dimensions

■ **Meter size 15 mm to 150mm**

(unit : mm)

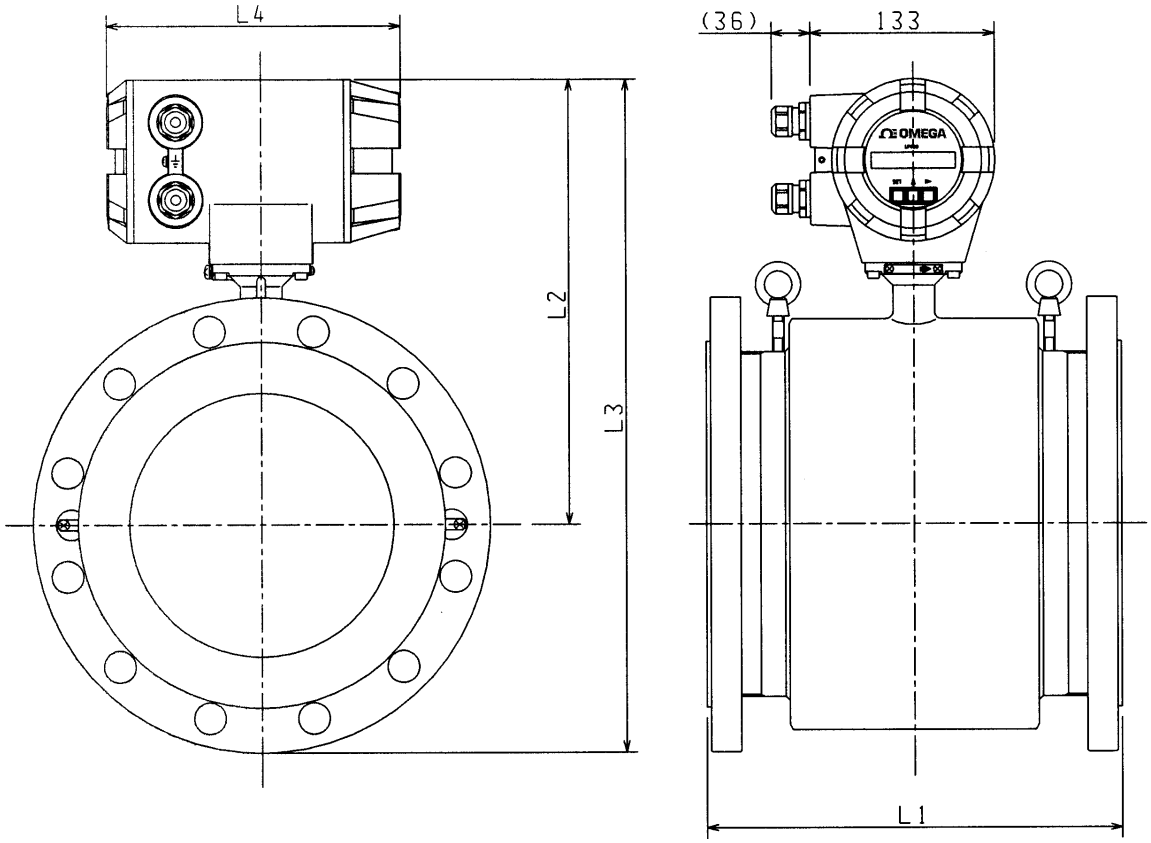


Meter size (mm)	L1 (mm)	L2 (mm)	L3 (mm)	No. of bolts	Mass (kg)
15	140	215	262	4	approx.8
25	160	218	280	4	approx.10
40	170	226	296	4	approx.12
50	180	235	312	4	approx.13
80	230	249	341	8	approx.19
100	240	267	372	8	approx.23
150	260	297	437	8	approx.39

Model FMG400 Series flange type

■ **Meter size 200 mm**

(unit : mm)



Meter size (mm)	L1 (mm)	L2 (mm)	L3 (mm)	No. of bolts	Mass (kg)
200	300	323	488	12	approx.78

Model FMG400 Series flange type

Appendix 1
Electromagnetic Compatibility and Low Voltage Safety

Electromagnetic Flowmeter FMG400 Series flange type has been confirmed to comply with the requirements of the EMC directive 89/336/EEC and the low voltage directive 93/68/EEC.

EMC directive

This device has been tested in a typical configuration in accordance with the following standards in an industrial environment.

Generic emission standard	EN50081-2
Conducted RF emissions	EN55011
Radiated RF emissions	EN55011
Generic immunity standard	EN50082-2
Conducted RF immunity	ENV50141
Radiated RF immunity	ENV50140/ENV50204
Electrostatic discharge	EN61000-4-2
Fast transient burst	EN61000-4-4

The above EMC tests have been carried out with the flowmeter installed properly in accordance with this instruction manual. However, there is no guarantee that interference will not occur in a particular installation.

To reduce interference to or from other equipment, please check the following installation points.

(1) Use shielded cables for all I/O cables. When the flowmeter is the separated type, the signal cable and excitation cable for the connection between the detector and the converter are supplied by OMEGA. To improve immunity, pass each cable through a thick steel conduit tube.

(2) If this device is installed in an area where RFI exists, deviation of the current output signal may be caused. In this case, ferrite cores will be required on each I/O cable. Please contact OMEGA or the agency if required.

(3) This device is designed to be used in an industrial environment and may cause reception interference to radio, television or wireless communications. In this case, relocate the receiving antenna.

(4) The use of a transceiver or wireless equipment near this device may cause interference to the accurate measurement. If deviation of the output signal appears during use of a radio, increase the distance between the converter or the signal cable and the antenna.

Low voltage directive

- Low voltage standards EN61010-1

Environmental conditions:

Installation category	Ⅱ
Pollution degree	2
Altitude	Up to 2000 m

Other conditions are specified in Chapter 14, “Specifications.”

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WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of 13 months from date of purchase. OMEGA Warranty adds an additional one (1) month grace period to the normal one (1) year product warranty to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit should malfunction, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components which wear are not warranted, including but not limited to contact points, fuses, and triacs.

OMEGA is pleased to offer suggestions on the use of its various products. However, OMEGA neither assumes responsibility for any omissions or errors nor assumes liability for any damages that result from the use of its products in accordance with information provided by OMEGA, either verbal or written. OMEGA warrants only that the parts manufactured by it will be as specified and free of defects. OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. LIMITATION OF LIABILITY: The remedies of purchaser set forth herein are exclusive and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.

CONDITIONS: Equipment sold by OMEGA is not intended to be used, nor shall it be used: (1) as a ‡ Basic Component ‡ under 10 CFR 21 (NRC), used in or with any nuclear installation or activity; or (2) in medical applications or used on humans. Should any Product(s) be used in or with any nuclear installation or activity, medical application, used on humans, or misused in any way, OMEGA assumes no responsibility as set forth in our basic WARRANTY / DISCLAIMER language, and additionally, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the Product(s) in such a manner.

RETURN REQUESTS / INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR WARRANTY RETURNS, please have the following information available BEFORE contacting OMEGA:

1. P.O. number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and PURCHASED,
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. P.O. number to cover the COST of the repair,
2. Model and serial number of product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

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