

**PIRANI VACUUM GAUGE  
MODEL GP-1G  
MODEL GP-1G WITH CASE  
(Pa/Torr)  
INSTRUCTION MANUAL**



This manual is for the following gauges.  
Serial Nos. 02000G and higher

Read this manual before operation and keep it  
at your hand for immediate reference.



**Prior to Use**

Upon receipt of this detector, make sure that it is the correct model you ordered and that it is not damaged in transit.

 <b>WARNING</b>	Read this instruction manual before installing, operating, inspecting, or maintaining the product and fully understand the safety precautions, specifications and operating procedures regarding the product.
 <b>WARNING</b>	The copyright of this instruction manual is held by ULVAC, Inc. You are prohibited from copying any portion of this instruction manual without the consent of ULVAC Inc. You are also prohibited from disclosing or transferring this instruction manual to third parties without the express written consent of ULVAC Inc.
 <b>CAUTION</b>	The contents described in this instruction manual are subject to change without prior notice because of changes in specifications or because of product improvements.

**Safety Denotations**

 <b>WARNING</b>	Safety symbols are used throughout this instruction manual to call the operator's attention to safety. The terminology used in safety symbols is classified below.
 <b>DANGER</b>	Indicate status of urgency of danger when failure to comply with DANGER results in serious personal injury or death The work ignoring this warning will lead to serious damage to human life or factory facility (including this equipment) at a high probability.
 <b>WARNING</b>	Indicate status of danger when failure to comply with WARNING results in serious worker's injury or death. The work ignoring this warning will cause possibility leading to serious damage to human life or factory facility (including this equipment)
 <b>CAUTION</b>	Indicate status of danger when failure to comply with WARNING results in minor injury or moderate damage. The work ignoring this warning will cause possibility leading to minor damage to worker or breakage to equipment or necessary to adjust.
 <b>Note</b>	Direct hazard is not existed, describe the necessity to know from the viewpoint of worker's safety or correct and safe operation of equipment

## Safety Cautions

For safe use of this vacuum gauge, carefully read this manual and comply with the warnings and cautions given in the manual.

 <b>WARNING</b>	<b><u>Turn OFF power</u></b> If the vacuum gauge fails, immediately turn OFF the power. Use of a failed gauge may cause fire or electric shock. For repair, contact your local ULVAC representative or ULVAC JAPAN.
 <b>WARNING</b>	<b><u>Turn OFF power</u></b> If the vacuum gauge gets unusually hot or gives off smoke or unusual smell, immediately turn OFF the power. Otherwise, fire can result. For safety, contact your local ULVAC representative or ULVAC JAPAN.
 <b>WARNING</b>	<b><u>Turn OFF power</u></b> Turn OFF the power before replacing a fuse. Replacing a fuse with the power turned ON can cause electric shock.
 <b>WARNING</b>	<b><u>Turn OFF power</u></b> Whenever mounting the gauge, unplug the power cable.
 <b>WARNING</b>	<b><u>Use rated fuse</u></b> Use a fuse of the prescribed rating. Do not use a fuse other than the prescribed one or do not short the fuse holder. Damage or fire may result.
 <b>WARNING</b>	<b><u>Check line voltage</u></b> Prior to turning ON the power, make sure that the vacuum gauge operating voltage and the supply voltage are in agreement. Connection of incorrect power can cause damage to the vacuum gauge and fire.
 <b>WARNING</b>	<b><u>Check recorder connection</u></b> The recorder output is afloat from ground potential. Always connect the recorder input to the recorder terminal by insulating it from ground. If it is connected to GND potential by mistake, the meter will not indicate the correct value. Also the vacuum gauge may be damaged.
 <b>CAUTION</b>	<b><u>Don't disassemble</u></b> Do not try to disassemble the vacuum gauge (controller, sensor head cable and sensor head).
 <b>CAUTION</b>	<b><u>Don't modify</u></b> Do not modify the vacuum gauge (controller, sensor head cable and sensor head). If it is modified, its functions are not warranted. Also fire or electric shock may result.
 <b>CAUTION</b>	<b><u>Operating environment</u></b> Do not connect the sensor head to a test object of which pressure is in excess of atmospheric pressure. If the pressure in the sensor head exceeds atmospheric pressure, the sensor head will be damaged or it will pop out from the connector, causing injury to the surrounding, including human body. If the pressure exceeds atmospheric pressure, provide an isolation valve so that the pressure in the sensor head does not exceed atmospheric pressure.
 <b>CAUTION</b>	<b><u>Operating environment</u></b> Do not use the gauge in a place where it may be splashed with water. If it is splashed with water, failure, earth leakage or fire can result.
 <b>CAUTION</b>	<b><u>Ventilation</u></b> Do not plug the air vents of the vacuum gauge. If the air vents are plugged, heat will be contained inside and the gauge may be damaged. The gauge will not indicate a normal value either.
 <b>CAUTION</b>	<b><u>Beware of impact</u></b> Do not give an impact to the sensor head.

Safety Cautions

 <b>CAUTION</b>	<b><u>Operating conditions</u></b> Operate the vacuum gauge under the environment set forth in the specifications.
 <b>CAUTION</b>	<b><u>Repacking for transfer</u></b> If the vacuum gauge is to be shipped to other site, repack it in the same way as on delivery. If the gauge is shipped bare, it may be damaged.
 <b>CAUTION</b>	<b><u>Disposal</u></b> When discarding the vacuum gauge, comply with your local regulations. If the gauge was used in an environment that can cause hazards to human body, have it disposed of by an authorized specialist in disposal. Customer shall be responsible for the cost relating to disinstallation.
 <b>CAUTION</b>	<b><u>Check line voltage</u></b> The operating voltage of this gauge is 100 to 240 VAC. Check the line voltage before connection. If incorrect power is applied, damage or fire can result.
 <b>CAUTION</b>	<b><u>Ratings of the power supply cable plug</u></b> Ratings of the power supply cable plug are 125V/10A. Please process the plug when you use it exceeding ratings of the power cable.
 <b>CAUTION</b>	<b><u>Meter panel</u></b> Don't long contact with chemical cleaning cloth, don't wipe with benzene or thinner. The pointer may become unstable due to static electricity. In the case, apply a commercially available antistatic agent to the cover.
 <b>CAUTION</b>	<b><u>Connection</u></b> The contact output capacity is 100VAC/0.5A, 24VDC/1A (resistance load). If power higher than this is opened/closed, do not use the contact of the vacuum gauge, but use a large capacity switch in conjunction.
 <b>Note</b>	<b><u>Maintenance</u></b> Aluminum electrolytic capacitor and relays is used for the electric circuit in the sensor controller. Generally, the life expectancy of the aluminum electrolytic capacity is limited and the higher the surrounding temperature, the shorter the life. It is recommended to replace the aluminum electrolytic capacitor and relays once every five years or at the time of repair or overhaul to prevent components from being damaged.
 <b>Note</b>	<b><u>Lifetime of sensor head cable and connector</u></b> Female connector is used in the sensor head cable and detection unit. This female connector has a lifetime. A large current load may cause a fire in the connector connection area. Avoid the frequent insert/remove of connector to prevent a heavy load and loosens of the connector connection.

## Revision History

DATE	No.	Description
Jul. 12, 2006	00	1 <sup>st</sup> version
Aug.28, 2006	01	<ul style="list-style-type: none"> <li>• P1. 1.1 Change Power supply Specification (Power requirements, Weight)</li> <li>• P5. Correction of Fig. 1-1</li> <li>• Section 4 Correction of Troubleshooting</li> </ul>
Jun. 25, 2007	02	<ul style="list-style-type: none"> <li>• P1,8,13 Change Power requirements</li> <li>• Section 5.3: Change Indication of Pirani gauge</li> <li>• Section 8 : Change Dimensions of GP-H</li> <li>• Section 5.3: Change figure numbers due to increased figures</li> </ul>
Jul. 3, 2008	03	<ul style="list-style-type: none"> <li>• PIII. Added Safety Cautions</li> <li>• Section 1.1 : Added operating temperature range</li> <li>• Section 2.2.4 : Added a method for attaching a probe to GP-H</li> <li>• Section 4 : Added Troubleshooting</li> </ul>
Nov.7, 2013	04	<ul style="list-style-type: none"> <li>• Corrected explanation of safety symbol mark</li> <li>• Section1.2 : Added Standard accessories (Instruction manual CD, Quick manual)</li> <li>• Section 1.3 : Added Measuring unit</li> <li>• Section 6 : Change Warranty</li> <li>• Section 7 : Added certificate of Decontamination.</li> </ul>
Jul. 4, 2013	05	<ul style="list-style-type: none"> <li>• Section 3.2 : Added about 15mV or more to the recorder output when the filament is Failed.</li> </ul>
Dec. 2, 2019	06	<ul style="list-style-type: none"> <li>• Added Picture of GP-1G to Cover</li> <li>• Added Revision History</li> <li>• Added Unit of pressure</li> <li>• PIII. Added Safety Cautions</li> <li>• Section 1.1, Added Power Cable length and Plug Specifications</li> <li>• Section 1.2, Do not attach instruction manuals from Standard Accessories</li> <li>• Section 1.3, Added option</li> <li>• Section 8, Corrected Related drawings</li> </ul>

**Contents**

	Page
<b>Prior to Use .....</b>	<b>i</b>
<b>Safety Denotations .....</b>	<b>i</b>
<b>Safety Cautions .....</b>	<b>ii</b>
<b>Revision History.....</b>	<b>iv</b>
<b>1. OVERVIEW .....</b>	<b>1</b>
1.1. SPECIFICATIONS .....	1
1.2. STANDARD ACCESSORIES .....	1
1.3. OPTIONS .....	1
1.3.1. <i>Sensor head</i> .....	2
1.3.2. <i>Measuring unit</i> .....	2
1.3.3. <i>Sensor head cable</i> .....	2
1.3.4. <i>Others</i> .....	2
1.4. DESCRIPTION OF COMPONENTS .....	3
1.4.1. <i>GP-1G</i> .....	3
1.4.2. <i>GP-1G with case</i> .....	5
<b>2. INSTALLING THE PIRANI GAUGE.....</b>	<b>7</b>
2.1. PRELIMINARY OPERATION .....	7
2.2. INSTALLATION.....	7
2.2.1. <i>Installing the controller</i> .....	7
2.2.2. <i>Installing the sensor head</i> .....	8
2.2.3. <i>Electrical connection</i> .....	8
2.2.4. <i>A sensor head installation method to GP-H</i> .....	10
<b>3. OPERATING PROCEDURE.....</b>	<b>11</b>
3.1. HANDLING .....	11
3.2. RECORDER OUTPUT .....	12
<b>4. TROUBLESHOOTING.....</b>	<b>14</b>
<b>5. APPENDIX .....</b>	<b>16</b>
5.1. PRINCIPLES OF OPERATION .....	16
5.2. TYPES OF GAS MEASURED AND INDICATION .....	17
5.3. ACCURACY OF PIRANI VACUUM GAUGE.....	19
<b>6. WARRANTY .....</b>	<b>22</b>
<b>7. RELATED DRAWINGS.....</b>	<b>25</b>

## 1. OVERVIEW

The Model GP-1G is a constant temperature type Pirani vacuum gauge that utilizes heat conduction of gas.

If the sensor head burns out, the meter pointer will deflect off-scale to the higher pressure side (atmospheric pressure side).

### 1.1. Specifications

Name	Pirani vacuum gauge
Model	GP-1G
Measurable range	0.4 to 2700 Pa (0.003 to 20 Torr)
Measurement error	Within $\pm 3\%$ of 100% full-scale as converted to linear scale. (Refer to 5.3)
Power requirements	100~240VAC, 10VA *Ratings of the power supply cable plug are 125V/10A. Power Cable 3m/ Outlet side: Plug Type B
Operating temperature range	10 to 40°C
Operating humidity rang	15 to 80% (No condensation)
Recorder output	0 to 10 mVDC
Fuse rating	250 V, 0.5 A
Outside dimensions (mm)	GP-1G: 100W×130D× 100H GP-1G with case: 150W×134D× 201H
Weight	GP-1G: 670 g GP-1G with case: 1365 g Measuring unit: 35 g(GP-H)

### 1.2. Standard Accessories

Quick manual	paper	1 pc.
--------------	-------	-------

### 1.3. Options

#### 1.3.1. Sensor head

Sensor head	WP-01, WP-02, WP-03., WP-16	WPB-10, WPB-10-034
Connecting flange	WP-01: $\phi$ 18 port, WP-02: $\phi$ 15 port WP-03:R3/8, WP-16(NW16)	WPB-10:UFC034 WPB-10-034:UFC034
Filament material	Pt	Pt
Other materials	BS/Ni-plating Ni, Kovar, Glass, SnSbCu	SUS304, Cu(Gasket) FeNiCo(Ni-plating), Al <sub>2</sub> O <sub>3</sub>
Weight(g)	WP-01 : about 26、 WP-02 : about 45 WP-03 : about 63、 WP-16 : about 77	about 173
Internal volume(cm <sup>3</sup> )	WP-01 : about 19、 WP-02 : about 17 WP-03 : about 17、 WP-16 : about 22	about 18
Pressure max※1	$< 2 \times 10^{+5}$ Pa(abs)	$< 2 \times 10^{+5}$ Pa(abs)
Bakeout※2	80°C max	250°C max

\*1:The breakdown pressure of the flange and clamp are to be considered otherwise.

\*2:Bakeout temperature is a temperature of the sensor unit. Please remove the electronics(GP-H) or the conversion cable(GP-BH).

**1.3.2. Measuring unit**

Measuring unit	GP-H	GP-BH (Conversion cable 2m)
Sensor head	WP-01, WP-02, WP-03, WP-16	WPB-10, WPB-10-034
Weight	35g	GP-BH: 0.13kg Conversion calbe: 0.2kg

\*Because of its circuitry, the indication of this vacuum gauge varies with the type of sensor head. Therefore, if the type of sensor head is changed after delivery, re-adjustment will be required. Before operation, check the conditions at the time of shipment from the factory (type of sensor head) that are indicated on the measuring unit.

**1.3.3. Sensor head cable**

Sensor head cable	2, 5, 10, 15, 20, 30, 50, 100m
Weight(kg)	0.2, 0.4, 0.7, 1.0, 1.3, 1.9, 3.9, 7.7

**1.3.4. Others**

Test results certificate	
Calibration certificate	Calibration certificate, JCSS Calibration certificate

 <b>CAUTION</b>	Because of its circuitry, the indication of this gauge varies with the type of sensor head and sensor head cable length. Therefore, if the type of sensor head or sensor head cable length is changed after delivery, re-adjustment will be required. Before operation, check the conditions at the time of shipment from the factory (type of sensor head) that are indicated on the rear panel.
---	--

1.4. Description of Components

1.4.1. GP-1G

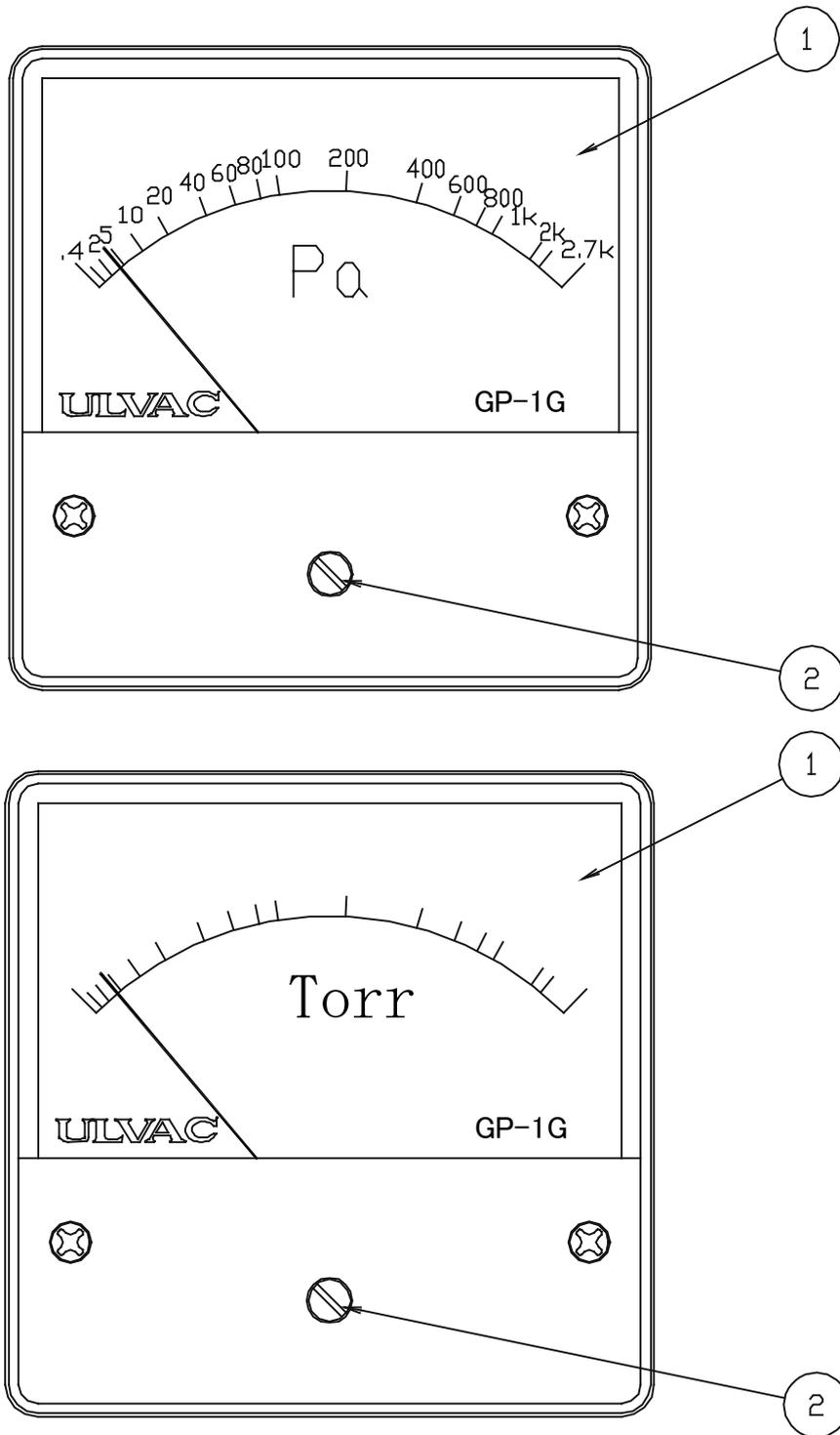


Fig. 1-1 Front view of GP-1G (Pa/Torr)

- ① Meter  
Pressure indicator.  
Indicates pressure by a needle.
- ② Zero adjustment  
Make adjustment so that the meter needle comes to the zero position (left of the scale) when the power is OFF.

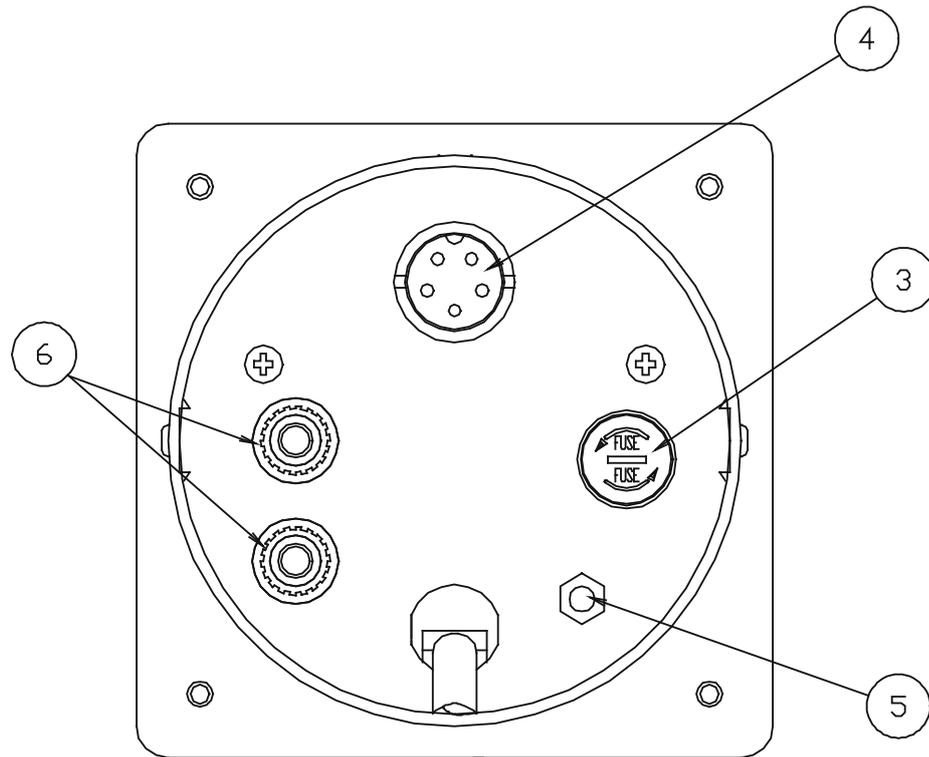


Fig. 1-2 Rear view of GP-1G

- ③ Fuse holder  
The ampacity of the fuse is 250V, 0.5 A.
- ④ Sensor head cable connector  
Connect the supplied sensor head cable to this connector.
- ⑤ Ground terminal  
Ground terminal of this gauge.
- ⑥ Recorder output terminal  
Red terminal (+)  
Black terminal (-)  
Analog signal is outputted between the two terminals.

 <b>CAUTION</b>	The recorder output is afloat from ground potential. <b>Always connect the recorder input to the recorder terminal by insulating it from ground.</b> If it is connected to GND potential by mistake, the meter will not indicate the correct value. Also the vacuum gauge may be damaged.
--	---

1.4.2. GP-1G with case

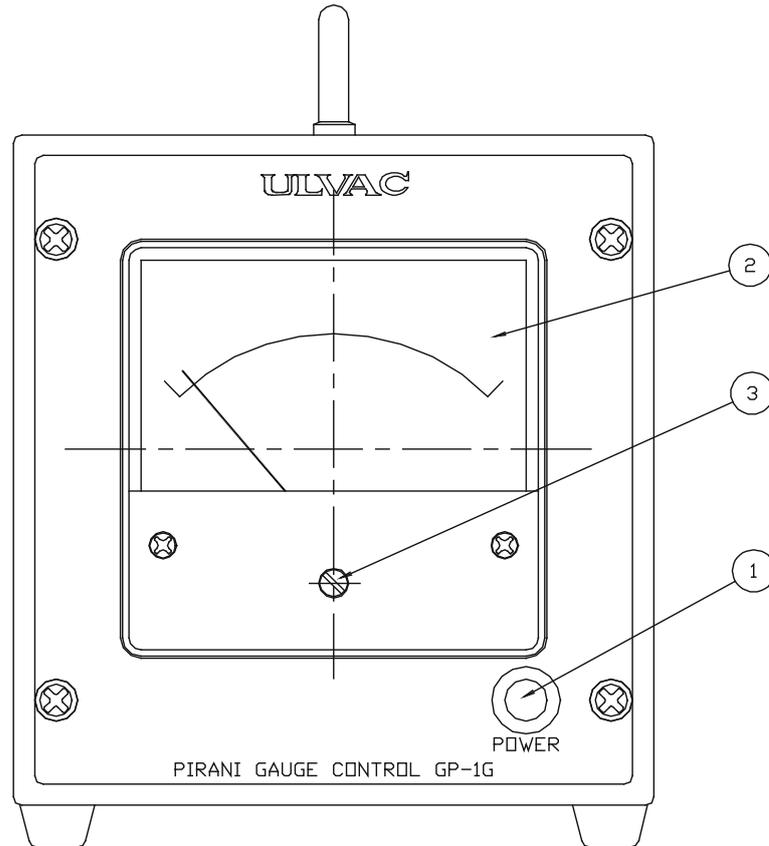


Fig. 1-3 Front view of GP-1G with case

- ① Power switch  
Main power ON/OFF switch.  
The lamp lights when the switch is turned ON.
- ② Meter  
Pressure indicator.  
Indicates pressure by a needle.
- ③ Zero adjustment  
Make adjustment so that the meter needle comes to the zero position (left of the scale) when the power is OFF.

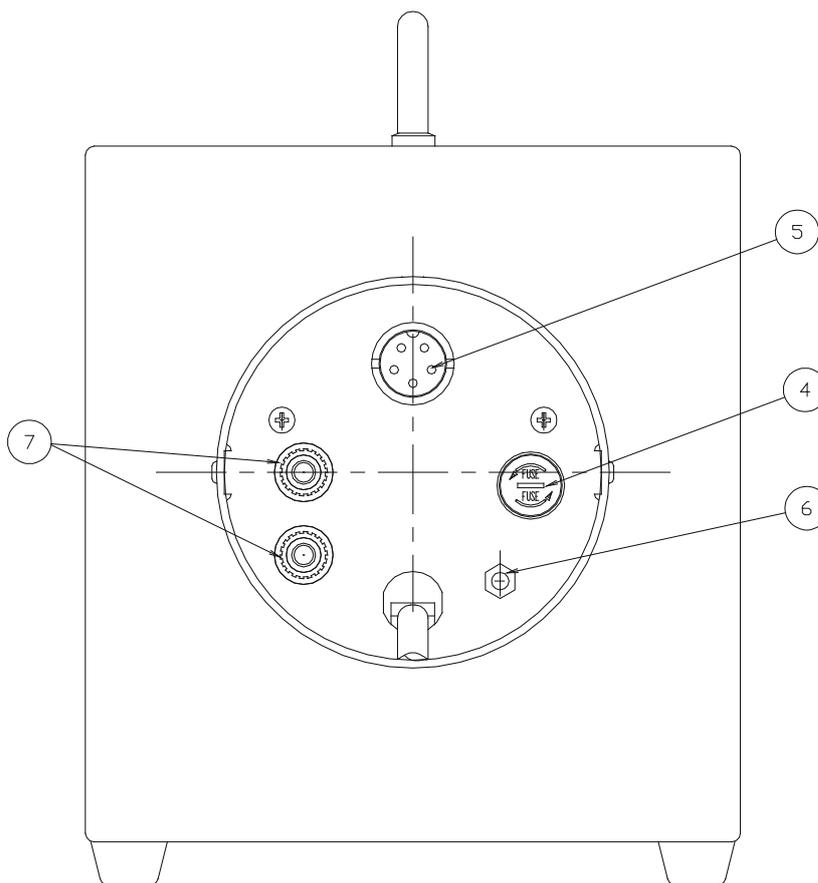


Fig. 1-4 Rear view of GP-1G with case

- ④ Fuse holder  
The ampacity of the fuse is 250V, 0.5 A.
- ⑤ Sensor head cable connector  
Connect the supplied sensor head cable to this connector.
- ⑥ Ground terminal  
Ground terminal of this gauge.
- ⑦ Recorder output terminal  
Red terminal (+)  
Black terminal (-)  
Analog signal is outputted between the two terminals.

 <b>CAUTION</b>	The recorder output is afloat from ground potential. <b>Always connect the recorder input to the recorder terminal by insulating it from ground.</b> If it is connected to GND potential by mistake, the meter will not indicate the correct value. Also the vacuum gauge may be damaged.
--	---

## 2. INSTALLING THE PIRANI GAUGE

 <b>CAUTION</b>	<b>Turn OFF power.</b> Whenever mounting the gauge, unplug the power cable.
--	--

### 2.1. Preliminary Operation

- (1) Unpack the gauge and check quantities.
- (2) Check components for possible damage.

### 2.2. Installation

#### 2.2.1. Installing the controller

 <b>CAUTION</b>	<b>Ventilation</b> Do not plug the air vents of the vacuum gauge. If the air vents are plugged, heat will be contained inside and the gauge may be damaged. Also the gauge will not indicate the correct value.
 <b>CAUTION</b>	<b>Keep out foreign matter.</b> If foreign matter like metal fragments or combustibles are admitted into the vacuum gauge through the air vents or other openings, remove them. Keep the cable connecting terminal of the meter free from contact with other objects. Otherwise, the vacuum gauge may be damaged.

Fig. 9-1 shows the panel cut drawing.

Keep a space for connecting the cable on the rear of the meter.

2.2.2. Installing the sensor head

 <b>CAUTION</b>	<b><u>Operating environment</u></b> Do not connect the sensor head to a test object of which pressure is in excess of atmospheric pressure. If the pressure in the sensor head exceeds atmospheric pressure, the sensor head will be damaged or it will pop out from the connector, causing injury to the surrounding, including human body. If the pressure exceeds atmospheric pressure, provide an isolation valve so that the pressure in the sensor head does not exceed atmospheric pressure.
 <b>CAUTION</b>	<b><u>Beware of impact</u></b> Do not give an impact to the sensor head.

Install the sensor head to the gauge port of a vacuum system.

- (1) Measuring position
  - This gauge measures the static pressure in the position where the sensor head is connected. If there is gas flow or an outgas source or an intense electron or ion generating source, the measurement value will be affected. So select the measuring position carefully. Note that if the sensor head is subjected to vibration, heat radiation, high intensity magnetic field or intense radiation, correct pressure measurement may not be made.
  - Because of its principles of operation, the Pirani vacuum gauge indication is affected by the ambient temperature of the sensor head. Be careful that the ambient temperature deviates considerably from the calibrating temperature (about 25°C).
- (2) Installing the sensor head
  - Install the gauge in such a manner that the sensor head mounting opening plane is parallel with gas flow. See to it that gas does not enter the sensor head in the form of beam.
  - The vacuum gauge filament is as thin as 25 microns in diameter. Avoid use in a place where vibration is at a high level, if possible. Be careful in selecting the installation place and handling the sensor because major cause of filament burnout is mechanical impact.
  - To install the sensor head, use an O-ring that releases little outgas. Use of a material that releases much outgas like rubber pipe or grease can be a cause of error.

2.2.3. Electrical connection

 <b>CAUTION</b>	<b><u>Check connection.</u></b> Before turning on power, make sure all cables are connected correctly. If cable connection is incorrect, damage or fire can result.
 <b>CAUTION</b>	<b><u>Check line voltage.</u></b> The operating voltage of this gauge is 100 to 240 VAC. Check the line voltage before connection. If incorrect power is applied, damage or fire can result.

- Make electrical connection after installing components.
- Fix the cable by taking care not to exert undue force to the connection between the sensor head and sensor head cable and the connection between the controller and sensor head cable.
- Lay the sensor head cable away from power lines, if possible. Noise may occur.
- Securely fasten the connector fixing screw.

**INSTALLING THE PIRANI GAUGE**

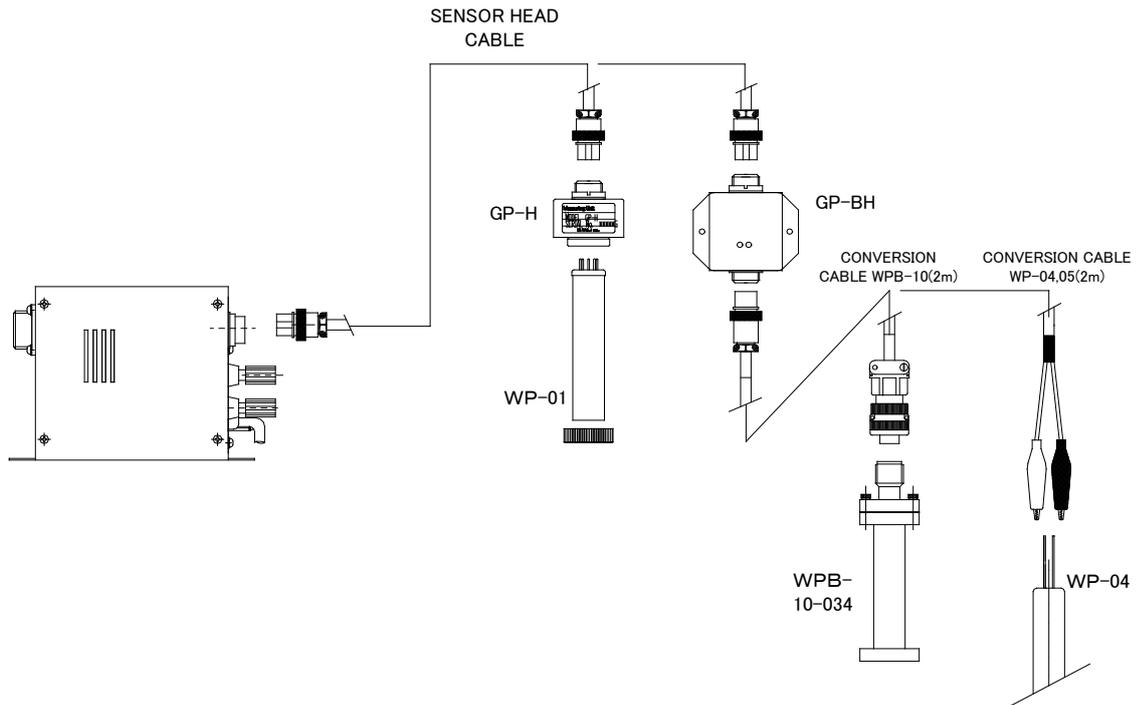


Fig. 2-1 GP-1G connection diagram

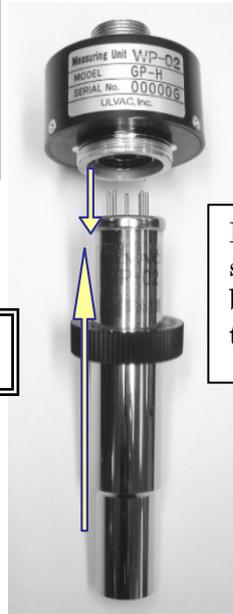
## INSTALLING THE PIRANI GAUGE

### 2.2.4. A sensor head installation method to GP-H

Caution: The installation methods of a screw for fixation are different by a sensor head.

① Install a screw for fixation that is attached to GP-H to a sensor head. By the kind of the sensor head, installation methods are different

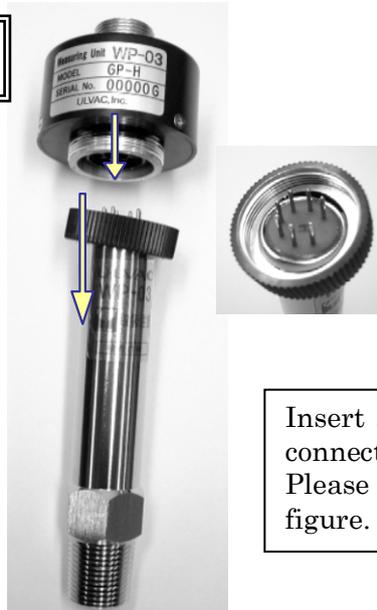
For sensor head WP-01, 02



It is inserted a screw for fixation by the vent side of the sensor head.



For sensor head WP-03, 16



② Tighten a screw for fixation in the main body of GP-H, and please fix it.

Insert a screw for fixation from the connector side of the sensor head. Please insert it diagonally like a figure.

### **3. OPERATING PROCEDURE**

#### **3.1. Handling**

- Start measurement more than one minute after power is turned ON and the indication is stabilized.
- For precision measurement, wait for at least 10 minutes until temperature equilibrium of the sensor head is established after power is turned ON. Do not turn OFF the power when a sequence of measurements is being made.

- If the sensor head is exposed to a chemically active gas or highly adsorptive gas, its characteristics may change.

In such a case, fill the chamber with nitrogen, inert gas or dry air with the sensor head energized with power, and then evacuate it. Repeat this purging operation. The sensor head may be restored to the condition before the characteristics changed. At this time, do not blow gas toward the opening plane of the sensor head even if the gas is inert or dry air.

If there is no prospect of the characteristics being restored by purging operation, replace the sensor head.

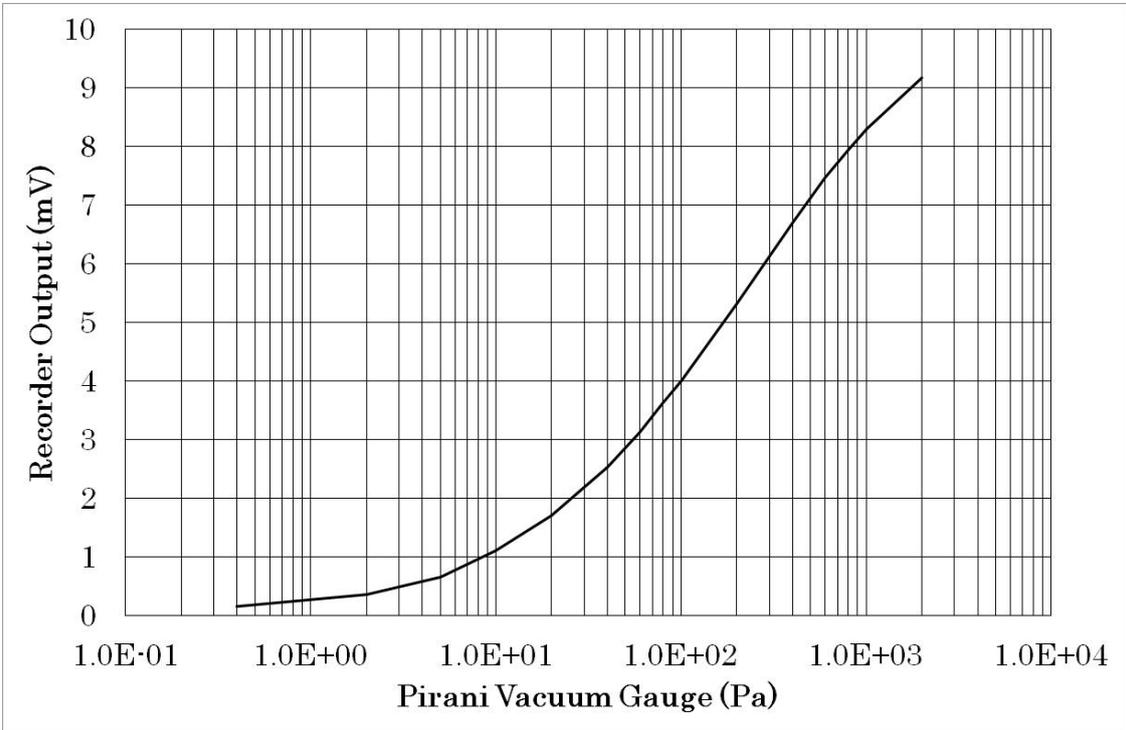
- The Pirani vacuum gauge is sensitive to all types of gas, but its sensitivity varies with the type of gas. This gauge indicates pressure by assuming that the gas is nitrogen (N<sub>2</sub>).

3.2. Recorder Output

 <b>CAUTION</b>	<b>Check recorder connection</b>
	The recorder output is afloat from ground potential. <b>Always connect the recorder input to the recorder terminal by insulating it from ground.</b> If it is connected to GND potential by mistake, the meter will not indicate the correct value. Also the vacuum gauge may be damaged.

Pa	mV	Torr	mV
0.4	0.15	0.003	0.15
2	0.35	0.01	0.27
5	0.65	0.05	0.83
10	1.10	0.1	1.30
20	1.70	0.2	2.02
40	2.53	0.4	2.97
60	3.13	0.6	3.62
80	3.63	0.8	4.12
100	4.00	1	4.52
200	5.31	2	5.91
400	6.70	3	6.70
600	7.46	4	7.26
800	7.94	6	7.94
1000	8.29	8	8.36
2000	9.17	10	8.65
		20	9.40

\*: Filament Error: More than approximately 15mV



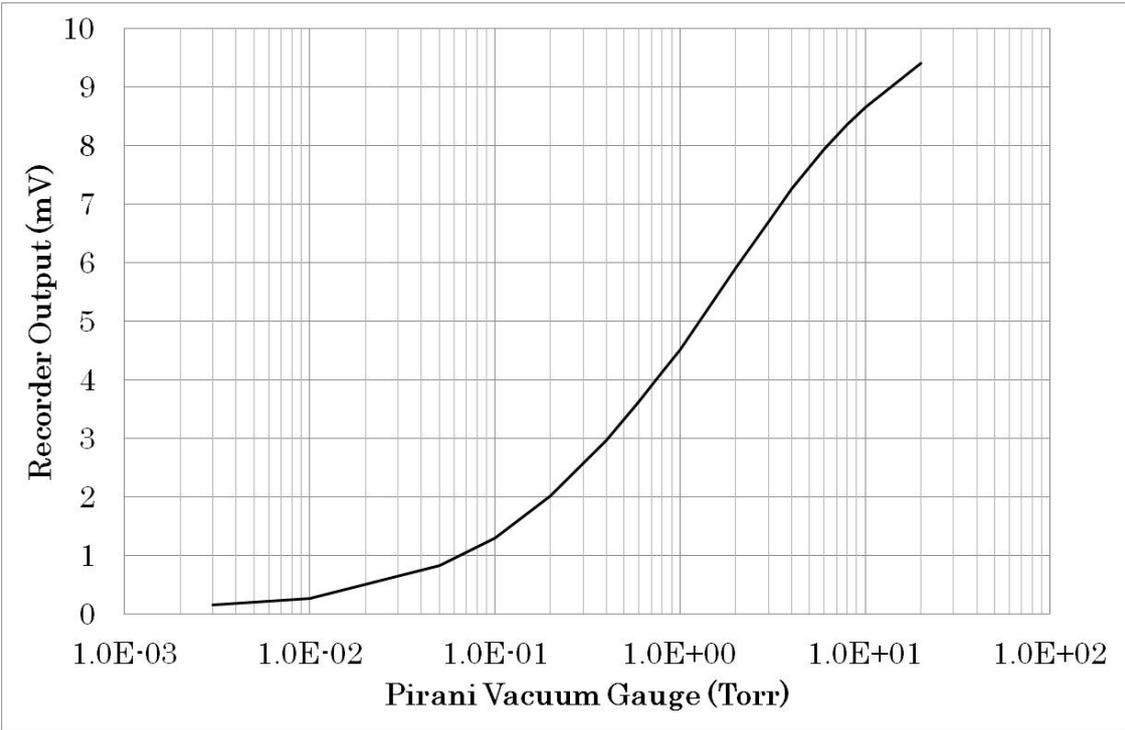


Fig. 3-1 Pressure vs. recorder output curve

**4. TROUBLESHOOTING**

Symptom: The meter needle does not deflect when power is turned ON.

Possible cause	Corrective action
<ul style="list-style-type: none"><li>Fuse has burnt out.</li></ul>	<ol style="list-style-type: none"><li>Replace the fuse (250 VAC, 0.5 A). Turn OFF the power to the controller before replacing a fuse.</li><li>If the fuse blows out immediately after replacement, repair is necessary.</li></ol>

 <b>CAUTION</b>	<b>Turn OFF power</b> Turn OFF the power before replacing a fuse. Replacing a fuse with the power turned ON can cause electric shock.
 <b>CAUTION</b>	<b>Use rated fuse</b> Use a fuse of the prescribed rating. Do not use a fuse other than the prescribed one or do not short the fuse holder. Damage or fire may result.

Symptom: The meter needle remains deflected off-scale to the right (atmospheric pressure side).

Possible cause	Corrective action
<ul style="list-style-type: none"><li>Pressure is beyond the measurable range.</li></ul>	<ol style="list-style-type: none"><li>The measurable range of the GP-1G is 0.4 to 2700 Pa. (0.003 to 20 Torr.)</li></ol>
<ul style="list-style-type: none"><li>Sensor head cable is not connected.</li></ul>	<ol style="list-style-type: none"><li>Reconnect the sensor head cable after turning OFF the power to the controller.</li></ol>
<ul style="list-style-type: none"><li>Sensor head cable is disconnected.</li></ul>	<ol style="list-style-type: none"><li>Check the sensor head cable for continuity by a circuit tester. (See Fig. 7-5)</li><li>If the cable is disconnected, replace it.</li></ol>

Symptom: The meter needle remains deflected off-scale to the right (atmospheric pressure side).

Possible cause	Corrective action
<ul style="list-style-type: none"><li>Filament has burnt out.</li></ul>	<ol style="list-style-type: none"><li>Check the filament for continuity by a circuit tester. At this time, do not energize the filament with a current more than 10 mA. Its life will be shortened. The filament resistance is about 13 <math>\Omega</math> at atmospheric pressure. (See Fig. 7-6)</li><li>If the filament has burnt out, replace it.</li></ol>

**TROUBLESHOOTING**

Symptom: The pressure indication does not exceed 2 kPa when atmospheric pressure is measured.

Possible cause	Corrective action
<ul style="list-style-type: none"><li>The type of the sensor head differs from the specified one.</li></ul>	(1) Change it with a specified one. (2) Adjust or recalibrate with the one currently in use.
<ul style="list-style-type: none"><li>Gas under measurement is not nitrogen.</li></ul>	(1) The type of gas used for calibration of this gas is nitrogen.
<ul style="list-style-type: none"><li>The sensor head is contaminated or its filament has worn out.</li></ul>	(1) Replace the sensor head.
<ul style="list-style-type: none"><li>The sensor head or controller is installed in a place where temperature is high. (This gauge was calibrated at about 25°C.)</li></ul>	(1) Move the gauge to a clean, well ventilated place not blown with draft.

Symptom: The needle vibrates and does not indicate a fixed value.

Possible cause	Corrective action
<ul style="list-style-type: none"><li>The type of the sensor head differs from the specified one.</li></ul>	(1) Change it with a specified one. (2) Adjust or recalibrate with the one currently in use.
<ul style="list-style-type: none"><li>The sensor head is contaminated or its filament has worn out.</li></ul>	(1) Replace the sensor head.
<ul style="list-style-type: none"><li>Leak in the sensor head or a leak in the area where the sensor head is installed.</li></ul>	(1) If there is a leak in the sensor head, replace it. (2) If the leak is elsewhere, stop it.
<ul style="list-style-type: none"><li>Increased wire resistance due to poor contact of the sensor head cable or corrosion of the wire rod.</li></ul>	(1) Check the sensor head cable referring to Fig. 7-5 (2) Replace the sensor head cable.
<ul style="list-style-type: none"><li>The line voltage is not within 100 to 240 VAC.</li></ul>	(1) Hold the line voltage within 100 to 240 VAC.

Symptom: Pointer does not move from the right (Atm pressure) but it start moving suddenly after the pressure decreases.

Possible cause	Corrective action
<ul style="list-style-type: none"><li>The gauge has been exposed to high temperature and high humidity above the specification for long time.</li></ul>	(1) Use the gauge at condition as listed on the specification. (2) If the same problem occurs in the regular environment, the gauge needs repair.

**5. APPENDIX**

**5.1. Principles of Operation**

When a cold gas molecule collides with a high temperature solid, it receives energy from the solid, is heated and flies away, collides with a low temperature portion and returns to the original state. The high temperature portion loses energy for the energy the cold gas molecule has obtained. This is the mechanism of thermal conduction of gas and is called transport phenomenon of energy by gas molecule.

In a pressure region (molecular flow region) in which collision of gas molecules is small, the amount of energy carried by gas is proportional to the frequency of gas molecules colliding with the high temperature portion. Thus it is also proportional to pressure.

Pressure can be measured by utilizing this principle.

Here, the following relationship holds between T and To [K] and the energy Q [J] carried away by filament per unit area in unit time, given that T is the temperature of the sensor head filament and To [K] is the temperature of the vessel wall.

$$Q = \alpha A (T - T_o) P \dots\dots\dots (1)$$

In this equation, A is a coefficient referred to as free molecule thermal conductivity [ $m^3 \cdot K^{-1}$ ] and its value varies with the type of gas. " $\alpha$ " is a coefficient that corrects the imperfectness of exchange of amount of energy at the time of collision of gas molecules and is referred to as an accommodation coefficient, which is defined as follows.

$$\alpha = \frac{T_g - T_o}{T - T_o} \dots\dots\dots (2)$$

where, T is the filament temperature, To is the temperature of gas molecule before collision and Tg is the temperature of gas molecule after collision. If the exchange of energy on the filament surface is perfect,  $\alpha = 1$ .

The value  $\alpha$  has complex properties that change with geometrical roughness, presence or absence of adsorption layer, heat history, type of gas, temperature and others and is not yet fully explored. The value  $\alpha$  directly affects the accuracy and stability of the vacuum gauge.

The constant temperature type Pirani gauge supplies the energy lost by collision of gas molecules from the heated filament and maintains the filament temperature constant all the time. The ULVAC Pirani gauge is this type of gauge.

This type of gauge is less susceptible to change of  $\alpha$  and more advantageous over other types of Pirani vacuum gauges in terms of small change in  $\alpha$ , stability and responsibility.

**5.2. Types of Gas Measured and Indication**

As briefly explained in "5.1 Principles of Operation", the indication of the Pirani vacuum gauge changes with the type of gas measured.

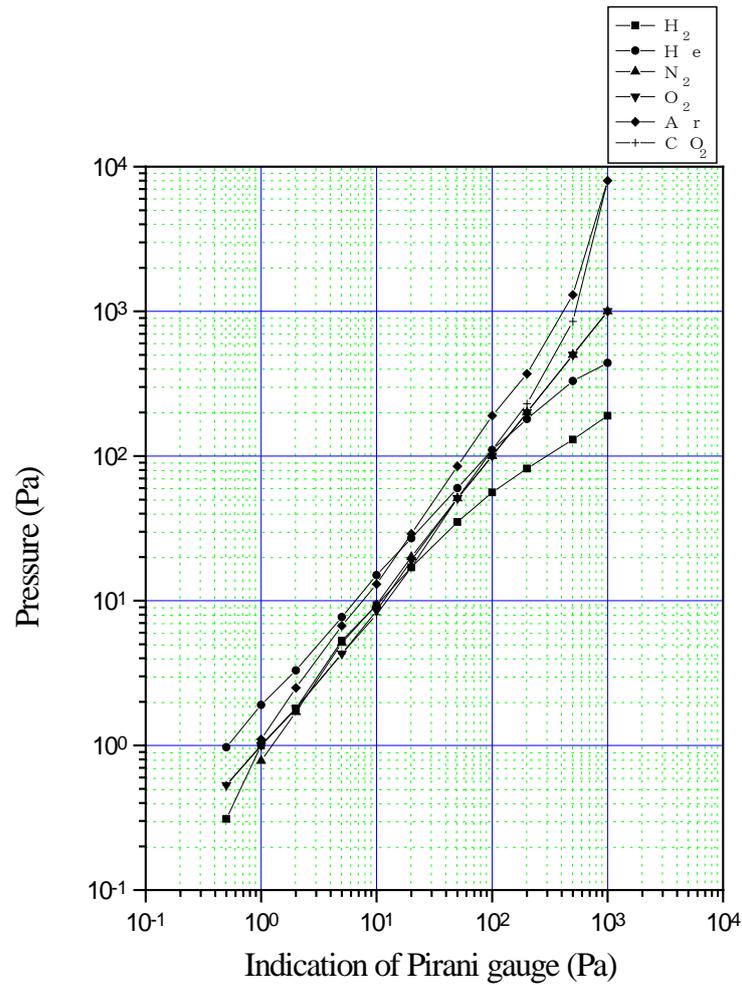
In the molecular flow region,  $\Lambda$  (free molecule thermal conductivity) is given by the following equation.

$$\Lambda = \frac{C_v + (R / 2)}{\sqrt{2\pi MRT'}} \dots\dots\dots (3)$$

where,  $M$  is molecular weight,  $R$  is a gas constant.  $T'$  is the average temperature of  $T$  and  $T_0$ , and  $C_v$  is specific heat at constant volume. This equation shows that it is dependent on  $C_v$  and is in inverse proportion to  $\sqrt{MT'}$ . In a high pressure region, the number of molecules that carry heat energy increases, while the free path of molecule becomes short, so that the amount of transport per molecule decreases in effect and the change of the indication due to the type of gas measured becomes complex.

Since the Pirani gauge measurement region is an intermediate region between molecular flow and viscosity flow, the difference in indication due to the type of gas is not simple and is difficult to express by an equation.

For your reference, Fig. 5-1 (Indication of various types of gas) shows the relationship between the indication and pressure when representative gases are measured.



Indication of Pirani gauge (Pa)	Absolute pressure of Gas (Pa)										
	H <sub>2</sub>	He	N <sub>2</sub>	O <sub>2</sub>	Ar	CO <sub>2</sub>	CO	SF <sub>6</sub>	CCl <sub>2</sub> F <sub>2</sub>	CCl <sub>4</sub>	NH <sub>3</sub>
0.5	3.1E-1	9.7E-1	-	5.3E-1	-	5.3E-1	5.9E-1	3.7E-1	7.4E-1	2.0E-1	4.3E-1
1	1.0	1.9	7.8E-1	1.0	1.1	1.0	1.2	8.2E-1	1.1	6.0E-1	8.2E-1
2	1.8	3.3	1.7	1.8	2.5	1.8	2.3	1.7	2.0	1.2	1.6
5	5.3	7.7	5.1	4.3	6.7	4.3	5.3	4.7	4.1	2.9	3.7
10	9.3	1.5E+1	9.4	8.5	1.3E+1	8.0	1.1E+1	9.8	7.4	5.6	7.2
20	1.7E+1	2.7E+1	2.0E+1	1.9E+1	2.9E+1	1.7E+1	2.1E+1	2.1E+1	1.5E+1	1.2E+1	1.9E+1
50	3.5E+1	6.0E+1	5.1E+1	5.1E+1	8.5E+1	5.1E+1	5.2E+1	4.0E+1	4.0E+1	3.7E+1	4.5E+1
100	5.6E+1	1.1E+2	1.0E+2	1.0E+2	1.9E+2	1.1E+2	1.1E+2	9.0E+1	9.6E+1	1.2E+2	8.0E+1
200	8.2E+1	1.8E+2	2.0E+2	2.0E+2	3.7E+2	2.3E+2	2.1E+2	2.4E+2	3.3E+2	-	1.3E+2
500	1.3E+2	3.3E+2	5.0E+2	5.0E+2	1.3E+3	8.5E+2	5.3E+2	2.0E+3	-	-	3.5E+2
1000	1.9E+2	4.4E+2	1.0E+3	1.0E+3	8.0E+3	8.0E+3	1.0E+3	-	-	-	5.9E+2

(Fron 12)

Remarks: Sensor head: WP-01, Controller: GP-2T.  
 The absolute pressure was measured by a diaphragm gauge.  
 The indication of the Pirani gauge was calibrated with dry air.

Fig. 5-1 Indications of various types of gas

**5.3. Accuracy of Pirani Vacuum Gauge**

The relationship between pressure and output of a Pirani vacuum gauge is nonlinear and its accuracy range varies with pressure values. To express the outgoing inspection criterion for a Pirani vacuum gauge, it is defined as "within  $\pm 3\%$  of 100% full scale as converted to the linear scale" and is given in the instruction manual as measurement accuracy.

To express the error range by pressure values

The pressure and recorder output of the GP-1G is in proportion to the controller meter scale graduations, as shown by the recorder output characteristic table (graph).

What is meant by "within  $\pm 3\%$  of 100% full scale as converted to the linear scale" is that an error of  $\pm 3\%$  of the linear scale is involved when the meter scale is replaced by a linear scale of 100% full scale.

To express the error range at a reference pressure of 40 Pa (0.4Torr) by pressure value, it is 32 to 49 Pa (0.33 to 0.48Torr), which is  $\pm 3\%$  as converted to a linear scale, as shown in Fig. 5-2.

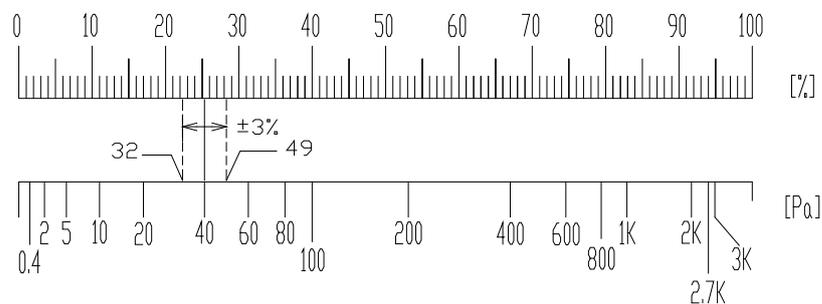
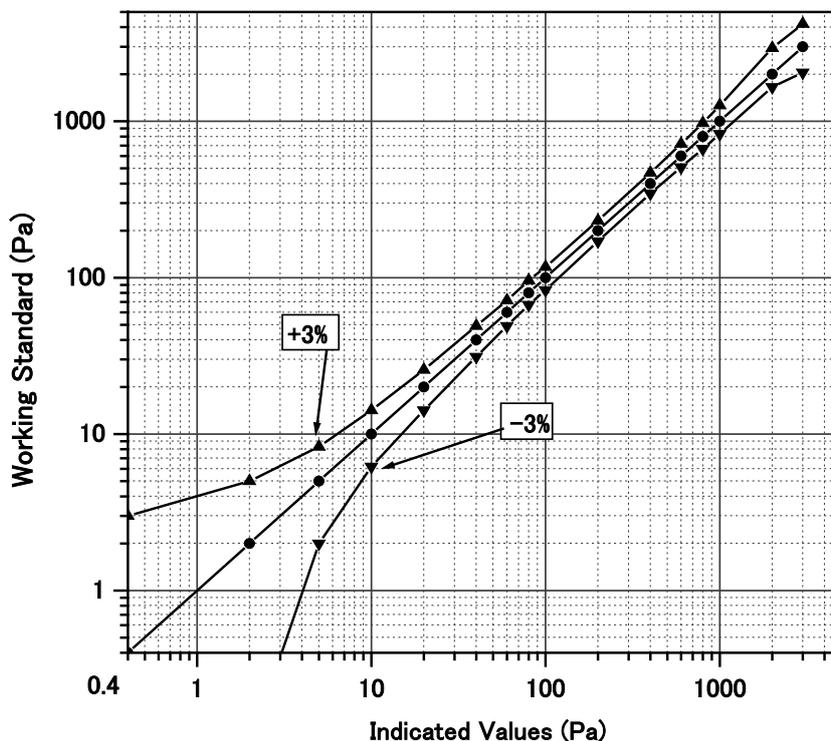


Fig. 5-2 Linear memory conversion

The "Error Range of Pirani Vacuum Gauge" table is given for reference.

Indicated Values (Pa)	Working Standard (Pa)		Indicated Values (Pa)	Working Standard (Pa)	
0.4	0	- 3	100	83	- 120
2	0	- 5	200	170	- 230
5	2	- 8	400	345	- 465
10	7	- 14	600	510	- 715
20	14	- 26	1000	825	- 1250
40	32	- 49	2000	1650	- 2900
60	49	- 71	2700	1920	- 3750

Indicated Values (Torr)	Working Standard (Torr)		Indicated Values (Torr)	Working Standard (Torr)	
0.003	0	- 0.02	1	0.85	- 1.2
0.01	0	- 0.03	2	1.7	- 2.3
0.05	0.03	- 0.08	3	2.6	- 3.5
0.1	0.07	- 0.13	4	3.4	- 4.6
0.2	0.14	- 0.26	6	5.0	- 7.2
0.4	0.33	- 0.48	10	8.0	- 13
0.8	0.68	- 0.92	20	15	- 27



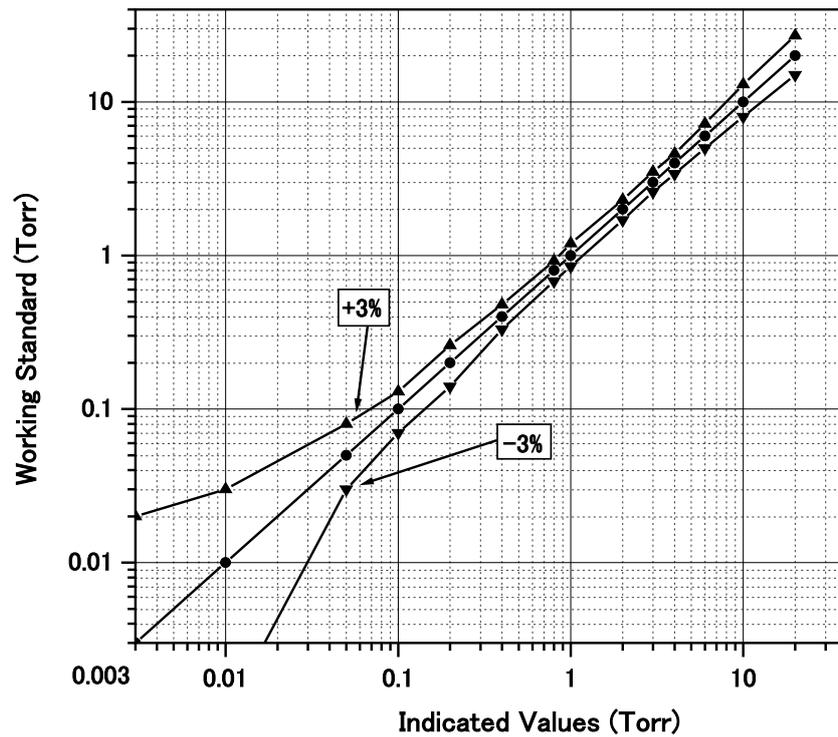


Fig. 5-3 Indication Values – Working Standard

Causes of deviation from measurement accuracy

Ambient temperature

The indication of the Pirani gauge varies with the ambient temperature of the sensor head.

Gas measured

Since the Pirani gauge is a molecular density measuring vacuum gauge, the indication of the gauge varies with the type of gas (difference in thermal conductivity). The Model GP-1G has been adjusted with nitrogen gas and its indication is a value converted to nitrogen.

Contamination of sensor head

The indication will be affected if the sensor head filament is contaminated with foreign matter.

## 6. WARRANTY

This product was shipped after rigid company inspection. However, in case any failure occurs under ULVAC's responsibility, such as defect in manufacturing and damage during transportation, Buyer shall inform ULVAC, Inc. or the local ULVAC representatives. ULVAC will repair or exchange it at free of charge.

Warrantable Items: Vacuum gauge (controller)

Duration of guarantee: One (1) year after shipping date from ULVAC

Warranty scope

- 1) Domestic business in Japan: Product, which has damage, caused by a failure on delivery.
- 2) Direct export transaction: Product, which has damage, caused by a failure on delivery. The warranty scope shall conform to the new INCOTERMS.
- 3) Products not satisfying meet the standard specifications although the product is used under the normal service conditions such as temperature range and power etc.

Response procedure

- 1) Domestic business in Japan: ULVAC send a replacement or Buyer return the defective items to ULVAC, Inc. or to the local ULVAC representatives for repair. If field service is required, Buyer shall ask ULVAC, Inc. or the local ULVAC representatives.
- 2) Direct export transaction: ULVAC send a replacement or Buyer return the defective items to ULVAC, Inc. or to the local ULVAC representatives for repair. Return charge shall be paid by Buyer.

Disclaimer

- 1) Failure occurred after expiration of warranty period
- 2) Failure caused by force majeure, such as fire, storm and flood damage, earthquake, lightning strike, war etc
- 3) Failure occurred due to carelessness handling or faulty usage
- 4) Products remodeled, disassembled or repaired without ULVAC's acceptance
- 5) Failure occurred under abnormal environment, such as intense electromagnetic field, radiation, high-temperature, high-humidity, flammable gases, corrosive gases, dust etc.
- 6) Failure occurred by noise
- 7) Product deficiency or secondary damage occurred to Buyer, from law suit to ULVAC by third party for patent infringement.
- 8) Sensor head being used (expiration of life, measurement error, etc.)
- 9) Sensor head cable being used (cable burnout due to improper installation, poor contact, etc.)

Others

- 1) In case, special agreement or memorandum for specifications is made individually, the descriptions are prior to this article "13 Product Warranty".
- 2) Buyer shall inform ULVAC when this product is exported out of Japan. In the meantime, Buyer shall take necessary procedures according to Foreign Exchange and Foreign Trade Law.
- 3) As for the question and consultation, Buyer shall check the model and serial number and ask the local representative or ULVAC, Inc.
- 4) The content of this document is subject to change without notice in future.

7. CERTIFICATE OF DECONTAMINATION



Form: A003S1268-04

ULVAC Components / Certificate of Decontamination

This is a certificate of decontamination for repair and inspection request of ULVAC Components. All material must be certified as decontaminated and this certificate must be submitted to your closest local ULVAC service center or sales office prior to shipment.

Please consult with your closest local ULVAC service center or sales office if our components are used with toxic gases or contaminated with reactive products or substances produced by reaction.

Product model:

Model:

Serial No.:

Application:

Remarks:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Contaminant (Check an applicable box.)

- I guarantee that above returned item(s) is not contaminated with harmful substances.
- Above returned item(s) is contaminated with the following harmful substances.

	Name of contaminant (molecular formula)	Characteristics
1		
2		
3		
4		
5		

To: ULVAC, Inc

Attn: \_\_\_\_\_

Date:        /        /        (YYYY/MM/DD)

Your company \_\_\_\_\_

Division \_\_\_\_\_

Contact \_\_\_\_\_

Phone \_\_\_\_\_

Fax \_\_\_\_\_

E-mail \_\_\_\_\_

Please pack returned item(s) carefully before shipment. Any accident occurred during transportation to us caused by contaminant is under your responsibility. It is also to be understood that ULVAC may decline to repair returned item(s) depending on the type of contaminant and degree of contamination, and return it to you.

To be filled in by ULVAC	Received by	
Request for MSDS: Yes/No		
ULVAC job No.		

## 8. CHINA ROHS DECLARATION



This mark is applied to the electronic information product sold in the People's Republic of China. The figure at the center of the mark is the validity date of environmental protection. This product does not influence the environment, the human body and the property during the period reckoning the manufacturing date as long as the caution for safe use regarding the products are observed.

\*The environmental protection validity date is not the product warranty period.

**Table. 8-1 Making format for names and contents of hazardous substances or elements**

Name of parts	Hazardous substances or elements					
	Pb	Hg	Cd	Cr <sup>6+</sup>	PBB	PBDE
Printed Circuit Board	×	○	○	○	○	○
Chassis	○	○	○	○	○	○
Connector	○	○	○	○	○	○
AC-DC Converter	○	○	○	○	○	○
Label	○	○	○	○	○	○
Detection Unit	○	○	○	○	○	○
Gauge Head	×	○	×	○	○	○
Cable	○	○	○	○	○	○

○: indicating that content of the hazardous substance or element in all homogeneous materials of the part does not exceed the requirements for concentration limits specified by SJ/T11363-2006.

×: indicating that content of the hazardous substance or element in, at least one kind of, homogeneous materials of the part exceeds the requirements for concentration limits specified by SJ/T11363-2006. Producer may further explain the technical excuse to the items marked with “X” perspecific conditions here.

**9. RELATED DRAWINGS**

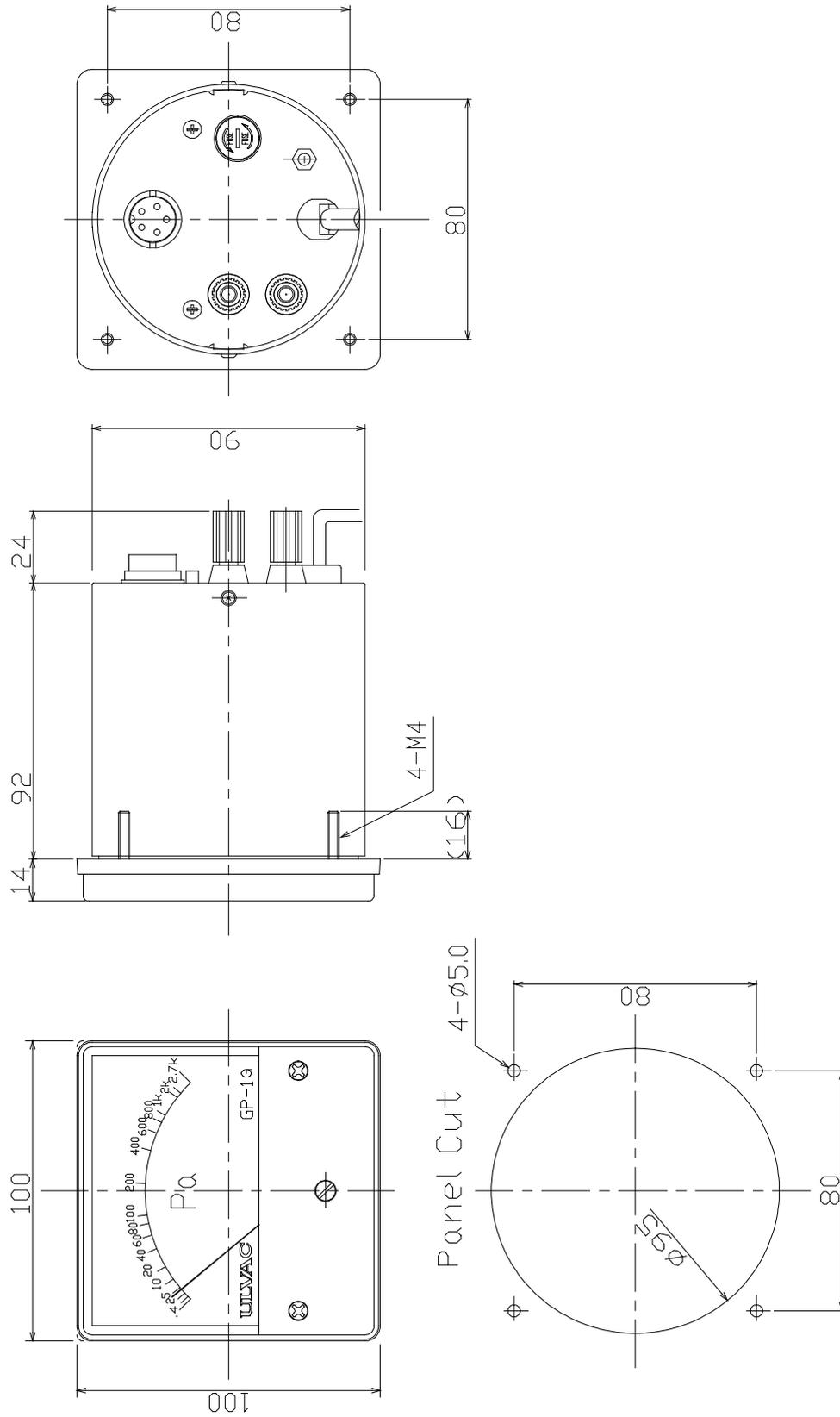


Fig. 7-1 Dimensional drawing for GP-1G

RELATED DRAWINGS

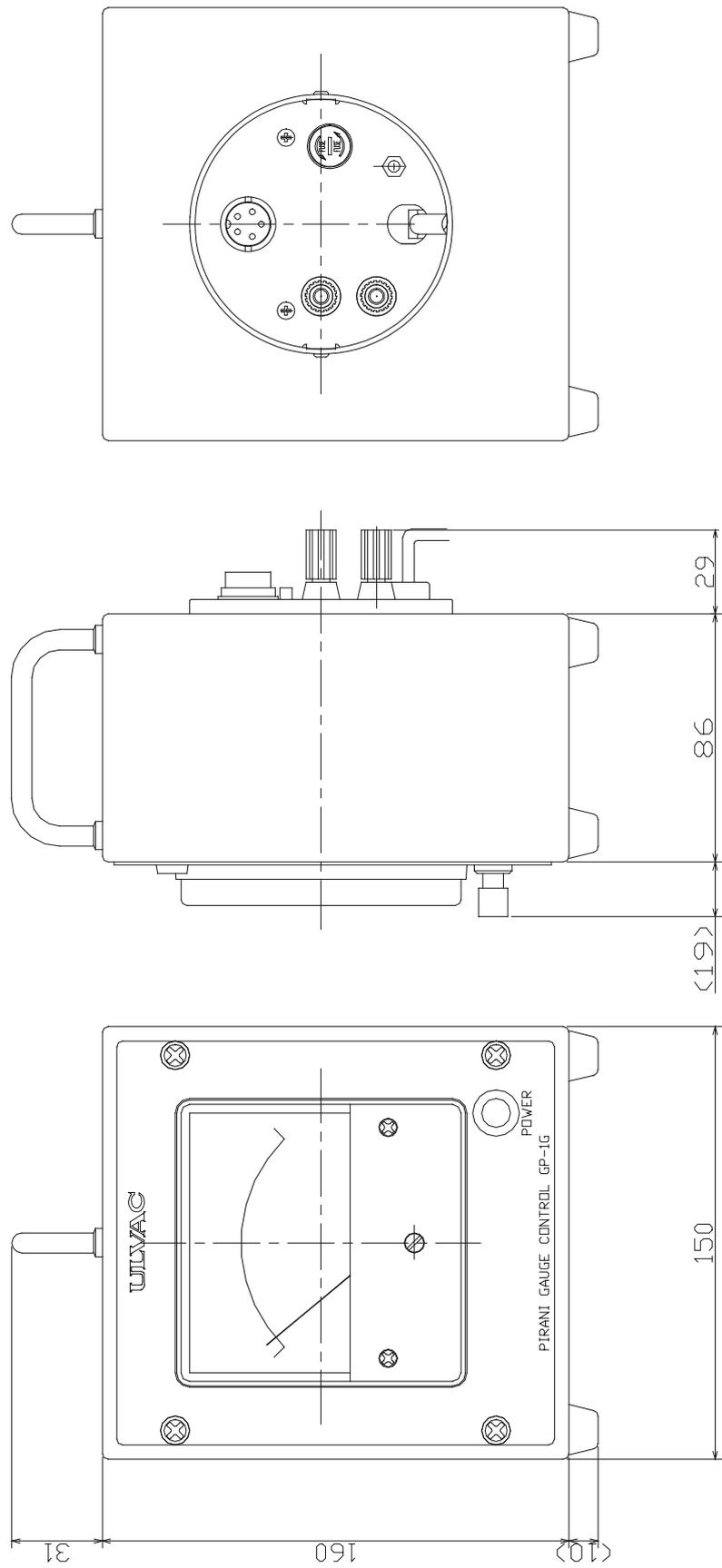


Fig. 7-2 Dimensional drawing for GP-1G with case

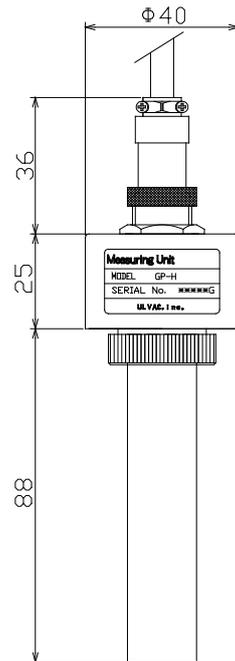


Fig. 7-3 Dimensional drawing for measuring unit GP-H

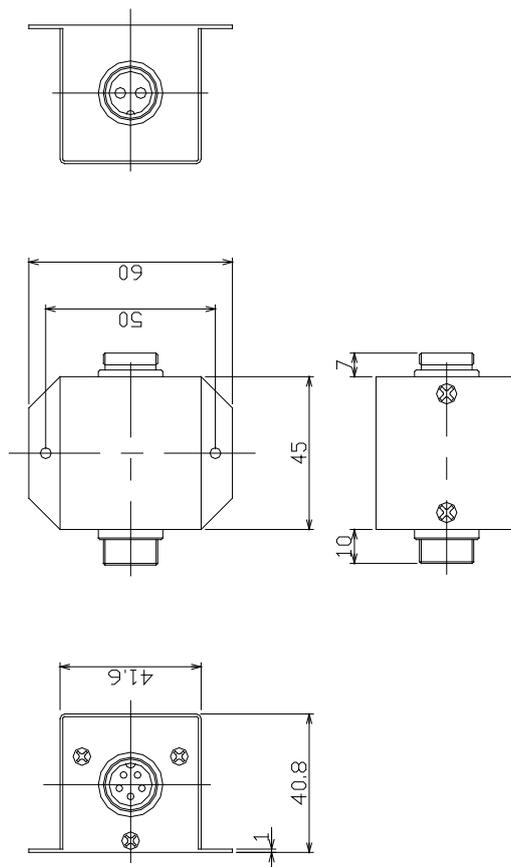
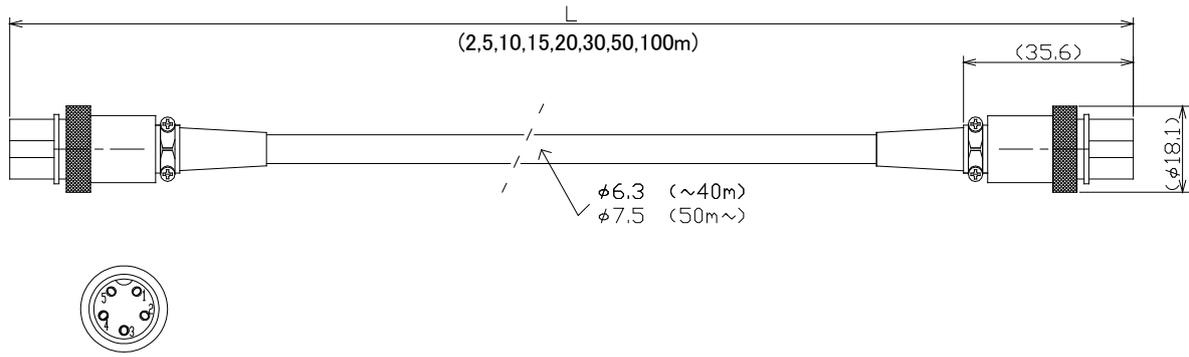


Fig. 7-4 Dimensional drawing for measuring unit GP-BH

**RELATED DRAWINGS**



Pin No.	Use
1	+5 V
2	+15 V
3	V+
4	V-
5	AG
Cover	FG

Fig.7-5 Sensor head cable

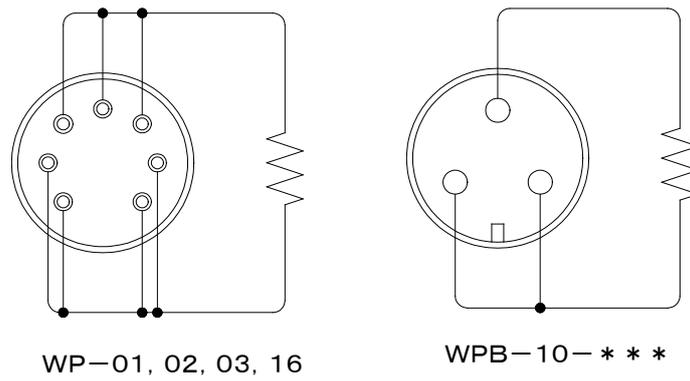
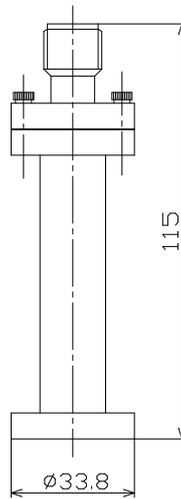
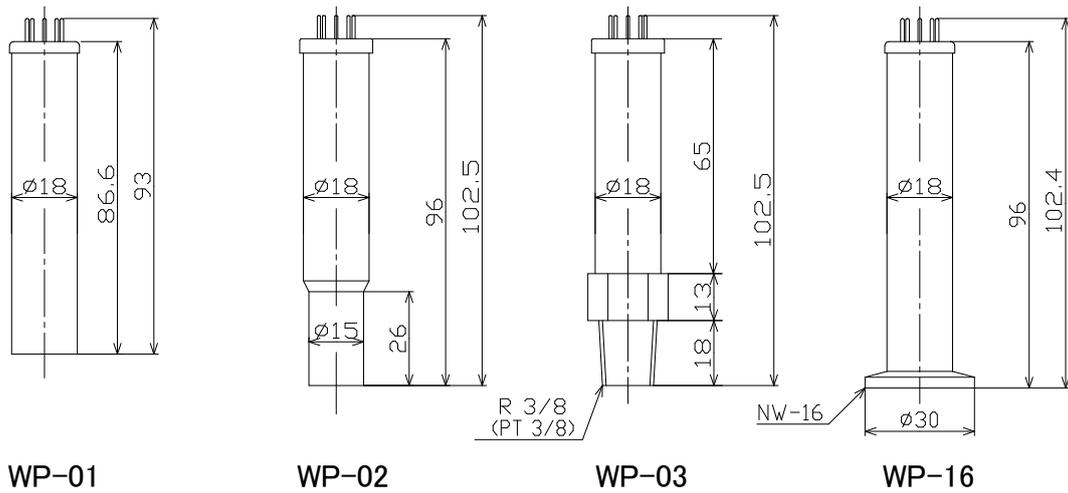


Fig. 7-6 Sensor head filament connection diagram

**RELATED DRAWINGS**



**WPB-10-034**

Sensor head model	Mounting port size (dia.)	Filament material	Case material	Compatible cable
WP-01	φ 18	Pt (φ 25μ)	BS (Ni plating)	Socket type
WP-02	φ 15 (18)	Pt (φ 25μ)	BS (Ni plating)	Socket type
WP-03	φ 3/8	Pt (φ 25μ)	BS (Ni plating)	Socket type
WP-16	NW-16 (φ 30)	Pt (φ 25μ)	BS (Ni plating)	Socket type
WPB-10-034	UFC-034	Pt (φ 25μ)	SUS304	WPB

Fig. 7-7 List of sensor heads compatible with GP-1G