Tough Gauge 301CD

Instruction Manual

Rev. 1.04

MIRAPRO

ESP60188

Contents

1. Safety Precautions

Incorrect use or handling can cause damage to the product and lead to serious accidents. To avoid any accidents, please read this instruction manual thoroughly and only use or handle this product after understanding how to do so correctly.

Items that are marked with the “Danger”, “Warning”, and “Caution” symbols are items that require special attention. Failure to obey these cautions can lead to injury to the operator or damage to the equipment. These instructions are essential for safety. Therefore, be sure to follow the instructions and use or handle the product correctly.

Definitions of symbols used in this manual:

 Caution	 Caution – Electric Shock	 Caution - Hot

Definitions of “Danger”, “Warning”, and “Caution” as used in this manual:

 **Danger**	Incorrect handling of this device will result in the imminent danger of death or serious injury to the user.
 **Warning**	Incorrect handling of this device will result in a hazardous situation that may result in death or serious injury.
 **Caution**	Incorrect handling of this device will result in a hazardous situation that may result in injury to the user or damage to equipment.

1.1. Device Installation

 **Danger**	Due to the high voltage being used, do not remove the controller cover irrespective of whether or not the power is switched on.

 **Caution**	Vibration or impact can cause distortion, broken wires, or malfunction in the electrodes inside the sensor. Install the sensors in location that is not subject to vibrations or impact.
	Always use shielded input and output cables for external signals. Additionally, always connect the shield to the frame ground of the controller via a connector shell.

1.2. Device Handling

 **Warning**	Do not touch sensors during or immediately after operation, as there is a risk of burning yourself.

 **Caution**	Vibration or impact while transporting sensors, such as by courier, or while carrying sensors can cause distortion, broken wires, or malfunctions in the electrodes inside the sensor. When transporting or carrying sensors, be careful not to subject the sensors to vibration or impact.
	Before using this product, check that none of the markings or labels are missing. If the labels have peeled off or if you have lost the instruction manual, and you are unsure of how to operate or handle the device, please contact Mirapro. before attempting to use the device.

1.3. General Safety Precautions

 **Caution**	Please undertake the necessary preventative steps for the process medium used pursuant to the relevant laws and regulations.
	Please be careful of any reactions that can occur in the process medium due to the heat generated by this product.
	Please be careful of to not allow flammable gas to ignite or explode due to the high voltage generated by this product.
	No matter what work you undertake, please undertake the necessary preventative steps pursuant to the relevant laws and regulations. Also, please be particularly careful to follow the safety precautions detailed in this manual.
	Before starting work, please check that there is no contamination in any of the vacuum parts. When handling contaminated parts, be sure to implement the necessary preventative steps pursuant to the relevant laws and regulations.
	Please ensure that any other users handling this product adhere to all safety cautions.

1.4. Other Precautions

 **Caution**	Transportation • Do not drop or strike this product. Doing so may cause damage to the device or affect its functions. • When transporting the product, be sure to minimize mechanical vibration and any impact as much as possible. Failure to do so can damage the product's functions.

 **Caution**	Overseas Transportation • This product may be classed as a strategic material under the Foreign Exchange and Foreign Trade Control Law, so please contact Mirapro. if you intend to take it outside of Japan.

 **Warning**	Returning this Product • Before returning products to Mirapro. for servicing or repairs, be sure to check that there are no harmful substances in the products. (E.g., radioactive substances, toxic substances, corrosive substances, harmful bacteria, etc.) • As prescribed in the Industrial Safety and Health Law and Poisonous and Deleterious Substances Control Law, be sure to write the name of the gas(ses) on the Repair Request From and include the form with the product.

 **Caution**	Disposal • Parts that are contaminated with harmful materials can be detrimental to human health. • Before starting work, check that none of the parts are contaminated with harmful materials. • When handling contaminated parts, observe all relevant laws and regulations and implement the necessary preventative steps.

 **Caution**	Inspections • A variety of factors such as the period of use, frequency of use, usage environment and storage period can cause this product to deteriorate over time. We therefore recommend requesting regular inspections from the product distributor or Mirapro.

1.5. Liability and Warranty

In order to use this product correctly and safely, users must comply with the precautions detailed above. In cases in which the instructions in this manual are not followed or this product is not used in accordance with the instructions, Mirapro. shall not accept any liability for any issue that occurs and shall not be liable for any type of compensation. Furthermore, the process medium used is the liability and responsibility of the end user.

Additionally, all of the work described in this manual must only be performed by persons who have received the appropriate training and have the necessary experience to undertake such work, or persons instructed by the end user.

1.6. Free Repairs

1) Mirapro. will repair a fault for free as long as it occurs in accordance with the correct use of the device as described in the instruction manual and within the warranty period.
2) The day the product is sent from Mirapro. will be counted as the day the warranty starts and the warranty period will be valid for one year.
3) The warranty applies to faults caused by the purchased device.
   The warranty does not apply to secondary damage caused due to defects.
4) Other than early-failure, the warranty does not apply to any broken while using filament.

Regardless of whether or not the warranty period is valid, repairs will be at a cost in the following situations:

① Damage occurred due reasons such as incorrect or inappropriate repairs or modification.
② Damage occurred due to reasons such as moving or dropping the device after opening it up.
③ Damage occurred due to natural disasters such as earthquake, fire, or lightning.

④ Damage occurred due to external factors such as pollution or abnormal voltage.

⑤ Damage occurred due to using the device other than for measuring vacuum pressure.

5) If a defect in the device occurs during the warranty period, please fill out the necessary sections of the Repair Request Form that came with the product and send it together with the product to Mirapro. The postage costs must be paid by yourself.

6) If after the warranty period corrections or the repair of defects become necessary, Mirapro. will undertake this work at a cost.

Please fill out the necessary sections of the Repair Request Form and send it together with the product to Mirapro.

For more details, please contact Mirapro.

2. External Appearance and Dimensions

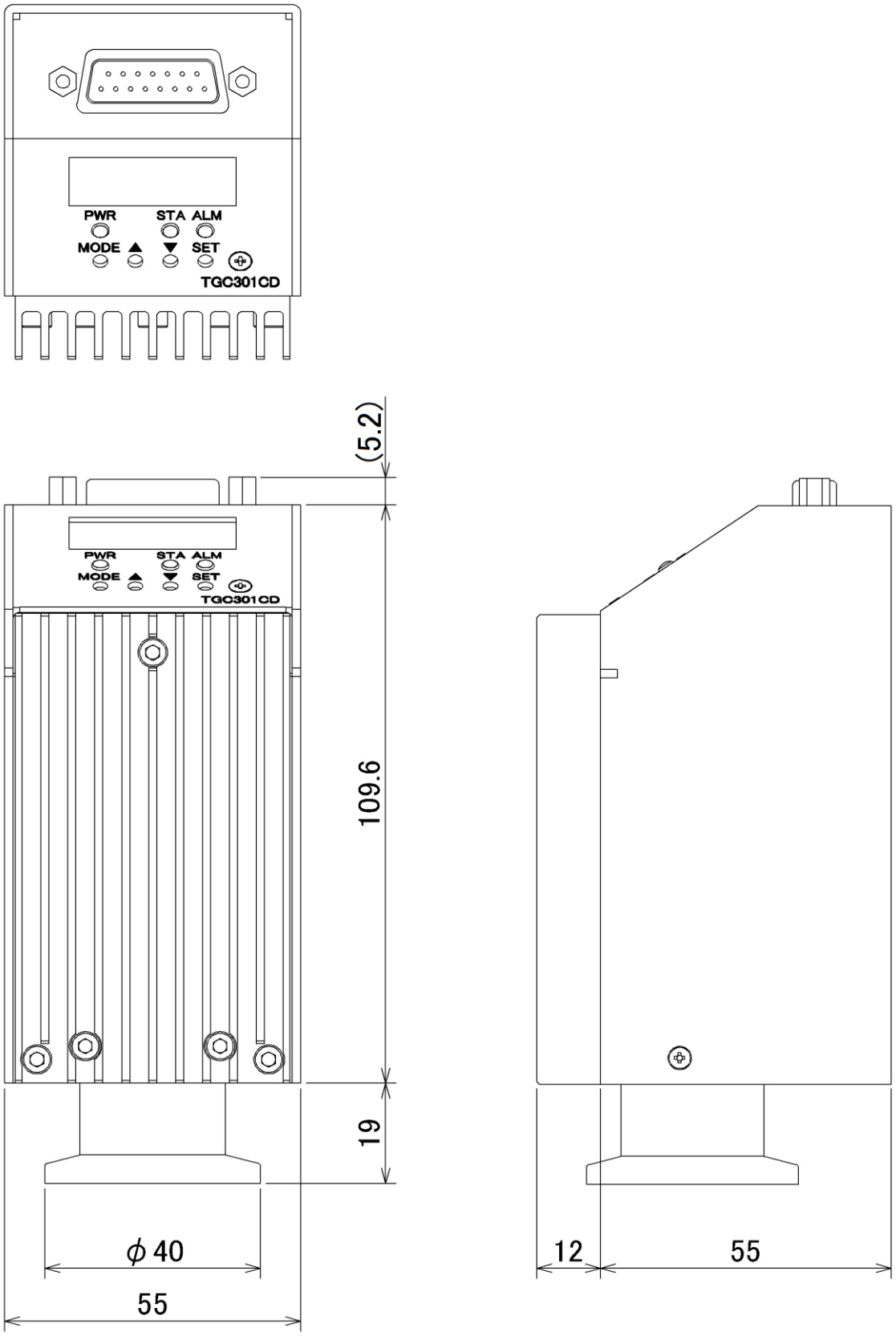


Fig. 1. External Appearance and Dimensions for the NW25 (Unit : mm)

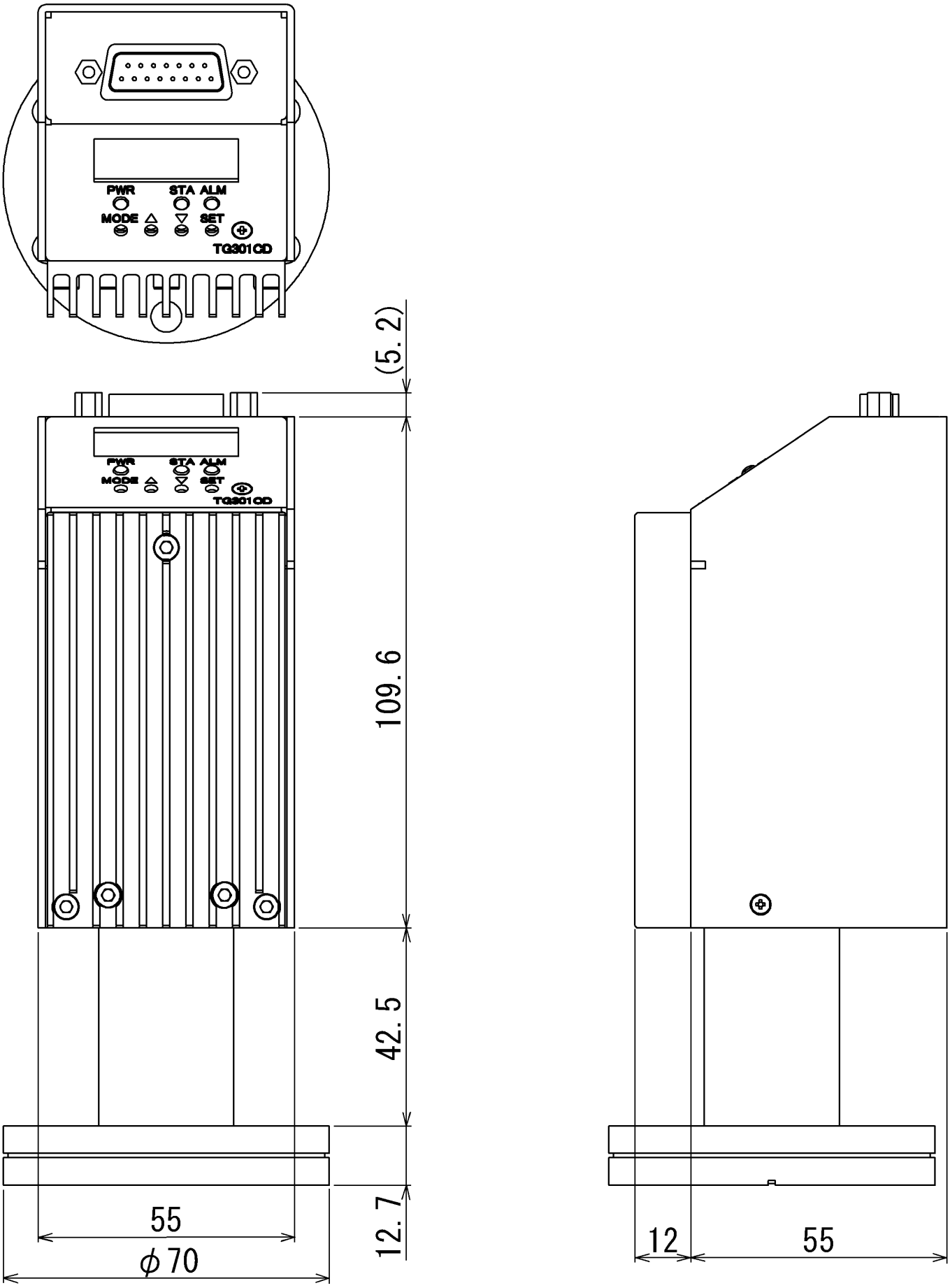


Fig. 2. External Appearance and Dimensions for the ICF70 (Unit : mm)

3. Specifications

Product	TG301CD (Tough Gauge)
Measurement pressure range	1×10^{-7}Pa to $1.2 \times 10^{+5}$Pa (According to the Pirani gauge + BA gauge) Pirani Gauge Range 0.05Pa to $1.2 \times 10^{+5}$Pa BA Gauge Range 1×10^{-7}Pa to 10Pa * When the sensors experience circumstances such as reaching a high temperature, it is possible for the Pirani gauge to not undertake measurements correctly. In particular, pressures of $1 \times 10^{+4}$ to $1 \times 10^{+5}$ are susceptible to large errors in calculation, so please use the measurement as a guide only. * The lower limit for measurement pressure indicates the limit according to the soft X-ray effect. The actual lower limit for measurement pressure fluctuated according to the ventilation composition and operations.
Accuracy	$1 \times 10^{+4}$ to $1.2 \times 10^{+5}$Pa : ±100% $1 \times 10^{+3}$ to $1 \times 10^{+4}$Pa : ±50% 0.1 to 1000Pa : ±30% 1×10^{-4} to 0.1Pa : ±20% 1×10^{-5} to 1×10^{-7}Pa : ±30%
Power supply	DC24V 0.8A
Power consumption	Maximum power consumption : 19.2W (when BA gauge is started) Power consumption during measurement : 6W (BA gauge ON, during Tough mode)
Measurement Filament	Iridium Filament (BA) x 1 Nickel Filament (Pirani) x 1
Emission Current	42μA, 2.5mA (automatic switching)
Tough mode temperature	High (approx. 700°C), medium (approx. 500°C), low (approx. 300°C) can be selected in settings. (Set to medium at time of sending out.)
Degas temperature	Approx. 900°C (2 mins)
Input/output connector	D-sub15 pin (used for both power and signals)
External input	Measurement ON/OFF, degas ON/OFF, tough mode ON/OFF
External output	Measurement mode signal *1,2. Alarm signal *1,3. Set-point dual system *1,2.
Pressure signal output	Measurement pressure and mode signals are output as voltage from 0 to 10V. *4 You can select the output signal format form LOG and LIN in settings. (Refer to “8.3.6 Output Control (Output Voltage Setting)”)
External interface	RS232C Interface (D-sub15 pin)
Mass	Approx. 550g
Operating temperature	0 to 40°C

*1. Open collector output for photocoupler insulation (Rated: 10mA)

*2. Normal open

*3. Normal close

*4. Output impedance 440Ω

4. Names and Operations of Parts

4.1. Indicators, Keys, and Connectors

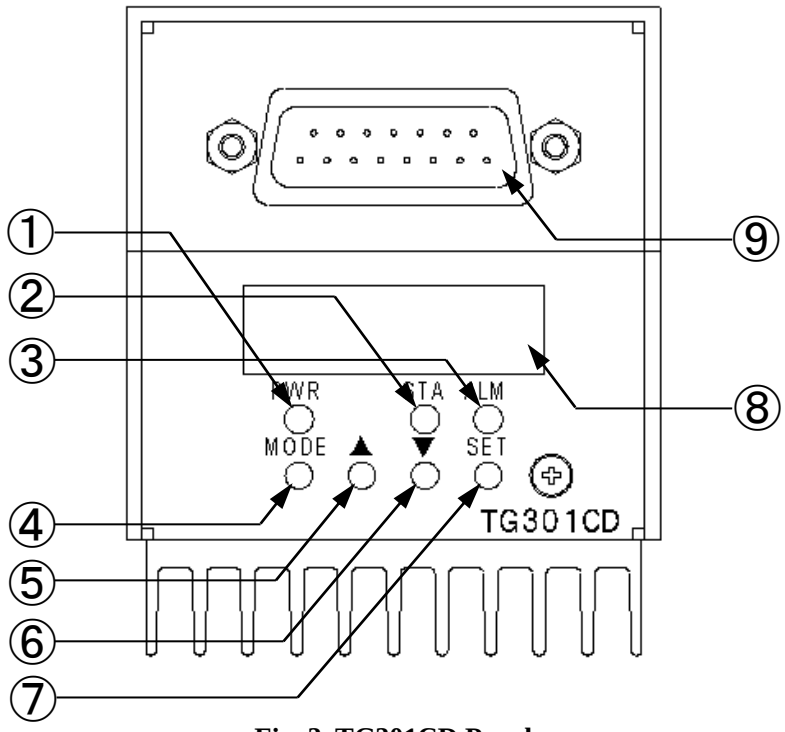


Fig. 3. TG301CD Panel

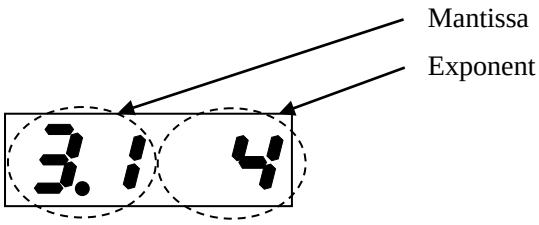
4.1.1. Names of Indicators, Keys, and Connectors

Number	Name	Function
①	Power indicator	Display the power.
②	Status indicator	Show the measurement status.
③	Alarm indicator	Show errors.
④	Mode key	Switch to settings mode and selects its items.
⑤	△ key	Used to change setting values and adjust the increment of them in settings.
⑥	▽ key	Used to change setting values and adjust the decrement of them in settings.
⑦	SET key	Used to make Pirani adjustments.
⑧	Seven segment indicator	Indicate pressure, the alarm code, and various setting values.
⑨	I/O Connector	The connector for power input as well as for RS232C communication and various signal input.

4.1.2. Seven Segment Indicator

4.1.2.1. During Measurement

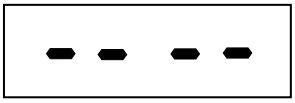
While undertaking measurements, pressure value is displayed in the seven segment indicator. Two Columns on the left and right side of the display indicate mantissa and exponent, respectively.



Example of pressure display for “31000Pa”

4.1.2.2. Measurement Stopped

While measurement is stopped, “-- --“ is displayed.



4.1.2.3. Alarm Code

When there is an abnormality, the alarm code corresponding to type of caused alarm is displayed.

(Refer to “10 Troubleshooting”)

4.1.3. Modes Shown by the Indicators

Number	Name	Lit	Flashing	Off
①	Power indicator	Green: Power on	-	Power off
②	Status indicator	White: Pirani gauge	White: Starting up	
		Blue: BA gauge	-	
		Green: Tough mode (BA gauge)	Green: Degas (BA gauge)	
		Purple: Settings mode	-	
③	Alarm indicator	-	Red: Alarm	Functioning normally
		-	Yellow: Warning	

4.1.4. Sensor Pin Configuration

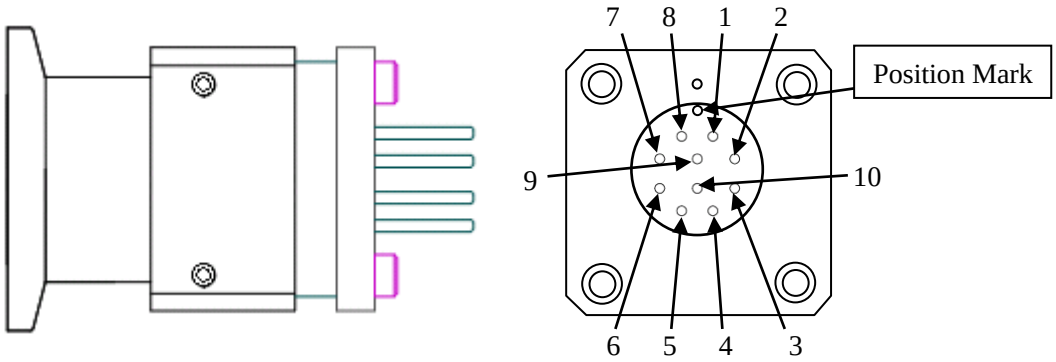


Fig. 4. Sensor (For the NW25 Type)

Pins	Name	Details
1 – 8	Temperature sensor	Connect to the temperature sensor. When functioning normally, there will be a resistance value of 110Ω at regular temperature.
2 – 6	Pirani filament	Connect to the Pirani gauge's filament electrodes. When functioning normally, there will be a resistance value of 30Ω at regular temperature.
3 – 7	Grid	Connect to the BA gauge's grid electrodes. When functioning normally, there will be a resistance value of 0.1Ω or below.
4 – 5	Filament	Connect to the BA gauge's filament electrodes. When functioning normally, there will be a resistance value of 0.1Ω.
9 - 10	Collector	Connect to the BA gauge's collector electrodes. When functioning normally, there will be a resistance value of 0.1Ω.

* Pin 8 connects to the sensor case (GND)

* The resistance value changes according to the environment temperature.

4.1.5. D-sub Connector Pin Configuration

Pin no.	Name	Details
1	Ready Output	This is the output pin for the ready signal. It will output when undertaking normally-functioning pressure measurement. Forms a connection with pin 10. *1, 2
2	Analog out	This is the output pin for the analog signal. The output is Measurement pressure and mode signal as voltage from 0 to 10V. (Log or linier combination) *4 While measurement is stopped, it will output 0V. On the other hand, it will output 10V when there is an abnormality,. (Refer to "8.3.6 Output Control (Output Voltage Setting)") *4
3	Alarm Output	This is the output pin for the alarm signal. Forms a connection with pin 10. *1, 3
4	Measure On	This is the input pin for the Measure On signal. Under factory settings, the rising signal starts measurement and the falling signal ends measurement. (0 – 24V input, 3V or below: ends measurement. 20V or above: starts measurement.) Forms a connection with pin 10. By changing the settings, it can also be used as a Pirani forced switch signal. (For details, refer to "8.3.9 Measure Control (Signal Settings for Measure On)")
5	Tough mode on	This is the input pin for the tough mode start signal. The rising signal turns tough mode on and the falling signal turns tough mode off. (0 – 24V input, 3V or below: ends tough mode. 20V or above: starts tough mode.) Forms a connection with pin 10. Please connect when controlling tough mode with a signal from an external device.
6	Set-point 2	This is the output pin for the set-point 2 signal. Forms a connection with pin 10. *1, 2
7	Degas on	This is the input pin for degas start/stop. Turns on or off with an input of 20V or above and a pulse width of 100ms. Forms a connection with pin 10. Please connect when starting/stopping degas with a signal from an external device.
8	DC24V+ Input	This is the plus input pin for the DC24V.
9	Set-point 1	This is the output pin for the set-point 1 signal. Forms a connection with pin 10. *1, 2
10	Output Common	This is the common for the ready signal, the measurement start signal, the tough mode start signal, the degas start signal, the alarm signal, and the set-point 1 and 2 signals.
11	DC24V- Input	This is the GND pin for the DC24V.
12	Analog GND	This is the ground pin for the analog signal output.
13	TXD	The signal output terminal for the RS232C interface.
14	RXD	The signal input terminal for the RS232C interface.
15	Signal GND	This is the ground pin for the digital signal. It is shared as the RS232C ground.

*1. Open collector output for photocoupler insulation (10mA or less)

*2. Normal open (NO) signal

*3. Normal closed (NC) signal

*4. Output impedance: 440Ω

5. Installation Method

5.1. Installing Controllers

When first purchasing, the sensor and controller are a single unit.

After detaching the controller to check that the sensor's electrodes are conducting, face them in the direction shown in the figure below and put them together.

Face the sensors and controller's fastening screw holes in the direction shown in the figure and fasten the holding screws to keep the heat sink and sensor in place.

If the parts were incorrectly faced and connected, an error will be detected and the alarm indicator will light up when the controller is powered on.

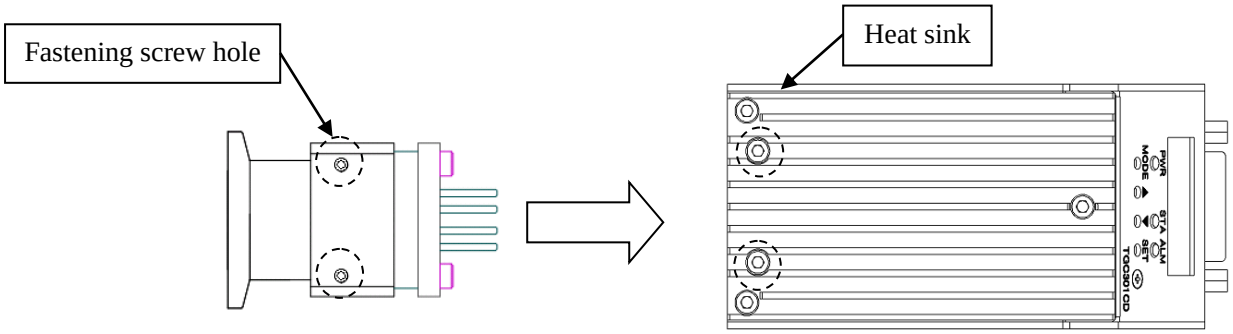


Fig. 5. Installing the Controller (For the NW25 Type)

Caution	Please check the direction of the screw hole and the position mark before connecting the sensor and the controller. Connecting the parts at an incorrect angle can cause the electrodes to break, causing the device to become unable to operate correctly.
Warning	Please only install the controller when the power connector has been disconnected. Attempting installation with the power on can cause electric shocks and injury or damage.

5.2. Connecting Power, Communication, and I/O Cables

Power supply, the input and output of signals and the interface are all performed thorough I/O connectors.

When connecting a computer with RS232C communication or when inputting or outputting an external signal, use a D-sub cable and connect to the TG301CD's D-sub.

Please either purchase a power/interface cable (sold separately) or use the provided D-sub connector to prepare your own connection cable. (For pin configuration and signal, refer to "4.1.5 D-sub Connector Pin Configuration".)

For details about the communication interface, please refer to "9 Communication Interface".

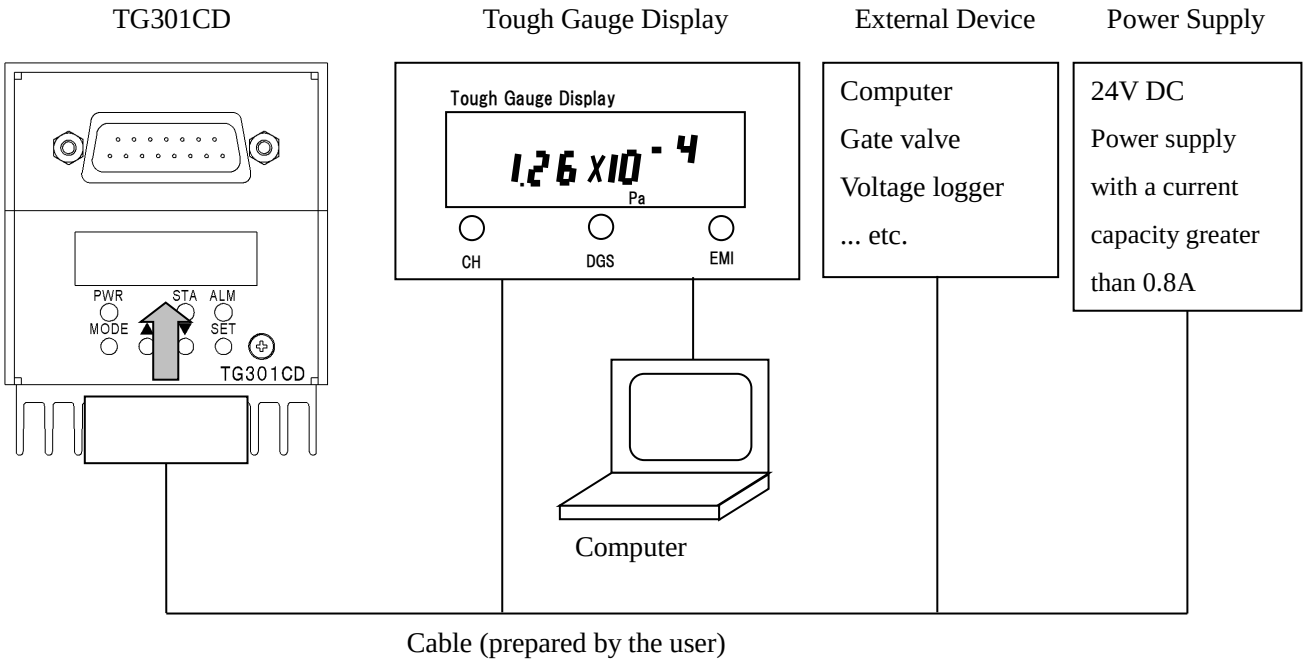
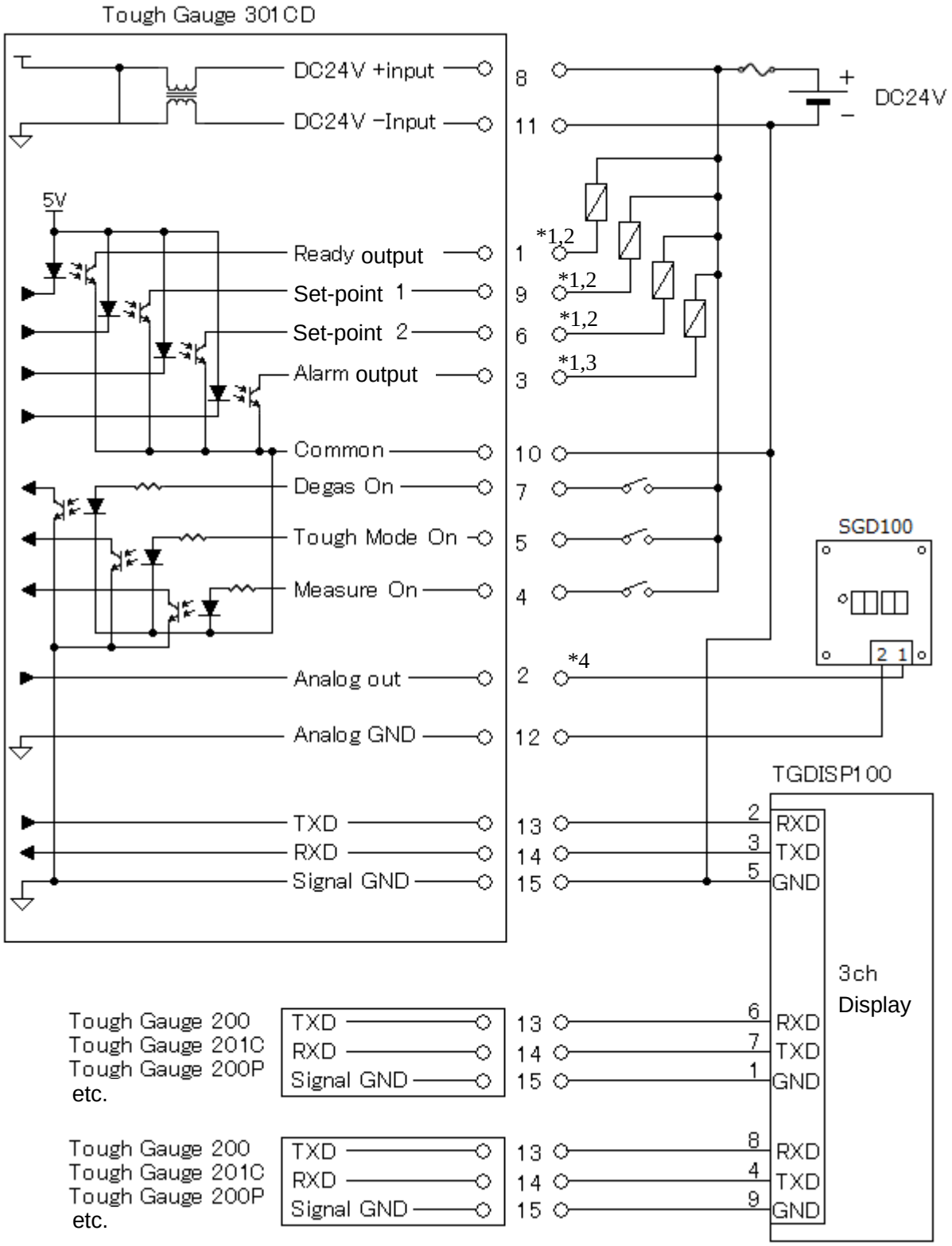


Fig. 6. Connecting D-sub

Caution	When preparing the cable, be very careful when connecting the signal line. Connecting cables incorrectly can prevent the device from functioning correctly, and also risks damaging the device or causing power failure.
Warning	Be sure to turn off the power supply when inserting or removing cables. Inserting or removing cables while power is being supplied can result in electric shock or damage to equipment.

5.3. Example Connection with Display

Fig. 7. Example Connection shows an example of how to connect the tough gauge display (TGDISP100), which is sold separately.



*1. Open collector output for photocoupler insulation (10mA or below). *2. Normal open (NO) signal.

*3. Normal close (NC) signal. *4. Output impedance: 440Ω

Fig. 7. Example Connection

6. Operations

6.1. Measurement Operations

When the power is turned on, the Pirani gauge will automatically start measuring. While undertaking measurements, the original settings will cause the device to switch between the Pirani gauge and the BA gauge (combination mode).

Other than switching between the Pirani gauge and the BA gauge, there are no other functions that will automatically switch. You can switch between tough mode and off mode by using serial commands or signal inputs.

When there is a high vacuum, the device will switch to the BA gauge. There are three modes for the BA gauge operations.

These are: off mode, which does not heat the grid collector electrodes, tough mode, which measures pressure while heading the grid collector electrodes, and degas, which removes impurities from the grid collector electrodes.

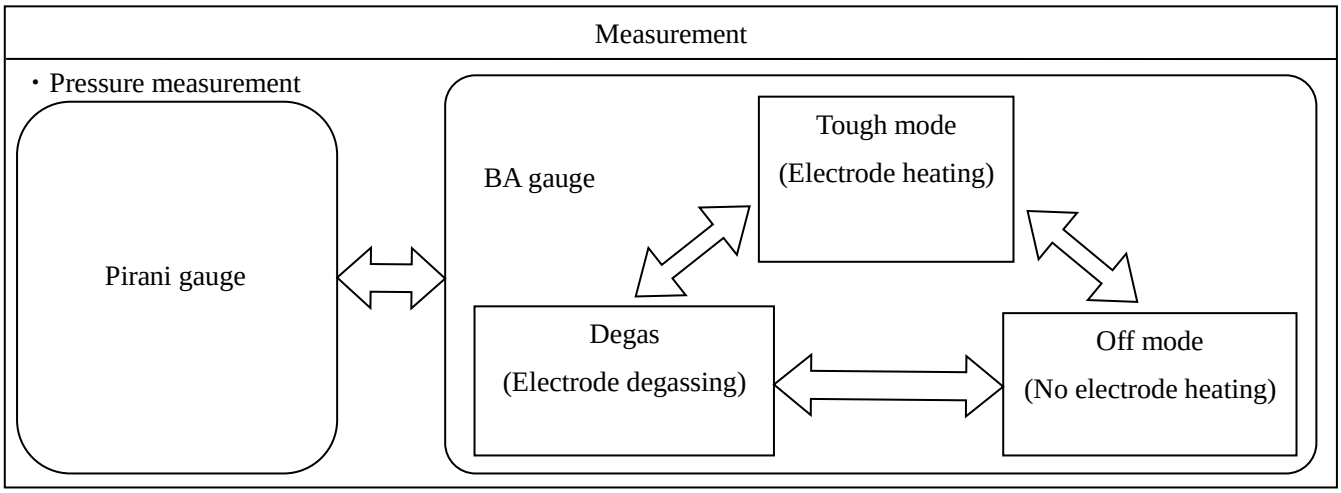


Fig. 8. Measurement Operations

6.2. BA Gauge Measurement

During BA gauge measurement, the status indicator will light up in blue.

Tough mode and degas can be used. The status indicator will light up in green during tough mode, and the green light will flash during degas.

The settings for tough mode are automatically saved, which means that once tough mode has been set to on, it will remain on each time the BA gauge is started up until tough mode is turned off by key, command, or signal.

The pressure measurement range is 1×10^{-7}Pa to 10Pa.

6.3. Pirani Gauge Measurement

While the Pirani gauge is measuring, the status indicator will be lit white.

The pressure measurement range is 0.05Pa to $1.2 \times 10^{+5}$Pa.

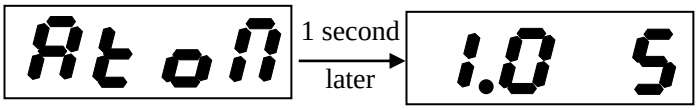
6.3.1. Adjusting the Pirani Gauge

The TG301CD is adjusted before it is sent from the factory. However, it is still possible for differences in pressure to occur due to the environment it is used in, changes over time, impurities, the changing of sensors, and the installation direction. To match the pressure of the Pirani gauge, it is necessary to make adjustments. When making adjustments, please follow the order in 6.3.1.1 to 6.3.1.2.

6.3.1.1. Atmospheric Pressure Adjustments

Atmospheric pressure adjustments are made by key operation.

1. Set the sensor pressure to atmospheric pressure (10^{+5}Pa), turn the power on, and leave in Pirani gauge measurement for 30 minutes or longer.
2. Press the SET key.
3. After “Atom” is displayed, check that “1.0E+5” is then displayed.



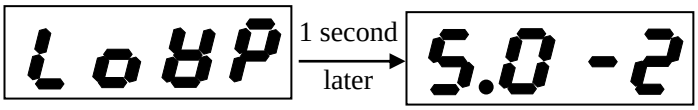
6.3.1.2. High Vacuum Adjustments

High vacuum adjustments are made by key operation. While the BA gauge is in operation, vacuum adjustments will be made automatically.

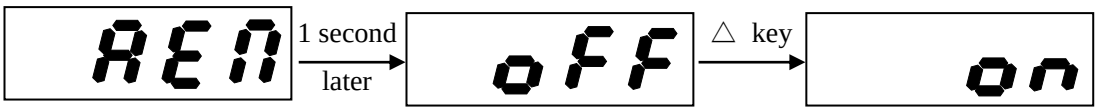
Vacuum adjustments will affect the lower limit of the Pirani gauge during measurement. If the pressure is dropping to much lower than 2.5Pa but the device will not switch to the BA gauge, please make a high vacuum adjustment.

1. Turn the “auto emission” setting off before lowering the pressure from atmospheric it.
   After pressing the MODE key multiple times to display “AEM”, and then when “on” is displayed, change to “oFF” by pressing the △ key.

2. Lower the pressure from atmospheric it, set the sensor pressure to 10^{-2}Pa or below while in Pirani gauge measurement mode, and leave it for 30 minutes or more.
3. Press the SET key.
4. After “LowP” is displayed, check that “5.0E-2” is then displayed.



5. Once adjustments are complete return to the “auto emission” settings to how they were.
   After pressing the MODE key multiple times to display “AEM”, and then when “oFF” is displayed, change to “on” by pressing the △ key.



7. Measurements

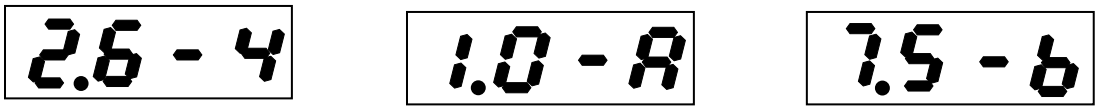
7.1. Starting Measurement

When the power is turned on, the Pirani gauge will automatically start measuring. It will take a few seconds of preparation for the measurement to begin once started. Once measurement begins, the status indicator will change from a flashing white to a lit white.

If the measurement pressure falls below 2.5Pa, the device will automatically switch to BA gauge measurement. It will take a few seconds of preparation until stabilization once the BA gauge has been started.

If the pressure rises to 7.5Pa while undertaking measurements with the BA gauge, the device will automatically switch to Pirani gauge measurement.

Example of pressure display is shown below.

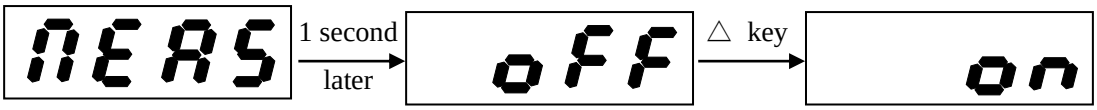


When at 2.6e-4Pa　　When at 1.0e-10mbar　　When at 7.5e-11Torr

Example of Pressure Display

When the measurement stops for reasons such as single mode (refer to “8.3.8 Sensor Type Settings”) being set or an alarm, the pressure measurement can be recommenced by following one of the methods below.

- After pressing the MODE key multiple times to display “MEAS”, and then when “oFF” is displayed, change to “on” by pressing the △ key.



- Send a serial command to start measurement.
- Press the “EMI” button on the “TGDISP100 (tough gauge display)” for more than 2 seconds.
- Press the “Start measurement” button in “TG Viewer” or “TG Display Viewer”.
- Input the signal for Measure On (refer to “4.1.5 D-sub Connector Pin Configuration”).

* For details on serial commands, see “Command Manual”.
* For details on the “TGDISP100 (tough gauge display)”, see the “TG Display Instruction Manual”.
* For details on “TV Viewer” and “TG Display Viewer”, see the “TG Viewer” or “TG Display Viewer” instruction manual.
* If the Sensor Type settings (refer to “8.3.8 Sensor Type Settings”) are on “Combination”, measurement will start automatically after the power is turned on.

When “E100” is displayed in the seven segment and the alarm indicator is flashing, measurement will be unable to be started due to sensor error. Please turn the power off, eliminate the error in “7.9 Sensor Check”, and then start measurement again.

7.2. Switching Between Gauge and Emission

a) Pressure for Switching from the Pirani gauge to the BA Gauge

When the Pirani gauge measurement pressure is 2.5Pa or below, and if the Auto Emission (refer to "8.3.4 Auto Emission Settings") is set to on, the Measure Control is set to "forced Pirani switch", and the Measure On signal is not on, then the device will switch to the BA gauge. *1

When the Auto Emission is set to off, Pirani gauge measurements will be undertaken to 0.05Pa of the lower limit. *2

b) Pressure for Switching from the BA Gauge to the Pirani Gauge

When the BA gauge measurement pressure is 7.5Pa or above, the device will switch to the Pirani gauge. *3

If the pressure rises to 30Pa while operating in single mode, an overload pressure error will occur, causing the measurement to stop. *4

c) Pressure for Switching from a BA Gauge 42μA Emission Current to a 2.5mA Emission Current

When the measurement pressure with a 42μA emission current is 5.0E-3Pa or below, the emission current will switch to 2.5mA.

d) Pressure for Changing from a BA Gauge 2.5mA Emission Current to a 42μA Emission Current

When the measurement pressure with a 2.5mA emission current is 1.0E-2Pa or above, the emission current will switch to 42μA.

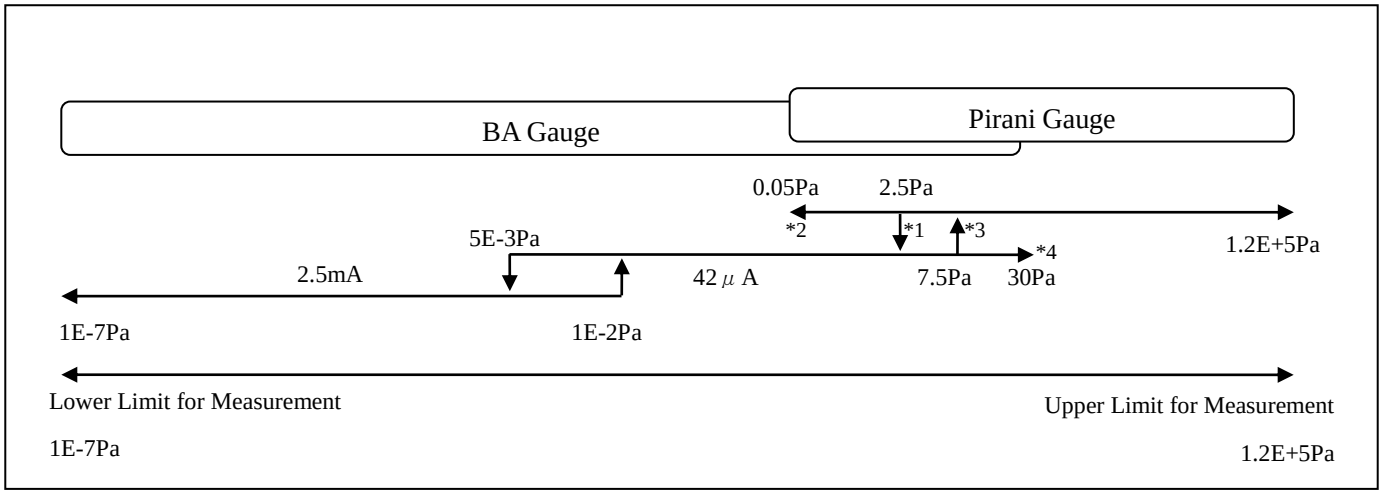


Fig. 9. Switching Between Gauges and Emissions

7.3. Forced Pirani Operations

If gas is suddenly introduced while the BA gauge is in operation (a pressure of 7.5Pa or below), the device will not be able to switch from the BA gauge to the Pirani gauge quickly enough and the BA gauge will operate at a high pressure. This can cause the BA gauge filament to become damaged.

If you foresee a sudden rise in pressure within a short time frequently when introducing atmosphere by valve or otherwise, you can introduce gas after preemptively turning off the BA gauge and operating the Pirani gauge by itself. Please use the following order to force the Pirani gauge to operate by itself:

1) Set the Measure Control (Measure On Signal Settings) to "Forced Pirani Switch" (refer to "8.3.9 Measure Control (Signal Settings for Measure On)").

2) Input the Measure On signal (refer to "4.1.5 D-sub Connector Pin Configuration").

7.4. Tough Mode

Tough mode allows for pressure measurement while heating the collector electrodes and grid electrodes. Undertaking pressure management in tough mode makes is possible to accurately measure pressure while preventing contaminants from sticking to electrodes. Electrode heating only occurs during BA gauge measurement.

The electrode temperatures for tough mode can be chosen from “oFF”, “Low”, “Mid”, and “Hi”. The appropriate tough mode temperature varies depending on the environment you use it in, so please try switching between the temperature to see what works for the environment you will use it in (refer to “8.3.5 Tough Mode (Tough Mode Temperature Settings)”).

The TG301CD has corrections made in the tough mode “Mid” temperature before it is sent out. Switching the tough mode temperature causes the temperature around the sensors to change due to the change in electrode temperature. This can cause the surrounding temperature to change. For this reason, in pressures of high and super high vacuums, switching the tough mode temperature can give rise to differences in the displayed pressure.

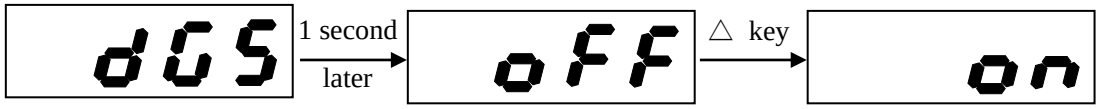
7.5. Starting Degas

When contaminants stick to the collector electrodes or grid electrodes, undertaking degas will remove the contaminants and allow for correct pressure measurement. Degas can only be undertaken during BA gauge measurement. After the degas has finished, degas cannot be undertaken again until after a one-minute cooling period.

Degas is started by one of the following methods:

- Input the pulse signal (100mS or above) to the Degas On signal (refer to “4.1.5 D-sub Connector Pin Configuration”). (Each input changes the degas from ON→OFF or from OFF→ON.)
- Start by key operation.

  After pressing the MODE key multiple times to display “dGS”, and then when “oFF” is displayed, change to “on” by pressing the △ key.



- Press the “DGS” button on the “TGDISP100” (tough gauge display) for two seconds or longer.
- Send the serial command to start degas.
- Click the “Start Degas” button for the “TG Viewer”/“TG Display Viewer”.

* For details on the “TGDISP100” (tough gauge display), please refer to the “TG Display Instruction Manual”.

* For details on serial commands, please refer to the “Command Manual”.

* For details on the “TG Viewer” and “TG Display Viewer”, please refer to the “TG Viewer” or “TG Display Viewer” instruction manuals.

* After the degas has finished, degas cannot be undertaken again until after a one-minute cooling period. If degas is undertaken during the cooling period, the display (“-Cd-”) indicating that the cooling period is in progress, and degas cannot be started.

7.6. Stopping Degas

Degas is stopped by one of the following methods:

- Input the pulse signal (100mS or above) to the Degas On signal (refer to “4.1.5 D-sub Connector Pin Configuration”). (Each input changes the degas from ON→OFF or from OFF→ON.)
- Start by key operation.

  After pressing the MODE key multiple times to display “dGS”, and then when “on” is displayed, change to “oFF” by pressing the △ key.

- Press the “DGS” button on the “TGDISP100” (tough gauge display) for two seconds or longer.
- Send the serial command to stop degas.
- Press the “Stop Degas” button on the “TG Viewer”/“TG Display Viewer”.
- The degas will automatically stop after two minutes of operation since starting.

* For details on the “TGDISP100” (tough gauge display), please refer to the “TG Display Instruction Manual”.

* For details on serial commands, please refer to the “Command Manual”.

* For details on the “TG Viewer” and “TG Display Viewer”, please refer to the “TG Viewer” or “TG Display Viewer” instruction manuals.

7.7. Ending Measurement

Pressure measurement is stopped by one of the following methods:

- Sending a serial command to end measurement.
- Pressing the “EMI” button on the “TGDISP100 (tough gauge display)” for more than two seconds.
- Pressing the “Stop Measurement” button in “TG Viewer”.
- Turning off the signal for Measure Control (refer to “4.1.5 D-sub Connector Pin Configuration”)

* For details on the “TGDISP100” (tough gauge display), please refer to the “TG Display Instruction Manual”.

* For details on serial commands, please refer to the “Command Manual”.

* For details on the “TG Viewer” and “TG Display Viewer”, please refer to the “TG Viewer” or “TG Display Viewer” instruction manuals.

7.8. Measurement Stopped

- While measurement is stopped, the status indicator will turn off and "----" will be displayed by the seven segments.
- In circumstances such as when the pressure is higher than the measurement range or when there is an abnormality in the electrode, causing an alarm, the alarm indicator will flash in red and pressure measurement will be stopped. To restart measurement, please undertake the measurement starting operations after eliminating the cause of the alarm (refer to "7.1 Starting Measurement"). The measurement starting operations will automatically release the error and start measurement.

* Measurement cannot be started while a sensor error is active. Please turn the power off, remove the controller, and check that there is no abnormality in the sensors or the connection.

* For details on alarm codes and types of alarms, please refer to "10 Troubleshooting".

7.9. Sensor Check

While the power is on, the device will check that the controller and sensors are correctly connected and that the sensors are functioning normally.

When a sensor error is detected, alarm code "100" will be displayed on the seven segments and the alarm indicator will flash red. If this happens, pressure measurement cannot be undertaken if the alarm cannot be released. After turning the power off and correctly connecting the controller and sensors, please turn the power back on.

If a sensor error occurs even after correct installation, refer to "4.1.4 Sensor Pin Configuration" and check each electrode with a tester to see if there are any abnormalities with the electrodes.

Table 1. Sensor Error Causes and Solutions

Cause	Solution
The sensors and controller are not connected.	Please connect the sensors and controller.
The Pirani filament is broken.	Please exchange the sensors. If Pirani measurement is not necessary, it is possible to undertake measurement with only the BA gauge by setting to single mode.
The connected sensor is not a combination sensor.	Please exchange the sensor with a combination sensor. If Pirani measurement is not necessary, it is possible to undertake measurement with only the BA gauge by setting to single mode.
The connection of the sensors and controller are 180° in the wrong direction.	Please turn the sensor and heat sink screws in the direction so they fit together and reconnect them.

7.10. Warning

If warning is caused, the alarm indicator will flash in yellow. The warning is display to call attention, and it don't affect operations. For details on types of warnings, please refer to "Table 7. Warning List" in "10 Troubleshooting".

7.11. Sensor Replacement

If you replace the sensors, the BA gauge measurement value will give rise to an error of around 30% of the correct pressure. Adjustment is necessary in order to undertake accurate measurements. If adjustment is necessary, please contact the Mirapro. sales department. The Pirani gauge requires adjustment after the sensors are exchanged. Please undertake adjustments after referring to “6.3.1. Adjusting the Pirani Gauge”.

7.11.1. How to Replace the Electrode Assembly

(1) Use a hexagonal wrench to remove the ○ screws in the figure below.

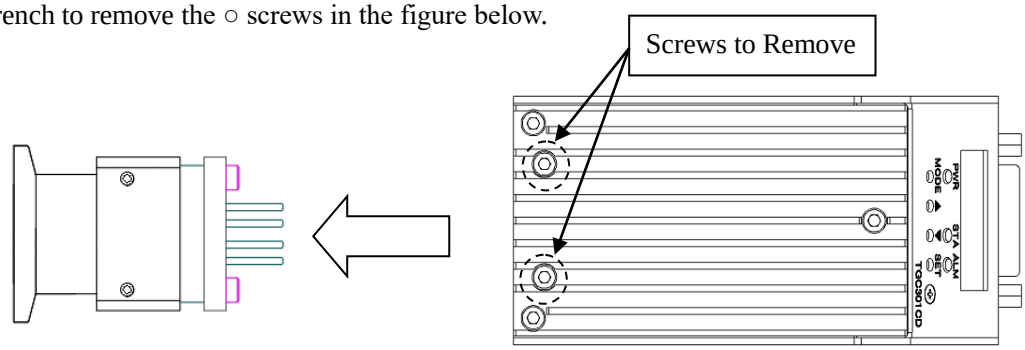


Fig. 10. Sensor Removal (For the NW25 Type)

(2) Pull the sensors toward the flange and take them out.

(3) Remove the four sensor screws and remove the fastening metal fitting.

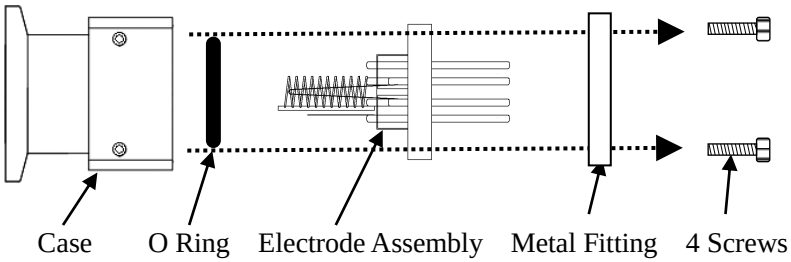


Fig. 11. Electrode Assembly Removal (For the NW25 Type)

(4) Exchange the electrode assembly.

(5) Make the electrode assembly’s position mark and the screw holes in the case face the direction in the figure below and install them.

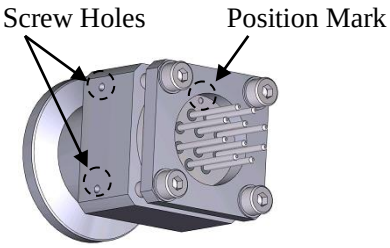


Fig. 12. Completed Sensor (For the NW25 Type)

(6) Put the controller and sensors together and fasten with screws. (Refer to “Fig. 10. Sensor Removal)”)

Caution	When replacing a sensor that is in use, be sure that the sensor has fully cooled before replacement.Attempting to a direct replacement after use can result in burns due to the sensor still being hot.

8. Various Setting Items

The various setting items are set by key operation as well as through Windows Applications “TG Viewer” and “TG Display Viewer”, through serial commands, by connecting to a device such as a computer and the RS232C. This section explains how to the setting methods by key operation, as well as each setting item. For details on commands such as format, Parameter, and others, see the “Command Manual”. For details on how to operate “TG Viewer” or “TG Display Viewer”, see the “TG Viewer” or “TG Display Viewer” instruction manuals.

Serial commands can be issued by connecting a computer to the RS232C connector and using terminal software. Terminal software must be prepared by the customer.

8.1. List of Setting Items

The following 13 items can be set in the setting mode. For details on the items, see “8.3 Setting Items”.

(1) Meas On (Start measurement) (Only when measurement is stopped) *
(2) Sensitivity (Sensitivity settings) *
(3) Gas Type (Gas type settings) *
(4) Set-Point 1 Attack (Set-point 1 attack point settings) *
(5) Set-Point 1 Release (Set-point 1 release point settings) *
(6) Set-Point 2 Attack (Set-point 2 attack point settings) *
(7) Set-Point 2 Release (Set-point 2 release point settings) *
(8) Auto Emission (Automatic emission) *
(9) Tough Mode Temp (Tough mode temperature settings) *
(10)Degas On(Start degas)(Only BA is measuring) *
(11) Measure Control (Measurement start signal settings) *
(12) Output Control (Output voltage settings)
(13) Unit (Pressure unit settings)
(14) Sensor Type (Types of sensors)

* (1) to (11) can be set by key operation.

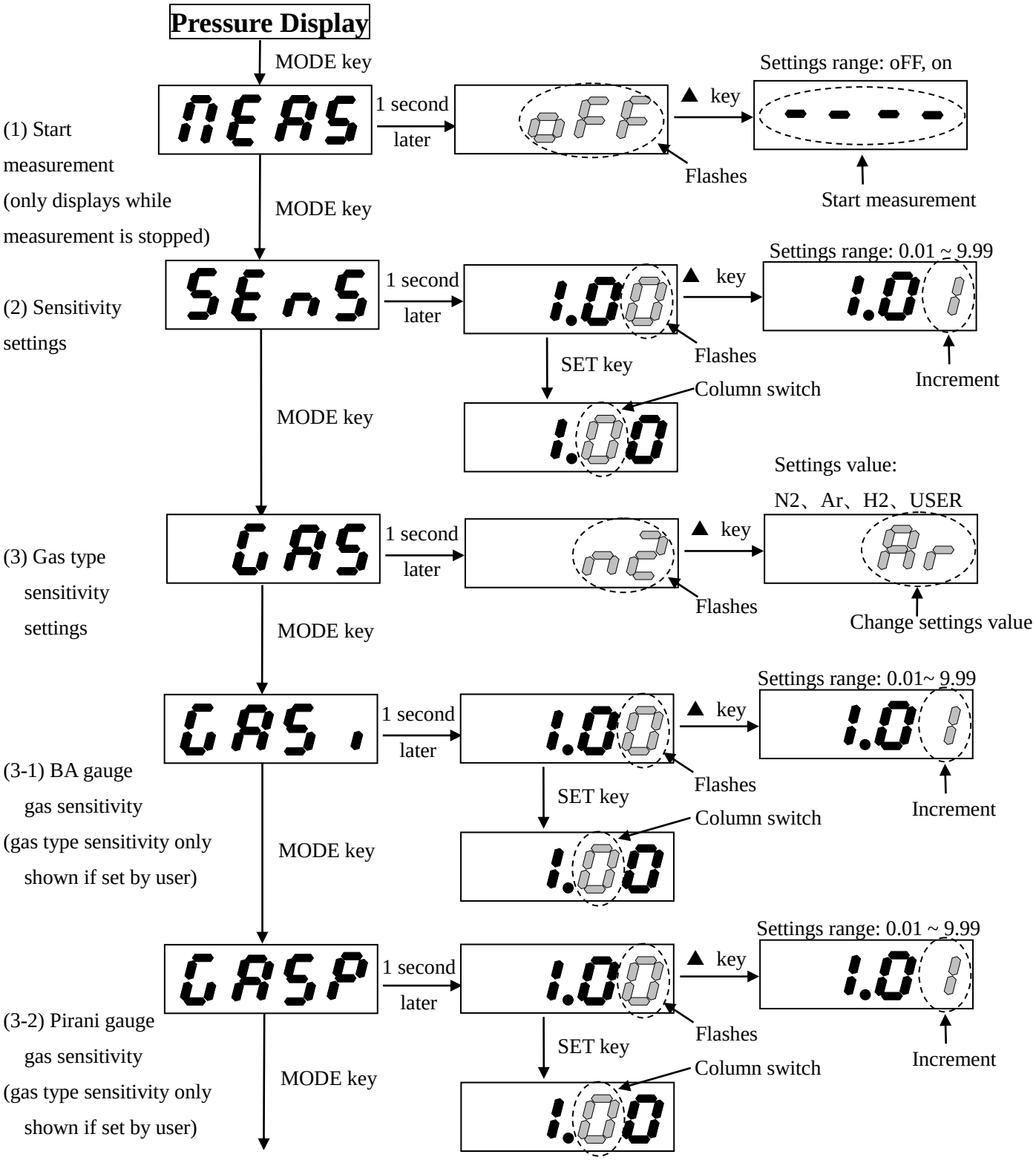
8.2. Key Setting Items

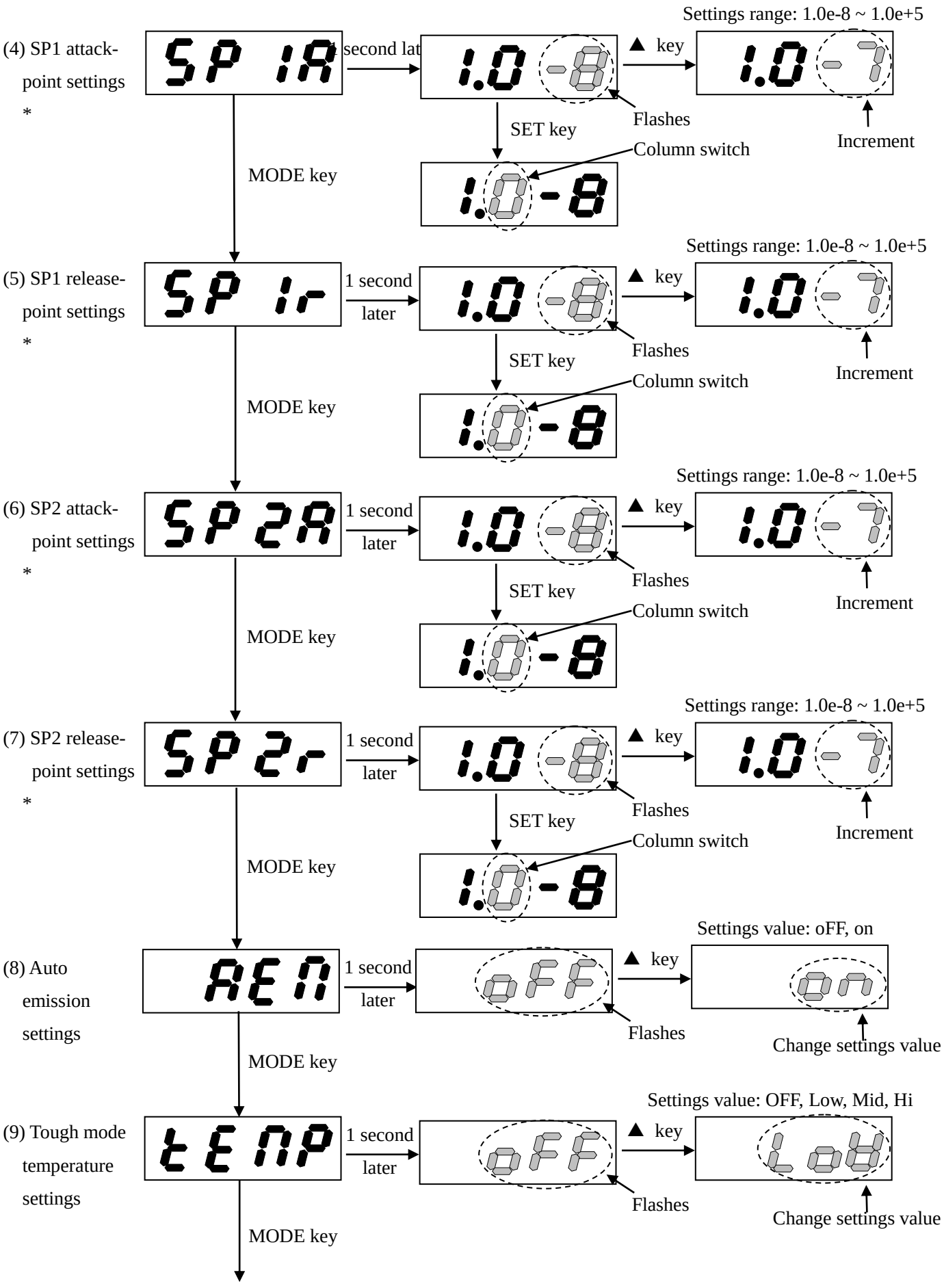
Pressing the MODE key during measurement or while measurement is stopped will cause the status indicator to light up in purple and each setting item will be displayed on the seven segments.

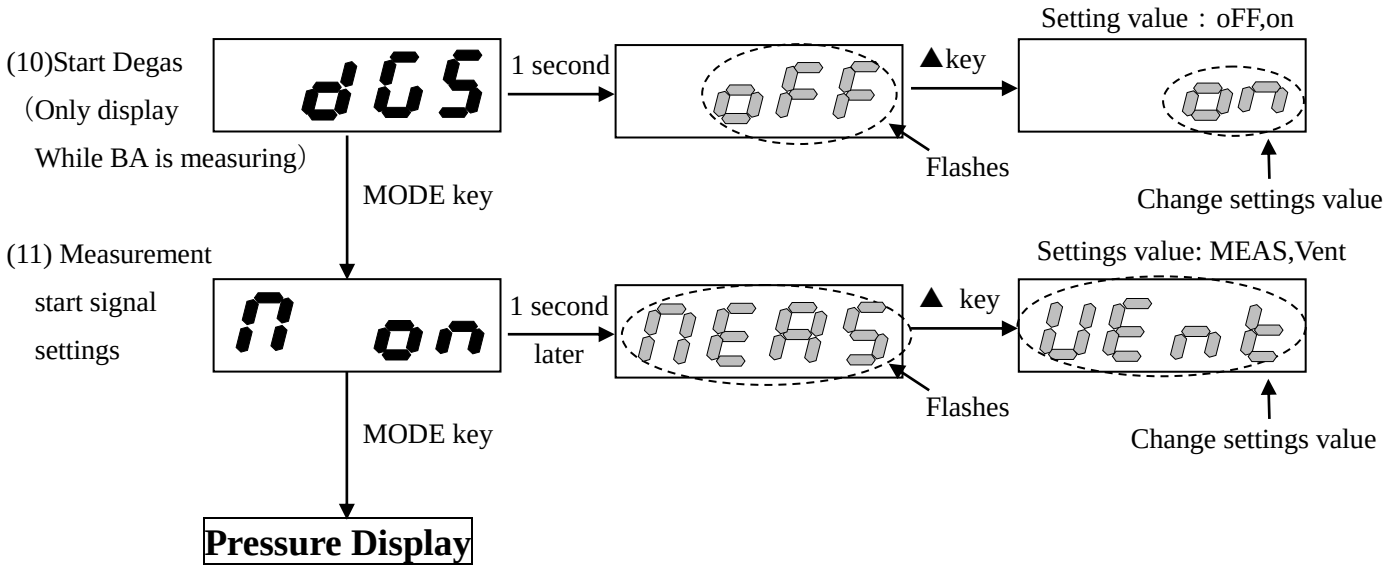
The setting item will change every time the MODE key is pressed.

Waiting over the setting item that you would like to set for around a second without pressing the key will switch to the settings screen. On the settings screen you can change the number value or the settings value with the ▲▼ keys and switch columns with the SET key.

(The below example display is for when units are set to “Pa”)




Settings range: 1.0e-8 ~ 1.0e+5
(4) SP1 attack-point settings *
SP 1A
1 second lat
▲ key
Flashes
SET key
Column switch
Increment
MODE key
Settings range: 1.0e-8 ~ 1.0e+5
(5) SP1 release-point settings *
SP 1r
1 second later
▲ key
Flashes
SET key
Column switch
Increment
MODE key
Settings range: 1.0e-8 ~ 1.0e+5
(6) SP2 attack-point settings *
SP 2A
1 second later
▲ key
Flashes
SET key
Column switch
Increment
MODE key
Settings range: 1.0e-8 ~ 1.0e+5
(7) SP2 release-point settings *
SP 2r
1 second later
▲ key
Flashes
SET key
Column switch
Increment
MODE key
Settings value: oFF, on
(8) Auto emission settings
AEn
1 second later
▲ key
oFF
Flashes
Change settings value
MODE key
Settings value: OFF, Low, Mid, Hi
(9) Tough mode temperature settings
tEnP
1 second later
▲ key
oFF
Flashes
Change settings value
MODE key



* Please ensure that the set-point is always set so attack-point < release-point.

8.3. Setting Items

8.3.1. Sensitivity Settings

The BA gauge sensitivity will be set. Please compare with the reference pressure gauge and match the pressure to it if necessary.

The calculation style for pressure is “Pressure = measured pressure × sensitivity”.

(Set to 1.0 at time of sending out.)

* Can be set by key operation or commands.

8.3.2. Gas Type Settings

A unique sensitivity factor will be set for each different gas type to be measured. Please choose from the settings N_2, Ar, H_2, and USR. If USR is selected, you can freely set the comparative sensitivity factor. The comparative sensitivity factor for when you change all gas type values to N_2 will be output the result calculated in the following style. (Set to N_2 at the time of sending out).

Output pressure = measured pressure × comparative sensitivity factor

(Set to 1.0 at time of sending out.)

* Can be set by key operation or commands.

Table 2. Gas Type Settings

Gas Type	N_2	Ar	H_2	USR
BA gauge comparative sensitivity factor	1.00	0.83	2.7	0.01 to 99.99 (optional)
Pirani gauge comparative sensitivity factor	1.00	1.93	0.83	0.01 to 99.99 (optional)

8.3.3. Set-Point (Setting the Set-Point)

A signal will be output when the set-point falls below the set measurement pressure. This can be used to control functions such as the opening and closing of the gate valve in the vacuum equipment.

There are two types of settings for the set-point setting values, the Attach Point and the Release Point. The Attack Point is the setting value that turns the signal output on, and the Release Point is the setting value that turns the signal output off. (See “Fig. 13. Set-Point Signal Output”)

The set-point is dual-equipped, meaning you can set the attack-point and release-point separately.

(Default settings: Attack Point: 1.0 x 10-8Pa for both set-points 1 and 2, Release Point: 1.0 x 10-8Pa)

* Be sure to set so that the Attack Point is smaller than the Release Point. If the Attack Point and Release Point are equal, the set-points are disabled.
* Can be set by key operation or commands.

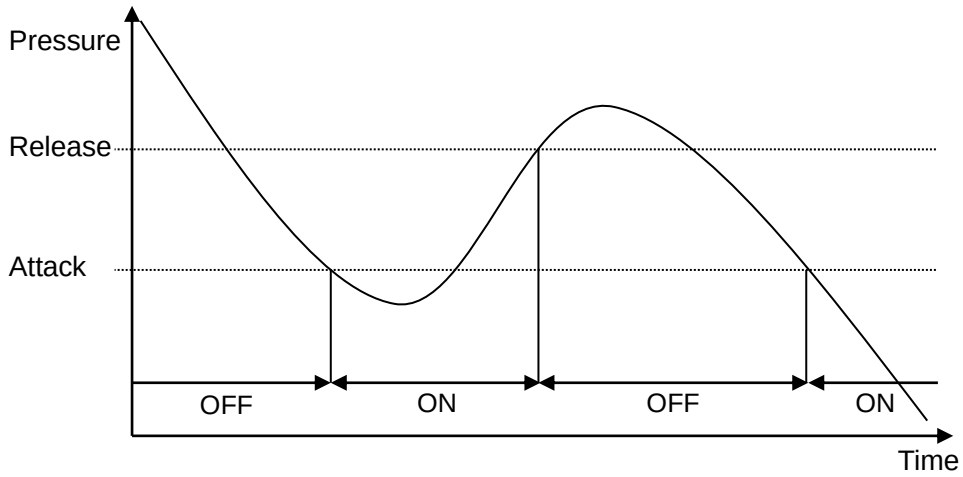


Fig. 13. Set-point Signal Output

The external output signal will turn on if the measurement pressure falls below the attack-point (refer to “4.1.5 D-sub Connector Pin Configuration”).

The external output signal will turn off if the measurement pressure goes above the release-point.

8.3.4. Auto Emission Settings

Whether or not the Pirani gauge automatically switches to the BA gauge will be set. The sensor type (refer to “8.3.8 Sensor Type Settings”) can only be set during combination mode.

(Set to on at time of sending out.)

* Can be set by key operation or commands.

8.3.5. Tough Mode (Tough Mode Temperature Settings)

Tough mode being on or off, the collector electrode heating temperature, and grid electrode heating temperature will be set. The temperature can be set to “Low”, “Mid”, or “Hi”. (Set to Mid at time of sending out.)

* Can be set by key operation or commands.

8.3.6. Output Control (Output Voltage Setting)

The format of the 0 - 10V analog signal output as the measured pressure value can be set.

LOG (logarithm) and LIN (compound linear) can be set for the analog signal. They should be set in accordance with the required use. (Default setting LOG)

* For details on the setting method, see the “TG Viewer Instruction Manual” or the “Command Manual”.

- Analog Signal Output

The analog signal uses the analog out terminal and outputs a voltage from 0 to 10V.

When $1\times10^{+5}$Pa (750Torr, 1000mbar) pressure is measured, it will output 8.6V. While measurement is stopped, it will output 0V. The output will be 10V, when there is an abnormality.

1. LOG (Logarithm)

The measurement pressure value from the analog out will output voltage as a compressed logarithm. When pressure is 1×10^{-8}Pa (7.5×10^{-11}Torr), the output will be 0.8V. When pressure is 1×10^{-7}Pa (7.5×10^{-10}Torr), the output will be 1.4V. In this way, as each column rises the output voltage will increase by 0.6V.

If you make the measurement pressure P,

Analog out = log (P) ×0.6+C[V]

(Pa: C=5.6, Torr: C=6.875, mbar: C=6.8)

the analogue out output voltage can be calculated with this calculation style.

You can backwards calculate the pressure from the voltage with the calculation style $P=10^{((\text{Analog out}-C)/0.6)}$.

Example 1. Calculation While Selecting LOG

1) When 2.74×10^{-4}Pa

Analog out: $\log(2.74\times10^{-4})\times0.6+5.6 \fallingdotseq 3.463$V

2) When 2.74×10^{-4}Torr

Analog out: $\log(2.74\times10^{-4})\times0.6+6.875 \fallingdotseq 4.738$V

3) When 2.74×10^{-4}mbar

Analog out: $\log(2.74\times10^{-4})\times0.6+6.8 \fallingdotseq 4.663$V

Example 2. Backwards Calculation While Selecting LOG (When Analog Out = 4.437V)

1) When Pa

Pressure: $10^{((4.437-5.6)/0.6)} \fallingdotseq 1.15\times10^{-2}$[Pa]

2) When Torr

Pressure: $10^{((4.437-6.875/0.6)} \fallingdotseq 8.64\times10^{-5}$[Torr]

3) When mbar

Pressure: $10^{((4.437-6.8)/0.6} \fallingdotseq 1.15\times10^{-4}$[mbar]

2. LIN (Linear)

When set to linear output, the relationship between the pressure (unit: Pa) and voltage output by analog out is as follows. The calculation base for the pressure value will be the Pa pressure value regardless of unit settings.

According to the mantissa and exponent of the measurement pressure,

Analog out = (pressure mantissa × 1/20) + (pressure exponent + 13) / 2[V]

the analogue out output voltage can be calculated with this calculation style.

Example) When calculating while LIN is selected

When $2.74\times10^{+2}$Pa

Analog out: (2.74×1/20)+(2+13)/2 ≒ 7.637V

For the relationship between measurement pressure and analog out voltage during all settings, please refer to Fig. 14 to Fig. 15.

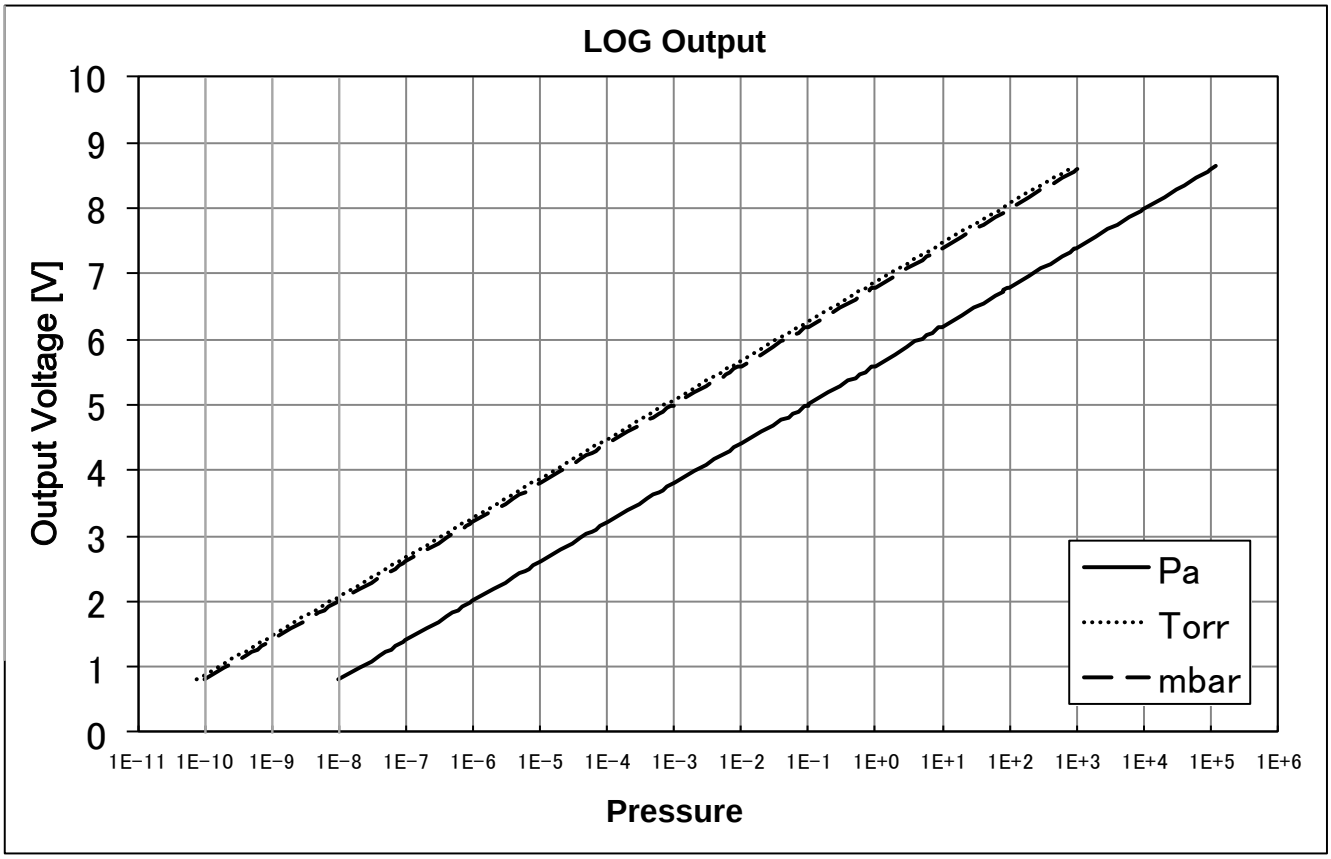


Fig. 14. LOG Output

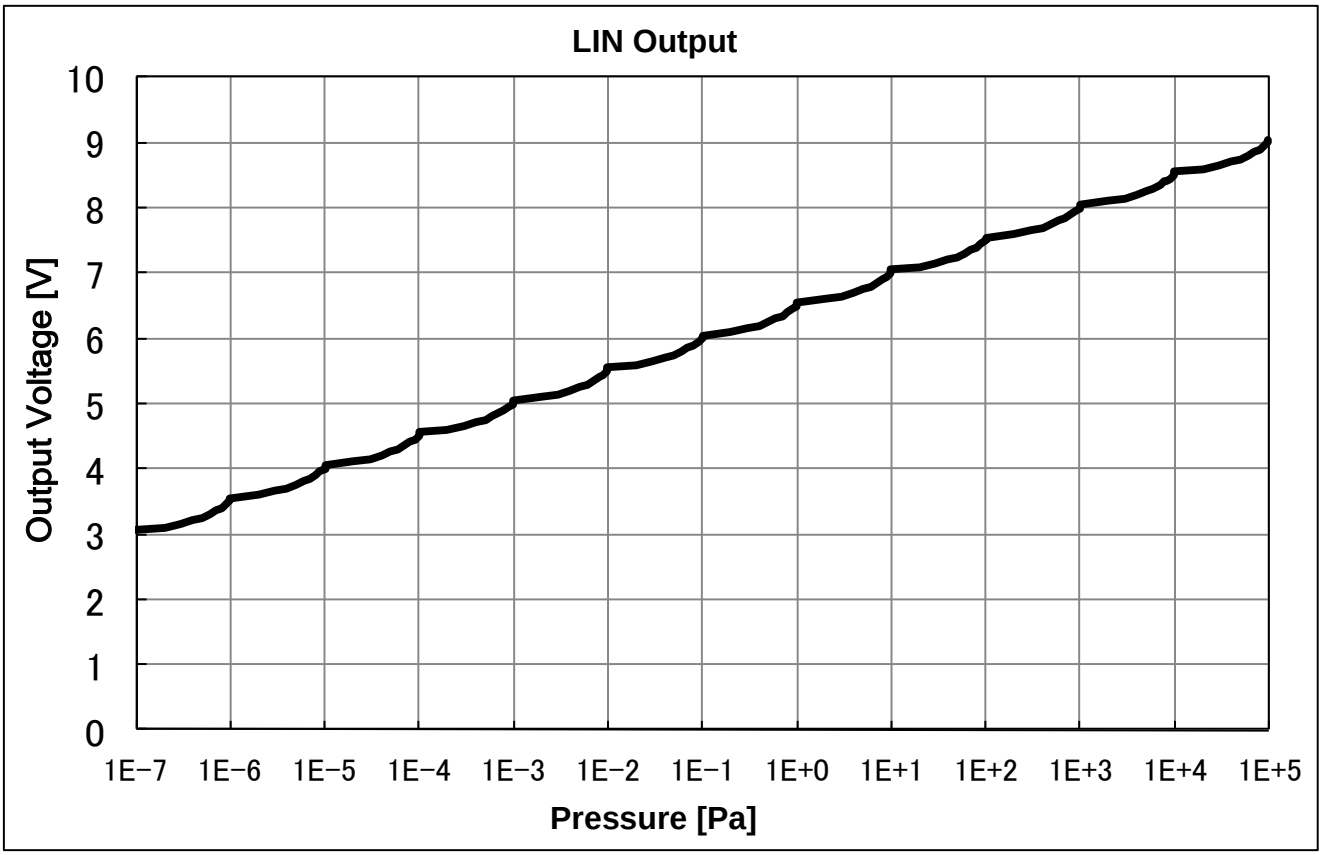


Fig. 15. LIN Output (Pa)

8.3.7. Units (Pressure Unit Settings)

The pressure units can be chosen from Pascal (Pa), Torr, and millibar (mbar). When you change units, set-points 1 and 2 will automatically change setting values, so there is no need to reset them.

(Set to Pa at time of sending out.)

* For setting methods, please refer to the “TG Viewer” instruction manual or the “Command Manual”.

8.3.8. Sensor Type Settings

The sensor type and measurement methods can be set to combination mode or single mode. The combination mode uses both the Pirani gauge and the BA gauge to measure pressure. Single mode uses only the BA gauge to measure pressure. Selecting single mode makes it possible to use a sensor worn out by the Pirani filament.

(Set to combination at time of sending out.)

* For setting methods, please refer to the “TG Viewer” instruction manual or the “Command Manual”.

8.3.9. Measure Control (Signal Settings for Measure On)

The Measure On signal operations will be set. The operations can be set are the following two: 1) measurement start/stop, 2) forced Pirani switch.

If “measurement start/stop” is set, measurement will start due to the Measure On signal input, and measurement will continue while the signal is being input. When the signal turns off, the measurement will stop.

If “forced Pirani switch” is set, the device will switch to the Pirani gauge due to the Measure On signal input if the BA gauge was in operation. (If the Pirani gauge was in operation, the Pirani gauge measurements will just continue.) While the signal is being input, the Pirani gauge measurement will continue and even if a high vacuum is reached the device will not switch to the BA gauge. If the signal is turned off, the device will automatically switch to the BA gauge during a high vacuum. During an atmospheric vent or otherwise, please adjust the settings if you would like to fix it to the Pirani gauge.

(Set to measurement start/ stop at the time of sending out.)

* For setting methods, please refer to the “TG Viewer” instruction manual or the “Command Manual”.

8.4. Setting Values List

The setting value at time of sending out and setting range of each setting item is below in “Table 3. Setting Values List”.

Table 3. Setting Values List

Setting Item	Setting Value at Time of Sending out	Setting Value Range
Sensitivity	1.00	0.01 to 9.99
Gas Type	N_2	N_2, Ar, H_2, USR [0.01 to 9.99]
Set-Point 1 Attack	1.00E-08Pa (No effect since the attack-point and release-point are the same value)	1.0E-08Pa to 1.0E+05Pa 7.5E-11Torr to 7.5E+02Torr 1.0E-10mbar to 1.0E+03mbar
Set-Point 1 Release		
Set-Point 2 Attack		
Set-Point 2 Release		
Auto Emission	ON	ON, OFF
Tough Mode	Mid	OFF, Low, Mid, Hi
Output Control	LOG	LOG, LIN
Unit	Pa	Pa, Torr, mbar
Sensor Type	Combination	Combination, Single

9. Communication Interface

By connecting the TG301CD to a PC with an RS232C cable, it is possible to undertake tasks such as monitoring of acquired pressure logs and TG301CD operations by serial command and Windows application “TG Viewer”. For information on serial commands, please refer to the “Command Manual”. Please contact Mirapro. about“TG Viewer”.

Additionally, if you connect the Tough Gauge Display (TGDISP100), which is sold separately, you can use the RS232C to show the TG301CD’s measurement pressure on the display. For information on the Tough Gauge Display, please refer to the instruction manual for the display.

By connecting the Tough Gauge Display to a PC with a (commercially-available) USB cable, it is possible to undertake tasks such as the monitoring of pressure and TG301CD operations. If using the Tough Gauge Display as an intermediary to connect to a PC, please do so by using “TG Display Viewer”. Please contact Mirapro. about “TG Display Viewer”.

9.1. RS232C

Table 4. RS232C Communication Specifications

Item	Specifications
Communication System	Full duplex, start-stop system
Bitrate	38,400bps
Data Bit	8 bit
Parity Bit	None
Stop Bit	1 bit
Flow Control	None

10. Troubleshooting

If the TG301CD is operating incorrectly or you suspect there is a failure, please begin by referring to the following items.

Table 5. Troubleshooting

Symptom	Possible Cause and Solution
Cannot change the set-point value.	・ When setting to a low pressure, change the setting from the Attack Point first. When setting to a high pressure, change the Release Point settings first. * The set-point settings cannot be set so that Attack Point ≦ Release Point. (See "Fig. 13. Set-point Signal Output")
Set-points do not operate.	・ It is possible that the set-points are disabled when the Attack Point is equal to the Release Point.
The ALM (alarm) display is flashing in red and pressure cannot be measured.	・ Turn the power off and then restart the device. ・ Measure again after thorough ventilation. *In single mode, pressure of 10Pa or above cannot be measured. ・ Check that the sensor is correctly connected to the controller. *The sensor has a polarity. ・ Check that the Pirani filament is not broken. The resistance of normal Pirani filament at regular temperature will be around 30Ω. (Will change depending on the temperature.) ・ Directly after ending measurement, it is possible for an error to occur when the sensors become hot. Please repower the device after waiting for a little. ・ Replace the sensors.
The ALM display is flashing in yellow.(Measurement continue.)	・ Turn the power off and then restart the device. ・ Turn the power off and then check the power supply voltage.
The pressure will not stabilize.	・ Check the connection between the sensors and the controller. ・ It is possible that the actual pressure is changing, so check that the vacuum equipment does not have a leak. ・ Replace the sensors. ・ Sputter equipment or otherwise can be influenced by plasma.
The actual pressure and the displayed pressure are different.	・ Degas, since there might be gas stuck to the sensors. ・ Check the connection between the sensors and the controllers. ・ Check the sensitivity settings. ・ Check the gas type settings.
Cannot start or stop pressure measurement.	・ If a sensor error occurs, you will be unable to start measurement. After turning off the power, check the sensor connection and if the electrodes are broken, eliminate the cause of the error, and then turn the power back on.
Measurement does not start when the power is turned on.	・ Check that the Sensor Type settings are not on "single". ・ Check the Measure On Signal.
The pressure is lowering but the device will not switch to the BA gauge.	・ Turn the auto emission settings on. ・ Even if the actual pressure is lowered, if the measurement temperature value is not 5Pa or below, it is possible for the Pirani gauge's zero point to be wrong. Please make high vacuum adjustments by following "6.3.1.2 High Vacuum Adjustments".

Table 6. Alarm List

Alarm Code	Details	Cause	Solution
001	EMISSION ERROR	Pressure is high.	Please check that the pressure is within the measurement range.
		Filament is broken or stained.	Please replace the sensors.
002	OVER PRESSURE	Pressure is high.	Please check that the pressure is within the measurement range.
004	FILAMENT ERROR	Filament is broken or stained.	Please replace the sensors.
008	GRID BIAS ERROR	Electrode is short-circuited.	Please replace the sensors.
010	HEATER ERROR	Cannot use tough mode or degas heating.	The grid electrodes or collector electrodes are stained or broken and unable to heat up. By setting to tough mode (refer to "7.4 Tough Mode") it is possible to undertake pressure measurement again. However, due to stains or broken to the electrodes, it is not possible to undertake correct pressure measurement, so please change the sensors as soon as possible.
020	OVER TEMP	The temperature is high.	Please cool the TG301CD and the area around the flange.
080	SELF CHACK ERROR	Abnormality in AD converter.	Please turn the power off and on and restart the TG301. If it occurs frequently, there might be an abnormality in the circuit.
100	SENSOR ERROR	Abnormality in sensors or abnormality in connection.	Please refer to "7.9 Sensor Check".
200	PARAMETER ERROR	Abnormality in setting values.	Please turn the power off and on and restart the TG301. Please issue a factory settings reset command.
400	FLASHMEMORY ERROR	Abnormality in flash memory.	Please turn the power off and on and restart the TG301. Please issue a factory settings reset command.
410	E2PROM ERROR	Abnormality in E2PROM.	Please turn the power off and on and restart the TG301. Please issue a factory settings reset command.
810	OUT OF MEMORY	Abnormality in memory.	Please turn the power off and on and restart the TG301. Please issue a factory settings reset command.
820	SERIAL ERROR	Abnormality in communication.	Please check the communication device and wiring. Please check that there is no noise impression on the communication wiring.

Table 7. Warning List

Warning Code	Details	Cause	Solution
040	POWER ERROR	Abnormality in power voltage.	Please check the input voltage. If there is no abnormality in the input voltage, it is possible that the controller is damaged.
800	BUFFER FULL	Alarm log overflow	Please turn the power off and on and restart the TG301.

MIRAPRO

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