KEYENCE

96M0723

Separate Amplifier Type Pressure Sensor
AP-40(P) Series

Instruction Manual

FEATURES

- **Separate amplifier-type pressure sensor**
  Faster response is achieved by reducing the total capacity of piping.
- **Two-color, LED digital display**
  High-intensity, two-color LED ensures high visibility. Four types of display patterns are selectable.
- **Chattering prevention function**
  The instantaneous drops in base pressure due to the activation of a large-bore ejector or other devices can be canceled. This eliminates the need for preparing a sequence program.
- **Automatic sensor head recognition function**
  When the power is turned on, the amplifier checks the sensor head connection automatically. A recognized sensor head type appears green on the display for 0.5 seconds.
- **Industry's smallest and lightest sensor head (AP-41M)**
  This sensor head with half the volume of conventional models weighs only 4.8 g, enabling flexible mounting.
- **High-resolution mode (AP-40R)**
  The resolution can be multiplied temporarily by 10 to stabilize detection of minute differential pressure.
- **Zero-shift function (AP-40R, 40Z)**
  The current pressure value can be reset to 0 at any time in order to prevent measurements from being affected by fluctuations in base pressure.

PART NAMES AND FUNCTIONS

■ Amplifier

AUTO key
In auto-tuning mode, use this key to detect pressure. In measurement mode, press this key for 2 seconds or more to adjust the zero-point.

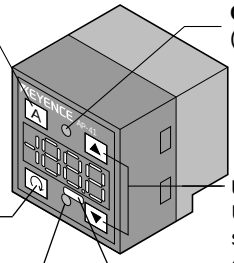
SET key
Use this key to display or change preset values.

Output indicator 2
(Green LED)

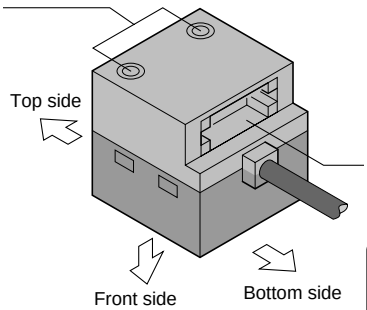
Output indicator 1
(Red LED)

UP/DOWN key
Use these keys to set output modes, or to change preset values or units.

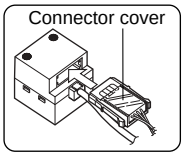
Display unit label



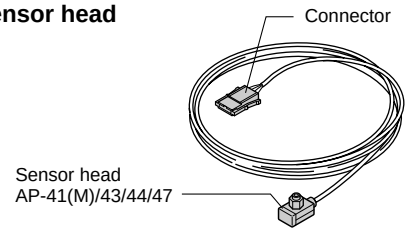
Screw hole
Use this hole to bolt the mounting bracket with a hexagonal socket bolt.



Connector port
Insert the sensor head connector.



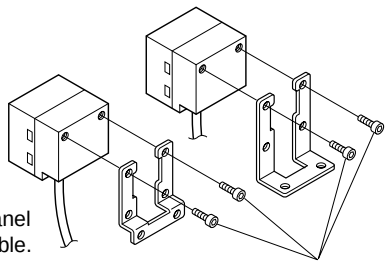
■ Sensor head



Amplifier accessories

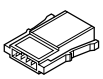
- Instruction manual: 1
- Mounting bracket A: 1
- Mounting bracket B: 1
- Hexagonal socket bolt: 2

Reference:
DIN-rail mounting or panel mounting is also available. (Optional brackets are required.)



Sensor head accessories

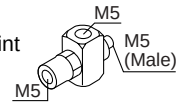
Spare connector: 1



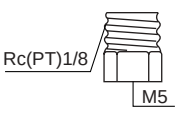
Mini-wrench: 1
(for AP-41M only)

Piping options

OP-33155
Screw pipe joint

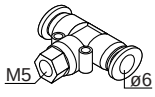


OP-35388
PT 1/8
conversion
joint

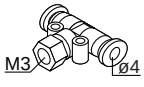


OP-33156
T-shaped quick-release joint (ø4)

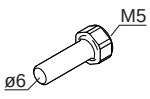
OP-33157
T-shaped quick-release joint (ø6)



OP-42220
T-shaped quick release joint (M3)



OP-33158
Reducer



MOUNTING

■ AP-40/40R/40Z

As shown in the figure with "Amplifier accessories" on page 1, attach the mounting bracket to the amplifier with hexagonal socket bolts. The mounting bracket can be attached laterally according to the location.

⚠ CAUTION ***To avoid breakage, limit the tightening torque for the hexagonal socket bolt to 0.3 N•m.***

■ AP-41(M)/43/44

⚠ CAUTION ***Limit the tightening torque for the screw hole of the sensor head to 0.3 N•m.***

■ AP-47

- The AP-47 is designed to detect slight pressure difference. Therefore, do not apply excessive pressure.
- Securely connect a flexible tube with a 4.4-mm outer diameter pressure port.
- To avoid deformation or damage during mounting, do not apply any force to the sensor body.
- Be sure to connect the "High" pressure port to the high-pressure side, and the "Low" pressure port to the low-pressure side.
- Be careful not to damage the two pressure ports. If one pressure port is to be left open, ensure that foreign objects do not enter the port.

■ Zero-point adjustment

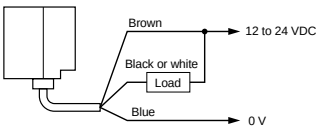
At normal atmospheric pressure (1 atm.), press A for at least 2 seconds in measurement mode. The display changes to "----", then to "0". The zero adjustment function can be used when the pressure is within ±5% of F.S.

CONNECTIONS AND INPUT/OUTPUT CIRCUIT

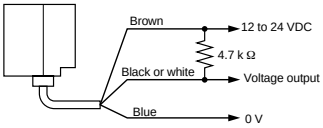
AP-40/40R/40Z

■ Connections

- **Drive current load**

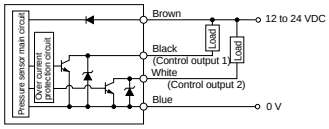


- **Input to voltage input equipment**



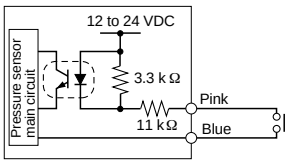
■ Input/output circuit

- **Output circuit**



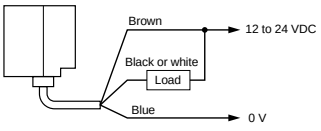
AP-40R/40Z (R/Z type only)

- **Input circuit (Zero-shift input)**
  Zero-shift input resets the display to "0" at the rising edge of the signal.

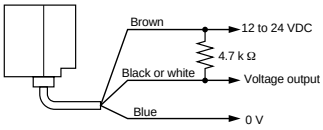


AP-40P

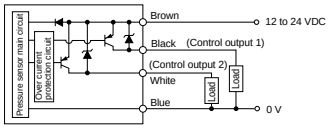
- **Drive current load**



- **Input to voltage input equipment**

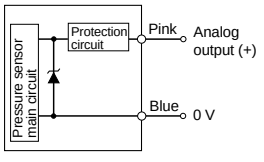


- **Output circuit**



AP-40/40P (40/40P type only)

- **Analog output circuit**



BASIC OPERATION

Basic operation (See also "ADJUSTMENT" on page 4.)
<Example>

● Checking the suction condition

1. Select F-3 (2-independent mode) and return to the measurement mode.
   ➪ Refer to the setting in **"Operation Mode"** on the left-hand side of page 4.
2. Enter the target pressure value (A) and return to the measurement mode. (You can specify another target pressure value (b).)
   ➪ Refer to the setting in **"Preset Value Input Mode"** on the right-hand side of page 4.
3. Start detection.

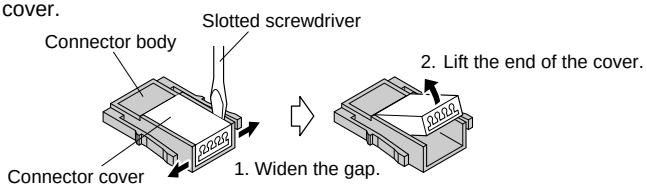
● Base pressure control

1. Select F-4 (Window mode) and return to the measurement mode.
   ➪ Refer to the setting in "Operation Mode" on the left-hand side of page 4.
2. Enter the upper (H) and lower (L) limit values of the allowable pressure and return to the measurement mode.
   ➪ Refer to the setting in **"Preset Value Input Mode"** on the right-hand side of page 4.
3. Start detection.

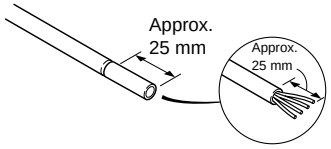
ATTACHING A SPARE CONNECTOR

Use the spare connector to change the length of the sensor head cable. Cables as long as 10 m can be used.

1. If the connector cover is fitted into the connector body, open the cover.



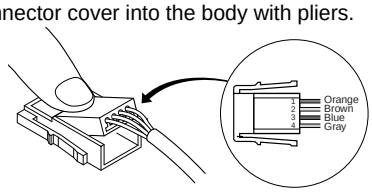
2. Cut a cable to the appropriate length and strip off the sheath for approximately 25 mm from the end.



Note: It is not necessary to remove the sheath of the core wire.

3. Insert the cables into the proper holes as deep as possible. Then, press the connector cover into the body with pliers.

Reference:



Note 1: Do not allow the cable to protrude from the other end of the connector cover.
Note 2: Ensure that the cables are inserted as far as they will go. If the inserted length is insufficient, the press-fitting fails.

SAFETY PRECAUTIONS

Be sure to follow the instructions below to avoid malfunctions.

⚠ CAUTION

■ Connection

- When using a commercially available switching regulator, be sure to ground the frame ground terminals.
- Isolate the sensor's wiring from power lines or high-voltage lines; otherwise, the sensor may malfunction due to noise interference.
- The amplifier becomes hot or breaks down due to improper wiring.
- The press-fitting is available only once for each sensor head connector.

■ Other

- Do not use the AP-40 Series for the detection of corrosive gases or liquid.
- Do not insert any objects, such as wires, from the pressure port. The pressure-sensing element may break, resulting in malfunctions.
- Do not press the front panel keys with a pointed object.
- The AP-40 Series does not have an explosion-proof structure. Do not use it for the detection of flammable gases.

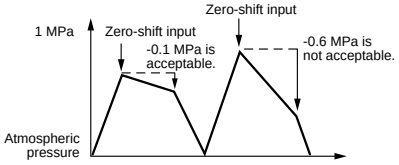
OTHER FUNCTIONS

■ Zero-shift function (AP-40R/40Z type only)

The zero-shift function is used to reset the current pressure value to "0" using an external signal input, in order to prevent measurements from being affected by fluctuations in base pressure.

Example: Leakage test

Input a zero-shift value after air supply is completed so that air leakage after a specified time is displayed as a negative value. The AP-40's detection is unaffected by fluctuations in air supply volume.



When the power is turned off, the value updated after the zero-shift input (zero-shift value) is lost.

Note 1: The zero-shift function cannot be used in auto-tuning mode.
Note 2: The zero-shift input is effective when the current pressure is between -3% of F.S. and 100% of F.S. for a shift of 0 (P = 0).
Note 3: If the applied pressure is outside the range of -15% to 110% of the rated pressure, "-FFF" or " FFF" appears.
Note 4: The display range for the zero-shift focus mode is ±19.9%. When the pressure value is out of this range, "-FF" or "FF" is displayed.

■ Analog output function (AP-40 only)

The voltage value according to the pressure value is output.

	1 V	to	5 V
AP-41(M)	0	to	-101.3 kPa
AP-43	0	to	+1.000 MPa
AP-44	+101.3	to	–101.3 kPa
AP-47	0	to	+2 kPa

■ Peak-hold/bottom-hold display function

The AP-40 Series internally updates the peak-hold and bottom-hold values at all times.

● **To display hold values**
- While ▲ is held down in measurement mode, the peak-hold value is displayed.
- While ▼ is held down in measurement mode, the bottom-hold value is displayed.

● **To reset the peak-hold and bottom-hold values**
- Hold down ▲ and press ▼ in measurement mode.

● **The peak-hold and bottom-hold values are also reset using the following procedure.**
- Turn the power off.
- Press ◯ for 3 seconds or more and change any settings.

Note: The hold values cannot be displayed when the front panel keys are locked with the key protection function. Disable the function before displaying the hold values.

■ Key protection

The key protection function is used to lock the front panel key in order to prevent preset values from being accidentally changed.
To enable the key protection function, hold down A and press ▲. "Loc" flashes for 2 seconds and the keys are locked.
To disable the key protection function, again hold down A and press ▼. "UnL" flashes for 2 seconds and the keys are unlocked.
Using the **EEPROM**, the AP-40 Series can retain the preset values even if the power is turned off.

■ Display color selection

You can set the color of the LED display either to the two-color mode which displays the numerical value in green or red according to OUT1, or to the single color mode which always shows the value in red or green. The two-color display allows you to check the output condition at a glance. (Refer to "ADJUSTMENT" on page 4 for the setting procedure.)
In two-color mode (2-C) (Regardless of N.O./N.C. selection)
- When OUT1 is turned on: Red
- When OUT1 is turned off: Green

ERROR INDICATIONS AND REMEDIES

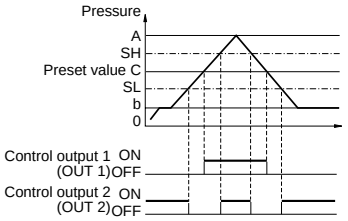
Error indication	Problem	Remedy
E	Zero-point adjustment was executed at a pressure of ±5% or more of F.S.	Perform zero-point adjustment at normal atmospheric pressure.
Ec	Overcurrent through OUT1 or 2	Turn power off and adjust the load so that the current is within the rated range.
FFF -FFF FF -FF	Applied pressure was outside of the display range. *(FF or -FF appears when the zero-shift focus mode is used.)	Adjust the pressure to within the rated range.
EH	The sensor head is not connected or the connecting cable has a break.	Connect the sensor head and turn on the power again.

OPERATION MODE SELECTION

■ Auto-tuning mode (F-1)

Using the AUTO key, detect the upper limit value (A) and the lower limit value (b). The detection level (C) is automatically set at the midpoint between the two values. (You can finely adjust the preset value C within the range between A and b.)

Control output 1: The sensor turns on when the pressure exceeds the preset value C.
Control output 2: The sensor turns on when the pressure goes outside the stability levels.



* The stability levels are automatically set as shown in the following calculations.

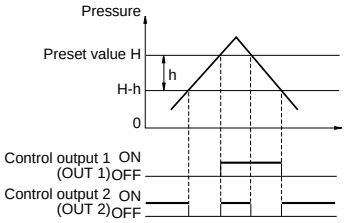
$$SH = \frac{(A + C)}{2}$$

$$SL = \frac{(C + b)}{2}$$

■ Hysteresis mode (F-2)

Set desired detection level (H) and hysteresis (h) for the detection.

Control output 1: The sensor turns on when the pressure exceeds the preset value H. When the pressure falls by the preset value h, the sensor turns off.
Control output 2: The sensor turns on when the pressure goes outside the hysteresis width (H - h).

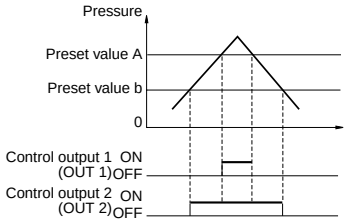


h: Hysteresis width of OUT1
* When h is set to a value close to 0, if pressure fluctuates around the detection point, OUT1 will chatter.

■ 2-independent mode (F-3)

Set two desired detection points (A and B).

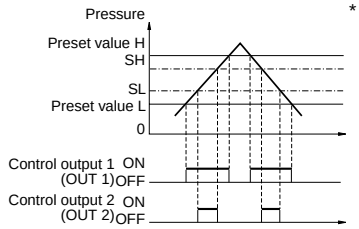
Control output 1: The sensor turns on when the pressure exceeds the preset value A.
Control output 2: The sensor turns on when the pressure exceeds the preset value b.



■ Window mode (F-4)

Set desired upper limit value (H) and lower limit value (L).

Control output 1: The sensor turns off when the pressure goes outside of the range between the upper limit value (H) and lower limit value (L).
Control output 2: The sensor turns off when the pressure goes outside of the stability levels.



* The stability levels are automatically set as shown in the following calculations.

$$SH = H - \frac{(H - L)}{4}$$

$$SL = L + \frac{(H - L)}{4}$$

Note 1: The above description shows the operation of control outputs 1 and 2 when the output selector switch is set to N.O.
When the output selector switch is set to N.C., the operation of control outputs 1 and 2 is inverted.
Note 2: Except for OUT1 in hysteresis mode, each control output includes an internal hysteresis of 0.5% of F.S.

ADJUSTMENT

Press the button for 3 seconds or more.

Measurement mode

Press the button once.

■ Unit Setting

Determine the desired units.

In measurement mode, press [◯] for at least 3 seconds. "- - - -" appears first, and then the current units are displayed. Use [▲] or [▼] to select the desired units. Pressing [◯] completes the unit setting procedure and enters operation mode selection.

Std	AP-41(M)/44: mmHg, AP-43: kgf/cm^2 AP-47: mmH_2O	PA	AP-41(M)/44: kPa, AP-43: MPa AP-47: kPa
Inch	AP-41(M)/44: inchHg, AP-43: Psi AP-47: inchH_2O	bAr	AP-41(M)/43/44: bar AP-47: mbar

* When the units are changed, the preset values are automatically converted to appropriate values for the updated units.

Press the button once.

■ Operation Mode

Determine the desired operation mode.
(⇨ Refer to "OPERATION MODE SELECTION" on page 3.)

The current operation mode is displayed. Use [▲] or [▼] to select the operation mode. Pressing [◯] completes the operation mode setting procedure and enters N.O./N.C. selection.

F-1	Auto-tuning mode	F-3	2-independent output mode
F-2	Hysteresis mode	F-4	Window mode

Press the button once.

■ N.O./N.C. Selection

Select N.O. (normally open) or N.C. (normally closed).

The current selection of "no" (normally open) or "nc" (normally closed) is displayed. Use [▲] or [▼] to select the desired mode. Pressing [◯] completes the N.O./N.C. selection procedure and enters the chattering prevention setting.

Press the button once.

■ Chattering Prevention

Determine the desired response time.

The current response time is displayed. Use [▲] or [▼] to select the response time. Pressing [◯] completes the setting procedure and enters the display color selection.

* AP-47: 100, 500 ms

2.5	2.5 ms
5	5 ms
100	100 ms
500	500 ms

Press the button once.

■ Display Color Selection

Determine the desired LED color for numerical value display.

The current color is displayed. Use [▲] or [▼] to select the color. Pressing [◯] completes the setting procedure and returns to the measurement mode.

* 1-d and 2-d can be selected with the AP-40R only.

1-C	Red LED only
2-C	Red/green LED (RED when output 1 turns ON)
1-d	Green LED only
2-d	Red/green LED 2 (Green when output 1 turns ON)

Press the button once.

■ Display Mode Selection (AP-40R only)

Determine the mode to display the pressure value.

The current display mode is displayed. Use [▲] or [▼] to select the display mode. Pressing [◯] completes the setting procedure and returns to the measurement mode.

* Accuracy is based on the rating even when the zero-shift focus mode is selected.

Lu	Normal display
10u	Zero-shift focus mode (10 times display)

Press the button once.
* The setting is saved in the EEPROM.

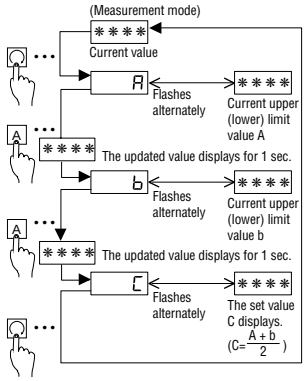
■ Preset Value Input Mode

Determine the preset values.

● Auto-tuning mode (F-1)

1. In measurement mode with the current measured value displayed, press [◯]. The AP-40 enters the preset value input mode.
2. "A" and the current preset value flash alternately.
3. Position the target at the desired upper (lower) limit.
4. Press [A] to register the value. The updated value is displayed for 1 second.
5. "b" and the current preset value flash alternately.
6. Position the target at the desired lower (upper) limit.
7. Press [A] to register the value. The updated value is displayed for 1 second.
8. "C" and the calculated preset value C flash alternately. (You can change the C value to any value between A and b using [▲] or [▼].)
9. Press [◯] to register the C value. The setting procedure is completed and the unit returns to measurement mode.

* To confirm the preset value, press [◯] repeatedly.



- **Example of auto-tuning mode setting: Confirmation of work piece pick-up.**

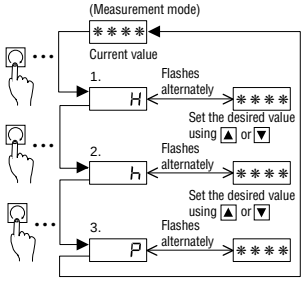
Set the upper limit (A) to the position where the work piece is taken. Set the lower limit (b) to the position where the nozzle becomes open after releasing the work piece. Press [A] to register the upper and lower limit values. The C value is automatically set to the midpoint between the upper and lower limit values.

■ Hysteresis Mode (F-2), 2-independent Output Mode (F-3), Window Mode (F-4)

[Example: In hysteresis mode]

1. In measurement mode with the current measured value displayed, press [◯]. The AP-40 enters the preset value input mode.
2. "H" [1.] and the current preset value flash alternately.
3. Use [▲] or [▼] to change the value to the desired value. Press [◯] to register the updated H value.
4. "h" [2.] and the current preset value flash alternately.
5. Use [▲] or [▼] to change the value to the desired value. Press [◯] to register the updated h value.
6. "P" [3.] and the shift value of the zero-shift adjustment flash alternately.
7. Press [◯] to complete the setting procedure and return to measurement mode.

* To confirm the preset value, press [◯] repeatedly.



1. "A" appears in the 2-independent output mode.
2. "b" appears in the 2-independent output mode. "L" appears in the window mode.
3. Shown with R/Z type only.

Press the button once.
* The setting is saved in the EEPROM.

Note 1: When the operation mode is changed, check the preset values in the preset value input mode.
Note 2: Perform the zero-shift adjustment periodically.
Note 3: The initial output voltage may fluctuate by ±1.0% immediately after the power is turned on. To measure minute differences in pressure, let the sensor warm up for approximately 15 to 30 minutes.
Note 4: The amount of zero shift ("P") is displayed without multiplication even in the zero-shift focus mode.

SPECIFICATIONS

Sensor head

Model	AP-41/41M	AP-43	AP-44	AP-47
Rated pressure	0 to -101.3 kPa (0 to -760 mmHg)	0 to 1 MPa (0 to 10 kgf/cm²)	+101.3 kPa to –101.3 kPa (760 to -760 mmHg)	0 to 2 kPa (0 to 204 mmHg)
Proof pressure	500 kPa	1.5 MPa	500 kPa	50 kPa
Fluid types	Air or noncorrosive gases			
Pressure type	Gauge pressure			Differential pressure gauge
Repeatability	±0.2% of F.S. max. (including amplifier)			±0.3% of F.S. max. (including amplifier)
Temperature fluctuation	±2% of F.S. max.			±3% of F.S. max.
Connection port diameter	M5 male screw (M3 male screw for the AP-41M only)			ø4.4 plastic port
Ambient temperature	0 to 50°C (32 to 122°F), No freezing			
Relative humidity	35 to 85%, No condensation			
Vibration	10 to 55 Hz, 1.5 mm double amplitude in X, Y, and Z directions, 4 hours respectively			
Shock	1000 m/s² in X, Y, and Z directions, 10 times respectively (Total: 60 times)			
Material	Housing: PBT, Screw: Stainless steel			Housing: Reinforced glass resin
Weight	AP-41M: 4.8 g (without cable), 67.8 g (including 3 m cable) AP-41/43/44: 7 g (without cable), 70 g (including 3 m cable)			13 g (without cable), 76 g (including 3 m cable)

Amplifier

Model	AP-40/40R/40Z			
Power supply	12 to 24 VDC±10%, Ripple (p-p): 10% max.			
Current consumption	105 mA (12 V), 55 mA (24 V) (including sensor head)			
Display	3 1/2-digit, 2-color, 7-segment LED (Character height: 11 mm), Display cycle: 5 times/sec.			
Detectable pressure range	-15% to +110% of F.S.			
Display resolution [3]	0.1 kPa, 1 mmHg, 0.1 inchHg 0.001 bar	0.001 MPa 0.01 kgf/cm² 0.2 Psi 0.01 bar	0.2 kPa 2 mmHg 0.1 inchHg 0.002 bar	0.01 kPa 1 mmH₂O 0.1 inchH₂O 0.1 mbar
Response time (chattering prevention function)	2.5/5/100/500 msec			100/500 msec
Zero-shift input (RA/ZA type only)	Non-voltage input (contact, solid-state), Input time: 20 ms or more			
Control output	NPN open-collector: 100 mA max. (40 V max.), Residual voltage: 1 V max. 2-output (N.O./N.C. selectable)			
Analog voltage output [1]	1 to 5 V			
Temperature fluctuation for display	±1.0% max. of F.S.			
Temperature fluctuation for analog output [1]	±2.0% max. of F.S.			
Ambient temperature	0 to 50°C (32 to 122°F), No freezing			
Relative humidity	35 to 85%, No condensation			
Vibration	10 to 55 Hz, 1.5 mm double amplitude in X, Y, and Z directions, 2 hours respectively			
Shock	100 m/s² in X, Y, and Z directions, 3 times respectively			
Material	Front housing: Polyamide, Front panel sheet: PET, Rear housing: Polysulfone, Cable: Oil-proof cabtyre cable			
Mounting	With supplied mounting bracket (2 types) or optional panel mounting bracket [2]			
Weight	80 g (including 2 m cable) (28 g without cable)			

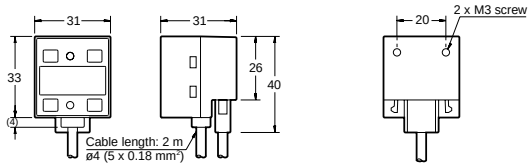
1. Not provided with the AP-40R or 40Z.
2. Optional panel mounting brackets: OP-31357 (black), OP-32808 (gray) and OP-42192 (for a 5 mm-thick panel)
3. Refer to the following table for the resolution in the zero-shift focus mode of the AP-40R.

Display range	±19.9% from the middle of the shift input value (within the sensor head rating)			
Display resolution	0.01 kPa	0.1 kPa (0.0001 MPa)	0.02 kPa	0.001 kPa
	1 mmHg	0.001 kgf/cm²	0.2 mmHg	0.1 mmHg
	0.01 inchHg	0.2 Psi	0.01 inchHg	0.001 inchHg
	0.1 mbar (0.0001 bar)	0.001 bar	0.2 mbar (0.0002 bar)	0.01 mbar

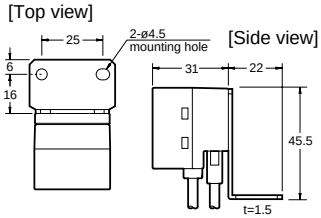
DIMENSIONS

Unit: mm

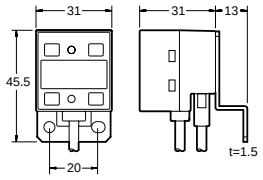
AP-40/40R/40Z



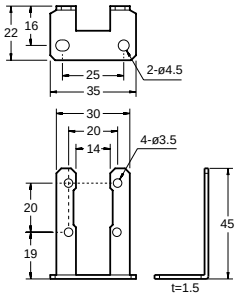
When mounting bracket A is attached



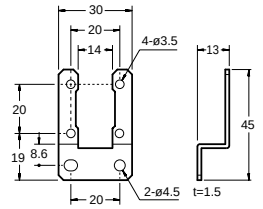
When mounting bracket B is attached



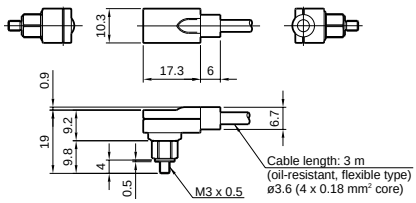
Mounting bracket A (Accessory)



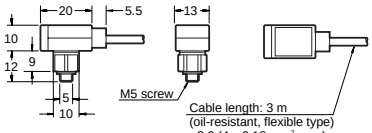
Mounting bracket B (Accessory)



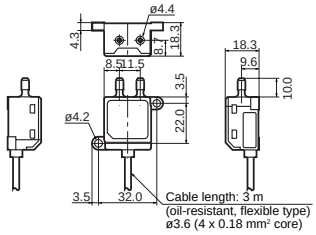
AP-41M



AP-41/43/44



AP-47



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AP40P-IM-1-0901 Printed in Japan