TPC PNEUMATICS
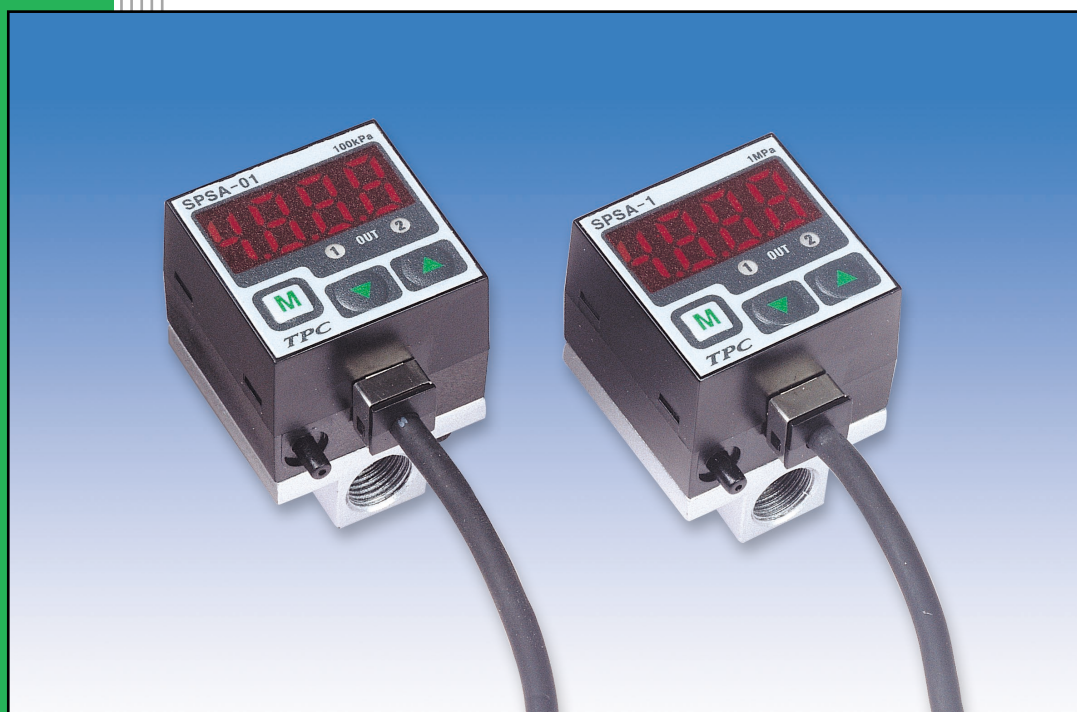
www.TPCpage.com

Digital Pressure Sensor

Series SPSA

- High accuracy semi conductor pressure sensor
- High brightness red LED.(Digit:9.5mm)
- Convertible pressure unit
- Various output modes
- Chattering prevention function of output
- Current protection circuit, Reverse power polarity protecting circuit
- Convertible Analog output(1−5VDC) scale
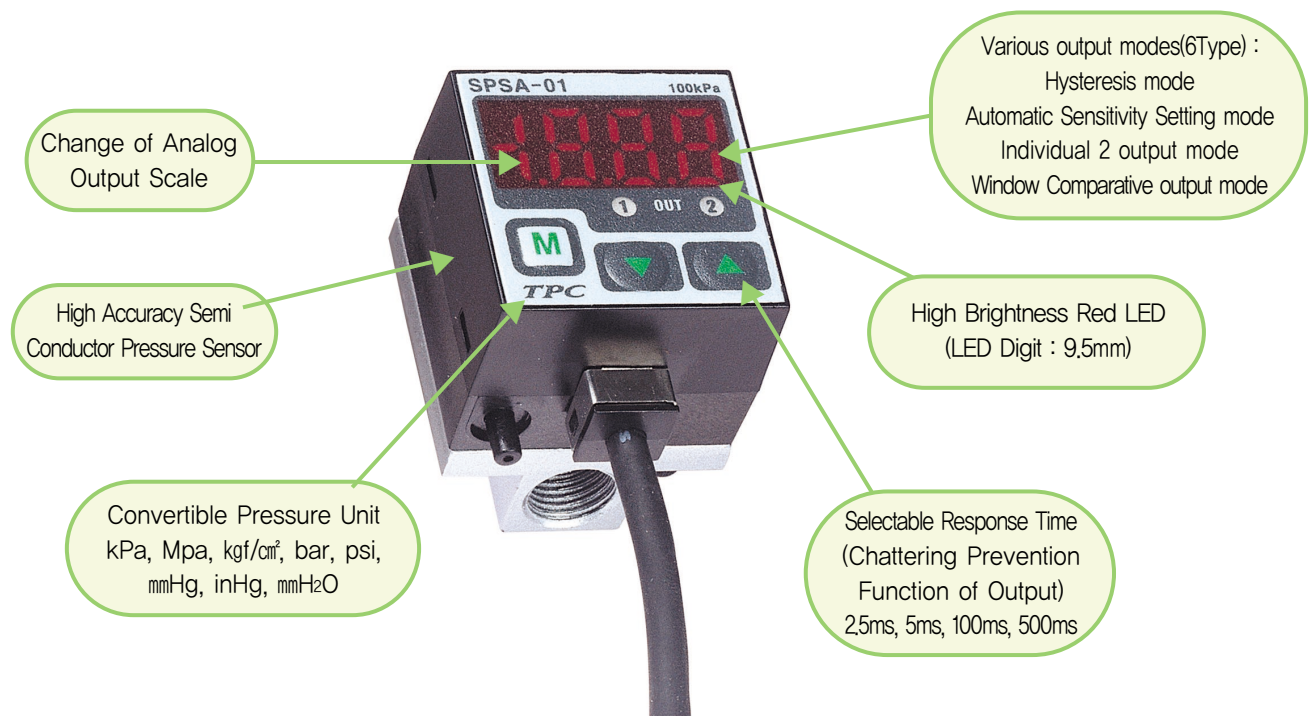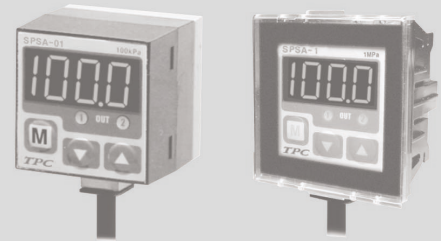
A Business Unit of **TANHAY**

www.tanhay.com

Digital pressure Sensor

Series SPSA

Change of Analog Output Scale

Various output modes(6Type) :
Hysteresis mode
Automatic Sensitivity Setting mode
Individual 2 output mode
Window Comparative output mode

High Accuracy Semi Conductor Pressure Sensor

High Brightness Red LED
(LED Digit : 9.5mm)

Convertible Pressure Unit
kPa, Mpa, kgf/cm², bar, psi,
mmHg, inHg, mmH₂O

Selectable Response Time
(Chattering Prevention
Function of Output)
2.5ms, 5ms, 100ms, 500ms

SPSA-01   100kPa

① OUT ②

M

TPC

Precision measurement of Pneumatic Pressure in Piping and Pneumatic products is necessary
in being used in Industrial Progress, Inspection Progress, Control & Analysis Equipments.

Digital Seonsors of TPC can effectively protect equipments by extraordinary pressure control
from various and obstacle factors such as supply pressure, flow, ambient temperature change etc.

Digital Sensors of TPC furnish the greatest stabilized conditions with accutacy and precision control.

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Series SPSA

- High accuracy semi conductor pressure sensor
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- Anglog output(1-5VDC)
- Current protection circuit, Reverse power polarity protecting circuit

How to order

SPS A － V 01 P □ □

  ①   ②   ③   ④ ⑤ ⑥

① Model
SPS：Pressure Sensor

② Body Type
A：Square(30mm×30mm)

③ Rating Pressure

Type	Range of Rating Pressure
01	0~100kPa(14.5psi)
1	0~1000kPa(145psi)
V01	-101.3~0kPa(-14.7~0psi)
C01	-100.0~100kPa(-14.5~14.5psi)

※ Blank：Standard pressure
   V：Negative pressure(Vacuum)
   C：Vacuum, Low pressure

④ Output
Blank：NPN Open Collector Output
    P：PNP Open Collector Output

⑤ Port Size
Blank：Rc(PT) 1/8
    U：NPT 1/8

⑥ Option
Blank：With Bracket(Bracket A, B)
    C：Panel Mounting Bracket(PSO-01)
    D：Panel Mounting Bracket
+Front Protection Cover(PSO-01+ PSO-02)

Pressure and Max. pressure display range

Pressure type	kPa	kgf/Cm²	bar	psi	mmHg	inHg	mmH₂O
Negative pressure	0~-101.3 (5.0~-101.3)	0~-1.034 (0.051~-1.034)	0~-1.034 (0.05~-1.034)	0~-14.70 (0.72~-14.70)	0~-760 (38~-760)	0~-29.9 (1.5~29.9)	0~-103.4 (5.1~103.4)
Standard pressure	0~100.0 (-5.0~110.0)	0~1.020 (-0.051~1.122)	0~1.020 (-0.050~1.100)	0~14.50 (-0.72~15.90)	-	-	-
	0~1000 (-50~1013)	0~10.20 (-0.51~11.22)	0~10.20 (-0.50~11.00)	0~145.0 (-7.2~159.0)	-	-	-

※( ) is Max. pressure display range.
※mmH₂O Unit：Displayed pressure number×100

Input conversion chart

from \ to	Pa	kPa	MPa	kgf/Cm²	mmHg	mmH₂O	psi	bar	inHg
1kPa	1000.000	1	0.001000	0.010197	7.500616	101.9689	0.145038	0.010000	0.2953
1kgf/Cm²	98069.10	98.06910	0.098069	1	735.5787	10000.20	14.22334	0.980691	28.95979
1mmHg	133.3220	0.133322	0.000133	0.001359	1	13.5954	0.019336	0.001333	0.039370
1mmH₂O	9.80665	0.00980	-	0.000099	0.0735578	1	0.00142	0.000098	0.002895
1psi	6894.939	6.89493	0.00689	0.070307	51.71630	703.07	1	0.068947	2.036074
1pa	100000.0	100.0000	0.100000	1.019689	750.062	10196.89	14.50339	1	29.52998
1inHg	3386.388	3.386388	0.003386	0.034530	25.40000	345.3240	0.491141	0.033863	1

Ex) When need to calculate 760mmHg as Pa unit.
: According to above chart, 1mmHg is 0.133322kPa, therefore 760mmHg will be 760x0.133322kPa=101.32472kPa.

⚠ Please read "Caution for your safety" in operation manual before using.

CE

Series *SPSA*

Specifications

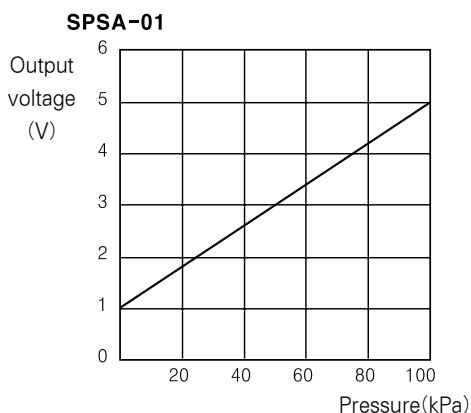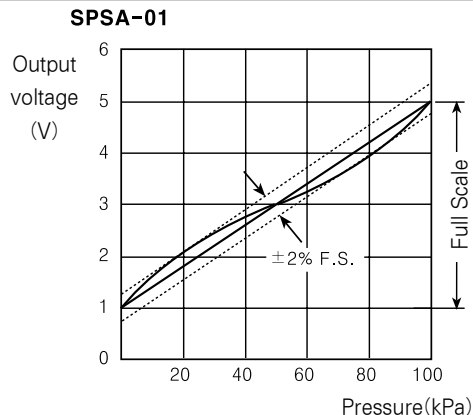| Pressure type		Gauge pressure		
		Nagative pressure type	Standard pressure type	
Model	NPN	SPSA-V01	SPSA-01	SPSA-1	SPSA-C01
	PNP	SPSA-V01P	SPSA-01P	SPSA-1P	SPSA-C01P
Rated pressure range		0.0~-101.3kPa(0.0~-14.7psi)	0.0~100.0kPa(0.0~14.5psi)	0.0~1,000kPa(0.0~145psi)	-100.0~100kPa(-14.5~14.5psi)
Display pressure range		5.0~-101.3kPa (0.72~-14.7psi)	-5.0~110.0kPa (-0.72~15.9psi)	-5.0~1,100kPa (-7.25~159.5psi)	-101.3~110kPa (-14.7~15.9psi)
Max. oressyre rabge		2 times of rating pressure		1.5 times of rating pressure	2 times of rating pressure
Applicable fluid		Air, Non-corrosive gas			
Power supply		12~24VDC±10%(Ripple P-P : Max. 10%)			
Current consumption		Max. 50mA			
Control output		· NPN open collector output ☞Load current : Max. 100mA, Load voltage : Max. 30VDC, Residual voltage : Max. 1V · PNP open collector output ☞Max. sink current : Max. 100mA, Residual voltage : Max. 2V			
	Hysteresis	1digit(2digit/psi) fixed			2digit/psi fixed
	Repeat error	±0.2% F·S ±1digit			±0.2% F·S ±2digit
	Response time	Selectable 2.5ms, 5ms, 100ms, 500ms			
	Short circuit protection	Built-in			
Analog output		· Output voltage:1V-5VDC±2% F.S. · Zero point:Within 1VDC±2% F.S.	· Resolution:Approx. 1/200 · Linear:Within ±2% F.S.	· Span:Within 4VDC ±2% F.S. · Output impedance:1kΩ	
Display method		3 1/2 digit LED 7Segment			
Min. display interval		1 digit(2digit/psi)			2digits
Display Pressure unit		kPa, kgf/Cm², bar, psi mmHg, mmH₂O, inHg	kPa, kgf/Cm², bar, psi		kPa, kgf/Cm², bar, psi mmHg, mmH₂O, inHg
Characteristic of control output and displayed temp		Max. ±1% F.S.			Max. ±2% F.S.
Analog output temperature characteristic		Max. ±2% F.S. (25℃(77℉) standard)			
Environment	Ambient temperature	-10℃ to ±50℃(14~122℉)(at non-dew status)			
	Storage temperature	-20℃ to ±60℃(-4~140℉)(at non-freezing status)			
	Ambient humidity	35 to 85% RH			
	Storage humidity	35 to 85% RH			
	Vibration	1.5mm ampltude at frequency of 10 to 55Hz in each of X, Y, Z directions for 2 hours			
Meterial		Front case : PC, Rear case : PC(Insert glas), Presure port : die-cast(Zn)			
Protection structure		IP40(IEC standard)			
Cable		5P, ∅4, Length : 2m(0.2mm2)			
Acquirement standard		C€			
Weight		Approx. 120g(4.23oz)			

※Weight : not including carton
※F.S. : Full Span
※(*1) Output operating, hysteresis is adjustable in F-1 mode
※(*2) ±1% F.S. or less (25℃)

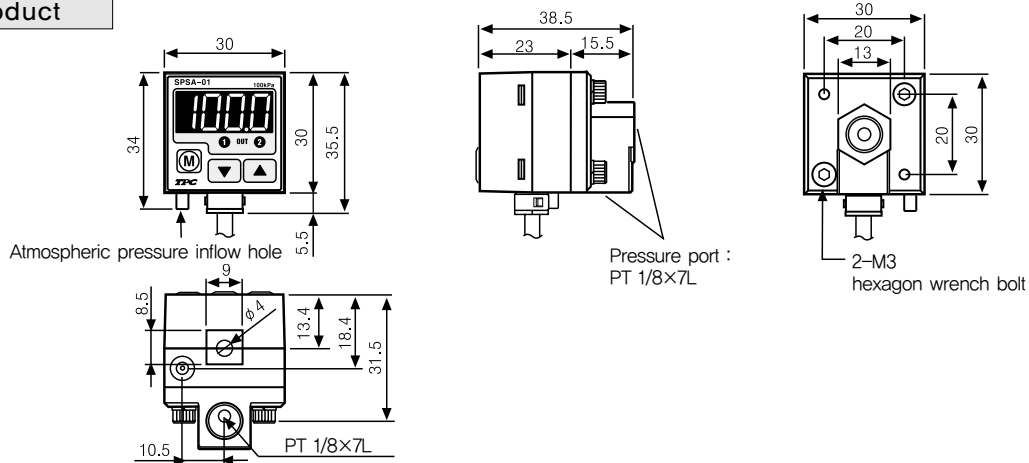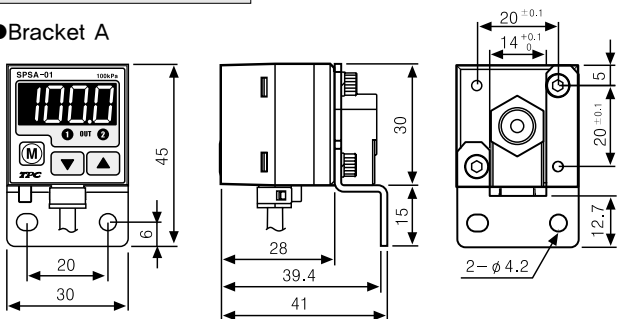## Analog output voltage–Pressure characteristic

SPSA-01

Output voltage (V) vs Pressure(kPa)

Analog output voltage linear

SPSA-01

Output voltage (V) vs Pressure(kPa), ±2% F.S., Full Scale

Dimensions

Product

(Unit : mm)

Atmospheric pressure inflow hole

Pressure port :
PT 1/8×7L

2−M3
hexagon wrench bolt

PT 1/8×7L
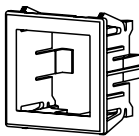
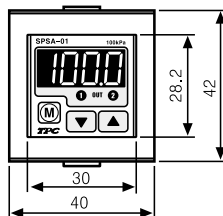### Fixed Bracket Dimensions

●Bracket A

2−φ4.2

●Bracket B

2−φ4.2
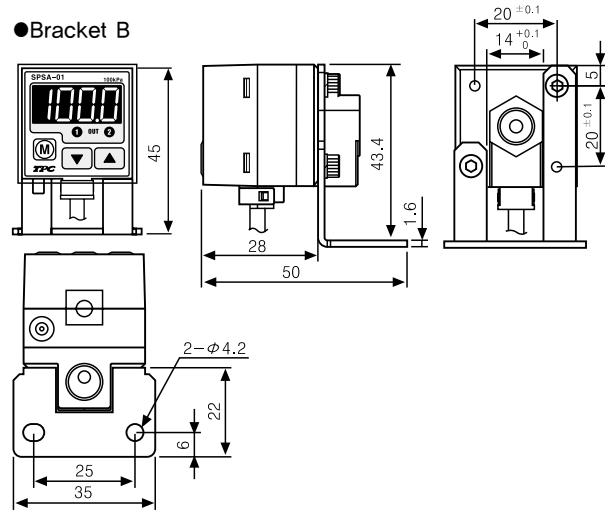
Panel Mounting Bracket Dimensions

●Accessory(Option)
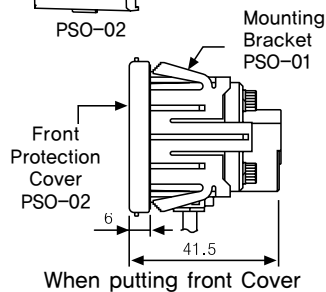
PSO−01
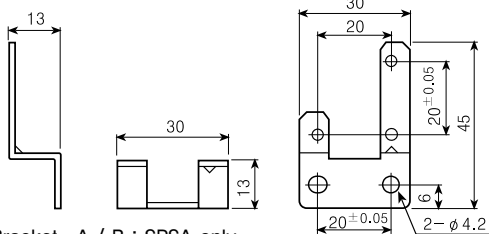
●Accessory:front protection
Cover(Option)
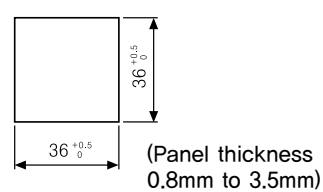
PSO−02

Mounting
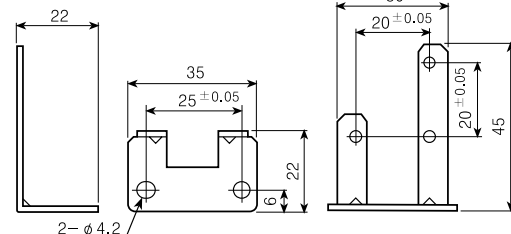Bracket
PSO−01
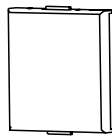
Front
Protection
Cover
PSO−02

When putting front Cover

●Panel cut-out

(Panel thickness
0.8mm to 3.5mm)

●Bracket−A

2−φ4.2

※ Bracket- A / B : SPSA only.

●Bracket-B

2−φ4.2

TPC
PNEUMATICS

Series SPSA

Input/Output circuit and connection diagram

NPN open collector output type

+V (Brown)
Analog voltage output(Orange)
Load
1kΩ
OUT1(Black)
Load
Main circuit
Over current protection circuit
OUT2 (White)
+ 12-24VDC −
Over current protection circuit
Over current protection circuit
0V(Blue)

PNP open collector output type
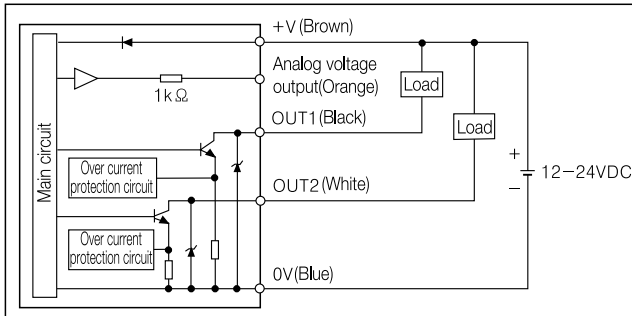
+V (Brown)
Over current protection circuit
OUT1(Black)
Main circuit
Over current protection circuit
OUT2 (White)
+ 12-24VDC −
Load
Analog voltage output(Orange)
1kΩ
Load
0V (Blue)
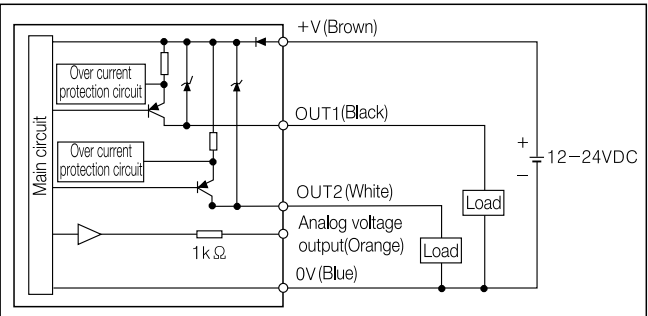
※There is no over current protection circuit in analog voltage output type. Do not connect this unit to power source or capacitive load directly.
※Please observe input impedance of connected equipment when suing analog woltage output. And be sure with voltage drop by resistance of extended wire.

Front panel identification and function

SPSA-01 100kPa
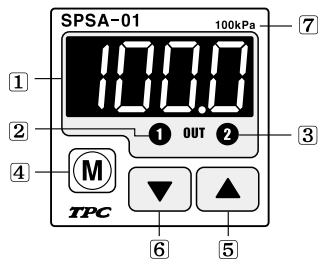
③ **2 output indicator(Red)** : Output 2 is ON, LED will be ON
④ **Mode key** : Parameter setting mode or preset setting mode, save setting value
⑤ **Up key** : Set the setting value to upper step in preset setting or pressure unit, output mode, response time, analog output scale, key lock, peak hold value, bottom hold value display in parameter setting.
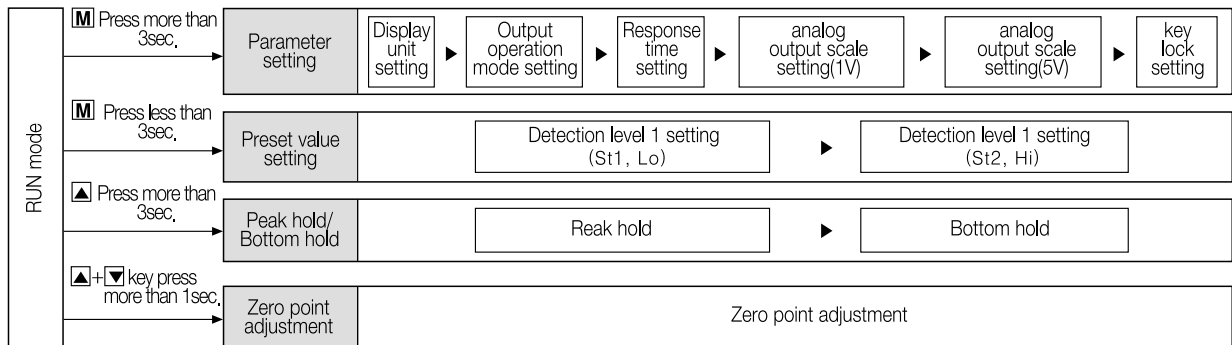⑥ **Down key** : Set setting value to lower step in preset setting or pressure unit, output mode. response time, analog output scale, key lock, peak hold, bottom hold display in parameter setting.

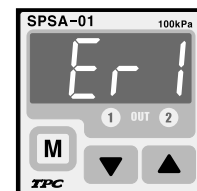① 3½ **LED display(Red)** : Display detected pressure, every setting value and display error
② **1 output indicator(Red)** : Output 1 is ON, LED will be ON
⑦ **Range of rating pressure** : It is possible to change the pressure unit in Pressure sensor. Please use different unit as label for your application.

Setting

RUN mode								
M Press more than 3sec.	Parameter setting	Display unit setting	▶ Output operation mode setting	▶ Response time setting	▶ analog output scale setting(1V)	▶ analog output scale setting(5V)	▶ key lock setting	
M Press less than 3sec.	Preset value setting	Detection level 1 setting (St1, Lo)			▶	Detection level 1 setting (St2, Hi)		
▲ Press more than 3sec.	Peak hold/ Bottom hold	Reak hold			▶	Bottom hold		
▲+▼ key press more than 1sec.	Zero point adjustment	Zero point adjustment						

Zero point adjustment

① SPSA-01 100kPa
② SPSA-01 100kPa
 SPSA-01 100kPa

1. In state of atmospheric pressure during RUN mode, press ▼Key and ▲Key at the same time for over 1 sec.
2. When the zero point adjustment is completed, it will display 0.0 and return to RUN mode automatically.

If excute Zero point when external pressure has been applied, Er1 will be flashing. Please execute Zero point again in state of atmospheric pressure.
※Please execute Zero point adjustment regularly.

Setting parameter

```
RUN mode
```
↓ Ⓜ press more than 3sec.

| `Unt` | Display unit setting |

↓ Ⓜ press one time

`Unt` and previous unit will flicker by turning on.(0.5sec.) Select the unit with ▲, ▼ key.(Pressing Ⓜ key momentarily, the unit will be saved, than move to the next mode)

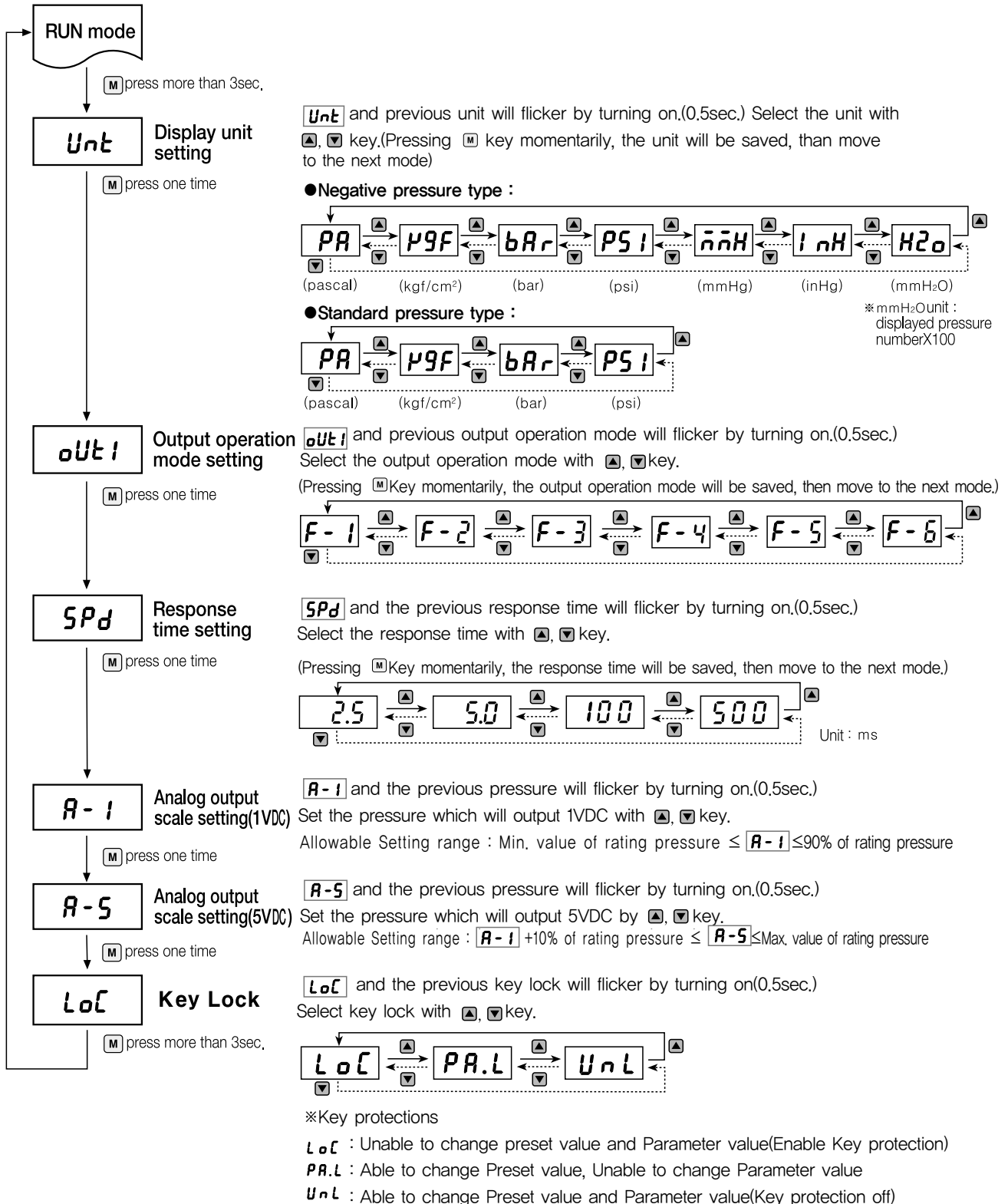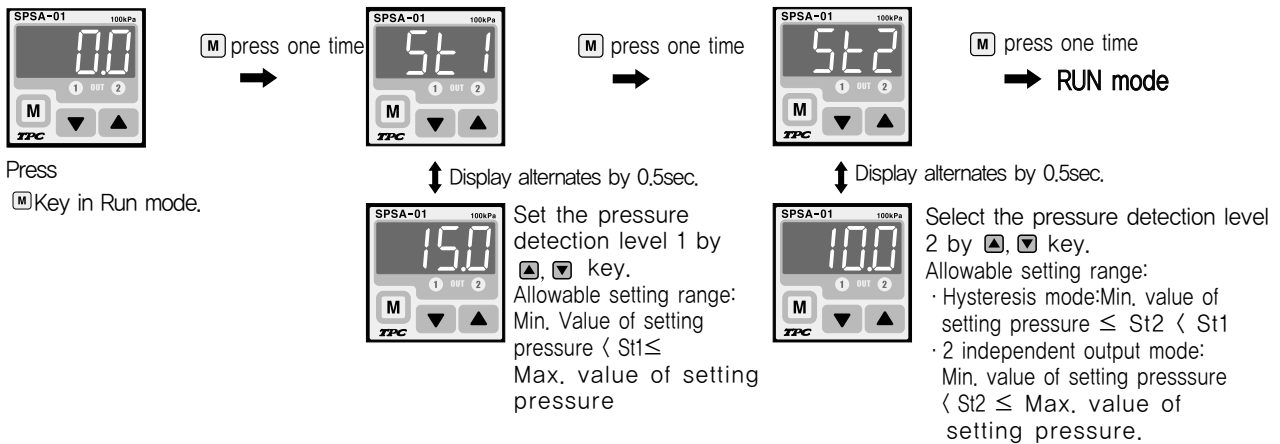● **Negative pressure type :**

`PA` → `ᵏᵍF` → `bAr` → `PSI` → `ᴍᴍH` → `InH` → `H2o`

(pascal)　(kgf/cm²)　(bar)　(psi)　(mmHg)　(inHg)　(mmH₂O)

※mmH₂Ounit : displayed pressure numberX100

● **Standard pressure type :**

`PA` → `ᵏᵍF` → `bAr` → `PSI`

(pascal)　(kgf/cm²)　(bar)　(psi)

| `oUt1` | Output operation mode setting |

↓ Ⓜ press one time

`oUt1` and previous output operation mode will flicker by turning on.(0.5sec.) Select the output operation mode with ▲, ▼ key.

(Pressing Ⓜ Key momentarily, the output operation mode will be saved, then move to the next mode.)

`F-1` → `F-2` → `F-3` → `F-4` → `F-5` → `F-6`

| `SPd` | Response time setting |

↓ Ⓜ press one time

`SPd` and the previous response time will flicker by turning on.(0.5sec.) Select the response time with ▲, ▼ key.

(Pressing Ⓜ Key momentarily, the response time will be saved, then move to the next mode.)

`2.5` → `5.0` → `100` → `500`

Unit : ms

| `A-1` | Analog output scale setting(1VDC) |

↓ Ⓜ press one time

`A-1` and the previous pressure will flicker by turning on.(0.5sec.) Set the pressure which will output 1VDC with ▲, ▼ key.

Allowable Setting range : Min. value of rating pressure ≤ `A-1` ≤90% of rating pressure

| `A-5` | Analog output scale setting(5VDC) |

↓ Ⓜ press one time

`A-5` and the previous pressure will flicker by turning on.(0.5sec.) Set the pressure which will output 5VDC by ▲, ▼ key.

Allowable Setting range : `A-1` +10% of rating pressure ≤ `A-5` ≤Max. value of rating pressure

| `LoC` | **Key Lock** |

↓ Ⓜ press more than 3sec.

`LoC` and the previous key lock will flicker by turning on(0.5sec.) Select key lock with ▲, ▼ key.

`LoC` → `PA.L` → `UnL`

※Key protections

`LoC` : Unable to change preset value and Parameter value(Enable Key protection)

`PA.L` : Able to change Preset value, Unable to change Parameter value

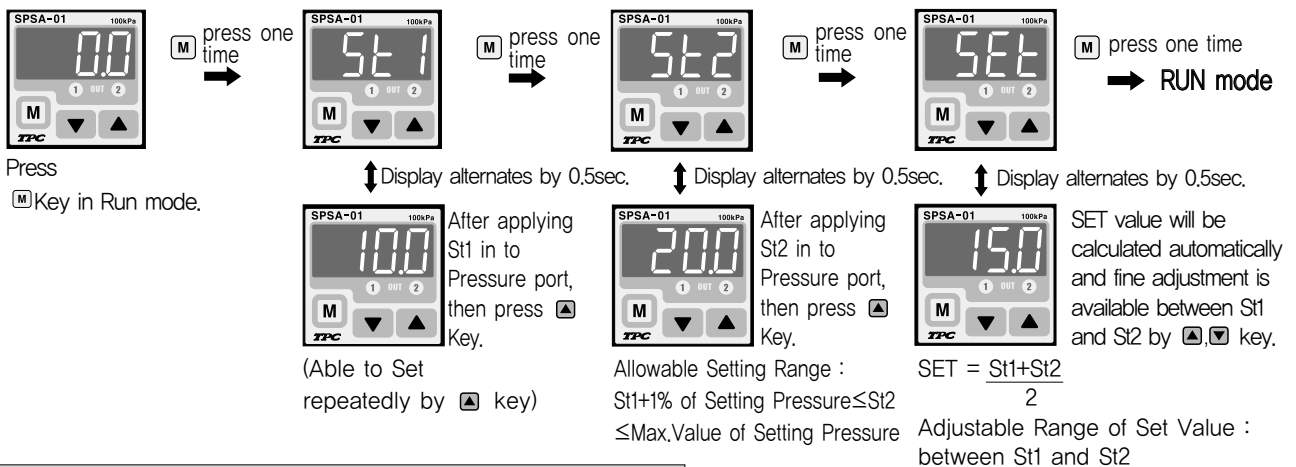`UnL` : Able to change Preset value and Parameter value(Key protection off)

※When entering into Parameter setting mode and preset setting mode, it displays "Setting item" and "Previous setting value" by 0.5sec. turn. This display will stop by pressing ▼ or ▲Key(Display setting value), if no key touched for over 1 sec., it will display old value by 0.5sec. turn again.

※If no key touched for 60sec. during setting, it will display previous setting value not current setting.

※Please check preset value again when changing the output mode.

※If changing pressure display unit, preset setting value will be changed automatically.

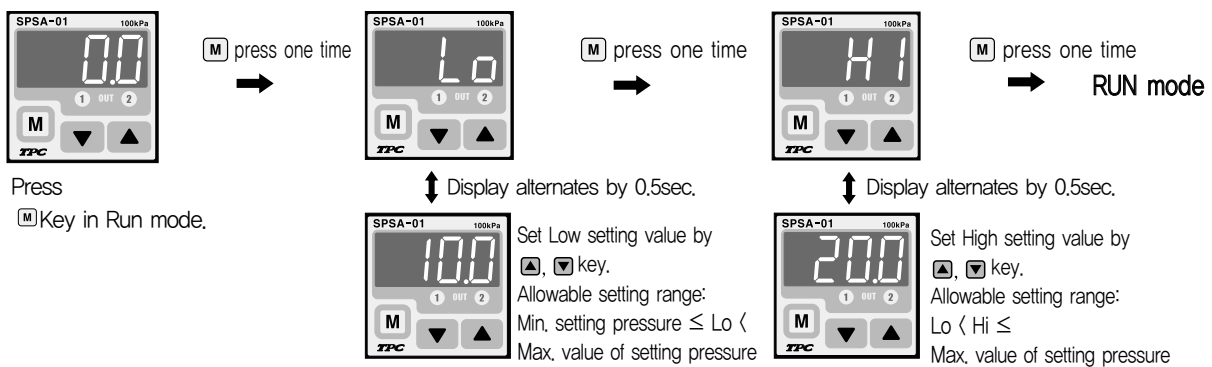※There is memory retention by EEPROM, but life cycle of EEPROM is 100,000 times.

TPC PNEUMATICS

Preset value setting

Hysteresis mode(F-1) and 1 independent(F-3,F-4,F-5) output mode

Press
Ⓜ Key in Run mode.

Ⓜ press one time

Ⓜ press one time

Ⓜ press one time ➡ RUN mode

Display alternates by 0.5sec.

Set the pressure detection level 1 by ▲, ▼ key.
Allowable setting range:
Min. Value of setting pressure 〈 St1≤ Max. value of setting pressure

Display alternates by 0.5sec.

Select the pressure detection level 2 by ▲, ▼ key.
Allowable setting range:
· Hysteresis mode:Min. value of setting pressure ≤ St2 〈 St1
· 2 independent output mode:
Min. value of setting presssure 〈 St2 ≤ Max. value of setting pressure.

Automatic sensitivity setting mode(F-2)

Press
Ⓜ Key in Run mode.

Ⓜ press one time

Ⓜ press one time

Ⓜ press one time

Ⓜ press one time ➡ RUN mode

Display alternates by 0.5sec.

Display alternates by 0.5sec.

Display alternates by 0.5sec.

After applying St1 in to Pressure port, then press ▲ Key.
(Able to Set repeatedly by ▲ key)

After applying St2 in to Pressure port, then press ▲ Key.
Allowable Setting Range : St1+1% of Setting Pressure≤St2 ≤Max.Value of Setting Pressure

SET value will be calculated automatically and fine adjustment is available between St1 and St2 by ▲,▼ key.

$$SET = \frac{St1+St2}{2}$$

Adjustable Range of Set Value : between St1 and St2

Window (F-6)

Press
Ⓜ Key in Run mode.

Ⓜ press one time

Ⓜ press one time

Ⓜ press one time ➡ RUN mode

Display alternates by 0.5sec.

Set Low setting value by ▲, ▼ key.
Allowable setting range:
Min. setting pressure ≤ Lo 〈 Max. value of setting pressure

Display alternates by 0.5sec.

Set High setting value by ▲, ▼ key.
Allowable setting range:
Lo 〈 Hi ≤ Max. value of setting pressure

- Please check the preset value again when changing output operation mode.
- When changing the display unit, preset value will be calculated according to the dissplay unit.
- If no key touched for 60sec., it will return to RUN mode. [automatic sensitivity setting mode(F-2) is exception]
- Whenever key touched one time, 2digits increased(decreased) but it will be continuously increasing(decreasing) by pressing key constantly.

Peak hold and Bottom hold

1. Press ▲ for more than 3sec. in RUN mode.
2. PE.H and memorized max. pressure(Negative type is for max. vacuum pressure) will flicker by turning on(0.5sec.)
3. bo.H and memorized min. pressure(Negative type is for min. vacuum pressure) will flicker by turning on(0.5sec.) then display Bottom hold value.
4. If press ▲Key one time shortly, memorized Peak hold and Bottom hold value will be removed then return to RUN mode.
※ When the Peak hold and Bottom hold value is over the max. display pressure value, it displays HHH , On the opposite, it displays LLL.

Pressure Sensor

Output operation mode

1. Hysteresis mode(F-1)
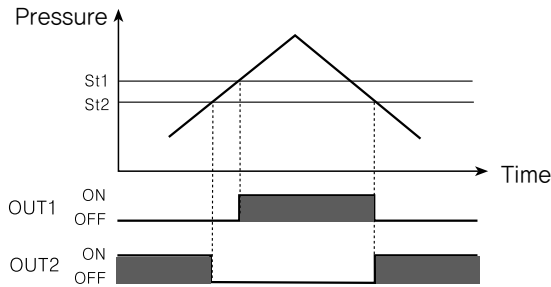
※It can be set for pressure detection lever(St1) and detection difference(St2)
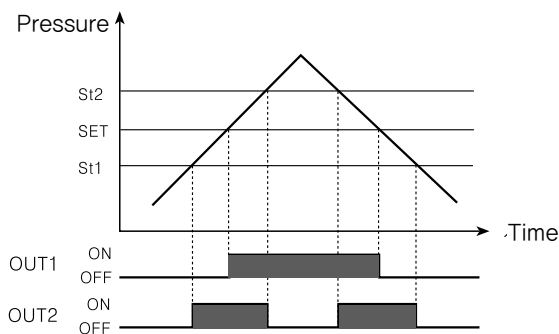※St1 setting range : Min.value of specified prssure ≤ St1 ≤
Max.value of specified pressure
St2 setting range : Min.value of specified pressure ≤ St2 < St1
• OUT 1 : When applying pressure is larger than St1, it will be ON.
• OUT 2 : When applying pressure is lower than St2, it will be ON.

2. Automatic sensitivity setting mode(F-2)

※This function is to set pressure detection level to the proper position automatically, it is set by received pressure from two position(St1, St2)
※SET value will be calculated as below.

$$SET\ value = \frac{(St1 + St2)}{2}$$

• OUT 1 : When applying pressure is larger than SET value, it will be ON.
• OUT 2 : When applying pressure is between St1 and St2, it will be ON.

Note1) If there is not enough difference of detecting level between St1 and St2, $Er3$ will be displayed.
Please set again after applying enough pressure.
Note2) When need fine adjustment for detection level, adjust detection level(SET) by ▲,▼ Key.
(Adjustment range : Between St1 and St2)

3. Independent 2 output mode(F-3, F-4, F-5)
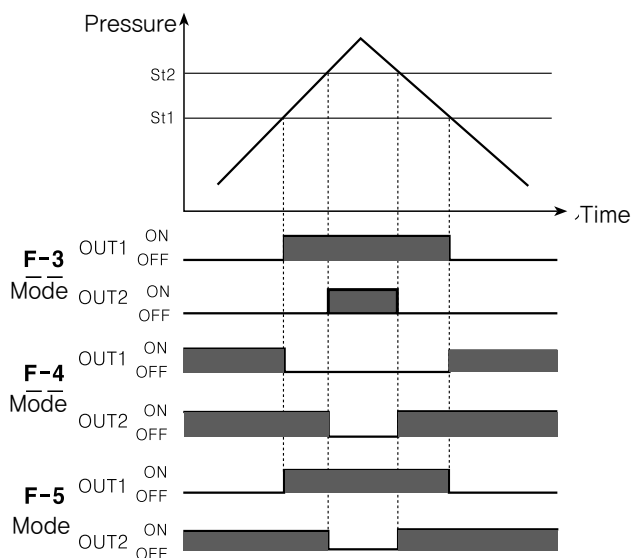
※St1 and St2 can be set independently within specified pressure range.
※One is for control, the other is for alarm or optional control.
※St1 setting range : Min.value of specified pressure ≤ St1 ≤
Max. value of specified pressure
St2 setting range : Min.value of specified pressure ≤ St2 ≤
Max. value of specified pressure

● 2 Independent output mode(F-3)
• OUT 1 : It will be ON, when it is beyond St1.
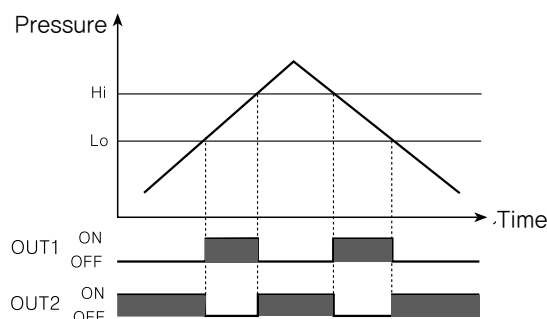• OUT 2 : It will be ON, when it is beyond St2.
● 2 Independent opposite mode(F-4)
• OUT 1 : It will be OFF, when it is beyond St1.
• OUT 2 : It will be OFF, when it is beyond St2.
● 2 Independent cross mode(F-5)
• OUT 1 : It will be OFF, when it is under St1.
• OUT 2 : It will be ON, when it is under St2.

4. Window mode(F-6)

※It is able to set Lo/Hi-limit value of pressure detection level in this mode.
※Lo setting range : Min.value of specified presssure ≤ Lo ≤
Max.value of specified pressure
Hi setting renge : Lo< Hi ≤ Max.value of specified pressure

• OUT 1 : It will be ON between High limit value(Hi) and Low limit value (Lo)
• OUT 2 : It will be ON when it is beyond High limit value(Hi) and Low limit value (Lo)

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Function

1. Change of display unit

SPSA-V01(P) and SPSA-C01(P) has 7 kinds of pressure unit. SPSA-01(P) and SPSA-1(P) has 4 kinds of pressure unit. Please select the proper unit for application.
- SPSA-V01(P), SPSA-C01(P) : kPa, kgf/cm², bar, psi, mmHg, inHg, mmH2O
- SPSA-01(P), SPSA-1(P) : kPa, kgf/cm², bar, psi

2. Change of output mode

There are 6 kinds of control output mode in order to realize the various pressure detection. Select a mode for your proper application.
- Hysteresis mode(F-1) : When needed to change hysteresis for detecting pressure.
- Automatic sensitivity setting mode(F-2) : When needed to set cletection sensitivity automatically at proper position.
- Indepentent 2 output mode(F-3, F-4, F-5) : When needed to detect pressure from two position with one product.
- Window comparative output mode(F-6:) : When needed to detect pressure in certain area.

3. Change of response time(Chattering prevention)

It cna prevent chattering of control output by changing response time. It is able to set 4 kinds of response time(2.5ms, 5ms, 100ms, 500ms) and if the response time is getting longer, the detection will be more stable by increasing the number of digital filter.

4. Change of Analog output scale

It is not set the analog output(1-5VDC) scale as a rated pressure range but also this is a function to change properly for user a application. It setting A1 position for 1VDC output and A5 position for 5VDC output, the pressure range of A1 to A5 is to 5VDC analog output. Therefore analog output will be 1-5VDC between A1 and A5.

5. Key lock function

This unit has 2 kinds of key lock function in order to prevent wrong operation.
- Loc : All keys are locked therefore it is impossible to change any parameter setting preset, Zero point adjustment, Peak hold and Bottom hold.(Able to change the status of lock)
- PA.L : This is partial locked status, therefore it is impossible to change parameter setting(Able to change the status of lock) only, the rest functions can be changed.
- UnL : All of the setting is available, all keys are unlocked.

6. Zero point adjustment function

This function is to set the display value pressure as Zero point forcibly in case that of port is opened to atmospheric pressure.

7. Peak hold and Bottom hold function

This function is to diagnosis malfunction of the system caused by parasitic pressure or to check through memorizing the max. /min, pressure occurred from the system.

8. Error

Error display	Problem	Remedy
Er 1	If external pressure applied, when adjusting Zero point	Please try again after external pressure removing
Er2	When overloaded on control output	Remove overload
Er3	When the setting value is not matched with setting condition	Set proper setting value after checking setting condition
HHH	When the applied pressure exceeds the upper display pressure range up	Apply pressure within display pressure range
LLL	When the applied pressure exceeds the lower display pressure range down	

Installation

1. When installing pressure port it is able to bring pressure from 3 directions by changing the mounting direction of the pressure port.
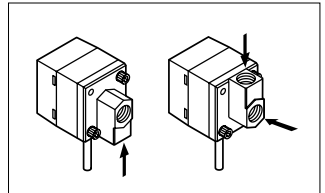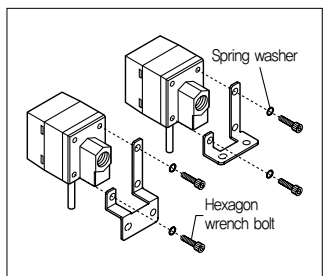
2. Pressure port is PT1/8 it is able to use general ont touch fitting.

3. Please use seal tabe at port plug in order to prevent pressure leak.

4. Please block another two pressure ports not used with port plug.

5. Please connect it by using spanner(13mm) at the metal part in order not to overload on the body when connecting one touch fitting.
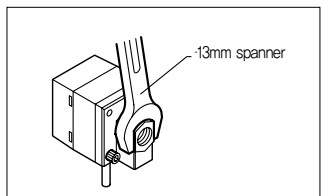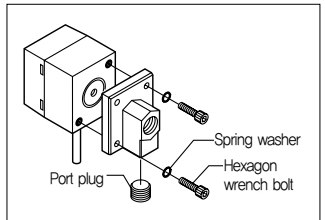
⚠ Caution

The tightening torque of one touch fitting should be Max 10N·m. it may cause mechanical trouble.

6. SPSA series has 2kinds of brackets so it is able to install it in two different ways.

7. At first, please unscrew hexagon wrench bolt and assemble the bracket on this unit by fixing the hexagon wrench bolt.
In this case, tightening torque of hexagon wrench should be max. 3N·m. It may cause mechanical trouble.

8. Bracket(PSO-01) and front protection cover(PSO-02) are optional to sell. Please see the pictures for installation.
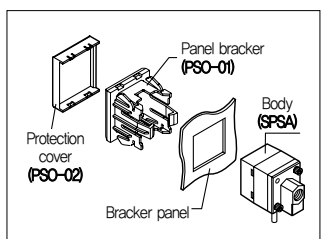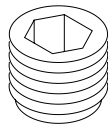
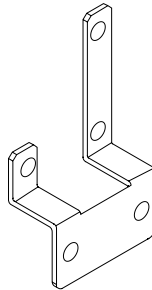## Accessories

• Pressure unit label

±100kPa	-101.3kPa	100kPa	1MPa
±1.020kgf/cm^2	-1.034kgf/cm^2	1.020kgf/cm^2	10.20kgf/cm^2
±14.50psi	-14.70psi	14.50psi	145.0psi
±1.000bar	-1.013bar	1.000bar	10.00bar
±750mmHg	-760mmHg	X10	X10
±29.5inHg	-29.9inHg	X100	X100
±102.0mmH$_2$0	-103.4mmH$_2$0	X1000	X1000

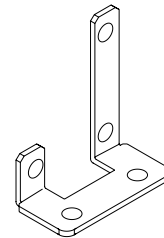**DISPLAY UNIT LABEL**

• Port Plug	• Bracket A	• Bracket B

Caution for using

1. Do not insert any sharp or pointed object into pressure port. It may cause mechanical trouble due to sensor damage.
2. Be sure that this unit must avoid direct touch with water, oil, thinner etc.
3. Be sure to avoid transient time(within 3sec.) after initial power on.
4. When a switching moving regulator is used for power supply, frame ground(F.G) terminal of its power supply part must be grounded.
5. It may cause malfunction by noise, if wiring with power line or high voltage line.
6. When moving this unit from warm place to cold place, please remove the humidity on the cover then use it.
7. Do not press the setting button with sharp or pointed object.
8. Do not put over 30N tensile strength on connection part or load.
9. When using mmH$_2$O unit, please multiply display value by 100.
※ **It may cause malfunction if above instructions are not followed.**

Switching regulator   +
                       −
                  F.G.   Ground

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