

# Sapphire capacitance diaphragm gauge

## Model SPG\_\_

### Overview

Model SPG\_\_ is a capacitance diaphragm vacuum gauge that uses a sapphire capacitance pressure sensor to achieve high accuracy and reliability, compact size, and light weight. Self-heating and nonself-heating models are available. The SPG is especially suited for use in semiconductor manufacturing.

### Features

- **Uses a single-crystal sapphire for excellent resistance to corrosion and high temperatures**  
Highly corrosion-resistant and heat-resistant single-crystal sapphire pressure sensing material also has excellent mechanical characteristics. Capacitive measurement has high repeatability even when used at high temperature.
- **Highly accurate measurement**  
Advanced signal processing technology contributes to excellent temperature characteristics and linearity of measurement.
- **Compact and light weight**  
Small in size and light in weight, thanks to micromachining technology.
- **Easy zero adjustment**  
Zero adjustment is performed with automatic adjustment button or up/down buttons.
- **Device status indicator**  
Device status (normal, warm-up, and abnormal) can be easily checked with the status LED.

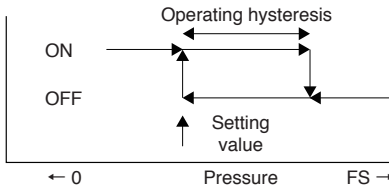
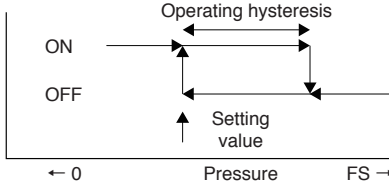


- **Fast warm-up time and stable sensor temperature control**  
Microprocessor-based digital PID control provides fast warm-up and stable sensor temperature (self-heating models).
- **Compatible with Smart Loader Package**  
Working from a PC, users can monitor the SPG and easily change its settings using the SLP-SP5 Smart Loader Package (sold separately).
- **CE-marked**  
Conformity to IEC directives; CE-marked; compliance with EN 61326-1. EN61326-2-3

### Specifications

Items	Specifications		
Pressure range	0-20 Pa, 0-25 Pa, 0-100 Pa, 0-200 Pa, 0-300 Pa, 0-1000 Pa, 0-2000 Pa, 0-3000 Pa, 0-10000 Pa, 0-20000 Pa, 0-100 kPa 0-13.332 Pa, 0-26.664 Pa, 0-33.331 Pa, 0-133.32 Pa, 0-266.64 Pa, 0-399.96 Pa, 0-1333.2 Pa, 0-2666.4 Pa 0-3999.6 Pa, 0-13332 Pa, 0-26664 Pa, 0-133.32 kPa		
Self-heating temperature	No self-heating/45/100/125/150/160/180/200 °C		
Accuracy	Accuracy	Pressure range	Self-heating temperature range
	0.25 % Reading	10 Pa to 33.331 Pa	45 °C
	0.5 % Reading		80 °C or more
	0.25 % Reading	100 Pa to 133.32 kPa	No self-heating or less than 160 °C
	0.5 % Reading		160 °C or more
Temperature coefficients zero	Temperature coefficients zero	Pressure range	Self-heating temperature range
	0.008 %FS/°C	10 Pa to 33.331 Pa	45 °C
	0.016 %FS/°C		80 °C or more
	0.008 %FS/°C	100 Pa to 133.32 Pa	No self-heating or less than 160 °C
	0.016 %FS/°C		160 °C or more
	0.004 %FS/°C	200 Pa to 133.32 kPa	No self-heating or less than 160 °C
	0.008 %FS/°C		160 °C or more
Temperature coefficients span	0.02 % rdg./°C		
Resolution	1/10000 FS		

Items	Specifications				
<b>Operating temperature range</b>	<b>Model SPG5</b> (standard model), <b>Model SPG7</b> (vacuum freeze-drying process model) Models whose self-heating temperature is 80 °C or more: 10 to 45 °C (Cooling air with a velocity of 0.5 m/s or more is required at 35 °C or more.) Models whose self-heating temperature is 45 °C: 10 to 40 °C (Cooling air with a velocity of 0.5 m/s or more is required at 35 °C or more.) Non self-heating models: 0 to 60 °C <b>Model SPG6</b> (extra high-temperature model) 10 to 65 °C (when mounted vertically), 10 to 70 °C (when mounted horizontally) (Cooling air with a velocity of 0.5 m/s or more is required at 45 °C or more.)				
<b>Operating humidity range</b>	10 to 90 %RH (without condensation)				
<b>Storage temperature and humidity range</b>	-20 to +80 °C, 10 to 95 %RH (without condensation)				
<b>Response time</b>	Model SPG_A: 35 ms Model SPG_B: 50 ms (Models with pressure range of 1000 Pa or more) 60 ms (Models with pressure range of less than 1000 Pa) Model SPG_C: 40 ms (Models with pressure range of 100 Pa or more) 50 ms (Models with pressure range of less than 100 Pa)				
<b>Gas-contacting materials</b>	Sapphire, DSALOY (equivalent to Inconel), SUS316L				
<b>Internal capacity</b>	4.6 cm <sup>3</sup> : 1/2 inch gauge port connection 7 cm <sup>3</sup> : 8 VCR connection 7 cm <sup>3</sup> : NW16 connection 5 cm <sup>3</sup> : IDF 1.5S ferrule connection IDF 2S ferrule connection				
<b>Allowable pressure</b> *1	300 kPa abs : Model SPG7 only 200 kPa abs : Models with pressure range of 100 kPa or more 110 kPa abs : Models with pressure range of less than 100 kPa				
<b>Marginal pressure</b> *2	300 kPa abs				
<b>Burst pressure</b> *3	700 kPa abs				
<b>Input power supply</b>	Voltage range: ±15 V DC ±10 % (dual power supplies) or 24 V DC ±10 % (single power supply) Allowable ripple voltage: 0.5 V p-p max.				
<b>Power consumption/ power current</b> *4 *5	Self-heating temperature	Power consumption		Power current	
		During normal operation	During warm-up	±15 V DC supply	24 V DC supply
	Non self-heating	3 W max.	3 W max.	0.12 A max.	0.14 A max.
	45 °C	5 W max.	8 W max.	0.3 A max.	0.4 A max.
	100 °C	9 W max.	13 W max.	0.5 A max.	0.7 A max.
	125 °C	10 W max.	14 W max.	0.6 A max.	0.7 A max.
	150 °C	12 W max.	16 W max.	0.6 A max.	0.8 A max.
	160 °C	13 W max.	17 W max.	0.7 A max.	0.8 A max.
	180 °C	15 W max.	19 W max.	0.8 A max.	0.9 A max.
	200 °C	16 W max.	23 W max.	0.9 A max.	1.1 A max.
<b>Output signal</b>	0 to 10 V DC Allowable load resistance: 10 kΩ min. Measurement output range: -0.5 to +11 V DC *6 Output during warm-up or abnormal status: Output depends on the measured pressure *7				
<b>I/O connector</b>	D-sub 15-pin connector (male), retaining screw #4-40UNC				
<b>Mass</b>	450 g: 1/2 inch gauge port connection 520 g: 8 VCR connection 470 g: NW16 connection 580 g: IDF 1.5S ferrule connection 650 g: IDF 2S ferrule connection				
<b>Warm-up time</b>	30 min (nominal), 1 h max.				
<b>Zero adjustable range</b>	±20 %FS				
<b>Coupling</b>	1/2 inch gauge port, 8 VCR (female) equivalent, NW16, IDF1.5S ferrule, IDF2S ferrule				
<b>Leak rate</b>	1×10 <sup>-10</sup> Pa m <sup>3</sup> /s or less (except ferrule model), 1×10 <sup>-9</sup> Pa m <sup>3</sup> /s or less (ferrule model)				
<b>Mounting angle</b>	Unrestricted *8				
<b>Allowable cable length</b>	10 m max.				
<b>Event relay ratings</b>	Number of relays: 3 Contact form: 1c (both NO and NC contacts) Maximum load: 1 A 30 V DC resistive load Minimum load: 10 μA 10 mV DC *9 Mechanical service life: 50 million cycles min. Electrical service life: 100 thousand cycles min. (at 1 A, 30 V DC resistive load) Certifications: UL, CSA				

Items	Specifications	
Event relay functions (default setting) *10	Event relay 1: Pressure low limit (direct action) Setting: value is assigned by model No. Operating hysteresis: 0.5 %FS Operation is always linked with pressure during warm-up or abnormal status.	
		
	Event relay 2: Pressure low limit (direct action) Setting: value is assigned by model No. Operating hysteresis: 0.5 %FS Always operates together with pressure during warm-up or abnormal status.	
		
Event relay 3: ON if warm-up is complete, OFF if warm-up is incomplete or status is abnormal Event relay LED: Green when event relay ON, off when event relay OFF		
Status LED display operation	Lit green	Normal operation status (after warm-up)
	Lit orange	Warm-up in progress (device temperature is not yet stable)
	Lit red	Abnormal status (device problem)
	Flashing red (0.3 s, 0.3 s)	Abnormal status (operating environment problem, such as excessive ambient temperature or wrong power voltage)
	3 green flashes (0.3 s, 0.3 s)	Automatic zero adjustment (after button pressed) is complete, and bias adjustment is within ±5 %FS.
	3 orange flashes (0.3 s, 0.3 s)	Automatic zero adjustment (after button pressed) is complete, and bias adjustment is between ±5 and ±20 %FS.
	Flashing green (0.1 s, 0.1 s)	Zero adjustment is being performed with up/down zero adjustment buttons, and bias adjustment is within ±5 %FS.
	Flashing orange (0.1 s, 0.1 s)	Zero adjustment is being performed with up/down zero adjustment buttons, and bias adjustment is between ±5 and ±20 %FS.
	Flashing red (0.1 s, 0.1 s)	During zero adjustment with up/down zero adjustment buttons, bias adjustment reached the maximum adjustable range of ±20 %FS.
	Lit alternately red and orange 3 times (0.3 s, 0.3 s)	Because of device conditions, neither auto zero adjustment nor manual zero adjustment is possible.
	Lit alternately green and orange 3 times (0.3 s, 0.3 s)	Bias adjustment value has been reset.
	Alternating green and orange with occasional red (1.9 s, 0.1 s)	The event relay is latched. *11
	Lit alternately green and red (0.3 s, 0.3 s)	Output is manually being controlled. *12
	Off	The device is not powered up.
Standards compliance	CE-marked (EN 61326-1, EN61326-2-3) (For use in industrial locations), KC-marked	

\*1 At the allowable pressure, the performance level of this unit can be maintained. However, if the SPG is repeatedly subjected to the allowable pressure, perform the zero adjustment periodically.

\*2 At the marginal pressure, this unit will continue to function. If the SPG is subjected to the marginal pressure, reperform the zero adjustment. If more accurate measurement is required, return the unit to Azbil Corporation for calibration. If the marginal pressure is exceeded, the proper operation of this unit can no longer be guaranteed. In this case, replace the unit with a new one.

\*3 The burst pressure is the pressure at which this device will break. To avoid an accident, never apply pressure equaling or exceeding the burst pressure.

\*4 Use an appropriate power supply with a rated current exceeding the max. power current value.

\*5 PID control is used to regulate the temperature and keep the rate of current supplied to the heater as constant as possible. Additionally, the maximum power current is varied depending on the power voltage, so that power consumption remains constant even during warm-up, irrespective of the power voltage. (Self-heating models only)

\*6 Since a negative voltage is generated inside this unit, a negative voltage output is available even with only a single-output power supply.

\*7 The conditions and voltage can be changed using the Smart Loader.

\*8 This unit was calibrated at the factory in a vertical position. Shift of the zero point may have occurred, depending on the mounting angle. In such a case, accuracy can be recovered by performing the zero adjustment after installation. Vertical installation is recommended to prevent contaminants from accumulating on the sensor unit.

\*9 The minimum load specification is an estimate of the minimum load at which the event relay is able to open and close. This value can vary depending on the frequency of operation, environmental conditions, and the expected reliability level. Before actual use, a check of the relay's operation using the actual load is recommended.

\*10 The event relay functions can be changed using the Smart Loader (sold separately).

\*11 Latching of the event relay must be set up with the Smart Loader (sold separately).

\*12 Output can be manually controlled with the Smart Loader (sold separately).

## Model selection table

I	II	III	IV	V	VI	VII	VIII	Example: SPG5AT11HD500500
Basic model No.	Type	Additional function	Pressure range	Self-heating temperature	Coupling	Event 1 setting	Event 2 setting	
SPG								Sapphire capacitance diaphragm gauge
	5							Standard model
	6							Extra high-temperature model
	7							Vacuum freeze-drying process model
		A						Standard model
		B						Atomic Layer Deposition model (Only model SPG6)
		C						ANTI-Deposition Model
			---					Refer to the table on the left
				R				Without self-heating function
				A				45 °C
Pressure code	FS pressure ranges (absolute pressure)			C				100 °C
	T1R	13.332	Pa	D				125 °C
	T2R	26.664	Pa	E				150 °C
	T2S	33.331	Pa	F				160 °C
	T10	133.32	Pa	G				180 °C
	T20	266.64	Pa	H				200 °C
	T30	399.96	Pa		A			1/2 inch gauge port
	T11	1333.2	Pa		D			8 VCR (female) equivalent (SUS316L with electrolytic grinding)
	T21	2666.4	Pa		E			NW16
	T31	3999.6	Pa		H			IDF 1.5S ferrule
	T12	13332	Pa		J			IDF 2S ferrule
	T22	26664	Pa		P			1/2 inch gauge port, with traceability certificate
	T13	133.32	kPa		S			8 VCR (female) equivalent (SUS316L with electrolytic grinding), with traceability certificate
	P21	20	Pa		T			NW16, with traceability certificate
	P2S	25	Pa		W			IDF 1.5S ferrule, with traceability certificate
	P12	100	Pa		Y			IDF 2S ferrule, with traceability certificate
	P22	200	Pa			***		**.* %FS Always OFF if "NNN" is specified.
	P32	300	Pa				***	**.* %FS Always OFF if "NNN" is specified.
	P13	1000	Pa					
	P23	2000	Pa					
	P33	3000	Pa					
	P14	10000	Pa					
	P24	20000	Pa					
	P15	100	kPa					

## Possible model No. combinations

	III		
I + II	A	B	C
SPG5	✓		✓
SPG6	✓	✓	✓
SPG7	✓		

	IV: Pressure range												
I + II + III	T1R	T2R	T2S	T10	T20	T30	T11	T21	T31	T12	T22	T13	
	P21	P2S	P12	P22	P32	P13	P23	P33	P14	P24	P15		
SPG5A				✓	✓	✓	✓	✓	✓	✓	✓	✓	
SPG5C	✓	✓	✓	✓		✓	✓			✓	✓	✓	
SPG6A				✓	✓	✓	✓	✓	✓	✓	✓	✓	
SPG6B	✓	✓	✓			✓	✓					✓	
SPG6C	✓	✓	✓	✓		✓	✓			✓	✓	✓	
SPG7A				✓	✓		✓	✓	✓	✓	✓	✓	

I + II + III	V: Self-heating temperature							
	R	A	C	D	E	F	G	H
SPG5A	✓			✓	✓	✓	✓	✓
SPG5C		✓*	✓*		✓			✓
SPG6A				✓	✓	✓	✓	✓
SPG6B			✓*	✓	✓	✓	✓	✓
SPG6C			✓*		✓			✓
SPG7A				✓				

I + II + III	VI: Coupling									
	A	D	E	H	J	P	S	T	W	Y
SPG5A	✓	✓	✓		✓	✓	✓	✓		✓
SPG5C		✓	✓				✓	✓		
SPG6A	✓	✓	✓		✓	✓	✓	✓		✓
SPG6B		✓					✓			
SPG6C		✓	✓				✓	✓		
SPG7A				✓	✓				✓	✓

\* This combination can be selected only when pressure range (IV) is less than 100 Pa.

Note: if a model No combination that is not listed as possible is needed, please contact the azbil Group.

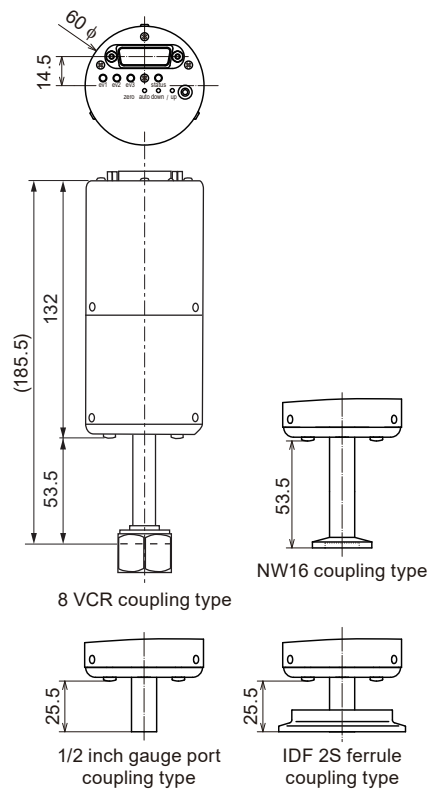
## Peripheral tools

Items	Model No.
Smart Loader Package (with loader cable)	SLP-SP5

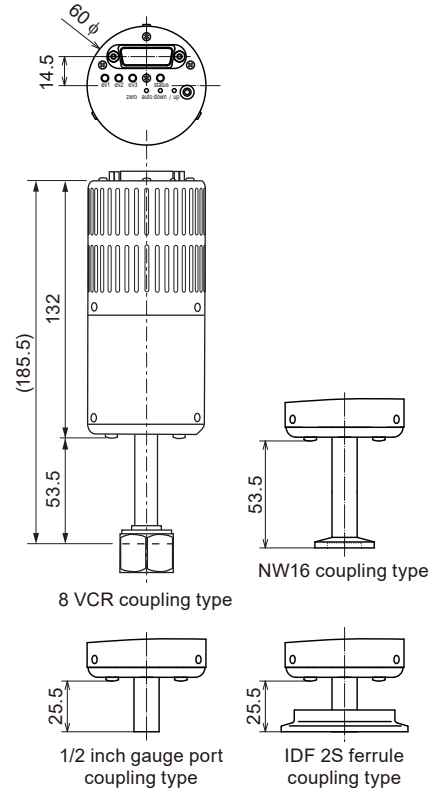
## External dimensions

(Unit: mm)

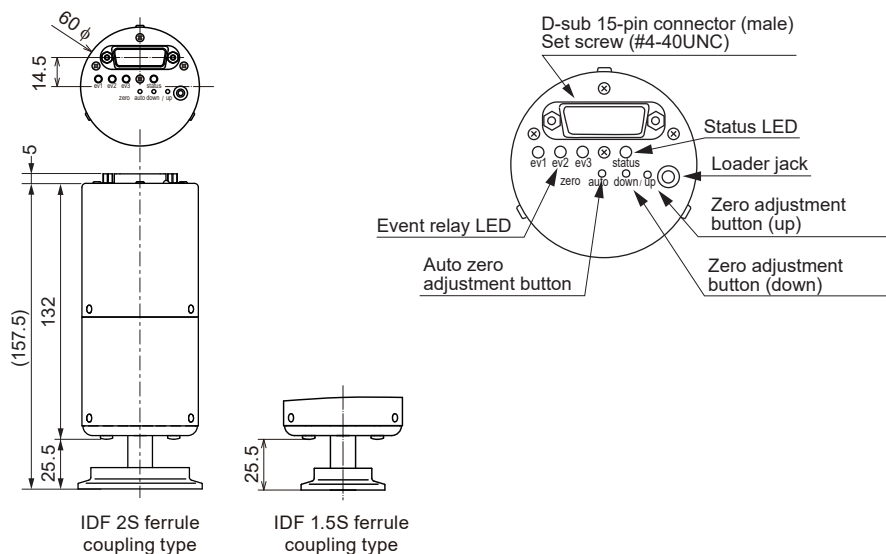
### ● Model SPG5 (standard model)



### ● Model SPG6 (extra high-temperature model)



### ● Model SPG7 (vacuum freeze-drying process model)



## Connector pin assignments

(D-sub 15-pin, male)

	Name
1	Event relay 3 (COM)
2	Output (+)
3	Power supply (COM) *1 *2
4	Event relay 2 (COM)
5	Power supply (-) *1
6	Event relay 3 (NO)
7	Power supply (+)
8	Event relay 3 (NC)
9	Event relay 2 (NO)
10	Event relay 2 (NC)
11	Event relay 1 (COM)
12	Output (COM) *2
13	Event relay 1 (NO)
14	Event relay 1 (NC)
15	FG *3

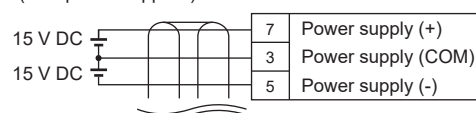
\*1 If using a single 24 V DC input power supply, connect the power COM to the power "+".

\*2 The power COM and output COM are internally connected. If using a single 24 V DC input power supply, do not connect the power COM and output COM together. Also, take care to avoid any wrong wiring that may cause a short circuit in other equipment. If the wiring is connected incorrectly, current from the power supply will also flow through the output line, and the voltage drop from wiring resistance may cause a measurement error.

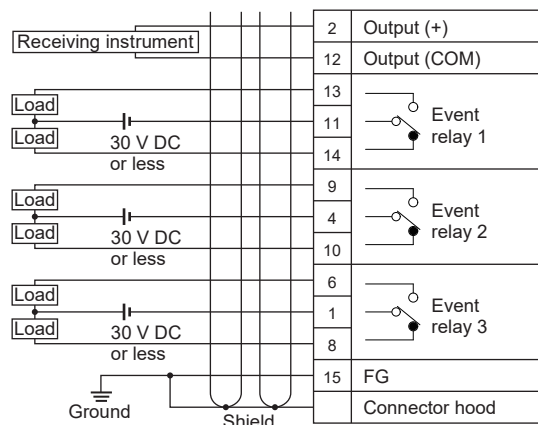
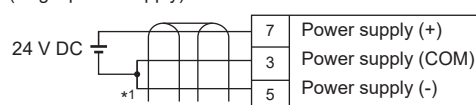
\*3 FG is electrically continuous with the case, but is isolated from the power COM, output COM, and other terminals.

## ● Example of external connection

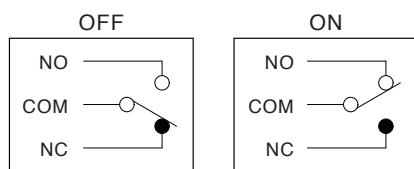
•  $\pm 15$  V DC (dual power supplies)



• 24 V DC (single power supply)



Note: Event relay connection



When the power supply is turned off, the event relay is turned off.



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