



DATE 7 January, 2015

No. V-70028A

Messrs. \_\_\_\_\_

# SPECIFICATION

Semiconductor Pressure Sensor - Standard Product

Model: AP3, AG3 Pressure Sensor

Project: \_\_\_\_\_

Distributor: \_\_\_\_\_

Reference: \_\_\_\_\_

A handwritten signature in black ink, appearing to read 'Y. Uchiyama', is written over a horizontal line.

Yoshiyuki Uchiyama, Application Engineer  
Sensor Department Fujikura Ltd.

## Fujikura Ltd.

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Table shown below is revision records of this specification

Rev. A	7 Jan., 2015	Y. Uchiumi	Added 700kPa(700KG).	A
Est.	7 Mar., 2014	Y. Uchiumi		
	Date	Name	Comment	Mark

**1. General**

This document describes the specifications of Fujikura Pressure Sensors, Type of AP3 and AG3.

**2. Principle**

Fujikura Pressure Sensor is composed of a silicon piezoresistive pressure sensing chip and a signal conditioning integrated circuit. The low-level signal from the sensing chip is amplified, temperature compensated, calibrated, and finally converted to a high-level output signal that is proportional to the applied pressure.

**3. Device lineup**

This device has the following lineup.

Model	Pressure Type	Supply Voltage	Accuracy	Pressure Range										
				-100	-50	0	25	50	100	200	500	700	1000	kPa
				(-15)	(-7)		(3)	(7)	(15)	(30)	(70)	(100)	(150)	psi
AP3 or AG3	Gauge	5.0 Vdc or 3.3 Vdc	±1.5 %FS			025KG	050KG	100KG	200KG	500KG	700KG	001MG		
		3.0 Vdc	±2.0 %FS	Same as the above										

**Features**

- ✓ Amplified and temperature compensated low noise full analog output
- ✓ Single point pressure threshold detection
- ✓ High accuracy
- ✓ Package compatible with XFPM & XFGM integrated pressure sensor
- ✓ Customization or modification available

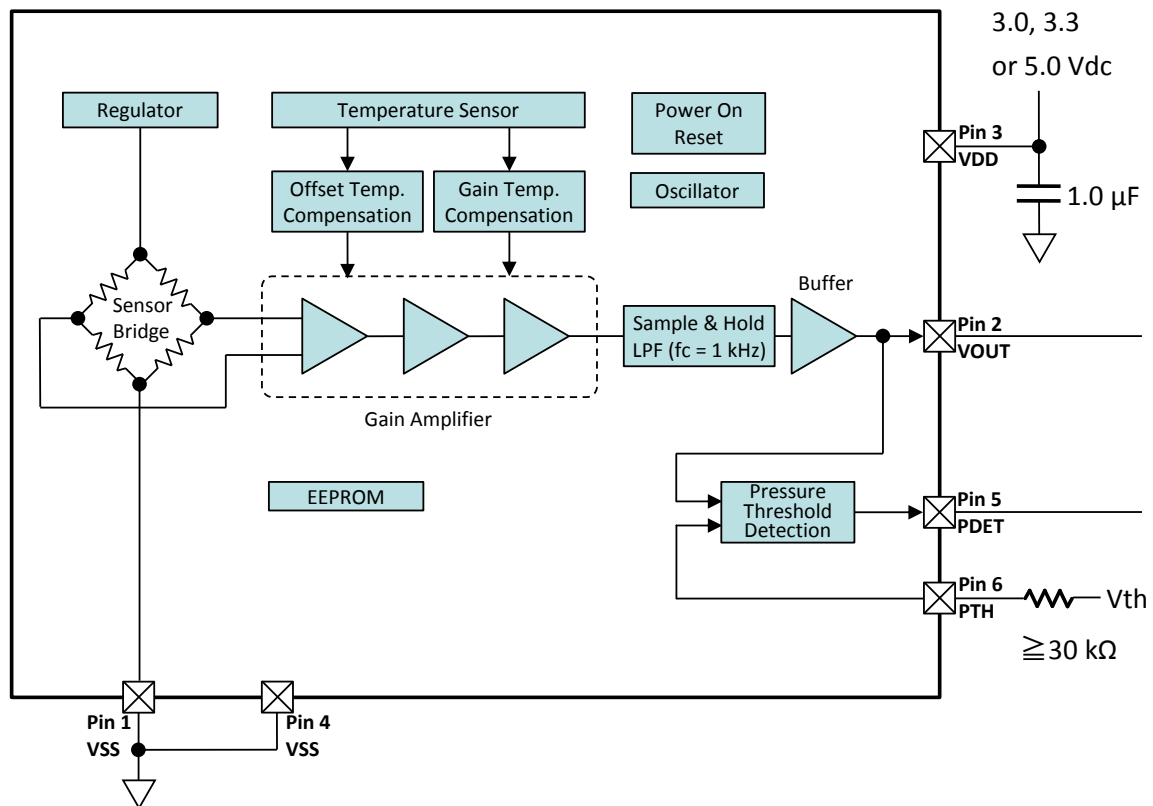
**Applications**

- ✓ Medical devices
- ✓ Industrial pneumatic devices
- ✓ Consumer devices

**4. RoHS**

This device is compliant with the Restriction of the use of certain Hazardous Substances in Electrical and Electronic Equipment (RoHS).

## 5. Block Diagram and Pin Connections



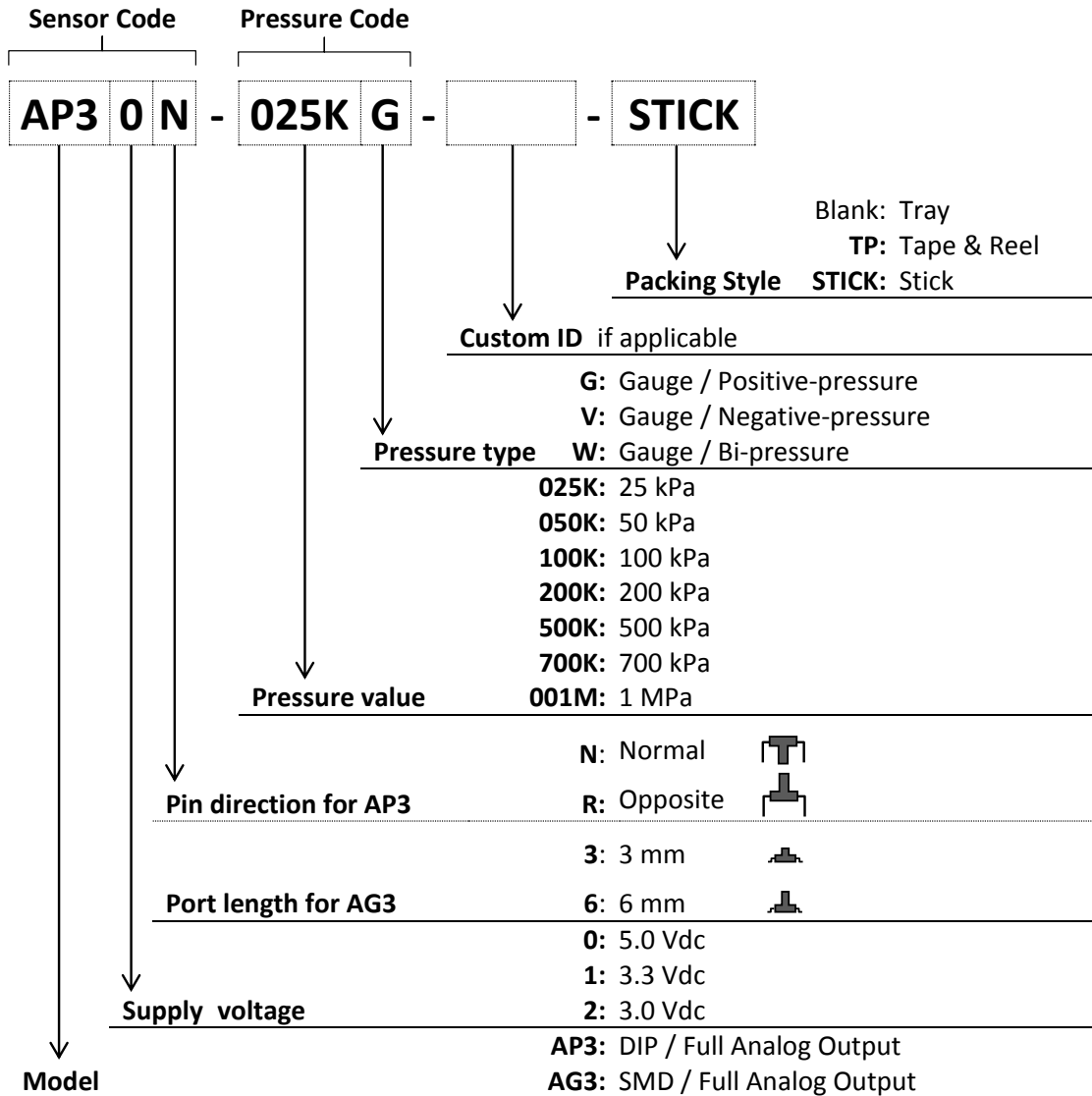
Pin Assignment		Pin No.	Pin Name	I/O	Type	Function	
AP3	AG3						
		1	VSS	-	-	Common voltage connection	*1
		2	VOUT	O	Analog	Analog output	
		3	VDD	-	-	Power supply connection	*2
		4	VSS	-	-	Common voltage connection	*1
		5	PDET	O	Digital	Pressure threshold detection	*4
		6	PTH	I	Analog	Pressure threshold input	*3, 4

### Notes:

- \*1) Both Pin 1 and Pin 4 must be connected to VSS.
- \*2) Put a 1.0  $\mu$ F capacitor between Pin3 (VDD) and VSS.
- \*3) Put a resistor in series with Pin6 (PTH), when inputting threshold voltage ( $V_{th}$ ). The minimum resistance value is 30 k $\Omega$ .
- \*4) When an application does not use Pressure Threshold Detection, put a pull-up resistor between Pin6 (PTH) and VDD, or put a pull-down resistor between Pin6 (PTH) and VSS, and Pin5 (PDET) must be non-connection. The minimum resistance value is 30 k $\Omega$ .

**6. Device Name Code**

The device name code is consisted of Sensor code, Pressure code, Custom ID and Packing style. For the exact ordering device number, please refer to Chapter 17 Ordering Information.



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## 7. Absolute Maximum Ratings

Item		Symbol	Rating	Unit	
Load Pressure	Pressure Code	Pmax+	025KG	+50	kPa
			050KG	+100	kPa
			100KG	+200	kPa
			200KG	+400	kPa
			500KG	+1000	kPa
			700KG	+1.4	MPa
			001MG	+1.5	MPa
			050KV	+100	kPa
			100KV	+200	kPa
			100KW	+200	kPa
Supply Voltage		VDDmax	6	Vdc	
Input Voltage		VIN	VSS-0.3~VDD+0.3	V	
Operating Temperature		Topt	-40 ~ +105	deg. C	
Storage Temperature		Tstg	-40 ~ +105	deg. C	

Note:

\*1) Absolute maximum ratings are the limits that the device will withstand without damage.

## 8. General Specifications

Item	Condition	Symbol	Rating			Unit	
			Min.	Typ.	Max.		
Supply Voltage	Sensor Code	VDD	AP30x, AG30x	4.75	5	5.25	Vdc
			AP31x, AG31x	3.135	3.3	3.465	
			AP32x, AG32x	2.85	3.0	3.15	
Type of Pressure		-	Gauge pressure				
Pressure Media		-	Non-corrosive gases				
Pressure Range	Pressure Code	Popt	025KG	0	-	+25	kPa
			050KG	0	-	+50	kPa
			100KG	0	-	+100	kPa
			200KG	0	-	+200	kPa
			500KG	0	-	+500	kPa
			700KG	0	-	+700	kPa
			001MG	0	-	+1	MPa
			050KV	-50	-	0	kPa
			100KV	-100	-	0	kPa
			100KW	-100	-	+100	kPa
Compensated Temperature		-	0	-	+60	deg. C	
Operating Humidity	Non-condensing	Hopt	30	-	85	%RH	
Storage Humidity	Non-condensing	Hstg	30	-	85	%RH	
Dielectric Strength		-	-	-	1	mA	
Insulation Resistance		-	100	-	-	MΩ	

Notes:

\*1) Output voltage (Vout) is not perfectly ratio-metric with the power supply voltage (VDD).

\*2) Gauge pressure is defined as the difference between applied pressure to the pressure port and atmospheric pressure of the device.

\*3) Ensure the pressure media contains no particulates. The device is not compatible with liquids.

\*4) Pressure range is defined as the measurable pressure range of the device. Do not expose intentionally beyond minimum Popt and maximum Popt.

\*5) Please also refer to Chapter 11 Transfer Function.

\*6) Do not wet the device with dew.

\*7) Dielectric strength is defined as the leakage current between all pins and the package with AC 500, 1 minute.

\*8) Insulation resistance is defined as the resistance value between all pins and the package with DC 500 V.

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## 9. Electrical Characteristics

Load resistor  $R_L = \infty$ , Ambient temperature  $T_a = 25$  deg. C

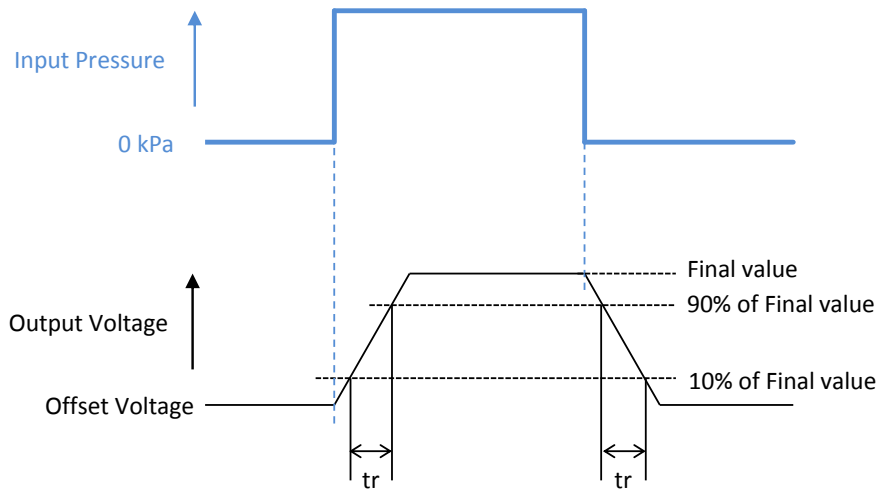
Item	Condition	Symbol	Rating			Unit	
			Min.	Typ.	Max.		
<b>Sensor Code: AP30x, AG30x (VDD = 5.0 Vdc)</b>							
Offset Voltage	Min. Popt, 050KV & 100KV: Max. Popt	Voff	0.1325	0.2	0.2675	V	*1, 2
Full Scale Voltage	Max. Popt 050KV & 100KV: Min. Popt	Vfs	4.6325	4.7	4.7675	V	*3
Span Voltage	Min. to max. Popt	SV	-	4.5	-	V	*4
Accuracy	0 to 60 deg. C	Error	-1.5	-	+1.5	%FS	*5, 6
			-0.0675	-	+0.0675	V	
Supply Current		Ic	-	-	6	mAdc	*7
<b>Sensor Code: AP31x, AG31x (VDD = 3.3 Vdc)</b>							
Offset Voltage	Min. Popt, 050KV & 100KV: Max. Popt	Voff	0.2595	0.3	0.3405	V	*1, 2
Full Scale Voltage	Max. Popt 050KV & 100KV: Min. Popt	Vfs	2.9595	3.0	3.0405	V	*3
Span Voltage	Min. to max. Popt	SV	-	2.7	-	V	*4
Accuracy	0 to 60 deg. C	Error	-1.5	-	+1.5	%FS	*5, 6
			-0.0405	-	+0.0405	V	
Supply Current		Ic	-	-	5	mAdc	*7
<b>Sensor Code: AP32x, AG32x (VDD = 3.0 Vdc)</b>							
Offset Voltage	Min. Popt, 050KV & 100KV: Max. Popt	Voff	0.096	0.15	0.204	V	*1, 2
Full Scale Voltage	Max. Popt 050KV & 100KV: Min. Popt	Vfs	2.796	2.85	2.904	V	*3
Span Voltage	Min. to max. Popt	SV	-	2.7	-	V	*4
Accuracy	0 to 60 deg. C	Error	-2.0	-	+2.0	%FS	*5, 6
			-0.054	-	+0.054	V	
Supply Current		Ic	-	-	5	mAdc	*7
Response Time	for reference	tr	-	2	-	msec.	*8
Load Resistor	VOUT - VSS or VDD - VOUT	RL	9.5	-	-	kΩ	*7
Load Capacitance	VOUT - VSS	CL	-	-	50	pF	*9

## Notes:

- \*1) Offset voltage (Voff) is defined as the output voltage at minimum Popt. In case of 050KV and 100KV, Offset voltage (Voff) is defined as the output voltage at maximum Popt.
- \*2) Offset error is calibration error of offset voltage at production. It does not include Long term offset drift. It would be suggested that applications have Auto-zeroing function.
- \*3) Full scale voltage (Vfs) is defined as the output voltage at maximum Popt. In case of 050KV and 100KV, Full scale voltage (Vfs) is defined as the output voltage at minimum Popt.
- \*4) Output span voltage (SV) is defined as the voltage difference between Offset voltage (Voff) and Full scale voltage (Vfs).
- \*5) Accuracy consists of the following:
  - Non-linearity
  - Temperature errors over the temperature range 0 to 60 degree C
  - Pressure hysteresis
  - Calibration errors of sensitivity and offset

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- \*6) The unit of Accuracy “%FS” is defined as a percent error by Span voltage (SV).
- \*7) Supply Current ( $I_c$ ) is increased depending on the value of Load resistor ( $R_L$ ).
- \*8) Response time ( $t_r$ ) is defined as the time for the change in output voltage from 10% to 90% or from 90% to 10% of its final value when the input pressure makes a step change.



- \*9) Do not put Load capacitance ( $C_L$ ) that is over 50 pF between VOUT and VSS.



10. Output versus Input Pressure

Sensor Code	Pressure Code			
	025KG, 050KG, 100KG, 200KG, 500KG, 700KG, 001MG	050KV, 100KV	100KW	
AP30x AG30x	<p>VDD = 5.0 Vdc Temp. = 0 to 60°C</p> <p>Output vs Input Pressure. Vfs: 4.7 V, Voff: 0.2 V, Error: <math>\pm 1.5\%FS</math>, SV: 4.5 V. Min. Popt: 0 kPa, Max. Popt.</p>	<p>VDD = 5.0 Vdc Temp. = 0 to 60°C</p> <p>Output vs Input Pressure. Vfs: 4.7 V, Voff: 0.2 V, Error: <math>\pm 1.5\%FS</math>, SV: 4.5 V. Min. Popt, Max. Popt: 0 kPa.</p>	<p>VDD = 5.0 Vdc Temp. = 0 to 60°C</p> <p>Output vs Input Pressure. Vfs: 4.7 V, Voff: 0.2 V, Error: <math>\pm 1.5\%FS</math>, SV: 4.5 V. Min. Popt, 0 kPa, Max. Popt.</p>	
	AP31x AG31x	<p>VDD = 3.3 Vdc Temp. = 0 to 60°C</p> <p>Output vs Input Pressure. Vfs: 3.0 V, Voff: 0.3 V, Error: <math>\pm 1.5\%FS</math>, SV: 2.7 V. Min. Popt: 0 kPa, Max. Popt.</p>	<p>VDD = 3.3 Vdc Temp. = 0 to 60°C</p> <p>Output vs Input Pressure. Vfs: 3.0 V, Voff: 0.3 V, Error: <math>\pm 1.5\%FS</math>, SV: 2.7 V. Min. Popt, Max. Popt: 0 kPa.</p>	<p>VDD = 3.3 Vdc Temp. = 0 to 60°C</p> <p>Output vs Input Pressure. Vfs: 3.0 V, Voff: 0.3 V, Error: <math>\pm 1.5\%FS</math>, SV: 2.7 V. Min. Popt, 0 kPa, Max. Popt.</p>
		AP32x AG32x	<p>VDD = 3.0 Vdc Temp. = 0 to 60°C</p> <p>Output vs Input Pressure. Vfs: 2.85 V, Voff: 0.15 V, Error: <math>\pm 2.0\%FS</math>, SV: 2.7 V. Min. Popt: 0 kPa, Max. Popt.</p>	<p>VDD = 3.0 Vdc Temp. = 0 to 60°C</p> <p>Output vs Input Pressure. Vfs: 2.85 V, Voff: 0.15 V, Error: <math>\pm 2.0\%FS</math>, SV: 2.7 V. Min. Popt, Max. Popt: 0 kPa.</p>

11. Transfer Function

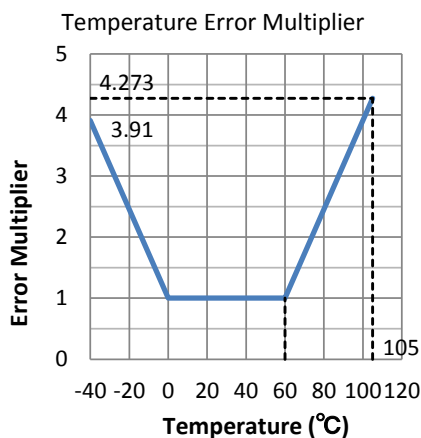
$$V_{out} = VDD \times ((P \times \alpha) + \beta) \pm (\text{Pressure Error} \times \text{Temperature Error Multiplier} \times \alpha \times VDD)$$

Parameters:

Sensor Code	Parameter Pressure Code	VDD (*1)	P (kPa)	$\alpha$	$\beta$	Pressure Error (kPa)
AP30x AG30x	025KG	5.0±0.25V	0 ~ +25	9/250	1/25	0.375
	050KG		0 ~ +50	9/500	1/25	0.75
	100KG		0 ~ +100	9/1000	1/25	1.5
	200KG		0 ~ +200	9/2000	1/25	3.0
	500KG		0 ~ +500	9/5000	1/25	7.5
	700KG		0 ~ +700	9/7000	1/25	10.5
	001MG		0 ~ +1000	9/10000	1/25	15
	050KV		-50 ~ 0	-9/500	1/25	0.75
	100KV		-100 ~ 0	-9/1000	1/25	1.5
	100KW		-100 ~ +100	9/2000	49/100	3.0
AP31x AG31x	025KG	3.3±0.165V	0 ~ +25	9/275	1/11	0.375
	050KG		0 ~ +50	9/550	1/11	0.75
	100KG		0 ~ +100	9/1100	1/11	1.5
	200KG		0 ~ +200	9/2200	1/11	3.0
	500KG		0 ~ +500	9/5500	1/11	7.5
	700KG		0 ~ +700	9/7700	1/11	10.5
	001MG		0 ~ +1000	9/11000	1/11	15
	050KV		-50 ~ 0	-9/550	1/11	0.75
	100KV		-100 ~ 0	-9/1100	1/11	1.5
	100KW		-100 ~ +100	9/2200	1/2	3.0
AP32x AG32x	025KG	3.0±0.15V	0 ~ +25	9/250	1/20	0.5
	050KG		0 ~ +50	9/500	1/20	1
	100KG		0 ~ +100	9/1000	1/20	2
	200KG		0 ~ +200	9/2000	1/20	4
	500KG		0 ~ +500	9/5000	1/20	10
	700KG		0 ~ +700	9/7000	1/20	14
	001MG		0 ~ +1000	9/10000	1/20	20
	050KV		-50 ~ 0	-9/500	1/20	1
	100KV		-100 ~ 0	-9/1000	1/20	2
	100KW		-100 ~ +100	9/2000	1/2	4

Note:

\*1) Output voltage (Vout) is not perfectly ratio-metric with the power supply voltage (VDD).



### 12. Single Point Pressure Threshold Detection

AP3 and AG3 have a comparator. Output voltage (VOUT) and threshold voltage from PTH are inputted into the comparator. Comparator's output will be changed when VOUT reaches a threshold voltage.

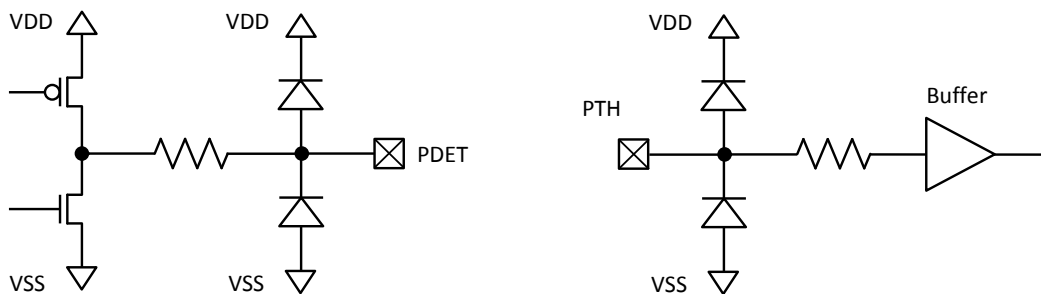
Ambient temperature Ta = 25 deg. C

Item	Condition	Symbol	Rating			Unit
			Min.	Typ.	Max.	
Type of Output		PDET	CMOS output			*2
Threshold Input voltage	PTH	Vth	0.1*VDD	-	0.9*VDD	V
Input Impedance	PTH	Zin	1	-	-	MΩ
Output voltage	VOUT < Vth	V <sub>OH</sub>	0.9*VDD	-	-	V
	VOUT ≥ Vth	V <sub>OL</sub>	-	-	0.1*VDD	V
Pressure Hysteresis		Phys	-	0.05*VDD	-	V
Detection Time		Tdetr	-	150	-	μsec
Non Detection Time		Tdetf	-	150	-	μsec

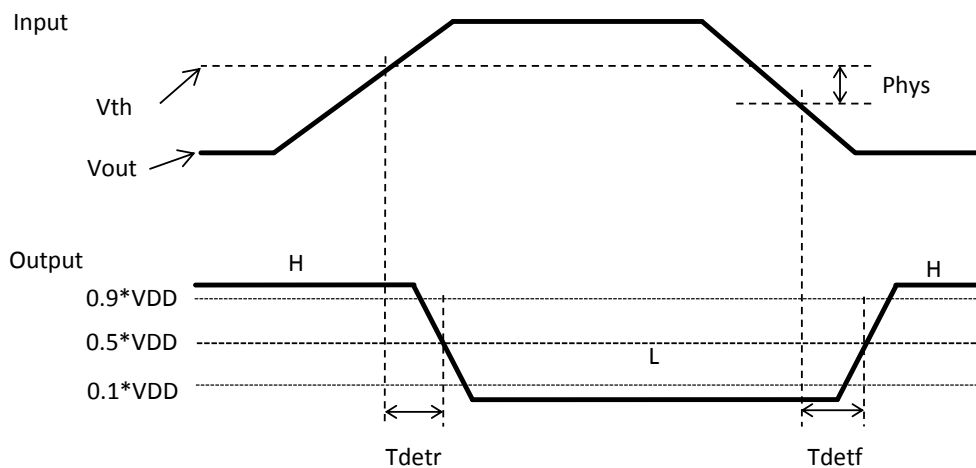
Notes:

\*1) Do not control any device directly using this function. Because there is indeterminate status during the supply voltage rises.

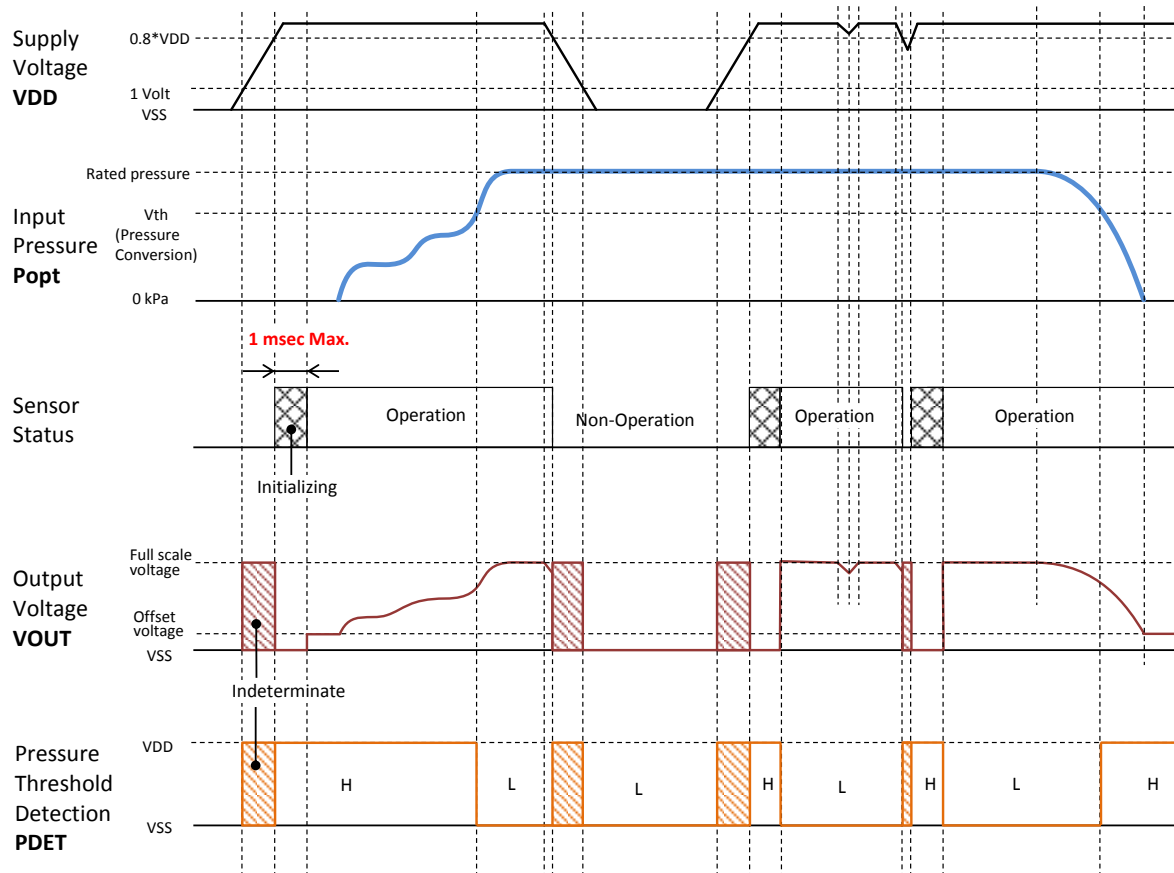
\*2) Equivalent circuits of PDET and PTH are as below:



\*3) Please also refer to the following timing chart.



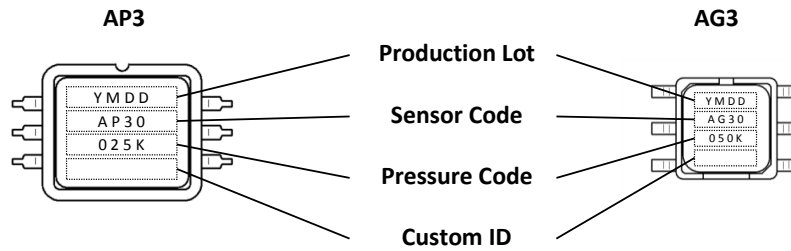
### 13. Operating Sequence



Notes:

- \*1) The status of VOUT, PDET and PTH are indeterminate when supply voltage is under 0.8\*VDD.
- \*2) Initializing process is started when supply voltage reaches 0.8\*VDD,. At initializing process, PDET is fixed 0.9\*VDD and over, and VOUT is fixed 0.1\*VDD and under.

14. Device Marking



Items		Marking
Production Lot		
Y	Last digit of Production year	0~9
M	Production month	1, 2, 3 ~ 8, 9, X=Oct., Y=Nov., Z=Dec.
DD	Production date	01~31
Sensor Code		
	AP30x	AP30
	AP31x	AP31
	AP32x	AP32
	AG30x	AG30
	AG31x	AG31
	AG32x	AG32
Pressure Code		
	025KG	025K
	050KG	050K
	100KG	100K
	200KG	200K
	500KG	500K
	700KG	700K
	001MG	001M
	050KV	050V
	100KV	100V
	100KW	100W
Custom ID		If applicable

Notes:

- \*1) Pin direction for AP3 or Port length for AG3 is not marked on the face plate.
- \*2) Custom ID will be added when a product is customized for a customer.

**15. Soldering**

Process	Sensor Code	Condition															
Hand soldering	AP3xx	Soldering iron temperature: 350 deg. C max. Soldering time: 3 seconds max. / each pin															
Wave soldering	AP3xR	Soldering bath temperature: 260 deg. C max. Soldering time: 5 seconds max.															
Reflow soldering	AG3xx	<div style="text-align: center;"> <p><b>Soldering Profile</b></p> <p><b>Temperature(°C)</b></p> <p><b>Time</b></p> <table border="1"> <thead> <tr> <th>A</th> <th>Ramp up</th> <th>2 to 4 deg. C / sec.</th> </tr> </thead> <tbody> <tr> <th>B</th> <th>Pre-heating</th> <th>150 to 180 deg. C 60 to 120 sec.</th> </tr> <tr> <th>C</th> <th>Ramp up</th> <th>2 to 4 deg. C / sec.</th> </tr> <tr> <th>D</th> <th>Heating</th> <th>Above 230 deg. C, 45 sec. max. 245 deg. C max., 10 sec. max.</th> </tr> <tr> <th>E</th> <th>Ramp down</th> <th>2 to 4 deg. C / sec.</th> </tr> </tbody> </table> </div>	A	Ramp up	2 to 4 deg. C / sec.	B	Pre-heating	150 to 180 deg. C 60 to 120 sec.	C	Ramp up	2 to 4 deg. C / sec.	D	Heating	Above 230 deg. C, 45 sec. max. 245 deg. C max., 10 sec. max.	E	Ramp down	2 to 4 deg. C / sec.
A	Ramp up	2 to 4 deg. C / sec.															
B	Pre-heating	150 to 180 deg. C 60 to 120 sec.															
C	Ramp up	2 to 4 deg. C / sec.															
D	Heating	Above 230 deg. C, 45 sec. max. 245 deg. C max., 10 sec. max.															
E	Ramp down	2 to 4 deg. C / sec.															

\*1, 2  
\*1, 2  
\*1, 2,  
3, 4

**Notes:**

- \*1) NEVER wash the device with any washing liquid. NEVER wash the device with any ultrasonic washing machine.
- \*2) Do not put the solder and flux on the device's package.
- \*3) Temperature means Surface temperature of the device's package.
- \*4) Do not reflow more than twice.

**16. Dimensions and Weights**

Refer to the following drawing as attached.

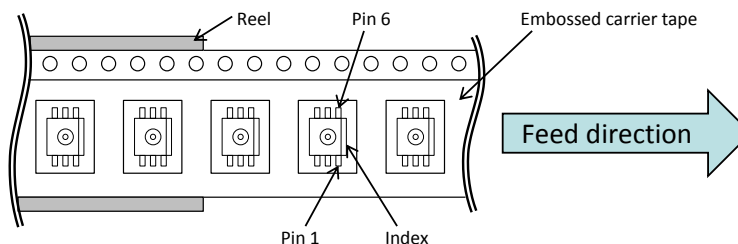
Sensor Code	Dimension Drawing	Weights
AP3xN	9-772-001	approx. 1.4 grams
AP3xR	9-772-002	
AG3x3	9-772-003	approx. 0.3 grams
AG3x6	9-772-004	approx. 0.4 grams

**17. Ordering Information**

Model	Package	Supply Voltage	Pin Direction	Packing	Ordering Device Number	Qty./Packing	
AP3	DIP	5.0 Vdc	Normal	Tray	AP30N- [Pressure Code]	150 Pcs/Tray	
				Stick	AP30N- [Pressure Code] -STICK	40 Pcs/Stick	
			Opposite	Tray	AP30R- [Pressure Code]	150 Pcs/Tray	
				Stick	AP30R- [Pressure Code] -STICK	40 Pcs/Stick	
			3.3 Vdc	Normal	Tray	AP31N- [Pressure Code]	150 Pcs/Tray
					Stick	AP31N- [Pressure Code] -STICK	40 Pcs/Stick
		Opposite	Tray	AP31R- [Pressure Code]	150 Pcs/Tray		
			Stick	AP31R- [Pressure Code] -STICK	40 Pcs/Stick		
		3.0 Vdc	Normal	Tray	AP32N- [Pressure Code]	150 Pcs/Tray	
				Stick	AP32N- [Pressure Code] -STICK	40 Pcs/Stick	
			Opposite	Tray	AP32R- [Pressure Code]	150 Pcs/Tray	
				Stick	AP32R- [Pressure Code] -STICK	40 Pcs/Stick	
			Port Length				
AG3	SMD		5.0 Vdc	3 mm	Tray	AG303- [Pressure Code]	300 Pcs/Tray
		Tape & Reel			AG303- [Pressure Code] -TP	500 Pcs/Reel	
		6 mm		Tray	AG306- [Pressure Code]	300 Pcs/Tray	
				Tape & Reel	AG306- [Pressure Code] -TP	500 Pcs/Reel	
		3.3 Vdc		3 mm	Tray	AG313- [Pressure Code]	300 Pcs/Tray
					Tape & Reel	AG313- [Pressure Code] -TP	500 Pcs/Reel
			6 mm	Tray	AG316- [Pressure Code]	300 Pcs/Tray	
				Tape & Reel	AG316- [Pressure Code] -TP	500 Pcs/Reel	
		3.0 Vdc	3 mm	Tray	AG323- [Pressure Code]	300 Pcs/Tray	
				Tape & Reel	AG323- [Pressure Code] -TP	500 Pcs/Reel	
			6 mm	Tray	AG326- [Pressure Code]	300 Pcs/Tray	
				Tape & Reel	AG326- [Pressure Code] -TP	500 Pcs/Reel	

Pressure Range	Pressure Code
0 ~ +25 kPa	025KG
0 ~ +50 kPa	050KG
0 ~ +100 kPa	100KG
0 ~ +200 kPa	200KG
0 ~ +500 kPa	500KG
0 ~ +700 kPa	700KG
0 ~ +1 MPa	001MG
-50 ~ 0 kPa	050KV
-100 ~ 0 kPa	100KV
-100 ~ +100 kPa	100KW

**18. Tape & Reel Information**



**19. Footprint for PCB (for Reference)**

Sensor Code	Footprint
AP3xN	
AP3xR	
AG3x3	
AG3x6	

Notes:

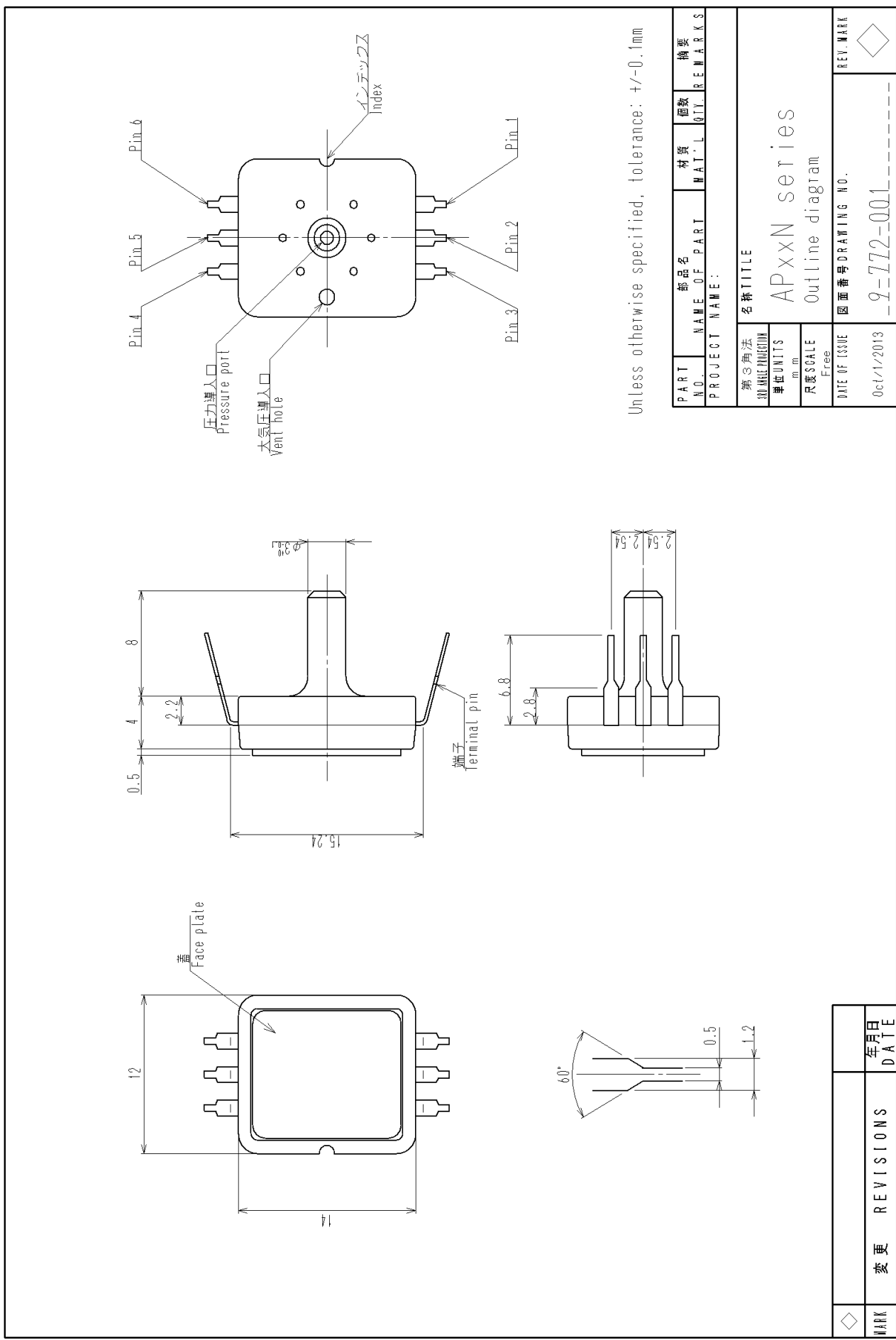
- \*1) These footprints are for reference. Please evaluate well these footprints, before your mass production.
- \*2) When designing your PCB, please also refer to the outline diagrams.



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**V-70028A****20. Notes**

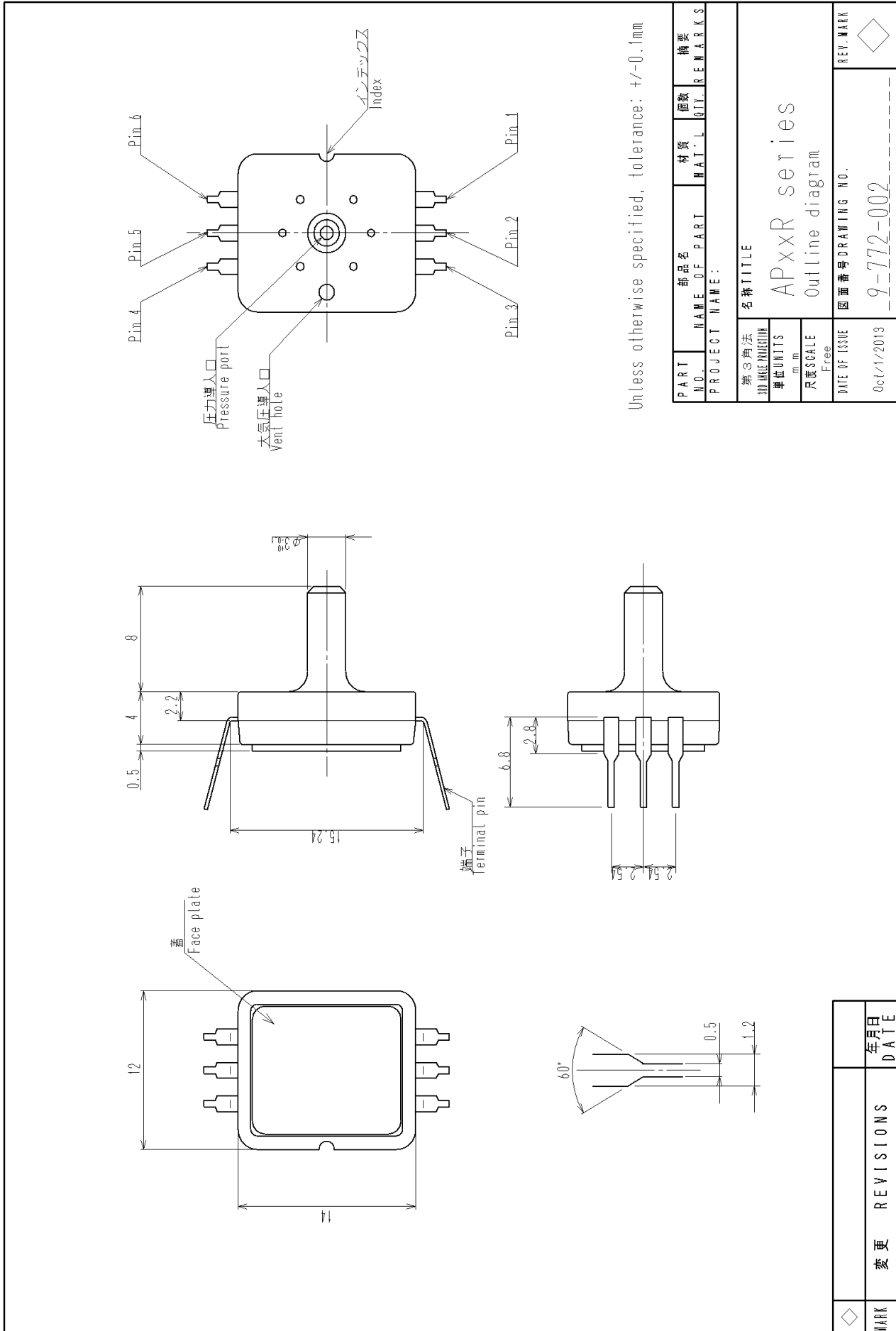
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- Please refer to the latest specifications.



Unless otherwise specified, tolerance: +/-0.1mm

PART NO.	部品名	材質	数量	摘要
NAME OF PART	MAT'L	QTY.	REMARKS	
PROJECT NAME:				
名称 TITLE				
APxxN series				
Outline diagram				
第3角法 3rd ANGLE METHOD	単位 UNITS mm	尺度 SCALE Free	DATE OF ISSUE	REV. MARK
			0ct/1/2013	
			図面番号 DRAWING NO.	
			9-772-001	

MARK	変更 REVISIONS	年月日 DATE
◇		



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