

SPECIFICATION

No. K11449	Rev. 00
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Title Customer Acceptance Specification - Meterbody -	Approved by	I.Ikeda	2009/1/15
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Revisions																			
Rev.	Page	Reason/Detail													Written	Approv.	Date		

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1. Scope

This document refers to the specification of Yamatake's AT9000 series electronic differential pressure transmitter Meterbody, to be supplied to JUMO.

A sales contract should be prepared separately from this document.

2. Model Number Configuration

Model Code - Category	G: Global M: Meterbody	GM
Model Code - Customer Code	Company code (JUMO)	J
Model Code - Range/MWP	-1 to 1kPa / 0.21MPa	15D
	-100 to 100kPa / 21MPa	31D
	-100 to 100kPa / 42MPa	32D
	-100 to 100kPa / 21MPa (Compound Chara.)	36D
	-100 to 100kPa / 42MPa (Compound Chara.)	37D
	-100 to 700kPa / 21MPa	41D
	-100 to 700kPa / 42MPa	42D
	-0.1 to 14MPa / 21MPa	71D
-0.1 to 14MPa / 42MPa	72D	
Fill Fluid	Silicone Oil (regular type)	-A
	Fluorine Oil (for oxygen service)	-H
Material (Meterbody Cover)	SCS14A or SUS316	A
Material (Meterbody)	SUS316 (Diaphragm: SUS316L)	A
	ASTM B575	B
	Tantalum	C
	SUS316L	D
Process Connection	1/2 NPT internal thread, with adapter flange	D
	1/4 NPT internal thread, with adapter flange	E
	1/4 NPT internal thread, without adapter flange	F
Bolt / Nuts	Carbon Steel	A
	SUS304	B
	SUS630	C
Optional Code	No Option	-XX
	With Adapter Flange for Corrosion Resistant Application	-A1

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3. Environmental Operating Conditions

Item	Unit	Reference Operating Condition	Normal Operating Condition	Operating Limit	Transportation and Storage Conditions	
Static Pressure Change	MPa/s	0	0 to 1000	0 to 10000	---	
Temperature Change	°C/h	0	0 to 15	0 to 100	---	
Vibration	5 to 60Hz	mm P-P	0	0.42	---	---
	60 to 200Hz	m/s ² (G)	0 (0)	0 to 29.4 (0 to 3)	0 to 34.3 (0 to 3.5)	0 to 9.8 (0 to 1)
Shock Wave Frequency above 10Hz	MPa P-P	0	0	0 to 7	---	
Impact	Maximum Acceleration	m/s ²	0	0 to 9.8	0 to 49	0 to 294
	Impact Duration	ms	0	---	0 to 50	0 to 11

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4. Working Pressure Limits

4.1 GMJ31D, GMJ41D, GMJ71D

Maximum Working Pressure

Depends on selected bolt material. See table 1.

Minimum Working Pressure

Depends on selected fill fluid and temperature of wetted parts.

See Fig.1 for silicone oil, and Fig.2 for fluorine oil.

Table 1. Maximum Working Pressure According to Bolt Material

Bolt Material	Maximum Working Pressure [MPa]	
	Normal Operating Condition	Operating Limit
SNB7 SUS630	21	31.5
SUS304	10	15

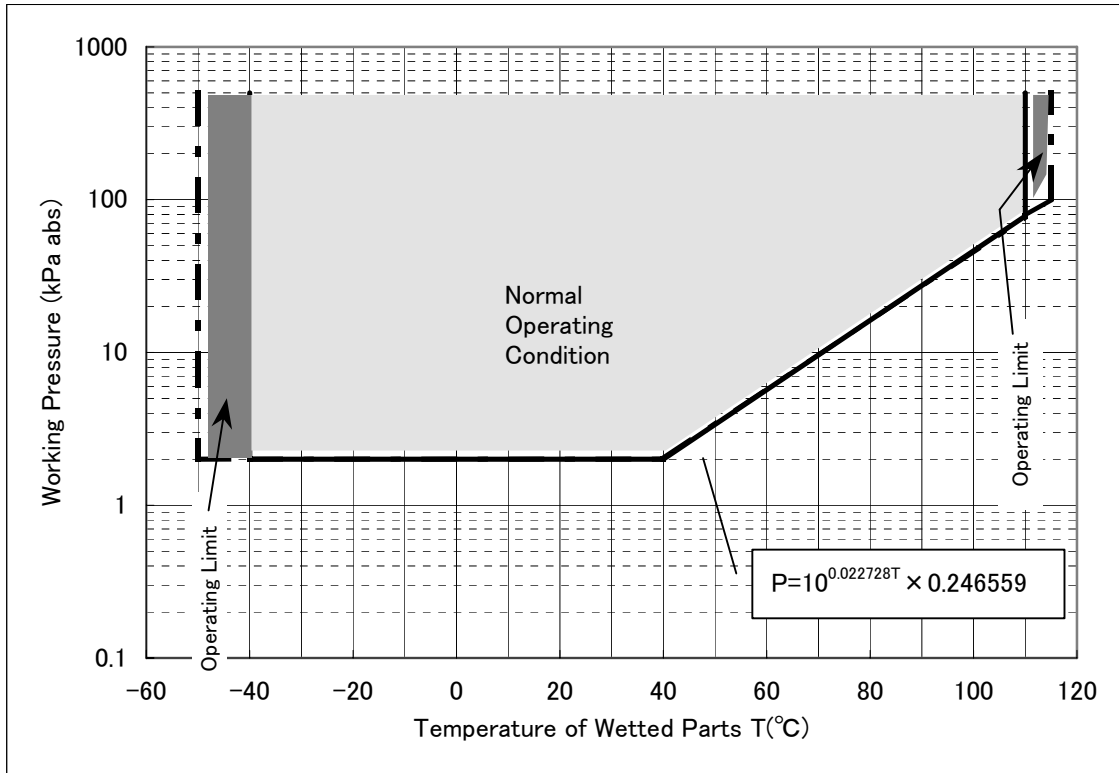


Fig.1 Minimum Working Pressure for Fill Fluid: Silicone Oil

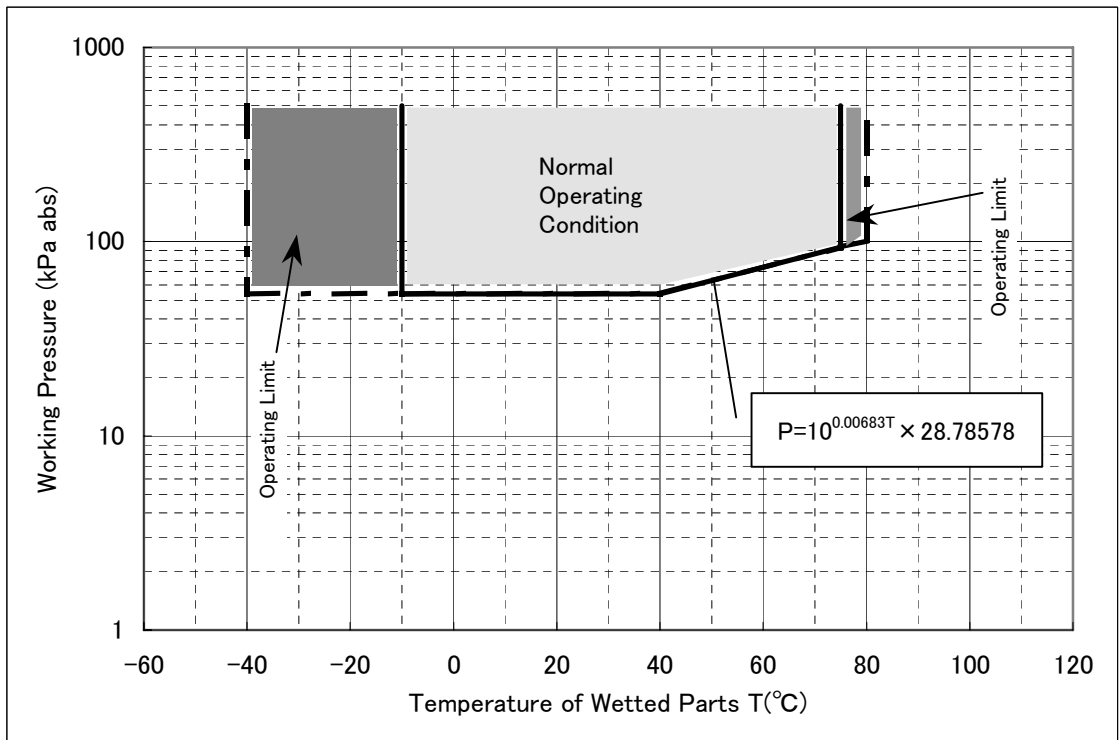


Fig.2 Minimum Working Pressure for Fill Fluid: Fluorine Oil

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4.2 GMJ32D, GMJ42D, GMJ72D

Maximum Working Pressure

Depends on selected bolt material. See table 2.

Minimum Working Pressure

Depends on selected fill fluid and temperature of wetted parts.

See Fig.1 for silicone oil, and Fig.2 for fluorine oil.

Table 2. Maximum Working Pressure According to Bolt Material

Bolt Material	Maximum Working Pressure [MPa]	
	Normal Operating Condition	Operating Limit
SNB7 SUS630	42	63
SUS304	23	34.5

4.3 GMJ15D

Maximum and Minimum Working Pressure

Depends on selected fill fluid and temperature of wetted parts.

See Fig.3 for silicone oil, and Fig.4 for fluorine oil.

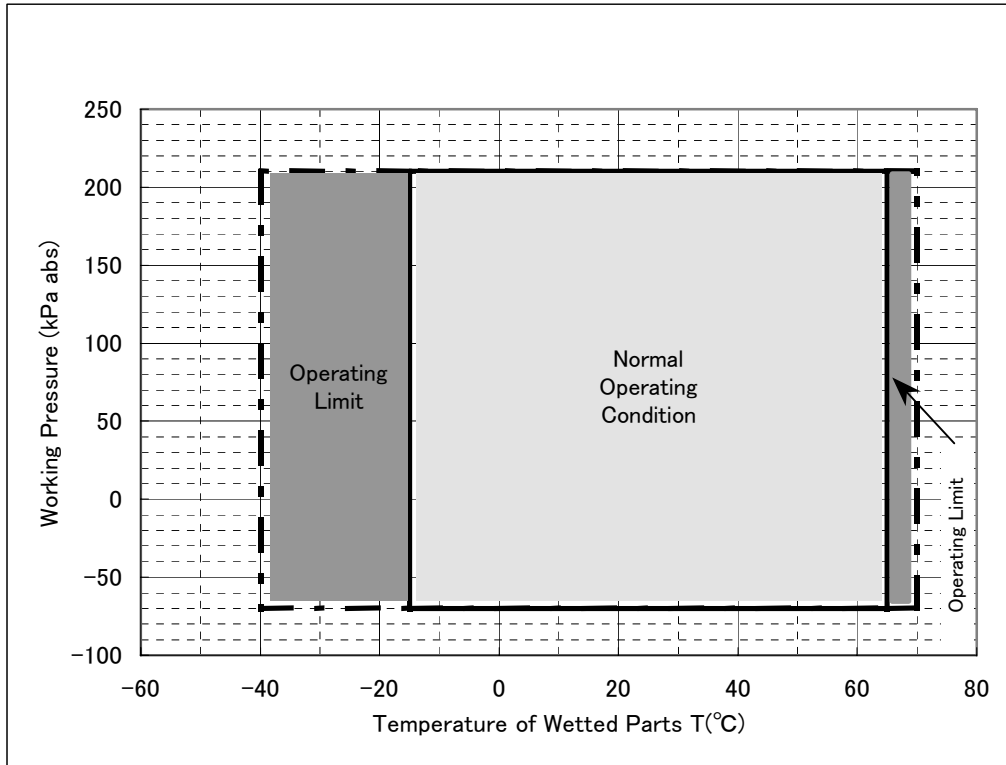


Fig.3 Working Pressure for GMJ15D, Fill Fluid: Silicone Oil

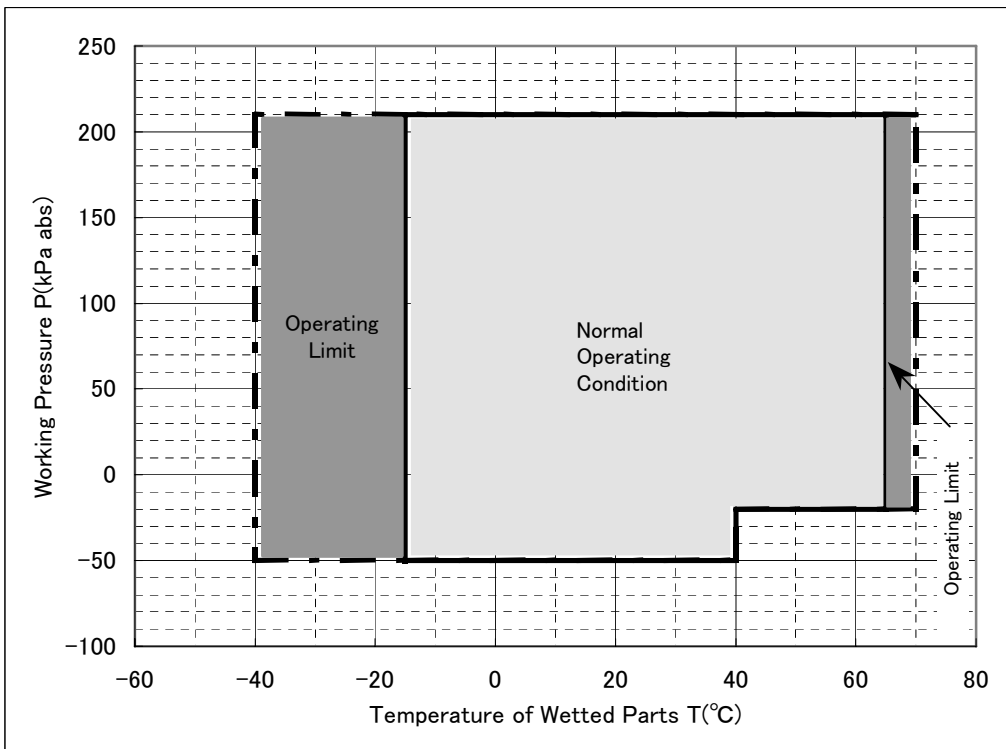


Fig.4 Working Pressure for GMJ15D, Fill Fluid: Fluorine Oil

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5. Working Temperature Condition

5.1 Reference Operating Condition

Ambient Temperature : $23 \pm 2^{\circ}\text{C}$
Wetted Parts Temperature : $23 \pm 2^{\circ}\text{C}$

5.2 Normal Operating Condition, Operating Limit, Transport and Storage Condition

Ambient Temperature refers to temperature of ADC Board and potting within sensor cover.

Wetted Parts temperature refers to process temperature.

Table 3. Temperature Conditions, Fill Fluid: Silicone Oil

Model	Temperature Item	Normal Operating Condition	Operating Limit	Transport and Storage Condition
GMJ15D	Ambient	-15 to 65°C	-40 to -15°C, 65 to 70°C	-15 to 65°C
	Wetted Parts	-15 to 65°C	-40 to -15°C, 65 to 70°C	---
GMJ31D GMJ36D GMJ41D GMJ71D	Ambient	-40 to 85°C	-50 to -40°C, 85 to 93°C	-40 to 85°C
	Wetted Parts	-40 to 110°C	-50 to -40°C, 110 to 115°C	---
GMJ32D GMJ37D GMJ42D GMJ72D	Ambient	-15 to 85°C	-20 to -15°C, 85 to 93°C	-15 to 85°C
	Wetted Parts	-15 to 110°C	-20 to -15°C, 110 to 115°C	---

Table 4. Temperature Conditions, Fill Fluid: Fluorine Oil

Model	Temperature Item	Normal Operating Condition	Operating Limit	Transport and Storage Condition
GMJ15D GMJ31D GMJ36D GMJ41D GMJ71D	Ambient	-10 to 75°C	-15 to -10°C, 75 to 80°C	-10 to 75°C
	Wetted Parts	See Fig.2 and Fig.4		---
GMJ32D GMJ37D GMJ42D GMJ72D	Ambient	-10 to 75°C	-15 to -10°C, 75 to 80°C	-10 to 75°C
	Wetted Parts	-10 to 75°C	-15 to -10°C, 75 to 80°C	---

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6. Electronics

6.1 Power Supply Voltage

VA to AG : 5.0V \pm 2%

VD to AG : 2.7V to 5.25V (3V Recommended)

6.2 Absolute Maximum Ratings

VA to AG : -0.3V to +7.0V

VD to AG : -0.3V to +7.0V

Digital Input Voltage to GND : -0.3 V to VD + 0.3 V

Digital Output Voltage to GND : -0.3 V to VD + 0.3 V

6.3 Currents

Total current consumption of VA line and VD line to be below 1200 μ A, at temperature within 25 \pm 5 $^{\circ}$ C

6.4 Withstand Voltage

500VAC between connector pin and body, with all connector pins connected, for 1min, permissible current 1mA.

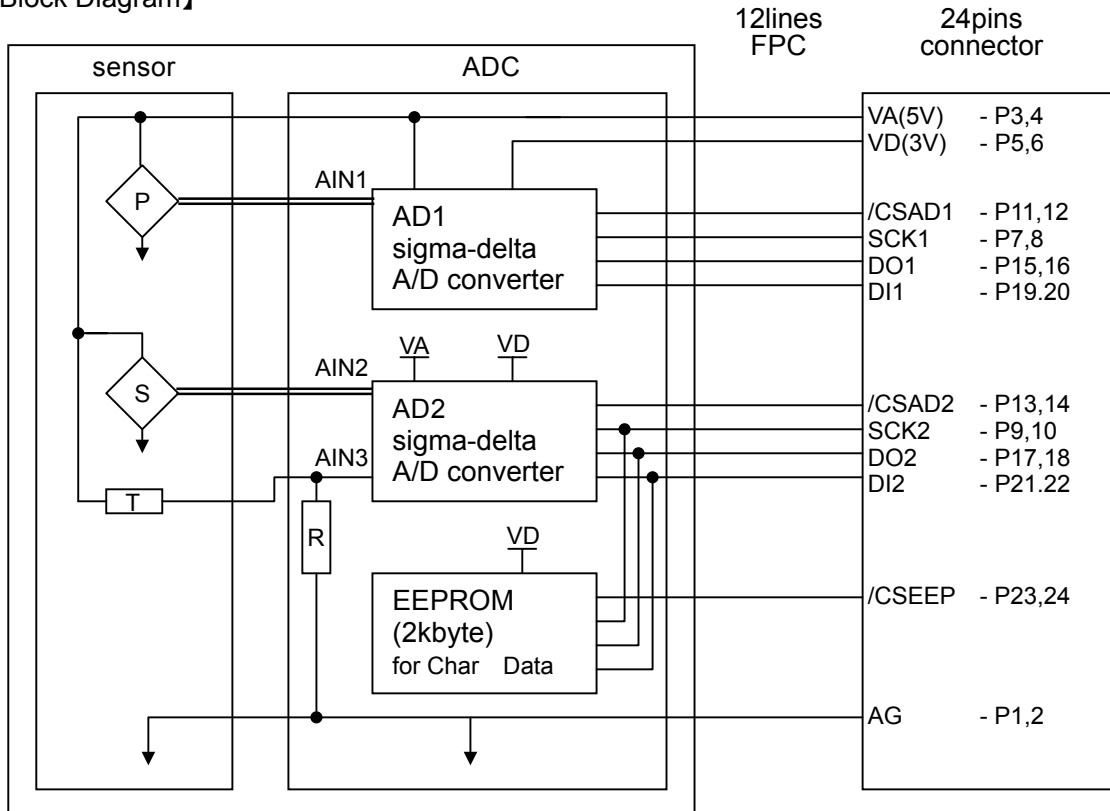
6.5 Insulation Resistance

Over $2 \times 10^7 \Omega$ between connector pin and body, with all connector pins connected, at 25VDC, humidity below 60%R.H.

7. Meterbody Specifications

7.1 A/D Section

【Block Diagram】



A-D converter : AD7798 (Analog Devices) ref.D04856-0-3/07(A)

EEPROM : AT25160A (ATMEL) ref.3347M-SEEPR-06/07

【Pin Assign】

Pin	name	description	
1,2	AG	input	Circuit Common
3,4	VA	input	Vcc 5V
5,6	VD	input	Vcc 3V
7,8	SCK1	input	Serial Clock to AD1
9,10	SCK2	input	Serial Clock to AD2
11,12	/CSAD1	input	Chip Select to the AD1
13,14	/CSAD2	input	Chip Select to the AD2
15,16	DO1	output	MISO for the AD1
17,18	DO2	output	MISO for the AD2/EEP
19,20	DI1	input	MOSI for the AD1
21,22	DI2	input	MOSI for the AD2/EEP
23,24	/CSEEP	input	Chip Select to the EEP

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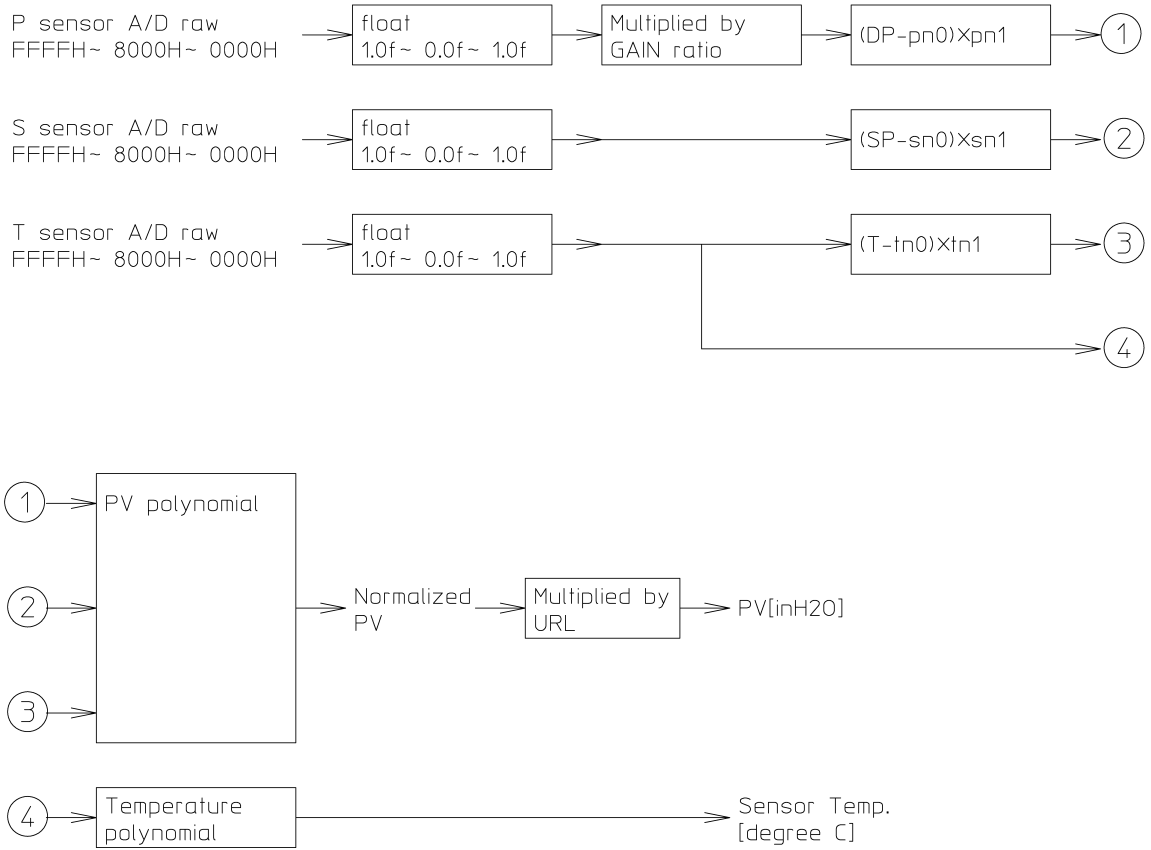
【AD7798 Set Up】

Bit Location	Bit Name	Set to	Description	State
CON13	BO	0	Burnout Current	Disabled
CON12	U/B	0	Unipolar/Bipolar	Bipolar
CON5	REF_DET	0	Reference Detection	Disabled
CON4	BUF	1	Buffered Mode	Always Use
MR12	PSW	0	Power Switch	Open
MR3	FS3	1	Conversion Rate	60ms (Recommended)
MR2	FS2	0		
MR1	FS1	1		
MR0	FS0	0		

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7.2 PV Calculation

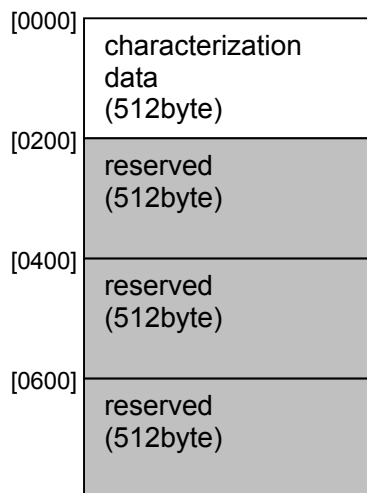
7.2.1 Calculation Block diagram



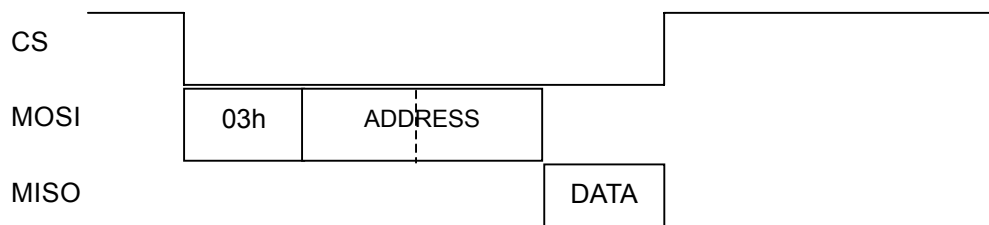
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7.2.2 Characterization Data

The characterization data for each Meterbody is stored within its EEPROM.
EEPROM is ATMEL AT25160A
Total Storage Space: 2kByte(2048 × 8bit), Used Space: 512Byte



7.2.3 Reading Method



Transmit the address following 03H. And, receive one byte data.
It is also possible to read data continuously by transmitting the head address.
Refer to the EEPROM data sheet for the signal timing.
When you access EEPROM, CS of AD2 must be H(=Disable).

7.2.4 CRC Check

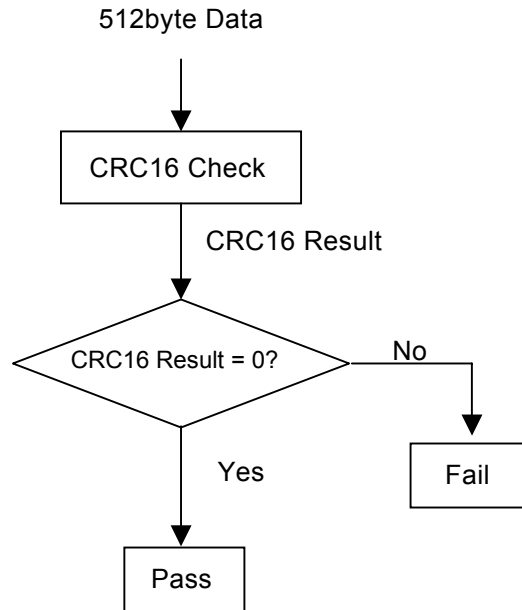
Last 2 bytes of Characterization Data is Check Data.

It is necessary to confirm reading correctly.

Name CRC-CCITT(CRC-ITU-T)

Polynomial $1 + x^5 + x^{12} + x^{16}$

Representations: Reverse →1000 0100 0000 1000 (0x8408)



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7.2.5 EEPROM Layout in Meterbody

【Data Format】

Address	Data Format	Symbol	Description
0x0000 - 0x0003	PB		Meterbody serial number
0x0004	PE	TR	Meterbody type and range
0x0005	--	UT	undef
0x0006	PE	MT	Mount type description
0x0007	--		undef
0x0008 - 0x000B	IFP	SRL	sensor range limit in inH ₂ O (not used in caculations)
0x000C - 0x000F	IFP	URL	Upper range limit in inH ₂ O
0x0010 - 0x0011	UI16		pointer to temperature coefficients of DP
0x0012 - 0x0013	UI16		pointer to BITMAPs of temperature terms
0x0014	UC8		DP degree
0x0015 -	UC8		SP degree for each DP (size is according to DP degrees)
address pointed by (0x0012 - 0x0013) -	BF		BITMAP of temperature terms (size is according to DP degrees and SP degrees)
address pointed by (0x0010 - 0x0011) -	IFP		temperature coefficients of DP (size is according to DP degrees, SP degrees and BITMAPs)
0x016C - 0x018B	--		reserved(factory data area)
0x018C - 0x018F	IFP		gain change point 1 (HH → H)
0x0190 - 0x0193	IFP		gain change point 2 (H → M)
0x0194 - 0x0197	IFP		gain change point 3 (M → L)
0x0198 - 0x019B	IFP		gain change point 4 (L → LL)
0x019C - 0x019F	IFP		gain change point 5 (LL → EL)
0x01A0 - 0x01A3	IFP	pn1	normalized data 1 of P sensor
0x01A4 - 0x01A7	IFP	pn0	normalized data 2 of P sensor
0x01A8 - 0x01AB	IFP	sn1	normalized data 1 of S sensor
0x01AC - 0x01AF	IFP	sn0	normalized data 2 of S sensor
0x01B0 - 0x01B3	IFP	tn1	normalized data 1 of T sensor
0x01B4 - 0x01B7	IFP	tn0	normalized data 2 of T sensor
0x01B8 - 0x01BB	--		Undef
0x01BC - 0x01BF	IFP	t4	coefficient of temperature polynomial T ⁴
0x01C0 - 0x01C3	IFP	t3	coefficient of temperature polynomial T ³
0x01C4 - 0x01C7	IFP	t2	coefficient of temperature polynomial T ²
0x01C8 - 0x01CB	IFP	t1	coefficient of temperature polynomial T ¹
0x01CC - 0x01CF	IFP	t0	coefficient of temperature polynomial T ⁰
0x01D0 - 0x01D3	IFP		gain ratio M/EL
0x01D4 - 0x01D7	IFP		gain ratio M/LL
0x01D8 - 0x01DB	IFP		gain ratio M/L
0x01DC - 0x01DF	IFP		gain ratio M/M
0x01E0 - 0x01E3	IFP		gain ratio M/H
0x01E4 - 0x01E7	IFP		gain ratio M/HH
0x01E8 - 0x01EB	IFP		Overload low limit
0x01EC - 0x01EF	IFP		Overload high limit
0x01F0 - 0x01FD	--		reserved
0x01FD	PB		Revision of characterization data layout
0x01FE - 0x01FF	UI16		CRC checksum

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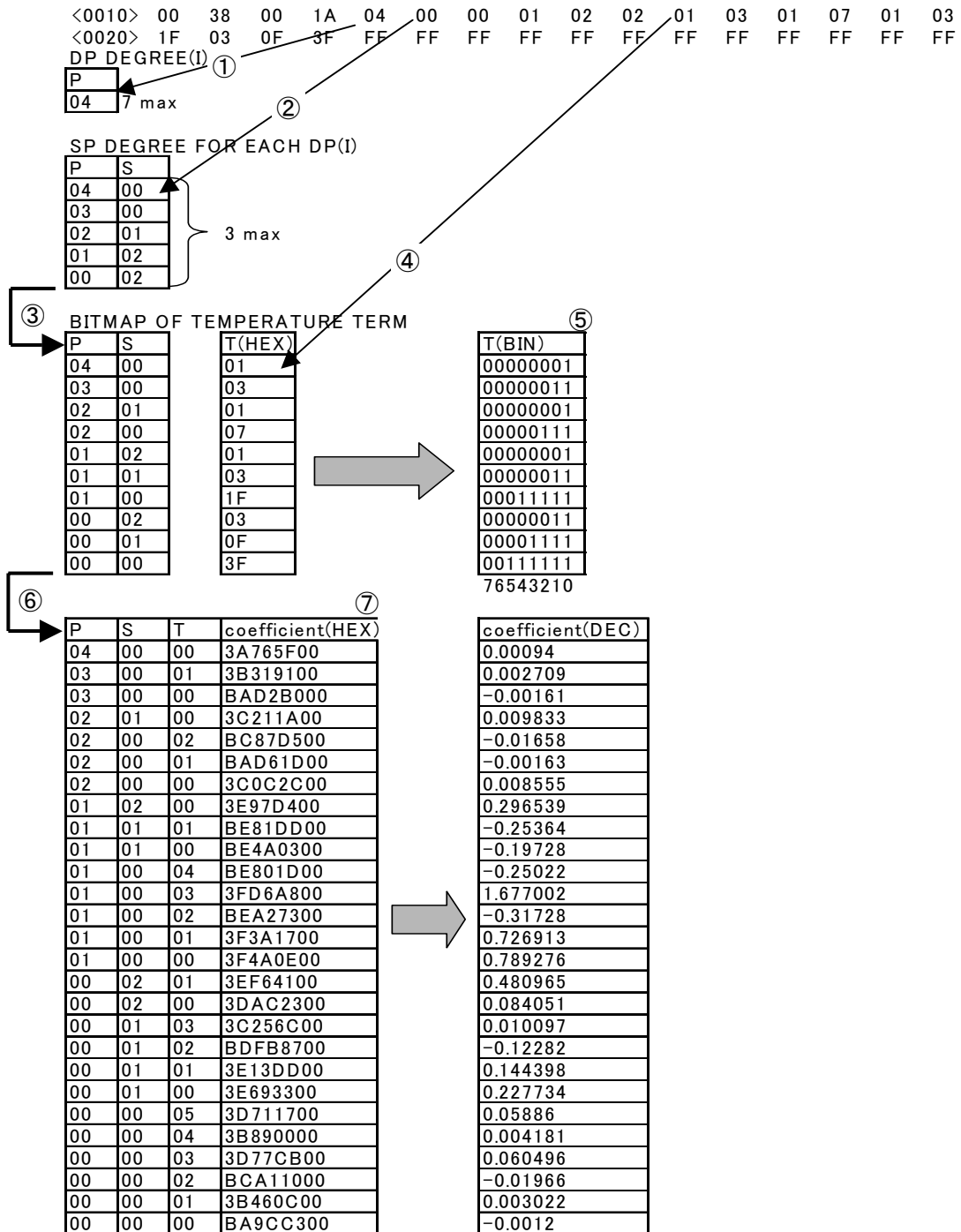
【Sample Characterization Data】

```

<0000> 28 35 91 97 01 FF 00 FF FF FF FF FF 45 2D 00 00
<0010> 00 38 00 1A 04 00 00 01 02 02 01 03 01 07 01 03
<0020> 1F 03 0F 3F FF FF FF FF FF FF FF FF FF FF FF FF
<0030> FF FF FF FF FF FF FF FF 3A 76 5F 00 3B 31 91 00
<0040> BA D2 B0 00 3C 21 1A 00 BC 87 D5 00 BA D6 1D 00
<0050> 3C 0C 2C 00 3E 97 D4 00 BE 81 DD 00 BE 4A 03 00
<0060> BE 80 1D 00 3F D6 A8 00 BE A2 73 00 3F 3A 17 00
<0070> 3F 4A 0E 00 3E F6 41 00 3D AC 23 00 3C 25 6C 00
<0080> BD FB 87 00 3E 13 DD 00 3E 69 33 00 3D 71 17 00
<0090> 3B 89 00 00 3D 77 CB 00 BC A1 10 00 3B 46 0C 00
<00A0> BA 9C C3 00 FF FF FF FF FF FF FF FF FF FF FF FF
<00B0> FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
<00C0> FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
<00D0> FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
<00E0> FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
<00F0> FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
<0100> FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
<0110> FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
<0120> FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
<0130> FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
<0140> FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
<0150> FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
<0160> FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
<0170> BE 41 11 EC FF FF FF FF FF FF FF FF BC 75 E5 1F
<0180> FF FF FF FF 3D D0 A5 1F 3E 21 55 C3 3E 7D 28 1A
<0190> 3F 00 35 27 3F 80 00 00 3F 80 00 00 3F 80 00 00
<01A0> 3F C8 00 00 00 00 00 00 3E C8 00 00 00 00 00 00
<01B0> BF 48 00 00 00 00 00 00 FF FF FF FF C5 98 40 F8
<01C0> C4 E0 7F 46 C2 17 9A 6D C3 9D 6B 38 41 A2 9C 00
<01D0> 40 FF CB 99 40 7F D0 96 3F FF D0 96 3F 80 00 00
<01E0> 3F 00 25 81 3E 80 1B 7F BF C9 42 8F 3F CA 8B 85
<01F0> FF FF FF FF FF FF FF FF FF FF FF FF FF 00 E6 3C

```

[BITMAP]



- ① Extract <0014> as max DPDEG. In this sample data, it is 04.
 - ② Extract max DPDEG+1 byte as max SPDEG for each DP. In this sample data, it is 5 bytes.
 - ③ Expand the degree of each SPDEG from maximum degree to 0 degree.
 - ④ Extract the bitmap of temperature term from where the bitmap pointer indicates. In this sample data, it is 10 bytes starting from <001A>.
 - ⑤ A coefficient exists where the bit of the bitmap is 1. The minimum is 0, and maximum is 7 degrees.
 - ⑥ In this sample data, this can be expanded to 27 coefficients.
 - ⑦ Extract the coefficient from where the coefficient pointer indicates. Coefficients are stored in the IEEE754 format, 4 bytes each. In this sample data, the coefficient pointer is <0038>.
- An example of calculation is shown in the next page.

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【Calculation】

In this calculation example, sensor output after compensation is assumed to be as follows.

P sensor: 0.48

S sensor: 0.13

T sensor: 0.26

P	S	T
0.48	0.13	0.26

URL
400 (inH2O)

i	j	k	C _{ijk}
04	00	00	0.00094
03	00	01	0.002709
03	00	00	-0.00161
02	01	00	0.009833
02	00	02	-0.01658
02	00	01	-0.00163
02	00	00	0.008555
01	02	00	0.296539
01	01	01	-0.25364
01	01	00	-0.19728
01	00	04	-0.25022
01	00	03	1.677002
01	00	02	-0.31728
01	00	01	0.726913
01	00	00	0.789276
00	02	01	0.480965
00	02	00	0.084051
00	01	03	0.010097
00	01	02	-0.12282
00	01	01	0.144398
00	01	00	0.227734
00	00	05	0.05886
00	00	04	0.004181
00	00	03	0.060496
00	00	02	-0.01966
00	00	01	0.003022
00	00	00	-0.0012

P ⁱ	S ^j	T ^k
0.05	1	1
0.11	1	0.26
0.11	1	1
0.23	0.13	1
0.23	1	0.07
0.23	1	0.26
0.23	1	1
0.48	0.02	1
0.48	0.13	0.26
0.48	0.13	1
0.48	1	0
0.48	1	0.02
0.48	1	0.07
0.48	1	0.26
0.48	1	1
1	0.02	0.26
1	0.02	1
1	0.13	0.02
1	0.13	0.07
1	0.13	0.26
1	0.13	1
1	1	0
1	1	0
1	1	0.02
1	1	0.07
1	1	0.26
1	1	1

C _{ijk} * P ⁱ * S ^j * T ^k
4.98901E-05
7.79073E-05
-0.000177768
0.000294514
-0.000258251
-9.78565E-05
0.001971167
0.002405527
-0.004115043
-0.012310089
-0.000548857
0.014147993
-0.010295219
0.090718799
0.378852539
0.002113359
0.001420464
2.30694E-05
-0.001079308
0.004880643
0.02960537
6.99336E-05
1.91057E-05
0.001063284
-0.00132908
0.000785708
-0.001195997

sum(=Normalized PV) 0.497091806
Pressure(=sum * URL) 198.8367223 (inH2O)

Accuracy of calculation should be single precision floating point or better.

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7.2.6 Gain

(1) P Sensor

There are several methods for switching gains of the P sensor.

- Variable Gain: Always use the most suitable gain according to the input value.
- Fixed Gain: Choose a fixed gain according to the measuring range.
- Combination of Variable and Fixed Gain: Combination of the above two methods.

(a) Variable Gain

Switch the sampling gain as follows.

- When AD value of P sensor is between 40% and 80%, the same gain is used.
- When AD value of P sensor is larger than 80%, gain is switched to a lower gain.
- When AD value of P sensor is smaller than 40%, gain is switched to a higher gain.

(b) Fixed Gain

The information to decide a gain is included in the EEPROM.

The mapping of data is as follows.

<18C> point1

<190> point2

<194> point3

<198> point4

<19C> point5

The method of switching gain is as follows.

X	Gain
point5 < X	4 (G2,G1,G0 = 0,1,0)
point4 < X ≤ point5	8 (G2,G1,G0 = 0,1,1)
point3 < X ≤ point4	16 (G2,G1,G0 = 1,0,0)
point2 < X ≤ point3	32 (G2,G1,G0 = 1,0,1)
point1 < X ≤ point2	64 (G2,G1,G0 = 1,1,0)
X ≤ point1	128 (G2,G1,G0 = 1,1,1)

X: Largest value of either |URV| or |LRV|, normalized by URL.

(c) Combination of Variable and Fixed Gain

This method is to use the fixed gain, but switch gain when there is an AD overload. Fixed gain is simpler than variable gain, and has a faster response time, but cannot measure beyond the range it first chooses. If this function is necessary, a structure to switch gains when there is an AD overload should be added to the fixed gain method.

(2) S Sensor

The following gain should be used for all sensor types.

Gain for Pressure S: Gain 32 (G2,G1,G0 = 1,0,1).

(3) T Sensor

The following gain should be used for all sensor types.

Gain for Temperature T: Gain 4 (G2,G1,G0 = 0,1,0).

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7.2.7 Mount Type

“MT”: the identification of the normal type and the compound type.

The characterization of the normal type is only positive side. The characterization of the compound type is both sides.

high-order four bits

Data	Description
0xH	Forward characterization
1xH	Reverse characterization (not used)
2xH	Compound characterization

low-order four bits

Data	Description
X0H	Standard mount

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7.3 Wetted Parts

7.3.1 Overload Protection

The overload protection is a function to protect the sensor from overpressure input. This is a function owing to the center diaphragm. See the following table for the pressure where the overload protection starts to function.

Overload Protection Functioning Pressure (in reference conditions)

Model	Functioning Pressure [kPa]	
	HP Side	LP Side
GMJ15D	No Protection	No Protection
GMJ31D, 32D, 36D, 37D	230 ± 50	230 ± 50
GMJ41D, 42D	1600 ± 300	1250 ± 250
GMJ71D, 72D	No Protection	1250 ± 250

7.3.2 Structure of Wetted Parts

(1) Standard Type

Wetted Parts Material: SUS316 (Diaphragm Material: SUS316L)

Applicable Models: GMJ31D, 32D, 36D, 37D, 41D, 42D, 71D, 72D

DWG. No. YTGT0028 Sheet1

(2) ASTM B575 Ring Weld Type

Wetted Parts Material: ASTM B575

Applicable Models: GMJ31D, 32D, 41D, 42D

DWG. No. YTGT0028 Sheet1

(3) Wetted Parts Compartment Add-On Type

Wetted Parts Material: ASTM B575 (GMJ71D)

Wetted Parts Material: Tantalum, SUS316L (GMJ31D, 41D, 71D)

DWG. No. YTGT0028 Sheet2

The Add-on type has a compartment welded on to the standard type Meterbody. The dimension between the high and low pressure ports will differ from the standard type. An adapter is prepared to change this dimension (optional code A1), so it will be the same as the standard type.

7.4 Weight

GMJ15D : Approx.3.4kg

GMJ31D, GMJ41D, GMJ71D : Approx.5.3kg

GMJ32D, GMJ42D, GMJ72D : Approx.6.3kg

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7.5 Materials

Connector Housing	PBT (Polybutylene terephthalate)
Connector Contact	Phosphorus bronze, Nickel under plating Contact area: gold plating Dip part: pure tin plating
Potting	Urethane
Flexible Printed Circuit Cover lay, base Conductor Backing board	Polyimide Rolled copper foil Epoxy resin / glass cloth laminated sheet
Body	SUS316
Center Diaphragm	MAR-aging steel or S-4(Stainless)
Sensor Cover	SUS304
Barrier Diaphragm	SUS316L, ASTM B575, Tantalum
Meterbody Cover	SCS14A, SUSF316
Connecting Flange	SCS14A
Bolts for Connecting Flange	SUS304
Gasket	PTFE (Poly-Tetra-Fluoro-Ethylene)
Fill Fluid	Silicone oil, Fluorine oil
Bolts for Meterbody Cover	SNB7, SUS304, SUS630
Nuts for Meterbody Cover	S45C, SUS304, SUS630
O Ring	NBR

7.6 Process Piping Connection

Meterbody Cover : 1/4 NPT Female Thread

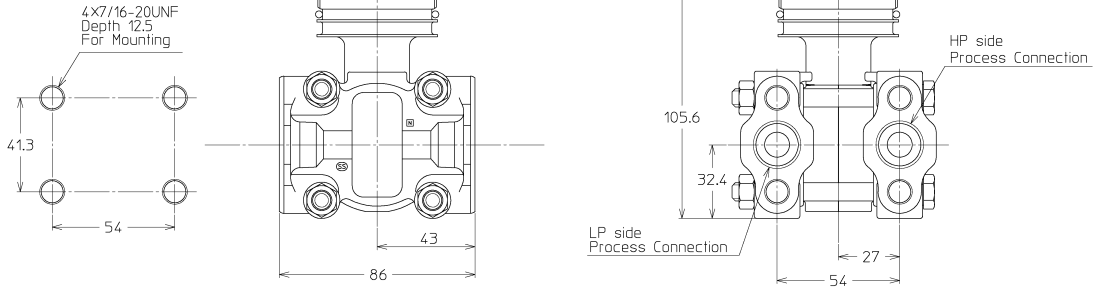
Adapter Flange : 1/2 or 1/4 NPT Female Thread

7.7 Tightening Torque of Meterbody Covers

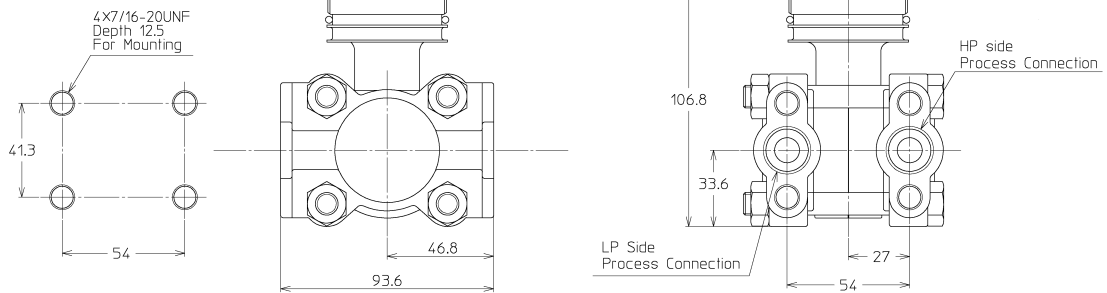
Model	Bolt Size	Bolt Material	Tightening Torque (N · m)	
			New Gaskets	Re-Tightening
GMJ15D	M8	SUS304	12 ± 1	8 ± 1
GMJ31D、GMJ36D GMJ41D、GMJ71D	M10	SNB7、SUS630	22 ± 2	17 ± 1
		SUS304	15 ± 1	10 ± 1
GMJ32D、GMJ37D GMJ42D、GMJ72D	M16	SNB7、SUS630	90 ± 2	
		SUS304	55 ± 1	

7.8 Dimensional Drawing

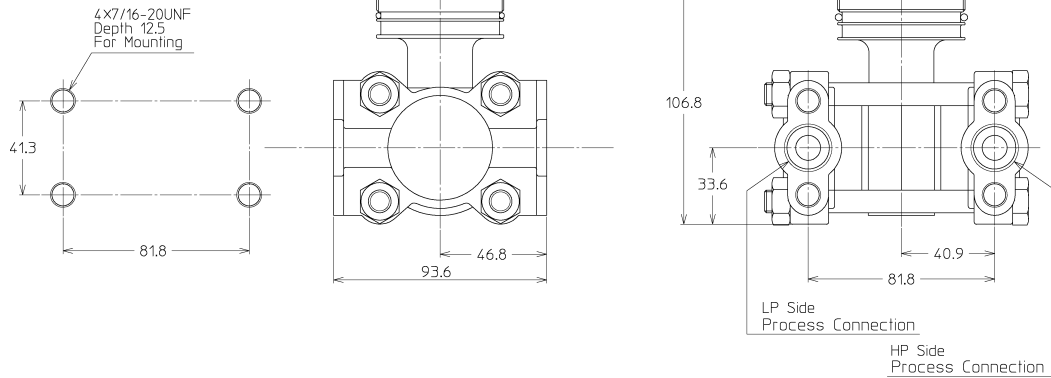
GMJ 15D



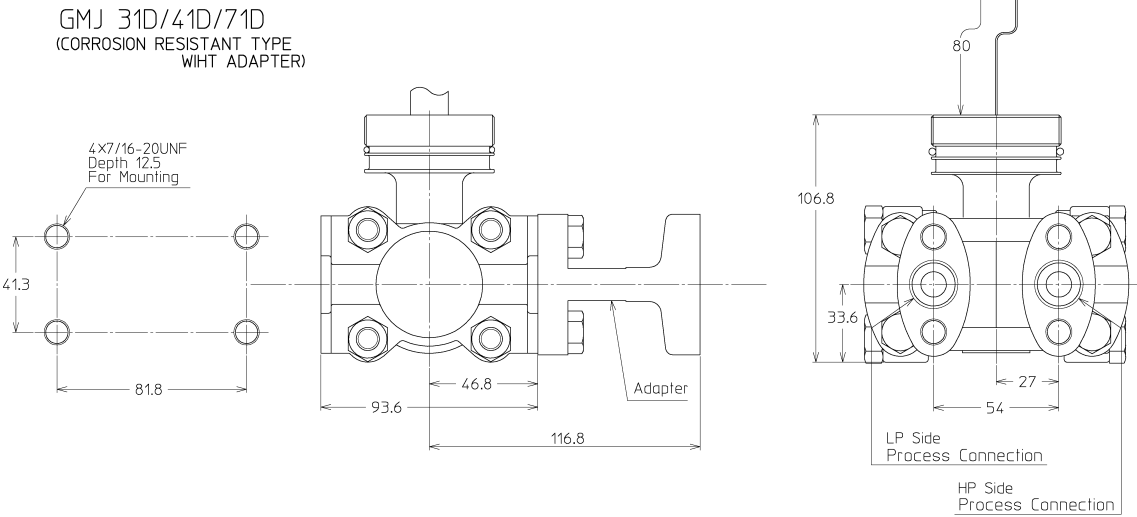
GMJ 31D/36D/41D/71D



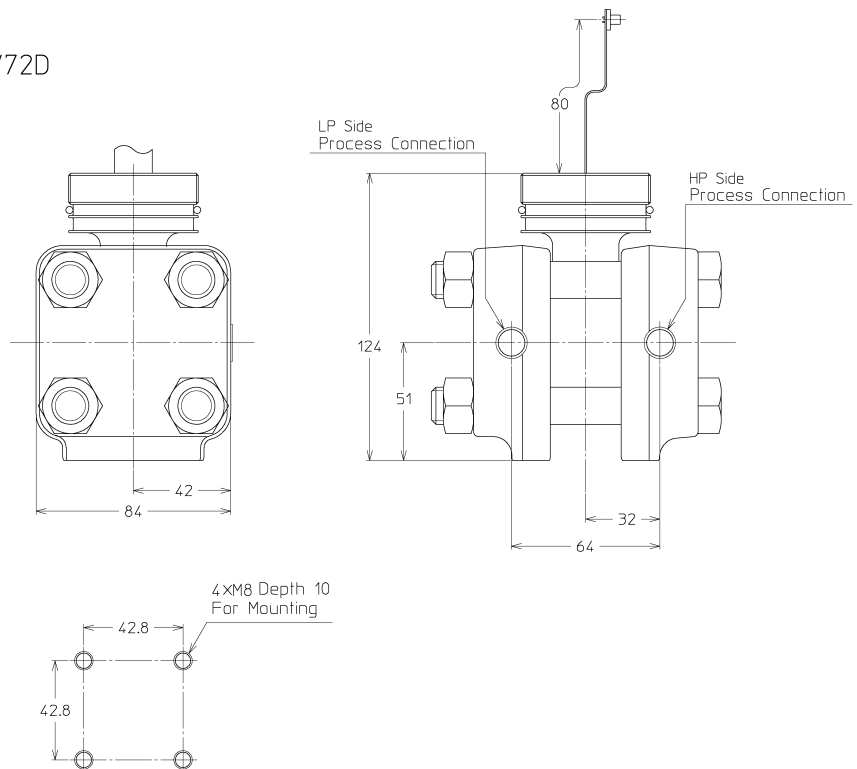
GMJ 31D/41D/71D
(CORROSION RESISTANT TYPE)



7.8 Dimensional Drawing (continued)



GTX 32D/37D/42D/72D



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8. Performance Specifications

8.1 Reference Accuracy

This section refers to the accuracy under the following conditions

- Condition : Within reference operating condition stated in clause 5.1.
- Pressure Range : Same as calibrated span
- Calibrating Condition : Test Uncertainty Ratio (TUR) better than 4 : 1
- PV calculation method: According to clause 7.2.

- Reference accuracy includes non-linearity, short-term repeatability, and hysteresis.
- Reference accuracy refers to the best straight line (BSL).
- Unit of accuracy refers to the percentage of X.

Terminology

LRV: Lower Range Value

URV: Upper Range Value

X: Greatest value of span, LRV, or URV. (Absolute value of each)

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8.1 Reference Accuracy (continued)

(1) Reference Accuracy of Non-Compound Characterization Type

Unit: %

Model	Value of X	Diaphragm Material	
		SUS316L	Tantalum or ASTM B575
GMJ31D Fill Fluid: Silicone Oil	$100 \geq X > 10$ kPa	± 0.032	---
	$10 \geq X \geq 0.5$ kPa	$\pm \left(0.032 \times \frac{10}{X}\right)$	---
	$100 \geq X > 5.0$ kPa	---	± 0.175
	$5.0 \geq X \geq 0.5$ kPa	---	$\pm \left(0.1 + 0.075 \times \frac{5}{X}\right)$
GMJ31D Fill Fluid: Fluorine Oil	$100 \geq X > 5.0$ kPa	± 0.075	± 0.175
	$5.0 \geq X \geq 0.5$ kPa	$\pm \left(0.075 \times \frac{5}{X}\right)$	$\pm \left(0.1 + 0.075 \times \frac{5}{X}\right)$
GMJ32D	$100 \geq X \geq 5.0$ kPa	± 0.075	---
	$5.0 \geq X \geq 0.5$ kPa	$\pm \left(0.075 \times \frac{5}{X}\right)$	---
GMJ41D	$700 \geq X > 140$ kPa	± 0.075	± 0.175
	$140 \geq X \geq 35$ kPa	$\pm \left(0.075 \times \frac{140}{X}\right)$	$\pm \left(0.1 + 0.075 \times \frac{140}{X}\right)$
GMJ42D	$700 \geq X > 140$ kPa	± 0.075	---
	$140 \geq X \geq 35$ kPa	$\pm \left(0.075 \times \frac{140}{X}\right)$	---
GMJ71D	$14 \geq X > 3.5$ MPa	± 0.125	± 0.275
	$3.5 \geq X \geq 0.25$ MPa	$\pm \left(0.075 + 0.05 \times \frac{3.5}{X}\right)$	$\pm \left(0.225 + 0.05 \times \frac{3.5}{X}\right)$
GMJ72D	$14 \geq X > 3.5$ MPa	± 0.125	---
	$3.5 \geq X \geq 0.25$ MPa	$\pm \left(0.075 + 0.05 \times \frac{3.5}{X}\right)$	---

(2) Reference Accuracy of Compound Characterization Type

Unit: %

Model	Value of X	Diaphragm Material
		SUS316L
GMJ15D	$2.0 \geq X \geq 0.1$ kPa	$\pm \left(0.125 + 0.15 \times \frac{1}{X}\right)$
GMJ36D GMJ37D	$100 \geq X \geq 5$ kPa	± 0.175
	$5 \geq X \geq 0.5$ kPa	$\pm \left(0.175 \times \frac{5}{X}\right)$

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8.2 Accuracy: Reverse Side of Non-Compound Chara. Type (for reference only)

This section is applicable for calibrated span when URV and/or LRV are below zero.

Model	Accuracy of Reverse Side [%]
GMJ31D, 32D	±5
GMJ41D, 42D, 71D, 72D	±2

8.3 Zero Drift

This section refers to the error under reference operating conditions.

Terminology

- Start Up : Difference between 5 minutes and 60 minutes after connecting power.
 24 Hours : Difference between 1 hour and 24 hours after connecting power.
 1 Month : Difference between 24 hours and 1 month after connecting power.
 1 Year : Difference between 24 hours and 1 year after connecting power.

Model	Value of X	Error According to Elapsed Time [%]				
		Start Up	24Hours	1 Month	1 Year	
GMJ31D GMJ32D GMJ36D GMJ37D	100 ≥ X > 12.5 kPa	±0.05	±0.05	±0.05	±0.1	
	12.5 ≥ X ≥ 0.5 kPa	$\pm 0.05 \times \frac{12.5}{X}$	$\pm 0.05 \times \frac{12.5}{X}$	$\pm 0.05 \times \frac{12.5}{X}$	$\pm 0.1 \times \frac{12.5}{X}$	
GMJ41D GMJ42D	700 ≥ X > 210 kPa	±0.05	±0.05	±0.05	±0.1	
	210 ≥ X ≥ 35 kPa	$\pm 0.05 \times \frac{210}{X}$	$\pm 0.05 \times \frac{210}{X}$	$\pm 0.05 \times \frac{210}{X}$	$\pm 0.1 \times \frac{210}{X}$	
GMJ71D GMJ72D	14 ≥ X ≥ 3.5 MPa	±0.05	±0.05	±0.1	±0.2	
	3.5 ≥ X ≥ 0.25 MPa	$\pm 0.05 \times \frac{3.5}{X}$	$\pm 0.05 \times \frac{3.5}{X}$	$\pm 0.1 \times \frac{3.5}{X}$	$\pm 0.2 \times \frac{3.5}{X}$	
GMJ15D	1kPa ≥ X	Reference Conditions	$\pm 0.06 \times \frac{1}{X}$	$\pm 0.06 \times \frac{1}{X}$	$\pm 0.3 \times \frac{1}{X}$	$0.6 \times \frac{1}{X}$
		Normal Operating Conditions	$\pm 0.2 \times \frac{1}{X}$	$\pm 0.2 \times \frac{1}{X}$	$\pm 0.5 \times \frac{1}{X}$	$1.0 \times \frac{1}{X}$

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8.4 Supplementary Effects

8.4.1 Ambient Temperature Effect

Applicable Temperature Range: 23 +62/-63 °C

(1) Ambient Temperature Effect: Meterbody Material SUS316 (effect per 30°C)

Model	Value of X	Zero Shift [%]	Zero+Span Shift [%]
GMJ15D	$2.0 \geq X \geq 0.1 \text{ kPa}$	$\pm(0.33 \times \frac{1}{X})$	$\pm(0.56 \times \frac{1}{X})$
GMJ31D Fill Fluid: Silicone Oil	$100 \geq X > 12.5 \text{ kPa}$	---	± 0.075
	$12.5 \geq X \geq 0.5 \text{ kPa}$		$\pm(0.075 \times \frac{12.5}{X})$
GMJ31D Fill Fluid: Fluorine Oil	$100 \geq X > 12.5 \text{ kPa}$	$\pm(0.075 \times \frac{12.5}{X})$	± 0.25
	$12.5 \geq X \geq 0.5 \text{ kPa}$		$\pm(0.25 \times \frac{12.5}{X})$
GMJ32D GMJ36D GMJ37D	$100 \geq X > 12.5 \text{ kPa}$	$\pm(0.15 \times \frac{12.5}{X})$	± 0.23
	$12.5 \geq X \geq 0.5 \text{ kPa}$		$\pm(0.23 \times \frac{12.5}{X})$
GMJ41D GMJ42D	$700 \geq X > 210 \text{ kPa}$	± 0.15	± 0.23
	$210 \geq X \geq 35 \text{ kPa}$	$\pm(0.15 \times \frac{210}{X})$	$\pm(0.23 \times \frac{210}{X})$
GMJ71D GMJ72D	$14 \geq X > 3.5 \text{ MPa}$	± 0.15	± 0.23
	$3.5 \geq X \geq 0.25 \text{ MPa}$	$\pm(0.15 \times \frac{3.5}{X})$	$\pm(0.23 \times \frac{3.5}{X})$

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8.4.1 Ambient Temperature Effect (continued)

(2) Ambient Temperature Effect: Meterbody Material Tantalum/ ASTM B575/ SUS316L
Temperature range: -5 to 55°C (effect per 30°C)

Model	Value of X	Zero Shift [%]	Zero+Span Shift [%]
GMJ31D	$100 \geq X \geq 0.5 \text{ kPa}$	$\pm (0.6 \times \frac{20}{X})$	$\pm (0.4 + 0.65 \times \frac{20}{X})$
GMJ41D	$700 \geq X > 210 \text{ kPa}$	$\pm (0.6 \times \frac{210}{X})$	± 1.05
	$210 \geq X \geq 35 \text{ kPa}$		$\pm (0.4 + 0.65 \times \frac{210}{X})$
GMJ71D	$14 \geq X > 3.5 \text{ MPa}$	$\pm (0.6 \times \frac{3.5}{X})$	± 1.05
	$3.5 \geq X \geq 0.25 \text{ MPa}$		$\pm (0.4 + 0.65 \times \frac{3.5}{X})$

Temperature range: -40 to -5°C, 55 to 85°C (effect per 30°C)

Model	Value of X	Zero Shift [%]	Zero+Span Shift [%]
GMJ31D	$100 \geq X \geq 0.5 \text{ kPa}$	$\pm (1.2 \times \frac{20}{X})$	$\pm (0.4 + 1.25 \times \frac{20}{X})$
GMJ41D	$700 \geq X > 210 \text{ kPa}$	$\pm (1.2 \times \frac{210}{X})$	± 1.65
	$210 \geq X \geq 35 \text{ kPa}$		$\pm (0.4 + 1.25 \times \frac{210}{X})$
GMJ71D	$14 \geq X > 3.5 \text{ MPa}$	$\pm (1.2 \times \frac{3.5}{X})$	± 1.65
	$3.5 \geq X \geq 0.25 \text{ MPa}$		$\pm (0.4 + 1.25 \times \frac{3.5}{X})$

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8.4.2 Process Temperature Effect

This section refers to error when Meterbody temperature is above 85°C.

Values refer to the amount of shift from output at 85°C. (effect per 25°C)

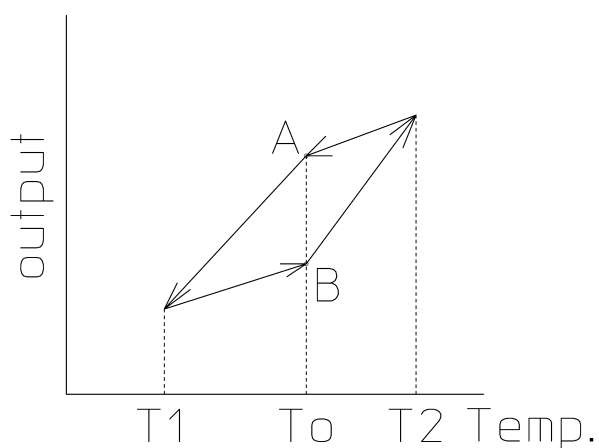
Model	Value of X	Meterbody Material			
		Zero Shift [%]		Zero+Span Shift [%]	
		SUS316	Tantalum ASTM B575 SUS316L	SUS316	Tantalum ASTM B575 SUS316L
GMJ31D GMJ32D GMJ36D GMJ37D	$100 \geq X > 20$ kPa	$\pm (1.0 \times \frac{20}{X})$	$\pm (2.0 \times \frac{20}{X})$	± 1.5	± 3.0
	$20 \geq X \geq 0.5$ kPa			$\pm (1.5 \times \frac{20}{X})$	$\pm (3.0 \times \frac{20}{X})$
GMJ41D GMJ42D	$700 \geq X > 210$ kPa	$\pm (1.0 \times \frac{210}{X})$	$\pm (1.3 \times \frac{210}{X})$	± 1.5	± 2.1
	$210 \geq X \geq 35$ kPa			$\pm (1.5 \times \frac{210}{X})$	$\pm (2.1 \times \frac{210}{X})$
GMJ71D GMJ72D	$14 \geq X > 3.5$ MPa	$\pm (1.0 \times \frac{3.5}{X})$	$\pm (1.3 \times \frac{3.5}{X})$	± 1.5	± 2.1
	$3.5 \geq X \geq 0.25$ MPa			$\pm (1.5 \times \frac{3.5}{X})$	$\pm (2.1 \times \frac{3.5}{X})$

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8.4.3 Thermal Hysteresis Effect

effect per 55°C(T2-T1), except for GMJ15D which is per 30°C(T2-T1)

Model	Value of X	Meterbody Material		
		Thermal Hysteresis [%]		
		SUS316	ASTM B575/ SUS316L	Tantalum
GMJ15D	$ LRV \leq 1Pa$ and $ URV \leq 1Pa$	$0.4 \times \frac{1}{X} / 30^\circ C$	---	---
GMJ31D GMJ32D GMJ36D GMJ37D	$100 \geq X > 20.0$ kPa	0.15	0.3	0.4
	$20.0 \geq X \geq 75$ kPa	$0.15 \times \frac{20.0}{X}$	$0.3 \times \frac{20.0}{X}$	$0.4 \times \frac{20.0}{X}$
GMJ41D GMJ42D	$700 \geq X > 35$ kPa	$0.15 \times \frac{700}{X}$	$0.16 \times \frac{700}{X}$	$0.16 \times \frac{700}{X}$
GMJ71D GMJ72D	$14 \geq X > 10.5$ MPa	0.15	0.15	0.15
	$10.5 \geq X \geq 0.25$ MPa	$0.15 \times \frac{10.5}{X}$	$0.15 \times \frac{10.5}{X}$	$0.15 \times \frac{10.5}{X}$



Thermal Hysteresis is the difference in output between A and B, when there is one temperature cycle as shown in graph.

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8.4.4 Transient Ambient Temperature Effect

This section refers to the error when temperature change rate is 15°C/hr.

All Models: 2 times the amount shown in clause 8.4.1

8.4.5 Static Pressure Effect

This section refers to the error when static pressure is not within reference condition.

(1) Model GMJ15D

Model	Value of X	Zero Shift [%]	Zero+Span Shift [%]
GMJ15D	$ LRV \leq 1Pa$ and $ URV \leq 1Pa$	$\pm(0.4 \times \frac{1}{X} + 0.03)$ per 70kPa	$\pm(0.45 \times \frac{1}{X} + 0.03)$ per 70kPa

Note 1: Static pressure effect for GMJ15D is limited to temperature range of $23 \pm 2^\circ C$.

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8.4.5 Static Pressure Effect (continued)

(2) Models Other Than GMJ15D

Model	Value of X	Zero Shift [%]	Zero+Span Shift [%]
GMJ31D	$100 \geq X > 12.5$ kPa	$\pm(A \times \frac{12.5}{X} + C \times \frac{12.5}{X} + 0.03)$	$\pm(B + C \times \frac{12.5}{X} + D + 0.03)$
	$12.5 \geq X > 0.5$ kPa		$\pm(B \times \frac{12.5}{X} + C \times \frac{12.5}{X} + D + 0.03)$
GMJ32D GMJ36D GMJ37D	$100 \geq X > 20$ kPa	$\pm(A \times \frac{20}{X} + C \times \frac{20}{X} + 0.03)$	$\pm(B + C \times \frac{20}{X} + D + 0.03)$
	$20 \geq X > 0.5$ kPa		$\pm(B \times \frac{20}{X} + C \times \frac{20}{X} + D + 0.03)$
GMJ41D GMJ42D	$700 \geq X > 35$ kPa	$\pm(A \times \frac{700}{X} + C \times \frac{700}{X} + 0.03)$	$\pm(B \times \frac{700}{X} + C \times \frac{700}{X} + D + 0.03)$
GMJ71D GMJ72D	$14 \geq X > 7.0$ MPa	$\pm(A \times \frac{7.0}{X} + C \times \frac{7.0}{X} + 0.03)$	$\pm(B + C \times \frac{2.0}{X} + D + 0.03)$
	$7.0 \geq X > 0.25$ MPa		$\pm(B \times \frac{7.0}{X} + C \times \frac{7.0}{X} + D + 0.03)$

A, B, C, D is as follows.

$$A = \frac{P}{7} \left[\frac{|T - 25|}{60} * 0.3 + 0.17 \right]$$

$$B = \frac{P}{7} \left[\frac{|T - 25|}{60} * 0.3 + 0.37 \right]$$

C and D differ according to model and Meterbody material.

Model	Meterbody Material	
	SUS316	Tantalum/ ASTM B575/ SUS316L
GMJ31D GMJ32D GMJ36D GMJ37D	C=0, D=0	$C = \frac{P}{7} \times 0.45, D = \frac{P}{7} \times 0.15$
GMJ41D GMJ42D GMJ71D GMJ72D	C=0, D=0	$C = \frac{P}{7} \times 0.125, D = \frac{P}{7} \times 0.05$

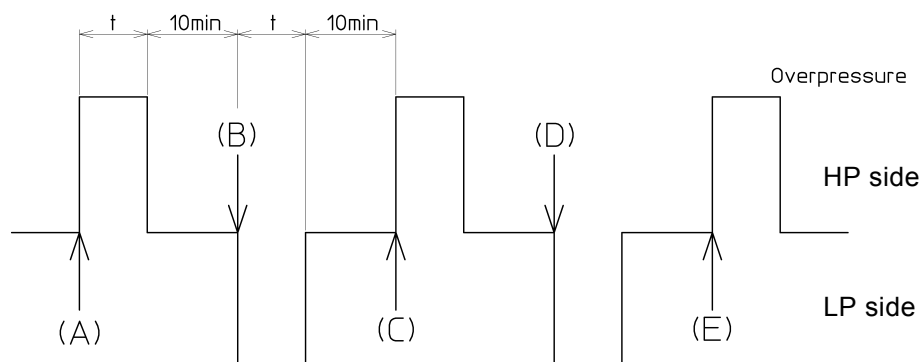
where,

T: Temperature [°C]

P: Static Pressure [MPa]

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8.4.6 Overpressure Effect



This section refers to the error when there is an overpressure input on both the HP side and LP side as shown in the above graph. Error is the difference between the zero output before and after overpressure input.

(1) Overpressure Effect: Meterbody Material SUS316

Zero Error for GMJ15D		Unit: Pa	
Meterbody Temperature T °C	Pressure Inflicted Duration t [minutes]		
	$t \leq 1$	$1 \leq t \leq 60$	$60 < t$
$-15 \leq T < 65$	2.0	6.0	16.0

Zero Error for Models Other Than GMJ15D		Unit: Pa	
Meterbody Temperature T °C	Pressure Inflicted Duration t [minutes]		
	$t \leq 5$	$5 < t$	
$-40 \leq T < 25$	75		1.5 times the error of $t \leq 5$
$25 \leq T \leq 110$	i) First time: $(13T-250)$ ^{note1} ii) Second time and after: $4.3T-32.5$ ^{note2}		

Note 1: First time refers to (B-A) and (C-B) in above graph.

Note 2: Second time and after refers to (D-C) and (E-D) in above graph.

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8.4.6 Overpressure Effect (continued)

(2) Overpressure Effect: Meterbody Material Tantalum

Zero Error		Unit: Pa
Meterbody Temperature T °C	Pressure Inflicted Duration t [minutes]	
	$t \leq 5$	$5 < t$
$-40 \leq T < 55$	200	200
$55 \leq T \leq 110$	600	600

(3) Overpressure Effect: Meterbody Material ASTM B575/ SUS316L

Zero Error		Unit: Pa
Meterbody Temperature T °C	Pressure Inflicted Duration t [minutes]	
	$t \leq 5$	$5 < t$
$-40 \leq T < 25$	270	1.5 times the error of $t \leq 5$
$25 \leq T \leq 110$	i) First time: (13T-55) ii) Second time and after: 4.3T-162.5	

9. Product Certifications (for reference only)

There is no approval for just the Meterbody. The following certifications are approved for the GTX transmitter as a whole.

Explosion Protection Type	Certification No.
FM Explosionproof + Dust Ignition Proof	3030557
FM Intrinsic Safety	3030716
FM Non-Incendive	3030716
NEPSI Explosionproof + Dust Ignition Proof	GYJ071268
NEPSI Intrinsic Safety	GYJ071269
NEPSI Type-n	GYJ071269
IECEX Flameproof + Dust Ignition Proof	IECEX KEM 08.0001
IECEX Intrinsic Safety + Dust Ignition Proof	IECEX KEM 07.0058X
IEC Ex Type-n+ Dust Ignition Proof	IECEX KEM 07.0058X
ATEX Flameproof + Dust Ignition Proof	KEMA 08ATEX0004
ATEX Intrinsic Safety + Dust Ignition Proof	KEMA 07ATEX0200 X
ATEX Type-n+ Dust Ignition Proof	KEMA 07ATEX0200 X

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10. Measurement Range

Model	Applicable Range	
	Minimum	Maximum
GMJ15D	-1 kPa	1 kPa
GMJ31D ^{note1} GMJ32D ^{note1} GMJ36D GMJ37D	-100 kPa	100 kPa
GMJ41D ^{note1} GMJ42D ^{note1}	-100 kPa	700 kPa
GMJ71D ^{note1} GMJ72D ^{note1}	-0.1 MPa	14 MPa

Note 1: For accuracy of reverse side, see clause 8.2

11. Stress Tolerance

11.1 Environmental Stress

Ambient Temperature Change at a rate of 15°C/hr, between 25 and +/-55°C
100 times

11.2 Functional Stress

All values refer to stress under reference conditions.

11.2.1 Fatigue

- (1) Repeat differential pressure from 0 to URL 10⁶ times
- (2) Repeat static pressure from 0 to Maximum Working Pressure
 - GMJ15D, GMJ31D, GMJ36D, GMJ41D, GMJ71D 10⁵ times
 - GMJ32D, GMJ37D, GMJ42D, GMJ72D 10⁴ times
- (3) Bending of FPC
 - Bending radius R3.2, 0 to 180° 10⁴ times

11.2.2 Wear

- (1) Insert/exert of connector 50 times

12. Interchangeable Parts

- (1) Gasket
Preferable to be changed each time Meterbody cover is removed.
- (2) O-Ring (using silicone grease)

Ambient Temperature	Exchange Period
Below 30°C	10 years
30 to 40°C	5 years
40 to 50°C	2 years

Ambient temperature refers to yearly average.

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10N5MD 5000

Wetted Parts Compartment: Normal Type

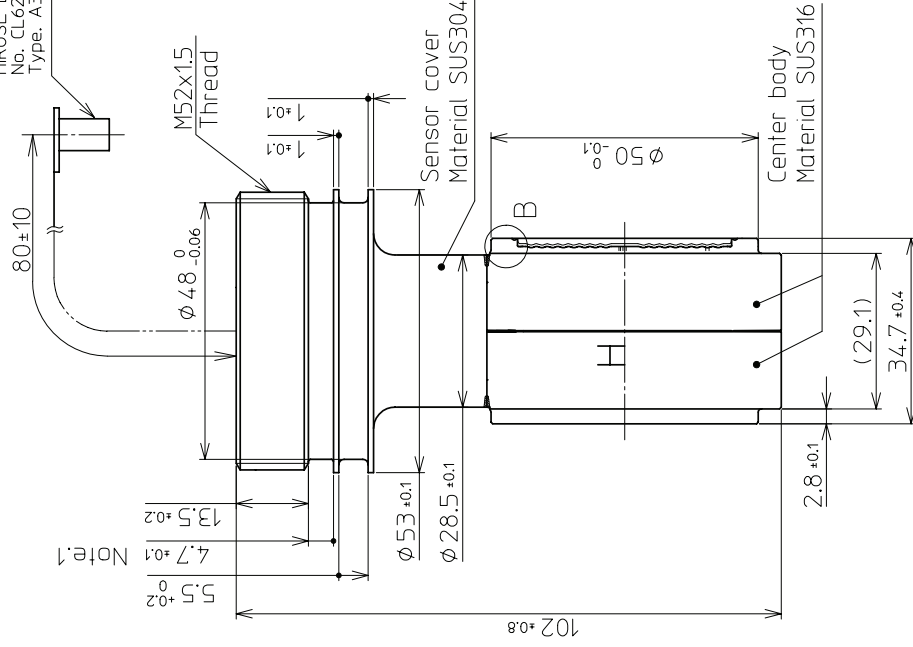
DIMENSIONS UNIT mm

Note 1. O-ring (ISO 3601, P48)

Inside Diameter : $\phi 47.7 \pm 0.44$

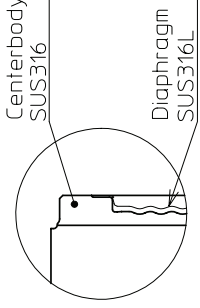
Width : 3.1 ± 0.1

HIROSE ELECTRIC Co.,LTD
No. CL621-1050-4
Type. A3A-Z4PA-2SV(71)

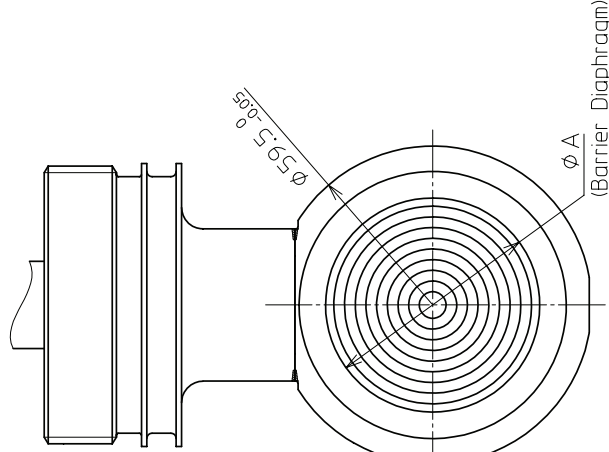
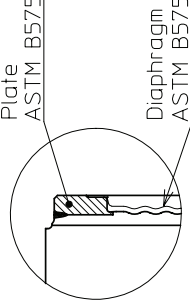


B(2:1)

Wetted Parts Material
SUS316+SUS316L



Wetted Parts Material
ASTM B575



Wetted Parts Material	Dimension A
SUS316L (Centerbody: SUS316)	$\phi 42 \pm 0.2$
ASTM B575	$\phi 44 \pm 0.2$

01	2
改	SHT

秘 YAMATAKE PROPRIETARY	YAMATAKE ASSY	種別 TITLE	Meterbody
DR.	N.C.	08-05-26	
検出 CHK.	T.J.	08-05-26	
許可 APPD.	I. I.	08-05-26	
尺規 SCALE	1:1		
Yamatake Corporation			
図番 DWGNO.		YTG0028	
改訂 REV.		01	1/2
シートの枚数		8	A3

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10N5MD 5000

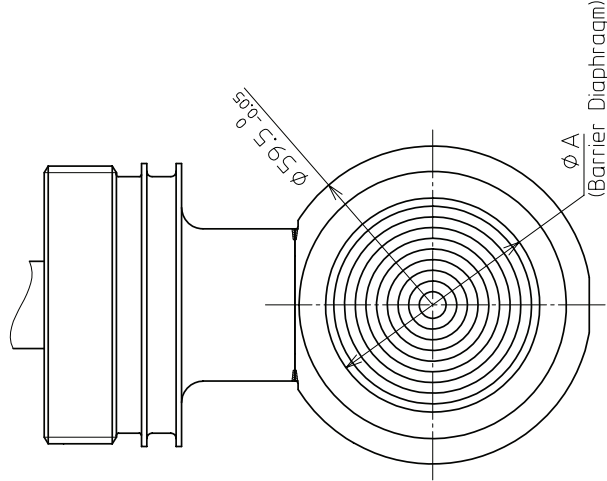
Wetted Parts Compartment: Add-On Type

DIMENSIONS UNIT mm

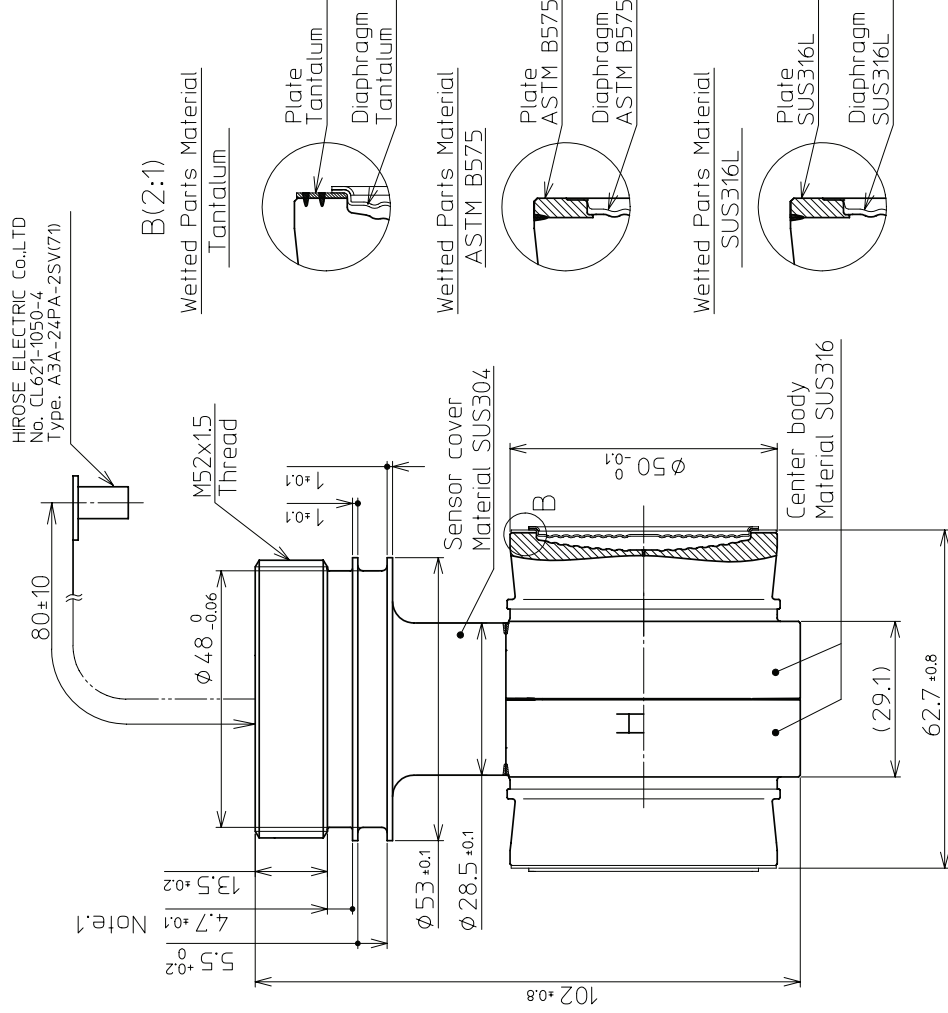
Note 1. O-ring (ISO 3601, P48)

Inside Diameter : $\phi 47.7 \pm 0.44$

Width : 3.1 ± 0.1



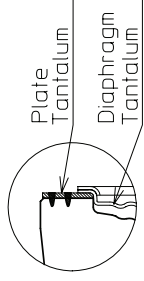
Wetted Parts Material	Dimension A
Tantalum	$\phi 43 \pm 0.2$
ASTM B575	$\phi 43 \pm 0.2$
SUS316L	$\phi 43 \pm 0.2$



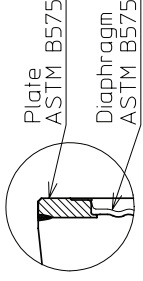
HIROSE ELECTRIC Co.,LTD
No. CL621-1050-4
Type. A3A-Z4PA-2SV(71)

B(2:1)

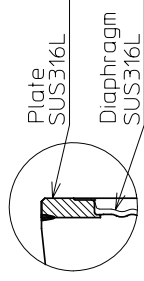
Wetted Parts Material
Tantalum



Wetted Parts Material
ASTM B575



Wetted Parts Material
SUS316L



YAMATAKE PROPRIETARY		YAMATAKE PROPRIETARY		YAMATAKE PROPRIETARY		YAMATAKE PROPRIETARY	
DR.	CHK.	APPD.	SCALE	DR.	CHK.	APPD.	SCALE
N.C.	-	-	1:1	N.C.	-	-	1:1
08-12-26	-	-	1:1	08-12-26	-	-	1:1
TOLERANCE UNLESS NOTED				SURFACE TEXTURE			
~				~			
MATERIAL				CHAMFER			
~				~			
TREATMENT/FINISH				TREATMENT/FINISH			
~				~			
Yamatake Corporation				Yamatake Corporation			
DWGNO. YTG0028				DWGNO. YTG0028			
REV. 00				REV. 00			
SHT. 2				SHT. 2			
A3				A3			