

Smart Ultrasonic Vortex Flowmeter

Model VRX

ULTRA Vortexor

OVERVIEW

ULTRA Vortexor is a smart ultrasonic vortex flowmeter which measures volumetric flow rate by sensing a Karman vortex. ULTRA Vortexor detects the Karman vortex by measuring lags and leads in ultrasonic wave transmission time using two pairs of ultrasonic sensors. Thanks to dual ultrasonic sensors, the ULTRA Vortexor minimizes measurable flow rate and brings about redundancy.

FEATURES

- Ultrasonic sensing

Karman vortices are generated by a bluff body in the flowtube. The frequency of a Karman vortex is proportional to flow velocity. ULTRA Vortexor detects a Karman vortex by measuring lags and leads in ultrasonic wave transmission time using two pairs of ultrasonic sensors. Compared with a vortex flow meter with a piezoelectric sensor, the sensitivity of the ULTRA Vortexor is greater. Also the ULTRA Vortexor is not affected by piping vibration.

- Dual ultrasonic sensors

Ultrasonic wave transmission speed varies by temperature. Temperature may have a significant effect on the detection of Karman vortices when using on ultrasonic sensor. The ULTRA Vortexor incorporates two ultrasonic sensors which cancel the effect of temperature.

- Redundancy

Even if one ultrasonic sensor fails, the second sensor maintains flow rate measurement.

- Expand Minimum measurable flow rate

The minimum measurable flow rate of a conventional vortex flow meter is 0.3m/s. Dual ultrasonic sensors bring about high sensitivity. ULTRA Vortexor improves the minimum measurable flow rate from 0.3m/s to 0.1m/s.



APPLICATIONS

ULTRA Vortexor measures flow in a wide variety of fluids.

- pure water, ion exchange water, tap water.
- organic solvent (ethylene, methanol, ethyl acetate, ethanol, toluene, etc.)
- gasoline, kerosene, light oil, diesel oil. Kinetic viscosity should be less than $20 \times 10^{-6} \text{ m}^2/\text{s}$.

FUNCTIONAL SPECIFICATIONS

Type of protection

Hazardous Locations Certifications

JIS Flameproof : Ex d IIB T4

Water-proof

Waterproof (Integral type): JIS C0920 waterproof standard, IEC IP66 equivalent.

Process Connections

JIS10K/20K/30K/40K, JIS G3451 F12

ANSI150/300

DIN PN10/16/25/40

JP150/300

Calibration Method

Actual flow calibration using water

Output signal

4 - 20 mA DC, Pulse (totalized value), Alarm : 4-wire

4 - 20 mA DC: 2-wired

Pulse: Open collector pulse

30 V DC, 50 mA

Alarm: Open collector contact

30 V DC, 50 mA

Communication

Via SFC (Yamatake Smart Field Communicator)

Indicator

LCD eight-digit (optional)

Totalized value, Flow rate, Reset totalized value

Alarm display

Damping time

1 to 199 seconds (adjustable)

Power failure

Save totalized value in EEPROM

LCD eight-digit (optional)

Power supply

21.6 V DC to 26.4 V DC (see Figure 1 for relationship between power supply voltage and load resistance)

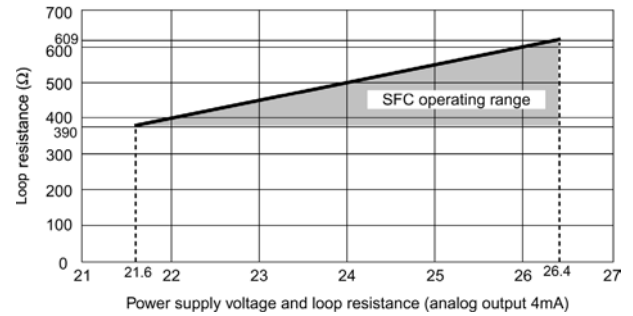
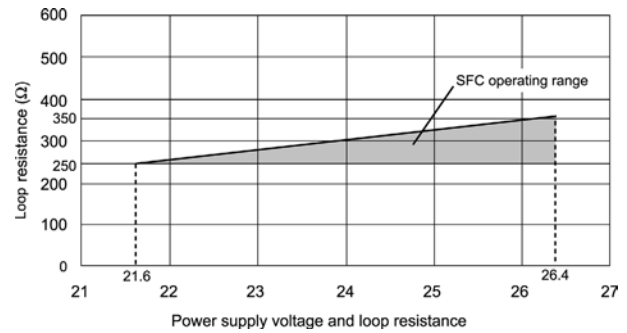


Figure 1.

In order to communicate via SFC, DCS or distributor needs to have a capability of driving the loop current as shown in Figure 2.

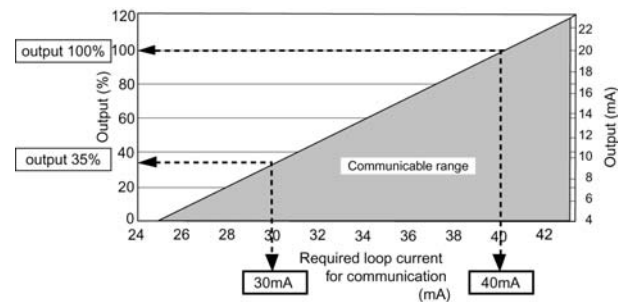


Figure 2. Required loop current and output

Data setter

Setting by SFC or key switch (when equipped with an indicator)

Ambient Temperature limit

-20 to +60°C

Ambient humidity limits

10 % to 95 % RH (no condensation)

Optional specifications

Test Reports

Calibration certificate

Traceability certificate

The following three documents are included.

Traceability System Chart

Traceability Certificate

Test Report

Material Certificate

Material Certificate for process wetted materials.

Strength Calculation Sheet

A set of documents showing strength calculations for the housing, cap, and welded parts.

Water Free Treatment

Condensation is removed from process wetted materials surface.

Oil Free Treatment

Oil is removed from process wetted materials surface.

Tagging

Stamp the tag with the specified number and attached to the Vortexor. The maximum number of characters of the tag is 8. Valid characters are capital letters, whole numbers, and hyphens (-).

Tropicalization Treatment

Protect the Vortexor in harsh environment during transportation and/or storage.

The following treatment is applied.

Corrosion protection

Moisture prevention

Mildew proofing.

PHYSICAL SPECIFICATIONS

Finish

Paint

Converter case, cover

Standard paint: corrosion-preventive acrylic resin

Corrosion-resistant paint: baked acrylic resin

Corrosion-proof paint: epoxy resin

Main body material

Non-Wetted Materials

Meter Body non-wetted parts: SUS316, SCS14

Converter case: Aluminum alloy

Bolts/nuts (optional): SUS304

Process-Wetted Materials

Meter Body/Shedder Bar: SCS 16 (SUS 316L equivalent)

Sensor Cap: SUS316L

PERFORMANCE SPECIFICATIONS

Flow Rate Range for Guaranteed Accuracy

Re > 25,000 and flow velocity of 0.3 m/s or more

Accuracy

±1% of rate (pulse output)

±1% of rate ±0.1% F.S. (4 - 20 mA DC output with dual sensor)

Reproducibility

±0.2% of rate

Process Fluid Temperature

-20 to +160°C (waterproof model)

-20 to +120°C (explosion-proof model)

Process Fluid Pressure

5 MPa maximum

Measurable Fluid

Liquid

Process Fluid Conditions

Kinetic Viscosity: 20X10⁻⁶ m²/s or less

No bubble is included.

No significant pulsation flow or pulsating pressure exists.

No slurry fluid and not adhesive fluid.

Measurable Range

Within the ranges specified in Table 1 and Table 2.

Table 1. Accuracy Guaranteed Flow Range

Diameter	Minimum flow rate that assures accuracy of ±1% of rate (m ³ /h)											Maximum measurable flow rate (m ³ /h)
	Kinetic Viscosity (×10 ⁻⁶ m ² /s)											
	0.3	0.5	0.7	1	2	3	4	5	7	10	20	
25	0.6	0.9	1.2	1.7	3.4	5.1	6.8	8.5	12			14
40	0.7	1.1	1.6	2.2	4.4	6.6	8.8	11	16	22		36
50	0.8	1.3	1.8	2.5	5.0	7.5	10	13	18	25	50	60
80	1.4	2.3	3.2	4.6	9.2	14	19	23	32	46	92	115
100	2.3	3.7	5.2	7.4	15	23	30	37	52	74	148	200

Table 2. Measurable Flow Rate Range (Note 2)

Diameter	Minimum measurable flow rate (m ³ /h) (Note 1)											Maximum measurable flow rate (m ³ /h)
	Kinetic Viscosity (×10 ⁻⁶ m ² /s)											
	0.3	0.5	0.7	1	2	3	4	5	7	10	20	
25	0.1	0.15	0.2	0.28	0.6	0.9	1.2	1.4	2.0	2.8	5.7	14
40	0.2	0.3	0.4	0.53	1.0	1.5	2.0	2.5	3.5	5.0	10.0	36
50	0.3	0.4	0.52	0.74	1.4	2.0	2.7	3.4	4.7	6.7	14	60
80	0.5	0.8	1.0	1.4	2.4	3.6	4.8	6.0	8.4	12	24	115
100	1.0	1.5	1.8	2.4	3.9	5.8	7.7	9.6	14	20	39	200

Table 3. Flow Range with ±0.5% of rate accuracy (Note 4)

Size (mm)	Flow rate with ±0.5% of rate accuracy (m ³ /h)	
	Process fluid: pure water/tap water	
40	4.5 to 16	
50	6.9 to 29	
80	15 to 70	
100	24 to 119	

(Note 1) Although accuracy is not guaranteed when measurement is performed with the flow rate range from the minimum measurable flow rate to the minimum flow rate that ensures accuracy of ±1% of rate, it is possible to obtain output of a sufficient accuracy.

(Note 2) The accuracy obtained using the flow rate range from the minimum measurable flow rate to the minimum flow rate that ensures accuracy of ±1% of rate is ±2% F.S.

$$\text{kinetic viscosity} = \frac{\text{process fluid viscosity (cp)}}{\text{Process fluid density (kg/m}^3)} \times 10^3$$

$$= \frac{\text{Process fluid viscosity (Pa} \cdot \text{s)}}{\text{Process fluid density (kg/m}^3)}$$

(Note 3) When a process fluid kinetic viscosity is between values listed in the Table 1 or Table 2, calculate an approximate flow rate by using the following expression.

<Accuracy guaranteed flow range>

Size

- 25mm Flow rate = kinetic viscosity X 1.7024 + 0.0214
- 40mm Flow rate = kinetic viscosity X 2.2206 + 0.0009
- 50mm Flow rate = kinetic viscosity X 2.5014 + 0.0977
- 80mm Flow rate = kinetic viscosity X 4.5962 + 0.0733
- 100mm Flow rate = kinetic viscosity X 7.3929 + 0.1888

<Measurable flow rate range>

Size

- 25mm Flow rate = kinetic viscosity X 0.2834 + 0.0153
- 40mm Flow rate = kinetic viscosity X 0.4978 + 0.0272
- 50mm Flow rate = kinetic viscosity X 0.6924 + 0.0167
- 80mm Flow rate = kinetic viscosity X 1.1914 + 0.1053
- 100mm Flow rate = kinetic viscosity X 1.9376 + 0.276

(Note 4) The optional calibration of ±0.5% of rate accuracy is only applied to the process fluid of tap water or pure water.

INSTALLATION

Electrical connection

- G1/2 internal thread, 1/2 NPT internal thread,
- CM20 internal thread

Pipe connection

- Wafer connection, Flange connection

Installation Notes

- The following guidelines should be considered when selecting an installation location:
 1. Install in any orientation, either horizontally, vertically, or diagonally, as long as the pipe is always filled with liquid. **For submerged use, avoid contact of converter case with water.**
 2. When installing on a vertical pipe, ensure that the process fluid flows from bottom to top and always fills the pipe.
 3. Avoid locations that experience large temperature fluctuations.
 4. Use supports. Although the flowmeter possesses a good vibration-proof structure, it is advisable, to protect piping and joints, to keep vibration and shock below 9.8 m/s².
- Install in a location having sufficient wiring and piping clearance.

Notes on Piping and Installation

The following points need to be considered during piping and installation:

1. Match the flow direction of the fluid with the direction indicated on the flowmeter.
2. Install straight pipes (of lengths specified in Table 4) upstream and downstream of the flowmeter.
3. To ensure an accurate flow measurement, the internal diameter of the pipe connected immediately before and after the flowmeter, should be of a size equivalent to or larger than the internal diameter of the flowmeter pipe.

Table 4. Required Straight Pipe Lengths

Piping for the Upper Stream	Straight Pipe Length for the Upstream side	Straight Pipe Length for the downstream side
One 90° bend	A minimum 23 straight pipe diameters	A minimum 5 straight pipe diameters
Two or more bends on the same surfaces	A minimum 25 straight pipe diameters	A minimum 5 straight pipe diameters
Two or more bends on a different surface	A minimum 40 straight pipe diameters	A minimum 5 straight pipe diameters
Reducer	A minimum 15 straight pipe diameters	A minimum 5 straight pipe diameters
Expander	A minimum 27 straight pipe diameters	A minimum 5 straight pipe diameters
Gate valve	A minimum 15 straight pipe diameters	A minimum 5 straight pipe diameters
Pump, control valve	A minimum 40 straight pipe diameters	A minimum 5 straight pipe diameters

Table 5. Connection Pipe

Nominal size	Internal Diameter of the Flowmeter	Connection Pipe
25 to 50mm	Equivalent to schedule 40	Schedule 40 or greater
80 to 100mm	Equivalent to schedule 80	Schedule 80 or greater

4. To ensure accurate flow measurement, ensure the gasket connecting the flowmeter and the connection pipe does not intrude into the flow path.
5. If a pressure tap is required to ensure accurate flow measurement, install it at a distance of 2 - 7 times the flowmeter diameter, away from the downstream end of the flowmeter. If a temperature tap is required, install it at a distance of 1 - 2 times the diameter, downstream away from the pressure tap.
6. When piping, ensure that the flowmeter and connection pipe are coaxial. Shift of center will cause unstable measurement and errors. Use the centering jig attached to the flowmeter.
7. Pulsation flow by such as a bellows pump or dosig pump may cause the error of the measurement. Use a damper to minimize pulsation flow.
8. For a line with valves, such as globe valves, that may be generating eccentric flow, install the flowmeter upstream of such valves.
9. When installing a heat exchanger that significantly changes the process fluid temperature, install it downstream of the flowmeter. If it must be installed upstream, secure a sufficient distance from the flowmeter.
10. Cavitation decreases the accuracy of the flow measurement. To prevent cavitation, be sure to maintain the lowest pressure in the line downstream (which is located at a distance of 2 to 7 times of the diameter of the flowmeter) at a pressure higher than or equal to the result of the expression shown below.

$$P_d = 2.7 \times \Delta P + 1.3 \times P_0$$

P_d : Downstream pressure (kPa, absolute pressure)

ΔP : Pressure loss (kPa)

P_0 : Vapor pressure of process fluid at the temperature during measurement (kPa, absolute pressure)

The following expression is used to calculate pressure loss:

$$\Delta P = c \times \gamma$$

ΔP : Pressure loss (kPa)

c : Pressure loss coefficient (according to Figure 3)

γ : Process fluid density (kg/m^3)

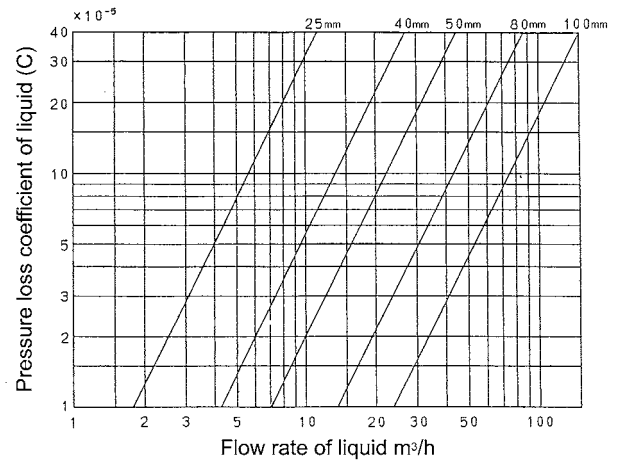


Figure 3. Pressure Loss Coefficient

Wiring

1. Follow Figure 4 to wire cables for the flowmeter, power supply, and external equipment.

Note 1. To make use of the communication function via the smart communicator, load resistance of 250 Ω or more is required, including the cable resistance (see Figure 1).

Note 2. Supply power for the flowmeter

Note 3. When grounding the cable shield, use single point ground on the flowmeter side or the upper side of the equipment.

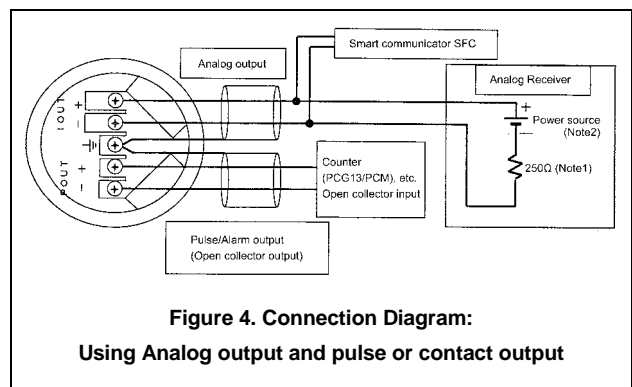


Figure 4. Connection Diagram:
Using Analog output and pulse or contact output

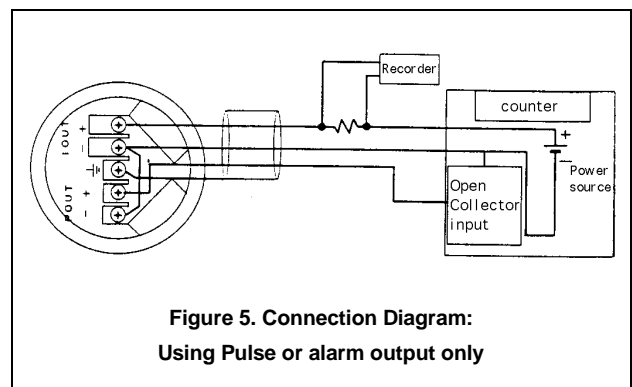


Figure 5. Connection Diagram:
Using Pulse or alarm output only

2. Analog output

The Analog loop of this flowmeter is created by installing load resistance between the + line and - line of the analog output line. The analog output line is also used as a power-supply line for the flowmeter.

3. Pulse output/Alarm output

The Pulse output/Alarm output of this flowmeter is an open collector type. Installing a current limiting resistance between a power source line and pulse/alarm output line, this flowmeter is used. Ensure to select an appropriate value of the current limiting resistance which the current does not exceed the value of the pulse output capacity.

4. To prevent noise, conduit tubes or ducts should be used for wiring.

Wiring Notes

1. The cable specifications are as follows:

Recommended cable: CVVS or CEVS

Table 6.

Flowmeter output	Number of leads	Cross-section area of the cable
Analog output only	2-cores shield	2mm ²
Analog out put+ Pulse output, or Analog output	2-cores shield x 2	2mm ²
Pulse or Alarm output only	3-core shield	2mm ²

2. To prevent noise, avoid locations containing noise sources, such as heavy-duty motors, transformers, and power supplies for motors, as well as locations containing high-voltage and high electric currents.

3. When using an explosion-proof model, use the Yamatake standard flame-proof cable gland which attached to the device.

MODEL SELECTION

ULTRA Vortexor Smart Ultrasonic Vortex Flowmeter (Integral Model)

VRX10A - I II III IV V VI VII - VIII IX X XI - Options (can select up to 7 options)

Basic model No.	VRX10A-		
I	Diameter	25mm	025
		40mm	040
		50mm	050
		80mm	080
		100mm	100
II	Body material	Stainless steel SCS16	S
III	Pipe connection	Wafer JIS10K	11
		Wafer JIS20K	12
		Wafer JIS30K	13
		Wafer JIS40K	14
		Wafer ANSI150	21
		Wafer ANSI300	22
		Wafer JIS G3451 F12 for 80/100mm	31
		Wafer DIN PN10	41
		Wafer DIN PN16	42
		Wafer DIN PN25	43
		Wafer DIN PN40	44
		Wafer JPI150	61
		Wafer JPI300	62
		IDF clamp	C1
		Flange JIS10K	J1
		Flange JIS20K	J2
		Flange ANSI150	A1
Flange ANSI300	A2		
Flange JPI150	P1		
Flange JPI300	P2		
IV	Outputs (Note 1)	4 to 20mADC and Pulse	P
		4 to 20mADC and Contact	A
V	Wiring connection	G1/2 internal thread (1 conduit)	G1
		G1/2 internal thread (2 conduits)	G2
		1/2NPT internal thread (1 conduit)	N1
		1/2NPT internal thread (2 conduits)	N2
		CM20 internal thread (1 conduit)	C1
		CM20 internal thread (2 conduits)	C2
VI	Installation/ display direction (Note 2)	Horizontal piping mounting (left side viewed from upstream)	H
		Horizontal piping mounting (right side viewed from upstream)	J
		Horizontal piping mounting upstream side	K
		Horizontal piping mounting downstream side	L
		Vertical piping mounting (display: right side from piping)	V
		Vertical piping mounting (display: left side from piping)	W
VII	Calibration	Standard calibration (3 point calibration)	3
		5point calibration	5
		+/-0.5% of rate accuracy calibration (only for size 40 to 100mm, non-explosion-proof model)	S
VIII	Display (Note 8)	None	X
		with LCD indicator (Note 3)	A
IX	Approval	None	X
		JIS Flameproof (G1 or G2 must be selected in "V"-wiring connection code.) (Note 4)	J
X	Finish	Standard	X
		Corrosion-resistant	1
		Corrosion-proof	2
XI (Note 5)	Bolts and nuts	None	X
		with SUS304 bolts and nuts	1

- Note 1) Pulse/alarm output is configurable in the field.
- Note 2) You can change the direction of converter in the field.
- Note 3) LCD is with parameters setting device.
- Note 4) JIS explosion-proof model is with flame-proof gland.
- Note 5) Only Code "X" can be selected for flanged VRX10A.
- Note 6) This calibration is only available for pure/tap water as process fluid.
- Note 7) The default pulse scale is the following.
25 and 40mm: 0.1liter, 50 50 100mm: 1liter
- Note 8) JIS Flameproof model is with LCD indicator model only.

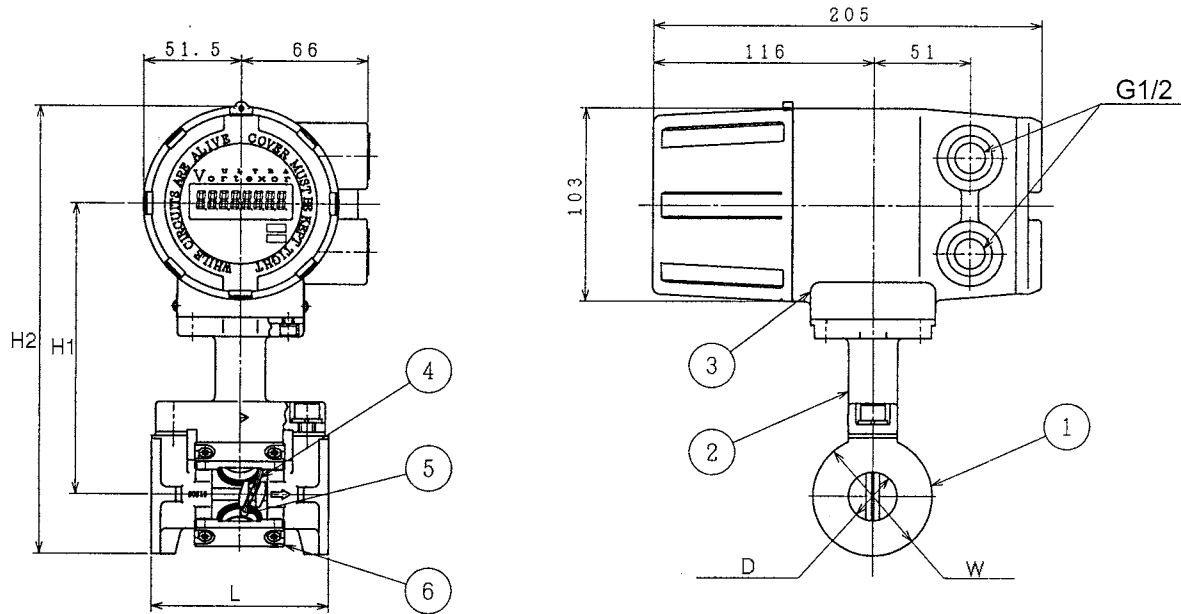
- Options	No option	X
	Test report	A
	Treaceability certificate	B
	Material certificate	C
	Strength calculation sheet	D
	Water free treatment	E
	Oil free treatment	F
	Gasket for piping	H
	TAG No attachment	J
	Tropicalization treatment	K

DIMENSIONS

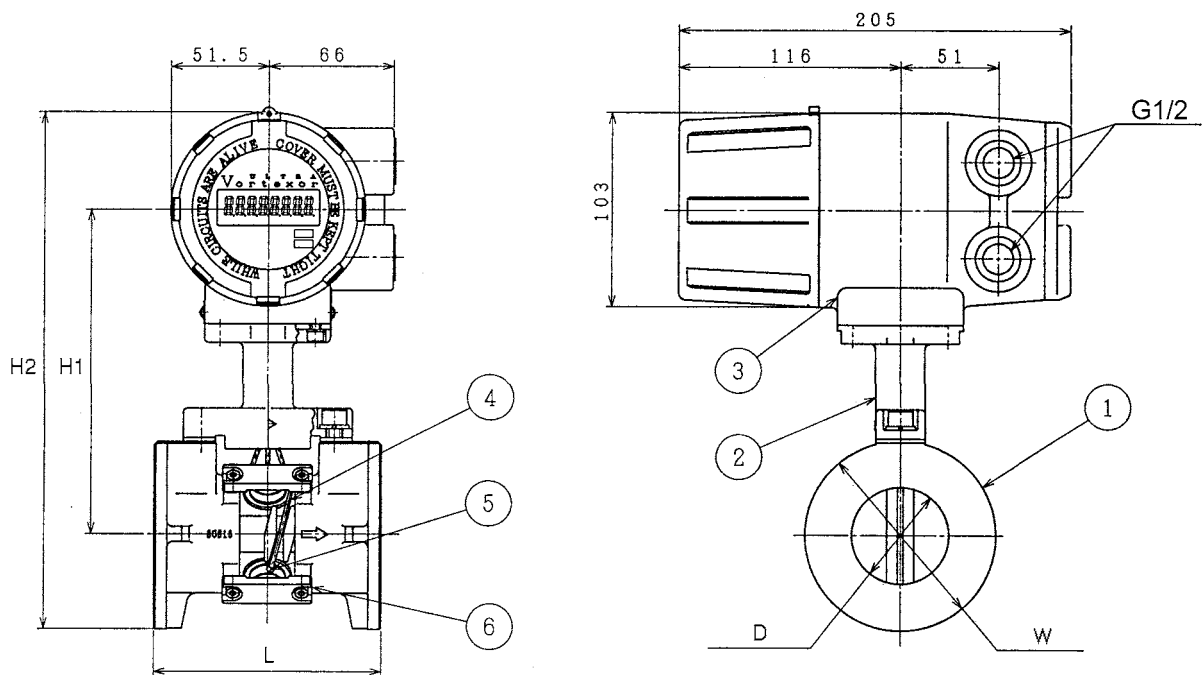
[Integral Type with Indicator]

25mm to 40mm

(Unit:mm)



50mm to 100mm

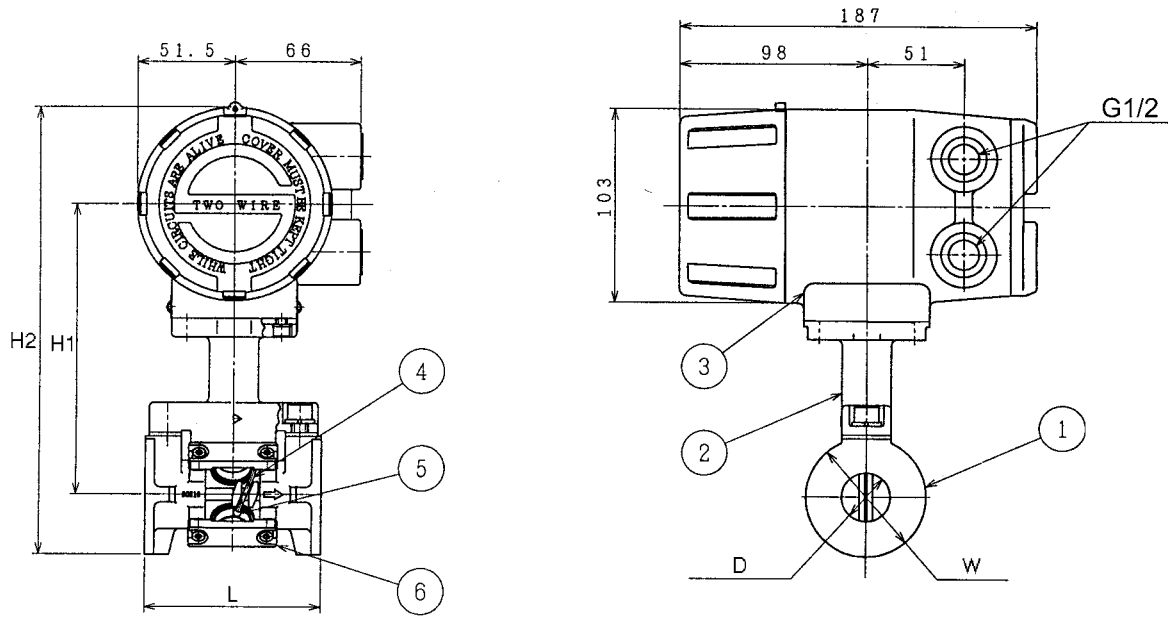


Nominal size		25	40	50	80	100
Length	L	93	106	120	160	180
	H1	155.0	163.5	173.0	177.5	189.0
Height	H2	238.0	255.5	274.5	292.5	319.1
	W	63	81	100	127	157.2
Case size	D	25.7	39.7	51.1	71.1	93.8
Mass (kg)		4	4.5	5	7	8.5

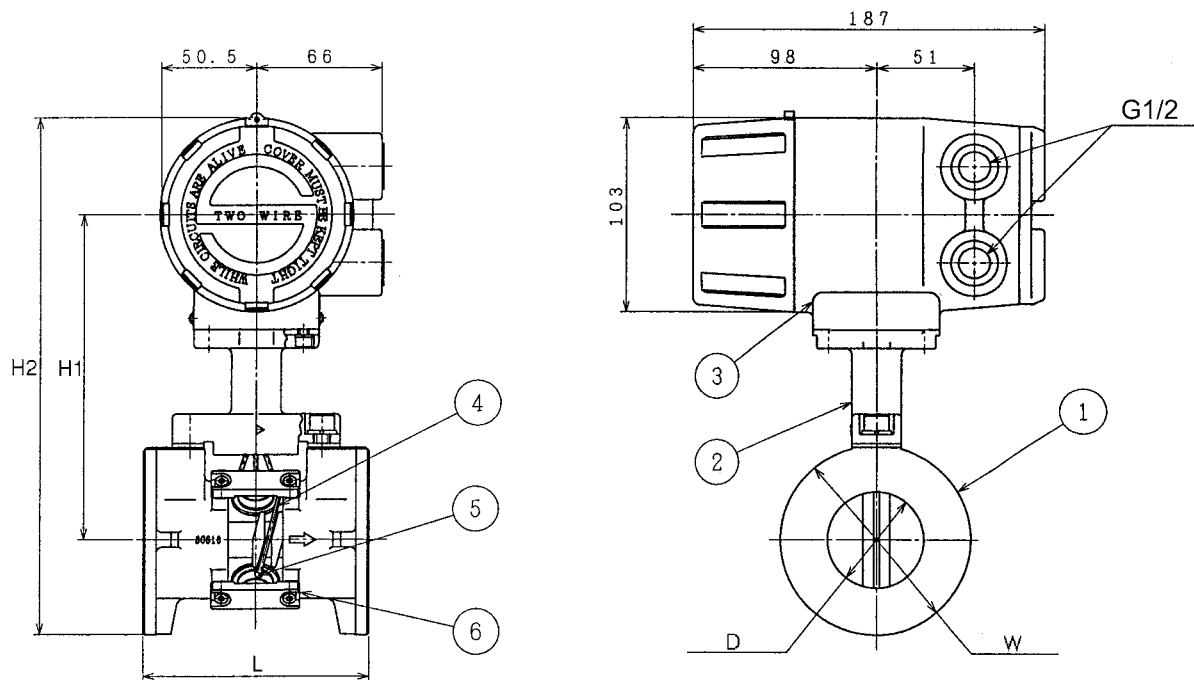
[Integral Type without Indicator]

25mm to 40mm

(Unit:mm)



50mm to 100mm

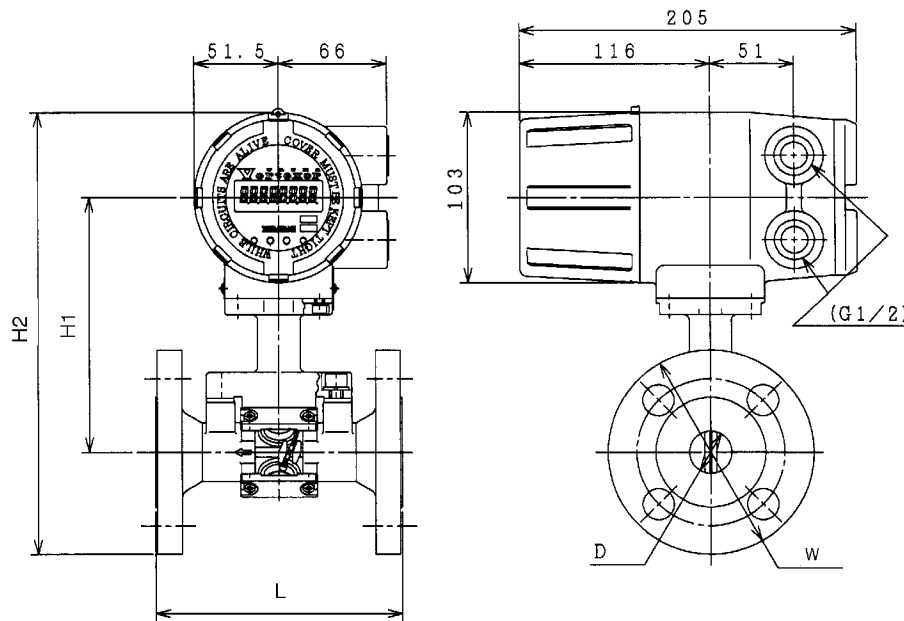


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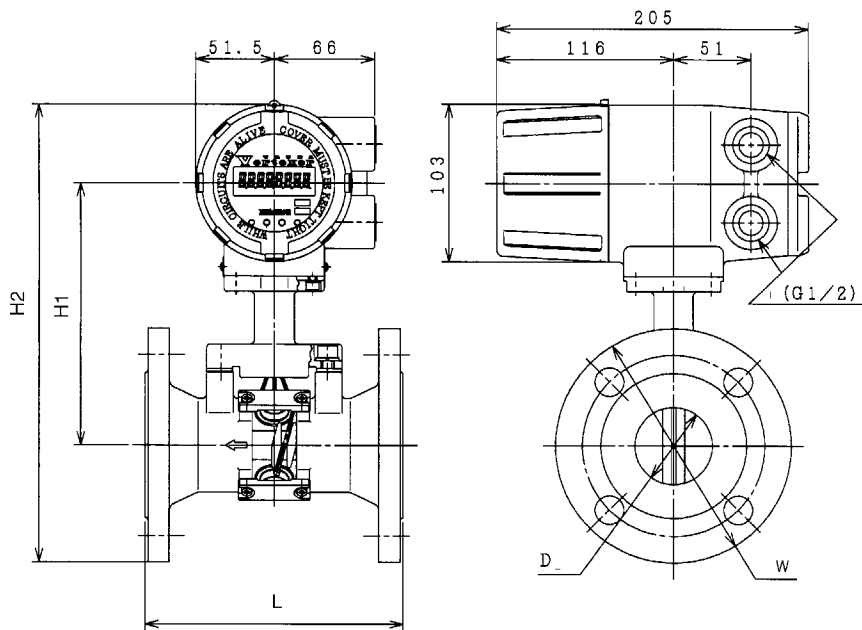
[Integral Type with Indicator]

25mm~40mm

(Unit:mm)



50mm to 100mm

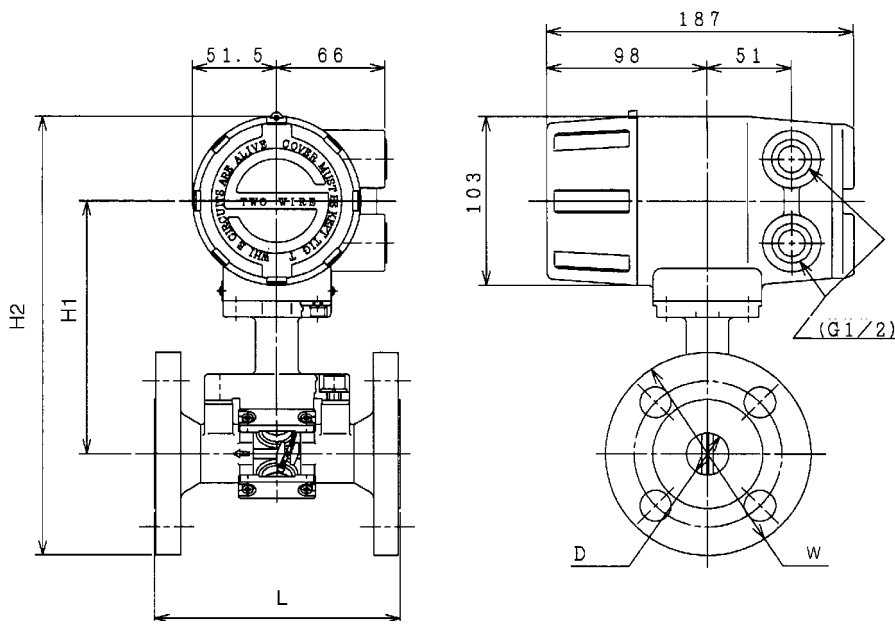


Nominal size		25	40	50	80	100
Length	L	150.0	150.0	170.0	200.0	220.0
	H1	155.0	163.5	173.0	177.5	189.0
Height	H2	238.0	255.5	274.5	292.5	319.1
	W	63.0	81.0	100.0	127.0	157.2
Case width	D	25.7	39.7	51.1	71.1	93.8
Mass (kg)	JIS10K	6.1	7.3	8.7	12.5	16.0
	JIS20K	6.6	7.7	8.8	15.0	20.0
	JPI/ANSI150	5.8	7.0	9.2	15.5	21.0
	JPI/ANSI300	6.8	9.5	6.8	19.0	30.0

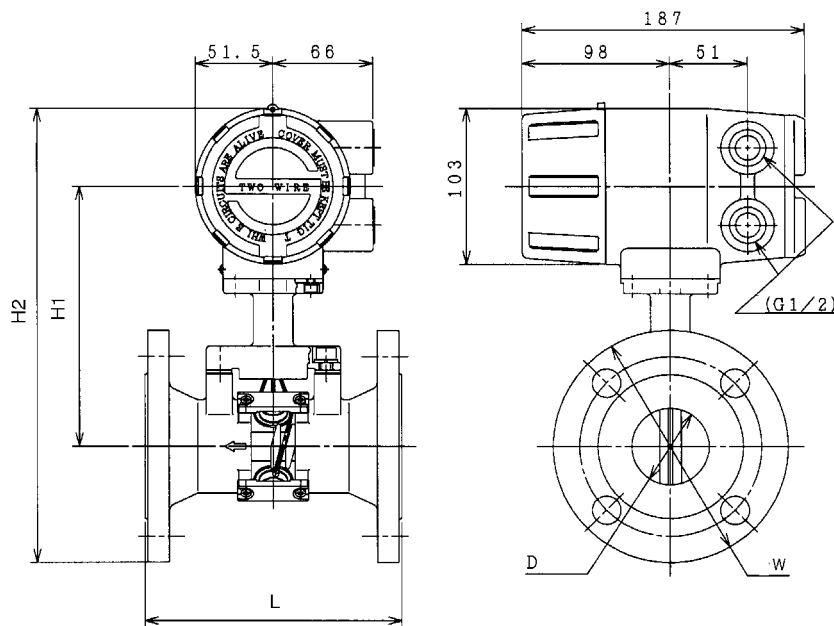
[Integral Type with Indicator]

25mm to 40mm

(Unit:mm)



50mm to 100mm



Nominal size		25	40	50	80	100
Length	L	150.0	150.0	170.0	200.0	220.0
Height	H1	155.0	163.5	173.0	177.5	189.0
	H2	238.0	255.5	274.5	292.5	319.1
Case width	W	63.0	81.0	100.0	127.0	157.2
Case size	D	25.7	39.7	51.1	71.1	93.8
Mass (kg)	JIS10K	6.1	7.3	8.7	12.5	16.0
	JIS20K	6.6	7.7	8.8	15.0	20.0
	JPI/ANSI150	5.8	7.0	9.2	15.5	21.0
	JPI/ANSI300	6.8	9.5	6.8	19.0	30.0

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