PRODUCT DATA SHEET

Open Channel

Ultrasonic Flowmeter

# UF-960

TOKYO KEIKI

TOKYO KEIKI INC.

1. Outline

1) The UF-960 flowmeter measures free surface flows of such fluids as supply water, agricultural water, river water, wastewater, process water, and industrial effluents. Flowmeters generally calculate flow by taking the product of average flow velocity and the flow cross-sectional area. The UF-960 flowmeter system however employs an ultrasonic flow rate meter to determine flow velocity and a level gauge to measure fluid level and computes flow based on signals from these instruments. (Ultrasonic or external level gauges may be used for level measurement.)

2) The UF-960 flowmeter can measure flows for water levels from zero to full. The flow detection unit is small, easy to install, and does not retain flow.

3) The UF-960 flowmeter provides outputs for flow velocity and water level in addition to flow rate and totalized flow. Measurement is possible in both the forward and reverse flow directions.

2. Configuration

Ultrasonic flowmeter for open channels
Standard configuration schematic (e.g., 1 path measurement)
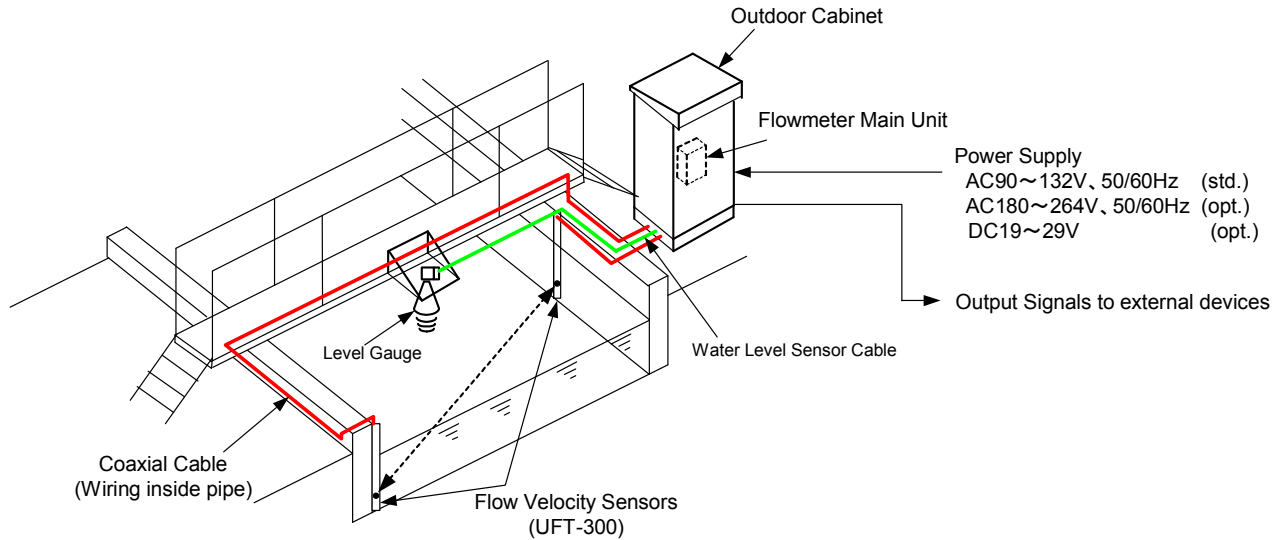
※ Level gauge used can be ultrasonic or other external 2-wire type water level gauge.
※ Level gauge cable may differ according to specifications of the level gauge used.

Item	Nomenclature	Model	Qty	Remarks,
1	Flow velocity transducer	UFT-300	1 set (2 pcs)	Submerged channel installation with accessory mounting fixtures. Ultrasonic pulses are transmitted and received below the water line.
2	Coaxial cable	5C-2WAE	2 pcs	Connects flow velocity transducer and main unit (less than 300m).
3	Cable junction material (Scotchcast)	JB-102	2 pcs	Used to joint flow velocity transducer cable and main unit extension cable. Junction box (JB-101) may also be used.
4	Level gauge		1 pc	Installed above water surface. Any 2-wire level gauge may be used with system.
5	Level gauge cable			Twisted pair cable (KPEES) recommended. If ultrasonic level gauge is used, cables should be complex cable (max. 150m).
6	Main unit	UF-960	1 pc	Receives signals from flow velocity transducer and level gauge and calculates flow rate, provides a display, and generates a variety of signal outputs.

3. Calculation of flow rate

1) Flow rate *'Q'* through the open channel is the product of average flow velocity *'V'* and the flow cross-sectional area *'A(h)'* which is a function of level *'h'* .

$$Q = A(h) \cdot V$$

Average flow velocity *'V'* is found by multiplying path flow velocity *'Vl'* by the correction coefficient *'Kl(h)'* of measurement path which is a function of level *'h'*.

$$V = Kl(h) \cdot Vl$$

If flow rate correction coefficient *'Kq'* is the product of *'A(h)'* and *'Kl(h)'* , *'Kq'* can be found as a function of level *'h'*.
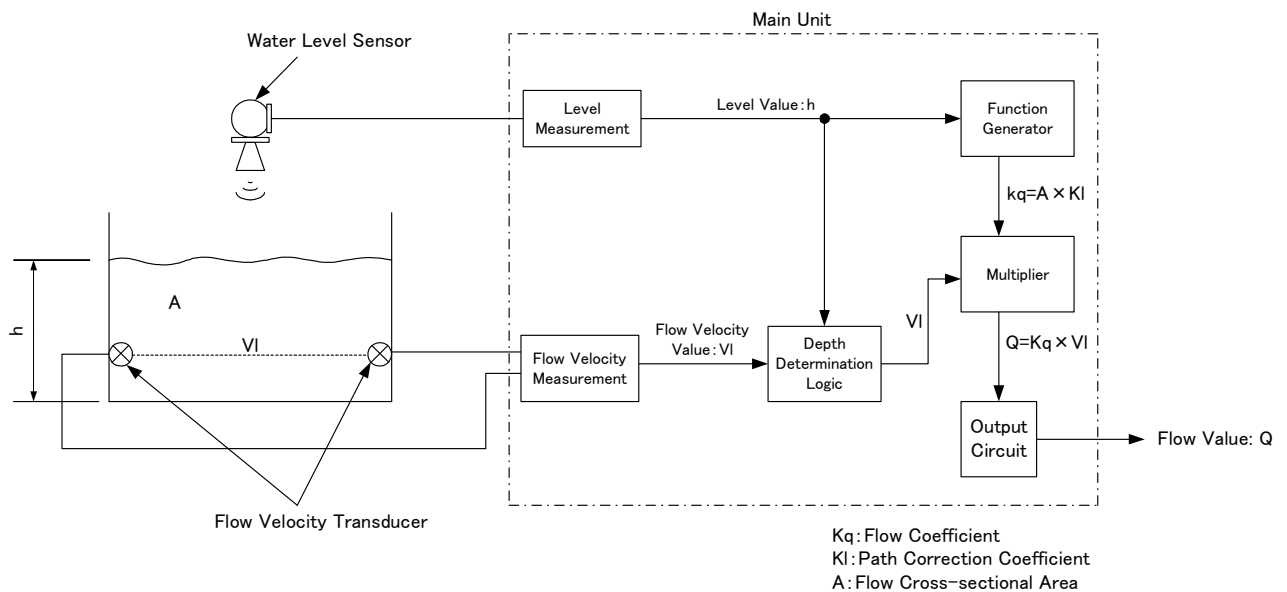
$$Kq(h) = A(h) \cdot kl(h)$$

When flow rate correction coefficient *'Kq(h)'* is found, flow rate *'Q'* is calculated by multiplying flow velocity *'Vl'* of measurement path by *'Kq(h)'*.

$$Q = Kq(h) \cdot Vl$$

2) In fluid channels where there is flow velocity turbulence, multiple path measurement (2 - 4 measurement paths) is employed. In such case, flow velocity would be the average of each of the measured path flow velocities, *'Vi'* , and *'Kq(h)'* would take into consideration multiple measurement paths.

3) Flow velocity measurements cannot be made if water level falls below the lowest sensor height, and flow rate would be calculated in accordance with the Manning formula.

Open Channel Ultrasonic Flowmeter – Block Diagram

3

4.   General Specifications

1. Overall specifications

Measurement	Application	Free surface flows such as agricultural water, river water, waste water, processing water, industrial effluents, etc.
	Fluid temperature	0 ～ 40℃
	Turbidity	Less than SS10,000mg/L
	Other	Consult manufacturer in the following cases: • Large amount of bubbles or debris on fluid surface • Very choppy fluid surface • Large amount of bubbles or debris in fluid • Drifting, solid, heavy objects such as wood • Sediment accumulation in water channel
Applicable Water Channel	Channel profiles	Rectangular, circular, trapezoidal, horseshoe, etc.
	Dimensions	Channel width : 0.3m ～ 15m Circular water channel: ϕ 0.3m ～ 10m
	Required straight channel length	See Table 7-1
Measurement Range	Flow rate	0 ~ full water level flow
	Water level	0m ～ 10m
	Flow velocity	Forward flow: 0m ～ 10m/s Reverse flow: consult Tokimec
Data update :	approx. 100ms	
Measurement Accuracy	Flow rate	Forward flow: ±3% FS [*1] Limited to natural flows (however max. flow limited by channel profile, max. level, max. flow velocity, etc.) Reverse flow: consult manufacturer
	Water level	Depends on level gauge used.
	Flow velocity	±1%RD [*2] (for flow velocity above 0.8m/s) ±8 mm/s (for flow velocity less than 0.8 m/s)
Measurement method	Flow rate	Flow velocity level calculation method
	Water level	Depends on level gauge used.
	Flow velocity	Ultrasonic pulse transit time difference method

*1)   FS: full-scale

*2)   RD: reading value

2. Main unit specifications

Main unit configuration	Flow velocity measurement and flow calculation sections are integrated into one unit. Level measurement unit - depends on level gauge used	
Water level analog input (A-IN)	Input	Water level analog signal from level gauge
	Specifications of connecting components	1) Two-wire level gauge which operates on DC24±20% 2) Level gauge with 4~20 mA current input, 300Ωload resistance
	Input signal	4-20mA DC current input (insulated) (max 30mA)
	Input terminal	Terminal board (M4)
Flow rate analog output (Q-OUT)	Output	Flow rate
	Output signal	4~20mA DC current output (insulated) Allowable load resistance: less than 750Ω
	Response speed	10~120 sec (90% response time)
	Output pattern	See Output Profile, Chap. 6 "-max. flow" = "max. flow" Forward flow/reverse flow direction directionality by relay output (QBW)
	Output terminal	Terminal board (M4)
Level analog output (H-OUT)	Output	Level
	Output signal	4~20mA DC current output (insulated) Allowable load resistance: less than 750Ω
	Output pattern	See Output Profile Chap. 6
Flow velocity analog output (V-OUT)	Output	Flow velocity
	Output signal	4~20mA DC current output (insulated) Allowable load resistance: less than 750Ω
	Output pattern	See Output Profile Chap. 6 "-max. flow velocity" = "max. flow velocity" Forward flow/reverse flow directionality by contact point output (QBW)
Totalizer output (INTG)	Output	Totalized pulse (contact point close time: approx. 100ms)
	Output signal	Power PhotoMOS relay (insulated)
	Contact point capacity	AC 3~264V DC 3~125V 0.6A (Derating necessary above 40°C, 0.4A@60°C)
	Totalized direction	Forward flow/reverse flow independent output Common setting for forward flow/reverse flow
	Totalized units	$1000m^3$(*1), $100m^3$, $10m^3$, $1m^3$, $0.1m^3$, $0.01m^3$, $0.001m^3$
	Output terminal	Terminal board (M4)
Water level anomaly warning output (HERR)	Output	Warning (during warning: closed) when values beyond specified water level range are acquired
	Output signal	Power PhotoMOS relay (insulated)
	Contact point capacity	AC 3~264V DC 3~125V 0.6A (Derating necessary over 40°C, 0.4A@60°C)
	Output terminal	Terminal board (M4)
Flow velocity anomaly warning output (VERR)	Output	Warning (during warning: closed) when values beyond specified flow velocity range are acquired
	Output signal	Power PhotoMOS relay (insulated)
	Contact point capacity	AC 3~264V DC 3~125V 0.6A (Derating necessary over 40°C, 0.4A@60°C)
	Output terminal	Terminal board (M4)

*1) $1m^3$ is displayed as $1m^3$ (example)

Directionality output (QBW)	Output	Forward flow and reverse flow detection (Forward flow: open, reverse flow: closed)
	Output signal	Power PhotoMOS relay (insulated)
	Contact point capacity	AC 3~264V DC 3~125V 0.6A (Derating necessary over 40°C, 0.4A`60°C)
	Output terminal	Terminal board (M4)
Multi-path flow velocity measurement (SCAN 1/2)	2 Path measurements	External measurement path switching unit not necessary
	3 Path measurements	External measurement path switching unit necessary (optional)
	4 Path measurements	
Flow velocity output	1 Path measurement	Standard specifications
	2 Path measurements	Optional
	3 Path measurements	
	4 Path measurements	

Data settings	Setting method	Flow computation and flow velocity measurement units: interactive 16 keys and display Level measurement unit: depends on level gauge used.
	Settings	Various settings such as analog output, etc.
Display	Display	With backlight, 16 digit × 16 line LCD display unit
	Display content	Measurement data - flow data, measurement units, various operational displays, etc.
	Display digits	Flow rate:　　dependant on max. flow value setting 　　　　　　　(max 6 digits, including comma, decimal point) Level:　　　　dependant on max. level setting Flow velocity: dependant on max. flow velocity setting 　　　　　　　(max. 6 digits, including comma, decimal point) Totalized value: 6 digits
Operation status display	Flow	Displays "flow units" (minus, "-", display for reverse flow)
	Totalizer	"INTG" displayed during totalizing operation
	AGC	If AGC is set at ON during flow velocity measurement, "VAGC" is displayed, if during warning, "wAGC" is displayed
	Anomalous value deletion	"VABN" displayed when anomalous data is deleted during flow velocity measurement
	No receiving echo	"VROFF" displayed during flow velocity measurement processing without receiving echo
		"HROFF" displayed during level measuring processing without receiving echo
	Wire breakage, failure, etc.	"VHALT" displayed when flow velocity values fall below 0% during measurement
		"HHALT" displayed when level values fall below 0% during measurement
	Checks	"CHK-Q" displayed during analog output check of flow rate "CGK-V" displayed during analog output check of flow velocity "CHK-H" displayed during analog output check of level "CHK-M" displayed during switching of measurement path "CHK-QVHM" displayed during multiple checks
	Over full-scale	"FS" displayed when individual measurement data analog outputs exceed displayable range

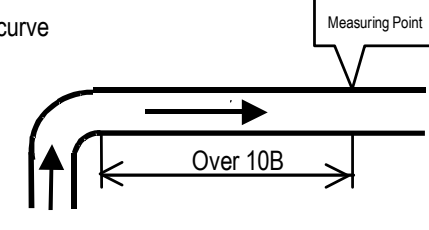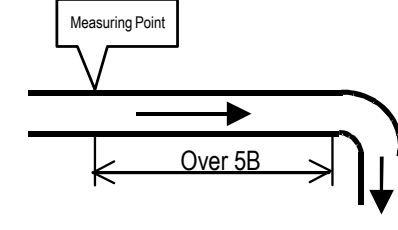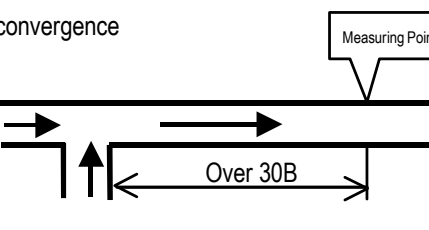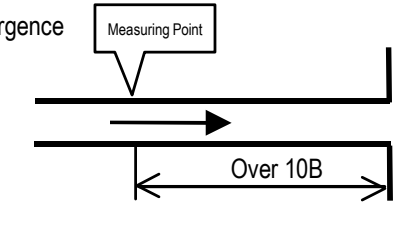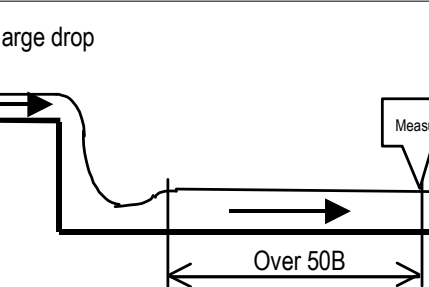|			
Functions	Processing for no receiving echo	Data prior to loss of receiving echo from level gauge and flowmeter is retained. Selectable flow output –within "0%", "100%", or "HOLD (retain prior data)"	
	Applicable time for no receiving echo processing	Flowmeter measurement: 15s Level gauge: dependant on level gauge	
	Self-diagnostics	Self-check routine runs when power is turned on or from check menu	

	Analog output check function	Analog check current outputs possible
		Setting range:
		    Flow rate, flow velocity; -100.0 - 100.0% of span (to max. 1 decimal point)
		    Level; 0.0 - 100.0% of span (to max. 1 decimal point)	

	Low flow rate 'cut'	Flow rates less than specified values are rejected
		    (individual setting of forward flow/reverse flow possible)
		Setting range:
		    Forward flow; 0.0000-9.9999 [flow setting units] (max. 4 decimal places)
		    Reverse flow; -99999 - 0.0000 [flow setting units] (max. 4 decimal places)	

	Flow rate span correction	Span compensation possible (individual setting for forward flow/reverse flow). Setting range: 0.100 - 2.000 (max. 3 decimal places)	
	Flow rate zero correction	Flow zero offset compensation possible (individual setting for forward flow/reverse flows) Setting range: -99999 – 999999 [flow setting units] (max. 4 decimal places)	
	'Cut' of Pool water	Set level of Pool water. Flow is zero if level falls below setting. Setting range: 0.000 - 10.000m (max. 3 decimal places)	
	Deletion of anomalous data	Deletes transient data distortions caused by air bubbles, particles, etc. during flow velocity measurement.	
	Flow velocity automatic gain setting function	Automatic gain setting for flow velocity measurement. Manual setting with oscilloscope to confirm wave profiles also possible	
	Flow velocity automatic gain control function	Automatic gain control to maintain fixed level relative to fluctuations in receiver sensitivity during measurement Note: not designed to respond to flow rate fluctuations	
	Basic data display function	Display of measured or calculated data possible	
	Flow direction output frequent change suppression	Suppresses troublesome directionality output changes under still water, etc.	
	Measurement path switching check function	In cases of multiple measurement paths, forcibly fixes measurement path and allows measurement checks of each path.	

	Low flow velocity 'cut'	Rejects flow velocity data below specified values
		  (separate settings for forward flow/reverse flow)
		Setting range:
		    Forward flow direction: 0.00 - 20.00m/s (max. 2 decimal places)
		    Reverse flow direction: -20.00 - 0.00 m/s (max. 2 decimal places)	

	Flow velocity zero correction	Zero offset compensation possible only for specified flow velocity (separate settings for forward flow/reverse flow) Setting range: -20.00 - 20.00 m/s (max. 2 decimal places)	
	Flow velocity span correction	Span compensation possible (individual setting for forward flow/reverse flow). Setting range: 0.100 - 2.000 (max. 3 decimal places)	
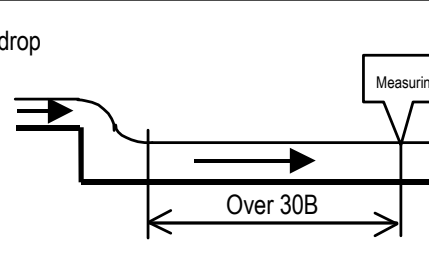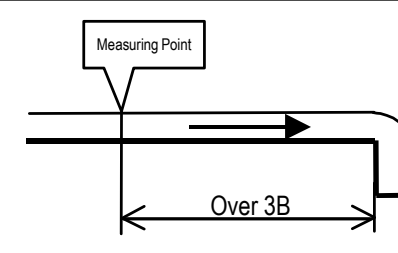
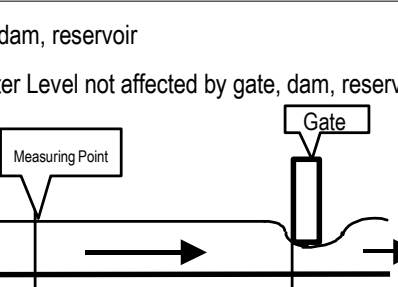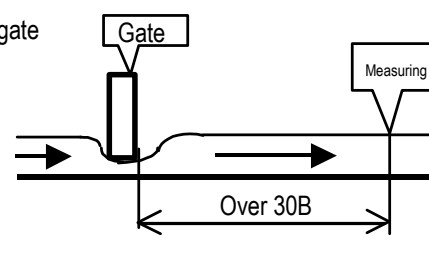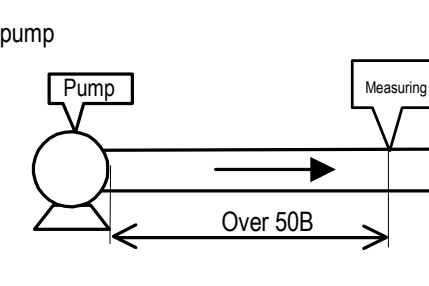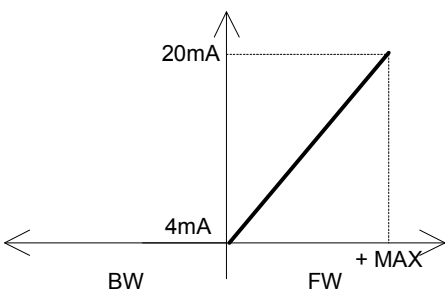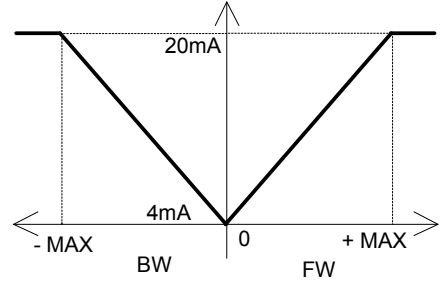|	Zero level correction	Zero offset compensation possible only for specified level Setting range: -9.999 - 11.000m (max. 3 decimal places)
	Level span correction	Span compensation possible Setting range: 0.100 - 2.0000 (max. 3 decimal places)
Power	AC 90-132V (50/60Hz±2Hz), AC 180-264V (50/60Hz±2Hz) DC 19-29V (Optional), momentary power outage response time 10ms	
Power consumption	AC 100V approx. 30VA AC 240V approx. 40VA DC 24V approx. 20W	
Fuse rating	For AC power source: 2A; For DC power source: 2A, For service outlets: 5A All time-lag type	
Arrester	Integrated for Analog Input Line, Analog Output Line, AC power Line: Performance: Complies with IEC61000-4-5; Common mode 4kV / Normal mode 2kV	
Temperature range	-10℃ ～ 50℃	
Humidity range	Less than 90% RH (non-condensation)	
Mounting method	Wall mounting	
Construction	1P5X (dust-proof)	
Power wiring connection port	Skin top, 10 pcs. Compatible cable size: (ϕ 6mm – 12mm, base Hole size ϕ 23.5mm) x 5 (ϕ 9mm – 14mm, base Hole size ϕ 23.5mm) x 5	
Case material	Steel	
Painting	Amino alkyd paint	
Color	Muncell 10YR9.4/0.5	
Weight	Approximately 14kg	
Dimensions	See Necessary straight length of channel, Chap. 5	
Flow velocity detection	SE040040(WL-04) for large channels SE200020 (WL-20) for small channels SE204020(PL-20B-20) for large round channel SE204014(PL-20B-14) for small round channel	
Integrated ultrasonic level gauge transducer (optional)	ULT-140A (measurement span: 0.3 - 5m) ULT-130 (measurement span: 2 - 10m) ULT-115 (measurement span: 5 - 20m)	

3. Optional specifications

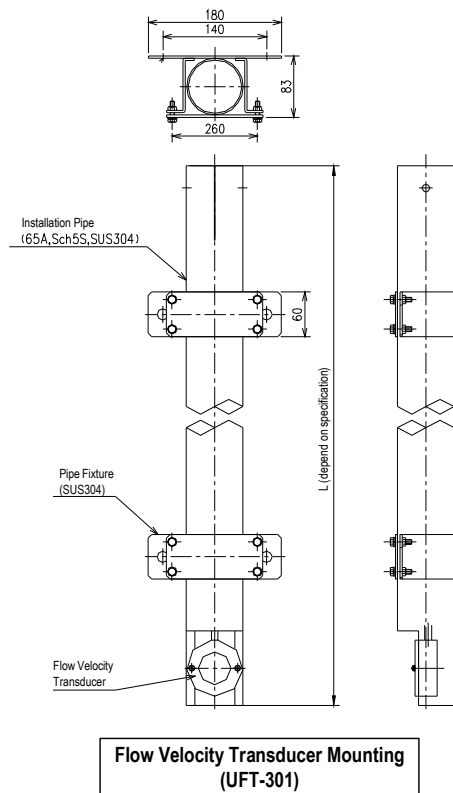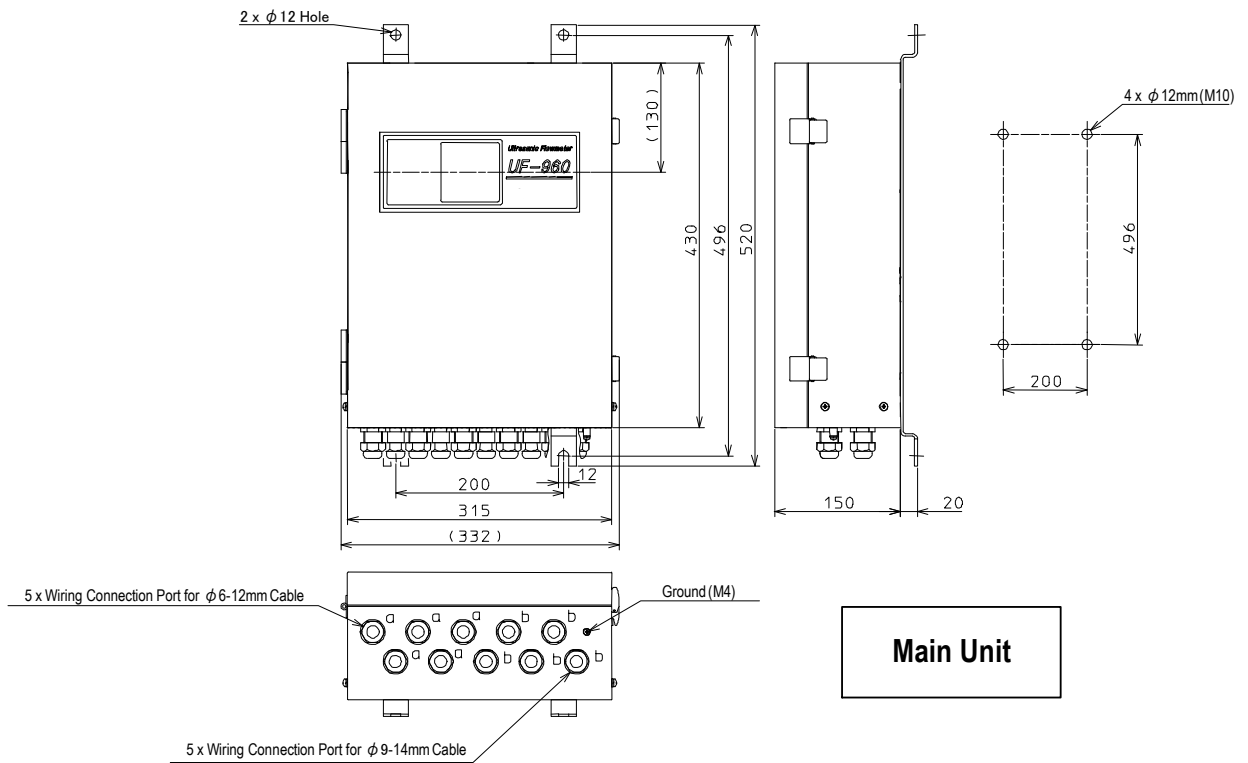| Multiple path flow velocity measurement	Applicable for short straight channels or channels with flow velocity turbulence. Automatic switching of applicable transducer is possible in conjunction with level Optional measurement paths: 2 – 4 In case of more than 3 measurement paths, external path switching unit is required

Necessary straight length of channel

Upstream Necessary Straight Length	Downstream Necessary Straight Length
From curve Measuring Point Over 10B	To curve Measuring Point Over 5B
From convergence Measuring Point Over 30B	To convergence Measuring Point Over 10B
From drop Measuring Point Over 30B	To drop Measuring Point Over 3B
From large drop Measuring Point Over 50B	To gate, dam, reservoir (1) Water Level not affected by gate, dam, reservoir Gate Measuring Point Over 10B (2) Multiple Path measurement employed when water level is affected by gate, dam, resoervoir
From gate Gate Measuring Point Over 30B	
From pump Pump Measuring Point Over 50B	

B: channel width

6. Analog output profile

Type	Output Profile
+	
+/-	

7.Dimensional Drawing

2 x φ12 Hole

4 x φ12mm (M10)

(130)

430

496

520

496

200

200

315

(332)

12

150

20

5 x Wiring Connection Port for φ6-12mm Cable

Ground (M4)

5 x Wiring Connection Port for φ9-14mm Cable

Main Unit

180

140

83

260

Installation Pipe
(65A,Sch5S,SUS304)

60

Pipe Fixture
(SUS304)

L (depend on specification)

Flow Velocity
Transducer

Flow Velocity Transducer Mounting
(UFT-301)

8. Wiring Connection

Switching Unit US-800 not used with 1 & 2 path systems.
Direct connection required.

9. Installation Example (2-path & 6 inch cone antenna system)