Supersonic Flowmeter

Instruction Manual

for

SSF series

⚠ Caution

Before using the **Supersonic Flowmeter**, please read this instruction manual thoroughly to fully understand the correct operation of this product. Please always keep this Instruction Manual at hand for your quick reference when necessary.

TOFLO CORPORATION

104-R08

Table of Contents

Prior to using the Supersonic Flowmeter

⚠Warning

- Start operating after making sure that the kind of fluid to be used is fitted into the materials of the wetted part.
- Please read this Instruction Manual with caution to fully understand the correct operation of this product.
- Keep this Instruction manual at hand for your quick reference when necessary.
- Be sure to observe the usages originated in this product and those provided here in this manual.
- Be sure to observe the instructions specified in this manual in confirmation of the contents.

Strictly comply with the instructions stated above. Failure to comply may result in injury and accident.

＜About the Instruction Manual ＞

- The contents of this Instruction Manual is subject to change due to improvement of performance and function without prior notice.
- It is prohibited from reprinting and making a copy of this Instruction either in its totality or partially.
- Should the manual be lost, then contact us at the nearest sales office.
- Every effort was made to ensure that all information included here in this Instruction Manual were complete and accurate. We would appreciate it if you could contact us should you find any doubtful point, error and omission in this manual.

Safety precaution for the safely and proper use

＜About safety alert symbols＞

Such distinguishing marks as **Danger**, **Warning** or **Caution** and so forth are used in this Instruction Manual in order that the products may be used properly, and that it may prevent the users or other people from the harm or damages to the property.
The meaning of the indications are as follows. Please read the text with a good understanding of the contents.

⚠ **Danger**	This is the safety-alert symbol which indicates the overhanging dangers to the users which may die or suffer from serious injury should the symbol be ignored and the products be wrongly used.
⚠ **Warning**	This is the safety-alert symbol which indicates the potential for death or serious injury which might be caused should the symbol be ignored and the products be wrongly used.
⚠ **Caution**	This is the safety-alert symbol which indicates the potential for injury or only the material damage which might be caused should the symbol be ignored and the products be wrongly used.
!	This is the safety-alert symbol which dsescribes important instructions and those in order that the products may be operated properly.

Warning ● Instruction

Prior to using the product, please read the following warning instructions with caution, and comply with them.

＜About installation location＞

⚠ Warning

- The Supersonic flowmeter is not designed for the explosion-proof specification. In no event should this Supersonic flowmeter be used in hazardous areas where inflammable gases will produce. Failure to observe this warning may result in fire, or explosion.
- The Supersonic flowmeter is designed for indoor-use only. Do not apply this product to outdoor use. Failure to observe this warning may cause short circuit or unexpected accidents.

＜About piping ● installation＞

⚠ Danger **Be sure to comply !!**

- **When using the dangerous chemicals and solvent, be sure to don the chemical resistant protective clothing such as the(protective glove, mask and suit) which cover your entire body. Should a liquid be belched up, it may cause a physical disability.**

⚠Warning

- Make up pipe correctly in confirmation of the arrow pointing to the direction of flow "IN → OUT" indicated on the side of flowmeter body. Piping incorrectly may result in personal injury due to liquid leakage arising from damage to the flowmeter body.
- Make up pipe not to exert any excessive forces and bending moment on the flowmeter. If not, it may result in personal injury due to liquid leakage arising from the damage to the flowmeter body.
- When tightening the tube fitting, with back-up wrench supporting the hexagonal part of the fitting, tighten it. In no event the meter body should be tightened with holding the meter body in one hand. Since doing so may cause damage to the product. It must be absolutely avoided.

<Wiring >

⚠Warning

- When wiring, be sure to do it after power has been switched off. Failure to observe this warning may cause an electric shock, or fire.
- Do not apply any voltage more than specified ranges. Failure to observe this warning may cause smoke, or fire.
- Do not impress the current and voltage more than capacity to the pulse output and alarm output(Open collector output). If not, it may cause damage to the product.

< Inspection and maintenance >

⚠Danger Be sure to comply !!

- **When using the dangerous chemicals and solvent, be sure to don the chemical resistant protective clothing such as the protective glove, mask and suit) which cover your entire body. If belching up a liquid, it may cause a physical disability.**

⚠Warning

- When removing the Supersonic fllowmeter installed to the pipe, do not remove it until after the pressure applied to inside of the pipe has been dropped to the atmospheric pressure. If not, it may cause it to belch up the liquid, and may cause personal injury.

!	Applying strongly permeating liquid to this flowmeter body(PFA) may sometimes cause to corrode the product. If such a case may arise, we recommend that the flowmeter be replaced periodically.

1. General description of the product

The Supersonic Flowmeter is all composed of PFA in the wetted part and it is most suitable for the flow measurement of chemicals and etc., since there is no sealed part which may lead to leakage.

1. 1 How it works

The regular pattern of vortices called Karman vortex occurs alternately under the stream of the vortex generator which has been put in the stream. Where the frequency of Karman vortex generation is f, the width of the vortex generator is d, and the velocity v, the following relationship comprises, that is,

$$f = S t \cdot v / d$$

S t is a dimensionless constant which is called Strouhal number. Based on the fact that Strouhal Number is a constant in accordance with the shape of the vortex generator in the ranges of a certain of Reynolds Number, V is to be determined by measuring the generated frequency f , thereby we can obtain the volumetric flowrate from V. This Supersonic flowmeter, as shown in Fig. 1, is equipped with an supersonic sensor that consists of a pair of transmitter(TX) and receiver(RX). This sensor is mounted at the wake flow of the vortex generator.

Supersonic waves are constantly sent out from the transmitter into the fluid and the supersonic waves which has been sent pass through the fluid and are transmitted to the receiver taking a certain time to carry. As shown in Fig. below, if a Karman vortex which flows reversely from the direction where supersonic waves will travel occurs, it will take longer time to transmit the supersonic waves to the receiver. To the contrary, if the direction of flow is coincident with both Karman vortex and supersonic wave, it will take just a short time to transmit the supersonic wave. Based on the fact that the time to transmit varies in proportion to the frequency of the vortex generation, the flow measurement can be carried out by the use of detecting the propagation time difference. Since the supersonic sensor has been provided outside the pipe conduit of the main body of the flowmeter, it enables to measure the flowrates without directly coming into contact with the measuring fluid, and is a sensing method which has such excellent features as is less subjected to vibration and is so high in sensitivity.

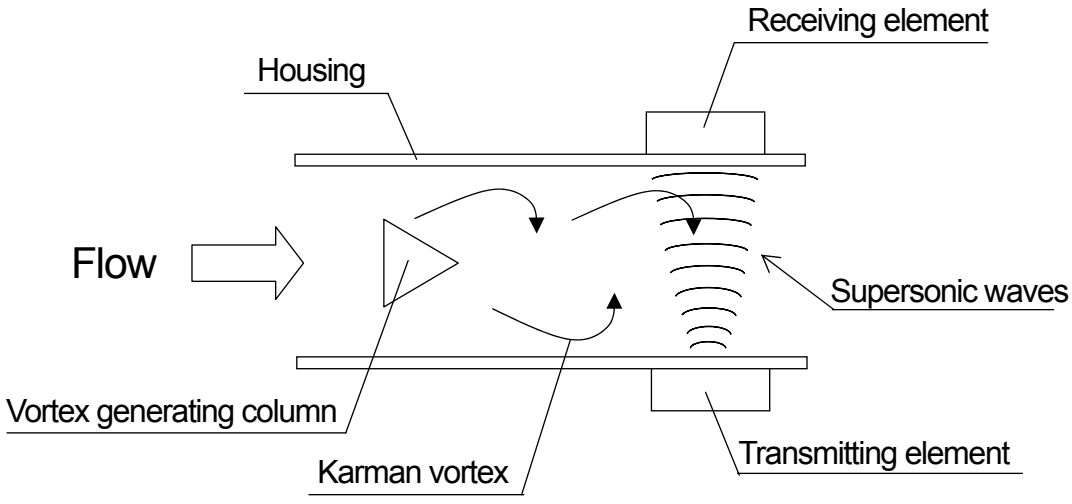


Fig. 1 Illustration about how it works

1. 2 Circuitry configuration

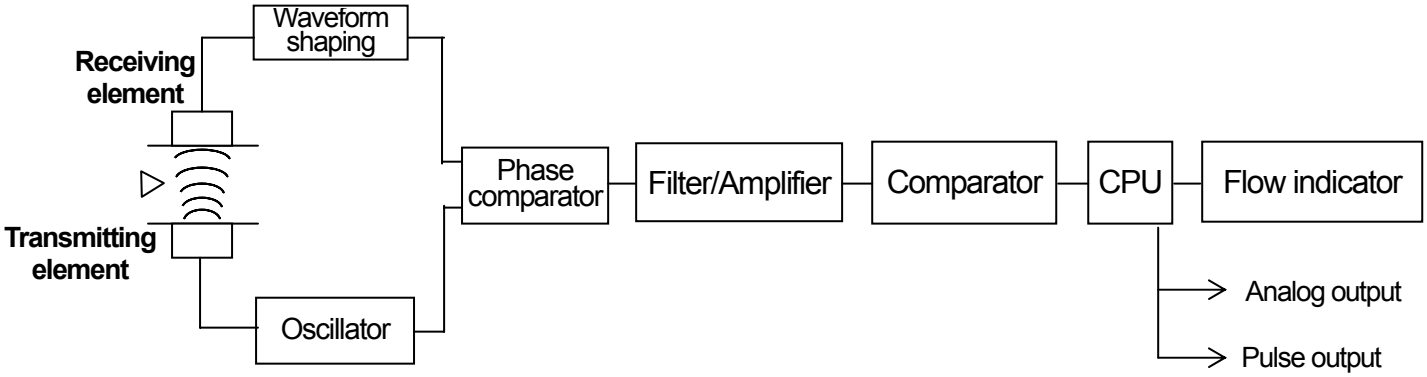


Fig. 2 Circuitry configuration

1. 3 Specifications

⚠Warning

● Be sure to use the Supersonic flowmeter within the flow ranges and the pressure ranges specified. Failure to adhere to this warning may result in failure, damage or accident.

!	Applying strongly permeating liquid to this flowmeter body(PFA) may sometimes cause to corrode the product. If such a case may arises, we recommend that the flowmeter be replaced periodically.

!	Do not use the Supersonic flowmeter for the slurry liquids or the liquids containing foreign materials. If not, it may result in performance decrement.

<list of the specifications>

			SSF10	SSF15	SSF20	SSF25
Operating fluid			Liquids(Chemicals, purified water, etc.)			
Connecting tube sizes			ϕ3/8" (ϕ9.53xϕ6.35)	ϕ1/2" (ϕ12.7xϕ9.53)	ϕ3/4" (ϕ19.05xϕ15.9)	ϕ1" (ϕ25.4xϕ22.2)
Flow ranges (※①)			0.5 – 3.5 L/min (at 1x10^{-6}m^2/s)	1 – 16 L/min (at 1x10^{-6}m^2/s)	2 – 40 L/min (at 1x10^{-6}m^2/s)	5 – 130 L/min (at 1x10^{-6}m^2/s)
Withstanding pressure(※②)			0.5MPa (at 25°C)			
Operating liquid temperature			5 – 85 °C	5 – 85 °C		
Ambient humidity			5 – 80 % RH (Provided the condensation of humidity will not occur.)			
Ambient temperature			5 – 60 °C			
Flow accuracy (※②)			FS±5%	FS±2.5%	FS±1.5%	FS±2.5%
			add ±1% to the full scale only in case of analog output			
Power supply voltage			24VDC ±10%			
Power consumption			120mA and below			
Output signal	**Pulse output**	**Form**	NPN Open Collector output			
		Capacity	30VDC/80mA at max.			
		Unit	10mL/P			100mL/P
		Width	5ms			

Output signal	Analog output	Form	4 - 20mADC
		Response time	Approx. 2s
		Load resistance	500Ω and below
	Compa-ative output	Form	NPN Open Collector output
		Capacity	30VDC/80mA at max.
Installation direction			Horizontal, vertical and diagonally
Materials for wetted part			PFA
Case materials for Amp.			P.P

※① About the flow ranges

Kinetic viscosity of liquids [$x10^{-6}m^2/s$]	1	2	3	4	5	6	7	Maximum flowrates [L/min]
Minimum flowrates on SSF25 [L/min]	30	60	90	120	–	–	–	130
Minimum flowrates on SSF20 [L/min]	4	8	12	16	20	24	28	40
Minimum flowrates on SSF15 [L/min]	2.5	5	7.5	10	12.5	15	–	16
Minimum flowrates on SSF10 [L/min]	0.5	1.4	2.1	2.8	–	–	–	3.5

Note) Each minimum flowrate more than 2 [$x10^{-6}m^2/s$] of the kinetic viscosity indicates theoretical values and yet may differ from the actual flowrate.

※ ② About the operating liquid pressure

The maximum operating pressure varies with liquid temperature. Computation should be carried out according to the following formula.

● For SSF10 and 15:

Maximum operating pressure = 800 x { 1 − ((T − 25) x 0.0043) } (k P a)

T = Liquid temperature when operating (℃)

● For SSF20:

Maximum operating pressure = 600 x { 1 − ((T − 25) x 0.0043) } (k P a)

T = Liquid temperature when operating (℃)

● For SSF25:

Maximum operating pressure = 450 x { 1 − ((T − 25) x 0.0043) } (k P a)

T = Liquid temperature when operating (℃)

※ ③ Relating to the SSF20 type, the flow range is between 6 and 40 L/min in case the liquid temperature rises more than 70℃.

※ ④ About accuracy

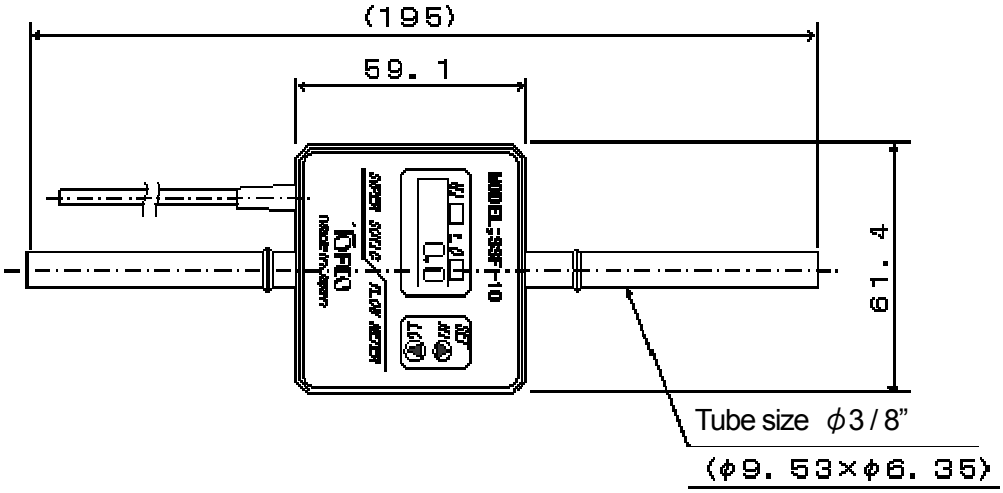
Since the measuring part of the Supersonic flowmeter has been made of PFFA resin, the internal diameter of the pipe conduit at the measuring section varies with the measuring liquid temperature changes, and therefore some changes will appear in the flow measurement characteristics. Use and compensate flowmeter output in accordance with the following formula, if requiring to use in excess of 50℃ at the liquid temperature and yet requiring to assure the specified accuracy of flowrate.

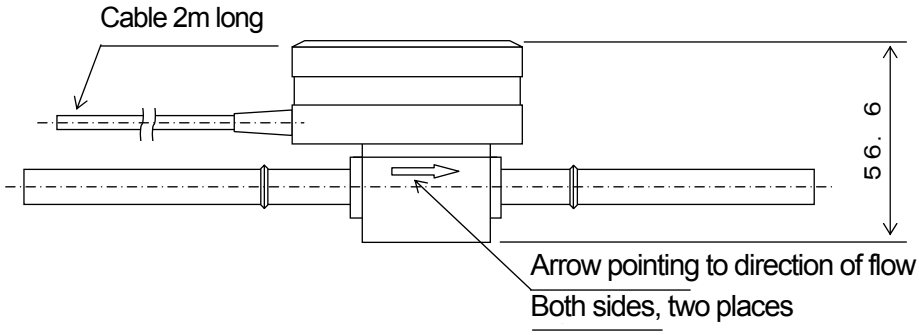
Actual flowrate in the operating condition=flowmeter output x {1+(0.0006 x (T-25)) }

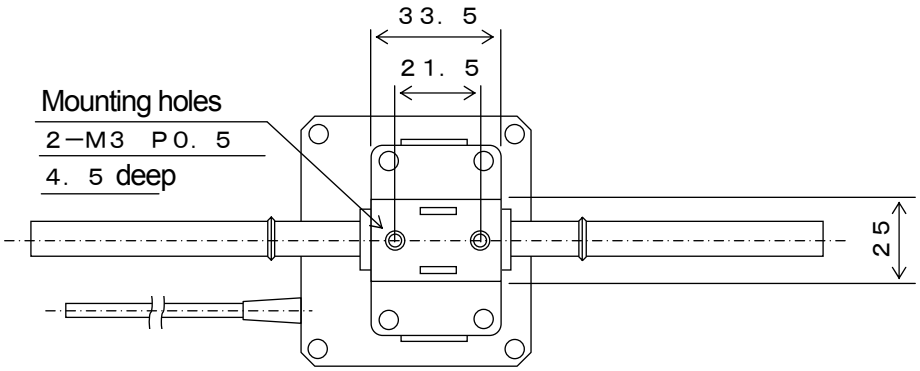
T: Liquid temperature in the operating condition(℃)

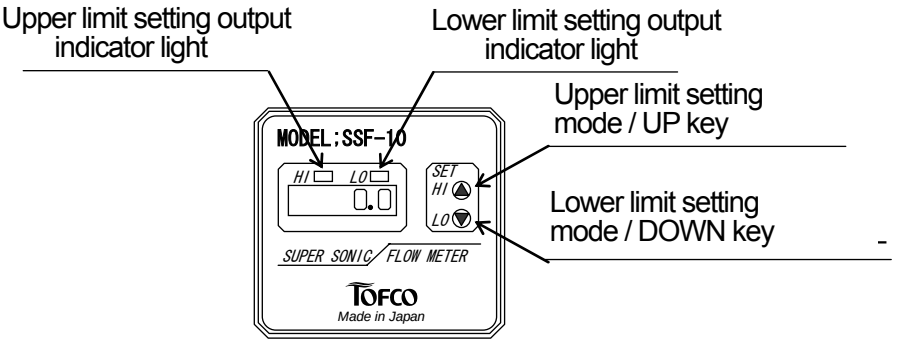
1. 4 Outside dimensional drawing and each part name

● For SSF-10









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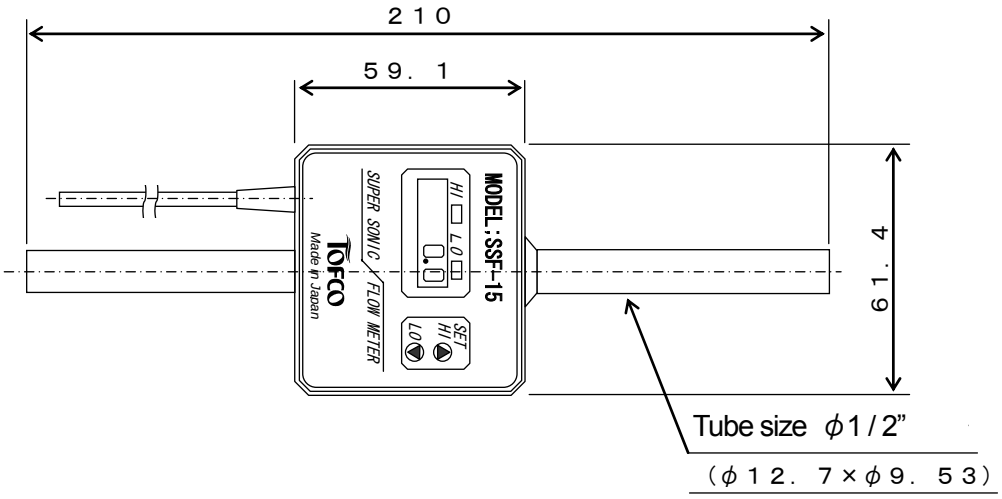
２１０
５９．１
MODEL:SSF-15
SUPER SONIC FLOW METER
TOFCO
Made in Japan
HI LO
SET
HI
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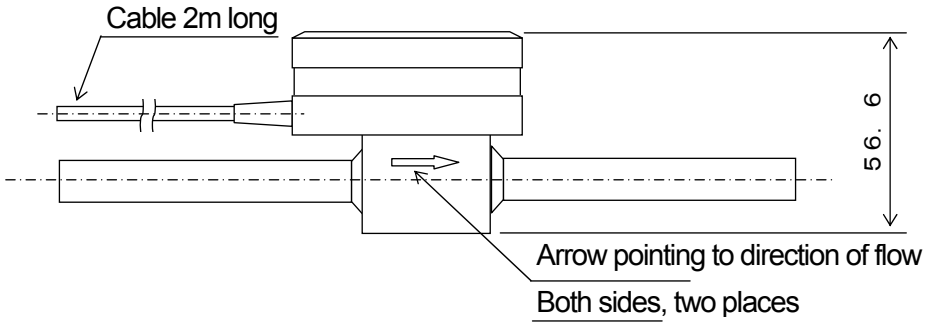
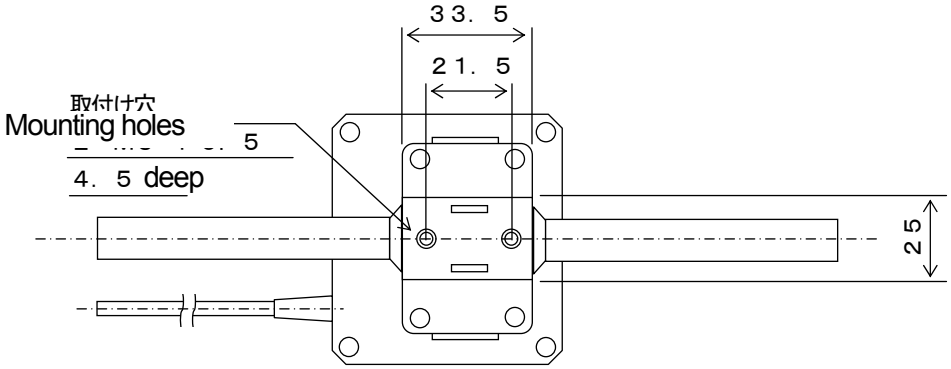
６１．４
Tube size φ1/2”
（φ１２．７×φ９．５３）


Cable 2m long
５６．６
Arrow pointing to direction of flow
Both sides, two places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取付け穴
Mounting holes
５
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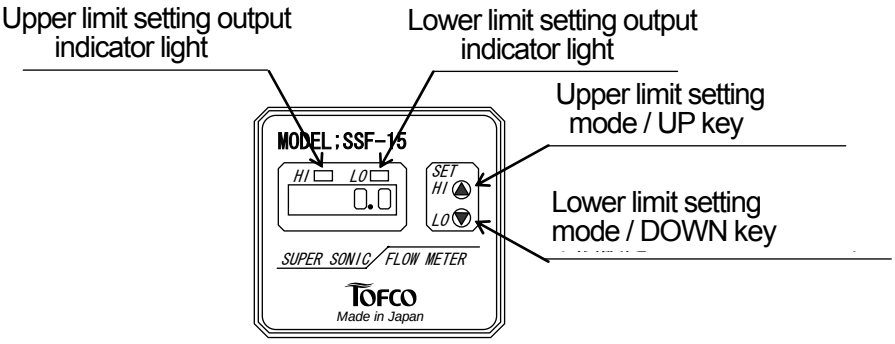
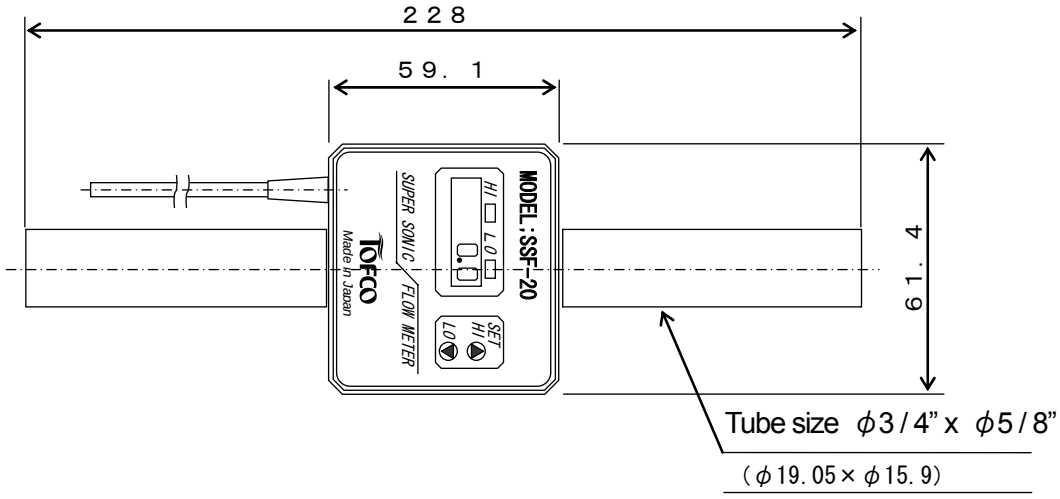
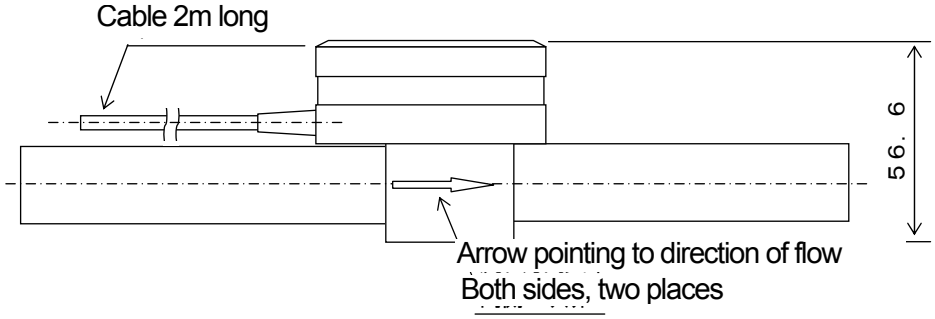
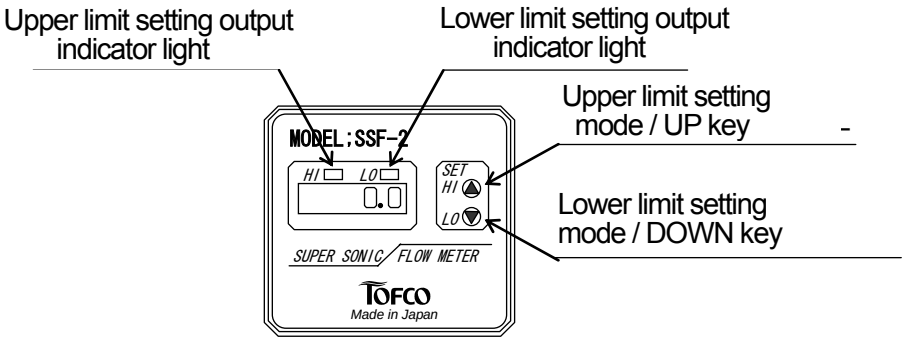

Upper limit setting output indicator light
Lower limit setting output indicator light
Upper limit setting mode / UP key
Lower limit setting mode / DOWN key
MODEL:SSF-15
HI LO
SET
HI
LO
SUPER SONIC FLOW METER
TOFCO
Made in Japan

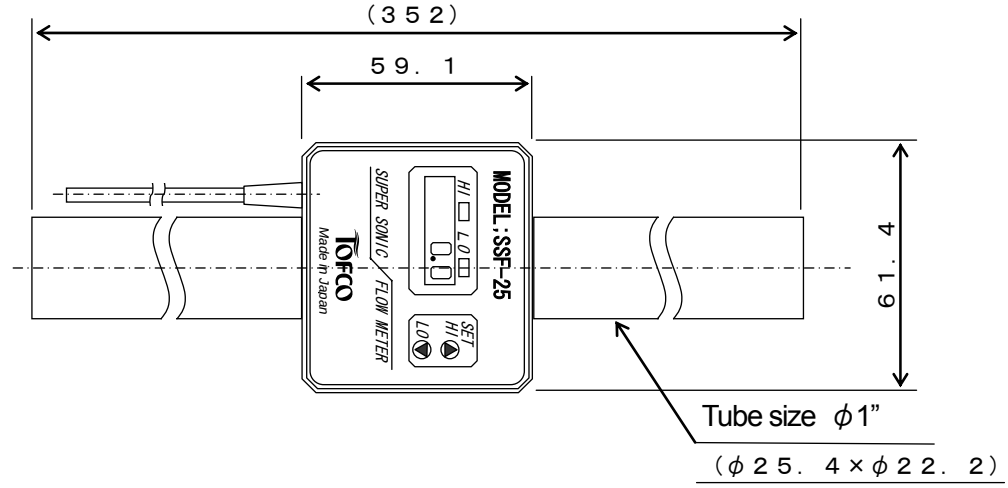
● For SSF20

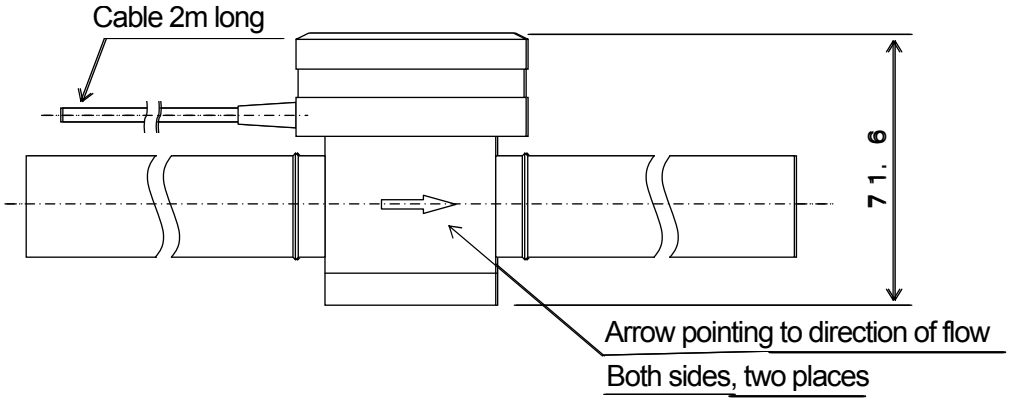

228
59．1
61．4
MODEL;SSF-20
SUPER SONIC FLOW METER
HI LO
SET
Made in Japan
Tube size φ3/4" x φ5/8"
(φ19.05×φ15.9)

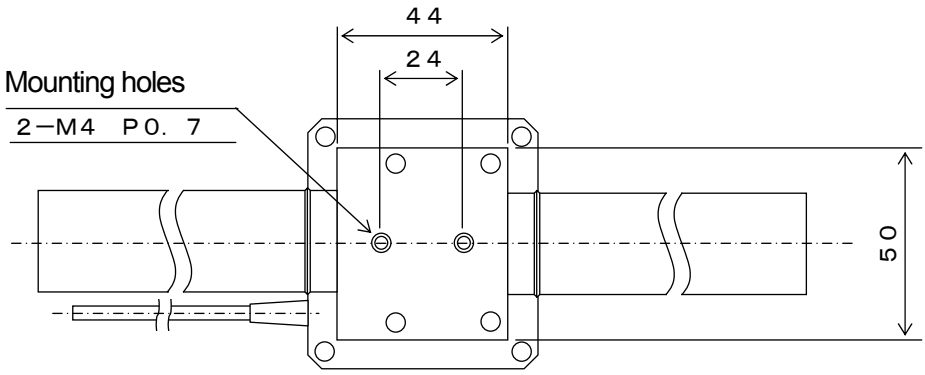

Cable 2m long
56．6
Arrow pointing to direction of flow
Both sides, two places


Upper limit setting output indicator light
Lower limit setting output indicator light
Upper limit setting mode / UP key
Lower limit setting mode / DOWN key
MODEL;SSF-2
HI LO
SET
SUPER SONIC FLOW METER
Made in Japan

● For SSF25


（３５２）
５９．１
MODEL:SSF-25
SUPER SONIC FLOW METER
TOFCO
Made in Japan
HI
LO
SET
６１．４
Tube size φ1”
（φ２５．４×φ２２．２）


Cable 2m long
７１．６
Arrow pointing to direction of flow
Both sides, two places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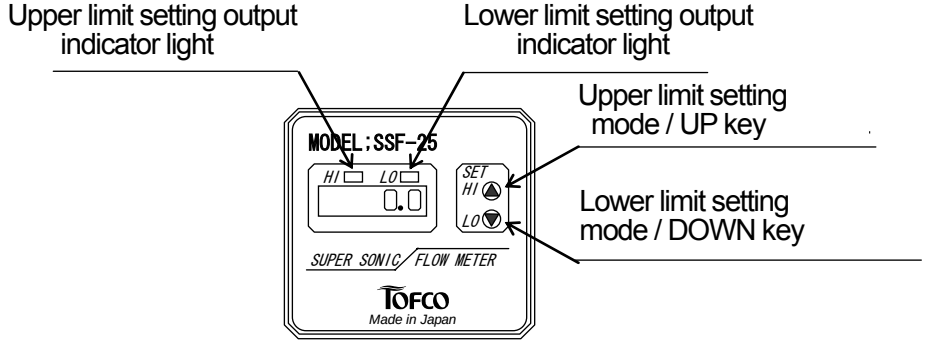
Mounting holes
２−M４ P０．７
５０


Upper limit setting output indicator light
Lower limit setting output indicator light
Upper limit setting mode / UP key
Lower limit setting mode / DOWN key
MODEL:SSF-25
HI
LO
SET
SUPER SONIC FLOW METER
TOFCO
Made in Japan

2. Handling

2. 1 Delivery and unpacking

We would like to request you to carry the products preferably as it was in the same packing condition as shipped from our factory to the installation location in order to prevent damaging during the transit. Upon receipt of our product you ordered, unpack and check to see if there is no damage in appearance during the transit. Notify the dealer and us immediately of any damage to the product.

!	Do not give the impact shock to the products. If not, it may cause damage to the main body

2. 2 Storage

Store the Supersonic flowmeters in the location where such conditions as shown below are satisfied, when storing them.

- In the locations where they are not splashed with rain or water
- In the locations where they are not subjected to the vibration, or impact shock.
- In the locations where the temperature is between 50 and 60 ℃ and the humidity is between 5 and 80 % RH (Provided that condensation of humidity will not occur.)
- In the location where no dust and etc. are present.
- In the location where they are not subjected to direct sunlight.

3. Installation

3. 1 Installation location

In order to use the Supersonic flowmeters in safThe installation location should be determined considering the following items in order to use the Supersonic flowmeters over the years, ensuring that the daily maintenance check and a good operational performance flow accuracy and yet to facilitate the routine maintenance check and the easy operation.

⚠Warning

- Supersonic Flowmeter is non-explosionproof. Do not use this Supersonic flowmeter in hazardous areas that produces inflammable gasses. Neglecting this may result in fire and/or explosion.
- Supersonic Flowmeter is designed for indoor-only use. Do not apply this product to outdoor use. Outdoor use may cause short circuit or unexpected accidents.

① Install the Supersonic flowmeter to the location where water, etc. will not splash directly to the main body. If not, it may cause failure.
② The gas-liquid two phasic flow and the flow containing bubbles can cause it to read inaccurately and/or malfunction.
③ Install the Supersonic flowmeter so as not to flow the bubbles into inside the flowmeter and not to be entrapped within it.
④ Do not install such as heat exchanger in the vicinity of the Supersonic flowmeter in the upstream. The abrupt change of liquid temperature can cause it to read inaccurately and/or malfunction. Keep away from such heat exchanger and make the temperature change lessen as smaller as possible.
⑤ Do not install the Supersonic flowmeter to the location where are high in the temperature gradient and the temperature changes.

⑥ If pulsation such as bellows pump is so high, it may cause an error. Make it to reduce the pulsation as small as possible.
⑦ Install the Supersonic flowmeter to the location, where is easily to check and make up pipe.
⑧ Cabling should be made with avoiding the noise source such as high capacity motor, electrical transformer and power source for power line, and avoid the high voltage and current. Otherwise it may cause malfunction due to the induction.
⑨ Install the Supersonic flowmeter so as not to give the vibration and shock. Otherwise it can cause it to read inaccurately.

3. 2 Piping and installation

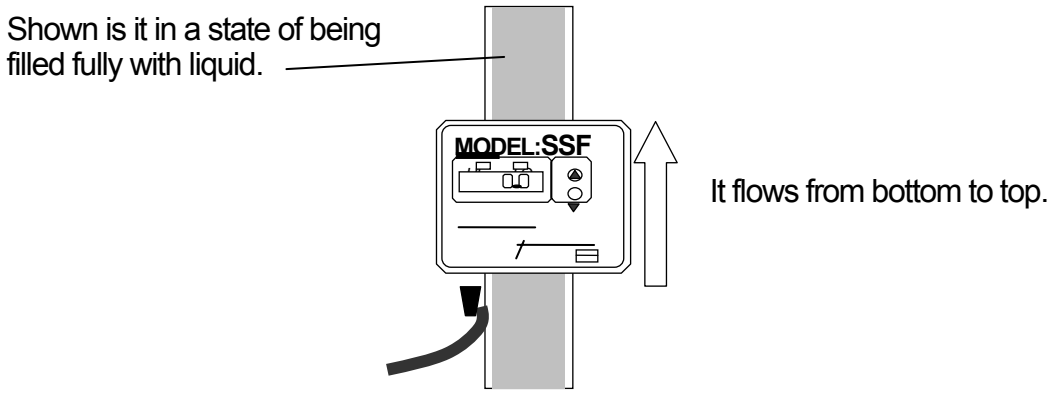
⚠ Warning

- Before making up pipe, confirm the correct flow direction by checking the arrowhead direction of "IN → OUT" marked on the side of flowmeter body. Incorrect piping may result in personal injury due to fluid leakage caused by damage of the flowmeter body.
- Before installing, align the axes of tube on both sides to avoid excessive forces to the Supersonic flowmeter. ncorrect axial alignment may result in personal injury due to fluid leakage caused by damage of flowmeter body.
- Use the tube of the designated size to be connected. If using any tube other than that of tube, it may result in personal injury due to fluid leakage caused by the damage of the flowmeter body.

!	● If the inside diameter of the pipe made up back and forth is smaller than that of flowmeter, it may cause an error. ● When installing the couplings, do the work in accordance with the catalog and instruction manual attached by the manufacturer of the couplings to be used. ● When using the Supersonic flowmeter, be sure to bleed air entrapped inside the pipe. Should air be present, it may cause incorrect flow indication. ● If air bubbles mix in inside the lliquid, they remain in Karman vortex generation part inside the main body, and it may cause it to read inaccurately.

① For the installation attitude, it is possible to install in any attitudes, such as vertically, horizontally and diagonally.
In any case the pipe shall be always filled fully with liquid.

We recommend that the installation attitude be vertical. Installing the Supersonic flowmeter so as to flow from bottom to the top may avoid flowing in the gas-liquid two-phase flow.



② Provide the straight pipe connection back and forth on the Supersonic flowmeter. The straight pipe at the side of the upstream should be more than seven times as long as that of the inside diameter, and for the straight pipe at the side of the downstream should be more than five times as long as that of the inside diameter.

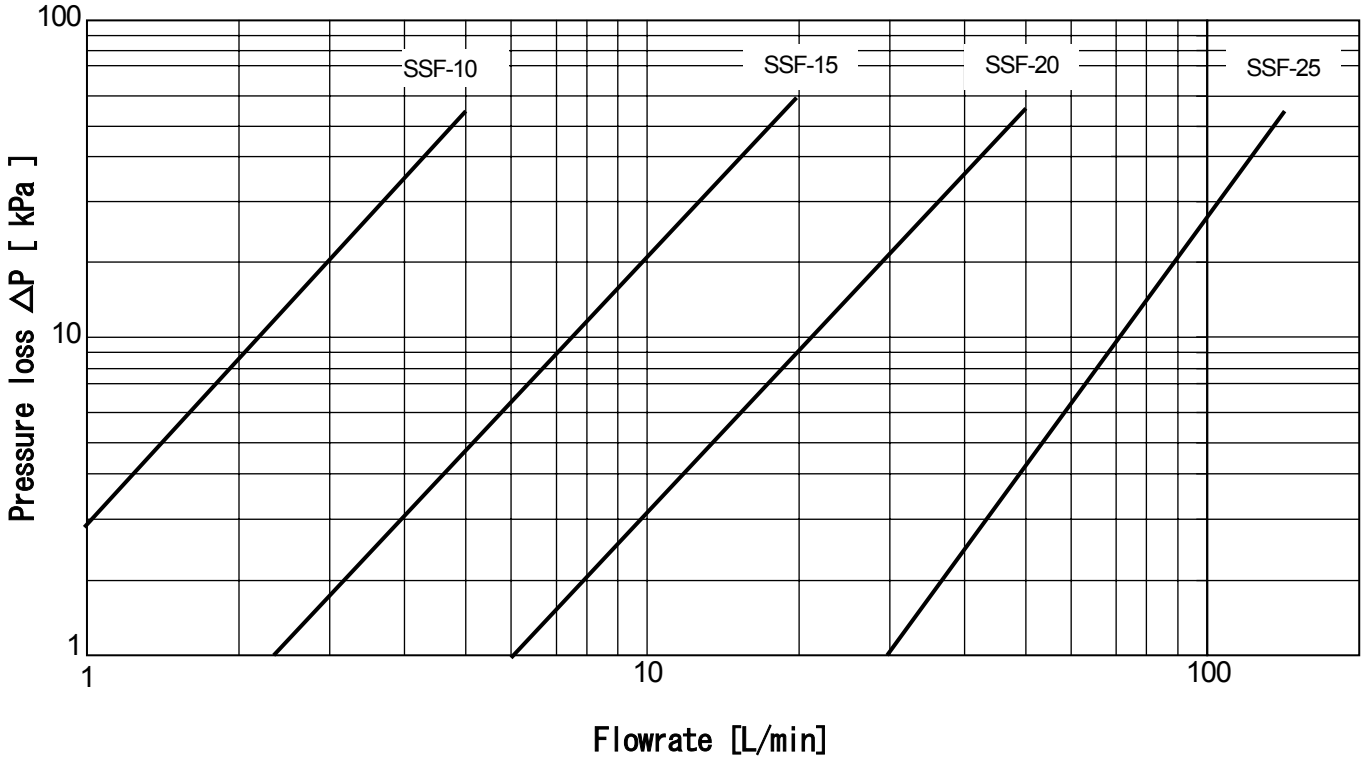
3. 3 About the downstream pressure

In order to prevent the cavitation occurrence the downstream pressure should be more than that which has been obtained from the following formula.

$$Pd : 2.7 \quad \triangle P + 1.3 P_0$$

Pd : Downstream pressure [kPa abs]
△P : Pressure loss [kPa]
P_0 : Vapor pressure of liquid [kPa abs]

＜ Pressure loss＞



※④ About the cavitation

A phenomenon that as the pressure of liquid decreases less than the saturated vapor pressure, the liquid evaporates and air bubble generates.

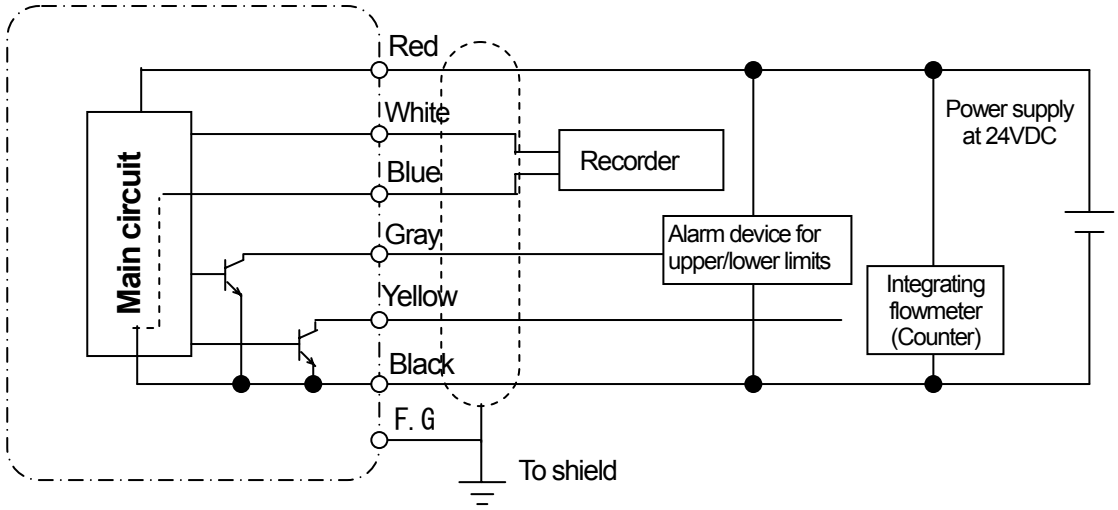
4. How to wire up

4. 1 Output stage circuit and how to wire up

Wiring should be correctly performed in reference to the output stage circuitry diagram, when wiring up.

⚠Warning

- ●When wiring, be sure to do it after power has been switched off. Failure to observe this warning may cause an electric shock, or fire.
- ● Do not apply more voltage than specified ranges. If not, it may cause smoke, or fire.
- ● Do not impress any more voltage and current than the capacity to the pulse output and upper/lower limits setting output (Open collector output). Failure to adhere to this warning may cause damage.



※ Black and blue cables have been connected within the circuit.

Signal names	Wire colors
Power supply at 24VDC	Red
Power supply at 0V	Black
Output at 4-20mA (+)	White
Output at 4-20mA (−)	Blue
Pulse output (+)	Yellow
Setting output at upper/lower limits	Gray

Circuit diagram at the output stage

4. 2 Connection to power supply

Connect power supply at 24VDC. In order to secure the specified accuracy, take a preheating time for more than 20 minutes after having powered up.

4. 3 Analog output

Connect a load resistance between 4-20mA output (＋) and 4-20mA (－) . The load resistance is 500Ω and under.

4. 4 Setting output at upper/lower limits

The setting output at upper/lower limits is a NPN open collector output.
Connect a load resistance between the setting output at upper/lower limits (＋) and power supply (＋) . The following is an example of the load resistance.

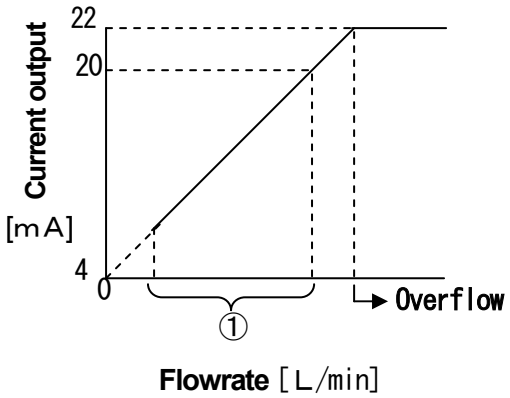
For example)	Load resistance	1 k Ω	1 W
		10 KΩ	1/4 W

4. 5 Pulse output

The pulse output is a NPN open collector output.
Connect a load resistance between pulse output (＋) and power supply (24VDC) . r source(24VDC). The following is an example of the load resistance.

For example)	Load resistance	1k Ω	1 W
		10 KΩ	1/4 W

4. 6 Analog output for the flowrate



● The area marked with ① is proportional to the flow increase.
（Flow ranges vary according to the types.）

＜Flow ranges＞

S S F 1 0	0.5 ～ 3.5 L／min
S S F 1 5	1 ～ 16 L／min
S S F 2 0	2 ～ 40 L／min
S S F 2 5	5 ～ 130 L／min

● If overflowing (“O F L O “ is displayed.), it produces current at the time of maximum flowrate. (The ranges vary according to the types.）

＜Overflow ranges＞

S S F 1 0	4 L／min and over
S S F 1 5	18 L／min and over
S S F 2 0	44 L／min and over
S S F 2 5	145 L／min and over

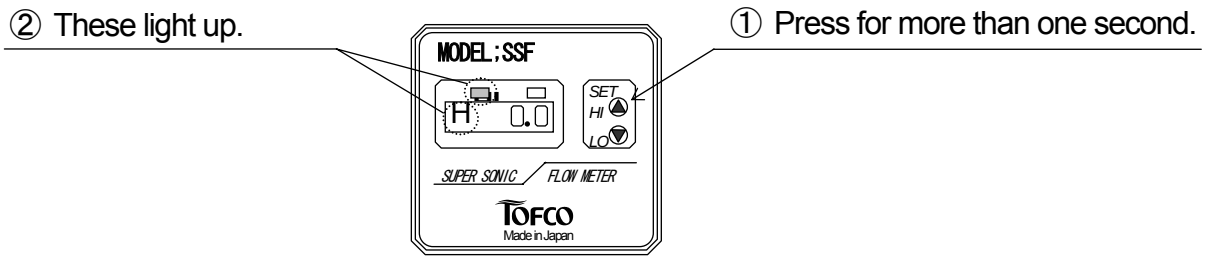
5. How to set upper/lower limits

5. 1 Changing over from flow measurement mode to upper limit setting mode

5. 1. 1 Changing over to the upper limit setting mode

① Press the button of SET H I (▲) during the flow measurement for more than one second.
② The screen is changed over to the upper limit setting mode.
- Indicator light of the upper limit setting output lights up.
- "H" lights up on the extreme left of the display unit.

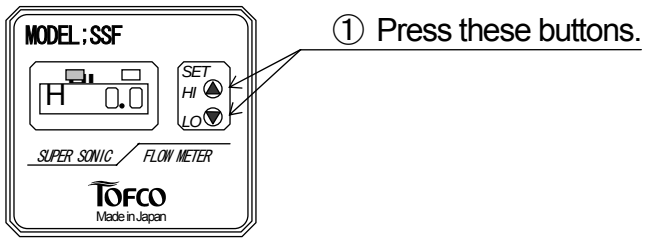
＜Changing over to the upper limit setting mode＞



5. 1. 2 Setting of the upper limit

① Prees the button of S E T H I (▲) once at the time of the uppper limit setting mode.
② The numerical value on diplay unit increments (decrements) in units of 0.1.
(The setting ranges vary according to the types.)
Continuously pressing button enables to make the numerical value faster to proceed

＜Setting of upper limit＞



＜Setting ranges according to types＞

SSF10	0.0 - 3.5
SSF15	0.0 - 16.0
SSF20	0.0 - 40.0
SSF25	0.0 - 130.0

5. 1. 3 Setting termination of upper limit

When setting the upper limit, the screen returns to the flow measurement mode in five seconds, after the button was finally pressed.

5. 2 Changing over from flow measurement mode to lower limit setting mode

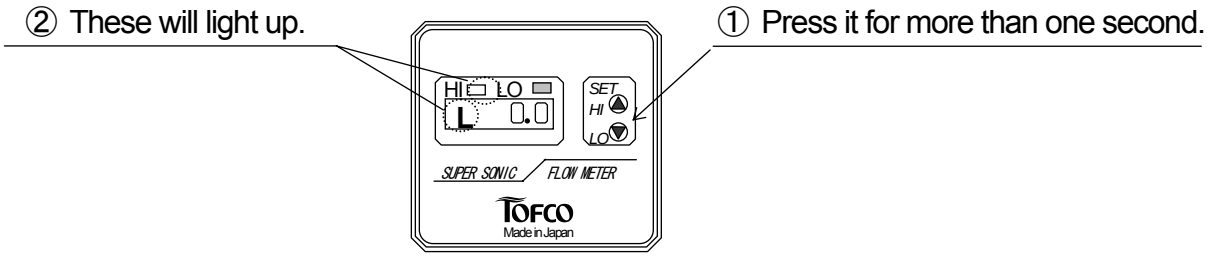
5. 2. 1 Changing over to the lower limit setting mode

① Press the button of SET L O (▼) during the flow measurement for more than one second.

② Screen is changed over to the lower limit setting mode.

- Indicator light of the lower limit setting output will light up.
- "L" lights up on the extreme left of the display unit.

＜Changing over to the lower limit setting mode＞

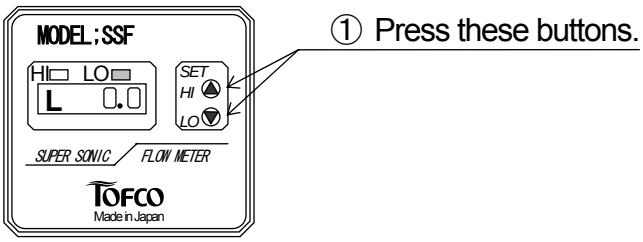


5. 2. 2 Setting of the lower limit

① Prees the S E T H I (▲) button S E T L O (▼) button]once at the time of the lower limit setting mode.

② The numerical value on diplay unit increments (decrements) in units of 0.1.
(The setting ranges vary according to the types.)
Continuously pressing button enables to make the numerical value faster to proceed

＜Setting of lower limit＞



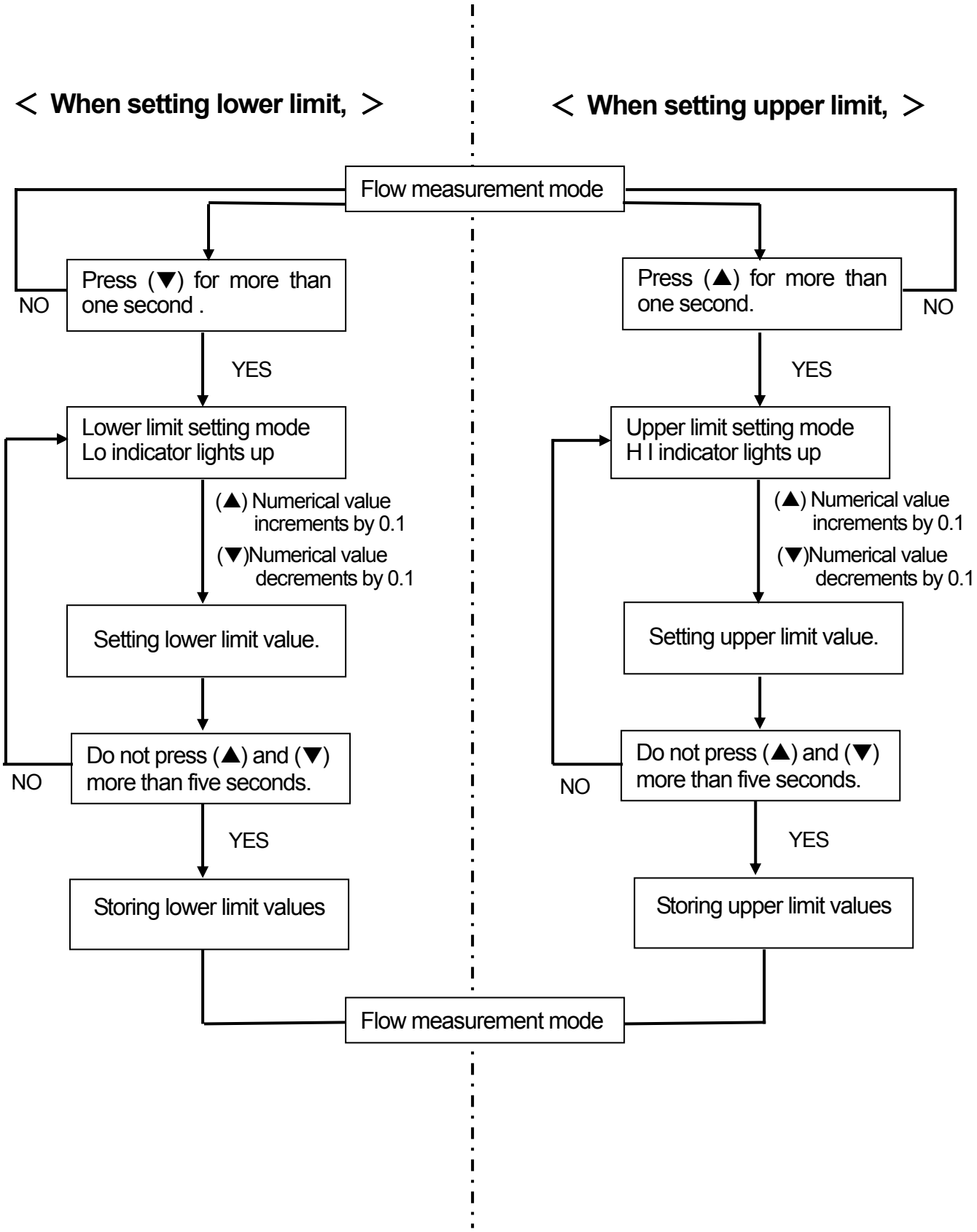
＜Setting ranges according to types＞

SSF10	0.0 - 3.5
SSF15	0.0 - 16.0
SSF20	0.0 - 40.0
SSF25	0.0 - 130.0

5. 2. 3 Setting termination of lower limit

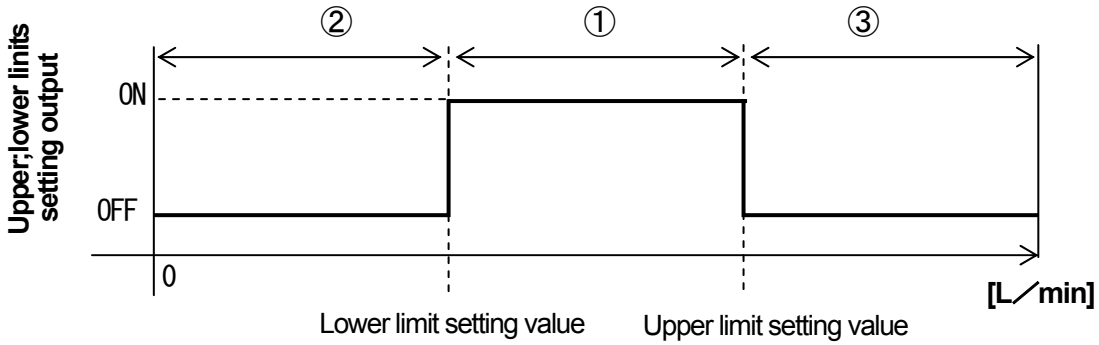
When setting the lower limit, the screan returs to the flow measurement mode in five seconds, after the button was finally pressed.

5. 3 Flow diagram regarding how to set upper/lower limits

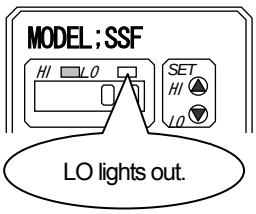
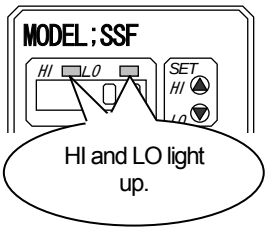
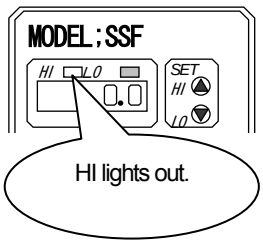


5. 4 Upper/lower limits setting output and LED lighting-up condition

● Upper/lower limits setting output



● LED lighting- up condition

Flow ranges	②	①	③
	Decreased less than lower limit setting vaulue	Within the ranges of upper/lower limits	Increased more than upper limit setting value
LED Lighting-up condition			

① If the flowrate is within the setting ranges, both HI and LO indicators will light up.
② If the flowrate decreases less than the lower limit setting value, LO indicator lights out. (Only HI indicator will light up.)
③ If the flowrate increases more than the upper limit setting value, HI indicator will light out. (Only LO indicator will light up.)

6. Inspection and maintenance

6. 1 Precaution for inspection and maintenance

⚠ Danger	Be sure to comply !!

- **When using the dangerous chemicals and solvent, be sure to don the chemical resistant protective clothing, such as the protective glove, mask and suit, which cover your entire body. Should a liquid be belched up, it may cause a physical disability.**
- **When removing the Supersonic flowmeter installed to the pipe, do not remove it until after the pressure applied to inside of the pipe has been dropped to the atmospheric pressure. If not, belching up of liquid may cause physical disability.**
- **When replacing parts or performing the maintenance work, do not perform the maintenance work until after power supply has been turned off, liquid flowing has been stopped, and the pressure inside the pipe has been reduced to atmospheric pressure. Failure to adhere to this may result in liquid leakage and a physical disability.**

!	Applying strongly permeating liquid to this flowmeter body (PFA) may sometimes cause it to corrode the product. If such a case may arise, we recommend that the flowmeter be replaced periodically.

6. 2 Actions to be taken, if failure occurs.

Although this product has been carefully inspected and adjusted at the factory shipment, however if a trouble occurs by any chance when or during setting up the product, check them in accordance with the contents listed below .In addition, should the failure contents be unknown to you, please consult us with your specifications.

Phenomena	Points to check	Measures to be taken
Proper output not come out. (Output does not come out, even though liquid is flowing.)	• Are wires correctly connected ?	• Connecting wires correctly(See p. 19)
	• Is power supply voltage applied within the range specified ?	• Applying power supply to the range specified. (See p.8)
	• Is the value of the load resistance correct ?	• Reducing the load resistance to less than 500Ω.
	• Is a pipe line filled fully with liquid ?	• Improving to fill the pipe line fully with water.
	• Is flowrate within measurable range ?	• Checking for the specifications. (See P.8)
Improper output comes out. (Output comes out, even though liquid is not flowing.)	• Is a pipe line filled fully with liquid ?	• Improving to fill the pipe line fully with water.
	• Is liquid within the pipe fluctuated greatly due to the pulse pressure(such as pumps) ?	• Making the liquid within pipe line not to fluctuate greatly.
There is a large margin of error in output.	• Is power supply voltage applied within the range specified ?	• Applying power supply to the range specified. (See p.8)
	• Is the value of the load resistance correct ?	• Reducing the value of the load resistance to less than 500Ω.
	• Is there any noise sources, such as power line or electromagnetic generator, in outside ?	• Keeping away it from noise sources.
	• Is there any factors which disturb the flow, such as valve located(upstream) right in front of flowmeter ?	• Changing the installation location of flowmeter.(securing a specified length of the straight pipe connection). At upstream: More than 7 times as long as that of inside diameter. At downstream: More than 5 t imes as long as that of inside diameter.
	• Does cavitation occur ?	• Securing a specified line pressure, so as not to cause cavitation. (See p.18)
	• Is air bubble mixed into liquid ?	• Making it so as not to mix air bubbles. (P. 17)
	• Are foreign matters entangled with vortex generation body ?	• Getting rid of foreign matter entangled.

7. Warranty

The product made by TOFLOW CORPORATION are warranted to be free from the defects in the performance and materials of the product under normal use for one year commencing from the date delivered to you, and also TOFLO CORPORATION warrants to replace the defective product with a new one as a replacement, if it arises from the defect in designing and manufacturing by TOFLO CORPORATION, and only if TOFLO CORPORATION has approved it in writing.
This warranty does not extend to any defects which has been arisen from being improperly used, altered, inadequately handled, or the different way from which it has been described in this Manual, and also does not extend to the cases where the product has been used without observing the recommendations and instructions given by TOFLO CORPORATION.
When using the product manufactured by TOFLO CORPORATION as a single unit or in conjunction with other product, we are not liable for the damage which arises as a result of direct or indirect loss and damages caused by the use in the conditions exceeding the product specifications, personal injury including other causes. Based on the warranty by TOFLO CORPORATION, the warranty is limited to the replacement of the product.

The cases arisen from the following situations shall not be covered by warranty.

- Failure and damage caused by any applications other than the contents as described in the instruction manual.
- Failure and damage caused by carelessness for use.
- Failure and damage caused by overhaul, modification, inadequate adjustment and repair.
- Failure and damage caused by natural disaster, fire and any other for force majeure
- Replacement of consumable parts and accessories not warranted.

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