

**INSTRUCTION MANUAL**  
**ULTRASONIC VISCOSITY METER**  
**FUV-1 Model-104**

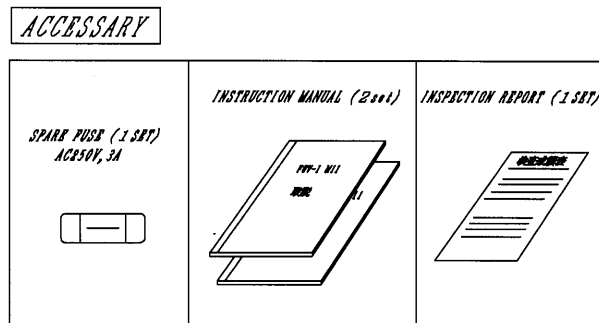
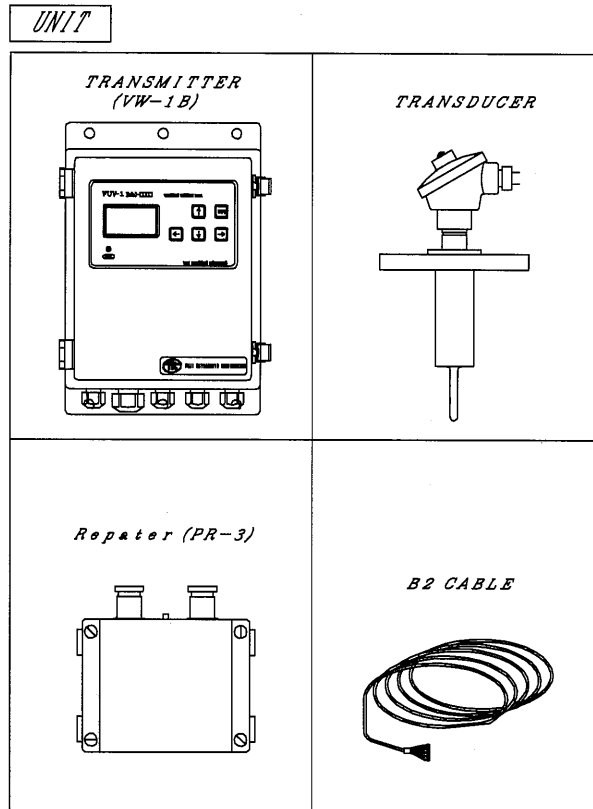
**FUJI ULTRASONIC ENGINEERING CO., LTD.**

**VER. V104.00E**

**11.2009**

# INTRODUCTION

Thank you for purchasing the FUJI FUV-1 MODEL-104 ultrasonic viscosity meter. This Instruction Manual describes how to use each function of the FUJI FUV-1 MODEL-104. Read through this Manual and understand each function before you use the FUJI FUV-1 MODEL-104.



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## 2: WARNING

### 2-1. Damage to the transducer

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The cable for connection between the transmitter and transducer has been calibrated according to the specifications before the shipment. The cable is susceptible to shock.

Do not cut or damage a cable.

### 2-2. Measurement accuracy

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Measurement accuracy can be fluctuated depending on the condition of the solution being analyzed, installation, and operating environment.

### 2-3. Warm-up

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The unit is a precision instrument. To get better results, warm-up (Approx. 20-30min) is required.

### 2-4. Warning for power switch

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Once turning the power switch off, turn the switch on after 10 seconds or more for normal operation. Also when you put the plug out under the condition of switching on, switch off once and put the plug in after 10 seconds or more.

### 2-5 Handle the transducer

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If the horn of the transducer is flamed or changes the condition of its surface (See Fig 12 page 14), the measurement value is changed.

Don't give a shock to it or use it for measurement of corrosive solution.

### 3: INSTALLATION

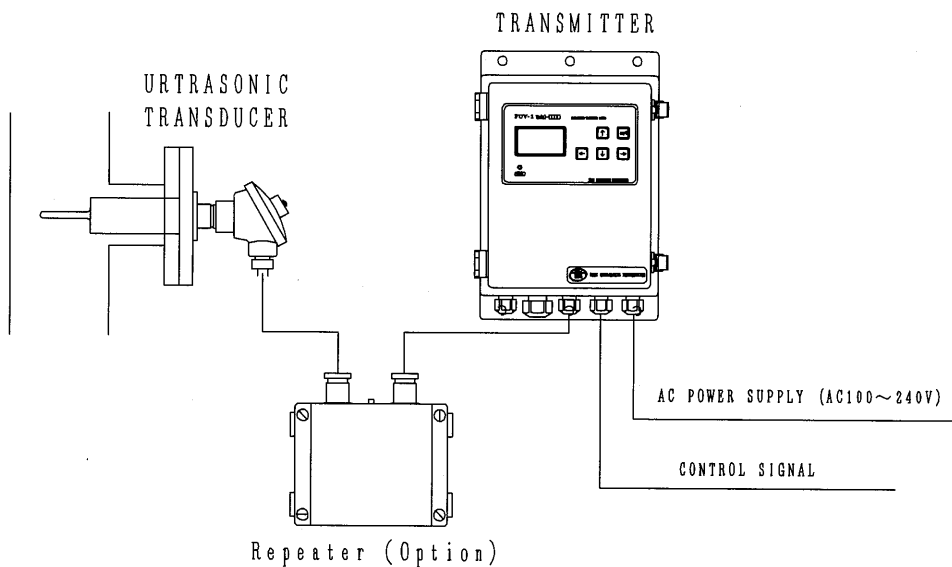


Fig-4 Installation and connection

#### 3-1. Transmitter

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- A. The transmitter is rain-proof type (Standard IP55) and can be installed outside.
- B. The transmitter is not explosion-proof type. It should not be installed in hazardous areas.
- C. The transmitter is susceptible to dust, vibration, corrosive / vapors and water. Install the transmitter in an environment free of these elements. Attach a pure air supply to the clean-air inlet valve (for 1/4") mounted underneath the unit to keep the unit free of dust and contamination.
- D. The transmitter is recommended to be installed in a place at 0-50°C. It is very susceptible to sudden temperature change. In case of that the transmitter is exposed to direct sunshine, connect the inlet valve to the air supply to moderate the temperature change.
- E. The ground wire must be connected to the electrical ground.

### 3-2. Transducer

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- A. The vibration part (horn) of the transducer should not touch the tank wall. It causes of incorrect viscosity measurement.
- B. FLANGE INSTALLATION  
When you attach the transducer to the flange, there are no limitations to the plumbing condition, such as a level, vertical or inclined. The transducer is not be affected by external vibrations and conditions.
- C. AIR BUBBLES  
The solution contains the air bubbles. If the air bubbles stick the transducer horn, the measurement of the viscosity is impaired. In case of that make sure to remove the gas before the solution comes into the transducer.
- D. THE CHANGE OF THE SOLUTION TEMPERATURE  
The sudden change of the temperature generates incorrect viscosity measurement. The transducer should be installed in a place where the temperature is stable.
- E. ADHESION AND DEPOSITS  
Incorrect viscosity measurement is also caused by the adhesions and deposits. Clean the transducer periodically to remove adhesions and deposits.
- F. FLUID SPEED  
Install the transmitter in a location where the speed of a flowing fluid is not high. Viscosity measurement is caused by the high speed of a flowing fluid.
- G. ENVIRONMENT TEMPERATURE FOR THE TRANSDUCER  
Install the transducer where the surrounding temperature is in the range of 0 ~50°C and there is no rapid change of temperature. In addition install it where there is no dust, vibration, flood or corrosive gas.

### 3-3. Repeater for explosion proof

---

- A. Install it at the place of 0~50°C and no rapid temperature change, no dust no vibration, no flood and no corrosive gas.
- B. The repeater is not the construction of rain proof. If you set it out of doors, put it into the box of rain proof.
- C. The earth of the repeater is not necessary.
- D. Wiring of the repeater for explosion proof on the side of the transducer (construction equivalent to Ex is standard) Should be set separately by the cable construction using metal protection tube or metal duct of tight sealed construction to avoid electrostatic induction, electromagnetic induction and mixed touch. If there are no other constructions and no fear of mixed touch and induction, you don't need protection such as metal tube. Moreover you don't need the construction of resisting pressure explosion proof metal tube for wiring, however you need to protect inflow of dangerous gas.
- E. Don't remodel the repeater of explosion proof and the transducer.

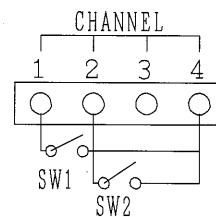
## 4: CONNECTION

### 4-1. Caution

- A. Numbers and symbols are printed on the cable sleeves. When you connect the cable, make sure to adjust each number to the Word of the mark tube and the transducer.
- B. Do not cut the cable because the transmitter, the transducer and the cable are calibrated as one unit.
- C. Don't put high voltage when checking the wire.
- D. Check the connection before giving power.
- E. Output signal terminal gives DC4-20mA that is related to the viscosity output range of lower and higher setting points. (Output range of lower and higher setting points are free of setting) Connect to the reporter machine (Load must be less than 500Ω)
- F. Alarm output terminal gives out the alarm signal C non voltage A connecting point by following lower and higher setting point. (Output range of lower and higher setting points are free of setting)
- G. Channel 1-3 terminal is used by switching each command setting information though remote operation. Operate the switch as per the following picture.

SWITCH No.	1	2	3	CHANNEL
OUTER	○	×	×	1
SWITCH	×	○	×	2
EXCHANGE	○	○	×	3

○ SWITCH ON (CONNECTED)



\* Connecting cable resistance should be lower than 5Ω.

\* If the external switch is connected, it is primary functioned.

Figure-5  
Connection and wiring

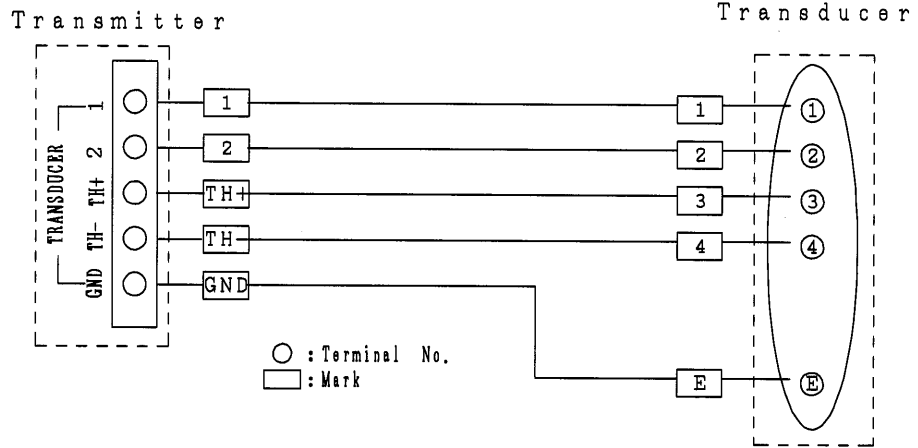
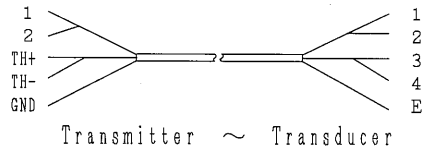
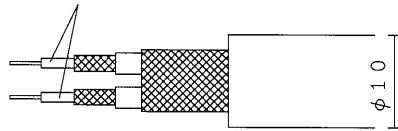


Fig. 6  
B2 cable

RG58A/U Coaxial cable





# Repeater Type (Option)

Figure-7  
Connection and wiring

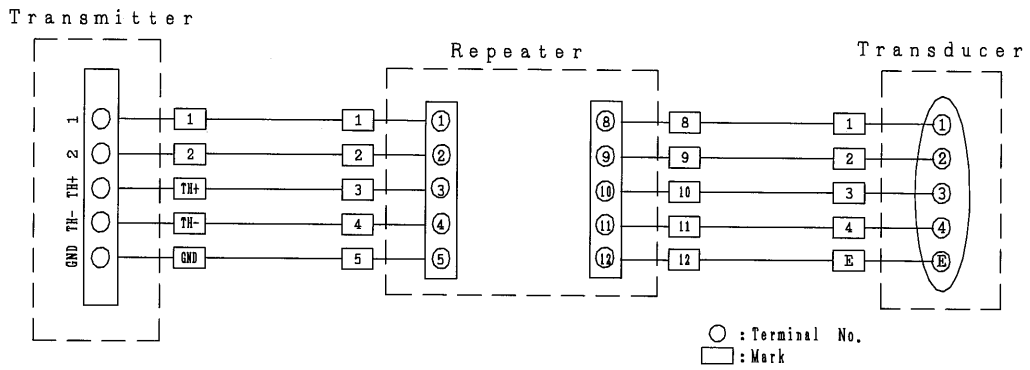
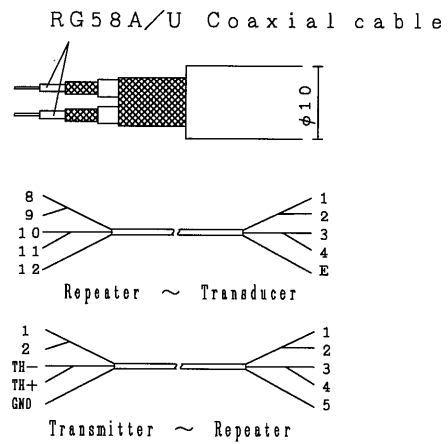


Figure-8  
B2 cable



4-3. Connection diagram

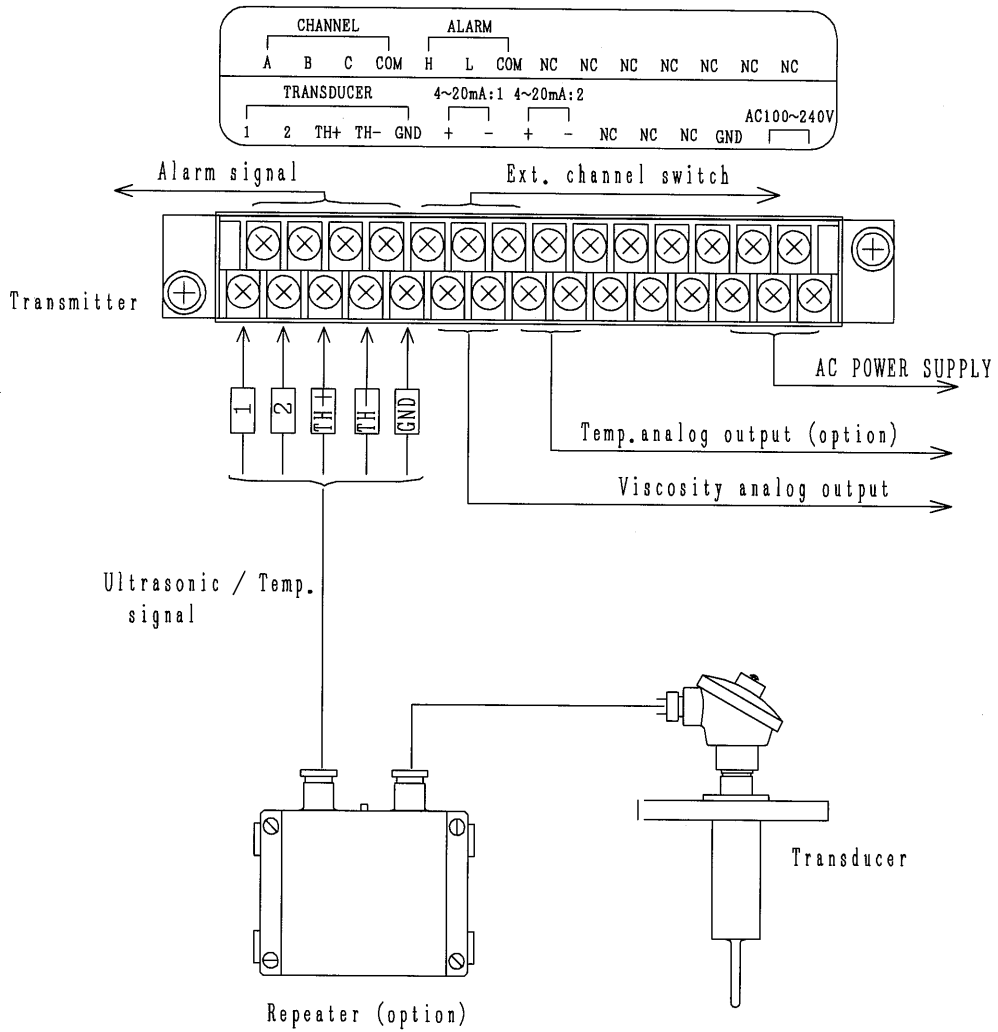


Fig.-7 Connection diagram

Figure-10  
 Terminal of transducer  
 Reflection type  
 (S6-N6, S6-N7 etc)

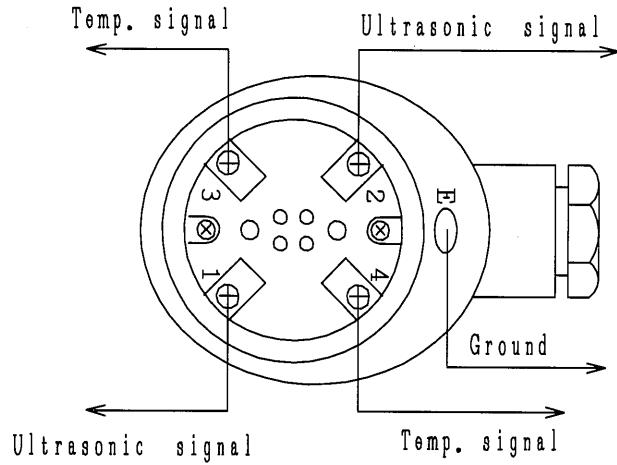
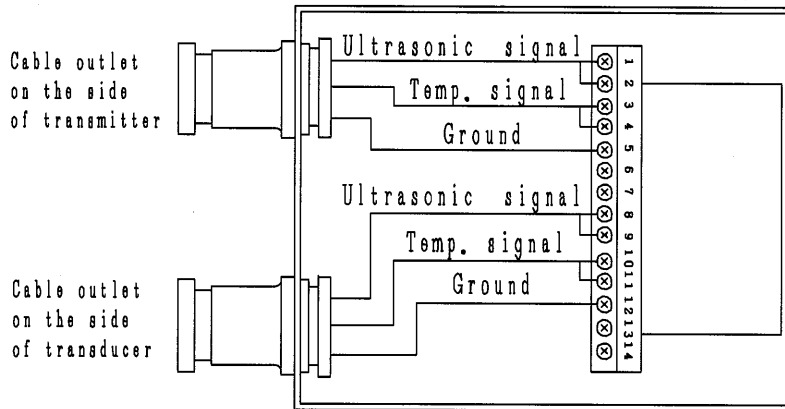


Figure-11  
 Terminal of repeater  
 (PR-3)



## 5: PRINCIPLES OF MEASUREMENT

### 5-1. Principles of measurement

---

When the horn is put into the solution and vibrated torsionally mechanical resistance against vibration is generated on account of viscosity resistance of the solution. The unit increases or decreases the driving current in proportion to the mechanical resistance and drives the horn at constant amplitude of the vibration. The unit measures the current and calculates the value of viscosity.

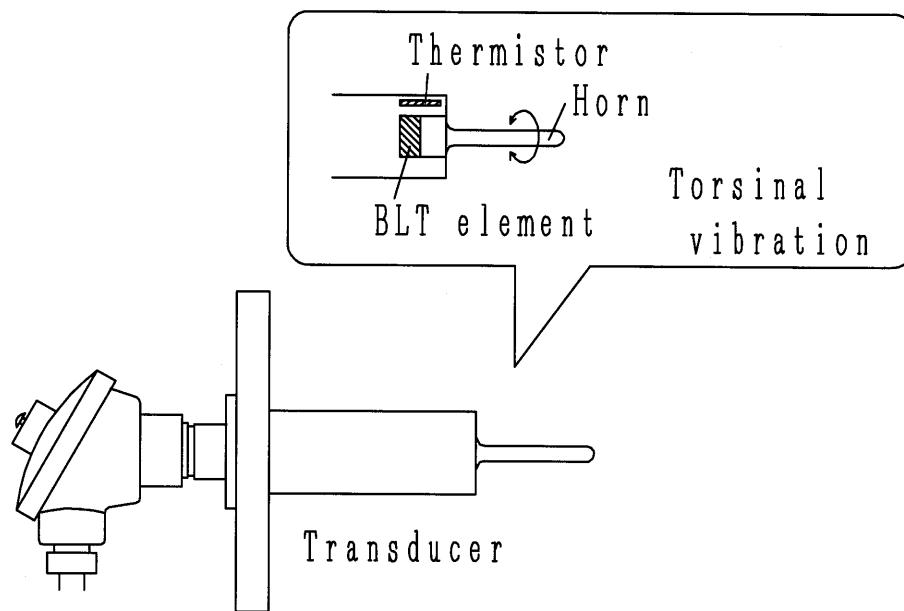


Fig.12 Construction of the transducer

## 5-2. Measuring method and explanation of each part

---

The ultrasonic viscosity meter determines viscosity by sending the measurement of the increase in mechanical resistance from driven torsion vibration of the solution to the internal processor (CPU). The unit subsequently calculates the viscosity.

The unit can be divided into four functional sections of Mechanical resistance measurement section, Temperature measurement section, Signal processing section and Output section.

A. Mechanical resistance measurement section

Measure the driving current changed according to increase or decrease of mechanical resistance generated against vibration of horn on account of viscosity resistance to get a constant amplitude of vibration.

B. Temperature measurement section

Temperature of the solution is measured by the thermistor.

C. Signal processing section

Operate the value of viscosity based on the signal from mechanical resistance measuring unit. Also change the display and the setting value with the operation key.

D. Output section

Control display output of viscosity, temperature and each setting value and digital output of RS232C. Also control output of analog signal of DC 4~20mA corresponding to the range of viscosity ( option ).

## 5-3. Calibration

---

The unit is calibrated in the standard solution for calibration of viscosity meter provided in JIS8809. So viscosity resistance of the measuring solution is compared with that of the standard solution whether it is a Newtonian solution or not.

## 5-4. Unit of viscosity

---

P ( Poise ) has ever been used as the unit of viscosity, but Pa·s is determined to be used as international unit (SI). So we use Pa·s in our viscosity meter.

The relation is as follows.

$$\text{cP} = \text{mPa}\cdot\text{s} \quad \text{-----} \quad (1)$$

$$\text{Pa}\cdot\text{s} = 10\cdot\text{P} \quad \text{-----} \quad (2)$$

## 6: OPERATION

### 6-1 Explanation of operation key

---

#### ( ↑ ) key

- Used for channel change in the initial display.
- Used for selection of parameter and raising up the setting value in the parameter setting display.

#### ( ↓ ) key

- Used for moving to CHANGE PARAMETER screen in the initial display.
- Used for selection of parameter and lowering the setting value in the parameter setting display.


#### ( ← ) key

- Used for rising up the position of setting figure while setting parameter.

#### ( → ) key

- Used for lowering the position of setting figure while setting parameter.

#### ( ENTER ) key

- The key mark (  ) on the right top in the initial display is canceled in the measurement 1~3 display , and you can enter into the setting display (condition of the key is recommended when you don't change the setting)
- Used before and after change in the parameter setting display. When pushing (ENTER) in the parameter setting display, parameter part blinks and change the setting display with ( ↑ ), ( ↓ )key. When pushing (ENTER) key again, the blink of the setting value finishes and the change finishes.

## 6-2 Contents display

### ★Display 1 (Concentration display)

```

1 - 1    V I S C .    E R R
          1 8 5
                    m P a S
TEMP :    2 3 . 6 ° C
  
```

- Viscosity display (initial display)
- Powering on after installation, initial display is indicated and indicates viscosity, temperature and error of the solution.

### ★Display 2 (Parameter setting 1)

```

1 - 2
OUTPUT  H           1 0 0
OUTPUT  L           0
ALARM   H           9 0
ALARM   L           1 0
TEMP    H           1 0 0
TEMP    L           0
  
```

OUTPUT H : upper limit of analog output (Viscosity)

OUTPUT L : lower limit of analog output (Viscosity)

ALM H : upper limit of analog

ALM L : lower limit of analog

※TEMP H : upper limit of analog output (Temperature)

※TEMP L : lower limit of analog output (Temperature)

※Temperature analog output is an extra option.

Note): Input the setting value of alarm output under the following condition.

upper limit of alarm output > lower limit of alarm output

The set value has hysteresis.

(2% within the range of alarm output)

It returns to the state of OFF when returning up to 2% in the alarm setting value,

It enters the state of ON when the alarm setting value is exceeded.

★Display 3 (Parameter setting 2)

```
1 - 3
OFFSET          0
GAIN            1.000
AVERAGE        1
```

•OFFSET

- Set the OFFSET compensation volume in case there is an error in viscosity value.

(Example)

When you want to display viscosity value higher by 0.5%, set the offset volume at +0.500.

•GAIN

- Set gain (slant) when there is an error between viscosity measurement value and analysis value. Optional setting of viscosity gain volume is available in range of 0~10.000.

(Example)

2.000→display 2.000 times as much as viscosity measurement value

\*Relation between OFFSET and GAIN is

$$y=ax+b \text{ (a: gain b: offset y: display value x: measurement value)}$$

•AVERAGE TIME

- Set the moving average number of times of viscosity value. Optional setting is possible in the range of 1~100.

(Example)

1.0 →Measurement value in real time

2.0 → Average value of past two times of measurement value

100.0→ Measurement value of past one hundred times of measurement value



★Display 4 (Parameter setting 3)

```
1 - 4
CONV.          OFF
CONV. TEMP.   25.0
TEMP. L       20.0
VISC. L-T     885
TEMP. H       30.0
VISC. L-T     432
DENSITY       1.875
```

Above parameter (TEMP. L, VISC. L-T, TEMP. H, VISC. H-T, and DENSITY) are for temp. Compensation functions on viscosity reading at setting temp. Please input TEMP. L, VISC. L-T, TEMP. H, and VISC. H-T parameters with data taken by the original unit. Also, it requires 5°C of temp. Difference between TEMP. H & TEMP. L

CONV.	----	Temp. compensation function ON/OFF
CONV. TEMP.	----	Temp. setting of the compensated viscosity
TEMP. L	----	Actual temp. data at lowest
VISC. L-T	----	Actual viscosity data at lowest temp.
TEMP. H	----	Actual temp. data at highest
VISC. H-T	----	Actual viscosity data at highest temp.
DENSITY	----	Density at the setting temp.

Please change parameter of 1-2 (Output setting: page 17) when the compensated viscosity value exceeds the upper or lower range of the analog output.

★Display 5 (RS232C spec. setting)

```
1 - 7
BAUD RATE     9600
BIT LENGTH    7BIT
PARITY BIT     EVEN
STOP BIT      2BIT
```

Adjust spec. of interface (RS232C) of the unit to the setting of the outer equipment connected to the unit.

## 6-3 RS232C Digital Output

- 1) Transmission system      Start/stop system Half duplex  
 2) Baud rate                    9600 or 19200 bps  
 3) Parameter                    Stop bit 2 or 1  
                                       Even or odd parity check  
                                       7 or 8- bit ASCII code

### 4) Data format

Receiving data

*   CR	* Symbol
0   2   CR	channel No.
0   0   1   2   3   4   0   CR	Viscosity
0   0   2   5   6   7   0   CR	Temperature
0   0   1   1   2   3   4   0   CR	Display conversion value

Contents of data

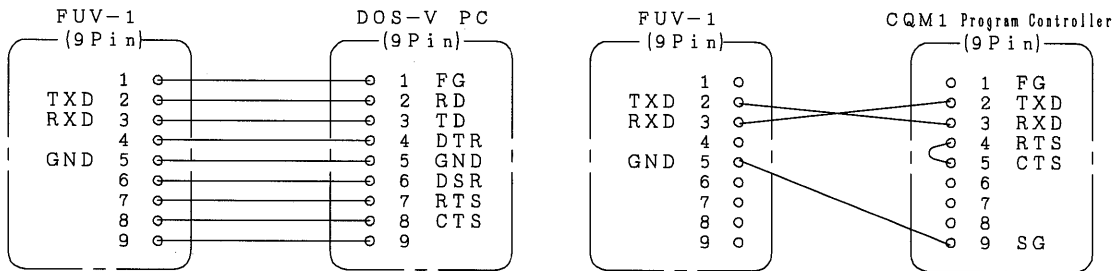
Number of figure 2 digits		EX. 2	→ channel 2
Viscosity	7 digits (3 place of decimal)	Ex. 0012340	→ 12.34 mPa·S
Temperature	7 digits (3 place of decimal)	Ex. 0025670	→ 25.67°C
Display conversion value	7 digits (3 place of decimal)	Ex. 0012340	→ 12.34 mPa·S

### 5) FUV-1

Pin No.	SIGNAL NAME	CONTENTS	I/O
2	RXD	Received Data	I
3	TXD	Transmitted Data	O
5	GND	Signal Ground (Common Return)	

- ① Signal name indicates the contents of viscosity meter.
- ② I/O (input / output) indicates the status on the side of viscosity meter.
- ③ Cable connector is female D-sub 9 pin
- ④ 7 pin and 8 pin connected in the transmitter.

### RS232C Cable connecting example



※ "WRS CHECK" Windows edition (option) of reception software for PC.

## 7. COUNTERMEASURES AGAINST TROUBLE

### 7-1 Countermeasures against trouble

If there are following troubles of A~G on measuring viscosity with ultrasonic viscosity meter, cope with them according to the process on next page.

- A No indication on the display when power is on
- B Values on the display are blinking (detect trouble)
- C Viscosity reading on the display remains at zero
- D Reading is unstable
- E Temperature reading is unusual
- F The display appears to be in unusual state
- G The analog output section on the display appears to be in unusual state

### 7-2 Basic motion

Check the basic motion of the unit by the following items.

- ① Leave the sensor of the viscosity meter in the air.  
→ It is OK if viscosity value on the display is 0.
- ② Put the sensor of the viscosity meter in the water.  
→ It is OK if viscosity value on the display is 0~2.
- ② Push the sensor with fingers.  
→ It is OK if viscosity value rises up.
- ④ If you have standard solution for the viscosity meter, check viscosity value with it.  
→ It is OK if value on the display is equal to the standard value.

There are a few cases when there is a difference of +/- 1°C compared with other thermometers, but this is not a trouble.

Troubles	Countermeasures	Supplement
A. No indication on the display when power is on	<ul style="list-style-type: none"> <li>• Check connection of power code.</li> <li>• Fuse ( AC125V 1A) may burn out</li> </ul>	Contact to us
B. Values on the display are blinking	<p>Viscosity measurement value is over the range of possible measurement. Check the followings.</p> <ul style="list-style-type: none"> <li>• Is viscosity of measurement solution getting higher?</li> </ul> <p>(Ex. Is the setting of temperature of measurement solution correct? )</p> <ul style="list-style-type: none"> <li>• Does the sensor of transducer touch the wall etc. or does the foreign matter etc. stick to the sensor and load it?</li> <li>• Confirm the basic motion</li> </ul>	Refer to Page 21
C. Viscosity reading on the display remains at zero.	<ul style="list-style-type: none"> <li>• It can be supposed that the cause is same as above B. Check as B.</li> <li>• Check wiring between transmitter and transducer.</li> </ul>	Refer to Page 10, 11
D. Reading is unstable	<p>Check the followings.</p> <p style="text-align: center;">↓</p> <ul style="list-style-type: none"> <li>• Is the sensor of transducer fully submerged in the solution?</li> <li>• Is the unit influenced by bubbles or slurry etc. in the solution?</li> <li>• If the unit has been used for a long time damp or corrosive gas may cause the insulation of the individual signal cables to deteriorate, or signal wire may break due to weariness and flexing of the cable.</li> <li>• Check if temperature is correct. If not, follow the steps outlined in next E.</li> </ul>	
E. Temperature reading is unusual.	<p>《a. Temperature reading remains at zero》</p> <ul style="list-style-type: none"> <li>• A wire in the part of temperature measurement may have been broken. Check connection and wiring in the terminal box of the transmitter.</li> </ul> <p>《b. Temperature reading remains at 100°C》</p> <ul style="list-style-type: none"> <li>• Thermistor may be completely shorted.</li> </ul> <p>Check the following C.</p> <p>《c. Temperature value is unstable or incorrect》</p> <ul style="list-style-type: none"> <li>• Remove the thermistor cable from the terminal block of the transmitter. Measure electric resistance and confirm that it is about +600Ω against the temperature of the solution in which the transducer is installed. If the resistance is very different or unstable contact to us.</li> </ul>	<p>Refer to Page 10, 11</p> <p>Page 24 Thermistor is different each other. So the data is tentative</p>
F. The display appears to be in unusual state.	<ul style="list-style-type: none"> <li>• There may be troubles on hard wear.</li> </ul>	Contact to us.

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G. The analog output. (option) section on the display appears to be in unusual state.	- Analog output corresponds to the viscosity measuring range. Check the viscosity range settings. - When analog output is short or the output is fixed even if viscosity value is correct, check the wiring and the load resistance. (under 500Ω)	Refer to Page 3, 17  Contact to us if there is any trouble.
---	---	---

\* Contact to us if you have any trouble whose cause is unknown.

## TEMPERATURE CHARACTERISTICS OF THERMISTOR

Values in the figure are tentative.

Consider the values in chart as standard.

$$R_0 = 14.885 \text{ k}\Omega \quad R_{25} = 5.300 \text{ k}\Omega \quad R_5$$

$$0 = 2.159 \text{ k}\Omega$$

$$R_{75} = 0.991 \text{ k}\Omega \quad R_{100} = 0.4976 \text{ k}\Omega$$

Temperature °C	Resistance kΩ	Temperature °C	Resistance kΩ
0	14.885	42	2.838
2	13.638	44	2.647
4	12.506	46	2.471
6	11.477	48	2.309
8	10.541	50	2.159
10	9.690	52	2.021
12	8.915	54	1.892
14	8.210	56	1.773
16	7.567	58	1.663
18	6.980	60	1.561
20	6.445	62	1.466
22	5.956	64	1.378
24	5.508	66	1.296
26	5.099	68	1.220
28	4.725	70	1.148
30	4.382	72	1.082
32	4.067	74	1.020
34	3.778	76	0.963
36	3.513	78	0.909
38	3.269	80	0.858
40	3.044		

### List-1

The above is a typical example calculated by general formula (the constant is above  $R_0 \sim R_{100}$ ) of temperature characteristics of thermistor (Type PSB-S3 made by Shibaura Electronics Co., Ltd.) used in our viscosity meter. And it is a little different from the unit delivered to you.

## Warranty Regulations

**Warranty Period:** The warranty period is 2 years from the date of shipment by our company. Should a product failure for which our company is responsible occur during that period, we will repair it free of charge. (The date of shipment is inscribed on the side of the transmitter.)

The following will be repaired for a fee even if occurring within the warranty period.

1. Product failure or damage caused by fire, disaster, abnormal voltage, etc.
2. Product failure or damage caused by inappropriate handling.
3. Product failure or damage caused by voltage, noise, etc., coming from the surrounding facilities, etc.
4. Product failure or damage caused by a failure of connected equipment.
5. Product failure or damage resulting from this product being dropped, hit, etc., while being transported or moved following its delivery.
6. Product failure or damage caused by inappropriate operation or maintenance, or by modification, etc.
7. Product failure or damage caused by corrosion, penetration, etc., of the transmitter by a measured liquid.
8. Product failure or damage caused by use or storage outside the specified range (of liquids, temperature, humidity, pressure, etc.).

Whether a repair will be free-of-charge or for-a-fee shall be determined by our company's Technology Department.

**Scope of Warranty:** This warranty applies to the main body of the product alone.

**Miscellaneous:**

1. Maintenance parts for this product shall be available for at least 7 years after the product is shipped. After 7 years, maintenance parts may be difficult to obtain and repairs may be impossible to carry out.
2. Should a separate contract, etc., exist the product shall be warranted in accordance with its provisions.

\*Please understand that the contents of the instruction manual may be changed without prior notice due to improvements in product quality or another reason deemed appropriate by our company.

### CONTACT:

Fuji Ultrasonic Engineering Co., Ltd.  
1068Iida-cho Minami-ku, Hamamatsu-city  
Shizuoka-pref. 435-0028 Japan  
TEL: +81-53-464-6449  
FAX: +81-53-465-3815