MAXIFLO

User Manual

Ultrasonic Flow Meter

MU Series

(Ver 15.76-18.25)

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PRECAUTIONS

1. Please make sure you have received all the components as was ordered and check if there's anything that's missing, broken or damage. If such things should be observed, please contact your supplier immediately.

2. For wall-mount (MU-WA) and panel-mount (MU-PA) models, please touch the tips of the cables of the sensor (+, - and shield) together before connecting to the converter to drain static that may have been built up in the ceramic piezoelectric element in the sensor. Otherwise, the static might damage the circuit of the converter.

3. For handheld (MU-HA) model sensors (framed sensors), please turn the sensor height adjustment screw knobs counterclockwise to have the sensor bottom face touch the pipe surface squarely and securely. Otherwise, the sensors will not touch the pipe securely and the sound wave signal cannot travel will not travel freely, thereby weakening the signal strength.

4. For handheld (MU-HA) model, if the coupling sealant provided is used up, users can buy and use grease instead.

5. For insertion sensors, you need to order the hot tapping drill tool from the factory if you don't have one already. This is needed to drill the hole on the pipe and install the insertion sensor without stopping the flow inside the pipe.

IMPORTANT NOTE:

For MU-WA/MU-RA/MU-PA models, you must save the SETUP parameters using Menu 26, "1. Solidify Setting" to permanently save the setting in FLASH memory in order not to lose the setup parameters during power off or power outage.

Contents

I. Introduction

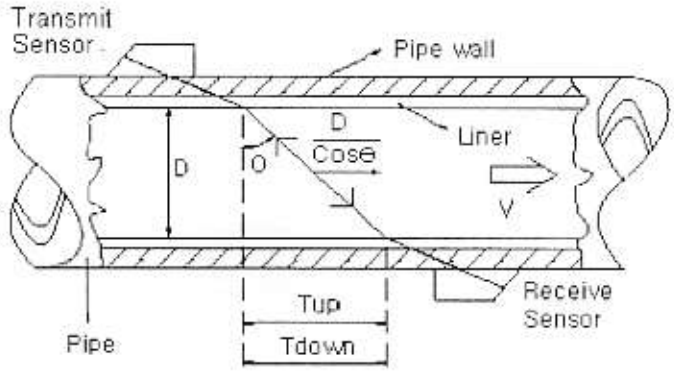
1. Preface

Welcome to MaxiFlow MU series ultrasonic flow meter. Please read this instruction manual thoroughly before installation and operation.

MU series ultrasonic flow meter is a transit-time (or time-difference) type ultrasonic flow meter. It's composed of 1 set of ultrasonic sensors (each installed at upstream and downstream respectively) and a converter. The 2 sensors at upstream and downstream receive and transmit ultrasonic signal alternately. Therefore, for ultrasonic flowmeters, you'll always need 2 ultrasonic sensors. This is called single path type. Multi-path types are integer multiple of this single path type. Usually they are dual-path or 3-path types.

2. Operation Principle

This time-of-travel (transit-time) meter has a pair of transducers mounted on each side of the pipe. The configuration is such that the sound waves traveling between the devices are at a 45-degree angle to the direction of liquid flow. The speed of the sound signal traveling between the transducers increases or decreases depending upon the direction of transmission and the velocity of the liquid being measured. A time-differential relationship proportional to the flow can be obtained by transmitting the signal alternately in both directions.



Transit Times for Up and Down Directions:

$$T_{UP} = \frac{M \times D / \cos\theta}{C_0 + V \sin\theta} \quad (1)$$

$$T_{DOWN} = \frac{M \times D / \cos\theta}{C_0 - V \sin\theta} \quad (2)$$

Time Difference:

$$\Delta T = T_{DOWN} - T_{UP} \quad (3)$$

Flow Velocity:

$$V = \frac{M \times D}{\sin 2\theta} \times \frac{\Delta T}{T_{UP} \times T_{DOWN}}$$

M- travel times
D- inner diameter of the pipe

Θ - transmission angle
C_0- sound velocity in a static fluid

T_{UP}- upstream travel time(reverse flow direction)
T_{DOWN}- downstream travel time(flow direction)
ΔT- difference of travel time between downstream and upstream

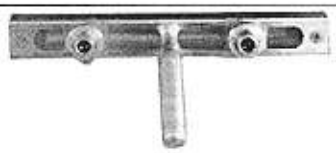
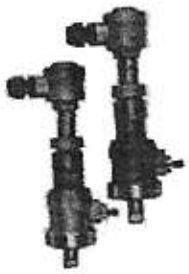
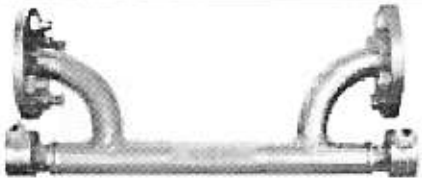
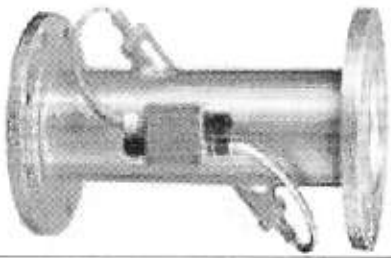
3. Characteristics

MU series ultrasonic flow meter is based on single-board technology where central computation, flow signal sensing, external interfaces, power supply, etc. are all integrated into a single PCB board, which makes it the most compact ultrasonic flowmeter and enables lowering the cost drastically. The merits it provides above else are;

- Transducers are not intrusive, meaning that they are mounted on the outside wall of the pipe, not inside the pipe. So, there's no pressure drop.
- Advanced intelligent instrumentation, processing and printing (logging) according to user requirements. Almost all common flow units are used. It uses normal power, built-in battery or DC power, etc.
- It uses the most advanced direct time measurement method with the resolution of 0.2 ns. Coupled with the advanced data processing functions, it provides high level of linearity.

- Various output options are available including analog current output, frequency output, RS-232 serial output, relay output, etc.
- Using analog inputs (5 analog inputs for MU-WA and MU-PA models for temperature, pressure, level, wind speed, hygrometer, etc.), the meter can act as the remote data terminal. Also, it can be configured as heat meter (calorimeter) using 2 temperature inputs.
- Under network environment, it can be remotely monitored and controlled from a central location.

4. Types of Sensors

Sensor Types		Sizes	Remarks
Clamp-on		S: DN 15 ~ DN 100 M: DN 50 ~ DN 700 L: DN 300 ~ DN 6000	1 set is provided for WA, PA and PO models as standard
		S: DN 15 ~ DN 100	1 set is provided for HA model as standard
		M: DN 50 ~ DN 700	
Insertion		> DN 80	The sensor tip can be either flat tip or 45° angle
Full-bore		DN 10 ~ DN 40	Suitable for very small flows such as dosing line, CMP slurries, etc.
		> DN 50	For this type, the converter can be integrated on to the sensor.

Clamp-on sensors are installed on the outside surface of the pipes. This is the biggest advantage of transit-time ultrasonic flowmeters over other types of conventional flowmeters. You don't have to cut the pipes or drill the holes on the pipe to install the sensors, meaning the installation work is much simpler and easier. And because of this eminent feature, transit-time ultrasonic flowmeters can be made portable or mobile.

Full-bore sensors are installed in-line with the pipe, meaning that the use must cut the pipe and install the sensor just like with conventional flowmeters such as turbine, orifice, electromagnetic, etc. It doesn't come with the eminent feature of clamp-on sensors. Nevertheless, because all the parameters are set at the factory accurately

based on the exact pipe parameters and calibrated accurately, the users can receive the flowmeters already configured for the site and the accuracy can be guaranteed from the factory.

The insertion sensors are installed on pipe by tapping hole and inserting the sensor into the flow. This is used usually for large pipes, when the site is in a harsh environment and cannot ensure good signal, or when the fluid is dirty. With this sensor, because the signal travels straight between the sensors and doesn't get scattered after reflections, you can get much stronger and better quality (higher SNR) signal. Also, while full-bore sensors become expensive in proportion to the size, the insertion sensors don't just like clamp-on sensors.

5. Types of Converters

The converters is the core of this flowmeter, which transmits and receives ultrasonic signals to and from the sensors, calculates the flow, displays it on the LCD, communicates with external interfaces, receives external inputs, outputs data to external systems, etc. Based upon its installation or operation method, it's configured into wall-mount (MU-WA), panel-mount (MU-PA), portable (MU-PO) and handheld (MU-HA) models. All of these models are compatible with all of the sensors described above.

Converter Models			Dimension	Descriptions
Fixed	Wall-Mount (MU-WA)		251 x 92 x 80mm	* The most widely used model; can be configured ex-proof. * Has wide room inside allowing for installation of other devices such as external data logger, communication device, external power, etc. * Provides a wide selection of inputs and outputs. * AC or DC power supply
	Panel-Mount (MU-PA)		90 x 90 x 34mm	* Basically the same configuration as the wall-mount; compact design to fit inside a panel * AC or DC power supply
Mobile	Portable (MU-PO)		258 x 180 x 100mm	* Paper printout * Powered by internal battery * Comes with transit case
	Handheld (MU-HA)		200 x 85 x 30mm	* Internal data logger stores data into memory, which can be browsed from the meter or downloaded to a PC. * Powered by internal battery * Comes with transit case

********* All the converters and the sensors are interchangeable. *********

Mobile types, i.e., **portable (MU-PO)** and **handheld (MU-HA)** models take the most advantage of the ultrasonic flowmeter sensor's clamp-on feature. They are not fixed on to a site. Rather they can be moved around taking measurements. It runs off the internal Ni-H battery, with which it can operate 20 hours after full charging for about 10 hours. The battery must be recharged by the dedicated recharging adapter that was supplied. When recharging, the CHARGE LED turns to red color and when it is about full, it changes to green. The charger is kind of free-volt type and connects to a 100 ~ 250V power source.

For **wall-mount and panel-mount (MU-WA & MU-PA)** model, the power source type must be specified either as 8 ~ 32 VDC or 100~240 VAC.

If an AC power is connected to a DC-power model, the internal circuit will be damaged. So, extreme caution is required.

6. Technical Specifications

Classification		Performance/Parameter	
Pipe	Materials	Steel, Stainless Steel, Cast Iron, Plastics, Concrete, etc.	
	Inner Diameter	15 ~ 6000mm	
	Straight Pipe Section Requirement	10D upstream, 5D downstream (In case there's pump or valve upstream, the lengths should be between 30D and 50D upstream.)	
Fluid	Types	Water, sea water and other clean liquids without high level of suspended particles	
	Turbidity	Smaller than 20,000ppm (Mg/l) with a low level of air bubble content	
	Temperature	-20℃~80℃ (Standard), -20℃~160℃ (High Temp Option)	
Flow Velocity		-30 ~ +30 m/s	
Transducer	Sizes	Clamp-on Sensor	S: DN 15 ~ 100mm
			M: DN 50 ~ 700mm
			L: DN 300 ~ 6000mm
		Insertion Sensor	> DN 80mm
		Full-Bore Sensor	> DN 10mm
	Protection	IP-65 (IP-68 optional)	
	Cable Length	5m (Max. 400m)	
Host	Display	MU-WA, MU-PA, MU-PO	Alphanumeric 2 x 20 digit backlight LCD
		MU-H	Alphanumeric 4 x 16 digit backlight LCD
	Keyboard	MU-WA, MU-PO, MU-HA	4 x 4 keypad
		MU-PA	1 x 4 keypad
	Mounting	Wall mount, handheld, portable and panel mount	
	Input	3 x 4-20mA analog inputs and 2 x RTD inputs (WA, PA)	
	Output	Analog, OCT Pulse, Frequency, Relay, Serial (RS-32/485)	
	Power	Internal Battery (recharged by 100 V ~ 240 VAC)	
		100 V ~ 240 VAC	
		8 V ~ 32 VDC	
	Printer	24-digit dot printer (for PO only)	
	Dimension	Wall Mount: 251 x 92 x 80mm	
		Panel Mount: 90 x 90 x 35mm	
		Portable: 258 x 180 x 100mm	
		Handheld: 200 x 85 x 30mm	
	Weight	WA - 7kg, PA – 4kg, PO – 9 kg, HA – 9 kg	
Operating Condition	Temperature	Converter: -20 ~ 40℃	
		Transducer: -20 ~ 150℃	
	Humidity	Converter: 85% RH (at 40℃)	
		Transducer: 98% RH (at 40℃) (Able to operate immersed in water depth smaller than 3m)	
Performance	Accuracy	±1.0% of Reading	
	Repeatability	±0.2% ~ 0.5%	
	Linearity	0.5%	
	Basic Totalization Cycle	500 ms	

II. Installation of the Sensors and Start Measurement

Installation of the sensors of ultrasonic flowmeters (especially clamp-on sensors) is the easiest among all of flowmeter sensors. Set the basic setup parameters and install the sensors on the surface of the pipe observing the sensor distance automatically calculated by the meter, and you are ready to go. Follow the flowing steps;

Connect the power

For DC power model, you can use 8 ~ 32 VDC power. Connect DC+ to terminal 23 and DC- to terminal 24.

For AC power model, you can use 100 ~ 240 VDC power. Connect the AC power to terminal 11 and 12, and the ground to 13.

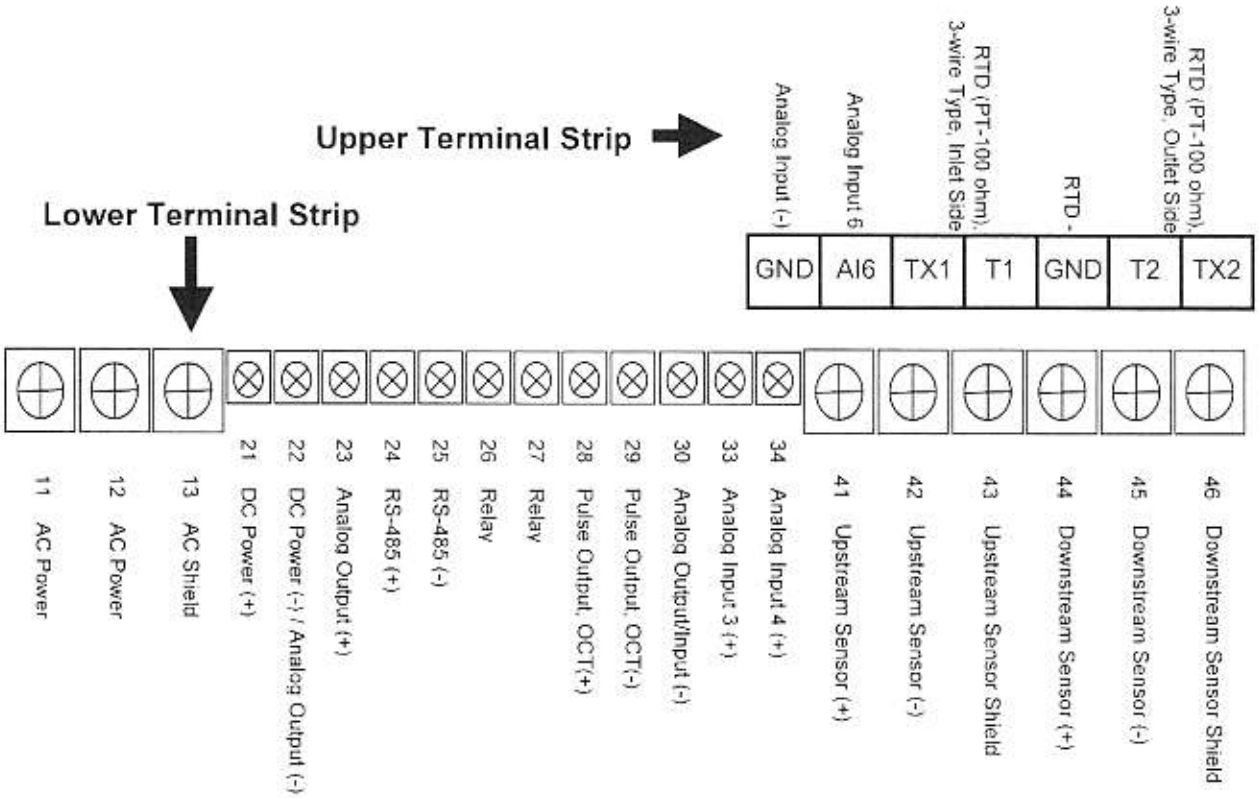
Connect the sensors

For fixed types

1 set of sensors is composed of 2 sensors (1 upstream and 1 downstream). Use the sensor cables provided. On the sensor end, remove the shield and connect the red cable to + and the black cable to – terminal of the sensor.

On the converter side, connect the upstream sensor black cable to terminal 41, red cable to 42 and shield to 43, and the downstream sensor black cable to 44, red cable to 45 and shield to 46. The terminal strip of the converter for fixed models (MU-WA and MU-PA) are shown below;

MU-WA



MU-PA

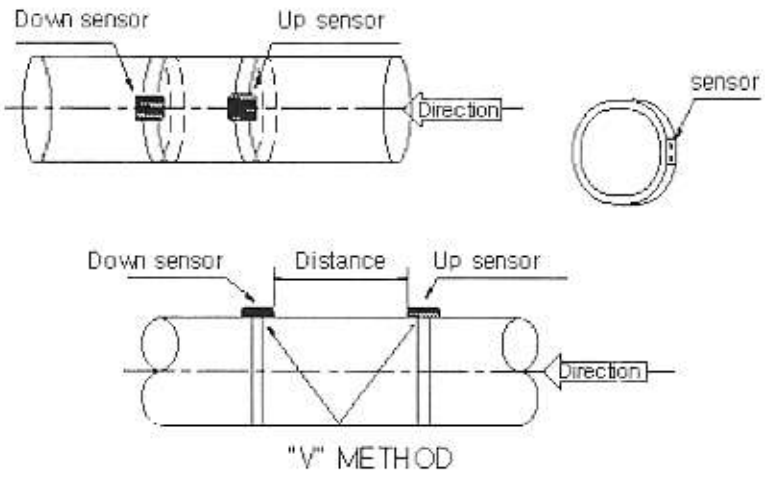
Bottom Strip		Top Strip	
8~36V+, 8~36V-	Power supply. 10~36VAC also usable	**T1, T2**	Signal terminals of PT-100Ω RTDs
485+, 485-	RS-485 terminals	**TX1, TX2**	Power terminals of PT-100Ω RTDs
AO+, AO-	Analog output, loop powered	**GND**	Return terminals of PT-100Ω RTDs and AI3, AI4, AI5
UP+, UP-	Upstream sensor	**AI3, AI4, AI5**	Analog inputs (4-20mA)
DN+, DN-	Downstream sensor	**OCT+, OCT-**	OCT pulse output. Controlled by Menu 78
GND	Ground for sensors	**Relay+, Relay-**	OCT relay output. Controlled by Menu 79

For mobile types (MU-PO & MU-HA)

1 set of sensors is composed of 2 sensors (1 upstream and 1 downstream). Use the sensor cables provided. Connect the cable with red connector to the upstream and that with blue connector to the downstream terminals of the converter.

Find out the sensor distance

- Go to M11 (press M, 1 and 1 in sequence) and enter the outside diameter of the pipe.
- Go to M12 and enter the pipe wall thickness.
- Go to M13 and verify if the inside diameter of the pipe displayed is correct. If not, please repeat the procedure from M11 above.
- Go to M14 and select the pipe material.
- Go to M16 and enter lining information (Material and thickness). (Usually there's no lining.)
- Go to M20 and select the type of liquid inside the pipe.
- Go to M23 and select the sensor type. (See the detailed description of M23 for selection of proper sensor.)
- Go to M24 and select the sensor installation method. (V method in most cases.)



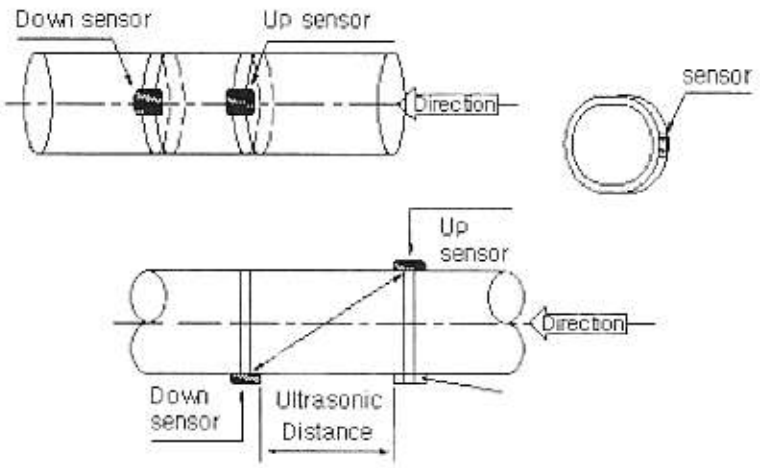
"V" METHOD

V Method

For clamp-on sensors, this is the most general method.

But if the signal travel distance should be too short because the pipe is too small, then choose W method instead to double the distance.

Because the sensors are installed on one side, it's easier for the installer to work.



Z Method

For insertion sensors, this is the most general method.

For clamp-on sensors, also, when the signal travel distance is too big, this is preferred because the signal travel distance can be shortened.

Because the sensors are installed on both sides, enough workspaces on both sides shall be secured. Also extreme caution should be made for the alignment of the each sensor face to one another.

*** The above installation methods are applied to clamp-on sensors and insertion sensors only, and not applied to full-bore sensors.

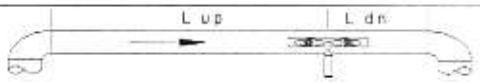
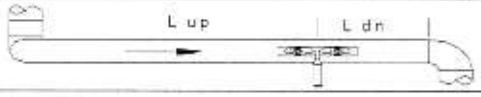
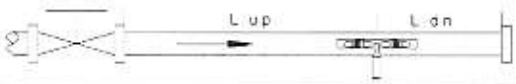
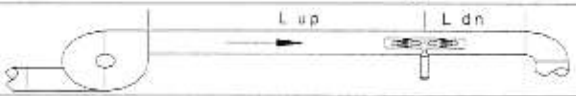
- Go to M25 and check the sensor distance that was calculated automatically based on the data entered above. This is the distance between both front edges of the sensors.

Install the sensors

A. Finding the right installation point

Selecting the right installation point is the most important element in ensuring the accuracy of measurement, and should be selected considering the following aspects;

- Make sure the pipe to be measured is full.
- Select a location where it allows for straight pipe run of 10D upstream and 5D downstream. In case there's a pump or a bending section in the upstream, increase the upstream run to 30D in order to allow the flow to fully develop into stable flow profile. Please see the table below;

Piping Configuration and Transducer Position	Upstream Dimension L up x Diameters	Downstream Dimension L dn x Diameters
	10D	5D
	10D	5D
	10D	5D
	12D	5D
	20D	5D
	20D	5D
	30D	5D

- Ensure the temperature at the measuring point is within the specified range.
- Avoid places where the inside wall of the pipe is scaled or rusted that can negatively affect the performance of the meter.
- Avoid places where there's excessive vibration.

B. Install the sensors

- Sensors must be installed on the side of the pipe (horizontally). If the sensors are installed on top of the pipe, the signal can be scattered by air bubbles or floating particles that may have been built up inside the pipe.
- After selecting the installation point, clean the surface using sand paper should there be any rust or scales.
- Mark the sensor distance shown in M25 on the pipe using a marker.
- For clamp-on sensors, apply the silicone couplant on the sensor bottom faces and the pipe surface sufficiently. There should be no gap between the sensor bottom face and the pipe surface; otherwise the sensor signal cannot travel smoothly. So, using the clamp provide securely tighten the sensors on the surface.
- For insertion sensors, please see the appendix, "How to install insertion sensors".

Verification of the installation and start measurement

When the sensor is installed. Then the machine searches for proper amplifier gain. After S1, S2, S3 and S4 steps, the machine enters into the normal operation mode. Go to M01 and see if the flow is being measured and displayed correctly. If the flow measurement is somewhat unstable and looks incorrect, see if there's any sign other than *R is displayed on the top right corner, and take proper actions according to the sign displayed. (For the detailed explanation of the signs and countermeasures, please see "Error Codes and Countermeasures"). When it shouldn't solve the problem, then check the following parameters;

A. Signal Strength (M90)

Signal strength indicates the amplitude of receiving ultrasonic signals by a 3-digit number. [000] means there is no signal detected, and [999] refers to the maximum signal strength that can be received.

Although the instrument works well if the signal strength ranges from 500 to 999, stronger signal strength should be pursued, because a stronger signal means a better result. The following methods are recommended to obtain stronger signals:

- Relocate to a more favorable location, if the current location is not good enough for a stable and reliable flow reading, or if the signal strength is lower than 700.
- Try to polish the outer surface of the pipe, and apply more coupler to increase the signal strength.
- Adjust the transducers both vertically and horizontally while checking the varying signal strength, stop at the highest position, and then check the transducers spacing to make sure the transducers spacing is the same as what the M25 shows.

B. Signal Quality (M90)

Signal quality is indicated as the Q value in the instrument. A higher Q value would mean a higher Signal and Noise Ratio (short for SNR), and accordingly a higher degree of accuracy would be achieved. Under normal pipe condition, the Q value is in the range 600-900, the higher the better.

Causes for a lower Q value could be:

- Interference from other instruments and devices such as a powerful transformer working nearby; try to relocate the flow meter to a new place where the interference can be reduced.

- Bad sonic coupling for the transducers with the pipe; try to apply more coupler or clean the surface, etc.
- The installation point is a tough spot to be measured. Relocation is recommended.

C. Total Transit Time and Delta Time

The numbers displayed on menu window M93 are called total transit time and delta time respectively. They are the primitive data for the instrument to calculate the flow rate inside the pipe. So the flow rate indication will vary accordingly with the total time and delta time.

The total transit time should remain stable or vary little.

If the delta time fluctuates higher than 20%, it means there are certain kinds of problems with the transducer installation.

D. Time Ratio between the Measured Total Transit Time and the Estimated Time

This ratio would be used to check the transducer installation. If the pipe parameters are entered correctly and the transducers are installed properly, the value for this ratio should be in the range of 100±3. If this range is exceeded, the user should check;

- If the pipe parameters are correctly entered.
- If the actual spacing of the transducers is right and the same as what the window M25 shows.
- If the transducers are installed properly in the right directions.
- If the mounting location is good and if the pipe has changed shape or if there is too much fouling inside the pipes
- Other poor conditions.

E. Zero Calibration, Reset Zero and Manual Zero Point (M42, M43, M44)

In normal case, you don't have to do this because the meters are zero-calibrated at the factory. But when the meter should display a value other than 0, when the flow is completely, then run Zero Calibration in M42. Make sure that the flow is completely stopped and stabilized when performing this function.

When the zero calibration is somehow made incorrectly (for example, when the zero calibration is run when the flow is not completely stopped.), you need to restore the factory default zero point. Go to M43 and reset the zero point back to the factory default.

If somehow the above doesn't work or if it's not possible to stop the flow for zero calibration, you can use Manual Zero Point (M44). For this, you must know the exact difference between the flow displayed and the actual flow. For example, if the actual flow is 30 m^3/h and the flow displayed is 35 m^3/h, that means 5 m^3/h is actually 0 m^3/h. So, in this case, go to M44 and enter 5 m^3/h as the zero point.

F. Scale Factor (M45)

Most flowmeters out there tend to drift a little because of many reasons. So, it's recommended the flowmeters are recalibrated at certain interval (1 year or 2 years) against a reference meter. There can be cases where with all the correct setups made above, the flow displayed is off actual flow. In that case, offset the difference by entering the offset value (scale factor) in M45.

III. Display & Command Menus

1. Summary

All display windows of MU series and their descriptions will be discussed in this chapter. The user can enter each menu pressing [MENU] [#] [#] (# means a number)

Common Menus	MU-HA Specific	MU-PO Specific
	◆ Flow Rate/Total Flow/Energy Flow Display	
00 Flow Rate/Net Totalizer	Pos./Neg./Net Total/System Status	
01 Flow Rate/Velocity	Pos. Total Flow/Flow Rate/Velocity/System Status	
02 Flow Rate/POS Totalizer	Neg. Total Flow/Flow Rate/Velocity/System Status	
03 Flow Rate/NEG Totalizer	Net Total Flow/Flow Rate/Velocity/System Status	
04 Date Time/Flow Rate	Date/Time/Flow Rate/System Status	
05 Energy Flow Rate/Totalizer	Date/Time/Velocity/System Status	
06 T1,T2 Input	Receive Signal Shape	
07 AI3,AI4 Input	Battery Status	
08 System Error Code		
09 Net Flow Today		
	◆ Initial Setup Menus	
10 Pipe Outer Perimeter		
11 Pipe Outer Diameter		
12 Pipe Wall Thickness		
13 Pipe Inner Diameter		
14 Pipe Material		
15 Pipe Sound Velocity		
16 Liner Material		
17 Liner Sound Velocity		
18 Liner Thickness		
19 Inside ABS Thickness		
20 Fluid Type		
21 Fluid Sound Velocity		
22 Fluid Viscosity		
23 Transducer Type		
24 Transducer Mounting		
25 Transducer Spacing		
26 Default Setting	Save Setup Parameters	
27 Save/Load Parameters	Load Setup Parameters	
28 Holding with Poor Signal		
29 Empty Pipe Setup		
	◆ Flow Unit Menu	
30 Measurement Units In		
31 Flow Rate Units		
32 Totalizer Units		
33 Totalizer Multiplier		
34 NET Totalizer		
35 POS Totalizer		
36 NEG Totalizer		
37 Totalize Reset		
38 Manual Totalizer		
39 Language Selection		
3. Segmental LCD		

◆ Adjustment & Options Menus		
40 Damping		
41 Low Flow Cutoff Val.		
42 Set Zero		
43 Reset Zero		
44 Manual Zero Point		
45 Scale Factor		
46 Network IDN		
47 System LockCode		
48 Entry to Calib. Data	No Menu	
49 Serial Port Traffic		
◆ External Output/Input Setup Menu		
50 Data Logger Option		
51 Data Logger Setup		
52 Send Log-Data to		
53 Analog Input AI5	View Data Logger	Print Scroll
54 OCT Pulse Width		Power on Printing
55 CL Mode Select		
56 CL 4mA Output Value	No Menu	No Menu
57 CL 20mA Output Value		
58 CL Checkup (mA)		
59 CL Current Output		
60 Date and Time Setup		
61 Software Version and ESN		
62 RS-485/232 Setup		
63 Select Comm Protocol		
64 AI3 Value Range	No Menu	
65 AI4 Value Range		
66 AI5 Value Range		
67 FO Frequency Range		
68 Low FO Flow Rate		
69 High FO Flow Rate		
70 LCD Backlight Option		
71 LCD Contrast		
72 Working Timer		
73 Alarm #1 Low Value		
74 Alarm #1 High Value		
75 Alarm #2 Low Value		
76 Alarm #2 High Value		
77 Beeper Setup		
78 OCT Output Setup		
79 RELAY Output Setup		
80 Batch Trigger Select	No Menu	
81 Flow Batch Controller		
82 Date Totalizer		
83 Automatic Amending		
84 Energy Units Select		
85 Temperature Select		
86 Specific Heat	No Menu	
87 Energy Totalize ON/OFF		
88 Energy Multiplier		
89 Temperature Diff.		
8. Heat Meter is On		
◆ Diagnosis Menus		

90 Single Strength and Quality		
91 TOM / TOS*100		
92 Fluid Sound Velocity		
93 Total Time and Delta Time		
94 Reynolds No, Profile		
95 POS Energy Totalizer NEG Energy Totalizer		
◆ Print Menus (MU-PO only)		
No Menu		96. Paper Feed 97. Print Setup Parameters 98. Print Diagnosis Result 99. Print Current Window
◆ Miscellaneous Menus		
+0 ON/OFF Times		
+1 Total Working Hours		
+2 Last Power off Time		
+3 Last Flow Rate		
+4 ON/OFF Times		
+5 Calculator		
+6 Media Vel. Threshold		
+7 Total Flow for Month		
+8 Total Flow for This Year		
+9 No-Ready Timer	No Menu	

2. Menu Descriptions

(1) Flow/Totalizer Displays

- **Flow Rate/Net Totalizer (M00)**

```
Flow -10.023 m³/h *R
NET   1342 x 0.01 m³
```

This window is only for display. The selection of the unit is made in M31 and M32 windows. If the NET totalizer is unselected, the value shown in the window is replaced by the last total flow. Add the negative total to the positive total to get the net total.

- **Flow Rate/Flow Velocity (M01)**

```
Flow -10.023 m³/h *R
VEL   -0.3215 m/s
```

This window is only for display. The selection of the unit is made in M31 and M32 windows.

- **Flow Rate/Positive Totalizer (M02)**

```
Flow -10.023 m³/h *R
POS   +1342 x 0.01 m³
```

This window is only for display. The selection of the unit is made in M31. If the POS totalizer is unselected, the value shown in the window is replaced by the last POS total.

- **Flow Rate/Negative Totalizer (M03)**

Flow -10.023 m^3/h *R NEG -1342 x 0.01 m^3

This window is only for display. The selection of the unit is made in M31. If the NEG totalizer is unselected (M36), the value shown in the window is replaced by the last NEG total.

- **Date and Time/Flow Rate (M04)**

05-10-20 10:10 *R Flow 10.023 m^3/h

This window is for displaying current date, time and flow rate. The time and date can be edited in M60.

- **Energy/Total Energy (M05)**

EFR +253.27 0kc/s *R E.T +12213414EO GJ

This window shows energy flow and the totalizer. The details on measuring energy are described in "Energy Measurement".

- **T1, T2 Input (M06)**

T1= 0.0000C 100.00 T2= 20.000C 107.79

This window shows the temperature values (PT-100 ohm) at T1 and T2 terminals.

- **Analog Input AI3 and AI4 (M07)**

AI3= 4.0000:20.000 AI4= 8.0000:40.000

This window shows analog inputs AI3 and AI4 in currents that represent temperature, pressure or liquid level, etc.

- **System Error Codes (M08)**

*R System Normal

It shows the status of operation and corresponding status (or error) code. There are several error codes, whose implications and solutions are discussed in "ERROR SEARCHING".

- **Net Flow Today (M09)**

Net Flow of Today 358.34m^3

This window displays the net total of the day.

- **User's Info Display (M0+)**

User's Info Display Use Command ' UINFO='

Enter user information via serial command 'UINFO='. For example, if you want to enter Tag No. of the meter, connect a PC to the meter using RS-232/485 and using a terminal emulator software such as HyperTerminal, type "UINFO= Tag No. FT-10001" and press Enter key. The this information will be displayed on this window. This information is stored on RAM. So, when the meter is powered off, this information is erased.

(2) Initial Setup Menus

- **Pipe Outer Perimeter (M10)**

Input the Outer Perimeter of Pipe 518.363mm

Input the outer perimeter of the pipe. If the outer diameter is available, please ignore this value and input the outer diameter of the pipe in M11.

- **Pipe Outer Diameter (M11)**

Input the Outer Diameter of Pipe 165mm

Input the outer diameter directly or input the outer perimeter in M10. The value should be between 10mm and 6,000mm.

Attention: Either outer diameter or outer perimeter is ok.

- **Pipe Wall Thickness (M12)**

Pipe Wall Thickness 5mm

Input the pipe wall thickness, if available, or skip this and go into M13.

- **Inner Diameter (M13)**

Pipe Inner Diameter 155mm

Input the inner diameter. If you have input other diameter or outer perimeter and wall thickness, skip this window.

Either the wall thickness or the inner diameter is ok.

- **Pipe Material (M14)**

Pipe Material 0. Carbon Steel

You can select one of the following materials from the list provided;

0. Carbon Steel	5. PVC
1. Stainless Steel	6. Aluminum
2. Cast Iron	7. Asbestos

3. Ductile Iron
4. Copper
8. Fiber Glass- Epoxy
9. Other

If '9. Other', you must input the corresponding sound velocity of the material in M15.

- **Pipe Sound Velocity (M15)**

Pipe Sound Velocity 1300.5 m/s

Use this menu only when '9. Other' is selected in M14. This menu is not activated if '9. Other' is not selected in M14.

- **Liner Material (M16)**

Liner Material 0. No Liner

You can select one of the following materials from the list provided;

0. No Liner
1. Tar Epoxy
2. Rubber
3. Mortar
4. Polypropylene
5. Polystyrol
6. Polystyrene
7. Polyester
8. Polyethylene
9. Ebonite
10. Teflon
11. Other

If '11. Other', you must input the corresponding sound velocity of the material in M17.

- **Liner Sound Velocity (M17)**

Liner Sound Velocity 3300.5 m/s

Use this menu only when '11. Other' is selected in M16.

- **Liner Thickness (M18)**

Liner Thickness 10mm

Only when a liner is selected in M16, this menu will be activated.

- **Inside ABS Thickness (M19)**

Inside ABS Thickness 0

Input ABS roughness coefficient. Not used. Reserved for future use.

- **Fluid (M20)**

Fluid Type 0. Water

You can select one of the following fluids from the list provided;

0. Water	8. Other
1. Sea Water	9. Diesel Oil
2. Kerosene	10. Caster Oil
3. Gasoline	11. Peanut Oil
4. Fuel Oil	12. Gasoline #90
5. Crude Oil	13. Gasoline #93
6. Propane (-45°C)	14. Alcohol
7. Butane (0°C)	15. Water (125°C)

If '8. Other' is selected, input the corresponding sound velocity of the fluid in M21.

- **Fluid Sound Velocity (M21)**

Fluid Sound Velocity 1600.0m/s

Enter the sound velocity of the fluid you chose in M20. This is activated only when '8. Other' is selected in M20.

- **Fluid Viscosity (M22)**

Fluid Viscosity 1.0054 cSt

Enter the viscosity of the fluid you chose in M20. This is activated only when '8. Other' is selected in M20.

- **Transducer Type (M23)**

Transducer Type 0. Standard – M

Select one of the transducer types from the list provided;

MU-WA & MU-PA

0. Standard – M	11. Standard-S1
1. Insertion Type C	12. Standard-L1
2. Standard – S	13. PI-Type
3. User Type	14. FS410 (FUJI)
4. Standard – B	15. FS510 (FUJI)
5. Insertion Type B45	16. Clamp-on TM1
6. Standard – L	17. Insertion TC-1
7. JH-Polysonics	18. Clamp-on TS-1
8. Standard-HS	19. Clamp-on TS-2
9. Standard-HM	20. Clamp-on TL-1
10. Standard M1	21. Insertion TLC-2

MU-PO & MU-HA

0. Standard – M	8. Standard – M1
1. Plug-in Type A	9. Plug-in Type C
2. Clamp-on TM-1	10. Standard – HS
3. User Type	11. Standard – HM
4. Standard – B	12. Standard – S1
5. Plug-in Type B45	13. Pipe
6. Standard – L	14. Standard – L1
7. Clamp-on TS-2	15. Clamp-on TL-1

* Select 10. Standard-HS or 11. Standard-HM for Handheld type framed clamp-on sensors.

If you select '3. User's Own Type, you should enter a group of transducer parameters such as sound wedge angle, sound wedge velocity, ultrasonic delay and distance between the edge of the transducer and sound.

- **Transducer Mounting Method (M24)**

Transducer Mounting 0. V

Select one of the transducer mounting types from the list provided;

0. V Method
1. Z Method
2. N Method (for small pipes)
3. W Method (for very small pipes)

- **Transducer Distance (M25)**

Transducer Spacing
50.00mm

This window is only for display of the transducer mounting distance that was calculated based on the parameters input in the foregoing menus. The distance is between the front edges of the transducers.

- **Default Setting (M26)**

Parameter Setups
1. Solidify Setting

0. Use RAM Setting 1. Solidify Setting

Use 1. Solidify Setting to make the current pipe and sensor setup parameters are permanently stored in FLASH memory. That way, the setting will be preserved even when the power is switched off or during power outage.

- **Save/Load Parameters (M27)**

Save Load Parameters
0. 15mm, PI-Type

A total of 18 setup parameters can be saved, retrieved and broswed for quick installation.

0. Entry SAVE 1. Entry LOAD 2. To Browse

- **Data Holding (M28)**

Holding With Poor Signals
Yes

Select "Yes" to hold the last good flow signal displayed if the flow meter experiences a poor signal condition. This function will allow continued data calculation without interruption.

- **Empty Pipe Setup (M29)**

Empty Pipe Setup
0

This value is used to solve the problem of the empty pipe. Even when the pipe is empty, the flow meter will show "Normal Working" for the signals that are transmitted and reflected through the pipe wall. In order to avoid this, set the lowest signal strength threshold to about 30~40, below which the system stops measurement because the pipe is deemed to be empty.

(3) Flow Units Menu

Measurement Unit (M30)

Measurement Units In 0. Metric

The following options are provided;

0. Metric 1. English

The default is Metric.

- **Flow Rate Units (M31)**

Flow Rate Units m3/h

The following flow units and time units are available;

Flow Units

0. Cubic Meters (M^3)	5. Cubic Feet(cf)
1. Liters (l)	6. (American) Barrels
2. (American) Gallons	7. Imperial Barrels
3. Imperial Gallons	8. Oil Barrels (ob)
4. Million Gallons	

Time Units

/hour /day /min /sec

- **Totalizer Units (M32)**

Totalizer Units Cubic Meters (M^3)

Select totalizer units. The available unit options are the same as those found in M31. The user can select units as required. Factory default is cubic meters.

- **Totalizer Multiplier Options (M33)**

Totalizer Multiplier m3/h

The totalizer multiplier acts as the function to increase the totalizer indicating range. Meanwhile, the totalizer multiplier can be applied to the positive totalizer, negative totalizer and net totalizer at the same time. The followings options are available;

0. X 0.001 (1E-3)	4. X10
1. X 0.01	5. X100
2. X0.1	6. X1000
3. X1	7. X10000 (1E+4)

Factory default factor is x1.

- **ON/OFF Net Totalizer (M34)**

Net Totalizer ON

On/off net totalizer. "ON" indicates that the totalizer is turned on, while "OFF" indicates it is turned off. When it is turned off, the net totalizer display in M00 will not change. Factory default is "ON".

- **ON/OFF Positive Totalizer (M35)**

POS Totalizer ON

On/off positive totalizer. "ON" indicates the flowmeter starts to totalize the value. When it is turned off, the positive totalizer display M02 won't change. Factory default is "ON".

- **ON/OFF Negative Totalizer (M36)**

NEG Totalizer ON

On/off negative totalizer. "ON" indicates the flowmeter starts to totalize the value. When it is turned off, the negative totalizer display M03 won't change. Factory default is "ON".

- **Totalizer Reset (M37)**

Totalizer Reset? Selection

Reset totalizer. Press [ENTER]; move UP or DOWN arrow to select "YES" or "NO". After "YES" is selected, the following operations are available;

None
All
NET
POS
NEG

If it is necessary to recover the factory default, press [.][←] keys after the above-mentioned characters are displayed on the screen.

- **Manual Totalizer (M38)**

Manual Totalizer Press ENT when ready

The manual totalizer is an independent, separate totalizer. Press [ENTER] to start, and press [ENTER] to stop it. It is used for tentative flow measurement totalization and calculation. Using this manual totalizer doesn't affect the systems automatic totalizations.

(4) Adjustment and Options Menus

- **Damping (M40)**

Damping 10 sec

The damping factor ranges from 0 to 999 seconds. 0 indicates no damping; 999 indicates the maximum damping. Damping smoothens out the flow measurement by using longer averaging of raw data. Its principle is the same as that in a single-section RC filter. The damping factor value corresponds to the circuit time constant. Usually a damping factor of 3 to 10 is recommended in applications.

- **Low Flow Cutoff Value (M41)**

Low Flow Cutoff Val. 0.01 m/s

Low Flow Cutoff is used to make the system display as "0" value at lower and smaller flows to avoid any inefficiency in totalizing. For instance, if the cutoff value is set as 0.03, system will take all the measured flow values of ±0.03 as "0". Usually 0.03 is recommended in most applications.

- **Set Zero (M42)**

Set Zero[42 Press ENT to go

When the fluid is in the static state, the displayed value is called "Zero Point". When "Zero Point" is not at zero in the flowmeter, the difference is going to be added into the actual flow values and measurement differences will occur in the flow meter.

Set Zero must be carried out after the transducers are installed and the flow inside the pipe is in the absolute static state (no liquid movement in the pipe). Thus, the "Zero Point" resulting from different pipe mounting locations and parameters can be eliminated. The measuring accuracy at low flow is enhanced consequently.

Press [ENT], wait for the processing instructions at the bottom right corner to reach 0.
Set zero within the existing flow may cause the flow to be displayed as "0". If so, it can be recovered via M43.

- **Reset Zero (M43)**

Reset Zero [43 No

Clear Zero Point set by the user, and restore the factory default.

- **Manual Zero Point (M44)**

Manual Zero Point [44 0m3/h

This method is not commonly used. It is only recommended for experienced users to set zero under conditions where it is not preferable to use other methods. Enter the value manually to add to the measured value to obtain the actual value. For instance:

Actual Value	= 250 m^3/h
Value Deviation	= 10 m^3/h
Displayed Value	= 240 m^3/h

Offset this deviation value by entering Manual Zero Point as –10.

- **Scale Factor (M45)**

Scale Factor [45
1

This factor is also called as calibration factor. If the measured value is consistently different from a value measured by a reference meter, the difference in percentage should be applied as calibration factor or scale factor. Thus scale factor is used to modify the measurement result of the meter. Factory default is 1. The user can enter a numerical value other than "1" according to calibration results.

- **Network IDN (M46)**

Network IDN [46
88

Identifier in a networked environment; it can be from 0 to 65535 except 13 (0DH ENTER), 10(0AH New Line), 42(2AH *) and 38(26H&), which can collide with communication protocols. You can use this IDN when approaching a meter in a network.

- **System Lock (M47)**

System Lock [47
= Unlock

Lock the flowmeter to prevent from inadvertent modification of the critical setup parameters. Once the system is locked, any modification is prohibited in the system. However, the parameter is readable. "Unlock" by the password only. The password is composed of 1 to 4 numbers. **(Please contact us if the password is forgotten)**

- **Entry to Calib. Data (M48)**

Entry to Calib. Data [48
Press ENT When Ready

Entry to linearity correct data inputs. There are as many as 12 point-data can be input.

First decide how many points you want to point calibrate. Then make the following calibration data table by measuring the flow rates using a reference meter and the ultrasonic flowmeter. (The following example is for making calibration on 6 points)

Data Point No.	Flow Rate by Reference Meter	Flow Rate by Ultrasonic Flowmeter	Calibration Factor
01	1	0.998	1.002004
02	5	5.505	0.908265
03	10	10.85	0.921659
04	20	19.78	1.011122
05	50	51.23	0.975991
06	100	102.55	0.975134

You need to enter only Flow Rate by Ultrasonic Flowmeter : Calibration Factor data pairs.

In the menu, press ENT, then enter number of data points you want to calibrate, and then press ENT to confirm.

Press DOWN key to start entering the actual data from low flow rate to high flow rate as below. When one data point is finished, press DOWN key to move to the next data point.

Data No 01 – 0.998:1.002
Data No 02 – 5.505:0.908
Data No 03 – 10.85:0.921
Data No 04 – 19.78:1.011
Data No 05 – 51.23:0.975
Data No 06 – 102.55:0.975

When all the data points (total 6 points) have been entered, ignore the remaining data points (07 – 12).

- **Serial Port Traffic (M49)**

Communication Tester

Echoes the characters received from the serial port.

(4) External Output/Input Menus

- **Logger Option (M50)**

Logger Option [50 OFF

Sets the printer on/off. When "ON" is selected. The following options will be displayed for further options (Use ▾ key to move to next item);

MU-WA		MU-HA	
0. Date and Time	11. Energy POS Total	0. Date and Time (OFF)	11. AI1 (OFF)
1. System Status	12. Energy NEG Total	1. System Status (OFF)	12. AI2 (OFF)
2. Current Window	13. Fluid Velocity	2. Current Window (OFF)	13. Working Timer (OFF)
3. Signal Strength	14. RTD T1	3. Flow Rate (ON)	14. Flow Today (OFF)
4. Flow Rate	15. RTD T2	4. Velocity (OFF)	
5. Velocity	16. Analog Input 3	5. NET Totalize (OFF)	
6. NET Totalizer	17. Analog Input 4	6. POS Totalize (OFF)	
7. POS Totalizer	18. Analog Input 5	7. NEG Totalize (OFF)	
8. NEG Totalizer	19. Working Timer	8. Signal Strength (OFF)	
9. Energy Flow Rate	20. Flow Today	9. Energy Flow Rate (OFF)	
10. Energy NET Total	21. Serial Number	10. Energy Totalize (OFF)	

Press ENT to select and set the setting.

- **Logger Time Setups (M51)**

Logger Time Setups [51 Start Time = 00:00:00

Window to setup the time of scheduled output function (data logger, or Thermo-printer). This includes start time, time interval and how many times of output. When a number great than 8000 entered for the times of output, It means the output will be keeping always. The minimum time interval is 1 second and the maximum is 24 hours.

- **Send Log-Data to (M52)**

Send Log-Data to [52
1. Send To RS-485

Data logging direction control.

(1) If 'Send to RS485' is selected, all the data produced by the data logger will be transmitted out through the RS-232/RS485 interface

(2) If 'To the internal serial BUS'is selected, the data will be transmitted to the internal serial bus which allows a data logger, thermal printer, a 4-20mA analog output module, to be connected to it.

For MU-PO and MU-HA, following additional options are provided:

0. To The Printer
1. To the Buffer
2. Buffer=> Printer
3. Buffer=> RS232
4. Clear the Buffer

- **Display AI5 (M53)**

Analog Input AI5 [53
AI5=4.0000:20.00

Displays the electric current of AI5 and its corresponding parameters such as temperature, pressure or level.

For MU-HA, this is replaced by Logger Data Viewer.
For MU-PO, this is replaced by Scroll Space Setup.

- **OCT Pulse Width (M54)**

OCT Pulse Width [54
199.981 mS

Pulse width setup for the OCT (OCT1) output. Minimum is 6 mS, maximum is 1000 mS.

- **Current Output Selection (M55)**

CL Mode Select [55
0.4-20mA

0. 4-20mA
1. 0-20mA
2. 0-20mA Via RS-232
3. 4-20mA vs. Flow
4. 20-4-20mA
5. 0-4-20mA
6. 20-0-20mA
7. 4-20mA vs. Vel.
8. 4-20mA vs. Energy

The serial port controls the output according to the command and parameter entered in the RS232 to output a definite current value through the current loop. The command formats are narrated in the command explanations to Serial Port controls. For instance, if it is necessary to output a 6mA current through the current loop, it can be

realized by setting M56 to mode "0-20mA Via RS232" and giving a command "AO6(CR)". This function is able to make the flowmeter operate a control valve conveniently.

- **4mA or 0mA Output Value (M56)**

CL 4mA Output Value[56
0 m^3/h

Use this window to set the flow value to 4mA or 0mA. The flow unit is the same that was set at M31.

- **20mA Output Value (M57)**

CL 20mA Output Value[57
1200 m^3/h

Use this window to set the flow value to 20mA. The flow unit is the same that was set at M31.

- **CL Checkup (mA) (M58)**

CL Checkup (mA) [58
Press ENT when ready

Check if the current loop has been calibrated before leaving the factory. Press ENT, move ▲ or ▼ separately to display 0mA, 4mA till 24mA, and at the same time, check with an ammeter to verify that CL output terminals No. 31 and 32 agree with the displayed values. It is necessary to re-calibrate the CL if over the permitted tolerance. For more information, refer to Chapter 3- Operating Instructions. Section 3.29-Analog Output Calibration.

- **CL Current Output (M59)**

CL Current Output [59
0.0000mA

Display CL current output. The display of 10.0000mA indicates that CL current output value is 10.0000mA. If the difference between displaying value and CL output value is too large, the current loop then needs to be re-calibrated accordingly.

- **Date and Time Settings (M60)**

YY-MM-DD HH:MM:SS
04-05-05 11:05:05

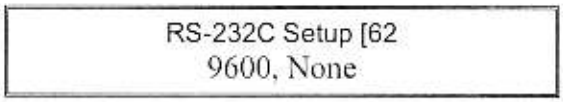
Date and time modifications are made. The format for setting time setting is 24hours. Press ENT, wait until ">" appears. The modification can then be made.

- **Serial Number (M61)**

MaxiFlo MU-WA Ver 15.66
S/N = 35800003

Displays the 8-digit serial number of the instrument. This SN is the only one assigned to each MU series flowmeter ready to leave the factory. The factory uses it for files setup and for management by the user.

- **Serial Port Setup (M62)**

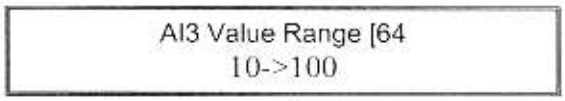


To set RS232 port property. The first information is bit rate and can be 110, 150, 300, 600, 1200, 240, 4800 or 9600. The second information is parity and can be either None, Even or Odd.

- **Comm Protocol Select (M63)**

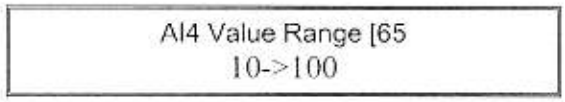
Select communication protocol. Factory default is 'MODBUS ASCII+TDS7'. This is a mode for MODBUS-ASCII, Meter-BUS, MaxiFlo/Fuji Extended Protocol and competitor's protocols. If you are going using MODBUS-RTU you have to select 'MODBUS_RTU'.

- **AI3 Range (M64)**



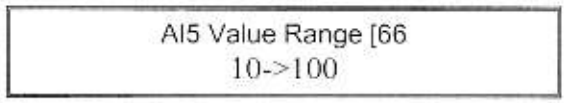
To input scale range of temperature, pressure or level for the analog input of 4-20mA. For example, the value 10 in the above box represents 4mA and 100 20mA.

- **AI4 Range (M65)**



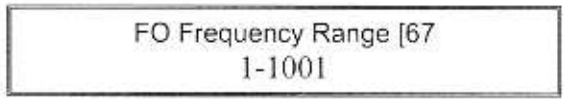
To input scale range of temperature, pressure or level for the analog input of 4-20mA. For example, the value 10 in the above box represents 4mA and 100 20mA.

- **AI5 Range (M66)**



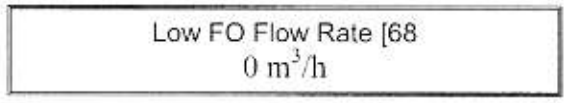
To input scale range of temperature, pressure or level for the analog input of 4-20mA. For example, the value 10 in the above box represents 4mA and 100 20mA.

- **Frequency Output Signal Frequency Range (M67)**



Windows to setup the frequency range (lower and upper limit) for the frequency output function. Valid range is 0Hz-9999Hz. Factory default value is 0-1000 Hz. Please remember to order the module if you need frequency output function, otherwise you will get a flow meter, which has no frequency output circuits.

- **Flow Value of Low Frequency Output (M68)**



To input flow rate value for the low frequency point.

- **Flow Value of High Frequency Output (M69)**

High FO Flow Rate [69
0 m^3/h

To input flow rate value for the high frequency point.

- **LCD Back Light Controller (M70)**

LCD Backlit Option [70
1. Always On

LCD can be controlled using this window. "Always On" means the back light will be always on. "Always Off" means always off. "Light for nn" means it will turn on when a key is pressed and will stay on for nn seconds after the keys have been pressed. This option is provided for power saving.

- **LCD Contrast Controller (M71)**

LCD Contrast [71
9

To control the LCD contrast. Press ENT and adjust the number using up or down keys, and press ENT again to confirm.

- **Working Timer (M72)**

Working Timer [72
0000054:34:23

Display the totalized working hours of the unit since last reset. It is displayed by HH:MM:SS. If it is necessary to reset it, press ENT and select "YES".

- **#1 Alarm Low Value (M73)**

Alarm #1 Low Value [73
0 m^3/h

Input the low value of alarm. When the value falls under this value, it will cause the alarm to be output using hardware OCT or relay as set in M78 and M79.

- **#1 Alarm High Value (M74)**

Alarm #1 High Value [74
1600 m^3/h

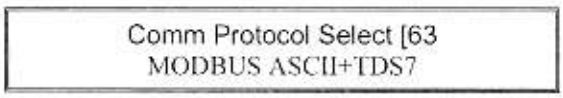
Input the high value of alarm. When the value exceeds this value, it will cause the alarm to be output using hardware OCT or relay as set in M78 and M79.

- **#2 Alarm Low Value (M75)**

Alarm #2 Low Value [75

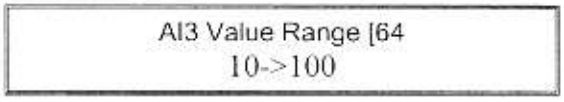
To set RS232 port property. The first information is bit rate and can be 110, 150, 300, 600, 1200, 240, 4800 or 9600. The second information is parity and can be either None, Even or Odd.

- **Comm Protocol Select (M63)**



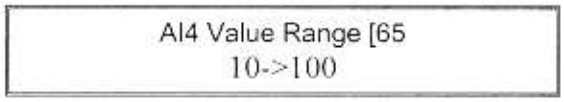
Select communication protocol. Factory default is 'MODBUS ASCII+TDS7'. This is a mode for MODBUS-ASCII, Meter-BUS, MaxiFlo/Fuji Extended Protocol and competitor's protocols. If you are going using MODBUS-RTU you have to select 'MODBUS_RTU'.

- **AI3 Range (M64)**



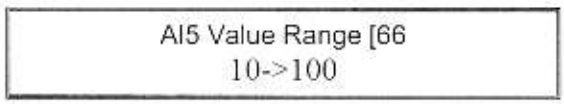
To input scale range of temperature, pressure or level for the analog input of 4-20mA. For example, the value 10 in the above box represents 4mA and 100 20mA.

- **AI4 Range (M65)**



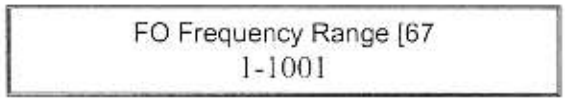
To input scale range of temperature, pressure or level for the analog input of 4-20mA. For example, the value 10 in the above box represents 4mA and 100 20mA.

- **AI5 Range (M66)**



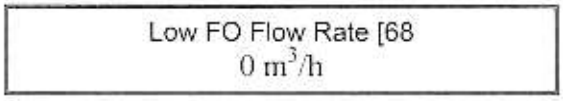
To input scale range of temperature, pressure or level for the analog input of 4-20mA. For example, the value 10 in the above box represents 4mA and 100 20mA.

- **Frequency Output Signal Frequency Range (M67)**



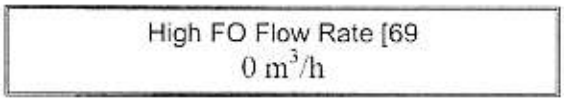
Windows to setup the frequency range (lower and upper limit) for the frequency output function. Valid range is 0Hz-9999Hz. Factory default value is 0-1000 Hz. Please remember to order the module if you need frequency output function, otherwise you will get a flow meter, which has no frequency output circuits.

- **Flow Value of Low Frequency Output (M68)**



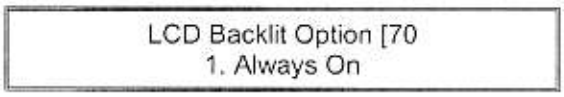
To input flow rate value for the low frequency point.

- **Flow Value of High Frequency Output (M69)**



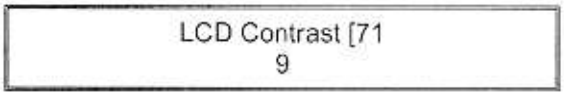
To input flow rate value for the high frequency point.

- **LCD Back Light Controller (M70)**



LCD can be controlled using this window. "Always On" means the back light will be always on. "Always Off" means always off. "Light for nn" means it will turn on when a key is pressed and will stay on for nn seconds after the keys have been pressed. This option is provided for power saving.

- **LCD Contrast Controller (M71)**

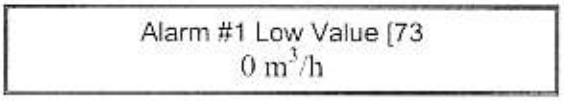


To control the LCD contrast. Press ENT and adjust the number using up or down keys, and press ENT again to confirm.

- **Working Timer (M72)**

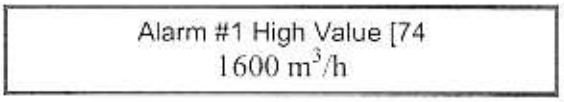
Display the totalized working hours of the unit since last reset. It is displayed by HH:MM:SS. If it is necessary to reset it, press ENT and select "YES".

- **#1 Alarm Low Value (M73)**



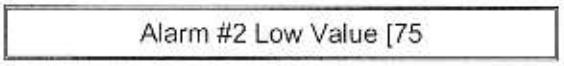
Input the low value of alarm. When the value falls under this value, it will cause the alarm to be output using hardware OCT or relay as set in M78 and M79.

- **#1 Alarm High Value (M74)**



Input the high value of alarm. When the value exceeds this value, it will cause the alarm to be output using hardware OCT or relay as set in M78 and M79.

- **#2 Alarm Low Value (M75)**



0 m^3/h

Input the low value of alarm. When the value falls under this value, it will cause the alarm to be output using hardware OCT or relay as set in M78 and M79.

- **#2 Alarm High Value (M76)**

Alarm #2 High Value [76 1600 m^3/h

Input the high value of alarm. When the value exceeds this value, it will cause the alarm to be output using hardware OCT or relay as set in M78 and M79.

- **Beeper Setup (M77)**

Beeper Setup [77 15. Key Stroking On

The following sources can be selected to set off the beeper;

MU-WA		MU-HA	
0. No Signal	13. Energy NEG Totalizer	0. No Signal	10. NEG into Pulse
1. Poor Signal	14. Energy NET Totalizer	1. Poor Signal	11. NET into Pulse
2. Not Ready(No*R)	15. MediaVel => Threshold	2. Not Ready(No*R)	12. Energy Pulse
3. Reverse Flow	16. MediaVel < Threshold	3. Reverse Flow	13. On/Off via RS232
4. AO over 100%	17. ON/OFF Via RS485	4. AO over 100%	14. Fluid Changed
5. FO over 120%	18. Timer (M51 Daily)	5. FO over 120%	15. Key Stroking On
6. Alarm #1	19. Timed Alarm #1	6. Alarm #1	16. Not Using
7. Reverse Alarm #2	20. Timed Alarm #2	7. Alarm #2	
8. Batch Controller	21. Batch Total Full	8. Batch Control	
9. POS Totalizer	22. Timer by M51	9. POS into Pulse	
10. NEG Totalizer	23. Batch 90% Full		
11. NET Totalizer	24. Key Stroking on		
12. Energy POS Totalizer	25. Disable Beeper		

- **OCT Output Setup (M78)**

OCT Output Setup [78 17. Not Using

Set the system to put hardware OCT output when one of the following sources occurs;

MU-WA		MU-HA	
0. No Signal	13. Energy NEG Totalizer	0. No Signal	10. NEG into Pulse
1. Poor Signal	14. Energy NET Totalizer	1. Poor Signal	11. NET into Pulse
2. Not Ready(No*R)	15. MediaVel => Threshold	2. Not Ready(No*R)	12. Energy Pulse

	Threshold		
3. Reverse Flow	16. MediaVel < Threshold	3. Reverse Flow	13. On/Off via RS232
4. AO over 100%	17. ON/OFF Via RS485	4. AO over 100%	14. Fluid Changed
5. FO over 120%	18. Timer (M51 Daily)	5. FO over 120%	15. Key Stroking On
6. Alarm #1	19. Timed Alarm #1	6. Alarm #1	16. Not Using
7. Reverse Alarm #2	20. Timed Alarm #2	7. Alarm #2	
8. Batch Controller	21. Batch Total Full	8. Batch Control	
9. POS Totalizer	22. Timer by M51	9. POS into Pulse	
10. NEG Totalizer	23. Batch 90% Full		
11. NET Totalizer	24. Flow Rate Pulse		
12. Energy POS Totalizer	25. Disable OCT		

The OCT circuit does not source voltage at its output. It must be connected with an external power and pull-up resistor for some occasions. When the OCT circuit closes, it will draw current. The maximum current shall not be over 100mA.

Attention: the maximum voltage applied to OCT cannot be over 80 volts.

- **Relay Output Setup (M79)**

Relay Output Setup [79
15. Not Using

Set the system to put Relay output when one of the following sources occurs;

0. No Signal	13. Energy NEG Totalizer
1. Poor Signal	14. Energy NET Totalizer
2. Not Ready (No*R)	15. MediaVel > Threshold
3. Reverse Flow	16. MediaVel < Threshold
4. AO over 100%	17. ON/OFF Via RS232
5. FO over 120%	18. Disable Relay
6. Alarm #1	19. Timed Alarm #1
7. Reverse Alarm #2	20. Timed Alarm #2
8. Batch Controlller	21. Batch Total Full
9. POS Totalizer	22. Timer by M51
10. NEG Totalizer	23. Batch 90% Full
11. NET Totalizer	24. Disable Relay
12. Energy POS Totalizer	

The RELAY is of SPST (Single pole, single throw) Normally Open (NO) type. It is rated for 125VAC 1A and 30VDC 2A. It is highly recommended that a slave relay to be utilized whenever a large resistive load or inductive load is to be controlled.

- **Batch Trigger Select (M80)**

Flow Batch CTRL in

0. Key Input

Select the batch control type. Available options are as follows;

0. Key Pressing	5. AI4 Falling Edge
1. Serial Port	6. AI5 Rising Edge
2. AI3 Rising Edge	7. AI5 Falling Edge
3. AI3 Falling Edge	8. Timer-Periodical
4. AI4 Rising Edge	9. Timer-Daily

For the input analog current signal, 0 mA indicates "0", 4mA or more indicates "1".

- **Flow Batch Controller (M81)**

Flow Batch Controller 10000 x $1m^3$

The built-in batch controller to set the flow batch value (dose).

The internal output of the batch controller can be directed either to the OCT or the RELAY output circuits. M81 and M80 should be used together to configure the batch controller.

Note: Because the measuring period is 500mS, the flow for every dose should be keeping at 60 seconds long to get a 1% dose accuracy.

- **Date Totalizer (M82)**

Date Totalizer [82 0. Day

In this window, it is possible to review the historical flow data totalizer for any day for the last 64 days, any month for last 64 months and any year for last 5 years. Press ENT, use UP or DOWN key to review totalizer in days, months and years. Use UP or DOWN key to review the flow total for a specific day, month or year.
For instance, to display the flow total for May 17, 2005, the display "----------" at the upper right corner of the screen indicates that it was working properly the whole day. On the contrary, if "G" is displayed, it indicates that the instrument gain was adjusted at least once. Probably it was offline once on that day. If "H" is displayed, it indicates that poor signal was detected at least once. Also, it indicates that the operation was interrupted or problems occurred in the installation.

For details, please refer to Chapter 5 – Error Diagnoses

0. Day
1. Month
2. Year

- **Automatic Amending (M83)**

Automatic Amending ON

With the function of automatic flow correction, the flow lost in an offline session can be estimated and automatically adjusted. The estimate is based on the average value, which is obtained from flow rate before going offline and

flow measured after going online the next time, multiplied times the time period that the meter was offline. Select "No" to cancel this function.

- **Energy Unit Selection (M84)**

Energy Unit Select [84
0. Giga Joule(GJ)

Select GJ, KC, KWh or BTU as energy unit. The default is GJ.

- **Energy Temperature Source Selection (M85)**

Temperature Select
0. From T1, T2

Select the sources for temperature signals when measuring energy. You usually use 0. From T1 and T2 PT-100 ohm sensors. But you can also use 1. From AI1, AI2 when you have other types of 4-20mA output temperature transmitters.

- **Specific Heat (M86)**

Specific Heat Select
0.0041868 GJ/m^{3o}C

Select the Specific Heat Value. Factory default is 'GB'. Under this setting, the flow meter will calculate the enthalpy of water based on the international standard. If the fluid is other than water, you should select option '1. Fixed Specific Heat', and enter the specific heat value of the fluid.

- **Energy Totalizer Switch (M87)**

Energy Totalizer ON/OFF
ON

Turn on/off the energy totalizing function.

- **Energy Totalize Multiplier (M88)**

Energy Multiplier [88
4. xl

Select the energy totalize multiplier. 10^{-4} – 10^{6}(E-4 – E-6)

- **Temperature Difference (M89)**

Temperature Diff. [89
3.0000 C

1. Display the temperature difference. 2. Window for entering the lowest temperature difference.

- **Heat Meter is On (M8.)**

Heat Meter is On [8.

1. Inlet

Displays the location of the sensors when used as heat meter.

(5) Diagnostics Menus

- **Signal Strength and Signal Quality (M90)**

Strength+Quality [90 UP:00.0 DN:00.0 Q=00

Display signal strengths S (one for upstream and one for downstream), and signal quality Q value. Signal strength is presented by 00.0 to 99.9, the bigger the value, the bigger the signal strength will be, and more reliable readings will be made. Q value is presented by 00 to 99, the bigger the better. It should at least be great than 50 for normal operations.

- **TOM/TOS*100 (M91)**

TOM/TOS*100 [91 0.0000

Display the ratio between the actual measured transmit time and the calculated transmit time according to customer's requirement. Normally the ratio should be 100±3%. If the difference is too large, the user should check if the parameters are entered correctly, especially the sound velocity of the fluid and the installation of the transducers. **This data is of no use before the system is ready.**

- **Fluid Sound Velocity (M92)**

Fluid Sound Velocity 0.0000 m/s

Displays the estimated fluid sound velocity. If this value has an obvious difference with the actual fluid sound speed, pipe parameters entered and the transducer installation should be checked again.

- **Total Time and Delta Time (M93)**

Total Time, Delta Time 8.9149uS, -171.09nS

Display the measured ultrasonic average time(unit: μS) and delta time of the upstream and downstream(unit: nS) time. The velocity calculation in MU ultrasonic flowmeter is based on the two readings; especially the delta time will best indicate if the instrument is running steadily. Normally the fluctuation in the ration of the delta time should be lower than 20%; Otherwise, the system may not run steadily. It is, then, necessary to check if the transducers are installed properly or if the parameters have been entered correctly.

- **Reynolds No, Profile (M94)**

Reynolds No, Profile [94 0.0000 1.0000

Displays the Reynolds number and the pipe factor used by the flow rate measurement program. Pipe factor is calculated based on the ratio of the line-average velocity and the cross-section average velocity.

(6) Print Menus (for MU-PO only)

(M96, M97, M98, M99

Press [MENU] [9] [6].	Feed the paper into the printer. Press any key to stop feeding. Refer to M53 for setting up the scroll space.
Press [MENU] [9] [7].	Prints the following working parameters as set by the user at the initial set up;

- Outer Diameter
- Wall Thickness
- Inner Diameter
- Pipe Material
- Liner Material
- Fluid Type
- Sensor Type
- Sensor Mounting Type
- Sensor Spacing

Press [MENU] [9] [8].	Prints diagnostic data.
Press [MENU] [9] [9].	Prints contents of the current window. If "YES" is selected in M52, this will be printed to RS232. Select "NO", to print it to the printer.

(7) Miscellaneous Menus

- **Power On/Off Time [MENU] + 0**

Power On/Off Time M+0 Press ENT when ready

To view the power on/off time and flow rate for the last 64 update times to obtain the offline time period and the corresponding flow rate. Enter the window, press ENT to display the last update before the last 64 times of on/off time and flow rate values. "ON" on right hand indicates that time power is on; "00" on the upper left corner indicates "00-07-18 12:40:12" the date time; flow rate is displayed in the lower right corner.

- **Total Working Hours [MENU] + 1**

Total Work Hours [+1] 00000115:12:08

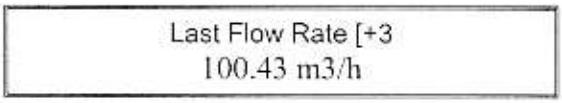
With this function, it is possible to view the total working hours since the flowmeter left the factory. The figure in the above indicates that the total working hours since the flowmeter left the factory is 115 hours 12 minutes and 8 seconds.

- **Last Power Off Time [MENU] + 2**

Last Power Off Time 04-07-12 10:12:02

Display the last power off time.

- **Last Flow Rate [MENU] + 3**

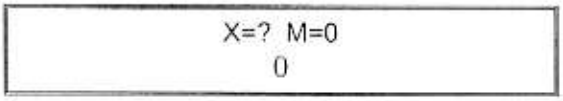


Displays the last flow rate.

- **ON/OFF Times [MENU] + 4**

Displays how many times of has been powered on and powered off.

- **Calculator [MENU] + 5**



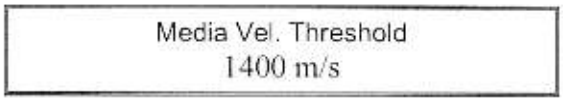
This window is a calculator which has the ability of functional operation. How to use: Input the first parameter X, then select an operator. If this operation has a second parameter, then input the second parameter Y and put the result of the operation in X. For example,

To calculate 1+2, press [MENU] [+] [5] [1] [ENT]. After selecting "+" operator by using [UP/+] key, press [ENT] [2] [ENT].

This calculator also has register function, which can be selected by operator selection.

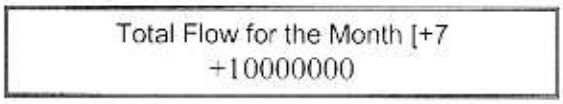
Note: The calculator can be used even when the meter is operating. The measurement result of the meter will not be affected by the calculation.

- **Media Vel. Threshold [MENU] + 6**



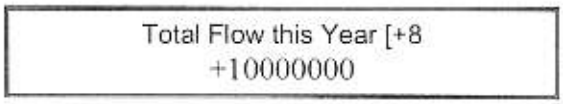
Set fluid sound speed threshold. Whenever the estimated sound speed (displayed in M92) exceeds this threshold, an alarms signal will be generated and can transmitted to BUZZER or OCT or RELAY. This function can used to produce an alarm or output when fluid material changes.

- **Total Flow for the Month [MENU] + 7**



Displays total flow for this month(only for the time past).

- **Total Flow this Year [MENU] + 8**



Displays total flow for this year (only for the time past).

- **No Ready Timer [MENU] + 9**

No Ready Timer [+9
00000644:21:19

Display the not-working total time in seconds. The total failure timer will also include the time when power off, if the back-up battery is applied.

IV. Trouble Shooting

With highly reliable design, the MU series ultrasonic flowmeter has a low failure rate. However, problems may occur as a result of unskillful handling, setting errors or working in an extremely undesirable working condition. For this reason, the meter is equipped with a self-diagnostic function. Problems detected are displayed in time order in code form on the upper right corner of the LCD screen. Hardware malfunctions, though generally checked after power is on, can also be detected(part of them) while the device is working normally. Information about "stop working" problems caused by wrong settings or undesirable working conditions can also be displayed, so users can locate the problems quickly and solve the problems according to the solutions offered in the following two tables in time.

There are two kinds of error displayed in MU series:

- Error messages are displayed during self-test after the power is switched on. After entering the measurement mode, if there is an error, "*F" will be displayed at the top right corner of the screen. Check the information being displayed and take specific steps according to the following tables. If problems persist, contact your MU distributor.

- Errors about the specific signal received or wrong settings can be displayed by the M08 window in error code formats. Errors and countermeasures are listed in the following tables;

Power-On self-test information, Causes and Solutions

LCD Display	Causes	Solution
ROM Parity Error	System ROM illegal or in error	Contact the manufacturer.
Stored Data Error	Stored Data Error	Restart the instrument or contact the manufacturer.
Handshaking Error	Hardware handle wrong, system will reset.	Restart.
SCPU Fatal Error	Fatal error in sub CPU circuit	Restart or contact the manufacturer.
Timer Slow Error Timer Fast Error	System clock is wrong.	Contact the manufacturer.
CPU or Interruption error, retry	Main CPU is wrong.	Restart
System RAM Error	System RAM has problems.	Restart or contact the manufacturer.
Time or Batt Error	System time chip error	Restart or contact the manufacturer.
When pressing the keys, no response from screen, no display or disorderly display	Wrong operation, poor cable contact on the panel	Soft Reset. Check whether the cables on the panel are contacted well.
PRN Time Over	Printer wrong or wrong connection.	Examine printer or cable.

Error Code Causes and Solutions

Code	Corresponding display on M08	Causes	Solution
*R	System Normal	System operates normally.	Contact the manufacturer.
*J	SCPU Fatal Error	Hardware failure	Contact the manufacturer.
*I	Signal Not Detected	* No signal received	* Make sure the sensor is close to the pipe. Use sufficient couplant.
		* A poor contact between sensor and the pipe, or too little couplant applied.	* Make sure no rust, stain, no oil paint on the pipe surface. Use flat file clean to clean the pipe surface.
		* The sensor has not been installed properly.	* Check the original settings.
		* Too much scale formation in the inside wall.	* You can clean the couplant or change the pipe. But under normal conditions, you can try to change the measuring point.
		* New Liner	* Wait until the liner is saturated and solidified.
*H	Low Signal Strength Poor Signal Quality	* Poor Signal Quality * The above mentioned causes are applicable here, too.	* The same as above column
*E	Current loop over 20mA (Ignore it if the measuring process don't use current output)	* 4-20mA current loop overflow over 120% * Wrong current loop output settings	* Recheck the settings(see M58 in the manual) or make sure the actual flow is not too big.
*F	See above Table	* Self-checking error	* Restart the device and observe the information displayed on the screen. If the problem persists, contact the company
		* Perpetual hardware failure	* Contact the company.

*G	Adjusting Gain=>S1 Adjusting Gain=>S2 Adjusting Gain=>S3 Adjusting Gain=>S4 (Displayed in M00, M01, M02, M03 windows)	* These all 4 steps means that the machine is going through the gain adjustment process, preparing for the normal measurement. If the machine stops on S1 or S2, or shifts between S1 and S2, it means that the received signal is too low or the waveform is not so good. The reasons may include all the above-mentioned causes.	
*K	Empty pipe, M29 menu settings	No liquid in the pipe or wrong settings	If there is liquid in the pipe, input "0" in the M29 menu.

V. Communication Protocol

The MU series ultrasonic flow meter integrates a standard RS-232C communication interface and a complete set of communication protocols that are compatible with that of the Fuji's ultrasonic flow meter.

1. Interface Pin-out Definition

Pin	1	for battery recharge, positive input
	2	RXD
	3	TXD
	4	not used
	5	GND
	6	OCT output
	7	not used
	8	for battery recharge, negative input
	9	RING input for connecting a MODEM

2. Communication Protocol

The protocol is comprised of a set of basic commands that is a string in ASCII format, ending with a carriage (CR) and line feed (LF). Commonly used commands are listed in the following table.

Command	Function	Data Format
DQD(CR)	Return flow rate per day	±d.dddddE±dd(CR) (LF) *
DQH(CR)	Return flow rate per hour	±d.dddddE±dd(CR) (LF)
DQM(CR)	Return flow rate per minute	±d.dddddE±dd(CR) (LF)
DQS(CR)	Return flow rate per second	±d.dddddE±dd(CR) (LF)
DV(CR)	Return flow velocity	±d.dddddE±dd(CR) (LF)
DI+(CR)	Return POS totalizer	±ddddddE±d(CR) (LF) **
DI-(CR)	Return NEG totalizer	±ddddddE±d(CR) (LF)
DIN(CR)	Return NET totalizer	±ddddddE±d(CR) (LF)
DID(CR)	Return Identification Number	ddddd(CR) (LF)
DL(CR)	Return signal strength and quality	S=ddd,ddd Q=dd (CR)(LF)
DT(CR)	Return date and time	yy-mm-dd hh:mm:ss(CR)(LF)
M@(CR)***	Send a key value as if a key is pressed	
LCD(CR)	Return the current window display	
FOdddd(CR)	Force the FO output with a frequency in dddd Hz	
ESN(CR)	Return the ESN for the instrument	Dddddddd(CR)(LF)
RING(CR)	Handshaking Request by a MODEM	
OK(CR)	Response from a MODEM	No action

GA	Command for GSM messaging	Please contact factory for detail
GB	Command for GSM messaging	
GC	Command for GSM messaging	
DUMP(CR)	Return the buffer content	In ASCII string format
DUMP0(CR)	Clear the whole buffer	In ASCII string format
DUMP1(CR)	Return the whole buffer content	In ASCII string Format, 24KB in length
W	Prefix before an Identification Number in a network environment. The IDN is a word, ranging 0-65534.	
N	Prefix before an Identification Number in a network environment. The IDN is a single byte value, ranging 00-255.	
P	Prefix before any command	
&	Command connector to make a longer command by combining up to 6 commands	

Notes * CR stands for Carriage Return and LF for Line Feed.
** 'd' stands for the 0~9 digit numbers.
*** @ stands for the key value, e.g., 30H for the '0' key.

3. Protocol Prefix Usage

(1) Prefix P

The prefix P can be added before any command in the above table to have the returning data followed with two bytes of CRC check sum, which is the adding sum of the original character string.

Take the DI+(CR) command as an example. Assume that DI+(CR) would return +1234567E+0m3(CR)(LF) (the string in hexadecimal is 2BH, 31H, 32H, 33H, 34H, 35H, 36H, 37H, 45H, 2BH, 30H, 6DH, 33H, 20H, 0DH, 0AH), then PDI(CR) would return +1234567E+0m3!F7(CR)(LF). '!' acts as the starter of check sum which is yielded by adding up the string 2BH, 31H, 32H, 33H, 34H, 35H, 36H, 37H, 45H, 2BH, 30H, 6DH, 33H, 20H.

Please note that there will be SPACES (20H) before '!'.

(2) Prefix W

The prefix W should be used in the network environment. The usage format is W + digit string which stands for the IDN + basic command. The digit string should have a value between 0 and 65534 except 13(0DH), 10 (0AH), 42(2AH,*), 38(26H, &). For example, if the IDN=12345 instrument is addressed and returning the velocity of that instrument is requested, the command will be W12345DV(CR).

(3) Prefix N

The prefix N is a single byte IDN network prefix, not recommended in a new design. It is reserved only for the purpose of the compatibility with the former versions

(4) Command Connector &

The & command connector can connect up to 6 basic commands to form a longer command so that it will make the programming much easier. For example, assume that the measurement of an instrument with IDN=4321 are going

to be returned, and (then) all the following 3 values--- (1) flow rate (2) velocity (3)POS totalizer---will be returned simultaneously. The combined command would be W4321DQD&DV&DI+(CR), and the result would be:
+1.234567E+12m3/d(CR)
+3.1235926E+00m/s(CR)
+1234567E+0m3(CR)

4. Codes for the Keypad

The codes for the keypad should be used when the instrument is connected with other terminals that operate the instrument by transmitting the 'M' command along with the keypad code. By this function, remote operation of this instrument can be realized, even via the Internet.

Key	Hexadecimal	Decimal	ASCII
0	30H	48	0
1	31H	49	1
2	32H	50	2
3	33H	51	3
4	34H	52	4
5	35H	53	5
6	36H	54	6
7	37H	55	7

Key	Hexadecimal	Decimal	ASCII
8	38H	56	8
9	39H	57	9
.	3AH	58	:
◀	3BH, 0BH	59	;
MENU	3CH,0CH	60	<
ENT	3DH,0DH	61	=
▲/+	3EH	62	>
▼/-	3FH	63	?