Handheld
Ultrasonic Flowmeter

User Manual

MC CE ISO9001

Contents

1. Introduction

§1.1 Preface

Welcome to the handheld ultrasonic flowmeter that has been manufactured with patent technologies and is equipped with more functions and advanced performance than our previous versions.

The ultrasonic flowmeter has been upgraded based on the previous ultrasonic flowmeter which is still the main product line of the company. The new Version retains most of the excellent features and functions of the previous versions: the pulse measurement technology, the ultrasonic igniting and the small signal receiving circuits etc. The main improvements are made on the battery supply circuit and on the transmitting circuits. All other circuits are simply integrated into this new version without major modifications, due to the fact that we have already applied the most advanced measurement technologies and attained a more reliable model of ultrasonic flow meter.

Handheld flowmeter incorporates the latest ICs manufactured from the famous semiconductor manufacturers like Philips, Maxim, TI, Winbond, and Xilinx. The hardware features the ease of operation, high accuracy and outstanding reliability, while the software provides a very friendly user interface and much more functions. It employs a patent balanced lower voltage multi-pulse igniting circuit which increases the anti-interference ability magnificently so that the flow meter will work properly even in demanding industrial environments such as those with power frequency transverter working nearby.

Other outstanding features:

----the signal receiving circuits feature self-adapting performance so as to ensure that the user can easily operate the instrument without any adjustment.

----the built-in rechargeable Ni-H battery can work continuously for more than 12 hours without recharging.

The advanced circuit design, the integration of the latest semiconductors, the user-friendly software interface both in English and Chinese languages and small-sized PCB board, all these features combine to make the handheld ultrasonic flowmeter the best and the biggest seller on the Chinese market. Moreover, it is gaining more and more recognition on the international flow meter market

§1.2 Main Features

* Large-screen LCD
* Built-in data-logger
* High accuracy measuring
* Non-contacting measuring
* Built-in rechargeable battery
* Wide measuring range

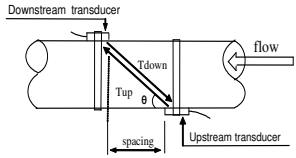
* Small and light
* RS-232 serial interface

§1.3 Principle of Measurement

The handheld ultrasonic flowmeter is designed to measure the fluid velocity of liquid within a closed conduit. The transducers are a non-contacting, clamp-on type, which will provide benefits of non-fouling operation and easy installation.

The transit time flowmeter utilizes two transducers that function as both ultrasonic transmitters and receivers. The transducers are clamped on the outside of a closed pipe at a specific distance from each other. The transducers can be mounted in V-method where the sound transverses the pipe twice, or W-method where the sound transverses the pipe four times, or in Z-method where the transducers are mounted on opposite sides of the pipe and the sound crosses the pipe once. This selection of the mounting method depends on pipe and liquid characteristics. The flow meter operates by alternately transmitting and receiving a frequency modulated burst of sound energy between the two transducers and measuring the transit time that it takes for sound to travel between the two transducers. The difference in the transit time measured is directly and exactly related to the velocity of the liquid in the pipe, show as follows:

$$V = \frac{MD}{\sin 2\theta} \times \frac{\Delta T}{T_{up} \bullet T_{down}}$$



θ is the include angle to the flow direction
M is the travel times of the ultrasonic beam
D is the pipe diameter
Tup is the time for the beam from upstream transducer to the downstream one
Tdown is the time for the beam from downstream transducer to the upstream one
ΔT=Tup –Tdown

§1.4 Front view

§1.5 Typical Applications

The handheld flowmeter can be virtually applied to a wide range of measurements. A variety of liquid applications can be accommodated: ultra-pure liquids, potable water, chemicals, raw sewage, reclaimed water, cooling water, river water, plant effluent, etc. Because the instrument and transducers are non-contacting and have no moving parts, the flow meter can not be affected by system pressure, fouling or wear. Standard transducers are rated to 110 ℃. Higher temperatures can be accommodated. For further information, please consult the manufacturer for assistance.

§1.6 Data Integrity and Built-in Time-Keeper

All user-inputted configuration values are retained in the built-in non-volatile flash memory that can store them for over 100 years, even if power is lost or turned off. Password protection is provided to avoid inadvertent configuration changes or totalizer resets.

A time-keeper is integrated in the flow meter for the index of date totalizing and works as the time base of flow accumulation. It keeps operating as long as the battery's terminal voltage is over 1.5V. In case of battery failure, the time-keeper will not keep running and it will lose proper time values. The user must re-enter proper time values in case the battery becomes totally exhausted. An improper time value affects no other functions but the date totalizer.

§1.7 Product Identification

Each set of the flowmeter has a unique product identification or ESN written into the software that can only be modified with a special tool by the manufacturer. In case of any hardware failure, please provide this number which is located on menu window number M61 when contacting the manufacture.

§1.8 Specifications

Linearity	**0.5%**
Repeatability	**0.2%**
Accuracy	**±1% of reading at rates>0.2 mps**
Response Time	**0-999 seconds, user-configurable**
Velocity	**±32 m/s**
Pipe Size	**15mm-6000mm**
Totalizer	**7-digit totals for net, positive and negative flow respectively**
Liquid Types	**Virtually all liquids**
Security	**Setup values Modification Lockout. Access code needs unlocking**
Display	**4x8 Chinese characters or 4x16 English letters**
Communication Interface	**RS-232, baud-rate: from 75 to 57600. Protocol made by the manufacturer and compatible with that of the FUJI ultrasonic flow meter. User protocols can be made on enquiry.**
Transducer Cord Length	**Standard 5m x 2, optional 10m x 2**
Power Supply	**3 AAA built-in Ni-H batteries. When fully recharged it will last over 12 hours of operation. 100V-240VAC for the charger**
Data Logger	**Built-in data logger can store over 2000 lines of data**
Manual Totalizer	**7-digit press-key-to-go totalizer for calibration**
Housing Material	**ABS**
Case Size	**210x90x30mm**
Handset Weight	**500g with batteries**

2. Starting Measurement

§2.1 Built-in Battery

The instrument can operate either from the built-in Ni-H rechargeable battery, which will last over 12 hours of continuous operation when fully recharged, or from an external AC/power supply from the battery charger.

The battery charging circuits employ a scheme of constant-current and constant-voltage. It has a characteristic of fast charging at the beginning and very slow charging when the battery approaches to full recharge. Generally, when the green LED starts coming on, the battery would be nearly 95% recharged and when the red LED is off, the battery would be 98% recharged.

Since the charging current becomes tapered when the battery recharge is nearly completed, i.e. the charging current becomes smaller and smaller, therefore, there should be no over-recharging problem. That means the charging progress can last very long. The charger can be connected to the handset all the time when an around-the-clock measurement is required.

When fully recharged, the terminal voltage reaches around 4.25V. The terminal voltage is displayed on window M07. When the battery is nearly consumed, the battery voltage drops to below 3V. The user can obtain an approximate battery working time from the battery voltage.

A software battery working time estimator is integrated in this instrument based on the terminal voltage. Please note that the estimator may have relatively bigger errors in the estimated working time, especially when the voltage is in the range of around 3.70 to -3.90 volt.

§2.2 Power On

Press the [ON] key to switch on the instrument and press the [OFF] to turn off the power.

Once the flow meter is switched on, it will run a self diagnostic program, checking first the hardware and then the software integrity. If there is any abnormality, corresponding error messages will display.

Generally, there should be no display of error messages, and the flow meter will go to the most commonly used Menu Window Number 01 (short for M01) to display the Velocity, Flow Rate, Positive Totalizer, Signal Strength and Signal Quality, based on the pipe parameters configured last time by the user or by the initial program.

The flow measurement program always operates in the background of the user interface. This means the flow measurement will keep on running regardless of any user menu window browsing or viewing. Only when the user enters new pipe parameters will the flow meter change measurement to the new parameter changes.

When new pipe parameters have been entered or when the power has been just switched on, the flow meter will enter an adjusting mode to make the signals magnified with proper amplification. By this step, the flow meter is going to find the best threshold of receiving signal. The user will see the progress by the number 1, 2, or 3, which are indicated on the right lower corner of the LCD display.

When the transducers have been adjusted on the pipe by the user, the flow meter will re-adjust the signal automatically.

Any user-entered configuration value will be retained into the NVRAM of the flow meter, until it is modified by the user.

§2.3 Keypad

The keypad for the operation of the flow meter has 16+2 keys, as shown by the right picture.

Keys [0]~[9] and [.] are keys to enter numbers
Key [▲/+] is the going UP key, when the user wants to go to the upper menu window. It also works as the "+" key when entering numbers
Key [▼/-] is the going DOWN key, when the user wants to go down-sided menu window. It also works as the "–" key when entering numbers.
Key [◄] is backspace key, when the user wants go left or wants backspace the left character that is located to the left of the cursor.
Key [ENT] is the ENTER key for any inputting or selections.
Key [MENU] is the key for the direct menu window jump over. Whenever the user wants to proceed to a certain menu window, the user can press this key followed by 2-digit numbers.
The [MENU] key is shortened as the 'M' key afterward when referring to the menu windows.
The [ON] key is for the power on.
The [OFF] key is for the power off.

§2.4 Menu Windows

The user interface of this flow meter comprises about 100 different menu windows that are numbered by M00, M01, M02 … M99.

There are 2 methods to enter certain menu window:
(1) Direct going/entering. The user can press the [MENU] key followed by two-digit number keys. For example, the menu window M11 is for the entering of pipe outer diameter. The display will go to the M11 menu window after the user presses [MENU] [1] [1].
(2) Pressing [▲/+] and [▼/-] keys. Each time of the [▲/+] key pressing will proceed to the

lower-numbered menu window. For example, if the current window is on M12, the display will go to the number M11 window after pressing the ▲/+ key.

There are three different types of menu windows:
(1) Menu windows for number entering, like M11 for the entering of pipe outer diameter.
(2) Menu windows for option selection/selecting options, like M14 for the selection of pipe materials.
(3) Displaying windows only, like M00 to display Velocity, Flow Rate etc.

For number entering windows, the user can directly press the starting digit key when the user is going to modify the value. For example, when the current window is on M11, and the user is going to enter 219.2345 as the pipe outer diameter, the user can get the numbers entered by pressing the following serial keys: 2 1 9 . 2 3 4 5 ENT.

For the option selection windows, the user should first press the ENT key to a selection modification mode and then select the relevant options by pressing the ▲/+ and ▼/- keys or the digit keys to select the option with a number antecedent to the option. In the end, the ENT key must be pressed to make the selection. For example, with menu window M14 for the selection of pipe material selection, (the MENU 1 4 should be pressed first to enter this menu window if the current menu window is on a different window. The pipe material is stainless steel which has a number "1" antecedent to "stainless steel" on the display, the user should first press the ENT key to enter into a selection modification mode, then either make the selection by pressing the ▲/+ and ▼/- keys to make the cursor on the line that displays "1. Stainless Steel", or make the selection by pressing the 1 key directly.

Generally, the ENT key must be pressed to enter a modification mode. If the "Locked M47 Open' message is indicated on the lowest line of the LCD display, it means the modification operations is locked out. In such cases, the user should go to M47 to have the instrument unlocked first before any further modification can be made.

§2.5 Steps to Configure the Parameters

The following parameters need to be configured for a proper measurement:
(1) Pipe outer diameter
(2) Pipe wall thickness
(3) Pipe materials (for non-standard pipe materials*, the sound speed for the material must be configured too)
*Standard pipe materials and standard liquids refer to those with the sound parameters that have already been programmed into software of the flow meter, therefore there is no need to configure them
(4) Liner material and its sound speed and thickness, if there is any liner.
(5) Liquid type (for non-standard liquids, the sound speed of the liquid is also needed)
(6) Transducer type adapted to the flow meter. Generally the Standard M1 clamp-on transducers will be the selected option.

(7) Transducer mounting methods (the V-method or Z-method is the common option)
(8) Check up the Space displayed on M25 and install the transducers accordingly.

For standard pipe materials and standard liquids, the following detailed step-by-step setup is recommended.

(1) Press keys [MENU] [1] [1] to enter M11 window to input the digits for the pipe outer diameter, and then press [ENT] key.
(2) Press key [▼/-] to enter M12 window to input the digits for the pipe outer diameter and then press [ENT] key.
(3) Press key [▼/-] to enter M14 window, and press [ENT] key to enter the option selection mode. Use keys [▲/+] and [▼/-] to scroll up and down to the intended pipe material, and then press [ENT] key.
(4) Press key [▼/-] to enter M16 window, press [ENT] key to enter the option selection mode, use keys [▲/+] and [▼/-] to scroll up and down to the liner material, and then press [ENT] key. Select "No Liner", if there is no liner.
(5) Press key [▼/-] to enter M20 window, press [ENT] key to enter the option selection mode, use keys [▲/+] and [▼/-] to scroll up and down to the proper liquid, and then press [ENT] key.
(6) Press key [▼/-] to enter M23 window, press [ENT] key to enter the option selection mode, use keys [▲/+] and [▼/-] to scroll up and down to the proper transducer type, and then press [ENT] key.
(7) Press key [▼/-] to enter M24 window, press [ENT] key to enter the option selection mode, use keys [▲/+] and [▼/-] to scroll up and down to the proper transducer mounting method, and then press [ENT] key.
(8) Press key [▼/-] to enter M24 window to install the transducers on the pipe, and then press [ENT] key to go to M01 for the results.

The first-time users may need some time to get familiar with the operation. However, the user friendly interface of the instrument makes the operation quite easy and simple. Before long, the user will configure the instrument with very little key pressing, since the interface allows the user to go to the desired operation directly without any extra steps.

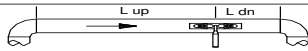
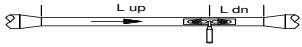
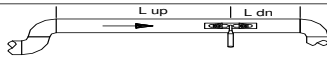
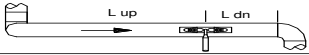
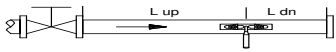
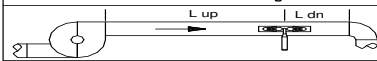
The following tips will facilitate the operation of this instrument.

(1) When the window display is between M00 to M09, press a number key [x], the user will go directly to the M0x window. For example, if the current window displays M01, press 7 and the user will go to M07.
(2) When the window display is under M00 to M09, press the ENT key and the user will go to M90; press ENT key to return. Press the dot key to go to M11
(3) When the window display is under M25, press ENT key to go to M01.

§2.6 Transducers Mounting Allocation

The first step in the installation process is the selection of an optimum location in order to obtain a more accurate measurement. For this to be completed effectively, a basic knowledge about the piping and its plumbing system would be advisable.

An optimum location would be defined as a straight pipe length full of liquid that is to be measured. The piping can be in vertical or horizontal position. The following table shows

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

Examples of optimum locations.

Principles to selection of an optimum location

(1) Install the transducers on a longer length of the straight pipe. The longer the better, and make sure that the pipe is completely full of liquid.

(2) Make sure that the temperature on the location does not exceed the range for the transducers. Generally speaking, the closer to the room temperature, the better.

(3) Take the pipe fouling into consideration. Select a straight length of a relatively newer pipe. If the condition is not satisfying, consider the fouling thickness as part of the liner for a better result.

(4) Some pipes have a kind of plastic liner, and between the outer pipe and the liner there may be a certain thickness difference that will prevent the ultrasonic waves from direct traveling. Such conditions will make the measurement very difficult. Whenever possible, try to avoid this kind of pipes. If impossible, try our plug-in transducers that are installed permanently on the pipe by drilling holes on the pipe while liquid is running inside.

§2.7 Transducers Installation

The transducers used by the TUF-2000 series ultrasonic flow meter are made of piezoelectric crystals both for transmitting and receiving ultrasonic signals through the wall of liquid piping system. The measurement is realized by measuring the traveling time difference of the ultrasonic

signals. Since the difference is very small, the spacing and the alignment of the transducers are critical factors to the accuracy of the measurement and the performance of the system. Meticulous care should be taken for the installation of the transducers.

Steps to the installation of the transducers

(1) Locate an optimum position where the straight pipe length is sufficient, and where pipes are in a favorable condition, e.g., newer pipes with no rust and ease of operation.

(2) Clean any dust and rust. For a better result, polishing the pipe with a sander is strongly recommended.

(3) Apply adequate coupler to the spot where the transducers are to be installed and leave no gap between the pipe surface and the transducers.

Extra care should be taken to avoid any sand or dust particles left between the pipe outer surface and the transducers.

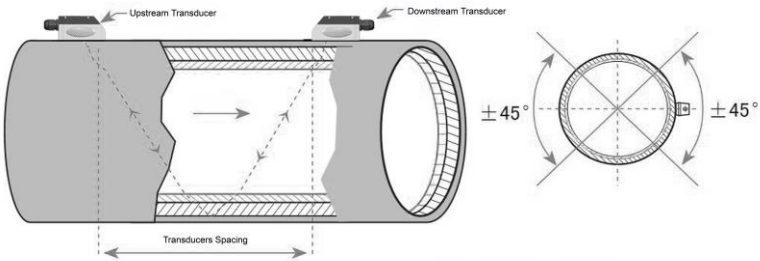
To avoid gas bubbles inside the upper part of the pipe, the transducers should be installed horizontally by the side of the pipe.

§2.7.1 Transducers Spacing

The spacing value shown on menu window M25 refers to the distance of inner spacing between the two transducers. The actual transducers spacing should be as close as possible to the spacing value.

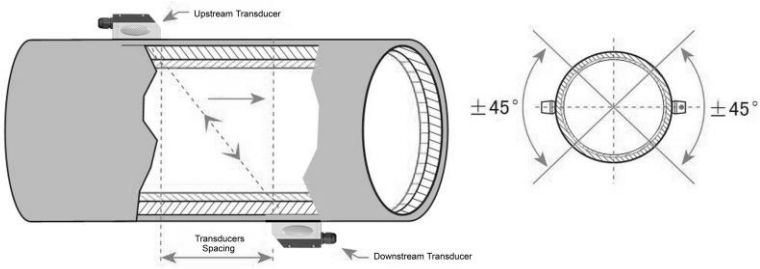
§2.7.2 V-method Installation

V-method installation is the most widely mode for daily measurement with pipe inner diameters ranging from 15 mm to 400 mm. It is also called reflective mode.



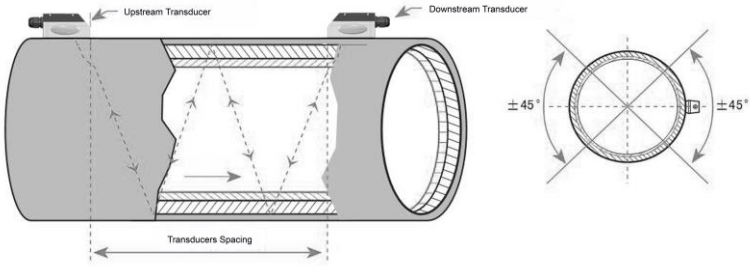
§2.7.3 Z-method Installation

Z-method is commonly used when the pipe diameter is above 200mm.



§2.7.4 W-method Installation

W-method is usually used on plastic pipes with a diameter from 15mm to 50mm.



§2.7.5 N-method Installation

Rarely used method.

§2.8 Installation Checkup

Through the checkup of the installation, one can: check the receiving signal strength, the signal quality Q value, the traveling time difference of the signals, the estimated liquid speed, the measured traveling time of the signals and the calculated traveling time ratio. Therefore, optimum measurement result and longer running time of the instrument can be achieved.

§2.8.1 Signal Strength

Signal strength indicates the amplitude of receiving ultrasonic signals by a 3-digit number. [00.0] means there is no signal detected and [99.9] refers to the maximum signal strength that can be received.

Although the instrument works well if the signal strength ranges from 50.0 to 99.9, stronger signal strength should be pursued, because a stronger signal means a better result. The following methods are recommended to obtain stronger signals:

(1) Relocate 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 70.0.
(2) Try to polish the outer surface of the pipe, and apply more coupler to increase the signal strength.
(3) 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.

§2.8.2 Signal Quality

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 60.0-99.0, the higher the better.

Causes for a lower Q value could be:

(1) Interference of other instruments and devices such as a powerful transverter working nearby. Try to relocate the flow meter to a new place where the interference can be reduced.
(2) Bad sonic coupling for the transducers with the pipe. Try to apply more coupler or clean the surface, etc.
(3) Pipes are difficult to be measured. Relocation is recommended.

§2.8.3 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.

§2.8.4 Time Ratio between the Measured Total Transit Time and the Calculated 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:

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

3. Menu Window Details

§3.1 Menu Windows Arrangement

M00~M09 windows for the display of the flow rate, velocity, date time, totalizers, battery voltage and estimated working hours for the battery.
M10~M29 windows for entering the pipe parameter.
M30~M38 windows for flow rate unit selections and totalizer unit selections.
M40~M49 windows for response time, zeroing, calibration and modification password setup.
M50~M53 windows for the built-in logger
M60-M78 windows for time-keeper initialization, version and ESN information viewing and alarms.
M82 window for viewing date totalizer.
M90~M94 are diagnostic windows for a more accurate measurement.
M97~M99 are not windows but commands for the outputting of display copying and pipe parameter setups.
M+0~M+8 are windows for some additional functions, including a scientific calculator, viewer on records such as total working hours, turn-on and turn-off times, dates and times when the flow meter has been turned on or turned off.
Other menu windows such as M88 have no functions, or functions were cancelled because they are not applied to this version of the software.

The major reason why the menu windows are arranged in this way is that the software programmer hopes that the menu window arrangement for this version can be compatibility with the previous versions of the flow meter software. This will make it easier for the former version users with this flow meter series.

§3.2 Menu Window Details

Menu No.	Function
M00	**Display three positive negative net totalizers, signal strength, signal quality and working status**
M01	**Display POS totalizer, flow rate, velocity, signal strength, signal quality and working status**
M02	**Display NEG totalizer, flow rate, velocity, signal strength, signal quality and working status**
M03	**Display NET totalizer, flow rate, velocity, signal strength, signal quality and working status**
M04	**Display date and time, flow rate, signal strength, signal quality and working status**
M05	**Display date and time, velocity, signal strength, signal quality and working status**

M06	**Display heat, net heat, and flow rate**
M07	**Display the battery terminal voltage and its estimated lasting time**
M08	**Display the current setting status code, signal strength, and signal quality**
M09	**Display today's total flow, velocity, signal strength, signal quality and working status**
M10	**Window for entering the outer perimeter of the pipe**
M11	**Window for entering the outer diameter of the pipe** **0 to 6000mm is the allowed range of the value.**
M12	**Window for entering pipe wall thickness**
M13	**Window for entering the inner diameter of the pipe**
M14	**Window for selecting pipe material** **Standard pipe materials (that the user need not know the speed) include:** **(0) carbon steel (1) stainless steel (2) cast iron (3) ductile iron (4) copper** **(5) PVC (6) aluminum (7) asbestos (8) fiberglass (9) others**
M15	**Window for entering the pipe material speed only for non-standard pipe materials**
M16	**Window for selecting the liner material** **Standard liner materials that the user need not know the speed include:** **(0)None (1) Tar Epoxy (2) Rubber (3) Mortar (4) Polypropylene(5) Polystryol** **(6)Polystyrene (7) Polyester (8) Polyethylene (9) Ebonite (10) Teflon（11）Others**
M17	**Window for entering the liner material speed only for non-standard liner materials**
M18	**Window for entering the liner thickness, if there is a liner**
M19	**Window for entering the ABS thickness of the inside wall of the pipe**
M20	**Window for selecting fluid type** **For standard liquids that the user need not know the liquid speed include:** **(0) Water (1) Sea Water (2) Kerosene (3) Gasoline** **(4) Fuel oil (5) Crude Oil (6) Propane at -45C** **(7) Butane at 0C (8)Other liquids (9) Diesel Oil (10)Caster Oil** **(11)Peanut Oil (12) #90 Gasoline (13) #93 Gasoline (14) Alcohol** **(15) Hot water at 125C (16) Others**
M21	**Window for entering the fluid sonic velocity only for non-standard liquids**
M22	**Window for entering the viscosity of the non-standard liquids**
M23	**Window for selecting the proper transducers** **There are 14 different types of transducers for selection.** **If the user-type-transducers are used, 4 user type wedge parameters, which will be prompted by the software, should be entered following.** **If the π type transducers are used, 3π type transducers and pipe parameters should be entered following.**
M24	**Window for selecting the transducer mounting methods** **Four methods can be selected:** **(0) Z-method (1) V-method (2) N-method (3) W-method**

M25	**Display the transducer mounting spacing**
M29	**Empty Pipe Setup**
M30	**Window for selecting unit system. Default value is 'Metric'. The change from English to Metric or vice versa will not affect the unit for totalizers.**
M31	**Window for selecting flow rate that will be used by the instrument afterward. Flow rate can be in** **0. Cubic meter short for (m3)** **1. Liter (l)** **2. USA gallon (gal)** **3. Imperial Gallon (igl)** **4. Million USA gallon (mgl)** **5. Cubic feet (cf)** **6. USA liquid barrel (bal)** **7. Imperial liquid barrel (ib)** **8. Oil barrel (ob)** **The flow unit in terms of time can be per day, per hour, per minute or per second. So there are 36 different flow rate units in total for selection.**
M32	**Select cumulative traffic unit**
M36	**Turn on or turn off the NEG totalizer**
M37	**(1) Totalizer reset** **(2) Restore the instrument to the default parameters as the manufacturer did by pressing the dot key followed by the backspace key. Take care or make note on the parameters before doing the restoration**
M39	**Operational interface language selection in Chinese and English. This selection makes it possible that more than 2 billions of people on the world can read the menu.**
M40	**Flow rate damper for a stable value. The input range is 0 to 999 seconds.** **0 means there is no damping. Default value is 10 seconds**
M41	**Lower flow rate cut-off to avoid invalid accumulation.**
M42	**Zero point setup under the condition when there is no liquid running inside the pipe.**
M43	**Clear the zero point set by the user, and restore the zero point set by the factory**
M44	**Set up a manual flow bias. Generally this value should be 0.**
M45	**Scale factor for the instrument. The default value is '1'.** **Keep this value as '1', when no user calibration has been made.**
M46	**Network environment Identification Number. Any integer can be entered except 13(0DH, carriage return), 10 (0AH, line feeding), 42 (2AH), 38, 65535.** **Every set of the instrument in a network environment should have a unique IDN. Please refer to the chapter for communication.**
M47	**System locker to avoid modification of the parameters**
M48	**Flow calib. data**
M49	**Network communication test window**

M50	**"Option" selection for the built-in logger. It also functions as the switch of logger**
M51	**Clear All Log**
M60	**Set date time**
M61	**Display Version information and Electronic Serial Number (ESN) that are unique for each TUF-2000 series flow meter. The users can employ the ESN for instrumentation management**
M62	**RS-232 setup. Baud rate can be 75 to 115200 bps**
M63	**Not used**
M64	**Not used**
M65	**Not used**
M66	**OCT Out Setup**
M67	**OCT Pulse Equi**
M68	**Enter a flow rate value that corresponds to lower frequency**
M69	**Enter a flow rate value that corresponds to higher frequency**
M70	**LCD display backlight control. The entered value indicates how many seconds the backlight will be on with every key pressing.**
M71	**LCD contrast control. The LCD will become darker when a small value is entered.**
M72	**LCD Contrastion**

M77	**Buzzer setup. If a proper input source is selected, the buzzer will beep when the trigger event occurs**
M82	**Date totalizer**
M86	**Pulse Number**
M87	**Noise Threshold**
M88	**Circuit operational amplifier status**
M89	**Echo signal amplitude**
M90	**Display signal strength, signal quality, time ratio on the upper right corner.**
M91	**Displays the Time Ratio between the Measured Total Transit Time and the Calculated time. If the pipe parameters are entered correctly and the transducers are properly installed, the ratio value should be in the range of 100± 3%. Otherwise the entered parameters and the transducer installation should be checked.**
M92	**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.**
M93	**Displays total transit time and delta time(transit time difference)**
M94	**Displays the Reynolds number and the pipe factor used by the flow rate program.**
M95	**Maximum fluid velocity**
M96	**Not used**

M+0	**Browse the 64 recorded instrument power-on and power-off date and time with the flow rate at the time of power on and off**
M+1	**Displays the total working time of the instrument**
M+4	**Displays the times of instrument powered on(the instrument has been powered on)**

M.1	**T1 T2 Cali OFF set**
M.2	**Factory Scale**
M.6	**Totalizer Reset**

4. How To

§4.1 How to judge if the instrument works properly

When 'R' is displayed in the lowest right corner of LCD display, the instrument is working properly, generally speaking.

If an 'H' flashes on that place, there could be poor signal received. Please refer to the chapters on diagnosis.

If an 'I' is displayed, it means that there is no signal detected.

If a 'J' is displayed, it means that the hardware of this instrument could be out of order. Refer to the chapter on diagnosis.

§4.2 How to judge the liquid flowing direction

(1) Make sure that the instrument works properly
(2) Check the flow rate for the indication. If the displayed value is POSITIVE, the direction of the flow will be from the RED transducers to the BLUE transducers; if the displayed value is NEGATIVE, the direction will be from the BLUE transducers to the RED transducers;

§4.3 How to change between units systems

Use menu window M30 for the selection of unit system in English or Metric system.

§4.4 How to select a required flow rate unit

Use menu window M31 to select the flow unit first and then the timing unit.

§4.5 How to open or shut the totalizers

Use M36 to turn on or turn off the NEG totalizer respectively.

§4.6 How to reset the totalizers

Use M37 to reset the proper totalizer.

§4.7 How to restore the flow meter with default setups

Use M37, when the 'selection' message is displayed. Press the dot key first and the message 'Master Erase' will display, then press the backspace key [◄]

The master erase step will erase all the parameters entered by the user and setup the instrument with default values.

§4.8 How to use the damper

The damper acts as a filter for a stable reading. If '0' is entered in window M40, that means there is no damping. A bigger number brings a more stable effect. But bigger damper numbers will prevent the instrument from acting quickly.

Numbers 0 to 10 are commonly used for the damper value.

§4.9 How to use the zero-cutoff function

The number displayed in window M41 is called the low-cutoff value. The flow meter will replace these flow rate values that are absolutely less than the low-cutoff value with '0'. This means the flow meter will avoid any invalid accumulation when the actual flow is below the zero-cutoff value.

The low-cutoff value does not affect the flow measurement when the actual flow is absolutely greater than the low-cutoff value.

§4.10 How to setup a zero point

There exists a 'Zero Point' with certain installation which means the flow meter will display a non-zero value when the flow is absolutely stopped. In this case, setting a zero point with the function in window M42 will bring a more accurate measurement result.

Make sure that the flow is absolutely stopped, then run the function in window M42 by pressing the ENT key.

§4.11 How to get a scale factor for calibration

A scale factor is the ratio between the 'actual flow rate' and the indicated value by the flow meter. The scale factor can be determined by calibration with flow calibration equipment.

§4.12 How to use the operation locker

The system locker provides a means of preventing inadvertent configuration changes or totalizer resets.

When the system is locked, menu window browsing can be done without affecting any change, but any modifications are prohibited.

The system can be locked without a password or with a one 1 to 4 digit password. With a no-password locking, directly press the ENT key when the password input prompt displays.

If the password is forgotten, please contact the factory.

§4.13 How to use the built-in data logger

Built in data logger can record over 10000 pieces of data

Set M50 storage interval time and store data regularly according to the interval time.

§4.14 How to use the OCT output

The OCT output is user-configurable, which can be performed by selecting the proper input source such as pulse output.
Use M66 for the setups.
Please make sure that the Frequency Output shares the OCT.

The OCT output shares pins with the RS-232C interface, and the terminal is at Pin 6 and the ground is at Pin 6.

§4.15 How to use the built-in Buzzer

The built-in buzzer is user-configurable. It can be used as an alarm. Use M77 for setups.

§4.16 How to modify the built-in calendar

No modification on the built-in calendar will be needed in most cases. The calendar runs on insignificant amount of power supply. Modification will be required only in such cases as when the battery is totally consumed, or when the changing of the battery takes a long time.

Press the ENT key under M60 for Modification. Use the dot key to skip over these digits that need no modification.

§4.17 How to adjust the LCD contrast

Use M70 to the LCD contrast. The adjusted result will be stored in the EEPROM so that the MASTER ERASE will make no effect on the contrast.

§4.18 How to use the RS232 serial interface

Use M62 for the setup of the RS-232 serial interface.

§4.19 How to charge the built-in battery

Refer to §2.1

§4.20 How to check the ESN and other minor details

Every set of the handheld flow meter utilizes a unique ESN to identify the meter. The ESN is an 8-digit number that provides the information of version and manufacturing date.

The user can also employ the ESN for instrumentation management.

The ESN is displayed in window M61.

Other details about the instrument are the total working hours displayed in window M+1, and the total power-on times displayed in window M+4.

5. Service

§5.1 Service

The manufacturer provides instrument installation for our customers, and the charges will be made according the cost.

(1) For any hardware failure of the instrument, we recommend that our customers send back the instrument to our factory for service, due to the fact that the instrument is made of microprocessors and it will be difficult to perform field maintenance. Before sending back the instrument, please try to contact the factory first to make sure what the problem is.

For other operational problems, please contact our service department by telephone, fax or email and internet. In most cases, the problem could be solved immediately.

§5.2 Software Upgrade Service

We provide free-of-charge software upgrade services. Please contact the factory for any lately developed software.

Appendix

1. Sound speed data of liquid (unit: m/s)

Liquids	Sound speed
Water (20℃)	1482
Water (50℃)	1543
Water (75℃)	1554
Water (100℃)	1543
Water (125℃)	1511
Water (150℃)	1466
Water (175℃)	1401
Water (200℃)	1333
Water (225℃)	1249
Water (250℃)	1156
Aceton	1190
Methanol	1121
Ethanol	1168
Alcohol	1440
Butanone	1310
Acetaldehyde	1180

Liquids	Sound speed
Glycerin	1923
Petrol	1250
66# Petrol	1171
80# Petrol	1139
0# Diesel	1385
Phenol	1330
Ethyl benzene	1340
Toluene	1170
Phenixin	938
Coal oil	1420
Petroleum	1290
Pine oil	1280
Chlorylene	1050
Castor oil	1502
Glycol	1620
Peanut oil	1472

2. Sound speed data of solid (unit: m/s)

Material	Sound speed
Steel	3206
ABS	2286
Aluminum	3048
Copper	2270
Cast Iron	2460
Bronze	2270
GRP	3430
Glass	3276
Polyethylene	1950
PVC	2540

Liner Material	Sound speed
Teflon	1225
Ti	3150
Cement	4190
Asphalt	2540
Enamel	2540
Glass	5970
Plastic	2280
Polyethylene	1600
PTFE	1450
Rubber	1600

Note: Please contact with the manufacturer for other sound speed data.

3. Sound speed in water at atmosphere pressure

Unit: t (Deg C) v (m/s)

t	v	t	v	t	v	t	v
0	1402.3	25	1496.6	50	1542.5	75	1555.1
1	1407.3	26	1499.2	51	1543.5	76	1555.0
2	1412.2	27	1501.8	52	1544.6	77	1554.9
3	1416.9	28	1504.3	53	1545.5	78	1554.8
4	1421.6	29	1506.7	54	1546.4	79	1554.6
5	1426.1	30	1509.0	55	1547.3	80	1554.4
6	1430.5	31	1511.3	56	1548.1	81	1554.2
7	1434.8	32	1513.5	57	1548.9	82	1553.9
8	1439.1	33	1515.7	58	1549.6	83	1553.6
9	1443.2	34	1517.7	59	1550.3	84	1553.2
10	1447.2	35	1519.7	60	1550.9	85	1552.8
11	1451.1	36	1521.7	61	1551.5	86	1552.4
12	1454.9	37	1523.5	62	1552.0	87	1552.0
13	1458.7	38	1525.3	63	1552.5	88	1551.5
14	1462.3	39	1527.1	64	1553.0	89	1551.0
15	1465.8	40	1528.8	65	1553.4	90	1550.4
16	1469.3	41	1530.4	66	1553.7	91	1549.8
17	1472.7	42	1532.0	67	1554.0	92	1549.2
18	1476.0	43	1533.5	68	1554.3	93	1548.5
19	1479.1	44	1534.9	69	1554.5	94	1547.5
20	1482.3	45	1536.3	70	1554.7	95	1547.1
21	1485.3	46	1537.7	71	1554.9	96	1546.3
22	1488.2	47	1538.9	72	1555.0	97	1545.6
23	1491.1	48	1540.2	73	1555.0	98	1544.7
24	1493.9	49	1541.3	74	1555.1	99	1543.9