| INSTALLATION & OPERATION MANUAL

MUF(B) 1200
Inline Ultrasonic BTU Meter

MIAL® INSTRUMENTS PVT.LTD.
Measuring & Beyond

www.mialinstruments.com

MUF (B) 1200
Inline Ultrasonic BTU Meter

Preface

- Thank you for purchasing our product.
- This manual is about the various functions of the product, wiring methods, setting methods, operating methods, troubleshooting methods, etc.
- Please read this manual carefully before operation, use this product correctly to avoid unnecessary losses due to incorrect operation.
- After you finish reading, please keep it in a place where it can be easily accessed at any time for reference during operation.

NOTE!

Modification of this manual's contents will not be notified as a result of some factors, such as function upgrading. We try our best to guarantee that the manual content is accurate, if you find something wrong or incorrect, please contact us. The content of this manual is strictly prohibited from reprinting or copying.

About this manual

- Please submit this manual to the operator for reading.
- Please read the operation manual carefully before installing the instrument. On the precondition of full understanding.
- This manual only describes the functions of the product. The MIAL Instruments pvt.ltd. does not guarantee that the product will be suitable for a particular application.

Warnings and symbols used

HAZARD!
If not taken with appropriate precautions, will result in serious personal injury, product damage or major property damage.

WARNING!
Pay special attention to the important information linked to product or particular part in the operation Manual

CAUTION!
Disregarding these instructions can result in damage to the device or other ancillary products.

INFORMATION!
These instructions contain important information for the handling of the dev

Table of Contents

1. INTRODUCTION

1.1 PURPOSE OF THE MANUAL

Overview:
Welcome to the user manual for the Mial MUF(B) 1200 – Inline Ultrasonic BTU meter. This comprehensiveguide is designed to assist operators, maintenance personnel, and system integrators in understanding,installing, operating, and maintaining the Mial MUF(B) 1200 – Inline Ultrasonic BTU meter effectively.

Objectives:
Clarification of Functionality: This manual aims to provide a clear understanding of the principles and functionality of the Mial MUF(B) 1200 – Inline Ultrasonic BTU meter. Users will gain insights into its design,components, and how it precisely measures fluid flow.

Guidance for Installation:
Step-by-step instructions and considerations for proper installation are provided to ensure optimal performance. Safety precautions are emphasized to create a secure working environment.

Training and Familiarization:
Users will be guided through the features, controls, and indicators of the BTU meter, facilitating efficient operation. This section aims to serve as a valuable training resource for users at various experience levels.

Maintenance and Troubleshooting Assistance:
Learn about routine maintenance procedures and effective troubleshooting techniques. This manual empowers users to address common issues and perform regular maintenance to enhance the longevity of the Mial MUF(B) 1200 – Inline Ultrasonic BTU meter.

Intended Audience:
This manual is intended for operators, maintenance personnel, and system integrators involved in the installation, operation, and maintenance of the Mial MUF(B) 1200 – Inline Ultrasonic BTU meter. It is suitable for both novice users seeking basic guidance and experienced professionals looking for specific details.

Important Notes:
Please read through the manual carefully, adhering to safety guidelines and following instructions precisely. If any uncertainties arise during the installation, operation, or maintenance processes, seek assistance from qualified personnel or our customer service / support team.

Reference to Other Documentation:
Refer to the accompanying technical specifications document for in-depth details about the Mial MUF(B) 1200 – Inline Ultrasonic BTU meter. Additional resources can be found on our website.

Intended use

CAUTION!
Responsibility for the use of the measuring devices with regard to suitability, intended use and corrosion resistance of the used materials against the measured fluid lies solely with the operator.

INFORMATION!
The manufacturer is not liable for any damage resulting from improper use or use for other than the intended purpose

Certification

The manufacturer certifies successful testing of the product by applying the CE marking

The manufacturer certifies successful testing of the product by applying the ISO marking

1.2 OPERATING PRINCIPLE

MUF(B) 1200 inline ultrasonic BTU (British Thermal Unit) meter uses the transit time principle to measure the flow rate of the fluid. Ultrasonic transducers are placed inline with the pipe and send ultrasonic pulses both upstream and downstream. The difference in the time it takes for the pulses to travel in each direction is used to calculate the flow rate.When the fluid is flowing, the ultrasonic signal traveling with the flow (downstream) will arrive faster than the signal traveling against the flow (upstream). The time difference between these signals is directly proportional to the velocity of the fluid.The meter includes temperature sensors, typically PT100 which measure the temperature of the fluid entering and exiting the system.The difference between the inlet and outlet temperatures is crucial for calculating the energy transferred.

Energy Calculation**:**

Heat Transfer Equation:

The BTU meter calculates the energy transferred using the formula:

$$Q=\dot{m}\cdot Cp\cdot(Tout-Tin)$$

Where:

- Q is the heat energy transferred (in BTUs or other units).
- $\dot{m}$ is the mass flow rate of the fluid.
- Cp is the specific heat capacity of the fluid.

- Tout and Tin are the outlet and inlet temperatures, respective

1.3 OPERATING PRINCIPLE

MUF(B) 1200 specifications*

Operation and performance

Flow measurement

Ultrasonic differential transit-time Technology

Fluid types

Single medium, including a non-conductive medium and most clean liquids.

Fluid properties

Clean liquids in full (pressurized) pipes

Pipe sizes

50 MM - 300 MM

Pipe materials

metallic and non-metallic materials.

Flow Range

±0.09ft/s ~ ±16ft/s (±0.03m/s ~ ±5m/s)

Flow accuracy

±1% of the measured Value

Achievable with process calibration

Repeatability

±0.2% of the measured value

Linearity

±1%

Measurement parameters

BTU meter- Instantaneous flow, totalized flow

Certification

Calibration certification, CE, ISO

Electronics

Enclosures

ABS

Wall mounted enclosure

Enclosure IP rating

IP65

Memory

EEPROM

Power supply

24 VDC/2A

Use 2-amp SMPS when employing AC power

Ambient temperature

32°F to 140°F (0°C to 60°C)

Humidity

Up to 99% RH,non-condensing

Standard output

Analog output : 4 to 20 mA ,750 Ω maximum load

Pulse output- 0~9999Hz, OCT, (min. and max. frequency is adjustable)

Alarm Relay output

Network Connection

Modbus RTU RS 485

Data logging

8 GB removable memory card

Cable

10 Meter

Flow Tube

Operating Temperature range (Fluid)

5°F to 176°F (-15°C to 80°C)

Nominal Pressure

1.6 Mpa

Process connections

ANSI 150 Flanges

Materials

Flow Tube : Stainless steel 304

Flange : Carbon Steel

Optional: Stainless steel

IP rating

IP68

Meter installation orientation

Horizontal or Vertical

In a vertical installation, it is essential that the pipe be fully filled, with the flow direction oriented from bottom to top.

**Specifications are subject to change without prior notice.*

2. DEVICE DESCRIPTION

2.1 SCOPE OF DELIVERY

INFORMATION!
Do a check of the packing list to make sure that you have all the elements given in the order

INFORMATION!
Inspect the packaging carefully for damages or signs of rough handling. Report damage to the carrier and to the local office of the manufacturer.

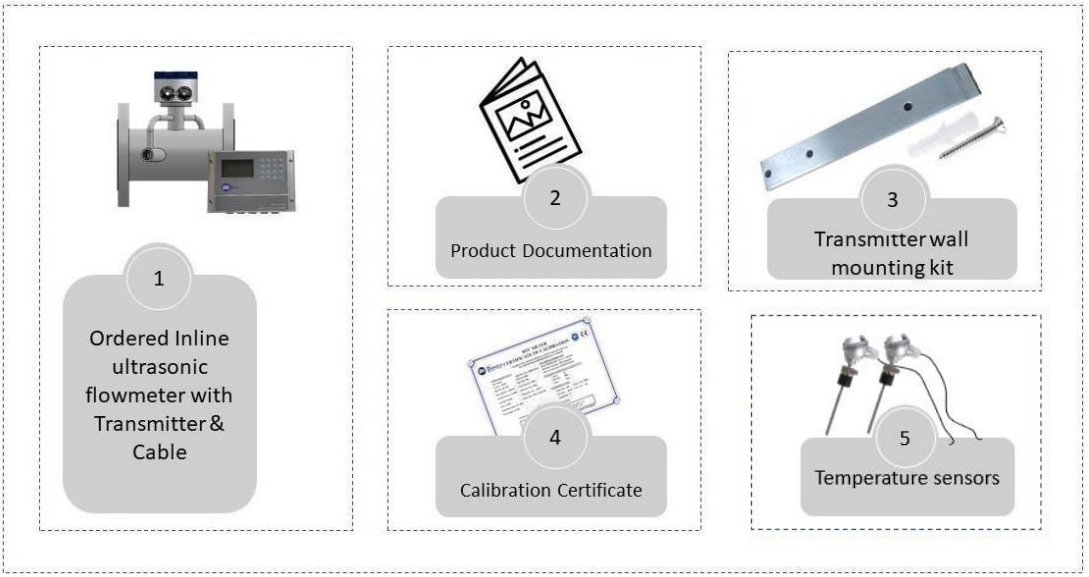
INFORMATION!
The MUF(B) 1200 transmitters and sensor bodies are components of a uniquely calibrated system andmust be installed together as per the serial number. Mixing components from other systems will result in significant calibration errors. The transmitter serial number can be found on the sticker on the side of the electronics enclosure, and the sensor serial number is located on the sticker onthe sensor body.

INFORMATION!

The field device will arrive in one standard cartons. The standard carton contains one small corrugated box containing Transmitter Unit. Also, the standard carton box contains Flow Tube, Temperature Sensors Product documentation, Test Certificates, Mounting Accessories

INFORMATION!

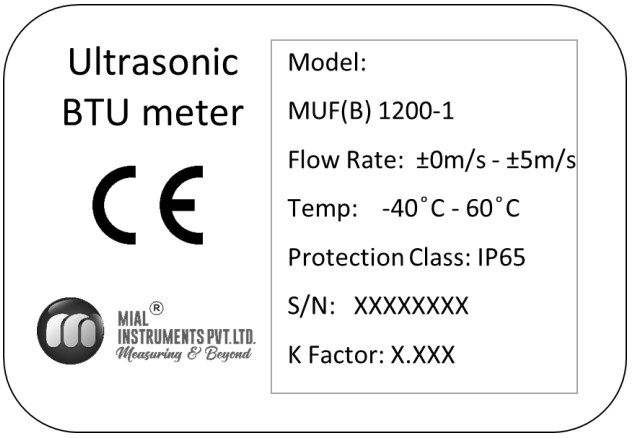
Make sure to combine the sensor and the converter correctly, so they match by the devices serial number



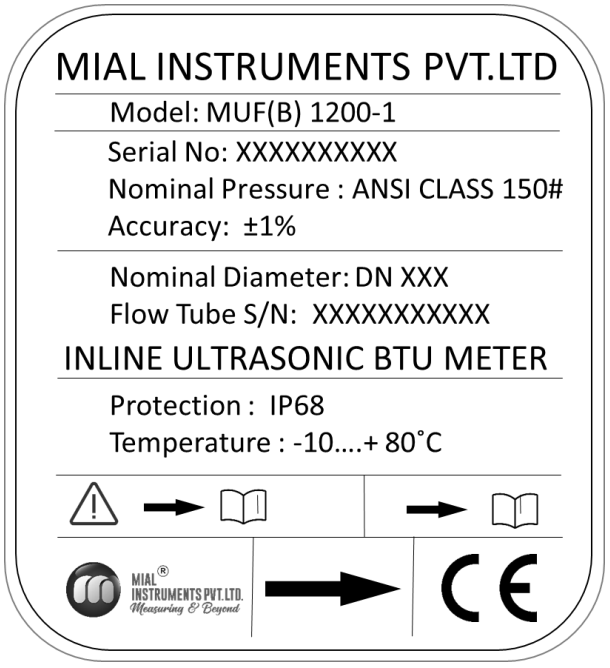
2.2 NAME PLATES

INFORMATION!
Look at the device nameplate to ensure that the device is delivered according to your order. Check for the correct supply voltage printed on the nameplate

EXAMPLE OF NAMEPLATE FOR THE TRANSMITTER



EXAMPLE OF NAMEPLATE FOR THE FLOW TUBE



3. INSTALLATION

3.1 SITE SELECTION

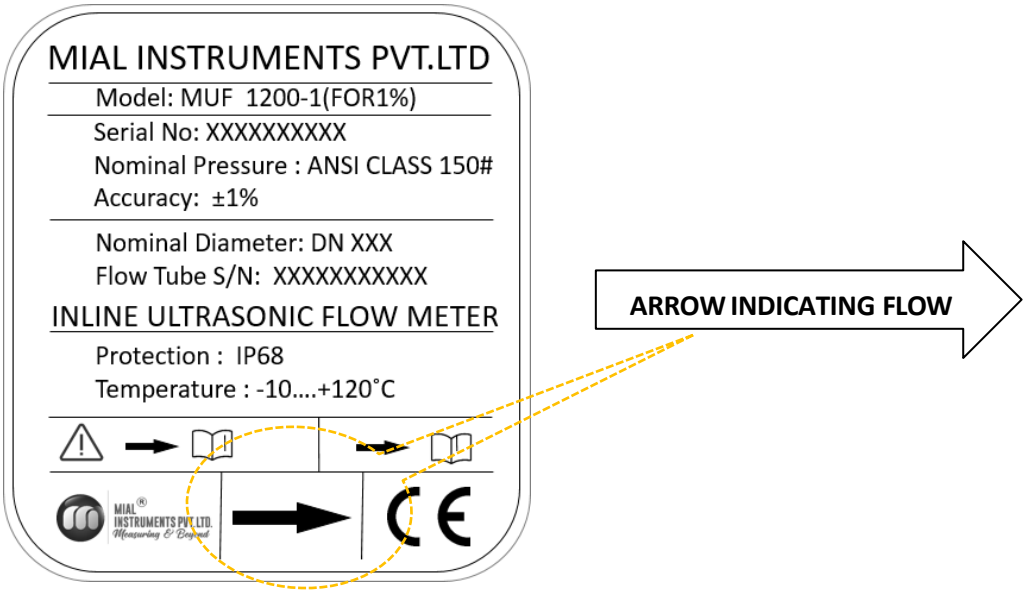
When selecting a site for a BTU meter installation, prioritize accessibility for installation and maintenance. Consider environmental factors like temperature and humidity as per guidelines. Ensure the flow profile is stable and the pipe is in good condition. Safety and ease of access for personnel should also be taken into account to optimize meter performance and longevity.

3.1.1 BASIC RECOMMENDATIONS

In general guidelines, it's recommended to find a location where the pipe has the longest straight segment with a clear run. This ensures smooth laminar flow of the fluid through the meter, which is crucial for accurate measurement. A longer clear run of pipe minimizes disturbances and turbulence that could affect the meter's performance. This approach helps optimize the meter's accuracy and reliability by providing a stable flow profile for measurement.

3.1.2 FLOW DIRECTION

The Mial MUF(B) 1200 Inline ultrasonic BTU meter should be installed ensuring the arrow indicated on the meter points in the direction of flow. When correctly installed, as illustrated, the arrowhead should align with the flow direction. The transmitter display will indicate positive values corresponding to the flow direction indicated by the arrow. If the fluid flows in the opposite direction to the arrow, the display will show negative readings reflecting the reverse flow direction.



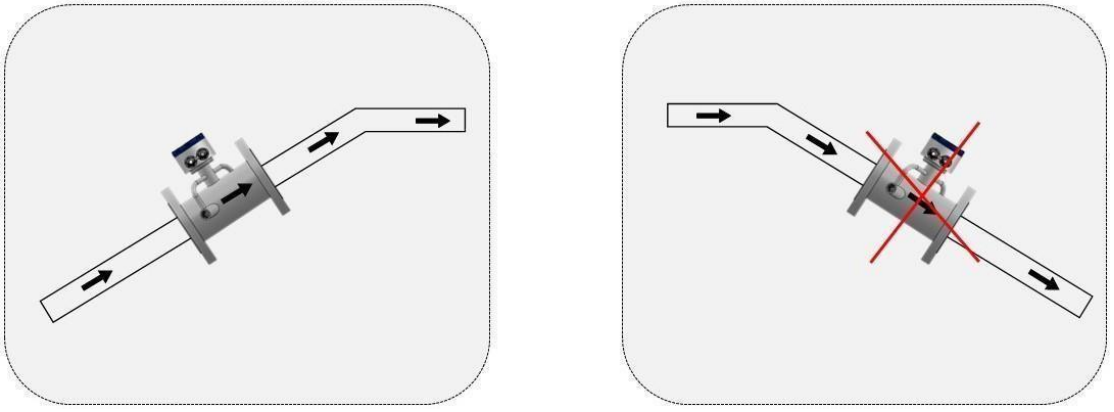
3.1.3 INSTALLATION OF REMOTE MOUNT TRANSMITTER

Installing a remote mount transmitter involves placing the unit at a distance where the display is easily visible to the user. It should be positioned away from equipment that may generate electrical interference. The standard cable length from the flow tube to the transmitter becomes 10 meters and it can't be cut or extendable at the site. For the outdoor installation mandatory to provide a non-metallic FRP/GRP enclosure

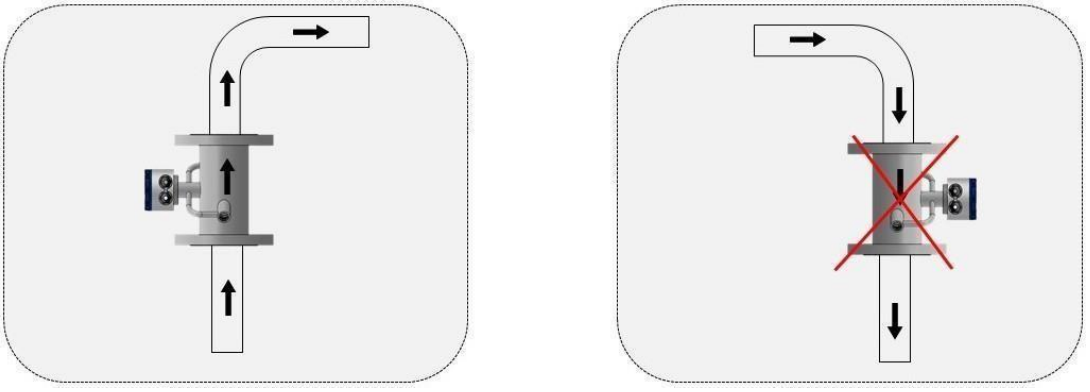
3.1.4 STRAIGHT LENGTH REQUIREMENT

In order to ensure correct measuring, please pay attention to the requirements mentioned below. Having additional straight length beyond this minimum requirement offers additional advantages, such as enhanced measurement precision and reduced potential for turbulence or flow disturbances that could affect meter performance. Therefore, maximizing the straight length of the pipe where the BTU meter is installed can contribute to optimizing the overall effectiveness and reliability of the measurement process.

SLOP & VERTICAL LINES

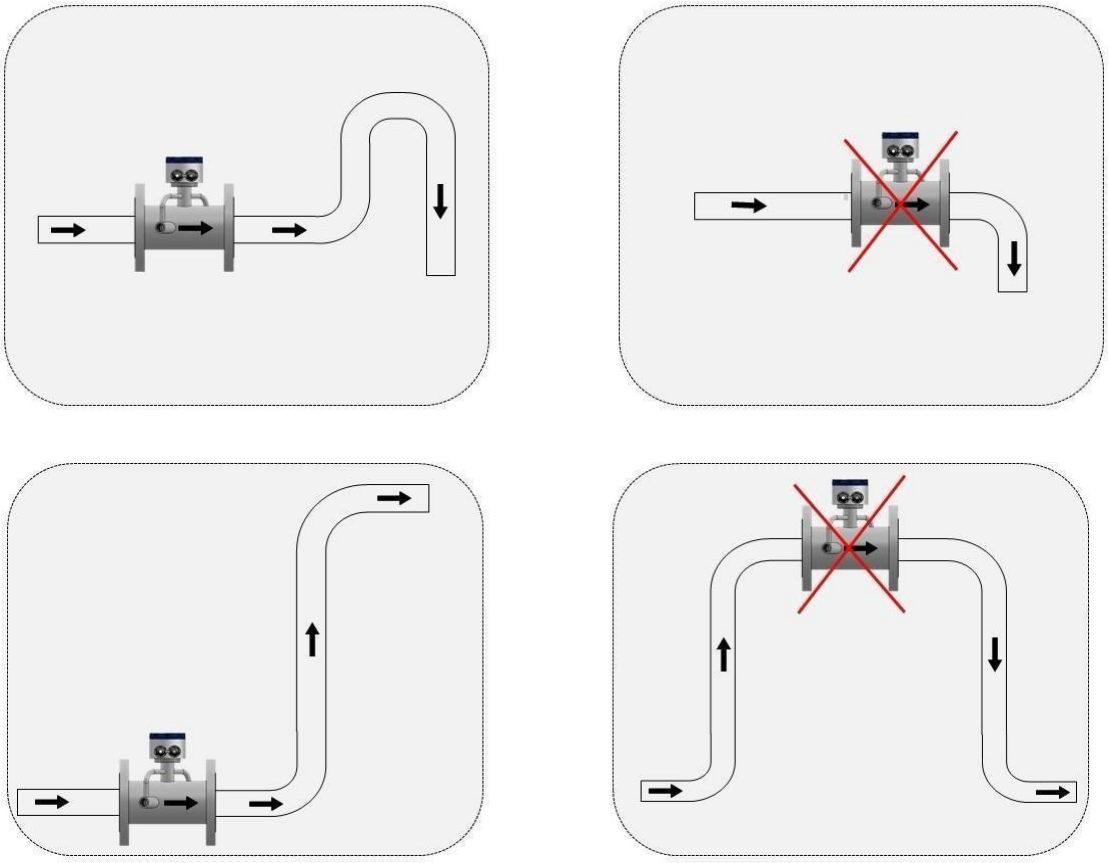


Install at the rising direction



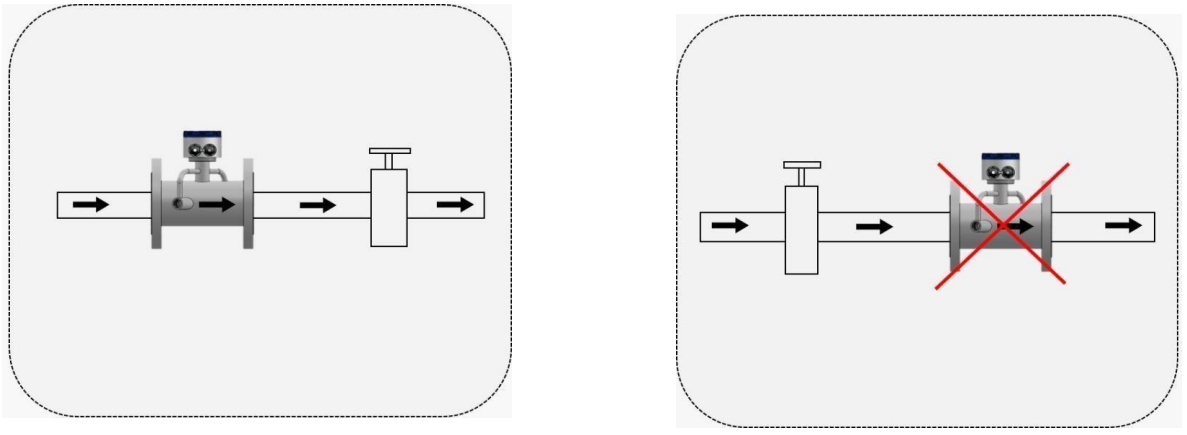
Install at the rising direction

OPEN FEED OR DISCHARGE



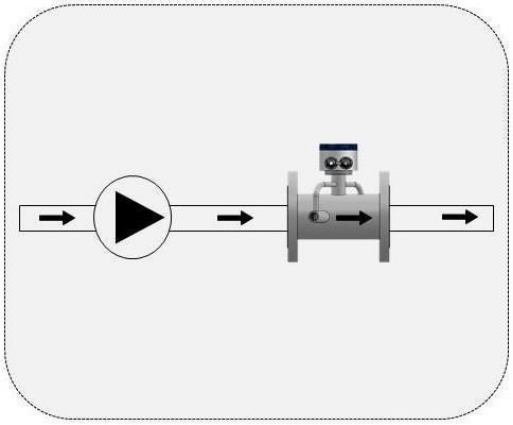
INSTALL AT THE LOWEST POINT WHEN USED IN OPEN DRAIN PIPE

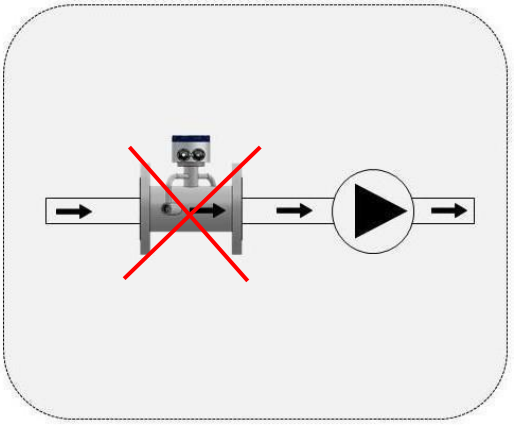
CONTROL VALVE



DON'T INSTALL IT AT THE EXIT OF THE VALVE, INSTALL IT AT THE ENTRANCE OF THE VALVE

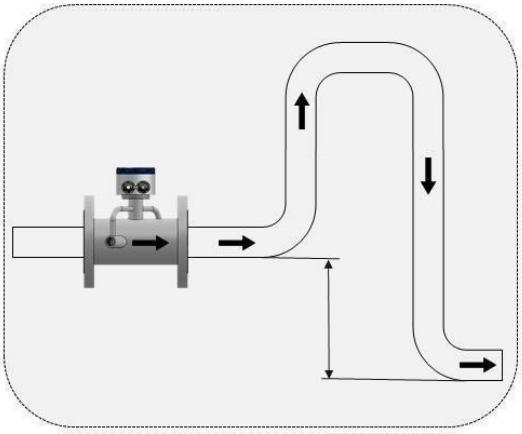
POSITION OF PUMP

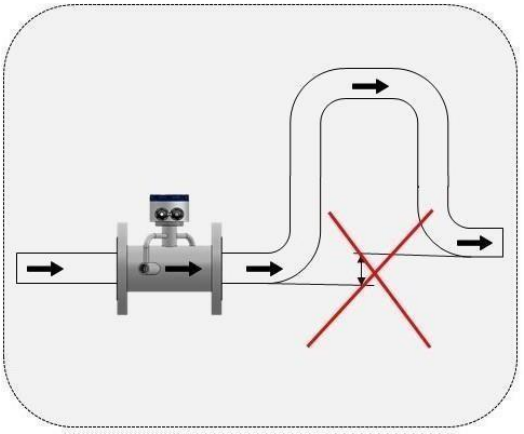




DON'T INSTALL IT AT THE ENTRANCE OF THE PUMP, INSTALL IT AT THE EXIT OF THE PUMP

DOWN GOING PIPELINE OVER 5 M /16 FT LENGTH





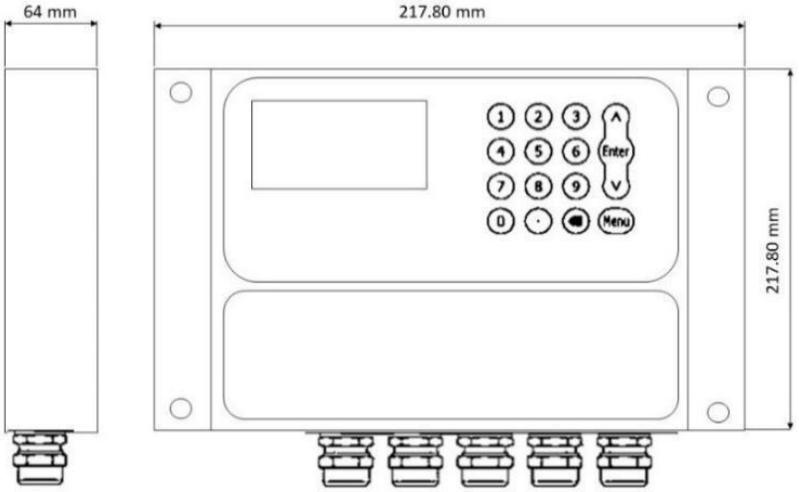
THE DOWNSTREAM OF BTU METER WHEN THE DROP IS MORE THAN 5 M

3.2 MECHANICAL INSTALLATION

IMPORTANT NOTE!

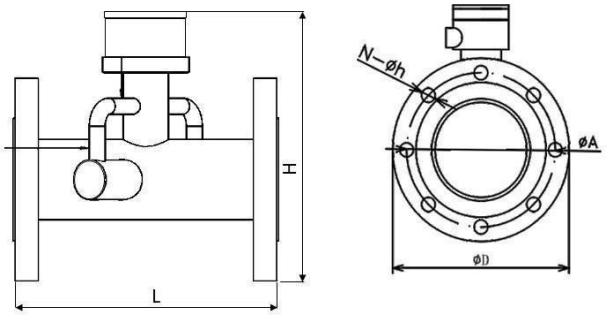
MUF(B) 1200 transmitters and sensor bodies are two parts of one uniquely calibrated system and mustbe installed together as per the serial Number . Mixing components from other systems will resultin significant calibration errors.

3.2.1 STANDARD TRANSMITTER DIMENSIONS



3.2.2 FLOW SENSOR DIMENSIONS

ANSI CLASS 150 FLANGED SENSOR OVERALL DIMENSION



PIPE SIZE	L	D	A	N- Ø h	H
DN50	200	152	120.7	4-Ø19.1	255
DN65	220	178	139.7	4-Ø19.1	280
DN80	250	190	152.4	4-Ø19.1	285
DN100	250	229	190.5	8-Ø19.1	315
DN125	250	254	215.9	8-Ø22.4	340
DN150	300	280	241.3	8-Ø22.4	370
DN200	350	343	298.5	8-Ø22.4	430
DN250	450	406	362	12-Ø25.4	495
DN300	500	483	432	12-Ø25.4	558

3.2.3 TEMPERATURE SENSOR INSTALLATION

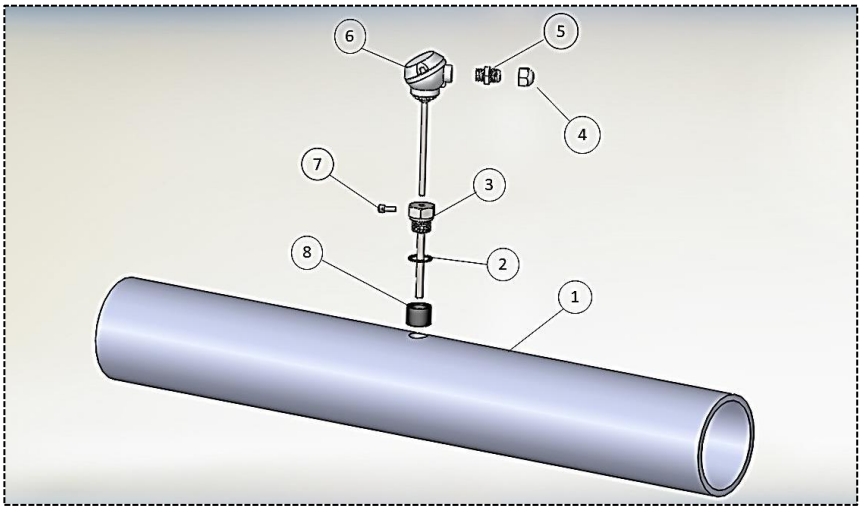
The accurate positioning of the two temperature sensors is vital for precise measurements. They should measure the temperature at the supply line as it enters and at the return line as it exits the designated energy measurement section of the piping system. Ideally, these sensors should be placed in an easily accessible location at ground level for convenient field wiring connections and future servicing. It's important to avoid placing the sensors near sources of strong electrical noise, which could affect their performance.

One of the temperature sensors, along with its thermowell, must be installed in the same pipe as the flow meter. This sensor should be positioned at least five pipe diameters downstream from the flow meter to ensure accurate readings. Ensure there is sufficient clearance between the sensors to allow for their removal from the pipe without interference from each other.

❖ Installation Instructions

When equipped with the PT1000, temperature sensors undergo factory matching and are tagged with serial numbers corresponding to a particular Btu meter. Standard temperature sensors according to MIAL 654321specifications are additionally identified and marked as either the SUPPLY or RETURN sensor, and installation should adhere to these designations

MIAL's standard temperature sensors need to be utilized in pairs for maintaining accurate differentials. Each sensor is specifically designated and labeled as either the SUPPLY or RETURN sensor and must be installed accordingly. To properly install, apply a thin layer of thermal compound to the sensor's tip area, then insert it fully into the thermowell until it reaches the bottom of the cavity. Gently tighten the retainer nut, being cautious not to overdo it. The thermowell effectively seals the plumbing system without the need for the retainer nut; its sole purpose is to ensure constant contact between the sensor tip and the thermowell's bottom.



1. ***Supply / Return Pipe Lile***
2. ***Thermowell Washer***
3. ***Thermowell***
4. ***Gland Cap***
5. ***Gland***
6. ***Sensor***
7. ***Thermowell Screw***
8. ***Welding Branch Outlet***

WARNING!

AVOID EXCESSIVE TIGHTENING. The thermowell provides full sealing for the plumbing system. Attaching the sensor ensures continuous contact between the sensor tip and the bottom of the thermowell.

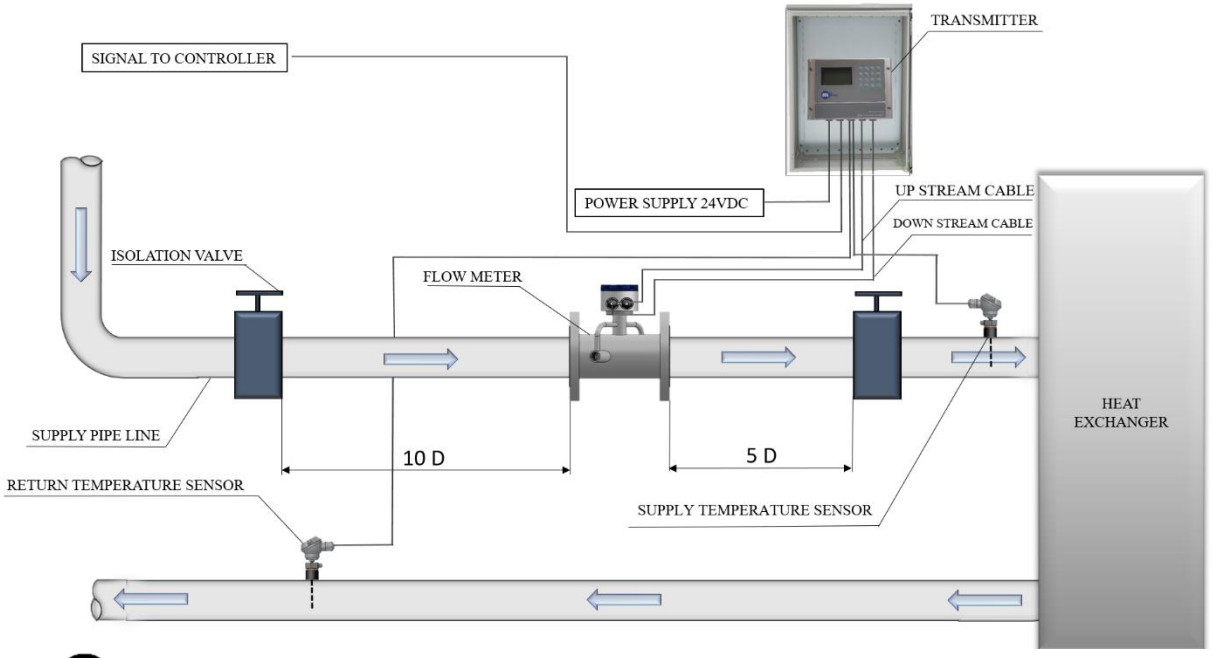
WARNING!
Install the sensor at the 12 o'clock position on the pipe. Incorrect placement can cause inaccurate readings and sensor damage.

WARNING!
Do not cut or extend the sensor cables at the site. This can lead to malfunction and void the warranty

3.2.4 INSTALLATION

Installation of this product should be carried out by qualified professionals, ensuring compliance with all relevant local, state, and federal building codes. Begin by thoroughly cleaning all flange surfaces to remove any old gasket material and adhesive residue. Inspect the flange surfaces for any warping, pitting, or imperfections that could affect the seal. Use new bolts, nuts, and hardened washers, and lubricate them to ensure even stress distribution during installation.

INSTALLATION DIAGRAM



INFORMATION!

To ensure proper operation,MUF(B) 1200 inline ultrasonic BTU meters require a pressurized pipeline that is completely filled with clean water and free of air. The presence of entrained air in the line can interfere with the ultrasonic signals and disrupt the normal operation of the meters. It is essential to activate the air purge valves in the line to remove any entrained air from the system for the meters to function correctly.

INFORMATION!

The head of the flow sensor should be installed at the 12 o'clock position on the pipe.

INFORMATION!
The cable length from the flow sensor to the display is 10 meters and cannot be cut or extended on-site.

4 ELECTRICAL CONNECTIONS

4.1 SAFETY INSTRUCTIONS

DANGER!
Only when power is switched off, can we do all the work about electrical connections. Please pay all attention to the power supply on the name plate!

DANGER!
Observe the national regulations for electrical installations!

DANGER!
For devices used in hazardous areas, additional safety notes apply; please refer to the Ex documentation.

WARNING!
Observe without fail the local occupational health and safety regulations. Any work done on the electrical components of the measuring device may only be carried out by properly trained specialists.

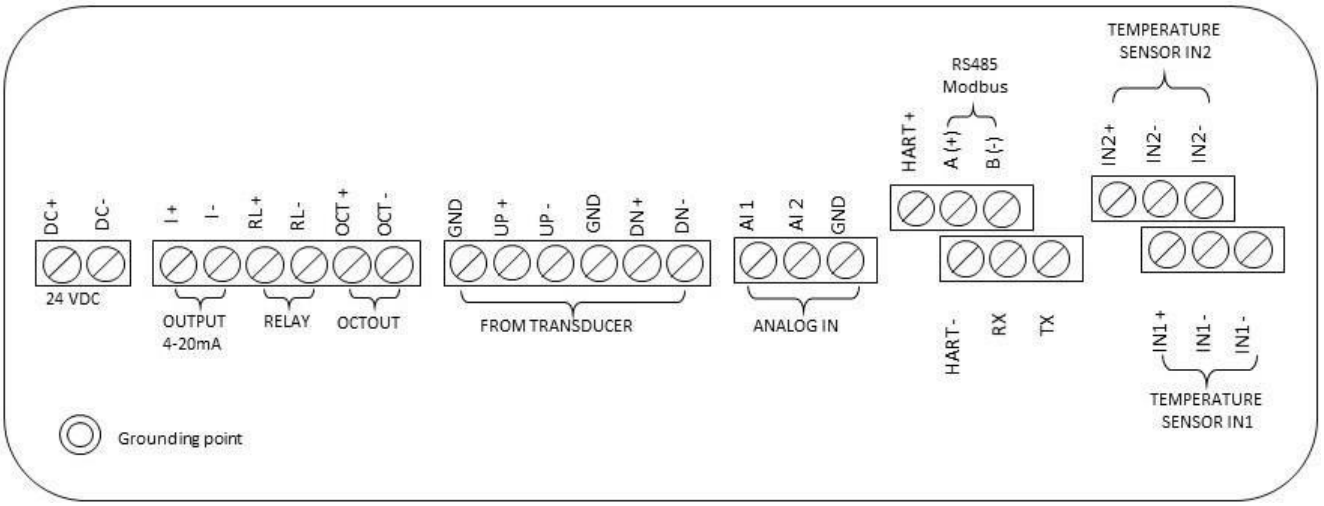
INFORMATION!
Look at the device nameplate to ensure that the device is delivered according to your order. Check for the correct supply voltage printed on the nameplate.

INFORMATION!
Connect the cable on connector with similar numeral marking

INFORMATION!

Ensure the meter operates correctly by supplying it with a dedicated 24 VDC input power source

4.2 MUF(B) 1200 Wiring Diagram and Modbus Register Details

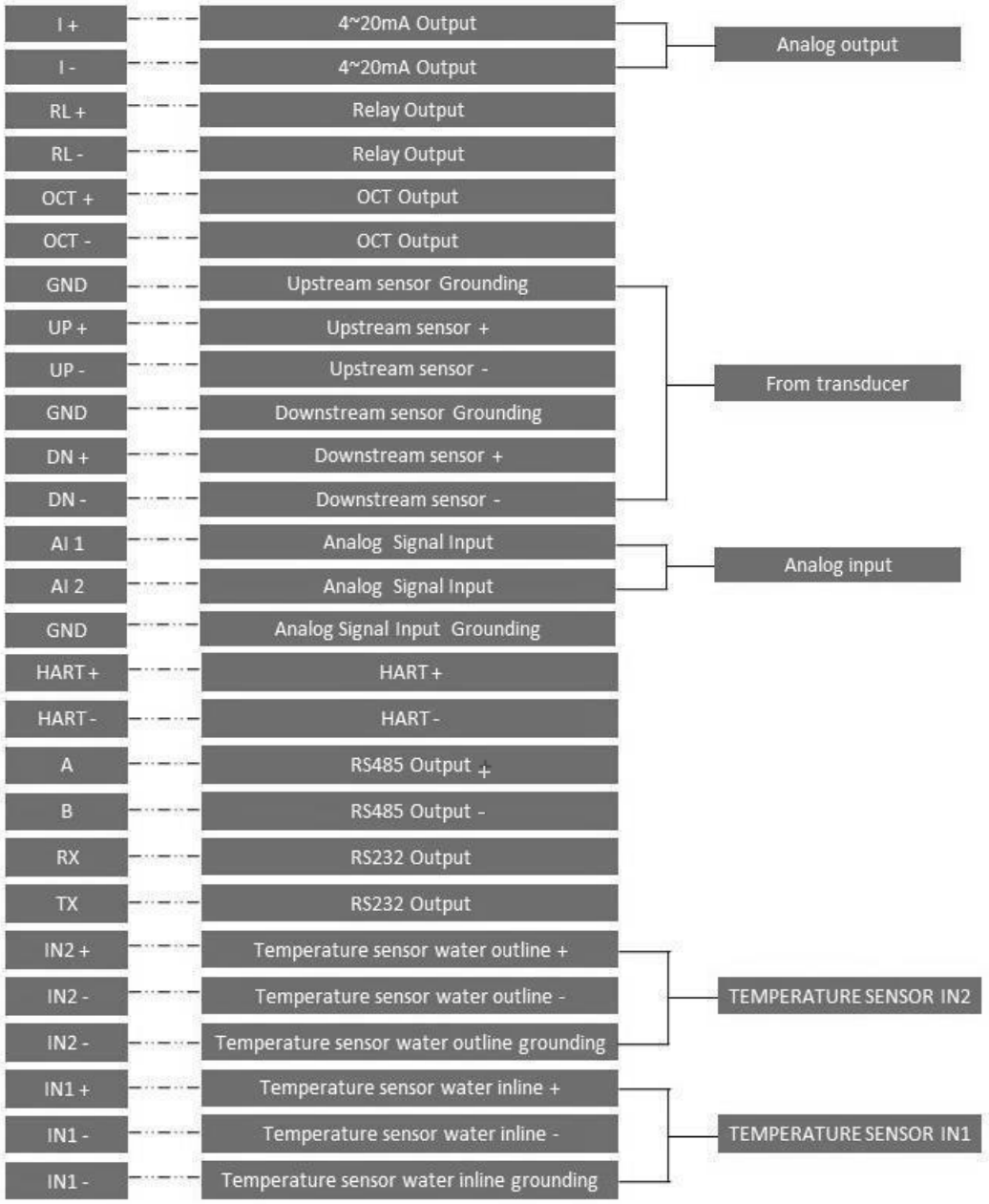


4.3 MUF(B) 1200 MODBUS Configuration Details of BTU METER to BMS

Function Code	Details	Register Address	Modbus Register	Register Type
03: Holding Register	Supply Temperature	74	40074	Floating Point (32 bit)
	Return Temperature	76	40076	Floating Point (32 bit)
	Energy Rate	18	40018	Floating Point (32 bit)
	Energy Total	23	40023	Floating Point (32 bit)
	Flow Rate	05	40005	Floating Point (32 bit)
	Flow Total	09	40009	Floating Point (32 bit)

Parity	: None
Word length	: 8
Stop Bit	: 1

Note: If your BMS register address starts from '0', please decrement '1' value from every register.
Example: Supply temperature register is 40075 then it should be configured as 40074.

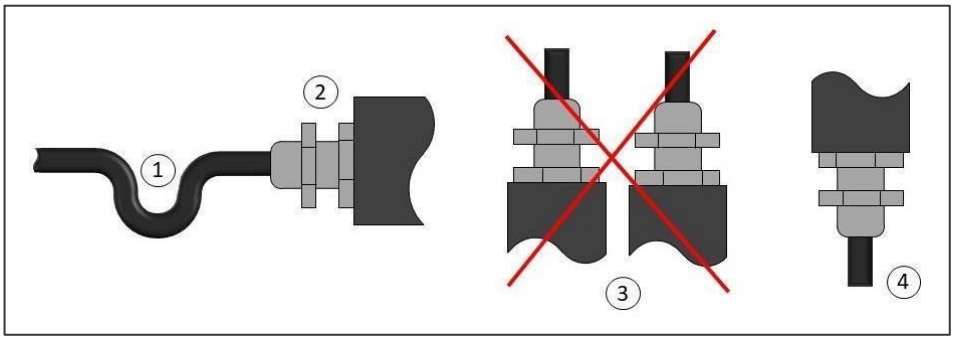


4.4 CONNECTED TO POWER

It is mandatory to provide an individual 24 VDC, SMPS (Switch Mode Power Supply) for energizing the BTU meters. Additionally, it is essential to pull three-core wires (DC+, DC-, and ground) for the 24 VDC input power supply. As these are Inline Ultrasonic BTU meters, a proper input power supply with an appropriate ground is crucial for their correct operations

DANGER!
The equipmentmust be grounded in accordance with regulations so as to protect the operator from electrical shock.

4.5 LAYING ELECTRICAL CABLES CORRECTLY



Keep the housing safe from dust and water

i. Create a loop with the cable just before it reaches the housing.
ii. Securely tighten the screw connection at the cable entry.
iii. Always mount the housing with the cable entries facing downward.
iv. Seal any unused cable entries with a plug.

4.6 EARTH CONNECTION

Proper earthing of the MUF(B) 1200 Inline ultrasonic BTU meter is critical for stable signalintegrity, ensuring accurate flow measurements, and protecting against electrical hazards.Follow manufacturer guidelines closely for secure grounding to optimize performance and maintain safety standards throughout installation and operation.

① Provide a quality Earth ground connection to the meter. From best to worst, grounding options include (stranded wire 14-18 AWG):

② Earth grounding rod driven into the ground

③ Earth wire connected directly to the building electrical service panel ground.

5. OPERATION

SYSTEM NORMAL IDENTIFICATION

If the letter "*R" displays on the screen, it indicates system normal.
If the letter "D" is displayed, it indicates that system is adjusting the signal gain prior to the measurement. Also, it means system normal. Only when the adjustment takes too long without stopping, can system be identified as abnormal.
Letter "E" indicates no signal is being detected. Check the transducer wiring connections are correct, the transducers are installed firmly, etc.
For further information, please refer to "Error Diagnosis".

LOW FLOW CUTOFF VALUE

The data in M21 is Low Flow Cutoff Value. If the flow rate falls below the low flow cutoff value, the flow indication is driven to zero. This function can prevent the BTU meter from displaying flow as "0"after a pump was shut down, but there is still liquid movement in the pipe, which will result in cumulative error. Generally, 0.03m/s is recommended to enter as the low flow cutoff point.
The low flow cutoff value has no relation to the measurement results once the velocity increases over the low flow cutoff value.

ZERO SETTINGS

Once zero flow occurs, a zero point may indicate on each measuring instrument, but the displayed measuring value is not equal to "0", this value indicates "Zero". To any measuring instrument, the smaller the "Zero" is, the better the quality is. Conversely, if the Zero is too big, that indicates the quality of the instrument is poor.
If the zero set point is not at true zero flow, a measurement difference may occur. The smaller the physical measurement capacity is, the larger the measurement difference from the zero point will exist. Only when zero point reduced to a definite degree, as compared with the physical measurement capacity, can the measuring difference from zero point be ignored.
For an Inline ultrasonic BTU meter, the measurement error from zero point cannot be ignored under low flow conditions. It is necessary to perform a static zero set calibration to improve low flow measurement accuracy.

CUTOFF ZERO

In Window M22- Cutoff- 1.Yes, window will show the —success‖ and back to M01 when you cut off the zero point successfully.Performing Set Zero In Window M22- Reset

SCALE FACTOR

Scale factor refers to the ratio between "actual value" and "reading value". For example, when the measurement is 2.00, and it is indicated as 1.98 on the instrument, the scale factor reading is 2/1.98. This means that the best scale factor constant is 1. However, it is difficult to keep the scale factor as "1" on the instrument especially in batch productions. The difference is called "consistency".
During operation, there still exists possible difference in pipe parameters, etc. The scale factor entered must be one that results from actual flow calibration. The scale factor can be input in Window M26.

SYSTEM LOCK

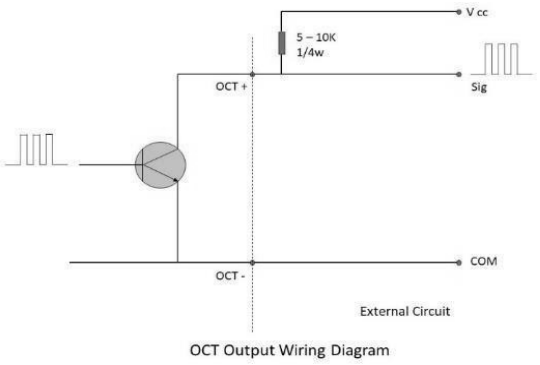
System lock is intended to prevent operation error due to tampering by unauthorized personnel. M54 is for system lock, unlock it by using the selected password only. If “lock” is displayed on the screen, then enter the correct password. Keep the password in mind or recorded in a safe place, otherwise the instrument cannot be used.

4~20mA ANALOG OUTPUT

With a current loop output exceeding an accuracy of 0.1%, the BTU meter is programmable and configurable with outputs such as 4 ~ 20mA or 0 ~ 20mA selected in Menu 32. For details, please refer to Menu 32 in "Window Display Explanations".
In Window M32- Range- LowL, enter a 4mA flow value. Enter the 20mA flow value in Window M32-Range-UpperL. For example, if the flow range in a specific pipe is 0 ~ 1000m3/h, enter 0 in window M32-Range-LowL and 1000 in window M32-Range-UpperL.. If the flow ranges from -1000 ~ 0 ~ 2000m3/h, configure the 20 ~ 4 ~ 20mAoutput by selecting in Window M32 when flow direction is not an issue.
Enter 1000 in Window M32 LowL and 2000 in Window M32 UpperL. When flow direction is an issue, module 0 ~ 4 ~ 20mA is available. When the flow direction displays as negative, the current output is in range of 0 ~ 4mA, whereas the 4 ~ 20mA is for the positive direction. The output module options are displayed in Window M32.
Calibrating and testing the current loop is performed in Window M32-Check. Complete the steps as follows: Use —↑‖ and —↓‖ to switch. "check 4mA", "check 8mA", "check 16mA", "check 20mA" readings, connect an ammeter to test the current loop output and calculate the difference. Calibrate the 4-20mA is in M62.

FREQUENCY OUTPUT

The BTU meter is provided with a frequency output transmitter function. The high or low frequency output displayed indicates the high or low flow rate reading. The user can reset the frequency output as well as flow rate as the user’s actual requirements.
For example: if a pipe flow range is 0 ~ 5000m3/h, the relative frequency output required is 100 ~ 1000Hz, and the configuration is as follows:
In Window M33-Range-LowerL (lower limit frequency output flow value), input 0;
In Window M33-Range -UpperL (upper limit frequency output flow value), input 5000;
In Window M33-Mode-F range (frequency range), input 100、1000;
In Window M33-Mode-Option, select —a. Flow Rate‖;
Typical OCT Output wiring diagram as shown



OCT Output Wiring Diagram

TOTALIZER PULSE OUTPUT

Each time the BTU meter reaches a unit flow, it may generate a totalizer pulse output to a remote counter. The totalizer pulse output can be transmitted through OCT or a relay. Therefore, it is necessary to configure OCT and the relay accordingly. (Please refer to Window M33 and M34). For example, if it is necessary to transmit the positive totalizer pulse through a relay, and each pulse represents a flow of 10m3, the configuration is as follows:
In Window M41-Unit, select the totalizer flow unit "m3";

In Window M41-MULT, select the scale factor "e. x10";
In Window M34-Option, select "g. POS Total ";

ATTENTION
Make sure to select an appropriate totalizer pulse. If the totalizer pulse is too big, the output cycle will be too long; if the totalizer is too small, the relay will operate too faster, you may shorten the life of the relay, as well as skip some pulses. The totalizer is recommended to transmit within the range of 1 ~ 3 pulse per second.

ALARM PROGRAMMING

The on-off output alarm is generated through OCT or transmission to an external circuit by opening or closing a relay. The on-off output signal is activated under the following conditions:
(1) Signal not detected;
(2) Poor signal detected;
(3) The BTU meter is not ready for normal measurement;
(4) The flow is in the reverse direction (back flow).
(5) The analog outputs exceed span by 120%.
(6) The frequency output exceeds span by 120%.
(7) The flow rate exceeds the ranges configured (Configure the flow ranges using the software alarm system. There are two software alarms: Alarm#1 and Alarm #2.

Example 1: When flow rate exceeds 300 ~ 1000 m3/h, in order to program the relay output alarm, Complete the steps as follows:
(1) In Menu 35, Alarm1 LowL 300;
(2) In Menu 35, Alarm1 Upper 1000;
(3) In Menu 34, Relay Setting-Option- d Alarm1

4-20mA ANALOG OUTPUT CALIBRATION

Each BTU meter is meticulously calibrated before leaving the factory. Recalibration is generally unnecessary unless the value displayed in Window M32 during current loop calibration does not match the actual output current value.

The hardware detect window must be activated prior to calibration the Analog Output. The procedure is as follows: Menu 62 is for 4-20mA calibration, if you need enter the password . With no effect tonext power on, this window will close automatically as soon as the power is turned off. Use —↑‖ and —↓‖ to switch. Calibrate the current loop 4mA output. Use an ammeter to measure the output current of current loop and adjust the displayed numbers at the same time. Watch the ammeter until it reads 4.00. Stop at this point, the 4mA has been calibrated. Use —↑‖ and —↓‖ to switch. Calibrate the current loop 20mA output. The method is the same as 4mA calibration. The results are automatically saved inEEPROM and won't lose when power off.

SD CARD OPERATION

SPECIFICATIONS

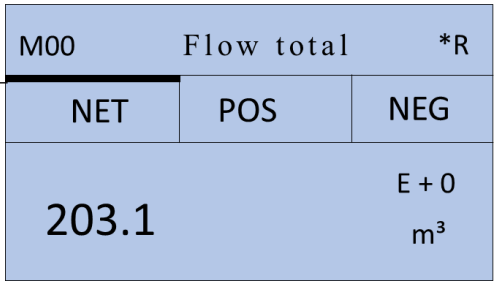
Data collection interval: any interval settings from 1 to 3600 seconds are OK according to the requirement.
Data content: date and time, flow rate, flow velocity, total flow, positive totalizer, negative totalizer.
Data storage format:
a=2017-11-16,16:21:12
b=+2.652471E+00 m3/h
c=+9.380460E-02 m/s
d=+3.520580E+02 m3
e=+3.520580E+02 m3
f=+0.000000E+00 m3
g=+0.000000E+00 GJ/h
h=+0.000000E+00 GJ
i=+0.000000E+00 GJ
j=+0.000000E+00`C
k=+0.000000E+00`CFile
system format: FAT16.
File type: plain text file (.TXT).
File number: maximum 512pcs.
It can save 120 bytes of data each time. If it is set to save once in per 5 seconds, the capacity of storing file in 24 hours is 120*3600/5*24＝2073600byte≈2.1Mbyte, therefore, 1Gbyte SD card can store for days: 1024/2.1=487.6≈487 days. When the capacity of the SD card is full, the new data will override the earliest files automatically.

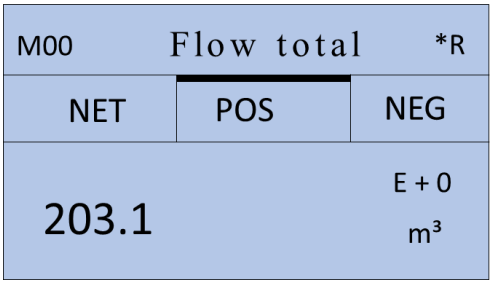
INSTALL OR REMOVE THE SD CARD WHILE THE METER IS POWERED ON

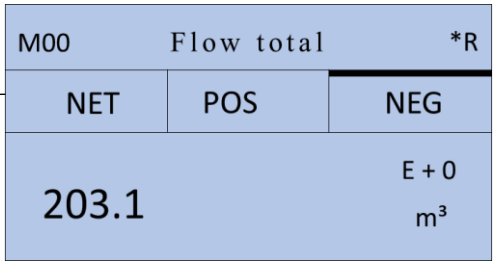
ATTENTION
Do not remove or insert the SD card from the reader while the BTU meter is powered on, as this can result in data loss or corruption. It is mandatory to turn off the BTU meter before removing or inserting the SD card.Save and store the data from the SD card in a separate location on the PC before processing it.
Processing data directly from the SD card file location on the PC could also lead to data loss or corruption.

ESN We provide the BTU meter with a unique electronic serial number to identify each flow mete r for the convenience of the manufacturer and customers. The ESN, instrument types and versions are able to view in Window M50.

M00
Flow Total
Display Net Totalizer.
Display Positive totalizer.
Display Negative totalizer.

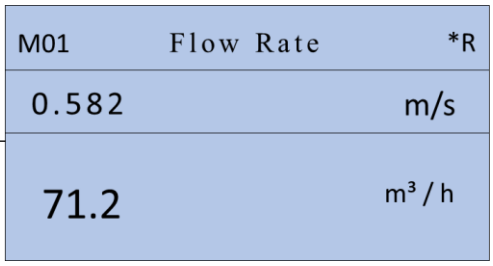






M01
Flow Rate
Display the Flow Rate and Flow Total

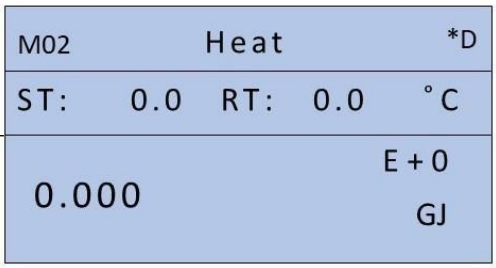
Display the Flow Velocity.
Flow Total and Flow Velocity switch every 6 seconds, with the ENTER key used to halt the transition

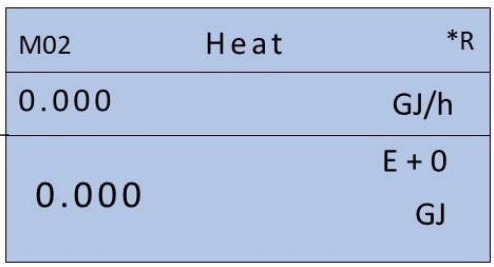


M02
Heat Rate
Display the Heat Total.
Display the Heat Rate and the Inlet Water Temp and Outlet Water Temp.
Note:
Instrument needs energy capacity

x 0.001 (E-3)	x 0.01(E-2)
x 0.1(E-1)	x 1(E+0)
x 10(E+1)	x 100(E+2)
x 1000(E+3)	x 10000(E+4)

Heat Rate, Inlet water Temperature and Outlet water Temperature switch every 6 seconds, Use the ENTER to stop the switch.





M03

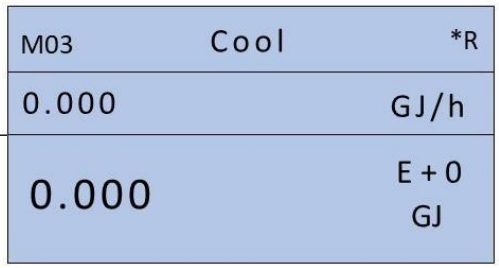
Cool Rate

Display the Cool Total.

Display the Cool Rate and the Inlet Water Temp and Outlet Water Temp.

x 0.001 (E-3)	x 0.01(E-2)
x 0.1(E-1)	x 1(E+0)
x 10(E+1)	x 100(E+2)
x 1000(E+3)	x 10000(E+4)

Cool Rate, Inlet water Temperature and Outlet water Temperature switch every 6 seconds, Use the ENTER to stop the switch.



M04

Status

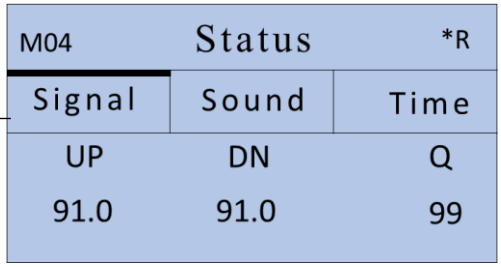
Display the Signal strength, the Upstream signal strength and Downstream signal strength.

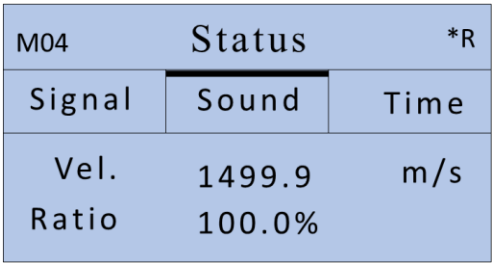
Signal quality Q is indicated by 00 ~ 99. Therefore, 00 indicates the poorest signal while 99 indicates the best signal.

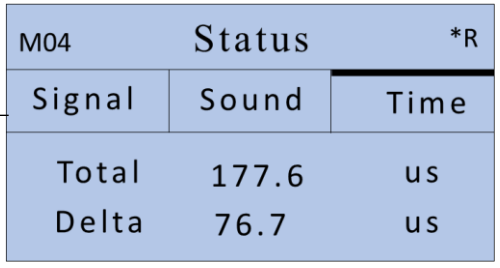
Display the measured fluid sound velocity. Normally this value should be approximately equal to the entered value in Window M12. If the difference is too large, it probably results from an incorrect value entered in Window M12.

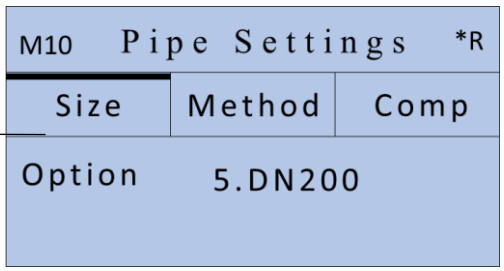
Display the ratio between the actual measured transmit time and the calculated transmit time according to customer's requirement. Normally the ratio should be 100 ±3%

Display the measured ultrasonic average time (unit: us) and delta time of the upstream and downstream (unit: ns) time. The velocity calculation in the flow meter is based on the two readings. The delta time is the best indication that the instrument is running steadily.



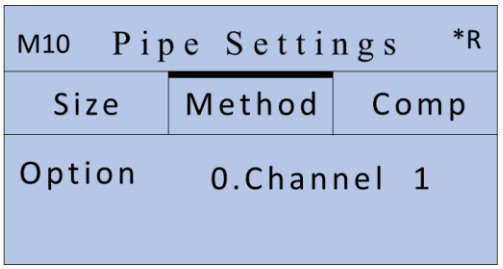


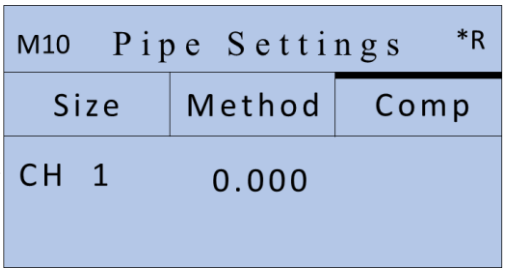


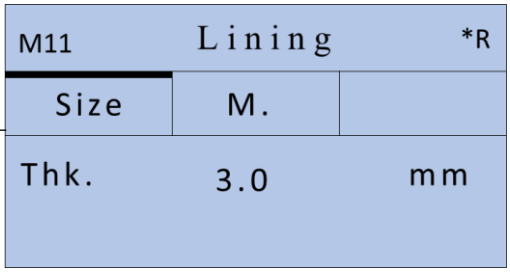


M10
Pipe settings
Enter the pipe outer diameter; the pipe outer diameter must range from 50mm to 300 mm.

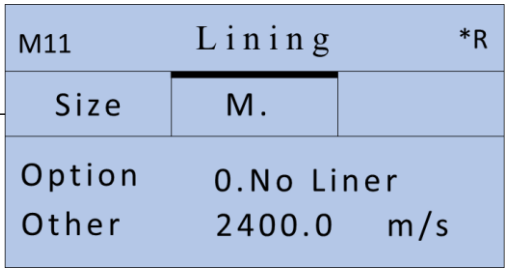
Important Note:
This menu is exclusively designated for use by the manufacturer during wet calibration at the factory. Users are emphatically cautioned against altering the values without prior permission from the manufacturer.



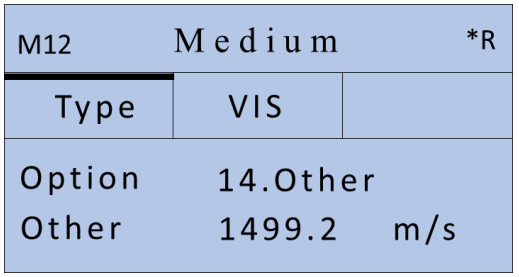


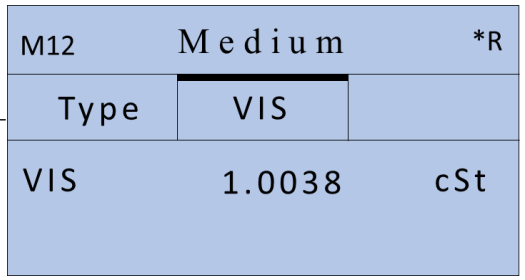


M11
Lining
Only the manufacturer should operate this menu. Users are strongly advised against entering or modifying any values within this menu.

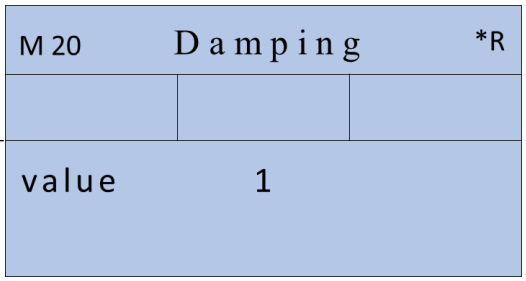


M12
Medium
Select the temperature of water. Temperature should be 0-80 deg. C. Press ―Enter‖ to confirm. Note: Room temperature is 25 deg C

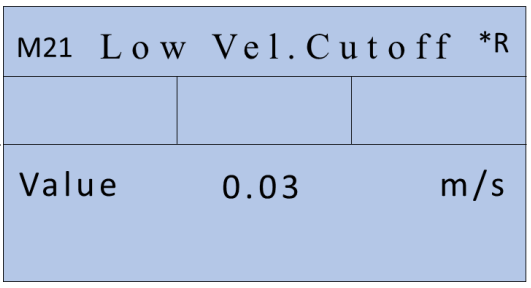




M20
Damping
The damping factor ranges from 1 ~ 999 seconds.1 indicates no damping; 999 indicates the maximum damping.
The damping function will stabilize the flow display. Usually a damping factor of 3 to 10 is recommended in applications.



M21
Low Vel. Cut off
Low Flow Cut off is used to make the system display as "0" value at lower and smaller flows to avoid any invalid totalizing. For example, if the cutoff value is set as 0.03, system will take all the measured flow velocity values from - 0.03 to + 0.03 as "0". Generally, 0.03 is recommended in most applications.



M22

Zero Settings

When fluid is in the static state, the displayed value is called "Zero Point". When "Zero Point' is not at zero in the flow meter, 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 by doing this and flow offset is eliminated. Select "YES"; reset "Zero Point" which was set by the user.

This method is not commonly used. It is only suitable for experienced operators to set zero under conditions when it is not preferable to use other methods. Enter the value manually to add to the measured value to obtain the actual value. For example:

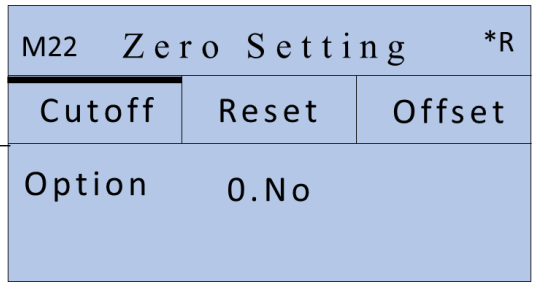
Actual measured value = 240 m3/H

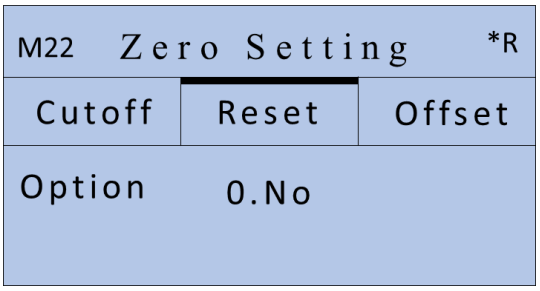
Value Deviation = 10 m3/H

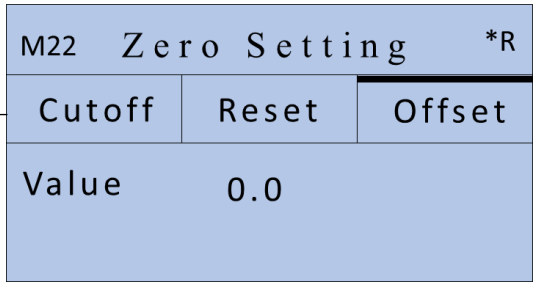
Flow meter Display = 250 m3/H

Normally, set the value as "0".

Use — ↑ ‖ and — ↓ ‖ to switch



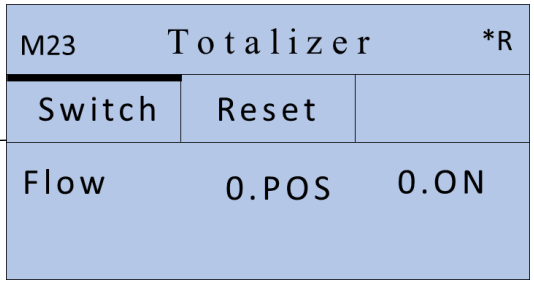


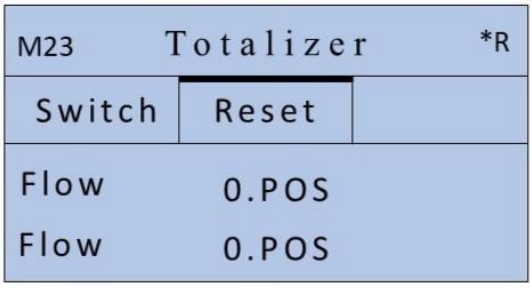


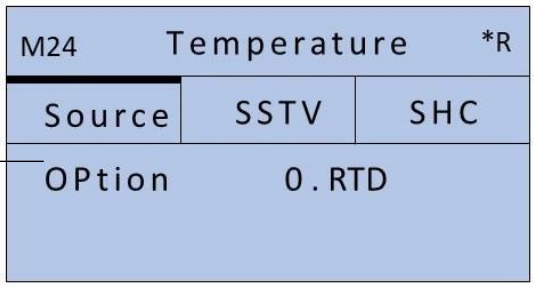
M23

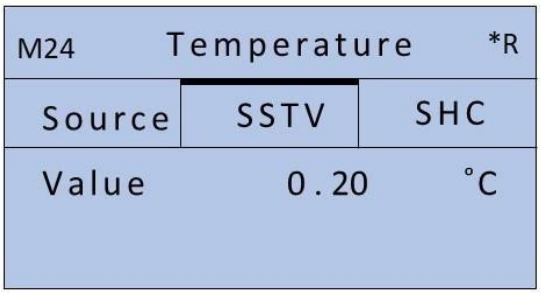
Totalizer

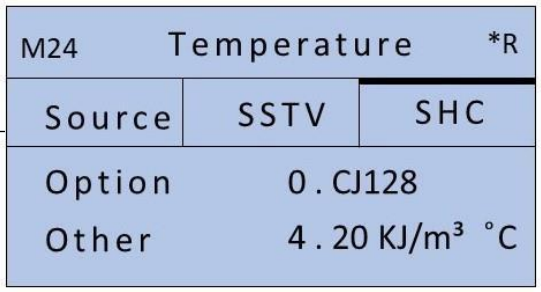
Select the totalizer type
0. POS Positive Totalizer
1. NEG Negative Totalizer
2. NET
Select "ON"/"OFF" to switch the totalizer.
Select the flow totalizer value you want Reset
0. POS Positive Totalizer
1. NEG Negative Totalizer
2. NET
3. All
Select the energy totalizer value you want reset
0.Heat
1. Cool
2.All











M24

Temperature

Select Heat Input Options:

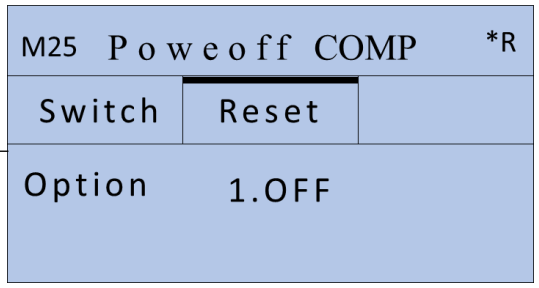
0. RTD
1. AI

Use —↑‖ and —↓‖ to switch Temperature Sensitivity Setting When the delta temperature is less than the sensitivity set, energy will not be accumulated. Set the adjustable temperature range of 0℃ ~ 20℃. The factory default setting is 0.2 ℃.

Select Specific Heat Options:

0. CJ128 SHC
1. Other

Use —↑‖ and —↓‖ to switch.



M25

Power Down Correction Switch

With the function of power down automation correction switch, 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 "ON" to use this function, select "OFF" to cancel this function.

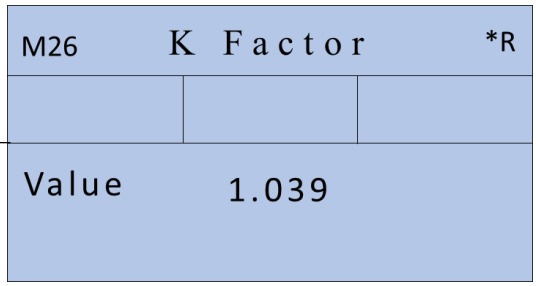
M26

K Factor

The K factor is used to modify the measurement results. The user can enter a numerical value (other than "1") according to the actual calibration results.

Important Note:

This menu is exclusively designated for use by the manufacturer during wet calibration at the factory. Users are emphatically cautioned against altering the values without prior permission from the manufacturer.



M27

Correction

K-Array

Sectional Correction

ON: Open the Sectional Correction Function;

OFF: Close the Sectional Correction Function

Delay correction

Engineer menu, suggest customer use the factory setting.

TPC

Transducers power control

Engineer menu, suggest customer use the factory setting.

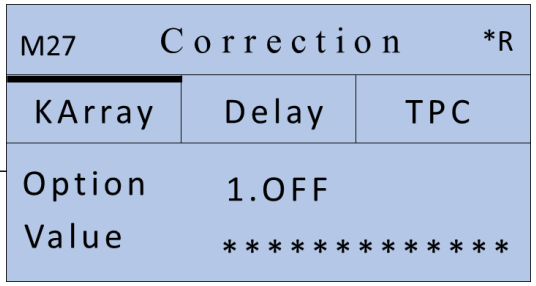
0. Auto

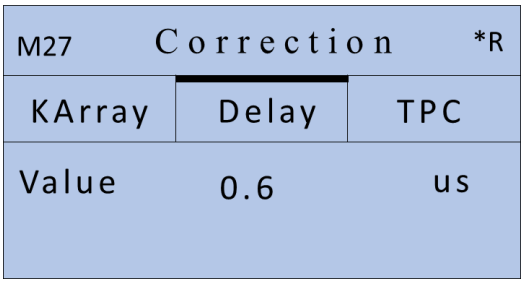
1. Low

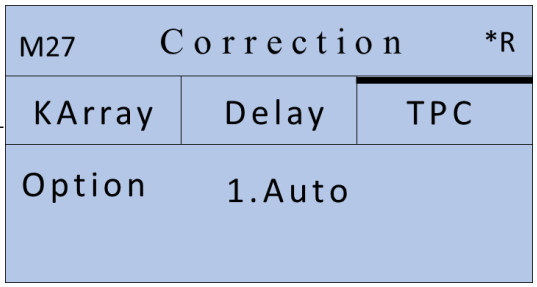
2. High

Important Note:

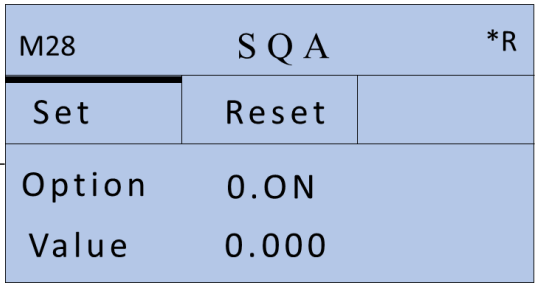
This menu is exclusively designated for use by the manufacturer during wet calibration at the factory. Users are emphatically cautioned against altering the values without prior permission from the manufacturer.

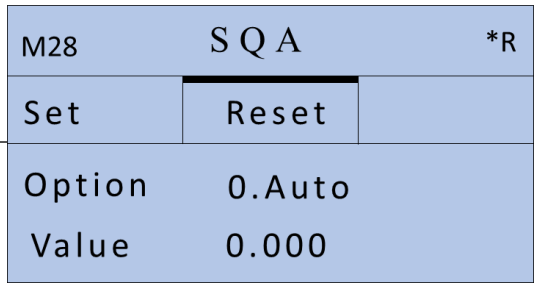






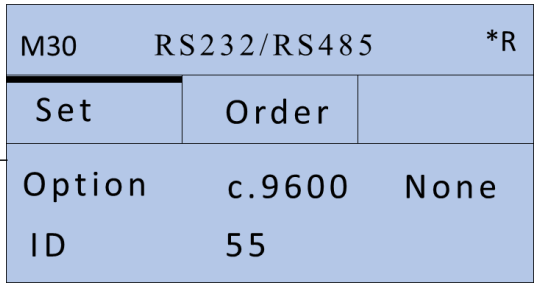
M28
SQA
Statistical Analysis

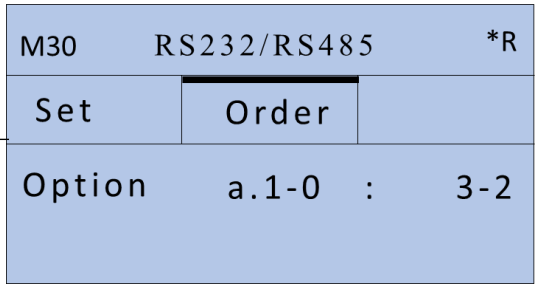




M30
RS232/RS485
Serial Port Setting
. 2400 None
. 4800 None
. 9600 None
. 19200 None
. 38400 None
. 56000 None
You can setting the order as following:

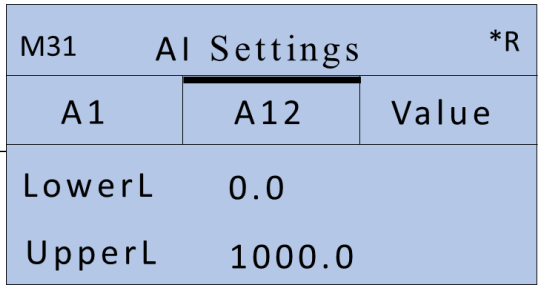
a. 1-0: 3-2
b. 0-1:2-3
c. 3-2:1-0
d. 2-3:0-1

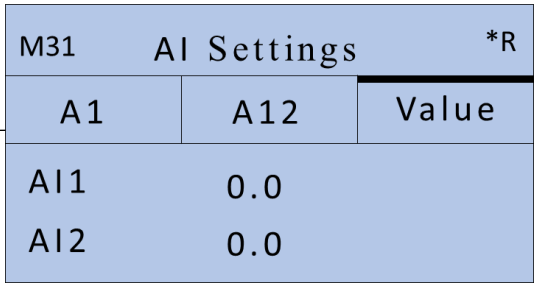


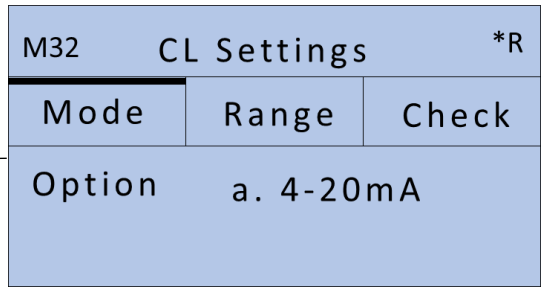


M31
AI Setting
Display analog input AI1 analog value.

Display analog input AI2 analog value.



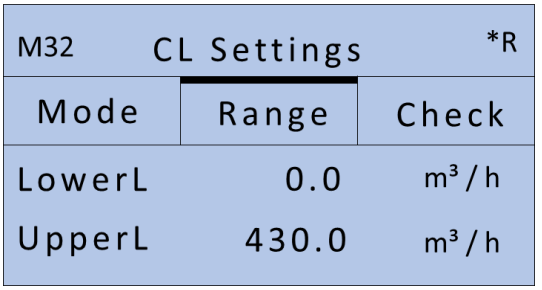


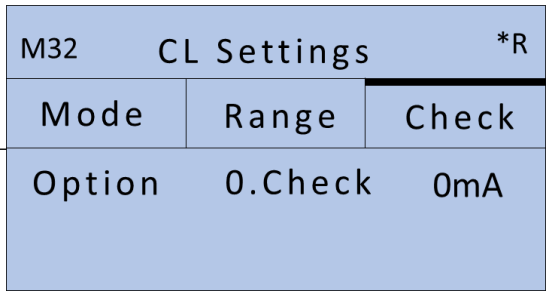


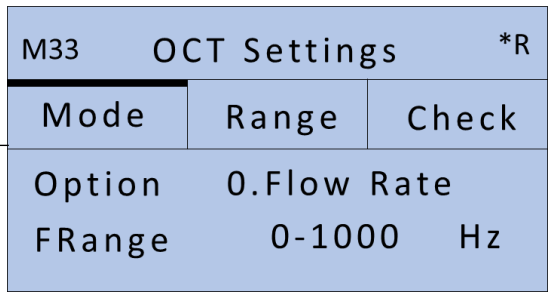
M32

CL Setting

Current Loop Mode Options
Select the CL Range value
Set the CL output value according to the flow value at 4mA or 0MA.
Set the CL output value according to the flow value at 20mA.
4-20mA check opinions
a. Check 4mA
b. Check 8mA
c. Check 12mA
d. Check 20mA





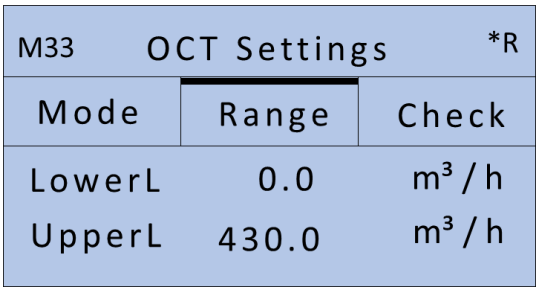


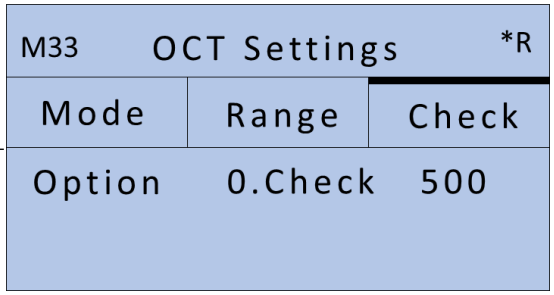
M33

OCT Setting

The following signal options are available:
a. Flow Rate
b. POS Total
c. NEG Total
d. NET Total
h. Rationing
i. Uart CTRL
Select the OCT Range value.

OCT check opinions
a. Check 500
b. Check 1000
c. Check 3000
d. Check 5000



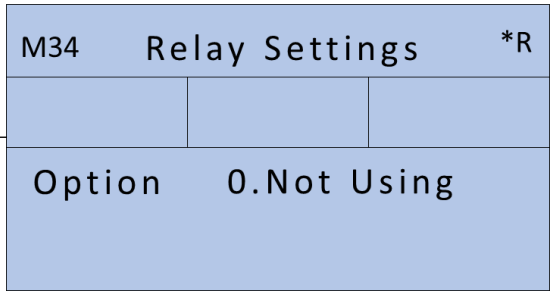


M34

Relay Setting

The following signal options are available:

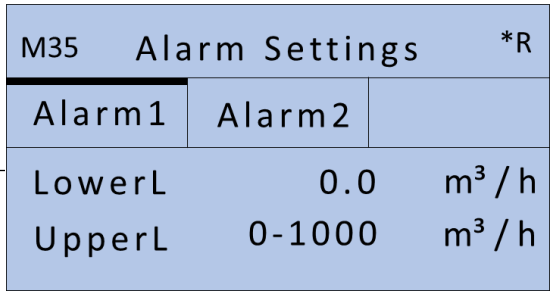
a. No Signal
b. *E
c. Reverse
d. Alarm1
e. Alarm2
f. Ration
g. POS Total
h. NEG Total
i. NET Total
j. Not Using

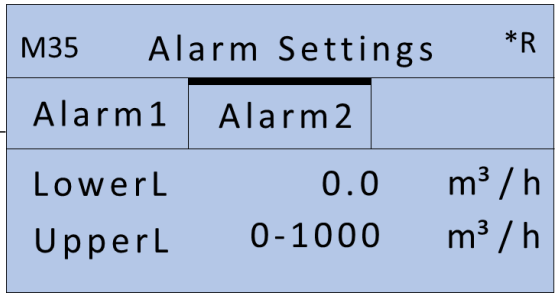


M35

Alarm Setting

Enter the Lower alarm value, any of the measured flow, which is lower than the low value, will activate the alarm in the OCT hardware or relay output signal. Enter the Upper alarm value, any of the measured flow, which is higher than the high value, will activate the alarm in the OCT hardware or relay output signal.





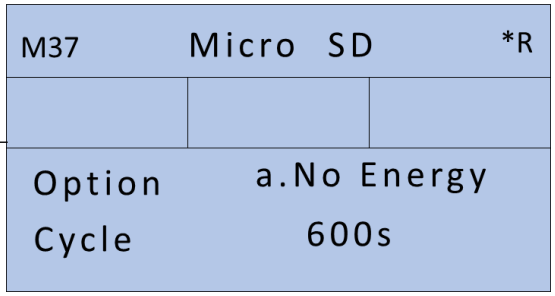
M37

Micro SD

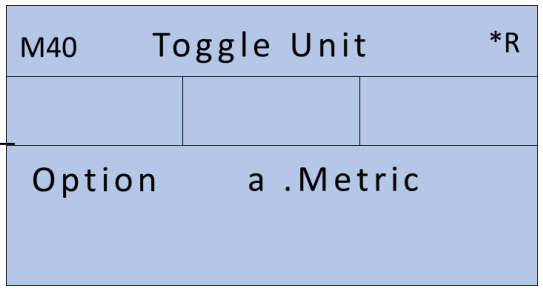
Following is the opinions for the record.

a. No Energy
b. All

Input the data collection time interval in this menu. Time is in seconds. The interval can be selected in the range of 1 ~ 3600 seconds.



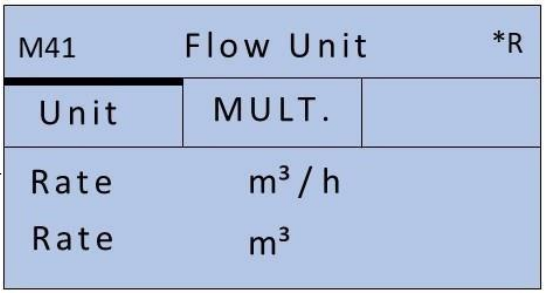
M40
Toggle Unit
Select the measurement unit as follows:
a. Metric
b. British

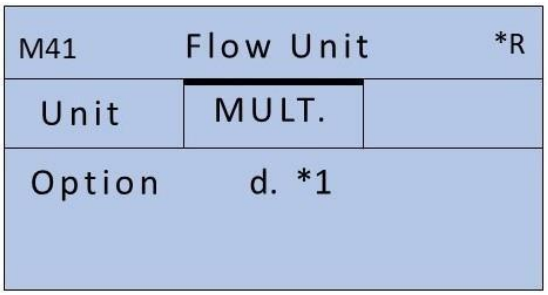


M41
Flow Unit
The following flow rate units are available:
0. Cubic Meters (m^3)
1. Liters (1)
3. Imperial Gallons (Imp gal)
4. Million Gallons (mg)
5. Cubic Feet (cf)
6. USA Barrels (US bbl)
7. Imperial Barrels (Imp bbl)
8. Oil Barrels (Oil bbl)

The following time units are available:
/Day /Hour
/Min /Sec
Factory default is Cubic Meters/hour.

a. x 0.001 (E-3)	b. x0.01 (E-2)
c. x 0.01 (E-1)	d. x1 (E+0)
e. x 10 (E+1)	f. x100 (E+2)
g. x1000 (E+3)	h. x10000 (E+4)



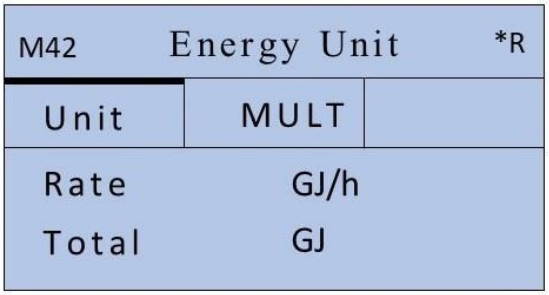


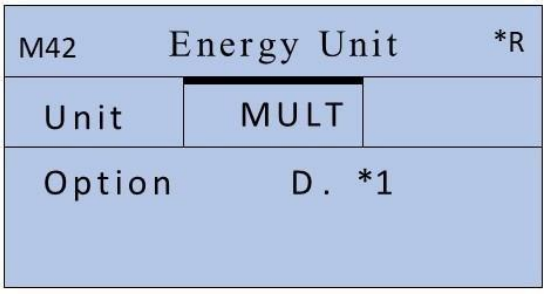
M42
Energy Unit

The following Energy units are available:

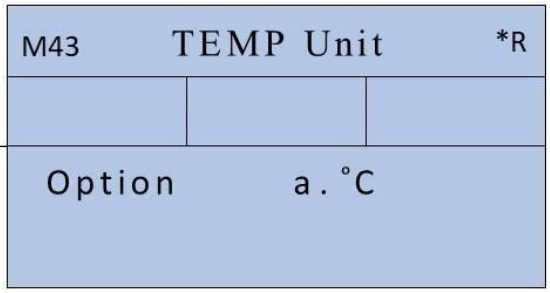
0. Giga Joule (GJ)	1. Kilocalorie (Kc)
2. MBtu	3. KJ
4. Btu	5. KWh
6. MWh	7. TH

a. x 0.001 (E-3)	b. x 0.01(E-2)
c. x 0.1(E-1)	d. x 1(E+0)
e. x 10(E+1)	f. x 100(E+2)
g.x 1000(E+3)	h.x 10000(E+4)

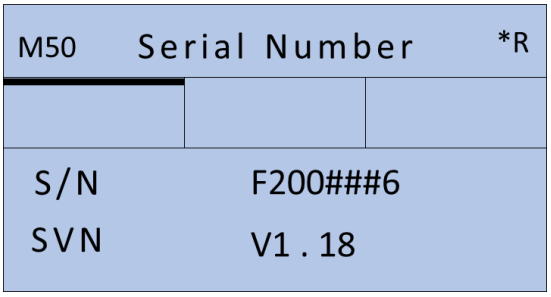




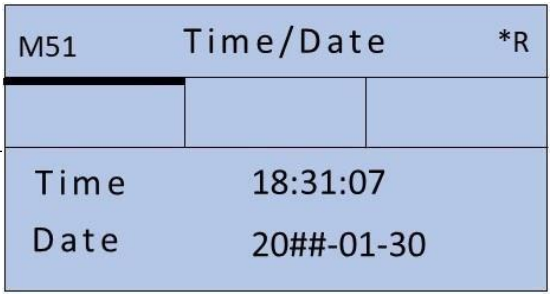
M43
Temperature Unit
a. ℃
b. °F
Use —↑‖ and —↓‖ to switch.



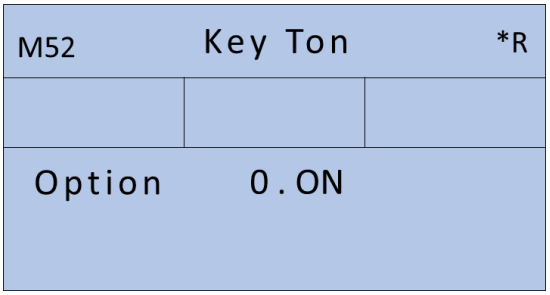
M50
Serial Number
Display electronic serial number (S/N) of the instrument. This S/N is the only one assigned to each flow meter ready to leave the factory. The factory uses it for files setup and for management by the user. SVN is the software version



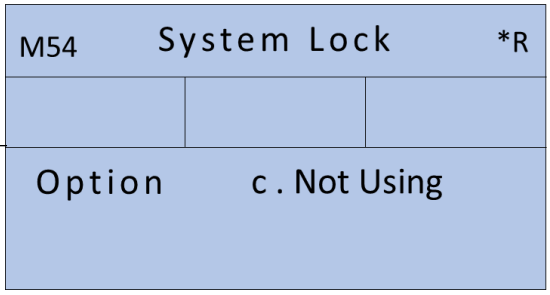
M51
Time and Date
Date and time modifications are made in this menu.



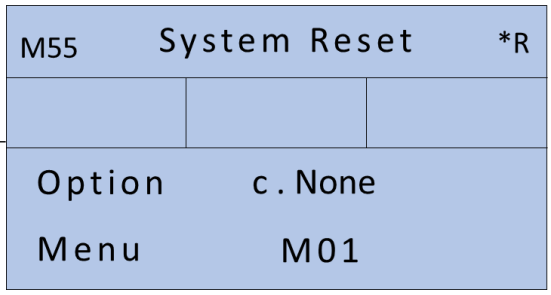
M52
Key Tone
Use this menu to —ON‖/ —OFF‖ the key tone.



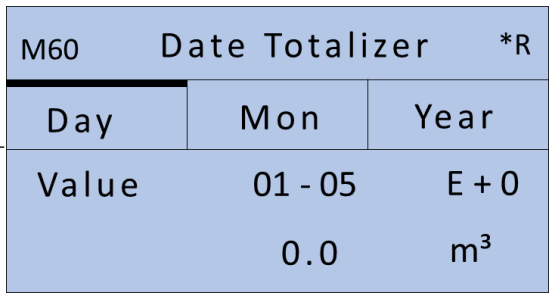
M54
System Lock
Lock the instrument. Once the system is locked, any modification to the system is prohibited, but the parameter is readable. Entering your designated password correctly can be the only way to "Unlock". The password is composed of 6 numbers. (Please contact the representative or manufacturer as soon as possible when the password is lost.)

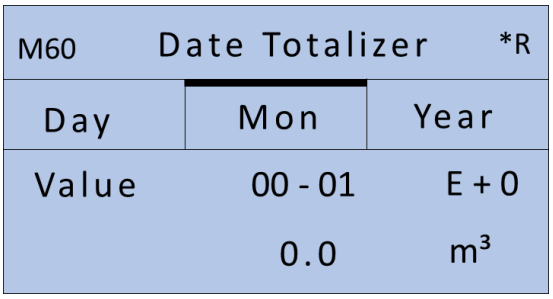


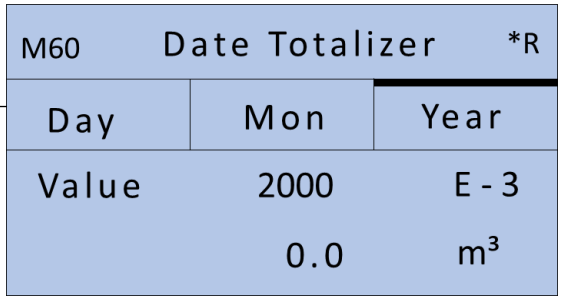
M55
System Reset
Select 1. Reset to make the instrument back to factory.



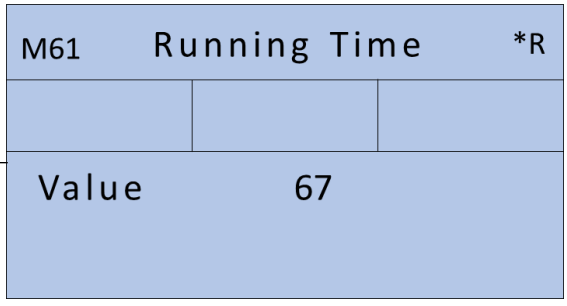
M60
Date Totalizer
The following options are available:
0. Day
1. Month
2. Year
In this window, it is possible to review the historical flow data net totalizer for any day for the last 31 days, any month for last 12 months and any year for last 6 years.



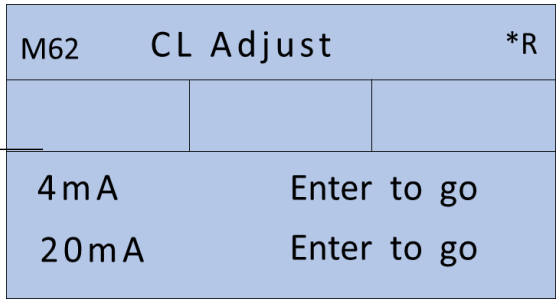




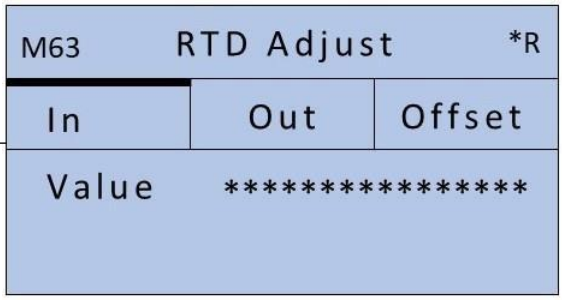
M61
Running Time
With this function, it is possible to view the total Working days since the flow meter left the factory.

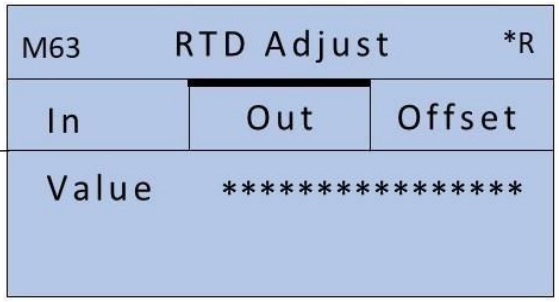


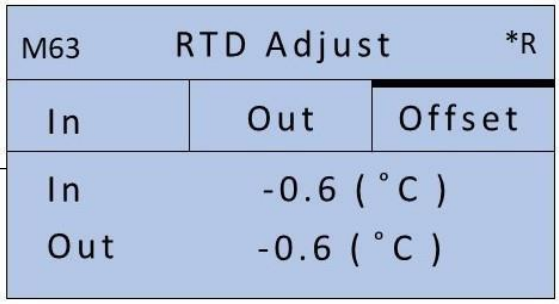
M62
CL Adjust
This menu is for the 4-20mA calibration; enter the password to adjust.



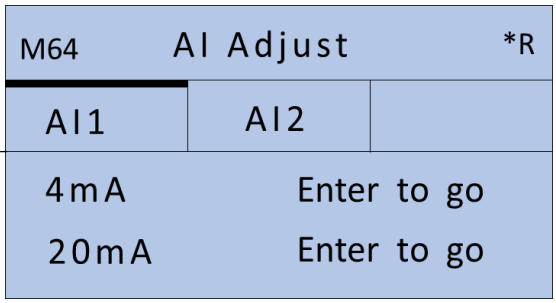
M63
RTD Adjust
This menu is for the RTD calibration; enter the password to adjust.

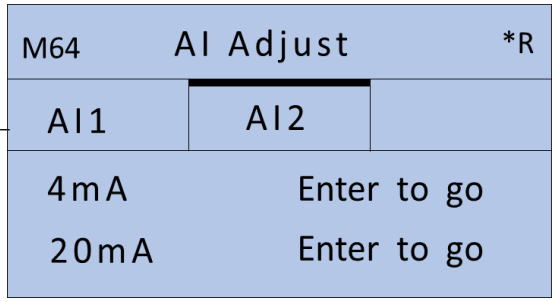






M64
RTD Adjust
This menu is for the AI calibration; enter the password to adjust.





Appendix 1– Serial Interface Network Use and Communications Protocol

Overview

The BTU meter features an excellent communication protocol and can be connected via RS-485 Modbus. When the serial port communications method is directly used to implement a monitoring network system, the address identification code of the BTU meter is used as a network address code. Expanded commandset with [W] is used as communication protocol. RS-485 (cable length 0 ~ 1000m) can be directly used for data transmission links for a short distance. Current loop can be used in medium or long-distance transmission.

When the BTU meter is used in a network environment, various operations can be performed by a host device, except for programming of the address identification code, which needs to be done via the BTU meter keyboard.

The command answer mode is used in data transmission, i.e. the host device issues commands and theBTU meter answers correspondingly.

Appendix 2– Communications protocol and the use

The BTU meter supports these three communication protocols: MODBUS-C Protocol, MODBUS-I Protocol.

MODBUS-I Communication Protocol

This MODBUS-I Protocol uses RTU transmission mode. The Verification Code uses CRC-16-IBM (polynomial is X16+X15+X2+1, shield character is 0xA001) which is gained by the cyclic redundancy algorithm method.
MODBUS-I RTU mode uses hexadecimals to transmit data.

MODBUS-I Protocol Function Code and Format

The BTU meter protocol supports the following two-function codes of the MODBUS:

Function Code	Performance data
0x03	Read register
0x06	Write single register

MODBUS Protocol function code 0x03 usage

The host sends out the read register information frame format:

Slave Address	Operation Function Code	FirstAddress Register	Register Number	Verify Code
1 byte	1 byte	2 bytes	2 bytes	2 bytes
0x01 ~ 0xF7	0x03	0x0000 ~ 0xFFFF	0x0000 ~ 0x7D	CRC (Verify)

The slave returns the data frame format:

Slave Address	Read Operation Function Code	Number of Data Bytes	Data Bytes	Verify Code
1 byte	1 byte	1 byte	N*x2 byte	2 bytes
0x01 ~ 0xF7	0x03	2xN*	N*x2 (Data)	CRC (Verify)

N* = Data register number

MODBUS Protocol function code 0x06 usage

The host sends a command to write a single register information frame format (function code 0x06):

Slave Address	Operation Function Code	RegisterAddress	Register Data	Verify Code
1 byte	1 byte	2 bytes	2 bytes	2 bytes
0x01 ~ 0xF7	0x06	0x0000 ~ 0xFFFF	0x0000 ~ 0xFFFF	CRC (Verify)

The slave returns the data frame format (function code 0x06):

Slave Address	Operation Function Code	RegisterAddress	Register Data	Verify Code
1 byte	1 byte	2 bytes	2 bytes	2 bytes
0x01 ~ 0xF7	0x06	0x0000 ~ 0xFFFF	0x0000 ~ 0xFFFF	CRC (Verify)

The CRC Verify Code adopts CRC-16-IBM (polynomial is X16+X15+X2+1, shield character is 0xA001) which is gained by the cyclic redundancy algorithm method. Low byte of the verify code is at the beginning while the high byte is at the end.

For example, to read the address 1 (0x01) in the RTU mode, if the instantaneous flow rate uses hour as a unit（m3/h）, namely reads 40005 and 40006 registers data, the read command is as follows:

0x01	0x03	0x00 0x04	0x00 0x02	0x85 0Xca
BTU meter Address	Function Code	First Address Register	Register Numbers	CRC Verify Code

BTU meter returned data is (assuming the current flow=1.234567m3/h)

0x01	0x03	0x04	0x06 0x51	0x3F 0x9E 0x3B 0x32
BTU meter Address	Function Code	Data Bytes	Data (1.2345678）	CRC Verify Code

The four bytes 3F 9E 06 51 is in the IEEE754 format single precision floating point form of 1.2345678.

Pay attention to the data storage order of the above example. Using C language to explain the data, pointers can be used directly to input the required data in the corresponding variable address, the low byte will be put at the beginning, such as the above example 1.2345678 m/s, 3F 9E 06 51 data stored in order as 51 06 9E 3F.

For example, it converts the address 1 (0x01) to 2（0x02） under the RTU mode, so to write the data of BTU meter 44100 register as 0x02, the write command is as follows:

0x0	0x06	0x10 0x03	0x00 0x02	0xFC 0xCB
BTU meter Address	Function Code	Register Address	Register Number	CRC Verify Code

BTU meter returned data is:

0x01	0x06	0x10 0x03	0x00 0x02	0xFC 0xCB
BTU meter Address	Function Code	Register Address	Register Number	CRC Verify Code

Error Check

The BTU meter only returns one error code 0x02 which means data first address in error.
For example, to read address 1 (0x01) of the BTU meter 40002 register data in the RTU mode, the BTU meter considers it to be invalid data, and sends the following command:

0x01	0x03	0x00	0x01 0x00 0x01	0xD5 0xCA
BTU meter Address	Function Code	Register Address	Register Number	CRC Verify Code

BTU meter returned error code is:

0x01	0x83	0x02	0xC0 0xF1
BTU meter Address	Error Code	Error Extended Code	CRC Verify Code

MODBUS Register Address List

The BTU meter MODBUS Register has a read register and a write single register.

a) Read Register Address List (use 0x03 function code to read)

PDU Address	Register	Read	Write	Type	No. registers*
$0000	40001	Flow/s - low word	32 bits real	2	
$0001	40002	Flow/s - low word			
$0002	40003	Flow/m - low word	32 bits real	2	
$0003	40004	Flow/m- high word			
$0004	40005	Flow/h - low word	32 bits real	2	
$0005	40006	Flow/h - high word			
$0006	40007	Velocity – low word	32 bits real	2	
$0007	40008	Velocity – high word			
$0008	40009	Positive total – low word	32 bits int.	2	
$0009	40010	Positive total – high word			

$000A	40011	Positive total – exponent	16 bits int	1	
$000B	40012	Negative total – low word	32 bits int	32 bits int	
$000C	40013	Negative total – high word			
$000D	40014	Negative total – exponent	16 bits int.	1	
$000E	40015	Net total – low word	32 bits int.	2	
$000F	40016	Net total – high word			
$0010	40017	Net total – exponent	16 bits int.	1	
$0011	40018	Energy flow – low word	32 bits int	2	
$0012	40019	Energy flow – high word			
$0013	40020	Energy total(hot) –low word	32 bits real	2	
$0014	40021	Energy total(hot) –high word			
$0015	40022	Energy total(hot) – exponent	16 bits int.	1	
$0016	40023	Energy total(cold) –high word	32 bits real	2	
$0017	40024	Energy total(cold) – exponent			
$0018	40025	Energy total(cold) – exponent	16 bits int	1	
$0019	40026	Up signal int – low word	32 bits real	2	0 ~ 99.9
$001A	40027	Up signal int – high word			
$001B	40028	Down signal int – low word	32 bits real	2	0 ~ 99.9
$001C	40029	Down signal int – high word			
$001D	40030	Quality	16 bits int.	1	0 ~ 99
$001E	40031	Error code – char 1	String	1	Refer to "Error Analysis" for detailed codes meanings.
$003B	40060	Flow velocity unit –char 1,2	String	2	Only m/s right now
$003C	40061	Flow velocity unit –char 3,4			
$003D	40062	Flow rate unit –char 1,2	String	2	Note 1
$003E	40063	Flow rate unit –char 3,4			
$003F	40064	Flow total unit – char 1,2			
$0040	40065	Energy rate unit – char1,2	String	2	Note 2
$0041	40066	Energy rate unit – char 3,4			
$0042	40067	Energy total unit – char 1,2	String	1	
$0043	40068	Instrument address –low word	32 bits real	2	
$0044	40069	Instrument address –high word			
$0045	40070	Serial number – char 1,2	String	4	
$0046	40071	Serial number – char 3,4			
$0047	40072	Serial number – char 5,6	String	4	
$0048	40073	Serial number – char 7,8			
$0049	40074	Analog Input AI1 Value- low word			Returned temperature value with RTD option
$004a	40075	Analog Input AI1 Value- high word			
$004b	40076	Analog Input AI2 Value- low word	32 bits real	2	
$004c	40077	Analog Input AI2 Value- high word			
$004d	40078	4-20mA Value- low word	32 bits real	2	Unit: mA
$004e	40079	4-20mA Value- high word			

Appendix 3 Sound Velocity in Water (1 atm) at different temperatures

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

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