ThermoPro Series

TP10 Ultrasonic Energy Meter

User's Manual

UMTP10-11-08C

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IMPORTANT:

This document only has to be used together with the user's manual of EF10 flowmeter, "Man_EF10.pdf". The flow measurement portion of the TP10 energy meter is extensively explained there.

TP10 Quick Start

TP10 Clamp-on Energy Meter with
Surface-mount Temperature Sensors

TP10 Clamp-on Energy Meter with
Insertion-mount Temperature Sensors

The ThermoPro series TP10 Clamp-on ultrasonic thermal energy meter is consisted of an EF10 Clamp-on flowmeter and a pair of PT100 temperature sensors.
There are two kinds of temperature sensors, the surface-mount type, PT100SM, and the insertion type, PT100IN.

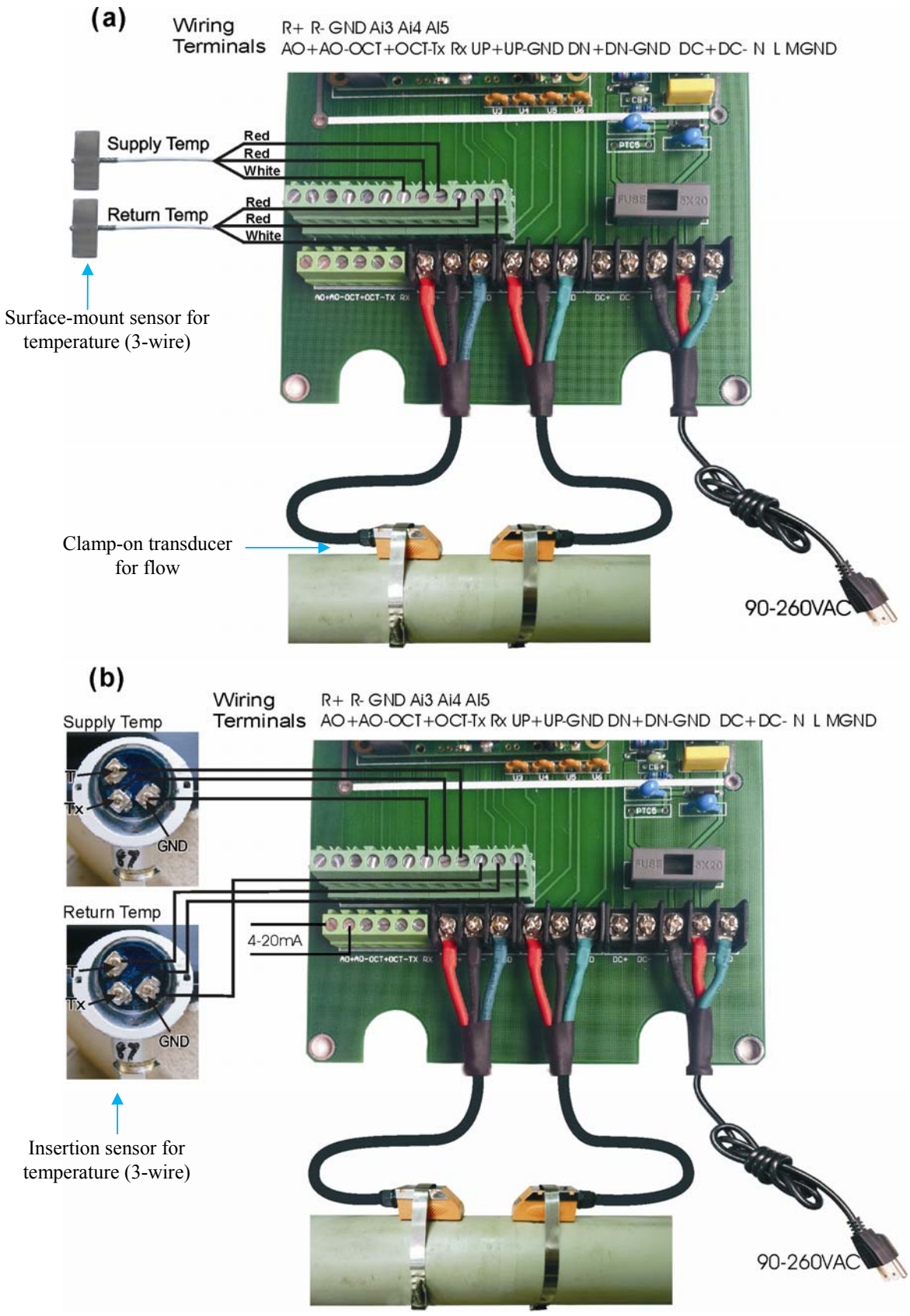
Step 1. Wiring and Power Up

Open the main unit cover. Do not turn on the power.

Wire the transducer cables, temperature sensors and the other input/output as shown on the next page. The top figure (a) is for PT100SM sensor, the lower figure (b) is for PT100IN sensor.

After finish the wiring, close the main unit's cover.

Turn the power on. The meter will be on immediately. It goes through a self-checking process to make sure everything is working properly. After a few seconds, main unit will enter into normal working status.


(a)
Wiring Terminals
R+ R- GND Ai3 Ai4 AI5
AO+AO-OCT+OCT-Tx Rx UP+UP-GND DN+DN-GND DC+DC- N L MGND
Supply Temp
Red
Red
White
Return Temp
Red
Red
White
Surface-mount sensor for temperature (3-wire)
Clamp-on transducer for flow
90-260VAC
(b)
Wiring Terminals
R+ R- GND Ai3 Ai4 AI5
AO+AO-OCT+OCT-Tx Rx UP+UP-GND DN+DN-GND DC+DC- N L MGND
Supply Temp
Rx
Tx
GND
Return Temp
Rx
Tx
GND
4-20mA
Insertion sensor for temperature (3-wire)
90-260VAC

Note:
The wiring terminal layout on the PCB board may change. Please use the label near each terminal block as the final one.
For 4-wire temperature sensor, tie the two red wires together and connected it to the GND terminal block.

Step 2. Program the Main Unit

2.1. Enter pipe info

Pipe OD: Switch to menu window M11 by pressing keys MENU, 1 and 1 orderly. Then, press the ENT key to enter into edit mode, key in the pipe outer diameter, and press the ENT key to confirm.

Wall-thickness: Press the ▼/- key to scroll down to the next menu, M12. Press ENT to enter into edit mode. Key in the pipe wall-thickness value. Press ENT again to confirm.

Note: For pipe OD or Wall-thickness, please go to *http://www.spiremt.com/support/PipeDimension.html*..

Note: to change the value of a menu window, you need always press the ENT key first to enter into edit mode. After keying in the new parameter, you need press ENT again to confirm the change.

Pipe Material: Press ▼/- to scroll down to M14. Press ENT and then use ▼/- to select the proper item. If pipe material is not shown on the list (non-standard material), select Others. Press ENT to confirm.

Sound Speed in Pipe Wall: If you selected Others in the above step, then, press ▼/- to scroll down to M15. Enter the sound speed of your pipe material. If your pipe is plastic, enter 3478ft/s (or 1060m/s). Press ENT to confirm.

Pipe lining: If your pipe has lining inside, enter the lining information on menu windows M16-M18.

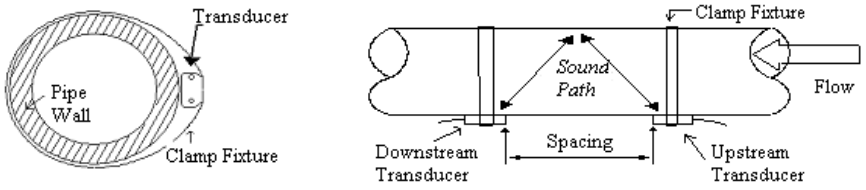
2.2. Enter fluid info

Fluid Type: Switch to menu M20 (simply press keys MENU, 2 and 0 orderly.) Then, press ENT, select the item that matches your fluid type and press ENT again.
If you do not find a match (non-standard fluid), select Others.

Sound Speed in Fluid: If you selected Others in the above step, then, scroll down to M21. Press ENT, key in the sound speed of the fluid and press ENT again.
You can find sound speed information in the EF10 User's Manual.

2.3. Enter transducer info

Transducer Type: Switch to M23. Press ENT, select the proper transducer type from the list, then, press ENT again.
If you have S1HT/ M1HT - type transducer, select *Standard-S1 / Standard-M1* respectively.
If you have HF0 transducer, select *User Defines*. Then enter the 4 Parameters for the transducer.
Frequency: Scroll down to M24. Select 2MHz if your transducer is HF. Select 0.5MHz if your transducer is LF. Select 1MHz for other transducers.
Note: If you do not see Frequency in M24, your system is a 1MHz system. Just go to Mounting Method.
Mounting Method: Scroll down to M24, select the proper installation method and ENT.
For 1" ~ 12" pipes, use the V-method (see figure below). For 12" and larger pipes, use the Z-method.



V-method Installation

Mounting Spacing: Scroll down to M25. The displayed value is the mounting spacing between the two transducers. Write down this number, as you will need it later when installing the transducers.

Transducer Scale Factor: Switch to M45. Press ENT and then enter the scale factor of the transducer you are going to use. Press ENT again to confirm the change.
Save Configuration: Switch to M26, press ENT, select item 1 and press ENT to save.

Note:
For temperature and thermal energy measurement, you may also need to check the following menus: M05 for Energy Rate and Energy Total and M06 for Temperature T1 and T2.

Step 3. Install Transducers

For ultrasonic transducer installation, please refer to *chapter 2 of the EF10 User's Manual.*

For temperature sensor PT100SM, please refer to the appendix A of this document.

For temperature sensor PT100IN, please refer to the appendix B of this document.

Step 4. Fine Tuning

Switch to M90 for signal strength S (UP or DN) and signal quality Q, and then go to M91 for transit-time ratio R. There are three important numbers displayed on these two menu windows. Their values shall fall into the right ranges in order to justify the reading:

S: 60 ~ 99
Q: 60 ~ 99
R: 97% ~ 103%

If the triplets are not in the range, please verify the parameters you have entered in Step 2. If you believe your entries are correct and the three numbers are still off their ranges, you may need to check your installation. Here are some tips:

- Make sure the pipe is full and no air bubble in the liquid. For vertical pipe, make sure flow goes upward
- Make sure the transducer mounting area on the pipe is coating-free and smooth
- Moving one transducer closer to or away from the other slowly to bring the triplets into the range
- For non-plastic pipes of 2" and less, we recommend to use HF0 2MHz transducer to achieve better results.

For more details, you may refer to section $2.11 of the EF10 manual as well as the Frequently Asked Questions section on web page http://www.spiremt.com/support/EnduroFlow.html.

Note: Please make sure to complete the installation before the silicon couplant begins to dry.

The sound speed information in menu M92 might also be useful for debugging. The displayed value should be close to the one you have entered in step 2.2. If you have entered fluid type in step 2.2 instead, and you do not know the fluid sound speed, you can find this information in the Appendix of the EF10 User's Manual.

If all the three parameters are good, and the measurement sound speed in M92 looks reasonable, your installation is done. You are ready to look at your measurement results on menu window M00.

TP10x User's Manual

- Thermal Energy Measurement

1. Introduction

The TP10 ultrasonic energy meter is equipped with a pair of PT100 RTD sensors. It not only measures the flow rate, but also measures the temperatures of the supply and the return. It then calculates the thermal energy transfer/consumption based on standard calculation formula.

The TP10 has two built-in signal conditioning circuit channels to accommodate the temperature sensors in order to obtain accurate temperature data. It has a generic energy totalizer which is resettable. It also has daily/monthly energy totalizers.

Here are some menu windows related to temperature than thermal energy measurement:

M05: Energy Rate and Energy Total

M06: Temperature T1 and T2

M37: Totalizer reset

M55-57: 4-20mA output

M82: Daily/Monthly totalizers

M84: Energy unit selection, KCAL/s - Kilocalories/second, GJ/s – Giga Joules/second

M85: Temperature selection (not recommended to change)

M86: Specific heat selection (or thermal capacity coefficient)

M87: Energy totalizer ON/OFF switch

M88: Energy multiplier

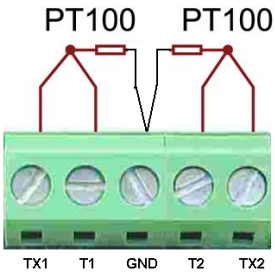
M89: Temperature difference

M8: Flow sensor location - inlet (supply) or outlet (return)

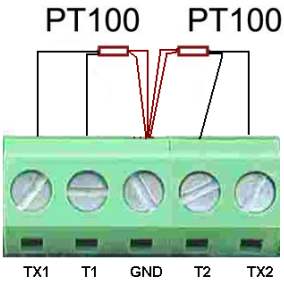
2. Wiring

The two temperature channels designed for thermal measurement function are wired to terminal block pins TX1, T1, TX2, T2 and GND. They can work with a 3-wire or 4-wire PT100 sensor without any extra parts. The wiring diagram is shown below.

Menu window M06 and M89 display the temperature measurement results. M07 displays the analog input current and its corresponding pressure or temperature value.



Wiring diagram for 3-wire PT100 sensors



Wiring diagram for 4-wire PT100 sensors

3. Thermal Energy Measurement

There are two methods for thermal energy calculation:

(1) Qt = Q x (T2 – T1) x Ct,

(2) Qt = Q x (TC2 – TC1)

Where Qt is the thermal energy (or caloric) consumed, Q is the flow rate, T1 and T2 are the temperature at supply and return points, respectively. Ct is the specific heat (or the thermal capacity coefficient) of the fluid, which can be entered in menu M86. For water, it is normally about 0.0041868GJ/m3°C. TC1 and TC2 are the thermal capacities corresponding to temperature T1 and T2, which are calculated by the flowmeter according to international standards and displayed in M05.

Note that, if the fluid temperatures at both supply and return points are stable, you may choose not to use temperature transmitters. Instead, you can directly enter the temperature difference of the two points on menu window M85.

4. Calibration of the Temperature Measurement System

The temperature measurement accuracy of the TP10, under the un-calibrated condition, is usually within the 1.0 ℃ range. That is, if the PT100 sensor was replaced, or if the temperature measurement devices were replaced, it will produce errors of about 1.0 ℃.

In order to achieve the temperature measurement accuracy of 0.1 ℃, the temperature measurement portion must be calibrated.

In general constant temperature baths are used for the calibration.

TP10 uses two reference temperature points of 50 ℃ and 84.5 ℃ for the calibration.

Two constant temperature baths are set, one at 50 ± 0.05 ℃, and the other at 84.5 ± 0.05 ℃, use the

following steps for the calibration:

(1) Immerse the two PT100 sensors into the 50 ℃ constant temperature bath.

(2) Key in 【M】【-】【0】for the "Hardware Adjusting Entry" window, then press 【ENT】and key in the Hardware Adjusting code 【4】【2】【1】【3】【0】【6】【8】【ENT】 to start the hardware adjustments.

(3) Key in 【M】【-】【9】for the "High Temp Zero Set" window, then press 【↓】 for the "Temp Calibration 50C" window, which will display the current un-calibrated T1 and T2 temperature values.

(4) After the PT100 sensors have reached temperature stabilization (about 2 minutes), press the 【ENT】 key and then press the【ENT】 key again to confirm calibration at 50℃. The display window will now jump to M06 and display the current calibrated temperature values.

(5) Now immerse the two PT100 sensors into the 84.5 ℃ constant temperature bath.

(6) Key in 【M】【-】【9】for the "High Temp Zero Set" window again, then press 【↓】 , 【↓】 for the "TempCalibration84.5C" window, which will display the current un-calibrated T1 and T2 temperature values.

(7) After the PT100 sensors have reached temperature stabilization (about 2 minutes), press the 【ENT】 key and then press the 【ENT】 key again to confirm calibration at 84.5℃. The display window will now jump to M06 and display the current calibrated temperature values.

(8) The temperature measurement calibration portion is now complete; you may now test the calibration results.

During the above (4) or (7) steps, if the display window shows: "Temperature Error? Press [ENT] to go", this indicate either a problem of your reference temperature, or the temperature measurement circuit has a problem.

If constant temperature baths are not available, you may use decade resistor boxes to achieve the temperature calibration. For calibrating the reference temperature of 50 ℃, you can connect two equivalent resistances of 119.397 ohms to the TX1, T1, TX2, T2, and GND terminals; likewise, for calibrating the reference temperature of 84.5 ℃, the equivalent resistances will be 132.613 ohms.

If constant temperature baths and decade resistor boxes are not available, the TP10 has a dual-channel PT100 sensors zero-set point function; this is to correct the dual-channel's temperature sensors' matching errors. In order to match the full scale range of zeroing, TP10 has two zero set points for both the low and high temperatures. "Low Temp Zero-Set" is in menu M-8, "High Temp Zero Set" is in menu M-9.

When setting the temperature zero set points, it is best that the two PT100 sensors be immersed into sufficient amount of water until they have reached temperature stabilization, and then go to menu M-8 or M-9 to set their respective zero set points. Please note that the temperature for setting the "Low Temp Zero-Set" cannot exceed 40 ℃, and the temperature of the "High Temp Zero Set" must be at least 55 ℃.

Setting the temperature zero set points is only for correcting the initial two temperature sensors' inherited "zero" offsets. The best way is still to use constant temperature baths for the temperature calibration.

Appendix A: PT100SM Surface Temperature Sensor

- **100 Ohm Thin Film DIN Platinum Class "B" (±0.12 Ohms, ±0.30°C at 0°C) Accuracy Standard**
- **Silicone Adhesive rated to 260°C (500°F)**
- **Temperature Range; -73C to 260°C Continuous,**
- **Stocked in 1m (40") Lengths**
- **3 Wire Construction Standard**
- **Response Time: Less than 0.9 sec (63% Response in Water Flowing at 3' Per Second); Less Than 2 Seconds On a Hot Plate**

The PT100SM is a surface temperature sensor that can be applied to most clean, dry surfaces. Just peel off the release sheet on the bottom of the sensor and the silicone adhesive bonds the sensor to the surface, no cements or epoxies to mix, apply and cure.
The thin design of the PT100SM minimizes the effects of having the sensor attached to the surface of interest. Containing a thin film platinum sensing element, the PT100SM resistance is not affected by mounting to curve surfaces. With a fast thermal response time, the PT100SM will quickly respond to changes in temperature for fast, reliable measurements.

After mounting the temperature sensor, we do recommend you to wrap around the pipe and the sensor with thermal-isolation material in order to make sure the temperature picked up by the sensor is close to the temperature of the liquid in the pipe.

Appendix B: PT100IN Insertion Temperature Sensor

Assemblies Include Spring Loaded Probes for Improved Response Time and Vibration Resistance When Used in Thermowells

Standard Probes Supplied with 100Ohm Thin Film Class “B” DIN Platinum Elements in 3-Wire Configurations with IEC751/ASTM-E-1137 Color Codes

Multiple Connection Head Options Include Screw Cover and Snap Locking Enclosures with Ceramic Terminal Boards

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