BTU Measurement System

C03P BTU METER serial
BTU Measurement System Operation Manual

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Chapter one: BTU Measurement System

1.1 General introduction

AKE BTU Measurement System is used to measure individual energy consumption in any liquid heating/cooling system such as apartment, commercial office, and condominiums. This system is also used to measure performance of energy saving system or the loss of efficiency which is directly tied to loss of revenue. The system real-time detects the temperature of supply and return pipe, monitors the instantaneous flow rate, according to Heat Exchange of thermodynamics principle the BTU meter accumulates each user’s heat energy consumption and transfer the data to up-PC, finally as per rated unit price (Dollars/MW) to calculate the total fee of them.

1.2 Working principle & process

1.2.1 Working principle

C03P BTU meter calculates energy consumption by flow rate and temperature different, the formula is:

\[ Q = \int_{\tau_0}^{\tau_1} q_m \Delta h \, d\tau = \int_{\tau_0}^{\tau_1} \rho q_v \Delta h \, d\tau \]

Notes:
- Q: Heat consumption or cool consumption (unit: J or wh)
- \( q_m \): Unit weight of water passed flow meter (unit: kg/h)
- \( q_v \): Unit volume of water passed flow meter (unit: m³/h)
- \( \rho \): Density of water (unit: kg/ m³)
- \( \Delta h \): Enthalpy of water (unit: J/kg)
- \( \tau \): Time (unit: h)

1.2.2 Working process:

When the water or other liquid passes through the water pipe, the flow meter measures the instantaneous flow rate ‘q’ and sends it to BTU meters, temperature sensor tests the return pipe temperature ‘T1’ and supply pipe temperature ‘T2’ and also sends it to BTU meter. According to above formula, BTU meter integrates the cooling or heat consumption. If T1 > T2, integrates cooling consumption, otherwise integrates heat consumption. Finally BTU meter stores the data and displays on LCD.
1.3 BUT meter component description:
Chapter two: C03P BTU Meter

2.1 General description

C03P BTU Meter is a liquid heat exchange calculation device for Central Air-conditioning. Besides heating calculation, it also could calculate cooling energy consumption. It collects the data from temperature sensor and flow meter, basing on Heat Exchange principle the system automatically integrates energy consumption and transfers it to PC. It can check consumption volume by tenant or operator, real time shows instantaneous temperature, flow rate and energy consumption etc., it also has the ability to show history data with bar chart.

1. BTU meter(Model: C03P)—Calculates the energy consumption with high accurate and reliable, mounted on the wall, no condensed water problems;
2. Temperature Sensors—PT1000
3. Flow meter: Electromagnetic Flow meter, Vortex Flow meter, Rotameter are available, recommends Electromagnetic Flow meter

2.2 Function

- Calculates heating and cooling energy consumption;
- Tracks accumulated energy consumption;
- Tracks historical data with graphic analysis;
- Has remotely warn function;
- Real-time monitor function;
- Storage security of data, stores data automatically once power failure;
- Has real-time clock function;

2.3 Characteristic:

- Large LCD screen, real time shows supply/return water temperature, instantaneous flow rate, cooling consumption value, heating consumption value, instantaneous power, total flow rate etc.;
- Shows history data with bar chart, easily analyze and check;
- All the designed parameter is much more closed to actual project application, multi-password protected prevents data missed and revised;
- Perfect interface design, Current input (4-20mA) and pulse input compatible, suitable for different kinds of flow meters to collect signal;
- RS485 or M-Bus Communication interface, reliable;
- Electricity and optics is isolated, good anti-interference performance;
- Remote warn and clock function, remotely revise the time periodically;
- Has data output interface, could be integrated into Auto Reading Meter system;
- Can be auto setup small flow rate ignored;
2.4 Parameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating voltage</td>
<td>220VAC±10% ,50±1Hz</td>
</tr>
<tr>
<td>Temperature range</td>
<td>(0.0～99.9)℃</td>
</tr>
<tr>
<td>Temperature accuracy</td>
<td>±0.1℃</td>
</tr>
<tr>
<td>Matched with temperature sensor</td>
<td>PT1000</td>
</tr>
<tr>
<td>Flow rate range</td>
<td>(0～9999.999999999) m³/h</td>
</tr>
<tr>
<td>Flow rate accuracy</td>
<td>±1.5%</td>
</tr>
<tr>
<td>Matched with flow rate sensor</td>
<td>Pulse mode or Current mode</td>
</tr>
<tr>
<td>Flow rate signal range</td>
<td>Pulse mode: 0～200Hz</td>
</tr>
<tr>
<td></td>
<td>Current mode: 4-20mA</td>
</tr>
<tr>
<td>Cooling consumption accumulated range</td>
<td>(0～999999.999999) MWh</td>
</tr>
<tr>
<td>Heating consumption accumulated range</td>
<td>(0～999999.999999) MWh</td>
</tr>
<tr>
<td>Resolution ratio</td>
<td>0.000001 MWh</td>
</tr>
<tr>
<td>Energy accumulated accuracy</td>
<td>Class II</td>
</tr>
<tr>
<td>Communication interface</td>
<td>RS-485</td>
</tr>
<tr>
<td>Communication rate</td>
<td>9600bps</td>
</tr>
<tr>
<td>Max. communication distance</td>
<td>400m</td>
</tr>
<tr>
<td>Dimension</td>
<td>250mm×150mm×60mm</td>
</tr>
</tbody>
</table>

2.5 Operation instruction

2.5.1 Keypad operation meaning

![ESC](Key.png) : Exit;

![Page up or upwards](Key2.png) : Page up or upwards;

![Page down or downwards](Key3.png) : Page down or downwards;

![Confirm or select](Key4.png) : Confirm or select;
2.5.2 Menu operation

**Usual Data**
- Tot. Cool: Mwh
- Tot. Heat: Mwh
- Water Return T1: °C
- Water Supply T2: °C

**Energy**
- Total Cooling 01/02
  - Today: MWh
  - Month: MWh
  - Total: MWh
- Total Heating 02/02
  - Today: MWh
  - Month: MWh
  - Total: MWh

**Flow Rate**
- Flow rate
  - Current: m³/h
  - Today: m³
  - Month: m³

**Water Temp.**
- Water return T1: °C
- Water supply T2: °C
- Temp. diff.: °C
- Max temp. diff.: °C

**Time**
- Date:
- Time:
- Tot. Run time:
- Tot. Alarm time:

**Hist. Data**
- [Cool analysis]
- Heat analysis
- Flow rate analysis
- Alarm list

**Para. set**
- Parameter setting
- User setting
- Project setting
- Factory setting

**Other info**
- Includes different running status and version information. The details please see as below

**Other info**
- Inst. Power: kJ/s
- Inst. FlowRate: m³/h
- Inst. Flux speed: m/s

**Other info**
- Tot. FlowRate: m³
- Tot. Heat: MWh
2.5.3 History data operation:
2.5.4 Parameter set – User setting

Please input password
Return Enter

User setting 1/12
T1 alarm upper limit: 80.0
Return Enter

User setting 2/12
T1 alarm lower limit: 02.0
Return Enter

User setting 3/12
T2 alarm upper limit: 80.0
Return Enter

User setting 4/12
T2 alarm lower limit: 02.0
Return Enter

User setting 5/12
T1 upper limit: 80.0
Return Enter

User setting 6/12
T1 lower limit: 02.0
Return Enter

User setting 7/12
T2 upper limit: 80.0
Return Enter

User setting 8/12
T2 lower limit: 02.0
Return Enter

User setting 9/12
Alarm time reset
Return Enter

User setting 10/12
History data reset
Return Enter

User setting 11/12
Meter mode: Cool & Heat
Return Enter

User setting 12/12
Password reset
Return Enter
2.5.5 Parameter set – Project setting

Please input password
Return Enter

Project setting 1/12
Flowmeter type
Return Enter

Flowmeter type
Electrical Pulse
Return Enter

Project setting 2/12
Coefficient of flow (P)
Return Enter

Coefficient of flow (P)
01.0000P/L
Return Enter

Project setting 3/12
Pipe diameter set (E)
Return Enter

Pipe diameter set (E)
050mm
Return Enter

Project setting 4/12
Max flow speed set (E)
Return Enter

Max flow speed set (E)
4.0 m/s
Return Enter

Project setting 5/12
Low flow ignored (E)
Return Enter

Low flow ignored (E)
0.0(0.0)m/s
Return Enter

Project setting 6/12
Min temp. different (C)
Return Enter

Min temp. different (C)
0.2 °C
Return Enter

Project setting 7/12
Min temp. different (H)
Return Enter

Min temp. different (H)
5.0 °C
Return Enter

Project setting 8/12
Sampling interval
Return Enter

Sampling interval
05s
Return Enter

Project setting 9/12
T1 zero compensation
Return Enter

T1 zero compensation
+0.0 °C
Return Enter

Project setting 10/12
T2 zero compensation
Return Enter

T2 zero compensation
+0.0 °C
Return Enter

Project setting 11/12
Meter address
Return Enter

Meter address
00
Return Enter

Project setting 12/12
Password modifying
Return Enter
2.5.6 Parameter set – Factory setting

- Please input password 0*****
  - Return Enter

  - Factory setting 01/07
    - Cool clear
      - Return Enter
    - Cool reset
      - ?
        - No Yes
          - Return Enter

  - Factory setting 02/07
    - Heat clear
      - Return Enter
    - Heat reset
      - ?
        - No Yes
          - Return Enter

  - Factory setting 03/07
    - Flow rate clear
      - Return Enter
    - Flow rate reset
      - ?
        - No Yes
          - Return Enter

  - Factory setting 04/07
    - T1 regulate
      - Return Enter
    - Regulate base point
      - 655.3°C
        - Return Enter
    - Regulate slope
      - 0.0°C
        - Return Enter

  - Factory setting 05/07
    - T2 regulate
      - Return Enter
    - Regulate base point
      - 655.3°C
        - Return Enter
    - Regulate slope
      - 0.0°C
        - Return Enter

  - Factory setting 06/07
    - All data initialize
      - Return Enter
    - All data initialize?
      - No Yes
        - Return Enter

  - Factory setting 07/07
    - Password modifying
      - Return Enter

Notes: Factory setting will not open to user and project engineering, will not display on menu.

2.5.7 Other information

- Other informations 01/04
  - Meter type: AKE-C03P
  - Address: 31
  - Meter mode: Cool&Heat

- Other informations 02/04
  - Alarm state: Alarm
  - Flowmeter type: Electrical
  - Temp. sensor type: PT1000

- Other informations 03/04
  - Flow coeff.: 01.0000 P/L
  - Pipe diameter: 050 mm
  - Max. flow speed: 4.0 m/s

- Other information 04/04
  - Meter NO.: xxxxxxx
  - Version: 1.23 (Modbus)
2.6 Installation and adjustment

2.6.1 Installation Notes

- Must cut off power when installing or operating, otherwise will damage component;
- Selects a correct installation locations;
- Environment temperature: -30°C - +70°C;
- Relative humidity: Max relative humidity 95% (Non-condensing);
- RS485 communication, strictly adopts RVS2*0.75mm² twisted-pair;
- Connects the wires according the label indication;
- Before power ON, please check the wires again to avoid wrong connection which will damage the component;
- check the wires again to avoid wrong connection which will damage the component;

2.6.2 Installation wiring schematic drawing
2.6.3 Connection instruction:

- In the end of C03P BTU Meter it has a 24bit standard connecting terminal, it is used for connecting signal and power supply;
- The connection method between C03P BTU Meter and temperature sensor PT1000 is four-wire system;
- The connection method between C03P BTU Meter and flow meter should be accordance with flow meter mode;
- If match with pulse mode flow rate, the terminal no. 5 should connect with flow meter DC power supply input point, terminal no.4 should connect with flow meter signal ground point, terminal no. 6 should connect with flow meter pulse signal output point;
- The power supply connection method is that connect terminal no. 1 and 3 with AC 200V null line and live wire, terminal no.2 connect with GND;

2.6.4 BTU Meter installation procedure:

- Puts BTU Meter into the iron box we offered before installing;
- Drills holes as per BTU Meter dimension by churn drill and then screwed;
- Connects iron box and temperature sensor and flow meter;
- Connects the wire as per label indication;

2.7 Equipment enlarge figure

![Diagram](image.png)

Drawing: BTU Meter electrical cabinet enlarge figure
Unit: mm

Drawing: BTU Meter enlarge figure
Unit: mm

Drawing: Installation gasket enlarge figure
2.8 Environment requirement and connection technology

**Installation:**
1) BTU Meter should be installed at waterproof environment;
2) Environment humidity can’t over 95%, temperature 0℃-50℃;
3) Forbid installing at air-conditioning water shaft or oil dirt environment.

**Connection:**
1) Please strictly connect the wires as per indication, otherwise will damage the component;
2) When connecting with other devices, please note the connection indication;
3) It is better to use cold compression plug while connecting;

2.9 Fault analysis and elimination

**Problem 1: Hasn’t flow rate display**

**Solution:**
1) Checks flow meter connection wires to judge whether have 24V output. For insert electromagnetic flow meter, if have, the power supply is normal. But for ducted electromagnetic flow meter, the power supply is directly offered by separately 220V, BTU Meter will not offer power to it,
2) Checks the low flow rate ignored parameter, normally it should be between 0.01-0.03. If the value is over and bigger than that range, it means the system have stream when set up this parameter, must be set under stagnant water situation.

**Problem 2: The temperature of water delivery or water return is 2℃ or 80℃**

**Solution:** Please check the connection wires between BTU Meter and temperature sensor.

**Problem 3: Can’t communicate**

**Solution:**
1) Please check the power supply AC 220V is normal or not, check fuse which inside the Meter is ok or not;
2) Please check communication positive pole and negative pole is correct or not;
3) Please cut off power supply and then connect again, checks if the fault is eliminated or not;
4) Please check whether the IP add is reduplicate in a same group;

**Problem 4: when matching with electromagnetic flow meter, it has flow rate but no current actually**

**Solution:** Checks the low flow rate ignored parameter, the zero point of electromagnetic flow meter will shift with long time used, please re-set up this parameter.

**Problem 5: No display on BTU Meter or display Unicode**

**Solution:** Please cut off power supply and then connect again, if still exist that’s means the BTU Meter is broken and need maintain.
Chapter three: Electromagnetic flow meter

3.1 Ducted Electromagnetic Flow meter

3.1.1 General introduction

Electromagnetic flow meter (EMF) consists of converter and sensor, all of AKE EMF is split designed, the converter and sensor is connected by a signal cables.

![EMF Sensor and EMF Converter](image)

Drawing 3-1

3.1.2 Technical parameter

- **Converter technical parameter**
  - Precious class 0.5%
  - Output single
    - Current output: 4-20mA
    - Frequency output:
      - Active pulse: High level ≥ 11V, Low level ≤ 0.5V, Load current ≤ 20mA;
      - Passive pulse: High level = External power - 1V (external power should below 30V), Low level ≤ 0.5V, Load current ≤ 50mA;
  - Protect IP: IP67
  - Voltage: AC 220V

- **Sensor tech. parameter**
  - Diameter: DN6-2000mm
  - Pressure: 0.6-4.0MPa
- Electropode material: FEP, NE, P0, PTFE selectable
- Medium temperature: -40-180°C  (decided by inner material)
- Shell material: Carbon steel
- Protect degrad: IP65, IP67, IP68

◆ Dimension

<table>
<thead>
<tr>
<th>Dimension (mm)</th>
<th>L (mm)</th>
<th>D (mm)</th>
<th>H (mm)</th>
<th>H1 (mm)</th>
<th>N.W. (Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>90</td>
<td>67</td>
<td>138</td>
<td>193</td>
<td>2.70</td>
</tr>
<tr>
<td>32</td>
<td>100</td>
<td>76</td>
<td>147</td>
<td>202</td>
<td>3.40</td>
</tr>
<tr>
<td>40</td>
<td>100</td>
<td>82</td>
<td>153</td>
<td>208</td>
<td>3.70</td>
</tr>
<tr>
<td>50</td>
<td>115</td>
<td>96</td>
<td>167</td>
<td>222</td>
<td>5.00</td>
</tr>
<tr>
<td>65</td>
<td>115</td>
<td>116</td>
<td>187</td>
<td>242</td>
<td>6.00</td>
</tr>
<tr>
<td>80</td>
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<td>127</td>
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<td>253</td>
<td>6.50</td>
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<td>328</td>
<td>13.50</td>
</tr>
<tr>
<td>200</td>
<td>215</td>
<td>257</td>
<td>328</td>
<td>383</td>
<td>21.00</td>
</tr>
</tbody>
</table>
3.1.3 Pipe design and installation

General speaking, the pipe structure must make sure that it has full of liquid on the measured pipes.
If the liquid has solid particle, in order to prevent block the flow meter, please install the flow meter at vertical direction and let the stream run from down to up.

Notes:
1) Please don’t put or install any materials which might effect the flow rate on the upstream pipes;
2) If there is any valve or material would effect the upstream flow rate, must put a 2D-3D distance straight pipe on the downstream pipe.
Must make sure that there isn’t any bubble on the measurement position:

**3.1.4 Connected with earth**

Because the electromagnetic flow meter inductive signal is very weak and it is easily effected by noise, the related sensor and converter GND should be same as measured liquid, that means they must connect with earth. The Connecting Earth Ring on the shell of electromagnetic flow meter are used for connecting with earth and keep the same potential as measured liquid.

**i) Pipe material: common metal pipes**

Remark: If the pipe do well in earth connected, could ignore this step, but the Connecting Earth Ring on the shell of the electromagnetic flow meter must connect with pipe.

**ii) Pipe material: insolated pipes (plastic pipes, rubber pipes)**
Must put two ground rings or grounding electrodes on the each side of sensor as above drawing 3-6 and adopts wires to connect with earth.

iii) Cathode protection pipes

Between pipe flange adopts cooper wires to connect, but this wires must insulated with earth wires.

3.1.5 Routing maintenance

1) Please visual inspect the meter periodically to make sure that the meter and environment around the meter is clean, the cable holder is tight, the cable is well connected, is there any intense magnetic equipment or other jamming things around the meter;
2) If the electrode or pipe wall is easy dirty because of measured liquid, please clean it on time;
3) Please inspect the meter zero point periodically, if any change, please adjust it as below drawing;
3.1.6 Fault analysis and elimination

The cause which led to flow meter couldn’t work normally is divided into two scopes: internal cause and external cause.

Internal cause: The problem is caused by flow meter itself which is included sensor problem and converter problem;

External cause: The problem is caused by environment and can’t normal worked;

General speaking, during the installation and adjustment time, the main problem is caused by external cause, but during the normal running time, the main problem is cause by internal cause. Please check the detail description from below sheet:

<table>
<thead>
<tr>
<th>Fault</th>
<th>Location</th>
<th>Phenomenon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal cause</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensor problem</td>
<td>Sensor inner electrode is affected with damp</td>
<td>Output signal is ‘0’, or measurement result is visibly smaller than actuality</td>
</tr>
<tr>
<td></td>
<td>Sensor inner coil is affected with damp</td>
<td>Output signal is ‘0’, or measured result is visibly bigger than actuality</td>
</tr>
<tr>
<td></td>
<td>Electrode leakage</td>
<td>Output signal is ‘0’, or measured result is just a half of actual data</td>
</tr>
<tr>
<td></td>
<td>Electrode wire is open circuit</td>
<td>Output signal is nearly full, or it is extremely unstable</td>
</tr>
<tr>
<td></td>
<td>Coil wire is open circuit</td>
<td>Output signal is ‘0’ or 4mA</td>
</tr>
<tr>
<td></td>
<td>Inner coil is short circuit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Electrode is short circuit due to too dirty</td>
<td>Output signal is ‘0’, or measured result is obvious smaller than actuality or extremely unstable</td>
</tr>
<tr>
<td></td>
<td>Lining break led up to electrode short circuit to earth</td>
<td></td>
</tr>
<tr>
<td>Connection wires problem</td>
<td>The connection cables and connection terminal aren’t well contacted</td>
<td>Output signal is extremely unstable, or it is equal to ‘0’ or near to full</td>
</tr>
<tr>
<td>Converter problem</td>
<td>Power supply converter is burn out</td>
<td>Output signal is ‘0’</td>
</tr>
<tr>
<td></td>
<td>Excitation signal is damaged</td>
<td>Output signal is ‘0’, or measurement result is just a half of actual data</td>
</tr>
<tr>
<td></td>
<td>Signal amplifier circuit is damaged</td>
<td>Output signal is bounce, or it is equal to ‘0’ or near to full</td>
</tr>
<tr>
<td></td>
<td>Contact pin J9 is inserted at wrong position</td>
<td>Output signal is ‘0’ (Inserts J9 at leg 2 and 3 or leg 3 and 4)</td>
</tr>
</tbody>
</table>

In a words, it is easy to judge the internal problem via a digital multimeter or Meg-ohmmeter.

1) Judging converter
   i) Converter excitation circuit test
      Opens the converter cover plate, first checks coil wires X, Y is correct connected and AC220V is normal input. Uses multimeter DC20V gears to test X, Y position voltage, if they are on positive and negative changing status it means the excitation circuit is normal working, we can roughly judge that sensor coil wires haven’t open circuit, otherwise please make a further test: put the contact pin on J9 (have 5 pins socket) located at the right-skewed position on the circuit and had total 5 pins into leg 1 and 2
located at left side of J9, at this time the voltage value should be between 10V to 25V, and then put the contact pin into leg 4 and 5 located at the right side of J9, the voltage value should be same as leg 1 and 2 but has different pole. Please remember while finish all testing, the contact pin must be put back leg 2 and 3 or leg 3 and 4 again.

ii) Converter signal amplifier circuit test
Pulls out electrode A and B from socket and lets it empty, tests sensor output current via multimeter 200mA gears, the data should be beat up and down or exceed 20mA; directly connects A and B with a cable to make it short circuit, the output current should be back to zero, otherwise we can judge that the signal amplifier circuit have some problem.

2) Judging sensor
First, cuts off power supply;
Make sure that the measured pipes are full of liquid, tests sensor parameters, such as electrode earth resistance, coil resistance, coil insulated earth resistance, when finish all the testing, we can rough judge whether sensor has problem or not. Please follow process as below:

i) Opens connection wires between sensor and converter (terminal A, B, C, X, Y);
ii) Tests the resistance between A, C and B, C via digital multimeter, the value should be similar otherwise maybe one electrode is leakage or affected with damp, or one electrode is too dirty;
If the value is under 5000Ω or near to zero, it means the electrode is leakage or affected with damp; if the value is infinite, it means the cable is open circuit;
iii) Checks excitation coil
Measures the resistance between X and Y, If the value is over 200Ω, it means excitation coil is short circuit, maybe because the coil or connection cables is short circuit; But if this problem will lead output signal smaller than actual data or near to zero, please contact our company;
Measures insulated resistance between coil output cable and C, it should be over 200MΩ. The coil is easy to effect with damp which will lead to flow meter’s zero point and output signal higher than normal. When the insulated resistance between 50MΩ to 200MΩ, maybe the problem is the measured pipe shell is affected with damp, can be dried by air heater; But after dried, if the value is still under 50MΩ, maybe the problem is sensor effected with damp serious, should be repaired.

<table>
<thead>
<tr>
<th>Fault</th>
<th>Location</th>
<th>Phenomenon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connected problem</td>
<td>AC220V cuts off</td>
<td>Output signal is ‘0’</td>
</tr>
<tr>
<td></td>
<td>The sensor connection point X, Y are wrong connected</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Output signal cable is open circuit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Current output signal cable is short circuit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The sensor connection point A, B, C are wrong connected</td>
<td>Secondary display is ‘0’, or smaller than actuality</td>
</tr>
<tr>
<td></td>
<td>Connection point X and Y or A and B</td>
<td>Output signal is ‘0’. For 4-20mA</td>
</tr>
<tr>
<td>Problem Type</td>
<td>Problem Description</td>
<td>Solution</td>
</tr>
<tr>
<td>------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Installed problem</td>
<td>Sensor position is connected conversely</td>
<td>Output signal is extremely unstable, big error</td>
</tr>
<tr>
<td></td>
<td>It has vapor-liquid two phase scene on measured pipe</td>
<td></td>
</tr>
<tr>
<td></td>
<td>There is some abnormal material from upstream entered into flow meter which effects conductivity unstably</td>
<td>Output signal is extremely unstable, big error</td>
</tr>
<tr>
<td></td>
<td>The straight pipe length on upstream is not enough</td>
<td></td>
</tr>
<tr>
<td></td>
<td>It has convex place on the upstream pipe or gasket is not well installed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The measured pipe is vibrant seriously</td>
<td></td>
</tr>
<tr>
<td>Model selection problem</td>
<td>Actual flow rate is bigger than the flow meter upper limit</td>
<td>Output signal is near to full, but the signal is normal while flow rate is decrease</td>
</tr>
<tr>
<td></td>
<td>Flow meter output signal type isn’t match with secondary meter</td>
<td>Secondary index is ‘0’, or actual data has big difference</td>
</tr>
<tr>
<td>Wrong judgement</td>
<td>Actual flow rate has big difference as user estimated</td>
<td>The display data is different as actual data</td>
</tr>
<tr>
<td></td>
<td>The measured pipe has sub-branch or sub-branch wasn’t considered when estimated</td>
<td></td>
</tr>
<tr>
<td>Electromagnetic interference</td>
<td>Flow meter output signal cables are put at the same or parallel cable duct with power cable</td>
<td>Output signal is extremely unstable, and big difference</td>
</tr>
<tr>
<td></td>
<td>There is big motor, inverter or other strong electromagnetic equipment around the measured location</td>
<td></td>
</tr>
<tr>
<td>Measured liquid problem</td>
<td>The measured liquid has solid material by itself</td>
<td>Output signal is extremely unstable and big difference, should choose a flow meter suitable for serosity</td>
</tr>
<tr>
<td></td>
<td>Measured liquid conductivity &lt; 10us/cm</td>
<td>Output signal is extremely unstable, big difference</td>
</tr>
<tr>
<td>GND problem</td>
<td>Measured liquid and flow meter shell is both connected earth</td>
<td>Output signal is ‘0’, drift slowly, or extremely unstable</td>
</tr>
</tbody>
</table>
3.2 DWM2000 inserted flow meter

3.2.1 General introduction

DWM2000 serial electromagnetic flow meter is used for measuring the flow rate for conducting medium, the output signal is 4-20mA.

Parameter characteristic:
- Internal protection: IP66;
- Immersion part material is stainless steel and ceramic;
- Working temperature: below 150°C;
- Working pressure: 25bar or 360psig;
- No mechanical moving part, free of maintenance;
- The electronic parts could be directly changed while working;
- Low power consumption;
- Suitable pipe: $\geq 50\text{mm or } \geq 2”$

3.2.2 Measuring principle

While conductor is moving in the magnetic field, the moving parts will generate voltage. In this system the liquid acts as conductor, magnetic direction B is vertical with flow direction, the generated voltage U will have linear relationship with flow rate V.

$$U = KBVD$$

K: meter coefficient  B: magnetic intensity
V: liquid flow rate  D: electrode gap

Drawing: 3-10
3.2.3 Combined equipment

(1) Connect cover
(2) Seal ring
(3) Sensor
(4) Connection thread
(5) Grounding cable
(6) GND terminal
(7) Cable input PG13.5
(8) Shell
(9) Empty socket
(10) Power supply connection
(11) Junction box
(12) Electromagnetic coil and electrode connection point
(13) Electronic amplifier
(14) Screw thread on shell
(15) Shell with seal ring

3.2.4 Installation & Connection

(1) All the solder should be operated while no water in the pipe;
(2) Installs the connection cover on the pipe line; (pipe diameter $\geq 50''$);
(3) Regarding the installation location and inserted depth, please check Drawing 3-17;
(4) Straight section of inlet and outlet: 10*DN/5*DN; (DN: pipe diameter)
(5) Chooses a suitable location to install flow meter on water return pipe and drills a hole (diameter: 39mm); (If there is no suitable place on return pipe, supply pipe is also ok)
(6) Must use stainless steel electrode ($\geq 2.5$ or $\geq 3.2$);
(7) Calculates the inserted depth, please notes that the scale should be aligned with pipe inner diameter but not the external diameter.
(8) Put the cover in the hole and align with pipe inner diameter as per scale, solders and makes it vertical on the pipe. The solder should be smooth and well soldered.

(9) It is better to use wet cotton fabric to protect the hole avoid some welding slag dropped on the screw and destroyed.
(10) After solder the cover, please use a test unit to screw it into cover, it is better to dip some butter on the screw as a lube to protect the screw, because the screw might be distorted due to high temperature when soldering. Must try screw first, otherwise it might damage the flow meter screw and then damage the flow meter. If the test unit could be smoothly screwed, we can install flow meter, otherwise, forbidden!

(11) Before installing flow meter, please make sure that there is no any welding slag around the pipe, gasket and screw, must make it very clear, otherwise would lead to leakaged;

(12) Please coats some lubricant on the screw, BUT please notice FORBID twist other material on the screw such as plastic, duct tape etc. Puts seal ring on the cover and screws flow meter inside, PLEASE NOTICE that it should be tightly screwed and pressed seal ring, otherwise the probe head can’t reach the end of cover, it would lead to measured result inaccurate or even can’t measure flow rate

Blew picture is WRONG operation.

(13) While screwing, the sensor direction is not important, because the electronic component could be adjusted inside;

(14) DON’T strength screw while installing, please screw it equable, otherwise would damage the screw thread;

(15) If the screw thread is damaged, MUST solder a new cover;

(16) If the pipe diameter is over 400mm, please choose lengthen mode flow meter;
Solder example: (if solder at DN250mm)

3.2.5 Product size and weight

Material of shell: cast aluminium with epoxy resin coating;
Weight: 1.85kg
3.2.6 Electrical connection and setup

Please see the PCB circuit as below drawing 3-20:

Setup:
- Must follow processes as below description;
- Electronic component adjustment;
- Setup full scale range;
- Zero offset adjustment;

![Drawing 3-20](image)

- **Setup direction**
  Opens shell, screws off the mounting screws (just rotate two circles, no need pull it out), adjusts electronic components to let the direction same as flow direction, finally screws the mounting screws again. If the direction isn’t same as water direction, the measured result would be wrong;

- **Setup full scale range**
  Before connecting electricity, must setup full scale range first. It could be adjusted between 1-8m/s, if it is wrong set, the device would be in warm status. According to air-conditioning normal flow rate, it could be set as 3m/s.

![Drawing 3-21](image)
✓ Electrical connection
1) Supply power: DC24V (power connection terminal 11(-) and 12(+)),
   max cable diameter: 1.5mm²;
2) Under DC24V, max power consumption: 50mA
3) 4-20mA output, max load ability: 500Ω;
4) Please attention the polarity.
5) Please see the electrical connection as below Drawing 3-22

![Drawing 3-22]

✓ Power On Self Test(POST)
While connecting electricity, flow meter will test it by itself (1 min), at this time, the output
current is under warm status (<3mA). If the test is passed, DWM2000 would start to measure,
otherwise, it would still under warm status.

✓ Zero offset adjustable
Makes sure the pipe is full of water and the flow rate is ‘0’, presses ‘zero call’, waits 1 min,
DWM2000 would finish zero offset. During zero offset adjustable period, the output
indication is under warm status (3mA).

✓ Change and install electronic component
Inserts electronic component into sensor, screws off mounting screw (19) but don’t pull it out,
rotates the electronic component same as water direction and then screws it tight, fixes the
electronic component.
3.2.7 Technical parameter

<table>
<thead>
<tr>
<th>Power supply and output</th>
<th>Input voltage</th>
<th>24VDC±20%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Output</td>
<td>Passive current output 4-20mA terminal(5/6) Max loaded : 500Ω(24VDC)</td>
</tr>
<tr>
<td></td>
<td>Power consumption</td>
<td>≤50mA(24VDC/20℃)</td>
</tr>
<tr>
<td></td>
<td>Functional Earthing</td>
<td>&lt;10Ω</td>
</tr>
<tr>
<td>Full scale range</td>
<td>1-8m/s adjustable</td>
<td></td>
</tr>
<tr>
<td>Time constant</td>
<td>3s (fixed)</td>
<td></td>
</tr>
<tr>
<td>Multiplicity</td>
<td>1% MV (MV : measured value)</td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td>V&gt;1m/s ±2% MV, V&lt;1m/s ±(3cm/s+2% MV)</td>
<td></td>
</tr>
<tr>
<td>Matched pipe diameter</td>
<td>&gt;DN50</td>
<td></td>
</tr>
</tbody>
</table>

| Operation parameter    | Medium conductivity | ≥20us/cm(umho/cm) |
|                       | Working pressure    | 250bar |
|                       | Working temperature | -25℃ - +150℃ |
|                       | Environment temperature | -25℃ - +60℃ |
| Connecting sleeves    | Screw G1A (R1”) |
| Straight section of outlet/inlet | 5*DN/10*DN |
| EMC                    | EN50081-11,50082-2 |
| Internal protection    | EN60529 / IEC529 / IP66 |
| Cable joint            | PG13.5 |
| Power supply cable     | Max:1.5mm² or 16AWG |

3.2.8 Fault analysis and elimination

Problem 1: Hasn’t output signal
- Hasn’t flow rate in the pipe, please check whether value or water pump is opened;
- The flow rate is too small, please open the water pump more;
- Please check if the pipe is blocked;

Problem 2: The output current shows 0mA
Please check if the power supply corresponds with rated voltage;
If the power supply polarity is wrong or the connection cables is wrong connected;
If the probe is touch with water;

Problem 3: After long time run, it has flow rate but no current actually
Normally it is caused by zero drift. Re-set low flow rate ignored parameter, the zero point of electromagnetic flow meter will shift with long time used, please re-set up this parameter.
Chapter four: Temperature sensor PT1000

4.1 General description

Hot resistance is a common temperature detector at middle-low temperature field, the characteristic is high accuracy and good stable performance. Platinum resistance thermometer is the highest accuracy type in that field, it is widely used at industrial field and even selected as a standard station meter. The measured principle is that with the temperature increased its resistance would be increased at the same time. Most of the hot resistance is make of metal, the common material is platinum and cooper, but nowadays the other materials such as nickel.

4.2 Characteristic

- High accuracy: it is the highest accuracy type in all thermometer, can be reach to 1Mk;
- Wide output signal and high sensitivity: The sensitivity of PT1000 hot resistance is higher 1 class than other thermoelectric thermometer;
- Wide testing range and good stable performance: Under low sensitivity situation, it could keep the error under 0.1°C.

4.3 Parameter

The common type of platinum resistance thermometer includes PT1000, the temperature coefficient is 3.9*10^{-3}/°C, when the temperature is 0°C, the related resistance is 1000Ω, resistance changing rate is 0.3851Ω/°C.

According to IEC751, the temperature coefficient (TCR)=0.003851, PT100=(R0=100Ω), PT1000(R0=1000Ω) is standard platinum resistance thermometer.

\[
TCR = \frac{R_{100} - R_0}{100 \times R_0}
\]

Notes:
R100: The resistance value when the temperature is 100°C
R0: The resistance value when the temperature is 0°C

### 4.4 PT1000 reference table

PT1000 reference table is the resistance value under different temperature. Via temperature value we can get the related resistance value or via resistance value we can get the related temperature value.

<table>
<thead>
<tr>
<th>℃</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1000</td>
<td>1003.9</td>
<td>1007.8</td>
<td>1011.7</td>
<td>1015.6</td>
<td>1019.5</td>
<td>1023.4</td>
<td>1027.3</td>
<td>1031.2</td>
<td>1035.1</td>
</tr>
<tr>
<td>10</td>
<td>1039</td>
<td>1042.9</td>
<td>1046.8</td>
<td>1050.7</td>
<td>1054.6</td>
<td>1058.5</td>
<td>1062.4</td>
<td>1066.3</td>
<td>1070.2</td>
<td>1074.0</td>
</tr>
<tr>
<td>20</td>
<td>1077.9</td>
<td>1081.8</td>
<td>1085.7</td>
<td>1089.6</td>
<td>1093.5</td>
<td>1097.3</td>
<td>1101.2</td>
<td>1105.1</td>
<td>1109.0</td>
<td>1112.8</td>
</tr>
<tr>
<td>30</td>
<td>1116.7</td>
<td>1120.6</td>
<td>1124.5</td>
<td>1128.3</td>
<td>1132.2</td>
<td>1136.1</td>
<td>1139.9</td>
<td>1143.8</td>
<td>1147.7</td>
<td>1151.5</td>
</tr>
<tr>
<td>40</td>
<td>1155.4</td>
<td>1159.3</td>
<td>1163.1</td>
<td>1167.0</td>
<td>1170.8</td>
<td>1174.7</td>
<td>1178.5</td>
<td>1182.4</td>
<td>1186.2</td>
<td>1190.1</td>
</tr>
<tr>
<td>50</td>
<td>1194.0</td>
<td>1197.8</td>
<td>1201.6</td>
<td>1205.5</td>
<td>1209.3</td>
<td>1213.2</td>
<td>1217.0</td>
<td>1220.9</td>
<td>1224.7</td>
<td>1228.6</td>
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<tr>
<td>60</td>
<td>1232.4</td>
<td>1238.2</td>
<td>1240.1</td>
<td>1243.9</td>
<td>1247.7</td>
<td>1251.6</td>
<td>1255.4</td>
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<td>1263.1</td>
<td>1266.9</td>
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<tr>
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<td>1274.5</td>
<td>1278.4</td>
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<td>1286.0</td>
<td>1289.8</td>
<td>1293.7</td>
<td>1297.5</td>
<td>1301.3</td>
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<tr>
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<td>1308.9</td>
<td>1302.7</td>
<td>1316.6</td>
<td>1320.4</td>
<td>1324.2</td>
<td>1328.0</td>
<td>1331.8</td>
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</tr>
<tr>
<td>90</td>
<td>1347.0</td>
<td>1350.8</td>
<td>1354.6</td>
<td>1358.4</td>
<td>1362.2</td>
<td>1366.0</td>
<td>1369.8</td>
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<td>1377.4</td>
<td>1381.2</td>
</tr>
<tr>
<td>100</td>
<td>1385.0</td>
<td>1388.8</td>
<td>1392.6</td>
<td>1396.4</td>
<td>1400.2</td>
<td>1403.9</td>
<td>1407.7</td>
<td>1411.5</td>
<td>1415.3</td>
<td>1419.1</td>
</tr>
</tbody>
</table>

### 4.5 PT1000 installation

i) Opens a hole on the measured pipe, hole diameter is 30mm;

ii) Solders Fitting seat on measured pipe;

iii) Screws Sleeve into Fitting seat;

iv) Puts PT1000 into sleeve and inserts it on the bottom of sleeve and then screws it tightly.

---

**Notes:** Please make sure that the sleeve is tightly screwed into fitting seat in to make a good waterproof.