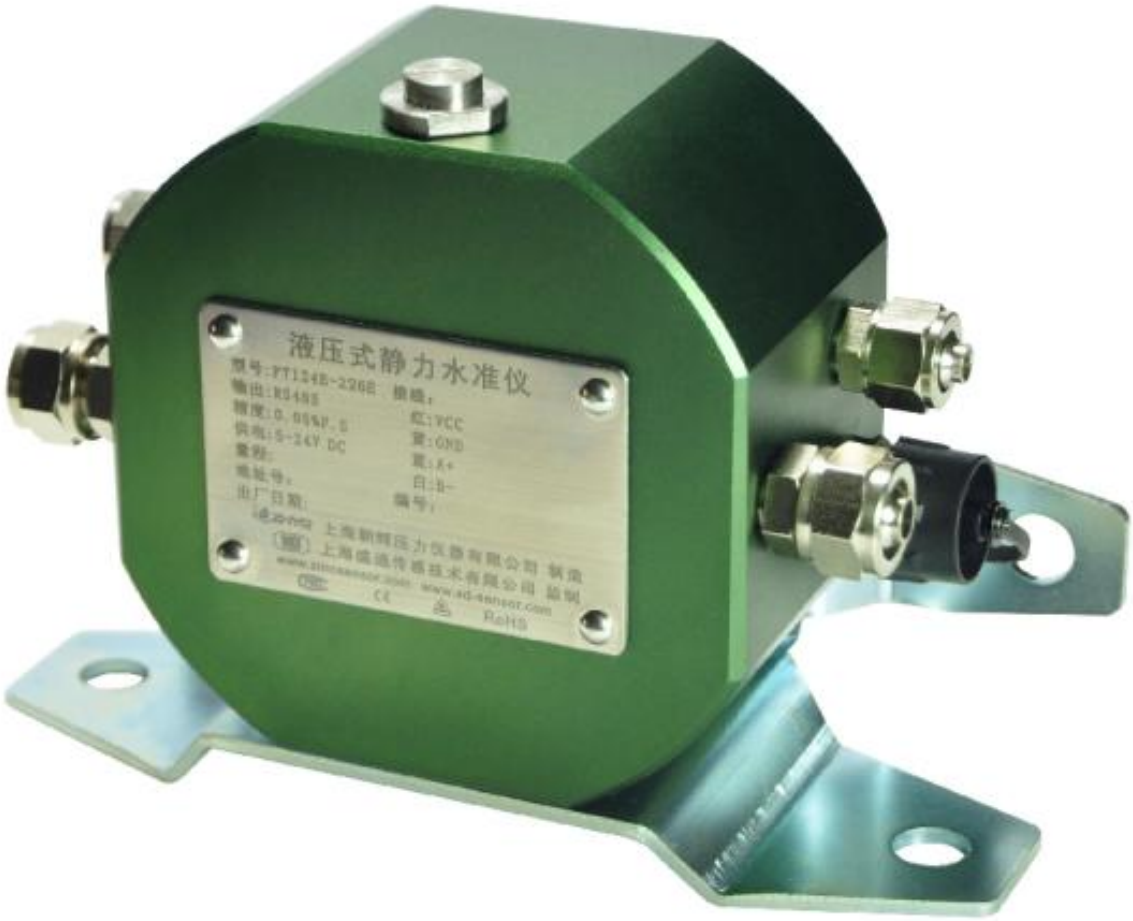
Manual and installation instructions



Intelligent structure health monitoring system
Settlement Sensor (Leveling sensor)
Model No.：PT124B-226E

Part 1 : Product overview

Description

The leveling sensor is an important bottom layer monitoring sensor in the monitoring engineering settlement system; it's a real-time precision monitoring of settlements system , that measures the change of the liquid level relative to the height of the liquid level between two or more points. Mainly used for vertical displacement and tilt monitoring of dams, nuclear power plants, wind power plants, high-rise buildings, mines, landslides, bridges, etc. The static leveling system is generally installed on the measuring pier (base station) of the measured object or the contour of the measured object wall. The modular automatic measuring unit is usually used to collect data, and it is connected to the computer through wired or wireless communication. Realize automatic observation.

It is composed of measuring point, datum point, liquid storage assembly, connecting pipe, remote monitoring terminal and large data platform measurement and control system software. it is a typical Internet of things application. According to the technical requirements, the collection period can be set. When the collection time is set, the remote measurement and control terminal will automatically collect the data and forward the local server through the way of object communication. The local server side can implement data preservation, query, operation. The system includes automatic alarm, settlement results 3D modeling, trend line analysis and other functions.

The wireless , built-in GPRS- connection in RS485 signal output , allows remote monitoring of the project . data can be uploaded at preset intervals for online monitoring . you can also choose to receive the data via email on your PC , when and where you want .

Intelligent structure health monitoring system
Settlement Sensor (Leveling sensor)
Model No.：PT124B-226E

Application

◆Tunnel , Bridge , foundation pits,
◆ Railway track, subway rail
◆ Architecture Building , High-rise buildings
◆ Dam , Nuclear power plant
◆ Geological subsidence

Features

◆Widely measurement range
◆Sub-millimeter accuracy
◆Single crystal silicon sensor chip high stability
◆Various standard signal outputs optional, easy for use
◆Ultra-low power consumption
◆Output : RS485
◆Real-time precision monitoring of settlements
◆Intelligent compensation, intelligent filtering, intelligent self-diagnosis

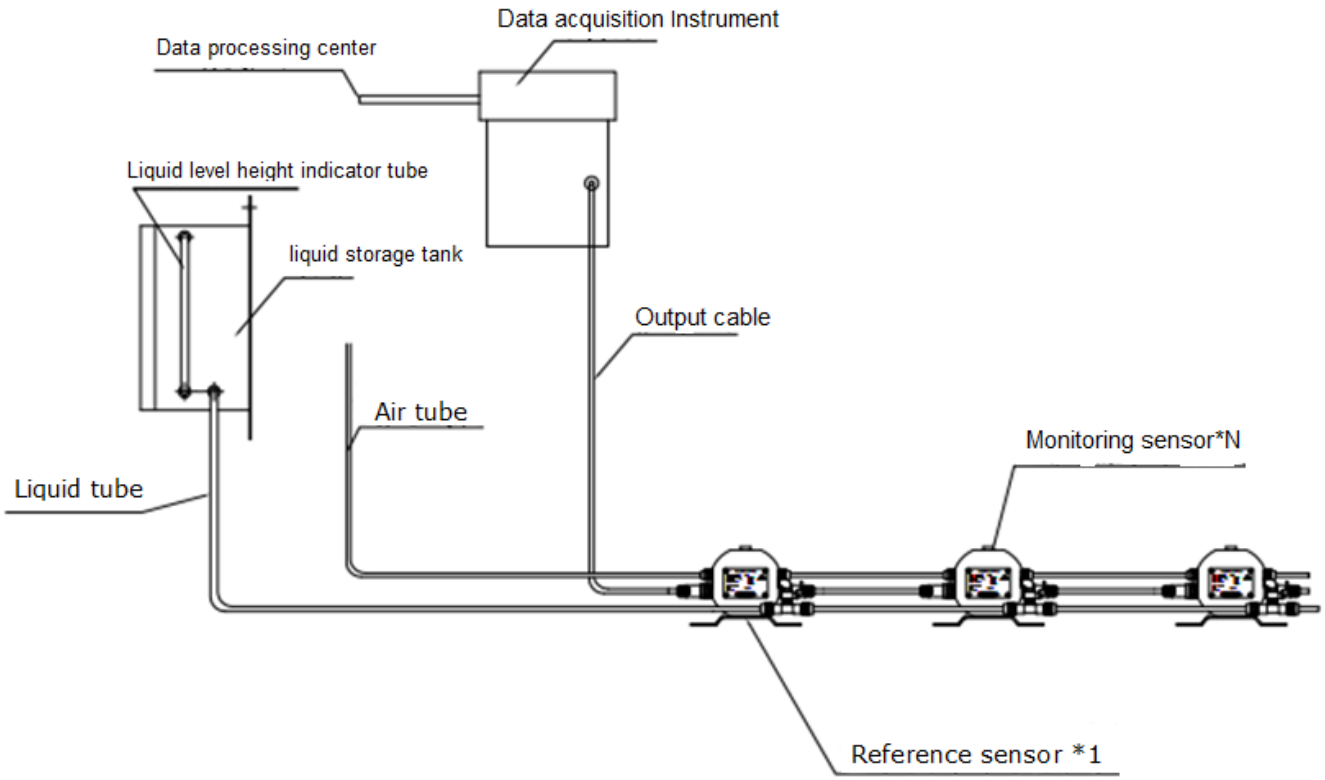
Specification

◆Range: 0～500mmH2O；0～1000mmH2O；0～1500mmH2O；0～2500mmH2O；
◆Combined accuracy: 0.05%F.S
◆Stability: 0.03%F.S/Yr
◆Output: RS485
◆Power supply: 9-24V DC
◆Operating temperature: -20～85℃
◆Temperature compensation: 0-60℃
◆House material: aluminum alloy with anodized surface
◆Electrical connector: water proof 4PIN connector
◆Protection grade: IP67
◆Pressure medium: water, antifreeze, silicone oil
◆Installation: vertical with exhaust valve upwards

Part 2: The monitoring system composition and working principle

1. System composition

The static level monitoring system consists of a data acquisition system , a reference sensor and several monitoring sensor, through the installation frame of the level gauge, data transmission cables, liquid tube and fixed accessories, air tube and fixed accessories, Composition of drying tube, liquid, etc. The installation methods are divided into two methods: pier level mounting and wall side mounting, depending on site conditions and design requirements.



2. How the system works ?

The level monitoring system consists of a monitoring sensor, a reference sensor, a liquid storage tank, a data acquisition instrument , and a data processing center. The sensor monitoring system is composed of at least three sensors, one of which is as a reference and at least 2 monitoring sensors .The data acquisition instrument collects the data of the monitoring sensor and the data of the reference sensor in real time or according to the set time and frequency and transmits it to the data processing center. This is to determine whether the monitored point is in a safe state.

The pressure of all sensors is connected to the interface of the liquid storage tank in series or in parallel through pipelines. After liquid is injected into the liquid storage tank, the liquid is transmitted to the pressure

chamber of each sensor through the liquid tube, and the chamber air is removed at the same time. And the air in the pipeline to reduce the influence of air on the accuracy of the sensor in the cold and hot conditions; when the liquid level is completely static, the liquid level in all connected sensors in the system should be at the same geoid. At this time, the liquid level is measured by the sensor to detect the differential settlement.

In order to ensure the accuracy of the measurement and the effectiveness of the application, the distance between multiple monitoring points and the adjacent monitoring points should be controlled within 30 meters, and the specific spacing arrangement is determined by the design unit according to the on-site working conditions.

3. Measuring principle

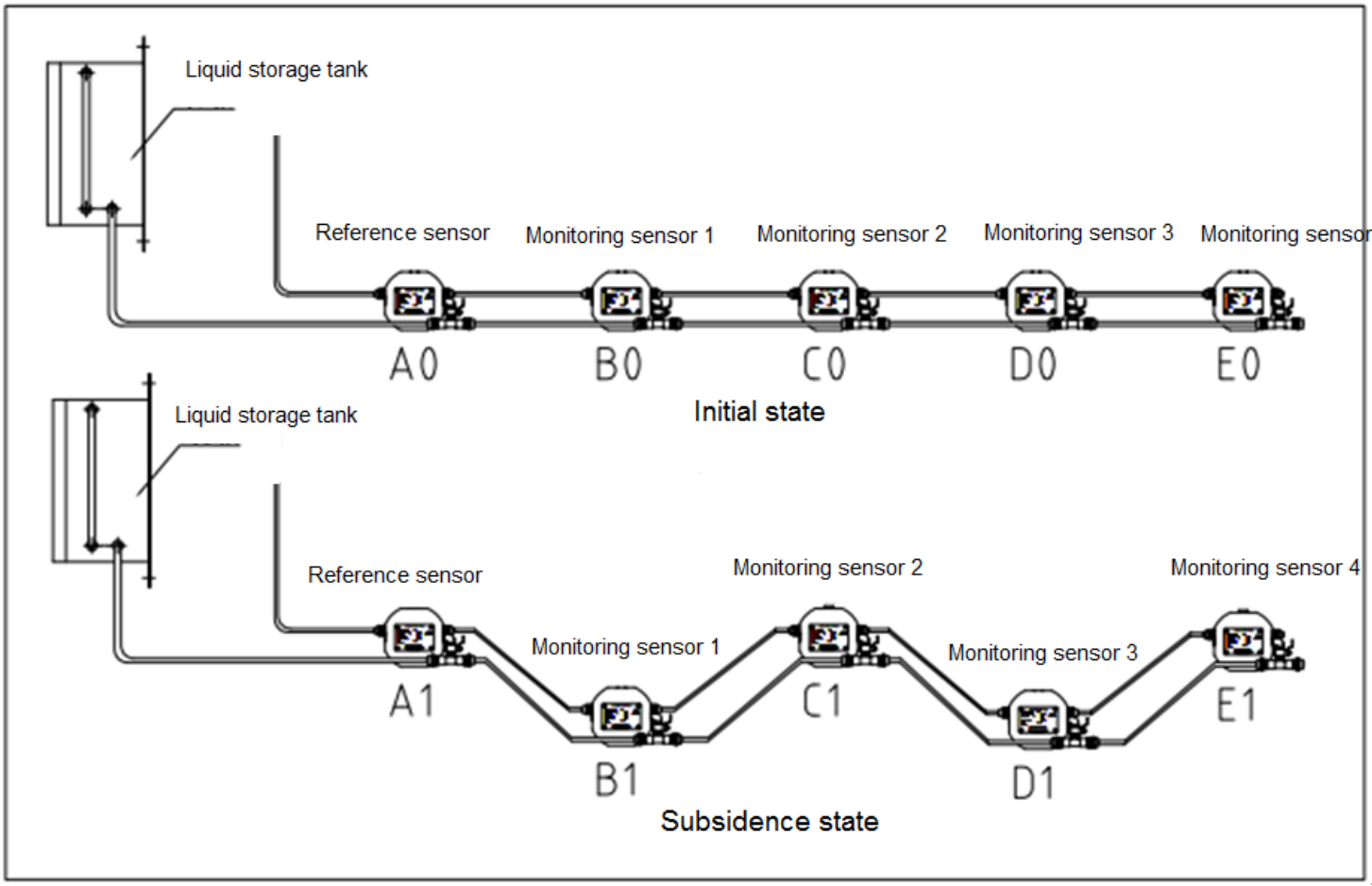
Assuming that the measuring range of the sensor is 0 ~ 1000mmH2O, the height difference between the reference sensor and the liquid storage tank is 800mm, the liquid medium is: water, and the density is substituted by 1, then the pressure generated by 1000mmH2O is 9.8KPa; the reference sensor is fixed. Then the reference sensor detects that the pressure value brought by the liquid level height is 7.84KPa, and the liquid level height value is displayed through the data center conversion: 800mmH2O, this data is the benchmark reference value;

The monitoring sensor are based on the reference sensor .After being arranged according to the position, each monitoring point must have some installation errors. This value does not affect the subsequent data analysis. The reference value can be substituted in the subsequent data comparison and can be ignored .

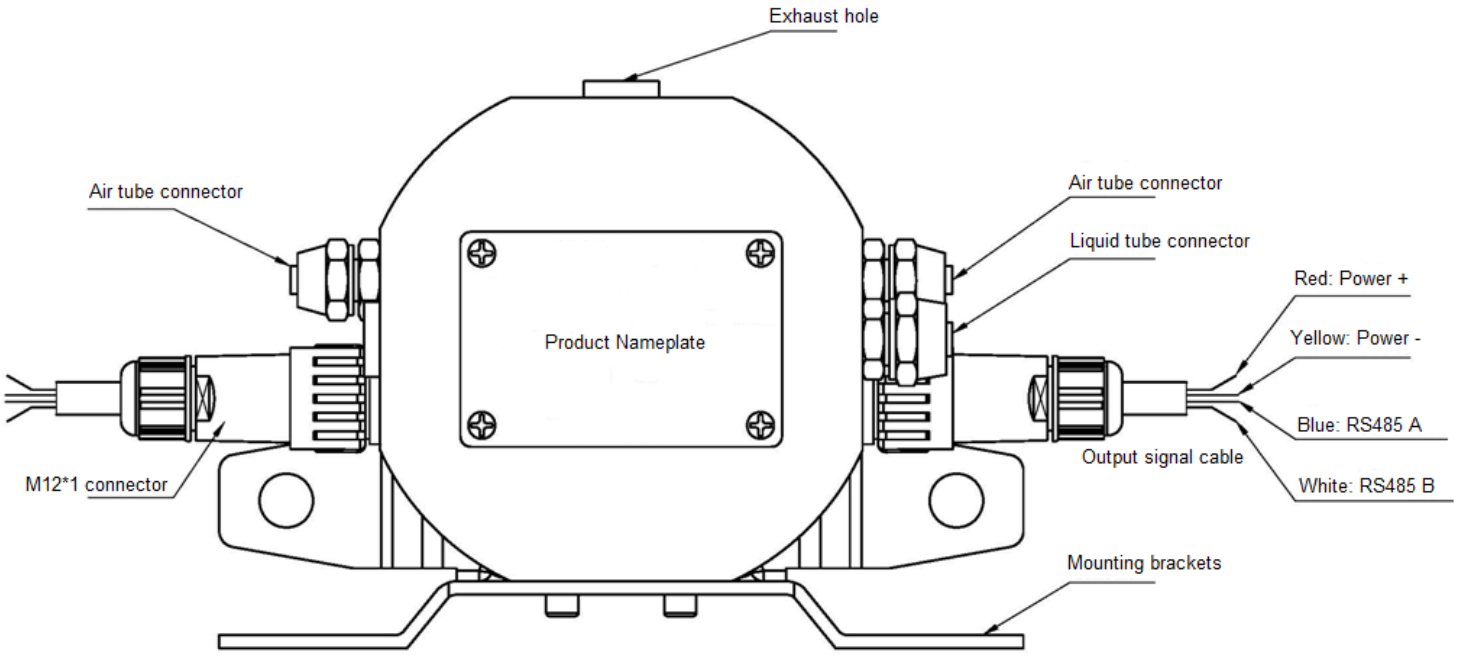
For example:

1 # monitoring sensor the actual display height of the monitoring point is 815mm after installation, the actual display height of the 2# monitoring sensor is 795mm after installation, the height of the 3# monitoring sensor is 815mm after installation, the time display height of the 4# monitoring sensor is 802mm after installation, and the reference sensor is the numerical reference , The difference of the remaining four monitoring sensor is used as the initial error compensation, which becomes normal after being set by software, and then real-time settlement monitoring can be started. Ignoring the daily evaporation of liquid water, if in the daily monitoring data comparison, the difference between the height value displayed by the monitoring point segment and the reference point value increases regularly, then it can be determined that the ground has slowly subsided; if the height value displayed by the monitoring point segment is equal to If the difference between the reference points increases and is irregular, there may be potential safety hazards in land subsidence, and timely response measures are required to avoid safety hazards.

4. The figure below is the monitoring principle diagram.



5. Product Structure



Part 3: monitoring system installation

1. Generalize

When the monitoring system is installed for the first time, it is necessary to follow the sequence of operations in accordance with the on-site construction situation. A reasonable planning of the installation sequence can effectively avoid rework caused by errors in the installation process;

The normal sequence is:

1. Determine the location of the measurement reference point and the location of the monitoring point and make a mark;

2. Reinforce the reference point, and pour a solid abutment under field conditions;

3. Perform preset drilling and installation of fixing screws at the installation point;

4. Install static level sensor and liquid storage tank at each installation point;

5. Connect the liquid pipe and the air pipe, and properly protect the front and back ends of the air pipe;

6. Connect the signal output line;

7. Inject liquid into the liquid pipe of the monitoring system;

8. Debugging and verification;

2. Measurement reference sensor point

First, select the reference sensor installation point according to the design requirements. The reference sensor installation point is a reference data platform for the monitoring sensor installation point as a basis for data support. Therefore, the reference point should be a solid and reliable permanent solid with no settlement site.

3. Fixing of mounting base or mounting bracket

The mounting base is a specially customized box-shaped protective box with protective performance, and the mounting bracket is an "L"-shaped steel plate. Different mounting parts are used to fix the sensor in different occasions. In extremely cold or extremely hot areas or sites with special requirements, you can consider using a protective box lined with temperature isolation; in areas where the temperature difference is not large, you can use an "L"-shaped mounting bracket to fix the sensor, and it can be used in the field. Can be matched with general protective shields.

The protection box or the mounting bracket and the product are fixed by four M4*8 hexagon socket screws.

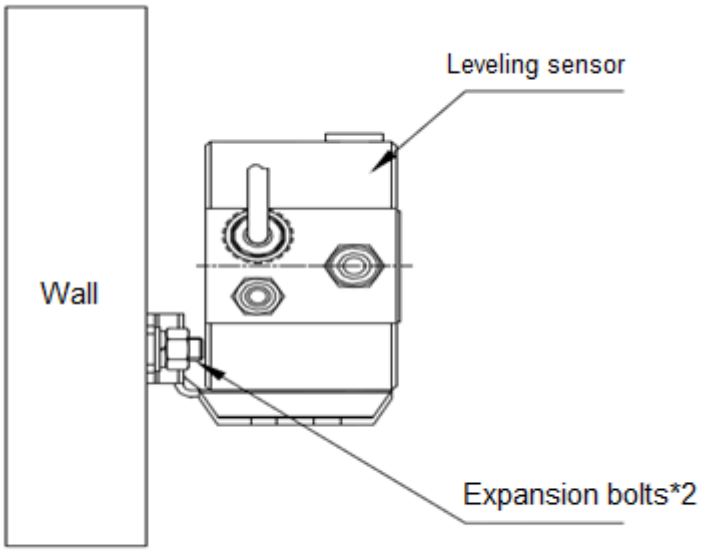
The installation of the product at the measuring point is fixed by expansion screws or other installation methods adapted to the requirements of the working conditions.

4. Monitoring sensor installation point installation: side-mounted

In order to meet the installation and measurement requirements of the level sensor monitoring point, this product can be adapted to the monitoring sensor point installation form under different working conditions; for example, the measuring points on the gallery walls of the dam, various tunnel walls, bridges, box beams and piers, etc. It is more appropriate to place it in the form of side loading;
The elevation needs to be determined before installation. According to the range of the level and the on-site working conditions, the height of the sensor lower than the height of the liquid storage tank should be controlled within the measurement range. During installation, the position of each monitoring sensor point must have a high and low deviation. It should be noted that the deviation cannot be greater than 1/2 of the measurement range.

The level of each monitoring sensor point is fixed on the wall with expansion bolts. When installing the level sensor on the wall, the routing direction and protection method of the observation cable should be considered. If the monitoring point is far away from the measuring point (> 2 meters)), the air tube and the liquid tube need to use a wire duct or PVC pipe as a guide support and be fixed on the wall.

When the distance of a section exceeds 150 meters, the size of the liquid storage tank should be considered, so that the liquid in the tank can normally maintain the measurement requirements; in special occasions, the level sensor needs to add a protective cover, and hot areas need to be filled with heat insulation in the cover Foam.



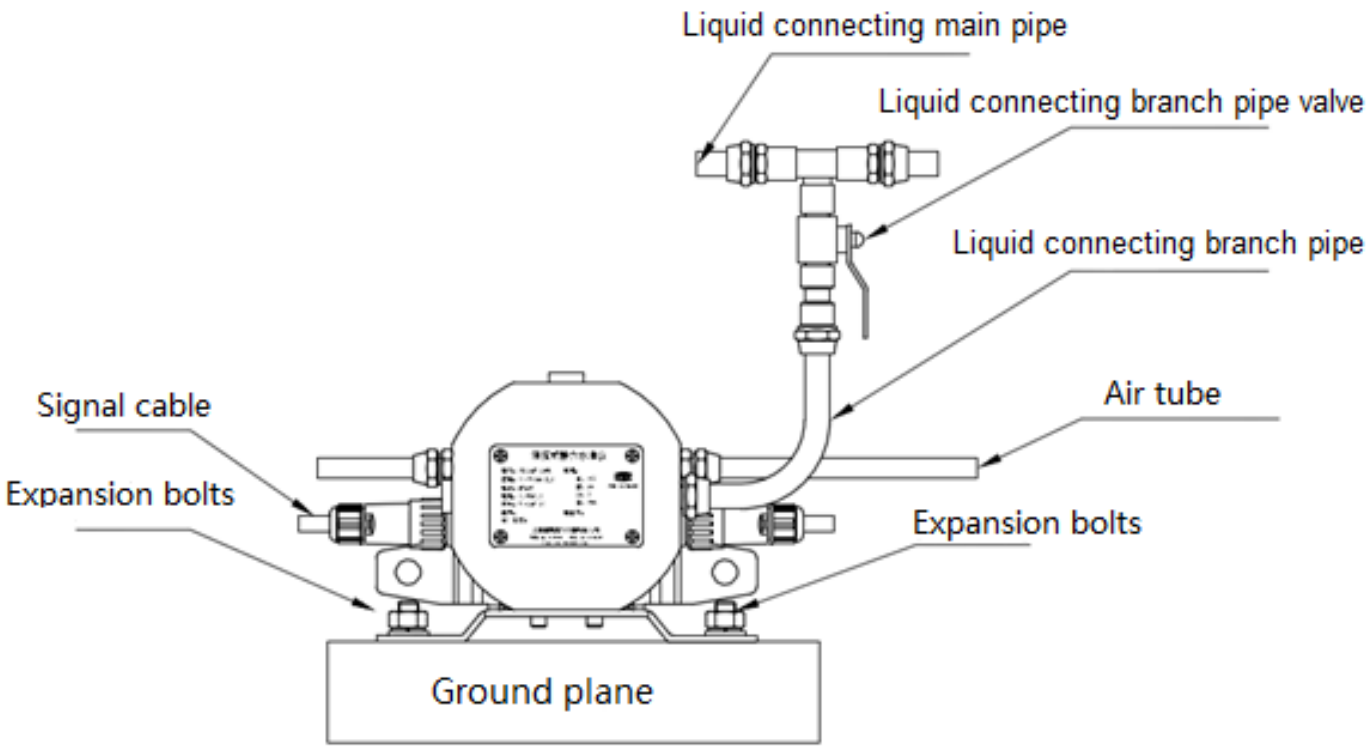
Side mounted diagram

5. Monitoring sensor point installation : Flat-mounted

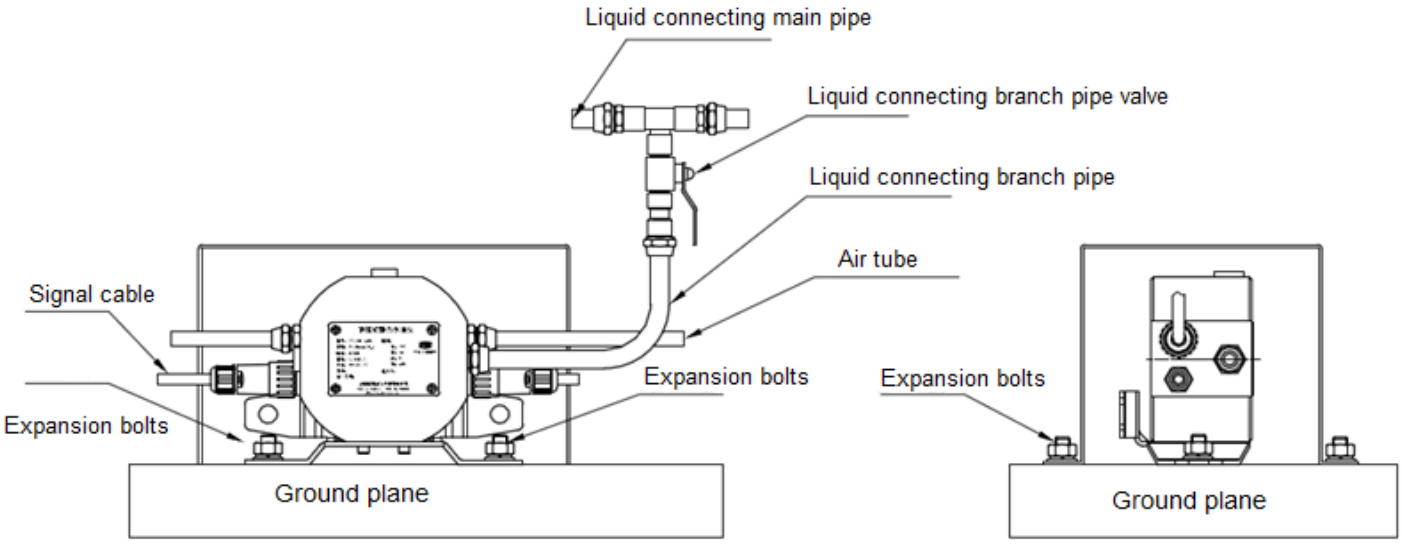
The flat-mounted measuring point is suitable for high-speed railway foundations, gallery foundations, field pouring foundations, and various tunnel foundations of dams. For field pouring foundations, relatively solid measuring abutments need to be constructed. The size of the measuring abutments is ≥400mm×400mm, The height is determined according to the design elevation of each monitoring point.

There are many applications for the construction of measuring abutments, and two commonly used are briefly introduced: 1. Direct concrete pouring and forming, then drill holes at the location where the level sensor is to be installed, install expansion screws, and then directly fix the level sensor ; 2. , When concrete is poured, the specific metal bases are poured together, and the fixing screws of the base are set aside according to the setting. In this way, a detachable metal base can be installed, and the static level can be installed on the metal base.

For other installation methods, please refer to the side-mounted installation specifications .
If the level sensor is buried underground or buried deep, at the same time, the liquid storage tank is also buried underground. A vent tube needs to be installed on the liquid storage tank to led out of the ground, and the air tube and liquid tube of the last level of the measurement line should also be led out of the ground.
The flat-mounted type can be divided into a screw-fixed type and a protective box integrally bonded type according to the product form.



Flat mounted：Screw-fixed type diagram



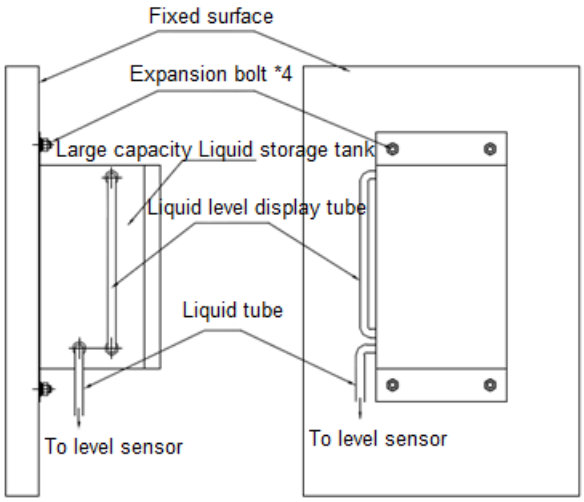
Flat mounted : Protective box integrally bonded type diagram

6. Liquid storage tank installation

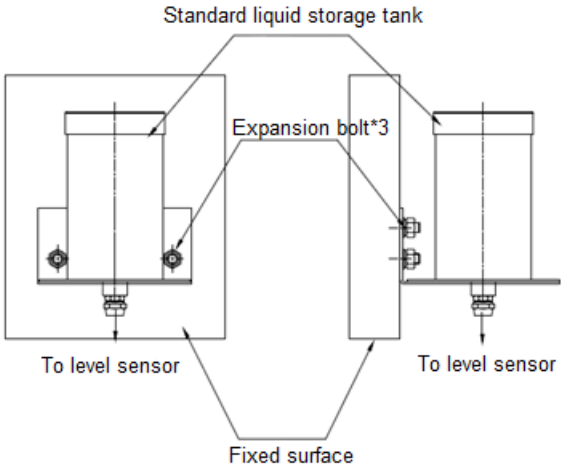
After the level sensor installation floor or mounting bracket of each monitoring point of the whole system is fixed, install the bottom plate of the liquid storage tank on the installation floor or the 3 adjusting bolts of the mounting bracket . After the installation of the liquid storage tank is completed, the elevation of each measuring point should be verified and adjusted so that it is basically the same as the elevation of the bottom plate.

It is recommended that the sensor installation horizontal line is controlled within the drop range of 400mm, and the liquid storage tank best position is to select the highest sensor installation position as the reference sensor point, and move it upwards to a horizontal position of about 300mm.
The head and tail of the trachea need to be vented to the atmosphere, and waterproof measures should be taken. If the sun is directly hitting the trachea, it is recommended that the trachea be shaded. If the length of the main air pipe is too long, it can be disconnected in the middle and exposed to the atmosphere.
If site conditions permit, it is recommended to use two storage tanks, one at the head and the other at the end.

Do not close the liquid storage tank, check the liquid level height of the liquid storage tank regularly, and replenish the liquid level in time if the liquid level is too low.



Large capacity liquid storage tank installation diagram



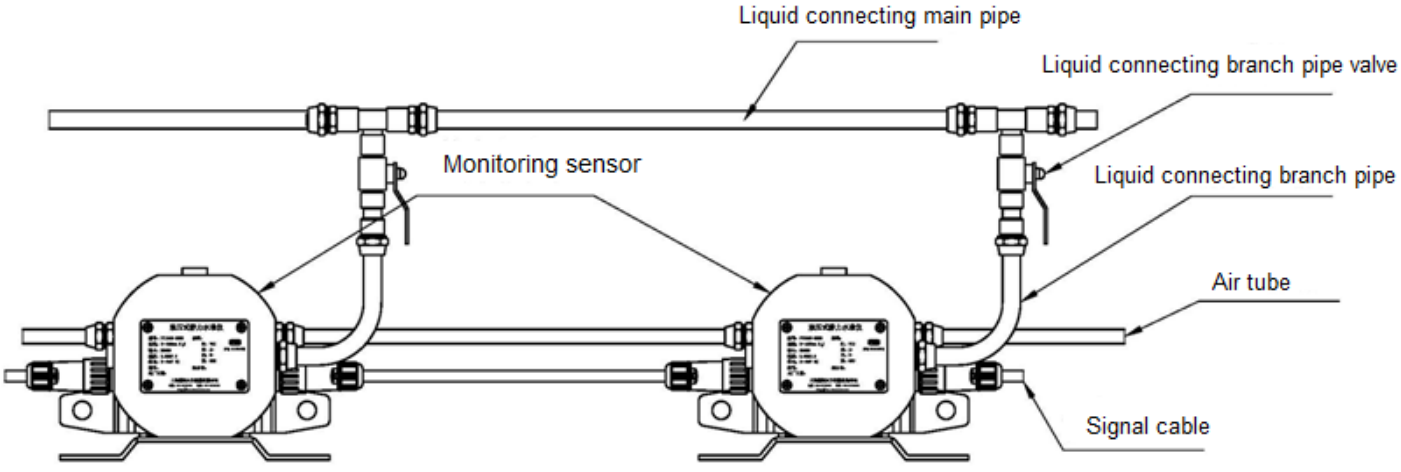
Standard liquid storage tank installation diagram

7. Liquid tube connection

The liquid tube connection of the product is a parallel connection. A connecting branch pipe will be provided on the body of the level sensor . The branch pipe has a valve and a joint for connecting the water pipe. When the pipeline is connected, the liquid main pipe can be connected to each joint. The advantages of this connection are: the connection is simple, convenient, fast, and easy to maintain, and it also has the function of preventing overload.

Due to the long distance between the two monitoring sensor, in order to maintain the liquid balance in the liquid tube, it's necessary to add a wire groove or PVC pipe to protect the liquid pipe. In extremely hot and cold areas, the pipelines need to be insulated/preserved. At the same time, the air tube and the signal output cable can be protected together.

After each monitoring sensors are connected, the connection point of the liquid pipe and the pipe joint should be locked with a tool to prevent loosening and liquid leakage.



Connection diagram

8. Air tube connection

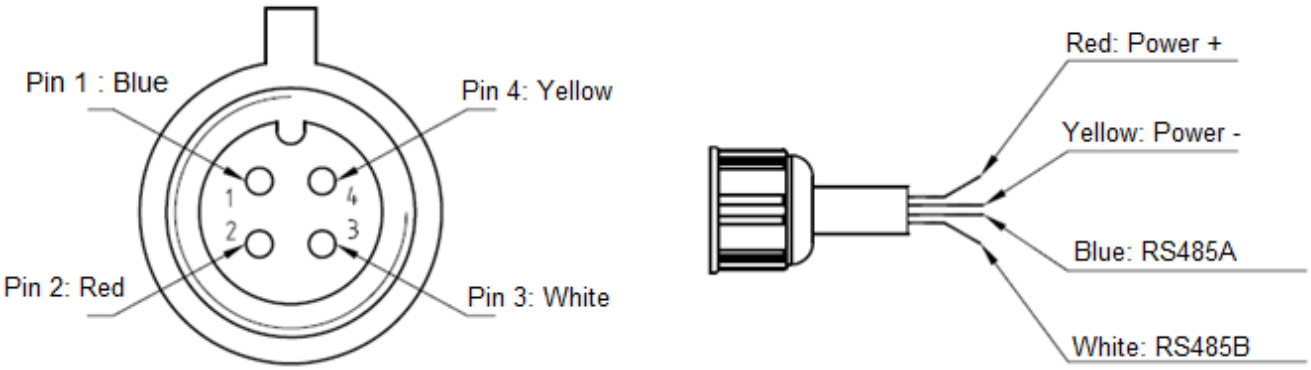
The function of the air tube designed by the level sensor is to keep the liquid pressure in the liquid storage tank of each monitoring sensor point consistent, so that the air tube of each monitoring sensor of the entire system are connected and communicate with the atmosphere , and only one point communicate with the atmosphere (choose one at both ends).
In the leveling sensor system, at both ends of the monitoring point, the air tube at any monitoring point is connected to the drying pipe, the drying pipe is open to the atmosphere, and the other end is used to block the air pipe with a right-angle elbow joint.

According to the distance between the monitoring points, cut the length of the air tube, then connect the air tube nozzle and the tube joint to connect the monitoring sensor in series, communicate with the atmosphere through the drying pipe, and finally fix the air tube .

Note: Do not place the air tube in a damp area or where rain can enter, and do not fill the air tube with liquid, otherwise it will cause irreparable damage to the level sensor !

9. Signal cable connection

Each product will be equipped with a signal output cable as standard. The cable is a 4pins wires, of which two twisted-pair wires are signal wires, and the other two are low-voltage DC power cables. The cable between the monitoring point and the monitoring point is standard with M12*1 plugs . the corresponding plug-in position can be directly screwed in, and they are connected in series; the end connected with the acquisition needs to be wired through the terminal of the collection system .



Wiring definition

10. System liquid filled

The filling liquid in the system pipeline should be antifreeze or silicone oil depending on the application environment. If the liquid in the pipeline is antifreeze, a small amount of glycerin can be added to the liquid storage container to prevent the liquid from volatilizing.

Note: The liquid filling operation requires at least two workers to cooperate and cooperate. The best inlet is at the end of the entire pipeline. The liquid filling should be carried out evenly, slowly and uninterrupted. The air in the liquid pipe should be completely removed and air bubbles should be removed.
When the pump is used to pressurize and fill the liquid, because the pressure generated by the pump is much greater than the measuring range of the sensor, you must first close all the valves on the sensor and open the exhaust port on the sensor at the same time; close the valve 1 under the liquid storage tank and open the overflow pipe Valve 2, open valve 3 at the end of the pipeline, and then follow the steps below:

1. There should be enough liquid medium available in the liquid tank to avoid filling failure due to insufficient liquid medium in subsequent operations, at least 10 to 30 times the baseline demand based on the pipeline demand;

2. Before pumping and filling the liquid, whether it is directly in a barrel or other container to hold the liquid, the pumping and filling operation can only be carried out after the liquid is still, because there will be bubbles in the liquid after shaking, when silicone oil is used as the medium , The static time must be increased to ensure that there is no air bubbles before the pumping operation is performed;

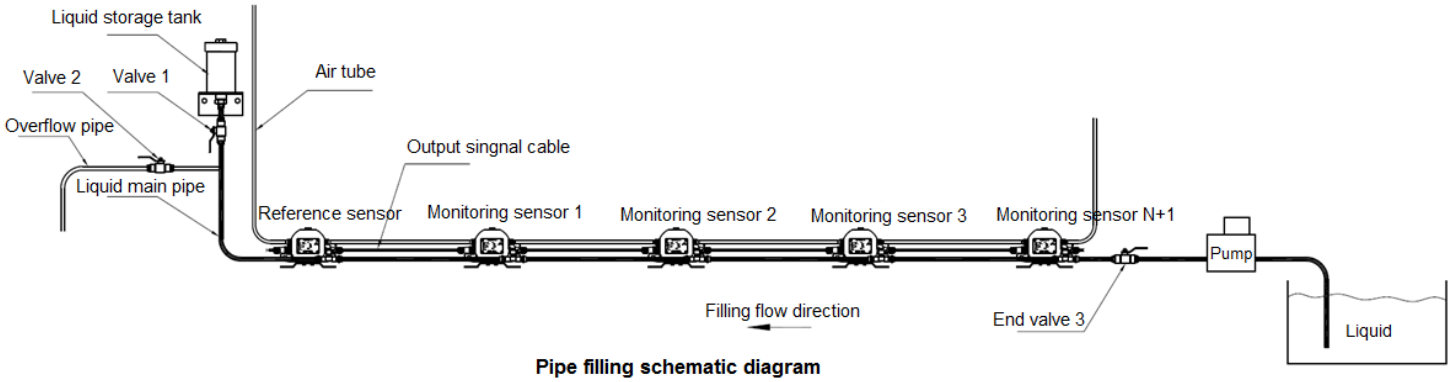
3. Fill the main liquid pipe with pressure and fill the liquid from the end of the pipe towards the liquid storage tank. When filling the liquid, make sure that the liquid output by the pump is free of bubbles. Observe the air removal situation when the liquid flows out at the overflow pipe. And use another container to connect the liquid flowing out of the overflow pipe. During the filling process, pay attention to the liquid margin at the pump inlet and the pipe suction port not to leave the liquid. If air enters during the filling process, continue the pump pressure cycle and add liquid until All bubbles are discharged out of the overflow pipe, so that after the main pipe circulates without bubbles, it indicates that the main pipe is exhausted and filled with liquid. At this time, open the valve 1 under the liquid storage tank without stopping the pump, and close the valve on the overflow pipe valve 2, when the liquid is continuously filled to the required height of the liquid storage tank, close the valve 1, and at the same time, operate the valve 2 at 1/2 opening; in the case of non-stop pump, start from the end sensor, open the valve on the sensor to make Liquid enters the sensor liquid chamber and discharges the liquid chamber air. When the liquid flowing out of the exhaust port lasts for more than 30 seconds without bubbles, close the valve on the sensor, and the exhaust port will not be closed temporarily. Repeat the above operation method to fill and exhaust the sensor. After the exhaust operation of all sensors is completed, starting from the reference point sensor, open the valves on the sensors one by one and tighten the vent screws of the sensors. In this way, the operations of filling and exhausting the liquid are completed one by one. When all the sensors are completed After the exhaust operation, two workers are required to operate together, close the overflow pipe valve 2 and the end valve 3 at the same time, and stop the pump;

4. After the operation is completed, check the filling of the liquid in the pipeline. Make sure that there is no air in the pipeline. Finally, open the valve 1 where under the liquid storage tank, and check the liquid remaining in the liquid tank again. If it is insufficient, it needs to be made up to the reference height;

5. After the liquid filling is completed, the sealing performance of the system should be checked in time to observe whether there is any leakage of liquid at the joints, and no leakage can proceed to the next step.

Warning: If there is a large amount of residual air left in the pipeline, it will cause the sensor to measure inaccurately, especially when the temperature difference between morning and night is large. The thermal expansion and contraction of the air will drive the sensor's numerical error to be very large, so the air in the filling process Exclusion is very important !

6. Pipe filling schematic diagram as follows:



Pipe filling schematic diagram

Part4: Protocol description

Communication description：

a. 9600bps baud rate, 8bit data, 1bit stop bit, no parity, communication using standard RS485

b. The data is a hexadecimal 4-byte floating point number (refer to the attachment for the conversion method)

c. Check using CRC16, low bit in front, high bit in back

Other devices send query commands to the sensor：{01} [04] [00] [00] [00] [04] {F1} {C9}

After the sensor receives the correct data query command, it returns the data to the sending data query end：

{01} [04] {08} {44} {7A} {00} {00} {43} {C8} {00} {00} {6E} {73}

This protocol transmits a byte stream, all the following characters use hexadecimal, and the display of the byte stream is replaced by a string, for example: 'FF' represents 1 byte = '1111 1111'[binary]

Protocol

The boundary internal data of the boundary is 1 byte

The variable part uses {} as the boundary

The fixed part uses [] as the boundary

1、Read data instruction

1.1 Command 1 (without temperature)

Host computer send：{Address} [04] [00] [00] [00] [02] {CRC16L} {CRC16H}

Sensor response：{Address} [04] {04} {42} {C8} {00} {00} {CRC16L} {CRC16H}

Annotation：{Address} is the device address

[04] [00] [00] [00] [02] are fixed value；

{04} is the data length；

{42} {C8} {00} {00} the data value is 100；

send	address	function code	Address high	Address low	Data high	Data low	CRC16 low	CRC16 high
HEX	01	04	00	00	00	02	71	CB

response	address	function code	data Number	Data bit	Data bit	Data bit	Data bit	CRC16 low	CRC16 high
HEX	01	04	04	42	C8	00	00	6E	02

Note: FE is a universal address, when Address=FE, all sensors on the bus response, and it is recommended to use it when querying the sensor address.

Example: Device No. 1

Host computer send：{01} [04] [00] [00] [00] [02] {71} {CB}

Sensor response：{01} [04] {04} {42} {C8} {00} {00} {6E} {02}

Example: Device No. 2

Host computer send：{02} [04] [00] [00] [00] [02] {71} {F8}

Sensor response：{02} [04] {04} {42} {C8} {00} {00} {5D} {02}

1.2 Command 2 (with temperature)

Host computer send：{Address} [04] [00] [00] [00] [04] {CRC16L} {CRC16H}

Sensor response：{Address} [04] {08} {42} {C8} {00} {00} {41} {C8} {00} {00} {CRC16L} {CRC16H}

Annotation：{Address} is the device address

[04] [00] [00] [00] [04] are fixed value；

{08} is the data length；

{42} {C8} {00} {00} the data value is 100；

{41} {C8} {00} {00} the temperature value is 25 degree C .

send	address	function code	Address low	Address high	Data high	Data low	CRC16 low	CRC16 high
HEX	01	04	00	00	00	04	F1	C9

respons e	addres s	function code	data Number	Dat a bit	Dat a bit	Dat a bit	Dat a bit	Dat a bit	Dat a bit	Data bit	Data bit	CRC1 6 Low	CRC1 6 High
HEX	01	04	08	42	C8	00	00	41	C8	00	00	7D	EA

Note: FE is a universal address, when Address=FE, all sensors on the bus reply, and it is recommended to use it when querying the sensor address.

Example: Device No. 1

Host computer send：{01} [04] [00] [00] [00] [04] {F1} {C9}

Sensor response：{01} [04] {08} {42} {C8} {00} {00} {41} {C8} {00} {00} {7D} {EA}

Example: Device No. 2

Host computer send：{02} [04] [00] [00] [00] [04] {F1} {FA}

Sensor response：{02} [04] {08} {42} {C8} {00} {00} {41} {C8} {00} {00} {72} {AE}

2、Change device address command

2.1 Command 1 (known original device address)

Host computer send：{Old_ Address} [06] [00] [01] [00] {New_Address} {CRC16L} {CRC16H}

Sensor response：{New_Address} [06] {CRC16L} {CRC16H}

send	addres s	function code	Addres s high	Addres s low	Reserve d	new addres s	CRC16 low	CRC16 high
HEX	01	06	00	01	00	05	18	09

response	address	function code	CRC16 low	CRC16 high

HEX	05	06	82	E2

Example: No. 1 device is changed to No. 5 device

Host computer send：{01} [06] [00] [01] [00] {05} {18} {09}

Sensor response：{05} [06] {82} {E2}

2.2 Command 2 (unknown original device address)

Host computer send： {EE} [04] [00] {New_Address} [00] [04] {CRC16L} {CRC16H}

Sensor response：{New_Address} [04] {08} {42} {C8} {00} {00} {41} {C8} {00} {00} 7D EA

Note: {New_Address} , it's a new address. You can also change the address without knowing the old address of the sensor, provided that there is one and only one sensor on the bus.

send	address	function code	Address bit	new address	Data low	Data high	CRC16 low	CRC16 high
HEX	EE	04	00	02	00	04	46	96

response	address	function code	Date number	Data bit	Data bit	Data bit	Data bit	Data bit	Data bit	Data bit	Data bit	CRC16 low	CRC16 high
HEX	02	04	08	42	C8	00	00	41	C8	00	00	72	AE

Example: Change the address of the unknown device to address 2

Host computer send：{EE} [04] [00] {02} [00] [04] {46} {96}

Sensor response：{02} [04] {08} {42} {C8} {00} {00} {41} {C8} {00} {00} {72} {AE}

Example: Change the address of the unknown device to address 10

Host computer send：{EE} [04] [00] {0A} [00] [04] {C7} {54}

Sensor response：{0A} [04] {08} {42} {C8} {00} {00} {41} {C8} {00} {00} {58} {CE}

3、Zero adjustment

3.1 Command 1

Host computer send： {Address} [24] [01] [00] [00] [00] [00] {CRC16L} {CRC16H}

Sensor response：{Address} [24] {CRC16L} {CRC16H}

send	address	Function code	01 zero Cleared	Data 00	Data 00	Data 00	Data 00	CRC16 low	CRC16 high
HEX	01	24	01	00	00	00	00	30	E4

response	address	Function code	CRC16 low	CRC16 high
HEX	01	24	00	3B

Example: Zero adjustment of No. 1 device
Host computer send：{01} [24] [01] [00] [00] [00] [00] {30} {E4}
Sensor response：{01} [24] {00} {3B}

3.2 Command 2

zero=1 means zero adjustment is on

Host computer send：{Address} [05] [00] [02] [00] {zero} {CRC16L} {CRC16H}

Sensor response：{Address} [05] {08} [00] [02] [00] {zero} {41} {C8} {00} {00} {CRC16L} {CRC16H}

{41} {C8} {00} {00} temperature value are 25 degrees

send	address	Function code	Address high	Address low	Reserved	01 zero Cleared	CRC16 low	CRC16 high
HEX	01	05	00	02	00	01	AD	CA

respon se	addr ess	Function code	Data number	Request address high	Request address low	Rese rved	01 zero Cleare d	Data bit	Data bit	Data bit	Data bit	CRC 16 low	CRC 16 high
HEX	01	05	08	00	02	00	01	41	C8	00	00	FE	0A

4、Add boot code function. (8000 0000) = 4C 98 96 80

The format of the boot code

response	addres s	Functio n code	Data length	error code	error code	error code	error code	error code	error code	error code	error code	CRCL	CRCH
HEX	01	04	08	4C	98	96	80	4C	98	96	80	CRCL	CRCH

5、Hardware error, including temperature IC error, AD error. (8100 0000) =4C 9A 7E C8

send

send	address	Function code	Address low	Address high	Data high	Data low	CRC16 low	CRC16 high
HEX	01	04	00	00	00	04	F1	C9

response	address	Function code	Date number	Data bit	Data bit	Data bit	Data bit	Data bit	Data bit	Data bit	Data bit	CRC16 low	CRC16 high
HEX	01	04	08	4C	9A	7E	C8	4C	9A	7E	C8	CRCL	CRCH

6、More than three times of the range, for example, the range is 1000mm. When the data is greater than 3000mm, it starts to report an error (8200 0000) =4C 9C 67 10

send	address	Function code	Address low	Address high	Data high	Data low	CRC16 low	CRC16 high
HEX	01	04	00	00	00	04	F1	C9

response	address	Function code	Date number	Data bit	Data bit	Data bit	Data bit	Data bit	Data bit	Data bit	Data bit	CRC16 low	CRC16 high
HEX	01	04	08	4C	9C	67	10	4C	9C	67	10	CRCL	CRCH

7、In the case of negative pressure, the negative pressure is less than one-fifth of the range. For example, the range is 1000mm. When the data is less than -200mm, an error will be reported. (8300

send

send	addr ess	Functio n code	Address low	Address high	Data high	Data low	CRC16 low	CRC16 high
HEX	01	04	00	00	00	04	F1	C9

resp onse	addr ess	Function code	Date number	Data bit	Data bit	Data bit	Data bit	Data bit	Data bit	Data bit	Data bit	CRC16 low	CRC16 high
HEX	01	04	08	4C	9E	4F	58	4C	9E	4F	58	CRCL	CRCH

8、Temperature IC error during power-on process，(8400 0000) =4C A0 37 A0

send	address	Function code	Address low	Address high	Data high	Data low	CRC16 low	CRC16 high
HEX	01	04	00	00	00	04	F1	C9

respons e	addres s	Functio n code	Date numbe r	Dat a bit	Dat a bit	Dat a bit	Dat a bit	Dat a bit	Dat a bit	Dat a bit	Dat a bit	CRC 16 low	CRC 16 high
HEX	01	04	08	4C	A0	37	A0	4C	A0	37	A0	CRC L	CRC H

9、The customer illegally modified the circuit, which caused the original temperature IC to change or

separate from the circuit board。(8500 0000) =4C A2 1F E8

send	address	Function code	Address low	Address high	Data high	Data low	CRC16 low	CRC16 high
HEX	01	04	00	00	00	04	F1	C9

respo nse	addr ess	Functio n code	Date number	Data bit	Data bit	Data bit	Data bit	Data bit	Data bit	Data bit	Data bit	CRC1 6 low	CRC16 high
HEX	01	04	08	4C	A2	1F	E8	4C	A2	1F	E8	CRCL	CRCH

10、During the power-on process, AD communication is abnormal (8600 0000) = 4C A4 08 30

send	address	Function code	Address low	Address high	Data high	Data low	CRC16 low	CRC16 high
HEX	01	04	00	00	00	04	F1	C9

response	address	Function code	Date number	Data bit	Data bit	Data bit	Data bit	Data bit	Data bit	Data bit	Data bit	CRC16 low	CRC16 high
HEX	01	04	08	4C	A4	08	30	4C	A4	08	30	CRCL	CRCH

Appendix 1. IEEE754 conversion

1）. Convert single-precision floating-point numbers to standard 4-byte numbers

```
//float Converted to IEEE754 4-byte big_endian
// If the compiler uses little “endian” mode, please reverse the “ bdat” array first
void float2byte(float fdat,unsigned char * bdat)
{
    unsigned char i;
    // Get the 4 byte address where the float data is located
```

```
    unsigned char *tmp=(unsigned char *)&fdat;
    // Indirect addressing, get the value in the 4-byte address where the float is located
    for(i=0;i<(sizeof(float));i++)
    *(bdat+i)=*(tmp+i);
}
```

2) . 4 bytes converted to standard single-precision floating point function

```
// IEEE754 4 bytes are converted to float big_endian
// If the compiler uses “little endian” mode, please reverse the “bdat” array first
float byte2float(unsigned char *bdat)
{
    return *((float *)bdat);
}
```

Appendix 2. CRC16 calculation program

*data= Data to be calculated

len= Need to calculate the number of data

*out= Output data, the first byte is CRC16L, the second byte is CRC16H

```
void CRC_read_data(unsigned char *data,unsigned char len,unsigned char *out)  //CRC16      Entry
function
{
        unsigned int XZ;
        XZ=UART_CRC16_Work(data,len);
       out[0]=XZ;
       out[1]=XZ>>=8;
}
```

```
unsigned int UART_CRC16_Work(unsigned char *CRC_Buf,unsigned char CRC_Leni)//CRC16 Internally calling function
{
    unsigned char i,j;
    unsigned int CRC_Sumx;

    CRC_Sumx=0xFFFF;
    for(i=0;i<CRC_Leni;i++)//??????????
    {
        CRC_Sumx^=*(CRC_Buf+i);//??
        for(j=0;j<8;j++)
        {
            if(CRC_Sumx & 0x01)
            {
                CRC_Sumx>>=1;
                CRC_Sumx^=0xA001;
            }
            else
            {
                CRC_Sumx>>=1;
            }
        }
    }
    return (CRC_Sumx);
}
```

Part 5. Monitoring System Test

After the entire monitoring system is installed, the system can be debugged; first, the high and low error values during installation need to be compensated by the data center software, and then moved up and down the sensor simulate the settlement state to verify the data transmission and accuracy of the data. Verify the measurement accuracy of the sensor; the measurement accuracy of the sensor is recommended to be carried out in the laboratory, and the site conditions are not suitable for accuracy verification

Part 6: Precautions and Simple exception and maintenance

1. Precautions

1. The output signal cable must avoid being close to high-power power sources, radio frequency signal sources and other noisy transmission lines, etc.;

2. The shielded wire of the cable must be intact and unbroken. When reading data with the secondary meter, the shielded wire of the sensor must be connected to the ground of the meter, and the meter must have lightning protection;

3. When eliminate the air in the liquid pipe, it is forbidden to knock the body of the level sensor with external force;

4. When installing in the field, in order to prevent wild animals from biting the pipelines and cables, protective measures should be taken for the pipelines and cables;

5. Air tube are not allowed to be placed in the open air at will. They should be protected by water ingress protection measures and placed in a protective box and in a ventilated place;

6. When installing a long-distance monitoring point, the height difference should not exceed the measurement range of the product;

2. Simple exception and maintenance

Item	Fault description	Cause Analysis	Exclusion method
1	The daily liquid level value drops more	There may be a leak	Check the joints of the liquid tank and each connection point, and eliminate the possible leakage of the connection point
2	Unstable data transmission	There may be a hardware or software problem	1. Check whether the sensor connector is loose; 2. Check the data collection system; 3. Check the data center;
3	The daily up and down values fluctuate greatly	There may be a lot of bubbles in the pipeline	Check the pipeline to eliminate air bubbles
4	Negative pressure at individual monitoring sensor points	Pipeline pressure may cause siphoning due to external factors	Check the pipeline and height difference of the adjacent points
5	When the monitoring line is long, no data is uploaded from the tail monitoring point	The voltage drop of the power supply causes insufficient power supply for the sensor	Add power supply or boost module

Part 7: Ordering Guide

Model	Range (mmH_2O)	Output signal	Electrical connector	Accuracy	Other requirement
PT124B-226E	--	--	--	--	---
For example: PT124B-226E-500mmH_2O-RS485-4PIN-0.02mm					

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