PT100 Temperature Sensor

I. Product Definition

The PT100 Integrated Temperature Sensor is an integrated temperature measurement and transmission device designed specifically for industrial applications. Featuring a standard HART connector design, it tightly integrates a PT100 platinum resistance temperature sensor, signal conditioning circuitry, an electrical isolation module, and a protective housing into a single unit, eliminating the need for an external junction box.

---Core Features: Precise PT100 temperature signal acquisition, three-terminal electrical isolation (input/output/power), standard industrial signal transmission, robust electromagnetic interference suppression, IP65 industrial protection rating, and a maintenance-free integrated design.

---Structural Characteristics: HARTING aviation-grade waterproof connector + stainless steel probe + integrated circuit module, achieving a "two-in-one" solution for sensing and transmission.

II. Operating Principle

Follows a closed-loop workflow of "Temperature Acquisition → Signal Conditioning → Electrical Isolation → Standard Signal Output" to meet industrial automation measurement and control requirements:

---Temperature Acquisition: The PT100 platinum resistance temperature probe contacts the measured medium, converting temperature changes into linear changes in resistance (compliant with DIN EN 60751 standard, TCR=3850 ppm/K).

---Signal Conditioning: Built-in high-precision conditioning circuits amplify and linearize the weak resistance signal, eliminating line losses and noise interference.

---Electrical Isolation: Utilizes electromagnetic/optical isolation technology to achieve complete isolation of the input, output, and power supply (isolation voltage ≥1500V), blocking ground potential differences and interference loops.

-- - Standard Signal Output: Converts to a 4-20mA current signal (optional 0-10V/RS485), compatible with mainstream control systems such as PLCs, DCS, and digital displays, supporting long-distance transmission without signal attenuation.

III. Key Advantages

--- Three-Point Full Isolation: Independent isolation of input, output, and power supply completely resolves common-mode interference, signal drift, and equipment crosstalk issues, protecting downstream control systems.

---Hirschmann High Protection: IP67-rated waterproof and dustproof connectors are resistant to oil, acids, alkalis, and vibration, making them suitable for harsh environments such as humidity, dust, and corrosion.

---Integrated Maintenance-Free Design: No exposed wiring or separate connectors reduces potential failure points; factory-sealed packaging eliminates the need for routine wiring maintenance.

---Precise and Stable Measurement: Utilizes Grade A/B PT100 elements, with accuracy ranging from ±0.15°C to ±0.3°C and temperature drift ≤0.01%/°C, ensuring strong long-term stability.

---Extremely Simple Installation: The HARTING connector is plug-and-play, with quick-mounting via threads or flanges, eliminating the complex wiring required by traditional split-type designs.

IV. Core Value

Compared to traditional split-type temperature sensors (probe + standalone transmitter), the Qidian PT100 HART Integrated Temperature Sensor delivers a comprehensive upgrade across six core dimensions—wiring, protection, anti-interference, maintenance, installation, and safety—precisely addressing the pain points of traditional equipment and enabling efficient, stable, and convenient industrial temperature measurement operations.

---Wiring Comparison: Say Goodbye to Complexity, Hello to Efficiency and Convenience

Traditional Split-Type: Requires multi-step wiring and connecting multiple connectors. Not only is the wiring process cumbersome, but it is also highly prone to issues such as incorrect connections and loose wires. Troubleshooting is difficult, severely impacting temperature measurement efficiency.

Qidian Integrated: Utilizing HARTING's plug-and-play design, all circuits and connectors are integrated into a single unit. No complex wiring is required, and with zero extra connectors, wiring is completed simply by plugging in. This completely eliminates the risk of miswiring or loose connections, significantly improving installation and commissioning efficiency.

---Protection Comparison: Upgraded Sealing for Harsh Conditions

Traditional Split-Type: With exposed connectors and poor sealing performance, these units are prone to water ingress, dust accumulation, and oil contamination. In harsh industrial environments—such as those with high humidity, dust, or corrosion—they suffer from extremely high failure rates, frequently compromising temperature measurement stability.

Qidian Integrated: Equipped with HARTING aviation-grade sealed connectors, featuring an IP67 protection rating. It effectively resists water, dust, oil, acids, alkalis, and vibration, ensuring stable operation even in harsh industrial settings and significantly reducing failure rates.

---Interference Resistance Comparison: Three-Terminal Isolation, Zero Signal Distortion

Traditional Split-Type: Lacks full isolation design; long wiring runs make it susceptible to strong electromagnetic interference from nearby sources (such as variable frequency drives and high-voltage cables), leading to signal drift and data distortion, which affects the precise control of downstream systems.

Qidian Integrated Design: Features a built-in fully isolated three-terminal module (input/output/power supply) with an isolation voltage of ≥1500V. Combined with a dedicated shielding design, it completely blocks ground potential differences and interference loops, effectively suppressing strong electromagnetic interference to ensure stable, distortion-free transmission of temperature signals.

--- Maintenance Comparison: Maintenance-free design reduces costs

Traditional Split-Type: Requires regular inspection of wiring tightness and connector sealing, as well as frequent maintenance. This not only consumes significant manpower and resources but also increases operational costs due to equipment failures caused by untimely maintenance.

Qidian Integrated System: Features a fully sealed enclosure design with no exposed components or vulnerable connectors. Pre-calibrated at the factory, it requires no daily wiring maintenance. Its service life is 3–5 times longer than that of traditional split-type systems, significantly reducing operational costs and downtime losses.

---Installation Comparison: Ultra-Simple Deployment, Saving Time and Effort

Traditional Split-Type: Requires separate installation of the sensor probe and standalone transmitter, along with complex wiring connections. The installation process is cumbersome, time-consuming, and demands a high level of expertise from installers.

Qidian Integrated: Single-component integrated design with threaded or flanged mounting options. No disassembly required; deployment can be completed in 10 minutes. Simple operation requires no specialized technicians, significantly reducing installation time and labor costs.

---Safety Comparison: Compliance Upgrade, Suitable for High-Risk Environments

Traditional Split-Type: Lacks isolation design, posing safety hazards in flammable and explosive environments such as chemical, oil, and gas industries. It fails to meet explosion-proof compliance requirements, presenting safety risks.

Qidian Integrated: Optional Exd II CT6 explosion-proof certification, specifically designed for high-risk flammable and explosive environments such as chemical, oil, gas, and coal mining industries. It complies with industrial safety standards, effectively mitigates safety risks, and ensures production safety.

V. Product Series and Applicable Scenarios

(1) Four Major Series

---General-Purpose: Standard measurement range -50°C to 200°C, IP65 protection, suitable for general industrial temperature measurement, offering high cost-effectiveness.

---Explosion-Proof: Exd II CT6 explosion-proof certification, -40°C to 180°C, used in flammable and explosive environments such as chemical, oil and gas, and coal mining.

--- High-Temperature Type: 316L stainless steel probe, measurement range -50°C to 500°C, high-temperature and high-pressure resistant,

suitable for metallurgy, boilers, and steam pipelines.
--- Corrosion-Resistant Type: PTFE/Hastelloy protective tube, resistant to acid and alkali corrosion, -40°C to 200°C, used in pharmaceuticals, electroplating, and wastewater treatment.
5.2 Core Application Industries
---Chemical Industry: Temperature monitoring of reactor vessels, storage tanks, and pipeline media (priority given to explosion-proof environments)
---Power Generation: Temperature measurement for generator sets, bearings, transformers, and cooling water systems
---Metallurgy: High-temperature monitoring of blast furnaces, hot blast stoves, steel rolling mills, and heat treatment furnaces
---Pharmaceutical: Cleanrooms, fermenters, reactors, sterile water systems (corrosion-resistant / sanitary grade)
---HVAC: Central air conditioning, heat exchange stations, heating pipelines, building temperature control
---Water Treatment: Sewage tanks, purified water systems, reverse osmosis equipment temperature measurement
---Smart Manufacturing: Temperature monitoring for machinery, bearings, hydraulic stations, injection molding machines, and air compressors

VI. Key Parameters & Specifications
6.1. Basic Electrical Parameters
1. Input Signal
Sensing Element: Standard PT100 platinum resistance thermometer, compatible with Class A/Class B accuracy elements
Measurement Range: Multiple specifications available to cover all application requirements
General-purpose: -50°C to 200°C
Medium-High Temperature: -50°C to 400°C
High Temperature: -50°C to 500°C (requires custom high-temperature probe)
Ultra-Low Temperature: -200°C to 50°C (customized for cryogenic applications)
2. Output Signals
Three standardized output options are provided to meet the integration requirements of various industrial control systems:
Analog Output: 4–20 mA (2-wire / 3-wire options available), 0–10 V
Digital Output: RS485 (Modbus-RTU protocol),
3. Key Performance Specifications
Accuracy Class: ±0.15°C to ±0.3°C Depending on the probe element grade and measurement range, Class B accuracy reaches ±0.3°C, and Class A accuracy reaches ±0.15°C
Resolution: 0.1°C
Response Time: ≤0.5 seconds
Load Capacity: 4–20mA output: ≤500Ω, 0–10V output: ≥10kΩ
6.2 Isolation Performance Parameters
1. Electrical Isolation
Isolation Structure: Complete three-way isolation of input, output, and power supply, blocking common-mode interference and ground loops
Dielectric Strength: ≥1500 V DC (1 minute, no breakdown)
Insulation Resistance: ≥100 MΩ (tested at 500 V DC)
2. Electromagnetic Compatibility (EMC)
Strictly complies with industrial-grade anti-interference standards to ensure signal stability in harsh environments:
Compliance Standards: IEC 61326-3-1:2015 (Industrial Equipment EMC Standard)
Immunity:
Radio Frequency Radiated Immunity: 10 V/m (80 MHz–1000 MHz)
Electrostatic Discharge (ESD): Contact Discharge ±8 kV, Air Discharge ±15 kV
Electrical Fast Transient Burst: ±2 kV (Power / Signal Lines)
3. Stability Specifications
Temperature Drift: ≤±0.01%/°C (across the entire operating temperature range),
Long-term Stability: ≤±0.1% FS/year,
6.3. Power Supply & Power Consumption Parameters
1. Power Supply Specifications
Standard Power Supply: DC 24V (wide-voltage design, supports DC 12V–30V input)
Power Consumption Parameters:
Full-Load Power Consumption: ≤1.2W (4–20mA output at full load)
No-Load Power Consumption: ≤0.8W; low-power design suitable for battery-powered applications (customization required)
2. Power Distribution Function
Supports reverse power distribution/feedback mode; can be powered by DC 24V from a downstream instrument or PLC, eliminating the need for an additional power module and simplifying field wiring
6.4 Environmental Adaptation Parameters
1. Temperature and Humidity Range
Operating Temperature and Humidity: -20°C to +60°C, relative humidity ≤95% (non-condensing)
Storage Temperature and Humidity: -40°C to +80°C, relative humidity ≤95% (non-condensing)
Protection Rating:
Hirschmann Connector: IP67 (waterproof and dustproof, withstands brief immersion)
Probe and Main Unit: IP65 (standard industrial environments); corrosion-resistant models available with IP68 (deep-water environments)
2. Safety Rating
Explosion-proof rating: Optional Ex ia IIC T6 Ga (intrinsically safe), suitable for Zone 0 / Zone 1 flammable and explosive environments in chemical, oil, and gas industries
Corrosion resistance rating: Standard 304 material suitable for general corrosive environments; 316L / Hastelloy / PTFE sleeve materials suitable for C2–C4 severe corrosion conditions
6.5. Physical Parameters
1. Structure and Installation
Overall Structure: Hirschmann aviation connector + integrated circuit module + stainless steel probe; no external junction box; high integration
Probe Specifications:
Tube Diameter: Φ6mm/Φ8mm (standard), Φ4mm (miniature custom)
Insertion Depth: 50mm/100mm/150mm/200mm (optional; custom lengths available)
Material: 304 stainless steel (standard), 316L stainless steel (corrosion-resistant), Hastelloy / PTFE (for highly corrosive environments / sanitary-grade customization)
Installation Methods:
Threaded Installation: G1/2“, M20×1.5 (standard), M16×1.5, NPT 1/2” (custom)
Flange Mounting: DN20/DN25/DN32 (compatible with pipe/equipment flanges)
2. Dimensions and Markings
Dimensions: HART connector diameter 22mm; probe length customized based on insertion depth; total unit length ≤300mm (excluding probe)
Weight: Approx. 0.3kg–0.8kg (depending on probe length and material)
Housing Material: Die-cast aluminum alloy (anodized for corrosion resistance), 304 stainless steel (explosion-proof version)
Indicator Light Definitions:
PWR (Power Indicator): Steady on = Normal power supply; Off = Power supply abnormality
ALM (Alarm Indicator): Flashing = Out of range / Signal failure; Steady on = Fault alarm; Off = Normal operation

VII. Selection Guide
7.1 Key Selection Criteria
The selection process should focus on three core aspects: on-site operating conditions, equipment compatibility, and environmental requirements. The following eight key criteria must be verified one by one to avoid selection errors that could result in equipment malfunction or reduced service life, thereby ensuring accurate temperature measurement and stable operation.
1. Temperature Measurement Range
Selection should be based primarily on the typical and extreme temperatures of the medium being measured. Taking into account the linear temperature measurement characteristics of PT100 platinum resistance thermometers (compliant with IEC 60751), a margin of 10%–20% should be reserved to prevent equipment damage caused by exceeding the measurement range: For standard applications, select -50°C to 200°C; for medium-to-high-temperature applications (e.g., boilers, heat treatment), -50°C to 400°C; for special high-temperature applications, -50°C to 500°C; and for ultra-low-temperature cryogenic applications, -200°C to 50°C. This ensures the measurement range fully

covers the target temperature range while maintaining measurement accuracy and avoiding accuracy dilution caused by an excessively wide range.

2. PT100 Temperature Scale

This series of sensors is configured by default to the PT100 temperature scale (standard resistance of 100 Ω at 0°C, sensitivity of approximately 0.385 Ω/°C). They are compatible with Class A and Class B precision elements and are the mainstream choice for industrial process control, offering strong compatibility and working with the vast majority of industrial PLCs and DCS control systems; It is not compatible with PT1000 or other temperature scales. When selecting a model, verify that the downstream control system interface supports PT100 signals to prevent data acquisition failures caused by signal mismatches.

3. Output Signal

Select the output based on the type of backend control system to ensure direct connectivity and minimize the need for additional conversion devices: For standard industrial control applications, prioritize 4–20 mA analog output (available in two-wire or three-wire configurations), which offers strong noise immunity and long transmission distances (up to 1,000 meters) and is compatible with most PLCs and digital display instruments; For applications requiring remote parameter reading and calibration, select RS485 (Modbus-RTU protocol) digital output, which supports multi-device networking; for small-scale control systems or simple temperature measurement scenarios, choose 0–10V analog output for convenient installation and commissioning.

4. Probe Specifications (Insertion Depth, Pipe Diameter, Material)

The probe comes into direct contact with the measured medium, and its specifications directly affect measurement accuracy and equipment lifespan: ① Insertion Depth: Ensure the probe's sensing element is fully immersed in the core of the measured medium. For standard piping, select an insertion depth of ≥50 mm; for large storage tanks and reactors, choose 100 mm, 150 mm, or 200 mm to prevent measurement errors caused by insufficient insertion depth; ② Tube Diameter: Standard applications use Φ6 mm or Φ8 mm; for confined spaces or precision equipment, custom Φ4 mm micro-probes are available; ③ Material: For general applications, select 304 stainless steel; for corrosive environments (e.g., pharmaceutical and chemical industries), select 316L stainless steel; for highly corrosive environments (e.g., electroplating, acid-base solutions), custom options such as Hastelloy or PTFE sheathing are available; for high-temperature applications, select high-temperature-resistant stainless steel to ensure the probe's temperature resistance, corrosion resistance, and wear resistance.

5. Thread Specifications

To match on-site installation interfaces, standard G1/2“ and M20×1.5 threads are provided by default, compatible with most industrial equipment and piping interfaces; for special installation scenarios, non-standard threads such as M16×1.5 or NPT 1/2” can be customized. When selecting a model, accurately confirm the thread specifications of the on-site installation interface to avoid installation failures or poor sealing due to thread mismatches, which could lead to water ingress, dust ingress, or other malfunctions.

6. Power Supply

The default power supply is 24 VDC (wide-voltage design supporting 12 VDC to 30 VDC input), compatible with standard industrial DC power systems; Supports reverse power distribution/feeding mode, allowing DC 24V power to be supplied by downstream instruments or a PLC, eliminating the need for an additional power supply module and simplifying on-site wiring. This is particularly suitable for scenarios with complex wiring or limited power interfaces. When selecting a model, verify the on-site power supply method and voltage range to prevent equipment damage caused by power supply abnormalities.

7. Explosion-Proof Requirements

Select the model based on the on-site hazard classification. For standard non-flammable and non-explosive environments (e.g., HVAC, general workshops), choose the non-explosion-proof version; For flammable and explosive environments such as chemical, oil and gas, and coal mining (Zone 0/Zone 1), select models with Ex ia IIC T6 Ga intrinsic safety certification to comply with industrial safety standards and effectively mitigate safety risks; When selecting a model, clearly identify the on-site hazardous area classification. It is strictly prohibited to use non-explosion-proof models in explosion-proof environments to prevent safety hazards.

8. Protection Rating and Installation Environment

The protection rating must match the installation environment: Select IP65 protection for standard indoor dry environments; select IP67 protection for humid, dusty, or outdoor environments (Hirschmann connectors feature IP67 sealing, allowing for brief immersion and providing effective protection against water, dust, and oil); For deep-water or heavily dusty environments, IP68 protection can be customized; simultaneously, consider the installation environment's temperature, humidity, and corrosion levels to select probes and housings made of appropriate materials, ensuring stable operation in harsh conditions and extending service life.

7.2. Industry-Specific Selection Recommendations

Based on typical operating conditions across various industries, match corresponding sensor models and configurations that balance accuracy, stability, and compliance, eliminating the need for complex selection processes and directly meeting on-site requirements.

1. Chemical Industry (Reactors, Storage Tanks, Pipelines)

Core Requirements: Corrosion resistance, explosion-proofing, and anti-interference capabilities, suitable for temperature measurement in acidic, alkaline, flammable, and explosive media; Recommended Model: Explosion-proof PT100 HESMAN integrated temperature sensor; Configuration Recommendations: Temperature measurement range -50°C to 200°C, PT100 (Class A), 4–20mA output, probe material 316L stainless steel (or custom PTFE), insertion depth 100mm to 150mm, M20×1.5 thread, 24 V DC power supply, explosion-proof rating Ex ia IIC T6 Ga, protection rating IP67, effectively resists corrosion, explosion-proof and flame-retardant, suitable for harsh conditions in chemical plants.

2. Power Industry (Generator Sets, Bearings, Transformers, Cooling Water Systems)

Core Requirements: High precision, electromagnetic interference resistance, stable transmission, and suitability for environments with alternating high and low temperatures; Recommended Models: General-purpose/medium-to-high-temperature PT100 HART integrated temperature sensors; Configuration Recommendations: Temperature measurement range -50°C to 400°C (boilers, steam turbines), -50°C to 200°C (cooling water, bearings), PT100 (Class A), 4–20mA/RS485 output, probe material 304/316L stainless steel, insertion depth 50mm–100mm, G1/2" thread, 24V DC power supply, IP65 protection rating, three-terminal isolation design, effectively resisting strong electromagnetic interference from inverters and high-voltage cables to ensure accurate temperature measurement.

3. Metallurgical Industry (blast furnaces, hot blast stoves, rolling mills, heat treatment furnaces)

Core Requirements: High-temperature resistance, wear resistance, vibration resistance, and suitability for harsh high-temperature environments; Recommended Model: High-temperature PT100 HESMAN integrated temperature sensor; Configuration Recommendations: Temperature measurement range -50°C to 500°C, PT100 (Class A), 4–20 mA output, probe made of high-temperature-resistant 316L stainless steel (or custom high-temperature alloy), insertion depth 150 mm–200 mm, M20×1.5 thread, 24 V DC power supply, IP65 protection rating, shock-resistant die-cast aluminum alloy housing, suitable for high-temperature, high-vibration, and dust-intensive metallurgical conditions, extending equipment service life.

4. Pharmaceutical Industry (Cleanrooms, Fermenters, Sterile Water Systems)

Core Requirements: Sanitary-grade, corrosion-resistant, high-precision, suitable for clean, contamination-free environments; Recommended Model: Corrosion-resistant PT100 HART integrated temperature sensor; Configuration Recommendations: Temperature measurement range -50°C to 200°C, PT100 (Class A), 4–20mA/RS485 output, probe material 316L stainless steel (or custom food-grade PTFE), insertion depth 50mm–100mm, G1/2" thread, 24V DC power supply, IP67 protection rating, fully sealed design with no dead zones to prevent contamination of the medium, compliant with pharmaceutical industry cleanliness standards.

5. HVAC Industry (Central Air Conditioning, Heat Exchange Stations, Heating Pipelines, Building Temperature Control)

Core Requirements: Easy installation, stable operation, suitability for indoor and outdoor environments; Recommended Model: Universal PT100 HESMAN Integrated Temperature Sensor; Configuration Recommendations: Temperature measurement range -50°C to 100°C,

PT100 (Class B), 4–20mA/0–10V output, 304 stainless steel probe, 50mm insertion depth, G1/2" thread, 24V DC power supply, IP65 protection rating, HART plug-and-play design for easy installation, suitable for conventional temperature measurement scenarios such as buildings and heat exchange stations, offering high cost-effectiveness.

6. Water Treatment Industry (Wastewater Tanks, Water Purification Systems, Reverse Osmosis Equipment)

Core Requirements: Corrosion resistance, waterproofing, and contamination resistance; suitable for humid and corrosive environments. Recommended Model: Corrosion-resistant PT100 HART integrated temperature sensor. Configuration Recommendations: Temperature measurement range -50°C to 200°C, PT100 (Class B), 4–20mA output, probe material 316L stainless steel (or PTFE sleeve), insertion depth 100mm, thread M20×1.5, 24 V DC power supply, IP67 protection rating, effectively resists corrosion from wastewater and chemicals, with a waterproof sealed design to prevent moisture from entering the equipment.

7.3. Common Selection Pitfalls

Based on feedback from actual field applications, we have identified six common selection pitfalls, clarified the risks associated with these errors, and provided methods to avoid them, ensuring accurate selection and reducing equipment failure rates and operational costs.

1. Incorrect Temperature Measurement Range Selection

Misconception: Selecting a model based solely on the typical temperature of the measured medium without allowing for a margin of safety, or choosing a model with an excessively wide measurement range;

Hazard: A measurement range that is too narrow can easily lead to sensor burnout due to overheating or probe damage; a range that is too wide dilutes measurement accuracy, causing data deviations beyond acceptable limits and failing to meet measurement and control requirements; Prevention Method: Confirm the typical and extreme temperatures of the measured medium. When selecting a model, allow for a 10%–20% measurement range margin. Combine this with the linear temperature measurement characteristics of PT100 to match the appropriate range specifications, avoiding both out-of-range conditions and excessive range redundancy.

2. Probe Material Lacking Corrosion Resistance

Misconception: Using generic 304 stainless steel probes for all scenarios while ignoring the corrosiveness of the medium; Hazards: In corrosive environments such as acids, alkalis, wastewater, and chemical agents, probes are prone to corrosion and damage, leading to signal interruption, equipment failure, and even contamination of the measured medium (e.g., in the pharmaceutical and food industries); Mitigation: Select probes based on the medium's corrosiveness. Use 316L stainless steel for general corrosion scenarios, and customize probes with Hastelloy or PTFE sheath materials for highly corrosive environments to ensure the probe is compatible with the medium's characteristics.

3. Ignoring Explosion-Proof Requirements

Misconception: Selecting non-explosion-proof sensors for flammable and explosive environments such as chemical and oil & gas facilities; Hazards: Poses significant safety risks, potentially causing explosions, fires, and other accidents, and violates industrial safety compliance requirements; Prevention: Clearly identify the hazard zone classification of the site; for flammable and explosive environments, models with Ex ia IIC T6 Ga intrinsic safety certification must be selected; the use of non-explosion-proof models in explosion-proof environments is strictly prohibited.

4. Insufficient Insertion Depth

Misconception: Selecting models based solely on installation space without considering the probe's temperature sensing requirements, resulting in insufficient insertion depth; Hazard: The probe's sensing element does not fully penetrate the core area of the measured medium, leading to significant measurement errors that fail to reflect the actual medium temperature and impair the precision of downstream control systems; Prevention Method: Based on pipe diameter and tank dimensions, ensure the probe insertion depth is ≥50 mm. For large equipment or pipes, increase the insertion depth appropriately to ensure the sensing element is in full contact with the measured medium.

5. Mismatched Protection Rating

Misconception: Selecting IP65-rated models for damp, outdoor, or dusty environments without matching the environmental requirements; Hazards: Moisture and dust entering the device can cause terminal oxidation, circuit short-circuits, and signal drift, shortening the device's service life; Prevention: Select models based on the installation environment; choose IP67 protection for humid, outdoor, and dusty environments, and customize IP68 protection for deep-water applications. Ensure the protection rating matches the environment to maximize the sealing advantages of HARTING connectors.

6. Incorrect Selection of HARTING Connectors

Misconception: Ignoring HART connector specifications and selecting models arbitrarily; Risks: Mismatched connectors result in installation failure or poor sealing, allowing water and dust ingress, which compromises the device's protection performance and causes malfunctions; Prevention: When selecting a model, verify that the HART connector specifications match those of the sensor and on-site wiring equipment. Prioritize HART connectors designed as integrated accessories for the sensor to ensure easy installation and a secure seal, thereby avoiding seal failure caused by replacing the connector later.

7.4 Customization Recommendations

For special operating conditions where standard models cannot meet requirements, we provide comprehensive customization solutions tailored to on-site needs. This ensures precise sensor fit and stable operation, resolving the challenges of "unavailability, installation difficulties, and operational instability."

1. Custom Insertion Depth

For special installation scenarios such as large storage tanks, extra-long pipelines, and confined spaces, we offer customizable insertion depths (up to 10 meters). We precisely match the probe insertion depth based on equipment dimensions and medium depth to ensure the temperature-sensing element makes full contact with the measured medium, thereby preventing measurement errors. Additionally, probe lengths can be customized to accommodate various installation space requirements.

2. Custom Thread Specifications

For non-standard on-site installation interfaces, we offer custom thread specifications such as M16×1.5 and NPT 1/2", or can create proprietary threads based on customer-provided interface dimensions. This ensures seamless integration between the sensor and on-site equipment, preventing installation difficulties and seal failures.

3. Customized Special Probes

Customized probes are available to meet specific operating conditions: ① Corrosion-Resistant Probes: Made from materials such as PTFE and Hastelloy to withstand highly corrosive environments; ② Wear-Resistant Probes: Featuring a wear-resistant coating on the probe surface, suitable for highly abrasive environments such as metallurgy and mining; ③ High-Temperature Probes: Made from high-temperature alloys to withstand temperatures ranging from -50°C to 500°C or higher, ensuring heat resistance, oxidation resistance, and extended service life; ④ Miniature Probes: Custom probes with diameters of 4 mm or smaller, suitable for temperature measurement in confined spaces and precision equipment.

4. Explosion-Proof Customization

For special explosion-proof scenarios (such as higher explosion-proof ratings or specific hazardous zones), we can customize explosion-proof ratings and structures, along with explosion-proof certification, to ensure compliance with on-site safety regulations. We also offer custom explosion-proof enclosures for installation and use in flammable, explosive, and high-risk environments.

5. Multi-Signal Integration Customization

For scenarios requiring the simultaneous output of multiple signals, we offer customized multi-signal integration solutions, such as the simultaneous output of 4–20mA analog signals and RS485 digital signals, to meet the integration needs of various backend control systems; we also provide customizable signal isolation and signal conversion functions to enhance interference resistance and ensure stable signal transmission.

VIII. Installation and Commissioning Specifications

8.1. Pre-installation Preparation

1. Verification of Components

After unpacking, verify the completeness of each component to ensure nothing is missing or damaged. The complete set of components compatible with this sensor model includes:

PT100 HART integrated sensor unit (including probe), HART connector (default Type A, compliant with DIN 43650 standard, suitable for temperature transmitter applications), sealing gaskets (made of high-temperature/corrosion-resistant material, compatible with the probe material), mounting nuts (matching thread specifications), mounting brackets (optional, for flange mounting), product manual, and calibration certificate; pay special attention to ensuring the probe is not deformed, the HART connector is undamaged, and the pins are not bent. Verify that all components fully match the sensor model to prevent installation failure due to incompatible parts.

2. Sealing Component Inspection

Sealing components are critical to ensuring the device's waterproof and dustproof performance. Key inspection points include: the internal O-ring of the HART connector (made of oil- and temperature-resistant rubber, compatible with IP67 protection) must show no signs of aging, damage, or deformation; the sealing gasket at the connection between the probe and the main unit must be intact, with no cracks or detachment; ensure that the dimensions of the sealing gaskets for threaded installations match the thread specifications; for explosion-proof models, additionally inspect the integrity of the explosion-proof seals to ensure sealing performance meets standards, preventing moisture or dust from entering the equipment during subsequent use.

3. Tool List (Prepare in Advance to Improve Installation Efficiency)

Prepare a full set of specialized tools according to the installation method to avoid equipment damage caused by using non-specialized tools. The specific list is as follows: ① Fastening Tools: Torque wrench (matching thread specifications to prevent over-tightening), screwdrivers (Phillips/flathead, for securing wiring); ② Auxiliary Tools: Wire strippers (strip 3–5 mm of insulation), multimeter (for post-installation wiring verification and signal testing), megohmmeter (for measuring insulation resistance), thermal grease (to ensure proper contact between the probe and mounting surface and reduce thermal resistance); ③ Protective Equipment: Insulated gloves, non-slip gloves (anti-static gloves required in explosion-proof environments); ④ Special tools: A flange wrench is required for flange installation; specialized welding tools are required for welding installation (to be operated by qualified personnel).

4. Safety Precautions

Implement safety precautions before installation to eliminate potential hazards: ① Before installation in explosion-proof environments, confirm that power and gas supplies have been shut off and that the site is free of flammable or explosive substances. Installation is strictly prohibited under live power conditions or in the presence of medium leaks; ② For installations at heights, safety barriers must be erected, and safety harnesses must be worn to prevent equipment damage from falling or personal injury; ③ Installers must be familiar with the product manual, clearly understand wiring specifications and explosion-proof requirements (if applicable), and must not perform operations in violation of regulations; ④ Avoid installation and wiring in environments with strong electromagnetic interference, high temperatures, or high humidity. If operation in such environments is necessary, appropriate protective measures must be taken; ⑤ Before installation, verify that the on-site supply voltage matches the sensor's rated voltage (DC 12V–30V) to prevent equipment damage caused by abnormal power supply.

8.2 Standard Installation Steps

1. Probe Installation (Critical Step Affecting Temperature Measurement Accuracy)

Select the appropriate installation method based on site conditions to ensure the probe is installed correctly and in close contact with the measured medium: ① Immersion Installation (Liquid/Gas Media): Insert the probe into the measured medium, ensuring the insertion depth meets requirements (typically ≥50 mm). The temperature-sensing element must be fully immersed in the core of the medium to avoid contact with container or pipe walls, thereby preventing measurement errors; Apply thermal grease to the probe's mounting end before installation to improve heat transfer efficiency and reduce thermal resistance; ② Threaded Installation: Align the probe's threads with the mounting hole, and slowly screw it in using a torque wrench. Tighten with moderate force (to avoid over-tightening, which can damage the probe or strip the threads), ensuring a tight seal with no looseness; ③ Flange Installation: Align the flange with the equipment flange, insert the sealing gasket, and tighten the bolts evenly to ensure a tight flange seal with no medium leakage, suitable for high-temperature and high-pressure environments; ④ Surface Mounting (Surface Temperature Measurement): Use thermal adhesive to attach the probe to the surface of the object being measured. Ensure the surface is clean, dry, and free of oil or grease, and secure the probe firmly to prevent it from detaching due to vibration

2. Thread Tightening

Thread tightening must follow the principle of "applying even force with moderate pressure": ① Thread connection between the main unit and the probe: After initially tightening by hand, use a torque wrench for fine-tuning to ensure a secure connection with no looseness or wobble, while avoiding over-tightening that could damage the probe's seals; ② Installation threads (G1/2", M20×1.5, etc.): Adjust the torque according to the thread specifications. The standard tightening torque for conventional threads is 20–30 N·m; explosion-proof models must be tightened in accordance with explosion-proof requirements to ensure both sealing and explosion-proof performance meet standards; ③ Post-tightening inspection: Gently shake the probe and main unit to confirm there is no looseness and no gaps at the threaded connection, preventing future vibration from causing loose connections or signal drift.

3. Connector Wiring (Critical Step—Incorrect Connections Strictly Prohibited)

HARTING connectors feature a plug-and-play design. Before wiring, verify the terminal definitions and follow these procedures: ① Open the HARTING connector housing and identify the power, input, and output terminals according to the terminal markings to prevent reverse connections; ② Wire Stripping: Strip the cable to a length of 3–5 mm to prevent short circuits caused by excessively exposed wire, and ensure the wire is free of damage or oxidation; ③ Wire Securing: Insert the corresponding wires into the terminals and tighten them with a screwdriver to ensure good contact, with no looseness or disconnection. After wiring is complete, organize the cables to prevent tangling or pulling; ④ Housing Sealing: Securely close and lock the HARTING connector housing to ensure a proper seal that meets the IP67 protection standard, preventing moisture and dust from entering the connector and damaging the terminals.

4. Distinguishing Between Power, Input, and Output Terminals

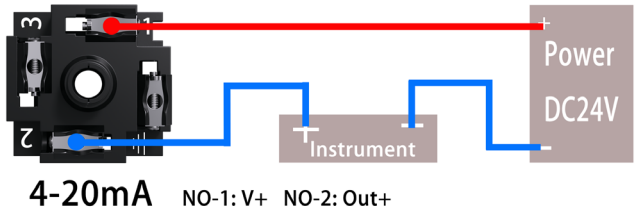
Strictly distinguish between these three types of terminals; incorrect or mixed connections are strictly prohibited. Terminal definitions are specific to this sensor model. The distinctions are as follows: ① Power Terminals: Labeled "V+" and "V-", these are for connecting a 12V–30V DC power supply. Connect "V+" to the positive terminal and "V-" to the negative terminal of the power supply; reverse connections are strictly prohibited; ② Input Terminals: Labeled "IN+" and "IN-", these are exclusively for connecting PT100 thermoresistor cables, corresponding to the probe's positive and negative terminals; connecting other types of signals is strictly prohibited; ③ Output Terminals: Labeled "OUT+" and "OUT-." Wire according to the output signal type—4–20 mA/0–10 V analog output or RS485 digital output—and connect to the downstream PLC, DCS, or digital display instrument. Ensure the terminals and cables are correctly matched.

5. Grounding Requirements

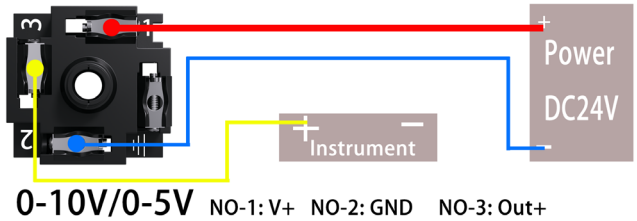
Grounding is critical for enhancing interference resistance and ensuring equipment safety. The following requirements must be strictly adhered to: □ The main unit housing must be grounded separately. Use a yellow-green bicolor wire with a cross-sectional area of no less than 1.5 mm² for the grounding wire, and ensure the grounding resistance does not exceed 4 Ω; □ Signal grounding and power grounding must be separated; shared grounding is strictly prohibited to prevent interference signals from entering the circuit and to ensure measurement accuracy; □ Grounding in Explosion-Proof Environments: Connect the sensor's grounding terminal to the on-site explosion-proof grounding system to ensure a secure connection that complies with explosion-proof safety standards; □ Post-Grounding Inspection: Use a multimeter to measure the grounding resistance and verify compliance with requirements to prevent interference or safety hazards caused by poor grounding.

6. Shielded Cable Handling

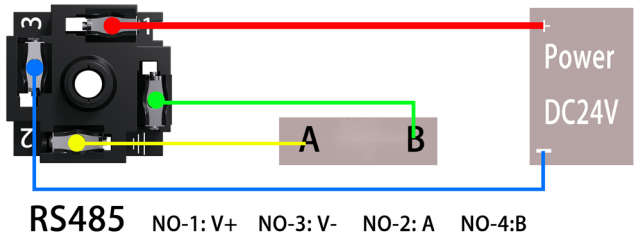
Shielded twisted-pair cables are preferred for PT100 signal lines and output signal lines to reduce external interference. The handling specifications are as follows: □ Shielding treatment: Ground one end of the shield (near the host's HART connector), and leave the other end floating. Never ground both ends simultaneously to avoid creating an interference loop;



4-20mA NO-1: V+ NO-2: Out+

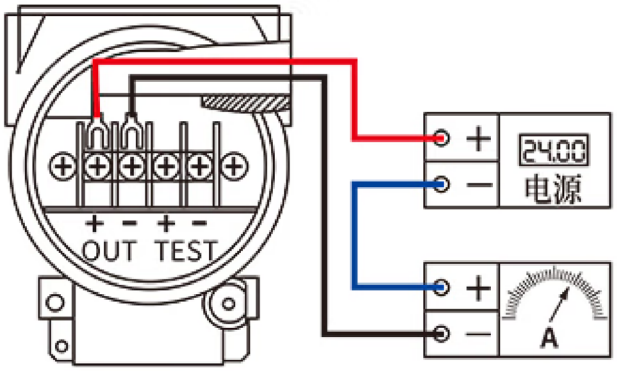


0-10V/0-5V NO-1: V+ NO-2: GND NO-3: Out+

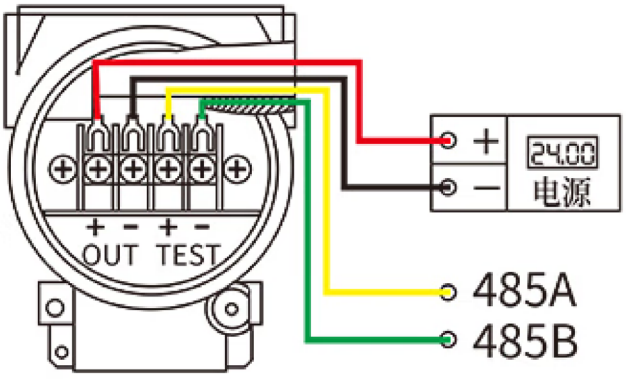


RS485 NO-1: V+ NO-3: V- NO-2: A NO-4:B

2-Wire 4-20mA



4-Wire RS485



8.4 Power-On Debugging Procedure

1. No-Load Test

After completing the wiring, perform a no-load test first to verify the power supply and the basic status of the main unit: ① Connect the power supply and confirm that the supply voltage is DC 12V–30V, consistent with the sensor's rated voltage; ② Run the unit under no-load conditions for 5–10 minutes and observe the main unit's status: the HART connector indicator light should illuminate normally, with no abnormal heating or unusual noises; ③ Check the main unit for any alarm indications. If the screen goes black or the indicator lights do not illuminate, immediately disconnect the power and inspect the power wiring, the sealing of the HART connector, and the main unit for faults; ④ No-load test in explosion-proof environments: This must be conducted in a safe area. After confirming the absence of flammable or explosive media, connect the power supply and observe the equipment's operating status.

2. Signal Calibration

After the no-load test is successful, perform signal calibration to ensure stable signal transmission and accurate temperature measurement: ① Connect the PT100 probe, place the probe in a room-temperature environment, and use a multimeter to measure the input/output signals. Verify that the displayed temperature (if applicable) matches the actual ambient temperature, with a deviation not exceeding the sensor's accuracy range (±0.15°C to ±0.3°C); ② Simulate different temperature scenarios: Use a standard resistance box to simulate the resistance values corresponding to different PT100 temperatures. Verify that the output signal (4–20 mA/0–10 V/RS485) matches the corresponding standard temperature, with no signal attenuation or fluctuations; ③ RS485 Output Verification: Use configuration software or debugging tools to confirm normal communication, stable data readout, and no packet loss; ④ Insulation resistance test: Use a megohmmeter to measure the insulation resistance, ensuring it is ≥100 MΩ and meets isolation performance requirements.

3. Indicator Light Status Interpretation

This sensor model features a HART connector equipped with two indicator lights, whose statuses correspond to the device's operational conditions, allowing for precise determination of the device's status: ① Power light (PWR): Steady on = Normal power supply; Off = Power supply abnormality (check power wiring and voltage); Flashing = Poor power connection; ② Alarm Indicator (ALM): Off = Normal operation; Flashing = Out-of-range, signal fault (PT100 wiring error, probe failure); Steady-on = Internal equipment failure, short circuit; power must be immediately disconnected for troubleshooting; ③ During commissioning, monitor the indicator light status to promptly detect faults and prevent equipment damage.

4. Accuracy Calibration and Range Calibration Methods

(1) Accuracy Calibration (in accordance with IEC 60751): ① Pre-calibration preparation: Prepare standard equipment (second-class standard platinum resistance thermometer, temperature bath, four-wire digital multimeter, standard resistance box). Ensure the laboratory ambient temperature is stable at 20±5°C, relative humidity ≤80%, and avoid strong electromagnetic interference; ② Selection of Calibration Points: The basic calibration points are 0°C (ice bath) and 100°C (water bath); extended calibration points are selected based on the sensor's measurement range (e.g., -50°C, 200°C, 400°C); ③ Calibration Procedure: Place the sensor probe and the standard platinum resistance thermometer together in the temperature bath, ensuring an insertion depth of ≥30 mm. Once the temperature has stabilized (fluctuation ≤±0.02°C/10 min), record the sensor's measured value and the standard value; Use a standard resistance box to simulate resistance values corresponding to different temperatures. Adjust the sensor's calibration potentiometer so that the output signal matches the standard temperature. Repeat the calibration three times to ensure the deviation is ≤±0.15°C to ±0.3°C; ④ Calibration Interval: Once a year under normal conditions; reduce to every 6 months in harsh environments (high temperatures, corrosion, strong interference).

(2) Range Calibration Method: □ Enter the calibration menu: Press and hold the sensor calibration button (refer to the product manual) to enter the parameter settings interface, then locate the "Range Calibration" option; □ Zero-point calibration: Place the PT100 probe into a 0°C temperature bath (ice-water mixture). Once the temperature has stabilized, adjust the zero-point potentiometer so that the output signal matches the value corresponding to zero (e.g., 4 mA);

③ Full-scale calibration: Place the probe in a temperature bath corresponding to the upper limit of the sensor's range (e.g., 200°C, 400°C). Once the temperature has stabilized, adjust the full-scale potentiometer so that the output signal matches the full-scale value (e.g., 20 mA); ④ Save Parameters: After calibration is complete, save the parameters and restart the device. Verify the range accuracy again to ensure the range settings meet on-site requirements. If you need to restore the default range, simply select "Restore Factory Settings."

8.5 Installation Precautions

1. Never exceed the rated voltage: This sensor model is rated for DC 12V–30V. Never connect it to AC 220V or DC voltages outside the rated range, as this will immediately burn out the internal circuitry, the PT100 probe, and the HART connector. Before installation, ensure the supply voltage meets the requirements.

2. Avoid Strong Electromagnetic Interference: Do not install the sensor near sources of strong electromagnetic interference, such as variable frequency drives or high-voltage cables (maintain a distance of at least 0.5 meters). Do not run the PT100 signal cable parallel to high-voltage power lines, as this may cause signal drift, display abnormalities, and affect temperature measurement accuracy. Proper shielding and grounding must be implemented.

3. Inadequate HART Connector Sealing: Never install or use the sensor if the HART connector housing is not securely fastened or if the seal is damaged. Failure to do so may allow moisture or dust to enter the connector, causing terminal corrosion or circuit short-circuits. After installation, inspect the connector seal to ensure it meets the IP67 protection standard.

4. Operating the probe beyond its temperature range: Never use the probe in environments exceeding its specified temperature range. Standard probes must not be used in environments above 300°C. High-temperature custom models must be used strictly within their specified range. Operating beyond the temperature limit may damage the probe's sensing element, cause measurement failure, or even burn out the main unit.

5. Rough handling during installation: Do not forcefully pull, strike, or impact the sensor unit, probe, or HART connector. Do not over-tighten threads (to prevent stripped threads and probe damage). Do not touch terminals or probes with sharp objects. Handle all components with care during installation to prevent mechanical damage.

6. Other Prohibitions: Never use non-explosion-proof sensors in flammable or explosive environments; after installing explosion-proof models, verify their explosion-proof sealing performance; ensure no excessively long exposed wire ends during wiring to prevent short circuits; never disconnect wires or adjust calibration parameters while the equipment is operating; and never modify the sensor yourself, as this will void the product warranty and affect performance.

IX. Recommendations for Daily Use and Operations & Maintenance

9.1 Key Points for Daily Inspections (Conducted daily/weekly to promptly identify potential hazards)

The core principle of daily inspections is "early detection, early investigation, and early resolution." Focus on equipment operating status, signal stability, and protective performance to prevent minor issues from escalating into equipment failures. Adjust inspection frequency based on operating conditions: once daily under normal conditions, and once every two hours in harsh environments (high temperatures, corrosion, or strong interference). Pay close attention to the following four points:

1. Check indicator light status

Pay close attention to the status of the PWR (power indicator) and ALM (alarm indicator) lights at the HART connector. Compare these against the equipment's operating standards to quickly determine if the device is functioning normally: ① PWR Power Indicator: A steady light indicates normal power supply; if off, it indicates a power supply issue—immediately check the power connections, voltage (ensure DC 12V–30V), and power module; if flashing, it indicates poor power contact—tighten the power terminals;

② ALM (Alarm) Indicator: Off indicates normal operation; flashing indicates out-of-range conditions, a PT100 probe failure, or signal abnormalities—verify the temperature measurement range, probe wiring, and probe condition; a steady light indicates an internal short circuit or core component failure—immediately disconnect power and follow the troubleshooting procedure for Module 6. Record indicator statuses during inspections to facilitate subsequent fault tracing.

2. Signal Stability Check

Observe the temperature signal transmission status via the backend PLC, DCS, or digital display instrument, focusing on the following three points: ① The signal should not exhibit frequent fluctuations, and the temperature variation range should be within the sensor's accuracy range (±0.15°C to ±0.3°C). If frequent fluctuations occur, investigate potential causes such as strong electromagnetic interference, loose wiring, or poor probe contact; ② The output signal (4–20 mA/0–10 V/RS485) matches the actual measured temperature with no significant deviation. If the deviation exceeds the allowable range, preliminarily determine whether it is due to temperature drift or probe contamination; ③ RS485 communication shows no packet loss or disconnections, and data retrieval is stable. If communication anomalies occur, check the wiring of the output terminals, shield grounding, and communication protocol compatibility. Additionally, compare data from sensors of the same type in the same area to identify abnormal signals.

3. Temperature Drift Inspection

Temperature drift is a key factor affecting measurement accuracy. During inspections, focus on monitoring the following: ① Short-term drift: Under the same operating conditions, observe continuously for 1–2 hours; temperature readings should not drift by more than ±0.01°C/°C. If the drift is excessive, investigate changes in ambient temperature, probe contamination, or loose wiring; ② Long-term drift: Record temperature readings at the same time and under the same operating conditions weekly, and compare them with the initial calibration values. If the cumulative drift exceeds ±0.1% FS per year, arrange for accuracy retesting and recalibration; ③ Special Environments: In high-temperature or corrosive conditions, increase the frequency of drift checks to prevent environmental factors from exacerbating drift and affecting production measurement and control accuracy. Note that abnormal temperature drift may be a precursor to sensor aging; such instances must be promptly recorded and addressed.

4. Sealing and Water Resistance Inspection

Leveraging the IP67 protection rating of the HARTING connectors, focus on inspecting sealing performance to prevent moisture and dust from entering the equipment: ① HARTING Connectors: Verify that the housing is securely fastened with no damage, that the O-rings show no signs of aging or detachment, and that there are no gaps at the connection between the connector and the cable. In outdoor or humid environments, additionally check for condensation or water stains at the connector. ② Probe-to-Host Connection: Ensure the sealing gasket is intact, with no looseness or damage, and that there are no gaps or media leaks at the threaded connection. ③ Additional checks for explosion-proof models: Ensure explosion-proof seals are intact, free of damage or looseness, and that grounding terminals are securely connected, in compliance with explosion-proof safety requirements; ④ If poor sealing is detected, immediately shut down the equipment for repair. Replace the O-ring or retighten the connector to prevent moisture and dust from corroding terminals, causing short circuits, or damaging internal components.

9.2. Regular Maintenance Plan (Performed on a scheduled basis to extend equipment service life)

Regular maintenance schedules should be established based on operating conditions, with the core principles being "cleaning, tightening, inspection, and calibration." This prevents issues such as component aging, loose wiring, and reduced accuracy resulting from prolonged operation. General maintenance intervals are as follows: once a month for standard environments; once every 15 days for harsh environments; and once every 7 days for high-temperature, explosion-proof, or corrosive environments. The specific plan is as follows:

1. Cleaning Frequency and Methods

The core of cleaning is to remove contaminants from the equipment surface and probes to prevent impacts on temperature measurement accuracy and sealing performance: ① Cleaning Frequency: Once a month for standard environments; once every 7 days for dusty, oily, or corrosive environments; once every 3 days for clean environments such

as pharmaceutical and food processing;□ Cleaning Method: Use a dry, soft cloth or soft-bristled brush to gently wipe the main unit housing, HART connectors, and probe surfaces to remove dust, oil, and other contaminants. For stubborn stains on the probe surface, use anhydrous ethanol (or a neutral cleaning agent). Avoid using corrosive cleaners to prevent damage to the probe material and seals; □ Cleaning Precautions: Never spray water directly onto the equipment. Never scrape the probe surface or HART connectors with sharp objects. Ensure the equipment surface is completely dry before powering on to prevent short circuits caused by residual moisture.

2. Thread Tightness Inspection

During long-term operation, vibration and temperature fluctuations may cause threads to loosen, affecting installation stability and sealing performance. Key inspection points include: ① Probe mounting threads (G1/2", M20×1.5, etc.): Use a torque wrench to gently check tightness, applying moderate force (20–30 N·m) to avoid over-tightening, which could cause thread stripping or probe damage. If loose, tighten slowly to ensure a good seal; ② Connection threads between the main unit and the probe: Check for looseness or wobbling, ensuring the connection is properly sealed to prevent the ingress of media or moisture; ③ Terminal fastening: Open the HART connector and check that the power, input, and output terminals are securely wired. Gently tighten them with a screwdriver to prevent signal drift or poor contact caused by loose connections; ④ Explosion-proof model fastening: Tighten threads and terminals in accordance with explosion-proof requirements to ensure compliance with explosion-proof standards. Never continue using the device if any parts are loose.

3. Wiring Inspection

The wiring inspection focuses on verifying the integrity and compliance of the wiring to prevent equipment failures caused by wiring errors or damaged cables: ① Cable inspection: Inspect PT100 signal cables, power cables, and output cables for damage, aging, or oxidation. Ensure the cable outer sheath is free of cracks. If damage is found, replace the cable immediately and perform proper insulation treatment; ② Wiring Compliance: Verify that terminal connections match the terminal definitions. Ensure that power supply positive and negative terminals, as well as PT100 positive and negative terminals, are not reversed. Confirm that output signal connections match the downstream equipment, with no incorrect or mixed connections; ③ Shielded Cable Inspection: Confirm that the shielded cable is grounded at one end (near the main unit) and left floating at the other end. Ensure the shielding layer is free of damage or peeling and does not come into contact with the signal wires to prevent the formation of interference loops; ④ Cabling Inspection: Ensure cables are routed according to specifications, with no tangling or pulling. Maintain a distance of at least 0.5 meters from high-voltage power lines (220V AC and above) to avoid electromagnetic interference.

4. Accuracy Retesting

Accuracy retesting is essential for ensuring precise temperature measurement. The retesting frequency should be adjusted based on the equipment's operational duration and working conditions: ① Retesting Frequency: Once every 6 months for standard applications; once every 3 months for high-precision and critical process applications; once every month for harsh environments. Additionally, in accordance with national standards, the equipment must be sent to a qualified metrology institution for comprehensive calibration every 2–5 years; ② Verification Method: Use a standard resistance box to simulate the resistance values of a PT100 at different temperatures, or place the probe in a temperature-controlled bath (at standard temperature points of 0°C and 100°C). Compare the deviation between the sensor's output signal and the standard temperature to ensure the deviation is ≤±0.15°C to ±0.3°C; ③ Retest Procedures: If the deviation exceeds the permissible range, perform accuracy calibration immediately (refer to the calibration method in Module 4). If the sensor still fails to meet standards after calibration, inspect the probe for damage or internal component aging, and replace the probe or main unit if necessary.

9.3 Long-Term Maintenance Tips (Targeted Protection to Enhance Equipment Stability)

Based on the structural characteristics of the Qidianjia PT100 HART integrated sensor (HART connector, three-terminal isolation, integrated design), long-term maintenance tips are formulated for different operating conditions. The focus is on enhancing the equipment's dust and moisture resistance, corrosion resistance, and anti-interference capabilities to extend service life and reduce operational and maintenance costs.

1. Dust and Moisture Protection Maintenance

The core objective is to prevent dust and moisture from entering the device interior and to protect the terminals and internal circuitry: ① Standard environments: Regularly clean the device surface and ensure the HART connector housing remains securely fastened to prevent dust ingress; ② Humid environments (e.g., water treatment, outdoor settings): Wrap waterproof tape around the connection between the HART connector and the cable to reinforce the seal, and regularly inspect the O-ring, replacing aged O-rings every 3 months; Prevent water accumulation around the equipment and install rain and sun shields to reduce moisture damage; ③ Dusty Environments (e.g., metallurgy, mining): Regularly clean dust from the surfaces of probes and the main unit to prevent dust buildup from affecting heat transfer and sealing performance; dust covers can be installed on the exterior of the equipment to reduce dust adhesion; ④ Long-term equipment shutdown: After cleaning and drying, disconnect the power supply and store the sensor in a dry, well-ventilated environment to prevent moisture and dust damage. Power on the equipment for a test once a month to prevent component aging.

2. Corrosion Protection and Maintenance

For corrosive environments (chemical, pharmaceutical, water treatment), focus on protecting the probe and housing to prevent corrosion damage: ① Probe Protection: Select probes made of appropriate materials (316L stainless steel, Hastelloy, PTFE sleeves) based on the corrosiveness of the medium. Regularly inspect the probe surface for corrosion or damage. If corrosion spots are found, clean or replace the probe promptly to prevent further corrosion and damage. In highly corrosive environments, such as electroplating, additional corrosion-resistant sleeves may be installed; ② Housing Protection: Regularly wipe down the main unit housing to remove residual corrosive media. For explosion-proof and corrosion-resistant models, apply a corrosion-resistant coating (appropriate for the operating conditions) to prevent oxidation and corrosion of the housing; ③ Wiring Protection: Use corrosion-resistant cables and ensure proper insulation and corrosion protection at cable joints to prevent corrosive media from eroding the cables, which could lead to cable damage or signal interruption; ④ Regular inspections: In corrosive environments, inspect the corrosion protection status once every 7 days. Address any corrosion risks immediately to prevent damage to internal components.

3. Anti-Interference Optimization and Maintenance

Leveraging the device's three-terminal isolation advantage, further optimize anti-interference measures to ensure signal stability: ① Wiring optimization: Route PT100 signal lines and output signal lines separately from high-voltage power lines, maintaining a minimum distance of 0.5 meters. Avoid parallel routing to reduce electromagnetic interference; ② Shielded Cable Maintenance: Periodically inspect the grounding of shielded cables to ensure secure single-point grounding with a grounding resistance ≤4Ω and no damage to the shielding layer. If the shielding layer is damaged, replace the cable immediately to prevent interference signals from infiltrating; ③ Environmental Optimization: Position sensors away from strong electromagnetic interference sources such as variable frequency drives and high-voltage cables. If separation is not possible, install electromagnetic shielding enclosures to enhance interference resistance; ④ Regular Testing: Use a multimeter to check for signal interference every 3 months. If signal drift or fluctuations occur, promptly identify the source of interference and optimize protective measures. Simultaneously, inspect the performance of the isolation modules to ensure effective three-terminal isolation.

4. Protection and Maintenance in Extreme Environments

Implement targeted protective measures for extreme operating conditions such as high temperatures, low temperatures, and strong vibrations to prevent equipment damage: ① High-Temperature Environments (Metallurgy, Boilers): Select high-temperature sensors, regularly inspect the probe's heat resistance, avoid operating above the temperature limit, clean the oxide layer on the probe surface every 7 days to reduce thermal resistance, and check the housing's heat dissipation to prevent internal component aging caused by high temperatures; In high-temperature environments, minimize continuous operation time as much as possible; install cooling devices when necessary;

avoid suddenly exposing the sensor to environments with extreme temperature differences to prevent thermal stress damage to components; ② Low-Temperature Scenarios (Cryogenic Equipment): Select custom ultra-low-temperature sensors; regularly inspect cables for cold-induced brittleness or damage; avoid pulling on cables; implement insulation measures around the equipment to prevent low temperatures from causing seal failure or internal circuit malfunctions; ③ High-vibration environments (power generation units, steel rolling mills): Install anti-vibration mounts and secure them firmly; regularly check the tightness of threaded connections to prevent probe detachment or loose wiring caused by vibration; simultaneously, select armored PT100 probes to enhance vibration resistance and extend equipment service life.

X. Troubleshooting & Emergency Response

10.1. List of Common Faults

1. No Output: The primary symptom is the absence of any signal output; the display (if present) shows "---" or an out-of-range warning, and the 4–20 mA signal remains fixed at 0 mA or 24 mA. This typically occurs due to power loss, open circuits or short circuits in the wiring, or power supply abnormalities.
2. Signal Drift: The primary symptom is a gradual deviation of the temperature reading from the actual value, with a deviation exceeding ±0.5°C. Stability deteriorates significantly after prolonged operation. This frequently occurs in scenarios involving high-temperature corrosion, vibration stress, or water ingress due to seal failure.
3. Inaccurate Temperature: The primary symptom is a fixed deviation or fluctuating temperature readings that differ significantly from the actual on-site temperature. This is often caused by wiring errors, probe contamination, or mismatched measurement ranges and calibration parameters.
4. Indicator Light Abnormalities: The primary symptoms include the PWR (power indicator) not lighting up or flashing, or the ALM (alarm indicator) remaining lit or triggering false alarms. These issues correspond to problems such as poor power supply contact, out-of-range readings, or probe malfunctions.
5. Water ingress failure: Key symptoms include sudden fluctuations in temperature readings, internal short circuits, decreased insulation resistance, and accelerated corrosion of the device. This is often caused by damaged seals, loose HART connectors, or moisture penetration in humid outdoor environments.
6. Interference and Distortion: Key symptoms include high-frequency fluctuations in the temperature signal, superimposed ripple, and packet loss in RS485 communication. These issues commonly occur near variable frequency drives, when shielded cables are not grounded at a single point as per specifications, or when signal lines are laid parallel to high-voltage power lines.1. No Output: The primary symptom is the absence of any signal output; the display (if present) shows "---" or an out-of-range warning, and the 4–20 mA signal remains fixed at 0 mA or 24 mA. This typically occurs due to power loss, open circuits or short circuits in the wiring, or power supply abnormalities.
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10.2 Analysis of Failure Causes

1. Wiring-related causes: Reversed polarity of the power supply; confusion between two-wire, three-wire, and four-wire PT100 configurations; loose or oxidized terminal blocks; shielding wires grounded at both ends, creating an interference loop; and use of incompatible compensation cable types (e.g., using Cu50 wire to connect a PT100 probe).
2. Power Supply Issues: Overvoltage (e.g., connecting AC 220V to a circuit rated for DC 24V), undervoltage, poor contact in power supply lines, reverse power distribution, or incorrect feeder wiring, resulting in the device being unable to receive power normally or experiencing unstable power supply.
3. Equipment-related causes: Open circuit or short circuit in the PT100 platinum wire (resistance deviates from the standard value of 100Ω at room temperature); scaling or corrosion on the probe surface; aging or damage to internal core components; or damage to the probe or main unit caused by operating beyond the measurement range.
4. Sealing-related causes: Aging or damage to the internal O-ring in the HART connector; failure of the threaded seal at the connection between the probe and the main unit; damage to the explosion-proof seals in explosion-proof models, leading to the ingress of moisture or dust into the device and causing malfunctions.
5. Environmental Causes: The device is installed near strong sources of electromagnetic interference, such as variable frequency drives or high-voltage cables; the device is operated beyond its rated range; a high-vibration environment causes the probe to shift or wiring to loosen; corrosive media erode the probe and the main unit's housing, affecting normal operation.

10.3 Step-by-Step Troubleshooting (Troubleshoot sequentially by priority, including emergency solutions)

1. No Output Fault

Step 1: Safely disconnect the power supply and disconnect the sensor from the downstream equipment. Use a multimeter to measure the supply voltage at the sensor input to confirm it falls within the rated range of 12V–30V DC, thereby ruling out abnormal supply voltage issues. If the voltage is out of range, adjust the power supply to the rated range, check for damaged or loose connections in the power supply lines, and retest after repairs.
Step 2: With the power off, use a multimeter to measure the resistance of the PT100 probe. At room temperature (25°C), the normal resistance value is approximately 105–110 Ω. If the resistance reads infinite, it indicates an open circuit in the PT100 platinum wire; if the resistance is close to 0 Ω, it indicates a short circuit in the PT100 platinum wire. In both cases, replace the PT100 probe with one of the same specifications.
Step 3: Emergency workaround: If no spare probe or main unit is available on-site, a temporary replacement sensor of the same specifications and parameters may be used. Connect it strictly in accordance with wiring standards to prioritize the restoration of on-site temperature measurement operations. Replace it with the original unit once the faulty equipment has been repaired or replaced.

2. Signal Drift and Inaccurate Temperature Measurement

Step 1: Conduct a preliminary inspection of the installation. Ensure the probe is inserted at least 50 mm deep, with the sensing element fully immersed in the measured medium and not in contact with the container or pipe walls. If the probe surface has scale or oil residue, gently wipe it clean with anhydrous ethanol to remove deposits and prevent interference with heat transfer efficiency.
Step 2: Verify the correctness of the wiring. Check the PT100 wiring configuration (two-wire, three-wire, or four-wire) to ensure there are no loose or incorrect connections; specifically, three-wire connections must follow the A/B/B configuration. Inspect the shielding wire to ensure the shield is grounded at one end (near the sensor) and left floating at the other end to prevent the formation of an interference loop.
Step 3: Perform accuracy calibration again. First, perform zero-point calibration by placing the PT100 probe in a 0°C ice-water mixture. Once the temperature has stabilized, adjust the sensor's zero-point potentiometer so that the output signal reaches the value corresponding to the lower limit of the measurement range (e.g., 4 mA for a 4–20 mA output);

Next, perform full-scale calibration: place the probe in a temperature-controlled bath corresponding to the upper limit of the range. Once the temperature stabilizes, adjust the full-scale potentiometer so that the output signal reaches the value corresponding to the upper limit of the range (e.g., 20 mA for a 4–20 mA output). After calibration is complete, conduct multi-point temperature testing to ensure the deviation is within the range of ±0.15–0.3°C; if so, the calibration is considered successful.

3. Indicator Light Malfunctions

3.1. PWR (Power Indicator) is off: The primary causes are an open circuit in the power supply line or loose terminal connections. The solution is to tighten the power terminals, use a multimeter to check the supply voltage and power lines, repair any damaged or broken power cables, and ensure normal power supply.

3.2. PWR (Power Indicator) Flashing: The primary causes are poor power contact or unstable supply voltage. The solution is to reinsert the HART connector, check the output voltage of the power supply module to ensure stability, and replace the power supply module promptly if it is faulty.

3.3. ALM (Alarm Indicator) Steady On: The primary causes are operating the device beyond its measurement range or a faulty PT100 probe. The solution is to verify the temperature of the measured medium on-site to confirm whether it exceeds the sensor's range. If it is out of range, adjust the sensor's range or replace it with a sensor suitable for the required range; if the range is normal, inspect the PT100 probe and replace any damaged probes.

3.4. ALM (Alarm Light) False Alarm: The primary causes are wiring errors or strong electromagnetic interference in the surrounding environment. The solution is to correct wiring errors, check the grounding of the shielded cable, strengthen anti-interference measures, and move the device away from sources of strong electromagnetic interference.

4. Water Ingress Failure

Step 1: Immediately shut down the system and drain the water. Disconnect the sensor power supply, open the HART connector housing, and use a dry hair dryer to remove internal moisture. Inspect the O-ring for signs of aging or damage; if damaged, immediately replace it with an O-ring of the same specification.

Step 2: Test insulation performance. Use a megohmmeter to measure the sensor's insulation resistance; the normal insulation resistance should be no less than 100 MΩ. If the insulation resistance is below 10 MΩ, it indicates a short circuit or corrosion inside the device, and the sensor unit must be replaced.

Step 3: Reinforce the seal. Apply specialized sealant to the connection between the HART connector and the cable, then securely fasten the connector housing to ensure a proper seal; In outdoor or humid environments, install a waterproof cover on the sensor to prevent water ingress.

5. Interference and Distortion Faults

Step 1: Reroute wiring. Run PT100 signal cables and output signal cables separately from high-voltage power lines (220 V AC and above), maintaining a minimum distance of 0.5 meters. Parallel routing is strictly prohibited to minimize strong electromagnetic interference.

Step 2: Standardize grounding procedures. Ensure the shielded cable is grounded at a single point (near the sensor end), and that the sensor's main unit housing is grounded separately. Maintain grounding resistance within 4 Ω to prevent the signal ground and power ground from sharing a common point, which could create an interference loop.

Step 3: Install anti-interference devices. If the equipment is located near strong interference sources such as variable frequency drives, use armored shielded cables and install anti-interference ferrite beads at both ends of the signal lines to further enhance the equipment's interference resistance and ensure stable signal transmission.

10.4, After-Sales Repair Guidelines

1. Criteria for Determining Malfunctions

1.1. After recalibration, the temperature measurement deviation remains greater than ±0.5°C and cannot be resolved by adjusting parameters or cleaning the probe.

1.2. The sensor's insulation resistance is below 100 MΩ and cannot be restored to normal after drying and sealing.

1.3. The PT100 probe exhibits issues such as corrosion, deformation, open circuit, or short circuit that cannot be repaired; the probe must be replaced.

1.4. Internal components of the sensor unit have aged or failed, resulting in inability to supply power or output signals, or persistent abnormal indicator lights that cannot be diagnosed or repaired.

1.5. Note: Equipment damage caused by improper operation (such as overvoltage, unauthorized disassembly of the unit, or use beyond the rated range) is not covered by the warranty and will require paid repair.

2. Repair Process

2.1. Prepare the following information regarding the malfunction in advance: sensor model (Qidianjia PT100 HART integrated temperature sensor), device serial number, specific symptoms of the malfunction, on-site installation environment (temperature, humidity, measured medium), photos of the wiring, and a record of the troubleshooting process.

2.2. Contact official after-sales support by calling the after-sales hotline. Provide the prepared information, describe the on-site situation, obtain a dedicated repair order number, and keep a record of the process.

2.3. Mail-in Repair or On-site Service: If the issue is non-urgent, securely package the faulty device, include a description of the problem and the repair order number, and mail it to the official designated repair address; if the issue affects a core production process, request on-site repair service. After-sales personnel will respond within 3 business days to conduct on-site troubleshooting and repair the fault.

2.4. Repair Acceptance: After the repair is completed, upon receiving the repaired equipment or following on-site debugging by the after-sales team, test all sensor functions to confirm that the issue has been resolved and that temperature measurement accuracy and signal transmission stability meet standards, then complete the acceptance process.

3. Contact Information

3.1. After-Sales Hotline: 19715617532 (Weekdays 9:00 AM–6:00 PM; extended hours on public holidays)

3.2. After-Sales Email: sales008@qd-zdk.com (Please send details of the malfunction and relevant documentation; we will reply within 24 hours)

3.3. Official WeChat Account: Qidianjia Industrial Instruments (Select "After-Sales Repair" from the menu bar to submit repair requests online)

4. Warranty Coverage

4.1. Warranty Period: For Qidianjia PT100 HART integrated temperature sensors, the main unit is covered by a 12-month warranty, and the PT100 probe is covered by a 6-month warranty, effective from the date of manufacture.

4.2. Warranty Coverage: During the warranty period, for failures caused by product quality issues (such as internal component malfunctions, probe defects, or natural aging of seals), we provide free repair and replacement of parts (excluding consumables such as O-rings), as well as free technical support and calibration guidance.

4.3. Exclusions: Damage caused by improper operation, force majeure (such as floods, lightning strikes, or earthquakes), malfunctions occurring after the warranty period has expired, or damage resulting from unauthorized modification or disassembly of the equipment is not covered by the warranty and will require paid repairs.

4.4. Extended Warranty: After the warranty period expires, you may contact after-sales service for paid repairs, parts replacement, and accuracy calibration. Pricing is transparent; please consult after-sales staff in advance for a detailed quote.

10.5. Troubleshooting Red Lines (Strictly Prohibited Operations)

1. It is strictly prohibited to disconnect wiring or disassemble the main unit while the equipment is energized to avoid electric shock or secondary damage to the equipment.

2. Do not use fixed-value resistors as substitutes for PT100 probes during testing, as this may trigger the device's internal protection mode and damage core components.

3. In explosion-proof environments, ensure the power is disconnected and that no flammable or explosive substances are present before troubleshooting. Strictly adhere to explosion-proof safety regulations; unauthorized operations that create safety hazards are strictly prohibited.