2088 Temperature Sensor

I. Product Definition

The 2088 Type PT100 Temperature Sensor (hereinafter referred to as the 2088 PT100) is an integrated temperature transmitter that utilizes an industrial-standard 2088-type explosion-proof enclosure and features a PT100 platinum resistance thermometer as its core sensing element. It combines temperature acquisition, signal conversion, transmission output, on-site display, and explosion-proof protection into a single unit. It is a mainstream standardized product for low-temperature, high-precision temperature measurement in industrial applications.
2088 Housing: A general-purpose industrial housing made of cast aluminum or stainless steel, featuring a cylindrical panel-mount design. It is equipped with standard electrical and mounting interfaces to accommodate various industrial installation and protection requirements.

PT100: A platinum resistance temperature sensor, where “PT” stands for platinum and “100” indicates a standard resistance value of 100 Ω at 0°C. The resistance increases approximately linearly with temperature, in accordance with the IEC 60751 international standard.

II. Core Applications

1. Precise Temperature Measurement: Real-time acquisition of surface or internal temperatures of gaseous, liquid, and solid media, replacing traditional thermometers and standard thermocouple probes to achieve high-precision, stable temperature measurement.
2. Remote Signal Transmission: Converts the PT100 resistance signal into standard industrial signals (4–20 mA, RS485, etc.), addressing the issues of weak signals, susceptibility to interference, and inability to transmit over long distances associated with standard probes.
3. Industrial Process Control: Provides stable temperature data to PLCs, DCS systems, industrial control instruments, variable frequency drives, and other equipment, supporting closed-loop temperature control, over-temperature alarms, and interlock protection in automated production.
4. On-site Status Monitoring: Features a built-in display for direct viewing of real-time temperature without the need for external instruments, making it suitable for on-site inspections and local monitoring scenarios.

III. Applicable Industries

Widely covers low-to-medium temperature, high-precision measurement scenarios across all industrial sectors, with core industries including:
1. Petrochemicals: Temperature monitoring of reactors, distillation columns, pipelines, and storage tanks, suitable for explosion-proof, corrosion-resistant, and high-pressure environments.
2. Power and Energy: Temperature monitoring of transformer windings, generator sets, switchgear, boilers, and heat exchange stations to prevent equipment failures caused by overheating.
3. Water, HVAC, and Heating: Measurement of water temperature and ambient temperature in water treatment plants, sewage treatment plants, central air conditioning systems, heating pipelines, and water conservancy projects.
4. Food and Pharmaceuticals: Temperature monitoring for sterilization equipment, fermentation tanks, cold chain storage, and pharmaceutical production lines, meeting sanitary-grade and high-precision measurement requirements.
5. Machinery Manufacturing: Temperature monitoring for bearings, gearboxes, motor stators, hydraulic equipment, and heat treatment furnaces, suitable for environments with vibration and dust.
6. Metallurgy and Environmental Protection: Temperature data acquisition for low-temperature sections of metallurgical furnaces, exhaust gas treatment, desulfurization and denitrification, and environmental monitoring stations.
7. Rail Transportation / Aerospace: Temperature monitoring for train carriages, rail equipment, aviation components, and military equipment, meeting high reliability requirements.

IV. Core Functions

1. Temperature Acquisition

Utilizes imported PT100 platinum resistance sensors (primarily three-wire type) to accurately capture temperature variations from -200°C to 400°C (standard range), with an acquisition accuracy of ±0.1% to ±0.5% FS.
2. Signal Transmission
Built-in signal processing circuitry converts the weak resistance signal from the PT100 into standard industrial signals:
Analog: 4–20 mA (two-wire/three-wire, most commonly used, suitable for 90% of industrial scenarios);
Digital: RS485 (Modbus-RTU protocol, supports multi-unit networking and digital transmission);
Digital Output: Some models support 1–2 relay alarm outputs (SPDT) for high-temperature and low-temperature alarms.
3. Interference Resistance
Dual-layer shielded circuitry + isolated transmission design to withstand electromagnetic interference in industrial environments (e.g., from inverters, motors, and high-voltage lines);
Signal isolation voltage ≥1000V to prevent interference from potential differences between devices and enhance transmission stability.
4. On-Site Display
The meter features an integrated LCD/LED display that shows real-time temperature readings, range, and units (°C). Some models also display percentage values and error codes, enabling convenient local monitoring.
5. Explosion-Proof Protection
Protection Rating: Standard IP65, waterproof, dustproof, and splash-proof, suitable for outdoor, humid, and dusty environments;
Explosion-Proof Rating: ExdIIBT4/ExiaIICT4, suitable for flammable and explosive hazardous areas such as petroleum and chemical plants;
Housing Material: 304/316 stainless steel or cast aluminum, resistant to acid and alkali corrosion, and capable of withstanding vibration and impact.

V. Working Principle

The Model 2088 PT100 temperature sensor follows the complete process of “Platinum Resistance Temperature Measurement → Signal Conditioning → Isolated Transmission → Standard Output.” Specific steps:
1. PT100 Platinum Resistance Temperature Measurement
Temperature change → Linear change in platinum resistance (0°C = 100 Ω, 100°C ≈ 138.51 Ω), following the Callendar-Van Dusen equation: $Rt = R_0(1 + At + Bt^2)$ (0–850°C, $R_0 = 100\ \Omega$, $A = 3.9083 \times 10^{-3}/°C$, $B = -5.775 \times 10^{-7}/°C^2$).
2. Signal Conditioning
Utilizes a Wheatstone bridge circuit combined with a constant current source to precisely measure changes in PT100 resistance;
Features laser-trimmed resistors and digital temperature compensation to eliminate lead resistance errors (three-wire system) and ambient temperature drift errors;
Amplifies weak signals, filters out noise interference, and outputs a stable voltage signal.
3. Isolation and Transmission
Optical isolation and/or electromagnetic isolation modules isolate the input and output circuits, blocking ground potential differences and electromagnetic interference to enhance signal transmission safety.
4. Standard Output
Converts the conditioned voltage signal into a 4–20 mA current signal (or RS485 digital signal) for transmission to industrial control systems; simultaneously drives a field display to show real-time temperature values.

VI. Product Advantages (Compared to Traditional Thermocouples / Standard PT100 Probes)

1. Compared to Traditional Thermocouples (Primarily Type K)
In terms of measurement accuracy, the 2088 PT100 temperature sensor achieves an accuracy of ±0.1°C to ±0.5°C (with Class A accuracy as low as ±0.15°C), whereas traditional Type K thermocouples have an accuracy of only ±1°C to ±5°C and are susceptible to cold-junction compensation errors. Therefore, the 2088 PT100 offers 5 to 10 times the accuracy of traditional thermocouples in the low-to-medium temperature range, making it better suited for precision temperature control applications.

In terms of signal stability, the Model 2088 PT100 employs a resistive signal combined with a standard transmitter design, offering exceptional resistance to interference. In contrast, traditional thermocouples output microvolt-level millivolt signals that are highly susceptible to electromagnetic interference in industrial environments, leading to signal distortion. By comparison, the Model 2088 PT100's signal transmission exhibits no drift and remains stable even in strong electromagnetic environments.
In terms of linearity, the resistance of the Model 2088 PT100 exhibits an approximately linear relationship with temperature. Its signal processing is straightforward, allowing direct integration with industrial control systems without the need for additional linear calibration. In contrast, the thermoelectric potential of traditional thermocouples has a non-linear relationship with temperature, requiring the use of lookup tables or complex compensation algorithms to ensure measurement accuracy—a cumbersome process.

In terms of long-term stability and service life, the Model 2088 PT100 has an annual drift of <±0.1% FS and a service life of 5 to 10 years, with no significant performance degradation over time; traditional thermocouples can have an annual drift of up to 1–2°C in the high-temperature range, requiring regular calibration and replacement, resulting in higher maintenance costs.

Regarding low-temperature performance, the 2088-model PT100 maintains stable accuracy within the range of -200°C to 600°C, making it suitable for ultra-low-temperature environments such as cold storage and liquid nitrogen; in contrast, measurement errors for traditional thermocouples increase significantly below -50°C, rendering them unsuitable for ultra-low-temperature measurement requirements.

2. Comparison with Standard PT100 Probes (No Transmitter, No Housing)
1. Easy Installation: The 2088 PT100 features an integrated housing design with standard threaded (G1/2, M20×1.5) or flange mounting interfaces, allowing for plug-and-play operation without the need for additional components; standard PT100 probes, however, require separate transmitters, protective tubes, junction boxes, and other parts, resulting in a complex, time-consuming, and labor-intensive installation process.

2. Integrated Functionality: The 2088 PT100 combines temperature sensing, signal transmission, on-site display, and explosion-proof protection into a single unit, fulfilling complete temperature measurement, transmission, and monitoring requirements without the need for external modules. Standard PT100 probes offer only basic temperature measurement; to achieve signal transmission or on-site display, multiple additional devices must be added, increasing both cost and operational complexity.

3. Signal Compatibility: The Model 2088 PT100 can directly output 4-20mA analog signals or RS485 digital signals, with a transmission distance of up to 1,000 meters, meeting the long-distance transmission requirements of industrial environments; standard PT100 probes only output resistance signals, with a transmission distance typically not exceeding 50 meters, and the signals are prone to external interference, resulting in poor stability.

4. Environmental Adaptability: The 2088 PT100 features an IP65 protection rating, combined with explosion-proof design (ExdIIBT4/ExiaIICT4) and a vibration-resistant structure. The housing is made of 304/316 stainless steel or cast aluminum, offering resistance to acid and alkali corrosion. It is suitable for harsh industrial environments such as outdoor, humid, dusty, and flammable/explosive sites; Standard PT100 probes lack any protective structure, making them susceptible to environmental damage and resulting in a shorter service life.

5. Easy Maintenance: The 2088 PT100 features an integrated design, facilitating quick troubleshooting. In the event of a malfunction, the entire unit can be replaced directly, ensuring high maintenance efficiency. Standard PT100 probes consist of multiple components; when a fault occurs, each part must be inspected individually, resulting in a cumbersome maintenance process and a relatively higher failure rate.

VII. Key Parameters & Specifications
7.1 Temperature Measurement Parameters
1. Temperature Measurement Range: Standard range: -200°C to 400°C (most commonly used); customizable extended ranges: -200°C to 600°C (high-temperature compatible) and -50°C to 200°C (for ambient temperatures). These ranges fully align with the basic measurement range of PT100 platinum resistance thermometers (-200°C to 850°C), meeting the needs of various industrial applications.

2. Accuracy Grades: The core is divided into three grades to suit different accuracy requirements: Grade A (±0.15°C, resistance tolerance at 0°C ±0.06Ω), Grade B (±0.3°C, resistance tolerance at 0°C ±0.12Ω), and Standard Grade (±0.5°C); High-end custom models can achieve Class AA (±0.10°C), complying with IEC 60751 and the Chinese national standard GB/T 30121, far exceeding the accuracy levels of ordinary temperature measurement devices.

3. PT100 Calibration Code: Standard PT100 (IEC 60751 International Standard), with a standard resistance value of 100 Ω at 0°C and approximately 138.51 Ω at 100°C, Platinum purity ≥99.99% (resistance ratio R100/R0 ≥1.3850). Resistance values follow the Callendar-Van Dusen equation, ensuring excellent linearity with a non-linearity error of <±0.3°C across the full range, allowing direct compatibility and interchangeability with various standard industrial control devices.

4. Response Time: Depends on the probe type. Standard armored probes (Φ3–6 mm) have a T90 ≤ 30 s; fast-response models (thin-diameter probes Φ2–3 mm) have a T90 ≤ 15 s; and corrosion-resistant and wear-resistant models (thick-walled probes Φ4–8 mm) have a T90 ≤ 45 s. These probes can quickly capture changes in medium temperature, reduce measurement lag errors, and are suitable for dynamic temperature measurement scenarios.

7.2 Output Signal (Optional; Single or Dual Output Available)
1. Analog Output:
--- 4–20 mA (2-wire/3-wire, most common): Load resistance 0–500 Ω, signal isolation design, strong anti-interference capability, transmission distance up to 1000 meters, compatible with over 90% of industrial automation control systems, supports fault alarm output (3.8 mA or 22.8 mA, user-configurable);
--- 0–10 V (3-wire): Load resistance ≥10 kΩ, stable linear signal, compatible with small industrial control instruments, variable frequency drives, and other equipment, transmission distance ≤500 meters;
--- 0–5 V (optional): Load resistance ≥10 kΩ, compatible with small display instruments and PLC analog input modules, meets the requirements of simple temperature measurement scenarios.
--- Digital Output: RS485 (Modbus-RTU protocol), adjustable baud rate 1200–115200 bps, supports multi-device networking (up to 32 sensors), drift-free digital signal transmission, extremely strong anti-interference capability, suitable for large-scale industrial control systems and remote monitoring platforms, enabling centralized collection and management of temperature data.
--- Digital Output (Optional): 1–2 relay outputs (SPDT), with contact ratings of 2A/250VAC or 2A/30VDC. Pre-set high/low temperature alarm thresholds are supported, enabling automatic temperature anomaly alarms and equipment interlock protection.

7.3 Electrical Specifications
1. Supply Voltage:
--- Two-wire (4–20 mA output): 12–36 VDC (24 VDC recommended, industrial standard power supply), compatible with common industrial DC power systems;
-- - 3-wire/4-wire (analog/digital output): 10–36 VDC; wide-voltage design accommodates on-site power fluctuations, preventing operational disruptions caused by voltage instability;

--- Special custom models: Support 220 VAC power supply, suitable for on-site scenarios without DC power.
--- Load Resistance: For 4–20 mA output, maximum load resistance is 500 Ω (including wire resistance); for 0–10 V/0–5 V output, minimum load resistance is 10 kΩ; for RS485 output, the bus load is ≤32 nodes to ensure stable signal transmission without attenuation.
--- Power Consumption: Normal operating power consumption ≤ 0.5W (24VDC power supply); models with on-site display have a power consumption of ≤ 1W; power consumption increases slightly when operating in low-temperature environments (below -40°C), ≤ 1.2W; the low-power design reduces energy consumption and is suitable for long-term continuous operation.
--- Insulation Withstand Voltage: Between input and output, input and power supply, and output and power supply, the insulation withstand voltage is ≥1000 VDC (no breakdown or leakage for 1 minute); insulation resistance is ≥100 MΩ (at 25°C and 60% relative humidity). The built-in isolation module effectively blocks ground potential difference interference, ensuring equipment and personnel safety, and complies with industrial electrical safety standards.

7.4 Environmental Parameters
1. Operating Temperature: Sensor housing operating temperature: -40°C to 85°C; probe operating temperature matches the measurement range (-200°C to 600°C). Custom high-temperature probes can withstand short-term temperatures up to 800°C, making them suitable for various environmental temperature scenarios, including low-temperature cold storage facilities and high-temperature industrial furnaces.

2. Operating Humidity: 0–95% RH (non-condensing); special custom models can reach 0–98% RH (with condensation protection), suitable for harsh environments such as sewage treatment plants and outdoor monitoring sites, preventing equipment failures caused by humidity.

3. Protection Rating: Standard IP65 (waterproof, dustproof, splash-proof), suitable for direct use in outdoor, dusty, and humid environments; custom models can be upgraded to IP67 (waterproof and dustproof, capable of short-term immersion) or IP68 (long-term underwater operation). The housing features excellent sealing performance, effectively protecting the internal circuitry and platinum resistance core.

4. Explosion-Proof Rating: Standard ExdIIBT4 (flameproof type), suitable for general flammable and explosive environments such as petroleum and chemical industries; custom models can be upgraded to ExiaIICT4 (intrinsically safe type) to meet the requirements of high-risk explosion-proof environments such as coal mines. Certified under GB3836 explosion-proof standards, some models can provide the MA mining product safety mark, eliminating explosion risks at the source.

5. Electromagnetic Compatibility: Complies with the GB/T 14048.1-2012 standard, featuring resistance to electromagnetic interference (EMI) and electromagnetic radiation (EMS); radio frequency interference (RFI) immunity ≥20 V/m (80–1000 MHz), and surge immunity ≥2 kV. It operates stably in strong electromagnetic environments such as those near variable frequency drives and high-voltage lines, preventing signal distortion.

7.5 Physical Parameters
1. Housing Material: The standard model is made of cast aluminum (powder-coated surface, corrosion-resistant and impact-resistant); the corrosion-resistant model is made of 304/316 stainless steel (acid and alkali resistant, wear-resistant), suitable for corrosive environments such as chemical, food, and pharmaceutical industries; the high-temperature model is made of high-temperature alloy material, capable of withstanding oxidation and deformation in high-temperature environments, protecting internal components from damage.

2. Process Connections: Standard threaded connections (M20×1.5, G1/2, most common); customizable flange connections (DN15, DN20, DN25), compression fittings, and welded connections to accommodate various installation scenarios such as pipelines, reactors, and storage tanks, ensuring a tight seal and preventing media leakage.

3. Probe Length and Diameter:
--- Probe Diameter: Standard sizes include Φ3mm, Φ4mm, Φ5mm, and Φ6mm; a custom fine-diameter version is available at Φ2mm (for confined spaces); a heavy-duty wear-resistant version is available at Φ8mm (for high-abrasion environments);
--- Probe Length: Standard 50mm, 100mm, 150mm, 200mm; customizable from 20mm to 1000mm, flexibly adjusted based on the depth of the measured medium and equipment structure to ensure precise temperature measurement. The 3×10mm (diameter × length) configuration is a commonly used small-sized specification in the industry, offering strong compatibility.

4. Installation Methods: Threaded installation (vertical/horizontal; recommended with sealing gaskets for enhanced sealing), flange installation (suitable for high-pressure, large-diameter pipes), compression fitting installation (quick disassembly for easy maintenance), and magnetic mounting (suitable for temporary surface temperature measurement on equipment, allowing flexible positioning). Installation is convenient, requiring no complex construction work—simply install and use.

5. Weight: Cast aluminum housing models weigh approximately 200–300 g; stainless steel housing models weigh approximately 300–500 g; models with flanges or extended probes increase in weight according to specifications (each 100 mm extension adds approximately 50–80 g). The lightweight design does not increase the load on the equipment.

6. Display: The standard model features an integrated LCD display (with red/blue backlight for clear visibility) with a resolution of 0.1°C, capable of displaying real-time temperature values, measurement range, and error codes. Custom models can be upgraded to an LED display (offering higher brightness for outdoor high-light environments). Some models support the display of percentage values and alarm thresholds, enabling convenient local monitoring without the need for external instruments.

Additional Notes: The above specifications are general for the 2088 series PT100 temperature sensors. All parameters can be customized and adjusted according to specific operating conditions (such as high temperature, high pressure, severe corrosion, or high-risk explosion-proof environments). Core parameters comply with the IEC 60751 international standard and domestic industrial temperature measurement equipment specifications, ensuring product compatibility, stability, and reliability.



VIII. Selection Guide

8.1 Key Selection Criteria

1. Temperature Measurement Range

Key Considerations: Select based on the typical temperature, extreme temperatures, and temperature fluctuation range of the measured medium, in conjunction with the fundamental temperature measurement characteristics of the PT100 platinum resistance thermometer. The theoretical temperature measurement range of the PT100 is -200°C to 850°C; however, the standard measurement range for the 2088 integrated sensor must be selected appropriately based on the housing and probe materials to avoid excessive or insufficient measurement ranges.

Selection Guidelines: For standard applications, prioritize the -200°C to 400°C range (balancing accuracy and service life); for high-temperature applications (e.g., low-temperature sections in metallurgy, high-temperature pipelines), the -200°C to 600°C range can be customized (requiring high-temperature-resistant probe materials); for ambient-temperature applications (e.g., HVAC, water treatment), the -50°C to 200°C range is recommended (offering better cost-effectiveness); For ultra-low-temperature applications (e.g., cold storage, liquid nitrogen storage), it is essential to verify the probe's low-temperature resistance to ensure stable accuracy below -200°C. Additionally, note that the selected range should include a 10%–20% margin to prevent sensor damage from extreme temperatures and to ensure accuracy within the typical operating range, avoiding accuracy degradation caused by an excessively wide measurement range.

2. Medium Type

Key Considerations: The physical state (gas, liquid, solid), corrosiveness, and viscosity of the medium being measured directly determine the sensor probe material, protective structure, and process connection method.

Selection Guidelines: For non-corrosive media (e.g., air, clean water, lubricating oil), a 304 stainless steel probe with a cast aluminum housing is sufficient; for corrosive media (e.g., chemical acid/alkali solutions, seawater, corrosive gases), select a 316 stainless steel or Hastelloy probe with a corrosion-resistant coating (e.g., PTFE) to prevent corrosion damage; For viscous media (e.g., asphalt, syrup), select a probe with a larger diameter (Φ6–8 mm) to reduce media adhesion and shorten response time; for temperature measurement on solid surfaces (e.g., equipment bearings, pipe outer walls), choose a surface-mount or magnetic-mount probe to ensure tight contact with the measured surface and improve measurement accuracy.

3. On-Site Pressure

Key Consideration: The operating pressure of the measured environment or medium determines the sensor's process connection method and sealing performance, preventing medium leakage or sensor damage caused by excessive pressure.

Selection Guidelines: For low-pressure applications (≤1.6 MPa, such as HVAC ducts and standard water tanks), use standard threaded connections (M20×1.5, G1/2) with sealing gaskets; For medium-to-high-pressure applications (1.6–10 MPa, e.g., chemical reactors, high-pressure pipelines), use flange connections (DN15, DN20) to enhance sealing performance and prevent medium leakage; For high-pressure custom applications (>10 MPa, e.g., geothermal wells, high-pressure storage tanks), select 2088 housings and probes with high-pressure sealing structures to ensure long-term pressure-resistant operation; in some cases, pair with pressure-resistant protective sleeves to enhance equipment safety.

4. Explosion-Proof Requirements

Key Consideration: Determine whether flammable or explosive gases or dust are present on-site. Select sensors with the appropriate explosion-proof rating based on the hazardous area classification to eliminate safety hazards and ensure compliance with industrial safety standards.

Selection Guidelines: For general flammable and explosive environments (e.g., chemical workshops, fuel storage tank areas, Class IIB hazardous areas), choose standard flameproof type (Exd IIB T4); For high-risk explosion-proof environments (e.g., coal mines, natural gas transmission, Class II C hazardous areas), select intrinsically safe type (Exia II C T4) and ensure the product has passed GB3836 explosion-proof certification; some coal mine applications require the MA safety mark for mining products; For non-explosion-proof environments (e.g., HVAC in ordinary office buildings, domestic water treatment), non-explosion-proof models are sufficient, eliminating the need for additional explosion-proof costs. It is strictly prohibited to use non-explosion-proof models in explosion-proof environments, nor should sensors with lower explosion-proof ratings be used in high-risk areas, to avoid the risk of explosion.

5. Protection Rating

Key Considerations: The dust, humidity, and exposure to rain in the on-site environment determine the sensor's dustproof, waterproof, and splash-proof capabilities, which directly impact the equipment's service life.

Selection Guidelines: For indoor dry environments (e.g., server rooms, control rooms), select an IP65 protection rating; For outdoor, humid, or dusty environments (e.g., outdoor heat exchange stations, wastewater treatment plants), prioritize IP67 protection (which allows for brief immersion); For underwater or extremely humid environments (e.g., underwater pipelines, areas subject to rainwater immersion), a custom IP68 protection rating is required to enhance housing sealing and prevent internal circuits from short-circuiting due to moisture. Additionally, ensure that the protection rating aligns with the installation method. For outdoor installations, take extra measures to seal the cables to prevent rainwater from seeping into the enclosure through cable connectors and damaging electronic components.

6. Output Signal

Key Consideration: The signal reception type of the backend industrial control system (PLC, DCS, display instruments). Ensure the sensor's output signal is compatible with the system to avoid signal recognition failures or transmission distortion.

Selection Guidelines: For standard industrial applications (e.g., factory automation, heating plants), prioritize 4–20 mA analog output (two-wire system, highly resistant to interference, long transmission distance—up to 1,000 meters—compatible with over 90% of industrial control systems); For scenarios requiring multi-device networking and centralized monitoring (e.g., large water treatment plants, metallurgical workshops), select RS485 (Modbus-RTU protocol) digital output, which supports networking of up to 32 sensors to enable centralized collection and management of temperature data; For small-scale equipment and simple monitoring scenarios (e.g., small water tanks, laboratory equipment), 0–10 V analog output is recommended; For scenarios requiring high-temperature or low-temperature alarms, 1–2 additional digital relay outputs can be added to trigger interlock protection in linked equipment. Additionally, verify compatibility between the power supply voltage and the output signal; for two-wire 4–20 mA output, prioritize 24 VDC industrial-standard power supply to ensure signal stability.

7. Installation Space

Key Considerations: The size of the installation space, pipe diameter, and equipment layout at the site determine the probe length, installation method, and housing size of the sensor, ensuring easy installation without affecting the operation of on-site equipment.

Selection Guidelines: For confined spaces (e.g., inside equipment, small-diameter pipes), select a slim probe (Φ2–3 mm) and a short probe (50–100 mm), paired with a compact 2088 housing, using threaded or compression-type mounting; For spacious environments (e.g., large storage tanks, large-diameter pipes), select standard probes (Φ4–6 mm) or extended probes (150–200 mm) with flange or threaded mounting; For temporary temperature measurement on equipment surfaces, choose magnetic mounting for flexible positioning without the need for drilling holes; In areas with dense piping, prioritize horizontal installation to prevent the protruding sensor from colliding with other equipment, while ensuring sufficient probe insertion depth (typically no less than 200 mm) to avoid inaccurate readings caused by shallow insertion.

8.2 Industry Application Guidelines

1. Chemical Industry

Core Operating Conditions: Corrosive media (acids, alkalis, chemical reagents), flammable and explosive environments, medium-to-high pressure, and medium-to-low temperature measurement (-50°C to 300°C). Primarily used for temperature monitoring in reactors, distillation columns, pipelines, and storage tanks. Must balance explosion-proof, corrosion-resistant, and pressure-resistant performance while ensuring signal stability to support precise temperature control and safety monitoring of chemical reactions.

Specifications: Temperature measurement range -50°C to 300°C (standard), -200°C to 600°C (high-temperature reaction scenarios); Accuracy class A (±0.15°C); Probe material: 316 stainless steel/ Hastelloy, with customizable PTFE anti-corrosion coating; Explosion-proof rating: ExdIIBT4/ExiaIICT4; Protection rating: IP67; Output signal: 4–20 mA/RS485; Process connection: flange/threaded (flange preferred for high-pressure applications); Probe length: 100–200 mm, diameter: Φ4–6 mm, suitable for temperature measurement in reactors and pipelines, minimizing the risk of medium corrosion and explosions.

2. Thermal Power Industry

Core operating conditions: High-temperature hot water, steam, and pipeline temperature measurement (50°C–200°C), with no strong corrosion and some outdoor installations. Primarily used for temperature monitoring in heat exchange stations, heating pipelines, and boilers, requiring protection, vibration resistance, and long-distance signal transmission to ensure the stability and efficiency of heat transfer.

Specifications: Temperature measurement range 50°C–200°C; Accuracy class B (±0.3°C); Probe material: 304 stainless steel; Explosion-proof rating: Non-explosion-proof (outdoor environments without flammable or explosive hazards); Protection rating: IP65/IP67 (outdoor environments); Output signal: 4–20 mA; Process connection: Threaded (M20×1.5); Probe length: 150–200 mm, diameter: Φ5–6 mm; Vibration-resistant design suitable for pipeline vibration conditions to ensure long-term stable operation; Supports long-distance signal transmission to meet the centralized monitoring requirements of heat exchange stations.

3. HVAC Industry

Core Operating Conditions: Ambient temperature measurement (0°C–50°C), air and water media, installed both indoors and outdoors. Primarily used for temperature monitoring in central air conditioning, heating pipelines, and underfloor heating systems. Must balance ease of installation, low cost, and ease of maintenance while ensuring measurement accuracy meets comfort control requirements.

Specifications: Temperature measurement range 0°C to 50°C; accuracy class: standard (±0.5°C); probe material: 304 stainless steel; explosion-proof rating: non-explosion-proof; protection rating: IP65 (indoor), IP67 (outdoor); Output signal: 4–20 mA / 0–10 V; Process connection: threaded / ferrule; Probe length: 50–100 mm, diameter: 3–4 mm. Compact in size, it fits into the confined installation spaces of air conditioning units and pipes. In certain scenarios, surface-mount probes can be selected to enhance installation convenience. It also supports seamless integration with HVAC control systems to optimize energy consumption management.

4. Pharmaceutical Industry

Core Operating Conditions: Sanitary-grade requirements, high-precision temperature measurement (±0.15°C), corrosion-resistant, ambient/ moderate temperatures (0°C–150°C). Primarily used for temperature monitoring in fermentation tanks, sterilization equipment, and pharmaceutical storage facilities. Must comply with sanitary standards to prevent contamination of pharmaceuticals while ensuring precise temperature control to safeguard product quality.

Compatible Specifications: Temperature measurement range 0°C–150°C; Accuracy class A (±0.15°C); Probe material: 316L stainless steel (sanitary grade), with a polished surface for easy cleaning and no dead corners; Explosion-proof rating: non-explosion-proof (for sterile rooms); Protection rating: IP65; Output signal: 4–20 mA/RS485; Process connections: Sanitary-grade ferrule/flange; Probe length: 100–150 mm, diameter: Φ4–5 mm, with no sanitary dead zones. Designed to meet the hygiene requirements of fermenters and sterilization equipment while ensuring high-precision temperature measurement to support process control in pharmaceutical production. For certain freeze-drying applications, a custom ultra-low temperature range (-80°C to 150°C) is available to ensure the stability of active pharmaceutical ingredients.

5. Food Industry

Core operating conditions: Sanitary-grade requirements, medium-to-low temperature measurement (-20°C to 120°C), water and food ingredient media. Primarily used for temperature monitoring in sterilization equipment, cold chain storage, and food production lines. Must be sanitary, corrosion-resistant, and easy to clean, while ensuring precise temperature measurement and compliance with food safety production standards.

Compatible Specifications: Temperature measurement range -20°C to 120°C (extendable to -50°C to 50°C for cold chain applications); Accuracy Class B (±0.3°C); Probe material: 304/316L stainless steel (sanitary grade); Explosion-proof rating: non-explosion-proof; Protection rating: IP65; Output signal: 4–20 mA; Process connection: ferrule/threaded; probe length: 80–120 mm, diameter: Φ3–4 mm. Suitable for pasteurization lines, cold chain storage, and similar applications. For pasteurization applications, a fast-response probe (T90 ≤ 15 s) is available to ensure precise control of sterilization temperatures between 72°C and 75°C, guaranteeing microbial inactivation rates. Additionally, the probe is easy to clean, preventing food contamination.

6. Metallurgical Industry

Core operating conditions: high temperature, dust, vibration, medium to high pressure, with a wide temperature measurement range (0°C–600°C). Primarily used for temperature monitoring in the low-temperature sections of metallurgical furnaces, exhaust gas treatment, and desulfurization and denitrification equipment. Must be resistant to high temperatures, vibration, and dust, while ensuring stable accuracy to support the safe control of metallurgical processes.

Specifications: Temperature measurement range 0°C to 600°C (custom high-temperature models available); Accuracy class A (±0.15°C); Probe material: high-temperature alloy/316 stainless steel; Explosion-proof rating Exd IIB T4 (dust-proof explosion-proof option available); Protection rating IP67; Output signal 4–20 mA/RS485; Process connection: flange/threaded; probe length: 200–300 mm, diameter: Φ6–8 mm; vibration-resistant and dust-proof design, suitable for the high-temperature, dusty, and vibrating conditions of metallurgical furnaces. Custom high-temperature, wear-resistant probes are available for certain applications to extend equipment lifespan, while also supporting long-distance signal transmission to meet the centralized monitoring needs of metallurgical workshops.

7. Water Treatment Industry

Core operating conditions: humid, dusty, and water-based environments (some with mild corrosion); ambient temperature measurement (0°C–50°C). Primarily used for temperature monitoring of tanks, pipelines, and pumps in water treatment plants and sewage treatment plants. Requires waterproof, dustproof, and corrosion-resistant features, along with easy installation and maintenance.

Specifications: Temperature measurement range 0°C to 50°C; accuracy class: standard (±0.5°C); probe material: 304/316 stainless steel; explosion-proof rating: non-explosion-proof; protection rating: IP67 (humid environments); Output signal: 4–20 mA; process connection: threaded/flanged; probe length: 100–150 mm, diameter: Φ4–6 mm. With excellent waterproof sealing performance, it is suitable for humid and dusty water treatment environments, preventing equipment failures caused by moisture. It also features easy installation and facilitates subsequent inspection and maintenance. For certain wastewater treatment scenarios, a custom anti-corrosion coating can be applied to enhance the probe's corrosion resistance.

8.3 Common Selection Pitfalls

1. Incorrect Measurement Range Selection

Common Mistake: Blindly pursuing a wide measurement range, such as using a -200°C to 600°C range in normal-temperature applications (e.g., HVAC,

general water treatment), which results in reduced accuracy (wider ranges have greater accuracy deviations) and increased costs; or using an insufficient range, such as a 0°C to 100°C range in high-temperature applications (e.g., thermal pipelines, low-temperature sections in metallurgy), which can cause sensor probe burnout, equipment damage, and even compromise on-site production safety. Correct Approach: Select a measurement range based on the typical temperature of the measured medium plus a 10%–20% margin of safety. Do not blindly pursue a wide range, nor should you overlook extreme temperatures. For example: For ambient temperature applications, prioritize a 0°C–50°C or -50°C–200°C range; for high-temperature applications, select a -200°C–600°C range as needed; and for ultra-low-temperature applications, choose a -200°C–100°C range. This ensures accuracy within the commonly used temperature range while avoiding cost waste and accuracy degradation caused by excessive range, balancing both accuracy and service life.

2. Inadequate Protection

Common Mistake: Selecting an IP65 protection rating for outdoor, humid, or dusty environments, or an IP67 rating for underwater applications, leading to rain, dust, or moisture penetrating the housing and damaging internal circuits and the PT100 sensor element. This results in sensor failure, measurement inaccuracies, or even equipment short circuits. In some cases, neglecting cable sealing allows rainwater to seep in through cable connectors, further exacerbating equipment damage. Correct Approach: Strictly select the protection rating based on the on-site environment; prioritize IP67 for outdoor and humid environments, and IP68 for underwater environments. Simultaneously, ensure cable interfaces are properly sealed and equipped with waterproof connectors to prevent rainwater and moisture from infiltrating. Unless specific requirements exist, IP65 is sufficient for dry indoor environments; however, for outdoor or humid environments, the protection rating must be upgraded to extend sensor lifespan, reduce failure rates, and avoid increased equipment replacement costs due to inadequate protection.

3. Incorrect Use of Explosion-Proof Ratings

Common Mistakes: Using non-explosion-proof sensors in flammable or explosive environments (such as chemical processing plants or fuel storage tanks), or using Exd IIB T4-rated sensors in high-risk Exia IIC T4 environments, creates explosion hazards, violates industrial safety standards, and may result in failed safety inspections or production shutdowns; some users excessively prioritize explosion-proof ratings, using high-risk explosion-proof models in environments with no such requirements, thereby incurring unnecessary costs. Correct Approach: First, clearly identify the hazard zone classification at the site. If there is no explosion-proof requirement, select a non-explosion-proof model. If an explosion-proof requirement exists, choose ExdIIBT4 for Class IIB hazard zones and ExiaIICT4 for Class IIC high-risk zones. Ensure that the explosion-proof rating matches the on-site hazard level and that the product has passed the corresponding explosion-proof certification. It is strictly prohibited to use a lower explosion-proof rating than required. Additionally, avoid cost wastage caused by over-specification, balancing safety and cost-effectiveness.

4. Inappropriate Probe Length

Common Mistake: The probe is too short, resulting in insufficient insertion depth into the medium (less than 200 mm), which leads to inaccurate temperature readings (due to interference from ambient temperature); or the probe is too long, exceeding the installation space, causing it to collide with or bend against on-site equipment, thereby damaging the probe. Some users neglect to match the probe length to the medium depth, preventing the probe from effectively contacting the medium being measured and affecting temperature measurement accuracy.

Correct Approach: Select the probe length based on the diameter of the installation pipe and the depth of the medium, ensuring the probe is inserted at least 200 mm into the medium (to avoid interference from ambient temperature) while not exceeding the installation space. Leave a 10–20 mm clearance to prevent damage from collisions. Select short probes (50–100 mm) for confined spaces, and long probes (150–300 mm) for large-diameter pipes and storage tanks. For temperature measurement on solid surfaces, use short probes with surface-mount installation to ensure full contact between the probe and the medium or surface. This enhances measurement accuracy and prevents measurement errors and equipment damage caused by improper probe length.

IX. Installation and Commissioning Specifications

9.1 Installation Preparation

Prior to installation, complete an inventory of components, seal inspections, insulation tests, and safety precautions to prevent issues such as missing parts, seal failure, or electrical malfunctions during installation, thereby laying the groundwork for a smooth installation.

1. Component Inventory

Verify each component required for installation to ensure nothing is missing or damaged. Key components include: the Model 2088 PT100 sensor body, installation fasteners (bolts, nuts, washers, with matching threads/ flange mounting), sealing components (O-rings, gaskets—temperature resistance ≥150°C, resistant to medium corrosion), shielded twisted-pair cable (recommended wire gauge 0.75–1.0 mm², compatible with two-wire/ three-wire/four-wire configurations), terminal blocks, explosion-proof sealing connectors (for explosion-proof environments), and thermal grease (optional, to improve heat transfer efficiency between the probe and the measured medium). After verification, organize the components by category to prevent loss or mix-ups.

2. Sealing Inspection

Focus on inspecting the sealing performance of the sensor housing. The 2088 housing features a dual-chamber design that isolates the electronic circuitry from the external environment, preventing damage to the equipment caused by environmental humidity or condensation in the conduit. Ensure that the housing O-ring is intact, undamaged, and free of aging, and that the housing interface threads are free of stripping or burrs; Verify that the dimensions of the sealing components match the sensor interfaces and installation locations. In explosion-proof environments, additionally inspect the sealing performance of the explosion-proof connectors to ensure compliance with the corresponding explosion-proof rating requirements, preventing process contaminants from entering the housing through the cable conduit via the terminal block.

3. Insulation Testing

Before installation, perform insulation testing on the sensor body and connecting cables to prevent issues such as short circuits or signal interference caused by poor insulation. Use a megohmmeter (500 V) to measure the insulation resistance between the sensor's input and output, between the input and power supply, and between the output and power supply, ensuring the insulation resistance is ≥100 MΩ (at 25°C and 60% relative humidity). Measure the insulation resistance between cable conductors and between conductors and the shielding layer; this must also be ≥100 MΩ. Record the test results upon completion. If the insulation resistance does not meet the standard, troubleshoot the sensor or replace the cable.

4. Safety Precautions

1. Before on-site work, confirm that the installation area is free of safety hazards. In flammable or explosive environments (such as petrochemical sites), cut off all ignition sources in advance and implement explosion-proof measures. Live-line work is strictly prohibited, and ensure the work environment is well-ventilated;
2. Before installation in high-temperature or high-pressure environments, confirm that the equipment being tested has been shut down, cooled down, and depressurized to prevent burns from high temperatures or injuries from high-pressure medium leaks;
3. Operators must wear protective gear such as insulated gloves and non-slip gloves,

and use certified electrical tools (multimeters, megohmmeters, torque wrenches, etc.). Tools must be inspected and calibrated in advance to ensure they meet accuracy standards; 4. When installing in explosion-proof environments, strictly adhere to explosion-proof regulations. Striking or open-flame work is strictly prohibited within explosion-proof zones to prevent sparks from causing safety incidents.

9.2 Installation Steps

Installation must follow the sequence of "Mounting → Wiring → Sealing → Shield Grounding." Each step must be performed in accordance with specifications to ensure the sensor is securely mounted, correctly wired, properly sealed, and reliably grounded, thereby preventing subsequent issues such as temperature measurement deviations, signal interference, or equipment damage.

1. Mounting

Select the appropriate mounting method based on site conditions and the sensor's installation type. The primary mounting methods and operational specifications are as follows:

1. Threaded Installation (Most Common): Align the sensor probe with the mounting hole and slowly screw it in clockwise. Use a torque wrench to tighten it to the manufacturer's specified torque (typically 15–25 N·m). Avoid over-tightening, which could damage the housing threads or the probe. During installation, a small amount of thermal grease may be applied to the threads (in non-explosion-proof environments) to enhance heat transfer efficiency. Never use oil-based sealants, as they may contaminate the platinum wire or compromise insulation;
2. Flange Installation: Place the flange gasket at the flange interface, align the mounting holes of the sensor flange with those of the equipment flange, insert the bolts, and tighten them diagonally and evenly to ensure a tight flange connection with no looseness or medium leakage. Suitable for high-temperature and high-pressure applications;
3. Ferrule/Welding Installation: For ferrule installation, ensure the ferrule fits snugly against the probe and installation tube, then quickly tighten the ferrule nut to secure it; welding installation must be performed by qualified personnel. After welding, insulation treatment must be performed to prevent short circuits; suitable for high-vibration and high-temperature environments;
4. The installation location must be selected to represent the true temperature of the measured medium. Prioritize straight pipe sections and avoid areas with severe temperature fluctuations, such as valves, elbows, dead corners, or heat exchanger inlets/outlets. Maintain a distance of at least 5 to 10 times the pipe diameter from elbows or valves. The probe insertion depth must meet the following requirements: for pipe fluid applications, 1/2 to 2/3 of the pipe diameter; for flue/furnace applications, the insertion depth must be ≥1 m, with a minimum insertion depth of no less than 10–15 times the outer diameter of the protective tube. For horizontal installations, the wiring box outlet should face downward to prevent rainwater, condensation, or dust from entering the wiring box.

2. Wiring Procedure

Before wiring, reconfirm the sensor's wiring configuration (two-wire/three-wire/four-wire system) and output signal type (4–20 mA/0–10 V/RS485) to ensure compatibility with the backend industrial control equipment (PLC, DCS, display instruments). Power must be disconnected during wiring to prevent short circuits and equipment damage.

1. Wire Stripping: Remove the cable jacket and the insulation from the conductors. Keep the stripped length between 5–8 mm to prevent short circuits caused by excessively long bare wire and to protect the conductors from damage;
2. Terminal Connection: Connect the conductors to the corresponding sensor terminals, distinguishing between power, signal, and ground wires. Ensure connections are secure with no looseness or loose contacts; conductors must not be twisted or damaged. For three-wire systems, all three leads must be of the same material, gauge, and length, and the resistance difference must be ≤0.05Ω; otherwise, bridge compensation will fail;
3. Wire Color Correspondence: It is recommended to follow industry standards for wiring. For example, in a two-wire system (4–20 mA), connect the red wire to the positive terminal (power +) and the blue wire to the negative terminal (signal –); in a three-wire system (PT100), connect the two wires of the same color (e.g., red) to the compensation terminals, and the wire of a different color (e.g., blue) to the signal terminal; RS485 Output: Connect A to the A terminal and B to the B terminal. Reversing the connections is strictly prohibited to prevent signal transmission failure or equipment damage; 4. Post-wiring Organization: Neatly organize excess cable and secure it to the equipment bracket to prevent pulling or kinking. Keep the cable away from high-temperature and moving parts to prevent wear and aging.

(3) Sealing Procedures

Sealing is critical to prevent media leakage and the ingress of moisture or dust into the sensor housing and terminal blocks. Sealing must be performed properly for each component:

1. Sealing between the sensor and mounting surface: Install sealing gaskets or O-rings at threaded mounting points to ensure no media leakage; for flange mountings, verify that gaskets are tightly seated with no misalignment or damage;
2. Terminal Sealing: After neatly organizing the wiring terminals, securely close the sensor housing's terminal box cover and tighten the mounting screws to ensure a proper seal. In outdoor, humid, or dusty environments, install a sealing connector at the terminal box's cable exit port and ensure the cable fits tightly against the connector to prevent moisture and dust from entering;
3. Sealing for Explosion-Proof Environments: Strictly adhere to explosion-proof regulations to ensure that the housing interfaces, junction box, and sealing connectors are all properly sealed. Never open the cover while the unit is energized to prevent flammable or explosive gases from entering the housing and causing an explosion. After sealing, inspect the sealing areas to ensure there is no looseness or gaps.

4. Shield Grounding

To enhance the sensor's resistance to electromagnetic interference, proper shield grounding must be implemented to prevent signal distortion caused by industrial electromagnetic interference (such as from variable frequency drives, high-voltage lines, and motors).

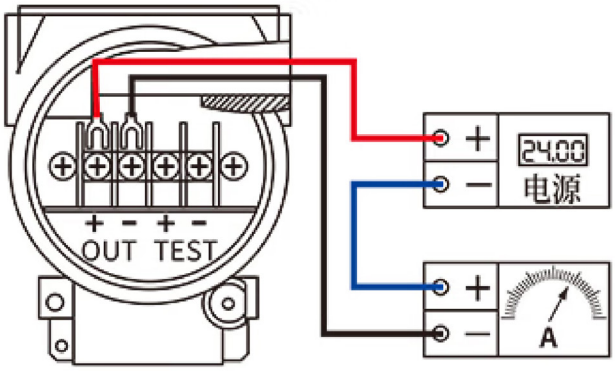
1. Shield Layer Treatment: Strip the cable shielding and run a separate grounding wire. Keep the shielding length between 3–5 mm to avoid contact with the core wires, which could cause a short circuit;
2. Grounding Procedure: Connect the shield grounding wire to a dedicated grounding terminal at the site. Ensure the grounding resistance is ≤4Ω. Prioritize single-point grounding (ground at either the sensor side or the industrial control equipment side; do not ground both ends simultaneously) to prevent ground loops that could cause interference;
3. Grounding Inspection: After grounding, pull firmly on the grounding wire to confirm a secure connection with no looseness. Inspect the grounding terminal for oxidation or corrosion to ensure reliable grounding. Additionally, maintain a distance of ≥300 mm between signal wires and power cables (such as motor wires), and ensure they cross at a 90° angle to further prevent electromagnetic interference.

9.3. Wiring Diagrams (2-Wire/3-Wire/4-Wire Systems)

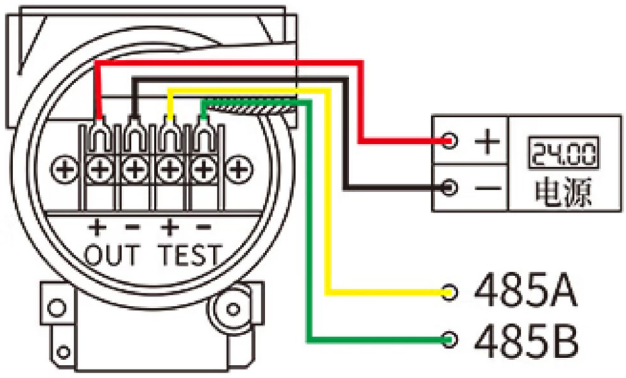
The 2088 PT100 temperature sensor supports three wiring configurations: two-wire, three-wire, and four-wire, to accommodate different accuracy and transmission distance requirements. The power supply and output terminals are clearly designated. When wiring, strictly follow the diagram below; reverse or incorrect connections are strictly prohibited.

2088 Temperature Sensor

2-Wire 4-20mA



4-Wire RS485



4. Commissioning Procedure

Commissioning must be performed after installation, wiring, sealing, and grounding are complete. Follow the sequence of "Power-on Check → Display Calibration → Signal Verification → Zero/Span Setting" to systematically troubleshoot issues, ensuring accurate temperature measurement, stable signal output, and normal communication with downstream industrial control equipment.

1. Power-On Check

1. After confirming correct wiring, proper sealing, and reliable grounding, connect the 24VDC power supply. Observe the indicator light on the sensor housing (if present). Under normal conditions, the indicator light should remain steady (or flash, depending on the manufacturer's specifications), with no error messages or abnormal flashing;
2. Observe the on-site display. After power-up, the display should start normally and show the current ambient temperature. There should be no garbled text or a black screen. If the display is abnormal, check the supply voltage and whether the wiring is loose;
3. Check that the sensor does not exhibit abnormal heating, unusual noises, or medium leakage. If heating or unusual noises occur, immediately disconnect the power and troubleshoot for wiring errors or sensor malfunctions;
4. Allow the power to stabilize for 15 minutes to ensure the sensor's internal circuitry is functioning properly, laying the foundation for subsequent calibration and verification.

2. Display Calibration

Display calibration ensures the accuracy of the sensor's on-site display, verifying that it matches the actual temperature. Calibration must be performed using standard temperature measurement equipment (such as a Class 2 standard platinum resistance thermometer or an infrared thermometer with higher accuracy than the sensor being calibrated).

1. Calibration Preparation: Place the standard temperature measurement equipment and the sensor probe in the same constant-temperature environment (e.g., room temperature of 25°C or a 0°C ice bath), ensuring both are in full contact with the medium being measured. Wait until the temperature stabilizes (fluctuation ≤ ±0.02°C/10 min);
2. Error Detection: Compare the temperature displayed on the sensor's screen with that displayed on the standard temperature measurement equipment, and calculate the error value. If the error exceeds the sensor's accuracy class (e.g., Class A ±0.15°C), calibration adjustment is required;
Calibration Procedure: Use the sensor's built-in calibration button (or host computer software) to adjust the display value until it matches the reading on the standard temperature measurement device. After calibration, lock the calibration parameters to prevent accidental changes;
4. Multi-point calibration: If the sensor has a wide measurement range, select 2–3 calibration points within the range (e.g., 0°C, 100°C, 200°C) and repeat the above steps to ensure display accuracy meets standards across the entire range. For high-temperature calibration (above 300°C), use an oil bath or salt bath with a cooling rate of ≤1°C/min (above 500°C).

3. Signal Verification

Signal verification is used to check the stability and accuracy of the sensor's output signal and ensure normal communication with downstream industrial control equipment. Tools such as a multimeter and signal generator are required.

1. Analog Output Calibration (4–20 mA/0–10 V): (1) Measure the sensor's output signal with a multimeter. After power-on stabilization, the 4–20 mA output should stabilize at 4 mA (corresponding to the lower limit of the range) under no-load conditions, and the 0–10 V output should stabilize at 0 V; (2) Place the sensor probe in a temperature-controlled bath and set different temperature points (e.g., lower limit, midpoint, and upper limit of the range). Once the temperature stabilizes, measure the output signal to confirm that the signal corresponds linearly to the temperature (e.g., if the 4–20 mA range corresponds to –200°C to 400°C, then 12 mA should correspond to 100°C). Signal fluctuation must be ≤ ±0.1 mA (or ±0.05 V); (3) Connect the sensor to the industrial control equipment. Observe the temperature value displayed by the control equipment and compare it with the values shown on the sensor's display and a standard temperature measurement device. The error must be within the allowable range. If the signal is abnormal, troubleshoot wiring, grounding, or sensor malfunctions.
2. Digital Output Calibration (RS485): (1) Connect the sensor via host computer software, set the baud rate (adjustable from 1200 to 115200 bps) and the Modbus-RTU protocol, and confirm normal communication; (2) Read the temperature data transmitted by the sensor and compare it with the values displayed on the on-site display and standard temperature measurement equipment to ensure data consistency, with no packet loss or distortion; (3) Test the multi-sensor networking function (if available). Connect multiple sensors and confirm that the host computer can read data from all sensors normally and that communication is stable.
3. Digital Output Verification (Relay): Set the high-temperature and low-temperature alarm thresholds. Simulate a temperature exceeding the thresholds and observe whether the relay operates normally and whether the alarm signal is transmitted correctly to the industrial control equipment, ensuring reliable operation and no false alarms.

4. Zero Point/Range Setting

Based on on-site temperature measurement requirements, set the sensor's zero point (lower limit of range) and range (upper limit of range) to ensure they match the temperature range of the measured medium. Setting methods include manual adjustment (using the sensor's built-in buttons) and configuration via the host computer (via RS485 communication).

1. Zero Point Setting:

(1) Place the sensor probe in an environment with a known zero-point temperature (e.g., a 0°C ice-water mixture) and wait for the temperature to stabilize;
(2) Use the manual buttons or host computer software to enter the zero-point setting interface, set the current temperature as the zero point (lower limit of the range), and save the parameters;
(3) Restart the sensor to confirm that the zero-point setting is effective; the display should show a temperature matching the zero-point environment temperature.

2. Range Setting: (1) Determine the measurement range based on on-site temperature measurement requirements (e.g., -50°C to 200°C). Use the manual buttons or host computer software to enter the range setting interface and input the upper and lower limits of the range; (2) Place the sensor probe in an environment at the midpoint temperature of the range and wait for the temperature to stabilize. Verify that the sensor's output signal corresponds to the midpoint temperature; if not, fine-tune the range parameters; (3) Save the range parameters and restart the sensor. Select multiple temperature points within the range to verify that the range settings are accurate and the signal output is normal. Calibration can be performed using a resistance box: set the resistance box to a value within the corresponding range, then adjust the zero and span potentiometers until the output reaches the corresponding standard value. Repeat this process several times to improve accuracy. 3. Precautions: After completing the zero and range settings, lock the parameters to prevent accidental changes that could invalidate the settings. If the on-site temperature measurement range changes, the zero and range settings must be reconfigured, and signal accuracy must be recalibrated.

9.5. Installation Prohibitions

To avoid sensor damage, excessive measurement errors, safety incidents, and other issues, strictly adhere to the following prohibitions during installation; unauthorized operations are strictly prohibited.

1. Strictly Prohibit Installation and Use Beyond Temperature Limits

Never expose the sensor probe to environments exceeding its rated temperature range (standard range: -200°C to 400°C; custom models: -200°C to 600°C). The housing operating temperature must not exceed 85°C. In high-temperature environments, failure to use a high-temperature custom model will result in damage to the PT100 platinum resistance core, deformation of the housing, and seal failure. Prolonged use at temperatures exceeding the rating will significantly shorten the sensor's service life and may even lead to safety incidents. In low-temperature environments, temperatures must not fall below the lower limit of the measurement range to prevent the probe from freezing and cracking or causing abnormal resistance values.

2. Strictly Prohibit Installation and Use Under Excessive Pressure

The rated operating pressure of the sensor housing and probe must match the on-site conditions (standard models ≤ 1.6 MPa, custom models ≤ 10 MPa). Installation and use in environments exceeding the rated pressure are strictly prohibited; Overpressure can cause sensor seal failure, media leakage, and damage to internal circuits and the platinum resistance core. This is particularly true for flange and threaded connections, where overpressure may lead to loosening of connections and media ejection that could injure personnel. For high-pressure applications, custom models with thick-walled or solid-forged sleeves must be selected.

3. Installation in high-vibration environments without protective measures is strictly prohibited

It is strictly prohibited to install the sensor directly on high-vibration equipment (such as fans, compressors, pumps, etc.) without any anti-vibration protection. Severe vibration can cause the sensor probe to fracture, wiring to loosen, and the housing to be damaged. Prolonged vibration can lead to fatigue failure of the PT100 platinum resistance core, resulting in reduced temperature measurement accuracy and signal distortion; If installation in a vibrating environment is necessary, a spring-mounted vibration-damping bracket must be installed, or an armored anti-vibration sensor must be selected. When the insertion depth exceeds 1 meter or the protective tube diameter is large, an intermediate support bracket must be installed to prevent the protective tube from bending or breaking.

4. Strictly prohibit installation in environments with strong electromagnetic interference without shielding and grounding

It is strictly prohibited to install the sensor in areas with strong electromagnetic interference (such as near variable frequency drives, high-voltage lines, or motors) without implementing shielding and grounding measures. Strong electromagnetic interference can cause signal distortion, excessive fluctuations, or even prevent normal signal transmission, thereby affecting temperature measurement accuracy and the proper operation of industrial control systems; If installation in such areas is necessary, enhanced shielding and grounding (grounding resistance ≤ 4 Ω) must be implemented. Use shielded twisted-pair cables, increase the distance between the sensor and the interference source (≥ 300 mm), and route signal cables separately from power cables; when they cross, ensure they do so at a 90° angle to avoid interference.

5. Other Prohibitions

1. Wiring errors (such as reversed polarity or mixing signal and power lines) are strictly prohibited to prevent short circuits that could damage the sensor and downstream industrial control equipment; 2. Inadequate sealing (such as failure to install sealing components or loosely secured junction boxes) is strictly prohibited to prevent moisture, dust, or process media from entering the housing and damaging internal components; 3. Improper installation (e.g., installation in temperature dead zones, insufficient probe insertion depth) is strictly prohibited, as it leads to inaccurate temperature measurements and fails to reflect the true temperature of the measured medium; 4. The use of substandard accessories (e.g., low-quality seals, unshielded cables) is strictly prohibited, as it affects the sensor's sealing performance, interference resistance, and service life; 5. In explosion-proof environments, opening the cover while the device is energized or performing improper wiring is strictly prohibited to prevent explosion accidents.

Supplementary Notes: After installation and commissioning are complete, detailed records must be maintained, including the installation location, wiring configuration, calibration data, and zero/span setting parameters, to facilitate future maintenance, repairs, and calibration. During sensor operation, regularly inspect the seals, grounding, and wiring, and perform periodic calibration (generally every 1 year; in harsh environments, this may be shortened to 6 months) to ensure long-term stable operation.

X. Daily Use and Maintenance

The daily use and standardized maintenance of the 2088 Model PT100 Temperature Sensor are critical to ensuring its long-term stable operation, maintaining measurement accuracy, and extending its service life. It is essential to strictly adhere to the following requirements and implement them in a manner tailored to specific industrial site conditions (such as high temperatures, humidity, corrosion, and strong electromagnetic environments). All maintenance operations must comply with the IEC 60751 international standard and domestic industrial equipment maintenance regulations to ensure the sensor continues to meet on-site temperature measurement requirements.

10.1 Inspection Key Points

The core of inspection is to promptly identify sensor malfunctions, ensuring early detection and resolution to prevent minor faults from escalating into equipment damage or measurement inaccuracies. Recommended inspection frequency: once daily under normal conditions; once every 4 hours under harsh conditions (high temperature, corrosion, strong vibration). Pay close attention to the following four points:

1. Normal Display

Observe the sensor's on-site LCD/LED display to confirm that the display is clear, free of garbled characters, black screens, or abnormal flickering, and that the displayed temperature generally matches the actual on-site operating temperature (with an error within the sensor's accuracy range); Check the display for any error codes. If errors such as "OPEN" or "short circuit" appear, immediately investigate issues with the probe, wiring, or power supply. Also verify that the display backlight brightness is normal; in outdoor environments with strong light, ensure the LED backlight is clearly visible to avoid misjudging on-site temperature conditions due to display abnormalities. Additionally, if the displayed value remains static for an extended period or fluctuates frequently, preliminarily assess this as a sensor malfunction or interference issue and shut down the system promptly for inspection.

2. Stable Output
Use a multimeter or industrial control systems (PLC/DCS) to monitor the sensor's output signal in real time. Analog outputs (4–20 mA/0–10 V) must remain stable within the standard range corresponding to the current temperature, with fluctuations ≤ ±0.1 mA (or ±0.05 V) and no significant drift; Digital outputs (RS485) must ensure normal communication with the host computer, with no packet loss or data distortion, and timely temperature data updates; switch outputs (relays) must operate normally during temperature anomalies, and alarm signals must be transmitted accurately. If output signal fluctuations are excessive, there is no output, or data is abnormal, investigate for loose wiring, poor grounding, electromagnetic interference, or sensor element failure to prevent disruption of normal industrial control system operations.

3. No Looseness or Leaks
Inspect the sensor mounting points (threads, flanges, ferrules) to confirm that fasteners (bolts, nuts) are secure and free of corrosion, and that torque meets installation specifications (15–25 N·m); Inspect sealing areas (housing interfaces, junction boxes, sealed connectors) to ensure there is no medium leakage, moisture ingress, or dust accumulation, and that O-rings and sealing gaskets show no signs of aging or damage; verify that the probe is securely connected to the mounting hole with no play to prevent measurement errors or medium leakage caused by looseness. In hazardous environments such as petrochemical plants or high-pressure settings, prioritize leak detection to prevent safety incidents. Simultaneously, verify that the cable is securely fastened, free from tension or kinks, and ensure that the terminal connections are tight.

4. Additional Inspection Items
During inspections, simultaneously verify that the sensor housing exhibits no abnormal heat or unusual noises, that the cable insulation is free from damage or aging, and that the shielding layer is reliably grounded. In explosion-proof environments, confirm that the housing is undamaged, the junction box cover remains sealed, and all requirements of explosion-proof standards are met; In high-temperature environments, inspect the housing for deformation and the probe for oxidation or discoloration to ensure safe operation. Additionally, use a megohmmeter to quickly test insulation resistance, ensuring it meets standards and preventing short-circuit failures caused by deteriorating insulation.

10.2 Maintenance Schedule
Establish a tiered maintenance schedule based on the sensor's operating conditions, focusing on three key areas: cleaning, tightening, and accuracy recalibration. This prevents both excessive and delayed maintenance. The specific schedules and operational guidelines are as follows; adjustments may be made flexibly based on the severity of on-site conditions:
1. Routine Maintenance Schedule (Applicable to general conditions: normal temperature, dry environment, non-corrosive, low vibration)
--- Cleaning: Once a month. Focus on removing dust, oil, and debris from the sensor housing, display screen, and probe surface to prevent contamination from affecting heat transfer efficiency or display clarity. Power must be disconnected before cleaning. Use a soft cloth dampened with a neutral detergent to wipe the surfaces. Never use hard objects to scrape or direct high-pressure water jets at the unit, as this may damage the sealing structure or display screen.
--- Tightening: Once every 3 months, inspect the tightness of mounting fasteners, terminal blocks, and sealed connectors. Tighten any loose bolts or terminals to ensure reliable connections. Check the shielding ground wire to confirm a secure ground connection with a ground resistance ≤4Ω, preventing signal interference or equipment damage caused by loose connections. Also inspect O-rings and gaskets; replace them promptly if signs of aging are observed.
--- Accuracy Verification: Once every 12 months, use standard temperature measurement equipment (second-class standard platinum resistance thermometer, infrared thermometer, with accuracy superior to the sensor being calibrated), compare the sensor's displayed temperature with the standard temperature under ambient conditions (25°C) or at the zero point (0°C ice-water mixture). If the error exceeds the sensor's accuracy class (Class A: ±0.15°C, Class B: ±0.3°C), perform calibration adjustments promptly to ensure measurement accuracy meets standards.

2. Maintenance Schedule for Harsh Operating Conditions (Applicable to high-temperature, humid, corrosive, high-vibration, and explosion-proof environments)
--- Cleaning: Once every 15 days. In corrosive environments, apply corrosion protection (e.g., anti-corrosion coating) to the sensor housing and probe after cleaning. In humid environments, focus on cleaning the interior of the junction box to prevent moisture buildup; apply moisture-proof silicone grease to enhance moisture resistance.

--- Tightening: Once a month. In high-vibration environments, additionally inspect the probe's mounting; for units with vibration-damping brackets, ensure the brackets are secure. Regularly replace aged fasteners and seals to prevent medium leakage or equipment loosening.

--- Accuracy Recalibration: Once every 6 months. In high-temperature or corrosive environments, increase the number of calibration points (e.g., mid-range and upper limit). Use a temperature-controlled bath for multi-point calibration. If the sensor exhibits significant drift, shorten the recalibration cycle to 3 months. Replace the PT100 element or the sensor body if necessary.

3. Maintenance Records
After each maintenance session, detailed records must be kept of the maintenance date, work performed, test data (such as accuracy error, ground resistance, and insulation resistance), any abnormalities, and corrective actions. Establish a sensor operation and maintenance log to facilitate subsequent traceability, repairs, and cycle adjustments. Additionally, record information such as the sensor model, installation location, and calibration date to enable full lifecycle management.

10.3 Maintenance Tips
Based on the structural characteristics of the 2088-model PT100 sensor (2088 housing, PT100 platinum resistance core), develop targeted maintenance techniques addressing the four core requirements of corrosion resistance, moisture resistance, vibration resistance, and interference resistance to extend equipment service life and ensure operational stability:

1. Corrosion Prevention Maintenance
(1) Material Selection: Choose housing and probe materials based on the type of on-site medium. For chemical, acidic, or alkaline environments, prioritize 304/316 stainless steel housings and probes. In highly corrosive environments (e.g., those containing chloride ions or strong acids), custom-made probes made of Hastelloy or PTFE can be selected to prevent equipment damage caused by material corrosion. For high-temperature environments, use high-temperature-resistant alloy materials to prevent high-temperature oxidation and corrosion.

2. Regular Protection: In corrosive environments, apply a corrosion-resistant coating (such as anti-corrosion grease) to the sensor housing and probe every month to prevent direct contact between the medium and the surface. When cleaning, avoid using corrosive cleaning agents; opt for neutral cleaners instead. Wipe the surface dry immediately after cleaning to prevent residual medium from corroding the equipment.

3. Abnormal Condition Handling: If corrosion spots or damage are detected on the housing or probe, shut down the equipment immediately for inspection. Minor corrosion can be addressed by sanding and applying a protective coating; severe corrosion requires replacement of the housing or probe to prevent corrosion from spreading to internal circuits and the platinum resistance core. Simultaneously, inspect the seals for corrosion and promptly replace any aged seals.

(2) Moisture Protection and Maintenance
1. Sealing Reinforcement: Ensure the sensor housing terminal box is tightly sealed and that sealed connectors are properly installed.

In outdoor or humid environments, use seals with an IP67 or higher protection rating. Regularly inspect O-rings and gaskets; replace any that are aged or damaged immediately. Install the terminal box with the cable outlet facing downward to prevent rainwater and condensation from entering. Placing desiccant packets inside the terminal box can enhance moisture protection.

2. Environmental Optimization: In humid environments (such as wastewater treatment plants or outdoors), install the sensor in a well-ventilated, dry location to avoid direct contact with moisture or standing water. If necessary, install a rain shelter or protective cover to reduce ambient humidity. Regularly inspect the interior of the junction box; if moisture or condensation is present, immediately disconnect the power, wipe it dry, and use dry compressed air to blow it dry to prevent internal circuit short circuits.

3. Regular Testing: Measure the sensor's insulation resistance with a megohmmeter every 3 months to ensure it is ≥100 MΩ. If the insulation resistance drops, investigate the cause of moisture protection failure and address it promptly to prevent internal component damage caused by moisture. For sensors not in use for extended periods, clean and dry them before storing in an anti-static, moisture-proof cabinet to prevent performance degradation due to humid environments.

(3) Anti-Vibration Maintenance

1. Installation Protection: In high-vibration environments (such as equipment like fans, compressors, and pumps), install spring-mounted vibration-damping brackets when mounting the sensor. Select armored, anti-vibration probes to minimize the impact of vibrations on the probe and internal circuits. When the insertion depth exceeds 1 meter or the protective tube has a large diameter, install intermediate support brackets to prevent the protective tube from bending or breaking.

2. Regular Inspection: Inspect the sensor's mounting every month, tighten any loose fasteners, and adjust the position of the vibration-damping brackets to ensure effective cushioning. Avoid direct contact between the sensor and vibrating equipment. Secure cables using flexible mounting methods to reduce cable strain and damage caused by vibration, and prevent fatigue damage to the platinum resistance core.

3. Avoid Impact: When handling or servicing the sensor, handle it with care to avoid violent collisions or drops, which can cause probe breakage, housing deformation, or loosening of internal circuits. During installation or removal, avoid excessive force to prevent stripped threads or probe damage. Additionally, avoid sudden temperature changes that could generate thermal stress and damage the platinum wire or protective sheath.

(4) Interference Suppression Optimization

1. Grounding Optimization: Ensure the sensor shield is grounded at a single point (preferably on the industrial control equipment side), with a grounding resistance ≤4Ω. Regularly inspect the grounding wire to prevent loosening or oxidation, and avoid ground loops that cause interference. Never ground both ends simultaneously to prevent the superposition of interference signals.

2. Cabling Standards: Use shielded twisted-pair cable (0.75–1.0 mm²) for sensor connections. Maintain a distance of ≥300 mm from power cables (motor cables, inverter cables). When crossing, ensure a 90° angle; avoid parallel routing to minimize electromagnetic interference. Keep cables away from strong interference sources such as high-voltage lines and inverters; install shielding sleeves when necessary to enhance interference resistance.

3. On-Site Optimization: In environments with strong electromagnetic interference, install a signal isolator between the sensor and industrial control equipment to further block interference signals. Regularly inspect the sensor's internal isolation module; if signal drift or fluctuations occur, promptly identify and eliminate the source of interference or replace the isolation module to ensure stable output signals. Simultaneously, check the supply voltage to prevent interference caused by voltage fluctuations and ensure the supply voltage remains stable between 12–36 VDC.

10.4 Parameter Settings: Calibration Method for Field-Display Models

For the 2088 model field-display PT100 temperature sensor, the core of calibration is to ensure that the temperature displayed on the screen matches the actual temperature, meeting on-site temperature measurement accuracy requirements. Calibration does not require disassembling the sensor and can be performed directly on-site. The following equipment must be prepared: standard temperature measurement equipment (second-class standard platinum resistance thermometer, temperature bath, with accuracy superior to the sensor being calibrated), a multimeter, and calibration software (optional). The specific steps are as follows, in accordance with the requirements of JJF 1664–2017 "Calibration Specifications for Temperature Display Instruments":

(1) Calibration Preparation

1. Confirm that the sensor is securely installed, the wiring is correct, and the power supply is stable (24 VDC). Power on the sensor and allow it to stabilize for 15 minutes to ensure the internal circuitry is functioning properly and the display is stable; 2. Prepare the calibration reference equipment. Place the standard platinum resistance thermometer and the sensor probe in the same temperature-controlled environment (e.g., room temperature of 25°C, a mixture of 0°C ice and water; for high-temperature scenarios, an oil bath or salt bath may be used). Ensure both are in full contact with the medium under test and wait until the temperature stabilizes (fluctuation ≤ ±0.02°C/10 min); 3. Record the current temperature displayed by the sensor and the temperature displayed by the standard device. Calculate the initial error. Simultaneously, check the sensor's wiring configuration. For three-wire systems, ensure that the material, gauge, and length of all three leads are consistent to prevent lead resistance from affecting calibration accuracy.

(2) Manual Calibration (Operated via the sensor's built-in buttons; most commonly used)

1. Enter calibration mode: Press and hold the calibration button (usually the "SET" button) below the sensor display for 5–10 seconds until the "CAL" calibration indicator appears on the display, entering calibration mode. Some models require entering a calibration password (consult the supplier for the manufacturer's default password) to unlock calibration access.

2. Zero Calibration (Lower Range Limit Calibration): Place the sensor probe and the reference device in a zero-temperature environment (0°C ice-water mixture; ensure the ice and water are thoroughly mixed and free of impurities). Once the temperature has stabilized, press the "ZERO" calibration button. The display will flash "ZERO OK" to indicate completion of zero calibration. At this point, the temperature displayed by the sensor should match that of the reference device. If there is an error, use the "+" and "-" keys to fine-tune the reading until the displays match.

3. Span Calibration (Upper Limit Calibration): Based on the sensor's actual measurement range (e.g., -200°C to 400°C), adjust the temperature-controlled environment to the upper limit of the range (e.g., 400°C). Once the temperature has stabilized, press the "SPAN" span calibration button. The display will flash "SPAN OK," indicating that the span calibration is complete. If the sensor has a wide measurement range, mid-point calibrations (e.g., 100°C, 200°C) may be added. Repeat the above steps to ensure accuracy across the entire range meets specifications. During calibration, a resistance box can be used to simulate the resistance values corresponding to specific PT100 temperatures, such as 100 Ω at 0°C and 138.51 Ω at 100°C.

4. Save Calibration Parameters: After calibration is complete, press the "SET" button to confirm. The display will exit calibration mode, automatically save the calibration parameters, and lock them to prevent accidental operation from invalidating the calibration. If the calibration error exceeds the allowable range, troubleshoot the sensor for faults (such as probe damage or sensor drift), and recalibrate after resolving the issue.

(3) Host Computer Calibration (RS485 Communication Type, Suitable for Batch Calibration)

1. Connect the Device: Use an RS485 data cable to connect the sensor to the host computer (PC). Install the corresponding calibration software, set the software baud rate (matching the sensor, adjustable from 1200 to 115200 bps), and configure the Modbus-RTU protocol to ensure normal communication.

2. Calibration Procedure: Open the calibration software and read the sensor's current temperature data. Place the sensor probe and the standard device in a constant-temperature environment. Once the temperature has stabilized, enter the standard temperature value in the software and click the "Calibrate" button. The software will automatically adjust the sensor parameters to ensure the sensor's displayed temperature matches the standard temperature. You can set calibration points in batches (zero point, midpoint, upper limit) to complete full-range calibration. The software automatically records the calibration data for traceability.

3. Parameter Locking and Restart: After calibration is complete, lock the calibration parameters in the software, restart the sensor, and verify that the calibration has taken effect. Compare the sensor's displayed temperature, the standard device's temperature, and the temperature read by the host computer; the error between these three values must fall within the sensor's accuracy range to ensure calibration accuracy.

(4) Calibration Precautions

1. During calibration, ensure a stable, temperature-controlled environment to prevent temperature fluctuations from affecting calibration accuracy. When performing high-temperature calibration (above 300°C), take appropriate protective measures to prevent burns; the cooling rate must not exceed 1°C/min (above 500°C).

2. Calibration tools (standard platinum resistance thermometers, multimeters) must be sent to a metrology institution for calibration on a regular basis to ensure they meet accuracy standards. The recommended standard uncertainty for standard platinum resistance thermometers is ≤0.05°C.

3. After calibration, record the calibration data (calibration date, calibration points, error values, and calibrator) and file it in the operation and maintenance log. Affix a calibration compliance label once the calibration is approved.

4. If the sensor fails to meet accuracy requirements after multiple calibrations, the PT100 element or the sensor body must be replaced. Continued use is strictly prohibited to avoid compromising temperature measurement accuracy.

5. During the calibration process, it is strictly prohibited to arbitrarily alter other sensor parameters (such as output signal type or alarm thresholds) to prevent equipment malfunction.

Supplementary Notes: During routine maintenance, if the sensor exhibits display abnormalities, unstable output, or excessive accuracy deviations, prioritize troubleshooting using the calibration methods described above. If the issue persists after troubleshooting, inspect the wiring, grounding, sealing, or check for internal sensor faults; contact the manufacturer for professional repair if necessary. Sensors that have been out of service for an extended period must undergo comprehensive calibration before being reactivated to ensure performance meets standards prior to use.