PA-21 AC Voltage Transducer

I. Product Definition

The Qidian PA-21 Series AC Voltage Transmitter with a black housing is a three-terminal isolated electrical signal converter designed specifically for industrial automation applications. Its core function is to accurately convert AC voltage signals from industrial sites (e.g., 0–300 V AC) into standard DC analog signals (e.g., 4–20 mA DC) on a linear scale, while achieving electrical isolation across the input, output, and auxiliary power supply ports. This provides safe, reliable, and easily transmissible voltage monitoring data for systems such as PLCs, DCSs, and industrial control instruments.

Its core functions can be broken down into the following modules:

1. Signal Conversion and Standardization

Supports non-standard AC voltage signals from industrial sites (0–100 V/0–300 V/0–500 V AC, etc., including non-sinusoidal distorted waveforms) and converts them into industry-standard DC signals (4–20 mA/0–20 mA/0–5 V/0–10 V DC), meeting the signal acquisition requirements of the vast majority of automation control systems.

The conversion process maintains strict linear proportionality; the output signal is directly proportional to the RMS value of the input voltage, with an error controlled within 0.2% FS, meeting the requirements of high-precision measurement scenarios.

2. Three-Port Electrical Isolation Protection

Achieves complete electrical isolation between the input (high-voltage AC side), output (low-voltage signal side), and auxiliary power supply (power supply side), blocking common-mode interference, ground loop currents, and high-voltage surges from entering the control loop. This protects downstream equipment and enhances signal transmission stability.

The isolation withstand voltage exceeds 2.5 kV AC, making it suitable for high-risk industrial environments with strong electromagnetic interference, such as power generation, chemical processing, and metallurgy.

3. Signal Conditioning and Anti-Interference Optimization

Built-in RC filtering and true RMS conversion circuits effectively filter out high-frequency noise and spike interference from the field, enabling precise measurement of AC voltage signals containing harmonics and distortion, and preventing measurement errors caused by waveform distortion.

When using current loop output (4–20 mA), signals can be transmitted over long distances (hundreds of meters). This method offers significantly better attenuation and interference resistance than voltage signals, making it ideal for signal acquisition in distributed industrial environments.

4. Standardized Compatibility and Plug-and-Play

Features an industrial-standard 35mm DIN rail mounting design. The black housing meets protection ratings suitable for indoor and cabinet-mounted industrial environments, supports base screw mounting, and is compatible with the layout of most automation control cabinets.

Features a zero-calibration design; linear calibration and accuracy verification are completed before shipment. It can be installed and used immediately without on-site debugging, lowering the operational and maintenance threshold.

II. Working Principle

The operational workflow of the PA-21 series transmitters can be broken down into a four-step closed-loop process: “Signal Input → Conditioning and Conversion → Isolation Processing → Standard Output.” A simplified explanation is as follows:

Step 1: Signal Input and Step-Down Conditioning

When high-voltage AC signals from industrial environments (e.g., 0–300 V AC) enter the transmitter, they first pass through a built-in precision voltage divider network or miniature voltage transformer. This step-down circuit proportionally reduces the high voltage to a safe low-voltage AC signal (e.g., 0–5 V AC). Simultaneously, an RC filter circuit removes high-frequency noise and spike interference from the field, yielding a clean raw voltage signal.

Step 2: RMS Conversion and Linear Processing

The conditioned AC signal enters a dedicated root mean square (RMS) conversion circuit, which converts the effective value of the AC signal (rather than the peak or average value) into a stable DC voltage signal. This signal is then scaled proportionally through a linear calibration circuit to ensure a strict linear relationship between the converted signal and the input voltage, thereby eliminating nonlinear errors.

Step 3: Three-Point Electrical Isolation

The processed signal is isolated at three points via an optocoupler or magnetic isolation module:

The input side (high voltage) is isolated from the processing circuit to prevent high-voltage intrusion;

The processing circuit is isolated from the output side (low voltage) to prevent interference coupling;

The auxiliary power supply is isolated from the input and output sides to eliminate ground loop interference.

This step is the core component of the transmitter’s interference resistance and safety assurance, effectively establishing an “electrical firewall” for signal transmission.

Step 4: Standard Signal Output

The isolated signal passes through a V/I (voltage-to-current) or V/V (voltage-to-voltage) conversion circuit, converting it into a user-specified standard DC signal (such as 4–20 mA DC). This signal is then output to downstream PLCs, DCS systems, or industrial control instruments, completing the full conversion from an “industrial high-voltage AC signal” to a “standard signal recognizable by the control end.”

III. Core Value and Solutions to Pain Points

3.1 Overview of Core Value

The core value of the PA-21 series transmitters lies in addressing the four major pain points—“inaccuracy, instability, insecurity, and incompatibility”—in the measurement and transmission of industrial voltage signals. They provide automation systems with “high-precision, highly reliable, secure, and easily adaptable” voltage monitoring data, thereby reducing the risk of system failures and lowering operational and maintenance costs.

3.2 Pain Points and Solutions

1. AC voltage in industrial environments contains harmonics and distortion; standard instruments suffer from significant measurement errors and cannot provide precise monitoring.

Solution: Built-in true RMS conversion circuitry supports non-sinusoidal waveform measurement with an accuracy of 0.2% FS, accurately reproducing the true RMS value of the voltage and eliminating measurement errors caused by waveform distortion.

2 Lack of isolation between the high-voltage side and low-voltage control circuits; high-voltage surges and ground loop currents can easily damage PLCs/instruments, posing safety hazards

Solution: Three-point electrical isolation (input/output/power supply) with a withstand voltage of ≥2.5 kV AC, blocking high-voltage intrusion and common-mode interference to protect downstream equipment and comply with industrial safety standards.

3 Strong electromagnetic interference in industrial environments causes signal distortion and attenuation during transmission, leading to control malfunctions.

Solution: Supports 4–20 mA current loop output with strong anti-interference capabilities and no signal attenuation over long distances; built-in filtering circuits eliminate on-site spikes and high-frequency interference to ensure stable and reliable signals.

4 Signal standards vary across different brands of PLCs and instruments, requiring custom adapters during field retrofits, which are costly and time-consuming.

Solution: Supports multiple standard output signals (4–20 mA, 0–10 V, etc.), compatible with the vast majority of automation systems; features standard DIN-rail mounting, eliminating the need for custom modifications and enabling plug-and-play installation.

5 Traditional transmitters require periodic on-site calibration, resulting in high maintenance costs; improper calibration can easily affect measurement accuracy.

Solution: Linear calibration and accuracy verification are completed before shipment. The use of imported components and an integrated design eliminates the need for periodic calibration, reducing on-site maintenance workload and the risk of errors.

6 In distributed industrial environments, voltage signals are prone to interference and attenuation over long transmission distances, making long-distance data acquisition difficult.

Solution: The 4-20mA current signal supports transmission over hundreds of meters without voltage attenuation, making it ideal for remote voltage monitoring in distributed factories, substations, and similar scenarios.

Additional Notes: Suitable Applications and Additional Benefits
The PA-21 series transmitters are widely applicable for voltage monitoring in industries such as power generation, chemicals, metallurgy, new energy, and municipal utilities. Additional benefits include:
Wide-range auxiliary power supply compatibility (AC 220V/DC 24V, etc., depending on the model), suitable for various industrial power supply environments;
Black industrial-grade housing that is impact-resistant, dustproof, and moisture-resistant, suitable for industrial environments inside control cabinets;
Maintenance-free design, long service life, and reduced total cost of ownership.

IV: Key Parameters & Specifications
4.1 Basic Electrical Parameters
Product Model: PA-21 Series Single-Phase AC Voltage Transmitter
Input Signal Range Standard Ranges: AC 0–100 V / 0–300 V / 0–500 V (Customizable up to 0–600 V)
Input Load: ≤0.1VA (Voltage Signal Input Side)
Output Signal Type Standard DC Signal, Optional:
· Current Type: DC 4-20mA / 0-20mA
· Voltage Type: DC 0–5 V / 0–10 V
Output Load Capacity: Current Type: ≤500 Ω (4–20 mA)
Voltage Type: ≥10 kΩ (0–10 V)
Accuracy Class: 0.2% FS (typical), optional 0.5% FS
Linearity Error: ≤±0.1% FS
Repeatability Error: ≤±0.05% FS
Response Time: ≤400 ms (step input)
Frequency Range: 45–65 Hz (compatible with 50/60 Hz power frequency)
Overload Capacity: 2 times rated value (continuous operation), 10 times rated value (10-second short-term surge)

4.2 Isolation Performance Parameters
Isolation Method: Three-terminal full isolation (input / output / auxiliary power supply are mutually independent), utilizing dual isolation technology combining magnetic isolation and optocoupling
Isolation Withstand Voltage: ≥2500 V AC (between input and output, 1 min, leakage current ≤ 1 mA)
≥2000 V AC (between input and power supply, 1 min)
≥1500 V AC (between output and power supply, 1 min)
Insulation resistance: ≥100 MΩ (tested at 500 V DC)
Common-Mode Rejection Ratio (CMRR):≥100 dB (50 Hz power-line interference)
Differential Mode Rejection Ratio (DMRR):≥60 dB (high-frequency noise interference)

4.3 Power Supply & Power Consumption Parameters
Auxiliary Power Supply Voltage Standard Options:
• AC 220 V ±10% (50 Hz)
• DC 24 V ±10%
· Customizable DC 12V/AC 110V
Power Consumption: ≤2VA (at full load)
Power Supply Ripple Rejection: ≥50dB
Power Distribution Output: No built-in power distribution output (signal conversion only)

4.4 Environmental Specifications
Operating Temperature Range: -10°C to +60°C (Industrial Grade)
Storage Temperature Range: -40°C to +85°C
Operating Humidity Range: 10% to 90% RH (non-condensing)
Protection Rating: IP20 (IEC 60529 Standard)
Explosion-Proof Rating: Non-explosion-proof (Standard Industrial Grade)
Electromagnetic Compatibility (EMC): Compliant with GB/T 17626 standard:
□Electrostatic Discharge Immunity: Level 3
□Electrical Fast Transient Burst Immunity: Level 3
□Surge (Transient) Immunity: Level 3 Suitable for industrial environments with strong electromagnetic interference

4.5. Physical Specifications
Mounting Method: Standard DIN 35mm rail mounting + base screw fixation
Dimensions (L × W × H): 75mm × 55mm × 120mm (including terminals)
Housing Material: Flame-retardant ABS engineering plastic (black, industrial grade)
Weight: Approx. 250g Lightweight design,
Terminal Specifications: Screw-type terminals, compatible with wire gauges 0.5–2.5 mm²
Indicator Light Definitions · PWR (Power Indicator): Green, steady light indicates normal power supply
· ALM (Alarm Indicator): Red, steady light / flashing indicates signal abnormality / overvoltage
Enclosure Protection Details: Flip-top dust cover on the terminal side reduces dust and oil contamination in the terminal area; Snap-fit housing design provides anti-loosening and shock resistance, enhancing long-term operational stability

Additional Notes: Specification Compatibility and Selection Guidelines
The above parameters are based on the standard models of the Anhui Qidian PA-21 series. Special measurement ranges (e.g., AC 0–600 V), special outputs (e.g., RS485 Modbus), and custom accuracy (0.1% FS) must be confirmed in advance during the selection process.
For use in explosion-proof environments, a Zener safety barrier compliant with the GB3836 standard must be installed to achieve an intrinsically safe circuit design.
When mounting on a DIN rail, ensure adequate ventilation inside the cabinet and avoid prolonged operation in high-temperature or enclosed environments, as this may affect the device's service life.

V. Application-Specific Selection Guide
5.1 Key Selection Criteria
The PA-21 series is designed exclusively for single-channel AC voltage measurement. It features a black housing and a standard three-terminal isolated structure. To ensure you select the correct model on the first try, prioritize the following five factors during selection:
1. Input Signal Type
Applicable only to: Power-frequency AC voltage AC
Common Ranges: AC 0–100 V / 0–300 V / 0–500 V
Not Applicable: DC voltage, current, frequency, power, or non-power-frequency high-frequency signals
2. Output Signal Type
Current Output: 4–20 mA (Recommended; suitable for long distances and high interference resistance)
Voltage Output: 0–5 V / 0–10 V (Suitable for short distances and connection to nearby instruments)
Special: RS485 communication requires customization; the standard PA-21 does not have a communication port
3. Channel Configuration
Standard model: 1 input, 1 output (1 AC voltage input → 1 analog output)
Optional: 1 input, 2 outputs (1 voltage input, 2 independent isolated outputs, connected to PLC and meter respectively)
No integrated multi-channel (2-channel/3-channel voltage) models available; multiple units must be installed side-by-side for multi-channel applications
4. Power Supply
Industrial Standard: 24 VDC
Common in Electrical Rooms: 220 VAC
Does not support wide-range voltages such as 110 VAC or 12 VDC; non-standard configurations require advance customization
5. Isolation and Safety Requirements
Standard: Three-terminal full isolation (input / output / power supply)
Explosion-proof environments: The PA-21 unit itself is not explosion-proof; it must be used with a safety barrier
High-interference environments: A three-terminal isolated model must be selected; standard non-isolated transmitters cannot be used
6. Installation Environment
Standard: Indoor control cabinet installation
Environment: Dust-proof, condensation-proof, and free from strong corrosion
Outdoor / Waterproof: A sealed enclosure must be installed; the product itself has an IP20 rating and is not waterproof

5.2. Industry Application Selection Table
1. Power Distribution: Power distribution cabinets, low-voltage busbars, UPS voltage monitoring
Reason: Power frequency standards, resistance to grid harmonics,

three-terminal isolation protection for PLC/DCS
2. Chemical Manufacturing: Workshop power distribution, power supply monitoring for pumps and fans
Reason: High interference resistance, suitable for long-distance cabling, safe for cabinet installation
3. Metallurgy / Mining High-power equipment, environments with strong electromagnetic interference
Reason: Enhanced three-terminal isolation High common-mode rejection, ground loop prevention, surge protection
4. Pharmaceutical / Food Cleanrooms, voltage monitoring for automated production lines
Reason: Stable accuracy, spark-free design, suitable for clean power distribution
5. Smart Manufacturing / Equipment: Main control cabinets, machine tool power monitoring
Reason: DIN rail mounting, compact size, no commissioning required
6. New Energy / Photovoltaic: AC-side voltage, grid-connection monitoring
Reason: Dual-output supports simultaneous backend data upload + local display
7. Buildings / Municipal Distribution panels, lighting circuit monitoring
Reasons: Low-cost, stable design; suitable for large-scale deployment
Uniform design: All feature a black flame-retardant housing and 35mm rail mounting

5.3 Common Selection Pitfalls
1. Pitfall: Ignoring isolation levels and arbitrarily selecting standard non-isolated models
Consequences: Ground-loop interference, signal fluctuations, and high-voltage intrusion causing damage to PLC modules
Correct Approach:
Industrial control systems must use three-terminal isolation (input/output/power supply). The PA-21 series features standard three-terminal isolation; do not substitute with lower-grade alternatives.
2. Misconception: Selecting the wrong voltage range (too narrow or too wide)
Range too narrow: Voltage fluctuations exceed the range, damaging the transmitter
Range too wide: Accuracy deteriorates in the low-voltage range, leading to inaccurate monitoring
Correct Approach:
Standard AC220 system → Select AC0-300V
High-voltage AC380 systems → Select AC0-500V
Low-voltage control circuits → Select AC0-100V
3. Misconception: Ignoring output load matching, resulting in insufficient drive capability
4-20mA output requires a load resistance ≤500Ω
Excessively long cables or too many devices in series → Load exceeds limit → Low output or no signal
Correct Approach:
Prioritize 4-20mA for long distances; keep total wiring resistance within 300Ω; allow for a margin of safety when uncertain.
4. Misconception: Using the general-purpose PA-21 directly in explosion-proof environments
The PA-21 is a general-purpose industrial model; it is neither explosion-proof nor intrinsically safe.
Direct use in hazardous areas violates safety regulations and poses safety risks.
Correct Approach:
Hazardous area → Safety barrier isolation + intrinsically safe wiring + PA-21 installed in a control cabinet in the safe area
5. Misconception: Using an AC voltage transmitter in DC applications
The PA-21 measures AC voltage only and cannot measure DC voltage
To measure DC voltage, select the Qidian DC voltage transmitter series

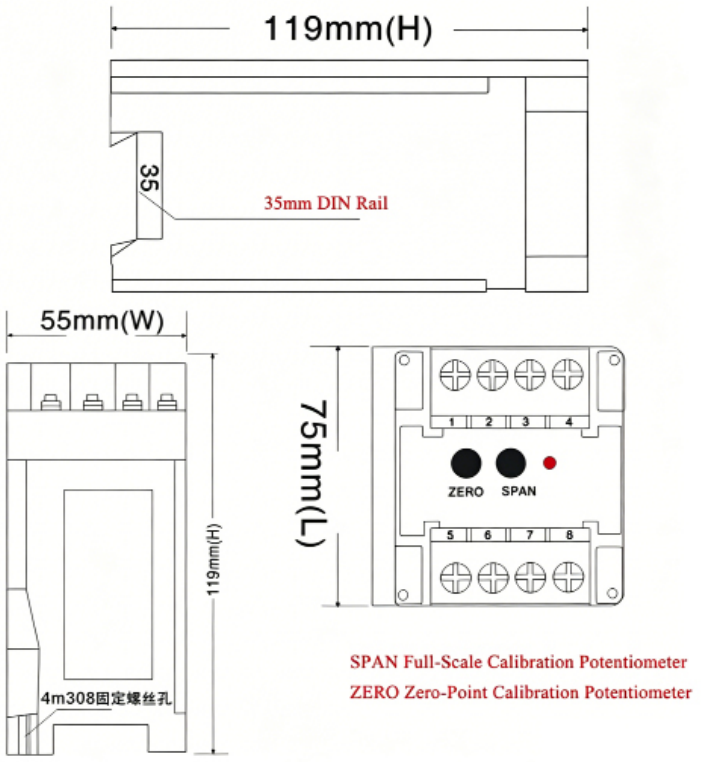
5.4 Customization Recommendations (Solutions for Non-Standard Operating Conditions)
1. Customized Special Signals
Non-standard AC ranges: AC 0–80 V, 0–150 V, 0–600 V, etc.
Special outputs: 0–20 mA, 1–5 V, 2–10 V, etc.
Faster response: ≤200 ms fast-response model (standard is ≤400 ms)
2. Customization for Non-Standard Operating Conditions
Wide-Temperature Version: -40°C to +85°C (for outdoor enclosures and extremely cold regions)
Enhanced surge protection: Suitable for areas prone to lightning strikes and applications involving the start-up and shutdown of large motors
High isolation voltage: 3 kV AC reinforced isolation (for special power projects)
3. Multi-channel integration solutions
The PA-21 is a single-channel unit; for multi-channel requirements, we recommend:
2 channels → Install 2 PA-21 units side-by-side on a DIN rail
3 or more channels → Combine multiple units, powered by a single 24V DC supply
For integrated multi-channel enclosures, contact Qidian for custom integrated chassis
4. Custom System Integration
1-input, 2-output configuration: One voltage input, two independent isolated outputs
Safety barrier selection list: Complete intrinsically safe circuit configuration solutions available
Customization of complete sets of labels, terminal definitions, and wiring diagrams to facilitate direct on-site installation

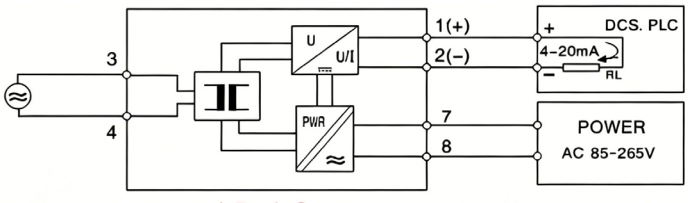
VI: Installation and Commissioning Guidelines
6.1. Pre-installation Preparation
1. Verification of Accessories and Documentation
Verify the product: PA-21 Series black-cased three-terminal isolated AC voltage transmitter; ensure the model, range, input/output, and power supply match the order.
Accessories: Transmitter unit, standard 35mm DIN rail mounting clip (pre-installed)
Documentation: Product label specifications, wiring definitions, certificate of conformity
Cabling Recommendations:
Route power, input, and output cables separately; prioritize shielded twisted-pair cables for analog outputs
2. Environmental Inspection
Installation Location: A safe area inside a control cabinet, free from direct sunlight, condensation, and corrosive gases
Ambient Temperature: -10°C to +60°C, Humidity 10% to 90% RH (non-condensing)
Keep away from strong interference sources: inverter outputs, high-current power cables, contactors, and high-voltage busbars
3. Tool List
Phillips screwdriver, wire strippers, multimeter (voltage/current range)
Terminal blocks (optional), cable ties, DIN rail mounting clips
Calibration source (standard AC voltage source, milliamp meter) for high-precision debugging
4. Safety Precautions
Never connect or disconnect wires while the unit is powered on.
The high-voltage AC input must be disconnected before operation to prevent electric shock.
Verify that the supply voltage matches the label on the transmitter. Never connect AC 220V to the DC 24V terminals.

6.2 Standard Installation Steps
1. DIN Rail Mounting
Align the mounting clips on the back of the PA-21 with a standard 35mm DIN rail and press down to secure.
When installing multiple units side-by-side, leave a 10–15 mm gap between them to facilitate heat dissipation.
Both vertical and horizontal installation are acceptable; vertical installation is recommended for easier wiring and viewing of indicator lights.
2. Terminal Function Identification (General Definitions)
Typical terminal layout for the PA-21 series (subject to actual silkscreen markings):
Power terminals: DC24V+/DC24V- or AC220V
Input Terminal: AC-IN (AC voltage input)
Output Terminal: OUT+/OUT- (Standard analog output)
3. Wiring Specifications
Power Cables
DC24V Power Supply: Connect the positive terminal to + and the negative terminal to -. Reverse connection is strictly prohibited
AC220V Power Supply: No polarity distinction; connect directly
AC Voltage Input Wires
Connect directly to the AC voltage circuit under test; no polarity

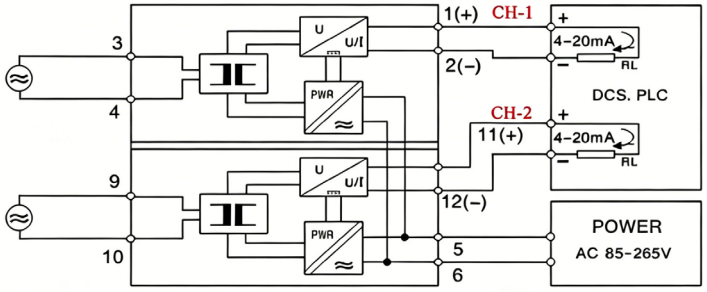
distinction; connect directly
AC Voltage Input Cable
Connect directly to the AC voltage circuit under test; polarity is not critical.
Never connect voltages exceeding the measurement range.
Output Signal Cable
Current Output (4–20 mA): Connect in series with the PLC or instrument's analog input circuit.
Voltage Output (0–5 V/0–10 V): Connect in parallel with the data acquisition device.
Shielding Cable Handling
Ground the shield at a single point (grounding at the control cabinet side is recommended).
Do not ground both ends simultaneously to avoid ground loop interference
4. Grounding Requirements
The transmitter housing does not require separate grounding; grounding via the cabinet is sufficient
The shielded cable, cabinet, and control system should be grounded at a common point, with grounding resistance ≤4Ω





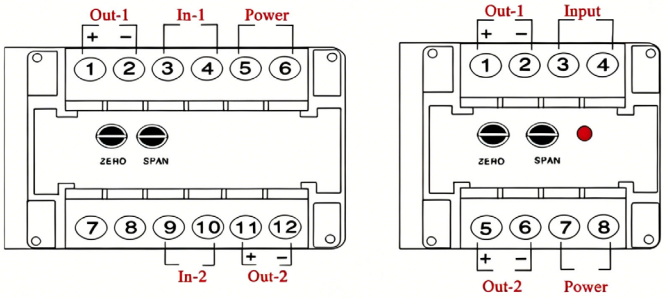


1 In 1 Out



2 In 2 Out

New Wiring



2 In 2 Out
1 In 1 Out
1 In 2 Out

1. Proper Wiring of Shielded Cables
Shield: Ground only at the control cabinet grounding busbar end
Leave the sensor/field side floating; wrap it with insulating tape to prevent contact with the enclosure
2. Specific Instructions for Three-Terminal Isolated Type
Input, output, and power supply are completely electrically isolated from one another
Differences in potential between input ground, output ground, and power supply ground are permitted; common grounding is not required
3. Correct vs. Incorrect Wiring Comparison
Correct:
Separate wiring for high-voltage and low-voltage circuits
Use shielded cables for analog signals
Single-point grounding
Incorrect:
Running power lines and signal lines in the same conduit
Grounding the shielded cable at both ends
Reversing the polarity of the power supply
Bundling output wires with high-voltage lines

6.4 Power-On Commissioning Procedure
1. No-Load Power-On Test
After completing the wiring, do not connect the input signal yet.
Apply power.
Observe the indicator lights:
PWR: Green, steady on: Power supply is normal.
Off: Check the power supply wiring and voltage to ensure they are correct.
Measure the output:
4–20 mA output: Should display approximately 4 mA.
0–10 V output: Should display approximately 0 V.
2. Signal Loading Calibration
Apply standard AC voltage (e.g., AC100V, AC200V, AC300V)
Record the corresponding output values; they should exhibit a linear relationship
Permissible error: ≤±0.2% FS
3. Indicator Status Interpretation
PWR (Green) Steady: Power supply normal

PWR flashing / off: Power supply failure, abnormal voltage, wiring error
No ALM alarm light: Abnormalities are indicated by output exceeding limits
4. Calibration Method
The PA-21 series is factory-calibrated; no on-site zero or full-scale adjustment is required.
If significant deviation occurs, check the following first:
Are the connections loose?
Is the power supply stable?
Is the input voltage within the range?
Is the load resistance out of range (4-20mA load ≤ 500Ω)?
Non-professionals are prohibited from opening the housing to adjust internal potentiometers

6.5 Installation Prohibitions (Mandatory Requirements)
Overvoltage supply is strictly prohibited.
DC24V models must not be connected to AC220V, as this will immediately burn out the module.
Input voltages exceeding the rated range are strictly prohibited.
Models rated for AC 0–300V must not be connected to high voltages of AC 380V or higher.
Avoid high-voltage interference.
Do not run wiring in parallel with inverter input lines or high-current power cables over long distances.
Direct installation in damp, condensing, or explosion-hazardous areas is strictly prohibited.
In damp environments, a dehumidifying heater or sealed enclosure must be used.
In explosion-hazardous areas, the module must be installed in a safe area and used in conjunction with a safety barrier.
Plugging or unplugging terminals while the unit is powered on is strictly prohibited.
This may cause voltage surges and damage the internal isolation circuitry.
Overloading the output is prohibited.
For 4-20mA outputs, short-circuiting is strictly prohibited, and the load must not exceed 500Ω.

7: Recommendations for Daily Use & Maintenance (Revised Version)
7.1 Key Points for Daily Inspections (High-Frequency / Mandatory Items)
1. Indicator Light Status Inspection
During daily inspections, a quick check of the transmitter panel indicator lights is sufficient for basic troubleshooting:
PWR Power Light: Should remain solid green during normal operation. If it is off or flashing, it indicates an issue with the power supply; investigate potential power outages, loose connections, or voltage fluctuations.
ALM Alarm Indicator (if configured): Should be off during normal operation. If it remains on or flashes, it indicates a signal fault—possibly out-of-range, open-circuit input, or short-circuit output—requiring immediate attention.
For standard scenarios, daily inspections are recommended; for typical control cabinet scenarios, this can be adjusted to once a week.
2. Signal Stability Monitoring
Use the backend system, on-site instruments, or a handheld multimeter to sample the output signal and assess the device's operational status:
4–20 mA current output: The signal must remain stable within the range corresponding to the input voltage, with no sudden jumps or gradual drift.
0–5 V/0–10 V voltage output: Signal fluctuations must be controlled within ≤±0.1% FS, with no significant variations.
If the signal exhibits sudden fluctuations >0.5% FS or persistent drift, immediately investigate wiring, environmental interference, or hardware malfunctions.
3. Temperature and Humidity Monitoring
Regularly verify that the temperature and humidity of the transmitter's installation environment remain within the permissible range:
The operating temperature must be maintained between -10°C and +60°C, avoiding extreme conditions such as high-temperature exposure or freezing.
Operating humidity must be maintained between 10% and 90% RH with no condensation; prevent condensation and moisture buildup inside the cabinet.
If the temperature or humidity inside the cabinet exceeds the specified limits, promptly activate the dehumidifier or heater, or improve ventilation and heat dissipation within the cabinet.

7.2. Regular Maintenance Schedule (Cyclical Maintenance)
1. Quarterly Maintenance (Basic Maintenance)
Quarterly maintenance focuses primarily on basic cleaning and functional verification. These simple procedures effectively prevent most common malfunctions:
Equipment Cleaning: Use a dry, lint-free cloth to wipe down the transmitter housing and terminal areas, removing surface dust, grease, and debris. Ensure the housing is free of dust accumulation and terminals are unobstructed by foreign objects to prevent dust and grease from affecting heat dissipation or connection reliability.
Tightening Connections: Use a Phillips-head screwdriver to evenly tighten all terminal screws, including input, output, and power terminals, to ensure connections are secure and free of loose or faulty contacts. Also, inspect the terminals for oxidation or discoloration; if present, address the issue promptly or replace the wiring.
Indicator Light Function Verification: Briefly disconnect power and then restart the transmitter. Observe whether the PWR power indicator light illuminates normally upon power-up. Apply a simulated input signal to confirm that the ALM alarm light (if configured) responds correctly, ensuring timely feedback in the event of a device malfunction.
2. Annual Maintenance (Thorough Maintenance)
Annual maintenance involves a thorough inspection. It requires the use of specialized tools to comprehensively verify the device's accuracy and insulation performance, ensuring long-term stable operation:
Accuracy Retest: Use a standard AC voltage source to input signals at 0%, 50%, and 100% of the full scale range. Simultaneously, measure the transmitter's output values with a high-precision multimeter to determine if the error is within ±0.2% FS. If the error exceeds the standard, contact a professional for calibration.
Internal Insulation Inspection: Use an insulation resistance tester to measure the insulation resistance between the input, output, and power terminals under 500V DC test conditions. The standard requires a value of ≥100 MΩ. If the insulation resistance has decreased, investigate whether the equipment has been exposed to moisture or if internal components are damaged.
Heat Dissipation and Installation Status Inspection: Confirm that the transmitter is securely mounted on the 35mm DIN rail with no loosening or deformation; simultaneously clear any obstructions around the transmitter to ensure unobstructed heat dissipation pathways and prevent overheating due to poor heat dissipation.
Shield Integrity Check: Inspect the shielding of the analog output shielded twisted-pair cable for damage or peeling, and confirm that the single-point grounding on the control cabinet side is secure and reliable to prevent signal interference caused by shield failure.
3. Maintenance for Special Operating Conditions
For special operating conditions such as high interference or high humidity, maintenance intervals should be appropriately shortened:
In high-interference environments such as metallurgy and chemical plants, it is recommended to retest the equipment's anti-interference performance every 6 months and check whether the shielded cable grounding has failed.
In humid environments such as basements or outdoor cabinets, it is recommended to check the operational status of the cabinet's dehumidifiers and heaters every 3 months and clean up any traces of condensation inside the cabinet to prevent equipment damage caused by moisture.

7.3 Long-Term Maintenance Tips (Long-Term Operation and Maintenance)
1. Dust and Moisture Prevention Tips
Cabinet Environment Optimization: Install transmitters in sealed, dust-proof control cabinets equipped with desiccants and temperature/humidity controllers to prevent direct contact between moisture and dust and the equipment. Additionally, avoid installing them in areas exposed to direct moisture or oil drips, such as near cooling towers or pumps.
Terminal Protection: Seal unused terminals with insulating tape to reduce the ingress of dust and moisture; periodically apply a small amount of insulating protective agent to the terminals to prevent oxidation from affecting electrical conductivity.
2. Techniques for Optimizing Interference Resistance
Optimizing Wiring Standards: Route input and output signal cables separately from power cables (such as those for variable frequency drives and high-voltage cables), maintaining a minimum distance of ≥20 cm

between them to avoid electromagnetic interference; analog signals must use shielded twisted-pair cables, and sharing cable conduits with power lines is strictly prohibited.
Grounding Optimization: Strictly adhere to single-ended grounding standards for shielded cables; ground them only on the control cabinet side to avoid ground loop interference caused by double-ended grounding. The transmitter enclosure and the control system must share a common grounding point with a grounding resistance of ≤4Ω to enhance overall interference resistance.
3. Protection Against Extreme Environments
Protection Against High Temperatures: When the internal cabinet temperature remains above 50°C for extended periods, additional cooling fans should be installed inside the cabinet, or high-temperature-resistant custom transmitters should be selected to prevent component aging caused by prolonged operation at high temperatures.
Protection Against Low Temperatures: When the internal cabinet temperature remains below -10°C for extended periods, an internal heater must be installed to ensure the equipment temperature is at least 0°C before power-up, thereby preventing internal components from cracking or failing due to freezing.
Outdoor Cabinet Protection: For outdoor installations, use control cabinets with an IP54 or higher protection rating to prevent rainwater ingress. During winter, outdoor cabinets must be equipped with additional insulation to prevent equipment shutdown due to low temperatures.
4. Tips for Extending Equipment Lifespan
Avoid Overloading: Never exceed the rated input voltage. For example, models rated for 0–300 V AC must never be connected to 380 V AC or higher voltages to prevent damage to internal circuits due to overvoltage.
Follow Proper Power On/Off Procedures: When powering down, disconnect the input signal first, then cut off the power supply; when powering up, connect the power supply first, then apply the input signal to avoid damage from voltage surges.
Do Not Disassemble Without Authorization: Non-professionals must not disassemble the transmitter housing. Do not adjust the ZERO/SPAN potentiometers without authorization. If calibration is required, contact the manufacturer or a professional to perform the operation using specialized tools.

VIII: Troubleshooting & Emergency Response Manual

8.1 List of Common Faults (Quick Reference)
The following are the five most common fault symptoms encountered with the PA-21 series in industrial settings; use this list for direct troubleshooting:
No Output Signal: After powering on the transmitter, the PLC or instrument receives no output current or voltage signal; the reading remains at 0 or full scale.
Signal Drift / Inaccuracy: The output signal is stable but consistently deviates from the theoretical value, or drifts slowly over time, with an error exceeding 0.2% FS.
Indicator Light Abnormalities: The power indicator does not light up or flashes, or the alarm indicator remains lit or flashes for no apparent reason.
Alarm Triggered (if equipped with alarm function): The equipment alarm indicator lights up, or the system prompts that the signal is out of range or a fault has occurred.
Interference and distortion: The signal exhibits sudden jumps and significant fluctuations, is noticeably affected by motor start/stop cycles and inverter operation, and cannot be reliably acquired.

8.2. Causes of Malfunctions and Troubleshooting (Symptoms – Causes – Solutions)
1. Symptom: No output signal
Possible Cause 1: Power supply abnormality
Troubleshooting: Use a multimeter to measure the voltage at the power supply terminals to verify that it matches the transmitter's rated power supply (DC 24 V/AC 220 V). Check for low or high voltage, reversed polarity, or a tripped circuit breaker.
Resolution: Replace with a compatible power supply, correct wiring polarity, and restore power; if power supply failures occur frequently, check the stability of the power circuit.
Possible Cause 2: Wiring Error / Loose Connection
Troubleshooting: Check whether the input, output, and power supply terminals are loose, miswired, or broken; verify if the 4-20mA loop is open or shorted.
Action: After powering down, retighten the terminals and correct the wiring according to the terminal definition diagram; replace damaged cables and repair short circuits or open circuits.
Possible Cause 3: Output Load Exceeds Limit
Troubleshooting: Check whether the load resistance of the 4–20 mA loop exceeds 500 Ω; excessive load may be caused by overly long cables or too many devices in series.
Action: Reduce the loop load, shorten the cable length, or replace the data acquisition device with a lower-impedance model.
Possible Cause 4: Hardware Damage
Troubleshooting: Check if the power supply is normal and the wiring is correct, yet there is still no output, and the indicator light is off or behaves abnormally.
Action: Replace with a spare transmitter; return the damaged unit to the factory for repair.
2. Fault Symptom: Signal Drift / Inaccurate Measurement
Possible Cause 1: Input Out of Range or Abnormal Signal
Troubleshooting: Check whether the input AC voltage exceeds the transmitter's rated range, or if there is severe distortion or harmonic interference.
Solution: Verify range compatibility; replace with a higher-range transmitter if necessary. Check if the on-site load is normal and eliminate sources of voltage distortion.
Possible Cause 2: Oxidation of Terminal Blocks / Poor Contact
Troubleshooting: Check if the terminals are oxidized or corroded, causing increased contact resistance and affecting signal transmission.
Action: After powering down, clean the terminal contact surfaces and retighten the connections; replace terminals or cables if necessary.
Possible Cause 3: Improper Load Matching
Troubleshooting: The input impedance at the output of a voltage-output transmitter is too low, or the load on a current-output transmitter is too high, causing signal attenuation.
Action: Replace the data acquisition device with one that has a matching impedance; adjust the loop load.
Possible Cause 4: Excessive On-Site Temperature and Humidity
Troubleshooting: Excessively high or low cabinet temperature, or excessive humidity, causing increased temperature drift in device components.
Solution: Improve cabinet ventilation and heat dissipation; install dehumidification or heating devices to restore the equipment to its rated operating environment.
Possible Cause 5: Equipment Requires Calibration
Troubleshooting: After prolonged use, the device's zero point or full-scale range has drifted, and the factory calibration has expired.
Action: Recalibrate the ZERO/SPAN potentiometers using a standard signal source (to be performed by qualified personnel), or return the device to the factory for calibration.
3. Fault Symptom: Abnormal Indicator Lights
Power indicator light is off
Cause: Power supply circuit failure, loose terminal connections, or damage to the device's power supply module.
Action: Troubleshoot according to the "No Output Signal" section regarding power supply; if the power supply is normal, determine that the device is damaged and replace it.
Power indicator flashes
Cause: Excessive power supply voltage fluctuations, power supply ripple exceeding limits, or poor power supply contact.
Action: Replace with a stable power supply, inspect the power supply circuit, and eliminate the source of voltage fluctuations.
Alarm indicator remains lit / flashes (if equipped)
Cause: Input out of range, output short circuit / open circuit, or internal device failure.
Action: Check if the input voltage is out of range; check the output circuit for short circuits or open circuits; if the alarm persists after eliminating external issues, determine that the device is faulty.
4. Fault Symptom: Alarm Triggered (if equipped with alarm function)
Possible Cause 1: Input Signal Out of Range
Troubleshooting: The measured voltage exceeds the alarm threshold set on the transmitter or exceeds the device's rated range.
Action: Verify if the on-site voltage is normal; adjust the alarm threshold or replace the device with one of a larger range if necessary.
Possible Cause 2: Output Circuit Failure
Troubleshooting: A break or short circuit in the output signal causes the

device to detect an output anomaly and trigger an alarm.
Action: Replace with a spare unit and return the faulty unit to the factory for repair.
5. Symptom: Signal interference and distortion (jitter, significant fluctuations)
Possible Cause 1: Improper cabling
Troubleshooting: Signal cables are routed in the same conduit or run parallel at close proximity to power cables or inverter output cables, without being separated.
Action: Route signal cables separately from power cables, maintaining a minimum distance of 20 cm to prevent cross-interference.
Possible Cause 2: Incorrect Shield Grounding
Troubleshooting: Shield grounded at both ends, not grounded, or poorly grounded, resulting in ground loop interference.
Action: Strictly implement single-end shield grounding (on the control cabinet side) and resolve any grounding issues.
Possible Cause 3: Strong Electromagnetic Interference at the Site
Troubleshooting: The device is installed near strong interference sources such as inverters, contactors, or high-voltage busbars.
Solution: Adjust the installation location to move away from interference sources; if necessary, install a metal shielding enclosure or replace the transmitter with a model designed for enhanced interference resistance.
Possible Cause 4: Power Supply Ripple Interference
Troubleshooting: Excessive ripple in the power supply affects the device's operational stability.
Solution: Replace the power supply with a low-ripple model, or install a filter module in the power circuit.