PHEC 1.0 Transmitter & Sensor 5-in-1 with Display RS485 4-20mA

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1.Overview & 5-in-1 Measurement Architecture

The PHEC / BGT WMPS-01 is an industrial DIN-rail multi-parameter water quality transmitter equipped with an integrated backlit LCD display, isolated RS485 Modbus-RTU digital interface, and dual 4–20mA analog current loop outputs. Using two external probe assemblies, the system continuously outputs five water quality parameters:

1. **pH (Physical Sensor):** Measured directly via the coaxial BNC high-temperature POM glass bulb combination electrode (0.00 to 14.00 pH).
2. **Electrical Conductivity / EC (Physical Sensor):** Measured directly via the 4-wire two-pole conductivity electrode (terminals C+ and C-).
3. **Temperature (Physical Sensor):** Measured directly via an integrated NTC thermistor embedded inside the EC probe (terminals T+ and T-), providing live temperature readings and Automatic Temperature Compensation (ATC).
4. **Total Dissolved Solids / TDS (Derived Parameter):** Calculated in real time by the internal microcontroller from the temperature-compensated EC reading (conversion ratio: 0.50 x EC, reported in ppm).
5. **Salinity (Derived Parameter):** Calculated in real time by the internal microcontroller from the live EC and temperature values (conversion ratio: ~0.65 x EC, reported in ppm).



Standard Plastic EC Probe Kit - PRO6072



Stainless Steel EC Probe Kit - PRO6075

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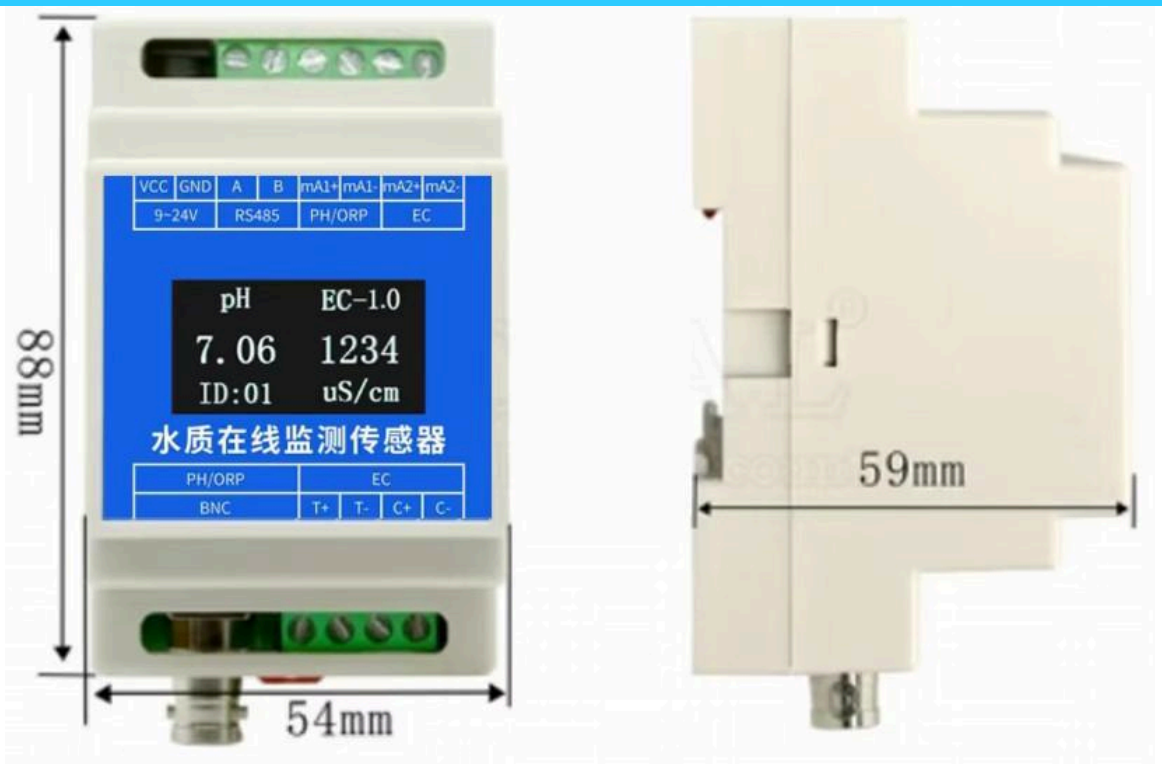
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2. Probe Variants & Mechanical Dimensions

Both product variants share the same DIN-rail transmitter electronics and POM-body glass pH electrode, differing only in the construction material and cell constant options of the paired EC probe:

Feature / Parameter	Standard Plastic Variant (PRO6072)	Stainless Steel Variant (PRO6075)
EC Probe Body Material	ABS / Engineering Plastic (White/Black)	316L Stainless Steel (Industrial Grade)
Default EC Cell Constant	K = 1.0 cm^{-1} (0 to 2,000 µS/cm)	K = 1.0 cm^{-1} (0 to 2,000 µS/cm)
Recommended Applications	Aquaculture, hydroponics, drinking water, RO systems, labs	Industrial wastewater, brine, chemical discharge, outdoor tanks
pH Electrode	POM High-Temp Glass Bulb Electrode (Ø28 mm x 160 mm, G3/4 thread)	POM High-Temp Glass Bulb Electrode (Ø28 mm x 160 mm, G3/4 thread)
EC Probe Dimensions	Ø12.8 mm x 133 mm (G3/4 mounting thread)	Ø12.8 mm x 133 mm (G3/4 mounting thread, PG7 cable gland)
Transmitter Enclosure	88 mm (H) x 54 mm (W) x 59 mm (D) — C45 35mm DIN Rail	88 mm (H) x 54 mm (W) x 59 mm (D) — C45 35mm DIN Rail
Standard Cable Length	5 meters (pH & EC probes)	5 meters (pH & EC probes)



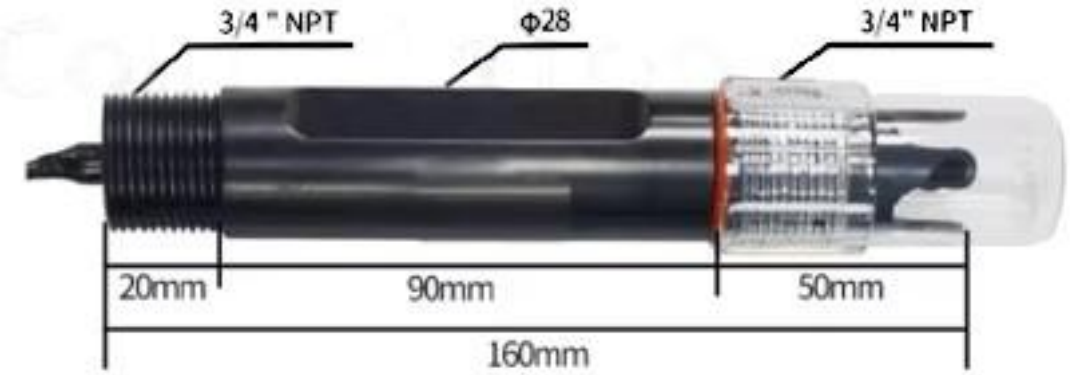
EC Stainless Electrode



EC Plastic Electrode



PH Electrode/Temperature Compensation Electrode



3. Measurement Specifications

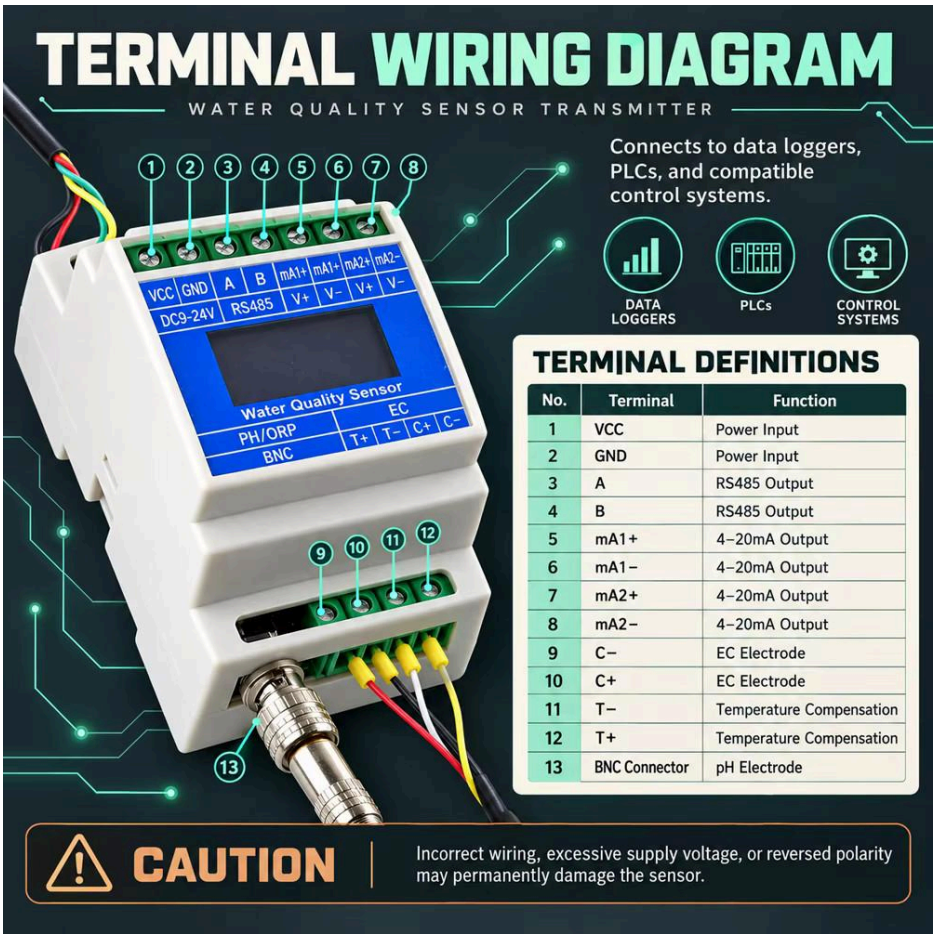
Parameter	Measurement Range	Resolution	Accuracy	Sensing Method
pH	0.00 to 14.00 pH	0.01 pH	±0.02 to ±0.03 pH	BNC Glass Electrode
Temperature	0.0 to 60.0 °C	0.1 °C	±0.5 °C	Built-in NTC Thermistor
EC (Cell K = 0.1 cm^{-1})	0 to 200 µS/cm	0.01 µS/cm	±1% to ±1.5% FS	Two-Pole Conductivity
EC (Cell K = 1.0 cm^{-1} - Std)	0 to 2,000 µS/cm	1 µS/cm	±1% to ±1.5% FS	Two-Pole Conductivity
EC (Cell K = 10.0 cm^{-1})	0 to 20,000 µS/cm	1 µS/cm	±1% to ±1.5% FS	Two-Pole Conductivity
TDS (K = 1.0 / K = 10.0)	0 to 1,000 ppm (up to 10,000 ppm w/ K=10)	1 ppm (0.01 w/ K=0.1)	±2% FS	Derived (0.50 x EC)
Salinity (K = 1.0 / K = 10.0)	0 to 1,300 ppm (up to 13,000 ppm w/ K=10)	1 ppm (0.01 w/ K=0.1)	±2% FS	Derived (~0.65 x EC)

4. Electrical, Environmental & Protection Specifications

Specification	Rating / Details
Power Supply Voltage	12V to 24V DC (Wide input range: 9V–24V DC; isolated 1500 VDC power isolation)
Power Consumption	≤ 0.2 W (35 mA @ 9V with display)
Digital Communication	Isolated RS485 (1414 VDC isolation), Standard Modbus-RTU Protocol (Default ID: 01)
Analog Outputs	2x Independent 4–20mA current loops (mA1: pH, mA2: EC)
Response / Stabilization Time	Response Time: < 1 s | Stabilization Time: < 15 s
Operating Pressure	0 to 0.5 MPa (for inline G3/4 threaded probe installation)
Medium Temperature	0 °C to +60 °C (Ambient transmitter environment: -20 °C to +70 °C, <100% RH)
Protection & EMC Immunity	Reverse polarity protection; ESD Level 2 (2 kV contact / 4 kV air); EFT Burst 0.5 kV; Surge 0.5 kV
Mounting Method	Standard C45 35mm DIN-rail mount

5. Terminal Pinout & Wiring Guide

Location	Terminal Label	Function & Wiring Connection
Top Block (Pin 1)	VCC (12~24V)	DC Power Supply Positive (+12V to +24V DC)
Top Block (Pin 2)	GND	DC Power Supply Ground (0V)
Top Block (Pin 3)	A (RS485)	RS485 Differential Data + (D+)
Top Block (Pin 4)	B (RS485)	RS485 Differential Data - (D-)
Top Block (Pins 5–6)	mA1+ / mA1-	4–20mA Analog Current Loop Output 1 (pH)
Top Block (Pins 7–8)	mA2+ / mA2-	4–20mA Analog Current Loop Output 2 (EC)
Bottom Left	BNC Connector	pH Glass Combination Electrode Coaxial Input
Bottom Right (Pins 1–2)	T+ / T-	EC Probe Internal NTC Temperature Sensor
Bottom Right (Pins 3–4)	C+ / C- (or IN+/IN-)	EC Probe Conductivity Sensing Electrodes



6. Sensor Calibration Guide

The transmitter incorporates internal axial capacitance filtering and a 100MΩ high-impedance input stage for stable readings. Periodic calibration is recommended to maintain rated accuracy:

A. pH Electrode Calibration (Recommended Interval: Every 2–4 Weeks)

- Rinse the glass sensing bulb with distilled or deionized water and gently blot dry with a lint-free tissue (do not rub the bulb).
- Zero / Neutral Point (pH 6.86 or 7.00): Submerge the electrode in neutral buffer solution, wait 1–2 minutes for thermal and signal stabilization, and record/apply the zero offset.
- Slope Calibration (pH 4.00 and/or pH 9.18): Rinse with distilled water, blot dry, submerge in the acidic or alkaline buffer, wait 1–2 minutes, and apply the slope calibration.

B. EC Electrode Calibration (Recommended Interval: Every 1–3 Months)

- Clean the conductivity pins with distilled water to remove any biofilm or mineral scale.
- Submerge the probe in a certified conductivity standard solution matching your probe's cell constant (1413 µS/cm for the standard K = 1.0 probe).
- Gently tap the probe inside the solution to dislodge any trapped air bubbles between the electrodes.
- Wait 1–2 minutes for the built-in NTC thermistor to stabilize temperature compensation, then calibrate to the standard value.

7. RS485 Modbus RTU Communication Protocol

The RS485 communication interface operates as a standard Modbus-RTU slave device. All register addresses, data types, scaling factors, and hex frames below have been verified on Probots' hardware test bench with live submerged probes.

7.1 Serial Port Settings

Communication Parameter	Factory Default / Supported Values
Protocol	Modbus RTU (Binary over RS485 Half-Duplex)
Default Baud Rate	9600 bps (Supported: 4800 / 9600 / 19200 / 38400 / 57600 / 115200 bps)
Data Frame Format	8 Data Bits, No Parity, 1 Stop Bit (8N1)
Default Slave Address	0x01 (Displayed as 'ID:01' on the transmitter LCD screen)
Supported Function Codes	0x03 (Read Holding Registers) | 0x06 (Write Single Register)
Valid Address Range	0x0000–0x001F (Addresses >= 0x0020 return Modbus Exception 0x02)

7.2 Verified Holding Register Map (Function Code 0x03)

Register (Hex)	Modbus Addr.	Parameter	Data Type	Scaling & Bench-Verified Conversion
0x0000	40001	pH Value	UInt16 (Unsigned)	Value / 100 (e.g., 665 -> 6.65 pH)
0x0001	40002	Electrical Conductivity (EC)	UInt16 (Unsigned)	Value / 1 (e.g., 884 -> 884 µS/cm)
0x0002	40003	Water Temperature	Int16 (Signed)	Value / 10 (e.g., 261 -> 26.1 °C)
0x0003	40004	TDS (Total Dissolved Solids)	UInt16 (Unsigned)	Value / 1 (e.g., 442 -> 442 ppm; 0.50 x EC)
0x0004	40005	Salinity	UInt16 (Unsigned)	Value / 1 (e.g., 574 -> 574 ppm; ~0.65 x EC)
0x0005–0x000F	40006–40016	Reserved	UInt16	Returns 0x0000
0x0010–0x0014	40017–40021	Factory Calibration & Config	UInt16	Internal factory constants (Do not overwrite)

7.3 Bench-Tested Command & Response Frames (Slave ID = 0x01, CRC Verified)

Example — Read All 5 Live Water Quality Parameters (Start: 0x0000, Count: 5 Registers):

- **Master TX (Hex):** 01 03 00 00 00 05 85 C9
- **Slave RX (Hex):** 01 03 0A 02 99 03 74 01 05 01 BA 02 3E 5A 40

Decoded Frame Breakdown (Captured directly from live hardware test bench):

- 01 : Slave Address (ID: 01)
- 03 : Function Code (Read Holding Registers)
- 0A : Byte Count (10 data bytes = 5 registers x 2 bytes)
- 02 99 : Reg 0x0000 = 0x0299 (665 decimal) -> 665 / 100 = 6.65 pH
- 03 74 : Reg 0x0001 = 0x0374 (884 decimal) -> 884 / 1 = 884 µS/cm (EC)
- 01 05 : Reg 0x0002 = 0x0105 (261 decimal) -> 261 / 10 = 26.1 °C (Temperature)
- 01 BA : Reg 0x0003 = 0x01BA (442 decimal) -> 442 / 1 = 442 ppm (TDS)
- 02 3E : Reg 0x0004 = 0x023E (574 decimal) -> 574 / 1 = 574 ppm (Salinity)
- 5A 40 : 16-bit Modbus CRC (Low byte first — CRC Valid)

8.Applications

Standard Plastic EC Probe Variant (PRO6072):

- **Hydroponics & Vertical Farming:** Continuous monitoring of nutrient reservoir EC/TDS and pH levels to ensure optimal plant growth.
- **Aquaculture & Hatcheries:** Real-time tracking of water salinity, pH, and temperature in fish tanks, shrimp farms, and breeding ponds.
- **Smart Agriculture:** Soil-water extract analysis and irrigation water quality monitoring.
- **Reverse Osmosis (RO) & Water Purifiers:** Monitoring output water quality and filter degradation in domestic or commercial RO plants.
- **Aquariums & Pools:** 24/7 water quality maintenance for large commercial aquariums or municipal swimming pools.

Industrial Stainless Steel EC Probe Variant (PRO6075):

- **Industrial Wastewater Treatment:** Monitoring effluent discharge and chemical neutralization processes in harsh environments.
- **Cooling Towers & Boilers:** High-pressure and high-temperature monitoring of scaling minerals (TDS) and conductivity.
- **Chemical Processing:** Tracking chemical concentration and fluid conductivity in manufacturing plants.
- **Environmental Monitoring:** Long-term deployment in rivers, lakes, and groundwater stations where durable, corrosion-resistant probes are required.

9.Important Notes & Best Practices

- ***The "5-in-1" Sensor Clarification:** This system uses two physical probes to deliver five parameters. It physically measures pH, EC, and Temperature. The internal microcontroller then mathematically derives TDS (Total Dissolved Solids) and Salinity in real-time based on the live EC and temperature readings. No extra probes are required to get all 5 readings.*
- ***Understanding EC and TDS Limits:** The standard EC probe included in these kits has a Cell Constant of K = 1.0 cm^{-1}. This limits the maximum measurement range to 2000 µS/cm (which equates to exactly 1000 ppm TDS). If your application requires measuring highly concentrated solutions (TDS > 1000 ppm), you must upgrade to a K = 10.0 cm^{-1} wide-range EC probe.*
- ***pH Probe Care & Hydration:** The glass pH electrode is highly sensitive and fragile. It must never be allowed to dry out completely. When not in active use, always store the pH probe tip in the included protective cap filled with a 3M KCL storage solution.*
- ***Calibration Frequency:** For accurate readings, the pH electrode requires regular calibration (every 2 to 4 weeks) using standard buffer solutions (pH 4.00, 6.86, 9.18). The EC probe requires less frequent calibration (every 1 to 3 months) but must be kept free of biofilm, grease, or mineral scale.*
- ***Microcontroller Integration (Arduino/ESP32):** The RS485 interface operates on industrial standard Modbus RTU. If interfacing with a 3.3V microcontroller (like an ESP32 or Raspberry Pi), ensure your MAX485 converter module is powered correctly (typically 5V) and use a logic level shifter or voltage divider on the RO (Receive) pin to prevent 5V logic from damaging your 3.3V pins.*
- ***Power Supply Safety:** The transmitter requires an isolated 12V to 24V DC power supply. Do not connect AC mains power directly to the unit, and ensure correct polarity before powering on to prevent permanent damage to the RS485 transceiver.*

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