# AGRINOVO-NH4-100

## Digital Ammonium Nitrogen ($NH_4^+$-N) Ion Electrode Sensor

3/4 inch front and rear threads

## 1. Overview

The AGRINOVO-NH4-100 is a digital ion-selective electrode (ISE) sensor for measuring ammonium nitrogen concentration in water. It integrates electronics and a microprocessor for real-time ion concentration and temperature measurement via RS485 Modbus-RTU, with up to 5-point calibration and automatic or manual temperature compensation.

### Features

- Ion range: 0.2 to 1000 ppm
- Resolution: 0.01 ppm
- Accuracy: ±5% F.S.
- Built-in temperature sensor (NTC10K)
- Up to 5-point calibration
- Auto/manual temp compensation
- RS485 Modbus-RTU
- Low power: ≤0.5W

### Applications

Aquaculture ammonia monitoring
Wastewater treatment
Environmental water quality monitoring
Industrial process control

## 2. Specifications

| Parameter | Specification |
|---|---|
| Ion Range | 0.2 to 1000 ppm |
| Ion Resolution | 0.01 ppm |
| Ion Accuracy | ±5% F.S. |
| Temperature Range | −10.0 to 110.0°C |
| Temperature Resolution | 0.1°C |
| Temperature Accuracy | ±0.5°C |
| Temperature Sensor | Thermistor NTC10K |
| Temperature Compensation | Automatic / Manual |

## 3. Electrical Characteristics

| Parameter | Specification |
|---|---|
| Supply Voltage | 12-24 VDC |
| Power Consumption | ≤0.5W |
| Isolation | 2500Vrms |
| Housing Material | PPS |
| Mounting Thread | 3/4 inch front and rear threads |

## 4. Wiring

| Wire Color | Function | Description |
|---|---|---|
| Red | V+ | DC Power Supply (12-24V DC) |
| Black | GND | DC Power Ground |
| Yellow | RS485-A | Data T/R+ |
| White | RS485-B | Data T/R− |

## 5. Communication Settings

| Parameter | Value |
|---|---|
| Protocol | Modbus-RTU |
| Baud Rate | 9600 bps (configurable: 1200/2400/4800/9600/19200) |
| Data Bits | 8 |
| Parity | None |
| Stop Bits | 1 |
| Default Address | 0x01 (range 1 to 247) |

**Notes:**

- All registers are dual-byte (16-bit). Transmitted high byte first, low byte second.
- Negative integers use two's complement (−1 = 0xFFFF, −2 = 0xFFFE).
- CRC16: Standard Modbus, high byte first, low byte second. CRC bypass code: 0x2A2A.
- Command frame length is fixed at 8 bytes. Frames shorter than 8 bytes after a 0.1s gap are ignored.

## 6. Register Map

The sensor has three register groups: **Measurement** (real-time data), **Parameter** (configuration), and **Information** (device status/ identity).

### 6.1 Measurement Registers - Integer Mode (Function 0x04)

| Address | Description | Range | Scaling | R/W |
|---|---|---|---|---|
| 0x0000 | Ion Concentration | 0 to 20000 | See decimal register | R |
| 0x0001 | Ion Decimal + Unit | - | See unit table | R |
| 0x0002 | Electrode Signal | −7500 to 7500 | ÷10 → mV | R |
| 0x0003 | Signal Decimal + Unit | - | See unit table | R |
| 0x0008 | Temperature | −100 to 1100 | ÷10 → °C | R |
| 0x0009 | Temp Decimal + Unit | - | See unit table | R |

**Over-range indicators:** 0x7FFF = above upper limit, 0x8000 = below lower limit.

### 6.2 Measurement Registers - Float Mode (Function 0x03)

Each value occupies 2 registers (float32):

| Address | Description | Range | Unit | R/W |
|---|---|---|---|---|
| 0x0000 to 0x0001 | Ion Concentration | 0.000 to 20000 | ppm | R |
| 0x0002 to 0x0003 | Electrode Signal | −750.0 to 750.0 | mV | R |
| 0x0008 to 0x0009 | Temperature | −10.0 to 110.0 | °C | R |

### 6.3 Parameter Registers (Function 0x03 read / 0x06 write)

| Address | Description | Range | Default | R/W |
|---|---|---|---|---|
| 0x0019 | Calibration Status | BIT1 - BIT5 (see calibration) | - | R/D |
| 0x001C | Electrode Efficiency | 70.0 to 130.0% (int: 700 to 1300) | 100.0% | R/D |
| 0x001D | Calibrated Point Count | 0 to 5 | 0 | R/D |
| 0x001E | Slave Address | 1 to 247 (0xFF = broadcast) | 1 | R/W |
| 0x001F | Baud Rate | 0:1200 · 1:2400 · 2:4800 · 3:9600 · 4:19200 | 3 (9600) | R/W |
| 0x0020 | Temp Compensation Type | 0: Manual · 1: Automatic | 1 (Auto) | R/W/D |
| 0x0021 | Temp Setpoint / Offset | Manual: −10.0 to 110.0°C · Auto: −10.0 to 10.0°C (×10) | 25.0 / 0.0°C | R/W/D |
| 0x0023 | Ion Valence | 0: Not set · 1: Monovalent · 2: Divalent | - | R/W |

**R/W/D:** D = reset to default by factory restore. Registers without D are unaffected by factory restore.

### 6.4 Information Registers (Function 0x03 read / 0x06 write)

| Address | Description | Values | R/W |
|---|---|---|---|
| 0x0040 | Working Mode | 0x0010: Measurement · 0x0050: Settings · 0x0060: Calibration | R/W |
| 0x0041 | Mode Parameter | See settings/calibration sections | R/W |
| 0x0042 | Work Event | - | R |
| 0x0043 | Calibration Status & Operation | See calibration section | R/W |
| 0x0044 | Device Type | 0x0010 (ION) | R |
| 0x0045 | Device Model | 0x1210 (ION1210) | R |
| 0x0046 | Software Version | BCD coded | R |
| 0x0047 | Hardware Version | BCD coded | R |
| 0x0048 | Serial Number High | BCD coded | R |
| 0x0049 | Serial Number Low | BCD coded | R |

## 7. Reading Data

### Integer Mode - Read ion concentration, electrode signal, and temperature (Function 0x04)

Read 10 registers from 0x0000:

```
Request:  01 04 00 00 00 0A 70 0D
Response: 01 04 14 03 EB 02 11 03 EC 01 00 00 00 00 00 00 00 00 00 00 FA 01 0B F1 B7
```

**Decoding:**

| Register | Hex | Decimal | Scaling | Result |
|---|---|---|---|---|
| 0x0000 Ion Value | 0x03EB | 1000 | ÷100 (from 0x0001) | 10.00 ppm |
| 0x0002 Electrode Signal | 0x03EC | 1001 | ÷10 (from 0x0003) | 100.1 mV |
| 0x0008 Temperature | 0x00FA | 250 | ÷10 (from 0x0009) | 25.0°C |

### Float Mode - Read ion concentration, electrode signal, and temperature (Function 0x03)

Read 10 registers from 0x0000:

```
Request:  01 03 00 00 00 0A C5 CD
Response: 01 03 14 00 00 41 20 33 33 42 C8 00 00 00 00 00 00 00 00 E3 E8 41 C7 43 0C
```

**Decoding:**

| Register | Float Value | Result |
|---|---|---|
| 0x0000 to 0x0001 Ion | 10.00 | 10.00 ppm |
| 0x0002 to 0x0003 Electrode | 100.1 | 100.1 mV |
| 0x0008 to 0x0009 Temperature | 24.986282 | 25.0°C |

## 8. Address Configuration

### Change Address (0x01 → 0x02)

```
Request:  01 06 00 1E 00 02 68 0D
Response: 01 06 00 1E 00 02 68 0D
```

### Change Baud Rate (9600 → 2400)

```
Request:  01 06 00 1F 00 01 79 CC
Response: 01 06 00 1F 00 01 79 CC
```

### Change Ion Valence (→ Divalent)

```
Request:  01 06 00 23 00 02 F9 C1
Response: 01 06 00 23 00 02 F9 C1
```

### Broadcast Discovery

Use address 0xFF with only one device connected.

## 9. Calibration

The ion electrode requires calibration with 2 or more standard solutions before it can calculate ion concentration. Up to 5 calibration points are supported.

### Standard Solution Codes

| Concentration | Code | Bit Position |
|---|---|---|
| 0.1 ppm | 0x0002 | BIT1 |
| 1 ppm | 0x0004 | BIT2 |
| 10 ppm | 0x0008 | BIT3 |
| 100 ppm | 0x0010 | BIT4 |
| 1000 ppm | 0x0020 | BIT5 |

### Calibration Flow

1. Place the electrode in standard solution.
2. Write the standard solution code to calibration register (0x0043).
3. Wait for completion. Read 0x0043 status:
   - **0:** Calibration successful (returned to measurement mode)
   - **1:** Calibrating - read again shortly
   - **2:** No valid standard value received within 180s (returned to measurement)
   - **3:** Signal unstable or out of range within 180s (returned to measurement)
   - **4:** Sensor performance (efficiency/offset) out of limits (returned to measurement)

### Calibration Notes

- Each successful calibration calculates electrode efficiency. If out of range, error 4 is returned.
- Writing 0x7FFF to 0x0043 clears all calibration data.
- Calibration status can be read from register 0x0019 and electrode efficiency from 0x001C.

• Ion valence must be configured (0x0023) before calibration if applicable.

### Calibration Commands

| Command | Addr | Func | Register | Value | CRC |
|---|---|---|---|---|---|
| Clear all calibration | 01 | 06 | 00 43 | 7F FF | 18 6E |
| Calibrate 0.1 ppm | 01 | 06 | 00 43 | 00 02 | F9 DF |
| Calibrate 1 ppm | 01 | 06 | 00 43 | 00 04 | 79 DD |
| Calibrate 10 ppm | 01 | 06 | 00 43 | 00 08 | 79 D8 |
| Calibrate 100 ppm | 01 | 06 | 00 43 | 00 10 | 79 D2 |
| Calibrate 1000 ppm | 01 | 06 | 00 43 | 00 20 | 79 C6 |
| Query calibration status | 01 | 03 | 00 43 | 00 01 | 75 DE |

## 10. Temperature Compensation

### Set to Manual Compensation

```
Request:  01 06 00 20 00 00 88 00
Response: 01 06 00 20 00 00 88 00
```

When manual: register 0x0021 is the manual temperature setpoint (×10).

### Set to Automatic Compensation

```
Request:  01 06 00 20 00 01 49 C0
Response: 01 06 00 20 00 01 49 C0
```

When automatic: register 0x0021 is the temperature offset (×10). Default 0.0°C.

### Set Temperature Offset to −5.0°C

```
Request:  01 06 00 21 FF CE 19 A4
Response: 01 06 00 21 FF CE 19 A4
```

## 11. Factory Reset

Factory reset requires two sequential commands:

**Step 1 - Enter Settings Mode** (write 0x0050 to 0x0040):

```
Request:  01 06 00 40 00 50 88 22
Response: 01 06 00 40 00 50 88 22
```

**Step 2 - Execute Factory Reset** (write 0x7FFF to 0x0041):

```
Request:  01 06 00 41 7F FF B9 AE
Response: 01 06 00 41 7F FF B9 AE
```

This clears all calibration data, resets temperature mode to automatic, offset to 0.0°C, and restores default parameter values. The device will restart.

## 12. Error Handling

When an invalid command is received, the device responds with the function code + 0x80:

| Error Code | Description |
|---|---|
| 01 | Invalid function code (only 0x03, 0x04, 0x06 supported) |
| 02 | Invalid register address |
| 03 | Invalid register count (exceeds register group boundary) |
| 04 | Invalid modification value (out of range) |
| 05 | CRC error |
| 06 | Write to read-only register |

## 13. Common Commands Reference

### Read Registers

| Command | Addr | Func | Start | Count | CRC |
|---|---|---|---|---|---|
| Read measurement (integer) | 01 | 04 | 00 00 | 00 0A | 70 0D |
| Read measurement (float) | 01 | 03 | 00 00 | 00 0A | C5 CD |
| Read all parameters | 01 | 03 | 00 19 | 00 0C | 94 08 |
| Read all info registers | 01 | 03 | 00 40 | 00 0A | C4 19 |

### Write Registers

| Command | Addr | Func | Register | Value | CRC |
|---|---|---|---|---|---|
| Set address to 0x02 | 01 | 06 | 00 1E | 00 02 | 68 0D |
| Set baud to 2400 | 01 | 06 | 00 1F | 00 01 | 79 CC |
| Temp comp → manual | 01 | 06 | 00 20 | 00 00 | 88 00 |
| Temp comp → auto | 01 | 06 | 00 20 | 00 01 | 49 C0 |
| Temp offset −5.0°C | 01 | 06 | 00 21 | FF CE | 19 A4 |
| Ion valence → monovalent | 01 | 06 | 00 23 | 00 01 | B9 C0 |
| Ion valence → divalent | 01 | 06 | 00 23 | 00 02 | F9 C1 |

## 14. Unit Lookup Table

The low byte of “Decimal + Unit” registers (0x0001, 0x0003, 0x0009) contains the unit code:

| Code | Unit | Code | Unit | Code | Unit |
|---|---|---|---|---|---|
| 0x00 | mV | 0x01 | nA | 0x02 | uA |
| 0x03 | mA | 0x04 | Ω | 0x05 | KΩ |
| 0x06 | MΩ | 0x07 | uS | 0x08 | mS |
| 0x09 | S | 0x0A | pH | 0x0B | °C |
| 0x0C | °F | 0x0D | ug/L | 0x0E | mg/L |
| 0x0F | g/L | 0x10 | ppb | 0x11 | ppm |
| 0x12 | ppt | 0x13 | % | 0x14 | mbar |
| 0x15 | bar | 0x16 | mmHg | | |

The high byte contains the number of decimal places for the value register.

## 15. Installation Notes

### Placement

- Mount using 3/4 inch thread fitting
- Ensure sensing tip is fully submerged
- Avoid air bubbles on electrode surface

### Maintenance

- Clean electrode periodically
- Re-calibrate after extended use or cleaning
- Store in clean water when not in use
- PPS housing is corrosion-resistant

## 16. Ordering Information

| Part number | Description |
|---|---|
| AGRINOVO-NH4-100 | Digital Ammonium Nitrogen ($NH_4^+$-N) Ion Electrode Sensor |

## 17. Revision History

| Rev | Date | Changes |
|---|---|---|
| 1.0 | June 2026 | Initial release |
| 1.1 | August 2026 | Layout revision |
| 1.2 | October 2026 | New layout; corrected Modbus example CRC values |

Modular IoT sensors and controllers for agriculture and aquaculture. Specifications subject to change without notice.