Modbus TCP/IP Register Documentation

Modbus TCP Register Map – Sensor Data Entries

Modbus TCP Input Registers

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Modbus TCP/IP Register Documentation

This document describes the register mapping for Modbus TCP/IP communication. It provides details for N_2O measurement, Temperature measurement, and TagName registers, along with instructions on how to configure the host IP address.

1. Changing TCP/IP Configuration on the N_2O Wastewater Operator Console

To modify the TCP/IP settings of the N_2O Wastewater Operator Console, follow these steps carefully. Connect the TCP/IP network cable to Ethernet1 port.
Important: Do not change any settings outside this section, as it may have critical effects on other system connections.

1. Login as **ADVANCED** user
2. Open the **Console configuration** menu.
3. Use the **down button** to navigate to **Ethernet1**, then press the **button with the three dots** to open the network settings.
4. In this section, you can adjust the desired parameters:
   - DHCP
   - IP address
   - Subnet mask
   - Default gateway
   - DNS settings and DNS server IP address
   - Auto negotiation
   - Speed settings
   - Duplex settings
5. After making the changes, press **Save and Reboot**.
6. Once the system restarts, it will be ready to communicate using the new network configuration.

2. Register Mapping and Word Order

In Modbus communication, data values larger than 16 bits are split across multiple registers. For floating-point values, which require 32 bits, each measurement spans **two consecutive 16-bit registers**.
This system follows the **low word first** convention. That means the **lower-order 16 bits** of the value are placed in the first register, while the **higher-order 16 bits** are placed in the following register. When combining the two registers back into a float, the order must be preserved to correctly reconstruct the IEEE-754 value.

MODBUS protocol description

Master-slave principle

The master-slave principle in a MODBUS connection is a communication protocol model used extensively in industrial automation and control systems. The communication between a master (e.g. SCADA system or PLC) and the slave N_2O Wastewater Operator Console takes

place in the form of a data request/instruction - response. The slaves are identified by the device address. Master devices do not need an address.

The MODBUS protocol uses a request-reply mechanism to exchange information. The master sends a request, and the slave processes it and sends back the requested data. This data can include single bits or 16-bit registers.

Each N_2O Wastewater Sensor on the MODBUS network is assigned a unique address between 1 – 16, which the master (SCADA/PLC) uses to direct its requests to the correct device. The N_2O Wastewater Sensor is setup to *Unicast Mode* where the master addresses a specific N_2O Wastewater Sensor using its unique address. The N_2O Wastewater Sensor processes the request and replies to the master.

3. Modbus TCP/IP Register Types and Commands

In this system, the Modbus register addresses are divided into **holding registers** and **input registers**, each accessed using specific Modbus commands:

1. **Registers starting with 40000 – Holding Registers**
    - These registers are used for values that are **transmitted to the sensor** or can be **written by the host**.
    - Typical Modbus command to access holding registers: **Function Code 03 (Read Holding Registers)** for reading, and **Function Code 16 (Write Multiple Registers)** for writing.
    - Example: Airflow Input and TagName registers fall into this category.
2. **Registers starting with 30000 – Input Registers**
    - These registers are **read-only** and are used for values **measured or reported by the sensor**, such as temperature and N_2O concentration.
    - Typical Modbus command to access input registers: **Function Code 04 (Read Input Registers)**.
    - Example: N_2O Measurement and Temperature Measurement registers fall into this category.

4. N_2O Measurement

The **N_2O measurement** values are transmitted as **32-bit floating-point numbers** over Modbus TCP. Each reading corresponds to a sensor and provides the measured concentration of N_2O in real time. The floating-point format ensures that even small variations in gas concentration can be captured with high accuracy.

N_2O Measurement (mgN/L or ppm):

Sensor	Address
N_2O Sensor 1	30103
N_2O Sensor 2	30203
N_2O Sensor 3	30303
N_2O Sensor 4	30403
N_2O Sensor 5	30503
N_2O Sensor 6	30603
N_2O Sensor 7	30703
N_2O Sensor 8	30803
N_2O Sensor 9	30903
N_2O Sensor 10	31003
N_2O Sensor 11	31103
N_2O Sensor 12	31203
N_2O Sensor 13	31303
N_2O Sensor 14	31403
N_2O Sensor 15	31503
N_2O Sensor 16	31603

5. Temperature Measurement

The Temperature measurement values are also encoded as 32-bit floating-point numbers. Each sensor provides its current temperature reading in this format, allowing for precise monitoring and trending. Using floating-point values guarantees consistent resolution and accuracy across the full operating range.

Temperature Measurement (°C or °F):

Sensor	Address
Temperature Sensor 1	30109
Temperature Sensor 2	30209
Temperature Sensor 3	30309
Temperature Sensor 4	30409
Temperature Sensor 5	30509
Temperature Sensor 6	30609
Temperature Sensor 7	30709
Temperature Sensor 8	30809

Temperature Sensor 9	30909
Temperature Sensor 10	31009
Temperature Sensor 11	31109
Temperature Sensor 12	31209
Temperature Sensor 13	31309
Temperature Sensor 14	31409
Temperature Sensor 15	31509
Temperature Sensor 16	31609

6. N_2O Emission Data

The **N_2O emission** values are transmitted as **32-bit floating-point numbers** over Modbus TCP. Each reading corresponds to a sensor and provides the measured emission of N_2O in real time. The floating-point format ensures that even small variations in gas concentration can be captured with high accuracy.

Aerated N_2O Emission Rate ($gN/m^3/d$):

Sensor	Aerated Emission Rate Address	Non-aerated Emission Rate Address
N_2O Emission Sensor 1	30113	30115
N_2O Emission Sensor 2	30213	30215
N_2O Emission Sensor 3	30313	30315
N_2O Emission Sensor 4	30413	30415
N_2O Emission Sensor 5	30513	30515
N_2O Emission Sensor 6	30613	30615
N_2O Emission Sensor 7	30713	30715
N_2O Emission Sensor 8	30813	30815
N_2O Emission Sensor 9	30913	30915
N_2O Emission Sensor 10	31013	31015
N_2O Emission Sensor 11	31113	31115
N_2O Emission Sensor 12	31213	31215
N_2O Emission Sensor 13	31313	31315
N_2O Emission Sensor 14	31413	31415
N_2O Emission Sensor 15	31513	31515
N_2O Emission Sensor 16	31613	31615

Sensor	Aerated Emission Address	Non-aerated Emission Address	Total Emission Address
N_2O Emission Sensor 1	30117	30119	30121
N_2O Emission Sensor 2	30217	30219	30221
N_2O Emission Sensor 3	30317	30319	30321
N_2O Emission Sensor 4	30417	30419	30421
N_2O Emission Sensor 5	30517	30519	30521
N_2O Emission Sensor 6	30617	30619	30621
N_2O Emission Sensor 7	30717	30719	30721
N_2O Emission Sensor 8	30817	30819	30821
N_2O Emission Sensor 9	30917	30919	30921
N_2O Emission Sensor 10	31017	31019	31021
N_2O Emission Sensor 11	31117	31119	31121
N_2O Emission Sensor 12	31217	31219	31221
N_2O Emission Sensor 13	31317	31319	31321
N_2O Emission Sensor 14	31417	31419	31421
N_2O Emission Sensor 15	31517	31519	31521
N_2O Emission Sensor 16	31617	31619	31621

7. Airflow Input

The Airflow input values are encoded as 32-bit floating-point numbers (float). Each value represents the airflow transmitted to the corresponding sensor, providing real-time measurement for monitoring and control. Using floating-point encoding ensures consistent accuracy and resolution across the entire operating range, allowing precise representation of both small and large airflow values.

Airflow input (Nm^3/h, m^3/h, or SCFM):

Sensor	Register Address
Airflow Input Sensor 1	40114
Airflow Input Sensor 2	40214
Airflow Input Sensor 3	40314
Airflow Input Sensor 4	40414
Airflow Input Sensor 5	40514
Airflow Input Sensor 6	40614
Airflow Input Sensor 7	40714
Airflow Input Sensor 8	40814

Airflow Input Sensor 9	40914
Airflow Input Sensor 10	41014
Airflow Input Sensor 11	41114
Airflow Input Sensor 12	41214
Airflow Input Sensor 13	41314
Airflow Input Sensor 14	41414
Airflow Input Sensor 15	41514
Airflow Input Sensor 16	41614

8. N_2O Sensor TagName Register Mapping

Sensor tags are user defined unique IDs (TagName). Each TagName entry is stored as a fixed-length string. It uses 24 characters plus 2 null-termination registers, for a total of 13 registers per TagName entry.

TagName:

Sensor	Start Address	Length (registers)
TagName Sensor 1	40101	13
TagName Sensor 2	40201	13
TagName Sensor 3	40301	13
TagName Sensor 4	40401	13
TagName Sensor 5	40501	13
TagName Sensor 6	40601	13
TagName Sensor 7	40701	13
TagName Sensor 8	40801	13
TagName Sensor 9	40901	13
TagName Sensor 10	41001	13
TagName Sensor 11	41101	13
TagName Sensor 12	41201	13
TagName Sensor 13	41301	13
TagName Sensor 14	41401	13
TagName Sensor 15	41501	13
TagName Sensor 16	41601	13

9. Additional Sensor Data Registers

In addition to the registers already described above, the following data points are available for each sensor. The table below gives a quick overview of each parameter, its description, register offset and data type, before the full per-sensor address tables.

Parameter	Description	Data type
Sensor Voltage	Measured supply voltage of the sensor (V)	float
Sensor Voltage Raw %	Sensor voltage expressed as raw percentage (%)	float
N_2O Unit	Unit of N_2O measurement (0 = mgN/L, 1 = ppm)	byte
Temperature Unit	Unit of temperature measurement (0 = Celsius, 1 = Fahrenheit)	byte
Q_{air}	Air flow rate (m3/h)	float
Henry	Henry's law constant for gas-liquid equilibrium	float
kLa N_2O	Volumetric mass transfer coefficient for N_2O (d^{-1})	float
vgas	Gas velocity ($m^3/m^2/s$)	float
Status	Sensor operational status and diagnostics (enumeration)	byte
Airflow	Measured airflow to the process (Nm^3/h, m^3/h, or SCFM)	float

Sensor Voltage (Volt):

Sensor	Address
Sensor Voltage Sensor 1	30101
Sensor Voltage Sensor 2	30201
Sensor Voltage Sensor 3	30301
Sensor Voltage Sensor 4	30401
Sensor Voltage Sensor 5	30501
Sensor Voltage Sensor 6	30601
Sensor Voltage Sensor 7	30701
Sensor Voltage Sensor 8	30801
Sensor Voltage Sensor 9	30901
Sensor Voltage Sensor 10	31001
Sensor Voltage Sensor 11	31101
Sensor Voltage Sensor 12	31201
Sensor Voltage Sensor 13	31301
Sensor Voltage Sensor 14	31401

Sensor Voltage Sensor 15	31501
Sensor Voltage Sensor 16	31601

Sensor Voltage Raw %:

Sensor	Address
Sensor Voltage Raw % Sensor 1	30107
Sensor Voltage Raw % Sensor 2	30207
Sensor Voltage Raw % Sensor 3	30307
Sensor Voltage Raw % Sensor 4	30407
Sensor Voltage Raw % Sensor 5	30507
Sensor Voltage Raw % Sensor 6	30607
Sensor Voltage Raw % Sensor 7	30707
Sensor Voltage Raw % Sensor 8	30807
Sensor Voltage Raw % Sensor 9	30907
Sensor Voltage Raw % Sensor 10	31007
Sensor Voltage Raw % Sensor 11	31107
Sensor Voltage Raw % Sensor 12	31207
Sensor Voltage Raw % Sensor 13	31307
Sensor Voltage Raw % Sensor 14	31407
Sensor Voltage Raw % Sensor 15	31507
Sensor Voltage Raw % Sensor 16	31607

Qair (m^3/h):

Sensor	Address
Qair Sensor 1	30123
Qair Sensor 2	30223
Qair Sensor 3	30323
Qair Sensor 4	30423
Qair Sensor 5	30523
Qair Sensor 6	30623
Qair Sensor 7	30723
Qair Sensor 8	30823
Qair Sensor 9	30923
Qair Sensor 10	31023
Qair Sensor 11	31123

Qair Sensor 12	31223
Qair Sensor 13	31323
Qair Sensor 14	31423
Qair Sensor 15	31523
Qair Sensor 16	31623

Henry (-):

Sensor	Address
Henry Sensor 1	30125
Henry Sensor 2	30225
Henry Sensor 3	30325
Henry Sensor 4	30425
Henry Sensor 5	30525
Henry Sensor 6	30625
Henry Sensor 7	30725
Henry Sensor 8	30825
Henry Sensor 9	30925
Henry Sensor 10	31025
Henry Sensor 11	31125
Henry Sensor 12	31225
Henry Sensor 13	31325
Henry Sensor 14	31425
Henry Sensor 15	31525
Henry Sensor 16	31625

kLa N_2O (d^{-1}):

Sensor	Address
k_La N_2O Sensor 1	30127
k_La N_2O Sensor 2	30227
k_La N_2O Sensor 3	30327
k_La N_2O Sensor 4	30427
k_La N_2O Sensor 5	30527
k_La N_2O Sensor 6	30627
k_La N_2O Sensor 7	30727
k_La N_2O Sensor 8	30827

k_La N_2O Sensor 9	30927
k_La N_2O Sensor 10	31027
k_La N_2O Sensor 11	31127
k_La N_2O Sensor 12	31227
k_La N_2O Sensor 13	31327
k_La N_2O Sensor 14	31427
k_La N_2O Sensor 15	31527
k_La N_2O Sensor 16	31627

V_{gas} ($m^3/m^2/s$):

Sensor	Address
vgas Sensor 1	30129
vgas Sensor 2	30229
vgas Sensor 3	30329
vgas Sensor 4	30429
vgas Sensor 5	30529
vgas Sensor 6	30629
vgas Sensor 7	30729
vgas Sensor 8	30829
vgas Sensor 9	30929
vgas Sensor 10	31029
vgas Sensor 11	31129
vgas Sensor 12	31229
vgas Sensor 13	31329
vgas Sensor 14	31429
vgas Sensor 15	31529
vgas Sensor 16	31629

Status:

Sensor	Address
Status Sensor 1	30131
Status Sensor 2	30231
Status Sensor 3	30331
Status Sensor 4	30431
Status Sensor 5	30531

Status Sensor 6	30631
Status Sensor 7	30731
Status Sensor 8	30831
Status Sensor 9	30931
Status Sensor 10	31031
Status Sensor 11	31131
Status Sensor 12	31231
Status Sensor 13	31331
Status Sensor 14	31431
Status Sensor 15	31531
Status Sensor 16	31631

Note: Status is a byte represented as a 16-bit value (single register), but follows the same register addressing scheme.

The Status byte is an enumeration with the following values:

Value	Meaning
0	No error or warnings
1	One or more warnings triggered
2	One or more errors triggered
3	One or more errors triggered and one or more warnings triggered

Airflow Measured (Nm^3/h, m^3/h, or SCFM):

Sensor	Address
Airflow Sensor 1	30135
Airflow Sensor 2	30235
Airflow Sensor 3	30335
Airflow Sensor 4	30435
Airflow Sensor 5	30535
Airflow Sensor 6	30635
Airflow Sensor 7	30735
Airflow Sensor 8	30835
Airflow Sensor 9	30935
Airflow Sensor 10	31035
Airflow Sensor 11	31135
Airflow Sensor 12	31235

Airflow Sensor 13	31335
Airflow Sensor 14	31435
Airflow Sensor 15	31535
Airflow Sensor 16	31635

N_2O Unit (*0 = mgN/L, 1 = ppm*):

Sensor	Address
N_2O Unit Sensor 1	30105
N_2O Unit Sensor 2	30205
N_2O Unit Sensor 3	30305
N_2O Unit Sensor 4	30405
N_2O Unit Sensor 5	30505
N_2O Unit Sensor 6	30605
N_2O Unit Sensor 7	30705
N_2O Unit Sensor 8	30805
N_2O Unit Sensor 9	30905
N_2O Unit Sensor 10	31005
N_2O Unit Sensor 11	31105
N_2O Unit Sensor 12	31205
N_2O Unit Sensor 13	31305
N_2O Unit Sensor 14	31405
N_2O Unit Sensor 15	31505
N_2O Unit Sensor 16	31605

Note: N_2O Unit is a byte represented as a 16-bit value (single register) indicating the unit of the N_2O measurement: 0 = mgN/L, 1 = ppm.

Temperature Unit (0 = Celsius °C, 1 = Fahrenheit °F):

Sensor	Address
Temperature Unit Sensor 1	30111
Temperature Unit Sensor 2	30211
Temperature Unit Sensor 3	30311
Temperature Unit Sensor 4	30411
Temperature Unit Sensor 5	30511
Temperature Unit Sensor 6	30611
Temperature Unit Sensor 7	30711

Temperature Unit Sensor 8	30811
Temperature Unit Sensor 9	30911
Temperature Unit Sensor 10	31011
Temperature Unit Sensor 11	31111
Temperature Unit Sensor 12	31211
Temperature Unit Sensor 13	31311
Temperature Unit Sensor 14	31411
Temperature Unit Sensor 15	31511
Temperature Unit Sensor 16	31611

*Note: Temperature Unit is a byte represented as a 16-bit value (single register) indicating the unit of the temperature measurement: 0 = Celsius (°C), 1 = Fahrenheit (°**F**).*

Airflow Unit (0 = Nm^3/h (default), 1 = m^3/h, 2= SCFM):

Sensor	Address
Airflow Unit Sensor 1	30137
Airflow Unit Sensor 2	30237
Airflow Unit Sensor 3	30337
Airflow Unit Sensor 4	30437
Airflow Unit Sensor 5	30537
Airflow Unit Sensor 6	30637
Airflow Unit Sensor 7	30737
Airflow Unit Sensor 8	30837
Airflow Unit Sensor 9	30937
Airflow Unit Sensor 10	31037
Airflow Unit Sensor 11	31137
Airflow Unit Sensor 12	31237
Airflow Unit Sensor 13	31337
Airflow Unit Sensor 14	31437
Airflow Unit Sensor 15	31537
Airflow Unit Sensor 16	31637

Note: Airflow Unit is a byte represented as a 16-bit value (single register) indicating the unit of the temperature measurement: 0 = Nm3/h (default), 1 = m3/h, 2= SCFM.

Modbus TCP Register Map – Sensor Data Entries

In addition to the registers already described above, the following data points are available for each sensor. The table below gives a quick overview of each parameter, its description, register offset and data

10. Overview

This section describes all available measurements and calculated data entries transmitted via **Modbus TCP/IP**. All values are provided as **32-bit floating-point numbers (IEEE 754)** and therefore occupy **two consecutive Modbus registers** per entry. Except **Status** which is a byte represented as a 16-bit value.
The addressing scheme is consistent across sensors. Each sensor is identified by **XX**, and all parameters for that sensor are accessed by reading the corresponding register pair.
Note: A general description of Modbus TCP/IP communication is provided in the previous section of this document.

11. General Addressing Scheme

- Data type: **32-bit floating point (2 registers) or byte (1 register, 16-bit)**
- Modbus function: **Input Registers**
- Base address format: **3XXYY**
    - **XX** = Sensor number
    - **YY** = Parameter offset

Example

- Sensor voltage for Sensor **X** → **3XX01**
- Power for Sensor **X** → **3XX63**

12. Data Entry Description and Register Map

Electrical and Sensor Diagnostics:

Parameter	Description	Register Adress Decimal	Total Emission Address
N_2O Emission Sensor 1	30117	30119	30121
N_2O Emission Sensor 2	30217	30219	30221
N_2O Emission Sensor 3	30317	30319	30321
N_2O Emission Sensor 4	30417	30419	30421

Gas Concentration and Emission Data:

Parameter	Description	Register Adress Decimal	Data type
N_2O	Measured nitrous oxide concentration	3XX03	float
N_2O Unit	Unit measured nitrous oxide concentration -> 0 = mgN/L, 1 = ppm	3XX05	byte
N_2O rate	Emission aerated area rate of N_2O gases	3XX13	float
non-N_2O rate	Emission aerated area rate of non-N_2O gases	3XX15	float
N_2O Emission	Calculated Emission aerated area N_2O emission	3XX17	float
non-N_2O Emission	Calculated Emission aerated area non-N_2O emission	3XX19	float
Total N_2O Emission	Total accumulated N_2O emission	3XX21	float

Temperature and Airflow:

Parameter	Description	Register Adress Decimal	Data type
Temperature	Process or ambient temperature	3XX09	float
Temperature Unit	Unit process temperature -> 0 = Celsius, 1 = Fahrenheit	3XX11	byte
Qair	Airflow rate process	3XX23	float
Airflow	Measured airflow to the process	3XX35	float
Airflow Unit	Unit airflow input -> *0 = Nm3/h (default), 1 = m3/h, 2= SCFM*	3XX37	byte
vgas	Gas velocity	3XX29	float
Pressure	Ambient air pressure	3XX77	float

Mass Transfer and Oxygen Parameters:

Parameter	Description	Register Adress Decimal	Data type
Henry	Henry's law constant for gas-liquid equilibrium	3XX25	float
kLa N_2O	Volumetric mass transfer coefficient for N_2O	3XX27	float

Notes:

- All registers listed represent the **starting register** of a 2-register floating-point value, except **Status, N_2O Unit** and **Temperature Unit** which are bytes represented as 16-bit values (single register)
- Register addresses increment by sensor number while keeping the same offset.
- Example for **Sensor 1**:
    - Sensor voltage → **30101**
    - Power → **30163**
- Example for **Sensor 16**:
    - Sensor voltage → **31601**
    - Power → **31663**

Modbus TCP Input Registers

13. Overview

This section describes input register data available via Modbus TCP/IP. All airflow input values are encoded as 32-bit floating-point numbers (IEEE 754) and occupy two consecutive input registers. Sensor identification data (TagName) is stored as fixed-length strings.

14. General Addressing Scheme

- Data type: **32-bit floating point (2 registers) or Fixed-length ASCII string**
- Modbus function: **Holding Registers**
- Base address format: **4XXYY**
    - **XX** = Sensor number
    - **YY** = Parameter offset

Example

- TagName for Sensor **XX** → **4XX01**
- Airflow Input for Sensor **XX** → **4XX14**

15. N_2O Sensor TagName

Sensor TagNames are user-defined unique identifiers used to label each sensor. Each TagName is stored as a fixed-length ASCII string consisting of **24 characters plus null termination**, resulting in a total length of **13 registers** per entry. TagName entries must be read as a contiguous block.

Parameter	Description	Register Adress Decimal	Data type
TagName Sensor X	User-defined sensor identifier (ASCII string)	**4XX01**	**13**

16. Airflow Input

Airflow input values represent the airflow transmitted to the corresponding sensor. These values are updated in real time and are intended for monitoring and control purposes. The use of floating-point encoding ensures consistent accuracy and resolution across the full operating range.

Parameter	Description	Register Adress Decimal
Airflow Input Sensor X	Measured airflow input value (float, 2 registers)	**4XX14**

Notes:

- Register addresses increment by sensor number while keeping the same offset.
- Example for **Sensor 1**:
    - TagName → **40101**
    - Airflow Input → **40114**
- Example for **Sensor 16**:
    - TagName → **41601**
    - Airflow Input → **41614**