GREYSTONE
ENERGY SYSTEMS INC

NTRC Series

Temperature/Humidity Sensor

SETUP GUIDE Modbus COMMUNICATION

ModBus Protocol

This section describes the implementation of the Modbus protocol. It is intended to assist control system programmers who may need to add support to their systems to communicate with this device. This device communicates on standard Modbus networks using RTU mode transmission. It operates as a slave device (address from 1 to 255) and expects a Modbus master device to transmit queries, which it will answer.

Only map the registers that are installed and required. Excessive point mapping will lower the network performance. Some registers will not be available if the hardware option is not installed. For example, register 40004 will always read 0 if there is no Fan Speed control installed. This could also be the case if the device has no RH, setpoint, digital input or relay options.

RTU Message Format

Modbus Framing	8 bit binary
Data Bits	start bits --- 1 data bits --- 8 parity bits --- none, odd or even stop bits --- 1or 2
Baud Rate	300, 600, 1200, 2400, 4800, 9600, 19200 or 38400
Duplex	Half duplex
Error Checking	Cyclical Redundancy Check (CRC) CRC-16 --- polynomial x16+x15+x2+x0 0x8005 or reversed version 0xA001 or CRC-CITT --- polynomial x16+x12+x5+x0 0x1021 or reversed version 0x8408
Latency	More than 3.5 characters --- minimum, 50, 100, 150, 200, 250, 300 or 350 mS

RTU Framing Support and Bit Sequences

Start	1	2	3	4	5	6	7	8	Stop	
Start	1	2	3	4	5	6	7	8	Stop	Stop
Start	1	2	3	4	5	6	7	8	Odd	Stop
Start	1	2	3	4	5	6	7	8	Even	Stop

Modbus Register Addressing

Modbus Address	Typical Offset	Units	Data Type	Access	Notes
40001	+0		Word	Read	Unsigned 16-bit integer, DI_STATUS 0x0000 = OFF status, 0x0001 = ON status
40002	+1	°C/°F	Word	Read	Unsigned 16-bit integer, TEMPERATURE_VALUE x 10 Multiplier = 10 0 to 500 °C, 320 to 1220 °F
40003	+2	%RH	Word	Read	Unsigned 16-bit integer, RELATIVE_HUMIDITY_VALUE 0 to 100
40004	+3		Word	Read	Unsigned 16-bit integer, FAN_SPEED_VALUE Auto=0, Off=1, Low=2, Med=3, High=4
40005	+4		Word	Read	Unsigned 16-bit integer, OVERRIDE_STATUS 0 = override not activated, 1 = override activated Note this value is latched when the switch is pressed
40006	+5	°C/°F %RH	Word	Read Write	Unsigned 16-bit integer, SETPOINT_VALUE For °C and °F multiplier = 10, ie: 23.5 °C = 235 For %RH multiplier = 1, ie: 60 %RH = 60
40007	+6	°C/°F	Word	Read Write	Unsigned 16-bit integer, TEMPERATURE_OFFSET = 0 to 0x14 C_OFFSET = TEMPERATURE_OFFSET / 2 - 5 = -5.0 to 5.0 °C F_OFFSET = TEMPERATURE_OFFSET - 10 = -10 to 10 °F
40008	+7	%RH	Word	Read Write	Unsigned 16-bit integer, RH_OFFSET = 0 to 0x14 RH_OFF = RH_OFFSET - 10 = -10 to 10 %RH
40009	+8	°C/°F %RH	Word	Read Write	Unsigned 16-bit integer, SETPOINT_MIN See register description 10 to 20 °C or 50 to 68 °F or 10 to 60 %RH
40010	+9	°C/°F %RH	Word	Read Write	Unsigned 16-bit integer, SETPOINT_MAX See register description 20 to 30 °C or 68 to 86 °F or 30 to 80 %RH
40011	+10		Word	Read Write	Unsigned 16-bit integer, DISPLAY_MODE = 0 to 0x03 0 = None, 1 = Temp, 2 = RH, 3 = Temp + RH
40012	+11		Word	Read Write	Unsigned 16-bit integer, TEMPERATURE_UNITS 0 = °C, 1 = °F
40013	+12		Word	Read Write	Unsigned 16-bit integer, TEMPERATURE_RESOLUTION 0 = 1°, 1 = 0.5° (for LCD display)
40014	+13		Word	Read Write	Unsigned 16-bit integer, OCC_ENABLE 0 = OCC Off, 1 = OCC On (for LCD display)
40015	+14		Word	Read Write	Unsigned 16-bit integer, OVERRIDE_RESET write 0 to reset OVERRIDE_STATUS to 0
40016	+15		Word	Read Write	Unsigned 16-bit integer, RELAY_ENABLE 0 = relay Off, 1 = relay On
40017	+16		Word	Read Write	Unsigned 16-bit integer, SETPOINT_MODE 0 = temperature, 1 = %RH

40018	+17		Word	Read Write	Unsigned 16-bit integer, SETPOINT_RESOLUTION 0 = 1°, 1 = 0.5° (for temperature setpoint only)

RTU Function Codes

0x03 --- Read holding registers
Query

Slave address (0x01 to 0xFF)	Function code (0x03)	Starting address MSB	Starting address LSB	Quantity of registers MSB	Quantity of registers LSB	CRC LSB	CRC MSB

* Starting address = 0x0000 to 0x0011,   Quantity of registers = 0x0001 to 0x0012

Response

Slave address (0x01 to 0xFF)	Function code (0x03)	Byte count 2N	Register value MSB	Register value LSB	…	CRC LSB	CRC MSB

* N= Quantity of registers

0x06 --- Write single register
Query

Slave address (0x01 to 0xFF)	Function code 0x06	Register address MSB	Register address LSB	Register value MSB	Register value LSB	CRC LSB	CRC MSB

Response

Slave address (0x01 to 0xFF)	Function code 0x06	Register address MSB	Register address LSB	Register value MSB	Register value LSB	CRC LSB	CRC MSB

* Register address = 0x0005 to 0x0011,   Registers value = 0x0000 to 0xFFFF

Exception response

Slave address (0x01 to 0xFF)	Function code + 0x80	Exception code 0x01, 0x02 or 0x03	CRC LSB	CRC MSB

* An exception response is only returned if the CRC is correct
  Exception code 01 --- illegal function, 02 --- illegal address, 03 --- illegal data value

Note that the registers may be read individually or multiple registers may be read at the same time by changing the query as shown below.

To read several registers with one query…

0x03 --- Read ALL REGISTERS
Query

Slave address (0x01 to 0xFF)	0x03	0x00	0x00 (Note 1)	0x00	0x05 (Note2)	CRC LSB	CRC MSB

Response

Slave address (0x01 to 0xFF)	0x03	0x0A (Note 3)	Register value MSB	Register value LSB	. . .	CRC LSB	CRC MSB

Note 1:   The starting address (A) may be 0x0000 to 0x0011. The read multiple feature will read all registers from the starting address forward. If the starting address is 0x0000 then registers 40001 to 40018 can be read. If the starting address is 0x000A then registers 40011 to 40018 can be read.

Note 2:   The quantity of registers (N) may be 0x0001 to 0x0012, but must be limited to 18 − A. If the starting address (A) is set to 0x0000 then N may be 0x0001 to 0x0012. If the starting address is set to 0x000A then N may be 0x0001 to 0x0008.

Note 3:   The byte count (B) will always be 2N. If the quantity of registers (N) is 0x0001 then B will be 0x02. If N is 0x0005 then B will be 0x0A.

The RTU function codes supported are shown below.

0x03 --- Read DI_STATUS
Query

Slave address (0x01 to 0xFF)	0x03	0x00	0x00	0x00	0x01	CRC LSB	CRC MSB

Response

Slave address (0x01 to 0xFF)	0x03	0x02	Register value 0x00	Register value LSB	CRC LSB	CRC MSB

* Register value = 0x0000 in OFF status, ie: the Digital Input terminal is open or floating
                0x0001 in ON status, ie: the Digital Input terminal is shorted to COMMON via a dry-contact

The register will always read 0x0000 if the Digital Input option is not installed.

0x03 --- Read TEMPERATURE_VALUE
Query

Slave address (0x01 to 0xFF)	0x03	0x00	0x01	0x00	0x01	CRC LSB	CRC MSB

Response

Slave address (0x01 to 0xFF)	0x03	0x02	Register value MSB	Register value LSB	CRC LSB	CRC MSB

* Register value = 0x0000 to 0x01F4, corresponding to 0 to 50.0 °C (multiplier = 10)
      or   = 0x0140 to 0x04C4, corresponding to 32.0 to 122.0 °F (multiplier = 10)

The temperature value is either in °C or °F depending on the value of the TEMPERATURE_UNITS register.
This register has a multiplier of 10, the application must divide by 10 to obtain the correct value.

0x03 --- Read RELATIVE_HUMIDITY_VALUE
Query

Slave address (0x01 to 0xFF)	0x03	0x00	0x02	0x00	0x01	CRC LSB	CRC MSB

Response

Slave address (0x01 to 0xFF)	0x03	0x02	Register value MSB	Register value LSB	CRC LSB	CRC MSB

* Register value = 0x0000 to 0x0064, corresponding to 0 to 100 %RH (multiplier = 1)

The register will always read 0x0000 if the Relative Humidity option is not installed.

0x03 --- Read FAN_SPEED_VALUE
Query

Slave address (0x01 to 0xFF)	0x03	0x00	0x03	0x00	0x01	CRC LSB	CRC MSB

Response

Slave address (0x01 to 0xFF)	0x03	0x02	Register value MSB	Register value LSB	CRC LSB	CRC MSB

* Register value = 0x0000 corresponding to the AUTO switch setting,
        = 0x0001 corresponding to the OFF switch setting,
        = 0x0002 corresponding to the LOW switch setting,
        = 0x0003 corresponding to the MED switch setting,
        = 0x0004 corresponding to the HIGH switch setting.

The register will always read 0x0000 if the Fan Speed option is not installed.

0x03 --- Read OVERRIDE_STATUS
Query

Slave address (0x01 to 0xFF)	0x03	0x00	0x04	0x00	0x01	CRC LSB	CRC MSB

Response

Slave address (0x01 to 0xFF)	0x03	0x02	Register value 0x00	Register value LSB	CRC LSB	CRC MSB

* Register value = 0x0000 override not pressed, 0x0001 override has been pressed.
  The register will always read 0x0000 if the override option is not installed.

0x03 --- Read SETPOINT_VALUE
Query

Slave address (0x01 to 0xFF)	0x03	0x00	0x05	0x00	0x01	CRC LSB	CRC MSB

Response

Slave address (0x01 to 0xFF)	0x03	0x02	Register value MSB	Register value LSB	CRC LSB	CRC MSB

* The setpoint may be configured in various ways as required by the application.

   The setpoint may be set to control either temperature or RH using the SETPOINT_MODE register.

     For temperature, Register value = 0x0064 to 0x012C, corresponding to 10.0 to 30.0 °C (multiplier = 10)
               or   = 0x01F4 to 0x035C, corresponding to 50.0 to 86.0 °F (multiplier = 10)

     For RH,   Register value = 0x000A to 0x0050, corresponding to 10 to 80 %RH (multiplier = 1)

   If SETPOINT_MODE is set to temperature, then the SETPOINT_VALUE units will be the same as the TEMPERATURE_UNITS, either °C or °F.

   The SETPOINT_VALUE is limited by the SETPOINT_MIN and SETPOINT_MAX registers. When the setpoint is adjusted with the front panel UP/DOWN switches, it cannot go below SETPOINT_MIN or above SETPOINT_MAX.

   The SETPOINT_VALUE must step according to the setting of the SETPOINT_RESOLUTION register, either in 1° or 0.5° steps. When the setpoint is adjusted with the front panel UP/DOWN switches, it will step by either 1° or 0.5°.

   The register will always read 0x0000 if the Setpoint option is not installed.

All additional registers from 40007 to 40018 may be read in the same way, with only the register address changing.

0x06 --- Write SETPOINT_VALUE

Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x05	Register value MSB	Register value LSB	CRC LSB	CRC MSB

Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x05	Register value MSB	Register value LSB	CRC LSB	CRC MSB

* The setpoint may be configured in various ways as required by the application.

The setpoint may be set to control either temperature or RH using the SETPOINT_MODE register.

For temperature, Register value = 0x0064 to 0x012C, corresponding to 10.0 to 30.0 °C (multiplier = 10)
or = 0x01F4 to 0x035C, corresponding to 50.0 to 86.0 °F (multiplier = 10)

For RH, Register value = 0x000A to 0x0050, corresponding to 10 to 80 %RH (multiplier = 1)

If SETPOINT_MODE is set to temperature, then the SETPOINT_VALUE units will be the same as the TEMPERATURE_UNITS, either °C or °F.

The SETPOINT_VALUE is limited by the SETPOINT_MIN and SETPOINT_MAX registers. When writing to the SETPOINT_VALUE register, the value cannot go below SETPOINT_MIN or above SETPOINT_MAX.

The SETPOINT_VALUE must step according to the setting of the SETPOINT_RESOLUTION register, either in 1° or 0.5° steps. When writing to the SETPOINT_VALUE register, the value must step by either 1° or 0.5°.

If the Setpoint option is not installed, attempting to write to the register will return an exception response of illegal address.

0x06 --- Write TEMPERATURE_OFFSET

Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x06	0x00	Register value LSB	CRC LSB	CRC MSB

Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x06	0x00	Register value LSB	CRC LSB	CRC MSB

* This register is used to add or subtract an offset to the temperature value if necessary to conform to a local reference.

Register value = 0x0000 to 0x0014
For °C operation, this corresponds to T_OFFSET / 2 - 5 = -5.0 to 5.0 °C. ie: 0x0003 => 3/2 - 5 = -3.5 °C offset.
For °F operation, this corresponds to T_OFFSET - 10 = -10 to 10 °F. ie: 0x0003 => 3 - 10 = -7 °F offset.

The operating temperature units (°C or °F) for the device should be selected first, and then add any offset if necessary.

0x06 --- Write RH_OFFSET
Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x07	0x00	Register value LSB	CRC LSB	CRC MSB

Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x07	0x00	Register value LSB	CRC LSB	CRC MSB

* This register is used to add or subtract an offset to the RH value if necessary to conform to a local reference.

Register value = 0x0000 to 0x0014, corresponding to RH_OFFSET - 10 = -10 to 10 %RH.
ie: 0x0003 => 3 - 10 = -7 %RH offset.

The value of this register will have no effect if the Relative Humidity option is not installed.

0x06 --- Write SETPOINT_MIN
Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x08	Register value MSB	Register value LSB	CRC LSB	CRC MSB

Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x08	Register value MSB	Register value LSB	CRC LSB	CRC MSB

* This register sets the minimum value of adjustment for the Setpoint option.

The setpoint may be set to control either temperature or RH using the SETPOINT_MODE register.

For temperature, Register value = 0x0064 to 0x00C8, corresponding to 10.0 to 20.0 °C (multiplier = 10)
or = 0x01F4 to 0x02A8, corresponding to 50.0 to 68.0 °F (multiplier = 10)

For RH, Register value = 0x000A to 0x003C, corresponding to 10 to 60 %RH (multiplier = 1)

If SETPOINT_MODE is set to temperature, then the SETPOINT_VALUE units will be the same as the TEMPERATURE_UNITS, either °C or °F.

The SETPOINT_VALUE is limited by the SETPOINT_MIN and SETPOINT_MAX registers. When the setpoint is adjusted with the front panel UP/DOWN switches, it cannot go below SETPOINT_MIN or above SETPOINT_MAX.

The SETPOINT_VALUE must step according to the setting of the SETPOINT_RESOLUTION register, either in 1° or 0.5° steps. When the setpoint is adjusted with the front panel UP/DOWN switches, it will step by either 1° or 0.5°.

The register will have no effect if the Setpoint option is not installed.

0x06 --- Write SETPOINT_MAX
Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x09	Register value MSB	Register value LSB	CRC LSB	CRC MSB

Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x09	Register value MSB	Register value LSB	CRC LSB	CRC MSB

* This register sets the maximum value of adjustment for the Setpoint option.

The setpoint may be set to control either temperature or RH using the SETPOINT_MODE register.

For temperature, Register value = 0x00C8 to 0x012C, corresponding to 20.0 to 30.0 °C (multiplier = 10)
or = 0x02A8 to 0x035C, corresponding to 68.0 to 86.0 °F (multiplier = 10)

For RH, Register value = 0x001E to 0x0050, corresponding to 30 to 80 %RH (multiplier = 1)

Conditions and operation are the same as for SETPOINT_MIN.

The register will have no effect if the Setpoint option is not installed.

0x06 --- Write DISPLAY_MODE
Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x0A	0x00	Register value LSB	CRC LSB	CRC MSB

Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x0A	0x00	Register value LSB	CRC LSB	CRC MSB

* Register value = 0x0000 = no display, no backlight (except for menu operation)
= 0x0001 = temperature value only is displayed
= 0x0002 = RH value only is displayed
= 0x0003 = temperature and RH values toggle every 5 seconds

A temperature only device will not have options 2 or 3 (the default = 1).
A temperature plus RH device has default = 3.

0x06 --- Write TEMPERATURE_UNITS
Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x0B	0x00	Register value LSB	CRC LSB	CRC MSB

Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x0B	0x00	Register value LSB	CRC LSB	CRC MSB

* Register value = 0x0000 = sets the device to °C operation
= 0x0001 = sets the device to °F operation

0x06 --- Write TEMPERATURE_RESOLUTION
Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x0C	0x00	Register value LSB	CRC LSB	CRC MSB

Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x0C	0x00	Register value LSB	CRC LSB	CRC MSB

* Register value = 0x0000 = sets the LCD display temperature resolution to 1° (ie: 23 °C)
        = 0x0001 = sets the LCD display temperature resolution to 0.5° (ie: 23.5 °C)

0x06 --- Write OCC_ENABLE
Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x0D	0x00	Register value LSB	CRC LSB	CRC MSB

Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x0D	0x00	Register value LSB	CRC LSB	CRC MSB

* Register value = 0x0000 = turns the LCD OCC symbol off , = 0x0001 = turns the LCD OCC symbol on

0x06 --- Write OVERRIDE_RESET
Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x0E	0x00	Register value LSB	CRC LSB	CRC MSB

Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x0E	0x00	Register value LSB	CRC LSB	CRC MSB

* If the OVERRIDE_STATUS has been activated, write 0x0000 to this register to reset it back to 0x0000.
  The register will have no effect if the Override option is not installed.

0x06 --- Write RELAY_ENABLE
Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x0F	0x00	Register value LSB	CRC LSB	CRC MSB

Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x0F	0x00	Register value LSB	CRC LSB	CRC MSB

* Register value = 0x0000 = turns the relay off
        = 0x0001 = turns the relay on
  The register will have no effect if the Relay option is not installed.

0x06 --- Write SETPOINT_MODE
Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x10	0x00	Register value LSB	CRC LSB	CRC MSB

Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x10	0x00	Register value LSB	CRC LSB	CRC MSB

* Register value = 0x0000 = sets the setpoint mode to temperature
= 0x0001 = sets the setpoint mode to %RH

The register will have no effect if the Setpoint option is not installed.

0x06 --- Write SETPOINT_RESOLUTION
Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x11	0x00	Register value LSB	CRC LSB	CRC MSB

Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x11	0x00	Register value LSB	CRC LSB	CRC MSB

* Register value = 0x0000 = sets the temperature setpoint resolution to 1° (ie: 23 °C)
= 0x0001 = sets the temperature setpoint resolution to 0.5° (ie: 23.5 °C)

This setting has no effect if the SETPOINT_MODE is set to %RH.

The register will have no effect if the Setpoint option is not installed.

Exception response

Slave address (0x01 to 0xFF)	Function code + 0x80	Exception code * 0x01, 0x02 or 0x03	CRC LSB	CRC MSB

* An exception response is only returned if the CRC is correct
Exception code 01 --- illegal function
Exception code 02 --- illegal address
Exception code 03 --- illegal data value

Modbus Trouble-shooting

The device operates as a slave. It will not communicate unless a master is connected to the network and sends a request for information, then the slave will answer. If the device does not communicate properly, first check that the communication wires are not reversed. Then check the communication parameters in the menu in the following sequence: Network address, baud rate, parity bit, stop bit, CRC polynomial and slave response delay.

The factory default Modbus address is 03 and each device must have its unique address to communicate properly on the bus. Use the menu to change the Slave address to a unique number for each unit.

The default Modbus baud rate is 9600. Use the menu to change the baud rate to the correct setting.

The default Modbus parity is None. If this is not correct, use the menu to change the parity from None to Odd or Even.

The default stop bits is 1. Use the menu to change the stop bit setting to 2. For some configurations the value is fixed.

The default Modbus CRC value is A001. The menu can be used to change this setting. It is the CRC polynomial setting and can be changed between A001, 1021, 8005 or 8408.

The default Modbus delay is minimum (0). This can be changed in the menu. It is the slave response delay and can be set from minimum to 350ms. For example, the minimum delay means 3.5 character time delays or 4ms for 9600 baud rate.