SENSAPHONE®
REMOTE MONITORING SOLUTIONS

SENSAPHONE TEMPERATURE/HUMIDITY SENSOR • FGD-0110
Installation Instructions

Introduction
The Modbus Temperature/Humidity Sensor features embedded ModBus communication. The basic unit accurately measures room temperature and RH measurement. The device connects to an RS-485 Modbus network to offer a single-point solution for monitoring indoor air quality and comfort. Features include a back-lit LCD and user menu for easy installation.

Before Installation
Read these instructions carefully before installing and commissioning the device. Failure to follow these instructions may result in product damage. Do not use in an explosive or hazardous environment, with combustible or flammable gases, as a safety or emergency stop device or in any other application where failure of the product could result in personal injury. Take electrostatic discharge precautions during installation and do not exceed the device ratings.

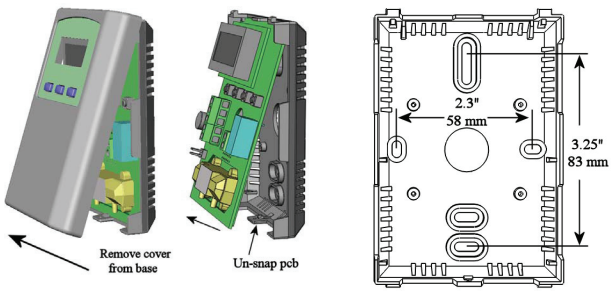
Set-up
The device parameters must be set before connection to the network and will ensure each device will have a unique address and the correct baud rate. Once set, all parameters are saved in non-volatile memory. The local menu and LCD are used to set the BACnet MAC device address (0-127) or the ModBus address (1-255) and the baud rate. The factory defaults are address 3 and 9600 baud. The menu and setup procedure is described in the Setup Menu section.

Mounting
The room type sensor installs directly on a standard electrical box and should be mounted five feet from the floor of the area to be controlled. Do not mount the sensor near doors, opening windows, supply air diffusers or other known air disturbances. Avoid areas where the detector is exposed to vibrations or rapid temperature changes.

The cover is hooked to the base at the top edge and must be removed from the bottom edge first. Use a small screwdriver to carefully pry each bottom corner if necessary. If a security screw is installed on the bottom edge, then it may have to be loosened or removed also. Tip the cover away from the base and sit it aside.

The pcb must be removed from the base to access the mounting holes. Follow usual anti-static procedures when handling the pcb and be careful not to touch the sensors. The pcb is removed by pressing the enclosure base to unsnap the latch near the bottom edge, then the pcb can be lifted out of the base. Sit the pcb aside until the base is mounted on the wall.

After the base is screwed to an electrical box or the wall using the appropriate holes, pull the wires through the wiring hole in the center of the pcb and then reinstall it in the enclosure base. Ensure the pcb is snapped into the base securely and correctly. The mounting hole locations are shown in the following drawing.



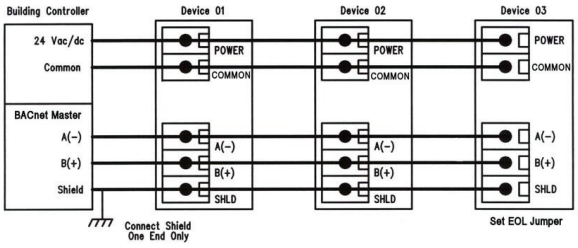
Wiring
Deactivate the 24 Vac/dc power supply until all connections are made to the device to prevent electrical shock or equipment damage. Follow proper electrostatic discharge (ESD) handling procedures when installing the device or equipment damage may occur. Use 22 AWG shielded wiring for all connections and do not locate the device wires in the same conduit with wiring used to supply inductive loads such as motors. Make all connections in accordance with national and local codes.

Connect the 24 Vac/dc power supply to the terminals labeled POWER and COMMON. Use caution if 24 Vac power is used and one side of the transformer is earth-grounded. In general, the transformer should NOT be connected to earth ground when using devices with RS-485 network connections. The device is reverse voltage protected and will not operate if connected backwards.

Connect the RS-485 network with twisted shielded pair to the terminals marked A(-), B(+) and SHIELD.

The positive wire connects to B(+) and the negative wire connects to A(-) and the cable shield must be connected to the SHIELD terminal on each device. If the device is installed at either end of an RS-485 network, an end-of-line (EOL) termination resistor (121 ohm) should be installed in parallel to the A(-) and B(+) terminals. This device includes a network termination jumper and will connect the 121 ohm resistor correctly on the pcb. Simply move the jumper to the EOL position and no external resistor is required. The ground wire of the shielded pair should be connected to earth ground at the end of the network and the master is not grounded. Do not run bus wiring in the same conduit as line voltage wiring or other wiring that switches power to highly inductive loads such as contactors, coils or motors.

A network segment is a single shielded wire loop run between several devices (nodes) in a daisy chain configuration. The total segment length should be less than 4000 feet (1220 meters) and the maximum number of nodes on one segment is 64. Nodes are any device connected to the loop and include controllers, repeaters and sensors such as this one but do not include the EOL terminators. To install more than 64 devices, or to increase the network length, repeaters will be required for proper communication. The maximum daisy chain length (segment) depends on transmission speed (baud rate), wire size and number of nodes. If communication is slow or unreliable, it may be necessary to wire two daisy chains to the controller with a repeater for each segment.



Start-up
Verify the transmitter is properly wired and connections are tight. Apply power and note that the LCD will indicate the software version number and then the device will begin reading the sensor values and display them on the LCD.

Operation
In normal operation the device reads the temperature and RH sensors and updates the register (ModBus) values accordingly. The LCD displays the sensor values as determined by the display mode object for either temperature only, RH only, both or none. Temperature units can be set to either C or F and the display resolution can be set also.

More details on the above features can be found in the following sections.

Setup Menu

To enter the menu, press and release the <MENU> key while in normal operation. This will enter the Setup menu step 1, pressing the <MENU> key a second time advances to step 2. Each press of the <MENU> key advances the menu item. No values are saved or changed by using the <MENU> key. The <UP> and <DOWN> keys are used to make changes to program variables by scrolling through the available options. When a value is changed, use the <SAVE> key to save it to memory and advance to the next menu item. Actual menu displays with the default value are shown.

<MENU> Press and release the <MENU> key to enter the Setup menu.

1. 

Network Protocol

Use <UP> or <DOWN> to select either bAC (BACnet) or bUS (ModBus) protocol.

Press <SAVE> to save the value. The default is bAC (BACnet).

<MENU>

2. 

Network Address

Press <UP> or <DOWN> to select a unique network address. It can be set from 1-255 for ModBus or from 0-127 for BACnet. The default address is 3. Press <SAVE> to save the setting and advance the menu.

<MENU>

3. 

Baud Rate

Use <UP> or <DOWN> to select a baud rate of 30 (300), 60 (600), 120 (1200), 240 (2400), 384 (38400), 480 (4800), 960 (9600) or 192 (19200) for ModBus or 960 (9600), 192 (19200), 384 (38400) or 768 (76800) for BACnet. The default baud rate is 960 (9600). Press <SAVE> to save the setting and advance the menu.

<MENU>

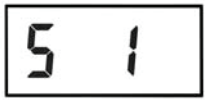
Items 4 to 7 are only shown if the protocol is set to ModBus RTU in Step 1

4. 

ModBus Parity

Use <UP> or <DOWN> to select a parity value of n (none), O (odd) or E (even). The default ModBus parity bit is n (none). Press <SAVE> to save the value.

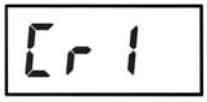
<MENU>

5. 

ModBus Stop Bits

Use <UP> or <DOWN> to set the stop bits to 1 or 2. The default ModBus stop bits is 1.

<MENU>

6. 

ModBus CRC

Use <UP> or <DOWN> to select a CRC value of 1 (A001 = CRC-16 reverse), 2 (1021 = CITT), 3 (8005 = CRC-16) or 4 (8408 = CITT reverse). The default CRC is 1
(polynomial is 0XA001).

<MENU>

7. 

ModBus Delay

Use <UP> or <DOWN> to change the value from 0 (minimum) to 50, 100, 150, 200, 250, 300 or 350 ms. The factory default slave response delay is 0 (minimum). Minimum delay means just more than 3.5 character time delays, 4ms for 9600 baud rate, for example.

<MENU>

Exits the menu and returns to normal operation.

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
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
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
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)
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 value 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	Register address LSB	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

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

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.

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.

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 DISPLAY_MODE

Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x00A	0x00	Register value LSB	CRC LSB	CRC MSB

Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x00A	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	0x00B	0x00	Register value LSB	CRC LSB	CRC MSB

Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x00B	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	0x00C	0x00	Register value LSB	CRC LSB	CRC MSB

Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x00C	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)

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.

General Specifications

Power Supply . . . . . 20 – 28Vac/dc (non-isolated half-wave rectified)
Consumption . . . . . 35 mA max @ 24 Vdc
Protection Circuitry . . . . . Reverse voltage protected, overvoltage protected
Operating Conditions . . . . . 32-122°F (0-50°C), 0-95 %RH non-condensing
Wiring Connections . . . . . Screw terminal block (14 to 22 AWG)
Enclosure . . . . . Wall mount enclosure, 3.3”w x 4.7”h x 1.15”d (84 x 119 x 29 mm)

Temperature
Sensing Element . . . . . 10K thermistor, ± 0.4°F (± 0.2°C)
Range . . . . . 32-122 °F (0-50°C)

Interface
Hardware 2-wire RS-485
Baud Rate. . . . . Locally set from 300 - 76800
Network Address Range . . . Locally set to 1-255 for ModBus (factory default is 3) (63 devices max on one daisy chain)

LCD Display
Resolution . . . . . 0.5°/1°C or 0.5°/1° F (selectable), 1 %RH
Size . . . . . 1.5” w x 0.65” h (38.1 x 16.5 mm) 3 digit
Backlight . . . . . Auto-dimming, enable or disable via jumper
Optional RH Signal
Sensor . . . . . Thermoset polymer based capacitive
Accuracy . . . . . ±2 %RH
Range . . . . . 0-100 %RH, non-condensing
Resolution . . . . . 1 %RH
Hysteresis. . . . . ±1.5 %RH
Response Time . . . . . 15 seconds typical
Stability . . . . . ±1.2 %RH typical @ 50 %RH in 5 years