MBUS_RTH User Guide (for firmware version 293)

Features:

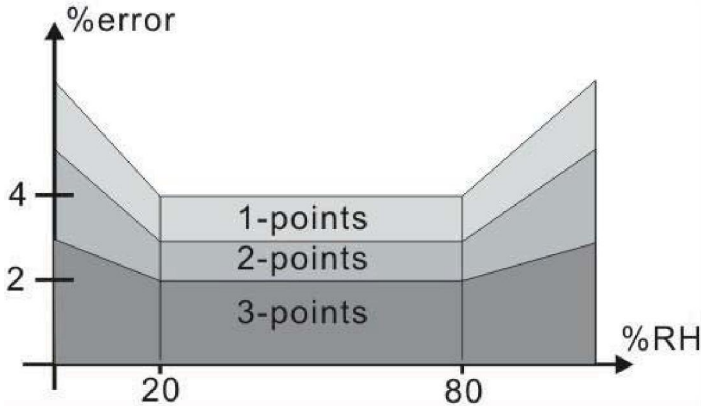
- High Impact Plastic Enclosure provides durability in Industrial & Commercial Environments
- Low Power Consumption
- Temperature and Humidity readings from a single sensor
- Network RS485 Communication via Modbus RTU
- Built-in 0-5V/10V transducers to convert the sensor readings to analog outputs.

Supply voltage	12~24VAC +/- 20%, 50-60Hz: 12-24VDC +/- 20%
Power consumption	55mA at 24Vdc
Operation	10-37°C (50-99°F)
Storage	2-50°C (35-122°F)
Ambient humidity range	0-99%Rh non condensing
Humidity Sensor Element	Humirel HS1101 (2% Accuracy from 10-90%)
Material, enclosure	Flame proof plastic
Enclosure rating	IP31
Temperature sensor	10K thermistor (± 0.5°C Accuracy)
Color	White/Off-white
Weight	200g

The MBUS_RTH sensor monitors temperature and humidity in the space.

Humidity monitoring is done with the Humirel HS1101 sensor element. The Humirel Sensing Element exhibits linear behavior with respect to Relative Humidity. This reduces its complexity and increases its reproducibility and reliability to an overall 2% accuracy. Nonetheless, with error induced in PCB production and associated chips production, accuracy may be slightly lower.

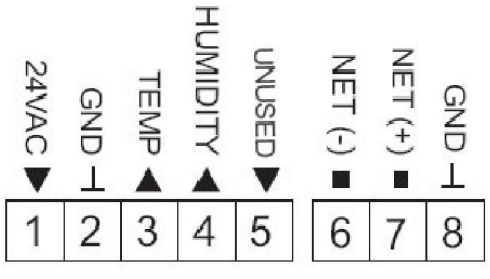
Performing at least a 3 point calibration procedure under a controlled humidity environment can be implemented to give an accuracy of 2% in the range of 10 to 90%.



The controller monitors temperature conditions in the space using a built-in thermistor sensor. It is located in such a way that it is not affected by the temperature of the wall or by internal heat created in the device cavity.

External wiring is connected to a terminal block on the back of the sensor.

1	24VAC live or + 24VDC (24VAC is recommended if using voltage outputs)
2	24VAC / 24VDC Common / Measurement neutral
3	Temperature Analog output 0-10V
4	Humidity Analog output 0-10V
6,7,8	Network communication



MODBUS Registers.

- Communication via RS485 at 19200, 8, None, 1

REG	BYTES	RANGE	DEFAULT	DESCRIPTION
4	1	0-255	- -	Software Version Lo Byte (37 for v293)
5	1	0-255	- -	Software Version Hi Byte (1 for v293)
6	1	0-255	254	ADDRESS. Modbus device address
7	1	0-255	13	Product Model # : MBUS_RTH = 13
8	1	0-255	- -	Hardware Version (varies)
9	1	0-255	3	PIC Firmware Version
100	2	0-3000	- -	**ROOM TEMPERATURE reading in DegF x 10**
101	2	0-3000	- -	**ROOM TEMPERATURE reading in DegC x 10** Writing a temperature value to this register will calibrate the temp by automatically adjusting the calibration register (217)
102	2	0-1000	- -	**ROOM HUMIDITY reading in %RH x 10**
121	1	0-1	0	Mode for Temp 0-10V Analog output. 0=DegC/10, 1=DegF/10
185	1	0-1	1	Baudrate: 0=9600, 1=19200
186	1	1-2	1	Voltage Output Range for AO's: 1=0-10V, 2=0-5V
217	2	0-1000	500	Temperature Calibration. Default value of 500 means an offset of 0. Each unit is equivalent to a temp offset of 0.1Deg.
220	2	0-1000	- -	humidity calibration RH value # 1
221	2	0-10000	- -	humidity calibration Sampling value # 1
222	2	0-1000	- -	humidity calibration RH value # 2
223	2	0-10000	- -	humidity calibration Sampling value # 2
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238	2	0-1000	- -	humidity calibration RH value # 10
239	2	0-10000	- -	humidity calibration Sampling value # 10
304	2	0-1000	- -	**RELATIVE HUMIDITY reading.** Writing a humidity value to this register will do calibration, for details, refer to Humidity Calibration.
305	2	0-10000	- -	Current Humidity Sampling Value
312	1	3-10	3	Number of Humidity Calibration points to use
313	1	0-2	0	Set this to 1 in order to back up humidity calibration values Set this to 2 in order to restore the backed up values

Reading the Temperature using the 0-10V output

To measure the temperature using a 0-10V analog input, simply connect your input to Pt.3 on the MBUS_RTH terminal block and connect your input common to Pt.2 on the MBUS_RTH terminal block. The voltage that you read corresponds to the actual temperature as follows:

Temperature (DegC) = (Volt x 10) + offset offset should be determined when calibrating

Reading the Humidity using the 0-10V output

To measure the humidity using a 0-10V analog input, simply connect your input to Pt.4 on the MBUS_RTH terminal block and connect your input common to Pt.2 on the MBUS_RTH terminal block. The voltage that you read corresponds to the actual humidity as follows:

%RH = (Volt x 10) + offset offset should be determined when calibrating

CALIBRATION

Calibration tips:

- The main error in calibration comes from not waiting long enough for everything to come to equilibrium.
- For temperature, the sensor inside the thermostat is a digital chip capable of resolving down to 0.06°C so the weak link in calibrating is usually the procedure used rather than the sensor accuracy.
- Make sure the sensor is mounted in a location free of drafts.
- The thermostat should be powered up for 5 minutes prior to any calibration.
- If using the voltage outputs to measure the temp & humidity, it is recommended to use 24VAC as the power source for the unit, because the voltage outputs will be most stable in this configuration.

Temperature Calibration

To calibrate the temperature you will need a handheld mercury or digital thermometer. Hold the meter close to the thermostat and allow it to come to equilibrium. Connect the MBUS_RTH sensor to a PC with a RS485 cable. Run a Modbus Tool that can display & modify the registers.

After the temperature settles, write the correct temperature in DegC x 10 to **Register 101**, which will automatically adjust the calibration register 217 by the proper amount. Or you can also directly adjust the calibration register 217 to have the same affect.

You can repeat writing if necessary until the readings from the thermostat and meter agree. Note that the written value should be ten times the actual temperature. For example, if the temp is 22.3 DegC you should write 223 to Reg101.

The thermostat will store the calibration figures through extended power outages and should not need to be adjusted for many years. When calibrating, make sure to let everything come to equilibrium. The thermostat should be powered up for 5 minutes prior to calibration and the thermometer should be left near the thermostat during that time.

See the Humidity calibration process on the next page.

Note: To initially configure, test, and calibrate the MBus_RTH it is helpful to have a pc based modbus software tool such as "Modbus Poll" which can be downloaded from www.modbustools.com

Humidity Calibration (this set of instructions is valid for MBUS_RTH software version 293)

To do 3pt calibration of the Humidity:

1) First write a value of 3 to register 312 to specify the number of calibration sets as 3 points.
2) Next, you need to make sure that registers 220-225 (used for the top 3 calibration sets) contain valid numbers. If there are not valid numbers in those registers then you will not be able to write in the calibration values as needed during the calibration process. You can use Register 304 to preset Registers 220-225 with valid default values by doing the following:
   - Write a value of 950 into register 304. This will populate Registers 220-221 with default values.
   - Write a value of 750 into register 304. This will populate Registers 222-223 with default values.
   - Write a value of 550 into register 304. This will populate Registers 224-225 with default values.
3) Now that there are valid numbers stored in Registers 220-225, you can manually write your desired calibration values into those registers for your 3 calibration sets by using a calibrated humidity instrument and the humidity sampling value in Register 305 of the MBUS_RTH as explained below.

Example: Assuming that you've completed steps 1 & 2 above, let's say that you want to do a 3pt calibration for the MBUS_RTH at values of around 35%, 50%, and 65%:

1st CALIBRATION SET - REGISTERS 220-221:

A. Put the MBUS_RTH sensor and your calibrated instrument into an environment where the humidity value is close to 65%.
B. Watch your calibrated Humidity instrument and wait until the %RH reading in that environment steadies out to some value that is close to 65%. Let's say it steadies out at 63.5%RH for this example.
C. Write the value of 635 (%RH value x 10) into Register 220, which contains the humidity value for the first calibration set.
D. Note the current Humidity Sampling Value that the MBUS_RTH sensor is showing in Register 305 and write that value into Register 221, which contains the Humidity Sampling Value for calibration set # 1.

2nd CALIBRATION SET - REGISTERS 222-223:

E. Put the MBUS_RTH sensor and your calibrated instrument into an environment that is close to 50%.
F. Watch your calibrated humidity instrument and wait until the %RH steadies out somewhere around 50%RH. Let's say 52% for this example.
G. Write the value of 520 (%RH value x 10) into Register 222, which contains the humidity value for the 2nd calibration set.
H. Note the current Humidity Sampling Value that the MBUS_RTH sensor is showing in Register 305 and write that value into Register 223, which holds the sampling value for the 2nd Calibration Set.

3rd CALIBRATION SET - REGISTERS 224-225

I. Put the MBUS_RTH sensor and your calibrated instrument into an environment that is close to 35%
J. Watch your calibrated humidity instrument and wait until the %RH steadies out somewhere around 35%RH. Let's say 34.2% for this example.
K. Write the value of 342 (%RH value x 10) into Register 224, which contains the humidity value for the 3rd calibration set.
L. Note the current Humidity Sampling Value that the MBUS_RTH sensor is showing in Register 305 and write that value into Register 225, which holds the sampling value for the 3rd Calibration Set.

NOTE: You can back up the calibration value pairs by writing a 1 to Register 313. To restore the values write a 2 to Register 313.

IF YOU WANT TO DO MORE THAN A 3PT CALIBRATION:

- Write the number of calibration sets that you want to use in Modbus Register 312 of the MBUS_RTH.
- Use Register 304 to write good starting values into all of the registers that your calibration sets will use. An example of how this works for the 3pt calibration process is shown in part 1 & 2 at the top of this page.
- We have a spreadsheet (next page) that shows the values that you need to write into Reg304 in order to preset the calibration registers with valid values. The values that you need to write will change based on the # of calibration sets defined in Reg312.
- Once you've written valid values into all of the calibration registers, you can go in and manually modify the values using your calibrated humidity instrument and the humidity sample value from Reg305 (as explained in the example 3pt process above).

10 calibration points

Register #	220	will be written if value is >=	901	AND <=	999
Register #	222	will be written if value is >=	813	AND <=	900
Register #	224	will be written if value is >=	725	AND <=	812
Register #	226	will be written if value is >=	637	AND <=	724
Register #	228	will be written if value is >=	549	AND <=	636
Register #	230	will be written if value is >=	461	AND <=	548
Register #	232	will be written if value is >=	373	AND <=	460
Register #	234	will be written if value is >=	285	AND <=	372
Register #	236	will be written if value is >=	197	AND <=	284
Register #	238	will be written if value is >=	109	AND <=	196

8 calibration points

Register #	220	will be written if value is >=	901	AND <=	999
Register #	222	will be written if value is >=	791	AND <=	900
Register #	224	will be written if value is >=	681	AND <=	790
Register #	226	will be written if value is >=	571	AND <=	680
Register #	228	will be written if value is >=	461	AND <=	570
Register #	230	will be written if value is >=	351	AND <=	460
Register #	232	will be written if value is >=	241	AND <=	350
Register #	234	will be written if value is >=	131	AND <=	240

7 calibration points

Register #	220	will be written if value is >=	901	AND <=	999
Register #	222	will be written if value is >=	776	AND <=	900
Register #	224	will be written if value is >=	651	AND <=	775
Register #	226	will be written if value is >=	526	AND <=	650
Register #	228	will be written if value is >=	401	AND <=	525
Register #	230	will be written if value is >=	276	AND <=	400
Register #	232	will be written if value is >=	151	AND <=	275

6 calibration points

Register #	220	will be written if value is >=	901	AND <=	999
Register #	222	will be written if value is >=	755	AND <=	900
Register #	224	will be written if value is >=	609	AND <=	754
Register #	226	will be written if value is >=	463	AND <=	608
Register #	228	will be written if value is >=	317	AND <=	462
Register #	230	will be written if value is >=	171	AND <=	316

5 calibration points

Register #	220	will be written if value is >=	901	AND <=	999
Register #	222	will be written if value is >=	725	AND <=	900
Register #	224	will be written if value is >=	549	AND <=	724
Register #	226	will be written if value is >=	373	AND <=	548
Register #	228	will be written if value is >=	197	AND <=	372

4 calibration points

Register #	220	will be written if value is >=	901	AND <=	999
Register #	222	will be written if value is >=	681	AND <=	900
Register #	224	will be written if value is >=	461	AND <=	680
Register #	226	will be written if value is >=	241	AND <=	460

3 calibration points

Register #	220	will be written if value is >=	901	AND <=	999
Register #	222	will be written if value is >=	608	AND <=	900
Register #	224	will be written if value is >=	315	AND <=	607