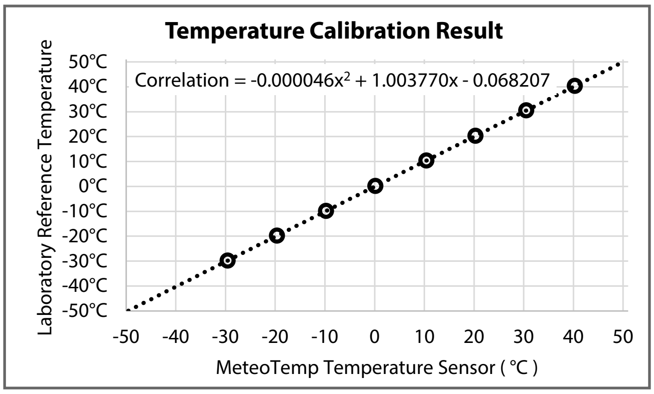
MODBUS sensor Calibration

BARANIDESIGN

RS-485 SENSOR WIRE COLORS (unified for all BARANI sensors)			
WHITE = GND	BROWN = VCC	GREEN = A	YELLOW = B
POWER & COM GROUND	POWER FOR SENSORS	NON-INVERTING	INVERTING

General Info

- Accredited laboratory calibration report for Temperature, Humidity, Pressure or Wind Speed usually contains a calibration equation for each measured variable.
- Calibration equation relates the readings shown by the tested sensor to the laboratory reference values.
- BARANI sensors accept linear and quadratic equations.
- Ultra-low power consumption of BARANI sensors ensures highly accurate readings of temperature & humidity, since self heating is negligible.
- TRACEABILITY is maintained because calibration coefficients are permanently stored in sensor memory until rewritten after recalibration and can be read out at any time via a simple MODBUS request.



- It is recommended to store previous calibration coefficient values to be able to see the long term behavior of the sensor and to have a record about the long term traceability.
- Sensor uncertainty defines (with 68% confidence) that the "true temperature" is within the stated sensor accuracy (ex. ±0.2°C) It includes all factors potentially influencing the sensor measurement. All these factors together are called the uncertainty budget.
- Final uncertainty can be calculated according to the internationally excepted document Evaluation of measurement data – Guide to the expression of uncertainty in measurement.
- Final uncertainty from a calibration certificate is the basic 68% uncertainty expanded to 95% or 99.7% confidence. (ex. if 68% = ±0.2°C, then 95% doubles the range to ±0.4°C, and 98.7% tripples the range to ±0.6°C)

Temperature calibration procedure example

- Calibration certificate contains a table of values relating laboratory accredited instrument readings to the tested sensor readings as shown on the right. A plot may also be provided as shown.
- Table of readings will contain columns for: laboratory reference sensor, tested sensor and residual difference between sensor and laboratory.
- Based on this table a plot is created (usually contained in the calibration report) which relates the laboratory reference values on the vertical axis to the tested sensor output on the horizontal axis.
- A regression curve fit is then created through the points of the plot by the laboratory and supplied with the calibration report as shown by the dotted line in plot at right:
  Correlation = -0.000046*raw^2 + 1.003770*raw - 0.068207.

Temperature Calibration Result				
Laboratory reference	Sensor		Residual	
	Before	After	Before	After
-29,80 °C	-29,58 °C	-29,80 °C	-0,22 °C	0,00 °C
-19,80 °C	-19,64 °C	-19,80 °C	-0,16 °C	0,00 °C
-9,90 °C	-9,79 °C	-9,90 °C	-0,11 °C	0,00 °C
0,10 °C	0,17 °C	0,10 °C	-0,07 °C	-0,00 °C
10,40 °C	10,43 °C	10,40 °C	-0,03 °C	0,00 °C
20,30°C	20,31°C	20,30°C	-0,01°C	0,00°C
30,50°C	30,50°C	30,50°C	0,00°C	-0,00°C
40,30°C	40,29°C	40,30°C	0,01°C	0,00°C

- This regression curve is the relationship between the tested sensor readings and laboratory readings. In this example, it has the form of a quadratic equation containing coefficients with 6 significant digits (BARANI sensors accept up to 9 significant digits).
- To obtain calibrated readings from a sensor, these equation coefficients need to be entered and saved in the sensor via simple MODBUS commands as instructed below.
- "Raw" value is the uncalibrated output value of the tested sensor.

Entering & saving equation coefficients via MODBUS (ASCII & RTU) protocol

1. Table on the following page contains names, register offset (address), and values of each coefficient for all BARANI sensors.
2. Input each coefficient of the calibration equation supplied in your calibration report into applicable register in IEE754 single precision floating point format (4 bytes).
3. **Save changes by inputing integer value 6 into holding register 11** to permanently store the new coefficient values in the sensor EEPROM memory.
4. Remember to always check that the new values are properly written in the sensor memory by reading them out from their memory registers after cycling (off/on) the power to the sensor.

Calibration instructions for 3rd party Modbus Poll software and supporting configuration files for Modbus Poll can be found here: http://bit.ly/2ghngHd Modbus Poll software can be obtained from http://www.modbustools.com

Register offset	Register name	Value type	Calibration equation: calibrated output = Cx2 + Bx + A | raw = uncalibrated raw output of sensor
Temperature sensor			
22	kt1[0]	f32	float temperature [°C]
23			
24	kt1[1]	f32	temperature = kt1[2]*raw² + kt1[1]*raw + kt1[0]
25			
26	kt1[2]	f32	
27			
Barometric pressure sensor			
42	kp[0]	f32	float pressure [Pa]
43			
44	kp[1]	f32	pressure = kp[2]*raw² + kp[1]*raw + kp[0]
45			
46	kp[2]	f32	
47			
Humidity sensor			
52	krh[0]	f32	float humidity [%]
53			
54	krh[1]	f32	humidity = krh[2]*raw² + krh[1]*raw + krh[0]
55			
56	krh[2]	f32	
57			
Wind speed sensor (anemometer)			
62	kws[0]	f32	float wind speed [ms-1]
63			
64	kws[1]	f32	
65			
66	kws[2]	f32	speed = kws[4]*raw⁴ + kws[3]*raw³ + kws[2]*raw² + kws[1]*raw+kws[0]
67			
68	kws[3]	f32	
69			
70	kws[4]	f32	
71			
Wind direction sensor (wind vane)			
73	kwd[1]	u16	angle [°]
kwd[1] is calculated by user			kwd[1] = (angle -raw) / 360 * 1024
Rain sensor (rain gauge)			
74	krn[0]	f32	rain [mm]
75			
76	krn[1]	f32	rain = raw*krn[1] + krn[0]
77			

NOTES:

1.

FACTORY MODBUS SETTINGS

MODBUS RTU: 19200/8/N/1 *

(Speed=19200 Baud / parity=none / stop bit=1 / MODBUS Address=1)

* Address/baud speed/parity/stop-bits are user selectable.

Additional information

Sensor connection recommendations & for MODBUS communication protocol details: see MODBUS Quick Guide.