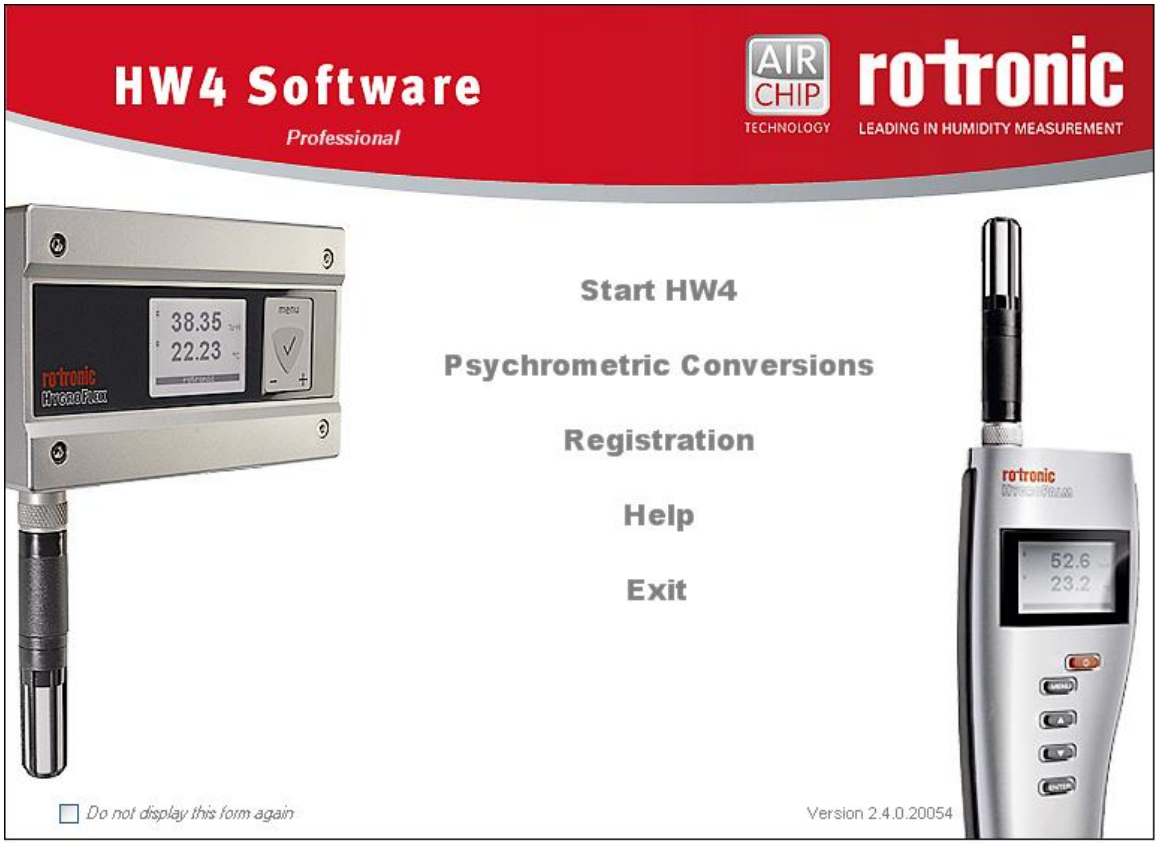
HW4 Software version 2

Humidity and Temperature Adjustment AirChip 3000 devices



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1 ORGANIZATION OF THE HW4 MANUALS

The HW4 manuals are organized in separate books so as to limit the size of the individual documents. A list of the HW4 manuals is provided in document **E-M-HW4v2-DIR**

HW4 Manuals	Contents
HW4 Main Book	General software description Installation, start-up and settings Device connection methods Functions common to all devices used with HW4
Device Specific Functions 1 (separate book for each device type or model)	Legacy devices (original HygroClip technology): o HygroLog NT data logger o HygroFlex 2, HygroFlex 3 and M3 transmitters (same icon in device tree) o HygroLab 2 and HygroLab 3 bench indicators o HygroPalm 2 and HygroPalm 3 portable indicators o HygroClip DI digital interface o HygroClip Alarm programmable logic o HygroStat MB Device Manager (device configuration) and other device specific functions
Probe Adjustment 1	Humidity and temperature adjustment function common to all legacy devices (original HygroClip technology)
Device Specific Functions 2 (separate book for each device type or model)	Devices based on the AirChip 3000 technology: o HygroClip 2 (HC2) probes o HF3 transmitters and thermo-hygrostats o HF4 transmitters o HF5 transmitters o HF6 transmitters o HF7 transmitters o HL20 and HL21 data loggers o HP21, HP22 and HP23 hand-held indicators o Custom designed OEM products Device Manager (device configuration) and Data Logging functions
Probe Adjustment 2	Humidity and temperature adjustment function common to all devices based on the AirChip 3000 technology
Data Recording Function	Data recording function common to all devices based on the AirChip 3000 technology

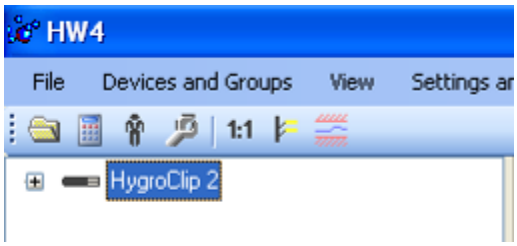
Both the HW4 manuals (software) and device specific manuals (hardware) are available on the HW4 CD. The manuals can also be downloaded from several of the ROTRONIC web sites.

2 OVERVIEW

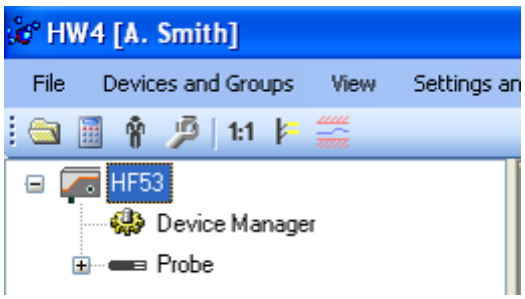
The Probe Adjustment function is used to adjust the HC2 probes and other AirChip 3000 devices against a reference humidity and temperature environment. This section of the HW4 manual covers only the HW4 Probe Adjustment function specific of AirChip 3000 devices such as:

- HygroClip 2 (HC2) probes
- HF3 transmitters and thermo-hygrostats
- HF4 transmitters
- HF6 transmitters
- HL20 and HL21 data loggers
- HP21 hand-held indicator
- Custom designed OEM products

HW4 functions that are not device dependent are covered in document **E-IN-HW4v2-Main**.



When HW4 has detected a HC2 probe or other AirChip 3000 device, an icon appears in the left pane of the HW4 main screen (HygroClip 2 probe in this example). Click on the + sign to the left of the icon to display a list of the available functional modules.



In the case of a HF53 or HF55 transmitter, HP22 indicator or similar device, HW4 displays a probe icon. This icon has the same functionality as the icon shown in the previous illustration.

Note: the probe icon is not available with the HF52 transmitter.

3 PROBE ADJUSTMENT

To select the Probe Adjustment module, click on it with the left mouse button. HW4 opens the Probe Adjustment form.

Probe Adjustment automatically interrogates the probe and downloads its current adjustment data.

3.1 *Function overview*

For both humidity and temperature, the adjustment function is a 2-step process. Please note that both steps do not have to be carried out at the same time or on the same day.

● Step 1: Calibration

Calibration consists in capturing humidity and / or temperature values measured by an instrument at a number of known reference conditions without making any changes to the instrument. As-Found data is the result of a calibration.

Temperature: the AirChip 3000 can retain in memory up to 2 calibration points, each consisting of: measured temperature value and reference temperature value. The calibration points are retained in memory until erased by the user or until the AirChip 3000 device is adjusted by the user. The calibration points are read by HW4 whenever the Probe Adjustment form is opened. In principle, the calibration points can be saved in any order.

Humidity: the AirChip 3000 can retain in memory up to 100 calibration points, each consisting of: measured humidity value, reference humidity value and temperature value measured at the time of calibration. The calibration points are retained in memory until erased by the user or until the AirChip 3000 device is adjusted by the user. The calibration points are read by HW4 from AirChip 3000 whenever the Probe Adjustment form is opened. In principle, the calibration points can be generated at any temperature and saved in any order.

Note: HW4 offers the possibility of using the dew or frost point measured by a chilled mirror instrument as the source for the reference humidity value. Based on the temperature measured by the AirChip 3000 device, HW4 converts the dew or frost point into relative humidity.

● Step 2: Adjustment

Adjustment consists in making the humidity and / or temperature values measured by an instrument agree as closely as possible with a number of known reference conditions. As-Left data is the result of an adjustment.

Temperature: the temperature signal of the AirChip 3000 device is adjusted based on the calibration points present in memory. The type of adjustment depends on the number of calibration points:

- 1 calibration point: offset adjustment (equivalent to a 1-point adjustment)
- 2 calibration points: offset and slope adjustment

The AirChip 3000 uses a 4^{th} degree polynomial to change the raw data generated by the temperature sensor to a linear response. For details, see document **E-T-AC3000-DF-V1**.

- A 1-point adjustment changes the offset used by the temperature A/D converter. This is equivalent to changing the value R_0 (resistance value of the RTD at 0°C) in the 4^{th} degree polynomial used by the AirChip 3000.

- A two-point adjustment changes both the offset used by the temperature A/D converter and the coefficient A (slope) of the 4^{th} degree polynomial used by the AirChip 3000.

In addition to the user generated values, the AirChip 3000 retains in memory the factory defaults for the value R_0 and the coefficients of the 4^{th} degree polynomial. The factory defaults cannot be changed by the user and are always available to return the AirChip 3000 device to its original condition.

Adjustment accuracy depends both on the number and on the distribution of the calibration points over the temperature range to be measured.

As an alternative method, the temperature signal of the AirChip 3000 device can be adjusted by doing a 1-point calibration at 0˚C and entering a new set of coefficients for the 4th degree polynomial. In this case temperature calibration points are not required.

Humidity: the AirChip 3000 adjusts the raw humidity data provided by the sensor so as to agree with the calibration points present in memory. The type of adjustment depends on the number of calibration points:

- 1 calibration point: general offset adjustment (equivalent to a 1-point adjustment)
- 2 calibration points: offset and slope adjustment
- 3 or more calibration points: offset, slope and linearization adjustment

The AirChip 3000 retains in memory two sets of tables. The combined data from both tables is used to change the humidity sensor raw data to a linear signal (see Measurement Model). Table A1% holds the factory default values and table A2% holds the values generated as a result of the most recent humidity adjustment by the user. Initially all values in table A2% are set to zero.

The values in both tables A1% and A2% are valid when the humidity sensor is at a temperature of 23 ˚C. Regardless of the actual temperature associated with each humidity calibration point, the values in table A2% are automatically brought back to the 23 ˚C reference temperature. This conversion relies on the sensor temperature compensation data that is programmed by the factory in the AirChip 3000 memory.

The accuracy of the user adjustments depends both on the number and on the distribution of the calibration points. The most accurate adjustment results are obtained by using several calibration points, equally distributed over the humidity range to be measured.
The factory values A1% cannot be changed by the user and are always available to return the AirChip 3000 to its original condition.

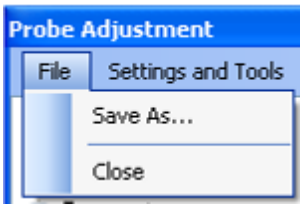
IMPORTANT:

- **Be sure that the reference environment is stable and that the instrument to be adjusted has equilibrated with the environment.**
- **Always verify that the instrument temperature measurement is accurate. If necessary, adjust temperature prior to any humidity adjustment.**
- **To obtain the best accuracy when calibrating humidity, we recommend using a sequence of increasing humidity values. In this manner the effect on the calibration data of the humidity sensor hysteresis is practically eliminated (sensor hysteresis is a temporary positive shift in the sensor response at low humidity following exposure of the sensor to high humidity)**
- **Do not interrupt the adjustment process while HW4 and the AirChip 3000 are communicating as this may give unexpected results**
- **Adjustment is not recommended while data is being logged**

3.2 *Menu Bar*

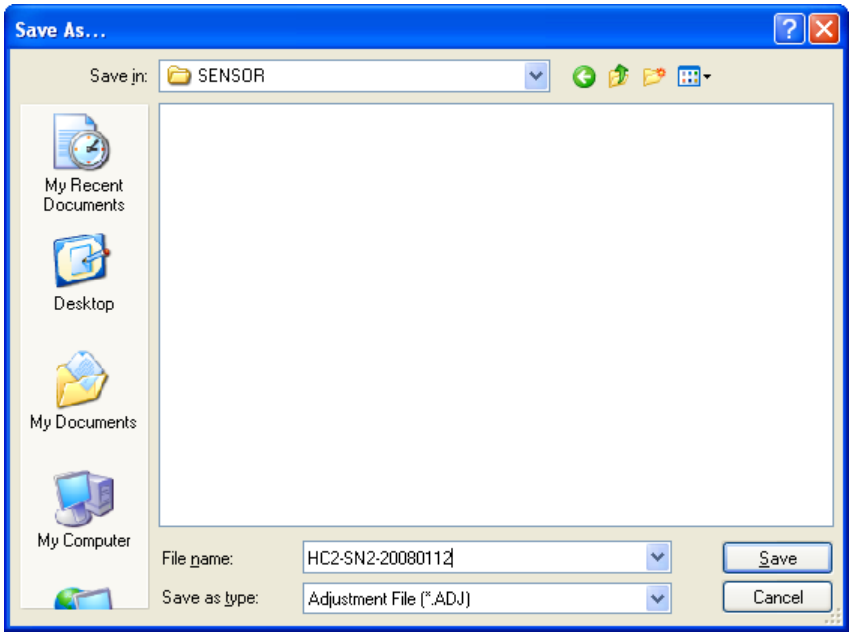
The menu bar is located at the top of the Probe Adjustment form.

3.2.1 File



The file menu is used to save to the PC the adjustment data that is currently in the AirChip 3000 memory. The data are saved in an XML file with extension ADJ. In case of problems, this file may be send to the ROTRONIC field support for trouble shooting.

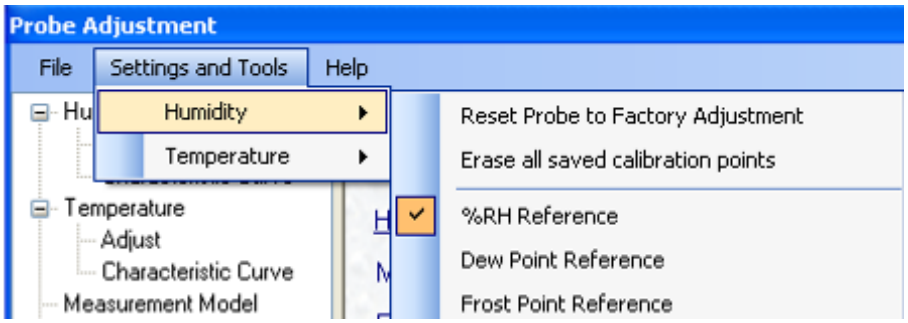
- **Save As**: saves the current configuration to an XML file with the extension ADJ in the selected folder.



- **Close**: closes the Probe Adjustment form

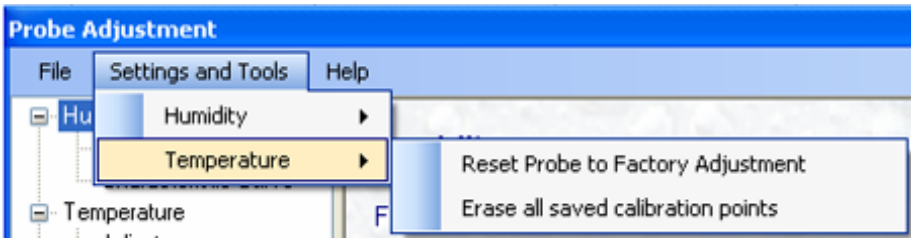
3.2.2 Settings and Tools

Humidity



- **Reset probe to Factory Adjustment:** returns the AirChip 3000 to the factory (default) humidity adjustment and reverts the effect of any adjustments made by the user.
- **Erase all saved calibration points:** deletes from the AirChip 3000 memory all humidity calibration points that may be present and that have not yet been used to adjust the AirChip 3000.
- **%RH Reference / Dew Point Reference / Frost Point Reference:** specify which parameter will be used for the reference humidity value when adjusting the AirChip 3000. Frost point gives the same results as dew point for values above freezing.

Temperature



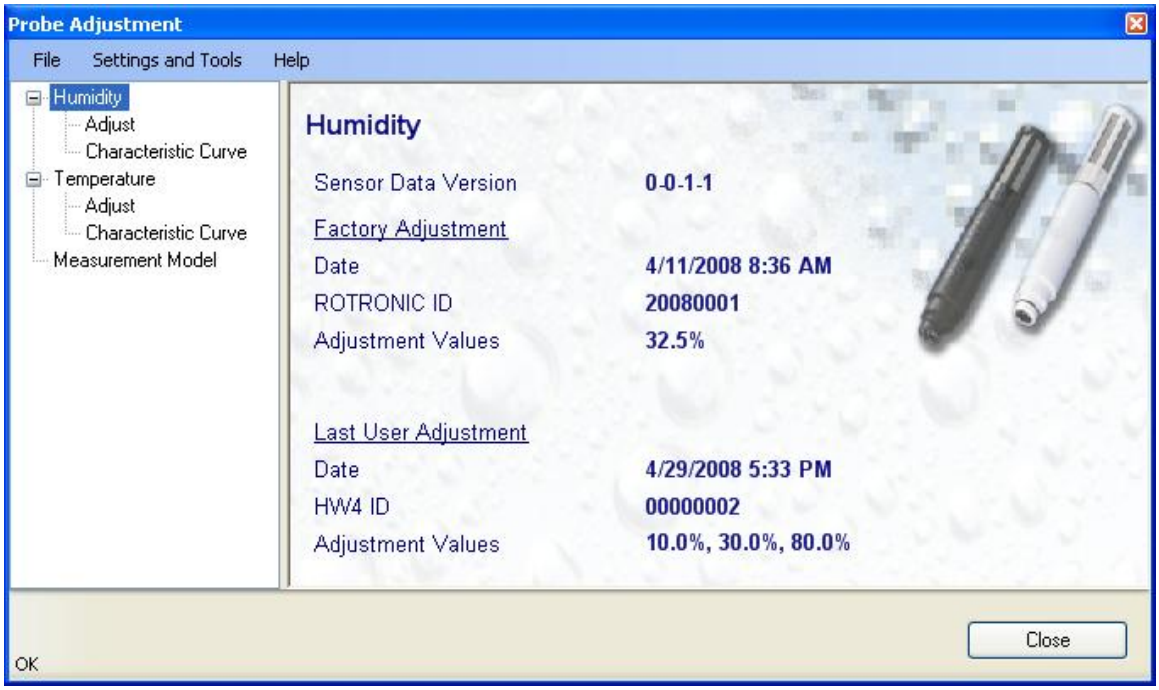
- **Reset probe to Factory Adjustment:** returns the AirChip 3000 to the factory default and reverts the effect of any adjustments made by the user.
- **Erase all saved calibration points:** deletes from the AirChip 3000 memory all temperature calibration points that may be present and that have not yet been used to adjust the AirChip 3000.

Help

- HW4 Help: **Opens HW4 Help**
- About HW4: **Displays the version number and ID number of HW4**

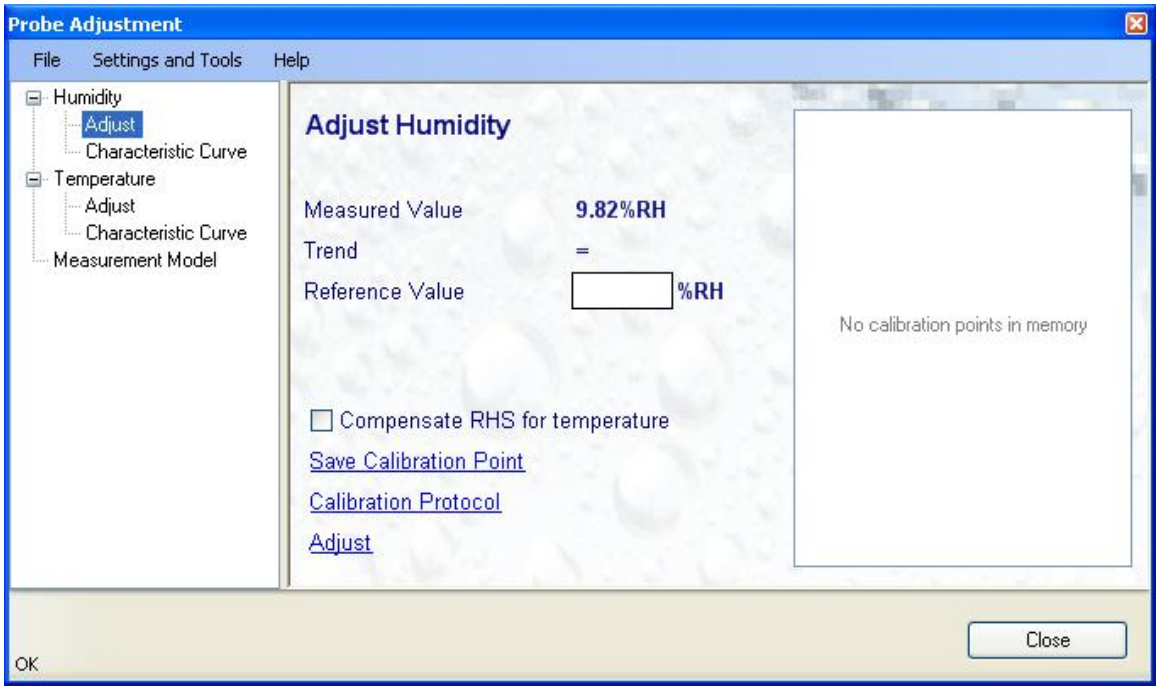
3.3 *Humidity*

Upon opening the Probe Adjustment form, HW4 reads all humidity and temperature calibration points present in the AirChip 3000 memory.



This form provides information both on the most recent factory adjustment and user adjustment. This information includes the values at which the AirChip 3000 device has been adjusted (up to 10 values).

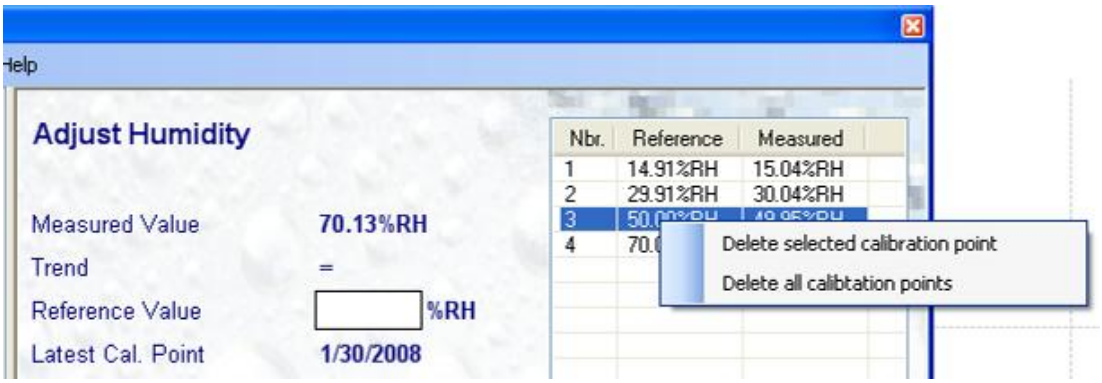
3.3.1 Humidity > Adjust



This form displays the currently measured humidity value and the trend. The = symbol means that the measurement is stable. The table on the right shows calibration points that are currently present in the AirChip 3000 memory.

- **Reference value**: When the measurement is stable, enter the reference humidity value in this box
- **Compensate RHS for temperature:** put a check mark in this box when using a ROTRONIC humidity standard (RHS) to generate the reference humidity value. HW4 applies an automatic correction for the effect of temperature on the humidity generated by the RHS.
- **Save Calibration Point:** click on this link to save the calibration point to the AirChip 3000 memory. The calibration point appears in the table located to the right (maximum 100 points).

  Any calibration point present in the table can be selected with a right mouse click. This opens the small menu shown below:

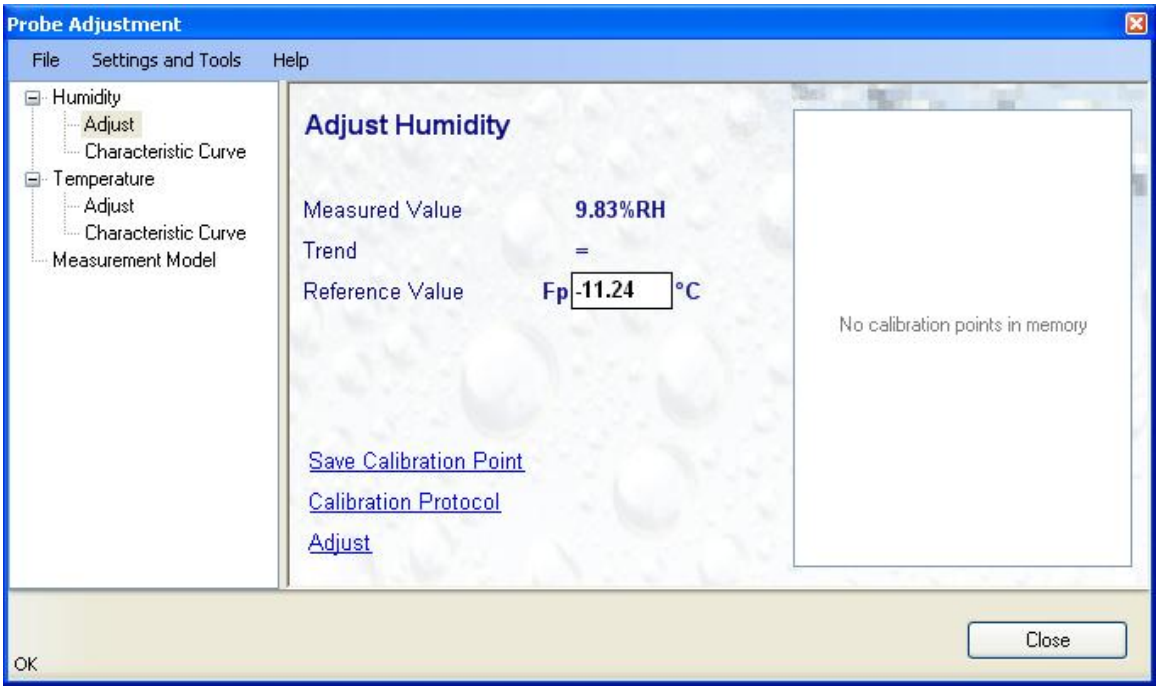


- **Calibration Protocol:** when calibrating humidity as opposed to adjusting humidity, click on this link to generate and save to the PC a calibration protocol with “As-Found” data. The protocol is a text file which can be printed.

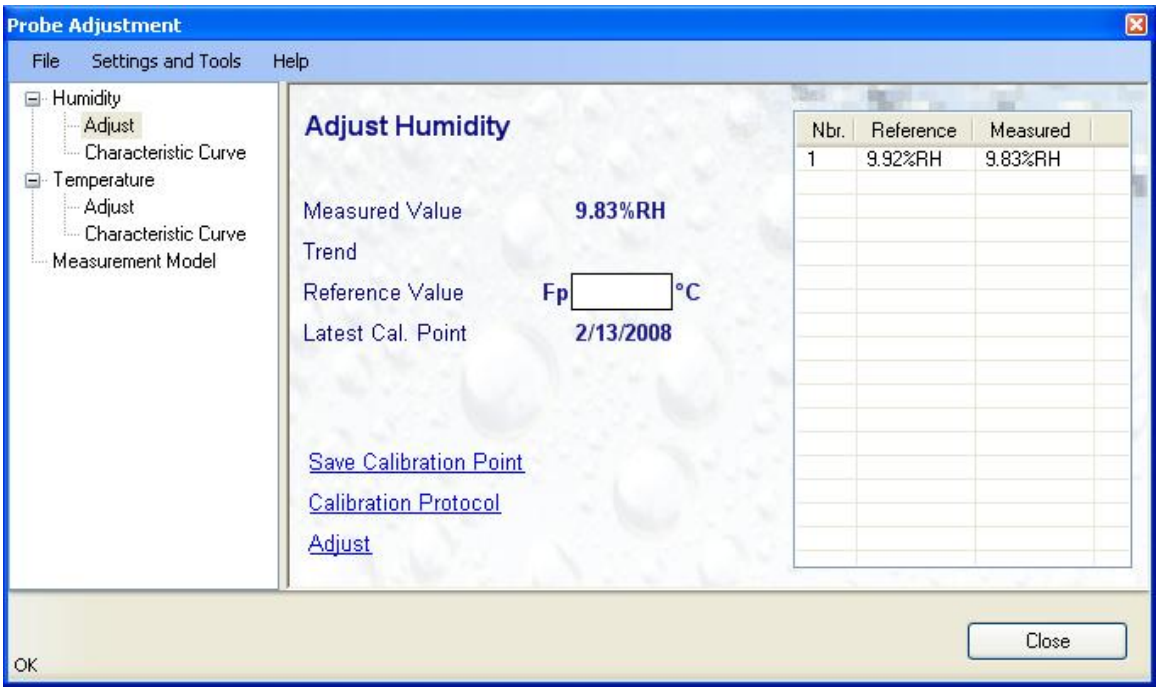
- **Adjust:** click on this link to adjust humidity, based on the calibration points listed in the box located to the right. After the adjustment, these calibration points are automatically erased from the AirChip 3000 memory.

  Depending on the HW4 Global Settings, an adjustment protocol is automatically generated after each adjustment (HW4 Main Menu Bar > Settings and Tools > HW4 Global Settings > Events Tab).

  Dew point or frost point as the reference value: HW4 offers the option of using either the dew point or the frost point as the reference value. For values below freezing, the user should determine whether the value given by the reference chilled mirror instrument is a dew point or a frost point.



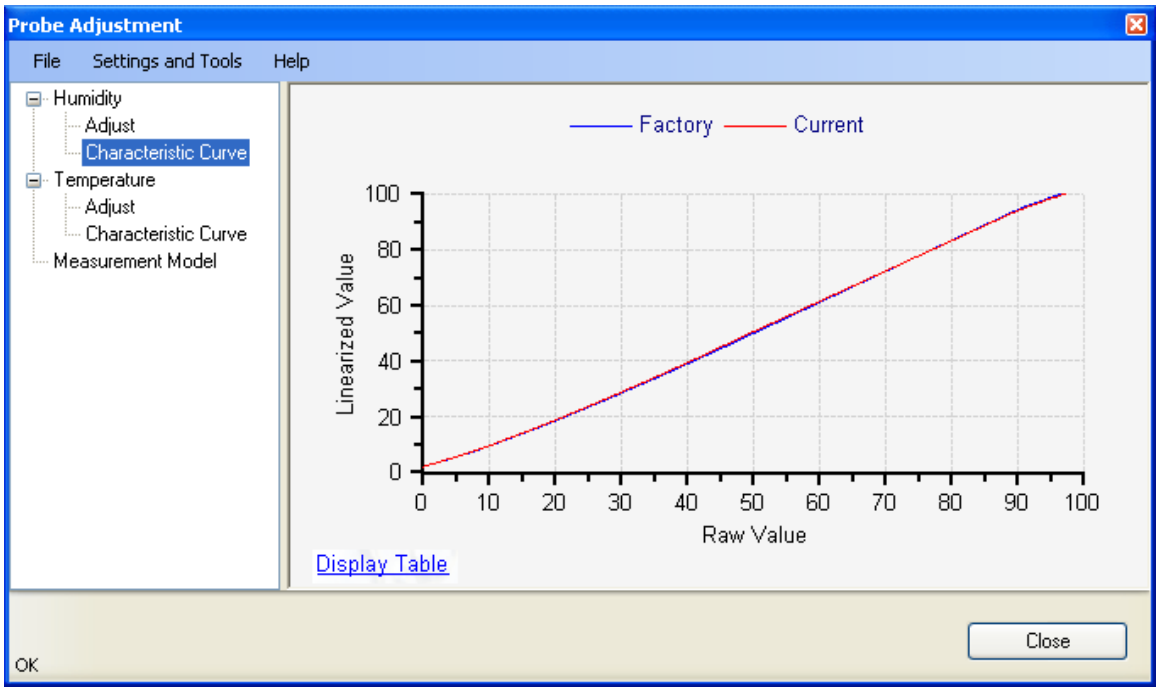
Prior to recording the calibration point, HW4 calculates the value of the reference relative humidity based both on the dew or frost point and on the temperature measured by the AirChip 3000 device. At values above freezing, the dew point and frost point give the same results.



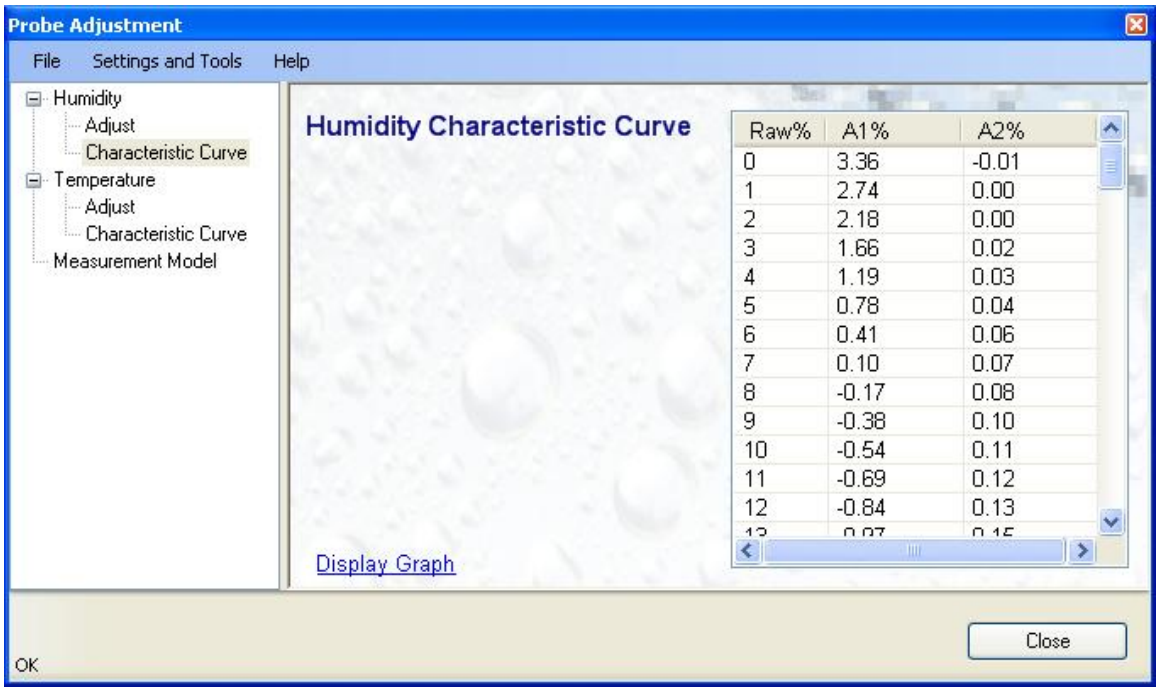
IMPORTANT:

- **The type of adjustment: 1-point (offset across the entire measuring range), two points (offset and slope) or 3 points and more (offset, slope and linearity) depends on the number of calibration points present in the AirChip 3000 memory prior to the adjustment.**
- **The humidity calibration points can be generated in any order but it is recommended to use an ascending sequence so as to minimize the effect of sensor shift as may result from extended exposure of the sensor to high humidity.**

3.3.2 Humidity > Characteristic curve



The humidity characteristic curve can be displayed either as a graph or as a table. The graph shows both the factory and the current curves over the range of 0 to 100 %RH. Raw humidity values come directly from the counts generated by the humidity analog to digital converter. Linearized humidity values are valid at a temperature of 23˚C.

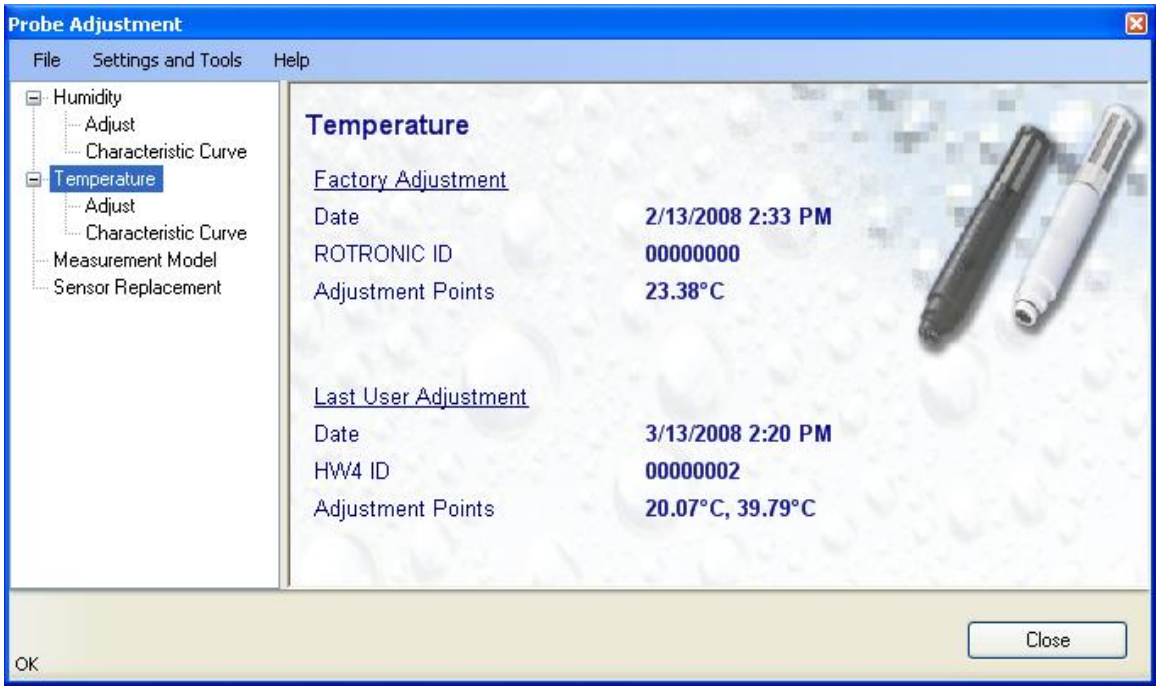


The table shows the corrections that the AirChip 3000 applies to the raw humidity values based on the factory values (A1%) and on the data generated during user adjustments (A2%) All values are in %RH and are valid at a temperature of 23°C. The values from columns A1% and A2% are added to the raw humidity value.

Notes:

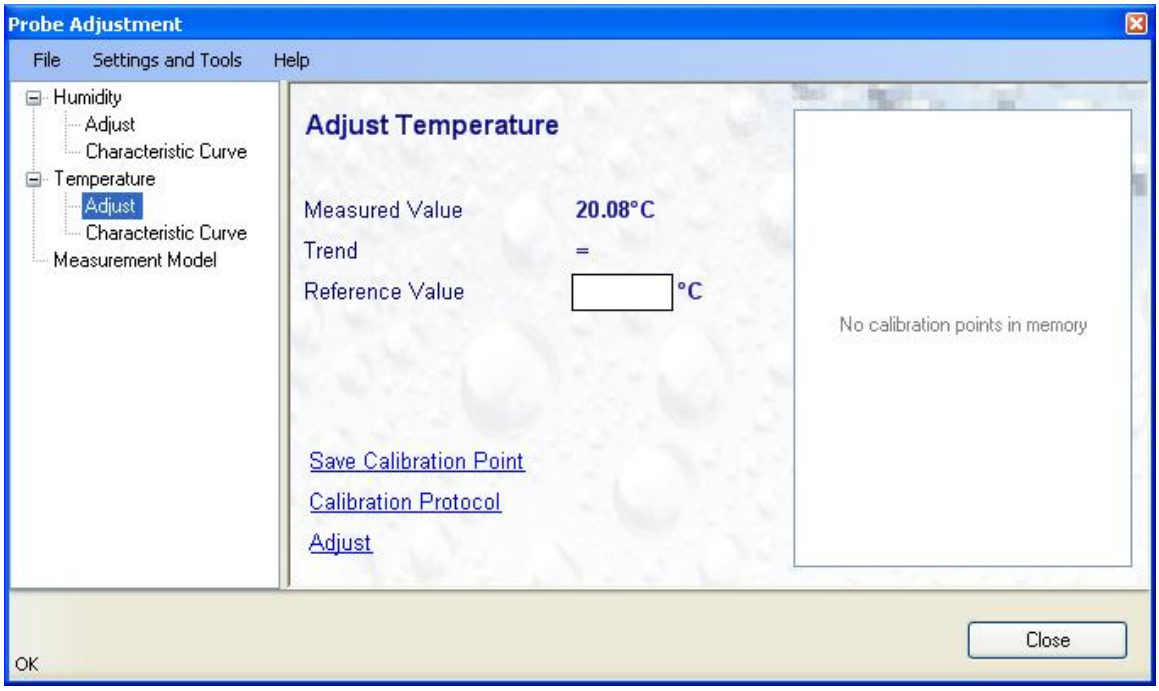
- For best accuracy, we recommend adjusting the AirChip 3000 device at a temperature close to 23°C, but other temperature values may also be used. HW4 automatically uses the temperature measured by the AirChip 3000 device and computes the values A2% for a temperature of 23°C.
- Each successive user adjustment has an incremental effect on the values of column A2%. When the AirChip 3000 device is adjusted by the user, the values in column A2% are replaced with new values. These values are computed taking into account both the values in column A1% (factory) and the values that were in column A2% prior to the adjustment.
- When the AirChip 3000 is reset to the factory data, all user generated corrections (A2%) are set to zero.

3.4 *Temperature*



The form provides information on the most recent factory adjustment and on the most recent user adjustment. This information includes the values at which the AirChip 3000 device has been adjusted.

3.4.1 Temperature > Adjust



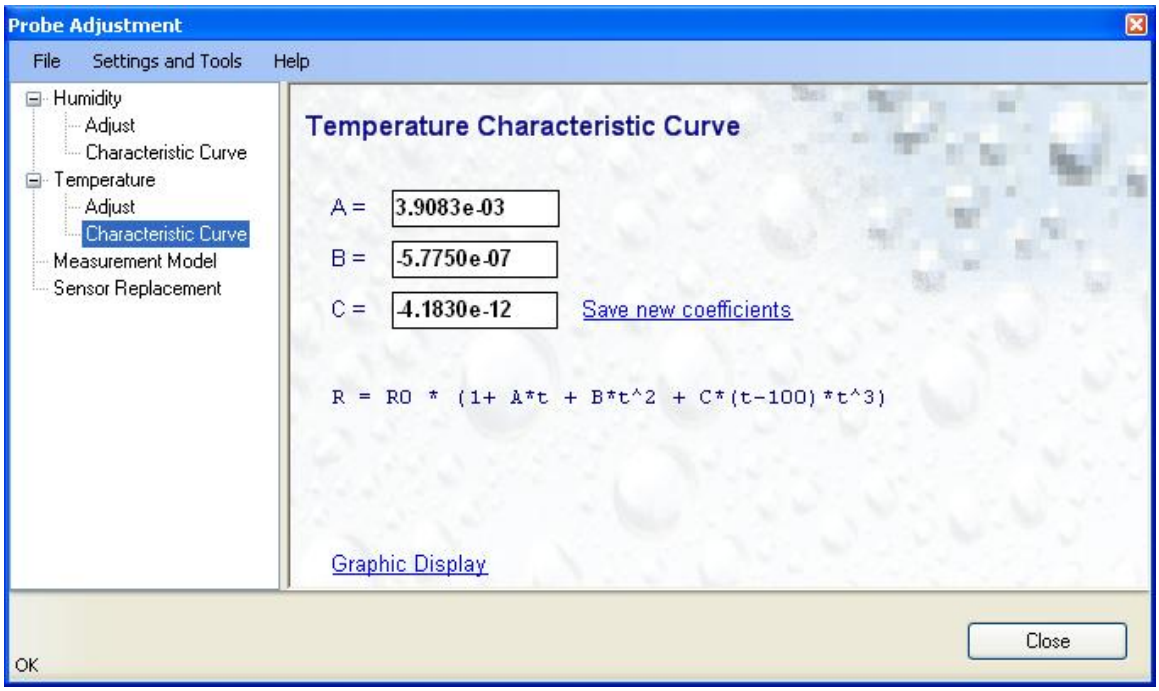
The form displays the currently measured temperature value and the trend. The = symbol means that the measurement is stable. Calibration points present in the AirChip 3000 memory are listed in the box on the right.

- **Reference Value**: When the measurement is stable, enter the reference temperature value in the box labeled “Reference value”.
- **Save Calibration Point:** click on this link to save the calibration point to the AirChip 3000 memory. The calibration point appears in the box located to the right (maximum 2 points).
- **Calibration Protocol:** when calibrating the AirChip 3000 device as opposed to adjusting it, click on this link to generate and save to the PC a calibration protocol with “As-Found” data. The protocol is a text file which can be printed.
- **Adjust:** click on this link to adjust the AirChip 3000 device, based on the calibration points listed in the box located to the right. After the adjustment, these calibration points are automatically erased from the AirChip 3000 memory.

IMPORTANT:

- The type of adjustment: 1-point (offset across the entire measuring range) or 2-point (offset and slope) depends on the number of calibration points present in the AirChip 3000 memory prior to the adjustment.
- The temperature calibration points can be generated in any order

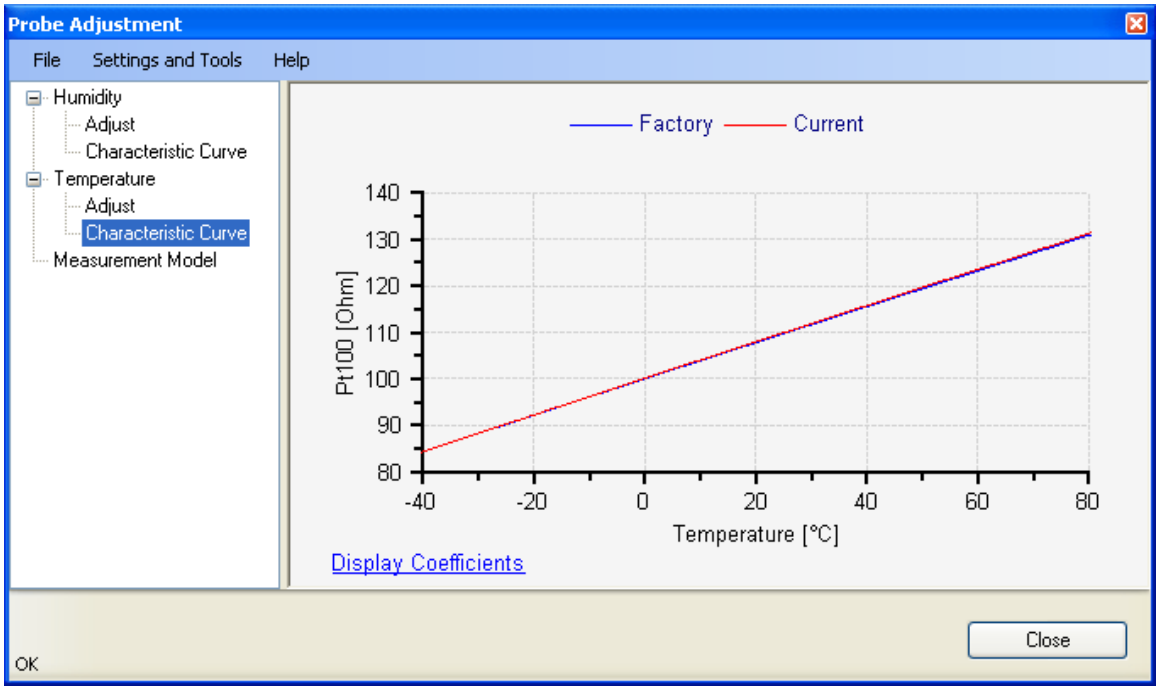
3.4.2 Temperature > Characteristic curve



The AirChip 3000 uses a 4th degree polynomial to define the correspondence between temperature [˚C] and the resistance value of the Pt100 temperature sensor [Ohm]. The default factory values for the polynomial coefficients are shown above.

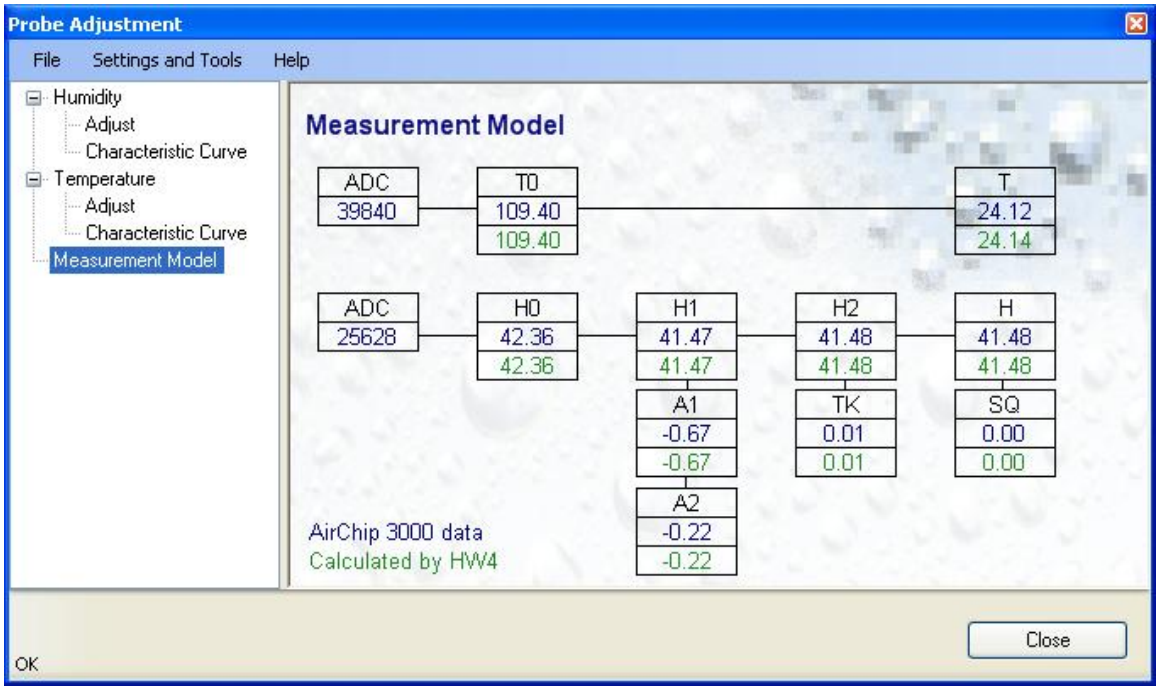
Following a 2-point temperature adjustment, both the value R_0 and the coefficient A may be changed automatically by HW4. The polynomial coefficients can also be changed manually by the user, but this should be done only when data has been developed at 3 of 4 temperature values. After changing one or more coefficients, the blue link “Save new coefficients” appears on the form. Click on this link to write the new values to the AirChip 3000.

The Pt100 polynomial can also be viewed as a graph.



3.5 *Measurement model*

The measurement model is a tool that displays both the values read from the AirChip 3000 and the values calculated by HW4. The values calculated by HW4 are based on the AirChip 3000 settings. When the AirChip 3000 is operating properly both sets of values should essentially be in agreement.



● Temperature measurement model (top)

ADC : Temperature digital counts
T0 : Pt100 resistance value [Ohms]
T : Temperature value as per current adjustment (factory or user)

● Humidity measurement model (bottom)

ADC : Humidity digital counts
H0 : Raw humidity value based on factory scaling of the digital counts [%RH]
H1 : Humidity value after linearization
A1 : Sensor linearization based on factory adjustment
A2 : Additional linearization based on user adjustment
H2 : Humidity corrected for sensor temperature
TK : Correction for sensor temperature
H : Humidity value
SQ : Correction for sensor quality. For details, see document **E-T-AC3000-DF-V1**

4 DOCUMENT RELEASES

Release	Software Ver.	Date	Notes
_10	2.1.0	Jun. 27, 2008	Original release
_11	2.3.0	Apr. 17, 2009	No changes
_12	2.4.0	Jan. 29, 2010	No changes