

# **MANUAL FOR CHECKING OF MEASUREMENT ACCURACY (CALIBRATION) AND ADJUSTMENT FOR DEVICES Txxxx**

## **A) Manual for accuracy verification (calibration)**

Checking of measurement accuracy (calibration) of temperature, relative humidity and barometric pressure require special equipment for generation of constant temperature, relative humidity or pressure (calibration box). Checking of measurement accuracy is performed by location of device under test into a calibration box and by comparing values of tested device with values of standard.

### **General conditions for calibration:**

- device should have proper power
- devices with analog outputs should have connected analog outputs to corresponding estimation device to reading of measured value
- devices with digital output allows to read measured values directly from LCD display (show value on LCD display must be ON) or by user's SW (it is necessary to connect device to PC and run user's SW)
- for calibration of temperature and humidity it is recommended (if it is possible) insert into calibration box only part of device with measuring sensors (measuring stem, external probe). Calibration box and the etalon should comply the accuracy of the tested device.
- measured quantities are always calibrated at points which you usually use, depends on required measured range. Temperature, relative humidity and pressure generated by calibration box can't step over range of calibrated device.
- calibration box should be equipped with suitable etalon for checking the calibration. The etalon accuracy should be at least 3 times better (if possible) than the calibrated device accuracy. Etalon must be metrologically linked up to valid higher etalons. Etalon should be located at proper place at the box, respecting the inhomogeneity of generated area.
- during calibration of temperature and humidity airflow must be ensured approximately 0,5 to 1 m/s.
- calibration box settling time must be known or easy detectable e.g. by etalon. Calibration is settled if calibrated value does not change and the air inside the box is at same temperature as walls of the box. No condensation and no influence from thermal radiation should exist.
- the right etalon reading should be taken after necessary time needed to settle of calibrated instrument. Settling time of the device starts after calibration box is settled at required value. Response time of calibrated device is specified in instruction manual as  $t_{90}$ . Necessary time needed for calibration is three times longer than  $t_{90}$ . After that time device reading approaches to 100% of real value. For devices with pressure measuring see "Appendix A" at the end of this document.
- in calibration it is necessary to specify the extended measurement uncertainty including parameters of the etalon and applied measuring method. The calculation of uncertainty is specified accordingly to the EA-4/02 document. The result logger evaluation depends also on this calculated uncertainty, not only on measured values. Calculated uncertainty depends on technical parameters of the calibration equipment.

### **Calibration procedure:**

- for calibration of temperature and humidity it is recommended (if it is possible) insert into calibration box only part of device with measuring sensors (measuring stem, external probe).
- devices with analog outputs should have connected analog outputs to corresponding estimation device to reading of measured value
- for devices with digital outputs is possible to read measured values directly from its LCD display but it is necessary to place device into calibration box at place where LCD display is readable or connect device communication interface to PC and run user's SW, where actual values are shown continually.
- place etalon into the calibration box too.
- close the calibration box and start its operation
- after settling of calibrating box at required value wait for specified time for settling of the calibrated instrument (at least three times longer than  $t_{90}$ ).
- when calibrated instrument is settled read etalon and value measured by device.
- set the box to the next required value and wait again till the calibration box will be settled and also calibrated device as well.
- when calibrated instrument is settled read etalon and device's value.
- take out the instrument from calibrating box after calibration.
- device accuracy for each calibration point is specified in instruction manual. Specific measurement uncertainty must be considered, which may differ for each calibration point.

### **Manual for adjustment of Txxxx devices**

Adjustment means action resulting in setting instrument to state, when its actual measurement accuracy measurement is identical or better than measurement accuracy specified in instruction manual. Adjustment is possible only for measured values (temperature, relative humidity or pressure). For this operation is needed as same as for calibration special equipment for constant temperature, relative humidity or pressure generation – a calibration box. Device adjustment is performed by placing of adjusted device to calibration box and by consequent assignment of measured values to etalon reading by means of the PC software.

### **General adjustment conditions**

- adjustment bears on calibration and that is why all condition for instrument calibration must be abided, as described above.
- during adjustment of device, it is necessary always connect device communication interface to PC.
- measured values are always adjusted at two points, as much distant as possible from each other at the required measurement range.
- incorrect temperature measurement always influences humidity measurement (temperature compensation of humidity sensors). Similarly adjustment of only temperature feeds back the humidity measurement (but temperature change up to 1°C influences humidity measurement insensibly). Incorrect temperature measurement doesn't influences pressure measurement.

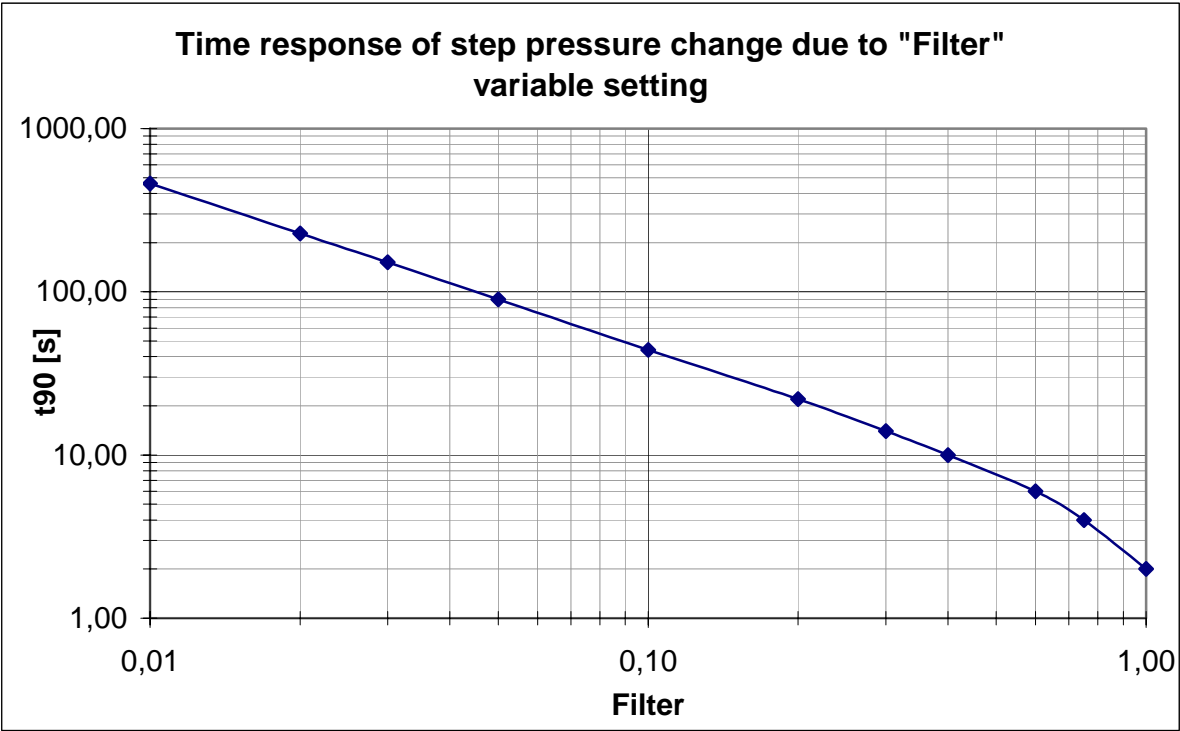
- in process of humidity adjustment, lower calibration point should not be lower than 10 %RH and higher calibration point should not be higher than 90 %RH. Recommended adjustment values for relative humidity are 11 %RH and 75 %RH.
- **each irresponsible entering of adjustment mode (from the PC software) can cause overwriting of actual calibration constants and resulting in instrument inability to measure correctly!**
- each time after instrument adjustment, it is necessary to verify the calibration – see Calibration procedure above.

### Adjustment procedure:

- to adjust use free user's software available at <http://www.cometsystem.cz> .
- in humidity adjustment it is recommended due to hysteresis of the etalon and adjusted device to settle device and etalon at room humidity firstly (for about 30 minutes).
- for devices with digital output is necessary to close internal jumper (see manual for device).
- for calibration of temperature and humidity it is recommended (if it is possible) insert into calibration box only part of device with measuring sensors (measuring stem, external probe).
- place etalon into the calibration box.
- run user's software with parameter */service* – e.g. click on the *Start* button, select item *Run...* Then *Browse..* and select program TSENSOR.EXE on your disk, mark it by mouse and click on *Open*. Type to field *Open:* to the very end of path type space mark, then parameter */service* and click on *OK*. Set "Communication settings" parameters and click *OK*. Program could have now a new menu item *Service*. Select it.
- close the calibration box and start its operation.
- after settling of calibrating box at required value for lower adjustment point wait for specified time for settling of the adjusted device – see General conditions for calibration.
- when calibrated device is settled press button ***Sample and Save*** for corresponding lower adjustment point. This saves corresponding value to device.
- set calibration box to generation of higher value of adjustment point and wait again for settling of the calibration box and consequently for settling of adjusted device.
- when calibrated device is settled press button ***Sample and Save*** for corresponding higher adjustment point. This saves corresponding value to device.
- if **relative humidity or pressure** adjustment is run **it is necessary** at the end (after both adjustment points are stored) **press button *Compute and Save Calibration Constants***. It run computing of new relative humidity or pressure constants stored inside device.
- adjustment mode is possible to leave by clicking the ***Disconnect*** button.
- after adjustment verify again measurement accuracy of the device according to Calibration procedure above.

### Appendix A

For devices with pressure measuring is possible to set required time response for pressure change. It is possible throw constant *Filter* displayed near by button *Compute and Save Calibration Constants*. Inserted value must be greater than zero and lower or equal to one. Corresponding response time for pressure step is shown at following graph. If *Filter* =1 then values read from device are equal to actual pressure, if *Filter* < 1 then they are read as weighted average with respect to previous values.



Examples of “Filter” setting:

<b>Filter</b>	1,00	0,75	0,60	0,40	0,30	0,20	<b>0,10</b>	0,05	0,03	0,02	0,01
<b>t90 [s]</b>	2	4	6	10	14	22	<b>44</b>	90	152	228	460

Default value is set to “Filter” = 0,1 (t90 is 44 s)