Calibration of climatic chambers

Assignment of measuring points, ALMEMO® 710 (example)

Sensor position	Measuring point	Variable	Note
Spatial center	0.0	t (dry temperature)	measuring channel -psychrometer
	0.1	U_w (humidity)	arithmetic channel (psychrometer)
	0.2	t_d (dewpoint)	arithmetic channel (psychrometer)
	0.3	p (atmospheric pressure)	device-internal atmospheric pressure sensor
Corner 1	1.0	t (temperature Pt100)	measuring channel (Pt100)
	1.1	U_w (humidity)	arithm. channel (humidity from Pt100 and psychrometer)
Corner 2	2.0	t (temperature Pt100)	measuring channel (Pt100)
	2.1	U_w (humidity)	arithm. channel (humidity from Pt100 and psychrometer)
Corner 3	3.0	t (temperature Pt100)	measuring channel (Pt100)
	3.1	U_w (humidity)	arithm. channel (humidity from Pt100 and psychrometer)
Corner 4	4.0	t (temperature Pt100)	measuring channel (Pt100)
	4.1	U_w (humidity)	arithm. channel (humidity from Pt100 and psychrometer)
Corner 5	5.0	t (temperature Pt100)	measuring channel (Pt100)
	5.1	U_w (humidity)	arithm. channel (humidity from Pt100 and psychrometer)
Corner 6	6.0	t (temperature Pt100)	measuring channel (Pt100)
	6.1	U_w (humidity)	arithm. channel (humidity from Pt100 and psychrometer)
Corner 7	7.0	t (temperature Pt100)	measuring channel (Pt100)
	7.1	U_w (humidity)	arithm. channel (humidity from Pt100 and psychrometer)
Corner 8	8.0	t (temperature Pt100)	measuring channel (Pt100)
	8.1	U_w (humidity)	arithm. channel (humidity from Pt100 and psychrometer)
	9.0	t (temperature Pt100)	measuring channel (Pt100), low emissivity (e.g. stainless steel surface)
	9.1	U_w (humidity)	measuring channel (Pt100), high emissivity (e.g. surface PTFE)

Guideline DAkkS-DKD-R 5-7 *The following section includes extracts from the guideline.*

Guideline DAkkS-DKD-R 5-7 Calibration of climatic chambers
(...)
4 Objectives of calibration
The calibration of a climatic chamber determines any deviation between the values displayed by the chamber indicators and the climatological variables, air temperature and relative humidity, measured in those parts of the chamber volume provided for use or at individual points in the chamber volume. (...)
The objectives of calibration are thus the following :
Calibration of the indicators for temperature and relative humidity by comparison with values for air temperature and atmospheric humidity measured in the useful space using reference equipment (also specifying any such deviation and the necessary corrections. (...)
6 Calibration methods
(...)
(A) *Calibration refers to the useful volume as spanned by the measuring locations in the unloaded climatic chamber. (...)*
(B) *Calibration refers to the useful volume as spanned by the measuring locations in the unloaded climatic chamber. The climatic chamber can be loaded in line with the user's typical application or by filling at least 40 percent of the useful volume with test pieces.*
(...)
7 Calibration procedures
7.1 Arrangement of measuring locations
(...) For chamber volumes of up to 2000 liters the requirements regarding the number and spatial positioning of the measuring points are as per DIN EN 60068, 3-5; i.e. the measuring locations are the corner points and the spatial center of the cuboid spanning the useful volume.
(...)
The calibration result is only valid for that volume spanned by the measuring points. (...)
7.6 Humidity calibration
For the purpose of calibrating relative humidity in a climatic chamber subject to air circulation the absolute humidity and dewpoint Td or frost point Tf can be determined in the center of the useful volume and the spatial distribution of relative humidity can be calculated on the basis of the measured air temperature distribution. (...)

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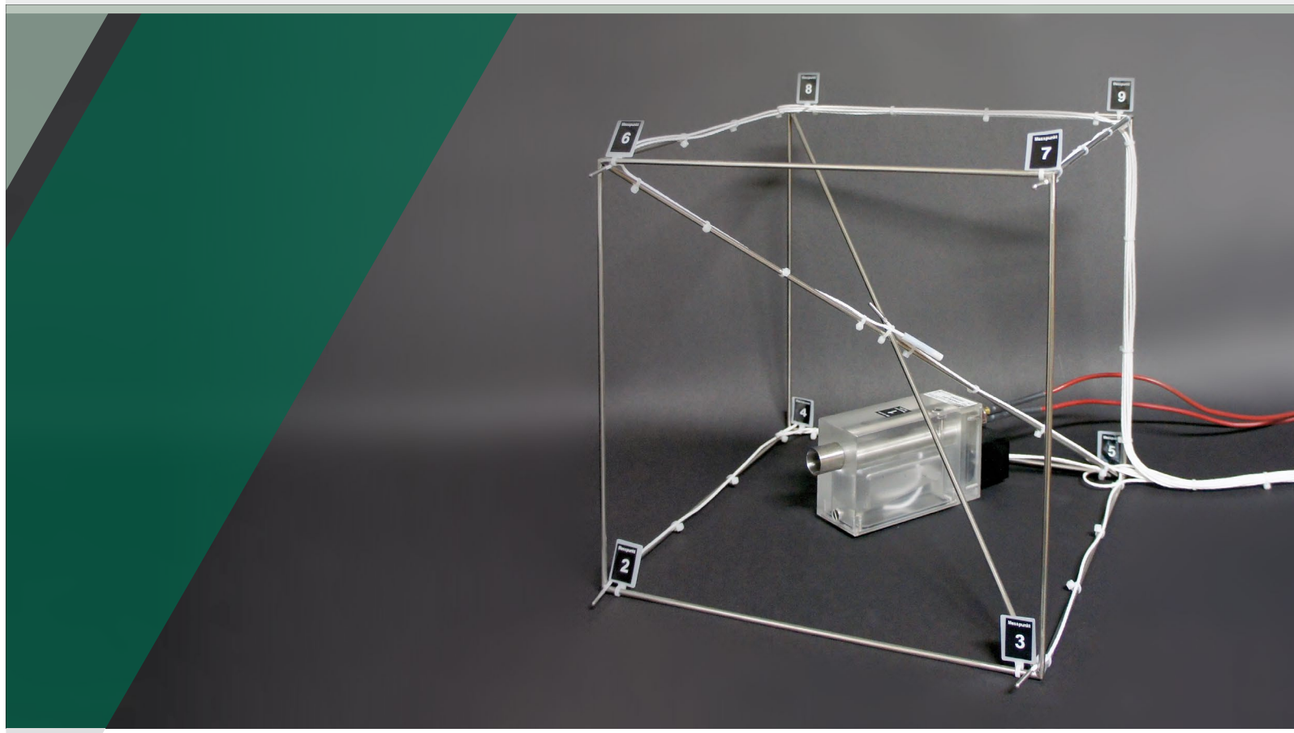


ALMEMO® measuring system for calibrating climatic chambers as per guideline DAkkS-DKD-R 5-7

- Guideline DAkkS-DKD-R 5-7 lays down minimum requirements for the calibration procedure and for the determination of measurement uncertainties when calibrating climatic chambers.
- This guideline describes inter alia the objectives, procedures, and methods of calibration, and the uncertainty components involved.
- The full text of this guideline is available as a PDF document on the home page of the Deutsche Akkreditierungsstelle GmbH (*www.dakks.de* > *Dokumente* > *Kalibrierlaboratorien*) and can be downloaded free-of-charge.

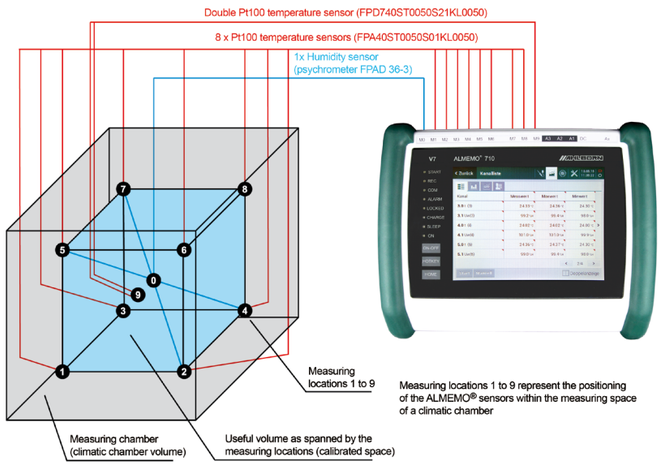
For the relative humidity, pressure, temperature, flow velocity
and for electrical quantities we are DAkkS accredited calibration laboratory
as per DIN EN ISO/IEC 17025:2018.

Calibration of relative atmospheric humidity at nine points in the climatic chamber using precision measuring instrument ALMEMO® 710

The ALMEMO® measuring system, comprising precision measuring instrument ALMEMO® 710, one humidity sensor, and eight temperature sensors, can be used to acquire all relevant measurable variables prevalent in the climatic chamber. The relative atmospheric humidity at the nine points in the climatic chamber is calculated in the ALMEMO® 710 itself. Climatic chambers can thus be calibrated in full and on site quickly and easily.

Humidity is calculated in the ALMEMO® 710 on the basis of formulae as per Dr. Sonntag and the enhancement factor as per W. Bögel (correction factor Fw(t,p)) for real mixed gas systems). This substantially widens the measuring range and improves the accuracy of humidity variable calculations.
The determination of the radiation influence on the air temperature measurement is done with 2 temperature sensors with different sensor surface (different emissivity e.g. stainless steel and PTFE). With an ALMEMO® double sensor the 2 temperatures can be measured simultaneously (additionally) with the 8 temperatures of the corner points.
All values, both measured and calculated, are shown in a clear and easy-to-understand way on the ALMEMO® 710's large touch display. The ALMEMO® 710 also operates as a data logger. Measuring series can be saved either to the internal memory (capacity for over 400,000 measured values) or via the ALMEMO® memory connector to an SD card (capacity for several millions of measured values).
WinControl can be used to display and document values e.g. as a line graphic - either online those measured values actually being acquired during a measuring operation or offline after a measuring operation those measured values previously saved. It also provides various evaluation and statistical functions.

Arrangement of ALMEMO® measuring system to implement guideline DAkkS-DKD-R 5-7 for calibrating climatic chambers



The ALMEMO® measuring system comprises:

Precision measuring instrument ALMEMO® 710

10 inputs for any ALMEMO® sensors,
atmospheric pressure sensor integrated in the measuring instrument

Precision measuring instrument ALMEMO® 710 including USB cable, mains unit, instrument case, and configuration software ALMEMO® Control	**MA710**

Precision measuring instrument ALMEMO® 500

Data acquisition system, Tablet control via app.
20 measuring inputs for any ALMEMO® sensors (expandable).

Data logger ALMEMO® 500 CPU card including interfaces and web service. 4GB SD memory card. 2 active measuring circuit cards MA10 featuring 20 input sockets for all ALMEMO® sensors (standard, DIGI, D6, D7). Mains adapter Control unit with preinstalled app.In desktop housing TG6, 9 free slots	**MA500CPUA20TG6B**

Calibration of climatic chambers

Digital Pt100 psychrometer with DAkkS calibration certificate

Operative range 0 (not ice) to 90 °C, 10 to 100 % RH
Built-in digital air pressure sensor: 700 to 1100 mbar
The psychrometer is positioned at the center of the useful volume. From the measured values - dry temperature (t) and wet temperature (tw) - and atmospheric pressure (p) (atmospheric pressure sensor integrated in the ALMEMO® connector) we can calculate the relative humidity (Uw) at the center and the dewpoint (td).

Digital Pt100 psychrometer FPAD 36-3 with ALMEMO® D6 connector, air pressure sensor installed, including mains unit, water bottle, one pair of wicks, carrying case	**FPA8363**
Programming for digital psychrometer: Dew point td	**OA9000PRTD**
DAkks calibration certificate for atmospheric humidity Two climate points at 25°C, 30%RH and 25°C, 75%RH (other points available on request)	**KH9146D**
DAkkS calibration certificate for air pressure sensor, 5 points in the range 700...1100 mb	**KD9213D**

Eight Pt100 temperature sensors with DAkkS calibration certificate

for operation in the climatic chamber stainless steel protective tube with PFA cable.
Operative range -100 to +250 °C, Protective class IP68
The eight temperature sensors are positioned at the corners of the cuboid spanning the useful volume. From the eight measured values for temperature (t) and the humidity variables from the psychrometer we can calculate the relative humidity values (U_w) at the corners of the cuboid

Eight Pt100 temperature sensors, diameter 4mm, for operation in the climatic chamber, IP68, Cable length = 5 meters	8 x **FPA40ST0050S01KL0050**
DAkks calibration certificate for temperature, three points at 0, 50, 100 °C (other points available on request)	
for 1st sensor	1 x **KT9021D**
for 2nd to 8th sensor	7 x **KT9021D2**
Multi-point adjustment for eight sensors (in certificate, sensor deviation virtually reduced to zero)	8 x **KT9001DW**
Programming for eight Pt100 temperature sensors for calculating humidity using ALMEMO® 710 including labeling of the sensor connector	**OA9000PRKS**
Cube for positioning temperature sensors: Wire cube, VA wire Ø4 mm. edge length 300 mm, vertices welded. Including spiral hoses to fix the sensor cables.	**ZB1002Q01**

Determination of the influence of radiation

Two temperature sensors with different surfaces to determine the radiation effects on air temperature measurement operations. (different emissivity e.g. stainless steel and PTFE)

Cover for Pt100 temperature sensor, diameter 4mm, PTFE, large emissivity	**ZT9000TS41**

With an ALMEMO® double sensor, the 2 temperatures can be measured simultaneously (additionally) with the 8 temperatures of the corners.

2 Digital Pt100 temperature sensors, diameter 4 mm each, for use in climatic cabinet, IP68, cable length 5 m each, mounted on 1 ALMEMO® D7 double connector	**FPD740ST0050S21KL0050**
DAkkS calibration certificate for temperature, 3 points at 0 / 50 / 100 °C (other points on request)	
for 1st sensor	**KT9021D**
for 2nd sensor	**KT9021D2**
Multi-point adjustment for 2 probes (with certificate probe deviation towards zero)	2 x **KT9001DW**

Measuring software WinControl

WinControl software, for measured value processing and documentation for any number of channels (i.a. arithmetic channels, statistic channels), all options included (except Data server, Web server, and additional modules)	**SW5600WC3**
Assistant for the calibration of climate cabinets. Automatic, convenient evaluation with protocol generation. (needed: WC3/WC4)	**SW5600WCZM13**
Additional protocol for direct integration of climate chambers into online measurement	**SW5600WCZM7**