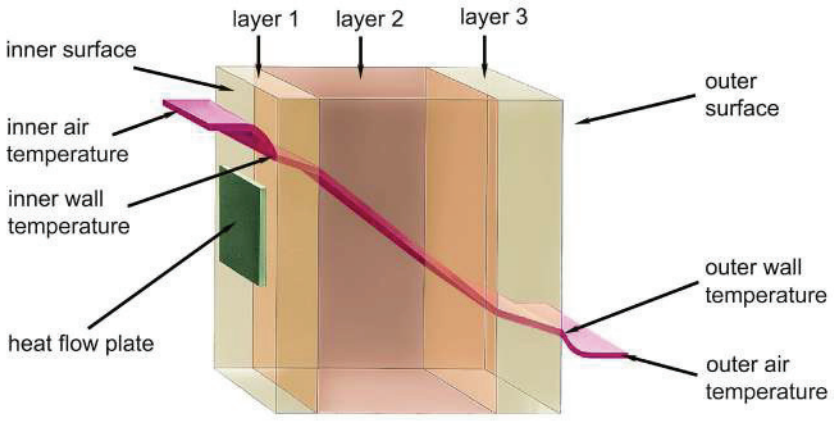
Building physics, Moisture in materials

Content

Measuring thermal transmittance (U) and heat flow

The heat transfer characteristics of any structural element depend on the thermal conductivity of the materials used, on the thickness of its various component layers, on its structural geometry (e.g. flat or cylindrically curved walls, etc.), and on the ambient conditions at the structure's surfaces inside and outside.

Presentation of the temperature behavior



The thermal transmittance coefficient (U value) of a structural element describes the quantity of heat that passes through it from one side to the other (no matter how many layers) per second and per square meter surface at a constant difference in ambient temperature inside / outside of 1K. This thermal transmittance coefficient (U) thus also includes the surface heat transfer coefficients, i.e. the thermal energy transferred at the boundary surfaces, interior air - structure - exterior air. The thermal transmittance coefficient (U) is measured in in (W/m²K) and is internationally defined in standard ISO 6946.

A structure's thermal transmittance coefficient (U) is the reciprocal of its total thermal resistance coefficient (R); R is the sum of the thermal transmission resistances between the structure's various contiguous layers and also the surface heat transfer resistances between the structure and the ambient media on either side (e.g. air).

Total thermal resistance (R) = thermal transmission resistances through the material + surface heat transfer resistances, inside and out

The thermal transmittance coefficient (U value) is an important rating in civil engineering and the construction industry where it is used to define a building's transmission heat loss through its various structural elements. Transmission heat loss is the term used to describe the energy-saving qualities of a building's shell (i.e. the thermal insulation of its roof, outside walls, windows, and floors). In Germany each residential structure is assigned a permissible maximum U value (depending on its external surface area and its internal volume); this is based on the most recently amended version of the Energieeinsparverordnung (EnEV) (German energy-saving legislation)

ALMEMO® Measuring system for Measuring thermal transmittance (U) and heat flow

The thermal transmittance coefficient (U value) is an important rating in civil engineering and the construction industry where it is used to define a building's transmission heat loss through its various structural elements. It is now possible, with the ALMEMO® measuring system, to measure and record all the physical parameters for the component parts of existing buildings (e.g. walls, etc.) in order to calculate their U value and other relevant thermal energy coefficients.

Measuring principle:

The measuring principle involved in quantifying heat loss at partition elements, e.g. walls, heating systems, etc., is based on the method which uses a heat flow plate (sensor) fitted on the surface of the structural element and thus incorporated directly in the heat flow. Using the known thermal characteristics of the heat flow plate and the thermo-electrically measured temperature gradient inside the heat flow plate the ALMEMO® measuring system can thus measure the heat flow density q in W/m².

The ALMEMO® measuring system can also be used to measure the surface temperatures on either side the structural element and the respective air temperatures immediately inside and outside; based on these results it is then possible to calculate all the relevant thermal coefficients.

The temperatures and heat flow density data on which these calculations are based are acquired cyclically as average values. Any influence that the structure's own thermal capacity may have on these calculations (e.g. time shifts between temperature and heat flow, affecting calculation of the U value) will, given a sufficiently long measuring period, become negligible and the calculated average value will certainly be very close to the structure's actual U value.

Operative range:

To ensure a stable and meaningful U value calculation it is possible to stipulate that measuring operations only be performed subject to certain specified conditions.

- The temperature difference between interior and exterior ambient air must be sufficiently large (typically 20 K, e.g. inside temperature 20°C and outside temperature 0°C).
- Any fluctuations in these temperatures (e.g. day / night) must throughout the measuring period be as small as possible.
- The measured values must be acquired and recorded on-site over a sufficiently long period (e.g. one whole day or even several days) and the parameters must be calculated on the basis of average values

Ordering information	Order no.
ALMEMO® measuring system - with 2 temperature sensors and 1 heat flow plate - for determining the U value - with straightforward calculation in the ALMEMO® measuring instrument:	
ALMEMO® data logger 2590-4AS, 4 inputs, including mains unit and USB data cable	MA25904ASKSU
Outside air temperature Thermo-wire sensor, with glass-fiber insulation, 5 meters long	FTA3900L05
Inside air temperature Thermo-wire sensor, with glass-fiber insulation, 1.5 meters long	FTA3900
Programming for inside sensor Differential channel and average value	OA9000PRUT
Heat flow plate, including installation materials see page 13.04 / 13.05 e.g. type 118, approx. 120 x 120 mm, cable 2 meters	FQA018C
Programming for Heat flow plate, Average value and U-value channel	OA9000PRUQ
ALMEMO® measuring system - with 4 temperature sensors and 1 heat flow plate - for determining the U value - using WinControl software (possible both online and offline) :	
ALMEMO® data logger 2690-8A, 5 inputs, including mains unit and data cable, USB	MA26908AKSU
Outside air temperature Thermo-wire sensor, with glass-fiber insulation, 5 meters long	FTA3900L05
Outside surface temperature Thermo-wire sensor, with glass-fiber insulation, 5 meters long	FTA3900L05
Inside air temperature Thermo-wire sensor, with glass-fiber insulation, 1.5 meters long	FTA3900
Inside surface temperature Thermo-wire sensor, with glass-fiber insulation, 1.5 meters long	FTA3900
Heat flow plate, including installation materials see page 13.04 e.g. type 118, approx. 120 x 120 mm, cable 2 meters	FQA018C
WinControl software for 20 measuring points, 1 device	SW5600WC1
Additional module U-value wizard	SW5600WCZM4
Hardlock USB dongle	SW5600HL
Accessories	
Carry case, large	ZB2590TK2

Heat flow

Heat Flow Plates FQAx

- For determining the heat flow density up to max. 150°C.
- Application-oriented designs, consisting of a meander of opposing thermocouples that are embedded in a substrate.
- In case of thick substrates no lateral circulation of the heat flow because of sufficient meander shell zone.
- Software for k value measurement, see chapter Software

! Each heat flow plate has been assigned a calibration value, which corresponds to the heat flow density in W/m^2 when the plate provides an output of 1mV. The calibration value will be stored as factory-setting in the ALMEMO® connector so that ALMEMO® devices will immediately indicate the current heat flow density in W/m^2.

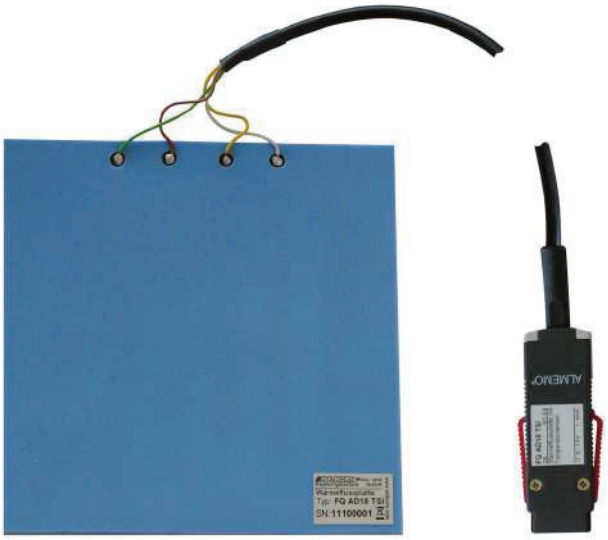
Technical Data:

Type	Dimensions (mm)	Meander Size (mm)	Substrate	Temperature Stability	Calibr. Val. appr. (W/m^2 ≈ mV)	Accuracy of Calibr. Value
117	100 x 30 x 1.5	80 x 20	epoxy resin	-40 ... 80°C	< 50	5% at 23°C
118	120 x 120 x 1.5	90 x 90	epoxy resin	-40 ... 80°C	< 15	5% at 23°C
119	250 x 250 x 1.5	180 x 180	epoxy resin	-40 ... 80°C	< 8	5% at 23°C
120	33 Ø x 1.5	20 Ø	epoxy resin	-40 ... 80°C	< 150	6% at 23°C
117SI	100 x 30 x 3	80 x 20	silikone	-40 ... 80°C	< 50	5% at 23°C
118SI	120 x 120 x 3	90 x 90	silikone	-40 ... 80°C	< 15	5% at 23°C
150-1	180 x 100 x 0.6	170 x 90	PTFE	150°C	< 80	5% at 25°C

Accessories	Order no.
Adhesive tape for room temperature	ZQ9017KB
Self-adhesive film 24 x 100cm for room temperature	ZQ9017KF

Types incl. connecting cable, 2 m, with ALMEMO® connector and manufacturer's test certificate		Order no.
Model	**Application**	
117	for even surfaces, e.g. casement sections	**FQA017C**
118	for universal applications, e.g. solar-electric systems and insulating plates	**FQA018C**
119	especially for constructional industry, brickwork insulating plates, old buildings	**FQA019C**
120	small heat flow plate, e.g. for medicine, veterinary medicine, small components etc.	**FQA020C**
117 SI	flexible heat flow plate, suitable for even surfaces, e.g. casement sections	**FQA017CSI**
118 SI	flexible heat flow plate, suitable for even surfaces, e.g. solar-electric systems and insulating plates	**FQA018CSI**
150-1	flexible heat flow plate, particularly suitable for high temperatures e.g. for brickwork, insulated boilers and pipes	**FQA0801H**

Digital heat flow plate FQADx, with integrated temperature sensor for automatically correcting the heat flow plate's temperature coefficient, with ALMEMO® D6 plug



- This automatically corrects the heat flow plate's temperature coefficient using a miniature NTC sensor integrated in the heat flow plate for the purpose of measuring the plate's mean temperature.
- It measures heat flows and temperatures using a A/D converter incorporated in the ALMEMO® D6 plug.
- Two measuring channels are programmed (at our factory).
- Plate's mean temperature (°C, t) Heat flow, temperature-compensated (W/m², fq)

model 117, 118, 119

Technical Data

Heat flow sensor (see table on page 13.04)	
Accuracy of calibration value at nominal temperature	5 %
Nominal temperature	23 °C
Temperature coefficient	-0.12 % / K (epoxide plate) or -0.17 % / K (silicone plates)
Temperature sensor	
Sensor element	Miniature NTC type N
Accuracy	±0.5 K at 0 to +80 °C

A/D converter incorporated in ALMEMO® D6 plug	
Input 1	NTC sensor (clamp connector in plug)
Resolution	0.01 K
Linearization	error-free computing method according to Galway Steinhart (no approximations)
Accuracy	±0.05 K
Nominal temperature	23 °C ±2 K
Temperature drift:	0.004 %/K (40 ppm)
Input 2	Voltage mV (clamp connector in plug)
Measuring range	0 to 26 mV, 0 to 260 mV
Precision class	AA see page 01.05
Refresh rate	0.4 seconds for both channels
Supply voltage	6 to 13 VDC
Current consumption	4 mA

Accessories — Order no.

see page 13.03

General features and accessories, ALMEMO® D6 sensors see page 01.08

Variants including manufacturer's test certificate — Order no.

Heat flow plate with integrated temperature sensor cable permanently fitted, PVC, length 2 meters with ALMEMO® D6 plug.

Type 117	Substrate Epoxy resin, Dimensions 100 x 30 x 1.5 mm	**FQAD17T**
Type 118	Substrate Epoxy resin, Dimensions 120 x 120 x 1.5 mm	**FQAD18T**
Type 119	Substrate Epoxy resin, Dimensions 250 x 250 x 1.5 mm	**FQAD19T**
Type 117SI	Substrate Silicone, Dimensions 100 x 30 x 3 mm	**FQAD17TSI**
Type 118SI	Substrate Silicone, Dimensions 120 x 120 x 3 mm	**FQAD18TSI**

Digital sensors for humidity, temperature, dew point FHAD 46-Cx for measuring the equilibrium moisture content in building materials

Measuring the equilibrium moisture content

A material's equilibrium moisture content is that level of relative humidity prevailing in the ambient atmosphere at which the material neither gains nor loses moisture.

All construction materials may - to a greater or lesser degree - attract water vapor from or emit water vapor to the ambient air. They are hygroscopic; i.e. they attempt to establish an equilibrium in terms of moisture content with respect to the ambient air. The construction material and the ambient air, depending on their respective temperatures, establish an interactive balance between the adsorption of and the emission of water vapor from / to one another. Each material thus has, depending on temperature and on atmospheric humidity, a certain moisture content level (measured in water as a percentage of overall weight).

In the state of equilibrium the relationship between the water content and the equilibrium humidity of a material can be displayed graphically as a curve, the so called moisture sorption isotherm. The sorption isotherm for the material in question indicates per atmospheric humidity value the corresponding water content value at a given constant temperature. If the composition or quality of the material changes then its sorption behavior - and thus its sorption isotherm - also changes. Given the great complexity of sorption processes these isotherms cannot be determined by calculation; they have to be recorded experimentally.

Digital sensors for humidity, temperature, air pressure FHAD 46-C0, uncovered sensor element, with ALMEMO® D6 plug.

FHAD 46-C0
Uncovered sensor element: Smallest design, short response time

Description andtechnical data see page 08.06

Digital sensor for temperature, atmospheric humidity, and atmospheric pressure FHAD 46-C2 Version in plastic, with slotted sensor cap with ALMEMO® D6 plug

FHAD 46-C2
Sensor element enclosed in slotted sensor cover,
compact design, short response time

Measurement of Moisture in Materials

Dielectric Measurement of Moisture in Materials

The measurement of the moisture in materials is performed indirectly via the determination of the dielectric constant. This is performed by using a capacity measurement via a high-frequency electrical field, which penetrates the material without disturbances.

Advantage:
- simple and fast measuring technology
- non-destructive contact measurement
- long term use is possible

Disadvantage:
- limited accuracy

Measurement of the Moisture in Materials according to the Principle of Conductivity

The measurement of the moisture in materials is performed indirectly via the determination of the electrical resistance, which depends on the moisture content of the material.

Advantage:
- simple and fast measuring technology

Disadvantage:
- limited accuracy
- probe insertions
- only for short term control measurements
- measured values depend on various material parametersMaterialparametern

DAkkS or factory calibration KH9xxx, temperature, humidity, and KD92xx, atmospheric pressure, for digital sensor (see chapter Calibration certificates).

DAkkS calibration meets all the requirements regarding test resources laid down in DIN EN ISO/IEC 17025.

Moisture Sensor FHA 696 MF

- Moisture sensor for determination of the moisture content in mineral construction materials, wood and cardboard.
- Indirect measurement of the moisture through the determination of the dielectric constant.
- Capacity measurement through a high frequency electromagnetic field, which penetrates the material in a non-destructive way.

Technical Data

Measuring method:	capacitive
Resolution:	0.1%
Measuring range (moisture):	0 to 50% moisture, referenced to mass
Measuring range (material):	
mineral construction materials	0 to 20%, moisture
woods	0 to 50%, moisture
paper and cardboard	0 to 20% moisture
Housing:	plastic handle with integrated electronics 40mm Ø, 130mm long
Terminal block:	aluminium/plastic 20 x 25 x 70mm
Measuring comb:	stainless spring steel 0.5mm, 70 x 35mm
Weight:	260g
Nominal temperature:	15 to 25°C
Operative range:	0 to +60°C
Storage temperature:	–20 to +80°C
Signal output:	0 to 2V
Power supply:	+8 to +12V
Current consumption	approx. 7 mA

Accessories	Order no.
Test block for min. construct. materials	ZB9696PE05
Test block for wood, paper, cardboard	ZB9696PE30

Type	Order no.
Moisture sensor	**FHA696MF**

Wood moisture probe FHA 636 MF Hand-held probe for mobile test measurements

- Moisture sensor for determination of the moisture content in wood.
- Indirect moisture measurement according to the principle of conductivity.
- Determination of the moisture content in the material through the dependence of the electrical resistance on the moisture.

Technical Data

Measuring method:	principle of conductivity
Measuring range:	7 to 30 % moisture, referenced to mass
Housing:	plastic handle 40mm Ø, 130mm long
Measuring tips:	stainless steel, uninsulated 3mm Ø, 50mm long
Weight:	260g
Reproducibility:	± 1%
Nominal temperature:	23°C ±2°C
Operating temperature:	0 to +60°C
Storage temperature:	–20 to +80°C
Signal output:	0 to 2V
Power supply:	7.5 to +12V
Current consumption	max. 10 mA

Accessories	Order no.
PTFE-insulated measuring tip - helps avoid measuring errors in the event of surface moisture, 1 piece (2 pieces are needed per probe)	ZB9636MFST

Type	Order no.
Wood moisture probe	**FHA636MF**

Moisture content sensor - for wood, for stationary measuring operations FHA696MFS1
Capacitive sensor for applying onto the wood‘s surface

- Moisture content sensor for comparative measurement of moisture in wood materials
- The capacitive sensor with the measuring electronics is completely integrated in the damp-proof sensor housing. Plug-in ALMEMO® connecting cable
- This device is designed for stationary installation and long-term monitoring e.g. of wooden parts of buildings, roof structures (with laminated beams).
- It is also suitable for data logger operation in energy-saving sleep mode (intermittent mode).
- The sensor housing is quick and easy to install on the wooden surface in question.
- The material‘s moisture content is measured indirectly by determining its dielectric constant, which is moisture-dependent (but not temperature-dependent).
- Its capacity is measured via a high-frequency electrical field which penetrates the wood without destroying it.
- The ALMEMO® device acquires the material‘s moisture content based on the linearization curve stored in the ALMEMO® plug.
- This measuring operation can be performed using any current ALMEMO® device (version 6 and above).

Technical Data

Measuring method	capacitive
Measuring range	0 to 50 % moisture percentage in wood with respect to total mass (at 23 °C)
Resolution	0.1 % moisture content
Reproducibility	±1 % moisture content
Nominal temperature	23 °C ±2 K
Suitable conditions	0 to +80 °C Air humidity 0 to 90 % RH (no dew formation, no ice)
Storage temperature	-20 to +80 °C

Housing	Plastic 51 x 53 x 36 mm (LxWxH)
Signal connection	Built-in plug
Protection	Housing and plug connection IP64
ALMEMO® connecting cable	Coupling, PVC cable, 5 meters
ALMEMO® plug	Linearization for wood, stored in the ALMEMO® plug (for ALMEMO® devices version 6 and above)
Supply voltage	via ALMEMO® plug (5 V)
Current consumption	approx. 7 mA

Variants	Order no.
Moisture content sensor for wood, sensor integrated in the sensor housing, with built-in plug, connecting cable 5 meters, ALMEMO® plug for current ALMEMO® devices, version 6 and above	**FHA696MFS1**

Moisture content sensor - for wood, for stationary measuring operations FHA 636-MFS1
Conductivity measurement with measuring tips that can be screwed into the wood
Sensor with integrated temperature sensor for automatic temperature compensation

- Moisture content sensor for comparative measurement of moisture in wood materials
- Two hanger bolts are screwed into the wood surface and connected via measuring lines to the measuring electronics in the damp-proof sensor housing.
- The sensor housing with the integrated temperature sensor is also fixed in position on the wood surface.
- Plug-in ALMEMO® connecting cable

- The material‘s moisture content is measured indirectly by determining its electrical conductivity, which is moisture-dependent.
- It is also temperature-dependent. However, the displayed moisture value is automatically temperature-compensated by means of an integrated temperature sensor.
- The ALMEMO® device acquires the material‘s moisture content based on the linearization curve stored in the ALMEMO® plug.
- This measuring operation can be performed using any current ALMEMO® device (version 6 and above).

! This device is designed for stationary installation and long-term monitoring e.g. of wooden parts of buildings, roof structures (with laminated beams).
Data logger operation in sleep mode (intermittent mode) is required in order to protect the wood from salinization or drying out!

Technical Data

Measuring method	Electrical conductivity
Measuring range	5 to 50 % moisture percentage in wood with respect to total mass (at 23 °C)
Resolution	0.2 % moisture content
Reproducibility	±1 % moisture content
Nominal temperature	23 °C ±2 K
Temperature sensor	NTC, integrated in sensor housing
Temperature compensation	in range 0 to +80 °C
Suitable conditions	0 to +80 °C Air humidity 0 to 90 % RH (no dew formation, no ice)
Storage temperature	-20 to +80 °C
Housing	Plastic 51 x 53 x 36 mm (LxWxH)
Measuring connection	2 built-in sockets, 4 mm, with transverse hole

Measuring lines	2 lines, PTFE-insulated, length = 0.5 meters with circular cable lugs 4 mm
Measuring tips	2 stainless-steel M4 hanger bolts Total length = 60 mm including 4 stainless-steel nuts, 4 stainless-steel lock washers
Clearance	2.5 cm at right angles to the grain
Signal connection	Built-in plug
Protection	Housing, including connectors IP63
ALMEMO® connecting cable	Coupling, PVC cable, 5 meters
ALMEMO® plug	Linearization for wood, stored in the ALMEMO® plug (for ALMEMO® devices version 6 and above)
Supply voltage	via ALMEMO® plug (5 V)
Current consumption	approx. 5 mA

Variants — Order no.

Moisture content sensor for wood, with measuring tips, measuring line, sensor housing, connecting cable, 5 meters ALMEMO® plug, for current ALMEMO® devices, version 6 and above **FHA636MFS1**

Sensor for measuring the moisture in materials FHA 696 GF1
For determining the moisture content in granulated materials such as wood chips, wood pellets, and sawdust

- The sensor operates on the principle of an open plate capacitor. The moisture contained in a material can be measured in terms of that material's dielectric constants.
- Moisture content can be determined in a matter of seconds - in wood chips or wood pellets, and sawdust, in grain and cereals, and other granulated materials.
- The characteristics of the materials to be measured can be specified on a highly customized basis; a wide variety of granulates, e.g. various cereal types, can thus be measured

Technical Data

Measuring principle	capacitive
Measuring range	0 to 99.9 % water content as a weight percentage H_2O
Resolution	0.1%
Measuring radius / penetration depth	approx. 10 cm around the sensor
Temp. range of material	+5 to +40 °C
Operating temp. range	+5 to +40 °C
Storage temp. range	-20 to +70 °C
Signal output	ALMEMO® (voltage)
Power supply	5 V from ALMEMO® measuring instrument
Current consumption	approx. 5 mA

Dimensions	
Sensor head	Ø = 22 mm, length = 200 mm Rounded tip
Extensions	3 pieces, screw-on Ø = 18 mm, length = 300 mm
End piece	Plastic Ø = 22 mm, length = 30 mm
Cable terminal	Mountable male connector on sensor head
Cable	PVC, length = 2 meters with ALMEMO® connector The cable is led through the extension tubes and end piecet.

Option — Order no.

Determining characteristics for special customer-specific materials

1. We need a sample of approx. 10 liters of your granulate (e.g. wood, cereal, plastic). This sample should be sealed in an air-tight package, e.g. shrink-wrapped in plastic film.
2. We use various dried samples to determine the characteristics of your particular material.
3. We then program these characteristics in the ALMEMO® connector for the moisture content probe..

Pro rata processing costs per material sample, net (service) — Order no. OA9696GFK

Advisory note:
If the material cannot absorb water (not hygroscopic), it will not be possible to measure its moisture content.
In this case the processing fee we charge will be reduced.

Variants — Order no.

Sensor for measuring moisture in granulated wood chips and pellets comprising :

Sensor head, 3 screw-on extensions, end piece, connecting cable 2 meters, with ALMEMO® connector programmed for wood chips (also programmable for wood pellets; if required, please indicate) including carry case — **FHA696GF1**

Test block for FHA696GF for wood chips and wood pellets — **ZB9696PE22**

Water Detection Probe FHA 936 WD

- Water detection probe for instant detection of uncombined water.
- Particularly suitable for construction applications, especially in locations that are difficult to check visually, e.g. at sealing joints, under cement floors etc.
- Indirect moisture measurement according to the principle of conductivity.
- Probe with two collets for easy electrode replacements.
- Electrodes in three different designs for matching any required application.

Technical Data

Measuring method:	detection of water
Meas. values:	<10% no water >10% water
Housing:	plastic handle 40mm Ø, 130mm long
Electrodes:	stainless steel
Electrode types:	uninsulated with rounded tip: 200mm long, 3mm Ø uninsulated with sharp-edged tip: 50mm long, 3mm Ø spring steel strap: 200mm long, 6mm wide, 0.5mm high

Weight:	260g
Nominal temperature:	23°C ±2°C
Operating temperature:	0 to +60°C
Storage temperature:	–20 to +80°C
Signal output:	ALMEMO® (approx. 0 to 2V)
Power supply:	7.5 to 15V
Current consumption	max. 10 mA

Type	Order no.
Water detection probe	**FHA936WD**

Tensiometer FDA 602 TM2

- Measurement of soil moisture through the identification of suction pressure. The suction pressure is the force with which water is being held in the soil or is available for absorption. This is the force that must be produced by the plant roots in order for water to be absorbed.
- The porous, clay tip of the tensiometer transfers water from within to the drier outer surroundings by means of capillarity, thereby, creating a sub-pressure within the sealed tensiometer tube. This sub-pressure is a measure of the moisture level and can be determined as a value or used directly to activate an electrical switch. The customary unit of measurement is hPa.
- However, a tensiometer also functions in dry air as long as evaporation can take place over the porous, clay chamber. Therefore, moisture levels can be measured even in coarse-grained or very loose substrate.
- Suction pressure measurements are largely independent of the salt concentration of the substrate or soil.

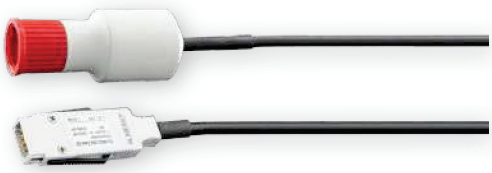
Typical Suction Pressure at Peat Substrates

30 - 40 hPa	very moist
50 – 120 hPa	moist
150 – 200 hPa	dried
>200 hPa	dry

Typical Suction Pressure at Open fields
(intermediate grade soil)

< 50 hPa	saturated
100 – 150 hPa	wet to moist
>200 hPa	start drying
200 – 500 hPa	Irrigation

Moisture tension meter, electronics



Technical Data

Measurement:	Measurement of soil moisture through the identification of suction pressure.
Measure range:	0 to -1000 hPa relative (negative pressure)
Output	0,5 to 4,5 V
Power supply	5 V via ALMEMO® connector
Cable	Sensor with cable, length = 5m, with ALMEMO® connector

Type	Order no.
Tensiometer electronics for screwing onto the tensiometer with cable and ALMEMO® connector	**FDA602TM2**

Types	Order no.

Insertion Tensiometer L2 — ZB9602TML2

Ceramic cell	Cylindrical, with tip, Ø 20 x 65 mm
Overall length	approx. 340 mm
Insertion depth	typical 250 mm

Insertion Tensiometer LKV2 — ZB9602TMKV2

Ceramic cell	Cylindrical, with tip, Ø 15 x 40 mm
Overall length	approx. 160 mm
Insertion depth	typical 70 mm

Surface Tensiometer FO — ZB9602TMFO

Sensor completely porous for measuring in thin layers of substrate.

Dimensions:	65 mm, Ø 70 mm
Sink deep:	approx. 30 - 60 mm

Surface Tensiometer FV — ZB9602TMFV

Standard model for use on capillary matting, for moist to moderately moist cultivation or for general measurement on moist surfaces.

Dimensions:	65 mm, Ø 70 mm

Moisture content sensor - for wood, for stationary measuring operations FHA 636-MF10 Conductivity measurement with measuring tips that can be screwed into the wood. Interval operation for long-term measurements.

- Wood moisture probe for long-term measuring
- Switched measuring current (intermittent mode) prevents salinization or dehydration of the material.
- For long-term monitoring of wooden parts of buildings (e.g. roof structures with laminated beams)

! Operation with the device in SLEEP mode is not possible.

Technical Data

Measuring method	Principle of conductivity Intermittent mode for long-term measuring Every 120 minutes the measuring current is activated very briefly and a new measured value is acquired; during the pauses the measuring current remains OFF.
Measuring range	5...50 % moisture content wood, mass related (at 23° C)
Housing	Metal case 65 x 60 x 35 mm (LxWxH) with cable bushings
Measuring cable	Permanently fitted, 2 sensor lines, PTFE insulated Length = 0.5 meters (= maximum possible length) with cable lugs in circular form, diameter 4 mm
Measuring tips	2 stainless-steel hanger bolts M4 Total length = 60 mm including 4 stainless-steel nuts 2 stainless-steel locking washers
Clearance	2.5 cm at right angles to the grain
Operating temperature	0 to +60 °C
Voltage supply	via ALMEMO® connector
Connecting cable	PVC Length = 5 meters with ALMEMO® connector

Variants	Order no.
Moisture content sensor for wood for long-term measurements (interval operation), with measuring tips, measuring line, connecting cable 5 m with ALMEMO® connector	**FHA636MF10**

Moisture in materials