




Operating Manual

Resistive Material Moisture And Temperature Measuring Instrument

ab Version 2.2

GMH 3831



-  Please carefully read these instructions before use!
-  Please consider the safety instructions!
-  Please keep for future reference!



WEEE-Reg.-Nr. DE 93889386

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1 General note

Read through this document attentively and make yourself familiar to the operation of the device before you use it. Keep this document in a ready-to-hand way in order to be able to look up in the case of doubt.

2 Safety

2.1 Intended use

The device is suitable for the measurement of moisture content and temperature.

The measurement is done using appropriate electrodes and cables. The electrodes are connected via a BNC (moisture) or thermocouple connector (temperature).

It is designed for the mobile use or the stationary operation in a controlled electromagnetic environment (lab). The electrodes are connected via 7-pole bayonet connection.

Personnel which starts up, operates and maintains the device has to have sufficient knowledge of the measuring procedure and the meaning of the resulting measured values, this manual delivers a valuable help for this. The instructions of the manual have to be understood, regarded and followed.

To be sure that there's no risk arising due to misinterpretation of measured values, the operator must have further knowledge in case of doubt - the user is liable for any harm/damage resulting from misinterpretation due to insufficient knowledge.

The manufacturer will assume no liability or warranty in case of usage for other purpose than the intended one, ignoring this manual, operating by unqualified staff as well as unauthorized modifications to the device.

2.2 Safety signs and symbols

Warning notices are marked in this manual as shown below:



Caution! This symbol warns of imminent danger, death, serious injuries and significant damage to property at non-observance.



Attention! This symbol warns of possible dangers or dangerous situations which can provoke damage to the device or environment at non-observance.





Note! This symbol point out processes which can indirectly influence operation, possibly cause incorrect measurement or provoke unforeseen reactions at non-observance.



2.3 Safety instructions

However, its trouble-free operation and reliability cannot be guaranteed unless the standard safety measures and special safety advises given in this manual will be adhered to when using it.

1. Trouble-free operation and reliability of the device can only be guaranteed if it is not subjected to any other climatic conditions than those stated under "Specification".
Transporting the device from a cold to a warm environment condensation may result in a failure of the function. In such a case make sure the device temperature has adjusted to the ambient temperature before trying a new start-up.

2.  Whenever there may be a risk whatsoever involved in running it, the device has to be switched off immediately and to be marked accordingly to avoid re-starting. Operator safety may be a risk if:
 - there is visible damage to the device
 - the device is not working as specified
 - the device has been stored under unsuitable conditions for a longer time
 In case of doubt, please return device to manufacturer for repair or maintenance.

3.  Do not use this product as safety or emergency stop device or in any other application where failure of the product could result in personal injury or material damage.
Failure to comply with these instructions could result in death or serious injury and material damage.




4.  This device must not be used at potentially explosive areas! The usage of this device at potentially explosive areas increases danger of deflagration, explosion or fire due to sparking.
5.  Risk of injury due to sharp measuring needles depending on the used electrode! Please protect needles while not used with suitable means of protection.

3 Product description

3.1 Scope of supply

Handheld instrument
9V battery
Operating manual

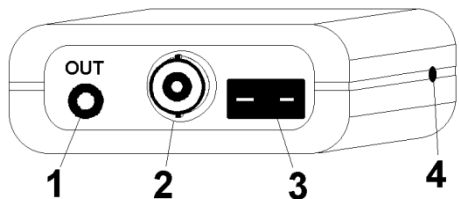
3.2 Operating and maintenance

1. Battery Operation
The battery has been used up and needs to be replaced, if 'bAt' is shown in lower display. The device will, however, continue operating correctly for a certain time.
The battery has been completely used up, if 'bAt' is shown in the upper display.
2.  The battery has to be removed, when storing device above 50°C.
We recommend to remove the battery if device is not used for a longer period of time!
Risk of leakage!
3. Treat device and probes carefully. Use only in accordance with above specification. (do not throw, hit against etc.). Protect plugs and sockets from soiling.
4. Mains Operation
 When using a power supply unit please note that operating voltage has to be 10.5 to 12 V DC. Do not apply over voltage!! Simple 12V-power supplies often have excessive no-load voltage. We, therefore, recommend using regulated voltage power supplies. Trouble-free operation is guaranteed by our power supply GNG10/3000.
Prior to connecting the plug power supply with the mains supply make sure that the operating voltage stated at the power supply is identical to the mains voltage.
5. Cable break or no connected / too dry / highly insulating material:
 **There may be still corresponding %-values displayed.**
- This shall not constitute a valid test result!
6. Maintenance: The device does not contain serviceable parts inside.
Regular inspection of contacts and cable is suggested, the precision of the measuring chain can be checked with the optional testing adapter GPAD 38
The measuring needles have to be fixed very well e.g. by means of a wrench. Loose needles can disturb the measuring.

3.3 Start up and readiness for operation

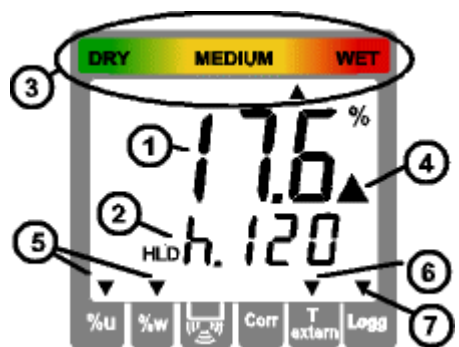
After switching on the instrument, a self test is performed (approximately 5 seconds).
During this time all display segments are shown.
After this sequence the instrument changes to measuring operation and is ready for use.

3.4 Connections



- 1: **Output:**
 Operation as interface: Connect to optically isolated interface adapter (accessory: GRS 3100 or USB 3100 N)
 Operation as analogue output: Connection via suitable cable.
 Attention: The output mode has to be configured (p.r.t chapter 7) and influences battery life!
- 2: **Sensor-connection:** BNC
- 3: **Temperature-probe-connection:** Thermocouple type K (NiCr-Ni) for temperature-compensation with an external temperature-probe
- 4: The **mains socket** is located at the left side of the instrument.

3.5 Display elements



- 1: **Main display:** Currently measured material moisture [percent moisture content]
 HLD: Measure value is 'frozen' (key 6)
- 2: **Auxiliary display:** Currently selected material (temperature when pressing key 3) Blinking display: Displayed value is out of specified range (wood 8..40 %u)
- Special display elements:**
- 3: **Moisture evaluation:** Evaluation of the material condition: via top arrows: DRY - MEDIUM - WET
- 4: **Warning triangle:** Indicates low battery
- 5: **“%u” or “%w”:** Displays unit: moisture content u or wet basis moisture content w
- 6: **T external-arrow:** Appears if an external temperature-probe is connected and automatic temperature compensation is activated.

All remaining arrows have no function in this version.

3.6 Keypad






- 1: **ON/Off key**
- 3: **Temp** **During measurement:** shortly displaying temperature or changing to temperature input.
- 4: **Mode/Menu** **Set/Menu:** press (Menu) for 2 s: configuration will activated

- 2 and 5: **Material** **During measurement: select a material**
 p.r.t.: 6.2 Pre-selection of favourite materials ('Sort')
 List of selectable materials:
 Appendix A; Appendix B
With manual temperature compensation:
 When displaying temperature (call via button ,Temp'): Input of temperature
up/down for configuration:
 to enter values or change settings
- 6: **Store** **During measurement:**
 - with **Auto-Hold off:** **Hold current measuring value** ('HLD' in display)
 - with **Auto-Hold on:** **Start a new measure**, which is ready when 'HLD' appears in the display. refer to chapter 5.4 Auto-Hold function**Set/Menu or temperature input:**
 confirming of selected input, return to measure

4 Device configuration

For configuration of the device press "**Menu**"-key (key 4) for 2 seconds, the first menu will be shown. Choose between the individual values that can be set by pressing the "**Menu**"-key (key 4) again. The individual values are changed by pressing the keys "**▲**" (key 2) or "**▼**" (key 5). Use key "**Store/↵**" (key 6) to leave configuration and to store settings.

Parameter	Values	Meaning	
	 or 		p.r.t.
Sort: limitation of the material selection			
<i>Sort</i>	oFF	Unrestricted material selection via key 2 and 5	
	1...8:	Material selection in-between 1 up to 8 selectable materials	
<i>Sor.1 ... Sor.8</i>		selectable materials (not available if Sort = off) Select the desired material that should be available during the measure via key 2 and 5.	
Generic settings			
<i>Unit</i> %	Arrow bottom left points to "u"	Moisture display = moisture content [%u]	
	Arrow bottom left points to "w"	Moisture display = wet-basis moisture content [%w]	
<i>Unit</i> °C	°C	All temperature values are in degrees Celsius	
	°F	All temperature values are in degrees Fahrenheit	
<i>Atc</i>	oFF	Atc off: temperature input for compensation via keys	5.4
	on	Atc on: temperature compensation via internally measured temperature or external probe	
<i>Auto</i> HLD oFF	oFF	Auto HLD off: continuous measuring.	5.4
	on	Auto-HLD on: when reaching a stable measuring result, this will be frozen with-HLD. When pressing the store-key a new measure will be initiated. If logger is switched on (,Func CYCL', ,Func Stor'): device works like setting would be "auto-HLD off"	
<i>3-Plt</i> on	oFF	Average value calculation off	5.4
	on	Average value calculation on: Average value out of 3 sequential measuring is calculated and displayed	
<i>P.off</i>	1...120	Power-off delay in minutes. Device will be automatically switched off as soon as this time has elapsed if no key is pressed/no interface communication takes place	
	oFF	Power-off function inactive (continuous operation, e.g. mains operation)	
<i>Out</i>	oFF	Function of the output: No output function, lowest power consumption	7
	SEr	Output is serial interface	
	dAC	Output is analogue output 0...1V	
<i>Adr.</i>	01, 11 ... 91	Base Address when Output = Serial Interface : Base address of device for interface communication.	7.1
<i>dA.C.0</i>	0.0 ... 100.0%	Enter desired moisture value at which the analogue output potential should be 0V	7.2
<i>dA.C.1</i>	0.0 ... 100.0%	Enter desired moisture value at which the analogue output potential should be 1V	7.2



The settings will be set to the settings ex works, if keys 'Set' and 'Store' are pressed simultaneously for more than 2 seconds.

5 Some basics of precision material moisture measuring

5.1 Measuring method

The electrical resistance depends on the material moisture in many cases. Therefore the device measures the (possibly extremely high) values of resistance and converts them to the displayed value by means of integrated characteristic curves. The temperature has to be compensated especially at the measurement of wood –please refer to chapter 5.5. The contact is realised e.g. by nails that are driven into the material or by injection probes. Frozen material cannot be measured!

5.2 Moisture content u and wet-basis moisture content w

Depending on the Application one of the two units is necessary. Carpenters, joiners and the like commonly use the moisture content u (sometimes referred to as MC). When evaluating firewood, wood chips etc., the wet basis moisture content w is needed. The instrument can be configured to both of the values. Please refer to chapter “configuration“.

Moisture content u or MC (relative to dry weight) = dry basis moisture content (mind the arrow at left bottom!)

The unit is %, sometimes used: % MC.

The unit expresses the moisture content like calculated below:

$$\text{Moisture content } u [\%] = (\text{weight}_{\text{wet}} - \text{weight}_{\text{dry}}) / \text{weight}_{\text{dry}} * 100$$

Or: $\text{Moisture content } u [\%] = (\text{weight}_{\text{water}}) / (\text{weight}_{\text{dry}}) * 100$

$\text{weight}_{\text{wet}}$: weight of the wet material
 $\text{weight}_{\text{water}}$: weight of water in the wet material
 $\text{weight}_{\text{dry}}$: oven-dry weight of material

Example: 1kg of wet wood, which contains 500g of water has a moisture content u of 100%

Wet-Basis moisture content w (relative to total weight, mind the arrow at left bottom!)

The wet-basis moisture content expresses the ratio of the mass of water to the total mass of the substance. The ratio is represented by the following equation (the unit is % as well):

$$\text{wet-basis moisture } w [\%] = (\text{weight}_{\text{wet}} - \text{weight}_{\text{dry}}) / \text{weight}_{\text{wet}} * 100$$

Or: $\text{wet-basis moisture } w [\%] = (\text{weight}_{\text{water}}) / \text{weight}_{\text{wet}} * 100$

Example: 1kg of wet wood, which contains 500g of water has a moisture content w of 50%

5.3 Special features of the device

466 wood specimens and 28 building materials are stored directly in the memory of the device:

Thus more exact measurements could be reached than with common devices with group selections would ever reach. Even the usage of complex conversion tables for building materials won't be necessary any more!

Example: Common wood-moisture-measuring-devices use one single group for spruce and oak, in reality the deviation of these characteristic curves is more than 3%! (Base for this statement are complex statistical surveys, considered measuring range 7-25%). This random error will not occur for the whole GMH38xx series, with the help of individual characteristic curves highest resolution is achieved.

Extreme wide measuring range: 0-100% (depending on characteristic curve) percent moisture content in wood.

Moisture evaluation: Additionally to the measuring value, an individual moisture evaluation will be displayed simultaneously.

5.4 Auto-Hold function

Particularly when measuring dry wood, electrostatic charges and other similar noise could dither the measuring value. With activated auto-hold function the device will acquire an exact measuring value automatically. During that, the device could be put down to avoid noise through discharge of the clothing etc. After having acquired the measuring value, the display will change to 'HLD': The value will be frozen as long as a new measuring is initiated by pressing key 6 (store).

5.5 Automatic temperature-compensation ('Atc')

An exact temperature compensation is important for a reliable wood-moisture-measuring. These devices feature a high quality thermocouple-input for type k thermocouples. Thus you could connect common surface-temperature-probes – The needed measuring-time 'afield' will be drastically lowered compared to common (non-surface-) temperature-probes. The used temperature-value therefore is:

Menu	Used temperature-value		Aux. Display
Atc on	Temperature-probe connected	Temperature-measuring through connected probe	Display-arrow 'T extern'
	No temperature-probe connected	Device-internal temperature-measuring	
Atc off	Independent from temperature-probe	Manual input of temperature: shortly press Temp-Button then use \blacktriangle (button 2) or \blacktriangledown (button 5) to input the temperature confirm selection with 'Store'(button 6)	



When connecting a probe that is not insulated you must have to observe not touching the wood or the electrodes nearby the unshielded electrode. We suggest using our insulated probe GTF38 (already included in standard case sets SET38HF and SET38BF).

5.6 Measuring in wood: Measuring with two measuring-needles

Normally wood is measured with measuring-needles. Used electrodes: impact-electrode GSE91 or GSG91, reciprocating piston electrode GHE91. For measuring wood, punch in the measuring-needles across to the wood-grain, having a good contact between the needles and the wood (measuring along wood-grain deviates minimal)



Reciprocating piston electrode GHE91 with temperature-probe GTF38

Select **correct wood-sort** (refer to Appendix A).

Ensure measuring the **correct temperature**. (refer to 5.5)

Hint: The special GTF38 temperature-probe can be stuck into a hole punched in with the electrode before (see picture on left). Now read the measuring-value or when having activated the auto-hold-function initiate a new measuring by pressing **Store/↓** (button 6). The measured resistance will be extremely high when measuring dry wood (<15%) thus the measuring will need more time to achieve its final value. Among other things static discharge could momentarily falsify the measuring. Therefore beware of static discharge and wait long enough until a stable measuring value is displayed (unstable: “%“ blinking) or use the auto-hold-function (see chapter 5.4 Auto-Hold function).

Most accurate measurements can be carried out within the range of **6 to 30%**.

Beyond this range the acquirable accuracy will lessen, but the device will deliver reference values still sufficient for the practitioner.

It is measured between the measuring-needles insulated among each other. Requirements for an exact measurement:

- choose right correct place to measure: place should be free of irregularities like resin-clusters, knurls, rifts, etc.
- choose correct depth: Recommendation for trimmed timber: punch in the needles up to 1/3 of the material thickness.
- Perform multiple measurements: the more measurements will be averaged, the more exact the result will be.
- Pay attention to temperature-compensation: the temperature-probe should be measuring the temperature of the moisture-measuring-place when measuring with external temperature-probe (Atc on).
Without temperature-probe: let the device adapt to the temperature of the wood (Act on) or enter the exact temperature manually (Act off).

Frequent sources of errors:

- Attention with oven-dried wood: the moisture dispersion may be irregular, often in the core is more moisture than on the edge.
- Surface-moisture: The wood-edge could be more humid than the core if the wood had been stored outside and e.g. was in rain.
- Wood preservative and other treatment could falsify the measuring.
- Fouling at the connections and round the needles could result in erroneous measurement, especially with dry wood.

5.7 Split log firewood measuring

For the firewood measuring there is a Average value calculation function integrated. The function calculates the average value of 3 sequential measuring. Combined with the method described in the following, a reliable measuring of split logs is possible.

5.7.1 Presetting

Auto Hold on: Automatic measurement

3-Pt on: Average function on

Common firewood specimens can be preset via the „Sort“-Menu, e.g.:

Sor.1	h.460	Spruce	
Sor.2	h.206	Pine	
Sor.3	h.86	Beech	
Sor.4	h.60	Birch	
Sor.5	h.401	Group hard wood	Beech Birch Oak Ash
Sor.6	h.402	Group soft wood	Pine, Spruce Fir
Sor.7	h.461	wood chips with GSF 50 or GSF 50 TF	
Sor.8	.ref	internal reference, e.g. for monitoring of the precision	

Please refer to chapter 4.

The specific sort has to be chosen before measuring getroffen werden

5.7.2 Sampling

- Choice of representative logs out of stack:
To be able to rate the stack, several logs from different positions should be measured (depending on position: Top, bottom, weather side...)
The Logs should be free of anomalies like branches, cracks, pitch pockets.
- Log size:
The logs to be measured should at least have a width of 10 cm and a length of 25 cm.

5.7.3 Measuring

Split the log:

Use an suitable axe for splitting. Fast working splitting machines can produce heat which may falsify the measuring.

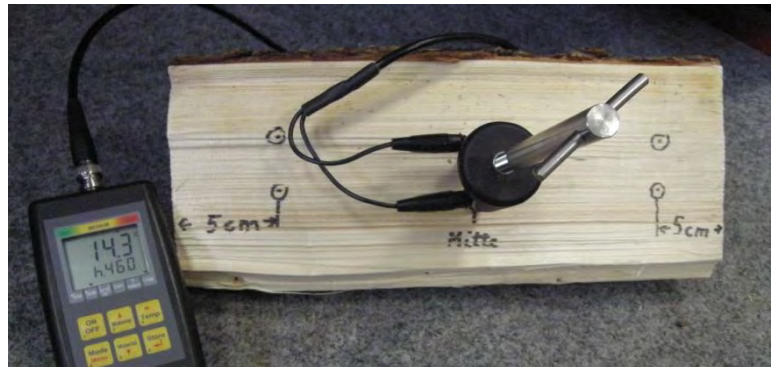
Preparation of core temperature measuring of log:

Drive in the impact electrode, put temperature probe into the generated hole.





Three measuring values have to be taken at the freshly split surface,

2 measuring spots should have 5 cm distance from cut side, the third should be placed in the center.

Drive in the needles sufficiently deep (> 5mm) and across the fibre direction



Measuring procedure:

Step	Action	Description	Display
Measuring 1	Drive in needles		
Start measuring	press 	Measuring value 1 will be automatically taken	PL.1G
Measuring stable		Instrument is ready for next step	PL.1
Measuring 2	Drive in needles		
Start measuring	press 	Measuring value 2 will be automatically taken	PL.2G
Measuring stable		Instrument is ready for next step	PL.2
Measuring 3	Drive in needles		
Start measuring	press 	Measuring value 3 will be automatically taken	PL.3G
Measuring stable		Average out of the 3 will be displayed	15.8% e.g. h.460
Return to continuous measuring display	press 		

5.8 Measuring other materials

5.8.1 'Hard' Materials (concrete or similar): Measuring with brush-type probes (GBSL91 or GBSK91)



with brush probe GBSL91

Drill two holes with Ø6mm (GBSK91) or Ø 8mm (GBSL91) at intervals of 8 to 10cm into the material to be measured. Do not use edgeless drills: the resulting heat will evaporate the moisture which will result in faulty measures. Wait for at least 10min, blow out the holes to clean them from dust. Apply conductivity compound on the brush-type probes and stick them into the holes. Choose correct material (see Appendix B: Additional materials), read the measuring value. Observe that the holes dry out by-and-by, and the device will measure a value too low, if you want to use them several times.

This effect can be compensated by using conductivity compound: insert profuse conductivity compound between the holes and the brush-type probe, and let the electrode stick in the hole for about 30min before measuring (with the device switched off). Temperature-compensation plays no role when using the building material measuring.

5.8.2 'Soft' Materials (polystyrene or similar): Measuring with Measuring-rods or -pins (GMS 300/91)

Useable electrodes: impact electrode GSE91 or GSG91, reciprocating piston electrode GHE91.

Procedure as described in chapter measuring in wood.

5.8.3 Measuring bulk cargo, bales and other special measures

Usable probes e.g. injection probe GSF 40, GSF 50 (GSF 38) or measuring rods GMS 300/91 mounted on GSE91 or GSG91.

Measuring of splints, wood chips, insulating material and similar – GSF 40 / GSF 50:

When using injection probes or measuring pins oscillating movements have to be avoided when pushing in the probes. Otherwise hollows between the probes and the material may falsify the measuring. The material should be sufficiently compressed. When in doubt repeat the measuring a few times: the highest measuring value is the most exact one. Especially when using the injection probe pay attention having a foulness-free plastic insulator (situated immediately underneath the measuring-needle).

Measuring bale of straw and hay bale – GSF 40 (GSF 38/50): Always inject the electrodes from the plain side of the bale, never from the round side, the probe can be inserted much more slightly, esp. when using GSF 38/50.

5.9 Measuring of materials, having no characteristic curves stored

Choose the representative universal material group "h.A", "h.b", "h.c" and "h.d" (for example corresponding to A,B,C and D of the GHH91) if a conversion table exists.

Attention: The moisture evaluation wet/dry of these material groups is only valid for wood!

Please keep in mind the following when using the temperature-compensation:

Automatic temperature-compensation should always be activated when measuring wood (Act on), with all other materials the automatic temperature-compensation should be switched off (Act off) and a manual temperature of 20°C should be entered.

Additionally at GMH 3851: The GMH3851 can store up to 4 additional user characteristic curves. For this the corresponding reference point measurements for the respective material has to be carried out, from which the exact moisture content has to be dedicated with the Darr-Probe or the CM-Method. The Results can be stored in the device with the help of the GMHKonfig-Software, and can be accessed by the device directly.

6 Hints for special functions

6.1 Moisture evaluation ('WET' - 'MEDIUM' - 'DRY')

Additionally to the measuring value, an individual moisture estimation will be displayed simultaneously. This moisture evaluation is only a guidance value, the final evaluation is depending on the application of the material e.g:

Cement floor pavement ZE, ZFE without additives: Readiness without floor heating at 2,3% with floor heating 1,5%

Anhydrit floor pavement AE, AFE: Readiness without floor heating at 0,5% with floor heating 0,3%

Also firewood may be already usable while instrument still displays 'wet'!

Corresponding Standards and Instructions must be observed!

The Device can only complement the skill of a tradesman or investigator but cannot replace it!

6.2 Pre-selection of favourite materials ('Sort')

A pre-selection of different materials (up to 8) can be selected from the menu for an effective working with the device. For example you can set the Menu Sort to 4 and save the desired materials in Sor.1, Sor.2, Sor.3 and Sor.4 if you only measure 4 different materials. Please refer to chapter limitation of the material selection.

Only the 4 desired materials can be selected via the buttons up and down, when exiting the menu, a changing during the measurement can be done comfortably. All materials will be available when setting Sort to off. Sor.1 to Sor.4 will still be available in the 'background', when setting the menu Sort to 4 the limited selection of the 4 entered materials will be active again. You only want to measure one material: set the menu Sort to 1 you cannot change to another material, thus a faulty operation is impossible.

7 Output

The output can be used as serial interface or as analogue output (0-1V). If none of both is needed, we suggest to switch the output off, battery life then is extended.

7.1 Interface - Base address ('Adr.')

By using an electrically isolated interface converter USB 3100 N, GRS 3100 or GRS 3105 (accessory) the device can be connected to a PC.

With the GRS3105 it is possible to connect up to 5 instruments of the GMH3000 family to a single interface (please also refer to GRS3105-manual). As a precondition the base addresses of all devices must not be identical, make sure to configure the base addresses accordingly (refer menu point "Adr." in chapter 4. In order to avoid transmission errors, there are several security checks implemented (e.g. CRC).

The following standard software packages are available for data transfer:

- **EBS20M/ -60M:** 20- / 60-channel software to record and display the measuring values
- **GMHKonfig:** Software for a comfortable editing of the device (e.g. Material selection...)

In case you want to develop your own software we offer a **GMH3000-development package** including

- an universally applicable 32bit Windows functions library ('GMH3000.DLL') with documentation that can be used by all 'serious' programming languages.
- Programming examples for Visual Basic 6.0™, Delphi 1.0™, Testpoint™, Labview™

The device has 2 channels:

- Channel 1: Material-moisture in % and base-address
- Channel 2: Temperature

Supported interface-functions:

1	2	Code	Name/Function	1	2	Code	Name/Function
x	x	0	read nominal value	x	x	202	read unit of display
x	x	3	read system status	x	x	204	read decimal point of display
x		12	read ID-no.	x		205	read extended measuring type in display
x	x	176	read min measuring range	x		208	read channel count
x	x	177	read max measuring range	x	x	214	read scale correction
x	x	178	read measuring range unit	x	x	215	set scale correction
x	x	179	read measuring range decimal point	x	x	216	read zero displacement
x	x	180	read measuring type	x	x	217	set zero displacement
	x	194	set display unit	x		222	read turn-off-delay
x	x	199	read measuring type in display	x		223	Set turn-off-delay
x	x	200	read min. display range	x		240	Reset
x	x	201	read max. display range	x		254	read program identification



The measuring and range values read via interface are always in the selected display unit (°C/°F)!

7.2 Analogue output – scaling with DAC.0 and DAC.1

With the DAC.0 and DAC.1 values the output can be rapidly scaled to Your efforts.

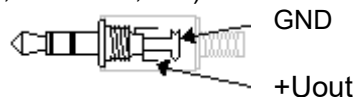
Keep in mind not to connect low-resistive loads to the output, otherwise the output value will be wrong and battery life is decreased. Loads above ca 10kOhm are uncritical.

If the display exceeds the value set by DAC.1, then the device will apply 1V to the output

If the display falls below the value set by DAC.0, then the device will apply 0V to the output

In case of an error (Err.1, Err.2, no sensor, etc.) the device will apply slightly above 1V to the output.

Plug wiring:



The 3rd contact has to be left floating!
Only stereo plugs are allowed!

8 Application in the glued timber construction and laminated timber production

The instrument with its curve h.460 (Fir) was certified by the MPA Stuttgart (Otto Graf institute) for applications in the glued timber construction according to following regulations:




EN 14080 : 2013

EN 16351 : 2015

Used equipment: Cable GMK38 and reciprocating piston electrode GHE91 (recommended) or impact electrode GSE91.

Therefore it is especially suitable for glued timber construction and laminated timber production.

9 Fault and system messages

Display	Meaning	Remedy
	Blinking curve display: Displayed value is out of specified range (Wood: 8..40%u)	Limited measuring precision! The display value is only usable as indication, not as measurement!
	low battery voltage, device will continue to work for a short time If mains operation: wrong voltage	replace battery replace power supply, if fault continues to exist: device damaged
	low battery voltage If mains operation: wrong voltage	replace battery Check/replace power supply, if fault continues to exist: device damaged
No display or weird display	low battery voltage If mains operation: wrong voltage	replace battery Check/replace power supply, if fault continues to exist: device damaged
Device does not react on keys	system error device defective	Disconnect battery or power supply, wait some time, re-connect return to manufacturer for repair
---	Sensor error: no material connected (meas. Value below permissible range), no valid signal charge at the probe, device will discharge (esp. at dry wood) Sensor broken or device defective	Connect meas. Material Wait until probe has discharged return to manufacturer for repair
Err.1	Value exceeding measuring range Wrong probe connected Probe or device defective Non-floating probe near the unshielded electrode	Check: Is the value exceeding the measuring range specified? ->temperature too high! Check probe return to manufacturer for repair Insulate probe or measure at shielded electrode
Err.2	Value below display range Wrong probe connected Probe, cable or device defective	Check: Is the value below the measuring range specified? -> temperature too low! Check probe return to manufacturer for repair
Err.7	system error	return to manufacturer for repair

10 Inspection of the accuracy / Adjustment Services

Accuracy can be inspected with the optional available testing adapter GPAD 38 (e.g. every year). To check precision select material characteristic curve ".rEF", choose display "%u" and connect the testing adapter. The device must display the printed value for the GMH38xx. If the precision is bad, we suggest to send the device to the manufacturer for a new adjustment.

11 Measuring precision

- Frozen wood cannot be measured!
- The measuring needles have to be fixed very well e.g. by means of a wrench
Loose needles can disturb the measuring

12 Reshipment and disposal



All devices returned to the manufacturer have to be free of any residual of measuring media and other hazardous substances.

Measuring residuals at housing or sensor may be a risk for persons or environment



Use an adequate transport package for reshipment, especially for fully functional devices. Please make sure that the device is protected in the package by enough packing materials.

Add the completed reshipment form of the GHM website

<http://www.ghm-messtechnik.de/downloads/ghm-formulare.html>.



Dispense exhausted batteries at destined gathering places.

The device must not be disposed in the unsorted municipal waste! Send the device directly to us (sufficiently stamped), considering the above if it should be disposed.

We will dispose the device appropriate and environmentally sound.

13 Specification

Measuring	Channel 1	Channel 2
Principle	Resistive material-moisture-measuring matching DIN EN 13183-2: 2002 or according VDI 4206 sheet 4	Temperature-measuring thermocouple type K or internal temperature-measuring
Char. curve	466 different kinds of wood 28 different building materials	matching DIN EN 60584-1: 1996, ITS90
Probe connection	BNC Plug	floating connector for mini-blade-terminal
Meas. range	0,0...100,0 % u moisture content (depending on characteristic curve) equal to approx. 3kOhm ... 2TerraOhm	thermocouple: -40,0... +200,0 °C / -40,0... +392,0 °F int. temp.-Meas: -30,0...+75,0 °C / -22,0...+167,0 °F
Spec. meas. range	Wood: 8 ... 40 % u	Wood temperature 0 ... 40 °C (no frozen wood!)
Resolution	0,1 % moisture content	0,1 °C / 0,1 °F
Evaluation	Evaluation of the material condition in 9 steps from DRY to WET	
Accuracy Device without probe	±1Digit (at nominal-temperature) Wood: ±0,2 % moisture content (deviation from characteristic curve, range 8..40 % u) building mat.: ±0,2 % moisture content (dev. from char. curve, range depending on char. curve)	Type K: ± 0.5% m.v. ± 0.3 °C int. t.-measuring: ± 0,3 °C (is type K reference junction)
overall accuracy	depending on used measuring equipment, measured material and the correct execution.	
Temperature drift	< 0,005 % moisture content per 1 K	0,01 % per 1 K
Nominal temperature	25°C	
Ambient condition	Temperature -25 ... +50 °C / -13 ... +122 °F (frozen material cannot be measured) Relative humidity 0 ... 95 %RH (non condensing)	
Storage temperature	-25 ... +70 °C / -13 ... +158 °F	
Output:	3.5 mm audio plug, stereo (max. permissible length of connection cable < 3 m) output selectable as:	
serial interface:	via optically isolated interface adapter GRS 3100, GRS 3105 or USB 3100 N (p.r.t. accessories) directly connectable to RS232- or USB-interfaces.	
analog output:	0..1 V, freely scalable (resolution 13 bit, accuracy 0.05 % at nom. temp., cap. load <1 nF)	
Power Supply	9V-Battery (included) as well as additional d.c. connector (diameter of internal pin 1.9 mm) for external 10.5-12 V direct voltage supply. (suitable power supply: GNG10/3000)	
Power Consumption	output off	approx. 2.5 mA
	output serial interface:	approx. 2.7 mA
	analog output:	approx. 3.0 mA
Display	Two 4 digits LCD's (12.4 mm high and 7 mm high) for material moisture temperature or characteristic curve, hold function, etc. as well as additional pointing arrows.	
Pushbuttons	6 membrane keys for on/off switch, menu operation, characteristic curve, hold-function etc.	
Housing	Dimension: 142 x 71 x 26 mm (L x B x D) impact resistant ABS, membrane keyboard, transparent panel, integrated pop-up-clip for table top or suspended use	
Weight	approx. 155 g	
Hold Function	Press button to store current value.	
Automatic-Off-Function	Device will be automatically switched off if no key is pressed/no interface communication takes place for the time of the power-off delay. The power-off delay can be set to values between 1 and 120 min.; it can be completely deactivated.	

Directives / standards: The instruments conform to following European Directives:

2014/30/EU EMC Directive

2011/65/EU RoHS

Applied harmonized standards:

EN 61326-1 : 2013 emissions level: class B

emi immunity according to table 3 and A.1

Additional fault: <1 %

The instrument with suitable Electrode (GHH91) is conform to the requirements of

EN 14080 : 2013

EN 16351 : 2015

for fir. Therefore it is suitable e.g. for glued timber construction and laminated timber (MPA certified and listed)

14 Appendix A: Sorts of wood

Select kind of wood you want to measure, enter number on the device, e.g. birch = h. 60

Identification	Number	Comment	Range
Group A	h. A	Wood-group A (equal to GHH91 selector "A")	0..100%
Group B	h. B	Wood-group B (equal to GHH91 selector "B")	1..100%
Group C	h. C	Wood-group C (equal to GHH91 selector "C")	2..100%
Group D	h. D	Wood-group D (equal to GHH91 selector "D")	3..100%
AS/NZS 1080.1	h. AS	Australian reference characteristic curve	4..100%
Group Birch Oak Ash Beech	h.401	Hardwood-Group	6..100%
Group Spruce-Pine-Fir	h.402	Softwood-Group	6..100%
Fir, Picea abies Karst.	h.460	applications in the glued timber construction, MPA certified	6..100%
Wood chips GSF 38 /GSF 50	h.461	Softwood chips with probe GSF 50 / GSF 38 or GSF 50 TF / GSF 38 TF	5..100%
GMH 38 reference	.rEF	Internal reference for determining additional characteristic curves / calculation tables (without temperature-compensation)	

Abura	Hallea ciliata	h.2	7..60%
Afromosia	Pericopsis elata	h.3	6..55%
Afzelia	Afzelia spp.	h.4	8..47%
Agba	Gossweilerodendron balsamiferum	h.426	6..82%
Albizia / latandza, New Guinea	Albizia falcatara	h.8	5..100%
Albizia / latandza, Solomon Island	Albizia falcatara	h.9	4..93%
Alder, Blush	Solanea australis	h.10	5..82%
Alder, Brown	Caldcluvia paniculosa	h.11	7..89%
Alder, Common	Alnus glutinosa	h.131	2..100%
Alder, Rose	Caldcluvia australiensis	h.12	6..91%
Alerce	Fitzroya cupressoides	h.13	7..77%
Amberoi	Pterocymbium beccarii	h.14	5..85%
Amoora, New Guinea	Amoora cucullata	h.15	3..100%
Andiroba	Carapa guianensis	h.16	5..73%
Antiaris, New Guinea	Antiaris toxicaria	h.7	6..100%
Apple, Black	Planachonella australis	h.17	7..78%
Ash Silvertop	Eucalyptus sieberi	h.27	2..100%
Ash, American	Fraxinus americana	h.132	5..100%
Ash, Bennet's	Flindersia bennettiana	h.18	6..99%
Ash, Crow's	Flindersia australis	h.19	7..88%
Ash, European	Fraxinus excelsior	h.133	7..69%
Ash, Hickory	Flindersia afflaiana	h.20	6..92%
Ash, Japanese	Fraxinus mandshurica	h.134	4..100%
Ash, Red	Flindersia excelsa	h.21	5..86%
Ash, Scaly	Ganophyllum falcatum	h.22	5..100%

Ash, Silver (Northern)	Flindersia schottina	h.23	7..89%
Ash, Silver (Queensland)	Flindersia bourjotiana	h.24	6..100%
Ash, Silver (Southern)	Flindersia schottina	h.25	7..100%
Ash, Silver, New Guinea	Flindersia amboinensis	h.26	5..100%
Aspen, Hard	Acronychia laevis	h.28	5..84%
Ayan	Distemonanthus benthamianus	h.285	7..67%
Balau	Shorea laevis	h.31	4..65%
Balau, red	Shorea guiso	h.32	4..88%
Balsa	Ochroma pyramidale	h.33	4..100%
Basralocus / Angelique	Dicorynia guianensis	h.34	6..67%
Basswood	Tilia americana	h.228	4..100%
Basswood, Fijian	Endospermum macrophyllum	h.35	4..79%
Basswood, Malaysian	Endospermum malacense	h.36	5..100%
Basswood, New Guinea	Endospermum medullosum	h.37	5..98%
Basswood, Silver	Polyscias elegans	h.38	7..93%
Basswood, Solomon Island	Polyscias elegans	h.39	4..83%
Bean, Black	Castanosperum australe	h.40	6..100%
beech, damped	Fagus sylvatica	h.87	6..68%
beech, european -	Fagus sylvatica	h.86	5..100%
Beech, Myrtle	Nothofagus cunninghamii	h.41	6..98%
Beech, New Zealand Red (hearted untreated)	Nothofagus fusca	h.42	7..100%
Beech, New Zealand Red (sapwood boron)	Nothofagus fusca	h.43	2..100%

Beech, New Zealand Red (sapwood untreated)	Nothofagus fusca	h.44	5..100%
Beech, Silky	Citronella moorei	h.45	8..85%
Beech, Silver	Nothofagus menziesii	h.46	8..73%
Beech, Silver (sapwood tanalith)	Nothofagus menziesii	h.47	6..99%
Beech, Silver (sapwood untreated)	Nothofagus menziesii	h.48	4..100%
Beech, Wau	Elmerrilla papuana	h.49	7..100%
Beech, White (Fiji)	Gmelina vitiensis	h.50	5..100%
Beech, White (Queensland)	Gmelina leichardtii	h.51	6..100%
Bintangor / Calophyllum, Fijian	Calophyllum leucocarpum	h.53	5..100%
Bintangor / Calophyllum, Malaysian	Calophyllum curtisii	h.54	6..99%
Bintangor / Calophyllum, New Guinea	Calophyllum papuanum	h.55	4..100%
Bintangor / Calophyllum, Phillipines	Calophyllum inophyllum	h.56	6..100%
Bintangor / Calophyllum, Solomon Islands	Calophyllum kajewskii	h.57	6..100%
Binuang	Octomeles sumatrana	h.130	5..95%
Birch, American	Betula lutea	h.59	7..94%
Birch, European	Betula pubescens	h.60	5..100%
Birch, White	Schizomeria ovata	h.58	7..97%
Bishop Wood (Fiji)	Bischofia javanica	h.61	5..94%
Blackbutt	Eucalyptus pilularis	h.62	4..100%
Blackbutt, Western Australia	Eucalyptus patens	h.63	6..100%
Blackwood	Acacia melanoxylon	h.64	6..97%
Bloodwood, Red	Corymbia gunmifera	h.66	7..100%
Bollywood	Litsea reticulata	h.67	5..100%
Bossime	Drypetes spp,	h.70	7..78%
Box Grey	Eucalyptus moluccana	h.75	8..94%
Box Grey Coast	Eucalyptus bosistoana	h.76	7..98%
Box, Black	Eucalyptus lafgiflorens	h.71	5..100%
Box, Brush (Location Unknown)	Lophostemon confertus	h.74	5..63%
Box, Brush (N.S.W.)	Lophostemon confertus	h.72	4..68%
Box, Brush (Queensland)	Lophostemon confertus	h.73	7..52%
Box, Kanuka	Tristania laurina	h.77	6..100%
Boxwood, New Guinea	Xanthophyllum papuanum	h.78	5..88%
Boxwood, Yellow	Planchonella pholmaniana	h.79	7..78%
Brachychiton	Brachychiton carthersii	h.80	5..67%
Bridelia	Bridelia minutiflora	h.81	5..100%
Brigalow	Acacia harpophylla	h.82	5..100%
Brownbarrel	Eucalyptus fastigata	h.83	5..100%
Bubinga	Guibourtia demeusii	h.84	7..90%
Buchanania	Buchanania arborescens	h.85	4..99%
Burckella, Solomon Island	Burckella obovata	h.88	4..73%
Butternut, Rose	Blepharocarya involucrigera	h.89	5..88%
Camphorwood, New Guinea	Cinnamomum spp,	h.90	6..96%
Camptosperma (Malaysia)	Camptosperma curtisii	h.91	8..100%
Camptosperma (Solomon Island)	Camptosperma kajewskii	h.92	3..100%
Cananga (Phillipines)	Canarium odoratum	h.93	7..78%
Canarium Solomon Island	Canarium salomonese	h.97	4..82%
Canarium, African	Canarium Scheinfurthii	h.94	7..100%
Canarium, Fijian	Canarium oleosum	h.95	5..100%
Canarium, New Guinea	Canarium vitiense	h.96	5..97%
Candlenut	Aleurites moluccana	h.98	0..100%

Carabeen, Yellow	Sloanea woollsii	h.99	6..85%
Cathormion, New Guinea	Cathormion umbellatum	h.100	4..68%
Cedar , Amercan	Cedrela odorata	h.102	8..86%
Cedar, incense	Calocedrus decurrens	h.65	5..100%
Cedar, White	Melia azedarach	h.101	7..100%
Cedar, Yellow	Chamaecyparis nootkatensis	h.457	4..100%
Celtis, New Guinea	Celtis spp,	h.103	5..86%
Celtis, Solomon Island	Celtis philippinesis	h.104	4..69%
Cheesewood, White (Queensland) /Asian Alstonia	Alstonia scholaris	h.105	5..100%
Chengal (Malaysia)	Neobalanocarpus heimii	h.106	4..99%
Cherry, American	Prunus serotina	h.216	5..100%
Cherry, European	Prunus avium	h.217	7..86%
Cleistocalyx	Cleistocalyx mirtoides	h.107	5..100%
Coachwood	Ceratopetalum apetalum	h.108	4..100%
Coondoo, Blush	Planchonella laurifolia	h.109	6..75%
Cordia, New Guinea	Cordia dichotoma	h.110	5..61%
Corkwood, Grey	Erythrina vespertillio	h.111	6..70%
Courbaril	Hymenaea coubaril	h.112	7..64%
Cudgerie, Brown	Canarium australasicum	h.113	7..85%
Cupiuba	Goupia glabra	h.147	6..69%
Curupixá	Micropholis	h.114	6..63%
Cypress	Cupressus spp,	h.456	5..100%
Cypress, Northern	Callitris intratropica	h.115	6..100%
Cypress, Rottnest Island	Callitris preisii	h.116	7..100%
Cypress, White	Callitris glaucophylla	h.117	6..100%
Dakua, Salusalu (Fiji)	Decussocarpus vitiensis	h.118	6..100%
Dibetou/African walnut	Lovoa trichilioides	h.119	7..87%
Dillenia (Solomon Island)	Dillenia salomonese	h.120	4..82%
Doi (Fiji)	Alphitonia zizphoides	h.121	5..92%
Duabanga, New Guinea	Duabanga moluccana	h.124	4..93%
Ebony, african	Diospyros spp,	h.125	6..68%
Ekki	Lophira alata	h.29	4..95%
Elm, European	Ulmus spp,	h.374	7..61%
Elm, White	Ulmus americana	h.373	5..88%
Evodia, White	Melicope micrococca	h.135	5..75%
Figwood (Moreton Bay)	Ficus macrophylla	h.139	7..69%
fir, alpine	Abies lasiocarpa	h.410	6..100%
fir, amabilis	Abies amabilis	h.411	4..100%
Fir, Douglas	Pseudotsuga menziesii	h.122	5..100%
Fir, Douglas (New Zealand) (sapwood treated)	Pseudotsuga menziesii	h.140	6..95%
Fir, Douglas (New Zealand) (sapwood untreated)	Pseudotsuga menziesii	h.141	5..100%
Fir, Douglas (New Zealand) (truewood untreated)	Pseudotsuga menziesii	h.142	3..100%
Fir, europ., MPA	Picea abies Karst.	h.460	6..100%
fir, grand	Abies grandis	h.412	4..100%
Fir, Spruce	Abies magnifica	h.413	5..100%
fir, white / fir, silver	Abies alba	h.414	5..100%
Galip	Canarium indicum	h.143	5..81%
Garo-Garo	Matrixiodendron pschyclados	h.144	5..86%
Garuga	Garuga floribunda	h.145	6..65%
Goncalo Alvez	Astronium spp,	h.146	6..51%
Greenheart	Ocotea rodiaei	h.148	6..100%
Greenheart, Queensland	Endiandra compressa	h.149	7..100%
Group Spruce-Pine-Fir	Weichhölzgruppe / Softwood-Group	h.402	6..100%

Guarea, black	Guarea cedrata	h.68	7..100%
Guarea, white	Guarea cedrata	h.69	9..85%
Guariuba	Clarisia racemosa	h.150	8..70%
Gum, Black	Nyssa sylvatica	h.162	7..100%
Gum, Blue, Sidney	Eucalyptus saligna	h.152	7..100%
Gum, Blue, Southern	Eucalyptus globulus	h.151	6..100%
Gum, Grey	Eucalyptus punctata	h.153	5..100%
Gum, Grey, Mountain	Eucalyptus cypellocarpa	h.154	6..100%
Gum, Maiden's	Eucalyptus maidenii	h.155	7..100%
Gum, Manna	Eucalyptus viminalis	h.156	4..100%
Gum, Mountain	Eucalyptus dalrympleana	h.157	3..100%
Gum, Pink	Eucalyptus fasciculosa	h.158	6..100%
Gum, Red, American	Liquidambar styraciflua	h.166	5..100%
Gum, Red, Forest	Eucalyptus tereticomis	h.159	7..100%
Gum, Red, River	Eucalyptus camaldulensis	h.160	7..100%
Gum, Rose / Gum, Saligna	Eucalyptus grandis	h.161	7..100%
Gum, Shining	Eucalyptus nitens	h.163	5..100%
Gum, Spotted (Victoria) (Lemon-Scented)	Corymbia spp,	h.164	4..94%
Gum, Sugar	Eucalyptus cladocalyx	h.165	6..100%
Gum, White Dunn's	Eucalyptus dunnii	h.167	4..93%
Gum, Yellow	Eucalyptus leucoxylon	h.168	7..94%
Handlewood, Grey	Aphananthe philippinensis	h.169	5..84%
Handlewood, White	Strebulus pendulinus	h.170	7..72%
Hardwood, Johnstone River	Bakhouisia bancroftii	h.171	5..78%
Hemlock / Hemlock, Western	Tsuga heterophylla	h.172	8..67%
Hemlock, Chinesische	Tsuga chinensis	h.173	5..98%
Hevea	Hevea Brasiliensis	h.174	7..92%
Hickory	Carya spp.	h.175	6..89%
Hollywood, Yellow	Premna lignum-vitae	h.176	7..86%
Horizontal	Anodopetalum biglandulosum	h.177	7..100%
Incensewood	Pseudocarapa nitidula	h.178	8..73%
Iroko	Chlorophora excelsa	h.179	7..54%
Ironbark, Grey	Eucalyptus drephanophylla	h.180	7..100%
Ironbark, Grey	Eucalyptus paniculata	h.181	5..100%
Ironbark, Red	Eucalyptus sideroxylon	h.182	8..100%
Ironbark, Red, Broad Leaved	Eucalyptus fibrosa	h.183	8..100%
Ironbark, Red, Narrow Leaved	Eucalyptus cerbra	h.184	5..100%
Jarrah	Eucalyptus marginata	h.185	5..100%
Jelutong	Dyera costulata	h.186	0..100%
Jequitiba	Cariniana spp,	h.187	5..81%
Kahikatea (New Zealand) (Boron)	Dacrycarpus docrydioides	h.188	7..80%
Kahikatea (New Zealand) (Thanalith)	Dacrycarpus docrydioides	h.189	6..94%
Kahikatea (New Zealand) (untreated)	Dacrycarpus docrydioides	h.190	6..96%
Kamarere (Fiji)	Eucalyptus deglupta	h.191	5..83%
Kamarere (New Guinea)	Eucalyptus deglupta	h.192	5..100%
Kapur	Dryobalanops spp,	h.193	7..94%
Karri	Eucalyptus diversicolor	h.194	5..100%
Kauceti	Kermadecia vitiensis	h.200	4..71%
Kauri	Agathis australis, boroneensis	h.201	5..100%
Keledang	Artocarpus lanceifolius	h.202	0..100%
Kempas	Koomapassia excelsa	h.203	4..100%
KerANJI (Malaysia)	Dialium platysepalum	h.204	5..60%
Keruing	Dipterocarpus spp,	h.205	6..81%

Kiso	Chisocheton schumannii	h.218	6..65%
Lacewood, Yellow	Polyalthia oblongifolia	h.219	5..87%
Laran	Anthocephalus chinensis	h.223	7..85%
Larch	Larix decidua	h.221	5..88%
Larch, American / Larch, Western	Larix occidentalis	h.220	5..100%
Larch, Japanese	Larix kaempferi	h.222	5..100%
Lauan, Red	Shorea negrosensis	h.224	5..78%
Leatherwood	Eucryphia lucida	h.225	6..100%
Lightwood	Acacia implexa	h.226	7..78%
Limba	Terminalia superba	h.227	6..70%
Lime, European	Tilia vulgaris	h.229	4..100%
Louro, Red	Ocotea rubra	h.231	5..99%
Macadamia	Floyda praealta	h.232	7..74%
Magnolia	Magnolia acuminata/grandiflora	h.233	6..100%
Mahogany, Brush	Geissos bentharii	h.242	7..70%
Mahogany, Miva	Dysoxylum muelleri	h.243	8..94%
Mahogany, New Guinea	Dysoxylum spp,	h.241	6..95%
Mahogany, Red	Eucalyptus botryoides	h.244	7..100%
Mahogany, Rose	Dysoxylum fraseranum	h.245	7..83%
Mahogany, Southern	Eucalyptus botryoides	h.246	5..100%
Mahogany, White	Eucalyptus acmenoides	h.247	6..100%
Mahogany Khaya	Khaya spp,	h.235	7..100%
Mahogany, American	Swietenia spp,	h.234	6..100%
Mahogany, Phillipines	Parashorea plicata	h.236	5..100%
Mahogany, Phillipines	Shorea almon	h.237	4..86%
Mahogany, Sapelli / Sapele	Entandrophragma cylindricum	h.238	5..100%
Mahogany, Sipo / Utile	Entandrophragma utile	h.239	6..100%
Mahogany, Tiama / gedu nohor	Entandrophragma angolense	h.240	10..66%
Mako	Trischospermum richii	h.248	3..87%
Makoré	Thieghemmella africana	h.123	6..100%
Makorè	Thieghemmella heckelii	h.249	7..100%
Malas	Homalium foetidum	h.250	5..92%
Malletwood	Rhodamnia argentea	h.251	5..87%
Malletwood, Brown	Rhodamnia rubescens	h.252	5..91%
Mangachapui	Hopea acuminata	h.253	6..100%
Mango	Mangifera minor	h.254	4..87%
Mango, Phillipines	Mangifera altissima	h.255	7..100%
Mangosteen (Fiji)	Garcinia myrtifolia	h.256	5..87%
Mangrove, Cedar	Xylocarpus australasicus	h.257	6..100%
Maniltoa (Fiji)	Maniltoa grandiflora	h.258	6..72%
Maniltoa (New Guinea)	Maniltoa pimenteliana	h.259	6..72%
Mansoniana	Mansoniana altissima	h.260	7..100%
Maple, New Guinea	Flindersia pimentelianan	h.261	6..100%
Maple, Queensland	Flindersia brayleyana	h.262	5..100%
Maple, Rose	Cryptocarya erythroxylon	h.263	6..80%
Maple, Scented	Flindersia laeviscarpa	h.264	7..70%
Mararie	Pseudoweinmannia lanchanocarpa	h.265	8..97%
Marri	Eucalyptus calophylla	h.266	5..81%
Masiratu	Degeneria vitiensis	h.267	5..86%
Massandaruba	Manilkara kanosiensis	h.268	4..83%
Matai	Podocarpus spicatus	h.269	6..95%
Mengkulang	Heritiera spp,	h.270	5..85%
Meranti, Buik from 1999	Shorea platyclados	h.271	4..76%
Meranti, Dark Red	Shorea spp,	h.272	5..100%

Meranti, Nemesu from 1999	<i>Shorea pauciflora</i>	h.274	4..100%
Meranti, Seraya from 1999	<i>Shura curtisii</i>	h.275	5..78%
Meranti, Tembaga from 1999	<i>Shorea leprosula</i>	h.276	3..93%
Meranti, White	<i>Shorea hypochra</i>	h.277	4..100%
Meranti, Yellow	<i>Shorea multiflora</i>	h.273	0..100%
Merawan	<i>Hopea sulcala</i>	h.278	4..100%
Merbau	<i>Intsia spp,</i>	h.279	6..100%
Mersawa	<i>Anisoptera laevis</i>	h.280	4..100%
Messmate	<i>Eucalyptus obliqua</i>	h.281	8..97%
Moabi	<i>Baillonella toxisperma</i>	h.282	6..100%
Mora	<i>Mora excelsa</i>	h.283	5..73%
Moustiquaire	<i>Cryptocarya spp,</i>	h.284	4..100%
Musizi	<i>Maesopsis eminii</i>	h.286	7..100%
Neuburgia	<i>Neuburgia collina</i>	h.287	7..98%
Nutmeg (Fiji)	<i>Myristica spp,</i>	h.290	5..95%
Nutmeg (New Guinea)	<i>Myristica buchneriana</i>	h.291	5..100%
Nyatoh	<i>Palaquium spp,</i>	h.292	4..92%
Oak, European	<i>Quercus robur L.,</i>	h.126	4..100%
Oak, Japanese	<i>Quercus spp,</i>	h.127	4..100%
Oak, New Guinea	<i>Castanopsis acuminatissima</i>	h.293	4..100%
Oak, Red	<i>Quercus spp,</i>	h.128	5..100%
Oak, Silky, Fishtail	<i>Neorites kevediana</i>	h.294	3..74%
Oak, Silky, Northern	<i>Cardwellia sublimia</i>	h.295	5..100%
Oak, Silky, Red	<i>Stenocarpus salignus</i>	h.296	6..86%
Oak, Silky, Southern	<i>Grevillea robusta</i>	h.297	5..81%
Oak, Silky, White	<i>Stenocarpus sinuatus</i>	h.298	6..82%
Oak, Tasmanian	<i>Eucalyptus regnans</i>	h.299	7..100%
Oak, Tulip, Blush	<i>Argyrodendron actinophyllum</i>	h.300	6..75%
Oak, Tulip, Brown	<i>Argyrodendron trifoliolatum</i>	h.301	9..75%
Oak, Tulip, Red	<i>Argyrodendron peralatum</i>	h.302	9..100%
Oak, Tulip, White	<i>Petrygota horsfieldii</i>	h.303	5..88%
Oak, White-	<i>Quercus spp,</i>	h.129	5..100%
Obah	<i>Eugenia spp,</i>	h.304	5..84%
Obeche	<i>Triplochiton scleroxylon</i>	h.1	5..60%
Odoko	<i>Scottellia coriacea</i>	h.305	6..93%
Olive	<i>Olea hochstetteri</i>	h.306	7..100%
Olivillo	<i>Atextoxicon punctatum</i>	h.307	5..90%
Opepe	<i>Nauclea diderrichii</i>	h.52	7..95%
Padauk, African	<i>Pterocarpus soyauxii</i>	h.308	4..100%
Palachonella, Fijian	<i>Planchonella vitiensis</i>	h.347	6..77%
Palachonella, New Guinea	<i>Planchonella kaembachiana</i>	h.348	4..92%
Palachonella, New Guinea	<i>Planchonella thyrsoides</i>	h.349	2..85%
Palachonella, Solomon Island	<i>Planchonella papuana</i>	h.350	4..70%
Paldao	<i>Dracontomelum dao</i>	h.309	4..100%
Panga Panga	<i>Millettia stuhlmannii</i>	h.312	6..52%
Papuacedrus	<i>Papuacedrus papuana</i>	h.314	6..100%
Parinari, Fijian	<i>Oarinaris insularum</i>	h.315	4..100%
Penarahan	<i>Myristica iners</i>	h.316	6..100%
Peppermint, Broad-Leaved	<i>Eucalyptus dives</i>	h.317	6..100%
Peppermint, Narrow-Leaved	<i>Eucalyptus australiana</i>	h.318	8..98%
Peroba, White	<i>Paratecoma peroba</i>	h.319	7..75%
Persimmon	<i>Diospyros pentamera</i>	h.320	5..90%
Perupok (Malaysia)	<i>Koona spp,</i>	h.321	1..100%
Perupok (Malaysia)	<i>Lophopetalum subovatum</i>	h.322	8..100%
Pillarwood	<i>Cassipourea malosana</i>	h.323	4..100%

Pine / Pine, Stone	<i>Pinus pinea</i>	h.345	6..100%
Pine, Aleppo	<i>Pinus halepensis</i>	h.324	8..98%
Pine, Austrian	<i>Pinus nigra</i>	h.212	5..100%
Pine, Beneguet	<i>Pinus kesya</i>	h.325	8..100%
Pine, Black	<i>Prumnopitys amarus</i>	h.326	5..98%
Pine, Bunya	<i>Pinus bidwillii</i>	h.327	8..88%
Pine, Canary Island	<i>Pinus canariensis</i>	h.328	6..100%
Pine, Celery-Top	<i>Phyllocladus aspenifolius</i>	h.329	7..92%
Pine, Hoop	<i>Araucaria cunninghamii</i>	h.330	7..100%
Pine, Huon	<i>Dacrydium franklinii</i>	h.331	8..90%
Pine, King William	<i>Athrotaxis selaginoides</i>	h.332	7..85%
Pine, Klinki	<i>Araucaria hunsteinii</i>	h.333	4..100%
Pine, Loblolly-	<i>Pinus taeda</i>	h.209	5..100%
Pine, Longpole-	<i>Pinus contorta</i>	h.207	5..100%
Pine, Maritime	<i>Pinus pinaster</i>	h.334	8..96%
Pine, Parana Red	<i>Araucaria angustifolia</i>	h.335	6..43%
Pine, Parana White	<i>Araucaria angustifolia</i>	h.336	7..72%
Pine, Pitch-, american	<i>Pinus palustris</i>	h.211	6..83%
Pine, Pitch-, caribbean	<i>Pinus caribaea</i>	h.210	6..100%
Pine, Radiata	<i>Pinus radiata</i>	h.337	5..100%
Pine, Radiata (New Zealand) (sapwood aac)	<i>Pinus radiata</i>	h.338	7..100%
Pine, Radiata (New Zealand) (sapwood boliden)	<i>Pinus radiata</i>	h.339	6..100%
Pine, Radiata (New Zealand) (sapwood boron)	<i>Pinus radiata</i>	h.340	6..89%
Pine, Radiata (New Zealand) (sapwood tanalith)	<i>Pinus radiata</i>	h.341	5..95%
Pine, Radiata (New Zealand) (sapwood untreated)	<i>Pinus radiata</i>	h.342	5..100%
Pine, Red	<i>Pinus resinosa</i>	h.343	2..100%
Pine, Scotts	<i>Pinus sylvestris L.</i>	h.206	6..100%
Pine, Shortleaf	<i>Pinus echinata</i>	h.213	5..100%
Pine, Slash (Queensland)	<i>Pinus elliottii</i>	h.344	6..100%
Pine, Southern	<i>Pinus echinata</i>	h.214	5..100%
Pine, Southern, yellow / Pine, Ponderosa	<i>Pinus ponderosa</i>	h.208	5..100%
Pine, Sugar	<i>Pinus lambertiana</i>	h.215	4..100%
Pine, western white	<i>Pinus monticola</i>	h.406	5..100%
Pittosporum (Tasmania)	<i>Pittosporum bicolor</i>	h.346	4..100%
Planchonia	<i>Pleiogynium timorense</i>	h.351	5..95%
Pleiogynium / Podo	<i>Podocarpus neriifolia</i>	h.352	7..71%
Podocarp, Fijian	<i>Decussocarpus vitiensis</i>	h.353	6..100%
Podocarp, Red	<i>Euroschinus falcata</i>	h.354	6..100%
Poplar, Black	<i>Populus nigra</i>	h.313	4..100%
Poplar, Pink	<i>Euroschinus falcata</i>	h.355	6..85%
Quandong, Brown	<i>Eurocarpus coorangooloo</i>	h.356	5..97%
Quandong, Silver	<i>Elaeocarpus angustifolius</i>	h.357	5..82%
Quandong, Solomon Island	<i>Elaeocarpus spaericus</i>	h.358	3..85%
Qumu	<i>Acacia Richii</i>	h.359	5..86%
Raintree (Fiji)	<i>Samanea saman</i>	h.360	5..57%
Ramin	<i>Gonystylus spp,</i>	h.361	6..67%
Redwood / Sequoia	<i>Sequoia sempervirens</i>	h.362	5..100%
Rengas	<i>Gluta spp,</i>	h.363	4..100%
Resak (Malaysia)	<i>Cotylelobium melanoxylon</i>	h.364	3..100%
Rimu (non-truewood boron)	<i>Dacrydium cupresinum</i>	h.365	7..82%
Rimu (non-truewood tanalith)	<i>Dacrydium cupresinum</i>	h.366	7..82%
Rimu (non-truewood untreated)	<i>Dacrydium cupresinum</i>	h.367	8..88%

Rimu (truewood untreated)	Dacrydium cupresinum	h.368	8..50%
Robinia	Robinia pseudoacacia	h.369	2..92%
Roble Pellin	Nothofagus obliqua	h.370	6..93%
Rock maple	Acer saccharum	h.6	5..100%
Rosewood, Brazilian	Dalbergia nigra	h.311	5..72%
Rosewood, Indian	Dalbergia latifolia	h.310	4..100%
Rosewood, New Guinea	Pterocarpus indicus	h.371	5..84%
Rosewood, Phillipines	Pterocarpus indicus	h.372	10..66%
Sapupira	Hymenobium excelsum	h.375	5..87%
Sasauria (Fiji)	Dysoxylum quercifolium	h.376	4..89%
Sassafras	Doryphora sassafras	h.377	6..90%
Sassafras, Southern	Atherosperma moschatum	h.378	7..84%
Satinash, Blush	Acmena Hemilampra	h.379	3..100%
Satinash, Grey	Syzygium gustavioides	h.380	5..100%
Satinash, New Guinea	Syzygium butternanum	h.381	5..87%
Satinash, Rose	Syzygium francisii	h.382	5..73%
Satinay	Syncarpia hillei	h.383	4..100%
Satinbox	Phenbaliu saquameum	h.384	5..100%
Satinheart, Green	Geijera salicifolia	h.385	8..62%
Satinwood, Tulip	Rhodospaera rhodanthema	h.386	6..100%
Scentbark	Eucalyptus aromapholia	h.387	5..90%
Schizomeria, New Guinea	Schizomeria serrata	h.388	5..100%
Schizomeria, Solomon Island	Schizomeria serrata	h.389	4..74%
Sepetir	Sindora coriaceae	h.390	1..100%
Sheoak, Fijian Beach	Casuarina nodiflora	h.391	6..91%
Sheoak, River	Casuarina cunninghamiana	h.392	7..74%
Sheoak, Rose	Casuarina torulosa	h.393	8..72%
Sheoak, Western Australia	Allocasuarina fraserana	h.394	7..80%
Silkwood, Bolly	Cryptocarya ablata	h.395	8..64%
Silkwood, Silver	Flindersia acuminata	h.396	7..92%
Simpoh (Phillippines)	Dillenia philippinensis	h.397	5..100%
Sirus, White	Ailanthus peekelii	h.398	5..97%
Sirus, White	Ailanthus triphysa	h.399	7..90%
Sloanea	Sloanea spp,	h.400	5..100%
Soft wood chips		h.461	4..100%
Spruce, European	Picea abies Karst.	h.136	6..100%
Spruce, Norway /Norway Spruce	Picea abies	h.137	6..100%
Spruce, Sitka	Picea sitchensis	h.138	5..100%
Sterculia, Brown	Sterculia spp,	h.230	4..100%
Stringybark, Brown	Eucalyptus capitellata	h.403	6..100%
Stringybark, Darwin	Eucalyptus tetradonta	h.404	5..100%
Stringybark, Yellow	Eucalyptus muelleriana	h.405	9..100%
Suren	Toona cilata	h.407	6..100%
Sweet chestnut	Castanea sativa	h.199	2..100%
Sycamore	Acer pseudoplatanus	h.5	7..70%
Sycamore, Satin	Ceratopetalum succirubrum	h.408	7..80%
Tallowwood	Eucalyptus microcorsis	h.409	4..100%

Tatajuba	Bagassa guianensis	h.30	7..50%
Taun Maleisien	Pometia pinnata	h.195	0..100%
Taun New Guinea	Pometia pinnata	h.196	6..100%
Taun Phillipines	Pometia pinnata	h.197	7..100%
Taun Solomon Island	Pometia pinnata	h.198	4..90%
Tawa	Beilschmiedia tawa	h.415	8..62%
Tawa (sap & heart boron)	Beilschmiedia tawa	h.416	6..77%
Tawa (sap & heart untreated)	Beilschmiedia tawa	h.417	7..82%
Teak	Tectona grandis	h.418	6..100%
Terap	Artocarpus elasticus	h.419	2..100%
Terentang	Camptosperma brevipetiolata	h.420	5..100%
Terminalia Braun	Terminalia microcarpa	h.421	3..91%
Terminalia Gelb	Terminalia complanata	h.422	3..100%
Tetrameles	Tetrameles nudiflora	h.423	5..91%
Tingle, Red	Eucalyptus jacksonii	h.424	5..100%
Tingle, Yellow	Eucalyptus guilfolei	h.425	5..100%
Tomillo	Cedrelinga catenaeformis	h.427	5..92%
Totara	Podocarpus totara	h.428	7..80%
Touriga, Red	Calophyllum constatum	h.429	8..95%
Tristiropsis, New Guinea	Tristiropsis canarioides	h.430	6..90%
Tulipwood	Harpullia pendula	h.432	7..99%
Turat	Eucalyptus gomophocephala	h.431	7..91%
Turpentine	Syncarpia glomulifera	h.433	5..100%
Vaivai-Ni-Vaikau	Serianthes myriadenia	h.434	5..77%
Vatica, Phillipines	Vatica, manggachopi	h.435	7..79%
Vitex, New Guinea	Vitex cofassus	h.436	5..100%
Vuga	Metrosideros collina	h.437	6..68%
Vutu	Barringtonia edulis	h.438	4..67%
Walnut, American	Juglans nigra	h.288	5..100%
Walnut, Blush	Beilschmiedia obtusifolia	h.439	8..81%
Walnut, European	Juglans regia	h.289	7..74%
Walnut, Queensland	Endiandra palmerstonii	h.440	6..100%
Walnut, Rose	Endiandra muelleri	h.441	3..100%
Walnut, White	Cryptocarya obovata	h.442	7..79%
Walnut, Yellow	Beilschmiedia bancroftii	h.443	5..84%
Wandoo	Eucalyptus wandoo	h.444	7..100%
Wattle, Hickory	Acacia penninervis	h.445	7..81%
Wattle, Silver	Acacia dealbata	h.446	7..95%
Wengé	Millettia laurentii	h.448	7..67%
Western Red Cedar	Thuja plicata	h.449	6..69%
Whitewood, American	Liriodendron tulipifera	h.447	5..100%
Woolybutt	Eucalyptus longifolia	h.450	7..100%
Yaka	Dacrydium nausoriensis/nidilum	h.451	6..88%
Yasi-Yasi I (Fiji)	Syzygium effusum	h.452	4..92%
Yasi-Yasi II (Fiji)	Syzygium spp,	h.453	5..100%
Yate	Eucalyptus cornuta	h.454	6..94%
Yertschuk	Eucalyptus considenia	h.455	7..100%

15 Appendix B: Additional materials

Select material you want to measure, enter number on the device, e.g. concrete b25 = b. 6

15.1 Measuring of building materials

Material	Number	Range
Concrete		
Concrete 200kg/m ³ B15 (200 kg concrete per 1m ³ sand)	b. 5	0,7..3,3%
Concrete 350kg/m ³ B25 (350 kg concrete per 1m ³ sand)	b. 6	1,1..3,9%
Concrete 500kg/m ³ B35 (500 kg concrete per 1m ³ sand)	b. 7	1,4..3,7%
gas-aerated concrete (Hebel)	b. 9	1,6..100,0%
gas-aerated concrete (Ytong PPW4, gross density 0,55)	b. 27	1,6..53,6%
Screed		
Anhydrite screed AE, AFE	b. 1	0,0..30,3%
Ardurapid screed-concrete	b. 2	0,6..3,4%
Elastizell screed	b. 8	1,0..24,5%
Screed-plaster	b. 11	0,4..9,4%
Wood-concrete screed	b. 13	5,3..20,0%
Screed-concrete ZE, ZFE without additives	b. 21	0,8..4,6%
Screed-concrete ZE, ZFE with bitumen additives	b. 22	2,8..5,5%
Screed-concrete ZE, ZFE with synthetic additives	b. 23	2,4..11,8%
Miscellaneous		
Asbestous cement panels	b. 3	4,7..34,9%
Bricks clay bricks	b. 4	0,0..40,4%
Plaster	b. 10	0,3..77,7%
Plaster synthetic	b. 12	18,2..60,8%
On-wall plaster	b. 20	0,0..38,8%
Lime mortar KM 1:3	b. 14	0,4..40,4%
Lime sand bricks (14 DF (200), gross density 1,9)	b. 28	0,1..12,5%
Limestone	b. 15	0,4..29,5%
MDF	b. 16	3,3..52,1%
Cardboard	b. 17	9,8..100,0%
Stone-timber	b. 18	10,5..18,3%
Polystyrene	b. 25	3,9..50,3%
soft-fibre-panel-wood, bitumen	b. 26	0,0..71,1%
Concrete mortar ZM 1:3	b. 19	1,0..10,6%
Concrete bounded fake boards	b. 24	3,3..33,2%

The accuracy of measuring building materials depends on manufacturing and using. The used additives may vary from manufacturer to manufacturer, therefore deviating measure results may occur. The given measuring-range is the theoretically measurable range.

15.2 Measuring of agricultural bulk cargo

Material	Number	Range	Comment
Softwood chips	h.461	4..100%	Injection probe GSF 38/50
Wheat	h.462	5..60%	Injection probe GSF 38/50 or GMS 300/91
Barley	h.463	4..60%	Injection probe GSF 38/50 or GMS 300/91
Hay	h.464	5..70%	Injection probe GSF 40 or GMS 300/91
Straw	h.465	5..72%	Injection probe GSF 40 or GMS 300/91

15.3 Estimation of additional materials

Following materials may be well estimated with the help of the device, but you won't reach such high accuracy than with materials listed in appendix A and B.

Material	Number	Comment
Flax	h. 458	Injection probe GSF 38/40/50 or GMS 300/91
Cork	h. A	
Fibre board	h. C	
Wood fibre insulating wall panel	h. C	
Wood fibre hard disks	h. C	
Kauramin-fake boards	h. C	
Melamine-fake boards	h. A	
Paper	h. C	
Phenolic resin-fake boards	h. A	
Textiles	h. C (D)	

