GREISINGER

EN

Resistive material moisture and temperature measuring Instrument

as of version 2.1   **Operating Manual**   # GMH 3830

CE

GMH 38 Series
Materialfeuche / material moisture

MPA certified
approved for glued timber construction
acc. to DIN 1052-1

keep for future reference

Made in Germany

WEEE-Reg.-Nr. DE 93889386

Index

1   General advice

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   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 or thermocouple connector.
The safety instructions of these operating manual must be followed (see below).
The device may be used only under the conditions and for the uses for which it was designed.
The device must be treated carefully and used according to the technical data (do not throw, hit, etc.).
Protect against contamination

2.1   Safety signs and symbols

Warning notices are marked in this manual as shown in table 1:

⚠ DANGER	Warning! Symbol warns of impending danger, death, serious bodily injury or serious property damage if ignored.
☞	Attention! Symbol warns of potential hazards or hazardous situations that can cause damage on the equipment or the environment if ignored.
ⓘ	Note! Symbol indicates incidents that have an indirect impact on the operation or can trigger an unforeseen reaction if ignored.

table 1

2.2   Safety Instructions

This device has been designed and tested in accordance to the safety regulations for electronic devices. 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. ⚠ **DANGER** 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. ⚠ **DANGER** 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.

3   Product description

3.1   Scope of delivery
GMH 3850
9V battery type IEC 6F22
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 still corresponding %-values are displayed**
        - This shall not constitute a valid test result!

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
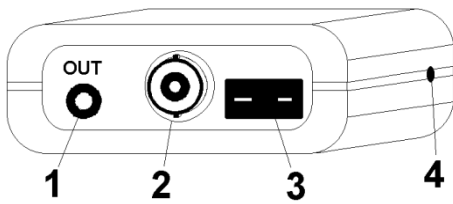
1.   **Output:** Operation as interface: Connect to optically isolated interface adapter (accessory: GRS 3100, GRS3105 or USB3100)
Operation as analogue output: Connection via suitable cable. Attention: The output mode has to be configured (p.r.t 2.7) and influences battery life!
2.   **Sensor-connection:** 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
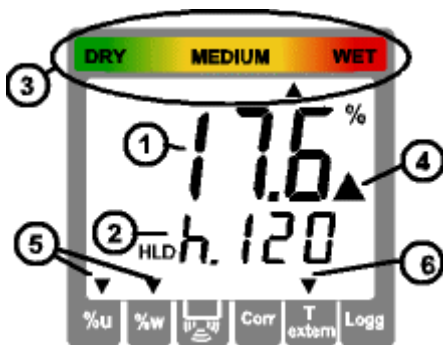
| 1 = Main Display: | Currently measured material moisture [percent moisture content] HLD: Measure value is 'frozen' (Button 6) |
| 2 = Auxiliary Display: | Currently selected material (or temperature when pressing Button 3) Blinking display: Displayed value is out of specified range (wood 8..40%u) |

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   Pushbuttons

Key 1:	On/Off key
Key 4:	Set/Menu
	press (Menu) for 2 sec.: configuration will activated
Key 2, 5:	**During measure: select a material**
	p.r.t.: limitation of the material selection, List of selectable materials: Appendix A; Appendix B
	With manual temperature compensation: When displaying temperature (call via button 3 'Temp'): Input of temperature
	up/down for configuration: to enter values or change settings

Key 6:   **Store/↵:**
-      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 5.3 Auto-Hold Function
-      Set/Menu or temperature input:
confirming of selected input, return to measure

Key 3:   **During the measure:** shortly displaying temperature or changing to temperature input.

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	
key **Menu**	key ▲ or ▼		p.r.t.
Sort: limitation of the material selection			
Sort.	**off**:	Unrestricted material selection via key 2 and 5	
	1...8:	Material selection in-between 1 up to 8 selectable materials	
Sor.1....Sor.8		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			
Unit %	Arrow bottom left points to **"%u"**	Moisture display = moisture content [%u]	
▾ ▾	Arrow bottom left points to **"%w"**	Moisture display = wet-basis moisture content [%u]	
Unit °C °F	°**C**	All temperature values are in degrees Celsius	
	°**F**	All temperature values are in degrees Fahrenheit	
Atc	**oFF**	Atc off: temperature input for compensation via keys	**5.4**
	on	Atc on: temperature compensation via internally measured temperature or external probe	
Auto HLD oFF	**oFF**	Auto HLD off: continuous measuring.	**5.3**
	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"	
P.oFF	**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)	
Out	**oFF**	Function of the output: No output function, lowest power consumption	
	SEr	Output is serial interface	
	dAC	Output is analogue output 0...1V	
Adr.	**01, 11 ... 91**	Base Address when Output = Serial Interface : Base address of device for interface communication.	**7.1**
dAC.0	**0.0 ... 100.0%**	Enter desired moisture value at which the analogue output potential should be 0V	**7.2**
dAC.1	**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 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:

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

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

weight_{wet}: $\quad$ weight of the wet material
weight_{water}: $\quad$ weight of water in the wet material
weight_{dry}: $\quad$ oven-dry weight of material
Example: $\quad$ 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):

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

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

Example: $\quad$ 1kg of wet wood, which contains 500g of water has a moisture content u of 50%

5.2 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.

5.3 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 button 6 (store).

5.4 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 ▲ (button 2) or ▼ (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).**

5.5 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 5.4)

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 5.3 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.

5.6 Measuring Other Materials

5.6.1 '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.

5.6.2 '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.

5.6.3 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 form 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.

5.7 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 3850: The GMH3850 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 (for GRS3100 or GRS3105 interface adapters) 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 USB3100, GRS3100 or GRS3105 (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:

GND

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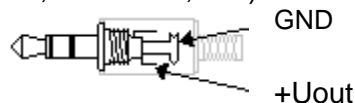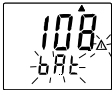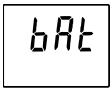
☞ The 3rd contact has to be left floating!
Only stereo plugs are allowed!

8   Application in the glued timber construction acc. to DIN 1052-1 (MPA certified)

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 DIN 1052-1 with the following equipment:

- measuring cable GMK38
- reciprocating piston electrode GHE91 (recommended) or impact electrode GSE91

9 Fault and System Messages

Display	Meaning	Remedy
67.6 **h.128**	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!
108 bAt	low battery voltage, device will continue to work for a short time	replace battery
	If mains operation: wrong voltage	replace power supply, if fault continues to exist: device damaged
bAt	low battery voltage	replace battery
	If mains operation: wrong voltage	Check/replace power supply, if fault continues to exist: device damaged
No display or weird display Device does not react on keys	low battery voltage	replace battery
	If mains operation: wrong voltage	Check/replace power supply, if fault continues to exist: device damaged
	system error	Disconnect battery or power supply, wait some time, re-connect
	device defective	return to manufacturer for repair
----	Sensor error: no material connected (meas. Value below permissible range), no valid signal	Connect meas. material
	charge at the probe, device will discharge (esp. at dry wood)	Wait until probe has discharged
	Sensor broken or device defective	return to manufacturer for repair
Err.1	Value exceeding measuring range	Check: Is the value exceeding the measuring range specified? ->temperature too high!
	Wrong probe connected	Check probe
	Probe or device defective	return to manufacturer for repair
	Non-floating probe near the unshielded electrode	Insulate probe or measure at shielded electrode
Err.2	Value below display range	Check: Is the value below the measuring range specified? -> temperature too low!
	Wrong probe connected	Check probe
	Probe, cable or device defective	return to manufacturer for repair
Err.7	system error	return to manufacturer for repair

10 Inspection oft the accuracy / Adjustment Services

Accuracy can be inspected with the testing adapter GPAD 38 (extra equipment).
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 Specification

Measuring	Channel1	Channel2
- **Principle**	Resistive material-moisture-measuring matching DIN EN 13183-2: 2002	Temperature-measuring thermocouple type K or internal temperature-measuring matching DIN EN 60584-1: 1996, ITS90
- **Char. curves**	466 different kinds of wood 28 different building materials	
- **Probe connection**	BNC Plug	floating connector for mini-blade-terminal
- **Display range**	0.0...100.0 % moisture content (depending on characteristic curve) equal to ca. 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
- **Specified measuring 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 6..40%) 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)
- **Total accuracy**	refer to chapter „11 Measuring precision"	
- **Temperature drift**	< 0.005 % moisture content per 1K	0.01% per 1K

Nominal temperature 25°C

Ambient   Temperature **-**25 ... **+**50°C (-13 .. 122°F)
                        Relative humidity 0 ... 95 %RH (non condensing)

Storage temperature -25 ... +70°C (-13 ... 158°F)

Housing   Dimension: 142 x 71 x 26 mm (L x B x D)
                        impact resistant ABS, membrane keyboard, transparent panel.
                        Front side IP65, integrated pop-up-clip for table top or suspended use
Weight   approx. 155 g

Output: 3.5mm audio plug, stereo
    Selectable as serial interface: via optically isolated interface adapter GRS3100, GRS3105 or USB3100 (p.r.t. accessories)
                        directly connectable to RS232- or USB-interfaces.
    or analogue output: 0..1V, freely scalable (resolution 13bit, accuracy 0.05% at nominal temperature, cap. load <1nF)

Power Supply   9V-Battery, type IEC 6F22 (included) as well as additional d.c. connector (diameter of internal pin 1.9 mm) for external 10.5-12V direct voltage supply. (suitable power supply: GNG10/3000)

Power Consumption
output off	approx. 2.5mA
output serial interface:	approx. 2.7mA
analogue output:	approx. 3.0mA
cyclic logger sleeping state with output deactivated:	< 0.1mA
cyclic logger sleeping state with activated serial interface:	< 0.3mA

Display   Two 4 digits LCD's (12.4mm 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.
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.

EMC: The device corresponds to the essential protection ratings established in the Directives of the European Parliament and of the council on the approximation of the laws of the member states relating to the electromagnetic compatibility (2004/108/EC).
                  EN61326 +A1 +A2 (Appendix B, class B), additional error: < 1% FS

13 Disposal Notes

Dispense exhausted batteries at destined gathering places.
This device must not be disposed as "residual waste". To dispose this device, please send it directly to us (adequately stamped). We will dispose it appropriately and environmentally friendly.

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%**
GMH38 reference	.rEF	Internal reference for determining additional characteristic curves / calculation tables (without temperature-compensation)	

Abura	Hallea ciliata	h.2	7..60%	Basswood, Fijian	Endospermum macrophyllum	h.35	4..79%
Afrormosia	Pericopsis elata	h.3	6..55%	Basswood, Malaysian	Endospermum malacense	h.36	5..100%
Afzelia	Afzelia spp.	h.4	8..47%	Basswood, New Guinea	Endospermum medullosum	h.37	5..98%
Agba	Gossweilerodendron balsamiferum	h.426	6..82%	Basswood, Silver	Polyscias elegans	h.38	7..93%
Albizia / Iatandza, New Guinea	Albizia falcatara	h.8	5..100%	Basswood, Solomon Island	Polyscias elegans	h.39	4..83%
Albizia / Iatandza, Solomon Island	Albizia falcatara	h.9	4..93%	Bean, Black	Castanosperum australe	h.40	6..100%
Alder, Blush	Solanea australis	h.10	5..82%	beech, damped	Fagus sylvatica	h.87	6..68%
Alder, Brown	Caldcluvia paniculosa	h.11	7..89%	beech, european -	Fagus sylvatica	h.86	5..100%
Alder, Common	Alnus glutinosa	h.131	2..100%	Beech, Myrtle	Nothofagus cunninghamii	h.41	6..98%
Alder, Rose	Caldcluvia australiensis	h.12	6..91%	Beech, New Zeeland Red (hearted untreated)	Nothofagus fusca	h.42	7..100%
Alerce	Fitzroya cupressoides	h.13	7..77%	Beech, New Zeeland Red (sapwood boron)	Nothofagus fusca	h.43	2..100%
Amberoi	Pterocymbium beccarii	h.14	5..85%	Beech, New Zeeland Red (sapwood untreated)	Nothofagus fusca	h.44	5..100%
Amoora, New Guinea	Amoora cucullata	h.15	3..100%	Beech, Silky	Citronella moorei	h.45	8..85%
Andiroba	Carapa guianensis	h.16	5..73%	Beech, Silver	Nothofagus menziesii	h.46	8..73%
Antiaris, New Guinea	Antiaris toxicaria	h.7	6..100%	Beech, Silver (sapwood tanalith)	Nothofagus menziesii	h.47	6..99%
Apple, Black	Planachonella australis	h.17	7..78%	Beech, Silver (sapwood untreated)	Nothofagus menziesii	h.48	4..100%
Ash Silvertop	Eucalyptus sieberi	h.27	2..100%	Beech, Wau	Elmerrilla papuana	h.49	7..100%
Ash, American	Fraxinus americana	h.132	5..100%	Beech, White (Fiji)	Gmelina vitiensis	h.50	5..100%
Ash, Bennet's	Flindersia bennettiana	h.18	6..99%	Beech, White (Queensland)	Gmelina leichardtii	h.51	6..100%
Ash, Crow's	Flindersia australis	h.19	7..88%	Bintangor / Calophyllum, Fijian	Callophyllum leucocarpum	h.53	5..100%
Ash, European	Fraxinus excelsior	h.133	7..69%	Bintangor / Calophyllum, Malaysian	Calophyllum curtisii	h.54	6..99%
Ash, Hickory	Flindersia ifflaiana	h.20	6..92%	Bintangor / Calophyllum, New Guinea	Calophyllum papuanum	h.55	4..100%
Ash, Japanese	Fraxinus mandshurica	h.134	4..100%	Bintangor / Calophyllum, Phillipines	Calophyllum inophyllum	h.56	6..100%
Ash, Red	Flindersia excelsa	h.21	5..86%	Bintangor / Calophyllum, Solomon Islands	Calophyllum kajewskii	h.57	6..100%
Ash, Scaly	Ganophyllum falcatum	h.22	5..100%	Binuang	Octomeles sumatrana	h.130	5..95%
Ash, Silver (Northern)	Flindersia schottina	h.23	7..89%	Birch, American	Betula lutea	h.59	7..94%
Ash, Silver (Queensland)	Flindersia bourjotiana	h.24	6..100%	Birch, European	Betula pubescens	h.60	5..100%
Ash, Silver (Southern)	Flindersia schottina	h.25	7..100%	Birch, White	Schizomeria ovata	h.58	7..97%
Ash, Silver, New Guinea	Flindersia amboinensis	h.26	5..100%	Bishop Wood (Fiji)	Bischofia javanica	h.61	5..94%
Aspen, Hard	Acronychia laevis	h.28	5..84%	Blackbutt	Eucalyptus pilularis	h.62	4..100%
Ayan	Distemonanthus benthamianus	h.285	7..67%	Blackbutt, Western Australia	Eucalyptus patens	h.63	6..100%
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%				

Blackwood	Acacia melanoxylon	h.64	6..97%	Cypress, Northern	Callitris intratropica	h.115	6..100%
Bloodwood, Red	Corymbia gunmifera	h.66	7..100%	Cypress, Rottnest Island	Callitris preisii	h.116	7..100%
Bollywood	Litsea reticulata	h.67	5..100%	Cypress, White	Callitris glaucophylla	h.117	6..100%
Bossime	Drypetes spp,	h.70	7..78%	Dakua, Salusalu (Fiji)	Decussocarpus vitiensis	h.118	6..100%
Box Grey	Eucalyptus moluccana	h.75	8..94%	Dibetou/African walnut	Lovoa trichilioides	h.119	7..87%
Box Grey Coast	Eucalyptus bosistoana	h.76	7..98%	Dillenia (Solomon Island)	Dillenia salomonese	h.120	4..82%
Box, Black	Eucalyptus lafgiflorens	h.71	5..100%	Doi (Fiji)	Alphitonia zizphoides	h.121	5..92%
Box, Brush (Location Unknown)	Lophostemon confertus	h.74	5..63%	Duabanga, New Guinea	Duabanga moluccana	h.124	4..93%
Box, Brush (N.S.W.)	Lophostemon confertus	h.72	4..68%	Ebony, african	Diospyros spp,	h.125	6..68%
Box, Brush (Queensland	Lophostemon confertus	h.73	7..52%	Ekki	Lophira alata	h.29	4..95%
Box, Kanuka	Tristania laurina	h.77	6..100%	Elm, European	Ulmus spp,	h.374	7..61%
Boxwood, New Guinea	Xanthophyllum papuanum	h.78	5..88%	Elm, White	Ulmus americana	h.373	5..88%
Boxwood, Yellow	Planchonella pholmaniana	h.79	7..78%	Evodia, White	Melicope micrococca	h.135	5..75%
Brachychiton	Brachychiton carrthersii	h.80	5..67%	Figwood (Moreton Bay)	Ficus macrophylla	h.139	7..69%
Bridelia	Bridelia minutiflora	h.81	5..100%	fir, alpine	Abies lasiocarpa	h.410	6..100%
Brigalow	Acacia harpohylla	h.82	5..100%	fir, amabilis	Abies amabilis	h.411	4..100%
Brownbarrel	Eucalyptus fastigata	h.83	5..100%	Fir, Douglas	Pseudotsuga menziesii	h.122	5..100%
Bubinga	Guibourtia demeusii	h.84	7..90%	Fir, Douglas (New Zealand) (sapwood treated)	Pseudotsuga menziesii	h.140	6..95%
Buchanania	Buchanania arborescens	h.85	4..99%	Fir, Douglas (New Zealand) (sapwood untreated)	Pseudotsuga menziesii	h.141	5..100%
Burckella, Solomon Island	Burckella obovata	h.88	4..73%	Fir, Douglas (New Zealand) (truewood untreated)	Pseudotsuga menziesii	h.142	3..100%
Butternut, Rose	Blepharocarya involucrigera	h.89	5..88%	Fir, europ., MPA	Picea abies Karst.	h.460	6..100%
Camphorwood, New Guinea	Cinnamomum spp,	h.90	6..96%	fir, grand	Abies grandis	h.412	4..100%
Campnosperma (Malaysia)	Campnosperma curtisii	h.91	8..100%	Fir, Spruce	Abies magnifica	h.413	5..100%
Campnosperma (Solomon Island)	Campnosperma kajewskii	h.92	3..100%	fir, white / fir, silver	Abies alba	h.414	5..100%
Cananga (Phillipines)	Canagium odoratum	h.93	7..78%	Galip	Canarium indicum	h.143	5..81%
Canarium Solomon Island	Canarium salomonese	h.97	4..82%	Garo-Garo	Matrixiodendron pschyclados	h.144	5..86%
Canarium, African	Canarium Scheinfurthii	h.94	7..100%	Garuga	Garuga floribunda	h.145	6..65%
Canarium, Fijian	Canarium oleosum	h.95	5..100%	Goncalo Alvez	Astronium spp,	h.146	6..51%
Canarium, New Guinea	Canarium vitiense	h.96	5..97%	Greenheart	Ocotea rodiaei	h.148	6..100%
Candlenut	Aleurites moluccana	h.98	0..100%	Greenheart, Queensland	Endiandra compressa	h.149	7..100%
Carabeen, Yellow	Sloanea woollsii	h.99	6..85%	Group Spruce-Pine-Fir	Weichhölzergruppe / Softwood-Group	h.402	6..100%
Cathormion, New Guinea	Cathormion umbellatum	h.100	4..68%	Guarea, black	Guarea cedrata	h.68	7..100%
Cedar , Amercan	Cedrela odorata	h.102	8..86%	Guarea, white	Guarea cedrata	h.69	9..85%
Cedar, incense	Calocedrus decurrens	h.65	5..100%	Guariuba	Clarisia racemosa	h.150	8..70%
Cedar, White	Melia azedarach	h.101	7..100%	Gum, Black	Nyssa sylvatica	h.162	7..100%
Cedar, Yellow	Chamaecyparsis nootkatensis	h.457	4..100%	Gum, Blue, Sidney	Eucalyptus saligna	h.152	7..100%
Celtis, New Guinea	Celtis spp,	h.103	5..86%	Gum, Blue, Southern	Eucalyptus globulus	h.151	6..100%
Celtis, Solomon Island	Celtis philippinesis	h.104	4..69%	Gum, Grey	Eucalyptus punctata	h.153	5..100%
Cheesewood, White (Queensland) /Asian Alstonia	Alstonia scholaris	h.105	5..100%	Gum, Grey, Mountain	Eucalyptus cypellocarpa	h.154	6..100%
Chengal (Malaysia)	Neobalanocarpus heimii	h.106	4..99%	Gum, Maiden's	Eucalyptus maidenii	h.155	7..100%
Cherry, American	Prunus serotina	h.216	5..100%	Gum, Manna	Eucalyptus viminalis	h.156	4..100%
Cherry, European	Prunus avium	h.217	7..86%	Gum, Mountain	Eucalyptus dalrympleana	h.157	3..100%
Cleistocalyx	Cleistocalyx mirtoides	h.107	5..100%	Gum, Pink	Eucalyptus fasciculosa	h.158	6..100%
Coachwood	Ceratopetalum apetalum	h.108	4..100%	Gum, Red, American	Liquidambar styraciflua	h.166	5..100%
Coondoo, Blush	Planchonella laurifolia	h.109	6..75%	Gum, Red, Forest	Eucalyptus tereticomis	h.159	7..100%
Cordia, New Guinea	Cordia dichotoma	h.110	5..61%	Gum, Red, River	Eucalyptus camaldulensis	h.160	7..100%
Corkwood, Grey	Erythrina vespertillio	h.111	6..70%	Gum, Rose / Gum, Saligna	Eucalyptus grandis	h.161	7..100%
Courbaril	Hymenaea coubaril	h.112	7..64%	Gum, Shining	Eucalyptus nitens	h.163	5..100%
Cudgerie, Brown	Canarium australasicum	h.113	7..85%	Gum, Spotted (Victoria) (Lemon-Scented)	Corymbia spp,	h.164	4..94%
Cupiuba	Goupia glabra	h.147	6..69%	Gum, Sugar	Eucalyptus cladocalyx	h.165	6..100%
Curupixá	Micropholis	h.114	6..63%	Gum, White Dunn's	Eucalyptus dunnii	h.167	4..93%
Cypress	Cupressus spp,	h.456	5..100%	Gum, Yellow	Eucalyptus leucoxylon	h.168	7..94%
				Handlewood, Grey	Aphanante phillipinensis	h.169	5..84%
				Handlewood, White	Strebulus pendulinus	h.170	7..72%

Hardwood, Johnstone River	Bakhousia bancroftii	h.171	5..78%	Mahogony, Phillipines	Shorea almon	h.237	4..86%
Hemlock / Hemlock, Western	Tsuga heterophylla	h.172	8..67%	Mahogony, Sapelli / Sapele	Entandrophragma cylindricum	h.238	5..100%
Hemlock, Chinesische	Tsuga chinensis	h.173	5..98%	Mahogony, Sipo / Utile	Entandrophragma utilie	h.239	6..100%
Hevea	Hevea Brasiliensis	h.174	7..92%	Mahogony, Tiama / gedu nohor	Entandrophragma angolense	h.240	10..66%
Hickory	Carya spp.	h.175	6..89%	Mako	Trischospermum richii	h.248	3..87%
Hollywood, Yellow	Premna lignum-vitae	h.176	7..86%	Makoré	Thieghemmella africana	h.123	6..100%
Horizontal	Anodopetalum biglandulosum	h.177	7..100%	Makorè	Thieghemella heckelii	h.249	7..100%
Incensewood	Pseudocarapa nitidula	h.178	8..73%	Malas	Homalium foetidum	h.250	5..92%
Iroko	Chlorophora excesla	h.179	7..54%	Malletwood	Rhodamnia argentea	h.251	5..87%
Ironbark, Grey	Eucalyptus drephanophylla	h.180	7..100%	Malletwood, Brown	Rhodamnia rubescens	h.252	5..91%
Ironbark, Grey	Eucalyptus paniculata	h.181	5..100%	Manggachapui	Hopea acuminata	h.253	6..100%
Ironbark, Red	Eucalyptus sideroxylon	h.182	8..100%	Mango	Mangifera minor	h.254	4..87%
Ironbark, Red, Broad Leaved	Eucalyptus fibrosa	h.183	8..100%	Mango, Phillipines	Mangifera altissima	h.255	7..100%
Ironbark, Red, Narrow Leaved	Eucalyptus cerbra	h.184	5..100%	Mangosteen (Fiji)	Garcinia myrtifolia	h.256	5..87%
Jarrah	Eucalyptus marginata	h.185	5..100%	Mangrove, Cedar	Xylocarpus australasicus	h.257	6..100%
Jelutong	Dyera costulata	h.186	0..100%	Maniltoa (Fiji)	Maniltoa grandiflora	h.258	6..72%
Jequitiba	Cariniana spp,	h.187	5..81%	Maniltoa (New Guinea)	Maniltoa pimenteliana	h.259	6..72%
Kahikatea (New Zealand) (Boron)	Dacrycarpus docrydiodies	h.188	7..80%	Mansonia	Mansonia altissima	h.260	7..100%
Kahikatea (New Zealand) (Thanalith)	Dacrycarpus docrydiodies	h.189	6..94%	Maple, New Guinea	Flindersia pimentelianan	h.261	6..100%
Kahikatea (New Zealand) (untreated)	Dacrycarpus docrydiodies	h.190	6..96%	Maple, Queensland	Flindersia brayleyana	h.262	5..100%
Kamarere (Fiji)	Eucalyptus deglupta	h.191	5..83%	Maple, Rose	Cryptocarya erythroxylon	h.263	6..80%
Kamarere (New Guinea)	Eucalyptus deglupta	h.192	5..100%	Maple, Scented	Flindersia laevicarpa	h.264	7..70%
Kapur	Dryobalanops spp,	h.193	7..94%	Mararie	Pseudoweinwannia lanchanocarpa	h.265	8..97%
Karri	Eucalyptus diversicolor	h.194	5..100%	Marri	Eucalyptus calophylla	h.266	5..81%
Kauceti	Kermadecia vitiensis	h.200	4..71%	Masiratu	Degeneria vitiensis	h.267	5..86%
Kauri	Agathis australis, boroneensis	h.201	5..100%	Massandaruba	Manilkara kanosiensis	h.268	4..83%
Keledang	Artocarpus lanceifolius	h.202	0..100%	Matai	Podocarpus spicatus	h.269	6..95%
Kempas	Koomapassia excelsa	h.203	4..100%	Mengkulang	Heritiera spp,	h.270	5..85%
Keranji (Malaysia)	Dialium platysepalum	h.204	5..60%	Meranti, Buik from 1999	Shorea platiclados	h.271	4..76%
Keruing	Dipterocarpus spp,	h.205	6..81%	Meranti, Dark Red	Shorea spp,	h.272	5..100%
Kiso	Chisocheton schumannii	h.218	6..65%	Meranti, Nemesu from 1999	Shorea pauciflora	h.274	4..100%
Lacewood, Yellow	Polyalthia oblongifolia	h.219	5..87%	Meranti, Seraya from 1999	Shura curtisii	h.275	5..78%
Laran	Anthocephalus chinensis	h.223	7..85%	Meranti, Tembaga from 1999	Shorea leprosula	h.276	3..93%
Larch	Larix decidua	h.221	5..88%	Meranti, White	Shorea hypochra	h.277	4..100%
Larch, American / Larch, Western	Larix occidentalis	h.220	5..100%	Meranti, Yellow	Shorea multiflora	h.273	0..100%
Larch, Japanese	Larix kaempferi	h.222	5..100%	Merawan	Hopea sulcala	h.278	4..100%
Lauan, Red	Shorea negrosensis	h.224	5..78%	Merbau	Intsia spp,	h.279	6..100%
Leatherwood	Eucryphia lucida	h.225	6..100%	Mersawa	Anisoptera laevis	h.280	4..100%
Lightwood	Acacia implexa	h.226	7..78%	Messmate	Eucalyptus obliqua	h.281	8..97%
Limba	Terminalia superba	h.227	6..70%	Moabi	Baillonella toxisperma	h.282	6..100%
Lime, European	Tilia vulgaris	h.229	4..100%	Mora	Mora excelsa	h.283	5..73%
Louro, Red	Ocotea rubra	h.231	5..99%	Moustiqaire	Cryptocarya spp,	h.284	4..100%
Macadamia	Floyda praealta	h.232	7..74%	Musizi	Maesopsis eminii	h.286	7..100%
Magnolia	Magnolia acuminata/grandiflora	h.233	6..100%	Neuburgia	Neuburgia collina	h.287	7..98%
Mahogany, Brush	Geissos benthamii	h.242	7..70%	Nutmeg (Fiji)	Myrstica spp,	h.290	5..95%
Mahogany, Miva	Dysoxylum muelleri	h.243	8..94%	Nutmeg (New Guinea)	Myrstica buchneriana	h.291	5..100%
Mahogany, New Guinea	Dysoxylum spp,	h.241	6..95%	Nyatoh	Palaquium spp,	h.292	4..92%
Mahogany, Red	Eucalyptus botryoides	h.244	7..100%	Oak, European	Quercus robur L.,	h.126	4..100%
Mahogany, Rose	Dysoxylum fraseranum	h.245	7..83%	Oak, Japanese	Quercus spp,	h.127	4..100%
Mahogany, Southern	Eucalyptus botryoides	h.246	5..100%	Oak, New Guinea	Castanopsis acuminatissima	h.293	4..100%
Mahogany, White	Eucalyptus acmenoides	h.247	6..100%	Oak, Red	Quercus spp,	h.128	5..100%
Mahogony Khaya	Khaya spp,	h.235	7..100%	Oak, Silky, Fishtail	Neorites kevediana	h.294	3..74%
Mahogony, American	Swietenia spp,	h.234	6..100%	Oak, Silky, Northern	Cardwellia sublimia	h.295	5..100%
Mahogony, Phillipines	Parashorea plicata	h.236	5..100%	Oak, Silky, Red	Stenocarpus salignus	h.296	6..86%
				Oak, Silky, Southern	Grevillea robusta	h.297	5..81%
				Oak, Silky, White	Stenocarpus sinuatus	h.298	6..82%

Oak, Tasmanian	Eucalyptus regnans	h.299	7..100%		Pine, Radiata (New Zealand) (sapwood tanalith)	Pinus radiata	h.341	5..95%
Oak, Tulip, Blush	Argyrodendron actinophyllum	h.300	6..75%		Pine, Radiata (New Zealand) (sapwoodt untreated)	Pinus radiata	h.342	5..100%
Oak, Tulip, Brown	Argyrodendron trifoliolatum	h.301	9..75%		Pine, Red	Pinus resinosa	h.343	2..100%
Oak, Tulip, Red	Argyrodendron peralatum	h.302	9..100%		Pine, Scotts	Pinus sylvestris L.	h.206	6..100%
Oak, Tulip, White	Petrygota horsfieldii	h.303	5..88%		Pine, Shortleaf	Pinus echinata	h.213	5..100%
Oak, White-	Quercus spp,	h.129	5..100%		Pine, Slash (Queensland)	Pinus elliottii	h.344	6..100%
Obah	Eugenia spp,	h.304	5..84%		Pine, Southern	Pinus echinata	h.214	5..100%
Obeche	Triplochiton scleroxylon	h.1	5..60%		Pine, Southern, yellow / Pine, Ponderosa	Pinus ponderosa	h.208	5..100%
Odoko	Scottellila coriancea	h.305	6..93%		Pine, Sugar	Pinus lambertiana	h.215	4..100%
Olive	Olea hochstetteri	h.306	7..100%		Pine, western white	Pinus monticola	h.406	5..100%
Olivillo	Atextoxicon puncttatum	h.307	5..90%		Pittosporum (Tasmania)	Pittosporum bicolor	h.346	4..100%
Opepe	Nauclea diderrichii	h.52	7..95%		Planchonia	Pleiogynium timorense	h.351	5..95%
Padauk, African	Pterocarpus soyauxii	h.308	4..100%		Pleiogynium / Podo	Podocarpus neriifolia	h.352	7..71%
Palachonella, Fijian	Planchonella vitiensis	h.347	6..77%		Podocarp, Fijian	Decussocarpus vitiensis	h.353	6..100%
Palachonella, New Guinea	Planchonella kaernbachiana	h.348	4..92%		Podocarp, Red	Euroschinus falcata	h.354	6..100%
Palachonella, New Guinea	Planchonella thyrsoidea	h.349	2..85%		Poplar, Black	Populus nigra	h.313	4..100%
Palachonella, Solomon Island	Planchonia papuana	h.350	4..70%		Poplar, Pink	Euroschinus falcata	h.355	6..85%
Paldao	Dracontomelum dao	h.309	4..100%		Quandong, Brown	Eurocarpus coorangooloo	h.356	5..97%
Panga Panga	Millettia stuhlmannii	h.312	6..52%		Quandong, Silver	Elaecarpus angustifolius	h.357	5..82%
Papuacedrus	Papuacedrus papuana	h.314	6..100%		Quandong, Solomon Island	Elaecarpus spaericus	h.358	3..85%
Parinari, Fijian	Oarinari insularum	h.315	4..100%		Qumu	Acacia Richii	h.359	5..86%
Penarahan	Myristica iners	h.316	6..100%		Raintree (Fiji)	Samanea saman	h.360	5..57%
Peppermint, Broad-Leaved	Eucalyptus dives	h.317	6..100%		Ramin	Gonystylus spp,	h.361	6..67%
Peppermint, Narrow-Leaved	Eucalyptus australiana	h.318	8..98%		Redwood / Sequoia	Sequoia sempervirens	h.362	5..100%
Peroba, White	Paratecoma peroba	h.319	7..75%		Rengas	Gluta spp,	h.363	4..100%
Persimmon	Diospyros pentamera	h.320	5..90%		Resak (Malaysia)	Cotylelobium melanoxylon	h.364	3..100%
Perupok (Malaysia)	Kokoona spp,	h.321	1..100%		Rimu (non-truewood boron)	Dacrydium cupresinum	h.365	7..82%
Perupok (Malaysia)	Lophopetalum subovatum	h.322	8..100%		Rimu (non-truewood tanalith)	Dacrydium cupresinum	h.366	7..82%
Pillarwood	Cassipourea malosano	h.323	4..100%		Rimu (non-truewood untreated)	Dacrydium cupresinum	h.367	8..88%
Pine / Pine, Stone	Pinus pinea	h.345	6..100%		Rimu (truewood untreated)	Dacrydium cupresinum	h.368	8..50%
Pine, Aleppo	Pinus halepensis	h.324	8..98%		Robinia	Robinia pseudoacacia	h.369	2..92%
Pine, Austrian	Pinus nigra	h.212	5..100%		Roble Pellin	Nothofagus obliqua	h.370	6..93%
Pine, Beneguet	Pinus kesya	h.325	8..100%		Rock maple	Acer saccharum	h.6	5..100%
Pine, Black	Prumnoptys amarus	h.326	5..98%		Rosewood, Brasilian	Dalbergia nigra	h.311	5..72%
Pine, Bunya	Pinus bidwillii	h.327	8..88%		Rosewood, Indian	Dalbergia latifolia	h.310	4..100%
Pine, Canary Island	Pinus canariensis	h.328	6..100%		Rosewood, New Guinea	Pterocarpus indicus	h.371	5..84%
Pine, Celery-Top	Phyllocladus aspenifolius	h.329	7..92%		Rosewood, Phillipines	Pterocarpus indicus	h.372	10..66%
Pine, Hoop	Araucaria cunninghamii	h.330	7..100%		Sapupira	Hymenolobium excelsum	h.375	5..87%
Pine, Huon	Dacrydium franklinii	h.331	8..90%		Sasauria (Fiji)	Dysoxylum quercifolium	h.376	4..89%
Pine, King William	Athrotaxis selaginoides	h.332	7..85%		Sassafras	Doryphora sassafras	h.377	6..90%
Pine, Klinki	Araucaria hunsteinii	h.333	4..100%		Sassafras, Southern	Atherospherma moschatum	h.378	7..84%
Pine, Loblolly-	Pinus taeda	h.209	5..100%		Satinash, Blush	Acmena Hemilampra	h.379	3..100%
Pine, Longpole-	Pinus contorta	h.207	5..100%		Satinash, Grey	Syzygium gustavioides	h.380	5..100%
Pine, Maritime	Pinus pinaster	h.334	8..96%		Satinash, New Guinea	Syzygium butterneranum	h.381	5..87%
Pine, Parana Red	Araucaria angustifolia	h.335	6..43%		Satinash, Rose	Syzygium francisii	h.382	5..73%
Pine, Parana White	Araucaria angustifolia	h.336	7..72%		Satinay	Syncarpia hilii	h.383	4..100%
Pine, Pitch-, american	Pinus palustris	h.211	6..83%		Satinbox	Phenbalium saquameum	h.384	5..100%
Pine, Pitch-, caribbean	Pinus caribaea	h.210	6..100%		Satinheart, Green	Geijera salicifolia	h.385	8..62%
Pine, Radiata	Pinus radiata	h.337	5..100%		Satinwood, Tulip	Rhodosphaera rhodanthema	h.386	6..100%
Pine, Radiata (New Zealand) (sapwood aac)	Pinus radiata	h.338	7..100%		Scentbark	Eucalyptus aromapholia	h.387	5..90%
Pine, Radiata (New Zealand) (sapwood boliden)	Pinus radiata	h.339	6..100%		Schizomeria, New Guinea	Schizomeria serrata	h.388	5..100%
Pine, Radiata (New Zealand) (sapwood boron)	Pinus radiata	h.340	6..89%					

Schizomeria, Solomon Island	Schizomeria serrata	h.389	4..74%	Walnut, American	Juglans nigra	h.288	5..100%
Sepetir	Sindora coriaceae	h.390	1..100%	Walnut, Blush	Beilschmiedia obtusifolia	h.439	8..81%
Sheoak, Fijian Beach	Casuarina nodiflora	h.391	6..91%	Walnut, European	Junglans regia	h.289	7..74%
Sheoak, River	Casuarina cunninghamiana	h.392	7..74%	Walnut, Queensland	Endiandra palmerstonii	h.440	6..100%
Sheoak, Rose	Casuarina torulosa	h.393	8..72%	Walnut, Rose	Endiandra muelleri	h.441	3..100%
Sheoak, Western Australia	Allocasuarina fraserana	h.394	7..80%	Walnut, White	Cryptocarya obovota	h.442	7..79%
Silkwood, Bolly	Cryptocarya ablata	h.395	8..64%	Walnut, Yellow	Beilschmiedia bancroftii	h.443	5..84%
Silkwood, Silver	Flindersia acuminata	h.396	7..92%	Wandoo	Eucalyptus wandoo	h.444	7..100%
Simpoh (Phillippines)	Dillenia philippinensis	h.397	5..100%	Wattle, Hickory	Acacia penninervis	h.445	7..81%
Sirus, White	Ailainthus peekelii	h.398	5..97%	Wattle, Silver	Acacia dealbata	h.446	7..95%
Sirus, White	Ailainthus triphysa	h.399	7..90%	Wengé	Millettia laurentii	h.448	7..67%
Sloanea	Sloanea spp,	h.400	5..100%	Western Red Cedar	Thuja plicata	h.449	6..69%
Soft wood chips		h.461	4..100%	Whitewood, American	Liriodendron tulipifera	h.447	5..100%
Spruce, European	Picea abies Karst.	h.136	6..100%	Woolybutt	Eucalyptus longifolia	h.450	7..100%
Spruce, Norway /Norway Spruce	Picea abies	h.137	6..100%	Yaka	Dacrydium nausoriensis/nidilum	h.451	6..88%
Spruce, Sitka	Picea sitchensis	h.138	5..100%	Yasi-Yasi I (Fiji)	Syzygium effusum	h.452	4..92%
Sterculia, Brown	Sterculia spp,	h.230	4..100%	Yasi-Yasi II (Fiji)	Syzygium spp,	h.453	5..100%
Stringybark, Brown	Eucalyptus capitellata	h.403	6..100%	Yate	Eucalyptus cornuta	h.454	6..94%
Stringybark, Darwin	Eucalyptus tetrodonta	h.404	5..100%	Yertschuk	Eucalyptus considenia	h.455	7..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 guianesis	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	Campnosperma 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-Veikau	Serianthes myriadenia	h.434	5..77%				
Vatica, Phillippines	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%				

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/m³ B15 (200 kg concrete per 1m³ sand)	b. 5	0,7..3,3%
Concrete 350kg/m³ B25 (350 kg concrete per 1m³ sand)	b. 6	1,1..3,9%
Concrete 500kg/m³ B35 (500 kg concrete per 1m³ 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		
Anhydrit 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)	