

Resistive material moisture and temperature measuring instrument with data logger and programmable user curves

as of version 2.1

Operating Manual

GMH 3851



GMH 38 Series
Materialfeuchte / material moisture



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

keep for future reference



WEEE-Reg.-Nr. DE 93889386

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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 3851

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!**

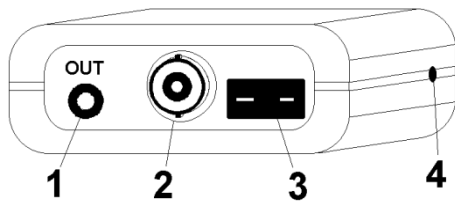
3.3 Start up and readiness for operation

After switching on the instrument, a self test is performed (approximately 5 seconds).

During this time all display segments are shown.

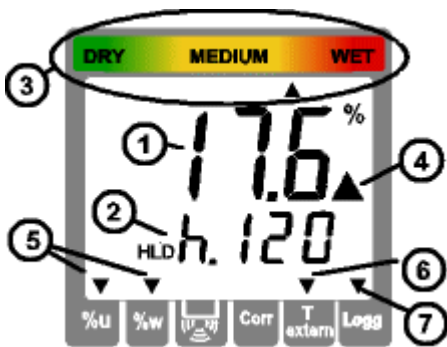
After this sequence the instrument changes to measuring operation and is ready for use.

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.
 - 7 = **Logg-arrow** Shown if logger function is selected, flashes if cyclic logger is running

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.: 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 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
or **calling of the logger functions** (refer to chapter 7)
 - 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

i Some menu items will be shown depending on the actual device configuration (e.g. there are some items disabled when the logger contains data). Please note the hints by the menu items.

For configuration of the device press "Menu"-key (key 4) for 2 seconds, the main menu will be shown (main display: "SEt"). Choose the desired menu branch by pressing the "Menu"-key (key 4). By pressing "▶" (key 3) the referring parameters can be chosen. The referring values are changed by pressing the keys "▲" (key 2) or "▼" (key 5) (Choice of parameter: "▶"). Pressing "Menu" (key 4) again will jump back to the main menu selection and stores the settings. Use key "Store/↵" (key 6) to leave configuration..

Menu	Parameter	Values	Meaning		
key Menu	key ▶	key ▲ or ▼			p.r.t.
Set Sort	Set Sort: limitation of the material selection				
SEt Sort	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.	*	
Set Conf	Set Configuration: Generic Settings				
SEt Conf	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	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	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"		
	3-Pl	off:	Average value calculation off		5.6
		on:	Average value calculation on: Average value out of 3 sequential measuring is calculated and displayed		
	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		8
		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.		0
	dARC0	0.0 ... 100.0%	Enter desired moisture value at which the analogue output potential should be 0V		8.2
	dARC1	0.0 ... 100.0%	Enter desired moisture value at which the analogue output potential should be 1V		8.2
Set Logg	Set Logger: Configuration Of Logger Function				
SEt Logg	Func	CYCL	Cyclic: logger function ,cyclic logger'	*	7
		Stor	Store: logger function ,individual value logger'		
		off	no logger function		
	CYCL	0:30 ... 60:00	Cycle time of cyclic logger [minutes:seconds]	*	7.2
Set CLOC	Set Clock: Setting Of Real Time Clock				
SEt CLOC	CLOC	HH:MM	Clock: Setting of time hours:minutes		
	YEAR	YYYY	Year		
	DATE	DD.MM	Date: day.month		



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

(*) If the logger memory contains data already, the menus/parameters marked can not be called! If these should be altered the logger memory has to be cleared before!

If the manual logger contains data (Logger: 'Func Stor'), the first menu displayed will be: 'rEAd Logg' please refer to chapter 7.1

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:

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

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%

5.2 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).

i If the logger is switched on ('Func CYCL' or 'Func Stor'), the auto-hold function can not be used. The device works like it is set to Auto-HLD = off.

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** (see chapter 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 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.

5.6.1 Presettings

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 “Device Configuration”.

The specific sort has to be chosen before measuring getroffen werden

5.6.2 Sample taking

- 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.

5.6.3 Measuring

Split the log:

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

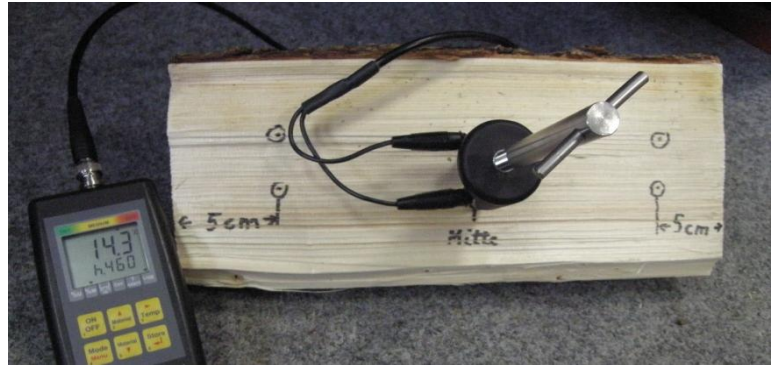
Preparation of core temperature measuring of log:

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


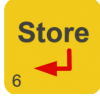
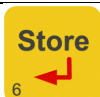

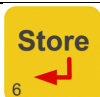
Three measuring values have to be taken at the freshly split surface,

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.10
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.20
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.30
Measuring stable:		Average out of the 3 will be displayed	15.8% e.g.  h.460
Return to continuous measuring display	press 		

5.7 Measuring Other Materials

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



Measuring with brush probe GBSL91

Drill two holes with $\varnothing 6\text{mm}$ (GBSK91) or $\varnothing 8\text{mm}$ (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.

5.7.2 '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.

5.7.3 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.

5.8 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 GMH3850: 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 evaluation 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 4

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.

6.3 Individually Programmable Characteristic Curves

There are 4 individually programmable characteristic curves integrated.

By using them there can be used other material curves than the already integrated ones.

The programmable curves can be read and programmed by the software GMHKonfig.

As standard they are pre set with the REF-curve. This curve is the base of the determination of user specific curves.

Each curve is defined by a table with two columns (measuring value REF [%] / display value [%]) with 20 rows.

The name of the curve, which is displayed in lower display, can be set individually. Characters which cannot be displayed are displayed as a space character.

Each curve contains also limit values for wet and dry evaluation.

As temperature compensation there is a choice between the standard compensation for wood or linear compensation.

If there should be used no temperature compensation should be used: Choose linear compensation and enter 0 as compensation factor.

Linear temperature compensation:

$$MC_{\text{compensated}}(T) = MC_{\text{uncompensated}} * (1 + \text{compensation factor} / 10000 * (T - 20^{\circ}\text{C}))$$

MC = moisture content

7 Operation of Logger

The device supports two different logger functions:

- „Func-Stor“: each time when „store“ (key 6) is pressed a measurement will be recorded.
- „Func-CYCL“: measurements will automatically be recorded at each interval, which was set in the logger menu ‚CYCL‘ until the logger will be stopped or the logger memory is full.
The recording is started by pressing „Store“ 2 seconds.

The logger records 1 measurement result each time

For the evaluation of the data the software GSOFT3050 (V1.7 or higher) has to be used. The software also allows easy configuration and starting of the logger.

When the logger is activated (Func Stor or Func CYCL) the hold and auto hold functions are no longer available, key 6 is solely used for the operation of the logger functions.

7.1 „Func-Stor“: Storing Single Measurements

Each time when „store“ (key 6) is pressed a measurement and its time stamp will be recorded.

The recorded data can be viewed either in the display (when calling the configuration an additional menu ‚REAd LoGG‘ is displayed, see below) or by means of the interface and a PC with GSOFT3050-software.

The logger stores the current measuring, independent from the stability of the value.

The material curve can be altered like during a normal measuring.

Max. number of measurements: 99

- A measuring contains:
- current measuring value at the time of recording
 - temperature value at the time of recording
 - material curve at the time of recording
 - time and date of the recording

After each recording „St. XX“ will be displayed for a short time. XX represents the number of the recording.

When logger memory contains recordings already:

When „Store“ is pressed for 2 seconds, the choice for clearing the logger memory will be displayed:



Clear all recordings



Clear the last recording



Clear nothing (cancel menu)

The selection can be made by ▲ (key 2) and ▼ (key 5). "Quit" (key 6) enters the choice.

If the logger memory is full, the display will show:



Viewing Recorded Measurements

Within the „LoGG Stor“ function the measurements can be viewed directly in the display not only by means of a computer (like at „Func CYCL“): press 2 seconds „Set“ (key 4): The first menu displayed now is „rEAd LoGG“ (read logger data). After pressing ▶ (key 3) the measurement recorded last will be displayed, changing between the different data referring to the measurement also is done by pressing ▶.

Changing the measurement is done by pressing the keys ▲ or ▼.

7.2 „Func-CYCL“: Automatic Recording With Selectable Logger-Cycle-Time

The Logger-Cycle-Time is selectable (p.r.t. Configuration). For example „CYCL“ = 1:00: A measuring is recorded after each 60 seconds.

Special feature of this logger function: The device will change to a **‘sleeping state’** during the measurings (lower display shows a count-down to the next measuring). Just before a new measuring should be recorded, the devices wakes up and measures until a stable measuring value is evaluated. This value will be stored, the device enters the sleeping state again. This procedure reduces the battery consumption dramatically, with a fresh zinc carbon battery the device is capable of recording more than a month without an additional mains adapter.

When the cyclic logger contains data (independent if running or stopped), the material cannot be changed.

The value measured during the last recording is shown in the upper display. During the pauses no measuring is done!

An adequate message is stored, if no stable value could be measured during the interval.

Max. number of measurings: 10000


Cycle time: 0:01...60:00 (minutes:seconds, min 1s, max 1h), selectable in the configuration

A measuring contains: - current measuring value at the time of recording
- temperature at the time of recording

Recording time: > 1 month (with output activated: OUT = SEr)
> 3 months (with output deactivated: OUT = off)
With mains adapter: limited just by memory and cycle time, up to 416 days

Starting a recording:

By pressing "Store" (key 6) for 2 seconds the recording will be initiated. After that the display shows 'St.XXXX' for a short time whenever a measuring is recorded. XXXXX is the number of the measuring 1..9999.

If the logger memory is full, the display will show:  The recording automatically will be stopped.

Stopping the recording manually:

By pressing "Store" (key 6) the recording can be stopped manually. Then the following choice appears:



Stop the recording



Do not stop the recording

The selection can be made by ▲ (key 2) and ▼ (key 5). "Quit" (key 6) enters the choice.



If you try to switch off the instrument in the cyclic recording operation You will be asked once again if the recording should be stopped.

The device can only be switched off after the recording has been stopped!

The Auto-Power-Off-function is deactivated during recording!

Clear Recordings:

When "Store" is pressed for 2 seconds, the choice for clearing the logger memory will be displayed:



Clear all recordings



Clear nothing (cancel menu)

The selection can be made by ▲ (key 2) and ▼ (key 5). "Quit" (key 6) enters the choice.

8 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.

8.1 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:

- **GSOFT3050:** Operating and evaluation software for the integrated logger function
- **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)!

8.2 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.

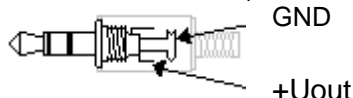
Keep in mind not to connect low-resistive loads to the output, otherwise the output value will be wrong and battery life is decreased. Loads above ca 10kOhm are uncritical.

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:





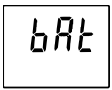
The 3rd contact has to be left floating!
Only stereo plugs are allowed!

9 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

10 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	replace battery
	If mains operation: wrong voltage	replace power supply, if fault continues to exist: device damaged
	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	low battery voltage	replace battery
	If mains operation: wrong voltage	Check/replace power supply, if fault continues to exist: device damaged
Device does not react on keys	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

11 Inspection of 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.

12 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

13 Specification

Measuring Principle	Channel1	Channel2
Char. curve	Resistive material-moisture-measuring matching DIN EN 13183-2: 2002 466 different kinds of wood 28 different building materials 4 individually programmable material curves	Temperature-measuring thermocouple type K or internal temperature-measuring matching DIN EN 60584-1: 1996, ITS90
Probe connection	BNC Plug	floating connector for mini-blade-terminal
Meas. 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
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..30%) 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)
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)	
Real time clock:	Integrated clock with date and year	
Logger:	2 Functions: individual value logger („Func–Stor“) and cyclic logger („Func–CYCL“)	
Memory:	Stor: 99 data sets; CYCL: 10000 data sets	
Cycle time CYCL:	0:30...60:00 (minutes:seconds, min 1s, max 1h)	
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	

14 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.

15 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%
Afromosia	Pericopsis elata	h.3	6..55%
Afzelia	Afzelia spp.	h.4	8..47%
Agba	Gosseweileroendron balsamiferum	h.426	6..82%
Albizia / latandza, New Guinea	Albizia falcata	h.8	5..100%
Albizia / latandza, Solomon Island	Albizia falcata	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	Planchonella 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 iffaiana	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	Castanospermum 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	<i>Litsea reticulata</i>	h.67	5..100%
Bossime	<i>Drypetes</i> spp,	h.70	7..78%
Box Grey	<i>Eucalyptus moluccana</i>	h.75	8..94%
Box Grey Coast	<i>Eucalyptus bosistoana</i>	h.76	7..98%
Box, Black	<i>Eucalyptus lafgiflorens</i>	h.71	5..100%
Box, Brush (Location Unknown)	<i>Lophostemon confertus</i>	h.74	5..63%
Box, Brush (N.S.W.)	<i>Lophostemon confertus</i>	h.72	4..68%
Box, Brush (Queensland)	<i>Lophostemon confertus</i>	h.73	7..52%
Box, Kanuka	<i>Tristania laurina</i>	h.77	6..100%
Boxwood, New Guinea	<i>Xanthophyllum papuanum</i>	h.78	5..88%
Boxwood, Yellow	<i>Planchonella pholmaniana</i>	h.79	7..78%
Brachychiton	<i>Brachychiton carthersii</i>	h.80	5..67%
Bridelia	<i>Bridelia minutiflora</i>	h.81	5..100%
Brigalow	<i>Acacia harpophylla</i>	h.82	5..100%
Brownbarrel	<i>Eucalyptus fastigata</i>	h.83	5..100%
Bubinga	<i>Guibourtia demeusii</i>	h.84	7..90%
Buchanania	<i>Buchanania arborescens</i>	h.85	4..99%
Burckella, Solomon Island	<i>Burckella obovata</i>	h.88	4..73%
Butternut, Rose	<i>Blepharocarya involucrigera</i>	h.89	5..88%
Camphorwood, New Guinea	<i>Cinnamomum</i> spp,	h.90	6..96%
Camptosperma (Malaysia)	<i>Camptosperma curtisii</i>	h.91	8..100%
Camptosperma (Solomon Island)	<i>Camptosperma kajewskii</i>	h.92	3..100%
Cananga (Phillipines)	<i>Canarium odoratum</i>	h.93	7..78%
Canarium Solomon Island	<i>Canarium salomonense</i>	h.97	4..82%
Canarium, African	<i>Canarium Scheinfurthii</i>	h.94	7..100%
Canarium, Fijian	<i>Canarium oleosum</i>	h.95	5..100%
Canarium, New Guinea	<i>Canarium vitiense</i>	h.96	5..97%
Candlenut	<i>Aleurites moluccana</i>	h.98	0..100%
Carabeen, Yellow	<i>Sloanea woollsii</i>	h.99	6..85%
Cathormion, New Guinea	<i>Cathormion umbellatum</i>	h.100	4..68%
Cedar , Amercan	<i>Cedrela odorata</i>	h.102	8..86%
Cedar, incense	<i>Calocedrus decurrens</i>	h.65	5..100%
Cedar, White	<i>Melia azedarach</i>	h.101	7..100%
Cedar, Yellow	<i>Chamaecyparis nootkatensis</i>	h.457	4..100%
Celtis, New Guinea	<i>Celtis</i> spp,	h.103	5..86%
Celtis, Solomon Island	<i>Celtis philippinesis</i>	h.104	4..69%
Cheesewood, White (Queensland) /Asian Alstonia	<i>Alstonia scholaris</i>	h.105	5..100%
Chengal (Malaysia)	<i>Neobalanocarpus heimii</i>	h.106	4..99%
Cherry, American	<i>Prunus serotina</i>	h.216	5..100%
Cherry, European	<i>Prunus avium</i>	h.217	7..86%
Cleistocalyx	<i>Cleistocalyx mirtoides</i>	h.107	5..100%
Coachwood	<i>Ceratopetalum apetalum</i>	h.108	4..100%
Coondoo, Blush	<i>Planchonella laurifolia</i>	h.109	6..75%
Cordia, New Guinea	<i>Cordia dichotoma</i>	h.110	5..61%
Corkwood, Grey	<i>Erythrina vespertilio</i>	h.111	6..70%
Courbaril	<i>Hymenaea coubaril</i>	h.112	7..64%
Cudgerie, Brown	<i>Canarium australasicum</i>	h.113	7..85%
Cupiuba	<i>Goupia glabra</i>	h.147	6..69%
Curupixá	<i>Micropholis</i>	h.114	6..63%
Cypress	<i>Cupressus</i> spp,	h.456	5..100%
Cypress, Northern	<i>Callitris intratropica</i>	h.115	6..100%
Cypress, Rottneest Island	<i>Callitris preisii</i>	h.116	7..100%

Cypress, White	<i>Callitris glaucophylla</i>	h.117	6..100%
Dakua, Salusalu (Fiji)	<i>Decussocarpus vitiensis</i>	h.118	6..100%
Dibetou/African walnut	<i>Lovoa trichilioides</i>	h.119	7..87%
Dillenia (Solomon Island)	<i>Dillenia salomonese</i>	h.120	4..82%
Doi (Fiji)	<i>Alphitonia zizphoides</i>	h.121	5..92%
Duabanga, New Guinea	<i>Duabanga moluccana</i>	h.124	4..93%
Ebony, african	<i>Diospyros</i> spp,	h.125	6..68%
Ekki	<i>Lophira alata</i>	h.29	4..95%
Elm, European	<i>Ulmus</i> spp,	h.374	7..61%
Elm, White	<i>Ulmus americana</i>	h.373	5..88%
Evodia, White	<i>Melicope micrococca</i>	h.135	5..75%
Figwood (Moreton Bay)	<i>Ficus macrophylla</i>	h.139	7..69%
fir, alpine	<i>Abies lasiocarpa</i>	h.410	6..100%
fir, amabilis	<i>Abies amabilis</i>	h.411	4..100%
Fir, Douglas	<i>Pseudotsuga menziesii</i>	h.122	5..100%
Fir, Douglas (New Zealand) (sapwood treated)	<i>Pseudotsuga menziesii</i>	h.140	6..95%
Fir, Douglas (New Zealand) (sapwood untreated)	<i>Pseudotsuga menziesii</i>	h.141	5..100%
Fir, Douglas (New Zealand) (truewood untreated)	<i>Pseudotsuga menziesii</i>	h.142	3..100%
Fir, europ., MPA	<i>Picea abies</i> Karst.	h.460	6..100%
fir, grand	<i>Abies grandis</i>	h.412	4..100%
Fir, Spruce	<i>Abies magnifica</i>	h.413	5..100%
fir, white / fir, silver	<i>Abies alba</i>	h.414	5..100%
Galip	<i>Canarium indicum</i>	h.143	5..81%
Garo-Garo	<i>Matrixiodendron pschyclados</i>	h.144	5..86%
Garuga	<i>Garuga floribunda</i>	h.145	6..65%
Goncalo Alvez	<i>Astronium</i> spp,	h.146	6..51%
Greenheart	<i>Ocotea rodiaei</i>	h.148	6..100%
Greenheart, Queensland	<i>Endiandra compressa</i>	h.149	7..100%
Group Spruce-Pine-Fir	Weichhölzergruppe / Softwood-Group	h.402	6..100%
Guarea, black	<i>Guarea cedrata</i>	h.68	7..100%
Guarea, white	<i>Guarea cedrata</i>	h.69	9..85%
Guariuba	<i>Clarisia racemosa</i>	h.150	8..70%
Gum, Black	<i>Nyssa sylvatica</i>	h.162	7..100%
Gum, Blue, Sidney	<i>Eucalyptus saligna</i>	h.152	7..100%
Gum, Blue, Southern	<i>Eucalyptus globulus</i>	h.151	6..100%
Gum, Grey	<i>Eucalyptus punctata</i>	h.153	5..100%
Gum, Grey, Mountain	<i>Eucalyptus cypellocarpa</i>	h.154	6..100%
Gum, Maiden's	<i>Eucalyptus maidenii</i>	h.155	7..100%
Gum, Manna	<i>Eucalyptus viminalis</i>	h.156	4..100%
Gum, Mountain	<i>Eucalyptus dalrympleana</i>	h.157	3..100%
Gum, Pink	<i>Eucalyptus fasciculosa</i>	h.158	6..100%
Gum, Red, American	<i>Liquidambar styraciflua</i>	h.166	5..100%
Gum, Red, Forest	<i>Eucalyptus tereticomis</i>	h.159	7..100%
Gum, Red, River	<i>Eucalyptus camaldulensis</i>	h.160	7..100%
Gum, Rose / Gum, Saligna	<i>Eucalyptus grandis</i>	h.161	7..100%
Gum, Shining	<i>Eucalyptus nitens</i>	h.163	5..100%
Gum, Spotted (Victoria) (Lemon-Scented)	<i>Corymbia</i> spp,	h.164	4..94%
Gum, Sugar	<i>Eucalyptus cladocalyx</i>	h.165	6..100%
Gum, White Dunn's	<i>Eucalyptus dunnii</i>	h.167	4..93%
Gum, Yellow	<i>Eucalyptus leucoxydon</i>	h.168	7..94%
Handlewood, Grey	<i>Aphanante philippinensis</i>	h.169	5..84%
Handlewood, White	<i>Strebulus pendulinus</i>	h.170	7..72%
Hardwood, Johnstone River	<i>Bakhousia bancroftii</i>	h.171	5..78%
Hemlock / Hemlock, Western	<i>Tsuga heterophylla</i>	h.172	8..67%

Hemlock, Chinesische	<i>Tsuga chinensis</i>	h.173	5..98%
Hevea	<i>Hevea Brasiliensis</i>	h.174	7..92%
Hickory	<i>Carya</i> spp.	h.175	6..89%
Hollywood, Yellow	<i>Premna lignum-vitae</i>	h.176	7..86%
Horizontal	<i>Anodopetalum biglandulosum</i>	h.177	7..100%
Incensewood	<i>Pseudocarapa nitidula</i>	h.178	8..73%
Iroko	<i>Chlorophora excelsa</i>	h.179	7..54%
Ironbark, Grey	<i>Eucalyptus drephanophylla</i>	h.180	7..100%
Ironbark, Grey	<i>Eucalyptus paniculata</i>	h.181	5..100%
Ironbark, Red	<i>Eucalyptus sideroxylon</i>	h.182	8..100%
Ironbark, Red, Broad Leaved	<i>Eucalyptus fibrosa</i>	h.183	8..100%
Ironbark, Red, Narrow Leaved	<i>Eucalyptus cerbra</i>	h.184	5..100%
Jarra	<i>Eucalyptus marginata</i>	h.185	5..100%
Jelutong	<i>Dyera costulata</i>	h.186	0..100%
Jequitiba	<i>Cariniana</i> spp.	h.187	5..81%
Kahikatea (New Zealand) (Boron)	<i>Dacrycarpus docrydioides</i>	h.188	7..80%
Kahikatea (New Zealand) (Thanalith)	<i>Dacrycarpus docrydioides</i>	h.189	6..94%
Kahikatea (New Zealand) (untreated)	<i>Dacrycarpus docrydioides</i>	h.190	6..96%
Kamarere (Fiji)	<i>Eucalyptus deglupta</i>	h.191	5..83%
Kamarere (New Guinea)	<i>Eucalyptus deglupta</i>	h.192	5..100%
Kapur	<i>Dryobalanops</i> spp.	h.193	7..94%
Karri	<i>Eucalyptus diversicolor</i>	h.194	5..100%
Kauceti	<i>Kermadecia vitiensis</i>	h.200	4..71%
Kauri	<i>Agathis australis, boroneensis</i>	h.201	5..100%
Keledang	<i>Artocarpus lanceifolius</i>	h.202	0..100%
Kempas	<i>Koomapassia excelsa</i>	h.203	4..100%
KerANJI (Malaysia)	<i>Dialium platysepalum</i>	h.204	5..60%
Keruing	<i>Dipterocarpus</i> spp.	h.205	6..81%
Kiso	<i>Chisocheton schumannii</i>	h.218	6..65%
Lacewood, Yellow	<i>Polyalthia oblongifolia</i>	h.219	5..87%
Laran	<i>Anthocephalus chinensis</i>	h.223	7..85%
Larch	<i>Larix decidua</i>	h.221	5..88%
Larch, American / Larch, Western	<i>Larix occidentalis</i>	h.220	5..100%
Larch, Japanese	<i>Larix kaempferi</i>	h.222	5..100%
Lauan, Red	<i>Shorea negrosensis</i>	h.224	5..78%
Leatherwood	<i>Eucryphia lucida</i>	h.225	6..100%
Lightwood	<i>Acacia implexa</i>	h.226	7..78%
Limba	<i>Terminalia superba</i>	h.227	6..70%
Lime, European	<i>Tilia vulgaris</i>	h.229	4..100%
Louro, Red	<i>Ocotea rubra</i>	h.231	5..99%
Macadamia	<i>Floyda praealta</i>	h.232	7..74%
Magnolia	<i>Magnolia acuminata/grandiflora</i>	h.233	6..100%
Mahogany, Brush	<i>Geissos benthamii</i>	h.242	7..70%
Mahogany, Miva	<i>Dysoxylum muelleri</i>	h.243	8..94%
Mahogany, New Guinea	<i>Dysoxylum</i> spp.	h.241	6..95%
Mahogany, Red	<i>Eucalyptus botryoides</i>	h.244	7..100%
Mahogany, Rose	<i>Dysoxylum fraserianum</i>	h.245	7..83%
Mahogany, Southern	<i>Eucalyptus botryoides</i>	h.246	5..100%
Mahogany, White	<i>Eucalyptus acmenoides</i>	h.247	6..100%
Mahogany Khaya	<i>Khaya</i> spp.	h.235	7..100%
Mahogany, American	<i>Swietenia</i> spp.	h.234	6..100%
Mahogany, Phillipines	<i>Parashorea plicata</i>	h.236	5..100%
Mahogany, Phillipines	<i>Shorea almon</i>	h.237	4..86%
Mahogany, Sapelli / Sapele	<i>Entandrophragma</i>	h.238	5..100%

	<i>cylindricum</i>		
Mahogany, Sipo / Utile	<i>Entandrophragma utile</i>	h.239	6..100%
Mahogany, Tiama / gedu nohor	<i>Entandrophragma angolense</i>	h.240	10..66%
Mako	<i>Trichospermum richii</i>	h.248	3..87%
Makoré	<i>Thieghemmella africana</i>	h.123	6..100%
Makorè	<i>Thieghemella heckelii</i>	h.249	7..100%
Malas	<i>Homalium foetidum</i>	h.250	5..92%
Malletwood	<i>Rhodamnia argentea</i>	h.251	5..87%
Malletwood, Brown	<i>Rhodamnia rubescens</i>	h.252	5..91%
Manggachapui	<i>Hopea acuminata</i>	h.253	6..100%
Mango	<i>Mangifera minor</i>	h.254	4..87%
Mango, Phillipines	<i>Mangifera altissima</i>	h.255	7..100%
Mangosteen (Fiji)	<i>Garcinia myrtifolia</i>	h.256	5..87%
Mangrove, Cedar	<i>Xylocarpus australasicus</i>	h.257	6..100%
Maniltoa (Fiji)	<i>Maniltoa grandiflora</i>	h.258	6..72%
Maniltoa (New Guinea)	<i>Maniltoa pimenteliana</i>	h.259	6..72%
Mansonia	<i>Mansonia altissima</i>	h.260	7..100%
Maple, New Guinea	<i>Flindersia pimentelianan</i>	h.261	6..100%
Maple, Queensland	<i>Flindersia brayleyana</i>	h.262	5..100%
Maple, Rose	<i>Cryptocarya erythroxylon</i>	h.263	6..80%
Maple, Scented	<i>Flindersia laevicarpa</i>	h.264	7..70%
Mararie	<i>Pseudoweinmannia lanchanocarpa</i>	h.265	8..97%
Marri	<i>Eucalyptus calophylla</i>	h.266	5..81%
Masiratu	<i>Degeneria vitiensis</i>	h.267	5..86%
Massandaruba	<i>Manilkara kanosiensis</i>	h.268	4..83%
Matai	<i>Podocarpus spicatus</i>	h.269	6..95%
Mengkulang	<i>Heritiera</i> spp.	h.270	5..85%
Meranti, Buik from 1999	<i>Shorea platyclados</i>	h.271	4..76%
Meranti, Dark Red	<i>Shorea</i> 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</i> spp.	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</i> spp.	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>Myrstica</i> spp.	h.290	5..95%
Nutmeg (New Guinea)	<i>Myrstica buchneriana</i>	h.291	5..100%
Nyatoh	<i>Palaquium</i> spp.	h.292	4..92%
Oak, European	<i>Quercus robur</i> L.,	h.126	4..100%
Oak, Japanese	<i>Quercus</i> spp.	h.127	4..100%
Oak, New Guinea	<i>Castanopsis acuminatissima</i>	h.293	4..100%
Oak, Red	<i>Quercus</i> spp.	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</i>	h.300	6..75%

	actinophyllum		
Oak, Tulip, Brown	Argyrodendron trifoliolatum	h.301	9..75%
Oak, Tulip, Red	Argyrodendron peralatum	h.302	9..100%
Oak, Tulip, White	Petrygota horsfieldii	h.303	5..88%
Oak, White-	Quercus spp,	h.129	5..100%
Obah	Eugenia spp,	h.304	5..84%
Obeche	Triplochiton scleroxylon	h.1	5..60%
Odoko	Scottellila coriancea	h.305	6..93%
Olive	Olea hochstetteri	h.306	7..100%
Olivillo	Atextoxicon punctatum	h.307	5..90%
Opepe	Nauclea diderrichii	h.52	7..95%
Padauk, African	Pterocarpus soyauxii	h.308	4..100%
Palachonella, Fijian	Planchonella vitiensis	h.347	6..77%
Palachonella, New Guinea	Planchonella kaernbachiana	h.348	4..92%
Palachonella, New Guinea	Planchonella thyrsoides	h.349	2..85%
Palachonella, Solomon Island	Planchonella papuana	h.350	4..70%
Paldao	Dracontomelum dao	h.309	4..100%
Panga Panga	Milletia stuhlmannii	h.312	6..52%
Papuacedrus	Papuacedrus papuana	h.314	6..100%
Parinari, Fijian	Oarinari insularum	h.315	4..100%
Penarahan	Myristica iners	h.316	6..100%
Peppermint, Broad-Leaved	Eucalyptus dives	h.317	6..100%
Peppermint, Narrow-Leaved	Eucalyptus australiana	h.318	8..98%
Peroba, White	Paratecoma peroba	h.319	7..75%
Persimmon	Diospyros pentamera	h.320	5..90%
Perupok (Malaysia)	Kokoona spp,	h.321	1..100%
Perupok (Malaysia)	Lophopetalum subovatum	h.322	8..100%
Pillarwood	Cassipourea malosano	h.323	4..100%
Pine / Pine, Stone	Pinus pinea	h.345	6..100%
Pine, Aleppo	Pinus halepensis	h.324	8..98%
Pine, Austrian	Pinus nigra	h.212	5..100%
Pine, Beneguet	Pinus kesya	h.325	8..100%
Pine, Black	Prumnopitys amarus	h.326	5..98%
Pine, Bunya	Pinus bidwillii	h.327	8..88%
Pine, Canary Island	Pinus canariensis	h.328	6..100%
Pine, Celery-Top	Phyllocladus aspenifolius	h.329	7..92%
Pine, Hoop	Araucaria cunninghamii	h.330	7..100%
Pine, Huon	Dacrydium franklinii	h.331	8..90%
Pine, King William	Athrotaxis selaginoides	h.332	7..85%
Pine, Klinki	Araucaria hunsteinii	h.333	4..100%
Pine, Loblolly-	Pinus taeda	h.209	5..100%
Pine, Longpole-	Pinus contorta	h.207	5..100%
Pine, Maritime	Pinus pinaster	h.334	8..96%
Pine, Parana Red	Araucaria angustifolia	h.335	6..43%
Pine, Parana White	Araucaria angustifolia	h.336	7..72%
Pine, Pitch-, american	Pinus palustris	h.211	6..83%
Pine, Pitch-, caribbean	Pinus caribaea	h.210	6..100%
Pine, Radiata	Pinus radiata	h.337	5..100%
Pine, Radiata (New Zealand) (sapwood aac)	Pinus radiata	h.338	7..100%
Pine, Radiata (New Zealand) (sapwood boliden)	Pinus radiata	h.339	6..100%
Pine, Radiata (New Zealand) (sapwood boron)	Pinus radiata	h.340	6..89%
Pine, Radiata (New Zealand) (sapwood tanalith)	Pinus radiata	h.341	5..95%

Pine, Radiata (New Zealand) (sapwood untreated)	Pinus radiata	h.342	5..100%
Pine, Red	Pinus resinosa	h.343	2..100%
Pine, Scotts	Pinus sylvestris L.	h.206	6..100%
Pine, Shortleaf	Pinus echinata	h.213	5..100%
Pine, Slash (Queensland)	Pinus elliotii	h.344	6..100%
Pine, Southern	Pinus echinata	h.214	5..100%
Pine, Southern, yellow / Pine, Ponderosa	Pinus ponderosa	h.208	5..100%
Pine, Sugar	Pinus lambertiana	h.215	4..100%
Pine, western white	Pinus monticola	h.406	5..100%
Pittosporum (Tasmania)	Pittosporum bicolor	h.346	4..100%
Planchonia	Pleigynium timorense	h.351	5..95%
Pleigynium / Podo	Podocarpus neriifolia	h.352	7..71%
Podocarp, Fijian	Decussocarpus vitiensis	h.353	6..100%
Podocarp, Red	Euroschinus falcata	h.354	6..100%
Poplar, Black	Populus nigra	h.313	4..100%
Poplar, Pink	Euroschinus falcata	h.355	6..85%
Quandong, Brown	Eurocarpus coorangooloo	h.356	5..97%
Quandong, Silver	Elaeocarpus angustifolius	h.357	5..82%
Quandong, Solomon Island	Elaeocarpus spaericus	h.358	3..85%
Qumu	Acacia Richii	h.359	5..86%
Raintree (Fiji)	Samanea saman	h.360	5..57%
Ramin	Gonystylus spp,	h.361	6..67%
Redwood / Sequoia	Sequoia sempervirens	h.362	5..100%
Rengas	Gluta spp,	h.363	4..100%
Resak (Malaysia)	Cotylelobium melanoxylon	h.364	3..100%
Rimu (non-truewood boron)	Dacrydium cupresinum	h.365	7..82%
Rimu (non-truewood tanalith)	Dacrydium cupresinum	h.366	7..82%
Rimu (non-truewood untreated)	Dacrydium cupresinum	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	Hymenolobium 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 coriacea	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 tetrodonta	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 microcoris	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-Veikau	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	Milletia 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%

16 Appendix B: Additional materials

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

16.1 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		
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.

16.2 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

16.3 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)	

Units of moisture measurements and their conversions

Established moisture measuring instruments (like GMH3830 before V1.4) are displaying the material moisture relative to the dry weight of a material. In practice other units are used, too, especially the wet basis moisture content. The display of newer instruments (like GMH3830 V1.4 or GMR100) can be switched to both units.

Moisture content MC or u (relative to dry weight) = dry basis moisture content

Most common unit for moisture measuring instruments. 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:

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

weight_{wet}: weight of the wet material

weight_{water}: weight of water in the wet material

weight_{dry}: oven-dry weight of material

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

1kg of wet wood, which contains 200g of water has a moisture content u of 25%

Wet-Basis Moisture Content w (relative to total weight)

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:

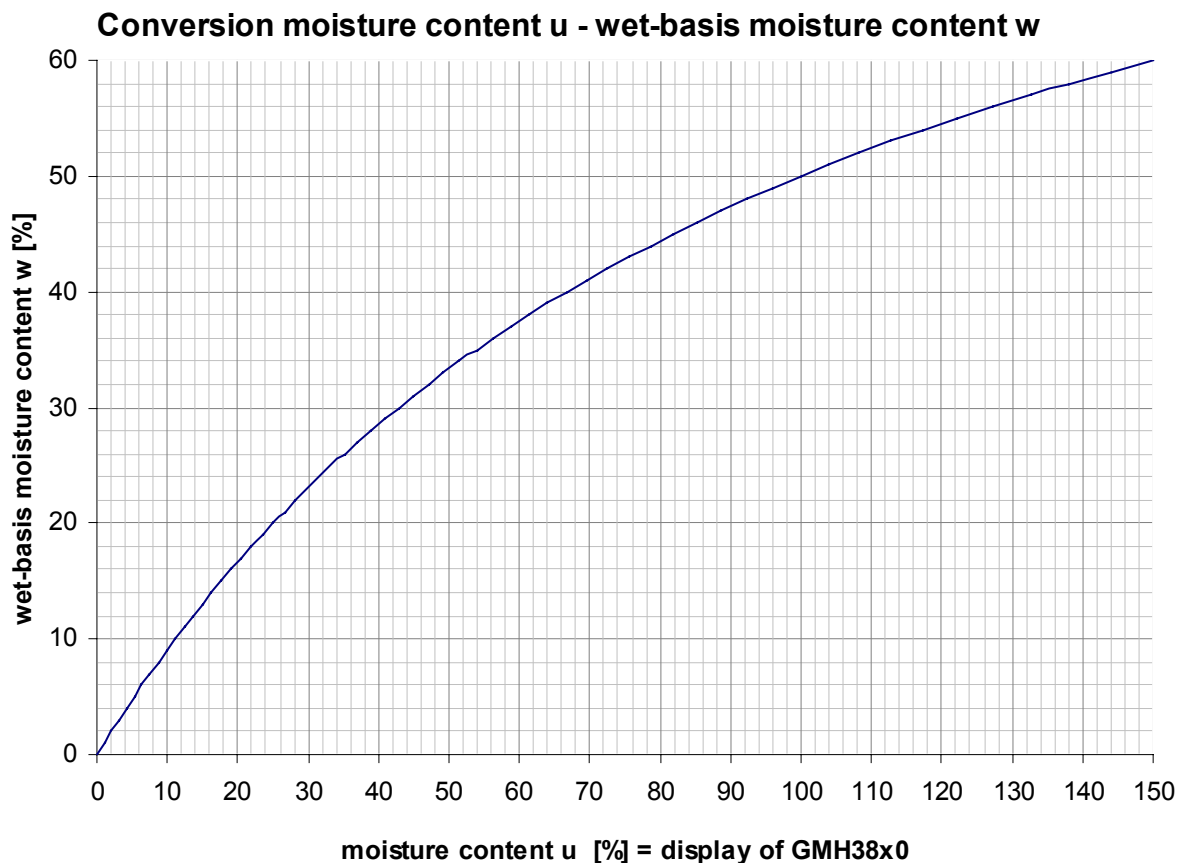
$$\text{wet-basis moisture } w [\%] = (\text{weight}_{\text{water}}) / \text{weight}_{\text{wet}} * 100$$

Conversion meter display u -> wet-basis moisture w

$$\text{wet-basis moisture } w [\%] = 100 * \text{Moisture content } u [\%] / (100 + \text{Moisture content } u [\%])$$

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

1kg of wet wood, which contains 200g of water has a moisture content u of 20%



rarely used:

Dry-Content

The unit is % again.

$$\text{dry content}[\%] = \text{weight}_{\text{dry}} / \text{weight}_{\text{wet}} * 100$$

Conversion meter display u -> dry content

$$\text{dry content}[\%] = 10000 / (100 + \text{Moisture content } u[\%])$$

Examples: 1kg of wet wood, which contains 500g of water has a moisture content u of 50%
 1kg of wet wood, which contains 200g of water has a moisture content u of 80%

Operating Manual Appendix

Moisture measuring set for agricultural applications

as of version 2.1

GMH 38-LW1 / -LW2



WEEE-Reg.-Nr. DE 93889386

1 General Note

Read this document carefully and get used to the operation of the device before you use it. Keep this document within easy reach near the device for consulting in case of doubt.

Mounting, start-up, operating, maintenance and removing from operation must be done by qualified, specially trained staff that have carefully read and understood this manual before starting any work.

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.

The manufacturer is not liable for any costs or damages incurred at the user or third parties because of the usage or application of this device, in particular in case of improper use of the device, misuse or malfunction of the connection or of the device.

The manufacturer is not liable for misprints.

2 Safety

2.1 Intended Use

The GMH 38-LW Set is a complete set for material moisture measuring including an handheld instrument (GMH 38 series) with moisture display and rating for agricultural use.

The robust measuring probe (GSF 50 TF / TFK) makes the set a first-class tool for humidity measurements of wood chips, grain and lightly pressed straw or hay (bales). With firmly pressed bales, we recommend the measuring probe GSF 40 TF (not in scope of supply).

The measuring probe is connected via BNC-plug and thermocouple connector and can be interchanged.

Depending on the application, either the moisture content u (**relative to dry weight**) or the wet-basis moisture content w (relative to total weight) can be displayed.

Please note the remark of measuring accuracy in chapter 5.

2.2 Safety signs and symbols

Warnings are labeled in this document with the followings signs:



Caution! 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! This symbol point out processes which can indirectly influence operation or provoke unforeseen reactions at non-observance.

2.3 Safety Instructions

This device has been designed and tested in accordance with 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 the device.



Risk of injury! Only use this injection probe is extremely carefully, keep it out of reach from children.

3 Operating and Maintenance

- Treat the injection probe carefully (do not throw, hit against etc.). Protect plugs and sockets from soiling.
- When disconnecting the cable from the socket do not pull at the cable but on the plug. For locking and unlocking the movable ring has to be turned in its according direction. When having attached the plug right, it can be connected or disconnected gently without effort.
- The plastic insulator **(3)** has to be clean and dry in the range of the sensor pike, when not, faulty measurements may occur.

4 Product Description

4.1 Scope of supply

The scope of supply of the GMH 38-LW Sets includes:

- measuring probe GSF 50 TFK or GSF 50 TF
- Display instrument of GMH 38 series with 9V battery and operating manual
- Operating manual appendix GMH 38-LW1/-LW2

4.2 The measuring probe GSF 50 TF(K)

The resistance of the medium between the conical metal surfaces (1) and (2) is measured. The medium being measured has to be compressed well enough.

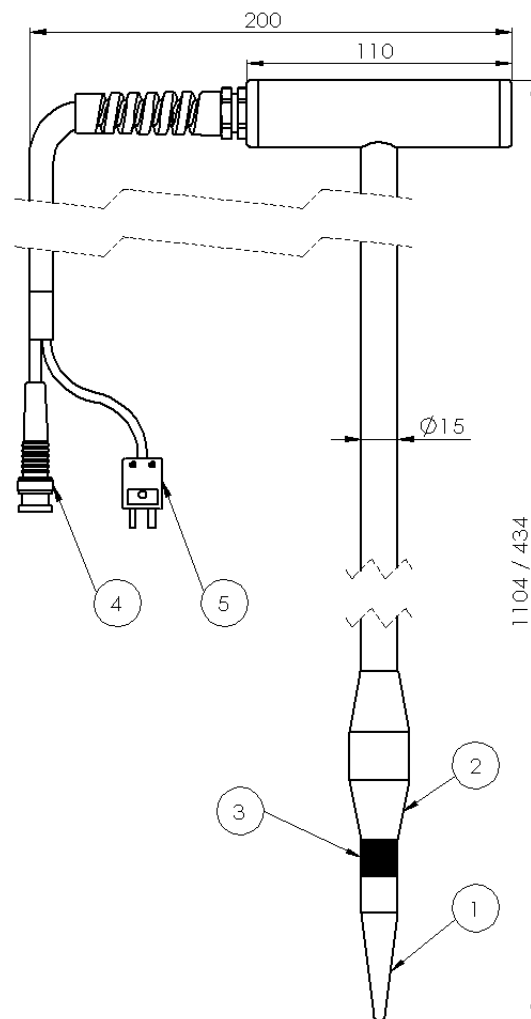
The best is, having a constant pressure onto the medium during the measurement. Do not release handle during the measuring, otherwise the contact to the medium can be interrupted, in this case a to dry value would be measured.

Attention: Especially at bulk material stored outside or very wet material, large distribution of the actual moisture values can appear.

It is best to do several measurements and taking the average in order to get meaningful results:

The measurement of wood chips or things like that is depending on temperature. For an exact measuring result the temperature is automatically compensated when using the suitable instrument (e.g. GMH 3830). The temperature-measuring is done at the tip of the probe (1), a sufficient time to adjust the sensors temperature to the material has to be waited for.

Different measuring results are depending on different types of material. Select correct material-group or material type before measuring. Refer to operation manual of the connected measuring device. When pushing in the probes, oscillating movements have to be avoided. Otherwise hollows between the probes and the material may falsify the measurement



minimum immersion 100 mm

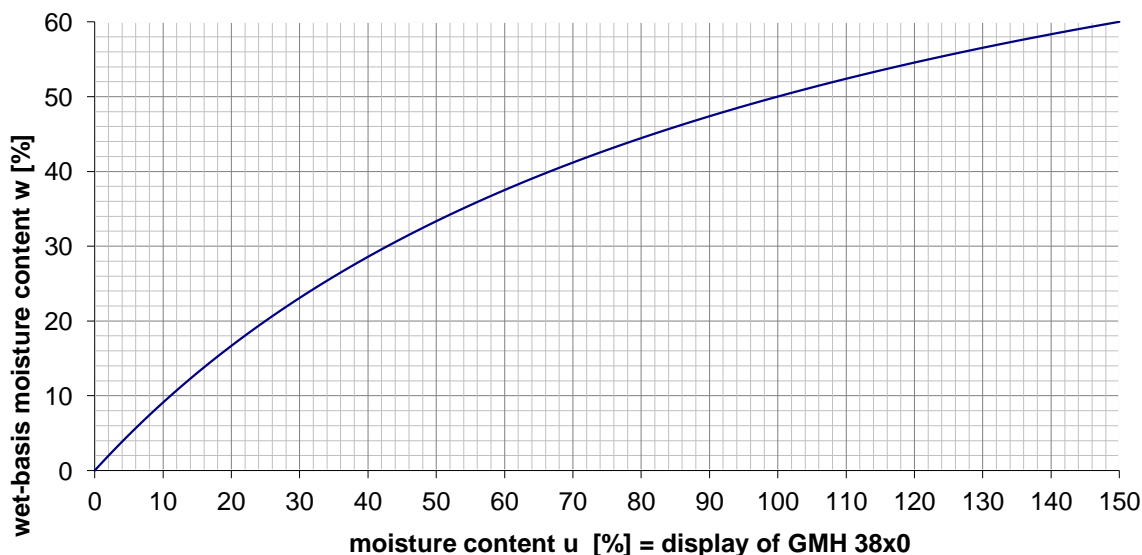
5 Unit conversion: moisture dry-and wetbasis

Older instruments (e.g. GMH 3830 before V1.4) cannot be switched from moisture content u to w, in this case the wet basis moisture content can be calculated like following:

$$\text{Wet-basis moisture } w \text{ [\%]} = 100 * \text{Moisture content } u \text{ [\%]} / (100 + \text{Moisture content } u \text{ [\%]})$$

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

Conversion moisture content u - wet-basis moisture content w




6 Handling

6.1 Start of operation

Switch the device on with the on/off key. After segment test the device is ready for measuring.

6.2 Selection of the characteristic curve

Selection of characteristic curve: by pressing  the characteristic curve can be selected.



The use of inappropriate characteristics can cause faulty measurements!

Selectable material characteristics: (via "Sort"-function preselected, please refer to operating manual GMH 38xx)

Display	Characteristic curve
r EF	Reference characteristic
h.458	Flax
h.461	Wood chips
h.462	Wheat
h.463	Barley
h.464	Hay
h.465	Straw



By means of additional equipment (not within scope of supply) wood and building materials of many kinds can be measured – therefore the user has to add the referring characteristic curves to the Sort- Preselection, or deactivate it complete.. With firmly pressed bales, we recommend the measuring probe GSF 40 TF (not included in scope of supply).

6.3 Temperature Measurement

The Temperature value will be displayed temporarily when key  is pressed.

Let the Probe adjust to the material for at least 20 seconds to achieve good measuring precision.

7 Principles of the measurements

7.1 Moisture rating (WET - MEDIUM - DRY)

In addition to the measuring value there is a moisture rating via bar graph.



This rating can only be a first approximate value, because factors like the application field of the measured material have to be taken into account for the final rating. Experience and knowledge can only be supported by this instrument, not replaced!

7.2 Temperature compensation

The temperature compensation is important for a reliable moisture-measuring.

There for the device features a temperature measuring at the Tip of the injection probe.

According to the selected material characteristic curve the device will use the associated temperature compensation.

8 Measuring bales of straw hay bales

Always inject the electrodes form the plain side of round bales never from the round side, the probe can be inserted much easier. For strongly pressed bales we suggest the probe GSF 40 or GSF 40 TF instead.

With loose medium ensure sufficient compression (e.g. like the description in chapter „Wood chips as fuel“)

For the storability, their quality assessment and purpose, the 38-LW Set is an important support of decision – beside the decision of smell (fusty?) – consistence (dust...) and appearance (colour, impurities).

Less than 16 % u

16 - 20 % u

Above 20 % u

Measured material is sufficiently dry and storable.

Measured material includes increased humidity, appropriate dry before storage.

extreme high humidity! Defer harvesting if possible or dry before storage

9 Measuring of grain

For the storability, their quality assessment and purpose, the 38-LW Set is an important support of decision – beside the decision of smell (fusty?) – Consistence (dust...) and appearance (colour, impurities).

When measuring grain pls keep in mind to use sufficient amount of measuring good (at least 500ml), surrounding the sensor and that there is sufficient pressure between sensor and grain (in heap >30 cm and an immersion depth of >20 cm this is usually automatically the case), otherwise there may be to low display values!

With freshly harvested grain, an approximate recommendation for barley, rye und wheat can be given:

Less than 16 % u	Measured material is sufficiently dry and storable.
16 - 20 % u	Measured material includes increased humidity, appropriate dry before storage.
Above 20 % u	extreme high humidity! Defer harvesting if possible or dry before storage

10 Wood Chips as fuel

Instrument settings for measuring wood chips:

GMH 3830/3850/3851 Version >= 1.5: **h.461 (specialised GSF 38 / GSF 50 curve)**

others: We recommend "Wood group C" (GMH 38x0 instruments: "h. C"). This group delivers a sufficient accuracy for the fuel application up to 30% MC – above there is larger deviation.

Wood chips are classified in different quality groups.

The size and the moisture content (MC or u) or the wet-basis moisture content (w) is the measure for the usability. Usually moisture content (w) of maximum 30% is recommended.

Chip size

Class		Size
G 30	small chips	smaller than 3 cm
G 50	mid size chips	3 – 5 cm
G 100	crude chips	5 – 10 cm

Moisture content

Class		Wet basis moisture content w (can be displayed directly of GMH 3830 V>=1.5)	moisture content u
w 20	air dry	<20 % w	<25 % u
w 30	storable	20 – 30 % w	25 – 43 % u
w 35	conditionally storable	30 – 35 % w	43 – 54 % u
w 40	wet	35 – 40 % w	54 – 67 % u
w 50	fresh cut	40 – 50 % w	67 – 100 % u

The higher the moisture content, the lower is the heating value per weight

10.1 Field measuring

At measuring in containers, silos, chip bunkers or similar storages and a measuring depth > 0.5 m commonly the compression is high enough for direct measuring.

Although keep pressure on the handle during the measuring!

For measuring in less than 0.5 m or in loose bulk material, best is to step on the measuring spot and insert the probe below the foot.

At values above 20%u the display may have falling values: The display after 10 seconds is valid!

10.2 Bucket test

The probes from suitable places in Your material into a bucket (≥ 10 litre).

Compress: Step into the bucket and compress with roughly 10 kg. Measure under Your foot:



During measuring keep pressure on the handle!

Repeat Your measuring and take average of 3 measurings!

At values above 20%u the display may have falling values: The display after 10 seconds is valid!

10.3 Additional Information about Moisture Measuring

10.3.1 Moisture gradients

Please keep in mind: Depending on Storage conditions and harvesting there can be large differences of moisture within bales or grain stocks!.

10.3.2 Measuring Precision

The 38-LW Set is perfect for approximate measuring of material moisture in Wood Chips, Hay, Straw and Grain. Depending on the sort and condition of the measured good there may appear deviations.

The main advantage of the system lies within the ability of comfortable measuring of many measuring spots (bottom, top, weather side...) within one stock in short time - without separate sampling.

This is in praxis very often much more valuable as single measurements with higher precision!

Precision of wood chip measuring

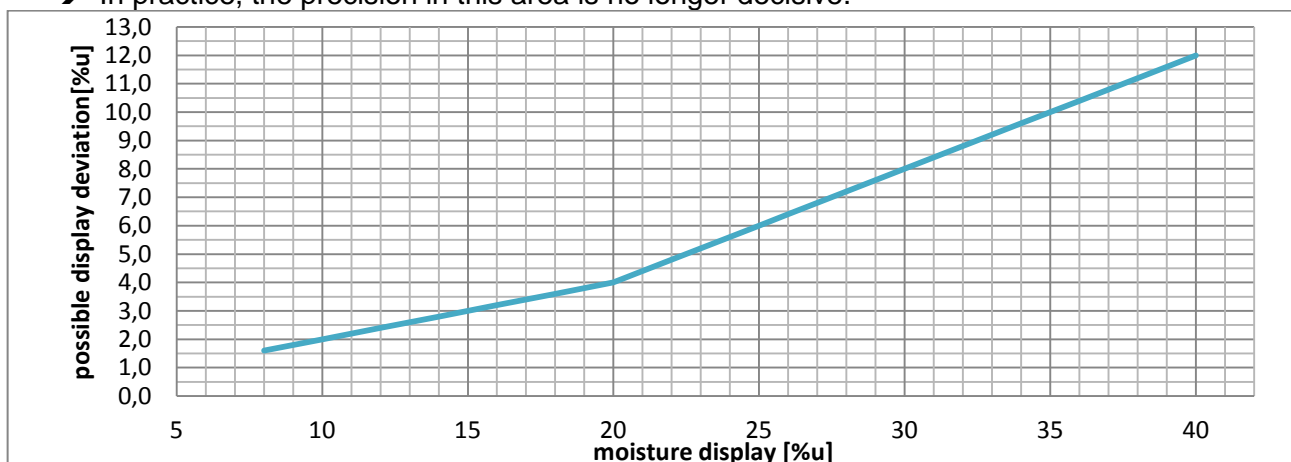
With the "bucket test" and good quality soft wood chips following precision can be achieved (curve setting h.461 GMH 3830/-3850/-3851 as of version 1.9):

- 8-20% u: better than $\pm 20\%$ of measured value
- 25-40% u: better than $\pm 4\%$ $\pm 40\%$ of (measured value-20%u)

At values out of the range of 8...40% the display value is increasingly unprecise and should only be used as an indicator.

Significant here is: $>25\%$ is definitively to wet!

→ In practice, the precision in this area is no longer decisive.



Accuracy Wood pellets

Pellet measuring is similar (also h.461), but the specified range ends already at 20 % u.

Keep probe clean!

Especially when measuring in wet hay, the probe may be soiled very strong, this may produce to low measuring displays.

In hard cases we suggest fine grinding fleece or at least suitable household sponges for cleaning. Do not use steel wool!

Display values at air

If the probe is not correctly in contact to material, the instrument may display any value!

This is caused by the design and measurement method.

11 Specifications

	GSF 50	GSF 50K
Measuring principle	Resistive material moisture measurement	
Connection	BNC (4) (cable fixed on probe)	
Profile	shaft Ø 15 mm, contact surface 2: Ø 25 mm	
Overall length	110 cm	43 cm
Measuring depth	107 cm	40 cm
Weight	650 g	420 g

12 Reshipment



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.



DANGER

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

13 Disposal Notes



The device must not be disposed in the unsorted municipal waste! Send the device directly to us (sufficiently stamped), if it should be disposed. We will dispose the device appropriate and environmentally sound.

