

# alphaDUR mini



**Manual**

**Version 1.1.5**





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## 1 Introduction

The alphaDUR mini is a portable hardness tester. Vickers hardness is measured according to the UCI (Ultrasonic Contact Impedance) method.

The measured Vickers hardness can be converted to Brinell hardness (HB), Rockwell hardness (HRC or HRB) or tensile strength (N/mm<sup>2</sup>) according to DIN standard 50150.

Up to 100 000 readings including hardness, date, time and measuring parameter can be stored to the internal memory of the alphaDUR mini.

The memory can be divided into sections for use by different users or projects. Saved series of measurements, including statistics, can be readily displayed or printed. The program alphaSOFT (not included with the alphaDUR mini) is used to transfer the series to a PC.

In addition to the permanent storage, the readings can be temporarily saved so that statistics can be computed even if the readings are not permanently saved.

Furthermore, the alphaDUR mini provides a so called 'instant printout' function. The readings will be instantly printed after measurement. No statistics will be calculated.

## 2 Manual

### 2.1 Lettering

<b><i>Operating elements</i></b>	Operating elements
KEY	Keys
Standard text	Descriptions and explanations in text form
<b><u>Important notes</u></b>	Important notes and remarks

### 2.2 Text boxes

<b>Operating elements</b>	Explanations of functions and operating elements are framed in blue.
<b>Entry fields</b>	Green fields describe user inputs and parameters
<b>Information</b>	Information and notes are provided with yellow background
<b><u>Important notes</u></b>	Important notes and warnings are represented in red boxes

## 3 The test probes

### 3.1 Probe selection

alphaDUR UCI test probes are available with test loads of 10, 20, 30, 49, and 98 N. This corresponds to HV1, HV2, HV3, HV5 and HV10 (1, 2, 3, 5 and 10 kg).

So the optimal load for a particular test task can be chosen. Two criteria are crucial for the selection of the appropriate test load: surface of the specimen and handling. For rough surfaces, high test loads are recommended, which leads to greater indentations. But it ought be considered,

that it may be necessary to apply a load of up to 10 kg manually. This is not a problem if the probe is fixed in a stand. But it could be difficult to apply the test load steadily and vertically if many consecutive measurements must be done.

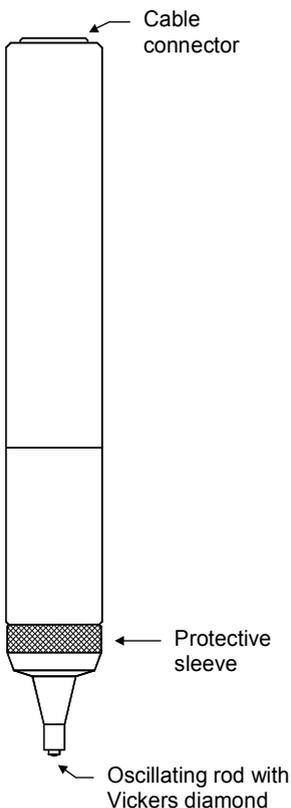


Fig. 1

### 3.2 Probe handling

The protective sleeve serves 2 purposes:

It protects the UCI rod against damages (as distortion).

It serves as a mechanical stop for the deflection of the rod during measurement.

To conduct a measurement, the probe must be held perpendicular to the specimen surface. (The alphaDUR mini has to be calibrated to the mater-

ial and must be in measuring mode.) The Vickers diamond may touch the surface slightly, but not for too long (otherwise an error occurs). Then the probe is pressed to the specimen until the protective sleeve hits the surface. An acoustic signal indicates the completion of the measurement. To achieve an accurate measurement, the probe must be pressed steadily and vertically onto the specimen.

To facilitate the measurement procedure, probe supports can be attached to the probe in place of the protective sleeve. These probe supports are obtainable for flat and convex surfaces.

A high precision stand is available, which eases load application, particularly when a large number of measurements has to be taken or in case of a high test load.

## 4 General working instructions

### 4.1 Key functions



Switching on/off the device.



Changes the hardness scale.



Changes the material.



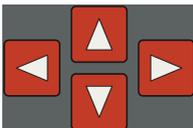
Delete last measurement point



Display statistics



Into the main menu



Cursor keys

With these keys, menu items are selected and the required values in input fields are set.



With this key, the current function is exited. The higher-level menu item is accessed.



The processing is completed with this key in a field, or a menu item is selected.

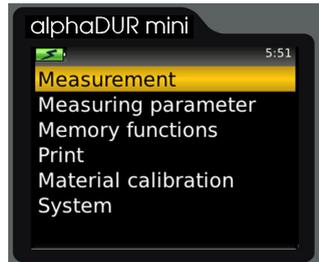
### 4.2 Status bar

The rechargeable battery status and the time are displayed in the status bar at the top of the window.

### 4.3 The menus

A menu consists of a list of available menu items and a bar which identifies the active menu item. This bar can be displaced in the menu with the aid of the cursor keys ▲ and ▼. As a result of pressing ENTER the marked menu item is selected. Either a window or a submenu are opened by that.

With ESC, a return is made to the former menu.



Particular attention has been paid to ease the operation by avoiding deeply nested menus.

### 4.4 Text entry

In case of saving measuring data and measuring parameters, inputs are possible in plain text. In these cases, the text entry window is opened.



Fig. 3 : Text entry

In the upper field (designated as text field in the following) the entered text is displayed, in the rows below are represented the characters which can be selected. The blank is identified with [ ].

Below the characters is located a strip with command buttons for control. These command buttons are allocated as follows:

<b>A/a</b>	Switching between upper case and lower case
<b>OK</b>	Accepting text and closing text entry window
<b>Cancel</b>	Closing text entry window without accepting the text

The field on which the focus is placed is identified by a yellow background. With the keys ▲ and ▼ the focus is set on the line above or below the current line. The allocation of the keys is different, depending on which field has the focus at the time.

Action	Key/s
<b><i>Focus on text field</i></b>	
Shift input mark	◀ and ▶
Deletion of the character in front of the input mark	DEL
Accepting text and closing text entry window	ENTER
Closing text entry windows and asking whether the text should be accepted.	ESC
<b><i>Focus on character area</i></b>	
Selection of the character to the left or right of the current character	◀ and ▶
Entering character in the text field	ENTER
Deletion of the last entered character	DEL
Closing text entry windows and asking whether the text should be accepted.	ESC
<b><i>Focus on command button</i></b>	
Implement action	ENTER
Selection of the command button to the left or right of the current one	◀ and ▶
Deletion of the last entered character	DEL
Closing text entry windows and asking whether the text should be accepted.	ESC

#### 4.5 The number field

A number field is used for the input of numbers. It consists of mostly several digits which can be changed separately, and a marker (cursor) which can be displaced with the cursor keys ◀ and ▶ within the number field. The Item on which the cursor is at this time can be modified through pressing the cursor keys ▲ and ▼

A further, leading digit for the input of larger numerical values can be generated by cursor ◀.

The input is saved and concluded with ENTER. With ESC, the entry field is closed without saving.

Action	Key/s
Displace marker	◀ und ▶
Increase digit	▲
Decrease digit	▼
Generating a further, leading digit if the marker is placed on the first digit.	◀
Accepting input and closing number field	ENTER
Closing number field and discard input.	ESC

## 5 Measurement

The measurement can be started with the menu item **Measurement**. If a probe is connected to the alphaDUR mini, the measurement window will be shown directly after start-up.

The test load of the connected probe will be detected automatically.

### 5.1 Specimen requirements

As in all hardness tests, besides the hardness of the specimen some other characteristics can influence the measurement result. These characteristics include the surface quality, the thickness and the homogeneity of the specimen. Some essential requirements have to be fulfilled to achieve reliable reproducible hardness values.

- Surface quality

The surface quality should be the same as for optical Vickers hardness tests according to DIN standard. For low test loads, the quality has to be higher than for high test loads. The surface must be free from oxides, impurities and lubricants. The surface roughness should not exceed 1/5 of the penetration depth.

- Thickness

For optical Vickers hardness tests, the thickness of the specimen should be at least ten times higher than the penetration depth. This applies also to the thickness of coatings.

The UCI method requires a higher thickness, because the oscillations of the UCI rod are transmitted to the specimen. They spread over the specimen and will be reflected at the boundaries. These reflected oscillations influence the frequency shift in the UCI rod and affect the accuracy of the measurement.

To avoid this effect, the specimen has to be thick enough to allow the oscillations to attenuate before the diamond is reached. With thin specimen, the mass of the specimen has an effect. If the mass of the specimen is high enough, a thickness of 8 mm for flat specimen or 10 mm for round stock is sufficient. If a specimen does not meet these requirements, it can be acoustically coupled to a massive support e.g. with a thin oil film between specimen and support. A steel plate is recommended as support (e.g. the precision stand comes with an appropriate plate).

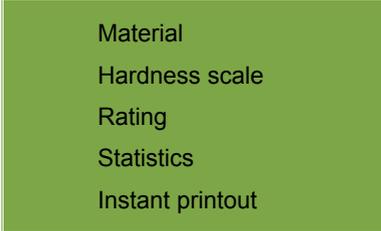
Small, irregular shaped parts can be embedded in plastic material.

- Homogeneity

As in optical Vickers hardness tests, the indentations are relative small. Therefore the homogeneity of the specimen can possibly influence the measurement results. To achieve reproducible hardness readings, the indentation must be significantly greater than the grain size of the test material. This may be not the case for some cast material even with a test load of 100N.

### 5.2 Measuring parameter

The measuring parameter must be set according to the demands. The parameter are in particular:



- Material
- Hardness scale
- Rating
- Statistics
- Instant printout

These parameter are described in detail in chapter 6.2. Select the menu item **Measuring parameter/Edit** to adjust them. If a set of measuring parameter that

meets the requirement already has been saved, you can use the menu item **Measuring parameter/Load** (see 6.2.3) to reload them.

After power-up, the alphaDUR mini restores the measuring parameter which were last used.

### 5.3 Measuring procedure

To take a measurement, put the probe vertically onto the specimen and press it down steadily as far as it will go. The hardness value will be determined shortly before the protective sleeve touches the surface of the specimen. Therefore vibrations caused by the protective sleeve hitting the surface will not influence the measurement result. The measurement is completed when you hear the beep. The number of fractional digits shown depends on the hardness scale. Rockwell scales will usually be displayed with 1 fractional digit, Vickers, Brinell and tensile strength without any fractional digits.

Within certain boundaries, the speed with which the probe is pressed down has no influence on the measurement result. If the probe is lowered too fast or if the probe is not raised from the specimen for some time, an error message will be shown.

### 5.4 Measuring window



Fig. 4: Measuring window

<b>Charge status display::</b>	Displays the residual charge of the batteries.
<b>Time:</b>	Current time
<b>Measured value:</b>	Current measured value
<b>Hardness scale:</b>	Current hardness scale
<b>Material:</b>	Current material
<b>Number of measurements:</b>	Number of measurements already carried out
<b>Average value:</b>	Average value of the measurements carried out
<b>Standard deviation:</b>	Standard deviation
<b>History:</b>	The last 4 measured values are displayed here

#### 5.4.1 Key assignment of the measuring window

SCALE	<p>Changes the hardness scale. If the tolerance limits cannot be converted to the new scale, they are automatically set to 0. However, the values set-adjusted in the measuring parameters are stored so that, in case of renewed changeover into a scale in which the limits can be converted, these are again set to the adjusted values. In the system settings it can be determined whether the scale should be changed automatically or a dialogue should be opened (see 10.4.2).</p> <p><b>Deactivated if the measured value memory is switched on.</b></p>
MAT	<p>Changes the material. If the currently selected hardness scale is not defined for the new material, the hardness scale is automatically reset to HL. In the system settings it can be determined whether the material should be changed automatically or a dialog should be opened (see 10.4.3).</p> <p><b>Deactivated if the measured value memory is switched on.</b></p>
DEL	Deletion of the last measured value
STAT	Display of the statistics concerning the already measured values

## 5.5 Statistics

If the measured value memory is switched on, the values of a series can be evaluated statistically at all times. Even if the measured value memory is not switched on, the hardness numbers are always temporarily stored until the measurement window is closed. Thus a statistical evaluation of the measured values can also be displayed with switched off measured value memory.

If the hardness scale or material is changed by key press in the measurement window, the statistics are reset.

### 5.5.1 Display of statistics

The output of the statistical evaluation is implemented as soon as the number of measurements set-adjusted in the measuring parameters have been made, or the key STAT is pressed. First to be displayed are average value, standard deviation, relative standard deviation (standard deviation in % of the average value), minimum, maximum and the number of values. Standard deviation and average value are displayed with 1 decimal place more than is



alphaDUR mini	
Mean value	610.8 HV3
Std. dev.	8.3
Std. dev. %	1.36
Minimum	601 HV3
Maximum	623 HV3
Number	8

*Fig. 5: Statistics*

usual for the hardness scale. The Rockwell scales are usually indicated with 1 decimal place, Vickers, Brinell, Shore and tensile strength without any decimal place. The relative standard deviation is displayed with 2 decimal places.

If the key STAT is pressed again in this view, a window is opened in which are displayed the measured values with which the statistics were calculated. Here it is possible to delete obviously incorrect values.



alphaDUR mini			
			5:50
HV3			
623	602	618	613
601	603	617	609

*Fig. 6: Values*

For the deletion of a value, the marker is set with the cursor key to the value to be deleted and then DEL is pressed.

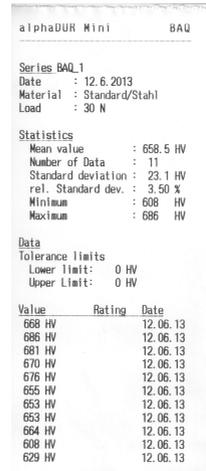
If the edit window is closed with ESC, a request is made as to whether the changes should be accepted or rejected. If the changes are accepted, the statistical values will be newly calculated.

The statistics window is closed with ESC. If the predetermined number of statistical data is not yet reached (because the display of statistics was started with key STAT or because a value has been deleted) the measurement series will be continued.

The alphaDUR mini can be configured to display a query whether the data should be saved as a new series (see 10.4.4) if the predetermined number of data is reached when the window is closed. Likewise, it is possible to have a query displayed whether the data should be printed (see 10.4.5).

## 5.6 Instant printout

If a mobile printer is connected, a consecutive printout can be made. The measured data are then instantly printed. The instant printout mode stays active when the measuring window is closed. It must be explicitly deactivated (see chapter 6.2.1).



The screenshot shows a software interface for a measurement device. At the top, it says 'alphaDUR Mini' and 'BAU'. Below that, it displays 'Series BAQ\_1' and some basic information: 'Date : 12.6.2013', 'Material : Standard/Stahl', and 'Load : 30 N'. The 'Statistics' section shows: 'Mean value : 658.5 HV', 'Number of Data : 11', 'Standard deviation : 23.1 HV', 'rel. Standard dev. : 3.50 %', 'Minimum : 608 HV', and 'Maximum : 686 HV'. The 'Data' section shows 'Tolerance limits' with 'Lower limit: 0 HV' and 'Upper limit: 0 HV'. At the bottom, there is a table with three columns: 'Value', 'Rating', and 'Date'. The table contains 11 rows of data.

Value	Rating	Date
668 HV		12.06.13
686 HV		12.06.13
681 HV		12.06.13
670 HV		12.06.13
676 HV		12.06.13
655 HV		12.06.13
653 HV		12.06.13
653 HV		12.06.13
664 HV		12.06.13
608 HV		12.06.13
629 HV		12.06.13

Fig. 7

## 6 Measuring parameter

### 6.1 Description

After power-up, the alphaDUR mini restores the last used measuring parameter.

#### **The measuring parameters in detail:**

**Material:** The currently selected material calibration. For details about material calibration see chapter 8.

**Hardness scale:** The current hardness scale (Vickers (HV), Rockwell (HRC or HRB), Brinell (HB) or tensile strength (N/mm<sup>2</sup>)), to which the readings will be converted. The result of an UCI measurement is Vickers hardness. If another hardness scale is selected, the values will be converted according to DIN standard 50150. In the measurement window the hardness scale can be switched with the aid of the key SCALE, unless the measured value memory is activated.

**Rating:** These are the upper and lower limits for rating. A signal of 2 short beeps sounds if a measured value lies outside these limits. A single beep sounds if the value is rated GOOD.

If both limits are set to 0, no rating will be done.

It is self-evident, that the the upper limit must be higher than the lower limit.

If rating is activated, in will be indicated in the measuring window when the upper or lower limit is exceeded.

**Statistics:** The number of measured values which should be statistically evaluated without the use of the measured value memory is defined here.

**Instant printout:** If a mobile printer is connected, a consecutive printout can be made (see 5.6). This parameter can be set On or Off.

## 6.2 Managing sets of measuring parameter

In the alphaDUR mini combinations of measuring parameters can be stored under a user-defined name. In this way, the measuring parameters required for specific applications can be called up easily.

### The following parameter are stored:

- Name
- Test load
- Material
- Hardness scale
- Upper and lower limit for the rating 'GOOD'
- Test report printout setting (on or off)
- The number of values which should be used for the statistical evaluation

### 6.2.1 Editing measuring parameter

Under the menu item **Measuring parameter / Edit**, the measuring parameters can be set.

Only the current measuring parameters can be changed. In order to change a stored configuration, this must first be loaded and stored again after the change has been implemented.

### 6.2.2 Saving measuring parameter

The current measuring parameters can be stored in the menu item **Measuring parameter / Save** under a user-defined name.

According to choice of the menu item, a text entry window is opened in which the new name for the set of measuring parameter can be entered.

### 6.2.3 Loading measuring parameter

Choose menu item **Measuring parameter / Load** to read back a set of measuring parameter.

Select the measuring parameter set from the list by means of the cursor keys. Then press ENTER to load the parameter.

### 6.2.4 Deleting a set of measuring parameter

Select menu item **Measuring parameter / Delete** to delete a set of measuring parameter which is no longer needed.

Choose the measuring parameter set from the list by means of the cursor keys. Then press ENTER to delete the set.

## 7 Hardness conversion

The alphaDUR mini can convert hardness values to another hardness scale or to tensile strength according to DIN standard 50 150:1976-12. This standard applies to mild steel, low alloyed steel and cast steel, hot formed or heat treated. For high alloyed and/or cold worked steel, mostly significant differences are to be expected.

It has to be pointed out, that there is no generally valid conversion relation. You must always consider the effect of the different indentors and test loads.

The alphaDUR mini determines Vickers hardness according to the UCI (Ultrasonic Contact Impedance) method (see chapter 12). In contrast to the classical method according to DIN EN ISO 6507-1, the measurement is done while the test load is applied. The results of the UCI method are comparable to the classical method as long as the elastic part of the deformation is negligible compared to the plastic part. This applies to metals and e.g. ceramics.

DIN standard 50 150:1976-12 covers the following ranges:

HRC:	240 HV / 20,3 HRC	to	940 HV / 68,0 HRC
HRB:	85 HV / 41,0 HRB	to	250 HV / 99,5 HRB
Brinell:	80 HV / 76,0 HB	to	650 HV / 618 HB
tensile strength:	80 HV / 255 MPa	to	650 HV / 2180 MPa

For HRC, HRB and tensile strength, the conversion is limited to these ranges. Brinell would be converted even if the value is not in the range covered by the DIN standard.

To change the hardness scale, select the menu item **Measuring parameter / Edit / Hardness scale** (see chapter 6.2.1) or press the SCALE key in the measuring window.

## 8 Material calibration

The alphaDUR mini has to be calibrated for every material that should be measured. These calibrations can be permanently stored to the device.

A factory-provided standard calibration for steel is preset in the alphaDUR mini and cannot be deleted.

The calibrations can be grouped to sections. So a two-level hierarchy is established to keep things clear if lots of calibrations shall be saved. E.g. ferrous materials and aluminium alloys can be assigned to different sections.

To calibrate a material, select menu item **Material calibration / Calibrate**. You will need a material sample of known hardness (reference sample) for the calibration.

This reference sample must fulfil the following requirements:

- Sufficient size. Especially the thickness should not be less than 16 mm (as for standard test blocks).
- The surface should be finely lapped. The dispersion of measured hardness values will rise with greater roughness of the surface and will lead to inexact calibrations.
- The hardness of the sample should be as homogeneous as possible over the total surface. Variability of the hardness effects the measurement and leads to inexact calibrations.

The hardness of the reference sample can be determined e.g. with a stationary hardness tester. If such an instrument is not available, the manufacturer of the device can assist you.

First the three calibration parameter must be set:

1. Select the hardness scale for the calibration. This is usually the hardness scale which was used to measure the hardness of the reference sample.
2. Enter the hardness of the reference sample.
3. Enter the number of measurements that should be included for calibration. Usually 4 to 5 measurements are sufficient. If great dispersions are to be expected, e.g. for rough surfaces, the number should be increased.

After the calibration parameter have been set, the calibration can be continued by cursor right ►.

Now, the measurements for calibration must be taken. The alphaDUR mini sounds a beep at the end of each measurement. The probe should be lowered evenly and steadily.

When the calibration is done, the standard deviation of the measurements will be displayed (in units of the selected hardness scale and as percentage of the mean value). This allows conclusions regarding the quality of the calibration. If the standard deviation is too high, press ESC to repeat the calibration. As for regular hardness measurements, the standard deviation of the calibration depends on surface quality, homogeneity and correct probe handling (perpendicular, without shaking). The standard deviation will be displayed with 1 more fractional digit than usual for the hardness scale (Rockwell scales will usually be displayed with 1 fractional digit, Vickers, Brinell and tensile strength without any fractional digits). The standard deviation as percentage of the mean value will be displayed with 2 fractional digits.

When the calibration turns out satisfactory, it can be saved. Now you have to decide if the new calibration shall replace an older one, or if the calibration should be saved as a new one.

In the former case, you have to select the material that should be replaced.

In the second case, there are 3 alternatives:

1. The material calibration should be assigned to an existing section. By these sections, the calibrations can be organized in a two-level hierarchy, so that you can keep track even if lots of calibrations are needed. E.g. ferrous materials and aluminium alloys can be assigned to different sections.
2. If a new section should be created, first the name of the section, then the name of the calibrated material must be entered.

3. If the material calibration shall not be assigned to any section, only the name of the calibrated material must be entered.

Now, the new calibration can be selected in **Measuring parameter / Edit / Material**.

## 9 Memory functions

The alphaDUR mini can store up to about 100.000 readings. These readings are organized in measurement series (groups).

When a new series is created, name for it must be entered. By these names the series can be selected for display and printout. The hardness values will be saved including time and date of measurement. In addition, the active measuring parameter are also saved including:

- Probe type
- Test load
- Material
- Hardness scale (HV, HB, HRC, HRB or tensile strength [N/mm<sup>2</sup>]).
- Upper and lower limit for rating GOOD

While values are saved to a series, the SCALE and MAT keys are disabled in the measuring window!

When a series is displayed or printed, standard deviation and mean value will be included.

### 9.1 Creating a new series

Select the menu item **Memory functions / Create new group** to start a measurement series. After a name for the series (see 4.4) has been entered, the measuring window will open and the following readings are saved to this series.

The measuring parameter cannot be changed, while a series of measurements is taken.

Press ESC to close the series. You will be asked, if the series should be saved finally.

### 9.2 Continuation of a series

To append further data to a series, select the menu item **Memory functions / Append data to series**. The new data will be saved with the current time and date.

### 9.3 Deleting a series

Select menu item **Memory functions / Delete** to delete a series.

### 9.4 Displaying a series

Select menu item **Memory functions / Show** to display a series and the related statistics (see 5.5.1). The values can be altered or deleted.

## 10 System settings

### 10.1 Language

Select the menu item **System / Language** to set the language. Select the desired language by means of the cursor keys. The chosen language will become active when you close the dialog by pressing ENTER.

### 10.2 Time

Select the menu item **System / Time** to set the current time. The format is HH:MM (hour:minute). Press ENTER to save the time. To cancel the input, press ESC.

### 10.3 Date

Choose the menu item **System / Date** to set the current date. Press ENTER to save the current time. To cancel the input, press ESC.

### 10.4 Configuration

#### 10.4.1 Date format

Under the menu item **System / Configuration / Date format**, the format in which the date is entered and displayed can be set.

Meaning of the alphabetic characters of the format specification:

**TT:** Day

**MM:** Month

**JJJJ:** Year

#### 10.4.2 Key SCALE

In the menu item **System / Configuration / key SCALE**, it is adjusted whether a dialogue for the selection of the new scale should be opened when activating the key SCALE in the measurement window, or whether the hardness scale should be set automatically to the next valid scale.

Select:

- |                      |  |
|----------------------|--|
| <b>Open dialogue</b> | If the new hardness scale should be selected in a dialogue.                |
| <b>Next scale</b>    | If the hardness scale should be set automatically to the next valid scale. |

#### 10.4.3 Key MAT

In the menu item **System / Configuration / key MAT**, it is adjusted whether a dialogue for the selection of the new material should be opened by activating the key MAT in the measurement window, or whether the material should be set automatically to the next valid material

Select:

- |                      |   |
|----------------------|---|
| <b>Open dialogue</b> | If the new material should be selected in a dialogue.                   |
| <b>Next material</b> | If the material should be set automatically to the next valid material. |

#### 10.4.4 Query whether series should be saved

Under the menu item **System / Configuration / Save series query** you can determine if you want to be queried whether the data should be saved when you close the measuring or statistics (see 6.1 Statistics) window. Select 'Off' to turn off the query and 'On' otherwise.

#### 10.4.5 Query whether values should be printed

Under the menu item **System / Configuration / Print values query** you can determine if you want to be queried whether the data should be printed when you close the statistics window (see 6.1 Statistics). Select 'Off' to turn off the query and 'On' otherwise.

### 10.4.6 Tensile strength unit

Under the menu item **System / Configuration / Tensile strength unit** it can be selected if the unit of tensile strength should be displayed as Mpa (Megapascal) or N/mm<sup>2</sup> (Newton per square millimetre).

### 10.5 Factory defaults

With the aid of the menu item **System / Factory defaults**, the current measuring parameters and the date format can be reset to the default values.

### 10.6 System information

Select **System / Info** from the menu to display the system information. The version numbers of software, kernel and system will be shown. If a probe is connected, the serial number of the probe, the version of probe software and the number of measurements done with this particular probe will be displayed additionally.

## 11 Maintenance and inspection

Periodically checks of the device should be executed with standard hardness test blocks. The thickness of the test block is very important, due to the measuring method. It should be no less than 16 mm. Test blocks of lesser thickness (e.g. 6mm) aren't suitable. DKD-certified test blocks of 16 mm thickness are available at the manufacturer of the device.

Depending on the frequency of use, a check / maintenance of the probes should be performed at intervals of 1 to 2 years.

## 12 The UCI method

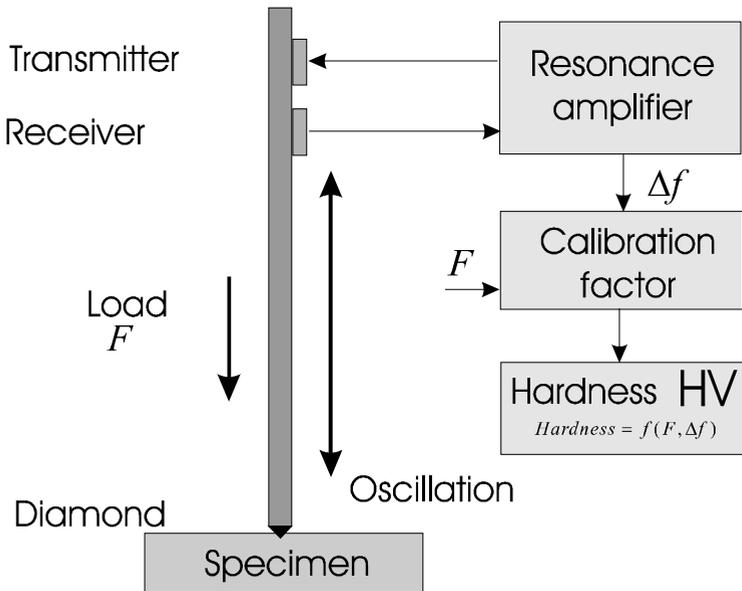
The UCI method (Ultrasonic Contact Impedance) is successfully used in hardness testing since many years.

A rod is excited into a longitudinal oscillation. At the tip of the rod, a Vickers diamond is placed. This diamond is pressed to the specimen with a discrete test load. Mostly the test load  $F$  is applied through a spring.

The rod oscillates with its self-resonant frequency which depends essentially on its length. When the Vickers diamond penetrates the specimen, the oscillation of the rod is damped. This causes a shift  $\Delta f$  of the resonance frequency, which can easily be measured.

The damping of the rod and the resulting shift in resonance frequency depends on the size of the area of contact between the diamond and the specimen and therewith on the hardness of the material if the test load is constant. Beneath the hardness, the elastic modulus of the material also affects the frequency shift.

The hardness of the material can be calculated from the known test load, the measured frequency shift and the material calibration factor (for taking the elastic modulus into account).



The advantages of the UCI method are the ease of automation and the very good reproducibility of the hardness readings. The reproducibility of the measurements is better than with optical methods of hardness testing because the total area of contact (proportional to  $d^2$ ) enters into the measurement and not only the diagonal  $d$  or a diameter. Moreover the measurement results are

independent from the subjective view of a single examiner and the test is very fast executable.

For carbon steel and low alloyed steel, hardness reference samples are used for purpose of calibration. The low variation of the elastic modulus of this group of materials can be neglected.

### 13 Proper disposal



Consumers are legally required to dispose of batteries at suitable collection points, vending points or dispatch bays. The crossed-out wheeled bin means that batteries must not be disposed of in the household waste. Pb, Cd and Hg designate substances that exceed the legal limits.

#### 13.1 Deutsch

Verbraucher sind gesetzlich verpflichtet Altbatterien zu einer geeigneten Sammelstelle/Verkaufsstelle/Versandlager zu bringen. Die durchgestrichene Mülltonne bedeutet: Batterien und Akkus dürfen nicht in den Hausmüll. Pb, Cd und Hg bezeichnet Inhaltsstoffe die oberhalb der gesetzlichen Werte liegen.

#### 13.2 Français

La législation exige des consommateurs le dépôt des piles usagées dans un lieu de collecte approprié, un point de vente ou un entrepôt d'expédition. La poubelle barrée signifie qu'il est interdit de jeter les piles et les batteries avec les ordures ménagères. Pb, Cd et Hg désignent les substances dont les valeurs dépassent les limites légales.

#### 13.3 Italiano

Per legge, i consumatori sono obbligati a depositare le batterie esaurite presso i punti di raccolta, i punti di vendita o i magazzini di spedizioni. Il simbolo del contenitore dei rifiuti sbarrato indica che è vietato smaltire le batterie con i rifiuti domestici. Pb, Cd e Hg indicano le sostanze presenti con valori superiori alla norma.

### 13.4 Español

Los usuarios están obligados por ley a depositar las pilas viejas en un punto de recogida adecuado /punto de venta/centro de envío. El contenedor de basura tachado significa: la pilas no deben desecharse en la basura doméstica. Pb, Cd y Hg designan sustancias que se encuentran por encima de los valores establecidos por ley.

## 14 Technical Data

Test method	Modified Vickers hardness according to the UCI-method (DIN 30159 and VDI/VDE Guideline 2616, Part 1). Measurement is done with test load applied.		
Indenter	Diamond, Vickers pyramid angle 136°.		
Test materials	Preferably metals, to which the alphaDUR mini can be calibrated with standard hardness test blocks. Tests on ceramics, glass and plastics are also possible using comparison measurements for calibration purposes.		
Test load	10, 20, 30, 49 or 98 N, depending on the UCI probe		
Measurement range	Vickers	HV	10 - approx. 3000
	Rockwell*C	HRC	20,3 - 68,0
	Rockwell*B	HRB	41,0 - 99,5
	Brinell*	HB	10 - approx. 2850
	Tensile strength*	N/mm <sup>2</sup>	255 - 2180
	* Conversion according to DIN 50 150		
Reproducibility	Vickers	HV	± 1% of Scale value
	Rockwell	HRC	± 0.5 Points
	Rockwell	HRB	± 1.2 Points
	Brinell	HB	± 1% of Scale value
Memory	100 000 readings including date, time and Pass/Fail evaluation.		
Statistics	Mean value, minimum, maximum and standard deviation (absolute and relative). Single readings can be deleted.		
Interfaces	USB		
Power supply	Mains adaptor/battery charger	5 V DC 1000mA	
	Li-ion battery	3,7 V / 2300 mAh	
Operating time	Battery operation:	approx. 9 hours	
	Charging time:	approx. 8 hours	
Temperatures	Operating range:	0°C to 50°C	
	Storage:	-20°C to 70°C	
Dimensions	Device	Height	135 mm
		Width	80 mm
		Depth	23 mm
	Probe	Diameter	19,5 mm
		Length	175 mm

Weights	Device	320 g
	Probe	190 g

## **Appendix 1: License information**

This product contains Free Software which is licensed under the GNU General Public License (GPL) or under the GNU Lesser General Public License (LGPL). The free software source code can at least for a period of 3 years be requested from BAQ GmbH. However, please be noted that we cannot provide guarantee with the source code, and there is also no technical support for the source code from us.

BAQ GmbH  
Bienroder Weg 53  
38108 Braunschweig  
Germany  
Tel: +49 531 21547 - 0  
Fax: +49 531 21547 - 20