

# alphaDUR II

**Manual**  
**Version 2.4**





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### 1 Introduction

The alphaDUR II is a portable hardness tester. UCI-probes and impact probes can be connected.

UCI-probes measure Vickers hardness 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.

The measurement of the impact probes is implemented according to the Leeb hardness testing method. Using this method, most metallic materials can be measured within a large measuring range.

For different applications, six impact device types are available. The type of the connected impact device is identified automatically.

Measurements can be made at any angle, even overhead.

The hardness is displayed directly in the hardness scales HRB, HRC, HV, HB, HS or tensile strength (MPa; measurable only with the impact device types D, DC and G). A limit-value acoustic alarm facilitates the evaluation.

Up to 500 000 readings including hardness, date, time and measuring parameter can be stored to the internal memory of the alphaDUR II. Saved series of measurements, including statistics, can be readily displayed or printed.

In addition to the permanent storage, the readings can be temporarily saved and accompanying statistics can be computed.

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

## 2 The test probes

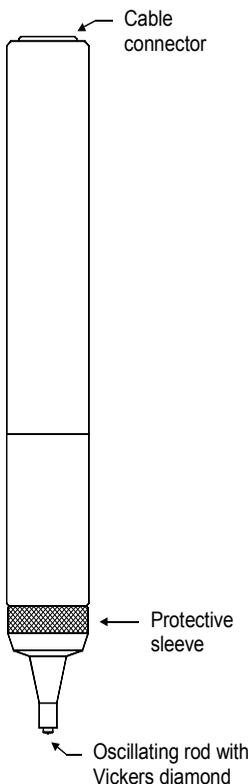
### 2.1 UCI probes

#### 2.1.1 Probe selection

alphaDUR II 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 probe: surface of the specimen and handling. For rough surfaces, high test loads are recommended,

which leads to greater indentations. But it ought to 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.



#### 2.1.2 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.

Fig. 1

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

## 2.2 Impact probes

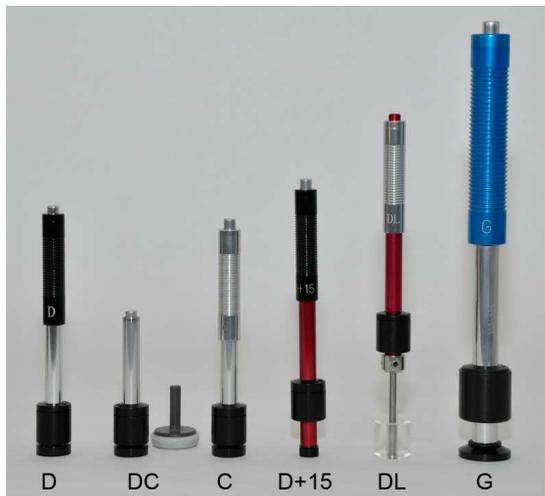
### 2.2.1 Impact device type D



- 1 - Release button
- 2 - Bolt-arming sleeve
- 3 - Guide pipe
- 4 - Reactance coil part
- 5 - Placement ring
- 6 - Impact body
- 7 - Connection cable

### 2.2.2 Special impact device types

The technical specifications of the individual impact devices are indicated in 4, the requirements on the sample surface in 5 and the diameters and depths of the arising impressions in 6.



- Type D : Standard impact device for most hardness testing tasks
- Type DC : Extremely short impact device for measurements at inaccessible locations or in pipes
- Type C : Impact device with lower impact energy e.g. for measurements on surface-hardened parts. The impressions are approximately only half as deep as in case of impact device D, however, the requirements on the surface quality are higher.
- Type D+15: The impact device has a recessed reactance coil and a smaller placement surface (11 mm x 14 mm instead of  $\varnothing$  20 mm) for hardness measuring in slots and deepened areas.
- Type DL : Impact device with longer impact body. The diameter of the front pipe is 4.2 mm.
- Type G : The impact energy increased with type G for measurements on heavy casting and forged parts. Measurement only in the Brinell range up to 650 HB. The requirements on the surface are not as extensive as with type D.

The precision and reproducibility of the measured values is represented in 3

## 3 General working instructions

### 3.1 Key functions



Switching on/off the device.

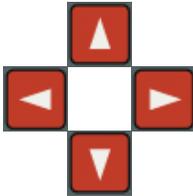


Press this key to cancel the current action or to return to the superior menu item . Changes are not assumed.



Press this key to select a menu item. This key is also used to select the characters in the text input.

Cursor keys



Use these keys to navigate through the menus or select the value in an input field.

Under certain circumstances, the function keys F1 – F4 will be used to ease the operation. E.g. in the measurement dialogue, the hardness scale can be switched by the F1 key, so you don't have to click through the menu to change it.

### 3.2 Status bar

On the status bar the battery charge condition and the current time are displayed.

### 3.3 The menus

A menu consists of a list of available menu items. The active menu item is marked by a red bar. The active menu item can be selected by means of the cursor keys. Press the ENTER key to choose a menu item. A dialog or a sub-menu will be opened, depending on the chosen menu item.

The ESC key closes the active menu and shows the superior menu.



Fig. 2: Main menu

Particular attention has been paid not to complicate the handling by deeply nested menus. Sometimes, the operation can be greatly facilitated by means of the function keys.

### 3.4 Text input

Whenever a set of measuring parameters is to be stored, a new series of measurement should be created or a new material should be calibrated, a name must be given in plain text. In all these cases, the text input dialog is opened.



Fig. 3 : Text input

In the upper field (hereinafter referred to as text field) the so far entered text is displayed. In the rows below, the available characters are shown. The blank is marked by [].

Select a character by means of the cursor keys and press ENTER to append it to the text in the text field.

F1 switches the available characters between upper- and lower-case.

Press F2 to delete the last character in the text field.

Press F4 to accept the input and close the dialog.

F3 or ESC discards the input and closes the dialog.

### **3.5 Numeric field**

Numerical data are entered in a numeric field. A numeric field consists of mostly multiple digits, which can be individually altered. The active digit is marked by a red background and can be selected with the cursor keys LEFT/RIGHT. To change the active digit, press the cursor keys UP/DOWN.

To add new digits to the left of the number, press the cursor key LEFT until the desired number of digits is reached.

Press F4 to accept the input and close the dialog.

F3 or ESC discards the input and closes the dialog.

## 4 UCI measurement

### 4.1 Specimen requirements for UCI measurements

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 require-

ments, 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.

## 4.2 Measuring parameter settings

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 8.1. Select the menu item **Measuring parameter/Edit** to set 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 8.2.3) to reload them.

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

### 4.3 Measuring procedure

Select **Measurement** from the main menu to start a measurement.

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

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.



Fig. 4: Measuring window

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.

In the lower part of the measuring window the selected material and, beneath it, the last measured values are displayed.

The hardness scale can be switched by the F1 key if the data storage is not in progress. When the scale is switched, the tolerance limits will be converted accordingly. The conversion may cause small rounding errors. If the limits can not be converted, they will be set to 0. But the original limit values will be saved and restored, when the scale is switched again.

## 5 Impact measurement

### 5.1 Preparation of the sample for impact measurements

The preparation of the sample surface should correspond to the relevant specifications from 5 (on Page 44 in the appendix).

- In case of sample preparation, procedures which can influence the surface hardness of the sample, such as e.g. overheating, cooling etc., should be avoided as far as possible.
- If the surface of the sample is too uneven, measuring errors can occur. The sample surface should shine metallic, be smooth, level and free of dirt and oil.
- Underlay for test specimens:
  - In case of heavy test specimens, no underlay is necessary (see 5 (Page 44 in the appendix): *Minimum weight of the sample*)
  - Test specimens of medium weight require a flat, solid underlay (see 5 (Page 44 in the appendix): *Minimum weight of the sample*)
  - The sample must be placed onto the underlay so that it is stable and flush
- In case of measurements on large plates, long rods or curved work pieces, the impact effect of the impact device can cause small deformations or vibrations which lead to measuring errors, also when the weight of the sample corresponds to the specifications in 5 (on

Page 44 in the appendix). In such cases, the sample should be reinforced or supported on the opposite side of the measuring point.

- In the ideal case, the sample surface should be level. In case of surfaces with a radius of curvature  $R < 30$  mm (with impact devices of the type D, DC, D+15, and C) and  $R < 50$  mm (with impact devices of the type G), a correspondingly shaped placement ring, which is adapted to the radius of curvature, must be screwed onto the impact device for the secure mounting of the impact device.

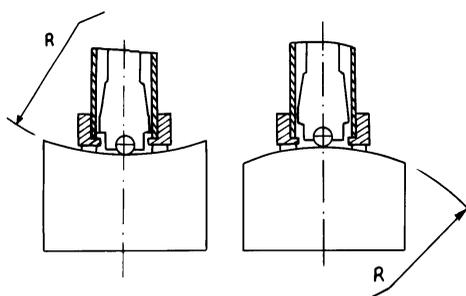


Fig. 5:

- In case of samples with hardened surface, the case hardening depth should correspond to the specifications in 5 (on Page 44 in the appendix).
- The sample should not indicate any internal magnetism, since this can influence the measurement of the speeds of the impact body.

### 5.2 Measuring parameter settings

The required measuring parameters must be set-adjusted according to requirements. It involves the following :

Material

Hardness scale

- Impact direction
- Tolerance limits
- Number for statistics
- Test report printout

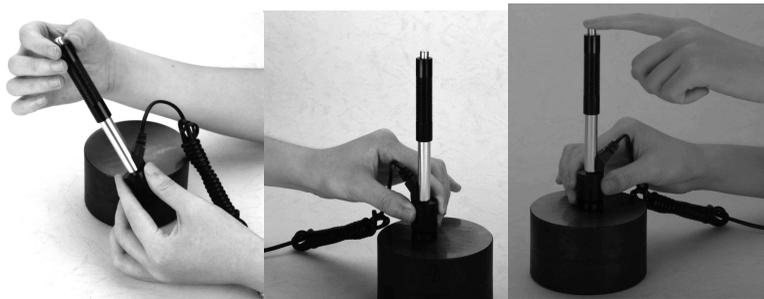
The measuring parameters are described in Chapter 8.1 .

### 5.3 Measurement

Before the measurements, the test device should be checked by means of a hardness comparison block. The precision and repeatability of the measurements should lie within the limits from 2 (on Page 42 in the appendix).

#### 5.3.1 Preparation of the impact device

Slide the bolt-arming sleeve down slowly and uniformly to the stop. Then slowly bring the bolt-arming sleeve into the starting position again.



#### 5.3.2 Mounting the impact device

Press the placement ring of the impact device firmly and without wobbling onto the test specimen. The impact direction must correspond to the set-adjusted direction.

#### 5.3.3 Measuring

Press release button above on the impact device. Sample and impact device must be held steady and stable in this case.

For every measuring point, 5 measurements should be carried out whose deviation should not exceed  $\pm 15$  HL .

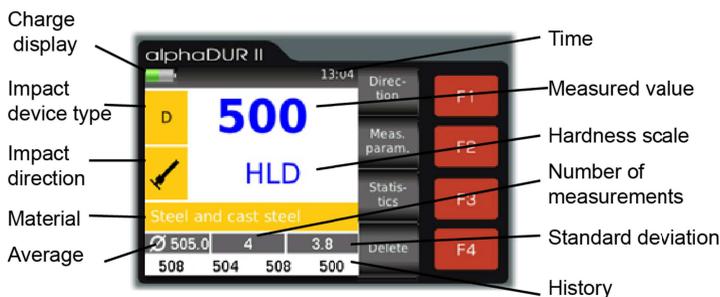
The minimum distance between two measuring points, and the minimum distance between a measuring point and the edge of the sample, should correspond to the specifications in 1.

Impact device type	Separation distance between the center points of two impressions	Separation distance between the center point of an impression and the edge of the sample
	Not less than /mm	Not less than /mm
D / DC	3	5
DL	3	5
D+15	3	5
G	4	8
C	2	4

**Table 1**

The measurement is completed with the acoustic signal.

The result of measurement is displayed immediately according to measurement implemented. The number of decimal places indicated is dependent on the hardness scale. The Rockwell scales are usually indicated with 1 decimal place, Vickers, Brinell, Shore and tensile strength without any decimal place. If the measured value lies within the tolerance limits, a short beep is emitted, otherwise a longer beep.



*Fig. 6*

## 6 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 any measurement parameter is changed by key press from the measurement window, the statistics are reset.

### 6.1 Display of statistics

The statistics will be displayed when the predetermined number of data has been measured or when the F3 key (Statistics) is pressed. First, mean value, standard deviation, standard deviation as percentage of mean value, minimum, maximum and the number of data will be shown. Standard deviation and mean value are indicated with one more fractional digits 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 as percentage of mean value is displayed with 2 fractional digits.



Fig. 7: Statistics

The measuring parameters can be displayed with F2 (Meas. param.).

Press F1 (Values) to show the statistical data. Clearly wrong values can be deleted.

To delete a value, move the red mark to the value you want to delete and press F2 (Delete).



Fig. 8: Values

F3 (Cancel) or ESC closes the statistical data windows and discards all changes. Press F4 (Save) to close the window and save all changes. The statistics will be refreshed.

Press ESC to close the display of statistics. If the predetermined number of statistical data not yet reached (because the display of statistics was started with F3 or because a value has been deleted) the measurements will be continued. If the predetermined number of data is reached, the data can be saved as a new series. Also, the data can be printed, even if they have not been saved as a new series.

## 7 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 8.2.1).

alphaDUR		BAQ
Group: BAQ1		
Date	:	1.1.1970
Material	:	Standard/Stahl
Load	:	30 N
Statistics		
Mean value	:	735.8 HV
Number of Data	:	13
Standard deviation	:	11.8 HV
rel. Standard dev.	:	1.61 %
Minimum	:	719 HV
Maximum	:	752 HV
Data		
Tolerance limits		
Lower limit:	:	0 HV
Upper limit:	:	0 HV
Value	Rating	Date
746 HV		03.04.70
740 HV		03.04.70
743 HV		03.04.70
727 HV		03.04.70
752 HV		03.04.70
735 HV		03.04.70
728 HV		03.04.70
748 HV		03.04.70
734 HV		03.04.70
719 HV		03.04.70
721 HV		03.04.70
720 HV		03.04.70
749 HV		03.04.70

Fig. 9

## 8 Measuring parameter

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

### 8.1 Description

#### UCI Measurement parameter:

- Material:** This is the active material calibration. For details about material calibration see chapter 10.
- Hardness scale:** This is the 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. To change the hardness scale, select the menu item **Measuring parameter / Edit / Hardness scale** or press the F1 key in the measuring window. If the instant printout mode or the datalogger is activated, the hardness scale can no longer be switched by the F1 key of the measuring window.
- Rating:** These are the upper and lower limits for rating. A long beep sounds if a measured value lies outside these limits. A short beep indicates that 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.
- Statistics:** The number of measured values which should be statistically evaluated without the use of the measured value memory is defined here. If this

number of measured values is reached, the statistics window is opened automatically (see 6.1).

**Instant printout:** If a mobile printer is connected, a consecutive printout can be made (see 7). This parameter can be set On or Off.

### **Impact measurement parameter:**

**Impact direction:** The impact direction is set-adjusted with the aid of the key F1 in the measurement window.

**Material:** The currently selected material.

**Hardness scale:** The current hardness scale into which the measured values are converted as appropriate.

**Rating:** Upper and lower limit for the rating GOOD are stored here. If a measured value lies outside of these limits, an acoustic signal is triggered with the measurement (2 short tones). If the measured value lies within the limits, an individual tone indicates the successful measurement.  
If the value 0 is entered for upper and lower limit, no verification of the measured value is implemented.

The value for the lower limit must of course be smaller than that of the upper limit.

**Statistics:** The number of measured values which should be statistically evaluated without the use of the measured value memory is defined here. If this number of measured values is reached, the statistics window is opened automatically (see 6.1).

**Test report printout:** If a mobile printer is connected, a consecutive printout can be made (see 7). This parameter can be set On or Off.

## 8.2 Managing sets of measuring parameter

Sets of measuring parameter can be stored to the alphaDUR II. So parameter combinations required for a particular application can conveniently be read back.

### For UCI measurements the following parameter will be saved:

- Name
- Test load
- Material
- Hardness scale ( HV, HB, HRC, HRB or tensile strength [N/mm<sup>2</sup>])
- Upper and lower limit for rating
- Instant printout state (on or off)
- Number of readings that should be used for the statistical evaluation

### For Impact measurements the following parameter will be saved:

- The assigned name
- The material
- The hardness scale
- The upper and lower limit for the rating 'GOOD'
- The test report printout (on or off)
- The number of readings that should be used for the statistical evaluation

### 8.2.1 Editing measuring parameter

Select menu item **Measuring parameter / Edit** to set the measuring parameter.

Only the active parameter can be changed. To alter a stored set of parameter, this set must first be loaded and stored again, when the changes are done.

### 8.2.2 Saving sets of measuring parameter

Select menu item **Measuring parameter / Save** to save the active measuring parameter. A name must be entered by means of the text input dialog (see 3.4). If you close the text input with the F4 key (Ok), the parameter set will be saved, otherwise the saving will be cancelled.

### 8.2.3 Loading a set of 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 F4 (Ok) to load the parameter or F3 (Cancel) to cancel the action.

### 8.2.4 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 F4 (Ok) to delete the set or F3 (Cancel) to cancel the action.

## 9 Hardness conversion

### 9.1 Conversion of UCI measurements

The alphaDUR II 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 II determines Vickers hardness according to the UCI (Ultrasonic Contact Impedance) method (see chapter 14.1). 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 N/mm <sup>2</sup>	to	650 HV / 2180 N/mm <sup>2</sup>

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 8.2.1) or press the F1 key in the measuring window. The F1 key will be deactivated if the instant printout mode (see 7) or the measured value memory (see 11) is activated.

### 9.2 Conversion of Impact measurements

From the HL values, hardness numbers in the usual hardness scales are obtained using empirically-determined revaluation tables. These revaluations are dependent on material.

If the Leeb hardness is to be converted into another hardness scale, a benchmark comparison test must be carried out in order to obtain a suitable conversion factor for the corresponding material. Test measurements are carried out on the same sample with a well calibrated Leeb hardness testing device, and with another hardness tester, according to the required hardness scale. For every hardness number, 5 measurements with the Leeb hardness testing equipment must be carried out, uniformly distributed around a hardness impression of the other hardness testing device. At least three hardness impressions should be measured. The average value of the Leeb hardness and the average value of the measured values in the other hardness scale are used for the generation of a comparison hardness curve. The comparison hardness curve should be calculated from at least three series of corresponding values.

## 10 Material calibration for UCI measurements

For UCI measurements, the alphaDUR II 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 pre-set in the alphaDUR II 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 alphaDUR II 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.

Now, take the measurements for calibration. The alphaDUR II sounds a beep at the end of each measurement. Hold the probe perpendicular to the sample surface and lower it 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 the appropriate function key 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 digits 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. In the simplest case, the section 'Standard' can be selected.
2. If a new section should be created, you are first asked to enter the name of the section, then you are asked to enter the name of the calibrated material.
3. If the material calibration shall not be assigned to any section, just enter the name of the calibrated material.

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

## 11 Memory functions

The alphaDUR II can store up to about 500.000 readings. These readings are organized in measurement series (groups).

When you create a new series, you must enter a name for it. 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:

**For UCI measurements the following parameter will be saved:**

- 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

**For Impact measurements the following parameter will be saved:**

- The impact device type
- The material
- The hardness scale
- The upper and lower limit for the rating 'GOOD'

While values are saved to a series, the F1 and F2 keys (measuring parameter and hardness scale) are disabled in the measuring window.

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

### 11.1 Creating a new series

Select the menu item **Memory functions / Create new group** to start a measurement series. After you entered a name for the series (see 3.4), 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 or F4 (Main menu) to close the series. You will be asked, if the series should be saved finally.

### 11.2 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.

### 11.3 Deleting a series

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

### 11.4 Displaying a series

Select menu item **Memory functions / Show** to display a series and the related statistics (see 6.1). The values can be altered or deleted.

### 11.5 Optional: Copying of series to an USB flash drive

If this option has been purchased, the measurement series can be copied to a USB flash drive under the menu item **Memory functions / Copy to USB flash drive**. Thus it is possible, to call up series, without connecting the alphaDUR II to the computer. (see chapter 17 Option: Copying of series to an USB flash drive).

## 12 System settings

### 12.1 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 F4 (Ok).

### 12.2 Ports

To change the serial port parameter, select the menu item **System / Ports**. Baud rate, number of data and stop bits and parity can be set.

Default is:

115200 Baud  
8 Data bits  
1 Stop bit  
No Parity

### 12.3 Time

Select the menu item **System / Time** to set the current time. The format is HH:MM (hour:minute). Press F4 (Ok) to save the time. To cancel the input, press F3 or ESC.

### 12.4 Date

Choose the menu item **System / Date** to set the current date. Select the month from the list in the upper left corner of the window. The year is displayed in the upper right corner. In the central part of the window, the day can be selected. Press F1 to switch between these 3 fields. The value can be selected by means of the cursor keys.

Press F4 (Ok) to save the current time. To cancel the input, press F3 or ESC.

### 12.5 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.

### 12.6 Unlock options

Under the menu item **System / Unlock options** the additional purchased options can be unlocked. The license is delivered on an USB flash drive. After connecting the flash drive to the alphaDUR II, the option can be selected and unlocked.

## 13 Maintenance and inspection

### 13.1 UCI probes

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

### 13.2 Impact probes

The impact device should be cleaned with the delivered cleaning brush after 1000 to 2000 measurements. For this purpose, the placement ring is screwed off, the impact body removed and the brush inserted into the guide tube rotating anti-clockwise approx. five times to the end stop, and pulled out again. After that, the impact body is again installed and the placement ring screwed on.

After use of the impact device, the spring should be decompressed.

No lubricants may be employed when cleaning the impact device!

If the measuring error of the device is greater than 2 HRC in case of measurements on the hardness comparison block supplied, the impact body or the test tip may possibly have to be replaced.

In case of all other functional disturbances, the device must be sent to the technical service. Replacement services cannot be made in case of repairs carried out by yourself.

## 14 Measurement methods

### 14.1 The UCI method

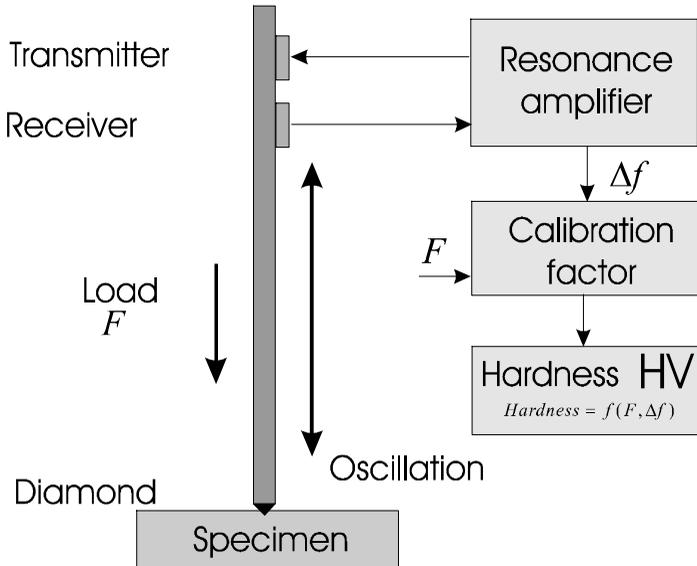
The UCI method (Ultrasonic Contact Impedance) is successfully used in hardness testing since many years.

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.

#### 14.2 The Impact (Leeb hardness) measurement method

The measurement process employed here exploits the difference between the impact and rebound speed of a small impact body. This is fired in the impact device onto the sample surface with an exactly defined energy. The plastic deformation on generating the impression on the sample surface requires energy. Therefore the rebound speed of the im-

part body is lower than the speed before the impact. Both speeds are measured inductively 1 mm above the surface.

The hardness number is calculated according to the following formula:

$$HL = \frac{1000 \cdot VB}{VA}$$

Where:

HL - Leeb hardness

VB – Rebound speed

VA – Impact speed

From the HL values, hardness numbers in the usual hardness scales are obtained using empirically-determined revaluation tables. These revaluations are dependent on material.

## 15 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.

### 15.1 German

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.

### 15.2 French

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.

### **15.3 Italian**

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.

### **15.4 Spanish**

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.

## 16 Technical Data

### 16.1 UCI probe

Test method	Vickers hardness according to the UCI-method (DIN 50159 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 II 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		
Uncertainty of measurement	<2% to the value of the hardness test block		
Dimensions	Diameter	19,5	mm
	Length	175	mm
Weight	Probe	190 g	

### 16.2 Impact probe

Measurement range	170 HLD to 960 HLD
Impact direction	360°
Hardness scale	HL, HB, HRB, HRC, HV, HS and tensile strength

The precision and reproducibility of the measured values is represented in table 2.

### 16.3 Basic device

Memory	32MB Flash memory for approx. 512.000 readings divided into variable groups. Storage includes date, time and Pass/Fail evaluation.		
Statistics	Mean value, minimum, maximum and standard deviation (absolute and relative). Single readings can be deleted and redone.		
Interfaces	USB-Master, USB-Slave, RS232, 10/100 MBit Ethernet		
Power supply	Mains adaptor/battery charger Input: 100 - 240 V AC Output: 12V DC LiFePO <sub>4</sub> 6,6 V / 2500 mAh		
Operating time	Battery operation: approx. 7 hours		
Temperatures	Operating range:	10°C to 40°C	
	Storage:	-10°C to 60°C	
Dimensions	Height	78	mm
	Width	198	mm
	Depth	160	mm
Weights	Device	1400 g	

## 17 Option: Copying of series to an USB flash drive

The measurement series can be copied via this option to a USB flash drive in CSV format (character set Unicode UTF8). Thus the alphaDUR II does not need to be connected to the computer to download the data. In addition, no PC program is needed, to call the values from the device. So the readings can be fast and easy transferred.

The CSV-Format can be opened by all popular word processing and spreadsheet programs, which allows a comfortable evaluation of the measuring results.

When importing the CSV files in word processing and spreadsheet programs, the character set 'Unicode UTF8' must be selected, otherwise the special characters will not be displayed correctly.

### 17.1 Transfer Data

In the menu item **Memory functions / Copy to USB flash drive** the series of measurements, that should be copied on the USB device, can be chosen. All series can be selected and copied at the same time as well.

### 17.2 Unlock options

The license for these options is bound to the alphaDUR II and is delivered on a USB flash drive. Connect it to the USB interface of the alphaDUR II. In the menu item **System / Unlock options** the option can be unlocked then.

## 18 Appendix 1

No.	Impact device type	Hardness of the Leeb hardness comparison block	Fault of the measured value	Repeatability
1	D	760 ±30 HLD 530 ±40 HLD	±6 HLD ±10 HLD	6 HLD 10 HLD
2	DC	760 ±30 HLDC 530 ±40 HLDC	±6 HLDC ±6 HLDC	6 HLD 10HLD
3	DL	878 ±30 HLDL 736 ±40 HLDL	±12 HLDL	12 HLDL
4	D+15	766 ±30 HLD+15 544 ±40 HLD+15	±12 HLD+15	12 HLD+15
5	G	590 ±40 HLG 500 ±40 HLG	±12 HLG	12 HLG
6	C	822 ±30 HLC 590 ±40 HLC	±12 HLC	12 HLC

Table 2

Material	Hardness scale	Impact device				
		D / DC	D+15	C	G	DL
Steel and cast steel	HRC	20,0 – 68,4	20,0 – 68,4	20,0 – 68,4		20,0 – 68,4
	HRB	38,4 – 99,5	38,4 – 99,5	38,4 – 99,5	47,7 – 99,9	38,4 – 99,5
	HB	81 – 654	81 – 654	81 – 654	90 – 646	81 – 654
	HV	81 – 955	81 – 955	81 – 955		81 – 955
	HS	29,7 – 99,5	29,7 – 99,5	29,7 – 99,5		29,7 – 99,5
	MPa / N/mm <sup>2</sup>	258-2180			304-1551	
Tempering steel, heat treated	HRC	20,0 – 68,4				
	HRB	38,4 – 99,5			47,7 – 99,9	
	HB	81 – 654			90 – 646	
	HV	81 – 955				
	HS	29,7 – 99,5				
	MPa / N/mm <sup>2</sup>	654-1454			651-1436	
Tempering	HRC	20,0 – 68,4				

steel, annealed	HRB	38,4 – 99,5			47,7 – 99,9	
	HB	81 – 654			90 – 646	
	HV	81 – 955				
	HS	29,7 – 99,5				
	MPa / N/mm <sup>2</sup>	460-826			503-823	
Tempering steel, hardened	HRC	20,0 – 68,4				
	HRB	38,4 – 99,5			47,7 – 99,9	
	HB	81 – 654			90 – 646	
	HV	81 – 955				
	HS	29,7 – 99,5				
Cold work tool steel	HRC	20,4 – 67,1	20,4 – 67,1	20,4 – 67,1		
	HV	80 – 898	80 – 898	80 – 898		
Stainless steel	HRB	46,5 – 101,7				
	HB	85 – 655				
	HV	85 – 802				
Grey cast iron	HB	93 – 334			92 – 326	
Nodular cast iron	HB	131 – 387			127 – 364	
Cast aluminum alloys	HB	19 – 164		23 – 210	32 – 168	
	HRB	23,8 – 84,6		22,7 – 85,0	23,8 – 85,5	
Brass (copper- zinc alloys)	HB	40 – 173				
	HRB	13,5 – 95,3				
Bronze (copper- aluminum / copper-tin alloys)	HB	60 – 290				
Wrought copper alloys	HB	45 – 315				

Table 3

Impact device type	DC/D/DL	D+15	C	G
Impact energy	11 mJ	11 mJ	2.7 mJ	90 mJ
Weight of the impact body	5.5 g /DL: 7.2 g	7.8 g	3.0 g	20.0 g
Hardness of the test tip	1600 HV	1600 HV	1600 HV	1600 HV

APPENDIX 1

Impact device type	DC/D/DL	D+15	C	G
Diameter of the test tip	3 mm	3 mm	3 mm	5 mm
Material of the test tip	Tungsten carbide	Tungsten carbide	Tungsten carbide	Tungsten carbide
Diameter of the impact device	20 mm	20 mm	20 mm	30 mm
Length of the impact device	86(147)/75 mm	162 mm	141 mm	254 mm
Weight of the impact device	50 g	80 g	75 g	250 g
Maximum sample hardness	940 HV	940 HV	1000 HV	650 HB

**Table 4 Properties of the impact devices**

Impact device type	DC/D/DL	D+15	C	G
Surface Roughness Ra / Rt ISO Class	2 µm/10 µm N7	2 µm/10 µm N7	0.4 µm / 2.5 µm N5	7 µm / 30 µm N9
Minimum weight of the sample				
For direct measurement	> 5 kg	> 5 kg	> 1.5 kg	> 15 kg
On stable underlay	2 - 5 kg	2 - 5 kg	0.5 - 1.5 kg	5 - 15 kg
Minimum thickness of the surface hardening	≥ 0.8 mm	≥ 0.8 mm	≥ 0.2 mm	

**Table 5 Requirements on the sample**

	D / DC / DL	D+15	C	G
<b>At 300 HV, 30 HRC</b>				
<b>Diameter/Depth</b>	0.54mm/24µm	0.54mm/24µm	0.38mm/12µm	1.03mm/53µm
<b>At 600 HV, 55 HRC</b>				
<b>Diameter/Depth</b>	0.45mm/17µm	0.45mm/17µm	0.32mm/8µm	0.90mm/41µm
<b>At 800 HV, 63 HRC</b>				
<b>Diameter/Depth</b>	0.35mm/10µm	0.35mm/10µm	0.30mm/7µm	

**Table 6 Size of the impressions in case of different hardening and impact devices**

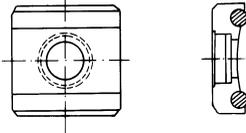
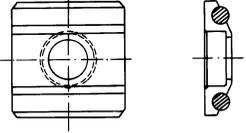
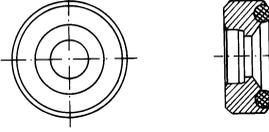
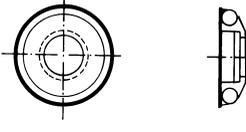
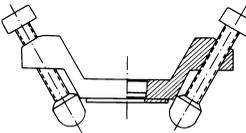
No.	Type	Sketch of the placement ring	Remarks
1	Z10-15		For convex surfaces R10 - R15
2	Z14.5-30		For convex surfaces R14.5 - R30
3	Z25-50		For convex surfaces R25 - R50
4	HZ11-13		For concave surfaces R11 - R13
5	HZ12.5-17		For concave surfaces R12.5 - R17
6	HZ16.5-30		For concave surfaces R16.5 - R30
7	K10-15		For spheres SR10 - SR 15
8	K14.5-30		For spheres SR14.5 - SR 30
9	HK11-13		For hollow bodies SR11 to SR13
10	HK12.5-17		For hollow bodies SR12.5 to SR17
11	HK16.5-30		For hollow bodies SR16.5 to SR30
12	UN		For convex surfaces, Radius adjustable R10 - $\infty$

Table 7

A complete set of placement rings is available as an option.

## Appendix 2: License information

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- 2) Crc16.c

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BAQ GmbH  
Hermann-Schlichting-Str. 14  
38110 Braunschweig  
Germany  
Tel: +49 5307 95102 - 0  
Fax: + 49 5307 95102 - 20