

# alphaDUR mini



**Manual**

**Version 1.5**





# Contents

1	Introduction.....	5
2	Manual.....	6
2.1	Lettering.....	6
2.2	Text boxes.....	6
3	Information on the probes.....	7
3.1	Probe selection.....	7
3.2	Probe handling.....	7
4	General working instructions.....	9
4.1	Key functions.....	9
4.2	Status bar.....	10
4.3	The menus.....	10
4.4	Text entry.....	10
4.5	The number field.....	12
5	Measurement.....	13
5.1	Specimen requirements.....	13
5.2	Measuring parameter.....	14
5.3	Measuring procedure.....	15
5.4	Measuring window.....	15
5.4.1	Key assignment of the measuring window.....	17
5.5	Statistics.....	17
5.5.1	Display of statistics.....	17
5.6	Instant printout.....	19
6	Measuring parameter.....	20
6.1	Description.....	20
6.2	Managing sets of measuring parameter.....	21
6.2.1	Editing measuring parameter.....	21
6.2.2	Saving measuring parameter.....	21
6.2.3	Loading measuring parameter.....	22
6.2.4	Deleting a set of measuring parameter.....	22
7	Conversion of hardness values.....	23
7.1	Selection of the conversion standard to be used.....	24
8	Material calibration.....	25
9	Memory functions.....	28

9.1 Creating a new series.....	29
9.2 Continuing a series.....	29
9.3 New serial measurements.....	30
9.4 Continuing a serial measurement.....	30
9.5 Deleting a series.....	30
9.6 Displaying a series.....	30
9.7 Copying of series to an USB flash drive.....	31
9.7.1 CSV file format.....	31
9.7.1.1 Single series and subordinated series of a serial measurement... 31	
9.7.1.2 Summary serial measurements.....	32
10 System settings.....	34
10.1 Language.....	34
10.2 Time.....	34
10.3 Date.....	34
10.4 Configuration.....	34
10.4.1 Date format.....	34
10.4.2 Key SCALE.....	34
10.4.3 Key MAT.....	35
10.4.4 Query whether the values should be saved in a series.....	35
10.4.5 Query whether the values should be printed.....	35
10.4.6 Tensile strength unit.....	35
10.5 Factory defaults.....	36
10.6 System information.....	36
11 Maintenance and inspection.....	37
12 The UCI method.....	38
13 Proper disposal.....	40
13.1 Deutsch.....	40
13.2 Français.....	40
13.3 Italiano.....	40
13.4 Español.....	41
14 Technical Data.....	42
15 Appendix 1: Hardness conversion validity ranges.....	44
15.1 DIN EN ISO 18265 - Feb.2014.....	44
15.2 ASTM E140 - 12b (2019).....	46
16 Appendix 2: License information.....	48

## 1 Introduction

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

The alphaDUR mini offers the opportunity to convert the measured Vickers hardness according to DIN EN ISO 18265 or ASTM E140 to other hardness scales.

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

The readings are arranged in series of measurements. A series of measurements is an aggregation of several readings. In addition to ordinary measurement series, serial measurement series which consists of multiple subordinate measurement series, can be recorded. Saved series of measurements, including statistics, can be displayed, printed or copied to a USB flash drive at any time.

## 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 Information on the probes

### 3.1 Probe selection

alphaDUR UCI probes are available with test loads of 10, 20, 30, 49 and 98 N. This corresponds to the Vickers test loads HV1, HV2, HV3, HV5 and HV10 (1, 2, 3, 5 and 10 kg). Like that the optimal test load for a particular test task can be chosen.

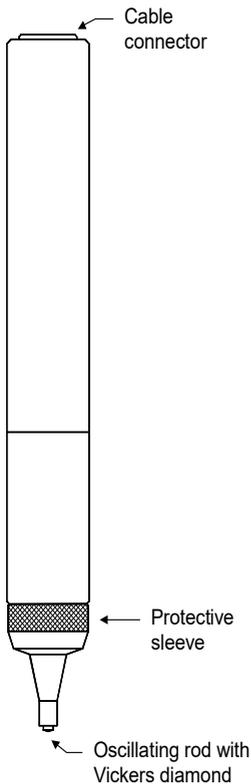


Fig. 1

For rough surfaces higher test loads are recommended to create greater indentations. If many measurements follow one another, tests could be difficult without using a bench stand to apply test loads like 10 kg steadily and vertically.

### 3.2 Probe handling

The protective sleeve serves two purposes: It protects the UCI rod against damages (as distortion). Furthermore, during the measurements, it functions as a mechanical stop for the deflection of the rod.

To carry out a measurement, the probe must be held perpendicular to the specimen surface. (The alphaDUR mini 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

## INFORMATION ON THE PROBES

---

achieve an accurate measurement, the probe must be pressed steadily and vertically onto the specimen.

To facilitate the ***pressing***, probe supports (separately available) can be screwed instead of the protective sleeve onto the probe. These probe supports are available for flat and convex surfaces.

Especially for tests with frequent measurements or larger test loads, a high precision stand is available in which the probe can be clamped.

## 4 General working instructions

### 4.1 Key functions



Switches on/off the device.



Changes the hardness scale.



Changes the material.



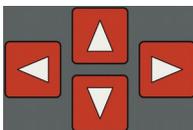
Deletes last measurement point



Displays statistics



Opens the main menu



Cursor keys

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

In drop-down lists, subordinate entries (marked with a previous '+') can be opened by pressing the right cursor key.



With this key, the current function is ended. The higher-level menu item is selected.



By pressing this key, the field's editing is completed or a subordinated menu item is selected.

### 4.2 Status bar

The rechargeable battery status, the time and the selected revaluation standard 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 moved in the menu with the aid of the cursor keys ▲ and ▼. After pressing ENTER the marked menu item is selected. Either a window or a sub-menu are now opened.

Press ESC to return to the previous menu.

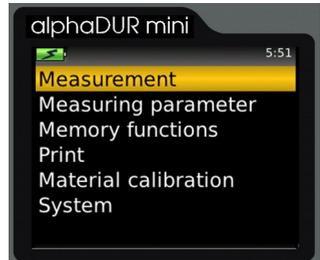


Fig. 2: Main menu

### 4.4 Text entry

When saving measurement data and measurement parameters, entries must be made 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 the characters represented, which can be selected. The blank is identified with [ ].

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

<b>A/a</b>	Switching between upper case and lower case
<b>OK</b>	Apply text and close text entry window
<b>Cancel</b>	Close text input window without applying the text

The field marked in yellow is the active field. With the keys ▲ and ▼ the line above or below the current line is selected.

The allocation of the keys differs, depending on the currently selected field.

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	◀ 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 to enter numbers. It consists of mostly several digits, which can be changed separately, and a marker (cursor) which can be moved with the cursor keys ◀ and ▶ within the number field. The figure on which the cursor is positioned, can be modified through pressing the cursor keys ▲ and ▼

A further digit for the input of larger values can be created by cursor ◀. The input is saved and completed with ENTER. With ESC, the entry field is closed without saving.

Action	Key/s
Move marker	◀ and ▶
Increase digit	▲
Decrease digit	▼
Creating a further, leading digit if the marker is placed on the first digit.	◀
Applying 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 the 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. As test loads become smaller, these requirements increase. The surface must be free from oxides, impurities and lubricants. The surface roughness should not exceed 1/5 of the penetration depth. According to DIN 50159 the surface roughness should not exceed the following values (Ra in  $\mu\text{m}$ ):

- 0.5 Ra with probes of 10 N test load
- 0.8 Ra with probes of 49 N test load
- 1.0 Ra with probes of 98 N test load

- 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. At thin blocks or round stock, the total 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 solid steel plate is recommended as support (e.g. the precision stand comes with an appropriate plate).

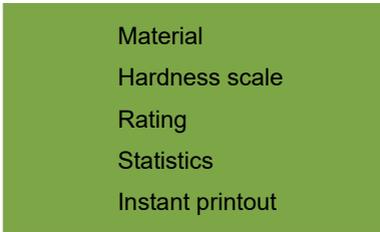
Small, irregular shaped parts can be embedded in plastic.

- Homogeneity

As in optical Vickers hardness tests, the indentations are quite 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 100 N.

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

After switching the alphaDUR mini on, the last used combination of measurement is always parameters active.

### 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. Within certain boundaries, the lowering speed has no impact on the measured values. If the test load has been applied too quickly 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 four measured values are displayed

The number of fractional digits shown depends on the hardness scale. Rockwell scales will usually be displayed with one fractional digit, Vickers, Brinell and tensile strength without any fractional digits. If the measured values have been converted from Vickers to another hardness scale, the hardness values lying outside of the definition range of the standardized hardness testing method (but may be used as approximate values) are displayed in red.

### 5.4.1 Key assignment of the measuring window

SCALE	Changes the hardness scale. If limits for the evaluation GOOD are specified, they are automatically set to 0. In the system settings it can be determined whether the scale should be changed automatically to the next valid scale or a dialogue should be opened (see 10.4.2). <b>Deactivated if the measured value memory is switched on.</b>
MAT	Changes the material. If the currently selected hardness scale is not defined for the new material, the hardness scale is automatically reset to HV. If limits for the evaluation GOOD are specified, they are automatically set to 0. In the system settings it can be determined whether the material should be automatically switched to the next valid material of the current reevaluation standard (see 7.1) or if a dialogue should be opened (see 10.4.3). <b>Deactivated if the measured value memory is switched on.</b>
DEL	Deletion of the last measured value
STAT	Display of the statistics concerning the already measured values

## 5.5 Statistics

The values of a measuring series can be evaluated statistically at all times. If the hardness scale or the material is changed in the measuring window or if a new measuring series is started, the statistics are reset.

### 5.5.1 Display of statistics

The statistical evaluation is displayed, as soon as the number of the measurements (as set in the measuring parameter) has been made, the key STAT is pressed or if a measuring series is completed. In the first view are the following information displayed: average value, standard deviation, relative standard deviation (standard deviation in % of the average value), minimum, maximum and the number of values. Standard deviation



Fig. 5: Statistics

and average value are displayed with one decimal place more than is usual for the hardness scale. Vickers, Brinell and tensile strength are displayed without any decimal place, the others with one decimal place. The relative standard deviation is displayed with two decimal places.

If the key STAT is pressed again in this view, a window is opened in which the measured values, by which the statistic was calculated, are displayed. If the measured values have been converted from Vickers to another hardness scale, the hardness values, which are outside of the definition area of the standardized hardness testing method, but may be used as approximate values, will be marked red.

In this view it is possible to delete obviously incorrect values.

To delete a value the marker is set onto the corresponding value and then DEL must be pressed.



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

Fig. 6: Values

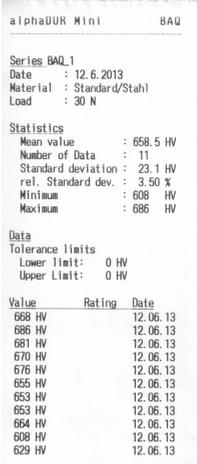
If the edit window is closed with ESC, a request is made as to whether the changes should be accepted or rejected. If the changes are accepted, the statistical values will be calculated again.

The statistic window is closed with ESC. If the predetermined number of statistical data is not yet reached (because the display of statistic 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), when the predetermined number of data is reached. Furthermore, 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 is 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 displays the following information:

alphaDUR Mini BAQ

Series: BAQ\_1  
Date : 12.6.2013  
Material : Standard/Stahl  
Load : 30 N

Statistics  
Mean value : 658,5 HV  
Number of Data : 11  
Standard deviation : 23,1 HV  
rel. Standard dev. : 3,50 %  
Minimum : 608 HV  
Maximum : 686 HV

Data  
Tolerance limits  
Lower limit: 0 HV  
Upper limit: 0 HV

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 switching the alphaDUR mini on, the last used combination of measurement parameter is always active.

#### The measuring parameter in detail:

**Material:** The currently selected material calibration. Materials that are not valid for the selected revaluation standard (see chapter 7.1) are displayed in gray. For details about material calibration see chapter 8.

**Hardness scale:** The current hardness scale to which, if necessary, the measured values are converted. Vickers hardness is always measured. If another hardness scale is selected, the measuring values are converted. (see chapter 7) In the measurement window the hardness scale can be switched with by pressing the key SCALE.

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

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

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

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

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

**Instant printout:** If a mobile printer is connected, a consecutive printout can be here be switched on or off (see 5.6).

## 6.2 Managing sets of measuring parameter

In the alphaDUR mini combinations of measuring parameter can be stored, under a user-defined name. In this way, the measuring parameter 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.

Just the current measuring parameters can be changed. In order to change a stored configuration, it must first be loaded and stored again after the changes 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.

After selecting 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.

If a measurement parameter data set is loaded in which a material is selected that is not valid in the current revaluation standard (see chapter 7 and 8), the revaluation standard is automatically switched to the value corresponding to the material.

### 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 Conversion of hardness values

The alphaDUR mini can convert hardness values to another hardness scale. The tables DIN EN ISO 18265 - Feb.2014 and ASTM E140 - 12b (2019) are used for the conversion. These tables partly contain values, which are outside of the definition area of the standardized hardness testing method, but may be used as approximate values. In the alphaDUR mini, these approximate values are considered in the conversion and shown in red on the display.

When applying revaluations, it should be noted that there is no universal conversion relation. That is why the conversions should only be used within a material group. The impact of different indenters and test loads should always be considered. The information given in the standards on the applicability, inaccuracy and the difficulties when converting hardness values should be taken into account. Before using the conversion it should be checked if all requirements for the conversion are met.

The alphaDUR mini determines the Vickers hardness. In contrast to the classical method according to DIN EN ISO 6507-1, the measurement is done while the test load is applied. Still the results of the UCI-Vickers and the Standard-Vickers 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.

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. The SCALE KEY is deactivated if the measured data storage is activated.

The ranges of validity for hardness conversion are shown in chapter 15 Appendix 1: Hardness conversion validity ranges

### **7.1 Selection of the conversion standard to be used**

In the menu item **Material calibration/ Conversion standard** can be selected if the DIN EN ISO 18265 or the ASTM E140 should be applied.

## 8 Material calibration

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

For measurements on samples made of the calibrated material, the corresponding material calibration must be selected. (Measuring parameter: Material see chapter 6.1).

In order to convert the measured hardness values to a hardness scale other than HV (see chapter 7), the material type for the conversion must be selected during the material calibration. If no material type is selected, the hardness scale cannot be switched to scales other than HV for measurements with this material calibration.

When delivered, there are already two material calibrations for steel in the alphaDUR mini stored. These cannot be overwritten or deleted. They only differ in the table that has been chosen. Steel DIN is converted according to the table A1 of DIN EN ISO 18265, Steel ASTM according to table 1 and 2 of ASTM E140.

The calibrations can be grouped to sections. Like that a two-level hierarchy is established to keep things clear if lots of calibrations shall be saved. E.g. ferrous materials and aluminum 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 fulfill 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 ground. 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 incorrect 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 four calibration parameter must be set:

1. Select the material type for the calibration. If no material type is selected, the hardness values determined with this material can later be not converted to a hardness scale other than HV.
2. Afterwards the hardness scale in which the calibration should be made, must be selected. This corresponds to the hardness scale of the reference sample.
3. Enter the hardness of the reference sample.
4. Enter the number of measurements that should be made for this calibration. Usually four to five measurements are sufficient. If great dispersion is to be expected, e.g. for rough surfaces, the number can be increased.

If necessary the calibration can now be interrupted by pressing ESC.

If the calibration should be continued, the cursor key right ► must be pressed.

Now, the measurements for calibration have to be taken. The alphaDUR mini makes 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. Same 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 one more fractional digits than usual for the hardness scale (Vickers, Brinell and tensile strength are displayed without any fractional digits, all other hardness scales with one fractional digit). The standard deviation as percentage of the mean value will be displayed with two fractional digits.

When the calibration is satisfying, 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 first case, you have to select the material that should be replaced.

In the second case, there are three 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 aluminum alloys can be assigned to different sections.
2. If a new section should be created, first the name of the section and 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 about 100,000 readings. These readings are organized in series of measurements.

A measurement series is defined as an aggregation of several readings.

In addition to single measurement series, serial measurement series which consists of multiple subordinate measurement series, can be recorded. All subordinate measurement series of a serial measurement have the same measurement parameter and the same number of readings. The subordinate series of a serial measurement will be numbered consecutively. Serial measurement series simplify the measuring process, if several series with the same parameter should be recorded, e.g. during the quality inspection of many identical parts.

As soon as the set number of values for the subordinated measurement series is recorded, the statistic is displayed. After pressing the MENU; ESC or ENTER key within the statistics window a prompt appears whether the series of measurements should be saved. Confirmed by ENTER, a new subordinated series of measurements starts. Rejected with ESC, the just completed subordinated series of measurements must be restarted. If readings have been deleted in the statistic window (see chapter 5.5.1) the corresponding number of measurements have to be redone.

Every series of measurements is named, by which it can be displayed, printed or exported later on. The hardness values will be saved including time and date of measurement. In addition, the active measuring parameter are also saved. This includes:

- Probe type
- Test load
- Material
- Hardness scale
- 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

Under the menu item **Memory functions / New series**, the name of a new single measurement series can be defined with the text input function (see 4.4). After this is completed, the measuring window will open automatically and the following readings are saved to this series.

The measurement parameter valid before the creation of the new measurement series are taken. The measuring parameter cannot be changed, while a series of measurements is taken.

The recording of the series is finished, if the measuring window is closed.

You will then be asked, if the hardness values should finally be saved to this series.

### 9.2 Continuing a series

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

The parameter are automatically put to the settings of the selected series. If applicable, the selected conversion standard (ISO or ASTM) is adapted.

### 9.3 New serial measurements

Under the menu item **Memory functions / New serial measurement**, a new serial measurement can be started. After defining the name of the new serial measurement with the text input function (see 4.4), the number of measuring points per subordinate series must be entered.

When this is completed, the measuring window will open automatically. The parameters set before starting the new series are applied. These parameters cannot be changed, while a new serial measurement is recorded. The recording of a new serial measurement is completed, if the measuring window is closed.

### 9.4 Continuing a serial measurement

Under the menu item **Memory functions / Continue serial m.**, a serial measurement can be selected, to which the now taken values should be added. The new readings are saved incl. the current date and time.

The measuring parameter are automatically set to the settings of the selected serial measurement. If applicable the selected conversion standard (ISO or ASTM) is adapted. If the last subordinated series is not completed, it is continued, otherwise a new subordinated series is created.

### 9.5 Deleting a series

If series or serial measurements are not needed anymore, they can be deleted under: **Memory functions / Delete**. The subordinated series, belonging to a serial measurement cannot be deleted separately. The complete serial measurement has to be deleted.

### 9.6 Displaying a series

Select menu item **Memory functions / Show** to display a series and the related statistics (see 5.5.1). If it is a single measurement series, single values can be deleted in the statistics view. This is not possible, if this series belongs to a serial measurement.

## 9.7 Copying of series to an USB flash drive

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 transfer the series.

The files will be stored on the USB flash drive in CSV format (character set Unicode UTF8). 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.

Only semicolons should be selected as the separator option when opening with a spreadsheet.

The USB flash drive should be formatted as MBR with FAT or FAT32. The included manual USB flash drive can be used without a problem.

When transferring serial measurements, several files are saved. This contains a huge file, in which all subordinated series are summarized as well as a sub-directory (under the name of the serial measurements) in which the subordinated series are saved separately (under the same format as the single series).

### 9.7.1 CSV file format

#### 9.7.1.1 *Single series and subordinated series of a serial measurement*

Probe type;< type description>

Name;<file name>

Test load;<e.g. 30>

Lower rating limit;<e.g. 0>

Upper rating limit;<e.g. 0>

Material section;<e.g. Standard>

Material name;<e.g. Steel DIN>

Conversion table; e.g. DIN\_ISO\_18265\_A1

Hardness scale;<e.g. HV>

Number of Data;<e.g. 5>

Mean value;<e.g. 321.6>

Minimum;<e.g. 312>

Maximum;<e.g. 334>

Standard deviation;<e.g. 10.1>

rel. Standard dev.;<e.g. 3.15>

Value /<Hardness scale>;Day;Month;Year;Hour;Minute

312;23;4;2020;10;51 <reading 1>

.... <more readings>

320;23;4;2020;10;51 <reading n>

### **9.7.1.2 Summary serial measurements**

Probe type;< type description>

Name;<file name>

Test load;<e.g. 30>

Lower rating limit;<e.g. 0>

Upper rating limit;<e.g. 0>

Material section;<e.g. Standard>

Material name;<e.g. Steel DIN>

Conversion table; e.g. DIN\_ISO\_18265\_A1

Hardness scale;<e.g. HV>

Number of subordinate single series;<e.g. 25>

Number of data per subordinate single series;<e.g. 5>

Single series;<name of subordinate single series: 1>

Number of Data;<e.g. 5>

Mean value;<e.g. 321.6>

Minimum;<e.g. 312>

Maximum;<e.g. 334>

Standard deviation;<e.g. 10.1>

rel. Standard dev.;<e.g. 3.15>

Value /<Hardness scale>;Day;Month;Year;Hour;Minute

312;23;4;2020;10;51 <reading 1>

.... <more readings>  
 320;23;4;2020;10;51 <reading n>  
 Single series;<name of subordinate single series: 2>  
 Number of Data;<e.g. 5>  
 Mean value;<e.g. 321.6>  
 Minimum;<e.g. 312>  
 Maximum;<e.g. 334>  
 Standard deviation;<e.g. 10.1>  
 rel. Standard dev.;<e.g. 3.15>  
 Value /<Hardness scale>;Day;Month;Year;Hour;Minute  
 312;23;4;2020;10;51 <reading 1>  
 .... <more readings>  
 320;23;4;2020;10;51 <reading n>  
 .... <more subordinate single series>  
 .... <more subordinate single series>  
 Single series;<name of subordinate single series: m>  
 Number of Data;<e.g. 5>  
 Mean value;<e.g. 321.6>  
 Minimum;<e.g. 312>  
 Maximum;<e.g. 334>  
 Standard deviation;<e.g. 10.1>  
 rel. Standard dev.;<e.g. 3.15>  
 Value /<Hardness scale>;Day;Month;Year;Hour;Minute  
 312;23;4;2020;10;51 <reading 1>  
 .... <more readings>  
 320;23;4;2020;10;51 <reading n>

## 10 System settings

### 10.1 Language

Select the menu item **System / Language** to set the language. Select the required language by means of the cursor keys. The chosen language will become active when you close the dialog  
47777777 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, press ESC to cancel the input.

### 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:

<b>TT:</b>	Day
<b>MM:</b>	Month
<b>JJJJ:</b>	Year

#### 10.4.2 Key SCALE

In the menu item **System / Configuration / Key SCALE**, the function of the key SCALE in the measurement window is set.

Select:

- |                    |  |
|--------------------|--|
| <b>Open dialog</b> | If the new hardness scale should be selected in a dialog.                  |
| <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**, the function of the key MAT in the measurement window is set.

Select:

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

#### 10.4.4 Query whether the values should be saved in a series

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' to turn it on.

#### 10.4.5 Query whether the 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). This happens, if the statistics configuration is switched on.

#### 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 millimeter).

### 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 the software, kernel and system will be shown. If a probe is connected, the serial number of the probe, the version of probe's 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 15 mm. Test blocks of lesser thickness (e.g. 6 mm) aren't suitable. The edge length of the hardness test block must be at least 50 mm.

These special UCI hardness test blocks, including ISO and ASTM, are available in various hardnesses from the manufacturer of the device.

A maintenance of the probes should be performed at intervals of 12 months.

## 12 The UCI method

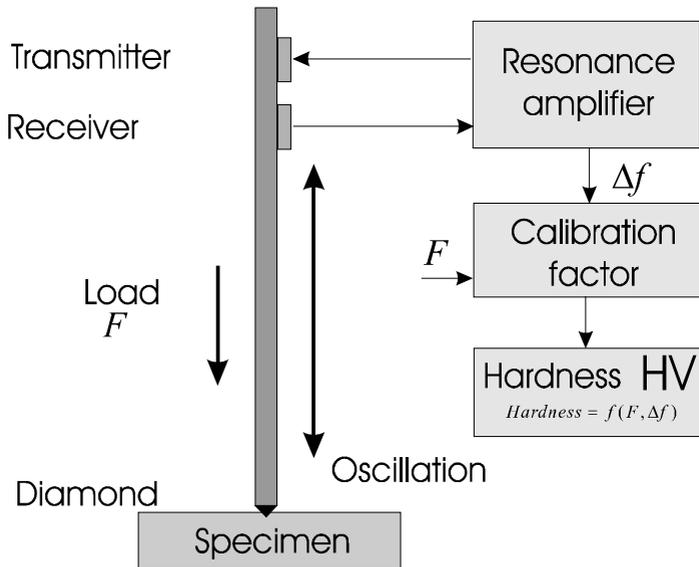
The UCI method (Ultrasonic Contact Impedance) is successfully used in hardness testing since many years.

A rod is excited into a longitudinal oscillation. The tip of the rod is equipped with Vickers diamond. This diamond is pressed to the specimen with a discrete test load. The test load  $F$  is mainly 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 repeatability of the hardness readings. The repeatability 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 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 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 Conversion range see chapter 15
Uncertainty of measurement	<2% to the value of the hardness test block
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 adapter/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

## 15 Appendix 1: Hardness conversion validity ranges

### 15.1 DIN EN ISO 18265 - Feb.2014

The tables of DIN EN ISO 18265 – Feb.2014, used for conversion in the alphaDUR mini, apply to the following materials and hardness scales:

<b>Material</b>	<b>from</b>		<b>to</b>	
Steel, cast steel (A1)	<b>80 HV</b>	<b>76 HB</b>	<b>650 HV</b>	<b>618 HB</b>
	<b>240 HV</b>	<b>20.3 HRC</b>	<b>940 HV</b>	<b>68.0 HRC</b>
	<b>85 HV</b>	<b>41.0 HRB</b>	<b>290 HV</b>	<b>105.0 HRB</b>
	<b>80 HV</b>	<b>255 MPa</b>	<b>650 HV</b>	<b>2180 MPa</b>
	<b>90 HV</b>	<b>82.6 HRF</b>	<b>250 HV</b>	<b>115.1 HRF</b>
	<b>240 HV</b>	<b>60.7 HRA</b>	<b>940 HV</b>	<b>85,. HRA</b>
	<b>240 HV</b>	<b>40.3 HRD</b>	<b>940 HV</b>	<b>76.9 HRD</b>
	<b>240 HV</b>	<b>19.9 HR45N</b>	<b>940 HV</b>	<b>75.4 HR45N</b>
Tempering steel, tempered (B2)	<b>210 HV</b>	<b>205 HB</b>	<b>650 HV</b>	<b>632 HB</b>
	<b>210 HV</b>	<b>15.3 HRC</b>	<b>650 HV</b>	<b>57.5 HRC</b>
	<b>210 HV</b>	<b>94.8 HRB</b>	<b>410 HV</b>	<b>113.6 HRB</b>
	<b>210 HV</b>	<b>651 MPa</b>	<b>470 HV</b>	<b>1460 MPa</b>
	<b>210 HV</b>	<b>110.4 HRF</b>	<b>410 HV</b>	<b>121.5 HRF</b>
	<b>210 HV</b>	<b>57.2 HRA</b>	<b>650 HV</b>	<b>79.9 HRA</b>
	<b>210 HV</b>	<b>13.4 HR45N</b>	<b>650 HV</b>	<b>60.6 HR45N</b>
Tempering steel, annealed (B3)	<b>150 HV</b>	<b>152 HB</b>	<b>320 HV</b>	<b>316 HB</b>
	<b>160 HV</b>	<b>1.0 HRC</b>	<b>320 HV</b>	<b>336 HRC</b>
	<b>150 HV</b>	<b>81.0 HRB</b>	<b>320 HV</b>	<b>108.9 HRB</b>
	<b>140 HV</b>	<b>460 MPa</b>	<b>240 HV</b>	<b>826 MPa</b>
	<b>150 HV</b>	<b>102.5 HRF</b>	<b>320 HV</b>	<b>118.4 HRF</b>
	<b>150 HV</b>	<b>48.4 HRA</b>	<b>320 HV</b>	<b>67.2 HRA</b>
	<b>170 HV</b>	<b>0.8 HR45N</b>	<b>320 HV</b>	<b>35.0 HR45N</b>
Tempering steel, hardened (B4)	<b>580 HV</b>	<b>572 HB</b>	<b>720 HV</b>	<b>677 HB</b>
	<b>580 HV</b>	<b>54.0 HRC</b>	<b>720 HV</b>	<b>60.1 HRC</b>
	<b>580 HV</b>	<b>78.1 HRA</b>	<b>720 HV</b>	<b>78.1 HRA</b>

**APPENDIX 1: HARDNESS CONVERSION VALIDITY RANGES**

<b>Material</b>	<b>from</b>		<b>to</b>	
	<b>580 HV</b>	<b>59.5 HR45N</b>	<b>720 HV</b>	<b>66.4 HR45N</b>
Cold work tool steel (C2)	<b>210 HV</b>	<b>205 HB</b>	<b>620 HV</b>	<b>600 HB</b>
	<b>220 HV</b>	<b>18.8 HRC</b>	<b>840 HV</b>	<b>65.8 HRC</b>
	<b>210 HV</b>	<b>95.6 HRB</b>	<b>340 HV</b>	<b>109.5 HRB</b>
	<b>210 HV</b>	<b>110.7 HRF</b>	<b>340 HV</b>	<b>118.6 HRF</b>
	<b>220 HV</b>	<b>59.4 HRA</b>	<b>840 HV</b>	<b>84.5 HRA</b>
	<b>220 HV</b>	<b>16.4 HR45N</b>	<b>840 HV</b>	<b>72.4 HR45N</b>
High speed steel (D2/4)	<b>589 HV</b>	<b>54.2 HRC</b>	<b>935 HV</b>	<b>67.6 HRC</b>
	<b>589 HV</b>	<b>77.9 HRA</b>	<b>935 HV</b>	<b>85.5 HRA</b>
	<b>589 HV</b>	<b>58.8 HR45N</b>	<b>935 HV</b>	<b>74.2 HR45N</b>
Hard metal (E2)	<b>780 HV</b>	<b>82.5 HRA</b>	<b>1760 HV</b>	<b>93.2 HRA</b>
Nickel and High-Nickel Alloys (F1)	<b>77 HV</b>	<b>77 HB</b>	<b>513 HV</b>	<b>479 HB</b>
	<b>164 HV</b>	<b>2.0 HRC</b>	<b>513 HV</b>	<b>50.0 HRC</b>
	<b>77 HV</b>	<b>30.0 HRB</b>	<b>309 HV</b>	<b>106 HRB</b>
	<b>119 HV</b>	<b>136 HK</b>	<b>382 HV</b>	<b>436 HK</b>
	<b>77 HV</b>	<b>73.0 HRF</b>	<b>309 HV</b>	<b>116.5 HRF</b>
	<b>112 HV</b>	<b>39.0 HRA</b>	<b>513 HV</b>	<b>75.5 HRA</b>
	<b>112 HV</b>	<b>8.0 HRD</b>	<b>513 HV</b>	<b>63.0 HRD</b>
	<b>171 HV</b>	<b>2.0 HR45N</b>	<b>513 HV</b>	<b>54.4 HR45N</b>
Cartridge Brass (F2)	<b>45 HV</b>	<b>42 HB</b>	<b>196 HV</b>	<b>169 HB</b>
	<b>60 HV</b>	<b>10.0 HRB</b>	<b>196 HV</b>	<b>93.5 HRB</b>
	<b>45 HV</b>	<b>40.0 HRF</b>	<b>196 HV</b>	<b>110.0 HRF</b>
Copper (F3) (strips excluded)	<b>40 HV</b>	<b>42.8 HK 0.5</b>	<b>130 HV</b>	<b>133.8 HK 0.5</b>
	<b>40 HV</b>	<b>40.2 HK 1</b>	<b>130 HV</b>	<b>138.7 HK 1</b>
Wrought Aluminum Products (F4)	<b>44 HV</b>	<b>40 HB</b>	<b>189 HV</b>	<b>160 HB</b>
	<b>80 HV</b>	<b>28.0 HRB</b>	<b>189 HV</b>	<b>91.0 HRB</b>
	<b>44 HV</b>	<b>46.0 HRE</b>	<b>135 HV</b>	<b>101.0 HRE</b>
Aluminum and aluminum alloys (F5)	<b>18 HV</b>	<b>17.1 HB</b>	<b>210 HV</b>	<b>199.5 HB</b>
	<b>80 HV</b>	<b>31.9 HRB</b>	<b>210 HV</b>	<b>95.7 HRB</b>
Tool steel 1.1243 (G1)	<b>305 HV</b>	<b>297 HB</b>	<b>474 HV</b>	<b>474 HB</b>
	<b>305 HV</b>	<b>31.2 HRC</b>	<b>474 HV</b>	<b>48.0 HRC</b>

**APPENDIX 1: HARDNESS CONVERSION VALIDITY RANGES**

<b>Material</b>	<b>from</b>		<b>to</b>	
	<b>305 HV</b>	<b>950 MPa</b>	<b>474 HV</b>	<b>1550 MPa</b>
	<b>305 HV</b>	<b>65.9 HRA</b>	<b>474 HV</b>	<b>74.9 HRA</b>
Tool steel 1.2741 (G1)	<b>280 HV</b>	<b>279 HB</b>	<b>424 HV</b>	<b>419 HB</b>
	<b>280 HV</b>	<b>27.7 HRC</b>	<b>424 HV</b>	<b>43.1 HRC</b>
	<b>280 HV</b>	<b>880 MPa</b>	<b>424 HV</b>	<b>1370 MPa</b>
	<b>280 HV</b>	<b>62.9 HRA</b>	<b>424 HV</b>	<b>72.3 HRA</b>

**15.2 ASTM E140 - 12b (2019)**

The tables of ASTM E140 - 12b (2019), used for conversion in the alphaDUR mini, apply to the following materials and hardness scales:

<b>Material</b>	<b>from</b>		<b>to</b>	
Non-Austenitic Steels (1/2)	<b>100 HV</b>	<b>100 HB</b>	<b>832 HV</b>	<b>739 HB</b>
	<b>238 HV</b>	<b>20.0 HRC</b>	<b>940 HV</b>	<b>68.0 HRC</b>
	<b>100 HV</b>	<b>55.0 HRB</b>	<b>234 HV</b>	<b>99.0 HRB</b>
	<b>100 HV</b>	<b>112 HK</b>	<b>940 HV</b>	<b>920 HK</b>
	<b>100 HV</b>	<b>88.2 HRF</b>	<b>137 HV</b>	<b>99.6 HRF</b>
	<b>100 HV</b>	<b>37.2 HRA</b>	<b>940 HV</b>	<b>85.6 HRA</b>
	<b>238 HV</b>	<b>40.1 HRD</b>	<b>940 HV</b>	<b>76.9 HRD</b>
	<b>238 HV</b>	<b>19.6 HR45N</b>	<b>940 HV</b>	<b>75.4 HR45N</b>
Nickel and High-Nickel Alloys (3)	<b>77 HV</b>	<b>77 HB</b>	<b>513 HV</b>	<b>479 HB</b>
	<b>164 HV</b>	<b>2.0 HRC</b>	<b>513 HV</b>	<b>50.0 HRC</b>
	<b>77 HV</b>	<b>30.0 HRB</b>	<b>309 HV</b>	<b>106 HRB</b>
	<b>119 HV</b>	<b>136 HK</b>	<b>382 HV</b>	<b>436 HK</b>
	<b>77 HV</b>	<b>73.0 HRF</b>	<b>309 HV</b>	<b>116.5 HRF</b>
	<b>112 HV</b>	<b>39.0 HRA</b>	<b>513 HV</b>	<b>75.5 HRA</b>
	<b>112 HV</b>	<b>8.0 HRD</b>	<b>513 HV</b>	<b>63.0 HRD</b>
	<b>171 HV</b>	<b>2.0 HR45N</b>	<b>513 HV</b>	<b>54.4 HR45N</b>
Cartridge Brass(4)	<b>77 HV</b>	<b>70.0 HRE</b>	<b>188 HV</b>	<b>108.5 HRE</b>
	<b>45 HV</b>	<b>42 HB</b>	<b>196 HV</b>	<b>169 HB</b>
	<b>60 HV</b>	<b>10.0 HRB</b>	<b>196 HV</b>	<b>93.5 HRB</b>
	<b>45 HV</b>	<b>40.0 HRF</b>	<b>196 HV</b>	<b>110.0 HRF</b>

**APPENDIX 1: HARDNESS CONVERSION VALIDITY RANGES**

<b>Material</b>	<b>from</b>		<b>to</b>	
Copper (7) (strips excluded)	<b>40 HV</b>	<b>42.8 HK 0.5</b>	<b>130 HV</b>	<b>133.8 HK 0.5</b>
	<b>40 HV</b>	<b>40.2 HK 1</b>	<b>130 HV</b>	<b>138.7 HK 1</b>
Alloyed White Irons (8)	<b>380 HV</b>	<b>357 HB</b>	<b>1000 HV</b>	<b>903 HB</b>
	<b>380 HV</b>	<b>35.0 HRC</b>	<b>1000 HV</b>	<b>70.0 HRC</b>
Wrought Aluminum Products (9)	<b>44 HV</b>	<b>40 HB</b>	<b>189 HV</b>	<b>160 HB</b>
	<b>80 HV</b>	<b>28.0 HRB</b>	<b>189 HV</b>	<b>91.0 HRB</b>
	<b>44 HV</b>	<b>46.0 HRE</b>	<b>135 HV</b>	<b>101.0 HRE</b>

## 16 Appendix 2: License information

This product contains third party software. The disclaimers and copyright notices provided are based on information made available by the third party licensors.

- 1) 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.

- 2) Crc16.c

Copyright 2001-2010 Georges Menie ([www.menie.org](http://www.menie.org))

All rights reserved.

Redistribution and use in source and binary forms, with or without modification, are permitted provided that the following conditions are met:

- \* Redistributions of source code must retain the above copyright notice, this list of conditions and the following disclaimer.
- \* Redistributions in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.
- \* Neither the name of the University of California, Berkeley nor the names of its contributors may be used to endorse or promote products derived from this software without specific prior written permission.

THIS SOFTWARE IS PROVIDED BY THE REGENTS AND CONTRIBUTORS ``AS IS'' AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL THE REGENTS AND CONTRIBUTORS BE LIABLE FOR ANY

DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

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