SonoDur-R Instruction Manual

Automated UCI-Hardness Testing System
with
Motorized and Hand-Held Probes

This edition 105, 04/2020 applies to software version V1.00 and higher using Android Operating System, SonoDur-R.
Original operating instructions EN_SonoDur-R_Android_V105

This document is subject to technical changes without prior notice.

Note concerning this manual

Please read this operating manual carefully before starting any work! Lack of understanding or lack of knowledge can lead to false test results and have unforeseeable consequences! In particular, observe all safety instructions in this manual and the applicable regulations at your site of operation. Illustrations and photos in this manual are intended to facilitate basic understanding, and may differ from the actual design.

Initial commissioning

Upon initial commissioning, take note of **chapter 4, page 10 et seq**. as well as the **safety instructions in Chapter 2.2, page 7**.

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1 Table of Contents

⚠	**WARNING**
Carefully read the safety instructions in Chapter 2.2 in this manual, before using this device.	

2 Introduction

The operating manual at hand describes the SonoDur-R test device with motor measuring probes and hand-held measuring probes for performing UCI hardness testing (Ultrasonic Contact Impedance).

2.1 Measuring methods and suitable test materials

A hardness test using the UCI method indirectly evaluates the test impression of the Vickers Diamond and immediately displays the result digitally. The application of force can be performed by means of a motor or by hand against a spring. A hardness value for a defined force (penetration force) is calculated that corresponds to the indentation surface after relief, although the measurement was performed under load. Basically, this testing method is suitable for most metallic materials, but has only limited suitability for ceramics and glass.

The UCI hardness testing is standardized according to ASTM A 1038, DIN 50159-1 and -2 and described in the VDI/VDE guideline 2616 sheet 1.

It should be noted in this context, that the measurement result inter alia depends on the elastic properties of the test material and therefore, the measuring device must be adjusted to the test material, if required. Our test probes are factory calibrated for materials with an elasticity modulus of 210 GPa and can therefore usually be used for such metallic materials without further adjustment.

The UCI hardness testing represents a comparative procedure that is traced back to a reference standard (calibrated or adjusted by the operator). The Vickers Unit (HV) is used as reference scale for the hardness Testing. The adjustment can be performed indirectly on the Hardness Reference Plates or via a comparative measurement, for example, by using a Vickers machine (same test force) directly on a sample of the to be tested material.

If another test method is used (Rockwell, Brinell, etc.), the shape and the material of the indenter, the indentation size and thus the measured area will be different. Therefore, and depending on the material, the condition of the treatment and the nature of the surface, the adjustment or the conversion of hardness values both with each other and as tensile strength values, may be inaccurate or inadmissible.

Conversion from the calculated Vickers Hardness Values are therefore only permitted with restrictions and only in accordance with the relevant standards. All conversion tables according to EN ISO 18265 and ASTM E 140, are stored in the SonoDur-R test device. However, the responsible person must make the decision on the permissibility of a conversion from the calculated Vickers Hardness into another hardness unit based on such persons, instructions and experiences.

2.2 Safety Instructions

SonoDur-R complies with the applicable safety regulations (EN 60950-1: 2006, EC Low Voltage Directive) and has left the factory in perfect technical condition. The following safety notices must be read before the equipment is operated, in order to maintain the perfect technical condition and to ensure safe operation.

⚠	**DANGER!**
The following general safety instructions must be mandatorily read.	

- Do not place the device near sources of heat (heaters, stoves or other devices that generate heat) or in places exposed to direct sunlight, excessive dust or moisture.
- Disconnect the device from the power supply during thunderstorms or when not in use for a long time.
- Never place the battery in a microwave oven, throw it in a fire, or expose it to heat or heat the battery in any other way.
- Avoid any short-circuiting of the battery contacts and make sure that no electrically conductive parts touch the contacts.
- UCI hardness measuring probes are very accurate precision measuring instruments that may not be exposed to shock or impact stress under any circumstances!
- The device may only be used as described in the manual at hand!
- Other applications e.g. medical applications are not permitted!
- Only original spare parts or accessories may be used.
- Measuring instruments and accessories must be kept out of the reach of children!
- The plug-in power supply SONO3-NG may only be used in dry rooms! Only mains adapter may be used that are approved for this product!
- The test device and/or the mains adapter may no longer be used and must be secured against commissioning if:
- damage is visible.
- the system is no longer working properly.
- after being exposed to extraordinary severe transport stress.
- following a prolonged storage in particularly unfavorable environmental conditions (temperature/humidity)
- The tester device and its accessories may only be operated and stored in the specified ambient space (temperature/humidity)!
- The accident prevention regulations and the rules of the employer's liability insurance association for electrical facilities must be observed, when the device is used in commercial facilities.
- Repairs may only be carried out by authorized specialist personnel using original spare parts.
- The unit/power adapter should never be turned on when the unit/accessory is moved from a cold to a warm room. The resulting condensation can destroy the device/accessories under unfavorable conditions! The device/accessory must be acclimatized to room temperature whilst being switched off.
- The usage in explosion-proof areas is forbidden!

2.3 Designated Use

The SonoDur-R incl. accessories shall be exclusively used for hardness testing of metallic components. Proper use of the device also requires compliance with the information and instructions described in the manual at hand. Other applications than those mentioned in the manual are not permitted!

2.4 Highlighting warnings and other instructions

Safety, warning and operating instructions are identified in the manual at hand by a combination of symbols and signal words indicating the possible extent of a hazard.

⚠	**DANGER!**
A warning of this level indicates an impending hazardous situation which, if not avoided, could result in death or serious injury.	

⚠	**WARNING**
A warning of this level indicates a potentially hazardous situation which, if not avoided, could result in personal injury or property damage.	

⚠	**CAUTION!**
A warning of this level indicates a potentially hazardous situation which, if not avoided, could result in minor or slight injury and/or property damage.	

i	**NOTE!**
This note highlights tips and recommendations for making work easier and improving results.	

2.5 Prerequisite for the hardness test

An appropriate training of the operating personnel in the field of material testing is required for performing hardness testing. This includes, for example, sufficient knowledge about:

- hardness testing in general
- influence of material properties on the hardness test and selection of the measuring system
- influence of the surface texture
- selection of the testing force
- understanding of the comparability to other testing methods, conversion

⚠	**DANGER!**
A warning of this level indicates an impending hazardous situation which, if not avoided, could result in death or serious injury.	

3 Device Connections, On/Off-Switch

All device connections and the on/off switch is located on the rear site of the instrument.

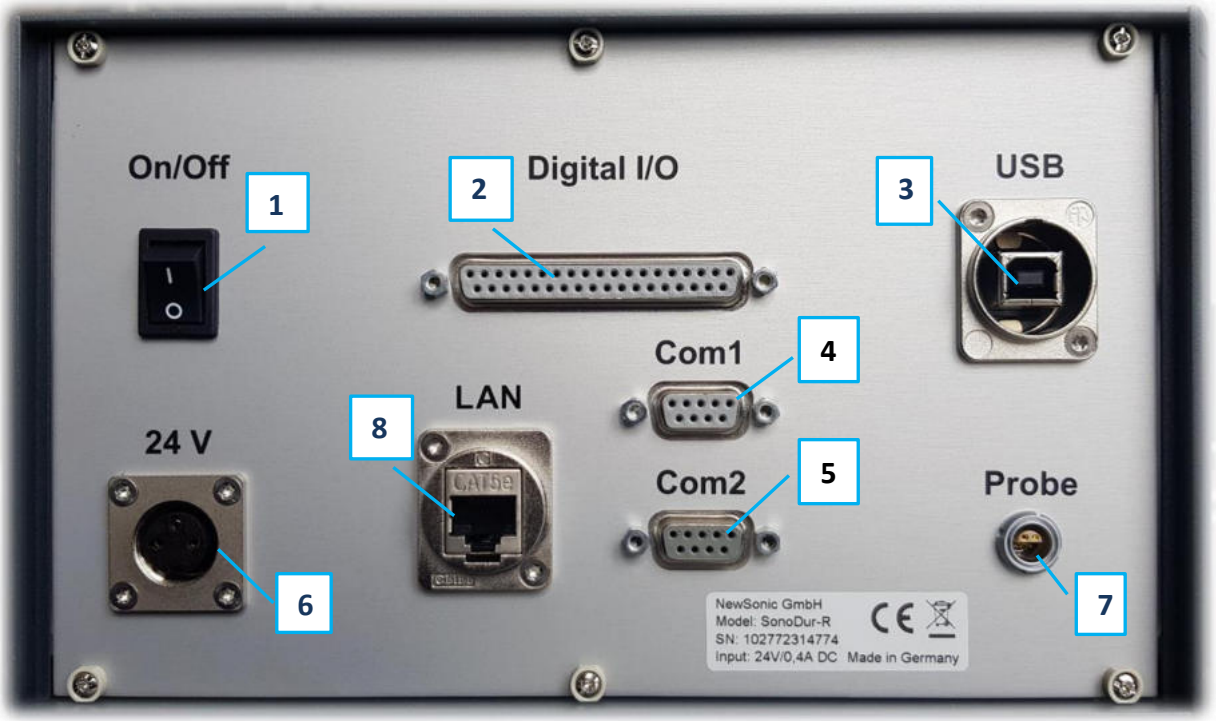


Figure 3.1

Nr.	Kurzbezeichnung	Beschreibung
1	On / Off	Power Switch
2	Digital I/O	Digital Input / Output signals, galvanically isolated
3	USB	USB (Device) interface, suitable for software updates, manual file transfer
4	COM1	Serial Interface RS232, data output and remote control, galvanically isolated
5	COM2	No function, for future extensions
6	24V DCin	Input power, 24V DC / 1A min.
7	Probe	Connector for probe cable, coded and with lock mechanism (Push-Pull)
8	LAN	LAN interface (no function, for future extensions)

Table 3-1

4 Preparation for operation

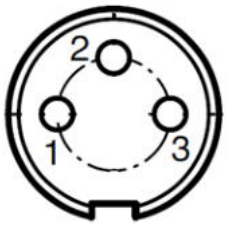
Each of our products is thoroughly inspected and carefully packed prior to delivery. However, please check that the shipment is complete and has not been damaged during transportation.

All connectors can only be inserted one way into the jack. Do not, under any circumstances, use force since the connector system may get damaged.

4.1 Supply Input Voltage

Because of country wise specific trade- and safety marks, the SonoDur-R benchtop instrument does not have an internal power supply. It just needs a single DC input voltage, please connect the power supply connector via the SONO-24V cable to a clean DC voltage, we recommend 24 VDC or use our 24 V power supply (order number 11307, see section 12.1 Scope of Delivery and Accessories, page 56).

The connector is specified according DIN EN 60130-9 (Type C901A 3-pin fem., Amphenol T 3263 000) (see Figure **4.1**, view on the contact side.



Pin	Signal Name	Description	Voltage Level
1	Vin	Power supply voltage	12-24 VDC
2	---	Not connected	---
3	GND	Ground	0 V

Figure 4.1

i	NOTE!
Note: The power input is reversed voltage protected and filtered.	

4.2 Connecting and disconnecting the test probe

Shielded connection cables are used to connect the test probes to the SonoDur-R. The contact arrangement via the above-mentioned half-shell enables the plugging of the connection in one position only (refer to **Figure 4.2**)! The silver metal connector on both ends of the cable is a locking plug-in connector that is based on the push-pull principle: During the plug-in, 3 claws will securely lock the connector in the socket.

It can only be released by pulling back the outer sleeve of the plug, which will release the locking claws!

⚠	CAUTION!
The contact arrangement of the connector only allows the plugging to be performed in one position! Force must be avoided, since the plug system can be damaged!	

Figure 4.2

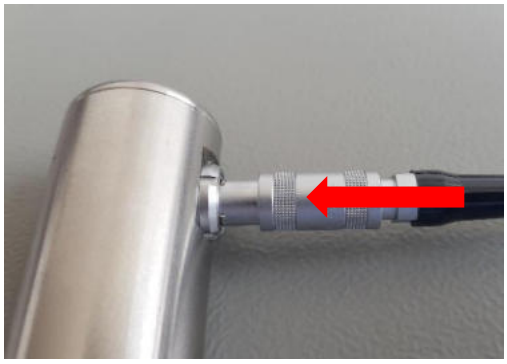


Figure 4.3

4.2.1 Connecting the test probe or test device

The silver metal plug shall be carefully pushed into the socket of the test probe while the contact arrangement allows the connection only in one position. Gently insert and adjust the plug into the socket without pressure until the plug has reached the correct position and can be easily pushed into the socket. The locking will be indicated by a 'click'. Afterwards, the plug is firmly locked in the socket by 3 claws.

4.2.2 Disconnecting the test probe or test device

The silver probe connector can be unlatched by pulling the sleeve back and pulling it out of the socket, refer to **Figure 4.5**.

i	NOTE!
The test probe can also be connected after the device was switched on or can be changed during operation (also refer to the notes in the following sections).	

Figure 4.4

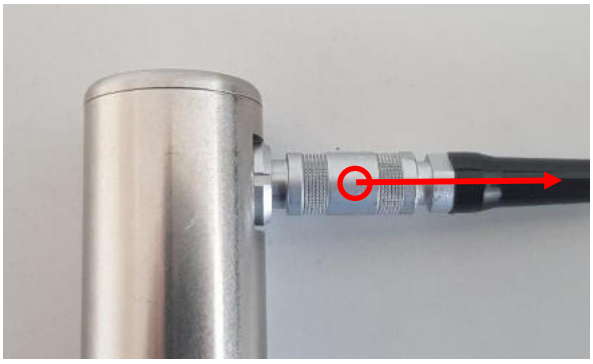


Figure 4.5

5 Switching On and Off

5.1 Power ON

The device is switched on/off via the rocker switch on the rear side of the device (refer to Figure **3.1**). After powering on the instrument, the home screen is displayed after approximately 20 seconds. If a probe is connected or by tapping on the SonoDur icon the SonoDur program starts (**6.1 Start the Test Program**).

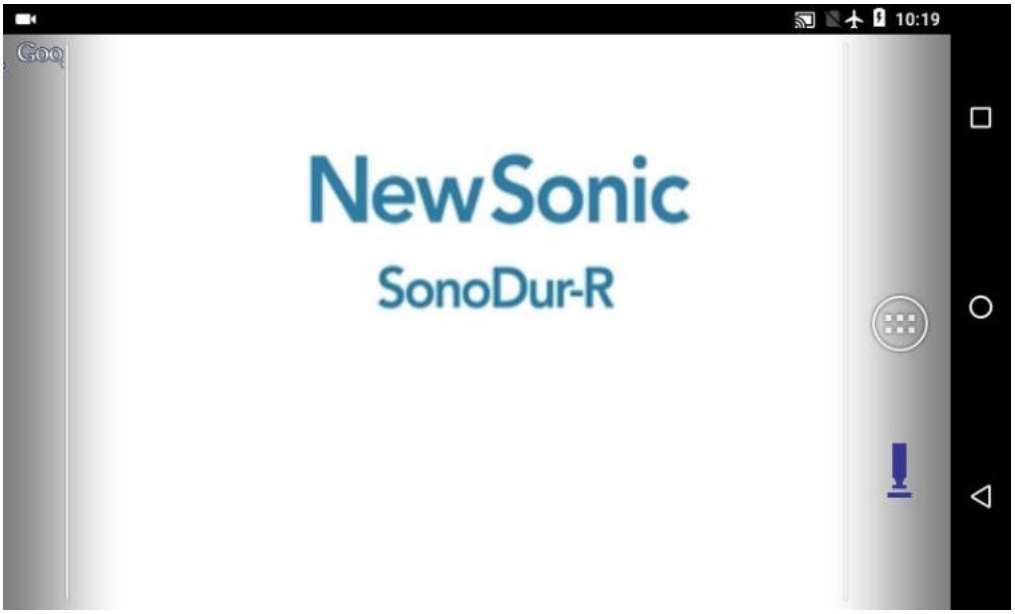


Figure 5.1

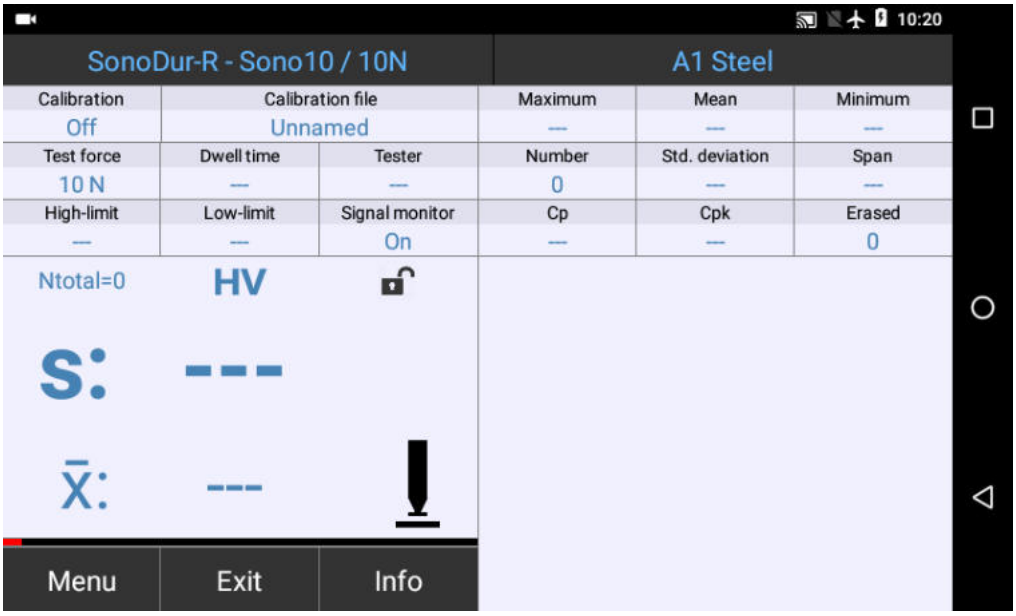


Figure 5.2

i	NOTE!
If no probe is connected, SonoDur-R starts in simulation mode (**6.1.2 Simulation Mode**). In this special operating mode, the instrument will not automatically switch over to regular measurement mode, if a probe is connected. Please end the program, connect the probe and start the SonoDur-R application again!	

5.2 Switching OFF

Always use the “EXIT” key first to end the SonoDur-R software before switching off the SonoDur-R via the rocker switch on the rear side of the device.

⚠	WARNING
Do not use the switch, before you have finished your measurement and stored all data! Use the “EXIT” key before switching-off the instrument!	

6 Operating

6.1 Start the Test Program

6.1.1 Measuring Menu (Main Menu)

SonoDur-R starts the measuring program automatically if a probe is connected (or changing a probe) or by touching the SonoDur-R icon and shows the measuring menu (main menu). The probe type and test force is shown in the upper left corner of the SonoDur-R status line. If no probe is connected or the probe is not recognized, SonoDur-R starts in simulation mode (**6.1.2 Simulation Mode**). The SonoDur-R testing device must be in the "Measure" mode, in order to be able to invoke a measurement. The "Measurement Menu" can be accessed from any sub menu via the Exit-Button. Please end all settings or inputs and return to the measuring menu (main menu). The left screen section contains essential control-, input- and status-fields, the actual measuring value and the mean value. **Ntotal** is a counter value and represents the total number of measurements within the actual measuring set. The right screen area shows statistic information for the selected number of last measurements, which could be selected from menu -> settings -> max. number of readings N). In the display there will be always the last N values visible and the statistic is calculated from these last readings (in this case 10).

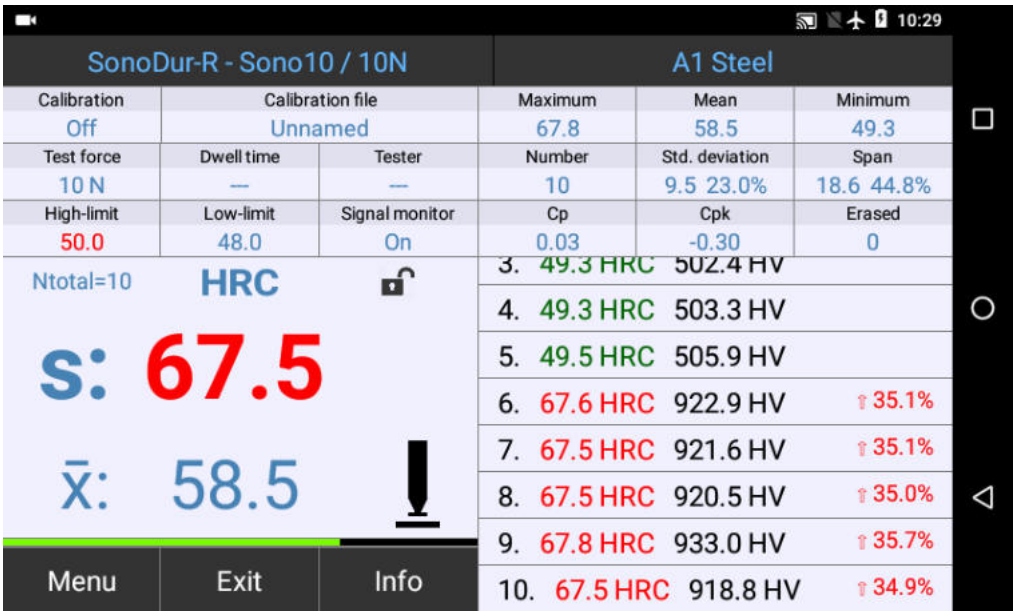


Figure 6.1

6.1.2 Simulation Mode

A special feature of SonoDur-R becomes apparent, when the device is switched on without a probe being connected: This simulation mode makes it possible to test all functions of the SonoDur measuring program without having to perform measurements with measuring probes. Starting the SonoDur program manually without a probe connected, a message box will pop up displaying “No probe connected. Start program in demo mode?“ Answering “Yes” will start the demo mode.

The demo mode is indicated by showing **SonoDur-R - SONO8M (demo)** in the status line (Figure **6.3**). "Measurement values" are then created by touching the probe icon (refer to Figure 6.10) and it will be possible to operate all functions related to the hardness measuring - a special function for fast operator training and also for demonstrations to interested parties.

In order to return to the normal measuring mode, the program must be terminated and switched to measuring mode after a test probe was connected.

Tap the EXIT button, the question Exit Program must be acknowledged with Yes. After connecting a probe, the measuring program should start automatically.

i	NOTE!
In order to return to the normal measuring mode, the program must be terminated and switched to measuring mode after a test probe was connected.	

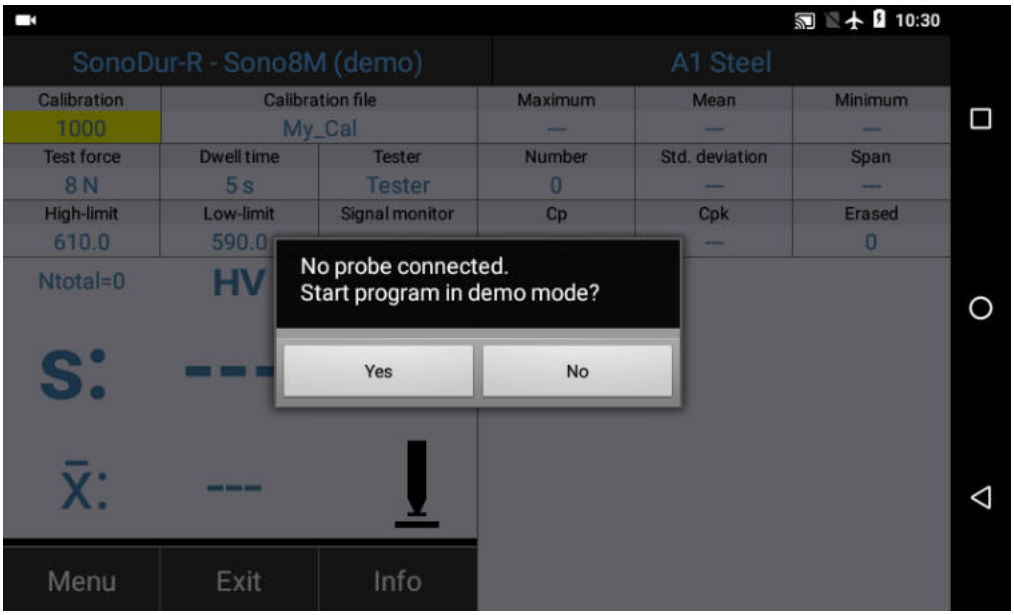


Figure 6.2

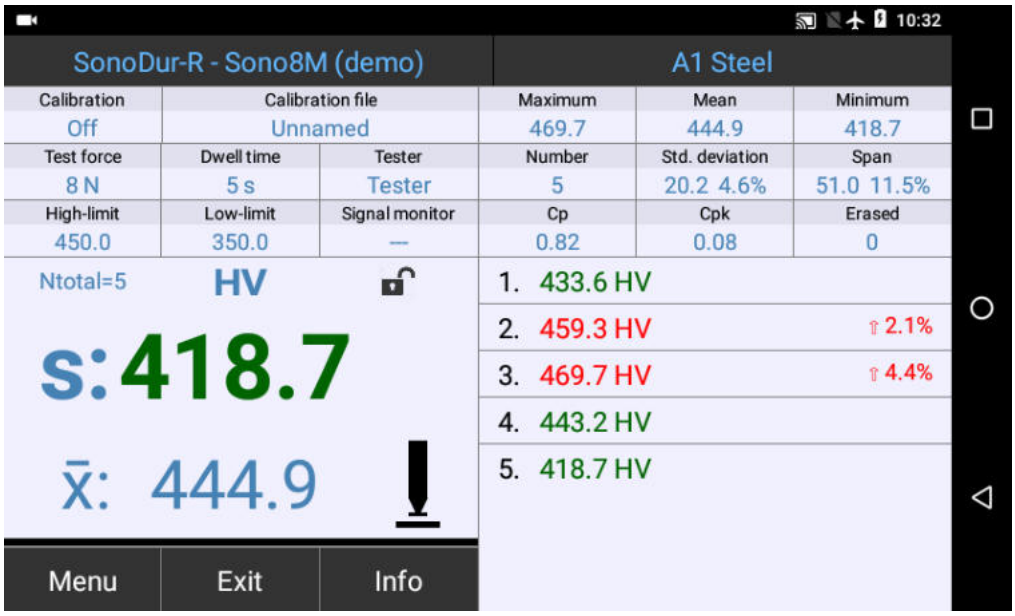


Figure 6.3

6.2 Der Start Screen (Home Screen)

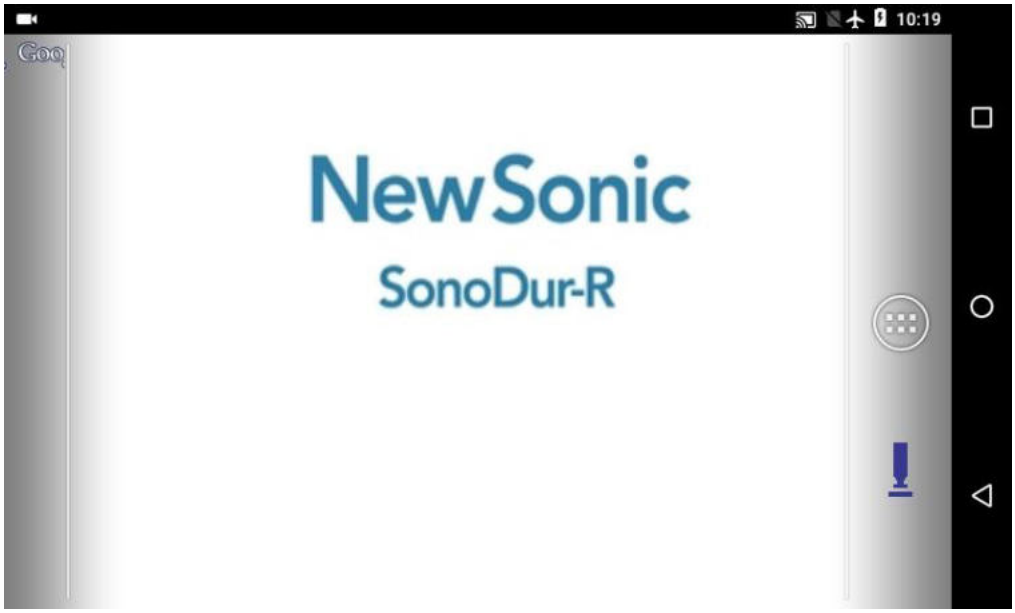


Figure 6.4

The start screen (Home Screen) shows the status line, the SonoDur-R icon to start the measuring program and the menu and navigation buttons. The start screen is made of several pages, which can be reached by wiping on the display to the left/right.

Nr.	Short abbreviation	Description
1	Status bar	Information on the device status as connections, power, time.
2		Menu-Button opens the application screen (displays all installed applications).
3	Navigation buttons	The system is operated via the navigation buttons:  Back  Home, jump to the home screen („Home-Button“)  Opens a screen with active applications

Figure 6.5

The menu button opens access to all installed applications and settings (refer to Figure **6.6**).

i	NOTE!
Application(s) will be called “APP(s)” hereinafter.	

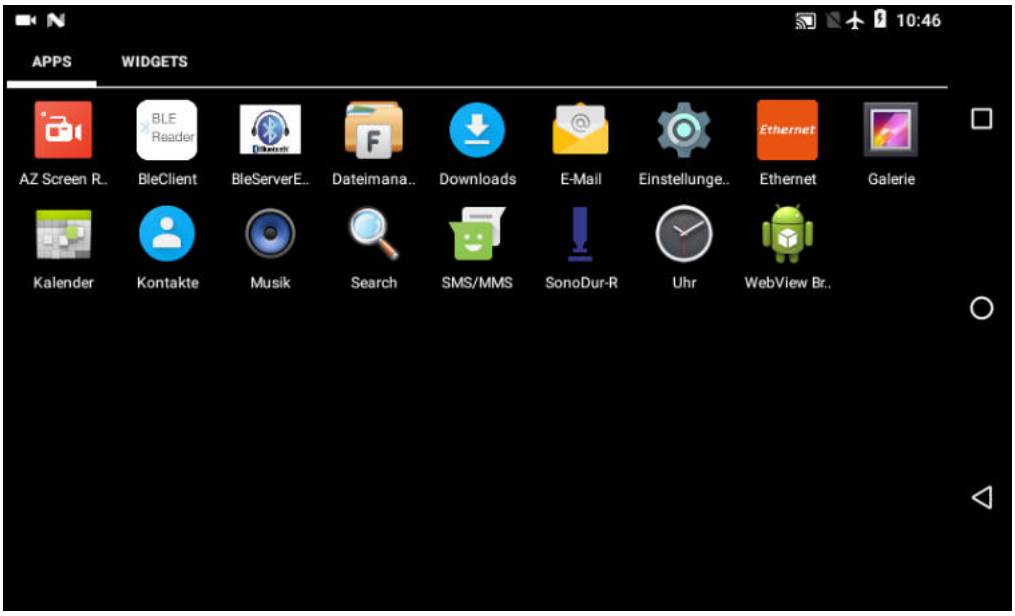


Figure 6.6

6.3 Change Language

The language can be easily changed via the system settings at any time on-the-fly. Open the "Settings" menu and select "Language & Input". Select the top entry "Language". A list with all installed languages will appear. The first item in the list defines the actual language setting. Use “Add languages” to add additional languages. Tap on “Add language” and select your country language from the list. This will create a new entry in the last position in the language list.

To make this language active, tap and hold on the line with the desired language and slide to the topmost (first) entry in the list. The language will change immediately. In this example the language is changed from English to German (Deutsch).

Restart the SonoDur-R measuring program, all menus and messages will appear in the so selected country language.

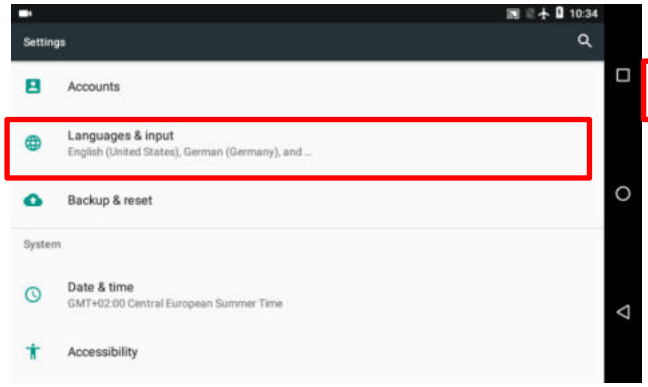


Figure 6.7

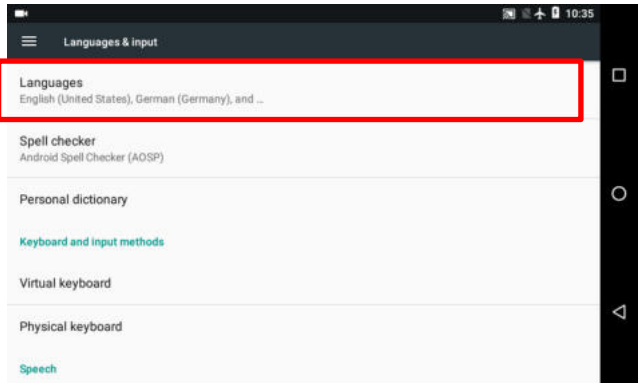


Figure 6.8

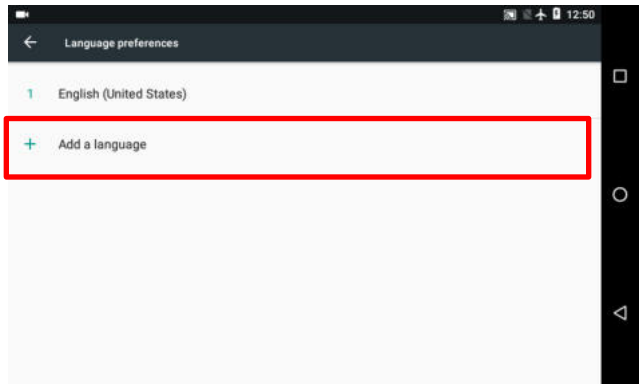


Figure 6.9

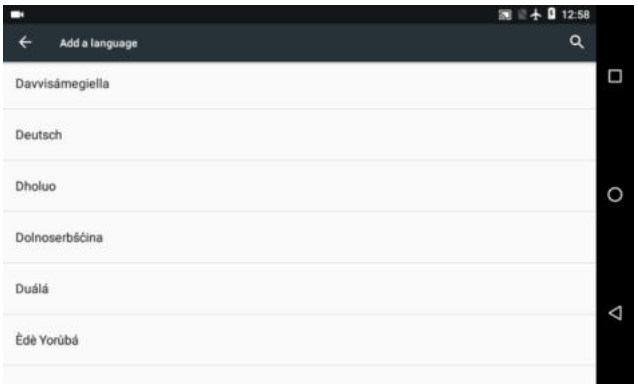


Figure 6.10

Figure 6.11

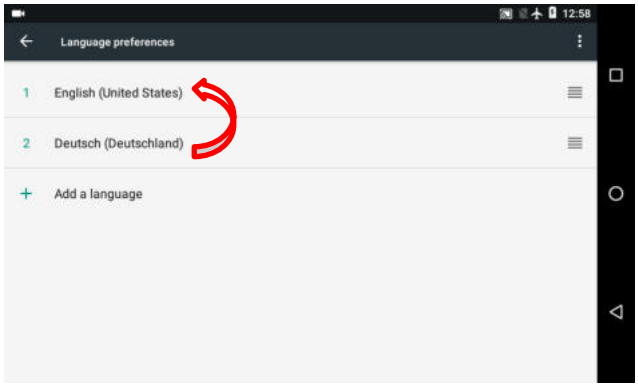


Figure 6.12

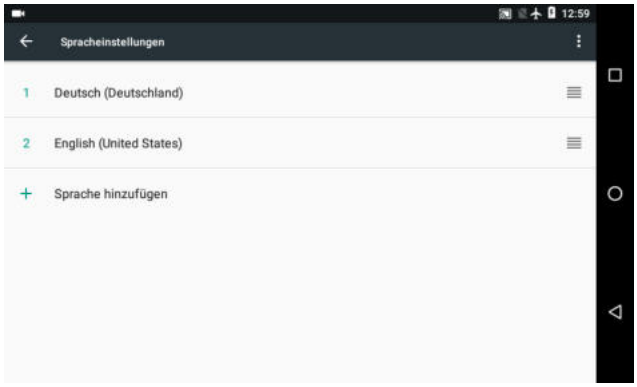


Figure 6.13

6.3.1 Delete Language

Language entries can be deleted by tapping on the small field in the right upper corner marked with 3 points, it opens a button area “Remove”. Tap on it, all language entries will appear with a blank check box. Selecting one or more check boxes and tapping on the paper bin symbol will open a menu “Remove selected language”. By tapping on OK the selected language entries will be deleted from the list. See following series of photos, in this example the Spanish (Espanol) language is removed.

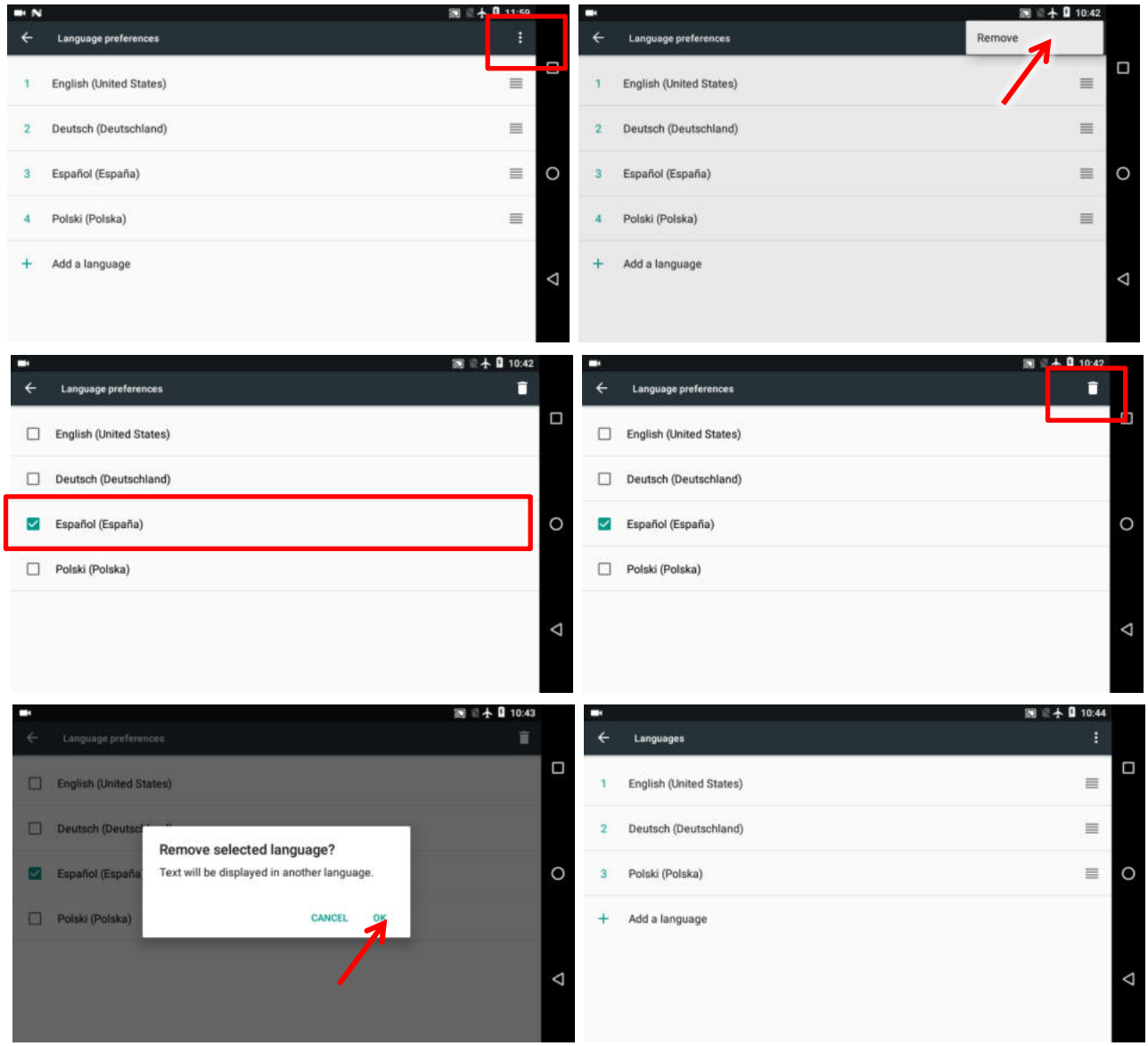


Figure 6.14

7 Operation and Menu Structure

The SonoDur-R is fundamentally operated at two levels, the measurement menu (**Figure 7.1**) and the device menu (**Figure 7.2**).

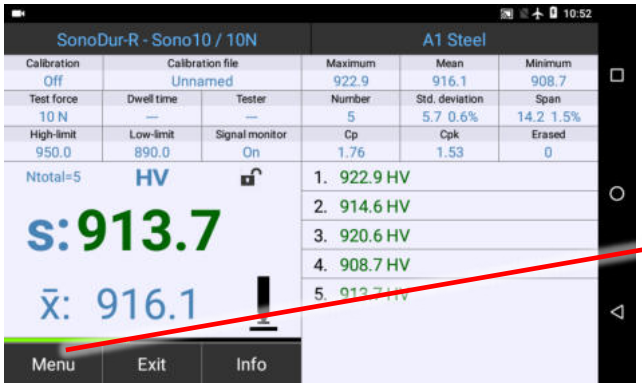


Figure 7.1

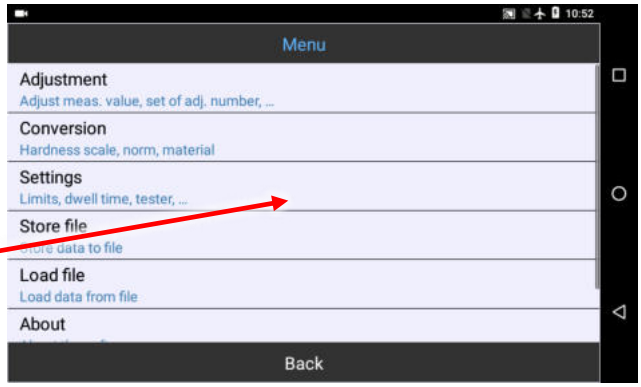


Figure 7.2

7.1 Description of the Operating Elements on the Bottom Menu Bar

The switching between the menus is performed by using the touch-sensitive menu buttons at the bottom of the display (black keys with white text):

Abbreviation	Meaning
Menu	Switching to the Device Menu.
Exit	1. Leaving the Measurement Menu, End of the measurement series. 2. Leaving any sub-program within the device menu and switching to the measurement menu. 3. Terminating SonoDur (after processing the last measurement series and before the first new measured value).
Info	Display of device settings for the measuring process, display of measuring results such as statistics, individual values and corresponding correction options.
Back	One step back within the submenu. Cancel
Cancel	Cancelling the current input, one step back.
File	Retrieving and displaying stored measurement data (within the submenu "Info")
OK	Confirming the input and returning

Figure 7.3

7.2 Buttons – Control Elements (Soft Keys)

Touching the buttons within the "Measurement Menu", allows direct transitions to specific sub-programs avoiding the search path through the menu branches. After completion of the entry in this submenu, the return to the starting point will be performed. Touching into the statistic area switches the presentation graphic -> Zoom -> statistic.

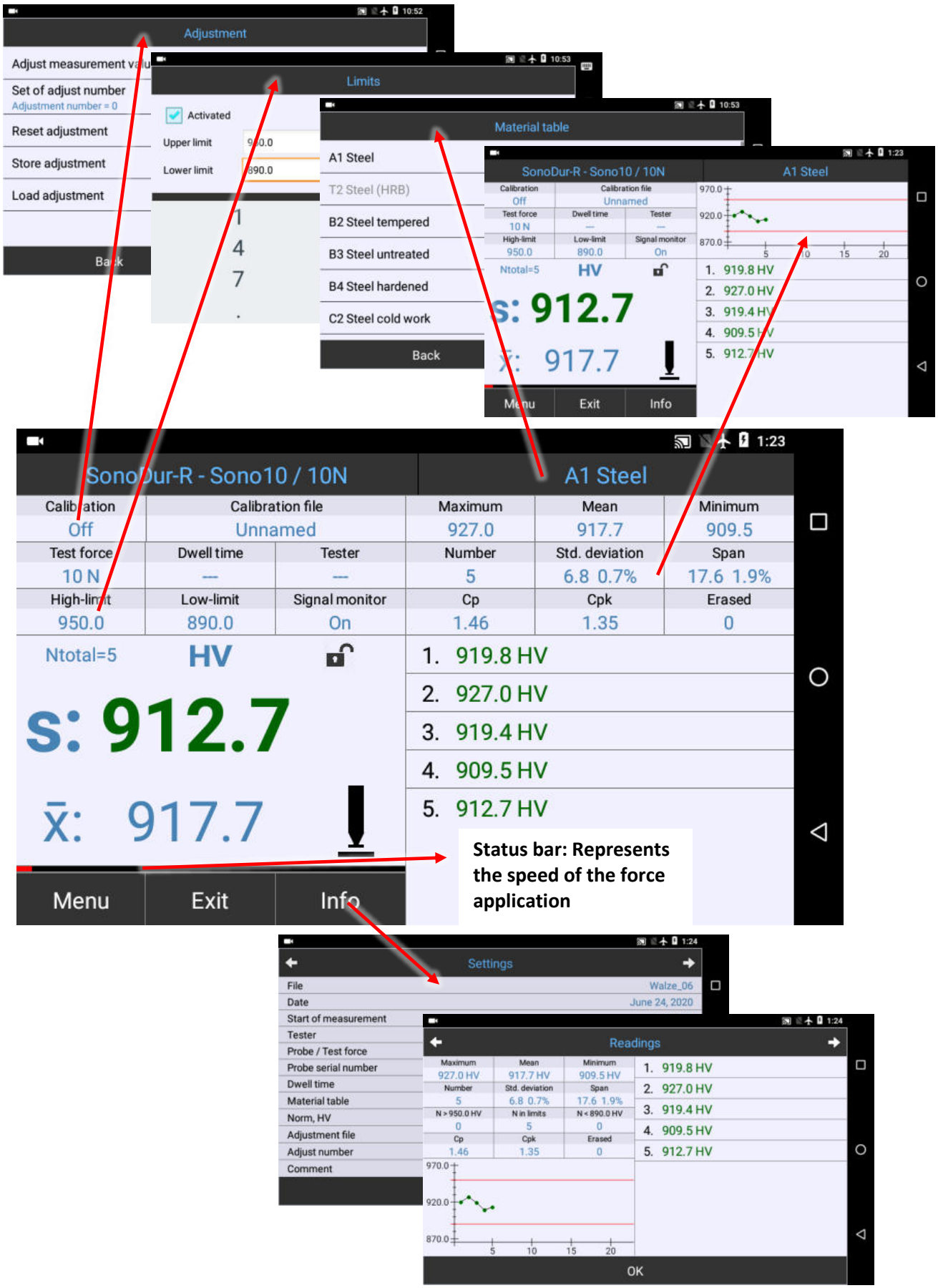

Adjustment
Adjust measurement value
Set of adjust number
Adjustment number = 0
Reset adjustment
Store adjustment
Load adjustment
Back
Limits
Activated
Upper limit
Lower limit
Material table
A1 Steel
T2 Steel (HRB)
B2 Steel tempered
B3 Steel untreated
B4 Steel hardened
C2 Steel cold work
Back
SonoDur-R - Sono10 / 10N
A1 Steel
Calibration
Off
Calibration file
Unnamed
Test force
10 N
Dwell time
Tester
High-limit
950.0
Low-limit
890.0
Signal monitor
On
Maximum
927.0
Mean
917.7
Minimum
909.5
Number
5
Std. deviation
6.8 0.7%
Span
17.6 1.9%
Cp
1.46
Cpk
1.35
Erased
0
Ntotal=5
HV
s: 912.7
x̄: 917.7
1. 919.8 HV
2. 927.0 HV
3. 919.4 HV
4. 909.5 HV
5. 912.7 HV
Menu
Exit
Info
Status bar: Represents the speed of the force application
Settings
File
Walze_06
Date
June 24, 2020
Start of measurement
Tester
Probe / Test force
Probe serial number
Dwell time
Material table
Norm, HV
Adjustment file
Adjust number
Comment
Readings
N > 950.0 HV
N in limits
N < 890.0 HV
OK

Figure 7.4

The Table below provides a description of these control elements.

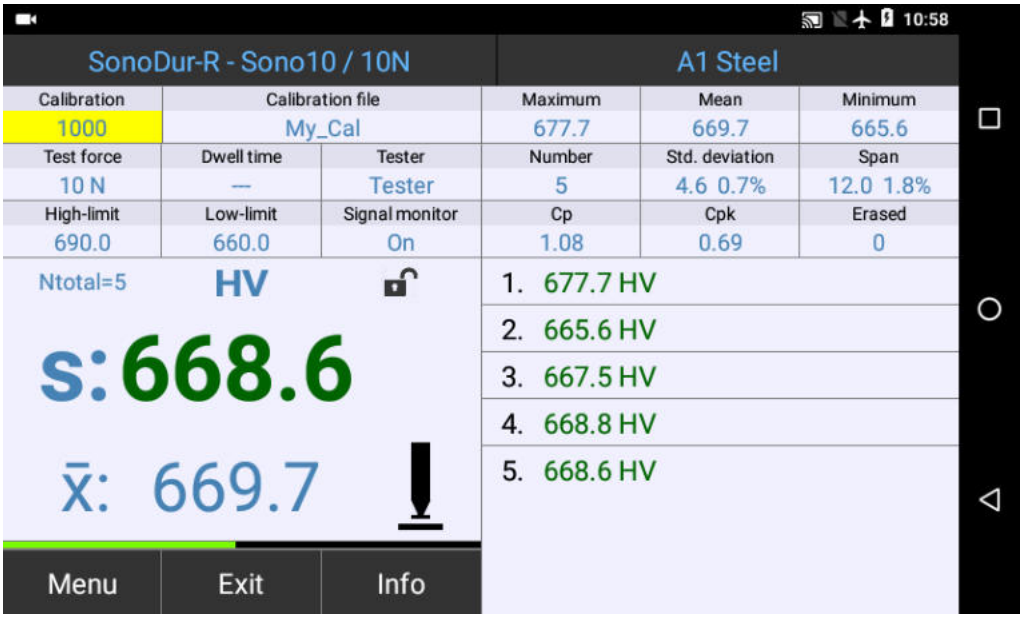


Figure 7.5

Button	Meaning	Instant access to
A1 Steel	Conversion table A1 selected	Material Table
Calibration 1000	User-specific adjustment active, Cal=1000	Adjustment
Calibration file My_Cal	Adjustment file saved under My_Cal	Open Adjustment files
Test force 10 N	Testing force, no function	
Dwell Time ---	Penetration time of test load, only valid for motor probes	Dwell time
Tester Tester	Name of the tester, in this case the Tester	Name of the Inspector
High-limit 690.0	Upper evaluation threshold, in this case 720.0	Limit
Low-limit 660.0	Lower evaluation threshold, in this case 690.0	Limit
Signal monitor On	Function to detect vibration effects in the test material	Frequency analysis
Ntotal=5	Number of total measuring values, In this case 5	No function
HV	Current hardness scale, in this case HV	Hardness scale
	operation lock, in this case off	Operation lock
x̄: 669.7	average value, in this case 864.1	Info menu, Measuring values
s:668.6	Last Measuring value, in this case 668.6	Delete measuring values
	Probe icon, manual start of a measurement, in simulation mode or with motor probe only	start measurement
Maximum 677.7 / Mean 669.7 / Minimum 665.6 / Number 5 / Std. deviation 4.6 0.7% / Span 12.0 1.8% / Cp 1.08 / Cpk 0.69 / Erased 0	change between statistics and graphic representation	Statistics <-> Graphics

Figure 7.6

7.3 Entry input via the system keyboard

Any position can be marked and changed or added to in the input field. The system keyboard (software keyboard) appears automatically when an input field is selected. Using the “Back” softkey closes the system keyboard.

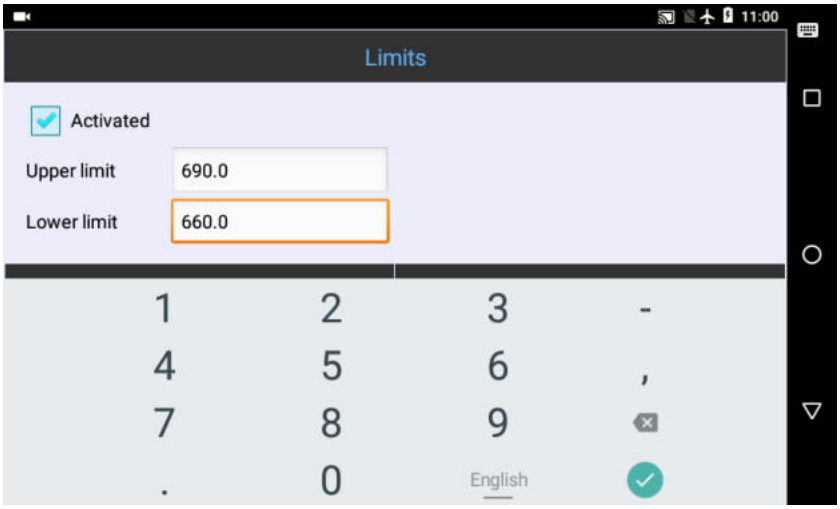


Figure 7.7

7.4 Main Menu Measuring

The SonoDur-R testing device must be in the measuring menu (main menu), in order to be able to invoke a measurement. The "measurement menu" can be accessed from any programme point via the Exit-Button. The measurements with motor and hand-held measuring probes are described below. When measuring using hand-held measuring probes, a horizontal coloured bar appears above the buttons Menu, Exit and Info, which represents a measurement of the speed in which the force is applied. This shall provide the operator with an indication for the correct handling of the probe. Short bar (left end) = force application too fast, Middle = OK Long bar (right end) = force application too slow (refer to **Figure 7.8** to **Figure 7.10**).

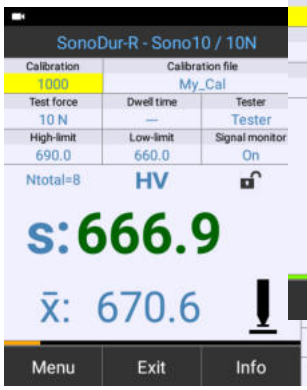


Figure 7.8

Figure 7.9

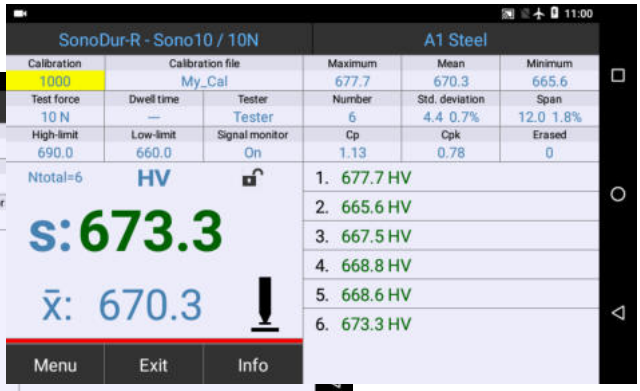


Figure 7.10

i	NOTE!
Touching on one of the control keys on the right screen area □ ○ ▽ to switch to system level will close the measuring program and must be started manually.	

By tapping the statistics window, a switch between Statistics -> Graphics -> Graphics (zoom) -> Statistics will be performed:

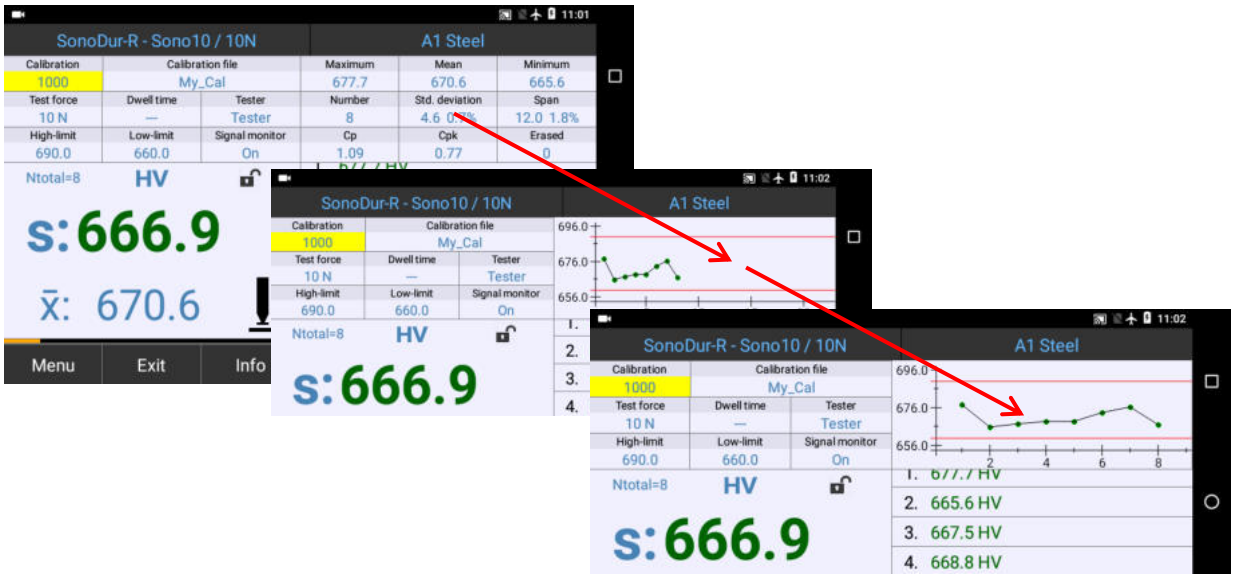


Figure 7.11 Figure 7.12 Figure 7.13

The operation lock is used to prevent unintentional changes and to lock and unlock the device. Tapping the lock symbol will start a query:

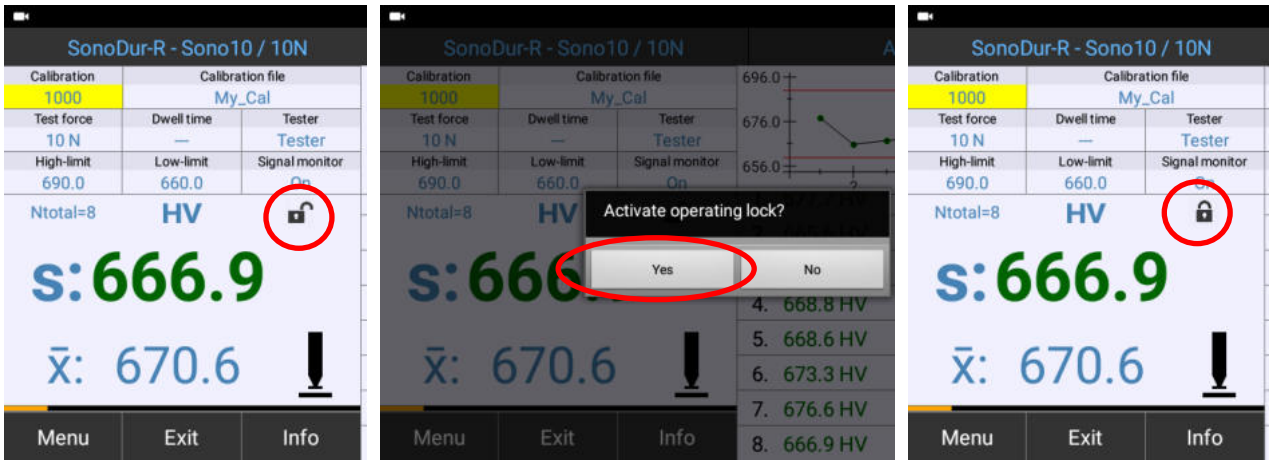


Figure 7.14 Figure 7.15 Figure 7.16

7.4.1 Signal Monitor

By tapping this touch-sensitive field a signal analysis could be switched on and off. The signal analysis detects abnormal frequency behavior, especially resonance effects in the test material. The factory default setting is “ON” and displays a warning (refer to Figure **7**.**18**)) if an abnormal frequency behavior is detected. The user must acknowledge the message with the option to accept or reject the measuring value. By switching off and on again the signal monitor a short description is displayed (refer to Figure **7**.**19**) and must confirmed with “OK”.

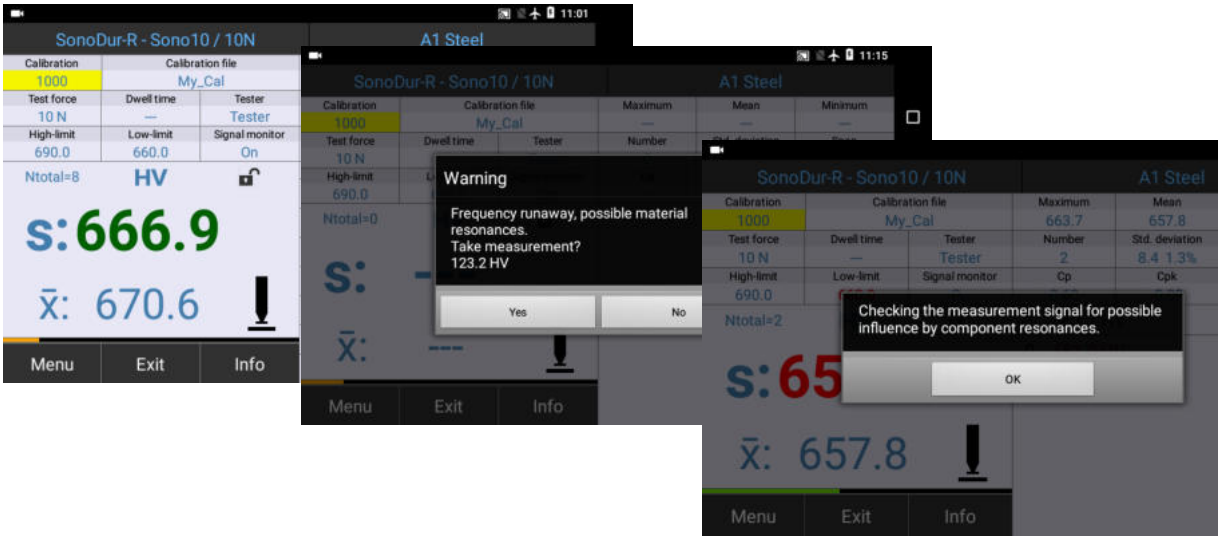


Figure 7.17 Figure 7.18 Figure 7.19

i	NOTE!
If this warning is displayed, the test position should be changed in order to find a position without disturbing component resonances.	

7.5 Performing a measurement with motor measuring probes

7.5.1 Automatic measuring with motor probe

The standard application is performed with a probe shoe and the switching socket (the two right parts in Figure **7.20**), so that the measurement is performed fully automatic by triggering the micro switch. The protective tube is only screwed on for hand measurements in order to protect the vibrating rod and may not be used together with the probe shoe (refer to **Figure 7.21**)! The synthetic part (2nd part from the left in **Figure 7.20**) is a special solution and exclusively intended for dust protection.

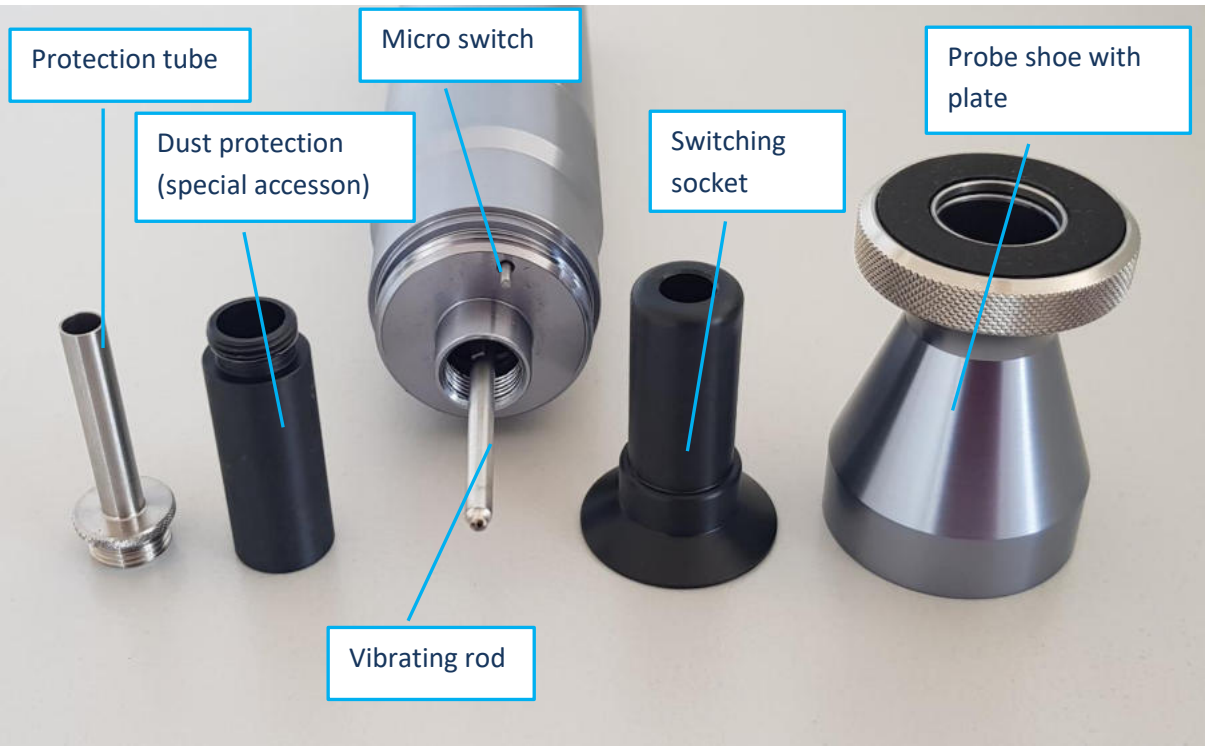


Figure 7.20

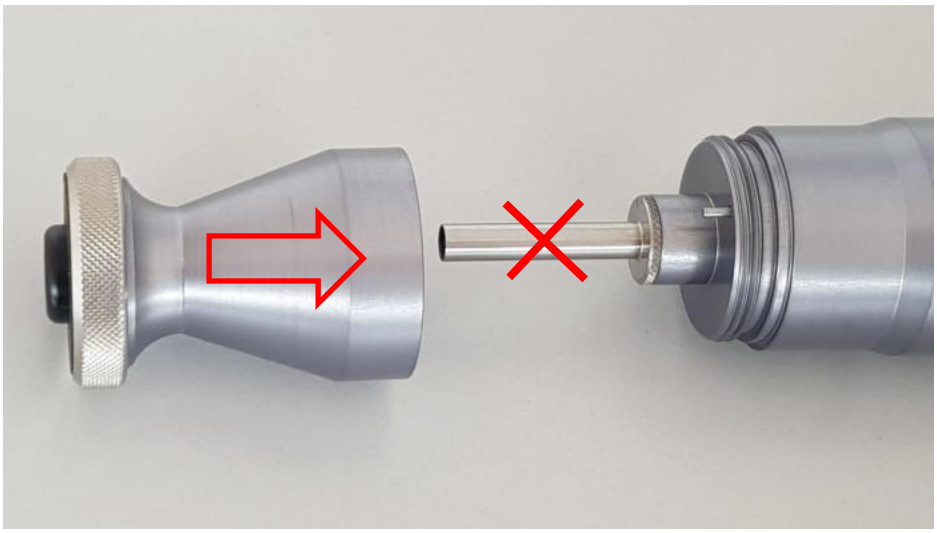


Figure 7.21

Carefully attach the SonoDur motor measuring probe (**Figure 7.23**), and wait until the measuring process is completed. The switching socket (**Figure 7.20**) in the probe shoe is pressed backwards during the placing and invokes the motor control via a micro switch. The Vickers Diamond is automatically moved out of the housing towards the material surface. In the probe icon of the device display indicates this process by an arrow pointing towards the probe icon (**Figure 7.22**).

In any case, a new measurement can only be invoked again once the end position is reached.

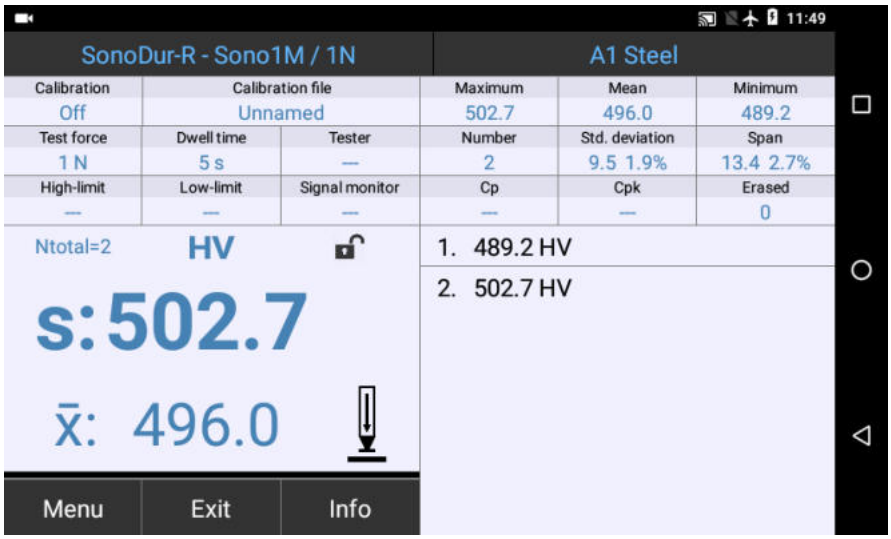


Figure 7.22

Figure 7.23

As soon as the nominal test force is reached, the probe symbol is replaced by the remaining penetration time (in seconds) and the time is counted down. Once the preset penetration time has elapsed, the measured value is displayed and at the same time, the rearward motor movement is indicated by an arrow pointing in the opposite direction until the end position is reached (refer to picture sequence below).

Measurement menu and probe guidance during the measurement; it is recommended to hold the probe at the bottom of the probe base as shown, in order to avoid tilting during the penetration phase. This risk of tilting exists especially if the probe is only held at the top.

It is recommended to lift the motor measuring probe for the next measurement only afterwards. Thus, any surface damage by the returning Vickers Diamond will be avoided with certainty.

⚠	**CAUTION!**
Never change the test position during the measurement and do not lift the probe until the upward arrow in the probe symbol has disappeared! Otherwise the diamond could be damaged!	

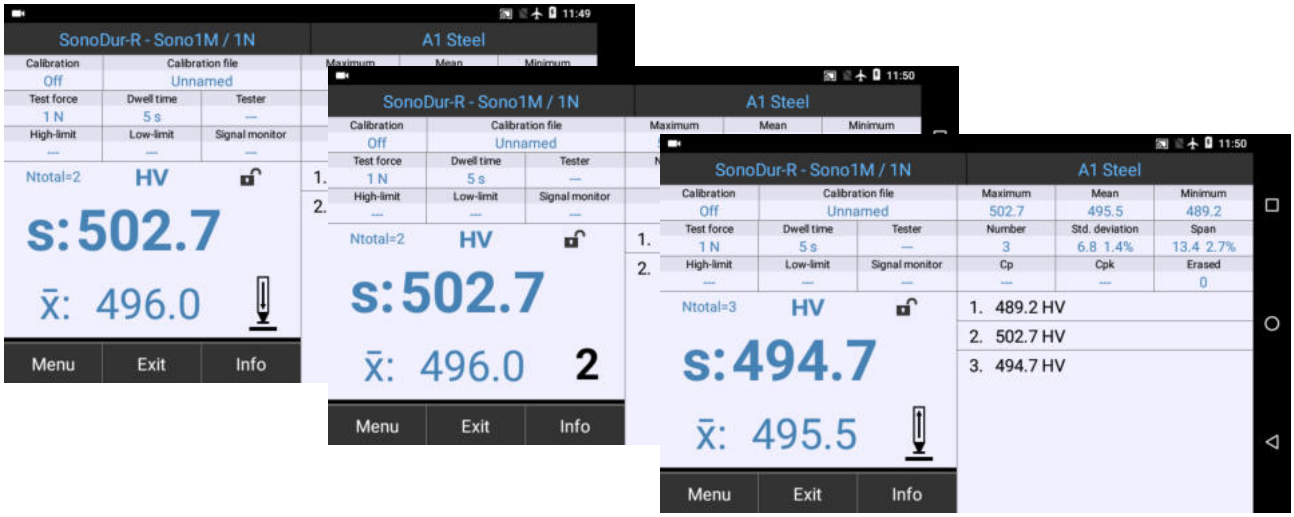


Figure 7.24 Figure 7.25 Figure 7.26

Figure 7.24 to **Figure 7.26**: Probe movement, count down the penetration time (in this case 3 seconds), probe moves up to the end point. Error message when lifting the probe prematurely, the diamond does not reach the surface.

i	NOTE!
If the Vickers Diamond does not reach the surface of the material, no measurement is generated and the vibrating rod is returned to the park position by the motor. No error message is displayed, but the digital outputs ERROR, HI and LO will get active.	

7.5.2 Manual measuring types with motor probe

7.5.2.1 Manual measuring using a probe shoe

In order to prevent the automatic measuring, start when placing the probe on the test surface, the black synthetic part (switching socket, left in **Figure 7.27**) must be removed from the probe shoe. Subsequently, the test probe can be placed on the test material and the measurement can be started manually: By touching the probe symbol on the SonoDur-R display or by pressing and holding the micro switch on the probe

Figure 7.27

Measuring points can be set close together without lifting the motor measuring probe. However, a visual inspection of the test position is hidden by the probe base. After reaching the upper position (end position) of the Vickers Diamond, it is sufficient to move the probe slightly and touch the probe symbol on the device to perform a new measurement.

⚠	**CAUTION!**
It is essential to wait for the upper probe position to be reached in order to prevent damage to the surface or to the Vickers Diamond due to a premature movement of the probe!	

7.5.2.2 Manual measuring without a probe shoe

It is necessary for some applications to unscrew the probe shoe and to only work with the unprotected vibrating rod.

The vibrating rod can easily be damaged through negligence (Figure **7**.**20**). This configuration is only recommended for operation in a tripod stand with good probe guidance and a defined distance between the probe tip and the test piece or by very well-trained and experienced operating personnel.

By screwing on the protective sleeve, the probe rod is perfectly protected against mechanical damage (Figure **7**.**28**). However, care must be taken at this point to ensure sturdy probe guidance.

Figure 7.28

In both cases, the measurement is triggered via touch screen command or by pressing the micro switch on the bottom of the probe

The probe is carefully placed on the test piece and the measuring is invoked. It is important to ensure that the probe is not tilted during the measuring phase. After the measuring time has expired, the vibrating rod returns to its starting position.

7.5.2.3 Manual measuring without a probe shoe and with extended vibration rod

In the device menu Settings (Figure **7.29 and** Figure **7.30**) the measuring mode with extended probe tip (approx. 4 mm) can be selected. In the measurement menu, this is displayed as 'Manual' in the field “Test force” (Figure **7.31**). For hardness testing, the operator should carefully press the vibrating rod onto the test material by hand. Shortly after the test piece has made contact, the penetration time is count down

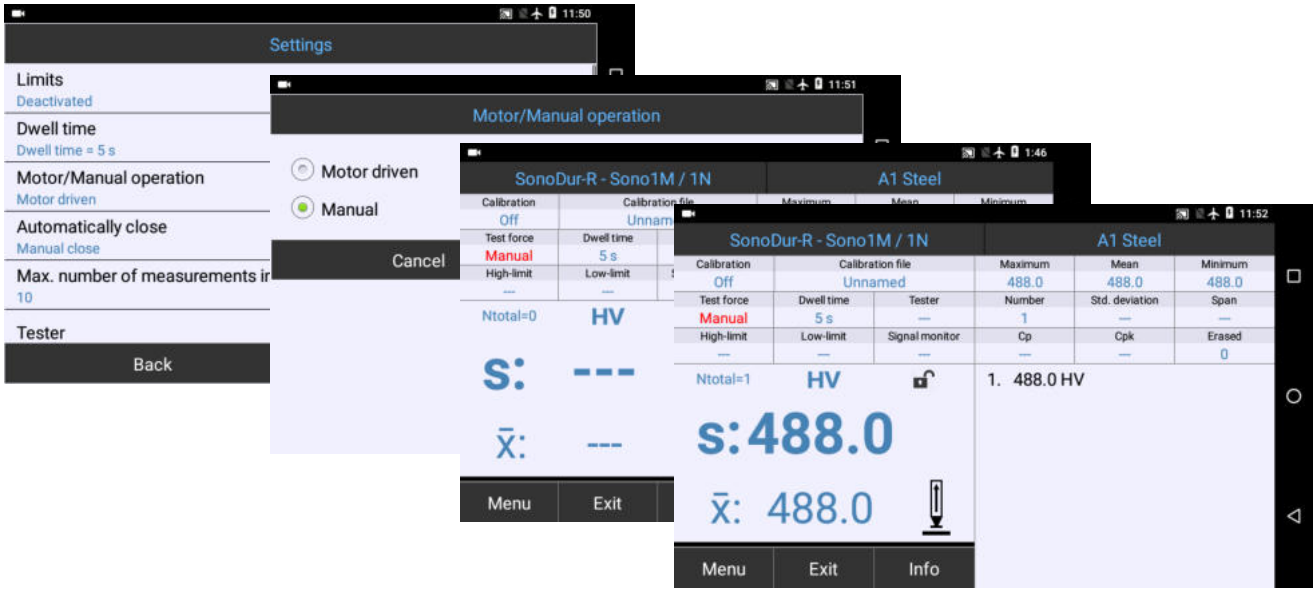


Figure 7.29 Figure 7.30 Figure 7.31 Figure 7.32

and the measuring is invoked. After the complete manual measuring is performed, an arrow is displayed on the screen to indicate that the probe should be lifted (Figure **7.32**). When measuring without a protective sleeve, the vibrating rod is carefully placed by hand and the probe is pressed down slightly (approx. - 4 mm) and held until the measuring time has expired (1 to maximum 2 seconds). Here again, extensive practical training is recommended.

7.6 Performing a measurement with hand-held measuring probes

Measuring is only possible when the SonoDur-R display device is in measuring mode. The test force must be applied manually against a spring system in the probe housing; the measuring is performed automatically when the nominal force is reached.
As a rule, the forces are usually much higher compared to motor probes HV1-10N, HV5-50N or HV10-100N) and the spring is already heavily preloaded, so that the nominal testing force is reached after a very short distance - approx. 0.6 mm penetration path. This requires very careful handling with hand-held measuring probes to avoid damaging the diamond by placing it too abruptly!

⚠	**WARNING**
The dwell time is set to 0 sec in this operating mode (is automatically preset when a hand-held measuring probe is detected) and must be monitored before commencing the measuring!	

1. **Hold the probe perpendicular to the surface and lightly place the tip of the diamond in position.**
2. **Subsequently press the probe at moderate speed evenly against the spring until it reaches the mechanical end stop.**

The hardness value is assessed before reaching the end position and displayed instantaneously on the screen, in addition an acoustic signal sounds. The color bar indicates the speed of the force

application. This can be helpful to verify correct handling (green bar in the middle = OK, long or short bar in yellow or red indicates that the speed is too high or too low).

⚠	**WARNING**
Between tests, the probe must always be lifted off perpendicular the surface before proceeding to the next test location. This can otherwise result in measuring errors. Avoid placing the probe abruptly as this can damage the diamond.	

i	**NOTE!**
Strong pressing is absolutely unnecessary and dangerous, as the measuring has been performed in time long before the end stop is reached. It is also not necessary to carry out the test steps within a short time limit, as required by other hardness testers. Also, no further holding is required.	

Using the above method, accurate measurement results can be achieved after short practising, which otherwise could only be achieved by using additional guide aids or tripods.

Figure 7.33

Figure 7.34

Figure 7.35

The force should exclusively be applied from the probe cover via the inner palm of the hand or the thumb. Other fingers are only intended for the 'force-free' probe guidance. A second hand can also be applied.

For difficult test geometries, the probe attachment (refer to **Figure 7.36**) can be removed to provide better accessibility or visual inspection of the test location. The handling remains the same, however care must be taken, as the probe is only protected by the internal mechanical end stop. Any overload of the probe should be avoided in this operating mode.

Even small, tight test positions can be reliably measured with unscrewed probe attachment sleeves, as displayed here by using the SONO100H - HV10-100N probe (**Figure 7.35**, Cut edge test on structural steel pursuant to DIN EN 1090-2 - mandatory with effect of July 2012!)

The protective sleeve is unscrewed anti-clockwise (refer to the Figure below).

Figure 7.36

7.7 Information Menu

By selecting 'Info', the Information Menu is invoked with current device settings, statistics and processing of measurement data. It is possible to switch between the menu pages using the arrow keys at the top of the screen.

If there are more than 8 measuring values, the list can be 'swiped' up or down to display other measuring values. Measuring values can be deleted by holding one finger for 1-2 seconds on the corresponding row and lifting it off again. The Query "Delete Measuring Value …. ?" appears (refer to **Figure 7.41.** For active thresholds, the measuring values are displayed in color. Values outside the specification limits are displayed in red with an arrow mark and an indication of percentage deviation from the specification limits. Measuring values within the specification limits are displayed in green.

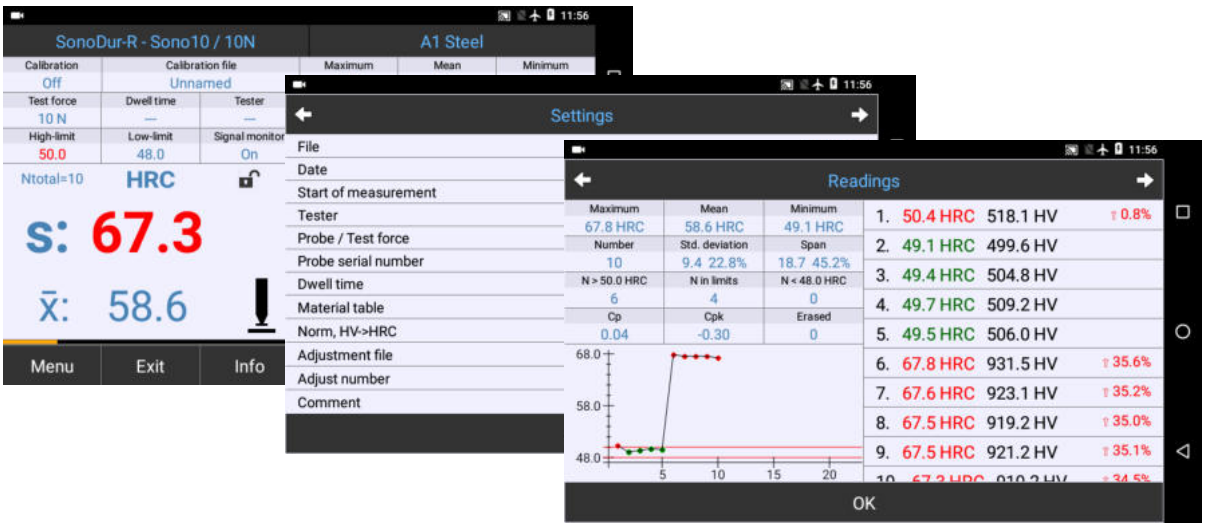


Figure 7.37 Figure 7.38 Figure 7.39

i	NOTE!
Just click on the Minimum or Maximum field to quickly retrieve the minimum or maximum in an extensive series of measurements. The sorting of the measuring value list is changed immediately, the value appears in the first row below the statistics.	

Information on the measuring results with an indication of exceeding or short falling specification limits. (thresholds). If another scale (in this case HRC) is selected rather than the original scale HV, the values of the Vickers scale are always included. The corresponding tolerance thresholds are automatically converted from the original scale to the re-evaluated hardness scale, as well as the summarised results for mean value Xquer, average error of the single measurement σ, Span R, minimum, maximum.

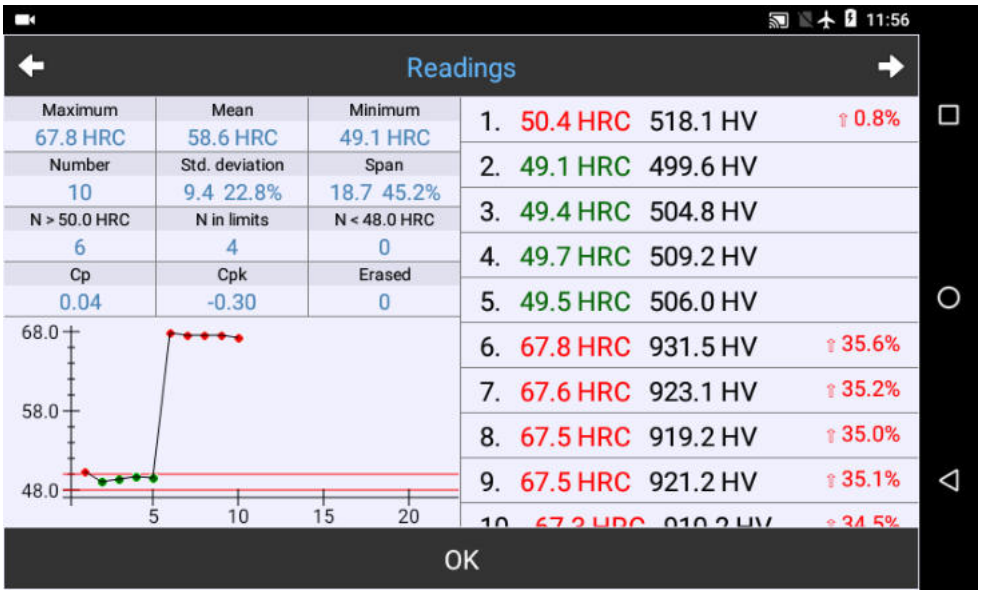


Figure 7.40

<u>Explanation of Statistic (Scale = HRC):</u>

Number of Measuring Values N = 10, 4 measuring values within the tolerance thresholds, 0 measuring values below, 6 measuring values above.
Average value, Xcross = 58.6 HRC, Std.Dev. σ = 9.4 HRC or 22.8 % (of Xcross)
Extreme values: Max = 67.8 HRC, Min = 49.1 HRC, Span R = 18.7 HRC or 45.2 % (of Xcross)
Process parameters: Cp = 0.04, Cpk = -0.30; Deleted values = 0
Measuring values: Green = Ok, Red = outside the tolerance range, X = deleted, Vickers (HV) values for comparison. ⇧34,5% indicates (in percent) how much the measuring value is above the threshold.

Refer to Appendix (Chapter ...) for further explanations of the terms and formulas.

Correction of measurement results by tapping a measured value (in this case **No. 6, 67,8 HRC**) with confirmation (Yes/No) and subsequently restoring of the deleted measured value.

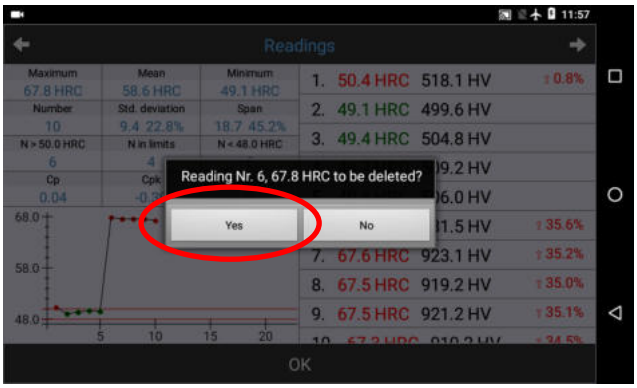


Figure 7.41

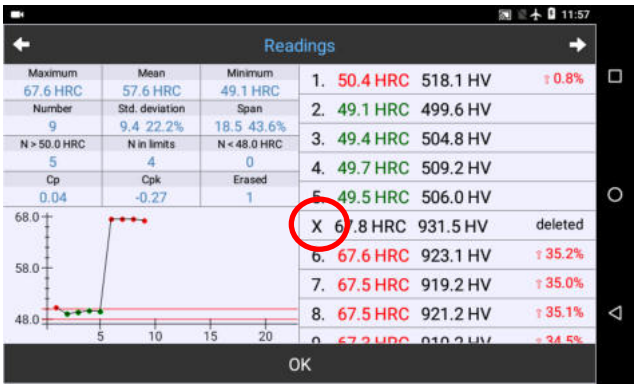


Figure 7.42

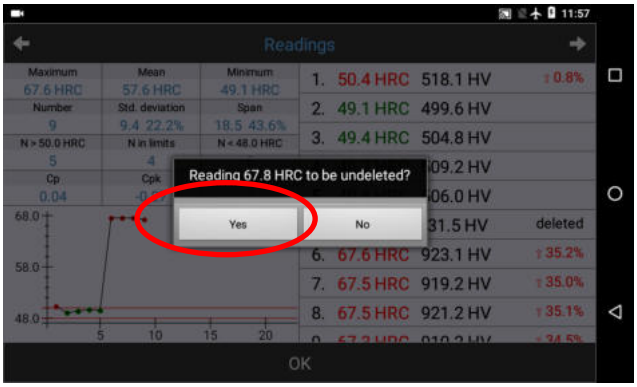


Figure 7.43

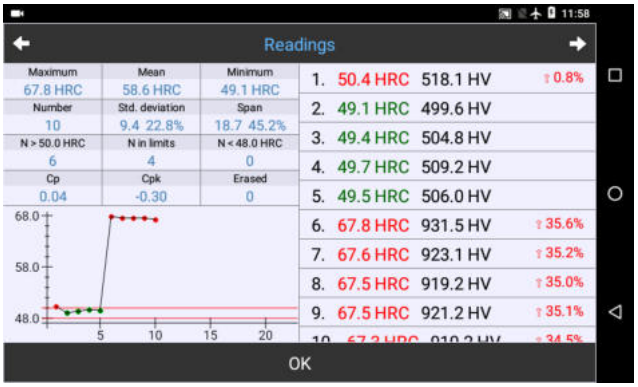


Figure 7.44

Any measuring values can be deleted or restored after analysis. The results are tracked and recalculated for each status.

i	NOTE!
Deleted measuring values are marked with an 'X' in the position column (**Figure 7.42**, red circle) and continue to be displayed, however, are not considered in the statistics calculation! The deletion can be reversed and the measuring value appears at the same position number with recalculation of the statistics.	

7.8 Instrument Menu

Press the Menu button to access the instrument menu with access to all device parameters, the data memory and the adjustment function. Some menu lists are larger as on one screen could be displayed. The menu list can be dragged up and down to make all menu lines visible. A “slider” shows the actual position at the right screen area (see **Figure 7.47**).

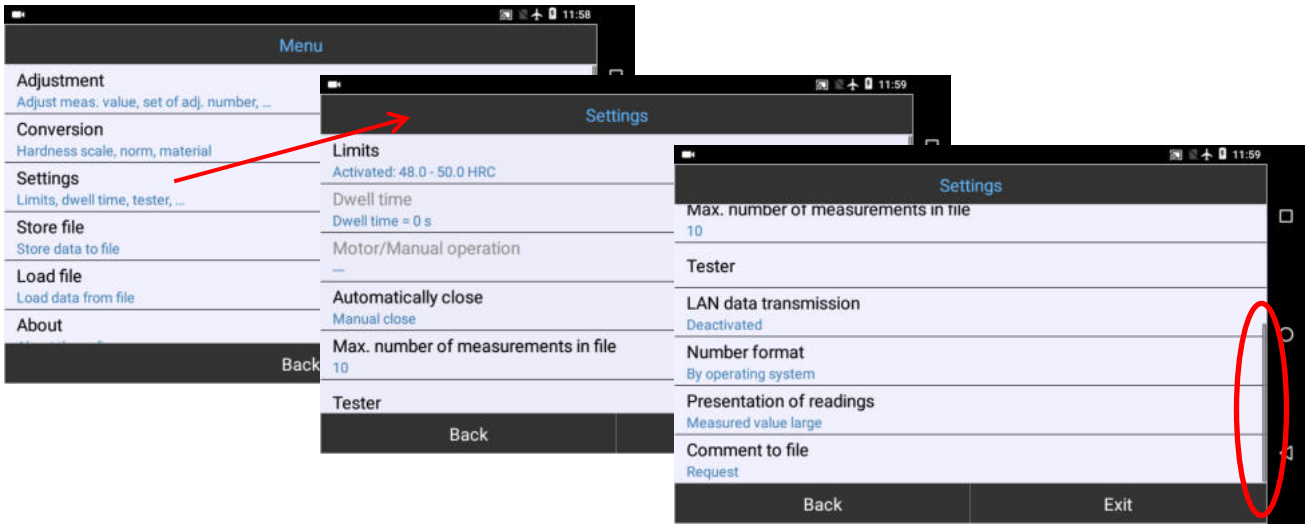


Figure 7.45 Figure 7.46 Figure 7.47

The setting options or current settings are displayed in short form below the respective menu item in blue.
Switching to the selected submenu is invoked immediately by tapping a row. The name of the sub-program is displayed again at the top of the status bar.

7.9 Adjustment

Here, the measuring system can be adjusted to the test material (previously frequently incorrectly referred to as calibration) by determining an adjustment number that includes the material properties (E-Module deviates from low-alloy steel) and is applicable for the specified test method. Such adjustment number depends on the testing force, the probe type (hand-held measuring probe or motor measuring probe) and on the test procedure (penetration time and measuring direction). Saved adjustments only apply to the respective probe type.

The adjustment can be started via the sub-program "Adjust measured value" in which the adjustment number is determined directly via an adjustment measurement directly on the test piece or via "Adjustment number direct" and the direct input of the adjustment number without performing an adjusting measurement, in which case all measured values will be immediately recalculated based on the directly entered adjustment number.

7.9.1 Adjusting the measuring value

There are 3 ways to perform an adjustment:

- Adjustment by using the measured values of the already recorded measurement series.
- Recording a new measurement series.
- Input of an adjustment number, if such number is already known.

7.9.1.1 Adjustment with current measured values

If a current measurement series is to be used for adjustment purposes, the process shown in the following illustrations must be followed. The question "Use recorded readings for the adjustment?" shall be acknowledged within "Yes" in this case.

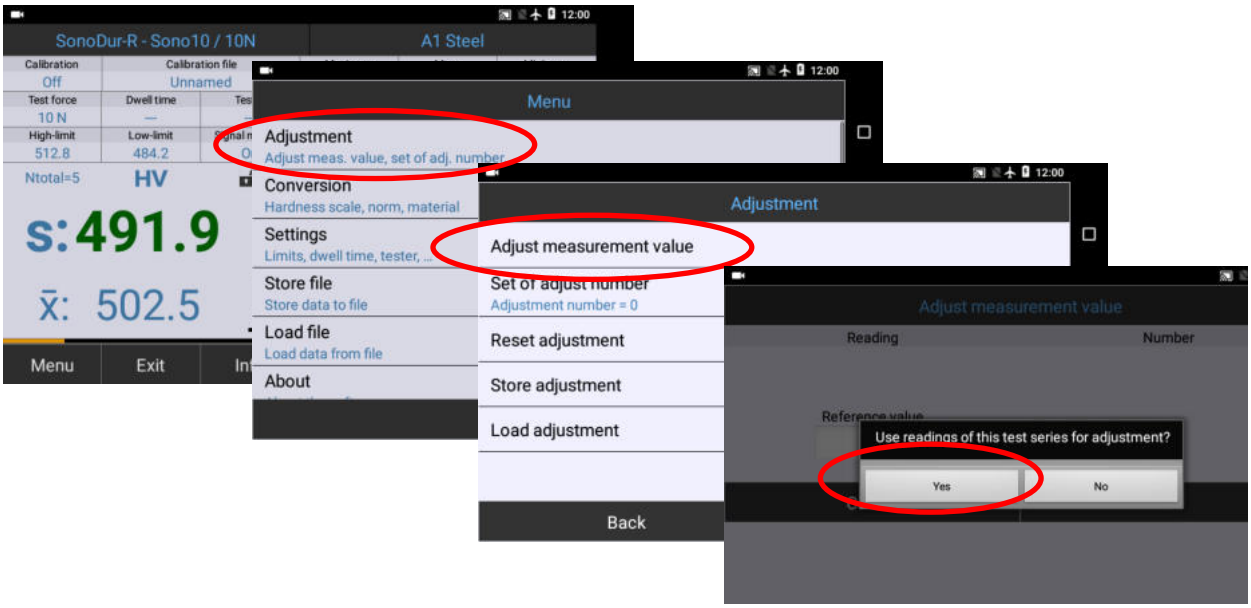
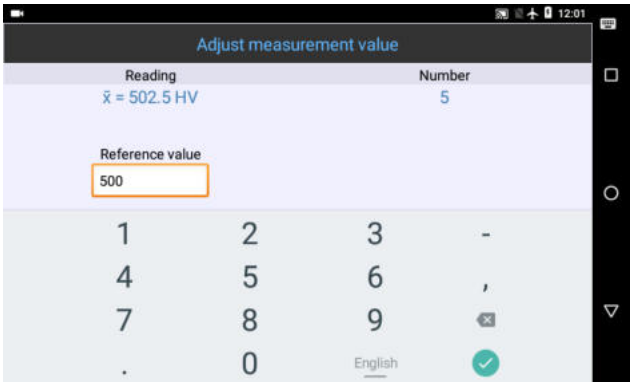


Figure 7.48 Figure 7.49 Figure 7.50 Figure 7.51

The mean value of the current measurement series is displayed in the "Setpoint" field, which can now be changed to the desired reference value. Following the confirmation by clicking "OK", the question as to whether a new measurement series should be started, will be shown. If the answer is "No", the measured data will be converted with the new adjustment number and the measurement series subsequently continues (refer to **Figure 7.54** and **Figure 7.55**. If the answer is "Yes", SonoDur will ask if the data should be saved. If this answer is also "Yes", the sub-program "Save data" will be invoked, refer to **Chapter** Fehler! Verweisquelle konnte nicht gefunden werden. Only if this step has been completed, will a new measurement series be started and the measurement counter will be set to N = 0.



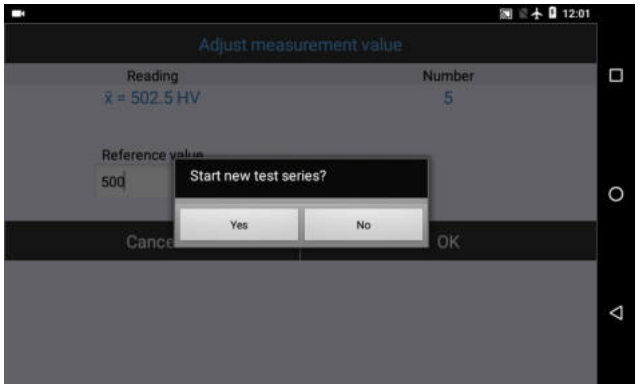


Figure 7.52 Figure 7.53

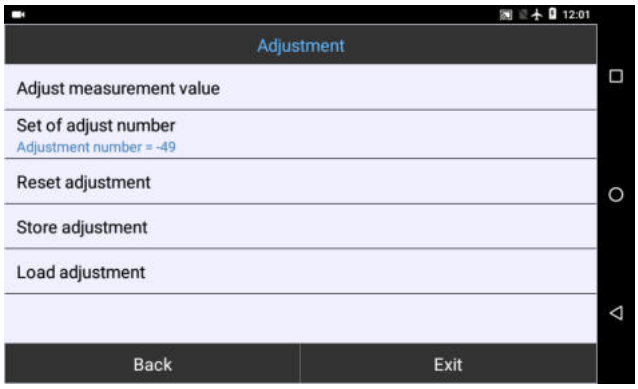


Figure 7.54

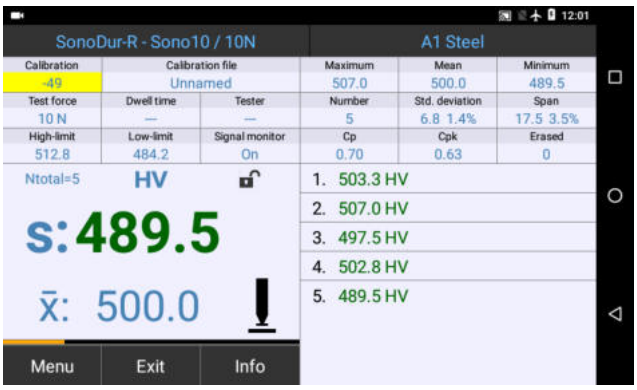
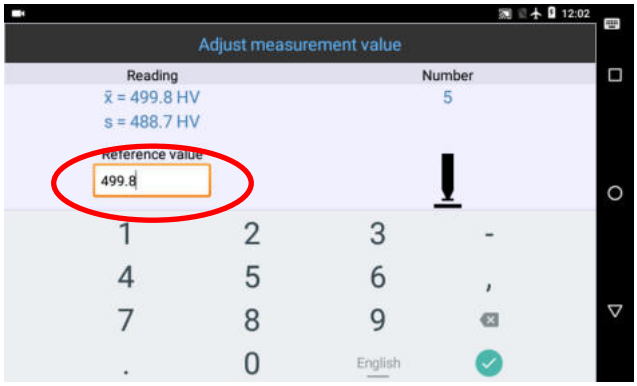


Figure 7.55

7.9.1.2 Adjustment by means of a new measured value recording

If the question "Use recorded readings for the adjustment?" was answered with "No", or if no current measured values are available, the new measured values for adjustment must be included in the submenu "Adjust measured value".
Thereafter, the target value must be changed to the reference value, as described above.



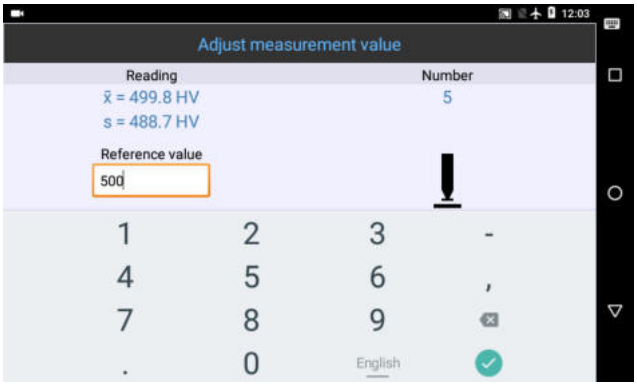


Figure 7.56 Figure 7.57 Figure 7.58

i	NOTE!
The procedure described in **Chapter 0** has the advantage that info key in the measurement menu can be used to analyze the individual measured values in advance, so that any outliers can be detected and eliminated. As a result, a "better" adjustment measurement is possible from the outset, because this correction option for individual measurements is not provided otherwise.	

7.9.2 Adjusting number directly

If the adjustment number is already known, it can be entered directly by selecting "Direct adjustment number". If a series of measurements is available, a question is raised again on whether a new series of measurements should be started or not.

If the answer is "No", all measured data will be converted with the new adjustment number and the measurement series subsequently continues (refer to the figures below).

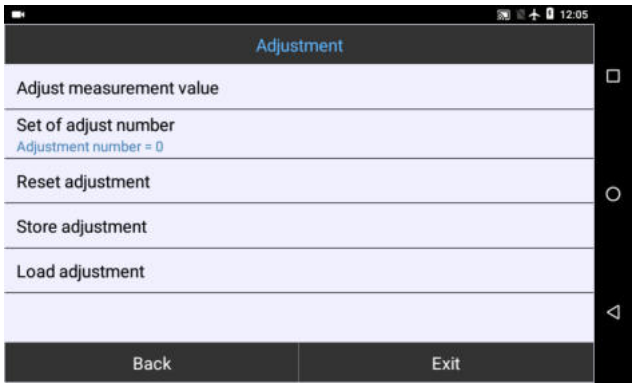


Figure 7.59

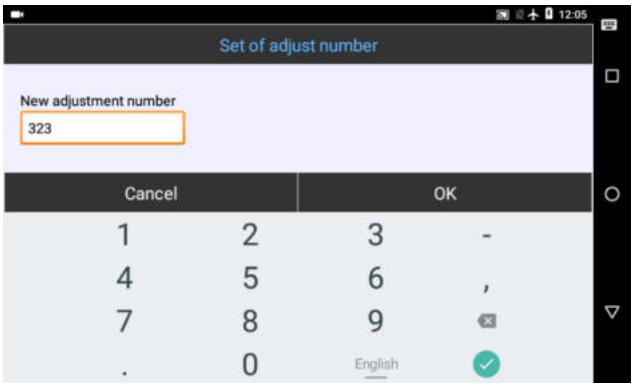


Figure 7.60

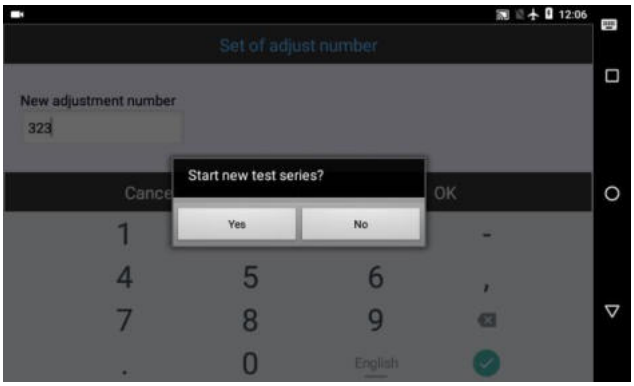


Figure 7.61

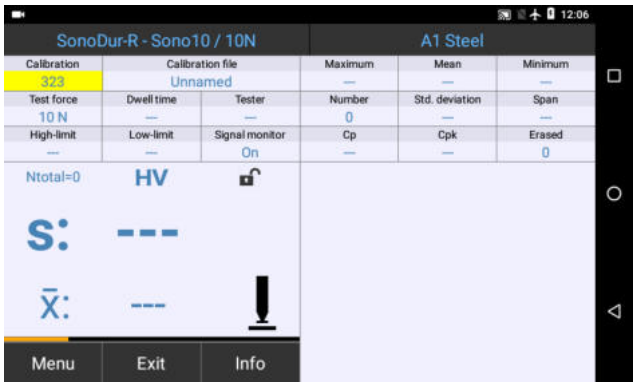


Figure 7.62

If the answer is "Yes", the question on whether the recorded dataset shall be saved, will be raised. If the answer is "Yes", the submenu "Save file" will be invoked and a new measurement series will be started and the measurement counter will be set to N = 0, once the files have been saved.

7.9.3 Deleting Adjustments

When "Yes" is clicked, the adjustment number will be reset to 0 = low alloy steel, if an adjustment already exists (**Figure 7.64)**. Beforehand, it is again asked whether the measurement series should be retained or not and the option to save the measurement series will also be provided.

Figure 7.63

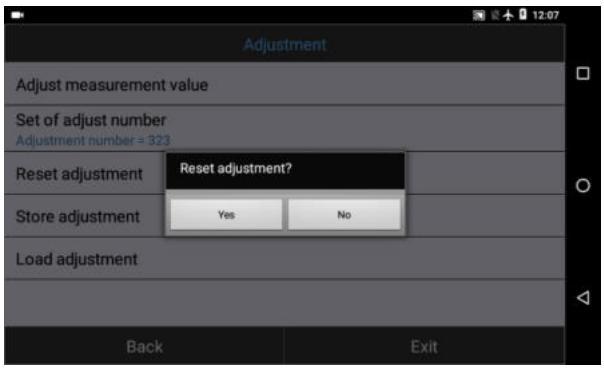


Figure 7.64

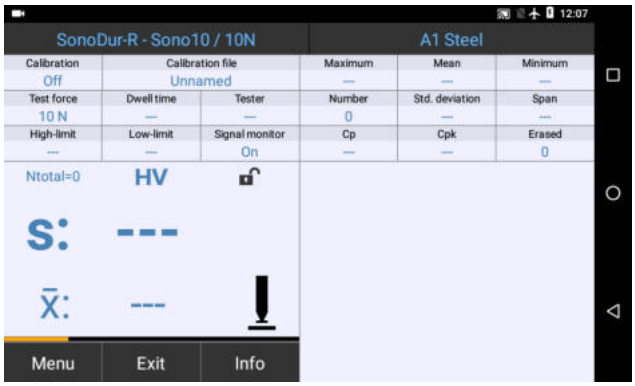


Figure 7.65

i	NOTE!
<u>If a Material Table other than A1 is selected</u> (e.g., F5 with the corresponding adjustment number), **<u>the adjustment cannot be deleted</u>**, but may be reset to the initial adjustment value for the respective material. In such case, the Material Table A1 must be selected before the adjustment can be subsequently deleted!	

7.9.4 Saving and Loading Adjustments

The completed adjustment can be easily saved as shown below. The program will propose a designation (in this case adjustment), which can be changed (My_Cal). Calibration will be the default folder.

i	NOTE!
In case the adjustment is not intended to be stored in the Calibration folder but in a different folder; such folder must first be created by using the file manager of the operating system.	

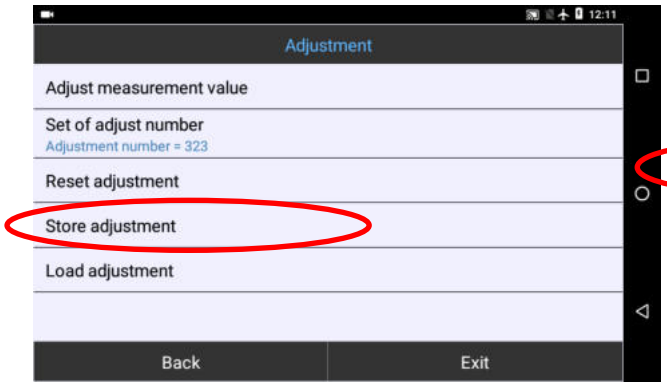


Figure 7.66

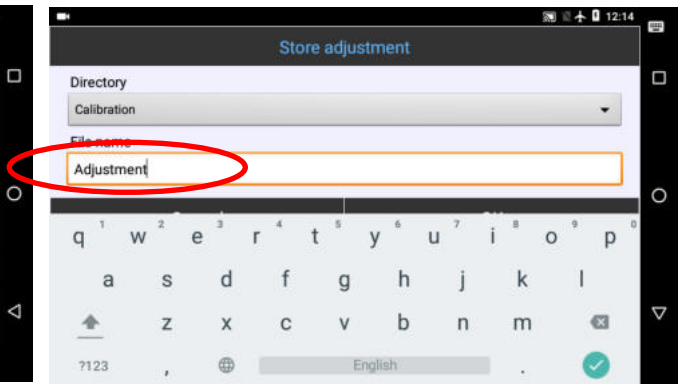


Figure 7.67

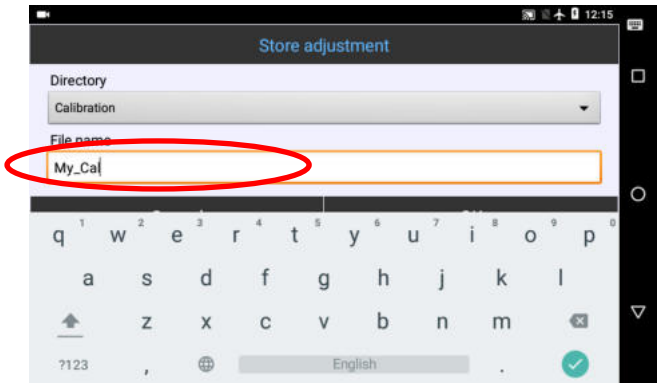


Figure 7.68

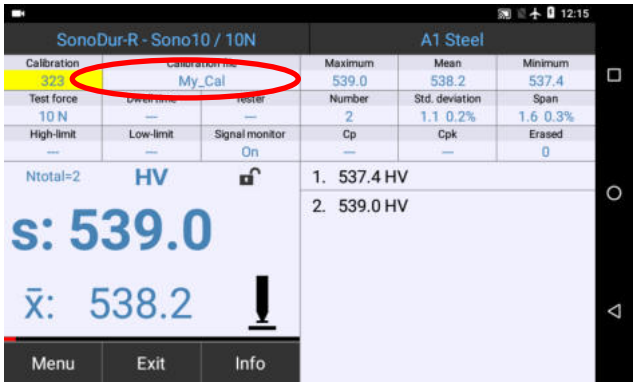


Figure 7.69

7.9.4.1 Load Adjustments

A stored adjustment can be reloaded at any time; refer to the following illustrations.
If applicable it is asked whether the measurement series should be retained or not and the option to save the measurement series will also be provided.

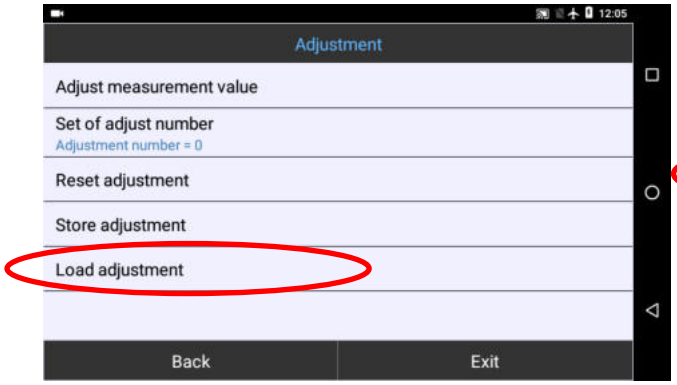


Figure 7.70

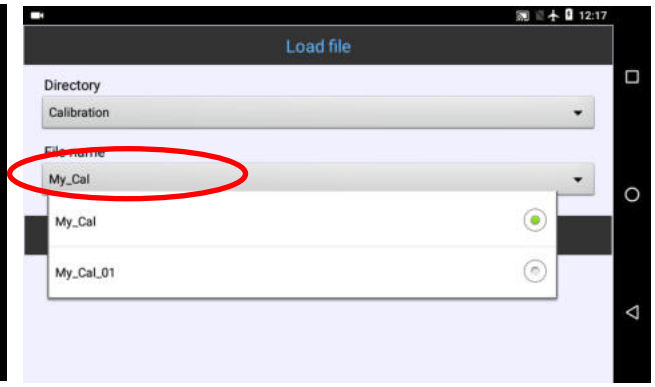


Figure 7.71

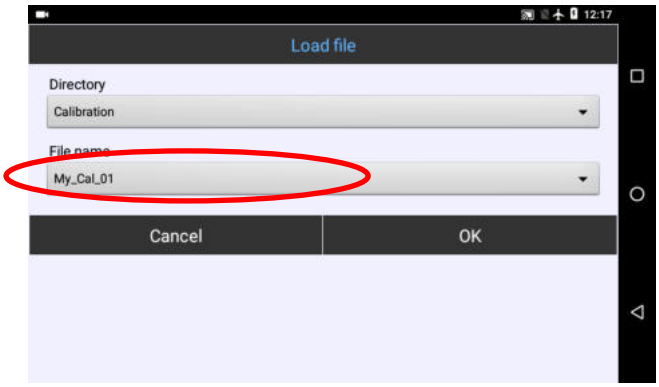


Figure 7.72

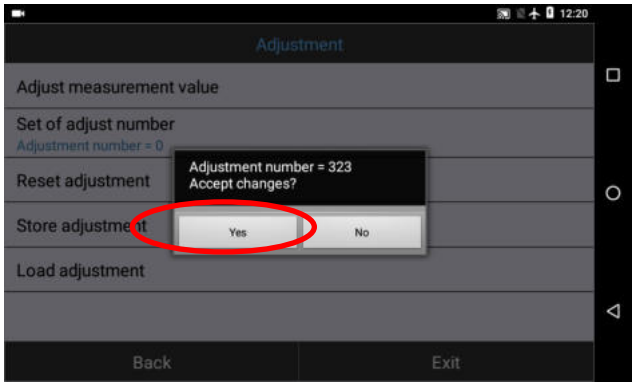


Figure 7.73

i	NOTE!
Adjustments are basically dependent on the selected testing force or probe type. If an adjustment file with a different testing force than the connected measuring probe is selected, an error message will be displayed (**Figure 7.74**).	

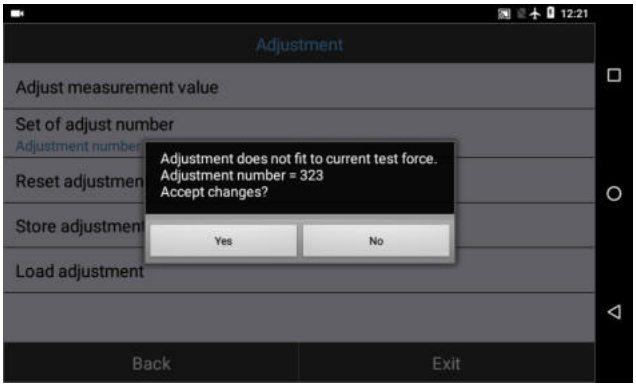


Figure 7.74

Practical experience gained from the very low exemplary scattering of SonoDur probes has shown that the adjustments with different testing forces and for all types of probes result in a very good concordance. Therefore, no distinction, e.g., for the adjustment number CAL, has been made between testing forces in the material tables F2, F3, F4, F5 (EN ISO 18265) or T4, T7, T8, T9 (ASTM E140). In any case, the use of a first approximation of an adjustment result for other testing forces is correct for the correction of the E-Module influence, provided that no surface effects (hardening layer, roughness) represent issues.

⚠	**WARNING**
Therefore, calibration data can in principle also be used for test probes with different testing forces. However, this resides in the responsibility of the tester. In case of doubt, a probe with suitable testing forces should be chosen!	

7.10 Conversions

7.10.1 Hardness Scale

The hardness scale can be accessed directly by tapping the current scale in the measurement menu or via Menu -> Conversions.

7.10.2 Standard (Norm)

The most recent versions of the two conversion standards are available according to ASTM E140 and EN ISO 18265, respectively - status 2015.

⚠	**WARNING**
Please absolutely comply with the conversion limits. When exceeding or falling below these values (e.g. in the HB scale), the message **Outside the HB conversion** will be issued and the info window will display the measured values as being deleted (also refer to the representation of the measured values outside the conversion limits, **Section 7.10.4 Presentation of the measurement values outside the conversion limits**).	

7.10.3 Materials

The reference relationships contained in EN ISO 18265 can be taken into account and the corresponding adjustment number can be automatically loaded by selecting "Material" (**Figure 7.75**).

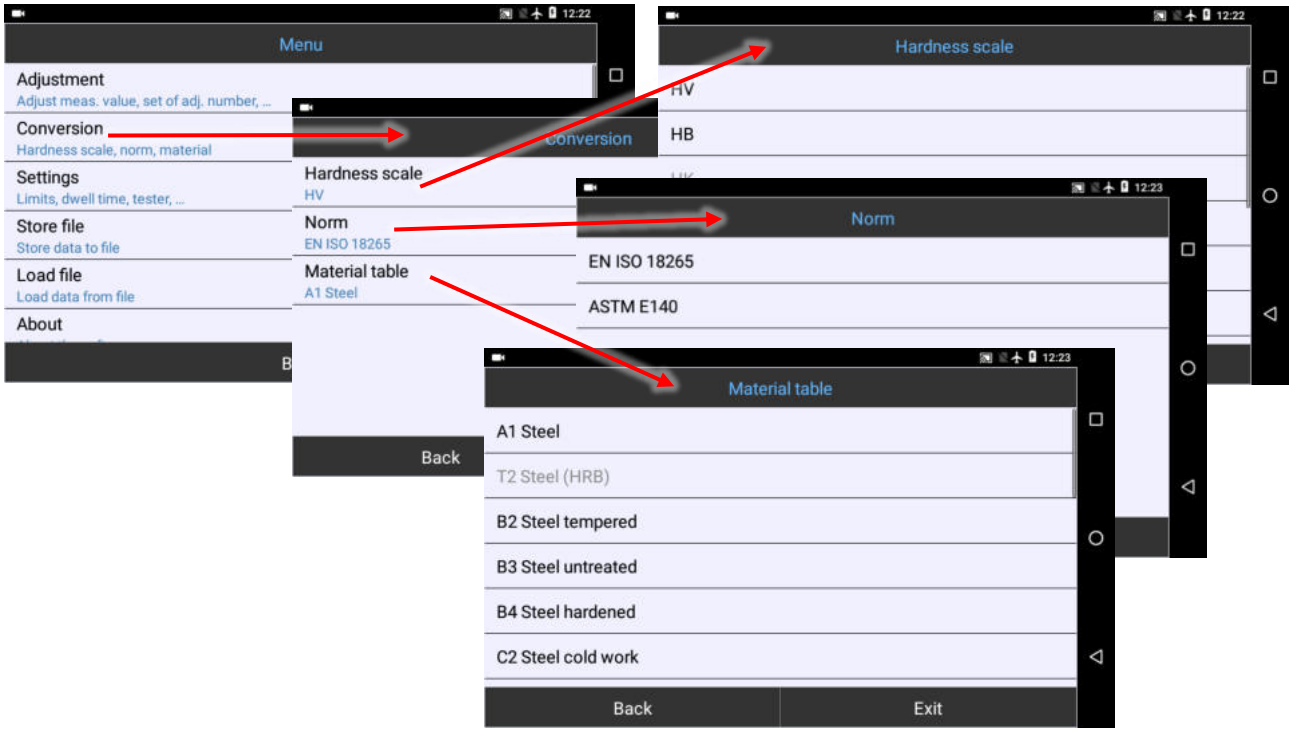


Figure 7.75

i	NOTE!
Some conversions are only defined in one standard, e.g., the conversion to "HK" is not defined in EN ISO 18265 and can therefore not be selected. The standard "ASTM140" must be selected in such cases.	

7.10.4 Presentation of the measurement values outside the conversion limits

The conversion tables according to EN ISO 18265 and ASTM E140 have different ranges for the different materials. For SonoDur devices, the load-bearing Vickers Hardness scale applies which always has a measurement value. If no value pairs in HRC, HB, etc. are available for certain scales, an extrapolation is initially attempted. If this results in no result, the operator must choose a different hardness scale for the existing measurement series or return only to the Vickers presentation. The extrapolated values are in any case not covered by standard values and are subject to a high degree of uncertainty. Therefore, they will be represented in **red** and offered to the operator for use.

- When slightly exceeding or falling below the conversion limits of the respective standard, a conversion by extrapolation will be performed and the measured value will be marked in red.
- No measuring value appears outside the extended conversion limits*, but the message "**Outside HB**" (when the HB scale is selected) will be issued. These measured values will be marked as being deleted in the information menu, and displayed as dashes (**Figure 7.77**). The last valid measured value will be displayed upon the return to the measuring menu..

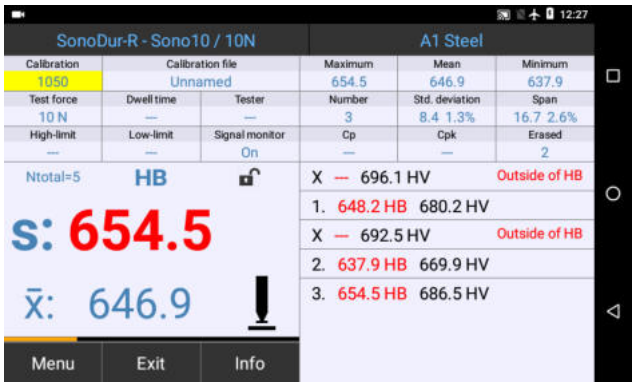


Figure 7.76

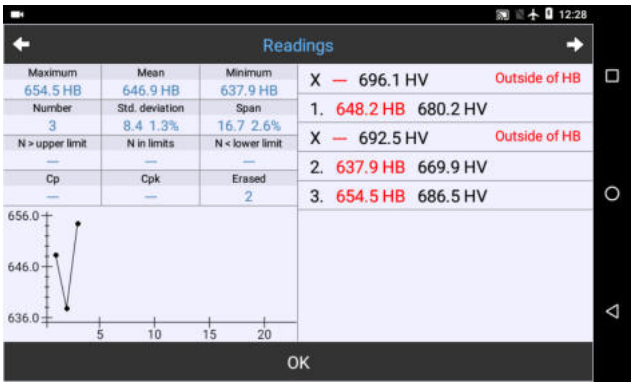


Figure 7.77

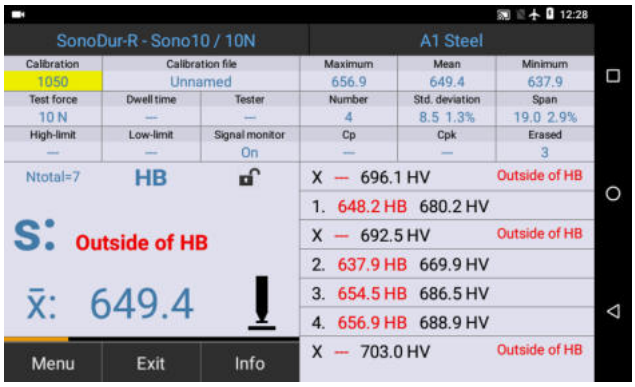


Figure 7.78

⚠	**WARNING**
The extended conversion limits* represent a continuation of the relationships specified in EN ISO 18265. However, the responsible person must make the decision on the permissibility of a conversion from the calculated Vickers Hardness into another hardness unit based on such persons instructions and experiences.	

7.11 Settings

7.11.1 Thresholds (Specification Limits)

If no thresholds have been defined (**Figure 7.79**), the maximum tolerance range for the selected hardness scale will be displayed for selection. After entering new tolerance limits and returning to the measurement menu, the thresholds will also be displayed in the graphic.

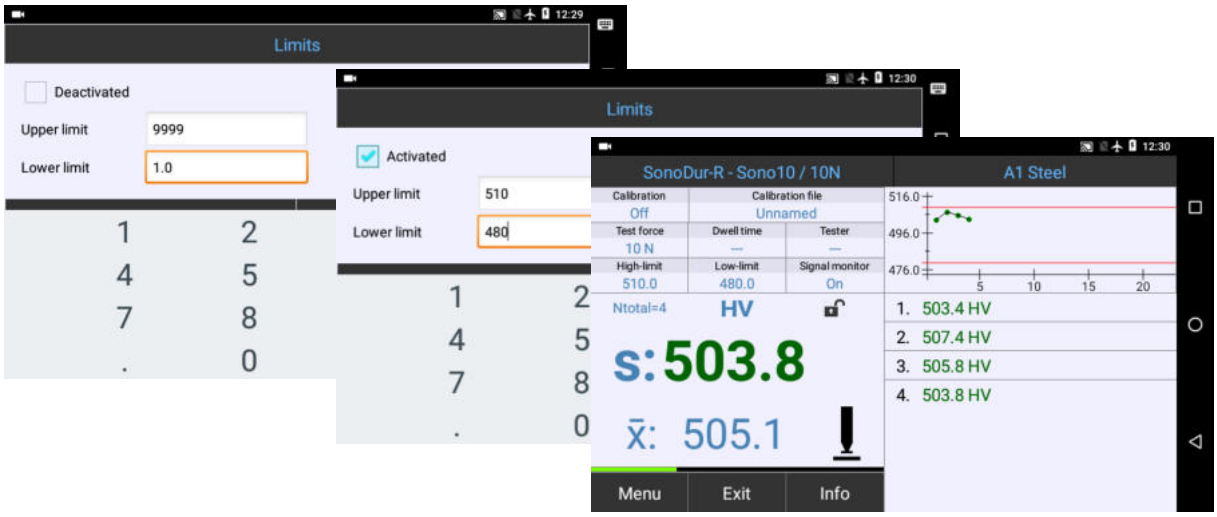


Figure 7.79 Figure 7.80 Figure 7.81

i	NOTE!
Using "Threshold active", the selected tolerance thresholds must be switched on (tick mark, **Figure 7.79**). Tolerance thresholds can be set at any time during the measurement in order to optimize the results analysis.	

7.11.2 Penetration time (Dwell Time)

According to the motor probe specifications, the penetration time may be set to a value between 1 and 99 seconds (Figure **7.83**). An error message will be generated, which must be acknowledged by using the OK button in the display field, if the input value is outside the permitted limits. Subsequently the original numerical value, which can then be corrected in the input field, will be displayed again. If the penetration time is modified, any current measurement series must be ended and a new measurement series must be started (**Figure 7.85**).

⚠	WARNING
The penetration time for hand-held measuring probes is preset to the fixed value of 0 s which cannot be changed. Please check this setting in any case, otherwise incorrect measurements are possible.	

Setting the penetration time (motor measuring probes only!):

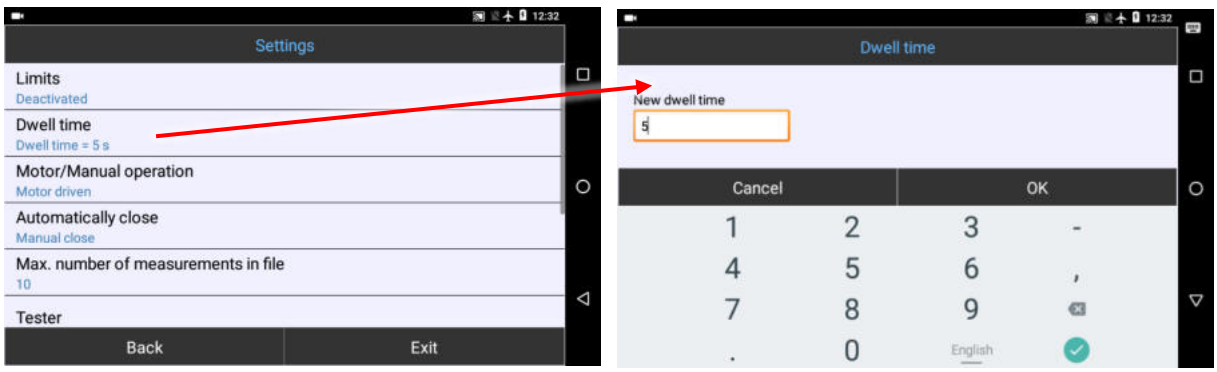
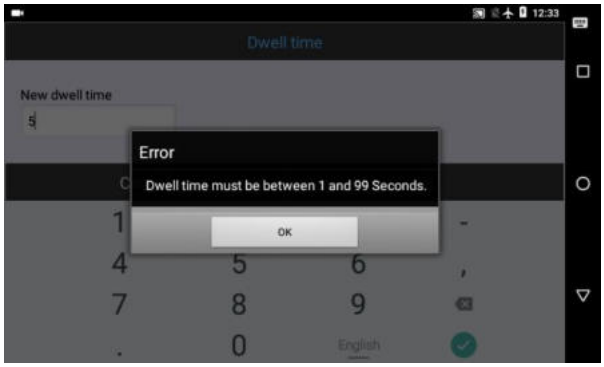


Figure 7.82 Figure 7.83



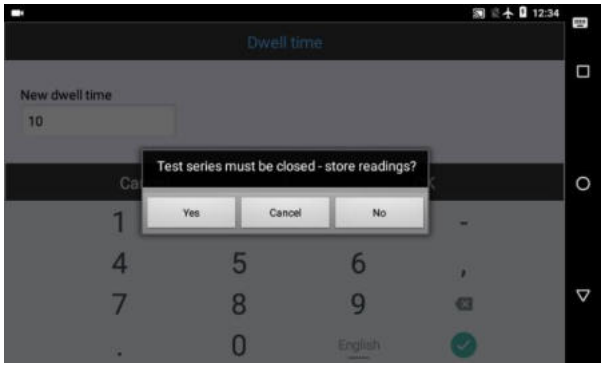
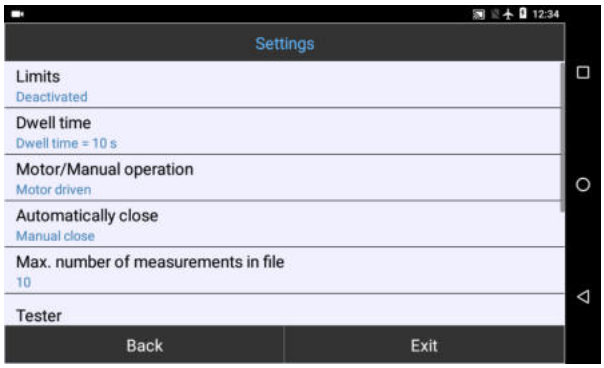


Figure 7.84 Figure 7.85

7.11.3 Motor / Manual

The operating mode for motor measuring probes can be set in the Motor/Manual (refer to **Figure 7.87)** menu (also refer to "Performing a measurement with motor measuring probes"). Switching between the (automatic) motor operation and the manual operation of the motor probe will extend the vibrating rod. When touching the surface, the measuring start will commence automatically. The measuring value will be generated and displayed when the set penetration time has elapsed. In this context, the motor probe behaves similar to a hand-held measuring probe, but features an adjustable application time of the testing force.



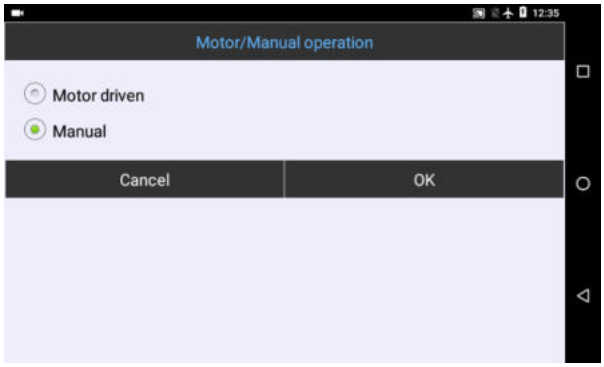


Figure 7.86 Figure 7.87

7.11.4 Automatic Closing

This function opens the setting options for the default storage of measurement series.

7.11.4.1 Manual Closing

The factory setting is "Manual Closing"; in this case, the user must save the measurement series at the appropriate time via the "Save File" menu.

7.11.4.2 Semi-automatic Closing

When choosing semi-automatic closing, the number of measurements can be pre-selected and will be shown in rectangular brackets. The dialogue for saving the series of measurements will be invoked once the preset number of measured values + 1 (6 in this case) is reached.

If the answer to the question "End measurement series?" is "Yes" (**Figure 7.89**), the same menu will be invoked as for the saving of files. Following the saving process, the last measured value (No. 6) will be displayed as the first measured value of the new series of measurements (**Figure 7.92**).

If the Question "End measurement series" is answered with "No", the measurement series will be continued and the count N for the number of measurements will be incremented by each measurement refer to (**Figure 7.93,** here **N=9,**). There is now no further question as to whether the measurement series should be concluded, this must then again be performed manually.

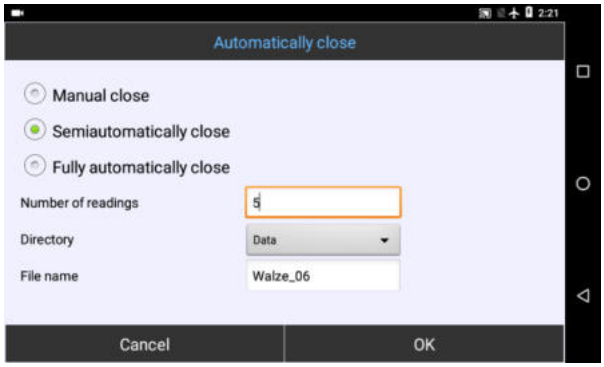


Figure 7.88

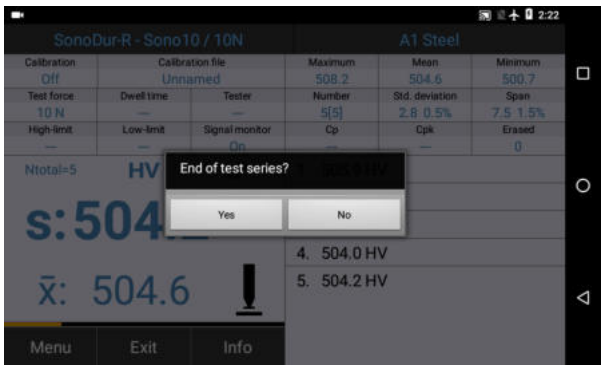


Figure 7.89

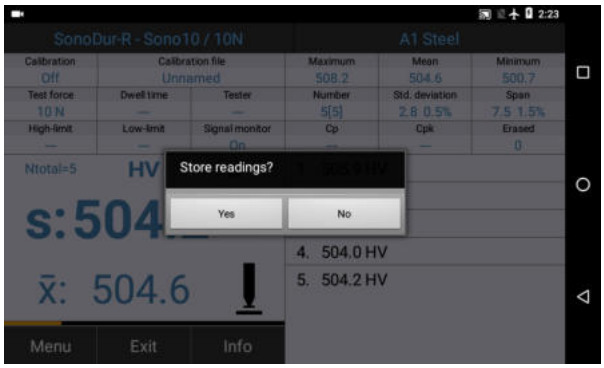


Figure 7.90

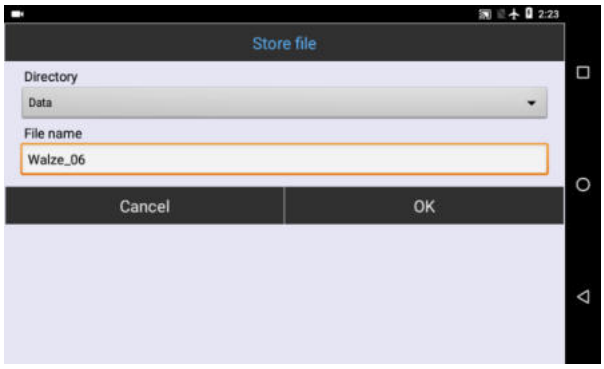


Figure 7.91

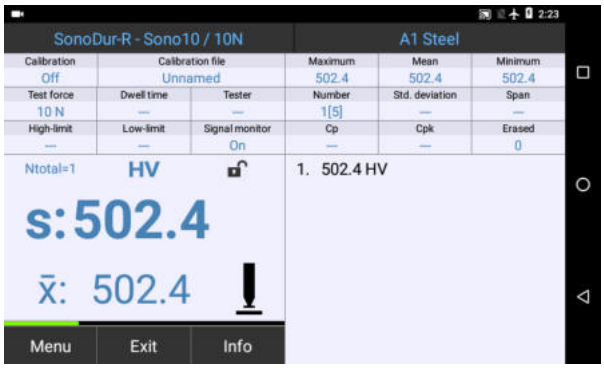


Figure 7.92

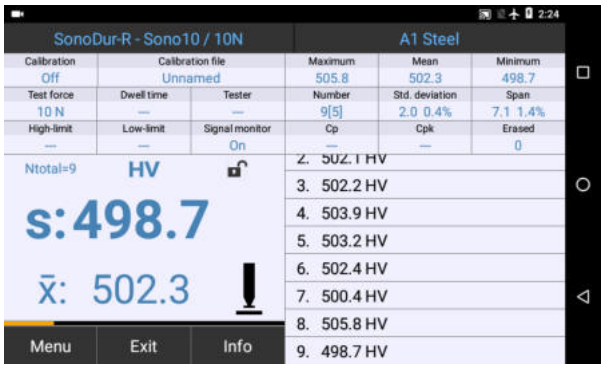


Figure 7.93

7.11.4.3 Fully-automatic Closing

This is particularly advantageous in cases where many measurements (at different test positions) must be carried out for a test object. The number of measurements per measurement series can be specified (at least 5) and will be indicated by a square bracket (**Figure 7.96**) in the measurement

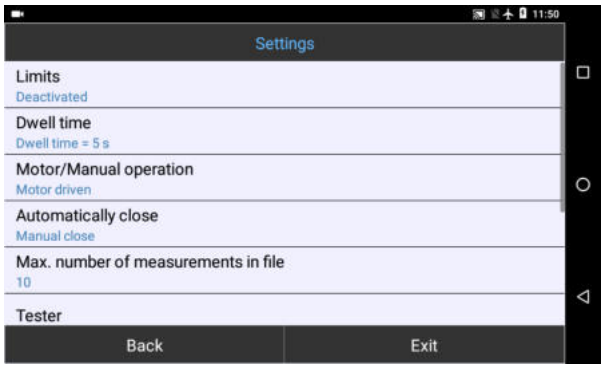


Figure 7.94

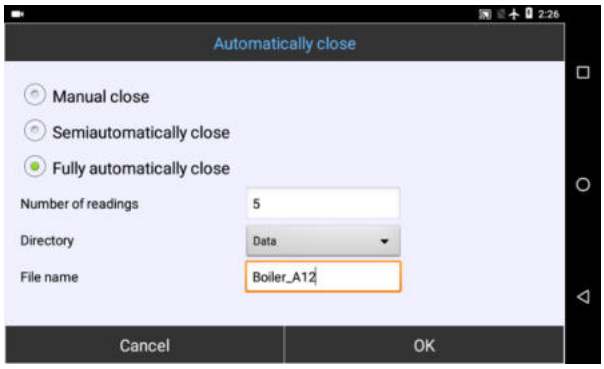


Figure 7.95

menu. If the counter N for the number of measurements (in this case still 0) reaches the value in the square brackets +1, the current series of measurements will be saved automatically.

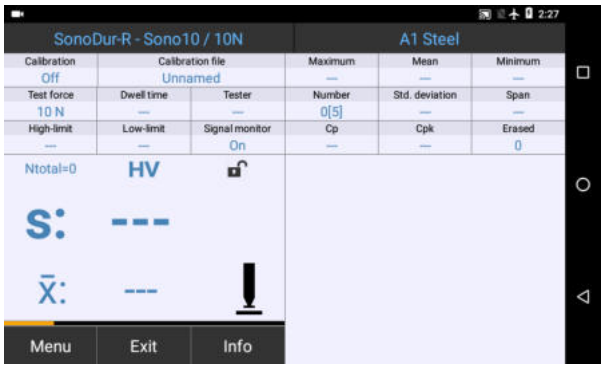


Figure 7.96

The last used file designation, possibly with indexing (index increase +1 so that the existing file is not overwritten) will be suggested as file designation. This designation can be edited if necessary.
When selected Fully-automatic Closing, the current measurement series will be stored under the entered file designation (in this case Boiler), once the number of measured values has been reached. Further measurements will be stored as Boiler_01, Boiler_02 etc. following every 5 measurements. In order to prevent the overwriting of existing files, the index of already existing files will be extended by +01; refer to the example below:

Boiler_A12	new Designation, 1. Save
Boiler_A12_01	2. Save
Boiler_A12_02	3. Save
Boiler_A12_02_01	4. Save, Designation Boiler_A12_02 already exist!
Boiler_A12_02_02	5. Save
Boiler_A12_02_03	6. Save

i	NOTE!
The actual measuring set is not stored, if the number of measurements equals the pre-setting value! It is necessary to take one more measurement!	

7.11.5 Maximum Number of Measurements in one File

This setting defines the number of readings in the actual measuring set, the valid range is 5 to 1000. If more than 1000 measurements are taken, the oldest values are being deleted and will not considered in the statistics any more. The memory works like a FIFO memory (First in – First out)

In the example below the number of measurements are set to 5, so there will be only the last 5 readings visible and used for the statistic. The measuring counter for the total number of readings Ntot equals 17, so the first 12 values have been deleted.

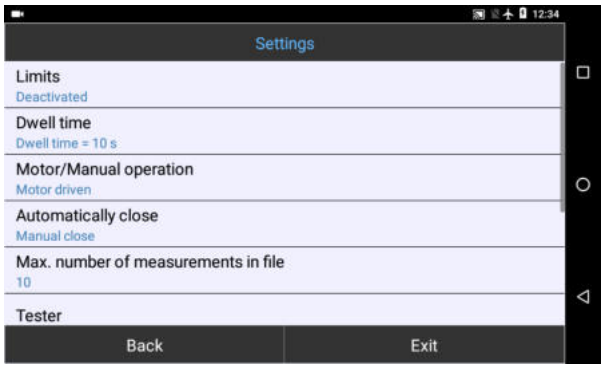


Figure 7.97

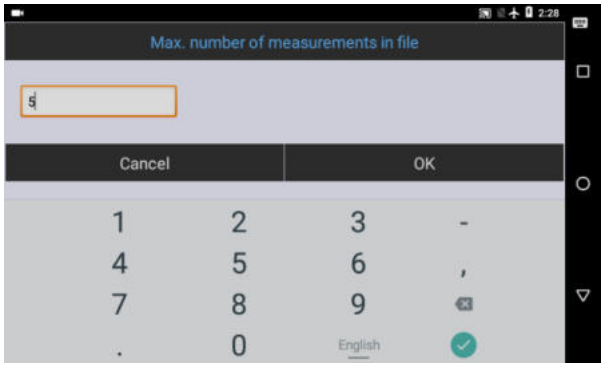


Figure 7.98

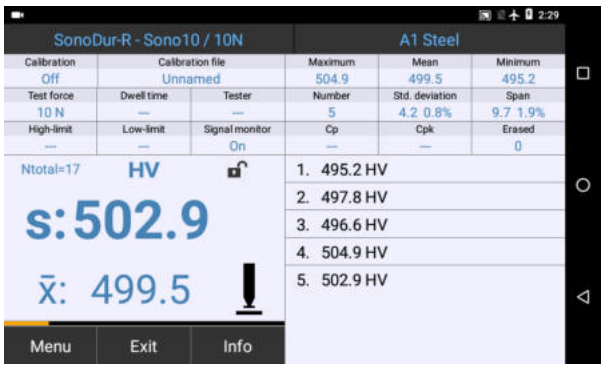


Figure 7.99

7.11.6 Tester

SonoDur-R offers the option to personalize the measurement results. For such purpose, the "Device menu" must be exited and "Tester" must be invoked in "Settings". The name of the tester can be entered by using the keyboard (refer to Figure **7.102**) or selected from a list. The List of Testers will be automatically created, once a tester is defined. A name can be deleted from the list by using "Delete entry". The list will be stored as "TesterList.txt" in the SonoDur_System folder and can also be edited manually.
Direct access is available via the "Tester" button in the measurement menu. The name of the tester also appears in the headers of the stored data.

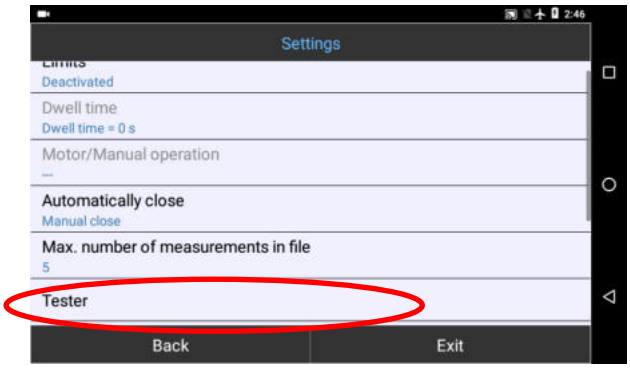


Figure 7.100

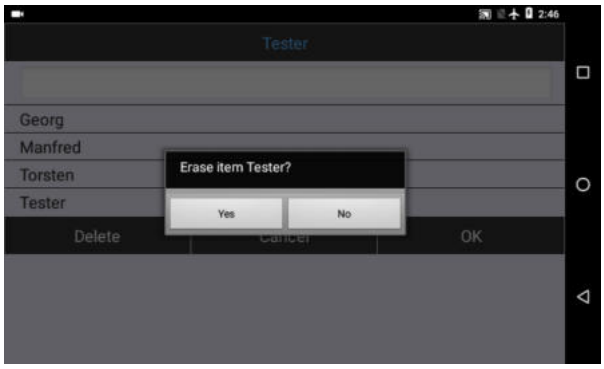


Figure 7.101

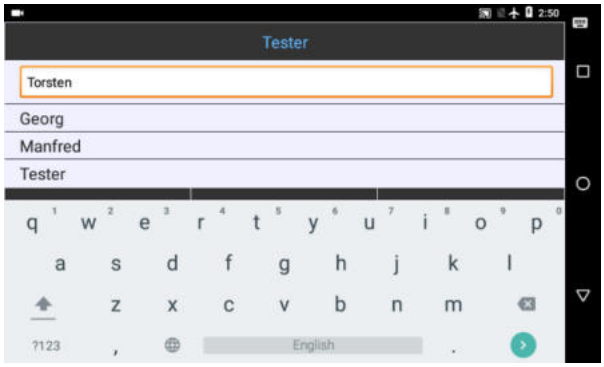


Figure 7.102

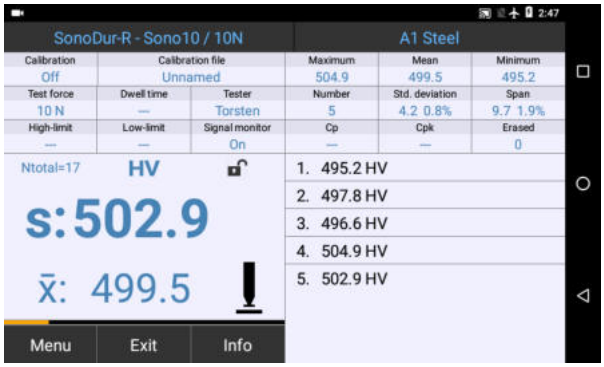


Figure 7.103

i	NOTE!
If the list has more than 3 entries, the buttons **Menu Exit** and **Info** will be covered from the system keypad. Please use the back button ▽ to close the system keypad!	

7.11.7 Number Format

This setting enables a user-specific representation of the data using a dot or a comma as separator or automatically depending on the locale. The advantage is that the data format can be adapted to the existing structure during further processing.

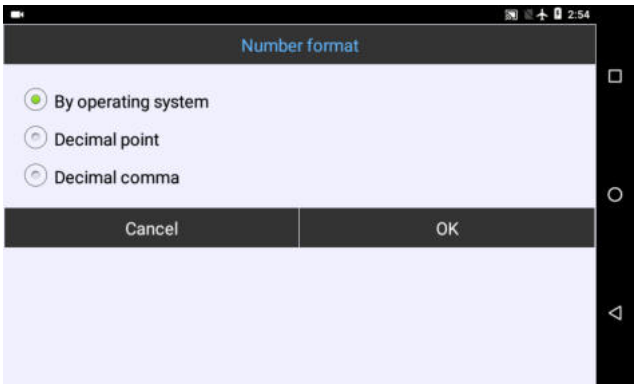


Figure 7.104

7.11.8 Presentation of Measuring Value

The display of the mean value and the last measured value can be changed in Settings -> Measurement display. This causes an interchange of the representation of the mean value and the individual value. In the example below, the single value (small) is now displayed after the mean value (large).

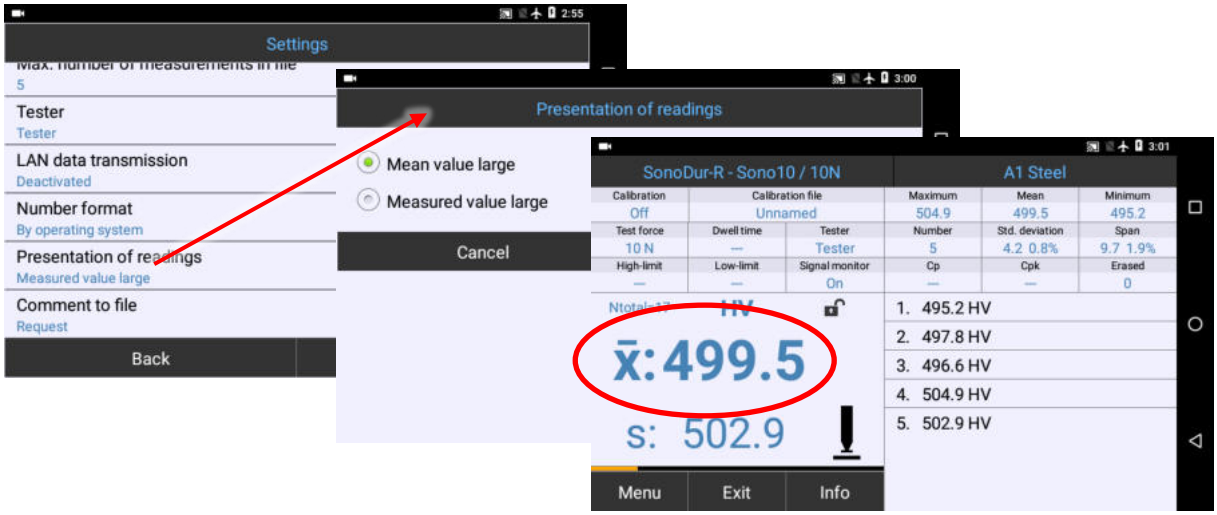


Figure 7.105 Figure 7.106 Figure 7.107

⚠	**WARNING**
At the factory, SonoDur is set to "Mean value large". It must be ensured that the correct setting is selected so that the correct measured value can be read!	

7.11.9 Comment Function

To every measuring set a short note can be added. To use this function, it must be enabled first: Change to Settings -> Comment to file and select “Request”.
When storing a measuring set, a message box appears displaying “Add a comment to file?”. If the question is answered with “Yes”, an input field opens.

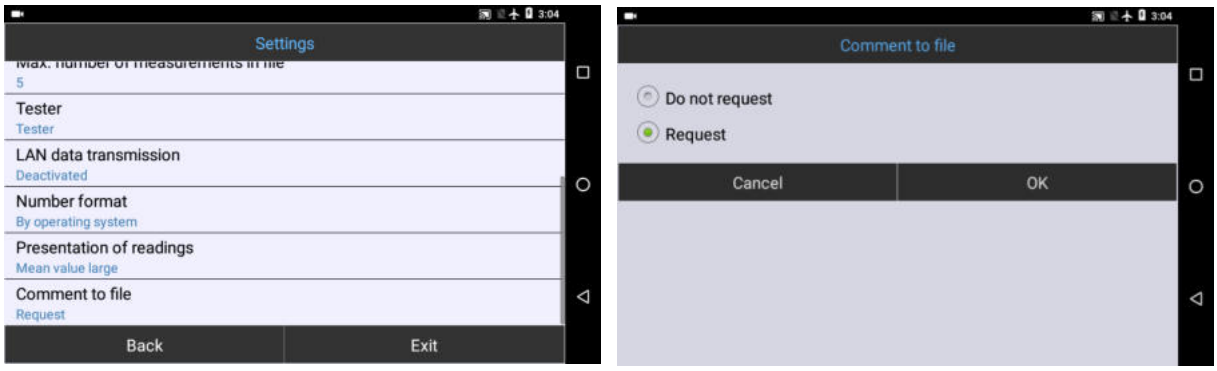


Figure 7.108 Figure 7.109

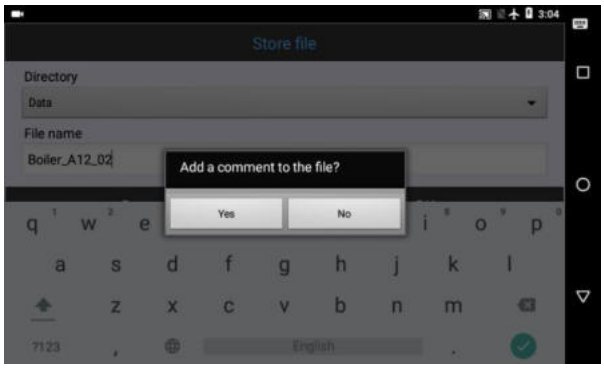


Figure 7.110

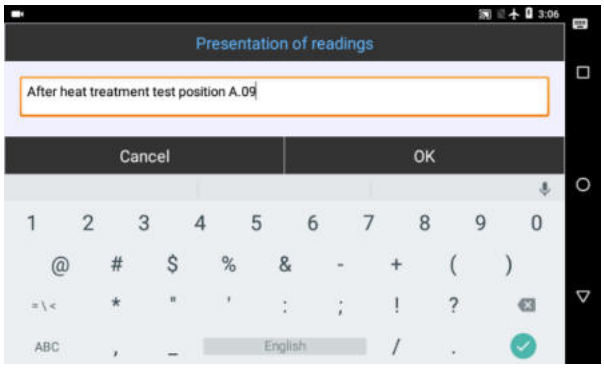


Figure 7.111

7.12 SonoDur Data Processing

SonoDur-R provides the ability to save, recall and transfer measurement data to external computers.

7.12.1 Storing Data

Measurement data can be saved with a designation and recalled at any time via the device menu. Furthermore, SonoDur-R asks when exiting the measurement series via the **Exit** button, whether the measurement data should be stored or not. This also applies in the case where the test procedure is to be changed (penetration time, new adjustment number). If the question is answered with "Yes", the device menu for storing measurement data will be invoked. SonoDur suggests a file designation and increments it by one each time a new series of measurements is started. An error message will be issued if the record is saved using an already existing designation (**Figure 7.113**) in this case chose another name.

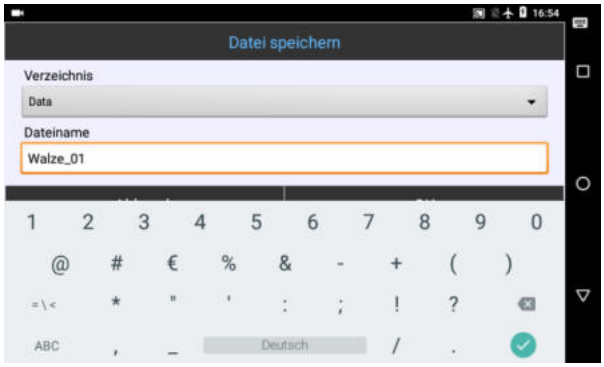


Figure 7.112

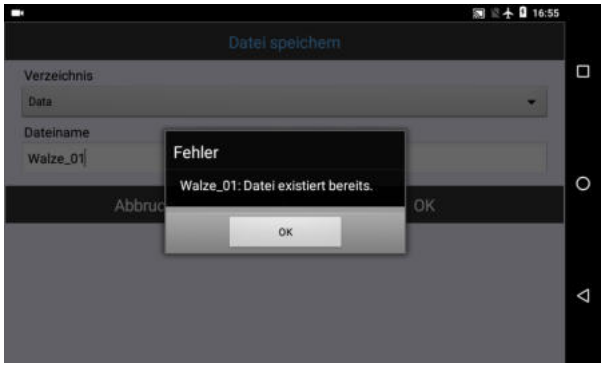


Figure 7.113

i	NOTE!
The "Data" area is predefined as data folder. A new storage location cannot be created in the test program; such task must be performed by using the file manager of the operating system.	

7.12.2 Opening File (Load File)

If "Load file" is invoked in the "Device menu", any stored measurement series can again be displayed. The accessible program area is restricted to the information area, i.e., the data can only be viewed (**Figure 7.114** bis **Figure 7.119**). The current measurement series must be closed before a file is opened that can be saved.

No more changes are possible (measuring value correction) and tapping on a measuring value row will result in an error message, which can simply be deleted by using the "OK" button.

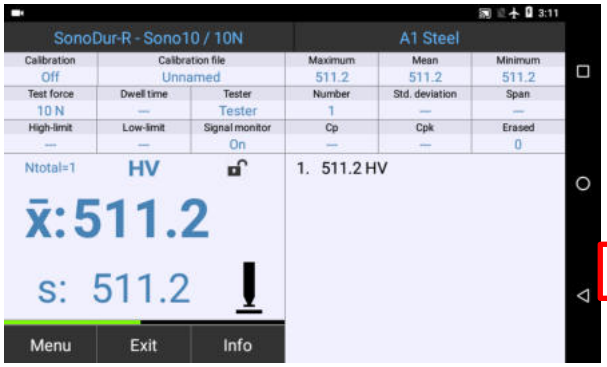


Figure 7.114

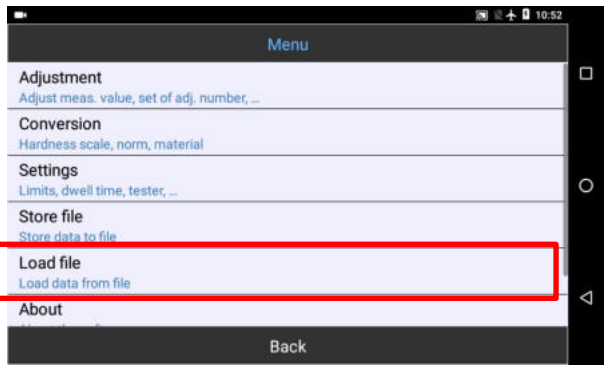


Figure 7.115

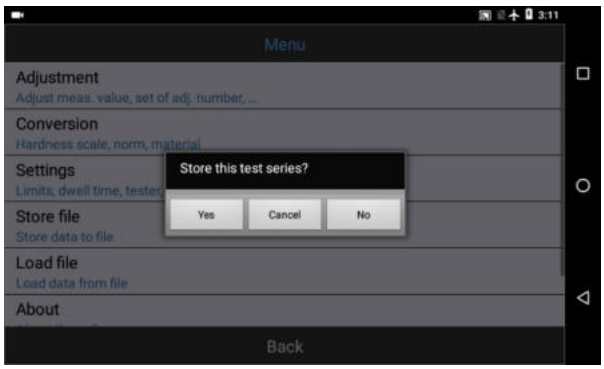


Figure 7.116

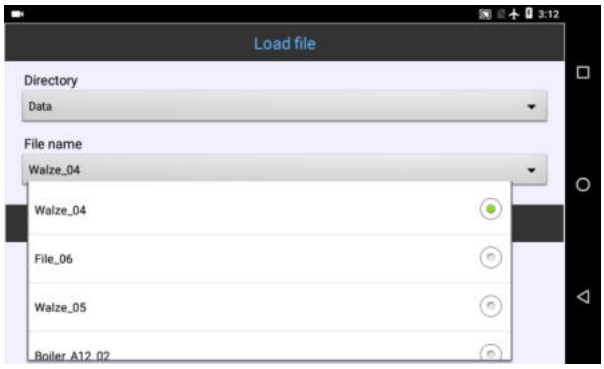


Figure 7.117

Figure 7.118

Figure 7.119

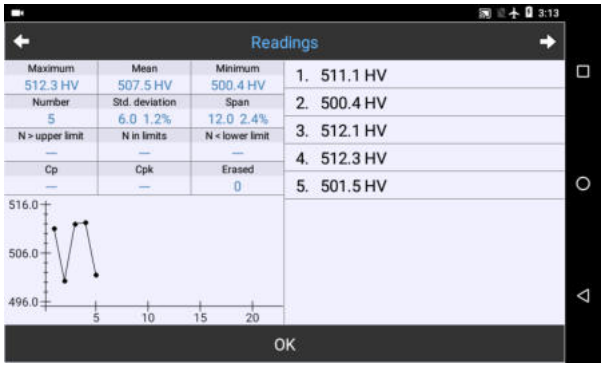


Figure 7.120

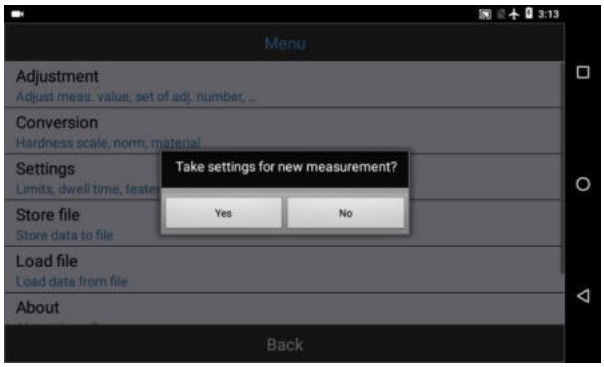


Figure 7.121

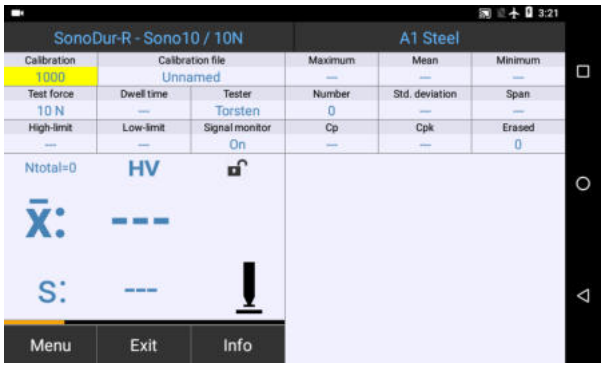


Figure 7.122

The settings from a measurement series can be transferred to a new measurement series provided, the testing forces are equal. In the example above, the adjustment and scale has been transferred to the new measurement series (refer to Figure **7.121**)

i	NOTE!
When using the OK button to exit the "INFO menu" (Figure **7.120**) the saved measurement settings from this file can be adopted when entering the measurement menu, if the question is answered with "Yes" (Figure **7.121**) and the currently connected probe has the same testing force as the probe for which the measurements have been stored. This enables the direct continuation of measurement series using the known settings.	

7.13 Data transmission and interfaces

Users should have a basic understanding of how to use a computer and the Microsoft File Manager. Incorrect operation can lead to data loss and /or damage to the system files, and thus result in a malfunctioning device!

SonoDur-R features 2 interfaces for data transmission, namely USB and RS232.

The USB interface is mainly used for manual data transfer using a standard windows file explorer on Windows 10 systems. RS232 is used for automatic data transfer and remote control.

i	NOTE!
It is generally recommended to back up important adjustment data in superordinate computing systems to avoid data loss in case of device defects.	

- The stored measurement data is stored in two file formats, i.e., in text files (.txt) and as original files (.hdt). The text files can be further processed after the data transfer in any form.
- However, the original data is immutable and should also be stored in superordinate computing systems.
- The original measurement data is important for the proof of data security and for the traceability of test results during possible audits.

7.13.1 USB Interface

Connect the SonoDur-R device to the PC via a standard USB cable (USB A – USB B, used for printers) and turn on the device. The connector(s) only allows the plugging to be performed only in one position! Force must be avoided, since the plug system can be damaged!

This is also possible while the device is running or a measuring program is active. The device must be switched on, if necessary.

Now the SonoDur-R automatically connects to the PC.

i	NOTE!
No further drivers or additional software is required.	

SonoDur-R is now visible in the file explorer as mobile device “IMX6GUF”, but no storage media are visible.

To get access to the main memory, it is necessary to wipe from the top edge of the screen downwards to open the pull-down menu below the status line. Tapping on the message „USB charging this device“ opens the menu “Use USB to” . If “Transfer files” is activated (**Figure 7.123** and **Figure 7.124**), the main memory will be visible in the file explorer at once. (**Figure 7.125**).

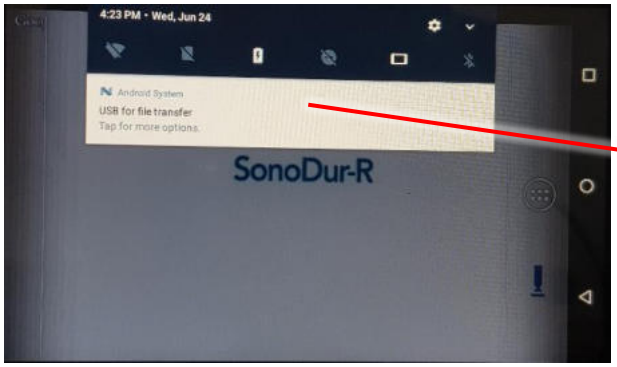


Figure 7.123

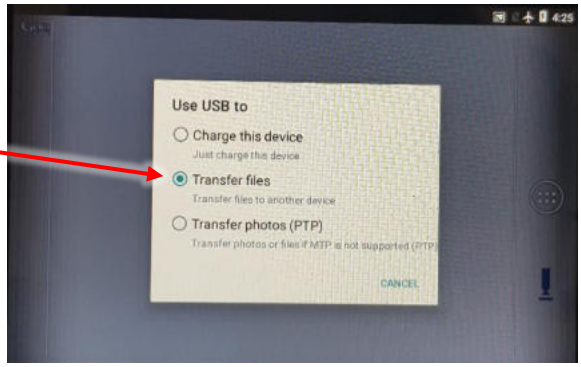


Figure 7.124

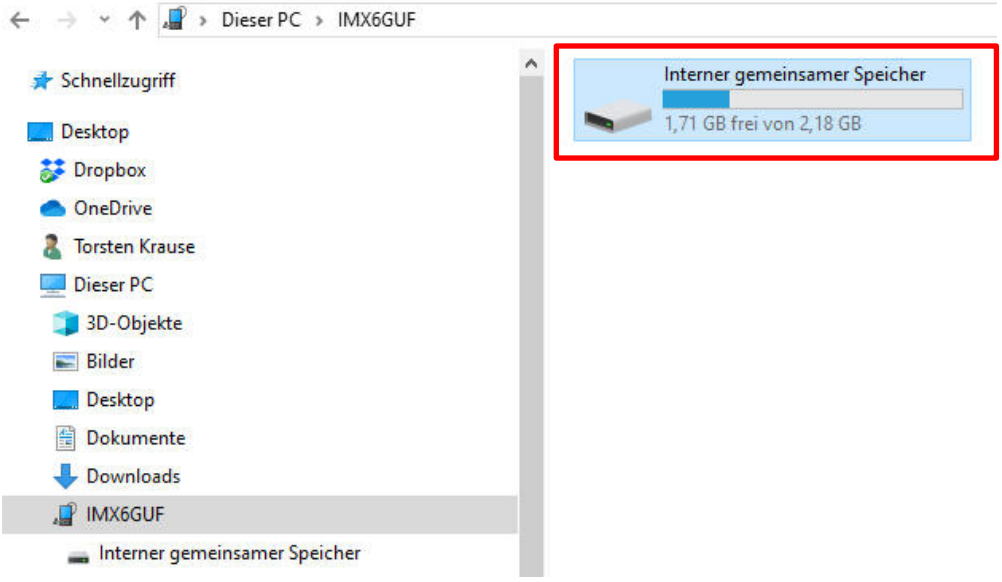


Figure 7.125

Content of the internal main memory:

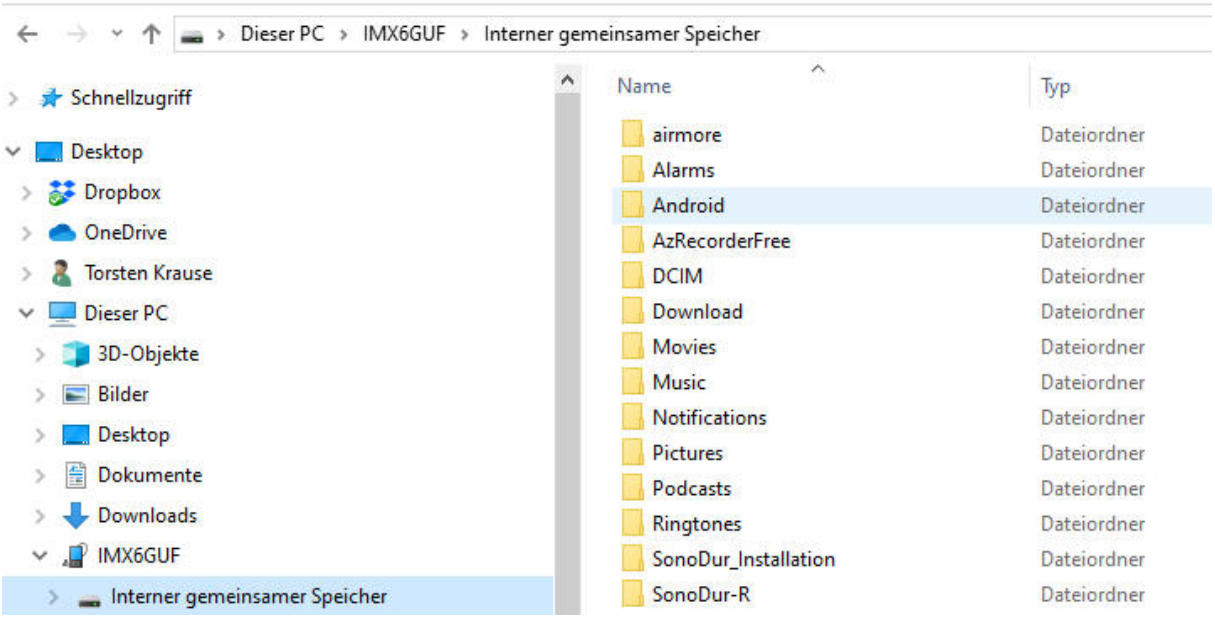


Figure 7.126

The sub-directory SonoDur_Installation contains the necessary backup installation files for the system. The directory SonoDur-R contains subfolders for calibration, measurement and system data.

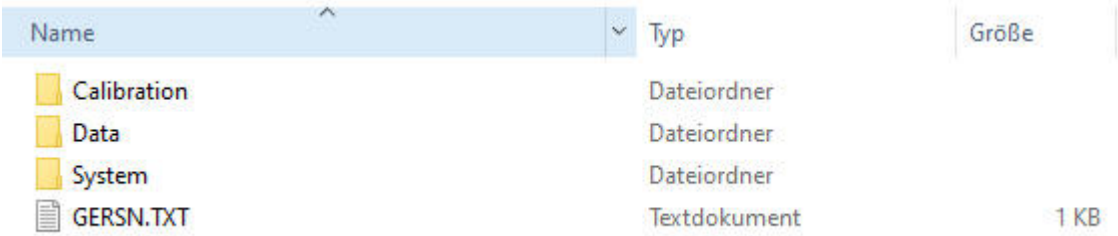


Figure 7.127

All stored data can now be transferred by using the File Explorer as usual from the SonoDur-R device to the PC, where the text files will be converted to e.g., Excel files. For this purpose, EXCEL will be invoked and the desired measurement series (in txt format) will be imported.

7.13.2 RS232 Schnittstelle

Through the serial interface COM1, the current value and the measurement unit are given with each measurement (factory setting, detachable through remote control).

The remote control, additionally, permits access to the equipment parameter, please see the list of instructions on the following pages.

COM2 is not connected.

For the connection to a computer you will need a 1:1 cable (9P male – 9P female).

Data format:

- 115200 Baud
- No Parity
- 1 Stop bit
- HW Handshake: no
- SW Handshake: no

Pin content of the 9-pole D-Sub connector (COM1):

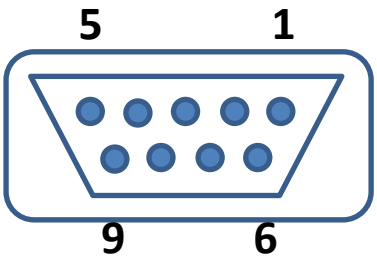


Figure 7.128

Pin	Signal	Type	Description
1	--	--	Not reserved
2	TXD	Transmit data	Output, V24 Level
3	RXD	Receive data	Input, V24 Level
4	--	--	Not connected
5	Mass	Mass	Signal ground 0 V
6	--	--	Not connected
7	CTS	Clear to send	Input, V24 Level
8	RTS	Request to send	Output, V24 Level
9	--	--	Not connected

Table 7-1

7.13.3 Remote Control Commands

Each communication is being initiated through a command from the Host-PC. SonoDur-R sends an answer with each command.

Each command and each answer are being packed in the control character <STX> (Start of Text, 0x02, CTRL B (Hyperterminal)) and <ETX> (End of Text, 0x03, CTRL C (Hyperterminal)).
The commands are complied, so that they could work wihtout control character in ASCII Terminal, in a Text-Modus.

After starting, the software automatically sends the measuring value after a successful measuring.
<STX>123.4 HRC<CR><ETX>
This automatic output can be turned on and off with the command **#AO**.

Switch of the automatic output of the measuring values:

OFF:

<STX>#AO 0<CR><ETX>

Answer from Sono-R: <STX>#AO 0<CR><ETX>

ON:

<STX>#AO 1<CR><ETX>

Answer from Sono-R: <STX>#AO 1<CR><ETX>

Writing of the CAL-Faktors:

<STX>#CL 1234<CR><ETX>

Answer from Sono-R: <STX>#CL 1234<CR><ETX>

Answer from Sono-R, if the CAL-Faktor was given wrong: <STX>#CL ERR<CR><ETX>

Depending on the CAL-Factor, the current measuring row is being closed, saved automatically under a standard-file name and the new measuring row will be stared.

Reading of the CAL-Faktors:

<STX>#CL ?<CR><ETX>

Answer from Sono-R: <STX>#CL 1234<CR><ETX>

Measuring start (only with Motor-Probe):

<STX>#MS<CR><ETX>

Answer from Sono-R: <STX>#MS<CR><ETX>

Answer from Sono-R, if measuring start is not possible (for Example whithin a current measuring time): <STX>#MS ERR<CR><ETX>

Status request:

<STX>#ST<CR><ETX>

Answer from Sono-R, ready for the start of measuring : <STX>#ST RDY<CR><ETX>

Answer from Sono-R, current measurement: <STX>#ST MAC<CR><ETX>

Answer from Sono-R, measurment ended sucessfully, single output of the current taken measurement value: <STX>#ST MEA 123.4 HRC<CR><ETX>

Answer from Sono-R, Motor drives up: <STX>#ST BSY<CR><ETX> (Only Motor-Probe)

Answer from Sono-R, Probe-Error (Probe disconnected, does not communicate): <STX>#ST PROBE ERR<CR><ETX>

Answer from SonoDur-R, general Error: <STX>#ST ERR<CR><ETX>

Release of the File-Headers:

<STX>#FH<CR><ETX>

Answer from Sono-R: <STX>#FH<CR> File-Header in Text-Format as already given, lines with <CR> separated <ETX>

Release of the last measuring value (repeatable):

<STX>#MW<CR><ETX>

Answer from SonoR-R: <STX>#MW 123.4 HRC<CR><ETX>

Answer from SonoR-R, if there is no measuring value given (only after the start of the software, before the first measuring): <STX>#MW ERR<CR><ETX>

Release of the equipment-Softwareversion:

<STX>#GV<CR><ETX>

Answer from Sono-R: <STX>#GV 2.16<CR><ETX>

Release of the Probe-Serial-Number:

<STX>#SN<CR><ETX>

Answer from Sono-R: <STX>#SN 100<CR><ETX>

Answer from Sono-R, if there is no probe connected: <STX>#SN ERR<CR><ETX>

Release of the equipment-Serial-Number:

<STX>#GN<CR><ETX>

Answer from Sono-R: <STX>#GN 100<CR><ETX>

Answer from Sono-R, if the GERSN.txt Data does not exist: <STX>#GN ERR<CR><ETX>

End of the programm:

<STX>#EX<CR><ETX>

Answer from Sono-R: <STX>#EX<CR><ETX>

After the answer, SonoDur-R software closes.

Writing of the measuring time (only with Motor-Probe):

<STX>#MT 4<CR><ETX> (hier: 4 sec)

Answer from Sono-R: <STX>#MT 4<CR><ETX>

Answer from Sono-R, if the measuring time was inserted wrong or no motor-probe is connected: <STX>#MT ERR<CR><ETX>

After each change of the measuring time, the current measuring row is being closed, saved automatically under a standard-file name and the new measuring row will be stared.

Reading of the measuring time (only with Motor-Probe):

<STX>#MT ?<CR><ETX>

Answer from Sono-R: <STX>#MT 4<CR><ETX>

Writing of material:

<STX>#MA A1<CR><ETX>

Answer from Sono-R: <STX>#MA A1<CR><ETX>

Answer from Sono-R, if a wrong short cut of the material is used or an invalid combination of scale-standard (norm)-material is set: <STX>#MA ERR<CR><ETX>

Every modification to the material will close and store the actual measuring set using a standard file name and open a new measuring set.

Valid material names for standard (norm) EN ISO 18265:

A1, T2, B2, B3, B4, C2, D2, D8, E2, F1, F2, T5, T6, F3, T8, F4, F5, G1, G2

Valid material names for standard (norm) ASTM E140:

T1, T2, B2, B3, B4, C2, D2, D8, E2, T3, T4, T5, T6, T7, T8, T9, F5, G1, G2

Reading of material:

<STX>#MA ?<CR><ETX>

Answer from SonoDur-R : <STX>#MA A1<CR><ETX>

Unknown command:

<STX>xxx<ETX>

Answer from Sono-R: <STX>CMD ERR<CR><ETX>

Example for Terminal print: During measurement process the command <STX>#FH<CR><ETX> has been executed (six measurements), after this command and three more measurements have been recorded.

File	**File_05**
Date	**5. August 2015**
Start of Meas.	**13:51**
Tester	
Probe/Test Force	**Sono8M/8N**
Probe-SN	**306**
Dwell Time	**5 sec**
Material	**Steel**
Norm; HV	**EN ISO 18265**
Calibration File	**Unnamed**
Adj. Number	**0**
Limits	**Off**
Number	**6**
Mean	**732 HV**
Std. Deviation	**5 HV; 0.7%**
Maximum	**738 HV**
Minimum	**726 HV**
R	**12 HV; 1.7%**
Cp	
Cpk	
749 HV	
747 HV	
748 HV	

Figure 7.129

7.13.4 Digital Interface

The digital I/O Interface provides signals

- Signals for the automatic test part evaluation (only with thresholds active!)
- Status signals during the measuring process
- Input for starting the measuring process with motor probes

All signals are galvanically isolated and protected against ESD and wired to the DB37 connector. Please note the wiring hints and technical specifications on the next pages!

WARNING

Warning: Please note the following specifications!
When the specification limits are exceeded, the electronic can be damaged; in this case we cannot give any guarantee.

⚠	**WARNING**
All outputs must be used with a serious resistor / pullup to the external voltage to limits the load current / dissipation power!! Values for resistors are given in Figure **7.131**.	

Isolations Voltage	**3750 Vrms for 1 min per UL1577**
ESD (Electric Static Discharge)	**IEC 61000-4-2 level 4** **15 kV (air discharge), 8 kV contact)discharge)**
Response time	**< 1ms**
Input / Output Withstand Voltage	**3 - 24 VDC / 30 VDC max.**
Output Load Current	**0,6 A max. / Output**
Output Power Dissipation	**0,36W max. / Output**

Table 7-2

Pin Description DB37

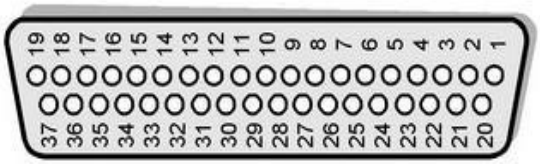


Figure 7.130

Circuit outputs

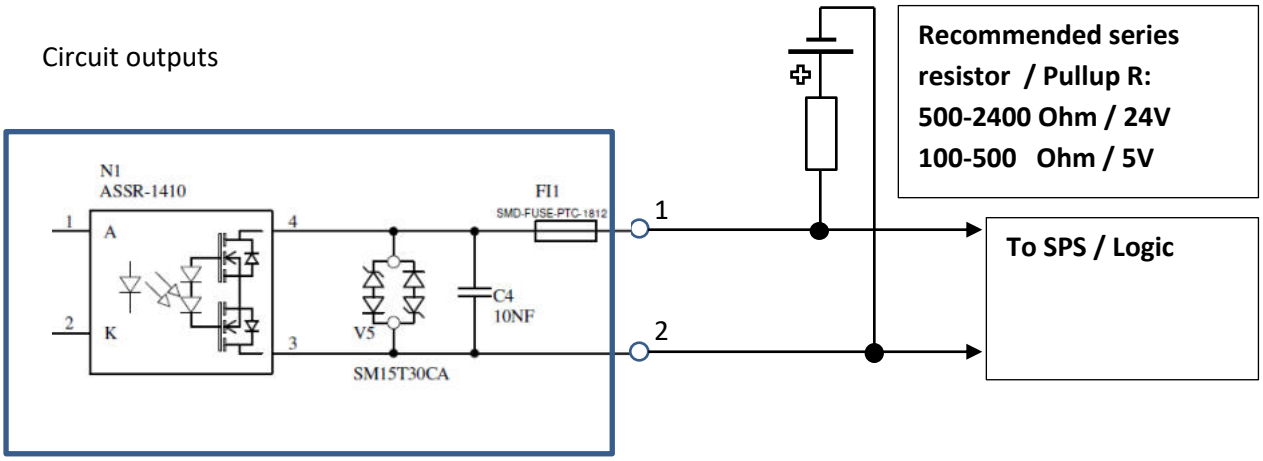


Figure 7.131

Pin	Signal	Type	Description
1-3	--	--	Not connected
4	EXIT_1	EXIT, Input Contact 1	No Function, do not use
5	EXIT_2	EXIT, Input Contact 2	No Function, do not use
6-7	--	--	Not connected
8	MOT_1	MOT, Input Contact 1	Start Measurement (only motorized probe)
9	MOT_2	MOT, Input Contact 2	
10-19	--	--	Not connected
20	--	--	Not connected
21	--	--	Not connected
22	LO_1	LO, Contact 1	Switch open (active, no current) if threshold is exceeded
23	LO_2	LO, Contact 2	
24	HI_1	HI, contact 1	Switch open (active, no current) if threshold is exceeded
25	HI_2	HI, Contact 2	
26	ERR_1	ERR, Contact 1	Switch open (active, no current) on error
27	ERR_2	ERR, Contact 2	
28	ALARM_1	ALARM, Contact 1	Switch open (active, no current) on error (Probe defect or not Connected, self-test error
29	ALARM_2	ALARM, Contact 2	
30	MEAS_1	MEAS, Contact 1	Switch open (active, no current) if measurement is active
31	MEAS_2	MEAS, Contact 2	
32	READY_1	READY, Contact 1	Switch open (active, no current) if measurement is finished
33	READY_2	READY, Contact 2	
34	OUT_VAL_1	OUT_VAL, Contact 1	Switch open (active, no current) when outputs (LO, HO, ERR) are valid
35	OUT_VAL_2	OUT_VAL, Contact 2	
36	OUT37_1	--	36 – 37 always bridged, switch closed
37	OUT37_2	--	36 – 37 always bridged, switch closed

Table 7-3

Signal Flow Chart Outputs

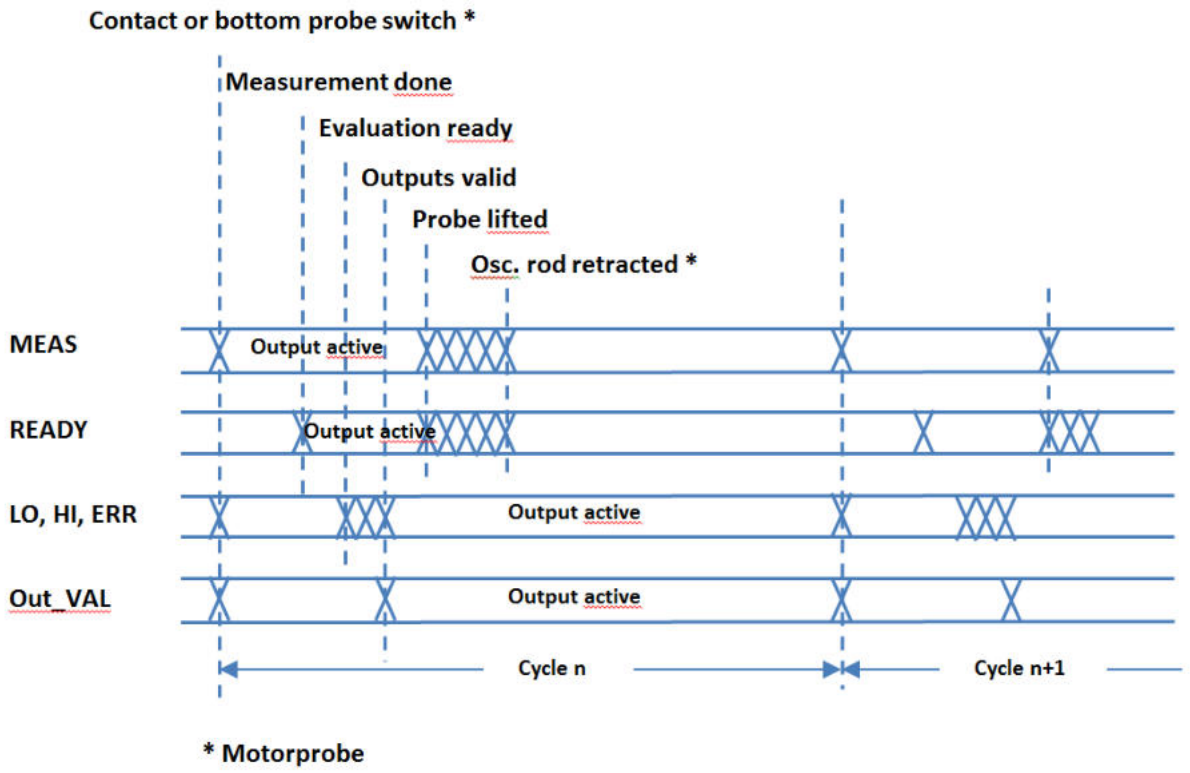


Figure 7.132

8 Functional Check by the User

The UCI tester is a precision instrument and, with appropriate care, should operate properly for a long period of time. Nevertheless, it is advisable to carry out the following system checks:

- Measuring accuracy and reproducibility check as described in DIN 50159-2 using Hardness Reference Plates. Only use Hardness Reference Plates that are suitable for UCI hardness measuring (we exclusively recommend our Yamamoto or Buderus reference plates). For this purpose, at least 3 measurements (distributed over the entire range of the Hardness Reference Plates) should be carried out. The permissible deviation of the average value from the nominal reference plate value may not exceed 4% for testing forces HV5 to HV10; for HV1, up to 7% is permissible, depending on the range. For the low load range from HV0.1 to HV0.8 the max. measurement uncertainty amounts up to 9% (**chapter 2.1, Measurement methods, Page 8**)
- The penetration diamond must be checked for damage under the microscope.

If any damage to the probe and/or tester is noticed, the device should be switched off immediately and returned to our service department for verification. This also applies to excessive measuring value deviations.

i	NOTE!
We recommend an annual inspection of the system at our service department or at any authorized NewSonic Sales and Service Partner.	

8.1 Software Version

The version of the SonoDur device software can be queried via "**Menu" -> "About**":

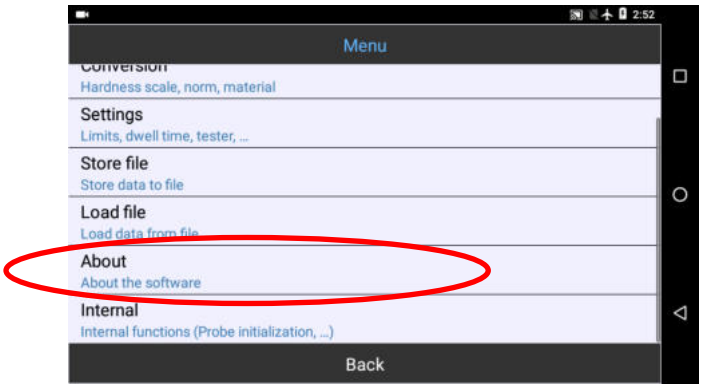


Figure 8.1

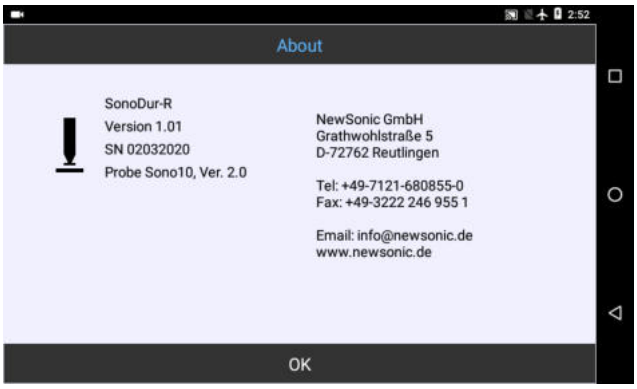


Figure 8.2

8.2 Error Messages

Error messages	Remedy
No probe connected, Start program in demo mode?	The tester could not find a probe. Check plug/cable. Is the USB interface switched to SonoDur?
Conversion in MPa only defined for testing forces greater than or equal to 100N (10kgf). Release anyway?	The conversion into tensile strength MPa is only defined for test probes ≥ 98N (10kgf). Select the correct test load or release conversion also for test loads <98N. In this case, larger errors must be expected. The decision is up to the user.
Penetration time must be in the range of 1 to 99 seconds	Only for motor probe operation, a force application time between 1 and 99 must be selected.
Too long coupling of the probe. Please lift the probe	Lift the probe from the material and perform a new measurement. Check the indenter/end of the vibrating rod/attachment sleeve bore for contamination. If necessary, the parts must be cleaned with a dry, soft cloth.
Wrong probe testing force, Cal = xxxx Apply changes?	The adjustment was performed with a different testing force, the adoption of the settings remains at the discretion of the tester. If unsure, utilise a test probe with a suitable test load for adjustment (refer to **Chapter 8.9.4 Saving adjustment and loading**).
Outside the XX conversion	The measuring value is outside the conversion limits defined in the standard. Select a different scale (Conversion Table or Material Table)
Probe defective, Deviation of the zero frequency is too high. Target: xxxxx Hz Actual: yyyyy Hz. The programme will be terminated.	Frequency deviation outside the tolerance range, the programme will be terminated. Possible causes include: Fall or impact load or contamination/damage of the diamond or the attachment sleeve. If cleaning does not solve the problem, the test probe should be sent for verification and recalibration to NewSonic or the NewSonic representative.

Table 8-1

8.3 Troubleshooting

SonoDur-R executes an internal system self-test during startup and monitors mains system functions during operation. If error messages are displayed, please follow the instructions

Screen remains dark after switch on.	Check voltage Supply and cable.
The screen flickers, the instrument starts up periodically.	Check voltage supply, if the start-up current is not limited to a low level (switch current sense to >= 1 A if available).

No measurement with hand held probe possible.	Check if dwell time is set to zero.
Measurement data are unsteady.	Does the piece have sufficient dimensions? Or if not, is it well coupled to a massive block? Is the material homogeneous? Is the surface clean and the roughness low enough? Correct dwell time? Check instrument with reference block
Readings are out of tolerance.	Does the test material have the correct young's modulus or does the test piece need calibration? Correct dwell time (0 for handheld probe)? Check instrument with reference block.
The input/outputs do not work.	Check if thresholds are set. Check wiring.
The instrument stops working	Power off / on. The instrument should restart normally.

9 Care and Maintenance

9.1 Instrument, measuring probe and cable

Clean the test device, test probe and connecting cable from time to time with a damp, but not wet cloth e.g. microfibre cloth. Chemicals or detergents should not be applied.

9.2 Display

Sharp objects or chemicals or cleaning agents should not be used to clean the display; this could destroy the display. Use moist tissue wipes for glasses instead. A protective film is affixed to protect the touch-sensitive Touch Screen. If this has bad dirt stains or scratches, it can be replaced with a new protective film.

10 System

The test device is a power efficient minicomputer with the popular easy-to-use Android operating system. This enables the customization of several power and display options. When shipped, SonoDur-R is preset to optimal defaults so one does not usually need to worry about these settings. The following instructions are intended for customer-specific settings.

⚠	**WARNING**
Caution must be applied for changing the system settings, since it could affect the correct operation of the device.	

10.1 System Settings

The system settings can be accessed via the icon with 6 points at the right area of the screen. The File Explorer is also located here, which can be used to view, copy or move files. The adjustment level can be reached from the start page via the round white softkey with the 6 dots at the bottom of the screen. A touch on "Settings" will open the menu for the setting of the system functions. Only the most important system functions will be explained below.

10.2 Wireless & Networks

10.2.1 WiFi / LAN

Not supported.

10.2.2 Bluetooth

Not supported.

10.2.3 Flight Mode

Factory setting active.

10.3 Device

10.3.1 Display

Settings for brightness, screen saver etc.

Figure 10.1

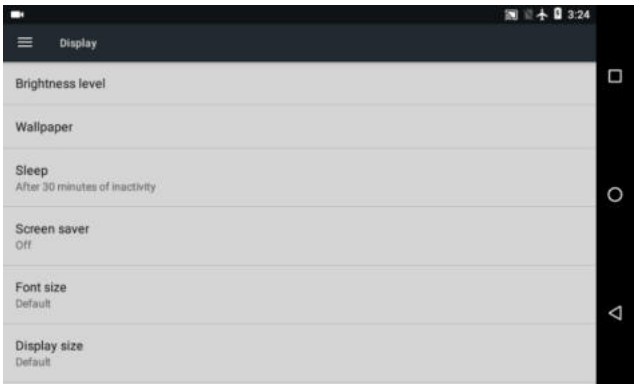


Figure 10.2

10.3.2 APPs – Information about Installed Programs

Information about installed or active programs with detailed information and the possibilities to uninstall or edit them (here SonoDur-R).

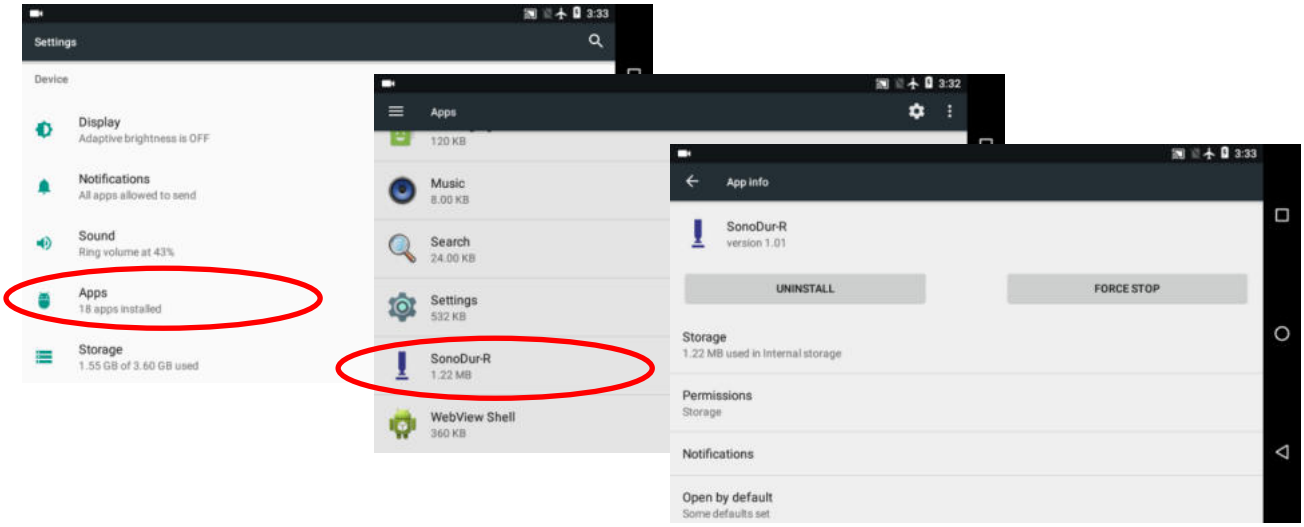


Figure 10.3 Figure 10.4 Figure 10.5

10.4 Personal

Modify of user specific settings like languages, device security etc.

10.4.1 Security

“Security” contains the security settings for the device. For example, the installations can be shared here with applications that are not from the Google Playstore (like the SonoDur-R APP).

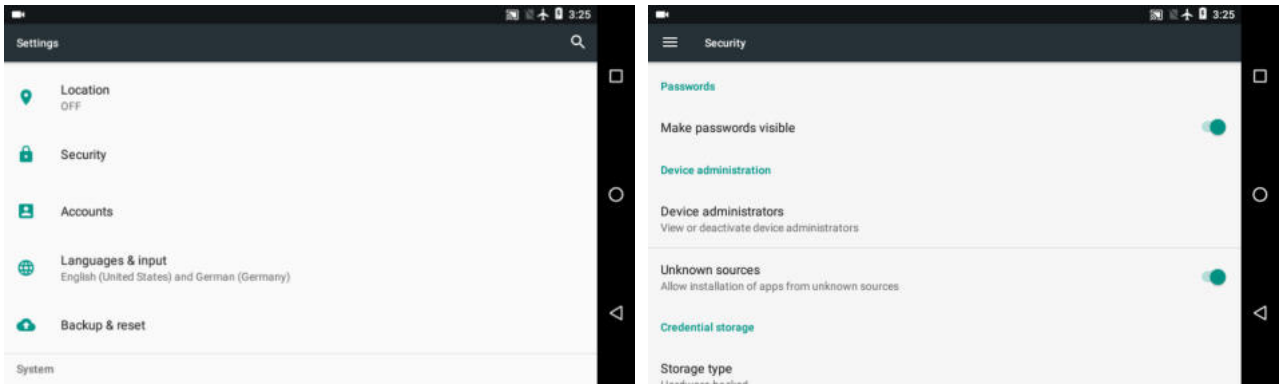


Figure 10.6 Figure 10.7

i	NOTE!
For software updates of the SonoDur software, the "Unknown source" switch must be set to "On" (factory setting)!	

10.4.2 Language

A detailed description of setting the country specific language is given in Chapter 6.3.

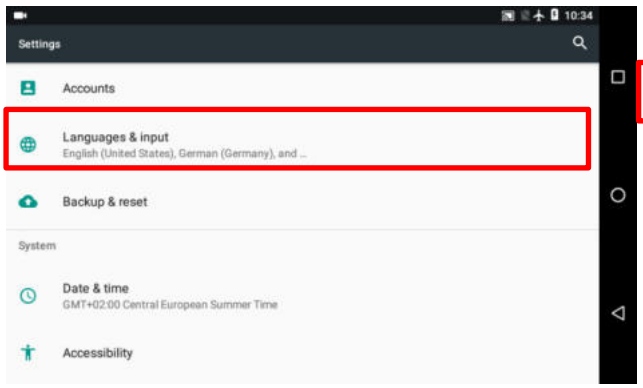


Figure 10.8

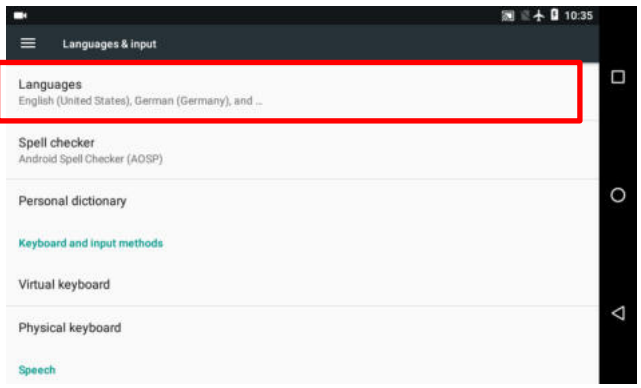


Figure 10.9

i	NOTE!
Not all languages are supported! If an unsupported language is selected, the current settings remain unchanged. It must also be noted that the position of some menu items may have changed in other languages! The device should not be set to languages that the user does not understand! A return to the original language could then become difficult!	

10.4.3 Date & Time

The date and time information can be obtained automatically via a network or set manually. We recommend the latter setting.

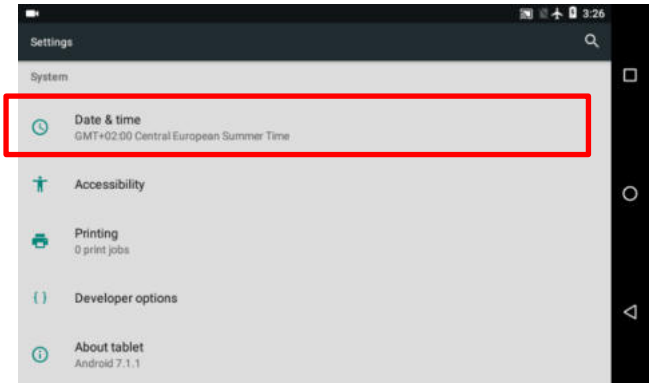


Figure 10.10

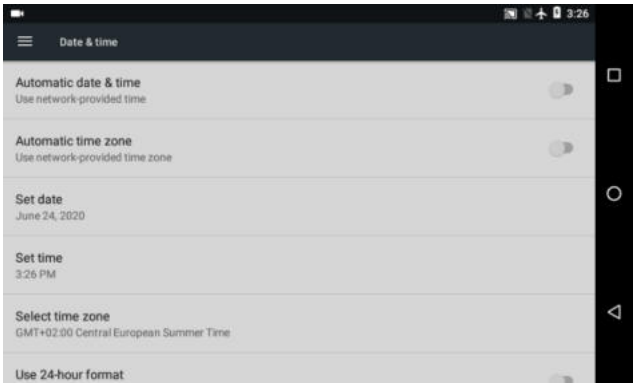


Figure 10.11

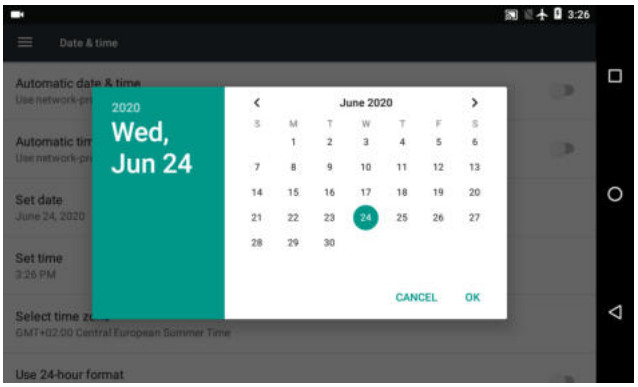


Figure 10.12

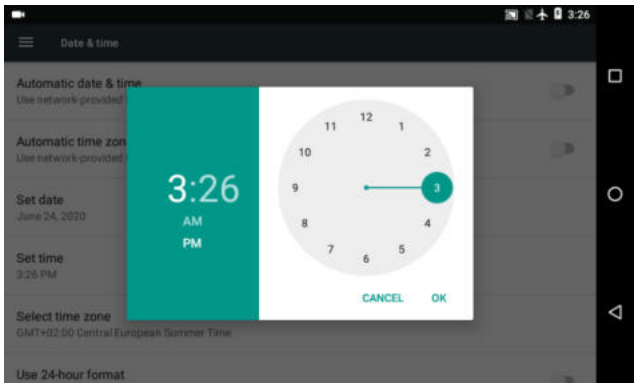


Figure 10.13

11 Appendix

11.1 Test probes and their fields of application

11.1.1 Motor Measuring Probes

Test forces: 1 N (HV0.1), 3N (HV0.3) and 8.6 N (HV1)
Load application by motor, fully automatic measurement procedure, the probe just needs to be placed on the surface.
Main application on smooth (polished, lapped), even coated surfaces (hard chrome, copper) such as rollers, gravure impression cylinders, automotive components and other components with high demands on a clean and undamaged material surface and with low surface roughness

11.1.2 Hand-held Measuring Probes

Test forces: 10N (HV1), 30N(HV3), 50N (HV5) und 100N (HV10)
Load application by hand against a spring system; the measuring value is generated automatically when the specified testing force is reached; load limitation by means of a mechanical stop. Different designs also with long free vibrating rod end, and/or extra thin diamond tip.

Information on the testing forces:
In the publications and in our documents, the conversions from HV1, HV5, HV10, etc. are sometimes rounded due to the conversion factor 1 kp (kgf) = 9.81N in Newton, N (HV5 = 49N is often referred to as 50N, and HV10 = 98N is often referred as 100N). However, the load is set very accurately in Newton, e.g., 49N or 98N!

The test conditions with respect to surface quality (surface roughness) and layer thickness meet the requirements of the classic Vickers Hardness Measurement. The UCI Standard DIN 50159-1/2 specifies a maximum roughness Ra of <0.5 µm for HV1 measurements, which, in relation to the penetration depth, corresponds to d≈10-20 *Ra. Accordingly, it is about 0.8 microns for HV5 and approx. 1.0 µm for HV10.

In this context, the penetration depth and the average diagonal length Ld will be determined as follows:

$$d = 62 * \sqrt{\frac{testload\ [N]}{hardness\ [HV]}}\ [\mu m] \quad \text{and} \quad Ld = 434{,}9 * \sqrt{\frac{testload[N]}{hardness[HV]}}\ [\mu m]$$

Formel 11-1

Some examples of the more important penetration depth are shown in the following Table in [µm]:

Hardness	HV10	HV5	HV1	HV0.3	HV0.1
800 HV	22	15	7	4	2
600 HV	25	18	9	5	2,5
300 HV	36	25	11	6	4

Table 11-1

In general, the condition of the component surface in the area of low load hardness testing is of particular importance. High measuring value scattering can be an indication of excessive roughness. If such case, it may be advisable to rework the surface with suitable abrasives and to subsequently repeat the test.

Some other influencing factors are summarized below:

- Minimum layer thickness: 10 x d (no noticeable influence of the base material following the adjustment)
- Minimum material thickness without coupling: > 3 mm (component resonances may corrupt measuring values)
- Minimum mass without coupling: > 0.3 kg (component resonances may falsify measuring values or make a measurement impossible)
- Minimum distance from the component edge = 3 x Ld, between the impressions = 6 x Ld
- Surface roughness should be much less than the penetration depth or, based on experience, not higher than 1/5 of the penetration depth

In the new edition of DIN 50159-1,2-2015, the required roughness values are shown by means of examples (Table 12-2); the same applies to the roughness achieved by grinding work (Table 12-3).

Test force [N]	10	50	98
Ra [µm]	0,5	0,8	1,0
Ra [µm] ASTM	5	10	15

Table 11-2: Specifications for Ra values are based on EN ISO 6507 (Vickers) and data from the ASTM A 1038 standard.

Grain size	120	180	240
Ra [µm]	1,2	1,0	0,6

Table 11-3: Achievable Ra values for steel with different grain size according to FEPA standard („Federation of the European Producers of Abrasives“).

In addition to the surface roughness, material properties such as texture, mechanical stresses, layer structures and underground also play a role for measured value fluctuations and deviations from the nominal values.

The above information is based on experience and must be verified in practice on the respective material and on the test piece.

When assessing the measurement accuracy of UCI instruments, the allowable measurement deviations apply to mean values of Hardness Reference Plates. This is demonstrated in the following Table (taken from DIN 50159-1/2):

Hardness Scale	Measurement deviations %			
	< 250 HV	250 HV – 500 HV	500 HV – 800 HV	> 800 HV
HV 0.1	6	7	8	9
HV 0.3	6	7	8	9
HV 0.8	5	5	6	7
HV 1	5	5	6	7
HV 5	5	5	5	5
HV 10	5	5	5	5

Table 11-4

All probes of the SonoDur series must comply with the internal specifications, i.e., max. ± 3% from 5 measurements at Hardness Reference Plates (refer to **, page 78**).

According to UCI standard DIN 50159-1/2, Hardness Reference Plates with specific dimensions are recommended for review purposes in order to avoid disturbing resonance vibrations. Much more important than the "correct" dimension however, is the coupling of the Hardness Reference Plate to a flat heavy base, preferable made of steel. Depending on the support material (wood, cloth, etc.), testing force and the test position at the Reference Plates, Hardness Reference Plates that freely lie on the table can produce very macroscopically complex plate vibrations, which make a UCI measurement difficult or impossible. In particular triangular Vickers Reference Plates with 6mm thickness (top of the picture) are vulnerable for such effects and should therefore always be well coupled.

Attention

These triangular plates must be coupled well!

Figure 11.1

This type of influence can best be derived by observing the spans in a series of measurements. In addition, the mean values, depending on the probe and the degree of hardness, are generally more or less clearly above or below the data on the plate itself.

Caution should also be exercised on some (square) Rockwell plates (HRC), as they are frequently roughly grounded resulting in a tendency that too low UCI hardness values will be displayed.

When using hardness reference plates following a hot isostatic pressing (often used with Leeb plates), special caution should be taken since local hardness or E-Module variations may occur.

In production, the test specimen surface must in any case be suitable (not necessarily blank) for the Vickers Test, free of surface coatings, surface decarburization, rolling and casting skin and scale as well as free of liquids. In addition, the test piece may not perform any movements or vibrations during the measurement.

During operation with induction hardening machines, the measurement must not be carried out during the application of the high-frequency field, since faults may occur in such case or the measuring system may temporarily fail completely (also refer to DIN 50159).

11.2 Scope of delivery and accessories

11.2.1 Standard products and accessories / spare parts

Order-no.	Description
11006	**SonoDur-R** Hardness Tester "Rack" for automatic online Hardness Testing in Production lines, WIN CE Operating System, with Android - 7.1 operation system and capacitive touchscreen including: build-in table housing 19" with screw fastening Connectors for Probe, Controls, 24V-Power Unit, USB-Client (PC), RS232 SONO-RM 3,0 m Probe Connection cable SONO-NG-24V Power supply 115VAC-230VAC/24VDC for SonoDur-R SONO-CD CD Product-USB-Stick incl. Operating Manual
Attention:	**Probes and hardness reference plates must be ordered separately!**

Hand-held measuring probes

	Standard
11101	**SONO-10H** Hand-Held-Probe 10N (1 kgf), Standard Version, incl. Certificate
11115	**SONO-30H** Hand-Held-Probe 30N (3 kgf), Standard Version, incl. Certificate
11102	**SONO-50H** Hand-Held-Probe 50N (5 kgf), Standard Version, incl. Certificate
11103	**SONO-100H** Hand-Held-Probe 98N (10 kgf), Standard Version, incl. Certificate
	Long rod version
11104	**SONO-10HL** Hand-Held-Probe 10N (1 kgf), Long rod Version, incl. Certificate
11116	**SONO-30HL** Hand-Held-Probe 30N (3 kgf), Long rod Version, incl. Certificate
11105	**SONO-50HL** Hand-Held-Probe 50N (5 kgf), Long rod Version, incl. Certificate
11110	**SONO-100HL** Hand-Held-Probe 98N (10kgf), Long rod Version, Special Version, incl. Handle and Certificate
	Special diamond tip
11112	**SONO-10H.17** Hand-Held-Probe 10N (1 kgf), Special Version with thin Oscillation rod / Diamond tip, incl. Certificate
11111	**SONO-50H.17** Hand-Held-Probe 50N (5 kgf), Special Version with thin Oscillation rod / Diamond tip, incl. Certificate
	Special diamond tip & long rod
11113	**SONO-10HL.17** Hand-Held-Probe 10N (1 kgf), Long rod Version with thin Oscillation rod / Diamond tip, incl. Certificate
11114	**SONO-50HL.17** Hand-Held-Probe 50N (5 kgf), Long rod Version with thin Oscillation rod / Diamond tip, incl. Certificate
	Short barrel
11131	**SONO-10HK** Hand-Held-Probe 10N (1 kgf), Standard Version with short barrel (144 mm), incl. Certificate
11132	**SONO-50HK** Hand-Held-Probe 50N (5 kgf), Standard Version with short barrel (144 mm), incl. Certificate
11133	**SONO-100HK** Hand-Held-Probe 98N (10 kgf), Standard Version with short barrel (144 mm), incl. Certificate
	Short barrel & long rod
11134	**SONO-10HLK** Hand-Held-Probe 10N (1 kgf), Long rod Version with short barrel (177 mm), incl. Certificate
11135	**SONO-50HLK** Hand-Held-Probe 50N (5 kgf), Long rod Version with short barrel (177 mm), incl. Certificate

Motor-measuring probe

11106	**SONO-1M** Motor Probe 1N (0,1 kgf) with attachment sleeve, incl. Certificate
11107	**SONO-3M** Motor Probe 3N (0,3 kgf) with attachment sleeve, incl. Certificate
11108	SONO-8M Motor Probe 8,6N (0,9 kgf) with attachment sleeve, incl. Certificate

Hand-held probes in a "mobile stand" (SONO-S)

11121	**"SONO-S10H** Handheld Probe 10N (1 kgf), Special version with integrated probe guidance, 5 Probe Shoes included, Prismatic (Ø 1,5-10 / 10-100 / 50-300 mm & flat / flat / standard), incl. Certificate"
11122	**SONO-S50H** Handheld Probe 49N (5 kgf), Special version with integrated probe guidance, 5 Probe Shoes included, Prismatic (Ø 1,5-10 / 10-100 / 50-300 mm & flat / flat / standard), incl. Certificate"
11123	**SONO-S100H** Handheld Probe 98N (10 kgf), Special version with integrated probe guidance, 5 Probe Shoes included, Prismatic (Ø 1,5-10 / 10-100 / 50-300 mm & flat / flat / standard), incl. Certificate"

Recommended accessories / spare parts

11220	**SONO-PS-1** Precision Test Stand for handheld probes
11221	**SONO-PS-2** Precision Test Stand for motor probes
11206	**SONO-PM-1** Prism support for concave surface shape approx. 5 to 1000 mm for Motor Probes
11209	**SONO-PM-4** Prism support set for motor probes
11223	**SONO-MSP-1** Magnetic Precision Scanning Test Stand for weld inspection with hand-held-probes
11210	**SONO-ZG-F** Special Coupling Fluid, to suppress resonances, 100 ccm **SONO-R-CD** USB Product-Stick incl. Operating Manual, driver, tools, product pictures, etc."
11307	**SONO-NG-24V** Powersupply 115VAC-230VAC/24VDC for SonoDur-R

Reference blocks 16x15 mm (Yamamoto)

1140806	**SONO-Y150HVy** Round Hardness Blocks, approx. 150±15 HV10, HV1; **Ø64x15 mm,** Factory Certificate
1140805	**SONO-Y200HVy** Round Hardness Blocks, approx. 200±15 HV10, HV1; **Ø64x15 mm**, Factory Certificate
1140804	**SONO-Y300HVy** Round Hardness Blocks, approx. 300±15 HV10, HV1; **Ø64x15 mm**, Factory Certificate
1140803	**SONO-Y400HVy** Round Hardness Blocks, approx. 400±15 HV10, HV1; **Ø64x15 mm**, Factory Certificate
1140809	**SONO-Y500HVy** Round Hardness Blocks, approx. 500±15 HV10, HV1; **Ø64x15 mm**, Factory Certificate
1140808	**SONO-Y600HVy** Round Hardness Blocks, approx. 600±15 HV10, HV1; **Ø64x15 mm**, Factory Certificate
1140801	**SONO-Y700HVy** Round Hardness Blocks, approx. 700±15 HV30, HV1; **Ø64x15 mm**, Factory Certificate
1140802	**SONO-Y800HVy** Round Hardness Blocks, approx. 800±15 HV30, HV1; **Ø64x15 mm**, Factory Certificate
1140807	**SONO-Y900HVy** Round Hardness Blocks, approx. 900±15 HV30, HV1; **Ø64x15 mm**, Factory Certificate
1141000	**SONO-CAL-Block** DAkkS Calibration for each test block and test force according to DIN EN ISO 6507-3 Delivery time: approx. 3-5 weeks
1141002	**SONO-CAL-Curve**, Indirect DAKKS Check of Calibriation Curve according DIN 50159-2

1141001	**SONO-CAL-Instr** DAkkS Calibration for Instrument plus Probe according to DIN 50159-2. Indirect Check of calibration curve plus direct calibration (force, Vickers diamond angle and tip) - not available for motor probes SONO-1M, SONO-3M and SONO-8M Delivery time: approx. 3-4 weeks
	Hardness levels between 150HV and 900HV or 25 HRC and 67 HRC. **xxx= Hardness value, y=test load in kgf**

Hardness testing blocks 80x16 mm incl. MPA Certificate DAkkS for one test force

1140810	**SONO-B140HVy** Round Hardness Blocks, approx. 140±15 HVxx; Ø80x16 mm, including MPA Certificate DAkkS Calibration for each test block and test force (HV10 or HV5 or HV1) according to DIN EN ISO 6507-3 please specify requested test force for Certification with your order
1140811	**SONO-B240HVy** Round Hardness Blocks, approx. 240±15 HVxx; Ø80x16 mm, including MPA Certificate DAkkS Calibration for each test block and test force (HV10 or HV5 or HV1) according to DIN EN ISO 6507-3 please specify requested test force for Certification with your order
1140822	**SONO-B280HVy** Round Hardness Blocks, approx. 280±15 HVxx; Ø80x16 mm, including MPA Certificate DAkkS Calibration for each test block and test force (HV10 or HV5 or HV1) according to DIN EN ISO 6507-3 please specify requested test force for Certification with your order
1140812	**SONO-B420HVy** Round Hardness Blocks, approx. 420±15 HVxx; Ø80x16 mm, including MPA Certificate DAkkS Calibration for each test block and test force (HV10 or HV5 or HV1) according to DIN EN ISO 6507-3 please specify requested test force for Certification with your order
1140813	**SONO-B560HVy** Round Hardness Blocks, approx. 560±15 HVxx; Ø80x16 mm, including MPA Certificate DAkkS Calibration for each test block and test force (HV10 or HV5 or HV1) according to DIN EN ISO 6507-3 please specify requested test force for Certification with your order
1140814	**SONO-B620HVy** Round Hardness Blocks, approx. 620±15 HVxx; Ø80x16 mm, including MPA Certificate DAkkS Calibration for each test block and test force (HV10 or HV5 or HV1) according to DIN EN ISO 6507-3 please specify requested test force for Certification with your order
1140823	**SONO-B700HVy** Round Hardness Blocks, approx. 700±15 HVxx; Ø80x16 mm, including MPA Certificate DAkkS Calibration for each test block and test force (HV10 or HV5 or HV1) according to DIN EN ISO 6507-3 please specify requested test force for Certification with your order
1140815	**SONO-B840HVy** Round Hardness Blocks, approx. 840±15 HVxx; Ø80x16 mm, including MPA Certificate DAkkS Calibration for each test block and test force (HV10 or HV5 or HV1) according to DIN EN ISO 6507-3 please specify requested test force for Certification with your order

Training

11505	**SONO-THT** Introduction into hardness testing and Instruments operation, plus travel expenses, living, per hour
11506	**SONO-TR** Group training Hardness Testing, Instrument Operation, per 1/2 day and person, 4 individuals max., plus travel expenses

11.3 Technical Data

Measuring Specifications			
Measuring principle	UCI Method, corresponds to DIN 50159, ASTM A1038		
Test indenter	Vickers diamond 136°		
Test loads Newton scale (1kgf = 9.81 N)	Motor probes: 1N (0.1 kgf), 3N (0.3kgf) and 8.6 N (0.9 kgf) Handheld Probes: 10N (1 kgf), 50N (5kgf), 98N (10kgf) (Other test loads on request)		
Hardness scales and range (according to relevant standards), in this case table A1 respectively T1, T2 (low alloy steel). Different measuring ranges are valid for other materials. When exceeding the limits the conversion range will be extended. The calculated values are highlighted in red besides the original data in HV. **Note:** Conversions are acc. to latest ASTM E140-12b$^{\varepsilon 1}$ (2013) und EN ISO 18265:2014. Conversions into tensile strength: 98N (10kgf) test load only.	Vickers Brinell Rockwell Rockwell Rockwell Rockwell Rockwell Rockwell (EN ISO 18265 only) Rockwell Knoop (ASTM E140 only) Shore (ASTM E140 only) Tensile strength	HV HB HRB HRC HRE HRF HRA HRD HR45N HK HS MPa	10 – 1999 (9999) 76 – 618 41 – 105 20,3 – 68 70 – 108,5 82,6 – 115,1 60,7 – 85,6 40,3 - 76,9 19,9 – 75,4 87 – 920 34,2 – 97,3 255 - 2180
Measurement uncertainty*	< 4 % (HV5, HV 10). For other test loads and ranges see table below.		
Relative repeatability*	< 5 % (HV5, HV 10). For other test loads and ranges see table below.		

*exceeds DIN 50159, dependent on test load and range (see table below). Specifications are valid for 5 measurements using Vickers reference blocks and according to test conditions given in standard DIN 50159.

Hardness scale	Measurement uncertainty [%]				Relative repeatability [%]	
	< 250 HV	250 HV - 500 HV	500 HV - 800 HV	> 800HV	< 250 HV	> 250 HV
HV 0,1	5	6	7	8	8	6
HV 0,3	5	6	7	8	8	6
HV 0,8	4	4	5	6	8	6
HV 1	4	4	5	6	8	6

Mechanical and Environmental (Instrument and probe)	
Operating Temperature	Probe: 0°C to ~ +45°C Instrument: -10° ~ +50°C // Charging +10°C ~ +40°C
Storage Temperature	-20°C ~ +70°C
Humidity	Max. 90%, non-condensing
Dimensions	Instrument H/B/T approx.: 133 x 236 x 314mm Motor probe Ø38mm, L=190 mm Handheld probe Ø25 mm, L=176 mm (free length oscillation rod ca. 12,5 mm) Handheld probe Ø25 mm, L=207 mm (free length oscillation rod ca. 43 mm)
Weight	Instrument approx. 3400 g Handheld probe approx. 280 g Motor probe approx. 370 g
Instrument	
Processor and Memory	i.MX6 Dual (ARM Cortex A9) 1 GHz Memory 4GB Flash / 1 GB RAM
Operating system	Android 7.1

Power	DC Power supply 12 - 24 VDC (max. 30 VDC), typ. 6 W, max. 23 W
Display **Size** **Resolution** **Colors / Brigthness**	PCT Touch-Screen, TFT-Display with LED-backlight 7.0”/ 178mm 800 x 480 pixel 262 K / 500 cd / m2
Interfaces **Probes** **Digital I/O** **USB** **RS232**	 Lemo ERD.0S.304, USB 2.0 DB37 female, galvanically isolated, max. voltage 30 VDC USB 2.0, type B female DB9 female, galvanically isolated, V24 level
IP-Proof	IP20
Instrument Language	D, EN, IT, FR, SP, PL, CZ, CN - more on request

Table 11-5

11.4 Conversion Limits

The Vickers Scale is the basis for all conversions. Currently, the conversion tables for all material tables have been entered in accordance with EN ISO 18265. Depending on requirements, enhancements of the conversion ranges and new material tables can be generated.

Measuring range in HV (UCI): 10 - 2000 (1 - 9999)

Minimal conversion: 80 HV = 76 HB, Maximum conversion: 940 HV = 68 HRC (for steel, Table A1 EN ISO 18265).

Conversion rules according to EN ISO 18265 for low alloy steel:

Scale	HB	HRB	HRF	HRC	HRA	HRD	HR45N	Rm [MPa]	HK
Min	76	41	82,6	20,3	60,7	40,4	19,9	255	-
Max	618	105	115,1	68,0	85,6	76,9	75,4	2180	-

Table 11-6

Conversion rules according to ASTM 140-07 for low alloy steel:

Scale	HB	HRB	HRF	HRC	HRA	HRD	HR45N	Rm [MPa]	HK
Min	100	55	88,2	20,0	37,2	40,1	19,6	-	112
Max	739	100	99,6	68,0	85,6	76,9	75,4	-	920

Table 11-7

WARNING

The conversion tables according to EN ISO 18265 and ASTM E140 have different ranges for the different materials. For SonoDur devices, the load-bearing Vickers Hardness scale applies which always has a measurement value. If no value pairs in HRC, HB, etc. are available for certain scales, an extrapolation is initially attempted. If this results in no result, the operator must choose a different hardness scale for the existing measurement series or return only to the Vickers presentation. The extrapolated values are in any case not covered by standard values and are subject to a high degree of uncertainty. Therefore, they will be represented in RED and offered to the operator for use.

11.5 Formulas and Designations

In **Chapter 7.7** "Info-Menu", the calculation results are shown, which are explained in more detail here (also refer to EN ISO 18265).

Maximum	Mittelwert	Minimum
715,1 HV	709,6 HV	704,4 HV
Anzahl	Std. Abweichung	Spannweite
5[5]	3,9 0,6%	10,7 1,5%
N > 720,0 HV	N in Schwellen	N < 690,0 HV
0	5	0
Cp	Cpk	Gelöscht
1,27	0,88	0

Figure 11.2

The mean value in Fig. 11.1 is X with overlined Beam here referred to as "Xquer".

$$\text{Xquer} = \frac{1}{N} * \sum_{1}^{N} X(i) \qquad (1)$$

With X (i) = individual hardness value, N = total number of measurements

If no hardness progression measurements are carried out, the mean value is usually the characteristic measure for the hardness of a material or for a specific test position at the test part. By averaging, operator influences and/or influences due to material inhomogeneity can be reduced (exceptions are strongly heterogeneous materials such as GG or GGG cast iron, for example).

R = range/span or maximum error of a series of measurements

R = X(Max) – X(Min) (2)

⚠	**NOTE:**
The relative span is calculated according to EN ISO 18265 depending on the selected scale:	

$$R\,[\%] = \frac{R}{\text{Xquer}} * 100 \quad \text{(for HV, HB, HK, MPa)} \qquad (3)$$

$$R\,[\%] = \frac{R}{100 - \text{Xquer}} * 100 \quad \text{(for HRC, HRA, HRD, HRN)} \qquad (4)$$

$$R\,[\%] = \frac{R}{130 - \text{Xquer}} * 100 \quad \text{(for HRB and HRF)} \qquad (5)$$

The span enables the trapping of individual erroneous measurements that can be deleted, taking also into account the distribution of measurements within a series of measurements. The respective test regulations and procedures must be observed for the deletion of obvious incorrect measurements.

Mean error of the single measurement σ:

$$\sigma = \sqrt{\frac{\sum_1^N (Xquer - X(i))^2}{(N-1)}} \qquad (6)$$

Or the relative mean error of the single measurement σ[%] from (6):

⚠	**NOTE:**
The mean error of the single measurement is calculated according to EN ISO 18265 depending on the selected scale.	

$$\sigma\,[\%] = \frac{\sigma}{Xquer} * 100 \qquad \text{(fo HV, HB, HK, MPa)} \qquad (7)$$

$$\sigma\,[\%] = \frac{\sigma}{100 - Xquer} * 100 \qquad \text{(for HRC, HRA, HRD, HRN)} \qquad (8)$$

$$\sigma\,[\%] = \frac{\sigma}{130 - Xquer} * 100 \qquad \text{(for HRB and HRF)} \qquad (9)$$

The **mean error** of the **single measurement** is an estimate of the individual measurement error, which contains both random and systematic components, such as:

- Individual care and skill in probe handling by the operators (free-handed measurements, guided measurements with tripods or probe guides).
- Properties of the test material (local solidification and mechanical stresses, porosity, thermal pre-treatment) as well as geometry (size, mass, thickness, shape, installation position)
- Surface condition (roughness, texture, graininess, processing marks)
- Environmental influences (temperature, humidity, cleanliness of the test piece)
- Device-specific variations

The mean error of the single measurement in its entirety best reflects the quality of the test result measured against the above influencing factors.

The process parameters Cp and Cpk:

The two parameters essentially describe the process capability primarily in automated test systems and in the measurement of large quantities.

Cp describes the scattering of the measured values (Xi) by an average value Xquer within a permissible tolerance range (upper and lower thresholds Smax, Smin). The respective formula is:

$$Cp = \frac{Smax - Smin}{6\sigma} \qquad (10)$$

where σ = mean error of the single measurement and 6σ = width of the normal distribution curve.

As already mentioned, the application of this formula requires the presence of a large number of measured values that approximate a normal distribution.

The second parameter Cpk characterises the position of the measured value distribution. Here, the distance of the mean value Xquer from the respectively closer limit value (Smax - Xquer) or (Xquer - Smin) will be related over half the width of the distribution of the Gaussian distribution curve.

$$Cpk = \frac{Smax - Xquer}{3\sigma} \text{ bzw. } \frac{Xquer - Smax}{3\sigma} \qquad (11)$$

depending on which difference is smaller.

A negative sign indicates that the process has shifted outside the tolerance limits. For further considerations, please refer to the relevant literature

11.6 Compliance with Environmental Regulations

The test device contains a built-in rechargeable Li-ion rechargeable battery (lithium-ion rechargeable battery), which could be harmful to health and/or the environment if not correctly disposed of and subsequently should not be disposed of as unsorted household domestic waste.

⚠	**Remark**
Please ensure the device is returned to the manufacturer, NewSonic, even after the end of the product service life!	

11.7 Limited warranty

We guarantee for a period of 2 (two) years from the date of purchase that this device (i) is free of third-party ownership claims, (ii) is new and free from defects in material and workmanship, and complies with the product specifications for normal use and service during the warranty period applicable from the date of purchase. The precondition for the second-year warranty is the calibration of the device to values within the stated specifications performed by us or by our certified service providers after twelfth months and before the beginning of the fourteenth month following purchase. The duration of the warranty can be extended or modified by the conclusion of explicit service contracts.

This limited warranty shall not apply if issues arise due to the following (i) the operating instructions were not followed or the preventive maintenance was neglected, (ii) customer service, repair or modifications were performed by a third party and not by us or our authorized service partners or (iii) external circumstances such as accident, abuse or misuse or related to the power supply.

This warranty shall not apply to parts identified as wearing parts nor to lamps, transducers, tubes, accessories, or optional third-party equipment which may be potentially warranted by the respective manufacturer. The obligations arising out of this warranty are limited to the repair or replacement of the components that we believe have become defective during the warranty period, without incurring any costs to the original purchaser, who shall however facilitate the return of the components to us in approved packaging material. This warranty shall apply to the original purchaser and cannot be assigned or transferred to third parties.

WITH RESPECT TO OUR PRODUCTS AND EXCEPT TO THE EXTENT AS DESCRIBED ABOVE, WE EXPRESSLY DISCLAIM ALL WARRANTIES AND REPRESENTATIONS, OF AN EXPLICIT OR IMPLIED NATURE. THIS ALSO INCLUDES ANY IMPLIED WARRANTIES OF MERCHANTABILITY, SUITABILITY FOR A PARTICULAR PURPOSE, NON-INFRINGEMENT OF RIGHTS OR PROPERTY RIGHTS AND ANY IMPLIED WARRANTIES OF BUSINESS COURSE OF EVENTS, BUSINESS PRACTICES, OR CUSTOM OF TRADE.

12 Accessories

12.1 SONO-PM-4, Prism Attachment Set for Motor Probes

The manual at hand describes how to use the prism attachments for motor measuring probes of the SonoDur product line. The SonoDur-R operating instruction manual explains how to operate the motor measuring probes. Knowledge of this subject is required.

12.1.1 Components and technical data

The prism attachment kit consists of a special screw-threaded probe base in four stages for the best possible adaptation to curved surfaces and of three shape-adapted plates and a flat surface plate which can be screwed onto the special probe base.

SONO-PM-4, Order Number: 11209

Special probe base with screw-in sleeve and switching sleeve probe plate for small, cylindrical parts, Ø 36mm probe plate with Ø 70mm

Probe plate with milled edges Ø 50, width 36mm probe plate for flat surfaces, Ø 36mm

Figure 12.1

Figure 12.2

WARNING

The switching sleeve of the special probe base (Fehler! Verweisquelle konnte nicht gefunden werden., parts in the right) has a different design to the standard probe base and should therefore not be mixed up.

Figure 12.3

12.1.2 Handling

To prepare, carefully unscrew the standard probe base from the probe. Select the desired probe plate and screw it into the special probe base, whilst paying particular attention to the engraved spacer rings, which indicate the possible diameter range for each test specimen as specified in Table 13-5, which applies to all probe plates. The special probe base for curved surfaces becomes ready for use by screwing on the motor measuring probe.

As with the use of the standard probe base, there is automatic measuring operation mode via the switching sleeve and manual measuring without the switching sleeve. For this purpose, the shift sleeve must be removed from the special probe base. At this point, invoking the measurement is only possible by touching the probe icon on the SonoDurR screen, however it does simplify the accurate positioning.

The flat surface probe plate serves the same purpose as the standard probe base and enables easy and quick exchange between different probe plates.

Figure 12.4

Ring	Possible diameters
3 (at the top)	0 to 10 mm
2	10 to 50 mm
1	50 to 100 mm
0 (bottom)	100 to flat
Measured respectively for the ring in the viewing window of the probe base, which is aligned with the lower edge of the probe base.	

Table 12-1

The spacer rings define the possible diameter range according to Table 12.1

⚠	**WARNING**
Incorrect diameter setting causes either too little or too much spring force through the motor measuring probe which in turn increases the risk of incorrect measurements. If the diameter is set too large, the Vickers Diamond may potentially not reach the test piece surface and an error message will be displayed (**chapter 7.5**Fehler! Verweisquelle konnte nicht gefunden werden.**, Performing a measurement with motor measuring probes.**	

After the correct diameter setting has been applied, carefully put the measuring probe in place with the notch in the longitudinal direction of the cylindrical surface and wait for the measuring process.

Figure 12.5

⚠	**WARNING**
Ensure that the measuring probe is firmly positioned and cannot wobble during the measurement!	

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14 Addresses

HQ and Service Center:

NewSonic GmbH, Grathwohlstrasse 5, D-72762 Reutlingen, www.newsonic.de, info@newsonic.de

Tel.: +49-7121-680855-0, Fax: +49-7121-270539, Mobile: +49-151-16503517

Service Hotline: +49-7121-680855-2