

# **Krautkramer TIV**

## **Technical Reference and Operating Manual**

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The version number of the software is displayed in the menu bar line on the screen or in the menu **Config – Info** (ref. chapter 4.6).

Subject to change without notice.

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# Introduction 1

## 1.1 Safety information

The Krautkramer TIV is designed and tested according to DIN EN 61 010 Part 1, March 1994, „Safety requirements for electric measuring, control, and laboratory devices”, and was technically in a perfectly safe and faultless condition when leaving the manufacturing works.

In order to maintain this condition and to ensure a safe operation, it is absolutely necessary that you read the following safety information before putting the instrument into operation.

**Attention:**

**The Krautkramer TIV is an instrument meant for materials testing. Any use in medical or other applications is not allowed!**

**The instrument may only be used in industrial environments.**

## Power supply

### Battery pack and power supply unit

The Krautkramer TIV can be operated using the battery pack MIC 20-BAT, or a power supply unit. You can charge the battery pack MIC 20-BAT in the instrument itself while the instrument is supplied with power via the power supply unit and turned off. As soon as you turn the instrument on, the power supply to the battery compartment is interrupted.

### NiCad or NiMH single cells

The operation using NiCad or NiMH single cells is likewise possible but is not recommended because of the clearly reduced operating time.

**Attention:**

You cannot charge NiCad or NiMH single cells in the instrument itself but only by means of an external battery charger approved for this purpose.

If you are only using the power supply unit for a longer period of time, you should remove the batteries from the instrument.

## Software

According to the current state of the art, software is never completely free from errors or defects.

For this reason, before using any software-controlled test equipment, it should be ensured that the required functions operate perfectly in the intended combination.

If you have any questions regarding the use of the instrument, please contact your nearest GE Inspection Technologies representative.

## 1.2 About this manual

This manual describes the operation of the hardness tester Krautkramer TIV.

Please read carefully through this manual in order to be able to operate all functions of your instrument quickly and reliably. You'll be able to use the complete range of instrument functions and, at the same time, to avoid faults and operating errors which may lead to incorrect test results.

### Important information

Even if you might be familiar with hardness testing methods, please always observe the information in chapters 1.4 and 1.5. In chapter 1.4, you will find important limitations and prerequisites for hardness testing in general (training, knowledge of the specific technical test requirements and limits of testing, choice of the appropriate test device).

In chapter 1.5, you will find concrete information about hardness testing using the Krautkramer TIV that you always have to follow in order to ensure correct test results.

## 1.3 Layout and presentation in this manual

To make it easier for you to use the manual, the operating steps, notes, etc. are always presented in the same way. This will help you find individual pieces of information quickly.

### Attention and note symbols



#### Attention:

You will find the **Attention** symbol in the case of any peculiarities or special aspects in the operation which could affect the correctness of the results.



#### Note:

At **Note**, you will find e.g. references to other chapters or special recommendations for a function.

### Listings

Listings are presented in the following form:

- Variant A
- Variant B
- ...

### Operating steps

Operating steps appear as shown in the following example:

- Place the handheld probe vertically to the surface to be tested.
- Hold the probe tight with one hand so that the foot stays perpendicular to the surface during the measurement.

## 1.4 Prerequisites for hardness testing

In this operating manual you will find all essential information on how to operate the Krautkramer TIV. In addition, there are a number of factors which affect the test results. As a description of these factors would go beyond the scope of an operating manual, only the three most important conditions are therefore described here:

- operator training
- knowledge of special technical test requirements and limits
- choice of the appropriate test equipment



### **Attention:**

Lack of knowledge of the above-mentioned subjects may lead to incorrect test results with unforeseeable consequences.

GE Inspection Technologies organizes training courses in the field of hardness testing. You will receive information on the scheduled dates on request.

## Operator training

The reliable and safe operation of a hardness testing device requires a proper training in materials testing.

A proper training comprises for example adequate knowledge of:

- hardness testing on metallic materials
- effects due to material properties, especially due to the microstructure, on hardness testing and on the corresponding choice of the appropriate hardness tester
- problems relating to the comparability of different hardness values, such as Vickers, Rockwell, and Brinell
- effects due to surface finish on the hardness value
- effects of the test load on the determined hardness value

**Technical test requirements**

Every hardness test is subject to specific technical test requirements. The most important ones are:

- definition of the scope of testing
- choice of the appropriate test method
- consideration of material properties
- determination of limits for evaluation

**Choice of the appropriate test equipment**

It is the task of those responsible for the test to fully inform the operator about the technical test requirements. Moreover, a clear and thorough interpretation of the corresponding test specifications is absolutely necessary.

Information about test methods and test specifications may be obtained, for example, from various institutions, industrial companies, and authorities.

## 1.5 Important information about hardness testing using the Krautkramer TIV

Please find in the following a summary of the most important technical test requirements that you always have to observe in order to obtain reliable and reproducible test results.



### **Attention:**

Do not carry out the hardness test twice at the same test position, otherwise measuring errors may occur due to the hardness increase of the surface. The distance between the test positions should be at least 3 mm.

## Test material

The surfaces must be free from any impurities (oil, dust, etc.), and rust. Rough surfaces lead to a greater variation or spreading of the single readings. If necessary, polish mainly rough surfaces, for example by means of our grinding set MIC 1060 (ref. chapter 2).

## The TIV test method

To be able to exclude the effects due to the test material's elastic properties, as well as those due to its mass and wall thickness on mobile hardness testing, a completely new method was developed: the TIV method (TIV = Through-Indenter Viewing).

Since the test load is applied statically as with the Vickers method, the TIV method enables to carry out hardness tests on different materials having the most different mass and geometry, without any additional calibration.

With the TIV method, the test load is applied manually via a spring. A Vickers-diamond is used as an indenter, and the hardness is measured under load.

The CCD camera integrated into the probe uses special optics to take a picture of the Vickers diamond penetrating into the surface. The camera views through the diamond during this (Through-Indenter Viewing).

Exactly at the moment when the specific test load of the probe (e.g. 50 N – or 5 kgf –) is attained, the picture of the photographed indentation is transferred to the instrument, and automatically evaluated. In this process, the instrument determines the length of the two diagonals of the indentation.

The corresponding numerical value is then derived from the determined diagonal lengths, according to the Vickers hardness definition, and immediately displayed on the Krautkramer TIV.

As the Vickers indentation may already be seen on the display screen during the measurement, the quality of the measurement, or the reliability of the reading, can be directly evaluated. Any effects on the indentation process due to surface effects or material structure are likewise immediately recognized, and can be taken into consideration.

## Evaluation of the test results

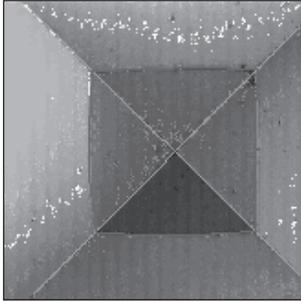
The automatic evaluation of the diamond indentation must in any case be verified by the operator. The determination of the edges of the diamond indentation, and consequently the measurement of the diagonals, is mainly based on an analysis of the different gray-scale values in the picture taken by the camera. The shadows on the edges produced by the diamond indentation are picked up by the camera as different gray-scale values. This makes an identification of the edges possible. Errors in this process may be caused for example by chatter marks or dirt.

The operator must use the camera picture visible on the screen, which can be enlarged for this purpose, to assess whether the system has correctly recognized the edges and diagonals. A manual correction may be necessary.

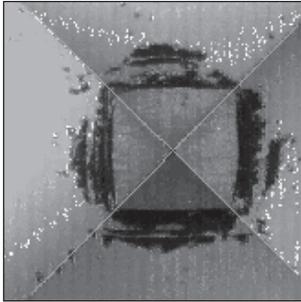


### Attention:

Soil particles deposited on the diamond affect the distribution of the gray-scale values in the camera picture, and consequently the determination of edges and diagonals. You must therefore clean the diamond with the diamond cleansing cloth at regular intervals in order to avoid incorrect test results.



**Clean diamond:**  
clear edge lines and clear  
ends of the diagonals



**Soiled diamond:**  
indistinctly edge lines,  
no clear ends of the  
diagonals

## Conversion of hardness values

The conversion of hardness values into other hardness scales is only possible with restrictions.

Hardness values determined according to different methods cannot be converted into each other by means of generally applicable relations. The restrictions regarding the conversion, stated in the DIN50150, ASTM E140 specifications, must therefore always be taken into account!

The indentation behavior of the material is determined by its stress-strain behavior. Shape and material of the indenter, the size of indentation, and consequently the measured area vary, depending on the test method used.

The conversion of hardness values both into one another and into tensile strength values can be inaccurate or unacceptable depending on the material, treatment condition, and surface quality.



### Attention:

**Any illegal or unacceptable conversions may lead to serious errors in the interpretation of test results.**

## 1.6 The Krautkramer TIV

The Krautkramer TIV is a portable and easy-to-use hardness tester based on the newly developed TIV method enabling quick tests without any difficulties.

You can use the Krautkramer TIV to measure anywhere you want and in any direction you choose; the direction does not have to be defined beforehand.

Hardness testing is carried out using a Vickers -diamond as indenter. On attaining the specific test load of the probe, the hardness value is automatically determined and displayed on the instrument's color LCD as a digital value according to the selected scale. The specially designed probe ensures a safe and reliable application of the test load without any problem.

The operation of the Krautkramer TIV (calibration, configuration, evaluation, data memory) is carried out by means of the graphic user interface appearing on the display and adapted to the known Windows standard. In this system, the mouse is replaced with the touch-sensitive screen (touch screen). As an alternative, conventional buttons are available for most of the operating functions.

### Special features of the Krautkramer TIV

- Measurements almost independently of the test material's mass and geometry
- Automatic evaluation of the Vickers indentation
- Test method is applicable to almost all materials
- Tests can be carried out without any additional calibration to the test material
- Color LCD screen (5.7" TFT) for displays and operating functions
- Optical monitoring of the diamond indentation by picture taken with a CCD camera, and transfer of the picture to the display during testing
- Characterization and assessment of the diamond and of the diamond indentation is possible by means of an exact picture shown when viewing through the diamond (Through-Indenter Viewing)
- Storage of test data and straightforward representation of test series as a diagram and histogram
- Operation by means of the battery pack MIC 20-BAT, or by means of the power supply unit

## Automatic evaluation

The automatic evaluation of the diamond indentation with the Krautkramer TIV is effected in three steps.

### Step 1: Localization of the indentation

The software uses the camera picture through the diamond to analyze the gray-scale values in the picture area. The edges and fringe ranges determined in this way are subjected to an additional plausibility check.

### Step 2: Determination of edge lines

The edge lines are determined on the basis of the different gray-scale values for surface and indentation crater.

### Step 3: Determination of diagonals

The diagonals are determined by means of the intersection points or corners of edge lines.

The Vickers hardness (HV) is subsequently determined using the following formula:

$$HV = \frac{\text{test load}}{\text{size of indentation}}$$

## Large variety of possible applications

The material-independent measurement and hardness test by means of the Krautkramer TIV opens up a wide range of application possibilities for testing by means of only one single method. This includes, among others, measurements on:

- steel
- nonferrous metals
- plastics
- glass
- ceramic
- color coats
- new types of surface coatings
- jewellery

In these cases, the hardness tests can be carried out without any additional calibration to the corresponding material under test.

## System components

The Krautkramer TIV consists of

- TIV hardness tester including software
- TIV probe
- probe cable to connect the TIV probe with the instrument

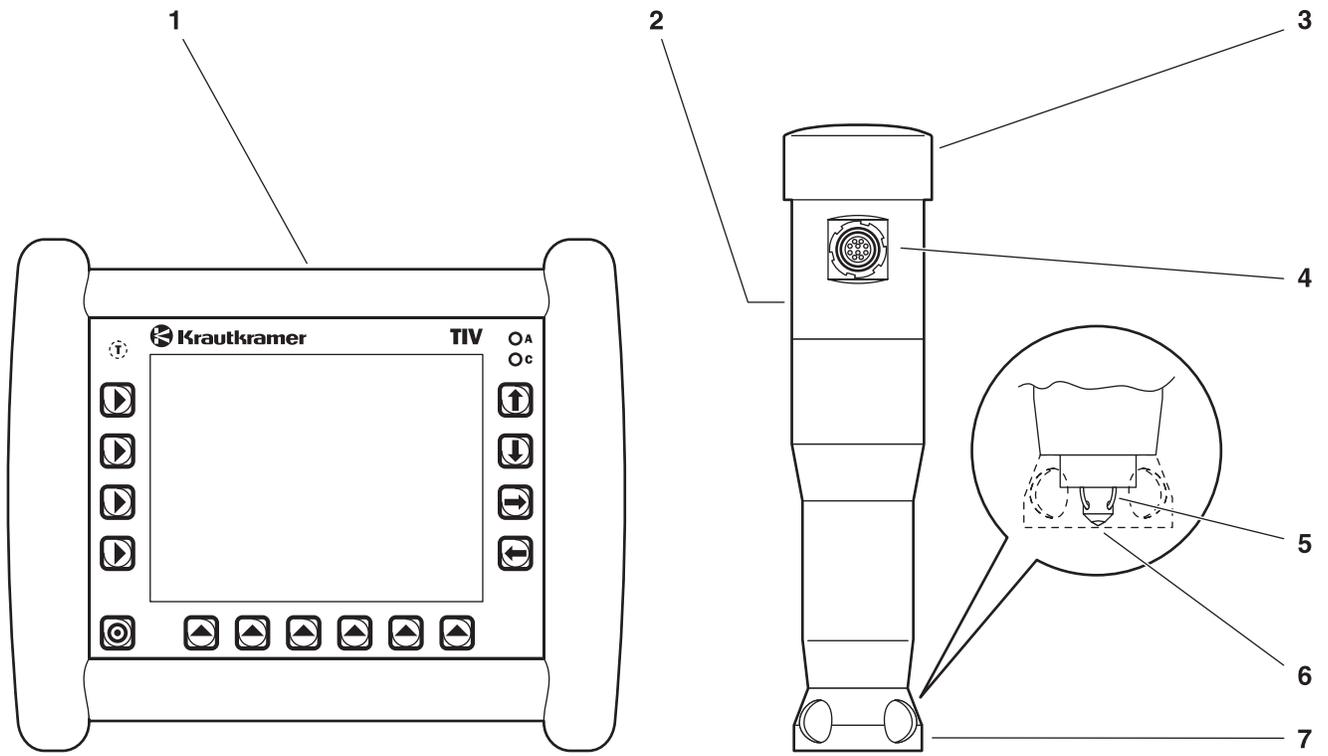
The TIV tester is provided with a 5.7" color TFT screen with a touch-sensitive surface (touch screen). The screen shows the graphic user interface adapted to the known Windows standards. The operation of the menus and functions is likewise possible by means of the sealed keypad arranged next to and below the screen.

The probe consists of

- probe shoe to position the probe
- optics (lighting of the Vickers diamond and optical lens system)
- CCD camera for taking a picture of the diamond indentation
- mechanics and electronics for the non-directional application of the test load

## Overview of the operator's controls

- 1 Tester with touch screen and pushbuttons
- 2 Handheld probe
- 3 Large pressure knob for the controlled application of the test load
- 4 Probe cable connection for the transmission of probe data and of camera picture to the instrument
- 5 Light guide for lighting the diamond indentation
- 6 Vickers diamond as indenter
- 7 Probe shoe





# Standard package and accessories **2**

This chapter informs you about the standard package and the accessories available for the Krautkramer TIV.

It describes

- component parts of the product
- required and recommended accessories
- spare parts requirements

## 2.1 Standard package

Product code	Description	Order no.
TIV	TIV – portable tester for hardness testing according to Vickers under test load (Through-Diamond technique) with digital display of the measured value in HV, HB, HRB, HRC or N/mm <sup>2</sup>	35 475
	Consisting of:	
	Basic instrument TIV	35 490
	Power supply unit	101 075
	Transport case	101 553
	Operating manual in German	28 703
	or	
	Operating manual in English	28 704

## 2.2 Required accessories

Product code	Description	Order no.
TIV 105	TIV handheld probe 50 N (5 kgf)	35 480
	consisting of:	
	TIV basic probe 50 N (5 kgf)	35 510
TIV C	Probe cable	35 494
	Diamond cleaning cloth	101 549

## 2.3 Recommended accessories

Product code	Description	Order no.
MIC 20-BAT	NiMH battery pack, 4.5 Ah, with temperature sensor and fuse, internal charging	35 452
MIC 300	Technical book on hardness testing	28 837
MIC 1060	Battery-driven grinding set for surface working	34 380
MIC 222-A	Precision test support	35 546
MIC 225	Camshaft test support	34 869
MIC 227	Test support for the determination of hardness curves	35 264
TIV 2V050	Hardness reference block 250 HV5, incl. works certificate	35 545
MIC 25C	Hardness reference block 25 HRC, incl. MPA certificate	33 905
MIC 45C	Hardness reference block 45 HRC, incl. MPA certificate	33 906
MIC 65C	Hardness reference block 65 HRC, incl. MPA certificate	33 907
MIC 2V050	Hardness reference block 240 HV5, incl. MPA certificate	33 899
MIC 5V050	Hardness reference block 540 HV5, incl. MPA certificate	33 900

MIC 8V050	Hardness reference block 840 HV5, incl. MPA certificate	33 901
	Printer cable (serial/parallel) for connection to Hewlett-Packard printers HP DeskJet 9xx series	101 761
UDAT	UltraDAT, Data management program for transmission and documentation of the hardness readings	35 549
	Data transmission cable for connection of the instrument with a computer (Ethernet interface)	101 785

## 2.4 Spare parts requirements

Product code	Description	Order no.
	TIV basic probe 50 N (5 kgf)	35 510
TIV C	Probe cable	35 494
	Replacement grinding wheel for battery-driven grinding set MIC 1060	18 115

# Initial start-up **3**

## 3.1 Power supply

You can operate the Krautkramer TIV either with the battery pack MIC20-BAT or with the power supply unit. The operation with the power supply unit is possible even if the battery pack MIC20-BAT is in the instrument. The power supply to the battery compartment is then automatically interrupted.

### Operation using the power supply unit

The Krautkramer TIV is supplied either with a desktop power supply unit or with a plug-in power supply unit. The power supply unit is automatically set to any a.c. voltage between 100 and 240 V (nominal voltage).

### Operation using the desktop power supply unit

The desktop power supply unit is provided with a cable equipped with a Euro plug connector and inlet connector for non-heating appliances.

Plug the cable's inlet connector for non-heating appliances in the socket for non-heating appliances of the power supply unit.

### Operation using the plug-in power supply unit

The plug-in power supply unit is delivered with two different socket-outlet adapters – for Euro and U.S. standard. If the adapter plug on your power supply unit does not correspond to your socket-outlet standard, you can exchange it.

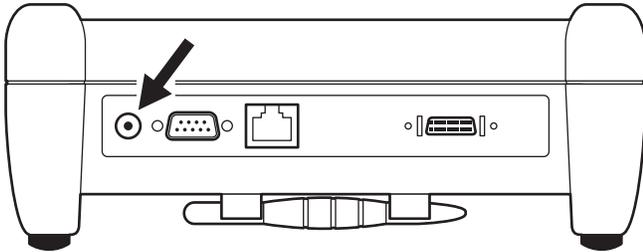
Just pull off the attached adapter, and replace it with the required one.

#### Note:

You should exchange the socket-outlet adapter only once; the plug-in power supply unit is not meant for frequent exchanges.

## Connecting

Use the corresponding power supply unit to connect the Krautkramer TIV to a suitable mains socket-outlet. The socket-contact for the power supply unit cable is located at the back of the instrument.



## Operation using the battery pack MIC 20-BAT

You can operate the Krautkramer TIV with the NiMH battery pack MIC 20-BAT (ref. chapter 2).

The operation is likewise possible with 6 NiCad or NiMH single C-cells each, however, it is not recommended because of the clearly reduced operating time.

## Inserting batteries

The battery compartment is located in the instrument bottom.

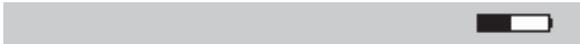
- Move the fastener towards the lid center in order to open the lid, and remove the lid.
- Insert the plug of the battery pack into the socket-contact in the battery compartment until it snaps into place. When inserting the battery pack, make sure that no squeezing or kinking of the cables is possible.
- If you use single cells, insert the individual cells into the battery compartment one by one. Follow the instructions regarding alignment and polarity in the battery compartment.
- Place the lid back on, move the fastener back and close the battery compartment so that the fastener locks home perceptibly.

### Notes:

Remove the batteries from the instrument if you're not going to use it for a longer period of time!

Used or defective batteries are special waste and have to be disposed of as provided by the law!

The current status of the battery charge is indicated by an icon on the display of the Krautkramer TIV:



An alarm is output with low voltage. In such a case, exchange the batteries at once. The Krautkramer TIV is automatically turned off if the voltage gets too low in order to ensure a reliable mode of functioning.

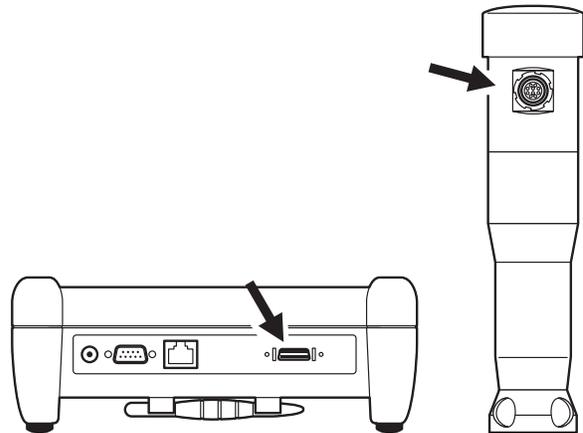
You will find more details on the care and charging of batteries in chapter 5.

## 3.2 Connecting the probe

The probe is connected with the instrument via the probe cable. The probe cable is provided with a round plug connector to connect it to the probe, and with a square plug connector to connect it to the instrument.

### Note:

You should always remember to only exchange the probe when the instrument is turned off.



## Connecting the probe cable

- Align the round 20-pin plug connector correctly to the socket in the upper part of the probe by means of the markings there, and insert it carefully into the socket until the fastener snaps into place.
- Plug the square plug connector of the probe cable in the socket at the back of the instrument.
- Check the tight fit of the two plug connectors one more time.

## Disconnecting the probe cable

The round plug connector is provided with a bayonet lock, and the square one with two locking clips.

- Carefully pull on the outer ring of the round plug connector on the probe in order to unlock it, and pull off the plug connector.
- Press on the two lateral clips of the square plug connector on the instrument in order to release the locking, and pull off the plug connector.

## Exchanging the probe shoe

For tests on small parts and on uneven or rough surfaces, you can replace the standard probe shoe with a special one that enables a better positioning of the probe.

- Slowly unscrew the probe shoe currently in use counter-clockwise by hand.
- Carefully place the required probe shoe. Make sure that the thread is not damaged by tilting.
- Carefully screw the probe shoe on clockwise all the way to the end by only using your hands.

### 3.3 Turning on/off

#### Turning on

- Briefly press the button  to turn the instrument on.

The operating system will start, and some information, e.g. about the software, is briefly displayed on the screen. When the instrument is ready, you will see the graphic user interface.

#### Turning off

- Briefly press the button  to turn the instrument off.

**Attention:**

You should always use the button  in order to properly turn the instrument off. In the case of an interruption of the power supply (battery removal, unplugging of power plug), the instrument is not turned off properly, and data may be lost.

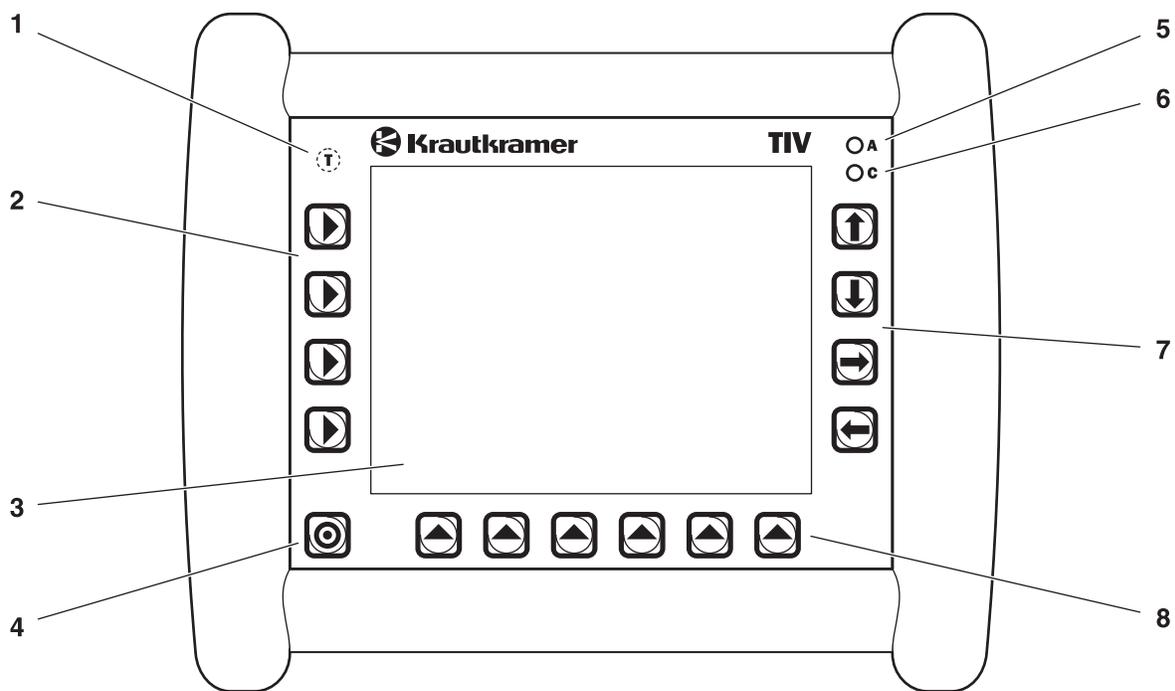
#### Emergency-stop

If the instrument no longer shows any reaction, you can turn it off without saving the current data. Afterwards, you can turn it back on as usual.

- To turn off, keep the button  pressed down until the screen is blanked, and the instrument is turned off.

# Operation 4

### 4.1 Fundamental principles of operation



## Operator's controls and displays

- 1 Temperature sensor (no operating function)
- 2 Select keys to select the main menus
- 3 Touch-sensitive screen (touch screen), for direct operation of the graphic interface
- 4 Key to turn on and off
- 5 Red LED,  
is lit in the case of alarms and if the preset threshold values for hardness measurements are exceeded
- 6 Green LED,  
is lit with an active charging process,  
flashes quickly with a finished charging process,  
flashes slowly if the battery voltage or the temperature are out of tolerances
- 7 Arrow keys for navigation in the menus, and for activation of functions
- 8 Select keys for submenus and functions

## Display screen

The Krautkramer TIV is equipped with a touch screen enabling a direct operation of the menus appearing on the screen.

The graphic user interface is adapted to the known Windows standards. The operation by means of a mouse (selecting and clicking) is in this case replaced with direct touch on the screen. A mouse pointer is therefore not necessary.

To select or to mark an element of the user interface, just touch the corresponding point of the screen briefly with your finger or with the pen provided for the instrument.

The pen is located in the holder at the instrument bottom.



### Attention:

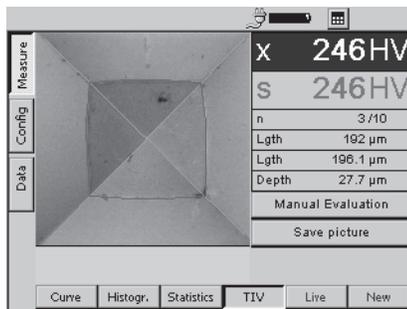
Do not touch the touch screen with any hard or sharp-edged objects (e.g. ball-point pen or screw driver). The touch-sensitive surface may be severely damaged by them.

Do not apply any high pressure to the screen, the touch screen needs only slight pressure to react.

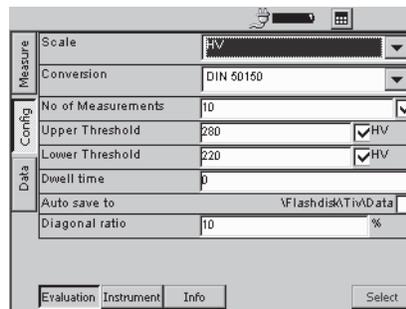
### User interface

The 3 main menus **Data**, **Config**, and **Measure** are displayed on the screen. The 3 main menus have different user interfaces.

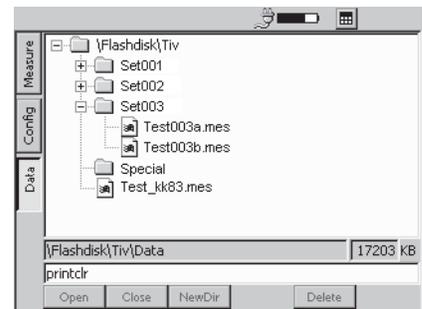
The buttons as well as the option and other boxes shown on the user interface can be operated by directly touching the touch screen, or by pressing the corresponding key next to the screen.



Main menu **Measure**



Main menu **Config**



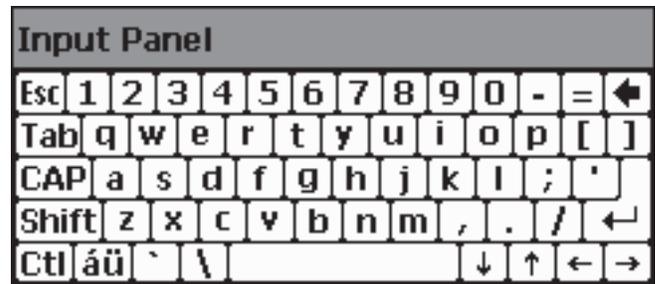
Main menu **Data**

## Virtual keyboard

A virtual keyboard is available for text and value inputs and is automatically displayed if the corresponding input fields are activated.

The virtual keyboard can also be turned on and off by hand.

- Touch the button with the keyboard icon on it, next to the battery icon. The virtual keyboard is displayed.
- Touch the broad bar above the displayed keys, keep the pen pressed down, and move the keyboard with the pen pressed down.
- Touch the button with the keyboard icon on it once again. The virtual keyboard is turned off again.



## Operation using the keypad or touch screen

You can use either the keys arranged around the screen to operate all menus and functions or, as an alternative, directly the touch screen.

At the beginning, use both alternatives in order to test the advantages of either one in practice.

In general, this manual only describes the direct operation by means of the touch screen. If the operation alternative using the keyboard presents a special advantage, it is additionally mentioned at that point.

The keys and menus or functions are arranged in such a way that a clear assignment can always be seen.

Consequently, you'll always have the following two alternatives:

- Touch the button of a function.
- or
- Press the key next to (or below) the function.

## Installing the instrument

The instrument has a prop-up lever stand at its bottom enabling you to install the instrument at varying angles.

You should always ensure that you have a good view of the screen in order to work as ergonomically as possible and to avoid overstraining yourself unnecessarily.

- Fold out the lever stand, and let it lock into the required position.
- Install the instrument in such a way that you have a good and non-dazzling view of it.

## 4.2 How to handle the probe

### Determination of diagonals

The Krautkramer TIV must always be set to the connected probe. This means that the automatic picture evaluation must be adjusted to the diamond (or to the camera picture of the diamond). The decisive thing in this regard is the position of the diagonals (edges) of the diamond. This information is stored in the probe and is automatically transferred when the probe is connected. However, if the green diagonal lines displayed in the camera picture deviate from the actual diagonals (the edges visible in the picture), manual readjustment is necessary.



#### Attention:

You should always check the diagonals in the **Live** function

- after turning on the instrument,
- after connecting a probe.

Readjust the instrument if the displayed diagonals do not correspond to the edges of the diamond!

### Prerequisites for the determination of diagonals

- The diamond must be clean.
  - The diamond must not penetrate the test material, no test load must be applied.
- 
- Connect the probe, and turn the instrument on.
  - Wipe the diamond briefly with the diamond cleansing cloth.
  - Select the main menu **Measure**.
  - Select the function **TIV** and then the function **Live**. The camera picture of the diamond is displayed on the screen.
  - Select the function **Cal**.

The camera picture of the diamond is analyzed, and two green lines, which have to be positioned exactly on top of the edges (diagonals) of the diamond, are displayed on the screen after a short while.

## Keeping the diamond clean

Tiny impurities are deposited on the surfaces of the diamond during measurements. They increasingly change the camera picture and consequently affect the automatic evaluation of the diamond indentation.

- Observe the picture of the diamond on the screen and, when doing this, pay attention to the dark spots caused by impurities.
- Wipe the diamond briefly at regular intervals using the diamond cleansing cloth in order to remove impurities and to avoid measuring errors.

## Guiding the probe

Make sure that you are using a probe equipped with an appropriate probe shoe and suitable for the application (ref. chapter 2).

- Select the main menu **Measure**.
- Select the function **TIV**.
- If necessary, disable the function **Live**. The **Live** button must not be displayed pressed down.

- Hold the probe with one hand, and place it on the surface to be tested.
- Hold the probe with one hand tight enough so that it does not tilt during the measurement and that the probe shoe lies completely against the surface.
- With the other hand, press the knob on the probe a short way downward until the diamond is pressed against the surface. The screen display shows the picture of the diamond.
- Press the knob slowly and uniformly further down. You can see on the screen how the crater of the diamond indentation grows.
- Increase the pressure on the knob evenly until the specific load of the probe is attained and you hear a beep tone. A red marking of the diamond indentation is displayed in addition to the green diagonals for checking purposes.
- Relieve the probe completely; take your hand off the knob.
- Lift off the probe. The measured hardness value is displayed on the screen.

 **Note:**

If you have pressed the probe's knob down to the limit stop without a measured value being determined (no acoustic signal), check the following possible causes:

- The load was applied too quickly. Try once again by increasing the pressure more slowly.
- The instrument was not calibrated beforehand (no green lines in the displayed picture).
- The diamond is too heavily soiled (dark spots in the displayed picture).
- The hardness of the surface tested is beyond the measuring range of the probe.

## 4.3 Hardness testing

### Starting and closing a test series

If you use test series, you can end a test series any time, and start a new one. The statistical evaluations always refer to the currently active test series.

- Select the main menu **Measure**.
- Select one of the functions **Curve**, **Statistics**, or **TIV** at the bottom edge of the display.
- Touch the button **New** in order to start a new test series.
- Touch the button **Delete** in order to delete a test series that has possibly already been recorded. The readings are deleted, and a new test series is started.

You can now start measuring.

The processes of saving and editing test results are described later in this manual (ref. chapter 4.4).

## Viewing and evaluating test results

You will see various information displayed in the main menu **Measure**, depending on the selected display mode, e.g. the current hardness value, the picture of the diamond indentation, or the determined diagonal lengths.

You have a choice between four display modes for the measurements:

- Curve
- Histogram
- Statistics
- TIV

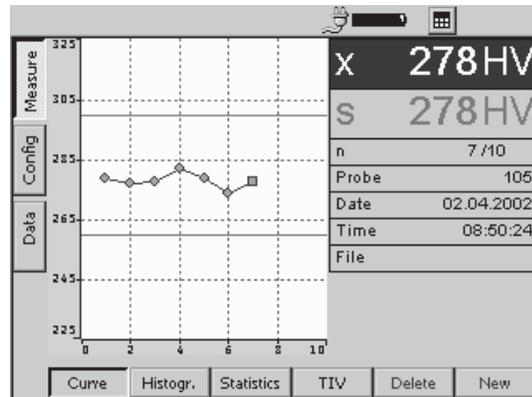
### Note:

The different display modes have no effect on the process of measurement. However, you can only assess the quality of the basis of measurement (the camera picture) in the display mode **TIV**.

The current reading (s), the current statistical average (x), and the number of measurements (n) can be seen in all four display modes.

- Select the main menu **Measure**.
- Select one of the functions at the bottom edge of the display in order to see the corresponding display mode.

### Curve function



The measured hardness values are displayed as a curve in a diagram. The shape of the curve helps you with the evaluation of the test results.

The horizontal green lines show the tolerance limit settings. Readings within the tolerance range are displayed in green, readings outside in red.

The designation of the probe, as well as the current date and time are additionally displayed, besides the diagram.

In case that you are editing a stored reading the file name is displayed, too.

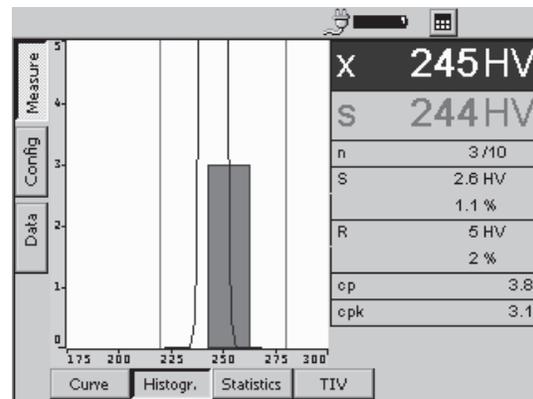
You can delete individual test results.

- Touch the required reading to select it.
- Touch the button **Delete**. The selected reading is immediately deleted.

 **Note:**

You can also select the reading by means of the arrow keys to the right of the screen display.

### Histogr. function



The histogram shows the statistical distribution of the readings of the current test series.

Besides the graphics, additional statistical single values are displayed (ref. chapter 6):

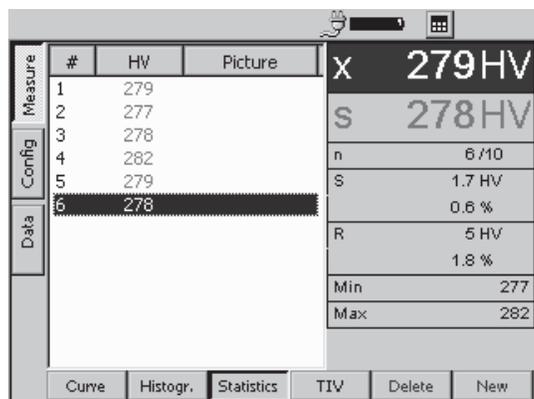
**S** = Standard deviation (absolute and percentage)

**R** = Range of spread (absolute and percentage)

**cp** = Process capability index

**cpk** = Critical process capability index

Statistics function



Test results situated within the set tolerance limits are shown in blue characters, test results outside the tolerance are shown in red characters.

You can delete individual test results.

- Touch the required reading in order to select it.
- Touch the button **Delete**. The selected reading is immediately deleted.

**Note:**

You can also select the reading by means of the arrow keys to the right of the screen.

The Statistics function shows the test results of a test series in tabular form.

Besides the table, additional statistical single values are displayed (ref. chapter 6):

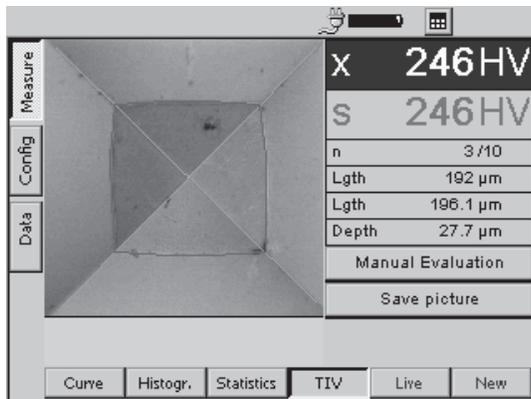
**S** = Standard deviation (absolute and percentage)

**R** = Range of spread (absolute and percentage)

**Min** = Minimum value

**Max** = Maximum value

## TIV function



The camera picture of the diamond indentation may be seen during the measurement. In addition, the diagonals and the edges of the indentation crater are highlighted with color lines.

Besides the TIV picture, the determined length values of the diagonals and the indentation depth of the diamond are additionally displayed.

## Saving the TIV picture

You can save the TIV picture if required.

### ! Attention:

The TIV picture can only be saved **immediately after the measurement**, as long as the picture is visible. If you change to another function, the picture is cleared at once.

The saved picture is assigned to the corresponding reading. You can view saved pictures by selecting the corresponding reading in one of the display modes **Curve** or **Statistics**.

Only if you save the test series the pictures saved here will be transferred to the instrument's memory. If you do not save the test series all corresponding TIV pictures will be deleted.

- Touch the button **Save picture** in order to temporarily save the TIV picture.
- If necessary, carry out further measurements, and save other TIV pictures.

- Select the function **Statistics**. The table containing the hardness readings is displayed.
- Touch a reading for which you have saved a picture.
- Select the **TIV** function again. The picture of the selected reading is displayed.

### Enlarged TIV picture

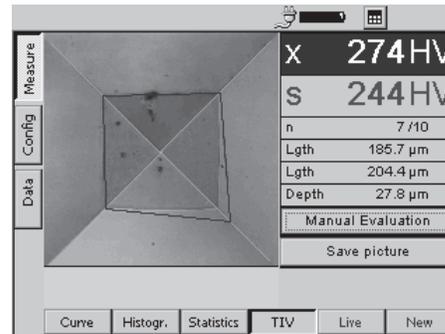
You can have the displayed picture of the diamond indentation enlarged to monitor it better. You can then move the picture detail in the enlarged display view.

- Double-touch the picture. You will then see an enlarged view of it.
- Touch the picture, keep the pen pressed down, and move it across the picture. The detail is moved according to your movements.
- Double-touch the picture again in order to see the normal view again.

### Manual evaluation

If you notice that the red lines in the TIV picture are not positioned on top of the edges of the indentation crater, you can correct the position of the lines and by this means manually evaluate the measurement. You can do this by moving the lines along the diagonals. After that the length of diagonals are evaluated anew and the corresponding new hardness value is displayed.

- Double-touch the picture in order to see an enlarged view of it.
- Touch the button **Manual Evaluation**. Additional blue lines are displayed in the picture.



- Touch one of the blue lines, keep the pen pressed down, and move it across the picture. The line is moved along the diagonals.

## Live picture

You can observe the penetration process of the diamond into the surface in a live picture without carrying out a measurement.

Besides the live picture, the determined length values of the diagonals, and the indentation depth of the preceding measurement are additionally displayed.

You can use the live picture e.g. to assess the quality of the diagonal determination, and to check the diamond for any impurities. The live picture mode is also used for setting the instrument to the probe used (ref. chapter 4.2).

- Select the display mode **TIV** in the main menu **Measure**.
- Select the **Live** function. You will see the camera picture of the diamond.

- If necessary, double-touch the picture in order to see an enlarged view (ref. preceding section).

## Conversion into other hardness scales

You can directly convert the test results obtained into other hardness scales.



### Attention:

**Any illegal or unacceptable conversions may lead to serious errors in the interpretation of test results.**

You should always pay attention to the information given in chapter 6 of this manual regarding the conversion of test results.

- Touch the abbreviation of the current hardness scale (e.g. HV) in the field of the average (x) in the right display half. An options menu is displayed.
- Touch the abbreviation of the required hardness scale (e.g. HB). All values of the current test series are displayed according to the new scale.

## 4.4 Saving the test data



### Attention:

Before starting a new test series, you can save the current test series to a file in the memory of the Krautkramer TIV. You can restore and view the data saved in this way any time later on.

You can interrupt and save test series any time by starting a new test series.

Depending on the configuration of the instrument, you are automatically prompted to save as soon as the last value that was set for a test series has been recorded.

- Select one of the functions **Curve**, **Statistics**, or **TIV** at the bottom edge of the display.
- Touch the button **New** in order to start a new test series. Three new buttons are displayed at the bottom edge of the display.

- If necessary, touch the button **Edit** if you want to make some further changes to the current test series (record other readings, delete reading or conversions). You will again see the display mode that was last selected.
- Touch the button **Delete** in order to delete the current test series and all corresponding TIV pictures.
- Touch the button **Save** in order to save the current test series. The window for selecting the directory and file name appears.

You can now select a directory and assign a file name as you're used to do in common Windows applications.

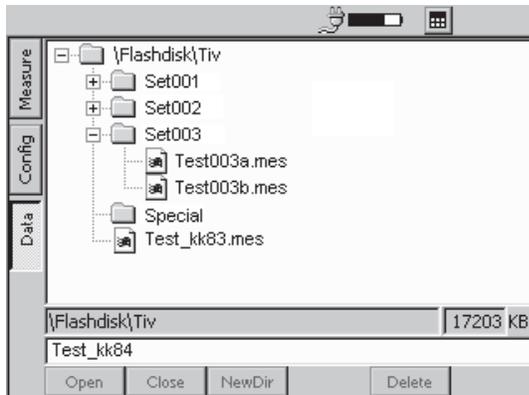


### Note:

The selection of the directory and the assignment of the file name are not necessary if you activate **Auto save to** (please see chapter 4.6).

## Saving files

- Touch the name of a directory in order to select the directory.
- Touch the text box at the bottom edge of the display. The virtual keyboard is displayed, and you can key in the required file name.
- Enter a name by touching the corresponding characters on the keyboard.
- Finally, touch the displayed ENTER key. The keyboard disappears again.



- Touch the button **Save**. The test series is saved to the currently selected directory using the specified name.

## Deleting files or directories

### ⚠ Attention:

When a directory is deleted, all files stored there are likewise deleted. You cannot cancel the deletion.

- Touch the name of a directory or a file in order to select the directory or file.
- Touch the button **Delete**. A safety prompt appears.
- Touch the button **Yes** in order to confirm the deletion process. The selected directory or the selected file is deleted.

### Opening and closing directories

- Double-touch a directory. The directory is opened.  
or
- Briefly touch a directory in order to select it, and then touch the button **Open**.
- Double-touch an open directory. The directory is closed.  
or
- Briefly touch an open directory in order to select it, and then touch the button **Close**.

### Creating new directories

- Touch the name of a directory in order to select the directory.
- Touch the text box at the bottom edge of the display. The virtual keyboard is displayed, and you can key in a name of a directory.
- Enter a name by touching the corresponding characters on the keyboard.
- Finally, touch the displayed ENTER key. The keyboard will again disappear.
- Touch the button **NewDir**. The new directory is created in the currently selected directory using the specified name.

## Opening files

You can open saved files, and view the readings of a test series stored there. If TIV pictures were saved for the selected test series, you can also view these pictures again on the screen.

- Touch the name of a file in order to select the file.
- Touch the button **Open**. The file is opened.

After opening the file, the main menu Measure will automatically appear. You can change between the different display modes, as well as view the saved data and the pictures if applicable.

If you start a new test series, the open file is closed without editing it.

You can also edit the open file. If the edited data should be saved, you have to save the file afterwards using a new name.

## Saving files under a new name

If you want to edit an already saved file, you have to save this file afterwards using a new name.

- Open the required file.
- If necessary, edit the required data in the main menu **Measure** (e.g. deleting of single readings).
- Go to the main menu **Data**.

You can now enter a new file name as described above, and save the edited file.

### **Note:**

You can only save the file under a new name after modifications have been carried out.

## File management using instrument keys

All main functions of file management, known to you from the Windows Explorer, are available to you in the main menu **Data**. Analogously to the operation using the mouse, the operation by means of the touch screen is the most convenient way with the Krautkramer TIV.

The operation using the keys arranged around the display screen, however, only makes a limited functionality available.

You can always navigate in the file structure, as well as select files and directories using the arrow keys to the right of the display screen.

The keys below the display screen enable you to operate the buttons appearing above each one of them, and carry out the corresponding functions (e.g. **Delete**, **Open**, or **Close**).

The access to the text box for keying in file or directory names, however, is not possible by means of the instrument keys. A character can only be keyed in via the virtual keyboard.

## 4.5 Printing test reports

You can print out the results of a test series in the form of a test report. To do this, you have to save the test results to a file beforehand.

You have a choice between two types of reports:

- Compact
- Complete

The compact-type report contains the following data:

- Date and name of the file
- Information on the instrument and probe
- Name of the operator
- Remarks on the test series
- All statistical evaluations referring to the test series
- Data regarding the tolerance threshold settings

 **Note:**

The compact-type report contains no single readings.

The complete-type report contains, in addition to the data of the compact-type report, the following:

- graphic display of the hardness values in a diagram (analogously to the display mode **Curve**)
- list of hardness values in tabular form (analogously to the display mode **Statistics**)
- all saved TIV pictures (camera pictures of the diamond indentation)

For both report types you can additionally select the options Color and Draft. The option Draft will accelerate the printing process with a slight loss of quality.

### Prerequisites for printing

The following requirements must be met for the printout of test reports.

A PCL-compatible laser or ink-jet printer must be connected to the serial interface of the instrument. To con-

nect the printer, you need a serial printer cable, or a serial-parallel converter (order no. 101 761).

 **Note:**

Information about the configuration of your model of printer you find in the documentation of the printer used.

### Serial printer

- Connect the printer with the serial interface (9-pin Sub-D-socket).
- Set the data transmission parameters on your printer as follows:
  - 1 start bit
  - 1 stop bit
  - 8 data bits
  - Parity: none
  - Software-Handshake: On
- Ensure that the baud rate set in the printer agrees with that selected in the TIV (ref. following section).

### Parallel printer

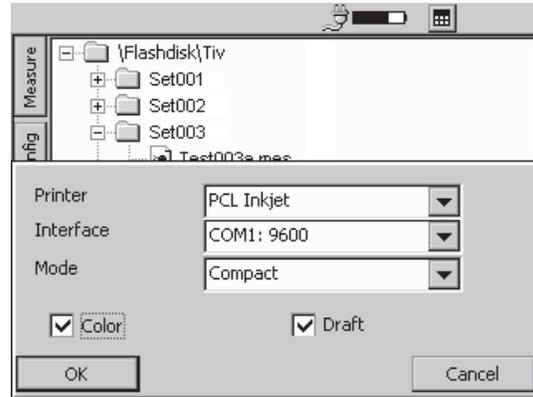
- Connect the printer by the serial-parallel-cable with the serial interface (9-pin Sub-D-socket).
- Ensure that the baud rate setting of the serial-parallel converter agrees with that selected in the TIV (ref. following section). The recommended baud rate is 4800 or 9600.

### Selecting and printing a test series

After connecting and configuring a compatible printer, you can select the required measured value file (\*.mes), and print out the test report.

- Go to the main menu **Data**.
- Touch the required measured value file in order to select it.
- Touch the button **Print**. A dialog box appears.
- Touch the list boxes one after another, and select the printer, the interface, and the mode of the report.

- Touch the button **OK**. The printing process starts immediately.



## 4.6 Instrument configuration

In order to use the Krautkramer TIV in an optimum way, you can configure it according to your requirements. The configuration of the instrument comprises three areas:

- Evaluation
- Instrument
- Info

### Note:

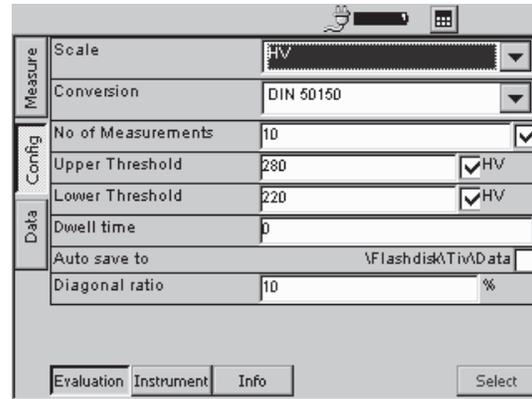
In the main menu **Config**, you have the additional button **Select** at your disposal. This button enables you to alternatively carry out most of the settings using the instrument keys. The touch screen or the virtual keyboard is only required for the input of a comment text if applicable.

You can use the key below the button **Select** e.g. to open list boxes in order to make the required choice there.

## Evaluation parameters

The following describes the various options available to you for the evaluation and the representation of test results.

- Select the submenu **Evaluation** in the main menu **Config**.



Measure	Scale	HV
	Conversion	DIN 50150
Config	No of Measurements	10 <input checked="" type="checkbox"/>
	Upper Threshold	280 <input checked="" type="checkbox"/> HV
	Lower Threshold	220 <input checked="" type="checkbox"/> HV
Data	Dwell time	0
	Auto save to	\\Flashdisk\Tiv\data
	Diagonal ratio	10 %

Buttons: Evaluation | Instrument | Info | Select

### Scale

The test result is displayed as HV value in the default setting (Vickers hardness according to the hardness testing method). You can select another hardness scale as required.

- Touch the list box, and select the required hardness scale.

### Conversion

You can make your choice between the conversion table according to DIN 50150, and the conversion according to ASTM E140 for the conversion of hardness values.

- Touch the list box, and select the required standard.

### No of Measurements

You can specify the number of single measurements to be contained in a test series. After recording the last reading, a message is then automatically displayed on the screen prompting you to save the test series.

- Double-touch the text box **No of Measurements** in order to select the current value.
- Touch the keyboard icon at the top edge of the display screen in order to display the virtual keyboard.
- Enter the required number, and touch the ENTER key in order to make the keyboard disappear again.
- Touch the check box in order to activate the function. If the function is activated, the box is ticked off.

#### **Note:**

If the function is not activated, test series are not automatically closed. However, you can also save test series which are not finished any time (ref. chapter 4.4).

### Upper Threshold, Lower Threshold

You can enter a minimum value and a maximum value for measured hardness values. If a hardness value is outside these tolerance thresholds, an alarm is output, and the red LED at the instrument front panel is lit.

In addition, hardness values outside the tolerance thresholds are marked red in the main menus **Measure**, viz. in the display modes **Curve** and **Statistics**.

- Double-touch the text box **Upper Threshold** or **Lower Threshold** in order to select the current value.
- Touch the keyboard icon at the top edge of display screen in order to have the virtual keyboard displayed.
- Enter the required number, and touch the ENTER key in order to make the keyboard disappear again.
- Touch the corresponding check box in order to activate the required function. If the function is activated, the box is ticked off.

### Dwell time (Using a test support)

You can specify the dwell time of the test load in seconds if required. This function is only useful with measurements using a test support and the special probe shoe (included in the standard package).

- Double-touch the text box **Dwell time** in order to select the current value.
- Touch the keyboard icon at the top edge of display screen in order to have the virtual keyboard displayed.
- Enter the required number, and touch the ENTER key in order to make the keyboard disappear again.

### Auto save to

You can specify a directory where the measured value files are automatically filed during saving.

If you activate this option, you don't have to select a directory and a file name by hand during every new saving process.

The name of the directory plus an appended numerical value, which is likewise increased by 1 with every new file, are then automatically assigned to the measured value files.

To start with, you have to select the required directory in the main menu **Data**. Chapter 4.4 describes how to proceed in the main menu **Data**.

- Go to the main menu **Data**.
- If necessary, create a new directory.
- Briefly touch the required directory in order to select it.
- Go to the main menu **Config**, and select the submenu **Evaluation**.

The selected **memory directory** is displayed at the parameter **Auto save to** for verification purposes.

- Touch the check box to activate the Auto-save option.

If the option is activated, the main menu **Data** is not opened any more during saving. After touching the button **Save**, you can immediately start a new test series.

### Diagonal ratio

You can define the maximum permissible deviation of the two diagonal lengths of the diamond indentation as a percentage value. In the case of deviations of the diagonal lengths exceeding the specified value, a corresponding warning is displayed on the display screen.

- Double-touch the text box in order to select the current value.
- Touch the keyboard icon at the top edge of display screen in order to have the virtual keyboard displayed.
- Enter the required number, and touch the ENTER key in order to make the keyboard disappear again.

## System settings

You can define various default settings for the Krautkramer TIV.

- Select the submenu **Instrument** in the main menu **Config**.

Measure	Backlight (0-9)	5	
	Auto switch off (0-60)	3	Min
	Beep	On	▼
Config	Language	English	▼
	Date	02.04.2002	▼
Data	Time	08:51:58	▲ ▼
	Network Address	192.168.5.186	

Evaluation **Instrument** Info Load Save Select

## Backlight

You can set the backlight of the display screen according to a scale from 0 to 9, with 9 being the value for the brightest backlight.

- Double-touch the text box in order to select the current value.
- Touch the keyboard icon at the top edge of display screen in order to have the virtual keyboard displayed.
- Enter the required value, and touch the ENTER key in order to make the keyboard disappear again.

### Note:

To save energy, the display screen is automatically slightly dimmed after a short while if you're not operating the instrument.

After a further period of time without any operation, the display screen is completely turned off.

As soon as you carry out an action, the display screen switches back to the normal backlight. You cannot influence this energy-saving function.

### Automatic turn-off

You can set a time in minutes after which the instrument is automatically turned off if there is no operation of the keys, the probe, or of the touch screen.

The current instrument configuration and the current test series are saved, and they are available again when the instrument is started the next time.

After the automatic turn-off, you have to turn the instrument on again by means of the On/Off key.

If you enter the value 0 (zero), this function is deactivated, and the instrument is no longer automatically turned off.

- Double-touch the text box in order to select the current value.
- Touch the keyboard icon at the top edge of display screen in order to have the virtual keyboard displayed.
- Enter the required number, and touch the ENTER key in order to make the keyboard disappear again.

### Beep

You can activate an acoustic signal to acknowledge different actions. The actions acknowledged with an acoustic signal include the successful recording of a reading, or errors during recording of readings.

- Touch the list box, and select the required option.

### Language

You can select the dialog language for the operation of the Krautkramer TIV. All texts of the user interface are displayed in the selected language. Reports are printed in the selected language as well.

- Touch the list box, and select the required language.

**Date**

Set the correct date, and make sure that the set date always corresponds to the current date. Date and time are saved together with the readings and used for printing test reports.

- Touch the list box containing the currently set date. A calendar is displayed.
- Use the arrow icons in the header area of the calendar to select the required month.
- Touch the required date. The calendar disappears, and you will see the new date in the list box.

 **Note:**

In case of a power interruption (e.g. when exchanging the batteries) longer than 5 minutes the date and time setting will get lost.

**Time**

Set the correct hour of time, and make sure that the set time always corresponds to the current time. Date and time are saved together with the readings and used for printing test reports.

The time is indicated in hours, minutes, and seconds.

- Touch the number of hours in the box **Time** in order to select it.
- Touch the arrow keys to the right of the box in order to change the selected value.
- Set the minutes and, if required, the seconds in the same way.

**Network Address**

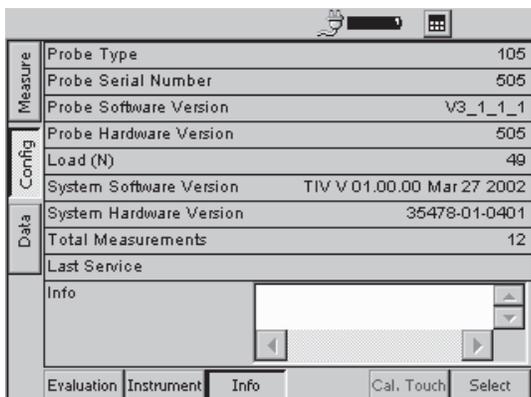
Here you can enter an IP address for the instrument. For data transmission to a computer by means of the UltraDAT software this address must correspond with the IP address set in the program.

## System information

The submenu **Info** provides you with various information about the instrument and the probe. These data are only meant for information, and they cannot be edited.

In the lower section of the window, you can key in a short comment or information text to be saved together with the current test series, and also to be printed out in the test report.

- Select the submenu **Info** in the main menu **Config**.



## Probe type

Type of the currently connected probe.

## Probe Serial Number

Serial number of the currently connected probe.

## Probe Software Version

Software version of the currently connected probe.

## Probe Hardware Version

Hardware version of the currently connected probe.

## Load

Nominal test load of the currently connected probe in N.

**System Software Version**

Software version of the instrument.

**System Hardware Version**

Hardware version of the instrument.

**Total Measurements**

Total number of measurements carried out using the currently connected probe.

**Last Service**

Date of the last instrument check by the authorized service of GE Inspection Technologies.

**Info**

This is where you can key in information or comments to be saved together with the current test series (e.g. name of operator, name of test object, and data on the test position).

 **Note:**

These data only apply to the current test series. As soon as a new test series is started, the text box is cleared again.

- Double-touch the text box in order to select the current text.
- Touch the keyboard icon at the top edge of display screen in order to have the virtual keyboard displayed.
- Key in the required text, and touch the ENTER key in order to make the keyboard disappear again.

## 4.7 Saving and loading instrument parameters

You can save the current specific parameters of the instrument. The current settings regarding the measurements are saved with a test series.

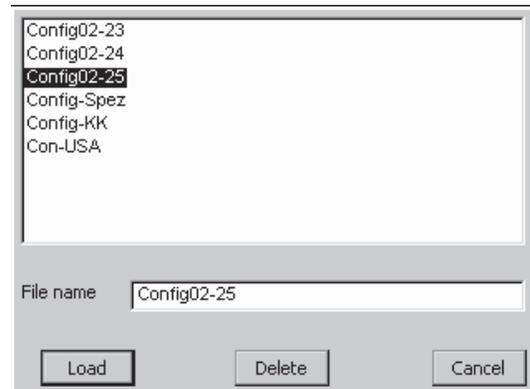
You can load the saved instrument parameters any time in order to quickly configure the instrument.

### Saving instrument parameters

- Go to the main menu **Config**, and select the submenu **Instrument**.
- Touch the button **Save**. A window for the input of the file name appears.
- Briefly touch the text box **File name**. The virtual keyboard is displayed.
- Key in the required file name, and touch the ENTER key in order to make the keyboard disappear again. The current instrument parameters are saved.

### Loading and deleting instrument parameters

- Go to the main menu **Config**, and select the submenu **Instrument**.
- Touch the button **Load**. A window for the selection of a parameter file appears.
- Touch the name of the required file in order to select it.
- Touch the button **Load**. The selected file is loaded and immediately active.
- Touch the button **Delete**. The selected file is deleted.



## 4.8 Functional test

### Hardness reference block

Check the instrument and probe functions before using them for the first time, and at regular intervals afterwards, by measuring the hardness value of the corresponding hardness reference block.

- To do this, carry out 3 to 5 measurements on the hardness reference block. Make sure that the distance between the measuring positions is at least 3 mm.
- Read the average, and compare it with the specified value of the hardness reference block.

Arrange for the instrument and probe to be checked by the service of GE Inspection Technologies if major deviations are detected.

### TIV picture

After turning the instrument on and, if possible, during every measurement, check the quality of the automatic evaluation on the basis of the green and red lines marked in the TIV picture.

The green lines must be positioned exactly on top of the diagonals of the diamond.

The red lines must be positioned exactly on top of the edges of the diamond indentation.

Always have a look at the enlarged TIV picture as well by double-touching the picture.

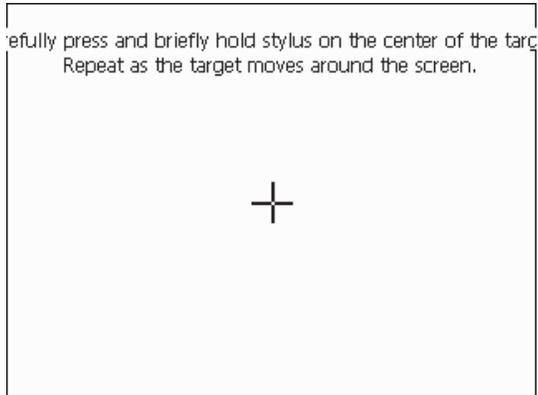
## 4.9 Calibrating the touch screen

If the operation of the touch screen frequently fails, you can recalibrate the touch-sensitive screen.

 **Note:**

The calibration of the touch screen does not affect measurements and test results in any way.

- Go to the main menu **Config**, and select the submenu **Info**.



- Touch the button **Cal. Touch**. A window for the calibration of the display screen appears.
- Press the center of the displayed crosshairs as exactly as possible. The crosshairs are moved to another position.
- Press the center of the crosshairs as exactly as possible one more time.
- Repeat the action until the calibration is finished, and a new information message is displayed.
- Briefly touch the touch screen once in order to confirm the new calibration, and to transfer it.

If you don't transfer the calibration, the old setting is used again after 30 seconds.

The calibration is finished, and you will again see the main menu **Config** after a short while.

## 4.10 Troubleshooting

After being turned on, the Krautkramer TIV carries out an automatic system self-check. In addition, the system also monitors itself during the operation.

### Error messages

If any system or operating errors occur, they are indicated by a corresponding error message on the display screen. Generally, the error message also contains information about the cause of the error, and about the further procedure.

### Errors

<b>Error</b>	<b>Possible remedy</b>
Instrument does not react when turned on.	Check power supply and battery charge status.
Instrument no longer reacts when operated.	Keep the On/Off key pressed down long enough (approx. 5 s) to turn off the instrument. Current data are not saved.
Diagonals have to be frequently readjusted.	Arrange for the probe to be checked by the service of GE Inspection Technologies.



# Care and maintenance **5**

## 5.1 Care



### Attention:

Never use water for cleaning! Water penetrating inside may cause severe damages to the instrument and the probe.

Do not use any solvents! Paint coating and plastic parts may become brittle or be damaged by them.

### Care of instrument

Clean the instrument and the probe cable at regular intervals by only using a dry cloth.

Do not use any sharp-edged objects or other tools for cleaning the display screen. The touch-sensitive foil may be damaged by them.

### Care of probe

Only use a dry cloth to clean the probe. Only use the diamond cleansing cloth to clean the Vickers diamond (ref. chapter 2).

### Care of batteries

Capacity and life of batteries mainly depend on their correct handling. You should therefore pay attention to the tips below. You should charge the batteries in the following cases:

- before the initial start-up,
- after a storage period of 3 months or longer,
- after frequent partial discharge.



### Note:

Used or defective batteries are special waste and must be disposed of as provided by the law!

## Charging the batteries



### Attention:

**Never try to charge alkaline batteries (explosion hazard)!**

You can only charge the NiMH battery pack MIC 20-BAT in the instrument itself.

You can only charge single NiMH or NiCad batteries outside the Krautkramer TIV using a battery charger approved for this task.

If necessary, read the operating manual of the battery charger, and pay special attention to the safety precautions recommended there.

The battery pack MIC 20-BAT is always automatically charged in the Krautkramer TIV if the instrument is supplied with power via the power supply unit and turned off at the same time. If the instrument is turned on, the connection to the battery compartment is always interrupted if the instrument is supplied with power via the power supply unit.

The green LED on the instrument front panel is lit during the charging process. If the green LED flashes quickly, the charging process is finished.



### Note:

Used or defective batteries are special waste, and must be disposed of as provided by the law!

## 5.2 Maintenance

As a general principle, no maintenance work is required on the Krautkramer TIV.

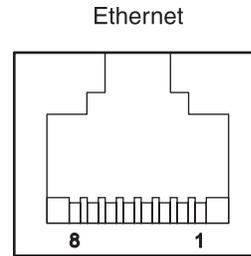
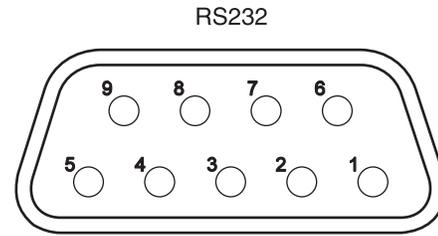
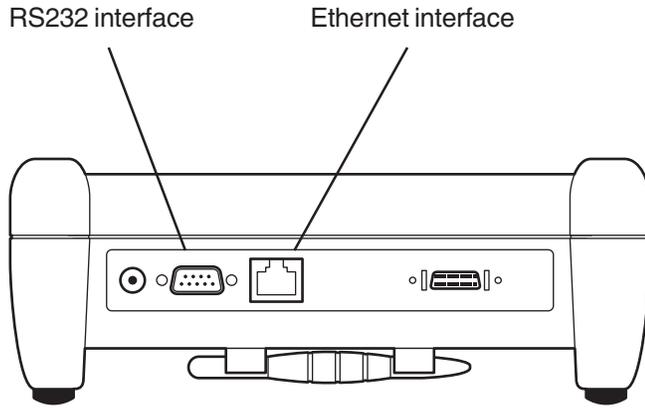
**Attention:**

Any repair work must only be carried out by the authorized service of GE Inspection Technologies.

# Interfaces and data transfer **6**

### 6.1 Interfaces

The Krautkramer TIV has two bidirectional interfaces that you can use to transfer the data to a printer or to a computer.



**Serial interface RS232**

Plug	Pin	Signal	Level	Direction
	1	DCD	RS232	Input
	2	RXD	RS232	Input
	3	TXD	RS232	Output
	4	DTR	RS232	Output
Sub-D	5	GND	0 V	Input
	6	DSR	RS232	Input
	7	RTS	RS232	Output
	8	CTS	RS232	Input
	9	–	–	–

**Ethernet interface**

Plug	Pin	Signal	Level	Direction
	1	TXD +	3.3 V	Output
	2	TXD –	3.3 V	Output
	3	RXD +	3.3 V	Input
	4	–	–	–
RJ45	5	–	–	–
	6	RXD –	3.3 V	Input
	7	–	–	–
	8	–	–	–

The signals are galvanically isolated.

**Note:**

You need a crossed data cable for the connection to a computer (Order number 34 943). You need a serial printer cable or a serial-parallel converter for the connection of a printer (Order number 101 761).

**Note:**

You need a crossed patch cable with RJ45 plugs for the connection to a computer (Order number 101 785).

## 6.2 Data transfer to a printer

You can print out the results of a test series in the form of a test report. To do this, you have to save the test results to a file beforehand (please see chapter 4 of this manual).

### Requirements for printing

The following requirements have to be met for printing test reports.

A PCL-compatible laser or ink-jet printer must be connected with the serial interface of the instrument. To connect the printer, you need a serial printer cable or a serial-parallel converter (Order number 101 761).

 **Note:**

You will find information about the configuration of your printer type in the documentation of the printer used.

### Transfer parameters

The transfer parameters must be set as follows for a serial printer:

- 1 start bit
- 1 stop bit
- 8 data bits
- no parity check
- software handshake on

In the case of a parallel printer, the baud rate setting of the printer must correspond to the selected baud rate in the TIV. A baud rate of 4800 or 9600 is recommended.

## 6.3 Data transfer to a computer

You can transfer the results of saved test series to a computer, and save them to an Excel file there.

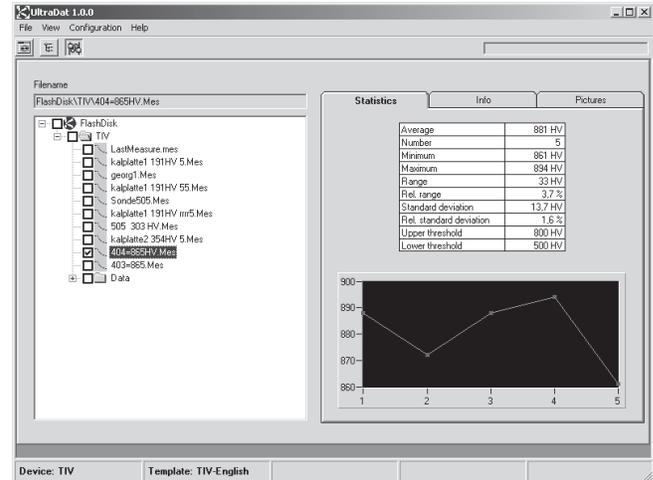
You need the UltraDAT program for the data transfer (ref. chapter 2).

UltraDAT enables the direct access to the file structure of the instrument and has a large variety of preview options. Besides the convenient selection of the test series to be exported, additional information can be added to the test series, e.g. test object, operator's name, or additional remarks.

### Note:

The data transfer to a computer may be carried out either via the serial interface or via the Ethernet interface. To do this, you need a corresponding data cable in each case (ref. section 6.1).

For more details on the data transfer, please read the documentation for the UltraDAT program (quick reference guide and online help).





# The TIV hardness testing method **7**

## 7.1 The test method

The following section provides you with some helpful information about the hardness testing method of the Krautkramer TIV.

The hardness tester Krautkramer TIV uses a completely new hardness testing method and, consequently, it clearly differs from the previous mobile hardness testers.

When applying the field-proven mobile test methods, most of all the elastic properties of the test material must be taken into consideration as they may affect the reading or the converted hardness value. In order to take the different elastic properties into consideration, and to avoid faulty measurements, it is necessary to calibrate the instrument to the corresponding material in each case.

Apart from that, due to the dynamic or quasi-static load application, the test object's mass, as well as its wall thickness are important in view of correctly applying this test method. Thin-walled or lightweight test objects may be excited to oscillations which may falsify the

hardness test under certain circumstances. The minimum mass and the wall thickness must therefore always be taken into account here.

To be able to exclude the effects due to the test material's elastic properties, as well as due to its mass and wall thickness on the hardness test, a method was developed which can be used independently of these conditions on different materials having the most different mass and geometry without any additional calibration – viz. the TIV method (TIV = Through-Indenter Viewing).

With the Krautkramer TIV, the test load is manually applied via a spring. A Vickers diamond is used as an indenter, and the hardness is measured under load!

With the test load applied, a picture is taken through the diamond by means of special optics and a CCD camera (Through-Indenter Viewing). The growing indentation of the Vickers diamond on the surface of the test object may be seen on the display screen during the measurement as the test load is increased.

Exactly at the moment when the probe's nominal test load is attained (e.g. 50 N - or 5 kgf -), the picture taken

of the indentation is transferred to the instrument, and automatically evaluated.

In the automatic evaluation, the system determines the length of the two diagonals of the diamond indentation. This means that the evaluation using a measuring microscope that was the common method up to date is no longer applicable. Firstly, this automatic method is essentially faster and, secondly, an error in the determination of the diagonal length caused by the subjective influence of the user is excluded here.

The diagonals determined are now taken as a basis to calculate the corresponding numerical value according to the definition of Vickers hardness, and to display it according to the HV scale.

Besides the above-mentioned advantages of this method, such as the applicability to different materials without any additional calibration (the static application of the test load has no effect on the test material's elastic properties), as well as the measurement's independence of the test object's geometry and mass (even small, thin parts can be tested), most of all the possibility to quickly display the test indentation on the instrument's screen should be pointed out.

Due to the fact that the Vickers indentation may already be seen on the screen during the measurement, the operator can directly assess the quality of the measurement, or the reliability of the measured value.

Any influence on the penetration process caused by surface effects or the material's microstructure are immediately recognized, and can be taken into consideration during the evaluation.

 **Note:**

The TIV probe enables measurements in any direction. The direction of measurement (or the direction of the test load) does not have to be specified.

## 7.2 Conversion of hardness values

Please note the following with regard to the conversion of hardness values (ref. DIN 50 150 or ASTM E140):

Hardness values measured according to different methods cannot be converted into one another by means of generally applicable relations.

The reason for this lies, on the one hand, in the fact that the indentation behavior of a material is determined by its stress-strain behavior. On the other hand, the shape and the material of the indenter, the size of the indentation, and consequently the measured zone differ depending on the hardness testing method.

You should therefore know that, depending on the material, the condition of its treatment, and the surface quality, the conversion of hardness values may be inaccurate or unacceptable both from one hardness value into the other and into tensile strength values.

You should indicate hardness values according to the scale that corresponds to the hardness testing method used (e.g. HV when using the TIV method).

You should only convert the values:

- if the specified test method cannot be applied, e.g. because there is no suitable instrument,
- if the required samples for the specified test method cannot be taken.

### Special conversion features in the Krautkramer TIV

The conversion of hardness values into other scales, which you can select on the instrument, is alternatively carried out in the default setting according to the standards DIN 50 150 or ASTM E140. All limitations of conversion specified in these standards apply.

**Ranges of validity of the conversion tables**

<b>Conversion type</b>	<b>HB</b>	<b>HRB</b>	<b>HRC</b>	<b>HS</b>	<b>N/mm<sup>2</sup></b>
DIN	80 – 650	40 – 106	19 – 70	30 – 100	275 – 2200
ASTM	90 – 560	52 – 102	19 – 70	30 – 100	300 – 2200

## 7.3 The treatment of the test material

To obtain reliable and reproducible test results, you have to pay attention to some information about the quality and treatment of the test material. Please read therefore the following notes.

### Surface quality

The surface must be clean, as well as free from oil, grease, and dust. The peak-to-valley height should not exceed 10 micrometers.

You should therefore grind off rougher surfaces, e.g. by means of the battery-driven grinding set MIC 1060 (ref. chapter 2).

### Curved surfaces

In the case of surfaces showing a radius of curvature < 30 mm (convex or concave), a probe shoe shaped accordingly must be used to be able to place the probe safely and reliably on the material.

## Measurements on small and thin parts

Measurements on small and thin test objects are possible using the Krautkramer TIV as no vibrations liable to falsify the test results occur thanks to the static test load.

You should nevertheless take into account the fact that the wall thickness of the test object should be at least 10 times the indentation depth of the Vickers diamond.

## 7.4 Information on the statistical evaluation

### Statistical average

The Krautkramer TIV always displays the current statistical average ( $\bar{x}$ ) in the main menu **Measure** on the screen.

Every measurement is subject to a measurement uncertainty. In this regard, the measuring errors are composed of the following single errors:

- the basic measurement uncertainty of the test method applied,
- the handling of the probe,
- the preparation of the test material (surface or heat treatment),
- the homogeneity of the test material,
- external influences (soiling, humidity, temperature).

The statistical evaluation is meant to help you to better assess your measurements, and to make your decision on the quality of the material tested more reliably.

The average of a test series is the more accurate the more single measurements you carry out. At the same time, however, many single measurements mean that they contain more "outliers".

For this reason, the difference between the minimum value and the maximum value is no reliable standard for the evaluation of a test series containing more than about 12 measuring points.

The average ( $\bar{x}$ ) is calculated arithmetically:

$$\bar{x} = \frac{(s_1 + s_2 + s_3 + \dots + s_n)}{n}$$

with

$\bar{x}$  = average

s = single measurement

n = number of measurements

### Relative range of spread

The relative range of spread (R) is calculated as follows:

$R = \text{maximum value} - \text{minimum value}$

$$R [\%] = \frac{(\text{maximum} - \text{minimum}) \cdot 100}{\text{mean}}$$

### Relative standard deviation

The relative standard deviation is calculated as follows:

$$S [\%] = \frac{S}{\bar{x}} \cdot 100$$

with

$\bar{x}$  = average

S = standard deviation (mean error of single measurement)

$$S = \sqrt{\frac{(s_1 - \bar{x})^2 + (s_2 - \bar{x})^2 + \dots + (s_n - \bar{x})^2}{(n - 1)}}$$

### Calculation of process capability

The calculation of process capability is carried out by the Krautkramer TIV according to the following formulae:

#### Process capability index Cp

The process capability index Cp is a measure for the spreading of measured values versus the specification limits. This value takes only the spreading into account.

$$C_p = \frac{USL - LSL}{6s}$$

LSL = lower specification limit

USL = upper specification limit

**Critical process capability index Cpk**

The critical process capability index Cpk takes the position of the average with reference to the specification limits into account in addition to the spreading.

$$C_{pku} = \frac{\bar{x} - USG}{3s}$$

$$C_{pko} = \frac{OSG - \bar{x}}{3s}$$

$$C_{pk} = \text{Min} \{C_{pku}, C_{pko}\}$$



# Specifications 8

## Specifications

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### Basic instrument

Housing	Injection-molded plastics, ABS
Size (L × W × DT)	approx. 215 × 180 × 78 mm (8.5" × 7.1" × 3.1")
Weight	approx. 1400 g (3.1 lb) (incl. battery pack)
Display	14.5 cm (5.7") TFT, 240 × 320 pixels, backlight via integrated CFL tube
Keypad	Sealed keypad with integrated touch screen (4-wire technique)

### Probe

Housing	VA, aluminum
Size (L × dia.)	approx. 220 × 52 mm (8.7" × 2.1")
Weight	approx. 630 g
Protection type	IP 42

---

## Connections and interfaces

RS-232	bidirectional, 9-pin Sub-D (m)
Ethernet	10 Mbit/s
Probe connection	20-pin AMP 050
Power supply	Extra-low-voltage socket 12 V, 2 A (according to DIN 45323)

## Power supply and operating time

Internally	NiMH battery pack MIC 20-BAT, 7.2 V, 4500 mA, with temp. sensor and fuse, or 6 × NiCad C-cells, or 6 × NiMH C-cells
Externally	Plug-in power supply unit 100 ... 240 VAC ( $\pm 10\%$ ), output 12 V, 2 A
Operating time	approx. 1000 measurements with NiMH battery pack MIC 20-BAT in continuous duty
Battery charge status indicator	Battery icon, warning with discharged batteries, hardware-triggered turn-off with undervoltage to protect the batteries

## Specifications

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### Ambient conditions

Protection type	IP 42
Operation	0 ... +50 °C (32 °F ... 122 °F)
Storage	-20 ... +70 °C (-4 °F ... +158 °F)
Rel. humidity of air	10 ... 75 % (no condensation allowed, moisture condensation excluded)
Vibro stability	according to EN 60068-2-6: 2 g (10 ... 150 Hz, 1 oct./min.)
Shock resistance	according to EN 60068-2-29: 11 g (11 ms, 1000 in every axis, in total 3000) according to EN 60068-2-27: 60 g (6 ms, 3 in every axis and direction, in total 18)

### Evaluation

Test method	TIV (Through-Indenter Viewing) with Vickers diamond
Indenter	Diamond pyramide according to Vickers, roof angle 136°
Measuring tolerance	$\pm 3.6$ % maximum deviation of the average from 5 measurements from the specified value of the hardness reference block  <b>Note:</b> The given tolerances apply for measurements at room temperature.
Range of spread	5 % maximum (200 ... 900 HV), depending on material, surface preparation and temperature.

Statistics	Average, range, standard deviation, minimum, maximum, process capability index
Conversion	according to DIN 50150, ASTM E140
Conversion scales	HV, HB, HRB, HRC, HS, N/mm <sup>2</sup>



# Annex 9

## 9.1 EC Declaration of Conformity

The Krautkramer TIV conforms to the requirements of the following EC directives:

- 89/336/EEC (electromagnetic compatibility) and
- 73/23/EEC (electrical equipment for use within certain voltage limits).

The correspondence with the requirements of EC directive 89/336/EEC is proved by keeping of following directives:

- EN 55011, 03/1991, class A, group 2
- EN 50082-2, 03/1995

## 9.2 Manufacturer/ Service addresses

The Krautkramer TIV is manufactured by:

### **GE Inspection Technologies GmbH**

Robert-Bosch-Straße 3  
D – 50354 Hürth

Phone +49 (0) 22 33 - 601 111

Fax +49 (0) 22 33 - 601 402

The Krautkramer TIV is manufactured according to state-of-the-art methods using high-quality components. Thorough in-process inspections or intermediate tests and a quality management system certified to DIN EN ISO 9001 ensure an optimum quality of conformance of the instrument. Should you nevertheless detect an error on your instrument or on the software, inform your local GE Inspection Technologies Service indicating the error and describing it.

If there is anything special that you would like to know about the use, handling, operation and specifications of the system, please contact your nearest GE Inspection Technologies representative or directly:

**GE Inspection Technologies GmbH**

Service-Center  
Robert-Bosch-Straße 3  
D – 50354 Hürth

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