

Krautkramer MIC 20

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 4.7).

Subject to change without notice.

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Introduction 1

1.1 Safety information

The Krautkramer MIC 20 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 MIC 20 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 MIC 20 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.

NiCd or NiMH single cells

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

**Attention:**

You cannot charge NiCd 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.

Note:

Alkaline cells are not suitable due to their high internal impedance.

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 MIC 20.

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 MIC 20 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 MIC 20. 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 MIC 20

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. The peak-to-valley height should not exceed approx. 30 % of the penetration depth. Rough surfaces lead to a higher variation range of the single readings. If necessary, polish rougher surfaces, for example using our grinding set MIC 1060 (ref. chapter 2).

Test method

The MIC 20 supports both quasi-static hardness testing according to the UCI method and dynamic hardness testing according to the rebound method.

All Krautkramer UCI probes and the rebound impact devices D, G, and E are supported in these processes.

The UCI method

The UCI method is a comparative method (contribution of the Young's modulus to the measurement) with a very high reproducibility of measurements. The UCI method does not replace the classical Vickers hardness testing method but constitutes a fast and reliable addition to it.

The direct comparison with the results of the standardized Vickers measurement according to the material samples is therefore indispensable for the assessment of the measuring accuracy of the UCI method. This means:

The test forces (probes) must match the surface quality of the material:

- Smooth, homogeneous surfaces require low test forces.
- Rougher, coarse-grained surfaces require as high test forces as possible.

 **Attention:**

It is absolutely necessary that you calibrate your MIC 20 to the material to be tested.

The calibration is required only once for this since you can save calibrations and recall them again as required without any problem (ref. chapter 4.4).

The calibration for low-alloy or unalloyed steel is already predefined in the instrument. You should check them from time to time (ref. chapter 4.9 Functional tests).

Please also read the notes on the UCI method in chapter 7.

The Rebound method

The rebound method is a dynamic method with a very high reproducibility of measurements. The rebound method does not replace the classical Brinell hardness testing method or other standardized methods but constitutes a fast and reliable addition to them.

The still existing energy of an impact body after the rebound from the material surface is measured. It should be kept in mind in this regard that the loss of energy suffered in this process also depends on the mechanical properties of the material, i.e. mainly on its Young's modulus or modulus of elasticity.

The direct comparison with the results of the standardized Vickers measurement according to the material samples is therefore indispensable for the assessment of the measuring accuracy of the method. This means:

⚠ Attention:

It is absolutely necessary that you set your MIC 20 to the suitable material group before carrying out the test and that you additionally calibrate it if necessary.

The calibration is necessary only once in this process since you can save the calibrations and recall them again as required without any problem (ref. chapter 4.4).

The material group for low-alloy or unalloyed steel is predefined in the instrument as a default setting.

You should check this from time to time (ref. chapter 4.9 Functional tests).

Test objects having a mass of at least 5 kg can be tested without any additional supports; more lightweight objects require a support to which they have to be rigidly coupled. You should use large metal supports that do not give way for this purpose.

The test objects should have a minimum wall thickness of 20 mm. We recommend the UCI method, or the use of a suitable UCI probe in combination with the MIC 20 for test objects having smaller wall thicknesses.

⚠ Attention:

Should the test objects give way or spring, the result may be measuring errors!

Please read also chapter 7 on the rebound method.

Conversion of hardness values

The conversion of hardness values into other hardness scales is only possibly 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 DIN 50 150, 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 MIC 20

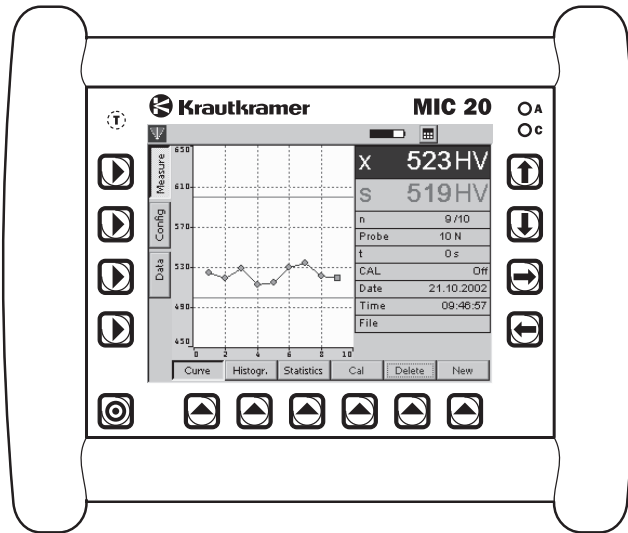
The Krautkramer MIC 20 is a mobile and easy-to-use hardness tester which can be equally used for tests according to the UCI method and for tests according to the rebound method.

After connecting the probe, the instrument is automatically set to the corresponding test method; tests can be carried out quickly and without any problem.

The fact that both methods are supported leads to a large variety of application possibilities with only one single instrument. Additional probes extend the range of applications if required.

The operation of the Krautkramer MIC 20 (calibration, setup, evaluation, data memory) is carried out by means of the graphic user interface presented on the display and adapted to the known Windows standard. The mouse is replaced by the touch screen for this purpose.

As an alternative, conventional buttons are available for most operating functions.



Special features of the MIC 20

- Measurements on castings and forgings, hardened surfaces and welds
- Automatic adaptation of the test method and of the test parameters to the connected probe
- Color LCD 5.7" for displays and operating functions (TFT or CSTN)
- Support of all Krautkramer UCI probes
- Support of the Krautkramer rebound impact devices D, G, and E
- Non-directional measurement (patented signal processing with the rebound method)
- Storage of measurement data and clear representation of measurement series as a diagram and histogram
- Simple and fast calibration, saving and recalling of calibration data at the press of a button
- Output of measurement data directly to a printer or transfer to a computer

- Operation using the battery pack or power supply unit

Large variety of application possibilities

You can use the Krautkramer MIC 20 to measure anywhere and in any direction; the direction must not be set beforehand.

The MIC 20 is mainly suitable

- for measuring hardness of low-alloy or unalloyed steels,
- for measuring hardness of high-alloy steels,
- for measuring hardness of nonferrous metals.

The MIC 20 is available in two versions:

- Basic version MIC 20 with color CSTN screen
- MIC 20 TFT with color TFT display screen

Standard package and accessories **2**

This chapter informs you about the standard package and the accessories available for the Krautkramer MIC 20.

It describes

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

2.1 Standard package

Product code	Description	Order no.
MIC 20	Portable Hardness Tester according to the quasi-static UCI principle and the dynamic Rebound principle. Display of the hardness values in HV, HB, HRC, HRB, N/mm ² and additional for the Rebound principle in HL and HS.	35 468
	including:	
	Instrument MIC 20	35 493
	Mains adapter	101 075
	Transport case	101 554
	Operating manual German	28 701
	or	
	Operating manual English	28 702

Product code	Description	Order no.
MIC 20 TFT	Portable Hardness Tester according to the quasi-static UCI principle and the dynamic Rebound principle. Display of the hardness values in HV, HB, HRC, HRB, N/mm ² and additional for the Rebound principle in HL and HS.	35 479
	including:	
	Instrument MIC 20 TFT	35 492
	Mains adapter	101 075
	Transport case	101 554
	Operating manual German	28 701
	or	
	Operating manual English	28 702

2.2 Required accessories

Product code	Description	Order no.
	Handheld Probes (UCI method) (each probe complete with cable)	
MIC 201-A	Handheld probe 10 N	34 104
MIC 205-A	Handheld probe 50 N	34 105
MIC 2010-A	Handheld probe 98 N	34 106
MIC 201-AL	Extended handheld probe 10 N	34 392
MIC 205-AL	Extended handheld probe 50 N	34 282
MIC 201-AS	Short handheld probe 10 N	34 711
MIC 205-AS	Short handheld probe 50 N	34 712

Product code	Description	Order no.
	Motorized Probes (UCI method) (each probe complete with cable)	
MIC 211-A	Motor probe 8.6 N	34 381
MIC 2103-A	Motor probe 3 N	34 382
MIC 2101-A	Motor probe 1 N	35 577
	Impact Devices (rebound method) (each without connecting cable for impact device)	
Dyna D	Impact device with 3 mm tungsten-carbide	34 248
Dyna G	Impact device with 5 mm tungsten-carbide	34 549
Dyna E	Impact device with diamond-tipped body	34 588
Dyna 50	Connecting cable for impact device	34 329

2.3 Recommended accessories (general)

Product code	Description	Order no.
MIC 20-BAT	NiMH accumulator pack, 4.5 Ah, internal charging	35 452
MIC 1060	Battery grinding set	34 380
MIC 300	Technical book on hardness testing (only in German)	28 837
	Printer cable (serial/parallel) for connection to Hewlett Packard Printers of the hpdeskjet 9xx series	101 761
UDAT	UltraDAT data management program for transfer and documentation of hardness measurement data	35 549
	Data transfer cable from the instrument to a PC	101 785
ZG-F	Couplant	54 558

2.4 Recommended accessories (UCI method)

Product code	Description	Order no.
Guiding devices and test supports		
MIC 270	Surface attachment for MIC 201-A, MIC 205-A, MIC 2010-A	32 084
MIC 271	Prism adapter for MIC 201-A, MIC 205-A	32 993
MIC 220	Test specimen holder for MIC 2101-A, MIC 2103-A and MIC 211-A	30 766
MIC 221	Universal test support with instrument holder	33 541
MIC 227	Test support for determination of hardness progression	35 264
MIC 222-A	Precision test support	35 546
MIC 2221	Magnetic foot for support MIC 222-A	33 909
MIC 2220	Support block for flat, thin parts	33 651
MIC 225	Camshaft test stand	34 869

Product code	Description	Order no.
Guiding devices for motor probes		
MIC 100	Probe attachment set	29 929
MIC 100-1	Prism attachment	29 920
MIC 120	Magnetic probe shoe for curved surfaces	31 854
MIC 223	Quick test support with magnetic foot	34 020
Hardness reference plates with MPA certificate		
MIC 25C	Hardness Reference Plate 25 HRC	33 905
MIC 45C	Hardness Reference Plate 45 HRC	33 906
MIC 65C	Hardness Reference Plate 65 HRC	33 907
MIC 1V100	Hardness Reference Plate 150 HV10	34 279
MIC 2V010	Hardness Reference Plate 240 HV1	33 896
MIC 2V050	Hardness Reference Plate 240 HV5	33 899

Product code	Description	Order no.
MIC 2V100	Hardness Reference Plate 240 HV10	33 902
MIC 5V010	Hardness Reference Plate 540 HV1	33 897
MIC 5V050	Hardness Reference Plate 540 HV5	33 900
MIC 5V100	Hardness Reference Plate 540 HV10	33 903
MIC 8V010	Hardness Reference Plate 840 HV1	33 898
MIC 8V050	Hardness Reference Plate 840 HV5	33 901
MIC 8V100	Hardness Reference Plate 840 HV10	33 904

2.5 Recommended accessories (rebound method)

Product code	Description	Order no.
Hardness reference blocks (rebound method)		
MIC D62	Hardness reference block 620 HV100	34 393
MIC D62MPA	Hardness reference block 620 HV100, certified by MPA, Germany	34 573
MIC G38	Hardness reference block 380 HV100	34 631
MIC G38MPA	Hardness reference block 380 HV100, certified by MPA, Germany	34 657
Test attachments for Dyna D and E (rebound method)		
Dyna 41	Set (5 pcs.) of test attachments for cylindrical and hollow-cylindrical surfaces	34 536
Dyna 42	Set (5 pcs.) of test attachments for spherical and hollow-spherical surfaces	34 539

2.6 Spare parts requirements (UCI method)

Product code	Description	Order no.
MIC 1050	Probe cable for handheld probes	34 071
MIC 1051	Probe cable for motor probes	34 378
MIC 1052	Probe cable for shortened handheld probes for MIC 201-AS and MIC 205-AS	34 713
	Ball headed probe grip	33 854

2.7 Spare parts requirements (rebound method)

Product code	Description	Order no.
	Impact body D, new	34 443
	Impact body G, new	34 596
	Impact body E, new	34 593
	Impact body D, replacement in exchange by Krautkramer Service Department	34 572
	Impact body G, replacement in exchange by Krautkramer Service Department	35 265
Dyna 50	Connecting cable for impact device	34 329
	Cleaning brush for Dyna D or Dyna E	34 420
	Cleaning brush for Dyna G	34 618
	Standard test attachment for impact device D or E	34 312
	Test attachment for impact devices D or E, Ø = 13.5 mm	34 656

Product code	Description	Order no.
	Standard test attachment for impact device G	34 569
	Test attachment for impact device G, diameter = 50 mm	34 634
	Replacement grinder for battery grinding set MIC 1060	18 115

Initial start-up **3**

3.1 Power supply

You can operate the Krautkramer MIC 20 either with the battery pack MIC 20-BAT or with the power supply unit. The operation with the power supply unit is possible even if the battery pack MIC 20-BAT is in the instrument. The power supply to the battery compartment is then automatically interrupted.

Operation using the power supply unit

The Krautkramer MIC 20 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.

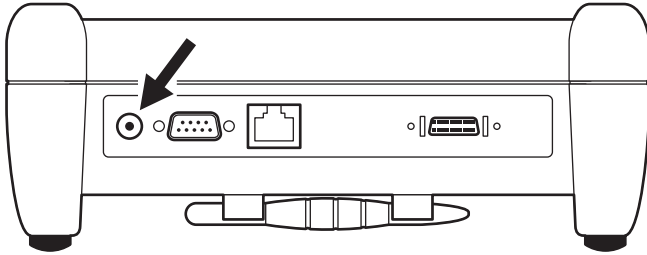
Just pull off the attached adapter, and replace it with the required one.

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 MIC 20 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 MIC 20 with the NiMH battery pack MIC 20-BAT (ref. chapter 2).

The operation is likewise possible with 6 NiCd 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!

When using the battery pack MIC 20-BAT (unless NiMH or NiCd single cells are used), the current status of the battery is indicated on the display of the MIC 20 by an icon:



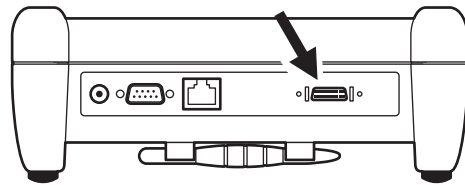
An alarm is output with low voltage. In such a case, exchange the batteries at once. The Krautkramer MIC 20 is automatically turned off if the voltage gets too low in order to ensure a reliable mode of functioning.

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

3.2 Connecting a probe or an impact device

You can connect probes for the quasi-static hardness testing according to the UCI method as well as impact devices for the dynamic hardness testing according to the rebound method to the MIC 20.

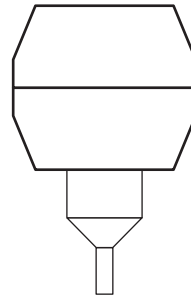
Probes and impact devices are connected to the MIC 20 via corresponding connecting cables. The connecting cables are equipped with a round plug for the connection to the probe or to the impact device, and with a square plug for the connection to the instrument.

**Note:**

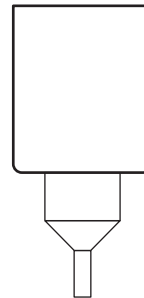
You should only change the probe or the impact device when the MIC 20 is switched off.

Connecting a UCI probe

- Align the round plug of the cable correctly with the socket of the probe by means of the markings, and push it carefully into the socket until it locks into place.
- Plug the square plug of the connecting cable in the socket at the back of the instrument.
- Check that both plugs fit tightly.
- Attach the probe handle to the probe if necessary.
- Screw on the conical test attachment for short-time measurements using the UCI handheld probes MIC 201-A, MIC 205-A, or MIC 2010-A. Use the cylindrical test attachment for measurements with defined dwell times.
- Switch the MIC 20 on. An icon in the top left corner of the screen shows that a probe has been correctly connected:



Conical probe attachment for short-time measurements



Cylindrical probe attachment for measurements with a defined dwell time

 **Note:**

If you want to carry out measurements with defined dwell times, please use the support

MIC 222-A (support with precise probe guidance).

This will help you to avoid measuring inaccuracies to a large degree.

In addition, other accessories are available to make the measurements easier for you to carry out (ref. chapter 2).

Connecting an impact device

The following impact devices are available for use in combination with the MIC 20:

- **Dyna D**
Standard impact device for all materials that can be tested
- **Dyna G**
Impact device for solid test objects, e.g. castings or forgings
- **Dyna E**
Impact device for the hardness range over 650 HV

 **Attention:**

The impact device Dyna G must only be used up to a hardness to be tested of max. 650 HB, otherwise the impact body may be destroyed.

 **Note:**

A larger test attachment (diameter 50 mm) is available for the impact device Dyna G for a more stable measurement on large, flat workpieces.

For measurements on test objects having curved surfaces, you have special test attachments at your disposal in order to achieve a better positioning with the impact devices Dyna D and Dyna E (ref. chapter 2).

- Align the round plug of the cable correctly with the socket of the probe by means of the markings, and push it carefully into the socket until it locks into place.
- Plug the square plug of the connecting cable in the socket at the back of the instrument.
- Check that both plugs fit tightly.
- Screw on the suitable test attachment for measurements on curved surfaces if necessary.
- Switch the MIC 20 on. An icon in the top left corner of the screen shows that a probe has been correctly connected:



Disconnecting the connecting cable

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

- Carefully pull the outer ring of the round plug on the probe or on the impact device in order to release the lock, and pull off the plug.
- Press the two lateral clips of the square plug on the instrument in order to release the lock, and pull off the plug.

Exchanging the test attachment

You can use special test attachments for testing on small parts and on uneven surfaces in order to achieve a better positioning of the probe or of the impact device.

- Slowly unscrew the currently used test attachment counter-clockwise by hand.
- Place the required test attachment on carefully. Make sure that the threads are not damaged by tilting.
- Carefully screw on the test attachment clockwise and by only using manual force all the way to the limit stop.

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.



Cold start

If the instrument no longer reacts and cannot be started properly, you can reset the settings with a cold start.



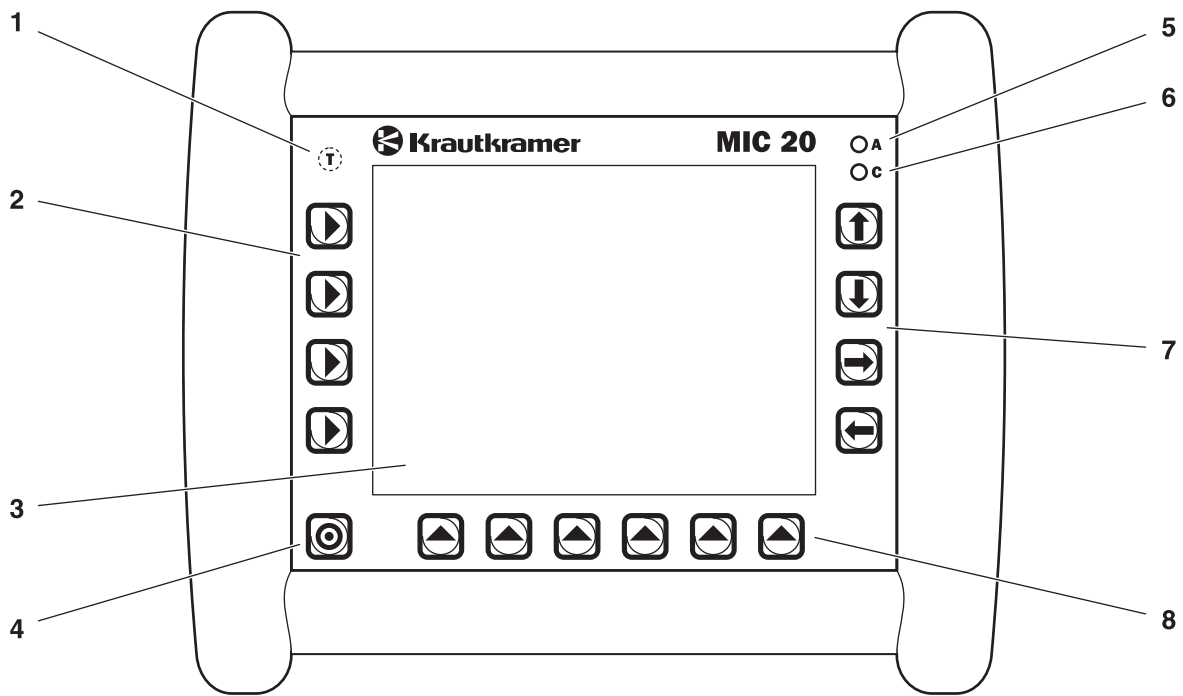
Attention:

In a cold start, the files LastMeasure.mes and last.set are deleted so that the last measurement series and the saved calibration data may be lost.

- To switch on the instrument, briefly press the button .
- As soon as the start screen (blue background) appears, press the button .

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 MIC 20 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.

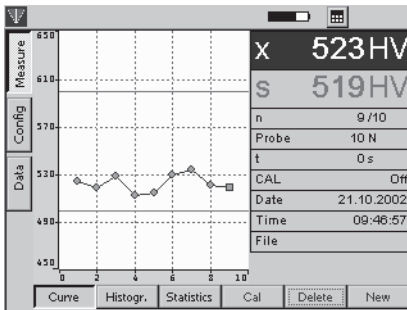
Note:

The contents of the menu differ in some details, depending on the fact whether a probe or an impact device is connected to the MIC 20.

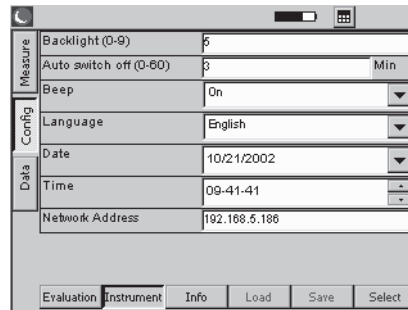
User interface

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

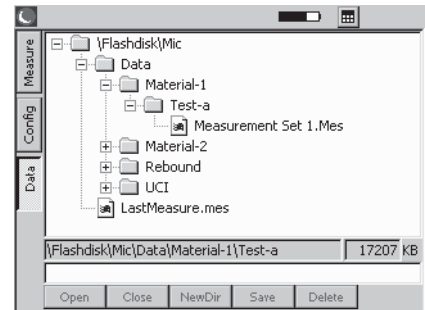
The buttons as well as the option and other boxes shown on the user interface can be operated by directly touching the touch screen, or by pressing the corresponding key next to the screen.



Main menu **Measure**



Main menu **Config**



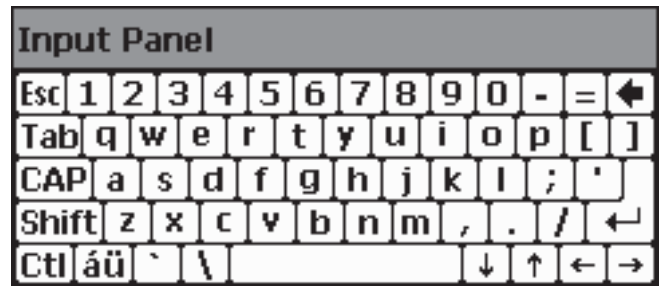
Main menu **Data**

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 Probe and impact device

Guiding the probe

**Attention:**

Make sure that the probe is connected before switching the MIC 20 on so that the instrument is automatically set to the UCI method.

Reliable measurement results can only be obtained if you know how to handle the probe correctly and safely.

Please always observe the following rules:

- Avoid any rough placing of the probe on the test surface in order not to damage the diamond.
- Do not move the probe under load on the test material.
- Pay attention to guiding the probe smoothly and steadily using your both hands.
- Do not carry out measurements twice at the same test position. The distance between the test positions should be at least 3 mm.

 **Note:**

After placing the probe on the test surface, the measurement must be carried out within 3 seconds. Otherwise an error message will be given and you have to start the process again.

- Select the main menu **Measure**.
- If necessary, remove the rubber protection cap from the probe.
- Screw on the conical test attachment for short-time measurements.
- Hold the probe with your both hands in order to have the best possible control during guidance and during impressing in the material surface.
- Place the probe vertically on the surface to be tested. An icon at the top edge on the screen shows the contact of the probe with the test material:



- Hold the probe with one hand tightly enough so that it doesn't tilt and press it evenly and steadily against the surface with the other hand.
- Increase the pressure steadily until the probe's specific load is attained and you hear an acoustic signal. The measured hardness value is displayed on the screen.
- Lift off the probe and place it again at another position in order to carry out other measurements.

Note:

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

- The load was applied too fast. Try again by increasing the pressure more slowly.
- The instrument has not been calibrated correctly beforehand.
- The hardness of the surface tested is beyond the probe's range of measurement.

Operating the impact device**Attention:**

Make sure that the impact device is connected before switching the MIC 20 on so that the instrument is automatically set to the rebound method.

The impact device Dyna G must only be used up to a hardness to be tested of max. 650 HB, otherwise the impact device may be destroyed.

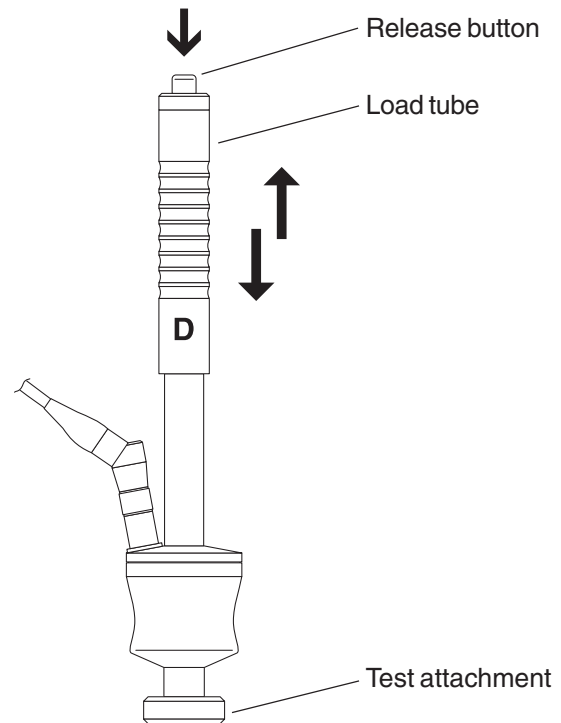
Reliable measurement results are only obtained if you know how to handle the impact device correctly and safely.

You should always observe the following rules:

- Always use an impact device suitable for the application and equipped with the appropriate test attachment.
- Do not carry out measurements twice at the same test position. The distance between the test positions should be at least 3 mm.

- Never load the impact device at the actual test position (surface hardening) but somewhere else (e.g. at a table or another position of the test object).
 - Keep the following in mind when using the test attachments Dyna 41 and Dyna 42 so that the impact device is correctly loaded: do not tension the impact device by pushing the load tube through „in the air” but by e.g. pressing one finger against it or by placing the impact device on the test surface. After that, put the impact device at the actual test position.
- Select the main menu **Measure**.
 - Tension the impact device by pushing the load tube all the way through to the limit stop and by moving it slowly back to the initial position.
 - Place the impact device vertically on the test surface and press it slightly against it with one hand so that it doesn't tilt.
 - Use the index finger of the other hand to press the release button. An acoustic signal is heard if the measurement was successful.

- Lift off the impact device. The measured hardness value is displayed on the screen.



4.3 Hardness testing



Attention:

In order to obtain correct measurement results, it is absolutely necessary to calibrate the MIC 20 to the test object's material before starting any measurements.

You have to repeat the calibration process for every new material. You must likewise repeat the calibration whenever you change the test method.

The calibration is described in detail in the following chapter 4.4. As you have to carry out measurements for the calibration, please read the present chapter first in order to learn how to edit measurement series and view measurement results.



Note:

When the MIC 20 is switched off, the instrument settings (including calibration) of the last measurement are saved and will again be available unchanged when the instrument is switched on the next time. Check the current settings prior to every measurement series.

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**, **Histogr.** or **Statistics** 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 4.5).

Viewing and evaluating test results

Various information is shown to you in the main menu **Measure**, depending on the selected view, e.g. the current hardness value, the list of previous measured values, or the statistical distribution of measured values. Details depend on the current method of measurement. You can choose between three display view modes for measurements:

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

- Curve
- Histogram
- Statistics

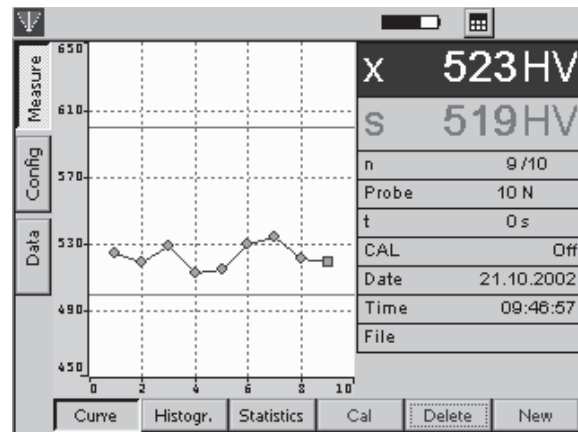
Note:

The different display modes have no effect on the process of measurement.

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.

In addition to the diagram, other information is displayed for every measured value:

Probe	Test load of the probe or type of the impact device
t	Dwell time (only with UCI method)
CAL	Calibration number (Off = standard material)
Mat.	Selected material group (only with rebound method)
Date	Date of measurement
Time	Hour of time of measurement
File	File name when editing an already saved measurement series

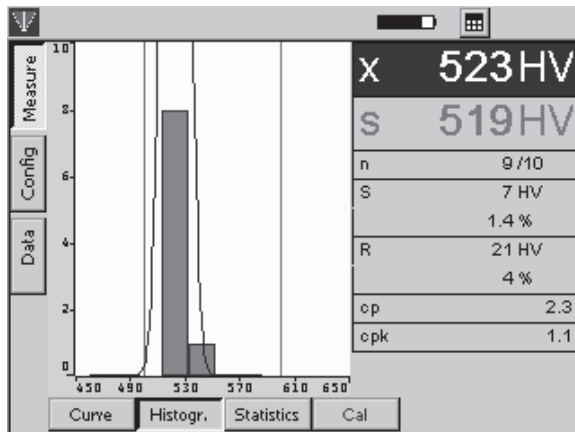
You can delete individual test results.

- 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



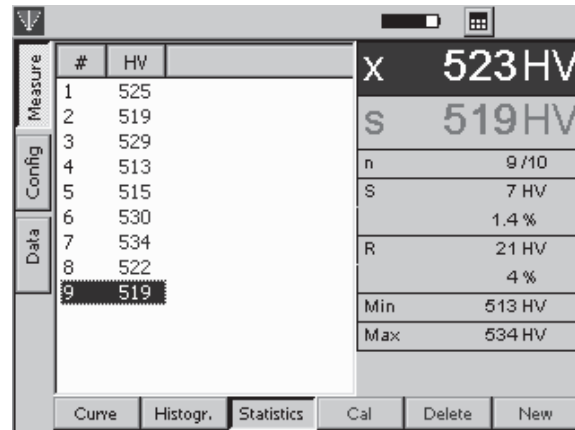
The histogram shows the statistical distribution of the readings of the current test series.

Besides the graphics, additional statistical single values are displayed (ref. chapter 7.4):

- S** Standard deviation (absolute and percentage)
- R** Range of spread (absolute and percentage)

- cp** Process capability index
- cpk** Critical process capability index

Statistics function



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 7.4):

- S** Standard deviation (absolute and percentage)
- R** Range of spread (absolute and percentage)
- Min** Minimum value
- Max** Maximum value

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:**

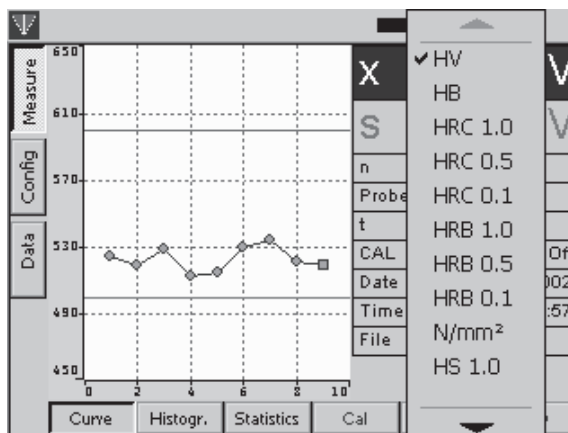
You can also select the reading by means of the arrow keys to the right of the screen.

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 7.3 of this manual regarding the conversion of test results.



 **Note:**

The list of hardness scale options is not automatically adapted to the test method or the impact device used. If your choice is not accepted by the instrument, the selected conversion is not possible. A corresponding note is displayed on the screen.

- Touch the abbreviation of the current hardness scale (e.g. HV) at the item Average (x) in the right-hand screen section. An options menu is displayed.
- Touch the abbreviation of the required hardness scale (e.g. HB). All values of the current measurement series are displayed in the new scale.

4.4 Calibration

**Attention:**

In order to obtain correct measurement results, it is absolutely necessary to calibrate the MIC 20 to the test object's material before starting any measurements.

You have to repeat the calibration for every new material. When changing the test method, you have to likewise repeat the calibration procedure.

**Note:**

If you want to measure on low-alloy or unalloyed steels, there's no need to set the instrument because this material group is the default setting of the MIC 20.

When switching the MIC 20 off, the instrument settings (including calibration) of the last measurement are saved and will be available again unchanged when the instrument is switched on the next time. Check the current settings prior to every measurement series.

Carrying out the calibration

The calibration procedure is basically identical for the UCI method and for the rebound method.

You only have to start by selecting one of the material groups stored in the instrument as an additional action with the rebound method.

You need a reference block made of the same material with known hardness for the calibration. During the calibration, you determine the calibration number that you need in other measurements on this material.

The calibration number is an auxiliary value that simplifies the subsequent change of the calibration setting. The calibration number has no physical reference whatsoever and consequently no name either.

As you can save the calibration in the MIC 20, you only have to carry out the calibration once for a certain material.

Only with calibration for rebound method:

If you want to carry out measurements on high-alloy steels or on other materials, e.g. nonferrous metals,

you have to set the MIC 20 to the required material. To do this, you start by choosing the suitable material from the 9 existing ones. For precision measurements, you have to carry out a calibration afterwards for the adjustment.

- Touch the button **Cal**. The calibration menu is displayed.
- Touch the list box **Material group**. The list of the stored material groups appears.

The screenshot shows the 'Actual Calibration' screen. At the top, it says 'Actual Calibration'. Below that, there are four input fields: 'Name' with the value 'STAND', 'Cal. Number' with the value '0', 'Target value' with the value '770 HL', and 'Real value' with the value '770 HL'. Below these fields is a section titled 'Settings'. Under 'Settings', there is a 'Material group' label and a list box. The list box contains the following items: 'ST - Steel' (which is highlighted with a dark background), 'AST - Alloy Steel', 'SST - Stainless Steel', 'GCI - Gray Cast Iron', 'NCI - Nodular Cast Iron', 'AL - Aluminum', and 'BRS - Brass'. There are up and down arrow buttons on the right side of the list box.

- Touch the material group corresponding to the test object. The list is closed again.
- Finally, touch the button **OK** to close the menu.

BRZ - bronze D
 CU - wrought copper alloys D

Notes on the material groups:

The MIC 20 makes 9 material groups available. However, not all material groups are suitable for the different impact devices. Please observe the assignment in the table below:

Material group	Impact device
ST - steel and cast steel	D E G
AST - tool steel	D E
SST - stainless steel	D
GCI - gray cast iron	D G
NCI - nodular cast iron	D G
AL - aluminum cast alloys	D
BRS - brass	D

Calibration for UCI and rebound method:

- Carry out a series of measurements consisting of about 5 single measurements on your reference block.
- Touch the button **Cal**. The calibration menu is displayed.

The current statistical average of your measurements is displayed at the item **Real value**. However, this value does not correspond to the known, real hardness value because you have not yet calibrated the instrument.

You will now have to adapt the displayed value to the known hardness value of your reference block.

- Double-touch the item **Target value** in order to mark the value displayed there.

- Touch the button **Select** at the bottom edge of the screen. The virtual keyboard is displayed, and you can input the required target value.
- Key in the value by touching the corresponding characters on the keyboard.
- Finally, touch the displayed Return (ENTER) key. The keyboard disappears again.

According to the input hardness value, the MIC 20 will automatically determine the calibration number which is immediately displayed at the item Cal. Number.

Having calibrated the MIC 20, you can carry out hardness tests as described above.

- Touch the button **OK** in order to close the calibration menu. You will see the normal display screen again. An icon at the top edge of the screen shows that a calibration is active (calibration number non-0):



Attention:

The calibration is active when the calibration menu is closed, however, it is not automatically saved. If you want to use a calibration again some time later, you have to save it under a new name (please see the following section).

Saving calibration data

If you want to use a calibration several times (e.g. after switching the instrument off and on again, or after exchanging the probe), you have to save it. To do this, you have to enter a name for the calibration.

Notes:

You cannot edit or overwrite saved calibrations. In order to save any changes, you have to enter a new name.

Calibrations for the UCI method are independent of the probe, and consequently they apply to all UCI probes. Calibrations for the rebound method are dependent of the

type of the impact device, and the letter of the impact device is therefore added to their name (D, G, or E).

- Touch the button **Cal**. The calibration menu is displayed and you will see the current calibration.
- Double-touch the item **Name** in order to mark the name displayed there.
- Touch the button **Select** at the bottom edge of the screen. The virtual keyboard is displayed, and you can key in the required name for the calibration.
- Finally, touch the button **OK** in order to close the menu. The current calibration is now saved under the input name, and you can always restore it at a later date.

Deleting calibration data

You can always delete calibrations that are no longer needed.

- Touch the button **Cal**. The calibration menu is displayed.
- Touch the item **List** containing the saved calibration data. The list appears.
- Touch the name of the required calibration.
- Touch the button **Delete** at the bottom edge of the screen. The current calibration is deleted after confirming the safety prompt. The following calibration in the list is now active.
- Finally touch the button **OK** in order to close the menu.

Restoring the standard calibration

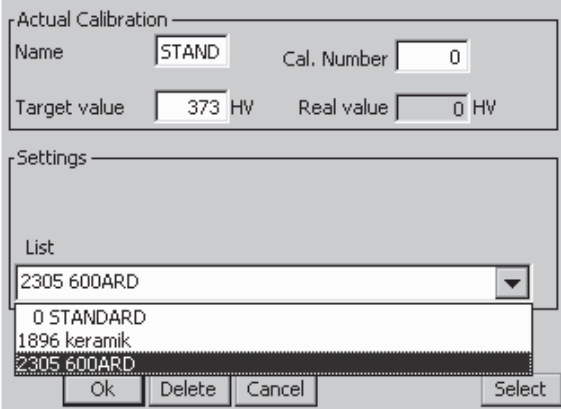
If you want to reset the calibration to the standard or default setting again after calibrating to a special material, just choose the option STANDARD from the list of calibration data. This setting is factory-programmed and cannot be deleted.

- Touch the button **Cal**. The calibration menu is displayed.
- Touch the item **List** containing the saved calibration data. The list appears.
- Touch the option STANDARD. The default setting is restored.
- Finally, touch the button **OK** in order to close the menu.

The icon for the active calibration is no longer shown at the top edge of the screen.

Note:

You can always restore all other saved calibration data as well in exactly the same way by making your choice from the list.



Actual Calibration

Name Cal. Number

Target value HV Real value HV

Settings

List

▼

0 STANDARD

1896 keramik

2305 600ARD

4.5 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 MIC 20. 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**, **Histogram** or **Statistics** 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.
- 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.

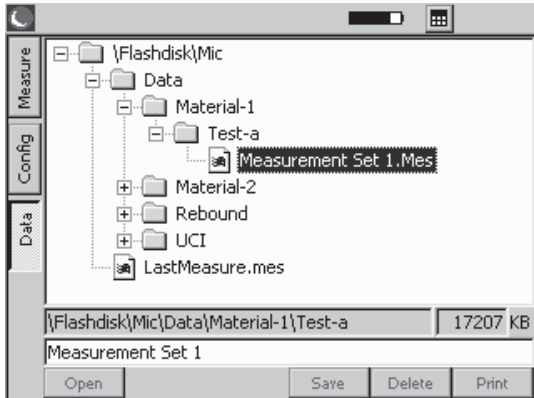


Note:

The selection of the directory and the assignment of the file name are not necessary if you activate **Auto save to** (please see chapter 4.7).

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.

- 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.

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.

Editing saved files

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 cannot add any other readings to a saved file. The file `LastMeasure.mes`, where the current readings that have not yet been saved are automatically filed when the MIC 20 is switched off, is an exception. You can continue with the measurement series after opening this file the next time the instrument is switched on.

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 MIC 20.

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.

4.6 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 about the instrument and the probe or impact device
- 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**)

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 connect 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
 - no parity check
 - software handshake on
- Ensure that the baud rate set in the printer agrees with that selected in the MIC 20 (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 MIC 20 (ref. following section). The recommended baud rate is 4800.

Selecting and printing a test series

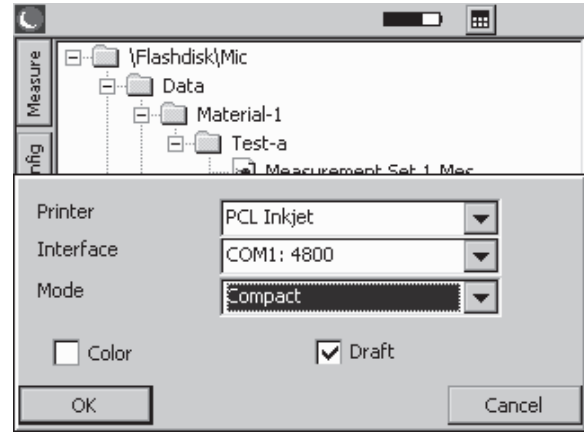
After connecting and configuring a compatible printer, you can select the required measured value file (*.mes), and print out the test report.

Note:

Due to the baud rate of 4800, the printout is recommended in the draft mode.

- 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.



Specimen test report complete

HARDNESS TESTING REPORT

HEADER DATA
Measurement set: V\ashdisk\Mic\Data\Rebound\Odyna D\meas-set 2.Mes
Date and Time: 10/30/02 3:30:03 AM
Info: _____

INSTRUMENT: MIC20 **CALIBRATION**
Instrument: Calibration Value 0
SN of Instrument: Y52F00a Material ST - Steel
Probe D
SN of Probe 825

STATISTICS
Number of readings: 10
Average: 56.1 HRC 0.1
Minimum: 55.8 HRC 0.1
Maximum: 56.4 HRC 0.1
Range (abs): 0.8 HRC 0.1
Range (%): 1.4 %
Standard Dev. (abs): 0.3 HRC 0.1
Standard Dev. (%): 0.5 %

Set hardness is met Set hardness exceeded Set hardness not reached

Signature: _____ Date: _____

- 1 -

READINGS

1.	56.4 HRC 0.1
2.	55.9 HRC 0.1
3.	56.4 HRC 0.1
4.	56.0 HRC 0.1
5.	56.0 HRC 0.1
6.	55.9 HRC 0.1
7.	56.0 HRC 0.1
8.	56.4 HRC 0.1
9.	56.3 HRC 0.1
10.	56.4 HRC 0.1

Specimen test report compact

HARDNESS TESTING REPORT

HEADER DATA
Measurement set: V:\ashdisk\Mic\Data\Rebound\Dyns D\meas-set 2.Me
Date and Time: 10/30/02 3:30:03 AM
Info: _____

INSTRUMENT: MIC20 **CALIBRATION**
Instrument: MIC20 Calibration Value 0
SN of Instrument: Y52F00a Material ST - Steel
Probe D
SN of Probe 625

STATISTICS
Number of readings: 10
Average: 56.1 HRC 0.1
Minimum: 55.6 HRC 0.1
Maximum: 56.4 HRC 0.1
Range (abs): 0.8 HRC 0.1
Range (%): 1.4 %
Standard Dev (abs): 0.3 HRC 0.1
Standard Dev (%): 0.5 %

Set hardness is met Set hardness exceeded Set hardness not reached

Signature: _____ Date: _____

4.7 Instrument configuration

In order to use the Krautkramer MIC 20 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.

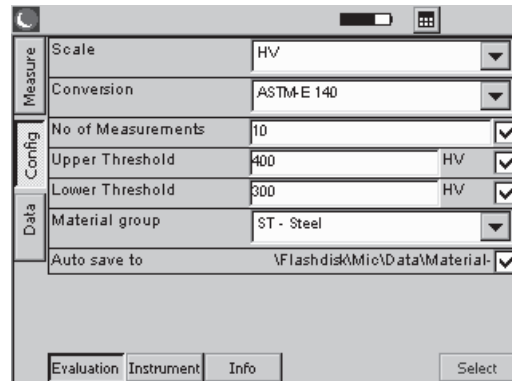
Evaluation parameters

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

Note:

The contents of the menu differ in some details, depending on the fact whether a probe or an impact device is connected to the MIC 20.

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



The screenshot shows a configuration window with a sidebar on the left containing three categories: Measure, Config, and Data. The main area displays the following settings:

Scale	HV	
Conversion	ASTM-E 140	
No of Measurements	10	✓
Upper Threshold	400	HV ✓
Lower Threshold	300	HV ✓
Material group	ST - Steel	
Auto save to	\Flashdisk\Mic\Data\Material- ✓	

At the bottom of the window, there are three buttons: Evaluation, Instrument, and Info, and a Select button on the right.

Scale

The test result is displayed as HV value in the default setting. You can select another hardness scale as required.

Notes:

The list of the hardness scale options is not automatically adapted to the test method or the impact device used. If your choice is not accepted by the instrument, the selected conversion is not possible. A warning message may be displayed under certain circumstances.

If readings are beyond the range of values when converting into another hardness scale, they cannot be converted. These values are reset to zero, and they are not taken into consideration in the statistical evaluation according to the currently active scale.

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

Conversion

You can choose between the conversion tables according to DIN 50 150, according to ASTM E140, and the DynaMIC-specific conversion table for the conversion of hardness values.

Note:

The list of the conversion table options is not automatically adapted to the test method or the impact device used. If your choice is not accepted by the instrument, the selected conversion is not possible. A warning message may be displayed under certain circumstances.

- 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 4.5).

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**.

Note:

If the input thresholds are beyond the range of values when changing to another hardness scale, they are automatically adjusted to the permissible maximum or minimum value. When changing back to the previous hardness scale, this may lead to threshold shifts.

- 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.

Material group (only with rebound method)

For dynamic measurements according to the rebound method, you have to choose one of the material groups stored in the MIC 20 in order to calibrate the instrument to the test material.

 **Note:**

Not all material groups can be selected for the different impact devices (D, E, or G). A corresponding note may be displayed if applicable. Please observe the assignment in the table below:

Material group	Impact device
ST - steel and cast steel	D E G
AST - tool steel	D E
SST - stainless steel	D
GCI - gray cast iron	D G
NCI - nodular cast iron	D G
AL - aluminum cast alloys	D
BRS - brass	D
BRZ - bronze	D
CU - wrought copper alloys	D

– Touch the list box and select the required material group.

Dwell time (only with UCI method)

You can specify the dwell time of test load in seconds if required. This function is only useful in measurements by means of a support when using a special test attachment or motor probes (ref. chapter 2).

- 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 4.5 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.

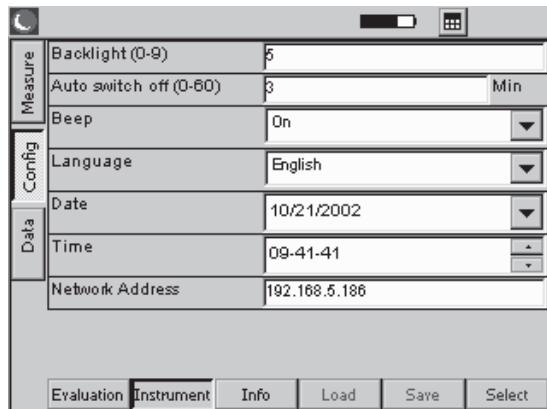
- Touch the check box to activate the Auto-save option.

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.

System settings

You can define various default settings for the Krautkramer MIC 20.

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



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.

Contrast (only with MIC 20 equipped with CSTN screen)

You can adjust the contrast of the display screen on a scale from 0 to 9. The value for the highest contrast is 9.

- Double-touch the text box in order to mark the current value.
- Touch the keyboard icon at the top edge of the screen in order to display the virtual keyboard.
- Key in the required value and touch the Return (ENTER) key in order to make the keyboard disappear again.

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 MIC 20. 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 (TCP/IP)

If required, specify an IP address for the instrument here. During data transfer operations to a computer using the UltraDAT program, this address must agree with the IP address specified in the program.

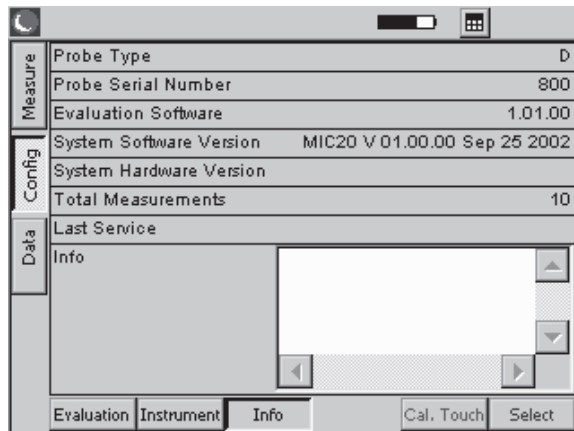
- Double-touch the text box in order to mark the current address.
- Touch the keyboard icon at the top edge of the screen in order to display the virtual keyboard.
- Key in the required IP address and touch the Return (ENTER) key in order to make the keyboard disappear again.

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 (H = handheld probe, M = motor probe) or of the connected impact device (D, G, or E).

Probe Serial Number

Serial number of the currently connected probe.

Load (N) (only with UCI method)

Nominal test load of the currently connected probe in N.

Evaluation Software

Version number of the current evaluation software.

System Software Version

Version number of the current system software.

System Hardware Version

Version number of the current system hardware.

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 **Info** 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.

4.8 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.

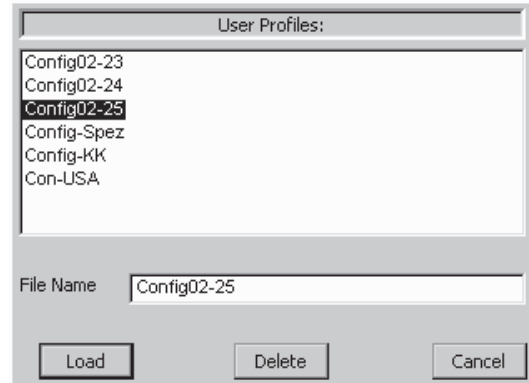
You can load the saved instrument parameters any time in order to quickly configure the instrument.

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.



4.9 Functional tests

Functional test for UCI method

Checking the Vickers diamond optically

Check the Vickers diamond under a microscope from time to time.

Ensure that the pyramid form of the diamond is not damaged.

Checking the measuring accuracy

All UCI probes are calibrated using hardness reference plates certified for the corresponding test load by the German material testing institute "Materialprüfungsanstalt MPA NRW". Every hardness reference plate shows natural variations that also affect the deviation of the value measured by the corresponding probe from the plate's value.

Under well defined conditions, as e.g. with the measurement in the test support MIC 222 on Krautkramer hardness reference plates with acoustic coupling (thin oil film or ultrasonic couplant ZG between the reference

plate and the support), a deviation from the plate's value amounting to ± 3.6 % of the average from 5 measurements is still permissible (with a range of variation of max. 5 % relative to the average).

Individual deviations from the plate's value may occur in freehanded measurements, depending on how the probe is handled. However, they should not amount to a deviation of more than 5 % from the plate's value in 10 measurements.

Make yourself thoroughly familiar with the handling of the probe and practice the handling of the probe using the measurements on the hardness reference plates until you obtain stable measured values.

Any sudden changes indicate a defective diamond or a de-calibration of the probe.

Have the instrument and the probe checked by the GE Inspection Technologies service if any major deviations occur.

- Carry out 3 to 5 measurements on the hardness reference plate. Ensure that the distance between the measuring positions is at least 3 mm.

- Read the average and compare it with the reference value of the hardness reference plate.

Have the instrument and the impact device checked by the GE Inspection Technologies service if any major deviations occur.

Functional test for rebound method

Check the functioning of impact device and of MIC 20 before using them for the first time, and afterwards from time to time (after 1,000 impacts in each case at the latest) by measuring the hardness value HL on the corresponding hardness reference block.

Minor deviations from the reference value of ± 5 HL can be compensated for by the calibration function. If any major deviations occur, it is necessary to replace the spherical carbide metal tip.

- Carry out 3 to 5 measurements on the hardness reference plate. Ensure that the distance between the measuring positions is at least 3 mm.
- Read the average, and compare it with the reference value of the hardness reference plate.

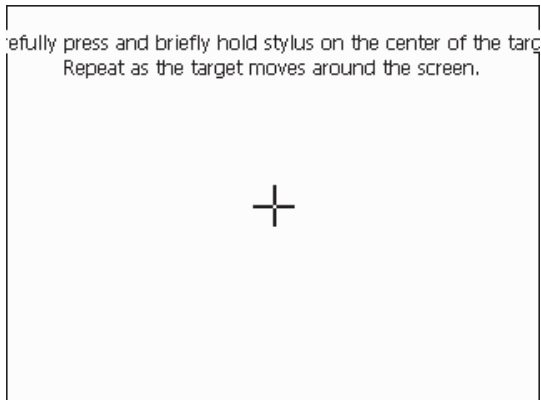
4.10 Calibrating the touch screen

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.

4.11 Troubleshooting

After being turned on, the Krautkramer MIC 20 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

Error	Possible remedy
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.

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 connecting cable for the probe or the impact device 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 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 MIC 20 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 MIC 20 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 MIC 20.

**Attention:**

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

Cleaning the probe

Clean the probe by just using a dry cloth.

Cleaning the impact device

**Attention:**

Never use oil for cleaning the impact device!

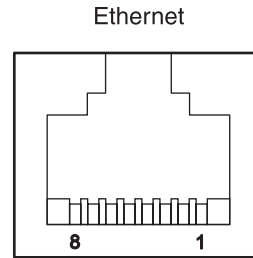
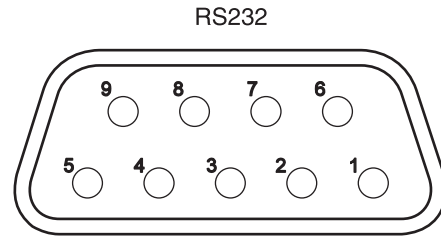
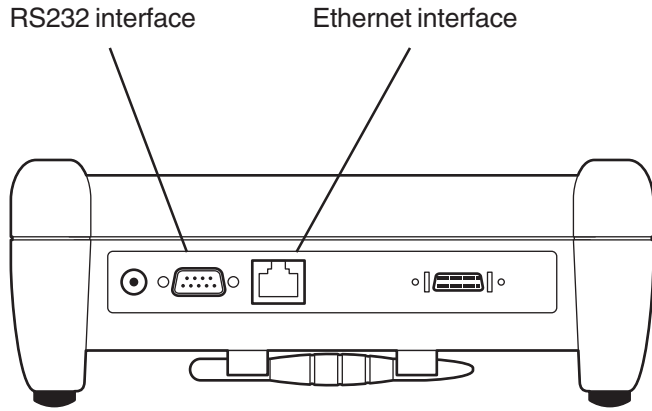
The impact device must be cleaned after approx. 1,000 measurements or if any incorrect readings are obtained.

- Unscrew the test attachment and remove the impact body from the guide tube.
- Clean the test attachment, impact body, and test tip using a dry cloth.
- Clean the guide tube using a cleaning brush.

Interfaces and data transfer **6**

6.1 Interfaces

The Krautkramer MIC 20 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 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 using the serial-parallel converter, the baud rate setting on the converter must correspond to the baud rate selected in the MIC 20. A baud rate of 4800 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.

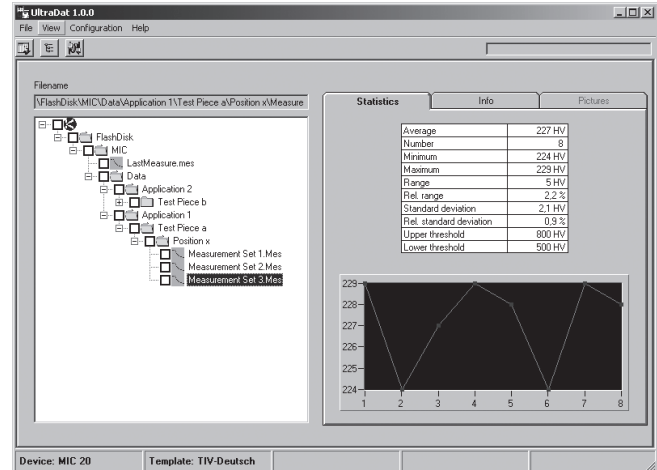
You need the UltraDAT program for the data transfer (ref. chapter 2).

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 is carried out either via the Ethernet interface. To do this, you need a corresponding data cable (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).



Hardness testing method **7**

7.1 The UCI method

The following section gives you helpful information about the UCI hardness testing method of the MIC 20.

Unlike conventional low-load hardness testers, the MIC 20 does not evaluate the Vickers indentation by means of a microscope but by electronic means using the UCI method.

This brings about an advantage with regard to the optical evaluation because a high reproducibility of the results is ensured even with small test indentations.

The Vickers diamond is attached to the tip of a round metal rod. This metal rod is excited to longitudinal oscillations in its resonant frequency of approx. 78 kHz.

If the Vickers diamond and the test material come into contact with each other, the resonant frequency changes. This happens as a function of the size of the indentation surface of the Vickers diamond. This is in turn the measure for the hardness of the material tested.

Resonant frequencies can be measured quite accurately. The UCI method is therefore especially suitable for a considerable simplification and acceleration of the evaluation of the Vickers indentations, and consequently of the complete test process.

As a result of this, there are two more benefits:

- The hardness measurement is carried out under load (no impairment of the measurement by elastic resilience).
- Basis for the hardness measurement is the surface of the indentation and not the length of the indentation diagonals. The measurement is consequently less influenced by the surface roughness. The measurement of burnished or gunmetal finish surfaces is also possible.

 **Note:**

In the UCI method, the measured value depends on the elastic properties of the material (Young's modulus or modulus of elasticity, Poisson's ratio) so that the instrument has to be calibrated for hardness measurements on different materials (ref. chapter 4.4).

The treatment of test material

In order to obtain reliable and reproducible measurement results, you have to observe a few notes on the quality and treatment of test material. You should therefore read the following notes.

Surface quality

The surface must be clean as well as free from oil, grease, and dust. The peak-to-valley height of the material surface must be small in comparison with the indentation depth of the Vickers diamond (approx. 14 to 200 micrometers). We recommend a peak-to-valley height of approx. 30 % of the indentation depth.

You should therefore grind off rougher surfaces, e.g. using the battery-powered grinding set MIC 1060 (ref. chapter 2).

Curved surfaces

Surfaces showing a radius of curvature < 30 mm (convex or concave) require the use of a correspondingly shaped test attachment for a steady and safe placing of the probe on the test surface.

Measurements on small and thin parts

Distinct variations of the measured values may occur in particular below a mass of 0.3 kg and with a test object thickness of less than 15 mm if the test material is excited to sympathetic oscillations. You should therefore fix such test materials to a rigid support, e.g. using a viscous paste. This also applies to the hardness reference plates.

Thin sheets must have a minimum thickness corresponding to the tenfold indentation depth of the Vickers diamond (please see tables below).

Diagonal lengths and indentation depths

Test load 10 N (1 kgf):

Hardness	Diagonal	Depth	Min. material thickness
250 HV	86 µm	12 µm	120 µm
500 HV	61 µm	9 µm	90 µm
750 HV	50 µm	7 µm	70 µm
1000 HV	43 µm	6 µm	60 µm

Test load 50 N (5 kgf):

Hardness	Diagonal	Depth	Min. material thickness
250 HV	193 μm	28 μm	280 μm
500 HV	136 μm	19 μm	190 μm
750 HV	111 μm	16 μm	160 μm
1000 HV	99 μm	13 μm	130 μm

Test load 98 N (10 kgf):

Hardness	Diagonal	Depth	Min. material thickness
250 HV	272 μm	39 μm	390 μm
500 HV	193 μm	28 μm	280 μm
750 HV	157 μm	22 μm	220 μm
1000 HV	136 μm	19 μm	190 μm

 **Note:**

According to DIN EN ISO 6507 (hardness testing according to Vickers), the center distance of two adjacent indentations with regard to the mean length of the indentation diagonal must be

- at least threefold with steel, copper, and copper alloys,
- at least six-fold with light metals, lead, tin, and their alloys.

If two adjacent indentations have different sizes, the mean indentation diagonal of the larger indentation must be used for the calculation of the minimum distance.

7.2 The rebound method

The following section gives you some helpful information about the rebound method of the MIC 20.

The equipment consists of impact body, impact device, and display unit. The impact body has a tungsten carbide or diamond ball at its tip, and a permanent magnet to generate a voltage pulse. The impact device has a spring drive to tension and to accelerate the impact body, as well as an induction coil to detect the magnet in the impact body. In the rebound method, the speed variation due to the impact body's impingement on the material surface is measured.

The impact energy is set by means of the spring for the purpose of measurement. The impact body is accelerated in the tube of the impact device toward the test surface by means of the release button.

During this process, the magnet of the impact body induces a voltage signal in the coil whose height is proportional to the impact speed (l_p). The impact causes a plastic deformation of the material, and a permanent spherical indentation is produced in the sur-

face. This plastic deformation leads to a loss of energy of the impact body and consequently to a lower speed after the rebound (R_p).

The hardness value is calculated on the basis of the ratio of these two speeds and output as follows:

$$HL = 1000 R_p/l_p.$$

The speed ratio is determined exactly at the time of the impact/rebound via the special signal processing. The speed ratio is therefore unaffected by the impact direction. Compared with that, the impact direction must be predefined in fixed steps in the case of other rebound hardness testers (gravitational effect on the speed ratio) – a considerable disadvantage in the case of frequently changing test positions.

 **Note:**

The input of the impact direction is not necessary with the MIC 20.

The treatment of test material

In order to obtain reliable and reproducible measurement results, you have to observe some notes on the quality and treatment of the test material. You should therefore read 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. using the battery-powered 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 correspondingly shaped test attachment must be used for a steady and safe placing of the probe on the test surface.

Measurements on small and thin parts

In the case of smaller and more lightweight test objects, vibrations may occur due to the impact effect of the impact device that might lead to a falsification of the measurement results.

Test objects having a mass of less than 2 kg must in any case be fixed to the support using couplant in such a way that no vibrations are produced.

Test objects having a mass between 2 kg and 5 kg must be placed on a large metal support (e.g. a table) in such a way they are not moved or do not vibrate due to the impact. If necessary, couple the test objects to the support using couplant.

Minimum wall thicknesses

Similar problems are caused with test objects having small wall thicknesses. Wall, e.g. on tubes, may be excited to vibrations by the impact of the impact device, similar to the membrane of a drum. This usually results in the display of too low hardness values.

For this reason, we recommend minimum wall thicknesses of the test object of 20 mm for the rebound method.

For measurements below 20 mm, the UCI method should preferably be used, likewise supported by the Krautkramer MIC 20.

7.3 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. HL when using the rebound 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 aspects of conversion in measurements according to the UCI method

The conversion of hardness values into other scales that you can select on the instrument is alternatively carried out according to the standard specifications DIN 50 150 or ASTM E140. All restrictions regarding the conversion mentioned in these standards apply.

It is advisable to be especially cautious when using the Brinell scale. You can never use the UCI method to measure materials showing a very coarse microstructure (e.g. gray cast iron). However, these are the very materials requiring a Brinell test.

Special aspects of conversion in measurements according to the rebound method

The conversion of hardness values into other scales that you can select on the instrument is effected in the default setting according to the instrument-specific conversion tables. You can nevertheless also carry out a conversion according to DIN 50 150 or ASTM E140. All restrictions regarding the conversion mentioned in these standards apply.

Please keep in mind that the conversions according to DIN 50 150 and ASTM E140 (for Rockwell scales) only become effective for the material group ST (low-alloy/unalloyed steel). The instrument-specific conversion is used for other material groups after selecting DIN 50 150 or ASTM E140.

There are 9 material groups available in the MIC 20 from which you must first choose the one coming closest to your test material. After that, you should carry out a calibration of the instrument to your specific material for accurate measurements (ref. chapter 4.4).

Please observe with the steel material groups that the hardness values are less material-dependent in the lower hardness ranges (up to approx. 500 HL) than in the upper ranges. You should especially check the calibration of your instrument whenever hardness values above 500 HL are concerned.

You may gather the existing conversion possibilities for the individual material groups from the overview below. Due to the higher material-dependency, converted hardness values in the upper hardness ranges show considerably larger differences.

Ranges of validity of conversion tables

Range of measurement for the basic scale 150 ... 1000 HL

Impact device	Standard	Mat.	HV	HB	HRB	HRC	HS	N/mm ²
Dyna D	DIN	ST	80 – 1000	80 – 650	40 – 106	19 – 70	30 – 100	275 – 2200
	ASTM	ST	90 – 1000	90 – 560	52 – 102	19 – 70	30 – 100	300 – 2200
	Dyna	ST	75 – 1000	75 – 700	35 – 100	20 – 70	30 – 100	250 – 2200
		AST	75 – 1000			20 – 70		
	SST	75 – 1000	75 – 700	35 – 100	20 – 70			
	GCI			90 – 350				
	NCI			120 – 400				
	AL			20 – 180	10 – 85			
	BRS			40 – 180	10 – 95			
	BRZ			45 – 320				
CU			45 – 320					

Impact device	Standard	Mat.	HV	HB	HRB	HRC	HS	N/mm ²
Dyna E	DIN	ST	80 – 1000	80 – 650	40 – 100	19 – 70	35 – 100	250 – 2200
	ASTM	ST	95 – 1000	90 – 560	52 – 100	19 – 70	35 – 100	300 – 2200
	Dyna	ST	80 – 1000	80 – 700	40 – 100	20 – 70	35 – 100	250 – 2200
		AST	80 – 1000			20 – 70		

Impact device	Standard	Mat.	HV	HB	HRB	HRC	HS	N/mm ²
Dyna G	DIN	ST	85 – 650	80 – 650	45 – 103	20 – 60	30 – 85	275 – 2200
	ASTM	ST	95 – 650	90 – 560	52 – 100	20 – 56	30 – 85	300 – 2200
	Dyna	ST	75 – 650	75 – 700	45 – 100	20 – 60	30 – 85	250 – 2200
		GCI		90 – 350				
		NCI		100 – 380				

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 or impact device,
- 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 MIC 20 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.

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

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

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

Specifications **8**

Specifications

Basic instrument

Housing	Injection-molded plastics, ABS
Size (L × W × D)	approx. 215 × 180 × 78 mm (8.5" × 7.1" × 3.1")
Weight	approx. 1400 g (3.1 lb) (incl. battery pack)
Display	MIC 20: 14.5 cm (5.7") CSTN, 240 × 320 pixels, MIC 20 TFT: 14.5 cm (5.7") TFT, 240 × 320 pixels, backlight via integrated CFL tube
Keypad	Sealed keypad with integrated touch screen (4-wire technique)

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 45 323)

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. 4 hours 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

Ambient conditions

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)

Specifications

Evaluation

Methods of measurement	UCI method (Ultrasonic Contact Impedance) with Vickers diamond Rebound method, dynamic method of measurement with ratio of rebound (Rp) and impact (Ip) speed
Test load	Handheld probes or motor probes (test loads from 1 N (0.1 kgf) to 98 N (10 kgf)), Indenter: diamond pyramid according to Vickers, roof angle 136° Impact device Dyna D with spherical tungsten carbide tip dia. 3 mm, length 160.5 mm, 12 Nmm impact energy, for standard applications Impact device Dyna G with spherical tungsten carbide tip dia. 5 mm, length 265 mm, 90 Nmm impact energy, for solid test objects Impact device Dyna E with diamond test tip, length 165 mm, 12 Nmm impact energy, for the hardness range over 650 HV
Test materials	Metallic materials, cast materials
Measuring tolerances	Rebound method: ± 5 HL deviation of average from the reference value of the hardness reference plate with 3 to 5 measurements UCI method: ± 3.6 % deviation of average from the reference value of the hardness reference plate with 3 to 5 measurements using the test support MIC 222-A Larger deviations are possible with freehanded measurements. Note: The given tolerances apply for measurements at room 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 ² , with rebound method additionally HL and HS

Annex 9

9.1 EC Declaration of Conformity

The Krautkramer MIC 20 conforms to the requirements of the following EC directive:

- 89/336/EEC (electromagnetic compatibility) and

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 MIC 20 is manufactured by:

GE Inspection Technologies GmbH

Robert-Bosch-Straße 3
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Phone +49 (0) 22 33 - 601 111

Fax +49 (0) 22 33 - 601 402

The Krautkramer MIC 20 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:

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