Waygate Technologies

Krautkrämer USM 100

Operating Manual

Id. No. 160M4395 Rev. - (09/2021)

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1.0 (September 2021)

You will find the software version and the serial number of your instrument
in the **About** section (see page 104) in the **General Settings** menu (see page 99).

Overview

Command bar

	Switch between Command bar icons		Reset envelope curve
	Switch to the next panel		Select the **Gain Step** (see page)
	Switch to the previous panel		**Magnify Gate** (see page)
	A-scan freeze (**Freeze**, see page 66)		Pause data recording
	Set the echo to defined screen height (**AutoXX**, see page 66)		Continue data recording
	Calibrate (record echo)		Save reading in data grid
	Delete (e.g. reference or data grid)		Stop data recording

Command bar (continued)

 Quick save	 Export CSV file
 Load settings	 Save screen capture
 Save settings	 Save report
 Load data	 Save multiple page report
 Save data	 Lock the touchscreen operation

Function group icons

 **A-Scan**	 **Auto Calibration**
 **Material Probe**	 **Probe Angle**
 **Pulser Receiver**	 **Evaluation**
 **UT Setup**	 **Setup (Data Recorder)**
 **Gates**	 **Display (Data Recorder)**

An alphabetical list of all functions in the function groups can be found in the **UT Function directory** (see page 206).

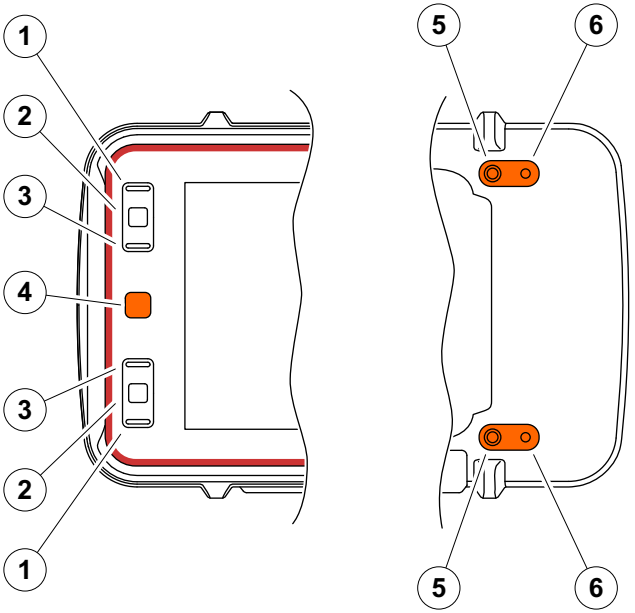
Status indicators

 Power level indicators (see following page)	 Reject function is active	 DAC mode = TCG is active
 Freeze active (Freeze), display is „frozen“	 AGT is active	 DGS reference echo has been recorded
 Magnify gate is active	 Angle probe 30° … 90°, flat surface, reflection from the backwall	 DGS reference echo has been recorded, transfer loss > 0
 Pulser-receiver separation is turned off	 Angle probe 30°, curved surface, reflection from the inner surface	 dB REF is active
 Pulser-receiver separation is turned on	 Angle probe 80°, curved surface, reflection from the outer surface	 Calibration reminder
 Pulser-receiver separation is turned on and set to through-transmission mode	 Angle probe 90°, surface wave	 Touchscreen operation is locked

Power level indicators

Internal	Second	
		Battery is charged, remaining operating time in hours (approx. value)
		Battery charge level, remaining operating time in hours (approx. value)
		Warning: Low battery charge
		Battery is empty
		Power adapter is connected, percentage of battery charge level (approx. value)

Key functions



1 Move up on a menu or list, decrement a numeric parameter

2 Select an item from a menu or list

3 Move down on a menu or list, increment a numeric parameter

4 Navigate between major areas of the screen to select items for action

5 On the back: Increase gain or move right

6 On the back: Decrease gain or move left

Note

Keys with the same numbers have the same functions when the instrument is inverted for right or left operation.

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Introduction 1

1.1 Safety information

The Krautkrämer USM 100 has been designed and tested according to IEC 61010-1, Safety requirements for electrical equipment for measurement, control and laboratory use, and was technically in perfectly safe and faultless condition when leaving the manufacturing works.

In order to maintain this condition and to ensure a safe operation, you should always read the following safety information carefully before putting the instrument into operation.

The USM 100 is designed to meet the ingress protection level IP67 per IEC 60529-1. It can be operated either with the corresponding lithium-ion batteries or with the power adapter. The power adapter meets the requirements of electrical safety class II.

ATTENTION

This product is not designed nor rated for use in hazardous locations.

ATTENTION

Risk of injury due to electric energy!

The pulse voltage on the probe ports of the USM 100 is exceeding 50 V but limited in charge.

Only operate the USM 100 in the defined operating ranges (see **Specifications** from page 219).

Only connect testing equipment conforming to the defined operating conditions (see **Connecting a probe** on page 51).

ATTENTION

The USM 100 is an instrument for materials testing. Any use for medical or any other applications is not permitted!

The instrument may only be used in industrial environments.

Battery operation

The USM 100 can be operated with the internal lithium-ion battery. The second, optionally usable lithium-ion battery extends the possible operating time and can be changed during operation (hot swapping).

ATTENTION

Only lithium-ion batteries recommended and supplied by Waygate Technologies may be used for instrument operation.

The internal battery may only be replaced by a factory trained service center. Opening the instrument case can cause severe damage and operational malfunctions.

You can charge the hot-swappable lithium-ion battery either within the instrument itself or in an external charger. If the lithium-ion battery is inserted, charging starts automatically as soon as you connect the power adapter to the instrument and to the mains power.

For power supply, please also see page 44.

For battery care, please also see from page 193.

Battery transport

Under IATA international battery transport regulations, lithium-ion battery only shipments are classified as dangerous goods shipments.

ATTENTION

Lithium batteries, identified as being defective for safety reasons, or that have been damaged, that have the potential of producing a dangerous evolution of heat, fire or short circuit are forbidden for transport by air.

For more information on transport and storage please see from page 193.

Software

According to the current state of the art, software is never completely free from errors. Before using any software-controlled test equipment, it is therefore necessary to make sure that the required functions operate perfectly in the intended combination.

If you have any questions about the use of your test equipment, please contact your nearest Waygate Technologies representative.

Defects/errors and exceptional stresses

If you have reason to believe that a safe operation of your USM 100 is no longer possible, you have to disconnect the instrument and secure it against unintentional re-connection. Remove the lithium-ion battery.

A safe operation is no longer possible for example

- if the instrument shows visible damages,
- if the instrument no longer operates perfectly,
- after prolonged storage under adverse conditions (e.g. exceptional temperatures or especially high air humidity, or corrosive environmental conditions),
- after being subjected to heavy stresses during transportation.

FCC compliance

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.

Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

1.2 Important information on ultrasonic testing

Please read the following information before using your USM 100. It is important that you understand and observe this information to avoid any operator errors that might lead to false test results. Such false test results could result in personal injuries or property damages.

Prerequisites for testing with ultrasonic test equipment

This operating manual contains essential information on how to operate your test equipment. In addition, there are a number of factors that affect the test results, but a description of all these factors goes beyond the scope of this operating manual. The three most important prerequisites for a safe and reliable ultrasonic inspection are:

- Operator training
- Technical test requirements and limits
- Choice of appropriate test equipment

Operator training

The operation of an ultrasonic test device requires proper training in ultrasonic test methods.

Proper training comprises for example adequate knowledge of:

- the theory of sound propagation,
- the effects of sound velocity in the test material,
- the behavior of the sound wave at interfaces between different materials,
- the propagation of the sound beam,
- the influence of sound attenuation in the test object and the influence of surface quality of the test object.

Lack of such knowledge could lead to false test results with unforeseeable consequences.

More specific information about operator training, qualification, certification, and test specifications is available from various technical societies, industry groups, and government agencies.

Technical test requirements

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

- the definition of the scope of inspection
- the choice of the appropriate test method
- the consideration of material properties
- the determination of limits for recording and evaluation.

It is the task of the those with overall responsibility for testing to ensure that the inspector is fully informed about these requirements. The best basis for such information is experience with identical test objects. It is also essential that the relevant test specifications be clearly and completely understood by the inspector.

Waygate Technologies regularly holds specialized training courses in the field of ultrasonic testing. The scheduled dates for these courses will be given to you on request.

Limits of testing

The information obtained from ultrasonic tests only refers to those parts of the test object which are covered by the sound beam of the probe used.

Any conclusions from the tested parts to be applied to the untested parts of the test object should be made with extreme caution.

Such conclusions are generally only possible in cases where extensive experience and proven methods of statistical data acquisition are available.

The sound beam can be completely reflected from boundary surfaces within the test object so that flaws and reflection points lying deeper remain undetected. It is therefore important to make sure that all areas to be tested in the test object are covered by the sound beam.

Ultrasonic wall thickness measurement

All ultrasonic wall thickness measurements are based on a time-of-flight measurement. Accurate measurement results require a constant sound velocity in the test object.

In test objects made of steel, even with varying alloying constituents, this condition is mostly fulfilled. The variation of sound velocity is so slight that it is only of importance for high-precision measurements.

In other materials, e.g. nonferrous metals or plastics, the sound velocity variations may be even larger and thus affect the measuring accuracy.

Effect of the test object material

If the material of the test object is not homogeneous, the sound waves may propagate at different velocities in different parts of the test object. An average sound velocity should then be taken into account for the range calibration. This is achieved by using a reference block with a sound velocity equal to the average sound velocity of the test object.

If substantial sound velocity variations are expected, then the instrument calibration should be adjusted to the actual sound velocity values at shorter time intervals. Failure to do so may lead to false thickness readings.

Effect of temperature variations

The sound velocity within the test object also varies as a function of the material's temperature. This can cause appreciable errors in measurements if the instrument has been calibrated on a cold reference block, whereas the measurement is carried out on a warm test object. Such measurement errors can be avoided either by adjusting the temperature of the reference block used for calibration or by taking the temperature effect into consideration on the basis of a correction factor obtained from published tables.

Measurement of remaining wall thickness

The measurement of the remaining wall thickness on plant components, e.g. pipes, tanks, and reaction vessels of all types which are corroded or eroded from the inside, requires a perfectly suitable gauge and special care in handling the probe.

The inspectors should always be informed about the corresponding nominal wall thicknesses and the likely amount of wall thickness losses.

Ultrasonic evaluation of flaws

In present-day test practice, there are basically two different methods of flaw evaluation:

If the diameter of the sound beam is smaller than the extent of the flaw, then the sound beam can be used to explore the boundaries of the flaw and thus determine its area.

If, however, the diameter of the sound beam is larger that the extent of the flaw, the maximum echo indication from the flaw must be compared with the maximum echo indication from an artificial flaw provided for comparison purposes.

Flaw boundary method

The smaller the diameter of the probe‘s sound beam, the more accurately the boundaries, i.e. the actual flaw area, can be determined by the flaw boundary method. If, however, the sound beam is relatively broad, the flaw area determined can substantially differ from the actual flaw area. Care should therefore be taken to select a probe which will give a sufficiently narrow sound beam at the position of the flaw.

Echo display comparison method

The echo from a small, natural flaw is usually smaller than the echo from an artificial comparison flaw, e.g. circular disc flaw of the same size. This is due, for instance, to the roughness of the surface of a natural flaw, or to the fact that the sound beam does not impinge on it at right angles.

If this fact is not taken into account when evaluating natural flaws, there is a risk of false evaluation.

In the case of very jagged or fissured flaws, e.g. shrink holes in castings, it may be that the sound scattering occurring at the boundary surface of the flaw is so strong that no echo at all is produced. In such cases, a different evaluation method should be chosen, e.g. use of the backwall echo attenuation in the evaluation.

The distance sensitivity of the flaw echo plays an important part when testing large components. Pay close attention to choosing artificial comparison flaws which are as far as possible governed by the same "distance laws" as the natural flaws to be evaluated.

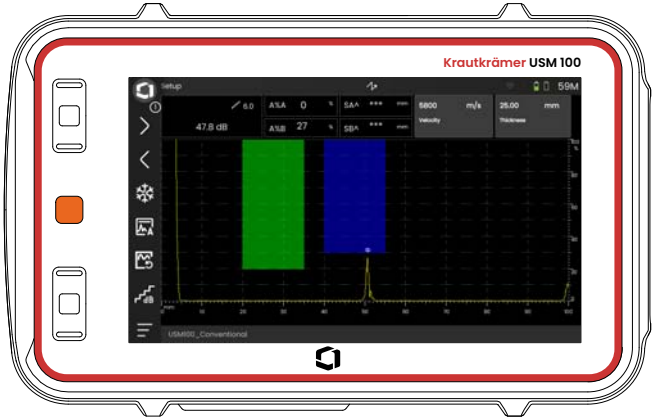
The ultrasonic wave is attenuated in any material. This sound attenuation is very low, e.g. in parts made of fine-grained steel, likewise in many small parts made of other materials. However, if the sound wave travels larger distances through the material, a high cumulative sound attenuation can result, even with small attenuation coefficients. There is then a danger that echoes from natural flaws appear too small. For this reason, an estimate must always be made of the effects of attenuation on the evaluation result and taken into account if applicable.

If the test object has a rough surface, part of the incident sound energy will be scattered at its surface and is not available for the test. The larger this initial scattering, the smaller the flaw echoes appear, and the more errors occur in the evaluation result.

It is therefore important to take the effect of the test object's surfaces on the height of the echo into account (transfer correction).

1.3 The Krautkrämer USM 100

Due to its design, the Krautkrämer USM 100 can be used in most flaw detection applications in a wide range of industries, including aerospace, power generation, automotive, as well as oil and gas.



General features

- Truly ambidextrous flip function
- 7 inch color LCD display 1,024 x 600 pixels
- Operation with touchscreen and keypad
- Weighs less than 1.2 kg with batteries
- Two Lemo 00 probe connectors
- USB ports type A (1) and type C (1)
- HDMI/VGA/Ethernet/SD card support through USB C
- Hot swappable batteries
- IP67
- 1 x alarm / analog / trigger out

USM 100 Standard

- Selectable 10 to 2,000 Hz pulse repetition rate
- Square-wave pulser, 50 to 350 volts, tunable 40 to 2,500 ns pulse width
- 2 independent flaw monitor gates
- Guided auto calibration of material velocity
- Probe delay and probe angle
- Trigonometric calculations with curvature correction for weld inspection
- Color coded data logger, 10,000 points including A-scan
- Evaluation modes: Dynamic DAC/TCG, AWS D1.1/ D1.5, dB Ref, DGS, JISDAC, CNDAC
- 200 % amplitude range for gate measurement
- Configurable sidebar for placement of critical parameters
- Alphanumeric on-screen keyboard for file naming
- Support for up to 3 on-device apps at a time
- Software Mentor PC for PC based analysis and file management
- Software Mentor Create for creating and editing customized on-device apps

USM 100 Pro

- Selectable 10 to 2,000 Hz pulse repetition rate
- Square-wave pulser, 50 to 350 volts, tunable 40 to 2,500 ns pulse width
- 2 independent flaw monitor gates
- Guided auto calibration of material velocity
- Probe delay and probe angle
- Trigonometric calculations with curvature correction for weld inspection
- Color coded data logger, 10,000 points including A-scan
- Evaluation modes: Dynamic DAC/TCG, AWS D1.1/ D1.5, dB Ref, DGS, JISDAC, CNDAC
- 400 % amplitude range for gate measurement
- Configurable sidebar for placement of critical parameters
- Alphanumeric on-screen keyboard for file naming
- Support for unlimited on-device apps at a time
- 3rd gate, can be used either as gate C or IF gate
- Customizable filter
- Waveform averaging
- Software Mentor PC for PC based analysis and file management
- Software Mentor Create for creating and editing customized on-device apps
- IOS app to enrich UT data with pictures and geo location of test object for end to end traceability
- Software Mentor PC live for tablet based inspection

USM 100 Digital

- Selectable 10 to 2,000 Hz pulse repetition rate
- Square-wave pulser, 50 to 350 volts, tunable 40 to 2,500 ns pulse width
- 2 independent flaw monitor gates
- Guided auto calibration of material velocity
- Probe zero and probe angle
- Trigonometric calculations with curvature correction for weld inspection
- Color coded data logger, 10,000 points including A-scan
- Evaluation modes: Dynamic DAC/TCG, AWS D1.1/ D1.5, dB Ref, DGS, JISDAC, CNDAC
- 400 % amplitude range for gate measurement
- Configurable sidebar for placement of critical parameters
- Alphanumeric on-screen keyboard for file naming
- Support for unlimited on-device apps at a time
- 3rd gate, can be used either as gate C or IF gate
- Customizable filter
- Waveform averaging
- Software Mentor PC for PC based analysis and file management
- Software Mentor Create for creating/editing customized on device Apps
- IOS App to enrich UT data with pictures and geolocation of test object for end to end traceability.
- Mentor PC live for tablet based inspection
- Digital Package 15 months subscription (optional paid renewal apply after expiration): data availability, fleet management, private store, remote collaboration

1.4 How to use this manual

General

This operating manual applies to all instrument versions of the USM 100. Any differences in the functions or adjustment values are marked in each case.

Before operating the instrument for the first time, it is absolutely necessary that you read the chapters 1, 3, and 4. They will inform you about the necessary preparations of the instrument, give you a description of all keys and displays, and explain the operating principle.

In doing this, you will avoid any errors or failures of the instrument and be able to use the full range of instrument functions.

To find information on a specific function, it is best to search the **Index** at the end of these operating instructions (see page 225).

The specifications of the instrument can be found in the **Specifications** chapter (see page 219).

Attention and note symbols

ATTENTION

The **ATTENTION** symbol indicates peculiarities and special aspects in the operation which could affect the accuracy of the results.

Note

Note contains e.g. references to other chapters or special recommendations for a function.

Standard package and accessories 2

2.1 Standard packages

Part No.	Short code	Description
150M5734	USM 100 Standard Instrument	USM 100 Standard Instrument Package
150M5734C	USM 100 Standard Instrument with CERT	Same as 150M5734 with ISO Certificate
150M5735	USM 100 Pro Instrument	USM 100 Pro Instrument Package
150M5735C	USM 100 Pro Instrument with CERT	Same as 150M5735 with ISO Certificate
150M5736	USM 100 Digital Instrument	USM 100 Pro Digital Package
150M5736C	USM 100 Digital Instrument with CERT	Same as 150M5736 with ISO Certificate

2.2 Accessories

Part No.	Short code	Description
	USM 100 Standard accessories	AC adapter/charger, 1 x Li-ion internal battery, 2 x lithium-ion removable battery, external battery charger, transport case, wrist strap, shoulder strap, USB C dock, Quick Start Guide, Operating Manual on USB flash drive. Certificate Of Conformity. DOES NOT INCLUDE power cord. Power cord needs to be ordered separately.
	USM 100 Pro accessories	AC adapter/charger, 1 x Li-ion internal battery, 2 x lithium-ion removable battery, external battery charger, transport case, wrist strap, shoulder strap, USB C dock, Quick Start Guide, Operating Manual on USB flash drive. Certificate Of Conformity. DOES NOT INCLUDE power cord. Power cord needs to be ordered separately.

Part No.	Short code	Description
	USM 100 Digital accessories	AC adapter/charger, 1 x Li-ion internal battery, 2 x lithium-ion removable battery, external battery charger, transport case, wrist strap, shoulder strap, USB C dock, Quick Start Guide, Operating Manual on USB flash drive. Certificate Of Conformity. DOES NOT INCLUDE power cord. Power cord needs to be ordered separately.
148M5839	USM 100 SW OPT, Pro	Upgrade USM 100 Standard to USM 100 Pro
148M5840	USM 100 SW OPT, Digital	USM 100 InspectionWorks subscription, 1 year
0102985	POWER CABLE 250V 6A 3X1,0 1,50M lg - (EU)	Power cord with EU type mains plug
0102986	NETZKABEL-US IEC/3 125V 6A 3X1 1,50m lg - (NA)	Power cord with US type mains plug
148M5844	WiFi & BT USB Dongle for EU/AU	WiFi & Bluetooth adapter for USM 100
152M6576	USB Stick Pulling Tool	Mini USB stick easy removal tool

Part No.	Short code	Description
151M4757	Cable extension for USBC Docking Station	Cable extension for USB-C docking station
148M5852	Magnetic pipe stand	Magnetic pipe stand
151M4758	USM 100 Adapter Cable for MUT-ODI-SINGLEPROB	USM 100 adapter cable for mini quadrature encoder
MUT-ODI-SINGLEPROB	Mentor UT Scanner in Confined Spaces	Mini quadrature encoder
0029017	Couplant	Couplant
159M0219	I/O open end cable	I/O cable (14-pin Lemo to open end)
148M5830	Wrist Strap for USM 100	Wrist strap for USM 100
144M4780	BATTERY_ NB2037QE34	USM 100 battery
148M5842	External Battery charger	USM 100 external battery charger, charges up to one battery at a time
147M3919	Power supply w/LEMO conn for USM 100	AC adapter/charger for USM 100

Part No.	Short code	Description
148M5829	USM 100 Transport case	USM 100 transport case
148M5843	USB Type-C Adapter Docking Hub	USB-C dock for connecting to external monitor through VGA/HDMI, SD card/USB & Ethernet
148M5831	Shoulder Strap	2-point shoulder strap
159M0234	Anti-Reflection Screen Protector	Screen protector for USM 100
022-505-604	PTPA--CBL MD-00LEMO RA 6'	Right angle Lemo #00 to Microdot cable
022-509-819	CABLE,LEMO-00 RT ANG/LEMO-00	Right angle Lemo #00 to Lemo #00 cable
022-509-820	CABLE,LEMO-00 RT ANG/LEMO-1	Right angle Lemo #00 to Lemo #1 cable
022-509-821	CABLE,LEMO-00 RT ANG/KBA 533	Right angle Lemo #00 to dual Lemo #00 (KBA 533)
022-509-822	CABLE,LEMO-00 RT ANG/BNC	Right angle Lemo #00 to BNC
081-018-700	PFA	BNC-Lemo 00 adapters (qty of 2 recommended)
022-509-749	CABLE,00 LEMO-BNC,6"OAL,SINGLE	6 inch right angle Lemo #00 to BNC adapter cable

Part No.	Short code	Description
022-506-187	PART--CBL 6" DU 00LM-FBNC	Dual Lemo #00 to BNC (female) adapter
291-556-200	CBL DU 6.25' MLMD-MLRA00LEMO	Dual right angle Lemo #00 to Microdot cable
0110084	KABEL,SEKG 2-GO 2 M STECKER OO - 1	Probe cable: 2 Lemo 00-90° / TR plug
0112730	CABLE	Probe cable: 2 Lemo 00-90° / Subvis twin
0112745	CABLE LEMO 00 R SINGLE 0540339	Probe cable: Lemo 00-90° / Subvis
0058160	CTPA--CL331	Probe cable: Lemo-00 / Microdot
0058791	PROBE CABLE,MPKLL 2	Probe cable: Lemo 00 / Lemo 00
0050486	SFPA--MPKL 2	Probe cable: Lemo 00 / Lemo 1
0054999	CTPA--DA 233	Probe cable: 1.5 m long, for DA 311, DA 411, DA 461
0066893	Cable - 2 M cable length BIS 2M	Probe cable: BNC / Lemo 00
021-999-100	SCHOL-UT-L1-L	Ultrasonic Testing Level I

Part No.	Short code	Description
021-999-101	SCHOL-UT-L2-L	Ultrasonic Testing Level II
021-999-196	UT Levels I &II-Practical Training (E)	UT Levels I & II, Practical Training, a supplement to eLearning
021-999-245	Ultrasonic Testing Level I	Ultrasonic Testing Level I
021-999-023	Ultrasonic Testing Level II eLearning	Ultrasonic Testing Level II

Initial start-up 3

3.1 Instrument positioning

Fold out the prop-up stand on the rear side of the USM 100 and position the instrument on a flat base so that you can easily read the display.

If the instrument has been moved from a cold room into a warmer one, wait until it has adapted to the room temperature before you power it on (to avoid condensation).

3.2 Power supply

The USM 100 can be operated either with the external power adapter or with one (internal) or two (internal and second) lithium-ion batteries.

You can also connect the USM 100 to the mains power supply if the second battery is in the instrument. Discharged batteries (internal and second) are charged in this case, during the instrument operation.

Operation with power adapter

Connection to power adapter

ATTENTION

The power adapter is approved for indoor use only.

You should only use the power adapter included in the standard package.

The power adapter is automatically adjusted to every AC voltage between 100 V and 240 V (nominal).

Connecting the instrument

Connect the USM 100 to the mains socket-outlet by means of the corresponding power adapter. The socket-contact for connecting the power adapter is located on the right side of the instrument.

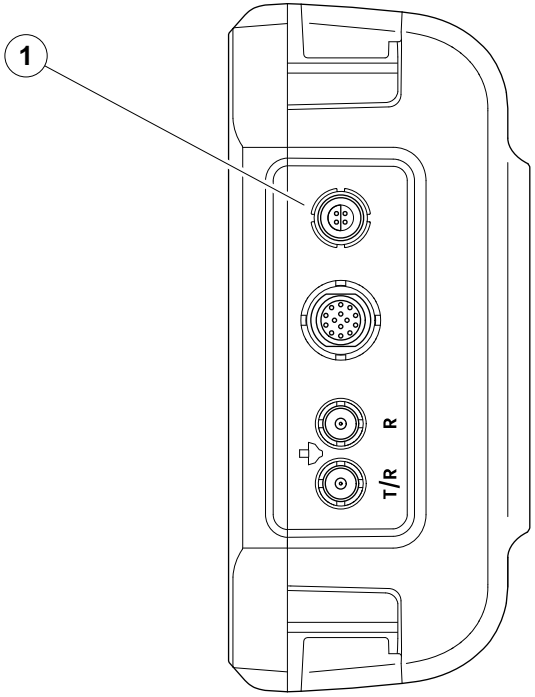
– Align the Lemo plug of the power adapter with the socket (1).

– Push the plug into the socket until it locks into place with a clearly audible click.

– When removing the Lemo plug, pull the metal sleeve on the plug back first in order to open the lock.

ATTENTION

In order to power the instrument off correctly, always use the **Shutdown** function (see page 55). If the power supply is interrupted (pulling out the mains plug while the batteries are completely discharged), the operation does not end correctly.



Using the batteries

The USM 100 has a built-in battery and can be operated with a second, optionally usable lithium-ion battery in order to extend the possible battery operating time. The second battery can be changed during operation (hot swapping).

ATTENTION

Only lithium-ion batteries recommended and supplied by Waygate Technologies may be used for instrument operation.

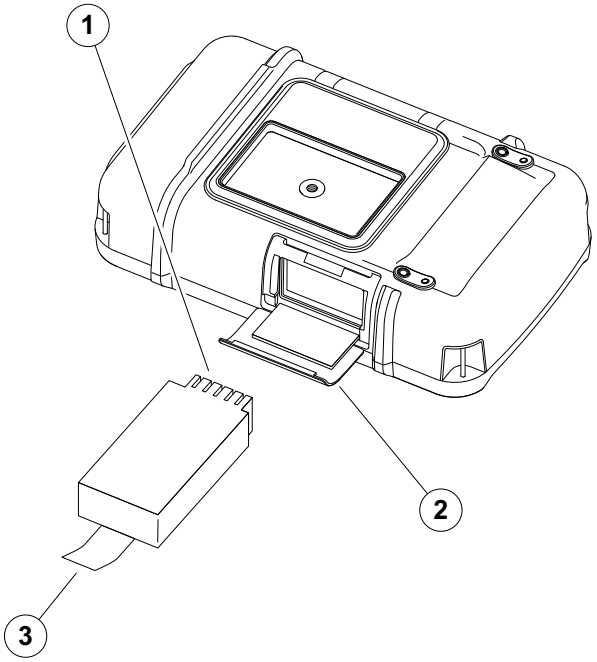
Changing the battery

The battery compartment is located on the bottom of the instrument.

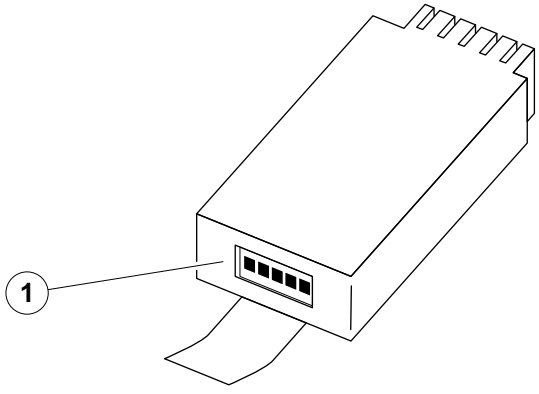
– Slide the cover (2) of the battery compartment towards the rear of the instrument all the way open.

– Align the battery so that the contacts (1) are facing the back of the instrument.

– Push the battery with the contacts first into the battery compartment until you feel the contacts snap into place at the end.



– Flip up the battery compartment cover and slide it back to its original position until it is firmly closed.
– To remove the battery, open the battery compartment as described above and carefully pull the battery out by the tab (3).



Checking the charge level of the lithium-ion battery

The lithium-ion battery is provided with a battery charge level indicator. Five squares (1) indicate the level of battery charge.

You can check the battery charge level before inserting it into the instrument. If one led is flashing, the charge level is less than 10 %.

Power level indicators

Two power level indicators on the screen allow to estimate the remaining operating time of the instrument.

The left battery symbol (1) represents the internal battery, the right symbol (2) the hot-swappable second battery.

The USM 100 is automatically powered off if the operation is no longer ensured.

ATTENTION

If the battery charge is low, immediately connect the power adapter or switch off the device. Otherwise, the instrument will turn off automatically because of low power. All data and settings will be saved.

Internal	Second	
		Battery is charged, remaining operating time in hours (approx. value)
		Battery charge level, remaining operating time in hours (approx. value)
		Warning: Low battery charge
		Battery is empty
		Power adapter is connected, percentage of battery charge level (approx. value)

Charging the batteries

The internal battery is always charged automatically as soon as you connect the power adapter to the instrument and to the mains power.

You can charge the hot-swappable lithium-ion battery either within the instrument itself or in an external charger. If the lithium-ion battery is inserted, charging starts automatically as soon as you connect the power adapter to the instrument and to the mains power.

Internal charging

Charging starts automatically as soon as you connect the power adapter to the USM 100 and to the mains power supply. You can carry out ultrasonic tests and charge the batteries at the same time.

The charging time is approx. ten hours with simultaneous ultrasonic testing. If the instrument is not used for ultrasonic testing, the charging time is approx. eight hours. This charging time applies to ambient temperatures of 25 … 30 °C.

Charging status

All battery charge controls and status updates are internal to the USM 100. Updates are given at the upper right corner of the display as described on the previous page.

The power adapter is a simple power supply with no charging controls or intelligence.

External charging

ATTENTION

Only chargers recommended and supplied by Waygate Technologies may be used for instrument operation.

Do not use any other chargers for charging the lithium-ion batteries for the USM 100.

3.3 Connecting a probe

To prepare the USM 100 for operation, you have to connect a probe to it. Any Waygate Technologies probe can be used for the USM 100, provided the appropriate cable is available and the operating frequency is within an adequate range.

ATTENTION

If a probe is connected incorrectly, the consequence would be a mismatching which may lead to considerable power losses or even to echo waveform distortions.

The probe is connected to the sockets on the right side of the instrument.

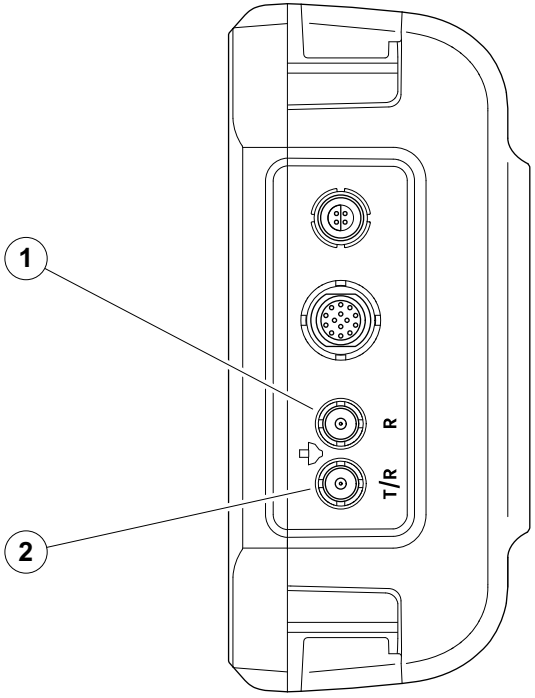
Connect a single element probe with the **T/R** socket (2).

Connect a dual element probe (having one transmitter or pulser element and one receiver element) or two probes (of which one is transmitting and the other one receiving) with the **T/R** socket (2) and the **R** socket (1).

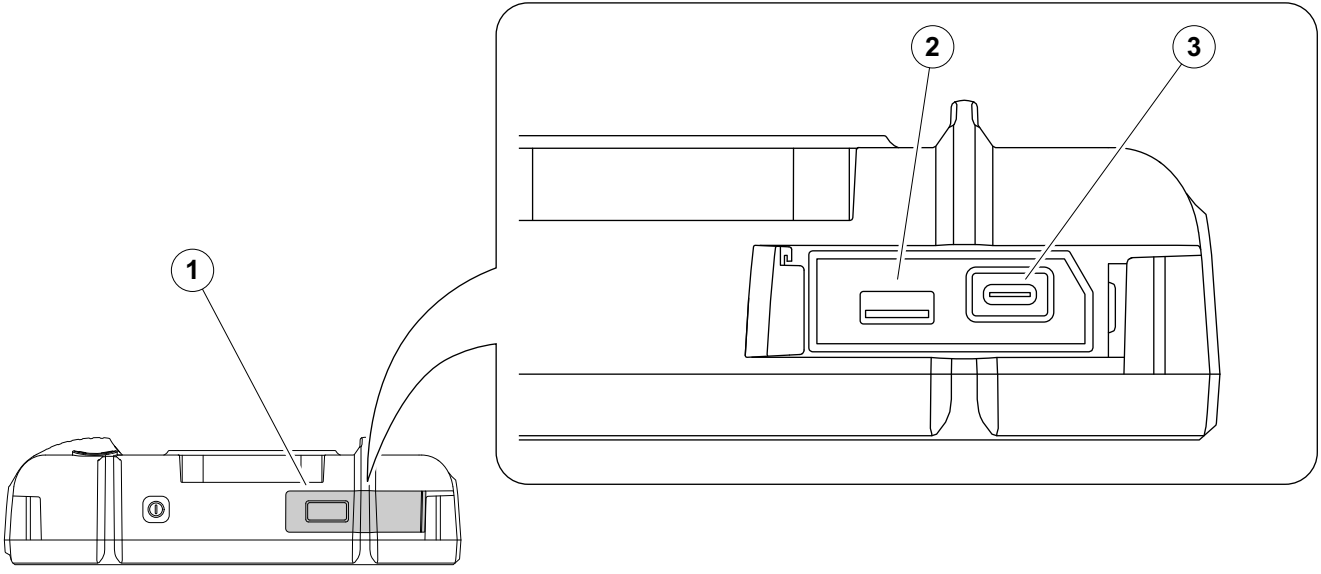
Observe the correct assignment of the cables:

R (black ring) – receiver connection (1)

T/R (red ring) – transmitter/receiver connection (2)



3.4 Inserting a USB stick

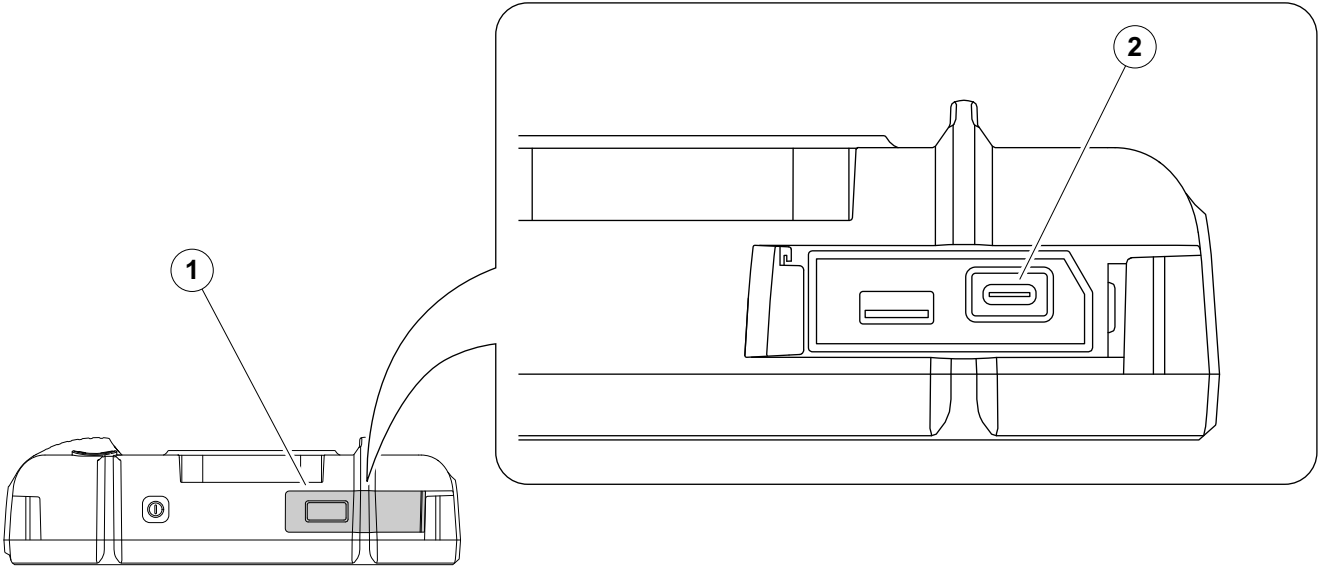


You can use any USB stick for data transfer to and from the USM 100.

– Slide the lid (1) on the top of the instrument to the right side until it swings open upwards.

– Insert the USB stick into the socket matching the type: USB-A (2) or USB-C (3).

3.5 Other connections



You can use a USB-C docking hub to connect the USM 100 to the LAN network and connect other peripherals (monitor, mouse, keyboard) to the instrument. For more information on interfaces see from page 200.

– Slide the lid (1) on the top of the instrument to the right side until it swings open upwards.
– Insert the USB-C plug of the docking hub into the socket (2).

3.6 Starting the USM 100

Powering On

The Power key (1) is located on the top of the instrument.

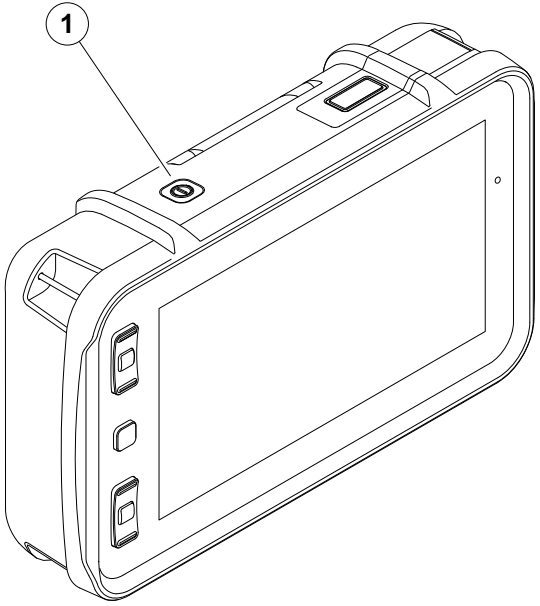
– Press the Power key for two seconds.

The software is initialized, the instrument carries out a self-check and then switches over to stand-by mode.

In the factory setting, after switching on the instrument and system boot-up, you will see the **Application desktop** (see page 61) with all applications stored in the instrument and available for selection.

Depending on the settings (see **Startup Application**, page 101), the **A-scan view** (see page 65) can be displayed alternatively. In this case, the application selected as the default is already loaded.

In case the instrument can not be started in the normal way, you can reset or reinitialize the operating system with a software update (see page 197).



Powering Off

ATTENTION

In order to power the instrument off correctly, always use the **Shutdown** function. If the power supply is interrupted (pulling out the mains plug while the batteries are completely discharged), the operation does not end correctly.

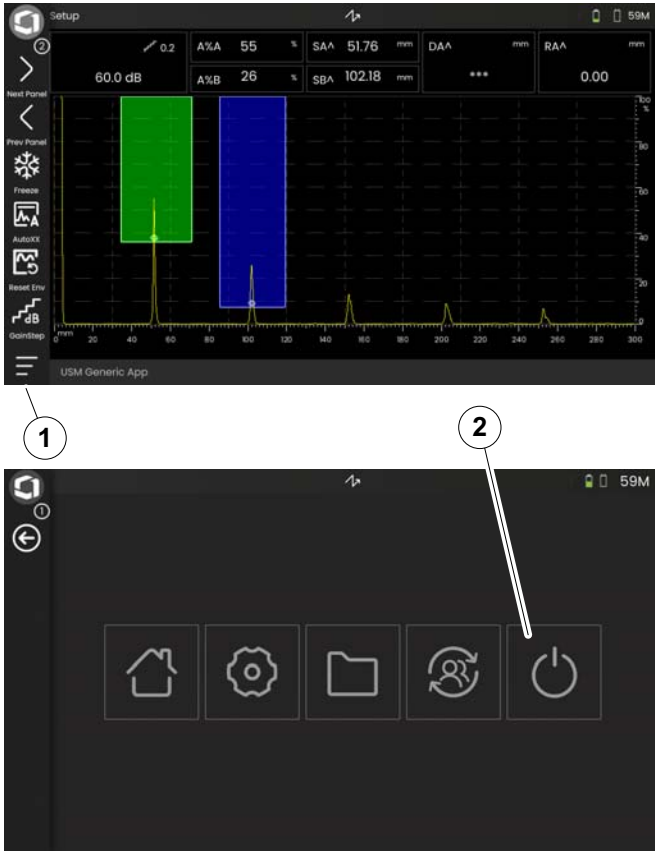
The settings of all function values and the default settings (language and units) are retained after powering off.

– Select the **Main Menu** (1).

– Tap on the **Shutdown** button (2).

The system is shut down and the instrument is switched off.

Alternatively, you can press the Power key on the top of the instrument (see page 54) for 3 seconds until the shutdown process starts. A shutdown message is shown.



3.7 Remote Connection Setup

The USM 100 supports Virtual Network Computing (VNC).

The VNC client displays the screen contents of a remote device on a local computer (client) and in return sends keyboard and mouse movements of the local computer to the remote device.

Prerequisites

- Computer with installed VNC client
- USB-C hub with RJ45 connector
- Network cable

VNC Client

To view and control the instrument‘s screen remotely you must have a VNC client installed on your computer.

As VNC is a standard protocol, any client application which supports VNC protocol can be used to remotely control the USM 100. The recommendation is to use RealVNC or TightVNC.

You can download the software from the respective site and install it on your computer:

https://realvnc.com/en/connect/download/viewer

https://tightvnc.com/download.php

After downloading, follow the respective installation instructions.

Network connection

The USM 100 does not have a native RJ45 connector for network connection.

You can connect a USB-C docking hub with network interface to the USM 100 and connect the hub to the network via its RJ45 connector (see page 53).

The computer with installed VNC client must be connected to the same network.

Settings in the USM 100

An overview of the remote connection settings can be found from page 104.

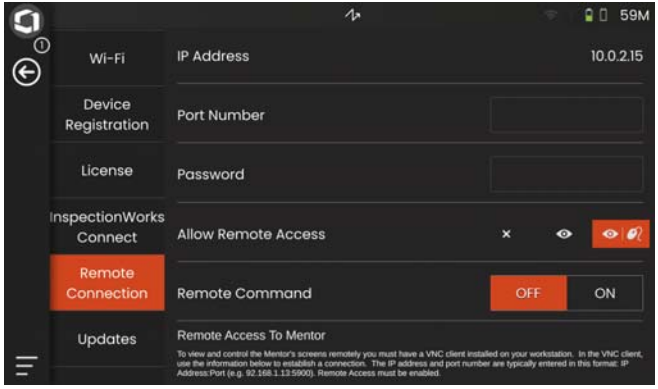
– Tap the **Main Menu** icon (see page 65) to display the **Main Menu** (see page 60).

– Tap on the **General settings** button.

– Select the section **Remote Connection**.

– Tap the icon on the far right (eye/mouse) to allow full remote access.

– If you only want to allow the screen display of the USM 100 on the computer, but no remote control, then tap the icon in the middle (eye).



Establishing the remote connection

– Check that the USB-C hub is correctly connected to the USM 100.

– Check that the computer and the USB-C hub are connected to the same network.

– Check that the remote control is enabled in the USM 100 (see page 57).

– Launch the VNC client, for example the **RealVNC viewer**.

– Enter the IP address of the USM 100 in the address field and press the Enter key.

The connection is established and after a short time you will see the screen of the USM 100 on the monitor of the computer.

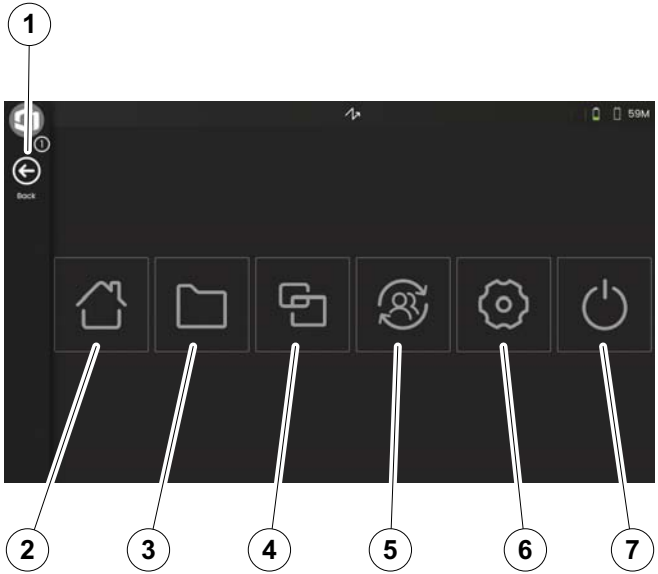
If an encryption warning message is shown on the screen, click the **Continue** button.

If there is a problem with the connection, check the website of the VNC client you are using for possible causes and suggested solutions.

Principles of operation 4

4.1 Main menu

In the **Main menu** you will find the basic settings and functions for working with the USM 100.



1 Return to the **A-scan view**

2 **Application desktop** (see page 61)

3 **File management** (see page 187)

4 Mentor server connection,
only visible if no Application is launched

5 **InspectionWorks Connect**

6 **General settings** (see page 99)

7 Shutdown (see page 55)

4.2 Application desktop

Applications contain a variety of UT data display capabilities, guides and illustration as well as text references.

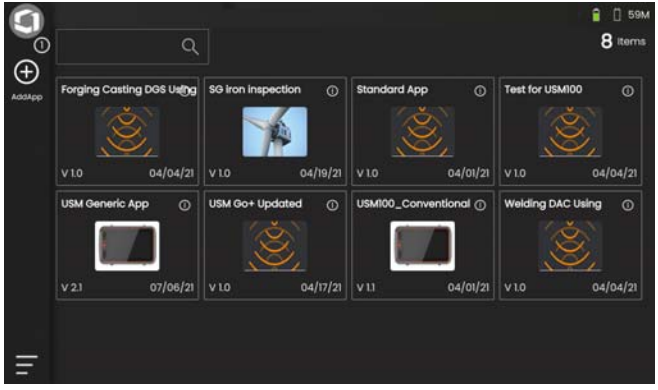
An application's architect determines its specific contents, the inspection parameters displayed, which parameters are adjustable by the user, and to within what range of values a particular parameter can be set.

Applications include one or more panels.

In the factory setting, after switching on the instrument and system boot-up, you will see the **Application desktop** with all applications stored in the instrument and available for selection.

Depending on the settings (see **Startup Application**, page 101), the **A-scan view** (see page 65) can be displayed alternatively. In this case, the application selected as the default is already loaded.

You can always access the **Application desktop** via the **Main menu** (see page 60).



Note

The **Startup Application** function allows you to select an application that will be automatically launched with the last used settings when the instrument is started (see page 101).

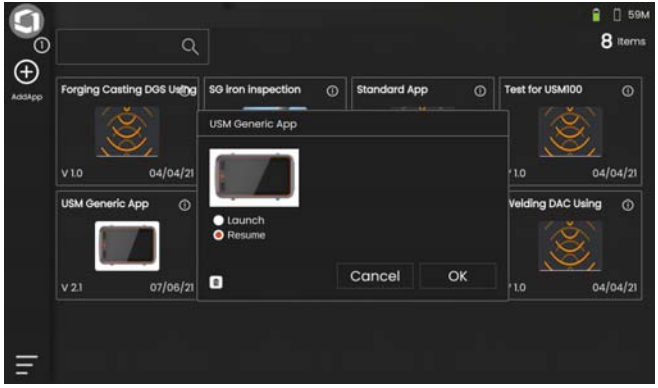
Launching an application

You can launch any application saved in the instrument. You can choose whether the application should be used with its basic settings or whether the last used settings should be applied.

A number of circles at the bottom of the screen indicate how many additional pages are viewable. An open circle indicates the position of the current view in relation to all available pages.

Note

The **Startup Application** function allows you to select an application that will be automatically launched with the last used settings when the instrument is started (see page 101).



– If necessary, swipe the screen to view more applications.
– Tap on the icon in the upper right corner of an application box to display a short description.
– Select **Launch** if you want to use the application with its basic settings

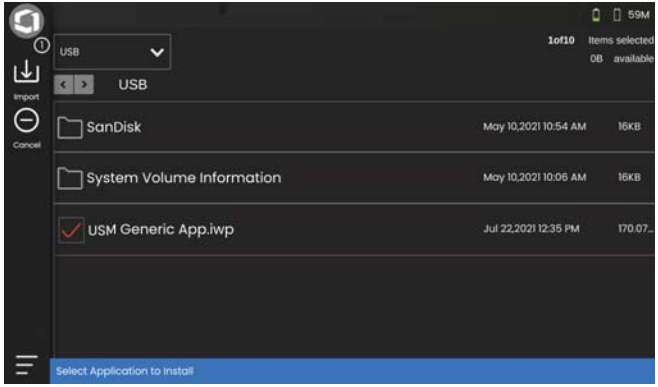
  or

  select **Resume** if you want to use the application with its last used settings.
– Tap **OK** to launch the Application. After a short time you will see the **A-scan view** (see page 65).

Installing new applications

If a new application is available, you can save it in the instrument and then launch it. Application files have the extension **iwp**.

– Insert a USB stick with one or more application files into the socket on the top of the instrument (see page 52).
– Tap on the **Plus** icon (+) in the upper left corner of the **Application desktop**. A dialog window opens.
– Tap in the field in the upper left corner and select the storage location **USB**.
– Tap on a folder symbol to select the directory.
– Tap on a filename to select the file.
– Tap on the **Import** icon in the upper left corner to copy the selected application file to the instrument.



Deleting applications

You can delete applications that are no longer needed.

Note

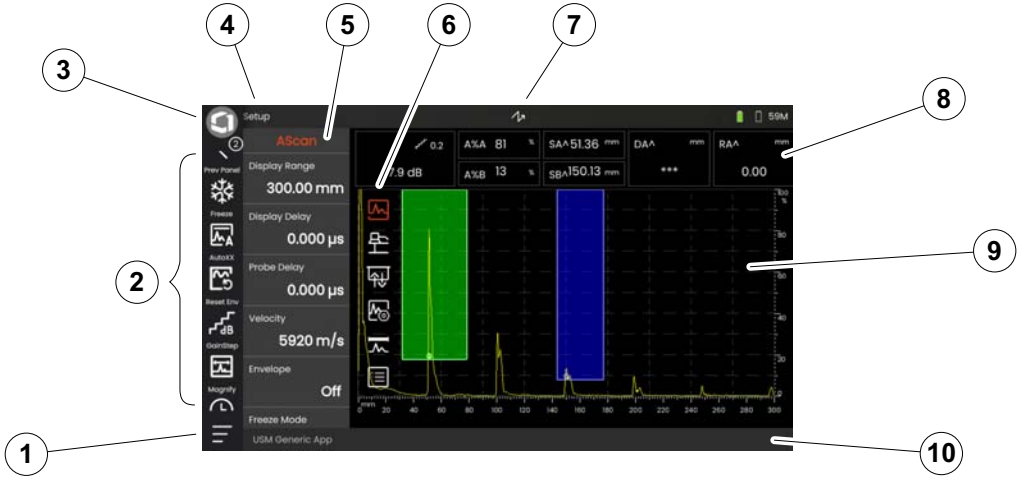
Before deleting, you can back up the applications to a USB stick (see page 188). The deletion can not be undone.

– Tap on the icon in the upper right corner of an application box to display a short description.

– Tap on the trash can icon in the lower left corner. A warning message is displayed.

– Select **Delete** to permanently delete the application from the instrument.

4.3 A-scan view



1 **Main menu** (see page 60)

2 **Command bar** (see page 66)

3 Switching Command bar icons (see page 78)

4 **Panel selector** (see page 72)

5 **Function groups and functions** (see page 73)

6 **UT function groups** icons (see page 106)

7 **Status indicators** (see page 75)

8 **Measurement line** (see page 76)

9 **A-scan representation** (see page 70)

10 **Information line** (see page 77)

Command bar

The Command bar gives you a quick and direct access to frequently used functions, regardless of the specific type of task.

Freeze

You can freeze the A-scan, for example for measurements on hot test objects, for measurements in difficult coupling conditions, or for spot weld testing.

When the A-scan is frozen, the icon is colored and a corresponding status indicator is displayed above the A-scan (see page 6 at the beginning of the operating manual).

You can define the **Freeze Mode** (see page 111).

AutoXX

You can automatically set the first echo to a certain screen height. This function is useful, for example, when recording DAC curve points.

You can define the screen height (default = 80%) for the echo amplitude (**Auto XX Amplitude**, see page 108).

Calibrate

During calibration this function is used to record the backwall echoes from the calibration block.

Clear

You can deleted the calibrated data including the probe delay, velocity, probe angle, and x-value.

This function can also be used to delete a recorded evaluation reference value or curve.

Envelope

With this function you can reset the envelope curve.

Gain Step

You can change the step size for quick gain adjustment using the keys on the back of the instrument. The first steps are fixed, the last step can be set individually with the function **Custom Gain Step** (see page 108).

Magnify Gate

This function causes the selected gate to span over the entire displayed range. You can select the gate for this function (see page 125).

Data Recorder

With these functions you can save data to the data grid and pause, continue and stop the **Data Recorder** (see from page 181).

Quick save

You can save data, settings, and a screen capture together. Quick save data are saved in the default directory.

Load settings

You can load and use instrument settings saved in a file. The instrument settings are immediately active after loading (see page 98).

Save settings

You can save the current instrument settings to a file in the device memory or on an inserted USB stick (see page 97).

Load data

You can load UT settings and data together. The A-scan will be redrawn on the screen.

Save data

You can save UT settings and data together.

Screen capture

You can save an image of the entire screen. Screen captures are saved in the default directory. The file name is generated automatically and consists of the name of the current application, the date and the time, for example USM100_Standard_2021-03-02_16.09.49.

Save report

You can save a single test report. A test report can contain different information and data, as well as screen captures. Test reports are saved in the default directory.

Save multiple page report

You can save a multiple page test report. Multiple page test reports are saved in the default directory.

Lock

You can lock the touchscreen to prevent unintended operation. When the lock is active, the icon is colored and a corresponding status indicator is displayed above the A-scan (see page 6 at the beginning of the operating manual).

When locked, this icon is the only function where touchscreen actions are recognized.

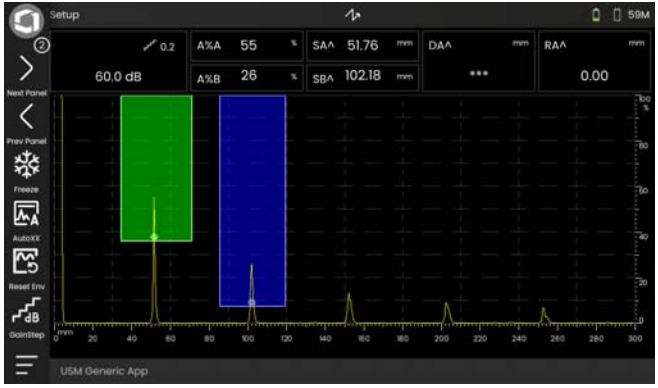
A-scan representation

The USM 100 has a high-resolution display screen for the display of the A-scan. The A-scan can be displayed in normal mode or in zoom mode.

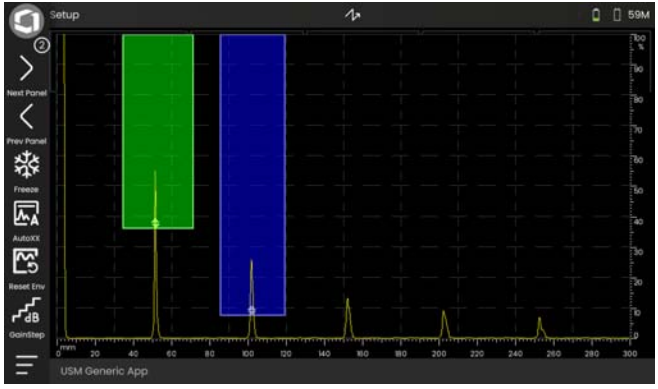
In the zoom mode, the measurement line is not visible. The gain can then only be adjusted with the keys on the back of the instrument, not with the function at the top left of the screen.

To toggle between the normal and the zoomed A-scan display, double-tap in the A-scan.

A-scan display in the normal mode:



A-scan display in the zoom mode:



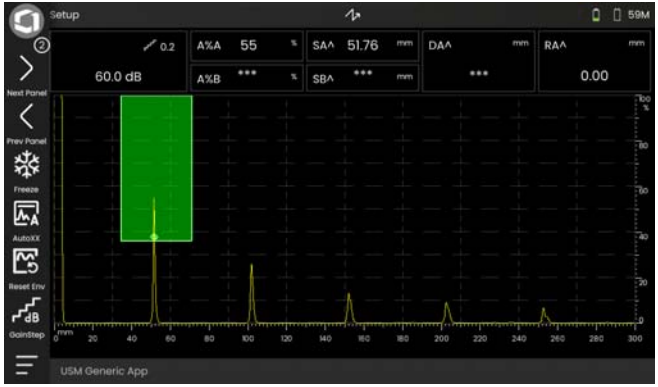
Gates

The gates are displayed as colored areas in the A-scan.

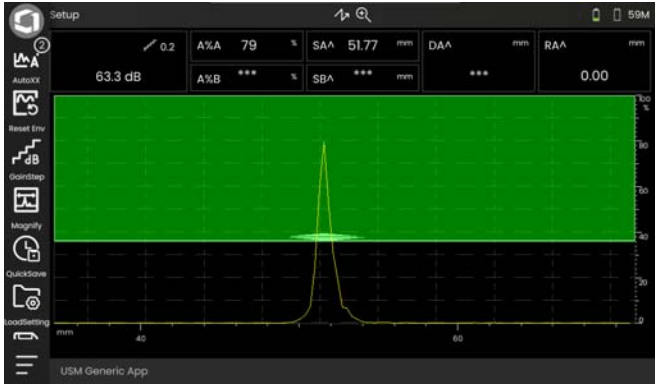
With the function **Magnify gate** (see page 67) in the Command bar you can span a selected gate over the entire displayed range.

You can select the gate for this function (see page 125).

Gate display in the normal mode:



Gate display in the **Magnify gate** mode:



Panel selector

Applications (see page 61) include one or more panels containing, among others, a variety of UT data display capabilities, guides, and references.

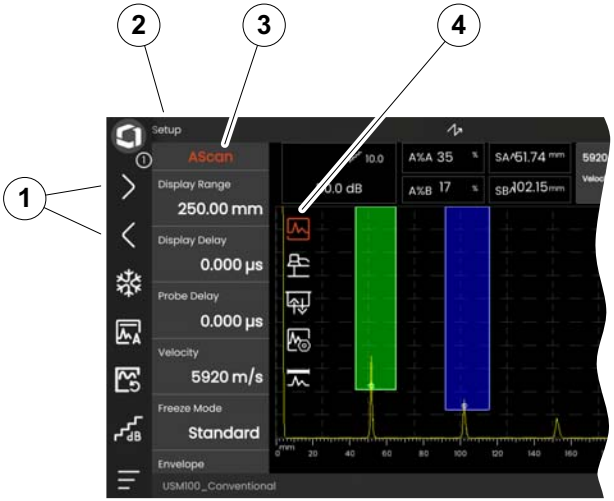
An application's architect determines its specific contents, the inspection parameters displayed, which parameters are adjustable by the user, and to within what range of values a particular parameter can be set.

The function groups with their individual functions (3) are divided into different application-specific panels for a better overview. Some function groups can be found on several panels, others only on a single one.

The possible selection of function groups (4) always depends on the currently selected panel (2).

You can switch between panels

- either by tapping the arrow icons (1)
- or by tapping the name of the current panel (2) and then tapping another name in the list.



Function groups and functions

The icons (3) for selecting a function group are always displayed in the A-scan when you briefly tap in the A-scan. After a short time, the icons are automatically hidden again.

The functions (1) of a function group are displayed when you tap the corresponding icon. The icon of the currently selected function group is colored.

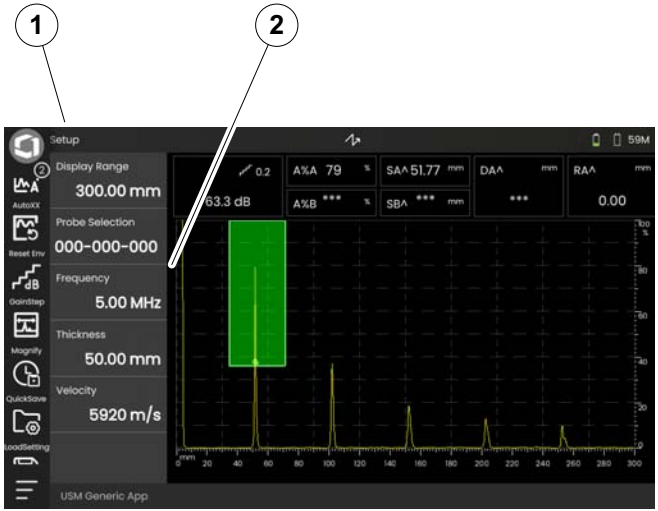
The name (2) of the selected function group is shown above the functions.

If you tap on the icon again, the function group will be hidden again.

Main functions sidebar

Independent of individual function groups, you can quickly access the main functions (2) of a specific panel (1) by sliding the sidebar from the left edge of the A-scan into the screen (see page 79).

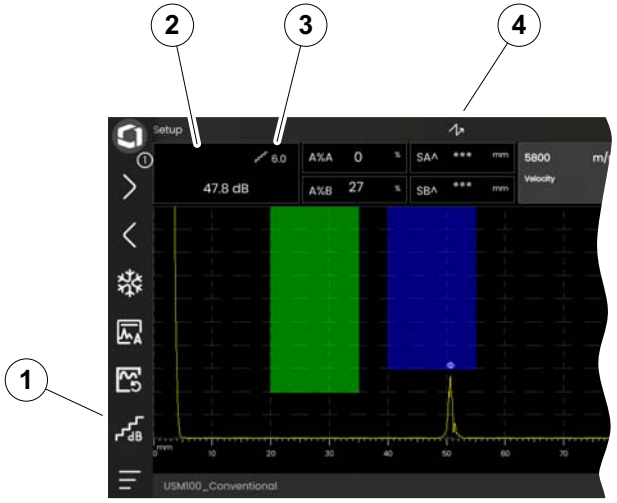
You can close the sidebar by sliding it back.



Gain

The current gain value (2) and the selected dB step value (3) are always displayed in the top left corner above the A-scan.

You can change the step size for quick gain adjustment with the function **Gain step** (1) in the Command bar (see page 67).



Status indicators

Above the A-scan is the area for various status indicators. The status indicators inform about active functions and certain settings (see page 6 at the beginning of the operating manual).

Measurement line

The measurement line on top of the A-scan shows a number of measurement readings (1), also one or two specific functions (3). Size and number of the boxes depend on the currently selected panel (see page 72).

In addition to the measurement reading, the measuring point (peak or flank) is displayed with a symbol in sound path measurements:

^ = measuring point Peak

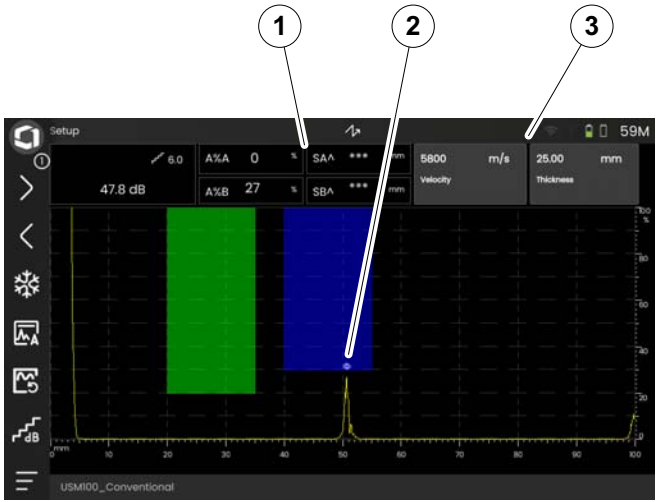
/ = measuring point Flank or first flank crossing the gate

Examples:

SA^ = sound path in gate A, measuring point Peak

SA/ = sound path in gate A, measuring point Flank

You can configure the individual boxes of the measurement line (see page 105).



Note

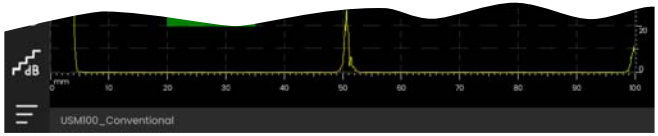
The measuring point for amplitude is marked at the bottom edge of the gate by a triangle pointing upwards (2), the measuring point for distance is marked by a triangle pointing downwards.

Information line

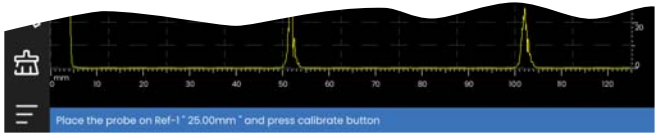
The information line at the bottom of the screen shows various information, notes, instructions and warnings depending on the situation.

You can tap on an instruction or warning to hide it.

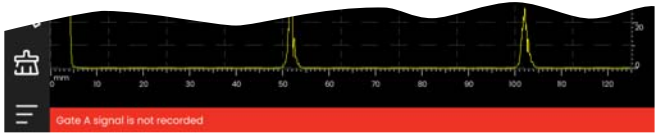
Example: Information on the current application



Example: Instruction for calibration



Example: Warning

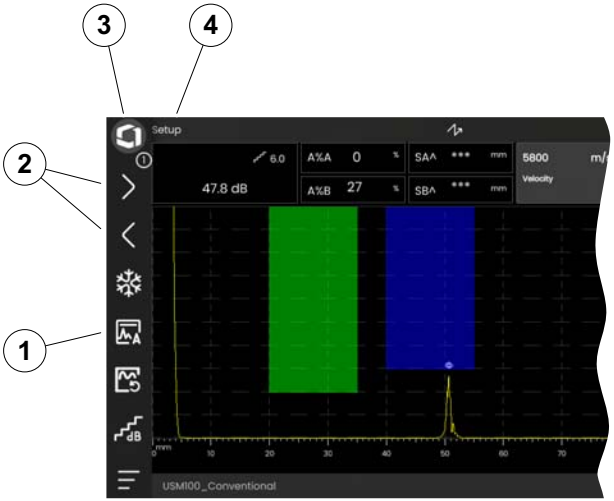


4.4 Operation with touchscreen

Executing or selecting a function

Command bar

The Command bar gives you a quick and direct access to frequently used functions, regardless of the specific type of task (see page 66).



- Tap on an icon (1) of the Command bar to execute the corresponding function.
- Swipe the Command bar up or down to display the icons of additional functions.
- Tap the Waygate icon (3) at the top to switch between Command bar icons.
- Tap the arrow icons (2) to select another panel (4). The icons displayed in the Command bar change accordingly.

Function groups and main functions sidebar

All functions are arranged in function groups. The possible selection of function groups always depends on the currently selected panel (see page 72).

– Tap in the A-scan to display the available function group icons (3).
– Tap on a function group icon to display the function group (2) with the associated functions.
– Tap on a function name (1) to set a parameter (see page 82) or execute a function.

Independent of individual function groups, you can quickly access the main functions of a panel.

– Tap the left edge of the A-scan and swipe to the right. The main functions slide into the screen (see page 74).
– Tap on the functions and swipe to the left to hide the main functions again.

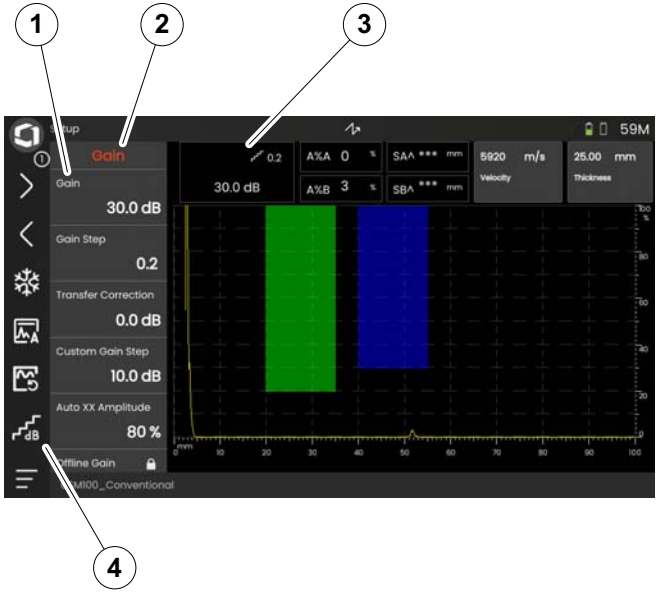
Gain functions

There is no icon in the A-scan for the function group **Gain** with the gain functions. The function group **Gain** for setting the gain and the related functions is always accessible, regardless of the selected panel.

– Above the A-scan, tap the box (3) that displays the gain. The function group **Gain** (2) is displayed.

– Tap on a function name (1) to set a parameter (see page 82) or execute a function.

– To change the **Gain Step** value, tap on the icon (4) in the Command bar.



Functions in the measurement line

The measurement line on top of the A-scan may also show one or two specific functions (1). You can set these functions directly without having to go via the function groups.

– Tap on a function name to set a parameter (see page 82) or execute the function.

Settings

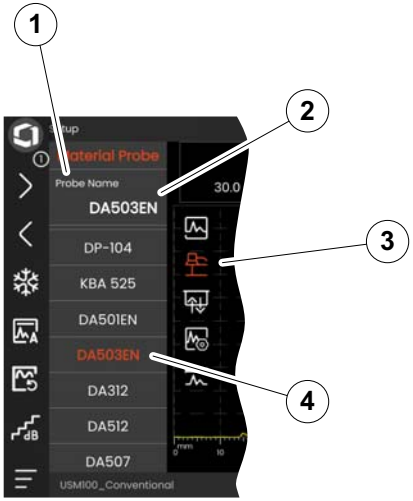
Many functions are parameters for which you can set a value, for example the **Display Range**.

– Select the panel **Setup** and display the function group **A-scan** (see page 79). The functions and their current settings are displayed.
– Tap on the function **Display Range** (1). The value selector is displayed.
– Swipe the selector up or down to show the possible values. The highlighted value in the center (3) is applied immediately without further saving. Depending on the parameter, the effect is immediately visible in the A-scan.
– Tap the calculator icon (2). A numeric keypad is displayed.
– Tap the digits to enter the required value.
– Tap **OK** (4) to complete the entry. The numeric keypad is hidden and the value is applied.
– Tap the function name (1) to close the value selector.

Selection lists

For various functions, you can select the desired setting from a list, for example the **Probe Name**.

- Select the panel **Setup** and display the function group **Material probe** (see page 79). The functions and their current settings are displayed.
- Tap on the function **Probe Name** (1). The list of probe names is displayed.
- Swipe the list up or down to see all list entries.
- Tap on the required name (4). The name is immediately applied to the function (2).
- Tap the function name (1) to close the list.
- Tap the icon of the function group (3) in the A-scan to close the function group, or select another function group.



Incompatible settings

When the values for two or more related functions or parameters create an incompatibility, the functions with incompatible settings are highlighted by a red background.

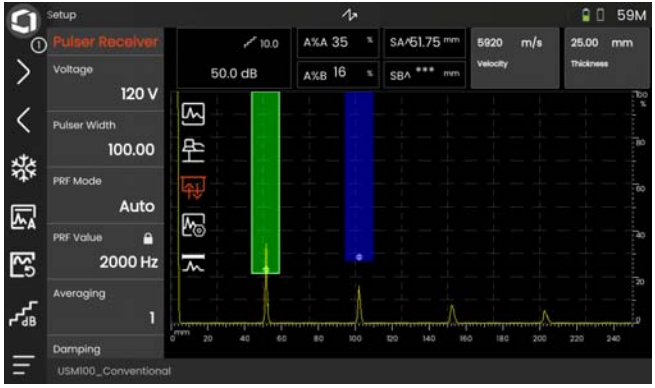
This incompatibility can occur, for instance, between the gate start and gate width, or if the PRF is too high and the gate is too far out in time.

If functions in different function groups are affected, the icons of the involved function groups are also highlighted in red.

– Select one of the highlighted functions and change the setting.
– If necessary, go to another function group to check the setting of the other function involved.

Locked functions

Individual functions may be locked. It is then not possible to change their settings. Locked functions can be identified by the lock symbol near the function name.



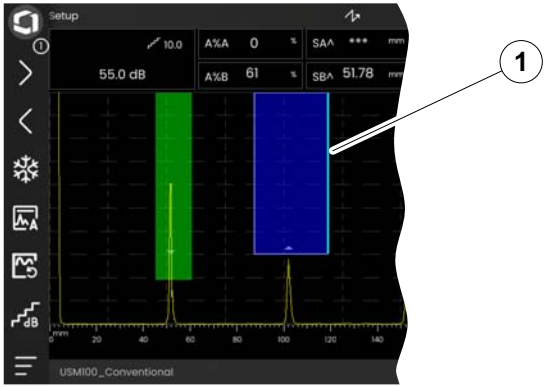
Reasons for locked functions can be:

- The application's architect intended the value to be observed but not altered.
- The display is frozen manually (see page 66) or automatically (see page 111). When frozen, all functions that affect only live data are locked.
- The value of a function is set automatically by the instrument, for example if **PRF Mode** is set to **Auto**, then **PRF Value** cannot be changed.

Positioning the gates

You can move and adjust the gates directly on the touchscreen.

- To move the entire gate, touch the center of the gate. The gate border is highlighted.
- Slide the gate to the desired position.
- To change the start or end position or the threshold, touch the respective edge of the gate. The edge is highlighted (1).
- Drag the edge to the desired position.



Alternatively, you can position the gates exactly by entering the numerical position values (see page 126).

4.5 Overview of key functions

The USM 100 is designed for convenient touchscreen operation. Nevertheless, all settings and operating procedures can alternatively also be performed with the keys (see page 88). The fastest way to set the gain is with the keys on the back.

1 Move up on a menu or list, decrement a numeric parameter

2 Select an item from a menu or list

3 Move down on a menu or list, increment a numeric parameter

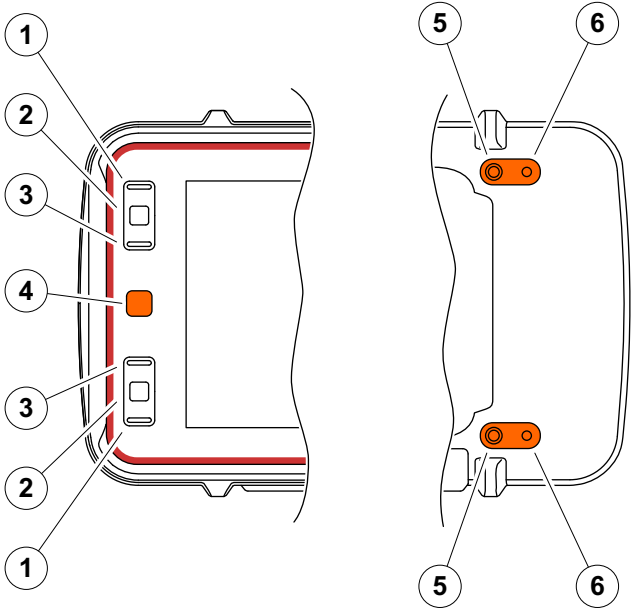
4 Navigate between major areas of the screen to select items for action

5 On the back: Increase gain or move right

6 On the back: Decrease gain or move left

Note

Keys with the same numbers have the same functions when the instrument is inverted for right or left operation.



4.6 Operation with keys

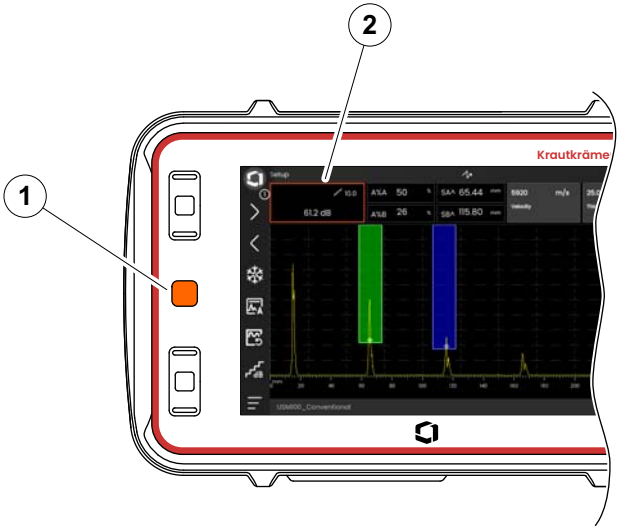
If it is not possible or not desired to operate an element on the screen, for example an icon or a function, by tapping, you can mark the respective areas on the screen with the keys and then execute the corresponding actions with the keys as well.

Selecting a screen area

You can select the various screen areas consecutively in order to perform further actions afterwards.

– Press the red key (1) briefly to start the selection. A screen area is marked with a red frame (2).

– Press the key repeatedly to mark the next element or area.

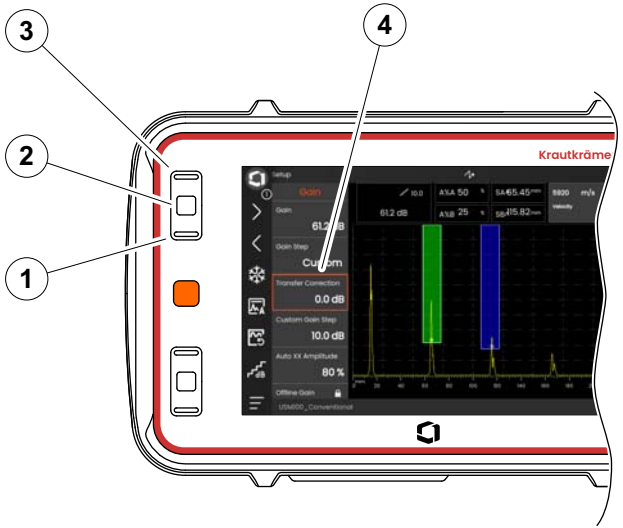


Executing or selecting a function

You must first select a screen area (see page 88).

If it concerns a single function, you can immediately execute or set this function in the next step. If the selected area contains several functions, you must first select the desired function and can then execute or set the function.

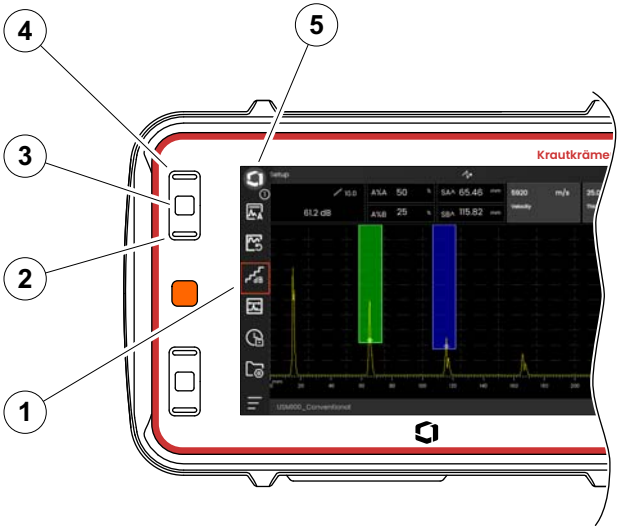
– Press the red key repeatedly to mark the **Gain** area (see page 88).
– Press the black center key (2) to display the associated functions.
– Press the upper (3) or the lower (1) black key to mark the desired function (4).
– Press the black center key (2) to execute or set the function.



Command bar

You can operate the Command bar with the keys as well.

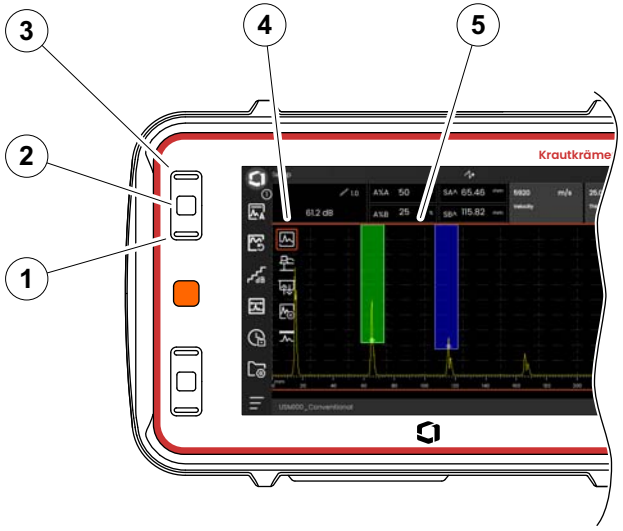
- Press the red key repeatedly to mark the **Waygate** icon (5).
- Press the black center key (3) to access the Command bar.
- Press the upper (4) or the lower (2) black key to mark the desired function (1).
- Press the black center key (3) to execute the function.



Function groups and functions

You can select function groups and functions with the keys as well. The possible selection of function groups always depends on the currently selected panel (see page 72).

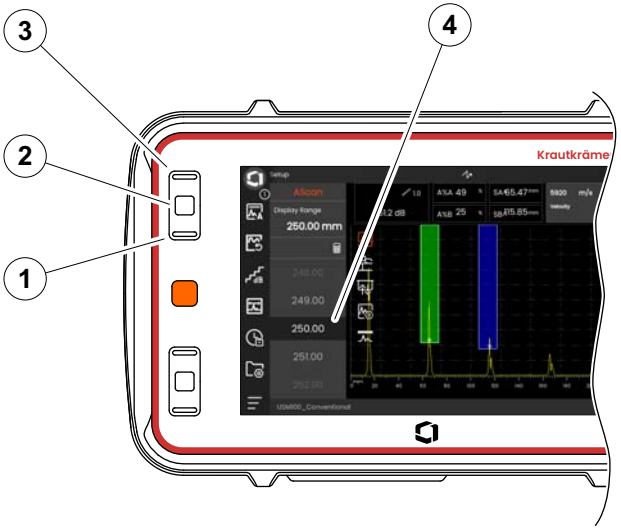
- Press the red key repeatedly to mark the whole A-scan area (5).
- Press the black center key (2) to display the function group icons. The first icon is selected (4).
- Press the upper (3) or the lower (1) black to select another icon.
- Press the black center key to display the function group.
- Press the upper or the lower black to select the required function.
- Press the black center key to set or execute the function.



Settings

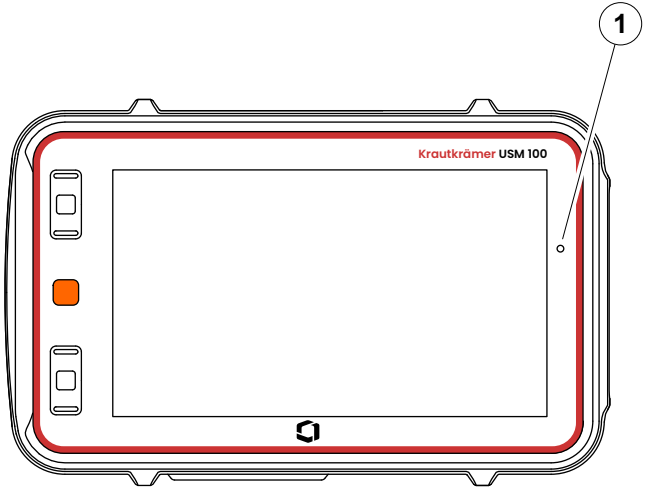
You can set the value of a function with the keys as well, for example the **Display Range**.

- Select the function **Display Range** from the function group **A-scan** (see page 91). The value selector is displayed.
- Press the upper (3) or the lower (1) black to highlight the required value (4).
- Press the black center key (2) to set the highlighted value for the function.
- Press the upper or the lower black to select another function.
- Press the red key to select another screen area.



4.7 Multi-color LED

The multi-color LED (1) next to the screen gives you various information about the device status and special events.



With the instrument switched off:

Blue The batteries are charged

Off Power adapter not connected

With the instrument switched on:

Green Powering on, normal operation

Cyan The batteries are being charged

Red Gate alarm

Operation 5

5.1 Important basic settings

Before you start working with the USM 100, you should configure the most important basic settings.

From the **General settings** (see page 99):

- **System** settings (see page 100)
- **Date and Time** settings (see page 102)
- **Regional** settings (see page 103)

From the function group **A-Scan** (see page 109):

- **A-Scan Color** selection (see page 113)
- **Grid Color** selection (see page 113)
- **Grid** selection (see page 112)

From the function group **Gates** (see page 126):

- **Gate A TOF Mode** selection (see page 128)

For displaying measurement values above the A-scan:

- **Measurement line configuration** (see page 105)

5.2 Saving the settings

You can save the current instrument settings to a file in the device memory or on an inserted USB stick (see page 52). The filename extension is .**ups**.

Note

The filename must not contain any of the following characters: / \ : * ? „ < > |

– From the Command bar tap the **Save settings** icon (see page 68). A dialog box opens.

– Tap in the field **Name**. A keyboard is displayed.

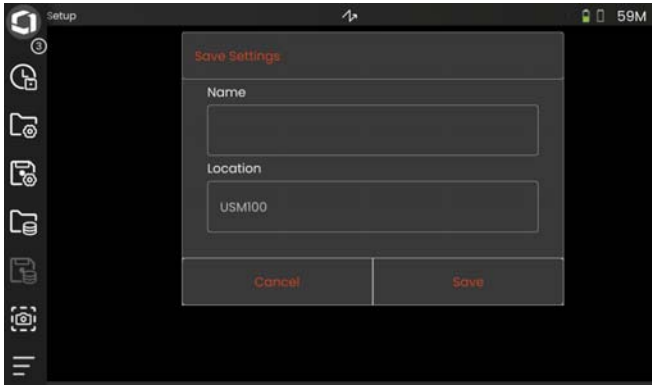
– Enter the name for the file.

– Tap on the keyboard symbol at the bottom right of the keyboard to hide the keyboard again.

– Tap in the field **Location** and select the storage location **USB** or **USM100**.

– Tap on a folder symbol to select the directory.

– Tap on **Save** to save the file in the selected location.



5.3 Loading settings

You can load and use instrument settings saved in a .**ups** file. The instrument settings are immediately active after loading.

Note

The settings must match the currently loaded application. Otherwise an error message is displayed.

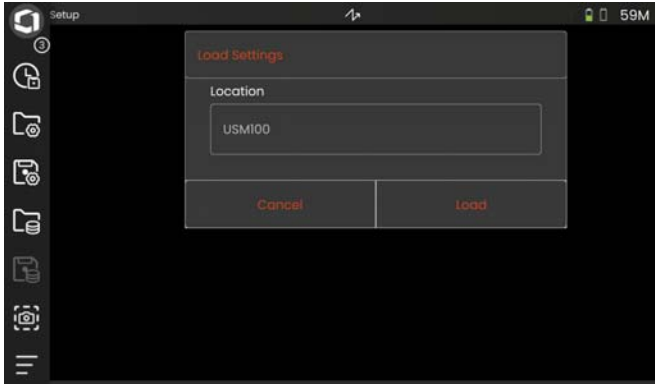
– From the Command bar tap the **Load settings** icon (see page 68). A dialog box opens.

– Tap in the field **Location** and select the storage location **USB** or **USM100**.

– Tap on a folder symbol to select the directory.

– Tap on a filename to select the file.

– Tap on **Load** to load the instrument settings from the selected file.

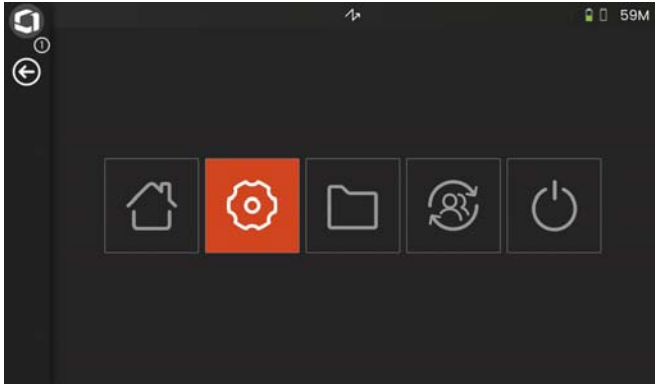


5.4 General settings

You find all general instrument settings in the **General settings** menu.

– Tap the **Main Menu** icon (see page 65) to display the **Main Menu** (see page 60).

– Tap on the **General settings** button.

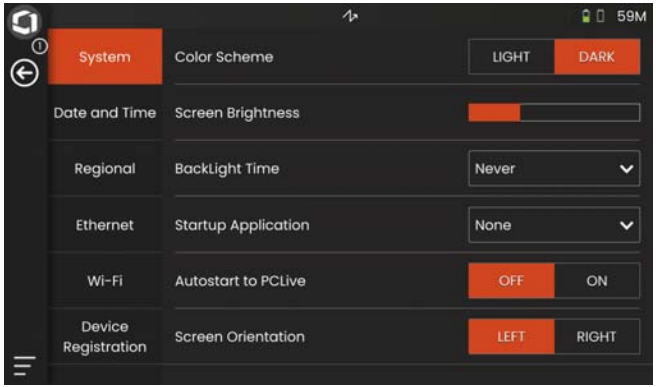


System

Color Scheme

You can switch between **LIGHT** and **DARK** to match the color scheme on the screen to the working environment. The screen colors are switched immediately.

You can set the color of the A-scan separately (see page 113) as well as the grid color (see page 113).



Screen Brightness

You can adjust the screen brightness to your working environment with the slider. The setting is visible immediately.

Note

Change to the higher brightness value reduces the time in battery operation (see page 194).

You can extend the operating time with the **BackLight Time** function (see page 101).

BackLight Time

The backlight of the screen requires a relatively large amount of energy. To save energy, you can select a time period after which the backlight is automatically turned off when there is no key press or tap on the touchscreen.

Startup Application

You can select an application that will be automatically launched with the last used settings when the instrument is started.

If you select **NONE**, you must first select an application after each start of the instrument (see page 61).

Autostart to PCLive

When connected via LAN network the dedicated software **USM 100 PC** can be used, besides other things, to control the instrument.

Normally, the connection is turned on manually. With this function you can activate the automatic connection when starting the instrument.

The prerequisite for this is an established LAN connection when starting the USM 100.

Screen Orientation

You can configure the instrument for right-handed (**RIGHT**) or left-handed operation (**LEFT**), referred to the probe. The screen display is then rotated through 180° and the keys on the front can be operated easily with the other hand.

Date and Time

ATTENTION

Always ensure that you are using the correct date and time for documentation purposes. Remember to adjust accordingly for Daylight Savings.

Date

The date is set automatically after connecting the instrument to the Internet via LAN (see page 201) or WLAN (see page 202). You cannot change the displayed date.

Time

The time is set automatically after connecting the instrument to the Internetvia LAN (see page 201) or WLAN (see page 202). You cannot change the displayed time.

Time Zone

You must select the appropriate time zone to use the correct date and time settings.

Date Format

You can choose the format for displaying the date on the screen and in reports.

MM = Month in numbers

MMM = Month abbreviated to 3 letters

DD = Day of the month in numbers

YY = Year in 2 numbers

YYYY = Year in 4 numbers

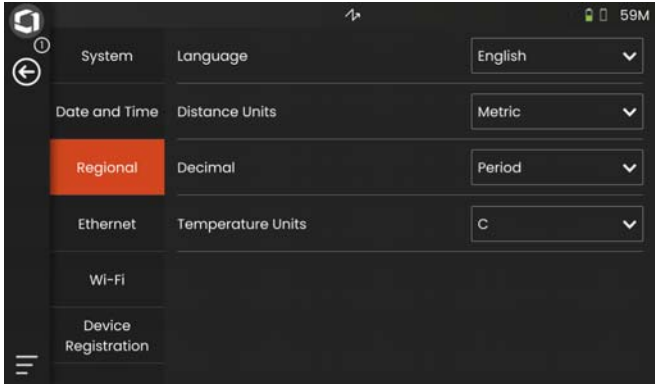
Time Format

You can choose the format for displaying the time on the screen and in reports.

12H = (for example **09:30 PM**)

24H = (for example **21:30**)

Regional



Language

You can select the language for the screen texts. The language is changed immediately.

Distance Units

You can switch the distance units between **METRIC** and **INCHES** any time. All values are adjusted accordingly.

Decimal

You can choose the decimal separator mark. All data are displayed and saved using the selected decimal separator.

Temperature Units

You can switch the temperature units between **C** (Celsius) and **F** (Fahrenheit) any time. All values are adjusted accordingly.

License

You can import licenses, which will then unlock additional functions for your instrument. For this you need a valid license file (extension .**mlp**).

For the complete license upgrade procedure see page 198.

Remote Connection

The USM 100 supports Virtual Network Computing (VNC).

The VNC client displays the screen contents of a remote device on a local computer (client) and in return sends keyboard and mouse movements of the local computer to the remote device.

The settings in the **Remote Connection** section allow you to configure the instrument for remote control via a network.

For the complete remote connection setup procedure see page 56.

Allow Remote Access

You can allow the remote access via the network either for viewing the screen only (eye icon) or for full remote control (eye/mouse icon) of the USM 100. If the X icon is marked, the remote access is blocked.

Remote Command

This function is reserved for service tasks.

Updates

Software updates are available via **InspectionWorks**. Please check for latest update before using the instrument.

For the update procedure see page 196.

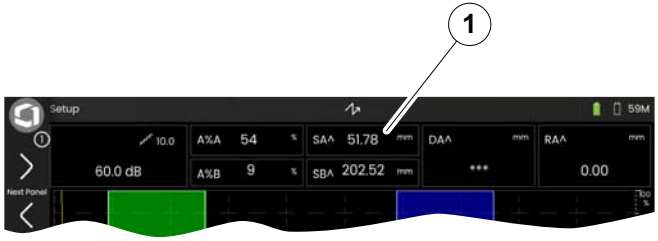
About

In the **About** section you will find information about the instrument and the currently installed software.

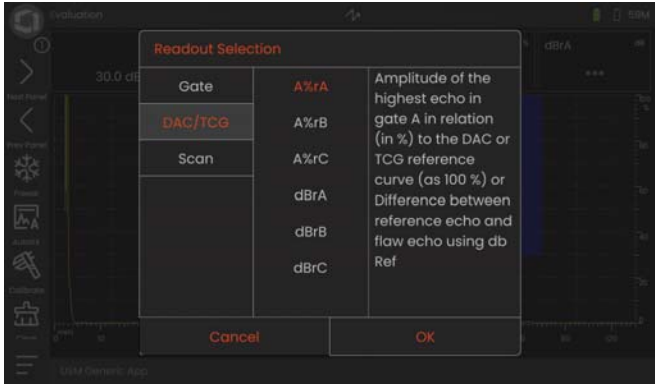
This information is important, for example, in connection with updates or when communicating with the customer service.

5.5 Measurement line configuration

You can select which measurement values are displayed in the different boxes of the measurement line. You can make the selection separately for each box.



- Tap on a box (1) in the measurement line. A dialog box opens.
- In the left column, select a category, for example **DAC/TCG**.
- In the middle column, select a measurement value. The right column displays information about the selected value.
- Tap on **OK** to save the selection. The selected measurement value is displayed in the box.



5.6 UT function groups

In the following chapters, the functions are described according to their order in the respective function group, or in the context of certain tasks, for example calibration.

Some functions are included in several function groups for reasons of more efficient operation. It does not matter in which function group you operate these functions.

The available function groups and functions depend on the panels (see page 72) set up in the loaded application (see page 61).

Note

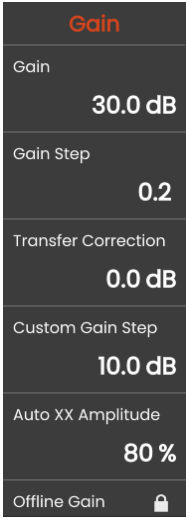
A quick way to find information about a particular function is to use the **Index** at the end of this manual (see page 225).

The **UT Function directory** gives you an alphabetical overview of all UT functions with assignment to the various function groups (see page 206).

Icon	Name	Page
no icon	**Gain**	107
	**A-Scan**	109
	**Material Probe**	116
	**Pulser Receiver**	119
	**UT Setup**	123
	**Gates**	126
	**Auto Calibration**	135
	**Probe Angle**	136
	**Evaluation**	138

5.7 Gain

The function group **Gain** is always accessible, regardless of the selected panel. The current gain value and the selected dB step value are always displayed in the top left corner above the A-scan (see page 75).



Gain

You can use the gain to adjust the sensitivity necessary for making echoes from reflectors to be detected visible on the display screen at the required height.

– Press the keys on the back of the instrument to increase or decrease the gain

  or

  tap on **Gain** to set the gain value exactly.

Gain Step

By pressing the keys on the back of the instrument, you will always set the gain by a certain dB increment. You can define this dB increment.

Note

You can define the dB increment of the highest level with the function **Custom Gain Step** (see page 108).

Transfer Correction

If the test object has a rough surface, part of the incident sound energy will be scattered at its surface and is not available for the test. The larger this initial scattering, the smaller the flaw echoes appear, and the more errors occur in the evaluation result.

It is therefore important to take the effect of the test object's surfaces on the height of the echo into account.

You can determine the value for the transfer correction by experiment. For more details on this, please read the corresponding technical literature of the national training centers for nondestructive testing.

Custom Gain Step

You can define the dB increment of the highest level selectable in the function **Gain Step** (see page 107).

Auto XX Amplitude

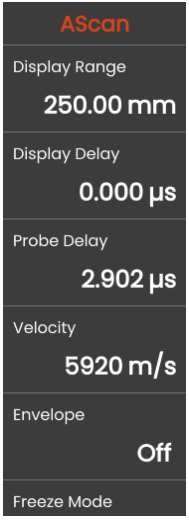
You can set the desired screen height (default = 80%) for the echo amplitude, when using the **AutoXX** function (see page 66).

Offline Gain

The **Offline Gain** value is applied to a frozen B-scan or C-scan image.

5.8 A-Scan

This function group provides all important settings for the A-scan representation. You have to set the sound velocity and the display range according to the material and the dimensions of the test piece. The probe delay must likewise be set.



Display Range

The display range must be adjusted to the sound velocity used (function **Velocity**) and to the connected probe (function **Probe Delay**).

The adjustment range for display range depends on the **Velocity** setting (see page 110) and on the **Frequency** (see page 118) setting in the function group **Material Probe**.

Note

For an exact adjustment of the sound velocity and the probe delay, please start by reading the **Calibration** chapter (see page 145).

Display Delay

You can use this function to choose whether to display the adjusted display range (for example 250 mm) starting from the surface of the test object or in a section of the test object starting at a later point. This allows you to shift the complete screen display and consequently also the display zero. For example, if the display should start from the surface of the test object, you have to adjust the value **0** for the display delay.

Probe Delay

Every probe is equipped with a delay line between the transducer and the coupling face. The sound pulse must first pass through this delay line before it can enter the test object. You can compensate for this influence of the delay line in the probe in this function **Probe Delay**.

Note

If the value for the probe delay is not known, please read chapter **Calibration** to determine this value (see page 145).

Velocity

You can use the function **Velocity** to set the sound velocity in the test object.

ATTENTION

Please always make sure that the setting of the function **Velocity** is correct. The instrument calculates all range and distance indications on the basis of the value adjusted here.

Freeze Mode

The instrument offers you various options for freezing the A-scan on the display automatically. You can choose between the following options. Manual freezing of the A-scan by tapping the icon **Freeze** in the Command bar (see page 66) is always possible, regardless of the selection here.

Standard

You can only manually freeze the A-scan by tapping the icon **Freeze** in the Command bar (see page 66).

A Freeze

The A-scan is frozen automatically when the signal touches the gate A. This setting is suitable e.g. for measurements on hot test objects, for measurements in difficult coupling conditions, or for spot weld testing.

B Freeze *

The A-scan is frozen automatically when the signal touches the gate B. This setting is suitable e.g. for measurements on hot test objects, for measurements in difficult coupling conditions, or for spot weld testing.

AB Freeze *

The A-scan is frozen automatically when the signal touches either one of the gates A or B.

Compare

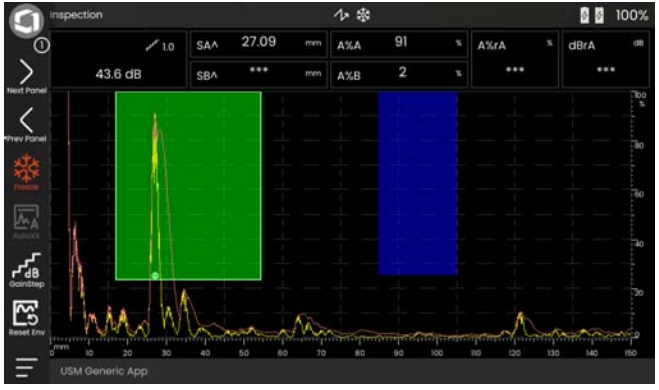
The manually frozen A-scan is displayed for comparison purposes in the background while the currently active A-scan is at the same time visible in the foreground. When leaving the **Freeze** function, the last A-scan is recorded and displayed for comparison purposes.

* If the function **Gate B Start Mode** (see page 132) is set to **Gate A**, the function **Freeze** will not be effective until the interface echo has also reached the gate A beforehand.

Envelope

In addition to the live A-scan, a frozen A-scan is displayed as an envelope curve in the background. The frozen A-scan is updated every time the maximum amplitudes are exceeded.

A-scan with envelope curve:



Envelope Color

You can choose the color of the envelope curve, independent of the selected **Color Scheme** (see page 100).

Grid

You can switch on a grid for the A-scan and choose between types **Coarse** and **Fine**.

Amplitude Ruler

Independently of the grid, you can switch on a ruler for the amplitude.

Range Ruler

You can switch on a ruler at the bottom of the A-scan. For this range ruler several options in [mm] and [µs] are available.

Sound Path

The sound path is always deduced from the time of flight of the pulse (TOF) and the material sound velocity.

Time Base

The ruler displays the TOF values in [µs].

Material Depth

When using angle probes, the material depth is different from the sound path. This ruler shows the material depth values.

A-Scan Color

You can choose the color of the A-scan, independent of the selected **Color Scheme** (see page 100).

Color Palette

At the right edge of the A-scan you can show the color palette that is set in the function **Amp Palette** (see page 186) in the **Data Recorder**.

Grid Color

You can choose the color of the grid (see function **Grid**), independent of the selected **Color Scheme** (see page 100).

Ref. A-Scan Color

You can choose the color of the reference A-scan, independent of the selected **Color Scheme** (see page 100).

Ref. Envelope Color

You can choose the color of the reference envelope curve, independent of the selected **Color Scheme** (see page 100).

Color Leg

For better orientation, the instrument can mark the legs for the first three reflections with different background colors. The range of each color corresponds to the length of the leg.

A-scan with **Color Leg** function switched on:

FileName Prefix

You can enter a character string as a prefix for the automatically generated file names, for example when saving screen captures or test reports. This prefix will be placed at the beginning of the file name, before the automatically generated data year-month-day-time. With the prefix **USM_**, for example, a file name will then be

USM_2021-03-02_16.09.49

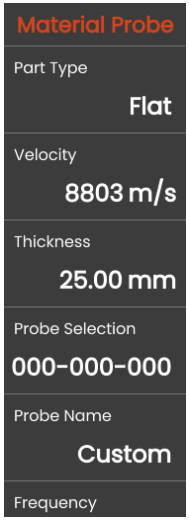
– Tap on the function name. A keyboard is displayed.
– Tap on **Clr** to delete the complete current prefix

  or

  tap on **Delete** to delete the characters one by one, starting from the last character.
– Enter the characters for the desired file name prefix.
– Tap on **Enter** to save the entered characters as a prefix. The keyboard disappears.

5.9 Material Probe

In this function group you can set the data for the test material and the probe.



Part Type

You need to specify the surface shape of the test object.

Select **Curved** when working with circular curved surfaces, e.g. when inspecting longitudinally welded tubes. To make the instrument carry out the corresponding correction of the (reduced) projection distance and depth, you must then enter the outside diameter of your test object in the function **Outer diameter** (see page 117).

Select **Flat** if you want to carry out the flaw position calculation for flat plane-parallel test objects.

Velocity

This is the same function as in the function group **A-Scan** (see page 110).

Thickness

You can use this function to set the wall thickness of the test object. This value is required for the automatic calculation of the true depth of a reflection.

Outer diameter

This function is only visible if you have selected the **Curved** option for **Part Type** (see page 116).

Enter the outside diameter of your test object to make the instrument carry out the corresponding correction of the (reduced) projection distance and depth.

Probe Selection

By selecting the number of the connected probe, you can quickly and correctly set the settings (name, probe delay, element diameter, and frequency) stored together with the number for the connected probe. The probe number **000-000-000** is user programmable with regard to all parameters.

Alternatively, you can select the probe by its name (see below).

Probe Name

By selecting the name of the connected probe, you can quickly and correctly set the settings (name, probe delay, element diameter, and frequency) stored together with the name for the connected probe. The probe name **Custom** is user programmable with regard to all parameters.

Alternatively, you can select the probe by its number (see above).

Frequency

With this function you can set the frequency of the receiver according to the frequency of your probe.

The frequency is set automatically when you select a probe by its number or name (see page 117).

Probe Delay

This is the same function as in the function group **A-Scan** (see page 118).

Probe Angle

With this function you can adjust the angle of incidence of your probe for the test material. This value is required for the automatic calculation of flaw position.

The probe angle is set automatically when you select a probe by its number or name (see page 117).

Probe X-Value

With this function you can set the X value (distance of probe front edge from the probe index or sound exit point) of the connected probe.

This value is required for the automatic calculation of the reduced projection distance.

Effective Diameter

With this function you can set the effective element or crystal diameter of the connected probe.

The effective diameter is set automatically when you select a probe by its number or name (see page 117).

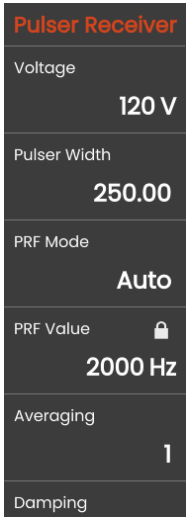
Delay Velocity

With this function you can set the sound velocity in the delay line of the connected probe.

The delay velocity is set automatically when you select a probe by its number or name (see page 117).

5.10 Pulser Receiver

In this function group you will find all functions for setting the pulser and the receiver.



Voltage

If your instrument is equipped with a square-wave pulser and the square-wave pulser is chosen as pulser type, then you can set the pulser voltage within the range of 100 … 350 V in steps of 10 V.

ATTENTION

Use the data sheet for your probe to check which maximum voltage is allowed to be applied.

Note

The pulser voltage and the pulse width can be automatically limited, depending on the pulse repetition frequency mode (see **PRF Mode**, page 120) or setting (see **PRF Value**, page 120). This function helps to avoid heat accumulations in the pulser electronics.

Pulse Width

You can use this function to adjust the pulse width for the square-wave pulser. You can adjust a value within the range of 40 … 500 ns (nanoseconds) in steps of 10 ns.

The following equation produces an approximation for the suitable pulse width:

Nominal width in nanoseconds

= 500/probe frequency in MHz

For example, the equation for a 2.25 MHz probe results in:

Nominal width in nanoseconds

= 500/2.25 ns = 222 nanoseconds

Note

The values of **Voltage** and **Pulse Width** can be automatically limited, depending on the PRF (pulse repetition frequency). This function is used for limiting the signal loss.

PRF Mode

You can choose between the **Auto** and the **Manual** mode for the PRF (pulse repetition frequency) setting.

When you select **Auto** the function **PRF Value** is locked. The PRF is set automatically to a value of 50% of the maximum possible PRF.

Select **Manual** to set the **PRF Value**.

PRF Value

The pulse repetition frequency indicates the number of times an initial pulse is triggered per second.

The larger your test object, the smaller PRF values are needed to avoid phantom echoes. However, the A-scan update rate becomes lower in the case of smaller PRF values. High values are therefore required if a test object should be scanned fast.

The best way to determine the suitable PRF value is by experimenting: Start from the highest value and reduce the value until there are no more phantom echoes.

Averaging

This function is used to optimize the A-scan representation by averaging several A-scan frames to one frame.

Damping

This function is used for matching the probe. By setting the damping level of the probe oscillating circuit you can vary the height, width, and resolution of the echo display.

400 Ohms

This setting gives a low damping, the echoes become higher and broader.

50 Ohms

This setting reduces the echo height but produces narrower echoes with a higher resolution.

Filter

You can optimize the signal by setting a frequency filter until a clear echo is visible. Filter and damping influence each other. Therefore you need to try all possible combinations to achieve an optimal result.

Rectify

You can use this function to select the rectification mode of the echo pulses according to your application.

RF (radio frequency)

There is no rectification. Both positive and negative wave portions are displayed with true amplitude.

Full Wave

All half-waves are displayed above the base line on the screen.

Positive HW

Only positive half-waves are displayed above the base line on the screen.

Negative HW

Only negative half-waves are displayed above the base line on the screen.

Dual Mode

You can toggle between single-element and dual mode.

Off

This setting is for single-element operation. The probe must be connected to the **T/R** socket (see page 51).

On

The dual mode is for using dual-element probes. The receiver must be connected to the **R** socket and the pulser to the **T/R** socket (see page 51).

Through

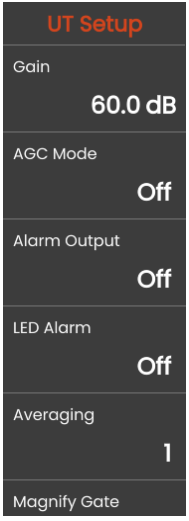
The through-transmission mode is for using two separate probes in a through shot configuration.

The receiver must be connected to the **R** socket and the pulser to the **T/R** socket (see page 51). As the sound wave passes through the test object only once in through-transmission mode, all range and wall thickness measurement functions are adjusted accordingly.

TOF values are calculated for a single through path, not for the pulse echo.

5.11 UT Setup

In this function group you will find the settings for gain control, alarms and output signals.



Gain

This is the same function as in the function group **Gain** (see page 107).

AGC Mode

Even smaller variations of the echo amplitude can lead to incorrect measurement results in wall thickness measurements. In these cases, the exact monitoring of the amplitude is therefore highly important. The automatic gain control (AGC) offers practical help for this purpose.

The automatic gain control of the USM 100 keeps the echo amplitude fully automatically at a specified screen height and, in this way, compensates for the amplitude variations of the signal received. This enables to clearly improve especially the wall thickness measurement and to make it easier.

The AGC can also be used during calibration in order to to keep the reference amplitude of 80 % screen height constant at ±1 % (setting **AGC Max Amp** = 81 %, **AGC Min Amp** = 79 %).

When the automatic gain control is switched on, further functions are displayed with which you can configure the AGC (see below).

AGC Max Amp / AGC Min Amp

To configure the automatic gain control, enter the minimum and the maximum height of amplitude in percent screen height that the echo signal should reach within the gate.

Note

The smaller the ratio between the values **AGC Max Amp** and **AGC Min Amp**, the more sensitive the control process.

AGC Noise

You can define a threshold for the noise. Signals below this threshold are not taken into account for the automatic gain control.

Alarm Output

You can assign an alarm event to the corresponding alarm output. If the alarm event occurs, a signal is output via the alarm output (see page 203).

You can choose a gate for triggering the alarm output.

LED Alarm

You can assign an alarm event to the multi-color LED next to the screen (see page 93). If the alarm event occurs, the LED lights up accordingly.

You can choose a gate for triggering the alarm signal of the LED.

Averaging

This is the same function as in the function group **Pulser Receiver** (see page 119).

Magnify gate

You can choose a gate for the **Magnify Gate** function in the Command bar (see page 67). The setting of this function causes the selected gate to span over the entire displayed range.

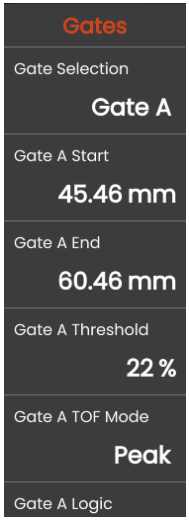
Analog Output

You can output measurement results via analog output (see page 203) for external further processing.

Use this function to specify the reading to be output as voltage signal.

5.12 Gates

In this function group you will find all functions for setting the gates.



Tasks of the gates

The gates monitor the area of the test object where you expect to detect a flaw. If an echo exceeds or falls below the gate, an alarm signal can be output (see page 124). Gates are displayed in different colors for ease of identification (see page 71).

The gates A and B are independent of each other. Gate A can also assume the function of an echo start gate for gate B (see page 132).

The gates are also used to choose the echo for the digital time-of-flight and amplitude measurement. The measured value is displayed in the measurement line (see page 76).

Gate Selection

With this function you first select the gate for which the following settings are to apply. You can set the settings for each gate independently.

Gate A Start

This function can also be set for gate B, C and IF.

You can set the starting point of the gate by entering the exact numerical values.

Alternatively, you can move and adjust the gates directly on the touchscreen (see page 86).

Gate A Width

This function can also be set for gate B, C and IF.

You can set the width of the gate.

Alternatively, you can set the width directly on the touchscreen by dragging the right edge (see page 86).

Gate A Threshold

This function can also be set for gate B, C and IF.

You can set the threshold of the gate by entering the exact numerical values within the range of 5 … 95 % screen height for triggering an alarm if this value is exceeded or not reached.

In RF mode, you can set the threshold within the range of –5 … –95 %.

Alternatively, you can adjust the threshold directly on the touchscreen (see page 86).

Gate A TOF Mode

This function can also be set for gate B, C and IF.

The sound path measurement by means of the echo evaluation depends on the choice of the measuring point.

ATTENTION

In any case, the setting of the measuring point for the calibration and for the subsequent test use must always be identical. Otherwise, measuring errors may occur.

Note

The highest echo in the gate does not have to be identical with the echo for which the sound path is measured. This can lead to evaluation errors!

Two measurement arrows are used in order to clearly identify readings and to avoid any misinterpretations. The display shows

- the position at which the sound path (distance) is measured: arrowhead downwards, and
- where the amplitude is measured: arrowhead upwards.

In addition to the measurement reading, the TOF mode measuring point (peak or flank) is displayed with a symbol in the measurement line in sound path measurements:

^ = measuring point Peak

/ = measuring point Flank

Examples:

SA^ = sound path within gate A, measuring point Peak

SA/ = sound path within gate A, measuring point Flank

Peak

The amplitude and the time-of-flight are measured at the absolutely highest amplitude value within the gate with maximum resolution of the instrument.

Flank

The amplitude is measured as in the case of **Peak**, however, the time-of-flight is measured at the first point of intersection between the echo and the gate with maximum resolution of the instrument.

J-Flank / First Peak

These are special parameters for the Japanese market. Both use the displayed A-scan for evaluation.

The time-of-flight is measured as in the case of **Flank**, the amplitude measurement before the 1st change of direction downwards if the gate threshold is afterwards not reached yet another time. In the case of larger values for the function **Display Range** (see page 109), it may happen that several points are combined into one. In these cases, the evaluation no longer corresponds to the displayed A-scan.

Zero Before

The sound path is measured at the zero crossing of the rising edge.

Zero After

The sound path is measured at the zero crossing of the falling edge.

Measurement between zero crossings

Accurate measurements can be achieved by a corresponding choice of the measuring point even if the shape of an echo has changed, e.g. due to phase reversal in immersion test applications.

Measurement errors may occur if there is noise within the range of the gate before the signal to be evaluated. When setting **Zero Before**, make sure that the base line is smooth. Set the gate start in such a way that it is at least half a wavelength before the measuring point to enable a reliable recording of the measured value.

Gate A Logic

This function can also be set for gate B, C and IF.

You can set the criteria for triggering a gate alarm.

Note

For the configuration of the alarm output, see function **Alarm Output** (see page 124).

Positive

The alarm is triggered if the gate is exceeded.

Negative

The alarm is triggered if the gate is not reached.

Off

The gate is turned off, alarms and measurement functions are disabled, and the gate is not visible on the display screen.

Gate B Start

This function corresponds to **Gate A Start** (see page 127).

Gate B Width

This function corresponds to **Gate A Width** (see page 127).

Gate B Threshold

This function corresponds to **Gate A Threshold** (see page 127).

Gate B TOF Mode

This function corresponds to **Gate A TOF Mode** (see page 128).

Gate B Logic

This function corresponds to **Gate A Logic** (see page 131).

Gate B Start Mode

The start of the gate B is normally positioned starting from the initial pulse as in the case of gate A.

You can alternatively specify the start of the gate B in relation to an event in gate A. This function is also referred to as automatic gate tracking. If there is no event in the gate A, the starting point of the gate B is identical with the value of the function **Gate A Start** (see page 127).

The width and the threshold of the gate B are not affected by the gate tracking.

The tracking of the optional gate C is identical with that of the gate B. However, the gate C can additionally still be coupled to events in the gate B.

IP

The gate B is normally positioned starting from the initial pulse.

IF

The gate B is positioned starting from the interface echo. The **IF** option can only be set when IF gate mode is selected.

Gate A

If you choose the setting **Gate A**, the gate B is afterwards always shifted automatically when you shift the starting point of the gate A.

C/IF Gate Mode

With this function you first select the gate for which the following settings are to apply. You can set the settings for each gate independently.

Gate C Start

This function corresponds to **Gate A Start** (see page 127).

Gate C Width

This function corresponds to **Gate A Width** (see page 127).

Gate C Threshold

This function corresponds to **Gate A Threshold** (see page 127).

Gate C TOF Mode

This function corresponds to **Gate A TOF Mode** (see page 128).

Gate C Logic

This function corresponds to **Gate A Logic** (see page 131).

Gate C Start Mode

This function corresponds to **Gate B Start Mode** (see page 132).

Gate IF Start

This function corresponds to **Gate A Start** (see page 127).

Gate IF Width

This function corresponds to **Gate A Width** (see page 127).

Gate IF Threshold

This function corresponds to **Gate A Threshold** (see page 127).

Gate IF TOF Mode

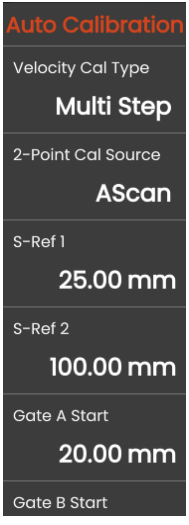
This function corresponds to **Gate A TOF Mode** (see page 128).

Gate IF Logic

This function corresponds to **Gate A Logic** (see page 131).

5.13 Auto Calibration

In this function group you will find all functions for the different calibration procedures. For the description of the calibration procedures see from page 145.



Velocity Cal Type

The USM 100 provides two calibration modes:

- **Multi BW** (see from page 146)
- **Multi Step** (see from page 147)

You must choose the calibration mode before entering the following parameter values.

2-Point Cal Source

For calibration you can choose between the A-scan and the envelope curve.

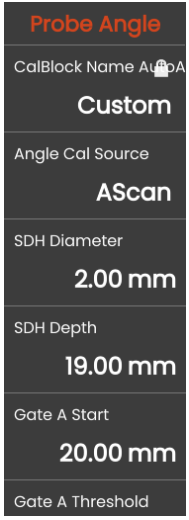
S Ref 1 / S Ref 2

You must set the thickness according to the calibration block or blocks used.

S Ref 2 is only visible when **Multi Step** has been selected in **Velocity Cal Type**. Here you must set the thickness according to the second calibration block or the second thickness value of a stepped reference block used.

5.14 Probe Angle

In this function group you will find all functions for defining the current index angle of a probe on a specified reference block. For the description of the calculation procedure see from page 149.



The current probe index angle is influenced, among other things, by different materials or by the wear of the probe contact face.

ATTENTION

You have to carry out the calibration before using the functions here (see page 145).

Block

By selecting the name of the calibration standard used, you can quickly and correctly set the settings for **SDH Diameter** and **SDH Depth**, that are stored together with the name.

When you select **Custom**, you must enter these values manually.

Angle Cal Source

You can choose between the A-scan and the envelope curve as basis for the probe angle calculation.

SDH Diameter

With this function you must set the side-drilled hole diameter of the calibration standard used.

The diameter is set automatically when you select a calibration standard by its name (see page 136).

SDH Depth

With this function you must set the depth of the side-drilled hole of the calibration standard used.

The depth is set automatically when you select a calibration standard by its name (see page 136).

Note that **SDH Depth** always refers to the center of the side-drilled hole and not to the real reflecting surface.

Gate A Start

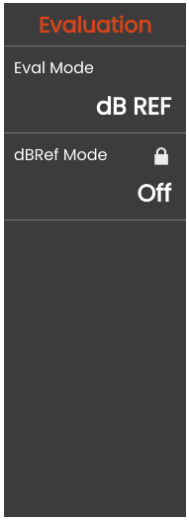
This is the same function as in the function group **Gates** (see page 127).

Gate A Threshold

This is the same function as in the function group **Gates** (see page 127).

5.15 Evaluation

In this function group you can choose a method for evaluating the measured reflector echoes.



The available methods depend on the activated instrument options and the loaded application (see page 61).

The use of the various methods is described in the respective chapters:

- **dB REF** (see page 150)
- **DAC** (see page 152)
- **DGS** (see page 159)
- **AWS D1.1 / AWS D1.5** (see page 171)
- **JISDAC** (see page 174)
- **CNDAC** (see page 175)

On the following pages the individual functions and parameters are described independently of each other.

Eval Mode

You must choose the evaluation mode before setting the following parameters.

dbRef Mode

This parameter is only visible when **dB REF** has been selected in **Eval Mode**.

You can switch this function on or off.

Gate A Start

This is the same function as in the function group **Gates** (see page 127).

Eval Source

This parameter is only visible when **DAC**, **JISDAC** or **CNDAC** has been selected in **Eval Mode**.

You can choose between the A-scan and the envelope curve as basis for the probe angle calculation.

Eval Points Source

This parameter is only visible when **DAC**, **JISDAC** or **CNDAC** has been selected in **Eval Mode**.

For creating and editing the DAC curve points you have two options:

- **DAC Table**, the DAC table is defined with the software **Mentor Create**
- **Custom**, you can record the DAC points with the instrument

The software **Mentor Create** is described in a separate manual.

Define Points

This parameter is only visible when **DAC**, **JISDAC** or **CNDAC** has been selected in **Eval Mode**.

You must set the number of points to be recorded.

DAC Point

This parameter is only visible when **DAC**, **JISDAC** or **CNDAC** has been selected in **Eval Mode**.

Select the point number for the following **DAC Distance** value.

DAC Distance

This parameter is only visible when **DAC**, **JISDAC** or **CNDAC** has been selected in **Eval Mode**.

In this parameter you must enter the TOF value of the DAC point selected with the parameter **DAC Point**.

DAC / TCG

This parameter is only visible when **DAC**, **JISDAC** or **CNDAC** has been selected in **Eval Mode**.

You can select the working mode DAC or TCG.

Offset Mode

You can set an offset mode for the evaluation lines.

Fixed

A fixed offset is set for all evaluation lines.

Custom

Different offset values can be set for the evaluation lines.

Offset

Here you can set the fixed offset for all evaluation lines.

Offset 1

When **Custom** has been selected in **Offset Mode**, you can define the different offsets for the evaluation lines with the parameters **Offset 1**, **Offset 2**, **Offset 3**, and **Offset 4**.

Curve Color

You can select the color for the DAC / TGC curve.

DGS Mode

This parameter is only visible when **DGS** has been selected in **Eval Mode**.

You can switch this function on or off.

DGS Curve

This parameter is only visible when **DGS** has been selected in **Eval Mode**.

You must enter the reference size for the evaluation.

Probe Selection

This parameter is only visible when **DGS** has been selected in **Eval Mode**.

This is the same function as in the function group **Material Probe** (see page 117).

Probe Name

This parameter is only visible when **DGS** has been selected in **Eval Mode**.

This is the same function as in the function group **Material Probe** (see page 117).

Frequency

This parameter is only visible when **DGS** has been selected in **Eval Mode**.

This is the same function as in the function group **Material Probe** (see page 118).

Effective Diameter

This parameter is only visible when **DGS** has been selected in **Eval Mode**.

This is the same function as in the function group **Material Probe** (see page 118).

Delay Velocity

This parameter is only visible when **DGS** has been selected in **Eval Mode**.

This is the same function as in the function group **Material Probe** (see page 118).

Reference Type

This parameter is only visible when **DGS** has been selected in **Eval Mode**.

You must select the type of the reference reflector:

- **BW** (backwall)
- **FBH** (flat bottom hole)
- **SDH** (side drilled hole)

Reference Size

This parameter is only visible when **DGS** has been selected in **Eval Mode**.

You must enter the reference size for the recording.

Reference Attenuation

This parameter is only visible when **DGS** has been selected in **Eval Mode**.

You can enter a value for the sound attenuation in the reference block.

Amplitude Correction

This parameter is only visible when **DGS** has been selected in **Eval Mode**.

When using an angle probe with the reference blocks K1 or K2, you must set a value for the amplitude correction.

Test Attenuation

This parameter is only visible when **DGS** has been selected in **Eval Mode**.

You can enter a value for the sound attenuation in the test object.

Transfer Correction

This parameter is only visible when **DGS** has been selected in **Eval Mode**.

With the transfer correction you can take the effect of the test object's surfaces on the height of the echo into account.

AWS Mode

This parameter is only visible when **AWS D1.1** or **AWS D1.5** has been selected in **Eval Mode**.

You can switch this function on or off.

JISDAC Mode

This parameter is only visible when **JISDAC** has been selected in **Eval Mode**.

You can switch this function on or off.

Bold Line

This parameter is only visible when **JISDAC** has been selected in **Eval Mode**.

CNDAC Mode

This parameter is only visible when **CNDAC** has been selected in **Eval Mode**.

You can switch this function on or off.

Acceptance Level

This parameter is only visible when **CNDAC** has been selected in **Eval Mode**.

Code

This parameter is only visible when **CNDAC** has been selected in **Eval Mode**.

You can select a reference block.

The option **Custom** allows the specification of an own reference block, whose data must be documented separately.

Cal Block

This parameter is only visible when **CNDAC** has been selected in **Eval Mode**.

You can select a reference block.

Defect Length

This parameter is only visible when **CNDAC** has been selected in **Eval Mode**.

Acceptance Line

This parameter is only visible when **CNDAC** has been selected in **Eval Mode**.

Recording Line

This parameter is only visible when **CNDAC** has been selected in **Eval Mode**.

Evaluation Line

This parameter is only visible when **CNDAC** has been selected in **Eval Mode**.

5.16 Calibration

Calibrating the probe delay and velocity

Before working with the USM 100, it must be calibrated.

You have to adjust the material velocity and the display range, as well as allow for the probe delay, depending on the material and the dimensions of the test object.

To ensure a safe and proper operation of the instrument, it is necessary that the operator be adequately trained in the field of ultrasonic testing technology.

The USM 100 provides two calibration modes:

- **Multi BW** (see page 146)
- **Multi Step** (see page 147)

Note

The angle calculation of angle probes is described from page 149.

Choice of the measuring point

The sound path measurement by means of the echo evaluation depends on the choice of measuring point (see **Gate A TOF Mode**, page 128).

ATTENTION

In any case, the setting of the measuring point in **Gate A TOF Mode** for the calibration and for the subsequent test use must always be identical. Otherwise, measuring errors may occur.

Calibration with Multi BW

With **Multi BW** (multi backwall), the calibration only needs one reference value **S Ref 1 / S Ref 2**. The first and the second backwall are generated on a single calibration block.

During the calibration process the **Display Range** is adjusted automatically.

– Select the **2-Point Cal.** panel.

– Tap in the A-scan and tap the **Auto Calibration** icon to display the function group (see page 135).

– Select **Velocity Cal Type** and select **Multi BW**.

– Select **S Ref 1 / S Ref 2** and set the thickness according to the calibration block used.

– Couple the probe to the calibration block.

– Position the gates A and B on the first and on the second backwall echo.

– In the Command bar tap on **Calibrate** (see page 66) to execute the calibration process.

Calibration with Multi Step

With **Multi Step**, the calibration needs two reference values **S Ref 1 / S Ref 2** and **S Ref 1 / S Ref 2**. The backwall echoes are generated on two calibration blocks of different thickness or a stepped reference block having different wall thicknesses.

During the calibration process the **Display Range** is adjusted automatically.

– Select the **2-Point Cal.** panel.

– Tap in the A-scan and tap the **Auto Calibration** icon to display the function group (see page 135).

– Select **Velocity Cal Type** and select **Multi Step**.

– Select **S Ref 1 / S Ref 2** and set the thickness to 5 mm.

– Select **S Ref 1 / S Ref 2** and set the thickness to 10 mm.

– Couple the probe to the 5 mm calibration block.

– Position the gate on the first backwall echo.

– In the Command bar tap on **Calibrate** (see page 66) to start the calibration process.

– Couple the probe to the 10 mm calibration block.

– Position the gate on the first backwall echo.

– In the Command bar tap on **Calibrate** to complete the calibration process.

Calibration using dual-element probes

Dual-element probes are especially used for wall thickness measurements. The following special features should be taken into account when using these probes:

V-path error

Dual-element probes produce a v-shaped sound path from the pulser via the reflection from the backwall to the receiver element. This V-path error affects the measuring accuracy. You should therefore choose two wall thicknesses that cover the expected thickness measurement range for the calibration. In this way, the V-path error can be corrected to a large extent.

Higher material velocity

Due to the V-path error, a higher material velocity than that of the material to be tested is given during calibration, especially with small thicknesses. This is typical of dual-element probes and serves for the compensation of the V-path error.

With thin wall thicknesses, the effect described above leads to an echo amplitude drop which has to be especially taken into account with thicknesses <2 mm.

A stepped reference block having different wall thicknesses is required for calibration. The wall thicknesses must be selected in such a way that they cover the expected measurement readings.

Note

Always keep in mind that the measurement value is determined at the intersection point of the gate and the echo flank if the function **Gate A TOF Mode** has been set to **FLANK**. The correct setting of the echo height and the gate threshold is therefore decisive for the accuracy of calibration and measurement!

Calibrations or measurements in **PEAK** mode require some experience when using dual-element probes in order to choose and set the correct echoes.

5.17 Defining the probe angle

The function group **Probe Angle** on the **Probe Angle Cal.** panel provides all functions to define the current index angle of a probe on a reference block. The current probe index angle is influenced, e.g. by different materials or by the wear of the probe contact face.

ATTENTION

You have to carry out calibration (see from page 145) before defining the probe angle.

– After calibration, select the **Probe Angle Cal.** panel and switch to the function group **Probe Angle** (see page 136).
– Select **Block** and choose the used calibration block.
– Check the values of **SDH Diameter** and **SDH Depth** and correct them if necessary.
– Couple the probe to the calibration block.
– Shift the gate to the calibration echo.
– In the Command bar tap on **Calibrate** (see page 66) to execute the calculation.

The calculated angle is briefly displayed in the information line at the bottom edge of the display screen.

5.18 dB REF

With the dB-difference measurement method (db REF) you can evaluate reflector echoes by means of reference echoes.

After selecting **dB REF** in the function **Eval Mode** in (see page 139) the function group **Evaluation** provides you with all the functions needed for the echo height comparison between a reflector echo and a reference echo.

Recording a reference echo

Before using the dB-difference measurement, you have to first record a reference echo.

If a reference echo has already been stored, you have to first delete it before recording a new reference echo (see section below).

– Peak the reference echo according to the test instruction.

– Use the function **Gate A Start** to position the gate A on the reference echo.

– Tap the **Calibrate** icon in the Command bar (see page 66). The reference echo is recorded and stored.

Deleting a reference echo

You can delete a stored reference echo at any time.

– Tap the **Clear** icon in the Command bar (see page 67). A confirmation message is shown.

– Confirm the deletion.

Echo height comparison

You can compare the echo from any chosen reflector with the reference echo.

The following values are available for indication in the **Measurement line** (see page 76).

- **dBrA**
  dB-difference between the reference echo and the highest echo in the gate A.
- **A%rA**
  Amplitude of the signal in the gate A in percent referred to the reference amplitude as 100 %.
- **dBrB**
  dB-difference between the reference echo and the highest echo in the gate B.
- **A%rB**
  Amplitude of the signal in the gate B in percent referred to the reference amplitude as 100 %.

Note

The dB-difference is independent of any possible gain variation.

5.19 DAC

You can evaluate reflector echoes by means of the distance-amplitude correction (DAC).

After selecting **DAC** in the function **Eval Mode** in (see page 139) the function group **Evaluation** provides you with all the functions needed for the echo height comparison between a reflector echo and a reference echo.

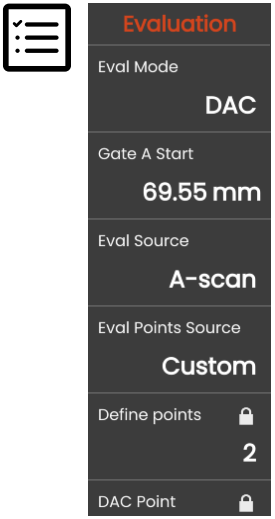
Due to the angle of beam spread and the sound attenuation in the material, the echo height of equally sized reflectors depends on the distance to the probe.

A distance-amplitude correction curve, recorded using defined reference reflectors, is a graphical representation of these influencing factors.

If you use a reference block having artificial flaws to record a DAC curve, you can use this echo amplitude for the evaluation of a flaw without any further corrections. The reference block should be made of the same material as the test object.

The time-corrected gain **TCG** increases the gain in distance sensitive mode so that all reference echoes reach 80 % screen height. The amplitude evaluation of echo indications is made in relation to the first reference echo.

– In the A-scan tap on the **Evaluation** icon to display the function group.



– In the function **Eval Mode** select **DAC**.

– Set all parameters in this function group (see from page 138).

Recording a DAC curve

ATTENTION

Before starting to record a reference curve, the instrument has to be correctly calibrated (see page 145).

As soon as a new curve is recorded, a possibly already existing curve must be deleted (see page 155). If necessary, make sure that the old curve has been saved to a free dataset before starting to record a new curve.

Note

You can configure the measurement line accordingly to display the specific readings (see page 105).

– Position the gate A on the first DAC echo (see page 86).

– In the Command bar tap on **AutoXX** (see page 66) to automatically set the echo to the required screen height.

– In the Command bar tap on **Calibrate** (see page 66) to record the first DAC point.

– Position the gate A on the second DAC echo.

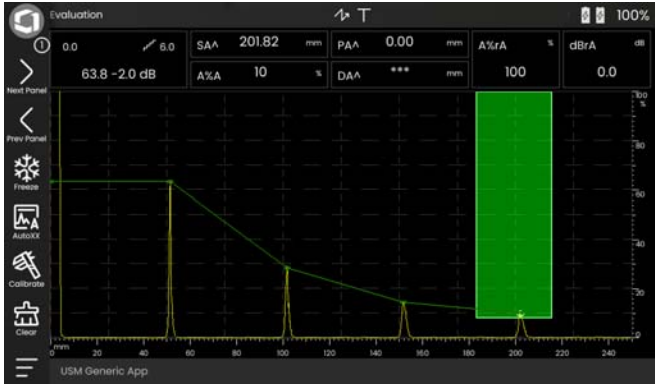
– In the Command bar tap on **AutoXX** to automatically set the echo to the required screen height.

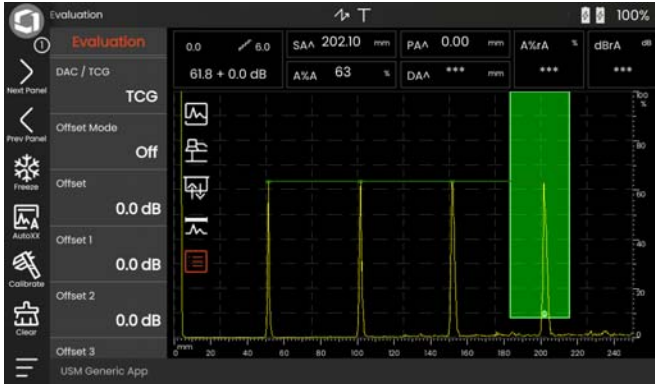
– In the Command bar tap on **Calibrate** to record the second DAC point.

– Record further DAC points in the same way. You can add individual DAC points at any time.

– If not yet done, then set the function **DAC / TCG** to **DAC** in order to display the DAC curve.

– Set the function **DAC / TCG** to **TGC** (time-corrected gain). The horizontal line of the time-corrected gain is displayed in the A-scan and all echoes are displayed at 80 % screen height of the first reference point.





Turning the DAC evaluation off

You can turn the DAC evaluation off at any time.

– Set the function **DAC / TCG** to **Off** in order to hide the curve.

Note

The DAC curve is not lost by turning the function off. By turning it on again, you can use the function **DAC / TCG** to go back to the DAC evaluation again without losing any settings.

Deleting the DAC curve

You can delete the DAC curve at any time. After this, the DAC evaluation is not possible until you have recorded a new DAC curve.

– In the Command bar tap on **Clear** (see page 67) to delete the DAC curve. A message box is displayed.

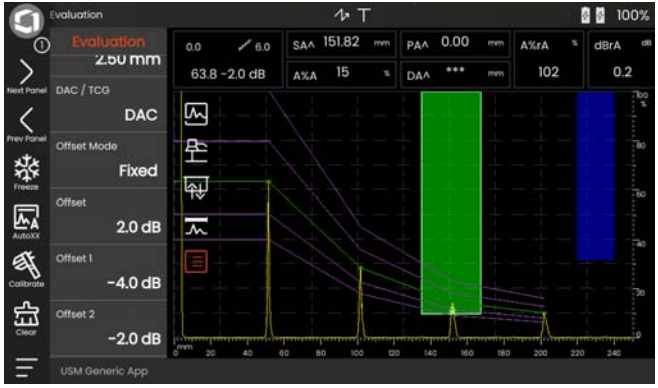
– Confirm the deletion of the DAC curve. The deletion is acknowledged in the **Information line** (see page 77).

Multiple DAC curves

You can activate multiple DAC curves and, at the same time, define the offsets between the multiple curves and the recording curve.

You can use fixed offsets for all curves or individual offsets for each curve.

– Set the **Offset Mode** (see page 140).
– If you have selected **Fixed**, set the desired value for **Offset** (see page 140).
– If you have selected **Custom**, set the desired values for several offsets starting with **Offset 1** (see page 140).



The offset 0.0 dB only represents the recording curve. Every setting varying from 0 produces four other curves with the corresponding dB offset between them.

For better distinction, the recording curve is shown in a different color with multiple DAC curves.

Echo evaluation using DAC/TCG

To be able to evaluate a flaw echo by means of the DAC, certain conditions must be met:

- The distance-amplitude correction curve has to be recorded beforehand.
- It only applies to the same probe that was used for recording the curve. It is not allowed to use even another probe of the same type!
- The curve only applies to the material corresponding to the material of the reference block.
- All functions affecting the echo amplitude must be set in the same way as they existed during the recording of the curve. This applies especially to the parameters voltage, frequency, rectification, material velocity, and reject.

Change in the probe delay with DAC/TCG

Generally, a change in the probe delay automatically also affects the shape of the sound field. This means that a new recording of the reference echo would be theoretically required. However, minor changes in the delay line, typically occurring due to the wear of the delay line, have no noticeable effect on the programmed distance laws.

ATTENTION

A recorded DAC curve no longer applies if the probe delay changes to a larger extent, e.g. caused by adding or removing a delay line after a DAC curve has been recorded.

The same applies to immersion testing: The DAC curve must be recorded after setting up the final water delay line.

Failure to do so may lead to evaluation errors.

Automatic variation of the measuring point in TOF mode

An echo amplitude evaluation is normally carried out at the echo peak of the signal under examination because this is the only way of ensuring that the displayed echo amplitude and the sound path (projection distance, depth position) always belong to the highest echo in the gate.

Note

The instrument checks the measuring point setting in TOF mode before processing any reference amplitudes. If **Peak** is not set as measuring point, the instrument will automatically switch to **Peak**. In this case, a note is displayed at the bottom edge of the display screen.

5.20 DGS

You can use the DGS mode (distance - gain - size) to compare the reflecting power of a natural flaw in the test object with that of a theoretical flaw (circular disk-shaped equivalent reflector) at the same depth.

ATTENTION

You are comparing the reflecting power of a natural flaw with that of a theoretical flaw. No definitive conclusions may be drawn about the natural flaw (roughness, inclined position, etc.).

The so-called DGS diagram forms the basis for this comparison of the reflecting power. This diagram consists of a set of curves showing the connection of three influencing variables:

- Distance **D** between the probe coupling face and the circular disk-shaped equivalent reflector
- Difference in gain **G** between a circular disk-shaped equivalent reflector and a reference reflector, e.g. an infinitely large backwall
- Size **S** of the circular disk-shaped equivalent reflector The influencing variable **S** remains constant for one curve in each set of curves.

The advantage of the DGS method lies in the fact that you can carry out reproducible evaluations of small discontinuities. This reproducibility is especially important, e.g. whenever you want to carry out an acceptance test.

In addition to the influencing variables already mentioned, there are other factors affecting the curve shape:

- sound attenuation,
- transfer losses,
- amplitude correction value,
- probe.

The following parameters of the probe affect the curve shape:

- element or crystal diameter,
- frequency,
- length of delay line,
- delay velocity.

You can adjust these parameters in the USM 100 in such a way that you can use the DGS method with many different probes and on various materials.

Note

Before setting up the DGS mode, the instrument has to be calibrated at first since none of the functions affecting the DGS evaluation (**Velocity**, **Probe Delay**, **Voltage**, **Damping**, **Frequency**, **Rectify**), can be changed any more after recording the reference echo.

For dual-element probes, the sound velocity can only be set between 5350 and 6500 m/s.

For more information on this subject, please refer to **Calibration**, page 145.

Validity of the DGS method

Echo amplitude evaluations using the DGS method are only reliable and reproducible under the following conditions:

- In test objects showing sound attenuation characteristics that cannot be neglected, the sound attenuation coefficient must be determined and entered in the DGS table. For this purpose, the sound attenuation coefficient is measured in the test object itself or in a reference test block made of identical material, with known reference reflectors at various distances according to the known methods and, afterwards, entered in the DGS tables. The subsequently displayed evaluation curve will then take the effective sound attenuation into account, independently of the distance.
- The reference echo must come from the test object if possible. If this is not possible, it should be ensured that the reference block is made of the same material as the test object.
- The evaluation must be carried out using the same probe that was used for recording the reference echo. Another probe of the same type can be used after recording a new reference echo.
- Echo amplitudes for reflector distances smaller than 0.7 of the near-field length of the probe used are subject to considerable variations, for physical reasons, due to the interference phenomena being effective in this area. Evaluation results may therefore vary by more than the usually permissible ±2 dB. It is therefore recommended to perform a DGS evaluation only in ranges above 0.7 of the near-field length of the probe.

Change in the probe delay with DGS

Generally, a change in the probe delay automatically also affects the shape of the sound field. This means that a new recording of the reference echo for the DGS setting would be theoretically required. However, minor changes in the delay line, typically occurring due to the wear of the delay line, have no noticeable effect on the programmed distance laws.

ATTENTION

An existing DGS setting no longer applies if the probe delay changes to a larger extent, e.g. caused by adding or removing a delay line after recording a DGS reference echo before changing the delay line.

The same applies to immersion testing: The DGS setting must be made after setting up the final water delay line.

Failure to do so may lead to evaluation errors.

Automatic variation of the measuring point in TOF mode

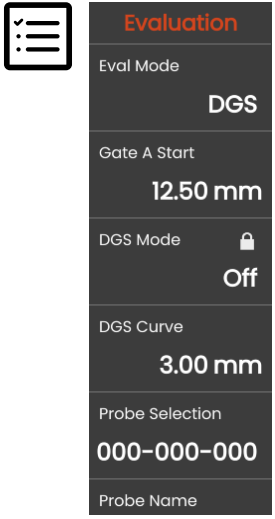
An echo amplitude evaluation is normally carried out at the echo peak of the signal under examination because this is the only way of ensuring that the displayed echo amplitude and the sound path (projection distance, depth position) always belong to the highest echo in the gate.

Note

The USM 100 checks the measuring point setting in TOF mode before processing any reference amplitudes. If **Peak** is not set as measuring point, the instrument will automatically switch to **Peak**. In this case, a note is displayed at the bottom edge of the display screen.

Settings for the DGS measurement

– In the A-scan tap on the **Evaluation** icon to display the function group.



– In the function **Eval Mode** select **DGS**.

– Set all parameters in this function group (see from page 138).

Recording a reference echo and turning the DGS curve on

To be able to display the required DGS curve, you have to record the reference echo.

– Peak the echo of the reference reflector, in this case the backwall echo from the test object.

– After this, position the gate A on the reference echo (see page 86).

– In the Command bar tap on **Calibrate** (see page 66) to record the reference echo.

The status icon **A DGS reference echo has been recorded** is displayed above the A-scan (see page 6).

– If not yet done, then set the function **DGS Mode** to **On** in order to display the curve.

Taking the general DGS diagram as a basis, the USM 100 calculates the required test sensitivity for displaying the 3 mm curve with its maximum at 80 % screen height, and makes this setting.

The curve is automatically adjusted in the case of subsequent gain variations.

The gain can be varied at any time. The difference in relation to the calibration value during the DGS calibration is directly displayed next to the gain value. If you set the function **DGS MODE** to **Off** and then to **On** again, the original gain setting is displayed with the difference value **+0.0**.

You can also adjust the DGS curve to the expected value of the ERS (equivalent reflector size) later on.

Locks, error messages

As long as a valid reference echo is stored, no functions can be changed which could cause an incorrect DGS evaluation, with the exception of **Probe Delay** (within tight limits). If an attempt is made to change such a function, the following error message appears:

Function locked: DGS reference has been recorded!

The DGS evaluation must likewise be turned off and the reference echo deleted when selecting a new probe, e.g. for a new test application.

Sound attenuation and transfer correction

There are two possibilities for setting the sound attenuation in the test object:

- before the DGS calibration using the function **Reference Attenuation**
- at any time (even after the DGS calibration) using the function **Test Attenuation**

The transfer corrections can be set as follows:

- before the DGS calibration using the function **Amplitude Correction**
- at any time (even after the DGS calibration) using the function **Transfer Correction**

The settings of the functions **Amplitude Correction** and **Transfer Correction** have an additive effect, likewise the settings of the functions **Reference Attenuation** and **Test Attenuation**.

Using multiple DGS curves

After turning the DGS evaluation on, at least one curve is displayed for a certain ERS (equivalent reflector size). For some test specifications according to DGS, certain tolerance limits in dB below and/or above this curve must be monitored.

You can set up to four additional curves by adjusting their offsets from the original curve in dB values. These curves have no effect on the displayed measurement reading or on other settings.

Turning the DGS evaluation off

You can turn the DGS evaluation off at any time.

– Set the function **DGS Mode** to **Off** in order to hide the curve.

Note

The DGS calibration is not lost by turning the function off. By turning it on again, you can use the function **DGS Mode** to go back to the DGS evaluation again without losing any settings.

Deleting a DGS reference echo

You can delete the echo of the reference reflector. After this, the DGS evaluation is not possible until you have recorded a new reference echo.

– In the Command bar tap on **Clear** (see page 67) to delete the reference echo. A message box is displayed.

– Confirm the deletion of the reference echo. The deletion is acknowledged in the **Information line** (see page 77).

Probe data

(Using SDH as reference reflector)

#	Probe name	Wavelength in steel [mm]	Min. diameter of SDH (1.5 λ) [mm]	Near-field length in steel (N) [mm]	Min. distance in steel (1.5 N) [mm]
1	B1-S	6.0	9.0	23	35
2	B2-S	3.0	4.5	45	68
3	B4-S	1.5	2.3	90	135
4	MB2-S	3.0	4.5	8	12
5	MB4-S	1.5	2.3	15	23
6	MB5-S	1.2	1.8	20	30
7 … 9	MWB …-2	1.6	2.4	15	23
10 … 12	MWB …-4	0.8	1.2	30	45
13 … 15	SWB …-2	1.6	2.4	39	59
16 … 18	SWB …-5	0.7	1.1	98	147
19 … 21	WB …-1	3.3	5.0	45	68
22 … 24	WB …-2	1.6	2.4	90	135

#	Probe	Wavelength in steel [mm]	Focus depth in steel [mm]
25	MSEB-2	3.0	8 ±2
26	MSEB-4	1.5	10 ±2
27	MSEB-4 0°	1.5	18 ±4
28	MSEB-5	1.2	10 ±2
29	SEB-1	5.9	20 ±4
30	SEB-2 KF5	3.0	6 ±2
31	SEB-4 KF8	1.5	6 ±2
32	SEB-2	3.0	15 ±3
33	SEB-4	1.5	12 ±2
34	SEB-2 0°	1.5	12 ±2

Note

The DGS curves for the dual-element probes are not derived from the general DGS diagram but have been individually measured for steel (5920 m/s) and stored in the instrument.

You can only carry out a DGS evaluation with one of the dual-element probes available if the sound velocity is between 5330 and 6500 m/s.

trueDGS angle-beam probes

trueDGS® angle-beam probes generate a rotationally symmetric sound field in the material to be tested like vertically beaming circular elements.

Because of this, the DGS evaluation using these angle-beam probes is considerably more accurate than with the conventional angle-beam probes which contain rectangular elements. In the case of conventional angle-beam probes, it may happen that the reflectors evaluated according to the DGS method are over-evaluated.

The following probes using the trueDGS® technology are currently available:

- MWB45-2 tD (probe # **35**)
- MWB60-2 tD (probe # **36**)
- MWB70-2 tD (probe # **37**)
- MWB45-4 tD (probe # **38**)
- MWB60-4 tD (probe # **39**)
- MWB70-4 tD (probe # **40**)

These new probes can be selected in the instrument. The corresponding settings are stored in the instrument and activated when the probe is selected.

5.21 AWS D1.1 / AWS D1.5

You can evaluate defects in welds according to the specifications AWS D1.1 or AWS D1.5.

After selecting **AWS D1.1** or **AWS D1.5** in the function **Eval Mode** in (see page 139) the function group **Evaluation** provides you with all the functions needed.

The rating of defects in welds according to the specification AWS D1.1 is based on an evaluation of the signal amplitude. In this method, the echo amplitude of the flaw echo is compared with the echo amplitude of a known reference reflector. In addition, the sound attenuation in the test object is also taken into account.

The result is a dB value which is called flaw class. The flaw class D is calculated according to the formula:

$D = A – B – C$

with:

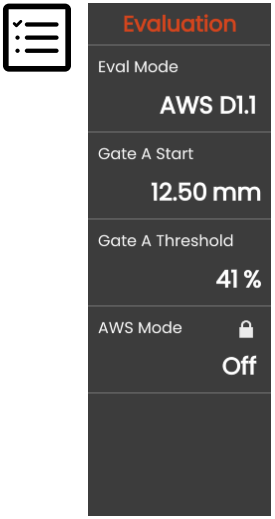
- **A = flaw gain (in dB)**
  Absolute instrument gain with which the maximum flaw echo is at 50 % (±5 %) echo height.
- **B = reference gain (in dB)**
  Absolute instrument gain with which the maximum reference echo (e.g. the 1.5 mm side-drilled hole from the reference standard K1 or IIW type 1 or 2) is at 50 % (±5 %) echo height.
- **C = sound attenuation factor (in dB)**
  The value is calculated according to the formula: $C = 0.079\ dB/mm \cdot (s – 25.4\ mm)$, with s = sound path of the flaw echo. The sound attenuation correction is calculated and displayed automatically by the instrument. The value is set to zero for sound paths smaller than or equal to 25.4 mm (1 inch).
- **D = flaw class (in dB)**
  This is the result of the evaluation according to AWS. The calculation is made in the instrument according to the above-mentioned formula.

Note

Make sure that all instrument options for the specific test are calibrated before starting the rating according to AWS D1.1 or AWS D1.5.

Remember to peak an echo with an amplitude between 45 % and 55 % screen height. A rating is not possible with other amplitudes.

– In the A-scan tap on the **Evaluation** icon to display the function group.



– In the function **Eval Mode** select **AWS D1.1** or **AWS D1.5**.

– Select the specific AWS parameters in the measurement line (see page 105).

– Couple the probe to the reference standard and maximize the echo from the 1.5 mm side-drilled hole.

– After this, position the gate A on the reference echo (see page 86).

– Adjust the gain so that the reference echo is indicated at 50 % screen height.

– In the Command bar tap on **Calibrate** (see page 66) to record the reference gain (**B**).

– Couple the probe to the test object to evaluate a flaw echo.

– Position the gate A on the flaw echo.

– Adjust the gain so that the flaw echo is indicated at 50 % screen height.

– In the Command bar tap on **Calibrate** to store the current flaw gain (**A**).

The USM 100 calculates the values of the AWS variables **C** and **D** which can be displayed in the measurement line.

5.22 JISDAC

The USM 100 has a DAC function for the echo evaluation by means of the distance-amplitude correction (DAC) and an additional class rating according to JIS Z3060-2002.

With the function JISDAC, you can activate a distance-amplitude curve according to JIS including three evaluation lines marked with the letters L (low), M (medium), and H (high). They are permanently connected to the DAC and shifted accordingly if the gain is varied.

In addition, a class rating takes place. Flaw echoes are evaluated according to their amplitude with reference to their position within the set of curves:

Class I: Amplitude < Line L

Class II: Line L < Amplitude < Line M

Class III: Line M < Amplitude < Line H

Class IV: Amplitude < Line H

5.23 CNDAC

CNDAC (China Distance Amplitude Correction) is an evaluation method for ultrasonic weld testing, based on the standards JB/T4730 and GB 11345 of the People's Republic of China.

In CNDAC, reference lines are defined for:

- the rejection (Reject Line RL),
- the amplitude measurement (Sizing Line SL), and
- the evaluation (Evaluation Line EL).

Defined as references are side-drilled holes having certain diameters.

The option **Custom** in the function **Code** allows the specification of an own reference block, whose data must be documented separately.

Evaluations according to CNDAC

After recording the reference echo, the CNDAC shows the reference lines **RL**, **SL**, and **EL** depending on the corresponding choice in the functions **Code** (standard) and **Cal Block** (reference block).

The reference line **SL** is used for the amplitude measurement. It can be assigned to all gates available (reading = **SLA**, **SLB**, optionally **SLC**).

Examples:

SLA indicates the difference in amplitude of an echo in the gate A in relation to the reference curve SL at the position of the echo in dB.

dBrA is identical with **SLA**.

A%rA indicates the difference in amplitude of an echo in the gate A in relation to the reference curve SL at the position of the echo in %. In this connection, the reference curve at the position of the echo is assumed at 100 %.

Standards and reference blocks

Code	Cal Block	Ø SDH (mm)	Wall thickness (mm)	RL (dB)	SL (dB)	EL (dB)
11345A	RB	3	–	DAC	DAC – 10	DAC – 16
11345B	RB	3	–	DAC – 4	DAC – 10	DAC – 16
11345C	RB	3	–	DAC – 2	DAC – 8	DAC – 14
4730	CSK IIA	2	8 … 46	DAC – 4	DAC – 12	DAC – 18
4730	CSK IIA	2	46 … 120	DAC + 2	DAC – 8	DAC – 14
4730	CSK IIIA	1	8 … 15	DAC + 2	DAC – 6	DAC – 12
4730	CSK IIIA	1	15 … 46	DAC + 5	DAC – 3	DAC – 9
4730	CSK IIIA	1	46 … 120	DAC + 10	DAC	DAC – 6
4730	CSK IVA	–	–	DAC	DAC – 10	DAC – 16
CUSTOM	CUSTOM	–	–	DAC	DAC	DAC

Documentation 6

6.1 Test reports

Saving test reports

You can use the USM 100 to save test reports. Test reports are stored as PDF files.

To view and print PDF files on computers, you need the free Acrobat Reader from Adobe. You can download it from the Adobe website and install it on your computer (https://www.adobe.com/acrobat.html).

To save the test report use the functions in the Command bar:

- **Save report** (see page 69)
- **Save multiple page report** (see page 69)

A message in the information line confirms the successful storing.

Printing test reports

The USM 100 is not meant to be directly connected to a printer.

You can use standard software (text and image editors) on your computer to view, edit, and print out the test reports and A-scans stored in the USM 100.

To do this, export the test reports to a USB stick (see page 189). Then connect the USB stick containing the test reports to your computer.

Deleting test reports

You can delete test reports stored in the USM 100 at any time (see page 190).

Displaying test reports

You can display test reports saved in the instrument on the screen of the USM 100.

Test report setup

A test report can contain different information and data, as well as screen captures.

Test report templates are created and edited with the software **Mentor Create**, which is described in a separate manual.

6.2 Screen captures

You can save an image of the entire screen. Screen captures are saved in the selected default directory. The file name is generated automatically and consists of the name of the current application, the date and the time, for example USM100_Standard_2021-03-02_16.09.49.

You can rename all stored files directly with the USM 100 (see page 189).

You can find the **Screen capture** function in the **Command bar** (see page 66).

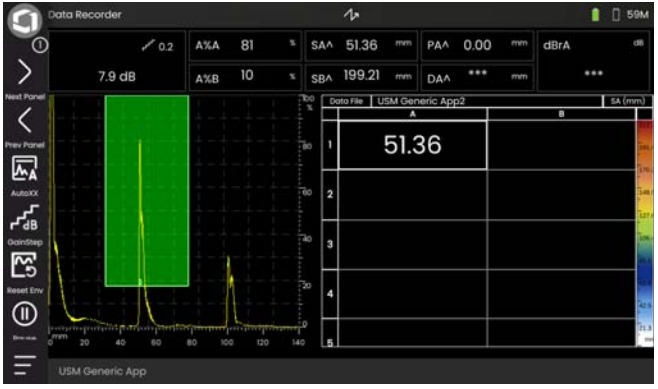
– If required, tap the **Freeze** icon in the Command bar.

– Tap the **Screen capture** icon. The screen capture is stored immediately.

A message in the information line confirms the successful storing.

6.3 Data Recorder

All functions and settings for documentation with the data recorder can be found on the **Data Recorder** panel (see page 72 for panel selection).



The data recorder enables you to easily manage test tasks with wall thickness measurements, and to store and to document readings in a structured manner with or without an A-scan.

You can store readings in a grid matrix and, in this way, structure them according to the test tasks. The grid matrix consists of rows and columns.

In this way, you can e.g. use the rows for test locations and the columns for single test points. In a grid matrix consisting of 9 rows and 4 columns, you will then store the results of a test location in one row each. If you have not processed a test point, the corresponding cell in the grid matrix remains empty.

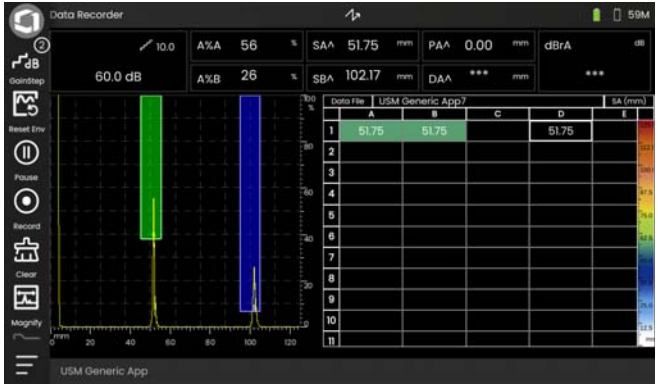
Switching between views

Together with the grid matrix the A-scan is displayed. This allows you to change UT settings without having to switch to another panel.

As an alternative the split-screen view, you can display either the A-scan or the data recorder matrix in full screen.

– Double-tap in the respective screen area to switch to the full-screen view.

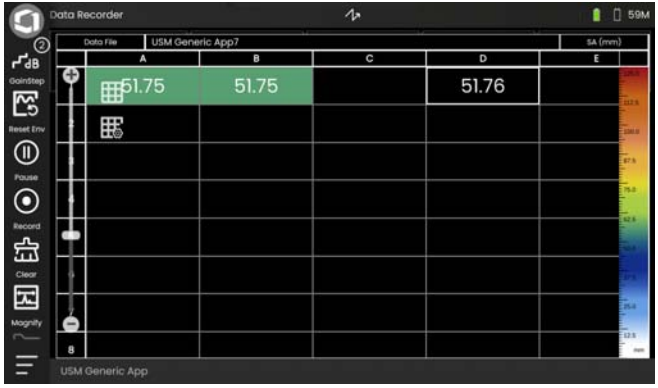
– Double-tap in the full-screen view to return to the split-screen view.



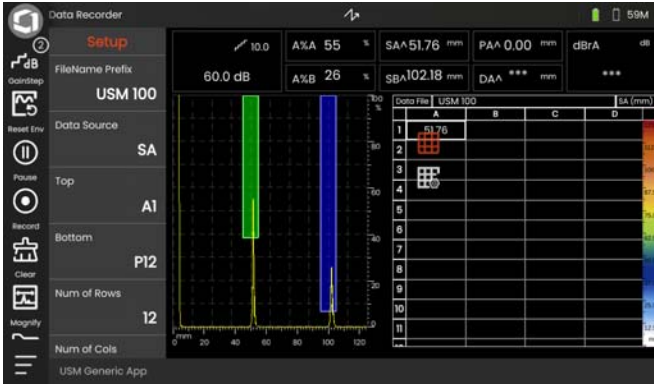
Changing the display size

– In the grid matrix tap on the first column with the row numbers. A slider is displayed.

– Tap the + (plus) and - (minus) symbols or move the slider to change the display size of the grid matrix.



Creating a data recorder file



Before you are able to store readings in a grid matrix, you have to create a data recorder file.

Among others, you define the following parameters:

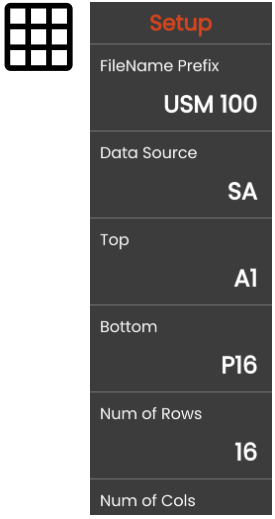
- the size (number of rows and columns),
- the automatic filling advance direction for the readings, and
- the data source for the readings (e.g. the sound path in a gate or between two gates).

ATTENTION

After generating the file, you can no longer change the number of rows and columns.

– Tap in the grid matrix to display the available function group icons.

– Tap on the **Setup** icon to display the function group.



FileName Prefix

You can enter a name for the Data Recorder file. If you start a new grid matrix and do not change the name, a sequential numbering is automatically appended to the name.

Data Source

You can select which reading should be stored in the grid matrix fields. This selection applies to all fields.

Possible options:

SA = sound path in gate A

SB = sound path in gate B

SBA = sound path between gates B and A

Amp A = amplitude (% screen height) in gate A

Amp B = amplitude (% screen height) in gate B

Top

You can set the name of the first field (top left) of the grid matrix. Together with the designation of the last field (**Bottom**), this then results in the total size of the grid matrix.

Alternatively, you can specify the number of rows (**Num of Rows**) and columns (**Num of Cols**).

For the name only combinations of letters (from A to ZZ) and numbers (from 1 to 999) are allowed, for example A1 or FA200, similar to tables in MS Excel.

Bottom

You can set the name of the last field (bottom right) of the grid matrix. Together with the designation of the first field (**Top**), this then results in the total size of the grid matrix.

Alternatively, you can specify the number of rows (**Num of Rows**) and columns (**Num of Cols**).

For the name only combinations of letters (from A to ZZ) and numbers (from 1 to 999) are allowed, for example A1 or FA200, similar to tables in MS Excel.

Num of Rows

You can set the total number of rows for the grid matrix. Together with the number of columns (**Num of Cols**), this then results in the total size of the grid matrix.

Alternatively, you can specify the first (**Top**) and the last (**Bottom**) field of the grid matrix.

The maximum number of rows is 999.

Num of Cols

You can set the total number of columns for the grid matrix. Together with the number of rows (**Num of Rows**), this then results in the total size of the grid matrix.

Alternatively, you can specify the first (**Top**) and the last (**Bottom**) field of the grid matrix.

The maximum number of columns is 999.

Advance Dir

You can set select the automatic filling advance direction for the grid matrix. With the setting **Row**, a row is completely filled from left to right before readings are stored in the next row. With the setting **Column**, a column is completely filled from top to bottom before switching to the next column.

Auto Reverse

If you switch on the **Auto Reverse** function, the filling direction always reverses when the end of a row or column is reached. Every second row is then filled from right to left, every second column from bottom to top.

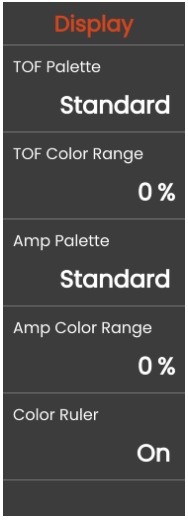
Selected

You can select a specific field to save the next measured reading there.

Alternatively, you can select a field by tapping in the field on the screen.

Display

With the **Display** settings you can



TOF Palette

Based on the stored TOF reading, the fields of the grid matrix are shaded in color. You can select the color palette for these colors.

TOF Color Range

This function can be set in the software **Mentor Create** only, which is described in a separate manual.

Amp Palette

Based on the stored amplitude reading, the fields of the grid matrix are shaded in color. You can select the color palette for these colors.

Amp Color Range

This function can be set in the software **Mentor Create** only, which is described in a separate manual.

Color Ruler

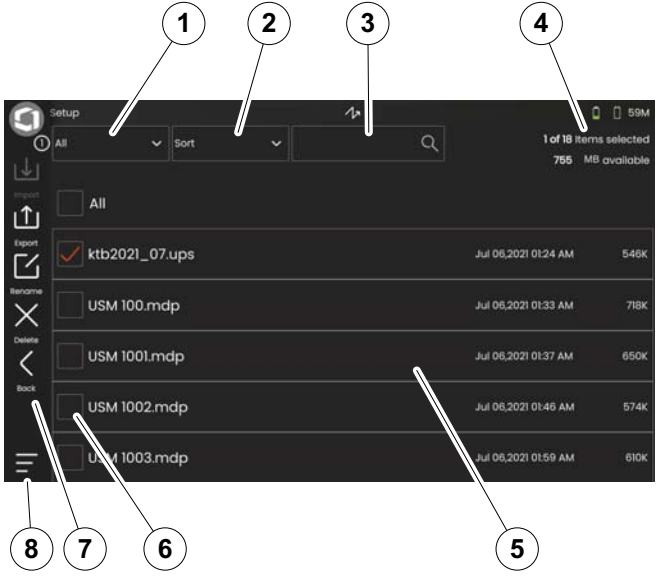
You can switch the color ruler at the right edge of the grid matrix on or off.

6.4 File management

All file management functions can be found in the **Main menu** (see page 60) under **File management**.

For special information on handling application files, see page 61.

The functions for saving reports, settings and screenshots as well as for loading settings and data can be found in the **Command bar** (see page 66).



1 Select file category

2 Sort displayed files

3 Search file

4 Information on file selection and free memory in the instrument

5 List of files stored in the instrument

6 File selection checkbox for subsequent operation

7 File management functions (see page 188)

8 **Main menu** (see page 60)

File management functions

Icon	Function	Page
	**Import**	188
	**Export**	189
	**Rename**	189
	**Delete**	190
	Back	

Import

You can import files from a USB stick or from the InspectionWorks server to the instrument's internal memory, for example settings or applications.

If you want to import one or more files from a USB stick, then first insert the USB stick into the socket on the top of the instrument (see page 52).

For data exchange with InspectionWorks, the USM 100 must be connected to the Internet via LAN (see page 201) or WLAN (see page 202).

– Tap on the **Import** icon. A dialog window opens.

– Select the file source **USB Drive** or **IW** (InspectionWorks).

– If necessary, tap on a folder symbol to select a directory, then select the files.

– Tap on **Download** to copy the selected files to the instrument.

– Tap on the **Back** icon to go back to the previous view.

Export

You can export files from the instrument's internal memory to a USB stick or to the InspectionWorks server, for example for backup purposes or for forwarding or further processing.

If you want to export one or more files to a USB stick, then first insert the USB stick into the socket on the top of the instrument (see page 52).

For data exchange with InspectionWorks, the USM 100 must be connected to the Internet via LAN (see page 201) or WLAN (see page 202).

– In the list of files (see page 187) tap the check boxes of the files you want to export.

– Tap on the **Export** icon. A dialog window opens.

– Select the export location **USB Drive** or **IW** (InspectionWorks).

– If necessary, tap on a folder symbol to select a directory, then select the files.

– Tap on **Upload** to copy the files to the selected location.

– Tap on the **Back** icon to go back to the previous view.

Rename

You can rename the files stored in the instrument's internal memory.

– In the list of files (see page 187) tap the check box of the file you want to rename.

– Tap on the **Rename** icon. A dialog box opens.

– Tap in the text field. A keyboard is displayed.

– Enter the name for the file.

– Tap on the keyboard symbol at the bottom right of the keyboard to hide the keyboard again.

– Tap on **OK** to save the file with its new name.

Delete

You can delete the files from the instrument's internal memory.

Note

Before deleting, you can export the files for backup purposes (see page 189). The deletion can not be undone.

– In the list of files (see page 187) tap the check boxes of the files you want to delete.

– Tap on the **Delete** icon. A dialog box opens.

– Tap on **Delete** to delete the selected file.

Maintenance and care 7

7.1 Maintenance

The USM 100 requires basically no maintenance.

ATTENTION

Any repair work may only be carried out by members of authorized Waygate Technologies service staff.

7.2 Instrument care

Clean the instrument and its accessories using a moist cloth. The following are exclusively recommended for cleaning:

- Water,
- a mild household cleaner, or
- alcohol (no methyl alcohol).

ATTENTION

Do not use any methyl alcohol, and no solvents or dye penetration cleaners! The plastic parts may be damaged or become brittle due to them.

7.3 Battery care

Transport and storage

ATTENTION

Lithium batteries, identified as being defective for safety reasons, or that have been damaged, that have the potential of producing a dangerous evolution of heat, fire or short circuit are forbidden for transport by air.

Pay attention to the permissible ambient conditions for transport and storage (see **Specifications** from page 219).

To prevent short circuits and the associated heating, lithium batteries must never be stored or transported unprotected. Suitable measures against short circuits are

- inserting the batteries in original packaging, in the system case of the instrument or in a plastic bag,
- taping the battery terminals.

Before transporting by air,

- make sure that the battery charge is below 30%,
- pay attention to the information on transport and storage in the technical documentation of the specific battery,
- follow the instructions of the shipping company for packing and transport of lithium batteries.

Charging

The capacity and life of batteries mainly depend on the correct handling. Therefore, please observe the tips below:

You should charge the batteries in the following cases:

- before the initial startup,
- after a storage time of 3 months or longer,
- after frequent partial discharge.

Battery life and temperature

The amount of time that the USM 100 can be run on fully charged batteries (and the heat generated internally) is directly related to current consumption in the instrument electronics.

One of the largest consumers of current, and the one most directly controllable by the user, is the brightness of the display. Running the display brighter than necessary will drain the battery faster and make the instrument run hotter.

We recommend setting the display brightness as low as possible (see page 100) and choosing the best color scheme for your lighting conditions. Our experience shows that 25% brightness works well for most applications, with the **DARK** color scheme for indoor use and the **LIGHT** color scheme for outdoor (see page 100).

Disposal of batteries

Lithium batteries are marked with the symbol of the crossed out symbol.

The symbol reminds you that batteries should not be disposed of with household waste, but must be collected separately (see **Disposal of batteries**, page 217).

To prevent short circuits and the associated heating lithium batteries must never be stored or transported unprotected (see **Transport and storage**, page 193).

7.4 Software updates

You can install the latest software updates for the USM 100 yourself.

Note

It is recommended to check for latest updates before using the instrument.

Look up the version installed in your instrument in the **About** section (see page 104) in the **General settings** menu (see page 99).

For software updates you need a valid update file (extension .**mup**). Software updates are available via **InspectionWorks**.

You can install the update file from a USB stick. If no USB stick is inserted or if no update file is found on it, the instrument will automatically try to connect to the **InspectionsWorks** platform and download and install the update file from there. The prerequisite for this is an established Internet connection via LAN (see page 201) oder WLAN (see page 202).

Installing an update

ATTENTION

During the update process, the power supply must not be interrupted. The battery charge must be at least 60% or you must connect the instrument to the power adapter.

– Copy the update file into the root directory of the USB stick.

– Insert the USB stick into the socket on the top of the instrument (see page 52).

– Access the **General settings** menu via the **Main menu** (see page 60).

– Select **Updates** from the left column.

– Tap on **Check**. The data of the update files is shown.

– Tap on **Install** to start the installation.

After successful installation the instrument is shut down automatically. Then, you can power on the instrument again and use the new software version.

Update in case of malfunction

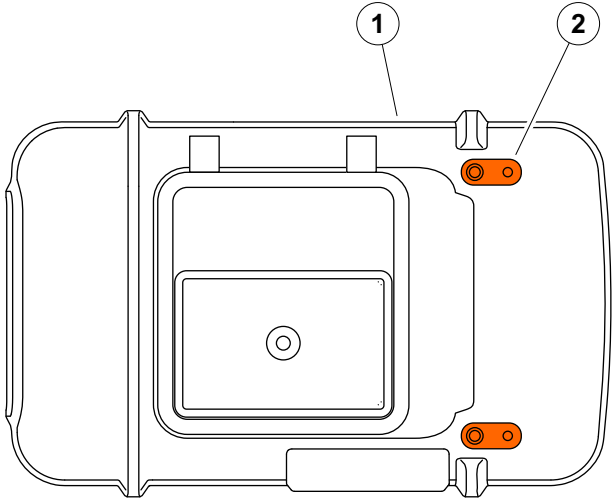
In the event of a system crash or if the instrument can no longer be started in the normal way, you can reset or reinitialize the operating system with a software update. To do this, you need a valid update file (extension .**mup**) on a USB stick.

– Copy the update file into the root directory of the USB stick.

– Make sure that the instrument is switched off.

– Insert the USB stick into the USB socket on the top of the instrument (see page 52).

– Simultaneously press the outer Gain key (2) on the back and the Power key (1) on the top, and hold the two keys pressed until the display is turned on.



The installation process will then start. After successful installation the instrument is shut down automatically. Then, you can power on the instrument again and use the new software version.

7.5 License upgrade

You can import licenses, which will then unlock additional functions for your instrument. For this you need a valid license file (extension .**mlp**).

You can import the license file from a USB stick.

– Copy the license file into the root directory of the USB stick.

– Insert the USB stick into the socket on the top of the instrument (see page 52).

– Tap on **Upgrade**. The license file on the USB stick is shown.

– Select the license file and tap on **Upgrade** to start the import.

After successful import the new license is shown next to the upgrade button (**My Device Model**).

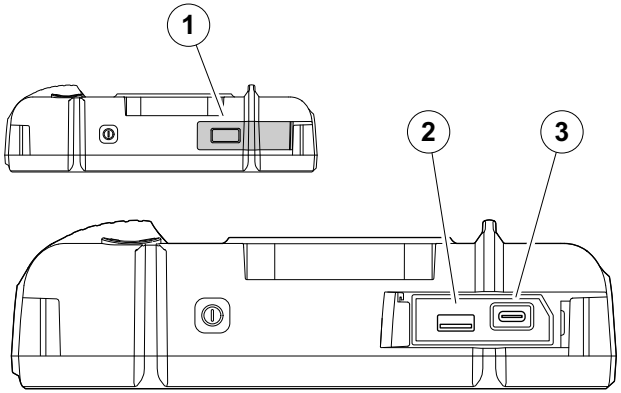
Interfaces and Peripherals 8

8.1 Interfaces

Overview

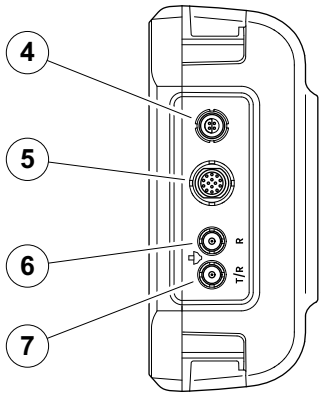
The interfaces are located on the top and on the right side of the instrument.

– To access the interfaces on the top of the instrument, slide the lid (1) to the right side until it swings open upwards.



The following interfaces are available:

- USB-A connector (2)
- USB-C connector (3)
- Connection for power adapter (4)
- I/O interface (5)
- Receiver connection (6)
- Transmitter/receiver connection (7)



USB-A interface

The USB interface type A (see page 200) is used for data exchange between the instrument and a standard USB stick (see page 52).

ATTENTION

It is not allowed to connect the instrument to a computer via a standard USB cable. Connection to a computer via USB interface could lead to serious damage and malfunctions.

USB-C interface

The USB interface type C (see page 200) can be used to connect a USB-C docking hub.

By means of the docking hub you can connect the USM 100 to the LAN network and connect other peripherals (monitor, mouse, keyboard) to the instrument.

When connected via LAN network the dedicated software **USM 100 PC** can be used, besides other things, to control the instrument.

The USB interface type C can also be used for data exchange between the instrument and a USB stick with type C plug.

WLAN

The USB interface type A (see page 200) can be used to connect a WLAN adapter.

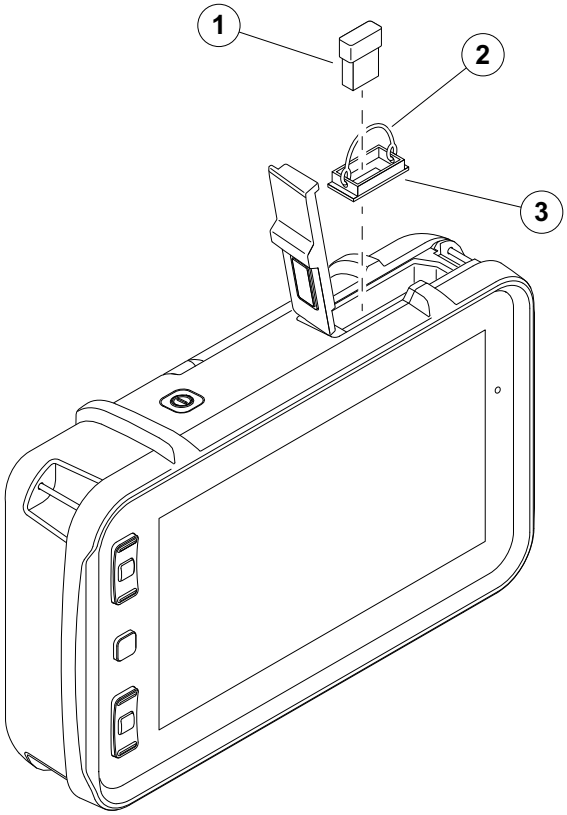
Note

It is recommended to plug in the WLAN adapter together with an extraction tool to make it easier to pull out the very small adapter later.

– Place the WLAN adapter (1) in the extraction tool (3).

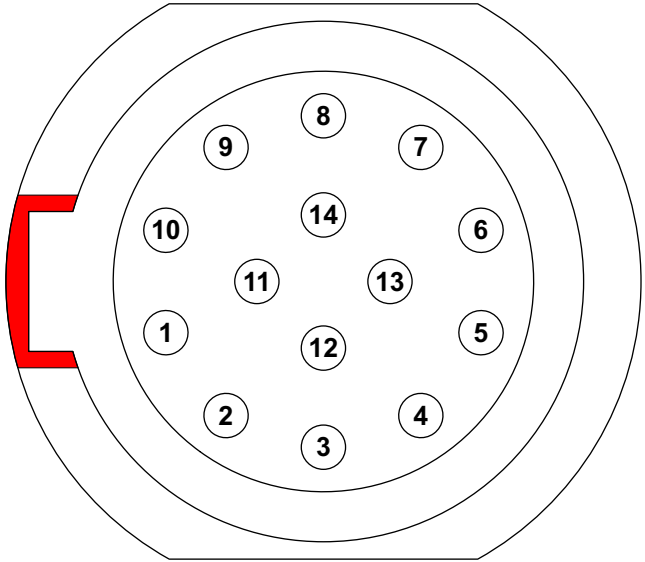
– Plug both together into the USB-A socket.

– Pull the WLAN adapter out of the socket by the loop (2) of the extraction tool.



I/O interface

The I/O interface (see page 200) is providing different input and output signals like gate alarm output (combined for all gates or individual for one selected gate), analog output, encoder inputs and signals for service purposes for the Waygate Technologies customer support.



Pin	Function		Color on cable 156M2384 Lemo LM.SDA311.[A][B]
1	Output	Analog signal, analog voltage corresponding to gate amplitude or TOF within the gate, 0 … 5V, I_{max} = 5 mA	Light blue
2	Output	SAP, external trigger, 5 V TTL, I_{max} = 5 mA	Pink
3	Output	Alarm signal, 0 V or 5 V, I_{max} = 5 mA, hold time 500 ms, also used for external horn	White
4	Input	Encoder x+	Gray
5	Input	Encoder x–	Purple
6	Input	Encoder y+	Orange
7	Input	Encoder y–	Yellow
8	Output	GND, system ground	Green
9	Input	Scan signal to start and stop encoded scan, 5 V TTL, I_{max} = 5 mA	Red
10	Output	For service, UART_TXD (RS232)	Light brown
11	Input	For service, UART_RXD (RS232)	Black
12	Output	+5 V power for encoder, 100 mA	Light gray
13	Output	Test signal	Brown
14	NC	No connection	Nature

Appendix 9

9.1 UT Function directory

Note

Some functions are only available if the corresponding options are enabled by entering the license code.

Function name	Gain									Page
2-Point Cal Source								■		135
A-Scan Color		■								113
Acceptance Level									■	144
Acceptance Line									■	144
AGC Mode					■					123
AGC Max Amp / AGC Min Amp					■					124
AGC Noise					■					124
Alarm Output					■					124
Amplitude Correction									■	142
Amplitude Ruler		■								112

Function name	Gain									Page
Analog Output					■					125
Angle Cal Source								■		137
Auto XX Amplitude	■									108
Averaging				■						121
AWS Mode									■	143
Block								■		136
Bold Line									■	143
C/IF Gate Mode						■				133
Cal Block									■	144
CNDAC Mode									■	143
Code									■	144
Color Leg		■								114
Color Palette		■								113
Curve Color									■	141

Function name	Gain									Page
Custom Gain Step	■									108
DAC / TCG									■	140
DAC Distance									■	140
DAC Point									■	140
Damping				■						121
dbRef Mode									■	139
Defect Length									■	144
Define Points									■	139
Delay Velocity			■						■	118
DGS Curve									■	141
DGS Mode									■	141
Display Delay		■								110
Display Range		■								109
Dual Mode				■						122

Function name	Gain									Page
Effective Diameter			■							118
Envelope		■								112
Envelope Color		■								112
Eval Mode									■	139
Eval Source									■	139
Eval Points Source									■	139
Evaluation Line									■	144
FileName Prefix		■								115
Filter				■						121
Freeze Mode		■								111
Frequency			■						■	118
Gain	■				■					107
Gain Step	■									107
Gate A Logic						■				131

Function name	Gain									Page
Gate A Start										127
Gate A Threshold										127
Gate A TOF Mode										128
Gate A Width										127
Gate B Logic										131
Gate B Start										131
Gate B Start Mode										132
Gate B Threshold										131
Gate B TOF Mode										131
Gate B Width										131
Gate C Logic										133
Gate C Start										133
Gate C Threshold										133
Gate C TOF Mode										133

Function name	Gain									Page
Gate C Width						■				133
Gate Selection						■				126
Grid		■								112
Grid Color		■								113
JISDAC Mode									■	143
LED Alarm					■					124
Magnify gate					■					125
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9.2 Manufacturer

The ultrasonic flaw detector USM 100 is manufactured by:

Baker Hughes Digital Solutions GmbH
Robert-Bosch-Straße 3
50354 Hürth
Germany

T +49 (0) 22 33 601 111
F +49 (0) 22 33 601 402

The USM 100 is manufactured according to the 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 and workmanship of the instrument.

Should you nevertheless detect an error on your instrument, power the instrument off and remove the batteries. Inform your local Waygate Technologies customer service and support, indicating the error and describing it.

Keep the shipping container for any repairs possibly required which cannot be made on the spot.

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

Baker Hughes Digital Solutions GmbH

Service-Center
Robert-Bosch-Straße 3
50354 Hürth
Germany

or:

Postfach 1363
50330 Hürth
Germany

T +49 (0) 22 33 601 111
F +49 (0) 22 33 601 402

9.3 Service contacts

Region	Location	Contact	
Europe	Germany / Headquarters	waygate.service.utsp@bakerhughes.com	+49 2233 601 111
Europe	UK	waygate.service.uk@bakerhughes.com	+44 845 601 5771
Europe	France	waygate.service.fr@bakerhughes.com	+33 4 72 17 92 16 +33 4 72 17 92 22 +33 4 72 17 92 23
Europe	Spain	waygate.service.es@bakerhughes.com	+34 91 7920321
Asia	Japan	UT.Services.Japan@bakerhughes.com	+81 3 6864 1737
Asia	Singapore	asiaservice.rvi@bakerhughes.com	+65 6213 5507
China	China	China_inhouse_service@bakerhughes.com	+86 400-818-1099
India	India	svc.it.india@bakerhughes.com	+91 2135620426
Latin America	Brazil	waygate.latam@bakerhughes.com	+55 11 3958 0098 +55 19 2104 6983
North America	USA	waygate.usa@bakerhughes.com	+1 832 325 4368
Russia	Russia	wt.service.RCIS@bakerhughes.com	+7 495 771 72 40 4320

9.4 Environmental protection regulations

This section contain information about the following topics:

- WEEE directive
- Disposal of batteries

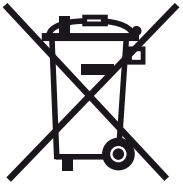
WEEE directive (Waste Electrical and Electronic Equipment)

Waygate Technologies is an active participant in Europe's Waste Electrical and Electronic Equipment (WEEE) take-back initiative, directive 2012/19/EU.

The instrument that you have bought has required the extraction and use of natural resources for its production. It may contain hazardous substances that could impact health and the environment.

In order to avoid the dissemination of those substances in the environment and to diminish the pressure on our natural resources, we advise you to use the appropriate take-back systems. Those systems will reuse or recycle in an environmentally safe way most of the materials of your instrument which is no longer capable of functioning.

The crossed-out wheeled bin symbol invites you to use those systems.



If you need more information on the collection, reuse, and recycling of recyclable material, please contact your local waste management company.

Visit **ec.europa.eu/environment/waste/weee/index_en.htm** for take-back instructions and more information about this initiative.

Disposal of batteries

This product contains batteries that cannot be disposed of as unsorted municipal waste in the European Union. Please read carefully the data sheets for the battery type used. Each battery is marked with this symbol which indicates that the product may contain cadmium (Cd), lead (Pb), or mercury (Hg). For proper recycling, return the batteries to the manufacturer or to a designated collection point.

What do the markings mean?

Batteries and accumulators must be marked (either on the battery, on the accumulator, or on their packaging, depending on the size) with the separate collection symbol. In addition, the marking must include the chemical symbols of specific levels or toxic metals as follows:

- Cadmium (Cd) over 0.002 %
- Lead (Pb) over 0.004 %
- Mercury (Hg) over 0.0005 %

The risks and your role in minimizing them

By participating in the proper waste disposal, you would make a valuable contribution towards reducing the damages possibly caused to the environment and human health by the batteries or accumulators. For proper recycling, you should return the instrument and/or the batteries it contains to the manufacturer or to a designated collection point.

Some batteries or accumulators contain toxic metals that pose serious risks to human health and to the environment. When required, the product marking may include chemical symbols that indicate the presence of toxic metals in the product: Pb for lead, Hg for mercury, and Cd for cadmium.

- **Cadmium** poisoning can result in cancer of the lungs and prostate gland. Chronic diseases may include kidney damage, pulmonary emphysema, as well as bone diseases such as osteomalcia and osteoporosis. Cadmium may also cause anemia, discoloration of the teeth, and anosmia (loss of smell).
- **Lead** is poisonous in all compounds. It accumulates in the body so that any form of exposure is critical. Ingestion and inhalation of lead can cause severe internal injuries. These may result in brain damage, convulsions, malnutrition, and sterility.
- **Mercury** creates hazardous vapors already at room temperature. Exposure to high concentrations of mercury vapor can cause a variety of severe symptoms. These include e.g. chronic inflammation of mouth and gums, personality change, nervousness, fever, and rashes.

Specifications 10

General features

Dimensions (W × H × D)	216 mm × 138 mm × 60 mm
Weight	1.2 kg (including two batteries)
Input supply voltage	+15 V DC
Battery operational time	5 h
Number and type of batteries	2 × Li-Ion, 1 for hot swap
Storage temperature	–20 … +70 °C
Operating temperature	–10 … +50 °C
Pulse repetition frequencies	10 … 2000 Hz
Maximum power consumption	45 W
Typical power consumption	9 W
Available measurement units	mm, inches
Compliance to UT standard	EN ISO 22232-1

Environmental

Protection grade	IP 67
Shock	IEC 60068-2-27
Vibration	IEC 60068-2-6
Humidity	EN 60068-2-30:2005
EMC	EN 61326-1, EN 55011
Low Voltage Directive	IEC 61010

Display

Screen size and resolution	1024 × 600 pixels
Range of sound velocities	250 … 16000 m/s
Available views	A-scan; B-,C-scan only available in certain models
Delay	–10 … +3500 µs
Depth	3 … 27000 mm (in steel)
Maximum digitization frequency without processing	100 MHz
Digitization frequency with processing	400 MHz
Digitizer vertical resolution	23 bit

Highest digitized frequency according to ISO 22232-1	30 MHz
Time base error	<+/- 0,5%

Interfaces

Power input	Lemo 0S
Probe connectors	Lemo 00
Input/Output	Lemo 1B, 14 pin
USB 2.0	Type A
USB 3.0	Type C

Transmitter

Pulse repetition frequency	10 … 2000 Hz
Shape of transmitter pulse	negative unipolar pulse
Transmitter voltage	50 … 350 V (10 V increments)
Fall time	<15 ns
Duration	40 … 2500 ns
Damping resistor	50 or 400 Ohm
Output impedance	<5 Ohm

Receiver

Maximum input voltage	40 Vpp
Linearity of vertical display	+/-2%
Frequency response	0,2 … 30 MHz (-3 dB)
Digital filters	12 bandpass and high pass filters
Dead time after transmitter pulse	< 5 µs
Equivalent input noise	<80 nV/SQR (Hz)
Gain range	110 dB
Input resistance	<400 Ohm
Input capacitance	<70 pF
Time-corrected gain (TCG)	16 points, 100 dB dynamic, 90 dB/40 ns slope
Cross-talk between transmitter and receiver	>80 dB
Signal averaging	2, 4, 8, 16, 32

Data acquisition

Maximum number of samples per A-scan	1024 points
Data storage, internal	64 GB

Gates

Number of gates	3 (one can be used as interface gate)
Measurement modes	flank, peak, zero crossing before, zero crossing after, J-flank, first peak
Threshold (all gates)	5 … 95%
Start/Width (all gates)	0 … 27000 mm
Resolution of TOF	2.5 ns
Resolution of amplitude	1 % FSH
Linearity of monitor gate amplitude	+/-2%
Linearity of analogue output	+/-2%
Evaluation modes	TCG, DAC, DGS, AWS, dB REF, JISDAC, CNDAC

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RemoteService@bakerhughes.com

waygate-tech.com

ISO 9001
REGISTERED COMPANY

Baker Hughes

bakerhughes.com