

Krautkrämer USM 100

Operating Manual



This Rev. 9 (09/2023) applies to software version:

1.7 (September 2023)

You will find the software version and the serial number of your instrument in the **About** section (see page 119) in the **General settings** menu (see page 108).

The illustrations and examples used in this operating manual, as well as the procedures described, apply to the application **USM Generic App [...]**, which you can download from **InspectionWorks**, the cloud service from Waygate Technologies (see page 114).

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Overview

Command bar



Switch between Command bar icons



Switch to the next panel



Switch to the previous panel



A-scan freeze (**Freeze**, see page 74)



Set the echo to defined screen height
(**AutoXX**, see page 74)



Record echo (e.g. for calibration)



Delete (e.g. reference or DAC point)



Reset the envelope curve



Set the gain by certain increment
(see page 123)



Scan Gain (see page 75)



Span the gate over the entire display
(see page 143)



Pause data recording



Continue data recording



Start data recording

Command bar (continued)



Stop data recording



Quick save



Load settings



Save settings



Load data



Save data



Save screen capture



Save report



Save multiple page report



Export data to CSV file



Lock the touchscreen operation

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

An alphabetical list of the basic UT functions in the function groups can be found from page 288.

Status indicators



Power level indicators
(see page 19)



AGT is active



DGS reference echo has
been recorded



Freeze is active,
display is „frozen“



Angle probe 30° ... 90°,
flat surface, reflection
from backwall



DGS reference echo has
been recorded,
transfer loss > 0



Magnify Gate is active



Angle probe 30°, curved
surface, reflection from the
inner surface



dB REF is active



Pulser-receiver mode is
turned off



Angle probe 80°, curved
surface, reflection from the
outer surface



Calibration reminder



Pulser-receiver mode is
turned on















DAC mode = TCG is active

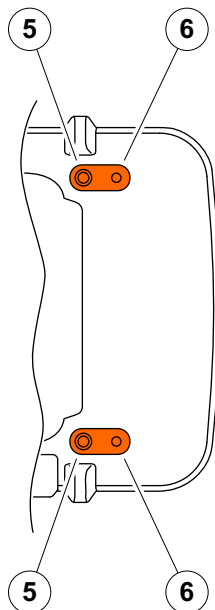
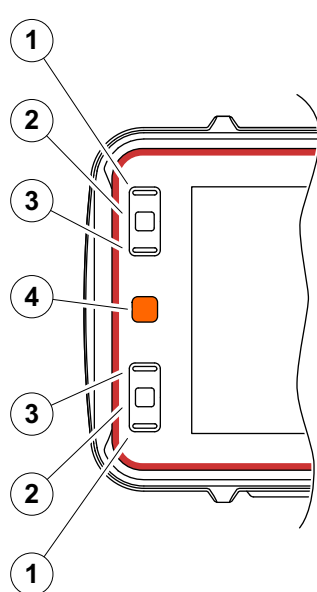


Touchscreen operation
is locked

Power level indicators

Internal	Second		
		100%	Batteries fully charged, power adapter is connected, percentage of charge level (approx. value)
		100%	Internal battery fully charged, second battery not inserted, power adapter not connected, percentage of charge level (approx. value)
		4H	Batteries fully charged, power adapter not connected, remaining operating time in hours (approx. value)
		2H	Internal battery fully charged, second battery not inserted, power adapter not connected, remaining operating time in hours (approx. value)
		2H	Percentages of charge levels (approx. values), power adapter not connected, remaining operating time in hours (approx. value)
		25M	Percentages of charge levels (approx. values), power adapter not connected, remaining operating time in minutes (approx. value)
		15M	Warning: Low charge level (less than 10% capacity), power adapter not connected, remaining operating time in minutes (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
- 6 On the back: Decrease gain



Note

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

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.

The device is designed to run in isolated network.



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 303).

Only connect testing equipment conforming to the defined operating conditions (see **Connecting a probe** on page 53).



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 46.

For battery care, please also see from page 259.

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 259.

Power adapter and charger

Only the power adapters and chargers recommended and supplied by Waygate Technologies may be used for the USM 100. Before handling the power adapter or the charger, read the related user information and follow the safety instructions in particular.

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.

To detect a flaw, the manual or automated scan speed with the probe has to be adequate for the application, taking in consideration, for example, the probe sound beam, the kind of defect and the PRF.

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 than 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)
- 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
- Installation of up to 3 applications
- 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
- Unlimited number of applications for the USM 100
- 3rd gate, can be used either as gate C or IF gate
- Encoded B-scan and C-scan
- Spike pulser
- 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 USM 100 PC 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 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
- Unlimited number of applications for the USM 100
- 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 geo-location of test object for end to end traceability
- Software USM 100 PC 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, be sure to read in full the chapters **Introduction** (see from page 21), **Initial start-up** (see from page 45) and **Principles of operation** (see from page 67). There you will find safety instructions, an overview and information on the necessary preparations of the instrument for the inspection. 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 309).

The specifications of the instrument can be found in the **Specifications** chapter (see page 303).

Attention and note symbols



ATTENTION

The **ATTENTION** symbol is used to indicate warnings that, if ignored, may result in personal injury or damage to the instrument or other property. It also indicates warnings concerning the safety of data or measurement results.



Note

The **Note** symbol is used to indicate special features of the device, important references to other information sources or special recommendations related to a function.

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Standard package and accessories **2**

2.1 Standard packages

Part No.	Short code	Description
150M5734	USM 100 Standard Instrument	USM 100 Standard instrument package
150M5734-C	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	<p>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.</p> <p>Does not include power cord. Power cord needs to be ordered separately.</p>
	USM 100 Pro accessories	<p>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.</p> <p>Does not include power cord. Power cord needs to be ordered separately.</p>

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	WLAN and Bluetooth adapter for EU/AU
152M6576	USB Stick Pulling Tool	WLAN adapter 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
156M2384-L=300	USM 100 IO cable L=300mm	I/O cable (14-pin Lemo to open end), 300 mm long
156M2384-L=1500	USM 100 IO cable L=1500mm	I/O cable (14-pin Lemo to open end), 1500 mm long
148M5830	Wrist Strap for USM 100	Wrist strap for USM 100
144M4780	BATTERY_ NB2037QE34	USM 100 battery

Part No.	Short code	Description
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
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 and 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)

Part No.	Short code	Description
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
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

Part No.	Short code	Description
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

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. Before handling the power adapter, read the related user information and follow the safety instructions in particular.

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

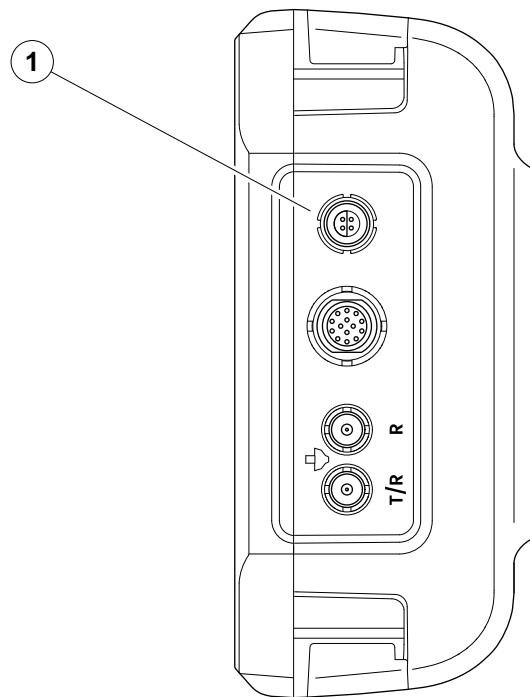
Connect the USM 100 to the mains socket-outlet by means of the corresponding power adapter. The socket-contact for connecting the power adapter is located on the right side of the instrument.

- 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 57). 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).



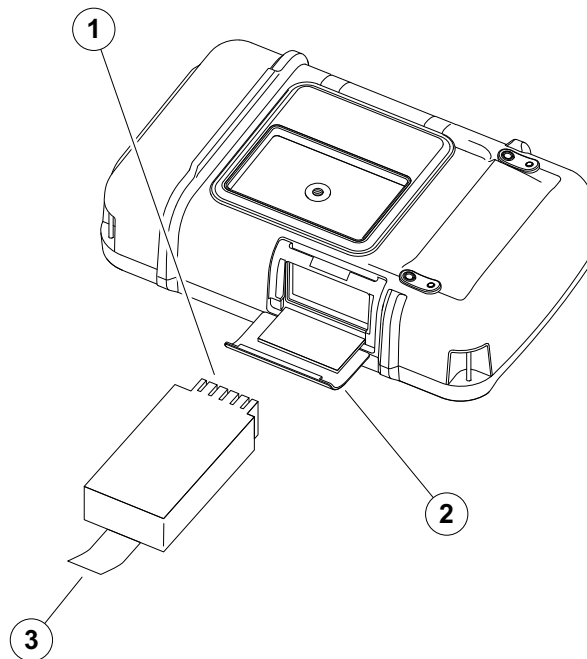
ATTENTION

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.

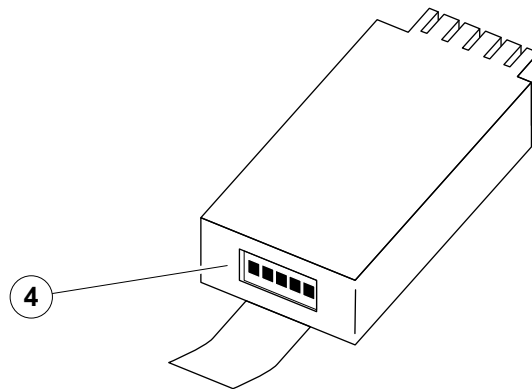


- Flip up the battery compartment cover and slide it back to its original position until it is firmly closed.
- To remove the battery, open the battery compartment as described above and carefully pull the battery out by the tab (3).

Checking the charge level of the lithium-ion battery

The lithium-ion battery is provided with a battery charge level indicator. Five squares (4) indicate the level of battery charge.

You can check the battery charge level before inserting it into the instrument. If only 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.



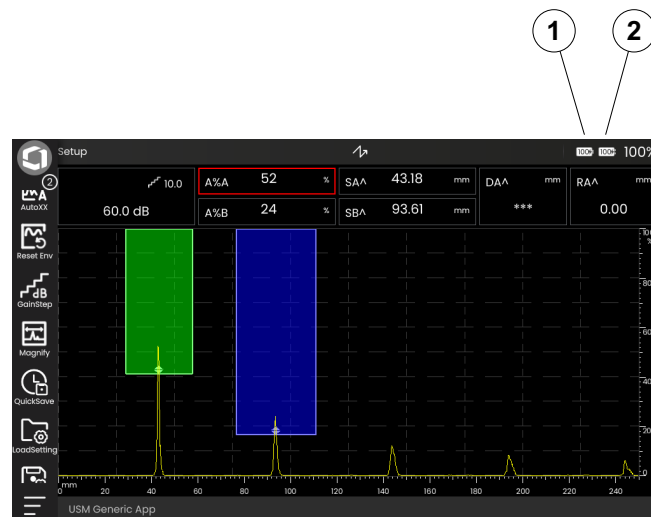
ATTENTION













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.



Note

For further information on the battery level and the logic of battery charging and discharging see from page 260.



Internal	Second		
		100%	Batteries fully charged, power adapter is connected, percentage of charge level (approx. value)
		100%	Internal battery fully charged, second battery not inserted, power adapter not connected, percentage of charge level (approx. value)
		4H	Batteries fully charged, power adapter not connected, remaining operating time in hours (approx. value)
		2H	Internal battery fully charged, second battery not inserted, power adapter not connected, remaining operating time in hours (approx. value)
		2H	Percentages of charge levels (approx. values), power adapter not connected, remaining operating time in hours (approx. value)
		25M	Percentages of charge levels (approx. values), power adapter not connected, remaining operating time in minutes (approx. value)
		15M	Warning: Low charge level (less than 10% capacity), power adapter not connected, remaining operating time in minutes (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. six hours with simultaneous ultrasonic testing. If the instrument is not used for ultrasonic testing, the charging time is approx. four 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 charging. Do not use any other chargers for charging the lithium-ion batteries for the USM 100.

Before handling the charger, read the related user information and follow the safety instructions in particular..

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.

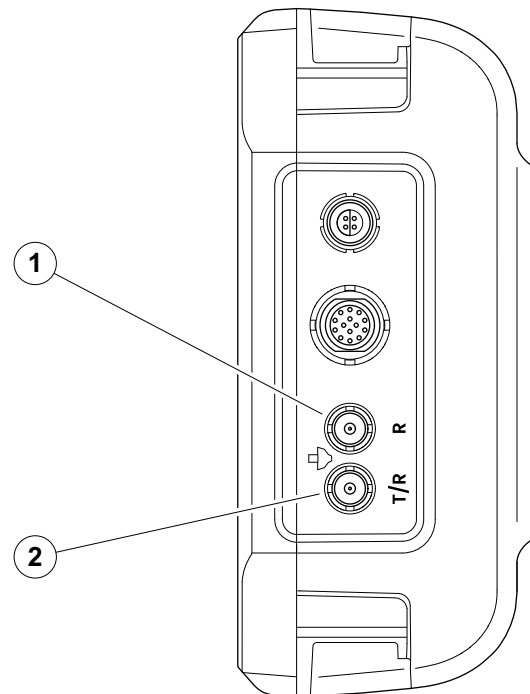
Connect a single element probe with the **T/R** socket (2).

Connect a dual element probe (having one transmitter 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).

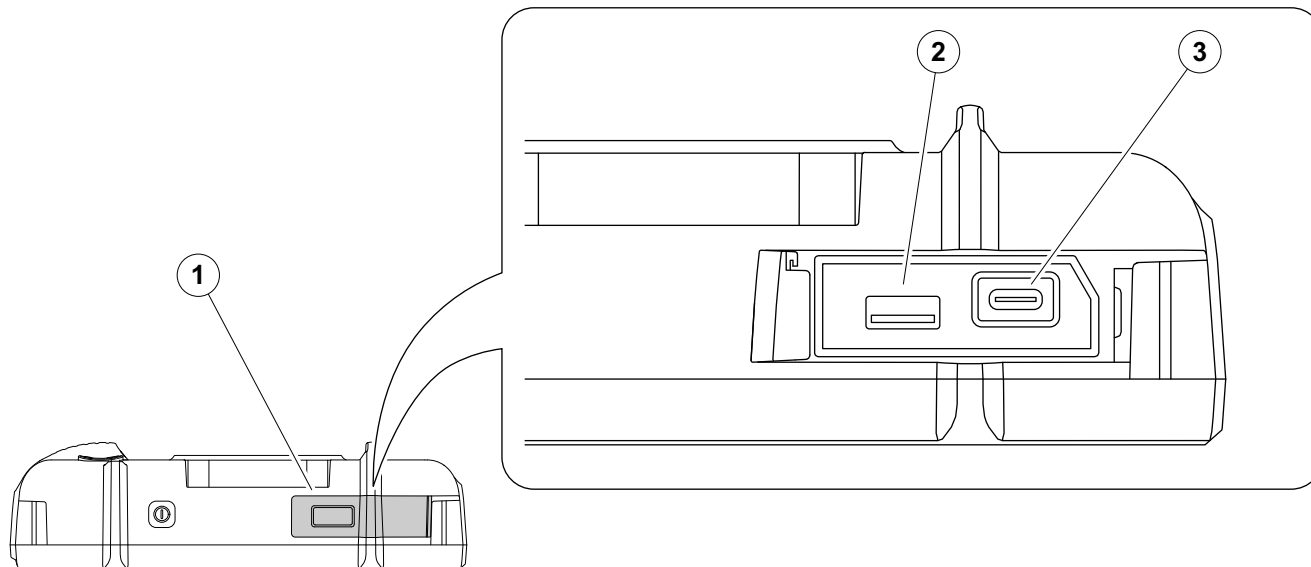
Observe the correct assignment of the cables:

R (red ring) – receiver (1)

T/R (black ring) – transmitter/receiver (2)



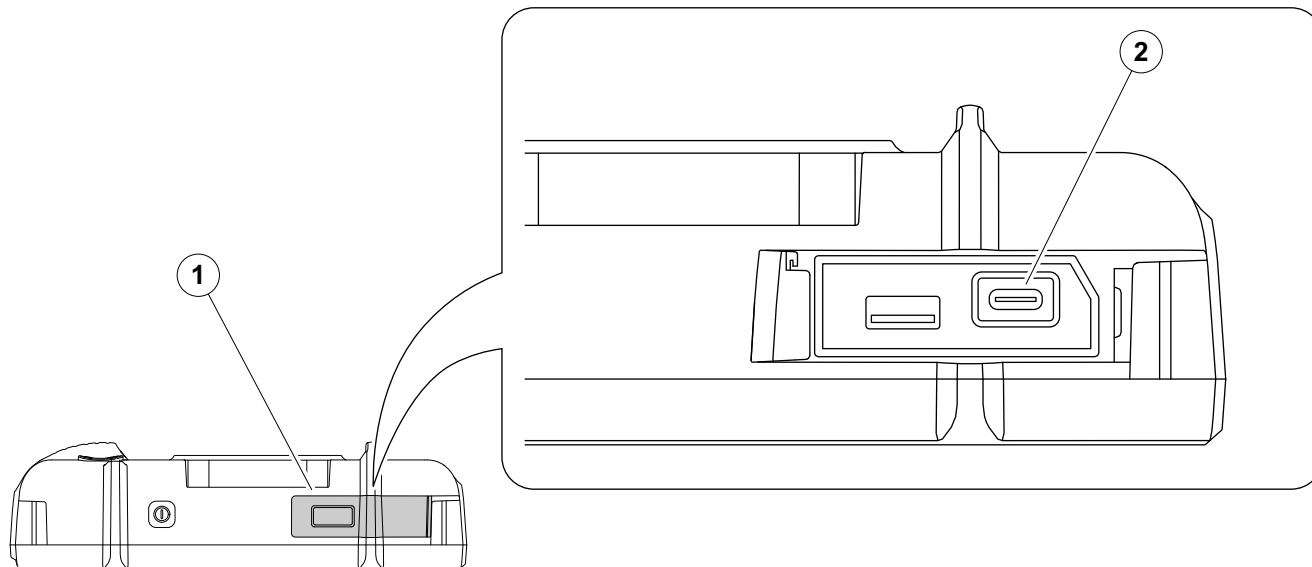
3.4 Inserting a USB stick



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 the USB-C docking hub included in the scope of delivery to connect the USM 100 to the LAN and connect other peripherals (monitor, mouse, keyboard) to the instrument. For more information on interfaces see from page 268.

- 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.

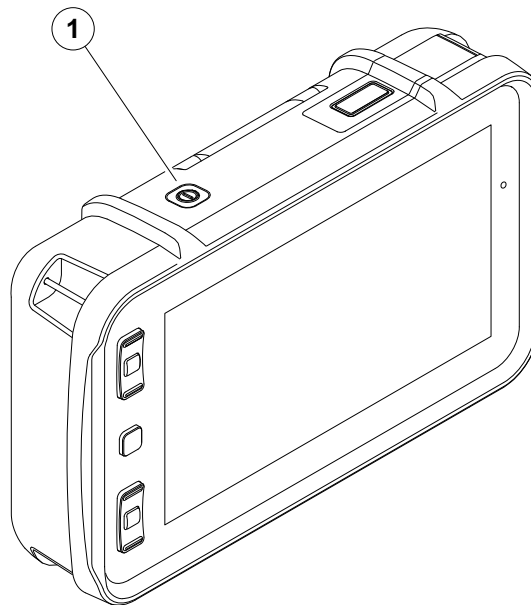
- Press the Power key for two seconds.

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 69) with all applications stored in the instrument and available for selection.

Depending on the settings (see **Startup Application**, page 110), the **A-scan view** (see page 73) 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 265).



Powering Off



ATTENTION

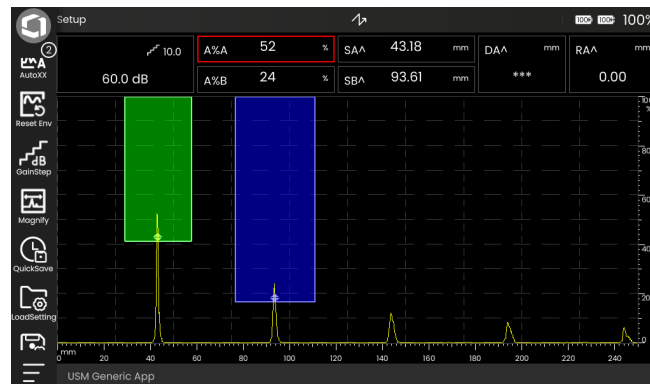
In order to power the instrument off correctly, always use the **Shutdown** function. If the power supply is interrupted (pulling out the mains plug while the batteries are completely discharged), the operation does not end correctly.

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).

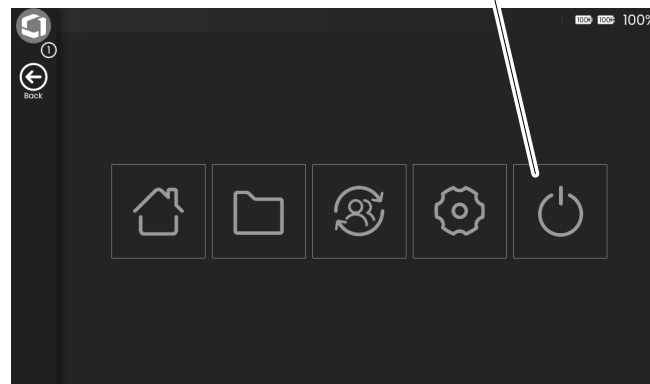
The system is shut down and the instrument is switched off.

Alternatively, you can press the Power key on the top of the instrument (see page 56) for 3 seconds until the shutdown process starts. A shutdown message is shown.



1

2



3.7 USM 100 PC Live

You can use the software **USM 100 PC** from Waygate Technologies to operate the USM 100 completely remotely from a computer (tablet) if both devices are on the same network.

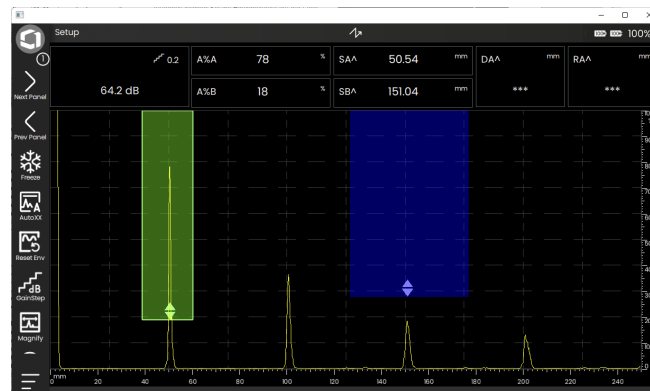
When the connection is established, the software shows exactly the current user interface of the USM 100 as it would otherwise be seen on the device. You can use the applications stored on the computer independently of the device.

Operation on the instrument itself is then not possible, not even with the keys.



Note

To operate the USM 100 with the software **USM 100 PC**, the instrument must be connected via LAN (see page 269) or WLAN (see page 270) to the same network as the computer on which the software is installed.



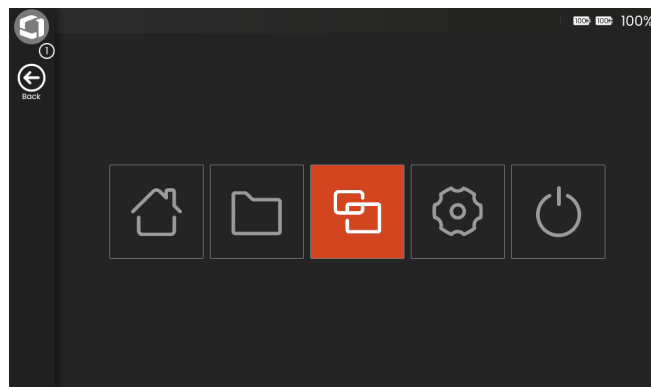
Establish connection

Prerequisite for the connection to the software **USM 100 PC** is an existing network connection to the computer via LAN (see page 269) or WLAN (see page 270).

- Install the software **USM 100 PC** on the computer.
- Check whether the USM 100 and the computer with the software are connected to the same network.
- Tap the **Main menu** icon (see page 73) to display the **Main menu**.
- Tap on the **USM 100 PC Live** button.

If the **USM 100 PC Live** button is not visible, then an application is currently loaded.

- In this case, tap the **Application desktop** button (see page 68) and then tap the **Main menu** icon again.



- Tap **START** to start the USM 100 Server, which connects to the software.

After starting the server, operation on the instrument itself is no longer possible, not even with the keys. Exceptions are the three buttons at the top right **STOP**, **START** and **Autostart** (symbol).

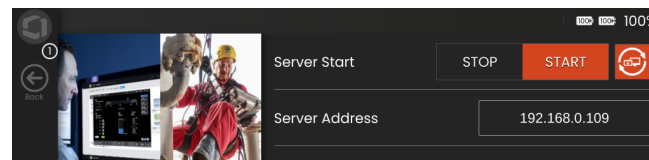
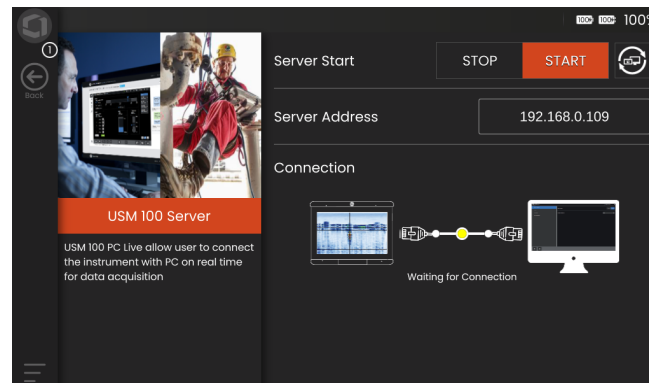
The IP address of the USM 100, which you must enter in the software **USM 100 PC**, is displayed below the buttons.

You can stop the server at any time (see page 62). Then operation on the instrument is possible again, but operation with the software **USM 100 PC** is no longer possible.



Note

You can activate the automatic start of the USM 100 Server when the instrument is started, either with the **Autostart** icon (far right) or with the corresponding function in the settings (see page 110).



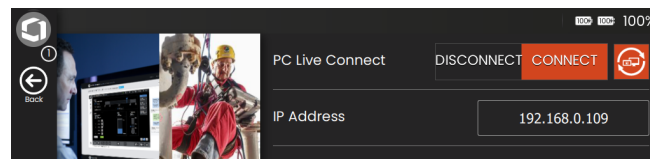
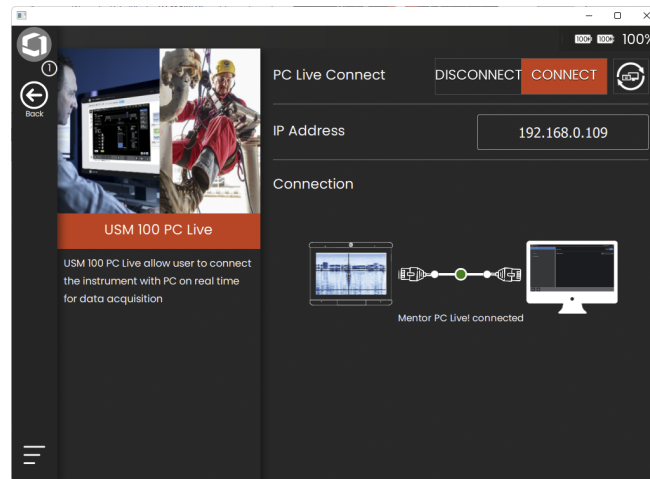
- On the computer, start the software **USM 100 PC**.
- In the software, select the **Main menu** icon (in the same place as on the USM 100 screen) to display the **Main menu**.
- In the software, select the **USM 100 PC Live** button (same as on the USM 100 screen).
- In the **IP Address** field, enter the IP address of the USM 100 as displayed on the screen of the instrument.
- Select **CONNECT** to establish the connection to the USM 100.

The operation is now completely possible with the software.



Note

With the **Autoconnect** icon (far right) you can activate the automatic connection to the USM 100 when starting the software. The prerequisite is that the USM 100 Server is started in the instrument.



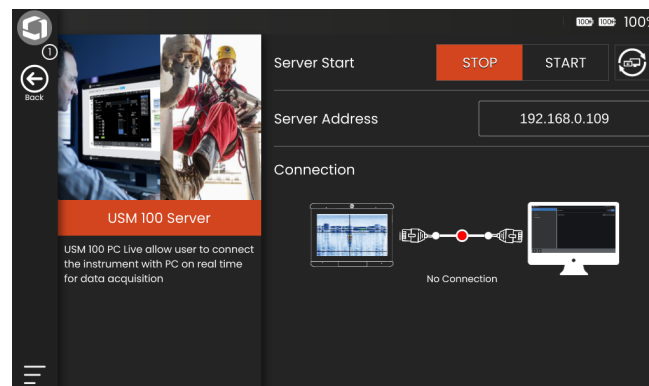
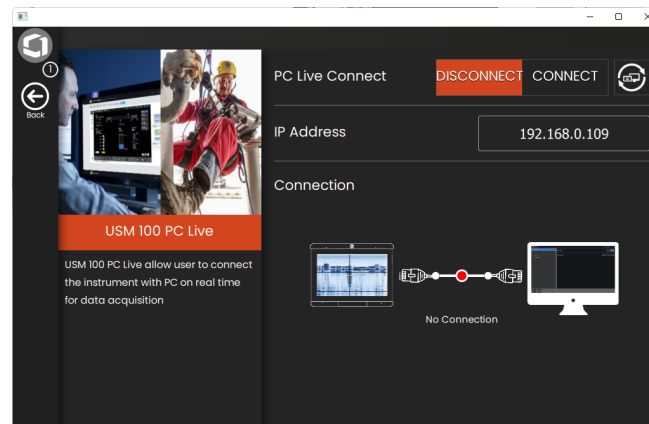
Close connection

You can terminate the connection to the USM 100 at any time, for example, to operate the device from another computer or to operate another device.

- Select **DISCONNECT** to close the connection to the USM 100.
- To exit the software **USM 100 PC**, select the **X** symbol at the top right of the window.

You can stop the USM 100 Server at any time. Operation on the instrument is then possible again, but operation with the software **USM 100 PC** is no longer possible.

- Tap **STOP** to stop the USM 100 Server.



3.8 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
- RJ45 connector and network cable, alternative: WLAN adapter

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.

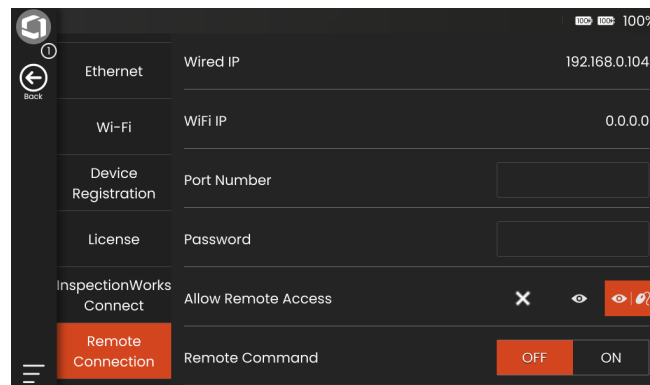
Use the USB-C dock included in the scope of delivery (see page 55) or the WLAN adapter to connect to the network.

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 118.

- Select the **Main menu** (see page 73).
- Select the **General settings** (see page 68).
- 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).



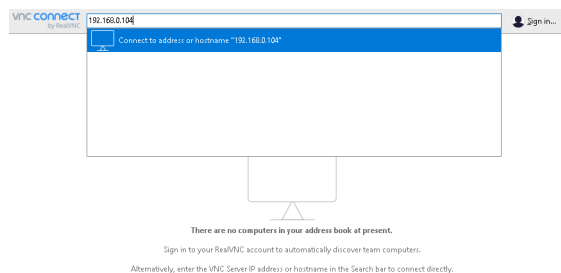
Establishing the remote connection

- Check that the USB-C hub is correctly connected to the USM 100.
- Check that the computer and the USM 100 are connected to the same network.
- Check that the remote control is enabled in the USM 100 (see page 64).
- 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.



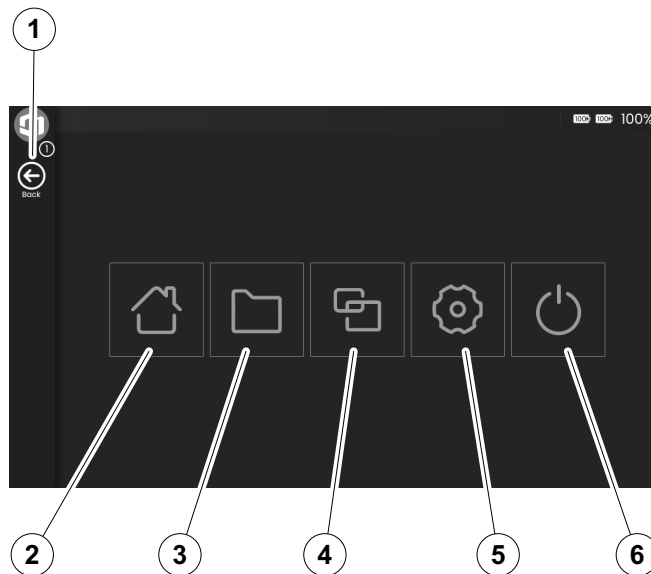
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Principles of operation **4**

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 69)
- 3 **File management** (see page 253)
- 4 **USM 100 PC Live**, only visible if no application is launched (see page 58)
- 5 **General settings** (see page 108)
- 6 Shutdown (see page 57)



4.2 Application desktop

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

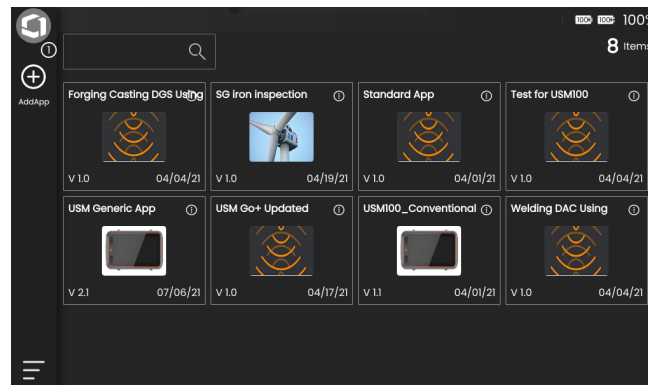
An application's architect determines its specific contents, the inspection parameters displayed, which parameters are adjustable by the user, and to within what range of values a particular parameter can be set.

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 110), the **A-scan view** (see page 73) 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 68).



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 110).

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.

- 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

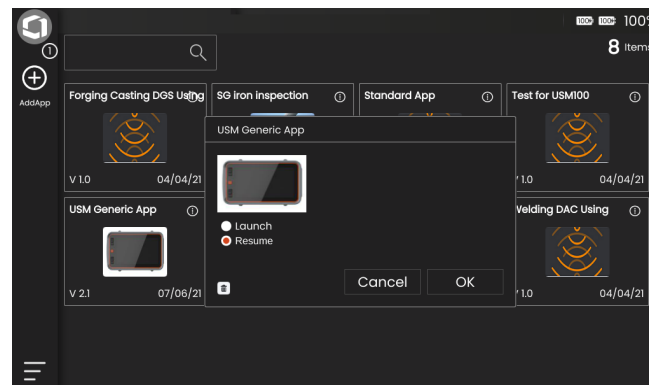
select **Resume** if you want to use the application with its last used settings.

- Tap **OK** to launch the Application. After a short time you will see the **A-scan view** (see page 73).



Note

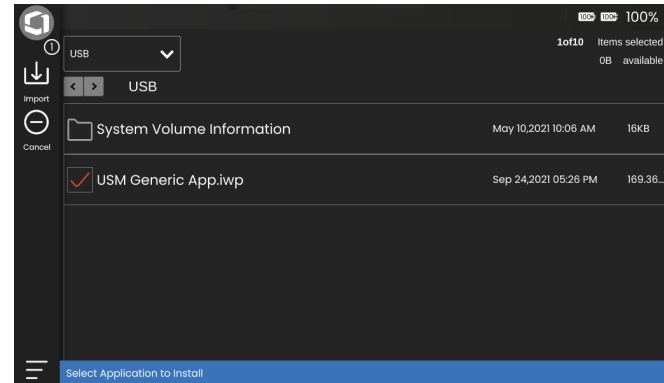
The **Startup Application** function allows you to select an application that will be automatically launched with the last used settings when the instrument is started (see page 110).



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**. For saving, you can select only one file at a time and have to repeat the process for several files.

- Insert a USB stick with one or more application files into the socket on the top of the instrument (see page 54).
- 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

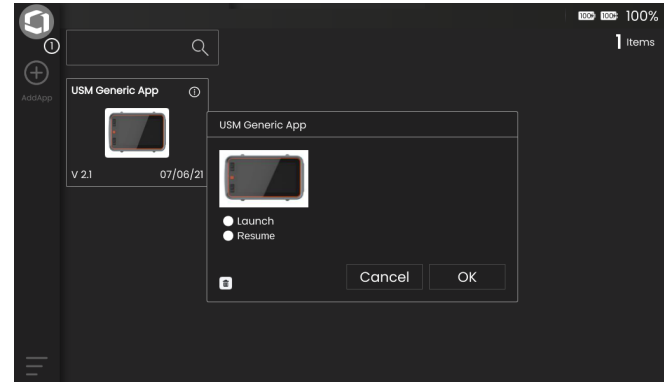
You can delete applications that are no longer needed.



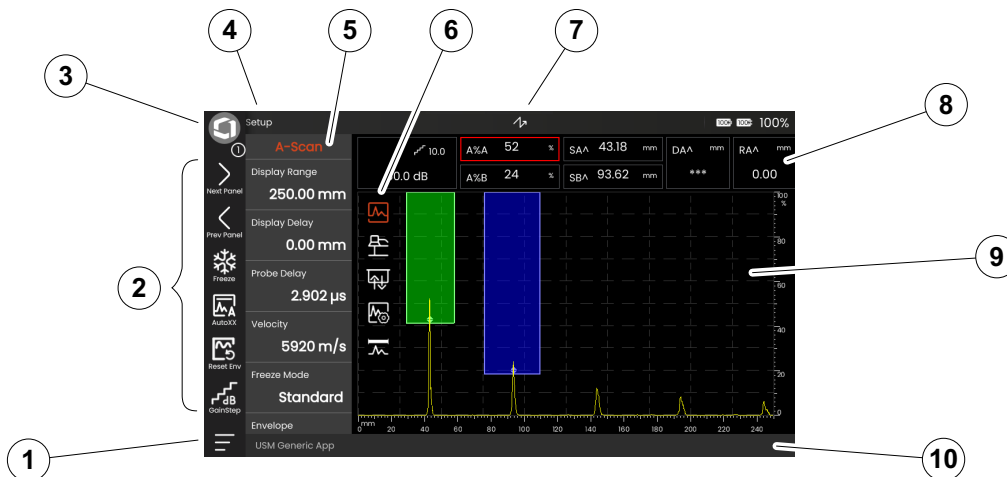
Note

Before deleting, you can back up the applications to a USB stick (see page 254). 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 68) | 6 Function group icons |
| 2 Command bar (see page 74) | 7 Status indicators (see page 84) |
| 3 Switching Command bar icons (see page 87) | 8 Measurement line (see page 85) |
| 4 Panels (see page 81) | 9 A-scan representation (see page 79) |
| 5 Function groups (see page 82) | 10 Information line (see page 86) |

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 18).

You can define the **Freeze Mode** (see page 127).

AutoXX



You can automatically set the first echo in gate A 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 124).

Calibrate



During calibration or setup of DAC curves this function is used to record the reference echoes from the calibration block.

Clear



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

This function is also used to delete a recorded evaluation reference value or curve, or to delete measurements, for example when working with scanner inspection systems (see from page 232).

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 124).

Scan Gain



This function allows you to quickly reset the gain to the original value after you have changed the gain of a DAC curve, for example.

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 143).

Record



With this functions you can start data recording, for example for saving in the data grid of the **Data Recorder** (see from page 243).

Stop



With this functions you can stop data recording, for example when working with scanner inspection systems (see from page 232).

Pause



You can pause the recording of data, for example for saving in the data grid of the **Data Recorder** (see from page 243).

Resume



With this function they can continue the data recording with the **Data Recorder** (see from page 243).

Quick save



You can save data, settings, and a screen capture together. Quick save data are saved using the default name (see **FileName Prefix**, page 246).

Load settings



You can load and use instrument settings saved in a file. The instrument settings are immediately active after loading (see page 106).

Save settings



You can save the current instrument settings to a file in the device memory or on an inserted USB stick (see page 105).

Load data



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

Save data



With this functions you can save recorded measurements, for example when working with scanner inspection systems (see from page 232).

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 (see page 240).

Save multiple page report



You can save a multiple page test report. Multiple page test reports are saved in the default directory (see page 241).

Export CSV



You can save the current readings in the data matrix in the **Data Recorder** in a CSV file (see page 252).

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 18).

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

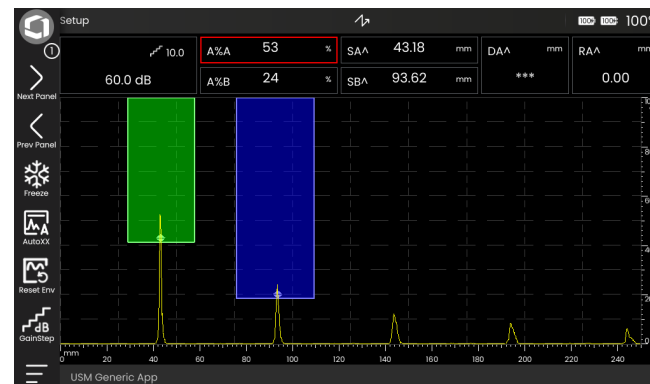
A-scan representation

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.

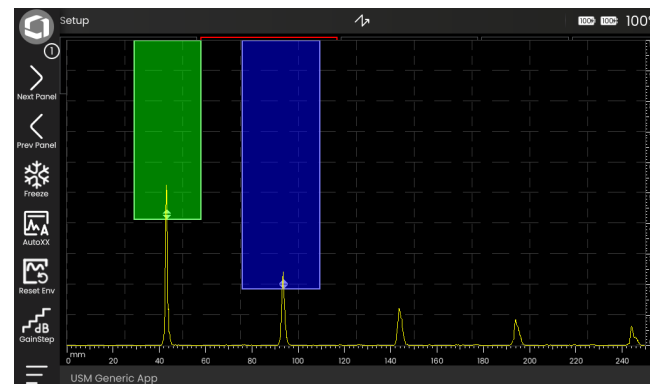
In the zoom mode, the measurement line is not visible. The gain can then only be adjusted with the keys on the back of the instrument, not with the function at the top left of the screen.

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:



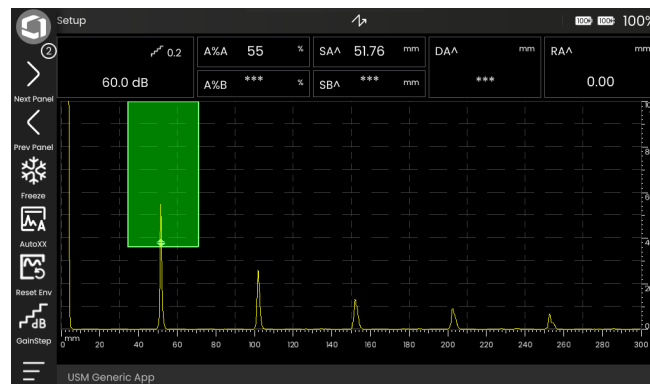
Gates

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

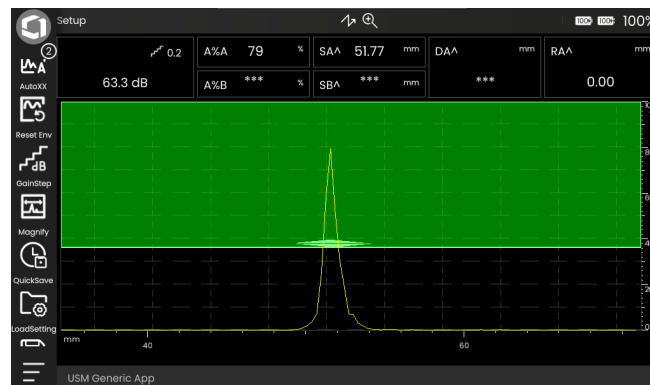
With the function **Magnify Gate** (see page 76) in the Command bar you can span a selected gate over the entire displayed range.

You can select the gate for this function (see page 143).

Gate display in the normal mode:



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



Panels

Applications (see page 69) include one or more panels containing, among others, a variety of UT data display capabilities, guides, and references.

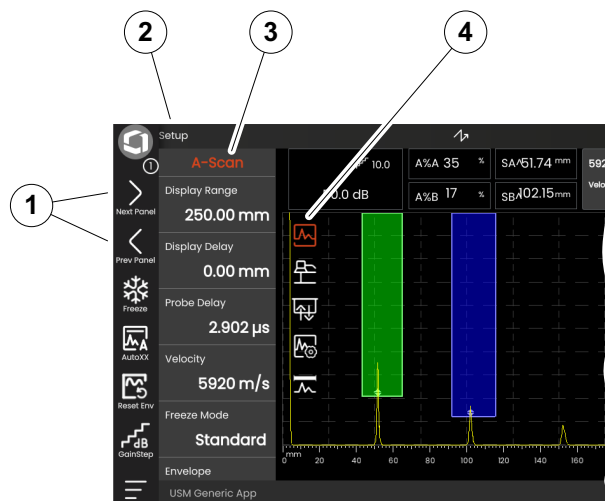
An application's architect determines its specific contents, the inspection parameters displayed, which parameters are adjustable by the user, and to within what range of values a particular parameter can be set.

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

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.

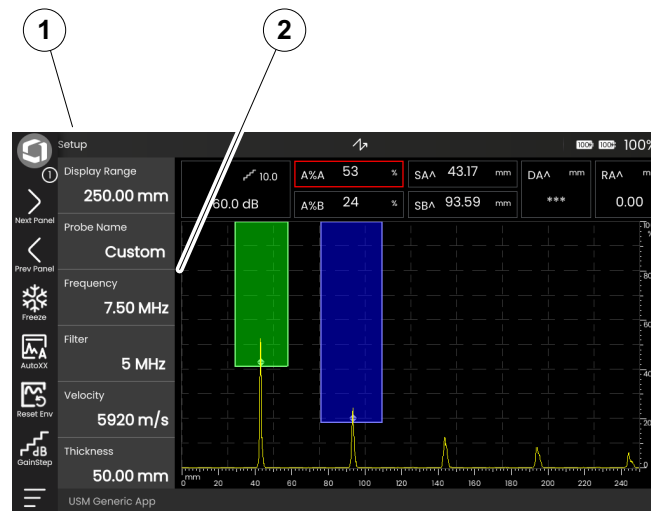
If you tap on the icon again, the function group will be hidden again.



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 88).

You can close the sidebar by sliding it back.



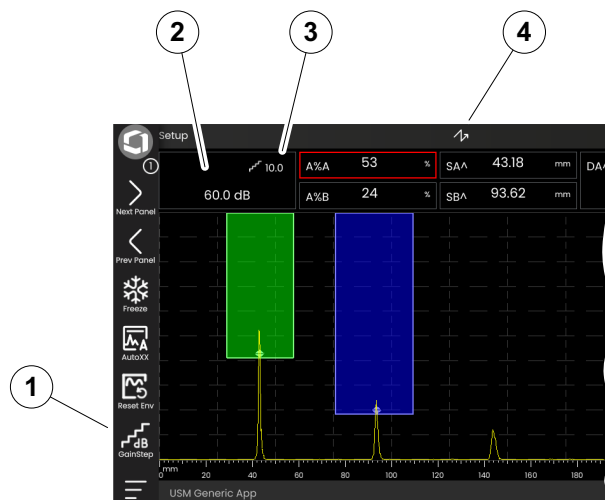
Gain

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 75).

Status indicators

Above the A-scan is the area for various status indicators (4). The status indicators inform about active functions and certain settings (see page 18).



Measurement line

The measurement line on top of the A-scan shows a number of measurement readings (1), also some larger boxes with specific readings or functions (3). Size and number of the boxes depend on the currently selected panel (see page 81).

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

^ = measuring point Peak of the highest echo in the gate

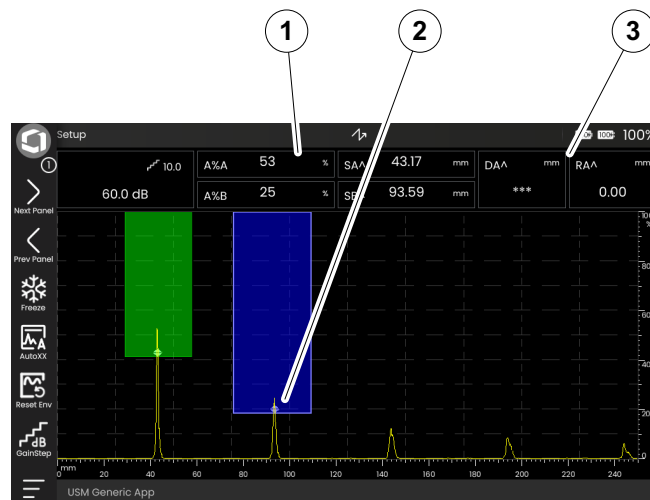
/ = measuring point Flank of the first echo in the gate

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 120).



Note

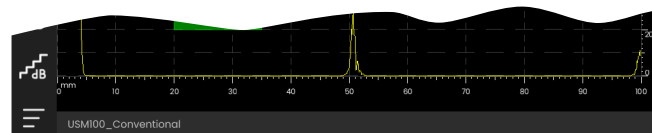
The measuring point for amplitude is marked at the bottom edge of the gate by a triangle pointing upwards (2), the measuring point for distance is marked by a triangle pointing downwards.

Information line

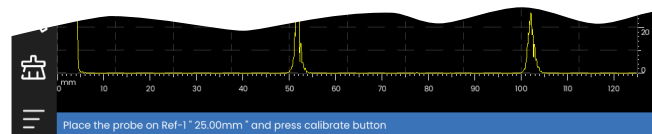
The information line at the bottom of the screen shows various information, notes, instructions and warnings depending on the situation.

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

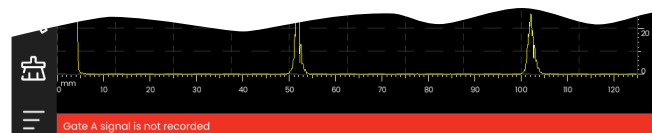
Example: Information on the current application



Example: Instruction for calibration



Example: Warning



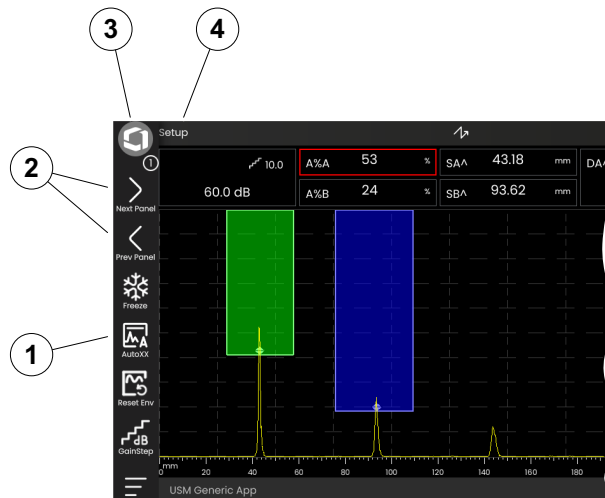
4.4 Operation with touchscreen

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 74).

- 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.



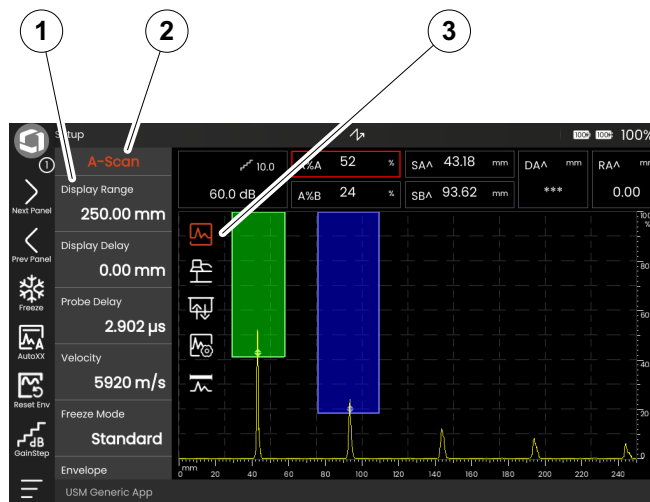
Function groups and main functions sidebar

All functions are arranged in function groups. The possible selection of function groups always depends on the currently selected panel (see page 81).

- 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 91) or execute a function.

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

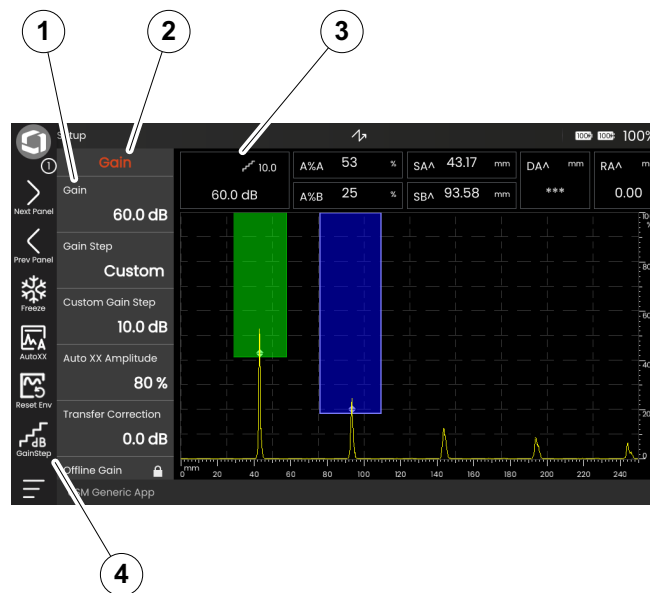
- Tap the left edge of the A-scan and swipe to the right. The main functions slide into the screen (see page 83).
- Tap on the functions and swipe to the left to hide the main functions again.



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 91) 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 more specific functions (1). You can set these functions directly without having to go via the function groups.

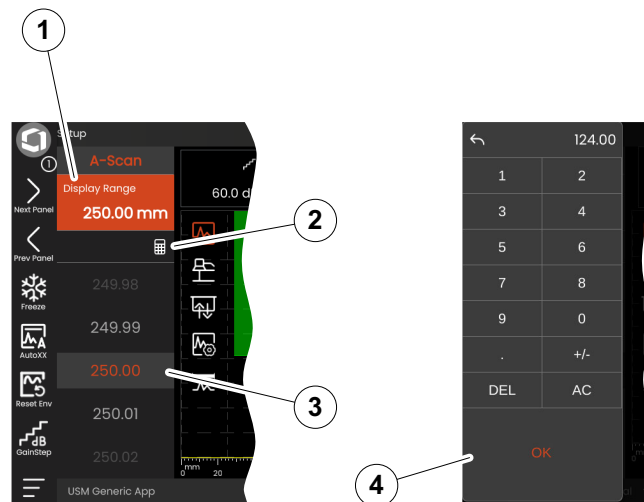
- Tap on a function name to set a parameter (see page 91) or execute the function.



Settings

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

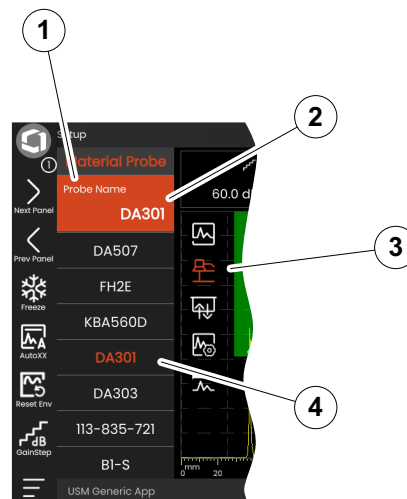
- Select the panel **Setup** and display the function group **A-Scan** (see page 88). The functions and their current settings are displayed.
- Tap on the function **Display Range** (1). The value selector is displayed.
- Swipe the selector up or down to show the possible values. The highlighted value 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**.

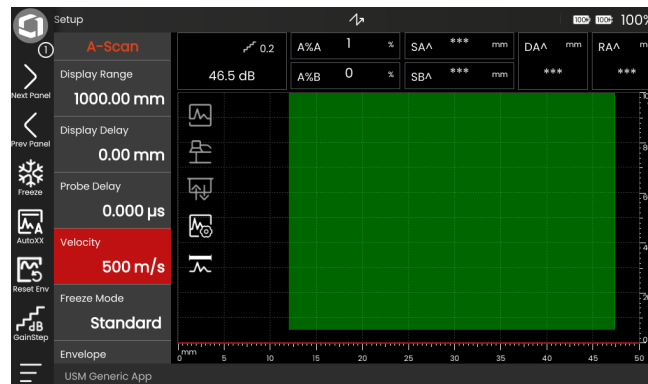
- Select the panel **Setup** and display the function group **Material Probe** (see page 88). The functions and their current settings are displayed.
- Tap on the function **Probe Name** (1). The list of probe names is displayed.
- Swipe the list up or down to see all list entries.
- Tap on the required 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.



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.

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.

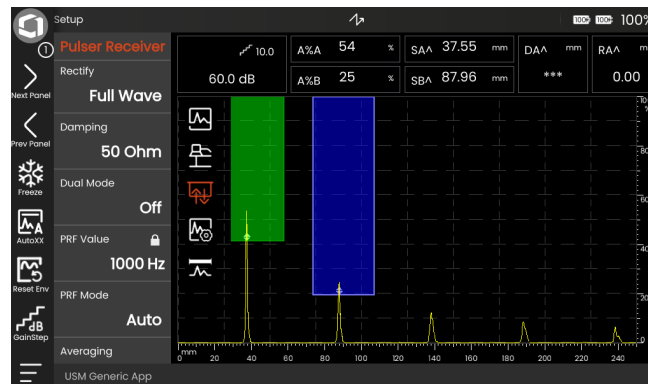


Locked functions

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 74) or automatically (see page 127). 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.

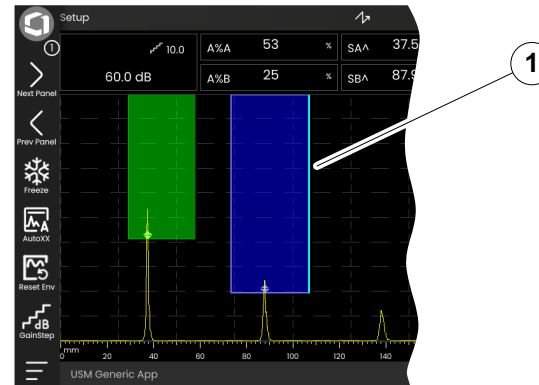


Positioning the gates

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 145).



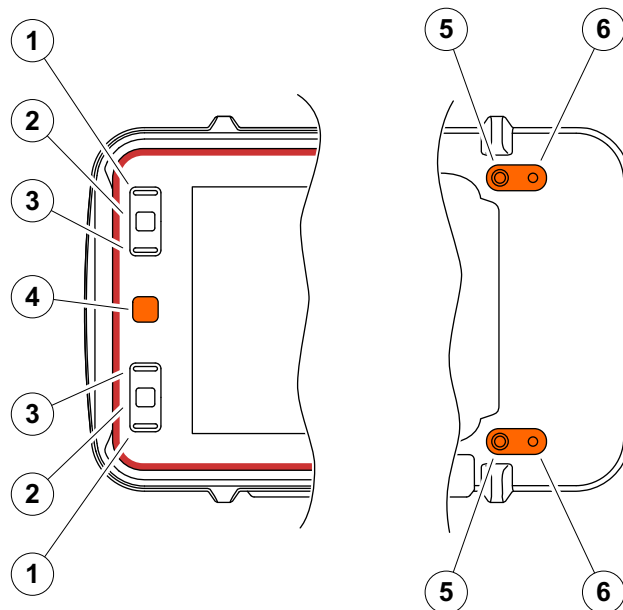
4.5 Overview of key functions

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 97). 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
- 6 On the back: Decrease gain

**Note**

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



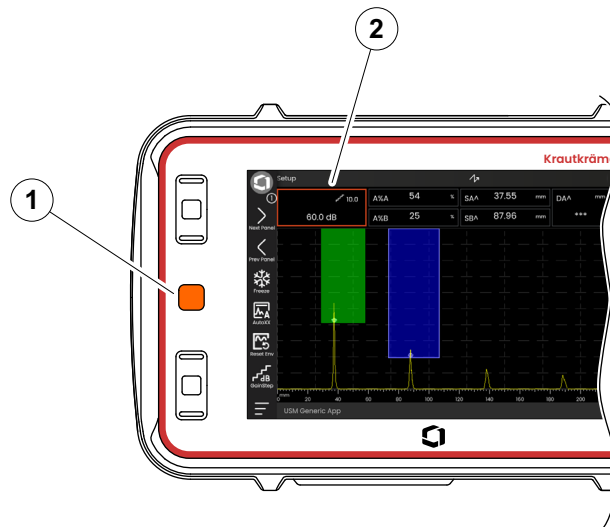
4.6 Operation with keys

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. The selected screen area is highlighted with a red frame (2).
- Press the key repeatedly to highlight the next element or area.

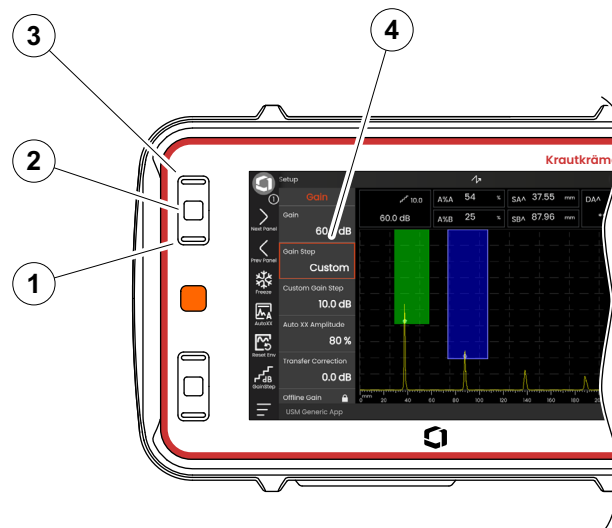


Executing or selecting a function

You must first select a screen area (see page 97).

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.

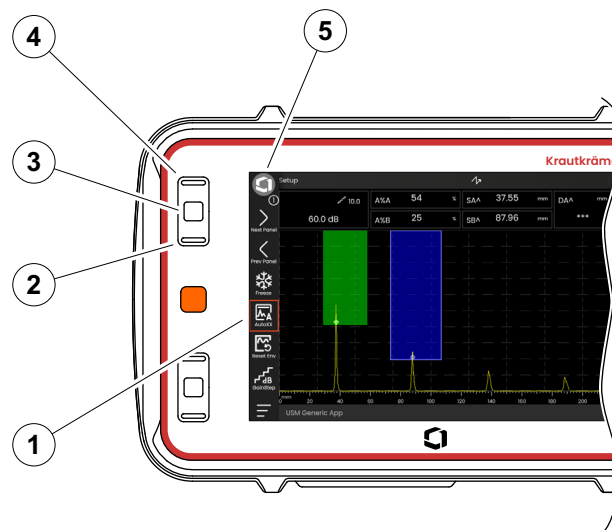
- Press the red key (see page 97) repeatedly to highlight the **Gain** area.
- Press the black center key (2) to display the associated functions.
- Press the upper (3) or the lower (1) black key to highlight the desired function (4).
- Press the black center key (2) to execute or set the function.



Command bar

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

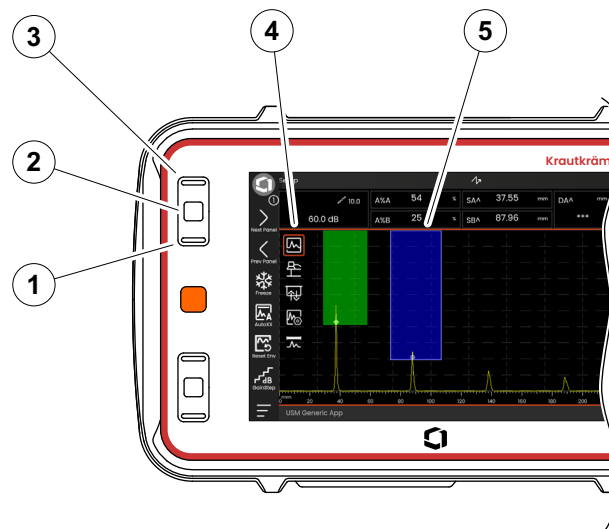
- Press the red key repeatedly to highlight the Waygate icon (5).
- Press the black center key (3) to select the Command bar.
- Press the upper (4) or the lower (2) black key to highlight the desired function (1).
- Press the black center key (3) to execute the function.



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 81).

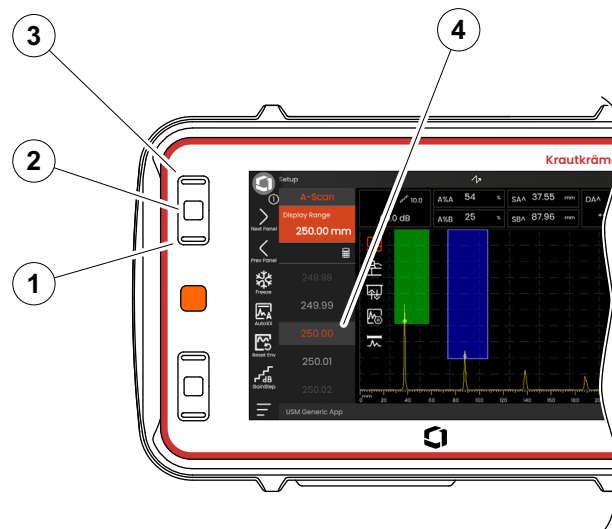
- Press the red key repeatedly to highlight the whole A-scan area (5).
- Press the black center key (2) to display the function group icons. The first icon is highlighted (4).
- Press the upper (3) or the lower (1) black to highlight another icon.
- Press the black center key to display the function group.
- Press the upper or the lower black to highlight 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 100). 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 highlight another screen area.



4.7 Multi-color LED

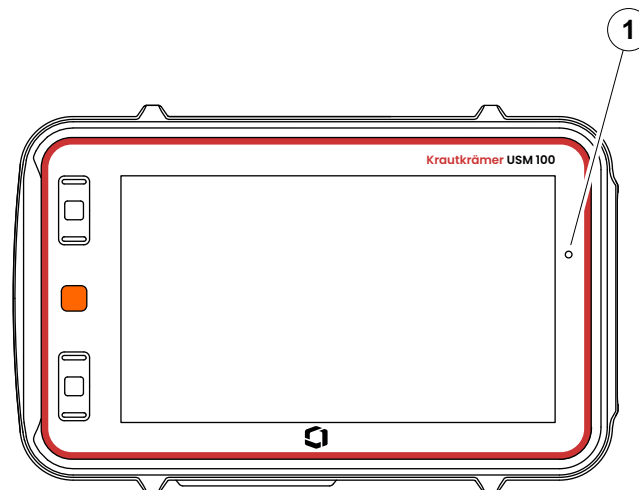
The multi-color LED (1) next to the screen gives you various information about the device status and special events.

With the instrument switched off:

- Blue** The batteries are charged
- Cyan** The batteries are being 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 108):

- **System** (see page 109)
- **Date and Time** (see page 111)
- **Regional** (see page 112)

From the function group **A-Scan** (see page 125):

- **A-Scan Color** (see page 129)
- **Grid Color** (see page 129)
- **Grid** (see page 129)

From the function group **Gates** (see page 145):

- **Gate A TOF Mode** (see page 147)

For displaying measurement values above the A-scan:

- **Measurement line configuration** (see page 120)

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 54). The filename extension is **.ups**.

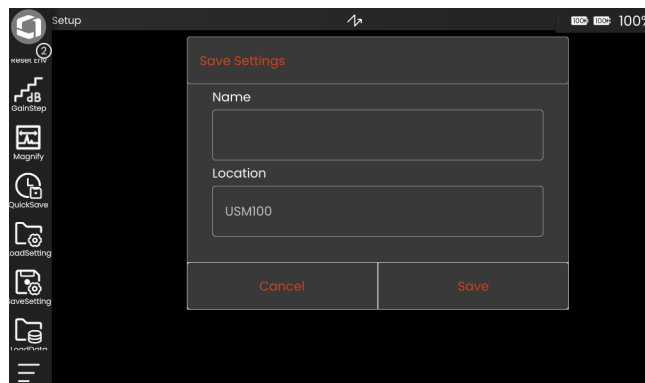


Note

The filename must not contain a blank or any of the following characters:

/ \ : * ? „ , < > |

- From the Command bar tap the **Save settings** icon (see page 77). 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**.
- Select a directory and tap on **Save** to save the file in the selected location.



5.3 Loading settings

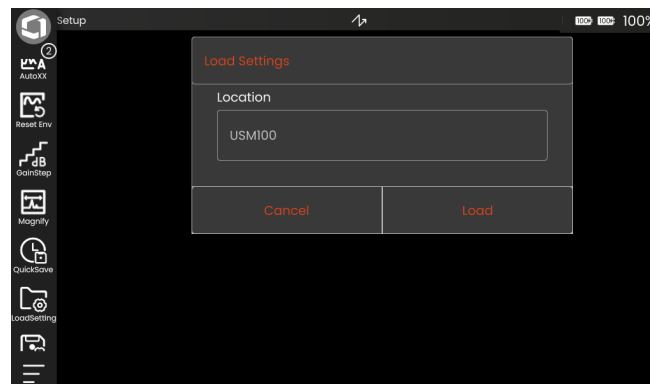
You can load and use instrument settings saved in **.ups** or **.ugo** (USM Go+) files. The instrument settings are immediately active after loading.



Note

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

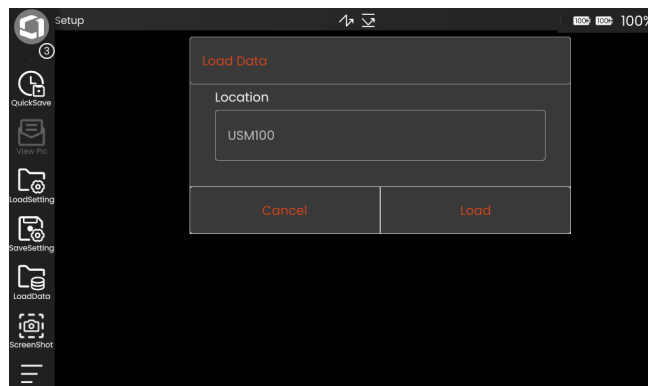
- From the Command bar tap the **Load settings** icon (see page 77). A dialog box opens.
- Tap in the field **Location** and select the storage location **USB** or **USM100**.
- Tap on a folder symbol to select the directory.
- Tap on a filename to select the file.
- Tap on **Load** to load the instrument settings from the selected file.



5.4 Loading data

You can load saved data and measurement results (including the A-scan) saved in **.ups** or **.ugo** (USM Go+) files and display them on the screen of the USM 100. A file contains all settings and data of a measurement.

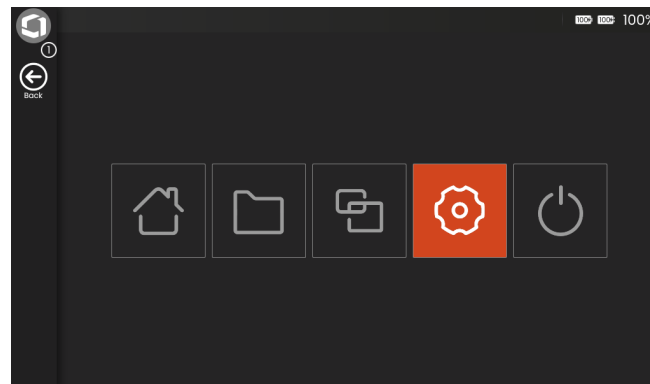
- From the Command bar tap the **Load data** icon (see page 77). A dialog box opens.
- Tap in the field **Location** and select the storage location **USB** or **USM100**.
- Tap on a folder symbol to select the directory.
- Tap on a filename to select the file.
- Tap on **Load** to load the data and settings of the measurement. The A-scan is frozen.



5.5 General settings

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

- Tap the **Main menu** icon (see page 73) to display the **Main menu**.
- 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 129) as well as the grid color (see page 129).

Screen Brightness

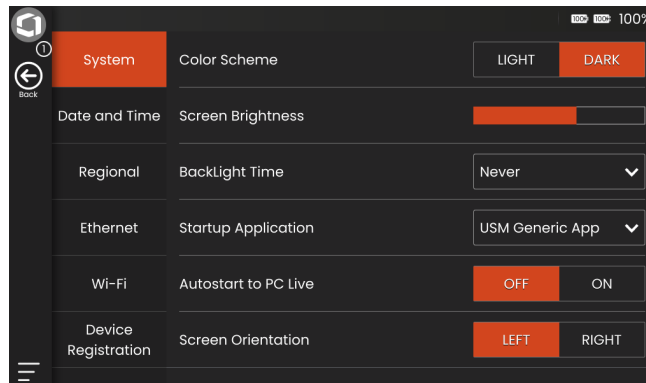
You can adjust the screen brightness to your working environment with the slider. The setting is visible immediately.



Note

Change to the higher brightness value reduces the time in battery operation (see page 263).

You can extend the operating time with the **BackLight Time** function (see page 110).



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 brightness level is automatically turned to a minimum value 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 69).

Autostart to PC Live

You can use the software **USM 100 PC** from Waygate Technologies to operate the USM 100 completely remotely from a computer (tablet) if both devices are on the same network.

When the USM 100 is remotely controlled by the software, operation directly on the instrument is locked. Therefore, the remote control is usually switched on manually.

With this function you can activate the automatic start of the USM 100 Server for the connection to the software **USM 100 PC** when starting the instrument. The prerequisite for this is an established network 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 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 269) or WLAN (see page 270). You cannot change the displayed date.

Time

The time is set automatically after connecting the instrument to the Internet via LAN (see page 269) or WLAN (see page 270). 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

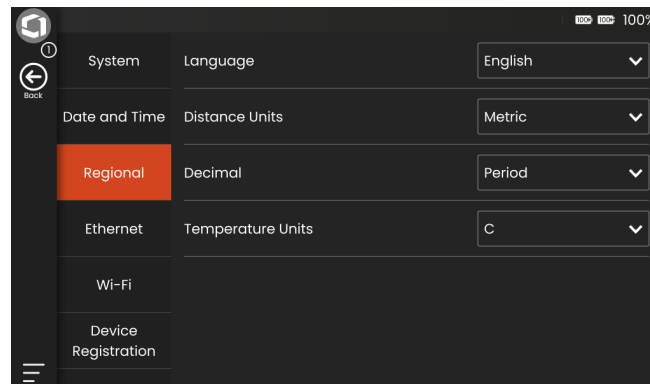
You can switch the distance units between **Metric** and **Inches** any time. All values are adjusted accordingly.

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.



Ethernet

IP Address

When the USM 100 is connected to the network via the USB-C docking hub and LAN cable (see page 269), the current IP address is displayed here for information. You cannot set anything here.

Subnet Mask

The subnet mask is displayed here for information. You cannot set anything here.

Default Gateway

The gateway address is displayed here for information. You cannot set anything here.

Physical Address (MAC)

The MAC address of the network adapter is displayed here for information. You cannot set anything here.

Wi-Fi

Wi-Fi

After plugging a WLAN adapter into the USB socket (see page 270), you can turn on the WLAN connection and then select a WLAN network.

Available Networks

After switching on the WLAN connection, the available networks are displayed here. You can select a network and make the required settings.

Device Registration

You can register your instrument for **InspectionWorks**, a cloud service hosted by Waygate Technologies. Among other things, this platform provides device management, data storage in cloud, and an app store.

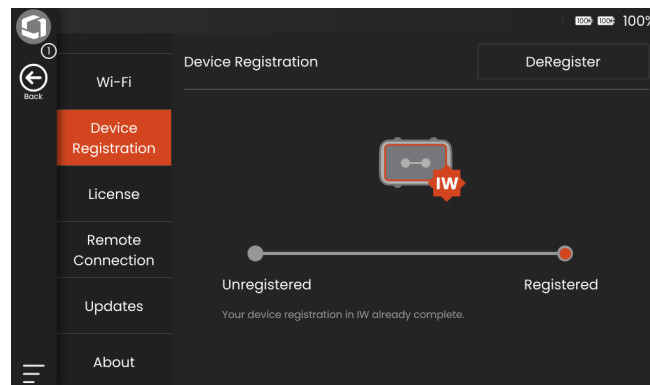
For registration you must enter the license key you receive when you sign up for an **InspectionWorks** account (<https://www.inspectionworks.com/>).

Once an instrument is registered with **InspectionWorks**, you can manage it on the website and, among other things, exchange data as import and export between the instrument and **InspectionWorks** (see from page 253).

For more information about the platform, please visit <https://www.inspectionworks.com/>.

You can log out an instrument from **InspectionWorks** at any time. Once the instrument is logged out, it will no longer be able to access the cloud service and associated features.

If your instrument is already registered, the status **Registered** is marked with a red dot.



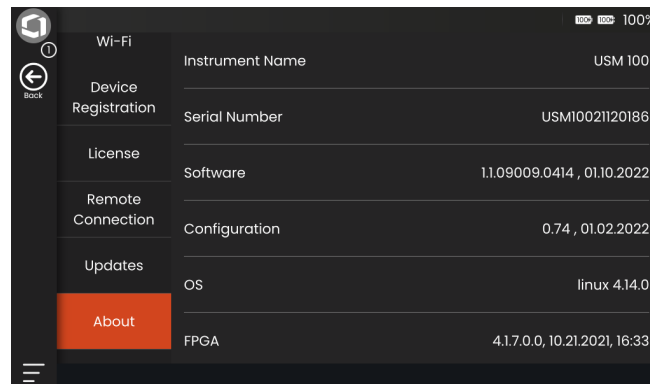
Create an account

If you already have an account at **InspectionWorks**, you can log in immediately and register the device (see **Register device**, page 116).

The serial number needed for the account can be found on the back of the instrument and in the **About** function (see page 119).

- On a computer with an established Internet connection, start a web browser and enter the address **<https://www.inspectionworks.com>**.
- Select **Products** in the navigation and then **InspectionWorks Login / Sign up**.
- In the **New Customers** area, select **Create an Account**.
- Select **USM 100 Account**.
- Fill in the registration form, enter the serial number of the instrument and follow the on-screen instructions.

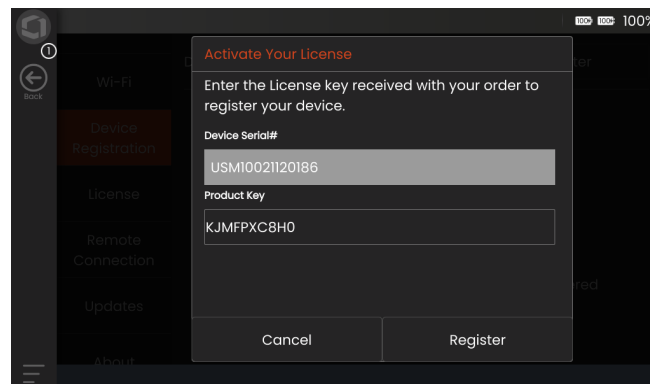
After successful registration, you can log in and register the instrument.



Register device

The prerequisite for using this function is an established Internet connection via LAN (see page 269) or WLAN (see page 270).

- On a computer with an established Internet connection, start a web browser and log in to **InspectionWorks**. After successful login, you will see the dashboard.
- Click in the **My License** area to display the licence key. You must enter the displayed licence key in the instrument.
- In the USM 100, call up the **General settings** menu in the **Main menu** (see page 68).
- Select **Device Registration**.
- Tap on **Register**.
- In the **Product Key** field, enter the licence key as displayed in **InspectionWorks**, and tap on **Register**.

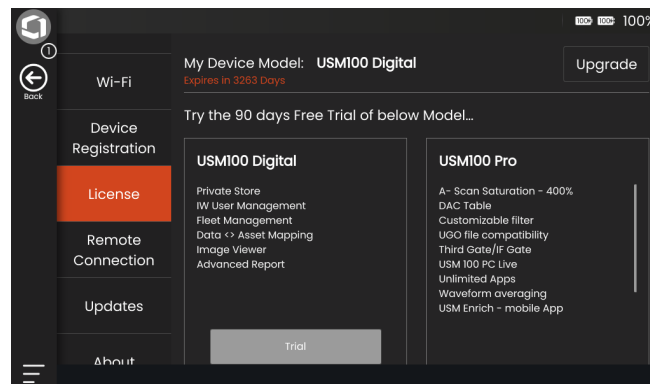


License

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

The license currently installed in the instrument is displayed next to the **Upgrade** button (**My Device Model**), along with the validity period.

For the complete license upgrade procedure see page 266.



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 63.

Wired IP / WiFi IP

When the USM 100 is connected to the network via LAN (see page 269) or WLAN (see page 270), the current IP address is displayed here for information. You cannot set anything here.

Port Number

For security purposes, you can set a specific port for the connection. The default port for VNC connections is 5900.

Password

You can set a password for remote access. If a password is set, you must enter it when establishing a connection.

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 264.

About

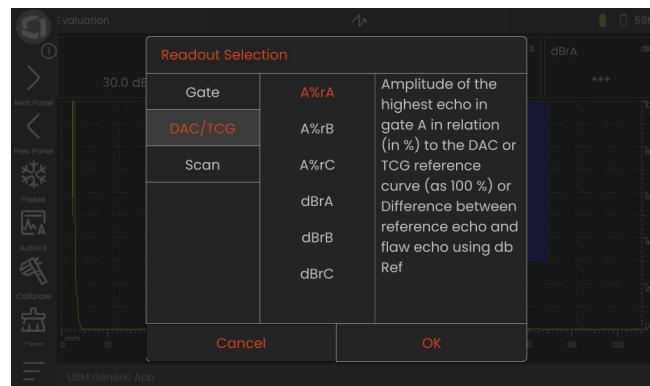
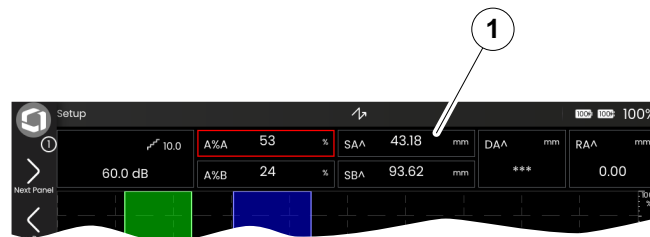
In the **About** section you will find information about the instrument and the currently installed software.

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

5.6 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.



5.7 Basic function groups

In the following chapters, the UT 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 81) set up in the loaded application (see page 69).



Note

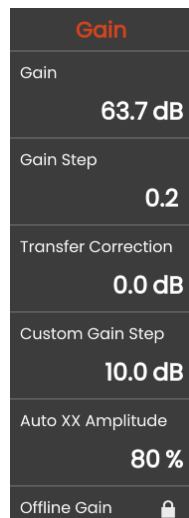
A quick way to find information about a particular function is to use the **Index** at the end of this manual (see page 309).

The **Overview of basic UT Functions** shows the basic ultrasonic functions in alphabetical order with assignment to the various function groups (see page 288).

Icon	Name	Page
no icon	Gain	122
	A-Scan	125
	Material Probe	131
	Pulser Receiver	135
	UT Setup	141
	Gates	145
	Auto Calibration	155
	Probe Angle	156
	Evaluation	158

5.8 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 84).



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 (see page 96), you will always change the gain by the certain dB increment that can be selected here.

In addition to the preset gain steps, you can use the setting **Custom** to select the individual gain step that is set with the function **Custom Gain Step** (see page 124).



Note

You can prevent the gain from changing with the buttons on the back of the instrument during inspection by selecting the setting **Custom** here and selecting the setting **0.0 dB** in the function **Custom Gain Step**.

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 set an individual dB increment for the function **Gain Step** (see page 123).

Auto XX Amplitude

You can set the desired screen height (default = 80%) for the echo amplitude in the **AutoXX** function (see page 74).

Offline Gain

The **Offline Gain** value is applied to a frozen B-scan or C-scan image. With the offline gain you can adjust the gain in stored data to check whether a different gain value has an impact on the test result.

5.9 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.

A-Scan	
Display Range	250.00 mm
Display Delay	0.00 mm
Probe Delay	4.800 μ s
Velocity	5920 m/s
Freeze Mode	Standard
Envelope	



Display Range

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

The adjustment range for display range depends on the **Velocity** setting (see page 126) and the **PRF Value** (see page 139) in the function group **Pulser Receiver**.



Note

For an exact adjustment of the sound velocity and the probe delay, please start by reading the **Calibration** chapter (see page 165).

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. When the third gate is enabled and set as IF gate, the value is automatically fixed at **0**.

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 with the value 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 165). The value is set automatically when you have selected a probe by its number or name (see page 132).

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 74) 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 74).

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

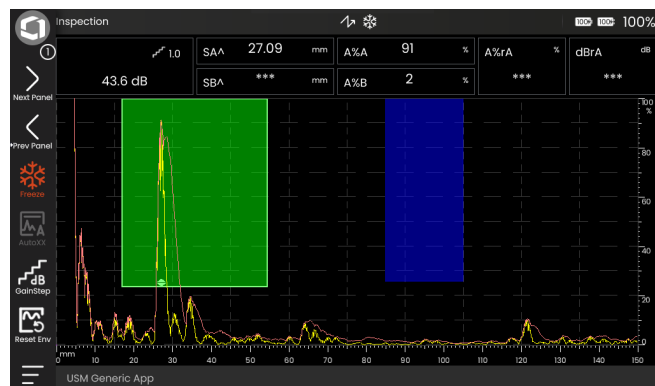
The manually frozen A-scan is displayed for comparison purposes in the background while the currently active A-scan is at the same time visible in the foreground. When leaving the **Freeze** function, the last A-scan is recorded and displayed for comparison purposes.

- * If the function **Gate B Start Mode** (see page 151) 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 current A-scan, the maximum echo amplitudes are displayed as an envelope curve in the background. This envelope curve is updated every time the maximum amplitudes are exceeded.

A-scan with envelope curve:



Range Ruler

You can switch on a ruler at the bottom of the A-scan. For this range ruler several options 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.

Amplitude Ruler

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

Grid

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

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:



A-Scan Color

You can choose the color of the A-scan, independent of the selected **Color Scheme** (see page 109).

Ref. A-Scan Color

You can choose the color of the reference A-scan, independent of the selected **Color Scheme** (see page 109).

Grid Color

You can choose the color of the grid (see function **Grid**), independent of the selected **Color Scheme** (see page 109).

Envelope Color

You can choose the color of the envelope curve, independent of the selected **Color Scheme** (see page 109).

Ref. Envelope Color

You can choose the color of the reference envelope curve, independent of the selected **Color Scheme** (see page 109).

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 249) in the **Data Recorder**.

5.10 Material Probe

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

Material Probe	
Part Type	Flat
Velocity	5920 m/s
Thickness	50.00 mm
Probe Name	DA301
Probe Selection	56904
Frequency	



Velocity

This is the same function as in the function group **A-Scan** (see page 126).

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 132).

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

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 131).

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 order 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 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 **Probe Name**).

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 probe. The probe name **Custom** is user programmable with regard to all parameters.

Alternatively, you can select the probe by its number (see **Probe Selection**).

Frequency

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

The frequency is set automatically when you select a probe by its number or name (see page 132).

Probe Delay

This is the same function as in the function group **A-Scan** (see page 126).

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 132).

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 transducer diameter of the connected probe.

The effective diameter is set automatically when you select a probe by its number or name (see page 132).

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 132).

5.11 Pulser Receiver

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

Pulser Receiver	
Voltage	50 V
Pulser Width Mode	Manual
Pulser Width	100.00
PRF Mode	Auto
PRF Value	600 Hz
Pulser Mode	



Voltage

If the square wave pulser is chosen as pulser mode (see page 139), 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 **Voltage** and the **Pulser Width** can be automatically limited, depending on the pulse repetition frequency mode (see **PRF Mode**, page 139) or setting (see **PRF Value**, page 139). This function helps to avoid heat accumulations in the pulser electronics.

Pulser Width Mode

You can choose between the **Auto** and the **Manual** mode for the pulse width setting.

When you select **Auto** the function **Pulser Width** is locked. The pulse width is calculated and set automatically depending on the frequency of the probe.

When the frequency of the probe is changed, the pulse width is automatically reset. If the frequency of the probe is higher than 15 MHz, the **Pulser Mode** (see page 139) is set to **Spike**, and the pulser width is set to 30 ns, the minimum value for the pulse width, to achieve good performance.

Select **Manual** to set the **Pulser Width**.

Pulser 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 ... 2500 ns (nanoseconds) in steps of 10 ns.

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

$$\begin{aligned} &\text{Nominal width in nanoseconds} \\ &= 500/\text{probe frequency in MHz} \end{aligned}$$

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

$$\begin{aligned} &\text{Nominal width in nanoseconds} \\ &= 500/2.25 \text{ ns} = 222 \text{ nanoseconds} \end{aligned}$$



Note

The pulser voltage and the pulse width can be automatically limited, depending on the pulse repetition frequency mode (see **PRF Mode**, page 139) or setting (see **PRF Value**, page 139). This function helps to avoid heat accumulations in the pulser electronics.

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 / Negative HW

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

Filter

This function is named as **Frequency** in Krautkrämer legacy products. 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.

In addition to the filter values available for selection, you can set your own filter range by specifying the upper and lower cutoff frequencies.

To do this, first select the setting **Adjustable**. Then two further settings **Low Freq** and **Upper Freq** are displayed, with which you can set the cut-off frequencies.

Low Freq

The function **Low Freq** is only visible if the setting **Adjustable** is selected in the **Filter** function.

Set the low cutoff frequency for the filter range here. Frequencies below this cutoff frequency are blocked.

Upper Freq

The function **Upper Freq** is only visible if the setting **Adjustable** is selected in the **Filter** function.

Set the low cutoff frequency for the filter range here. Frequencies below this cutoff frequency are blocked.

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.

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 53).

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 53).

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 30% 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.

Pulser Mode

The USM 100 can be equipped with an optional spike pulser. If the function **Pulser Mode** is available, you can choose between the **Spike** and the **Square** pulser type.

When the spike pulser is selected here, the functions **Voltage** and **Pulser Width** are locked. These parameters are then set automatically and optimized for high frequency probes.

Phantom Echo

With the function **Phantom Echo** you can switch on the phantom echo detection. When the function is switched on, detected phantom echoes become visible by causing the A-scan to jump. If no phantom echoes are detected, no difference is visible in the A-scan display.

Phantom echoes can occur depending on the material properties and the set pulse repetition frequency, especially if the pulse repetition frequency is too high.

If phantom echoes are detected, change the pulse repetition frequency until the phantom echoes disappear or at least become sufficiently small.

**Note**

It is recommended to always leave the phantom echo detection switched on. This will make problems visible immediately.

Averaging

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

5.12 UT Setup

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

UT Setup	
Gain	63.7 dB
AGC Mode	On
AGC Max Amp	95 %
AGC Min Amp	5 %
AGC Noise	5 %
LED Alarm	



Gain

Gain is only visible when **AGC Mode** is set to **On**.

This is the same function as in the function group **Gain** (see page 122).

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 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.

LED Alarm

You can use the multi-color LED next to the screen (see page 102) as an alarm signal. If the alarm event occurs, the LED lights up accordingly.

The gate for triggering the alarm is selected in the function **Alarm Select**.

Tone Alarm

You can output alarms as an acoustic signal directly with the device. If an alarm event occurs, the signal sounds.

The gate for triggering the alarm is selected in the function **Alarm Select**.

Alarm Select

You can assign an alarm event to the alarm output. If the alarm event occurs, a signal is output via the TTL alarm output (see page 271). Here you can select the gate for triggering the alarm.

Averaging

This is the same function as in the function group **Pulser Receiver** (see page 135).

Magnify gate

You can choose a gate for the **Magnify Gate** function in the Command bar (see page 76). The selected gate will be spanned over the entire displayed range.

Analog Output

You can output measurement results via analog output (see page 271) for external further processing.

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

If **Amp** (amplitude) is selected, the following applies to the output voltage:

0 V = 0 % screen height,

5 V = maximum screen height.

If **saturation** is set in the application (only possible with the software **Mentor Create**), then the maximum screen height is 400 %, for example. This means that the output voltage also applies to the range from 0 % to 400 % screen height. In this case 100 % screen height would generate 1.25 V output voltage.

If **TOF** (time of flight) is selected, the following applies to the output voltage: .

0 V = measuring point at the start of the gate,

5 V = measuring point at the end of the gate.

Echo Max

The USM 100 usually generates more A-scans per second (= PRF) than the screen of the device can display (= refresh rate of the screen). Therefore, the first A-scan from the raw data is selected and displayed in the interval of each screen update.

With the **Echo Max** function switched on and a PRF higher than the screen refresh rate, the instrument analyzes all A-scans generated in the respective interval and displays the maximum amplitude at each of the 1024 individual A-scan points. This feature provides a high flaw detectability even at high scanning speeds, both for manual inspection and for automatic inspection systems.

Since the maximum amplitude at each point is displayed on the screen, the A-scan waveform will appear wider than the original waveform.

Example

With a PRF of 1200 Hz, a screen refresh rate of 30 Hz and the function **Echo Max** switched on, $1200/30 = 20$ A-scans are analyzed as raw data at each interval. The highest amplitude at each of the 1024 individual A-scan points is displayed as a combined A-scan.



Note

All measurement readings are calculated based on all A-scans per second (= PRF). The measurement readings are always calculated according to the maximum amplitude at each point in the interval of each screen refresh and displayed on the screen, regardless of whether the function **Echo Max** is switched on or off.

With a PRF = 30 Hz and lower, no echo maximizing takes place any longer.

5.13 Gates

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

Gates	
Gate Selection	Gate A
Gate A Start	29.14 mm
Gate A Width	28.70 mm
Gate A Threshold	41 %
Gate A TOF Mode	Peak
Gate A Logic	



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 143). Gates are displayed in different colors for ease of identification (see page 80).

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 151).

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 85).

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 95).

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 95).

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 also within the range of -5 ... -95 %.

Alternatively, you can adjust the threshold directly on the touchscreen (see page 95).

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:

\wedge = measuring point Peak

/ = measuring point Flank

Examples:

SA \wedge = 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.

When changing the **Display Range** (see page 125), the evaluation may vary if several echoes are combined into one or if one echo is divided among several.

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 143).

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 146).

Gate B Width

This function corresponds to **Gate A Width** (see page 146).

Gate B Threshold

This function corresponds to **Gate A Threshold** (see page 146).

Gate B TOF Mode

This function corresponds to **Gate A TOF Mode** (see page 147).

Gate B Logic

This function corresponds to **Gate A Logic** (see page 150).

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 146).

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 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 the interface echo gate (**IF**) is selected in the function **C/IF Gate Mode** (see page 152).

Gate A

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

C/IF Gate Mode

With this function you select the third gate. You can then make the settings for the selected gate.

The USM 100 provides an interface echo gate option (IF gate). The interface echo gate is normally used for immersion testing and with probes that don't have a solid delay line, for example probes for spot weld testing.

This type of delay line is not constant and varies every time the probe position is changed and with every variation of the load applied to the probe. The continuous variations of the delay line bring about an alternating horizontal time of flight shift of the display in the A-scan with every movement of the probe, the A-scan “shakes” or “wobbles”. By using the interface echo gate, the display can be continuously aligned on the position of the interface echo. In this process, the display zero is set to the point of intersection of the interface echo with the gate and tracked in real time.

If a DAC/TCG reference is recorded, this intersecting point is also used as the reference point for all data points. Once the interface echo gate is enabled, the start mode of gate A and gate B is switched to follow the interface echo gate automatically.

Gate C Start

This function corresponds to **Gate A Start** (see page 146).

Gate C Width

This function corresponds to **Gate A Width** (see page 146).

Gate C Threshold

This function corresponds to **Gate A Threshold** (see page 146).

Gate C TOF Mode

This function corresponds to **Gate A TOF Mode** (see page 147).

Gate C Logic

This function corresponds to **Gate A Logic** (see page 150).

Display Start Mode

This function is only visible when the interface echo gate (**IF**) is selected in the function **C/IF Gate Mode** (see page 152).

You can link the start of the A-scan display to the interface echo.

Normally, the display zero is above the initial pulse (setting **IP**). In this context, also note the setting of the function **Display Delay** (see page 126).

With the **IF** setting, the display start is positioned above the interface echo.

Gate IF Start

This function corresponds to **Gate A Start** (see page 146).

Gate IF Width

This function corresponds to **Gate A Width** (see page 146).

Gate IF Threshold

This function corresponds to **Gate A Threshold** (see page 146).

Gate IF TOF Mode

This function corresponds to **Gate A TOF Mode** (see page 147).

Gate IF Logic

This function corresponds to **Gate A Logic** (see page 150).

5.14 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 165.

Auto Calibration	
Velocity Cal Type	Multi BW
2-Point Cal Source	A-scan
S-Ref 1	25.00 mm
Gate A Start	20.00 mm
Gate B Start	45.00 mm



Velocity Cal Type

The USM 100 provides two calibration modes:

- **Multi BW** (see from page 166)
- **Multi Step** (see from page 167)

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.

5.15 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 169.

Probe Angle
Block
Custom
Angle Cal Source
A-scan
SDH Diameter
2.00 mm
SDH Depth
5.00 mm
Gate A Start
12.50 mm
Gate A Threshold



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 165).

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 156).

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 156).

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

Gate A Start

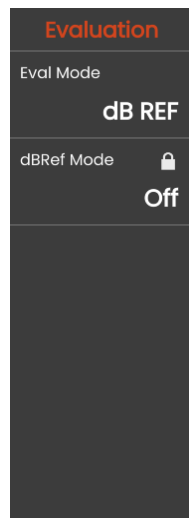
This is the same function as in the function group **Gates** (see page 146).

Gate A Threshold

This is the same function as in the function group **Gates** (see page 146).

5.16 Evaluation

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



The available methods depend on the activated instrument options and the loaded application (see page 69).

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

- **dB REF** (see page 171)
- **DAC** (see page 173)
- **DGS** (see page 180)
- **AWS D1.1 / AWS D1.5** (see page 192)
- **JISDAC** (see page 198)
- **CNDAC** (see page 204)

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 the evaluation method on or off.

Gate A Start

This is the same function as in the function group **Gates** (see page 146).

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 evaluation.

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 can 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 / TCG curve.

DGS Mode

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

You can switch the evaluation method 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 132).

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 132).

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 133).

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 133).

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 134).

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 the evaluation method on or off.

JISDAC Mode

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

You can switch the evaluation method on or off.

Bold Line

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

You can select which evaluation line is displayed bold.

CNDAC Mode

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

You can switch the evaluation method on or off.

Acceptance Level

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

You can set the acceptance level line according to the required quality.

Code

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

You can select a standard according to the inspection requirement.

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**.

The evaluation curve offset will be adapted to the value entered here for the expected defect length.

SL

This parameter is only visible when **CNDAC** has been selected in **Eval Mode**. Here you can set the Sizing Line (SL) according to CNDAC.

RL

This parameter is only visible when **CNDAC** has been selected in **Eval Mode**. Here you can set the Rejection Line (RL) according to CNDAC.

EL

This parameter is only visible when **CNDAC** has been selected in **Eval Mode**. Here you can set the Evaluation Line (EL) according to CNDAC.

5.17 Calibration

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 166)
- **Multi Step** (see page 167)



Note

The angle calculation of angle probes is described from page 169.

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 147).



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

For calibration you can use the envelope curve instead of the A-scan (see **2-Point Cal Source**, page 155).

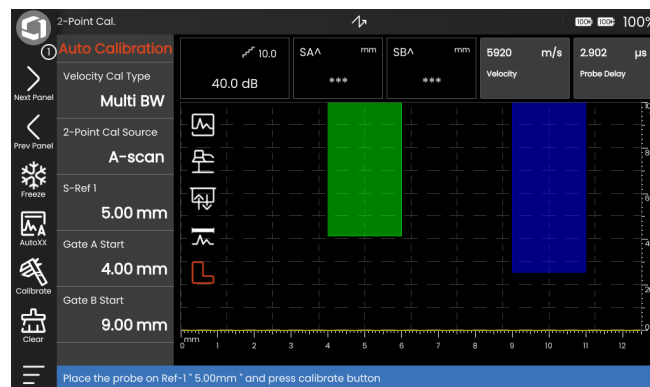
Multi BW

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

During the calibration procedure 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 155).
- Select **Velocity Cal Type** and select **Multi BW**.
- Select **S Ref 1** and set the value according to the calibration block used.

- Couple the probe to the calibration block. The gates are set automatically according to the value of **S Ref 1**.
- In the Command bar tap on **Calibrate** (see page 74) to execute the calibration procedure.



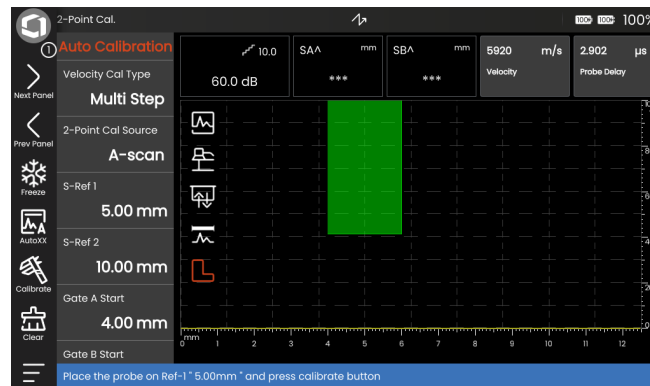
Multi Step

With **Multi Step**, the calibration needs two reference values **S Ref 1** and **S Ref 2**. The reference echoes are generated on two calibration blocks of different thickness, a stepped reference block or standardized calibration blocks, for example K1 or K2.

During the calibration procedure 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 155).
- Select **Velocity Cal Type** and select **Multi Step**.
- Select **S Ref 1** and set the value according to the calibration block used.
- Select **S Ref 2** and set the value according to the calibration block used.
- Couple the probe to the calibration block so that the echo for the path **S Ref 1** is displayed on the screen. The gate is automatically set in this range.

- In the Command bar tap on **Calibrate** (see page 74) to start the calibration procedure.
- Couple the probe to the calibration block so that the echo for the path **S Ref 2** is displayed on the screen. The gate is automatically set in this range.
- In the Command bar tap on **Calibrate** to complete the calibration procedure.



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.

5.18 Defining the probe angle

The function group **Probe Angle** 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.

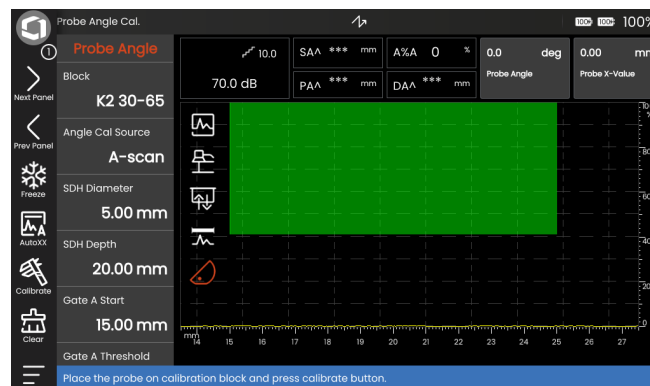


ATTENTION

You have to carry out calibration (see from page 165) before defining the probe angle.

- After calibration, select the function group **Probe Angle** (see page 156).
- 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.
- Position the gate on the calibration echo.
- In the Command bar tap on **Calibrate** (see page 74) to execute the calculation.

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



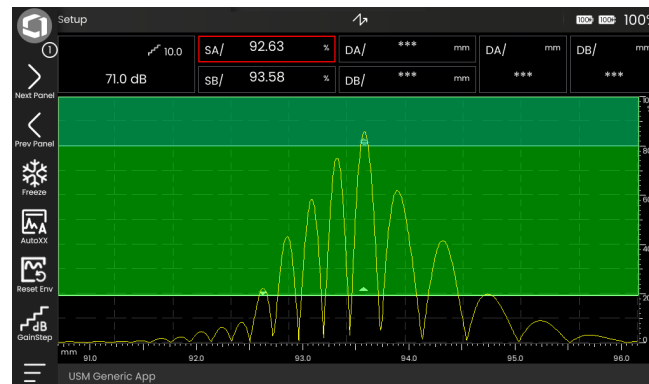
5.19 Making measurements

General notes

Please pay attention to the following notes when using the USM 100 for measurements:

- To ensure proper measurements, please make sure to calibrate correctly.
- All amplitude measurements are made at the highest or the first signal in the gate.
- All distance measurements are made at the intersection point between the gate and the first echo flank (TOF mode = **Flank**, **J-Flank** / **First Peak**) or at the peak of the highest echo in the gate (TOF mode = **Peak**).
- If the amplitudes of the echoes in the gate do not exceed 5 % screen height, all corresponding sound path and amplitude readings are rejected. This enables to avoid quickly changing, random readings based on background noise of the USM 100.

The following example shows the dependency of distance measurement on the echo waveform, i.e. on the height of the gate threshold and thus on the selection of the intersection point at the signal.



Gate A set to 20 % screen height
measured sound path **SA/** = 92.63 mm

Gate B set to 80 % screen height
measured sound path **SB/** = 93.58 mm

5.20 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 159) 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.
- Position the gate A on the reference echo.
- Tap the **Calibrate** icon in the Command bar (see page 74). 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 75). 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 85).

- **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.

5.21 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 159) 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.

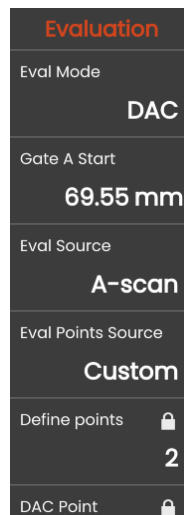
A distance-amplitude correction curve, recorded using defined reference reflectors, is a graphical representation of these influencing factors.

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.

DAC settings

- 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 158).

Recording a DAC curve



ATTENTION

Before starting to record a reference curve, the instrument has to be correctly calibrated (see page 165).

Before a new curve is recorded, a possibly already existing curve must be deleted (see page 176). If necessary, make sure that the old curve has been saved to a dataset before starting to record a new curve.

When the setting **RF** (radio frequency) is selected in the **Rectify** function (see page 137), after recording the first DAC point all further DAC points can only be recorded on the same side of the zero line. All DAC points will then be either in the positive or negative range, depending on the first DAC point recorded. For measurements, you can position the gates in the entire range above and below the zero line.

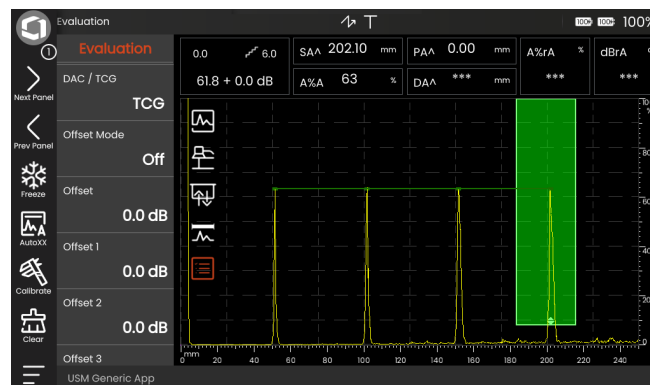
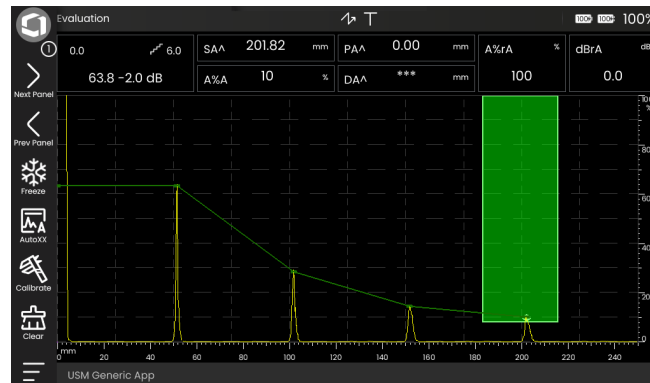


Note

To record DAC echoes, you can use the envelope curve instead of the A-scan (see **Eval Source**, page 159). You cannot use the envelope curve when the setting **RF** (radio frequency) is selected in the **Rectify** function (see page 137).

You can configure the **Measurement line** accordingly to display the specific readings (see page 120).

- Position the gate A on the first DAC echo (see page 95).
- In the Command bar tap on **AutoXX** (see page 74) to automatically set the echo to the required screen height.
- In the Command bar tap on **Calibrate** (see page 74) to record the first DAC point.
- Position the gate A on the second DAC echo.
- 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 **TCG** (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.

- Tap the **Clear** icon in the Command bar (see page 75). A confirmation message is shown.
- Confirm the deletion.

Multiple DAC curves

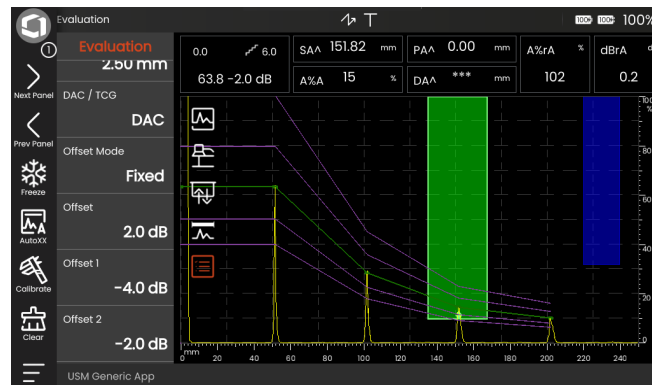
You can activate multiple DAC curves and, at the same time, define the offsets between the multiple curves and the recording curve.

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

- Set the **Offset Mode** (see page 160).
- If you have selected **Fixed**, set the desired value for **Offset** (see page 160).
- If you have selected **Custom**, set the desired values for several offsets starting with **Offset 1** (see page 160).

The offset 0.0 dB only represents the recording curve. Each setting other than 0 generates another curve. A maximum of four additional curves can be displayed.

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 **Velocity**, **Voltage**, **Damping**, **Frequency**, and **Rectify**.

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.

5.22 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.

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.

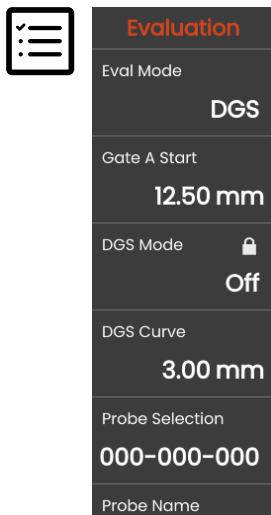


Note

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 158).

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 95).
- In the Command bar tap on **Calibrate** (see page 74) to record the reference echo.

The status icon **A DGS reference echo has been recorded** is displayed above the A-scan (see page 18).

- 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 selected 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 select the curve for a equivalent reflector size after taking the reference echo.

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 recording the reference echo using the function **Reference Attenuation**
- at any time (even after recording the reference echo) using the function **Test Attenuation**

The transfer corrections can be set as follows:

- before recording the reference echo using the function **Amplitude Correction**
- at any time (even after recording the reference echo) 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 (see page 177). 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 recorded reference echo 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.

- Tap the **Clear** icon in the Command bar (see page 75). A confirmation message is shown.
- Confirm the deletion.

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°	3.0	30 ±6

**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 probes

trueDGS® angle 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 probes can be selected in the instrument. The corresponding settings are stored in the instrument and activated when the probe is selected.

5.23 AWS D1.1 / AWS D1.5

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

After selecting **AWS D1.1** or **AWS D1.5** in the function **Eval Mode** in (see page 159) 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:
 $C = 0.079 \text{ dB/mm} \cdot (s - 25.4 \text{ mm})$, 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.

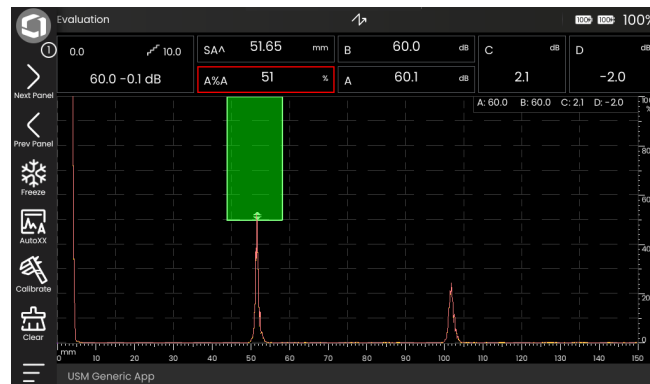
- In the A-scan tap on the **Evaluation** icon to display the function group.



Evaluation	
Eval Mode	
AWS D1.1	
Gate A Start	
12.50 mm	
Gate A Threshold	
41 %	
AWS Mode	
Off	

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

- Select the specific AWS parameters in the measurement line (see page 120).
- Couple the probe to the reference standard and maximize the reference echo.
- After this, position the gate A on the reference echo (see page 95).
- Adjust the gain so that the reference echo is indicated at 50 % screen height.
- In the Command bar tap on **Calibrate** (see page 74) 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.

5.24 Flaw position calculation with angle probes

You will find the functions for setting the flaw position calculation when using angle probes in the function group **Probe Angle**.

- In the A-scan tap on the **Probe Angle** icon to display the function group.



Probe Angle	
Block	
Custom	
Angle Cal Source	
A-scan	
SDH Diameter	2.00 mm
SDH Depth	5.00 mm
Gate A Start	12.50 mm
Gate A Threshold	

Probe Angle

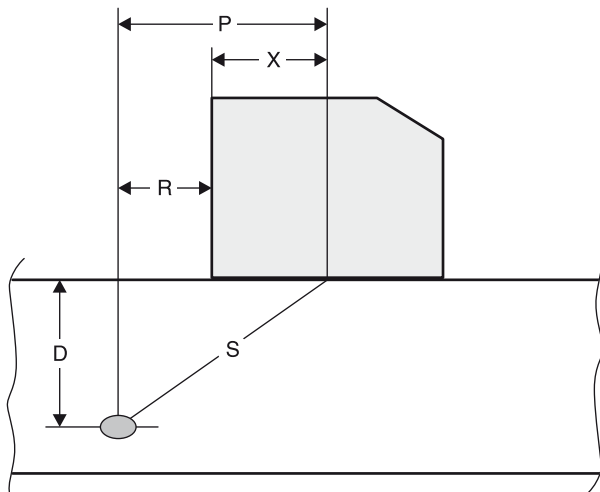
You can use the function **Probe Angle** to adjust the angle of incidence of your probe for the material used. This value is required for the automatic calculation of flaw position.

- In the **Measurement line** tap in the **Probe Angle** box.
- Set the probe angle
- or
- couple the probe to the calibration block and calculate the probe angle (see page 169).

The probe angle is displayed in the **Measurement line**.

10.0	SA^ mm	A%A %	PA^ *** mm	45.0 deg
63.9 dB	***	39	RA^ *** mm	Probe Angle

In addition to the sound path **S**, the (reduced) projection distance and the true depth of the flaw are calculated automatically and can be indicated in the **Measurement line** (see page 120).



- **Projection distance P**

Distance from the probe beam index point to the position of the flaw in gate A, projected onto the surface.

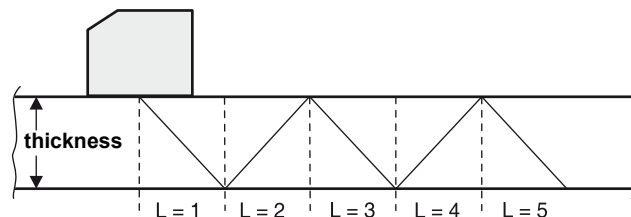
- **Reduced projection distance R**

Distance from the probe front edge to the position of the flaw, projected onto the surface.

- **Depth D**

Distance between flaw position and surface.

When working with angle probes, the USM 100 can calculate the skip distance **L** up to the next reflection point as well. This skip distance can be indicated as the reading **LA**, **LB**, or **LC** in the **Measurement line** (see page 120).



Further settings

You must set several values that are required for the automatic calculation of the true depth or the reduced projection distance of a reflection:

- **Thickness** (see page 132)
- **Probe X-Value** (see page 133)

For better orientation you can use the **Color Leg** function (see page 129) to mark the skip distances for the first three reflections with different background colors.

5.25 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 the Japanese standard 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 recorded DAC curve 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

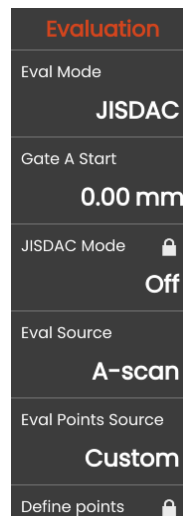
Class II: Line L < Amplitude < Line M

Class III: Line M < Amplitude < Line H

Class IV: Amplitude > Line H

Activating JISDAC

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



- In the function **Eval Mode** select **JISDAC**.
- Set all parameters in this function group (see from page 158).

Recording a DAC curve



ATTENTION

Before starting to record a reference curve, the instrument has to be correctly calibrated (see page 165).

As soon as a new curve is recorded, a possibly already existing curve must be deleted (see page 201). If necessary, make sure that the old curve has been saved to a free dataset before starting to record a new curve.

When the setting **RF** (radio frequency) is selected in the **Rectify** function (see page 137), after recording the first DAC point all further DAC points can only be recorded on the same side of the zero line. All DAC points will then be either in the positive or negative range, depending on the first DAC point recorded. For measurements, you can position the gates in the entire range above and below the zero line.

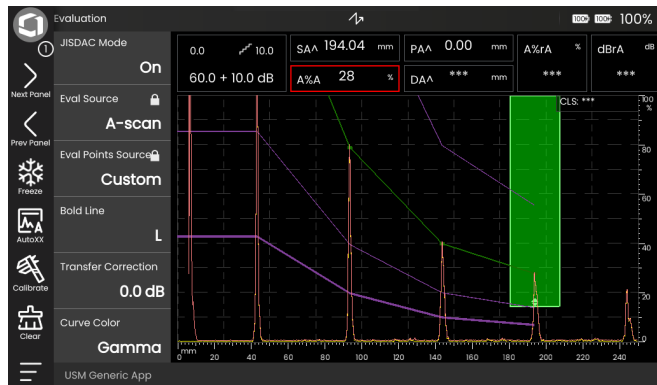


Note

To record DAC echoes, you can use the envelope curve instead of the A-scan (see **Eval Source**, page 159). You cannot use the envelope curve when the setting **RF** (radio frequency) is selected in the **Rectify** function (see page 137).

You can configure the **Measurement line** accordingly to display the specific readings (see page 120).

- Position the gate A on the first DAC echo (see page 95).
- In the Command bar tap on **AutoXX** (see page 74) to automatically set the echo to the required screen height.
- In the Command bar tap on **Calibrate** (see page 74) to record the first DAC point.
- Position the gate A on the second DAC echo.
- 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 **JISDAC Mode** to **On** in order to display the DAC curve.
- With the function **Bold Line** you can select which evaluation line should be displayed bold.



Sensitivity correction

You can use the function **Transfer Correction** to compensate for transfer losses in the material to be tested. A correction is necessary if the test object and the reference standard have different surface qualities.

You have to determine the adjustment value for the compensation of transfer losses by way of experiment. In this connection, the gain is varied accordingly but the curve shape remains the same.

Turning the JISDAC evaluation off

You can turn the DAC evaluation off at any time.

- Set the function **JISDAC Mode** to **Off** in order to hide the curve and the evaluation lines.



Note

The DAC curve is not lost by turning the function off. By turning it on again, you can use the function **JISDAC Mode** 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 75) 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 86).

Echo evaluation using JISDAC

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 **Velocity**, **Voltage**, **Damping**, **Frequency**, and **Rectify**.

Change in the probe delay with JISDAC

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.

5.26 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**.

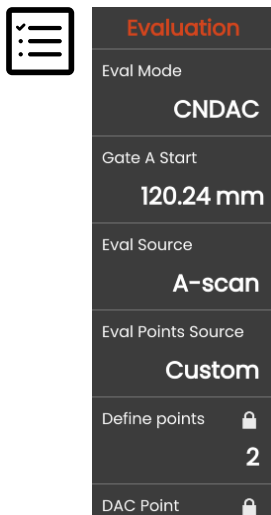
A%rA indicates the difference in amplitude of an echo in the gate A in relation to the reference curve SL at the position of the echo in %. In this connection, the reference curve at the position of the echo is assumed at 100 %.

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

Activating CNDAC

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



- In the function **Eval Mode** select **CNDAC**.
- Set all parameters in this function group (see from page 158).

Recording a DAC curve



ATTENTION

Before starting to record a reference curve, the instrument has to be correctly calibrated (see page 165).

As soon as a new curve is recorded, a possibly already existing curve must be deleted (see page 210). If necessary, make sure that the old curve has been saved to a free dataset before starting to record a new curve.

When the setting **RF** (radio frequency) is selected in the **Rectify** function (see page 137), after recording the first DAC point all further DAC points can only be recorded on the same side of the zero line. All DAC points will then be either in the positive or negative range, depending on the first DAC point recorded. For measurements, you can position the gates in the entire range above and below the zero line.

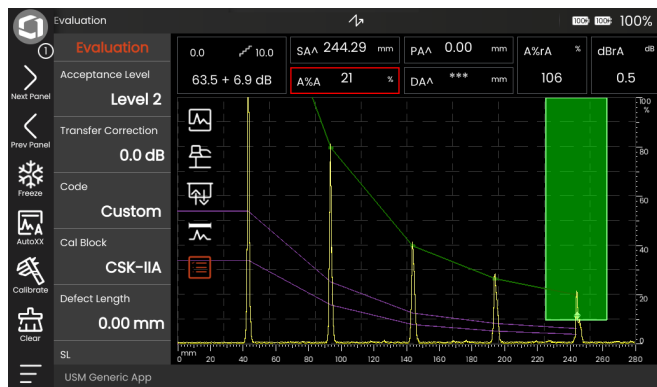
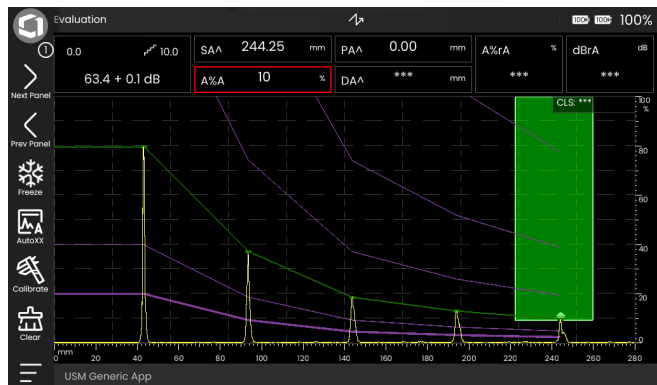


Note

To record DAC echoes, you can use the envelope curve instead of the A-scan (see **Eval Source**, page 159). You cannot use the envelope curve when the setting **RF** (radio frequency) is selected in the **Rectify** function (see page 137).

You can configure the **Measurement line** accordingly to display the specific readings (see page 120).

- Position the gate A on the first DAC echo (see page 95).
- In the Command bar tap on **AutoXX** (see page 74) to automatically set the echo to the required screen height.
- In the Command bar tap on **Calibrate** (see page 74) to record the first DAC point.
- Position the gate A on the second DAC echo.
- 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 **CNDAC Mode to On** in order to display the DAC curve.
- Make further settings for the evaluation in the various functions.



Sensitivity correction

You can use the function **Transfer Correction** to compensate for transfer losses in the material to be tested. A correction is necessary if the test object and the reference standard have different surface qualities.

You have to determine the adjustment value for the compensation of transfer losses by way of experiment. In this connection, the gain is varied accordingly but the curve shape remains the same.

Adjusting reference lines

You can change the reference lines SL, RL and EL at any time. The dB values always refer to the reference line during recording. These values can also be positive, i.e. positioned above the reference.

- Select the function **SL** and change the Sizing Line as required.
- With the functions **RL** and **EL** adjust the Recording Line and the Evaluation Line in the same way.



Turning the CNDAC evaluation off

You can turn the DAC evaluation off at any time.

- Set the function **CNDAC Mode** to **Off** in order to hide the curve and the evaluation lines.



Note

The DAC curve is not lost by turning the function off. By turning it on again, you can use the function **JISDAC Mode** 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 75) 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 86).

Echo evaluation using CNDAC

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 **Velocity**, **Voltage**, **Damping**, **Frequency**, and **Rectify**.

Change in the probe delay with CNDAC

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.

5.27 Encoder Cal

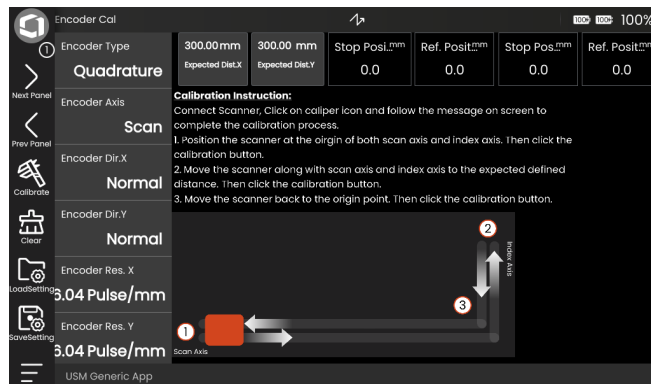
For material testing with B-scan or C-scan (see from page 221), usually manually or automatically controlled scanner inspection systems are used. These inspection systems use a position encoder which can be verified before use.

In most scanner inspection systems the probe is hold on a bar. The probe is moved over the inspection area along the bar. In addition, the bar can be moved to inspect a larger area with multiple parallel inspection tracks.

The moving direction of the probe is the scan axis. The moving direction of the bar is the index axis.

Before starting the verification you have to set the parameters of the scanner system.

- Slide the sidebar from the left edge into the screen (see page 83).
- Set the parameters according to the scanner system you are using.



Encoder Type

You must select the encoder type depending on the scanner system you are using and the encoders installed.

Select **Directional** or **Quadrature** for each axis depending on the encoder. One can be used for the scan axis, the other for the index axis.

Encoder Axis

You must select which axis is equipped with an encoder. The standard setting is **Scan** (one encoder for the scan axis). Select **Both** for systems with two encoders, one for the scan axis and one for the index axis.

Encoder Dir. X

Set the moving direction of the encoder on the X-axis.

Normal

The moving on the scan axis is from left to right.

Reversed

The moving on the scan axis is from right to left.

Encoder Dir. Y

Normal

The moving on the index axis is from the bottom to the top.

Reversed

The moving on the index axis is from the top to the bottom.

Encoder Res. X

If the resolution of the encoder signals for the scan axis (X-axis) is known, you can enter the value here directly in ticks per mm.

Otherwise, the resolution is determined during the verification and the value is entered here automatically.

Encoder Res. Y

If the resolution of the encoder signals for the index axis (Y-axis) is known, you can enter the value here directly in ticks per mm.

Otherwise, the resolution is determined during the verification and the value is entered here automatically.

Expected Dist. X

To calculate the encoder resolution, you must enter the length of the reference path on the scan axis (X-axis) here. During the verification, the probe must be moved over this distance.

Expected Dist. Y

To calculate the encoder resolution, you must enter the length of the reference path on the index axis (Y-axis) here. During the verification, the probe must be moved over this distance.

Scan Tolerance

During the encoder calibration of the scan axis (X-axis) you have to move the probe back to the origin position on the X-axis. If this cannot be done exactly, without any deviation, you can set a tolerance value. A deviation of the position within the tolerance value is accepted during calibration.

Index Tolerance

During the encoder calibration of the index axis (Y-axis) you have to move the probe back to the origin position on the Y-axis. If this cannot be done exactly, without any deviation, you can set a tolerance value. A deviation of the position within the tolerance value is accepted during calibration.

5.28 Verifying the encoder

Once all parameters of the scanner system are set (see from page 213), you can start the verification.

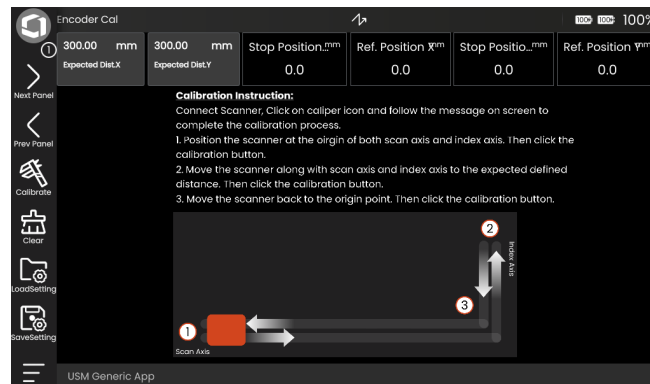
- Mark the reference distance for verification according to the settings in **Expected Dist. X** and **Expected Dist. Y** (see page 215).
- Move the probe to the starting position on the X-axis and the Y-axis.
- In the Command bar tap on **Calibrate** (see page 74) to start the procedure.
- Follow the instructions on the screen.

Once the verification is completed, the encoder resolution settings are updated.



Note

When using the Phoenix Inspection System tracer encoder, no verification is required. Set the resolution of the encoder to 5 ticks/mm as described in the encoder manual. Then the device can detect the correct position of the probe..



5.29 Scan

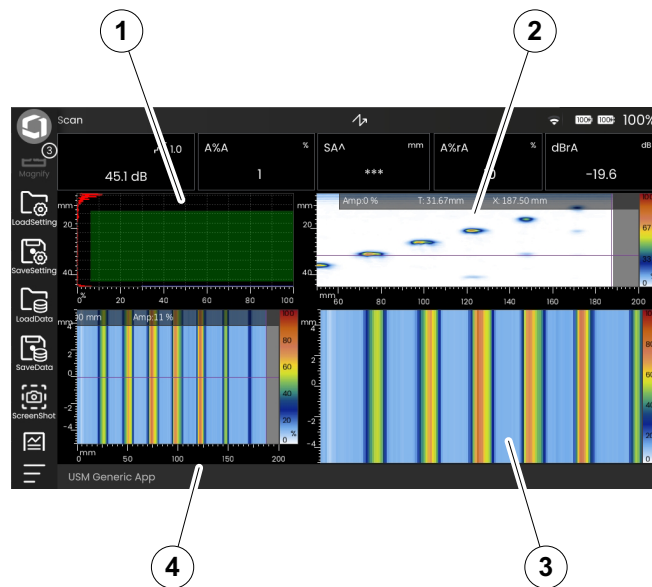
UT representation formats

Ultrasonic data is collected and displayed in different formats. The three most common formats are A-scan, B-scan, and C-scan. Each presentation mode provides a different way of looking at and evaluating the region of part under inspection.

In the USM 100, the B-scan (2) and C-scan (3, 4) representations are combined with the A-scan (1) representation and the associated functions on a special panel.

As in the normal A-scan representation (see from page 79) the B-scan and the C-scan can be displayed in normal mode or in zoom mode. To toggle between the normal and the zoomed display, double-tap in the respective view.

The "active" C-scan (3) of the USM 100 shows a zoomed section from the entire C-scan (4). During the scan, this section shows the area around the probe position so that you can observe the process more closely. For the subsequent evaluation, you can select the zoom area freely (see from page 235).

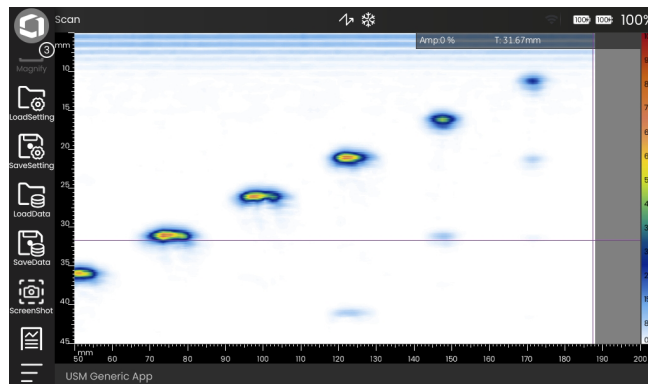


B-Scan representation

The B-scan presentation is a side view of the part under inspection.

In the B-scan view, the TOF (time of flight) of the ultrasonic signal is displayed along the Y-axis. The probe position is displayed along the X-axis. The depth of a reflector and its position on the part can be determined.

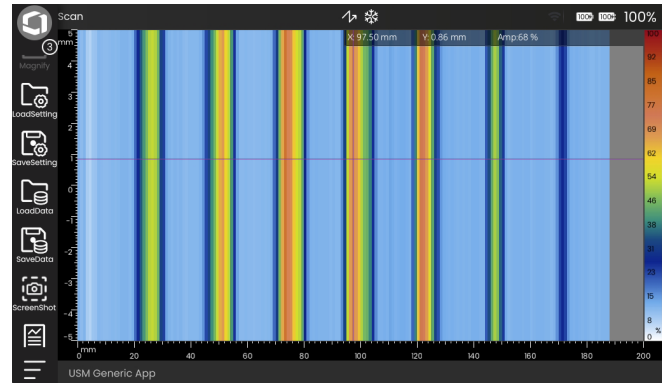
All received signals in the same position can be plotted in the B-scan. The amplitude height is displayed as different color and plotted along the TOF.



C-Scan representation

C-scan presentation is a top view of the part under inspection. The location and size of reflector in part can be determined.

Typically, a gate is defined in the A-scan. When the probe is moved over the part under inspection, the amplitude or TOF values of the echoes are recorded at a constant interval, and displayed as dots in different colors or shades of gray.



5.30 Scan Setup

In this function group you can set the parameters for the B-scan and C-scan representations and the scanning process.

Scan Setup
Scan Pattern
Bi - Dir Raster
Position Mode
Encoded
Manual Index
On
Scan Size
150.00 mm
Index Size
100.00 mm
Scan Resoln. (Dist)



Scan Pattern

You must select the scan pattern depending on the scanner system you are using and the encoders installed.

Line

Only the scan axis is equipped with an encoder.

Bi - Dir Raster

Both the index axis and the scan axis are equipped with an encoder. The scanning direction can be reversed.

Uni - Dir Raster

Both the index axis and the scan axis are equipped with an encoder. Scanning is only possible in one direction.

Free Hand

Select this setting when a tracer scanner is used.

Single-Shot

This setting is not available for B-scan and C-scan.

Position Mode

You can choose between two methods for determining the probe position.

Encoded

The position of the probe is determined by evaluating the encoder signals.

Timed

The position of the probe is calculated based on the movement time. With this method, the probe must be moved at a constant speed.

Manual Index

If the scanner system does not have an encoder for the index axis, you must select the setting **On** for manual entry of the index value.

During the scanning procedure, you must then set the value for the track shift on the index axis. To do this, you will use the arrow buttons that appear in the C-scan (see page 232). These arrow buttons are only visible if you select the setting **On** here.

Scan Size

You must set the maximum length of the scan axis.

Index Size

You must set the maximum length of the index axis.

Scan Resoln. (Dist)

You can set the distance between the individual measuring points along the scan axis.

Scan Resolution (Time)

You can set the time interval between the individual measuring points along the scan axis, when **Timed** is selected in **Position Mode**.

Active Scan Size

You can set the scan size (X-axis) of the active C-scan (see page 218).

CV Index Overlap

For unidirectional or bidirectional scanning you can define the overlap of the individual passes.

CV Index Distance

For unidirectional or bidirectional scanning you must set the distance of the individual passes along the Y-axis.

Encoder Type

This is the same function as in the function group **Encoder Cal** (see page 214).

Encoder Dir. X

This is the same function as in the function group **Encoder Cal** (see page 214).

Encoder Dir. Y

This is the same function as in the function group **Encoder Cal** (see page 214).

Encoder Res. X

This is the same function as in the function group **Encoder Cal** (see page 215).

Encoder Res. Y

This is the same function as in the function group **Encoder Cal** (see page 215).

Active Scan Start

You can set the starting point on the scan axis (X-axis) of the active C-scan (see page 218). independently of the C-scan. You can also change this setting after a scan has been acquired in order to display an enlarged area in the active C-scan for evaluation (see page 235). This setting is locked during the scan.

Active Scan End

You can set the end point on the scan axis (X-axis) of the active C-scan (see page 218). independently of the C-scan. You can also change this setting after a scan has been acquired in order to display an enlarged area in the active C-scan for evaluation (see page 235). This setting is locked during the scan.

Active Index Start

You can set the starting point on the index axis (Y-axis) of the active C-scan (see page 218). independently of the C-scan. You can also change this setting after a scan has been acquired in order to display an enlarged area in the active C-scan for evaluation (see page 235). This setting is locked during the scan.

Active Index End

You can set the end point on the index axis (Y-axis) of the active C-scan (see page 218). independently of the C-scan. You can also change this setting after a scan has been acquired in order to display an enlarged area in the active C-scan for evaluation (see page 235). This setting is locked during the scan.

5.31 Display

In this function group you can set the parameters for the display of the image.

Display
Data Source
Amp A-Scan
Beam Fill
Interpolate
Amp Palette
Standard
Amp Color Pal. Lower
0 %
Amp Color Pal. Upper
100 %
Range Ruler



Data Source

You must select which measured value is to be used for the representation of the B-scan or C-scan:

Amp A-Scan	= highest amplitude in the A-scan
Amp A	= highest amplitude in gate A
Amp B	= highest amplitude in gate B
TOF A-Scan	= time of flight of the first echo in the A-scan
TOF A	= time of flight of the first echo in gate A
TOF B	= time of flight of the first echo in gate B
TOF A-B	= time of flight between the first echo in gate A and the first echo in gate B

Beam Fill

You can define the color mapping of the beam fill. The beam fill is used to smooth the adjacent A-scan pixels in the respective view. The A-scan amplitude will be interpolated to smooth the edges.

Interpolate

If interpolate is selected an interpolation method is implemented.

Constant

A constant value is used to fill the gap.

Amp Palette

You can select the color palette for the representation of the measured amplitude values.

Amp Color Pal. Lower

You can set a lower limit for the amplitude measurement values. Echoes with an amplitude below this limit are displayed in the same color.

Amp Color Pal. Upper

You can set an upper limit for the amplitude measurement values. Echoes with an amplitude above this limit are displayed in the same color.

Thickness Palette

You can switch on a simplified color palette for evaluating wall thickness measurements in the C-scan (see page 237).

The wall thickness palette consists of five fixed colors for different wall thickness ranges that you can define (see following settings).

You can only switch on the wall thickness palette if **TOF A** is selected in the **Data Source** setting (see page 226).

Thickness

This function is only available when the thickness palette is switched on.

This is the same function as in the function group **Material Probe** (see page 132).

TMin

This function is only available when the thickness palette is switched on.

Enter the value for the minimum wall thickness. Wall thicknesses up to this value are displayed in green in the C-scan.

Zone 1

This function is only available when the thickness palette is switched on.

With reference to the minimum wall thickness entered in the **TMin** setting (= 100 %), select a wall thickness value in percent.

Example:

Thickness: 50 mm

TMin: 40 mm

Zone 1: 90 % = 36 mm

Wall thickness measurements below **TMin** up to the percentage value selected here are shown in blue in the C-scan. Based on the example, these are all values between 40 mm and 36 mm.

Zone 2

This function is only available when the thickness palette is switched on.

With reference to the minimum wall thickness entered in the **TMin** setting (= 100 %), select a wall thickness value in percent. The value selected here must be smaller than the value selected in the **Zone 1** setting.

Wall thickness measurements below **Zone 1** up to the value selected here are shown in beige in the C-scan.

Zone 3

This function is only available when the thickness palette is switched on.

With reference to the minimum wall thickness entered in the **TMin** setting (= 100 %), select a wall thickness value in percent. The value selected here must be smaller than the value selected in the **Zone 2** setting.

Wall thickness measurements below **Zone 2** up to the value selected here are shown in yellow in the C-scan. Wall thickness measurements below the value selected here are shown in red.

Index Ruler

You can switch on a ruler along the index axis (Y-axis).

Range Ruler

You can switch on the material depth ruler along the Y-axis of the B-scan representation.

Scan Pos. Ruler

You can switch on the scan position ruler along the X-axis of the B-scan representation.

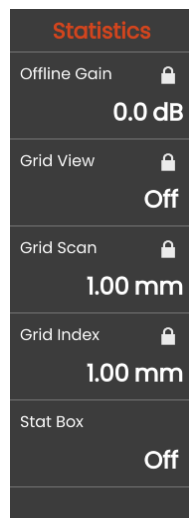
Snap to Cursor

This function is only used when evaluating stored data.

You can enable or disable this function to let the index cursor snap in according to the index width of each pass in the scan.

5.32 Statistics

In this function group you can set the parameters for the measurement values.



Offline Gain

This parameter can only be set for stored measurement results, not during recording.

You can change the gain for the analysis of the measurement results.

Grid View

This parameter can only be set for stored measurement results, not during recording.

You can switch on the grid view in the B-scan.

Grid Scan

This parameter can only be set for stored measurement results, not during recording.

You can set the size of the grid along the scan axis.

Grid Index

This parameter can only be set for stored measurement results, not during recording.

You can set the size of the grid along the index axis.

Stat Box

You can switch on the statistical measurement box over the B-scan or C-scan.

5.33 Scanning and evaluation



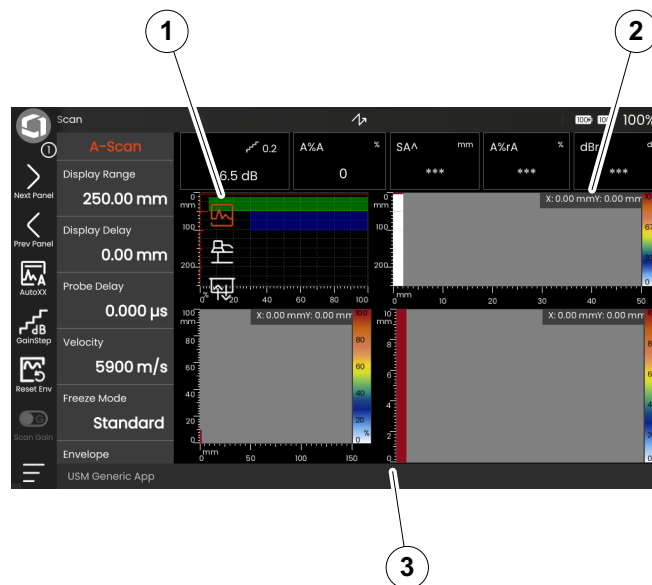
Note

For the operation of the scanner system, please refer to the operating manuals of the devices used.

Scan panel

The USM 100 provides a specific scan panel for scanner system operation with B-scan and C-scan evaluation (see page 218). By using the function groups in the A-scan view (1), the display range and the gate position can be set for each inspection (see from page 125). For example, the display range can be set related to the material thickness, and the gate can be moved to the area of interest from which the amplitude or the TOF should be displayed in the C-scan.

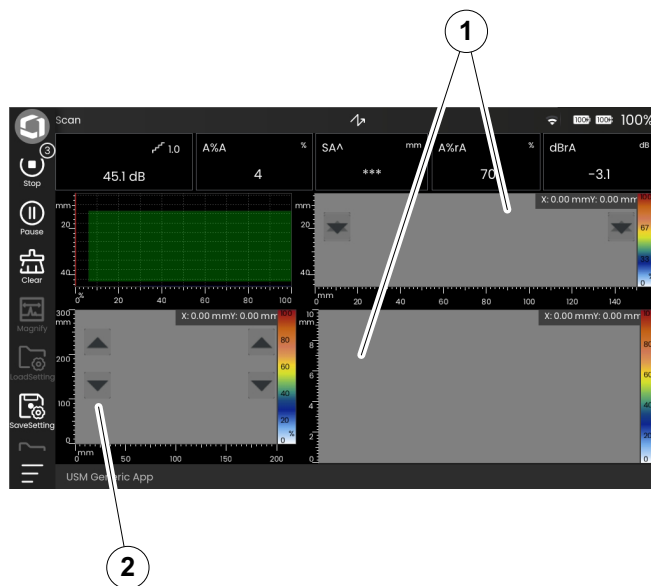
The display ranges of both the B-scan and the C-scan are aligned (3). The current position of the probe (X-axis and Y-axis) is always displayed (2).



Scan procedure

After setting the display range and the gate position, the ultrasonic signals of defects can be easily identified in the A-scan. Now you can start the inspection.

- Move the probe to the starting point and check the position on the screen.
- In the Command bar tap the **Record** icon (see page 76). The instrument is now ready for displaying the measurements in the B-scan and the C-scan.
- Move the probe over the surface to be inspected as previously set in the various parameters (see from page 221). In B-scan and C-scan, you can follow the display of the measurement results in real time (1).
- When using a scanner without encoder for the index axis, tap the arrow buttons (2) to set the value for the track shift on the index axis manually (see **Manual Index** on page 222).



- Tap the **Pause** icon (see page 76) to interrupt the scanning.
- Tap the **Resume** icon (see page 76) to continue the scanning.
- Tap the **Stop** icon (see page 76) to finish the scanning. The inspection data is not yet stored.
- Save the inspection data.
- Before starting a new scan tap the **Clear** icon (see page 75) to delete the recorded data from the B-scan and the C-scan.

Saving and loading data

You can save the scan data for later analysis.

- In the Command bar tap the **Save data** icon (see page 77). 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**.
- Select a directory and tap on **Save** to save the file in the selected location.
- To load the saved data for analysis tap the **Load data** icon (see page 77) and select the file.



Note

For evaluation the stored data can also be loaded in the software **USM 100 PC** from Waygate Technologies.

Evaluation

For evaluation, you must first load the saved scan data. Then you have the possibility to display details and individual values of the measurements.

You can use the crosshair cursor (2) to mark a specific location in the B-scan or the C-scan. When moving the cursor in the C-scan, the B-scan is updated synchronously. When moving the cursor in the B-scan, the corresponding A-scan is loaded.

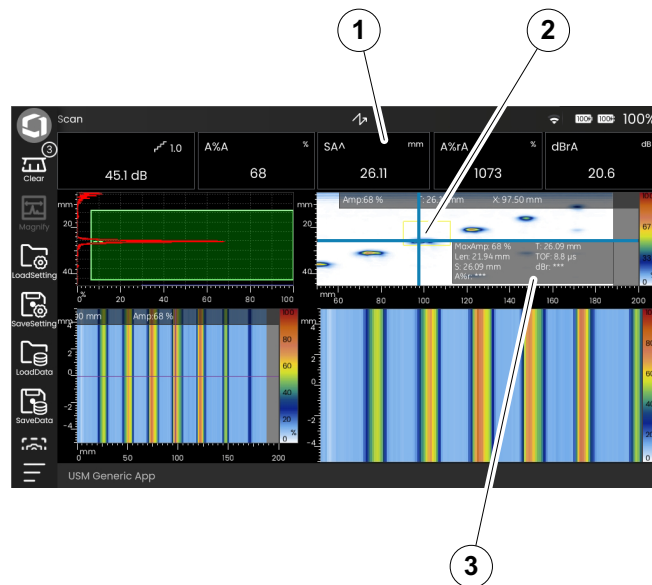
The statistics box (3) in the B-scan displays selected measurement values, when it is switched on (see **Stat Box** on page 231). The other values are displayed in the **Measurement line** (1) as usual (see page 85).

The selection of values displayed in the statistics box can be set in the software **Mentor Create** only, which is described in a separate manual.

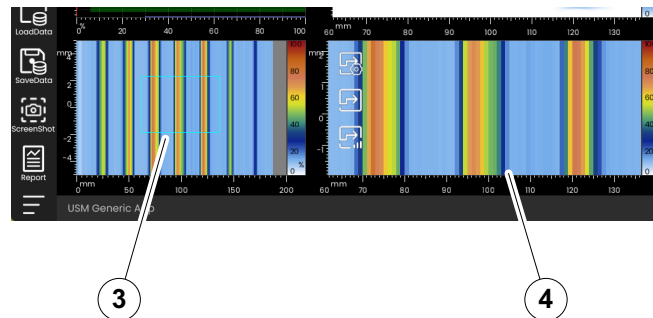
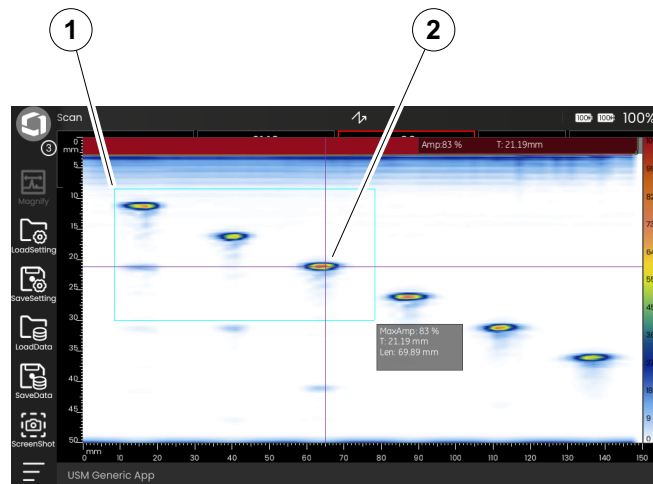


Note

The data volume may have impact on the analysis performance. If the scan size exceeds 100 mm x 100 mm with a resolution of 1 mm, we recommend using the software **USM 100 PC** from Waygate Technologies for inspection and analysis.



- To toggle between the normal and the zoomed display, double-tap in the respective view.
- Tap in the B-scan and drag an area (1) while holding down your finger. The cursor is automatically set to the highest amplitude (2) within the area.
- Tap in the C-scan and drag an area (1) while holding down your finger. The area is displayed zoomed in the active C-scan (4).



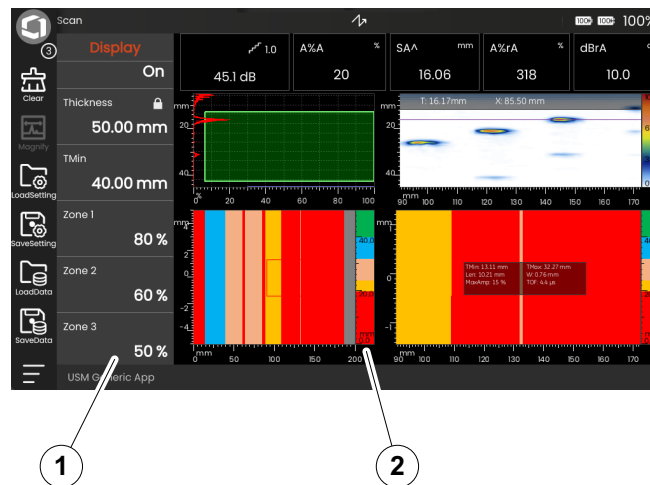
Wall thickness measurement

For easier evaluation of wall thickness measurements, you can switch on a simplified color palette (2) in the C-scan and define wall thickness ranges (1) that are displayed with clearly distinguishable colors.

- Tap in the C-scan and tap on the **Display** icon to display the function group (see page 226).
- Select **TOF A** (sound path of the highest echo in gate A) in the **Data Source** setting (see page 226).
- Select **On** in the **Thickness Palette** setting (see page 228).
- Select the different wall thickness areas (see from page 228).

Wall thickness values in the example on the right:

Green	=	40 ... 50 mm	(TMin ... Thickness)
Blue	=	32 ... 40 mm	(80 ... 100 % TMin)
Beige	=	24 ... 32 mm	(60 ... 80 % TMin)
Yellow	=	20 ... 24 mm	(50 ... 60 % TMin)
Red	=	< 20 mm	(< 50 % TMin)



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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 78)
- **Save multiple page report** (see page 78)

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 the software **USM 100 PC** to view, edit, and print out the test reports and A-scans stored in the USM 100 (see page 58).

Deleting test reports

You can delete test reports stored in the USM 100 at any time (see page 256).

Test report setup

A test report can contain different information and data, as well as screen captures. The test report template is part of the application (see page 69), created with the software **Mentor Create**.

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

Multiple page test report

If additional screen captures are to be saved in the test report in addition to the current screen content, you must save a multi-page test report. The additional screen captures must have been saved in the USM 100 with the function **Screen capture** before creating the multi-page test report (see page 242).

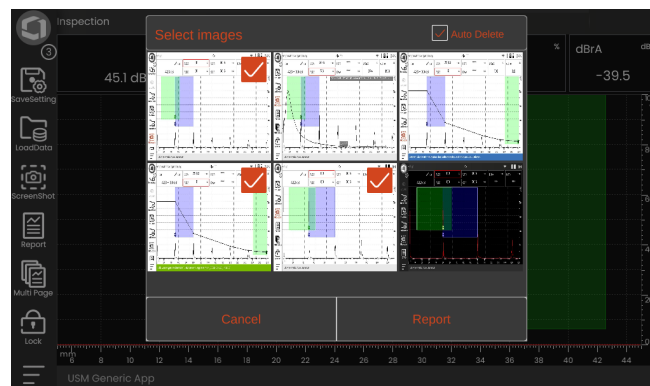


ATTENTION

In the standard setting, the automatic deletion of images is selected in the dialogue window for image selection. The function **Auto Delete** is marked with a tick.

- From the Command bar tap the **Save multiple page report** icon (see page 78). The dialogue window for image selection opens.
- Tap on all images that are to be saved in the test report. Selected images are marked with a tick.

- If the marked images are to be deleted automatically afterwards, mark the function **Auto Delete** in the top right corner with a tick.
- Tap on **Report**. The multi-page test report is saved.



6.2 Screen captures

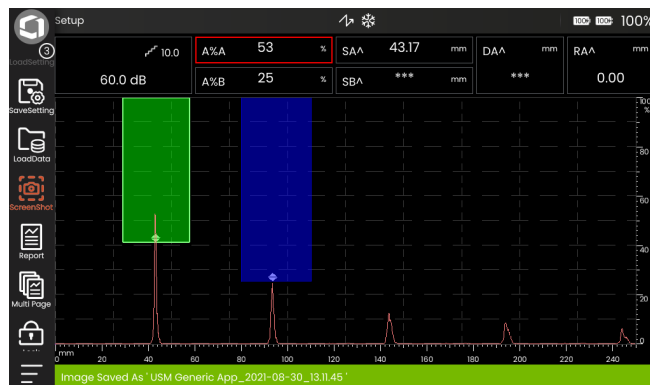
You can save an image of the entire screen. Screen captures are saved in the selected default directory. The file name is generated automatically and consists of the name of the current application, the date and the time, for example USM100_Standard_2021-03-02_16.09.49.

You can rename all stored files directly with the USM 100 (see page 255).

You can find the **Screen capture** function in the **Command bar** (see page 74).

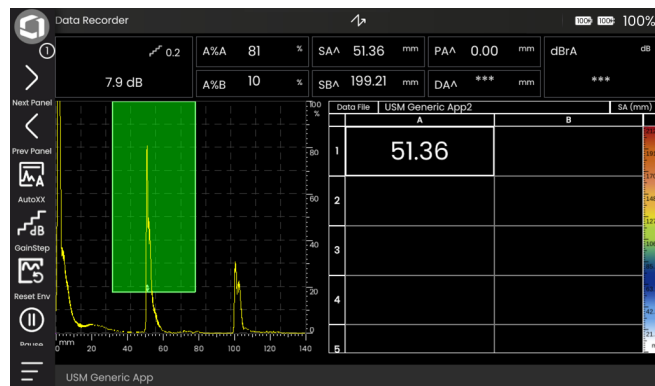
- If required, tap the **Freeze** icon in the Command bar.
- Tap the **Screen capture** icon. The screen capture is stored immediately.

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 81 for panel selection).



The data recorder enables you to easily manage test tasks with wall thickness measurements, and to store and to document readings and associated A-scans in a structured manner.

You can store readings in a data matrix and, in this way, structure them according to the test tasks. The data 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 data 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 data matrix remains empty.

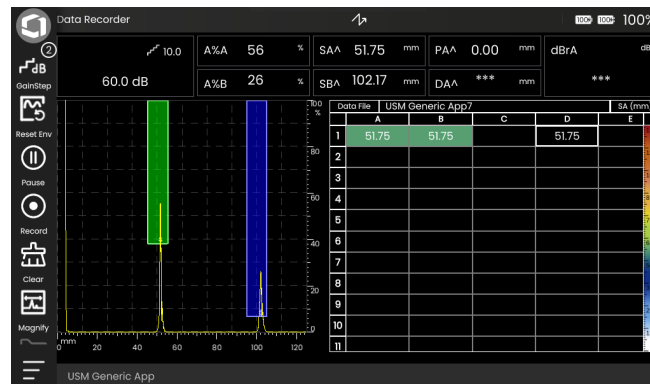
Data File	USM Generic App7				SA (mm)
	A	B	C	D	E
1	51.75	51.75		51.75	
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					

Switching between views

Together with the data 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 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.

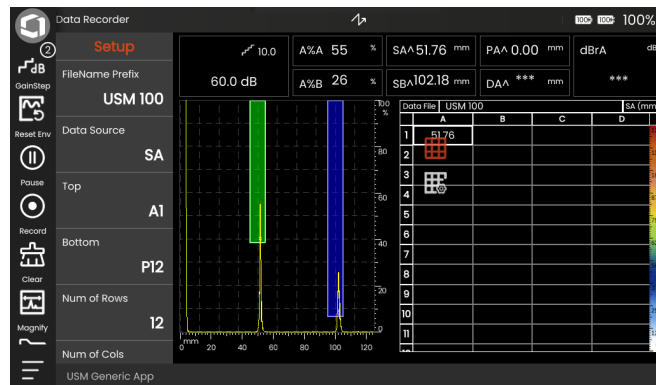


Changing the display size

- In the data 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 data matrix.



Setup



Before you are able to store readings in a data 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 data matrix to display the available function group icons.
- Tap on the **Setup** icon to display the function group.



Setup

FileName Prefix
USM 100

Data Source
SA

Top
A1

Bottom
P16

Num of Rows
16

Num of Cols

FileName Prefix

You can enter a character string as a prefix for the automatically generated file names. 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.



Data Source

You can select which reading should be stored in the cells of the data matrix. This selection applies to all cells.

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 cell (top left) of the data matrix. Together with the designation of the last cell (**Bottom**), this then results in the total size of the data 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 cell (bottom right) of the data matrix. Together with the designation of the first cell (**Top**), this then results in the total size of the data 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 data matrix. Together with the number of columns (**Num of Cols**), this then results in the total size of the data matrix.

Alternatively, you can specify the first (**Top**) and the last (**Bottom**) cell of the data matrix.

The maximum number of cells (rows x columns) is 10000.

Num of Cols

You can set the total number of columns for the data matrix. Together with the number of rows (**Num of Rows**), this then results in the total size of the data matrix.

Alternatively, you can specify the first (**Top**) and the last (**Bottom**) cell of the data matrix.

The maximum number of cells (rows x columns) is 10000.

Advance Dir

You can set select the automatic filling advance direction for the data 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

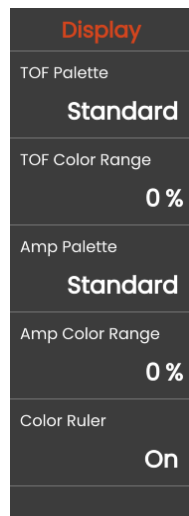
If you switch on the **Auto Reverse** function, the filling direction always reverses when the end of a row or column is reached. Every second row is then filled from right to left, every second column from bottom to top.

Selected

You can select a specific cell to save the next measured reading there.

Display

You can configure the display of the data matrix.



TOF Palette

Based on the stored TOF reading, the cells of the data 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 cells of the data 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 on the color ruler at the right edge of the data matrix.

The color scale serves as additional information and shows with different colors in which range a measured value lies. The same color ruler applies to all cells of the data matrix.

During the recording of measured values, the range of the color scale can change. This range is automatically calculated from the following factors:

- maximum display range of the A-scans of all cells with recorded values
- display range of the current A-scan
- end of gate A
- end of gate B

The end of the gate results from the gate start and the gate width.

The color ruler is adjusted when one of the above factors changes. This may result in a change of the assigned color, but it is always synchronous with the color ruler visible at the right edge of the data matrix.

Storing readings

Following the creation of the data recorder file (see page 245), you can store readings the individual cells.



Note

During the recording process the settings are not changeable. To change the data matrix you must first stop the recording. Then you can create a new data recorder file.

All recorded data is immediately stored in the data recorder file. You can pause and resume recording at any time.

If you delete the recorded data, a new data recorder file will be created automatically. When deleting, no data is lost, because it is already stored in the data recorder file.

- Couple the probe to the first measuring point. The reading can be displayed in the **Measurement line** (see page 120).
- In the **Command bar** tap the **Record** icon (see page 76). The reading is stored and visible in the first cell. After storing, the next cell is automatically selected.
- Store more measurements in the same way.
- Tap the **Pause** icon (see page 76) to interrupt the recording of measurements. The data recorder file remains open.
- Tap the **Resume** icon (see page 76) to continue storing measurements.
- Tap the **Clear** icon (see page 75) to finish the recording of measurements.
- Confirm the security prompt that appears.

The data recorder file is closed and you can start a new file.

Deleting readings

You can overwrite any readings in the data grid. To do so, you need to select a specific cell and then record a new reading.

- Select the desired cell with the function **Selected** (see page 248).
- Couple the probe and tap the **Record** icon.
- Confirm the security prompt that appears.

The new reading is stored and visible in the cell. After storing, the next cell is automatically selected.

Saving a CSV file

You can save the current readings in the data grid as a CSV file. The name of the CSV file is generated automatically and consists of the name of the application and the date and time.

- In the **Command bar** tap the **Export CSV** icon (see page 78).
- Select the storage location **USB** or **USM100**.
- Tap on a folder icon to select a directory.
- Tap on **Save**. The measured values are saved in the CSV file.



ATTENTION

Depending on the number of readings, the saving process may take some time. If you save the CSV file directly to a USB stick, do not pull out the USB stick before the saving process is finished.

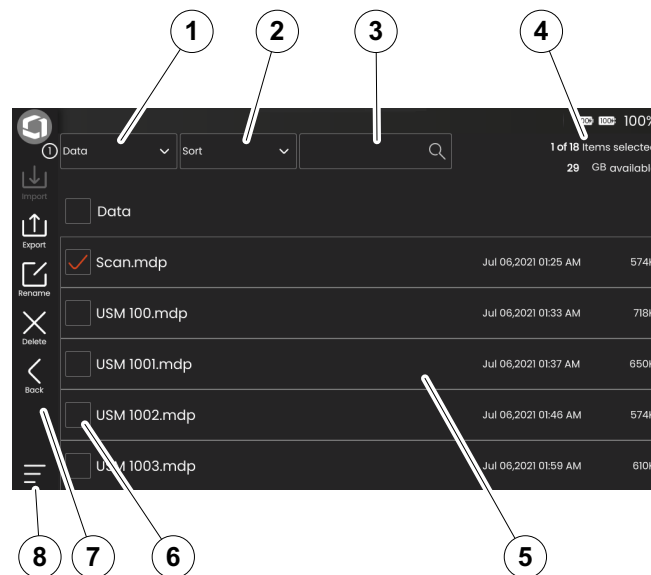
6.4 File management

All file management functions can be found in the **Main menu** (see page 68) under **File management**.






For special information on handling application files, see page 69.

The functions for saving reports, settings and screen-shots as well as for loading settings and data can be found in the **Command bar** (see page 74).

- 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 254)
- 8 **Main menu** (see page 68)



File management functions

Icon	Function	Page
	Import	254
	Export	255
	Rename	255
	Delete	256
	Back	



Note

For data exchange with **InspectionWorks**, the instrument must be registered in advance (see page 114).

Import

You can import files from a USB stick or from the **InspectionWorks** cloud service 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 54).

For data exchange with **InspectionWorks**, the USM 100 must be connected to the Internet via LAN (see page 269) or WLAN (see page 270).

- 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** cloud service, 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 54).

For data exchange with **InspectionWorks**, the USM 100 must be connected to the Internet via LAN (see page 269) or WLAN (see page 270).

- In the list of files (see page 253) 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)**.
- Select a directory and tap on **Upload** to export the selected files.
- 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 253) 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 255). The deletion can not be undone.

- In the list of files (see page 253) 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 303).

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 both batteries (internal fixed battery and swappable battery) in the following cases:

- before the initial startup,
- after a storage time of 3 months or longer,
- after not having charged the internal fixed battery with the power supply for 3 month or longer,
- after frequent partial discharge.

For information on operating the USM 100 with rechargeable batteries, see from page 48 onward.

Logic of battery charging and discharging

Batteries in the USM 100

The USM 100 contains two batteries. The first battery is a fixed battery. It is inside the instrument and can only be charged using the power supply of the USM 100. The second battery is a swappable battery, that can be hot swapped during the operation of the instrument. It can be charged using the power supply of the USM 100 or, after removal, with the external charger.

For inspections you have several possibilities to extend the operating time of the instrument:

- You can operate the instrument and charge both batteries (internal, and second if inserted) at the same time (see page 46).
- You can prepare several fully charged batteries and swap the used-out battery during the operation to extend the operating time.

Charging process

When the battery is charged inside the instrument, the charging process is controlled by the instrument. It takes 4.5 hours to fully charge an empty battery. If both batteries are empty, the instrument gathers more current to charge both together. This won't have big impact on the charging time.

Due to the safety requirements, when there are two batteries in the instrument, the instrument must minimize the battery level difference between the two batteries. This means that if the difference is large, the battery with the lower battery level is charged first. When the battery level difference goes down to 10 %, the instrument charges both batteries alternately. When both batteries are fully charged, the charging process stops automatically.

When charging a battery in the external charger, the charging process is controlled by the external charger. It takes four hours to fully charge an empty battery.

The batteries can only be charged with the USM 100 or the external charger. The swappable second battery cannot charge the fixed internal battery.

Discharging process

The battery discharging is controlled by the USM 100. The operating time of one fully charged battery is more than 2.5 hours when the instrument is configured according to the requirement in ISO 22232-1 section 8.2.1 and at 25 °C.

When there are two batteries inside the instrument, as same as for the charging process, due to the safety requirements, the instrument tries to minimize the battery level difference between the two batteries. This means that if the difference is large, the battery with the higher battery level outputs more current than the one with lower level. When the battery level difference goes down to 10 %, the discharging currents of both batteries are the same. The discharging current is also related to the temperature.

Battery level indication

There are different battery levels indicators including 100 %, 75 %, 50 % and 25 % (see page 50). Usually both show the same value. Sometimes two different indicators are shown on the screen, for example 76 % for the first battery and 70 % for the second battery.

When the total battery level is 30 %, 20 %, and 10 %, a warning message is displayed. Once the total battery level goes to 5 %, the instrument is turned off automatically.

Recommendations

To use the USM 100 for a long operating time in field, for example more than 10 hours, you should take care of two points:

- enough swappable batteries and
- the time to change the swappable battery.

The internal battery can only be charged inside the USM 100 by means of the external power adapter. Although a fully charged hot swappable battery provides more power, as described in the discharging process (see page 261), the fixed battery still outputs current. this means the internal battery capacity is also consumed in such a scenario.

To extend the operating time to 10 hours, you can proceed as follows:

- Start the inspection with two fully charged batteries.
- When the total battery level goes to 40 %, change the swappable battery. Charge the used battery with the external charger.
- Continue inspection until both batteries reach the same level. Then change the swappable battery again.
- Repeat the previous step. The battery level of the internal battery is going down during the operation. But it won't be used out after 10 hours of operation. After 10 hours of operation and changing the swappable battery five times, the level of the internal battery should still be higher than 10 %.

Battery life and temperature

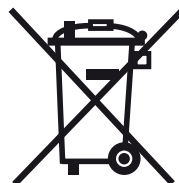
The amount of time that the USM 100 can be run on fully charged batteries (and the heat generated internally) is directly related to current consumption in the instrument electronics.

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 109) 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 109).

Disposal of batteries

Lithium batteries are marked with the symbol of the crossed-out trash can.



The symbol reminds you that batteries should not be disposed of with household waste, but must be collected separately (see **Disposal of batteries**, page 301).

To prevent short circuits and the associated heating lithium batteries must never be stored or transported unprotected (see **Transport and storage**, page 259).

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 119) in the **General settings** menu (see page 108).

Software updates are available here:

<https://www.inspectionworks.com/dis-store/#/store/public>

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 **InspectionWorks** platform and download and install the update file from there. The prerequisite for this is an established Internet connection via LAN (see page 269) or WLAN (see page 270).

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 54).
- Access the **General settings** menu via the **Main menu** (see page 68).
- 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.

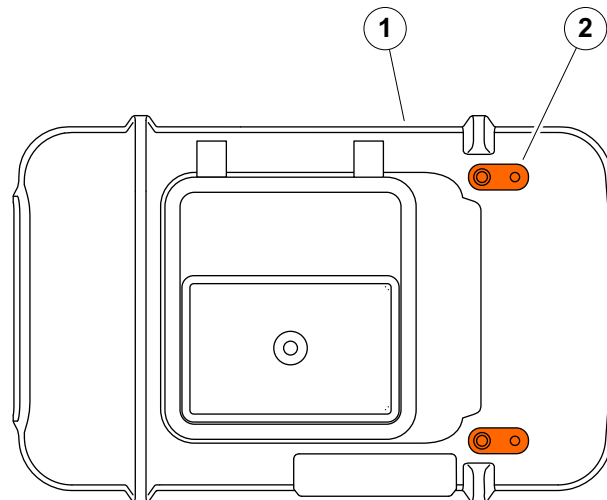


Note

The USB stick may only contain one single update file. Otherwise the installation process will be stopped.

- 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 54).
- 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**).



Note

You can use a free trial license to test the extended range of functions for a limited time period.

You can import the license file from a USB stick to the instrument.

- If necessary copy the license file into the root directory of the USB stick and insert the USB stick into the socket on the top of the instrument (see page 54).
- Access the **General settings** menu via the **Main menu** (see page 68).
- Select **License** from the left column.
- Tap on **Upgrade**.
- Select the source **USB**.
- Select the license file and tap on **Upgrade**.

After successful import the new license is shown next to the **Upgrade** button (**My Device Model**).

Interfaces and Peripherals 8

8.1 Interfaces

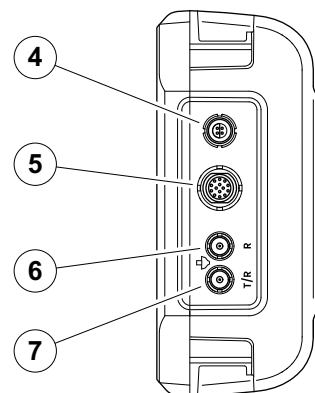
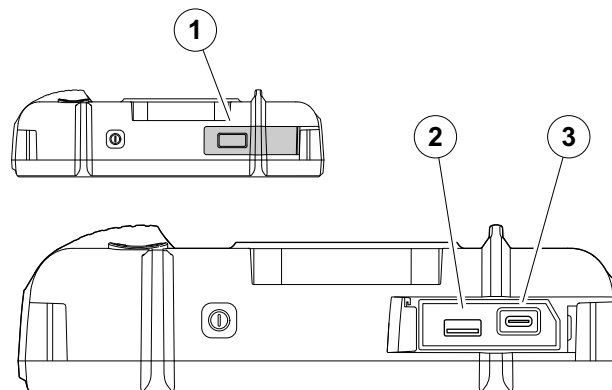
Overview

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 268) is used for data exchange between the instrument and a standard USB stick (see page 54).



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 268) 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 the software **USM 100 PC** can be used to completely operate the instrument (see page 58).

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 268) can be used to connect a WLAN adapter. When connected via WLAN the software **USM 100 PC** can be used to completely operate the instrument (see page 58)

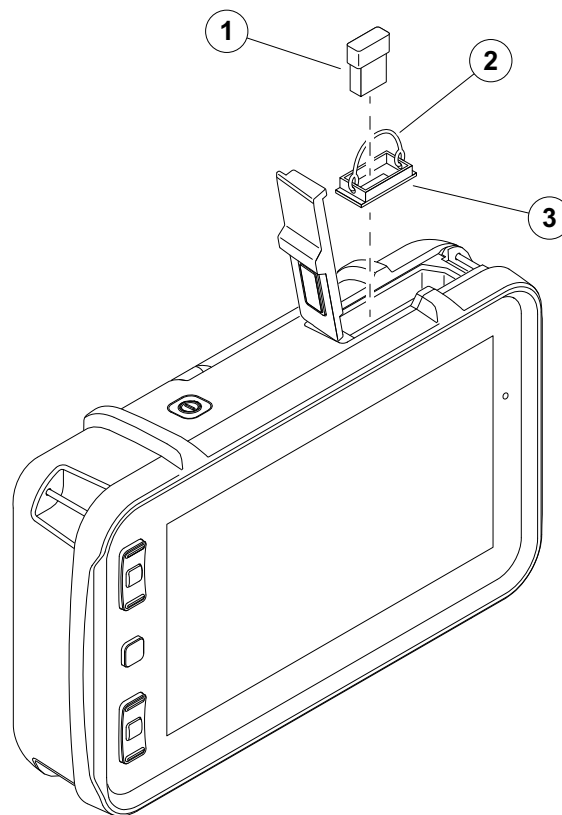


Note

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.

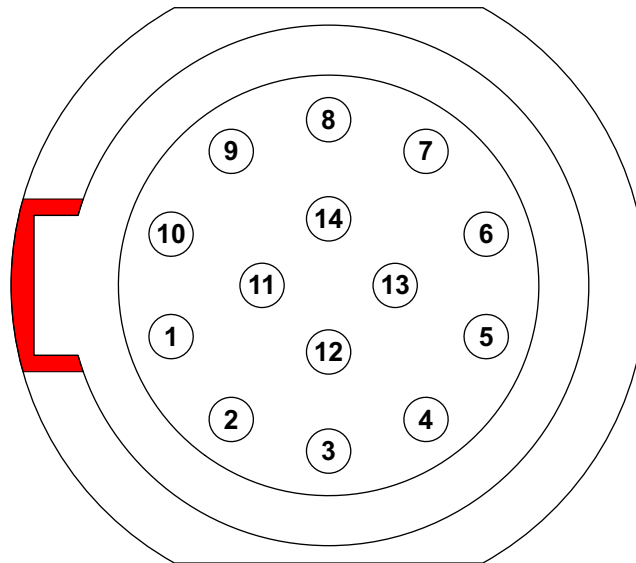
- Place the WLAN adapter (1) in the extraction tool (3).
- Plug both together into the USB-A socket.
- Pull the WLAN adapter out of the socket by the loop (2) of the extraction tool.

After switching on the WLAN connection you can select a network and make the required settings (see page 113).



I/O interface

The I/O interface (see page 268) 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, $I_{\max} = 5 \text{ mA}$	Light blue
2	Output SAP, external trigger, 5 V TTL, $I_{\max} = 5 \text{ mA}$	Pink
3	Output Alarm signal, 0 V or 5 V, $I_{\max} = 5 \text{ mA}$, 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, $I_{\max} = 5 \text{ mA}$	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

8.2 Remote control

You can remotely control the USM 100 by means of a connected Computer.

The data transfer is carried out by means of a terminal program and the corresponding remote control codes. These commands represent instructions referring to the individual functions of the instrument.

The factory-set default interface configuration is as follows:

- 57600 baud rate
- 8 data bits, 1 stop bit
- No parity

The commands are input via computer keyboard after starting the remote control program and configuring the program interface. In this process, a difference must be made between:

- Inquiry of the value or status of a function by means of the command structure:

<COMMAND><RETURN>

The USM 100 will send the current value.

- Input of a new value or status of a function by means of the command structure:

<COMMAND><SPACE><VALUE><RETURN>



Note

All values are input or sent by the USM 100 without a decimal point. It is therefore necessary to observe the resolution of the function in question with all values (see column **Description** in the following table).

Remote control codes

Code	Data type	Description	Function	Page
AA	dec	Read the gate A amplitude. Identical to code SA (1 count = 0.1 % screen height).		
AB	dec	Read the gate B amplitude. Identical to code SB (1 count = 0.1 % screen height).		
AD	hex	Read or set the gate A start. AD <n> where n = 0 ... 6D24 (1 count = 1 mm) *	Gate A Start	146

Code	Data type	Description	Function	Page
AG	flag dec	<p>Perform the AutoXX gain adjustment on the specified gate. The system gain is adjusted so that the peak signal in the specified gate is set to 80 % screen height or a user specified amplitude.</p> <p>AG <s t></p> <p>where</p> <p>s = A or a for gate A B or b for gate B</p> <p>t = 10 ... 100 (1 count = 1 % screen height, optional user specified amplitude)</p> <p>The message ERROR: Automatic Gain Adjustment Failed indicates that the dynamic range of the system gain can't achieve the target amplitude.</p>	AutoXX	74
AM	dec	<p>Read or set the gate A logic.</p> <p>AM <n></p> <p>where</p> <p>n = 0 for Off, 1 for Positive, 2 for Negative.</p>	Gate A Logic	150

Code	Data type	Description	Function	Page
AT	hex	Read or set the gate A threshold. AT <n> where n = FFFFFFFA1 ... FFFFFFFFB (1 count = 1 % screen height) 5 ... 5F (1 count = 1 % screen height)	Gate A Threshold	146
AW	hex	Read or set the gate A width. AW <n> where n = 1 ... 6D24 (1 count = 1 mm) *	Gate A Width	146
BA	hex	Read or set the gate B start. BA <n> where n = 0 ... 6D24 (1 count = 1 mm) *	Gate B Start	150
BL	hex	Read or set the display backlight level value (0x01 = minimum, 0x0A = maximum). BL <n> where n = 0x01, 0x02, 0x03, ... 0x0A (backlight level value)	Screen Brightness	109

Code	Data type	Description	Function	Page
BM	dec	Read or set the gate B logic. BM <n> where n = 0 for Off, 1 for Positive, 2 for Negative.	Gate B Logic	150
BT	hex	Read or set the gate B threshold. BT <n> where n = FFFFFFFA1 ... FFFFFFFFB (1 count = 1 % screen height) 5 ... 5F (1 count = 1 % screen height)	Gate B Threshold	150
BW	hex	Read or set the gate B width. BW <n> where n = 1 ... 6D24 (1 count = 1 mm) *	Gate B Width	150
D1	hex	Read gate A TOF (time of flight). 1 count = 5 ns		

Code	Data type	Description	Function	Page
DB	hex	Read or set the gain. DB <n> where n = 0 ... 44C (1 count = 0.1 dB)		
DD	hex	Read or set the display delay. DD <n> where n = FFFFC568 ... 003567E0 (-15.000 ... 3500.000 ns, 1 count = 1 ns)	Display Delay	126
DM	flag	Read or set the dual mode. DM <n> where n = 0 for Off, 1 for On	Dual Mode	138
DT	dec	Read or set the date. DT <n> where n = dd-mm-yyyy (dd = day of the month, mm = month, yyyy = year)	Date and Time	111

Code	Data type	Description	Function	Page
DW	hex	Read or set the display range. DW <n> where n = 3E8 ... 1AA54A0 (1.000 ... 27940.000 mm, 1 count = 0.001 mm) **	Display Range	125
FR	dec	Read or set the filter selection. FR <n> where n = 1 for 0.5 MHz 2 for 1 MHz 3 for 2 MHz 4 for 2.25 MHz 5 for 4 MHz 6 for 5 MHz 7 for 10 MHz 8 for 15 MHz 9 for 0.2 ... 4 MHz 10 for 0.8 ... 8 MHz 11 for 2 ... 30 MHz 12 for 0.2 ... 25 MHz	Filter	137

Code	Data type	Description	Function	Page
FZ	dec	Read or set the state of the Freeze function. FZ <n> where n = 0 for Freeze off 1 for Freeze on 2 to toggle the Freeze state	Freeze	74
I0 ... I8		Read code versions and dates. I0 main application version I1 main application create date I2 upload version I3 upload date I4 u-boot version I5 u-boot date I6 FPGA version I7 FPGA date I8 kernel version		
ID		Returns the instrument identification string. The message USM100 is returned.		

Code	Data type	Description	Function	Page
KA	string	Read or set the gate A TOF mode. KA <n> where n = P or p for Peak F or f for Flank J or j for J-Flank 1 for First Peak	Gate A TOF Mode	147
KB	string	Read or set the gate B TOF mode. KB <n> where n = P or p for Peak F or f for Flank J or j for J-Flank 1 for First Peak	Gate B TOF Mode	150
PA	dec	Read or set the pulser width. PA <n> where n = pulser width in ns	Pulser Width	136

Code	Data type	Description	Function	Page
PB	dec	Read or set the pulser status. PB <n> where n = 0 for Off, 1 for On		
PD	dec	Read or set the probe delay. PD <n> where n = 0 ... 10000000 (1 count = 1 ns)	Probe Delay	133
PF	dec	Read or set the PRF mode. PF <n> where n = 1 for Manual, 3 for Auto	PRF Mode	139
PG	dec	Read or set the damping. PG <n> where n = 0 for 50 Ohms, 1 for 400 Ohms	Damping	138

Code	Data type	Description	Function	Page
PR	dec	Read the PRF value. Set the PRF value if the PRF mode is set to Manual (see code PF). PR <n> where n = 10 ... 2000 *	PRF Value	139
PT	dec	Read or set simulated spike pulser or square wave pulser mode. Spike pulser mode is only available with license for spike pulser. PT <n> where n = 0 to indicate spike pulser mode n = 1 to indicate square wave pulser mode	Pulser Mode	139

Code	Data type	Description	Function	Page
PV	dec	<p>Read or set the pulser voltage.</p> <p>PV <n></p> <p>where</p> <p>with simulated spike pulser mode:</p> <p>n = 0 for low voltage pulser, 1 for high voltage pulser</p> <p>with square wave pulser mode:</p> <p>n = 50 ... 350 (voltage, in steps of 10)</p>	Voltage	135
PW	dec	<p>Read or set the pulser width (only possible if the square wave pulser is enabled).</p> <p>PW <n></p> <p>where</p> <p>n = 40 ... 2000 (width in ns, in steps of 5)</p>	Pulser Width	136

Code	Data type	Description	Function	Page
RF	dec	Read or set the rectification mode. RF <n> where n = 0 for RF (radio frequency) 1 for Negative HW 2 for Positive HW 3 for Full Wave	Rectify	137
SA	dec	Read the gate A amplitude. Identical to code AA (1 count = 0.1 % screen height).		
SB	dec	Read the gate B amplitude. Identical to code AB (1 count = 0.1 % screen height).		
SV	dec	Read or set the velocity. SV <n> where n = 2500 ... 160000 (1 count = 0.1 m/s)	Velocity	126

Code	Data type	Description	Function	Page
TI	dec	<p>Read or set the time.</p> <p>TI <n></p> <p>where</p> <p>n = 0 for 12 hour format AM/PM 1 for 24 hour format (default format)</p> <p>hh:mm:ss (hh = hour 00 ... 23, mm = minute 00 ... 59, ss = second 00 ... 59)</p>	Date and Time	111
TZ		<p>Read or set the time zone.</p> <p>TZ <UTC +/-08></p>		

* The actual limits depend on the system settings.

** The actual limits depend on the system settings and the velocity.









Appendix 9









9.1 Overview of basic UT Functions



















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										155
A-Scan Color										129
Acceptance Level										164
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AGC Max Amp / AGC Min Amp										142
AGC Noise										142
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Amplitude Correction										162
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Function name	Gain									Page
Angle Cal Source										157
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Block										156
Bold Line										163
C/IF Gate Mode										152
Cal Block										164
CNDAC Mode										163
Code										164
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Color Palette										130
Curve Color										161
Custom Gain Step										124









Function name	Gain									Page
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DAC Point										160
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dbRef Mode										159
Defect Length										164
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DGS Curve										161
DGS Mode										161
Display Delay										126
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Display Start Mode										153
Dual Mode										138









Function name	Gain									Page
Echo Max										144
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Function name	Gain									Page
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Offset Mode										160
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Function name	Gain									Page
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Pulser Mode										139
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Function name	Gain									Page
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S Ref 1 / S Ref 2										155
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Transfer Correction										123
Upper Freq										138

Function name	Gain									Page
Velocity										126
Velocity Cal Type										155
Voltage										135

9.2 EU Declaration of Conformity

The USM 100 conforms to the requirements of the following EU directives:

- 2014/30/EU (Electromagnetic compatibility)
- 2014/35/EU (Low voltage)
- 2011/65/EU (RoHS) +
Commission Delegated Directive (EU) 2015/863

The conformity with the requirements of the EU directives is proven by the observance of the standard specifications

- EN 61 326-1:2013
- EN 61 010-1:2010

9.3 UK Conformity Assessment

The mark **UKCA** indicates that this product complies with all of the applicable requirements for Great Britain in order to place it on the market.



UK Local Importer:

Druck Limited
Fir Tree Lane, Groby,
Leicester LE6 0FH

9.4 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

9.5 Service contacts

Region	Location	Contact	
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North America	USA	waygate.usa@bakerhughes.com	+1 832 325 4368
Russia	Russia	wt.service.RCIS@bakerhughes.com	+7 495 771 72 40 4320

9.6 Environmental protection regulations

This section contains information about the following topics:

- WEEE directive
- Disposal of batteries

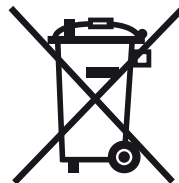
WEEE directive (Waste Electrical and Electronic Equipment)

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 osteomalacia 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	IP67 (battery compartment and connection covers closed)
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	7 inches, 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

10 Specifications

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
Pulse width	40 ... 2500 ns (square wave pulser)
Damping resistor	50 or 400 Ohm
Output impedance	< 5 Ohm

Receiver

Maximum input voltage	40 Vp-p
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 μ s
Equivalent input noise	< 80 nV/ $\sqrt{\text{Hz}}$
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 analog output	+/-0.1 V (compared with nominal value)
Evaluation modes	TCG, DAC, DGS, AWS, dB REF, JISDAC, CNDAC

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