Operating Instructions

BANDELIN
Ultraschall seit 1955

SONOPULS

Ultrasonic Homogenisers

Ultrasonic Homogeniser HD 4100

valid for:

HD 4050	Volume:	0.5 ml – 100 ml
HD 4100	Volume:	2 ml - 200 ml
HD 4200	Volume:	5 ml - 1000 ml
HD 4400	Volume:	100 ml - 3000 ml

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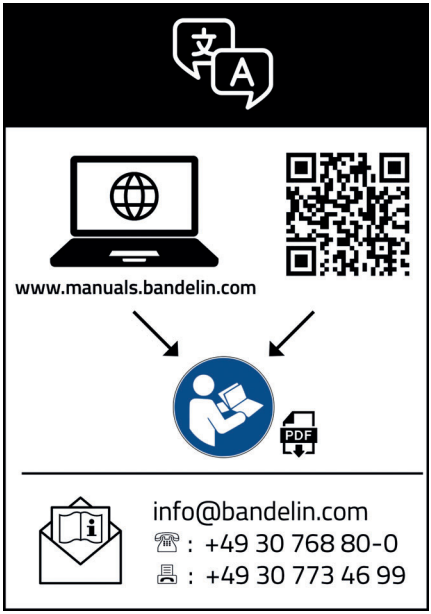

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General

The equipment, the accessories and the preparations are to be used in accordance with the user instructions and/or the product information.

The instructions are part of the scope of delivery and are to be stored in the vicinity of the device for later reference. This also applies if possession of the device is transferred elsewhere.

Before the device is put into operation, these instructions are to be read carefully and completely in order for the user to become familiarised with all functions.

The warnings and safety precautions (chapter 1.5) are always to be followed during use.

The manufacturer will not assume any responsibility for the device's safety or functional ability in the event of improper handling or usage contrary to the intended purpose. In the event of unauthorised alterations/modifications, both the warranty claim and the CE conformity will become void.

If service is required, please contact the authorised dealer or the manufacturer.

Symbols used:

Symbol	Meaning	Explanation
	Danger	Denotes information that, if not observed, could pose a risk to life and limb, especially from electric shock.
	Caution	Identifies information that must be observed and complied with in order to prevent damage to the device or injury to the user. When device parts are labelled with this symbol, reference must be made to the documentation.
	Warning	Warning of hot surface.
	Important	Identifies information that is important for execution.
	Note	Identifies explanatory information.
	Wear ear protectors	For health reasons, spending long periods of time in the vicinity of the device without ear protectors is prohibited.
➢	Instructions	Identifies instructions that must be carried out in the described sequence.

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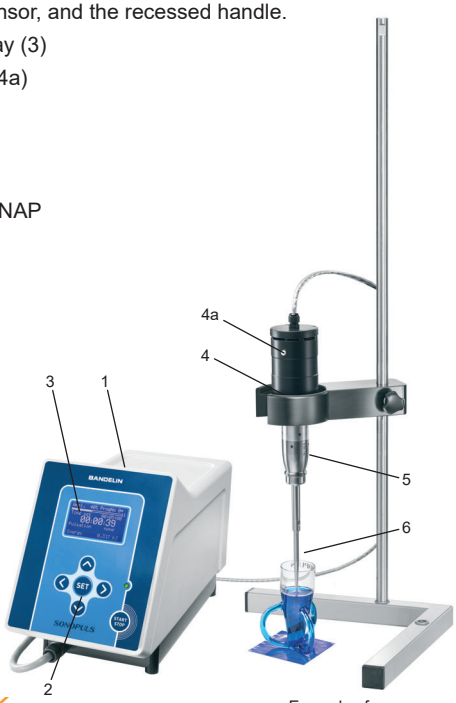
Informative annexes

1 Product description

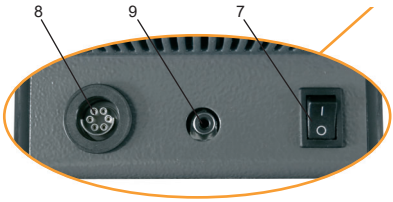
The SONOPULS ultrasonic homogeniser essentially consists of three device components: the ultrasound generator, the ultrasonic converter, and the working tip (probe). The individual components can be varied using a multitude of options and accessories. The type specification and serial number are found on the type plate.

Product features:

- Ultrasound generator (1) in low-maintenance, robust plastic housing, with connections for the ultrasonic converter and temperature sensor, and the recessed handle.
- Operating and display panel (2) with LCD display (3)
- Ultrasonic converter (4) with Start/Stop button (4a)
- Standard/booster horn (5), omitted for UW 50
- Probe (6)
- Mains switch (7)
- Connection (8) for ultrasonic converter – MINISNAP
- Connection for temperature sensor (9)



Example of use



Rear side of the ultrasound generator:

- Cold device socket (10) with fuse holder
- Remote control connector (11)
- RS 232 interface (12)

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1.1 Mode of operation

The ultrasound generator transforms the mains energy input (mains frequency 50 or 60 Hz) into high-frequency energy with a frequency of 20 kHz. The ultrasonic converter connected to the ultrasound generator converts the high-frequency energy into ultrasound. The emitted ultrasound has a high mechanical energy that is used for a wide range of applications. Thus, mechanical deflections with the same frequency of 20 kHz are generated on the tip of the probe and transferred into the sonication medium as ultrasonic waves with a high power intensity. The amplitude is held constant via a signal feedback by the ultrasonic converter (AMPLICHRON® circuitry), independently from the applied load, as long as the maximum power allowed is not exceeded. Thanks to these measures, the reproducibility of the process parameters is guaranteed and validation of the process is supported.

Standard/booster horns with probes are mounted on the ultrasonic converter. These work as mechanical transformers and enable repeated mechanical augmentation of the ultrasound amplitude at the tip.

1.2 Intended purpose

SONOPULS ultrasonic homogenisers generate high-performance ultrasound with high intensities and ultrasound amplitudes that are transferred into liquid media using working tools called probes. They are used in laboratories, clinics, and in industrial research, and they perform diverse tasks during sample preparation in Quality Assurance, scientific experiments, analyses, and in pilot or short-series manufacture.

Examples of use:

- Cell disruption for paternity tests
- Cell disruption (extraction of microorganisms, tissue cells)
- Homogenising of liquids
- Emulsifying hard-to-mix liquids
- Dispersion of agglomerates
- Acceleration of chemical reactions
- Degassing of liquids
- Sample preparation in environmental analytics (wastewater tests, soil samples)
- Sonochemistry

1.3 CE conformity

SONOPULS ultrasonic homogenisers satisfy the CE-marking criteria in the European Union:

- 2014 / 35 / EU - Low Voltage Directive
- 2014 / 30 / EU - EMC Directive
- 2011/ 65 / EU - RoHS Directive

A declaration of conformity can be requested from the manufacturer by providing the serial number.

1.4 Technical data

SONOPULS ultrasonic homogenisers are interference-free and CE-marked.
Safety: EN 61010-1, EMC: EN 61326-1

1.4.1 Ultrasound generator (GM)

Mains supply:	230 V~ (± 10 %) 50/60 Hz or 115 V~ (± 10 %) 50/60 Hz
Protection class:	I
Ultrasonic frequency:	20 kHz ± 500 Hz
Frequency control/1:	automatic, resonance frequency search
Time setting range:	0:00:01 – 9:59:59 [h:mm:ss] or continuous operation
Ultrasound operating mode:	pulsating or continuous
Pulsation time ON (t_E):	0.2 - 600 s - (see chapter 3.2.2)
Pulsation time OFF (t_A):	0.3 - 600 s - (see chapter 3.2.2)
Ultrasound control:	amplitude or power - (see chapter 3.2.4)
Amplitude setting range/2:	10 to 100 % in 1 % steps
Amplitude/power display:	default and progress bars
Energy display:	kJ
Temperature sensor:	optional (TM 50 or TM 100)
Temperature display:	-10 to +120°C
Data memory locations:	9
Operating elements:	foil button
Operating data display:	LC graphic display, illuminated
Remote operation (turning on/off):	button on the ultrasonic converter, potential-free contact, foot switch TS 8 (optional)
Interface:	RS 232
Degree of protection:	IP 30 pursuant to DIN EN 60529

Generator:

Generator	GM 4200	GM 4400
Power/3, maximum	50/100/200 W	200/400 W
Ultrasonic frequency	20 kHz	
Power setting range	30 - 150 W	60- 300 W
Weight (approx.)	3.2 kg	3.6 kg
External dimensions (L × W × H)	335 × 150 × 230 mm	

/1 Frequency control:
The ultrasound generator has an automatic search feature for resonance frequency and rate adaptation while in operation. Causes for a change in the resonance frequency are, for example, a warming of the ultrasonic converter and the probes, a change in the acoustic load due to changes in viscosity, and even the mounting of another probe. A frequency drift during operation is corrected by the automatic frequency control. The optimum working frequency is sought using the resonance frequency search, e.g. after a change in probe.

/2 The minimum and maximum amplitude setting range depends on the respective probe type. The valid amplitude setting range is stored in the program.

/3 Power:
In the case of amplitude control, the ultrasonic power that is needed for the desired probe amplitude is dependent on the viscosity of the medium. In order to prevent damage to the ultrasound generator and converter, the power is limited to the maximum permitted peak value. In the case of highly-viscous media, this can result in the desired amplitude not always being reached.
The power depends on the connected ultrasonic converter.

1.4.2 Ultrasonic converter (UW)

	UW 50	UW 100	UW 200	UW 400
Start/Stop key:	✓	✓	✓	✓
Stable at continuous operation:	✓	✓	✓	✓
Frequency:	20 kHz	20 kHz	20 kHz	20 kHz
Weight:	0.6 kg	1.5 kg	1.6 kg	1.7 kg
Dimensions:	Ø 50 × 190 mm	Ø 70 × 170 mm	Ø 70 × 170 mm	Ø 90 × 180 mm
Degree of protection:	IP 20	IP 20	IP 20	IP 20

1.4.3 Other data

Ambient conditions according to DIN EN 61 010-1

Overvoltage category:	II
Degree of contamination:	2
Permissible relative humidity up to 31 °C:	80 %
Permissible relative humidity up to 40 °C:	50 %
Permissible ambient temperature:	5 to 40 °C
Altitude:	up to 2000 m above sea level

No dewing.
Only for indoor operation.

1.4.4 Electromagnetic compatibility (EMC)

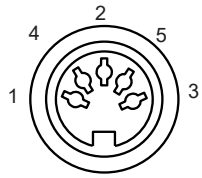
The device has been checked for electromagnetic compatibility (EMC) in accordance with DIN EN 61326-1 and meets the requirements for Class B devices in accordance with EN 55011. Suitable for use in institutions and other areas that are directly connected to a public low-voltage power supply, e.g., laboratory facilities.

1.4.5 Remote operation

Several options are available for remote control and remote operation. Depending on requirements, the most convenient solution may be selected.

	Operating element	Methods	Functions	Connection
1	Key	manual	Ultrasonic operation ON/OFF	Fixed on theultrasonic converter
2	Foot switch	foot-operated	Ultrasonic operation ON/OFF	Remote control connector
3	External	control signal	• Ultrasonic operation ON/OFF • Status confirmation	Remote control connector
4	External	data protocol	• Status inquiry • Full device control	RS 232 interface

a) Remote control connector
Contact assignment and functional description of the remote control connector

Diagram	Contact	Assignment	Signal	Function
	1	Input	0V L 5V H	L → Ultrasound operation ON H → Ultrasound operation OFF
	2	Output	0V L 5V H	L → Ultrasound operation OFF H → Ultrasound operation ON
	3	Earth		
	4	Output		like contact 2
	5	n.a.		

Notes:

- The connection of power or voltage sources of any type is not permitted.
- The source resistance for the outputs is of 3.3 kΩ. The input resistance for subsequent signal inputs, e.g. optocouplers, must be greater than or equal to 47 kΩ.
- The function of the signal input (contact 1) depends on the operating mode that is set for the pulsation (see chapter 3.2.2). With the operating mode "by hand key", control is performed statically, i.e. the ultrasonic operation is always activated under L status, and deactivated under H status.
  With all other operating modes, the input works as an edge-controlled changeover switch. The input resistance totals approx. 50 kΩ.
- When connecting a changeover contact (toggle function) to connector 1, the make time must be > 100 ms.

b) RS 232 interface

The RS 232 interface connection is located on the rear side of the ultrasound generator.

A standard serial conductor (RS 232) can be used for connection and communication purposes. Implementation of the technical programs required for communication is the responsibility of the operator and is not supported by the manufacturer. The manufacturer only guarantees the proper functioning of the interface.

The instruction set for the RS-232 interface will be made available by the manufacturer free of charge, upon request.

Note:

Proper operation will depend on the length of the connection cable. If an extension is used, a length of 5 m may not be exceeded.

Caution!

The inputs and outputs of the remote control connector and RS-232 interface may only be connected with devices of protection class I that are connected to the same mains supply circuit.

1.5 Warnings and safety instructions

General

- Keep the device and accessories out of the reach of children and also of persons who have not been instructed in their operation by reference to these instructions.
- The use of the device or parts thereof on humans or animals is not authorised.
- Keep the ultrasound generator and operating elements clean and dry.
- Do not expose the device to corrosive materials.
- It is imperative that you observe the hygiene instructions when working with the device.
- The connection of any type of power or voltage sources to the signal inputs or outputs is forbidden.
- Signal wires for foot switches, temperature sensors, etc., may not exceed a maximum length of 3 m.
- All plug connections (such as for ultrasonic converters, foot switches) may only be plugged or unplugged while the device is turned off or in idle mode (pause mode).
- The ultrasound generator and ultrasonic converter must be transported separately.
- Ultrasonic homogenisers adhere to prescribed EMC limit values, so that it can be assumed that the electromagnetic radiation emanating from the devices is harmless to humans. A binding statement for wearers of implants can only be made at the place of work together with the implant manufacturer. In case of doubt, information regarding the allowable electromagnetic exposure level should be obtained from the implant manufacturer.

Operation

- Observe environmental and set-up conditions, see chapter 1.4.
- Determine the mains voltage before connecting the ultrasound generator.
- Only connect the ultrasound generator to an earthed socket.
  Fuse protection 16 A (main fuse).
- The ultrasonic converter may only be firmly mounted onto the black housing using a suitable support.
- Before each start-up, check that the probe is firmly positioned on the standard or booster horn; if necessary, tighten the probe (see chapter 4.3.1).
- Do not touch any oscillating parts (e.g. standard or booster horns, micro tips or tapered tips, titanium plates, ultrasonic converter) during operation! Damage to health is possible.
- Do not touch the sonication vessels with the oscillating probe - probes and vessels could be damaged.

- The sonication of liquids generates noise. Suitable accessories such as a sound proof box, significantly reduce this noise. If operating without a sound proof box, wear hearing protection.

- Warning, risk of splashing!
  This is especially the case with small sample quantities and when immersing oscillating probes.

- Do not use combustible solvents in open reaction vessels since the operating safety of the ultrasonic homogeniser could be compromised. Safe extraction of combustible vapours must be guaranteed. When using a sound proof box, the vapours cannot escape.
- Before any mounting or dismounting (chapters 4.3 and 4.4) of probes or standard booster horns as well as accessories, turn off the device and disconnect the ultrasonic converter from the ultrasound generator.
- Only use the prescribed tool for mounting and dismounting (see appendix A).
- Do not use any bent probes (⇒ unstable operation, loss of power).

- Liquids must not penetrate the inside of the ultrasonic converter or ultrasound generator.
- Never twist the ultrasonic converter's housing toward the aluminium cylinder (ultrasonic oscillating system). The ultrasonic oscillating system and its electrical connections would be damaged as a result.
- Do not operate the device without supervision.
- The ultrasonic homogeniser is only intended for use by qualified personnel.
- In isolated cases, unfavourable operating conditions may result in EMC disruptions that may affect devices that are in the direct vicinity.
- During operation, portable or mobile HF communication systems in the vicinity of the ultrasonic homogeniser should be turned off - operation may be disrupted.

Damage

- If damage to the ultrasonic homogeniser is detected, do not connect the ultrasonic homogeniser to the mains.
- In the event of defects, disconnect the mains plug immediately.
- Repairs must only be conducted by authorised skilled personnel or by the manufacturer.
- Defective parts must only be replaced with original parts or parts of the same quality!

2 Preparation

Carefully unpack the ultrasound generator, ultrasonic converter and accessories, and inspect them for completeness or possible transportation damage. If damage or defects are ascertained, notify this to the forwarding agent and the supplier immediately and in writing.
Before start-up, the ultrasonic homogeniser should be allowed to stand for 2 hours at its operating location so that it can adjust to the ambient conditions.

2.1 Scope of delivery

The scope of delivery depends on the order size. In general, it comprises the following order parts:

1 Ultrasound generator (GM) ...

1 Mains cable, 2 m

1 Ultrasonic converter UW ...

1 Standard/booster horn ...

1 Probe

1 Tool set

1 Operating instructions

Additional accessories in accordance with order.

2.2 Setup / assembly

- Place the ultrasound generator atop a firm, level and dry surface. In doing so,
  - do not group it or stack it over other electrical or electronic devices,
  - do not cover the ventilation holes on the ultrasonic converter's housing,
  - guard against moisture and wetness - risk of electric shock.

- The ultrasound generator must be positioned in such a way that disconnection of the power supply is easy.

- On delivery, the standard/booster horn is, if necessary, already firmly screwed to the corresponding ultrasonic converter. Other standard/booster horns can be mounted, see the notes in chapter 4.4.
- Screw the delivered probe to the standard/booster horn, see chapter 4.3.1.
- Position the ultrasonic converter safely and correctly in a suitable holder. For this purpose, firmly clamp the ultrasonic converter only onto the black housing.
- Position the ultrasonic converter and holder in a sound proof box.
- The ultrasonic converter is connected to the ultrasound generator through a push-pull circular connector with lock (MINISNAP). To connect, hold the mains connector from the handle and position it in such a way that the arrow points toward the left. The mains connector can only be plugged in when in this position. Plug the mains connector into the socket up to the limit, and let it snap into place. In order to unplug the connection, hold the mains connector only from the handle, pull it back and remove the connector. If necessary, see chapter1.
- Verify that the mains switch is in the "0" position.
- Before the mains connection, identify the mains voltage at hand and compare it with the voltage specified on the type plate on the generator bottom. Connect to a grounded socket only if type is suitable.

2.3 Putting into service

- ➢ Check the firm positioning of the probe and, if needed, clean thoroughly.
- ➢ Check the positioning of the ultrasonic converter in the holder.
- ➢ Connect the ultrasound generator to the mains (earthed socket) and switch on.
- ➢ Set the probe type (see chapter 3.1.1).
- ➢ Conduct a function test in accordance with chapter 6.2.1, if required (e.g. after replacing the ultrasonic converter).
- ➢ Connect the temperature sensor if necessary.

3 Operation

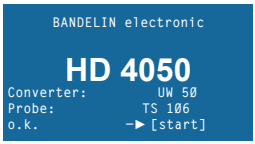
3.1 Operating elements

Operation is conducted from the operating and display panel on the front side of the ultrasound generator:

1	LCD Display	Display of the operating parameters and status information
2	"START/STOP" key	Starting or stopping the ultrasound emission, ending functions, exiting the menu
3	"SET" key	Call-up of the menu. Navigation within the menu
4	"Arrow" keys	Setting the menu or operating parameters
5	Control LED	Solid green: Ultrasound emission Blinking green: Remote operation through the RS 232 interface or Solid red: Error messages Blinking red: Warning messages

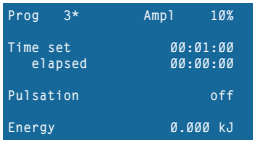
3.1.1 Switching the ultrasonic homogeniser on/off

The ultrasonic homogeniser is turned on with the mains switch (front side, bottom). After turning on, the LCD display must light up. Initialisation occurs automatically. The ultrasonic homogeniser will display the manufacturer's information, type designation, and the last-connected probe. The type designation depends on the ultrasonic converter that is connected



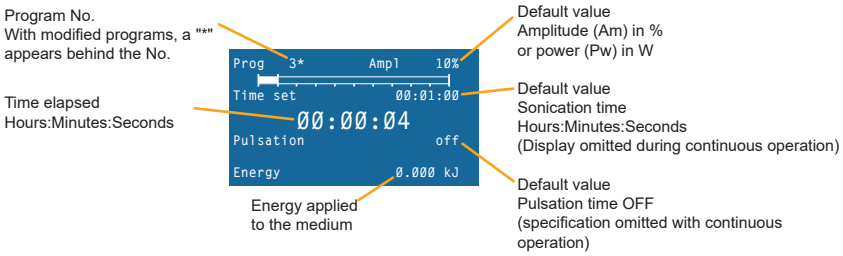
UW 50 → HD 4050
UW 100 → HD 4100
UW 200 → HD 4200
UW 400 → HD 4400

If the probe type displayed does not conform with the probe that is mounted, the correct probe type will have to be set using the arrow keys ∧∨ before the next steps are performed. By pressing the "START/STOP" button, the menu switches into stand-by mode (pause mode) and the ultrasonic homogeniser is ready for operation. The parameters used during the last operation will be set again and displayed. If the ultrasonic converter was exchanged in the meantime, the earlier settings will be replaced by standard values and must be re-edited. The temperature display is only visible when a temperature sensor is connected.



The mains switch can also be used for powering off.
The powering-off process may take a few seconds while the current data is saved internally. The monitor is turned off during this process. When powered-on again, the data becomes available once again.

3.1.2 Explanation of the display fields



3.2 Setting the operating parameters

With the exception of the amplitude and power, the operating parameters can only be set while in stand-by mode (pause mode). In order to set or edit the parameters, the desired field can be selected by pressing the "SET" key. The respective function can then be selected using the arrow keys ∧∨. If the parameter has number values that can be edited, the editing mode is then activated with the arrow key ›. In the marked area (inverse view) of the parameter, the desired value can then be set with the arrow keys ∧∨. It is possible to move between individual setting fields within the parameter using the arrow key ‹. Editing mode is cancelled with the "SET" or "START" keys.

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The following operating parameters can be set:

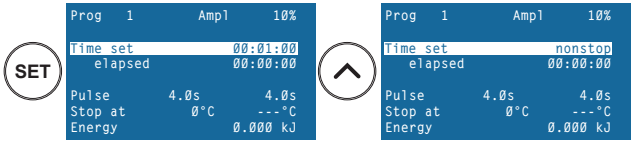
- Default values for the relative amplitude or power ([Ampl [%] or Power [W])
- Default values for the sonication time (Time set [hh:mm:ss])
- Default values for the pulsation of the ultrasound (turn-on and turn-off time) (Pulsation [s])
- Limit value for the temperature monitoring [°C]

The operating parameters "Energy" and "Elapsed sonication time" cannot be edited.

3.2.1 Sonication time [Time set]

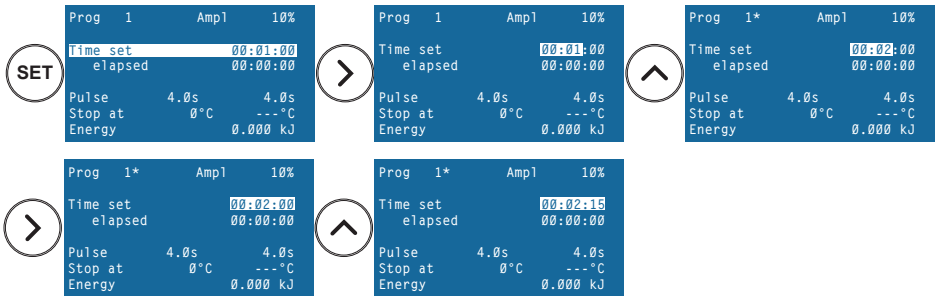
A value of 9 hours, 59 minutes and 59 seconds (9:59:59) is the maximum sonication time that can be set. If the default value is exceeded during ultrasonic operation, the sonication will stop. The parameter "non-stop" is equivalent to unlimited continuous operation until ultrasonic operation is ended by pressing the "START/STOP" key.

a) Setting continuous operation [non-stop]



b) Setting the sonication time

If a value of 59 minutes or seconds is exceeded when setting the time, or if a shortfall occurs when setting back the time, the values for the set hours or minutes will change accordingly. Example:



or START STOP back to stand-by mode

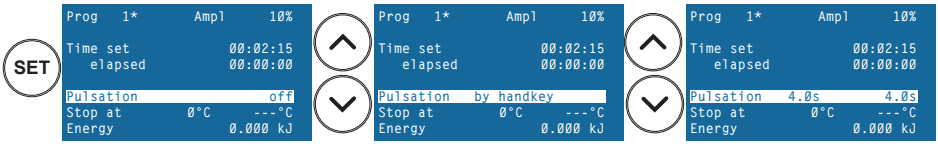
SET proceed to next set value or operating parameter

3.2.2 Pulsation [Pulsation][4]

In addition to setting the pulse turn-on time t_E and the pulse turn-off time t_A, two additional operating modes can also be set:

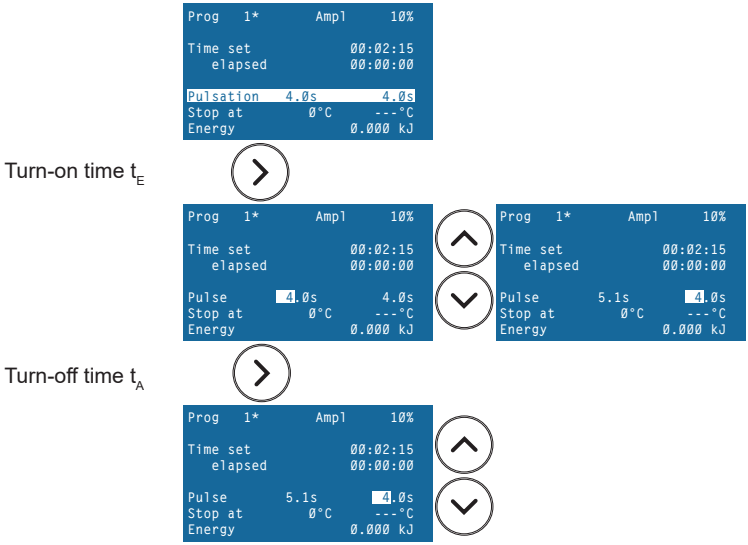
off	no pulsation or continuous sound
by hand key	manual pulsation can be performed with the button on the ultrasonic converter. Ultrasound operation is active as long as the button on the ultrasonic converter is pressed.

a) Setting the operating modes



b) Setting the time intervals

The maximum setting value is 600.0 s. The minimum setting value will depend on the type of device and ranges between 0.1 und 0.3 s.



START STOP — back to stand-by mode

SET — proceed to next operating parameter

/4 The pulse period duration is the sum of the turn-on and turn-off time $t = t_E + t_A$

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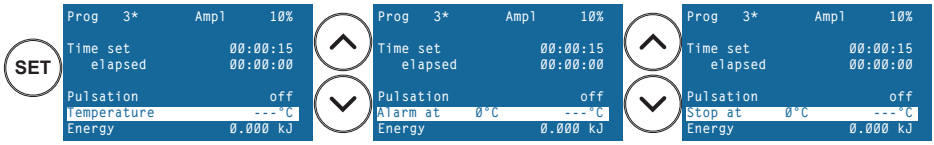
3.2.3 Temperature monitoring [Temperature]

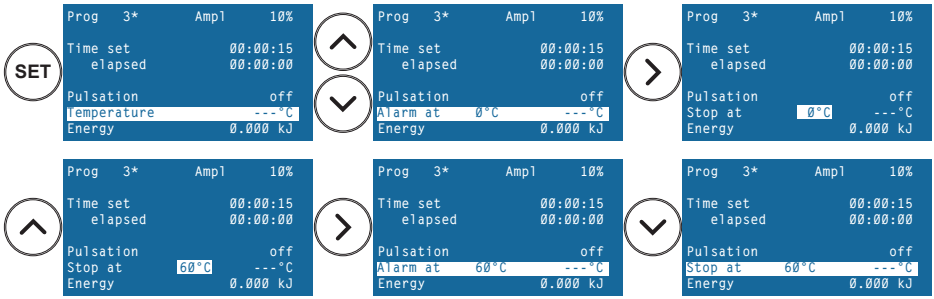
The temperature in the sonicating medium can be monitored using the temperature sensor. The following functions can be set:

off no monitoring
stop when reaching or exceeding the set temperature limit value, the ultrasound operation will be turned off. If the temperature falls below the limit value once again, the ultrasound operation will not automatically continue.
alarm when reaching or exceeding the set temperature limit value, an acoustic and visual warning signal (red blinking LED) will be triggered. The ultrasound operation will not be turned off.

a) Setting the type of monitoring

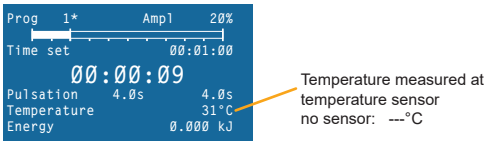


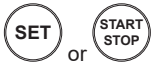
Example:



The maximum setting value is 120 °C, the minimum is -10 °C.

As shown in the example, the values for the Alarm and Stop functions are carried over when defining a limit temperature. An alarm is triggered simultaneously in Stop mode.





back to stand-by mode

3.2.4 Miscellaneous functions and settings

Additional functions are available within a second menu level. These can be accessed by simultaneously pressing the "SET" key and arrow key >. Switching between these functions is accomplished with the "SET" key in the manner already described. The menu level can only be exited by pressing the "START/STOP" key. In doing so, settings and function statuses are carried over and executed.

Check the ultrasonic converter [probe check]

This function is used for quick verification of whether the ultrasonic converter is recognised and can be correctly activated by the ultrasound generator. After a change in probe or in operating conditions it is possible, for example, that the ultrasound generator cannot synchronise with the ultrasonic converter and issues an error message, e.g. Error 011. The frequency is reset to the base value and the function is restored if no device fault or other cause is present.

The default value is "off". In order to activate the function, set the parameter to "start" using the arrow keys ^ v, and then press the "START/STOP" key. See chapter 6.2.1 for additional information.

Search for resonance frequency [scan frequency]

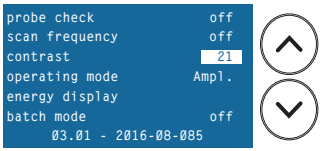
This function is an expansion of the above-mentioned "probe check" function. In addition, a frequency scan is conducted in order to determine the correct ultrasonic frequency for the ultrasonic converter. Depending upon the probe used and the operating conditions, the frequency can fluctuate significantly at times. When switched off, the ultrasound generator saves the current frequency value and uses it as the start value when switched on again. If there are significant deviations in the current frequency, this can lead to malfunctions.

Note:

After a successful scan while in continuous operation (pulsation = off, time > 30 s), start with an amplitude setting of 50 % and check the operation. Next, set the desired default value.

Setting the monitor contrast [contrast]

With this function, the monitor contrast can be adapted to the local light conditions. The contrast values range between 1 and 68, and can be set with the arrow keys ^ v. Smaller values result in a darker image and larger values result in a lighter image. The default value is 22.



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Type of ultrasound control [operating mode]

Here you can define whether the ultrasonic homogeniser is to work with amplitude or power control.

Ampl. → Amplitude control = constant amplitude

Thanks to the direct data logging in the ultrasonic converter (AMPLICHRON® system), the amplitude is precisely and quickly measured and set. In the process, the power output may fluctuate based on the physical state of the medium.

Power → power control = constant power output

The control variable is calculated based on the measured electrical power, and has a process-dependent time delay. Faster fluctuations are balanced only on average. Depending on the physical state of the medium, the amplitude may fluctuate. This type of regulation cannot be recommended for reproducible results.

Switch display [display]

Here you can choose whether the cumulative energy or the current ultrasonic frequency is displayed.

Sequencing [batch mode]

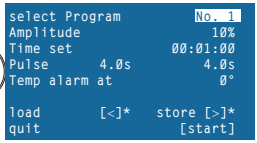
With this function (batch mode: on), it is possible to process previously compiled sonication programs. The design of the sonication programs is described in chapter 3.3, the activation in batch mode is described in chapter 3.4 .

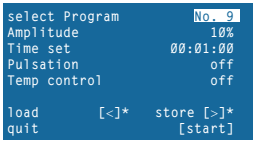
3.3 Loading / saving sonication programs

The ultrasonic homogeniser possesses a working memory and 9 memory locations for sonication programs.

In order to work with a sonication program, it must be loaded into the working memory. If changes in the operating parameters are made in the working memory, a * (asterisk) will appear after the program number [Prog]. If these changes need to be available later as samples, the current operating parameters may be saved in one of the 9 memory locations.

Memory management is called up with the keys "SET" and the arrow key <.





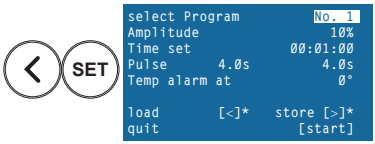
By pressing the "SET" key, the content of the working memory (current program) can be displayed for comparison purposes, e.g. to facilitate the selection of a memory location.
The desired memory location for loading or saving the sonication program is selected with the arrow keys ∧ and ∨.

Loading the sonication program

In order to copy the content of the selected data memory in the working memory, the arrow key < is pressed and held until an audible signal is emitted. The data can be used after leaving the program administration.

Saving the sonication program

By continuously pressing the arrow key > until an audible signal is emitted, the content of the working memory is transferred into the selected data memory. Then, the new contents are displayed.

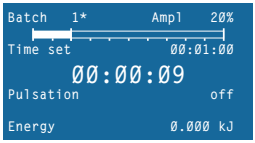


The "START/STOP" key is used to exit memory management and return to stand-by mode.

3.4 Batch operation (batch processing)

Simple sonication profiles can be assembled thanks to the automatic, step-by-step processing of saved sonication programs.

Sonication programs intended for batch operation are selected with the arrow keys ∧ and ∨. The arrow key > is used to mark the memory location for batch processing with a “B” and the arrow key < is used to remove it. This allows for simple sonication profiles to be assembled. The execution of the marked programs always starts with the lowest program number and continues with the ascending program number.



Batch operation must be activated for this procedure (see chapter 3.2.4). The currently active batch program is then displayed (inverse presentation) instead of the current program (prog).

Note:
In this operating mode, no changes can be made to the settings in stand-by or ultrasonic operation.

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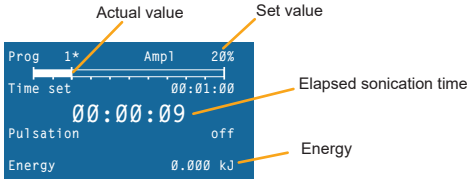
3.5 Activating / deactivating the ultrasound

Ultrasonic operation can be started and stopped by pressing the "START/STOP" key or the key on the ultrasonic converter. With an activated target time, the ultrasound operation ends and a signal tone (short + short) is emitted, once the target time has elapsed. When the device is restarted, the displays for the elapsed sonication time and for the energy are set to zero.



In contrast to stand-by mode, ultrasound operation displays the actually achieved value in bar graph form, in addition to the pre-set amplitude or power.

Note:

Depending upon the physical conditions, i.e. the viscosity of the sonicated medium and the thus-resulting control processes, a difference between the target and the actual value, as well as a fluctuating display, may occur.

The amplitude and the power can be changed at any time during ultrasound operation with the arrow keys ∧ and ∨. All other operating parameters can only be edited while in stand-by mode (see chapter 3.2).

Notes:

- If the ultrasonic operation is manually interrupted before it reaches the activated target time, the display values for the elapsed sonication time and for the energy will be saved and will continue running upon restart. The display values can be reset to zero by pressing the "SET" key and then pressing the "START/STOP" key.
- With the "non-stop" setting, the elapsed sonication time and energy must also be manually reset, if needed. Once the maximum displayable time has been reached and exceeded, the time display will start again at 0:00:00.
- If the maximum displayable energy value of 99999.99 kJ is exceeded, the display starts again at 0.000 kJ.
- The display value for the energy is a guideline value and does not correspond to the acoustic energy actually applied.

4 Use

4.1 Instructions for use

- Do not touch the sonication vessels with the oscillating probe - probes and vessels could be damaged.
- The recommended immersion depth for probes is of 10 - 20 mm, to prevent the aspiration and mixing-in of air. If mixed-in air is desired, the probe may be immersed just a few millimetres. In the case of greater immersion depths and/or the sonication of liquids with high viscosities, the probe is more heavily damped. As a result, it is possible that the pre-set amplitude may not be reached, especially with higher default settings (>50 %). The reason is that the ultrasound generator can no longer provide the required power, or the power limit value has been reached (protective function).
- When producing emulsions, the probe should be immersed to the level of the interface between the liquids to be mixed.
- Do not use combustible solvents in open reaction vessels since the operating safety of the ultrasonic homogeniser could be compromised.
- In order to take the unit out of service, disconnect the device from the mains (pull the plug).

4.2 General use

Before starting use, the important instructions in chapter 4.1 should always be heeded!

Step 1 : Check the ultrasonic converter

- Verify that all connecting cables and couplings are correctly connected.
- The probe type must conform to the sonication volume, see table in chapter 4.3.
- The probe must be cleaned and correctly mounted (see chapter 4.3.1).
- The ultrasonic converter must be securely affixed.

Step 2 : Prepare for sonication

- Prepare the sonicating medium.
- Position the sonication vessel below the ultrasonic converter in such a manner that the probe does not come in contact with the vessel.
- Set the immersion depth for the probe (approx. 10 -20 mm).
- If necessary, connect the temperature sensor and position it in the medium.

Step 3 : Switch on the ultrasonic homogeniser

- Switch on the ultrasonic homogeniser at the mains switch.
- All saved data and settings will be loaded. Check the settings and load a different program if necessary, see chapter 3.3.

Step 4 : Activate the ultrasound

- Start with a small amplitude to avoid spraying. Observe the maximum allowed amplitude, see chapter 4.3.
- Activate the ultrasound.

Warning: risk of splashing!
This is especially the case with small sample quantities and when immersing oscillating probes.

Step 5 : Remove the sample

After sonication, the probe must be removed from the medium. Leaving it in the sonicating medium for a longer time can cause damage to the probe.

- Once the program or time setting has elapsed, the ultrasound emission ends automatically.
- If continuous sonication has been set, the ultrasound emission must be stopped manually.
- Remove the probe and the temperature sensor, if present, from the sonicating medium.

Step 6 : Clean the probe

In order to prevent contamination with other sonicating media, probes are to be thoroughly cleaned after every sonication.

- Switch off the ultrasonic homogeniser at the mains switch.
- Clean the probe and check the wear on the sound emitting surface at regular intervals, see chapter 5.1.

4.3 Selecting a suitable probe

Detailed information on the individual probes can be found in the separate product information.

GM 4200 with UW 50

Probe		TS 102	TS 103	TS 104	TS 106	TS 109
Ø Tip	[mm]	2	3	4.5	6	9
Sonication volume	[ml]	0.5 - 20	1 - 25	3 - 50	5 - 75	10 - 100
Max. amplitude	[μm_{ss}]	135	105	90	75	65
Max. setting	[%]	100	100	100	100	100

GM 4200 with UW 100 and SH 100 G

Probe		TS 102	TS 103	TS 104	TS 106	TS 109	TS 113	TT 213
Ø Tip	[mm]	2	3	4.5	6	9	12.7	12.7
Sonication volume	[ml]	2 - 25	3 - 50	5 - 75	10 - 100	15 - 150	20 - 200	20 - 200
Max. amplitude	[μm_{ss}]	260	245	190	160	135	80	80
Max. setting	[%]	90	100	100	100	100	100	100

GM 4200 with UW 200 and SH 200 G / GM 4400 with UW 200 and SH 200 G

Probe		TS 103	TS 104	TS 106	TS 109	TS 113	TT 213	TS 216	TS 219	TS 225
Ø Tip	[mm]	3	4.5	6	9	12.7	12.7	16	19	25
Sonication volume	[ml]	5 - 90	5 - 100	10 - 350	10 - 500	20 - 900	20 - 900	25 - 900	25 - 900	30 - 1000
Max. amplitude	[μm_{ss}]	320	265	230	200	140	140	105	80	50
Max. setting	[%]	65	70	75	80	100	100	100	100	95

GM 4400 with UW 400 and SH 400 G

Probe		TS 413	TS 416	TS 419	TS 425	TS 425 L	TS 432	TT 438
Ø Tip	[mm]	13	16	19	25	25	32	28
Sonication volume	[ml]	100 - 750	250 - 1000	250 - 1500	500 - 2000	500 - 2000	500 - 2500	500 - 3000
Max. amplitude	[μm_{ss}]	260	180	130	75	75	50	40
Max. setting	[%]	80	100	100	100	100	65	50

Note on maximum settings:

The information may change after the probes have been technically updated.
The data stored in the program is always valid!

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4.3.1 Mounting and dismounting of the probes

Probes

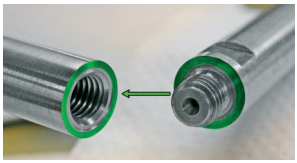
- are screwed onto the standard/booster horns or directly onto the ultrasonic converter,
- transmit ultrasonic power into the medium to be sonicated,
- are made of high-strength titanium alloy.

Caution !

Probes are sensitive to shock.

Before mounting or dismounting the probes, the ultrasound generator must be turned off and the ultrasonic converter must be disconnected from the ultrasound generator.

The mounting surfaces[/5] must be thoroughly cleaned so that the amplitude and/or power can be transmitted to the medium. If the mounting surfaces are not cleaned, the probe and the standard/booster horn could be destroyed.



Note

The tool required for mounting/dismounting is included in the scope of delivery.

/5 Mounting surfaces are the contact surfaces between the standard/booster horn and the probe.

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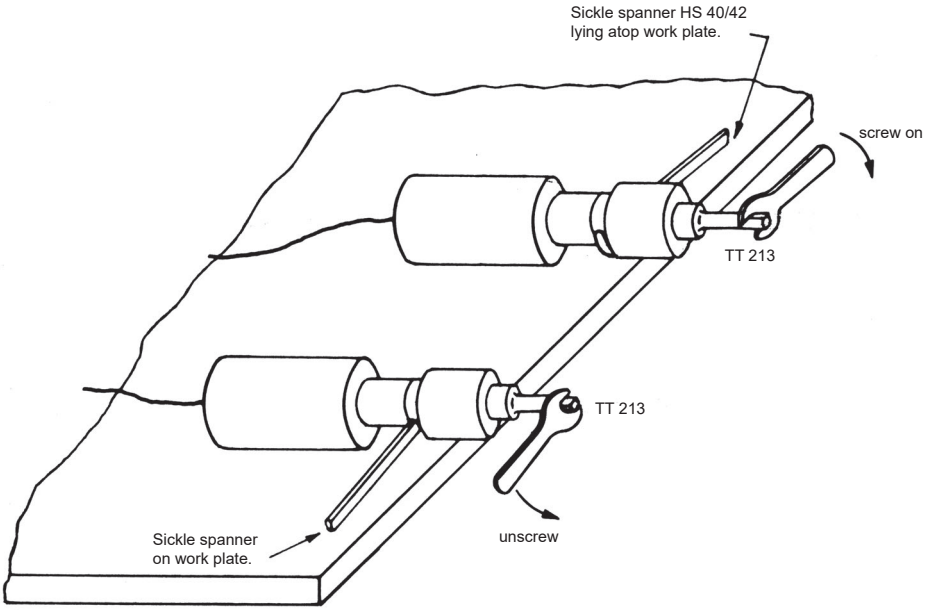
4.3.1.1 Mounting and dismounting the titanium plates

The TT 213 titanium plate is mounted on the standard/booster horn SH 100 G or SH 200 G.

- First, carefully wipe the mounting surfaces of the standard/booster horn and of the titanium plate ⇒ ensure clean mounting surfaces.
- Screw on the titanium plate by hand.
- Apply spanner - SW 10 for TT 213 - to the steel fitting on the titanium plate.
- Firmly hold the standard/booster horn using the sickle spanner HS 40/42 and firmly mount the titanium plate to the standard/booster horn.
- Dismount in the reverse order.

Note: Observe the permissible torque! - see product information

Video available at:
https://www.youtube.com/watch?v=hjTC_cvO4kQ



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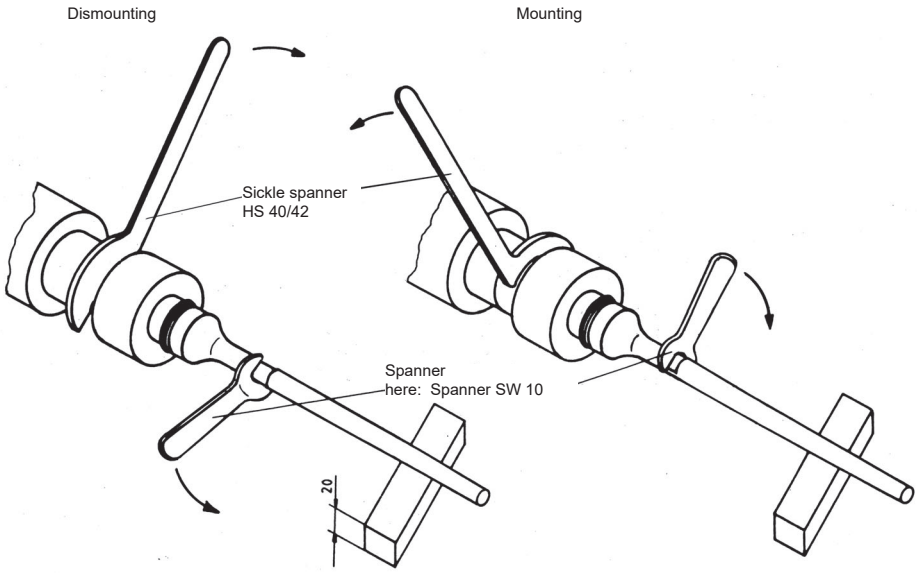
4.3.1.2 Mounting and dismounting of the titanium probes

Titanium probes (TS ...) are mounted directly on the UW 100/200 on the standard/booster horn SH 100 G/SH 200 G or on the UW 50.

- First, carefully wipe the mounting surfaces of the standard/booster horn and the probe ⇒ ensure clean mounting surfaces.
- Screw on the probe by hand.
- Lay the probe on an approx. 20 mm thick base so that it does not bend.
- Firmly hold the standard/booster horn in place using sickle spanner HS 40/42, and tighten the probe using the appropriate spanner, see illustration. The use of the torque wrench DMS 10 is recommended.
  Note: Observe the permissible torque!- see product information
- With the UW 50 use the sickle spanner HS 25/28 - the probe is mounted directly onto the UW 50.
- Dismount in the reverse order.



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4.4 Dismounting and mounting the standard/booster horns

Standard/booster horns

- are screwed onto the respective ultrasonic converter,
- are made of high-strength titanium alloy,
- transmit the oscillations to the probe,
- enhance the amplitude thanks to their geometry.

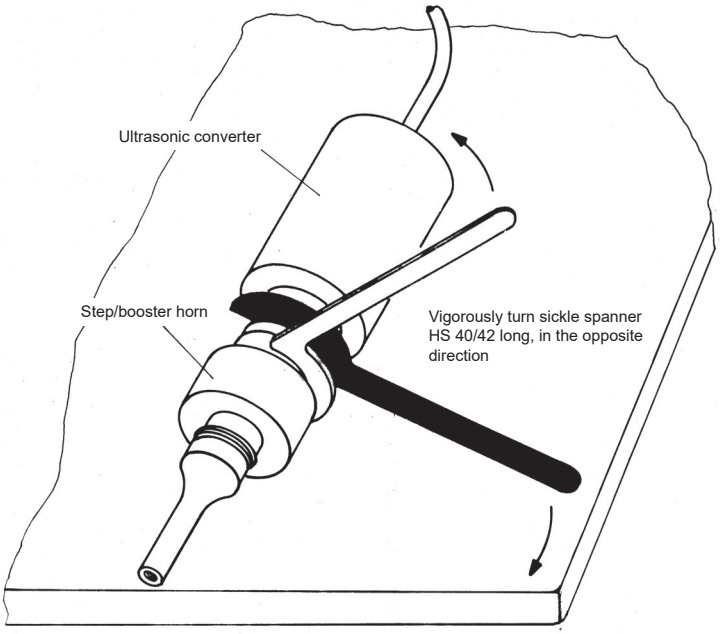
At the time of delivery, standard horn SH 100 G is firmly mounted onto the UW 100, and booster horn SH 200 G is firmly mounted onto the UW 200.

Before mounting the standard/booster horns, the ultrasound generator must be turned off and the ultrasonic converter must be disconnected from the ultrasound generator.

Video available at:
https://www.youtube.com/watch?v=NXbGc6nAb5c

Disassembly

- ➢ Release the permanently mounted standard/booster horn SH from the ultrasonic converter UW. To do so, place the ultrasonic converter on a firm base (non-slip, if possible).
- ➢ Place one sickle spanner on the ultrasonic converter and the other sickle spanner on the standard/booster horn. To dismount, press the first sickle spanner against the firm base, and very firmly press the other sickle spanner in the opposite direction.
- ➢ One sickle spanner is part of the scope of delivery of one standard/booster horn.



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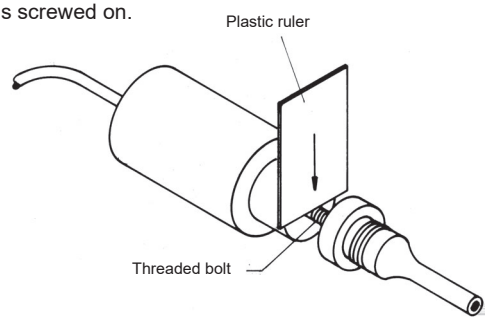
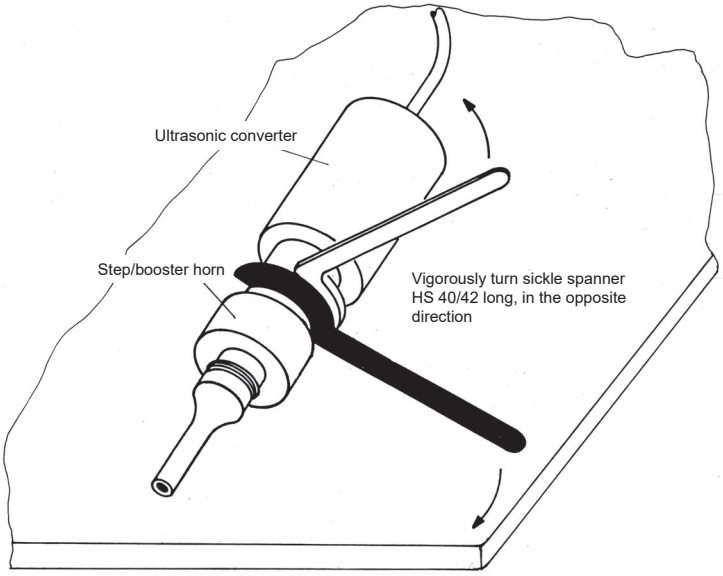
Assembly

- Keep the mounting surfaces/threads to be screwed clean, using alcohol and a fibre-free cloth if needed.
- Screw in approx. 2/3 of the length of the threaded bolts of the new standard/booster horn to be mounted, into the mounting surface of the ultrasonic converter.
- Place a plastic ruler or similar on the threaded portion of the bolt, and press lightly in the direction of the arrow ⇒ this will prevent the bolt from turning any further when the standard/booster horn is screwed on.



- Screw the standard/booster horn onto the threaded bolt and then tighten by hand after removing the ruler.
- Next, mount the standard/booster horn firmly onto the ultrasonic converter using both sickle spanners.



Detailed information on the individual standard/booster horns can be found in the separate product information.

Caution

The black housing of the ultrasonic converter and the aluminium cylinder (ultrasonic oscillating system) may not be twisted toward each other. The ultrasonic oscillating system and its electrical connections would be damaged as a result.

5 Cleaning and maintenance of the ultrasonic homogeniser

To achieve an optimum lifespan for the ultrasonic homogeniser, cleaning and maintenance must be conducted regularly.

CAUTION!

Always disconnect the ultrasonic homogeniser from the mains before performing cleaning / maintenance.

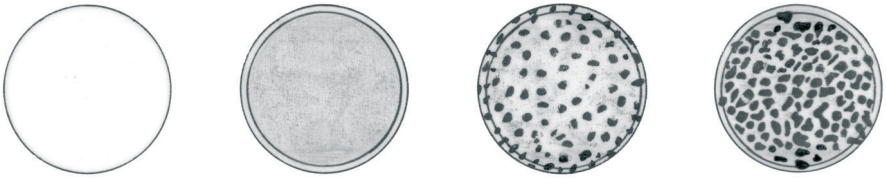
Do not rinse or immerse the ultrasonic homogeniser in water and do not expose it to splash water.

5.1 Cleaning and care

The cleaning and disinfection, if needed, must be carried out regularly by the user with a suitable cleaning agent and a lint-free cloth.
In most cases, a cloth soaked in alcohol is sufficient to wipe off the probe.
If sterilisation is required, the probe must be unscrewed after wiping and sterilised in a steriliser.

Reconditioning probes

All probes are subject to process-related wear, which leads to erosion on the sound-emitting surface and thus to a reduction in power.
In the case of frequent use, it is recommended that an inventory supply of probes be kept.
Examples of wear, e.g. on titanium plate TT 13:



New titanium plate | Erosion still permissible, plate can be polished | Start of pitting, milling or grinding necessary | Limit value for erosion exceeded, replacement necessary

The sound-emitting surfaces can be carefully polished or milled a few times. If material residue due to erosion or post-processing exceeds a value of approx. 1 mm, or if there is no power display on the generator, the probe is non-resonant and can no longer be used.

Reconditioning of the sound-emitting surface:
Reconditioning can be performed using a grinding machine with a fine grinding wheel of suitable grain size. Suitable grinding materials are, for example:

- Fine abrasive wheel, polyurethane-bound – grain size 220
- Fine abrasive wheel, rubber-bound – grain size 180

Ultrasonic converter/ultrasound generator

- Do not use abrasive cleaners, only use commercially-available care products without scouring agents.
- Wipe the housing only from the outside with a moist cloth; if needed, use a suitable surface disinfectant, then allow to dry or rub dry.

5.2 Warehousing / storage

During extended periods without use, the ultrasonic homogeniser should be stored in a cool, dry place. The ultrasonic converter should be covered in order to protect the electronics from outside contamination.

6 Maintenance and repair

6.1 Maintenance

SONOPULS ultrasonic homogenisers are maintenance-free.

Aside from the process-dependent cavitation erosion on the sound-emitting surfaces of the probes, no other ultrasonic homogeniser parts are subject to wear. Worn out or faulty probes can be replaced following the instructions in chapters 4.3.1 to 4.4.

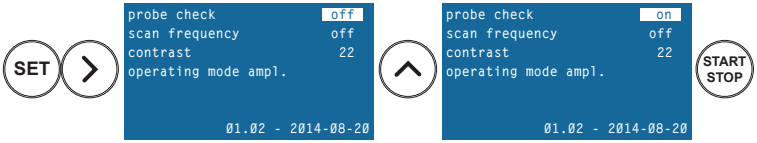
The devices are calibrated at the time of delivery. A control of the calibration is only required after repairs, and will only be conducted by the manufacturer.

6.2 Functional checks

See also chapter 3.2.4 for description and operation.
For error messages Error 011 and Error 012, always start with the test according to chapter 6.2.1 first.

6.2.1 Testing the ultrasonic converter (probe check) – Error 011

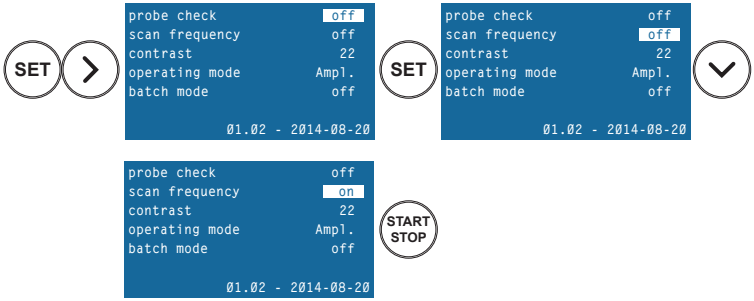
The test is preferably conducted while the probe is acoustically uncoupled, i.e. the probe should be immersed in the sonicating medium.



The ultrasonic frequency depends on the probe, and the actual value may vary from the example presented here. After successful completion, the monitor display switches back to stand-by mode. Otherwise, an error message appears again.

6.2.2 Conducting a frequency scan (scan frequency) – Error 002/011/012

The conditions for execution are similar to those for conducting checks with the "probe check" function, see chapter 3.2.4.



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The frequency scan is completed once fine-tuning has been successful, and the display switches back to stand-by mode.
Otherwise, an error message such as Error 012 appears again.

6.3 Troubleshooting

Errors may arise

- on the plug connections
- on the ultrasonic converter
- on the probes
- on the ultrasound generator

The device is robustly constructed and designed for a high level of reliability. Nevertheless, the possibility of a malfunction due to a defective component can never be fully discounted. Mechanical defects of the connection for the ultrasonic converter, the plug connectors, the ultrasonic converter, etc., are possible as a result of frequent use or even incorrect handling, e.g. by dropping them.

Critical faults are recognised by the device and signalled by a red LED and an intermittent signal tone (3 times), and displayed with an error number, see next page.

Error No.	Possible cause	Remedial action
Converter: No USC	No ultrasonic converter (UW) connected to the ultrasound generator (GM)	Connect the UW to the horn/probe on the GM. The GM should then automatically recognise which UW has been plugged in.
002	Frequency setting not possible	Perform frequency scan. If the error occurs again, contact BANDELIN.
003	No power output, amplitude setting not possible	Error correction should only be carried out by BANDELIN. Send in the complete ultrasonic homogeniser.
004	Mains voltage fallen short of	Check mains connection, check fuse
010	Frequency synchronisation malfunctioning, frequency display is currently not possible	- Check whether the probe has been mounted correctly = sufficiently tight - Check for damage: • Horn/probe contact surfaces • Horn/probe threads • Probe radiation surface If needed, replace the UW/probe and then check its function. Use the "probe check" or "scan frequency" functions for this purpose. After successfully completing the frequency scan, do not restart operation until initialisation is complete. In the event of failure, contact BANDELIN.
011	No return signal from UW, UW or probe defective	
012	Error in frequency scan, no resonance frequency found, probe defective	
014	Permissible internal operating temperature exceeded, ultrasonic homogeniser switches off	Allow the ultrasonic homogeniser to cool down for at least 10 minutes, if necessary check with a temperature sensor that the operating temperature of the GM has dropped to < 50 °C.

Error No.	Possible cause	Remedial action
020	Unknown command (communication error), remote control command was not executed or ignored	Observe the application information "Protocol and command set for remote operation" and check commands.
021	Incorrect command length (communication error), remote control command was not executed or ignored	
022	Unknown type (e.g. probe)	Check the UW, standard/booster horn, and probe for compatibility.

General device errors

Error	Possible cause	Remedial action
Device cannot be switched on? (display without function)	No power Mains cable loose or faulty?	- Check that plug connection is firmly in place. - Check the cable for continuity or, if needed, exchange the mains connector.
	Device fuse tripped?	- Replace fuses. The fuses are located in the cold device socket on the rear side of the generator, see chapter 1. (2 fuses: F2A)
	Main fuse faulty?	- Replace main fuse.
Little or no ultrasonic power?	Is the connection from the ultrasonic converter to the standard/booster horn, or from the horn to the probe not secure?	- Using the tool supplied, separate parts from one another, clean the surfaces, and firmly screw together once again, see chapters 4.3.1 ... 4.4.
	Standard/booster horn or probe faulty?	- Check horn, probe and threaded pins for cracks, if necessary dismount and replace. ⇒ Ensure clean and flat surfaces, see chapter 4.3.1.
	Check for erosion on the titanium plate / probe - see chapter 5.1.	
	slight?	- Polish the titanium plate and/or probe.
	slight pitting?	- Grind or mill the titanium plate and/or probe until flat (max. 1 mm).
	heavy pitting?	- Replace the titanium plate and/or probe with new ones.
	Liquid has penetrated between standard/booster horn and probe?	- Dismount the probe, clean the mounting surfaces and threads, dry and check for evenness, remount the probe and tighten, see chapter 4.3.1.
	Is the threaded pin attachment on the titanium plate defective?	- Replace the titanium plate, see chapter 4.3.1.
	Is the threaded bolt on the standard/booster horn cracked?	- Disassemble the parts, check the threaded bolt, replace if necessary, reassemble the parts, see chapter 4.3.1.
	Wrong resonance frequency?	- Conduct frequency scan, see chapter 6.2 (search frequency).

Error	Possible cause	Remedial action
Significant heating in the vicinity of the mounting surfaces between the ultrasonic converter and standard/booster horn or standard/booster horn – probe?	Sonicating parts (standard/booster horn and probe) not mounted firmly enough? Are mounting surfaces of the sonicating parts soiled?	- Dismount the respective parts, clean the surfaces and firmly retighten, see chapter 4.4.

If it is not possible to rectify the error using these short instructions, please contact your local specialist dealer or write to us at the address below.

6.4 Repairs and service

If you identify errors or defects that cannot be rectified, the ultrasonic homogeniser may no longer be used.
If this occurs, please contact the supplier or the manufacturer, use the enclosed questionnaire.

BANDELIN electronic GmbH & Co. KG
Heinrichstrasse 3-4
12207 Berlin

Repairs/Maintenance Department:
Tel.: +49-(0)-30 - 768 80 - 13
Fax: +49-(0)-30 - 76 88 02 00 13

E-mail:
info@bandelin.com

Returns are subject to the General Conditions of Delivery and Payment of BANDELIN electronic GmbH & Co. KG.
In addition, the ultrasonic homogeniser must be cleaned and decontaminated (if necessary), see the following chapter.

Caution

- Only allow repairs to be conducted by authorised skilled personnel!
- Before each repair, turn off the device and disconnect the plug from the mains!
- Defective parts may only be replaced with original parts.
- The black housing of the ultrasonic converter and the aluminium cylinder (ultrasonic oscillating system) may not be twisted toward each other. The ultrasonic oscillating system and its electrical connections would be damaged as a result.

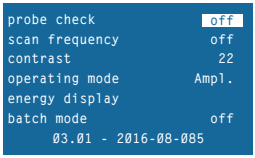
6.4.1 Certificate of Decontamination

If the ultrasonic homogeniser (with accessories, if applicable) is sent back to the manufacturer, the form "Certificate of Decontamination" must be filled out and affixed to the packing on the outside, in a visible spot.
If this form has not been filled out, we reserve the right to refuse receipt of the package in order to protect our employees.

The form can be downloaded as a PDF file from our website:
www.bandelin.com/downloads ...

6.4.2 Software version display

In some cases it may be necessary to inform authorised skilled personnel or the manufacturer of the software version for the ultrasonic homogeniser.
The software version will be displayed in the menu "Miscellaneous functions and settings" (see chapter 3.2.4).



The software version provided here is illustrative, the actual specifications may differ.

BANDELIN electronic GmbH & Co. KG • Heinrichstraße 3-4 • 12207 Berlin • Deutschland • info@bandelin.com

7 Accessories

The proper accessories facilitate use of the ultrasound and at the same time protect the device and the materials used.

BANDELIN offers a broad range of accessories, see the Product Information. Additional information may be obtained from our supplier, our sales representatives, or from our website.

Telephone consultation:
+49-(0)-30 - 768 80 - 0

Website:
www.bandelin.com

7.1 Required accessories

In order to dismount/ mount standard/booster horns or probes, only use the tools specified in Appendix A.

7.2 Optional accessories

Stand HG 40

Stands are used for correct, variable positioning of the ultrasonic converter.

Only ultrasonic converters, but not oscillating elements such as standard/booster horns with probes, may be affixed to the special clamp. An adapter ring AH 50 is required for the UW 50 (included in the scope of delivery).

HG 40

Sound proof box LS 40

The sonication of liquids generates noise. The sound proof box dampens the noise emission by approx. 30 dB(AU).

LS 40

Ultrasonic converter / standard / booster horn

The following ultrasonic converters and standard/booster horns can be connected to the ultrasound generators:

Ultrasound generator	GM 4200			GM 4400	
Ultrasonic converter	UW 50	UW 100	UW 200	UW 200	UW 400
Standard horn	-	SH 100 G	-	-	-
Booster horn	-	-	SH 200 G	SH 200 G	SH 400 G

8 Consumable materials

No consumables are available for this ultrasound application.

9 Taking the unit out of service

The device must be disposed of appropriately, not with household waste.

Disposal must be conducted in accordance with the Waste, Electrical and Electronic Equipment Directive 2012/19/EU.
Any supplementary/deviating national regulations must be observed.

- The device must be decontaminated before disposal. It can then be disposed of as electronic waste. If decontamination is incomplete/cannot be correctly performed, a material safety data sheet noting the liquids used must be affixed to each device.
- Metal accessories such as probes or standard horns should be decontaminated and disposed of as metal waste.
- The packaging is recyclable.

10 Keyword index – not applicable –

A Spanner for mounting/dismounting

Probes and standard/booster horns are highly-sensitive parts that must be mounted and dismounted with the greatest amount of care.
For this reason, only use the following spanners for the mounting/dismounting of probes from standard/booster horns, as well as of standard/booster horns from the ultrasonic converter:

Spanner Type	Usage
Spanner MS 10, long 	Mounting/dismounting of probes UW 50 / SH 100 G / SH 200 G
Open-end spanner MS 22 	Mounting/dismounting of probes on SH 400 G
Sickle spanner HS 25/28, long 	To hold UW 50 in place during mounting/dismounting of the probes
Sickle spanner HS 40/42 	Mounting/dismounting of the probes (used to hold SH 100 G / SH 200 G)
Sickle spanner HS 40/42, long 	Mounting/dismounting of the standard/booster horn on the ultrasonic converter SH 100 G / SH 200 G / TH 100 G / TH 200 G / FZ 5 G / FZ 7 G
Sickle spanner HS 45/50, long 	For holding SH 400 G
Torque wrench DMS 10 	Code No.: 3662