Training Aid

SOUND WAVE CONTROLLER SC600

Ultrasound Generator with Accessories for the Debye-Sears Test and Projection of Standing Ultrasonic Waves

User Manual

www.gampt.de

gaMPT
ULTRASONIC SOLUTIONS

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! **Please read through the whole user manual before using the device and accessories.**

1 Safety Instructions

Please read through the following instructions thoroughly before commissioning the ultrasonic generator and accessories for your own safety and the operational safety of the device.

- *The opening slits on the device are for ventilation and must be kept absolutely free in order to prevent the device from overheating. It is recommended to use the folding feet on the device.*
- *Make sure that the voltage values and fusing stated for the device are adhered to in the electricity supply.*
- *Never try to insert objects through the openings on the device, because this can lead to short circuits or electric shocks.*
- *Only connect the ultrasonic transducer supplied by the company GAMPT mbH to the output of the ULTRASONIC unit marked PROBE. Be careful, there are voltages of up to 50 V and currents of up to 1000 mA.*
- *Do not operate the connected ultrasonic transducer without contact with a liquid, because it can lead to overheating and thus to the destruction of the transducer.*
- *Switch off the output PROBE of the SC600 if the ultrasonic probe is not connected or not needed.*
- *Because power ultrasound is produced with the device and the associated sonic transducer, the sonic transducer must not be used on people or animals.*
- *The laser modules currently supplied by us are equipped with laser diodes of the laser classes 2 and 3R (EN 60825-1) with a performance of ≤ 1 mW or ≤ 5 mW. Before using them, find out about the necessary protective measures.*
- *Do not switch on a laser module connected to the output LASER of the SC600 if there is a person in the direction of the beam. Do not look into the laser beam and do not direct the laser at other people or animals.*

2 Introduction

In 1932 Debye and Sears showed for the first time that light undergoes diffraction when passing through a liquid excited to high-frequency vibrations. Here, the density fluctuations caused by a standing or travelling ultrasonic wave act like the grating elements of an optical diffraction grating. The grating constant then corresponds to the wavelength of the ultrasound and is consequently dependent on its frequency and its speed in the medium through which the waves are passing.

With the cw ultrasonic generator SC600 (4) from the company GAMPT mbH, the wide-band ultrasonic probe (2), the sample reservoir (3) with adjuster and built-in laser support and a laser module (1), there is a device set available with which this phenomenon can be demonstrated to trainees at schools, colleges and universities in a simple and compact way (Fig. 1). With this, both the frequency dependence can be demonstrated and the wavelength of the ultrasound in different liquids and thus the material-specific sound velocity can be determined.

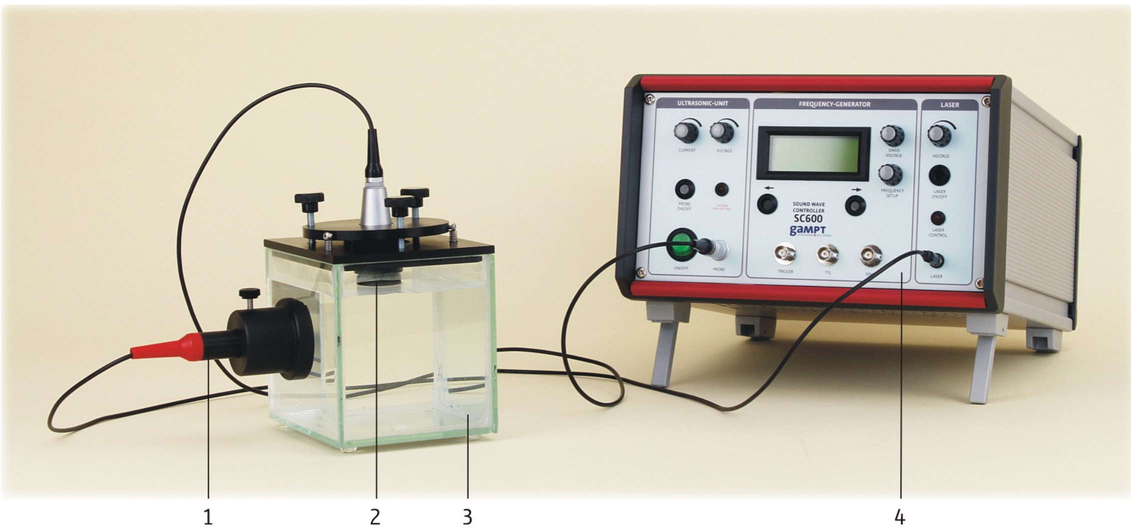

Fig. 1: SC600 and Debye-Sears set

(1) laser module
(2) ultrasonic probe
(3) sample reservoir with probe adjustment and laser support
(4) Sound Wave Controller SC600

Furthermore, it is possible to project a standing ultrasonic wave simply. For this, an optical lens is placed between the laser source and ultrasonic wave, so that the standing wave is shone through by divergent laser light. The periodically repeating fluctuations in density along the sonic beam axis cause a varying refraction of the laser light. The result is an image with a distribution of bright and dark areas, which is determined by the wavelength and thus the frequency of the ultrasound.

You can find further information on other possible applications and accessories in our current catalogue and on our website.

3 Sound Wave Controller SC600

The device allows the generation of continuous sound waves (cw: continuous wave) at high power over a wide frequency range up to 20 MHz and can also be operated in burst or pulse mode. In addition to the ultrasonic generator, a signal generator and a control unit for laser diode modules are also built-in. All adjustable device parameters and important output parameters are shown on the centrally located LCD display.

! *Attention! SC600 and ultrasonic probes/laser modules are adapted to each other. Before you use the probes of other manufacturers, please check whether the technical parameters are compatible.*

3.1 Front View of the SC600

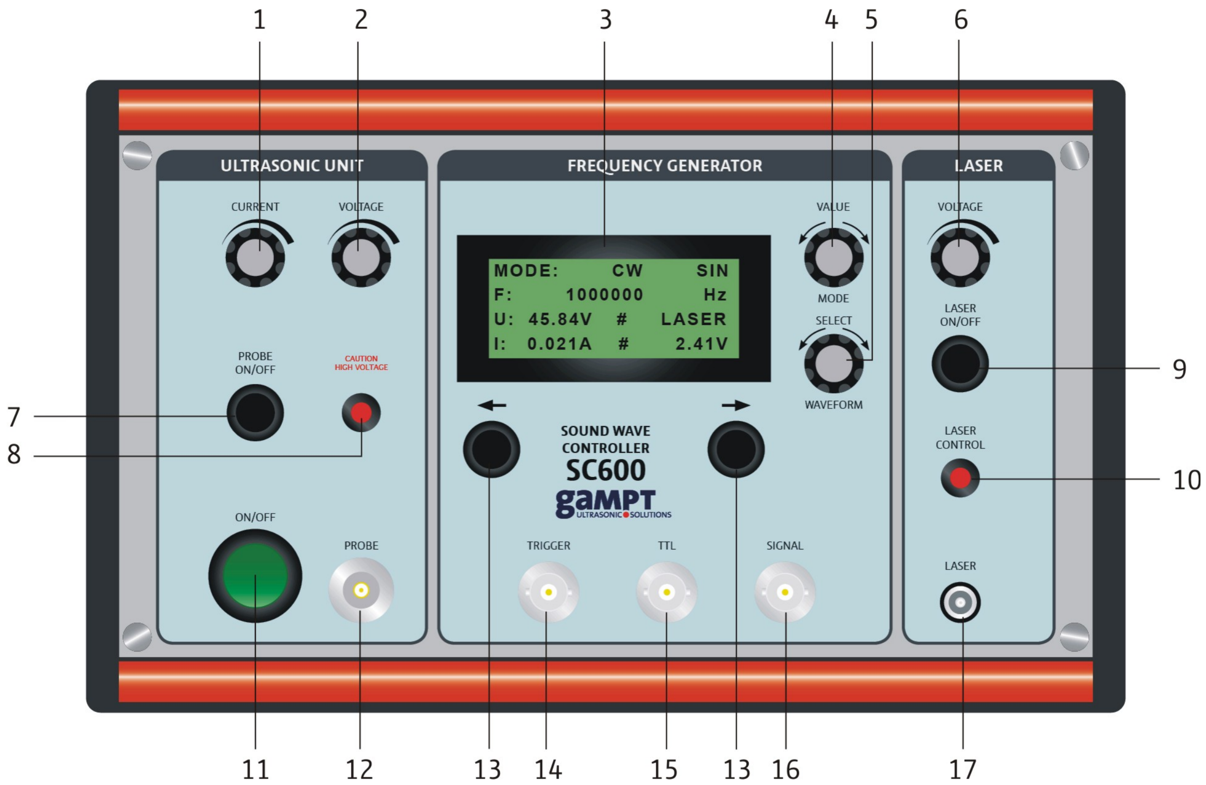

Fig. 2: front view of the SC600

(1) current regulator output PROBE
(2) voltage regulator output PROBE
(3) LCD display
(4) setting value/mode
(5) setting selection/signal shape
(6) voltage regulator output LASER
(7) on/off button output PROBE
(8) status LED output PROBE
(9) on/off button output LASER
(10) status LED output LASER
(11) on/off switch device
(12) output ultrasound generator
(13) button decimal place selection
(14) trigger output
(15) TTL output
(16) signal output signal generator
(17) output laser voltage

3.2 Back of the SC600

Fig. 4: view of the back of the SC600

On the back of the device there is a socket for the mains connection. A fuse holder is built into the bottom part of the socket. This holds the fuse for the device and a reserve fuse.

Changing the Fuse

To change the device fuse, the fuse holder must be pulled out of the socket (Fig. 4).

Necessary fuse type: T 1A (see section 6)

Fig. 3: socket with partially pulled out fuse holder

! *Caution! The device works with mains voltage. Touching voltage-carrying parts is dangerous to life. Switch the device off and pull the mains cable out of the plug before you pull out the fuse holder.*

! *Attention! Only replace the fuse with the type stated in the manual. If the wrong type of fuse is used, there is a risk of fire.*

3.3 LCD Display

For the setting and presentation of the device parameters there is an LCD display with 4 lines, each with 16 characters. About 2 seconds after the device is switched on, the welcome screen appears in the LCD display, also stating the version number of the device software (Fig. 5).

```
GAMPT mbH SC600
Software
Version 2.1
Maerz 2013
```

Fig. 5: welcome screen

After initialisation has finished, the start screen (Fig. 6) is displayed. Line 1 now contains information on the operating mode and the signal shape. Line 2 is for displaying the setting values of the signal generator. In lines 3 and 4, the voltage and current values on the PROBE output are shown on the left, and on the right, the voltage value on the LASER output is displayed.

LCD	
MODE: CW SIN	Line 1: signal mode and signal shape display
F: 1000000 Hz	Line 2: setting value display
U:45.89V # LASER	Line 3: ultrasonic voltage display
I:0.021A # 2.41V	Line 4: ultrasonic current display and laser voltage display

Fig. 6: start screen Version 2.1

3.4 Operation of the SC600

3.4.1 Signal Generator (Frequency Generator)

The built-in signal generator can generate signals with frequencies from 1 Hz to 20 MHz, which can be digitally adjusted in steps of 1 Hz. As well as the cw mode (CW), the device can also be operated in burst and pulse mode (BURST, PULSE). Sine, triangular and square wave signals (SIN, TRI, SQU) can be generated.

The settings are made using two knobs with pressing function, (4) VALUE/MODE and (5) SELECT/WAVEFORM, and the two buttons ←→ (13) to select the decimal place.

The signal frequency can be tapped at the TTL output (15) as a square wave signal (0-5 V). At the SIGNAL output (16), the generator signal is supplied according to the parameters set.

Changing the Mode

The currently set mode – cw, burst or pulse – is displayed in the first line of the LCD. The change between the modes is carried out by **pressing** the knob (4) VALUE/**MODE**.

```
MODE:        CW   SIN
F:        1000000  Hz
U:45.89V  #   LASER
I:0.021A  #   2.41V
```

Fig. 7: cw mode (initial state)

```
MODE:     BURST   SIN
F:        1000000  Hz
U:45.89V  #   LASER
I:0.021A  #   2.41V
```

Fig. 8: 1 × pressing - change into the burst mode

```
MODE:     PULSE   SIN
F:        1000000  Hz
U:45.89V  #   LASER
I:0.021A  #   2.41V
```

Fig. 9: 2 × pressing - change into the pulse mode

Selection of the Signal Shape

The currently set signal shape - sine, square or triangle – is also displayed in line 1 of the LCD. It can be changed by **pressing** the knob (5) SELECT/**WAVEFORM**.

```
MODE:        CW   SIN
F:        1000000  Hz
U:45.89V  #   LASER
I:0.021A  #   2.41V
```

Fig. 10: sine (initial state)

```
MODE:        CW   SQU
F:        1000000  Hz
U:45.89V  #   LASER
I:0.021A  #   2.41V
```

Fig. 11: 1 × pressing - selecting square signal

```
MODE:        CW   TRI
F:        1000000  Hz
U:45.89V  #   LASER
I:0.021A  #   2.41V
```

Fig. 12: 2 × pressing - selecting triangular signal

Selection and Display of the Signal Variables of the Generator Signal

The following signal variables, as shown in Table 1, can be displayed and changed at the frequency and/or signal generator: signal frequency, signal amplitude, pulse repetition frequency and burst length. The signal variable to be displayed and/or set is selected by **turning** the knob (5) **SELECT**/WAVEFORM.

```
MODE:        CW    SIN
F:      1000000    Hz
U:45.89V  #  LASER
I:0.021A  #  2.41V
```

Fig. 13: frequency (initial state)

```
MODE:        CW    SIN
AMP:       1000  mVss
U:45.89V  #  LASER
I:0.021A  #  2.41V
```

Fig. 14: turn right – amplitude of the SIGNAL output

```
MODE:        CW    SIN
PRF:         1000  Hz
U:45.89V  #  LASER
I:0.021A  #  2.41V
```

Fig. 15: turn right – pulse repetition frequency with burst and pulse

```
MODE:        CW    SIN
BuL:          10  mys
U:45.89V  #  LASER
I:0.021A  #  2.41V
```

Fig. 16: turn right – burst length (is also equal to the double pulse width in the pulse mode)

Setting the Values of the Signal Variables

After the signal variable to be set has been selected (Fig. 13-16), the value of the signal variable can be set using the knob (4) **VALUE**/MODE and the two buttons ←→ (13). By **turning** the knob (4) the value of the selected decimal place is changed. Turning to the left reduces the value and turning to the right increases the value.

```
MODE:     CW   SIN
F:      1000000 Hz
U:45.89V #  LASER
I:0.021A #  2.41V
```

Fig. 17: initial state

```
MODE:     CW   SIN
F:      1100000 Hz
U:45.89V #  LASER
I:0.021A #  2.41V
```

Fig. 18: increase the value by turning right

```
MODE:     CW   SIN
F:       900000 Hz
U:45.89V #  LASER
I:0.021A #  2.41V
```

Fig. 19: reduce the value by turning left

With the buttons ←→ (13), the decimal place to be changed can be selected.

```
MODE:     CW   SIN
F:      1000000 Hz
U:45.89V #  LASER
I:0.021A #  2.41V
```

Fig. 20: initial state

```
MODE:     CW   SIN
F:      1000000 Hz
U:45.89V #  LASER
I:0.021A #  2.41V
```

Fig. 21: right button → – one place to the right

```
MODE:     CW   SIN
F:      1000000 Hz
U:45.89V #  LASER
I:0.021A #  2.41V
```

Fig. 22: left button ← – one place to the left

Setting Values Signal Generator (Signal Variables)

The possible setting values of the signal variables are summarised in Table 1. The smallest possible increment is given as the step size. The actual step size is dependent on the decimal place that was selected beforehand in the setting.

Table 1: setting values for the signal variables of the signal generator.

Signal Variable	Unit	Minimum	Maximum	Step Size
Frequency	Hz	1	20 000 000	1
Amplitude	mVss	0	2 500	1
Pulse Repetition Frequency	Hz	1	20 000	1
Burst Length	µs	1	65 000	1

3.4.2 Ultrasound Generator (ULTRASONIC UNIT)

The connections and controls of the ultrasound generator are located on the left side of the device. The multi-frequency probe from GAMPT is connected to the output marked PROBE (12). The sound power is set via two knobs. With the left knob (1), the threshold value for the transmitting current (CURRENT) is regulated. The transmitting voltage (VOLTAGE) is set with the right knob (2). The possible setting values for current and voltage are summarised in Table 2. All other parameters such as mode, signal frequency, pulse frequency, pulse repetition frequency or brush length are set using the signal generator as described above (Section 3.3.1).

Table 2: setting values transmitting voltage und current limit on the ultrasound generator

Variable	Unit	Minimum	Maximum	Step Size
Voltage	V	2	50	Continuous
Current	mA	0	1 000	Continuous

The current values of transmitting voltage and current limit can be read in lines 3 and 4 of the LCD display (3).

```
MODE:       CW   SIN
F:      1000000  Hz
U:45.89V  #  LASER
I:0.021A  #  2.41V
```

Fig. 23: voltage U and current I at the ultrasound generator

The power supply of the ultrasonic probe can be switched on and off using the switch (7) (PROBE ON/OFF). The status of the PROBE output (12) is displayed by the indicator LED (8) above the connection. If the die LED lights up, the ultrasound generator output is switched on and the ultrasonic probe is supplied with power.

Be careful! There can be voltages up to 50 V and currents up to 1000 mA at the PROBE output. Switch off the PROBE output (indicator LED is off), if the ultrasonic probe is not connected or not needed.

Attention! A high wattage is used in the ultrasonic probe, which leads to heating of the probe. Do not operate the connected ultrasonic probe without contact to the test object (liquid, sample reservoir etc.), because otherwise the probe will overheat and thus be destroyed. Switch off the power supply of the probe via the switch (7), if the probe is not required.

3.4.3 Voltage Supply for Laser Modules (LASER)

For the acousto-optical tests based upon the diffraction or refraction of light at an ultrasonic wave, GAMPT supplies laser modules, the laser diodes of which continually emit monochromatic light in the red, green or blue range of the visible spectrum.

You will find the connection and controls for the laser modules on the right side of the device front under LASER. The laser module to be used is connected to the output marked LASER (17). The supply voltage (Table 3) is set and regulated via the knob (6).

Table 3: setting values for supply voltage of laser

Variable	Unit	Minimum	Maximum	Step Size
Voltage	V	1.7	3.5	Continuous

The current voltage value at the LASER output (17) can be read in line 4 of the LCD display (3).

```
MODE:       CW    SIN
F:      1000000   Hz
U:45.89V  #  LASER
I:0.021A  #  2.41V
```

Fig. 24: display of the voltage at the LASER output

Below the knob (6) there is the on/off switch for the LASER output (17). The status of the output is displayed via the indicator LED (10) below the on/off switch (9). If the LED lights up, the LASER output is switched on and the connected laser module is supplied with power.

! *Attention! The laser modules supplied by GAMPT are equipped with laser diodes of the laser classes 2 and 3R (EN 60825-1) with a wattage from ≤ 1 mW and/or ≤ 5 mW. Before using these modules, please find out about the necessary protective measures.*

! *Be careful! Do not switch on a connected laser module if there are people in the direction of the beam. Do not look into the laser beam and do not direct the laser at other people or animals. Switch the laser module off when you do not need it.*

4 Accessories

In the following, the accessories required for the Debye-Sears test and the projection of standing ultrasonic waves are described. You can find information about other accessories in the GAMPT Catalogue Education and on our website.

4.1 Ultrasonic Probe

Especially for use with the cw generators SC500 and SC600, a multi-frequency probe was developed by GAMPT that is distinguished by very good sound-producing characteristics in a frequency range from 1 MHz to over 10 MHz. It is equipped with a robust metal housing and the sound radiation surface is moulded to be watertight. The probe can be directly connected to the output PROBE of the ultrasound generator of the SC600 via a special LEMO plug.

Fig. 25: multi-frequency probe

(1) sound radiation surface, moulded
(2) probe housing
(3) connecting plug (LEMO)
(4) connection cable

! *Be careful! Do not operate the ultrasonic transducer without contact with a liquid to avoid overheating and thus the destruction of the transducer (see also chapter 3.4.2, page 11 ed seq).*

4.2 Laser Modules

The laser modules of GAMPT are equipped with red, green or blue laser diodes of the laser classes 3R (green and red) and/or 2 (blue) for carrying out acousto-optical experiments (Debye-Sears effect, projection of standing ultrasonic waves etc.). For the carrying out of experiments, the laser

Fig. 26: laser module (red)

(1) laser beam exit window
(2) laser diode shell
(3) coaxial power connector for connection to SC600
(4) connection cable

modules are fastened in the laser support of the AOM sample reservoir (Fig. 27). Voltage is supplied to the modules via the LASER unit of the SC600. For this, the laser module is connected via its coaxial power connector (3) to the SC600.

4.3 Sample Reservoir and Probe Adjustment

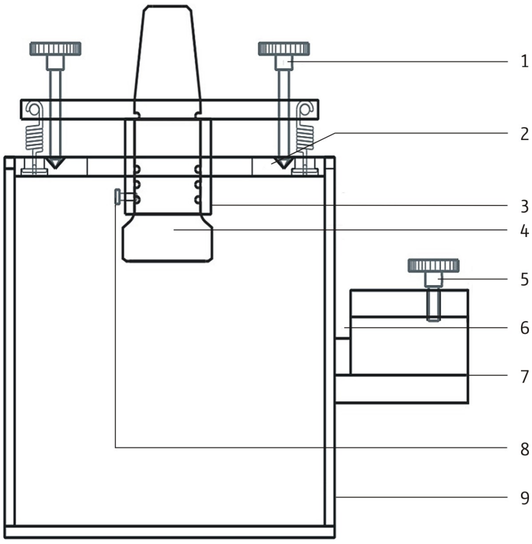

Fig. 27: cross-sectional diagram of sample reservoir, cover with probe adjustment, probe and laser support

(1) adjustment screws for probe alignment
(2) cover
(3) probe support
(4) ultrasonic probe
(5) locking screw for laser module
(6) holding well for projection lens
(7) support for laser modules
(8) locking screw for ultrasonic probe
(9) glass vessel

The production of standing ultrasonic waves takes place in a glass vessel open at the top (9).

The sample vessel is covered with a special cover (2). The cover is equipped with a support (3) for the ultrasonic probe (4). Cover and probe support are connected to each other via three tension springs and three adjustment screws (1) so that the sound axis of the ultrasonic probe being used can be aligned exactly perpendicularly to the bottom of the tank. Due to the possibility of three-point adjustment, the incident sound wave and the sound wave reflected at the vessel bottom can be made to overlap precisely, thus producing a standing ultrasonic wave.

A support (7) for a laser module is attached to one wall of the sample vessel, so that the sound wave can be shone through at a perpendicular angle. The support is also equipped with a holding well (6) for a projection lens for the experiment of projection a standing ultrasonic wave.

4.4 Projection Lens

The projection lens consists of a rectangular glass substrate (2) with gripping surface (3) and the actual optical lens (1). The lens is plano-convex and glued onto the glass substrate. For the projection experiment the projection lens is pushed into the holding well of the laser support on the sample vessel. The correct positioning of the projection lens is shown in Fig. 29.

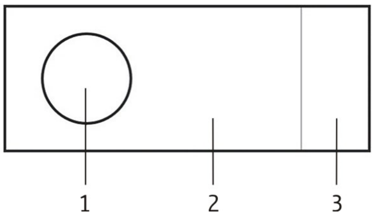

Fig. 28: top view of projection lens

(1) plano-convex lens
(2) glass substrate
(3) gripping surface

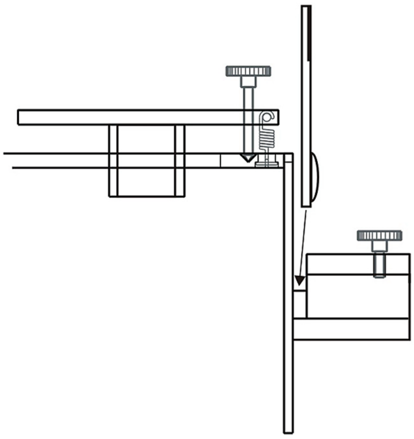

Fig. 29: positioning of the projection lens

5 Practical Experiments

The following list contains suggestions on practical experiments that can be carried out with the SC600 and appropriate accessories. Brief descriptions of and information on the required equipment, setting-up and performance can be found in our catalogue and on our website. The Debye-Sears effect and the projection of standing waves are described in more detail in the sections 5.2 and 5.3.

PHY11	Debye-Sears Effect
PHY12	Projection of Standing Waves
PHY17	Acousto-Optical Modulation at Standing Waves
PHY19	Phase and Group Velocity
PHY24	Thermoacoustic Sensor
IND04	Concentration Measurement with Resonance Cell

5.1 General Experiment Instructions

The following instructions should be adhered to in order for the experiments to work:

- If possible, degassed water is to be used because air bubbles interfere with the sound field as well as the course of the laser light.
- Air bubbles on the ultrasonic probe are to be removed.
- The largest possible distances between the sample vessel and projection wall are to be used, in order to enlarge the spacings between the diffraction orders and to minimise measurement mistakes.
- If no measurement is being carried out, the ultrasound should be switched off in order to prevent the sample liquid from heating up.
- For exact measurements, the temperature should be determined and compared.
- For all frequencies up to 9 MHz, with higher voltages and a good orientation of the transducer, at least two to three diffraction maxima should be visible.
- The projection test is substantially more sensitive to tilting of the transducer than to light diffraction. In the case of projection, the requirements for producing a standing wave must be more closely adhered to.

5.2 Debye-Sears Effect

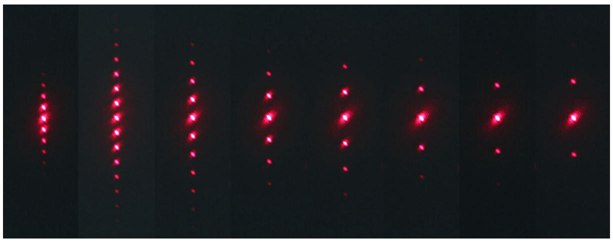

Fig. 30: diffraction patterns for red laser light at sound frequencies of 3-10 MHz in steps of 1 MHz.

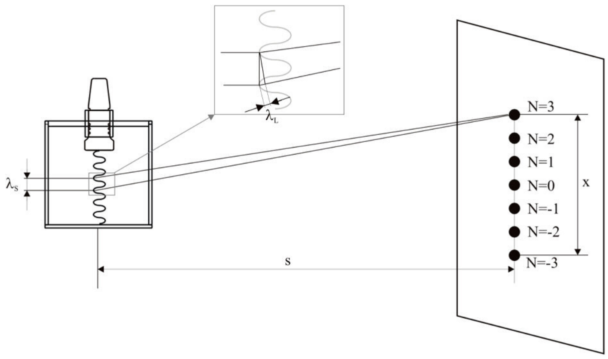

Fig. 31: diagram of the geometric conditions for the Debye-Sears test.

In 1932 Debye and Sears showed that light undergoes diffraction when passing through a liquid being excited into high-frequency vibrations. By means of this effect, ultrasound can be made more or less "visible". When this effect is used, the density maxima and minima produced in the liquid by a standing or travelling ultrasonic wave act like an optical diffraction grating. The grating constant of such a grating produced by an ultrasonic wave corresponds to the wavelength of this ultrasonic wave (Fig. 31). It can be determined by means of the diffraction patterns of the light of a laser beam of known wavelength (Fig. 30). Because the wavelength is defined by frequency and sound velocity, the Debye-Sears effect can be used in this experiment set-up to determine - with a high degree of precision - the sound velocity in the liquid thorough which the sound is passing. If the distance s between ultrasonic wave and diffraction pattern, the number N of diffraction maxima, the distance x between the –Nth and +Nth diffraction order, the sound frequency ν and the wavelength λ_L of the laser light are known, the wavelength of the sound λ_s and the sound velocity c in the liquid can be calculated according to the following formulae:

$$\lambda_S = 2N \cdot \lambda_L \frac{s}{x} \qquad (1)$$

$$c = \lambda_S \cdot \nu \qquad (2)$$

Example Measurements:

Table 4: summary of given, measured and calculated values

Liquid	Given Values		Measured Values			Calculated Values		Literature Values
	ν in MHz	λ_L in nm	N	s in m	x in cm	λ_S in µm	c in m/s	c in m/s
Water	4	650 (rot)	4	2.9	4.1	367.8	1,471	1,480 at 20 °C
Glycerine	4	650 (rot)	2	2.9	1.6	471.2	1,885	1,900 at 25 °C

5.3 Projection of Standing Waves

A standing ultrasonic wave in a liquid can be directly imaged by means of divergent monochromatic light. Due to the standing wave, sound pressure differences are produced in the liquid which repeat periodically along the sound beam axis. The localised density differences caused by this result in spatially differing and periodically repeating refraction indices along the sound beam axis. When monochromatic light is used, the projection of the standing wave therefore shows a light-dark modulation with periodically repeating brightness maxima which correspond to the density differences (Fig. 32).

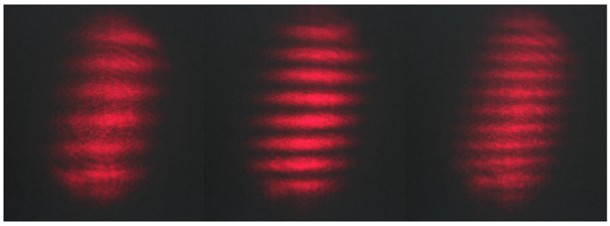

Fig. 32: projection patterns of standing ultrasonic waves in water at sound frequencies of 2.8 MHz, 3.5 MHz and 4.5 MHz, obtained with red laser light.

To determine the wavelength from the distribution pattern and the geometry, refraction corrections due to the glass walls and the measuring liquid must still be taken into account (Fig. 33) as well as the focal distance f of the lens in air. To determine the wavelength exactly, it is therefore recommended that the method of light refraction be used, as described in Section 5.2.

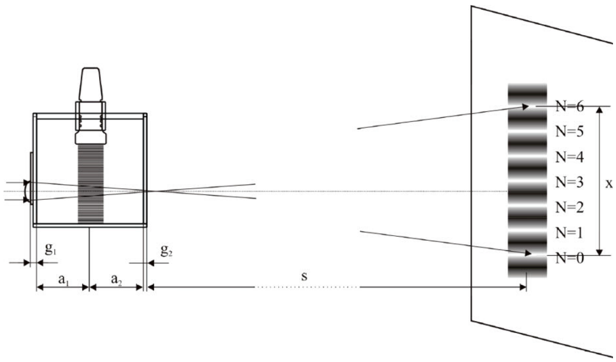

Fig. 33: diagram of the geometric conditions during the projection of a standing ultrasonic wave.

$$\lambda_S = \frac{2x}{N} \cdot \frac{f - \frac{g_1}{n_G} - \frac{a_1}{n_L}}{s - \left(f - \frac{g_1 + g_2}{n_G} - \frac{a_1 + a_2}{n_L} \right)} \tag{3}$$

The formula (3) states the exact calculation rule for the sound wavelength λ_S from the projection image. The spacing a_1 between sound field and glass wall on the lens side and the distance a_2 can be assumed, as an approximation, to be half of the respective inside dimension. The thickness of the glass g_1 corresponds to the sum of the wall thickness of the glass vessel and the thickness of the glass substrate of the projection lens. The refraction indices n_L of the measurement liquid and n_G of the glass must be determined or taken from the literature. N is the number of the brightness maxima and x the respective distance. The sound velocity in the liquid is again calculated according to the equation (2).

Comment: A good projection of the standing ultrasonic wave can usually only be achieved for 4 MHz with the glass sample vessel that is supplied. Particularly for 1 MHz there can be destructive overlapping of the incoming ultrasonic waves with the ultrasonic waves reflected at the underside of the vessel bottom. For 8 MHz, the amplitude of the radiated ultrasonic wave is too low and in addition the absorption is considerably higher (the absorption coefficient is proportional to the frequency squared), so that no distinctly formed wave is produced.

Example Measurement for Water:

Given values:	focal distance of the lens in air:	f	= 10 cm
	refraction index of glass:	n_G	= 1.45
	refraction index of water:	n_L	= 1.33
	sound frequency:	ν	= 4 MHz

Table 5: summary of the measurement values and results

Measured Values						Calculated Values		Literature
$a_{1,2}$ in cm	g_1 in cm	g_2 in cm	s in m	x in cm	N	λ_S in µm	c in m/s	c in m/s
4.8	0.5	0.4	3.03	8.9	9	397	1590	1,480 at 20 °C

6 Technical Details

6.1 Sound Wave Controller SC600 (GAMPT 20100)

General

Dimensions:	255 mm × 170 mm × 265 mm (W × H × D)
Mains Voltage:	100-240 V, 50/60 Hz
Power Consumption:	max. 100 VA
Fuse:	T 1A (EN 60127-2-3) G fuse link, time-lag, 1 ampere, 5 × 20 mm
Modules:	ultrasound generator (ULTRASONIC UNIT) signal generator (FREQUENCY GENERATOR) power supply for laser modules (LASER)

Signal Generator (FREQUENCY GENERATOR)

Signal Modes:	cw, burst or pulse
Signal Shapes:	sine, triangle or rectangle
Frequency:	≤ 20 MHz, adjustable in 1Hz steps
Pulse Repetition Frequency:	1 Hz – 20 kHz, adjustable in 1 Hz steps
Burst Length:	1-65,000 µs, adjustable in 1 µs steps, (pulse width in pulse mode = ½ burst length)
Output TRIGGER:	TTL pulse in burst or pulse mode
Output TTL:	0-5 Vpp, square wave signal
Output SIGNAL:	signal corresponding to the settings of the signal generator at ≤ 2.5 Vpp
Display:	4-line LCD for the display and setting of the parameter values of the signal generator and of the ultrasound generator and of the output voltage of the LASER unit.

Ultrasound generator (ULTRASONIC UNIT)

Signal Output PROBE:	LEMO jack, can be switched off
Status Display:	LED indicator light
Output Voltage:	2-50 Vpp, continually adjustable
Current Limit:	0-1000 mA, continually adjustable
	mode, frequency, pulse repetition frequency and burst length correspond to the values set at the signal generator

LASER Unit

Output LASER:	coaxial power connector jack for plug with 5.5 mm outside diameter and 2.5 mm internal diameter; can be switched off
Status Display:	LED indicator light
Voltage:	1.7-3.5 V DC, continually adjustable

6.2 Accessories

Multifrequency Probe (GAMPT 20138)

Frequency:	1 MHz up to approx. 13 MHz
Dimensions:	65 mm × 27 mm (L × D without cable)
Transducer Element:	disc with 16 mm diameter
Cable:	length approx. 1.5 m; LEMO jack for connection to PROBE output of the SC600

Sample Reservoir (GAMPT 20225)

Dimensions:	123 mm × 115 mm × 144 mm (W × H × D)
Material:	glass, wall thickness 4 mm
Laser Support:	17 mm holding opening for laser modules, holding well for projection lens

Probe Adjustment (GAMPT 20224)

Dimensions:	123 mm × 52 mm × 105 mm (W × H × D)
Material:	POM
Probe Support:	suitable for GAMPT ultrasonic probes, three-point adjustment apparatus

Laser Modules (GAMPT 20210-20212)

Beam Spot:	< 6 mm at distance of 3 m
Wavelengths:	650 nm (red), 532 nm (green), 405 mm (blue)
Power:	red/green: ≤ 5 mW, laser class 3R (EN 60825-1) blue: ≤ 1 mW, laser class 2 (EN 60825-1)
Supply Voltage:	max. 3.5 V DC
Power Consumption:	red: max. 40 mA green: max. 375 mA blue: max. 90 mA
Module Dimensions:	length approx. 90 mm, diameter 17 mm
Connection Cable:	cable length approx. 1 m, coaxial power connector with 5.5 mm outside diameter and 2.5 mm inside diameter

Projection Lens (GAMPT 20230)

Glass Substrate:	25 mm × 75 mm, roughened gripping surface
Lens:	plano-convex diameter: 16 mm (until 2013), 12.5 mm (since 2014) focal distance: 100 mm (until 2013), 173 mm (since 2014)

7 Revisions of the user manual

Revision	Revision date	Description
1.00	May 7, 2013	First edition
1.01	Dez 10, 2015	Updated chapter „Accessories“