PHYWE
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Basic Set Ultrasonic Echography II

13924-99

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13924-99 Basic set Ultrasonic Echography II

Operating instructions

CE *The device complies with the applicable EU directives.*

CONTENT

1 SAFETY INSTRUCTIONS

- The ultrasonic echoscope is a laboratory device for training and teaching and ***not a medical device!*** Do not apply the ultrasonic probes to persons or animals.
- Check the ultrasonic probes before each use. Replace damaged probes. Do not use probes that are cracked or broken.
- Only connect ultrasonic probes that are explicitly intended for this device. Caution! Peak voltages of up to 300V are present at the connection sockets!
- Disconnect the ultrasonic probes from the device by pulling on the plug. Never pull on the cable. This also applies to all other cables connected to the device.
- Read these operating instructions carefully and completely before operating the device. This will help you avoid damage to the device.
- Only use the device for its intended purpose.
- The device may only be used in dry rooms where there is no risk of explosion.
- Before connecting the mains voltage, make sure that the protective earth conductor of the power supply unit is connected to the earth conductor of the mains voltage supply in accordance with the regulations. The mains plug may only be plugged into a mains socket outlet with an earth conductor. Do not cancel out this protective effect by using an extension cord without an earth conductor.
- Make sure that the mains voltage specified on the rating plate of the power supply unit matches the mains voltage

of your power supply.

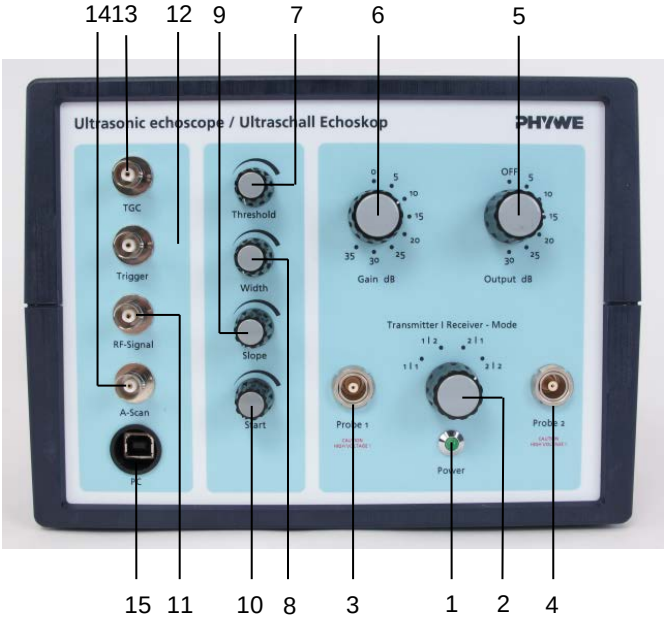
- Set up the experiment so that there is free access to the power supply unit or mains plug of the device at all times. The ventilation slots of the device must not be covered.
- The experimental setup may only be used as intended.
- Do not open the electric device.
- Do not connect the device to other equipment for which it was not designed.
- Caution: Disconnect the device from the power supply before disconnecting, replacing or removing cable connections!

2 PURPOSE AND CHARACTERISTICS

Ultrasonic echography (also sonography) is one of the most important examination methods in medicine and non-destructive materials testing. Therefore there is an almost unmanageable variety of ultrasonic devices for different areas of application. They are all based on the same basic principle, namely the emission of a mechanical waves whose reflection or interaction is recorded in the form of an echogram.

The echoscope is a highly sensitive ultrasonic measuring instrument that can be connected to a PC or an oscilloscope. With the software included in the scope of delivery, comprehensive signal analyses can be carried out (HF signals, amplitude signals, B-mode, TM-mode, spectral analyses).

3 FUNCTIONAL AND OPERATING ELEMENTS



Front view ultrasound echoscope

1. **ON/OFF LED**
2. Transmitter/Receiver switch
3. Probe connection: Sample 1
4. Probe connection: Sample 2
5. Transmitter power
6. Receiver amplifier
7. Threshold
8. Width
9. Slope
10. Start
11. RF signal
12. Trigger signal
13. TGC signal
14. A-Scan signal
15. USB port

Switch position	Transmitter	Receiver	Operating mode
1 | 1	Probe 1	Probe 1	Reflection
1 | 2	Probe 1	Probe 2	Transmission
2 | 1	Probe 2	Probe 1	Transmission
2 | 2	Probe 2	Probe 2	Reflection

Possible switch positions

Ultrasonic probes of the same type and frequency should always be used for transmission measurements.

4 NOTES ON OPERATION

The echoscope is an ultrasonic A-scan device for pulse-echo operation with one probe (reflection mode) or for two identical probes (transmission mode). The device is a stand-alone device with a USB interface.

The ultrasonic probes are connected via robust snap-in connectors. The probe frequency is automatically detected by the device. With the help of the adjustable transmitting and receiving power, the ultrasound signals can be adapted to almost any examination object. The intensity losses of the ultrasound signals from deeper examination areas can be compensated by the so-called Time Gain Control (TGC) - a depth-selective amplification. The threshold value, the slope as well as the start and end point of the TGC can be set as desired.

All parameters are set via controls on the front panel of the echoscope. The results are displayed either via an oscilloscope or on a computer. The software for Windows is supplied together with the echoscope.

With an oscilloscope only the A-scan can be displayed. The following signals can be taken at the BNC outputs: Trigger, TGC, RF and Amplitude (RF envelope).

When using a computer, the data can be processed with the ***measure Ultra Echo*** software. The following functions are available:

- A-scan [amplitude scan] (transmission, reflection)
- Conversion of TOF [Time of Flight] to depth measurement using the sound velocity parameter
- Zoom functions, data export, print function
- Frequency and spectral analysis (FFT) of a selected signal range, frequency filter
- TM-Mode [Time-Motion-Mode]
- Manually-guided B-Mode [Brightness Mode]
- Option: Computed tomography and scanner-guided B-mode

An extensive range of ultrasound probes (1, 2 and 4 MHz) and accessories is available for setting up lab experiments. The range of topics extends from the physical principles of ultrasound to industrial and medical applications. In combination with the scanner system, a precise imaging system can be set up.

5 HANDLING

5.1 Switching on the power supply

Make sure that the mains voltage indicated on the type plate corresponds to the mains voltage of your power supply.

Connect the echoscope and the power supply and switch it on. The power switch is located on the back of the instrument.

5.2 Transmission / Reflection Mode

Choose between transmission and reflection mode.

5.3 Transmitter and receiver settings

The transmit power can be adjusted in the range of 0 to 30 dB in steps of 10 dB each. The receive gain range is between 0 and 35 dB and can be changed in steps of 5 dB.

The transmitter and receiver settings depend on the sound attenuation in the material under investigation. In general, a low transmission power should be selected. Then increase the receiver gain until the highest echo peak amplitude is approx. 80% of the scale maximum. If you cannot achieve a sufficiently high peak amplitude, reduce the receiver gain and then increase the transmission power step by step. Start again by increasing the gain.

5.4 TGC Settings (Time Gain Control)

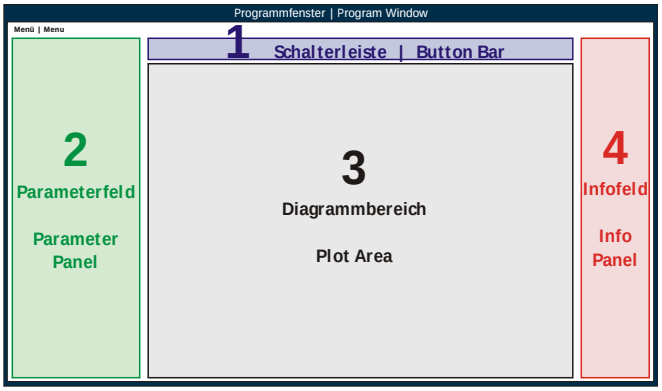
The TGC increases the signal amplification as a function of the time of flight (TOF) to compensate for the ultrasonic attenuation caused by the material being transmitted. In a perfectly calibrated system, material defects of the same size are always displayed with the same peak amplitude, regardless of their depth in the sample.

In practice, TGC is also used to increase the amplitude of small peaks that lie between larger peaks. To limit the TOF interval, operate the Start switch and the Width control. For gain adjustment, operate the slope control and the threshold control.

5.5 Software

5.5.1 Program interface

The program interface of the echoscope software is generally divided into a maximum of four areas, the contents of which may vary according to the selected program modes.



Program interface

1 - Button bar. This is where the selection switches for selecting the program modes (*A -mode, B mode, M mode, CT mode and Imaging*) are located. Depending on the selected program mode, further function switches can be added. The button bar is not available in the *Image* program module.

2 - Parameter panel. In this field, which can be opened and closed, all relevant adjustable program and measuring parameters are grouped together. The assignment of the parameter groups that can be selected via registers varies depending on the program mode. For the sake of clarity, individual parameter groups can be expanded and collapsed.

3 - Plot area. Depending on the program mode, one to nine diagrams can be displayed in the central area of the program interface for the evaluation and visualization of the measurement data supplied by the echoscope. Except in *imaging mode,* each diagram can be configured and operated separately via toolbars.

4 - Info panel. This field provides information on the front panel settings of the echoscope (operating mode, transmission power, gain, connected probes) as well as information on the program and device status.

5.5.2 Function switch

Program functions and actions such as starting the measuring mode, switching to another program mode, updating the information in the info field, etc. are selected using switches.

Depending on the function, the switches can show different behavior and layout. Possible switch states are described below.

State	Layout	Description
1	Freeze	Switch is deactivated, function/action cannot be executed
2	Freeze	Switch is activated, function/action can be selected [1)]
3	Freeze	Switch is activated, function/action is executed [1)]

Some functions automatically reset the switch to state 2 after execution. Other functions or actions must be terminated directly by clicking again.

[1)] *In certain situations, switches cannot be accessed even though they are in state 2 or 3. For example, in B, M, or CT mode, the* **Start A-scan** *and* **Freeze** *switches or the program mode change switches cannot be accessed during a B-scan, M-scan, or CT measurement.*

5.5.3 Diagrams

The following descriptions refer to diagrams in the A-, B-as well as M- and CT-modes of the program.

5.5.4 Diagram toolbars

The configuration and operation of the diagrams is done via toolbars.

When moving the mouse pointer over a diagram, the main toolbar is displayed in its upper right area. This comprises two groups of symbols. The upper group contains functions for copying, printing and saving or for setting the graphical representation of the measurement data itself (line type, color, points, etc.). The lower group provides zoom functions.

If the mouse pointer is moved over the x- or y-axis, their toolbars open. The axis toolbars only contain zoom functions concerning the respective axis.

Main toolbar:

Toolbar of x-axis:

Toolbar of y-axis:

1 Hold/resume
2 Mouse shift
3 Copy
4 Print
5 Save
6 Setup
7 Zoom in
8 Zoom out
9 Zoom auto
10 BackwardZoom history
11 Forward Zoom history
12 Enlarging of a zoom window in the respective directions

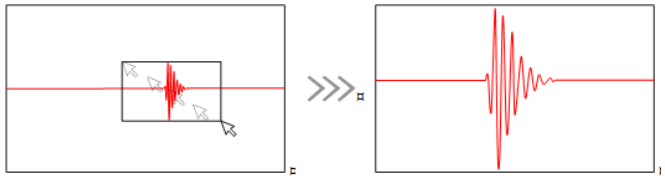
5.5.5 Zooming and moving diagram contents with the mouse

Using the mouse, the content of a diagram can be zoomed (*Mouse Zoom*) and zoomed content can be moved in the diagram window (*Mouse Shift*). The mouse assignment is selected via Tool 2 in the main toolbar (see overview above). In *Mouse Zoom mode the* tool icon shows a hand and in *Mouse Shift* mode it shows a magnifying glass.

Mouse zoom

For zooming, the diagram window is clicked with the left mouse button and a zoom window is opened by keeping the mouse button pressed. The type of zoom window (arbitrary, parallel to the x-axis or parallel to the y-axis) is defined using Tool 12 in the respective toolbar.

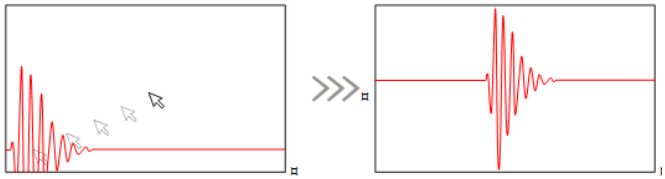
in the main toolbar.



Expanding any zoom window with the mouse

Mouse Shift

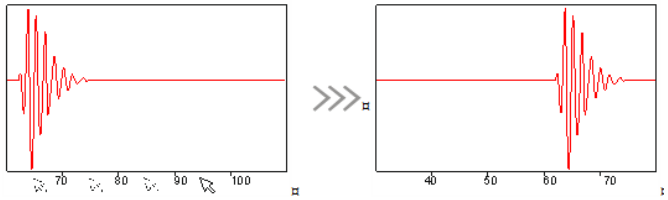
Zoomed diagram content can be moved freely in the diagram window. To do this, click the left mouse button in the diagram and move the mouse pointer in the desired direction while holding down the mouse button.



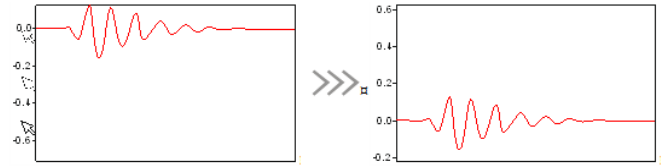
Free moving of a zoomed diagram content

Axis-parallel shifting

Zoomed diagram content can also be moved parallel to the axes in the diagram window regardless of the set mouse mode. To do this, click on the x- or y-axis with the left mouse button and drag the mouse pointer in the desired direction while holding down the mouse button.



Move parallel to x-axis



Move parallel to y-axis

5.5.6 Measuring cursor

In general, two measurement cursors (*cursor 1* and *cursor 2*) are preset in each diagram. With their help, e.g. transit times/depths or amplitudes can be determined absolutely and relatively in the diagrams. The display of the measurement cursors can be switched on and off via a checkbox in the lower left corner of the diagram.

Selected cross cursor in A-scan diagram

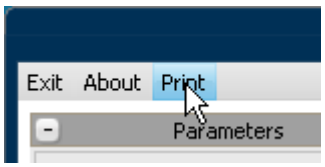
The measurement cursors are designed as cross cursors, each consisting of two measurement lines - one parallel to the x-axis and one parallel to the y-axis. For each of the two measuring cursors, the associated x-y coordinates of their position (intersection points of the measuring lines with the diagram axes) are displayed below the diagram (*cursor 1* and cursor 2). In addition, the difference values between the x and y coordinates of the two measurement cursors are displayed (*delta cursors*).

Further cursors can be defined via the setup function in the main toolbar. However, only for the preset measuring cursors 1 and 2 the associated coordinates and difference values are displayed below the diagram.

Positioning the measuring cursors

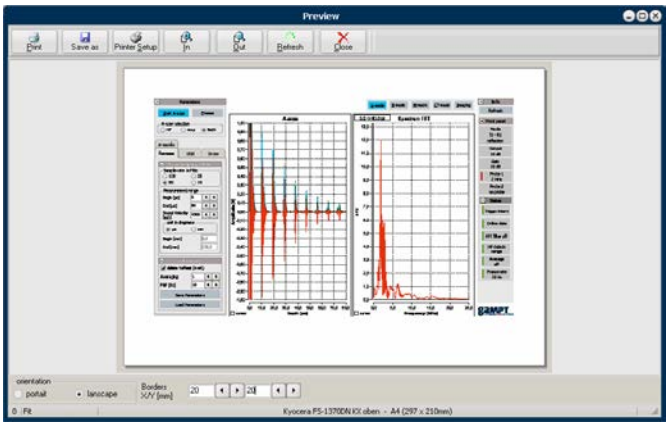
Double-clicking with the left mouse button positions measurement cursor 1 at the position of the mouse pointer in the diagram and double-clicking with the right mouse button analogously positions measurement cursor 2. In addition, the measurement lines of a cursor can be selected and moved in the diagram individually or together using the mouse. To do this, the mouse pointer is positioned over the respective measurement line, which is highlighted optically. The selected measurement line can now be moved in the diagram by keeping the left mouse button pressed.

5.5.7 Print command



Print command

The **Print** command in the program menu is suitable for quickly recording the program status (measurement curves, parameter settings, status information). The command creates a screen shot of the program interface and displays it in a preview window. From here, the screenshot can be printed directly or saved as a pixel graphic (jpg, bmp).



Preview window of the print function

Similarly, the print function in the main chart toolbar can be used to create a screenshot of a single chart.

5.6 Program start

Initialization

During the program start, the program runs through an initialization phase.

First the connection status to the echoscope is checked. Then measurement parameters and program settings are loaded, which were saved when the program was exited previously. Finally, the device and program status is determined and displayed in the info field.

After initialization is completed, the program is in stand-by mode.

measure Ultra Echo II after program start

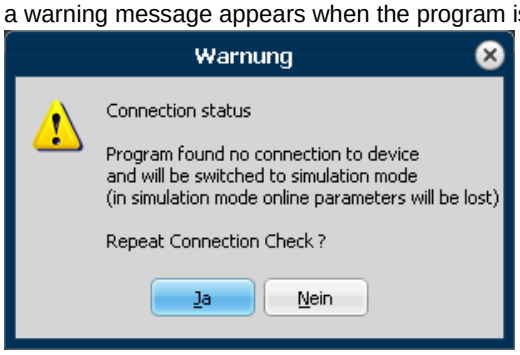
The program always starts in **A-mode***. All further actions or evaluations are selected and started from this mode.*

When the program is in stand-by mode, the info field is not updated (e.g. when the probe is changed, the transmission level or the gain is changed, etc.), since there is no data transfer between the program and the echoscope. However, the **refresh switch** *can be used to force an update of the info field without having to put the program into measuring mode.*

5.6.1 Simulation mode

The software has a simulation mode that is activated when no echoscope is connected or the connected device is offline

(USB connection failure, device switched off, etc.). In this case, a warning message appears when the program is started.



Warning message in the event of a connection error or disconnection

Now the following options exist:

A) The connection of the echoscope (USB and power cable, device switched on) is checked and then the connection setup is attempted again.

B) The program is started directly in simulation mode.

If the echoscope is correctly connected and switched on, but the connection is still not established successfully, the USB settings of the program must be checked. To do this, start the program in simulation mode and select the **USB** tab in the parameter field.

The program behavior described above also occurs if the connection from the echoscope to the computer (program) is lost during program operation.

Simulation data

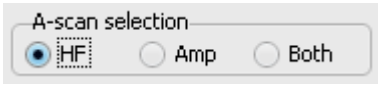
The software scope includes simulation data with which the ultrasonic measurements are simulated. Depending on the program mode, some of the display and evaluation functions can be applied directly to the simulation data.

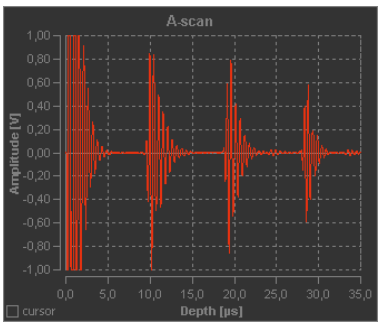
*By executing simulated measurements with the simulation data, stored measurement parameters of a previous online measurement are overwritten. Use the save and load function for parameters under **Additionals** in the **Params** tab.*

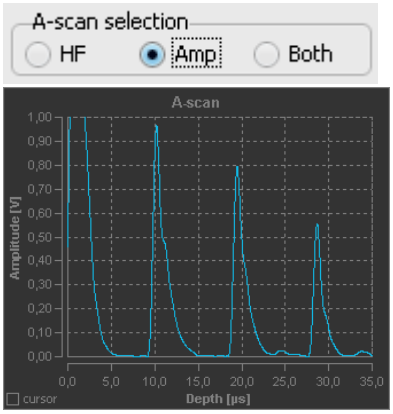
Display of the measurement signals in the A-scan diagram

The graphical representation of ultrasonic signals in the A-scan diagram can be done in three different ways:

- **HF**: Only the ultrasonic signal (the digitized measurement signal) is displayed.
- **Amp**: Only the amplitude signal (the envelope of the ultrasonic signal calculated by the program) is displayed.
  ultrasonic signal) is displayed.
- **Both**: Both ultrasound and amplitude signals are displayed.







5.6.2 Measurement and program parameters

In the **Parameters** field on the left-hand side of the program interface, you will find almost all the functions, parameters and setting options that are required for carrying out, recording and evaluating ultrasound measurements with the 1-, 2- or 4-MHz ultrasound probes.

Tabs for measurement and program parameters

The parameters and functions are organized thematically in the following tabs:

Tab	Description
Params	Basic and generally valid in all program modes measurement and additional parameters for the A-scans.
USB	Functions for checking and resetting the USB connections to the echoscope and the CT controller. Switch between online and simulation modes of the program.
Draw	Basic color settings for all charts. Saving options of the chart settings.
A-mode	Parameters, settings and functions for performing and evaluating ultrasonic measurements using the A-scan method.
B-mode	Parameters and settings for generating and evaluating hand-held B-scans with the single-element transducers.
M-mode	Parameters and settings for generating and evaluating ultrasound images using the time-motion method.
CT-mode	Parameters and settings for generating and displaying ultrasound computer tomograms.
Scanner	Scanner functions.

5.6.3 Tab Params

The **Params** tab contains measurement and software parameters that apply to all four program modes. The individual parameters are combined in two groups: **A-scan parameters** and **additionals**.

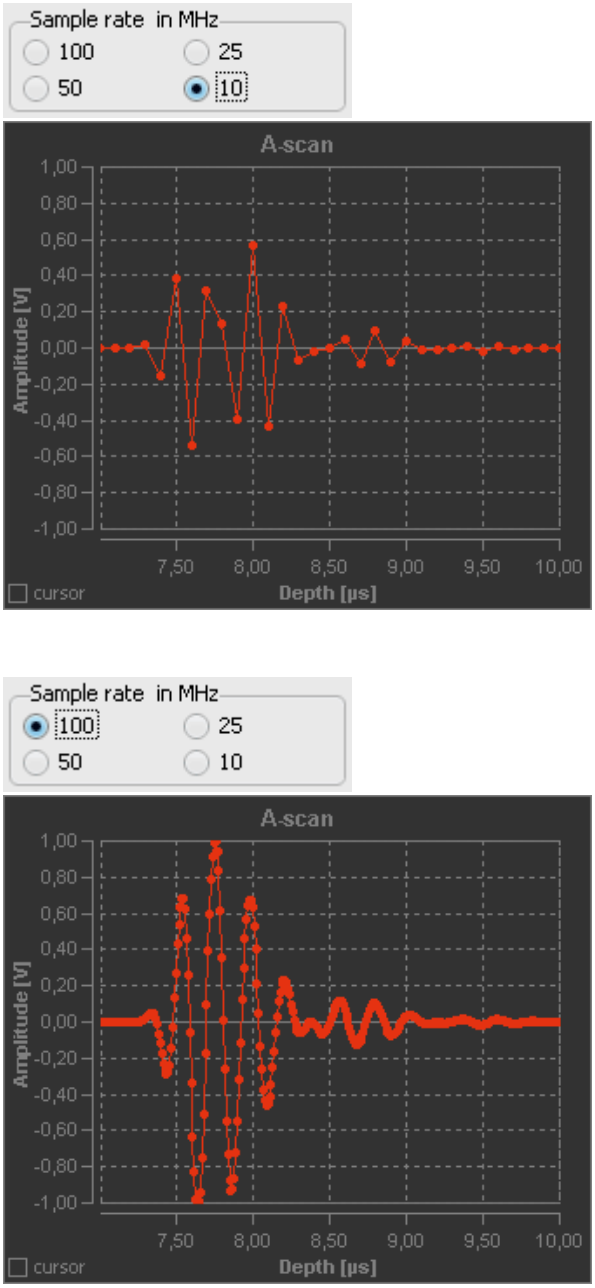
A-scan parameters: Sample rate

The analog measurement signals of the ultrasound scans are digitized in the echoscope for data transmission via the USB interface. Four sampling rates -- 10, 25, 50 or 100 MHz -- can be selected for digitization.

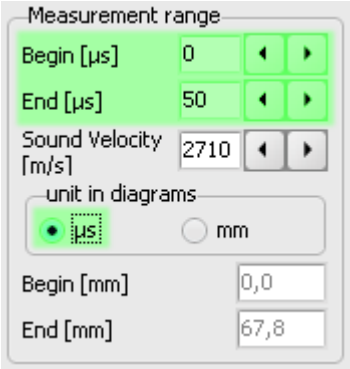
A-scan parameters: Measurement range: Begin / End [µs]

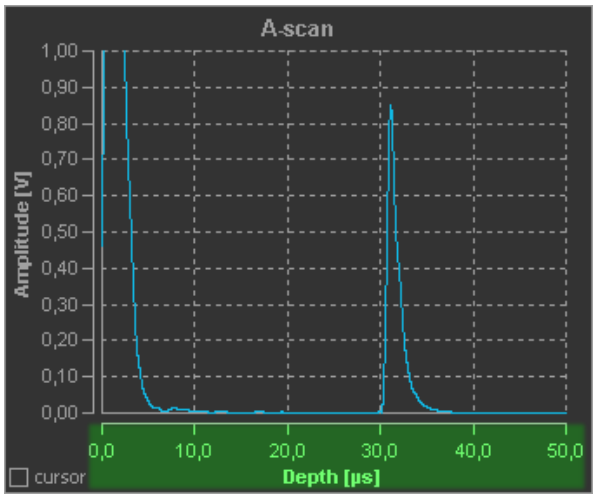
The measuring range designates the transit time range of an ultrasonic signal or the depth range of the ultrasonic measurement that is detected and recorded by the echoscope. The range is defined by a start value in µs (*Begin*) and an end value in µs (*End).*

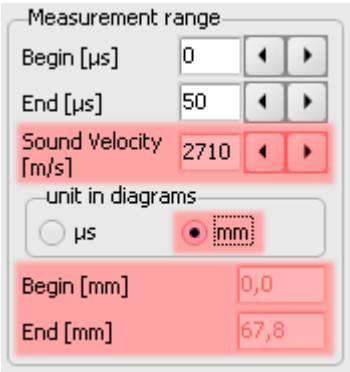
The maximum detectable measuring range (*End* minus *Begin*) depends on the selected sampling rate.

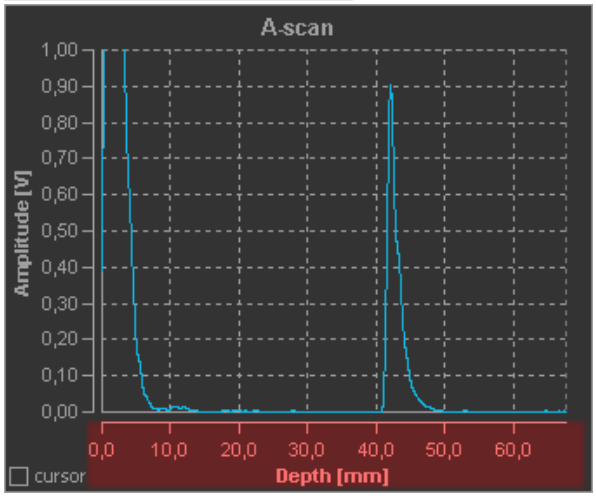


Ultrasonic echo pulse digitized with sampling rates of 10 and 100 MHz (4 MHz probe)









Amplitude scan above as time-of-flight measurement and below as depth measurement

5.6.4 Tab Draw

Color Schemes

The Draw tab can be used to make basic color settings for the diagrams, which apply to all diagrams and are automatically saved when the program is closed. It is possible to switch between two color schemes:

- **Dark**: Background dark, foreground (axes and labels) light. This setting is particularly suitable for working on the screen.

- **Bright**: Background bright, foreground (axes and labels) dark. This color scheme is advantageous when diagrams or screen copies are to be printed

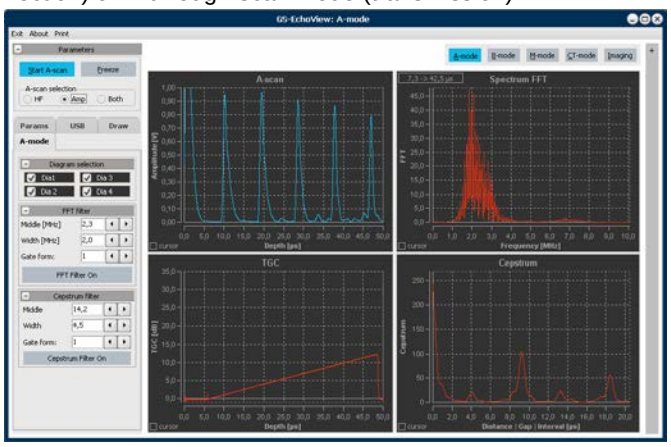
5.6.5 Software settings

The ***measure Ultra Echo* II** software is used to record, display and evaluate the data supplied by the echoscope. In addition to the display of diagrams, the software offers a number of different evaluation and filter functions. If no device is connected, the offline simulation mode is automatically activated.

After the program start, the system measures in A-mode. Starting from this screen, all further actions and evaluation functions are activated. In addition to the A-mode, there are other measuring modes: manual B-mode, M-mode, an optional mechanical CT-scanner mode (CT) and a scanner-guided B-mode (the CT-scanner accessory is required for this).

5.7 A- Mode

As described above, the software always starts in **A-mode**. In this program mode, ultrasonic measurements can be carried out according to the A-scan method in pulse-echo mode (reflection) or in through-scan mode (transmission).



Program view in A-mode operation

The parameters for the measurements are set in the **Params** tab and using the controls on the front of the echoscope.

Start the measurement operation. The echoscope will now continuously perform ultrasonic scans and provide the measurement data for transfer to the PC. The program retrieves the provided measurement data from the echoscope and displays them graphically in the diagrams. The *frame rate* displayed in the info field indicates the refresh rate of the diagrams, i.e. the number of data series that can actually be displayed by the program.

The four diagrams **A-scan** (Dia1), **TGC** (Dia2), **Spectrum FFT** (Dia3) and **Cepstrum (**Dia4) are available in the **A-mode** of the program for the display and evaluation of the measurement data. The diagrams can be switched on and off individually via the **A-mode** tab.

Since all other ultrasound imaging methods in the program are based on the amplitude scans, the A-scan and TGC diagrams are also available in **B-**, **M-** and **CT-mode.**

The main screen is the A-Scan screen (see below). The toolbar of the A-Scan screen displays the transducer frequency and the current measurement method (reflection or transmission).

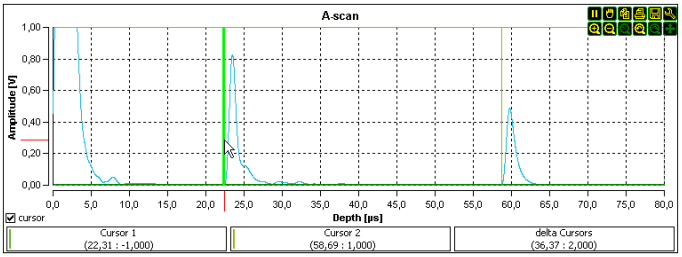
Time of flight and amplitude measurements

With the help of the measurement cursors, sound travel times and echo amplitudes can be measured in the A-scan diagram.

Runtime measurement

Time-of-flight measurements are made, for example, to determine the depth of disturbances in a body (e.g. the ultrasonic test block) or to determine the speed of sound in a particular material (e.g. for the ultrasonic cylinder set). If the speed of sound is known, the scaling of the x-axis can be switched from transit time to depth.

To measure the transit time of an echo signal or the depth of a disturbance, place the vertical measurement line from one of the measurement cursors at the beginning of the rising edge of the echo pulse to be measured.



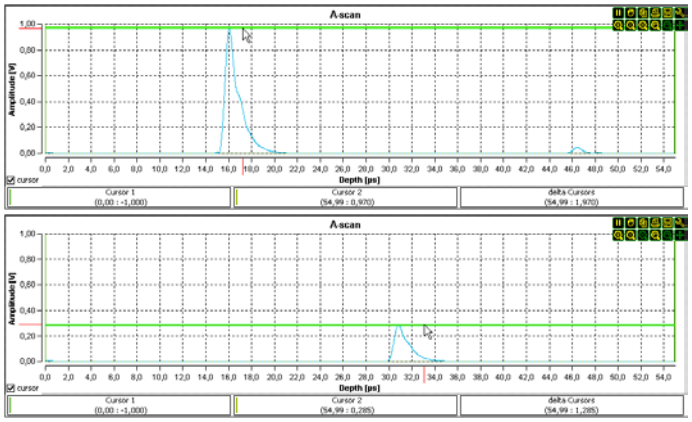
Positioning of the measurement cursor for time-of-flight measurement in the Amp display of an ultrasonic scan

Measurements of the absolute transit time can be subject to errors, e.g. due to the transit time measured in the matching layer of the transducers. These errors can be avoided by relative time-of-flight measurements using both measurement cursors (use of multiple reflections, use of a forward path, difference determination by measuring the time-of-flight for different sound paths).

Amplitude measurement

Amplitude measurements are performed, for example, to determine the sound attenuation in a material. To measure the amplitude of an echo signal, the horizontal measurement line from one of the measurement cursors is used.

The amplitude value of a single echo signal has no significance on its own. Therefore, comparative measurements are generally performed. The amplitude scans in the figure show, for example, amplitude measurements on acrylic cylinders of different lengths. In this example, the decrease in the amplitude of the pulse signal with increasing transit time is a measure of the sound attenuation in acrylic.



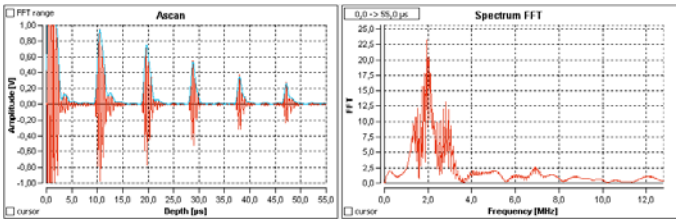
Transmission measurements on acrylic cylinders of different lengths (Top: 40 mm, bottom: 80 mm)

In order to be able to compare the measured amplitude values with each other, the measurements must be performed under the same conditions (transmitting power, amplification, test setup, ...). For example, values from TGC-amplified ranges cannot be compared with other amplitude values.

Frequency spectrum and frequency filter in A-mode

a) Frequency spectrum

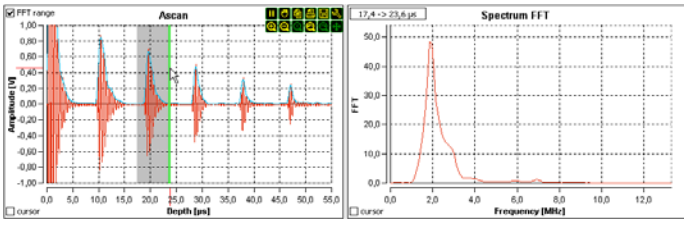
In the A-mode of the program, a frequency analysis of the retrieved ultrasonic scans can be performed. The frequency spectrum of the ultrasonic scans calculated using a Fast Fourier Transform (FFT) is displayed in the Spectrum FFT diagram.



A-scan (left) with associated frequency spectrum (right)

The frequency range of the calculated FFT spectrum depends on the sampling rate of the measurement. The resolution of the spectrum is limited by the number of measurement points used for the calculation.

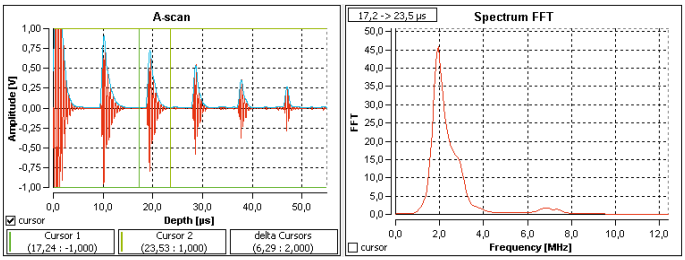
When the program is started for the first time, the frequency spectrum is calculated over all measuring points of an A-scan. In order to limit the data range, the selection field "FFT range" must be set. The data range for the calculation of the spectrum is highlighted in grey. By moving this range with the mouse, the data range can be adjusted as desired.



Frequency spectrum over the part of the measurement signal between 17.4 µs to 23.6 µs

The signal range over which the frequency spectrum is calculated is always displayed in the upper left part of the spectrum diagram. This makes it possible to recognize whether the calculated frequency spectrum refers to a complete data set or only a part of the measurement data even if the data range for the FFT is not highlighted in the A-scan diagram.

In older program versions the vertical measuring lines are used to limit the data range for the calculation of the frequency spectrum. Here it is to be noted that when measuring run times/depths by means of these measuring lines then also the data range for the calculation of the FFT spectrum is changed.



Restriction of the data range for FFT calculation using vertical measurement lines in older program versions

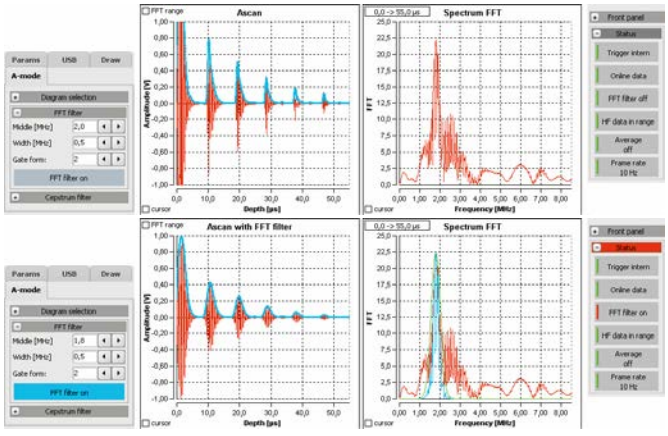
b) Frequency filter

A frequency filter can be placed over the frequency spectrum. This allows certain (interfering) signal components to be eliminated from the measurement signal.

The frequency filter can be switched on and off via the switch **FFT Filter** on in the register **A-mode.** Depending on the filter parameters set there, a bandpass, highpass, lowpass or bandstop can be generated. *Middle* determines the position of the filter over the spectrum and *Width* the filter width. The *Gate form* parameter determines the steepness of the filter edges. A value of 0 corresponds to a rectangle and negative values result in a bandstop.

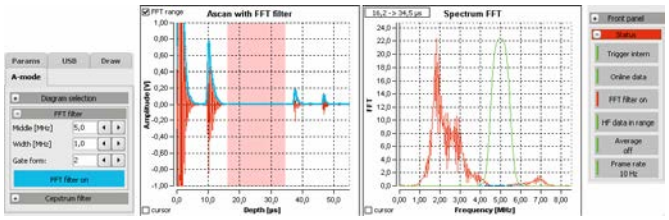
When the frequency filter is switched on, the filter curve and the filtered spectrum are displayed in the spectrum diagram in addition to the spectrum.

The filtered frequency spectrum is back-calculated with an inverse FFT. Filtered measurement data is now displayed in the A-scan diagram.



Measurement with 2 MHz probe above without and below with bandpass filter

If the data range of the ultrasonic signal over which the frequency spectrum is calculated has been restricted, then the frequency filter also only acts on the data of this signal range.



Bandpass filter applied to a frequency spectrum that was calculated for only a part of the measurement signal

The activated frequency filter is not only active in A-mode but also in B-, M- and CT-mode of- the program. It is applied to the measurement data transmitted by the echoscope before all other evaluations, so that all further evaluation steps of the imaging procedures (A, B, M, CT) work with filtered measurement data. With unfavorable filter settings, it can therefore happen that the generated ultrasound images show artifacts to a greater or lesser extent or simply cannot be evaluated.

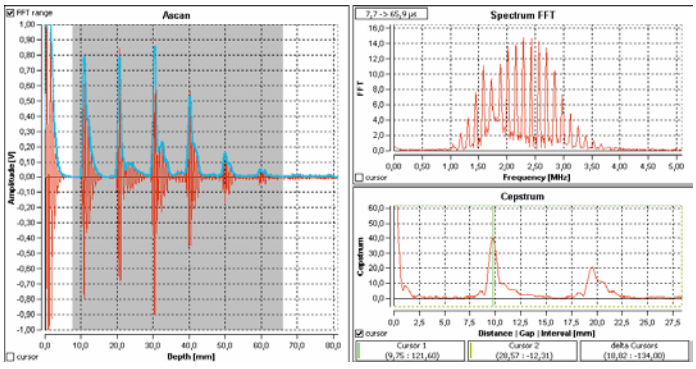
The frequency filter can only be switched on and off in A-mode. By displaying the filter status in the info field, it is possible to check whether the frequency filter is active at any time in the other program modes. Status info: | FFT filter on.

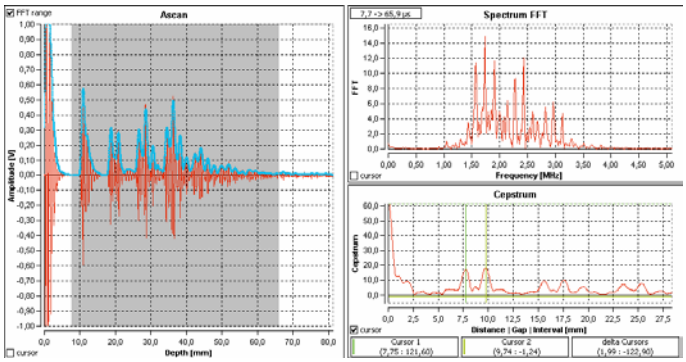
Cepstrum

The **cepstrum diagram** is another possibility of spectral evaluation in the **A-mode of** the program. The cepstrum is generally determined by applying a Fast Fourier Transform again, this time to the frequency spectrum described above. The term ***cepstrum*** is derived from the term spectrum, where the first four letters are arranged in reverse order.

Cepstrum analysis provides information on whether certain intervals in the frequency spectrum are repeated (these become visible as peaks in the cepstrum). Such information can be very helpful, for example, in the evaluation of multiple echoes on thin layers.

The dimension of the independent variables of the cepstrum is identical to the dimension of the independent variables of the output function from which the spectrum was derived. Depending on the unit set for the A-scan diagram (µs or mm), the cepstrum can thus be used to read runtimes in a thin layer, for example, or directly the thickness of such a layer.





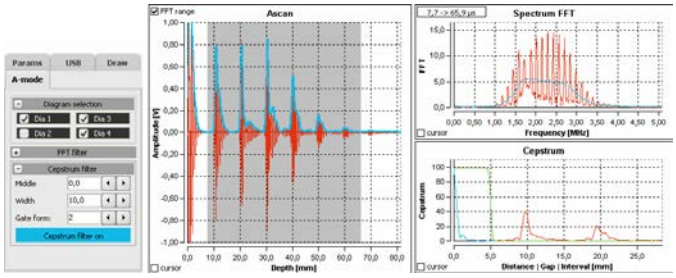
Amplitude scan, frequency spectrum and cepstrum using the example of thin acrylic plates (top: one plate with 9.7 mm thickness; bottom: two plates with 7.8 mm and 9.7 mm thickness)

Cepstrum filter

A cepstrum filter can be placed over the cepstrum. This calculates a reverse transformation of the cepstrum data, which is displayed as a light blue line in the **Spectrum FFT** diagram in the program's default setting (e.g. for smoothing the frequency spectrum).

The cepstrum filter can be switched on and off via the switch **Cepstrum filter on** in the register **A-mode.** The filter parameters *Middle*, *Width* and *Gate form* are set in the same way as for the frequency filter described above.

When the filter is switched on, the filter curve and the filtered cepstrum are also displayed in the cepstrum diagram.

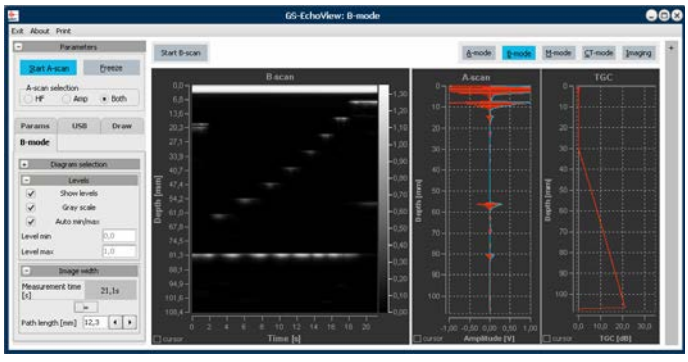


Cepstrum filter

In contrast to the frequency filter, the cepstrum filter has no influence on the measurement data of the ultrasonic scans.

5.8 B-Mode

The **B-mode of** the program allows hand-held B(rightness) images to be acquired with the single-element transducers. The figure below shows such a B-scan on the acrylic test block.



Three diagrams are available for the evaluation: **B-scan** (slide 1), **A-scan** (slide 2) and **TGC** (slide 3). The A-scan and TGC diagrams are aligned with the B-scan diagram. Thus, the formation of a B-scan can be directly traced by stringing together gray-value or color-value coded amplitude scans.

The actual start of the recording of a **B-scan** (B-scan measurement) takes place with the aid of the **Start B-scan** switch. The ultrasonic transducer is then pulled evenly by hand along the desired cutting line over the surface of the test object. The measurement is ended by pressing the switch again, which is labeled **Stop B-scan** during the B-scan measurement.

After finishing the B-scan measurement, the measurement cursors and the tools of the diagram toolbar can be used to evaluate the B-scan.

During a B-scan measurement, all other switches, the diagram tools and the measurement cursors are deactivated. If the program was still in stand-by mode when the measurement was started, it is automatically switched to measurement mode. After ending the measurement, the program remains in measurement mode, i.e. amplitude scans continue to be performed.

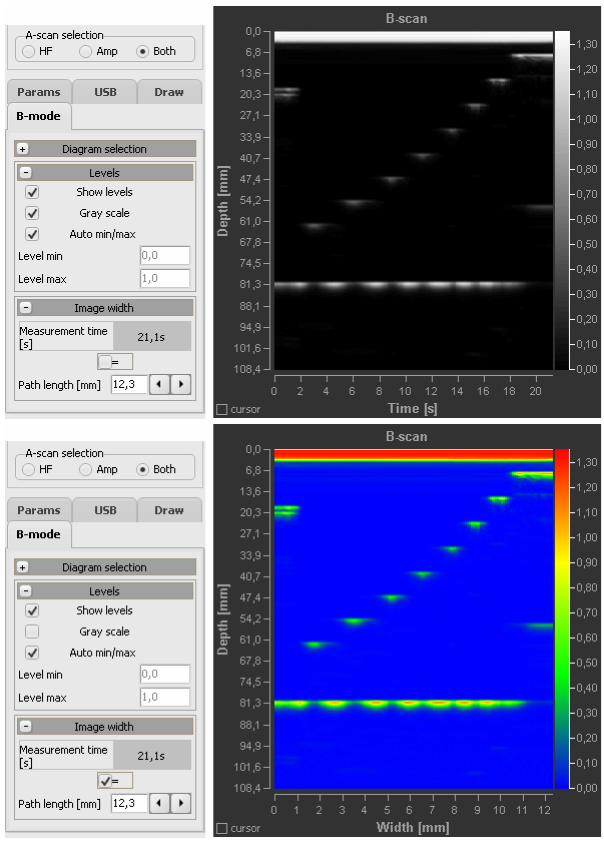
Coding of the amplitude scans

The coding converts the amplitude scans into line scans, whereby each measuring point of a scan is assigned a gray or color value corresponding to its amplitude. The normalization and scaling of the gray or color values can be done automatically or manually. For this purpose, the Levels group is provided in the B-mode tab.

Show levels: Display of the gray value or color value scaling to the right of the B-scan.

Gray scale: Switching between gray scale and color scale coding.

Auto min/max: Automatic or manual (level min/max) scaling.



Gray value/color value coding and assignment of time/location coordinates of a B-scan measurement

Time/location coordinates of a B-scan

Y-axis: On the y-axis of the B-scan, the runtime or the depth can be displayed. The selection is made again by setting the diagram unit (µs or mm) for the A-scan in the tab **Params**. For the correct conversion of transit time and depth, the correct sound velocity of the transmitted medium must of course also be entered there.

X-axis: For a B-scan measurement, the duration of the measurement is recorded and displayed in the *Image width* group in the **B-mode** tab. If the length of the section line of the B-scan over which the ultrasonic transducer was moved is known, location coordinates can be assigned to the measured times. For this purpose, the path (*Path length*) must be specified and the checkbox next to the actual-equal sign (=) must be activated. This converts the times on the x-axis into paths or distances (see Time and location coordinates in the figure).

A prerequisite for the assignment of time coordinates to location coordinates is that the scan is performed at a uniform speed. On the other hand, the start and stop times must match the distance. When evaluating with the help of the measurement cursors, small deviations may occur.

Selection of the measurement signal to be encoded

In general, B-scans are generated by encoding the amplitude signal, i.e. the envelope of the actual ultrasonic signal. In the program, this is done if the *Amp* or *Both view is* set for the A-scan diagram. In the *HF view*, on the other hand, the measured ultrasonic signal is encoded. This results in ultrasonic images, such as those known from TOFD measurements in non-destructive materials testing.

5.9 M-Mode

In the **M-mode** of the program, ultrasonic measurements can be carried out according to the **TM (time-motion) method.** Representation and function are similar to the B-mode of the program (see in the corresponding chapter).

As with a B-scan, the amplitudes of the ultrasound signal echoes of an A-scan are mapped on the Y-axis of the TM-scan in gray or color values. The echoes, which are temporally offset at a high PRF, are displayed side by side on a horizontal time axis. In contrast to the B-scan method, the ultrasound transducer is not moved during the measurement. In addition, only the last ultrasonic echoes of a definable time window are displayed in the TM image. In this way, a curve image is generated that runs from right to left and reflects the temporal movement of the examined structure.

The actual start of the acquisition of a TM image is done with the help of the **Start M-scan** switch. The measurement is terminated by pressing the switch again, which is labeled **Stop M-scan** during the TM scan.

After finishing the TM scan, the measurement cursors and the tools of the diagram toolbar can be used to evaluate the B-scan.

During a TM measurement, all other switches, the diagram tools and the measurement cursors are deactivated. If the program was still in stand-by mode when the measurement was started, it is automatically switched to measurement mode. After the measurement has been terminated, the program remains in measurement mode, i.e. amplitude scans continue to be performed.

Time window of an M-scan

While the B-scan consists of all amplitude scans of the measurement, the TM-scan is always built up from a certain number of amplitude scans only. The size of the mapped time window of the TM measurement is set in the M-mode register via the Image width parameter. A value of e.g. 10 s means that the TM image is composed of the amplitude scans of the last 10 seconds. In this way, movements of an examined structure and their changes can be followed optimally and promptly over a longer period of time.

The temporal resolution of the TM image depends on the set PRF value and is mainly limited by the maximum achievable frame rate of the program.

Other applications

Non-destructive material testing

Can be performed together with an optional extension set. Please refer to the experiment guide for Detection of discontinuities (P5160600) for the extension set with item number 13921-01.

Medical ultrasound diagnosis

Can be performed together with the Extension Set: Medical Ultrasonic Diagnostics (item number 13921-04), consisting of breast model with tumor, simplified heart model and eye model.

Computed tomography

Can be performed together with a supplementary set. Please refer to the operating instructions for the Extension Set: CT Scanner II with item number 13925-99.

6 TECHNICAL DATA

This quality measuring instrument meets all technical requirements listed in the current EU directives. The characteristics of this product qualify it for the CE mark.

Frequency range:	1 MHz to 5 MHz
Measuring mode:	Switchable between pulse-echo and transmission (through-sounding)
Transmit signal:	Dirac pulse (<1µs, 10 V - 300 V)
Transmit power:	0-30 dB, in steps of 5 dB
Gain:	0-35 dB, in steps of 5 dB
TGC:	Continuously adjustable threshold, rise time and duration, gain up to 30 dB
Connections:	2 connection sockets for single-element ultrasonic transmitters (transmitter and receiver mode freely selectable), each via BNC sockets: TGC signal, trigger, US signal, A-scan.
Computer connection:	USB port
Fuse protection:	T1A (EN 60127-2-3), G-fuse link, slow-blow, 1 A, 5 mm x 20 mm.
Dimensions:	230 x 236 x 168 mm
Mains voltage:	100 V - 240 V wide range power supply, 50/60 Hz
Power consumption:	approx. 100 VA

7 SCOPE OF DELIVERY

Basic Set: Ultrasound Echography **13924-99**

Scope of delivery:

- Ultrasonic echoscope
- Software measure Ultra Echo II
- Ultrasonic probe 1 MHz
- Ultrasonic probe 2 MHz
- Ultrasonic gel

- Ultrasonic test block, transparent
- Ultrasonic cylinder set (3 cylinders)
- Ultrasonic reflection plates

8 ACCESSORIES

13921-01	Extension Set: Non-destructive Testing
13921-04	Extension Set: Medical Ultrasonic Diagnostics
13925-99	Extension Set: CT Scanner II
13924-01	Ultrasonic probe 1 MHz
13924-02	Ultrasonic probe 2 MHz
13924-04	Ultrasonic probe 4 MHz
13924-25	Ultrasonic gel, 250 ml

Ultrasonic probes

The ultrasonic probes are characterized by high sound intensity and short sound pulses. This makes them particularly suitable for pulse-echo operation. All probes have a robust metal housing. The probes are waterproof at the sample contact surface (sound emission surface). They are connected to the echoscope with a special snap-in connector. All probes can be used either as transmitters or receivers.

- Due to their high sound intensity, the **1MHz** probes with **blue** colour coding are particularly suitable for investigations with a large penetration depth. Their use is particularly recommended for the examination of strongly attenuating materials as well as for the generation of Rayleigh and shear waves.
- The **2MHz** probes with **red** colour coding are particularly suitable for general applications. Due to their higher frequency, which leads to better axial and lateral resolution, these probes are particularly suitable for examinations of medical objects and as ultrasonic Doppler probes. The attenuation of the 2MHz sound is not particularly pronounced in most materials, so that examinations at medium depths are possible without any problems.
- The **4MHz** probe with **green** color coding has the highest axial resolution. This probe is mainly used where very small structures have to be detected. For some materials the limited penetration depth is not a problem. Due to the high resolving power and the associated spectral bandwidth, these probes are particularly recommended for investigations on thin plates.

9 WARRANTY NOTICE

For the device delivered by us we assume a warranty of 24 months within the EU, outside the EU of 12 months. Excluded from the warranty are: Damage caused by non-observance of the operating instructions, improper handling or natural wear and tear.
The manufacturer can only be considered responsible for the function and safety-related properties of the device if maintenance, repair and modifications to it are carried out by himself or by bodies expressly authorised by him for this purpose.

10 DISPOSAL

The packaging consists mainly of environmentally friendly materials, which should be taken to local recycling points.

This product does not belong in the normal waste disposal (household waste). If this device is to be disposed of, please send it to the address below for proper disposal.

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Fax +49 (0) 551 604-246