Sauter GmbH

Ziegelei 1
D-72336 Balingen
e-mail: info@kern-sohn.com

Phone : +49-[0]7433- 9933-0
Fax: +49-[0]7433-9933-149
Internet: www.sauter.eu

Instruction Manual Multimode Ultrasonic Material Thickness Gauge

SAUTER TO

Version 2.0
04/2020
GB

PROFESSIONAL MEASURING

TO-BA-e-2020

GB

SAUTER TO

V. 2.0 08/2020

Instruction Manual Multimode Ultrasonic Material Thickness Gauge

Congratulations on the purchase of a multimode ultrasonic thickness gauge from SAUTER. We wish you much pleasure with your quality measuring instrument with a high functional range. For any questions, requests and suggestions, please contact our customer service by telephone.

Table of contents:

1 General information

The model TO-EE is an ultrasonic material thickness gauge with several operating modes. Based on the same operating principles as SONAR, the instrument can measure the thickness of various materials with an accuracy of down to 0.1 / 0.01 millimetres. The gauge's multi-mode function allows the user to switch between pulse-echo mode (error and indentation detection) and echo-echo mode (determination of the actual material thickness without the presence of any paint or coating thickness).

1.1 Product specification

- Multi mode: Pulse-echo mode (P-E mode) and echo-echo mode (E-E mode). In the echo-echo mode, the wall thickness can be measured without taking the paint or coating thickness into account.
- Wide measuring range: pulse-echo mode: (0.65 ~ 600) mm (in steel, depending on the probe). Echo-Echo mode: (3 ~ 60) mm.
- V-path correction to compensate for the non-linearity of the probe.
- TFT colour display (320 × 240 TFT-LCD) with adjustable backlighting allows the user to work at workstations with low visibility.
- Up to 100 groups of measured thickness values can be stored in the non-volatile memory. A maximum of 100 data sets per group are permitted.
- Two AA alkaline batteries are used as power source. This ensures continuous operation of at least 100 hours (standard setting for brightness). Energy-saving functions "Display Standby" and "Auto Power Off" are available.
- With the internal Bluetooth module, a wireless connection with PC or other mobile devices can be established.
- USB 1.1 port. Online transmission of measurement data via USB to PC.

1.2 Measuring principle

The ultrasonic thickness gauge determines the thickness of a part or structure by accurately measuring the time it takes a short ultrasonic pulse generated by a transducer to pass through the thickness of the material, reflect off the back or inner surface and return to the transducer. The measured bi-directional travel time is divided by two to account for the outward and return paths and is then multiplied by the speed of sound in the respective material. The result is reflected in the following ratio:

$$H = \frac{v \times t}{2}$$

H = thickness of the test sample

v = sound velocity in the respective material

t = measured outward and return time

1.3 Converters: technical data

Model	Freq [MHz]	Φ [mm]	Measuring range [mm].	Lower limit value [mm]	Description

N02	2,5	14	3.0 ~ 300.0 mm (in steel) 40 mm (in grey cast iron HT200)	20 mm	for thick, strongly weakening or strongly scattering materials
N05	5	10	1 ~ 600.0 mm (in steel)	Φ 20 mm × 3,0 mm	Normal measurement
N05/90°	5	10	1 ~ 600.0 mm (in steel)	Φ 20 mm × 3,0 mm	Normal measurement
N07	7	6	0.65 ~ 200.0 mm (in steel)	Φ 15 mm × 2,0 mm	For measurements of thin pipe walls or pipe walls with low curvature
HT5	5	12	1 ~ 600.0 mm (in steel)	30 mm	For measurement at high temperatures (below 300 °C)
P5EE	5	10	P-E: 2~ 600 mm E-E: 3 ~ 60 mm	Φ 20 mm × 3,0 mm	Normal measurement and thickness measurement via the paint or coating thickness

1.4 Configuration

	No.	Article	Piece.	Remarks
Standard configuration	1	Housing	1	
	2	P5EE probe (5 MHz)	1	
	3	Coupling agent	1	
	4	Device packaging	1	
	5	Operating instructions	1	
	6	Alkaline battery	2	Type AA
	7	USB cable	1	
Optional configuration	8	Probe N02 (2.5 MHz)		
	9	Probe N05/90° (5 MHz)		see table 1.1.
	10	Probe N05 (5 MHz)		
	11	Probe N07 (7 MHz)		
	12	Probe HT5 (5 MHz)		

1.5 Working conditions:

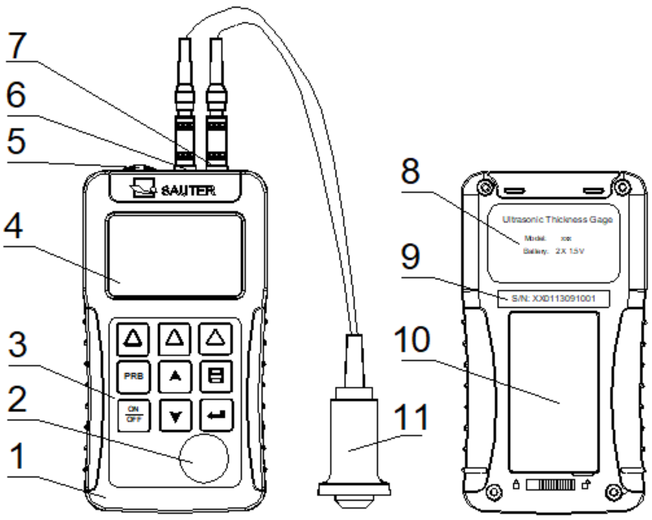
Operating temperature: 0 °C ~ +50 °C

Storage temperature: -20 °C ~ +70 °C

Relative humidity: ≤ 80 %

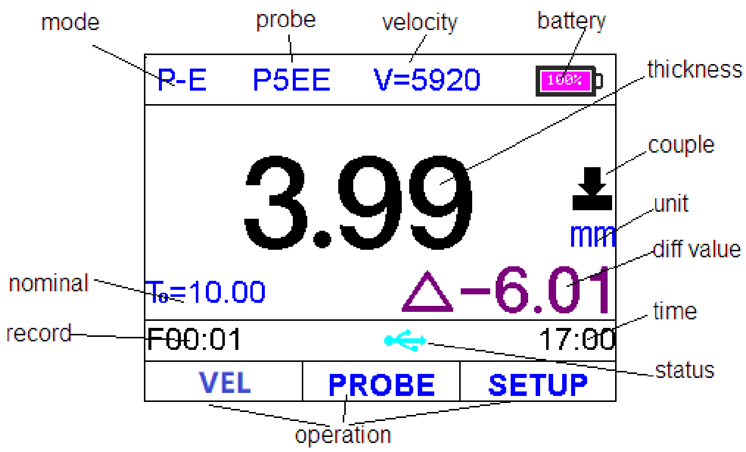
At the place of use, vibrations, strong magnetic fields, corrosive media and heavy dust accumulation must be avoided.

2 Keypad and display



1 Housing
2 Record "Probe Zero"
3 Keyboard
4 TFT display
5 USB connection
6 Pulse encoder socket
7 Receiving socket
8 Sticker
9 Serial number
10 Battery compartment cover
11 Probe

2.1 Main screen

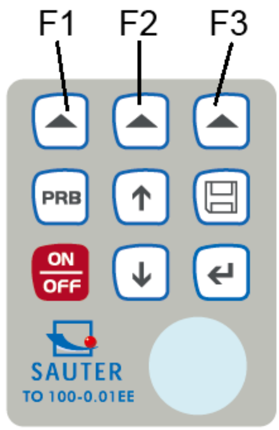


Function	Declaration
Mode	"E-E" indicates that the instrument is operating in echo echo mode; "P-E" indicates that the instrument is operating in pulse echo mode;
Sample	Probe selection
Velocity	Sound velocity
Battery	Indicates the remaining capacity of the battery
Thickness	Last measurement result
Unit	Unit system: mm or inch
Diff value	Measurement result when working in Diff mode
Time	System time
Status	USB communication status
Operation	indicates which process is already active
Record	displays the selected data group and the number of data records
Couple	Displays the coupling status
Nominal Thickness	Keyboard combinations

2.2 Control panel

The design of the device allows the user quick access to all device functions. A user-friendly menu system allows access to any function by pressing a few keys.

Function keys for selecting the desired function on the display. In the following sections of this manual they are referred to as F1, F2 and F3, from left to right.



ON OFF	ON/OFF or CANCEL	PRB	Sample-Zero process
	Save measurement result		Confirm/Enter
	Plus or scroll up		Minus or scroll down

3 Preparation for measurement

3.1 Selection of the converter

The meter is designed to perform measurements on a wide range of materials, from various metals to glass and plastics. However, different types of materials require the use of different transducers. Choosing the right transducer for the application is essential to ensure accurate and reliable measurements. The following sections highlight the important characteristics of transducers that should be considered when selecting a transducer for a particular application.

In general, the best transducer for a given application is a sensor that emits sufficient ultrasonic energy into the material to be measured so that a strong, stable echo is received by the instrument. The strength of the ultrasound during propagation can be influenced by several factors. These are listed below:

- Initial signal strength: The stronger the signal is at the beginning, the stronger its back echo. The initial signal strength is largely determined by the size of the ultrasonic transmitter in the transducer. A large emitting area emits more energy into the material to be measured than a small emitting area. Therefore, a so-called "1/2 inch" transducer emits a stronger signal than a "1/4 inch" transducer.

- Absorption and scattering: If the ultrasound propagates through any material, it is partially absorbed. If the material through which the sound propagates has a grain structure, the sound waves are scattered. These two effects reduce the strength of the waves and thus the ability of the instrument to detect the returning echo. The ultrasonic sound with higher frequency is absorbed and scattered more than the ultrasonic sound with lower frequency. Although it seems advisable to use a lower frequency transducer in all cases, low frequencies are less directional than high frequencies. Therefore, a higher frequency transducer is the better choice for determining the exact position of small indentations or flaws in the material to be measured.
- Transducer geometry: The physical boundary conditions of the measurement environment sometimes determine the suitability of a transducer for a specific measurement task. Some transducers may simply be too large to be used in space limited areas. In addition, the contact area available for contacting the transducer may be limited, which requires the use of a transducer with a small contact area. Measuring on a curved surface, such as an engine cylinder wall, may require the use of a transducer with a suitably curved contact area.
- Temperature of the material: When measuring on very hot surfaces, high temperature transducers must be used. These transducers are manufactured using special materials and techniques that allow them to withstand high temperatures without damage. In addition, care must be taken when using a high temperature transducer to perform "Sensor *Zeroing*" or "Calibration to Known Thickness".

The choice of the appropriate converter is often a question of compromise between different properties. It may be necessary to test different transducers in order to find a suitable sensor for the respective application.

The converter is the "working tool" of the device. It transmits and receives ultrasonic waves with which the instrument calculates the thickness of the material to be measured. The transducer is connected to the instrument via the cable supplied and two coaxial connectors. When using transducers, the arrangement of the double coaxial connectors is irrelevant: each connector can be connected to any of the two jacks on the instrument.

The transducer must be used correctly in order to obtain an accurate and reliable measurement result. Below is a brief description of the transducer, followed by its operating instructions.

The left figure shows a typical transducer from below. The two semicircles of the contact surface are visible, as is the barrier separating them. One of the semicircles is responsible for propagating ultrasound in the material to be measured and the other semicircle is responsible for returning the echo to the transducer. When the transducer is in contact with the material to be measured, the area just below the centre of the contact surface is measured.
The right figure shows a top view of a typical transducer. Press the transducer upwards with thumb or index finger to fix the transducer in place. Moderate pressure is sufficient as the transducer only needs to be held immobile and the contact surface must beflat against the contact surface of the material to be measured.

3.2 Condition and preparation of surfaces

In any ultrasonic measurement scenario, the shape and roughness of the measurement surface are of utmost importance. Rough, uneven surfaces can restrict the propagation of ultrasound through the material and lead to unstable and therefore unreliable measurements. The surface to be measured should be clean and free of small particles, rust or scale. The presence of such obstacles prevents the transducer from contacting the contact surface correctly. Often a wire brush or scraper will help to clean the surface. In extreme cases, rotary grinders or grinding wheels can be used. However, care must be taken to avoid surface cracks that prevent proper coupling of the transducer.
Extremely rough surfaces, such as the siliceous surface of some cast iron, are the most difficult to measure. Such surfaces act on the sound beam like frosted glass on light, the beam is diffused and dispersed in all directions.
Rough surfaces are not only an obstacle to measurement, but also contribute to excessive wear of the transducer, especially in situations where the transducer "scrubs" along the surface. Transducers should be checked regularly for signs of uneven wear of the contact surface. If the contact surface is worn more on one side than the other, the sound beam passing through the specimen may no longer be perpendicular to the material surface. In this case, it is difficult to locate the smallest irregularities in the material to be measured precisely, since the focus of the sound beam is no longer directly below the transducer.

4 Operation

4.1 Power supply

Two AA alkaline batteries are required as power supply. The battery compartment is located at the rear. The cover is fixed with two screws. To insert the batteries:

- ➢ Loosen the two screws of the battery cover.
- ➢ Lift the cover upwards.
- ➢ Insert the batteries into the battery compartment.
- ➢ Close the battery compartment and tighten the screws.
- ➢ Turn on the power to ensure that the batteries are inserted correctly and securely.

4.2 Connection of the probe

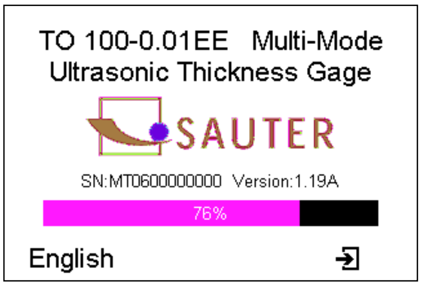
To prepare the instrument for operation, you must connect a probe to it. The instrument is equipped with the Lemo sockets.

When connecting a probe to the instrument, it is not only important that a physical connection is properly established. It is also important that the instrument is properly configured to work with the installed probe.

4.3 Switching on the device (Power ON)

To start the unit, press the key ON/OFF until the display is activated. While the unit is starting a start-up screen, the display shows the serial number of the unit, the installed software version, the date and time of the system.

The initial screen of the machine appears as shown in the following figure:

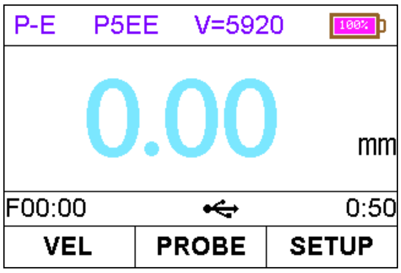


Press the F1 key to switch to another language.

Press the F3 key to skip the boot check procedure and immediately switch to the measuring mode.

The instrument carries out a self-test and then automatically switches to the measuring mode if no further key is pressed.

The instrument is now ready for the first measurement.



The device automatically reloads the last settings. It has a special memory in which all settings are retained even when the power supply is switched off.

To turn off the instrument, press and hold the button ON/OFF until the shutdown message appears.
The meter also has an automatic power-off function to save battery capacity. If there is no operation for a certain period of time (set as automatic power-off delay), the meter will automatically turn off.
Note: the device switches off automatically if the battery capacity is too low.

4.4 Configuration of the standby settings

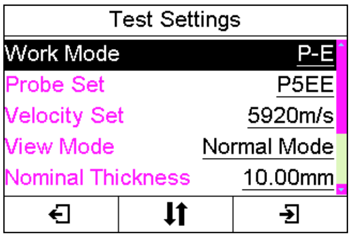
To save battery power, the device supports the following power supply modes:
Run state - The unit operates at full frequency
Standby **state** - After 5 seconds (default setting), the LCD brightness is set to a low level and the CPU operates at a lower frequency. This has no effect on the data or memory. Pressing any button or taking a measurement will return the unit to the operating mode and reset the default brightness.
Power off state - After 2 minutes (default setting), the unit will go from standby mode to power off mode. The unit and display are off and consume very little power. Pressing any key will prevent the unit from entering the power off state with a message "Idle Timeout! (period of inactivity expired!) is displayed and the operating mode is restored. Switching from operating mode to standby mode is done according to the standby delay setting of the display. The time delay can be configured by the user in the Display Standby *Delay* dialog box. The unit can be reset from standby mode to operating mode by any user activity.

5 Operation

5.1 Setting the working mode

Users and inspectors often deal with coated materials such as pipes and tanks on site. Typically, inspectors must remove the paint or coating prior to measurement or take into account a certain number of defects caused by paint or coating thickness or speed. The error can be eliminated with this meter by using a special echo-echo mode designed for measurements in such cases. The gauge is equipped with this user-friendly feature, so there is no need to remove the paint or coating.

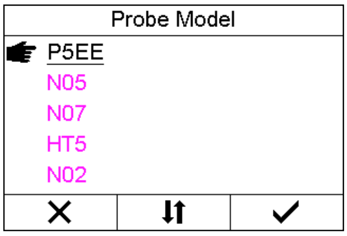
To switch between P-E mode and E-E mode, press [*Test* Settings] in the Test Settings dialog box.



5.2 Probe selection

Make sure that you have set the correct probe model in the device. Otherwise, the measurement may be incorrect. In the Probe *Model* dialog box, use the and keys to scroll to the currently used probe model.

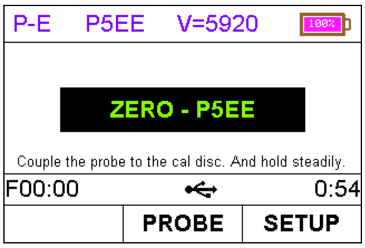
Then press the or F3 key to confirm the selection. Press to cancel the operation and exit the dialog box.



5.3 Function "Probe Zero"

The key is used to zero the instrument in the same way as a mechanical micrometer is zeroed. If the gauge is not set to zero correctly, some error may occur in all measurements taken with the gauge. When the Meter is zeroed, this fixed error value is measured and automatically corrected in all subsequent measurements. Zeroing the instrument can be done in the following ways:

1. Connect the converter to the device. Make sure that the connectors are fully engaged. Make sure that the wear surface of the converter is clean and free of any foreign matter.
2. Press the button to activate the *Probe* Zero mode (see figure below).
3. Apply a single drop of the coupling agent to the surface of the metal plate of the probe.



4. Press the transducer against the probe plate and make sure that the transducer is flat against the surface.
5. When the progress bar is complete, remove the transducer from the probe plate. Repeat this procedure four times if necessary.
6. At this point the internal error factor is successfully calculated by the instrument and compensated for in all subsequent measurements. When performing the "*Probe* Zero" function, the instrument always uses the sound velocity value of the built-in probe plate, even if a different velocity value was entered for the actual measurements. Although the instrument remembers the last zero setting, it is generally advisable to perform the "*Probe* Zero" function when the instrument is turned on and when using another transducer. This will ensure that the instrument is always zeroed correctly.

In Probe Zero PRB mode, press to exit the Zero function and return to the measuring mode.

5.4 Calibration of the sound velocity

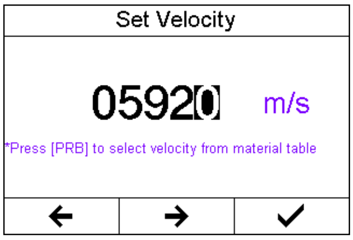
In order for the measuring instrument to perform accurate measurements, it must be set to the correct sound velocity for the material to be measured. Different types of material have different inherent velocities. If the gauge is not set to the correct speed of sound, all measurements made with the gauge will have a certain percentage of error. **Single point calibration** is the simplest and most commonly used calibration method that optimizes linearity over large ranges. **Two-point calibration** allows greater accuracy in small ranges by calculating the zero point of the probe and the velocity.

Note: One or **two-point calibration** must be performed on a material after the removal of paint or coating. Otherwise, it will result in a calculation of the material speed that is different from the actual material speed of the material to be measured.

5.4.1 Calibration to known speed

Note: This procedure requires a sample of the specified material to be measured, the exact thickness of which is known, e.g. by measuring it in a different way.
A table with common materials and their sound velocities can be found in Appendix A to this manual.

In the Set *Velocity* dialog box, press the F1 / F2 and / keys to adjust the velocity value up or down until it matches the sound velocity of the material being measured.

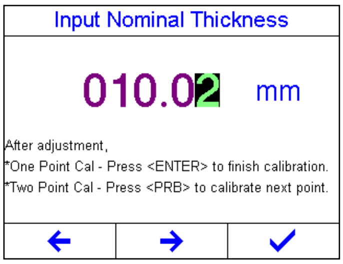


You can also press the button to select between the preset speeds.

5.4.2 Calibration to known thickness

Note: This procedure requires a sample of the specified material to be measured, the exact thickness of which is known, e.g. by measuring it in a different way.

1. Perform the "Probe *Zero*" function with a standard 4.00 mm plate.
2. Apply the coupling agent to the test sample.
3. Press the transducer against the sample and make sure that the transducer is flat against the surface of the sample. The display should show a certain thickness value and the connection status indicator should be steady.
4. After you have achieved a stable measured value, remove the transducer. If the displayed thickness differs from the value displayed during transducer coupling, repeat the step in section 3.
5. Press the or key to display the Input Nominal *Thickness* dialog box. See the figure below.



6. Press F1 / F2 and or to enter the thickness value until it matches the thickness of the sample.
7. Press / F3 to confirm the entry. The meter exits the input field and returns to the measuring mode. It now displays the calculated sound velocity value determined from the entered thickness value.

The measuring instrument is now ready to measure.

5.4.3 Two-point calibration

Note: This method requires two known thickness points on the test piece, which are representative for the range to be measured.

1. The "*Probe* Zero" function must first be performed on the standard plate of the instrument.
2. Apply the coupling agent to the test sample.
3. Press the transducer against the sample at the first / second calibration point and ensure that the transducer is flat against the surface of the sample. The display should show a (possibly incorrect) thickness value and the link status indicator should be steady.
4. After you have achieved a stable measured value, remove the transducer. If the displayed thickness differs from the value displayed during transducer coupling, repeat the step in section 3.
5. Press the or key to display the Input Nominal *Thickness* dialog box. See the figure at the right.
6. Press F1 / F2 and or to enter the thickness value until it matches the thickness of the sample. Then press to calibrate the second point (see the following figure):

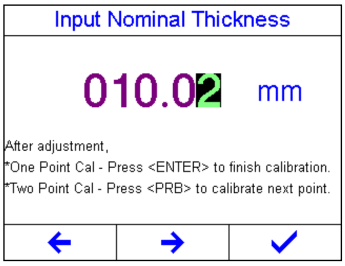
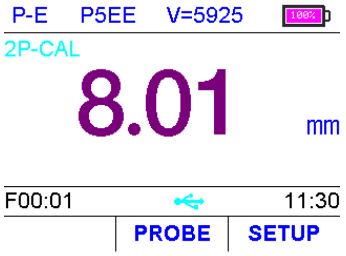


Figure below: Measuring the second point during two-point calibration.



7. Repeat steps 2 to 6 at the second calibration point.
8. Finally, press the / F3 key to complete the two-point calibration. The meter is now ready to take measurements within this range.

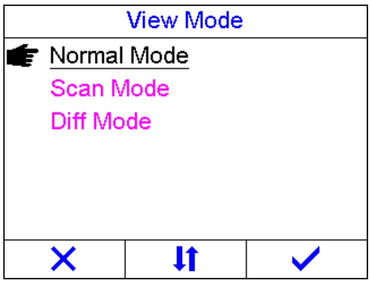
5.5 perform measurements

When the instrument displays thickness measurements, the display shows the last measured value stored until a new measurement is performed.
In order for the transducer to fulfil its task, there must be no air gaps between the wear surface and the surface of the material to be measured. This is achieved by using a "coupling liquid", which is usually called "coupling agent". This liquid is used to transmit (couple) the ultrasonic waves from the transducer into the material and back again. Before attempting to perform a measurement, a small amount of coupling agent should be applied to the surface of the material to be measured. Normally a single drop of coupling agent is sufficient.
After applying the coupling agent, press the transducer (contact surface down) firmly against the area to be measured. The Coupling Status Indicator should be displayed and the display should show a numerical indication. When the unit is properly set to "zero" and the correct sound velocity, the digit on the display will show the actual material thickness directly below the transducer.
If the coupling status indicator does not appear or does not appear stable, or if the digits on the display appear irregular, first check that there is a sufficient coupling agent film under the transducer and that the transducer is flat on the material. If this condition persists, it may be necessary to select a different transducer (size or frequency) for the material to be measured.
While the transducer is in contact with the material to be measured, the instrument performs four measurements per second by continuously updating its display. When the transducer is removed from the surface, the display shows the last measurement taken, stored in memory.

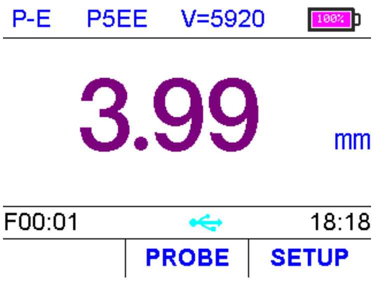
Note: When removing the transducer, a thin film of coupling agent is occasionally drawn between the transducer and the surface. If this is the case, the measurement is made through this film of coupling agent, resulting in a reading that is greater or less than it should be. This effect is obvious when one thickness value is observed while the transducer is being used and another value is observed after the transducer is removed. In addition, measurements through very thick resist films or coatings can result in the resist film or coating being measured rather than the actual material. It is the sole responsibility of the user of the instrument to use the instrument correctly and to detect such effects.

5.6 Set View Mode

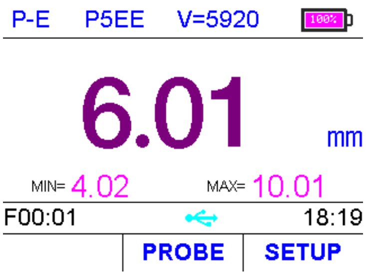
Three view modes can be selected to display the measured value: *Normal* Mode, Scan *Mode* and Diff *Mode*.



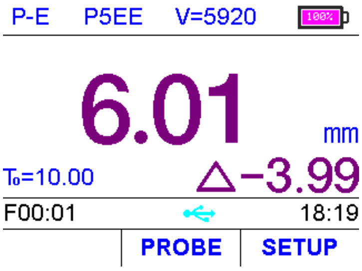
Normal Mode [*Normal Mode*]. As shown in the figure on the right, the last thickness reading is displayed.



Scan Mode [*Scan Mode*]. In addition to the last thickness value measured, the minimum and maximum thickness values are also displayed during the measurement. By pressing , ON/OFF the minimum and maximum values are reset.



Diff **Mode**. Both the last thickness reading and the differential thickness value are displayed (of the absolute thickness value and the nominal thickness value).



Although the gauge is excellent for single point measurements, it is sometimes advisable to examine a larger area and search for the point with the smallest thickness. The gauge has a "Scan *Mode*" function that enables it.

In *Normal* **Mode**, the meter takes and displays ten measurements per second, which is sufficient for single measurements. However, in Scan *Mode,* the Meter takes more than ten measurements per second and displays the readings during scanning. While the transducer is in contact with the material to be measured, the gauge tracks the minimum and maximum values determined. The transducer can be "scrubbed" over a surface, and all short signal interruptions are ignored.

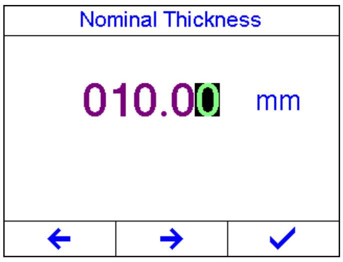
5.7 Set normal thickness

In differential measuring mode, the nominal thickness of the test piece must be set. The setting procedure is as follows:

Press the F1 / F2 key to move the highlighted cursor. Press the arrow keys to increase / decrease the values.

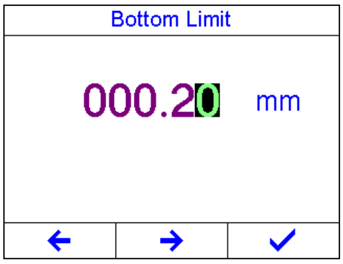
Press the key or the F3 key to confirm the setting.

Press key to cancel the change and exit the mode.

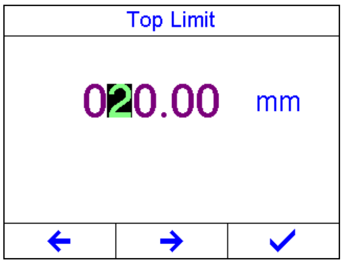


5.8 Set limit value

Test results outside limits are displayed in red to alert the user. To change the limit setting, press the F1 / F2 key to move the highlighted cursor. Press the arrow keys to increase / decrease the values.

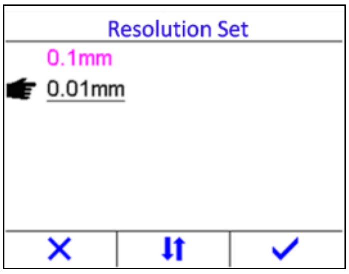


Press the key or the F3 key to confirm the setting. Press the key to cancel the change and exit the mode.



5.9 Set resolution

The resolution of the display of the measuring instrument can be set within a range of 0.1 mm or 0.01 mm.



When the resolution is set to 0.01 mm, the surface of the test piece should be smooth to obtain accurate test results. When measuring rough surfaces or coarse-grained materials, it is recommended to use the low resolution.

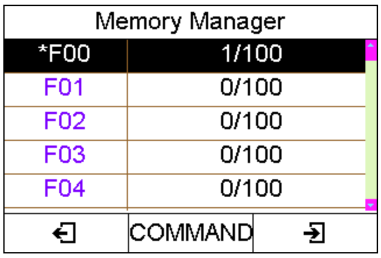
5.10 Memory management

5.10.1 Save record

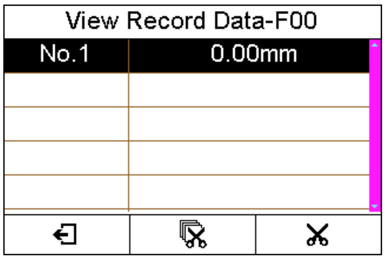
By pressing the key , as soon as a new measured value display appears, the measured thickness value is stored in the currently selected data group. It is added to the group as the last data set.

5.10.2 Display stored data records

This function allows the user to display records of a desired data group that was previously stored in memory. The procedure is as follows:
Activate the "*Memory* Manager" function (right figure).
Press or to move the cursor; press or F3 to *display* the View Record Data dialog box (see the following figure).



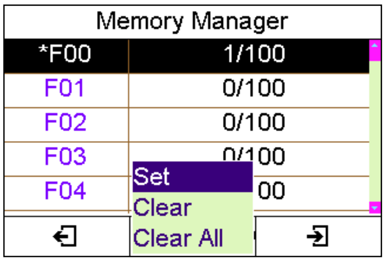
Press or to move the cursor to the desired record.
Press F3 to delete the selected record.
Press F2 to delete all records in this group.
To exit, press / F1.



5.10.3 Select current data group

The meter contains 100 data groups (F00 ~ F99) in which the measured values can be stored. A maximum of 100 data sets (thickness values) can be stored in each group. To change the target data group for storing measured values, proceed as follows:

Activate the "Memory Manager" function. Press or to select the desired data group. Press F2 to retrieve the command list. Then select the "*Set*" command and confirm it with .



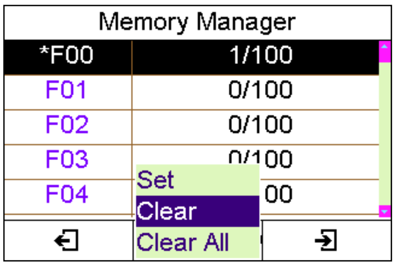
After completing the above steps, the newly selected data group is set as the current data group for storing new measurement results.

5.10.4 Delete data group

It may be necessary to completely delete all measurements of an entire data group. In this way, the user can create a new list of measurements, starting from memory location no. 00. The procedure is described in the following steps.

Activate the "Memory Manager" function.

Press or to select the desired data group. Press the F2 key to display the command list. Then select the "*Clear*" command and confirm it with .



If the command "Clear All" is selected and confirmed, all data groups of the measuring instrument are deleted.

Note: The data cannot be restored after deletion!

5.11 Setting the key tone

The key tone can be switched on or off. If the key tone is switched on, the buzzer in the device emits a short acoustic alarm after each key is pressed.

5.12 Set warning tone

The warning tone can be switched on or off. If the warning tone is switched on, the buzzer in the device emits a long acoustic alarm after each new measured value. If the instrument emits an action warning, an alarm will also sound if the setting is activated.

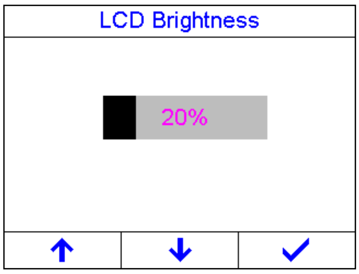
5.13 Set LCDbrightness level

The different brightness levels of the LCD screen affect the standby time and continuous operation.

The setting can be changed by scrolling with the F1 (increase) and F2 (decrease) keys or by pressing the arrow keys.

Press the key  or the F3 key to confirm the setting.

Press the button  to cancel the change and exit the dialog box.



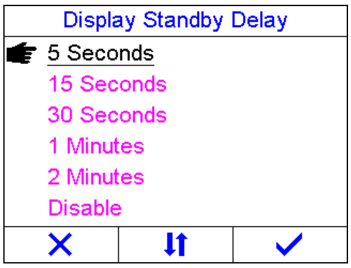
With lower brightness, less power is consumed and therefore the operating time is extended.

Note: Reduce the brightness of the LCD screen in good lighting conditions to save energy.

For the settings, refer to the right figure of the Display Standby *Delay* dialog box.

Press the arrow keys or the F2 key to select the desired setting.

Selecting the "*Disable*" option prevents the unit from switching to standby mode.



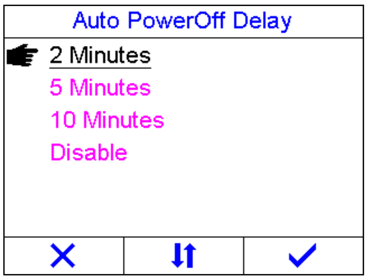
The device goes into standby mode after a certain time. Perform a measurement or press any key to wake the unit from standby mode.

5.14 Setting the display readiness

The standby mode reduces the LCD brightness and puts the CPU into a power saving mode. Switching from power mode to standby mode is controlled by setting the "Display *Standby* Delay" function.

5.15 Set automatic switch-off

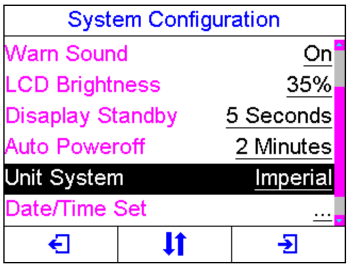
Switching from standby mode to off mode is controlled by setting the *Auto* Shutdown Delay function.
The time delay can be configured by the user in the *Auto* Shutdown *Delay* dialog box. Press the arrow keys or the F2 key to select the desired setting.
Selecting the "*Disable*" option prevents the unit from being automatically turned off.



Note: If the battery voltage is too low, the LCD display will show "Battery Exhausted! will appear on the LCD and the unit will automatically turn off.

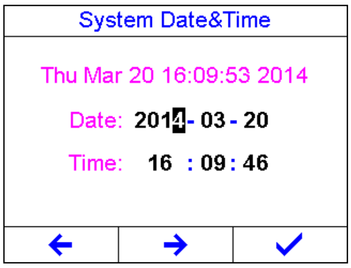
5.16 Change system of units

The device supports both the metric and imperial unit system. With the Unit *System* option selected, press [*System* Configuration] in the System Configuration dialog box to switch between imperial and metric units.



5.17 Setting the date and time

To create correct documentation, you should always ensure that you use the correct date and time settings. Open the System Time dialog box to set the system date and time.
The format for the date: Year-Month-Date
The format for the time: hour - minute - second
Use the F1 and F2 keys to move the cursor. Use the arrow keys to increase or decrease the values.
Press the / F3 button to confirm the setting. Press the button to cancel the setting changes and exit the dialog box.



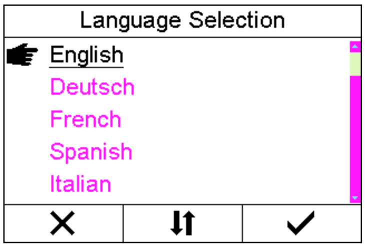
After setting, the current date and time are maintained by the internal clock of the device.

5.18 Set language

The operating language of the measuring instrument can be selected.
Use the arrow keys and the F2 key to select the operating language.

Press the key or the F3 key to confirm the selection.

Press the key to cancel the selection and leave the dialog box.

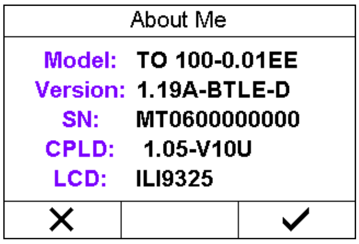


Note: The user can also change the operating language during the startup process in the home screen.

5.19 Product info

Information on the device model, software version and serial number of the device is displayed in windows as shown in the following figure.

Press the , , F1 or F3 key to exit the dialog box.



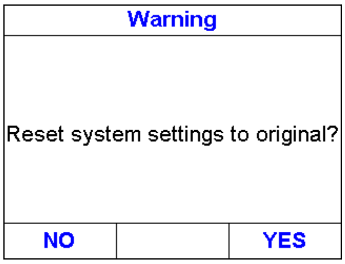
5.20 Reset system

If the device can no longer be operated or if it is necessary to restore factory settings, you can reset the device.

The function "System Reset" is used to reset the *system*. When this function is selected, all data stored in the instrument and the user calibration are deleted. The device settings are reset to the default settings.

To reset the unit:

- activate the "*System* Reset" function. The dialog box on the right appears.
- Press the or the F3 key to confirm the reset operation. Press the F1 key to cancel the reset.



NOTE: *The effects of resetting the unit may be irreversible. No button should be pressed during the reset process.*

5.21 USBcommunication

The device has a USB port in the upper left corner. The USB cable can be used to connect the unit to a PC.

- Insert the mini-USB plug of the USB cable into the USB socket at the top of the unit.
- Plug the other end of the USB cable into the USB port of the computer.

6 Measurement technology

6.1 Measurement procedure

- <u>Single point measuring method</u>: the probe is placed at any point on the workpiece. The instrument displays the thickness at the point where the probe is placed.

- Two-point measuring method: the probe is measured twice at the same point of the test sample, whereby the separation plane of the probe remains 90° for two measurements. The smaller value should be the thickness at the respective point.
- Multi-point measurement method: several measurements are made in a circle of 30 mm diameter, the thickness value of the tested part being the minimum value.
- Continuous measurement method: a continuous measurement is carried out along the specified line at a distance of less than 5 mm using single-point measurement, the thickness value of the tested part being the minimum value.

6.2 Wall measurement

During the measurement, the probe parting line can run along the pipe axis or the vertical pipe axis. For larger pipe diameters, the measurement must be carried out on the vertical axis. For smaller pipe diameters, the measurement shall be carried out in both directions, with the thickness value being the minimum value.

7 Service

If the device shows other unusual deviations, no permanently mounted parts may be disassembled or repaired. In this case, contact our customer service department by e-mail or telephone to initiate the appropriate service procedure.

8 Transport and storage

Keep the device away from vibrations, strong magnetic fields, corrosive media, dirt and dust. Store the device at normal temperature.

9 Sound velocity

Material	Sound velocity	
	in/µs	m/s
Aluminium	0,250	6340 – 6400
Steel, usual	0,233	5920
Stainless steel	0,226	5740
Brass	0,173	4399
Copper	0,186	4720
Iron	0,233	5930
Cast Iron	0,173 – 0,229	4400 – 5820
Lead	0,094	2400
Nylon	0,105	2680
Silver	0,142	3607
Gold	0,128	3251
Zinc	0,164	4170
Titanium	0,236	5990
Tin	0,117	2960
Epoxy resin	0,100	2540
Ice	0,157	3988
Nickel	0,222	5639
Plexiglas	0,106	2692
Polystyrene	0,092	2337
Porcelain	0,230	5842
PVC	0,094	2388
Quartz glass	0,222	5639
Rubber, vulcanised	0,091	2311
Teflon	0,056	1422
Water	0,058	1473

10 Instructions for use

10.1 Measurement of large and small pipes

When measuring a pipe section to determine the thickness of the pipe wall, the alignment of the transducers is important. If the pipe diameter is larger than approx. 4 inches, the measurements should be carried out with the transducer arranged so that the gap of the contact surface is perpendicular (at right angles) to the longitudinal axis of the pipe. For smaller pipe diameters, two measurements should be made, one with the gap perpendicular to the contact surface and the other with a gap parallel to the longitudinal axis of the pipe. The smaller of the two displayed values is considered to be the thickness at the respective point.

Perpendicular Parallel

10.2 Measurement of hot surfaces

The speed of sound propagation through a material depends on its temperature. As the materials heat up, the speed of sound propagation decreases. For most applications with surface temperatures below about 100 °C, no special procedures are required. At temperatures above 100 °C the change in the speed of sound of the material to be measured has a significant effect on the ultrasonic measurement. At such elevated temperatures, it is advisable to perform a calibration procedure on a sample of known thickness that is at the temperature of the material to be measured or at a comparable temperature. This will allow the instrument to correctly calculate the speed of sound propagation through the hot material.

For measurements on hot surfaces it may be necessary to use a specially designed high temperature transducer. Such transducers are made of materials that can withstand high temperatures. However, it is recommended to leave the probe in contact with the surface only as long as necessary for a stable measurement. When a transducer comes into contact with a hot surface, it begins to heat up, and thermal expansion and other effects can affect measurement accuracy.

10.3 Measuring of laminate materials

Laminate materials are unique in that their density (and thus the speed of sound propagation) can vary considerably from one piece to another. Some laminate materials can even show significant variations in the speed of sound on a single surface. The only way to reliably measure such materials is to perform a calibration procedure on a sample of known thickness. Ideally, this sample material should be part of the same DUT, or at least come from the same batch. By calibrating each test piece individually, the effects of sound velocity deviations can be minimized.

Another important factor to consider when measuring laminate materials is the fact that trapped air gaps or pockets cause early reflection of the ultrasonic beam. This effect is noticeable by a sudden decrease in thickness on an otherwise homogeneous surface. Although this can affect an accurate measurement of the overall thickness of the material, it does indicate air gaps in the laminate material.

10.4 Measurement through paint layers and coating

Measuring through paint layers and coating is also unique in that the speed of sound propagation for paint layers and coating differs significantly from the speed of sound propagation for the actual measured material. A perfect example would be a mild steel pipe with about 0.6 mm coating on the surface, where the speed of sound propagation is 5920 m/s for the pipe and 2300 m/s for the coating. If the calibration procedure for mild steel pipes and the measurement is performed through both materials, the actual coating thickness appears to be 2.5 times greater than it really is due to the speed differences. This error can be corrected by using a special echo-echo mode to perform measurements in such cases. In the echo-echo mode, the paint or coating thickness is completely eliminated and the only material measured is steel.

10.5 Suitability of materials

The ultrasonic thickness measurements require that a sound wave is passed through the material to be measured. Not all materials have good sound conducting properties. Ultrasonic thickness measurement is applicable to a wide range of materials including metals, plastics and glass. Some cast materials, concrete, wood, fiberglass, and some rubbers are considered difficult cases to measure.

10.6 Coupling agent

All ultrasonic applications require a medium to couple the sound from the transducer to the specimen. Normally a liquid with high viscosity is used as medium. The propagation in air of the sound used for ultrasonic thickness measurement is ineffective.

A wide range of coupling agents can be used for ultrasonic measurement. Propylene glycol is suitable for most applications. Glycerine is recommended for difficult applications where maximum transmission of sonic energy is required. However, on some metals, glycerine can promote corrosion by absorbing water and may therefore be undesirable. Other suitable coupling agents for measurements at normal temperatures are water, various oils and greases, gels and silicone fluids. Measurements at elevated temperatures require specially formulated heat-resistant couplants.

When measuring ultrasonic thickness, the instrument may use the second echo instead of the first echo from the back of the material to be measured by operating in standard pulse-echo mode. This can result in a thickness measurement that has a thickness value twice as large as it really is. It is the sole responsibility of the user of the instrument to use the instrument correctly and to detect such effects.

Note:

The CE Declaration of Conformity is available under the following link: https://www.kern-sohn.com/shop/de/DOWNLOADS/