ULTRASONIC THICKNESS GAUGE

PenGauge

OPERATION MANUAL

ACS-Solutions GmbH
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The present operation manual (hereinafter referred to as "operation manual") contains technical specifications, description of design and operation principle of the Ultrasonic Thickness Gauge “PenGauge” (hereinafter referred to as "thickness gauge" or “instrument”), as well as information required for proper working with the instrument.

Carefully read the operation manual prior to working with the instrument.

Only properly trained personnel who carefully read the operational documentation and understand general principles of the ultrasonic vibration propagation theory should be allowed to work with the instrument.

Test problems must be identified, inspection layouts shall be chosen, conditions of performing inspection using similar materials shall be estimated, etc., for proper ultrasonic inspection.

Continuous improvement of the instrument functions and its reliability and usability sometimes results in minor changes that are not reflected in the current version of the operation manual therefore they do not affect the technical specifications of the instrument.

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Description and operation of the instrument

1.1 INTENDED USE OF THE INSTRUMENT

1.1.1 Intended use and operation range

Thickness gauges are pocket-type portable ultrasonic gauges of general purpose.

The instruments are designed to perform wall thickness measurements of boilers, containers, pressure-operated vessels, hull plates and other items made of black and non-ferrous metals, as well as small-diameter metal and plastic pipes (from 20 mm) with even and corroded surfaces with roughness Rz160 and minimum bending radius from 10 mm.

The instrument can be used under laboratory, field and workshop conditions in various industries. Please be sure to perform the surface pre-treatment using couplant. Contact lubricants can be as follows: various oils, water, glycerin, special contact liquids and ultrasonic testing gels, etc.

1.1.2 Operation Conditions

The instrument is designed to work under the following conditions:

– ambient air temperature range from - 30 to +50 °C;

– relative air humidity up to 95 % at +35 °C.

1.2 TECHNICAL SPECIFICATIONS

The key instrument parameters are listed in Table 1.

T a b l e 1

Parameter	Value
Measurement range of the thickness (steel), mm	from 0.8 to 100.0
Sampling rate of the thickness indication, mm: from 0.80 to 9.99 mm from 10.0 to 100.0 mm	 0.01 0.1
Limits of permissible absolute error, mm, where X - thickness is measured	$\pm(0.005 \cdot X + 0.1)$
Setting range of ultrasound velocity, m/s	from 1000 to 9000
Type of the built-in transducer	single element
Frequency of the built-in transducer, MHz	5
Diameter of the work surface of the built-in transducer, mm	5

Parameter	Value
Power	built-in LiPol rechargeable battery
Nominal battery voltage, V	3,7
Period of continuous operation of the instrument powered from the completely charged accumulator under normal environmental conditions, min.	16 h
Overall dimensions, max.	125 × 25 × 15 mm
Maximum weight	40 g
Average time between failures, min.	18 000 h
Average service life, min.	5 years

1.3 INSTRUMENT DESIGN AND OPERATION PRINCIPLE

1.3.1 Instrument Design

Ultrasonic Thickness Gauge “PenGauge” is a pocket-type one-piece case (Figure 1) with a built-in accumulator battery and a built-in single element transducer.

Figure1

The design of the instrument allows for the replacement of the worn-out capsule of the built-in transducer by means of unscrewing the tip detaching the transducer capsule from the instrument without extra tools (see 3.3).

The Enter key is used to:

– switch the instrument On/Off;

– toggle between the measurement units (millimeters / inches).

The setting keys − and + are used to switch:

– the velocity adjustment mode;

– the calibration mode.

The results of the digital measurement, the ultrasound velocity, the accumulator battery state, and the current measurement units (Figure 2) are displayed on the screen.

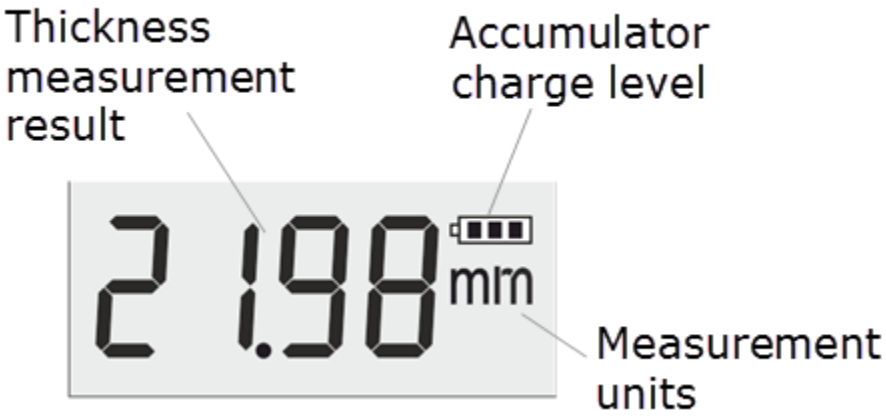

Figure2

The USB connector is used for connection of the power adaptor 220 V – USB to charge the built-in accumulator battery.

1.3.2 Operation Principle

The instrument measures the time of the double movement of ultrasonic pulses through the object being inspected from one surface to another. This time is converted to the thickness value using a known velocity value.

The piezoelectric transducer integrated into the instrument's case sends ultrasonic pulses into the object being inspected and receives their reflections. The transducer is put on the surface of the tested object in the point where the thickness should be measured.

2 INTENDED USE

2.1 OPERATING RESTRICTIONS

The instrument is designed to be operated under conditions listed in the Chapter **Ошибка! Источник ссылки не найден.**

2.2 FACTORS INFLUENCING THE OPERATION OF THE INSTRUMENT AND ACCURACY OF THE READINGS

2.2.1 State of the surface

Loose or exfoliating rust, corrosion or dirt on the surface of the object to be tested can influence the transmission of the ultrasonic sound in the material. Hence such surface should be cleaned of the rust and scale followed by applying more contact fluid as compared to the fluid amount required for the smooth surface.

Thorough cleaning of the rough corroded surfaces will increase accuracy of the measurements and as well prolong the lifetime of the transducer.

If there is a thick layer of paint on the surface or the paint started to pill off, then remove it since the thick paint layer reduces the signal and can produce a false echo thus resulting in false measurement results. The measurements can be executed through the thin paint layer (0.1-0.3 mm). At that, the result of the measurements will include the thickness value of the paint layer.

If there is a thick layer of paint on the surface or the paint started to pill off, then remove it since the thick paint layer reduces the signal and can produce a false echo resulting in false measurement results.

2.2.2 Putting the piezoelectric transducer onto the surface

The piezoelectric transducer should be tightly pressed to the surface of the tested item to provide a good transmission of the ultrasonic sound into the material.

When measuring wall thicknesses of the cylindrical objects especially of small diameters, it is recommended to use viscous lubricant (viscous contact liquid) and apply more liquid to the point of contact. Tightly pressing the piezoelectric transducer to the tube’s surface and watching the readings of the instrument, lean the transducer from side to side in plane perpendicular to the tube’s axis. At that move the transducer gradually along the tube’s wall. Do not slide along the wall to decrease wearing of the working surface of the piezoelectric transducer.

If scanning is required, e.g. when searching for local thin areas of the material, then do it as gently as possible, do not apply strong pressure and use clean contact grease only on the pre-cleaned surface.

The instrument's readings when the transducer is leaning from the middle position will be increased a little. The minimum steady reading of the instrument contacting the tube’s wall with the middle of the working surface of the piezoelectric transducer will be considered the actual value of the measured thickness. If the

transducer strongly leans from this position, then the readings of the instrument could increase in discrete steps.

The tested objects with double convex curvature (tubes' bends, spherical coverings and so on) are the most difficult for inspection since they can be contacted in a single point only. If so, the transducer should contact the object with the middle of its working surface.

2.2.3 Non-parallelism or eccentricity

If the external and internal surfaces of the inspected material are not parallel or are eccentric to each other, then the reflected wave (echo – signal) will deviate from the required direction and the accuracy of the readings will decrease.

2.2.4 Acoustic properties of the material

Some properties of the constructive materials can essentially limit the measurement accuracy and measurable thickness range, and they can as well increase the measurement error.

2.2.4.1 Sound dispersion

In some materials (some types of stainless steel, cast-iron, composites) the sound energy is being dispersed (on the crystallite molding or on additions in the composites). This effect reduces the possibility of the quality receipt of the signal reflected from the backside of the tested object, thus limiting the abilities of the ultrasound measurements.

2.2.4.2 Variation of velocity

Sound velocity can vary essentially when sound goes from one point to another in some materials. This effect in some types of the cast stainless steel and copper is caused by the relatively big size of the grains and by the anisotropy of the sound velocity with respect to the grain orientation.

2.3 MAKING THE INSTRUMENT READY FOR OPERATION

2.3.1 Surface preparation

Carefully clean the surface of inspected item from dirt, friable rust and scale prior to measurements. Apply sufficient amount of the lubricant to the area of inspection.

2.3.2 Switching On/Off the instrument

To **switch on** the thickness gauge, shortly press the 

key.

On the screen of the instrument a moving message with the manufacturer name and firmware version is displayed for several seconds (Figure 3).

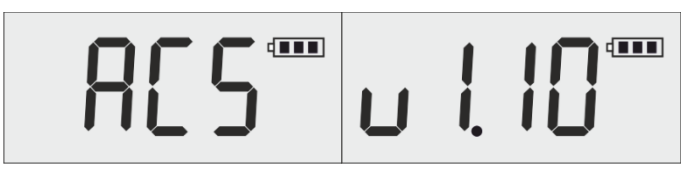

Figure3

The instrument will switch into the measurement mode. The horizontal strokes, the accumulator battery state and the current measurement units are displayed on the screen (Figure 4).

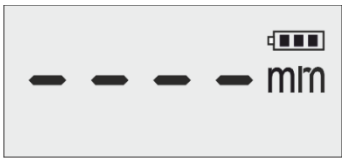

Figure4

To **switch off** the thickness gauge, press and hold the Enter key for more than two seconds.

N o t e – The instrument will automatically switch off in 5 minutes if neither keys are pressed nor the measurement process goes.

2.3.3 Select the measurement units

Select the measurement units: metric or imperial.

METRIC ("mm" shall be indicated) - the thickness will be measured in mm; the velocity will be set in m/s.

IMPERIAL ("in" shall be indicated) - the thickness will be measured in inches (in), the velocity will be set in inch/ms (in/ms).

To select the measurement units, while switching on the instrument, press and hold the Enter key untill the screen changes the displayed measurment values from "mm" (metric system) to "in" (imperial system) or vice-versa (Figure 5).

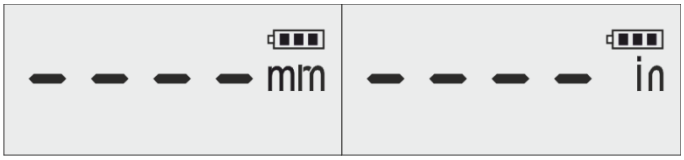

Figure5

2.3.4 Adjustment of the instrument

2.3.4.1 Current ultrasonic sound velocity

To view current ultrasonic sound velocity (Figure 6) shortly press (hold no longer than 2 seconds) the − or + key while in the measurement mode.

Figure 6

2.3.4.2 Edit current ultrasonic sound velocity

To edit the current ultrasonic sound velocity value, do the following:

– press (hold longer than 2 seconds) the [−] or [+] key while in the measurement mode, at that the current velocity value will start blinking;

– set the required velocity value using the [−] or [+] key;

– the velocity value will stop blinking in three seconds, and the instrument will switch to the measurement mode; at that the set velocity value will be saved.

N o t e – The instrument saves the set velocity value when off.

2.3.4.3 Measure the ultrasonic sound velocity in the sample of known thickness

To measure the ultrasound velocity in the sample of known thickness, do the following:

– set in the instrument the ultrasonic sound velocity value in the sample of known thickness (see 2.3.4.2);

– place the instrument onto the surface of the sample with a layer of the coupling media pre-applied;

– measured thickness value will be blinking;

– adjust the velocity value by means of the [−] or [+] keys, so that the known thickness value is displayed as the measurement value;

– take the instrument from the sample, the measured resulting velocity value will be blinking on the screen;

– the velocity value will stop blinking in three seconds, and the instrument will switch to the measurement mode; at that the measured velocity value will be saved.

N o t e – If there is no material sample, though the tested item is accessible from both sides, you can measure its thickness (Figure 7) in the place convenient for inspection (using a micrometer), and then adjust the instrument in the way similar to adjustment using a sample of known thickness.

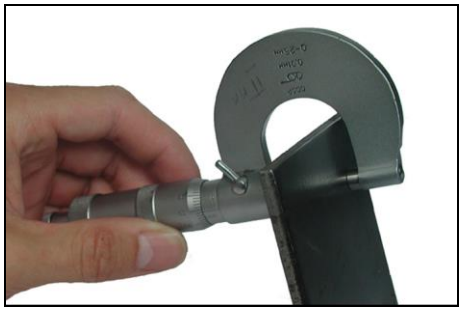

Figure7

2.3.4.4 Calibration mode

Calibration mode consists of two stages. The first stage is the turning off the noise threshold. The second stage is the determination of the latency value in the transducer using the calibration sample included in the delivery kit. The second stage is not obligatory. It shall be executed after replacement of the transducer.

ATTENTION: PRIOR TO CALIBRATION, SET THE VELOCITY VALUE IN THE INSTRUMENT INDICATED ON THE CALIBRATION SAMPLE!

To enter the calibration mode, simultaneously press and hold (longer than 2 seconds) the ⊖ and ⊕ keys. The blinking message "CLbt" is displayed on the screen (Figure 8).

Figure8

The noise threshold will be determined automatically. Now the first calibration stage is finished; the instrument will switch into the measurement mode in three seconds.

To perform the second stage of calibration, within three seconds after the instrument has entered the calibration mode, place the instrument onto the surface of the calibration sample with a layer of the coupling media pre-applied.

The instrument shall remain on the sample until the calibration is completed. The procedure is indicated by a countdown from "9" to "0" ("CLb9", "CLb8", … "CLb0 The procedure is indicated by a countdown from) (Figure 9).

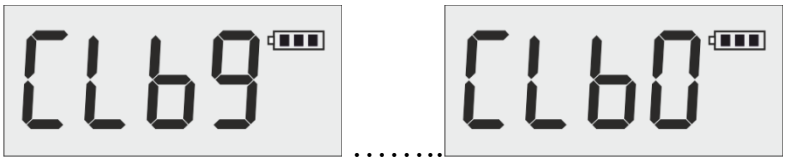

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Figure9

If the calibration result is negative, the screen will display "FAIL" (Figure 10). If so, restart the calibration on the sample.

Figure10

If the second stage is completed successfully, the instrument will go to the measurement mode.

2.4 USING THE INSTRUMENT

2.4.1 Switch on the instrument.

2.4.2 Set the velocity value of the material of the tested item.

2.4.3 Place the instrument on the sample surface with a layer of the coupling media pre-applied, wait for 1-2 seconds, so that the screen will display constant thickness measurement values.

2.4.4 Read the displayed value.

2.4.5 Remove the instrument from the tested item.

N o t e –The measured thickness value will be displayed on the screen for 7 - 10 seconds, after that the four strokes will appear on the display.

3 MAINTENANCE

The maintenance of the instrument includes cleaning it from dirt and dust and recharging the accumulator.

3.1 ACCUMULATOR BATTERY

The rechargeable battery of the instrument is designed for operation over a wide range of temperatures. The battery capacity decreases at negative temperatures. The capacity is lower by appr. 15% than at normal temperatures.

If the battery is almost dead when the power is on, its state will be indicated by the blinking unshaded battery symbol. The instrument will automatically switch off when the accumulator battery is dead.

The rechargeable battery has a built-in protection against overcharge, over discharge, excess current and temperature.

The rechargeable battery is designed for entire warranty period of the instrument operation.

The rechargeable battery shall be replaced by the service centers only.

ATTENTION: REPLACING THE BATTERY BY THE OPERATOR IMMEDIATELY VOIDS THE WARRANTY FOR THE INSTRUMENT!

3.2 RECHARGING THE ACCUMULATOR

The accumulator is charged via the external charger or from PC via USB.

When the charger is connected to the instrument, the battery filling sign starts blinking. During the charging process the blinking symbol "moves" to the top of the battery sign.

The period of charging depends on the discharge level. The full charge takes 4-5 hours. Repeated recharge is allowed.

The instrument can be operated during charging. In this case the charging time will be 2-3 times longer.

ATTENTION: DON’T STORE THE INSTRUMENT WITH DISCHARGED BATTERY TO PREVENT ITS FUNCTIONAL LOSS!

3.3 REPLACEMENT OF THE TRANSDUCER CAPSULE

The user can independently replace the worn out piezoelectric transducer capsule without any additional tools. On the Figure 11 a sample of a capsule is shown.

Figure11

To replace the capsule of the transducer, proceed as follows:

– Switch off the instrument;

– Unscrew the tip;

– Disconnect the capsule from the instrument (Figure 12).

Figure12

– Reinsert a new capsule;

– Screw in the tip.

ATTENTION: AFTER THE CAPSULE IS REPLACED, CALIBRATE THE DEVICE USING THE CALIBRATION SAMPLE (see 2.3.4.4).

3.4 COMMON TROUBLSHOUTING AND REMEDIES

Operators experiencing troubles during the instrument operation or having any questions relating its operation, please immediately contact the manufacture representatives.

4 STORAGE

A1207 Ultrasonic Thickness Gauge should be shelf stored in the bag included in the delivery kit of the instrument.

The arrangement of the instruments in warehouses shall enable their free movement and unrestricted access to them.

The distance between the instruments and the walls, floor of the warehouse and other warehoused instruments shall be at least 100 mm.

The distance between the heating of a warehouse and the instruments shall be at least 0.5 m.

The storage room shall be free from the current-conducting dust, admixtures of aggressive gases and corrosive vapors able to attack the instruments.

5 TRANSPORTATION

A1207 Ultrasonic Thickness Gauge should be transported in the bag included in the delivery kit of the instrument.

The transportation conditions with regard to the impact of the external environment climatic factors should correspond to storage conditions.

The packaged instruments can be transported by any vehicle types for any distances without speed restrictions.

The packaged instruments shall be properly fastened in the transport vehicle. The packaged instruments shall be protected from precipitation and water splashes if the instruments will be transported in an open transport vehicle.

The packaged instruments should be properly and steadily fixed to prevent shocks of devices against each and against vehicle walls during the transportation.

The transportation conditions should confirm to the requirements of the technical conditions and regulations applicable to each type of transportation.

If shipped by air, properly packed instruments should be placed in hermetically sealed and heated compartments.

In case the transportation conditions differ from the operation conditions, the instruments shall be kept under normal environmental conditions for at least 2 hours prior to operation.

APPENDIX A

(reference)

Propagation speeds of the longitudinal ultrasonic waves in some materials are presented in Table A.1.

T a b l e A.1

Material	Velocity, m/s	Material	Velocity, m/s
Aluminium	6260	Concrete	2000 – 5400
Aluminium alloy D16T	6320	Ragstone	5930
Bronze (phosphor)	3530	Gabbro 38	6320
Vanadium	6000	Plaster stone	4790
Bismuth	2180	Foliated granite	7870
Tungsten	5460	Granite	4450
Ferrum	5850	Toadstone 85	5800
Gold (Aurum)	3240	Dolomite	4450
Constantan	5240	Limestone	6130
Brass	4430	Limestone 86	4640
Brass LS-59-1	4360	Capron	2640
Magnesium	5790	Quartz glass	5930
Manganin	4660	Labradorite 44	5450
Manganese	5561	Ice	3980
Copper	4700	Marble	6150
Molybdenum	6290	Plexiglass	2670
Nickel	5630	Polystyrol	2350
Stannum	3320	Rubber	1480
Osmium	5478	Mica	7760
Lead	2160	Acrylic plastic	2550
Silver (Argentum)	3600	Silicate glass	5500
Glass-ceramics	6740	Steel H15N15GS	5400
Steel 20 GSNDM	6060	Steel St3	5930
Steel HN77TUR	6080	Thermazote	2920
Steel 40HNMA	5600	Teflon	1350
Steel HN70VMTU	5960	Porcelain	5340
Steel HN35VT	5680	Ebonite	2400
Tantalum	4235	Circonium	4900
Chromium	6845	Cast iron	3500 – 5600
Zinc	4170		

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