Distributed by: ABQ Industrial LP USA
Tel: +1 (281) 516-9292 / (888) 275-5772 **eFax:** +1 (866) 234-0451
Web: https://www.abqindustrial.net **E-mail:** info@abqindustrial.net

Technical Manual and Operating Instructions

Ultrasonic Thickness Gauge MiniTest 420

ABQINDUSTRIAL
PRECISION. RELIABILITY. QUALITY.

Distributed by: ABQ Industrial LP USA
Tel: +1 (281) 516-9292 / (888) 275-5772 **eFax:** +1 (866) 234-0451
Web: https://www.abqindustrial.net **E-mail:** info@abqindustrial.net

Important Note

In ultrasonic thickness measurement it is inherent to the measuring procedure that the gauge might use the second echo rather than the first one reflected from the material being measured. This may result in a thickness reading **TWICE** as high than the actual thickness.
When measuring through extremely thick coatings in the echo-echo mode, it may occur that the thickness of coating layer is measured instead of the wall thickness that actually was intended to be measured.

The responsibility for proper use of the gauge and recognition of this phenomenon rests solely with the user of the gauge.

Table of Contents

1. Introduction

MiniTest 420 is a non-destructive ultrasonic thickness gauge for portable or stationary use. Working according to the ultrasonic principle it enables quick and easy measurement of wall thickness. It can also be used for the measurement of the sound velocity of metals and various other materials.

Prior to use, please read the operating instructions carefully in order to get familiar with the use and all functionalities of the MiniTest 420.

Even if you are already familiar with measurement according to the ultrasonic principle, it is highly recommended to read section 1.1 carefully. This section provides important information on the limitations to and conditions for reliable wall thickness measurement such as technical training, required knowledge on the specific requirements for testing and the selection of a suitable test equipment.

The gauge is easy to use. To enable its quick use, please read the sections below to get familiar with the preparatory requirements and basic functions.

1.1 Important Notes on Wall Thickness Measurement

Before using the wall thickness gauge, please read the following instructions carefully. Make sure to fully understand and follow the instructions in order to avoid errors that might lead to erratic readings. Any decisions based on erratic readings may cause damage to property or personal injury.

Prerequisites for the use of ultrasonic wall thickness gauges

This manual contains essential information on how to operate your measurement device. In addition, there are a number of other factors to influence measurement. A detailed description of all such factors would be beyond the scope of this manual. For that reason, this manual is limited to the three most important requirements for reliable ultrasonic wall thickness measurement:

- adequate training of the person in charge of measurement
- fundamental knowledge on the specific requirements on and limitations to the measuring technique used for testing
- choice of a suitable measuring equipment

1.1.1 Training of the Person in Charge of Testing

The proper use of ultrasonic test equipment requires an adequate training in the field of ultrasonic wall thickness testing. Such training should include the following subjects:

- theory of sound propagation in materials
- effect of the sound velocity inherent to material to be tested
- behaviour of sound waves at the interfaces between different materials
- propagation of the sound beam in the material
- effect of the surface quality of the material to be tested

Insufficient knowledge on the above topics may result in erratic readings and thus lead to unforeseen consequences. For more information on the availability of training opportunities for examiners in ultrasonic testing, qualifications and certificates, please contact your national NDT partner, or, in Germany Deutschen Gesellschaft für Zerstörungsfreie Prüfung e.V., Motardstraße 54, D-13629 Berlin.

1.1.2 Limitations to Ultrasonic Testing

The results obtained from measurement solely relate to areas of the measuring object that have been targeted by the sound beam. Conclusions to other areas of the measurement object are not admissible. They are only allowed if extensive experience on the process of manufacture of the measuring objects is available and if appropriate methods of statistical evaluation can be applied. It should be taken into consideration that the ultrasound beam might be completely reflected by interfaces being present in the measuring object so that deeper reflection points will not be reached by the ultrasound any more. For that reason it must be ensured that all areas of the measuring objects to be measured can be reached by the sound beam.

1.1.2.1 Ultrasonic Wall Thickness Testing

Ultrasonic wall thickness measurement is based on the measurement of travel times of sound pulses in the object to be measured. For reliable wall thickness measurement it is presumed on the assumption that the velocity in the measuring object remains constant. Generally, this is given for the majority of work-pieces made of steel. Even if they include different alloy components, the sound velocity changes will be small enough to be neglected (unless high-precision measurement is required).
In other materials such as non-ferrous metals or plastics, the sound velocities are subject to major changes that might impair the measuring accuracy.

1.1.2.2 Influence of the Material to be tested

Material discontinuities may lead to strong variations of the sound velocity within a measuring object. In such case, an average sound velocity should be used for testing.
However, the best results will obtained when calibrating the gauge by means of a reference sample. This sample must be made of the same material as the object to be measured and should exhibit plane parallel surfaces. Its thickness should equal the maximum thickness of the later object to be measured. Please note that any heat treatment might considerably change the sound velocity and thus influence the measuring precision accordingly.
If dramatic changes of the sound velocity are to be expected, it is recommended to readjust the sound velocity within shorter time intervals. This is to avoid erratic readings.

1.1.2.3 Influence of Changes in Temperature

The sound velocity is also influenced by the temperature prevailing in the material. If the gauge has been adjusted to a “cold” reference sample and wall thickness measurement is made on a “warm” object, major measuring errors are very likely to occur.
To avoid such measuring errors, it is recommended to use a temperature-adapted reference sample for adjusting the gauge. Another option would be to correct for the applicable temperature influence by means of the sound velocity/temperature correction table.

1.1.2.4 Measurement of the Residual Wall Thickness

Measuring the residual wall thickness of internally eroded or corroded objects such as tubes, containers or reaction vessels makes it necessary to choose a most suitable test equipment and to handle the sensor with utmost care. In addition, the nominal wall thickness as well as the suspected degree of wall thickness loss should be known.

1.1.2.5 How to use the Couplant

Make sure the user is familiar with the use of couplant. For each measurement, the couplant must be applied evenly over the surface of the measuring object. Any variations in couplant layer thickness will influence measuring accuracy. Both, adjustment of the gauge and wall thickness measurement must be made under the same coupling conditions. Make sure to use a quantity of couplant as small as possible and to apply a constant contact pressure of the sensor.
When measuring on curved surfaces such as pipes or tubes make sure the coupling of the transceiver is made properly. The acoustic layer interface of the transceiver must be aligned so as to form a right angle to the axis of curvature of sample (longitudinal axis of tube). For small tube

diameters it is recommended to carry out two measurements: one with the layer interface in vertical position to the longitudinal axis of tube, another one in parallel position to the longitudinal axis of tube. The smaller of the two readings obtained should be used as the correct one for this measuring spot.

(senkrecht = vertical)

1.1.2.6 Duplication of Reading

Do not measure in a range lower than the measuring range specified for the sensor. In such case, the first back wall echo would not be strong enough for being processed whereas the amplitude of the second one would be strong enough to be processed accordingly. As a result, the reading obtained would be twice the actual wall thickness. In order to avoid such errors when measuring at the limit of the measuring range it is recommended to verify results by using another sensor.
In critical cases, it is recommended to use display screen equipment to provide additional information on the echo curve.

2. Technical Specifications

Display screen:	128 x 64 pixel dot matrix LC display, backlit
Digital display:	four-digits
Measuring range:	0.65 mm ... 500.0 mm (steel)
Display resolution:	0.1 mm (if readings > 100 mm)
	0.01 mm (if readings < 100 mm)
Measuring accuracy:	0.65 mm ... 9.99 mm: ± 0.04 mm
	10 mm … 99.99 mm; ± (0,1% of reading + 0,04) mm
	100 mm ... 500 mm: ± 0,3 % of reading
Sound velocity:	1000 ... 9999 m/s
Measuring frequency:	2 readings/second
Zero point calibration:	manual
Auto switch-off:	2 minutes, 5 minutes or shut down manually
Power supply:	2 x AA battery, battery life 80 h in continuous operation
Operating temperature:	-20°C ... 50°C
Storage temperature:	-25°C ... 60°C
Dimensions:	130 x 73 x 24 mm
Weight:	190 g (without batteries)
Options	Transducers U2.0, U5.0, U7.5, U10.0, U5.0HT

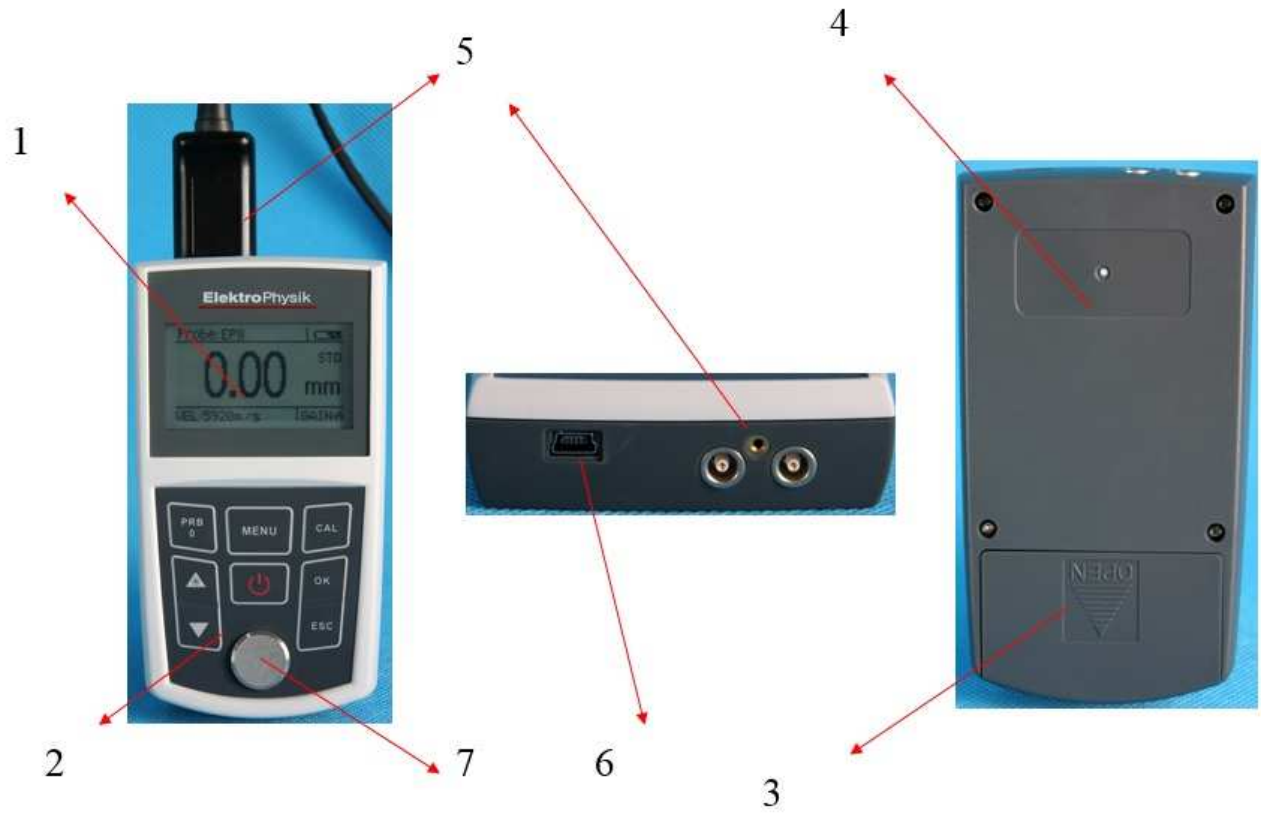
3. Measuring Principle

The ultrasonic sensor head emits an ultrasonic signal to travel through the sensor head, the couplant and finally to the measuring object. A portion of the ultrasound signal is reflected from the surface of measuring object, another one is reflected from the opposite side of the object when travelling back. The sensor receives both echoes. The wall thickness is calculated according to the exact time of travel of pulse and shown as reading on display.

.

4. Description of the Gauge and Schedule of Supply

4.1 Description of the gauge (Front and back side)



1. display
2. keyboard
3. battery compartment (back panel)
4. name plate (back panel)
5. transducer socket (Identify PIN)
6. service interface (behind rubber stopper, NO USB interface !)
7. test block for calibrating of the transducer

4.2 Supply Schedule

1. 1 x plastics carrying case
2. 1 x MiniTest 420 gauge
3. 1 x ultrasonic transducer (U5.0 for MiniTest 420)
4. 1 x couplant (gel, 200ml)
5. 1 x operating instructions (German / English) on CD Rom
6. 1 x USB connecting cable
7. 2 x 1,5V (AA) batteries

4.3 Display MiniTest 420

1. sensor head
2. battery state
   - fully charged
   - empty
3. measuring mode
4. measuring icon and measuring unit
5. gain mode of amplifier selection (A = Auto, L= Low , M = Medium, H = High).
6. sound velocity selection
7. current reading

4.4 Keyboard of MiniTest 420

	ON / OFF button
	Menu key Press to enter the operating menu
	Arrow UP/DOWN keys Press UP/DOWN to scroll through the different menu options. Press arrow UP to enable / disable the backlight.
	OK/ESC key Press OK to confirm a selection in the menu. Press ESC to quit the menu.
	CAL key Quick access for sound velocity calibration (it is required the wall thickness is known).
	Quick access for transducer (PRB = transducer) calibration. Put transducer onto the test block and press “PRB 0”. Transducer calibration is done.

5. Preparing Measurement

5.1 Preparing the Gauge

Please check gauge and accessories immediately upon receipt. For the supply schedule, please refer to section 4.1.2 of this manual. Please contact your supplier in case delivery is not complete or does not comply with the supply schedule you have ordered. Any damage of the gauge should be reported upon delivery. Do not use the gauge in case it seems to be damaged!

5.2 Selection of the Transducer

Type	Frequency	Measuring range	Temperature
U5.0	5.0 MHz	0.8 mm.n.300 mm	< 60°C
U5.0HT	5.0 MHz	3.0 mm…200 mm	< 350°C
U7.5	7.5 MHz	0.65 mm… 50 mm	< 60°C
U10.0	10.0 MHz	0.65 mm... 20 mm	< 60°C
U2.0	2.0 MHz	2.0 mm...500 mm	< 60°C

Make sure to select a suitable transducer according to the thickness of your measuring object. The transducer used for measurement must be in a good condition. Make sure transducer tip and coupling surface are not worn off. The measuring range of transducer should cover the complete wall thickness range to be measured (application range). The temperature of measuring object must not exceed the temperature range specified for the transducer you have selected.

Transducer model	Application
U5.0:(5,0 MHz)	Standard transducer for MiniTest 420 to cover a wide range of applications such as measurement on - flat surfaces - large curvature radii - objects with a thickness > 50 mm
U5.0HT (5 MHz)	Temperature < 350°C
U7.5 (7,5 MHz)	Thin wall thickness and small curvature radius
U10.0 (10 MHz)	Thin wall thickness and small curvature radius (small geometries)
U2.0 (2,0 MHz)	Rough surfaces, such as on cast components

5.3 Preparing the Surface of Measuring Object

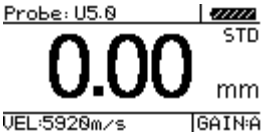
Very rough and/or corroded surfaces should be pre-treated as follows:

1. Smoothen the surface by grinding, polishing or filing or use a high-viscosity couplant.
2. Apply some couplant to the surface of measuring object.
3. Take several readings around the measuring spot.

6. How to operate the MiniTest 420

6.1 Switch ON

Connect the transducer to the gauge socket. Press the ON/OFF button  to switch on. The following appears on display:



If no transducer has been connected prior to switch ON, the following message will appear: ”Please insert the transducer”. Insert the transducer into the gauge socket and wait for the measuring status to appear.

Please make sure to connect solely original ElektroPhysik transducers suitable for MiniTest 420. Otherwise, the gauge will not work correctly and the error message “ERROR” will appear.

6.2 How to take readings

There are two options to access the measuring mode:

1. Connect transducer and switch on the gauge.
2. From the menu you can press ESC and go back to the measuring mode.

Once you have put the transducer onto the measuring object, the display will show the measuring icon to indicate the coupling action. Once the reading has stabilized, you can detach the transducer from the measuring object. Remove the transducer in a quick action. The last reading taken appears on display.

6.3 Calibration

6.3.1 Gauge Setting

Prior to measurement, a zero point calibration is required and the MiniTest 420 must be adjusted to the material to be measured.

The gauge housing includes an integrated zero test block. Zero point calibration should be done on this test block.
Set the sound velocity to 5920m/s.
Apply a thin layer of couplant to the transducer test surface. Place the transducer onto the circular zero point of the zero test block of the MiniTest 420.

Press Transducer Zero key 

and wait for 2 seconds until the zero point calibration has been completed. On display, the following reading should appear: 4,0 ± 0,01mm .

Please note:
If you have set a sound velocity other than 5920m/s, you can also calibrate the gauge. However, in such case it is required to use a reference sample with a defined thickness and sound velocity.

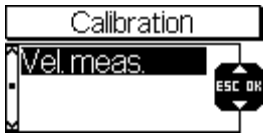
6.3.2 Influence of the Sound Velocity on Measurement

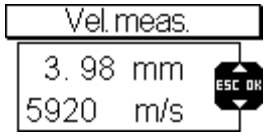
The sound velocity in the measuring object depends on the material the object is made of. In addition, measuring objects might exhibit material irregularities (if produced in different product batches). As a result, the sound velocity might vary according to the sample to be tested. To prevent measuring errors based on divergent sound velocities, it is absolutely necessary to determine the precise sound velocity of an object unless measuring errors are small enough to be neglected. To calibrate the gauge to the correct sound velocity of an object, the function “Sound velocity” is available.

6.3.3 How to determine the Sound Velocity

1. Select a stored sound velocity or set the gauge to a sound velocity as close as possible to the sound velocity of the material to be measured.
2. Take a sample of a defined thickness as close as possible to the thickness of the later measuring object. If no such sample is available, take your measuring object and measure its thickness using a caliper or another measuring tool.
3. Now use MiniTest 420 to measure the sample in order to get a thickness value.
4. First press 

-key to go to the “Sound velocity”. Then press  or  in order to adjust to the thickness reading you have measured and get the correct sound velocity accordingly.





5. Adjust the sound velocity so that the material thickness shown on display corresponds to the measured thickness of sample.
6. Re-measure the sample and check the deviation between reading and actual thickness. If both values are identical, the sound velocity is correct for this material.

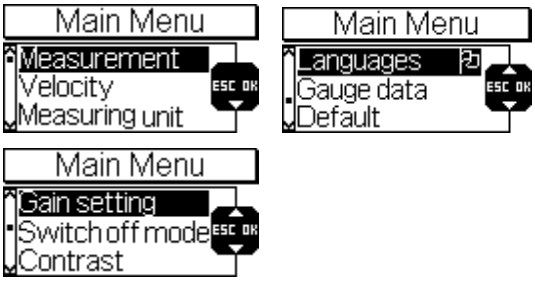
6.4 User Menu

Press MENU to go to the main menu. Us ▲ or ▼ keys to make your selection.

Press OK to confirm your selection.

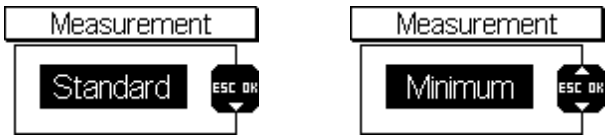
Press ESC to quit the main menu and go back to the measuring mode (Meas. Mode).

MiniTest 420



6.4.1 Measuring Mode (Meas. Mode)

MiniTest 420 offers two different measuring modes the user can select according to his setting of task and requirements.



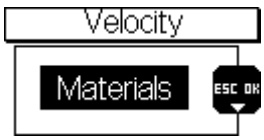
Standard:
In this mode, the current reading is shown. This mode is recommended for standard measuring requirements.

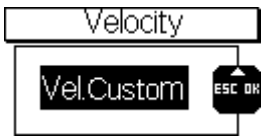
Minimum:
In this mode, the lowest values is being shown during measurement. This mode is recommended for curved surfaces or if it is required to indicate the lowest thickness values. This would be a typical application of tube measurement.

Caution! This mode is NOT recommended for cast iron or aluminium alloys.

6.4.2 Sound Velocity

The correct selection of the sound velocity is vital for accurate measurement. Different materials exhibit different sound velocities. If you select the wrong sound velocity, measurement will be erroneous.
There are two ways to select the material's sound velocity: material selection and sound velocity setting.



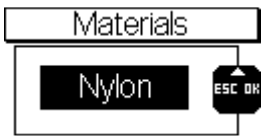


Materials:
You select the sound velocity according to the material and the pre-set sound velocity.

Vel. Custom:
The sound velocity is user adjustable.

6.4.2.1 Materials

If the material and its specific sound velocity are known, users can select the sound velocity from the gauge accordingly. Nine (9) different velocities are stored in the gauge and can be selected by the user: Aluminium, titanium, steel, stainless steel, glass, copper, brass, polystyrene and nylon.



Note: The 9 velocities are just theoretical ones. To increase measuring accuracy, please refer to "Setting Sound Velocity" under 6.4.2.2. The sound velocity functionality enables you to set the gauge to the correct sound velocity of a material.

6.4.2.2 Setting Sound Velocity

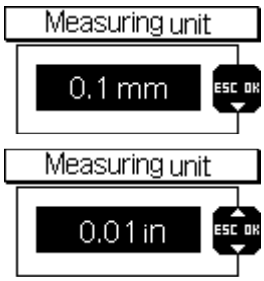
If none of the sound velocities as stored for the 9 materials meet your requirements, the sound velocity can be adjusted individually. Please refer to the table given in the appendix, section 9 of this manual. Use this table to set to the correct sound velocity as requested.

Note: For more accurate measurements, please refer to section 6.3.3 "How to determine the sound velocity".

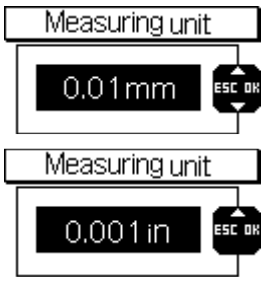
6.4.3 Measuring Unit

Read-out resolution and measuring unit are user-adjustable. When selecting "High resolution", the surface of measuring sample should smooth in order to obtain accurate readings.

Low resolution



High resolution



Note:

For using the U5.0HT or U2.0 transducers, the following setting is recommended:

0.1 mm / 0.01 in.

6.4.4 Gain Setting

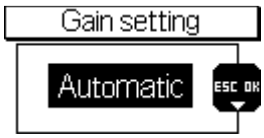
Measuring accuracy and consistency of readings are influenced by the material to be measured and its composition. In order to meet the requirements for accurate measurement, it is requested to set the gauge according to the special characteristics of a sample and measuring conditions. For the majority of materials and conditions the auto gain adjustment will be sufficient whereas some specific measuring tasks might require specific gauge settings. For gain setting, the gauge offers four different working modes: Auto, Low, Medium and High.

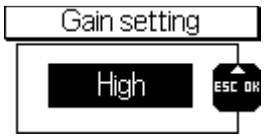
Auto: This mode matches different transducers and is suitable for the majority of measuring requirements.

Low: Suitable for high scattering and materials exhibiting low attenuation properties.

Medium: Suitable for a large field of applications.

High: Suitable for high attenuation materials.





6.4.5 Switch-Off Mode

The gauge offers three different service modes:

- after 2 min: automatic switch off after two minutes of idle state
- after 5 min: automatic switch off after five minutes of idle state
- disable: automatic switch off is disabled, the gauge is in continuous operation

Note:
When the automatic switch off has been disabled, make sure to switch off the gauge manually after use in order to save power.

6.4.6 Contrast

The gauge offers 6 levels for contrast setting.

6.4.7 Language

The gauge offers the following languages: Chinese, English, German, French.

6.4.8 Gauge Data

This functionality allows you to read out the following data:

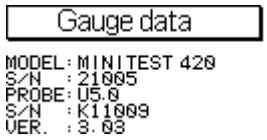
Gauge model

Serial of gauge

Transducer type

Serial of transducer

Software version of gauge



6.4.9 Standard Setting

For trouble shooting, it is recommended to use this function to reset the gauge to the factory settings.

7. Measuring Technology

7.1 Measuring Methods

The gauge provides four different measuring methods.

1. Single point measurement: use the transducer to measure any point of the measuring object. The reading shown is the thickness value.

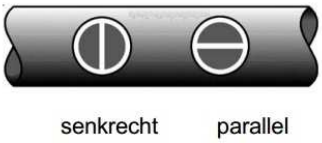
2. Two point measurement (on cylindrical parts, e. g. pipes and tubs): perform two measurements on the same point of the surface of object. During the second measurement, make sure the black line on the transducer head (layer to separate the transmitter and receiver part of transducer) is oriented in a 90 degree position to the axis of the pipe or tube. The smaller of the two readings obtained represents the thickness value.

3. Multiple point measurement: perform several measurements on the measuring object within a range of about 30mm in diameter. The smaller of the readings represents the thickness of the measuring object.

4. Continuous measuring method: use the single point measuring method and take readings continuously along the designated route. The intervals between measurements should be less than 5mm. The smallest reading represents the thickness of the measuring object.

7.2 Measurement on Pipes and Tubes

During measurement, make sure to position the transducer's separating layer perpendicular or parallel to the longitudinal line of the pipe or tube. For pipes and tubes of large diameters, the separating layer of transducer should be perpendicular to the longitudinal line the measuring object whereas for small diameters, it is recommended to carry out measurement in both directions, perpendicular and parallel to the longitudinal line of the measuring object. The minimum readout represents the thickness of object at this measuring spot.



perpendicular parallel

8. Maintenance and Precautions

8.1 Power Check

When the power is low, the low battery indicator appears. At this moment, users should replace the battery in time, or it will affect the measuring accuracy. Please note that the backlight will use additional power. If the battery is too low, the backlight will automatically shut down in order to ensure reliable service.

For use on site it is recommended to make available a set of replacement batteries.

Note: If the gauge is not in use for a longer period of time, make sure to remove the batteries in order to prevent battery leakage and damage to the gauge.

8.2 Precautions

8.2.1 General Precautions

Keep the gauge away from strong vibrations. Do not stock in an environment with increased levels of air humidity. To prevent cable damage, plug or unplug the transducer by holding the cable jacket.

8.2.2 Precautions to take during Measurement

1. Once you place the transducer on the measuring object, the measuring symbol appears on display (arrow down) to indicate the coupling action. As soon as the reading has stabilized, you can lift the transducer from the measuring object.
2. Make sure to remove the transducer immediately after a reading has been taken successfully as putting the transducer down again might cause erratic readings if big amounts of coupling agent are placed on the measuring object.
3. Please note: a worn off transducer will lead to unstable and erratic readings and should be replaced by a new one.

Annex

Table of materials and their typical sound velocity (Longitudinal wave)

Material	Sound velocity	
	in/µs	m/s
Air	0,013	330
Aluminium	0,250	6300
Aluminium oxide	0,390	9900
Beryllium	0,510	12900
Boron carbide	0,430	11000
Brass	0,170	4300
Cadmium	0,110	2800
Cast iron	0,180	4600
Crown glass	0,210	5300
Cupper	0,180	4700
Glycerine	0,075	1900
Gold	0,130	3200
Ice	0,160	4000
Inconel	0,220	5700
Iron	0,230	5900
Lead	0,085	2200
Magnesium	0,230	5800
Mercury	0,057	1400
Molybdenum	0,250	6300
Monel	0,210	5400
Neoprene	0,063	1600
Nickel	0,220	5600
Nylon, 6.6	0,100	2600
Oil (SAE 30)	0,067	1700
Platinum	0,130	3300
Plexiglass	0,110	1700
Polyethylene	0,070	1900
Polystyrene	0,0930	2400
Polyurethane	0,0700	1900
Quartz	0,230	5800
Rubber, Butyl	0,070	1800
Silver	0,140	3600
Stahl stainless	0,228	5800
Steel, commercial	0,233	5920
Teflon	0,060	1400
Tin	0,130	3300
Titan	0,240	6100
Tungsten	0,200	5200
Uranium	0,130	3400
Water	0,584	1480
Zinc	0,170	4200

Please note: The actual sound velocities depend on the temperature, composition and treatment of a material. Especially metal alloys or plastic materials may exhibit strong variations. For that reason, all values stated in the table are approximate ones.

9. Safety Notes

Safe operation will be ensured as far as the instructions and notes in this manual and on the gauge are observed.

Prior to any installation work the power supply must be cut.

Please do only use original spare parts or accessories.

	**Storage batteries and accessories** Make sure to use only original accessories and batteries supplied / recommended by the manufacturer of the gauge. Connect only to compatible peripheral devices.
	**Connecting other devices** If you connect the gauge to any other device, please refer to the respective instructions manual of such device for detailed information on safety issues. Do only connect original accessories.
	**Keep away from water** The measuring unit is not waterproof. Keep in a dry place.
	**Keep away from explosion-hazardous area.**
	**Approved after-sales service** The gauge may only be repaired by approved and qualified after-sales service personnel.
	**Medical facilities** Please ask for permission before using the gauge in medical facilities.

10. Declaration of Conformity

We herewith declare that the gauge MiniTest 420 is in conformity with the provisions of directive 89/ 336 / EEC (Electromagnetic compatibility), in Germany: EMVG (Gesetz über die elektromagnetische Verträglichkeit) of November, 9th, 1992.

.

11. After-Sales Service

The MiniTest 420 gauges are manufactured according to state-of-the-art production methods under the use of high-quality components. Careful production controls along with a Certified Quality Management according to DIN EN ISO 9001 ensure optimum product quality.
Should you nevertheless notice any error, please contact the ElektroPhysik after-sales-service and advise your problem.
Please retain the original packing for future transportation needs if a repair should become necessary.
For more detailed information on the use, applications, service or technical data, please contact your local agent or ElektroPhysik

12. Change History

This section is to backtrack any changes and modifications to this manual. If no changes are available, this section shall remain empty.