Ultrasonic Thickness Gauge

TIME2110/TIME2113

(V20140815)

Beijing TIME High Technology Ltd.

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1. General Description

1.1 Scope of Application

Adopting the theory of ultrasonic wave measurement, the TIME2110/TIME2113 Ultrasonic Thickness Gauge is capable of measuring the thickness of various kinds of materials in which ultrasonic wave pulses propagate with a constant velocity and reflect off the back interface. The device can be used to perform accurate measurements on various kinds of plates and parts. Another prominent characteristic of the device is monitoring the decrease in wall thickness of various kinds of pipes and pressure vessels caused by corrosion and erosion during use. The TIME2110/TIME2113 enjoys a wide range of applications in many areas, such as petroleum, chemical engineering, metallurgy, shipbuilding, and aviation and spaceflight.

1.2 Basic Working Principle

The principle of ultrasonic wave thickness measurement is similar to that of an optical wave. The ultrasonic wave pulses transmitted by the probe are reflected back when they reach an interface. The thickness of the object is determined by precisely measuring the time the ultrasonic wave travels within the object.

1.3 Basic Configuration and Description of Device Parts

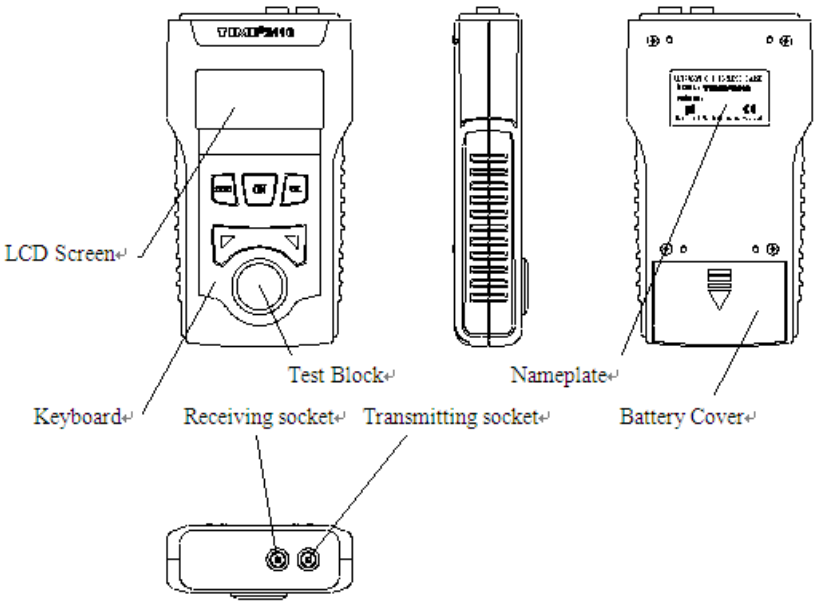
1.3.1 Basic Configuration:

- Main unit: 1 piece
- Probe 5PΦ10: 1 piece
- Coupling agent: 1 bottle

1.3.2 Optional Probes:

- Probe 5PΦ10/90: 1 piece
- Probe SZ2.5P: 1 piece
- Probe 7PΦ6: 1 piece

1.3.3 Name of Each Part of the Device (see figure below):



LCD display:

- BATT: low battery voltage indication

- 凸 : coupling indication
- m/s: metric unit of sound velocity
- mm: metric unit of thickness
- inch/μs: imperial unit of sound velocity
- inch: imperial unit of thickness

Keyboard:

- ON: power
- ZERO: calibration
- VEL: sound velocity
- ▲ / ▼: adjustment keys for sound velocity, thickness and thickness unit
- VEL + ZERO: keys for thickness memory

2. Performance Parameters

Parameter	Value
Display	4-digit LCD
Operating temperature range	0 °C – 40 °C
Power supply	2 × AAA alkaline batteries, 1.5 V
Power consumption	Working current less than 20 mA (3 V)
Weight	140 g
Dimensions	124 × 68 × 27 mm
Minimum display unit	0.1 mm – TIME2110 / 0.01 mm – TIME2113
Sound velocity range	1,000 – 9,999 m/s
Measuring error	±(1% H + 0.1) mm, H = actual thickness of the object measured
Measuring range probe 5PΦ10	1.2 – 225.0 mm (steel)
Measuring range probe 5PΦ10/90	1.2 – 225.0 mm (steel)
Measuring range probe SZ2.5P	3.0 – 300.0 mm (steel)
Measuring range probe 7PΦ6	0.75 – 60.0 mm (steel)

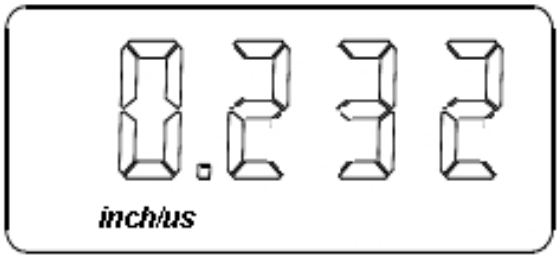
3. Main Functions

1. Two display units: metric and imperial
2. Automatic calibration to zero: automatically corrects system errors
3. Automatic non-linear compensation: across the full range, the software corrects non-linear errors of the probe to improve measuring accuracy
4. The up/down adjustment keys enable prompt selection of sound velocity and thickness, and allow checking the thickness memory units
5. Coupling state indication: provides coupling indication; observing the stability of the indication shows whether the coupling is normal
6. Ten thickness values can be stored without loss after turn-off, which is very convenient for measurements in the field and on high platforms
7. Sound velocity measurement: sound velocity can be measured directly from the thickness of a test block, without the need to look it up in a conversion table
8. Sound velocities of five different materials can be stored
9. Low voltage indication
10. Automatic turn-off
11. All keys enclosed – oil-proof for a longer service life

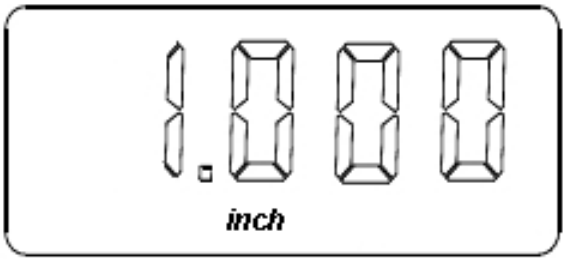
4. Switching Between Metric and Imperial

This instrument can display in two units, metric or imperial. While the instrument is off, hold down the ▼ key and then press the ON key to turn on the instrument; this switches between metric and imperial display.

- Metric display: m/s is the metric unit of sound velocity, mm is the metric unit of thickness.
- Imperial display: inch/μs is the imperial unit of sound velocity, inch is the imperial unit of thickness.



Sound velocity

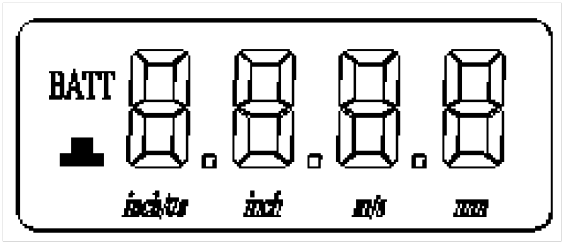


Thickness

5. Measuring Steps

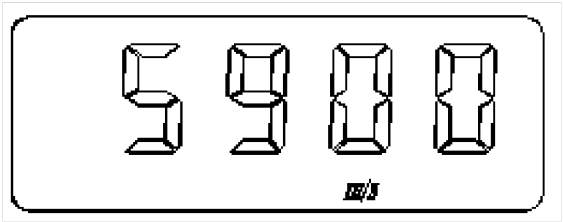
5.1 Preparation for Measurement

Insert the probe into the probe socket of the unit and press the ON key to turn on the unit, as shown in the figure below:



Full display screen

After a few seconds of full-screen display, the sound velocity used at the last shutdown will be shown. The measurement can now begin.



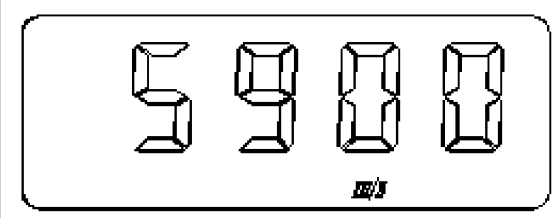
Sound velocity used at the last shutdown

Note: 5900 m/s = 0.232 inch/μs

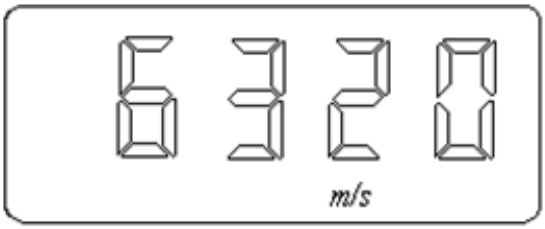
5.2 Adjusting the Sound Velocity

If the screen currently displays the thickness value, press the VEL key to enter sound velocity mode. The screen will display the content of the current sound velocity memory unit. Each time the VEL key is pressed, the sound velocity memory unit changes; five different sound velocity values are displayed in turn. If the

currently displayed sound velocity needs to be changed, the keys ▲ / ▼ can be used to adjust it to the desired value. This value will automatically be stored as one of the five saved velocities.



Press the VEL key to enter the sound velocity mode

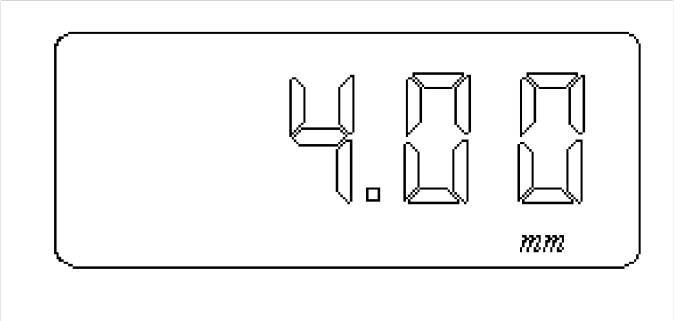


Value after adjustment with the ▲ / ▼ key

5.3 Calibration

Calibration should be performed each time the probe or battery is changed. This step is critical for measuring accuracy. If necessary, calibration can be repeated several times. Apply coupling agent to the test block supplied with the unit, set the sound velocity to 5900 m/s, then couple the probe to the test block. Press the ZERO key to enter calibration mode; the screen will display as follows:

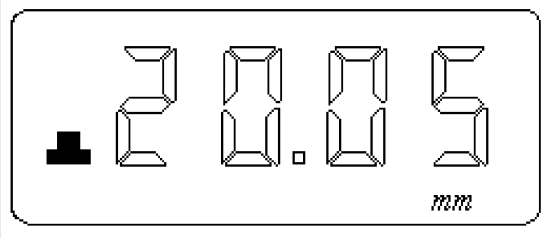
The bar lines shown on the screen will disappear one after another until the screen displays 4.0 mm (0.158 inch). This indicates that the calibration is complete. Then enter measurement mode and measure a random test block. If the measuring error exceeds the permitted measurement tolerance, calibration should be performed again until the measured value falls within the permitted tolerance.



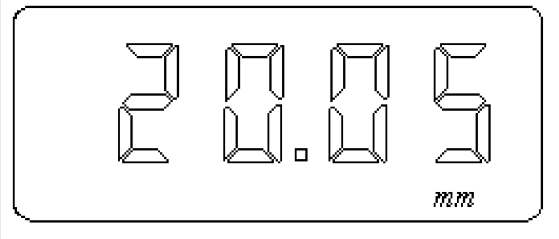
Calibration mode

5.4 Measurement of Thickness

Apply coupling agent to the spot to be measured, then couple the probe to the material to be measured. The measurement will start automatically. The screen will display the measured thickness of the material. See the figure below:



When the probe is removed, the thickness value remains on display and the coupling indication disappears. See the figure below:

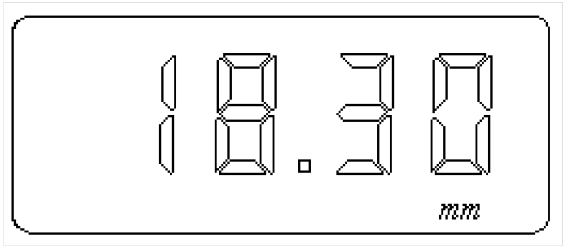


6. Sound Velocity Measurement

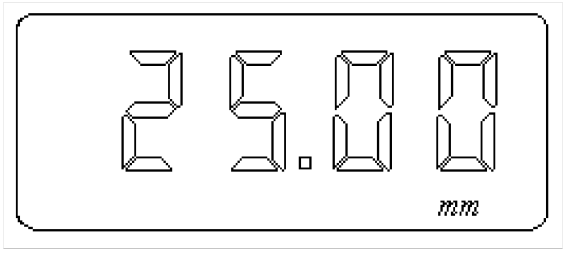
If the sound velocity of a certain material is to be measured, a test block with a known thickness is used to measure the sound velocity. First, the accurate thickness value should be obtained using vernier calipers or a micrometer. By coupling the probe to the test block of known thickness, the screen will display a thickness value; remove the probe and adjust the displayed value to the actual value using the keys ▲ / ▼. Press the VEL key to obtain the desired sound velocity; at the same time this sound velocity is stored in the current memory unit. For sound velocity measurement, the test block must be thick enough. A minimum thickness of 20 mm is recommended.

Example: measuring the sound velocity of a material with a thickness of 25 mm – procedure:

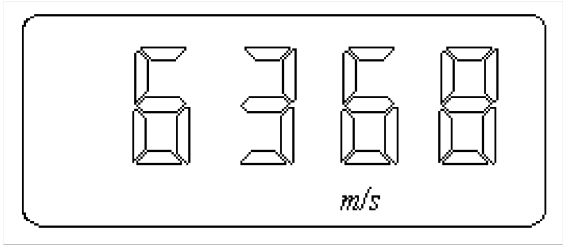
1. Enter sound velocity mode and couple the probe to the test block; a thickness value is displayed as follows:



2. Remove the probe and use the keys ▲ / ▼ to adjust the displayed thickness value to 25 mm, as shown in the following display:



3. Press the VEL key; the sound velocity measured for this material will be displayed.

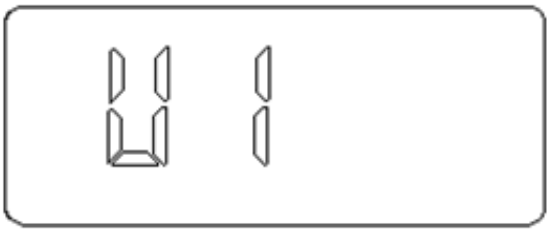


4. Repeat steps 1–3 to improve the measuring accuracy.

7. Memory of Thickness Values

7.1 Memory State

Press the VEL key and then the ZERO key to enter thickness memory mode; the screen will show a memory unit with a certain thickness value. Use the keys ▲ / ▼ to select the desired unit (the up/down keys scroll through units 0 to 9 in turn). While measuring thickness, the measured value can be stored in the selected unit. Each time a new value is measured, the old value in this unit is automatically replaced; the value stored in this memory unit is always the latest measurement. Press the VEL key to leave thickness memory mode.

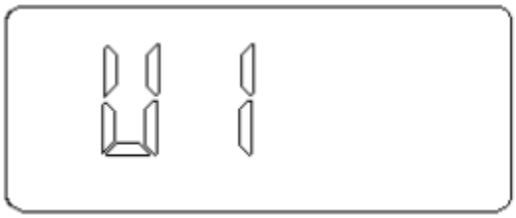


7.2 Reviewing a Memory Unit

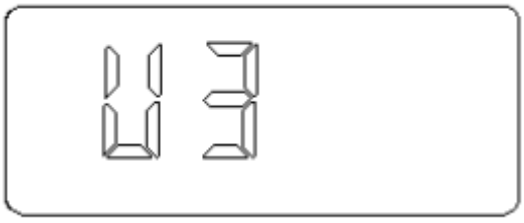
Press and hold the VEL key, then press the ZERO key to show the current memory unit number. Use the keys ▲ / ▼ to look for the required unit (the up/down keys scroll through units 0 to 9 in turn). Operate again to show the content of the memory. A new measurement value can also be stored in this unit. Press the VEL key to exit thickness memory mode.

Example: check the thickness value in memory unit 3

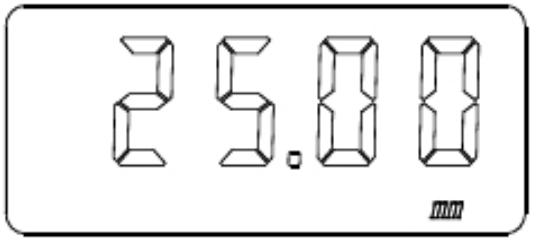
1. Press and hold the VEL key, then press the ZERO key; the display shows:



2. Use the keys ▲ / ▼ to find memory unit 3; the display shows:



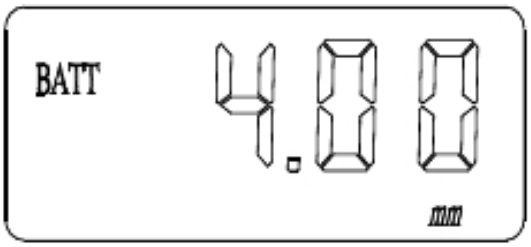
3. Press and hold the VEL key, then press the ZERO key; the thickness value stored in memory unit 3 will be displayed:



4. Press the VEL key to exit. If thickness memory mode is left without pressing the VEL key, the new measurement value will overwrite the content of this memory unit.

8. Low Voltage Indication

If BATT is displayed on the screen, the battery voltage is running low. The batteries should be replaced in time before the unit is used again.



9. Automatic Turn-Off

If no key is pressed within two minutes, the unit will turn off automatically.

10. Measuring Technology

10.1 Cleaning the Surface

Before measurement, dust, dirt, rust and any coatings must be removed from the surface of the test object.

10.2 Reducing Roughness

A surface that is too rough may cause measuring errors or no reading at all. Before starting the measurement, the test surface should be smoothed by grinding, polishing or filing. Alternatively, a high-viscosity coupling agent can be used.

10.3 Roughly Machined Surfaces

Regular fine furrows on roughly machined surfaces (e.g. machined by lathe or planer) can also cause measuring errors. The remedy is the same as in section 10.2. A better result can also be achieved by adjusting the angle between the probe's cross-talk isolating board (the thin metal layer at the bottom center of the probe) and the fine furrows of the test material (perpendicular or parallel). Select the smallest reading as the accurate thickness of the material.

10.4 Cylindrical Surfaces

When measuring materials with a cylindrical surface, such as tubes or barrels, it is essential to select the correct angle between the probe's cross-talk isolating board and the axis of the test material. Couple the probe to the test material so that the isolating board is parallel or perpendicular to the axis of the test material, then gently move the probe along the axial direction of the test material. The reading will change regularly; select the smallest reading as the accurate thickness of the material. The suitable angle depends on the curvature of the material: for tubular material with a larger diameter, keep the isolating board perpendicular to the axis of the tube; for tubes with a smaller diameter, check both orientations (parallel and perpendicular to the axis) and select the smaller reading as the measured thickness.

10.5 Compound Contours

When measuring parts with a compound contour (such as elbows), the method described in section 10.4 may be used. The difference is that a second measurement is required to obtain two readings; take the smaller reading as the thickness at the point measured.

10.6 Non-Parallel Surfaces

To obtain a satisfactory ultrasonic response, the opposite side of the test material must be parallel to, or on the same axis as, the test surface. Otherwise there will be errors or no reading at all.

10.7 Temperature Effect on the Test Material

Both the thickness and the ultrasonic wave transmission speed are affected by temperature. If high accuracy is required, the test block comparison method should be used. This method corrects the measured value using a temperature compensation coefficient obtained by measuring test blocks of the same material at the same temperature.

10.8 High-Attenuation Materials

In fibrous, porous or large-grained materials, the ultrasonic wave is scattered and attenuated in energy; this can cause an abnormal display or even no display at all (the abnormal displayed value is usually less than the actual one). In such cases the gauge is not suitable for this material.

10.9 Reference Test Block

For calibration of the instrument, a test block with a thickness of 4.00 mm is fitted to the TIME2110/TIME2113 housing; the calibration method is described in figure 4.3. This supplied test block alone is not sufficient for calibration when measuring different materials under various conditions. The more similar the test block material is to the material being measured, the more accurate the measurement. Ideally, a series of test blocks of different thicknesses should be used, which allows the device's compensation calibration coefficients to be determined (e.g. for material microstructure, heat treatment condition, grain orientation, surface roughness). Having such a series of test blocks is very important for achieving maximum accuracy.

In most cases, however, a single test block is sufficient for satisfactory measuring accuracy. This test block should be of the same material and a similar thickness to the material being tested. Select as a reference test block a test material with an evenly distributed thickness, measured with a micrometer. When the thickness of a thin material is close to the lower testing limit of the probe, a test block can be used to determine the exact lower limit (1.2 mm for steel). Materials whose thickness is below this limit should not be measured. If the thickness range can be estimated, the upper limit of the thickness of the test block should be selected.

When the material is thick, especially alloys with a complex microstructure, a similar test block from the same series should be used for proper correction.

Most castings and forgings have a directional internal structure; the sound velocity may vary slightly with direction. To address this, the test block should have a structure similar to that of the test material, and the direction of sound propagation in the test block should match that of the test material.

In some cases, the known sound velocity of a material can be looked up as a substitute for a test block, but this can only approximately replace a test block. In some cases there are differences between the value in the sound velocity table and the actual value, due to differences in the physical and chemical properties of the material. This method is often used only for approximate testing of low-carbon steel.

Since the TIME2110/TIME2113 ultrasonic gauge is also capable of measuring sound velocity, the sound velocity can first be determined and the subsequent part measurement carried out on this basis.

10.10 A Few Measuring Methods

- Single measuring method: measuring at one point.
- Double measuring method: measuring twice at one point, with the cross-talk isolating board rotated 90° between measurements. Select the smaller displayed value as the accurate thickness of the material.
- Multi-point measuring method: measuring several times across a measurement area; select the smallest reading as the thickness of the material.

10.11 Selection of the Probe

Probe type	**5РФ10**	**5РФ10/90**	**7РФ6**	**SZ2.5P**
Frequency (MHz)	5	5	7	2.5
Operating temperature range	-10 – 60 °C	-10 – 60 °C	-10 – 60 °C	-10 – 60 °C
Measuring range	1.2 – 225.0 mm	1.2 – 225.0 mm	0.75 – 60 mm	3.0 – 300.0 mm

10.12 Wear of the Probe

Wear of the probe's cross-talk isolating board can affect the measurement results; the probe should be replaced if the following occurs:

12. The screen always displays the same measurement value when measuring different thicknesses.
13. An echo indication or measurement value is displayed even though the probe is connected but no measurement is being taken.

11. Prevention of Measuring Errors

11.1 Super-Thin Materials

Any material whose thickness is below the lower limit of the probe will cause measuring errors. The instrument should be coupled again to the same material to obtain the smallest possible thickness reading.

When measuring super-thin materials, the error known as “dual deflection” may occasionally occur, where the displayed reading is twice as large as the actual thickness. Another possible error is known as “pulse envelope cyclic jumping”, where the displayed value is larger than the actual thickness. To avoid these errors, critically thin materials should be measured repeatedly for verification.

11.2 Rusty Spots and Eroded Pits

Rusty spots and eroded pits can cause readings to fluctuate irregularly; in extreme cases there may be no reading at all. Small rusty spots can be hard to detect. If an eroded pit is found or suspected, the area should be measured with particular care – if necessary using several measurements with different orientations of the probe's cross-talk isolating board.

11.3 Errors in Material Identification

Even though the device has been calibrated for one material, errors can still occur when measuring another material; the appropriate sound velocity must always be selected.

11.4 Wear of the Probe

The probe surface is made of acrylic resin. After prolonged use, its roughness may increase, reducing sensitivity. If it has been determined that the error is caused by roughness, the probe surface can be ground smooth and flat using sandpaper or an oil grinding stone. If the reading remains unstable, the probe must be replaced.

11.5 Use of the ZERO Key

This key is used only for correction by coupling the probe to the standard test block fitted on the instrument. It must not be used with any other kind of test block, as this will cause measuring errors.

11.6 Laminated and Compound Materials

Uncoupled laminated materials cannot be measured, because the ultrasonic wave cannot penetrate spaces that are not coupled. Since ultrasonic waves do not propagate at a uniform speed in compound materials, instruments that measure thickness based on ultrasonic time-of-flight principles are not suitable for measuring laminated or compound materials.

11.7 Effect of the Metal Oxide Layer

Some metals, such as aluminum, develop a dense oxide layer that is tightly bonded to the base material without a clear interface. However, since ultrasonic waves travel at different velocities in these two materials, measuring errors result. Different oxide layer thicknesses result in different measuring errors. Caution is required in such cases. It is advisable to select a sample block of the material in question, measure its thickness with vernier calipers or a micrometer, and use this sample to calibrate the gauge.

11.8 Abnormal Readings

Operators should be able to identify abnormal readings. Usually, rusty spots, corroded pits and internal flaws in the test material can all cause abnormal readings. For solutions, see chapter 10 of this manual.

11.9 Use and Choice of Coupling Agents

Coupling agent is used to transmit high-frequency ultrasonic energy between the probe and the test material. Incorrect selection or improper use of coupling agent can cause errors or a flashing coupling indicator, making thickness measurement impossible. Coupling agent should be applied evenly and in an appropriate amount.

Selecting the right type of coupling agent is important: for smooth test surfaces, a low-viscosity coupling agent should be used (coupling agent and light machine oil are supplied with the instrument). High-viscosity coupling agents (such as glycerin paste or lubricating grease) may be chosen for rough, vertical or uneven surfaces.

11.10 Protective Sheath for the Probe

When measuring curved surfaces, a probe sheath designed for curved surfaces should be used to achieve a more accurate measurement. The probe protective sheath is available as an optional accessory.

12. Precautions

12.1 Cleaning of Test Blocks

Since calibrating the instrument with the supplied test block requires coupling agent, measures against corrosion are necessary. The test block must be cleaned after use. At high temperatures, care must be taken to avoid contact with sweat. When not used for a long time, the test block should be coated with a thin layer of grease to prevent corrosion. Before reuse, remove the grease; the instrument will then work normally again.

12.2 Cleaning the Housing

The housing of the instrument should be cleaned with a small amount of clean water. Alcohol or thinner must not be used, as they are corrosive to the housing – especially the display window.

12.3 Protecting the Probe

The probe surface is made of acrylic resin and is sensitive to rough surfaces. The probe must therefore be handled with care. When measuring rough surfaces, sliding the probe across the surface should be avoided as far as possible.

Under ambient conditions, the temperature of the test surface must not exceed 60 °C, otherwise the probe can no longer be used.

Accumulation of grease and dust will cause the probe cable to age faster or fracture. Please clean the cable after each use.

12.4 Replacing the Batteries

When the low-voltage indicator flashes, the batteries should be replaced in time. Procedure:

- Wait for the automatic turn-off.
- Open the battery compartment (push down with the thumb and slide it out).
- Remove the old batteries and insert new ones. Note the correct polarity.

If the instrument is left unused for a long time, remove the batteries to prevent leakage that could corrode the battery compartment and contacts.

12.5 Strictly Avoid Any Collision or Damp Environment, etc.

13. Maintenance

13.1 If the measured value is too large, please refer to chapters 10 and 11.

13.2 If any of the following problems occur, please contact the manufacturer:

- Components of the instrument are damaged and there is no output.
- The display is abnormal.
- Errors are too large during normal use.
- Keyboard failure or malfunction.

13.3 As the TIME2110/TIME2113 Ultrasonic Thickness Gauge is a high-tech product, repairs and servicing must be carried out by properly trained personnel. Unauthorized persons are not permitted to open the device for repair.

Table: Sound Velocities of Different Materials

Material	Sound velocity (m/s)
Aluminum	6320
Zinc	4170
Silver	3600
Gold	3240
Tin	3320
Iron	5900
Brass	4430
Copper	4700
SUS (stainless steel)	5970
Acrylic resin	2730
Water (20 °C)	1480
Glycerine	1920
Sodium silicate	2350

14. Non-Warranty Parts

14. Display window
15. Batteries
16. Probe
17. Keyboard
18. Test block
19. Device sheath
20. Coupling agent
21. Hand strap

ULTRASONIC THICKNESS GAUGE TIME2110/TIME2113 – PACKING LIST

No.	Description	Qty.	No.	Description	Qty.
1	Main unit	1			
2	Probe 5РФ10	1			
3	Coupling agent	1			
4	AAA battery	2			
5	Instruction Manual	1			

15. Environment and Disposal

In the interest of environmental protection, please dispose of the device properly.

Do not dispose of the device in household waste; instead, take it to a collection point for electronic waste or return it to your supplier.

Please remove the battery beforehand and dispose of it properly at a battery collection point.

Packaging materials are also raw materials! Please return them to the material cycle.

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