Ultrasonic Thickness Gauge
TIME2110
(V20140815)

Beijing TIME High Technology Ltd.

Content

1. General description

1.1 Scope of application

Adopting the theory of ultrasonic wave measurement, TIME2110 Ultrasonic Thickness Gauge possesses the capability of thickness measurement for various kinds of materials in which ultrasonic wave pulses propagate with a constant velocity and reflect on the back interface.
The device can be used to perform accurate measurement for various kinds of plates and parts. Another prominent characteristic of it is to monitor various kinds of pipes and pushure vessels for the decrease of their thickness during the use because of corrosion and erosion. TIME2110 enjoys a wide range applications in many areas, such as petroleum, chemical engineering, metallurgy, shipbuilding, aviation and spaceflight, etc.

1.2 Basic working principle

The principle of ultrasonic wave in the thickness measurement is similar to that of optical wave. The ultrasonic wave pulses transmitted by the probe will be reflected back, while they reach the interfaces. The thickness of the object is determined by precisely measuring the time the ultrasonic wave travels in the object.

1.3 Basic configuration and each part description of the tester

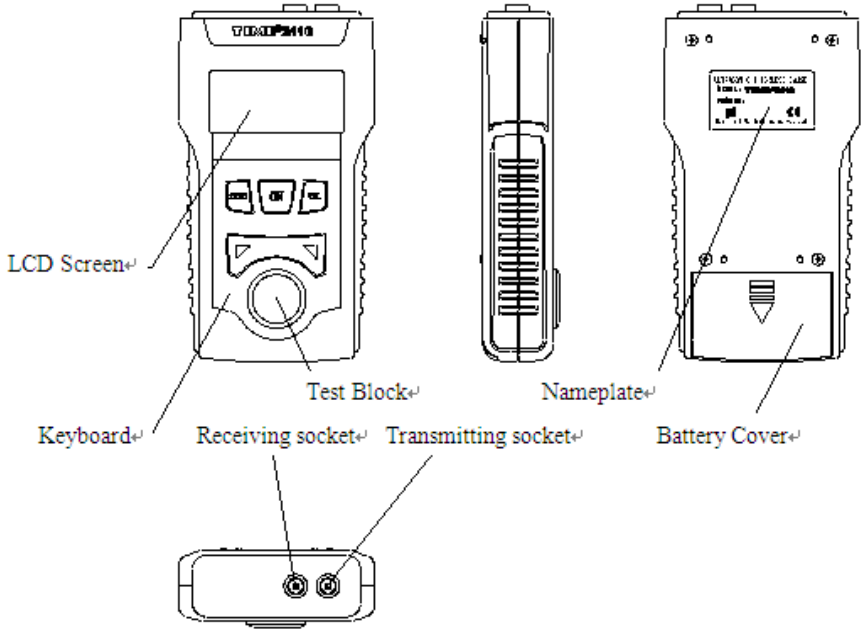
1.3.1 Basic configuration:

Main processor: 1 piece 5PΦ10 probe: 1 piece Coupling agent: 1 bottle

1.3.2 Optional probes:

5PΦ10/90	probe	1 piece
SZ2.5P	probe	1 piece
7P6	probe	1 piece

1.3.3 The name of each part of the testing meter (see figure below):



LCD screen display:

BATT : low voltage indication

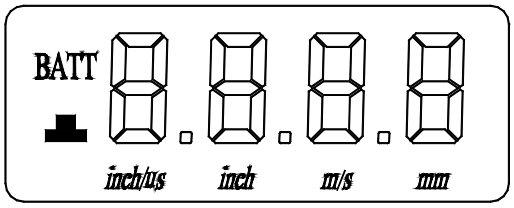
凸 : coupling indication

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

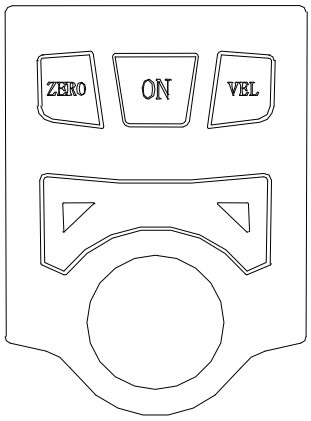
ZERO : calibration

VEL: sound velocity

◸-: adjustment key for sound velocity, thickness and thickness unit

◹: adjustment key for sound velocity, thickness and thickness unit

VEL+ZERO : keys for thickness memory



2. Performance parameters

Display type:	4-digit LCD
Range of operating temperature:	0℃～40℃
Power supply:	two AAA alkaline cells 1.5V
Power consumption:	working current is smaller than 20mA (3V)
Weight:	140 g
Dimensions:	124×68×27 mm
Minimum display unit:	0.1 mm
Sound velocity range:	1000m/s~9999m/s
Measuring error:	±(1％H+0.1) mm, H is the actual thickness of the object to be measured.
Measuring range:	
5PΦ10 probe	1.2 mm~225.0 mm (steel)
5PΦ10/90 probe	1.2 mm~225.0 mm (steel)
SZ2.5P probe	3.0 mm~300.0 mm (steel)
7PΦ6 probe	0.75 mm~60.0 mm (steel)

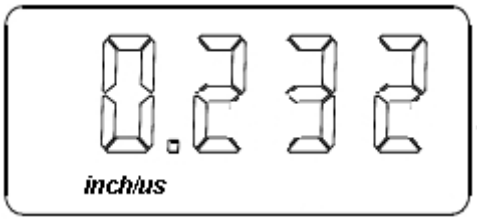
3. Main functions

1) Two display units: metric and imperial
2) Automatic calibration to zero: automatically correct the system errors

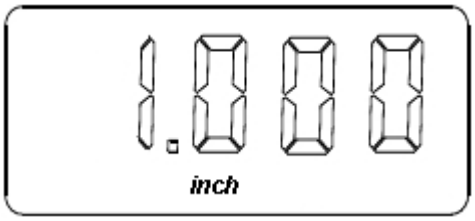
3) Automatic non-linear compensation: within the full range, computer software is used to correct the non-linear errors of the probe for the purpose of improving the accuracy
4) The upward and downward adjustment keys enable prompt selection of sound velocity, thickness, and check the thickness memory units
5) Prompt for coupling state: provide coupling indication and the observation of the stability of the indication can tell if the coupling is normal
6) Ten thickness values can be stored without loss after turn-off, which is very convenient for measuring in field and high platform
7) Measuring sound velocity: according to the test block's thickness, sound velocity can be measured directly needless to search in the conversion table
8) Sound velocity of five different materials can be stored
9) Low voltage indication
10) Automatic turn-off
11) All keys enclosed----oil proof for longer service life

4. Switch between metric and imperial

This instrument can display in two units, metric or imperial. When the instrument is off, push ◹ key, and then push ON key to turn on the instrument, so to achieve the function of Imperial-metric conversion
Metric display: m/s is metric unit of sound velocity; mm is metric unit of thickness
Imperial display: inch/μs is imperial unit of sound velocity; Inch is imperial unit of thickness



Velocity

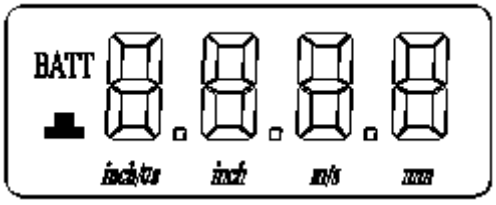


Thickness

5. Measuring steps

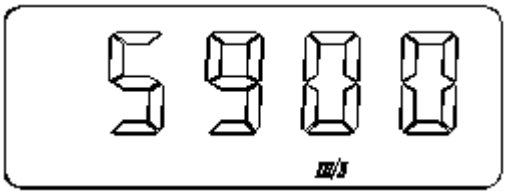
5.1 Preparations for measurement

Put the probe into the probe socket of the unit, push ON-key to turn on the unit. As it is shown in the figure below:



Full display screen

Sound velocity of last turn-off will be shown after the full screen displays for a few seconds. The measurement can start now.

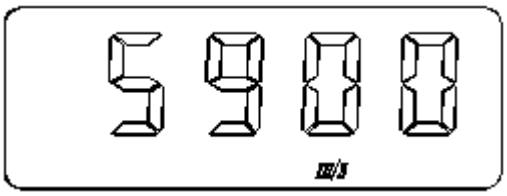


Sound velocity of last turnoff

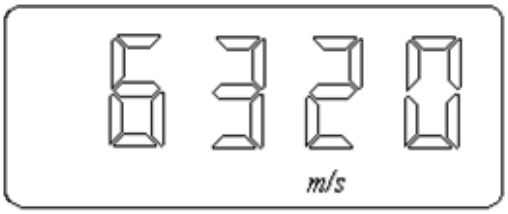
Note: 5900 m/s= 0.232 inch/μs

5.2 The adjustment of sound velocity

If the screen currently displays the thickness values, then push the VEL-key to enter into sound velocity state. The screen will display the content of the current memory unit of sound velocity. Each time the VEL-key is pushed the sound velocity memory unit will change. Five different sound velocity values will be displayed in turn. If the current displayed sound velocity is desired to be changed, the keys ◹◸ can be used to adjust the display the desired value. This value will be stored automatically as one out of five stored velocities.



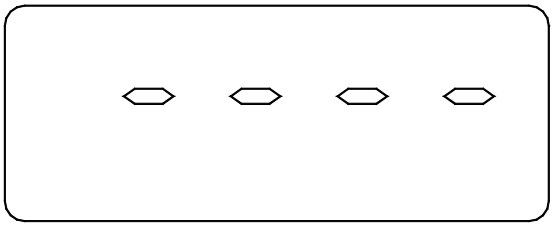
Push VEL-key to enter into state of sound velocity



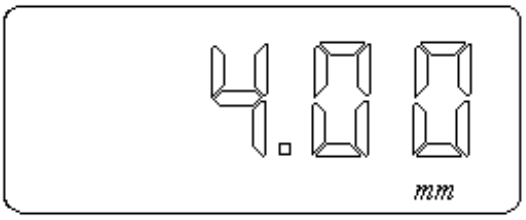
Value after adjustment by ◹◸ key

5.3 Calibration

Each time the probe or battery is changed, calibration should be performed. This step is rather critical to secure the measuring accuracy. If necessary, calibration can be repeated several times. Put the coupling agent on the testing block supplied with the unit, set the sound velocity to 5900m/s then couple the probe with the testing block. Push the ZERO-key and enter into the state of calibration, the screen display as follow:

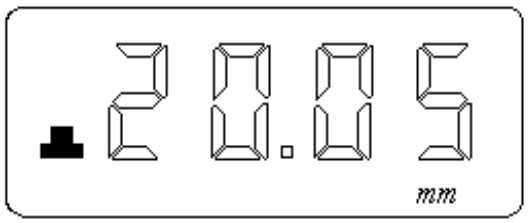


At this time, the bar lines displayed on the screen will disappear one after the other until the screen display 4.0mm (0.158inch). This indicates that the calibration is over. Then enter the measurement state and measure a random test block. If the measuring value error exceeds the measurement error range, the calibration should be operated again until the measuring value lies within the measurement error.

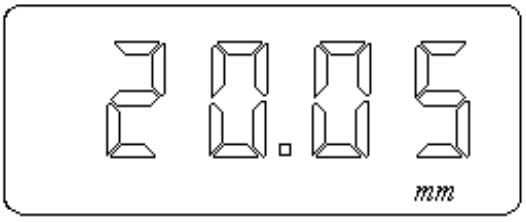


5.4 Measurement of thickness:

Put the coupling agent in the place to be measured and then couple the probe with the material to be measured. The measurement can thus start. The screen will display the thickness of the material measured. See the figure below:



Take the probe away, the thickness value will remain and coupling indication will disappear. See the figure below:

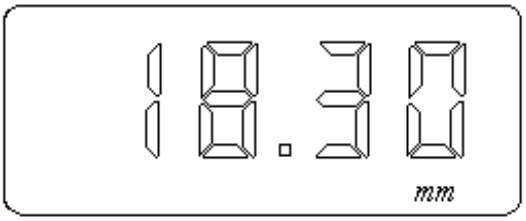


6. Sound velocity measurement

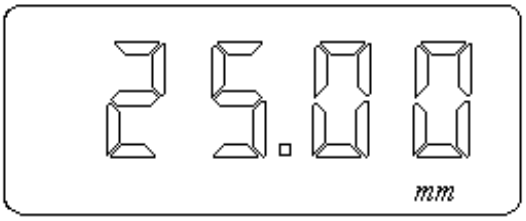
If the sound velocity in a certain kind of material is to be measured, a test block with a known thickness is employed to measure the sound velocity. At first the accurate thickness value should be obtained by using vernier calipers or micrometer. By coupling the probe with the test block of known thickness, the screen will display a thickness value, then remove the probe and adjust the shown value to the actual one using the keys ◹-◸. Push VEL-key to get the desired sound velocity, at the same time this sound velocity will be stored in the current memory unit. In sound velocity measurement, the test block is required to be thick enough. The recommended minimum thickness is 20mm.

Example: Measuring the sound velocity of material with the thickness of 25mm, the operation procedure is as follows:

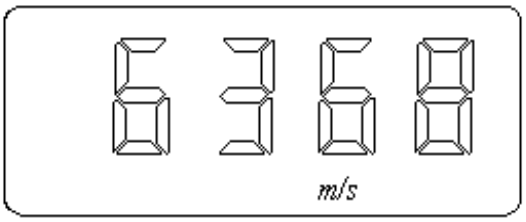
1. E.nter sound velocity state, coupling the probe with the test block, a thickness value is displayed as:



2. Remove the probe, push keys ◹-◸ to adjust the displayed thickness value to 25mm, just as the following display:



3.Push the VEL-key, the sound velocity measured for this material will be displayed.



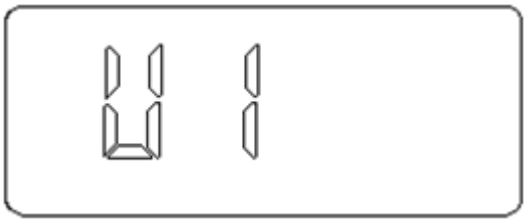
4. Repeat the step from 1-3, so to improve the measuring accuracy.

7. Memory of thickness values

7.1 Memory state

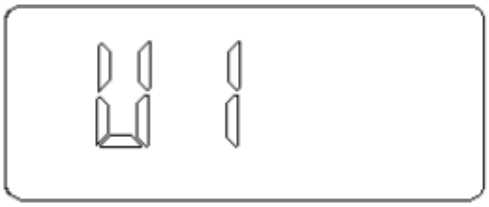
Push VEL-key and then ZERO-key to enter into thickness memory state and the screen will show a memory unit of a certain thickness. Use keys ◹-◸ to set required unit (use upward or

downward keys can display unit 0 to unit 9 in turn). While measuring the thickness, the value measured can be stored in the chosen unit. Each time when a new value is measured, the old one in this unit will be automatically replaced. The stored value in this memory unit is the latest measurement value. Push
VEL-key to leave the thickness state.

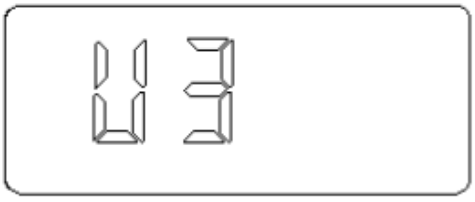


7.2 Reviewing the memory unit

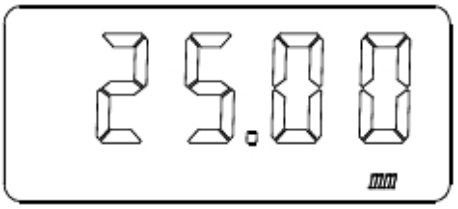
Push and hold VEL-key and then push the ZERO-key to show current memory unit number. Use keys ◹◸ to look for required unit (use upward or downward keys can display unit 0 to unit 9 in turn). Operate again to show the content of the memory. A new measurement value can also be stored in this unit. Push VEL-key to exit thickness memory state.
Example: Check the thickness value in memory unit 3



1.Push and hold VEL-key and then push ZERO-key, the display is as follows:
2.Use keys ◹◸ to find memory unit 3, the display is as follows:



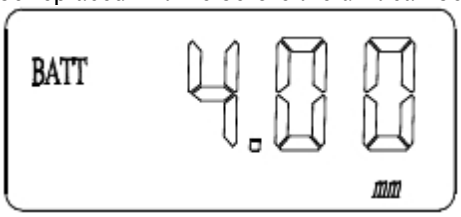
3. Push and hold VEL-key and then push ZERO-key, the thickness value in memory in unit 3 will be displayed:



4.Push VEL-key to exit. If leaving the thickness memory state without pushing VEL-key, the new measurement value will replace the content of this memory unit.

8. Low voltage indication

If BATT is displayed on the screen, it shows that the battery voltage is running low and the batteries should be replaced in time before the unit can be used again.



9. Automatic turn off

If no operation is performed within two minutes, the unit will turn off automatically.

10. Measuring technology

10.1 Cleaning the surface

Before measurement, it is necessary to clean the dust, dirt or rusty matters and coatings of the surface off the test object.

10.2 Lessening the roughness

Too rough a surface may cause errors or no reading. Before measurement starts, measures should be taken to keep the test surface smooth by way of grinding, polishing and filing. High viscosity coupling agent may also be used.

10.3 Roughly machined surface

The regular fine furrows of roughly machined surface (such as machined by lathe or planer) may also cause errors. The remedy method is similar to 10.2. Better result can also be achieved by adjusting the intersectional angle between the probe cross talk isolating board (the thin metal layer on the bottom center of the probe) and the fine furrows of test materials (vertical or parallel). And select the minimum of the readings as the accurate thickness of the materials.

10.4 Cylindrical surface

It is essential to select the right intersectional angle between the probe cross talk isolating board and the axial line of the test materials in measuring materials with Cylindrical surface, such as tubes or barrels. Simply speaking, make the probe coupled with test materials and the probe cross talk isolating board and the axial line of the test materials parallel or perpendicular and then gently shake the probe vertically along the direct of the axial line of the test material, the reading will change regularly. Select the minimum of the readings as the accurate thickness of the materials.

The standard for the intersectional angle is determined by the curvature of the material. For tubular material with bigger diameters, make the cross talk isolating board perpendicular to the axial line of the tube; for tubes with a smaller diameters, select two methods (making the intersectional angle

parallel with and perpendicular to the axial line) and select the minimum value of the readings as the thickness measured.

10.5 Compound contour

In measuring materials with compound contour (such as elbows), the method introduced in 10.4 may be used. The difference is that there is the need to measure the second time to obtain two readings and take the smaller reading as the thickness of the point measured.

10.6 Non-parallel surface

In order to obtain a satisfactory ultrasonic response, the other side of the test materials must be parallel or on the same axial with the test surface. Otherwise, there will be errors or no reading at all.

10.7 Temperature effect of test material

The thickness and ultrasonic wave transmission speed are all affected by temperature. If a high accuracy is required, test block comparison method should be employed. This method is to correct the measurement value by temperature compensation coefficient obtained by measuring test blocks of the same materials at the same temperature.

10.8 High attenuation materials

In the fiber, porous, large-grained materials, the ultrasonic wave will be scattered and got energy attenuation, the above phenomena will cause abnormal display and even no display (generally the

abnormal displayed value is less than the actual one). In this case, it's not suitable to apply the gauge to this material.

10.9 Reference test block

For the calibration of the instrument, a test block with the thickness of 4.00mm is configured on the TIME2110 cabinet, calibration method is scheduled in figure 4.3. The attached test blocks are not enough for calibration while measuring different materials on various conditions. The more similar the test block materials are to the tested materials, the more accurate the measurement is. The ideal one is a series of test blocks with different thickness. This series can offer device compensation calibration coefficient (such as material microstructure, heat treatment condition, grain orientation, surface roughness). It's very important to possess a series of test blocks to guarantee the maximum accuracy.

In most cases, only one test block is enough to get satisfactory measurement precision. This test block should be of the same material and similar thickness to the testing material. Select the testing material whose thickness is well-distributed and measured by micrometer as a reference test block.

When the thickness of a thin material is close to the lower testing limit of the probe, a test block can be employed to determine the exact lower limit (1.2mm for steel). Do not measure the materials whose thickness is lower than the low limit. 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 complex microstructure, a similar test block in the series should be employed for proper correction.

Most of the casting and forging are directional in internal structure. The speed of sound may have a little change along different directions. In order to solve this problem, the test block should have

similar structure to the testing material. The direction of the spread of sound in the test block should also be the same as the testing material.

In some cases, look up the sound velocity of known materials for replacement of the test block, but this can only approximately replace some of the test blocks. In some cases, there are differences between the two values in the sound velocity table and the actual one because of the difference in the physical and chemical properties of material. This method is often used to test low carbon steel only for approximate measurement.

Since TIME2110 ultrasonic wave gauge possesses the capability to measure sound velocity, sound velocity can be obtained at first and then measurement of the part can be undertaken according to this velocity.

10.10 A few measuring methods

a) single measuring method: measuring on one point
b) double measuring method: measuring two times on one point, make the cross talk isolating board perpendicular to each other. Select the minimum display as the exact thickness for the materials.
c) multi-point measuring method: measuring many times at a range of measurement, select the minimum as the thickness of the material

10.11 Selection of the probe

Probe type	5PΦ10	5PΦ10/90	7PΦ6	SZ2.5P
Frequency (MHz)	5	5	7	2.5
Working temperature range	-10~60℃	-10~60℃	-10~60℃	-10~60℃
Measurement range	1.2~225.0mm	1.2~225.0mm	0.75~60mm	3.0~300.0mm

10.12 The wear of probe cross talk isolation board may affect the results of measurement; probe should be replaced when the following phenomena occur:

1. The screen always displays the same measurement value while measuring different thickness.
2. There is echo wave indication or measurement value displayed when the probe has been inserted without measurement.

11. Prevention of measuring errors

11.1 Super-thin materials

Any material whose thickness is lower than the low limit of the probe will cause measurement errors. Instrument should be connected again for measuring the same material in order to obtain the result of the minimum thickness.

In measuring super-thin materials, there might be such erroneous results as “dual deflection” sometimes. That means that the displayed reading is twice as big as the actual thickness. Another error is known as “pulse envelope, cyclic jumping”. The result is bigger than the actual thickness. To prevent these errors, the critical thin materials should be measured repeatedly for verification.

11.2 Rusty spots and eroded pits

Rusty spots and eroded pits may cause the readings to change irregularly. Under extreme circumstances, there is even no reading. It is hard to discover a small rusty spot. When a eroded pit is found or in suspicion, care is needed to measure the area. Different positions of angles of the probe cross talk isolating board may be selected to carry measurements for many times.

11.3 Error in materials identification

Though the device has been corrected by one material, there is still mistake when measuring another materials, so proper sound velocity should be selected.

11.4 Wear of the probe

The probe surface is made of acrylic resin. After using for a long times, the roughness may increase, thus causing the sensitivity declines. If it has been determined that the error is caused by roughness, the sand paper or oil grinding stone may be used to grind the surface of the probe so that it will become smooth and parallel. If the reading is still unstable, the probe must be replaced.

11.5 Use of the ZERO-key

The key is used only for correction by coupling the probe onto the standard test block on the instrument panel. It is not to be used on any other kinds of test blocks. Otherwise it will cause measurement errors.

11.6 Laminated and compound materials

It is impossible to measure the uncoupled laminated materials, because the ultrasonic wave cannot penetrate the spaces that have not been coupled. As the ultrasonic waves can not spread in a uniform speed in compound materials, the instruments measuring thickness according to the ultrasonic deflection theories are not applicable to measuring laminated or compound materials.

11.7 The effect of the metal oxide layer

Dense oxide layer may be found in some metals, such as aluminum etc. This oxide layer contacts with the substrate tightly without clear interface. But ultrasonic wave transmits with different velocities in these two materials, which will cause measurement error. Different thickness of oxide layer will result in different measurement errors. It should be cautious to deal with this kind of situation. It’s applicable to select one block of testing material as sample, measure its thickness by vernier caliper or micrometer and use this sample to calibrate the gauge.

11.8 Abnormal reading

Operators should have the ability of identifying abnormal readings. Usually, rusty sports, corroded pits and the interior flaws of the test materials can all cause abnormal readings. For solution, see chapter 10 of this manual.

11.9 Use and choice of coupling agents

Coupling agent is used for transmitting high frequency ultrasonic energy between the probe and the test material. Incorrect selection of the types of coupling agents or improper usage may cause errors or flashing of the coupling sign, making it unable to measure the thickness. Coupling agent should be used in proper amount and coated evenly.

It is important to select the proper type of coupling agents. When the surface of the test material is smooth, low viscosity coupling agent should be used (coupling agents and light machine oil are provided with the instrument). High viscosity coupling agents (such as glycerin paste and lubricating fat，etc.) may be chosen for rough surface or vertical surface or peak surface.

11.10 Protective sheath of probe

When measuring curved surface, curved surface probe sheath should be used so as to gauge the thickness more accurately. Probe protective sheath is optional in purchasing.

12. Precautions

12.1 Cleaning of test blocks

As the correction of the instrument by using the test block provided needs coupling agents, it is necessary to take measures against rusting. After usage, the test blocks must be cleaned. When the temperature is high, caution must be taken not to stain it with sweat. When not used for a long time, the test block should be coated with a thin layer of fat to prevent rusting. To use again, clean the fat, the instrument will work normally.

12.2 Cleaning of the shell of the instrument

The shell of the instrument should be cleaned with a little amount of clean water instead of alcohol or dilution liquid which are corrosive to the shell, especially the window.

12.3 Protection of the probe

The surface of the probe is made of acrylic resin, sensitive to rough surface. It must be handled gently. When measuring rough surface, the sliding of the probe over the surface should be prevented as far as possible.

At the ambient condition, the temperature of the test surface should not exceed 60°C. Otherwise, the probe cannot be used any more.

The collection of grease and dust will make the probe wire aging fast or fracture. After usage, please clean the cable.

12.4 Replacement of batteries

When the low voltage indicator flashes, the batteries should be replaced in time. The method of replacement is shown in below:

a) Wait for the automatic turnoff
b) Open the battery chamber (use the thumb to push down the chamber and slide it out)
c) Take off the batteries and put in the new batteries. Note the polarity of the battery.

When the instrument lies idle for a long time, take out the batteries to prevent leaking that will corrode the battery chamber and the poles.

12.5 Strictly avoid any collision or damp environment, etc.

13. Maintenance

13.1 When the measured value is too big, please consult chapter 10 and 11.

13.2 If the following problems occur, please contact the company.

a) Components of the instruments are damaged and there is no output.
b) The display is abnormal.
c) Errors are too big in normal use.
d) Keyboard failure or disorder.

13.3 As the TIME2110 Ultrasonic Thickness Gauge is a high-tech product, repairs and services must be undertaken by well-trained person. No unqualified person is allowed to dismantle it for repairs.

Table: Sound velocities of different materials

Materials	Sound velocity (m/s)
Aluminum	6320
Zinc	4170
Silver	3600
Gold	3240
Tin	3320
Iron	5900
Brass	4430
Copper	4700
SUS	5970
Acrylic resin	2730
Water(20℃)	1480
Glycerine	1920
Sodium siliate	2350

14. Non-warranty Parts

1. Window, 2. Battery, 3. Probe. 4. Keyboard 5.Test block. 6. Sheath of gauge. 7. Couplant 8. Hand string

ULTRASONIC THICKNESS GAUGE TIME®2110
PACKING LIST

	Description	Qt.	Note	No.	Description	Qt.
1	Main unit	1		11		
2	5РФ10 Probe	1		12		
3	Couplant	1		13		
4	AAA battery	2		14		
5	Instruction Manual	1		15		
6	TIME Certificate	1		16		
7	Warranty Card	1		17		
8				18		
9				19		
10				20		