

Ultrasonic Thickness Gauge TT100

Instruction Manual



TIME Group Inc.

Beijing TIME High Technology Ltd.

CONTENTS

1. GENERAL DESCRIPTION.....	2
2. PERFORMANCE PARAMETERS.....	6
3. MAIN FUNCTIONS	7
4. MEASURING STEPS	8
5. MEMORY OF THICKNESS VALUE	15
6. MAINTENANCE	17
7. OPERATION.....	19
8. PREVENTION OF MEASURING ERRORS.....	26
9. NON-WARRANTY PARTS.....	29

1. General description

1.1 Scope of applications

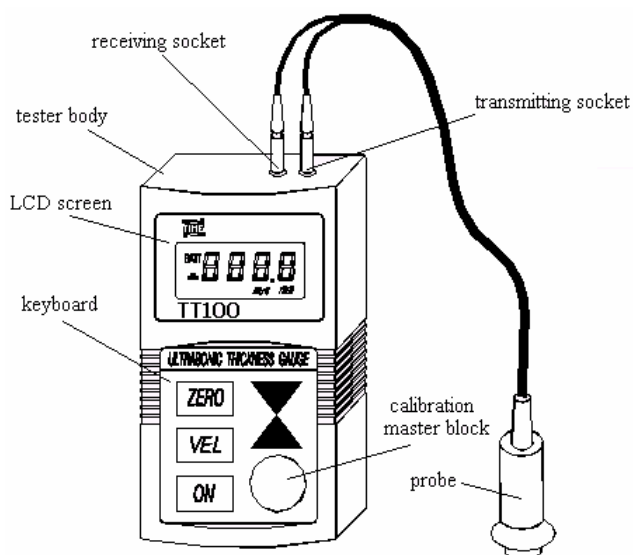
The handheld microprocessor-controlled thickness gauge is designed for measuring the thickness of metals, and non-metallic materials e.g. aluminum, titanium, plastics, ceramics, glass and any other good ultrasonic wave-conductor as far as it has two parallel surfaces on the top and bottom.

The **TT100** can be used in industrial applications to perform precise measurements on various kinds of new materials, parts and components, and it can also be used to monitor various kinds of pipes and pressure vessels for the decrease of their thickness due to corrosion and/or erosion.

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.

2



3

1.3 Basic configuration and each part description of the tester

1.3.1 Basic configuration:

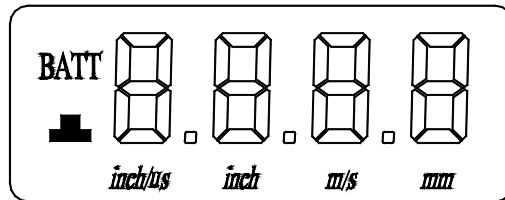
Main processor: 1 piece

Transducer: 2 piece

Couplant: 1 bottle

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

LCD screen display:



BATT : low voltage indication

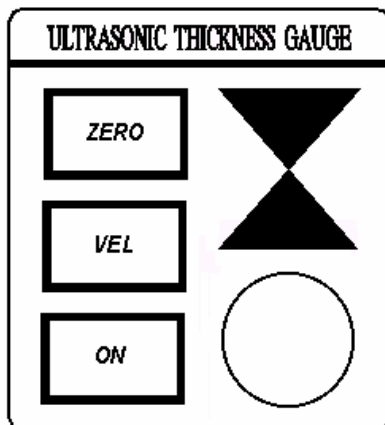
□: coupling indication for satisfactory acoustic coupling between probe and test piece

m/s : measurement unit of sound velocity

4

mm : measurement unit of thickness

Keyboard:



ON : power

ZERO: transducer zero procedure

VEL : sound velocity value / 5 velocity are stored

▲-▼: adjustment keys for sound velocity, thickness, 10 memory units for thickness storage

5

2. Performance parameters

Display type:	4-digit LCD
Display resolution:	0.1 mm
Measuring range:	1.2mm – 225.0mm with 5MHz transducer
Lower limit for steel pipes:	Φ 20 mm × 3.0 mm
Measurement accuracy:	±0.1mm
Sound velocity range:	1000 – 9999 m/s
Coupling check:	satisfactory / no probe coupling
Memory:	10 thickness readings
Range of operating temperature:	0 ~40
Surface temperature of workpiece:	-10° C~60° C
Working frequency	5 MHz
Update rate:	4 Hz
Power supply:	2 AA batteries 1.5V
Battery life:	250 hours
Dimensions:	126mm×68mm×23mm
Weight:	250g including batteries

6

3. Main functions

- 1) Automatic transducer zero adjustment: automatically correct the system errors
- 2) Automatic non-linear compensation: within the full range, computer software is used to correct the non-linear errors of transducer with the purpose of improving the accuracy
- 3) Keys ▲-▼ are used for fast adjustment of sound velocity and thickness as well as fast checking the thickness memory unit
- 4) Calibration of known sound velocity
- 5) Calibration of a known thickness (the sound velocity can be directly determined according to a known thickness, avoiding the trouble of looking into table.)
- 6) Ten different thickness values can be stored and kept after switch-off
- 7) Coupling indication: the stability can tell if the coupling is normal
- 8) Sound velocity of five different materials can be stored
- 9) Indication at low voltage
- 10) Automatic switch off

7

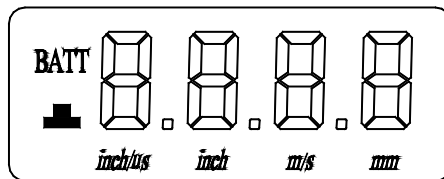
11) Oil proof keyboard with longer service life

4. Measuring steps

4.1 Preparations for measurement

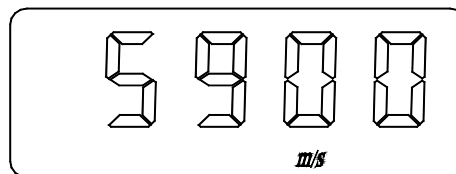
- Connect the transducer plug to the socket on top of the unit.
- Turn on the gauge.

As it is shown in the figures below, after the full screen display for a few seconds, the screen will display the sound velocity used last time. The measurement can start now, but read other paragraphs first.



8

Full screen display



Sound velocity

Note: The surface of the probe is made of propylene resin and is very sensitive to heavy scratches on rough surfaces, so in application, push the probe gently on the surface.

Automatic turning off

If no operation performed within two minutes, the unit will be turned off automatically.

4.2 The adjustment of sound velocity

9

If the screen currently is displaying the thickness value, then press the VEL-key to enter into sound velocity state. The content of the current memory unit of sound velocity will be displayed on the screen. Each time the VEL-key is pressed 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 it to the desired value. This value will be stored automatically as one out of five stored velocities.

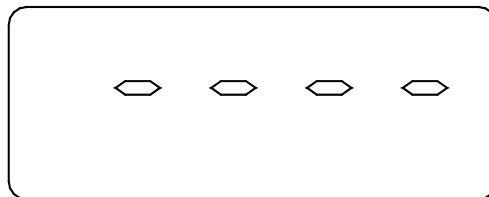
4.3 Calibration

Each time the transducer 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. Take following steps:

- Put a little coupling agent on the steel master testing block on the unit, which has a thickness of 4.0mm.
- Adjust the sound velocity to 5900 m/s (steel) using the VEL-key and the keys ▲-▼

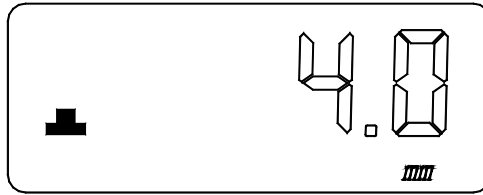
10

- Press the ZERO-key and enter into the state of calibration and on the screen displaying:



- Coupling the transducer with test block. At this time the bar lines displayed on the screen will disappear one after the other until the screen displays 4.0mm. That means the calibration is over:

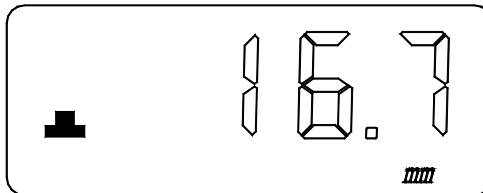
11



4.4 Calibration to a known velocity: thickness measurement

- Lay the coupling agent on the place to be measured.
- Adjust the sound velocity according to the material (refer to table in paragraph 7). (If it is not clear what the right sound velocity should be, for example when the material is unknown or readings are not correct at a certain velocity, please refer to paragraph 4.5)
- Couple the transducer with the workpiece to be measured.
- Start the measurement. On the screen it will display the thickness of the material to be measured, for example:

12



Note: When the transducer is coupled with the workpiece to be measured, the coupling indication sign will be displayed on the left side on the screen. If the coupling indication flicks or does not appear, it shows that the coupling is not well done. Take the transducer away, the thickness value will remain and coupling indication will disappear.

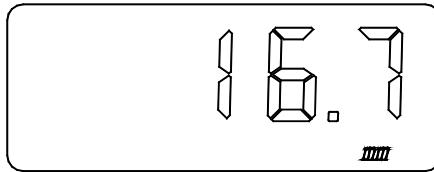
4.5 Calibration of a known thickness: sound velocity measurement

If it is desired to measure the sound velocity of a certain material, a testing block with a known thickness must be used, operation is as the follows:

- Measure the test piece thickness with a caliper or micrometer

13

- Couple the transducer with the test piece of known thickness until a (wrong) thickness value is displayed:



- Remove the transducer.
- Adjust the displayed thickness value to the actual known thickness of the testing block by keys ▲-▼, for example 25.0 mm:

$16.7 \quad > \text{keys } \blacktriangle-\blacktriangledown >$

mm
mm

- Now press the VEL-key. The correct sound velocity for this material will be displayed, and at the same time this sound velocity will be stored in the current sound velocity memory unit:

$25.0 \quad > \text{VEL-key} >$

mm
m/s

- Start new thickness measurements on the same material with this velocity.

5. Memory of thickness value

5.1 Thickness memory state

- Set the right sound velocity for a new measurement (see chapter 4).
- Press and hold VEL-key and then press the ZERO-key to enter into the thickness memory state.
- The display will show a memory unit of a certain thickness: Unit 1 up to Unit 9.
- Use the upper and down keys ▲-▼ to look for the required unit:

$U1 > U2 > U3 > \dots > U9$

- While measuring the thickness, the value measured will be stored in the chosen unit automatically. Each time a new value is measured, the old value in this unit will be automatically replaced.

U1 >> 3.0
mm

- Press the VEL-key once more to leave the thickness memory state.

5.2 Reviewing the thickness memory units

- Press and hold the VEL-key and then press the ZERO-key to enter the thickness memory
- The display will show a memory unit of a certain thickness: Unit 1 up to Unit 9.
- Use the upper and down keys ▲-▼ to look for the required unit:

U1 > U2 > U3 > > U9

- Again press and hold the VEL-key and press ZERO-key to show the stored reading:

U1 > VEL + ZERO > 3.0
mm

- Press the VEL-key to leave the thickness memory state.

16

6. Maintenance

6.1 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.

Battery replacement:

- A. Wait until the unit turns off automatically.
- B. Open the battery compartment (press down the compartment cover and slide it out).
- C. Remove the used batteries and put in new batteries. Note the polarity of the battery.

6.2 Precautions

- The surface of the transducer is made of propylene resin and is very sensitive to heavy scratches on rough surfaces, so in application, push the probe gently on the surface.
- The temperature of the workpiece surface should not exceed 60° C, otherwise the transducer will be damaged.
- Dust, iron chips, and carbon particles will cause trouble; keep the gauge clean all the time.
- Grease, oil and dust will make the cable of the transducer aged and cracked, therefore,

17

after the use, the cable should be cleaned of dust and dirt.

- If the gauge is not to be used for a long time, remove the batteries.
- Strictly avoid any collision or damp environment, etc.
- Automatic switch-off of the machine

In addition to two AA batteries, there is a lithium cell inside the thickness gauge to provide uninterrupted power source for the ROM. If the two AA batteries are taken out before the thickness gauge has not automatically switched off, the instrument will be forced to use the lithium cell and once the cell is exhausted and replaced, all the data stored in the ROM will be lost. So the batteries can be taken out only after the instrument switches off automatically.

- 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 use, 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 grease to prevent rusting.

- Cleaning of the shell of the instrument

18

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.

7. Operation

7.1 Scope of application

Metals, plastics, porcelain, glass and other good conductor of ultrasonic waves, as long as there are two parallel planes, such as aluminum, copper, gold, resin, water and glycerin.

The instrument can not be used to measure the thickness of cast iron because of too big grain inside.

7.2 Requirements for work pieces

7.2.1 Requirements for the area of work piece

All work pieces with area larger or equal to the area of the probe can be measured. But for long slender pieces, errors may occur when it is measured in the axial direction or the side of the work piece is not vertical to the testing surface as the testing surface is too small.

7.2.2 Requirements for curved surface

When the test piece has curved surface (such as the side wall of a boiler or tubular materials), the radius of the curvature should be $R \geq 10$ and the wall thickness ≥ 3 mm. But

19

this is applicable to steel only. We have not worked out accurate requirements for other materials due to our inexperience. Users may gain experience in the process of use and we shall be very grateful if you can tell your experience to us.

7.2.3 Requirements for roughness.

The requirements for roughness are very lenient. In usual circumstances, accurate measurement can be attained if the probes we supply are used. But if the roughness is too big due to serious rust or other reasons, errors may occur. When this occurs, measures should be taken to lessen the roughness or select the 2.5mm probe, which can be ordered from our company.

7.2.4 Requirements for working temperature

The thickness of materials and the transmission speed of ultrasonic waves are all affected by changes in temperature. But for measurement that requires only general accuracy, the effect of temperature can be ignored.

However, the working surface temperature should not be higher than 60°C out of the consideration of protecting the probe and ensuring accuracy as the probes are made of propylene resin.

20

7.3 Working environment

Working temperature: 0~40°C;
Relative humidity: 90%;
Temperature of work piece: <60°C;
No violent vibration or corrosive media;
Strictly avoiding colliding and humidity.

7.4 Measuring technology.

7.4.1 Cleaning the surface.

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

7.4.2 Lessening the roughness.

Too rough 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.

7.4.3 Roughly machined surface.

The regular fine furrows of roughly machined surface (such as lathing or planer) may also

21

cause errors. The remedy is similar to 2.5.2. Better result can also be achieved by adjusting the intersectional angle between the probe crosstalk isolating board (the thin metal layer on the bottom center of the probe) and the fine furrows of test materials (orthogonal or parallel).

7.4.4 Special surface.

It is essential to select the right intersectional angle between the probe crosstalk isolating board and the axial line of the test materials in measuring materials with spherical surface, such as tubes or barrels. Simply speaking, make the probe coupled with test materials and the probe crosstalk 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 crosstalk isolating board perpendicular to the axial line of the tube, for tubes with a smaller diameter, select two methods, that is, making the intersectional angle parallel with and perpendicular to the axial line and select the minimum value of the readings as the thickness measured.

22

7.4.5 Compound contour

In measuring materials with compound contour (such as elbows), the method introduced in 2.5.4 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.

7.4.6 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.

7.4.7 Effect of temperature of test material

The thickness and ultrasonic wave transmission speed are all affected by temperature. If a high accuracy is required, test block of the same material may be tested under the same temperature are calculated for revision purposes. For iron and steel, high temperature will cause bigger errors (the reading is smaller than the actual data), the method can also be used.

7.4.8 Materials with big attenuation.

23

For some materials, such as fiber, porous and rough grained materials, the ultrasonic waves would be deflected and attenuation of energy, so much so that the readings may be abnormal of there may even be no readings (usually the abnormal reading is smaller than the actual thickness). In such circumstances, the instrument is not applicable to test the thickness.

7.5 The ultrasonic speed table of common industrial materials:

Name of material	Ultrasonic speed(m/s)	Name of material	Ultrasonic speed(m/s)
Aluminum	6260	Acetic resin	2670
Zinc	4170	Phosphor bronze	3530
Silver	3600	Pine resin	4430
Gold	3240	Glass	5440
Tin	3230	Inconel	5720
Iron and steel	5900	Magnesium	6310
Brass	4640	MoNi alloy	3020
Copper	4700	Nickel	5630
SUS	5790	Steel4330 (low carbon)	5850
Acrylic resin	2730	Steel 330	5660
Water (20°C)	1480	Titanium	6070
Glycerin	1920	Zirconium	4650
Sodium silicate	2350	Nylon	2620

Note: Different types and components of materials may have bigger range of ultrasonic speed.

8. Prevention of measuring errors

8.1 Supper-thin materials

Any material whose thickness is lower than the low limit of the probe will 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.

8.2 Rusty spots and eroded pits.

Rusty spots and eroded pots 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 convex is found or suspicion, care is needed to measure the area. Different positions of angles of the probe crosstalk isolating board may be selected to carry measurements for many times.

26

8.3 Error in identifying materials.

When the instrument is corrected for measuring one materials and it is used to measure another kind of material, errors may occur. Attention should be paid to select the correct ultrasonic speed.

When the ultrasonic speed is deviated from the corrected ultrasonic speed, it might cause wrong results. Proper adjustments are needed in actual operation.

8.4 wear of the transducer

The transducer surface is made of acrylic resin. When in long use, the roughness may increase, thus causing the result less accurate. If it has been determined that the error is caused by roughness, 500# sand paper (the diameter of each piece of paper is 50~40μm) or oil grinding stone may be used to grind the surface of the probe so that it will become smooth and parallel. If that does not work, the probe must be changed.

8.5 Use of the ZERO key

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

27

8.6 Laminated and compound materials

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

8.7 Effect of oxidized layer of metals.

Some metals may correct very close oxidized layers in their surfaces, such as aluminum. The oxidized layer and the base metal are closely bound together, without marked boundaries. But the spread speed of ultrasonic wave for these two kinds of matters is not the same. So error may occur, with different thickness of oxidized layers having measuring. A block measured by micrometer may be selected from the test material as a test block for use in correcting the instrument.

8.8 Abnormal reading

Operators should have the ability of identifying abnormal readings. Usually, rusty spots, corrected pits and the wrong use of material or ultrasonic speed to correct the instruments and flaws of the test materials may cause abnormal readings.

28

8.9 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 use may cause errors or flashing of the coupling marks, making it unable to measure the thickness. Coupling agent should be used in proper amount and coated evenly. Normally, the coupling agent is laid over the surface of the test material. But when the measuring temperature is high, the coupling agent is laid over the bottom of the transducer.

It is important to select the proper type of coupling agents. When the surface of the test material is smooth, low viscosity of 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 grease) may be chosen for rough surface or when the test piece is perpendicular to the surface and the top surface.

8.10 Protective sheath of transducer.

When measuring curved surface, transducer sheath should be used so as to measure the thickness more accurately. Transducer protective sheath is optional purchasing.

9. Non-warranty parts.

1. Window, 2. Battery, 3. Transducer. 4. Test block. 5. Sheath of gauge. 6. Couplant

29