LA-30

Ultrasonic Thickness Gauge

Instruction Manual

Jinan Sanmu Instrument Detection Technology Co., LTD

Content

1 Introduction

1.1 Scope of applications

Ultrasonic Thickness Gauge measuring with ultrasonic wave, is applicable for measuring the thickness of any material in which ultrasonic wave can be transmitted and reflected back from the other face.

The gauge can provide quick and accurate measurement to various work pieces such as sheets of board and processing parts. Another important application of the gauge is to monitor various pipes and pressure vessels in production equipment, and monitor the thinning degree during using. It can be widely used in petroleum, chemical, metallurgy, shipping, aerospace, aviation and other fields.

1.2 Primary Theory

The primary theory of measuring thickness with ultrasonic wave is similar to that of measuring thickness with optical wave. The ultrasonic wave emitted from the probe reaches the object and transmits in it. When the ultrasonic wave reaches the bounding surface of the material, it is reflected back to the probe. The thickness of the material can be determined by accurately measuring the time of the ultrasonic wave transmitting in it.

1.3 Measuring Principle

The digital ultrasonic thickness gauge determines the thickness of a part or structure by accurately measuring the time required for a short ultrasonic pulse generated by a transducer to travel through the thickness of the material,reflect form the back or inside surface, and be returmed to the transducer.The measured two-way transit time is divided by two to account for the down-and-back travel path,and then multiplied by the velocity of sound in the material.

The result is expressed in the well-known relationship:

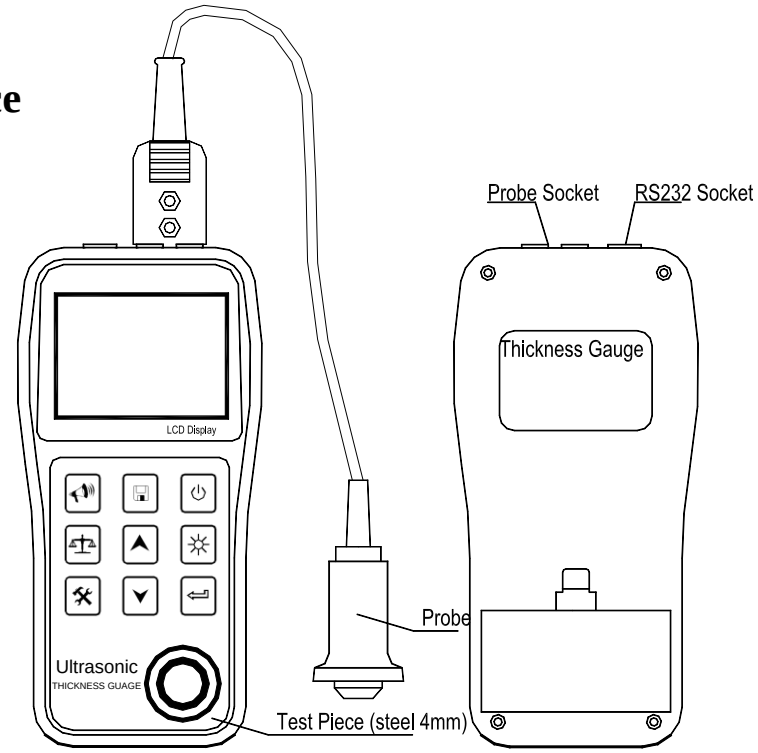
$$H = \frac{v \times t}{2}$$

Where: H—Thickness of the test piece.

v----Sound Velocity in the material.

t----The measured round trip transit time.

1.4 Appearance



1.5 Keyboard

Power ON/OFF

LCD backlight on/off

sound velocity

Save data / Browse data

Calibration standard block of 4.00mm

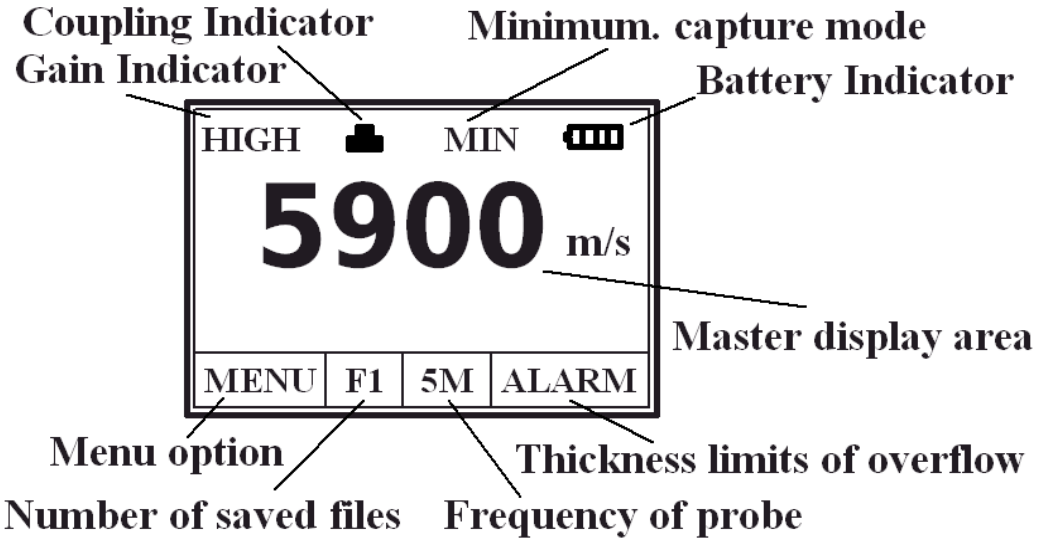
Function selector

Adjusting sound velocity and thickness; key for moving menu cursor

Adjusting sound velocity and thickness; key for moving menu cursor

2-point calibration; To be used together with function keys.

1.6 Display symbols



2 Product Specifications

2.1 Technology parameter

- **Display:** 128×64 LCD with LED backlight.
- **Measuring range:** 0.75mm~300.0mm (0.03inch~11.8 inch)
- **Sound Velocity Range:** 1000m/s~9999m/s (0.039~0.394in/μs
- **Display resolution:** 0.01mm or 0.1mm (lower than 100.0mm)
  0.1mm (more than 99.99mm)
- **Accuracy:** ±(0.5%Thickness +0.02)mm, depends on Materials and conditions
- **Units:** Metric/Imperial unit seletable.
- Lower limit for steel pipes:
  5MHz probe: Φ20mm×3.0mm (Φ0.8× 0.12 inch)
  10MHz probe: Φ20mm×3.0mm (Φ0.6× 0.08 inch)
- **Power Source:** 2pcs 1.5V AA size, batteries.100 hours typical operating time(LED backlight off).
- **Communication:** RS232 serial port
- **Outline Dimensions:** 150mm×74mm×32mm
- **Weight:** 238 g
- Four measurements readings per second for single point measurement,
- Memory for up to 5 files(up to 100 values for each file) of stored values

2.2 Main Functions

1) Capable of performing measurements on a wide range of material, including metals,plastic,ceramics,composites,epoxies,glass and other ultrasonic wave well-conductive materials.
2) Transducer models are available for special application,including for coarse grain material and high temperature applications.
3) Probe-Zero function,Sound-Veloctiy-Calibration function.
4) Two-Point Calibration function.
5) Coupling status Indicator showing the coupling status.
6) Battery information indicates the rest capacity of the battery.
7) Auto sleep and auto power off function to conserve battery life.
8) Optional software to process the memory data on the PC.
9) Optional thermal mini-printer to print the measured data via RS232 port.

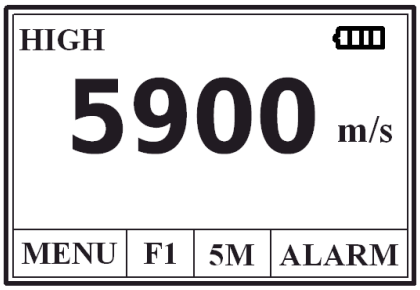
3 Operation

3.1 Preparation for measurement

3.1.1 Insert the probe plug into the socket for the probe on the main unit,

3.1.2 Press ⏻ to turn on the instrument。

3.1.3 Lcd will Display soft editions information about the instrument. And then display Latest sound velocity.

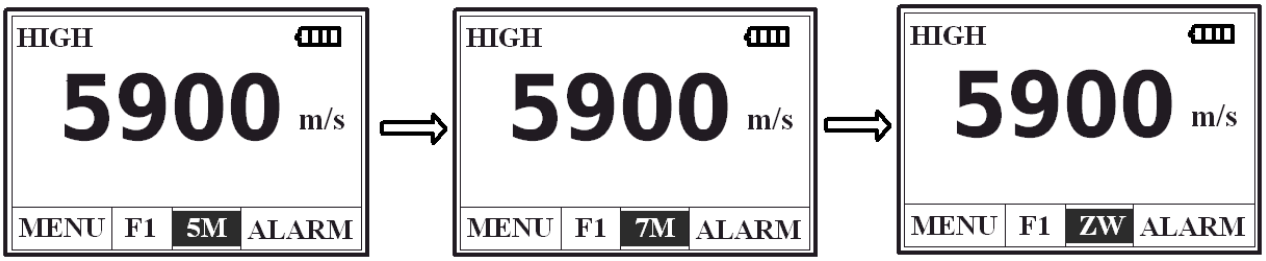


3.2 Adjusting sound velocity

If the current display is thickness, by pressing 🔊, you can come into speed-of-sound state, and it will display content in current sound velocity memory unit. The sound velocity memory unit will change once every time when you press the VEL key, it can display 5 sound velocity alternatively. If you hope to change the contents in the current sound velocity unit, you can adjust that with ⬆ or ⬇ till reach the desired value, and then the value be saved to memory.

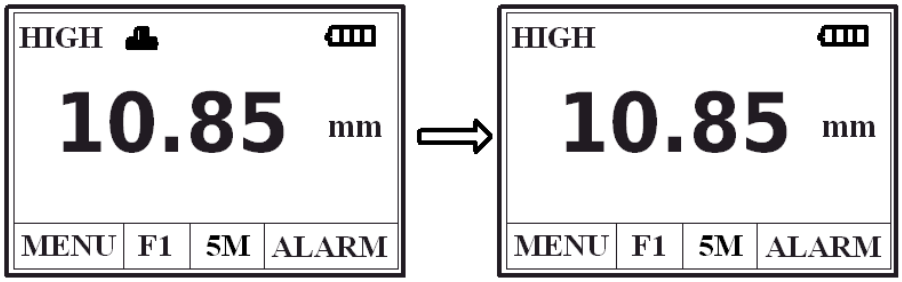
3.3 Setting probe frequency

Press 🛠 key to move the cursor to the position as that shown in the following figure. Press ↵ to change the frequency setting. LCD will display in sequence the probe frequency to be set2M, 5M, 7M or ZW.



3.4 Measurement of thickness

First, set the sound velocity, then coat the coupling agent at the place to be measured, couple the probe with the material to be measured, now you can begin the measurement. The screen will display the thickness of material to be measured. After you remove the probe, the thickness value will be maintained, while the coupling indicator will disappear.

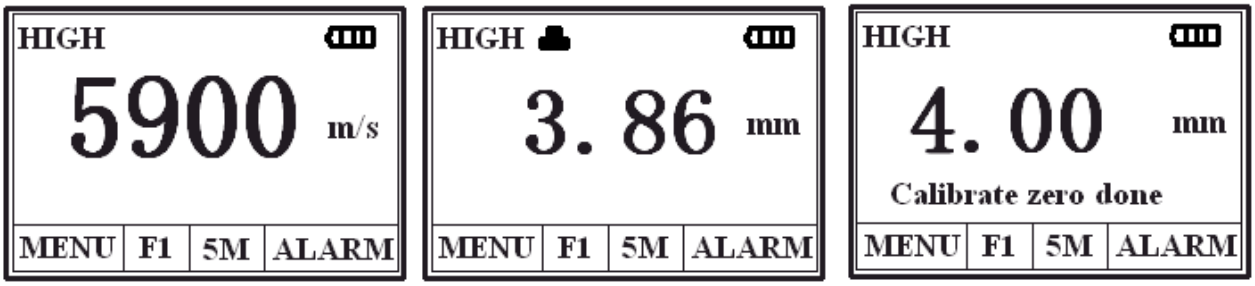


Note: when the probe is coupled with the material to be measured, the instrument will display the coupling indicator; if the indicator flashes or doesn't appear, it means that the coupling is not so good.

3.5 Zero calibration

Select the correct transducer frequency，The sound velocity adjusted to 5900m / s，While the gain is set to use when measuring the gain，Then the probe with the case on 4mm standard test block and displayed good coupling couplingsigns，Zero point calibration by the key. Instruments buzzer about the same time, the screen instructions to complete the calibration:calibrate zero done, That the calibration is complete, while calibration data is stored in the instrument, If want to erase the calibration data,Please operate according to memory manage,

If the instrument before the keys are not well coupled with the standard test block completion instructions or display calibration is not succeed, the calibration instrument will retain the original value, the screen display process as shown below:



Note: After every change of the probe, probe temperature, ambient temperature changes, etc. After the work environment, or working for some time after the discovery measurement errors should see the standard test block measured value is accurate, if the difference would be larger school Zero operation.

Calibrated display thickness may be bias 4.00 ± 0.02, now only shows the calibration is complete instructions, without further calibration.

3.6 Measurement of sound velocity

The sound velocity of a material can be measured using a test piece with given thickness. First, measure the test piece with caliper or micron micrometer and read the thickness accurately. Couple the probe with the test piece with given thickness till it displays a value, remove the probe, then adjust the display to the actual thickness with ⇧ or ⇩, press 📣, now it will display the sound velocity to be measured. Save the value into current sound velocity memory unit. For measuring sound velocity, one must select a test piece with adequate thickness, and the recommended min. wall thickness is 20.0mm. When measuring the sound velocity, please turn off the min. capturing function.

For example: To measure the sound velocity of a material with a thickness of 25.0mm, the procedure is:

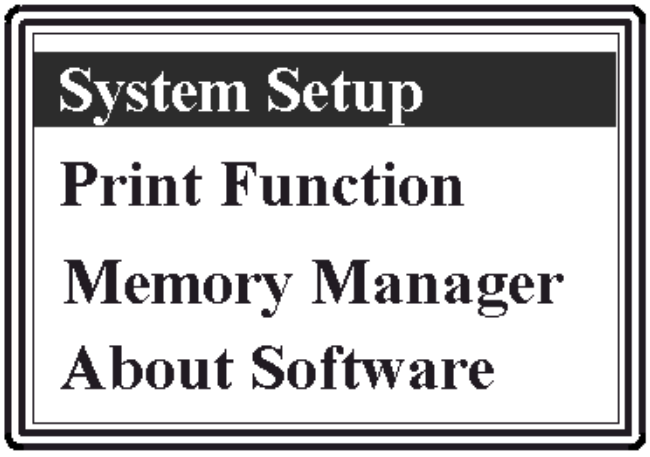
3.7 Setting alarm thickness limits

The instrument will alarm if the measurement is out of limits. When the measurement is lower than the low limit or higher than the high limit, the buzzer will alarm. The alarming limit is set as follows:

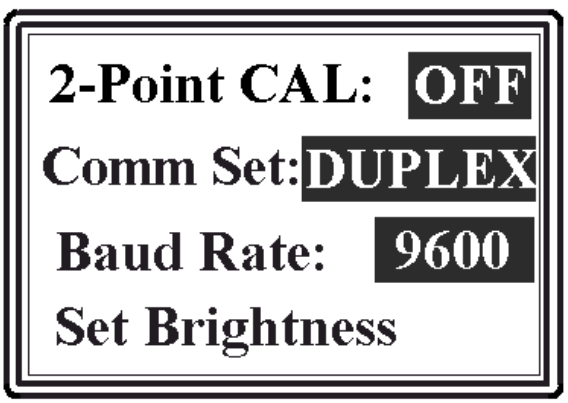
1) Press , move cursor to ALARM.
2) Press display the low and high limit of previous setting, use or to set the new low or high limit.
3) To exit the Limit Setting, press , , or start to measure.

3.8 Menu option

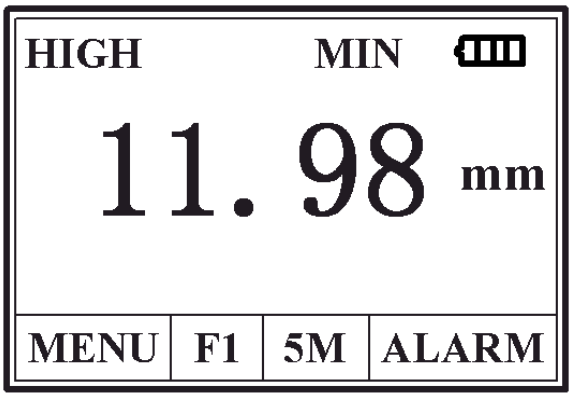
The setting and function of the instrument be handle in Menu option.
Press , move cursor to MENU then Press display main menu.



3.8.1 System Setup



1) **Measurement units:** metric and Imperial
2) **Receiving gain:** LOW and HIGH
    1. The LOW is mainly used for measuring coarse material with high scatter and small sound absorption, such as cast aluminum, cast copper and other metallic parts.
3) **Display resolution:** 0.1mm(LOW) and 0.01mm(HIGH)
4) **Minimum capture measurement** OFF and ON

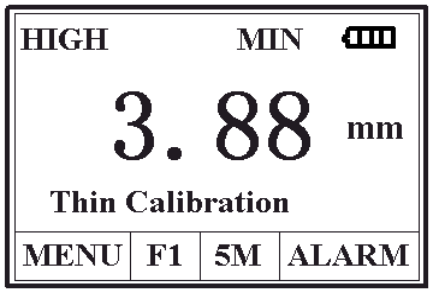


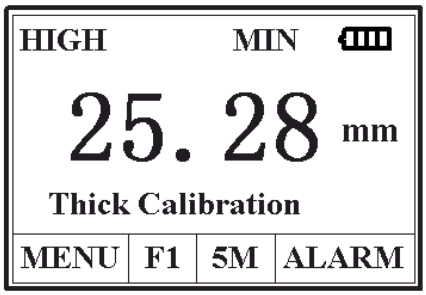
1. To capture min. measurement is to trap the minimum value in a group of measured values. When the probe couples with the work piece, it will display actual measurement, when the probe is taken away, it will display the min. value of measurement carried out a moment ago, and the MIN indicator for the minimum value will flash several seconds. If you continue the measurement when the MIN is flashing, the former measurements will continue to take part in the min. value capturing. If you carry out measurement after MIN indicator stops flashing, the min. value capturing will begin from then on.
2. When the Min. capture function is ON, LCD will have MIN indication

5) **2-Point Calibration:** OFF and ON

1. Select two standard samples of the same material with workpiece to be measured, among which, one has a thickness equal to or slightly higher than the tested piece, and the thickness of another test piece is slightly lower than the tested piece.
2. Before carrying out 2-point calibration, please turn off Min. Capture function, perform the Erase CAL Data function in the Memory Manager, and erase the former calibration record.
3. Set the 2-point calibration is ON.
4. Press key return main display.
5. One can carry out 2-point calibration at any time during measurement.

6. Press ↵ under thickness-measuring state to enter into 2-Point CAL, the screen will prompt to calibrate the thinner piece.





7. Measure the thinner standard test piece, use ↑ or ↓ to adjust the measurement to standard value. Press ENTER, the screen prompts to measure the thicker piece.

8. Measure the thicker standard test piece, use ↑ or ↓ to adjust the measurement to standard value.

9. Press ↵, the calibration operation is finished.

6) Comm Set : SIMPLEX and DUPLEX(default)

7) Baud Rate: 1200;2400;4800;9600

8) Adjusting Display Brightness

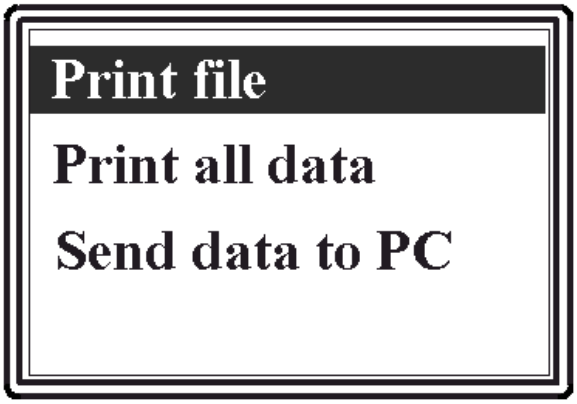
1. Press ↵ select “Set brightness”:

2. Use ↑ or ↓ to adjust the display brightness.

3. Press ↵ exit setup.

3.8.2 Print function

Connect main unit with micro printer from by the communication cable, print measured results through menu selection.

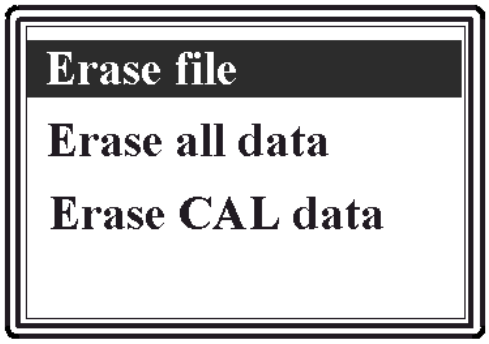


When the printing is completed, the buzzer will give out sound, the display will return to MENU state.

Send data to PC:

Connect main unit with PC by using the communication cable, one can send measured results through menu selection.

3.8.3 Memory Manage



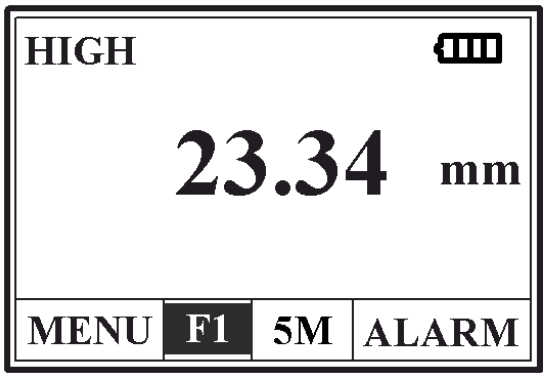
Erase file: Clearing selected files
Erase all data: Clearing entire memory
Erase CAL data: Clearing calibrating data

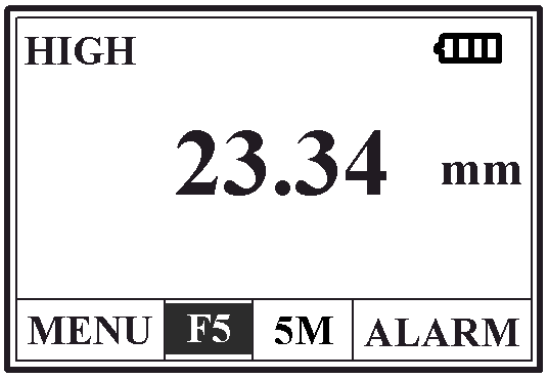
4 Data logger operation

4.1 Logging readings into memory

The instrument divides the memory unit into 5 files. Each can save 100 measurement values. Before saving data, Please set file number first. If you select the current file No., you can save the measurement directly by pressing . The procedures for setting file No. are:

1) Use to move the cursor to the position shown in the following figure:

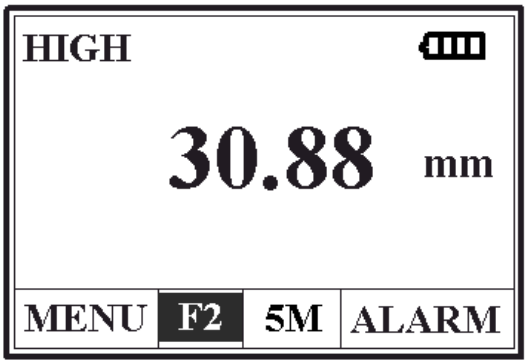




2) Press , by pressing F1~F5 to display file No.s cyclically. You can exit by pressing or conducting one measurement.

4.2 Reviewing stored thickness readings

1) Use to move the cursor to the position shown in the following figure:



2) Pressing to brown the contents of memory. Press , erase current data.
3) Pressing or review stored thickness.

4.3 Clearing current thickness Value

Under the state of Reviewing stored readings, press to erase a saved value currently displayed.

5. Measuring technology

5.1 Cleaning surface

Before measuring, please clean any dust, dirt and rust on the object, and remove any cover such as paint, etc. on it.

5.2 Improving requirement on roughness

Too rough surface will cause error in measurement. Before measuring, please smooth the surface of object by grinding, polishing or filing, etc. or use coupling agent with high viscosity for that.

5.3 Rough machined surface

The regular fine slots on rough machined (by such machines as lathe or planer) surface will also cause error in measurement. The way for compensating that is the same as that in 5.2. In addition, by so adjusting the included angle between the probe's crosstalk interlayer plate (the metallic layer passing through the center of probe bottom) and the fine slots of the object that the interlayer plate is perpendicular or parallel to the fine slots, and by taking the min. value of the readouts as the measured thickness, one can also get better results.

5.4 Measuring cylindrical surface

When measuring cylindrical material, such as pipes, oil tubes, etc., it is very important to select properly the included angle between the probe's crosstalk interlayer plate and the axial line of the material to be measured.

Briefly to say, first couple the probe with the material to be measured, make the probe's crosstalk interlayer plate be perpendicular or parallel to the axial line of the object, shake the probe vertically along the axial line of the object, the readouts displayed on screen will change regularly. Select the min. readout from displayed ones as the accurate thickness of the object.

The standard for selecting the included angle between the probe's crosstalk interlayer plate and the axial line of the object is depending on the curvature of it. For a pipe with large diameter, the probe's crosstalk interlayer plate should be perpendicular to the axial line of the object; for a pipe with small diameter, one can measure with the probe's crosstalk interlayer plate being both parallel and perpendicular to the axial line of the object, and take the min. readout as the thickness.

5.5 Compound profile

When the material to be measured has compound profile (such as bend of a pipe), one can use the way described in 5.4 to measure. The exception is that one should have two analysis, get two results when the probe's crosstalk interlayer plate being both parallel and perpendicular to the axial line of the object, and take the min. readout as the thickness.

5.6 Un-parallel surface

To get a satisfactory ultrasonic response, the other surface of the object must be parallel to or co-axial with the surface to be measured, otherwise, it will cause measuring error or even no display.

5.7 Influence of material's temperature

Both the thickness and transmitting speed of ultrasonic wave are influenced by temperature. If it has a high requirement on the measuring accuracy, one can use comparison method by test pieces, i.e., use a test piece with same material to measure under same temperature, and get temperature compensation coefficient, and use this coefficient to correct the actual measurement of the object.

5.8 Material with large attenuation

For some material such as fiber, with porous and coarse particles, they will cause large scatter and energy attenuation in ultrasonic wave, which will cause abnormal readouts even no display (generally, the abnormal readout is less than actual thickness). In this situation, this kind of material doesn't apply to be measured with this instrument.

5.9 Reference test piece

When making accurate measuring for different materials under different conditions, the more the standard test piece is near to the material to be measured, the more accurate the measurement is. The ideal reference test

pieces should be a group of test pieces with different thickness made of materials to be measured, the test pieces can provide calibrating factors for the instrument (such as the microstructure of the material, heat-treating condition, direction of particles, surface roughness, etc.). To meet the highest requirement on measuring accuracy, a set of reference test pieces will be critical.

Under most situations, one can get satisfactory measuring accuracy with only one reference test piece, which should have same material and similar thickness with the object. Take an even object, measure it by using a micron micrometer, then it can be used as a test piece.

For thin material, when its thickness is near to the low limit of the probe's measuring range, one can use test piece to determine the accurate low limit. Never measure a material with a thickness lower than the low limit. If the thickness range can be estimated, the thickness for the test piece should select the high limit.

When the object is thick, especially for alloy with complex internal structure, please select a test piece similar to the object from a group of test pieces, thus to can have idea of calibration.

For most casting and forging, their internal structures have some direction. In different direction, the sound velocity will have some change. To solve the problem, the test piece should have an internal structure with same direction as that of the object, and the transmitting direction of sound wave in it should also be same as that for the object.

Under certain circumstances, look up the speed-of-sound table for given materials can replace reference test pieces. But this is approximately to substitute some test pieces. Under some situations, the value in the speed-of-sound table will have some difference from the actual measured values, this is due to difference in the material's physical and chemical characteristics. This way is usually used for measuring low-carbon steel, and can only be taken as a rough measurement.

Thickness Gauge can measure sound velocity. Measure the sound velocity first, then measure the workpiece with the measured speed.

5.10 Several measuring methods

a) Single measuring way: measurement at one point.

b) Double measuring way: measure with probe at one point twice. During the two measurements, the probe's crosstalk interlayer plate should be placed in perpendicular direction, and take the min. readout as the accurate thickness of the material.

c) Multi-point measuring way: make several measurements in a range, and take the min. readout as the thickness of the material.

5.11 Selecting probes

Probe	Frequency	Measuring range	Min. area ϕ	Application
5P ϕ10	5MHz	1.0mm~300.0mm (steel)	ϕ20×3mm	General Straight probe
5Pϕ10/90°				General bent probe
7Pϕ6 300	7 MHz	0.75mm~25.0mm (steel)	ϕ15×2mm	thin work piece
ZW5Pϕ10	5 MHz	0.75mm~25.0mm (steel)	30mm	high temperature
2P ϕ14	2 MHz	3．0mm~300.0mm (steel)	20mm	casting work piece

5.12 Changing probe

The wearness of the probe's interlayer plate will influence the measurement. Please replace probe when the following situation happens.

1. When measuring different thickness, it always displays the same value.
2. When plugging the probe, it has echo indication or measured value display without measuring.

5.13 Measuring casting

It has specialty for measuring casting. The crystal particles for castings are coarse, the structures are not dense enough, plus that they are in gross state, which makes difficulty in measuring their thickness.

First of all, due to coarse crystal particles and not-so-dense structure, it will cause large attenuation in sound energy. The attenuation is due to material's scatter and absorption of sound energy. The attenuation degree is closely relative with the size of crystal particle and ultrasonic frequency. Under the same frequency, the attenuation will increase with the crystal diameter, but it has a high limit, when it reaches to this limit, if the crystal diameter increases, the attenuation will tend to be a fixed value. For attenuation under different frequencies, it will increase as the frequency.

Secondly, due to coarse crystal particle and if coarse out-phase structure exists, it will cause abnormal reflection, i.e. the grass-shaped echo or tree-shaped echo, so that the measuring will have error reading, and cause wrong judgement.

Thirdly, as the crystal particle is coarse, the anisotropy in flexibility in metal's crystallizing direction will be obvious, which results in difference

in sound velocities in different directions, and the max. difference can even be up to 5.5%. What's more, the compactness in different positions of the workpiece is different, which will also cause difference in sound velocity. All of these will produce inaccuracy in measurement. Therefore, one must be very careful in measuring castings.

During measuring castings, please pay attention to the following points:

1. When measuring casting with unmachined surface, please use engine oil, consistent grease and water glass as coupling agent.
2. Calibrate the sound velocity for the object with a standard test piece having the same material and measuring direction as that for the object to be measured.

3.If necessary, take 2-point calibration.

6 Preventing errors in measurement

6.1 Ultra-thin Material

For any ultrasonic thickness-gauge, when the thickness of object is less than the low limit of the probe, it will cause measurement error. When necessary, measure the min. limit thickness by comparing with the test pieces.

When measuring ultra-thin object, sometimes error called "double refraction" may occur, its result is that the displayed readout is twice of the actual thickness. Another error result is called "pulse envelop, cyclic leap", its result is that the measured value is larger than the actual thickness. To prevent these kinds of errors, please repeat the measurement to check the results.

6.2 Rust, Corrosion and Pit

The rust and pit on the other surface of the object will cause irregular change in readouts. In extreme situation, it will even cause no readout. It is very difficult to find small rust. When one finds a pit or is in doubt, he should be very careful in that area. In such situation, one can orient the probe's crosstalk interlayer plate in different directions to have multiple measurements.

6.3 Error in Identifying Material

When calibrates the instrument with one material, and then uses it to measure another material, error will occur. Please be careful in selecting correct sound velocity.

6.4 Wearness of Probe

The surface of the probe is allyl resin, after long time of usage, its roughness will increase, and the sensitivity will drop. If the user can be sure that this is the reason for error, he can grind the surface with sand paper or oilstone to make it smooth and has good parallelism. If it is still not stable, the probe must be replaced.

6.5 Overlapped Material and Compound Material

It is impossible to measure uncoupled overlapped material, because the ultrasonic wave can't pass an uncoupled space. Since the ultrasonic wave can't transmit in compound material in even speed, it is not applicable to use ultrasonic thickness-gauge to measure overlapped material and compound material.

6.6 Influence of Oxidation Layer at Metal's Surface

Some metals can produce dense oxidation layer on its surface, such as aluminum, etc. The layer is closely contacted with the substrate, and it has no obvious interface, but the ultrasonic wave has different transmitting speed in these two materials, which will cause error. In addition, different thickness in oxidation layer will cause different error. Please be careful in this. One can make a reference piece from a batch of objects by measuring with micron micrometer or caliper, and use it to calibrate the instrument.

6.7 Abnormal Readout of Thickness

The operator should be able to identify abnormal readout. Generally, the rust, corrosion, pit and internal defect of the object will cause abnormal readout. For the solution for that, please refer to chapter 4 and 5.

6.8 Utilization and Selection of Coupling Agent

The coupling agent is for transmitting high-frequency energy between the probe and the object. If the type of agent is wrong, or the utilization is wrong, it will cause error or flashing coupling indicator, and it will be impossible to measure. The coupling agent should be used in proper amount and be coated evenly.

It is very important to select proper coupling agent. When it is used on a smooth surface, you'd better use an agent with low viscosity (such as coupling agent provided along with the instrument and light engine oil, etc.). When it is used on a coarse object surface, or vertical surface and top surface, one can use agent with high viscosity (such as glycerin grease, consistent grease and lubricating grease, etc.).

Various coupling agents with different components are available everywhere.

7. Attention

7.1 **Cleaning the Test Piece**

Since the test pieces supplied along with the instrument will be coated with coupling agent when being used for inspection, so please prevent it from rust. After the measurement, the test pieces should be cleaned. When the weather is hot, never stick any sweat on the pieces. If the pieces are not to be used for a long time, please paint them with some oil to prevent rust. When one wants to use them again, first clean them, then he can have normal operation.

7.2 Cleaning the Instrument's Case

Alcohol, diluent will corrode the case, especially the LCD of the instrument. Therefore, when you clean the instrument, you can do that just with some clean water and clean it slightly.

7.3 Protecting the Probe

The surface of the probe is allyl resin, which is very sensitive to the heavy scratch from the coarse surface. Therefore, during operation, Please press it lightly. When measuring coarse surface, please minimize scratch on the working surface of the probe.

When measuring under normal temperature, the temperature of the surface to be measured should not be more than 60°C, otherwise the probe can't be used.

The oil and dirt will age and break the probe line, so please remove dirt on the cable after operation.

7.4 Replacing Batteries

When indication for low voltage occurs, please replace batteries on time :

a. Turn off the instrument
b. Open the battery chamber
c. Take out the batteries, put in new ones. Please note the polarity.

If the instrument will not be used for a long time, please take out the batteries to avoid leakage, and corrosion in the battery chamber and pole piece.

7.5 Absolutely avoid collision and moisture.

8. Maintenance

8.1 When the error of measurement is too large, please refer to chapter 6, 7.

8.2 If the following problems occur, please contact the Maintenance

Department of Time Group:

a.The component of the instrument is damaged and it is impossible to measure.

b. The LCD is abnormal.

c.During normal operation, the error is too large.

d. The keyboard doesn't function or is in disorder.

8.3 Since Thickness Gauge is a high-tech product, its maintenance should be conducted by professional trained person. The user should not disassemble and repair it by himself.

9.Configuration

	No	ITEM	QUANTITY	NOTE
Standard configuration	1	Main Unit	1	
	2	Transducer	1	
	3	Couplant	1	
	4	Instrument case	1	
	5	Operating Manual	1	
	6	1.5V battery	2	
	7			
Optional Configuration	1	Transducer:N02		
	2	Transducer:N07		
	3	Transducer:HT5		
	4	Mini Thermal printer		
	5	Print cable		
	6	DataPro Software		
	7	Communication cable		
	8			
	9			

Sound velocity for Different Materials

Material	Sound velocity	
	(m/s)	(inch/μs)
Aluminum	6320-6400	0.250
Zinc	4170	0.164
Silver	3607	0.142
Gold	3251	0.128
Tin	2960	0.117
Steel,common	5920	0.233
Steel,stainless	5740	0.226
Brass	4399	0.173
Copper	4720	0.186
Iron	5930	0.233
Case Iron	4400-5820	0.173-0.229
Lead	2400	0.094
Nylon	2680	0.105
Titanium	5990	0.236
SUS	5970	0.240
Epoxy resin	2540	0.100
Ice	3988	0.222
Plexiglass	2692	0.106
Gray Cast	4600	0.180
Porcelain	5842	0.230
Glass (quartz)	5570	0.220
Polystyrene	2337	0.092
PVC	2388	0.094
Quartz glass	5639	0.222
Rubber,Vulcanized	2311	0.091
Teflon	1422	0.058
Water	1473	0.058