Ultrasonic thickness gauge TM210 PLUS

1 Introduction
1.1 Scope of applications

The 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 Configuration and name of parts
1.3.1 Configuration

Main unit
Transducer TM-08
Couplant

1.3.2 Optional accessories:

Transducer TM-2M
Transducer TM-7M
Transducer TM-HT
Standard test block

control:data

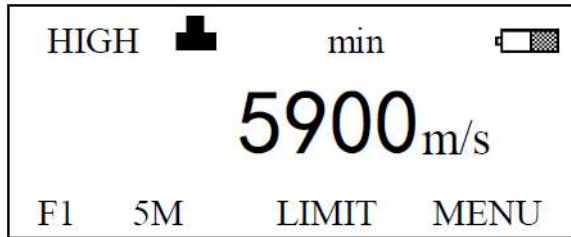|	
⏻	-- On / Off
MODE	-- Function selector
▭	-- Memory
VEL	-- Sound velocity
ENTER	-- 2-point calibration; to be used together with function keys.
▲	-- Adjusting sound velocity and thickness; key for moving menu cursor
▼	-- Adjusting sound velocity and thickness; key for moving menu cursor
✳	-- Backlight
ZERO	-- zero calibration

control:data

Display symbols:

F1 — number of saved files
5M — frequency of transducers
LIMIT — thickness limits
MENU — menu
▟ — coupling indicator
▭▨ — low battery indicator
Min — min. capture mode
HIGH (LOW) — indicator for gain

2 Specifications

Measuring range: depending on transducer and material
0.75mm~225.0mm (0.03inch~8.9 inch)

Display resolution: 0.01mm or 0.1mm (lower than 100.0mm)
0.1mm (more than 99.99mm)

Lower limit for steel pipes:
5MHz probe: ⦰20mm⦰3.0mm (⦰0.8⦰ 0.12 inch)
7MHz probe: ⦰15mm⦰2.0mm (⦰0.6⦰ 0.08 inch)

Material velocity range: 1000m/s~9999m/s (0.039~0.394in/μs)
Environment temperature: 0~40⦰C

control:data

Power supply: 4pcs. 1.5V AAA batteries
Power consumption: working current <30mA (without back light)
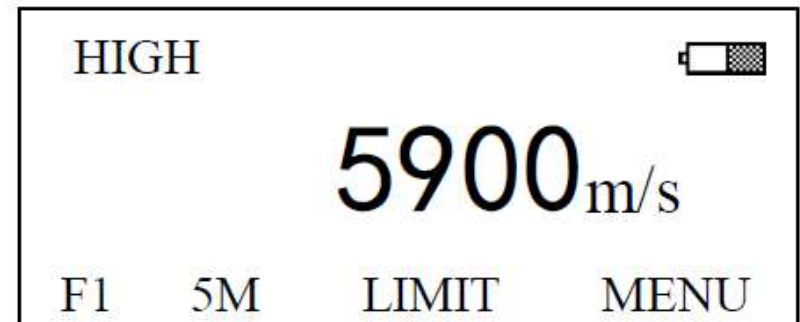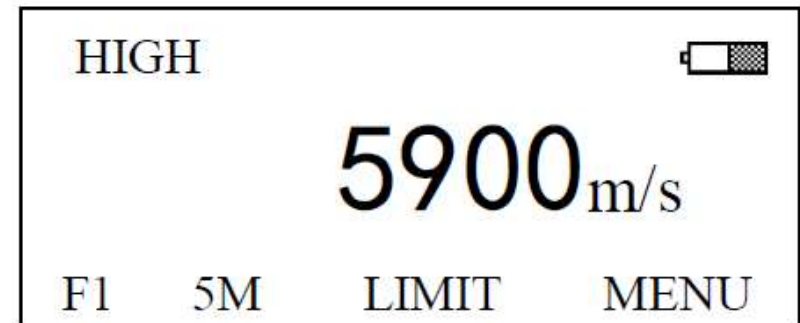Dimensions: 165mm × 81mm × 31mm
Weight: 320g

3 Operation

3.1 Preparation for measurement

(1). Insert the transducer plug into the socket on the main unit,
(2). Press Ө to turn on the instrument, and enter the main interface as follows:

```
┌─────────────────────────────┐
│ HIGH                    ▭▨   │
│                              │
│              5900 m/s        │
│                              │
│ F1    5M     LIMIT    MENU   │
└─────────────────────────────┘
```

(3). Setting transducer frequency

Press MODE to move the cursor to the required position.

Press ENTER to change the setting.

```
┌─────────────────────────────┐
│ HIGH                    ▭▨   │
│                              │
│              5900 m/s        │
│                              │
│ F1    5M     LIMIT    MENU   │
└─────────────────────────────┘
```

control:data

It will display, in turns, the frequency of transducer available at ZW, 5M, 7M, 2M, 5M.

(4) Zero calibration

Couple the transducer and integrated test block (4mm) properly, and press the key "ZERO", then "Calibrate zero done" will be displayed in the screen as following sketch shows.
If this does not display, the zero calibration has failed, you must repeat the process.


Note: users are required to complete the ZERO Calibration every time the transducer is changed or the testing temperature / environment changed, and after long periods of disuse.

control:data

3.2 Adjusting sound velocity

If the current display is thickness, by pressing VEL, you can come into speed-of-sound state, which will display content in current speed-of-sound memory unit. The speed-of-sound memory unit will progress every time when you press the VEL key, it can display 5 speeds of sound. To change the contents in the current speed-of-sound unit, you can adjust with up or down arrows until you reach the desired value.

HIGH

5900m/s

F1   5M   LIMIT   MENU
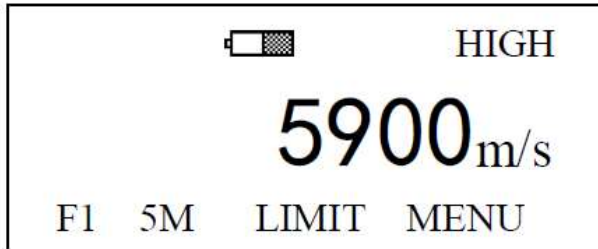
Press VEL to enter sound-velocity state

HIGH

5920m/s

F1   5M   LIMIT   MENU
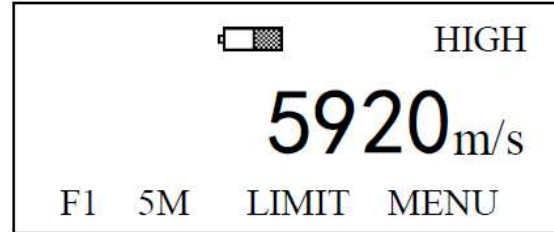
Value after adjusting with ∧ or ∨

3.3 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 good.

HIGH

20. 05 mm

F1   5M   LIMIT   MENU

HIGH

20. 05 mm

F1   5M   LIMIT   MENU

control:data
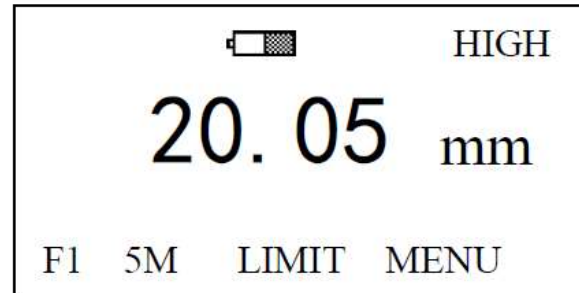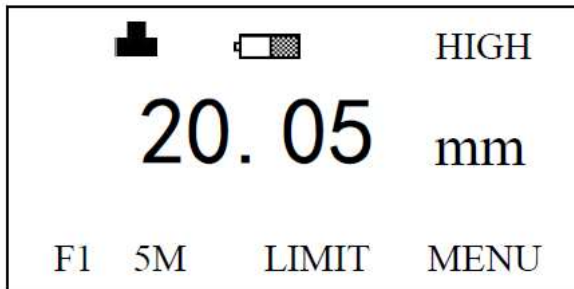
3.4 Measurement of sound velocity

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 up or down arrows, press VEL. Now it will display the sound velocity to be measured. Save the value into current speed-of-sound memory unit.

For measuring sound velocity, select a test piece with adequate thickness, the recommended minimum wall thickness is 20mm. 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 20.0mm, the procedure is:
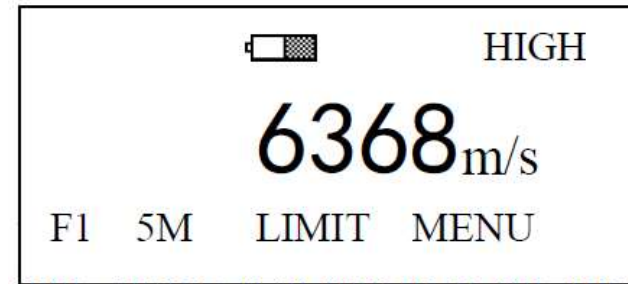
a. Measure with any sound velocity, get a thickness value as following shows;
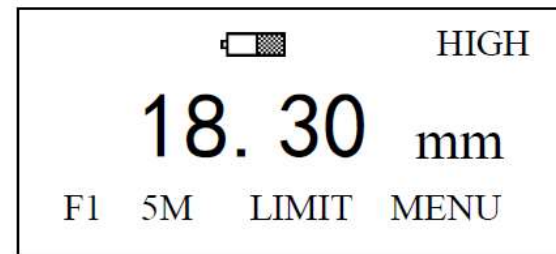
b. Use up or down to adjust the displayed value to 20.00mm, as shown in the following figure:

control:data
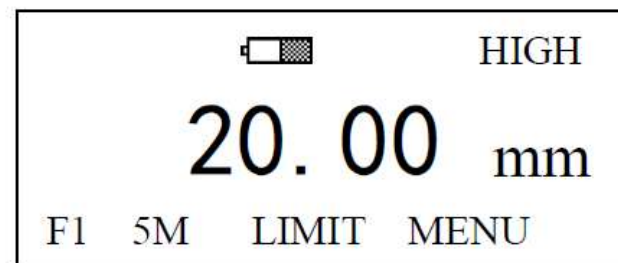
c. Press VEL to display the sound velocity to be measured, as shown in the following figure:

```
                          HIGH

       6368 m/s

   F1   5M   LIMIT   MENU
```

3.5 Setting Thickness Limits

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

1) Press MODE, move cursor to LIMIT

```
                          HIGH

       5900 m/s

   F1   5M   LIMIT   MENU
```
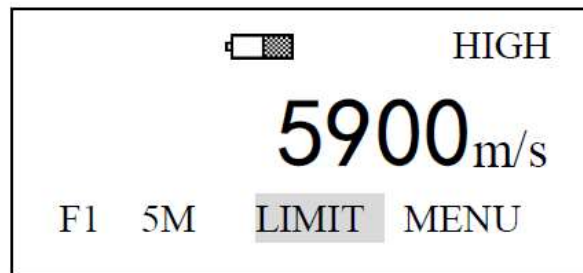
2) Press "Enter" to display the low and high limit of previous setting (as shown in the figure), use ^ or > to set the new limits.

```
                          HIGH

    0. 75      mm

   Low limit
   F1   5M   LIMIT   MENU
```
Setting low limit
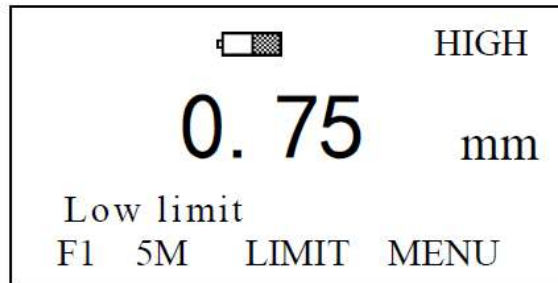
```
                          HIGH

    300. 0    mm

   High limit
   F1   5M   LIMIT   MENU
```
Setting high limit

control:data

3) To exit the Limit Setting, press VEL, MODE, or start to measure.
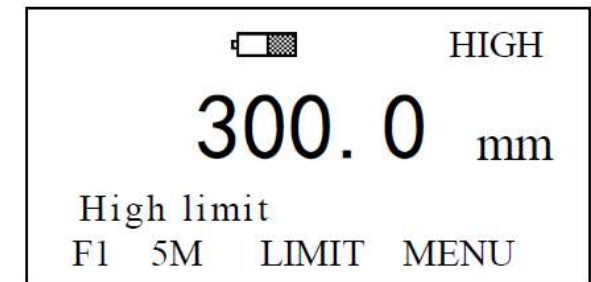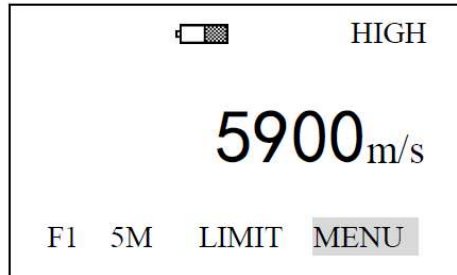
3.6 Setting receiving gain

The gauge has two setting of gains, LOW and HIGH. 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.
The setting procedures are:

1) Press MODE, move cursor to MENU, as shown in the figure

```
                    HIGH
         5900 m/s
F1   5M   LIMIT   MENU
```

2) Press Enter to enter the main menu, move cursor with up or down to System setup.

```
System   setup
Function   setup
↓
```
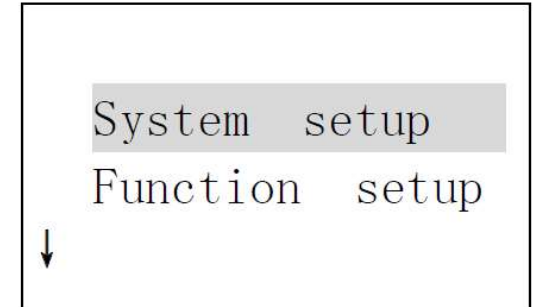
3) Press ENTER and enter System setup menu

```
Unit:           METRIC
Gain:           LOW
Resolution:   HIGH
```
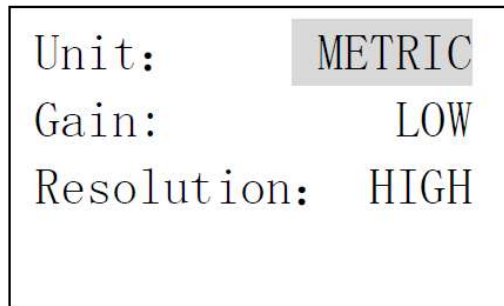
4) Press up or down to move the cursor to Gain setting

```
↑
Unit:           METRIC
Gain:           LOW
Resolution:   HIGH
↓
```

control:data
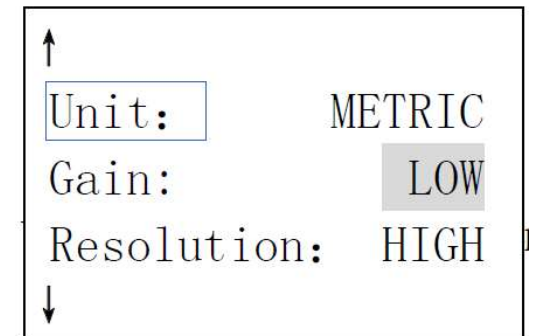
5) Use Enter to select LOW or HIGH:

```
↑
Unit:        METRIC
Gain:          HIGH
Resolution:    HIGH
↓
```
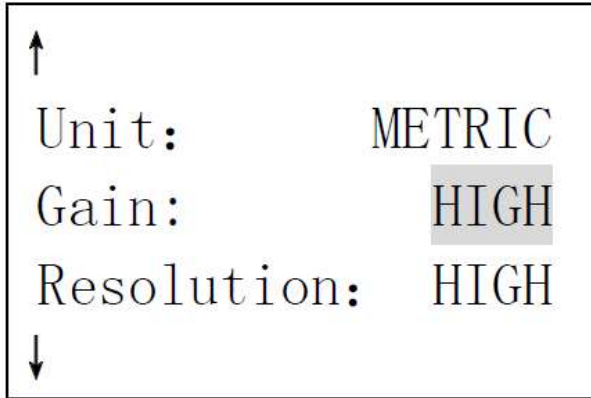
6) Use VEL to exit, and MODE to back to up menu

```
                    ▭              HIGH

              5900 m/s

F1   5M    LIMIT   MENU
```
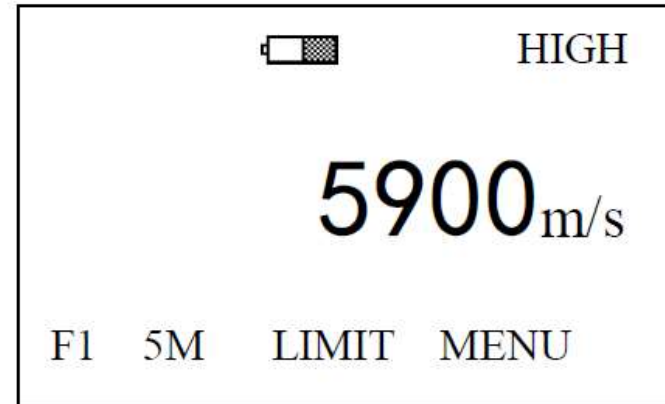
3.7 Setting measurement units and display resolution

The gauge has two display resolutions—0.1mm and 0.01mm, and two measurement units—metric and Imperial, they can be selected with menu.
The procedure for setting is:

control:data

1) Press MODE, move cursor to MENU, as shown in the figure:

```
         ▭▨           ┌──────┐
                      │ HIGH │
                      └──────┘
         ┌──────────────┐
         │  5900 m/s    │
         └──────────────┘
  F1   5M    LIMIT   MENU
```
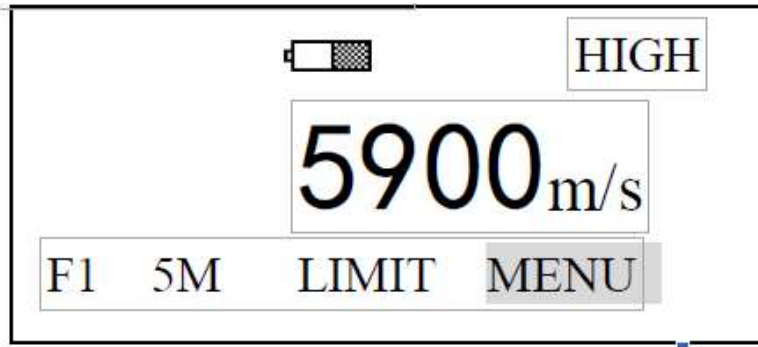
2) Press Enter enter the main menu, move cursor with up or down to System setup.

```
  System   setup

  Function   setup

  ↓
```
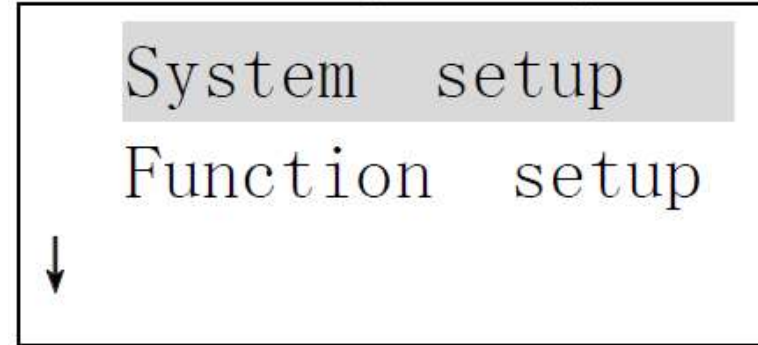
3) Get into setup menu, press Enter to display METRIC and IMPERIAL :

```
  Unit:          METRIC
  Gain:            LOW
  Resolution:    HIGH

  ↓
```

control:data
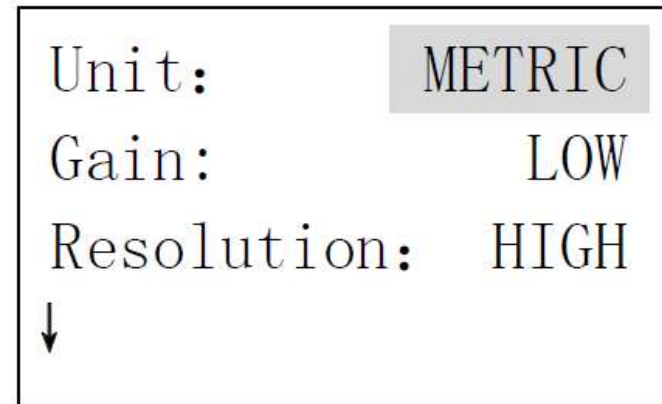
4) Press up or down to select Resolution, press Enter display HIGH (0.01mm) and LOW (0.1mm):

```
↑
Unit:        METRIC
Gain:           LOW
Resolution:    HIGH
↓
```

5) Press MODE to back to upper menu. To exit, press VEL or carry out measurement.

3.8 Minimum capture measurement

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. The setting of min. measurement capturing is as follows:

control:data

1) Press MODE to select MENU, as shown in the figure

```
┌─────────────────────────────────┐
│  ▭▓          HIGH                │
│                                 │
│        5900 m/s                 │
│                                 │
│  F1  5M   LIMIT   MENU          │
└─────────────────────────────────┘
```
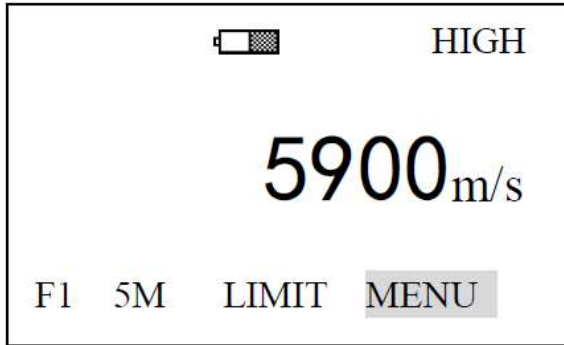
2) Press Enter to select System setup.

```
┌─────────────────────────────────┐
│  System   setup                 │
│  Function   setup               │
│                                 │
│  ↓                              │
└─────────────────────────────────┘
```

3) Get into System setup:

```
┌─────────────────────────────────┐
│  Unit:        METRIC            │
│  Gain:          LOW             │
│  Resolution:   HIGH             │
│  ↓                              │
└─────────────────────────────────┘
```
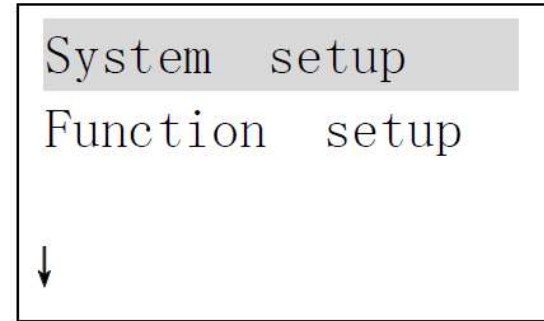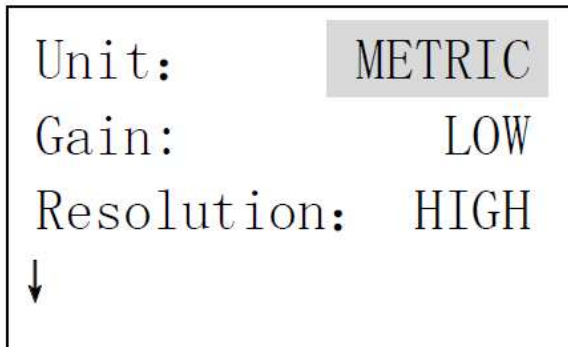
4) Press up or down to select Min capture:

```
┌─────────────────────────────────┐
│  ↑                              │
│  Gain:          LOW             │
│  Resolution:   HIGH             │
│  Min measure:   OFF             │
│  ↓                              │
└─────────────────────────────────┘
```
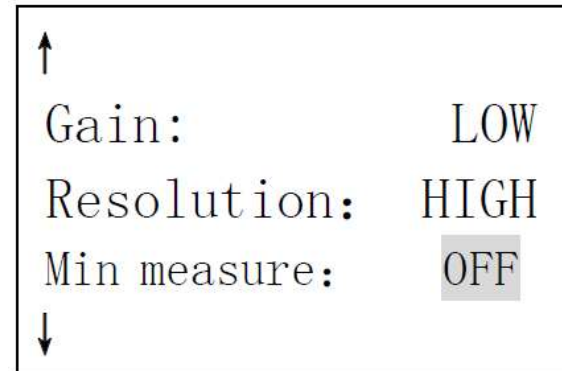
5) Press Enter display ON (Min. capture function is on) and OFF (Min. capture function is off) alternatively. When the Min. capture function is on, it will have MIN indication on the screen. Users can exit the setting by pressing VEL or carrying out one measurement.

control:data

3.9 2-Point Calibration:

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. Before carrying out 2-point calibration, please turn off Min. Capture function, perform the Erase CAL data function in the menu Function setup, and cancel the former calibration record. then turn on the 2-point calibration. Steps are as following:

1. Setting of 2-point calibration:
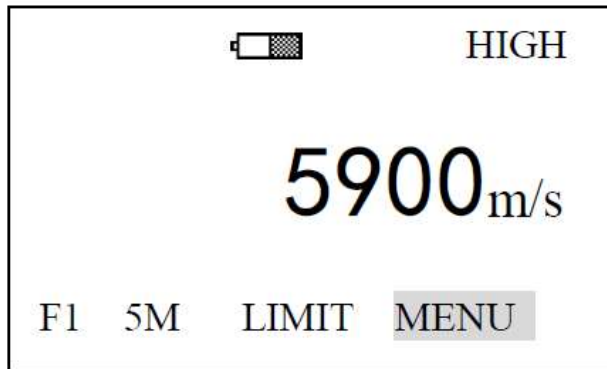
1) Press MODE to select MENU, as shown in the figure

2) Press Enter to enter into main menu, use up or down arrows to select system setup

HIGH

5900m/s

F1   5M   LIMIT   MENU

System   setup

Function   setup

↓

control:data

3) Get into System setup:

```
Unit:          METRIC

Gain:            LOW

Resolution:     HIGH
```
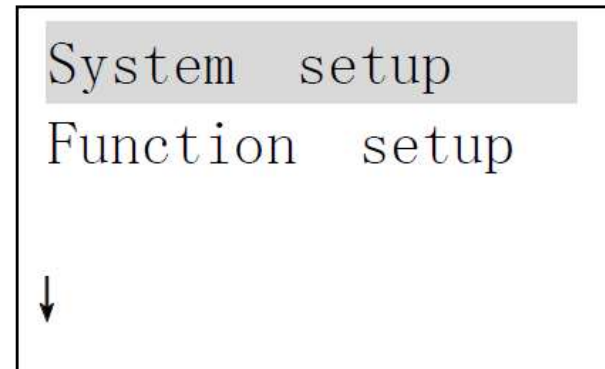
4) Press up or down to select 2-Point CAL:

```
Resolution:   HIGH
Min capture:   OFF
2-Point CAL:   OFF
↓
```

5)   Press Enter display ON (2-point CAL is on) and OFF (2-point CAL is off) alternatively.
6)   Users can exit with VEL or by carrying out a measurement. If the 2-Point CAL is set to ON, you can carry out 2-point calibration at any time during measurement.

2. Operation of calibration:

1) Press ENTER under thickness-measuring state to enter into 2-Point CAL.
The screen will prompt to calibrate the thinner piece, displaying thus:

```
                  ▭▨▨      HIGH

            2.89         mm

   Thin calibration
   F1   5M    LIMIT   MENU
```

control:data

2) Measure the thinner standard test piece, use up or down to adjust the measurement to standard value. Press ENTER, the screen prompts to measure the thicker piece, the display is as follows:

```
┌─────────────────────────────────┐
│                                 │
│      ▭▓   HIGH                   │
│                                 │
│    3. 00   mm                    │
│                                 │
│   Thick calibration             │
│   F1  5M   LIMIT  MENU           │
│                                 │
└─────────────────────────────────┘
```
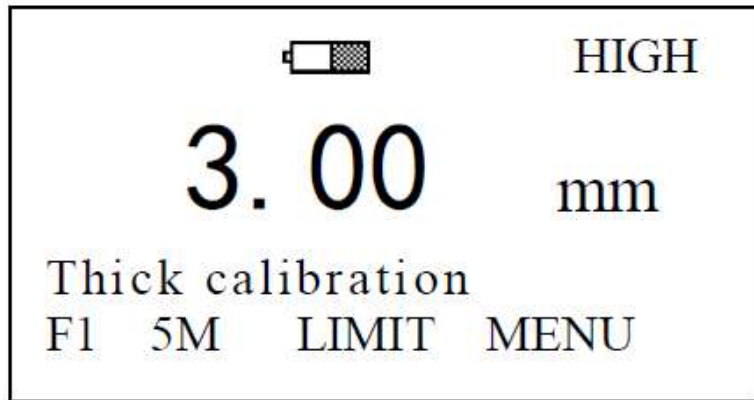
3) Measure the thicker standard test piece, use up or down to adjust the measurement to standard value. Press ENTER, the calibration operation is finished.

3.10 Saving, reviewing and deleting of thickness values

The instrument divides the memory into 5 files. Each can save 100 measurement values. Before saving data, set file number first. If you select the current file number, you can save the measurement directly by pressing MEM. The procedures for setting file number are:

3.10.1 saving of thickness values
1) Press MODE to move the cursor to the position shown in the following figure:

control:data

```
        ┌─────────────────────────────┐
        │        ▭▦        HIGH        │
        │                             │
        │      20. 00  mm             │
        │                             │
        │ F1   5M   LIMIT   MENU      │
        └─────────────────────────────┘
```
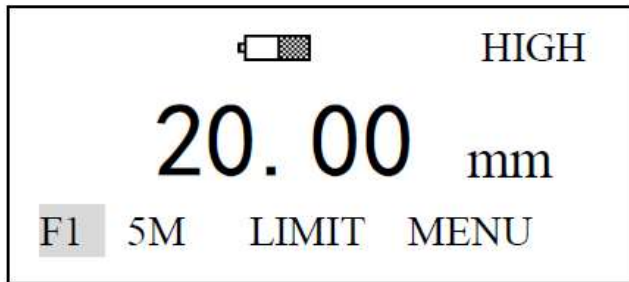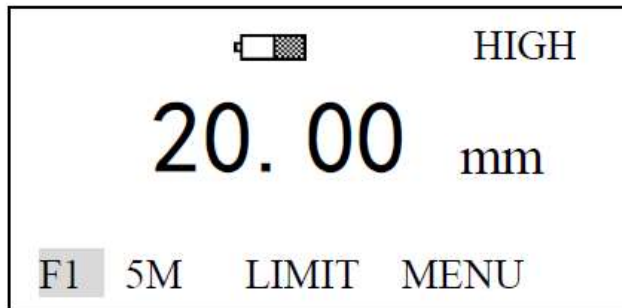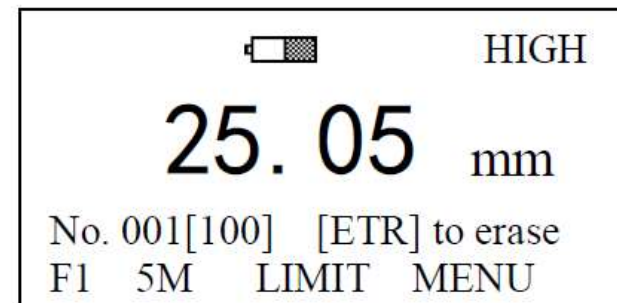
2) Press ENTER, by pressing F1~F5 to display file numbers cyclically. Exit by pressing VEL or conducting measurement. After setting file number, you can save the measured values into the file every time after you finish the measurement by pressing MEM.

3.10.2 Reviewing stored thickness readings

1) Use MODE to move the cursor to the position of file

```
        ┌─────────────────────────────┐
        │         ▭▦        HIGH       │
        │                             │
        │       20. 00  mm            │
        │                             │
        │                             │
        │  F1   5M   LIMIT   MENU     │
        └─────────────────────────────┘
```

2）Pressing MEM to check the contents of the memory

```
        ┌─────────────────────────────┐
        │         ▭▦        HIGH       │
        │                             │
        │       25. 05  mm            │
        │                             │
        │  No. 001[100]   [ETR] to erase │
        │  F1   5M   LIMIT   MENU     │
        └─────────────────────────────┘
```

control:data

Note: "No." means the serial number of the saved data displayed at present; "Total" is the total number of data saved in the file.
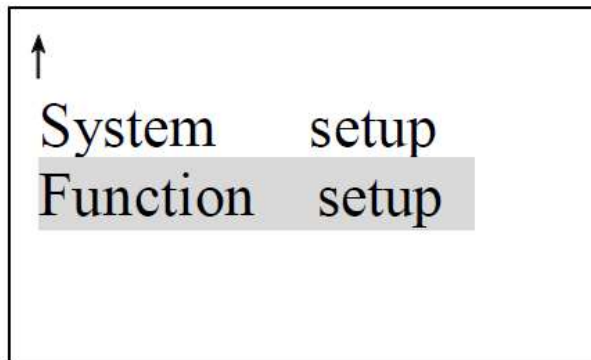
3）You can check all data saved by pressing up or down.

3.10.3 Clearing readings
In the state of Reviewing stored readings, press Enter to erase a saved value currently displayed. And the next reading will appear.

How to delete current file or all files.
1) Go to the following interface and select Function setup:

```
↑
System      setup
Function    setup
```

2) Press ENTER to enter into Function setup, and select "Erase file":

```
Erase file
Erase all data
Erase CAL data
↓
```

control:data
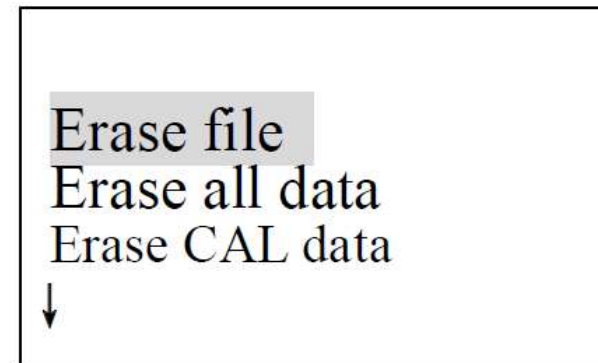
3) Press Enter to confirm Erase file, when the erasing is completed, the buzzer will sound, and the display will return to MENU state, and the Erase information displays.

7) Press up or down to move the cursor to "Erase all data":
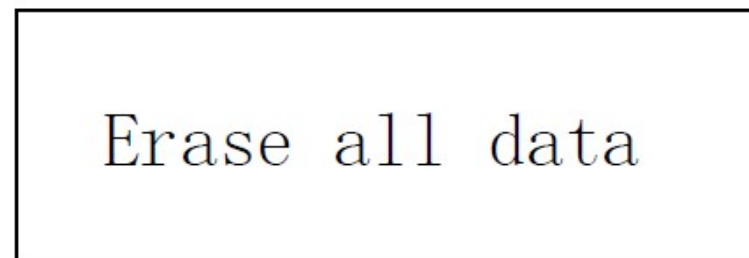
Erase file
Erase all data
Erase CAL data
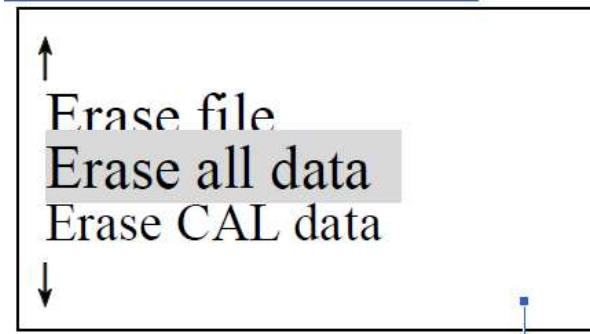
8) Press Enter confirm Erase all data. When the deletion is completed, the buzzer will sound and the display will return to MENU state. The display for Erase is as follows:

Erase all data

control:data

3.11 Adjusting Display Brightness

1) Press MODE to select MENU, as shown in the following figure
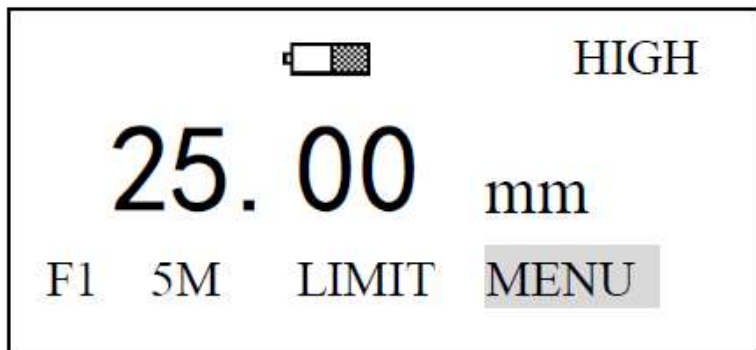
2) Press Enter to get into menu:

```
           🔋          HIGH

      25. 00  mm

   F1   5M    LIMIT   MENU
```

```
System    setup

Function    setup


↓
```
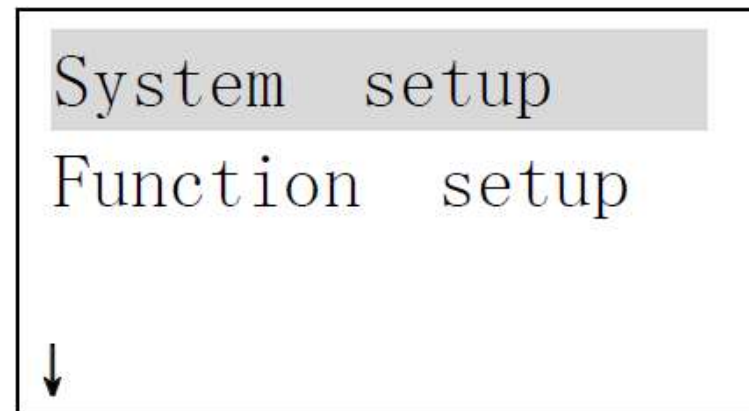
3) Press down to move the cursor to Function setup, the display is as follows:

```
↑
System    setup

Function    setup
```
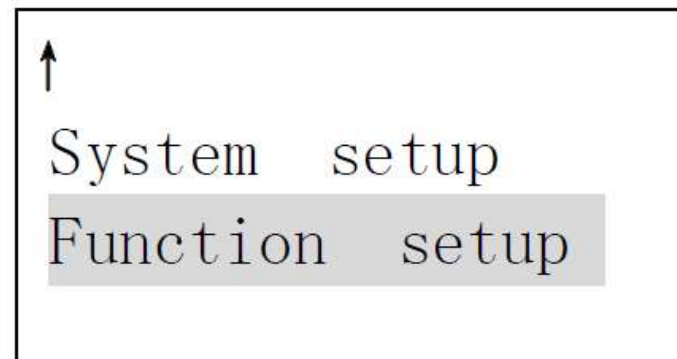
control:data

4) Press Enter to enter into Function setup, use up or down to move cursor to Set brightness:

```
↑
Erase all data
Erase CAL data
Set brightness
```
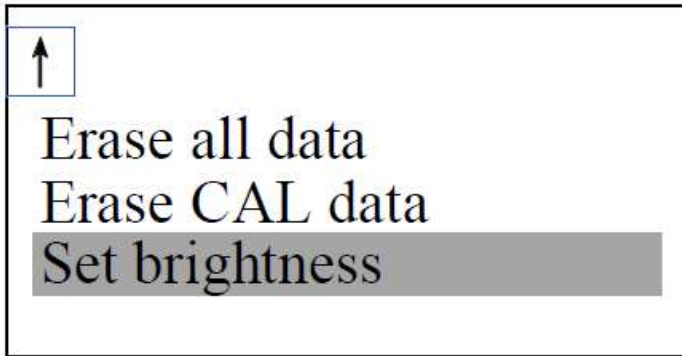
5) Press Enter select "Set brightness":

```
Brightness:  04
[ENTER]   to   Esc
[ ↑ ] to +
[ ↓ ] to -
```

6) Use up or down to adjust the display brightness, and exit setup by using ENTER

control:data
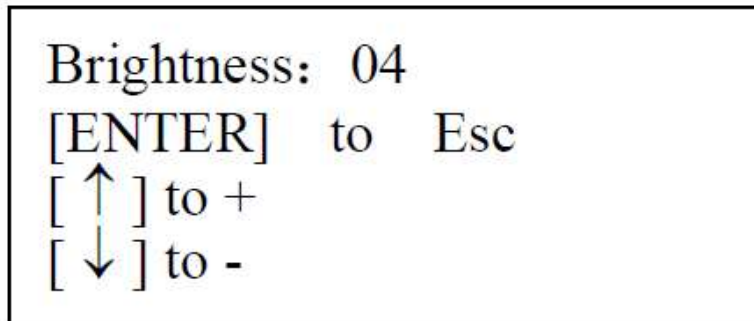
3.12 Backlight

Switch back light ON and OFF at any time by pressing this key

3.13 Low voltage indication

If ▭ occurs on the screen, it means the battery voltage is low, please change batteries.

HIGH

5900m/s

F1 5M   LIMIT MENU
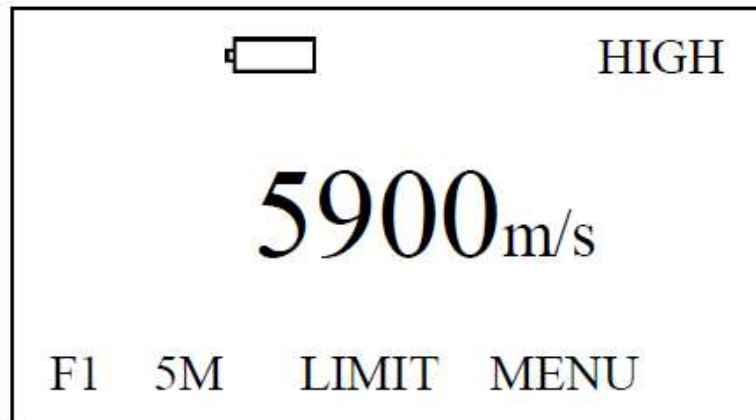
3.14 Turning off

The gauge can be turned off automatically or manually.

If one carries out no operation in 2min, the instrument will turn off automatically; by pressing θ, one can turn off the instrument manually.

control:data

4. Measuring technology

Follow these tips for problems-free measurement

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

4.2 Improving requirement on roughness
Too rough a 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.

4.3 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 4.2. 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.

4.4 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.

control:data

The standard for selecting the included angle between the probe's crosstalk interlayer plate and the axial line of the object depends 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 a small diameter, you 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.

4.5 Non-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.

4.6 Influence of material's temperature
Both the thickness and transmitting speed of ultrasonic waves are influenced by temperature. If you have a high requirement on the measuring accuracy, you 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.

4.7 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 or even no display (generally, the abnormal readout is less than actual thickness). In this situation, this kind of material cannot be measured with this instrument.

control:data

4.8 Reference test piece

For accurate measurement of different materials under different conditions, the closer the standard test piece is 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 as 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 a 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 alloys 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.

control:data

THE GAUGE can measure sound velocity. So users can measure the sound velocity first, and then measure the workpiece with the measured speed.

4.9 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.

Probe	Frequency	Measuring Range	Diameter	Application
TM-08	5MHz	1.2mm~225.0mm (steel)	8mm	-10 ~ 60 C
TM-13	2MHz	3.0mm~300.0mm (steel) ≤40mm(HT200)	13mm	-10 ~ 60 C
TM-06	7MHz	0.75mm~25mm (steel)	6mm	-10 ~ 60 C
TM-HT	5MHz	5mm~80mm (steel)	14mm	≤300 C

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4.11 Changing probe

Wear 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.

4.12 Measuring casting

It has specialty for measuring casting. The crystal particles for castings are coarse, the structures are not dense enough, plus they are in a gross state, which makes difficulty in measuring their thickness. These coarse crystal particles and less-dense structure 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. It has a high limit however, 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%.

control:data

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.

5 Preventing errors in measurement

5.1 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 an error called "double refraction" may occur. The result is that the displayed readout is twice of the actual thickness.

Another error result is called "pulse envelop, cyclic leap", where the measured value is larger than the actual thickness. To prevent these kinds of errors, please repeat the measurement to check the results.

5.2 Rust, Corrosion and Pit
Rust and pitting on the surface of the object will cause irregular change in readouts. In extreme situations, it will even cause no readout. It is very difficult to find small rust. When one finds a pit or is in doubt, 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.

control:data

5.3 Error in Identifying Material

If you calibrate the instrument with one material, and then use it to measure another material, error will occur.
Please be careful in selecting correct sound velocity.

5.4 Wear on Probe

The surface of the probe is allyl resin. After long 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.

5.5 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.

5.6 Influence of Oxidation Layer at Metal's Surface

Some metals such as aluminium can produce dense oxidation layer on the surface. 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.

5.7 Abnormal Readout of Thickness

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

control:data

5.8 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, 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 widely available.

control:data

6. Maintenance

6.1 Cleaning the Test Piece

Since the test pieces supplied along with the instrument will be coated with coupling agent when being used for inspection, please prevent it from rust. After the measurement, the test pieces should be cleaned. 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 before normal operation.

6.2 Cleaning the Instrument's Case

Alcohol, diluent will corrode the case, especially the LCD of the instrument. Therefore, when you clean the instrument, please use clean water and clean it gently.

6.3 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 60C, 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.

6.4 Replacing Batteries

When indication for low voltage occurs, please replace batteries:

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.

6.5 Absolutely avoid collision and moisture

control:data

7. Maintenance

If the following problems occur, please contact Control Data:

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. Non warranty Parts

1. Window
2. Probe
3. Test block
4. Sheath of gauge
5. Couplant

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APPENDIX: Sound velocity for Different Materials

Material	Velocity m/s	Velocity inch/μs
Aluminium	6320	0.25
Zinc	4170	0.17
Silver	3600	0.14
Gold	3240	0.13
Tin	3320	0.13
Steel	5900	0.24
Brass	4430	0.18
Copper	4700	0.19
SUS	5970	0.24
Plexiglas	2730	0.11
Gray Cast	4600	0.18
Porcelain	5600	0.22
Glass (quartz)	5570	0.22

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