MOORE & WRIGHT

MWT-2500 Ultrasonic Thickness Gauge

Operating Instructions

BOWERS GROUP

Contents

1. Brief Introduction

1.1 Application Field

This thickness gauge uses the Interface-Echo-Echo ultrasonic measurement principle (IE), which is suitable for the thickness measurement of any materials in which the ultrasonic wave can propagate at a constant speed and be reflectied from the back face. The device also contains a function to test precious metals and determine their purity. This may be used for the identification of gold and other precious metals.

1.2 Working Theory

An ultrasonic pulse is emitted by the probe which propagates through the test material until it reaches the the back surfce and is reflected back to the probe. The thickness of the measured material is determined by measuring the time taken for the wave to return back to the probe.

1.3 Part Identification

Main View of Through-coating Thickness Gauge

1.4 Keypad

	Backlight/switch		Down
	Up		Mode Button
	Enter		Velocity
	SAVE		Benchmark Block
	Calibration		

1.5 Measurement Modes

- This device has 3 measurement modes:
  - P-E: Measures the thickness of a material
  - I-E: Measures the thickness of a material through a surface coating
  - TEST: Authenticates precious metals.

Measurement information can be stored, including thickness values, measured sound velocity and time.

1.6 Features

- Zero calibration automatically corrects any system errors
- If a materials' thickness is known, the sound velocity can be measured to improve the measurement accuracy.
- Battery status is displayed to indicate the remaining power.
- Measurement information can be stored, including thickness values, measured sound velocity and time

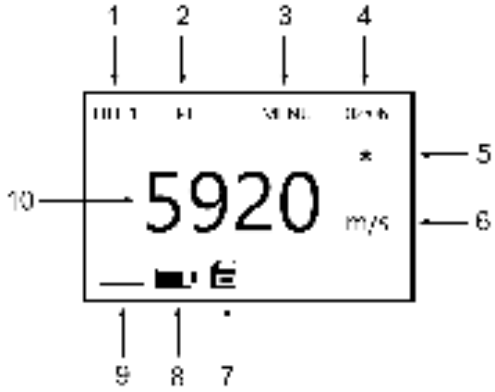
1.7 Technical Parameters

MWT-2500	
Testing Range (Steel)	1.0 - 300mm
Testing Error (H<10mm)	±0.05mm
Testing Error (H≥10mm)	0.04 + 0.5%H mm (Where H is the thickness of the material)
Test Frequency	5 MHz
Display Accuracy (mm)	0.01
Display Resolution	0.1mm/ 0.01"
Measurement Interval	250m/s
Velocity Range	1000-9999m/s
Display	FSTN LCD with adjustable brightness
Power	2x AA batteries
Continuous Working Time	50 hours (without backlight)
Data Storage	500 groups of measurement results, including measurement time and sound velocity
Auto Power off	Automatic shutdown without use for a set time. Adjustable from 0-20 minutes
Display Information	Thickness value, coupling state, electric quantity state, calibration state, sound velocity, time, etc
Size	150mm x 71mm x 33mm
Weight	200g

2 Testing and Operation

2.1 Measuring Preparation

1. **Insert the probe plug into the device's probe socket.**
   Press the key to turn on the gauge the display will power on and look lik the image below:



Description	
1.	Current document number (five documents in total)
2.	Measurement mode
3.	Menu options
4.	System time
5.	Frozen result flag
6.	Unit
7.	Automatic storage flag

2. **Measurement Mode Selection**
   Press the key to move the cursor to measurement mode, press the key to cycle between IE, TEST and PE. Press or to confirm and exit.

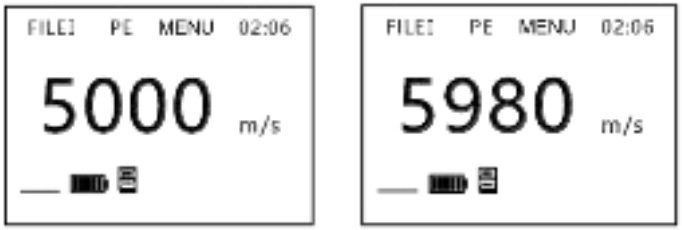
3. **Set probe frequency**
   Press the key to move the cursor to the menu (as shown in the figure below), and press the key to enter the menu. Select "System Setting" by pressing the keys, and then press to enter. Select probe by pressing the keys, and then press to select the probe model. Each press of will cycle through 5m, 7m, 2m and h2m. After selection, press to confirm and exit.

Note: the probe frequency setting must be consistent with the probe frequency used, otherwise the measurement accuracy will be affected.

2.2 Velocity Adjustment

If the current screen displays the thickness value, press the [VEL] key to enter the Velocity display.

Then press the [VEL] key to cycle through six options; five common speeds, including fixed steel (5920m/s), gold (3240m/s), silver (3650m/s), platinum (3960m/s), palladium (3070m/s) and a user-defined velocity. When the user-defined speed is selected, the value can be adjusted by pressing the ▲ ▼ keys. After confirmation, press [MODE] and exit.



Due to the high measurement accuracy, a small change of velocity will affect the measurement results, especially for thicker measured objects. Accurate measurement requires the input of an accurate velocity value. If the sound velocity of the measured object is unknown, refer to section 2.5. Sound Velocity Calibration. Sound velocity will also change with temperature, make sure to adjust the sound velocity value to compensate for change in temperature.

2.3 Zero Calibration

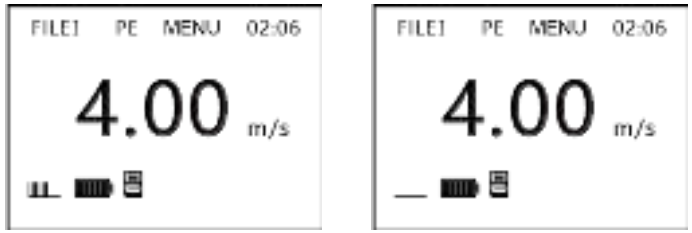
After changing probe measurement mode or the ambient temperature, it is necessary to recalibrate the zero point before measurement. Following the steps below:

1. Adjust the velocity to 5920m/s, which is the value for steel, the material of the standard test block attached to the thickness gauge
2. Apply the couplant gel to the test block, touch the probe to the test block check the coupling indicator on screen, then press the [CAL] key to start calibration, the progress will be displayed on the screen
3. Once complete 4.00mm will be displayed on the screen, indicating that the calibration is successful. The screen will display an X if the calibration has failed. This indicates that the coupling may not have been correct during the calibration process and the gauge needs to be calibrated again.

   Note: if the value displayed on the screen is not 4.00 after a successful calibration, please check whether the currently set sound speed is 5920.

2.4 Thickness Measurement

First set the appropriate sound velocity, then apply the couplant to the test material, and then touch the probe to the material to measure. The coupling indicator on the screen will fill to represent the quality of the connection, the fuller the mark, the better the coupling effect. The screen will display the thickness of the measured material. After removing the probe, the thickness value will remain and the coupling mark will disappear. As shown in the figure below:



The coupling mark will be displayed when the probe is in contact with a test material. A connection is considered good if there are more than 5 lines in the icon.

Note: 1. Press the [REAP] key to record the measured value before the probe is lifted to reduce the chances of a poor measurement being taken as the probe is removed.

Note 2. If there is a large deviation between the measured value and the real value, it indicates that the gauge may have made an incorrect measurement. Lift the probe and measure again until the correct value appears or check the calibration.

2.5 Sound Velocity Calibration

To measure the sound velocity of a material, use a test block of known thickness. First measure the test block with vernier caliper or micrometer to find its thickness. Then select the sound speed as the user-defined speed, and then couple the probe with the test block of known thickness until a stable thickness value is displayed. Press the [SAVE] key to freeze this value, the freezing mark * will be displayed as shown on the next page.

After removing the probe, press the ↑ or ↓ key to adjust the value displayed to the measured thickness value, and then press the CAL key to calculate the sound speed. A progress bar will appear on the screen as this is calculated, then the measured velocity will be displayed on the screen and will be stored as the current sound speed.

For sound speed measurement, the recommended minimum wall thickness is 4.0mm. If X is displayed after the calculation this indicates the calculation has failed and the current sound speed will not be changed. Reasons for a failure may include:

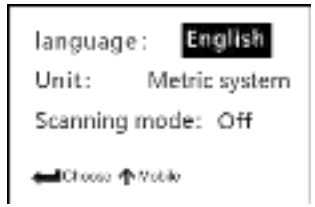
1. Movement during coupling;
2. Calculation overrun.
3. No custom sound speed selected.

To try again, repeat the steps above, taking care to ensure the connection is good.

2.6 Language Setting

The thickness gauge has English, Spanish and Chinese language options. To change language, use the following steps:

1. Press the MODE key to move the cursor to Menu.
2. Press ↵ to enter the menu.
3. Press ↑ or ↓ to select the System Setting and press ↵ to enter.
4. The ↵ key will cycle between English, Spanish and Chinese.
5. After selection, press the MODE key to save the setting and return to the main screen.



2.7 Setting Measurement Units

The thickness gauge has two measurement units, Metric and Imperial. To change units use the steps described in 2.6 to open the system settings, then use ↓ to select unit.

2.8 Scanning Mode

The thickness gauge can be used in either single point measurement mode, or scanning mode. Follow Section 2.6 to open the system settings then select Scanning Mode.

If scanning mode is on, SCN will be displayed at the bottom of the screen as shown in the figure below.

In this mode, the thickness measurement is shown in real-time. If the coupling to the material, the probe can be moved across the test piece to carry out continuous measurement.

2.9 Setting the Buzzer

Follow the steps in Section 2.6 to access System Settings, then scroll to the buzzer bar.

When the buzzer mode is turned on, a tone will be given during operation. When turned off, the instrument will operate silently.

2.10 Set the Flashing Alarm

Follow the steps in Section 2.6 to access System Settings then scroll down to control the flashing alarm.

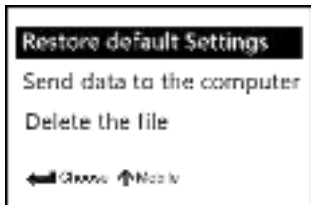
This alarm is used in test modes. When a test passes, the screen will display pass or cal and the ● key will flash yellow. When the test fails, the screen will display fail and the ● key will flash red.

2.11 Setting the Probe

Follow the steps in Section 2.6 to access system settings then scroll down to the probe settings. These settings must be consistent with the attached probe's parameters for accurate measurement.

2.12 Setting Recovery Recognition Settings

1. Press MODE to move the cursor to menu.
2. Press ↵ to enter the menu.
3. Press ↑ or ↓ to select the Function Setting and press ↵ to enter.
4. Press the ↑ or ↓ key to select the Restore Default Setting option, and press MODE to restore default settings.



2.13 Setting and Deleting Files

Use steps 1-3 in section 2.12 to open fuction settings.

Press ↑ or ↓ to select delete the file and press ↵ to delete the contents of the folder currently selected. Then, press MODE to exit.

2.14 Setting and Deleting All Data

Use steps 1-3 in section 2.12 to open fuction settings.

Press ↑ or ↓ to select Delete All Data and press ↵ to delete all data. This will delete the data saved in all folders.

2.15 Setting Contrast

Use steps 1-3 in section 2.12 to open fuction settings.

Press ↑ or ↓ to select Set Contrast and press ↵ to enter.

There are 10 levels of contrast settings for the screen. Press the ↑ or ↓ key to set the contrast according to their preferences. After setting, press MODE and exit.

2.16 Setting System Time

Use steps 1-3 in section 2.12 to open fuction settings.

Then press ↑ or ↓ to select Set System Time, and press ↵ to enter. To adjust the system and display time. Press ↵ to select the setting to be adjusted, and press ↑ or ↓ to change the value. The date format is in year month day hour minute.

The display is shown in the figure below. Once set, press MODE to exit.

2.17 Setting Standby Time

Use steps 1-3 in section 2.12 to open fuction settings.

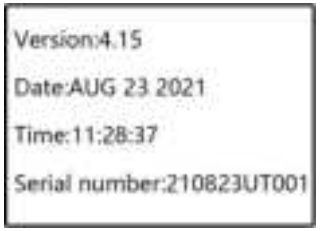
Then press ↑ or ↓ to select the Set Standby Time option, and press ↵ to enter. Press the ↑ or ↓ key to adjust the time. The default standby time is 2 minutes and the maximum time is 20 minutes. Press MODE to exit.

Note: if the standby time is set to 00 minutes, the device will never shut down automatically

2.18 Version Information Viewing

Use steps 1-3 in section 2.12 to open fuction settings.

Then press ↑ or ↓ to select the Version Information, and press ↵ to enter. The display is shown in the figure below.



2.19 Thickness Value Storage, Viewing and Deletion

The thickness gauge can store measurement data. The storage is divided into 5 files, and each file can store 100 groups of data. Each group of measurement data contains complete measurement information, including thickness value and measurement time. The file number shall be set before storing data. The operation steps are as follows:

1. **Set storage file**

a. Press the MODE key to move the cursor to File, as shown in the following figure:

b. Press the ↵ key, the stored files will be displayed from to file I to file V. Press the MODE key or ESC key to return to measurement mode.

Note: each file can only store 100 groups of data. When it is full, a prompt will state that the file is full.

2. **Save the measurement results manually**

a. During or after the measurement, press the REAP key, and the * sign will be displayed on the screen, indicating that the current measurement result has been frozen.

b. When the measurement results are frozen, press and hold the REAP key to save and unfreeze the display, or short press the key REAP to unfreeze without saving.

3. **Automatically save measurement results**

a. When the measurement results are not frozen, long press the REAP key, the automatic storage flag will be displayed at the bottom of the screen, and the device enters automatic storage mode.

b. When each measurement is completed, the results are automatically saved to the current file.

4. **View stored content**

a. Press the MODE key to move the cursor to File, and press the ↵ key to switch and select the file.

b. Press the REAP key to view the status of the stored content, as shown in the following figure:

In this example 001 is the serial number of the stored data currently displayed, 007 is the total number of tests in the current file, 00-01-01 is the measurement date, 21:48 is the measurement time, and 4.00mm is the measurement thickness value. 5920 is the speed of sound used for the measurement.

c. Press the ▲ or ▼ key to view all stored data.

d. Press ↵ to delete the current data and display the next stored value.

e. Press MODE to return.

2.20 Backlight

When the power is on, press ☼ once to turn on the backlight. Press ☼ again to turn this off.

2.21 Test Function

To use the Test Function for testing gold or other precious metals use the following steps.

1. Press the MODE key to move the cursor to the measurement mode setting, press the ↵ key to cycle through the 3 modes to select the TEST mode, then press the MODE key until the cursor disappears, or press ZERO to enter the measurement mode.

2. Press the ZERO key to select the material to be tested, including steel, gold, silver, platinum, palladium, and custom material, press the ▲ or ▼ key to set the sound velocity value for this manually. Then press ↵ to set the thickness of the measured material, and press ▲ or ▼ to adjust the value. Press ↵ to save again and exit.

3. Use the probe to measure the material. If meets the set requirements, the screen will display PASS, and the ⊙ key will display a green light.

If the tested material does not meet the set requirements, the screen will display FAIL and the ⊙ key will display a red light.

2.22 Shutdown Mode

The thickness gauge has two shutdown modes: automatic shutdown and manual shutdown. It will shut down automatically if there are no operations for two minutes. It can be shut down at any time with a long pressing ⏻ key.

3 Measurement Techniques

3.1 Cleaning Surfaces

Before measurement, the surface of the measured object should be cleaned. Any rust or paint should be removed.

3.2 Surface Roughness Requirements

An excessively rough surfaces may cause measurement error or test failure. Before measurement, try to make the surface of the measured material smooth, by grinding, polishing, filing and other methods. High viscosity couplants can also help.

3.3 Measuring Cylindrical Surfaces

When measuring cylindrical materials, such as pipes, oil drums, etc., it is ideal when the probe axis intersects with the axis of the measured material. Couple the probe with the measured material, then rotate the probe around the axis of the measured object or move the probe parallel to the axis of the measured object to make the center line of the probe contact with the measured object, then select a stable reading as the accurate thickness of the material.

3.4 Non-parallel Surfaces

To obtain the required ultrasonic response, the back surface of the measured material must be parallel or coaxial with the measured surface, otherwise it may cause measurement errors or a failed reading.

3.5 Temperature Effect of Materials

The thickness of a material and its ultrasonic propagation speed are both affected by temperature. If the required measurement accuracy is high, the test block comparison method can be used. Use a test block of the same material to measure under the same temperature conditions, obtain the temperature compensation coefficient, and use this coefficient to correct the measured value of the measured working piece.

3.6 Large Attenuation Materials

Some materials such as fibers have porous and coarse particles that may cause a large amount of scattering and attenuation of ultrasonic waves, resulting in abnormal readings or failed readings, If this happens, it indicates that the material is likely not suitable for testing with this thickness gauge.

3.7 Reference Test Block

For accurate measurement of different materials under different conditions, the closer the calibration block material is to the measured material, the more accurate the measurement will be. The ideal reference test block will be a group of test blocks with different thicknesses. The test block can provide instrument compensation correction factors (such as material micro structure, heat treatment conditions, particle direction, surface roughness, etc.). For maximum accuracy, a set of reference test blocks will be neccessary. In most cases, satisfactory accuracy can be obtained by using only one reference block with the same material and similar thickness

as the measured material. Take the uniform measured material and use it as a test block after measuring with a micrometer.

For thin materials, when the thickness is close to the lower limit of this device, the test block can be used to determine the accurate lower limit. Do not measure material below the lower limit thickness. If a thickness range can be estimated, the upper limit of the thickness of the test block shall be selected.

When the measured material is thick, especially in an alloy with a complex internal structure, select one close to the measured material in a group of test blocks for calibration. The internal structure of most forgings and castings is directional, and the sound velocity will change a little in different directions. In order to solve this problem, the test block should have the internal structure in the same direction as the tested material, and the propagation direction of sound wave in the test block should also be the same as that in the tested material.

In some cases, the reference test block can be replaced by checking the sound velocity of known materials, but this only approximately replaces some reference test blocks. In some cases, the velocity is different from the actual measurement because of the differences in the physical and chemical conditions of the materials. This method is often used to measure low carbon steel, but it can only be used as a rough measurement.

3.8 Measurement Methods

1. Single measurement: measurement is taken at one point.
2. Double measurement: the probe is used for two measurements in one place, and the probe positions shall be perpendicular to each other in these two measurements. Select the smaller of the readings as the thickness of the material.
3. Multi-point measurement: multiple measurements are carried out within a certain measurement range, and the minimum value is the material thickness.

4 Preventing of Measurement Error

4.1 Ultra Thin Materials

If the thickness of the measured material falls below the lower limit of the probe will lead to measurement error. If necessary, the minimum limit thickness can be measured by the test block comparison method.

When measuring ultra-thin materials, sometimes an error result called double refraction occurs. where the display reading is twice the actual thickness. Another possible error is called pulse envelope and cycle jump. Where the measured value is greater than the actual thickness. In order to prevent these errors, repeat the measurement when measuring thin materials.

4.2 Rust Spots and Corrosion Pits

Rust spots and pits on either surface of the tested material will cause irregular readings, or failed readings in extreme cases.

4.3 Material Identification Error

When the instrument is calibrated with one material and is tested with another material, incorrect results will occur. Always use the correct sound velocity for the test material.

4.4 Probe Wear

The surface of the probe is made of propylene resin. Long term use will increase the roughness of its surface and reduce its sensitivity. When error is caused by this reason, the user can polish the surface of the probe using fine sandpaper or an oilstone to make it smooth and ensure parallelism. If it is still unstable, replace the probe.

4.5 Influence of Oxide Layer on Metal Surface

Some metals can produce a dense oxide layer on their surface, such as aluminum. which will effect the propagation speed and cause errors. If an oxide coating is found and such errors are suspected, use a sample from the same batch as the material under test and use a caliper to measure the block and calibrate the instrument to reduce this risk.

4.6 Abnormal Thickness Readings

Generally, rust spots, corrosion pits and internal defects of the tested material will cause abnormal readings. Refer to chapters 4 and 5 for solutions.

4.7 Use and Selection of Coupling Agent

The couplant is used as a high-frequency ultrasonic energy transfer between the probe and the measured material. Couplant shall be used in proper amount and coated evenly. It is important to select a suitable kind of coupling agent. When used on smooth material surfaces, low viscosity coupling agent (such as randomly configured coupling agent, light machine oil, etc.) is very suitable. When used on rough material surfaces, or vertical surfaces and top surfaces, coupling agents with high viscosity (such as glycerin paste, butter, grease, etc.) can be used.

5 Precautions

5.1 Cleaning of Test Block

Clean the test block after use. If it is not used for a long time, the surface of the test block should be coated with a little grease for rust prevention. Wipe to remove this before its next use.

5.2 Cleaning of Casing

Alcohol and diluent can corrode the casing, to clean, gently wipe the casing with a slightly damp cloth.

5.3 Probe Protection

The probe surface is very sensitive When measuring a rough surface, minimise any abrasion of the probe tip. During normal temperature measurement, the surface of the measured object shall not exceed 60˚C, otherwise the probe cannot be used again. The adhesion of oil and dust will gradually degrade the probe cable. After use, remove any dirt on the cable.

5.4 Battery Change

When the battery power is too low, replace the battery using the following steps.

- Press the  button to shut down, open the battery compartment cover and take out the battery.
- Put the charged battery into the battery compartment (in the correct orientation) and recover the battery compartment.
- When the instrument is not used for a long time, the battery should be taken out to avoid battery leakage and corrosion of the instrument.

Appendix

Appendix: Sound Velocity of Various Materials

Media Material Name	Velocity (m/s)
aluminium	6320
chromium	6200
copper	4700
gold	3240
iron	5930
lead	2400
magnesium	5750
silver	3600
steel	5900
titanium	5990
zinc	4170
tungsten	5174
tin	3320
Brass	4280—4700
cast iron	4400—5820
Glass	5260—6120
nylon	2680
stainless steel	5740
Water (20 ° C)	1480
glycerol	1920
water glass	2350

Note: the sound velocity in the above table is for reference only, and the actual sound velocity calibration refers to Section 3.1.