Coating Thickness Gauge TT220

Instruction Manual

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1. General Descriptions

1.1 Scope of application

The instrument is a super mini-gauge, capable of measuring rapidly, nondestructively and precisely the thickness of non-magnetic coating on magnetic metallic base. It can be applied broadly in the industries of manufacture, metal processing and chemical and commodity inspection. Due to its small size and the integration of the probe and the instrument, it is especially suitable in on-the-spot measuring at engineering sites.

1.2 Basic principles

The instrument adopts the magnetic thickness gauging method to measure the thickness of non-magnetic coatings on magnetic metal base (aluminum, chromium, enamel, rubber and paint coatings on the base of steel, iron and non-austenitic stainless steel), without doing harm to the object tested.

The basic working principle is: When the measuring head is in contact with the coating, it would form a closed magnetic circuit, which changes in its magnetic resistance due to the existence of non-magnetic coating and the thickness of the coating can be calculated according to the changes of the magnetic resistance.

1.3 Basic setup and names of parts

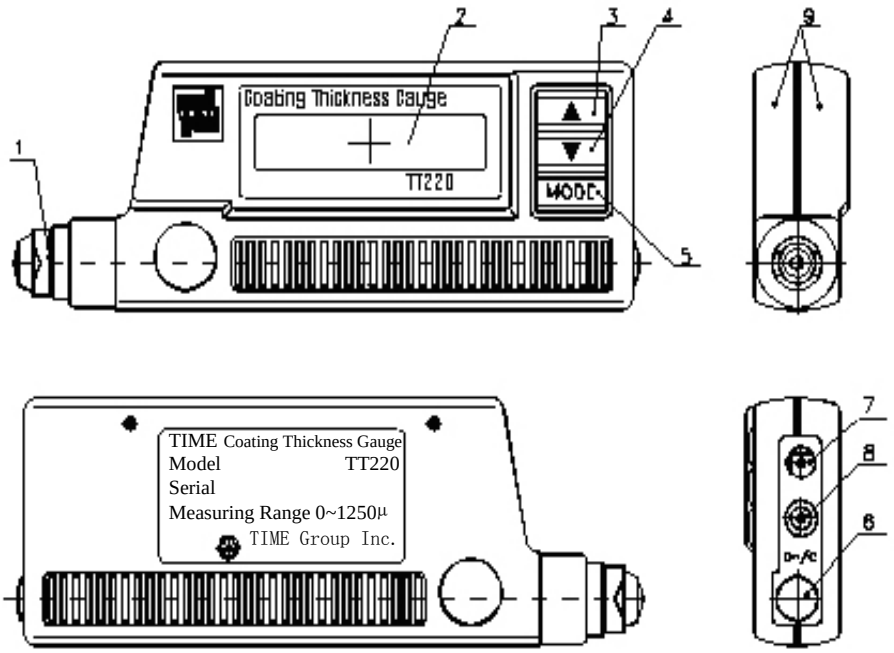
(1) Basic setup:

TT220 main frame	one unit
Standard sample sheet	one box
Standard base	one block
Electric charger	one unit

(2) Optional:

TA210 printer	one unit

(3) Name of parts:



1. Measuring head 2. LCD 3. ▲ key 4. ▼ Key 5. MODE key
6. ON/C Key 7. Charging socket 8. Printer socket 9. Shell

2. Technical Parameters

2.1 Property index

(1) Scope and tolerance of measurement (See table below)

Type	Working principle	Scope of Measurement (μm)	Low limit differentiation (μm)	Display Value Tolerance (μm)	
				Zero point calibration	Two-point calibration
TT220	Magnetic	0-1250	1	± (3%H+1)	± [(1%~3%) H+1]

	induction				

Type	Min. curvature radius of the object to be measured (mm)		Min. area diameter of the base (mm)	Critical thickness of the base (mm)
TT220	1.5	9	∅7	0.5

Note: H -- nominal value.

(2) Environment of application:
Temperature: 0~40°C
Humidity: 20%~75%
No strong magnetic field

(3) Power source: One 3.6v nickel-cadmium battery

(4) Dimension: 150mm X 55.5mm X 23mm

(5) Weight: 150g

2.2 Main functions

- Zero point calibration and two-point calibration, with the system error of the measuring head correctable by the basic calibration method;
- Two measuring methods: Continuous and single;
- Two working mode: direct and batch;
- Delete: Data in suspicion can be deleted. All the data in the memory area can be deleted in order to conduct new measurement;
- Five statistical values: mean value, maximum value, minimum value, number of measurement, and standard deviation;
- Metric conversion function;
- Print-out function, capable of printing out measured values and statistical values;
- Low voltage indication;
- Buzzer prompt of operations;
- Error messages;
- Automatic shut-off.

3. Operation

3.1 Basic steps of measurement

(1) Get ready the object to be tested (See Chapter Five).
(2) Put the probe on an open space, press the “ON/C” key to switch on the machine.
(3) Check the power source:
- If the sign “ ” is not displayed, it indicates that the voltage of the battery is normal;

- If the sign “ ” is displayed, it indicates that the voltage of the battery is low and recharge is needed.
- If the sign “ ” is displayed after switching on and the machine is automatically shut off, it indicates that the voltage has gone down to the limit and immediate recharge is necessary.

(4) In normal circumstances, the instrument displays the previous measurement value after being switched on.

30 μm

(5) If calibration is needed, choose the appropriate method to do so (See Chapter Four).

(6) Start measuring:

Swiftly bring the probe into contact vertically with the testing surface and press it lightly and, with a buzzer sound, the measured value would be displayed on the screen. Lift the measuring head and conduct the next measurement.

If an obvious suspicious value is displayed due to unsteady position of the measuring head, the value can be deleted in the “DEL ONE?” mode.

When measurement is repeated for more than three times, five statistical values would be displayed in the “DIS STATS?” mode: Mean, Max., Min., No. and S. Dev.

(7) Switch off the machine.

The instrument will shut off automatically if operation stops for about 2-3 minutes.

3.2 Functions and operations

(1) Measuring methods: (Single ⇔ Continuous)

- Single measurement method -- the probe is in contact with the tested object once and the measured value is displayed with a buzz sound. If another measurement is taken, the probe must be lifted and touched down again.
- Continuous method -- the probe is not lifted and there is no buzz sound during the operation and the screen displays the measured values continuously.
- Method to change over from one method to the other: in the shut-off state, press down and hold the “MODE” key while pressing the “ON/C” button. The change-over is completed when a buzz sound is heard. In the single mode, the screen displays:

SINGLE

When in continuous mode, the screen displays:

CONTINUE

(2) Working methods (Direct ⇔ Batch)

- Direct mode: It is used random measurement, with the values stored up temporarily in the memory unit (there are 15 memory units). When all the 15 units are occupied, the new values will take place of the old ones, with the last 15 values participating in the statistical calculation.

- Batch method: The method facilitates users to record data taken in batches, with each batch containing 15 values. Each time when a batch of 15 values are stored, the screen displays:

Tested 15!

The group of data and its statistical value can be printed out by using the mode “PRINT ALL” or can be deleted by using the “DEL ALL?” mode. Otherwise, no new measurement can be taken. The batch method prevents the replacement of the old values with the new ones under the direct method.

- Change-over between the two methods:

a. Press “MODE” key until the screen displays:

DIRECT?

Press “ON/C” key to confirm and the screen displays:

DIRECT

to enter the direct method mode.

b. Press “MODE” key until the screen displays:

BATCH ?

Then, press “ON/C” key to confirm and the screen displays:

BATCH

to enter the batch method mode.

(3) Delete

- Delete the current value: In case of big errors occur in the measured value and it is not hoped to include the value in the statistical data, press the “MODE” key until the screen displays:

DEL ONE?

Then, press the “ON/C” key to delete the data. (If no deletion is desired, press the ▲ or ▼ keys in the “DEL ONE?” mode.)

- Delete all the data: To delete all the data in the memory and take new measurements, press the “MODE” button until the screen displays:

DEL ALL?

Then, press the “ON/C” button to delete all the data in the memory. (If no deletion is desired, press the ▲ or ▼ key in the “DEL ONE?” mode.)

(4) Statistical calculation

So long as there are three values, calculation can be done. Repeat the testing at least three times and press the “MODE” button until the screen displays

DIS. STATS?

Press the ▲ or ▼ key, the screen displays the mean value, max. value, min. value, no. and S. Dev in that order. As:

MEAN 100 μm

MAX 103μm

MIN. 99μm

NO. 5

S. DEV 1.6μm

To return to the measuring mode, press the “MODE” button or “ON/C” button.

(5) Shift between Metric/English systems

Press the “MODE” button until the screen displays:

UNIT ?

Then, press the ▲ button to display the English unit “mil”, such as:

40 mil

Press the ▼ button to display the metric unit “μm” or “mm”, such as

1.00 mm

Only the measured value and statistical value are involved in the conversion between the metric and English systems.

(6) Print -Out

- Single print-out – Corresponding to single measurement method, it prints out the measures value for each measurement. The method of operation is: in the single measurement mode, press “MODE” button until the screen displays:

PRT ONE?

Then press the “ON/C” button to confirm and the screen displays:

PRT ON

Then, the value of each measurement is printed out. To give up printing, press the ▲ or ▼ key in the “PRT ONE ?” mode.

- Continuous printing -- continuous printing is applicable to both the single measurement method and the continuous measurement method. All the data in the memory, including the measured value and statistical value, are printed out. The operational method is: Press the “MODE” button until the screen displays:

PRT ALL ?

Then, press the “ON/C” button to confirm and the screen displays:

PRT ON

It will output and print out all the measured values and the statistical value in the memory. To give up printing, press the ▲ or ▼ key in the “PRT ONE ?” mode.

- Connect printer to the instrument
  Only printers developed by this company can be connected with the instrument and do the printing. Use a cable to connect the printer with one end and the instrument with the other end, switch on the power source for the printer and operate by the above mentioned methods.

(7) MODE button

Press the MODE button and hold it, the various modes prompts will be displayed in the sequential order.

4. Calibration

In order to measure the thickness accurately, it is necessary to correct the instrument on the measuring site.

4.1 Standard sheets for calibration (Foil and Base)

Foils with known thickness or samples with known thickness of their coatings can be made as standard sheets.

(1) Standard foil.
To this instrument, foil refers to non-magnetic or non-metallic foil or pad. Foil is favorable for calibrating curved surface.

(2) Standard sheets with coatings.
Coating with known thickness and evenly and solidly attached to the base is selected as standard sheet. A coating should be non-magnetic.

4.2 Base

(1) The magnetism and roughness of the surface of the standard base metal should be similar to those the objects to be tested.
In order to prove the applicability of the standard sheet, it is necessary to compare the readings of the base of the standard sheet and the base of the object to be tested.

(2) If the thickness of the base metal to be tested does not exceed the critical thickness listed in the parameters, the following two methods may be used for calibration.
a. To calibrate on the basis of a standard metal sheet with the thickness the same as the base metal of the object to be tested;
b. To calibrate by using metal pads or objects thick enough and similar in electrical or magnetic property, making sure that there is no seam between the base metal and the pad metal. The pad method is not applicable to objects with coatings on both sides.

(3) When the curvature of a coating to be tested cannot be calibrated on a plain, the curvature of the coated standard sheet or the curvature of the base metal put below the standard foil should be the same as the curvature of the object to be tested.

4.3 Methods of calibration

There are two methods of calibration often used in measuring, that is, zero point calibration and two-point calibration. There is another method of calibration, that is the basic calibration of the probe.

(1) Zero point calibration
a. To conduct measuring once on the base, the screen displays <X.Xμm>.
b. Press the "ON/C" button, the screen displays <0.00μm> and the zero point calibration is finished.
c. To calibrate the zero point accurately, the procedure of a and b should be repeated until the measured value of the base is less than 1μm. This will raise the accuracy of measuring, but the repetition should not exceed 15 times. Otherwise, the error message <E07> will be displayed. Measuring can start after the zero point calibration.

(2) Two-point calibration
a. To do the zero point calibration first (See above);
b. To conduct measuring once on the standard sheet with the thickness of the coating by and large the same as the object to be tested and the screen displays <XXXμm>.
c. To use the ▲ or ▼ key to correct the reading until it reach the nominal value of the standard sheet. The calibration is thus finished and measuring can start.

Attention: The pressing of the ▲ or ▼ key is indispensable to two-point calibration even if the display result coincides with the nominal value of the standard sheet, for instance, press ▲ once and ▼ once.
To make the calibration more accurate, repeated the b and c processes so as to raise the accuracy of calibration and reduce accidental errors.

(3) Calibration on the grit blasted surface.
The special features of grit blasted surface leads to big deviations from the true value. In such cases, the thickness of the coating can be determined by the following method:
a. To calibrate on the smooth surfaces with the same curvature radius and base materials by using (1) and (2) of (3).
b. To conduct measuring for about ten times on coating surface with the same grit blast treatment to obtain the mean value Mo.
c. Then, conduct measuring on the grit blast surface for about ten times to obtain the mean value Mm.
d. The formula (Mm-Mo)±S indicates the thickness of the coating. S (standard deviation) is the bigger one among Smm and Smo.

(4) Basic calibration
The basic calibration is necessary in the following circumstances:
-- The top end of the measuring head is worn;
-- After the measuring head is repaired;
-- When used for special purposes.

In measuring, if the tolerance obviously exceed the given scope, the property of the measuring head should be re-calibrated and this is called basic calibration. The re-calibration can be done of the probe by inputting six standard values (one zero value and five thickness values).

The operation of the basic calibration is as follows:

a. Hold ▼ and press ON/C button to switch on. With a buzz, the instrument enters the mode for basic calibration as the screen displays:

B ---- Calibrate

b. To calibrate the zero value first (See zero point calibration). The process can be repeated many times in order to obtain a mean value to make the calibration more accurate.
c. To use standard sheets to conduct calibration five times according to the order of the increase in thickness (See b and c of two-point calibration), with one thickness being at least 1.6 times the previous one. The ideal difference is two times, such as 50, 100, 200, 400, 800μm. The maximum value should be close to but lower than the maximum scope of measuring of the measuring head.
d. After the six values are input, measure the zero point and the instrument automatically shuts off, with the new calibrated values stored in the memory. When the instrument is switched on again next time, it will work according to the calibrated values.

5. Points for Attention

The factors affecting the measuring accuracy include: magnetic property of the base metal, basic thickness, marginal effect, curvature, roughness of surface, external magnetic field, matters attached, pressure of the measuring head, position of the probe and deformation of objects tested.

5.1 Factors affecting the measuring accuracy and explanations

(1) Magnetic property of the base metal
Thickness gauge by the magnetic method is affected by the changes in the magnetic property of the base metal (In real application, the changes in the magnetic property of low carbon steel can be regarded very slight). In order to prevent the effect of thermal treatment and cold processing, calibration should be done by using standard sheets with the same property as the objects to be tested or by using test objects to be coated.

(2) Thickness of base metal
Each instrument has a critical thickness for a base metal. When it is bigger than this, the measuring should not be affected by the thickness of the base metal. For the critical thickness required by this instrument, see Chapter Two Technical Parameters.

(3) Marginal effect
This instrument is very sensitive to the abrupt changes in the surface of the objects to be tested and so it is not reliable to measure the thickness on the edges or at the turns.
(4) Curvature
The curvature of the test object has some impact on the measuring, which obviously increases with the reduction in the curvature radius.

(5) Roughness of surface

The roughness of the base metal and coating affects the measuring. The bigger the roughness, the bigger its effect. Surface roughness affects the system error and accidental error. So the number of measuring should increase in different positions in order to overcome the accidental errors.
If the base metal is rough, it is necessary to obtain the zero point from several positions on the base metal test objects that have not been coated or calibrate the zero point after the coating is removed by using solvent not corrosive to the base metal.

(6) Magnetic field
The strong magnetic fields generated by all kinds of electrical equipment around can seriously interfere in the thickness gauge by the magnetic method.

(7) Matters attached.
The instrument is sensitive to matters attached that hamper the close contract of the measuring head with the coating surface. It is, therefore, necessary to remove the attached matter in order to ensure close contract between the probe and the test surface.

(8) Pressure of the measuring head
The pressure exerted on the measuring head on the test surface affects the reading and so a spring is used to keep a basic constant pressure.

(9) Position of measuring head
The positioning of the measuring head affects the measuring. So the probe should be kept in a position perpendicular to the test surface.

(10) Deformation of test piece
The measuring head can deform the test piece with soft coating, thus leading to not very reliable data about its thickness.

5.2 Rules to observe in using the instrument

(1) Special property of base metal
The Magnetic property and surface roughness of the base metal of the standard piece should be similar to those of the base metal of the objects to be tested.

(2) Thickness of base metal
Check the thickness of the base metal to see whether or not it has exceeded the critical thickness.

(3) Marginal effect
Measuring should not be done in abrupt changes of the object to be tested, such as edges, holes or corner.
(4) Curvature
Measuring should not be done in the curved surface of the test piece.

(5) Number of readings
As the reading of each time is not entirely the same, it is necessary to obtain several reading for an area measured. The local differences of the thickness of coating also call for a number of measuring to be taken in a designated area, especially when the surface is rough.

(6) Cleanliness of surface
Before measuring, it is necessary to clean the surface of the test piece, removing any foreign matters attached, such as dust, fat or corrosive matters, but take care not to remove matter of the coating.

5.3 Some points about measuring results

(1) From the statistical point of view, one reading is not reliable. The measured result displayed is the invisible mean value of five times of measuring, which are completed by the measuring head and the instrument within less than one second.

(2) In order to make the measuring more accurate, measuring should be done many times, with big tolerances deleted and then use the statistical function of the instrument to obtain five statistical values: the mean value (MEAN), maximum value (MAX), minimum value (MIN), the number of measuring (NO>) and standard deviation value (S. DEV).

(3) According to international standards, the ultimate results of measuring can be expressed:

$$CH=M\pm 2S$$

Of which: CH -- Thickness of coating
M -- Mean value of measuring
S -- Standard deviation

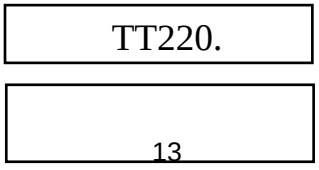
6. Maintenance and Repair

1. Strictly guard against collision, heavy dust, dampness, strong magnetic field and oil stains etc.

2. The battery should be recharged regularly: once for every 8 working hours and each recharge should take 12-14 hours.

3. If the instrument does not work property without any error messages showing, such as:
- Unable to shut off automatically;
- Unable to conduct measuring;
- Buttons refuse to work;
- Abnormal reading.

The instrument should be forced reset.
The method of reset is:
a. Press ▲ and MODE buttons simultaneously and the screen display the following:



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RESET?

b. Press ▲ +▼ and the screen displays:

BE SURE1?

c. Press ▲, the screen displays:

BE SURE2?

d. press ▼, screen displays:

BE SURE3?

e. Press ▼ again, the screen displays:

BE SURE4?

Release the button and the screen displays:

RESET TT220

The reset is thus completed.
f. When giving up forced reset in the “RESET” mode, press ▲ or ▼.

Attention: After reset, all the previously obtained calibration values are lost and the basic calibration should be re-done (for method, see Chapter Four).

When the troubles cannot be removed by using the above methods, please send the instrument to the maintenance department of our company. Do not disassemble the instrument yourselves.

We would be very much grateful if you send back the instrument together with a brief description of the errors.

Table of Error Messages

Error Code	Meaning of the code	Causes and solution
E01	Instrument trouble	Forced reset
E02	Probe worn	Replace probe
E03	Damaged probe or instrument	Repair
E04	Measuring value not reliable, such as big fluctuations in the value obtained in a magnetic field or on a soft coating	Away from the magnetic field. Auxiliary device should be employed when measuring soft coating
E05	Probe too close to metal base when switched on	Keep probe away from metal base
E06	Reserved by manufacturer	
E07	Deviation of zero value too big, unable to calibrate zero point	Choose property base or have the instrument repaired
E08	Damaged instrument	Repair

7. Non-warranty Parts

1.Window 2. Battery 3. Charger 4. Key film 5. Sheath of TT210 6.Probe