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9501-1200 COATING THICKNESS GAUGE OPERATION MANUAL

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1. Introduction

The instrument is a type of portable measuring gauge, capable of measuring rapidly, nondestructively, and precisely the thickness of coating and cladding material. It is suitable for on site as well as for laboratory uses. Via the using of different probes, many sorts of measuring can be satisfied by the gauge. It can be applied comprehensively to manufacturing, metal processing and chemical profession as well as to commercial inspection. It is indispensable for the major of materials protection.

Features:

- Two thickness measuring methods adopted, the gauge can be applied to thickness measuring of non-magnetic coating on magnetic metal substrate as well as non-conductive coating on non-magnetic metal substrate
- Multi type probe can be used (F1,N1,F1/90°,F10)
- 2 measuring modes are available: CONTINUE and SINGLE
- Built-in wireless Bluetooth module can connect printers and data transmission modules
- One key click data sending function, which can send measurement results to statistical software or excel
- 5 statistic values: mean value (MEAN), max. value (MAX), min. value (MIN), standard deviation (S. DEV)
- 2 methods can be used to calibrate the gauge, and the system error of the probe can be corrected by use of basic calibrating method
- Storage function: 600 measuring results can be stored
- Deletion function: delete the single questionable data occurring in measuring, as well as all of the data in memory area to perform the new measuring
- Limit can be set: capable of alarming automatically for measuring values out of limit
- Indication of low voltage
- Buzzing indication in the course of operation

- With the function of error warning, error warning can be carried out through display or buzzing
- Two shut down modes are available: manual shut down mode and automatic shut down mode

1.1 Measuring principles

The gauge adopts two measuring thickness methods of magnetic method and eddy current method, is capable of measuring the thickness of non-magnetic coating (aluminum, chromium, copper, enamel, rubber, paint and etc.) on magnetic metal substrate (steel iron, alloy, magnetic hardness steel and etc.), and the thickness non-conductive coating (enamel, rubber, paint, plastic and etc.) on non-magnetic metal substrate (copper, aluminum, zinc, tin, and so on)

a) Magnetism method (F-probe)

The probe and the magnetic metal substrate will form a closed magnetic circuit when probe contacting with the coating; the magnetic resistance of closed magnetic circuit varies due to the existing of non-magnetic coating. The thickness of the coating can be measured through the variation of magnetic resistance.

b) Eddy current method (N-probe)

The high frequency alternating current generates an electromagnetic field in probe coil, eddy current will be formed on metal substrate when the probe contacting with coating, and the eddy current has an effect of feedback on the coil in probe. The thickness of the coating can be calculated through measuring the effect of feedback.

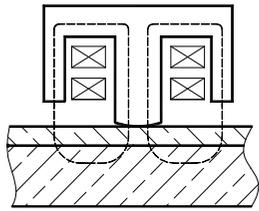


Fig. 1-1
principle of magnetism method

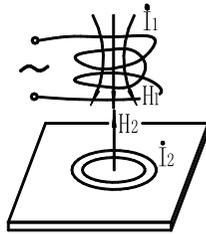
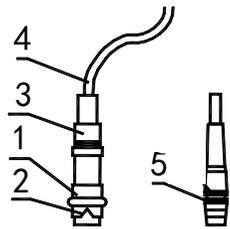


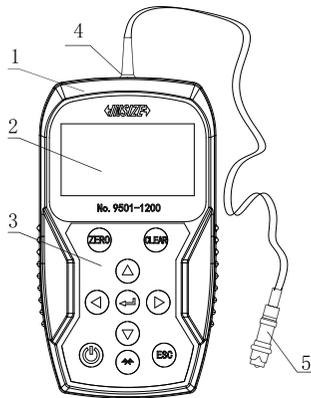
Fig. 1-2
principle of eddy current method

1.1.1 Name of every part of probe



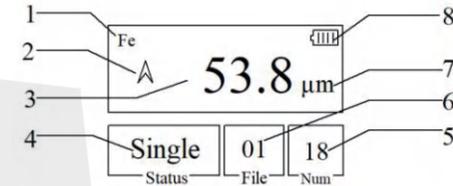
1. Positioning sleeve
2. V-groove in probe
3. Loading sleeve
4. Connecting cable
5. Plug

1.1.2 Name of every part of gauge



1. Main unit
2. Display
3. Keypad
4. Probe socket
5. Probe

1.1.3 Screen display



No	Name	Content	Detailed description	Remarks
1	measuring methods	Fe	Magnetism method	
		nFe	Eddy current method	
2	limit	▲▼	Upper and lower limit indication	
3	Measuring Result	0.0-99.9	<100μm, resolution:0.1μm	
		100-1250	≥100μm, resolution:1μm	
4	Testing mode	Single	Single measuring	
		Contin.	Continuous measuring	
5	Number of records	01-100		Each file
6	Number of Files	00-05		6 files in total
7	Unit	μm mil		
8	Battery Level			

1.1.4 Specifications

Measuring scope and measuring error (See Appendix)

Environment of application:

Operation Temp: -10~50 °C, Storage Temp:-30~70 °C

Humidity: 20% ~0%RH

No strong magnetic field

Power source: 2×1.5V AA

Dimensions: 135×77×32mm

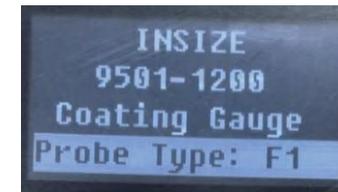
Weight of main unit: approximate 172g

2. Operation

You must read carefully the Calibration and the Factors affecting the measuring accuracy prior to the use of the gauge.

2.1 Basic steps

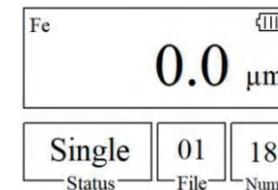
- Get the object to be tested ready
- Insert probe plug into the probe socket of main body
- Put the probe on an open space, press the "  " key to switch on the machine
- Self Check the Probe type, the interface is as follows:



- Check the voltage of battery

Notes:

- Battery symbol will twinkle, if battery capacity runs out . User s need replace the batter ies ASAP
 - Please remove the batteries, if the instrument won 't be used for long time
- In normal circumstances, the instrument displays the previous measurement value after being switched on. For example:



- f) If calibration is needed, choose the appropriate method to do so. (See Calibration)
- g) Start measuring Swiftly take the probe to contact with the tested surface vertically and press it lightly. With a buzzer sound, the measured value would be displayed on the screen. Lift the probe and conduct the next measurement

List of Key Operations

Name	Function	Remarks
ZERO	Zero calibration	
	Bluetooth sending measurement results	for manual single data transfer
	Menu/Confirm	Short press 1 time
	Switch language	Under measuring interface, long press for 6 seconds
ESC	Cancel/Exit	
CLEAR	Delete the latest one measured data	Under measuring interface, 1 st short press
CLEAR	Delete all measured data in current file, including its statistical, calibration and limit values	Under measuring interface, 2 nd short press
↑ ↓ → ←	Digital adjustment	
	Power On/Off	

Note:

1. An obvious questionable value will be appeared if the probe is unstable during the measuring . It can be deleted by pressing "CLEAR " key
2. The function of "CLEAR" key can be applied for both off-line working and data transmission with Excel, only deleting related data

stored in main unit
2.2 Test Set Operations

2.2.1 Testing Mode: (Single ↔ Continuous)

- Single measurement mode: For each time the probe contacts with the tested object, the measured value is displayed with a buzzing indication
- Continuous measurement mode: No need lift the probe during dynamic measuring. And there is no buzzing sound during the operation. The screen displays the flashing measured values.

2.2.2 Save File No.

The measured values are automatically stored in the specified group , 6 groups in total (00-05). Each group can store 100 values. High-capacity storage instruments can be customized.

2.2.3 Comm BPS

4 kinds of Comm BPS included: 2400/4800/9600/115.2K. For details, please refer to the introduction of data output and data print.

2.2.4 Tolerance Limit

Each group can be set with an upper limit value and a lower limit value, 6 groups in total.

Notes:

1. Different group can have different tolerance limits
2. Warning will be sound when measured result is out of the limits
3. Both the measuring results out of limits and others will be stored together and used to perform statistical calculation

2.3 Memory Manager

Name	Function	
Data Statistic	MEAN	Mean value
	S.DEV	Standard Deviation
	MAX	The maximum value
	MIN	The minimum value
View Now File	Display all measured values for in current group	
Delete Now File	Delete all measured values in current group	
Delete All File	Delete all measured values that stored in all groups	
Del. Calib Data	Delete the calibration data that stored in main unit, including zero calibration, 1 or 2 point calibration	

Note: The 5-point basic calibration data of the probe is stored inside the probe. Any deletion operation will not change that

2.4 Print Function

Name	Function
Print Current	Print the results and statistical values of the current group
Print All Mem	Print the results and statistical values of all the groups

Pre-condition: In System Set, "Auto Trans" is off, "Auto Print" is on

2.5 System Set

Name	Options	Function
Auto Save	OFF	
	ON	Automatically save data results to current group
Key Sound	OFF	
	ON	Prompt sound when pressing the Key or measuring

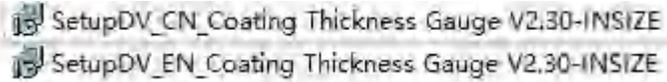
Warn Sound	OFF	
	ON	prompt sound when exceeding the limit
Auto Trans	OFF	
	ON	Automatically send measurement results to EXECL or statistical software
Auto Print	OFF	
	ON	Automatically data transfer to printer
Auto Sleep	OFF	Always working
	ON	Automatic shutdown while there is no operation for 300 seconds
Blue Tooth	OFF	
	ON	Printing function and data transmission function via Bluetooth will be available for use
Auto Del.	OFF	After storing 100 data , new measurement results will no longer be saved
	ON	Always store the latest 100 measurement results
Disp Unit	um	Unit: um (Metric system)
	uin	Unit: mil (imperial system)
Comm Mode	Mas	Master Mode For the connection with micro printers or Receiver
	Sla	For the connection with mobile apps
Send Unit	OFF	Only send data result values
	ON	Send both data results and measurement unit
Auto LF	OFF	For the case that sent the data to excel without unit, end character is 0X0D.
	ON	For the case that sent the data to excel with unit, end character is 0X0D ,0X0A.

2.6 Data output to Statistical software

The instrument needs be connected with computer by the standard delivered cable, Comm BPS is 2400. Besides this, the setup program of statistical software and its driver need be copied from the standard delivered U disk and installed in the computer

Operation steps:

1. Copy the setup program and driver from U disk to computer D:\
2. Double click the setup program to start the installation on D:\ , “_CN_” is the Version in Chinese, “_EN_” is the version in English



3. During the installation, shortcut on desktop can be selected to be created, after the successful installation, following icon of shortcut will be appeared



4. Double click above shortcut, select the right COM port number >> click “CONN ” button >> click “START” button, the automatically data transfer to Statistical software can be proceed, the maximum quantity of measuring records is 65535 Other operations in Statistical Software:
 - STOP: Stop the automatic data transfer
 - SAVE: Save the transferred data into software, type of probe (sensor) and comments can be marked
 - LOAD: the former saved data in software can be loaded, it can be selected by No., Time, Sensor and Comments
 - PRINT: the measured data can be print out as a paper report or PDF file

- FILE: Downloaded the stored data from main unit to software
- LIMIT: Setting the tolerance limit for visual judgment, if the measured result is out of limit, the color of that bar will be red

2.7 Data output to excel in computer

- By Bluetooth
The receiver ISR-C300-RECEIVER is needed, all those 4 kinds of Comm BPS are suitable.

Operation steps:

1. Turn of the power button of the receiver The power button is on the side of the receiver . Push the button close to side of the USB port. After connecting with the computer, blue light can be seen from the hole of indication light.
2. Ensure the “Bluetooth ” is on in System Set of main unit, the main unit will connect with the receiver automatically When the connection is successful, the regular on and off of blue light can be detected from the hole of indication light. When the connection is failed, the continuous twinkling blue light can be detected from the hole of indication light.
3. Once the instrument connected with the receiver successfully, select the cell in excel, the one that you 'd like the 1st measured data to be transferred into, the automatic data transfer can be started. After inputting the measured data, the select cell will turn to be the nether one.

If the status of “Auto Trans ” in System Set is off, the manual

single data transfer can be realized by short press the Bluetooth button on keypad. If the status of "Auto Trans" in System Set is on, the automatically data transfer to excel can be proceed.

- By optional cable
Both the ISR-C300-RECEIVER and 9501-1200-CABLE need be used. Only 115.2K is the right Comm BPS for this case.

Operation steps:

1. Turn off the power button of the receiver
The power button is on the side of the receiver. Push the button close to side of the Mini port. After connecting with the computer, No light can detected from the hole of indication light.
2. Ensure the "Bluetooth" is off in System Set of the instrument
3. Connect the instrument with the receiver by 9501-1200-CABLE, connect the receiver with the computer by USB port
4. Select the cell in excel, the one that you'd like the 1st measured data to be transferred into, the automatic data transfer can be started. After inputting the measured data, the select cell will turn to be the nether one. (About the manual single data transfer and the automatic data transfer, the operations are same to "By Bluetooth".

2.8 Data output to printer

Take printer ISR-C002-PRINTER for example.

- By Bluetooth
All those 4 kinds of Comm BPS are suitable.

Operation steps:

1. Turn of the power button of the printer
There is no individual power button for Bluetooth, once the printer is powered on, the Bluetooth is available for working.
2. Ensure the "Bluetooth" is on in System Set of main unit
3. The main unit will connect with the printer automatically When the connection is successful, the indication light beside the marking "BT" is on and blue.
If the "Bluetooth" is set to be off in main unit, the connection will be failed, and the indication light beside the marking "BT" is off.
4. Other System Set in main unit
Manual single data transfer: "Auto Trans" is off, "Auto print" is off, short press the Bluetooth button on keypad. Automatic data transfer: "Auto Trans" is off, "Auto print" is on
5. Measuring and printing

- By optional cable
The optional cable 9501-1200-CABLE is needed. Only 115.2K is the right Comm BPS for this case.

Operation steps:

1. Turn of the power button of the printer
2. Ensure the "Bluetooth" is off in System Set of the instrument
3. Connect the instrument with the printer by 9501-1200-CABLE
4. Sytem Set of main unit
Manual single data transfer: "Auto Trans" is off, "Auto print" is off, short press the Bluetooth button on keypad. Automatic data transfer: "Auto Trans" is off, "Auto print" is on
5. Measuring and printing

3. Calibration

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

3.1 Calibration standards

Foil with known thickness or sample with known thickness of coating can be used as calibration standards. They are called standards for short.

a) Calibration foil.

As for magnetism method, "foil " refers to non-magnetic metal or non-metal foil or sheet. As for eddy current method, plastic foil is usually adopted. Foil is favorable for calibrating curved surface. It is more suitable than standard sample with coating.

b) Standard sample with coating.

Coating of known thickness, evenly and solidly attached to the substrate is selected as standard sample. As for magnetism method, the coating is non-magnetic; and as for eddy current, coating is non-conductive.

3.2 Substrate

a) For magnetism method, the magnetism and roughness of the surface of the standard substrate metal should be similar to those of the substrate metal of the object to be tested. As for eddy current method, the electric properties of standard substrate metal should be similar to those of the substrate of the object to be tested. In order to prove the applicability of the standard substrate, it is necessary to compare the readings of the standard

substrate and the substrate of the object to be tested.

b) If the curvature of the coating to be tested is too big to be calibrated on a flat surface, the curvature of the coated standard sample or the curvature of the substrate metal placed below the standard foil should be the same as the curvature of the object to be tested.

3.3 Methods of calibration

Following are the calibration methods can be adopted in measuring: zero calibration, two-point calibration and basic calibration. Two-point calibration includes one-foil method and two-foil method. The basic calibration is for the probe.

3.3.1 Zero calibration

This method is applicable to all probes .

a) Conduct measuring once on the substrate, the screen displays "x.x μ m"

b) Press the "ZERO " key, the screen displays "0.0 ". The calibration is finished and the measurement can be performed

c) The procedure of a) and b) can be repeated to obtain a more accurate zero point and high accurate measuring. Measuring can start after the zero point calibration is completed.

3.3.2 Two-point calibration

3.3.2.1 One-foil method

It is suitable for high precision measurement, small work piece, quenched steel and alloy steel.

a) First carry out zero point calibration according to the procedure mentioned above.

- b) Conduct measuring once on standard foil which thickness is approximate equivalent to the estimated coating thickness of coating to be measured. Screen will display < xx.xµm >.
- c) Correct the readings with " ↑ " and " ↓ " key to make them to be same to the standard value. The calibration is finished and the measurement can be performed.

Note s:

1. Even if the resulting value is identical to that of the standard sheet, it is still necessary to press the " ↑ " and " ↓ " key (for example, press " ↑ "once and " ↓ " once). This note applies to all calibration methods.
2. In order to carry out two-point calibration accurately, repeat b) and c) procedure is possible to improve the accurate of calibration and reduce the accidental error.

3.3.2.2 Two-foil method

The two standard foils should be different in thickness beyond 3 times. The estimated thickness of the coating to be measured should be between the two calibration values. This method is especially suitable for making measurement on rough sand blasting surface and for high precision measurement.

- a) First carry out zero point calibration.
- b) Make one measurement on the thinner standard foil. Correct the readings with " ↑ " and " ↓ " key to make them to be same to the standard value.
- c) Thereon conduct one measurement on the thicker standard foil and correct the readings with " ↑ " and " ↓ " key to make them to be same to the standard value. The calibration is finished and the measurement can be performed.

Caution:

1. Re-calibration is necessary in case of the following cases:
 - ◆ An error value had been input when calibrating
 - ◆ Operation mistake
 - ◆ Probe had been changed.
2. Zero point calibration and two-point calibration can be repeated for many times to obtain more accurate values and improve the precision of measuring. However, the calibrating phase will stop, once a measurement is performed in this course.
- 3.4 Correcting basic calibration
During measurement, if the error significantly exceeds the given range, the line calibration of the probe should be re-calibrated, this is called basic calibration.
For following cases, it is necessary to proceed the basic calibration:
 1. Probe tip worn
 2. A new probe
 3. Special application

To finish the basic calibration, 6 thickness need be calibrated, that is the zero point and 5 points distribute within measuring range.

Calibration steps:

Step	Operation	Displayed No.
1	Press the enter button to enter into the menu, then select Calibration	00
2	Measure the substrate	00
3	Press ZERO key on keypad	01
4	Measure the 1st thickness on the substrate	01
5	Adjust the displayed value to be same to the standard value	02
6	Measure the 2nd thickness on the substrate	02
7	Adjust the displayed value to be same to the standard value	03
8	Measure the 3rd thickness on the substrate	03
9	Adjust the displayed value to be same to the standard value	04
10	Measure the 4th thickness on the substrate	04
11	Adjust the displayed value to be same to the standard value	05
12	Measure the 5th thickness on the substrate	05
13	Adjust the displayed value to be same to the standard value	06
14	Measure the substrate	
15	Automatic powered off (Remind "Calibration Finish")	

Cautions:

- a) Calibrate zero point firstly. It can be repeated for many times to obtain a mean value from many calibration values, thus the accuracy of calibration can be improved.
- b) Calibrate using different standard foils. Many measurements can be performed on one thickness. The thickness of one foil should be over 1.6 times than that of the other foil. The optimized factor should be 2 time, such as: 50, 100, 250, 500 and 1000 μm . The maximum value should be close to but lower than the upper limit of measuring range. Each thickness should be over 1.6 times than the previous thickness, or the calibration should be regarded as invalid basic calibration.
- c) Measure zero after the 6 calibration values had been input. Gauge will switch off automatically and the new calibration value has been stored in the probe. The gauge will operate according to the new calibration value after being switched on.

4. Factors influencing accuracy

4.1 Relative influencing factors

Influencing factor \ Measuring method	Magnetic method	Eddy current method
Magnetic property of the substrate	▲	
Electric property of the substrate		▲
Thickness of substrate	▲	▲
Fringe effect	▲	▲
Curvature	▲	▲
Deformation of measured object	▲	▲
Surface roughness	▲	▲
Magnetic field	▲	
Impurity matters attached	▲	▲
Contact pressure of the probe	▲	▲
Direction of probe placing	▲	▲

▲ ----- indicates some effects existing

4.2 Explanations for influencing factors

a) Magnetic property of metal substrate

The accuracy of thickness measurement with magnetism method will be influenced by the variation of metal substrate magnetism (in practical operation, low carbon steel is deemed as having slight influence). To avoid the impact of heat treatment and cold processing, it is recommended to calibrate using the standard substrate with the same property as the substrate of the object to be measured. It is also applicable to calibrate the gauge with coating sample.

b) Conductivity of metal substrate

Measurement results are affected by the conductivity of metal substrate, and the conductivity depends on its materials composition and the way of heat treatment. The gauge should be calibrated by using a standard substrate with property similar to the substrate of the object to be measured.

c) Thickness of metal substrate

For each gauge, there is a critical thickness of metal substrate. If thickness of the metal substrate is greater than the critical value, the measuring will not be affected by it. The critical values of the gauge are listed in appendix.

d) Fringe effect

This instrument is sensitive to sharp changes in the surface shape of the test part. Measuring should not be carried out in the positions of abrupt deformation, such as edges, holes or inner corner. The distance between the edge of probe and the sharp change edge of test part should be no less than the diameter of probe.

e) Curvature

The curvature of the object has some effect on the measuring, and the effect will increase obviously with the decreasing of curvature radius. Therefore it is not reliable to measure on the bent surface.

f) Deformation of measured subject

Probe can make soft coating deform, so reliable data can not be measured on these sample.

g) Roughness of surface

The roughness of substrate metal and the coating have effect on measurement. The greater is the roughness, the more serious is its effect. Surface roughness can result in system error and accidental error. So the number of measuring should increase in different positions to overcome the accidental error. If the substrate metal is rough, it is necessary to calibrate the zero point on several positions on the metal substrate (without coating) which has similar surface roughness; or calibrate the zero point of the gauge after the coating had been removed by using solvent which is non-corrosive to the substrate metal.

h) Magnetic field

The strong magnetic field generated by all kinds of electrical equipments around can seriously interface with the thickness measuring by magnetic method.

i) Matters attached

The instrument is sensitive to the matters attached, which can hamper the close contract of the probe with the coating surface. It is, therefore, necessary to remove the attached matter in order to ensure close contract between the probe and the surface to be measured.

j) Pressure of the probe

The pressure exerted on the probe has effect on the readings. It should be kept constant.

k) Direction of the probe placing The direction of the probe can affect the measuring. Therefore the probe should be kept in perpendicular to the measured surface.

Measuring should not be carried out in the positions of abrupt deformation, such as edges, holes or inner corner.

Cautions:

- ◆ During measurement, the contact with the measured surface shall be fast and stable.
- ◆ After each single measurement, the probe needs be lifted up no less than 20mm high.
- ◆ As the reading of each time is not entirely identical, it is necessary to obtain several readings for an area measured.

4.3 Measurement and error

- If appropriate calibration has been performed, all of the measuring values should be in a specified limit of accuracy. (See Appendix)
- Only one reading is not reliable according to the viewpoint of statistics. Thus any measuring value displayed on gauge is the mean value of five "invisible " measuring values. The five measurements are finished by gauge automatically in less than one second.
- To make a more accurate measurement, a multiple measuring on a point can be performed by using statistical program . The great error can be canceled by using "CLEAR ". The final thickness of coating is:
 $CH = M + S + \delta$
Of which: CH: Coating thickness
M: The mean value of multiple measurements
S: Standard deviation
 δ : The allowable error of gauge

5. Maintenance and trouble shooting

5.1 Requirements for environment

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

5.2 Changing battery

The normal work life of battery used in the gauge is 3 years. it can be replaced by user after the battery had failed. The method is as following:

5.3 Trouble shootin list

Error code	Possible cause	Solution
E02	Probe or gauge damaged	Repair the probe or gauge
E03	Probe or gauge damaged	Repair the probe or gauge
E04	·Great variation on measuring value (for example: measuring on soft coating). ·Affected by magnetic field	·Auxiliary equipment should be used when measuring on soft coating to get stable pressing force ·Be away from the strong magnetic field
E05	Probe is too close to metal substrate when switching on	Keep probe away from metal substrate when switching on
E08	Probe or gauge damaged	Repair the probe or gauge
E11	Probe model is not in conformity to the model corresponding with original	·Replaced by a suitable probe ·Select another group that
	data in the group	hasn't been used ·Re-calibration after canceling
E15	The deviation of zero value is too great that calibration is impossible	Select a suitable substrate or repair the instrument
E20	Calibration value has been existed in the group	·Select another group that hasn't nbeen used ·Re-calibration after canceling.

If the instrument does not work properly, and no error code is shown, such as:

- Unable to shut off automatically
- Unable to conduct measuring
- Keys does not work
- Abnormal measuring values

If the troubles can't be eliminated using the methods mentioned above, you are advised not to dismantle the instrument. Please return the gauge to the after ervice of our company. We will perform the warranty regulations. We would be very grateful if you send back the instrument together with a brief description of troubles.

Dodatek

Probe type	9501-1200-FE magnetic induction probe	9501-1200-NFE eddy current probe	9501-1200-FE90 magnetic induction probe for bores and grooves	9501-1200-FE10 magnetic induction probe range
Measuring range	0~1250µm	0~1250µm	0~1250µm	500~10000µm
Accuracy	±(3%L+1)µm ±(3%L+10)µm	(range>1250µm) (range>1250µm)	L is measuring thickness in µm	
Resolution	0.1µm(range<100µm) 1 µm(range>100µm)			
Measuring mode	continuous and single			
Minimum substrate thickness	0.5mm	0.3mm	0.5mm	2mm
Minimum measuring area	Ø7mm	Ø15mm	Ø7mm	Ø40mm
Minimum curvature radius of convex workpiece	1.5mm	3mm	—	10mm
Memory	600			
Output	USB			
Power supply	2×1.5V AA batteries			
Dimension	135×77×32mm			
Weight	172g			