Coating Thickness Meter

Salu*Tron*® D6

- Manual -

Content

1 Introduction

The newly developed thickness gauge **Salu***Tron*® D6 is very solid (aluminum-case) and has high accuracy. The simple and safe operation is done by menu navigation. Complicated and time-intensive settings are therefore eliminated. 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.

The **Salu***Tron*® D6 is a combination gauge with 3 Fe- and 2 NFe interchangeable probes.

- With Fe-probes (F400, F1 and F10) you can measure non-magnetic coatings such as paints, plastics, chromium, copper, zinc, enamel, etc. on metal substrates as steel or iron.
- With the NFe-probes (N1 and CN02) you can measure non-conductive layers such as paints, enamels, plastics, rubber, glass, paper, etc. on non-magnetic metal substrates as aluminum, copper, brass, zinc and certain grades of stainless steel. You can also measure anodized aluminum.

Measuring Features:

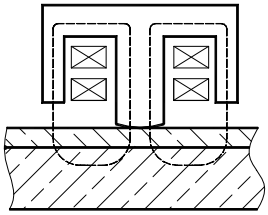
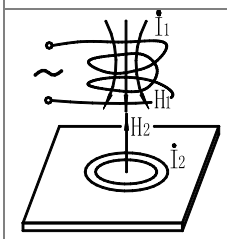
- Measuring range of 0-1250 micron (F1 standard probe)
- Measuring range of 0-10 mm (F10 special probe)
- High accuracy
- Switch between mil and micron
- Upper and lower limits can be preset; with visual and audible alarm when exceeding
- 2 measuring modes: continuing mode and single mode
- 2 operation modes: direct mode with 99 storage places and batch mode with 495 locations (5 blocks with 99 values each)
- Automatic recognition of the probes
- Quick calibration and zeroing of the instrument
- 2 methods for calibration; error system of the probe can be corrected with basic calibration method

Functions:

- Statistic values: mean, minimum, maximum, number of measurements, standard deviation
- Switch between manual or automatic memory
- Delete function: single data or all data in memory
- Analysis of measured values via histogram
- Acoustic signal after each measurement / buttons beep adjustable
- Backlight
- Low battery indicator

- Automatic or manual shutdown
- Transfer of results to PC

1.1 Measuring principles

<table>
<tr><th>Probe</th><th>Coating</th><th>Substrate</th></tr>
<tr><td rowspan="2">Fe – magnetic method</td><td>non-magnetic</td><td>magnetic</td></tr>
<tr><td>aluminum, chromium, copper, enamel, rubber, paint and etc.</td><td>steel, iron, alloy, magnetic hardness steel and etc.</td></tr>
<tr><td>  </td><td colspan="2">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.</td></tr>
<tr><td rowspan="2">NFe – eddy current</td><td>non-conductive</td><td>non-magnetic</td></tr>
<tr><td>enamel, rubber, paint, plastic and etc.</td><td>copper, aluminum, zinc, tin, etc.</td></tr>
<tr><td>  </td><td colspan="2">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.</td></tr>
</table>

1.2 Standard configuration and optional parts

Delivery range

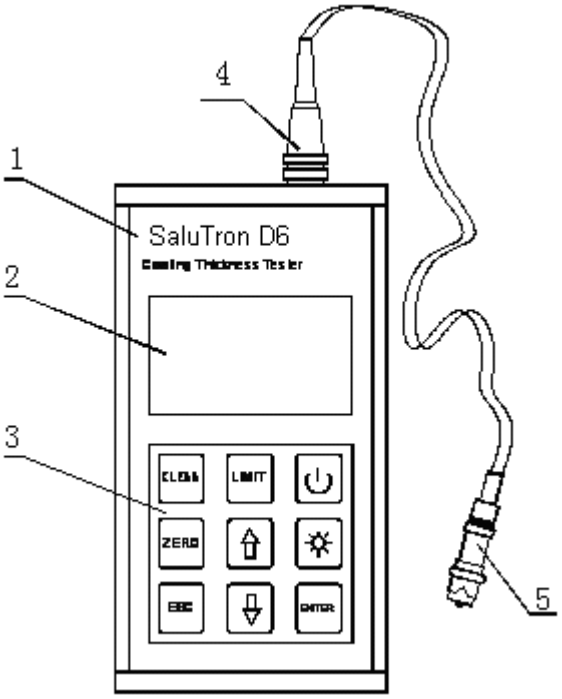
- Fe (F1) - or NFe (N1)-probe
- 5 Standard test plates
- 1 Substrate
- Stable service case
- Manual
- RS232 or USB cable and software for PC transfer

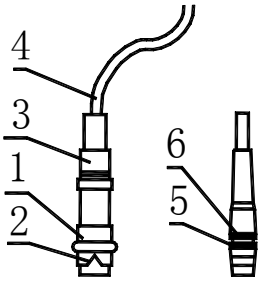
Optional accessory

- additional Fe- and NFe-probes

1.3 Name of every part of the gauge

1.3.1 Name of every part of the gauge

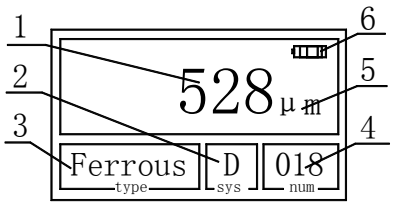




1: Positioning sleeve
2: V-groove in probe
3: Loading sleeve
4: Connecting cable
5: Plug
6: Locking nut

1: Gerätebezeichnung
2: Display
3: Key Pad
4: Probe socket
5: Probe

1.3.2 Screen display



1: Measuring result
2: Measuring mode
3: Probe type indication
4: Operation mode indication
5: Unit of measurement
6: Low voltage indication

1.4 Specifications

1.4.1 Measuring scope and measuring error

See Appendix 1

1.4.2 Other specifications

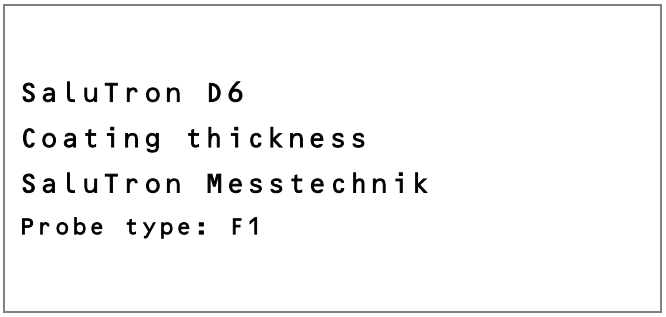
Environment Temperature	0-40°C
Relative Humidity	20-90%
Power source	2 x 1.5 V Mignon Alkali
Dimensions	ca. 125 x 65 x 30 mm bzw. 4,7" x 2,6" x 0,9"
Weight	ca. 400 g (with batteries) or 17 oz

2 Operation

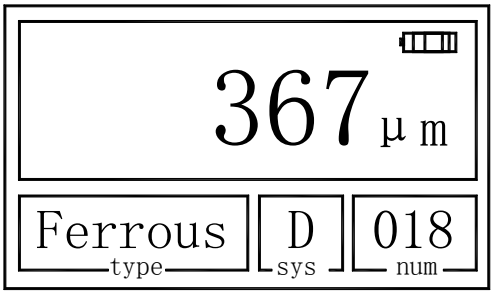
You must read carefully the Chapter 3 (Calibration) and the Chapter 4 (Factors affecting the measuring accuracy) prior to the use of the gauge.

2.1 Basic steps

1. Get the object to be tested ready. See Chapter 4.
2. Insert probe plug into the probe socket of **Salu***Tron*® D6, and tightening the locking nut.
3. Press ⏻ to switch on **Salu***Tron*® D6.
4. Self Check the Probe type, the interface is as follows:



5. Check the voltage of battery.
   - If the indicator "**Fehler! Es ist nicht möglich, durch die Bearbeitung von Feldfunktionen Objekte zu erstellen.**" is not display, it indicates that the voltage of the battery is normal; if the indicator "BATT" is displayed, it indicates that the voltage of the battery is low and recharge is needed; "BATT" will be displayed for about 1 second if the voltage of battery is insufficient when switching on the machine, then the machine will shut down automatically.
6. In normal circumstances, the instrument displays the previous measurement value after being switched on. For example:
   - „367 µm"is the last measuring value before the last shutting down of machine
   - „Ferrous" means F-Probe
   - D means direct mode
   - „018" memory group 18



7. If calibration is need, choose the appropriate method to do so. (See the chapter 3)
8. MEASURING: Swiftly bring the probe into contact vertically with the tested surface 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.
9. An obvious questionable value will be appeared if the probe is unstable during the measuring; it can be delete by pressing "CLEAR" key.
10. Switch off the machine with ⏻. The **Salu***Tron*® D6 will shut off automatically if operation stops for about 1-2 minutes.

Windows	Display content	Meaning	Remarks
Type	NON-FERROUS	N type probe	
	FERROUS	F type probe	
Sys	D	Direct measuring	
	APPL 01	Batch measuring 1	
	APPL 02	Batch measuring 2	
	APPL 03	Batch measuring 3	
	APPL 04	Batch measuring 4	
	APPL 05	Batch measuring 5	
Num Storage Unit	1-99	Storage Units	5 totally

2.2 Functions and operations

Menu	Abbreviation	Explanation
Data Statistic	Total	Total Amount of Statistic samples
	Mean	Mean value
	Max	The maximum
	Min	The minimum
	Sdev	Standard Deviation
Measuring Mode	Single	Single measurement
	Continue	Continous measurement
Working Mode	DIRECT	Direct measuring
	APPL 1	Batch measuring 1
	APPL 2	Batch measuring 2
	APPL 3	Batch measuring 3
	APPL 4	Batch measuring 4
	APPL 5	Batch measuring 5
Measuring Unit	µm	Metric unit
	mil	English unit
Delete Files	APPL 1	Delete Batch measuring 1
	APPL 2	Delete Batch measuring 2
	APPL 3	Delete Batch measuring 3
	APPL 4	Delete Batch measuring 4
	APPL 5	Delete Batch measuring 5
View Data File	APPL 1	Check the corresponding recorded data
	APPL 2	
	APPL 3	
	APPL 4	
	APPL 5	
About Software	Version	Instrument software version
	Code	Instrument factory No.
	SN	Instrument serial No.

2.2.1 Measuring methods: Single ⇔Continuous

The section states all of the functions of the machine and its operating methods in detail.

- **Single measurement method**—— Each time the probe contacted with the tested object, the measured value is displayed with a buzzing indication;
- **Continuous measurement method**—— Not to lift the probe during dynamic measuring. And there is no buzzing sound during the operation. The screen displays the flashing measured values.
- **Method of changing between the two methods**: in the shut-on state, press down ↑and↓ choosing in the "Measuring Mode"; and press the "ENTER" is displayed, entering the measuring mode setting interface, Press ↑and↓ to choose the measuring mode Single or Continue, press "ESC" back to the main display interface then to measure in the new measuring mode.

2.2.2 Operating methods Direct ⇔ Batch

- **Direct mode** —— it is used for random measurement. The values are stored temporarily in the memory unit (there are 99 memory units). When all the 99 units are occupied, the new values will take place of the old ones. The last 99 values participate in the statistical calculation.

- **Batch mode（APPL）**—— the mode facilitates users to record data in batches, with each batch containing 99 values. 495 values can be stored by the total 5 batches. "FFFF" will be displayed when each batch is occupied by 99 values. At this time, the gauge still can be used to measure, however, the measuring value can only be displayed other than stored and participated in the statistical calculation.
  - If necessary, the data of batch can be deleted to perform the new measurement. A calibration value has been set in each batch, and every measuring value of the batch is made out on the substrate of the calibration value.
  - Limit can be set in each batch, thus beyond limit identifying and warning can be carried out on measuring results in the batch. In batch mode, each measuring value can be automatically sent into the statistical program to take part in statistical calculation.
  - Several sets of measuring values based on different calibration values can be stored in this mode, thus the mode is especially suitable for on the spot measuring.
  - **Note:** All of the measuring values can be sent into statistical program (Program not suitable for F1/90° and N1/90°)
- **Changing method between the two modes**:
  - The instrument will be in direct operating mode automatically after switching on, and "D" is displayed in operating mode area.
  - Press "↑" "↓" key to choose the items choosing in the "Working mode"

- Press “ENTER” key, press “ESC” back to the main display interface it will be in batch mode, and “SYS” is displayed in operating mode area; “APPL 01”; “APPL 02”…“APPL 05”； will be displayed in the “sys” working mode area.

.2.2.3 Switch of unit system (Metric system <=> imperial system)

1. In the shut-on state, press the “ENTER” is displayed, the press down ↑and↓ and entering the “Measuring Unit” interface, the press “ENTER” , Enter the unit mode setting interface.
2. Press ↑and↓ to choose the measuring mode μm（Metric)； mils(English). Press “ESC” back to the main display interface then to measure in the new measuring mode.

2.2.4 Statistical calculation

At least 3 measuring values are needed to produce the following 5 statistical values: Mean value (MEAN), Standard deviation (S. DEV), Number of measurement (No), the Max. value (MAX) and the Min. value (MIN).

Measured values participating in statistical calculation

- In direct mode, all of the measured values (including the measured value prior to switching off) will take participate in statistical calculation.
  - Note: The old measured values will be replaced by new values when all of the 99 memory cells are occupied. The latest 99 measured values will be stored in memory.
- In batch mode, only the measured values in one batch take participate in one statistical calculation.
  - Note: The statistical value can not be modified after 99 values are stored in a batch, though measurement can continue. If necessary, the memory cells can be cleaned up to perform the next measuring.
- Display statistical values
  - Press “ENTER” button, choose the item in “Data Statistic” then press “ENTER”, the total 5 statistic values will be all displayed.

2.2.5 Storage

- In batch mode, measuring values can be stored in memory cells automatically; with 99 values in each batch at most, thus 495 values can be stored in the total 5 batches.

2.2.6 Deletion

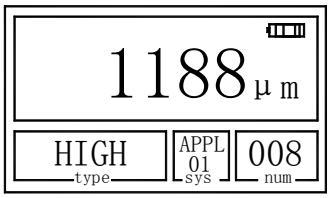
- Delete the current value
  - In despite of direct mode or batch mode, press “CLEAR” key in the status of displaying measuring value, the current value will be deleted with a buzzing sound.
- Delete all of the measured values, statistical values and two-point calibration value in direct mode
  - Press “CLEAR” key twice in the status of displaying measured value under direct mode, all of the measuring values, statistical values and two-point

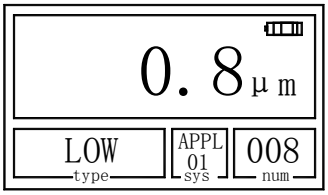
calibration value in direct mode will be deleted with a long buzzing sound.

- Deletion of a group
  - Press “ENTER” button, choose the item in “Delete files”.
  - Press “ENTER”, entering the delete interface.
  - Press “🡅”“ 🡇”to choose the Batch No.
  - “Clear” ,with a long buzzing sound. All of the measured values and statistical values will be deleted in this batch.

2.2.7 Setting limits

1. Press the “LIMITS” key, the LCD will show the lower limit previously set. Set the new lower limit by pressing “↓” and “↑” key.
2. Press the “LIMITS” key again. LCD will show the upper limit previously set. The new upper limit can be set by pressing “↓” and “↑” key.





Notes:

- The limits are only valid in batch mode;
- Buzzing sound warning will be sound when measured result is out of the limits;
- Both the measuring results out of limits and others will be stored to perform statistical calculation;
- The closing extent between upper limit and lower limit is limited. The min. closing extent between upper limit and lower limit is 3% of upper limit if the upper limit is above 200µm. And the min. closing extent is 5µm if the upper limit is below 200µm.

2.2.8 Keys and Operations

Key name	Function	Remark
ZERO	Zero calibration	3.3.1
LIMIT	Setting limits	2.2.7
CLEAR	Delete test value, statistical value, limit and calibration value	2.2.6
⏎ ⇧	Digital adjust	
⏻	Turn on ,off	2.1
⏎+⏻	Enter the basis calibration condition	3.4

*The marking number in the column of remark refers to the chapter which explaining the function in the operation instruction.

2.2.9 Measurement and error

If appropriate calibration has been performed, all of the measuring values should be in a specified limit of accuracy. (See Appendix 1);

- Only one reading is not reliable according to the viewpoint of statistics. Thus any

measuring value displayed on ACT280 is the mean value of five “invisible” measuring values. The five measurements are finished by ACT280 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 cancelled by using “CLEAR”.

The final thickness of coating is: **CH = M+S+δ**

CH: Coating thickness

M: The mean value of multiple measurements

S: Standard deviation

δ: The allowable error of gauge

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.

- 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.
- 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

- 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.
- If the thickness of the substrate metal of the object to be tested is less than the critical thickness prescribed in the list 1, the following two methods may be used for calibration.

- To calibrate on the standard metal substrate of the same thickness as the substrate metal of the object to be tested.

♦ To calibrate by placing a metal pad, which is thick enough and has similar electrical or magnetic property, under the standard metal substrate. Make sure that there is no seam between the substrate and the metal pad. This method is not applicable to objects with coatings on both sides.

♦ 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 calibration on the surface of sand blasting. Two-point calibration includes one-foil method and two-foil method. There is another basic calibration method for the probe. The calibration of the gauge is very simple.

3.3.1 Zero calibration

This method is applicable to all probes, except CN02.

1. To conduct measuring once on the substrate, the screen displays ＜×.×μm＞.
2. Press the “ZERO” key, the screen displays <0.0>. The calibration is finished and the measurement can be performed.
3. 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

This method applies to all probes except CN02. It is suitable for high precision measurement, small work piece, quenched steel and alloy steel.

1. First carry out zero point calibration according to the procedure mentioned above.
2. Conduct measuring once on standard foil which thickness is approximate equivalent to the estimated coating thickness of coating to be measured. Screen will display ＜××.×μm＞.
3. Correct the readings with “↑” and “↓” key to make them accord with standard value. The calibration is finished and the measurement can be performed.

Notes:

♦ 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.

♦ 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.

- When probe F5 and F10 are used to measure the thickness of metallic coating, two-point calibration method should be adopted.

3.3.2.2 Two-foil method

This method applies to all probes except CN02. 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.

1. First carry out zero point calibration.
2. Make one measurement on the thinner standard foil. Correct the readings with "↑" and "↓" key to make them accord with standard value.
3. Thereon conduct one measurement on the thicker standard foil and correct the readings with "↑" and "↓" key to make them accord with standard value. The calibration is finished and the measurement can be performed.

3.3.2.3 Calibration on sand blasting surface

The special features of sand blasting surface leads to great deviations between measuring values and true values. The thickness of the coating can be determined by the following method:

Method 1:

1. The gauge should be calibrated first on the smooth surface with the same curvature radius and substrate materials according to the methods described in Chapter 3.3.1 or
2. 3.3.2.4 Calibrate on the surface (without coating) processed with the same sand blasting method about ten times to obtain the mean value Mo.
3. Then, conduct measuring on the sand blasting surface (with coating) for ten times to obtain the mean value Mm.
4. （Mm—Mo）±S indicates the thickness of the coating.
5. Of which, S（standard deviation）is the bigger one between SMm and SMo.

Method 2:

1. Measuring with the single measuring method in direct mode.
2. Calibrate the gauge with two-foil method first.
3. Perform the measurements for about 5～10 times on the object to be tested. Press "STATS" key, and the mean value in statistical values indicates the coating thickness.

3.3.2.4 The calibration method for chroming coating on copper

The method is suitable for N400, N1 and N1/90° probes, and special calibration standard sheet should be adopted.

Only one-foil method can be used. The special standard sample marking with "CHROME ON COPPER" are used.

3.3.2.5 The calibration method for CN02 probe

A patulous probe, CN02 is only suitable for measuring the thickness of copper plate or

copper foil on smooth surface.

1. Place the CN02 probe stably on a copper block of 5.0mm after the starting up of the machine. Press “ZERO” key and the screen will display “00”;
2. Perform once measurement on standard foil;
3. Correct the readings with “↑” and “↓” key to make them accord with standard value. The calibration is finished and the measurement can be performed.
4. To measure the two sides coating copper plate, the two sides coating copper standard sheet is necessary for calibration.

Notes:

- In case of extreme variation of temperature, such as operating outdoor in winter or hot summer, calibration should be carried out on a standard foil whose thickness is close to the thickness of foil to be measured.
- The ambient temperature when calibrating should be identical to the ambient temperature when using.

Caution:

- Re-calibration is necessary in case of the following cases:
  - An error value had been input when calibrating
  - Operation mistake
  - Probe had been changed
- In direct mode, if an error calibration value had been input, please conduct another calibration, thus a new value can be obtained to cancel the error value.
- Only one calibration value can exist in each batch
- Zero point calibration and two-point calibration can be repeated by many times to obtain more accurate values and improve the precision of measuring. However, the calibrating phase will stop as long as a measurement is performed in this course.

3.3.3 Correcting calibration value in batch FX

Re-calibrating can only be carried out after all of the data and calibration value in batch unit had been deleted, or error code E20 will occur and buzz warning will sound. This method must be adopted after the probe had been changed.

3.4 Correcting for basic calibration

In the following case, it is necessary to change basic calibration:

- Probe tip worn
- Probe changed justly
- Special application

In measuring, the properties of probe should be re-calibrated (called basic calibration) if the error exceeds obviously the specified range. The probe can be re-calibrated by input 6 calibration values (one zero and five thickness values).

1. Under the status of shut off, press ⊡ or ⊡ and ⏻.. The gauge will be in the status of basic calibration with a long buzzing sound.

2. Calibrate zero point first. Calibrations can be repeated many times to obtain a mean value from many calibration values, thus the accuracy of calibration can be improved.
3. 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 Such as: 50, 100, 200, 400 and 800μm. The max value should be close to but lower than the max measuring range of probe.
   - **Caution:** Each thickness should be over 1.6 times than the last thickness, or the calibration should be regarded as invalid basic calibration.
4. 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 gauge. The gauge will operate according to the new calibration value when the gauge is switched on again.

4 Factors influencing accuracy

4.1 Relative influencing factors

No	Measuring method ➡ Influencing factor ⬇	Magnetic method	Eddy current method
1.	Magnetic property of the substrate	✔	
2.	Electric property of the substrate		✔
3.	Thickness of substrate	✔	✔
4.	Fringe effect	✔	✔
5.	Curvature	✔	✔
6.	Deformation of measured object	✔	✔
7.	Surface roughness	✔	✔
8.	Magnetic field	✔	
9.	Impurity matters attached	✔	✔
10.	Contact pressure of the probe	✔	✔
11.	Direction of probe placing	✔	✔

✔ ------ indicates some effects existing

4.2 Explanations for influencing factors

1. **Magnetic property of the 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.

2. Electric property of the substrate

Measurement results are affected by the conductivity of metal substrate.

- 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.

3. Thickness of 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 1.

4. Fringe effect

The instrument is very sensitive to the abrupt deformation of object surface, and so it is not reliable to measure the thickness on the fringes or at the inner corners.

5. 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.

6. Deformation of measured object

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

7. Surface roughness

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
- Calibrate the zero point of the gauge after the coating had been removed by using solvent which is non-corrosive to the substrate metal.

8. Magnetic field

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

9. Impurity 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.

10. Contact pressure of the probe

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

11. Direction of probe placing

The direction of the probe can affect the measuring.

- Therefore the probe should be kept in perpendicular to the measured surface.

4.3 Rules to observe in using the instrument

- **Special property of substrate metal**

For magnetism method, the magnetic property and surface roughness of the substrate metal of the standard should be similar to those of the substrate metal to be measured.

For eddy current method, the electric property of substrate metal of standard should be similar to those of the substrate metal to be measured.

- **Thickness of substrate metal**

Check the thickness of the substrate to confirm whether it exceeds the critical thickness or not; a certain method in Chapter 3.3 can be adopted to calibrate if the thickness is lower than critical value.

- **Fringe effect**

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

- **Curvature**

Measuring should not be done on the curved surface of sample.

- **The number of readings**

As the reading of each time is not entirely identical, it is necessary to obtain several readings for an area measured. The local differences of the thickness of coating also call for many measurements to be taken in a designated area, especially when the surface is rough.

- **Surface clearness**

It is necessary to remove any attached matters, such as dust, grease, corrosive products and so on, however, take care not to remove any coating matters.

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 batteries

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:

1. Press the power source switch out.
2. Unscrew the battery cover on the bottom of the D6.
3. Remove the old batteries.
4. Put two new batteries 1.5 V size AA in (take care not to reverse the anode and the cathode).

5. Screw the battery cover on again.

5.3 Trouble shooting

The following table of error messages explains how to identify and eliminate failure:

Error code	Possible cause	Resolving
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 equipments should be used when measuring on soft coating; away from the strong magnetic field
E05	Probe is too near to metal substrate when switching on	Keep probe away from metal substrate.
E08	Probe or gauge damaged	Repair the probe or gauge
E11	Probe model is not in conformity to the model corresponding with original data in the batch	Replaced by a suitable probe; Select another batch unit having not 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 batch unit.	Select another batch unit having not been used; or 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 in above table, you are advised not to dismantle the instrument. Please return the gauge to:

SaluTron Messtechnik GmbH

Max-Planck-Str. 62

D-32107 Bad Salzuflen

Tel.: 0049 / 5222-959760

Fax: 0049 / 5222-50499

info@salutron.de

www.salutron.de

We will perform the warranty regulations. We would be very grateful if you send back the instrument together with a brief description of the troubles.

6 Non-warranty Parts

- Window, Battery, Key film, Sheath, Probe

7 Appendix

Probe model		**F400**	**F1**	**F1/90°**	**F5**	**F10**
Function principle		Magnetic induction				
Measuring area		0-400 µm (0-0.4 mm) 0-16 mil	0-1250µm (0-1.25mm) 0-49mil		0-5000µm (0-5mm) 0-197mil	0-10000 µm (0-10 mm) 0-394 mil
Resolution		0.1µm	0.1µm		1µm	10µm
Accuracy (H=nominal value)	One-point calibration	±(3%H+1) µm			±(3%H+5) µm	±(3%H+10) µm
	Two-point calibration	±((1-3)%H+0.7) µm	±((1-3)%H+1) µm		±((1-3)%H+5) µm	±((1-3)%H+10) µm
Measuring Conditions	Min curvature radius	convex 1 mm	1.5 mm	flat	5 mm	10 mm
	Diameter of the minimum area	Ø 3 mm	Ø 7 mm	Ø 7 mm	Ø 20 mm	Ø 40 mm
	Critical thickness of substrate	0.2 mm	0.5 mm	0.5 mm	1 mm	2 mm

Probe model		**N400**	**N1**	**N1/90°**	**CN02**	**N10**
Function principle		Eddy current				
Measuring area		0-400µm 0-0.4mm 0-16mil (Chrome on copper: 0-40µm)	0-1250µm (0-1.25mm) 0-49mil		10-200µm (0.01-0.2mm) 4-8mil	0-10000 µm (0-10 mm) 0-394 mil
Resolution		0.1µm	0.1µm		1µm	10µm
Accuracy (H=nominal value)	One-point calibration	±(3%H+0.7) µm	±((1-3)%H+1.5) µm		±(3%H+1) µm	±(3%H+25) µm
	Two-point calibration	±((1-3)%H+0.7) µm	±((1-3)%H+1.5) µm		-	±((1-3)%H+25) µm
Measuring Conditions	Min curvature radius	convex 1.5 mm	3 mm	flat	only flat	25 mm
	Diameter of the minimum area	Ø 4 mm	Ø 5 mm	Ø 5 mm	Ø 7 mm	Ø 50 mm
	Critical thickness of substrate	0.3 mm	0.3 mm	0.3 mm	no limit	50 µm on aluminum foil

Substrate \ Coating		Non-magnetic coating of organic material (e.g. paintings, finishes, enamels, porcelain, plastics, anodizing etc.)	
		Coating thickness ≤ 100 µm	Coating thickness > 100 µm
FE: Magnetic metal such as iron, steel, etc.	Measuring area Ø > 30 mm	Probe F1 0-1250 µm Probe F400 0-400 µm	Probe F1 0-1250 µm Probe F5 0-5 mm Probe F10 0-10 mm
	Measuring area Ø < 30 mm	Probe F400 0-400 µm	Probe F1 0-1250 µm Probe F400 0-400 µm
NFe: Non-magnetic metal such as copper, aluminum, brass, zinc, tin, etc.	Measuring area Ø > 10 mm	Probe N1 0-1250 µm Probe N400 0-400 µm	Probe N1 0-1250 µm Probe N10 0-10 mm Probe N400 0-400 µm
	Measuring area Ø < 10 mm	Probe N1 0-1250 µm Probe N400 0-400 µm	Probe N1 0-1250 µm Probe N400 0-400 µm

Substrate \ Coating		Non-magnetic non-ferrous metal coatings (such as chromium, zinc, aluminum, copper, tin, silver, etc.)	
		Coating thickness ≤ 100µm	Coating thickness > 100 µm
Fe: Magnetic metal such as iron, steel, etc.	Measuring area Ø > 30 mm	Probe F1 0-1250 µm Probe F400 0-400 µm	Probe F1 0-1250 µm Probe F5 0-5 mm Probe F10 0-10 mm Probe F400 0-400 µm
	Measuring area Ø < 30 mm	Probe F1 0-1250 µm Probe F400 0-400 µm	Probe F1 0-1250 µm Probe F400 0-400 µm
NFe: Non-magnetic metal such as copper, aluminum, brass, zinc, tin, etc.	Measuring area Ø > 10 mm	only for chrome coating on copper Probe N1 0-1250 µm Probe N400 0-40 µm	
	Measuring area Ø < 10 mm		
Non-metal such as plastic, printing circuit etc.	Large measuring area	Probe CN02 10-200 µm	Probe CN02 10-200 µm

Specifications

Probe model		**F1**	**Special probe F10**	**F400**	**N1**	**CN02**
Base material (substrate)		iron or steel			non-magnetic metals such as aluminum, zinc, copper, brass, some stainless steel grades	
Layers		paints, lacquers, plastics, chromium, copper, zinc, enamel, etc. (non-magnetic)			anodized aluminum, lacquer, enamel, plastics, paper, glass, rubber, etc. (non-conductive)	
Function principle		**magnetic induction**			**eddy current**	
Measuring range		0-1250 µm (0-1.25 mm) 0-49 mil	0-10000 µm (0-10 mm) 0-394 mil	0-400 µm (0-0.4 mm) 0-16 mil	0-1250 µm (0-1.25 mm) 0-49 mil	10-200 µm (0.01-0.2 mm) 4-8 mil
Resolution		0.1 µm	10 µm	0.1 µm	0.1 µm	1 µm
Accuracy (H=nominal value)	One-point-calibration	±(3%H+1) µm	±(3%H+10) µm	±(3%H+1) µm	±(3%H+1.5) µm	±(3%H+1) µm
	Two-point-calibration	±((1-3)%H +1) µm	±((1-3)%H +10) µm	±((1-3)%H +0.7) µm	±[(1-3)%H +1.5] µm	–––
Measuring conditions	Min. curvature radius	1.5 mm	10 mm	convex / 1 mm	3 mm	only flat
	Diameter of minimum area	Ø 7 mm	Ø 40 mm	Ø 3 mm	Ø 5 mm	Ø 7 mm
	Critical thickness of substrate	0.5 mm	2 mm	0.2 mm	0.3 mm	no limit

Salu*Tron*® D6	
Memory capacity	Direct mode with 99 storage places and batch mode with 495 locations (5 blocks with 99 values each)
Memory mode	Automatically or manually
Measuring unit	Mil or µm
Limits	Minimum and maximum can be preset; with visual and audible alarm when exceeding
Statistic values	Mean, minimum, maximum, number of measurements, standard deviation
Delete function	Single data or all data in memory
Error warning	Visually or acoustically
Probe recognition	Automatic
Calibration methods	2-point or zero calibration
Menu and manual language	English
Buttons beep	adjustable
Backlight	adjustable
Shutdown	manually or automatically
Battery capacity indicator	available
Power supply	2 x 1.5 V Mignon Alkali
Size	125 x 65 x 30 mm or 4.7" x 2.6" x 0.9"
Weight	500 g (with batteries) or 17 oz

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