**NOTICE**

**Please read and precisely follow this operating manual before commissioning the instrument.**

**Operating Manual**

# Layer Thickness Measuring Instrument PAINT BORER

## Model 518 USB

**Country of origin:** **Germany**

**Status: X/2016**

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Declaration of Conformity (page 33)

# 1 General information

## 1.1 Incoming goods inspection

Check the delivery for completeness. Report any transport-related damages directly to the supplier or the responsible insurance agent.

## 1.2 Proper and intended usage

The **PAINT BORER 518 USB** is used to measure the thickness of organic coatings on substrates using the wedge cut method.

Erichsen GmbH & Co. KG is not liable for damages caused by improper use.

## 1.3 Storage and operations

Refer to section 2.3.1 for the permissible temperature ranges.

## 1.4 Safety information

The generally applicable laws and regulations concerning accident prevention and environmental protection are applicable.

## 1.5 Copyright protection

The copyright of this operating manual is kept by
ERICHSEN GmbH & Co. KG, D-58675 Hemer, Germany.
This manual is intended only for the operator and their staff. It contain regulations and instructions that may not be fully or partially reproduced, distributed or otherwise communicated.
Violation of these rights could result in a criminal prosecution.

## 1.6 Address of the manufacturer

**ERICHSEN GmbH & Co. KG**
**Am Iserbach 14**
**D-58675 HEMER, Germany**

Telephone: 49 - 2372 9683 -0
Fax: 49 - 2372 6430
E-mail: info@erichsen.de
Internet: http://www.erichsen.de

# 2 Device specifications

## 2.1 Designation and type

**The layer thickness measuring instrument TNO PAINT BORER Model 518 USB:**
(order number 2348.01.31) featuring a high-resolution digital microscope with integrated light

## 2.2 Included in the delivery

### *2.2.1 Base unit*

1 No.5 drill, for layer thicknesses up to 300 microns
1 felt-tip marker, black
1 felt-tip marker, silver
1 screwdriver
1 rechargeable battery (9 V)
1 power supply (100 – 240) VAC / (47 – 63) Hz
1 software
1 calibration template
1 operating manual
1 plastic case

### *2.2.2 Additional accessories (must be ordered optionally)*

Drill No.2 for layer thickness to 200 microns (order number 910927241)
Drill No.4 for layer thickness to 500 microns (order number 910927741)
Drill No.3 for layer thickness to 1000 microns (order number 910927841)
Drill No.1 for layer thickness to 2000 microns (order number 910927141)

### *2.2.3 Replacement parts*

Drill No.5 for layer thickness to 300 microns (order number 910928241)

## 2.3 Technical specifications

### *2.3.1 Base unit*

| | |
|---|---|
| Dimensions (L x W x H) | 155 mm x 55 mm x 110 mm |
| Weight excluding packaging: | approx 850 g |
| Drill speed: | approx. 180 rpm |
| Min. sample dimensions: | 150 mm x 25 mm |
| Power supply (alternative) | |
| - 9 volt battery | 6F22 |
| - 9 volt battery | 6LR61 |
| - Power supply | (100 – 240) VAC / (47 – 63) Hz<br>18 VDC / 0.8 A |
| Temperature range | |
| - During storage: | -10 °C to +70 °C |
| - During measuring: | -10 °C to +40 °C |

| | |
|---|---|
| Image sensor microscope: | 2 mega-pixels (5 mega-pixels interpolated) |
| Lighting: | eight white LEDs, adjustable |
| PC interface: | USB 2.0 or 3.0 |
| Magnification: | 50x |
| Image format: | PNG |
| Operating system: | Windows2000/XP/Vista/7/8/10 |
| Menu language: | English, German |

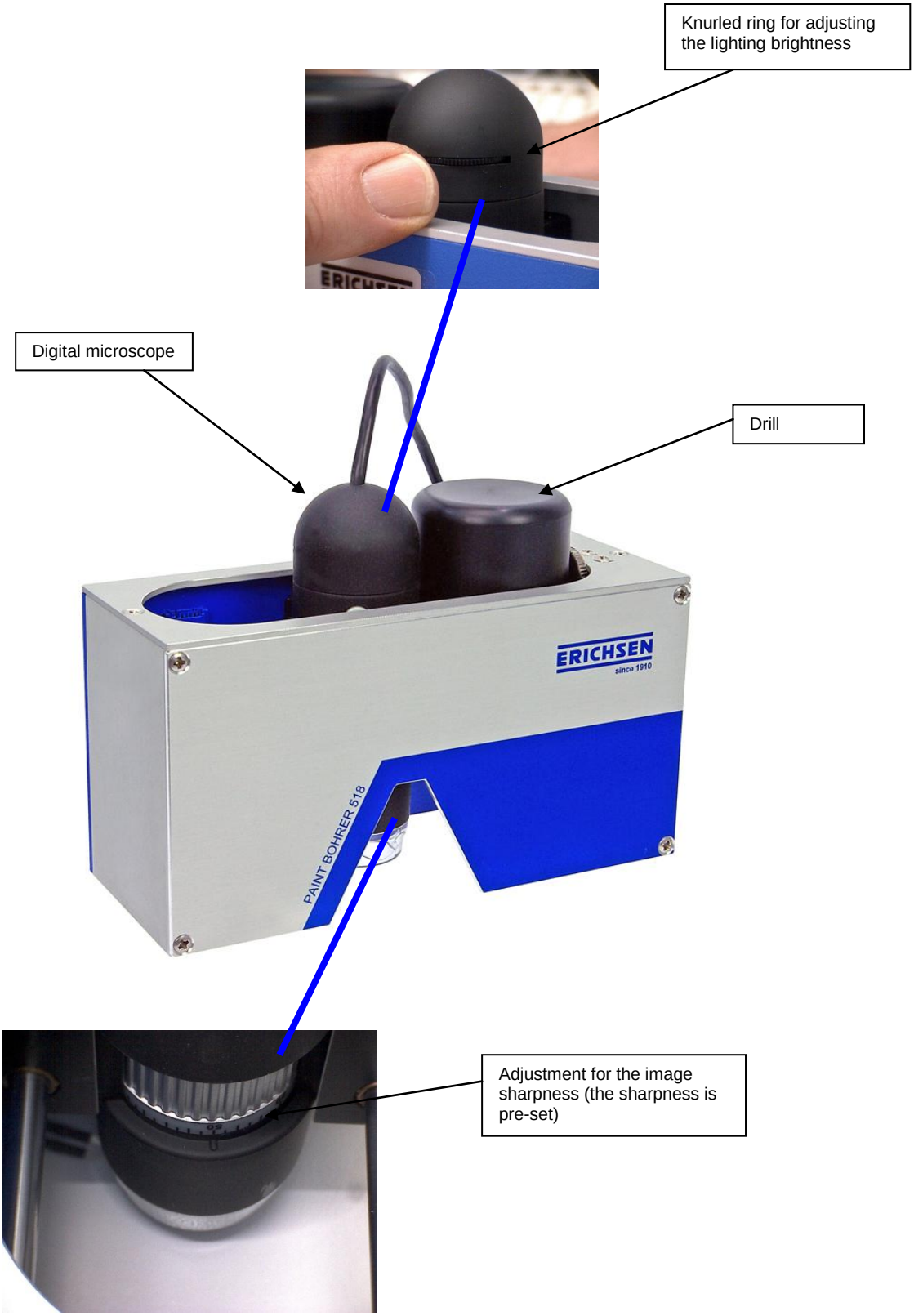
### *2.3.2 Wedge cut drill*

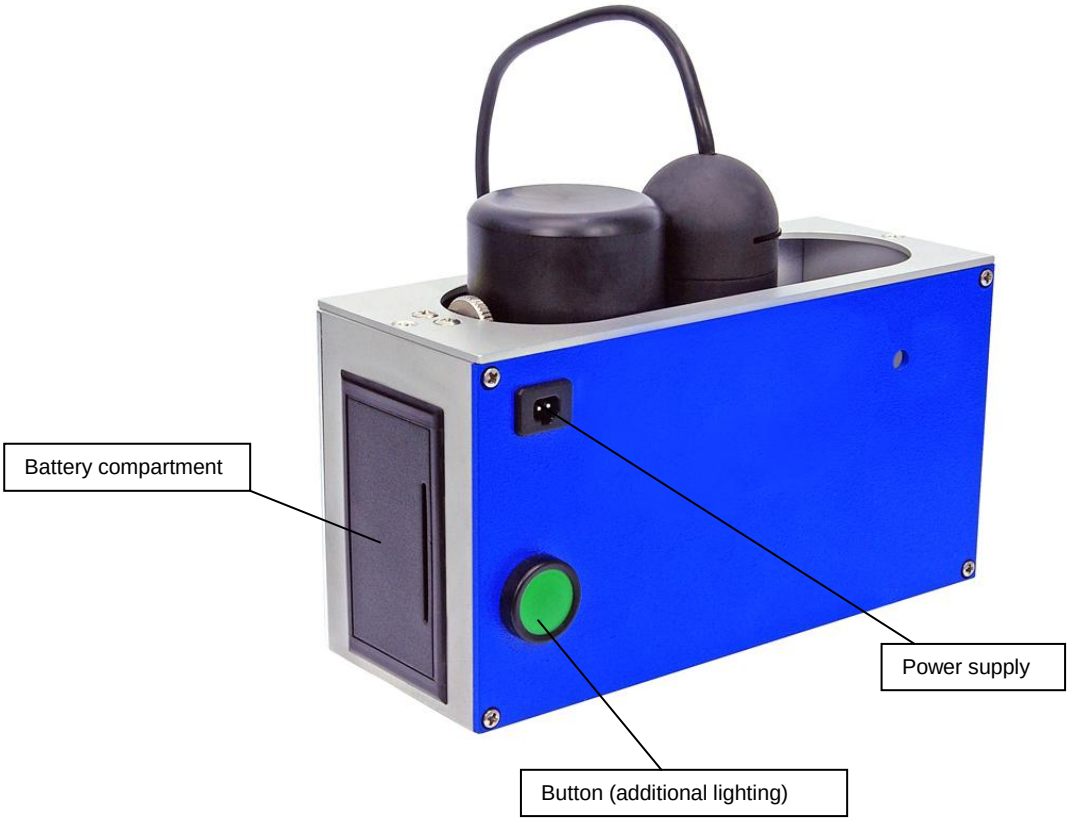
**Table: Characteristics of the wedge cut drill**

| **Drill** | **No. 2 [1])** | **No. 5 [2])** | **No. 4 [1])** | **No. 3 [1])** | **No. 1 [1])** |
|---|---|---|---|---|---|
| Measurement range | up to 200 microns | up to 300 microns | up to 500 microns | up to 1000 microns | up to 2000 microns |
| Scale factor (f) | 2 microns / div. | 3 microns / div. | 5 microns / div. | 10 microns / div. | 20 microns / div. |
| Cutting angle ( $\alpha$ ) | 5.7° | 8.5° | 14.0° | 26.7° | 45° |
| tan $\alpha$ | 0.10 | 0.15 | 0.25 | 0.50 | 1.0 |
| Geometry | double-edged | | | | single-edged |
| Head diameter | 5 mm | | | | |
| Material | Hard metal | | | | |

[1)] Available as an accessory
[2)] Included in the delivery

## 3 Commissioning – Operations – Handling




Battery compartment
Power supply
Button (additional lighting)

## 3.1 Commissioning / driver and software installation

### *3.1.1 Minimum system requirements*

- PC laptop or tablet with WIN7, VISTA, WIN8, WIN8.1 or WIN10
- Unused USB-2 port or USB-2 hub
- 4 GB of free space
- Graphics: 1280 x 800

### *3.1.2 Camera driver*

- Connect the PC to the internet.
- Connect the camera to a free USB-2 port.

*The driver will be automatically downloaded and installed from the internet; follow the instructions from your operating system if necessary.*

Install the software after the message **Device can be used** is displayed.

### *3.1.3 Software installation*

We have deliberately omitted an installer program to simplify file access and to minimize OS dependencies.

- Copy the **Erichsen** file (from the supplied USB flash drive) onto the C: drive or another Windows partition.
  - Open the **Erichsen** folder.
  - Open the **518** folder.
  - Open the **bin141** folder.
  - Select the **518.exe**, right click and select "Send to -> Desktop (Create Shortcut)".
  - Repeat this procedure with the folder **Protocols** in the same directory.

The software program can be started directly from the desktop and the data can be viewed by double-clicking on it.

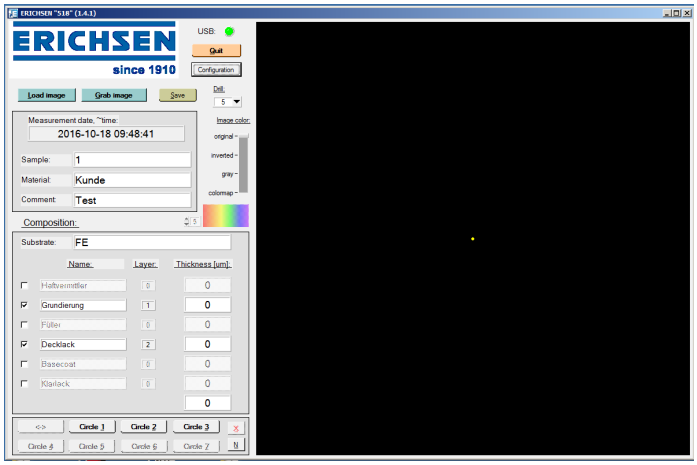
If there is a network/software administrator at your company, contact him or her for help.

The software runs directly from the included USB flash drive.
The space for logs is limited to the size of the USB flash drive.

## 3.2 Commissioning and calibration

The calibration is only required for the initial commissioning and after the optical focusing.

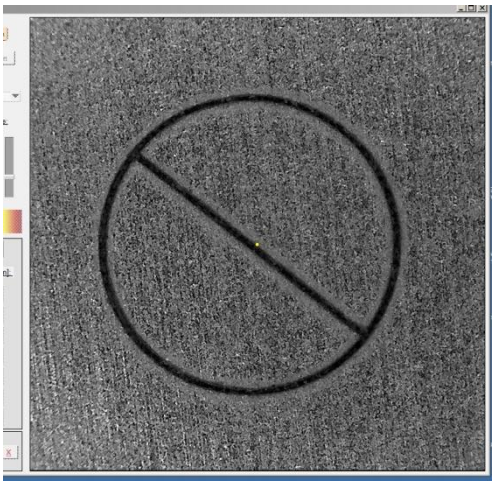
- Start the program (main screen)




- Click on the Grab image button (= live image)

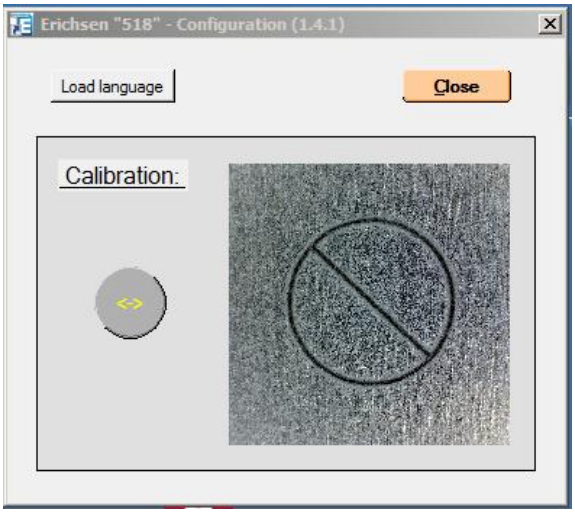
- Align the standard plate with the calibration circle in the middle.

The image must appear sharp; focus the sharpness before the calibration!

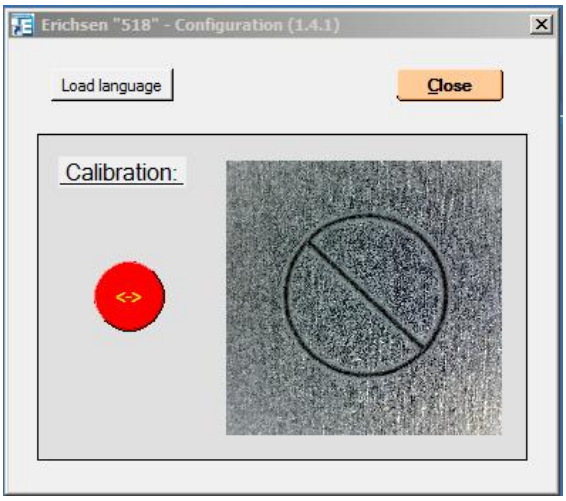


- Click on the Grab image button again.
  The image is now stored for calibration.

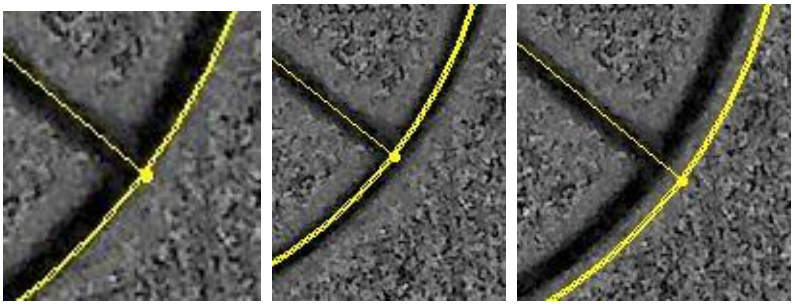
- Click on the Configuration button. The configuration window opens.




- Click on the Calibration button ; the button will now be colored red.



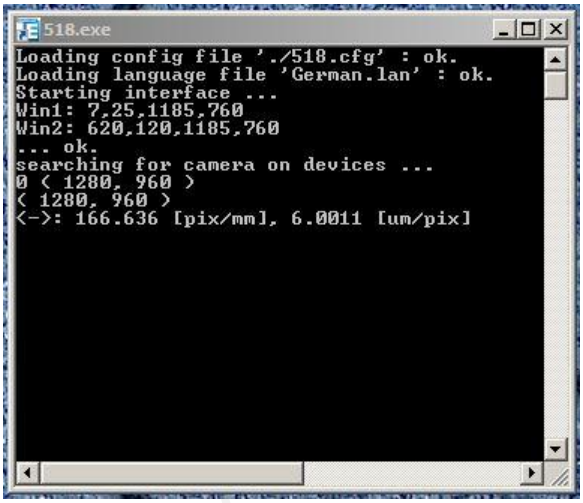
- Use the mouse pointer and the left mouse button to trace the edge of the calibration circle in the main window.



**correct** wrong wrong

If the first attempt is not successful, you may retrace the circle with the left mouse button until it is correct.

- Click on the calibration button again. The calibration is finished.
- Close the configuration window.
- The calibration can be checked to see if it was successful from the control monitor.



- The calibration value should be maintained between 5.0 and 6.0 microns.
- For the vertical measurement of the drilled hole diameter, the resolution of the USB camera is approximately 5.5 microns per pixel. (This can vary from 5 to 6 microns, depending on the focus adjustment of the lens.)
- The calibration of the USB microscope results in an average achievable resolution for depth measurements of:

  Drill 1 (0 – 2000 microns): 5.5 microns

  Drill 2 (0 – 200 microns): 0.55 microns

  Drill 3 (0 – 1000 microns): 2.75 microns

  Drill 4 (0 – 500 microns): 1.375 microns

  Drill 5 (0 – 300 microns): 0.825 microns

### 3.3 Power supply

The **PAINT BORER 518 USB** can be operated in the field – when it is disconnected from the mains power supply. A 9-volt NiCd rechargeable battery (IEC No. 6F22) can be used as the internal voltage source. Alternatively, a 9-volt non-rechargeable battery (alkaline type IEC No. 6LR61) may be used.

The 9-volt battery is delivered in a separate package; it must be inserted in the black plastic compartment on the right side of the instrument before you start using the instrument.

Caution

**The charging socket for connecting the AC adapter is located on the rear of the PAINT BORER. The charging time is 14 hours. Measurements may be taken during the charging phase even when the battery is not installed.**

**Do not connect the charger while you are operating the instrument with the battery!**

**We recommend removing the battery if you are always using the PAINT BORER with the mains power supply. Otherwise, the battery can be over-charged.**

**If you are using the instrument in the field (with the battery) sporadically, then the battery may be left inserted. However, the charger should not be permanently connected.**

### 3.4 Lighting and auxiliary lighting

The lighting intensity can be adjusted using the knurled dial on the digital microscope.
Turn the dial to adjust the lighting intensity from 0 to 100%.
In this way you can adjust the illumination for the particular sample.
We recommend using a medium setting so that the lighting intensity can be adjusted in both directions (lighter or darker) if needed.

When working with certain coatings, it may be helpful to also use indirect lighting.
For additional sample illumination, a white light emitting diode (LED) with diffuse light is used.

The green button at the rear of the instrument can be pressed to activate the side lighting. When switched on, the LED can be adjusted to three brightness levels.

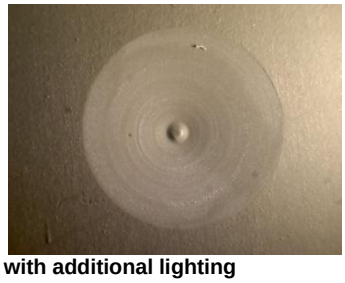
Briefly press the button to turn on the LED. The mid-level brightness will be set automatically after the LED is turned on.

The three levels of brightness can be switched on consecutively by repeatedly pressing the button.
Press and hold the button to turn the LED off. The LED will also turn off automatically after 60 seconds.

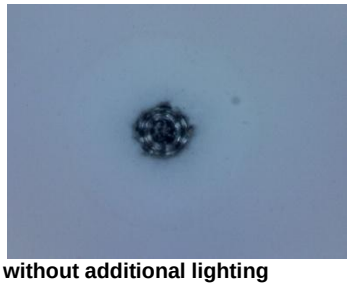
*Example:*

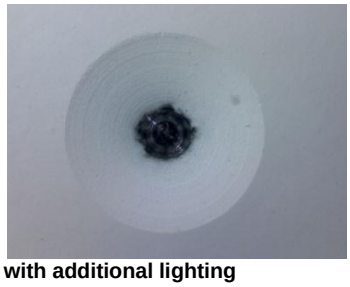
*Grey plastic coating*

**without additional lighting**


**with additional lighting**

*White top coating*


**without additional lighting**


**with additional lighting**

Colored coatings or multi-colored coating systems provide a higher contrast so that side lighting is not necessary.

### 3.3 Setting the image focus

The image focus is pre-set.

If you still need to adjust the focus, the adjusting dial can be turned slightly to the left or right to make adjustments.

! You will then need to carry out a calibration!

### 3.4 Slider mechanism

The slider is a key functional element of the **PAINT BORER**. It holds the drill apparatus and the measuring microscope. The slider can be moved along a lengthwise guide so that either the drill or the microscope is in the end position above the test point.

The slider is in the **drill position** when it is slid all the way to the left (left end stop). By pressing down gently from above on the spring-loaded drill unit, it will lower and simultaneously switch on the motor.

The right end stop position of the slider is the **measurement position of the digital microscope.**

### 3.5 Wedge cut drill

(Refer to the table in section 2.3.2.)

The basic configuration of the **PAINT BORER 518 USB** includes a boring tool for the measurement range of 300 microns (the No.5 drill). Additional drills are available as accessories: for up to 200 microns (drill number 2), 500 microns (drill number 4), 1000 microns (drill number 1) and 2000 microns (drill number 3).

Drill number 1 has a single-edge cutting profile. Drills numbered 2, 3, 4 and 5 have a two-edge cutting profile so that they can make proper conical bores at very shallow incidence angles (5.7°, 8.5°, 14° or 26.7°).

All drills are made of solid hard metal (carbide) which is extremely wear-resistant but also extremely brittle. Therefore, the drills should not be exposed to excessive shock (especially when working on hard substrates).

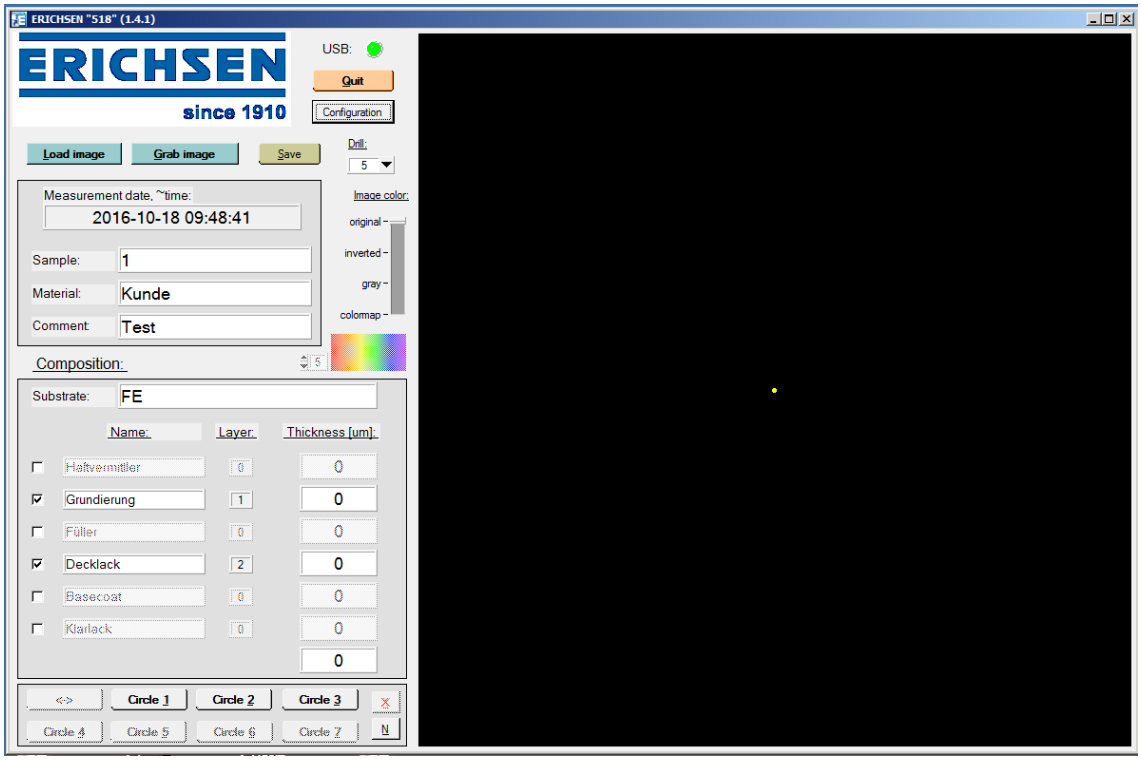
In order to change the drill bit, loosen the clamping screw in the drill chuck (using the screwdriver included with the delivery) and pull out the drill bit. Insert the new drill bit so that it snaps into the coupling. Then tighten the clamping screw.

# 4 Program functions

1. Double click on

to open the program.

2. The Main screen is shown below.

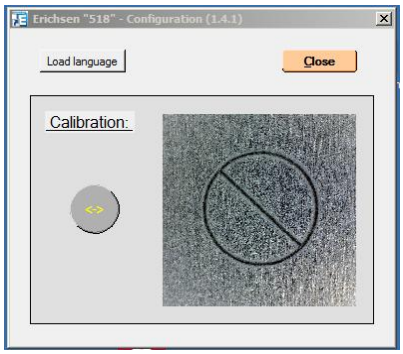


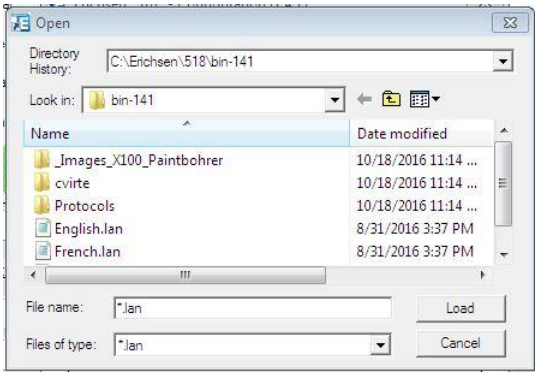

## 4.1 Menu and screen components

Quit: Exits the program.

Green: Connection to the camera is established.
Red: there is no connection.

Configuration: Opens the window for calibration and for language selection.



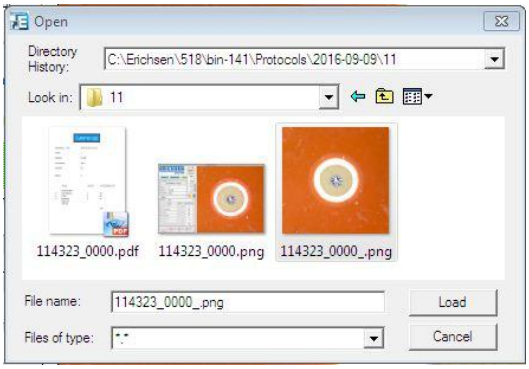




Load language: Opens the window for selecting the language.

Select the desired *.lan (language) file and load it by clicking on Load.

The selected language will be activated after the program is restarted.

Calibration: Refer to page ... for instructions.




Load image: Loads a previously saved image.

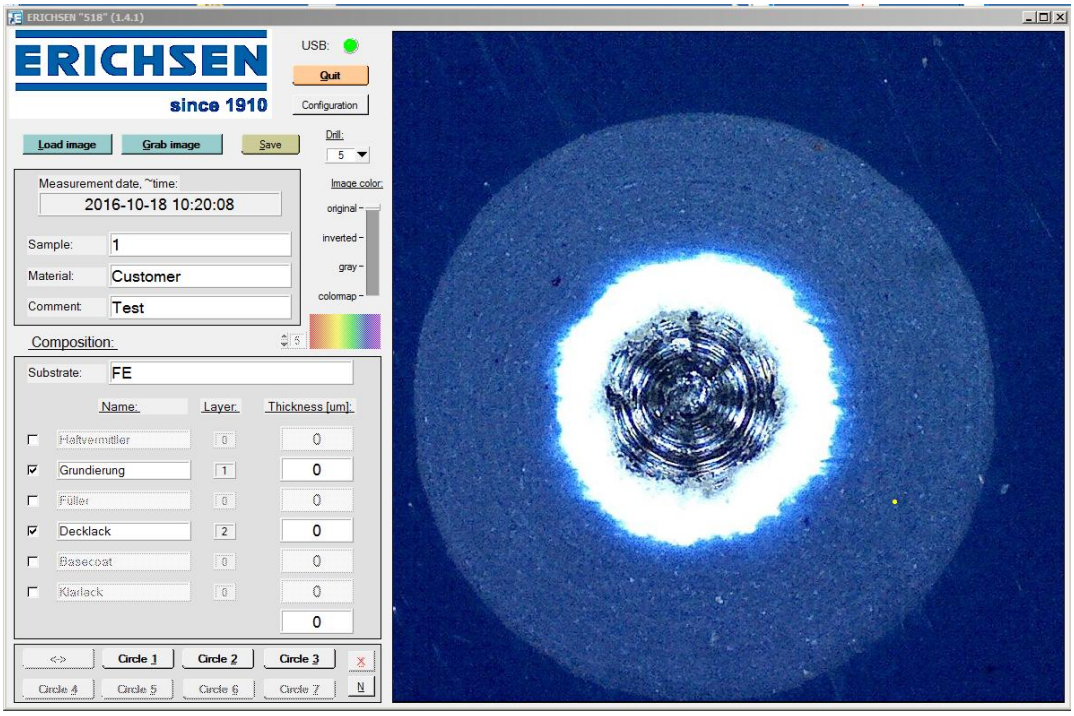
The image can be edited as a newly captured image.

Grab image: Click on the Grab Image button once: a video image of the measurement appears in the main window.

This enables you to position and process holes for which no image processing was carried out.

☞ Establishing the initial connection to the camera can take up to five seconds.

By default after the drilling is completed, the microscope is inserted and does not need to be positioned.

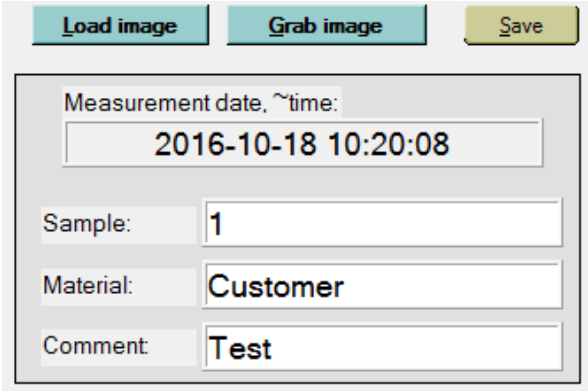



The Grab image button is now colored red.
When the button is pressed again, the image is stored for processing and can be measured.

"Measurement" is discussed separately on page 23 in section 5.3.

Save button: the measurement is saved and the log file is created.

## 4.2 Information about the sample




Measurement date and time: cannot be changed; the time setting is taken from the system

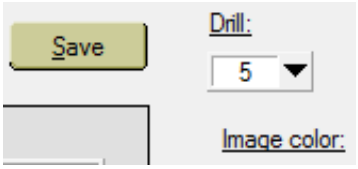
Sample: can be edited

Material: can be edited

Comment: can be edited

## 4.3 Selection of drill and image color

### *4.3.1 Drill selection*

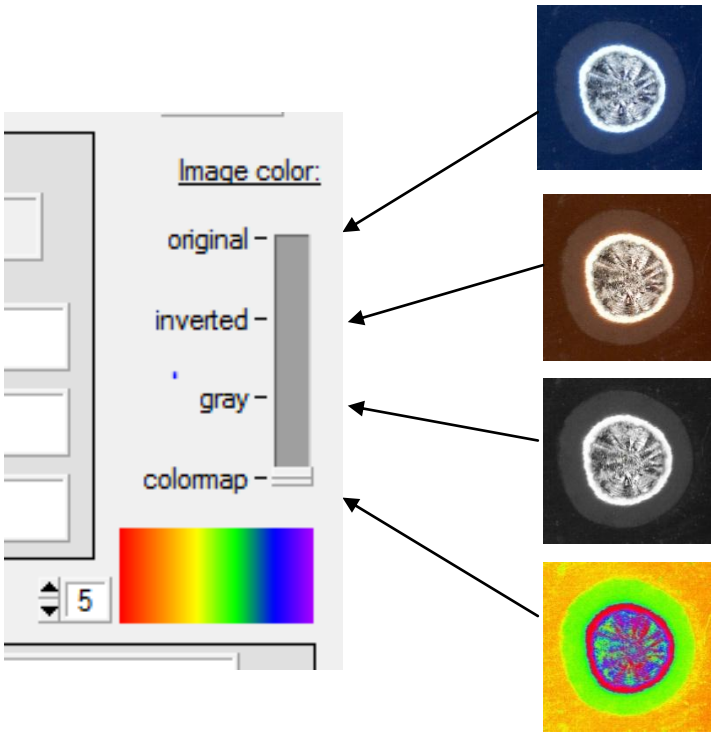


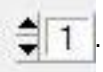

You can select one of the five standard drills
(for example:drill number 5 is included in the delivery).

**It is very important to choose the proper drill for the measurement.
If the wrong drill is selected for the measurement, the incorrect angle will result in a false measurement result.**

### *4.3.2 Image color*

There are four modes available for displaying the image and image contrast optimally.

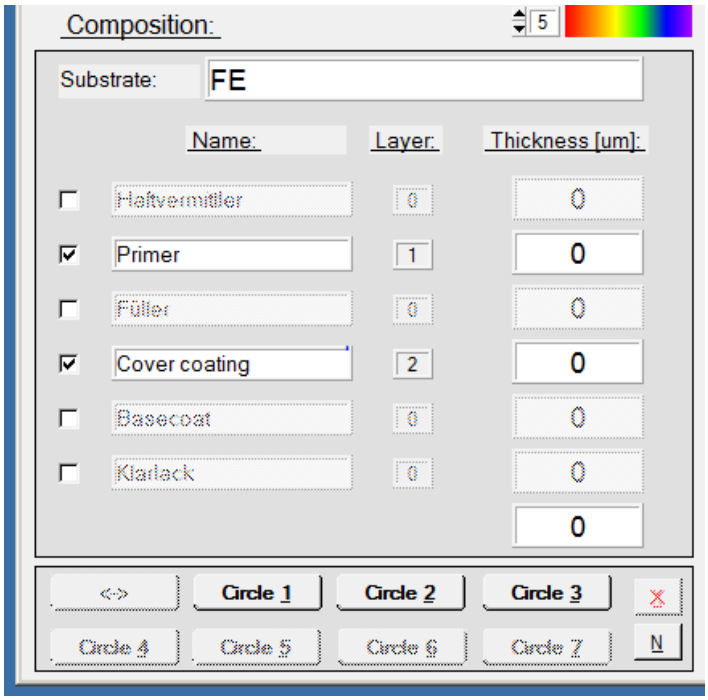



False colors: There are 13 different variations that can be chosen from the list of numbers 

.

## 4.4 Composition of the sample (layer composition)

A measurement of the layer structure is possible for up to six layers:




You can activate (with ☑) or deactivate the selection, depending on the layer compositions.

☞ You should only select the layers that are actually present in your sample!

Substrate: The coated substrate can be specified here.

Name: Identification fields for the individual layers (shown here as an example).
The fields can be edited and may be assigned any name (e.g. the technical designation for a coating).

Layer: The number of layers, starting with the first layer.

Layer thickness [µm]: Displays the thickness of each layer in microns.

Circle 1 to Circle 7: Selection button for tracing the measured circles (whereby circle 1 is always the drill tip in the substrate).

X deletes a selected circle; a circle can then be re-traced.

N deletes all circles.

# 5 Layer thickness measurement

## 5.1 Preparing the test samples

First, select a flat section on the sample such that the **PAINT BORER**'s rubber side skids can safely stand on the base. The minimum sample dimensions are 150 x 25 mm.

Apply a contrast marking to the area being tested. This should cover an area with a minimum diameter of 6 mm. This marking should facilitate the microscopic analysis by emphasizing the color contrast between the sample surface and the drilled layer.

Use the included black felt-tip marker for marking the contrast on bright samples. Use the sliver felt-tip marker for marking darker layers (apply thinly and let it harden well).

## 5.2 Drilling into the sample

Insert and secure the cutting tool for the desired measuring range in the drill's tool holder.

If the layer thickness is unknown, initially carry out a trial drilling with large drilling angle and then select the optimum drill.

If you are working with a multi-layer system, you can work with different drills. You can first drill with a large angle to determine the total layer thickness and to cover the entire layer profile visually. Then use another drill to measure the top layer separately (use a smaller angle for higher accuracy).

Move the **PAINT BORER**'s slider all the way to the left (left end stop). Then set the measuring instrument onto the sample so that the drill tip is positioned over the middle of the contrast mark.

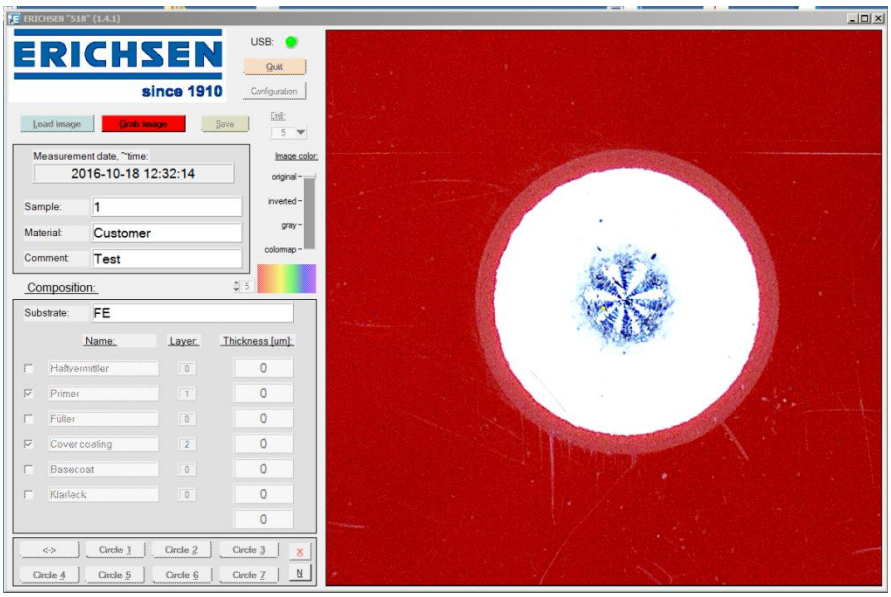
Start the drill process by pressing gently on the drill mechanism. This touch-regulated press start can be adapted to the particular coating system and, if necessary, optimized through preliminary testing.

The substrate must always be drilled into. The drill heads of the cutting tools are dimensioned so that the drilling depth into the base material can be a quarter of the respective measuring range without restricting it.

## 5.3 Carrying out the measurement (via software)

After drilling the sample, move the **PAINT BORER**'s slide all the way to the right (so that microscope is above the drilled hole). Use the additional lighting if needed.

Open the program and click on the Grab image button.



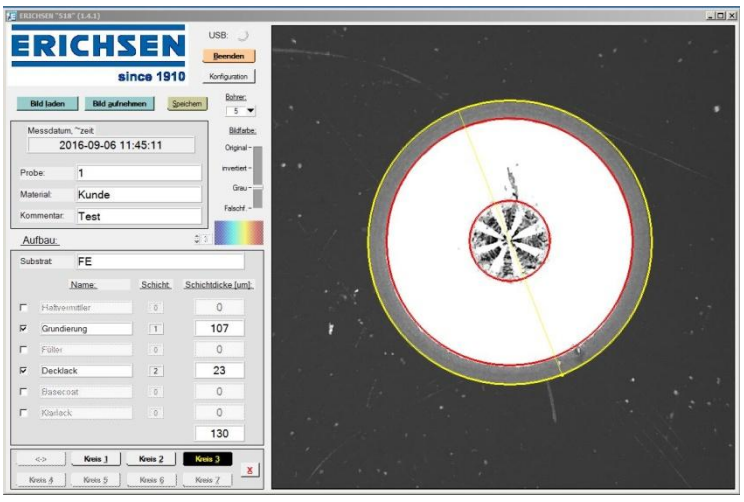

### *5.3.1 Grab image*

Grab image is now displayed in red. All other buttons are greyed out and disabled.

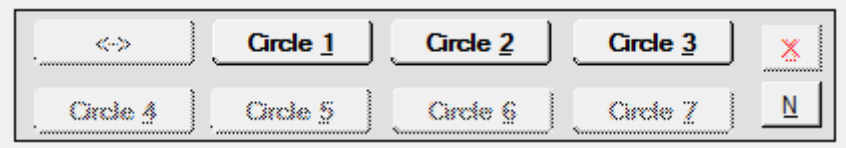
A live image of a two-layer structure consisting of a primer and top coat is shown here. If the image and the drilled depth are okay and the substrate can be clearly seen, click on the Grab image button again.

The image is now ready for measuring.

- Select the image's color scheme (in this case, "grey" provides the best contrast).
- Select the top coat and primer ( ☑ ).
  *(Only circles 1 – 3 can now be selected.)*



### *5.3.2 Selecting the circles*




**(Always start with circle 1.)**

**Circle 1** is always the inner substrate circle.

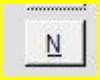
**Circle 2** is, in this case, the primer.

**Circle 3** is, in this case, the top coat.

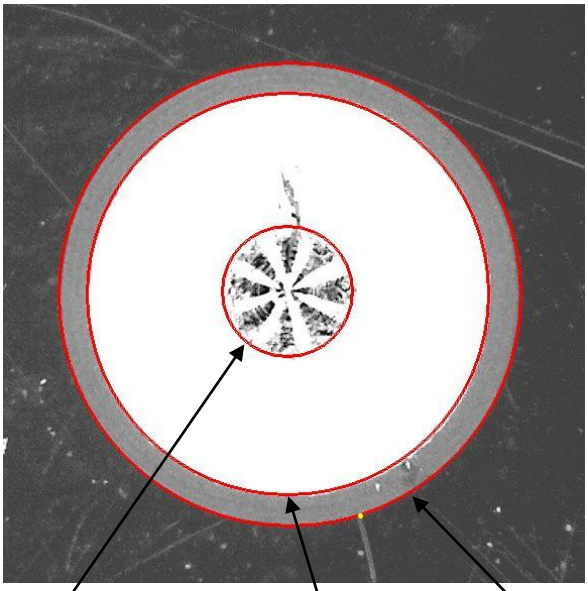
### *5.3.3 Tracing the circles*

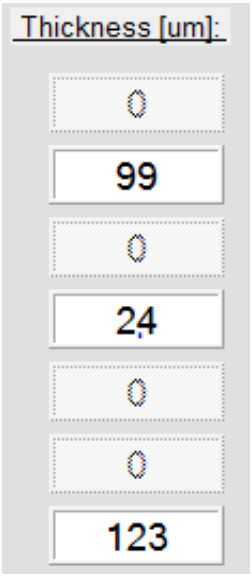
- Select the Circle 1 (which is now dark) and move the cursor to the edge of the substrate borehole. Press and hold the left mouse button in this position. Press down on the mouse button as you draw the circle and align it accurately; then release the mouse button.
- Select the Circle 2. Draw a circle on the outer edge of the primer and position it.
- Click on the Circle 3. Draw a circle on the outer edge of the top coat and position it.
- Click with the **right** button to finish after the last circle. All circles and circle buttons should now be red.

If the positioning is not successful, then select the circle button corresponding to the "unsuccessful" circle button again. Then delete the circle ( ) or draw and position a new circle. This process is almost always successful after a little practice.

Click on  to delete all circles simultaneously.

### *5.3.4 Display of measured values*






Circle 1 Circle 2 Circle 3

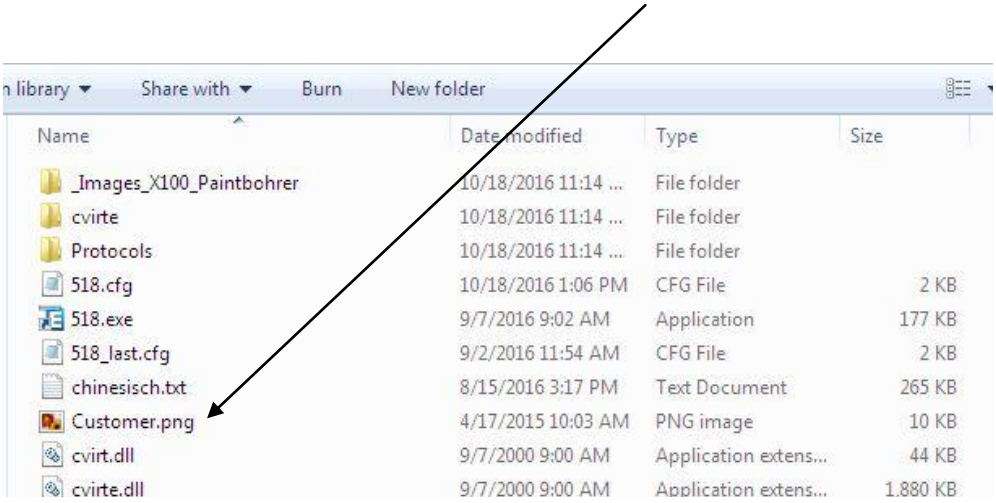
The measured layer thickness is displayed immediately.

This procedure is the same when processing a multi-layer coating structure; only the number of circles (number of layers) changes.

When the measurement is okay, click on the Save button to save and to create the log file.

## 6 Inserting a customer logo

A custom logo can be added to the log.
The logo must be a PNG image with a max. size of 70 KB and max. dimensions of 450 x 160.
The image should be copied into the folder "Erichsen/518/bin-141/" with the name **Customer.png**. (Make sure this is the exact name of the logo file!)



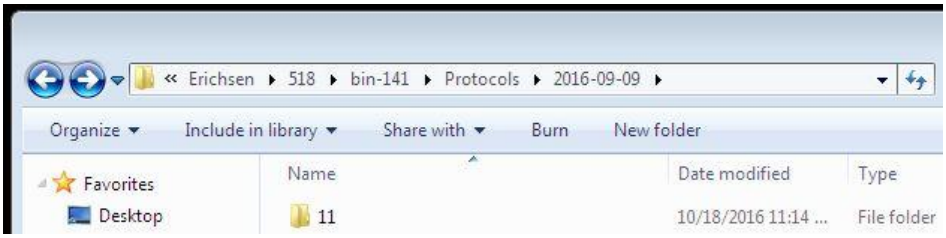

If different logos are used, we recommend renaming the logos and leaving them in the same directory.

## 7 Logs

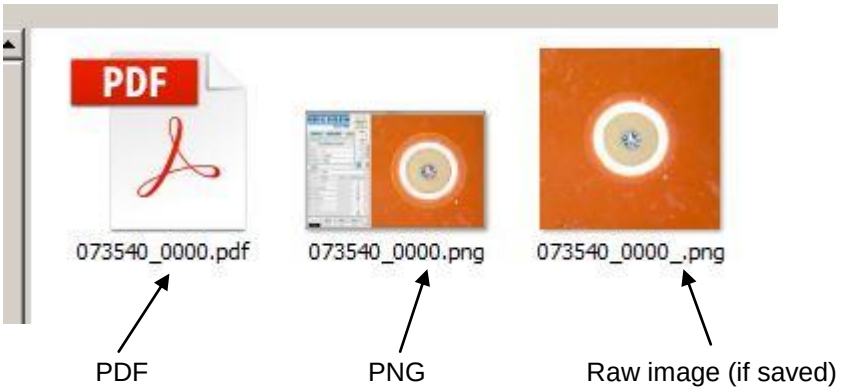
The log files are created automatically when the measurement is saved (when the Save button is clicked on).
A day folder and an hour folder are created automatically in the "Protocols" folder.

Day folder

Hour folder




The hour folders contain all logs from measurements that have been carried out and saved within that hour.

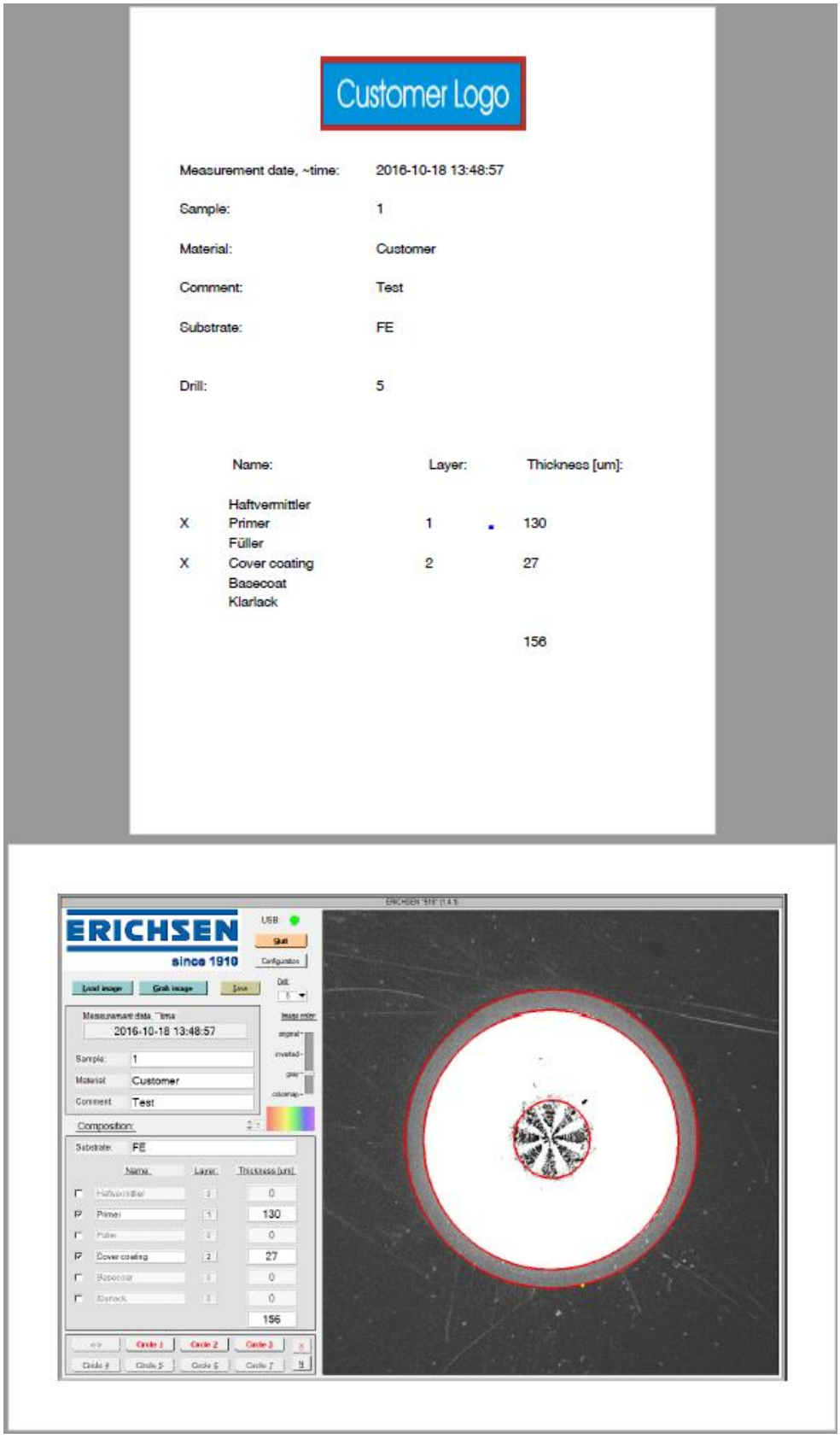



All information about the sample and an image of the real test are listed separately in the **PDF document**.

The **PNG file** is a screen shot of the measurement.

The second **PNG file** is a raw image of the sample and can be reloaded for another measurement.

PDF document



# 8 Special measuring problems

## 8.1 Delamination

Brittle coating materials or coatings with poor adhesion to the base material often result in boreholes where the boundary between the coating and the substrate is not circular but rather irregularly bounded.

Several holes should then be drilled in the sample. Take as many measurements as possible at each hole. The largest measured value for the layer thickness is then a good approximation of the true thickness.

There are some additional steps that may be helpful when working with poorly adhering coatings:

- The delamination issue is especially acute when the drill bit just penetrates the boundary
  between the coating and substrate.
  Therefore, it is better to drill as deeply as possible into the substrate.
- Always drill intermittently. Do not drill in a single stroke. Blow away the residue chips between the individual drilling strokes. This interrupted drilling method is especially important for tough substrate materials (e.g. certain types of plastic), because these tend to form large chips.
- The mechanical properties of soft plastic substrates are not favourable for drilling. Such materials can be drilled better if they are cooled (in a freezer or with a cold spray). When using cold spray, protect the coating surface with aluminium foil against the harmful solvent.

## 9 Maintenance and care

• The **PAINT BORER 518 USB** requires no maintenance.

• When used in wet conditions outdoors, this measuring instrument should be completely and immediately dried off in order to avoid corrosion and malfunctions.

• The hard-metal (carbide) drill bits should be regularly checked for wear (using a 10x magnifying glass) and replaced if necessary.

• Contact the manufacturer if you experience technical problems:

**ERICHSEN GmbH & Co. KG**
**Am Iserbach 14**
**D-58675 HEMER, Germany**
**Telephone: 49 - 2372 9683 -0**
**Fax: 49 - 2372 6430**
**E-mail: info@erichsen.de**
**Internet: http://www.erichsen.de**

We reserve the right to make technical changes.

# EC Declaration of Conformity

# EC Declaration of Conformity

Wir/We **ERICHSEN GmbH & Co. KG, Am Iserbach 14, 58675 Hemer, Germany**

erklären in alleiniger Verantwortung, dass das nachfolgend aufgeführte Produkt
*declare under our sole responsibility that the product described below*

**Schichtdickenmessgerät PAINT BORER**
**PAINT BORER layer thickness measuring instrument**

Modell / Model: **518 USB**

- konform ist mit den Bestimmungen folgender Richtlinien:
*- complies with the provisions of the following directives:*

**EMV-Richtlinie (2014/30/EU) – *EMC Directive***
**Niederspannungsrichtlinie (2014/35/EU) – *Low Voltage Directive***

Angewandte Normen:
*Applied Standards:*

**DIN EN 61000-6-2 (VDE 0839-6-2):2006-03**

Bevollmächtigter für die Zusammenstellung der technischen Unterlagen:
*Agent for the compilation of technical documents:*

***Bettina Betzinger-Rabe (Technical documentation)***

Hemer, 21/03/2016

.....
ppa. ***Stefan Schneider***
Technischer Leiter/*Technical Director*