

EN Version 23.08

# User manual

## OS Manager Classic

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# 1. OptiSense OS Manager License Agreement

By using the Software in any form, you agree to accept the following terms and conditions:

OptiSense grants you a non-exclusive right to use the OS Manager Software (Product) on any number of PCs or workstations as long as you own at least one OptiSense PaintChecker coating thickness measurement device. This license expressly excludes the right to copy, modify, rent, lease, sell, transfer or sublicense the product or any part thereof. You may not reverse engineer, decompile or disassemble the product.

OptiSense warrants that the product, when used as intended, will perform substantially as described in this user manual for a period of 90 days from the date you accept the license terms. OptiSense is not responsible for any transmission errors (downloads) and does not guarantee that the product is error-free or can be operated without malfunctions.

OptiSense disclaims all other warranties with respect to the software and accompanying materials, including warranties of merchantability and fitness for a particular purpose, whether implied by contract or by law.

In no event shall OptiSense be liable for any damages whatsoever (including, without limitation, indirect, incidental, consequential, lost business profits, business interruption, loss of business information, or other pecuniary loss) arising out of the use of or inability to use this product, even if OptiSense has been informed of the possibility of such damages occurring.

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## 2. Introduction

The OS Manager is a PC software to control and operate Optisense PaintChecker coating thickness measurement devices via a graphical user interface.

With the OS Manager and one of the supported PaintChecker devices, coating thickness measurements can be taken and visualized, and measurement data stored in the device can be saved on a PC. This simplifies data acquisition, analysis and archiving, reduces the risk of reading errors and allows measure-

ment data to be collected, structured and displayed in Microsoft Office or other third-party software.

The OS Manager is also used to identify and optimize the measurement parameters for special combinations of coating material and substrate and to store, load, transfer and organize these as so-called calibrations.

## 3. OptiSense support

OptiSense will be happy to support you in working with the PaintChecker and OS Manager.

The Infothek on our website <https://optisense.com/> has various explanation videos on how to use our products at your disposal. There you will also find the latest brochures, data sheets and success stories.

If you have any questions or suggestions, please contact our service hotline:

**Tel. +49 2364 50882-22 | Mon-Fri 8 am - 3 pm**  
**Mail: [service@optisense.com](mailto:service@optisense.com)**

Or simply use our contact form at <https://optisense.com/en/contact.html>

## 4. OS Manager Features

When connecting the PC running the OS Manager software to an OptiSense PaintChecker via a USB cable, the following functions are available:

- Coating thickness measurement and easy-to-read indication of the measured value on the PC
- Displaying the measured data as a line chart
- Indication and evaluation of setpoint and tolerance bands
- Statistical evaluation of a measurement batch
- Saving measurement batches on the PC in various formats
- Archiving measurement batches taken with the PaintChecker on the PC
- Creating calibrations for special material combinations

## 5. Installation

This section describes how to install the OS Manager on a PC. It also applies if an older version of the software is to be updated.

### 5.1 System requirements

#### 5.1.1 Software

- Operating system: Windows 7 SP1, 8.1, 10 and higher in 32- or 64-bit version
- Runtime environment: Microsoft.NET Framework 4.0
- Offline data analysis: Microsoft Office Excel 2007 or higher

#### 5.1.2 Hardware

- Processor: 1 GHz or faster, x86 or x64 architecture
- Display: 1280 × 960 or higher recommended
- RAM: min. 2 GB
- Hard disk space: min. 512 MB + space for data
- Interface: 1 x USB 2.0 or higher

### 5.2 OS Manager installation

OS Manager installation files can be found on the USB stick that comes with the PaintChecker. The latest version can also be downloaded from our Infothek at <https://optisense.com/en/publications.html> in the *PaintChecker OS Manager Software* tab.

**Important:** Administrator rights are required to install the OS Manager.

First copy the installation file *OSManagerInstall\_reseller.exe* to the desktop. Start the installation by double-clicking on this file and confirm the Windows User Account Control notification. The rest of the installation process is performed automatically. After installation is complete, the OS Manager can be found in the *OptiSense* program group of the Windows Start menu.

### 5.3 Update and uninstall

The OS Manager can be removed from the PC using Windows settings. This operation should also be performed prior to updating an existing installation:

- Open *Settings* in the Windows start menu
- In *Apps* you will find a list of installed programs
- Click on *OS Manager* in the list and then *Uninstall*
- Confirm the uninstall and the Windows User Account Control notification.

An Installer window will open. By clicking *Remove all components* and *Next*, the OS Manager will be removed from the PC.

After finishing the uninstall process, a new OS Manager version can be installed.

## 6. Overview

### 6.1 File types

#### 6.1.1 Measurement batches

In the OS Manager, measured values are organized as measurement batches. A batch consists of a number of measurements with the coating thickness and the time of measurement. Measurement batches can be imported from an attached PaintChecker measurement device or created with the OS Manager.

The OS Manager features the graphical presentation and statistical evaluation of a measurement batch as well as the storage and archiving as a file on the PC. Measurement batches can be saved in CSV and PDF file format.

#### 6.1.2 Calibrations

The PaintChecker measuring systems use the non-contact photothermal measuring method to determine the thickness of coatings on a wide variety of substrates. The coating thickness is not measured directly, but calculated based on temperature behavior. Therefore, the individual thermal properties of coating material and substrate have to be taken into account. Similar to photography, it is important to adjust the strength of the light source and the measurement time to the respective situation in order to obtain accurate and reproducible measurement results.

Another aspect arises when measuring freshly applied powder or wet films. Here, it is not the actual thickness of the raw material that is to be measured, but rather the final thickness after baking or drying that is to be predicted. For this purpose, the instrument includes the expected coating material shrinkage during curing into the measurement.

These material properties of coating and substrate are combined into one data set – the calibration. PaintChecker devices are already factory equipped with calibrations for particular combinations of substrates and coatings.

With the OS Manager, these calibrations can be loaded, archived, edited and stored on the device. Furthermore, you can also create completely new calibrations with the OS Manager.

### 6.2 Typical usage

The OS Manager supports you in the typical workflows of quality assurance in a coating company:

- Saving and archiving of measurement batches from coating thickness measurement during production
- Measurement, graphical visualization and analysis of coating thicknesses in the QA laboratory
- Creation and optimization of measurement parameters (calibrations) for new substrate-coating material combinations

Most users launch the OS Manager, connect a PaintChecker Mobile device, take measurements and analyze the displayed measurement batches.

Advanced users modify calibrations to optimally adapt the measuring system to a particular material combination or create a new calibration for previously unused coating materials and substrates.

### 6.3 Launching the OS Manager

The OS Manager is invoked via the OS Manager icon in the OptiSense folder of the Windows Start menu.

For quick access to the OS Manager, you can right-click the icon to pin it to the Windows taskbar.

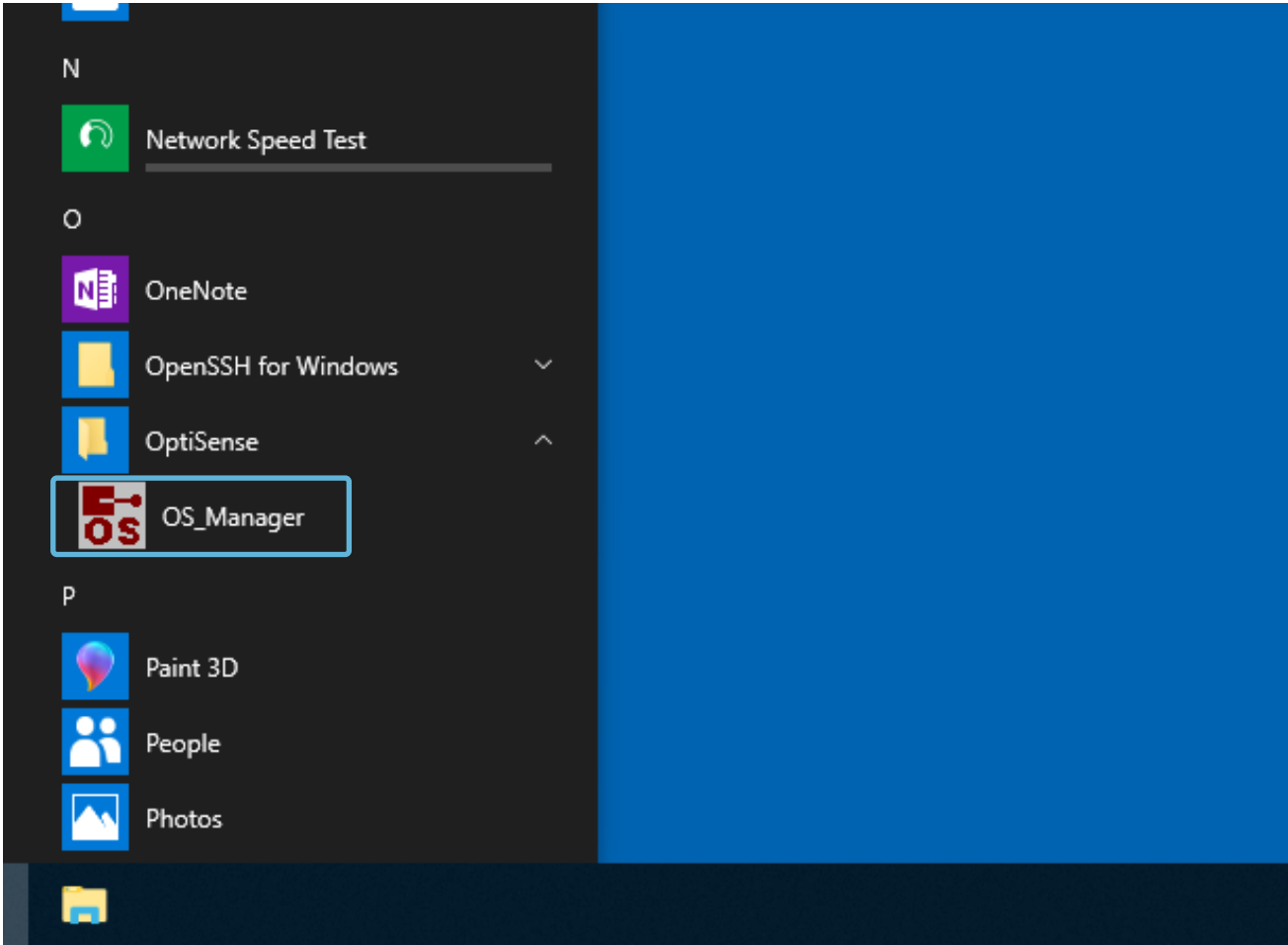


Figure 1: The OS Manager is invoked via the OptiSense folder in the Windows Start menu

#### 6.4 User interface

When started, the OS Manager opens the measurement view. The interface is divided into four areas:

##### Status pane (1)

The *status pane* displays the connection status of the attached PaintChecker device. Here you can switch between several connected devices and set the user interface language.

##### Action pane (2)

The *action area* contains tabs of different actions you can perform with the OS Manager. By selecting the appropriate tab, you can perform measurements, import measurement batches from a PaintChecker device, organize, edit and create new calibrations, and query version information of the connected device.

##### Diagram pane (3)

The *diagram pane* displays the measured values as a line chart and shows the statistical parameters of the measurement batch. Tolerance limits entered in the statistics pane are highlighted in color. Zoom and roll-over features enable convenient navigation and easy measurement analysis with the mouse.

##### Operating panel (4)

The *operating panel* is used to control the operation of the various tabs. Here you can select the calibration used for measuring and start a measurement. Loop measurement support the automatic recording of measurement batches in an adjustable time grid.



## 6.5 Measuring with the OS Manager

As one of the first steps after installation, you can set the language of the OS Manager user interface in the Status pane.

German, English and Chinese language versions are available. You can change the user interface language later at any time.

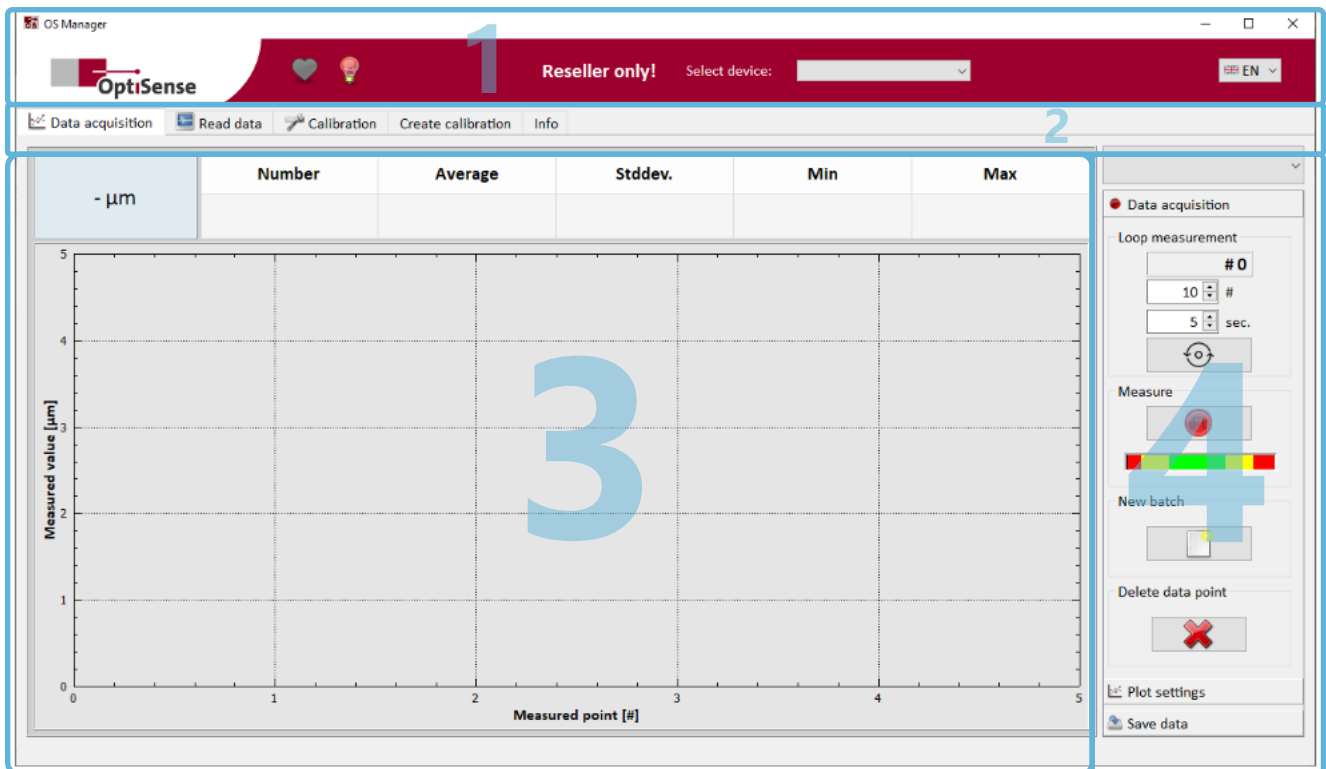


Figure 2: The user interface is organized in four sections

## 7. Measurement View

One of the most common OS Manager applications is the interactive measurement and recording of coating thickness with a PaintChecker Mobile.

### 7.1 Measurement view

Interactive measurements are performed in the mea-

surement view. To switch to measurement view, click the *Data acquisition* tab in the Action pane. As long as no PaintChecker device is connected and no measurements are available, the link indicator (heart) in the Status pane remains gray most of the controls are inactive or empty.

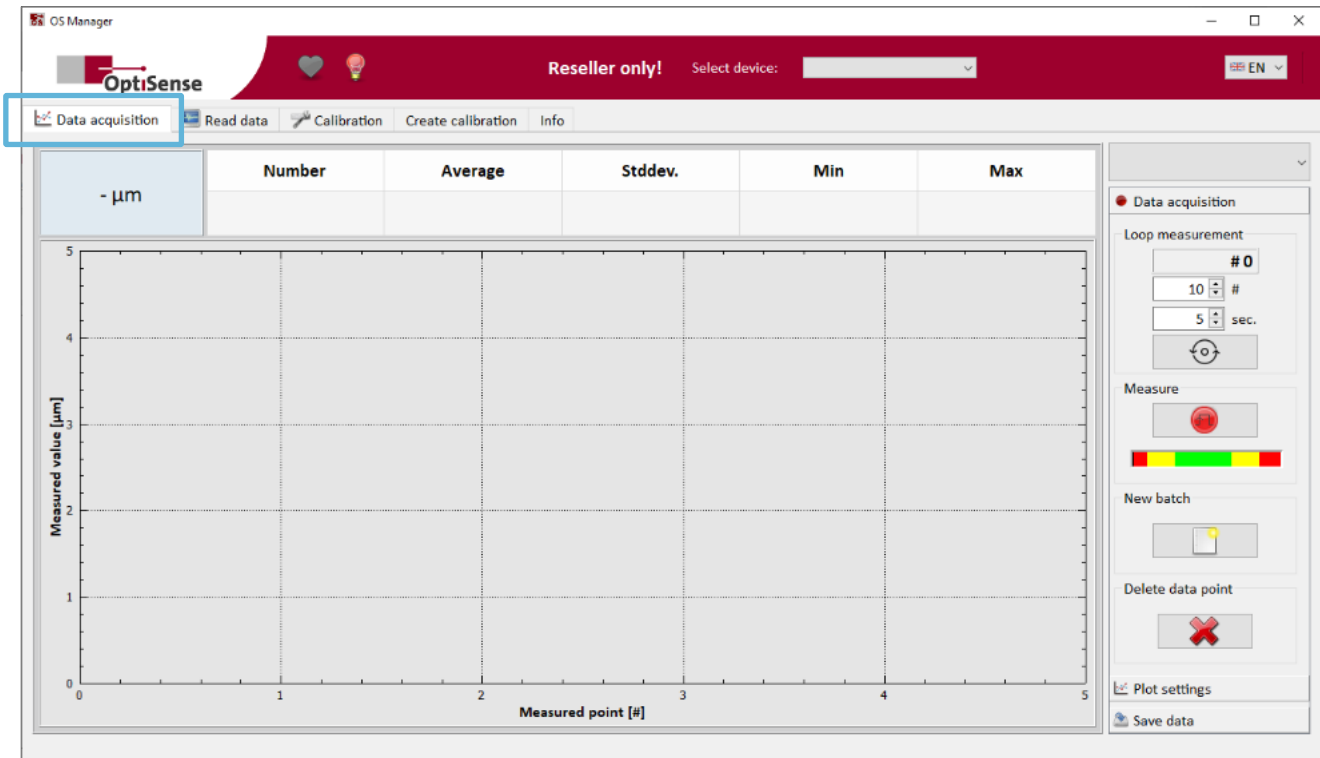


Figure 3: Interactive measurements are taken in the DATA ACQUISITION tab.

### 7.2 Connecting the PaintChecker

For interactive measurements, connect the Paint Checker Mobile to a USB port of the PC via the supplied cable and switch on the device.

As soon as the PaintChecker is detected, the link indicator (heart) starts flashing green and the type of device connected appears in the *Select device* drop-down menu. The OS Manager is now ready to measure the coating thickness.

If more than one PaintChecker is connected to the PC, the *Select Device* drop-down menu can be used to switch between devices.

### 7.3 Measuring coating thickness

#### 7.3.1 Measuring coating thickness

After connecting the PaintChecker, a calibration suitable for the measuring task needs to be selected in the Operating panel.

Clicking on the *drop down menu* provides a list of calibrations available on the connected PaintChecker. The *Cured* calibration is e.g. suitable for the measurement of powder coatings after baking.

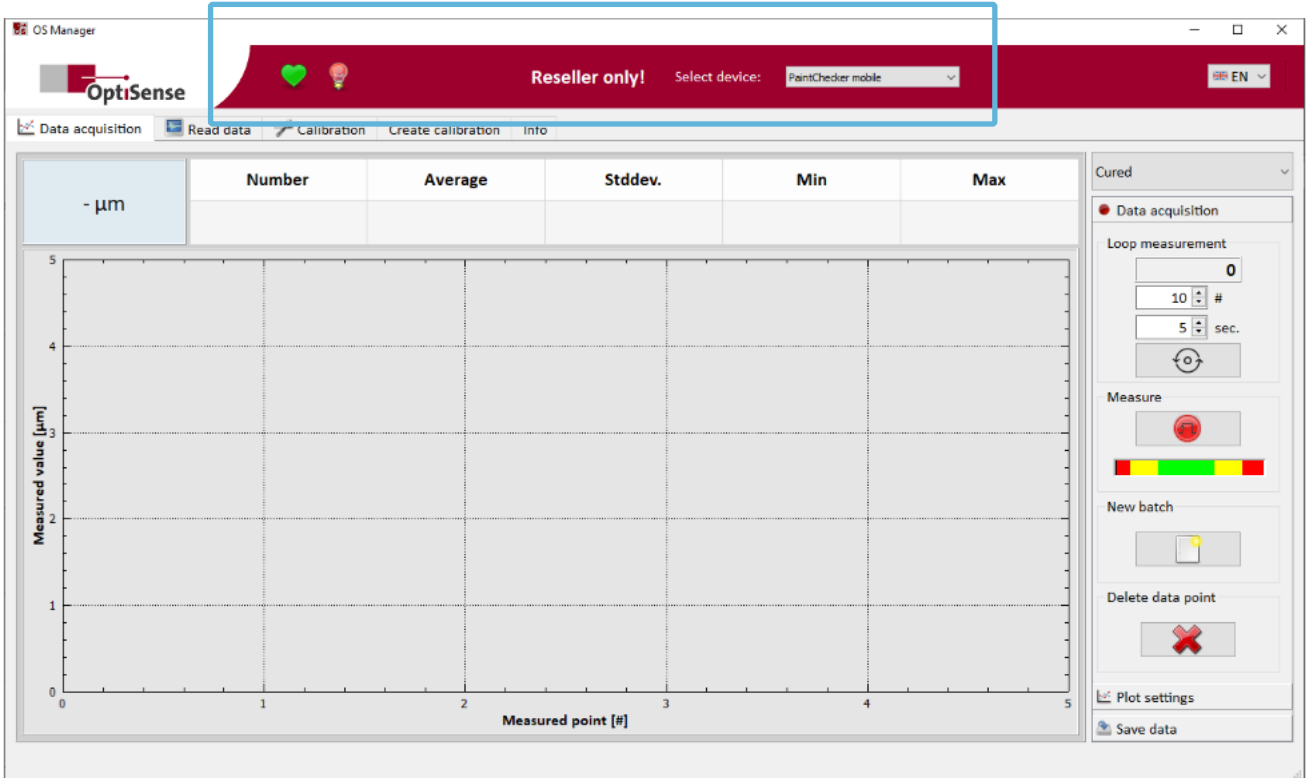


Figure 4: The OS Manager is ready to measure the coating thickness

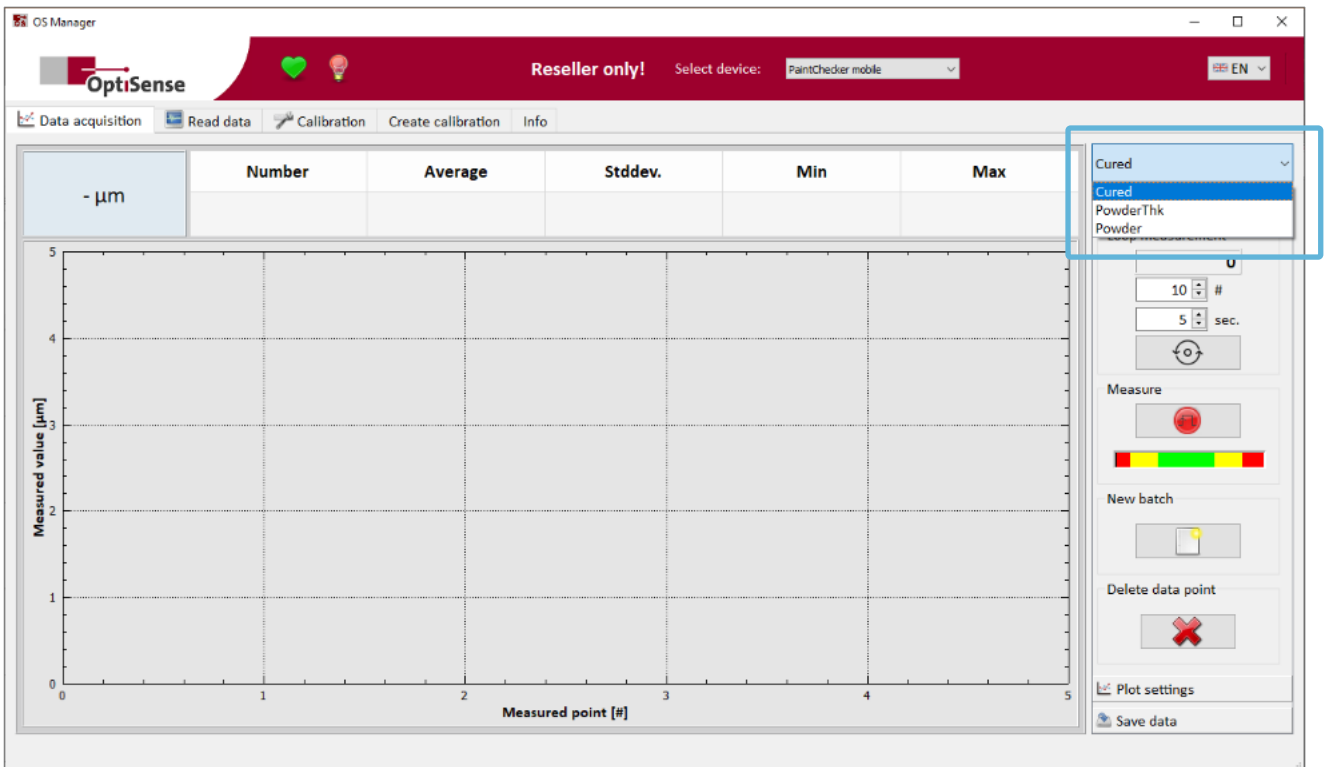


Figure 5: Selecting the application on the connected PaintChecker

### 7.3.2 Single measurements

After choosing an appropriate calibration, a click on the *Measure* button starts the measurement. The measuring process is similar to manual measurement with the PaintChecker Controller:

- Aim the sensor at the target
- Align the three lights of the sight at the desired measuring spot
- Start the measurement by clicking on the *Measure* button

**Note:** After some time of inactivity, the PaintChecker switches to power saving mode, where the three lights of the sight only flash briefly instead of being permanently lit. Before taking another measurement, click the *Measure* button once to exit power saving mode.

### 7.3.3 Loop measurement

Series measurements on several parts or the recording of a measurement grid are supported by the Loop measurement mode, where an adjustable num-

ber of measurements are performed automatically at a selectable time interval. During Loop measurement, the measuring head can be manually guided from part to part or point to point with one measurement taken at a time.

To perform a Loop measurement, first select the number of measurements and the time interval between two measurements in the two corresponding controls.

Check if the three lights of the sensor sight are permanently on. If not, click the *Measure* button once to exit power saving mode and activate the sight.

Click on the *Start loop measurement* button to start loop measurement. The loop counter counts up and the recording stops automatically after the specified number of measurements have been taken. Clicking the button again starts another loop measurement.

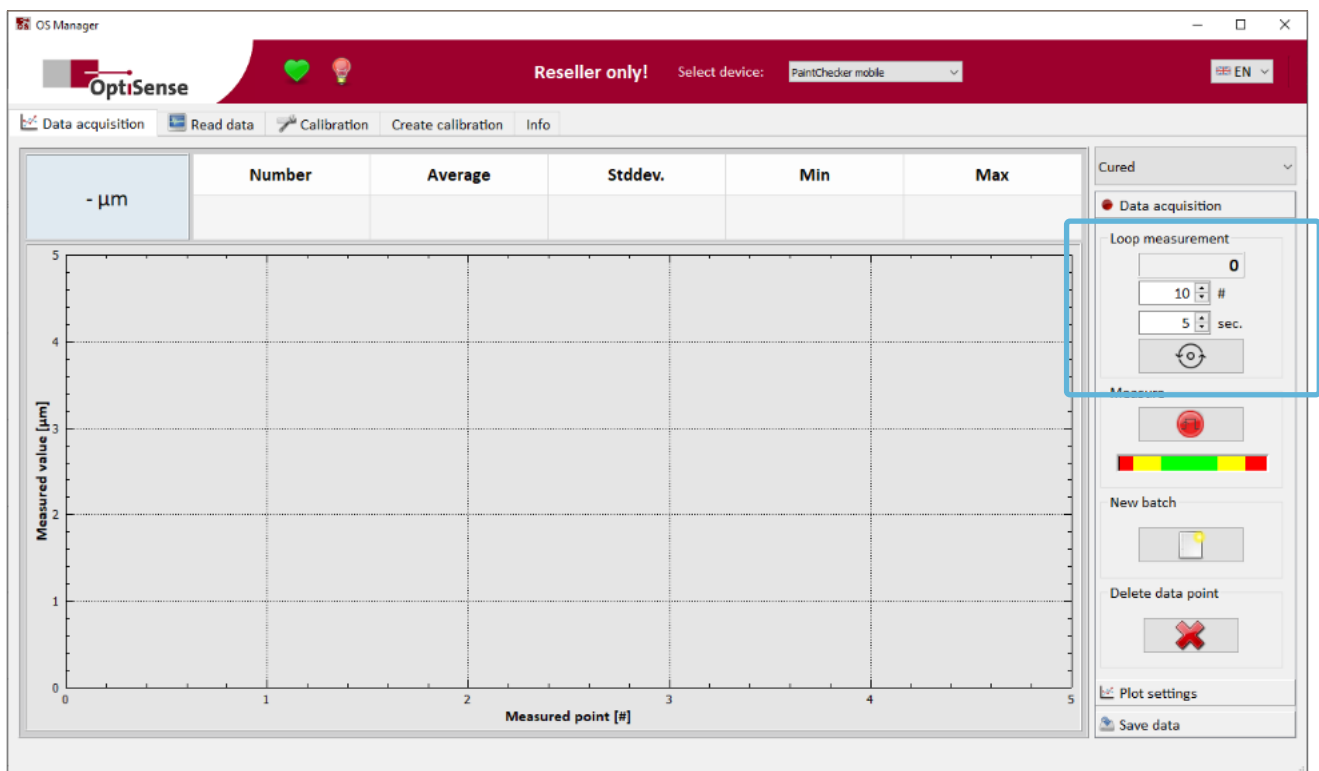


Figure 6: A loop measurement is started by clicking on the START LOOP MEASUREMENT button

### 7.3.4 Statistics

The statistical parameters of the measurement batch are displayed at the top of the diagram area. The values indicated have the following meaning:

The statistical parameters always refer to all measurements of the batch, even if a part of the batch is hidden (see 7.7).

Value	Description
Number	The number of measuring points
Average	The arithmetic mean of the measuring points
Stddev.	The variation of the measuring points around the mean value (standard deviation)
Min	The measuring point with the least coating thickness
Max	The measuring point with the largest coating thickness

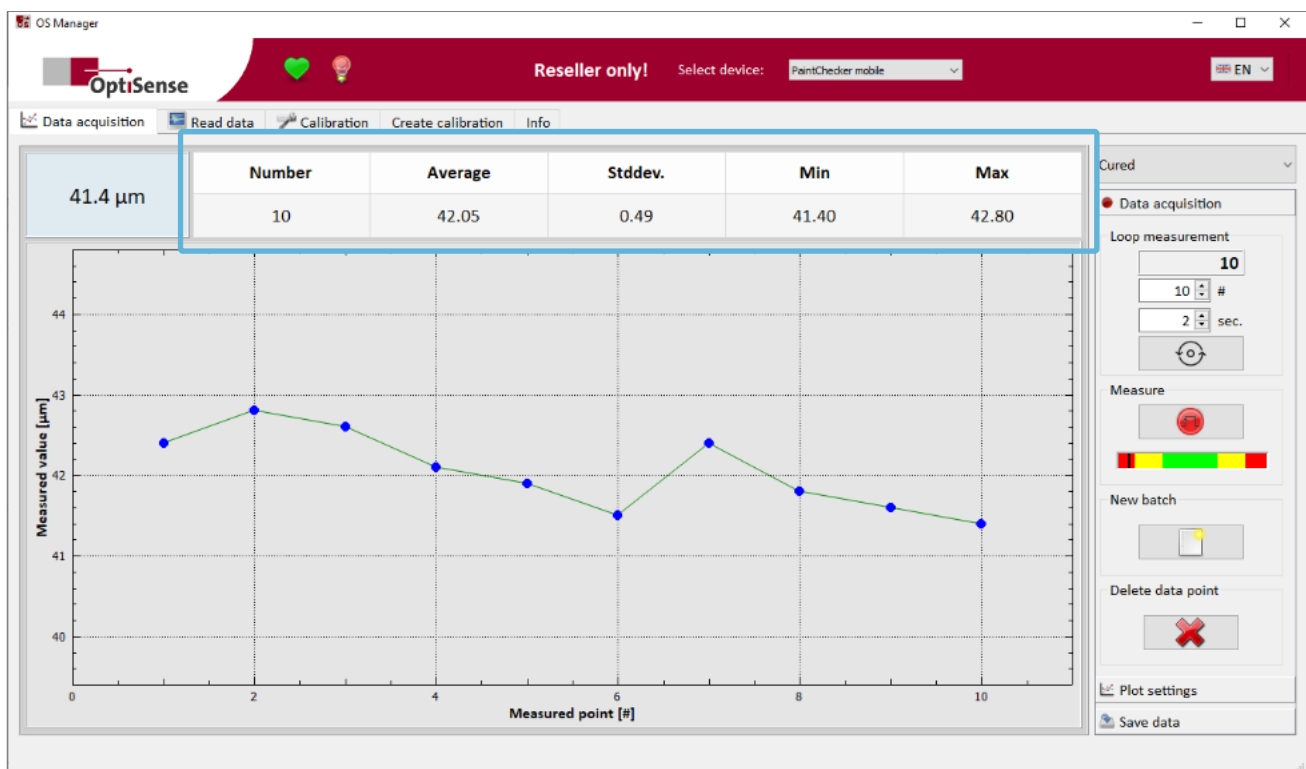


Figure 7: The statistical parameters are displayed at the top of the diagram area

### 7.4 The line chart

The values of a measurement batch are displayed in the diagram pane as a line chart connecting the measurement points. The index number of the measurement is plotted on the X-axis and the coating thickness on the Y-axis. If a measurement is taken, the measured coating thickness is displayed in the upper left corner and another point is added to the line chart at the right end.

If you move the mouse pointer close to a measuring point in the diagram (Roll-over), the measured coating thickness and the time of measurement are displayed next to the point.

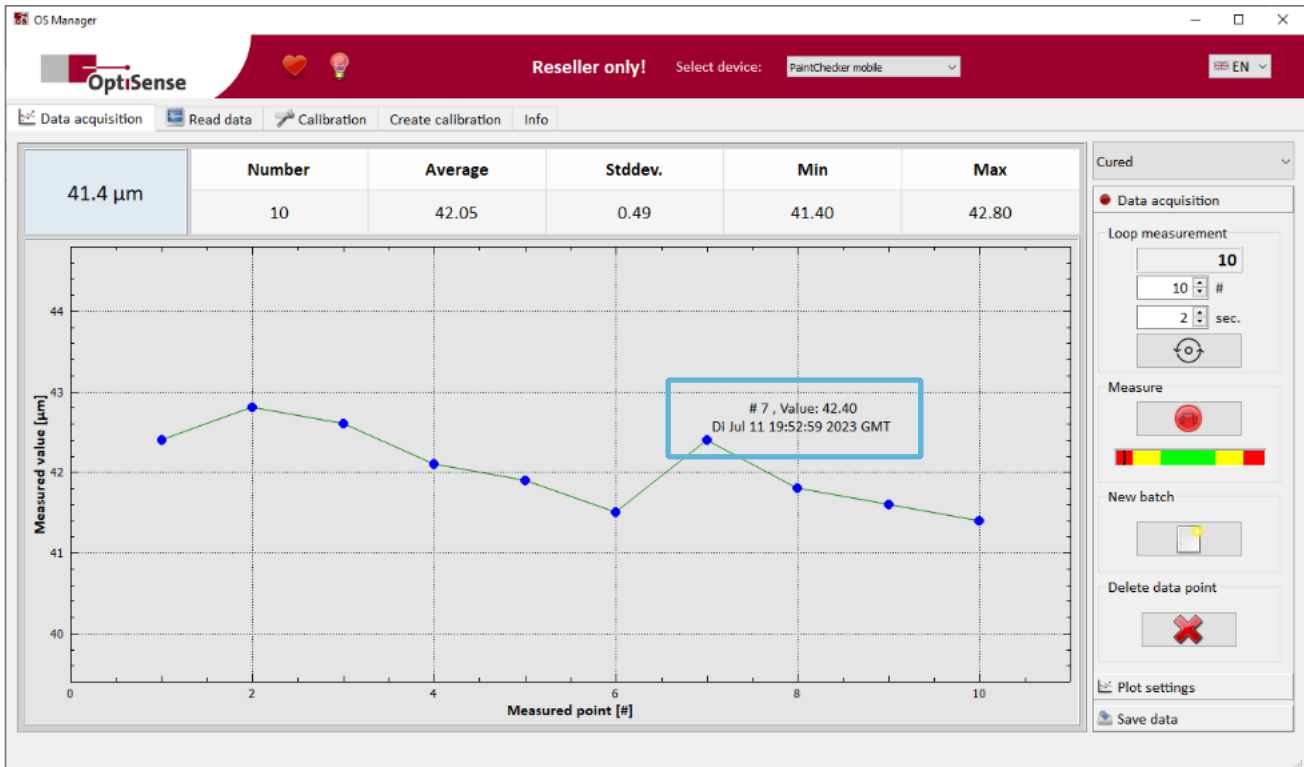


Figure 8: Current measured value and details of a measuring point

### 7.4.1 Zoom

For more detailed investigations, the line chart of the measurement batch can be enlarged (zoomed). To zoom in, left-click in the diagram and drag a selection box in the diagram area by holding down the mouse button. Releasing the button will zoom into the selected region.

Right-clicking the mouse resets the line chart to display all points of the measurement batch.

### 7.4.2 Delete measuring points

Click the *Delete data point* button to remove the last measured point. Several measurements can be deleted by pressing *Delete data point* button multiple times. This always removes the last, rightmost point of the line diagram.

Clicking the *New batch* button deletes all points in the diagram and starts a new batch. Before creating a new, empty batch, the OS Manager offers to export any existing measurements to a file on the PC or to finally discard the values.

### 7.4.3 Display a subsection

With a large number of measurements, displaying all points of a batch in the line chart can easily become confusing. In this case, you can limit the display range

to the last measurements taken by using the *Plot settings*.

Click the *Plot settings* tab in the operating panel, tick the *Display mode* checkbox and enter the number of measuring points to be displayed in the input control. Instead of entering a number, you can increase or decrease the number of points to show step by step using the up/down arrows of the input control.

Each change needs to be confirmed with the *Enter* key to take effect. The settings remain effective for all further measurements even after exiting the *Plot settings* tab. To return to displaying all points of the batch, uncheck *Display mode* in the *Plot settings*.

### 7.5 Saving a measurement batch

The measured values can be saved as a file on the PC using the *Save data* tab in the operating panel. The file can be saved in PDF or CSV format.

The CSV format is particularly suitable if the measured values are to be further processed with another application, e.g. Microsoft Excel. Most databases and measurement data processing tools can import CSV files.

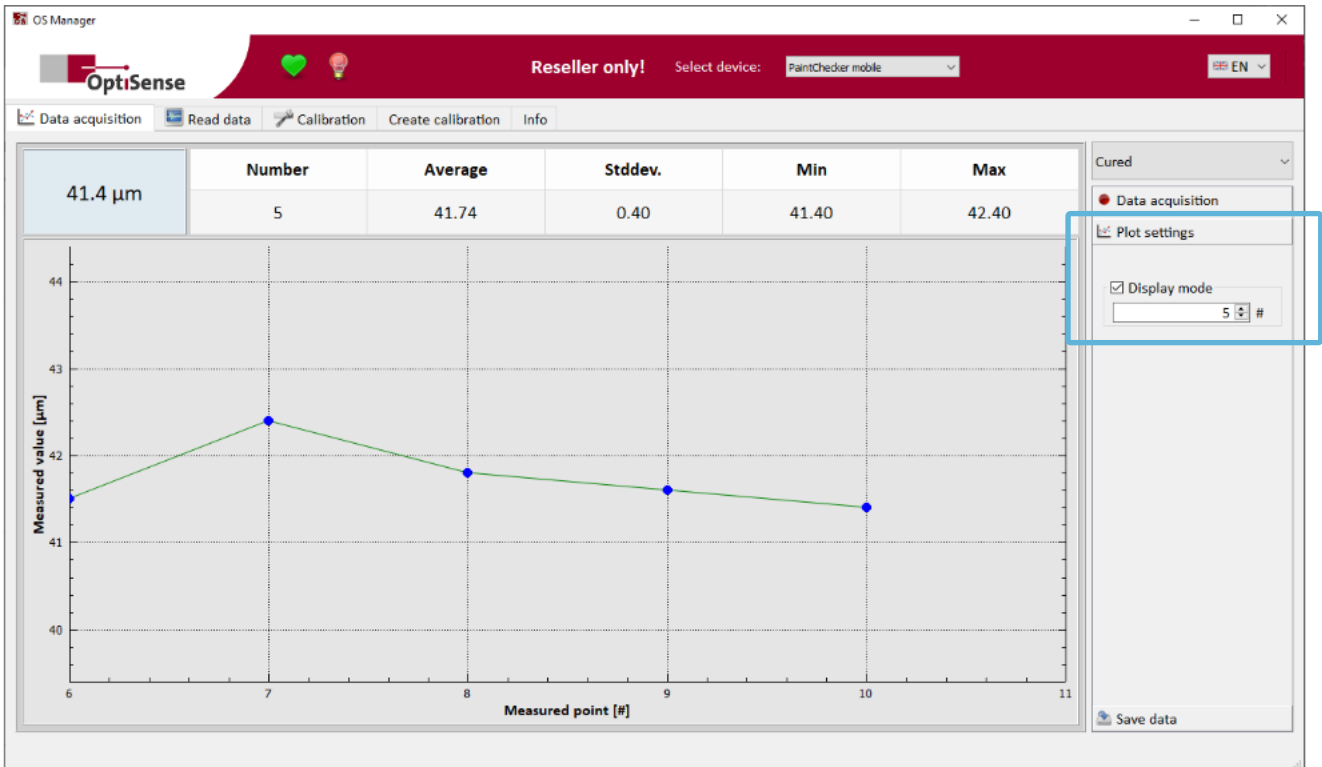


Figure 9: The Plot settings for choosing the points to be displayed

The PDF format is particularly suitable for creating reports that are to be printed or archived. When saving in PDF format, the OS Manager will ask for a report title which will be added to the header of the report.

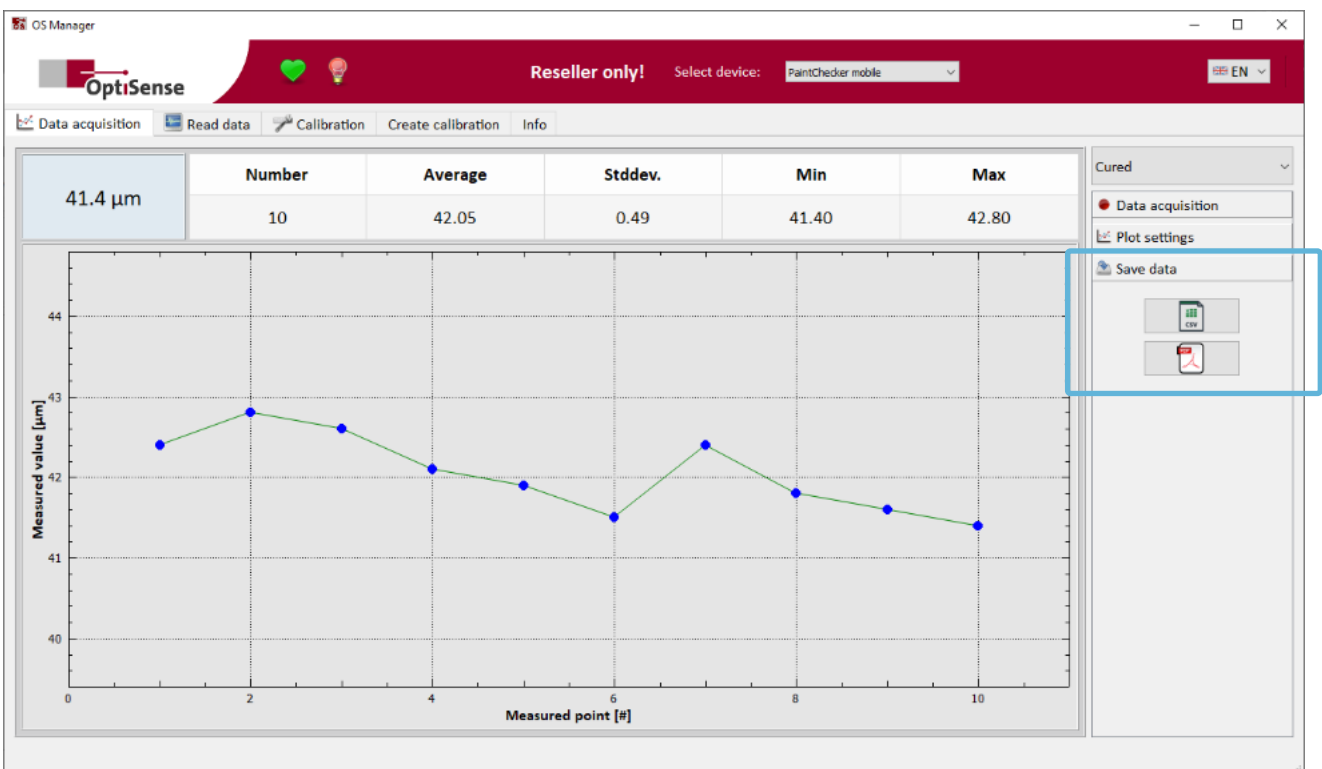


Figure 10: Saving a measurement batch

## 7.6 Managing measurement batches

The PaintChecker Mobile devices can record measurement batches stand alone without connection to a PC. This allows the coating staff to take measurements directly at the line, which are stored as batches internally in the device.

With the *Read data* tab in the Action pane, these stored batches can be imported in order to visualize and analyze them in the OS Manager or to archive them as a file on the PC.

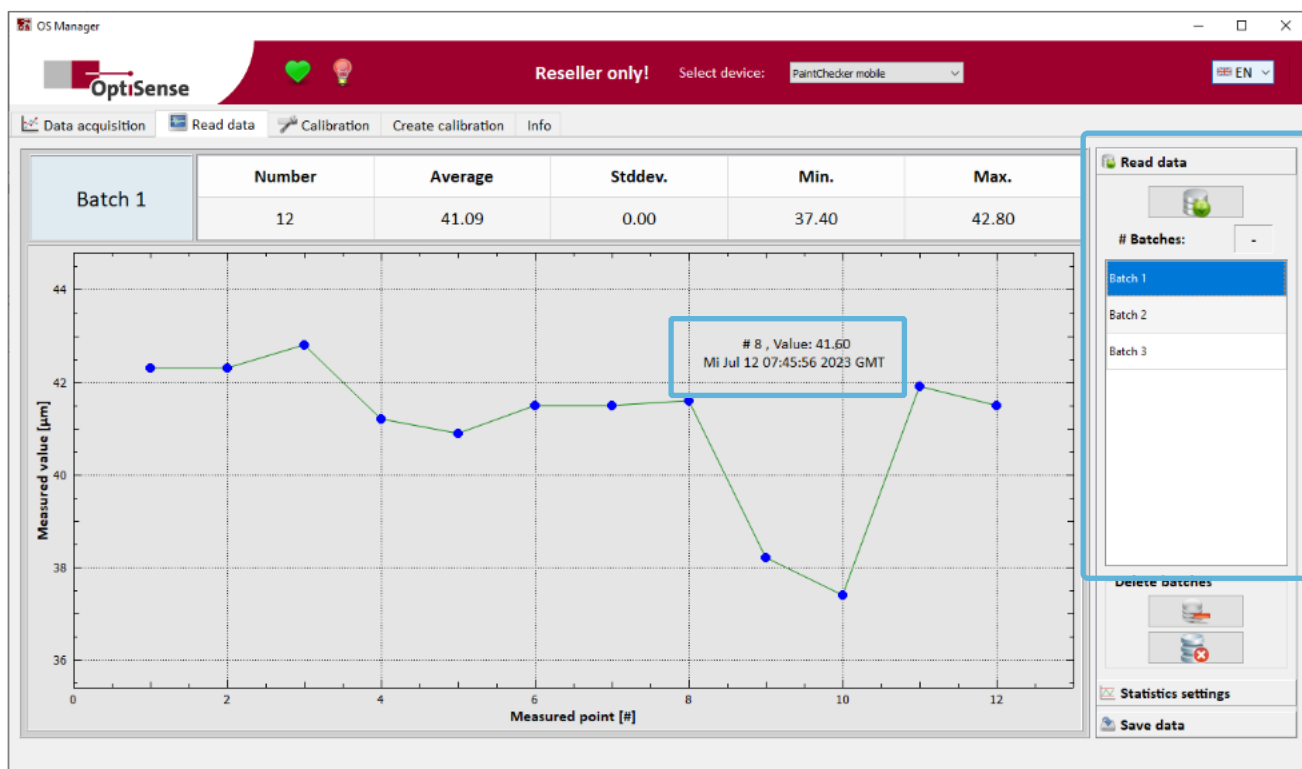


Figure 11: In the *Read data* tab, measurement batches can be imported from the PaintChecker

### 7.6.1 Importing a batch

Clicking on the *Read data* tab in the operating pane displays a list of the measurement batches stored on the connected PaintChecker. The batches are numbered in the order in which they were recorded.

Click on a batch in the list to import and display the recorded measurement values as a line chart in the diagram pane. By clicking on different items in the list, you can quickly switch between the charts of different batches, e.g. for making visual comparisons.

If you move the mouse pointer close to a measuring point in the diagram (rollover), the measured coating thickness and the time of measurement are displayed next to the point.

### 7.6.2 Zoom

For more detailed investigations, the line chart of the measurement batch can be enlarged (zoomed). To zoom in, left-click in the diagram and drag a selection box in the diagram area by holding down the mouse button. Releasing the button will zoom into the selected region.

Right-clicking the mouse resets the line chart to display all points of the measurement batch.

### 7.6.3 Messreihen löschen

The batches stored in the connected PaintChecker can be deleted in the *Read data* tab in the operating panel. Click in the list on the batch to be deleted and then on the upper button *Delete selected batch*. The measurement batch will be immediately deleted without further confirmation dialog.



The lower *Delete all batches* button removes all batches stored on the connected PaintChecker.

**Note:** Batches are permanently deleted. There is no way to restore a deleted batch.

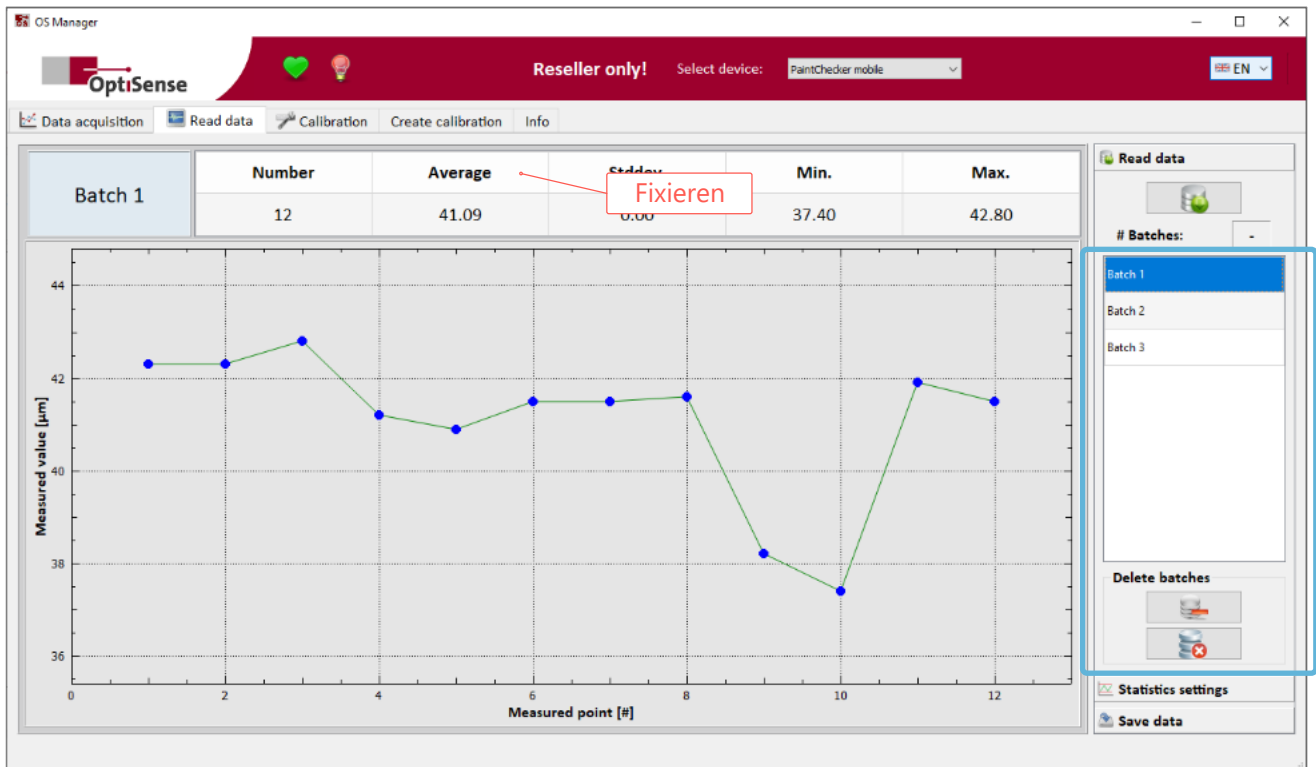


Figure 12: Deleting measurement batches on the connected PaintChecker

### 7.6.4 Statistics

The statistical parameters of the measurement batch are displayed at the top of the diagram area. The values indicated have the following meaning:

Additional statistical figures are available by clicking the *Statistics settings* tab in the operating panel.

Value	Description
Number	The number of measuring points
Average	The arithmetic mean of the measuring points
Stddev.	The variation of the measuring points around the mean value (standard deviation)
Min	The measuring point with the least coating thickness
Max	The measuring point with the largest coating thickness

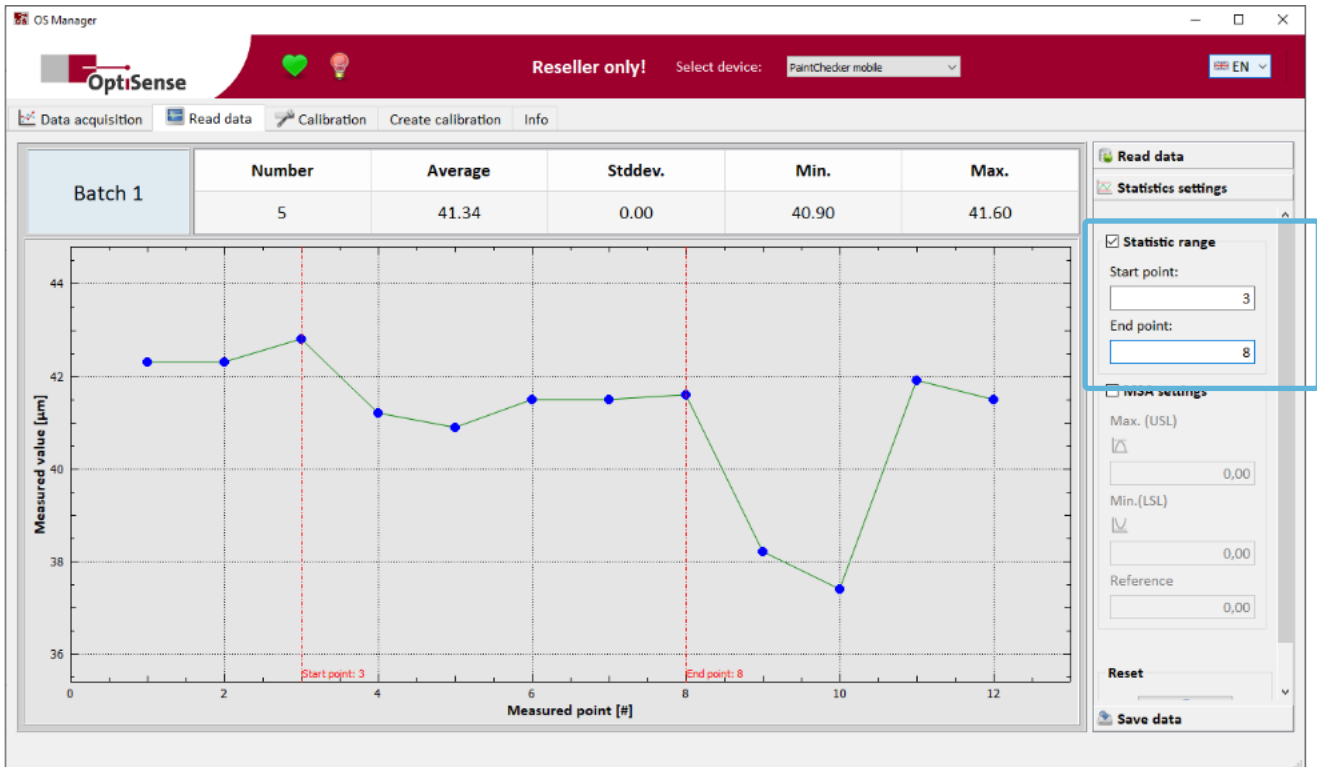


Figure 13: Statistics of a batch subrange

### 7.6.5 Statistic range

As a rule, the statistical parameters are calculated from all points of the measurement batch. However, by selecting a *Statistic range*, the calculation can be limited to a subset of the batch. Tick the *Statistics range* checkbox and enter the index number of start point and end point of the desired subrange in the *Start point* and *End point* inputs. The boundaries of the selected subrange are shown as vertical red lines in the diagram pane.

### 7.6.6 Measurement system analysis

Further statistical parameters can be determined using Measurement system analysis (MSA). Tick the *MSA settings* checkbox and enter the upper and lower limits as well as the target value of the coating thick-

ness in the *Max (USL)*, *Min (OSL)* and *Reference* inputs. The coating thickness boundaries are represented by horizontal red lines in the diagram pane.

**Note:** *Statistic range* and *MSA settings* can be combined to analyze only a subrange of the measurement batch.

Value	Description
Reference	The nominal value of the coating thickness
Cp	The process capability index Cp
Cpk.	The process capability index Cpk
#Outlier	The number of points exceeding the tolerance range defined by <i>Min (USL)</i> and <i>Max (OSL)</i>

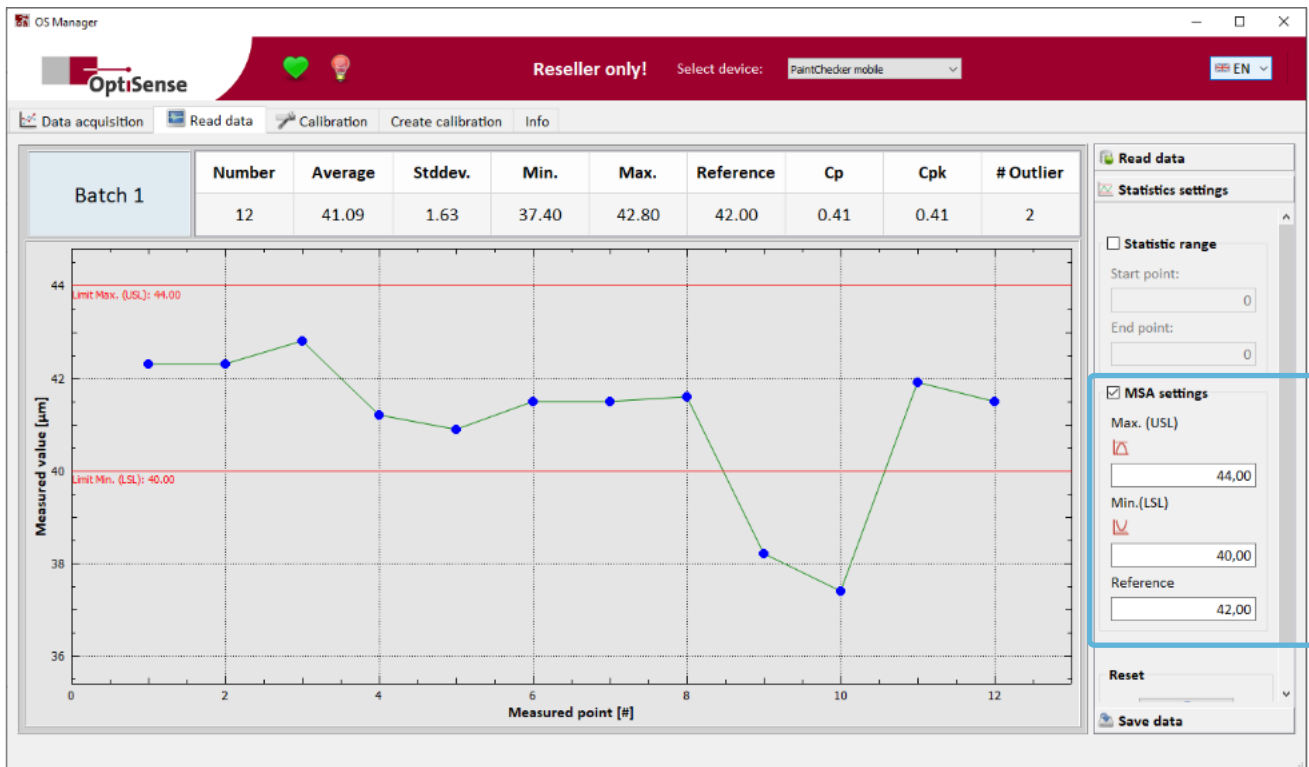


Fig. 14: Coating thickness limits and MSA parameters

## 7.7 Save imported measurement batch

The imported and optionally analyzed measurement batch can be saved as a file on the PC using the *Save data* tab in the operating panel. The file can be saved in CSV and PDF format.

The CSV format is particularly suitable if the measured values are to be further processed with another application, e.g. Microsoft Excel. Most databases and measurement data processing tools can import CSV files.

The PDF format is particularly suitable for creating reports that are to be printed or archived. When saving in PDF format, the OS Manager will ask for a report title which will be added to the header of the report. The Statistic range, MSA settings and process capability indices are also included in the report.

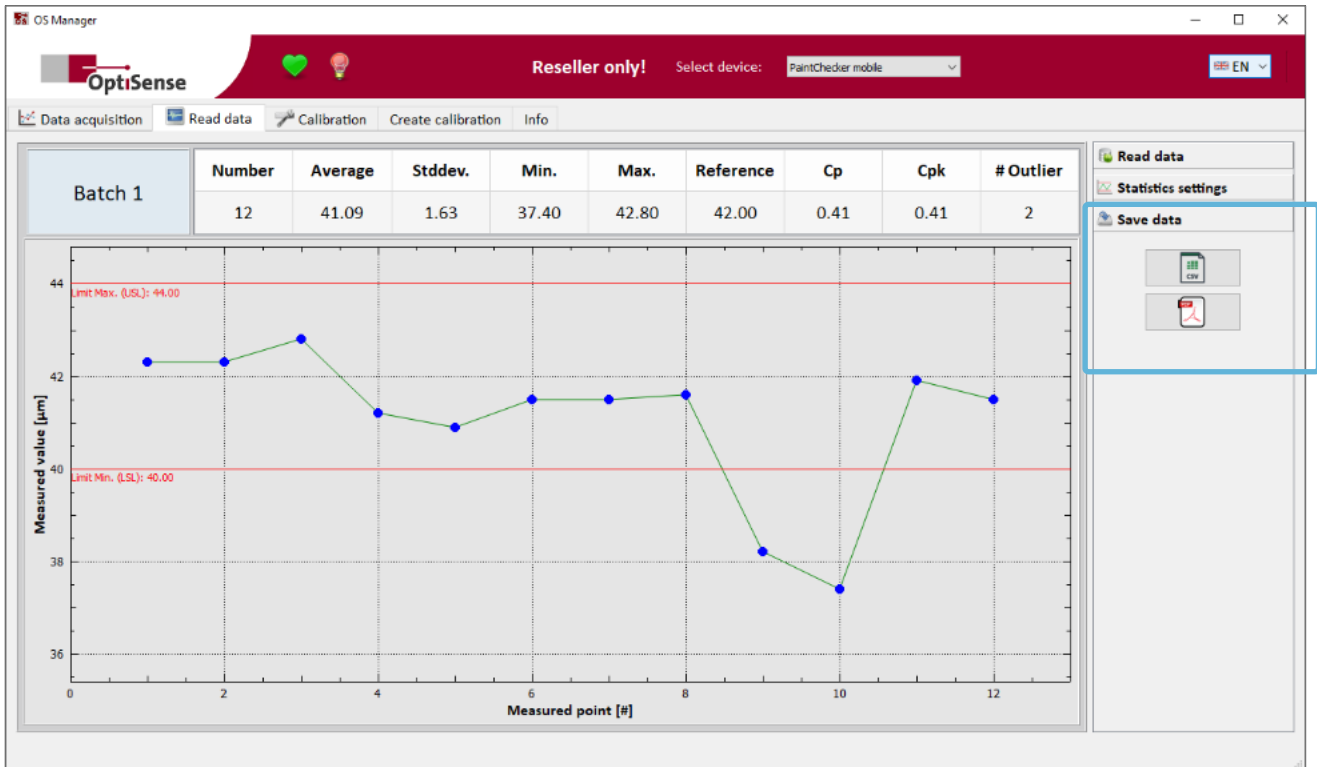


Figure 15: Saving an imported batch

## 8. Calibrations

### 8.1 Overview

The PaintChecker Mobile devices from OptiSense use the photothermal method for coating thickness measurement. This is a contactless measurement method for paints, powder coatings and glazes on metallic and non-metallic substrates. The different thermal properties of coating and substrate are used to determine the coating thickness.

#### 8.1.1 The photothermal method

The surface of the coating is warmed up by a few degrees with a short, intense light pulse and then cools down again by dissipating the heat into deeper areas. The thinner the coating, the faster the temperature drops. The temperature curve over time is recorded with a highly sensitive infrared sensor and converted into the coating thickness.

The measurement is carried out without contact from a distance of several centimetres. This means that wet and sticky coatings can be measured just as easily as soft and sensitive surfaces.

As with other non-destructive coating thickness measurement methods, e.g. ultrasonic, eddy current or induction, photothermal coating thickness is not measured directly, but calculated from measurement signals. It is therefore important to consider the individual thermal properties of the coating material and the substrate.

#### 8.1.2 Material specific calibration

Thick, heavy coatings need more energy to heat up and cool down more slowly than thin, light coatings. During the measuring process, it is therefore important, as in photography, that the strength of the light source and the measuring time are optimally adjusted to the respective situation, in order to obtain accurate and reproducible measurement results.

in case of powder coatings and paintwork, the user often does not want to know the thickness of the powder or wet film that has just been applied, but the later, final thickness after baking or drying. To achieve this, the device must take into account the expected shrinkage of the coating material during curing.

Optimum power level, measurement time and number of measurement cycles as well as the correlation between thermal behavior and thickness of the coating are compiled in so-called calibrations.

Included with the PaintChecker devices are several calibrations for standard situations that cover a wide range of typical applications.

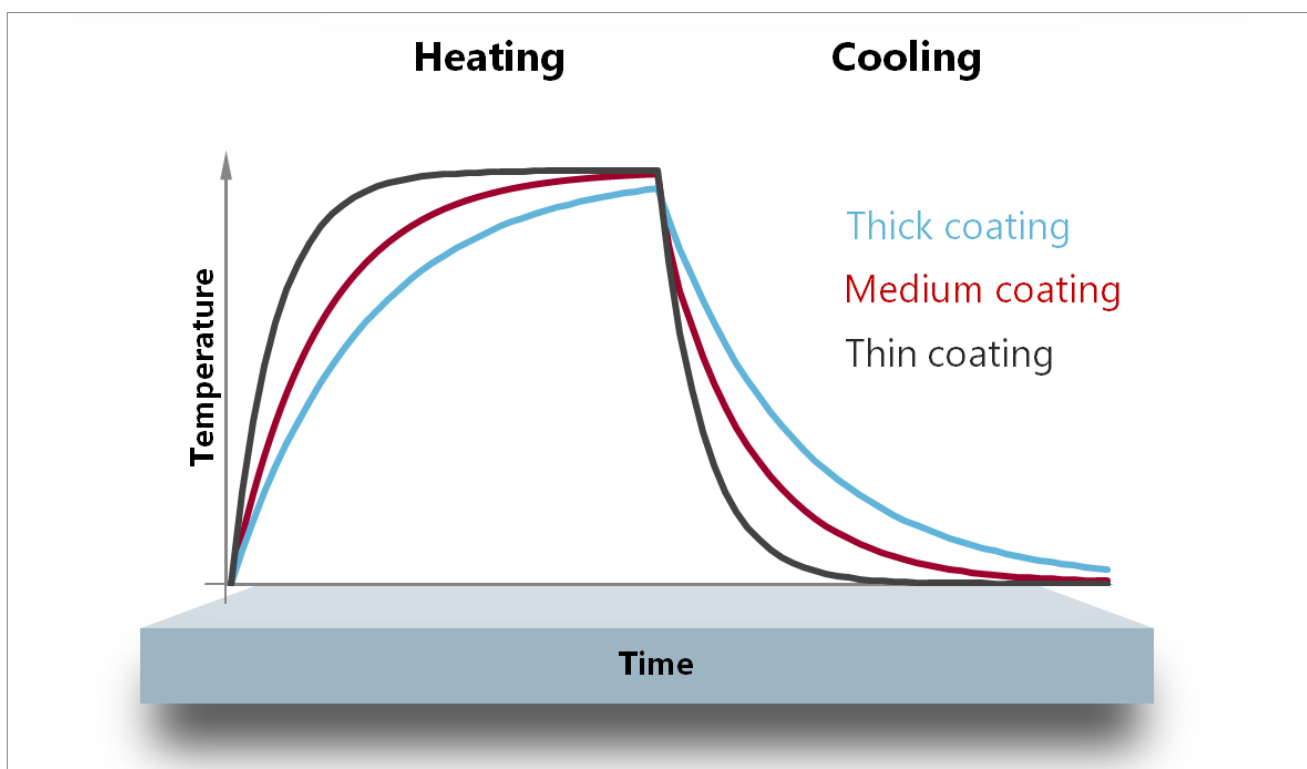


Bild 1: Das photothermische Messprinzip

### 8.1.3 Creating a calibration

Creating a calibration is a multi-step process. First, the basic parameters of the photothermal measurement system have to be set so that it provides reproducible and well-distinguishable raw signals at different coating thicknesses while heating the parts sufficiently but not excessively.

In the next step, actual coating thickness values are assigned to the raw signals. This is done in the form of grid points, which are pairs of raw signal (measured value) and the associated coating thickness. The OS Manager then calculates a calibration curve that approximates these grid points as close as possible.

Finally, measurement parameters and calibration curve are combined into a calibration and transferred to the PaintChecker measurement device.

The PaintChecker uses this calibration to calculate all intermediate values of the coating thickness between the grid points.

### 8.2 Managing calibrations

Calibrations are managed in the *Calibration* tab. It contains two workspaces, the calibration table with the calibrations available on the connected PaintChecker and the calibration properties with the parameters of the respective calibration.

#### 8.2.1 Calibration table

The PaintChecker devices can store up to 20 different calibrations. The 20 cells of the calibration table (1) are assigned to these storage locations. When connecting a PaintChecker, the OS Manager reads out the calibrations available on the instrument and displays them in the calibration table by their name. Write-protected calibrations are marked with a lock symbol and cannot be changed. You can fill the empty cells of the calibration table with your own calibrations.

With the three buttons located above the calibration table you can organize the content of the table, i.e. import a calibration from a file on the PC, export it as a PC file and delete it from the PaintChecker.

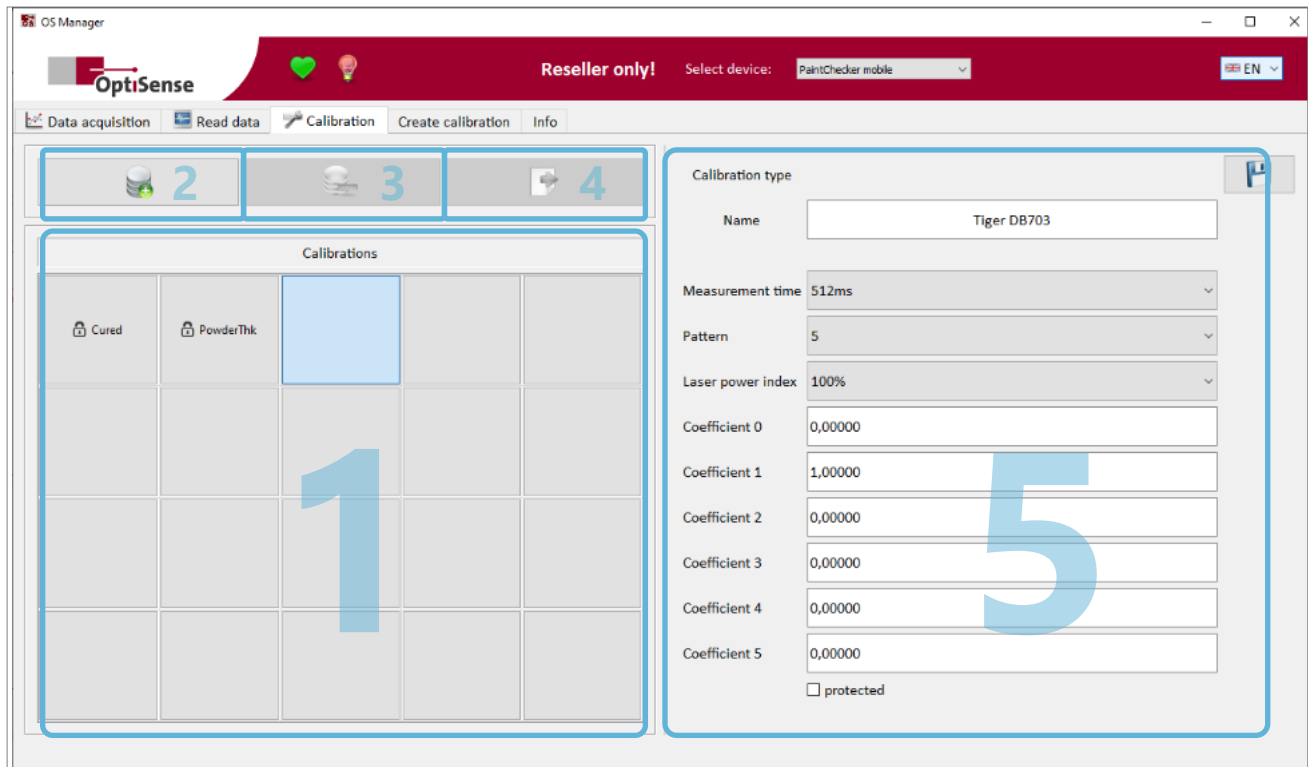


Figure 17: The CALIBRATION tab for managing calibrations

### 8.2.2 Import a calibration from file

Calibrations are saved on the PC as files with a *.opt* extension. To import a calibration from the PC to the connected PaintChecker, first select the next free, empty cell in the calibration table (1) and click the *Import calibration* button (2).

The Windows file dialog appears, where you select the file to be imported and click *Open* to confirm. The calibration is loaded, transmitted to the connected PaintChecker and included in the calibration table.

### 8.2.3 Delete a calibration

To delete a calibration from the connected PaintChecker, select the corresponding cell in the calibration table and click the *Delete Calibration* button (3). After confirming the safety prompt, the calibration is deleted from the device and removed from the calibration table.

Please note that write-protected calibrations can also be deleted.

### 8.2.4 Export a calibration as a file

Calibrations can be saved as *.opt* files on the PC for archiving purposes or to distribute them to other PaintChecker users. To export a calibration, first select the corresponding cell in the calibration table (1) and then click the *Export Calibration* button (3). The Windows file dialog appears, allowing you to enter a file name and save the calibration as an *.opt* file.

### 8.3 Adjusting the measurement parameters

If no suitable calibration is available for a particular combination of coating material and substrate, a new calibration must be created. First, the basic parameters of the photothermal measurement system need to be adjusted to provide reproducible and distinct raw signals at different coating thicknesses while heating the samples sufficient but not excessive.

Creating a new calibration and setting the photothermal measurement system parameters is performed in the *Calibration* tab.

Select the next free, empty cell in the calibration table (1) and enter a name in the *Name* field in the calibration properties (5). Since the new calibration contains only the photothermal measurement system parameters, the following naming convention has proven useful:

TaaaPbbXccc  
(having the following meaning:)

For the calibration shown in Figure 18, this results in the name T512P5X100.

The next step is to set suitable parameters for the photothermal measurement system. The aim is to obtain well distinguishable raw signal values for different coating thicknesses without overheating the samples. Enter suitable initial values for measurement time, measurement pattern and laser power.

Value	Description
T	Measurement time in milliseconds (64 - 4096)
P	Excitation pattern (1 - 25)
X	Laser power index in percent (12, 25, 50,75, 100 without decimal places)

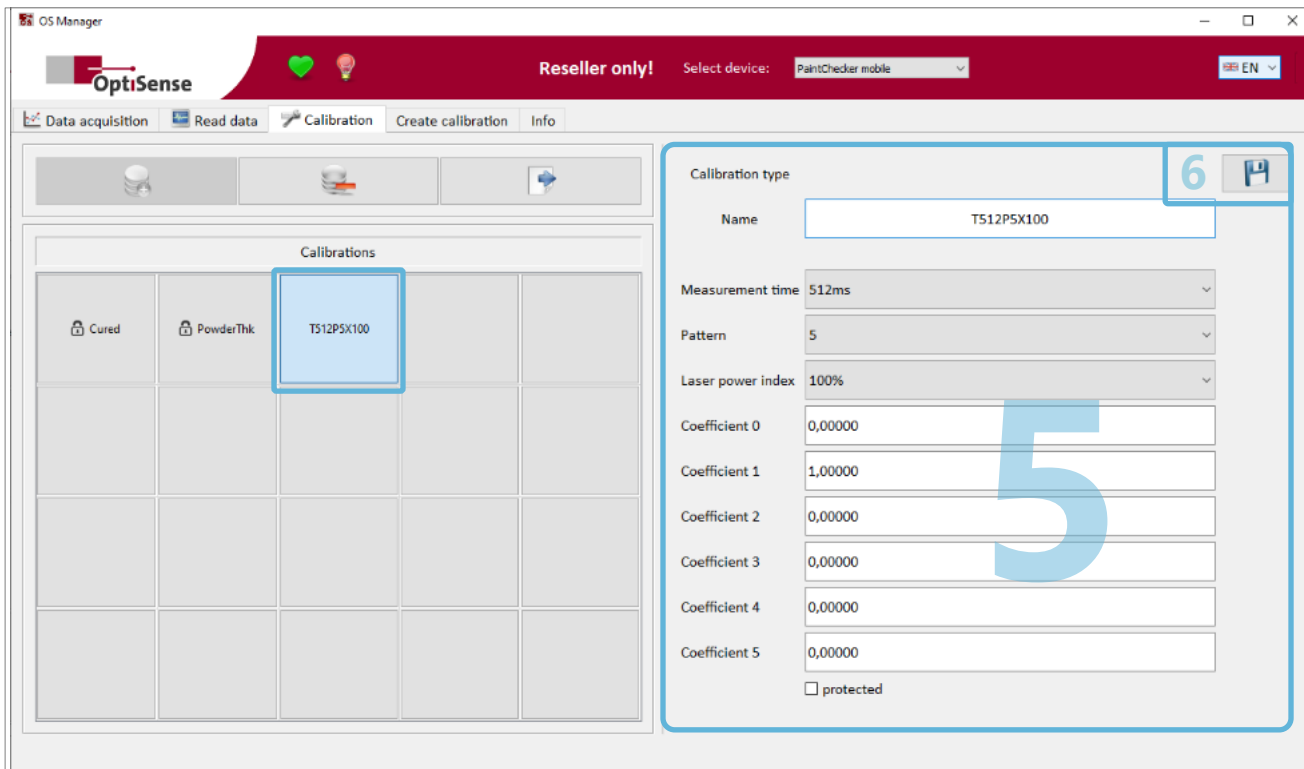


Figure 18: Setting the photothermal measurement system parameters

The values shown are well suited as starting points for most coatings. However, for temperature-sensitive samples, you should begin with reduced laser power.

Then transfer the parameters to the PaintChecker by clicking *Apply changes* (6). The new calibration is transferred to the calibration table at the same time.

### 8.3.1 Measurement time

The measurement time is the period of time during which the temperature curve of the part is recorded after excitation and used to calculate the coating thickness. Thick, heavy coatings react slower than thin, light coatings and therefore require a longer measurement time.

A suitable compromise between accuracy and measurement duration has to be found for the particular application, depending on the required measurement accuracy and the time available between two measurements.

### 8.3.2 Laser power

The laser power is the intensity of the light source heating the part in the focal point of the measuring system. The first generation of photothermal measuring instruments used a laser for excitation.

Therefore, the excitation power is called laser power; even if the excitation source is not a laser.

For stable, reproducible measurement results, the laser power should be selected so that the temperature rises as high as possible, without, however, damaging the coating. Therefore, when selecting the laser power, check the sample surface for damage after each measurement and reduce the excitation power in case of visible material changes.

### 8.3.3 Measurement pattern

You can use the *Pattern* control to specify whether the time span entered in the Measurement time control is used for one long measurement or whether the PaintChecker takes several short measurements and then averages the results.

E.g. if a number of 5 measurements is entered for a measuring time of 512 ms, the PaintChecker performs 5 measurements over 102.5 ms each and then calculates the average. The optimum measurement pattern depends on the surface properties of the coating.

### 8.3.4 Coefficients

The coefficients determine the relationship between the measured signal of the photothermal measurement system and the actual coating thickness. They



are calculated automatically in a second step based on coating samples. Leave the coefficients in the standard configuration shown (coefficient 1 : 1.0 and all others 0.0) during the setting of the measurement parameters.

ferent coating thickness. Mark these areas without covering them, e.g. with a ring sticker, and note the reference values of the coating thickness. The target is to find reference points for the entire coating thickness range to be measured later.

## 8.4 Finding suitable measurement parameters

### 8.4.1 Sample selection

To create or optimize a calibration, at least two samples with different coating thicknesses are required.

These samples must match both the coating (type of paint, pretreatment) and the substrate (material, thickness) of the series parts to be measured later. Ideally, you take some parts from the ongoing production for this purpose. Use a reference method, e.g. ultrasound or eddy current, to find areas with dif-



*Figure 19: Ring stickers marking the points where the reference coating thickness was measured*

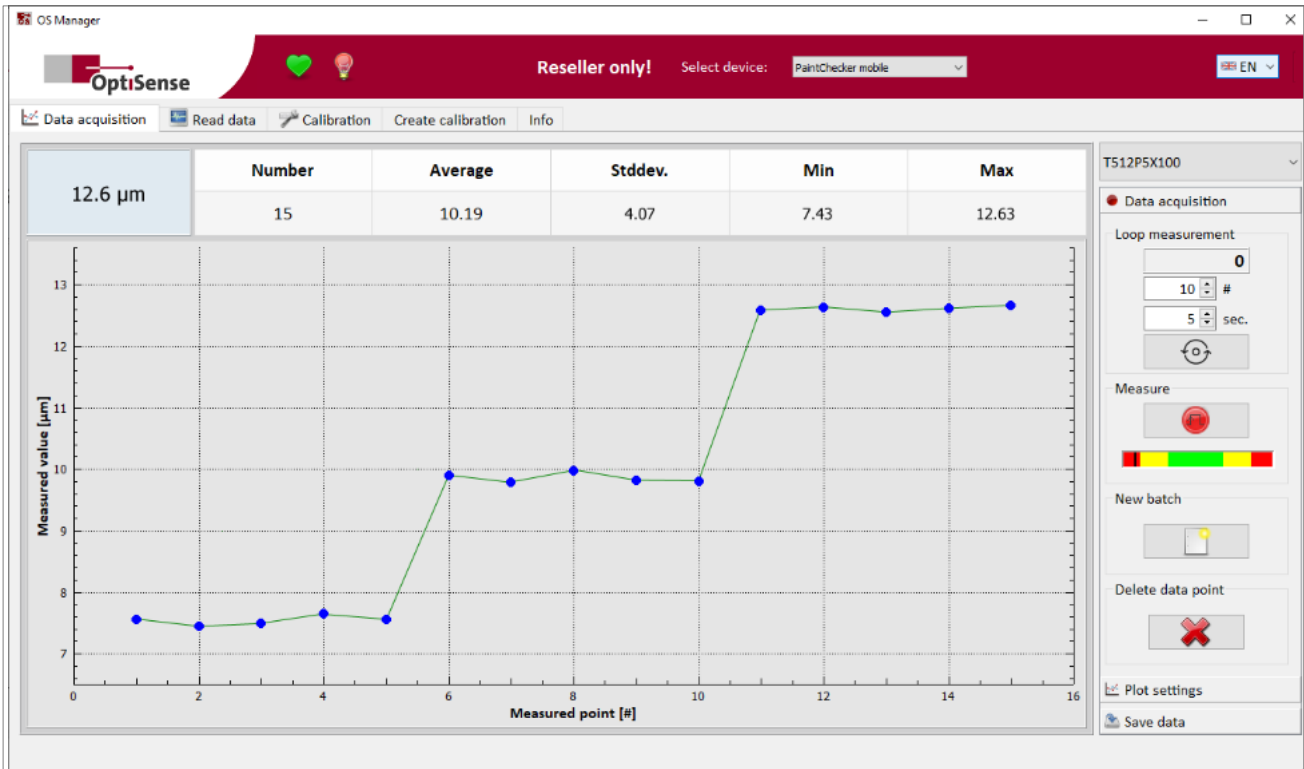


Figure 20: Suitable measurement parameters

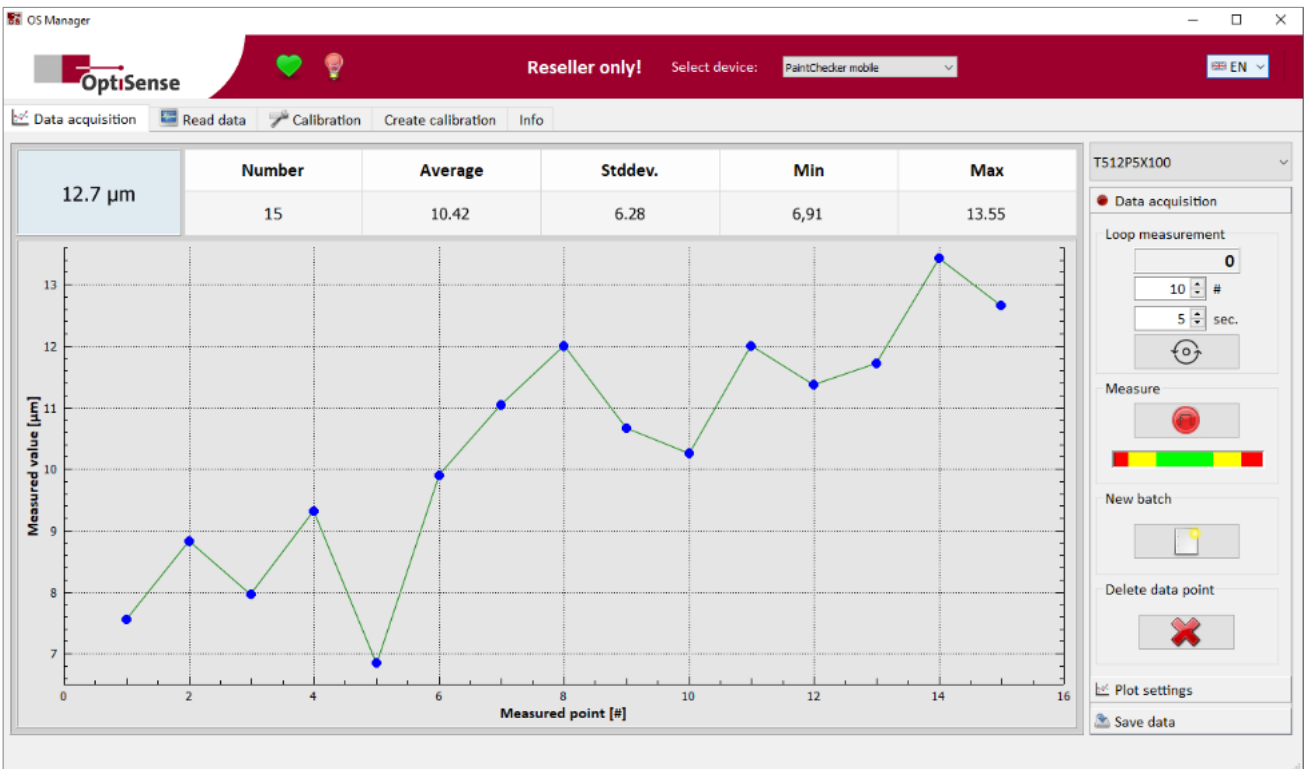


Figure 21: Unsuitable measurement parameters

### 8.4.2 Staircase chart

A staircase chart is well suited for the qualitative assessment of the measurement parameters. You first select the parameters (laser power, measure time and pattern) and then create a line chart from raw values of different reference points.

To create a staircase chart, switch to the *Data acquisition* tab in the action pane and select the new calibration you have just created. Then perform several measurements at the different reference points.

Suitable measurement parameters provide a chart with clearly distinguishable steps in staircase form. If the steps are hardly distinguishable or very uneven, the parameters are unsuitable for this application. In this case, switch back to the *Calibration* tab, edit and accept the measurement parameters and repeat the measurement of the staircase chart.

Please note that the staircase chart does not yet show the actual coating thickness. It is only used to evaluate the measurement parameters.

### 8.5 Create calibration curve

After suitable measurement parameters have been found, the calibration curve can be created. This is a curve that represents the relationship between the measured signal and the actual coating thickness. It takes the specific material properties of coating and substrate into account. In case of measurements before curing or baking, the calibration curve also includes the expected shrinkage of the coating material.

Calibrations initially apply only to the material combinations and measurement parameters with which they were created. However, the photothermal properties of many materials are so similar that the same calibration can be used. The basis for a calibration are at least two grid points. For each grid point, a coating sample is measured with a reference method and the reference value of the coating thickness is entered in a grid point table. The OS Manager connects these grid points by a curve, which is then used to measure the intermediate values.

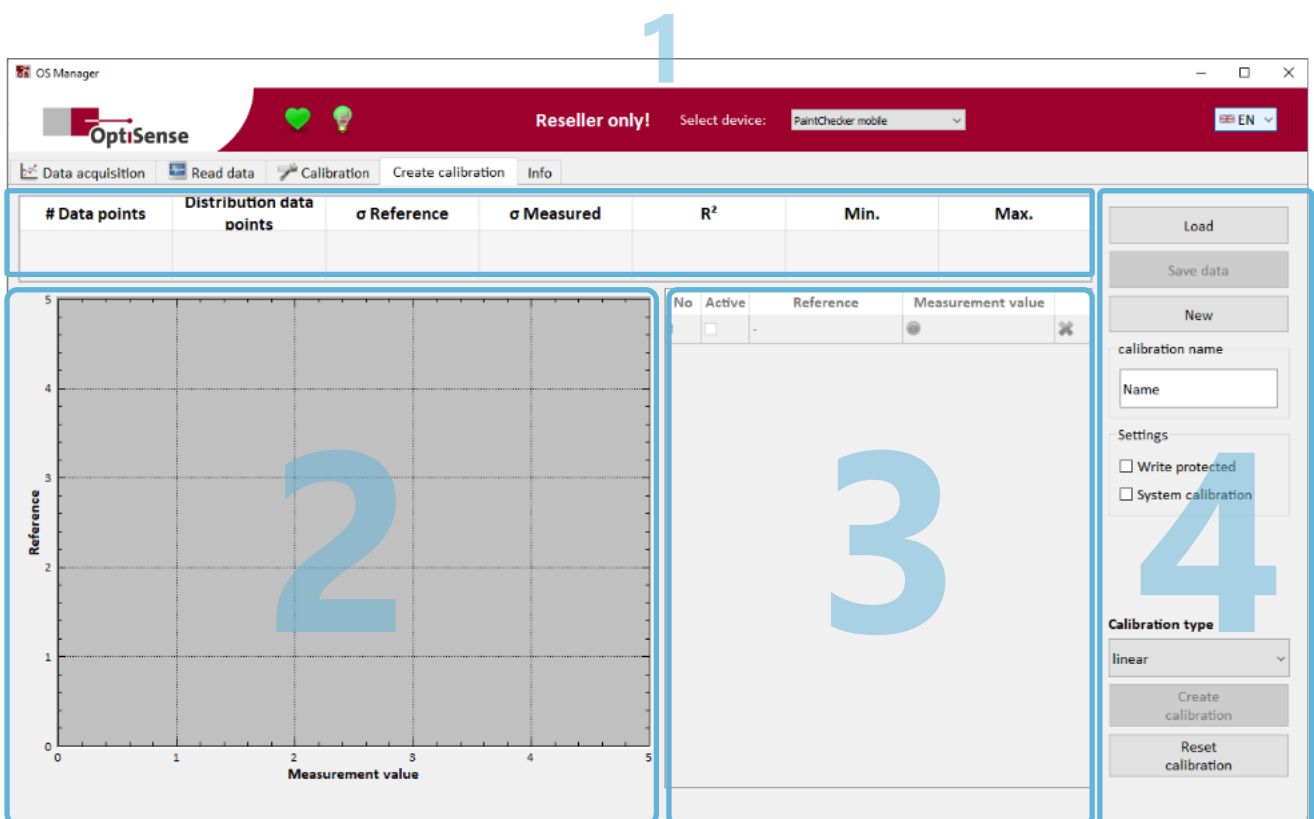


Figure 22: Calibration grid points are created in the CREATE CALIBRATION tab

The *Create calibration* tab in the Action pane is used to create the grid points. It contains four workspaces:

### 8.5.1 Statistics pane (1)

The quality of a calibration essentially depends on the accuracy and distribution of the calibration grid points. Several key figures are provided in the statistics pane to indicate the quality of the current grid point configuration. The statistical evaluation determines the quality (variance) of the grid points and provides information on how well the number and distribution of the grid points are suitable for the targeted coating thickness measurement range.

### 8.5.2 Diagram pane (2)

The grid points are displayed in an X-Y diagram in the diagram pane. A horizontal line runs through each point, whose length represents the spread (standard deviation) of the grid point. If at least two grid points are available, the OS Manager can calculate a calibration curve that optimally connects the grid points.

### 8.5.3 Grid point table (3)

The relationship between the photothermal measurement signal (raw signal) and the actual coating thickness is characterized by a calibration curve. This calibration curve is based on a collection of grid points measured with different material samples. These grid points can be created and organized in the grid point table.

The grid point table contains the grid points of a calibration. Each row of the table represents a single grid point or a material sample and contains the following columns:

### 8.5.4 Operating panel (4)

Calibrations are managed in the operating panel. Calibrations can be created as well as saved and loaded as files on the PC. The properties of the calibration such as name, write protection, class and type are also defined in the operating area.

Column	Description
1	No: Index number of the grid point
2	Active: If the box is checked, the calibration point is used for the calibration curve, otherwise not
3	Reference: Enter the actual coating thickness of the sample measured with a reference method. For measurements in the raw state, this is the coating thickness after curing or baking
4	Measurement value: The raw signal from the sensor of this sample. Activate this control by clicking with the left mouse button to receive raw signal values from the measurement

## 8.6 Capturing a grid point

Initially, the grid point table consists only of an empty row whose columns are grayed. The diagram pane is also still empty. Click the *New* button in the operating panel to create a new calibration curve. A window opens to select a template that contains suitable measurement parameters (see section 8.3).

Now prepare the first coating sample and click in the *Measurement value* column in the first row of the grid point table. A measurement window opens for gauging the first coating sample. Perform about 5 - 10 measurements on the coating sample. The raw signal values of the photothermal measuring system appear line by line in the measurement window. Make sure that the measured values are stable. Erroneous measurements can be deleted by clicking the red cross behind the measured value. Finally, click *Ok* to transfer the measurement to the grid point table.

Now click in the *Reference* column of the first row of the calibration table. A reference value window opens to enter the actual coating thickness of the first coating sample.

Here you can either directly enter the coating thickness of the coating sample measured with a reference method and its standard deviation or, alternatively, several reference measurement values, from which the mean value and standard deviation are calculated automatically. Incorrect entries can be deleted by clicking the red cross behind the value. Finally, click *Ok* to transfer the reference value to the grid point table.

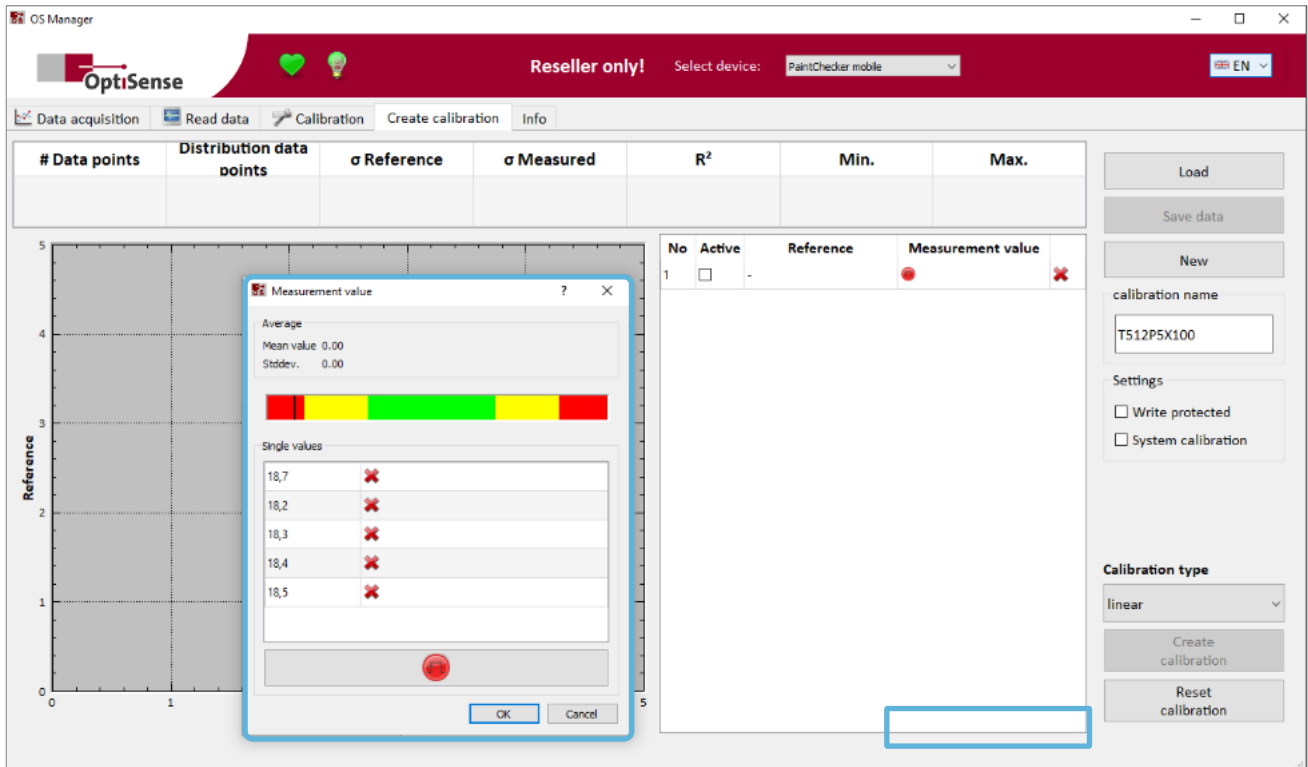


Figure 23: Measuring a coating sample

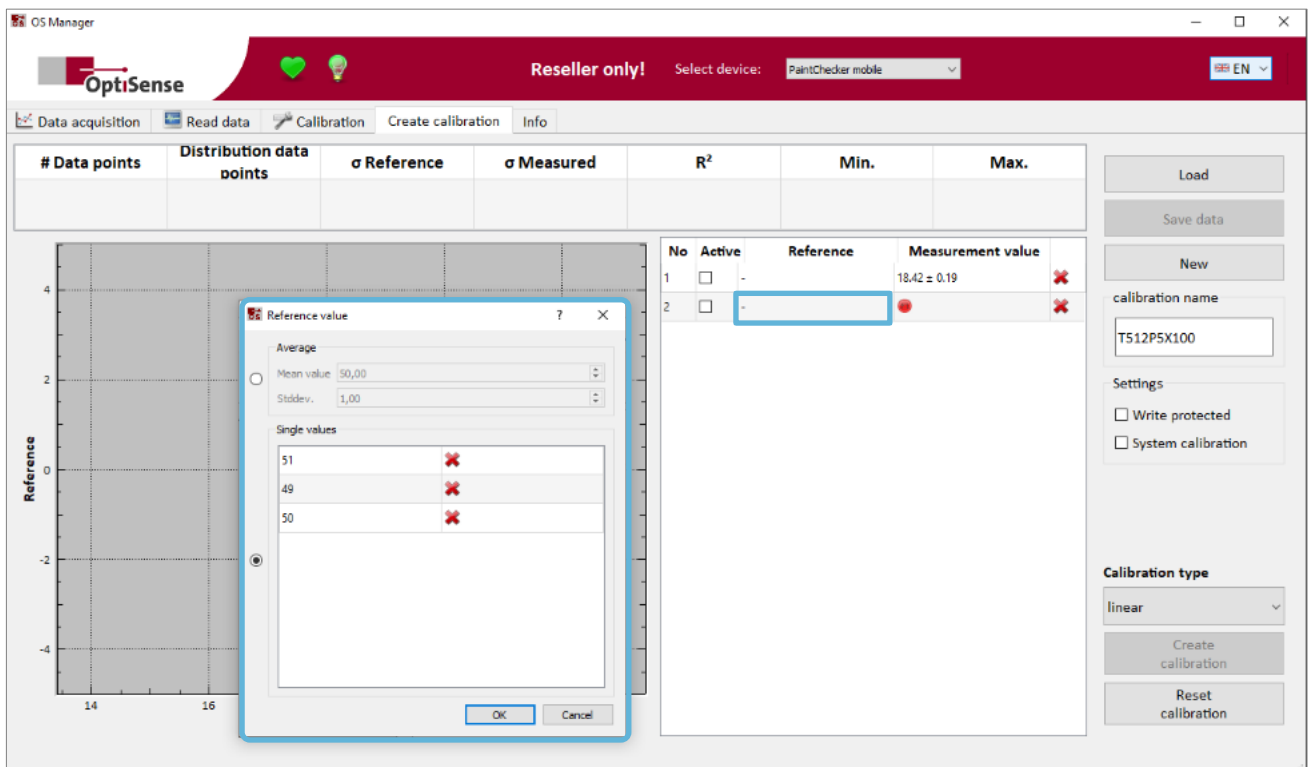


Figure 24: Entering the actual coating thickness

The value is transferred to the table and another empty row is appended to the grid point table. At the same time, the grid point appears in the diagram pane at the intersection between the photothermal raw signal on the X axis and the reference coating thickness on the Y axis. The lengths of the horizontal and vertical lines running through the point indicate the spread (standard deviation) of the measured raw signal and the reference value.

If you move the mouse pointer near a grid point in the diagram area (Roll-over), the associated line number in the grid point table, the measured raw signal value and the reference coating thickness are displayed.

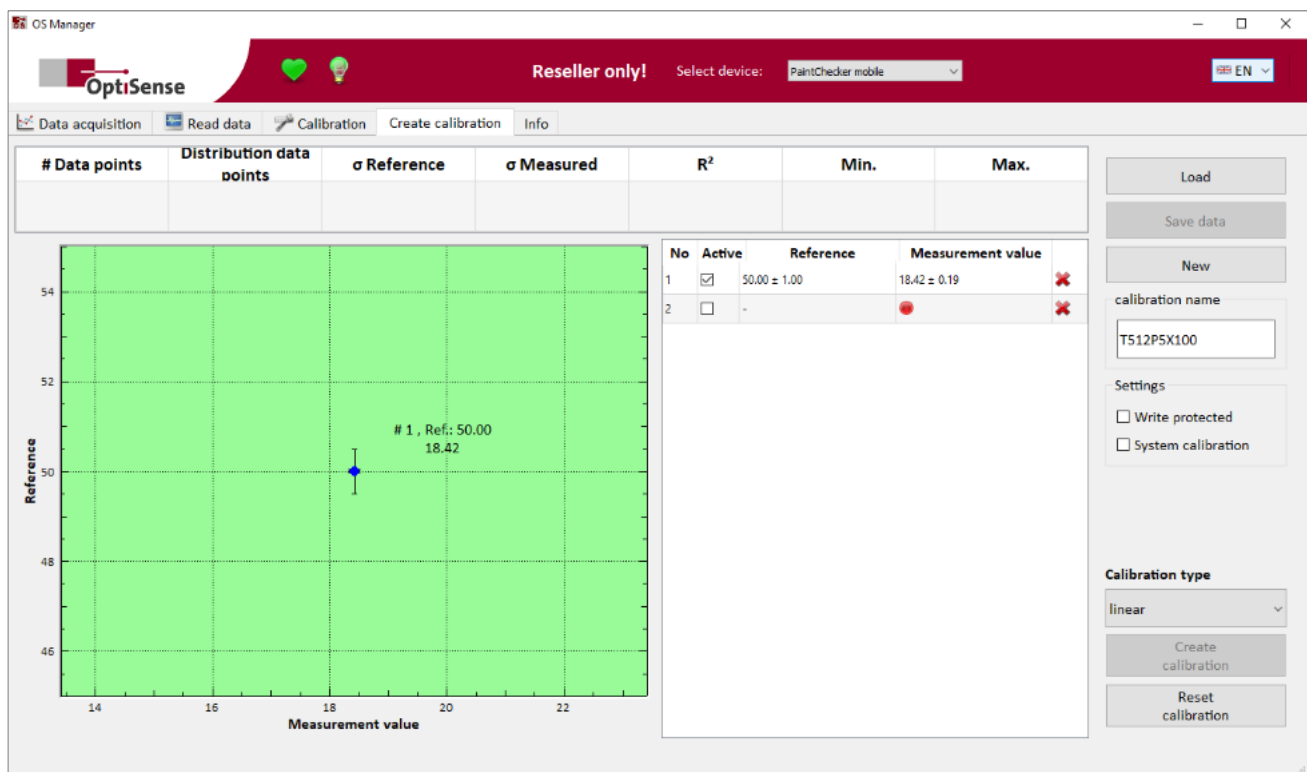


Figure 25: After entering the reference coating thickness, the grid point appears in the diagram

Now add more grid points in the same way by measuring additional coating samples. As soon as two or more grid points are available, the OS Manager can calculate a calibration curve and displays it in the diagram pane. Select Calibration type *linear* in the operating panel and click the *Create calibration* button. The optional calibration type *Polynom 3. Grades* (Polynomial 3rd degree) is only needed in rare cases, when the grid point distribution deviates too much from a straight-line. At least five grid points are required for this type of calibration.

After the calibration curve has been calculated, the Measurement value column of the grid point table no longer displays the raw signals of the photothermal measuring system, but the coating thickness resulting from the calibration curve, i.e. the values that the PaintChecker actually displays for this coating sample. To return to displaying raw signals, click the *Reset Calibration* button.

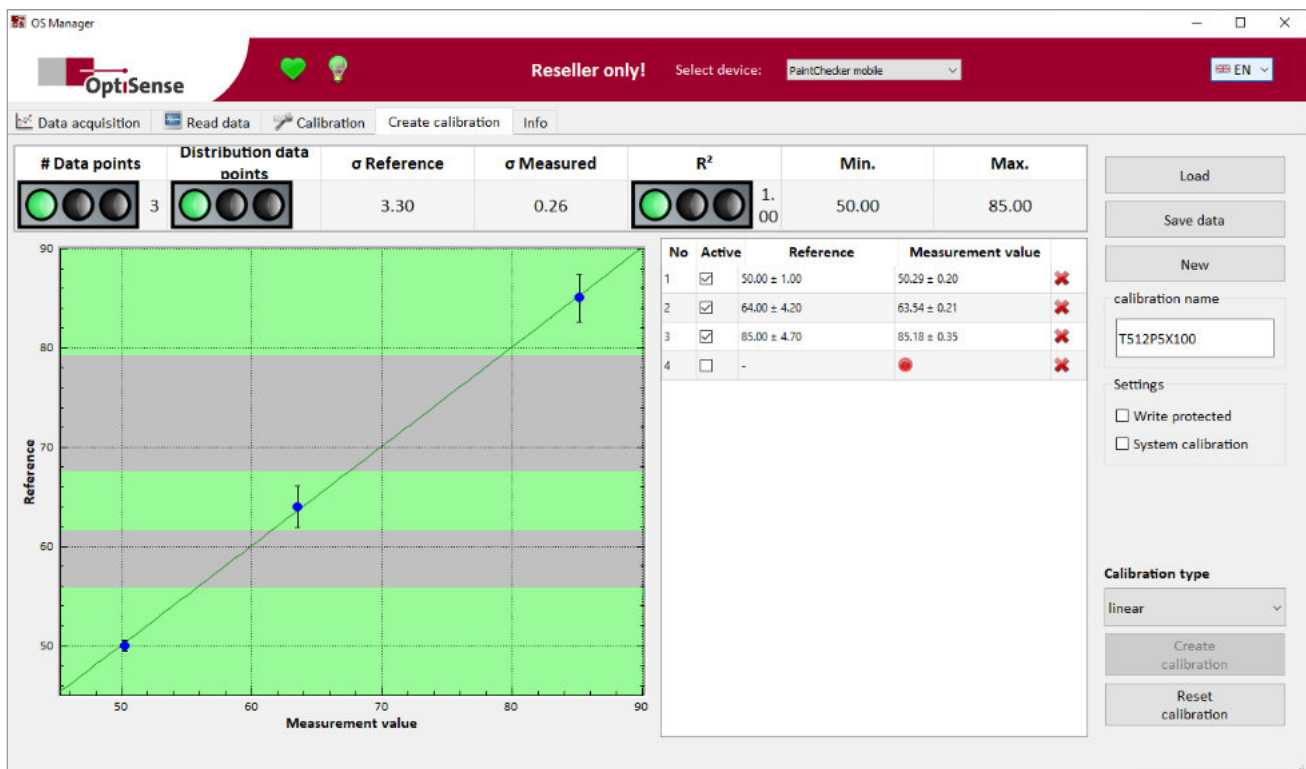


Figure 26: A calibration curve can be calculated with at least two interpolation points

By default, all grid points are used to calculate the calibration curve. Sometimes, however, it may make sense to exclude individual grid points in order to better fit the calibration curve to the other grid points.

If a grid point is not to be used, remove the corresponding check mark in the *Active* column of the grid point table. Then calculate a new calibration curve by clicking on the *Create calibration* button. Inactive grid points will not be used, but will still be displayed in the diagram area. They are marked in red to separate them from active grid points.

## 8.7 Grid point quality

### 8.7.1 Spread

The grid points are displayed in the diagram pane. The reference value from the grid point table is plotted on the X-axis and the corresponding raw signal value from the measurement is plotted on the Y-axis. Each additional, completely filled line of the grid point table adds another point to the grid point diagram.

Each grid point is based on the repeated measurement of a single coating thickness sample. The mean value of these measurements becomes the *Measurement value* in the grid point table. The spread of the

measurements is displayed as a horizontal line through the grid point in the diagram, where the line length represents the standard deviation. The shorter the line, the less varies the measured value, i.e. the more accurate is the grid point. There should be as much distance as possible between the spread lines of different grid points and they should not overlap under any circumstances.

If at least two active grid points are available, the OS Manager can calculate a regression curve that leads through all activated grid points with the smallest possible error. This calibration curve is later used by the PaintChecker Mobile to measure the values between the grid points.

Using the grid point diagram, you can visually check how well and evenly the calibration curve runs between the grid points. Implausible grid points are easy to recognize due to their distance apart from the calibration curve and should be measured again or deactivated. To delete a grid point, click on the corresponding red cross in the rightmost column of the grid point table.

### 8.7.2 Statistical evaluation

When selecting the coating samples, make sure that the entire coating thickness range to be measured later is covered as completely as possible and that the grid points are evenly distributed.

The key figures in the statistics pane provide information about the quality of the grid points and their distribution in the intended measuring range.

An optimal grid point configuration is achieved when a sufficient number of data points (grid points) have been created, the data point distribution is uniform and the correlation  $R^2$  is as close as possible to 1. The traffic light symbols help to evaluate the current grid point configuration.

## 8.8 Organizing calibrations

The OS Manager combines measurement parameters, grid point table and calibration curve into a calibration. These calibrations can be organized in the operating panel of the *Create calibration* tab.

### 8.8.1 Saving, loading from file

Calibrations can be saved as files on the PC for archiving or later editing. The binary OPT format with the *.opt* file extension is used for this purpose. Click the *Save data* button to save the calibration to a PC file. The Windows Explorer provides the usual file operations.

By clicking the *Load* button, calibration files in *.opt* format can be reloaded into the OS Manager at a later time, e.g. to edit a calibration or to transfer it to a PaintChecker device. Editing is limited to simple, basic calibration features, such as those of calibrations created with the OS Manager. The factory-supplied calibrations like *Cured* or *PowderThk* are much more complex, adaptive calibrations suitable for a wide range of materials. These cannot be fully edited but be saved with the OS Manager and used as templates for new calibrations if necessary.

Please note that the *Load* and *Save data* buttons refer to files on the PC. To use a calibration from the *Create Calibration* tab on a PaintChecker device, it must first be saved as a file on the PC and then imported into a free cell of the calibration table in the *Calibration* tab (see section 8.2).

### 8.8.2 New calibration

Clicking the *New* button creates a new, empty calibration. Any existing grid points are discarded and the measurement parameters are reset to their default state. Immediately after creating a new calibration, a unique name must be assigned in the *calibration name* input.

### 8.8.3 Calibration properties

Various properties of a calibration can be defined in the operating panel of the *Create calibration* tab:

In the *calibration name* input of the Calibration tab the file name for saving the calibration on the PC when clicking the *Save* button is defined. The calibration name is also used in the PaintChecker device when selecting a calibration for measurement.

By ticking the *Write protected* checkbox the calibration can be saved from unintentional changes. It can then no longer be edited in the *Calibration* tab. Please note that write-protected calibrations can still be deleted and that the write protection does not apply to the saved *.opt* file on the PC.

User-created calibrations are saved in the User calibration menu of the PaintChecker by default. These user calibrations can be edited and deleted on the device. Checking the *System calibration* checkbox moves the calibration to the System calibrations menu. These calibrations cannot be modified on the PaintChecker device.



## 9. System information

The *Info* tab in the OS Manager action pane can be used to retrieve software and hardware version information and to synchronize the time of the connected PaintChecker device.

In the Device information section, the OS Manager software version and version information about the connected PaintChecker device are displayed. The version numbering scheme of controller and sensor firmware consists of two six-digit numbers/groups of letters followed by a three-part version number in the format

aaaaaa - bbbbbb - x.x.x

In case of support requests, please provide OptiSense with all details listed in the Device information section.

The PaintChecker contains an internal clock to add time stamps to the measured values. In the Synchronize device time section, the system date and time of the PC and the connected PaintChecker are displayed. Clicking the *Synchronize device time* button overwrites the device time with the PC time.

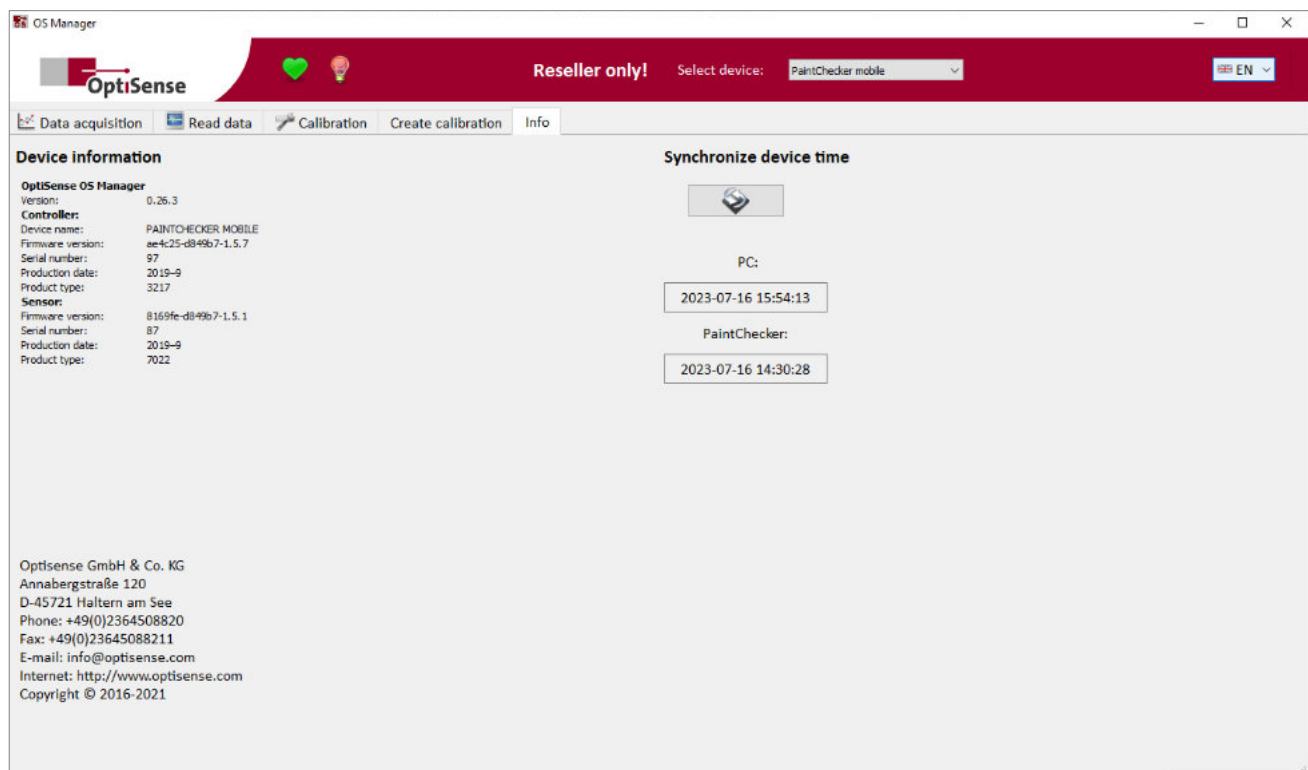


Figure 27: System information

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