ZDR 6020
Dynamic Retroreflectometer R$_L$

for the following versions

6020.EU.1m and 6020.OV.1m

Instruction Manual

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Exclusion of liability

Illustrations, descriptions as well as the technical specifications conform to the instruction manual on hand at the time of publishing or printing.

However, Proceq SA policy is one of continuous product development. All changes resulting from technical progress, modified construction or similar are reserved without obligation for Proceq SA to update.

Some of the images shown in this instruction manual may be of a pre-production model and/or are computer generated; therefore the design / features of the delivered product may differ in various aspects.

The instruction manual has been drafted with the utmost care. Nevertheless, errors cannot be entirely excluded. The manufacturer will not be liable for errors in this instruction manual or for damages resulting from any errors.

The manufacturer will be grateful at any time for suggestions, proposals for improvement and indications of errors.

1	Description of device

The ZDR 6020 is a vehicle mounted mobile retro-reflectometer with 300 measurements per second guaranteeing accurate and continuous coverage of the night visibility (R_L) of all types and colours of road markings.

A measuring head can be mounted on either side of the measuring vehicle, which allows for continuous recording of the R_L-values of road markings at normal traffic speed up to 150 km/h (93 mph). Mobile measurements are particularly helpful on motorways or roads with heavy traffic, as no additional safety precautions need to be taken.

In particular, this instrument has the following features

- Double and even triple lines are recognised and measurements are automatically stored separately.
- Handheld precision at traffic speed up to 150 km/h (93 mph).
- Industrial grade ruggedized touchscreen tablet.
- The intuitive RetroGrabber software is easy to use for one- or two-person operation.
- The data file generated by the RetroGrabber software is text based and any type of spreadsheet software can be used for further analysis of the measurements. The included mapping and data analysis software "MappingTools" is used for graphical visualization and one-click generation of measuring reports.
- A progression chart shows the R_L-values. This graph is a visual support and shows irregularities of the measured results at a glance.
- Data transfer into Microsoft Excel enables statistical analysis of the measurements. The measuring data can also be transferred to in-house databases.
- All important data are recorded at the same time: R_L, day contrast ratio, GPS co-ordinates, ambient temperature (°C/°F), relative humidity (rH %), speed, picture, voice recording as well as date and time.
- Measures in all ambient lighting conditions, Day and Night, even bright sunlight.
- Integrated camera for road surveillance with 10 meter (32.81 ft.) picture sequence.
- Microphone for voice recording to comment on special events e.g. roadworks.
- GPS with dead reckoning (DR) providing accurate GPS signals even in urban canyons and tunnels.
- Easy and fast attaching and removing of the measuring head.
- Easy and fast calibration.
- To guide the driver the R_L values are shown in a bar diagram on the driver display.

- Markings of different colours can be measured.
- User friendly, multilingual user interface
- In accordance with true CEN geometry of EN 1436 (RL), ASTM E1710 (RL) as well as ASTM E2177 (RL wet).
- Approved by the accredited association StrAus-Zert, Germany (test No. 0913-2009-05).

Measuring principle:

The ZDR 6020 Dynamic Retro-reflectometer R_L measures the Retroreflection of road markings true to scale.

R_L is the coefficient of retroreflected luminance (night visibility) of road markings. The observation angle of 2.29° corresponds to the viewing distance of a vehicle driver of 30 m under normal conditions. The illumination angle is 1.24°.
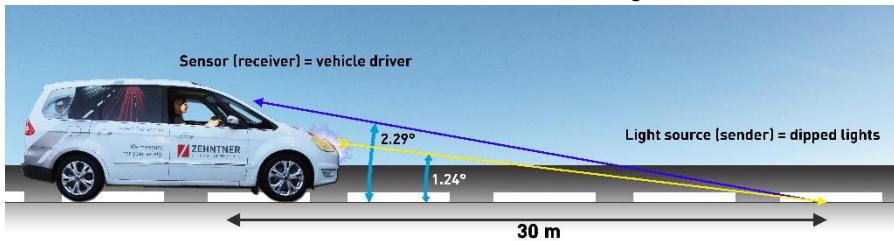
The angle definitions above are valid for EN 1436. It is important to understand that EN 1436 and ASTM E1710 use a different illustration of the same angles.
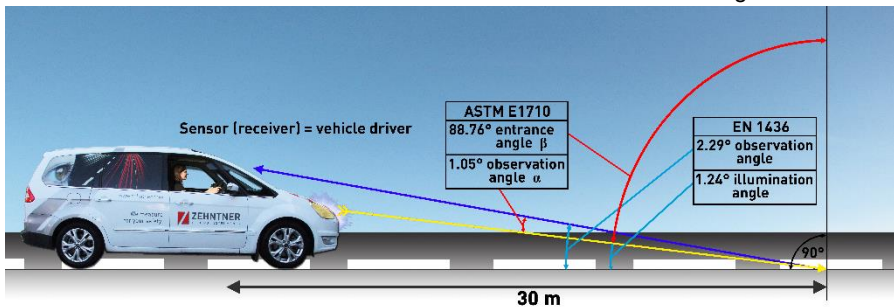
2 Safety information

2.1 Symbols used

⓵ This note comprises instructions needed to follow directions, specifications, proper working procedure and to avoid data loss, damage or destruction of the instrument.

⚠ This note signifies a warning about dangers to life and limb if the apparatus is handled improperly. Observe these notes and be particularly careful in these cases. Also inform other users on all safety notes. Besides the notes in this instruction manual the generally applicable safety instructions and regulations for prevention of accidents must be observed.

2.2 Safety notes and hints

⚠ The ZDR 6020 is a high quality, state of the art instrument and is safe to operate. Nevertheless, there is always risk when the instrument is handled inappropriately.

⚠ Every person working with the ZDR 6020 or maintaining the ZDR 6020 must read and understand the manual completely. In particular the safety precautions and warnings.

⓵ The ZDR 6020 is exclusively intended for the determination of night visibility (R_L) for all types of road markings. Any other use is considered as not being in accordance with the intentions of the manufacturer. The manufacturer is not liable for damage resulting from inappropriate application. The user bears full responsibility.

⚠ Avoid any mode of operation that could affect the safe working with the ZDR 6020. Especially the determination of the night and/or day visibility of road markings must take place as described in this instruction manual.

⚠ Laser radiation class 2. Avoid direct eye contact to beam.

⓵ **Proceq SA** refuses all warranty and liability claims for damages caused by usage of the ZDR 6020 in combination with **non-original accessories**, or accessories from 3rd party suppliers.

⓵ Unauthorized modifications and changes of the ZDR 6020 are not allowed.

⓵ Reproduction without permission is not permitted.

⚠ All maintenance and repair work which is not explicitly allowed and described in this manual (see chapter 10.1 "Maintenance carried out by the user" on page 60) shall only be carried out by **Proceq SA** or your authorized Proceq agent, failure to comply voids warranty.

⚠ Keep the device dry. Danger of short circuit!

⚠ Make sure that the ZDR 6020 is unplugged and turned off before any maintenance.

⚠ For the operation of the ZDR 6020 apply all local safety regulations.

⚠ Check for local regulations concerning the car equipment, such as flashing lights and annunciates. Furthermore, authorizations and/or escort vehicles may be needed to measure.

⚠ Do not get distracted by the operation of the device. Always concentrate on the traffic situation. Lack of attention to traffic may result in severe injury or accidents. The operator is responsible for his/her safety during use of the system.

⚠ When driving with the tablet mount in place, the passenger side airbag should be deactivated.

⚠ It is forbidden to operate the vehicle with a person seated in the passenger seat while the tablet mount is in use.

| **3** | **Delivery of device** |

3.1 Damages during carriage

On receipt of the goods, check for any visible damages on the packaging. If it is undamaged you may sign the receipt of the goods. If you do suspect by your visual

inspection that damage has occurred, make a note of the visible damage on the delivery receipt and request the courier to countersign it. Moreover, the courier must be held responsible for the damage in writing.

If any damages are discovered during unpacking, you have to inform and hold the courier liable immediately in the following way: "When opening the parcel, we noticed that … etc. "This superficial checking of the goods has to be done within a time limit set by the carrier, which is normally 7 days. However, this period may vary depending on the courier. Hence, it is recommended to check the exact time limit when receiving the goods.

If there are any damages also inform your authorized Proceq agent or **Proceq SA** immediately.

3.2 Shipment
Should the device be transported again, it must be packaged properly. Preferably use the original packaging for later shipments. Additionally, use filling material in the package to protect the device from any shock during carriage.

3.3 Standard delivery

Following parts are included in the delivery:

1	ZDR 6020 1 m Measuring head	
1	Removable sunshade	
2	Mounting adapters (left/right) for measuring head mounting	
1	Ruggedized touchscreen tablet with installed ZDR 6020 "RetroGrabber software and microphone	
1	Tablet docking station	
1	Tablet mount	
1	Calibration unit with calibration standard	
1	GPS unit with DR for improved precision also in tunnels	
1	Mapping and data analysis software "MappingTools"	
1	Camera	

1	Power supply unit (car box)	
1	Storage box	
1	Gauge	
2	Auxiliary height indicators	
1	Set of tools • 6 Allen keys (1.5 mm, 2 mm, 2.5 mm, 3 mm, 4 mm, 5 mm) • 1 Allen screw M4 • 2 Spanner wrenches (10 mm, 19 mm – 1 each) • 1 Screwdriver type Allen key 5 mm	
2	Set of spare parts • 1 Halogen lamp • 1 Set of fuses • 2 Safety glasses	
1	Instruction manual	
1	Quick start guide	
1	Certificate of manufacturer	

1 Certificate of calibration	

3.4 Options

• ZRM 6014 Retro-reflectometer R_L/Qd	
• ZRM 6013+ Retro-reflectometer R_L/Qd	
• ZRM 6006 Retro-reflectometer R_L/Qd	

All spare parts can be purchased from Proceq or an authorized agent.

🛈   **Proceq SA** refuses all warranty and liability claims for damages caused by usage of the ZDR 6020 in combination with **non-original accessories**, or accessories from 3rd party suppliers.

4	System components

4.1 General overview

The ZDR 6020 Dynamic Retroreflectometer R_L consists of several components that are necessary for the operation. These components are described in the following chapters:

- Measuring head
- External connectors
- Carrier pipe
- Tablet, docking station and tablet mount
- Camera
- Panel switches
- Power supply unit (car box)
- Storage box
- Calibration unit
- Wiring

The ZDR 6020 Dynamic Retro-reflectometer R_L may be operated by one or by two people. However, Zehntner recommends two people for long distances. The co-operator may then take care of comments and events, allowing the driver to concentrate on driving.

Flashing lights and announcement may have to be installed to comply with local safety regulations.

4.2 Measuring head

The measuring head is designed to be mounted on either side of the measuring vehicle or on a stationary test stand.

A real-time computer inside the measuring head controls and monitors the data acquisition process. Furthermore, it streams the measured values to the RetroGrabber software on the tablet.

White front light

3 Status LEDs

Auxiliary laser (factory use only)

Observation optics

Mounting hole for sunshade

Levelling laser (front wheel)

Removable cooling-air inlet

Illumination optics

Safety glass

Red backlight

Serial number

Levelling laser (rear wheel)

Removable cooling-air outlet

Cable and connector plug
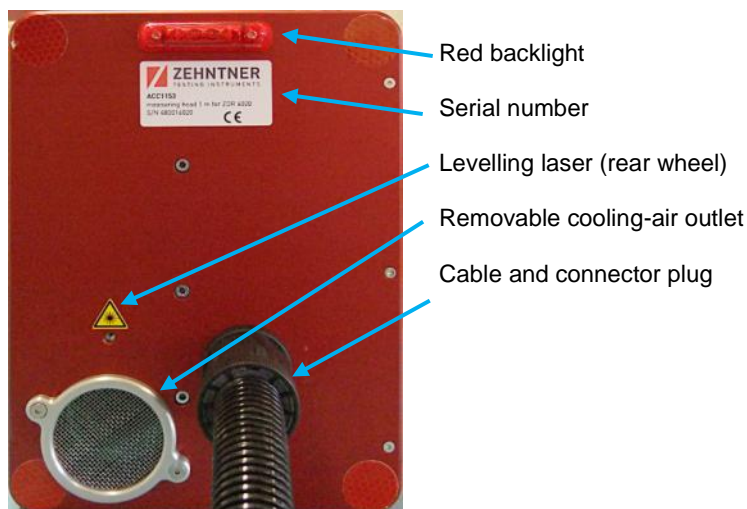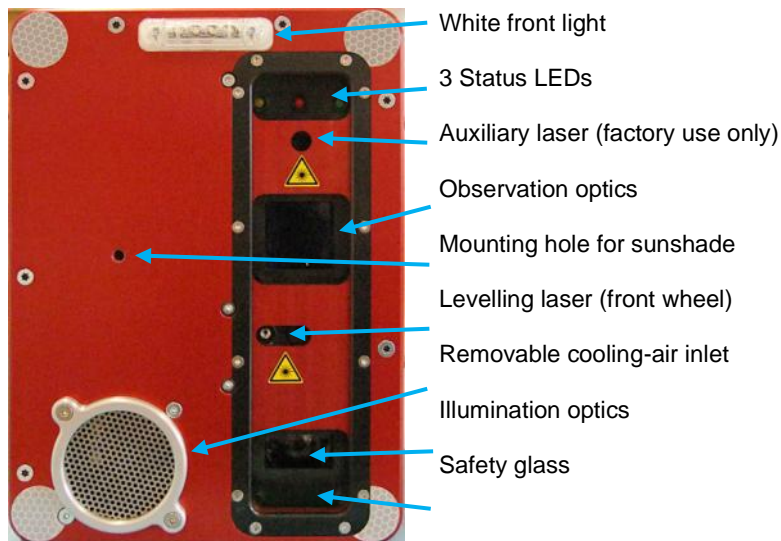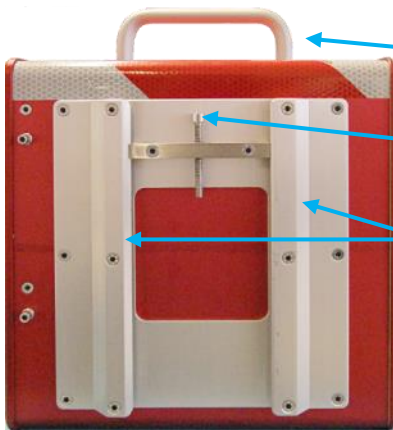
Connector plug

Handle

Height adjustment screw

Mounting bracket

⚠️ Keep the device dry. Danger of short circuit!

4.3 External connectors

The measuring head is connected to the system by a heavy duty industrial plug connector. They are located next to the rear wheel on either side of the measuring vehicle, see picture below.

The connector pins are protected by a protective cap, which must be closed and secured tightly with the attached locking clamp when not in use.
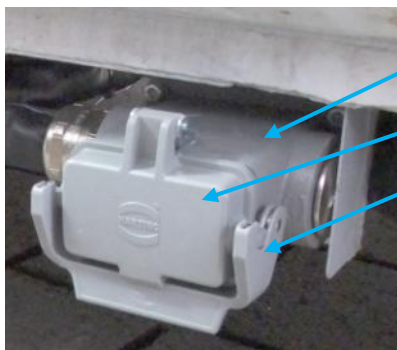
External connector

Protective cap

Locking clamp

4.4 Carrier pipe

The carrier pipe is located underneath the car. It is securely mounted to the vehicle`s chassis, there are black protective caps fixed by fasteners on either end.

The measuring head is fixed to the carrier pipe with a special mounting adapter. There is an adapter for the right and left side respectively.
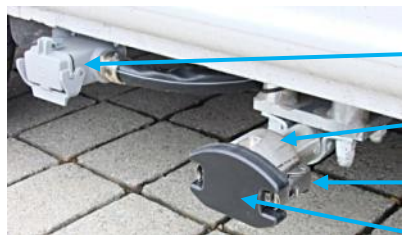
External connector

Carrier pipe

Fasteners

Protective cap for console

Angle adjustment screw

Mounting adapter

Fasteners

Quick release

4.5 Tablet, docking station and tablet mount

A ruggedized touchscreen tablet is used to operate the ZDR 6020. With the installed RetroGrabber software, it communicates with the measuring head and records measured data to its hard drive.

The tablet is connected to a docking station on a tablet mount, which is installed on the co-driver's seat.

Ruggedized touchscreen tablet

Tablet

Docking station

Tablet mount

Co-driver seat

Two cables are plugged into the docking station:

Ethernet connector

Power docking station

⚠️   When driving with the tablet mount in place, the passenger side airbag should be deactivated.

⚠️   It is forbidden to operate the vehicle with a person seated in the passenger seat while the tablet mount is in use.

4.6 Camera

The ZDR 6020 is equipped with an auto-iris camera mounted on the windscreen with vacuum cup. It records a picture of the road ahead and its markings every 10 m. While measuring it is also possible to have a live image displayed by pressing the button "Camera" in the RetroGrabber software.

To get good quality pictures, adjust the focus and zoom angle by turning the corresponding ring on the lens. The camera has a built-in auto-iris, thus it adjusts the aperture automatically depending on the light conditions

Rear mirror

Vacuum cup on windscreen

Camera

Ethernet connector

Power connector

Focus

Zoom
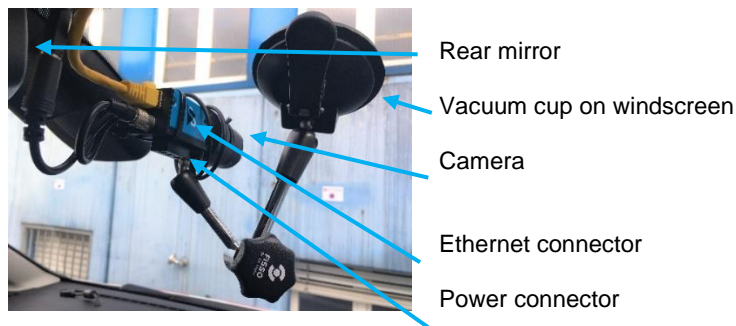
Take care when handling the camera's power connector. Camera failure may result if plugged in incorrectly.

4.7 Panel switches

The panel switches are located on the car's main panel. They are used to power the system and its components on and off.

Main power on/off

Measuring head on/off

Laser on/off
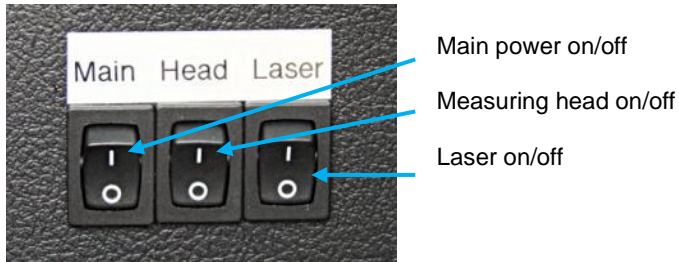
Main: Main switch that powers the following components on and off:

- Power supply unit (car box)
- Tablet docking station
- Camera

Head: Switches on the measuring head. The boot-up procedure may take as long as 20 seconds. It is ready to operate when the yellow status LED on the measuring head is blinking.

The measuring head is only powered when the main switch is on.

Laser: Switches on the levelling lasers in the measuring head.

The lasers are only powered on when the measuring head switch is on as well.

The ZDR 6020 consumes a lot of power during operation. It is therefore essential that the car engine is always running while the system is switched on.

⚠ **Laser radiation class 2. Avoid direct eye contact to beam.**

4.8 Storage box

The grey storage box sits in a black aluminium frame which is usually located in the car trunk. It contains the measuring head, the mounting adapters, all tools and spare parts.
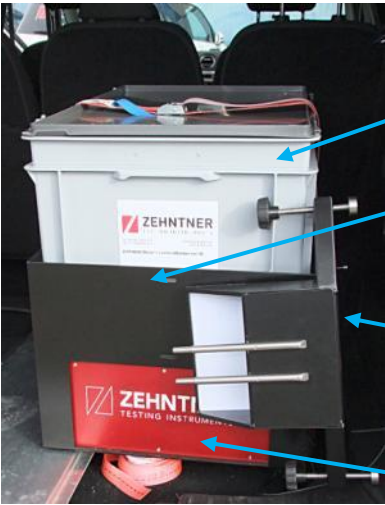
Storage box

Black aluminium frame

Calibration unit

Power supply unit (car box)
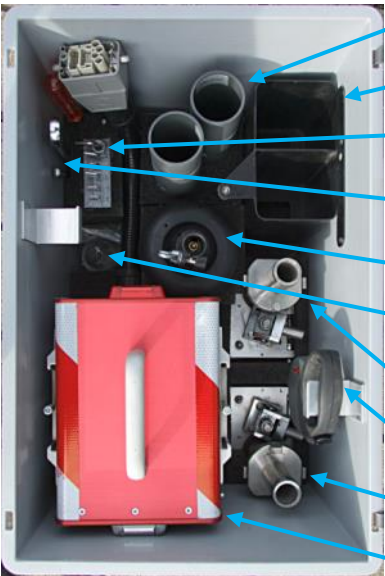
Auxiliary height indicators

Sunshade

Allen keys

Wrenches

Space for flash light (not included)

Spare parts

Left mounting adapter

Gauge

Right mounting adapter

Measuring head

4.9 Power supply unit (car box)

The power supply unit (car box) is usually located in the car trunk below the grey storage box, see pictures in chapter 4.8 "Storage box" on page 22. It is the central wiring point connecting different components of the system. Most fuses are located in the power supply unit (car box).

The system runs on 12 VDC. It is connected to the car battery and protected by a 40 A fuse, which is usually located near the car battery.

4.10 Calibration unit

The calibration unit is usually located in the car trunk, see pictures in chapter 4.8 "Storage box" on page 22. It is used to calibrate the measuring head quickly and easily.

4.11 Wiring

The wiring between the different system components is installed once and is invisible to the user. Most cables go to the power supply unit (car box) and don't need to be manipulated for normal measuring operation.

Wiring schematics:
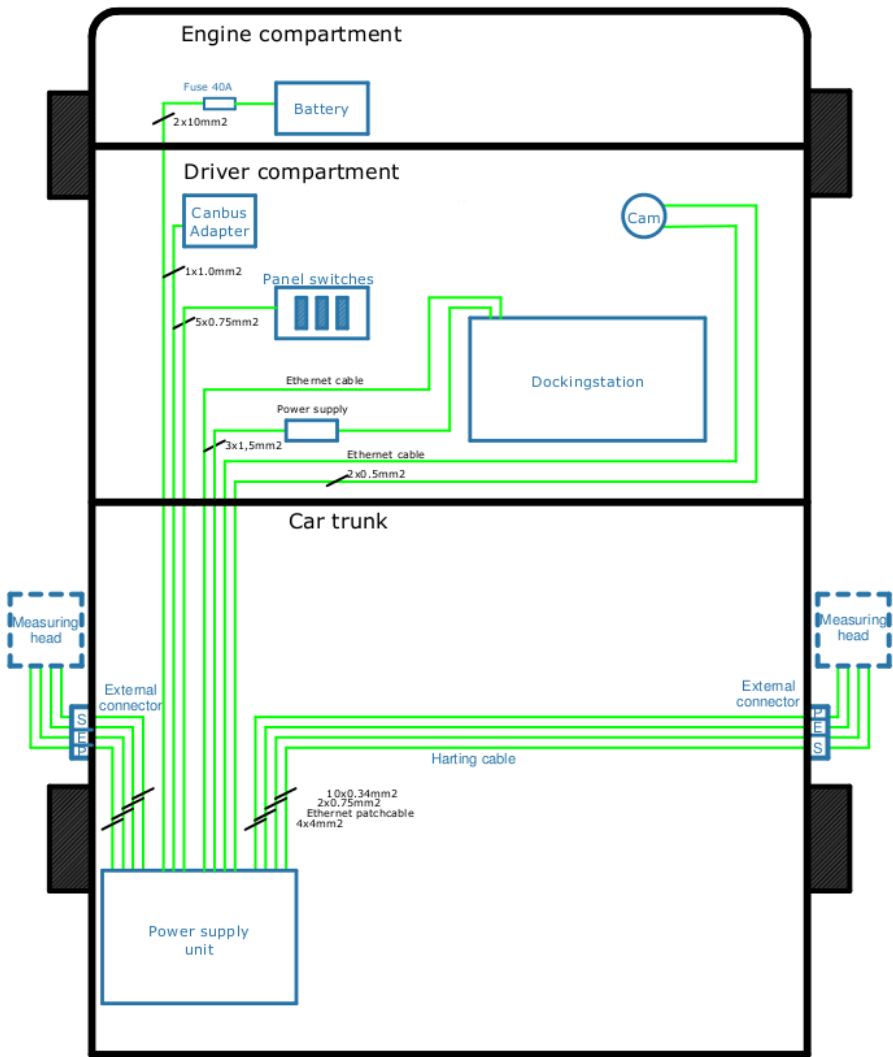
5	RetroGrabber Software

The RetroGrabber software is needed to operate the ZDR 6020 Dynamic Retro-reflectometer R_L. It performs the following operations:

- Obtaining the measurements from the measuring head
- Calculating an average value of all received sensor signals
- Verifying and filtering single values according to filter settings
- Averaging single measurements according to the given interval
- Storing the measured value together with additional information in the measuring file

5.1 Installation
For the current version, the software needs to be installed and configured at our premises.

5.2 Program start
To start the RetroGrabber software, click on the RetroGrabber icon on the desktop or navigate to Start - Programs - Zehntner – RetroGrabber.

5.3 Main screen
The main screen is divided into three sections:

1. Main window
2. Main menu
3. Status bar
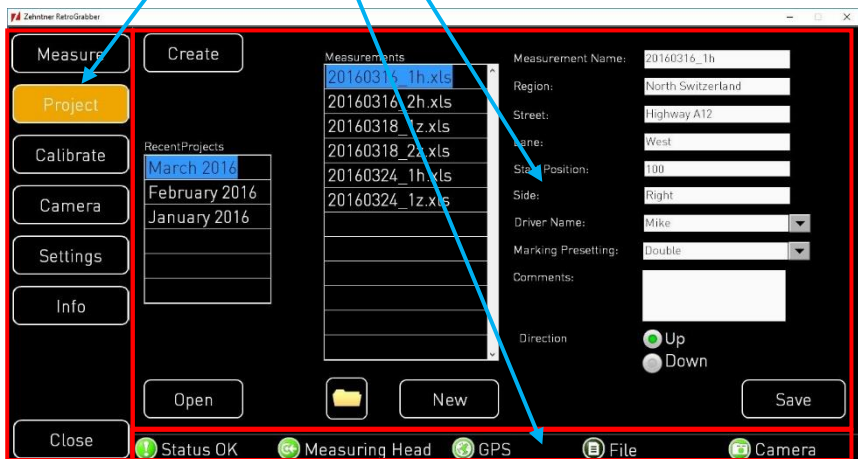
5.3.1 Main window
Based on the chosen menu item different dialogs and submenus appear in the main window. Usually this will be the measuring window.

5.3.2 Main menu

The main menu is located on the left side of the main screen. It contains seven different buttons:

Measure:	Measuring mode
Project:	Create and open projects and measuring files
Calibrate:	Calibration of measuring head, speed calibration
Camera:	Camera settings
Settings:	System configuration, filter settings, marking presettings
Info:	Errors and warnings, system information
Close:	Close program

Please refer to the following chapters for a detailed explanation.

5.3.3 Status bar

The status bar is located at the bottom of the main window. It contains five icons which indicate the current state of the corresponding system component (from left to right):

1. Errors and warnings
2. Measuring head
3. GPS
4. Measuring file
5. Camera

The different colours have the following meaning:

 Light green: Component active or connected

 Dark green: Component inactive or neutral

 Red: Error, warning or component not connected

5.4 Measure

By clicking on "Measure" in the main menu, the measuring window is displayed, which is also RetroGrabber's default window.

5.4.1 Measuring window

If the measuring head has not established a connection to the RetroGrabber software (icon in the status bar is dark green), a black window is displayed:

As soon as the measuring head has established a connection to the RetroGrabber software (icon in the status bar is light green), the measuring window appears.
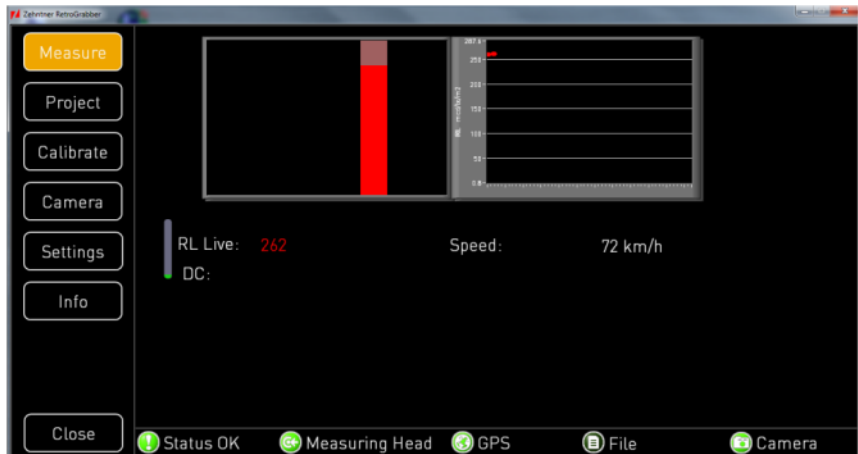
🛈   Depending on the "Bar Graph Settings" the bars might look different, see chapter 5.8.5 "Bar Graph settings" on page 41 .

As neither a project nor a measuring file have been opened yet, no data will be stored on the tablet and only a limited number of features are displayed in the measuring window. For a detailed explanation of all available features in the measuring window, please see below.
This mode is used for control measurements or comparisons with a handheld device.

The full range of features is displayed in the measuring window only when a project and a measuring file have been opened or created; please refer to chapter 5.5 "Project" as from page 29. This enables the system to record and store the measured data in a measuring file on the tablet.

The measuring window is divided into different sections:

1. Bar diagram
2. Measuring buttons
3. Time diagram
4. Signal quality
5. R_L-values
6. Event buttons
7. Parameters

Bar diagram:	The bar diagram represents the road ahead and its markings. Up to three markings can be detected and displayed simultaneously. The width of the bar depends on the width of the marking and on the filter settings. To distinguish between the markings, they are displayed in different colours:

- First marking: red
- Second marking: green
- Third marking: blue

Measuring buttons:	Buttons used to operate the system:

- Picture: Start/stop picture recording
- Voice: Start/stop voice recording
- Capture: Start/stop measurement

Time diagram:	This graph shows the R_L-values over time. This allows for visual control of the measured marking.

Signal quality:	Visually indicates the signal quality of the measured data. A full green bar means good signal quality. Note: Despite this bar showing bad quality for short periods, the measuring result still may be fine. Only if the bar is empty all the time this indicates a bad signal caused by vibrations, electrical fields or other interferences.

R_L-values:	Night visibility R_L of the markings in [mcd$\cdot$m$^{-2}\cdot$lx^{-1}]. Two different values are indicated:

- R_L DB: Distance based average value (interval) which is written into measuring file
- R_L Live: Time based average value (~1 second)
- DC: Day contrast ratio

Event buttons:	User configurable buttons used for indicating special events when measuring. A reference text is written into the measuring file.

Parameters:	Different measuring parameters such as position (mileage), speed, project name and name of measuring file.

5.5 Project

To prepare the system for recording and storing measuring data on the tablet, both a project and a measuring file must be opened or created first.

5.5.1 Project

A project is a container for measuring files, pictures and voice recordings. By clicking on "Project" in the main menu, the project window is displayed.
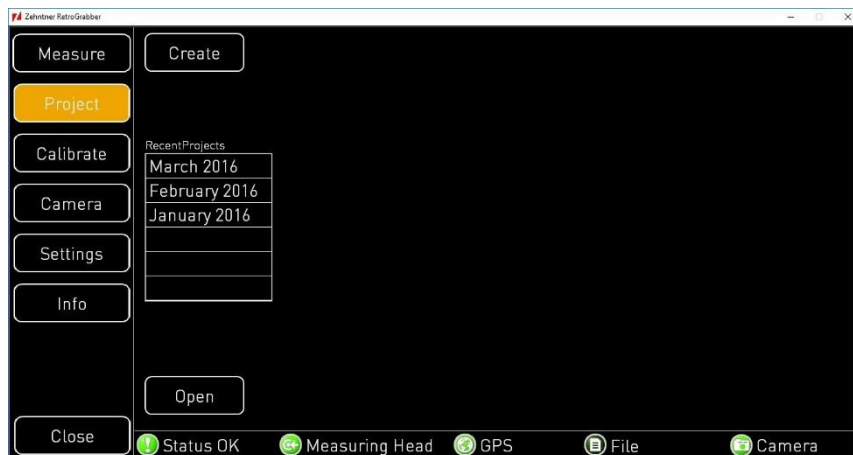
Create:		Opens a file explorer window. Browse to the appropriate folder location and enter a project name to create a new project.
Recent Projects:		Choose a recently opened project from the list.
Open:		Opens a file explorer window. Select an existing project by browsing to the project folder and choosing the file with .zdp file extension.

On the tablet, a project is a folder containing subfolders and different files. Commonly they are stored in Libraries/Documents/RetroGrabber. A project has the following structure:

Project name/:	Main project folder, name of the project
Filename/:	Subfolder with pictures and voice recordings belonging to the same called measuring file
Filename.xls:	Measuring file
Projectname.zdp:	Project file for choosing the project, please also have a look at the picture above

5.5.2 Measuring file

After having chosen a project, a measuring file needs to be created or opened. The following project window is displayed:
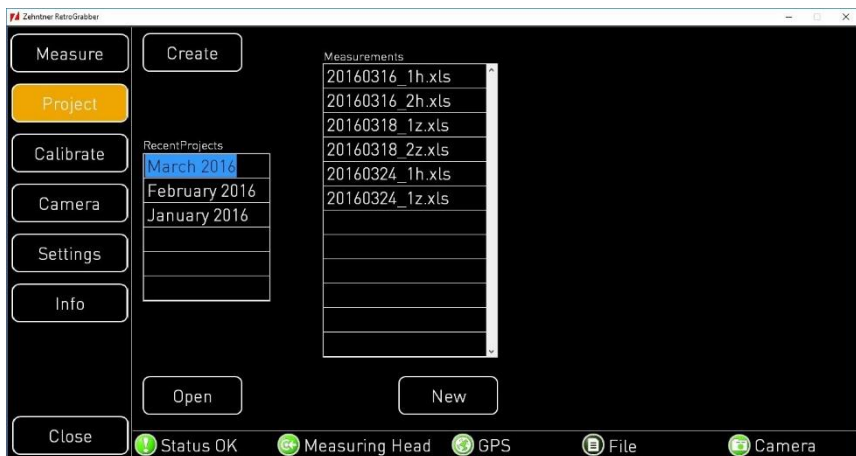
| **Measurements:** | List with all measuring files from the current project |
| **New:** | Opens an editor mask with file header information, see picture below: |
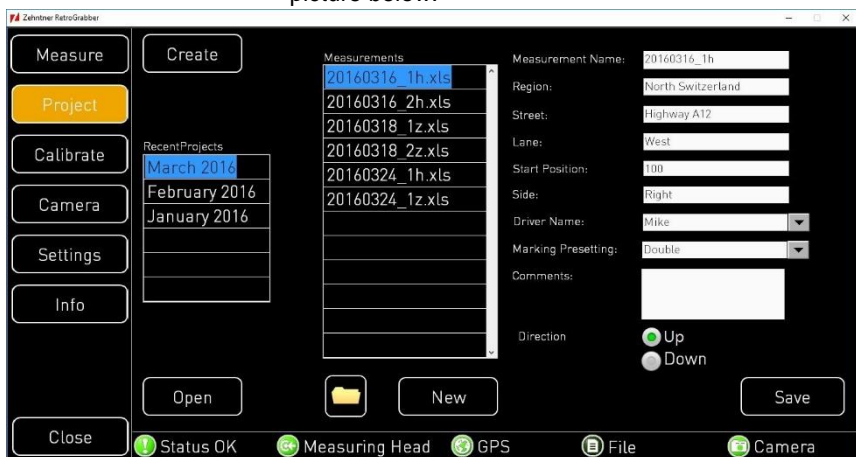
Measurement Name:	Filename, compulsory
Region:	Measuring area, optional
Street:	Street name, optional
Lane:	Lane name, optional
Start Position:	Start position (km) of measurement, default = 0
Side:	Lane position, optional
Driver Name:	Name of the operator, optional
Marking Presetting:	Selection of Marking Presetting, default = last setting
Comments:	Comments, optional
Direction:	Counting mileage upwards (up) or downwards (down)

	Save:	Creates an empty measuring file with the above header information and the same called subfolder for pictures and voice messages in the project folder
	Folder icon:	Opens a file explorer window in the current project folder

5.5.3 Measuring file format

The measuring file generated by the ZDR 6020 is stored in an open source, tab separated text file. Even though it has an ".xls" file ending, it can be opened and altered with any text editor like Notepad.

Double click on a measuring file to open it in Microsoft Excel.

! Microsoft Excel is not part of the ZDR 6020 system.

! A warning appears when opening the measuring file in Microsoft Excel. This is because the file is not a native Excel file but a tab separated text file, see above. Click "Yes" to open the file.

The header section contains the measuring head type and serial number, the file creation date and the information typed in the editor mask, see chapter 5.5.2 on page 30. Additionally, the interval length taken from the current marking presetting is indicated; see chapter 5.8.1 on page 37.

The measured data is stored beginning from line 19. Each line represents the different average values over a certain interval length, usually 50 meters.

	Position km:	Distance from the start of the measurement
	Date/Time:	Date and time
	R_L:	The average value of R_L in [mcd·m^{-2}·lx^{-1}] over the last interval
	R_L Min:	The minimum R_L value in [mcd·m^{-2}·lx^{-1}] over the last interval

R_L Max:	The maximum R_L value in [mcd·m^{-2}·lx^{-1}] over the last interval
R_L Std Dev:	Standard deviation (type: population) of R_L during the interval
R_L % Pass:	Percentage of values that have passed the data process filters. A high value means high signal quality.
DC:	Day contrast ratio
Marker:	Event buttons pressed
Temperature:	Ambient temperature in [°C]
Humidity:	Ambient relative humidity in [% rH]
Speed km/h:	Speed in [km/h]
Reference:	Not used
GPS Long Start:	GPS longitude at interval start, format 0.000000°
GPS Lat Start:	GPS latitude at interval start, format 0.000000°
GPS Long:	GPS longitude at interval end, format 0.000000°
GPS Lat:	GPS latitude at interval end, format 0.000000°
Files:	Hyperlink to voice recordings (audio format: OGG) and pictures. A click on the hyperlink opens the voice file in the Windows Media Player and the pictures in the Windows Picture Viewer.

❗ Do not save the measuring file in Microsoft Excel or you will lose all hyperlinks to the voice files and pictures. Use a text editor to edit the measuring file.

5.6 Calibrate
5.6.1 Calibrate measuring head

The ZDR 6020 should be levelled and calibrated every time it is mounted on the vehicle. Click on "Calibrate" in the main menu to open the calibration window:
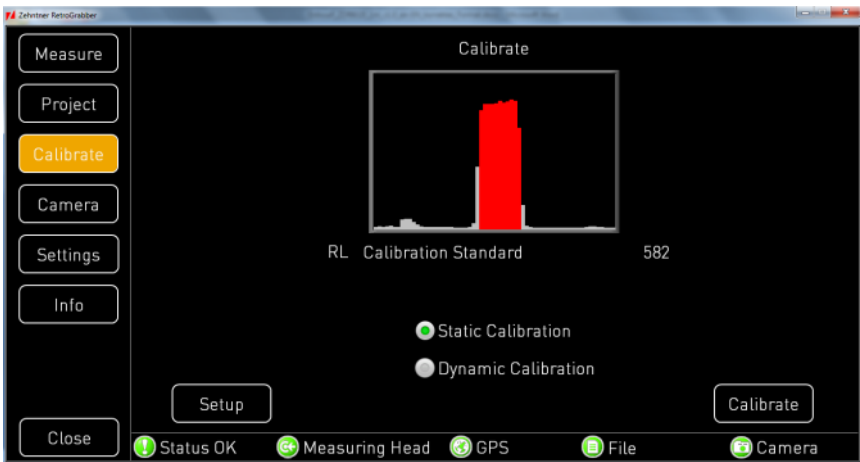
Calibrate:	Bar diagram
R_L Calibration Standard:	R_L value in [mcd·m^{-2}·lx^{-1}] of reference calibration standard
Static Calibration:	Stationary calibration mode, default mode
Dynamic Calibration:	Calibration with moving vehicle
Setup button:	Calibration settings and speed calibration
Calibrate button:	Calibrate measuring head

To change the calibration parameters, click on "Setup":

Calibrate R_L:	Enable/disable calibration
Calibrate on:	Either the included calibration unit or a different calibration plate
Standard Value:	R_L value in [mcd·m^{-2}·lx^{-1}] of chosen calibration standard above
Last Calibration:	Date and time of last measuring head calibration

5.6.2 Speed calibration

The ZDR 6020 takes the speed information from an adapter connected to the internal car communication system (CAN bus). The extracted signal is proportional to the vehicle speed and needs to be calibrated for proper mileage calculation.

Click on "Calibrate – Setup – Speed Calibration" in the main menu to open the speed calibration window:
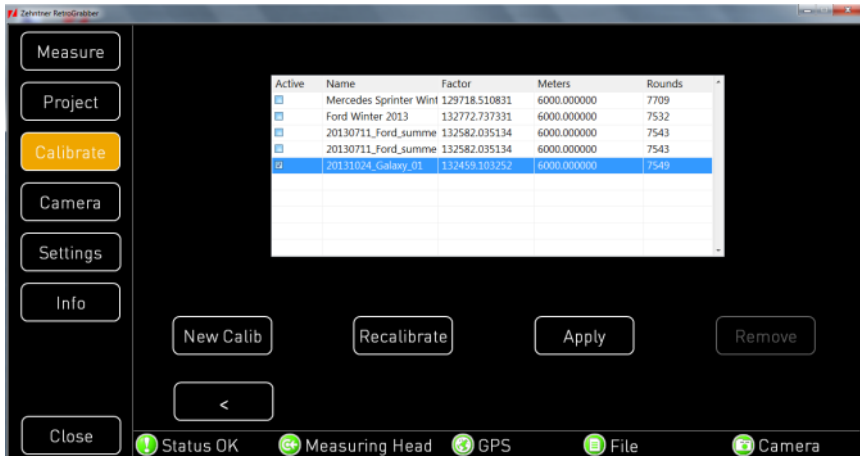
🔴 The button is disabled if the measuring head is not connected to the system.

New Calib:	New speed calibration
Recalibrate:	Recalibrate existing speed calibration
Apply:	Activate current speed calibration from list
Remove:	Remove highlighted speed calibration
Back arrow:	Close the speed calibration dialog

For detailed explanation on how to do the speed calibration, see chapter 7 "Speed Calibration" on page 57.

5.7 Camera

The camera is mounted on a vacuum cup on the windscreen and takes pictures of the road ahead as seen by the driver. This allows visual control of the road markings. The system is configured to take a picture every 10 meters. Click on "Camera" in the main menu to open the camera window to see a live picture:

5.7.1 Camera properties

The camera properties can be adjusted in the properties window. The default values work well for most cases. Click on "Properties" in the camera window to open the camera properties window:
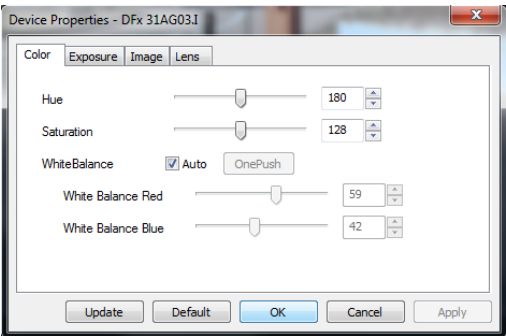
5.8 Settings

A multitude of settings can be adjusted in the settings window. Click on "Settings" in the main menu to open the settings window:
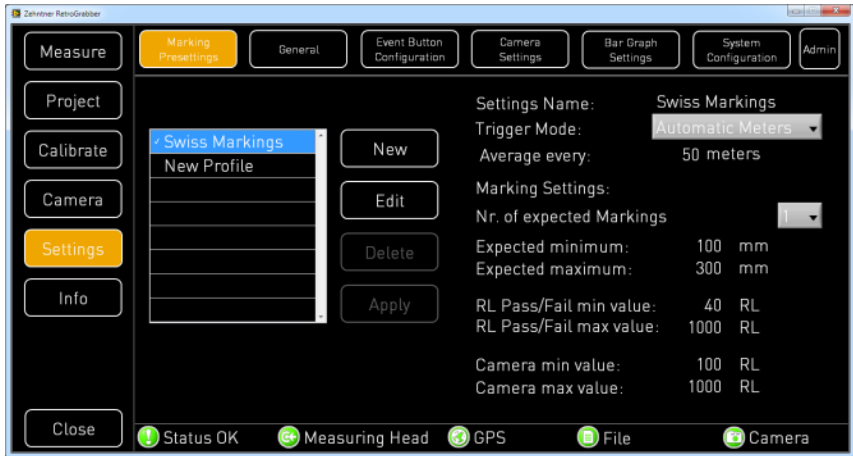
5.8.1 Marking presettings

Marking presettings are used to store measurement parameters for a marking. The marking presettings can be prepared in the office before measuring and then be applied on site. When a marking presetting is applied, all parameters for measuring a marking will be taken as defined in the presetting.

1. List of marking presettings
2. Parameters
3. Submenu

The following parameters can be adjusted:

Settings Name:	Name of the marking presetting
Trigger Mode:	Automatic Meters (distance based, default) or Automatic Seconds (time based for stationary wet measurements). Indicates the distance or time interval for calculating the average R_L value in the measurement file
Average every:	Interval length (meter or seconds), depending on the trigger mode.
	Interval length in meter: 10 – 10.000 m
	Interval length in seconds: 1 – 1.000 s
Nr. of expected Markings:	Number of markings that will be detected (1, 2 or 3)
Expected min width:	Minimum width of marking. Markings less wide will not be measured (default: 80)
Expected max width:	Maximum width of marking. Wider markings will not be measured (default: 280)
R_L Pass/Fail min value:	Minimum R_L value of a marking, lower values will be stored as 0 in the measuring file (default: 40)
R_L Pass/Fail max value:	Maximum R_L value of a marking, higher values will be stored as 0 in the measuring file (default: 1000)
Cam trigger low value:	Picture will be taken if R_L is lower
Cam trigger high value:	Picture will be taken if R_L is higher

5.8.2 General settings

The language can be changed in the general settings, click on "General" in the settings window to open the general settings window:

Language:	Language
Beep on Error:	Beep if error occurs
GPS Model:	Trimble LAN (default)

GPS Precision:	12 (default)
Convert to old Format:	Converts measurement files to old format See chapter 9 "Data analysis" on page 59.

5.8.3 Event button configuration

The buttons underneath the bar diagram in the measuring window are called "Event Buttons", see chapter 5.4.1 on page 27. They store predefined texts in the measuring file when pressed during a measurement. The event buttons can be named individually, e.g. "Roadwork" or "Wet marking".

The first three buttons have a punctual setup which means the event will only be written once into the measuring file when pressed. The other seven buttons have a linear setup which means the event will be written in the measuring file as long as the button is activated.

Click on "Event Buttons Configuration" in the settings window to open the event button configuration window:
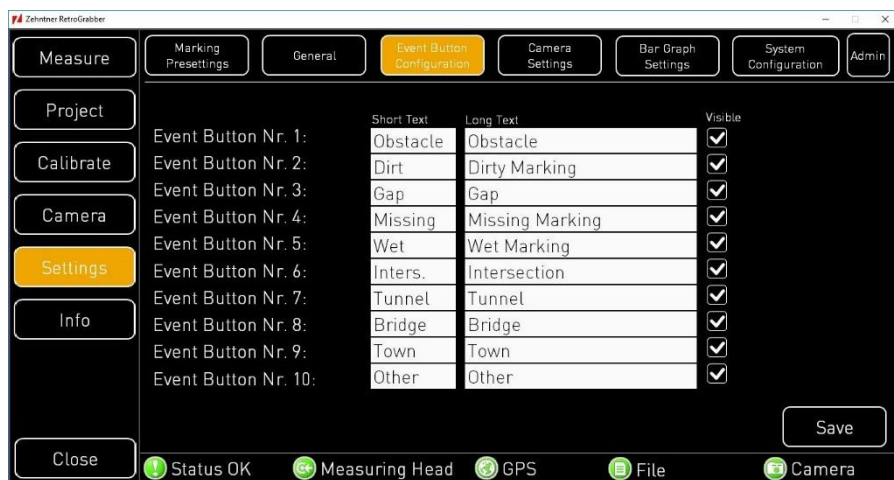
Short Text:	Caption on the button
Long Text:	Text written in measuring file
Visible:	Button visible/invisible
Save button:	Save changes

5.8.4 Camera settings

The behaviour of the camera can be set with the camera settings, click on "Camera Settings" to open the camera settings window:

Cameras:	Cameras connected to the system
Enable Pictures:	Enable / disable camera
Take Pic every full km:	Automatically takes several pictures every km. This is meant to detect position indicators on the road and adjust the mileage accordingly
Take always Pictures:	Takes pictures every 10 m
Apply Marking Presetting:	Takes a picture if the R_L value is below or above the camera values in the marking presetting, see chapter 5.8.1 on page 37.
Show Label in Picture:	Adds a name to the picture and shows two lines on the picture which can be adjusted with the arrows to indicate the position of the measuring field on the road

5.8.5 Bar Graph settings

The bars in the bar diagram can be configured in the "Bar Graph Settings".

Show simplified Bar-graph: Bar in the bar graph is rectangular

Show grey Bars on Bar-graph: Hides bars that are not recognized as markings

5.8.6 System configuration

🛈   There is no need to change the settings in this window for normal operation. Only use this window if you are asked to do so by an administrator.

More advanced features like filter settings can be configured in the System Configuration. Click on "System Configuration" in the configuration window to open the system configuration window:
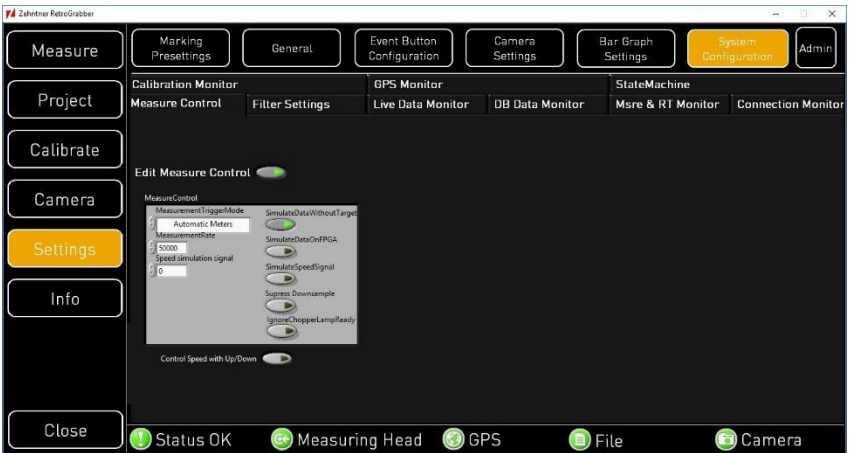
Measure Control: Internal use only

Filter Settings:	Data filter needed to calculate R_L
Live Data Monitor:	Internal use only
DB Data Monitor:	Internal use only
Msre & RT Monitor:	Important system parameters like lamp voltage
Connection Monitor:	Information about TCP parameters and active connection.
Calibration Monitor:	Calibration parameters, internal use only
GPS Monitor:	GPS, temperature and humidity
State Machine:	Internal use only

Filter Settings

Before an R_L value is calculated and displayed, the measured raw data need to pass several filter and validation checks. Click on the "Filter Settings" tab in the system configuration window:
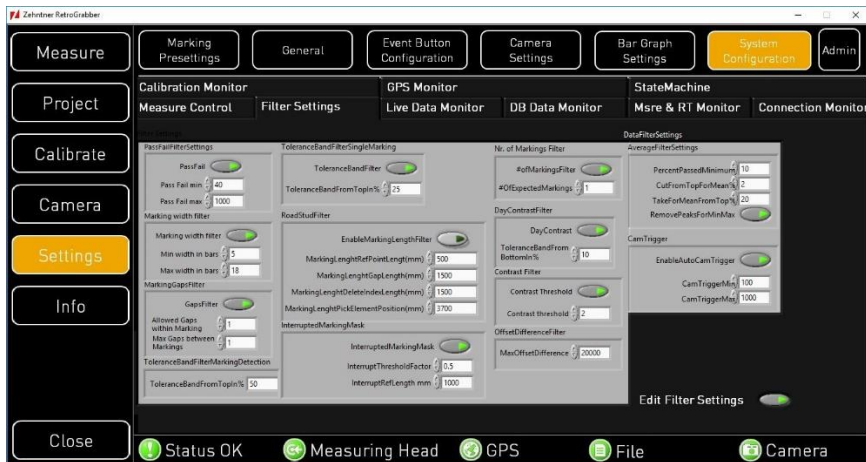
🛈 Be aware that wrong filter settings may result in erroneous measurements. The default values should not be changed.

Edit Filter Settings: Enable editing filter settings

PassFailFilterSettings

Upper and lower limit for valid R_L values. Taken from the current Marking Presetting, see chapter 5.8.1 on page 37. Values outside of limits are discarded.

- PassFail: Enable / disable filter
- Pass Fail min: Lower limit, R_L not valid if lower, default = 40
- Pass Fail max: Upper limit, R_L not valid if higher, default = 1000

Marking width filter

Maximum and minimum width of a valid marking. Taken from the current Marking Presetting, see chapter 5.8.1 on page 37. Instead of millimetres, the width given here is in bars. A bar represents one channel of the sensor, its width in the measuring field is approx. 1.5 cm (100 cm / 64 = 1.5 cm). Values outside of limits are discarded.

- Marking width filter: Enable / disable filter
- Min width in bars: Lower limit, marking not valid if lower
- Max width in bars: Upper limit, marking not valid if higher

MarkingGapsFilter

Number of gaps (in bars) allowed within and between markings.

- GapsFilter: Enable / disable filter
- Allowed Gaps within: Number of gaps allowed within a marking
- Max Gaps between: Number of gaps allowed between two markings

ToleranceBandFilterMarkingDetection

Max difference (tolerance band) of R_L value in % between best and worst marking when measuring double or triple lines

- ToleranceBandFromTopIn%:   Tolerance band in %, default = 50

ToleranceBandFilterSingleMarking

Max difference (tolerance band) of R_L value in % between best and worst channel when measuring single lines

- ToleranceBandFilter: Enable/disable filter
- ToleranceBandFromTopIn%:   Tolerance band in %, default = 25

RoadStudFilter

Road stud detection

InterruptedMarkingMask

Interrupted marking filter

No. of Markings Filter

Number of expected markings, value taken from the current Marking Preset, see chapter 5.8.1 on page 37. Default = 1

DayContrastFilter

Calculation of day contrast ratio.

- DayContrast: Enable / disable filter
- ToleranceBandFromB.:   Tolerance band in %, default = 10

Contrast Filter

Calculation of day contrast ratio.

- Contrast Threshold: Enable / disable filter
- Contrast Threshold.:   Contrast threshold, default = 2

OffsetDifferenceFilter

Internal filter, do not change

AverageFilterSettings

Filter settings for average calculation of R_L (R_L DB).

- PercentPassedMin.:   Min percentage of measurements within an interval that must have passed all filters, default = 10
- CutFromTopForMean%: Percentage of the highest measurements to be eliminated (noise reduction), default = 2
- TakeForMeanFromTop%: Percentage of measurements (counted from top) to be included in average calculation, default = 20
- RemovePeaksForMinMax: Enable / disable removal of peaks

CamTrigger

Filter settings for automatic camera triggering. Values taken from the current Marking Preset, see chapter 5.8.1 on page 37.

- EnableAutoCamTrigger: Enable / disable filter
- CamTriggerMin: Takes a picture if R_L is lower, default = 100
- CamTriggerMax: Takes a picture if R_L is higher, default = 1000

Msre & RT Monitor

Important system parameters like lamp voltage, signal quality and vehicle speed are shown. Click on the "Msre & RT Monitor" tab in the system configuration window:
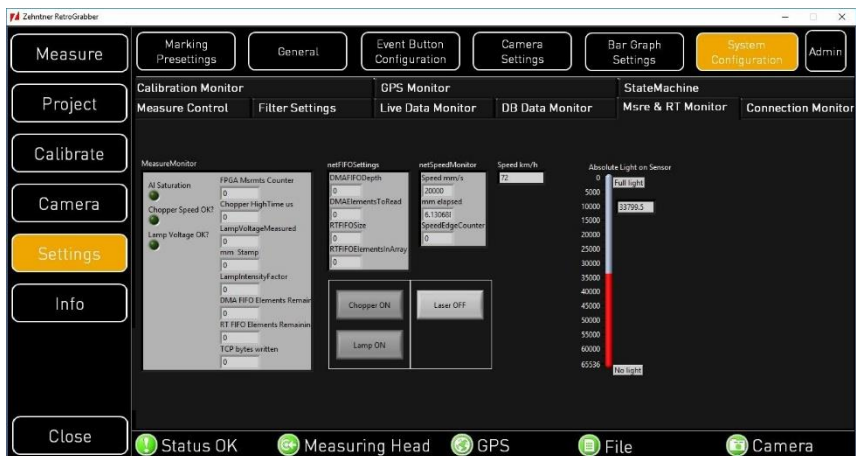
LampVoltageMeasured: Voltage on halogen lamp

Speed km/h: Vehicle speed

5.8.7 Admin

Password protected administration area, for internal use only.

5.9 Info

Errors, warnings and general system information. Click on "Info" in the main menu to open the info window.
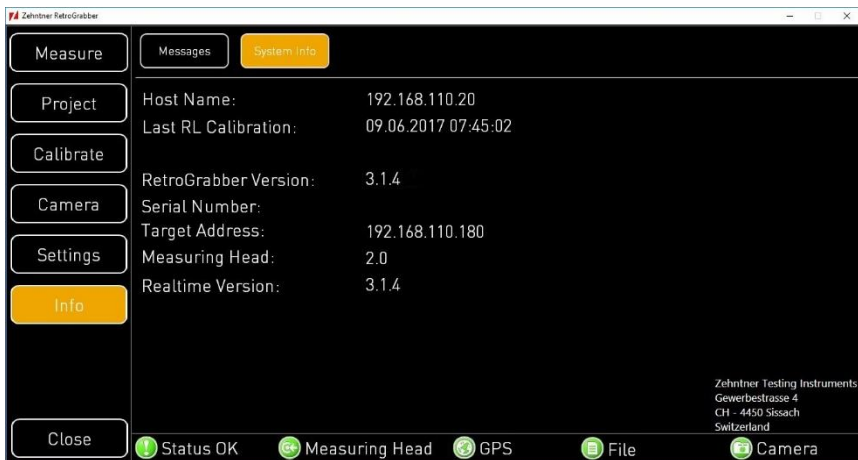

5.9.1 Messages

Errors and messages are displayed and explained in this area. The "Status OK" icon in the status bar changes to red if an error or warning message appears.

5.9.2 System info

Host Address:	IP of RetroGrabber
Last R_L Calibration:	Date of last calibration
RetroGrabber Version:	RetroGrabber software version
Serial Number:	Serial number of measuring head
Target Address:	IP of measuring head
Measuring head Version:	Measuring head hardware version
Realtime Version:	Measuring head software version

6   Measuring

⚠️   Keep the device dry. Danger of short circuit!

6.1 Country regulations

Please take into consideration that several countries have certain regulations concerning the measurement of road markings. Please inform yourself before starting to measure in order to comply with these regulations.

6.2 Setting up the system

Preparing the system for measuring involves placing the tablet in the docking station, starting the RetroGrabber software and attaching and levelling the measuring head. Follow the guide below to set up the system:

Put the lever on the docking station's upper side in open position. Place the tablet in the docking station and push down the lever, lock docking station with the key if needed.

Lever in locking position

Tablet

Docking station

Lever in open position
Push down lever

Lever in locking position

Start the car and then switch on "Main" on the panel:

Main switch

Switch on the tablet. Mount the measuring head while the tablet is booting up:

Open the fasteners and remove the protective cap from the carrier pipe.

Open the protective cap on the external connector by pushing back the safety clamp underneath.
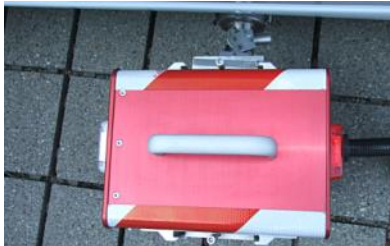

Slide the mounting adapter with the nozzle on top into the carrier pipe.

⚠ The left mounting adapter does **not** fit the right vehicle side and vice versa.

Lock the fasteners.

Attach the measuring head to the mounting adapter by sliding it from above.
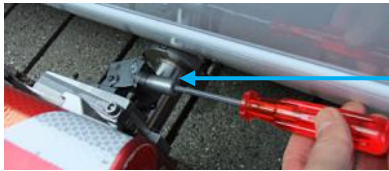
Plug in the connector.

Secure the connector by locking the safety clamp.
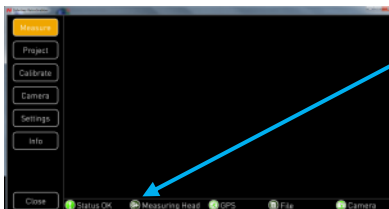

Use the screwdriver type #5 Allen key to lock the quick release fastener.

Quick release fastener locked.

Start the RetroGrabber software then switch on "Head" on the panel and wait approx. 20 seconds until the RetroGrabber has connected to the measuring head. The icon changes from dark to light green:

RetroGrabber software, measuring head not connected yet (icon dark green)

Head switch

Measuring head connected to RetroGrabber software (icon light green)
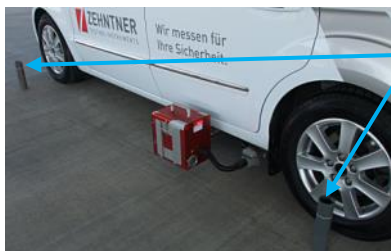
Switch on "Laser" on the panel:

Laser switch.

⚠ **Laser radiation class 2. Avoid direct eye contact to beam.**

Place the corresponding auxiliary height indicator next to the centre of the front and rear wheel, so that the laser beams are visible:

Auxiliary height indicators

❗ The height indicator for the front wheel is marked with **F**, the one for the rear wheel with **R.**

Use the height adjustment screw on the measuring head and the angle adjustment screw on the mounting adapter to level the measuring head in a way that both laser beams point to the white ring on the auxiliary height indicators:
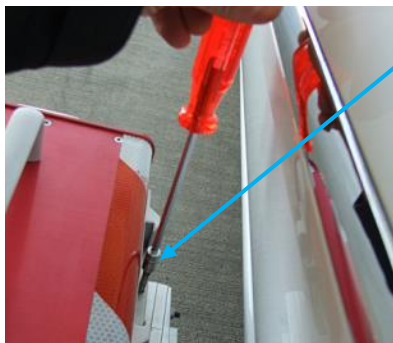
Height adjustment screw on the measuring head

Use the screwdriver type #5 Allen key to adjust the height of the measuring head.

⚠ The quick release fastener must be unlocked when moving the screw.

Angle adjustment screw on the mounting adapter

Use the screwdriver type #5 Allen key to adjust the inclination of the measuring head.

⚠ The quick release fastener must be unlocked when moving the screw.

Laser beam pointing to white ring on front wheel height indicator.

Laser beam pointing to white ring on rear wheel height indicator

Remove the height indicators and switch off "Laser" on the panel.

6.3 Calibration

Each time the measuring head is mounted on the vehicle it should be calibrated, at least once a day. Calibration means that the ZDR 6020 is compared to a reference calibration standard with a known R_L value. The deviation between the measured and the reference values should not exceed 5 %.

> ! Calibrating the system correctly is essential to get good measuring results. Use a flat and even spot for calibration.

> ! Make sure you use the same marking presetting for calibration as for measuring, see chapter 5.8.1 on page 37.

Make sure the measuring head is properly levelled as described above before calibration. Place the calibration unit in front of the measuring head as described below:
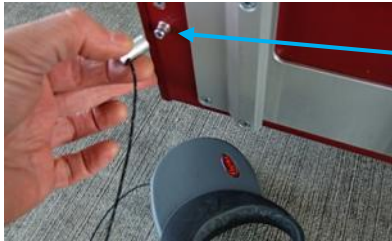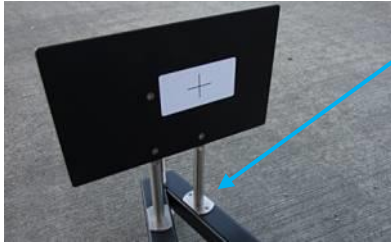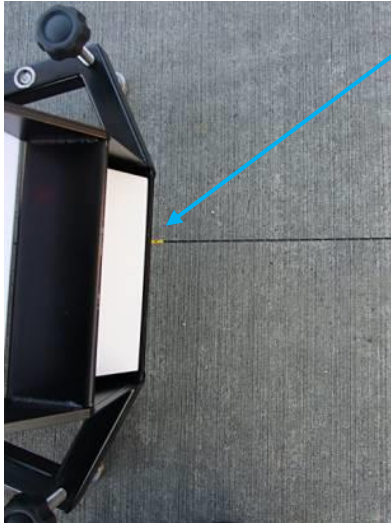

Attach the gauge to the measuring head.

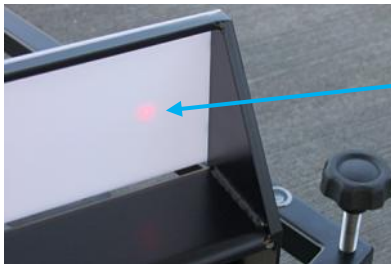Walk four meters forward until the yellow mark is visible and place gauge on the floor.

Place calibration unit on yellow mark and remove the front cover plate.

Insert the cover plate into the two holes at the far end of the calibration unit. Make sure the plate is correctly seated.

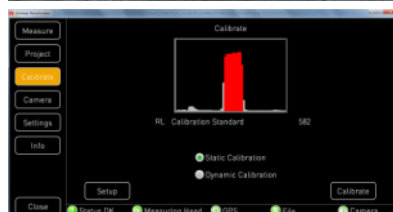The yellow mark must be in level with the calibration unit.

Adjust position and height of the calibration units´ front part so that the laser beam is passing the little hole in the white screen.
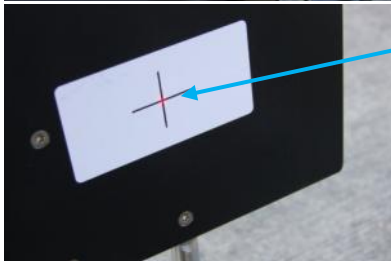
Adjust position and height of the calibration units´ rear part in a way that the laser beam is in the centre of the cross.

Properly placed calibration unit

Open the calibration dialog in the RetroGrabber software. Make sure that "R_L Calibration Standard" is the reference value of the calibration unit. Change that value in the Setup if necessary. Press Calibrate.

The calibration process takes a couple of seconds. Accept the calibration if the deviation does not exceed 5 %.
Otherwise, discard it. Make sure the measuring head is levelled correctly and reposition the calibration unit as described above. Repeat the calibration.

Open the measuring window and check R_L. It must be within a digit or two of the reference value.
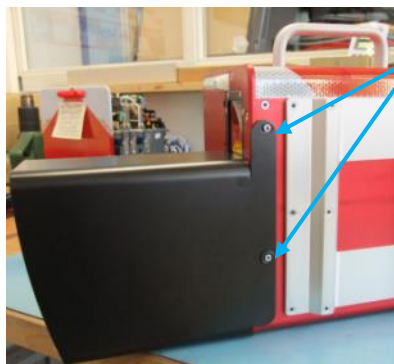
6.4 Measuring

Measuring is done by driving along the road and scanning the road pavement markings with the measuring head. In the driver display you will see the red, green and blue sensor bars that represent the markings. While driving, always make sure the markings are inside the detection area.

Set up the system as described in chapter 6.2 on page 47. It is recommended to do a calibration each time the measuring head is mounted, or at least once a day, see chapter 6.3 on page 52.

It is also recommended to prepare all projects and measuring files in advance and not on the road, see chapter 5.5 on page 29.

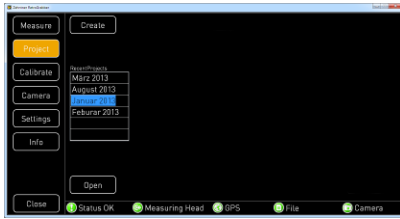Always attach the sunshade when measuring:

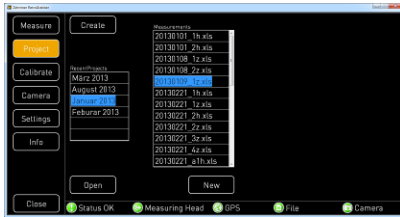Hold the sunshade over the optics and attach it onto the fittings.
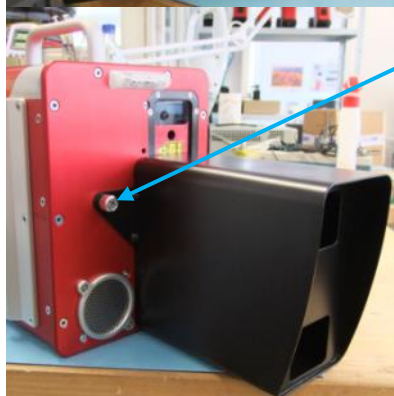
Tighten the screw to fix it completely.

Open a project and a measuring file in the RetroGrabber software. Press Project in the main menu, see also chapter 5.5.1 on page 30.

Open or create a project

Open or create a measuring file

Open the measuring window. All icons in the status bar are now light green and the system is ready for measuring

Having reached the point where you want to start to measure, press "Capture" and the software will then record the measurement information on the tablet. At the end of the measuring area press Capture again to stop recording.

You may interrupt measuring by pressing "Capture" again. When continuing later on, the software will append the measurements to the existing file.
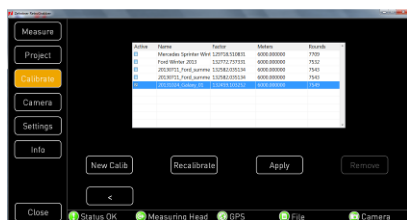
7   Speed Calibration

The speed is calculated from the car's odometer pulse and needs to be calibrated by the RetroGrabber software. After the initial factory calibration it is only necessary to do a speed calibration when changing tires, e.g. changing from summer to winter tires.

To do so, set up the system as described in chapter 6.2 on page 47 and drive along a known reference distance. The street should be 5 – 10 km long and as straight as possible, a motorway is best suited.

🛈   As all mileage and speed information is derived from that calibration, the length of the reference distance must be as accurate as possible.

In the RetroGrabber software go to Calibrate – Setup – Speed Calibration. Click on New Calib.
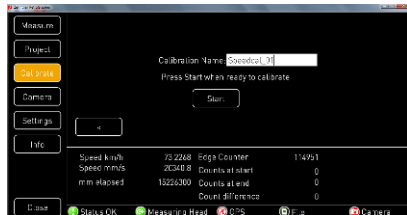
Type in a name, then drive to the start of the reference distance and press Start. Do not stop, keep on driving with a constant speed while passing the start point.

When reaching the end of the reference distance, press Stop while passing the end point.
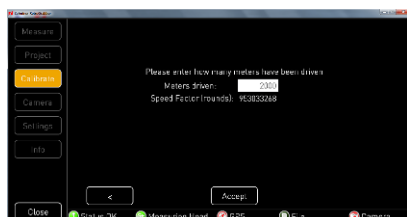
Type in the driven distance in meters and press Accept.

Choose the new speed calibration from the list and press Apply.

8	**Tools**

8.1 NetSetMan

The communication between the different system components (measuring head, camera, GPS) is based on an Ethernet connection which uses the tablet's local network adapter. The program NetSetMan is used to change the adapter settings. Two profiles are available:

ZDR 6020:	Used for measuring, default
Office:	Used for internet connections while working in the office.

🛈   The measuring head will not connect when NetSetMan is set to Office. Do not forget to switch to ZDR 6020 profile before setting up the system.

8.2 LogMeIn

The program LogMeIn allows remote access to the tablet. This feature is used by Zehntner for maintenance purposes such as software updates or trouble shooting.

🛈   By default, LogMeIn is disabled and it needs to be enabled by the customer. Zehntner cannot and will not access your tablet remotely without your prior consent.

9	Data analysis

The measuring data is stored in an open source, tab separated text format, which makes adapting and importing the data easy. See chapter 5.5.3 on page 32 for a detailed description of the file format. It can also be analysed with a spread sheet program like MS Excel.

Zehntner provides a free software called "MappingTools" for easy and quick data analysis. Please refer to the separate "MappingTools" instruction manual for more information.

🛈 For RetroGrabber Versions 3.0.x and 3.1.x the following steps must be taken in order to import the measuring file into the "MappingTools" software Version 1.25 or older.

Go to "*Settings – General*" and press the button labelled "*Convert to old format*" on the right side.

Choose the appropriate ZDR 6020 measuring file "*xxx.xls*" from the explorer window.

Now there are three files called *xxx_converted_1.xls, xxx_*converted_*2.xls* and *xxx_converted_3.xls* which can be imported in the "MappingTools" software.

The new version of "MappingTools" (1.26 and higher) can import all ZDR 6020 measuring files without prior conversion.

10	Maintenance

10.1 Maintenance carried out by the user

The user may only carry out the following maintenance and repair:

- Cleaning as described in chapter 10.2 on page 60.
- Replacing the lamp as described in chapter 10.3 on page 60.
- Replacing the protective glass on the measuring head as described in chapter 10.4 on page 65.
- Replacing the fuses in the car and the power supply unit (car box) as described in chapter 10.5 on page 65.

🛈 All other maintenance and repair work may only be carried out by Proceq SA Instruments or your authorized Proceq agent, otherwise all warranty is void.

⚠ Make sure that the ZDR 6020 is turned off and unplugged before doing any maintenance.

10.2 Cleaning

We recommend that the instrument is checked and certified by Zehntner every two years. Clean the **aluminium housing** with a proper, soft cloth and use commercially available cleaning agents such as cleaning agents for glass, benzene, acetone. Furthermore, we recommend cleaning the instrument periodically using water- and oil-free compressed air (max. 1.5 to 2 bar).

🛈 Do not use strong acids or alkaline liquids!

🛈 Unplug the measuring head from the car before cleaning.

🛈 Never immerse the device into water or other liquids.

🛈 Make sure that no cleaning liquid flows into the interior of the instrument.

The **optics window** is coated with a special antireflection coating that should not be damaged. If the soft brush is not sufficient for cleaning the window, you may use a soft paper tissue and window cleaner.

🛈 The instrument consists of delicate optical and electronic precision parts. Do not drop it and protect it from shocks, moisture and dust.
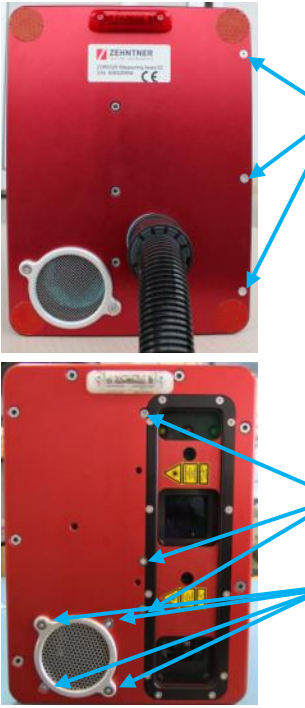
🛈 Do not open the measuring head for cleaning. If you recognize dust or small particles on the cooling air inlet and outlet, you may remove the protection grid and clean the inside of inlet and outlet with a vacuum.
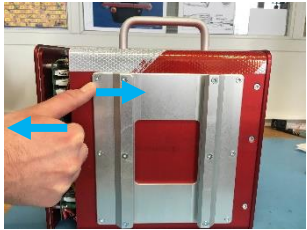
10.3 Replacing the lamp

⚠ Make sure the lamp is cold before you replace it. Please do not touch the bulb and reflector.

The lamp inside the measuring head may be replaced by a technician. Please follow the instructions below:

	Tools and parts needed: 1 Allen key 3 mm 1 Allen key 2.5 mm 1 Allen key 2 mm 1 Spare lamp Note: The spare lamps are aligned optically and then glued to the lamp holder part. This alignment process may only be performed at Proceq SA Factory.
	Open the measuring head housing: 1. Loosen the three screws on the right side of the cable on the back side (Allen key 2 mm).
	2. Loosen the three central screws on the front side (Allen key 3mm). 3. Loosen the four screws on the cooling air outlet on the front side (Allen key 2.5mm).
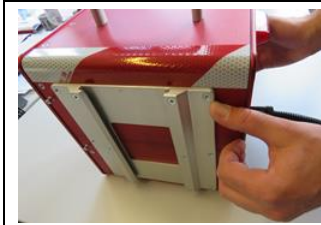
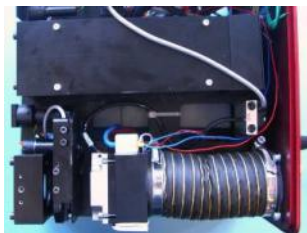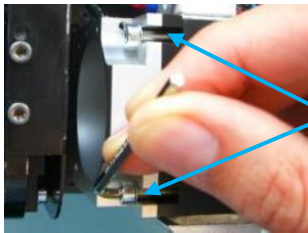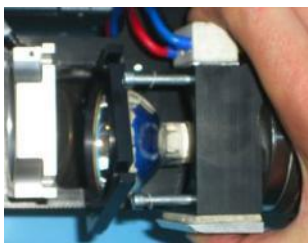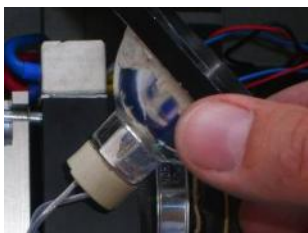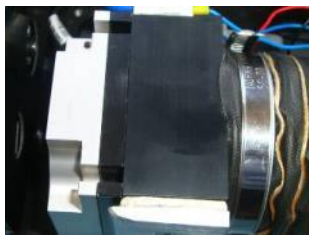|	
	Place both hands on each side of the measuring head as shown in the picture. The thumb against the edge of the mounting bracket and all other fingers against the small edge of the back plate.
	Press on both sides simultaneously. Press with the thumb forward against the mounting bracket and pull back the back plate with all other fingers. The measuring head should now begin to slide out of the housing gradually.
	Alternative solution: If the head doesn't slide out easily, try the following: Screw the M4 screw from the storage box into the centre hole as much as possible. Take a rubber mallet or similar and hit the screw gently. The measuring head should now begin to slide out of the housing gradually
	Gently slide the measuring head out of its housing. Note: Do not pull the main cable.
	Lay down the measuring head, facing the left side to the top.

	Loosen the two screws on the lamp holder with a 3mm Allen key.
	Lift up the air outlet part a little, and then push back the air outlet part by squeezing the flexible tube together.
	When the flexible tube is squeezed, the lamp with its holder is laid open.
	Gently pull the lamp out of the fit it is sitting in.
	Unplug the lamp and replace it by the new lamp. You may plug in the lamp either way, polarity does not matter.

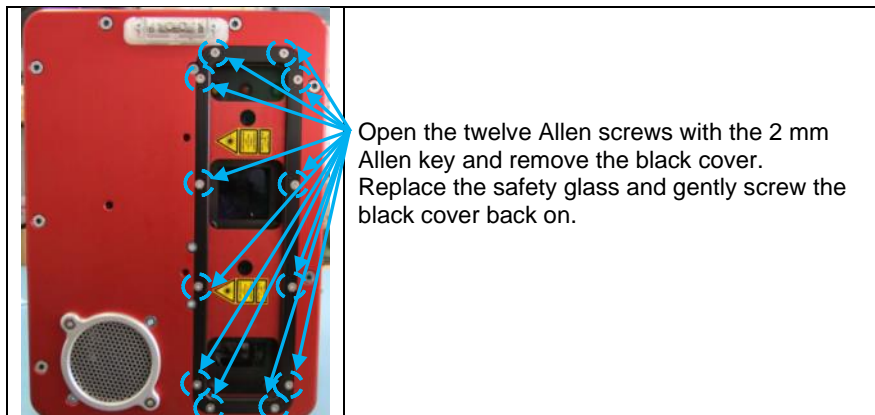|	
	Put back the lamp to its position carefully. Always make sure it sits nice and tight in its fit. For easier operation it is recommended to remove the screws before positioning the lamp.
	Afterwards place the air outlet part into its position. Make sure this part sits in its fit correctly as well. You may check whether the parts sit in their fit correctly by sliding over the three parts with your fingertip.
	Reassemble and tighten the two screws.
	Slide the measuring head back into its housing and close it by tightening the housing screws in reverse order.
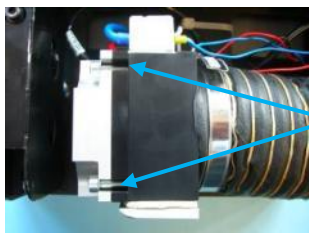
10.4 Replacing the protective glass

Open the twelve Allen screws with the 2 mm Allen key and remove the black cover.
Replace the safety glass and gently screw the black cover back on.

🛈   Do not overtighten the screws as the protective glass might crack.

10.5 Replacing the fuse

There is a set of spare fuses to be found in the grey storage box.

The 40A main fuse is located near the car battery. It protects the feed line from the car battery to the power supply unit (car box). Please refer to the wiring schematics in chapter 4.11 on page 24.

A 30A fuse protects the entire system, it is located inside the power supply unit (car box).

There are four fuses located on the plug side of the power supply unit (car box), see chapter 4.9 on page 23:

F2: measuring head power 2A
F3: camera, GPS 2A
F4: halogen lamp 15A
F5: tablet 10A

🛈   Replace fuses only with one of the same rating.

11 Error messages

Error	Description	Solution
6100 Carbox fan error	Fan in power supply unit is blocked	Make sure the fan is not blocked mechanically.
6110 Lamp fan blocked	Halogen lamp fan is blocked	Make sure the fan is not blocked mechanically. Remove cooling air inlet and check visually if fan is blocked.
6112 Lamp voltage error	Lamp voltage is out of range	Make sure the measuring head is plugged in correctly. Clean contacts on connector plug with contact spray.
6113 Lamp power error	Lamp power is out of range	Make sure the lamp is not broken. Check visually if the lamp is on. If not it might be broken.
6114 Chopper speed error	Chopper speed is out of range	Make sure the chopper is not blocked. Restart the system.
6116 CRio fan blocked	CRio vent is blocked	Make sure the fan is not blocked mechanically. Restart the system.
7110 Measuring head not connected	Unable to connect to the measuring head	Make sure the current NetSetMan profile is set to ZDR 6020. Restart the system. Check the LEDs at the network plug of the docking station.
7210 LAN connection not available	Ethernet Controller not active or no power on docking station	Check your network adapter and the docking station's power cable.
7310 Data communication error	Data format error	Restart the system.
7312 Sensor saturation	Too much light on sensor	Adjust alignment of measuring head.
7420, 7422 State machine error	Cannot measure because lamp, chopper or FIFO is not OK	Restart the system.
7501 GPS NL-404P serial port error	Cannot open GPS serial port	Select the right COM port in the app settings.
7502 GPS Trimble serial port error	Cannot open GPS serial port.	Select the right COM port in the app settings.
7511 GPS NL-404P error	No GPS Data available	Make sure the GPS sensor is connected to the docking station.
7515 GPS Trimble error	No GPS data available	Make sure the GPS antenna is plugged in correctly in the power supply unit (car

		box).
7516 GPS Trimble Settings	No connection to GPS receiver available	Check GPS settings and network connection.
7530 Camera error	Camera not connected	Make sure the camera is connected correctly.
7531 Camera error	No camera available	Make sure the camera is connected correctly.
7540 Data serial port error	Cannot open data serial or COM port	Make sure the COM port is not blocked by another program.
7550 Data serial port error	Cannot write to data serial port	Select the right COM port in the app settings.
7610, 7620 Write XLS header error	Unable to write parameters to specified measuring file	Make sure the measuring file exists and you have write permission. Make sure the measuring file is not opened by another program like MS Excel.
7630 Write parameter error	Unable to write parameters to specified measuring file	Make sure the measuring file exists and you have write permission. Make sure the measuring file is not open in another program like MS Excel.
7660 Calibration Error	Calibration Error	The R_L calibration value is either 0 or not a defined number. Probably the marking preset is not defined well for the current marking.
7661 Load speed calibration error	Speed calibration values could not be loaded	Make sure the measuring head is connected to the software. Restart the system.
7662 Save speed calibration error	Speed calibration values could not be saved	Make sure the measuring head is connected to the software. Restart the system.
7663 State machine error	State Machine cannot be put into idle state	Restart the system.

12 Technical specification

Observation distance: 30 m, according to CEN-geometry, equivalent
Observation angle: EN 1436: 2.29°
                          ASTM E1710: 1.05°
Illumination angle: EN 1436: 1.24°
                          ASTM E1710: 88.76°

Measuring area (WxL):	≥ 1000 mm x 880 mm (≥39.4" x 34.65")
Measuring distance:	6 m (19.7 ft.)
Measuring speed:	max. 150 km/h (93.21 mph)
Measuring range R_L :	0 - 4'000 mcd·m^{-2}·lx^{-1}
	profiled markings -≈20 mm (0.79")
Power consumption:	12 - 16VDC; 20 A nominal; 33 A maximum
Picture interval:	10 m (32.81 ft.)
Light source:	Halogen lamp
Working life of the lamp:	approx. 1'500 hours
Operating temperature:	0°C - +55°C (32°F - 131°F)
Storage temperature:	-15°C - +60°C (5°F - 140°F)
Humidity :	non condensing
Dimensions (LxWxH):	measuring head 270 mm x 207 mm x 310 mm
	(10.63" x 8.15" x 12.2")
	power supply unit (car box): 360 mm x 150 mm x 450
mm	
	(14.17" x 5.91" x 17.72")
Weight:	measuring head: 10.5 kg (23.1 lbs)
	power supply unit (car box): 8.5 kg (18.74 lbs)
Standards:	EN 1436 (R_L), ASTM E1710 (R_L)
	ASTM E 2177 (R_L wet),
	ASTM E 2176 (R_L continuous wetting, withdrawn in
2013)	
EG-directives:	EN 60950-1 (safety), EN 50371 (safety),
	EN 55022 (EMC),
	EN 55024:1998+A1:2001+A2 (EMC)
	The device is compatible with car equipment
Approval:	StrAus-Zert, Germany (No.: 0913-2009-05)
Warranty:	2 years

Glossary