LTL3000 and LTL3500 Retroreflectometer

User Manual

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USA Statement

Note:

LTL3000 and LTL3500 have been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Canada Statement

Note:

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his/her own expense.

Declaration of Conformity for EU, USA and Canada.

See FORCE website – LTL3000: https://roadsensors.com/products/ltl3000/#certification

See FORCE website – LTL3500: https://roadsensors.com/products/ltl3500/#certification

Disclaimer

The information contained in this document is subject to change without notice.

DELTA MAKES NO WARRANTY OF ANY KIND WITH REGARD TO THIS MATERIAL, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICU-LAR PURPOSE. DELTA SHALL NOT BE LIABLE FOR ERRORS CONTAINED HEREIN OR FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES IN CONNECTION WITH THE FURNISHING, PERFORMANCE OR USE OF THIS MATERIAL.

LTL3000 AND LTL3500 ARE BUILT ON GENERAL PUBLIC LICENSE COMPONENTS. THE SOURCE CODE IS AVAILABLE UPON REQUEST.

Intended use/purpose

LTL3000 and LTL3500 retroreflectometer are portable field instruments used for on-site inspection and quality control of retroreflection properties of road markings.

Important Safety and Handling Information

Caution
Changes/modifications not approved by the responsible party could void the user's authority to operate the equipment.

Use the unit only in the way described in this manual. Failure to follow the guidelines and instructions in this manual may be dangerous and illegal.

LTL3000 and LTL3500 may not be used with other batteries than those supplied with the product.

Disposal and Recycling Information

Please ask your appointed dealer concerning disposal of LTL3000 / LTL3500 in your country.

Visit our website: https://roadsensors.com/

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Introduction

The LTL3000 and LTL3500 retroreflectometers are portable field instruments intended for measuring the retroreflection and reflection properties of road markings. This manual covers both instruments. Throughout the manual it is indicated in the text if a topic or feature applies to both instruments (LTL3000/LTL3500) or only applies to one of the instrument types (e.g., LTL3500).

What does the instrument measure?

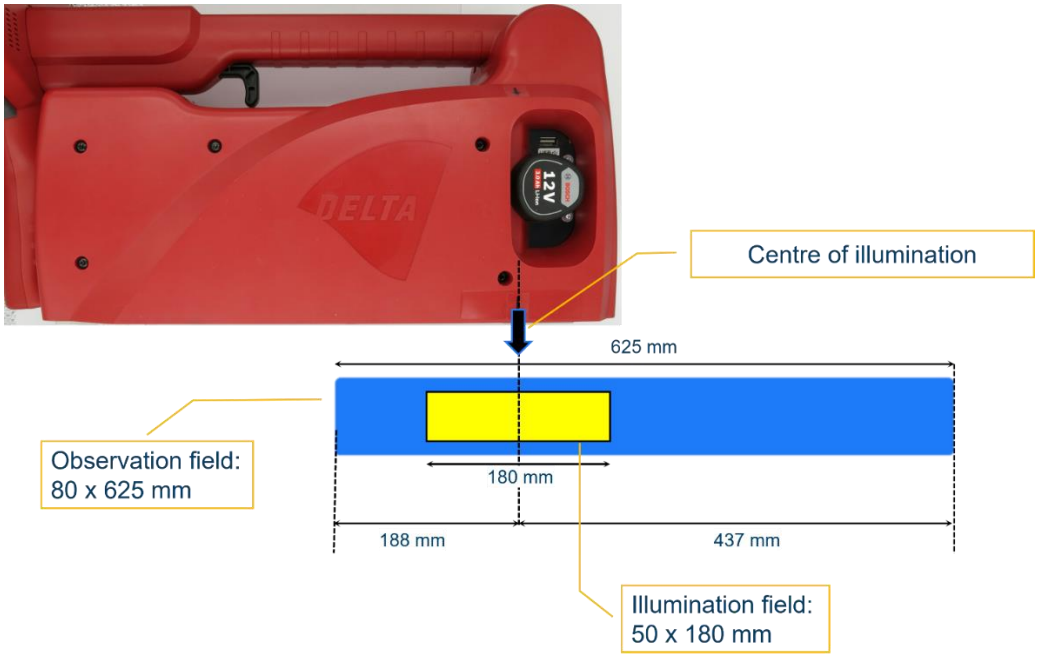
LTL3000/LTL3500 measures the RL value (coefficient of retroreflected luminance at night / in darkness) and the Qd value (day light visibility). RL is a measure of the road marking's brightness as seen by drivers of motorized vehicles with headlights turned on. For RL, the road is illuminated at an angle of 1.24°, whereas the illumination for Qd (daylight) is diffuse.

The reflected light for both RL and Qd is measured at an angle of 2.29°, which corresponds to an observation distance of 30 meters - i.e., a motorist's viewing situation under normal conditions. Further information about measuring principles and standards can be found on https://roadsensors.com/.

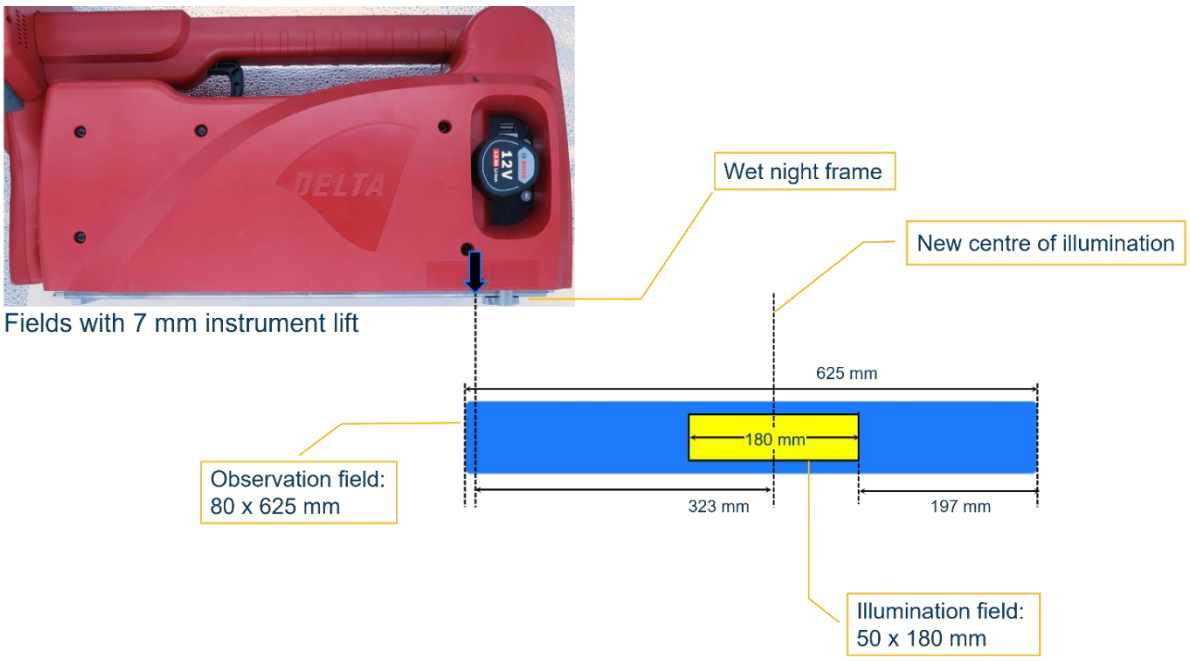
Measurement fields

The center of the illumination field length (180 mm / 7.1 inch) is marked with a black arrow on the body of the instrument (see picture below). The width of the measurement field (50 mm / 2 inch) is centered.

The figures below show the placement of the fields for normal and continuous wetting operations.



For continuous wetting measurements the instrument is raised 7 mm by mounting the wet night frame.



Note: Ensure that reflective objects such as RPM, shoes and similar are not in the instrument's field of view as this can affect the measurement.
Objects within 1 m / 39.37 inch can affect the measurement. With wet night frame the distance is approx. 1.5 m / 59 inch.

LTL3000/LTL3500 measures:

- RL (nighttime visibility) of markings under dry and wet conditions. RL range: 0 to 4000 mcd·m^{-2}·lx^{-1}
- Qd (daytime visibility) of markings under dry and wet conditions. Qd range: 0 to 318 mcd·m^{-2}·lx^{-1}
- Nighttime chromaticity coordinates (x, y).

LTL3000/LTL3500 has automatic ambient light compensation. Thus, daylight and other outside light sources will not affect the accuracy of the measurements.

Overview of LTL3000 and LTL3500

The LTL3000/LTL3500 retroreflectometer is easy to operate and requires a minimum of instructions.

The measurement results are presented on the instrument's touch screen. Each measurement can be linked to a user/operator name and a series name.

The instrument provides a warning message or sound in case of unreliable measurement.

Most action buttons on the instrument are accessible via the touch screen. The physical buttons and features on the instrument are shown below.

Front and side of the LTL3000/LTL3500:

The LTL3000/LTL3500 is equipped with a USB port on the side of the instrument for data export via a memory stick.

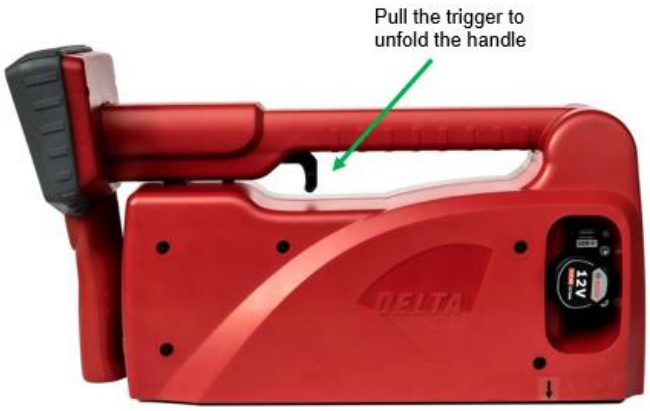
The instrument is powered by a rechargeable battery, offering many hours of measurement capacity. A mains powered battery charger is supplied with the instrument as standard delivery.

Extractable handle *(only LTL3500)*

The LTL3500 is featured with an extractable handle enabling the user to operate the instrument and view the instrument display from an upright working position.

The handle can be adjusted in various lengths (high/low) by pushing the black trigger on the handle.

For easy transportation when the instrument is not in use, the extractable handle can be folded down. Pull the black trigger unfold the handle again.



Getting started

Insert battery: before using the LTL3000/LTL3500 instrument make sure that the battery is charged and inserted in the battery slot on the side of the instrument.

Turn on: press the green button on the handle of the instrument. After 10-15 seconds, the system has booted, and the instrument is ready for use.

Standby: the instrument automatically switches to **standby mode** if the instrument has not been used for a specific amount of time. From stand-by mode the instrument is instantly ready when pressing the green button on the handle.

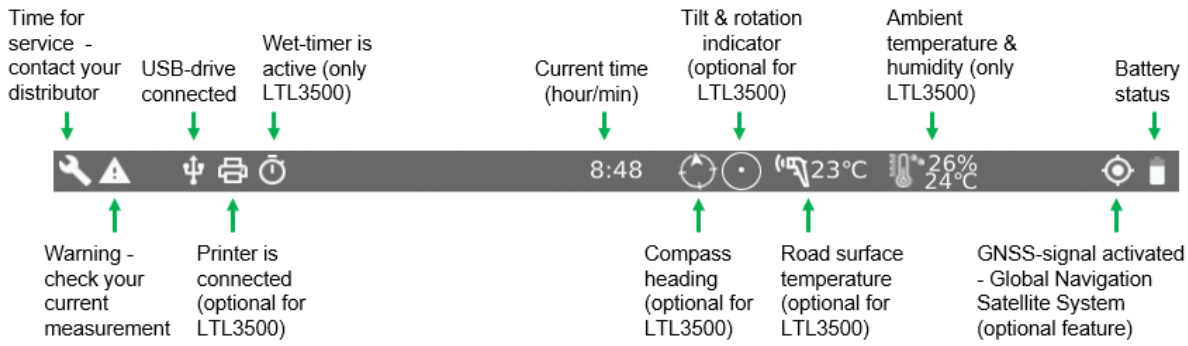
Calibrate: to ensure high quality of data we recommend that you perform an RL calibration of the instrument every day the instrument is in use, typically in the morning before commencing the measurements (see how in the section named 'Calibration' in this manual).

The Qd (optional feature) measurement system is factory calibrated and calibration can be done occasionally.

Switch off: press the X-button on the handle of the instrument and then press 'Shutdown' in the menu on the touch screen, and the instrument will switch off.
Note: The instrument automatically turns off when it has not been used for an extended amount of time.

Icons

The icons in the status bar at the top of the display screen give you information about the instrument status and operational mode:



Icon explanation:

	It is time for service on your instrument. Please contact your local distributor
	Warning signal for your current measurement
	USB drive is connected and accepted
	Printer is connected and accepted
	Wet timer is active (only LTL3500)
	The current time (hour/min)
	Compass heading (optional feature - only LTL3500)
	Tilt and rotation indicator (optional feature - only LTL3500)
	Road surface temperature (optional feature - only LTL3500)
	Ambient temperature & humidity (only LTL3500)
	GNSS-signal is activated e.g., Global Navigation Satellite System (optional feature)
	Battery status

Main menu

The various instrument actions can be accessed via the main menu on the display screen:

You can activate the main menu in 3 ways:

- press ☰ at the top left corner of the display screen to access the main menu,
- or press **X** on the instrument handle.

If you want to close the menu again, just touch the display or press X on the instrument handle.

The main menu consists of these elements:

Icon	Function	Explanation
	Measure	Perform an inspection
	Series	Select, add, edit, or delete series of measurements
	Templates (only LTL3500)	Select, add, edit, or delete a template
	Users	Select, add, edit, or delete a user
	Log	Export measurement series to USB stick or delete data
	Calibrate	Calibrate the LTL3000/LTL3500
	Settings	Adjust settings (language, time, date etc.)
	Shutdown	Power off the instrument

Note: all information you enter or alter under the individual menu items is automatically stored in the instrument.

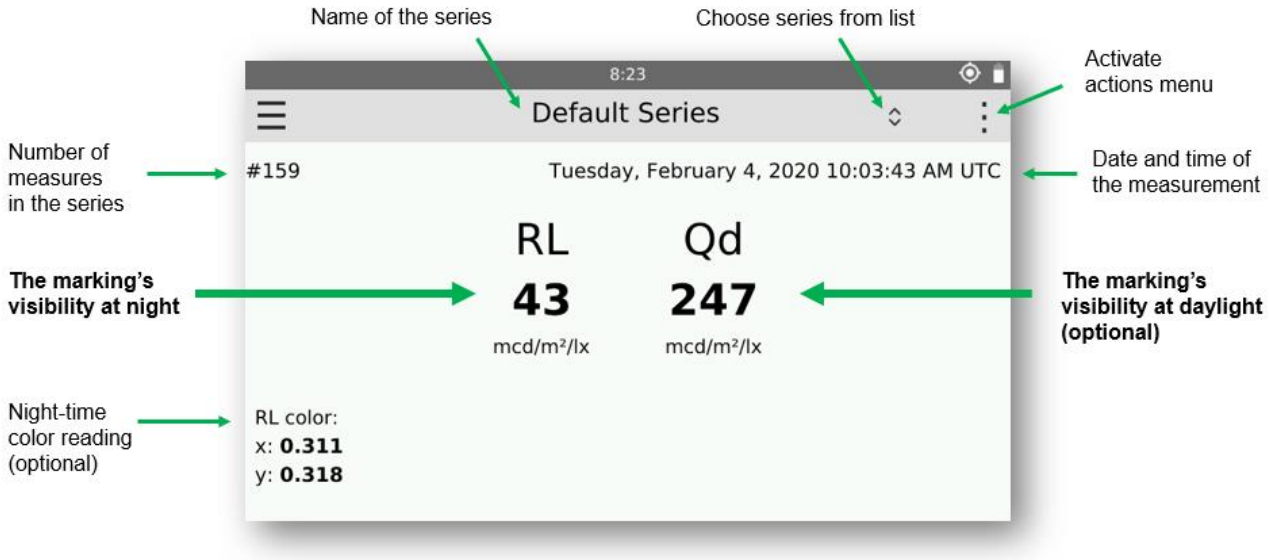
Perform a measurement

Select ‘Measure’ from the main menu, and the instrument is now ready to perform a measurement.

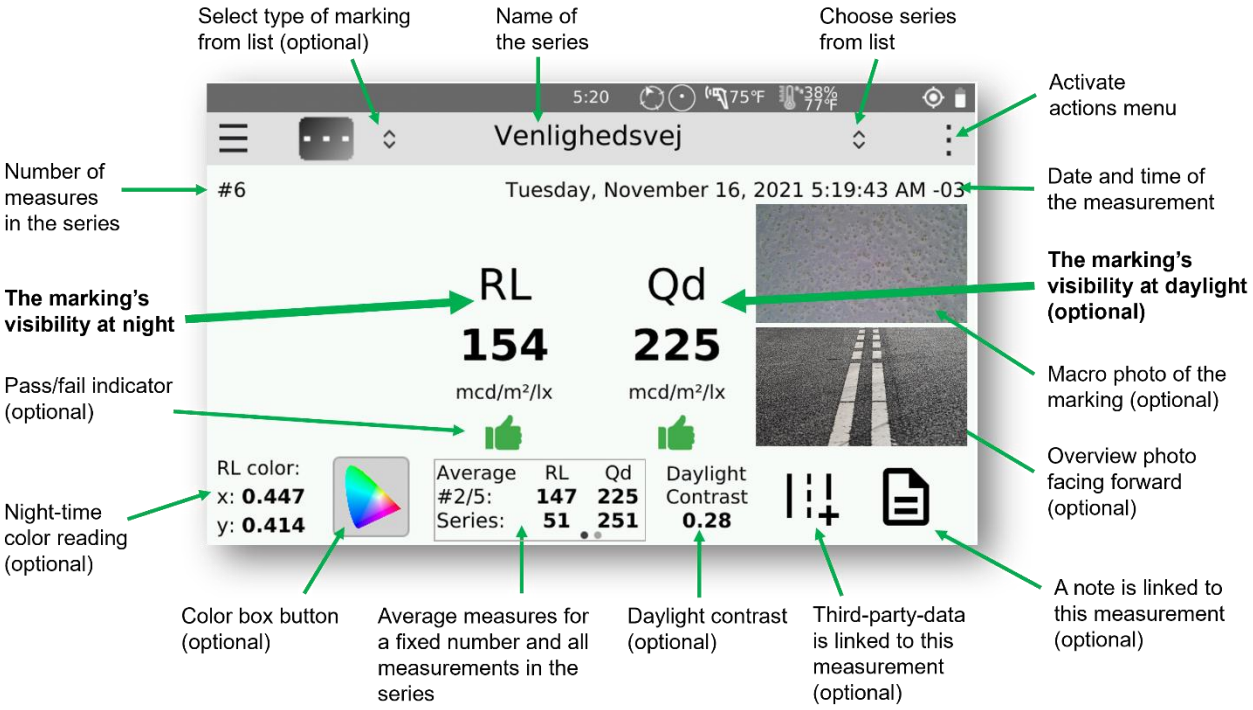
Place the instrument on top of the specific road marking you want to measure and press the green button on the instrument handle.

Wait a second until the reading is shown on the display.

LTL3000 display:



LTL3500 display:



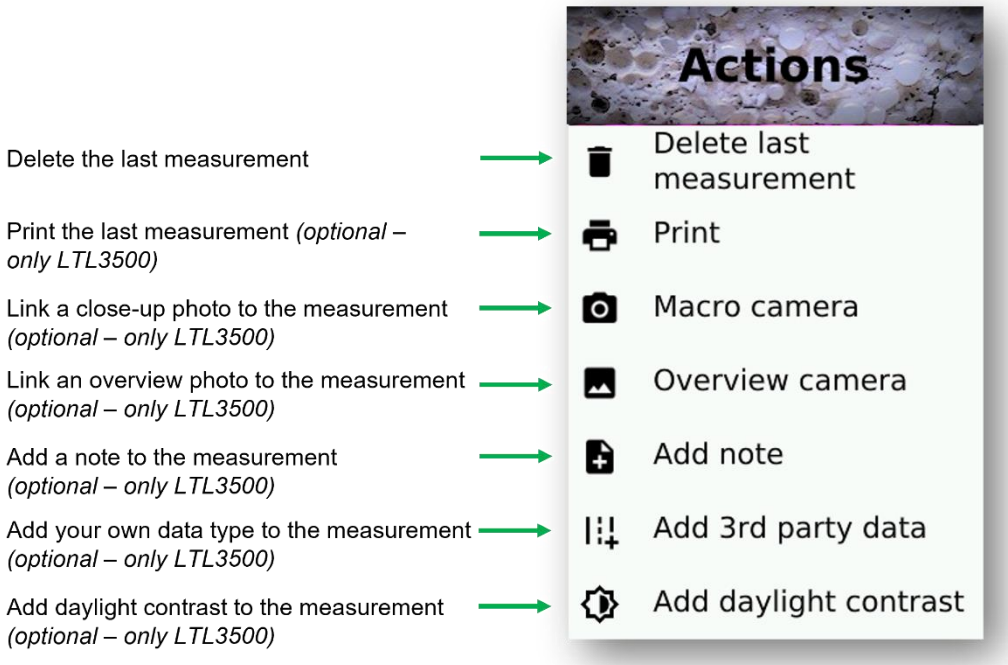
The measurement data is automatically saved by the instrument. You can now continue to conduct another measurement.

If you want to switch to another series, pressing ⇕ and choose the relevant series from the drop-down menu (or select it in the Series menu) and continue with your measurements.

Actions

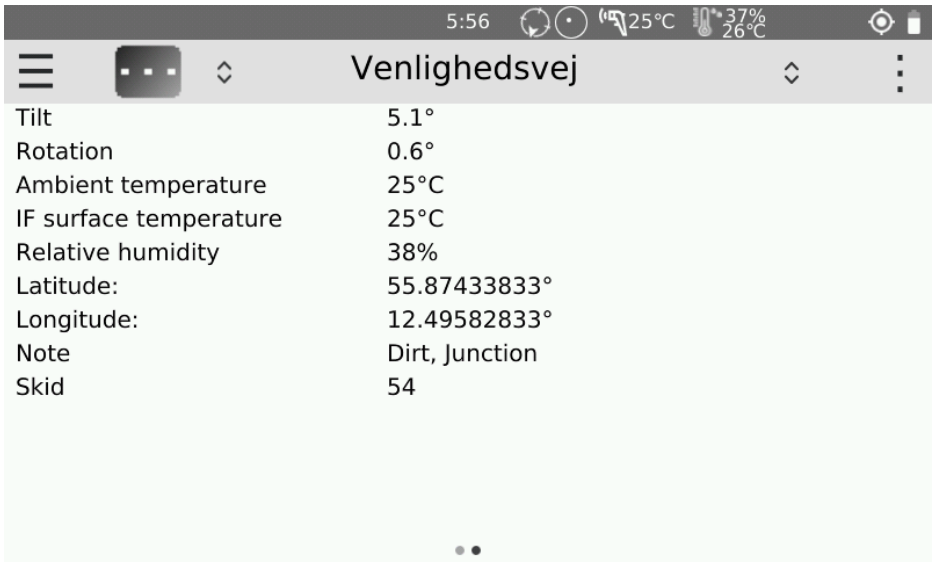
There are various actions you can do with your current measurement. Activate the actions menu by pressing ⋮ at the top right corner on the screen.

Elements in the actions menu:



The elements in the actions menu are explained in detail in section ‘Actions Menu’ later in this manual.

Swiping from right to left on the measure screen lets you see auxiliary data which are attached to the current measurement.



Working with series and templates

It is very easy to use the instrument to conduct measurements, and the instrument helps you organize the data:

- Your measurements are stored in series. A **series** is defined as all the collected data and measurements for a specific work assignment.
- Your series are based on a template (only LTL3500). A **template** defines which settings should be applied to a series. The template specifies the data fields to be captured during an inspection e.g., wet timer, RL pass/fail check.

You can add, select, edit, or delete series of measurements. Likewise, you can add, select, edit, or delete templates.

In practice, when you add a new series you must decide which template to use for your series before you conduct the measurements. If you select an existing series from your list, then a template is already linked to the series.

Templates *(only LTL3500)*

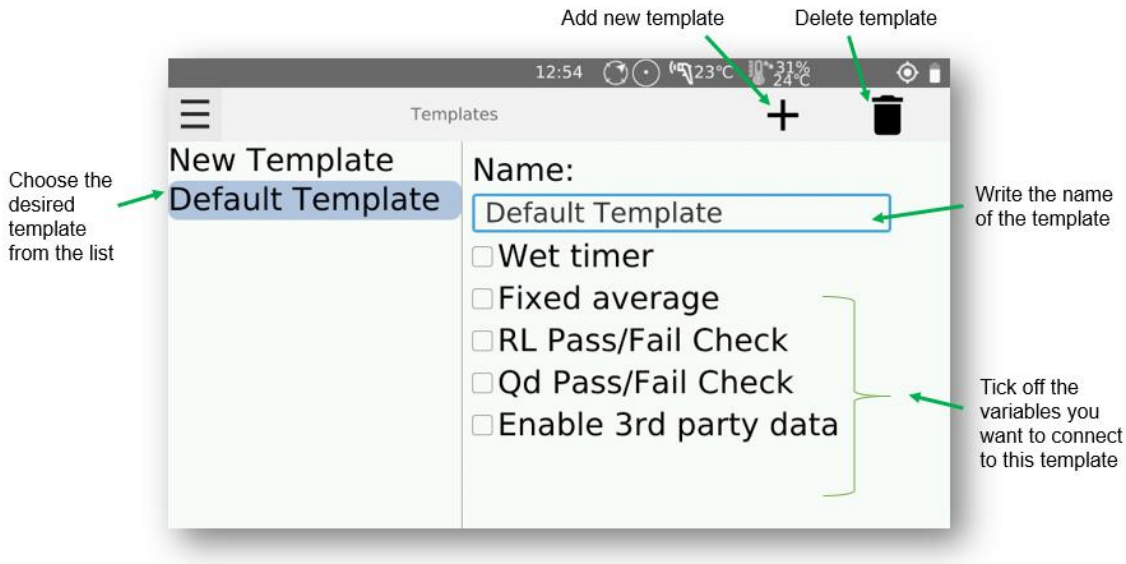
Start by selecting 'Templates' from the main menu. On the display, all your templates are now listed on the left side of the screen.

Select a template: Press the template on the list, you want to use – the template is now selected. Tick off the template variables you want to activate. Add user defined variables by ticking off 'Enable 3rd party data'. You can now continue selecting a series for your measurements (switch to 'Series' in the main menu).

Add a new template: Press + on the top bar to add a new template and write a name in the 'Name' field for your new template (use the keyboard on the touch screen). Tick off the variables you want connected to this template. The template is now added, and you can continue selecting at series for your measurements (switch to 'Series' in the main menu).

Edit a template: From the template list, select the template you want to edit and type the new name of the template in the 'Name' field. Select or deselect variables from the variable list. When finished press return arrow, and the new name of the template is saved.

Delete a template: Press the template on the list that you want to delete, then press 🗑 on the top bar. The template is now deleted.
Note: It is required that at least one template exists, thus it is impossible to delete the last template.



Explanation to the individual template variables:

Wet timer: Introducing a delay from pressing the measurement button until the actual measurement is taken e.g., 30 second's delay.

Fixed average: Calculates an average of a user-defined number of measurements e.g., 5 measurements.

RL Pass/Fail Check: Set a pass/fail threshold for the RL value. If the RL value of your measurement is above this threshold, then a green thumps-up symbol is visible on the display, but if the RL value is below then a red thumps-down symbol appears on the display.

Pass:

Fail:

Qd Pass/Fail Check: Set a pass/fail threshold for the Qd value. If the Qd value of your measurement is above this threshold then a green thumps-up symbol is visible on the display, but if the Qd value is below then a red thumps-down symbol appears on the display.

Enable 3rd party data: Option of collecting 3rd party data, which will be added to your log file. Remember to name the 3rd party data e.g., 'Skid Resistance' or 'Marking Thickness'.

Series

First, start by selecting 'Series' from the main menu. On the display, all your series are now listed on the left side of the screen.

Select a series: Press the series on the list, you want to use – the series is now selected. For LTL3500 a specific template is linked to the series: Tick off the template variables you want to activate and write a value for each of them in the box next to the variable.

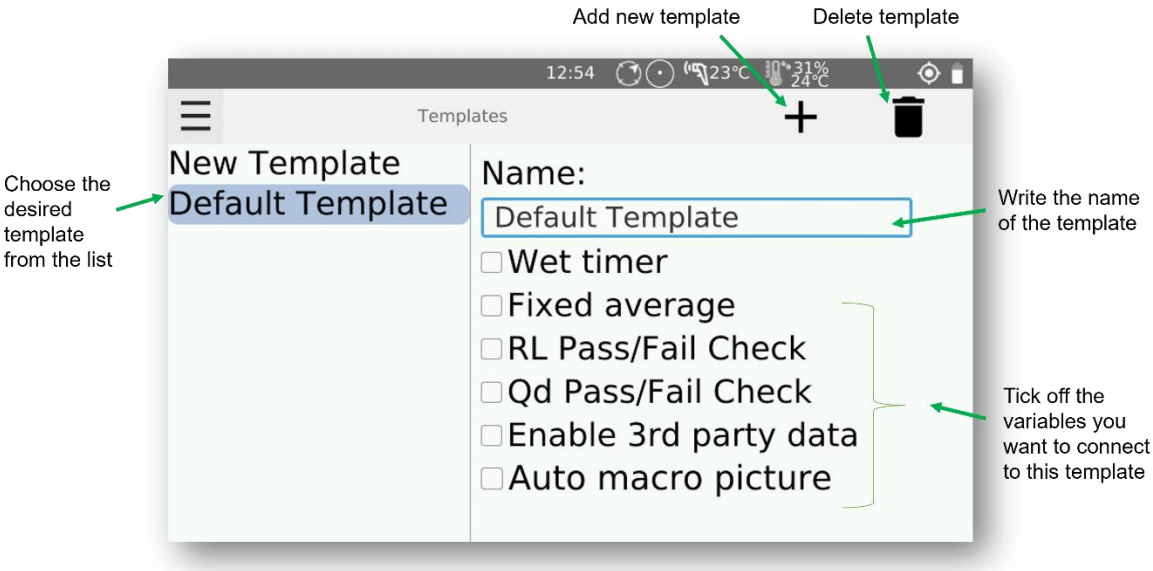
You can now continue with your measurements (switch to 'Measure' from the main menu) and the data will be linked to the chosen series.

Add a new series: Press + on the top bar to add a new series and write a name in the 'Name' field for your new series (use the keyboard on the touch screen). For LTL3500 you will be asked which template to use for this series: Select the relevant template and tick off the variables you want to activate. Write a value for each of the variables.

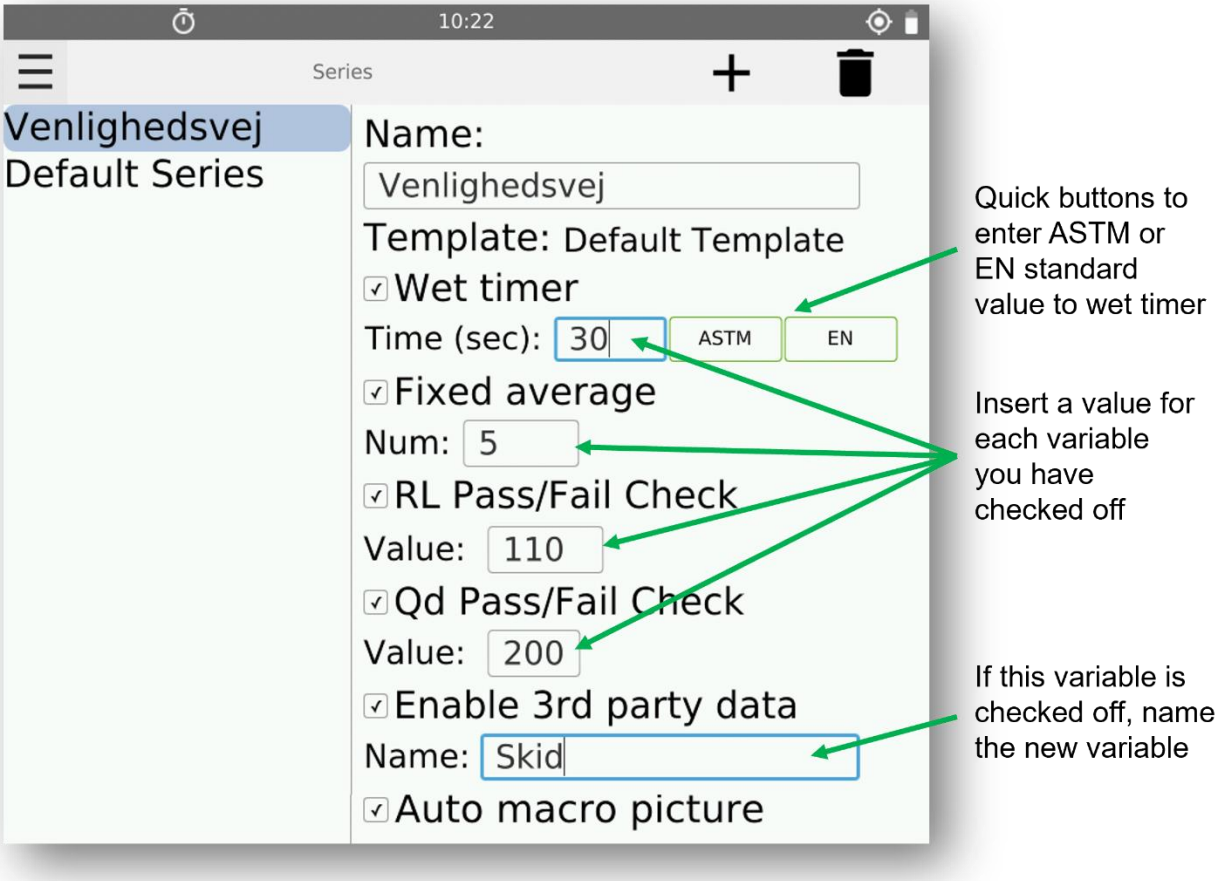
The series is now added, and you can continue with your measurements (switch to 'Measure' from the main menu) and the data will be linked to the new series.

Edit a series: From the series list, select the series you want to edit and type the new name of the series in the 'Name' field. When finished press return arrow, and the new name of the series is saved.

Delete a series: Press the series on the list you want to delete, then press 🗑 on the top bar. The series and associated measurement data are now deleted.
Note: It is required that at least one series exists, thus it is impossible to delete the last series.



For LTL3500: Insert an appropriate value for each template variable you have ticked off. If you have ticked off '3rd party data', then remember name this new variable e.g., "Skid Resistance' or "Marking Thickness":



Users

It is possible to link the measurements to a specific person. It could be relevant in cases where the instrument is used by different staff, and you want to identify which measurements have been conducted by whom.

You can select, add, edit, or delete users. First, start by selecting ‘Users’ from the main menu. On the display, all your users are now listed on the left side of the screen.

Select a user: Press the user on the list, you want to use – the user is now selected. You can now continue with your measurements (switch to ‘Measure’ in the main menu) and the user will be linked to the data.

Add a new user: Press + on the top bar to add a new user. Type the name of the new user in the ‘Name’ field by using the keyboard on the touch screen. Press the return arrow to finish. The user is now added, and you can continue with your measurements (switch to ‘Measure’ from the main menu) and the user will be linked to the data.

Edit an existing user: Select the user on the list and rename the user profile (using the keyboard on the screen and press the return arrow to finish.). The user is now renamed, and you can continue with your measurements.

Delete a user: On the list select the user you want to delete. Press 🗑 on the top bar. The user and the related measurements are now deleted.

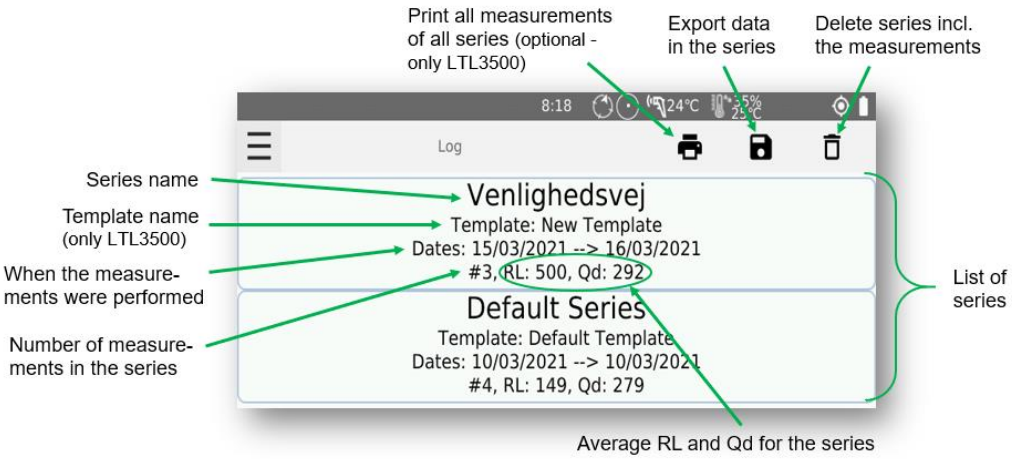
Note: it is required that at least one user exists, in other words it is impossible to delete the last user.

Log

The LTL3000/LTL3500s keep a log of all the measurements conducted. In the log you can see the data for each series and export the data.

View list of series

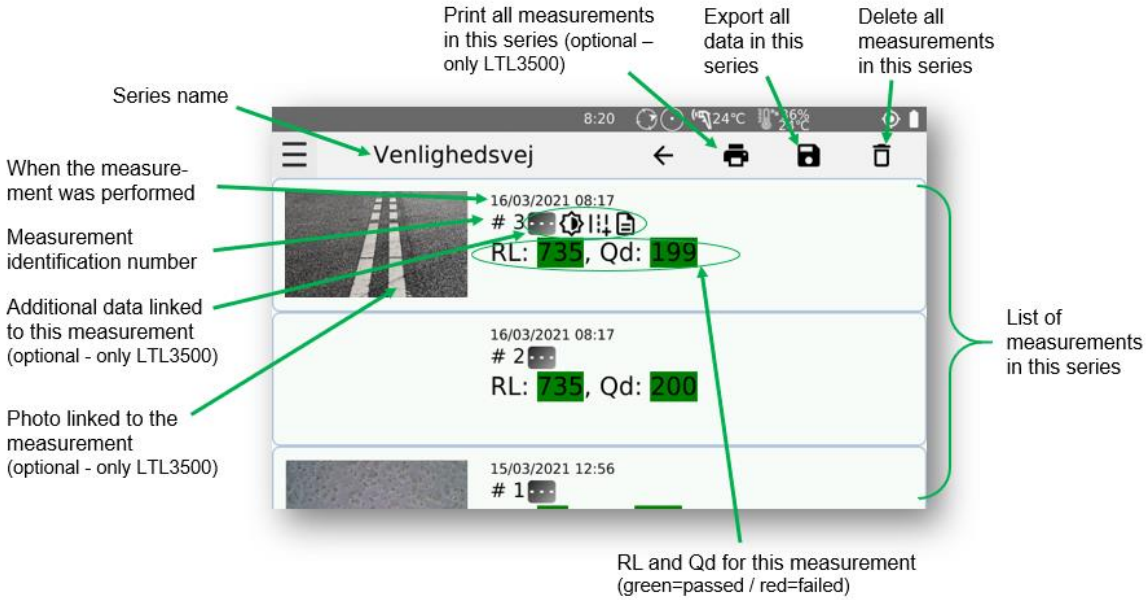
Start by selecting 'Log' from the main menu. Series containing measurement data are now displayed in a list on the screen.



Press the symbols at the top of the screen to print (optional feature), export, or delete all the series including the associated measurements and data. You can also see the measurements in a series by selecting the series.

View list of measurements in a series

From the log list, press the series you are interested in. A list of all the measurements in this series are now shown on the screen.

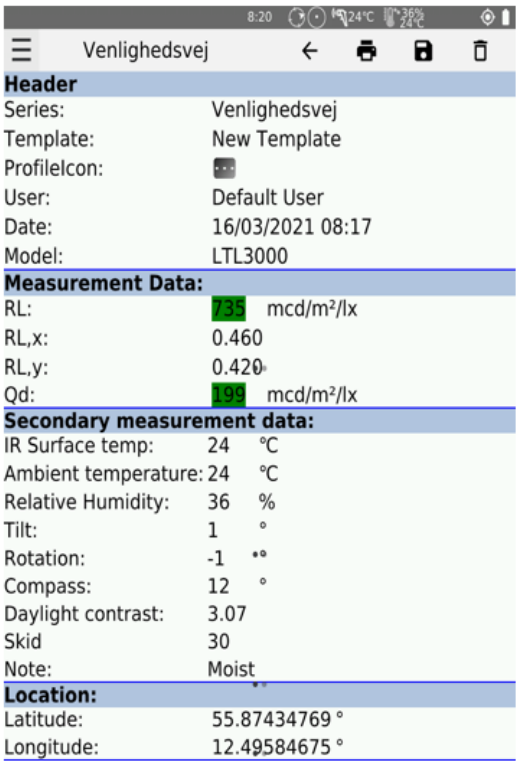


Press the symbols at the top of the screen to print (optional feature), export, or delete all the measurements in the series (including the associated data).

You can also see the measurement data in full detail by selecting the measurement.

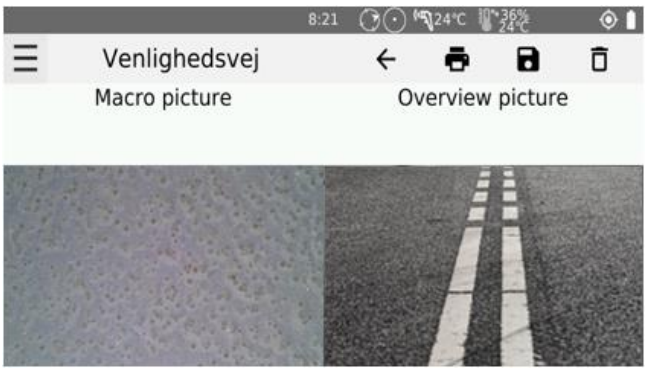
View all data for a measurement

From the log list of measurements, press the particular measurement you want to see details for. Now you can see all the measurement data in details:



Press the symbols at the top of the screen to print (optional feature), export, or delete all the data in this measurement.

Swipe to the left to see macro and overview pictures (optional feature – only LTL3500):

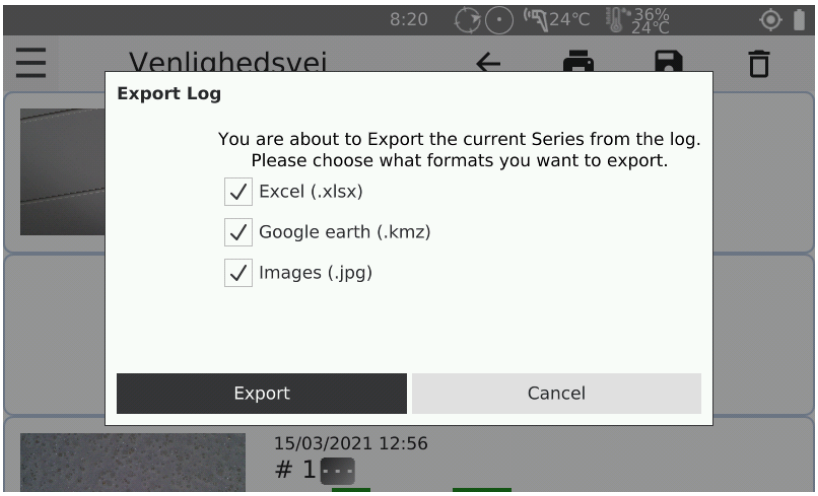


Export measurement data

Series and measurement data can easily be exported to a USB stick for further analysis.

How to transfer data:

- Choose the relevant series or measurement
- Press at the top of the screen. If pressed while viewing all series, all series will be exported.
- In the dialog box, tick the formats you want to export and press ‘Export’.



The data is now transferred to the USB stick. Google Earth files will only be available if the instrument is equipped with GNSS and if there is valid GNSS data recorded. Likewise, images will only be available if the instrument is equipped with macro/overview camera (optional feature for LTL3500 only) and if one or more pictures are captured.

Note: remember to insert a FAT32-formated USB memory stick in the USB port before you transfer the data.

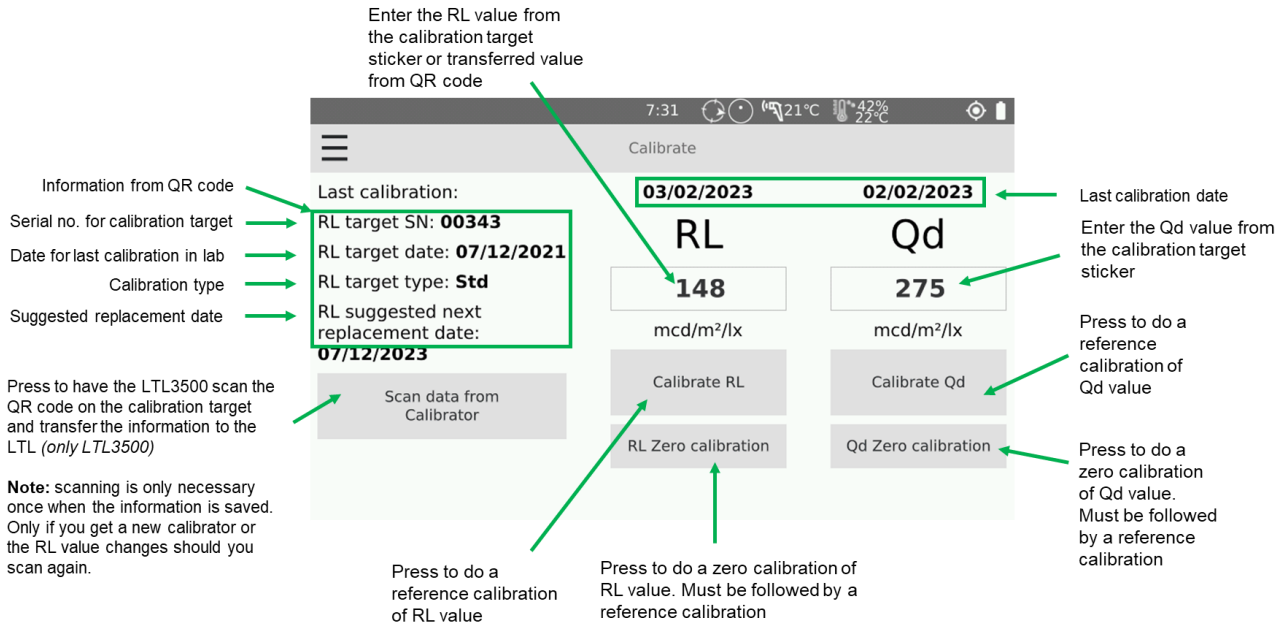
Calibration

To ensure high quality of the measurement data, DELTA recommends that you calibrate the LTL3000/LTL3500 daily.

Each day you use the instrument - typically in the morning before commencing your measurements you should perform a ***Zero calibration*** followed by a ***Reference RL calibration*** *and a* ***Reference Qd calibration*** (optional).

The calibration process automatically compensates for instrument offsets etc.

Calibration screen overview:



RL calibration

Zero RL calibration

To do a zero calibration follow these steps:

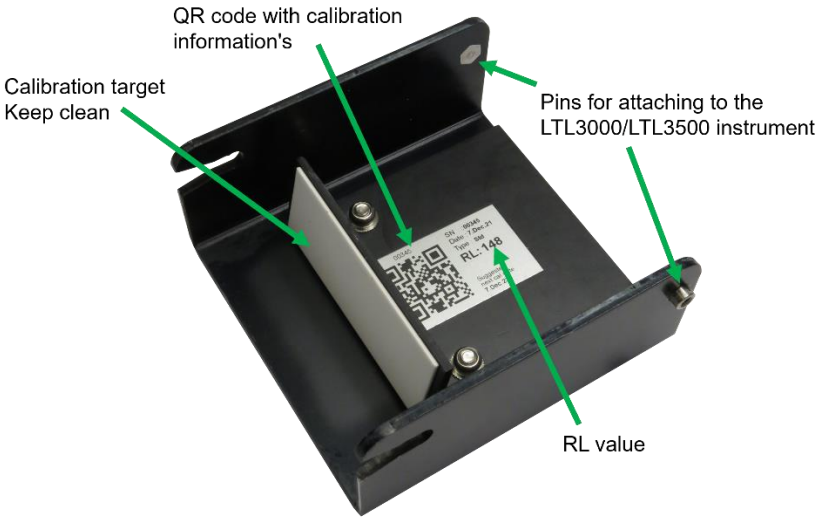
- Make sure the protection window underneath the instrument is clean. If necessary, clean it following the instruction described in section ‘Maintenance’.
- Select ‘Calibrate’ from the main menu.
- Press ‘RL Zero calibration’ on the screen.
- Tilt the instrument backwards and make sure it is not pointing at anything within several meters. **Note: Especially reflective materials e.g., from lamps will affect the calibration.**
- Press OK and wait for success confirmation.

Important: Zero calibration must be followed by a Reference RL calibration

Reference RL calibration

RL calibration can be done without performing a *Zero RL calibration* first, but it is recommended to do the *Zero RL calibration* also, at least at regular intervals e.g., once a week.

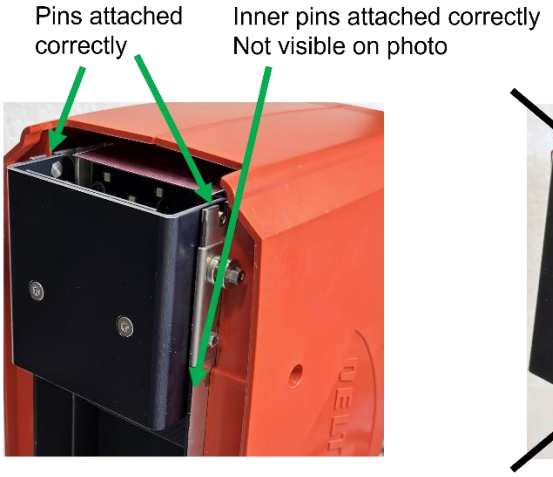
To calibrate the LTL3000/LTL3500 use the RL calibration target delivered with the instrument:



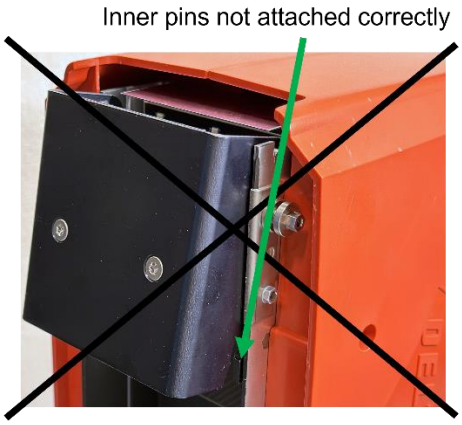
RL calibration target.

Calibrate the RL by following these steps:

- Make sure the protection window underneath the instrument is clean. If necessary, clean it following the instruction described in section ‘Maintenance’.
- Select ‘Calibrate’ from the main menu.
- Type in the RL-calibration value printed on the calibration target sticker or scan the QR code on the calibration target by pressing ‘Scan from Calibrator’ (only LTL3500).
- Place the calibration target under the LTL3000/LTL3500 (in the front) and press ‘Calibrate RL’ on the screen.



Correct position of calibration target



Wrong position of calibration target

Note: the pins on the calibration target must fit into the slots underneath the instrument.

- Wait for success confirmation.

RL calibration is now done.

Qd calibration

Zero Qd calibration

Normally, it is sufficient to make a reference calibration of the instrument prior to conducting measurements. However, if the instrument in rare occasions measures incorrectly it is recommended to do a zero calibration.

To do a zero calibration follow these steps:

- Make sure the protection window underneath the instrument is clean. If necessary, clean it following the instruction described in section ‘Maintenance’.
- Select ‘Calibrate’ from the main menu.
- Press ‘Qd Zero calibration’ on the screen.
- Tilt the instrument backwards and make sure it is not pointing at anything within a few meters.
- Press OK and wait for success confirmation.

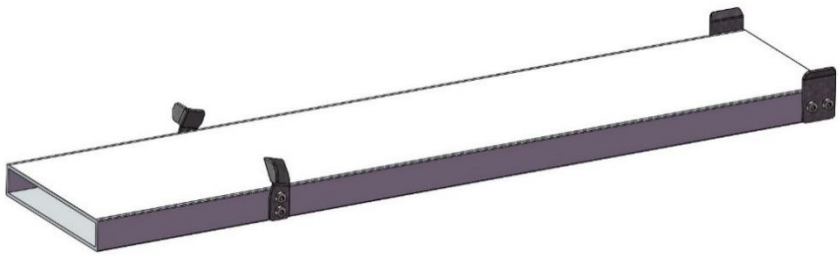
Important: Zero calibration must be followed by a Reference Qd calibration

Reference Qd calibration

Qd calibration can be done without performing a *Zero Qd calibration* first, but it is recommended to do the *Zero Qd calibration* also, at least at regular intervals e.g., once a week.

The calibration can be verified by performing a Qd measurement on the Qd calibration target. If the reading is within a few values compared to the Qd value on the Qd calibrator, calibration is not required.

Qd calibration requires the Qd calibration target. The instrument will warn about this fact before calibration.

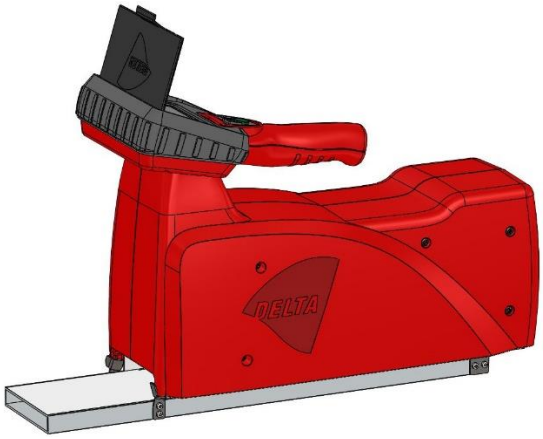


Qd calibration target.

To calibrate the Qd follow these steps:

- Make sure the protection window underneath the instrument is clean. If necessary, clean it following the instruction described in section ‘Maintenance’.
- Select ‘Calibrate’ from the main menu.
- Type in the Qd calibration value printed on the calibration target sticker.

- Place the LTL3000/LTL3500 fully back on the Qd calibration target, facing in the direction indicated.



- Press ‘Calibrate Qd’ on the screen.
- Wait for success confirmation.

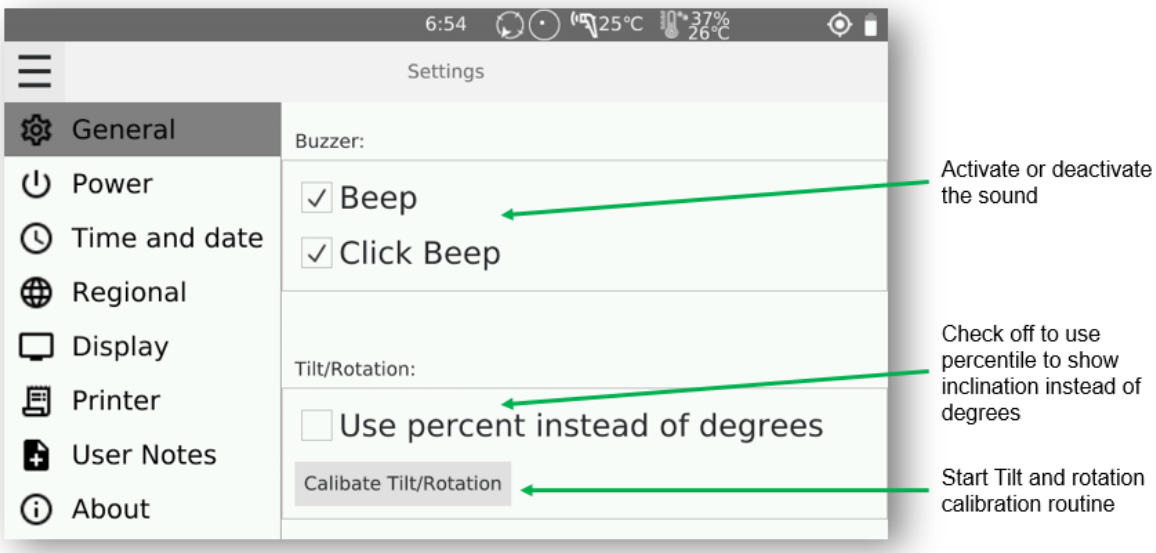
Qd calibration is now done.

Settings

Select ‘Settings’ from the main menu to adjust various instrument settings from the list below.

General

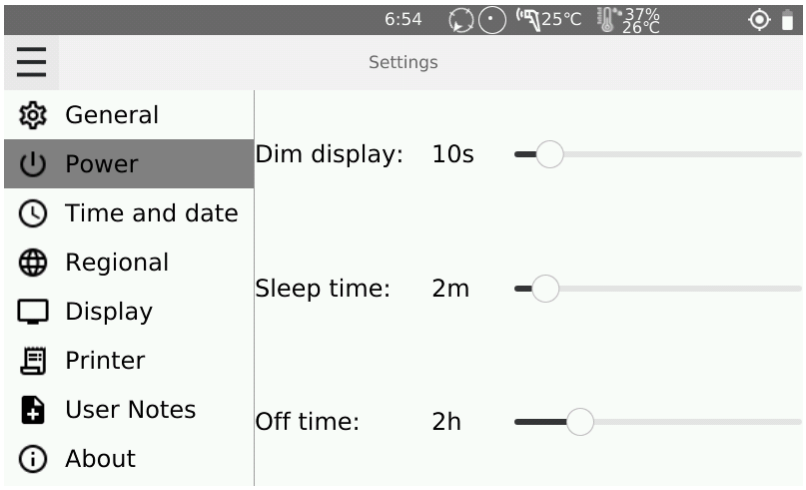
The instrument will send out a short beep when a new measurement is done, and a long beep if there is an error. To turn the sound on or off just check the “Beep” box. If you also want the instrument to make a short sound as feedback to the touch display, check the box “Click Beep”



Power

You can adjust certain power elements to save battery power:

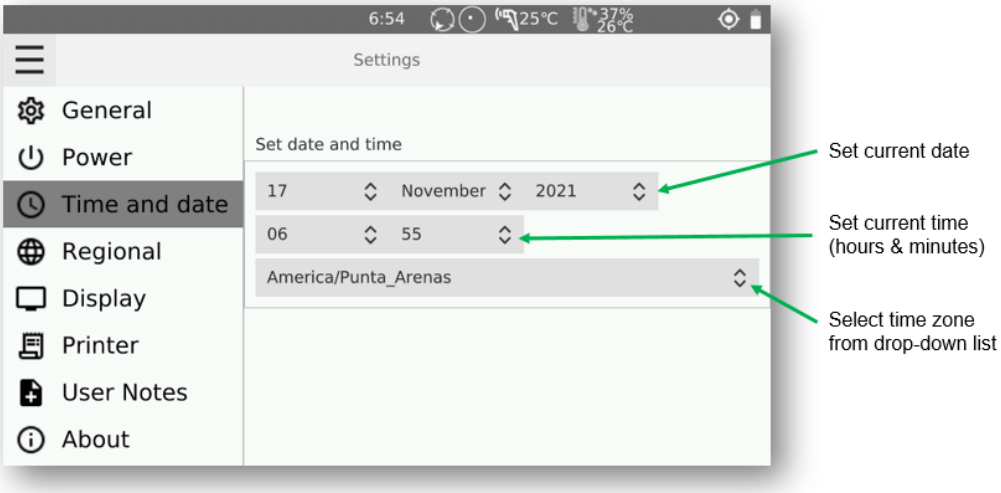
- **Dim display:** set timer for when the display light should dim (e.g., after 20 seconds)
- **Sleep time:** set timer for when the instrument should switch to stand-by mode (e.g., after 2 minutes)
- **Off time:** set timer for when the instrument should turn off automatically if not in use (e.g., after 2 hours).



Note: drag the curser all the way to the left to turn the function off.

Time and date

Adjust time and date linked to the measurements.



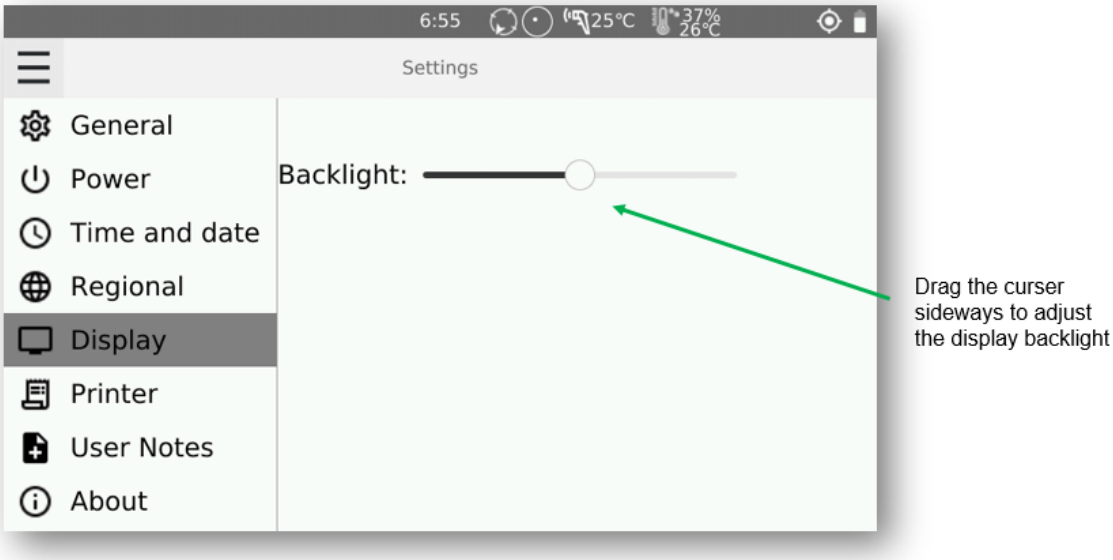
Note: If the GLSS feature is activated on your instrument, time and date are automatically updated according to the selected time zone.

Regional

You can adjust the format for how the instrument shows e.g., dates, numbers, temperature, and language. Select the relevant regional settings from the drop-down menu.

Display

Adjusting the light of the display by dragging the curser sideways.
Note: it may drain the battery faster if the backlight is set high intensity.

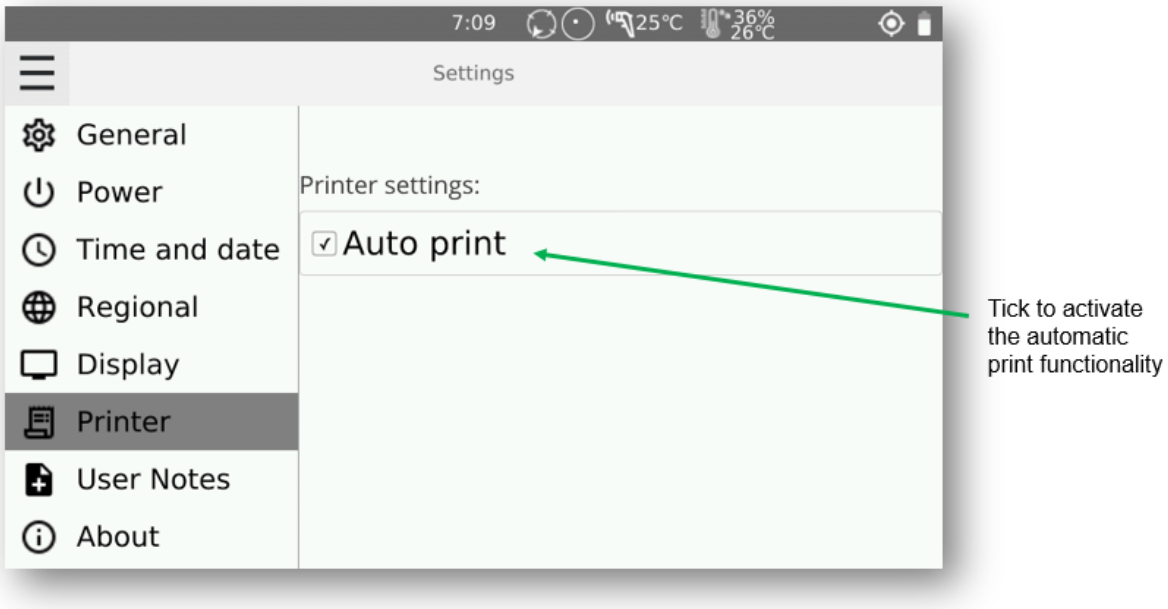


Printer

Activate or deactivate the automatic print functionality.

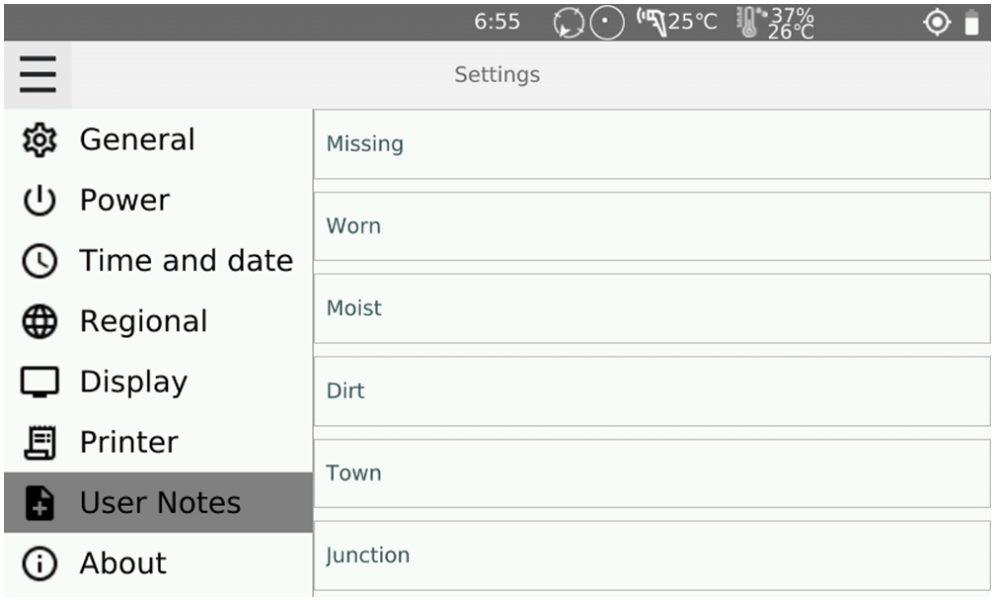
If activated the instrument will automatically print out data after each measurement. Remember to turn the printer on and press ‘Connect printer’ in the instrument display in the actions menu (see Actions Menu section).

If deactivated, the automatic printing is turned off. It is still possible to make ad-hoc prints of measurement data by selecting ‘Print’ in the Actions menu.



User notes

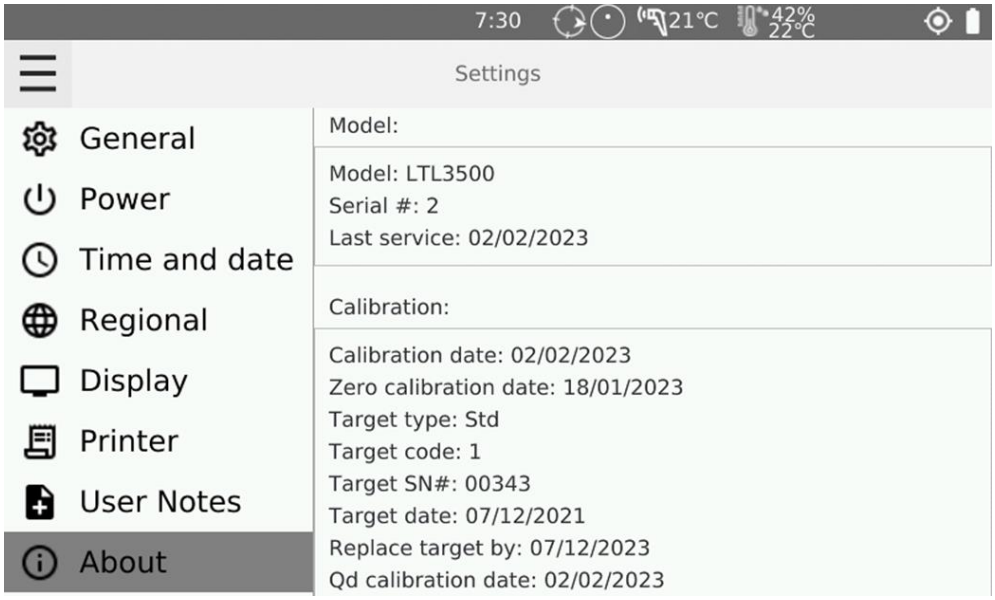
Customize the six quick notes that are available in the “Add note” screen.



About

Information about your instrument e.g., instrument model, serial number, version number, most recent service date, date of last calibration.

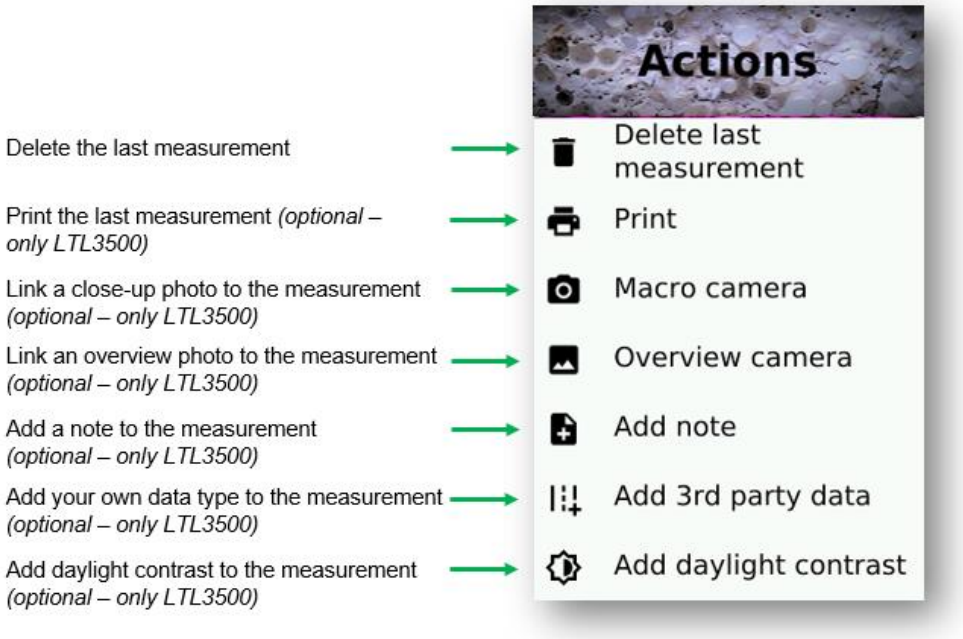
Swipe down to see more informations.



Actions menu

When you have performed a measurement there are various actions you can do with the measurement. These are explained in this section.

To activate the actions menu (after you have performed a measurement) press ⋮ at the top right corner on the screen (or press ○ on the instrument handle), and this menu appears:



Note: you can only use the actions in this menu <u>after</u> you have performed a measurement.

Delete last measurement

This action deletes the last measurement performed with the instrument.

Print (optional feature – only LTL3500)

This print action enables you to print data from the last measurement.

If the printer is already connected to the instrument press 'Print' to print the measurement data.

If the printer is not already connected to the instrument:

- Turn the printer on
- Press 'Connect printer' in the actions menu
- Wait for the printer icon to turn on in the top status bar
- Press 'Print' to print the measurement data

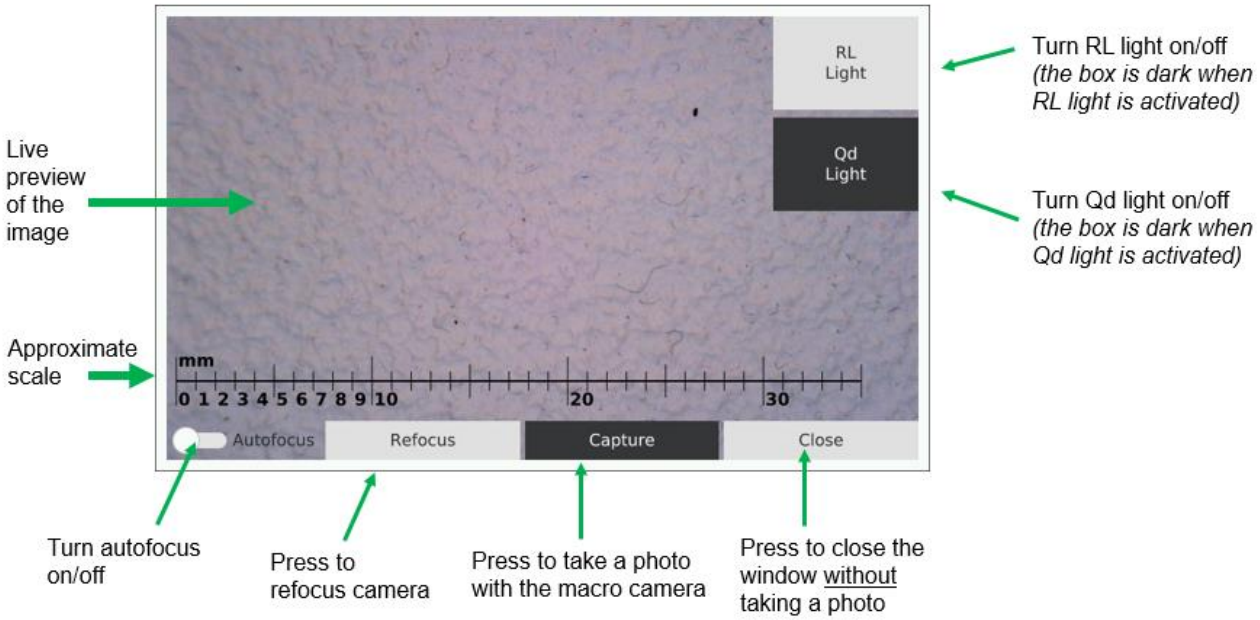
Macro camera (optional feature – only LTL3500)

This action enables you to take a close-up photo of the markings. The size of the photo is:

- Normal: width 27.5 mm / 1.08", height 15.5 mm / 0.61"
- With wet night frame: width 33 mm / 1.30", height 18.5 mm / 0.73"

How to take a photo:

- Place the LTL3500 on top of the road marking
- Turn the light on (press either RL or Qd or both on the screen)
- Activate or deactivate autofocus (or tap on the screen where you want the autofocus point to be)
- Pinch to zoom and drag to reframe the image (Optional)
- Pinch to zoom and drag to reframe the image (Optional)
- Press 'Capture' to take the photo
- The photo is now added to your measurement.

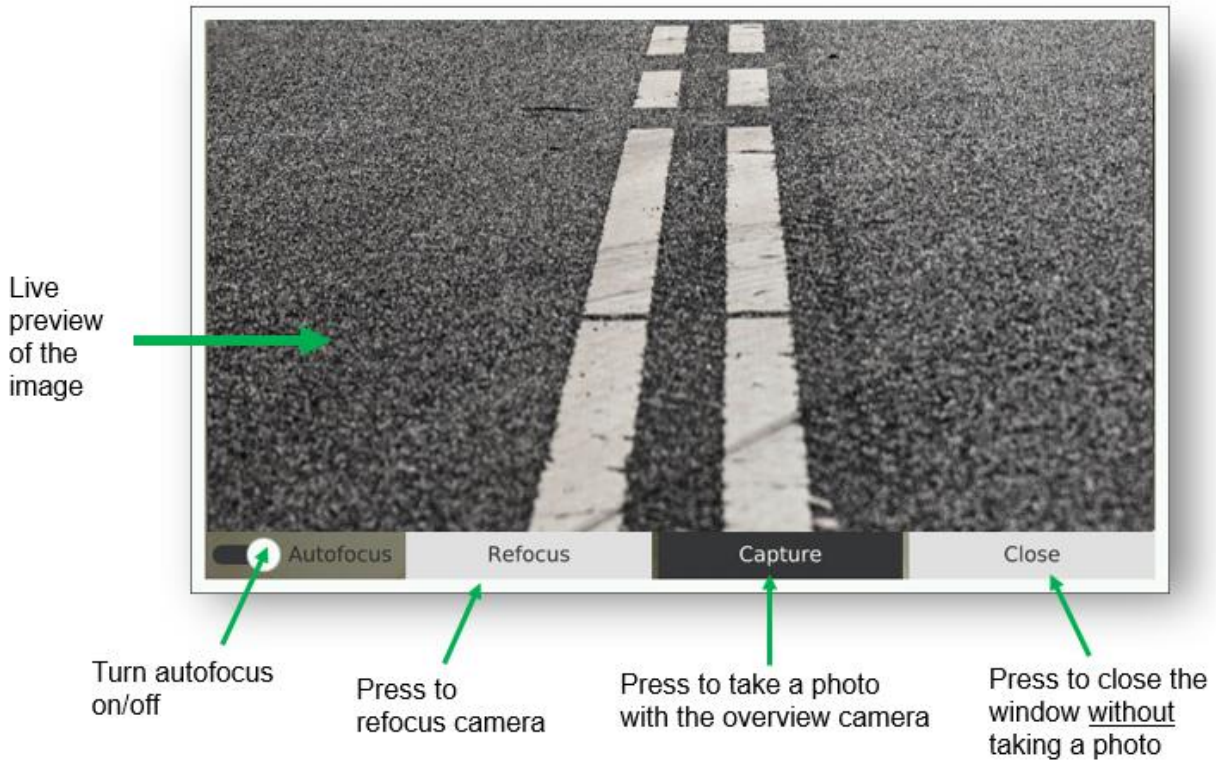


Overview camera (optional feature – only LTL3500)

This action enables you to take an overview photo of the surrounding area by the marking.

How to:

- Place the LTL3500 in the desired direction
- Activate or deactivate autofocus (or tap on the screen where you want the autofocus point to be)
- Pinch to zoom and drag to reframe the image (Optional)
- Press ‘Capture’ to take the photo
- The photo is now added to your measurement.

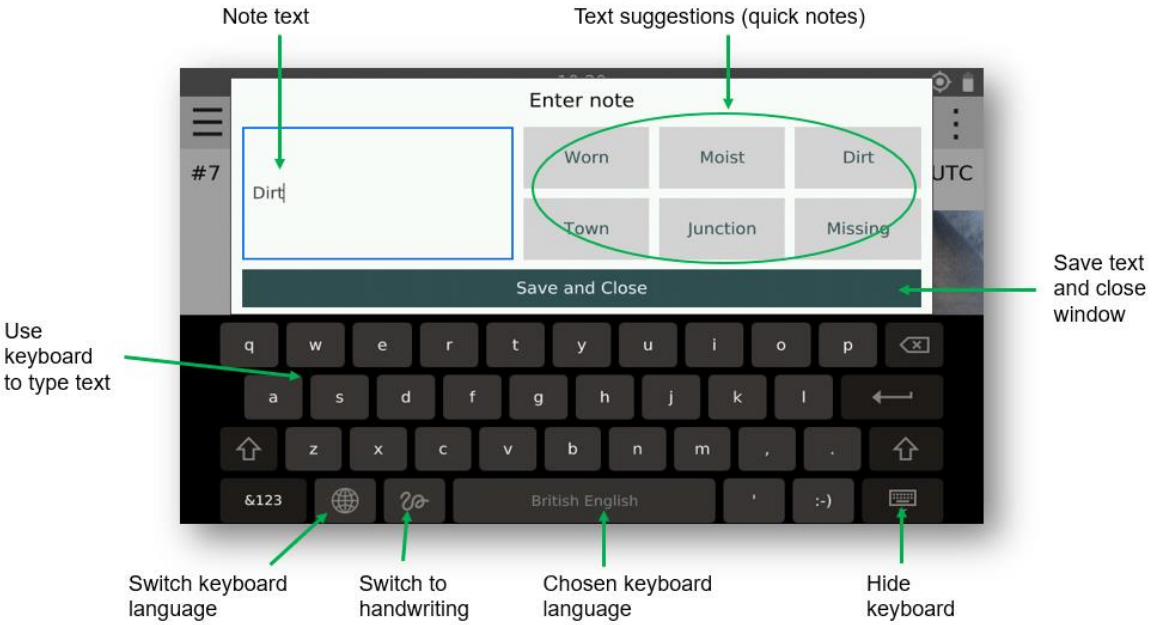


Add note (optional feature – only LTL3500)

This action enables you to add a note to your measurement e.g., a comment about the condition of the marking or an explanation as to why the measurement value turned out as it did.

How to:

- Type the text of your note either by using the keyboard on the screen or choose one of the six predefined quick notes. The quick notes can be edited in settings.
- Press ‘Save and close’ to finish and close the window. The text is now added as a note to your measurement and a note icon is visible on the measurement display.

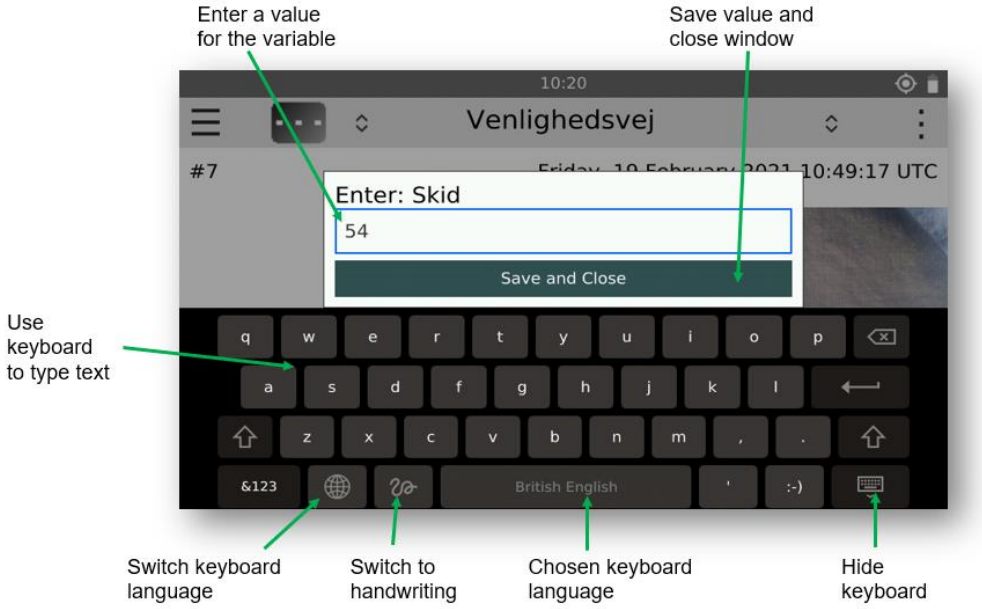


Add 3rd party data (optional feature – only LTL3500)

This action enables you to add a value for the 3rd party e.g., ‘skid resistance’ or ‘marking thickness’.

How to:

- Type a value (text and/or numbers) for the 3rd party variable.
- Press ‘Save and close’ to finish and close window. The entered value will automatically be added to the measurement’s logfile.



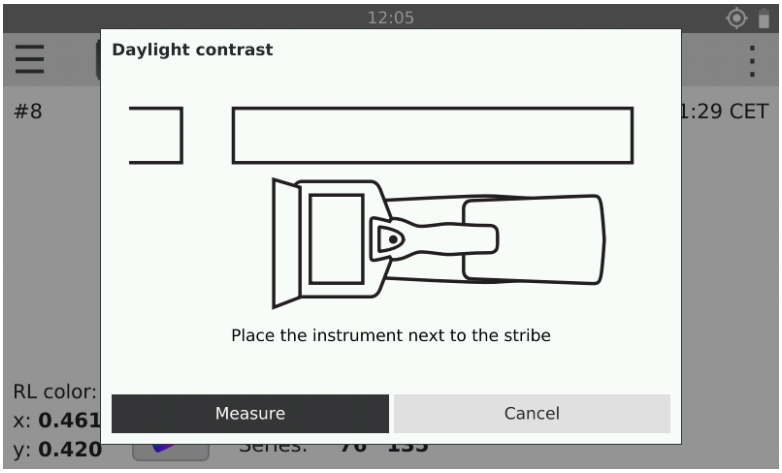
Add daylight contrast (optional feature – only LTL3500)

With this action you can add a measurement of the surface next to the marking, for the instrument to calculate a daylight contrast value.

Daylight contrast is an indication of the marking's visibility at daylight compared to the surface's visibility.

How to:

- Place the LTL3500 instrument on the surface right next to the marking.
- Press 'Measure'.
- The instrument will now automatically calculate the daylight contrast value and added the data to your measurement.



GNSS (optional feature)

If your LTL3000/LTL3500 is equipped with GNSS (Global Navigation Satellite System) it will show the measurement locations. GNSS make use of 4 satellite systems: BeiDou, Galileo, GLONASS and GPS.

The measurement locations with measurement results can be viewed on Google Earth after downloading data to a computer.

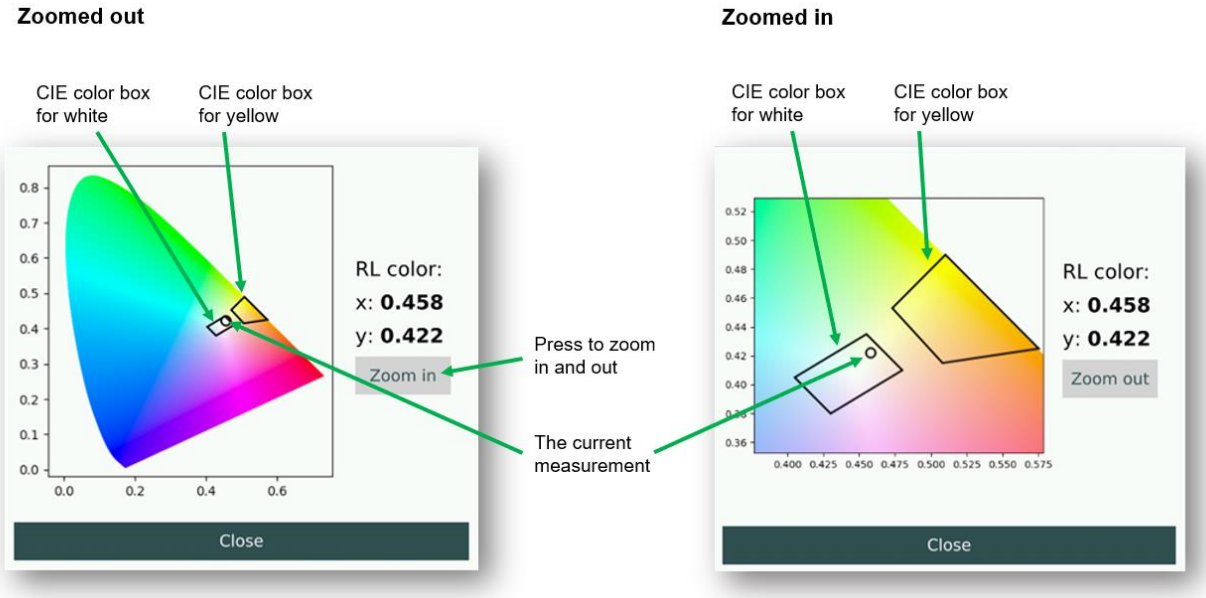
Note: GNSS cannot be expected to work indoors

Nighttime retroreflected color (x,y) *(optional feature)*

LTL3000/LTL3500 measure **nighttime retroreflected color** – CIE chromaticity - for white and yellow markings according to EN1436 and ASTM D6628.

With this feature installed nighttime reflected color will automatically be measured and recorded in the log file for each measurement.

When pressing on the measurement screen (only available on LTL3500) then the graphic illustration below appears on the screen, showing where your measurement is situated on the color scale. This way you can detect if the road marking has the correct color at nighttime when retroreflected.



Note: LTL3000 provides data for RL color but without the graphic illustration.

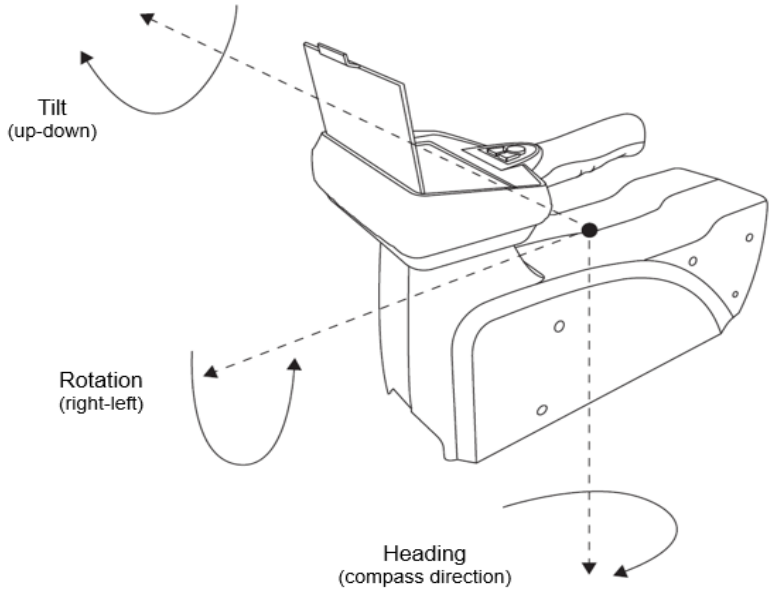
Sensors and cameras *(only LTL3500)*

The LTL3500 instrument is equipped with various sensors and cameras.

Temperature and humidity sensor: sensor that registers temperature and humidity in the surrounding environment. This data will automatically be linked to the measurement.

IR surface sensor (optional feature): an infrared sensor placed underneath the instrument. The sensor registers the road surface temperature, and this data will automatically be linked to the measurement.
Note: if the measurement is conducted on a surface with extra high reflection (e.g., water or broken glasses) the reading might be incorrect.

Orientation sensors (optional feature): sensors that register the physical orientation of the instrument i.e. tilt (up/down), rotation (right/left), and heading (compass direction). This data will automatically be linked to the measurement.



Macro camera (optional feature): an image sensor that is placed next to the Qd light source underneath the LTL3500 instrument. The camera can be activated/deactivated from the actions menu (see section ‘Actions menu’).

Overview camera (optional feature): an image sensor that is placed on the LTL3500 handle facing forward. The camera can be activated/deactivated from the actions menu (see section ‘Actions menu’).

Wet Night Frame *(optional feature)*

Wet Night Frame

The wet night frame is mounted underneath the instrument in order to move the measurement field outside the horizontal base cover during continuous wet measurements - this elevates the instrument, and the measurement field is moved forward.

How to mount the wet night frame:

- Place the end of the wet night frame under the instrument and push the 'legs' up to fixate.
- The wet night frame is now ready for use.

- After use, remove the wet night frame by reversing the above operations.

Battery

The instrument is powered by a Li-Ion battery, which under normal use requires no maintenance. The battery is a standard Bosch Li-Ion battery.

Bosch Li-Ion battery delivered with the LTL3000/LTL3500.

The battery is equipped with a thermal sensor that only allows charging within a range between 0ºC and 45ºC (32ºF and 113ºF). This ensures long battery life.

A substantial drop in obtainable measurements on a fully charged battery indicates that the battery is worn out and must be replaced.

Insert the rechargeable battery on the side of the LTL3000/LTL3500.

For your safety
Do not expose the battery to heat or flames: **Danger of explosion.** Do not place the battery on a heater or expose to direct sunlight for long periods.

The battery can be stored within a temperature range between -10°C to +60°C (14°F to 140°F), but we recommend storage between 0°C to +30°C (32°F to 86°F), due to lifetime considerations of the battery.

Allow a warm battery to cool before charging.

When handling or storing the battery take special care to avoid possible short circuiting the battery contacts.

Do not insert the battery in the charger if the battery is cracked. Using a damaged battery may result in electric shock or fire.

See further details in the battery user guide on the supplied USB stick.

Safety precautions:

- The battery should be protected against impact. Do not open the battery.
- Store the battery in a dry and clean place.
- Due to environmental protection do not dispose the battery with household waste.

Battery charger

A battery charger is provided as a standard accessory for charging the battery from the mains. The battery charger comes in two models depending on the options chosen:

- Bosch 230V AC, 50/60 Hz
- Bosch 120V AC, 60 Hz

The battery will be fully charged in approx. 1hour and 15 minutes (3Ah battery).

Due to the intelligent charging method, the charging condition of the battery is automatically detected, and the battery is charged with the optimum charging current, depending on battery temperature and voltage.

To recharge the battery, first make sure that the LTL3000/LTL3500 is turned off, remove the battery from the handle and insert it in the charger. Make sure the battery and battery charger are clean and dry before and during charging takes place.

For your safety
Read all instructions. Failure to follow all instructions listed below may result in electrical shock, fire and/or serious injury.

- The battery and the charger are specifically designed for use in conjunction with one another. Charging should be done only with the charger delivered with the instrument.
- Protect the battery from rain and moisture. The penetration of water in a battery charger increases the risk of electric shock.
- Do not insert battery pack in charger if battery is cracked. Using damaged battery may result in electric shock or fire.
- Do not disassemble charger or operate the charger if it has received a sharp blow, been dropped or otherwise damaged in anyway. Incorrect reassembly or damage may result in electric shock or fire.
- Keep the battery charger clean. Contamination may cause the danger of electric shock.
- Check the battery charger, cable and plug each time before using. Do not use the battery charger when defects are detected. Do not open the battery charger yourself and have it repaired only by qualified personnel using original spare parts. Damaged battery chargers, cables and plugs increase the risk of electric shock.
- Do not operate the battery charger on easily inflammable surfaces (e.g. paper, textiles, etc.) or combustible environments. There is danger of fire due to the heating of the battery charger during charging.

- Do not store battery in charger. Storing the battery in the charger over a long period of time could lead to battery damage and fire.
- See further details in the charger user guide.

Practical advice
With continuous or repetitive charging cycles without interruption, the charger can warm up. This is of no consideration and does not indicate a technical defect of the unit.

USB connection

The LTL3000/LTL3500 is featured with an USB port for connection to a USB memory stick when you want to transfer measurement data. The USB port is placed on the side of the instrument above the battery slot.

Only use a FAT32-formated USB memory stick. Other file formats are not supported. If your USB stick is not working, reformat it and select ‘FAT32’ as file system.

Maintenance

Service:

Regular service every 24 months is recommended. The instrument's last service date can be seen in the 'About' section in the settings menu. A spanner icon will appear in the top status bar when it is time for service.

Service on the LTL3000/LTL3500 instrument must be done by DELTA or DELTA trained personal. All spare parts (except for battery and charger) must be supplied only by DELTA.

General care:

The LTL3000/LTL3500 is constructed for outdoor use in fair weather conditions. The retroreflectometer can withstand moist weather, but caution must be taken against rain or splashes and dirt from traffic. Even though it is a robust instrument, it is also an optical instrument and must be handled with care:

- Avoid exposing the instrument to high mechanical shocks and vibrations.
- Avoid exposing the instrument to rapidly changing temperatures.
- When not in use, store the instrument in its case in a clean and dry environment.

When the instrument is not in use, turn off the instrument and fold the screen cover down to protect the touch screen. If the battery is not properly turned off, it will deplete the battery during storage.

You may clean the LTL3000/LTL3500 instrument and the touch screen using a soft, clean linen cloth with mild detergent.

Protection window:

The protection window is accessible from underneath of the instrument. The protection window is coated with a high-efficiency anti-reflection coating. Take care not to damage this coating when cleaning. Compressed air or a fine brush can be used for removing loose particles/dust. If this is not sufficient the window should by cleaned using a soft paper tissue or cloth and some window cleaning liquid.

Battery:

A substantial drop in obtainable measurements on a fully charged battery indicates that the battery is worn out and must be renewed.

For your safety:
Do not expose the battery to heat or flames: **Danger of explosion.** Do not place the battery on a heater or expose to direct sunlight for long periods.

The battery can be stored within a temperature range between -10°C to +60°C (14°F to 140°F), but we recommend storage between 0°C to +30°C (32°F to 86°F), due to lifetime considerations of the battery.

Allow a warm battery to cool before charging. When handling or storing the battery take special care to avoid possible short circuiting the battery contacts.

See further details in the battery user guide.

Safety precautions:

- The battery should be protected against impact. Do not open the battery.
- Store the battery in a dry and clean place.
- Due to environmental protection do not dispose the battery with household waste.

Battery charger:

Keep the battery charger clean by blowing compressed air on charger vents and wiping the charger housing with a damp cloth. Contamination may result in electric shock or fire. Make sure the battery charger is unplugged before cleaning it.

Calibration target:

To make sure that the calibration of the retroreflectometer is correct it is important that the surface on the calibration target is clean and undamaged. Be careful not to touch the calibration target (white side).

When not in use, keep the calibration target protected in the box, in which it has been delivered.

If the surface is stained, scratched, or broken the calibration target must be replaced. A replacement calibration reference can be purchased from DELTA.

In general, DELTA recommends changing the calibration target every two years to ensure that the target always provide correct calibrations.

Appendix A: Specifications

General characteristics

Measurement geometry and optical characteristics

Illumination angle 1.24º

Observation angle 2.29º

Equivalent observer distance ..... 30 m

Observation angular spread ..... ±0.17º

Type 30m CEN

Illumination angular spread horizontal 0.33º

Illumination angular spread vertical 0.17º

Field of measurement:

Width ..... 50 mm (2 inch)

Length (typ.) ..... 180 mm (7.1 inch)

RL range ($mcd \cdot m^{-2} \cdot lx^{-1}$) 0-4000

Qd range ($mcd \cdot m^{-2} \cdot lx^{-1}$) - optional 0-318

Nighttime chromaticity coordinates (x,y) according to - optional ..... ASTM E 2367 and CIE 1931

Location position system (GNSS)

Latitude / Longitude Format ..... Decimal degrees

Datum ..... WGS 84

Electrical characteristics

Pollution Degree: 2

Overvoltage Category: I

Battery supply: ..... Rechargeable and replaceable 12V/3Ah Li-ion

Supply current, full load: 1A

External charger: ..... Mains voltage 230 V/50 Hz or 120V/60Hz

Charge time (3Ah battery): ..... approx. 1 hour 15 minutes

Other

Data memory: ..... 8 GB

Data transfer ..... USB memory stick

Environmental specifications

Operation temperature: ..... 0°C to +60°C / 32°F to 140°F

Storage temperature: ..... -10°C to +60°C / 14°F to 140°F

Recommended storage (due to lifetime considerations of the battery): ..... 0°C to +30°C / 32°F to 86°F

Relative Humidity: ..... 20% - 85%, Non-condensing

Altitude: ..... 4,000 m / 13,000 feet

Instrument dimensions

LTL3000 Length: ..... 420 mm / 16.5 inch

LTL3500 Length: ..... 420 mm / 16.5 inch

LTL3000 and LTL3500 Width: ..... 150 mm / 5.9 inch

LTL3000 Height: ..... 300 mm / 11.8 inch

LTL3500 Height: ..... 280 mm / 11 inch

LTL3000 Weight: ..... 4.7 kg / 10.4 lbs.

LTL3500 Weight: ..... 5.6 kg / 12.3 lbs.

Regulatory compliance

EU:

EMC (LTL-3000): ..... EN 301 489-19 V2.1.1 (2019)

Radio (LTL-3000):..... EN 303 413 V1.1.1:2017

EMC (LTL-3500): ..... EN 301 489-19 V2.1.1:2019; EN 301 489-17 V3.2.4:2020

Radio (LTL-3500):..... EN 303 413 V1.1.1:2017; EN 300 328 V2.2.2:2019

Safety:..... IEC 61010-1:2010, AMD1:2016; EN 61010-1:2010+A1:2019

USA:

EMC:..... FCC 47 CFR Part 15B (class B). Contains FCC ID 2AIG4-MOD1

Canada:

EMC:..... ICES 003:2016 (Class B). Contains IC 21541-MOD1

Appendix B: Safety symbols and model identification

Below are explanations of symbols related to safety which are used on the LTL3000/LTL3500 equipment:

CE	CE mark – indicates conformance with the essential requirements of the directive
	Dispose of the instrument in compliance with local regulations for the disposal of electronic equipment. Do not put in domestic waste.
	Attention, see the instructions for use
	Universal Serial Bus (USB), port/plug

Label/marking for model identification:

Appendix C: Delivery

The LTL3000 instrument is delivered with the below items:

1. Carrying case
2. LTL3000 instrument including battery
3. Battery charger
4. Spare battery
5. Qd calibration reference (optional)
6. RL calibration reference
7. DANAK accredited calibration certificate (not shown)

The LTL3000 user manual can be located on the following weblink:
https://roadsensors.com/products/ltl3000-retroreflectometer/#user-manual

The LTL3500 instrument is delivered with the below items:

1. Carrying case
2. LTL3500 instrument including battery
3. Battery charger
4. Spare battery
5. Printer (optional)
6. Qd calibration reference (optional)
7. Wet night frame (optional)
8. RL calibration reference
9. DANAK accredited calibration certificate (not shown)

The LTL3500 user manual can be located on the following weblink:
https://roadsensors.com/products/ltl3500-retroreflectometer/#user-manuals