LTL-X Mark II RETROREFLEKTROMETER

User Manual

On site quality control of road markings & road surfaces in accordance with CEN / ASTM
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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.

Visit our web-site: www.roadsensors.com
R&TTE Declaration of Conformity (DoC)

We,

DELTA Dansk Elektronik, Lys & Akustik
Venlighedsvej 4
DK-2970 Horsholm

declare under our sole responsibility that the product:

Product name: LTL-X Mark II Retrometer
Trade name: DELTA LTL-X Mark II
Type or model: All types pursuant to the referenced trade name

is which this declaration relates is in conformity with the essential requirements and other relevant requirements of the R&TTE Directive (1999/5/EC).
The product is in conformity with the following standards:

HEALTH & SAFETY (Art. 3(1)(a)):

EMC (Art. 3(1)(b)):
EN 301 489-1 V1.9.2:2011
EN 301 489-3 V1.6.1:2013

SPECTRUM (Art. 3(2)):
EN 300 440-2 V1.1.4:2010

Supplementary information:

The equipment incorporates a GPS module.
The equipment is Class 1 radio equipment which can be placed on the market and be put into service without restrictions.

Technical file held by the undersigned.

Place and date of issue (of this DoC): June 24\textsuperscript{th} 2015.

Signed by or for the manufacturer:

\[Signature\]

Name (in print):
Leif Madsen
Senior Specialist QA/RA & E
US Attestation of Conformity (AoC)

We,

DELTA Dansk Elektronik, Lys & Akustik
Venligheds vej 4
DK-2970 Hørsholm

declare under our sole responsibility that the product:

Product name: LTL-X Mark II Retrometer
Trade name: DELTA LTL-X Mark II
Type or model: All types pursuant to the referenced trade name

to which this attestation relates is in conformity with the essential requirements and other relevant requirements of 47 CFR FCC Part 15.

The product is exempted from other specific FCC rule parts than the general rule parts 15.5 and 15.29 pursuant to specific rule part 15.103(c), as it is intended solely for use as industrial test equipment. However, the product is verified according to the specific rule parts:

47 CFR Part 15B, subpart 15.107 (Class A)
47 CFR Part 15B, subpart 15.109 (Class A)

The equipment is safety tested with CB Scheme certification under the internationally harmonized safety standard:

IEC 60950-1:2005 (2nd Edition); Am 1:2009

Supplementary information:

The equipment incorporates a GPS module.

Technical file held by the undersigned.

Place and date of issue (of this AoC): June 24th 2015

Signed by or for the manufacturer:

[Signature]

Name (in print):
Leif Madsen
Senior Specialist QA/RA & E

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 own expense.
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SECTION 1

OPERATING INFORMATION

LTL-X Mark II introduction

The LTL-X Mark II retroreflectometer is a portable field instrument intended for measuring the retroreflection and reflection properties of road markings. LTL-X Mark II measures the $R_L$ value (coefficient of retroreflected luminance at night). $R_L$ is a measure of the lightness of the road marking as seen by drivers of motorized vehicles in car headlight illumination. The road is illuminated at an angle of $1.24^\circ$. The reflected light $R_L$ at an angle of $2.29^\circ$, which corresponds, to an observation distance of 30 meters. This is relevant for a motorist’s viewing situation under normal conditions. Further information on measuring principles and standards can be located on: www.roadsensors.com.

| $R_L$ is an important factor in the ON-SITE quality control of road markings. |

Figure 1. The instrument

The operation of the retroreflectometer is very simple and requires minimal instruction.

The LTL-X Mark II measures the retroreflectivity and calculates $R_L$ according to the international CEN and ASTM standards like EN 1436, ASTM E 1710, ASTM E 2177 and ASTM E 2832. Results are presented in plain text on a large graphic display. Error messages or warnings are shown in the display in case of any problems during use.
The memory of the instrument provides registration of measurements with corresponding date, time and following data (if enabled):

- Name of measuring series (road name)
- Profile icon for road marking type
- User name
- GPS data (if installed)
- Temperature & humidity
- Instrument status

The measurement results can be printed by the built-in printer. Communication with a PC using the LTL RSC (Road Sensor Control) software program (see pg. 47) allows for data exchange with other PC programs.

A rechargeable NiMH (Nickel-Metal Hydride) High capacity battery powers the LTL-X Mark II, allowing approx. 2,500 measurements on a new and fully charged battery. A mains powered 15V power adaptor for charging (the instrument has a built-in charging circuit) is supplied as customary delivery. Charging time is approx. 3½ hour. The instrument can also be charged from a 15-18 VDC source. For field charging the 15V power supply could be powered from an “AC power inverter” connected to the car battery.

**LTL-X Mark II retroreflectometer features**

- Portable instrument
- Ergonomic operation height
- Fast measurement. Completed in approximately 1 sec.
- Measuring on dry and wet surfaces as well as under continuous wetting
- Flat, textured & profiled markings
- Fully documented measurements with automatic data storage, user and series identification for labeling and grouping measurements
- Audible signals during use (if enabled)
- Easy one-step calibration procedure
- Traceable and accredited calibrated reflection standard
- User replaceable battery
- Battery charging time is approx. 3½ hour for high capacity battery pack
- Rechargeable from mains using power adapter
- Average calculation of 2 to 99 readings
- Multiple languages
- RSC (Road Sensor Control) PC software for data exchange. Logged data can easily be exported to applications such as Microsoft Excel or displayed on Google Earth

LTL-X Mark II comes as customary delivery with extendable handle, wheels, built-in printer and built-in GPS.
Getting started

Height adjustment
Before using the LTL-X Mark II, notice that the operating panel can be adjusted in height for ergonomic considerations. The height is adjusted by pressing the red knob on the front of the instrument and at the same time lifting the handle on the operating panel. Release the knob and continue lifting until the handle locks.

Buttons

![Buttons diagram]

Figure 2. Buttons

For more information about buttons: see pg. 16

Turn on

Switch on the LTL-X Mark II by pressing and holding the ON/OFF button until the display turns on. The instrument will be ready for measuring within 10-12 sec from cold. From idle the instrument will be ready within 1 sec.

Measuring

Calibrate the instrument if necessary. DELTA recommends calibrating the instrument every time the instrument is switched on and / or starts a new series of measurements or minimum once a day typically in the morning before measurements start. See Calibration, pg. 40.

Place the instrument on the road marking. See positioning on the road, pg. 11

Press the green OK-button to take the measurement. A measurement will be finished in approx. 1 sec.

When the measurement is complete the display will be updated with information from the measurement. Data is automatically transferred to the data log. If there is a problem with the measurement a warning icon or an error icon will pop up (see Errors and warnings, pg. 10) and an audible alarm will sound (if enabled, see Sound settings, pg. 23).
Measurements taken with a low battery warning are marked in the log and a warning icon appears. If battery voltage gets too low measurements can’t be taken and an error icon appears.

To print out the last measurement data, press the PRINT button.

**User select (user initials)**

If the User icon is displayed in the upper icon row on the measuring display, press the UP button ▲ (and if necessary ◄ or ►) to mark the user icon. Press the OK-button to enter the user select menu.

If icon is not shown or if further information is needed, see User Id, pg. 19.

**Series Id select (name)**

If the Series Id icon is displayed in the upper icon row on the measuring display press the UP button ▲ to mark the road icon. Press the OK-button to enter the Series Id select menu. Choose SELECT to use a name from the list.

If the icon is not shown or if further information is needed, see Series Id, pg. 29.

**Errors and warnings**

An error or warning icon will appear in the upper row of the display if the LTL-X Mark II detects a problem.

Press the UP button ▲ to get a description of the most serious error or warning. Now press the OK-button to display a total list of all errors or warnings related to the measurement and the instrument in general.

**Miscellaneous**

The HOME screen can be activated at any time by pressing the HOME button.

Reset log:

Press the MENU button and select LOG and CLEAR DATA. Now select from the menu: CLEAR LAST DATA, CLEAR ALL DATA or CLEAR SERIES DATA.

Date and time:

Press the MENU button and select SETTINGS AND DATE & TIME. Choose SET TIME/DATE. Use the UP ▲ and DOWN ▼ buttons to set the different time related settings.

Power save:

Press the MENU button and select SETTINGS and POWER. Choose AUTO SLEEP or AUTO OFF. Use ▲ and ▼ to edit the values.
Data exchange / communication
The RSC software program, developed by DELTA for use on a PC, allows data to be exchanged between the LTL-X Mark II and a PC. See RSC-program, pg. 47.

Important guide lines for the correct use of the LTL-X Mark II

Positioning of the instrument on the road marking
Select an area of the pavement marking that is level when taking readings. The measurement field is marked with a yellow sticker on one side of the base cover. The measurement field is approximately 45 mm / 1.77 inch wide and 200 mm / 7.87 inch long. Ensure that the pavement marking to be measured is free of debris before taking measurements. Make sure that the instrument is stable positioned.

Reason: The LTL-X Mark II has three support pads, each with a small footprint, two smaller in the front and one larger at the back. An uneven marking or a small piece of gravel trapped below one of the pads will move the measurement field and affect the reading.

Taking the measurement
Press the OK-button to take a reading. Do not put pressure on the handle when taking a measurement.

Reason: Pressure on the handle can tilt the instrument slightly and affect the measurement geometry and therefore influence the reading.

Number of measurements.
For accurate readings, do not take just one reading of a road marking. Three readings will give a more accurate result than one reading. Five readings will give an even more accurate result than three readings, etc. Take the readings in adjacent areas of the marking. Let the instrument calculate the average of the readings (fixed or moving average options). See pg. 35

Reason: A road marking’s retroreflectivity varies from area to area. It is not unusual to see variations of 5% - 20% when the instrument is moved even less than 12 mm / ½” in either direction.

Protection of the display/display shield.
For the protection of the display and longevity of the instruments keep the display shield closed when the instrument is not used. For further information please see High temperature conditions, pg. 14.

Remember:
- LTL-X Mark II is an optical precision instrument, handle with care.
- Keep the protection window and calibration unit clean and undamaged.
- Store in a clean, dust free and dry environment.

Read:
“Measurement practice for road markings”. This leaflet can be located on: www.roadsensors.com under “Technical Background” and “Introduction”
SECTION 2

GENERAL INFORMATION

The measurement
The LTL-X Mark II retroreflectometer measures the RL (coefficient of retroreflected luminance) parameter. The RL parameter represents the brightness of road markings seen by drivers of motor vehicles by headlight illumination.

In the LTL-X Mark II the illumination angle is 1.24 degrees for RL. The observation angles are 2.29 degrees. According to both ASTM and CEN standards these angle simulates a driver’s viewing distance of 30 meters. The instrument’s illumination field is approximately 200 mm x 45 mm / 7.87 x 1.77 inch.

The LTL-X Mark II is controlled by multiple microprocessors. It is operated with an extractable keyboard located at the top of the retroreflectometer.

Push the button to take a measurement. Shortly after, the RL and related information are presented on the color display. The result is automatically transferred to the internal memory. The measurement, along with its corresponding time, date, and other data can be printed using the built-in printer.

Each time a measurement is taken, a status information is generated. If any error occurs the information can be interpreted by the warning/error icon in the top line of the display. The information is available until a new measurement is taken or the problem is resolved. The status information is also stored in the log.

Errors and warnings
When a measurement is taken, a warning text is generated if a problem arises and saved in the log together with the measurement. If a problem occurs, a warning icon or an error icon is show above the HOME screen and an audible alarm is sounded (if enabled) and the warning / error information are stored in the log.

To view the nature of the problem, press the UP button and the warning/error icon will be highlighted. The most severe problem will be stated in the message line underneath. Then press the OK button to view a total list of problems starting with the most severe. Press the BACK button to return to the HOME screen. If the problem did not hinder the completion of the measurement, the erroneous value(s) will be stored in the log. If an error is registered the measurement will not be stored in the log.

When printing out, on the built-in printer, or transferring logged data to a PC using the RSC program, any trouble will be shown in clear text on the concerned measurement.

Optical principle
The optical system in the LTL-X Mark II is covered by a patent. A LED lamp in the top of the tower generates the light for the RL measurements. After a field stop the light is collimated by a lens and deflected through a mirror toward the road.
The reflected light from the road uses the same mirror and lens. Between the lens and the photo detector field aperture, stops define the observation area. The illumination field is inside in the observation field. This is important to assure correct measurement on profiled markings.

V₂ spectral correction is achieved by use of advanced optical filters.

Notes on error sources

Stray light can occasionally enter the instrument but will be insignificant under normal measurement conditions. Before each measurement, the LTL-X Mark II automatically evaluates the leakage and compensates for it before the readout. In case of a significant leakage level, a warning or error message is given and special precautions may be necessary.

Instrument leak, drift and offset errors are compensated by means of data obtained during the calibration procedure. It is very important to keep the protection window and the ceramic on the calibration unit clean.

The LTL-X Mark II illumination angle is 1.24° relative to the road surface. Because of this small angle accurate placement on the road is important. Avoid pebbles and abnormal irregularities. The LTL-X Mark II must be parallel and in contact with the marking surface.

The LTL-X Mark II retroreflectometer is a rugged instrument, but it is an optical instrument and must be handled as such.

The LTL-X Mark II is factory calibrated. Nevertheless start measurements with a calibration. Study the display for any warning or error icons. See also Section 4 – Maintenance, pg. 37

Note

Keep the protection window and ceramics on the calibration unit clean.

Keep the battery fully charged. A well charged battery is more resistant to aging and damage.
High temperature conditions.

**Display**
If the display is exposed to intense direct sunlight during a longer period of time the display could become overheated. It is recommended to close the protective display shield. The shield also protects against damages and scratches. "Daylight readable" displays are vulnerable to high temperatures. High temperature will decrease the display service life.

**Battery**
The battery is rated to operate between 0°C / 32°F and 45°C / 113°F.
SECTION 3

THE USER INTERFACE

![Display and keyboard layout](image)
Figure 4: The display

**Display and keyboard layout**

The user interface consists of a rectangular display surrounded by push buttons. The display has two main modes: the measurement display (HOME screen) and the menu display. The instrument will start up with the measurement display shown. The display area is divided into four areas: a large main display in the middle, an icon row at the top, a message or caption field underneath and an icon row at the bottom.

**Measurement display**

Here the last measured $R_L$ value is presented with large digits together with other information from the measurement. On the graphic in figure 4, all available information’s are shown in the display. If a function is deactivated, it will not be shown. The actual date and time are always shown.

**Upper icon row**

The upper row of icons is accessed by pressing the UP button ▲. One of the icons is then highlighted and can be activated by pressing the OK-button. The other icons in the row can be accessed by using the LEFT ◀ or RIGHT ► buttons. The meanings of the icons are (from left to right):

- Series Id selection, can be switched off (see pg. 29).
- User Id selection, can be switched off (see pg. 19).
- Error/warning alarm. Will be shown in case of an error/warning (see pg. 10).
- GPS indication (see pg. 25).
- Battery status (see pg. 39).
Lower icon row

- From the lower icon row you can select a road marking icon that will be saved together with the measurement in the log for future measurement identification. Access the icons by pressing the DOWN button ▼. Use the LEFT or RIGHT button to mark the preferred icon. Pressing DOWN again shows more icon rows from a roll stack of four rows. One row, marked with a "PR" for "Preset" can be preset by the user (see pg. 31) and is saved separately for each measuring series. It will be the active icon row, ready for selection, when a measuring series is selected.

- Activate the marked icon with the OK-button or exit with the HOME  or UP ▲ button. The selected icon is now shown in the left side of the HOME screen and the instrument is again ready for measuring.

- Other functionality regarding the lower icon row:
  Activating an already selected icon will cancel the activation and remove the icon from the main display (and no icon will be saved with the next measurement).

Push buttons

OK
When the message row shows MEASURE, press the OK-button to take a measurement. In most other cases pressing the OK-button will activate a highlighted selection.

ON/OFF
The button turns the instrument ON or OFF. Press the button to turn the instrument ON. It will take 10-12 seconds from cold start, warm start within 1 sec. before the main menu is shown and the instrument is ready to operate.

To turn the instrument OFF, hold down the button about 4-5 second. If the ON/OFF button is held less than 4 seconds the instrument will enter standby mode and turn off the display.

From standby mode, a short press on the button will wake up the instrument and turn on the display. It is not possible to turn off the instrument during battery charging or when connected to a USB port.

HOME  
Bring you back to the measurement display.

BACK  
Bring you backward one step in the menu and cancel new settings, which have not yet been confirmed by the OK button. In most cases the LEFT  button has the same function.

Pressing BACK from the HOME screen will, in most cases, jump to the last used menu / sub menu point.
HELP
The button presents a context sensitive help text. The help presented will be on the subject headline shown in the display. Another press on the button will open up a general help menu.

Menu
The button selects the top level of the menu tree, see pg. 18 (the main menu). Use the UP and the DOWN buttons to scroll through the menu items. Press OK to select the highlighted item. In most cases it opens up further submenu levels.

SMART
This button is user programmable to one out of several functions, e.g. to clear the last measurement, see pg. 25.

CALIBRATE
This button starts the calibration wizard, see pg. 40.

PRINT
Print out the last measurement or selected parts of the log to the internal printer. In the diagnostics menu you can print out different instrument information’s.
Figure: 5 – The menu tree
SETTING UP FOR MEASUREMENTS

Selecting a User Id

The User Id (user profile) is used to identify the operator and is saved in the log together with each measurement. If enabled, it can be seen at the lower left side of the measurement display. Measurements can also be taken without a User Id. Unlimited User Id’s can be stored in the instrument.

Certain instrument settings are stored individually for each user. Selecting a user will restore these settings. Following settings are stored:

- User, sel at start
- Time format
- Sync to gps
- Backlight time
- Dimmer time
- Dim level
- Background (on/off)
- Key repeat (time)
- Setup (basic/advanced)
- Auto off time
- Auto sleep time
- Key click sound level
- Sound level
- Beep (on/off)
- Activate series
- Average (on/off)
- Average type
- Average number
- Wet timer
- Wet timer alarm/measure
- Calibration value
- Temperature (°C/°F)
- Languages
- Smart key

Selecting a user.

If the user select icon is not seen in the upper icon row:

Press the button and select SETTINGS / USER / SELECT to display the USER menu.
If the user select icon 🧑 is seen in the upper icon row:
Press the UP button. Then, if necessary, use the LEFT or RIGHT button to highlight the user icon. Press the OK button. The USER menu is shown:

Now use the UP or DOWN button to highlight a user name. Press the OK button to select the user.

Changes made to the above mentioned individual instrument settings are automatically stored in the selected User Id.

Selecting OFF will deactivate the user function and set all individual instrument settings to default.

Edit user
User names can be edited from the menu SETTINGS / USER / EDIT (see editing pg. 36).

New user
A new user can be made from the menu SETTINGS / USER / NEW (see editing pg. 36).

Clear user
Deleting the User Id will remove the user and settings from the memory.

Select at start

Enabling SEL. AT START will force the user to select a User Id each time the LTL-X MARK II is turned on.

Press the MENU button and select SEL. AT START. Press OK to toggle between YES and NO.
Selecting a road marking icon

**The purpose of the road marking icon.**
The road marking icons are used as labels for the individual measurement corresponding to
the measured road marking and will be saved in the log together with the measuring result.
The icon will be presented together with the corresponding measurement when viewing the
log, print out or in the RSC program (see pg. 47).

There are 24 fixed icons to select from. Six of the icons can be programmed as individual pre-
sets for each series (see pg. 31) and will be ready for selection when a series is selected.

**Selecting an icon.**
From the HOME screen press the DOWN button. Then use the LEFT or RIGHT button to high-
light the wanted icon. Pressing DOWN button steps through and displays the four icon rows.
Pressing UP button will return to the HOME screen without selecting a new icon.

![Select marking](image)

Pressing the OK button will activate the selected icon. The selected icon is now shown in the
left side of the measuring field and the instrument is again ready for measuring.

**Deactivating the profile icon.**
Activating an already selected marking icon will cancel the activation and remove the icon
from the main display.

**Setting the date and time**
Date and time is always shown in the display. Every measurement taken is stamped with the
date and time, so it is essential that the settings are correct.

Press the MENU button and select SETTINGS / DATE & TIME. Press OK and the time format sub
menu is shown.
Setting the time format

Press OK when \textit{TIME FORMAT} is highlighted and toggle between 12 and 24 hr format by pushing the OK button.

Setting the date format

Navigate to \textit{DATE FORMAT} and press OK.

Highlight the preferred date format using UP or DOWN. Press OK to accept.

Adjusting the time and date

Press OK when \textit{SET TIME/DATE} is highlighted.

Press OK to activate each line and use UP or DOWN to set the figure. Press OK to accept the setting.

Note: the time in this menu is not live updated, but it will synchronize the time shown in the HOME screen.
Setting the Time zone
Press OK when TIMEZONE is highlighted. Press OK to open the list of geographical locations. Choose your area. Press OK to select. Now a new list shows up with national time zones. Scroll to your location and press OK to select.

Time zone is used in relation with automatic daylight saving and When SYNC. TO GPS is enabled.

Note:
Be aware that if the time zone is changed, the recorded time stamp in the logged data will be updated to the new time zone.

Synchronize to GPS
When SYNC. TO GPS is highlighted press OK to toggle between ON and OFF. By activating this function make sure that the time zone is correct otherwise the clock in the LTL-X Mark II and the time stamp in the log data will probably not be correct.

Setting the dimmer and back light for the display
The backlight and dimmer can be adjusted. Press the MENU button and select SETTINGS / DISPLAY.

The levels can be adjusted on a scale from 1 (lowest intensity) to 10. Press OK to activate the function and use UP and DOWN to change the values. Press LEFT or BACK to store.
It is also possible to adjust the time before the light switch to dimmer mode from 5 to 120 seconds or set to OFF.
The BACKGROUND option toggles the background colour of the display.

Note: Using high backlight intensity will drain the battery faster!

Setting the sound
Press the MENU button and select SETTINGS / SOUND. Select KEY CLICK or SOUNDS to set the individual sound levels for key click and system sounds. Use the UP or DOWN button to set the level. Accept the setting by pressing the OK-button.
To activate a high level beep when the instrument has finished measurement set *BEEP* to *ON* by pushing the OK-button.

![SOUND Configuration Screen]

**Note:**

The beep indicates that the measurement is taken and the instrument can be removed from the road marking. Data processing can be ongoing after the beep and after a moment the display is updated.

**Auto Sleep (Power)**

To save power the instrument can be set to automatically change to Auto Sleep mode. The Auto Sleep time can be set from 1 to 30 min. in intervals of 1 min. or it can be deactivated (*OFF*). Startup will be instantaneous pushing the ON/OFF -button.

Press the MENU button and select **SETTINGS / POWER / AUTO SLEEP**. Use UP and DOWN to edit the auto turn sleep time.

**Auto Off (Power)**

To save power, the instrument can be programmed to automatically shut down if not used for a certain period of time.

Press the MENU button and select **SETTINGS / POWER / AUTO OFF**. Use UP and DOWN to edit the auto turn off time. The off time can be set from 1 to 8 hours in intervals of 1 hour or it can be deactivated (*OFF*).

When communicating with RSC program or when the charger is connected the instrument will not power down automatically.

**Setting the language**

Press the MENU button and select **SETTINGS / LANGUAGE**. Use the UP or DOWN button to select a language. Accept by pressing the OK button or leave unchanged by pressing BACK.

**Setting the temperature unit**

Press the MENU button and select **SETTINGS / TEMPERATURE**. Use the OK button to select between Celsius and Fahrenheit.
Setting the SMART key function

This button is user programmable to one of several functions, e.g. to clear the last measurement. Press the MENU button and select **SETTINGS / SMART**.

![Setting SMART Key Function](image)

Use the **UP** or **DOWN** button to select the SMART KEY function. Accept by pressing the **OK** button.

The selected function is now accessed every time the button is pressed.

Setting the AUX functions / GPS

The AUX function is used to enable auxiliary built-in equipment like the GPS.

![Setting AUX Functions](image)

**Using GPS**

The GPS receiver is mounted inside the instrument. The GPS system is used to log position data (latitude and longitude) together with the measurement data.

If activated a GPS icon is shown in the upper icon row.

The icon will display the quality (reliability) of the GPS signal.
Below is an explanation of the GPS icon states.

**GOOD:** The GPS HDOP (Horizontal Dilution Of Precision) value is below 5.

**FAIR:** The GPS HDOP value is larger than 5, but the GPS can FIX.

**NO:** The GPS cannot FIX (weak or no signal).

The GPS position data, HDOP value, and the number of satellites used in the position calculation are saved in the log together with the RL data.

**Activating the GPS**

Press the MENU button and select **SETTINGS / AUX**, highlight the GPS line and press the OK button to toggle the GPS ON or OFF. Press the BACK button or the HOME button to return to the HOME screen.

The GPS data can be viewed from the HOME screen by pressing the UP button and then highlighting the GPS icon by using LEFT or RIGHT buttons. Press the OK button to display the GPS data. When the GPS data changes the display is updated.

If the GPS does not fix and a measurement is taken a warning menu appears. You will be presented with the following option:

- No GPS fix. Measure anyway: NO / YES?

**More about the GPS**

The GPS unit will typically acquire satellite signals and process a position fix in 1-15 seconds after the LTL-X Mark II is turned on. If the GPS receiver has been turned off for a long period of time or the instrument has been moved far away for its last position, the time to first fix will take longer.

LTL-X Mark II will log following GPS information’s:

- **LATITUDE, LONGITUDE, UTC TIME, HDOP, NUMBER OF SATELLITES USED, POSITION FIX FLAGS AND DATUM.**

“Position Fix Flags” is interpreted by the LTL-X Mark II software and the information’s are shown in plain text in the View log see pg. 32.

Datum is by default set to: **WGS84** and can’t be changed.

Latitude and Longitude are output in the format:

- **Degrees, Minutes and (Decimal) Fractions of Minutes.**

The GPS engine used has a navigation performance of 2.5 m CEP\(^1\)

The precision of the GPS receiver is determined by many factors. A few are listed below:

- Signal obstruction. The GPS receiver requires a clear view of the sky. Trees, buildings and other environmental objects may affect the satellite signals.
- Satellite constellation and geometry.
- Multi path (reflection of signal from buildings etc.).
The HDOP (Horizontal Dilution of Precision) is a number that indicates the quality and precision of the received GPS data (low values are better than high). A HDOP value <1 indicates a high precision position. HDOP signals between 1 and 5 indicates a fair precision and DHOP values >5 a poor precision.

When the GPS is used, the operating time for the LTL-X Mark II will be decreased and you may have to charge the battery more often.

1) CEP (Circular Error Probable): A statistical measure of the horizontal precision. The CEP value is defined as a circle's radius, when centered at the true position, encloses 50% of the data points in a horizontal scatter plot. Thus, half the data points are within a 2-D CEP circle and half are outside the circle.

Setup (basic / advanced)

Setup is used to separate between basic and advanced users. The basic settings reduce the number of menus available to the user. For example, in basic menu operation, users cannot clear the log.

The following menu points can be selected in basic mode:

- **Settings:** User, Date & Time, Display, Sound and Temperature, Setup
- **Measurement type:** R_t, Wet timer, Timer alarm
- **Log:** View log
- **Diagnosis:** Instrument, Battery, Boards, GPS, System
- **Help:** All menus available
- **Auto Print**

**ADVANCED** setting will provide access to all menu functions.

To change the setup, press MENU and select **SETTINGS / SETUP**. Pressing OK will toggle between **ADVANCED** and **BASIC**. To return from setup press BACK or HOME.
MEASURE TYPE

When taking wet or rain simulation measurements some procedures describe to wait a certain amount of time from the marking is made wet and to the measurement is taken. The WET TIMER assists the operator to time this kind of measurements.

Depending on the “wetting” method it can be necessary to mount wet night rails. See pg. 44.

Wet timer
The wet timer can be adjusted between 15 and 60 seconds. The wet timer automatically carries out the measurement or sound an alarm after the set period of time.

Timer Alarm
Toggle between “Measure” or “Alarm”. The selected option is used when wet timer times out.
SERIES ID

Working with Series Id

The purpose of a Series Id
The Series Id is a label, for example the name of a road. Although measurements can be performed without selecting a Series Id, it is convenient to group (name) the measurements for each geographical spot, road or part of a road for easier recognition. The Series Id for such a group of measurements will be saved in the log together with the measuring results. The Id must be selected prior to the measurement.

The individual measurements in a group can further be labeled by selecting a road marking icon (see pg. 31) corresponding to the actual road.

The instrument can store unlimited Series Id’s.

Activate Series
To use the Series Id it must be activated. Press the MENU button and select: SERIES ID / ACTIVATE SERIES. By pressing OK you can toggle between ON and OFF, to activate or de-activate the Series Id function. Press BACK or HOME button to return to the HOME screen. When the Series Id is OFF no Id is shown in the Measure display.

Selecting a Series Id
There are two ways to select the Series Id. It can be done from the MENU or more quick from the HOME screen.

Selecting from the Menu
Press the MENU button and select SERIES ID / SELECT to display the Series Id list.
Selecting from the HOME screen
From the HOME screen press UP. If necessary, use the LEFT or RIGHT button to highlight the road icon 🛠️. Press the OK button. The SERIES ID menu is shown. Choose SELECT to access the available Series Id.

Press the OK button to use the name.

Enter a new Series Id
Press the MENU button and select SERIES ID / NEW. Proceed by spelling the series name (see Editing pg. 36). Press “END” in the spelling section to save.

Edit a Series Id
Do the same as above but select EDIT from MAIN MENU / SERIES ID. Proceed by editing the series name (see Editing pg. 36). Press “END” in the spelling section to save.

Removing a Series Id
This will remove the series ID from the selection list. Press the MENU button and select SERIES-ID / DELETE:

Use UP or DOWN to select the series that should be deleted. Accept by pressing the OK button.
A confirmation menu is shown:

ARE YOU SURE?
OK: NO ← YES

Note! All measurements in the selected series will be erased from the log!

If a large numbers of Series Id’s are to be deleted this can more easily be done from the RSC program from the project tab click .

Presetting the road marking icon

Six of the 24 icons symbolizing road markings can be programmed as individual presets for each Series Id and will be ready for selection when a Series Id is selected. Press the MENU button and select SERIES-ID / PRESET ROAD MARKINGS to enter the Select marking menu:

The bottom line shows the present six preset icons.

Use the LEFT, RIGHT, UP and DOWN buttons to choose a new icon for the first position, accept by pressing the OK button and the cursor (frame) will move to the next icon. Repeat for all six icons or you can exit and save the preset at any time, by pressing the BACK button.
THE LOG

Each time a measurement is taken data is stored in the log. The following data, among others, are saved, if enabled:

- Measurement result incl. average
- Date and time.
- Name of measuring series (Series ID) and sequence number.
- Road marking icon
- User name (User ID)
- GPS data
- Instrument status
- Temperature & humidity

The instrument can store >200,000 measurements in the log.

Clearing data in the log

Press the MENU button and select LOG / CLEAR DATA:

![CLEAR DATA Menu]

This menu gives the option to clear:

- the last measurement,
- all measurements
- one of the measuring series stored in the log.

By pressing the OK button you will be asked to confirm the erasure of the data. By pressing LEFT data will be cleared. By pressing OK they will not be cleared.

![CLEAR DATA Confirmation]

If you selected **SERIES**, you must choose the series you wish to delete from the list shown. Only the log entries will be erased. The series will still be available in the series select list.

**Viewing the log**

Press the **MENU** button and select **LOG / VIEW LOG**:

![View Log Menu]

This menu gives the possibility to view and print data from:
- the last measurement
- measurements
- one of the measure series

stored in the log.

Selecting All Data or Series Data will display a brief list. Scroll through the list with **UP** or **DOWN** button. Press **OK**-button to get further information on the selected log entry:

![View Log Table]

The figure below shows detailed information of logged from a measurement
In the first line, the menu shows the $R_L$ value, thereafter in the following lines other key measurement data. To view a list of the individual errors/warnings in the status, print out the measurement (see below).

Press the PRINT button to print the log from the highlighted measurement. Any warning or errors detected during the measurement will be shown in the print out.

To return to the log menu, press BACK

**View series data.**

In the LOG MENU, select **SERIES DATA** to view the list of series.

The menu shows a Series ID in each line. Pressing DOWN or UP, will scroll through the series list. Highlight a series and press the OK button to view the individual measurements.

Highlight a measurement in the individual display and press the PRINT button to print out the measurement.

To return press the BACK button.

---

The LTL-X Mark II log and display will be able to show the most recent 500 measurement taken, additional measurements will still be kept in the log and can be viewed when transferred to a PC.

The LTL-X Mark II log is not intended for data storage. Even if the log may store up to 200,000 measurements an increasing number of logged measurements will gradually slow down the performance of the LTL-X Mark II. If a slowdown is seen make a transfer of data to reduce or empty the log.
OTHER SETTINGS

Average function

An average function can be activated showing the average of the measured $R_L$ value calculated over a selectable number of measurements ($N = 2$ to 99). The average mode can be fixed or moving. In moving mode the average is always calculated from the last $N$ measurements where $N$ is the selected number of measurements. In fixed mode the averaging will start over again when $N$ measurements have been taken. The average data is shown in the HOME screen at the lower right corner.

Press the MENU button and select AVERAGE:

<table>
<thead>
<tr>
<th>AVERAGE</th>
<th>▲▼OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVERAGE:</td>
<td>ON</td>
</tr>
<tr>
<td>TYPE:</td>
<td>Fixed</td>
</tr>
<tr>
<td>NUMBER:</td>
<td>5</td>
</tr>
<tr>
<td>RESET</td>
<td></td>
</tr>
</tbody>
</table>

**AVERAGE:**
Use the UP or DOWN button to highlight the first line. Press the OK button to toggle between AVERAGE ON and AVERAGE OFF.

**TYPE:**
When selected, press the OK button to toggle between type: MOVING and type: FIXED.

**NUMBER:**
When selected, press the OK button to focus on the NUMBER digit. Use the UP or DOWN button to change the value between 2 and 99. Finally press the OK button to confirm the new value. The default setting is 4.

**RESET:**
When selected, press the OK button to reset the calculated average value and reset the number of measurements included in the average to zero.
Editing names

From specific menu points you arrive to the EDIT menu e.g. is you want to define a USER. You will see the following screen:

```
    USER
   ▼▲OK
  A B C D E F G H
 I J K L M N O P
 Q R S T U V W X
 Y Z 0 1 2 3 4 5
 6 7 8 9 @ # * :
 - / + ( ) .. END
   User 1
```

With **UP, DOWN, LEFT** and **RIGHT** you can navigate in the character map. The “arrow” will delete the last character.

Press 🔄 to select the highlighted character. Press “END” to exit the EDIT menu.

Auto print

Press the **MENU** button and highlight **AUTOPRINT**. Press the **OK** button to toggle between **ON** and **OFF**. If AUTOPRINT is activated a print is automatically made every time a measurement is taken. Press **BACK** to return to **MENU**.

Diagnostics

Press the **MENU** button. Highlight the line **DIAGNOSTICS**. Press the **OK** button, and the menu showing the following:

```
    DIAGNOSTICS
   ▲▼OK
  INSTRUMENT
  BATTERY
  BOARDS
  GPS
  SYSTEM
```

Each line gives information aimed at extended service and factory use. The information presented on the screen will be printed if you press the **PRINT** button.

The help system

Press the **HELP** button to show a context dependent help page. Pressing **HELP** once more will present a general help menu in which you can highlight a subject by using the **UP** or **DOWN** button and the press the **OK** button to show the help text. The **HELP** section is also accessible on the main menu.
SECTION 4
MAINTENANCE

General care
The retroreflectometer is constructed for outdoor use in ordinary good weather conditions. It will stand moist weather with wet roads, but caution must be taken against heavy rain and dirt. The LTL-X Mark II retroreflectometer is an optical instrument and shall be handled as such. Avoid shock and vibration if possible.

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.

MAKE SURE THE PROTECTION WINDOW IS CLEAN AND UNDAMAGED AT ANY TIME TO ENSURE CORRECT MEASUREMENT RESULTS

Battery
The LTL-X Mark II retroreflectometer is powered by a high capacity 12V/4.5Ah NiMH (Nickel-Metal Hydride) battery. Under normal use, this battery requires no maintenance. However it is recommended to keep the battery fully charged. A fully charged battery is more capable of withstanding degeneration.

A mains powered 15V power adaptor for charging (the instrument has a built-in charging circuit) is supplied as customary delivery. If the instrument was turned off it will automatically power on when the power adaptor is connected. The battery icon in the upper right corner will also indicate the charging state. Charging time will be 3½ hours and a new and fully charged battery will provide approx. 2.500 measurements.

No harm done if leaving the power adaptor connected after the charging process has finished. However, the instrument must be disconnected from the power adaptor if disconnecting the battery from the instrument. In addition, the battery can be charged using any DC supply from 15-18 VDC.

For “field” charging the 15V power supply could be powered from an “AC power inverter” connected to the car battery.

When storing the instrument for a long period of time fully charge the battery.

THE BATTERY SUPPLIED WITH LTL-X Mark II IS SPECIALLY DESIGNED FOR THE INSTRUMENT TO ENSURE SAFE USE. IF A NON DELTA SUPPLIED OR APPROVED BATTERY IS USED, DELTA CAN TAKE NO RESPONSIBILITY FOR ANY DAMAGES CAUSED DUE TO THE PERFORMANCE OF THIS BATTERY.
Replacing the battery
A depleted battery will not hold a charge very long, and it should be replaced. This can be done by the user.

Note:
Always turn off LTL-X Mark II before removing the battery to make sure that the processor is shut down properly.
Disconnected the battery for a longer period of time can reset the internal clock in the instrument.

The battery is located in a compartment at the low end of the rear of the tower. To replace the battery, remove the two screws from the back cover and remove the cover.

Loosen the big screw at the battery cover. You can now remove the cover.

Lift the battery out of the compartment. Press the snap-on clip on the connector and carefully withdraw it from the printed circuit board.

The battery can now be removed and replaced. Refit in reverse order. Please check your local regulation for disposal of the battery.
**Battery status**
An indication of the capacity of the battery can be seen from the icon, in the upper icon row.

- Shows that charging takes place
- Shows that the charging is finished
- Indicates that the battery is fully charged
- Indicates that the capacity of the battery is half empty
- The battery is almost empty and need recharging

**Fuses**
Two fuses are located in the battery compartment. The **charger fuse** protects the battery against short circuit and other errors in the charging connector, charger or charging system.

The **main fuse** protects the battery and electronics against short circuit and other errors in the electronic system. If the main fuse is removed no power will be drawn from the battery.

Always replace a blown fuse with one of equal rating See Electrical Characteristics pg. 48. To change the fuses you need access to the battery compartment. See replacing battery pg. 38. Carefully unscrew the plastic cap fuse holder. Pull out the fuse from the cap and insert the new one and reassemble

**Lamp**
The light source is a maintenance free LED lamp. Only trained personnel should replace the lamps if damaged.
Calibration

The instrument is delivered with two calibration units.

- the RED field calibration unit, for calibration of the instrument at regular intervals. This unit should be kept together with the LTL-X Mark II.

- the BLACK reference calibration unit, for verification of the (red) field calibration unit. This unit should be kept away in a safe place, and is only needed when the field calibration unit has to be checked.

The LTL-X Mark II is factory calibrated and very stable. Anyway, during daily use it is recommended that the operator calibrate the instrument, with the RED field calibration unit, at suitable intervals e.g. before starting a new series of measurements. This procedure is called calibration.

The daily use of the calibration unit can affect the accuracy of the calibration value due to dirt, scratches etc. Therefore, at appropriate intervals, the RED field calibration unit must be verified against the BLACK reference calibration unit. This procedure is called verification.

The BLACK reference calibration unit is factory calibrated and traceable to the International calibration institutes PTB and NIST.

Calibration procedure

To calibrate the LTL-X Mark II carry out the following steps using the RED field calibration unit:

- Before mounting the calibration unit note the R_L value written on label on the calibration unit.
- Place the instrument upon the calibration unit. It is done by tilting the instrument slightly backward, and then mount the unit underneath the front end of the instrument.
Make sure that the pins on the side of the unit fit into the slots in the LTL-X structure.

It is important that the calibration unit faces with the white ceramic towards the instrument tower.

- Press the CALIBRATION button. Select CALIBRATE RL and press OK-button.

![Calibrate RL](image)

- Check the value displayed and, if necessary, adjust it using the DOWN or UP buttons so it match the value stamped on the calibration unit.

![Calibrate RL](image)

- Press the OK-button to calibrate.
- When calibration is finished, press HOME.

![Calibrate RL](image)

The calibration procedure is now completed. Before removing the calibration unit, check the calibration by taking a regular measurement on the calibration unit. The measured value should preferably match the value stamped on the calibration unit (± 2-3 unit deviation is acceptable). Remove the calibration unit and store it properly.
Verification procedure
At appropriate intervals the value on the RED field calibration unit must be verified, or if necessary updated. The procedure to do this is:

- Do a calibration on the BLACK reference calibration unit. Follow the instructions in the calibration procedure above.
- Following take 2-3 measurement on the RED field calibration unit. If the average $R_L$ value on the RED field calibration unit differs from the measured value, shown in the display, update the label on the RED field calibration unit with the new average $R_L$ value.

The verification is now done and the RED field calibration unit is “recalibrated”.

Keep the calibration ceramic in good condition!
To make sure that calibration of the retroreflectometer is correct, it is important that the ceramic on the calibration units is clean and undamaged. Always keep the calibration units well protected.

If the ceramic on a calibration unit is stained, scratched or broken, the calibration unit has to be repaired and recalibrated or changed to a new one. In case of dust on the ceramics surface, the use of clean compressed air is recommended for removal. The use of a soft damp cloth is recommended if compressed air fails to remove the dirt. If necessary, use a mild household detergent.

Calibration service
To ensure reliable measurements, it is recommended that the BLACK reference calibration unit periodically is recalibrated to a traceable standard or replace by purchasing a new ceramic reference block.
DELTA offers calibration traceable to PTB (Physikalsich-Technische Bundesanstalt, Germany) and NIST (National Institute of Standards and Technology, USA).

For information about service please contact your DELTA distributor or DELTA directly. At DELTA you can forward your request via our web-site www.roadsensors.com or send a mail directly to: roadsensors@delta.dk.

Always store the calibration unit in a dry, dust free and clean environment.
If stained, scratched or broken it must be replaced.
**Printer**

The printer is located at the back of the tower. The printer is a high-speed high quality mini thermal printer. It has only a few moving parts and does not require any special or periodic maintenance.

The printer uses a thermal paper roll, width: 57.5±0.5 mm (2.26 in), diameter: max. 31 mm (1.22 in)

**Replacing paper**

Replacing the paper is simple. First, pull the little lever out with your finger and the cover will open into the paper roll compartment.

Insert the new paper roll and let a short paper tail hanging out at the top. Close the cover with a firm push and with some of the paper sticking out.
Mounting the wet night rails for rain measurements

In order to move the measurement field outside the horizontal base cover during continuous wet measurements, as shown on the figure (see pg. 13) the two wet night rails should be mounted.

You will find two wet night rails in the carrying case. Be aware of that there is a left and a right one.

Mount the wet night rails by inserting the rails into the bushing underneath the LTL-X
Fasten the wet night rails in the rear plate with the screws delivered (M6*16 mm) with the rails. Make sure that the LTL-X is resting on the rails before lightening the screws.

The wet night rails are now ready for use. After use dismount the wet night rails by reversing above operations.
Mounting the wheel unit

A wheel unit can be mounted in the rear of the instrument for easy transportation during heavy use.

The wheels are mounted easily to the rear by fastening the two nuts mounted on the wheel block.
The LTL-X Mark II is equipped with a USB Host Port and a USB Device Port.

The USB Host Port can be used to connect to a USB memory stick, e.g. for software updates.

The USB Device Port is used to connect the instrument to a PC.

The ethernet connector is for test / service purpose.

RSC software program

Main features of the LTL RSC (Road Sensor Control) software program delivered together with the LTL-X Mark II:

- Transfer of logged data to a PC via the USB connection
- Export of logged data to other programs e.g. Excel
- Upload / download projects between PC and LTL-X Mark II
- Printing reports of the logged data

For more details see the separate user’s manual for the RSC program. This can be found on the internet (www.roadsensors.com) or in the “documentation pack” with LTL-X Mark II.
APPENDIX B

SPECIFICATION

General characteristics

Illumination angle ................................................................................................................................ 1.24°
Observation angle ................................................................................................................................ 2.29°
Equivalent observer distance .................................................................................................................. 30 m

Observation angular spread .................................................................................................................. ±0.17°
Type 30m CEN
  Illumination angular spread horizontal ........................................................................................... 0.33°
  Illumination angular spread vertical ................................................................................................. 0.17°

Field of measurement:
  Width ............................................................................................................................................... 45 mm (1.77 inch)
  Length (typ.) ................................................................................................................................... 200 mm (7.87 inch)

R_L range (mcd·m⁻²·lx⁻¹) ................................................................................................................... 0-2000

Radio: .................................................................................................................................................. EN 300440-1 V1.6.1:2010
FCC: .................................................................................................................................................. 47 CFR, FCC Part 15B, Class A

Power supply:
  Battery .............................................................................................................................................. Built in 12 volt / 4.5 Ah NiMH
  External charger power supply ........................................................................................................ Friwo FW7530/15 (100-240 VAC / 15VDC )
  Charging time ................................................................................................................................. Approx.3 hour 30 min

  Charger fuse (5*20 mm) ............................................................................................................... T3.15A
  Power supply fuse (5*20 mm) ....................................................................................................... T3.15A

Data memory ...................................................................................................................................... >200,000 measurements

Data transfer ...................................................................................................................................... USB 2.0
Environmental characteristics

Temperature:
Operating ................................................................. 0°C to + 45°C (32°F to +113°F)
Storage *) ................................................................. -15°C to + 55°C (5°F to +131°F)
Humidity ........................................................................ 85% and non-condensing

*) Battery must be fully charged

Mechanical characteristics

Max. length ........................................................................ 573 mm / 22.6 in
Max. width .......................................................................... 222 mm / 8.7 in
Max. height .......................................................................... 538 mm / 21.2 in
Weight of base unit ............................................................. 9.7 kg / 21.4lbs

Construction:
Structural parts ................................................................. Aluminum
Housing ................................................................. Polymer
Keyboard ................................................................. Silicone rubber
Circuit boards ................................................................. Epoxy glass

Printer:
Thermal paper ................................................................. width/dia. 57.5 ±0.5 mm / 31mm (2.26 in / 1.22in)