Revision 3.4a

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The MINI

Retroreflectometer
User's Manual

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Figure 1. The MINI

1 Introduction

> They did not know it was impossible so they did it.
>
> *Mark Twain*

A retroreflectometer is an optoelectronic equipment that translates human visibility perception into numbers.

The MINI family is a line of innovative instruments to measure retroreflection and reflection properties of road markings, road signs, road studs, safety clothing and other materials, either in the field or in the lab.

The MINI is very light (2.2 kg with the AA-size batteries) and compact (255 mm x 160 mm x 220 mm). Such dimensions are almost the half of those of the old technology retroreflectometers.

The MINI handheld instruments are available in 3 different configurations:

- Horizontal - for measuring road markings retroreflectivity - R_L and Qd.
- Vertical - for measuring traffic signs and clothing retroreflectivity.
- Road Studs - for measuring retroreflectivity of raised road pavement markers - RRPM.

1.1 MINI Horizontal

The MINI Horizontal Retroreflectometer measures the nighttime visibility, R_L value (coefficient of retroreflected luminance), and daytime visibility, Qd value, of road markings. Very small size and low weight make the new MINI the ideal choice for use in the field. It also can be transported in the aircraft cabin as hand luggage. The MINI Horizontal meets all requirements of the international standards:

- ASTM E1710 and EN1436 for 30-meter geometry R_L (88.76° / 1.05°).
- ASTM E2302 and EN 1436 for Qd (2.29°).
- ASTM E2177 and EN 1436 for R_{Lwet}.
- ASTM E2832 (E2176) and EN 1436 for Continuous Wetting R_{Lrain}.
- 15-meter geometry (86.5° / 1.5°). (optional).

1.2 MINI Vertical

The MINI Vertical is a handheld instrument to measure the coefficient of retroreflection, R_A of road signs and other materials. It is capable of taking simultaneous measurements of up to 4 (four) observation angles in a single unit. The entrance angle (β) can be set to $-4\,^\circ$ or $+5\,^\circ$, or it can be continuously adjusted by the operator. The unique quadruple geometry enables the MINI Vertical to comply with all international standards:

- ASTM E1709 (0.2 °).
- ASTM E2540 (0.5 °).
- EN 12899 (0.33 °).
- ISO 20471 (0.2 °, 0.33 °, 1.0 ° , and 1.5 °).

1.3 MINI Road Studs

The MINI Road Studs measures the coefficient of luminous intensity, R_I, of RRPM (Raised Road Pavement Markers or road studs) over an area of 75 mm x 30 mm with a dual observation angle of 0.2 ° (or 0.3 °) and 1 °.

Thanks to the exclusive stray light suppression technology, the user has full access to the measurement area and can correct its position or adjust the entrance angle, as well as the final position of the sample under test.

The unique 1 ° observation angle simulates how truck drivers experience the brightness of road studs. The MINI Road Studs meets all requirements of international standards:

- ASTM E1696 (0.2 ° and 1.0 °).
- EN1463 (0.3 ° and 1.0 °).

2 MINI Features

"It always seems impossible until it is done."

- *Nelson Mandela*

- Weighs less than 2.2 kg - with the AA-size batteries.
- Super-compact handheld instrument (255 mm x 160 mm x 220 mm).
- Uses standard rechargeable AA-size batteries.
- Bluetooth interface to Android smartphones or tablets on Bluetooth interface (optional).
- Temperature and humidity recording.
- Inclination recording. (Tilt X and Tilt Y).
- WAAS GPS (optional). Record GPS with each measurement.
- User removable SD Card (4 GB).
- Color transflective touchscreen LCD (sunlight readable).
- Energy efficient system based on LED technology - more than 8000 measurements per battery charge.
- Exclusive airplane carry-on luggage compatible carrying case - sum of dimensions is less than 100 mm.
- Customizable pass/fail values.

- Stores user, place and additional information about the place or material under test like stripe type, color, special notes, etc...
- Ergonomic KIT with a telescopic extension pole and an IrDA remote control.
- Fast measurement - each observation angle or coefficient measurement takes less than 1 s.
- Measurements on dry and wet surfaces (MINI Horizontal only).
- Measures R_L of flat and profiled markings of up to 15 mm without special instructions (MINI Horizontal only).
- Measures R_{Lwet} (ASTM E2177) or continuous wetting (ASTM E2832) $\mathbf{R_{L\text{-}2}}$ without any attachments or modifications (MINI Horizontal only).
- Completely immune to sun or any kind of external light: measurement area is clearly visible, allowing easy alignment.
- Interface with portable Bluetooth printer.
- Option to average multiple measurements.
- Fully documented measurements (date, time, Tilt X, Tilt Y, GPS, etc.).
- Audible signals (if enabled).
- EasyData PC software for data exchange, Google Maps integration and Microsoft Excel reports.
- Easy calibration procedure.
- Traceable calibrated ceramic reflection standard for MINI Horizontal .
- Traceable calibrated retroreflection standard for MINI Vertical and MINI Road Studs .

- Rechargeable from a wall power outlet or a car battery by using an adapter.
- Multiple languages.
- Simultaneous quadruple observation angle measurements (MINI Vertical only).

2.1 MINI Optional Features

- GPS (WAAS).
- External Color Camera.
- Bluetooth interface to:

  Android smartphones or tablets.

  Bluetooth printers.
- Telescopic Extension Pole.

3 Care and Maintenance

"The measure of intelligence is the ability to change."

- *Albert Einstein*

The MINI uses LED technology, which makes the instrument almost maintenance-free, as well as fast and energy efficient.

Spectral color correction $V(\lambda)$ is achieved by advanced optical filters assembled in the MINI's innovative optical system. [1]

The MINI is an optical instrument and must be handled with care, avoiding intense shocks, strong vibration, moisture and dust. Make sure that the front lens is **clean and undamaged** to ensure correct measurements.

[1] The optical system is covered by a patent.

Do not remove screws or seals from your retroreflectometer device. There are no internal parts that can be repaired by the user. Handling can cause misalignment of the optical measurement system or permanent damage to your instrument.

In case of maintenance, get in touch with EASYLUX Technical Assistance Service by www.easylux.com.br contact form.

The retroreflectometer is constructed for outdoor use under ordinary good weather conditions. Special caution must be taken with rain, dirt, or deep wet surfaces.

Be careful so that splashing water, rain, and wet waste do not reach the instrument panel directly.

Clean the outside of the device with a wet piece of cloth. Do not use thinner or other strong solvents. Dust on the calibration base or white ceramic reference standard can be removed with compressed air or with a soft damp cloth.

MINI uses daylight readable transflective (sunlight readable) LCD technology. If the display is exposed to intense, direct sunlight for a long time, it could become overheated and shorten the display's service life.

Avoid strong light intensity changes over the measurement area (moving shadows) after pressing the trigger key to take measurements.

DO NOT POINT THE RETROREFLECTOMETER LENS DIRECTLY TO THE SUN. IT MAY CAUSE SEVERE DAMAGE TO THE INTERNAL SENSORS!

Store your equipment and accessories in a clean and dry place.
Always keep the calibration base protected inside its carrying bag.

3.1 Battery

MINI uses 6 standard AA-size 1.2 V rechargeable batteries.

The battery level is continuously monitored by the instrument. An alert will be displayed whenever recharging the batteries is required.

To ensure reliability, the device will not start measurements when the batteries charge is insufficient.

The multi-voltage power adapter and the vehicle power adapter recharge the batteries within 8 hours. For fast recharging, a third-party external battery charger can be used. Never leave the batteries uncharged for too long. Recharge them as soon as possible.

The batteries can be damaged if you keep them recharging for more than 12 hours.

Keep the batteries charged to prevent aging and damage.

3.1.1 Replacing the batteries

Worn out batteries will not hold a charge very long and must be replaced.

The batteries are located on the back of the MINI body.

To replace the batteries, remove the two screws and remove the cover then the batteries can be removed and replaced.

In case of strong impacts or vibrations one or more AA battery units can slip out of the contacts. If the machine does not turn on, remove and reinsert each battery on the holder to fix the contact fault.

Use only AA-size rechargeable batteries, 2500 mAh or higher.

3.2 Servicing

For servicing information, please contact your local distributor or EASYLUX at www.easylux.com.br.

You can use our Basic Troubleshooting Guide to help you identify and resolve basic problems you may be experiencing with your product. (See details in Appendix C)

3.2.1 Calibration Service

Easylux instruments do not need re-calibration or special services unless damaged by external factors. To ensure reliable measurements, periodic checking or replacement of the instrument reference standard is recommended.

In case of MINI Vertical or MINI Road Studs the reference standard could be replaced by a new Easylux traceable reference standard. Please contact your local distributor or EASYLUX at www.easylux.com.br to learn more about replacement of calibration standards.

In case of MINI Horizontal the ceramic reference can be checked independently with a special Easylux Calibration Kit (sold separately).

In case of damage or preventive maintenance, Easylux offers service of the instrument at our factory and re-calibration of the reference standards according to traceable references.

4 Getting Started

"All that is good is easy, everything divine runs with light feet."

- F. W. Nietzsche

Switch on the MINI by pressing and holding the POWER key until the display turns on.

MINI Horizontal place the instrument on the road marking, in case o MINI Vertical and Road Studs, place the instrument facing the material under test and press the trigger button to take a measurement.

When the measurement finishes, a value is displayed.

The measured data is automatically transferred to the current LOG (see details in section 6.4).

If the battery level is below the minimum level, then the measurement will be blocked and an error message will be displayed. Please see section 3.1 about how to recharge the batteries.

It is recommended to calibrate the MINI at least once a day and always before starting to work. See more about **Calibration** in section 6.1.

For accurate results, take at least 3 readings in adjacent areas of the material under test.

The instrument will calculate the moving average of the last measured values according to the number of points selected on the screen setup menu.

Stray light and sunlight are completely eliminated by MINI's technology and do not cause any impact on measured values.

The MINI will record detailed information related to every measured value.

Each time a measurement is taken, data is stored into the current LOG file.

The following data are saved (among others):

- Road name,
- Operator's name,
- Direction (south, north, east, west),
- Material classification,
- Temperature and humidity,
- GPS data (if installed),
- Tilt X and Tilt Y (% inclination),
- Date and time,
- Measurement place,
- Material color,

- Milestone (road km marker).

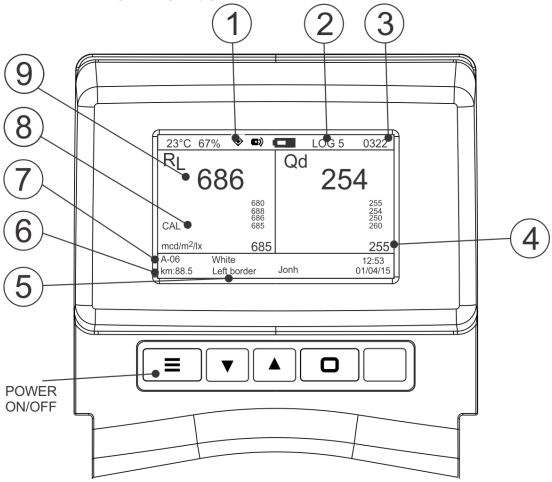
The user can change the **measurement place**, **material color** and current **milestone** (road km marker) for every measurement through the *control panel menu*. To learn more about *the control panel*, please see section 6.7.

The road name is defined when you create a new LOG. To learn more about LOG, please see section 6.4.

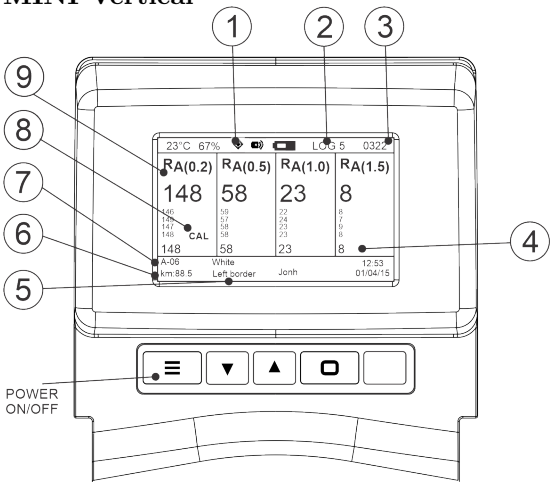
The MINI light suppression algorithm might not update the screen if the new reading does not differ in more than 3.5 % from the previous one.

4.1 Measurement Screen

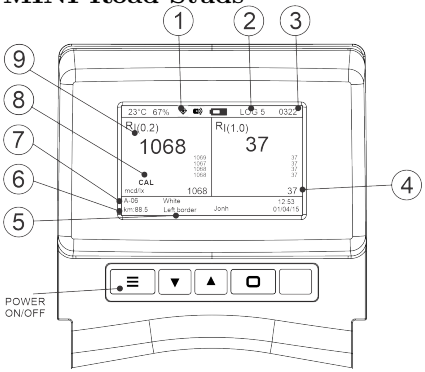
MINI Horizontal



MINI Vertical



MINI Road Studs



① **Hardware icons.**

② **LOG file name.**

③ **Current LOG record.**

④ **Averaged result.**

⑤ **Color and place.**

⑥ **Milestone (road km marker).**

⑦ **Road name.**

⑧ **CAL warning message.**

The message (CAL) will be displayed when the system detects a calibration fault.

⑨ **Measured value.**

4.2 MINI Horizontal - Warning notes

The light angle of the MINI Horizontal is very narrow in relation to the pavement surface. As a result, the correct positioning of the equipment is very important.

Easylux must be positioned directly over the pavement marking and parallel with the marking, as shown in figure 2. Any other positioning will give erroneous results.
Make sure the instrument is firmly placed on the surface.

The retroreflectivity will vary from one area to another over a horizontal road marking. Small changes in the equipment position may result in variations ranging from 5 to 20 %.

4.2.1 Support pads

Please read the FAQ question number 11 about this subject.

Easylux retroreflectometer measures white and yellow markings without any adjustment to the instrument. It can also measure any kind of marking design.

The MINI is powered by AA-size batteries. Do not stress the system with several consecutive readings at less than 1 second intervals. The MINI was not designed to repetitive readings. It could overheat the batteries and add instability to the light compensation system or readings.

Ensure that the measurement area in front of the instrument is free of dust and small stones.

Ensure the correct alignment of the instrument in relation to the road marking. Road markings less than 1 **meter** long cannot be accurately measured by the MINI HORIZONTAL.

Do not put pressure on the handle when taking a measurement. That can affect the measurement geometry and influence the reading.

An uneven marking or a small piece of gravel trapped below the instrument will affect the measurement geometry and the reading.

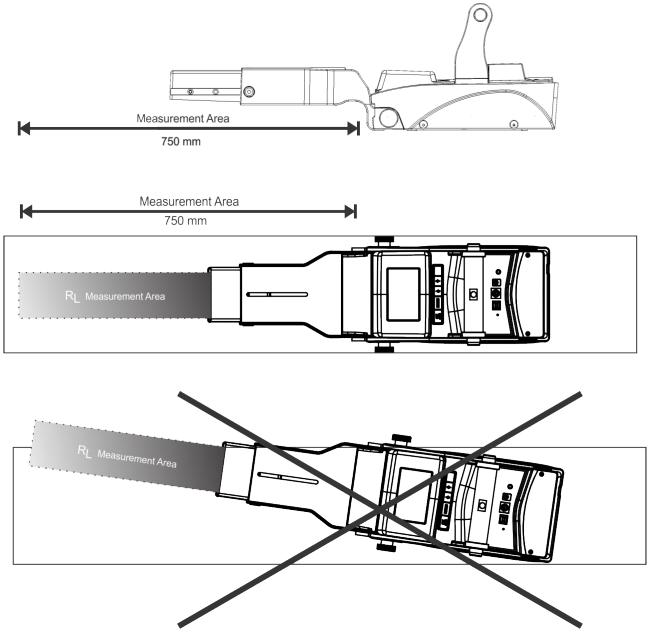


Figure 2. MINI HORIZONTAL alignment and measurement area.

4.2.2 Qd light source

It is very important to fix the Qd light source in the correct position. Figure 5 in section 5.4 explains how to make the Qd light source ready to use.

4.2.3 Calibration warning message

The calibration warning message will be displayed every time the system detects a calibration fault. You should calibrate the instrument again.

4.3 Setting up for measurements

4.3.1 Create a new LOG file

The MINI implements a LOG file system that can be used to organize your measurements.

When a new LOG is created, the user is asked for the following:

- LOG alias name;
- Road name;
- Starting milestone;
- Operator's name;
- Direction (north, south, east, west);
- Material type (Paint, Thermoplastic, Epoxy, etc.);
- Special NOTE.

Please see section 6.4 to get details about LOG Files.

4.3.2 Screen and Hardware Settings

The main menu CONFIG options allow you to adjust the most common MINI user interface settings.

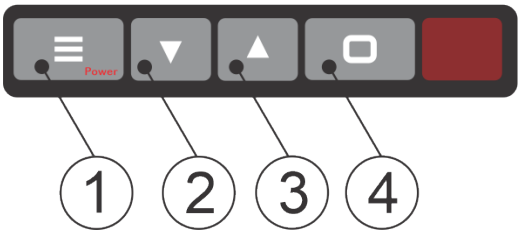
From the submenu SCREEN, you can select how many readings the average will be calculated from and how many measurements will be displayed on the screen at the same time.

Most MINI Horizontal users do not need Daytime Visibility - Qd - for all measurements. It can be disabled to make measurements faster.

From the submenu HARDWARE, you can erase the SD Card files, turn off the GPS, or select energy saving configurations. See section 6.6.2.

5 User Interface

5.1 Keyboard



① List key (power).

Hold the list key for more than 2 seconds to switch the instrument ON or OFF.

Hold the power button for **2 second**s to start the machine.

The equipment will be ready to operate when the measurement screen is displayed.

A short press on this button will open the **Control Panel**. See **Control Panel** in section 6.7.

It is not possible to turn off the instrument when the battery charger is plugged in.

② Down Arrow key.

Use this key to move forward and view the next measurement record.

③ Up Arrow key.

Use this key to move backwards and view the previous measurement record.

④ Main Screen key.

Use this key to switch between the main menu and the measurement screen.

When the instrument is showing the main menu, use the touch screen to select the menu item.

⑤ Trigger Button.

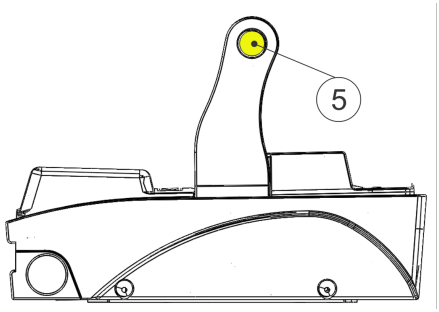


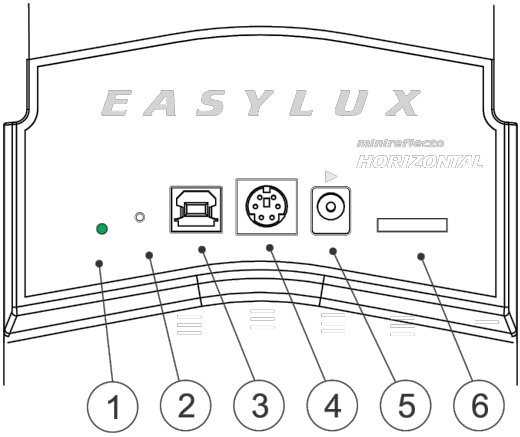
Figure 3. Trigger Button.

When the instrument is showing the measurement screen, press the trigger button to take a measurement.

Hold the Trigger Button for at least **2 seconds** to see the Angle Meter (Vertical model only).

Hold the Trigger Button for at least **2 seconds** to delete the current record (Horizontal and Road Studs model only).

5.2 Connector Panel



① Charger LED.

It will be turned on (green) when a battery charger power supply is plugged into the power connector ⑤.

② Reset Key.

If the system freezes for a long time, you can reset it by pressing the Reset key (use a long object to press it through the hole such as an extended paper clip).

③ USB Port.

The USB Port is used to connect the instrument to a Personal Computer.

④ Expansion Port.

The Expansion Port is used to add optional hardware to the MINI (Color Camera, for example).

⑤ Power (Trigger key).

Plug the power supply into the power connector to recharge the batteries inside the device. The batteries can be charged using any DC supply from 10 V to 12 V.

The instrument could be damaged if connected to a 15 V or higher voltage supply.

The battery icon in the upper status bar will also indicate the charging state.

The instrument cannot be turned off when the battery charger is plugged in.

If the battery level is below the minimum level, the measurement will be blocked and an error message will be displayed.

Trigger Key - The Power connector can also be used as a trigger key by connecting a wired remote control to it.

⑥ SD Card.

The instrument requires a **minimum 4 GB** mini SD Card - SDHC -, FAT formatted.

Do NOT erase the folder named *RES* on the SD Card because it contains important system files.

In case of accidental erasing of the *RES* folder, you can download the files from EASYLUX website.

If you want to erase all SD Card files, please use the instrument system facilities as described in HARDWARE SETUP, section 6.6.2.

5.3 Telescopic Extension Pole (optional)

The MINI can be operated by an infrared remote control. A telescopic extension pole can also be adjusted for ergonomic considerations.

To turn on the remote control, please see instruction on section 6.6.2.

When the extension handle is attached to the MINI HORIZONTAL it can tilt back over inclined surfaces due the natural change of the mass center. Always make sure that the MINI is in contact with the surface before taking readings. In case of low readings or ZERO, move the machine to another position and press down the extension handle to avoid tilt.
TIP: On inclined surfaces you can decrease the length of the handle to avoid tilts.

5.4 Qd - Daytime Visibility (MINI Horizontal optional)

The Diffuse Illumination light source is sold separately and can be added to the MINI at any time. The installation demands a special Qd calibration KIT. It allows MINI to check Daytime Visibility as per ASTM E2302 and EN 1436 standards (Figure 4).

Do not disassemble the Qd light source and always release the locking pin before folding it. Strong forces in case of abnormal handling can damage the Qd light source brackets.

Figure 4. MINI HORIZONTAL with Qd.

It is very important to fix the Qd light source in the correct position:

1. Move the Qd light source to the horizontal position.
2. Hold the security pin.
3. Carefully, press down the Qd light source to fix it in the correct position.
4. Make sure that the side screws (black handle) are both very well tightened.

Make sure that the side screws (black handle) are both very well tightened.

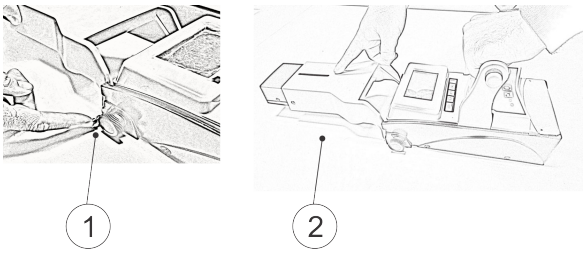


Figure 5. Qd - Daytime Visibility - It should be firmly set in place to avoid mechanical misalignment.

① Security Pin

It should be locked on the correct position to avoid mechanical misalignment.

② Press down

Carefully, press down the Qd light source and tighten the side screws.

6 System Details

"I am looking for a lot of men who have an infinite capacity to not know what can't be done."

- *Henry Ford*

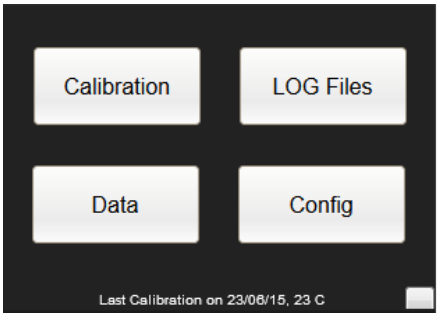


Figure 6. Main Menu.

Press the MENU key on the keyboard (section 5.1) to access the main menu. When a menu item is selected, a help text is shown at the bottom of the screen. The main menu consists of four choices as follows:

1. Calibration;
2. LOG files;
3. Data;
4. Config.

6.1 Calibration

The instrument is supplied with a calibration reference standard.
It is recommended to calibrate the MINI at least once a day, after recharging the batteries, before starting to work, and after a significant temperature change.

If the MINI is calibrated at room temperature and used at a different temperature, its output may include a bias error. Environmental factors, such as the ambient temperature, can introduce errors that may not be readily evident when testing samples with unknown values. It is important to calibrate the instrument again in the field temperature, after stabilization. The typical temperature stabilization time is around 10 minutes.

It is important to periodically calibrate the instrument at a temperature close to that at which it will be operated.

It is very important to keep the calibration reference standard clean, as well as the instrument front lens. Please, take the time to read the care and maintenance recommendations in section 3.
EASYLUX calibration standards are traceable in accordance with NIST (National Institute of Standards and Technology - USA).

The instrument will display a warning (***CAL***) on the measurement screen whenever the system detects a calibration fault.
It will be displayed 24 hours after the last calibration or for every critical change in internal temperature. Please recalibrate the machine whenever you see the (***CAL***) message

The instrument will not calibrate with the wall charger adapter plugged.

6.2 Fast Calibration (MINI Horizontal model)

The fast calibration mode is available for MINI HORIZONTAL model only. In quick calibration mode, the unit can zero out during calibration without the use of a light trap or the black reference external device.

To do the quick calibration, keep the DOWN button pressed when selecting the CALIBRATION option in the main menu 6.

6.2.1 MINI Road Studs and MINI Vertical calibration

To start a new calibration, select the CALIBRATION option from the main menu and follow on-screen instructions.

MINI Vertical and MINI Road Studs are supplied with a calibrated **reference standard**. The reference standard is an attachable part with two sides. The white side is the calibrated reflective reference. The backside is covered with a black and non-reflective surface. To ensure reliable measurements, periodic checking of the instrument reference standard (white side) is recommended. The user can buy a new calibrated reference standard to replace the old one or it can be checked independently at an optical laboratory. You can adjust the calibration references in the Reference Values screen 6.6.6.

Only MINI Road Studs and MINI Horizontal are supplied with CALIBRATION BASE.

It is very important to keep the CALIBRATION BASE clean, as well the reflective (white) side of the **reference standard** and the instrument front lens as recommended in section 3.

Always keep the **reference standard** clean and protected inside its carrying bag.

The MINI will request the **reference standard** white reference on the calibration process. Insert the reflective (white) reference side and follow on-screen instructions.

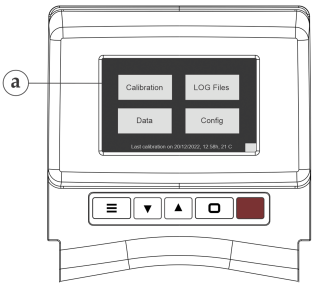
(a) Select Calibration on the menu

(b) Place the white side of the reference standard in front of the device

(c) Place the black side of the reference standard in front of the device

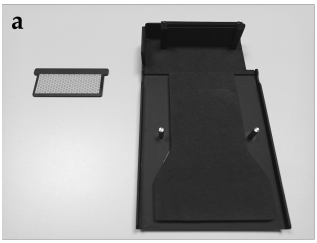
Figure 7. Reference standard - Calibration procedure for MINI Vertical

(a) Select Calibration on the menu



(b) Place the device on the calibration base

(c) Place the white reference standard in front of the device and press ok



(d) Remove the reference standard and press ok

Figure 8. Reference standard - Calibration procedure for MINI Road Studs

6.2.2 MINI Horizontal calibration

The MINI Horizontal is supplied with special hardware called CALIBRATION BASE.

It is very important to keep the CALIBRATION BASE clean, as well as the ceramic reference standard and the instrument front lens as recommended in section 3.

Always keep the calibration base clean and protected inside its carrying case.

Follow the instructions in section 5.4 to fasten the Qd light source in place with the security side pin. Make sure that the side screws (black handle) are both very well tightened.

To start a new calibration, select the CALIBRATION option from the main menu and follow on-screen instructions.

1. Select Calibration on the Main Menu.

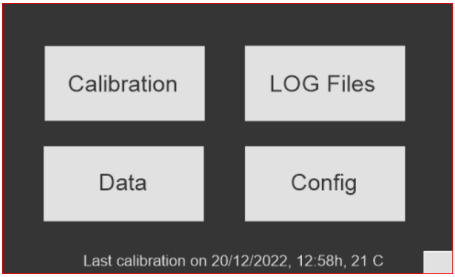


Figure 9. Main Menu - Calibration

2. Place the Equipment on the calibration base and select OK.

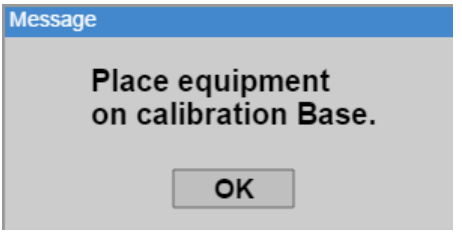


Figure 10. Place the Equipment on the calibration base.

Figure 11. Calibration base.

3. Wait until the process is completed.

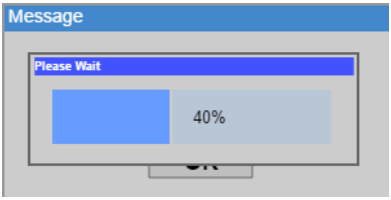


Figure 12. Calibration process.

4. Insert the Black reference in the calibration base and press OK.

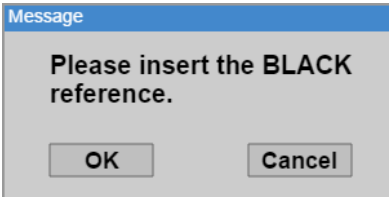


Figure 13. Insert the Black reference.

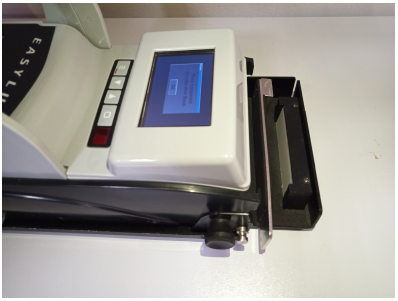


Figure 14. Insert the Black reference.

5. Wait until the process is completed.

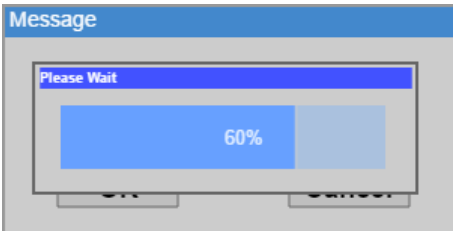


Figure 15. Calibration process.

6. Wait for the message: “Done!” and Press OK. Your equipment is calibrated.

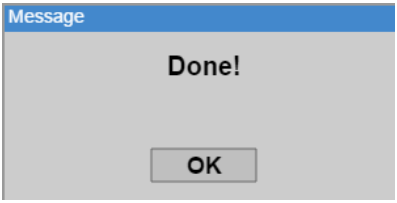
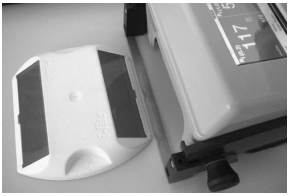


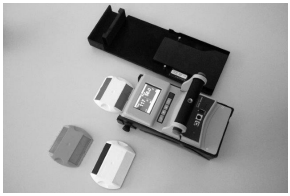
Figure 16. Done! Equipment calibrated.

6.3 MINI Road Studs - measurement position

Make sure that the road stud is in contact with the area delimiter.



(a)



(b)

Figure 17. Measurement position.

Thanks to the exclusive stray light suppression technology the user has full access to the measurement area. It makes correct field positioning and precise entrance angle control possible. Please see the pictures 19 and 20 for entrance angle component β_2.

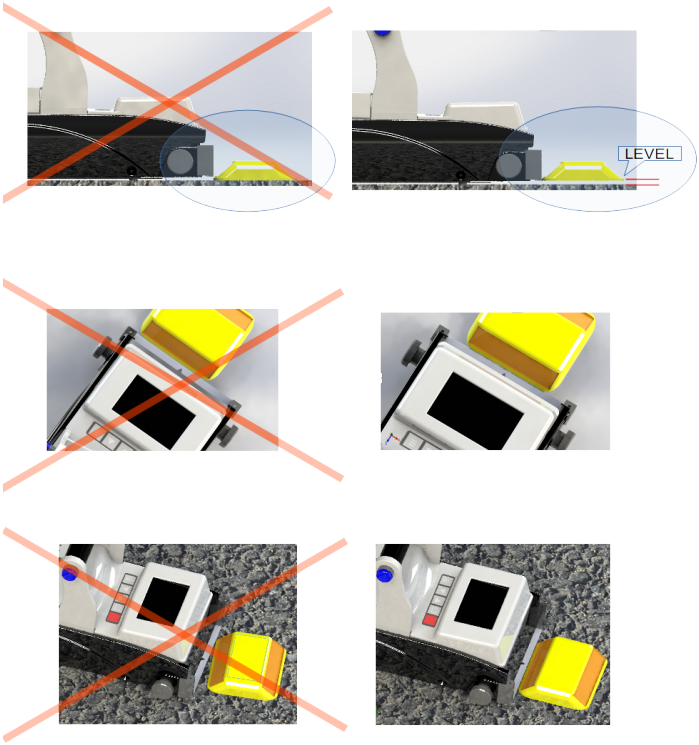


Figure 18. How to check RRPM retroreflectance.

Figure 19. If necessary the ASTM D4280 20° entrance angle can be easily adjusted by the user.

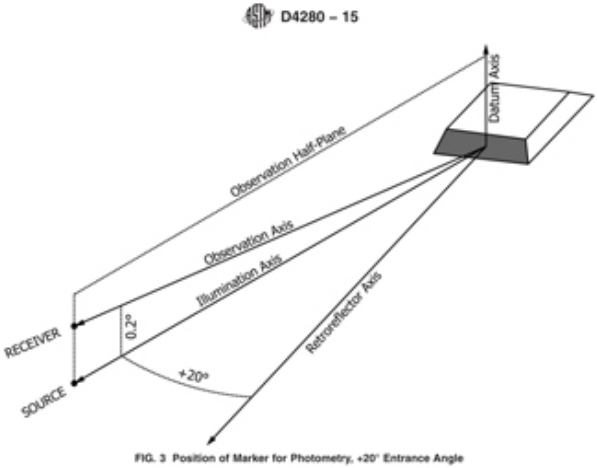


Figure 20. ASTM D4280 20° entrance angle component.

6.4 LOG files

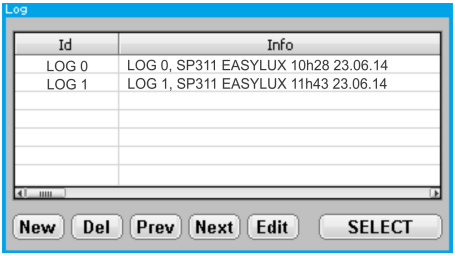


Figure 21. The LOG file is a text database into which all measurement-related data are saved.

The MINI will show all LOG files stored on the SD Card.

The LOG files are automatically numbered by the system starting from LOG 0. When a new LOG is created, the user is asked to inform:

- LOG alias name;
- Road name or ID;
- Starting milestone;
- Operator's name;
- Direction (north, south, east, west);
- Material type (paint, thermoplastic, reflective sheeting grade);
- Special NOTE.

The Special NOTE can be used to record any relevant information about the current work.

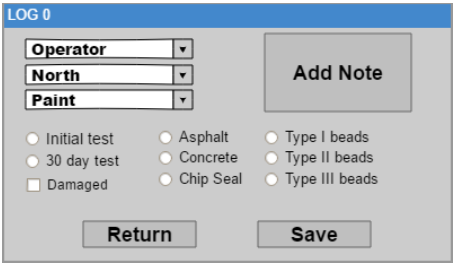


Figure 22. The LOG file is a text database into which all measurement-related data are saved.

Use separate LOG files to organize your data collection. It is also recommended to create a new LOG file every time you have a change of material type.

It is also a good practice to avoid LOG files with more than 8000 measurements.

6.5 Data Transfers

The MINI can communicate with other digital devices through the USB port, PS/2 connector, and Bluetooth interface (optional).

The free EasyData software is a helpful tool to receive, inspect, analyze and organize the collected data:

- Filter values, classifying them into different

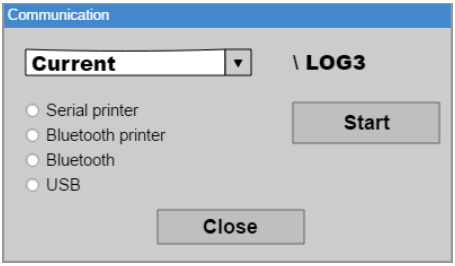


Figure 23. From the Communication Menu other devices can be enabled to transfer data.

retroreflectance ranges;

- Show all measured values on a map, each retroreflectance range in a different color (GPS required);
- Export all data as a KML file to integrate them into other softwares, such as Google Earth;
- Export all data as an Excel spreadsheet.

Visit *www.easylux.com.br* and download the latest version of EasyData software tool.

6.5.1 Android interface

The MINI can be controlled by an Android smartphone application through a Bluetooth interface. The Android software can be downloaded from Google Play store. You should enable the Bluetooth on Hardware Options Menu 6.6.2.

6.6 CONFIG

From the CONFIG menu, all operation and technical configurations of the instrument can be adjusted.

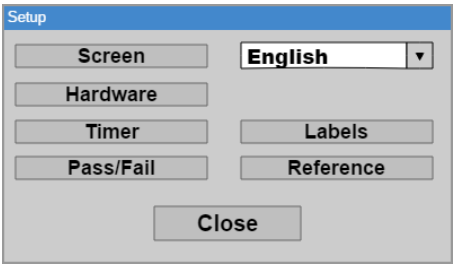


Figure 24. MINI Horizontal and MINI Road Studs CONFIG menu.

The Angle Meter button DEGREE is available only for MINI Vertical model. It displays an auxiliary digital compass to help the user to adjust the incident light entrance angle. The Digital Compass has a precision of $\pm 2 degree$

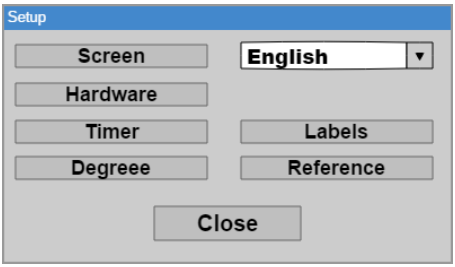


Figure 25. MINI Vertical CONFIG menu.

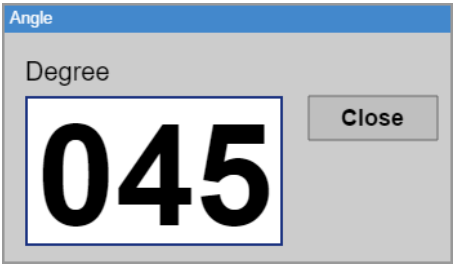


Figure 26. MINI Vertical Angle Meter menu.

6.6.1 Screen

Qd The user can disable the Qd measurement by selecting *Only RL* option. Please, do not remove the Qd light source without our technical support. It can be damaged.

Average mode The AVERAGE option is available for MINI HORIZONTAL and MINI Road Studs. By selecting the "Average mode", the unit is able to use a user-selectable number of readings to save as a single data point.

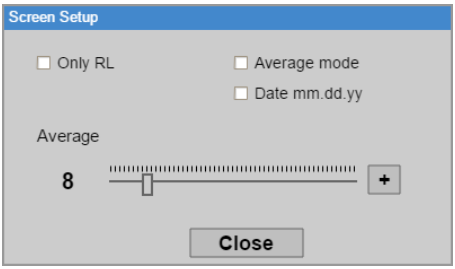


Figure 27. MINI HORIZONTAL menu.

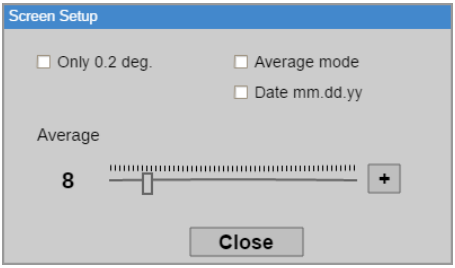


Figure 28. MINI Road studs menu.

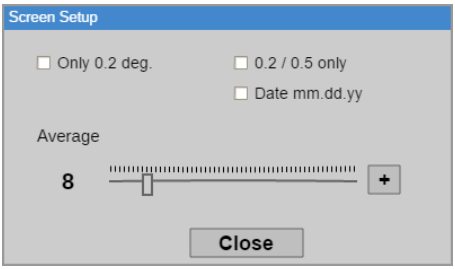


Figure 29. MINI Vertical SCREEN menu.

Observation angles - MINI Vertical The user can enable simultaneous angles for measurements from the Screen menu.

6.6.2 Hardware

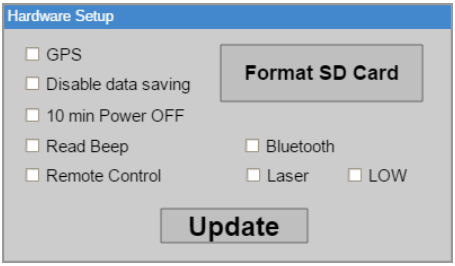


Figure 30. From the Hardware menu you can enable or disable the hardware resources

Hardware settings, such as GPS, energy saver, sounds, data saving and remote control can be enabled or disabled. The GPS hardware option will be grayed out if it is not installed. The Bluetooth hardware should be enabled to allow smartphone interface (Bluetooth is an optional item).

6.6.3 Timer

Adjust the timer operation mode (stop timer, continuous timer), timer interval, and clock/calendar settings.

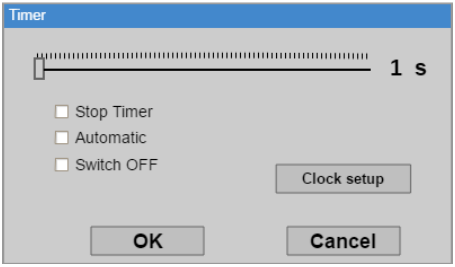


Figure 31. Time menu to adjust the times settings

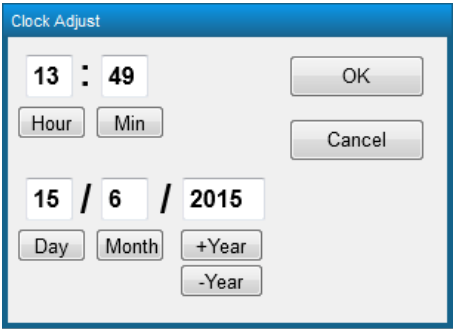


Figure 32. Clock setup menu.

6.6.4 Clock setup

6.6.5 Pass / Fail (MINI Horizontal and Road Studs Only)

Pass / Fail menu allows you to establish a limit indicator. When the measurement result is lower than the established value, it will be displayed in red.

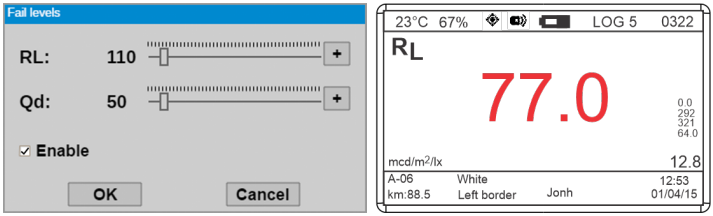


Figure 33. MINI HORIZONTAL - Pass/Fail menu.

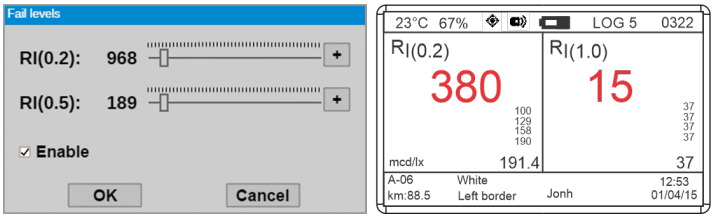


Figure 34. MINI Road Studs - Pass/Fail menu.

6.6.6 Reference Value

The reference values must be defined previously, according to the center of the reference standard range supplied with the instrument.
Do not switch the calibration base between different instruments or randomly change the values in these fields, as this would affect the measured values.

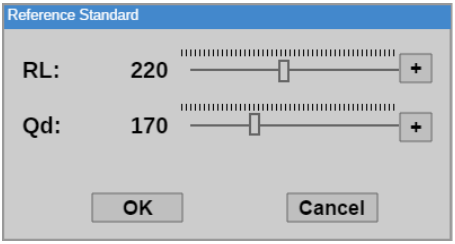


Figure 35. Reference menu of MINI Horizontal.

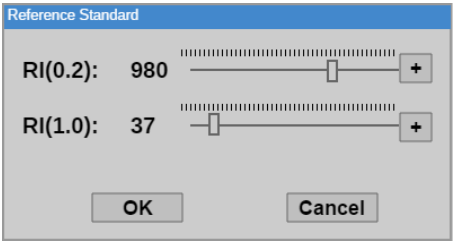


Figure 36. Reference menu of MINI Road Studs.

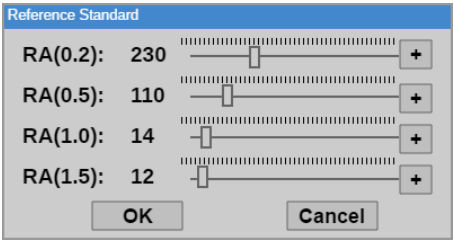


Figure 37. Reference menu of MINI Vertical.

6.6.7 Custom Labels

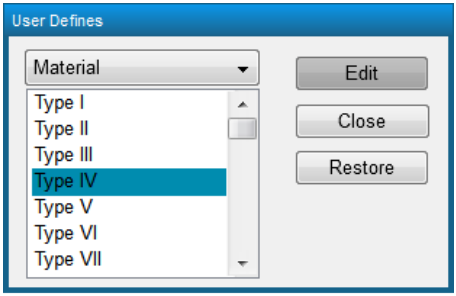


Figure 38. Select the label you want to change and then press the EDIT button.

Use this option to edit the material names, place names, and to add new operators' names to the system memory.

There are 3 groups of labels that can be edited by the user: **Users' names**, **Places** and **Materials**.
The **Places** group stores typical names used in daily services like *Right edge, Center line, Pedestrian cross*, etc.
The user can also *reset* all that to the factory defaults by selecting the RESTORE option.

6.7 Control Panel

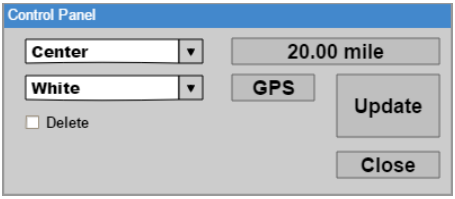
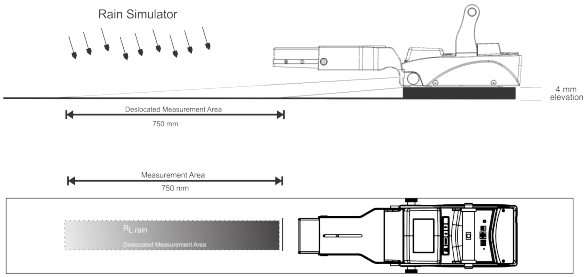


Figure 39. MINI Control Panel menu

A quick Press on the POWER key to open the control panel on the screen. The control panel lets you set a precise description of the current record:

- Set current measurement as DELETED;
- Change the color, material type, and milestone information of the current measurement;
- View the current GPS coordinates and equipment TILT percentage.

7 R_{Lrain} Measurement under Continuous Wetting with MINI Horizontal



ASTM E2832- Measuring the Coefficient of Retroreflected Luminance of Pavement Markings in a Standard Condition of Continuous Wetting.

The measurement area will be moved forward around 46 **mm per elevated millimeter. Be sure you have enough area in front of the instrument. Do not elevate it more than 8 mm**

8 Specifications

"Progress is impossible without change, and those who cannot change their minds cannot change anything."

- George Bernard Shaw

8.1 General Characteristics

Table 1. MINI technical specifications.

Battery	6 AA-size 1.2 V 2500 mAh (or better)
Battery charger	100 – 240 V AC / 50 – 60 Hz / 12 V DC
Charging time	approx 8 hours
Battery capacity	more than 8000 sequential measurements
Operating temperature	$-10\,°C$ to $+50\,°C$
Storage temperature	$-15\,°C$ to $+60\,°C$
Length	255 mm (without Qd light source)
Width	155 mm
Height	170 mm
Weight	2.2 kg
Weight with Carrying Case	6 kg
Carrying case dimensions	470 mm x 380 mm x 240 mm
Data memory	4 GB SD Card SDHC
Display	Color touch (sunlight readable)

8.2 MINI Horizontal technical specifications.

Table 2. MINI Horizontal technical specifications.

Illumination angle	1.24 °
Observation angle	1.05 °
Geometry	30-meter
Observation aperture	±0.16 °
Projected light area	56 x 350 mm
Measurement sensor	$V(\lambda)$ adapted
Profiled size	15 mm -10% tolerance
R_L Range	$0 - 4000\, mcd.m^{-2}.lx^{-1}$ (*)
Qd Range	$0 - 400\, mcd.m^{-2}.lx^{-1}$

* up to 5000 $mcd.m^{-2}.lx^{-1}$ by special request

8.3 MINI Vertical technical specifications.

Table 3. MINI Vertical technical specifications.

Illumination angle	$-4\,^{\circ}$, $+5\,^{\circ}$, or continually variable
Observation angle	$0.2\,^{\circ}$, $0.33\,^{\circ}$, $0.5\,^{\circ}$,$1.0\,^{\circ}$,and $1.5\,^{\circ}$
Observation aperture	$\pm 0.05\,^{\circ}$ annular
Measurement area	25 mm diameter
Measurement sensor	$V(\lambda)$ adapted
$\mathbf{R_A}$ **Range**	$0 - 2000\, cd.lx^{-1}.m^{-2}$

8.4 MINI Road Studs (RRPM) technical specifications

Table 4. MINI Road Studs technical specifications.

Illumination angle	$0.0\,^{\circ}$
Observation angle	$0.2\,^{\circ}$, $0.33\,^{\circ}$, and $1.0\,^{\circ}$
Observation aperture	$\pm 0.05\,^{\circ}$
Measurement area	75 mm x 30 mm
Measurement sensor	$V(\lambda)$ adapted
$\mathbf{R_I}$ Range	$0 - 2000\,mcd.lx^{-1}$

9 Warranty

EASYLUX EXPORTAÇÃO, IMPORTAÇÃO E FORNECIMENTO DE EQUIPAMENTOS LTDA confers upon the purchaser of this product warranty against defects in materials and workmanship for a period of 640 days counting from the legal end of the 90 days period after the issuance of the sales invoice to the consumer, totaling 730 days, as long as the product has been used and operated as defined in the User's Manual.

The product warranty covers labor and spare parts for duly confirmed manufacturing defects. The product warranty does not cover required calibrations and adjustments.

Parts subject to natural wear, external parts and accessories, in general, have their warranty restricted to a time period of 90 days.

The product warranty does not cover transportation, customs charges, import and export duties and taxes for maintenance, calibration or repair purposes.

The product warranty is void if the device has been used in disagreement with the instructions in this manual.

The product warranty is void if the product has been damaged as a result of fall, accident, natural forces, change, misuse, or repair made by any person not authorized by the manufacturer.

Disclaimer

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

EASYLUX makes no warranty of any kind with regard to this material. EASYLUX shall not be liable for errors contained herein or for incidental or consequential damages in connection with the use of this material.

Appendix

Field sampling, Reference panels, Frequently asked questions, Troubleshooting

A MINI Horizontal - Road Marking Sampling

> "The victim is always guilty."
>
> *- The Dreamer - Prof. Stefano D'Anna*

The measurement angles of the MINI Horizontal - or any road marking 30-meter retroreflectometer - are very close to the pavement surface (1.24° / 2.29° for 30-meter geometry) . As a result, the correct positioning of the equipment is critical.

The instrument must be positioned directly over the pavement marking and parallel with the marking as shown in figure 2. Any other positioning will give erroneous results. Make sure the instrument is firmly placed on the surface.

Ensure the correct alignment of the instrument with the road marking, figure 2.

Road markings less than 1 meter long cannot be accurately measured by the MINI HORIZONTAL.

An uneven marking or a small piece of gravel stuck below the instrument will affect the measurement geometry and the reading! Ensure that the measurement area in front of and under the instrument is free of dust and small stones.

Several factors can cause inaccuracies on readings that are not attributable to the instrument: Road markings present uneven surface, non-homogenous structure, and non-homogenous glass bead distribution.

Do not take just one or two reading of a road marking. The retroreflectivity may varies from area to area. It means that a small change in the retroreflectometer position can produce variations as large as 20% in the readings. It is important to get readings separated sufficiently to provide meaningful data (typically one meter) and record the results (10 or more) for average. See the picture 62.

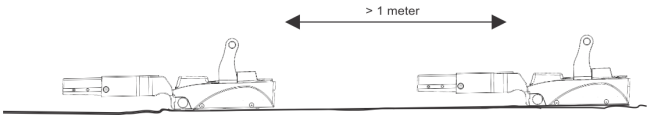


Figure 40. 1 meter to provide meaningful data

All measurements obtained in a sampling run should be made in the direction of the traffic flow, except on the median line of two-lane roads, where the required number of measurements must be made in both directions.

The retroreflectometer must be positioned parallel to and right over the delimitation demarcation to be evaluated. Avoid pebbles and abnormal irregularities. Make sure that the instrument is steadily positioned.

A 0.5-degree inclination, for example, cannot be detected by our eyes. However, it translates into big measurement errors. It is important to remember that the illumination angle is only 1.24 degree for 30-meter geometry devices.

When working with 30-meter devices, move the instrument to a new adjacent position every time you get inconsistent readings on the screen, figure 41.

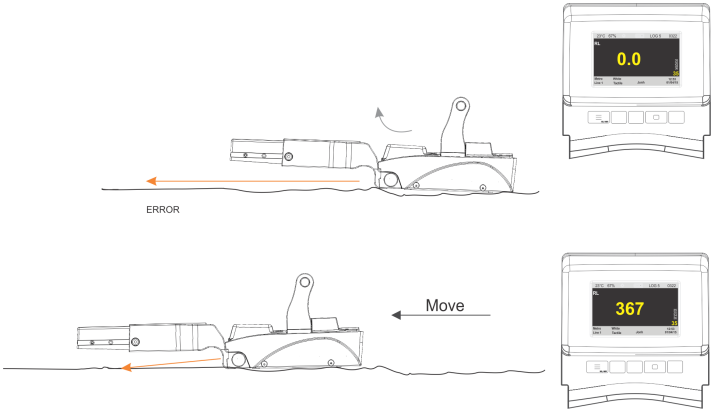


Figure 41. Surface irregularities may change the **light entrance angle**!

For measurements, keep the MINI 1 meter away from Retroreflective Road Studs (RRPM), figure 42.

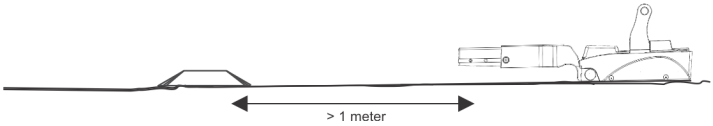


Figure 42. Keep the MINI 1 meter away from Road Studs.

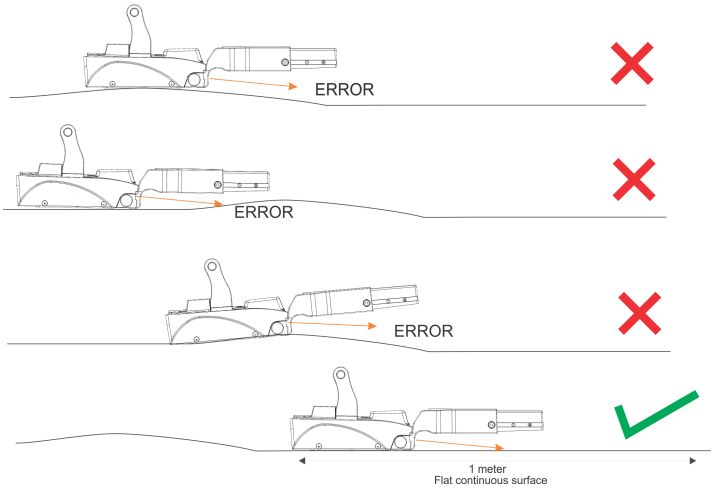


Figure 43. Minimum 1 meter flat surface, consistent or uniform profiled.

The typical MINI measurement area is 350 mm x 57 mm. However, it may change. The figure 44 shows the maximum values.

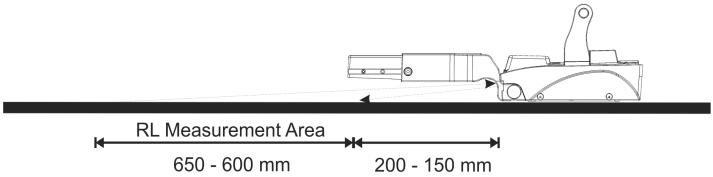


Figure 44. Maximum MINI measurement area.

It is important to record the retroreflectometer reading and then move to other locations on the same sample set separated sufficiently to provide meaningful data (typically one meter) and record the results (10 or more). See the figure 62

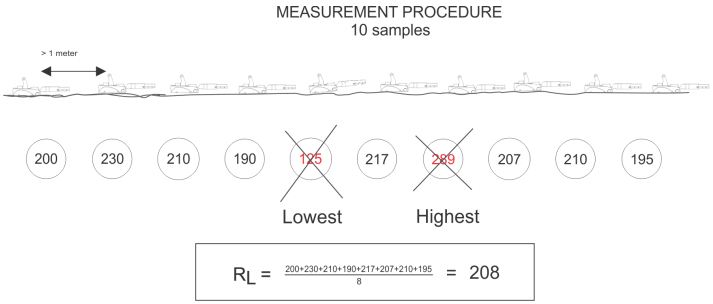


Figure 45. For calculating the average, after taking 10 measurements, eliminate the highest and lowest values.

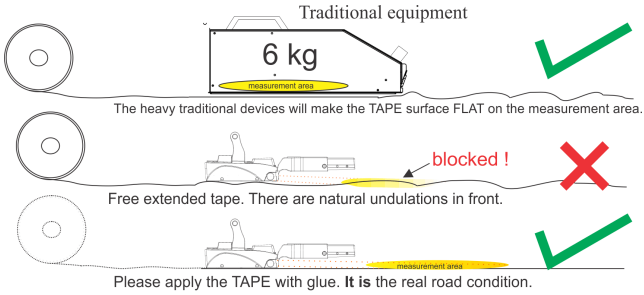
Easylux retroreflectometer will measure any marking design, white or yellow markings without any adjustment to the instrument.

When working with Road Marking TAPES then it must be applied over the test surface. If it is not applied with glue then the tape could present odd, uneven shape with small undulations and natural deformations (It is stored in a roll!). It could add too many variations on measurements and the instrument may show wrong results.
The tape should be applied with glue or you can use hot-air to deal with shape problems. The undulations and shape problems were emphasized on figure 68 for didactic purposes.

The MINI technology is completely immune to sunlight.

If there is sunlight contamination, then any old-technology device is likely to provide wrong values.

Since the EASYLUX measurement area is larger and external to the instrument, it is not possible to precisely measure the same area as current technology instruments, where the measurement area is underneath the instrument. This strongly recommends using average values of retroreflectivity rather that specific point values.



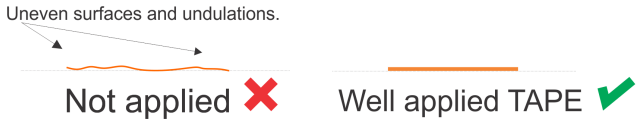


Figure 46. TAPES must be applied with glue.

When working with a Profiled Road Marking you may add an auxiliary surface (flat and rigid) under the MINI. The sum of the profiled size and the auxiliary surface thickness should be less than 15 mm.

The measurement area will be moved forward around 46 mm per elevated millimeter. Be sure you have enough area in front of the instrument.

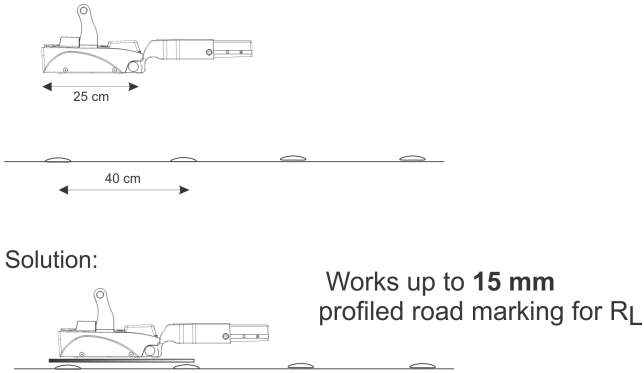


Figure 47. Profiled road markings.

B MINI Horizontal - Working with reference plates (reference panels) or laboratory samples

B.1 Short Panels

Short panels (less than 800 mm length) should be positioned in front of the MINI. To take readings it is mandatory to use a level compensation, figure **??**, to have the machine at the same level as the sample under reading.

compensation.png

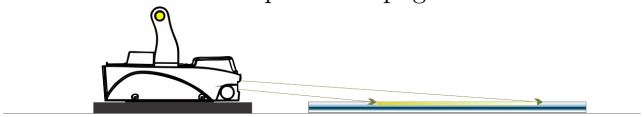


Figure 48. Use of a level compensation under the MINI. The MINI should be at the same level as the short-sample under reading.

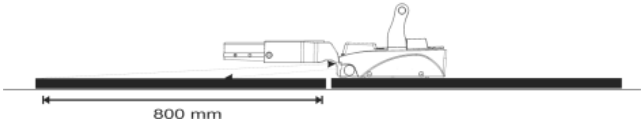


Figure 49. Short panel and a level compensation.

Add an auxiliary surface under the MINI to put the instrument at the same level as the sample plate. It should have the same thickness as the sample under test. Auxiliary surfaces with different thickness will move the measurement area far away from the sample under test! See figure 50

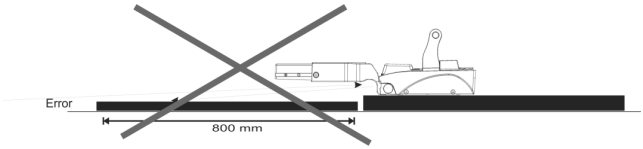


Figure 50. Wrong level compensation.

Auxiliary surfaces will not work on irregular (not smooth) surfaces. It should always be placed on a rigid, flat and uniform surface.

You should never do measurements of short road marking samples over irregular (not smooth) surfaces. The figure 51 illustrates (exaggeratedly) a very common situation.

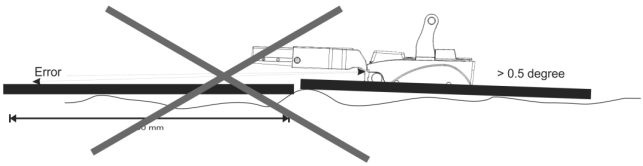


Figure 51. Irregular (not smooth) surface effect.

Avoid placing the road making sample or the reference plate over a standard office table. It could present unperceptive deformations between the legs that may influence the results .

B.2 General guidelines

Working with reference plates (reference panels) or laboratory samples requires care.

Often samples are less than 1 meter long and prepared on aluminum panels that tend to warp. **As the MINI retroreflectometer is vertically shorter and lightweight, any little bend or warpage effect on the metal sheets can introduce errors on the measurement geometry**.

The figure 52 illustrates the typical *warpage effect* on the ends.

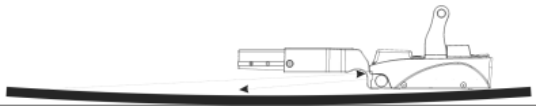


Figure 52. Warpage effect.

Samples of 1.5 meter or longer and not less than 4 mm thick will reduce the warpage effect. It is always recommended to take measurements in the middle of the reference plate, figure 53

Figure 53. Warpage effect reduced.

It is important to note that a 0.5-degree inclination error on an auxiliary surface cannot be detected by our eyes. However, it will introduce big errors on your readings! The illumination angle is only 1.24 degree for CEN 30-meter geometry.

Road marking samples 1.5 meter long and at least 4 mm thick are also more adequate for not smooth surfaces. See the figure 54.

Avoid placing the road making sample or the reference plate over a standard office table. It could present unperceptive deformations between the legs that may influence the results .

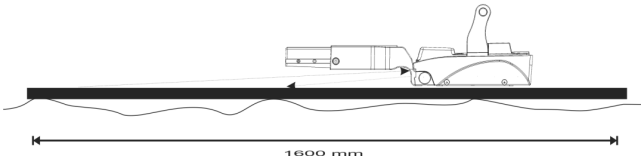


Figure 54. 1.5 meter long and 4 mm thick .

C Basic Troubleshooting Guide

"It's not what happens to you, but how you react to it that matters."

Epictetus

C.0.1 Troubleshooting

1. My instrument won't start.
Solution 1:
Press and hold the power button for at least 2 or more seconds. See the section 5.1.
Solution 2:
Remove and reinsert each battery. They may have slipped out of the pack.
Solution 3:
Replace the batteries or let them charge for at least 2 hours (10 hours for full charge).

2. My instrument won't charge.
Solution 1:
Check if there is a green light on in the connector panel. If it is not on, try the next steps:
Solution 2:
Remove and reinsert each battery. They may have slipped out of the pack.
Solution 3:
Replace the batteries with new ones.
Solution 4:
Replace the wall charger with a new one .

3. My instrument freezes or stops responding.
Solution:
Press and hold the power on key for 5 seconds
Solution:
RESET by pressing the Reset key. Use a long object, such as an extended paper clip, to press it through the hole on the top panel.

4. My instrument won't connect by Bluetooth interface.
Solution:
It is an optional item and should be installed at the factory. Check if it is installed.
Solution:
The default password is 0000.
Solution:
Click on DATA-¿Android option menu.

5. My instrument won't connect with GPS.
Solution 1:
You should be outdoors to work with GPS.
Solution 2:
It could take 1 or 3 minutes for satellite synchronization.
Solution 3:
Press **+info** button on the Control Panel to check the coordinates or GPS status. See **Control Panel** in section 6.7.
Solution 4:
It is an optional item and should be installed at the factory. Check if it is installed.

6. The screen won't respond.
Solution:
Press and hold the power button for 3 or more seconds. See the section 5.1.

7. Error messages on calibration.
Solution 1:
The instrument will not calibrate with the wall charger adapter plugged.
Solution 2:
Check if the front lens is clear - free of ice or dust.
Solution 3:
Check if the batteries are charged.

8. Missing characters, empty text box or messages.
Solution 1:
Ensure the SDCard is correctly inserted.
Solution 2:
Check for the RES directory on the SDCARD. If it is not present, contact EASYLUX to get the RES directory content.
Solution 3:
Check if the batteries are charged.

9. Low value measurements or inconsistent readings
Solution 1:
Check if the front lens is crystal clear - free of oil, water, ice (thick layer of ice) or dust.
Solution 2:
Beware of fog, very low temperatures (below zero Celsius degree), high humidity places, dust or situations that can block the measurement light or add contamination (dust, ice, water) on the front lens.
Solution 3:
Check the positioning. Please read the section A and B.
Solution 4:
Do not take measurements with the wall charger plugged.
Solution 5:
Recalibrate the instrument according to instructions of the section 6.1.
Solution 6:
Replace the batteries with new ones.
Solution 7:

Avoid strong light intensity changes over the measurement area (moving shadows) during measurements (immediately after pressing the trigger key). The MINI takes around 2 seconds to stabilize again.

Solution 8:

When the extension handle is attached to the MINI it can tilt back over inclined surfaces due the natural change of the mass center. Always make sure that the MINI is in contact with the surface before taking readings. In case of low readings or ZERO, move the machine to another position and press down the extension handle to avoid tilt.

Solution 9:

The MINI horizontal is an external beam retroreflectometer. Make sure that there is enough retroreflective material in front of the device.

Solution 10:

Remove small stones or gravels that can be on the road surface. It can affect the measurement geometry of the MINI horizontal.

10. Touchscreen problems

Solution 1:

Recalibrate the touchscreen:
Turn on the machine and then **immediately** PRESS and HOLD the yellow button (trigger button).
The touchscreen calibration routine will guide you.

Solution 2:

The touchscreen is pressure sensitive. Try using a pointer device.

Solution 3:

Disconnect the battery charger from the MINI.

11. MINI Horizontal presenting unstable measurements

Solution 1:

Replace the batteries for new ones. Any aged or

damaged battery holder should also be replaced.

C.0.2 Error messages

Message: SDCard not found.
Solution 1:
Check for the RES directory on the SDCARD. If it is not present, contact EASYLUX to get the RES directory content.
Solution 2:
Ensure the SDCard is correctly inserted.

Message: SDCard Full.
Solution 1:
Delete some old LOG files.
Solution 2:
Ensure the SDCard is correctly inserted.

Message: SDCard Error.
Solution:
Ensure that the 4GB SDCard is correctly inserted and FAT formatted.

Message: Qd Light: Not found
Solution:
Ensure that the Qd light is correctly attached.

Message: File too big. Please create a new LOG
Solution:
The system will not work with more than 65000 measurements on one LOG file.

Message: LOW BAT!
Solution:
It is time to recharge the batteries.

Message: CAL
Solution:
Calibration warning. Please, recalibrate the instrument.

Message: Empty messages, symbols (! ? $ #) or inconsistent messages
Solution 1:
Low battery levels can cause unstable readings of the SDCARD memory. Charge the batteries for at least 2 hours.
Solution 2:
Replace the RES directory content of the SDCARD to restore corrupted or deleted files.
Solution 3:
Check for the RES directory on the SDCARD. If it is not present contact EASYLUX to get the RES directory content.
Solution 4:
Ensure the SDCard is correctly inserted.
Solution 5:
Contact EASYLUX for a firmware update.

You should never delete the RES directory from the SDCARD. Do not format the SDCARD on a external computer or remove any file from the RES directory.

D Frequently asked questions (FAQ) about the MINI technology

"If you would be a real seeker after truth, it is necessary that at least once in your life you doubt, as far as possible, all things."

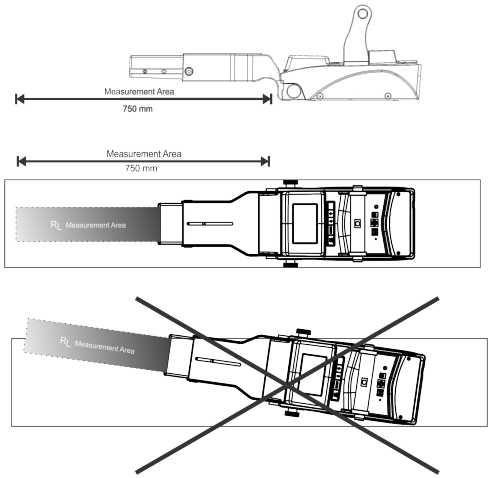
René Descartes

List of Frequently Asked Questions

Question 1: Can I use the MINI technology as I have been using my traditional retroreflectometer?

Yes - But both a smart phone and an old rotary phone can make calls, however there are big differences on technology, size, weight and operational procedures.

When working with road markings, watch the positioning, as shown in the following image, and also remember that you need at least a 1 meter free distance in front of the MINI since it is an external reading instrument.



Question 2: Where is the MINI measurement area? What is it size?

The MINI for road marking is an external beam instrument. The $\mathbf{R_L}$ measurement area has around 400 mm length and starts around 200 mm in front of the MINI. The figure 55 presents maximum values.

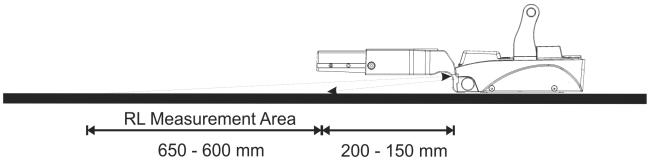


Figure 55. Maximum MINI measurement area.

It is **mandatory to keep at least** 1 **meter** free distance in front of the MINI horizontal, since it is an external reading instrument. Ensure that the measurement area in front of the instrument is free of dust and small stones.

There may be some unique situations where the MINI and other traditional internal beam instruments give different values. The differences could be do to larger measurement are of the MINI. The MINI is an external beam instrument.

Make sure that the instrument is perfectly aligned with the pavement marking. Failures in alignment or positioning cause the measurement area to not match the marking, which affects the results.

Question 3: Can I see the MINI measurement area?

The MINI horizontal is an arrangement B device: **The illuminated area is the measured area**. A darkened room will demonstrate the illuminated area and importance of placement and "aiming" of the MINI. The MINI optical arrangement B (ASTM $E1710$) is advantageous in the sense that it leads to less variation of the measured value with small tilts of the retroreflectometer that are unavoidable in practical field measurements.

Question 4: Should I send my MINI back to factory for calibration?

Easylux instruments do not need re-calibration or special services unless damaged by external factors. To ensure reliable measurements, periodic checking or replacement of the instrument reference standard is recommended. Please contact www.easylux.com.br or your local distributor to learn more about how to replace the calibration standards.

In case of MINI Horizontal the ceramic reference can be checked independently with a special Easylux Calibration Kit (sold separately).

Question 5: How many measurements can I take with new charged batteries? Can I use any model of AA-size battery?

Full charged batteries will provide more than 8000 consecutive measurements. You should use AA-size rechargeable batteries with at least 2300 mAh. A fully charged brand new battery will make around 8000 consecutive measurements. If the number of measurements falls much below, it is time to replace it.

Question 6: How long is the charging time of the batteries?

The multi-voltage power adapter and the vehicle power adapter will recharge the batteries within 8 hours. With 4 hours it is possible to get around 4000 consecutive measurements. For fast recharging, a third-party external AA battery charger can be used. Never leave the batteries uncharged for too long.

Question 7: The MINI does not turn-on or recharge. Can I change the battery myself?

Yes. The MINI uses 6 units of rechargeable AA-size battery. Just remove the back battery cover to access the batteries. It requires use of a small Phillips screw driver.

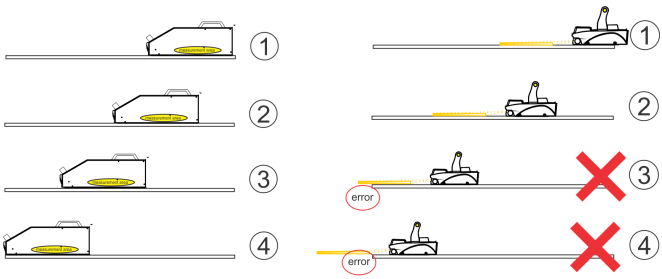
In case of strong impacts or vibrations one or more AA battery unit can slip out of the

contacts. If the machine does not turn-on, you should remove and reinsert each battery in the holder to fix any contact fault.

Question 8: The results of MINI horizontal are decreasing when I check a SAMPLE of road marking in my laboratory. It does not happen with my traditional retroreflectometer. What is the problem?

Working with reference plates or laboratory samples requires special care. Often the MINI measurement area can not match the sample surface if it is less than 1 meter long.

Please check the figure 55 to see typical MINI horizontal measurement area start and stop points.



POSITION	TRADITIONAL mcd/m²/lx	MINI mcd/m²/lx
1	257	245
2	230	230
3	235	145 ×
4	245	55 ×

Figure 56. Always keep 1-meter in front to avoid edge errors.

Question 9: Wrong results when reading road marking short SAMPLE plates. What is the problem?

Working with reference plates or laboratory samples requires special care. Samples with less than 0.45 m length can not be accurately read by the MINI.

When reading short sample plates (from 0.45 m to 1 meter) you should use a level compensator, as shown in the pictures.

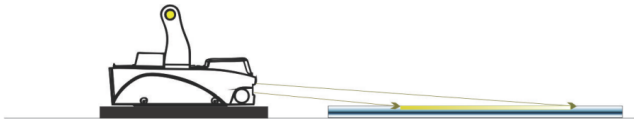


Figure 57. Use of a level compensation under the MINI. The MINI should be at the same level as the short-sample under reading.

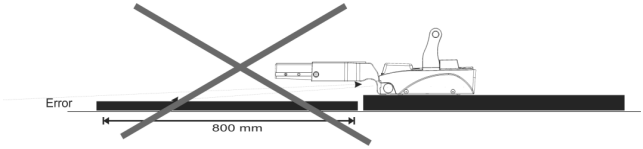


Figure 58. Wrong level compensation. Auxiliary surfaces with different thickness will move the measurement area away.

Auxiliary surfaces will not work on irregular or uneven surfaces. The MINI should always be placed on a rigid, flat and uniform surface.

You should never take measurements of any road

marking sample plate over irregular (not smooth) or uneven surfaces. The figure illustrates (exaggeratedly) a typical situation.

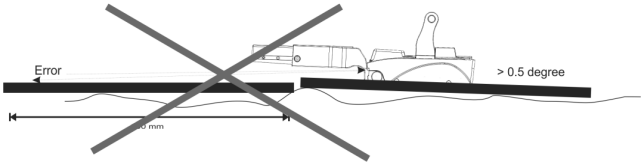


Figure 59. Irregular (uneven) surface effect.

> The MINI measurement area is uncovered and is not pressed against the surface, as in traditional retroreflectometers. To avoid errors, it is important to always use sample metal sheets with at least 4 mm and a polished granite table as a test surface.

Question 10: How can I check the same point as my traditional retroreflectometer?

The MINI horizontal measurement area is **almost** 4 **times larger** than traditional devices.
Since the EASYLUX measurement area is larger and external to the instrument, **it is not possible to precisely measure the same area as traditional instruments**, whose measurement area is underneath the instrument. Because of this, it is strongly recommended to use average values of retroreflectivity rather than specific point values.

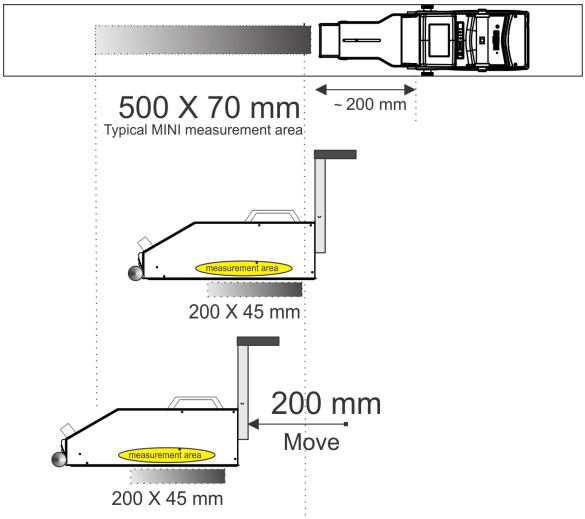


Figure 60. It is not possible to precisely measure the same area as traditional instruments.

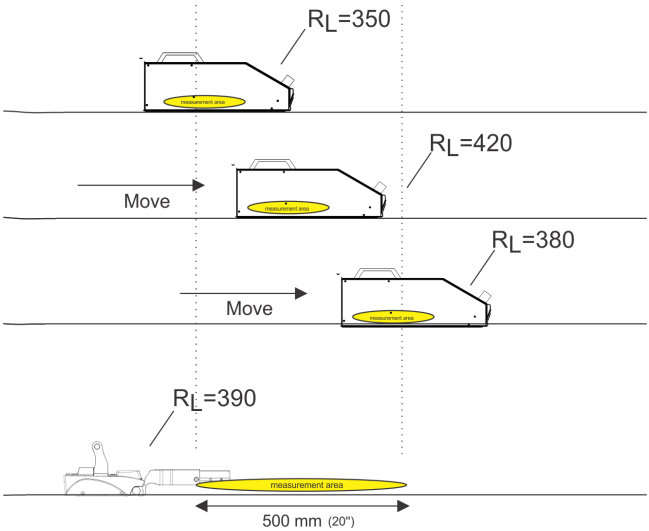


Figure 61. The MINI provides a better average of the night visibility, especially in cases of degraded road markings.

Question 11: Variations on adjacent points when working on surfaces with exposed stones (chip seal). What can I do to solve it?

Adjacent measurements over chip seal or similar pavement could present a big variation due the high mean profile depth of the surface.

When working with uneven surfaces like chip seal, it is very important to record the retroreflectometer reading and then move to other locations on the same sample set separated sufficiently to provide meaningful data (typically one meter) and record the results (10 or more). For calculating the average, after taking 10 measurements, eliminate the highest and lowest values.

Please see the picture 62.

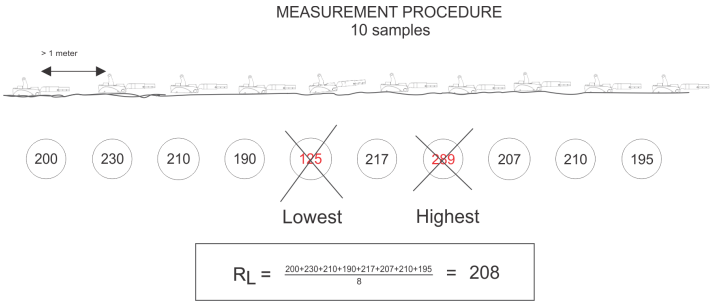


Figure 62. For calculating the average, after taking 10 measurements, eliminate the highest and lowest values.

> Regardless of the retroreflectometer brand or type, it is important to avoid uneven surfaces and non-homogenous structures that can affect the standard 30-meter CEN geometry for all instruments. The entrance angle with respect to the specimen plane will be affected by the physical characteristics of the specimen.

Question 12: Can MINI Horizontal deal with small tilts on field test? Is that a arrangement B device?

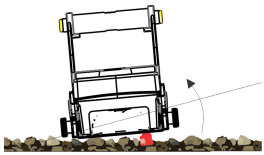


Figure 63. Optical arrangement B: Low sensibility to small tilts.

The MINI horizontal a optical arrangement B device. It

means that the illuminated area is enclosed within the detected area. The MINI optical arrangement B (ASTM E1710) is advantageous in the sense that it leads to less variation of the measured value with small tilts of the retroreflectometer that are unavoidable in practical field measurements.

Question 13: How can I replace the bottom rubber pads?

Use only flat self adhesive rubber pads with thickness from 1 **mm to** 1.2 **mm** and diameter of 10 mm.

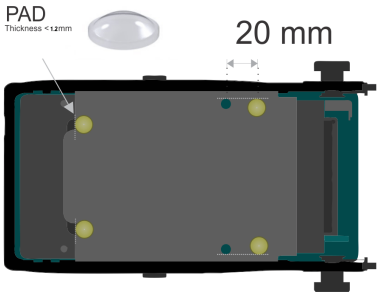


Figure 64. Make sure the pads are placed at the correct position. See the dotted line at the picture for alignment.

The pads on the MINI footprint will minimize unexpected elevations (small stones) of the MINI footprint. Make sure that all rubber pads are in good conditions and at the correct places.

Notes:

- The measurement area will be moved 46 mm further ahead per millimeter of pad thickness.

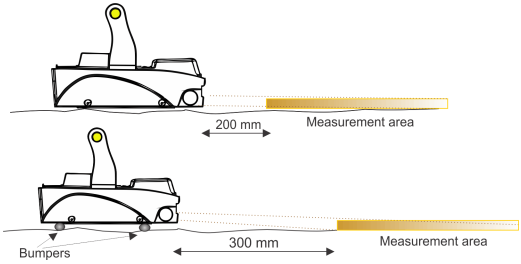


Figure 65. A 2 mm thickness pad will move the measurement area around 92 mm further ahead.

- It is important to make sure that there is at least 1 meter of material in front of the lens.
- Do not use support pads with 2 mm or more. It could introduce errors of around −10 % in **Qd** (day visibility) readings per each mm over the pavement surface.

Do not use support pads made of foam or any kind of soft material. These pads will deform and could affect the measurement geometry.

Question 14: Different results when checking transverse lines on test deck. Why?

Transverse lines may yield less uniform readings than longitudinal lines. Transverse lines have high wear in the wheel track area and less wear in the non-wheel track area.

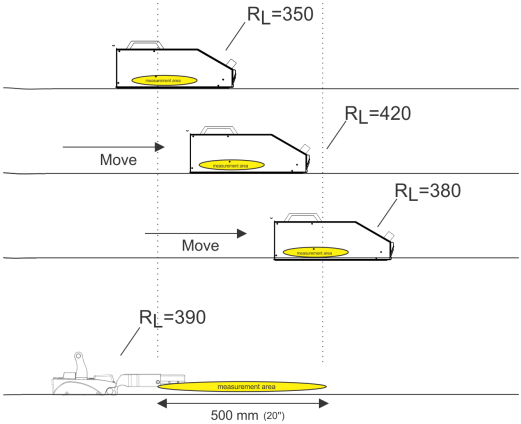


Figure 66. The MINI will provide a better average of the night visibility, especially in cases of degraded road markings.

Question 15: Variations when checking road marking TAPES inside my office. Why?

Road marking TAPES must be applied over the test surface. If it is not applied with glue, the tape could present odd, uneven shape, with small undulations and natural deformations (*It is stored in a roll!*). It could add too many variations on measurements and the instrument may show wrong results or present high variability from one point to another.

The undulations and shape problems were emphasized on figure 68

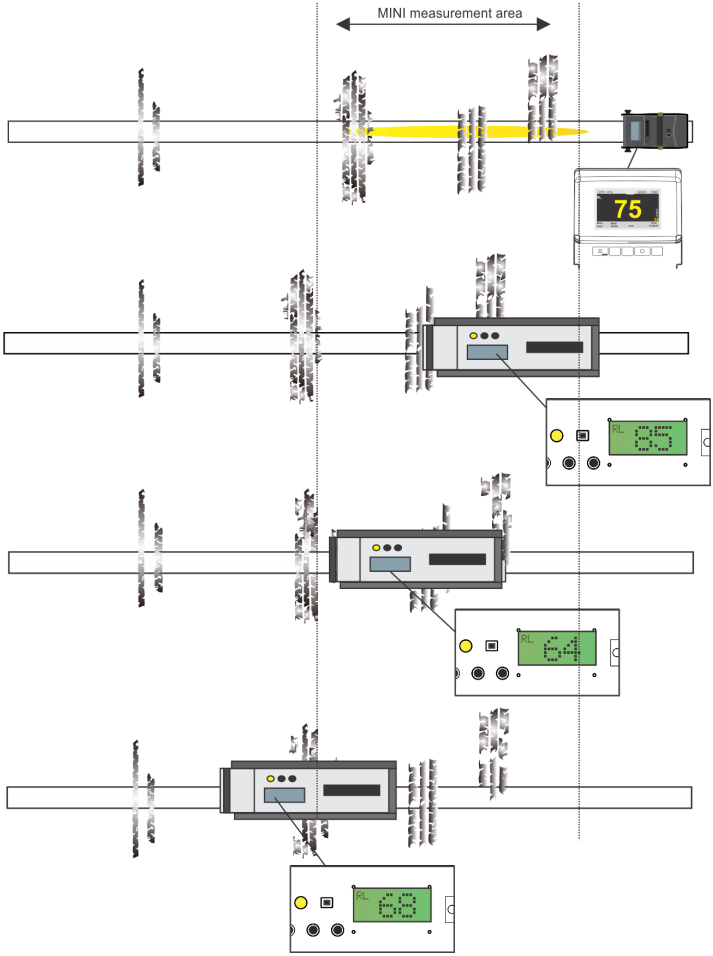


Figure 67. Degraded marking. The MINI horizontal measurement area is almost 4 times larger than traditional devices.

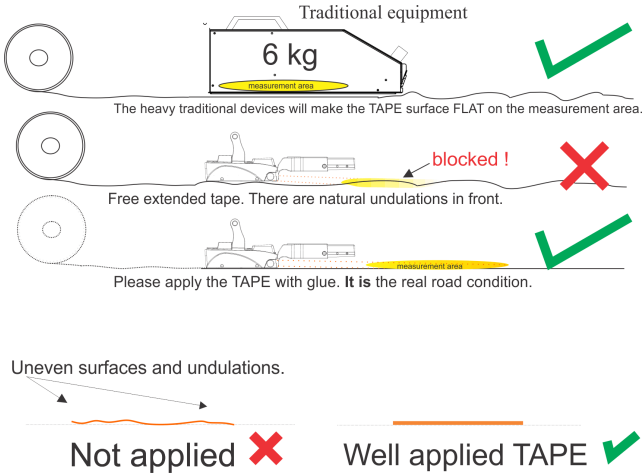


Figure 68. Road marking tapes must be applied with glue before test.

Question 16: Should I calibrate the MINI every day?

Yes. It is recommended to calibrate the MINI at least once a day, after recharging the batteries, before starting to work, and after a significant temperature change.
If the MINI is calibrated at room temperature and used at a different temperature, its output may include a bias error. Environmental factors, such as the ambient temperature, can introduce errors that may not be readily evident when testing samples with unknown values. It is important to calibrate the instrument again at the field temperature, after stabilization. The typical temperature stabilization time is around 10 minutes.

It is always important to adopt the best practices recommendations, as ASTM E1710, that recommends calibrations at hourly

intervals.

Question 17: Does the sun affect the measurements?

No. The MINI is completely immune to solar light or any kind of external light (indoor lamps and road lamps).

Avoid strong light intensity changes over the measurement area (moving shadows) **immediately after pressing the trigger key** to take measurements or during the reading time when under strong sun light.

Question 18: Why does my device present a CAL message on screen?

The instrument will display an warning (***CAL***) on the measurement screen whenever the system detects a calibration fault. It will be displayed 24 hours after the last calibration or for every critical change in internal temperature. Please recalibrate the machine whenever you see the (***CAL***) message.

Question 19: How can I adjust the calibration point of my MINI?

It is **strongly *not* recommended** to change the MINI internal calibration reference values.

It is strongly not recommended to change the MINI internal calibration reference values. In very special cases, the MINI internal calibration reference can be adjusted by the user:

- To follow a secondary reference standard (from a local laboratory, for example).
- To adjust the calibration point to the upper uncertainty value of the reference laboratory (+10%).
- To follow the reference of another manufacturer or local authority.

Laboratory references (NIST, METAS, IPT) are under

an uncertainty range of at least ±5%.

Uncertainty of measurement is the doubt that exists about the result of any measurement.
The uncertainty of any reference laboratory is at least ±5%. As it is obvious, any field retroreflectometer should have a worse uncertainty.

To adjust the calibration point the MINI, go to the REFERENCE menu.

Figure 69. Reference menu.

Road marking retroreflectometers, by example, are standardized in factory with known and reproducible coefficient of retro luminance, according EN 1436 and ASTM E1710 geometry. The reference is under an uncertainty range of ±5%.

The following pictures illustrate the effect of the internal reference adjustments on measured results.

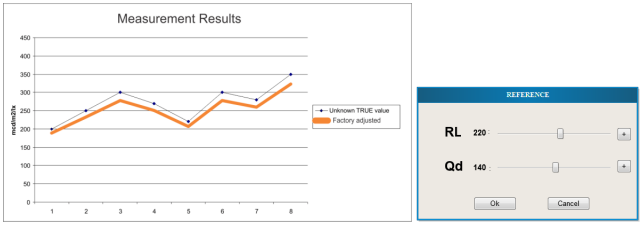


Figure 70. Default reference.

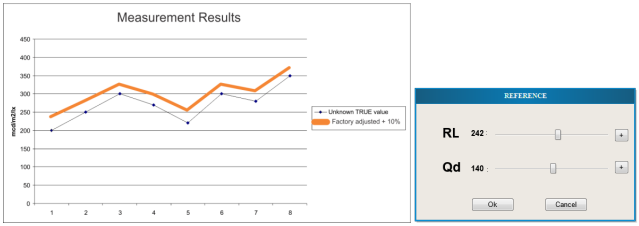


Figure 71. + 10% adjust.

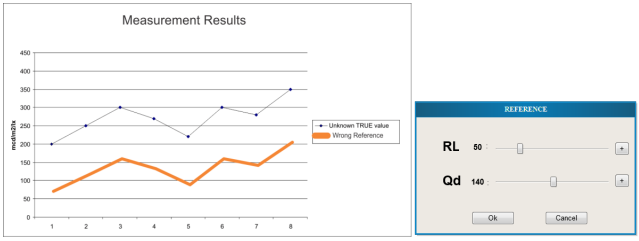


Figure 72. Wrong adjustment.

Question 20: Can I check the retroreflectivity in wet conditions (ASTM E2177) or in continuous wetting ASTM E2832 $R_{L\text{-}2}$ procedure?

Yes. You can work without any attachments or modifications.
The MINI for road marking is an external beam instrument. It is completely immune to solar light or any kind of external light.

Question 21: Can the MINI record GPS coordinates?

It is stored for every measurement.

The GPS synchronization could take from 3 to 10 minutes after power on. The MINI should be outdoors to get the GPS coordinates. It works outdoors only. The precision of any commercial GPS (CEP) is from 3 to 5 meters. The GPS positioning is updated every 5 seconds, the customer must wait until the machine has a good connection with GPS satellites. It is shown on the screen as an icon.

The GPS is an optional item.

Question 22: Are there options to store user, place and additional information about the place or material under test like stripe type, color, special notes, etc... ?

The MINI implements a LOG file system that can be used to organize your measurements.

When a new LOG is created, the user is asked for the following:

- LOG alias name;
- Road name;
- Starting milestone;
- Operator's name;
- Direction (north, south, east, west);
- Material type (paint, thermoplastic, Epoxy, etc.);
- Special NOTE.

Please see section 6.4 to get details about LOG Files.

Question 23: I want to change color nomenclatures in the control panel. Is it possible ?

The MINI stores important system files on the SDCARD folder named **RES**. It is strongly not recommended to change the content of the RES folder. In very special cases the user can edit color names or typical nomenclatures stored on files *COR0.dat* to personalize the CONTROL PANEL menu, described on section 6.7 of this manual.

Example:

Excerpt of original *COR0.dat* file.

```
#0,White,Yellow,Blue,Red,Black,-,-,-,-,-,
```

The names "White" and "Yellow" were replaced by "GRAY" and "DARKGRAY":

```
#0,GRAY,DARKGRAY,Blue,Red,Black,-,-,-,-,-,
```

Important notes:

- Use a text editor - like Windows Notepad - to open and edit the *.dat* files. Do not change the file extension.
- The names are limited to 16 characters. Do not enter names with more than 16 characters. It could freeze the system.
- Do not add or remove commas. Do not use special characters like **&, % ,$** or similar. It could freeze the system.
- Do not change or replace the first characters ("#0"). It is the language index reference.

- You should never delete the RES directory from the SDCARD. Do not format the SDCARD on a external computer or remove any file from the RES directory.

Question 24: Can the MINI for road markings work with high intensity materials over $2000\,mcd.m^{-2}.lx^{-1}$?

Yes. The MINI horizontal can reach $4000\,mcd.m^{-2}.lx^{-1}$

Question 25: What is the memory capacity?

All data are stored into a removable SDCARD. A 4GB SDCARD (MINI standard) can store over 900.000 measurements.

Question 26: Can MINI meets EN1436 and ASTM E1710? Is there any independent test of compliance?

The MINI is fully compatible with $EN1436$ and ASTM E1710 standards. It was certified by independent laboratory StrausZert (Germany): Test certificate number $0913 - 2014 - 04$.

Question 27: How long does it take to measure?

Single geometry instruments will take less than 0.8 second to update the result on the screen. Dual geometry (or more) will take 1 second by each geometry or each parameter.

Example: The MINI horizontal will take less than 0.8 second to update the $\mathbf{R_L}$ and 2 seconds to check both $\mathbf{R_L}$ and **Qd**.

Question 28: My MINI freezes or stops responding.

It could happen when MINI tries to communicate by USB in absence of Windows device driver. Make sure that your PC computer has the MINI USB device driver installed.

If the system freezes for a long time, you can press and hold the power on key for 5 seconds or RESET by pressing the Reset key (use a long object, such as an extended paper clip, to press it through the hole).

Question 29: Sometimes my MINI presents low values when reading road marking broken lines. Why?

It is a common mistake of new users. The MINI horizontal is an external beam retroreflectometer. Since the measurement area is external to the instrument, it is not possible to precisely know the measurement region. It is important to assure 1 meter of road marking in front of the MINI horizontal to avoid errors.

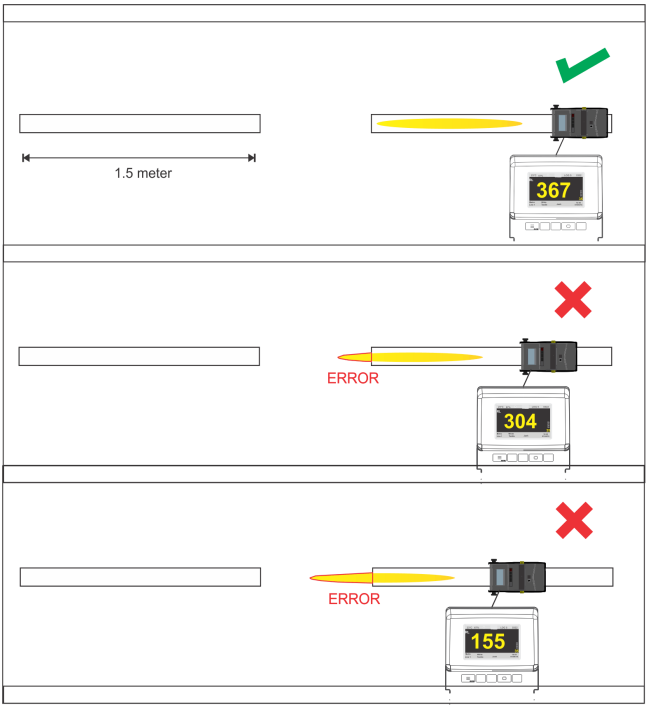


Figure 73. Always keep 1 meter in front of the MINI.

Question 30: The measured values of my MINI for road markings change when I move the road marking sample on different positions over a table. Could it be a light contamination problem?

The MINI can only detect coded light, it completely eliminates any stray light contamination.

The entrance angle will be affected by the physical characteristics of the surface. Surface imperfections - that can not be detected by our eyes - will be translated to numerical changes in retroreflectance measurements.

The MINI measurement area is uncovered and is not pressed against the surface, as in traditional retroreflectometers. To avoid errors it is important to place the both - MINI and the material under test - on a rigid, flat and uniform surface like a polished granite table. In case of test panels, select metal sheets with more than 4 mm thickness to minimize mechanical deformations.

The MINI is an external beam device. Surface imperfections - that can not be detected by our eyes - will be translated to numerical changes in retroreflectance measurements. Always work over a rigid, flat and uniform surface like a polished granite table.

Make sure that the sample holder is thicker than 4 mm.

Question 31: My MINI for road markings is showing around 15% higher than our old traditional instrument. Why?

There are several points to check:

- The MINI measurement area is 4 times larger than traditional devices. It is important to follow the sampling recommendation of the **Appendix A** to get comparable results. Punctual measurements are not valid due the difference on measurement areas. Check question number 2, 3 and 10.

  If you are working with samples or at your laboratory, watch the test surface. The entrance angle will be affected by the physical characteristics of the surface. Check question number 28.

  To avoid errors it is important to always use sample metal sheets with at least 4 mm and a polished granite table as a test surface. Check question number 9 and 13.

- If the results seem higher, make sure that the calibration reference is clean. Use a soft tissue to clean finger stamps or dusty from the reference standard.

- You can also adjust the MINI internal reference number to follow a secondary standard or to compensate the inherent uncertainty. Check question number 17. Retroreflectometers are sophisticated optical comparators. The MINI will learn and follow any reference through CEN-prescribed geometry.

Question 32: Can I remove the Qd light source by releasing the lateral screws?

Please, do not remove the Qd light source without our technical support. It can be damaged in case of torsion.

Question 33: Can I check surfaces that are not totally flat?

The MINI can work with any type of road marking surface, even profiled up to 15 mm.

The MINI uses an innovative technology with external light beam, completely immune to sun light. On traditional retroreflectometers, the measurement area is under the machine body to avoid sun light contamination. On the MINI, the measurement area is projected in front of the device.

When working with retroreflectance measurements it is mandatory to take spatially uniform samples. Check ASTM D6359.

Always work with spatially uniform samples to minimize the unavoidable CEN 30-meter geometry implementation errors over uneven surfaces.

*R*ecord the retroreflectometer reading and then move to other locations on the same sample set separated sufficiently to provide meaningful data (typically one meter) and record the results (10 readings). For calculating the average, disregard the highest and lowest values . See the picture74.

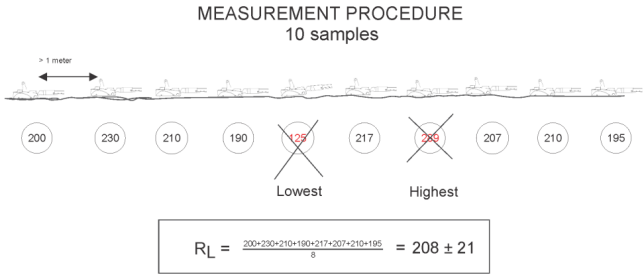


Figure 74. Always work with spatially uniform samples to minimize errors. For calculating the average, eliminate the highest and lowest values.

Question 34: What is the difference about the MINI and the Classic instrument technology ?

The MINI uses an innovative technology with external light beam, completely immune to sun light. On traditional retroreflectometers, the measurement area is under the machine body to avoid sun light contamination. On the MINI, the measurement area is projected in front of the device.

> The Classic Horizontal retroreflectometer may suffer sunlight interference if the bottom brush sealing tapes have worn down from use. This is the most common reason for artificially high readings.
> It is recommended to replace bottom brush sealing tapes strips periodically.

Always look for a good position to place the instrument, according to picture 76. Note if there are obvious surface damage, debris such as stones, either brush off the debris or move to another measurement point.

Figure 75. Easylux classic road marking retroreflectometer.

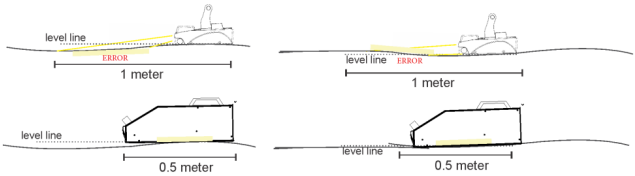
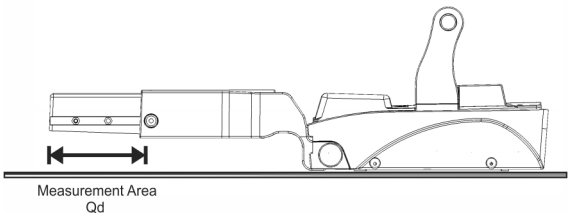


Figure 76. The traditional and the new MINI measurement technology.

Question 35: Where is the Day Visibility (Qd) measurement area ?

The coefficient of visibility under diffuse illumination - Day Visibility - Qd - is evaluated in 60 cm2 areas. The measurement area is right below the light source, as indicated in the image.



Do not take just one or two reading of a road marking Qd value. It may varies from area to area. Take readings separated sufficiently to provide meaningful data (typically one meter) and record the results (5 or more) for average.

Question 36: Why the battery charger never detects the battery as 100% charged ?

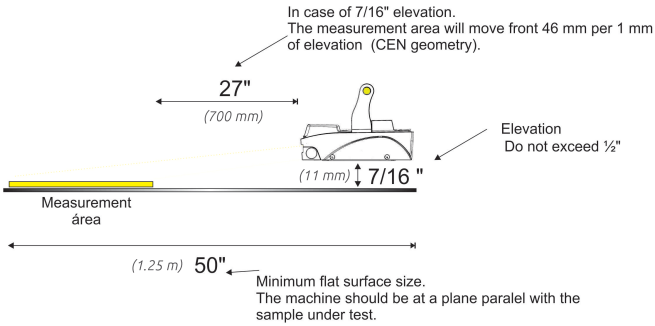
Indication of battery charge above 90% means the battery is fully charged. Regardless of the battery level, the system always performs tests to ensure full charge. For this reason, the charger system never show 100% indication.

Question 37: Can I use the MINI for marking production line quality control ?

Yes. The MINI can check any surface located around 1/2 inch (12 mm) under the instrument base plane.

The figure illustrates the suggested work arrangement for production line quality control. It is not recommended to exceed the values shown in the figure. In order to avoid errors at CEN 30-meter geometry, the user must ensure that the equipment and the reading area are in perfectly **parallel planes**.

When raising the MINI from the support surface, by a maximum of 12 mm, the measurement area is projected ahead at the rate of 46 mm for each 1 mm elevation. That is a physical consequence of geometry CEN 30-meters, arrangement B, implemented in the instrument.



Question 38: Does the MINI VERTICAL has a Entrance angle sensor ? How can I adjust the entrance angle?

The MINI has a sensor that provides data on the relative tilt of the equipment body. The sensor provides auxiliary data for the operator to adjust the entrance angle by the movement of the device body.

In field operations, with the equipment in the standard position, the entrance angle is mechanically defined by the contact of the equipment with the surface.

Question 39: What is the PASS / FAIL function?

The MINI has a PASS / FAIL resource that allows set limit values for each observation angle. With the PASS / FAIL resource enabled, the measured value is displayed in red, if it is below the limit set by the user.