

# ***QD30 Reflectometer Manual***

***On Site quality control of road markings in agreement with CEN specifications***



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# INDEX

|  |           |
|--|-----------|
| <b>SECTION 1</b> .....                                   | <b>5</b>  |
| <b>INTRODUCTION</b> .....                                | <b>5</b>  |
| Qd30 Introduction .....                                  | 5         |
| Qd30 Reflectometer features .....                        | 6         |
| <b>SECTION 2</b> .....                                   | <b>7</b>  |
| <b>OPERATING INFORMATION</b> .....                       | <b>7</b>  |
| Getting started with Qd measurements.....                | 7         |
| Calibration check.....                                   | 7         |
| Instrument test .....                                    | 7         |
| Warning and errors .....                                 | 7         |
| Data log .....   | 8         |
| Miscellaneous .....                                      | 9         |
| Calibration .....  | 9         |
| Battery low warning .....                                | 10        |
| <b>SECTION 3</b> .....                                   | <b>11</b> |
| <b>GENERAL INFORMATION</b> .....                         | <b>11</b> |
| Qd parameter .....                                       | 11        |
| Optical principle .....                                  | 12        |
| Note on error sources.....                               | 12        |
| <b>SECTION 4</b> .....                                   | <b>15</b> |
| <b>KEYBOARD, DISPLAY AND FUNCTIONS</b> .....             | <b>15</b> |
| Keyboard layout .....                                    | 15        |
| Keyboard functions .....                                 | 15        |
| Measurement id .....                                     | 17        |
| Mean calculation .....                                   | 18        |
| Menu system.....   | 19        |
| Qd calibration .....                                     | 19        |
| Qd log status .....                                      | 19        |
| Test log status .....                                    | 20        |
| Clear measurement id .....                               | 20        |
| Status .....   | 20        |
| Date and time.....                                       | 22        |
| Automatic power off.....                                 | 22        |
| Log full warning .....                                   | 22        |
| Print Qd log .....                                       | 22        |
| Default setting .....                                    | 23        |
| Mean Calculation.....                                    | 23        |
| Paper Load (only on versions with the ALFA printer)..... | 23        |
| Result printouts.....                                    | 24        |
| <b>SECTION 5</b> .....                                   | <b>25</b> |
| <b>MAINTENANCE AND CALIBRATION</b> .....                 | <b>25</b> |
| General care .....                                       | 25        |
| Battery .....  | 25        |
| Fuses .....  | 25        |
| Lamp.....  | 25        |

|                                       |           |
|---------------------------------------|-----------|
| Printer .....                         | 25        |
| Calibration .....                     | 26        |
| Calibration unit .....                | 26        |
| <b><i>APPENDIX A</i></b> .....        | <b>27</b> |
| <b>COMMUNICATION FACILITIES</b> ..... | <b>27</b> |
| RS-232C specification .....           | 27        |
| Data protocol .....                   | 29        |
| Command format .....                  | 29        |
| Qd command set .....                  | 30        |
| <b><i>APPENDIX B</i></b> .....        | <b>34</b> |
| <b>SPECIFICATION</b> .....            | <b>34</b> |
| General characteristics .....         | 34        |
| Electrical characteristics .....      | 34        |
| Environmental characteristics .....   | 34        |
| Mechanical characteristics .....      | 34        |

## SECTION 1

### INTRODUCTION

#### Qd30 Introduction

The Qd30 Reflectometer is a portable field instrument, intended for measuring the Qd value. Qd is a measure of the lightness of road surfaces and road markings, as seen by drivers of motorised vehicles in daylight or with stationary lighting. The reflected light is measured at an angle of 2.29 deg., which corresponds, to an observational distance of 30 metre. Thus, relevant for a motorist viewing situation under normal conditions.

Qd is an important factor in the ON-SITE quality control of road surfaces and road markings.



The handling of the instrument is very simple and requires a minimum of instruction. An error message or warning is given in case of unreliable or erroneous measurements.

The Qd30 measures the reflections and calculates Qd according to international agreements. Results are presented in plane text on a LCD panel. The built in printer and non-volatile memory provide ON SITE registration of measurements with corresponding date and time.

There are two built in data log's, the *Qd log* and the *Test log*. The *Qd log* stores every measurement taken by pressing the <QD> button. The *Test log* stores every measurement taken by pressing the <TEST> button.

The instrument has a built in function to mark each measurement with a user-defined name (measurement id) and auto incrementing measurements number (sequence id), see section 4.

A computer interface on the Qd30 provides extended command, calibration, diagnostics and data dump facilities. See appendix A.

The Qd30 is powered by a rechargeable battery, giving several hours of measurement capacity. A mains powered battery charger is supplied as standard.

**Qd30 Reflectometer features**

- Measurement in full daylight
- Dry and wet surfaces
- Plane, textured & profiled markings
- Measurement geometry and illumination corresponding to realistic viewing conditions in day and night time traffic
- Portable, self-contained instrument
- Direct digital read out
- Automatic leak compensation and error diagnostics
- Built in printer
- Real time clock
- Automatic data storage in internal non-volatile memory
- Automatic calculation of mean value and standard deviation,
- RS232 serial communication for data dump, extended control, calibration and diagnostics
- Automatic programmable power off function
- Calibration unit
- Easy calibration procedure
- Carrying case

## SECTION 2

### OPERATING INFORMATION

#### Getting started with Qd measurements

Turn on the Qd30 by pressing and holding the <ON> button until the display shows:

|               |   |                |
|---------------|---|----------------|
| Retrometer    | → | Ready          |
| Qd30 rev. #.# |   | Year date Time |

Calibrate the instrument if necessary, see Calibration

Press the <CANCEL> button to see the last measurement.

Press the <QD> button to take a new measurement. The measurement will be finished in approx. 4 sec.

When the measurement is complete, the Qd value, date/time and status prompt are shown on the LCD panel. If the measurement *id* function is in use, the measurement id text and the sequence number will be displayed instead of the data and time.

Check the status code for any problems, see **Warning and errors below**.

Qd value, time, status and measurement id is automatically transferred to the data log for later readout to the serial communication port.

To print-out whatever operation was last completed press the <PRINT> button.

#### Calibration check

Periodically during use, you should check the calibration of the instrument. Place the calibration unit in the observation port, with the open end of the unit facing towards the “tower end”, and very important, the four fix points inside the port.

Take a normal Qd measurement of the unit by pressing the <QD> button. If the Qd value on the LCD panel and the Qd value marked on the unit is equal, the calibration is in order. If not, calibrate the instrument.

#### Instrument test

You can perform an instrument test by pressing the <TEST> button. In addition to taking a measurement, it will collect other information pertaining to how the instrument is working. This information will be stored in the test data log. It can also be printed out by pressing the <PRINT> button immediately after the measurement has been taken.

#### Warning and errors

A status indicator will be displayed in the bottom right-hand corner of the LCD panel every time a measurement is taken.

Status codes:

- \* = No problem was detected
- W = A problem was detected but the measurement should be reliable
- L = A high level of stray light was detected but the measurement should be reliable
- E = A problem was detected and the measurement is **unreliable**.

If a status code other than “\*” appears on the panel you can find the exact nature of the problem

by pressing the <MENU> button until *Status Display* appears on the LCD panel. Use <↑↓> buttons to scroll through the status display options. See Status in section 4 for details.

### **Data log**

Qd30 has two built in data logs, the *Qd log* and the *Test log*. Both logs are **always** enabled and can hold all data for approx. a days work. It is possible to clear the log's one at a time from the <MENU>. This should be done prior to starting a new measurement series, to avoid problems with the log getting full.

#### ***Qd log:***

Each time the <QD> button is pressed the following information is stored in the Qd log:

*Date and time, Qd value, instrument status, measurement id and sequence number.*

The *Qd log* can store more than 1000 data sets. When the log gets full a W is shown in the lower right corner of the display (and the status code is set to 4). The Qd30 can still measure but data are no longer stored in the log. To remove the log warning (W) you must clear the log, see section 4 - Menu system. Remember to dump the log data if you want to use the data later. If you are not using the log's, you can disable the log full warning, see section 4 - Menu system. When the log full warning is disabled, data are still stored in the log until it gets full but when the log is full no warning is given and new data are no longer stored.

#### ***Test log:***

Each time the <TEST> button is pressed or a calibration is done the following information is stored in the Test log:

*Date and time, Qd value, instrument status + information for instrument diagnostics.*

The *Test log* can store more than 200 data sets. If the Test log gets full, it is affected by the same rules given for the Qd log (the status code is instead set to 8).

### ***Using logged data***

The contents of the logs can be transferred to a PC using a communication program, e.g. Hyper terminal (for details about the communications and command set, see appendix A - Communication facilities).

When the Qd30 is connected to a PC, you can use command LE to dump the Qd log data to the PC. Data is dumped in a comma-separated format:

```
2001-02-07 11:39:19, 209, 0,AA ,1
2001-02-07 11:39:33, 209, 0,,
2001-02-07 11:39:38, 209, 0,,
2001-02-07 11:39:45, 209, 0,TEST ,1
2001-02-07 11:41:27, 209, 0,TEST ,2
2001-02-07 11:49:20, 205, 0,,
2001-02-07 11:49:48, 126, 0,,
2001-02-07 11:56:40, 126, 0,,
```

The contents of the "columns" are: data and time, Qd value, status, measuring id and sequence no.

If you want to use the data in, e.g. a spread sheet program you can either copy and paste the dumped data from the hyper terminal program or let the communication program save the data directly in a text file (capture text).

## Miscellaneous

*Reset log:* Press the <MENU> button until *Free \_Log = xx.x%* appears. Press the <ENTER> button twice.

*Date/time:* Press the <MENU> button until *Date and Time* appears. Press the <ENTER> button and use <↑↓> to edit..

*Power save:* Press the <MENU> button until *Off time: nn sec* appears. Press the <ENTER> button and use <↑↓> to edit.  
To disable automatic shut off, set the *Off time* to less than 60 sec.

*Meas-ID:* Press the <↓> button to edit the measurement ID. Press the <ENTER> button and use <↑↓> to edit, switch to next position with <ENTER>. Characters can be: 0..9, A..Z and <space>.

*Reset top log:* Press the <↑> button to clear the latest measurement from the Log in use. Press <ENTER> to clear. For Qd measurements the Measurement ID and the Sequence count is changed to the previous value. The display is updated with the newest data in the log.

*Mean calc:* Press the <MENU> button until *Mean Calc:* appears. Press <↑> to enable or disable the function and press <ENTER> to change. If the Mean function is enabled the result display changes after taking two or more measurements to show the Qd value and the calculated Mean value of all Qd measurements since last mean initialising.  
Initialisation of the mean calculation will be done in the following situations:  
At power <ON>, a <TEST> measurement, a Calibration, Removal of the last entry from the data log, changing the measurement ID or by pressing the <CANCEL> button in operation mode, all these events will cause the mean calculation to start over.  
The calculated values will not be stored in the DATA log but will be printed.

## Calibration

Press the <MENU> button until the LCD panel shows:

**Qd Calibration**  
**Enter To Start**

Press the <ENTER> button. The LCD panel should show:

**Mount Qd Normal**  
**Enter when Ready**

To get access to the measuring port carefully tilt the instrument on its rear end. Take a note on the calibration units Qd value.

Place the calibration unit in the observation port, with the open end of the unit facing towards the "tower end" and the four fix points inside the port.

Make sure that the calibration unit is firmly inserted in the Qd base plate.

Press the <ENTER> button. The calibration will take approx. 4 sec. When finished calibration the LCD panel should display:

Where ### represents the Qd value of the calibration unit last used.

**Qd Normal ###**  
**ENTER = OK ↑↓ =edit**

If the Qd value on the LCD and the Qd value marked on the unit are **equal**, then press <ENTER>.

If the Qd normal value on the LCD and the Qd value marked on the unit are **different**, use the <↑↓> buttons to change the Qd value on the LCD to match the Qd value marked on the unit, then press the <ENTER> button.

Calibration of the Qd30 is now complete. Check the calibration before removing the calibration unit. This is done by pressing the <QD> button. The value measured should match the Qd value marked on the unit. If not, repeat the calibration procedure.

Remove the calibration unit from the instrument and store it properly.

### **Battery low warning**

The battery voltage status is only updated during Qd- and Test measurements and therefore a possible battery warning will first be shown after a measurement is taken.

A battery low warning is indicated with a W in the lower right corner of the display (and the status code is set to 16). The warning appears when the voltage drops below approx. 10.5V. The instrument can still take measurements but no other warning or alarm is given not even if the voltage gets to low to take reliable measurements. It is expected that the instrument can take reliable measurements down to 10V.

If any doubt, the reliability of the measurement can be tested very simple. Just mount the calibration unit (do not calibrate) and take a measurement. The measured value should match the value on the calibration unit.

### **Points to remember:**

- \* Recharge battery when possible. Never leave battery discharged for longer periods of time.
- \* Keep optic window and calibration unit clean.
- \* Qd30 is a precision optical instrument, handle with care.

## SECTION 3

### GENERAL INFORMATION

#### **Qd parameter**

Qd is a measure of the lightness of road surfaces and road markings, as seen by drivers of motorized vehicles in conditions of illumination as found in road light or daylight. Qd is actually the average luminance coefficient in diffuse illumination.

Qd is a parameter related to the visual properties of the road under daylight and road light conditions. It differs significantly from the Rl parameter (coefficient of retroreflected luminance). The Rl parameter represents the brightness of the road markings seen by drivers of motor vehicles by headlight illumination.

In the Qd30 sensor the observation angle is fixed at 2.29 degrees, simulating a drivers viewing distance of 30 m at an eye height of 1.2 m. The observation area is approx. 45 mm. x 175 mm. The diffuse illumination of the road is implemented by using an integrating sphere illumination system with 0.5 metres in diameter, a standard method known from photometry. Physically the sensor is dominated by the illumination system. The integrating sphere illuminates the road through a port. The light source is a 20-watt halogen lamp. The observer is simulated by an optical system, which for practical reasons is placed in a tower outside the sphere. The tower and sphere are connected through a tunnel. An optical fiber guides the light from the tower to the detector circuit.



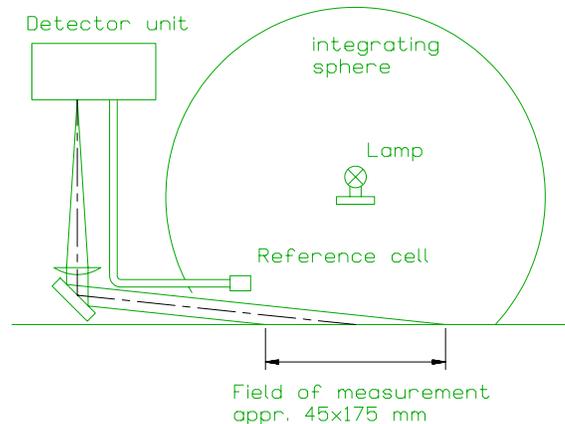
The sphere illumination varies due to the relative large observation port. This variation, caused by the road influence, is compensated by a light meter cell near the port. The light meter cell is connected to the detector circuit by an optical fiber. The ratio between observer and sphere illumination is a direct measure for the Qd value.

The Qd30 sensor is controlled by a microcomputer. The microcomputer executes the measurement automatically by the push of a button and presents the result on a display. The

result is automatic transferred to an internal non-volatile memory. The result and corresponding time and date can be printed by a built-in printer. The Qd30 sensor is operated from a small keyboard situated near the display on top of the sensor. Further, sensor control is possible by a serial communication link (RS 232). Stored data can be transferred to a host for further processing.

The Qd30 sensor is factory calibrated. The enclosed calibration unit can be used for control or recalibration of the sensor.

The Qd30 sensor is powered by a built-in lead acid battery, which under normal operation



will keep the sensor operating a day. The battery can be recharged by an external charger.

### Optical principle

The light is generated by a halogen lamp placed in the centre of the integrating sphere. A small light baffle prevents direct illumination of the road. The sphere will generate diffuse illumination on the road. Due to the relative large measuring port the road will influence the loss in the sphere. This gives an illumination dependant on the actual road. To ensure reliable and accurate measurement the instantaneous sphere illumination is measured by a cell near the port.

The observer is simulated by an optical system and detector circuit. The light reflected from the road leaves the sphere through a tunnel. Then it is deflected by a mirror and send to the detection system through a lens. The observation angle is 2.29 deg. The observation field is 45 mm wide and approximately 175 mm in length, dependant on surface texture. Observation field and angle are defined by baffles.

### Note on error sources

Stray light can enter the instrument between bottom and road. Normally this contribution will be modest. The Qd30 illumination system will give a relative high illumination on the road surface, app. 2000 lux. Leakage will under normal conditions not be significant. Nevertheless, it may occur. Before each measurement the Qd30 evaluates the leakage. The result is compensated before read out. In case of significant leakage a warning or error message is given and special precautions may be necessary.

The Qd30 measuring angle is 2.29 deg. relative to the road surface. Because of this small

angle, accurate placement on the road is important. Avoid pebbles and abnormal irregularities. The Qd30 sensor must be parallel and close to the road.  
The Qd30 sensor is a rugged instrument. Nevertheless, it is an optical instrument and must be treated as such.

The Qd30 is factory calibrated. Under normal use, an everyday calibration is not necessary. When calibrating avoid direct sun and mount calibration unit with care.

Keep battery fully charged. A well-charged battery is more resistant to ageing and protects against possible freezing damage.

Avoid fouling the optical surfaces and the internal of the integrating sphere. Fouling will degrade the measurement quality, check by using the calibration standard and study the sensor status and error messages, if any.

### ***Instrument status***

If any special condition exists (status > 0) then the status code is decoded (see below). The measured signal levels are shown in % (their nominal values are set to 100%). The battery voltage status is only updated during Qd- and Test measurements and therefore a battery warning will first be shown after a measurement is taken.

### ***Status code breakdown:***

|           |     |                              |
|-----------|-----|------------------------------|
| 00000001: | 1   | Converter error              |
| 00000010: | 2   | High leak warning            |
| 00000100: | 4   | Qd log full warning          |
| 00001000: | 8   | Test log full warning        |
| 00010000: | 16  | Low battery warning          |
| 00100000: | 32  | Backup memory power failure  |
| 01000000: | 64  | Low reference signal warning |
| 10000000: | 128 | High signal warning          |

E.g. Status code 20 is composed of Low battery warning (16) + Qd log full (4).

### ***Memory problem***

The internal data memory has a built-in backup battery with a lifetime of typ. more than five years. In addition to the data log the internal memory also keeps vital information about instrument and calibration settings. If a memory power problem is detected, the instrument can still be used but special precautions must be taken.

If a power problem is detected, during instrument power on, the Qd30 reacts in this way.

LCD panel will show (with 2 sec delay):



The text will be shown until any key is pressed.

On the printer the following message will be written:

**RAM Memory Failure!**  
**See Manual for Information!**  
**No Auto Off Function!**

The instrument can be used with some precautions and limitations, but it has to be calibrated and internal factors are set to default values:

- Calibration values are not stored during power off. Instrument must be calibrated each time it is powered on.
- Data log's can be used but they must be cleared before first measurement. **Data will be lost when the instrument is powered off**
- Watch is not working
- Auto off (off time) is disabled
- LCD panel will show **E** (for error) on the last position on line 2
- Measuring results can be printed yet the status line will always contain "RAM Error"

## SECTION 4

### KEYBOARD, DISPLAY AND FUNCTIONS

#### Keyboard layout

|      |       |        |      |     |
|------|-------|--------|------|-----|
| QD   | ENTER | CANCEL | MENU | OFF |
| TEST | PRINT | ↑      | ↓    | ON  |

#### Keyboard functions

- ON** Turn Qd30 on. Hold the button activated until the sign on message appears in the LCD panel. Qd30 always starts in *operation mode*.
- OFF** Turn Qd30 off and terminates all activity and powers off.
- QD** Begin Qd measurement. After a measurement the Qd result and measuring date and time stamps are shown in the display. If the measurement *id* function is in use, the *measurement id* text and the sequence number will be displayed instead of the data and time. Result, date and time go into the *Qd log* for a later dump to the communication port.
- TEST** Begin extended Qd measurement while recording various operating conditions. The results and date/time will be stored in the *Test log* for a later dump to the communication port.

The following conditions are measured:

- Leak signal
- Diffuse signal
- Reference signal
- Battery condition

A status number is built from the following conditions:

- Analog to digital converter failure
- Warning for high leak signal
- Warning for critical low battery voltage
- Warning for reference signal out off limits
- Warning for signal overflow
- Warning for full *Qd log*
- Warning for full *Test log*
- Backup memory power failure

- ENTER** Activates the selected function or accept changed settings.

This button only functions when the menu system is activated. In some cases it opens lower levels in the menu hierarchy and in other cases it is used to accept new settings and/or to activate selected functions.

## PRINT

Output latest Qd result or Test results on the printer. Print-out has to finish completely before any other function can be selected, print-out can only be terminated with the <OFF> button.

## MENU

When the Qd30 is in *operation mode* the <MENU> button activates the Qd menu system and displays the first option in the menu. When in the *menu mode* repeated activation of the button selects the next menu function. It is possible to leave the menu system entirely at any time and with no changes to the current menu function with the <CANCEL> button or by pressing one of the other keyboard buttons. See also Menu system on the next pages.

## ↑

In *operation mode* this button allows the user **to delete the top level of the active data log**. Following a Qd measurement it operates on the *Qd log* and following a measurement made with the <TEST> button it operates on the *Test log*. The deletion following a Qd measurement restores the *Measurement ID text* string and measurement counter from the log. If the deleted measurement was marked with a measurement id and the sequence number was 1 then the previous measurement id and sequence number (if any) will be restored, otherwise the measurement id function is disabled and you must enter a new measurement id if needed for the next measurements.

The deletion process can be continued until the log is empty. Deleted data **cannot** be recalled.

When in the *Menu system* this button activates a scroll or increment function. Values are incremented until they reach their predefined max. limit and then automatically change to their predefined min. limit. The button is auto repeating and the scroll speed will increase with time.

## ↓

In *operation mode* this button allows the user to edit the **Measurement ID** text string and by pressing the <↓> one more time the **edit Sequence Number** function is activated. See also Measurement id and Menu system - Clear measurement id.

When in the *Menu system* this button activates a scroll or decrement function. Values are decremented until they reach their predefined min. Limit and then automatically change to their predefined max. limit. The button is auto repeating and the scroll speed will increase with time.

## CANCEL

Cancel the selected function and return to *operation mode* displaying the latest Qd result. If in operaton mode the mean calculation will be reset if

nabled.

### Measurement id

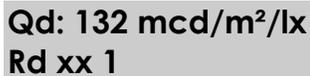
Qd30 has a built in function to mark each measurement with a user-defined name (*measurement id*) and a sequence number that automatically increments after each measurement. The measurement id and the sequence number will be stored in the *Qd log*. The measurement id text can be up to 6 characters in length.

To enter the *measurement id* function press the <↓> button. If any measurement id is defined, it is shown in the display. To edit the id press the <ENTER> button. The cursor is placed at the first character position. Use the <↑> button to scroll through the alphabet (in direction A..Z) starting with space, next are the numbers and then capital letters. The <↓> button will scroll through the alphabet in the opposite direction. When the wanted character is shown press the <ENTER> button to advance to the next position. You have to step through all 6 positions before the *measurement id* function is accepted. If the user wants to change the sequence number it can be done by pressing the <↓> button 2 times and then using <↑↓> buttons to change the number. The change is only activated by pressing <ENTER> or discarded by pressing <CANCEL>.

When typing a new measurement id or editing an old one, the measurement sequence number is reset to 0.

### Example

Enter the measurement id function by pressing the <↓> button followed by <ENTER>. Type in: RD XX. When taking the first Qd measurement by pressing the <QD> button, the LCD panel will show:



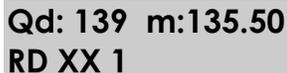
Qd: 132 mcd/m<sup>2</sup>/lx  
Rd xx 1

Next time a Qd measurement is taken the LCD panel will show:



Qd: 139 mcd/m<sup>2</sup>/lx  
RD XX 2

If the mean function is enabled the display will show:



Qd: 139 m:135.50  
RD XX 1

The measurement id can be disabled (deleted) by setting all 6 character positions to *space*, or from the *menu system* - Clear measure id. Using the menu system is the easiest way.

### Mean calculation

Qd30 has a built in function to calculate and display the mean of a series of measurements.

Press the <MENU> button until *Mean Calc* appears. Press <↑> to enable or disable the function and press <ENTER> to change.

If the *mean* function is enabled the result display changes after taking two or more measurements to show the Qd value and the calculated mean value of all the Qd measurements since last mean initializing.

Initialization of the *mean* calculation will be done in the following situations: At power <ON>, a <TEST> measurement, a calibration, removal of the last entry from the data log, changing the *measurement ID* or by pressing the <CANCEL> button in operation mode, all these events will cause the mean calculation to start over.

The calculated values will not be stored in the *Qd log* but will be printed during print-outs.

## Menu system

### Qd calibration

| LCD panel   | Explanation  |
|---|--|
| Qd Calibration<br>Enter To Start                  | Perform instrument calibration. See also section 5, calibration.<br><ENTER> opens Qd calibration sub menu.   |
| Mount Qd Normal<br>Enter When Ready               | The user is requested to mount a calibration unit on the Qd30 instrument.<br>Press <ENTER> when it is mounted correctly.   |
| Calibrating<br>Please wait                        | Measures Qd on the calibration unit.   |
| Qd:141 mcd/m <sup>2</sup> /lx<br>Enter=OK ↑↓=edit | The display shows the Qd calibration value from the previous calibration.  |
| Calibration OK<br>Remove Qd normal                | <b>Step 1:</b><br>If the reading is identical to the calibration unit used press the <ENTER> button. If not go to step 2.<br>The calibration is completed successfully. Remove the calibration unit.   |
| Qd Normal 142<br>Enter When Ready                 | <b>Step 2a:</b><br>Use <↑> / <↓> buttons to change the Qd reading.<br>When the shown Qd value is identical to that of the calibration unit press the <ENTER> button to store the new calibration values.   |
| New Qd Normal<br>Check Qd and<br>Remove Qd Normal | <b>Step 2b:</b><br>The display shows that a new Qd calibration value has been calculated. The user is requested to make a control measurement on the calibration unit by pressing the <QD> button and then to remove the calibration unit if the reading is correct. If not, the calibration procedure must be repeated. This also applies if for some reason the display shows detection of an error or warning. See Warning and errors in section 2. |

### Qd log status

| LCD panel                            | Explanation   |
|--------------------------------------|---|
| Free Q_LOG: ##.##%<br>Enter to Clear | The display shows the free space in the Qd log.<br>Press <ENTER> to enable clearing of the log. |
| Enter to Confirm                     | Press <ENTER> again to actually clear the Qd log to 100% free.                                  |

## Test log status

| LCD panel                            | Explanation  |
|--------------------------------------|--|
| Free T_LOG: ##.##%<br>Enter to Clear | The display shows the free space in the Test log. Press <ENTER> to enable clearing of the log. |
| Enter to Confirm                     | Press <ENTER> again to actually set the Test log to 100% free.                                 |

## Clear measurement id

| LCD panel                          | Explanation   |
|------------------------------------|---|
| Clear Id: xxxxxx<br>Enter to clear | Clears the measurement id shown on the LCD panel. Press <ENTER> to clear. When cleared the measurement id function is disabled. Use the <↓> button to enter a new measurement id. |

## Status

| LCD panel                                   | Explanation.  |
|---|---|
| Status Display<br>Use ↑↓ to view            | The results and status made with the <TEST> and the <QD> buttons can be displayed in the LCD panel one at a time by use of the <↑>/<↓> buttons.   |
| <b>The following messages are possible.</b> |   |
| Signal = 112.5%                             | The measured signal strength in % of the selected analog to digital working point, depending on measurement conditions the signal lies in the range 0,0% to 120.0%  |
| Ref. = 114.3%                               | The measured signal from the reference channel. The reference signal must be within specified limits in order for the Qd30 to operate properly. A warning is given in the display if this signal lays outside these limits.   |
| Leak = 0.0%                                 | The measured starlight, representing the amount of light getting into the Qd30 from outside. A high leak signal can indicate problems with direct sunlight from a low sun on a very rough or uneven surface. special precautions must be taken to hinder the light from shining directly on the measurement area. A warning is given in the display if the signal gets critical.  |
| VBat idle =12.0V                            | The battery voltage measured just before the lamp is lit. The reading can be used to check the charge condition of the built in 12 V lead acid accumulator. A warning is given in the display if the voltage drops below its minimum limit.   |
| VBat load =11.2V                            | The battery voltage measured while the lamp is lit. The reading can be used to check the charge condition of the built in 12 V lead acid accumulator. A warning is given in the display if the voltage under load drops to a critical low value. If the battery voltage gets very low, the Qd30 will shut off during the measurement because the battery voltage drops below its minimum level when the lamp is lit. This condition will be reported in the display on the next power up. Measurements will not be possible until the battery is. |

|   |  |
|---|--|
| Free Q_Log: ##.##%                        | Percentage of free Qd log.   |
| Free T_Log: ##.##%                        | Percentage of free Test log.   |
| Qd30 rev. 4.00<br>(C)99-11-03             | Firmware version and date.   |
| Qd=100 mcd/m <sup>2</sup> /lx             | The latest Qd value measured.  |
| <b>Error and warning messages if any.</b> |  |
| Converter OK                              | The A/D converter is working properly.   |
| Converter Error                           | An severe error has been detected in the A/D converter system. It is not possible to make any Qd measurements when this error is reported. If the error persists the Qd30 instrument must be serviced by trained personal before any measurements can be done.                                   |
| High Signal Warning                       | The signal has come critically close to the max limit for the analog to digital converter and thereby causing a possible signal overrun witch would give wrong Qd readings. This condition can result from high leak.<br>If this warning persists the Qd30 requires service by trained personal. |
| High Refearence Warning                   | The reference signal has for some reason become very high, if the error persists the Qd30 requires service.  |
| High Leak Warning                         | The Qd30 has detected a high background signal, possible due to starlight coming into the instrument from a low sun and a very rough measuring surface. Try to block the sunlight while making the measurement. If the error persists the Qd30 requires service.                                 |
| Low Reference Warning                     | The reference signal is missing or has become very low. Check that the reference detector is clean. If the warning persists the Qd30 requires service.   |
| Qd Log Full                               | The Qd log has run full. This means that it contains approx. 1000 Qd readings, and that no new measurements can go into the log. The log will have to be cleared before this warning goes away. Also the measurement number in the print-out will not change until the log is cleared.           |
| Test Log Full                             | The Test log has run full. This means that it contains approx. 100 Test readings, and that no new Test measurements can go into the log. The log will have to be cleared before this warning goes away. Also the Test number in the print-out will not change until the Test log is cleared.     |
| Low VBat Warning                          | The voltage on the lead acid battery has become low and it needs recharging. The Qd30 will run out of power in the next few measurements.  |
| RAM OK                                    | The internal backup battery is OK.   |
| RAM Error                                 | The internal backup battery has run out of power. The instrument will have to be returned to the agent for maintenance.  |

### Date and time

| LCD panel                      | Explanation  |
|--------------------------------|--|
| Date and time<br>Enter to Edit | The built in real time clock can be set by selecting this menu function. Press <ENTER> to show and edit the present setting. The format is year-month-day hour:minute  |
| Edit Year<br>2001-02-08 13:30  | Use the <↑> / <↓> buttons to change the setting. Press the <ENTER> button to edit month, date, hour and minute. When the display shows the desired date and time press <ENTER> to actually set the real time clock to the displayed setting. |

### Automatic power off

| LCD panel                          | Explanation.  |
|------------------------------------|---|
| Off Timer: ## sec<br>Enter to Edit | In order to prolong the operational time of the Qd30 it has an automatic turn off function that shuts off the power when no action has been going on for more than a programmable time. |
| Off Timer: ## sec<br>Use ↑↓ Keys   | The automatic turn off time can be from 60 to 600 seconds or it can be disabled entirely (time < 60 seconds).   |

### Log full warning

| LCD panel                       | Explanation.  |
|---------------------------------|---|
| LogWarn: disable<br>↑ to change | The Log full warning message in the LCD panel is disabled. Toggle between disable and enable with the <↑> button. When disabled and log is full no further data will be added to the log. |

### Print Qd log

| LCD panel                        | Explanation.   |
|----------------------------------|--|
| Print Qd log<br>Enter to confirm | Output all the data in the Qd log to the built in printer. Data in the Test log can not be printed.  |
| nn entry's<br>Enter to Confirm   | Reconfirm that you really want to print all data in the log. If a print job is started and you will abandon it you must switch off the instrument. |

### Default setting

| LCD panel                            | Explanation.  |
|--------------------------------------|---|
| Set ROM defaults<br>Enter to Reset   | If something goes wrong or appears to be wrong in the programming, it is possible to reestablish the default settings for various programmable values. This enables the user to start over from a known state. Qd30 must be calibrated following the calibration procedure. <b>This command should only be used as a last resort.</b> |
| Set ROM defaults<br>Enter to Confirm | Confirm the operation by pressing the <ENTER> button.   |

### Mean Calculation

| LCD panel                       | Explanation.  |
|---------------------------------|---|
| Mean Calc: On<br>↑to Change     | Enable or Disable the automatic calculation and display of the mean value |
| Mean Calc: Off<br>Enter to Save | Save the setting by pressing the <ENTER> button.                          |

### Paper Load (only on versions with the ALFA printer)

| LCD panel                          | Explanation.  |
|------------------------------------|---|
| Paper Load<br>Enter to Start       | Activate a special mode that energises the printer to enable the RED feed button for paper loading. |
| Load paper. Use<br>Red feed button | Use Red button on printer to feed paper. exit function with any other key.                          |

## Result printouts

```
-----  
Qd: 134 mcd/m2/lx
```

```
QD30 s/n: 256  
2001 Feb 08 14:12:02 Status code =0  
Q#19 Measurement ID: LIGHT 3  
-----
```

```
-----  
Qd: 134 mcd/m2/lx
```

```
QD30 s/n: 256  
Count: 2 Mean: 134.43  
2001 Feb 08 14:12:12 Status code =0  
Q#20 Measurement ID: LIGHT 4  
-----
```

```
-----  
Qd: 134 mcd/m2/lx
```

```
QD30 s/n: 256  
Count: 3 Mean: 134.44  
2001 Feb 08 14:12:22 Status code =0  
Q#21 Measurement ID: LIGHT 5  
-----
```

### Qd print-out

The normal result print-out showing the measured Qd (emphasized), the instrument serial number and if the mean function is enabled, the number of measurements and the calculated mean value is shown, the measuring date and time and the related status code. The last line shows a Q# number showing the total number of measurements in the *Qd log* and if defined the Measurement ID text string and the corresponding sequence number. The normal result print-out can follow after a measurement performed with the <Qd> button.

```
----- Test Printout -----
```

```
Qd: 135 mcd/m2/lx
```

```
QD30 s/n: 256  
2001 Feb 07 10:08:42 Status code =0  
T#4  
Ref. signal = 81.7%  
Signal = 34.9%  
Leak signal = 0.0%  
Vbat Lamp On = 11.86 V  
Vbat Lamp Off = 13.65 V  
-----
```

### Test print-out

The test print-out showing the measured Qd (emphasized), the instrument serial number, the measuring date and time, the related status code and a T# number showing the number of measurements in the *Qd test log*. Various instrument status are detected during measurements and are included in the test print-out. For further information about the status, see Instrument status in this section. The test print-out can follow after a measurement performed with the <TEST> button.

### Special status print-outs

The Qd30 can print a special status at power up showing all internal settings and values generated by the different functions.

The status print-out is activated by holding the keys <↑> and <↓> activated during power up. Once the print process has started release all keys and wait for the completion. The print process can only be turned off with the <OFF> key.

The purpose of this Special Status Printout is to give the user an easy way to communicate the instrument status to a technician in case of problems.

## SECTION 5

### MAINTENANCE AND CALIBRATION

#### General care

The Reflectometer is constructed for outdoor use in ordinary good weather conditions. It will stand moist weather with wet roads, but caution must be taken against heavy rain or splashes, dirt from traffic and situations with risk of condensing water eg when going from a cool storage to a warm and humid measuring site. The Qd30 Reflectometer is an optical instrument and shall be handled as such. Avoid shock and vibration if possible.

#### Battery

The Qd30 Reflectometer is powered by a sealed 12V/3.5Ah lead acid battery, which under normal use requires no maintenance. However, it is recommended to keep the battery fully charged. A fully charged battery is more capable of withstanding low temperature and ageing.

A battery charger is provided as a standard accessory for charging the battery from mains. The output cable of the charger is equipped with a socket matching the connector in the instrument. Connect the charger to mains and instrument. The red indicator will be switched on as long as the charging is in progress. Thereafter it switches periodically on and off. Normally the charging will take about 8-12 hours. Typically the battery achieves 90% of the capacity in 5 hours. No harm will result from leaving the charger connected for time in excess of the above indicated duration of the charging process. However, the battery must be disconnected from the charger when disconnecting from the mains.

#### Fuses

Fuses, two pieces, are placed in the rear of the instrument. The charging fuse protects the battery against short circuit and other errors in the charging connector, charger or charging system. The battery fuse protects battery and electronics against short circuit and other errors in the electronic system.

Always renew a blown fuse with one of equal rating. To change fuses carefully unscrew the plastic cap fuseholder by using, e.g. a coin. Pull out the fuse from the cap and insert the new one.

#### Lamp

The halogen lamp requires no maintenance but should be kept free from dust. At life end it must be replaced. Reduced light output due to lamp fatigue or dust will be reported on the display, printer and internal log.

#### Printer

The printer is a high speed high quality full graphic mini thermal printer. It uses standard thermal paper (Seiko 58 mm/12.7 m). It has only a few moving parts and does not require any special or periodic maintenance. Keep the paper in a dry and cool place.

Replacing the paper is easily done by first pushing the spring loaded transparent cover downwards to disengage it from the upper block part, let it swing down and insert a new paper roll. A handwheel makes it easy to insert the paper. Close the cover in reverse order.

## Calibration

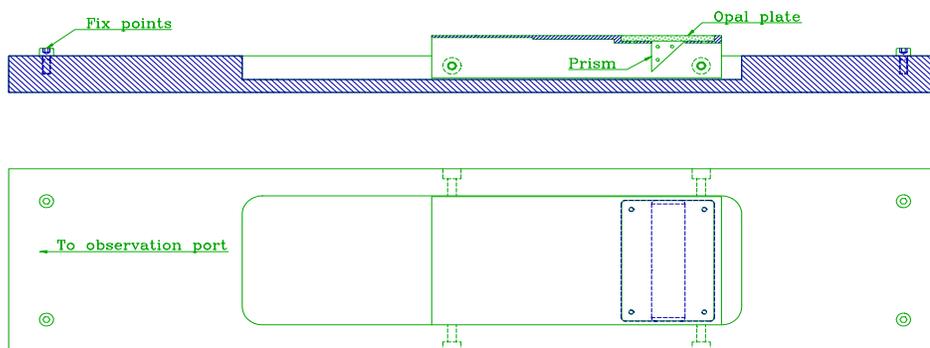
The Qd30 Reflectometer is factory calibrated. This calibration is carried out by using a special Qd calibration unit. The calibration unit's Qd value is measured in the laboratory using traceable methods and equipment. The traceable calibration unit can be used for future control and recalibration of the instrument.

Mount the calibration unit on the Qd30 measurement port and follow the instructions given in section 3 or the guidance in the Qd30 display when calibrating. A calibration is done in short time. If only control is wanted, perform a normal Qd measurement with the calibration unit mounted.

## Calibration unit

The road marking is simulated by a white plastic diffuser. The diffuser collects the light from the illuminating sphere. A prism below the diffuser directs the light towards the observation port. By using this method the calibration value will be close to the normal road marking Qd value, without making the specular contribution dominating.

Cleaning is made easy because of the smooth surface. The calibration unit is mounted in a fixture that fits the measuring port. Reflections and stray light are removed by a shield.



This way of calibration will provide a reliable calibration of the Reflectometer.

In order to minimize instrument drift and errors, the ratio between the sphere illumination and road luminance is measured simultaneously. Qd is proportional to this ratio. After compensation of dark signal, leakage and other known errors the calibration factor is easily calculated. This is done automatically by the Reflectometer if the calibration routine is followed. After a calibration the Reflectometer will display *true Qd*.

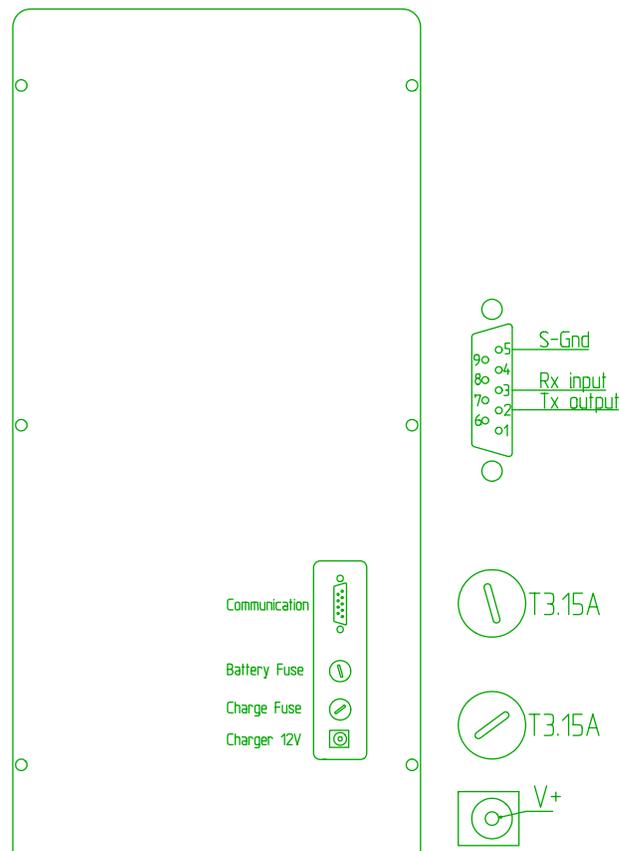
Please keep optical surfaces clean. This will insure reliable operation for long periods.

## APPENDIX A

### COMMUNICATION FACILITIES

#### RS-232C specification

The Qd30 is equipped with a communication facility that enables the use of a simple terminal or an ordinary PC type computer for control of Qd30 functions and for dump of data from the internal data logs.



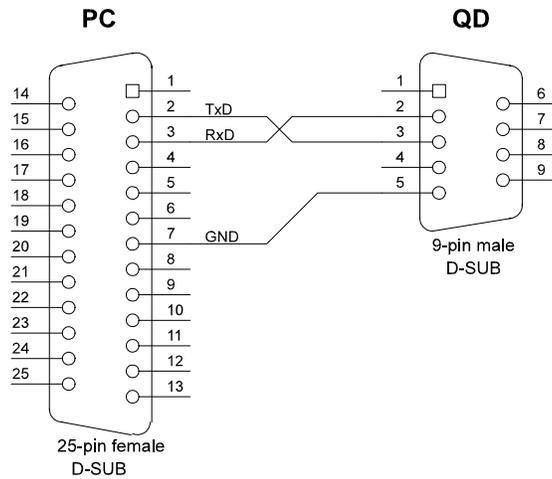
The computer or terminal connects to the Qd30 using a standard communication cable fitted with a 9-pin male d-sub connector in one end and a 9 or a 25-pin connector in the other end. The electrical connection's meet the normal standard for serial communication.

9-pin d-sub connector on Qd30.

| Pin no | Function      | Signal direction |
|--------|---------------|------------------|
| 3      | Receive data  | Data to Qd30     |
| 2      | Transmit data | Data from Qd30   |
| 5      | Signal ground | Common           |

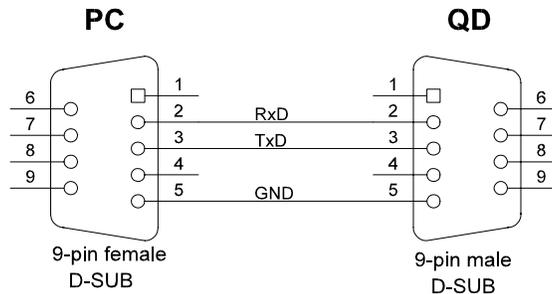
Connection example 1.

PC's with a 25-pin d-sub communication port connector.



Connection example 2.

PC's with a 9-pin d-sub communication port connector.



As it can be seen, the interconnections have been held to an absolute minimum, and in some rare situations there will have to be established additional connections on the PC side. Please refer to your PC manual for further information.

## Data protocol

The communication between the Qd30 and the computer equipment takes place using the following settings:

|                         |               |
|-------------------------|---------------|
| Baudrate.....           | 9600 bit/sec. |
| Number of data bit..... | 8             |
| Parity.....             | none          |
| Stop bit .....          | 1             |
| Data flow control ..... | Xon/Xoff      |

## Command format

All Qd30 commands are built using the following template.

|             |   |
|-------------|---|
| Command     | One ore two capital letters, <?> or <space> |
| Delimiter   | One space, optional                         |
| Parameter   | Integer or real number, optional            |
| Delimiter   | One ore more spaces, optional               |
| Command end | Carriage Return (<CR>), mandatory           |

## Example

The user wants to set the automatic *off timer* to 120 seconds.

The command should look like this:

**OT 120 <CR> or OT120<CR>**

If the Qd30 accept the command it responds with the message:

**Automatic Off Timer = 120 sec.**

If for some reason the communication fails or the command is undefined the Qd30 responds with a question mark <?>.

If the parameter's lies outside the defined range for that parameter, the Qd30 returns the present setting without any change.

## Qd command set

The Qd30 is equipped with a serial communication port primarily for log data acquisition, calibration and test, however all normal Qd30 functions can be controlled via this interface.

The following commands have been defined

| Command | Parameter          | Response  | Meaning.   |
|---------|--------------------|---|--|
| ?       | none               |   | Displays online help menu                                    |
| DA      | none<br>2001 02 09 | 2001 feb 04 16:39:45<br>2001 feb 09 16:39:45  | Real time clock date and time<br>New date (time unchanged)   |
| DPS     | none               | <pre> ----- Calibration Status ----- Qd Normal.....: 150 mcd/m<sup>2</sup>/lx Calibration done: 2001 Jan 14:12:14 Diffuse Signal..: 16891  61.4% Reference Signal: 25734  93.6% Dark Signal.....: -47   -0.2% Leak Signal.....: -43   0.2%  -- Values from last Test Measurement -- Test Done.....: 2001 Jan 11:08:44 Qd.....: 126 mcd/m<sup>2</sup>/lx Diffuse Signal..: 16745  60.9% Reference Signal: 25642  93.2% Dark Signal.....: -43   -0.2% Leak Signal.....: -34   0.1%  --- Values from last Qd Measurement --- Done at.....: 2001 Jan 02 14:37:24 Qd.....: 150 mcd/m<sup>2</sup>/lx Diffuse Signal..: 16866  61.3% Reference Signal: 25722  93.5% Dark Signal.....: -52   -0.2% Leak Signal.....: -43   0.2% Measurement ID.....: Test Measurements with this ID: 3  ----- Status ----- Status Code.....: 0 ----- Special Status ----- Printer.....: Present Real Time Clock : 2001 Jan 17 13:25:38 Off timer set to: 900 sec Battery Ok.....: 12.48 volt  ----- Data Log Status ----- Log Full Warning: Enable DataPoints in Log.....: 27 Free Data Log.....: 29.55 % DataPoints in Test Log: 0 Free Test Log.....: 100.00 %  ----- Dynamic Factors ----- Calculated VBat Factor:  0.01530 Calculated Qd Factor..:  0.71865 VBat Lamp Off.....:  12.48V VBat Lamp On.....:  11.77V </pre> | Dump the complete instrument settings. Used for diagnostics. |



| Command | Parameter                                   | Response  | Meaning.   |
|---------|---|---|--|
| LT      | none  | Qd30 Test Log Dump 2001 Feb 09 10:29:13 Qd30 s/n: xxx<br>2 Entries 99.20% free<br>Date/Time Qd Leak Sig Ref Idle Load Status Type<br>Y:M:D H:M:S mcd % % % [v] [v] byte<br>2001-Feb-09 09:53:05 131 0.0 112.2 114.3 12.44 11.77 0 T<br>2001-Feb-09 09:57:58 131 0.0 110.1 113.1 12.42 11.75 0 C<br>*  | Test log dump date and time.<br>Log statistics.<br>Log header.<br>Data units.<br>Qd test data (oldest)<br>Qd test data (newest)<br>End of test Log.<br>Type T indicates a test measurement and type C a calibration.   |
| LW      | none<br>F<br>T                              | Log Full Warning Enable<br>Log Full Warning Disabled<br>Log Full Warning Enable   | Log full warning settings.<br>Disables log full warning.<br>Enables log full warning.  |
| LX      | none<br>Y<br>N                              | Clear Test Log? [Y/N]<br>Qd Test Log Empty<br>Not Confirmed. Function Terminated  | Clears the Qd test log. Confirm with Y to empty the test log.<br>Clear log terminated.   |
| OT      | none<br>59<br>180                           | Automatic Off Timer = 120 sec.<br>No Automatic Off Function<br>Automatic Off Timer = 180 sec.   | Automatic turn off time when not in use. Range 60 to 600 sec. disable for time < 60 sec.   |
| QC      | none<br><br>150 (Calib. unit)<br>Y<br><br>N | Q_Factor = 0.97012<br>Q_Normal = 163<br><br>Calibrate instrument (Y/N)<br>Confirm with Y to start calibration<br>Q_Normal = 150<br>Q_Factor = 0.9805<br>Not Confirmed. Function Terminated.   | Displays the calculated Qd factor<br>Qd calibration value.<br><br>Calibrates Qd30. Calibration unit must be mounted.   |
| QD      | none  | 2001-Feb-08 17:21:30 Qd: 165 (mcd/m <sup>2</sup> )/lx<br>QD30 s/n: xxx<br><br>2001-Feb-08 17:21:30 Qd: 165 (mcd/m <sup>2</sup> )/lx<br>Measurement id: nnnnnn #3<br>Qd30 s/n: xxx<br>Count: 2 Mean: 165.34  | Performs a normal Qd measurement.<br>If sequence id text is enabled, the id and seq. no are added.<br>If Mean calc is enabled then the number of measurements and the mean value are added.  |
| QT      | none  | 2001-Feb 08 17:22:18 Qd = 163 (mcd/m <sup>2</sup> )/lx<br>Signal = 66.8% 18377<br>Ref. = 103.4% 28455<br>Dark = 0.2% 42<br>Leak = 0.0% 32<br>VBat Lamp Off: 12.59V<br>VBat Lamp On : 11.95V<br>Status = 0: 00000000<br>QD30 s/n: xxx  | Performs an extended Qd measurement.<br>Measured Signal.<br>Measured Ref. Signal.<br>Measured Dark Signal.<br>Measured Leak Signal.<br>Battery voltage with min. load.<br>Battery voltage with max. load.<br>Actual status code.<br>Instrument serial number |
| SD      | none<br><br>255                             | Status Code: 97 : 100001<br><br>255 Bit Pattern : 11111111<br>Requested Status Map:<br><br>Status Code: 0 00000000 Instrument OK<br>Status Code: 00000001 Converter Error<br>Status Code: 00000010 High Leak Warning<br>Status Code: 00000100 Qd Log Full Warning<br>Status Code: 00001000 Test Log Full Warning<br>Status Code: 00010000 Low Bat Warning | Status code and bit pattern.<br>If status not zero then the status code is broken down.<br><br>The example shows all status bits set forming the number 255  |

| Command  | Parameter                           | Response  | Meaning.   |
|----------|-------------------------------------|---|--|
| SD cont. |                                     | Status Code: 00100000 Memory Power Failure<br>Status Code: 01000000 Reference Signal Warning<br>Status Code: 10000000 High Signal Warning   |  |
| SN       | none<br><br>nnnnnn<br><br>6 <space> | Measurement ID: TEST<br>Measurements in Sequence: 2<br>Measurement ID: nnnnnn<br>Measurements in Sequence: 0<br><br>Measurement Id Disabled | Displays actual id status<br><br>Enter new sequence id text.<br>Maximum 6 characters incl.<br>Spaces. 6 spaces disables the<br>sequence id text. Characters can<br>be: space, 0..9, A..Z<br>Enter 6 spaces to disable<br>measurement id. |
| TI       | none<br>17 05 22                    | 1998 jul 20 16:39:45<br>1998 jul 20 17:05:22  | Real time clock date and time<br>New time (date unchanged)   |
| TO       | none                                | Sensor Off  | Turn sensor off  |
| VA       | none<br>10.3                        | Low VBat Alarm: 10.50 V<br>Low VBat Alarm: 10.30V   | Set point for Low batt warning.<br>New Set point for Low batt warn-<br>ing. Should <b>not</b> be altered!  |
| VB       | none                                | VBat =12.61 V   | Measure the battery voltage.   |
| VF       | none<br>12.57                       | Volt Factor =0.0153<br>Volt Factor =0.0146  | Voltage calibration factor.<br>New wanted reading (in Volt!)   |
| VS       | none                                | VBat Lamp Off: 12.59 V<br>VBat Lamp On : 11.95 V  | Measured battery with min. load.<br>Measured battery with max. load.   |

## APPENDIX B

### SPECIFICATION

#### General characteristics

|  |                          |
|--|--------------------------|
| Illumination .....   | diffuse according to CEN |
| Field of measurement:  |                          |
| Width .....  | 45 mm                    |
| Length (typ.) .....  | 175 mm                   |
| Observation angle .....  | 2.29°                    |
| Equivalent observer distance .....                                       | 30 m                     |
| Min. reading ( $\text{mcd}\cdot\text{m}^{-2}\cdot\text{lx}^{-1}$ ) ..... | 0                        |
| Max. reading ( $\text{mcd}\cdot\text{m}^{-2}\cdot\text{lx}^{-1}$ ) ..... | 318                      |

#### Electrical characteristics

|                                      |  |
|--------------------------------------|--|
| EMC .....                            | EN 50081-1<br>EN 50082-1                         |
| Power supply .....                   | Built-in 12 volt 3.5Ah. sealed lead acid battery |
| External charger .....               | 230VAC   |
| Charger fuse .....                   | T3.15A   |
| Power supply fuse .....              | T3.15A   |
| Data Memory (Qd log) .....           | 1100 measurements                                |
| Data retention (from purchase) ..... | Typ. 5 years                                     |
| Interface .....                      | RS 232   |
| Serial communication mode .....      | 9600,N,8,1                                       |
| Data flow control .....              | Xon/Xoff   |

#### Environmental characteristics

|                 |   |
|-----------------|---|
| Temperature:    |   |
| Operating ..... | 0°C to + 45°C<br>32°F to 113°F                  |
| Storage .....   | -15°C to + 55°C<br>5°F to 131°F                 |
| Humidity .....  | Battery must be fully charged<br>Non condensing |

#### Mechanical characteristics

|                    |                 |
|--------------------|-----------------|
| Max. length .....  | 630 mm/ 24.8 in |
| Max. width .....   | 450 mm/ 17.7 in |
| Max. height .....  | 470 mm/ 18.5 in |
| Weight .....       | 11.4 kg/ 25 lb  |
| Gross weight ..... | 30 kg/ 66 lb    |

