RetroSign GR1 & GR3 Retroreflectometer

On site quality verification of road signs

User's Manual

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Rev.: 1.3 Marts 2009

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Section 1 – Introduction

RetroSign introduction

The RetroSign Retroreflectometer is a portable field instrument intended for measuring the retroreflection properties of road signs in car headlight illumination. The value R_A (coefficient of retroreflected luminance) is used for the measurement. R_A is a measure of the visibility of the road signs as seen by drivers of motorized vehicles in headlight illumination. The RetroSign is available in different versions.

For type GR3 ASTM the sign is illuminated at an entrance angle of -4º and the measurements are made with angles between illumination and observation of 0.2º, 0.5º and 1.0º. This is relevant for a motorist viewing situation under normal conditions.

For type GR3 CEN the sign is illuminated at an entrance angle of +5º and the measurements are made with angles between illumination and observation of 0.33º, 0.5º and 1.0º. This is relevant for a motorist viewing situation under normal driving conditions.

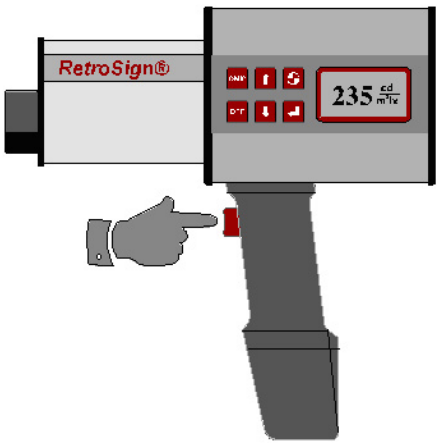
For type GR1 SAFETY the measurement area is illuminated at an entrance angle of +5º and the measurements are made with an observation angle of 0.2º, angles used to measure Safety Clothing according to EN 471

The ASTM and CEN type instruments is also offered in a GR1 version with only the primary observation angles of 0.2º (ASTM) and 0.33º (CEN).

The range of RetroSign instruments available are summarized below:

	ASTM	CEN	Safety	
RetroSign GR1	√	√	√	1 primary observation angle
RetroSign GR3	√	√		3 observation angles
Geometry	ASTM E 1709	EN 12899-1	EN 471	

R_A is an important factor in the onsite quality control of road signs.



DELTA RetroSign Retroreflectometer.

The operation of the Retroreflectometer is very simple and requires a minimum of instruction. An error or warning message is given in case of unreliable or measurement.

The RetroSign measures the retroreflection and calculates R_A according to international standards. Results are presented on an LCD panel.

Each measurement can be marked with a user defined name (measurement ID) of up to 12 alphanumeric characters and an auto incrementing sequence number.

The memory provides on site registration of measurements with corresponding date, time, ID, measurement status, GPS position (optional) and RFID tag code (optional).

The GR1 or GR3 is equipped with a USB port that gives easy PC access to measurement data and diagnostics.

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

RetroSign Retroreflectometer features

- Portable instrument
- Measurement in full daylight
- Photopic corrected detector and source »A«
- Automatic stray light compensation and error diagnostics
- Measurement geometry and illumination corresponding to realistic viewing condition in night time traffic
- Direct digital read out
- Easy calibration procedure
- Reference cap for calibration
- Real time clock
- Automatic data storage in non-volatile memory
- Automatic programmable power off function
- USB port providing easy communication for data transfer, extended control and diagnostics
- Long lifetime battery
- 230 V/ 50 Hz or 120V/60 Hz mains powered battery charger
- Small support flange with cross hair
- Aperture reducer Ø15 mm (0.60 in)
- USB cable
- Shoulder strap
- Carrying case

Options

- Extension pole kit with remote trigger, display and large support flange.
- Advanced 16 channel GPS receiver
- RFID (Radio Frequency ID) tag reader, for measurement documentation using wireless smart tags
- Bluetooth (wireless communication link) for wireless data and control
- Fast 12V powered battery charger (approx. 15 minutes)
- Extra Battery.
- Aperture Reducer Ø10 mm (0.40 in)

Section 2 – Operating Information

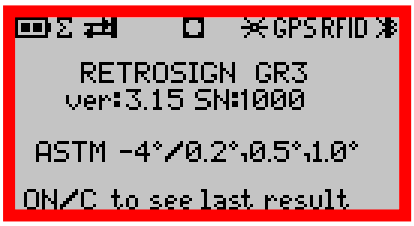
Getting started

Turn the RetroSign on by pressing **ON/C**.

After approx. 2 seconds the display will show:

Calibrate the instrument if necessary,

See calibration section.



Icons

Instrument status and operational mode are signaled by the use of icons. Icons are shown in the top line of the display.

- Instrument is calibrated and ready.
- Menu selected.
- Calibration selected
- Zero calibration in progress.
- Reference calibration in progress.
- Calibration monitor active for normal aperture
- Calibration monitor disable for reduced aperture
- Battery fully charged
- Battery getting low
- Battery discharged, measurement not possible
- **GPS** GPS position fix, (strikeout if no fix)
- Display backlight is on.
- **Σ** Mean calculation enabled
- **RFID** RFID option installed and enabled (optional)
- Bluetooth option enabled and connected (optional)
- Bluetooth option enabled but not connected (optional)

When is shown the instrument is calibrated and ready for use.

Perform a measurement

Place the instrument front on the surface to measure.

Start the measurement by pressing the red trigger knob on the handle.

The display shows **WAIT** for the duration of the measurement, approx. 2 seconds.

A sound [1] signals the end of the measurement and the result is displayed together with other relevant information.

If errors or warning conditions are detected during the measurement sequence, this will be shown as “Err” or “Warn” together with the result.

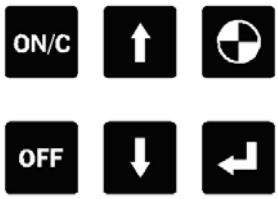
Sequence ID

The RetroSign has a built in function to mark each measurement with a user defined name (Sequence ID) and a unique [2] Sequence Number automatically generated by the instrument. The Sequence ID and the Sequence Number will also be stored in the log. The maximum length of the Sequence ID text is 12 alphanumeric characters.

[1] The sound generation has to be turned on in the menu

[2] The Sequence number can be edited from the menu.

Keyboard functions

Keyboard layout	Trigger on handle
	

	Push shortly to switch on the instrument. Redisplay the last measurement result. Clear the mean calculation when displayed Cancellation of current menu operation.
	Turn Instrument Off. Changed settings will be stored
	Select menu items Scroll keys when in menus Parameter and value increment (+) / decrement (-)
	Start instrument calibration function Select / change settings in menus
	Switch between result and status displays Activate selected functions
	Start **R’** measurement. Select quick calibration mode. Select next calibration step Read RFID tag when mounted and enabled

Calibration

RetroSign features two levels of calibration: **Quick** and **Full**.

Quick calibration is an “everyday” calibration using zero results and reference values from the latest full calibration. This option may only be used with the same reference unit that was used for the full calibration.

Full calibration is used for high accuracy calibration of zero and reference.

Quick calibration

Quick calibration is initiated by pressing the button and then the trigger. Mount the reference cap (reflective side) before triggering. The display shows **WAIT** and the Calibration is executed immediately using previous defined reference values. If the calibration fails, the display shows a short warning message saying that the old calibration values will be used; a status flag will be set and logged for this condition.

Full calibration

Full calibration is initiated by pressing the button and then. Follow the displayed procedure.

Zero

Mount the zero cap (dark side) on the instrument. Press the or the trigger when ready. The display shows **WAIT** while measuring and then shortly displays the measured zero values. If the measured values are ok the instrument is ready for the next step in the calibration procedure. If high zero values are measured, a warning text will be shown and the user asked to check the black target and try again.

Reference

Mount the reference cap (reflective side). If necessary edit the displayed reference value using or until it matches the value printed on the reference unit, press or the trigger to advance to the next reference value. When all reference values has been checked and edited the instrument executes the calibration process. **WAIT** is displayed during the actual calibration measurement and then the calculated calibration factors are shortly displayed. If errors are detected during the calibration process a warning text is displayed and the user is asked to check the white target and retry the calibration by pressing or the trigger again. The reference values will not need to be checked again.

When the calibration is successful, continue by pressing ON/C, or the trigger.

After a successful calibration the icon is shown and the instrument is ready for measurements. It is good practice to do a measurement on the calibration unit immediately after the calibration to check the values.

Reduced aperture option

When the instrument is configured for measurements with reduced aperture the calibration monitor should be disabled. This changes the checking of the calculated calibration values and displays the icon to alert the user that this option has been selected.

The instrument must be recalibrated whenever this function is enabled or disabled.

See also paragraph *Aperture Reduction* in this section for further information.

Menu system

General menu operations:

When in measurement mode pressing ↑ or ↓ activates the menu system. When in menu mode, use the ↑ and ↓ to scroll through the functions or to change values. Press ↵ to select or accept the displayed function or value. In some menus the ⊕ key is used to switch between different selections.

Pressing ON/C terminates the menu and switches back to the results display.

Use ↑ to scroll through the menu list as shown below, using ↓ reverses the list.

Menu items:

Sequence ID: (Measurement ID)

A measurement series can be assigned a unique ID that is logged together with the results. Each measurement made with the ID is also assigned a sequence number that automatically increments by one for each measurement.

The Sequence ID is shown as **Seq ID[string]** where string can be up to 12 alphanumeric characters, e.g. [**CARLANE 1 XY**]

To edit the sequence ID press ↵. The display changes to show the defined ID and a line showing the new ID. To a start the new ID will be identical to the old ID. Underneath the new ID the edit position is marked with an up-arrow symbol. Use the edit keys to make changes to the marked position.

When defining a new ID, the sequence number will be reset to zero.

ID Count: (Display ID count for edit)

The auto incremented Sequence ID number can be changed, use the normal edit keys to change the value.

Clear ID: (Set Sequence ID to undefined)

The display shows the defined sequence ID, the ID can be set to undefined using the edit keys.

Use this option to completely remove the ID string.

Clear Work Log: (Set user log record counter to zero)

The display shows the number of records in the work log.

This function allows the user to reset the log record counter. The function can be used when starting a new measurement series without first reading the records already in the log. It should be emphasized that no data actually is erased by this operation; it is merely the presentation of the number of new records in the log that changes, and it should also be emphasized that all old data records can still be read out at a later time. Normally this counter will be reset by the PC program after reading the data to a file.

Sound Control: (Control generation of system sounds)

This function controls how the instrument uses sounds to report different conditions, e.g. the end of a measurement cycle, error conditions etc.

Setting this control to off completely silences the instrument.

Off Timer: (Power Saver)

This function controls how long the instrument stays ON when not used. This function is to preserve power before powering off. Changed values and setting will be saved, and selecting a value less than 60 seconds will disable this function.

Mean Calculation: (Calculate and display mean values)

The Mean values are calculated and displayed together with the number of measurements used for the calculation.

Shift to main display screen #2 *(see appendix F)* by pressing ↵ to see the calculated values.

In display line 2 the value MC= shows the number of measurements used to calculate the mean value. *See appendix F*

The display shows both the measured value (raw) and the calculated value (mean)

When in the main display screen #2 press ON/C two times to clear the mean calculation.

Enabling this function affects the way the RFID function works. *See appendix E*

Calibration Monitor: (Calibration factor monitor)

The build in calibration monitor is used to check the calculated calibration factors against minimum and maximum limits, it can be disabled; this should be done when using the aperture reducer's as this can result in factors outside the normal limits, marking the measurements with a calibration warning.

The normal limit checking is designed to be a safeguard against errors in the calibration procedure.

When the Monitor is enabled the ⛶ icon displays, when disabled the ✚ icon displays.

IMPORTANT: the instrument must be recalibrated whenever changing form normal to reduced aperture and vice versa.

Remote-Box Display: (Select result for extender box display)

The remote trigger can only display one result at a time, this function selects which result to display on the remote trigger unit, the normal setting would be the primary observation angle of 0.2º or 0.33º

Display Backlight: (Control LCD backlight)

The automatic LCD display backlight function can be disabled. Doing so will allow for more measurements on the same battery charge, as backlighting consumes lots of energy.

DGPS Mode: (Select GPS position correction method) (Optional)

The GPS receiver can use different methods to obtain greater position precision by using different correction signal sources.

Depending on the location, different systems can be selected:

WAAS should be used in North America.

EGNOS should be used in Europe.

Auto: should select the best possible available correction signal. However, not all systems may be fully operational or they may be in test modes. Selecting a wrong correction system might actually reduce the precision.

Disable: Don't use any correction signals.

GPS State: (Control the GPS function) (Optional)

The GPS receiver can be disabled if desired, the main reason for doing this would be to reduce the overall power consumption maximizing the number of possible measurements on the available battery charge.

RFID State: (Control the RFID option) (Optional)

The GR1 and GR3 have an option for inputting data from an external RFID reader. This will make it possible to use RFID tags to uniquely identify signs.

Enabling the RFID option changes the way the instrument behave when taking measurements. When no reader is connected this option must be disabled

When enabled, the instrument will ask for a RFID tag on the first trigger. When the tag has been read the instrument will do the measurement on the second trigger. See appendix E

When the Mean Calculation is enabled the instrument will only ask for the RFID tag on the first measurement in a series (Mean Count < 2). This allows for doing multipoint measurements with the same RFID code.

After clearing the mean calculation the instrument will again ask for the RFID tag on the first trigger.

Remove Latest Measurement: (undo the most recent measurement)

It is possible to remove the most recent measurement record from the work log. To maintain data integrity only one data record can be removed and only if it is done before the instrument is turned off.

Battery / charging

Never disconnect the battery while the instrument is turned on as this may result in lost data and malfunction of the instrument.

Temperatures in excess of 50º C (122º F) will damage the battery. Do not short circuit the battery. Do not dispose with household waste.

To remove the battery swing the battery retaining spring over, and disengage the battery from the handle. See *Section 4 - Battery* for further information on charging.

Remote control

External trigger option (Optional)

By connecting a remote trigger box to the rear connector on the instrument it is possible to do measurements using an extension pole.

As an accessory an Extension pole kit can be supplied.

Computer interface

The instrument is equipped with a device USB port; this allows complete remote instrument control and measurement data collection.

Use the Road Sensor Control (RSC) software to offload measurement records or to control the RetroSign.

Use of the USB connection requires the installation of a special software driver on the PC which can be found on the instrument CD..

See *Appendix B - Communication facilities*.

Support flange

The support flange is provided with cross hair markings. It makes it easier to decide the measuring position when taking measurements on small objects, e.g. letters and numbers on a sign.

Aperture reduction

For special measurement requirements on small targets, the RetroSign can be mounted with a special aperture reducer adaptor; this reduces the field of measurement to either ø 15 mm (0.6 in) or ø 10 mm (0.4 in) depending on the unit used. The ø 15 mm is supplied with the RetroSign while the Ø 10 mm is optional.

To achieve the smaller aperture, the reduction unit is simply mounted in front of the lens barrel.

Disable the Calibration Monitor when using the Reducer!

See Menu Items on how to disable the monitor.

IMPORTANT! Remember always to calibrate the instrument after changing the aperture setting.

Note:

- RetroSign is an optical precision instrument, handle with care.
- Store in clean and dry environment.
- Do not recharge after using the instrument only briefly.
- Never remove the battery when the instrument is ON
- Carefully check and clean the *reference cap*, the reading is very sensitive to contamination.

Section 3 – General Information

RetroSign GR1 & GR3

The RetroSign Retroreflectometer measures the R_A (coefficient of retroreflected luminance) parameter. The R' parameter represents the retroreflection of the road signs seen by drivers of motor vehicles by headlight illumination.

Physically the Retroreflectometer is a small hand held instrument. It is constructed in aluminum housing, containing electronics and an optical system. The measurement trigger button and the replaceable battery are housed in the handle.

The RetroSign is controlled by a micro controller that executes a measurement automatically when the trigger is activated. The result and status are shown on the LCD display. The result and other related information is automatically transferred to the internal non-volatile memory. The RetroSign is operated from a small keyboard on the left hand side of the Retroreflectometer. The Retroreflectometer control is also possible using a USB device connection. The USB connection is used to transfer data records to a PC for further processing.

Factory calibrations

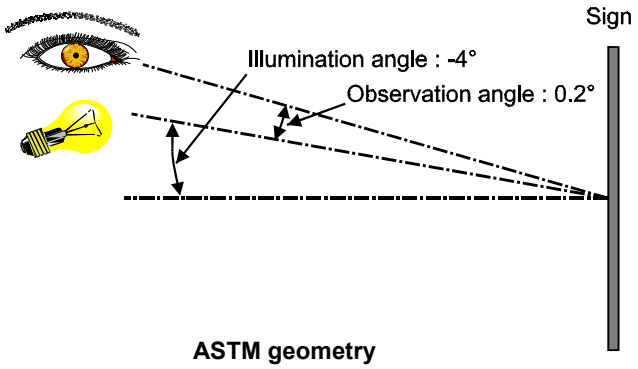
The RetroSign GR1 and GR3 is factory calibrated. This calibration is carried out using a standard. The reference's $\mathbf{R_A}$ value is measured in the laboratory using traceable methods and equipment.

The enclosed reference cap should be used for verification and recalibration of the Retroreflectometer.

Measurement geometry

GR1 and GR3 type ASTM

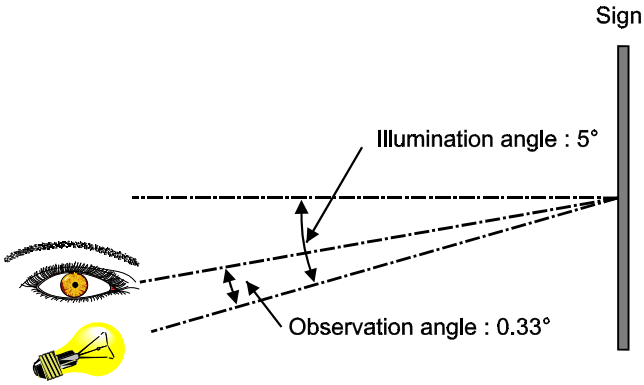
The illumination angle is -4°. The offsets between the illumination and the primary observation angle are 0.2° (GR1) and the three observation angles are 0.2°, 0.5°and 1.0° (GR3) respectively. The measurement area is approx. ø 30 mm. in the standard configuration, ø 15 mm or ø 10 mm when using the reduced aperture adaptors.



ASTM geometry

GR3 type CEN

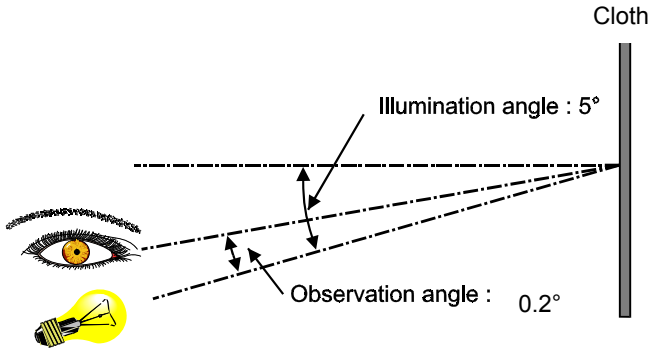
The illumination angle is +5°. The offsets between the illumination and the primary observation angle are 0.33° (GR1) and the three observation angles are 0.33°, 0.5°and 1.0° (GR3) respectively. The measurement area is approx. ø 30 mm. in the standard configuration, ø 15 mm or ø 10 mm when using the reduced aperture adaptors.



CEN geometry

GR1 type SAFETY

The illumination angle is +5° and the offsets between the illumination and observation angle is 0.2°. The measurement area is approx. ø 30 mm. in the standard configuration, ø 15 mm or ø 10 mm when using the reduced aperture adaptors.



CEN EN 471 geometry

Battery

The RetroSign is powered by a replaceable rechargeable battery, which under normal operation will keep the Retroreflectometer operating for many hours. The battery must be recharged by the included external charger. See *Section 4 - Battery*.

Note on error sources

Before measuring

The RetroSign is factory calibrated; nevertheless, begin important measurements sessions with a calibration, dust and smear from touching the optical surfaces might influence the measured values considerably.

It is very important to keep the instrument front lens and the white reference cap clean.

See also *Section 4 - Maintenance*.

Instrument orientation

The RetroSign can take measurements without being in close contact with the sign surface. But to obtain the most reliable results the front of the RetroSign should be in contact with, and perpendicular to, the sign surface when taking measurements.

Sign conditions

The optical property of a sign alters when the retro reflective material becomes wet. The RetroSign can take measurements on wet or dewy sign surfaces but readings are not comparable with readings taken on dry signs.

Because of the special optical properties of micro prismatic sheeting, precautions like turning the instrument correctly and holding it vertical should be taken to get correct readings. Always use the RetroSign in the angle specified for the sign.

Normally the RetroSign instrument must be held in the vertical position.

Leakage

During each measurement the RetroSign automatically evaluates the leakage (optical background signal) and the result are compensated before read out. Leakage will under normal conditions not be significant. Nevertheless, leakage may occur and a warning will be shown in the display. Leakage is primarily caused by stray light entering the optics between the sign and the instrument.

Instrument leak, drift and offset errors are compensated for by means of data obtained during the calibration procedure, so perform the calibration procedure carefully.

Low battery condition

The instrument always monitors the battery voltage and automatically blocks for further measurements when the battery voltage gets very low. Due to the nature of the battery it may happen, when the instrument is turned on, that the voltage will be high enough to start a measurement but not to turn the light source on causing the measurement to fail.

Doing measurements with a nearly discharged battery should be avoided as this might influence the measured values.

Section 4 – Maintenance

General care

The Retroreflectometer is constructed for outdoor use in fair weather conditions. The Retroreflectometer will withstand moist weather, but caution must be taken against rain or splashes and dirt form traffic. The RetroSign Retroreflectometer is a robust instrument, but it is an optical instrument and must be handled as such.

Avoid exposing the instrument to high mechanical shocks and vibrations.

Avoid exposing the instrument to rapidly changing temperatures.

When not in use store the instrument in the caring case in a clean and dry environment.

Front lens

The lens does not need special maintenance. If dirty carefully moist the lens with ordinary window cleaning liquid and clean it with a soft linen cloth.

Battery

The instrument is powered by a NiMh battery, which under normal use requires no maintenance.

A battery charger is provided as a standard accessory for charging the battery from mains.

To recharge the battery first make sure that the instrument is off, then release the battery retaining spring, remove the battery from the handle and insert it in the charger.

Please refer to the enclosed charger instructions for operation.

A new battery or one which has not been used for an extended period of time will reach full performance only after approx. 5 charging and discharging cycles.

The battery is equipped with a temperature monitor that only allows charging within a range between 0°C and 45°C (32°F and 113°F). This ensures long battery life. When used properly, the battery can be recharged up to 1000 times.

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

The Battery and the charger are specifically designed for use in conjunction with one another. Charging should be done only with the charger delivered with the instrument.

Do not expose the battery to heat or flames: **Danger of explosion**. Do not place the battery on a heater or expose to direct sunlight for long periods. Temperatures in excess of 50°C (122°F) will damage the battery. Allow a warm battery to cool before charging. When handling or storing the battery take special care to avoid possible short circuiting the battery contacts.

Avoid repeated consecutive rapid charges of the battery. Do not recharge after using only briefly.

Note

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

Lamp

The lamp requires no maintenance. At the end of the lamps service life the instrument will display a lamp error message, and the lamp must be replaced.

The lamp must be replaced only by DELTA or personal trained by DELTA.

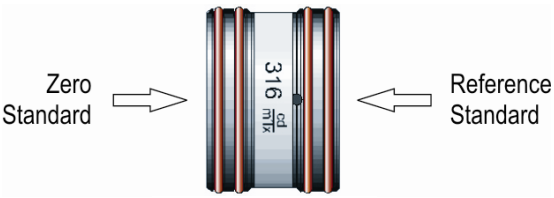
Reference cap

To make sure that the calibration of the Retroreflectometer is correct it is important that the surface on the reference cap is clean and undamaged. Keep the cap protected, and be careful not to touch the reference cap (reflective side).

If the surface is stained, scratched, or broken the reference cap must be replaced.

In case of dust on the surface, clean the reference cap gently by using a soft cloth with a mild household detergent. Wipe carefully with dry linen cloth afterwards.

To ensure reliable measurements, it is recommended that the reference cap is periodically recalibrated to a traceable standard. DELTA Light & Optics offers calibration traceable to PTB (Physikalisch-Technishe Bundesanstalt) and NIST (National Institute of Standards and Technology). For information contact your local distributor or DELTA Light & Optics, Denmark.



Reference cap.

Calibration

The RetroSign is factory calibrated, but a calibration should always be carried out before starting a series of measurements.

The calibration process automatically compensates for instrument offsets, leakage and other known “errors” and calculates calibration factors for each observation angle.

After a calibration the Retroreflectometer will display »true« $\mathbf{R_A}$ values.

Store the reference cap in a dry and clean environment.

APPENDIX A – Specifications

General characteristics

Type ASTM

Geometry	**ASTM E-1709**
Illumination angle	-4°
observation angles	**0.2°**, 0.5°, 1.0°

Type CEN

Geometry	**CEN EN 12899-1**
Illumination angle	+5°
observation angles	**0.33°**, 0.5°, 1.0°

Type SAFE

Geometry	**CEN EN 471**
Illumination angle	+5°
observation angle	0.2°

Light source angular aperture	0.1°
Receptor angular aperture	0.1°
Field of measurement	ø 30mm/1.2in
Light source	Illuminant »A«
Receptor sensitivity	Precise eye corrected (ASTM-E1709para. 6.4.2 for selected color filters)
Min. reading (cd/lx×m²)	0
Max reading (cd/lx×m²)	2000

Electrical characteristics

EMC	EN 50081-1 EN 50082-1
Power supply:	
Battery	Replaceable NiMh 9.6 V/2.6Ah
External charger	Mains voltage 230 V / 50 Hz Optional: 110V / 60 Hz
Charge time	approx. 15 minutes
Data memory	> 250.000 measurements
Interface	USB
RFID tag reader	13.56MHz ISO15693
Interface	Bluetooth

Environmental characteristics

Operation temperature: ..... 0°to +50°C
32°F to 122°F

Storage temperature: ..... -15°C to +55°C
5°F to 131°F

Humidity ..... Non condensing

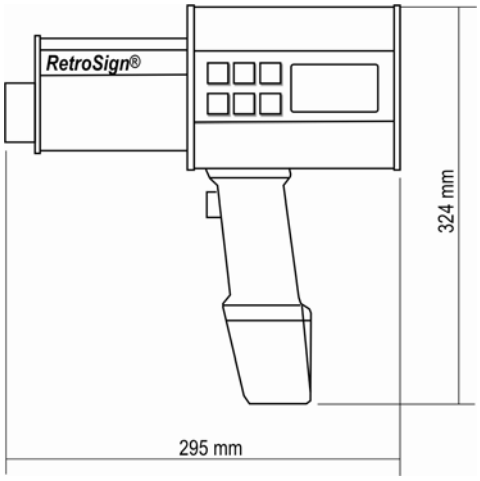
Mechanical characteristics

Length ..... 295mm/ 11.6 in

Width ..... 83 mm / 3.3 in

Height ..... 324 mm/ 12.8 in

Weight ..... 2.1 kg / 4.6 lbs



RetroSign dimensions.

Carrying case content

A. RetroSign GR3 Instrument with Lens Cap
B. Quick Guide, Warranty and Certificate
C. Reference unit for calibration
D. Battery charger
E. Small Support flange
F. Charger manual, instrument CD, aperture reducer Ø15mm (0.60 in), Registration card and keys for case
G. RFID reader unit
H. USB A-B communication cable
I. Adaptor for Battery charger
J. Shoulder strap
K. Sample: RFID tags

APPENDIX B – Communication Facilities

USB specification

The RetroSign is equipped with a USB connection that enables the use of a standard Windows PC to control instrument functions and for downloading measurement records from the internal data log.

The PC connects to the RetroSign using the USB device connector on the rear end of the instrument and a standard USB A/B cable.

Important!

The connection requires the installation of a USB driver on the PC. This has to be done before the instrument is connected to the PC for the first time.

The driver can be found on the Instrument CD, and can easily be installed from the main screen.

The instrument will not draw power from the USB connection.

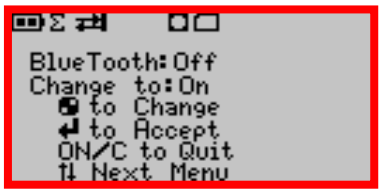
Bluetooth specification

The RetroSign can be equipped with a build-in Bluetooth module that enables the use of a remote Bluetooth master device to control the instrument functions, e.g. a Bluetooth enabled laptop, PDA or even a smart phone. To operate the instrument the master has to have a kind of application program that can handle the special instrument communication protocol. In its simplest form this can be the windows hyper terminal using the Bluetooth channel as a serial comport.

The BT communication will under normal conditions work well for distances up to at least 10m (33Ft)

Enabling/disabling the Bluetooth function:

Open the Bluetooth menu with the Up/Down keys.



BT Menu 1

BT Menu 2

BT Menu 3

BT menu 4

BT Menu 1: The BT unit is off, change to On, BT will try to reconnect to the last connected BT master.

BT Menu 2: The BT unit if off, change to Discoverable, BT unit will be turned on and made discoverable.

BT Menu 3: The BT unit is on, change to Discoverable mode for connection to a new BT master.

BT Menu 4: The BT unit is on and connected, break connection and change to discoverable mode.

Select desired function and press the Accept key.

When turned ON the instrument will try to reconnect to the last known Bluetooth master and will not be searchable.

By selecting the Discoverable mode, the instrument can be discovered by other Bluetooth masters.

A Bluetooth ICON appears in the top right display corner. It shows a broken Bluetooth symbol when not connected, see Menu 3. When a connection has been set up, the ICON changes to show the normal Bluetooth symbol. See Menu 4.

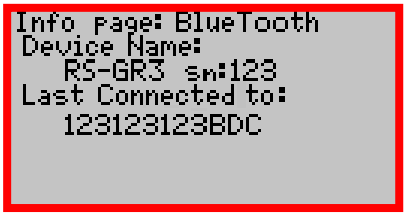
Note: First time you whish to connect a Bluetooth master to the instrument you have to select the **Discoverable** option The Bluetooth master can locate and connect to the instrument. The instrument will then automatically try to reconnect to the known master each time it is turned on.

Use the default access code 1234 on the master when asked.

The Bluetooth name will be: ”**RS-GR3:serial number**” e.g. RS-GR3:12345678

When connected, the Bluetooth connected LED is turned on. It is located near the USB connector on the instrument back plate.

The Bluetooth status can be checked in the **Info Page: Bluetooth**; here the device name and the ID of the connected Bluetooth master will be displayed.



Connected to BT master 123123123BDC

BT Enabled but not connected

APPENDIX C – Quick Guide for RetroSign Extension Kit

Preparation

Attach the adaptor plate to the instrument according to the Kit documentation.

Fasten the instrument to the extention pole and adjust the tilt head.

Connect the Extension kit cable to the appropriate connector on the rear end of the instrument.

Mount the support plate if needed.

Precation

If the instrument is equipped with the bluetooth option, make sure it is turned off, if not the Kit will not be able to communicate with the instrument.

Operation

Turn the RetroSign on.

Hoist the instrument to the measurement target, observing the correct orientation.

Press the **R_A** button on the extension kit.

The display first shows:

The instrument takes a measurement and the result is displayed e.g.

230

The value shown is the same as one of the results shown on the RetroSign. For GR1 it will be the value from the primary observation angle (0.2º or 0.33º) and for GR3 it will normally be the value from the the primary observation angle but it depends on the selection made in the RetroSign. *For details see the menu items section.*

To take new measurements just press **R_A** again.

If no measurements are made, the Extension kit will keep the RetroSign on for approximately 4 minutes, where after the Extension kit automatically shuts down. The RetroSign will then shut down according to the time-out for the instrument.

If an error occurs during a measurement the Extension kit will show:

Err

Operation with the RFID option

Turn the instrument on, enable the RFID option, *see menu item section*, and turn the instrument off again.

Mount the RFID reader on the front and connect the cable to the front connector.

Turn the instrument on again and observe that the display shows “RFID Found”

Press the **R_A** button on the extension kit.

The display first shows:

Then changes to 998 indicating that the reader is ready

998

Press the R_A button again, the display once again shows

Hoist the instrument to the sign so that the RFID reader comes into close proximity of the RFID tag mounted on the sign. When the reader gets close enough to the tag to read it, the display changes to 999**,** indicating that the tag has been read.

999

Place the instrument on the sign and press R_A again

The instrument performs the R' measurement and displays the result on the extension kit.

230

If the tag is read while the display shows 998 then pressing R_A will go directly to the measuring sequence displaying the result and completely skip the 999 display.

Doing multipoint measurements reading the RFID tag only once.

Enabling the mean calculation option has the consequence that the RFID tag only will be read when doing the first measurement in a multipoint series, this means that pressing R_A again after having done the first measurement simply executes the next measurement.

The RFID code is logged together with the measurement results.

Important

The Extention Kit MK-2 has no build in battery; it is powered entirely from the instrument.

The Kit MK-2 can not be used together with the older RetroSign series of instruments

The GR1/GR3 instrument firmware should be version 3.21 or greater. *See Appendix F Status Page for firmware version.*

Battery

The battery in the display module can be exchanged by carefully unscrewing the bottom plate and removing the battery container. Insert the new battery. **Very important!** Notice that the red wire of the battery container must be connected to the **+** terminal. Assemble the Extension kit in reverse order.

Depending on use, the battery should be changed at least once a year.

When not in use the Extension kit still uses a small amount of power, so dismount the internal battery if storing for longer periods of time.

When the battery voltage is low, the display will show »LO BAT« or nothing at all.

The battery type is: DL123A, 3V, 1.300 mAh. (or similar).

APPENDIX D – GPS

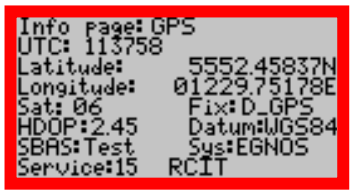
GPS Implementation

The GPS function is activated when the GPS Option has been enabled in the menu. Due to the fact that the GPS receiver first has to receive signals from several satellites before it can calculate its position, it will take a short time before a “Good Fix” can be achieved. Typical this process will take only a few seconds but depends on how long the device has been out of use and also on how far it has been moved away from the last fix position.

When the GPS function is enabled but no fix has yet been calculated the icon row shows GPS (strikeout)

When a position has been calculated, the Icon changes to GPS and the position and status will be updated. The GPS position data and status can be displayed by selecting **Info page: GPS.** This is done by pressing ↵ two times from the main result display. See. *Appendix F Result and Info Pages*

Display example:



Line 2:	UTC:	113758	universal time code (London time)
Line 3:	Latitude:	5552.45837N	format ddmm.mmmm
Line 4:	Longitude:	01229.75178E	format dddmm.mmmm
Line 5:	Sat:	06	Number of satellites used
Line 5:	Fix:	D_GPS	Fix type
Line 6:	HDOP:	2.45	Horizontal Dilution Of Precision
Line 6:	Datum:	WGS84	Map reference system
Line 7:	SBAS	Test	Satellite Based Augmentation Systems
Line 7:	Sys:	EGNOS	The position correction system in use
Line 8:	Service:	15 RCIT	system service status bitmap (4 bit)

*Fix: The **Fix** type can be:*

- ***NoFix** Invalid position*
- ***2D/3D** Standard GPS*
- ***D_GPS** Differential GPS*
- ***Estim** Estimated (Dead Reckoning) Fix*

*HDOP: The Horizontal Dilution Of Precision **HDOP** value in the range from 0.10 to 99.99, the lower the value the more accurate the position Fix.*

Datum: The Map reference system can only be changed with the RSC2 software.

*Sys: The **DGPS** mode received by the GPS unit, it can be:*

- ***GPS** when no correction data is received.*
- ***WAAS** when correction data from the WAAS satellites is used*
- ***EGNOS** when correction data from the EGNOS satellites is used*
- ***Unknown** when ambiguous correction data.*

Service: R: Ranging, C: corrections, I: integrity, T: test mode

All GPS Position data and status are stored in the internal data log and will be retrieved with the normal Log Dump action.

Controlling the GPS function from the menu system

Use the edit keys to select the GPS menu.

GPS State: On The GPS unit is on, press  to turn it off.

GPS State: Off: The GPS unit is off, press  to turn it on, position acquisition starts and a position fix should be ready in a few seconds.

Use the edit keys to select the DGPS menu.

The display can show

DGPS Mode: WAAS. The DGPS mode is set to use the WAAS satellites for position corrections. Use in the North American region.

DGPS Mode: EGNOS. The DGPS mode is set to use the EGNOS satellites for position corrections. Use in the European region

DGPS Mode: Auto. The DGPS mode is set to use the available satellites for position corrections.

DGPS Mode: Off. If DGPS mode is turned off, the correction signals will be received but not used, this can be desirable in situations where the correction satellites is very low on the horizon, as would be the case at high latitudes. Also take note that using a correction signal from a Satellite designed to correct position data for a different region, can result in degraded precession, this would be the case when using WAAS in Europe.

Switch between the different modes with the  key.

Changing the DGPS mode is only possible when the GPS unit is on.

GPS spec.

- 16 channel Receiver
- DGPS for best position accuracy
- Earth Datum WGS84, can be changed from RSC2 program
- Fast Time-To-First-Fix (TTFF)
  - 34 s cold start
  - 5 s TTFF with assisted GPS
  - <3.5 s hot start
- Excellent navigation performance
  - 2.5 m CEP
  - 2.0 m CEP with DGPS / SBAS (depending on accuracy of correction data)

APPENDIX E – RFID*

RFID implementation

The Multitag Reader Module is a proximity reading device supporting 13,56 MHz tags according to the ISO/IEC 15693 specification.

The reader is easily attached to the device shoe mounted on the front of the instrument and connected to the front mounted connector.

The RFID function is activated when the RFID option has been enabled in the menu.

When enabled, the tag reader is checked every time the instrument is turned on; if the function is on and the reader has been detached the user is asked to disable the RFID function.

The reader is activated prior to every measurement on the first trigger action. When the tag has been read, the tag ID is displayed and the next trigger action will execute the measurement.

If the mean calculation function is on, the reader will only be activated prior to the first measurement. This makes it possible to do multipoint measurements without the need to read the tag for each measurement.

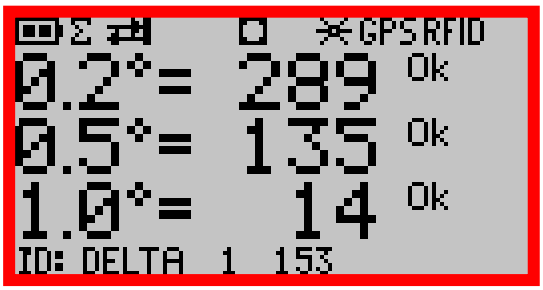
RFID spec.

- 13,56 MHz tags according to the ISO/IEC 15693
- Reading distance 30mm (with recommended tag type)
- Fast tag reading

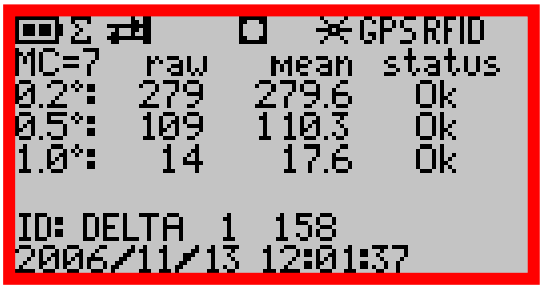
APPENDIX F – Result and Info Pages (examples)

Switch between the Result and Info pages by pressing ↵ when not in menu mode.

All following examples are shown for the GR3 configuration; GR1 instruments will only show values for the primary observation angle.

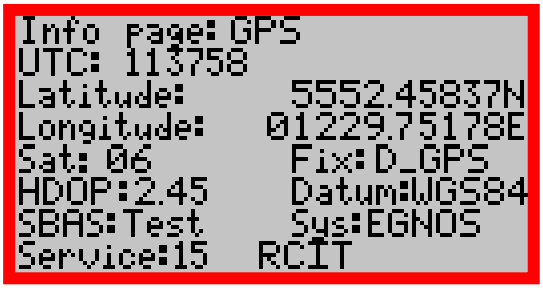


Main result display #1 showing instrument status icons, result and status from each observation angle and the measurement ID text and sequence number

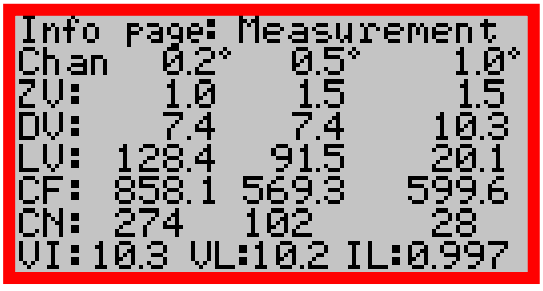


Main result display #2 showing same information as #1 and additionally the calculated mean values for each observation angle. MC= is the number of measurements used in the mean calculation. Date and time for the measurement is also shown.

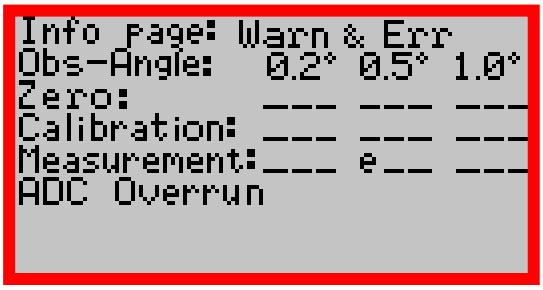
If the RFID option is on and a tag has been red, the tag code will be displayed in the empty line e.g. **RFID:E004010001800745**



GPS Information, see appendix D for explanation of the displayed values



Measurement information page showing for each observation angle the measured raw values for ZV: Zero signal, DV: Dark signal (leak) and LV: Light signal (with lamp on), CF: The calculated calibration factors and CN: The used calibration normal values. VI: Battery Voltage in Idle condition, VL: Battery Voltage under load (lamp on) and IL: Lamp current.



Information on warning and error conditions for each angle.

e: Error condition

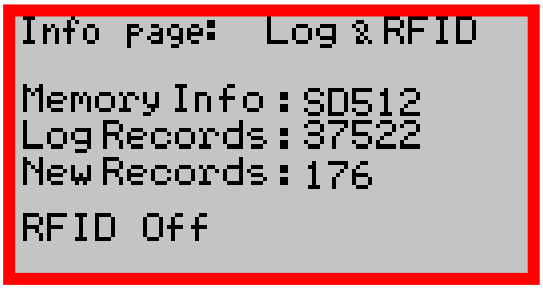
w: Warning condition

h: High signal

Analogue to Digital Converter status: Ok, Overrun or Underrun

Calibration factor: Ok or “out of limit” error

Lamp status: Ok or Error



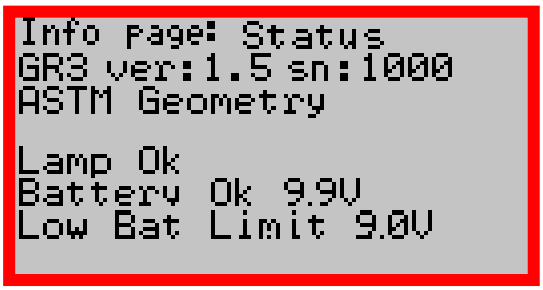
Information on LOG and RFID.

Memory type and size

Total number of log records used

Number of new Log records

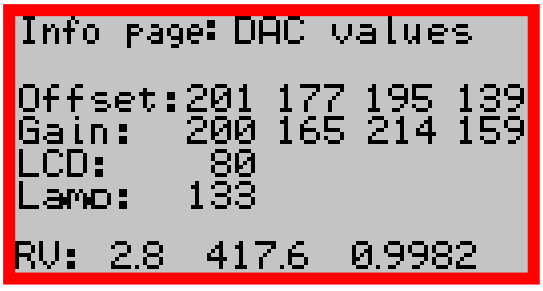
RFID reader status or TAG code



Miscellaneous information

Instrument type, firmware version and serial number.

Power status.

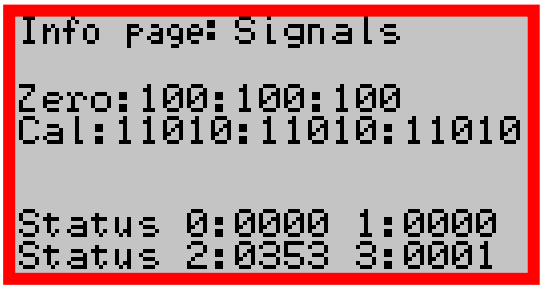


Setting for the electronic offset and gain potentiometers.

LCD: back light DAC

Lamp: current DAC

RV: Reference signal info



Instrument status flags

Zero: zero status

Cal: calibration status

Status: 0 Main status bitmap

Status: 1-3 secondary status bitmaps

The display always returns to Main #1 or #2 when performing a new measurement.

APPENDIX G – RSC for RetroSign GR1 & GR3

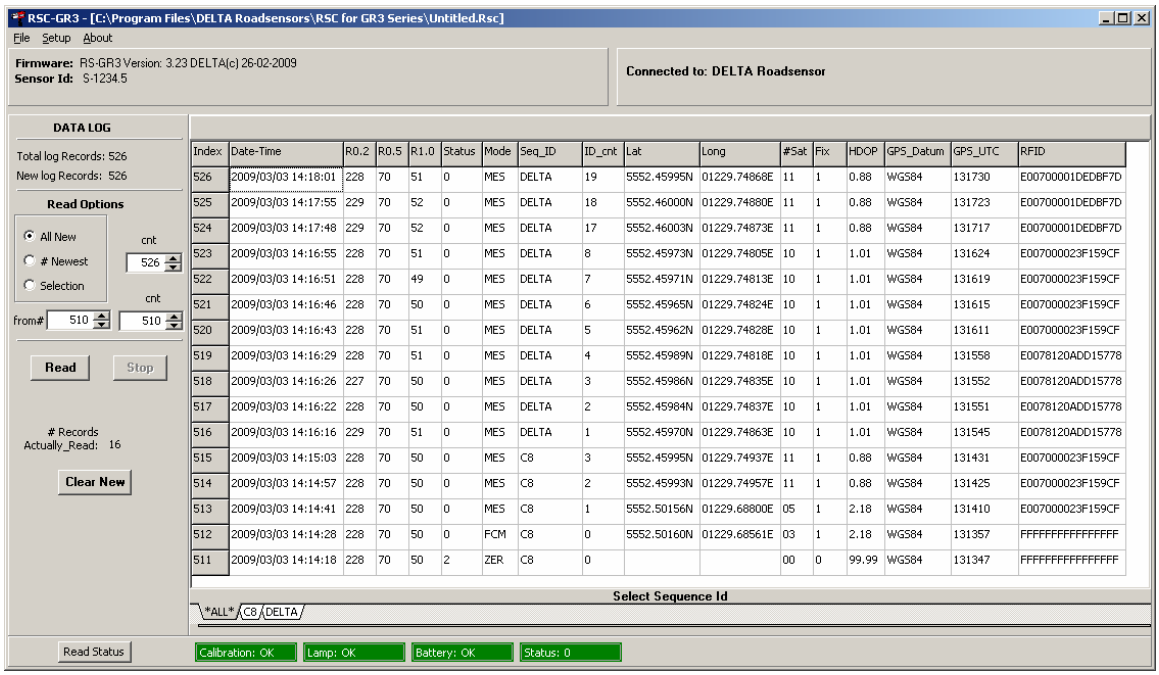
The RSC program short for ”RoadSensorControl” is used to download data records and to control the instrument from a more user friendly interface.

The RSC program runs on a Windows PC that has to have a USB port. The instrument connects to the PC using a USB A/B cable.

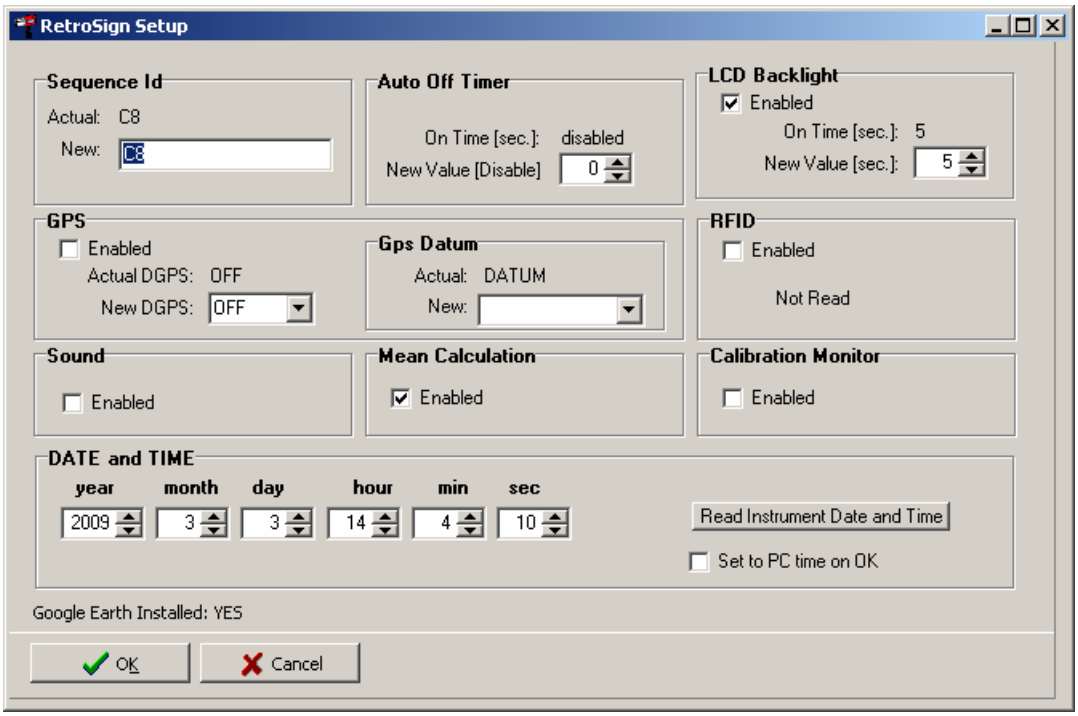
The program installs a special USB device driver that is necessary for the PC to communicate with the instrument.

Note! Install the driver before connecting the instrument for the first time

See documentation included on the CD for details on the RSC software



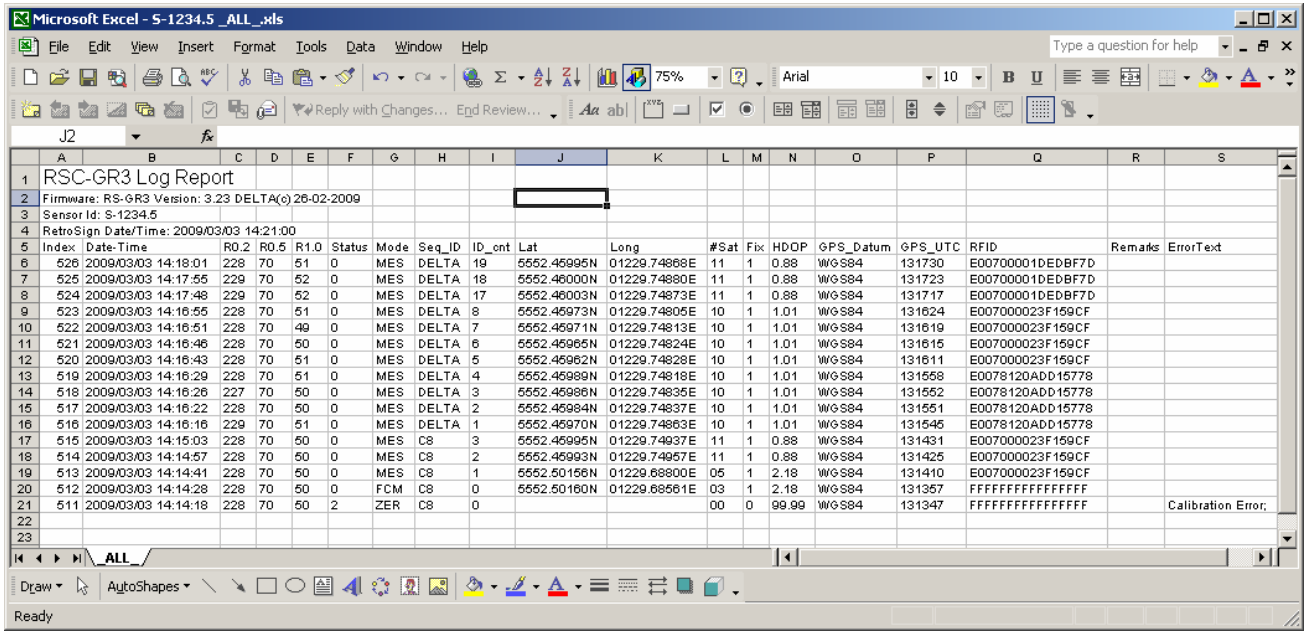
RSC main user interface, data has been read from the instrument.



RSC Instrument setup interface.

RSC Log dump example:

Log dump example:



Microsoft Excel - S-1234.5 _ALL_.xls

RSC-GR3 Log Report

Firmware: RS-GR3 Version: 3.23 DELTA(c) 26-02-2009

Sensor Id: S-1234.5

RetroSign Date/Time: 2009/03/03 14:21:00

Index	Date-Time	R0.2	R0.5	R1.0	Status	Mode	Seq_ID	ID_cnt	Lat	Long	#Sat	Fix	HDOP	GPS_Datum	GPS_UTC	RFID	Remarks	ErrorText
526	2009/03/03 14:18:01	228	70	51	0	MES	DELTA	19	5552.45995N	01229.74868E	11	1	0.88	WGS84	131730	E00700001DEDBF7D		
525	2009/03/03 14:17:55	229	70	52	0	MES	DELTA	18	5552.46000N	01229.74880E	11	1	0.88	WGS84	131723	E00700001DEDBF7D		
524	2009/03/03 14:17:48	229	70	52	0	MES	DELTA	17	5552.46003N	01229.74873E	11	1	0.88	WGS84	131717	E00700001DEDBF7D		
523	2009/03/03 14:16:55	228	70	51	0	MES	DELTA	8	5552.45973N	01229.74805E	10	1	1.01	WGS84	131624	E007000023F159CF		
522	2009/03/03 14:16:51	228	70	49	0	MES	DELTA	7	5552.45971N	01229.74813E	10	1	1.01	WGS84	131619	E007000023F159CF		
521	2009/03/03 14:16:46	228	70	50	0	MES	DELTA	6	5552.45965N	01229.74824E	10	1	1.01	WGS84	131615	E007000023F159CF		
520	2009/03/03 14:16:43	228	70	51	0	MES	DELTA	5	5552.45962N	01229.74828E	10	1	1.01	WGS84	131611	E007000023F159CF		
519	2009/03/03 14:16:29	228	70	51	0	MES	DELTA	4	5552.45989N	01229.74818E	10	1	1.01	WGS84	131558	E0078120ADD15778		
518	2009/03/03 14:16:26	227	70	50	0	MES	DELTA	3	5552.45986N	01229.74835E	10	1	1.01	WGS84	131552	E0078120ADD15778		
517	2009/03/03 14:16:22	228	70	50	0	MES	DELTA	2	5552.45984N	01229.74837E	10	1	1.01	WGS84	131551	E0078120ADD15778		
516	2009/03/03 14:16:16	229	70	51	0	MES	DELTA	1	5552.45970N	01229.74863E	10	1	1.01	WGS84	131545	E0078120ADD15778		
515	2009/03/03 14:15:03	228	70	50	0	MES	C8	3	5552.45995N	01229.74937E	11	1	0.88	WGS84	131431	E007000023F159CF		
514	2009/03/03 14:14:57	228	70	50	0	MES	C8	2	5552.45993N	01229.74957E	11	1	0.88	WGS84	131425	E007000023F159CF		
513	2009/03/03 14:14:41	228	70	50	0	MES	C8	1	5552.50156N	01229.68800E	05	1	2.18	WGS84	131410	E007000023F159CF		
512	2009/03/03 14:14:28	228	70	50	0	FCM	C8	0	5552.50160N	01229.68561E	03	1	2.18	WGS84	131357	FFFFFFFFFFFFFFFF		
511	2009/03/03 14:14:18	228	70	50	2	ZER	C8	0			00	0	99.99	WGS84	131347	FFFFFFFFFFFFFFFF		Calibration Error;

The example shows the output from the log dump program saved as an excel file.

Column #A	The log index number, e.g. 504 is the absolute record number in the log.
Column #B	The date and time for the measurement
Column #C	Measured R' values for 0.2°
Column #D	Measured R' values for 0.5°
Column #E	Measured R' values for 1.0°
Column #F	Instrument Status for this measurement
Column #G	Measurement mode: ZER, FCM, MES
Column #H	Defined Sequence ID
Column #I	Sequence ID counter
Column #J	GPS Latitude information
Column #K	GPS Longitude information
Column #L	Number of satellites used
Column #M	Fix type: 0=no fix, 1=2D/3D, 2= D_GPS, 6=estimated
Column #N	HDOP figure for the horizontal fix quality
Column #O	MAP datum information
Column #P	GPS Universal Time Code
Column #Q	RFID Tag code, (16 x F if undefined
Colume #R	User Remarks
Colume #S	Status code in legible form

APPENDIX H – Using the Bluetooth option*

Using the Bluetooth link to do measurements

The procedure depends on the state of the mean calculation and the use of the RFID option.

RFID option turned OFF and the mean calculation disabled

1. Send “#DRM” to start a measurement
2. The instrument prompts with “DRM:1*4E28”, the command has been activated
3. After about 2 seconds the instrument sends the result string. (see below)

RFID option turned OFF and the mean calculation enabled

1. Send “**#MCC1”** to initiate a new mean calculation sequence
2. The instrument prompts with “**MCC:1*3EFB”**
3. Send “**#DRM”** to start a measurement
4. The instrument prompts with “**DRM:1*4E28”**, the command has been activated
5. After about 2 seconds the instrument sends the result string, (see below)

Repeat steps 3 to 5 until all measurements on the object have been done.

RFID option turned ON and the mean calculation disabled

1. Send “**#DRM”** to start a measurement
2. The instrument prompts with “**DRM:1*4E28”**, the command has been activated
3. The instrument then prompts “**507:1*0713”** indicating that it is ready to read a RFID tag, the instrument repeats the “**507:1*0713”** prompt until the next action.
4. Put the RFID reader in close proximity to the tag
5. The instrument prompts “**507:2*0814”** when the tag has been read
6. Place the instrument on the target and send “**#DRM”** to do the measurement
7. The instrument prompts “**DRM:1*4E28”**, the command has been activated
8. After about 2 seconds the instrument sends the result string, (see below)

RFID option turned ON and the mean calculation enabled

1. Send “**#MCC1”** to initiate a new mean calculation sequence
2. The instrument prompts with “**MCC:1*3EFB”**
3. Send “**#DRM”** to start a measurement
4. The instrument prompts “**DRM:1*4E28”**, the command has been activated
5. The instrument then prompts “**507:1*0713”** indicating that it is ready to read a RFID tag, the instrument repeats the “**507:1*0713”** prompt until the next action. (If the prompt is “**507:0*xxxx”** then no RFID was detected)
6. Put the RFID reader in close proximity to the tag
7. The instrument prompts “**507:2*0814”** when the tag has been read
8. Place the instrument on the target and send “**#DRM”** to do the measurement
9. The instrument prompts “**DRM:1*4E28”**, the command has been activated
10. After about 2 seconds the instrument sends the result string, (see below)

Repeat steps 8 to10 until all measurements on the object has been done.

Example result string: (all in one line!)

4;2007/04/19 09:54:46;0;0;0;0;MES;DELTA
BT;64;5552.46167N;01229.75111E;07;1;1.09;WGS84;073735;0.12;0.00;0.00;1;E0078120ADD1501D*680B

Commands that can be used on the BT connection

(Commands start with the char <#> and must end with a Carriage Return code <CR>

#DRM	Do R' measurement RFID disabled
DRM:0*4D27	Instrument not calibrated
DRM:1*4E28	Executing measurement

Result string*xxxx (one line)

#DRM	Do R' measurement RFID enabled
DRM:0*4D27	Instrument not calibrated
DRM:1*4E28	Executing measurement
507:0*xxxx	No RFID device
507:1*xxxx	Ready to read Tag
507:2*xxxx	Tag Read, ready to measure

#DRM	Second Do R' measurement

DRM:1*4E28
Result string*xxxx (one line)

Result string example: (one line!)

```
0;2007/04/19
11:17:49;0;0;0;0;MES;DELTA;77;5552.46178N;01229.75047E;09;1;0.81;WGS84;090036;0.29;0.09;0.12;3;E0078120ADD
1501D*7DF1
```

#LHS		Query Log Header Selection for dump
#LHS	n	Set Log Header Selection for dump
		n=0 Normal Log Header (Default)
		n=1 Full Log Header (TBD)
		n=2 Special Log Header (TBD)

n=0 Log Header:

Index,	Log record
Date and time,	Measurement time
R0.2,	R' 0.2º
R0.5,	R' 0.5º
R1.0,	R' 1.0º
Status,	Instrument status (4 HEX char)
Mode,	Operation mode
Seq_ID,	Sequence ID
ID_cnt,	Number in sequence
Lat,	Latitude N/S
Long,	Longitude E/W
#Sat,	Number of satellites
Fix,	Fix type
HDOP,	HDOP info
DATUM	GPS DATUM
UTC	GPS Universal Time Code

M0.2	R’ 0.2º calculated mean value
M0.5	R’ 0.5º calculated mean value
M1.0	R’ 1.0º calculated mean value
M_Cnt	Number of measurements in the mean calc
RFID,	RFID code (16 HEX char)

#LHS:n*xxxx

s*xxxx String containing log header used by LOG command

#LOG n m	Dump n records starting m records down
	Omitting n and m returns latest log entry
	Omitting m returns n records from top
	Log dump according to selected Header (LHS)
#LOG	Dump Latest Log entry
LOG:n*	
#LOG n	Dump n records from top
LOG:n*	
#LOG n m	Dump n records starting m records down
LOG:n;m*xxxx	
#LNR	Query number of unread log records
LNR:n*xxxx	Returns the number of unread Log records
#LRR	Mark Log Records as read
#LRR:1*xxxx	
#LST	Query total number off LOG records
LST:n*xxxx	
#MCC	Query Mean Calculation status and reset
#MCC n	Mean Calculation Control enable/disable
	n=0 disable
	n=1 enable
MCC:0*xxxx	off and reset
MCC:1*xxxx	on and reset
#QVB	Query Battery Voltage
QVB:n*xxxx	n in Volt
#QID	Query Sequence ID
QID:sssssssssss*xxxx	Sequence ID string

#SIDsssssssssss	Set Sequence ID string
SID:sssssssssss*xxxx	

#QII	Query Instrument Information
QII:info string*xxxx	e.g.RS-GR3;2.0;DELTA;18-04-2007*563D

#QFV	Query Firmware version
QFV:s*xxxx	s = (type;ver;firm;cdate)

#RFI	Query RFID enable status
#RFI n	Set RFID enable/disable
	n=0 disable, n=1 enable
RFI:n*xxxx	

#TSO	Turn Sensor Off
TSO:1*xxxx	Sensor turning off
TOS:s1;s2,s3;s4*xxxx	Memory write status s = 0 no error

#QAS	Query Instrument Status
QAS:s1;s2;s3;s4*xxxx	s1=status[0] (se below)
	s2=status[1]
	s3=status[2]
	s4=status[3]

Status Code Breakdown

Status[0] is the same status word contained in the normal log record.

Ignore Status[1] to status[3]

```
Status[0]   xxxx.xxxx.xxxx.xxxx
             ----.----.----.---|-- bit 0     Zero error                              0
             ----.----.----.--|--- bit 1     Calibration error                       0
             ----.----.----.-|---- bit 2     Rm Factor error                         0
             ----.----.----.|----- bit 3     Leak error                              0
            ----.----.---|.------ bit 4      Signal error                            0
            ----.----.--|-.------ bit 5      zero measurement error                  0
            ----.----.-|--.------ bit 6      Using old calibration values            0
            ----.----.|---.------ bit 7      Error in measurement                    0
            ----.---|.----.------ bit 8      Warning in measurement                  0
            ----.--|-.----.------ bit 9      Low Lamp current                        0
            ----.-|--.----.------ bit 10     Low V-Bat warning under load            0
            ----.|---.----.------ bit 11     Low V-Bat Warning in idle mode          0
            ---|.----.----.------ bit 12     Very low V-Bat Error                    0
            --|-.----.----.------ bit 13     TBD                                     0
            -|--.----.----.------ bit 14     TBD                                     0
            |---.----.----.------ bit 15     TBD                                     0
```

Translates to 0x0000 for normal operation

Bit	Description	define	comment
0	Zero	zero_done	1 = no valid zero values
1	Calib	Calib done	1 = no valid calibration values
2	Rm	Rm factor Ok	1 = no valib calibration factor
3	Leak	High Leak	1 = high background signal detected
4	Signal	High Signal	1 = converter overrun detected
5	Zero_Error	zero_error	1 = converter underrun detected during zero
6	Old Cal used	Old_Cal_Val	1 = using old calibration values
7	Mes_Error	Error in Measurement	1 = error detected in measurement
8	Mes_Warn	Warning in Measurement	1 = warning detected in R’ measurement
9	Lamp	Lamp Current	1 = lamp current error detected during measurement
10	Battery	Battery warn condition	1 = low battery condition detected during measurement
11	Bat_Warning	Battery low warning	1 = the battery voltage is getting very low
12	Bat_Error	Battery low error	1 = the battery voltage is to low to perform a measurement
13	TBD	TBD	0
14	TBD	TBD	0
15	TBD	TBD	0