



On site quality verification of road signs

## User's Manual



## DISCLAIMER

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

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

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

**RF Exposure compliance statement:** This device incorporates a certified Bluetooth module, FCC ID: S7APARANIESD200, which may be used in portable exposure conditions with no restrictions on host platforms, since the source-based time-averaged output power is  $\leq 60/f(\text{GHz}) \text{ mW}$ .

Rev.: 15 August 2012

# R&TTE Declaration of Conformity (DoC)

Unique identification of this DoC: 80\_RetroSign EU\_DoC 001

We,

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

*declare under our sole responsibility that the product:*

Product name: RetroSign Retroreflectometer GR1/GR3  
Trade name: DELTA RetroSign  
Type or model: All types pursuant to the referenced trade name

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

HEALTH & SAFETY (Art. 3(1)(a)):  
EN 60950-1:2006 + A11:2009 + A1:2010 + A12:2011  
EMC (Art. 3(1)(b)):  
EN 301489-1 V1.8.1:2008  
EN 301489-3 V1.4.1:2002  
SPECTRUM (Art. 3(2)):  
EN 300440-2 V1.4.1:2010

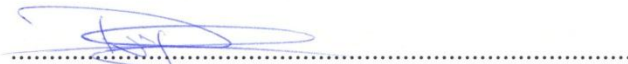
Supplementary information:

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

Technical file held by the undersigned.

Place and date of issue (of this DoC): July 1<sup>st</sup> 2012

Signed by or for the manufacturer:



(Signature of authorized person)

Name (in print):  
Pernille Veje  
Vice President QA/RA & E



# US Attestation of Conformity (AoC)

Unique identification of this AoC: 80\_RetroSign US\_AoC 001

We,

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

*declare under our sole responsibility that the product:*

Product name: RetroSign Retroreflectometer GR1/GR3  
Trade name: DELTA RetroSign  
Type or model: All types pursuant to the referenced trade name

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

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

47 CFR Part 15B, subpart 15.109 (Class A)  
47 CFR Part 15B, subpart 15.209 (Class B)

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

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

Supplementary information:

The equipment is battery powered.  
The equipment incorporates a GPS module.  
On US models only, this equipment incorporates a certified, portable Bluetooth radio module, FCC ID: S7APARANIESD200, which may be used in portable exposure conditions with no restrictions on host platforms.

Technical file held by the undersigned.

Place and date of issue (of this AoC): July 1<sup>st</sup> 2012

Signed by or for the manufacturer:



(Signature of authorized person)

Name (in print):  
Pernille Veje  
Vice President QA/RA & E

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

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# Section 1 – 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  $-4^\circ$  and the measurements are made with angles between illumination and observation of  $0.2^\circ$ ,  $0.5^\circ$  and  $1.0^\circ$ . This is relevant for a motorist viewing situation under normal conditions.

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

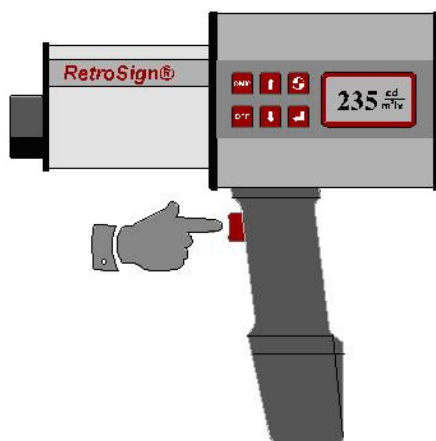
For type GR1 SAFETY the measurement area is illuminated at an entrance angle of  $+5^\circ$  and the measurements are made with an observation angle of  $0.2^\circ$ , angles used to measure Safety Clothing according to EN 471

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

The range of RetroSign instruments available are summarized below:

	ASTM	CEN	Safety	
<b>RetroSign GR1</b>	√	√	√	1 primary observation angle
<b>RetroSign GR3</b>	√	√		3 observation angles
<b>Geometry</b>	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 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
- Barcode reader for measurement documentation
- RFID (Radio Frequency ID) tag reader, for measurement documentation using wireless smart tags
- Bluetooth (wireless communication link) for wireless data and control
- Extra Battery.
- Aperture Reducer Ø10 mm (0.40 in)



## Section 2 – Operating Information

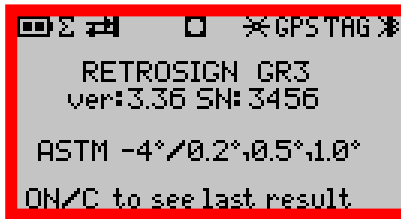
### Getting started

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.
-  Mean calculation enabled
- TAG** Tag reader 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 <sup>(1)</sup> signal 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.

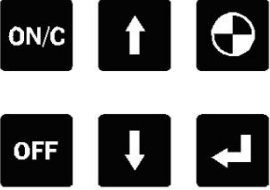







## Sequence ID

The RetroSign has a built in function to mark each measurement with a user defined name (Sequence ID) and a unique <sup>(2)</sup> 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.

<sup>1)</sup> The sound generation has to be turned on in the menu

<sup>2)</sup> 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 <b>R'</b> measurement. Select quick calibration mode. Select next calibration step Read RFID/Barcode 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 ,  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  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 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  two times to clear the mean calculation.

**Enabling this function affects the way the Tag Reader 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 from 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 0.2° or 0.33°

**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.

**Tag Reader:** (Control the RFID or Barcode reader option) (Optional)

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

Enabling the reader 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 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 tag on the first measurement in a series (Mean Count < 2). This allows for doing multipoint measurements with the same Tag code.

After clearing the mean calculation the instrument will again ask for the 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 50° C (122° F) under operation 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.

THE BATTERY SUPPLIED WITH RETROSIGN IS SPECIALLY DESIGNED FOR THE INSTRUMENT TO ENSURE SAFE USE. IF A NON DELTA SUPPLIED OR APPROVED BATTERY IS USED WITH RETROSIGN DELTA CAN TAKE NO RESPONSIBILITY FOR ANY DAMAGED CAUSED DUE TO THE PERFORMANCE OF THIS BATTERY.

## 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  $\varnothing$  15 mm (0.6 in) or  $\varnothing$  10 mm (0.4 in) depending on the unit used. The  $\varnothing$  15 mm is supplied with the RetroSign while the  $\varnothing$  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

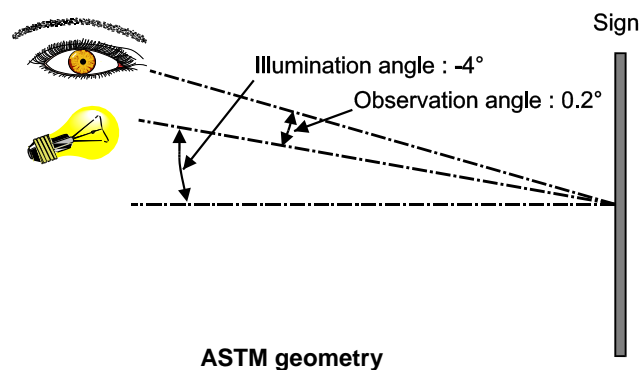
The RetroSign GR1 and GR3 is factory calibrated. This calibration is carried out using a standard. The reference's  $R_A$  value is measured in the laboratory using traceable methods and equipment.

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

### Measurement geometry

#### GR1 and GR3 type ASTM

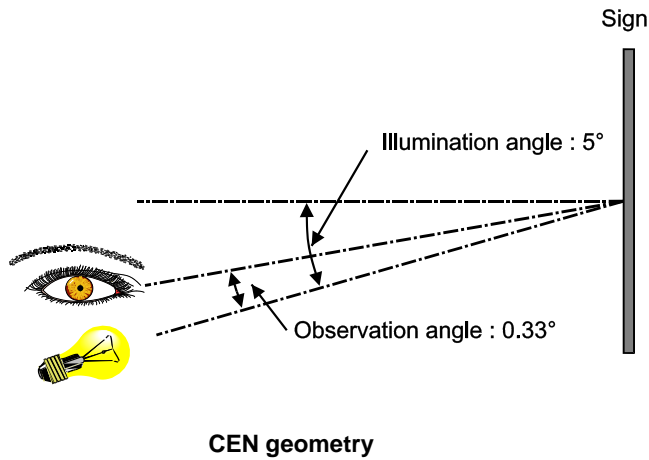
The illumination angle is  $-4^\circ$ . The offsets between the illumination and the primary observation angle are  $0.2^\circ$  (GR1) and the three observation angles are  $0.2^\circ$ ,  $0.5^\circ$  and  $1.0^\circ$  (GR3) respectively. The measurement area is approx.  $\varnothing$  30 mm. in the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





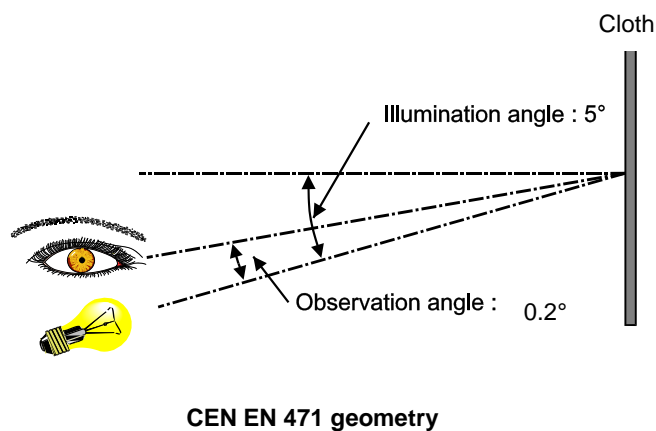
## GR3 type CEN

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



## GR1 type SAFETY

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



## 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 from 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 carrying 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 & Battery charger

The instrument is powered by a NiMh (Nickel Metal Hydride) battery, which under normal use requires no maintenance. The battery used is Sanyo Akku APBO 9,6V, 2600mA (P 217).

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

- 230V AC, 50/60 Hz (Bosch AL 2450 Professional)
- 120V, 60 Hz (Bosch BC 130)

The battery will be fully charged in approx. 35 minutes

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. Make sure the battery and battery charger is clean and dry before and during charging takes place.

The battery charger will during charging give the following information

- If the green indicator light is “ON” the charger is plugged in but the battery pack is not inserted, or the battery pack is fully charged and is being trickle charged
- If the green indicator light is “BLINKING”, the battery pack is being fast-charged. Fast-charging will automatically stop when the battery pack is fully charged
- If the red indicator light is “ON”, the battery pack is too hot or cold for fast-charging. The charger will switch to trickle charge, until a suitable temperature is reached, at which time the charger will switch automatically to fast-charging
- If the red indicator light is “BLINKING”, the battery pack cannot accept a charge (the battery may be defective) or the contacts of the charger or battery pack are contaminated. Clean the contacts of the charger or battery pack and check. Change the battery if no solution can be found.

A new battery or one which has not been used for an extended period of time will reach full performance only after approximately 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) during operation 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.

### For your safety, battery charger:

- **Read all instructions.** Failure to follow all instructions listed below may result in electrical shock, fire and/or serious injury.
- **Protect the battery from rain and moisture.** The penetration of water in a battery charger increases the risk of electric shock
- **Keep the battery charger clean.** Contamination may cause the danger of electric shock.
- **Check the battery charger, cable and plug each time before using. Do not use the battery charger when defects are detected. Do not open the battery charger yourself and have it repaired only by qualified personnel using original spare parts.** Damaged battery chargers, cables and plugs increase the risk of electric shock.
- **Do not operate the battery charger on easily inflammable surfaces (e.g. paper, textiles, etc.) or combustible environments.** There is danger of fire due to the heating of the battery charger during charging

### Practical advice, battery charger

- With continuous or several repetitive charging cycles without interruption, the charger can warm up. This is not meaningful and does not indicate a technical defect of the unit

### Maintenance and cleaning, battery charger

- The unit is maintenance free. Always keep the unit and the ventilation slots clean

### Note

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

## 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.

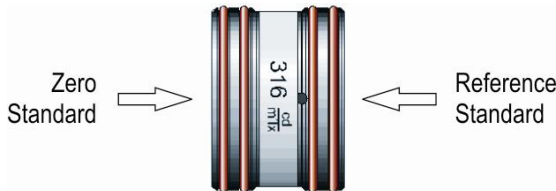
## Reference cap

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-Technische 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«  $R_A$  values.

Store the reference cap in a dry and clean environment.

## APPENDIX A

### COMMUNICATION FACILITIES

The RetroSign is at the front equipped with a connection for the tag readers (Barcode, RFID)



The RetroSign is at the back equipped with a USB Device Port and a connection to remote control of extension pole.



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

# APPENDIX B

## Specifications

### General characteristics

#### Regulatory compliance

##### EU

The equipment complies with the following directives of the European Parliament and of the Council:

Directive 1999/5/EC of 9 March 1999 on radio equipment and telecommunications terminal equipment.

Directive 2011/65/EU of 8 June 2011 on restriction of the use of certain hazardous substances (RoHS).

Directive 2002/96/EC of 27 January 2003 on waste electrical and electronic equipment (WEEE).

The equipment is tested to the following standards:

R&TTE article 3.1a (health & safety): .....

EN 60950-1:2006 + A11:2009 + A1:2010 + A12:2011

R&TTE article 3.1b (electromagnetic compatibility): .....

EN 301489-1 V1.8.1:2008

EN 301489-3 V1.4.1:2002

R&TTE article 3.2 (radio parameters): .....

EN 300440-2 V1.4.1:2010

##### USA

The equipment complies with the following rule part of the Federal Communications Committee:

FCC CFR 47 Part 15 Subpart B, Class A.

The equipment incorporates a separately certified Bluetooth radio module, FCC ID: S7APARANIESD200

The equipment complies with the following safety specification:

IEC 60950-1:2005 (2<sup>nd</sup> Edition); Am 1:2009

#### 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°

### Common geometry parameters

Light source angular aperture .....	0.1°
Receptor angular aperture .....	0.1°
Field of measurement .....	∅ 30mm/1.2in
Light source .....	Illuminant »A«
Receptor sensitivity.....	Precise eye corrected (ASTM-E1709 para. 6.4.2 for selected color filters)
Min. reading (cd/lx×m²) .....	0
Max reading (cd/lx×m²) .....	2000

### Electrical characteristics

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

Barcode reader..... 617nm LED Solid state scanner

Interface..... Bluetooth

### Environmental characteristics

Operation temperature:.....0°to +45°C  
32°F to 113°F

Storage temperature:..... -15°C to +50°C  
5°F to 122°F

Humidity .....85% and non-condensing

### Mechanical characteristics

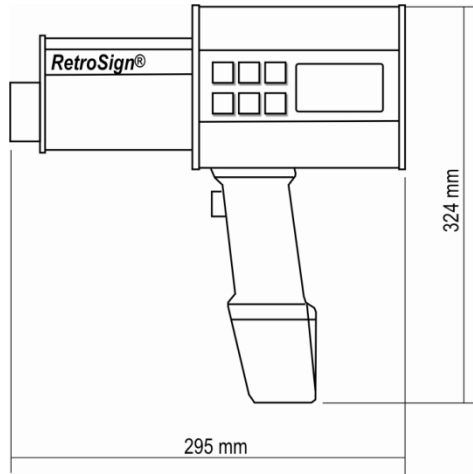
Length.....295mm/ 11.6 in

Width.....83 mm / 3.3 in

Height .....324 mm/ 12.8 in

Weight..... 2.1 kg / 4.6 lbs





**RetroSign dimensions.**

## APPENDIX C

### 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  $\varnothing 15\text{mm}$  (0.60 in), Registration card and keys for case
- G. RFID or Barcode reader unit (optional)
- H. USB A-B communication cable
- I. Adaptor for Battery charger
- J. Shoulder strap
- K. Sample: RFID tags (optional)

# APPENDIX D

## 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.**

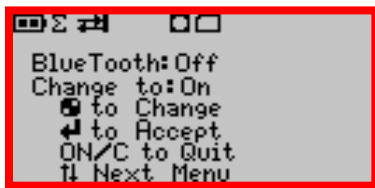
### Bluetooth specification

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.

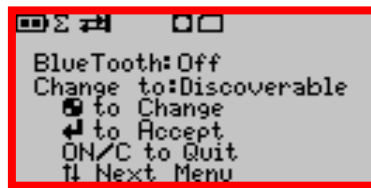
The BT communication will under normal conditions work well for distances up to at least 10m (33Ft)

#### Enabling/disabling the Bluetooth function:

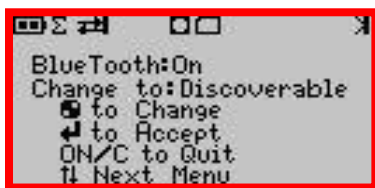
Open the Bluetooth menu with the Up/Down keys.



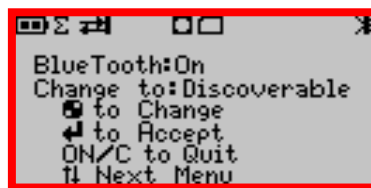
BT Menu 1



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 is 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 for details.

Note: First time you wish 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.

```
Info Page: BlueTooth
Device Name:
  RS-GR3 sn:123
Last Connected to:
  123123123BDC
```

Connected to BT master 123123123BDC

```
Info Page: BlueTooth
Device Name:
  RS-GR3 sn:123
Disconnected
```

BT Enabled but not connected

# APPENDIX E

## Quick Guide for RetroSign Extension Kit

### Preparation

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

Fasten the instrument to the extension 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.

### Precaution

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<sub>A</sub>** button on the extension kit.

The display first shows:



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



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 (0.2° or 0.33°) and for GR3 it will normally be the value from 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<sub>A</sub>** 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:



### Operation with the RFID or Barcode Reader option

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

Mount the Reader on the front and connect the cable to the front connector.

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

Press the **R<sub>A</sub>** button on the extension kit.

The display first shows:



Then changes to 998 indicating that the reader is ready

998

Press the **R<sub>A</sub>** button again, the display once again shows

---

Hoist the instrument to the sign so that the Tag reader comes into close proximity of the RFID tag or so that the Barcode reader can scan the tag mounted on the sign. When the reader comes 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<sub>A</sub>** 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<sub>A</sub>** will go directly to the measuring sequence displaying the result and completely skip the 999 display.

### **Doing multipoint measurements reading the Tag only once.**

Enabling the mean calculation option has the consequence that the Tag only will be read when doing the first measurement in a multipoint series, this means that pressing **R<sub>A</sub>** again after having done the first measurement simply executes the next measurement.

The Tag code is logged together with the measurement results.

## **Important**

The Extension 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.*

# APPENDIX F

## 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:

```
Info Page:GPS
UTC: 113758
Latitude: 5552.45837N
Longitude: 01229.75178E
Sat: 06 Fix:D_GPS
HDOP:2.45 Datum:WGS84
SBAS:Test Sys:EGNOS
Service:15 RCIT
```

Line 2:	UTC:	113758	universal time code (London time)
Line 3:	Latitude:	5552.45837N	format ddmn.mmmmm
Line 4:	Longitude:	01229.75178E	format dddmm.mmmmm
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 precision, 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 G

## TAG Readers

### 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 Tag Reader 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

## Barcode Reader Implementation

The Barcode Reader Module is a LED based line scanner making it totally safe to operate.

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

The Barcode Reader function is activated when the TAG 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 TAG reader function.

The reader is activated prior to every measurement on the first trigger action. When the tag has been read, the tag code 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.

To guide the aiming process the scanner LED's are pulsed on and off until the bar code has been read.

### Barcode Reader spec.

- Mechanical: Solid state, no moving parts
- Light Source: 617nm highly visible LED
- Ambient Light: up to 100.000 lux
- Scan angle: up to 40°
- Scan skew: up to 65°
- Scan pitch: up to 75°
- Tilt: up to 25°
- Reading distance: up to 90cm / 35" (depending on code type and tag condition)
- Bar Code geometry: min x dimension 0.1mm / 4mil with a contrast down to 25%
- Symbologies: Codabar, Code 39, Code 93, Code 128/GS1-128, UPC-A, UPC-E, EAN-8, EAN-13
- GR1-3 Limitations: Characters truncated after 20 symbols.



```

Info page: Warn & Err
Obs-Angle: 0.2° 0.5° 1.0°
Zero: --- --- ---
Calibration: --- --- ---
Measurement: --- e ---
ADC Overrun

```

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

```

Info page: Log & TAG
Memory Info: S0512
Log Records: 37522
New Records: 176
TAG Reader : Off

```

Information on LOG and Tag Reader.  
Memory type and size  
Total number of log records used  
Number of new Log records  
Tag Reader status or TAG code

```

Info page: Status
GR3 ver: 1.5 sn: 1000
ASTM Geometry
Lamp Ok
Battery Ok 9.9V
Low Bat Limit 9.0V

```

Miscellaneous information  
Instrument type, firmware version and serial number.  
Power status.

```

Info page: DAC values
Offset: 201 177 195 139
Gain: 200 165 214 159
LCD: 80
Lamp: 133
RV: 2.8 417.6 0.9982

```

Setting for the electronic offset and gain potentiometers.  
LCD: back light DAC  
Lamp: current DAC  
RV: Reference signal info

```

Info page: Signals
Zero: 100:100:100
Cal: 11010:11010:11010
Status 0:0000 1:0000
Status 2:0353 3:0001

```

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 J

## RSC for RetroSign GR1 & GR3

The RSC program short for "Road Sensor Control" 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**

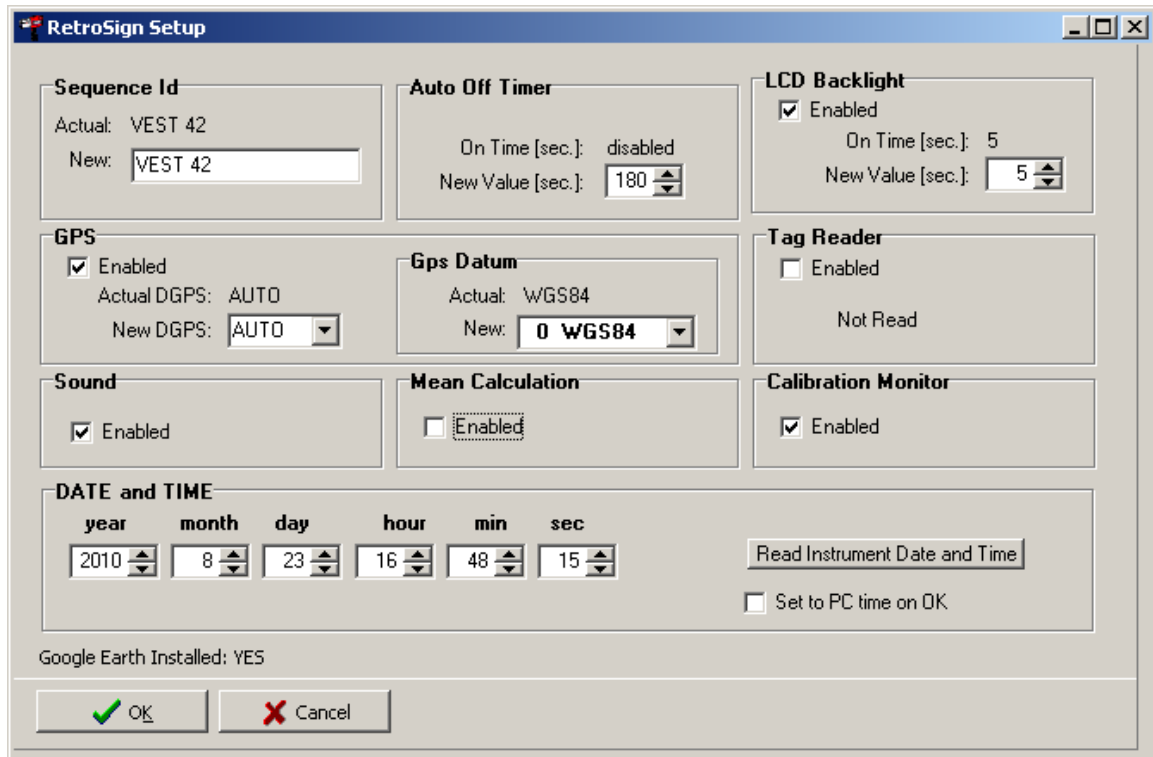
See documentation included on the CD for details on the RSC software

The screenshot displays the RSC-GR3 software interface. At the top, it shows the title bar "RSC-GR3 - [K:\Development\Sensor\APPLICATIONS\RSC3\Ver1.0.8.4\Untitled.Rsc]". Below the title bar, there is a menu bar with "File", "Setup", and "About". The main window is divided into several sections:

- Header Information:**
  - Firmware: RS-GR3 Version: 3.36 DELTA(c) 29-06-2010
  - Sensor Id: 1-999
  - Sensor Type: ASTM
  - Connected to: DELTA Roadsensor
- DATA LOG:**
  - Total log Records: 31
  - New log Records: 25
- Read Options:**
  - Buttons: Read, Stop
  - Radio buttons: All New, # Newest, Selection
  - Input fields: cnt (25), from# (31), to# (25)
  - Buttons: Clear New
  - Text: # Records Actually Read: 25
- Data Table:**

Index	Date-Time	R0.2	R0.5	R1.0	Status	Mode	Seq_ID	ID_cnt	Lat	Long	#Sat	HDOP	GPS_Datum	GPS_UTC	MO.2	MO.5	M1.0	M_Cnt	TAG	
31	2010/08/23 13:38:26	485	172	28	0	MES	DEMO_DATA	22	5552.46133N	01229.74927E	10	1	0.94	WGS84	113943	542.48	194.37	31.90	4	FFFFFFFFFFFFFFFF
30	2010/08/23 13:38:22	502	171	33	0	MES	DEMO_DATA	21	5552.46133N	01229.74927E	10	1	0.94	WGS84	113943	561.61	201.81	33.36	3	FFFFFFFFFFFFFFFF
29	2010/08/23 13:38:17	591	217	33	0	MES	DEMO_DATA	20	5552.46137N	01229.74925E	10	1	0.94	WGS84	113939	591.47	217.23	33.38	2	FFFFFFFFFFFFFFFF
28	2010/08/23 13:38:13	592	217	33	0	MES	DEMO_DATA	19	5552.46147N	01229.74930E	10	1	0.94	WGS84	113934	592.05	217.08	33.43	1	FFFFFFFFFFFFFFFF
27	2010/08/23 13:33:19	227	101	28	0	MES	DEMO_DATA	18	5552.46166N	01229.75000E	09	1	1.43	WGS84	113440	228.25	102.27	27.94	4	FFFFFFFFFFFFFFFF
26	2010/08/23 13:33:13	228	102	28	0	MES	DEMO_DATA	17	5552.46184N	01229.74974E	09	1	1.43	WGS84	113435	228.62	102.56	27.98	3	FFFFFFFFFFFFFFFF
25	2010/08/23 13:33:08	228	103	28	0	MES	DEMO_DATA	16	5552.46224N	01229.74952E	09	1	1.43	WGS84	113430	228.73	102.63	28.01	2	FFFFFFFFFFFFFFFF
24	2010/08/23 13:33:03	229	103	28	0	MES	DEMO_DATA	15	5552.46354N	01229.75012E	09	1	1.71	WGS84	113424	229.13	102.62	28.12	1	FFFFFFFFFFFFFFFF
23	2010/08/23 12:20:17	101	45	13	0	MES	DEMO_DATA	14	5552.46134N	01229.74894E	09	1	1.12	WGS84	102137	0.00	0.00	0.00	0	FFFFFFFFFFFFFFFF
22	2010/08/23 12:20:07	180	81	23	0	MES	DEMO_DATA	13	5552.46042N	01229.74958E	09	1	1.18	WGS84	102129	0.00	0.00	0.00	0	FFFFFFFFFFFFFFFF
21	2010/08/23 12:19:47	0	0	0	0	MES	DEMO_DATA	12	5552.46019N	01229.75018E	09	1	1.12	WGS84	102109	0.00	0.00	0.00	0	VE0078120AD011C41
20	2010/08/23 12:19:22	120	54	13	0	MES	DEMO_DATA	11	5552.46111N	01229.75135E	09	1	1.12	WGS84	102044	0.00	0.00	0.00	0	VE00700001DED8D2E
19	2010/08/23 12:19:06	228	101	27	0	MES	DEMO_DATA	10	5552.46144N	01229.75053E	09	1	1.16	WGS84	102028	0.00	0.00	0.00	0	VE00700001DED8D30
18	2010/08/23 12:18:57	228	102	28	0	MES	DEMO_DATA	9	5552.46134N	01229.74982E	09	1	1.16	WGS84	102019	0.00	0.00	0.00	0	VE0078120AD015778
17	2010/08/23 12:18:01	229	103	28	0	MES	DEMO_DATA	8	5552.46028N	01229.75186E	09	1	1.11	WGS84	101923	0.00	0.00	0.00	0	VE00700001DED8F7F
16	2010/08/23 12:17:20	228	102	28	0	MES	DEMO_DATA	7	5552.46052N	01229.75019E	09	1	1.11	WGS84	101842	0.00	0.00	0.00	0	FFFFFFFFFFFFFFFF
15	2010/08/23 12:15:12	227	101	28	0	MES	DEMO_DATA	6	5552.46129N	01229.75044E	09	1	1.12	WGS84	101634	0.00	0.00	0.00	0	FFFFFFFFFFFFFFFF
14	2010/08/23 12:15:03	228	102	28	0	MES	DEMO_DATA	5	5552.46129N	01229.75018E	09	1	1.12	WGS84	101624	0.00	0.00	0.00	0	FFFFFFFFFFFFFFFF
13	2010/08/23 12:14:32	228	102	28	0	MES	DEMO_DATA	4	5552.46123N	01229.74967E	09	1	1.20	WGS84	101554	0.00	0.00	0.00	0	2501228816018
12	2010/08/23 12:14:20	228	102	28	0	MES	DEMO_DATA	3	5552.46145N	01229.74916E	10	1	1.00	WGS84	101541	0.00	0.00	0.00	0	7046261974004
11	2010/08/23 12:13:32	228	102	28	0	MES	DEMO_DATA	2	5552.46115N	01229.74984E	10	1	0.92	WGS84	101454	0.00	0.00	0.00	0	4212082970
10	2010/08/23 12:13:15	228	102	28	0	MES	DEMO_DATA	1	5552.46099N	01229.74952E	10	1	0.92	WGS84	101437	0.00	0.00	0.00	0	123146136647070366
9	2010/08/23 12:11:12	228	102	28	0	FCM	DEMO_DATA	0	5552.46116N	01229.75039E	12	1	0.78	WGS84	101234	0.00	0.00	0.00	0	FFFFFFFFFFFFFFFF
8	2010/08/23 12:10:46	222	0	0	2	ZER	DEMO_DATA	0	5552.46134N	01229.74998E	12	1	0.78	WGS84	101208	0.00	0.00	0.00	0	FFFFFFFFFFFFFFFF
7	2010/08/23 12:10:33	222	0	0	23	ZER	DEMO_DATA	0	5552.46142N	01229.74914E	12	1	0.78	WGS84	101155	0.00	0.00	0.00	0	FFFFFFFFFFFFFFFF
- Footer:**
  - Read Status: Calibration: OK | Lamp: OK | Battery: OK | Status: 0

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



Instrument setup interface.

Most settings can also be done from the instrument menu.

RSC-GR3 Log Report example:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1	RSC-GR3 Log Report																							
2	Firmware: RS-GR3 Version: 3.36 DELTA(c) 29-06-2010																							
3	Sensor Id: 1-999 ASTM																							
4	Retro Sign Date/Time: 2010/08/30 14:17:48																							
5	Index	Date-Time	R0.2	R0.5	R1.0	Status	Mode	Seq_ID	ID_cnt	Lat	Long	#Sat	Fix	HDOP	GPS_Datum	GPS_UTC	M0.2	M0.5	M1.0	M_Cnt	TAG	Remarks	ErrorText	
6	39	2010/08/23 17:00:51	230	102	28	0	MES	VEST 42	10	5552.46189N	01229.72914E	5	1	1.82	WGS84	150211	0.00	0.00	0.00	0	FFFFFFFFFFFFFFFF			
7	38	2010/08/23 17:00:31	230	102	28	0	MES	VEST 42	9			0	0	99.99	WGS84	150152	0.00	0.00	0.00	0	FFFFFFFFFFFFFFFF			
8	37	2010/08/23 15:36:51	232	103	29	0	MES	VEST 42	8	5552.45873N	01229.75114E	6	1	2.02	WGS84	133811	230.56	102.94	28.38	5	FFFFFFFFFFFFFFFF			
9	36	2010/08/23 15:36:26	232	104	29	0	MES	VEST 42	7	5552.45814N	01229.75076E	6	1	2.03	WGS84	133746	230.08	102.95	28.25	4	FFFFFFFFFFFFFFFF			
10	35	2010/08/23 15:36:09	232	104	29	0	MES	VEST 42	2	5552.45821N	01229.75199E	5	1	2.11	WGS84	133730	229.37	102.58	28.14	3	FFFFFFFFFFFFFFFF			
11	34	2010/08/23 15:35:43	228	102	28	0	MES	VEST 42	1			0	0	99.99	WGS84	133703	227.97	101.95	27.92	2	FFFFFFFFFFFFFFFF			
12	33	2010/08/23 14:43:04	228	102	28	0	MES	DBMO DATA	23			0	0	99.99	WGS84	124425	228.07	101.84	27.87	1	FFFFFFFFFFFFFFFF			
13	32	2010/08/23 14:41:21	228	102	28	0	FCM	DBMO DATA	22			0	0	99.99	WGS84	124242	0.00	0.00	0.00	0	FFFFFFFFFFFFFFFF			
14	31	2010/08/23 13:38:26	485	172	28	0	MES	DBMO DATA	22	5552.46133N	01229.74927E	10	1	0.94	WGS84	113943	542.48	194.37	31.90	4	FFFFFFFFFFFFFFFF			
15	30	2010/08/23 13:38:22	502	171	33	0	MES	DBMO DATA	21	5552.46133N	01229.74927E	10	1	0.94	WGS84	113943	561.61	201.81	33.36	3	FFFFFFFFFFFFFFFF			
16																								
17																								

Log dump example:

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

Explained:

Firmware: The instrument software version and date

Sensor Id: The instrument serial number and type

RetroSign Date/Time: Date and time for the data offload

Column headers:

Column #A The log index number, e.g. 14 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° or 0.33°

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 Mean result for 0.2° or 0.33°

Column #R Mean result for 0.5°

Column #S Mean result for 1.0°

Column #T Number of measurements in mean calculation

Column #U RFID or Barcode Tag code, (16 x F if undefined)

Column #V User Remarks

Column #W Status code in legible form



# APPENDIX K

## 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 Tag Reader option.

#### Tag Reader 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)

#### Tag Reader 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.

#### Tag Reader 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 or Barcode tag, the instrument repeats the “507:1\*0713” prompt until the next action.
4. Put the Reader in close proximity to the tag or barcode
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)

#### Tag Reader 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 or Barcode tag, the instrument repeats the “507:1\*0713” prompt until the next action. (If the prompt is “507:0\*xxxx” then no Reader was detected)
6. Put the Reader 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 to 10 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;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 Tag Reader disabled
DRM:0*4D27    Instrument not calibrated
DRM:1*4E28    Executing measurement
Result string*xxxx (one line)
```

```
#DRM          Do R' measurement Tag Reader enabled
DRM:0*4D27    Instrument not calibrated
DRM:1*4E28    Executing measurement
507:0*xxxx    No Reader 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 result on each line!)
```

```
0;2007/04/19 11:17:49;0;0;0;MES;DELTA;77;5552.46178N;01229.75047E;09;1;0.81;WGS84;090036;0.29;0.09;0.12;3;E0078120ADD1501D*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' 0.2°
               R0.5,          R' 0.5°
               R1.0,          R' 1.0°
               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' 0.2° calculated mean value
M0.5	R' 0.5° calculated mean value
M1.0	R' 1.0° calculated mean value
M_Cnt	Number of measurements in the mean calc
TAG,	Tag code (up to 20 alpha numerical characters)

#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 Tag Reader enable status
#RFI n	Set Reader status 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	comment0	Zero	zero_done
		1 = no valid zero values			
1	Calib	Calib done	1 = no valid calibration values		
2	Rm	Rm factor Ok	1 = no valid 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		