![Kipp & Zonen logo — SINCE 1830]

SOLRAD
Integrator

Instruction Manual

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Declaration of Conformity

According to EC guideline 89/336/EEC 73/23/EEC

We   **Kipp & Zonen B.V.**
                      Delftechpark 36
                      2628XH Delft

Declare under our sole responsibility that the product

Type: **SOLRAD**
Name: **Read-out unit and integrator**

To which this declaration relates is in conformity with the following standards

Imissions   EN 50082-1   Group standard

Emissions   EN 50081-1   Group standard
                      EN 55022

Safety standard   IEC 1010-1

Following the provisions of the directive

B.A.H Dieterink
President
KIPP & ZONEN B.V

Important user information

Reading this entire manual is recommended for full understanding of the use of this product.

The exclamation mark within an equilateral triangle is intended to alert the user to the presence of important operating and maintenance instructions in the literature accompanying the instrument.

Should you have any comments on this manual we will be pleased to receive them at:

Kipp & Zonen B.V. reserve the right to make changes in the specifications without prior notice.

WARRANTY AND LIABILITY

Kipp & Zonen B.V. guarantees that the product delivered has been thoroughly tested to ensure that it meets its published specifications. The warranty included in the conditions of delivery is valid only if the product has been installed and used according to the instructions supplied by Kipp & Zonen B.V.

Kipp & Zonen B.V. shall in no event be liable for incidental or consequential damages, including without limitation, lost profits, loss of income, loss of business opportunities, loss of use and other related exposures, however caused, arising from the faulty and incorrect use of the product.

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1. GENERAL INFORMATION

1.1 INTRODUCTION

The SOLRAD Radiation Indicator is a hand-held read-out / integrator for the following types of Kipp & Zonen sensors:

- Pyranometers
- PAR sensors
- CUV sensors
- LUX sensors
- UV-S-A/E/B sensors

The Radiation Indicator displays the measured value in units appropriate to the type of sensor that is used. The calibration factor of the sensor is taken into account; therefore the value on the display is calibrated.

The Radiation Indicator can also integrate the measured values. Both manual reset and automatic reset of the integrator can be selected. The automatic reset occurs at midnight (according to the internal clock). The integrated values are stored in an internal memory. Up to 31 values can be stored in the memory.
This allows for unattended operation, leaving an integration value in the memory every day of the month.

Both the actual measured value and the integration totals can be transmitted to a personal computer through a 'COM'-port. The Radiation Indicator is delivered with a PC program that enables you to log measured values on disk, display real-time values and graphs and read-out and store the integrated values. The data that is stored on disk can be processed with popular spreadsheets like Excel.

The Radiation Indicator can be powered with a battery or from the mains through an adapter. A standard 9 Volt battery will last for approximately 25 hours (see specifications).

1.2 CONNECTING THE SENSOR

All types of sensors are connected to the same connector on the Radiation Indicator. The connections for each sensor are listed below.
A wire can be inserted in the upper slot while putting the screwdriver in the lowest slot. When the screwdriver is levered towards the bottom of the instrument the wire can be moved in the slot.
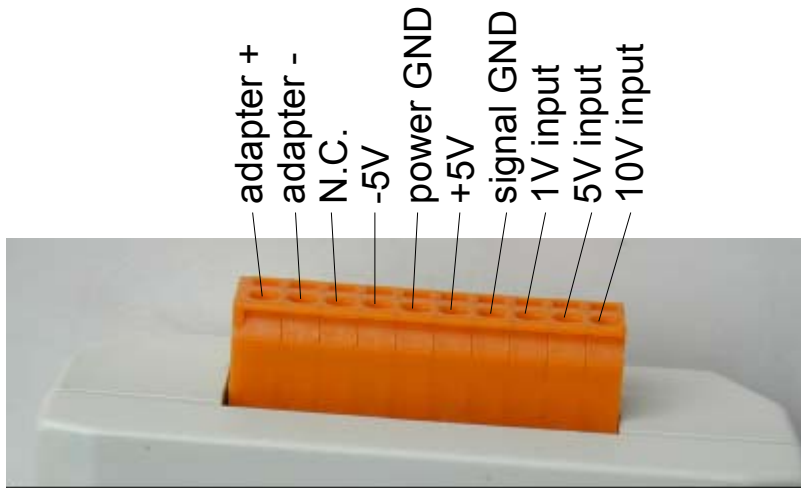
Sensor type	sensor connections	SOLRAD connections
Pyranometer	signal +	1V input
	signal -	signal GND
	cable shield	power GND
PAR sensor	signal +	1 V input
	signal -	signal GND
	GND/shield	power GND
LUX sensor	signal +	1 V input
	signal -	signal GND
	GND	power GND
CUV 4 sensor	signal +	1 V input
	signal -	signal GND
	GND/shield	power GND
UV-S-E/B sensor external supply needed	signal +	5 V input
	signal -	signal GND
	GND/shield	power GND
UV-S-A sensor 12 V external supply needed	signal +	5 V input
	signal -	signal GND
	GND/shield	power GND
CM 4	signal +	1 V input
	signal -	signal GND
	GND/shield	power GND

1.3 POWER SUPPLY

Install a standard 9 Volt battery in the battery compartment in the bottom of the Radiation Indicator. The battery life-time depends on the type of sensor that is connected to the Radiation Indicator. If continuous read-out is required over a long period of time, the external mains-adapter can be connected to the Radiation Indicator. The maximum current drawn by the Radiation Indicator, including a UV-sensor is 50 mA. If there is no external load and the RS-232 interface is idle, the supply current is 15 mA. The SOLRAD power supply range is 8...24 Volt DC.
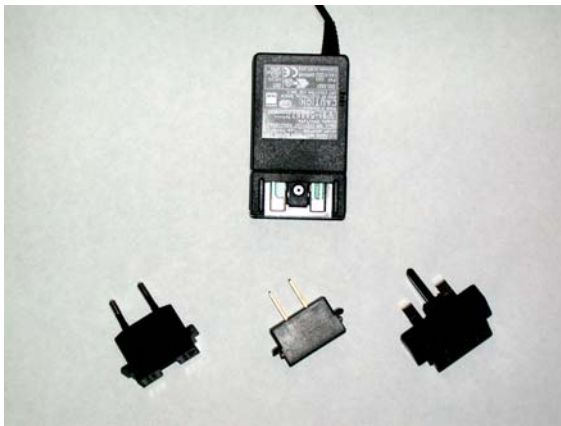
This figure shows the SOLRAD adapter suited for 100 – 240 VAC. The separate mains connectors allow for use in almost every country.

The cable coming out of the adapter has a stripped end with one black (-) and one red (+) sleeve.

These wires can be directly connected to the SOLRAD input connector (adapter + / -)

2. OPERATION GUIDE

There are two basic measuring functions in the Radiation Indicator:
- **Measuring** the actual value ('direct')
- **Integrating** the measured values ('integrate')
These two functions work for all types of sensors that can be connected. The operation mode of the Radiation Indicator can be selected through a menu.

If the operation mode 'integrate' is selected, either manual reset or automatic reset of the integrated value is possible. If manual reset is specified, the integration goes on until the value is reset to zero by pressing the '+' and '-' key simultaneously for more than 2 seconds (there is a maximum to the integrated value, see specifications). If automatic reset is selected, the integrated value is set to zero at midnight (according to the internal clock). After either a manual or an automatic reset, the integrated value is stored in an internal memory. Up to 31 values can be stored in this memory. The memory contents can be read-back from the display and can be transmitted to a P.C. If it is attempted to store more than 31 values, the oldest value will be over-written. No error messages are generated. At the moment the operation mode 'integrate' is selected, the memory can be cleared. Integration starts at the moment the 'integrate' mode is selected.

The settings for the sensor type, the internal clock, the sensor calibration factor and the modes as described above are entered as follows:
In general, to change a setting, start with pressing 'SELECT'. The Radiation Indicator then displays a menu item. If you want to select that menu, press 'SELECT' again. If you want to go on to another menu item, press '+' to go forward, '-' to go backward. Then, at the desired menu, press 'SELECT'.

Changes within a menu item are also made by pressing '+' or '-'. When finished, press 'SELECT'.

When changes are being made, the Radiation Indicator does not measure and the integration stops for a while! The integrator will not give the correct values.

After the Radiation Indicator is switched on, the display shows the selected sensor type and the calibration factor for approximately 10 seconds. This allows you to check if this is still correct.

After approximately 10 seconds, or as soon as any of the keys is pressed, the display will show the measured value for the sensor type and measuring mode that are selected (here shown: the default factory setting 'pyranometer', direct measuring mode).

```
HH:MM:SS DIRECT
   +xxxx W/m2
```

This screen shows the time according to the internal clock, the measuring mode ('DIRECT' in the direct measuring mode and either 'ACTUAL' or 'ELAPSED' in the integrating mode) and the measured value. The internal clock is reset to zero when the Radiation Indicator is switched off.

The selected sensor type can be changed as follows:
- press SELECT, the display now shows:

```
┌─────────────────────┐
│  CHANGE             │
│ SENSOR  TYPE        │
└─────────────────────┘
```

- activate this option by pressing the 'SELECT' pushbutton again.

```
┌─────────────────────┐
│ PYRANOMETER         │
│                     │
└─────────────────────┘
```

- the current selection is shown
- now change the selection with the '+' or '-' key
- the following sensor types are shown:

```
┌─────────────────────┐
│ PAR Lite            │
│                     │
└─────────────────────┘
```

```
┌─────────────────────┐
│ CUV A               │
│                     │
└─────────────────────┘
```

```
┌─────────────────────┐
│ CUV B               │
│                     │
└─────────────────────┘
```

```
┌─────────────────────┐
│ LUX Lite            │
│                     │
└─────────────────────┘
```

```
┌─────────────────────┐
│ CUV 3               │
│                     │
└─────────────────────┘
```

```
┌─────────────────────┐
│ UV-S-E/B            │
│                     │
└─────────────────────┘
```

```
┌─────────────────────┐
│ UV-S-A              │
│                     │
└─────────────────────┘
```

```
┌─────────────────────┐
│ CM 4                │
│                     │
└─────────────────────┘
```

The sensor type can be selected by pressing 'SELECT'.

If the sensor type is selected, the calibration factor for this sensor has to be entered. The calibration factors for all types of sensors are stored in non-volatile memory, so the values are retained even if the battery is removed from the Radiation Indicator. If you changed the sensor type in the above menu, the Radiation Indicator will automatically ask for a new calibration factor (or confirmation of the factor that is stored in the memory).

For SOLRAD with sensor combinations, that are purchased together, the calibration factor of the sensor is already set in the Radiation Indicator.

- use the '+' and '-' key to increase, respectively decrease the calibration factor. The longer the keys are
  pressed the faster the value will change.
- when done, press 'SELECT'

I.e. if 'Pyranometer' was selected:

```
ENTER CAL.FAC.
1000W/m2= xx.xxmV
```

PAR Lite selected:

```
ENTER CAL.FAC.
1uE/sm2= x.xxuV
```

An Einstein is defined as a mole of photons. Therefore: (microEinsteins per second) per m^2 is identical to (micromoles per second) per m^2. (1000 $\mu E\ m^{-2}\ s^{-1}$ = 1000 $\mu mol\ m^{-2}\ s^{-1}$).

CUV A sensor selected:

```
ENTER CAL.FAC.
1W/m2nm= -x.xxxV
```

CUV B sensor selected:

```
ENTER CAL.FAC.
1W/m2nm= -xx.xxV
```

LUX Lite selected:

```
ENTER CAL.FAC.
100klx= xx.xxmV
```

CUV 3 selected:

```
ENTER CAL.FAC.
1W/m2= xxxxµV
```

UV-S-E/B sensor selected:

```
ENTER CAL.FAC.
1W/m2= x.xxxV
```

UV-S-A sensor selected

```
ENTER CAL.FAC.
1W/m2=   xx.xxmV
```

CM 4 sensor selected

```
ENTER CAL.FAC.
1000W/m2=  xx.xxmV
```

If the calibration factor of the current selected sensor type has to be changed, this can also be done directly by entering the 'SET CAL.FAC.' menu item. To go to this menu, press SELECT when the Radiation Indicator is measuring. The first menu item appears:

```
CHANGE
  SENSOR TYPE
```

Press '+' to go on to the next item:

```
NEW CALIBRATION
COEFFICIENT
```

Press 'SELECT' to activate this menu. Depending on the type of sensor that is selected, the screen in which the calibration coefficient for that sensor type can be set appears (here: pyranometer):

```
ENTER CAL.FAC.
 1000W/m2= xx.xxmV
```

Press '+' or '-' to adjust the value and press 'SELECT' to start measuring using the new factor.

Other menu's in the system are:

```
SET MEASURING
   MODE
```

To select 'DIRECT' or 'INTEGRATE'.

```
SET RESET
METHOD
```

To select manual or automatic reset.

```
SET TIME
```

To set the internal clock.

2.1 DIRECT MEASURING MODE

Depending on the type of sensor, one of the following screens is displayed when measuring 'direct'.

(Pyranometer)
```
HH:MM:SS DIRECT
+XXXX  W/m2
```

(PAR sensor)
```
HH:MM:SS DIRECT
+XXXX uE/sm2
```

(CUV A-sensor)
```
HH:MM:SS DIRECT
+X.XXX W/m2nm
```

(CUV B-sensor)
```
HH:MM:SS DIRECT
+X.XXXX W/m2nm
```

(LUX sensor)
```
HH:MM:SS DIRECT
+XXX.XX klx
```

(CUV 3 sensor)
```
HH:MM:SS DIRECT
+XX.XX W/m2
```

(UV-S-E/B sensor)
```
HH:MM:SS DIRECT
+X.XXX W/m2
```

(UV-S-A sensor)
```
HH:MM:SS DIRECT
+XXX.X W/m2
```

(CM 4 sensor)
```
HH:MM:SS DIRECT
+XXXX W/m2
```

The Radiation Indicator can transmit the measured values to a computer. There are no other functions available in this mode.

2.2 INTEGRATING MODE

In the integrating mode, both the actual and the integrated measured values are available. When entering this mode the following screen appears:

(Pyranometer)

```
HH:MM:SS ACTUAL
+XXXX W/m2
```

The actual measured value is shown. The integration is running but the total is not shown.

Press '-' to change the information that is displayed:

```
HH:MM:SS ELAPSED
+XXXXXXXXX kJ/m2
```

Now, the elapsed time since the start of the integration and the total measured value are shown. After the first automatic reset, the total elapsed time equals the time of day since the reset took place at midnight (assuming the internal clock has been set correctly).

The integrated value has a maximum of 2147483648 (2^{31}). If the integrated value increases to a value with more than 7 figures, the units will be shifted off the display to allow this value to be displayed.

To return to the 'ACTUAL' screen, press '+'.

If 'manual reset' is selected, the reset is performed by holding down the '+' and '-' key simultaneously for more than 2 seconds. Each time the Radiation Indicator is reset, the total measured value is stored in the internal memory, and a new integration cycle is started. The display shows the 'ELAPSED' time after a reset (both manual and automatic).

The memory contents can be read back as follows:
- in the 'ACTUAL' screen, press '-' twice

```
MEMORY –01
  XXXXXXXX kJ/m2
```

The stored totals are displayed with the appropriate units.

- press '-' to see more:

```
MEMORY -02
  XXXXXXXX kJ/m2
```

- '+' and '-' can be used to scroll through the memory, and to bring you back to the measuring screen.

```
HH:MM:SS ACTUAL
+XXXX W/m2
```

In the 'integrate' mode the measured values can be transmitted to a computer without disturbing the integration process.

3. COMPUTER INTERFACE

The Radiation Indicator can be connected to the COM-port of a Personal Computer. By sending commands to the Radiation Indicator the P.C. can obtain the measured values from the Radiation Indicator. The commands and responses are listed below.

Command description	Command code	Response description	Response code
Start sending measured values real-time	SRT(CR)	Each time a value is measured (see specifications), it is transmitted to the P.C.	XXXXX.X(CR)
Stop sending values	STP(CR)	Stops the Radiation Indicator sending data	(ACK)(CR)
Send single value	SSV(CR)	Radiation Indicator sends a single value to the P.C.	XXXXX.X(CR)
Send integrated values	SIV(CR)	Sends the stored integrator values, starting with memory 0	XXXXXXX.XX(CR) XXXXXXX.XX(CR) XXXXXXX.XX(CR) ..... (ACK)(CR)

When changes are being made to the settings of the Radiation Indicator, the inputs are not measured. Hence, transmission of data is suspended until the Radiation Indicator is in one of the measuring modes again.

When the RS232 interface has been idle for more than 12.5 seconds, the interface will be shut down to preserve the battery. To activate the interface, the external equipment (i.e. the PC) must send two or more CR characters, and then wait for at least 0.5 seconds before a command is transmitted to the Radiation Indicator. The line is assumed to be idle when there is no communication from the Radiation Indicator to the PC, nor from the PC to the Radiation Indicator.
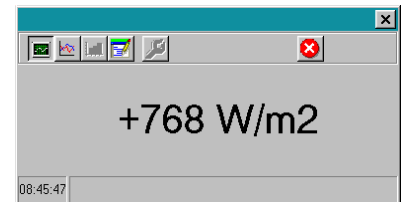
4. PC SOFTWARE SOLRAD

A PC program that utilizes the commands above and stores the measured values on disk, is delivered with Radiation Indicator. The data that is stored on disk can be read-in by popular spreadsheets for analysis.

The Radiation Indicator must be connected to the PC by means of an RS-232 cable (9-pin 1:1). It can be connected to either COM1: or COM2:.
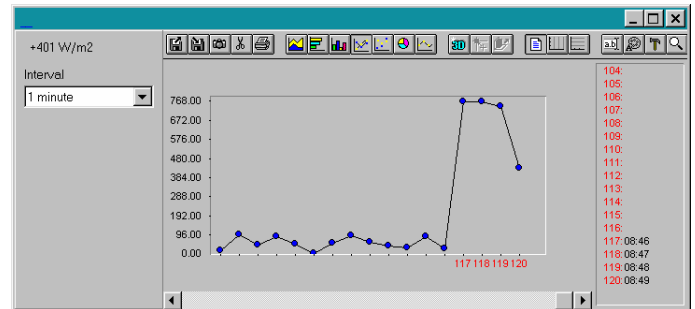
The software comes on one 3.5" disk. Install the program by double-clicking 'setup' and follow the instructions. The software is easy to use. It runs under Windows 95/98/2000.

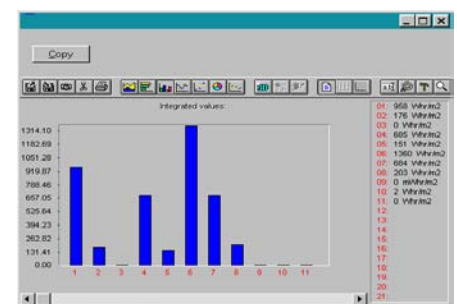The software offers the following functions:

- The real-time measured value in a window

Real-time value.

- A real-time graph

- Store the data on disk

- Select the sample interval for the graph and for the data logging

Real-time graph.

- Read the 31 integrator registers and export the values to the clipboard for subsequent processing

Integrator values.

5. SPECIFICATIONS

General: - Display: 2x16 characters
                 - Controls: ON/OFF switch and 3 control knobs ('SELECT', '+' and '-')
                 - Connector: WAGO series 231
                 - Complies with IPX0 (not protected against ingress of water)

Power supply: - Standard 9-Volt battery or mains-adapter (8 - 24 VDC, 50mA max.)
                 - Battery life-time: 25 hours minimal (Alkaline battery, no RS232 communications)

A/D conversion: - resolution 1:10.000
                 - Offset $<5\mu V$ over -20...40°C
                 - Linearity error <1LSB
                 - Temperature coefficient <0.01%/^{o}C
                 - Conversion rate: > 10 samples per second

Sensor inputs: - Pyranometer: 3 mV ...100 mV /1000 W/m^2
                 - CM 4: 5 ... 25 mV / 1000 W/m^2
                 - Par sensor: 4µV ...6 µV / µE/s.m² (= µV/µmol/s.m²)
                 - CUV A sensor: 0.5 V ...5 V / W/m^{2}nm
                 - CUV B sensor: 4 V ...40 V / W/m^{2}nm
                 - Lux sensor: 5 mV...15 mV /100klx
                 - CUV 3: 100µV ... 1400 µV / W/m^2
                 - UV-S-E/B: 0.6 ... 6 V / W/m^2
                 - UV-S-A: 3 ...30 mV / W/m^2

Functions: - Actual or integrated value read-out
                 - Integrator reset-method: manual or automatic
                 - Internal clock
                 - Internal storage of last 31-measured integration values

Integrator: - Update of integrated value every two seconds.
                 - Maximal integration value for all sensor types 2^{31}

Computer port: - RS-232 standard
                 - 9600 baud, 8 data bits, no parity, 1 stop bit
                 - 9-pin sub-D connector

Weight: - 450 g.

Dimensions :   - 100x197x50 mm^3 (WxLxH)

MEASURING AND DISPLAY RANGES:

	Pyranome-ter	PAR Lite	LUX Lite	CUV 4	UV-S-E/B	UV-S-A	CM 4
Sensitivity setting range	1000 W/m2 3.00… 99.99 mV	1 µE/sm2= 4.00… 6.00 µV	100 klx= 5.00… 15.00 mV	1 W/m2= 100… 1400 µV	1 W/m2= 0.600… 6.000 V	1 W/m2= 3.00… 30.00 mV	1000 W/m2 5.00 … 25.00 mV
Nominal sensitivities (design values)	3.33 mV 6.66 mV 13.33 mV 33.33 mV 66.66 mV 99.99 mV	5 µV	10 mV	200 µV 500 µV 1000 µV	4 V (E) 0.8 V (B)	20 mV	12.5 mV 25 mV
Display* range at nominal sensitivities	-500… 1500 W/m2	0…9999 µE/ sm2	0…200.00 klx	0…100.00 W/m2	E 0…0.688 B 0…3.440 W/m2	0…140.0 W/m2	-1000 … 4000 W/m2
display resolution at nominal sensitivity	1 W/m2	1 µE/ sm2	0.05 klx	0.01 W/m2	0.001 W/m2	0.1 W/m2	1 W/m2
maximum integrated total unit	2^{31} kJ/m2	2^{31} mE/m2	2^{31} klx.s	2^{31} J/m2	2^{31} J/m2	2^{31} J/m2	2^{31} kJ/m2

*: Lower than nominal sensitivity results in a larger display range.

APPENDIX A: Ordering information

A.1 STANDARD DELIVERY

- SOLRAD Integrator / read-out unit
- Sensor connector
- Mains adapter 100 – 240 VAC
- RS-232 cable (9/9 pin)
- PC software / manual on CD ROM

A.2 ORDERING SPECIFICATIONS

SOLRAD   Integrator   part number: 3303-008   (SOLRAD without a sensor)

A.3 SPARE PARTS

SOLRAD sensor connector   3303-025
100 - 240VAC universal mains adapter 2547-122
PC-cable 9p male / 9 pin female   3329-203

SOLRAD manual (English)   3303-007

KIPP & ZONEN

SINCE 1830

Our customer support remains at your disposal for any maintenance or repair, calibration, supplies and spares.

Für Servicearbeiten und Kalibrierung, Verbrauchsmaterial und Ersatzteile steht Ihnen unsere Customer Support Abteilung zur Verfügung.

Notre service 'Support Clientèle' reste à votre entière disposition pour tout problème de maintenance, réparation ou d'étalonnage ainsi que pour les accessoires et pièces de rechange.

Nuestro apoyo del cliente se queda a su disposición para cualquier mantenimiento o la reparación, la calibración, los suministros y reserva.

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