



**Kipp &  
Zonen**

*INSTRUCTION MANUAL*

**CSD** **1**

*SUNSHINE DURATION METER*



0342 300



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## 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.  
Röntgenweg 1 2624 BD Delft Holland  
P.O. Box 507 2600 AM Delft Holland  
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Fax +31 (0)15 262 0351  
E-mail info.holland@kippzonen.com

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

### WARRANTY AND LIABILITY

Kipp & Zonen 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.

Kipp & Zonen 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. User-made modifications can affect the validity of the CE declaration.

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**Manual version 0104**





## DECLARATION OF CONFORMITY

According to EC guideline 89/336/EEC

We Kipp & Zonen B.V.  
Röntgenweg 1  
2624 BD Delft

declare under our sole responsibility that the product

Type: **CSD 1**  
Name: **SUNSHINE DURATION SENSOR**

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

Imissions	EN 50082-1	Group standard	
	IEC 100-4-2	IEC 801-2	8 kV
	IEC 100-4-3	IEC 801-3	3 V/m
	IEC 100-4-4	IEC 801-4	1 kV

Emissions	EN 50081-1	Group standard
	EN 55022	

following the provisions of the directive



R.E. Ringoir  
Product management  
KIPP & ZONEN B.V.



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## 1. GENERAL INFORMATION

CSD 1 is a sensor for measurement of sunshine duration. The sunshine duration is defined as the time during which the direct solar radiation exceeds the level of  $120 \text{ W/m}^2$ .

CSD 1 can also supply a derived value of the level of direct radiation.

CSD 1 was designed for use in agricultural meteorology (evaporation), for tourist information (number of sunshine hours), for building automation (automatic control of sunscreens), and for health resorts (climatology for treatment and recovery).

One of the main features of CSD 1 is the built-in two-level heating, which can remove dew, frost and even ice. In many applications this provides a significant improvement in the reliability of the measurement.

CSD 1 employs 3 detectors, each covering part of the sky. The direct radiation is calculated from the differences in signal levels.

Great care has been taken to design the angular characteristics of the detector, resulting in a measurement that can be used anywhere on Earth in a fixed position, and that minimises seasonal effects.

The three detectors have exactly the same spectral and angular characteristics. This makes the process of recalibration very easy.

CSD 1 has no moving parts and low power consumption.

The following chapters will explain the various aspects of using CSD 1.

### 1.1 USING THE CSD 1

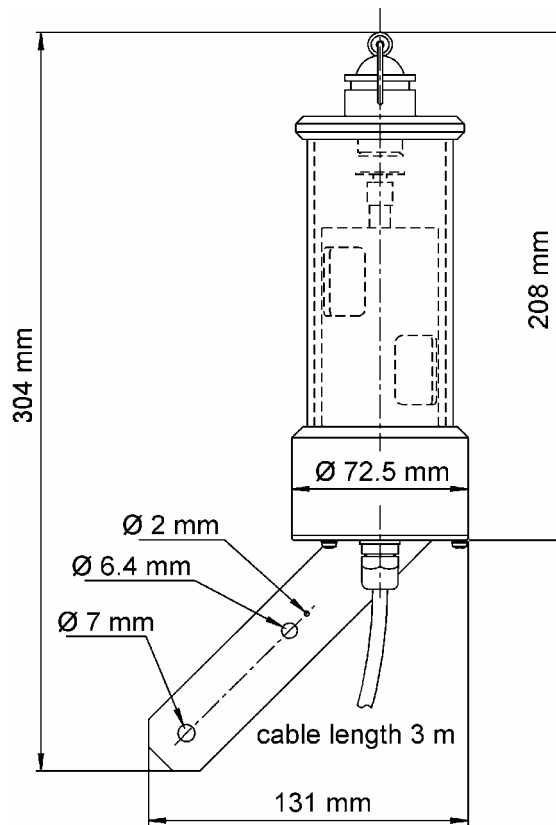
Using CSD 1 is easy. Figure 1.1 shows the dimensions. The unit must be installed, using the mounting hole in the instrument arm. The sunny/not sunny switched output for sunshine duration must be connected to a recorder with a voltage input. If desired the continuous output of the estimated direct radiation can be connected to another voltage recorder.

If the instrument is covered by dew, frost or snow, the measurement can be improved by switching on the built-in heater.

Typically the unit will run without attendance. Paragraphs 1.2 to 1.6 expand upon the above.

CSD 1 should be regularly maintained and if possible be re-calibrated once every year in order to check the instrument stability. These items are addressed in 1.7 and 1.8.

More about the optical theory can be found in 1.9.



*Figure 1.1 Dimensions of CSD 1*

## 1.2 THE MINIMUM NECESSARY REQUIREMENTS

For working with CSD 1 at least 1 channel of data acquisition is needed. Usually the measurement values are stored and integrated during each day. After a day of measurement, the daily total is usually stored and reset to 0. The output of the sunshine duration signal is 0 Volt when it is not sunny, or 1 Volt if the direct solar radiation exceeds the level of 120 W/m<sup>2</sup>.

Secondly one needs a suitable place for installation. The most suitable location is a where the sun is visible during the full day. An open horizon is best. In any case, during the day there should always be exposure to the direct radiation.

The sensor needs power from a source that can provide 9-15 VDC at a power of 10 mW (without heating on). This can easily be supplied by a small solar panel or a battery.

When using the measurement of the direct radiation, an additional voltage channel of data acquisition is required.

The expected output range is 0-1000 mV.

When using the heaters, additional power must be supplied. There are two power levels available at 12 VDC, 1 Watt and 10 Watts.

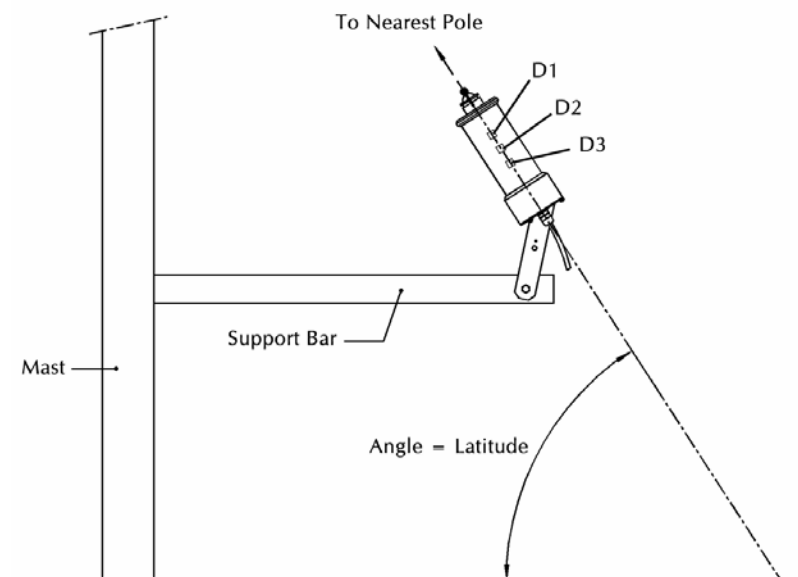
## 1.3 INSTALLATION

For proper installation one must know the latitude of the location and have a map or compass available to determine the North-South axis.

When using a mast, the CSD 1 must be mounted south of the mast in the northern hemisphere, north of the mast in the southern hemisphere, to avoid the shadow of the mast falling on the instrument.

As seen from above, the instrument "axis" must be North-South.

As seen from figure 1.3.1, the angle between the instrument axis and a horizontal plane should be equal to the latitude of the installation location. Installing like this the measurement is optimised. When connecting the wiring, make sure to shield the power and signal cables as much as possible.



*Figure 1.3.1 installation of the CSD 1. The unit has to be installed at an angle that depends on the latitude of the location, and be positioned parallel to the North-South axis.*

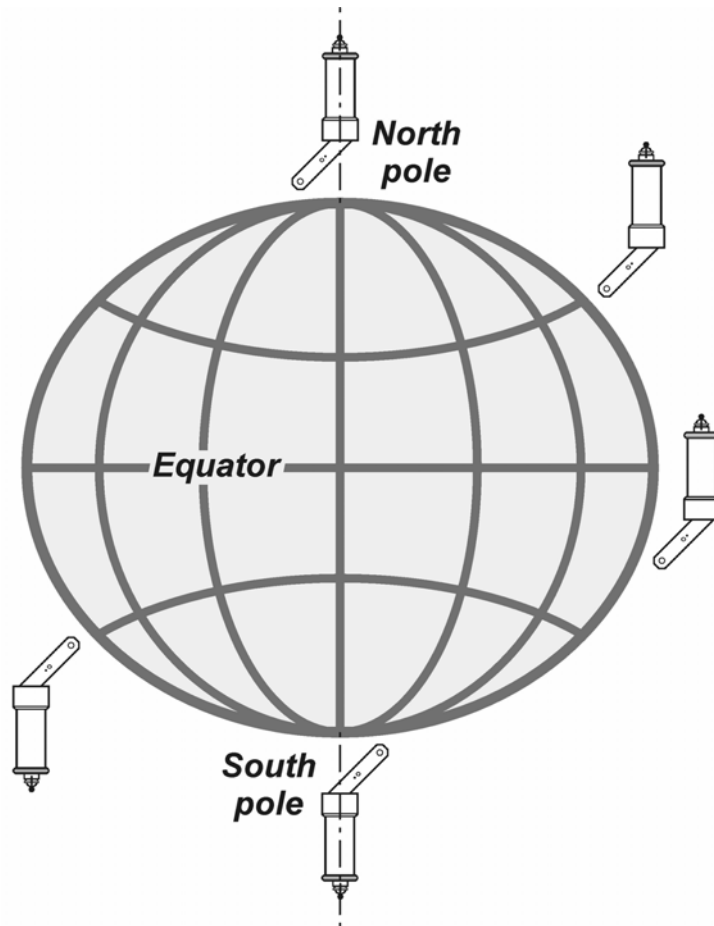


Figure 1.3.2 a global view of the installation of the CSD 1

colour	signal outputs	
red	not sunny/sunny	0 V/1 V
blue	both signals	ground
grey	direct radiation, 1 W/m <sup>2</sup>	1 mV

colour	power input	
brown	power supply	+ 12 VDC
yellow	power supply	ground

colour	heater inputs	
white	heater supply 10 W	+12 VDC
black	both heaters common	0 V
green	heater supply 1 W	+12 VDC

*Figure 1.3.3 wiring schedule of CSD 1. Outputs: sunshine duration, direct radiation, Inputs: heater low, heater high, power supply.*

#### 1.4 MEASUREMENT OF SUNSHINE DURATION

For measurement of sunshine duration, connect the power supply input and the sunshine duration output. If the direct radiation level is higher than 120 W/m<sup>2</sup> by definition the time should be added to the sunshine duration. The output voltage is 1 V. When the sun is not shining the output is 0V. The usual procedure is to integrate the period with high output, and to store either the 1 minute values or the totals for each day.

## 1.5 MEASUREMENT OF DIRECT RADIATION

An output representing the direct radiation is available. This signal is 0 V when no direct radiation is present, and varies linearly with the irradiance. The calibration is factory set at a level of 1 mV equivalent to 1W/m<sup>2</sup>. Measuring this parameter can be useful because the information in the sunshine duration signal is limited, only showing if this signal is above or below a certain level.

**Note:** This signal is not a substitute for Pyranometer/Pyrheliometer measurements and does not have the same level of accuracy.

## 1.6 USING THE HEATER

One of the major error sources in the sunshine duration measurement is the obstruction of the light by water that is deposited on the instrument. This can be caused by rain, dew, frost or snow, and can be greatly reduced by heating the instrument.

CSD 1 has on-board heaters that can be used at two levels. The heaters are simple high power resistors that deliver 1 or 10 Watts at the recommended supply voltage of 12 VDC. Switching of the heating levels can be done externally with a switch or by a thermostat system (not included).

The low level heating will keep dew away and heating at the high level will melt snow and ice at an ambient temperature not lower than -15 °C

It is recommended to use the heater only when this is strictly necessary. At ambient temperatures of more than +10 °C the heater could be conditionally switched off. Also in order to save power, during the night it is suggested not to use the heater.

## 1.7 CALIBRATION & QUALITY CONTROL

CSD 1 has 3 detectors that have exactly the same spectral and angular characteristics. This will benefit the process of re calibration. At Kipp & Zonen, the calibration is done against a reference that is traceable to a broadband solar radiation measurement under clear sky conditions.

Re-calibration should preferably be carried out by Kipp & Zonen. If done locally, the resistors for adjusting the sensitivity are accessible. A special chapter has been dedicated to the procedure for adjustment of the sensitivity.

## **1.8 MAINTENANCE**

CSD 1 needs limited maintenance only. Regular cleaning of the transparent window is recommended. If the desiccant in the plastic cartridge on top of the instrument has turned pink (normally it is blue), this indicates saturation with water. The tube can be opened and refilled. It is possible to recondition the desiccant by heating it in an oven at 300°C for 15 minutes.

## **1.9 OPTICAL THEORY**

The sunshine duration is defined as the time during which the direct solar radiation exceeds the level of 120 W/m<sup>2</sup>. The reference measurement of direct radiation can be done using a radiation sensor with a limited field of view (a Pyrhelimeter) and pointing this towards the sun (typically done using a solar tracker).

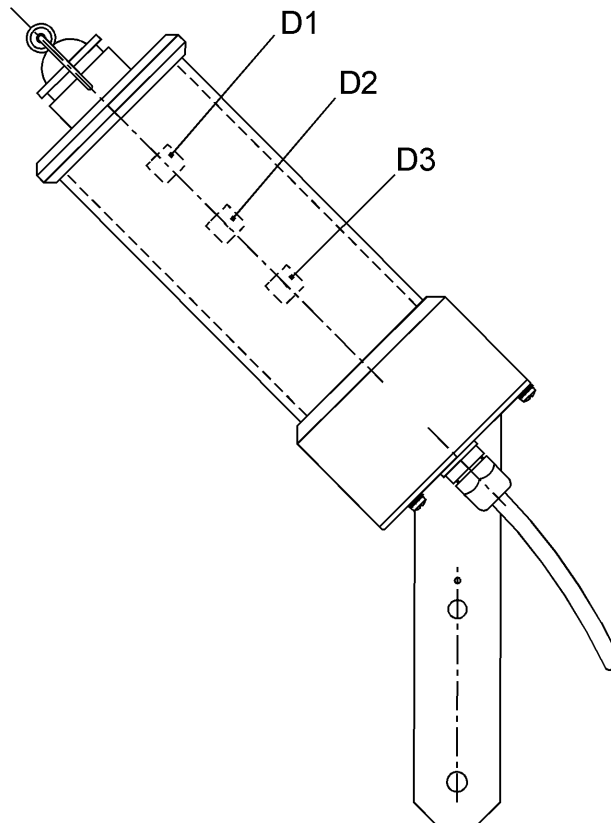
CSD 1 is an instrument that is primarily designed to offer a relatively simple way of measuring the sunshine duration. Relative to the standard method, several compromises had to be made. The direct radiation level is not determined directly, but derived from a differential measurement between the signal levels of several detectors. Also the full solar spectrum is not measured due to the response characteristics of the detectors.

This philosophy has made it possible to make a sensor that does not require moving parts, and has a relatively low cost.

Further features of the CSD 1 design are:

- Low power consumption;
- Easy to recalibrate;
- Minimal seasonal effects;
- Installation at any latitude and longitude.





*Figure 1.9.1 CSD 1 with its three detectors, D1, D2 and D3.*

The way that CSD 1 works is as follows:  
CSD 1 has three detectors, D1, D2 and D3. D1 detects all the solar radiation, direct and diffuse. D2 and D3 only cover part of the sky; the part that is covered by D2 is not seen by D3.



The electronics of CSD 1 first determines whether D2 or D3 is receiving direct radiation (maximum signal). It chooses the detector with the smallest signal, and assumes that this output represents approximately  $\frac{1}{3}$  of the diffuse radiation. Some corrections,  $C$ , for geometry are made, (see the formula below).

The value of D1 is reduced by the estimated value of the diffuse radiation to result in the direct radiation.

Direct radiation =  $D1 - C * (\text{smallest of } D2 \text{ and } D3)$

*Where  $D1, D2, D3$  are the signals of detectors  $D1, D2, D3$ .  $C$  is a geometry correction.*

This direct radiation signal can be monitored at one of the instrument outputs and is compared internally with a voltage reference equivalent to the 120  $W/m^2$  level recommended by WMO, in order to switch the sunny/not sunny output signal for sunshine duration.

Sunshine Duration output high (sunny) if direct radiation  $> 120 W/m^2$ .

## 2. PROPERTIES OF CSD 1

Measurement accuracy was determined by experimental comparison with reference instruments that are traceable to WRR (World Radiometer Reference) standards.

Operating temperature of CSD1	-30 °C (10 W heating on) to +70 °C (no heating)	
Location	any longitude and latitude	
Required power supply		
without heating	< 0.1 W	at 12 VDC
heating low level	1 W ± 0.1 W	at 12 VDC
heating high level	10 W ± 1 W	at 12 VDC

### 2.1 SPECIFICATIONS OF THE SUNSHINE DURATION MEASUREMENT

Estimated accuracy of the sunshine duration measurement			
sunny	> 120	± 40 W/m <sup>2</sup>	1 ± 0.1 V
not sunny	< 120	± 40 W/m <sup>2</sup>	0 ± 0.1 V

### 2.2 SPECIFICATIONS OF THE DIRECT RADIATION MEASUREMENT

Estimated accuracy of the direct radiation measurement		
output level	1 mV/W/m <sup>2</sup> ± 33% at 120 W/m <sup>2</sup>	
expected output range	0-1000 mV	

### 2.3 SPECIFICATIONS OF THE HEATER

Power supply heating low level	1 W $\pm$ 0,1 W	at 12VDC
Power supply heating high level	10 W $\pm$ 1 W	at 12VDC
Expected temperature range for melting ice		
heating low level		only dew removal
heating high level	0 °C to -15 °C (wind <1 m/s)	

### 3. TROUBLE SHOOTING

The following contains a procedure for checking the instrument in case it appears that it does not function as it should, i.e. the sunshine duration signal fails or shows improbable results:

Check the instrument orientation. The tilt angle should be equal to the local latitude, the top should point North in the northern hemisphere, South in the southern hemisphere, both with an accuracy better than  $\pm 10$  degrees.

Check the instrument location. Are there obstructions that cast a shadow on the instrument by blocking the direct sun in some part of the day?

Check the window, it should be clear and clean. If water is deposited on the inside change the desiccant. If too much water is deposited, the instrument should be dried inside.

If the orientation and window are satisfactory, check the power supply. The voltage input between the connections J15 and J16/J17 should be minimum 9 VDC and maximum 15 VDC.

Check the input current. It should be between 0.2 mA and 2 mA.

If the above tests are passed, the CSD1 should be transferred to an indoor facility. Here the instrument can be opened by unscrewing the bottom plate, and inspected. Any damage should be reported to Kipp & Zonen, who will suggest appropriate action.

If inspection does not show any clear signs of damage, check the response of each individual detector to light with a power supply connected. The response of detector D1 to an ordinary desk-type lamp can be measured at connector J18, across pins 1 and 2; for D2 across pins 5 and 2; for D3 across pins 6 and 2 (see figure 4.1).



The row of 6 pins beside the central hole of the printed circuit board is labelled J19 is used for service purposes.

Check the pins of J19 for the correct voltages (J16 or J17 is ground):

pin 1	output sunny/not sunny	1 V = sunny; 0 V = not sunny
pin 2	output direct signal	1 mV/(W/m <sup>2</sup> )
pin 3	reference voltage	1.115 V (± 0.003 V)
pin 4	un-buffered direct signal	same as pin 2
pin 5	stabilized power supply	5 V (± 0.2 V)
pin 6	internal supply voltage	approx 1 - 1.5 V less than input power supply voltage

If one of the values is not correct, please contact the service department of Kipp & Zonen for further assistance.

#### **4. ADJUSTMENT OF THE CALIBRATION FACTOR**

The following contains a procedure for adjustment of the calibration factor. For reference see the chapter on electrical diagrams.

Calibration of CSD1 is normally performed by Kipp & Zonen. For local calibration use a Pyrheliometer that is traceable to WRR. In case that the user has a wider network equipped with CSD1, it is feasible to do a simplified calibration which can serve for quality assurance. This latter type of calibration utilises a "reference CSD1" and a solar simulator. The "reference CSD1" is simply a CSD1 which is kept in a dark place, and can be considered stable. The solar simulator can be any kind of beam representing the sun. Some laboratories might have a classified solar simulator, others might utilise a simple slide projector. The beam spectrum should resemble the solar spectrum as close as possible and have a small opening angle.

The procedure for calibration by the customer will generally have an accuracy of +/- 5%. The general policy is to adjust the sensitivity of the detectors in CSD1 only if they show a deviation from the reference that is more than 5%, and to leave things as they are if a deviation of less than 5% is measured.

The calibration procedure step by step:

1. Install the reference instrument in the beam of the solar simulator with the beam covering the entire instrument, the local intensity of the beam should be at around 500 Watts per square meter and the room temperature at about 20 degrees. The latter specifications are not critical, but should be stable.
2. The detector D1 of the reference is always considered to be the reference detector. Take the average reading of J18-1 and J18-2, and rotate the CSD1 around its axis to take a total of 4 readings at 90 degree intervals. The average is called REF1.

The sensitivity of FD1 is adjusted at the factory at 50 microvolt per Watt per square meter. This offers the opportunity to check the intensity of the beam. At 500 Watt per square meter, the output voltage should be 25 millivolts.

3. Now take the test CSD1 that needs to be checked, and put it in the position of the reference.
4. Take 4 readings of D1 of the CSD1 (J18-1 and J18-2) at 90 degree intervals. The average is called FD1.
5. Put D2 of the test CSD1 in the position of D1. Take the readings of D2 of the test CSD1 (J18-2 and J18-5) in 2 opposite directions. The average is called FD2.
6. Put D3 of the test CSD1 in the position of D2. Take the readings of D3 of the test CSD1 (J18-2 and J18-6) in 2 opposite directions. The average is called FD3.
7. FD1 should equal REF1. If the deviation is more than 5% it is suggested to replace the resistors at location 1, RES1 to adjust the sensitivity. The value of the replacement resistors is a function of the resistors that are present, and the ratio REF1/FD1. First the resistors at location 1 are removed, and their total resistance is measured. After this the value of the replacement resistors REP1 can be calculated according to the following formula:

$$\text{REP1} = \text{total old resistance} * ( \text{REF1} / \text{FD1} )$$

**Note:** The calibration resistance consists of two separate resistors.  
The total value can be calculated by adding the two resistor values.

8. FD2 should equal 3.3 times REF1. If the deviation is more than 5% it is suggested to replace the resistors at location 2, RES2 to adjust the sensitivity. The value of the replacement resistors is a function of the resistors that are present, and the ratio REF1/FD2.



First the resistors at location 2 are removed, and their total resistance is measured. After this the value of the replacement resistors REP2 can be calculated according to the following formula:

$$\text{REP2} = \text{total old resistance} * ( 3.3 * \text{REF1} / \text{FD2})$$

9. REP3 can be treated as REP2. The location of the resistors is 3, RES3.

$$\text{REP3} = \text{total old resistance} * ( 3.3 * \text{REF1} / \text{FD3})$$

10. It is recommended to check the result of the resistor replacement by performing a second calibration check.

Recommended resistors:

Type	1206 series ceramic chip, surface mount
Resistance tolerance	± 1 %
Temperature coefficient	± 100 ppm/°C

Example:

Manufacturer	Bourns
Type	Commercial Thin Film Chip Resistor
Series number	1206, Alumina substrate
Resistance tolerance	± 1 %
Temperature coefficient	± 100 ppm/°C
Power rating	0.3 W

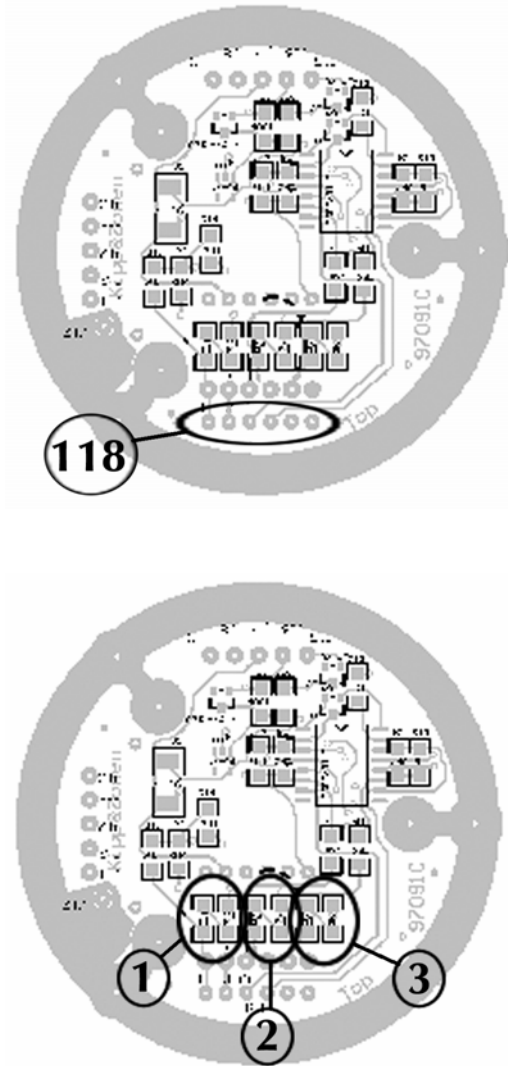


figure 4.1 position of the calibration resistors and connector J18



## 5. DELIVERY

Delivery of CSD 1 includes the following items:

CSD 1 sunshine duration meter	0342901
CSD 1 manual	0342300



## 6. SPARE PARTS

The following spare parts are available:

Silica gel 2643943 ( 1 kg)

Complete drying cartridge consisting of:

clamp-spring	0305165
drying cartridge (without cover)	9012106
cover for cartridge	9012107
rubber ring	2132153



## 7. ELECTRICAL DIAGRAMS

The following contains electrical diagrams to be used during trouble shooting and adapting the calibration factor.

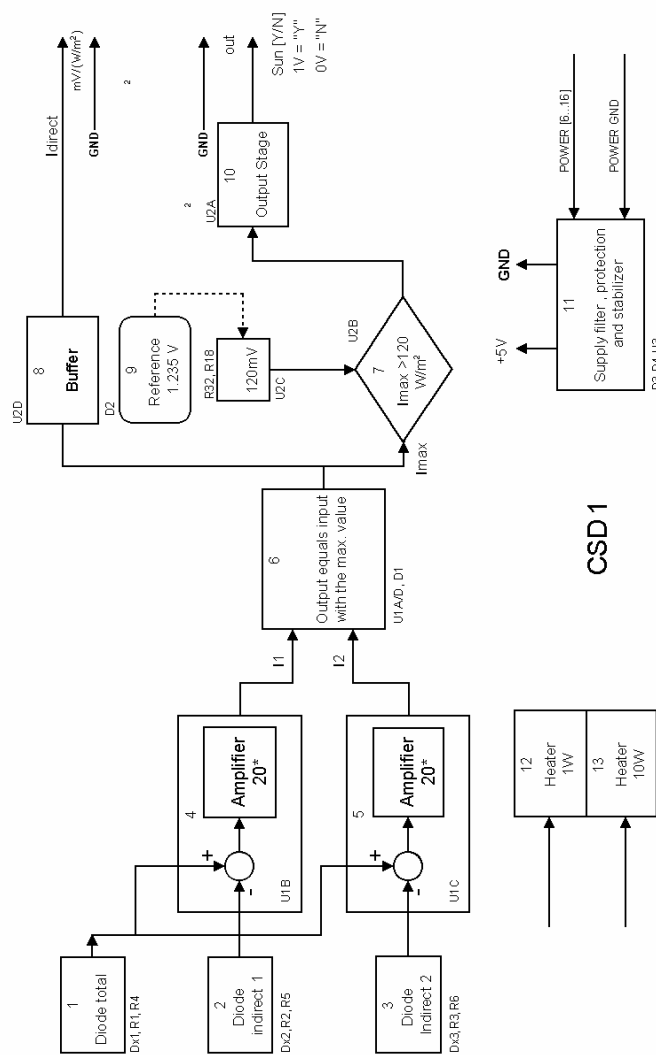


Figure 8.1 Electrical diagram CSD1







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## 8. RECALIBRATION SERVICE

### **Pyranometers, UV Radiometers, Pyrgeometers & Sunshine duration meters**

Kipp & Zonen solar radiation measurement instruments comply with the most demanding international standards. In order to maintain the specified performance of these instruments, Kipp & Zonen recommends calibration of their instruments at least every two years.

This can be done at the Kipp & Zonen factory. Here, recalibration to the highest standards can be performed at low cost. Recalibration can usually be performed within four weeks. If required, urgent recalibration can be accomplished in three weeks or less (subject to scheduling restrictions). Kipp & Zonen will confirm the duration of recalibration at all times. Please note that special quantity recalibration discounts are available.

For your convenience we added three fax forms to schedule the recalibration of your instrument(s) at Kipp & Zonen.





RECALIBRATION FORM

NAME :
COMPANY/INSTITUTE :
ADDRESS :
CITY + POSTCODE :
COUNTRY :
PHONE :
FAX :
E-MAIL :

I would like to receive a price list for recalibration

I would like to submit my instruments for recalibration

Table with 3 columns: Type/Model, Qty, Requested delivery time. It contains two rows for delivery dates: 'I intend to send the instruments to Kipp & Zonen on:' and 'I would like to receive the instrument(s) back on:'.

Conformation by Kipp & Zonen

- Yes, the dates are acceptable to us
No, unfortunately the dates do not fit into our calibration schedule.

We suggest the following dates:

...../...../.....
...../...../.....

Fax +31-15-262-0351

or mail to:
Kipp & Zonen,
P.O. Box 507, 2600AM Delft, The Netherlands





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I would like to submit my instruments for recalibration

Type/Model:	Qty:	Requested delivery time
		I intend to send the instruments to Kipp & Zonen on: ...../...../.....
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Confirmation by Kipp & Zonen
<p><input type="checkbox"/> Yes, the dates are acceptable to us</p> <p><input type="checkbox"/> No, unfortunately the dates do not fit into our calibration schedule. We suggest the following dates: ...../...../..... ...../...../.....</p>

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**RECALIBRATION FORM**

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**Conformation by Kipp & Zonen**

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No, unfortunately the dates do not fit into our calibration schedule.

We suggest the following dates:

...../...../.....

...../...../.....

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or mail to:

**Kipp & Zonen,**

**P.O. Box 507, 2600AM Delft, The Netherlands**





## CUSTOMER SUPPORT

Our customer support remains at your disposal for any maintenance or repair, calibration, supplies and spares. The address is as follows:

Für Servicearbeiten und Kalibrierung, Verbrauchsmaterial und Ersatzteile steht Ihnen unsere Customer Support Abteilung unter folgender Adresse 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. Leur adresse est la suivante :

*Holland* **Kipp & Zonen B.V.**  
Röntgenweg 1  
2624 BD DELFT  
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**F** +31 15 262 0351  
**E** [kipp.holland@kippzonen.com](mailto:kipp.holland@kippzonen.com)

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**F** +33 1 49 62 4102  
**E** [kipp.france@kippzonen.com](mailto:kipp.france@kippzonen.com)

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