Kipp & Zonen

INSTRUCTION MANUAL

CM 3

PYRANOMETER

0338 300

IMPORTANT USER INFORMATION

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

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

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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 use and other related exposures, however caused, arising from the faulty and incorrect use of the product.

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Manual version: 1004

CE

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: **CM 3**
Name: **Pyranometer**

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

Imissions	EN 50082-1	Group standard
Emissions	EN 50081-1 EN 55022	Group standard

Following the provisions of the directive

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

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1 GENERAL INFORMATION

The pyranometer CM 3 is an instrument for measuring the solar irradiance. The sensor construction is such that it measures the solar energy that is received from the whole hemisphere (180 degrees field of view). The output is expressed in Watts per metre square.

Pyranometers can be specified according to the intern standard ISO 9060 (also accepted by WMO). CM 3 is a second class pyranometer.

The pyranometer is designed for continuous outdoor use. Because of the fact that it has a flat spectral sensitivity from 0.3 to 3 microns, its calibration is valid for natural sunlight and for most types of artificial light (Xenon lamps, Halogen lamps ect). For the same reason, use of CM 3 is suggested for use with other spectra, e.g. under plant canopy or reflected solar radiation.
In its most frequent application the pyranometer is used for measuring the solar radiation falling on the horizontal surface. It can however also be used to measure in the inverted or in a tilted position.

Two pyranometers can be used in combination with an albedometer fixture CAF 1 to form an albedometer.
CM 3 can be levelled using CLF1.

1.1 TEN MINUTES USER GUIDE

Requirements: pyranometer, voltmeter with a range from 0 to 50 millivolt and an input impedance of more than 20.000 ohm, light.

-Connect the red wire to the voltmeter **+**, the blue wire to the voltmeter **-**, the shield to ground.
-Position the instrument such that the sensor is parallel to the surface that you want to investigate. Avoid contact of the instrument with mounting plates of a temperature that differs from ambient temperature. Pyranometer, mounting plate and ambient air should be at the same temperature as much as possible. Let CM 3 rest for at least five minutes to get to thermal equilibrium.
-Put the voltmeter range to the most sensitive.
-Darken the sensor. The signal should read zero. Mind that the response takes about one minute. Small deviations from zero signal are possible; this is caused by thermal effects like touching the pyranometer with your hand. The latter effect can be demonstrated by deliberately heating CM 3 with your hand. Another cause might be the zero offset of the amplifier. When this is the case, the same offset will also be present when the amplifier is short circuited with a resistance of 200 ohms. This is an amplifier error.
-Expose the sensor to light. The signal should give a positive reading.
-Adjust the voltmeter range in such a way that the expected full scale output of the pyranometer fits the full scale input of the voltmeter. This can be done on theoretical considerations. (When the maximum expected radiation is 1500 Watts per metre square, (this is under normal outdoor sunshine) and the sensitivity of the pyranometer is 15 microvolts per Watt per metre square, the expected output range of the pyranometer is 1500 times 15 makes 22500 microvolts or 0.0225 volts.)

-Calculate the radiation intensity by dividing the pyranometer output (0.0225 volts) by the calibration factor (0.000015 volt per watt per metre square).
- For permanent installation mounting should be done using the holes through the pyranometer body. Mounting should be such that the field of view of the sensor is free from obstructions. Under no condition a shadow should be cast upon it.
- Maintenance: the sensor should be kept clean, using water or alcohol.
- Recalibration is suggested every two years, preferably by recalibration at the factory, otherwise by letting a higher standard run parallel to it during two sunny days, and by comparing the results. Deviations of more than 6% can be used to correct the calibration factor.

2 INSTRUMENT PROPERTIES

A drawing of the pyranometer is shown in figure 2.1.
The pyranometer consists of a thermopile sensor, housing, a dome and a cable. The thermopile is coated with a black absorbant coating. The paint absorbs the radiation, and converts it to heat. The resultant energy flow is converted to a current by the thermopile.
Most electrical specifications are determined by thermopile.
Spectral specifications are determined by the thermopile and the dome.
The thermopile is encapsulated in the housing in such a way that it has a field of view of 180 degrees, and that its angular characteristics fulfil the so-called cosine response.

2.1 ELECTRICAL

The electrical circuit of the pyranometer is drawn in figure 2.2.
The nominal output resistance of the pyranometer is 200 ohm. This implies that the input impedance of the readout equipment should at least be 20.000 ohm in order to make an error of less than 0.1 percent.
Cable can be extended without problems to a length of 100 metres, provided that cable resistance is less than 0.1 percent of the input impedance of the readout equipment.

The electrical sensitivity of the thermopile changes with the temperature. This change however is minimised. Calibration is done at 20 degrees Celsius and traceable to the World Radiometric Reference.

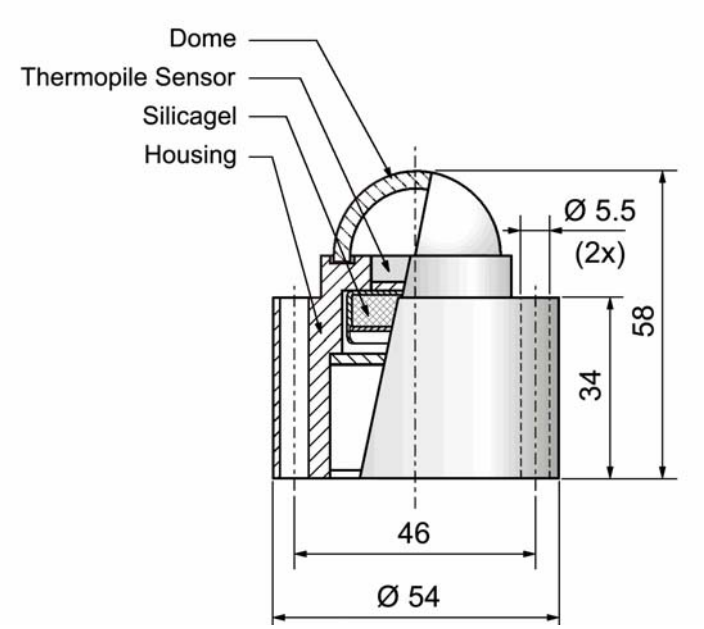

Figure 2.1 Construction Details of the CM 3 Pyranometer

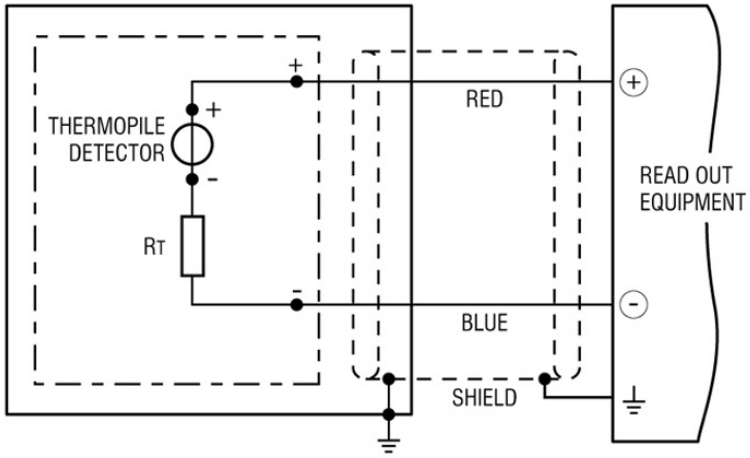

Figure 2.2 Electrical circuit of the pyranometer CM 3

2.2 SPECTRAL

The spectral properties of the pyranometer are mainly determined by the properties of the black paint and the glass dome. These are indicated in figure 2.3.

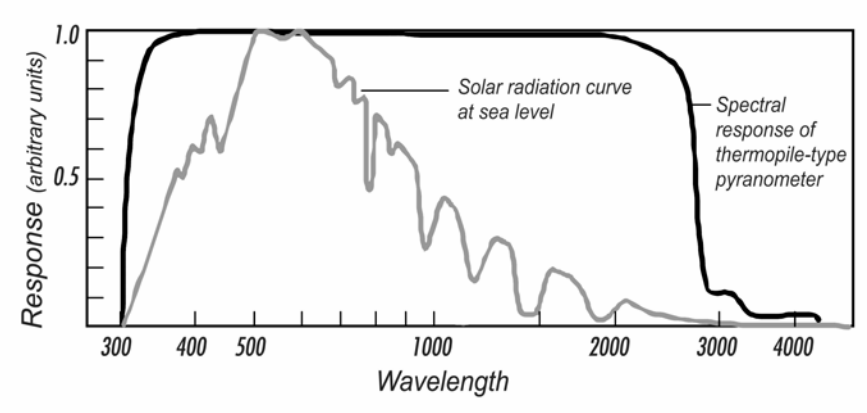

Figure 2.3 The spectral sensitivity of the pyranometer combined with the spectrum of the sun under a clear sky.

2.3 DIRECTIONAL / COSINE RESPONSE

The measurement of the solar radiation falling on a surface (also called irradiance or radiative flux) requires two assumptions: that the surface is spectrally black (that it absorbs all radiation from all wavelengths) and that it has a field of view of 180 degrees. Another way of expressing these directional properties is to say that the sensor has to comply with the cosine response.
A perfect cosine response will show maximum sensitivity (1) at an angle of incidence of 0 degrees (perpendicular to the sensor surface) and zero sensitivity at an angle of incidence of 90 degrees (radiation passing over the sensor surface). In between 0 and 90 degrees the sensitivity should be proportional the cosine of the angle of incidence. Figure 2.4 shows the behaviour of a typical pyranometer CM 3. The vertical axis shows the deviation from ideal behaviour, expressed in percents of the ideal value.

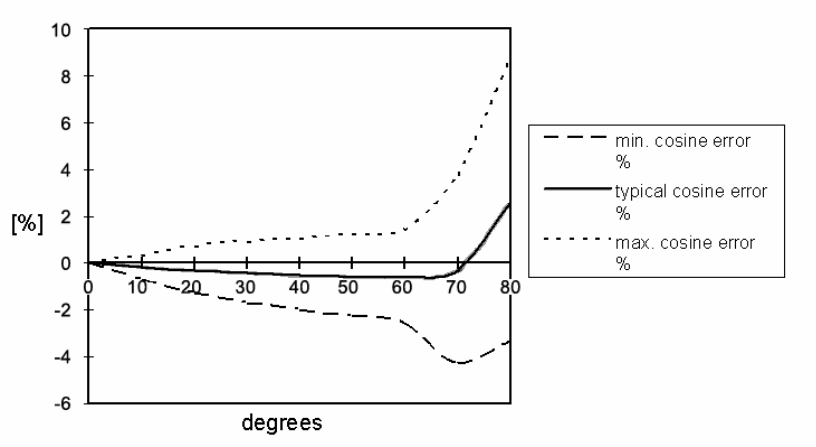

Figure 2.4 The mean cosine response of the pyranometer. On the horizontal axis the angle of incidence. On the vertical axis the percentage deviation from ideal cosine behaviour.

2.4 LIST OF SPECIFICATIONS

ISO specifications:	
Response time 95%	18 s
Zero offsets 1 and 2	
1: 200 W/m^2 thermal radiation	< 15 W/m^2
2: 5 K/h change in ambient	
Temperature	< 4 W/m^2
Non-stability	< 1% change per year
Non-linearity	± 2.5% (D1000 W/m^2)
Directional error	< ± 25 W/m^2 at 1000 W/m^2
(for beam radiation)	
Spectral selectivity	± 5% (350-1500 nm)
Temperature dependence	
of sensitivity	6% (-10 to +40°C)
Tilt response	< ± 2%

Overall ISO classification: second class

Other specifications:	
Sensitivity	10 - 35 µV/Wm^{-2}
Impedance	60 - 200 Ohm
Operating temperature	-40 to +80°C
Cable length	5 m
Spectral range	305-2800 nm (50% points)
Expected signal range for	
Atmospheric application	0 - 50 mV
Expected accuracy for	
Daily sums	± 10%

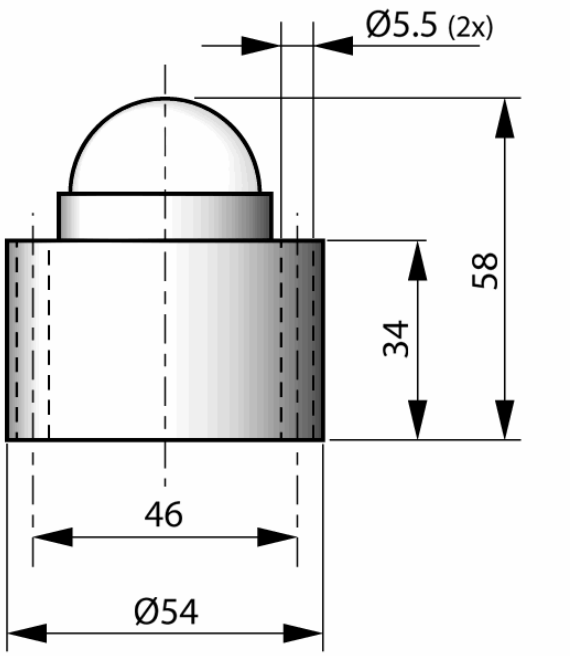

Figure 2.5 Dimensions of CM 3 in mm

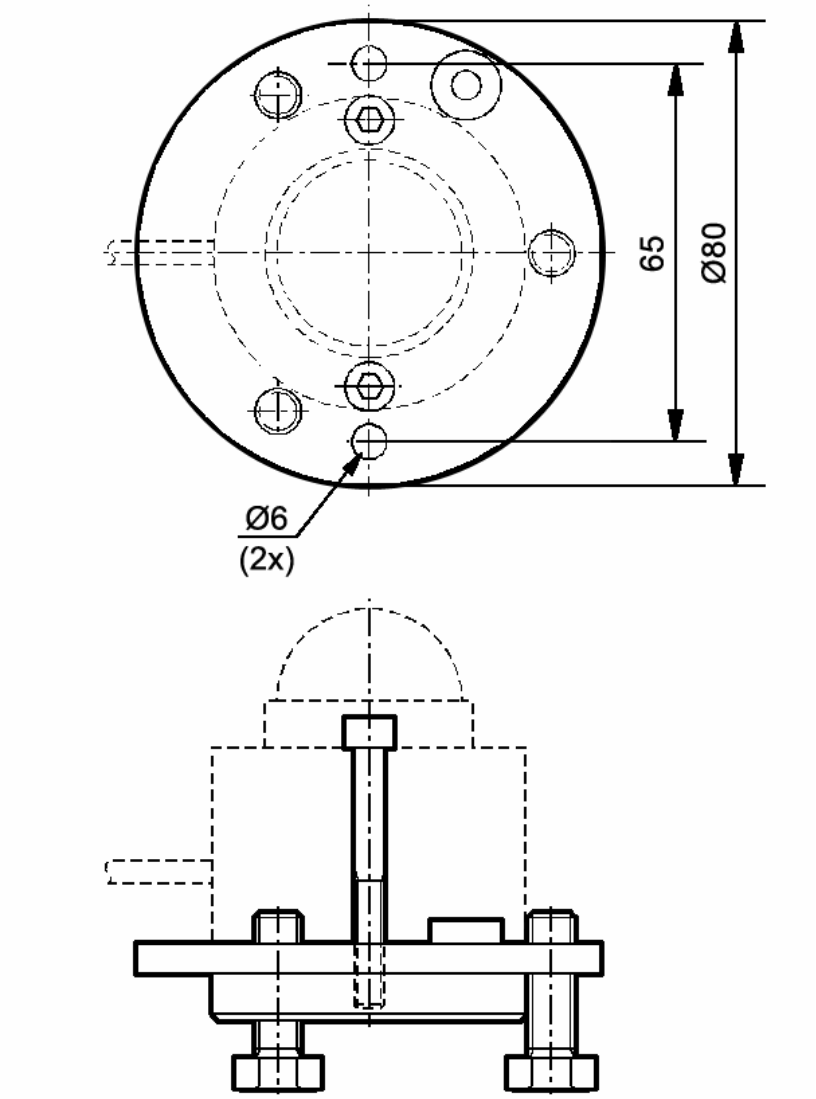

Figure 2.6 Dimensions of CLF1 in mm

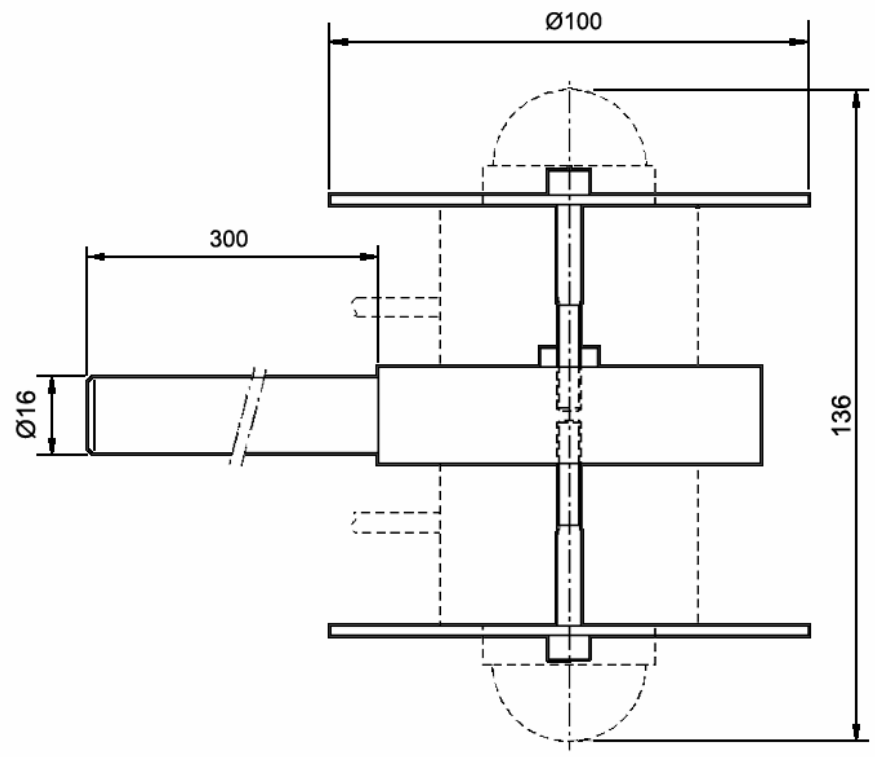

Figure 2.7 Dimensions of CAF1 in mm

3 CALIBRATION

The primary standard for pyranometers is the World Radiometric Reference. Reference pyranometers that are used at Kipp & Zonen are calibrated using the primary standard.
Kipp & Zonen CM 3 calibration is traceable to the World Radiometric Reference.
Further reference conditions are as follows: temperature 20 degrees Celsius, irradiance 500 Watts per metre square. Each pyranometer is supplied with an individual calibration factor. This factor can be found on the instrument and on the added calibration certificate.

4 INSTALLATION AND MAINTENANCE

When installed permanently, the pyranometer can be attached to its mounting platform by means of the holes that are drilled through the body.
Preferred orientation is with the cable pointing to the nearest pole (this prevents excessive heating of the leads). When installed on a mast, preferred orientation is such that no shadow is cast on the pyranometer during any time of the day. On the northern hemisphere this implies that the pyranometer should be south of the mast.

The pyranometer can be used to measure reflected radiation, for instance when pointed towards the earth in the inverted position. When measuring reflected radiation (with the albedometer) it is advised to do this at a height of at least 1.5 meters above the surface, to avoid shading effects and to promote spatial averaging.

The pyranometer is an all weather instrument.
Once installed the pyranometer needs little maintenance. It is suggested to clean the window as part of a regular routine, using water or alcohol.

Recalibration is suggested every two years. This can be done in two ways. The first is by comparison to the measurement of a similar sensor at the same site. Preferably daily totals of several days should be compared. Calibration factor could be corrected if results differ by more than six percent.
The second way is to let a recalibration be performed at the Kipp & Zonen factory (see APPENDIX I recalibration service).

5 TROUBLE SHOOTING

If your pyranometer does not seem to work at all, please follow the following procedure:

- Check if the pyranometer reacts to light, using the procedure in the “ten minutes user manual".
- No result? Measure the impedance of the sensor across the blue and the red wires. This should be close to 200 ohms. If it is close to five ohms, there is a short circuit. If it is infinite, the circuit is blown.

If the pyranometer shows bigger or smaller results than expected, the following questions might help you out:

- Are you measuring under natural sunlight? If so the maximum expected radiation is 1500 Watts per metre square. Under lamps this might be more.
- Are you correcting for the calibration factor? Please mind that this factor is an individual property, that is different for each sensor. Do you divide by the factor? This is correct.
- What is the input impedance of your readout equipment? It should preferably be more than 20000 ohm. If smaller than 1000 ohm you will notice errors.
- Is your readout equipment properly calibrated?

If still no satisfactory answer is found, please contact your supplier.

6 DELIVERY

Delivery includes:

1 Pyranometer
1 Calibration certificate
1 Manual

7 ACCESSORIES

The following accessories can be used:

Kipp & Zonen albedometer fixture CAF1 (can be combined with two CM 3 instruments)	**0338701**
Kipp & Zonen shadow ring CM121 (CLF1 levelling fixture needed for CM 3)	**0346900**
Kipp & Zonen levelling fixture CLF1	**0338700**
Kipp & Zonen SOLRAD Radiation Indicator Hand-held solar radiation integrator for direct reading and recording. Single channel with LCD display, RS232 output, internal data storage of 31 measured integration values. Includes: 115 / 230 VAC mains adapter, internal 9 V battery, 3 m long 9 pin RS232 communication cable, tool for connecting sensors, Windows™ based read-out software , manual.	**3303008**

APPENDIX I RECALIBRATION SERVICE

Pyranometers, UV-meters, Pyrgeometers & Sunshine duration sensors

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.

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

☐ **I would like to receive a price list for recalibration**

☐ **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: . . . . . ./. . . . . ./. . . . .
		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 +31-15-2620351

or mail to:

Kipp & Zonen P.O. Box 507 2600AM
Delft The Netherlands

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

☐ **I would like to receive a price list for recalibration**

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Fax +31-15-2620351

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, Verbrauchs-material 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 :

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