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USER'S GUIDE

for

MIDDLETON SOLAR

CN1-R NET PYRRADIOMETER

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Middleton Solar
20/155 Hyde Street
Yarraville
Victoria 3013
Australia

www.middletonsolar.com
Fax: +61-3-9689 2384

adm@middletonsolar.com
Phone: +61-3-9396 1890

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1 INTRODUCTION

The Middleton CN1-R is a pyrradiometer for the measurement of net total radiation flux (solar, terrestrial, and atmospheric). It can be used for portable or stationary applications.

2 CONSTRUCTION AND PRINCIPLES OF OPERATION

The head of the CN1-R is cast from epoxy resin and has a weather resistant polyurethane finish. A double sided sensor thermopile is fitted to the middle of the head and is protected from wind and rain by semi-rigid polythene domes. The instrument is hermetically sealed to keep the domes inflated and dry. A circular level is fitted into the head to aid in levelling of the sensor.

The sensor consists of a zigzag shaped 250-junction thermopile bonded between a pair of thin flat aluminium plates. The aluminium plates are blackened with a coating that has a flat spectral response through the spectrum from visible light to far infra-red.

Incident radiation from the sky is absorbed by the upper sensor disc, resulting in an elevation of its temperature. Incident radiation from the ground is absorbed by the lower sensor disc, resulting in an elevation of its temperature. A temperature gradient forms between the upper and lower junctions of the thermopile, resulting in a linear emf output which is proportional to the differential magnitude of the upper and lower irradiance.

3 INSTALLATION

3.1 SITE SELECTION

The instrument should be setup in such a way as to sample a patch of ground as free as possible from artificial obstructions including the mounting structure. Care should be taken to site the instrument so it is not affected by shadows or reflected light from buildings, windows or other bright surfaces. Also avoid siting near sources of artificial light.

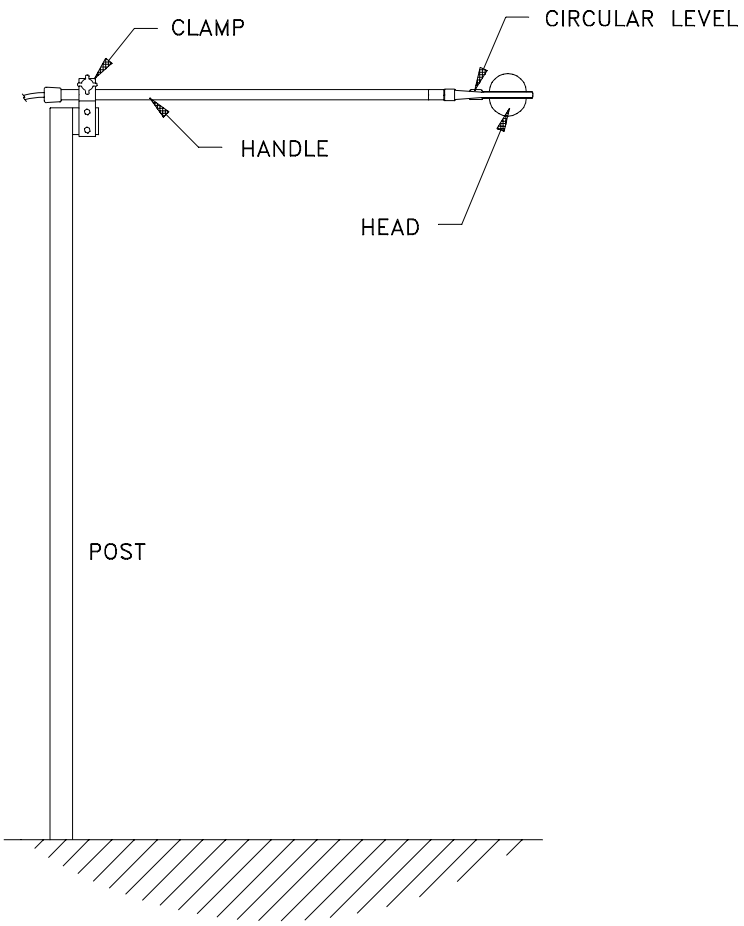
3.2 MOUNTING

The CN1-R should be clamped by its handle to a post or other appropriate structure (see Figure 1). The position of the head should be adjusted until the circular level is centred.
The height of the head above ground is not critical; 1 to 2m is recommended.

The voltage output signal can be recorded using an automatic data logger (having a suitable amplifier) or similar measuring device that can accept an input in the range of 0-50mV. The measuring device should exceed 1MΩ input impedance.

The blue output wire from the CN1 head is negative and the red wire is positive when the circular level is facing upwards (the polarity is reversed if the circular level is facing downwards).

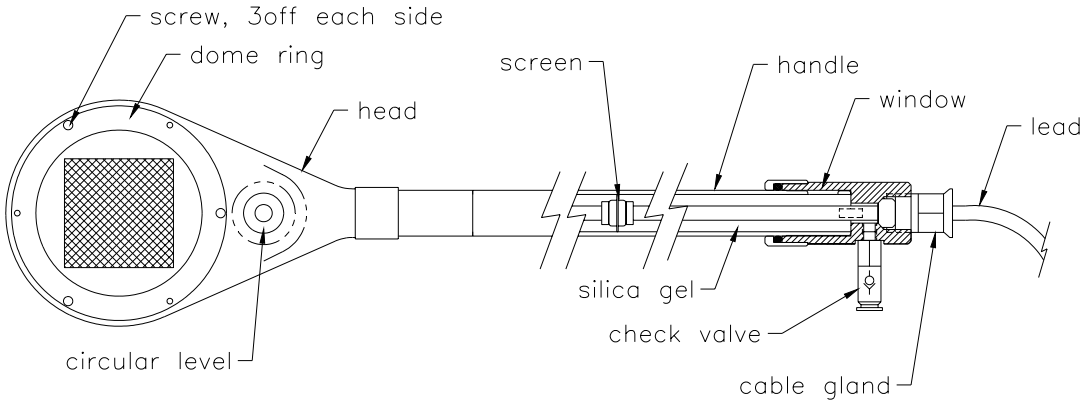
Figure 1. CN1-R Mounting



3.3 DOME INFLATION

Refer to Figure 2.
The instrument is supplied with the semi-rigid domes deflated.
Blow into the check valve until the domes just inflate[1]. A fall in temperature may cause the domes to temporarily partially loose their tension as the internal pressure decreases[2].

Figure 2. CN1-R Instrument



4 MAINTENANCE

Remove dust and dirt from the domes regularly. Wipe gently with a damp chamois and mild detergent. Do not use a sponge or cloth as scratching will result. Do not allow dew to accumulate as this may obscure the long wave transparency of the domes.

Inspect the condition of the silica gel desiccant. The crystals, as seen through the window in the end of the handle, should be blue. Replace them if they are pink.

Inspect both sides of the sensor to ensure that the blackened surface is not faded or flaking. If either of these occurs the unit should be repaired and calibrated.

Inspect the head for crack damage due to rough handling. Repair any external cracks with epoxy adhesive as water ingress may corrupt the sensor signal. Cracks inside the dome perimeter generally render the instrument beyond repair.

The polythene domes should be replaced as a pair every six months if the instrument is in continuous use, or sooner if they show signs of reduced transparency or are damaged. Changing the domes will not alter the calibration.

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[1] Use lung air pressure or Dome Inflator (see Section 8.2); insert a blunt probe (eg match stick) to lightly depress the check valve ball if the valve is stuck closed; avoid using compressed air as the domes may burst.
If the check valve is fitted with a dust-plug, release the dust-plug by pushing inwards on the blue ring of the check valve, and remove the plug.
[2] The free end of the output lead is sealed to prevent air leakage down the lead; do not breach this seal.

4.1 DOME REPLACEMENT

Refer to Figure 2.
Hold the instrument head and remove the six screws securing the dome holding rings together. Do not support the instrument by the handle as you may crack the head stem. Loosen the six screws evenly and progressively so as not to overload a single screw and strip its thread. Remove the rings, the old domes, and the gaskets while taking care not to touch the sensor surface. Carefully position the gaskets and ring/dome on the head. Fit the six screws and tighten them evenly and progressively.
Check the silica gel and replace if necessary. Inflate the domes and check the instrument for leaks (by immersion in water)[3].

4.2 SILICA GEL REPLACEMENT

Refer to Figure 2.
Loosen the cable gland, but do not remove it. Pull the cap from the handle and slide it along the lead. Remove the old silica gel and fill the handle with fresh silica gel. Smear a little silicone paste on the end of the handle and replace the cap; take care not to damage the O-ring in the cap, and make sure that the slot on the end of the handle is aligned with the pin inside the cap. Pull the lead tight and secure the cable gland. Inflate the domes and check for leaks.

5 CALIBRATION

Each CN1-R instrument is individually calibrated for short-wave and long-wave response and is supplied with a calibration certificate showing the sensitivity in $\mu V/W.m^{-2}$ for the particular instrument. When necessary diagonal white lines are painted on the sensor surface to selectively attenuate the response to short-wave radiation (the lines are transparent to long-wave radiation) and thus balance the spectral response. The calibration is undertaken by indoor comparison with a reference net pyrradiometer. The reference pyrradiometer calibration is traceable to the WMO standard. It is recommended that the instrument be recalibrated annually.

[3] use silicone sealant between ring and body to cure persistent leaks

6 TECHNICAL SPECIFICATION

6.1 PERFORMANCE

viewing angle	4π steradians
sensitivity (typical)	25 μV/W.m^{-2}
impedance	70-80 ohm
response time	45 sec @95%
non-stability	+2%, -1% per year
non-linearity	<± 1% at 500W/m2
operating temperature	-40° to +60°C
temperature response	-0.05%/ºC
cosine response (at 80º incidence)	-4% of ideal
spectral range	0.3 to 60μm

6.2 PHYSICAL

sensor: 38x38mm; 250 copper/constantan thermocouples

domes: 0.4mm polythene film (UV stabilised)

head: cast epoxy resin; polyurethane enamelled gloss white

external fittings: chrome plated brass

handle: anodised aluminium

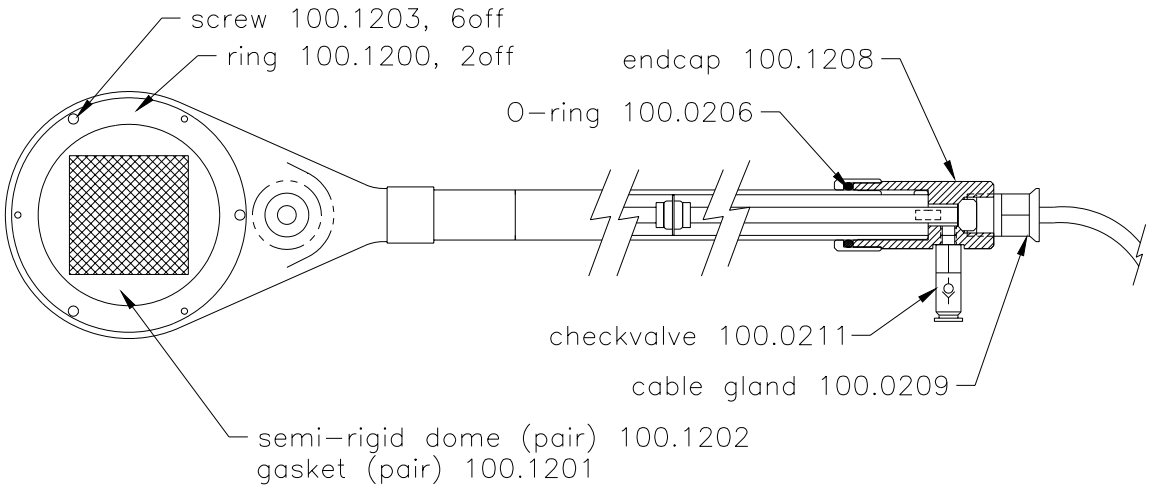
output lead: 2m

7 SPARE PARTS

Spare parts may be ordered from the manufacturer or through an approved distributor. The part names and numbers are shown in Figure 3. Please quote both when ordering. It is also important when ordering parts to include the Serial Number of the instrument.

It is recommended that a damaged instrument be returned to the manufacturer or approved distributor for repair.

Figure 3. CN1-R Part Numbers



8 OPTIONAL ACCESSORIES

8.1 DOME INFLATOR

P/N 100.1235

The Dome Inflator is a hand operated rubber bladder that fits to the checkvalve on the handle of the CN1-R.

8.2 SIGNAL AMPLIFIER

The Signal Amplifier is designed to boost the output of the CN1-R. The typical non-amplified output ranges from -5 to +30mV full scale. The amplifier has a 100X gain with an output zero-offset of 0.5V. The unit is in a small IP65 sealed box, and requires 5.5-14.5VDC, 5mA, supply.

8.3 HANDLE CLAMP

P/N 101.1036

The Handle Clamp clasps the handle of the CN1-R so it can be bolted to a vertical pole.

8.4 UNIDIRECTIONAL ADAPTOR

P/N 100.1236

This Adapter consists of an internally blackened aluminium cavity that can be screwed to one side of a CN1-R head in place of the standard polythene dome and holding ring. It is used to convert the CN1-R to a single sided instrument. The temperature of the cavity is monitored by an inbuilt thermocouple. The Adaptor can not be used with the Heating Ring.