
User Manual for the

Net Radiometer

type NR2



NR2-UM-1.1

AT
DELTA-T DEVICES

CONTENTS

| | |
|-------------------------------------|----|
| INTRODUCTION | 3 |
| DESCRIPTION | 3 |
| UNPACKING AND INSTALLATION | 4 |
| CONNECTIONS TO DELTA-T LOGGERS..... | 6 |
| MAINTENANCE | 7 |
| CALIBRATION AND ACCURACY | 7 |
| GUARANTEE, REPAIRS AND SPARES..... | 9 |
| SERVICE AND SPARES..... | 9 |
| REFERENCES | 10 |
| APPENDIX | 10 |

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In this manual, all references to loggers and weather stations relate to the Delta-T Logger DL2, its software LS2Win, and the WS01 Weather Station, and the sensor codes used with them. The references also apply to the DL2e and its derivatives.

For the DL3000 logger, you must refer to the DL3000 documentation which contains specific connection details and sensor type codes used by the DL3000. General information in this manual concerning the performance and installation of the sensor remains relevant.

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INTRODUCTION

The first part of this manual provides a brief summary of the factors you need to consider when installing the Net Radiometer type NR2 and connecting it to Delta-T Loggers. Reference is made to the appendix pages (called A1, A2 etc) which contain more detailed information on the performance and specifications and maintenance of the instrument.

Net Radiation

Net radiation is an important quantity governing evapotranspiration from surfaces and vegetation. When combined with measurements of windspeed, temperature and humidity, estimates of potential evapotranspiration can be derived from the Penman-Monteith equation. This, together with rainfall data can be used to calculate soil moisture deficit.

The NR2 may also be used as a reference instrument in experiments requiring the use of Tube Net Radiometers.

Instruments used for measuring net radiation are called net pyrradiometers by the WMO (World Meteorological Organisation), but the term net radiometer will be used in this manual for brevity. Full details of WMO procedures and guidance for using net radiometers can be found in ref.1.

DESCRIPTION

The NR2 net radiometer has a thermopile sensor head which is exposed to both the downward and the upward fluxes of radiation. The thermopile produces a millivolt output proportional to the net flux of radiant energy. If the net flux is downwards, a positive signal is produced, whereas if the net flux is upwards (which may occur at night) the signal becomes negative.

The thermopile is shielded from wind and rain by thin polythene domes. In order to prevent condensation occurring inside the domes, a desiccant tube is incorporated in the support arm of the radiometer. The desiccant material must be refreshed from time to time, and the polythene domes must be replaced if they become degraded by sunlight, or physically damaged.

UNPACKING AND INSTALLATION

Unpacking

The instrument is ready for installation. Check the consignment immediately on arrival and contact your agent or Delta-T Devices if damage has occurred, or if any parts on the packing list are missing.

Siting the net radiometer

(See pages A3-4)

Generally, the WMO recommendation (see ref.1) is that a height of 2 m above short homogeneous vegetation is adopted. Practical considerations may require a compromise height of between 1 and 2 m.

The upward facing surface of the sensor requires a site free from obstructions around the horizon, or at least having no obstruction of angular size greater than 5° in any direction which has a low sun angle at any time during the year.

The sensor head must be installed above the surface of interest. The downward facing surface of the sensor is influenced most by the ground directly beneath the sensor, which must of course be as representative as possible of the surrounding terrain. For a sensor mounted 1 m above the surface, 90% of all the radiation measured is emitted by a circular surface of diameter of 6 m, 95% by one of 9 m, and 99% by one of 20 m.

The output of a sensor located too close to the surface will show large effects due to its own shadow, and may be affected by other parts of the weather station appearing in the field of view.

If the surface close to the M2 mast is not representative, an alternative site for the NR2 must be found in the vicinity, and a separate mast or mounting method must be provided. Extension of the cable may also be required.

Mounting brackets, and support arm extension

The NR2 is supplied with a tube mounting bracket which fits on to the Delta-T weather station M2 mast. Using this you can position the NR2 sensor head up to 0.85 m horizontally away from the mast. An optional 1 m support arm extension tube increases this capability to about 1.75m.

When using the Delta-T support arm extension, you will have to remove the support arm from the extension tube to gain access to the desiccant tube. Leave enough slack in the cable to facilitate this.

An additional clamping bracket is provided if you are not using the standard M2 mast. See page A4 on the importance of levelling the NR2 sensor head.

Bird damage prevention

If bird damage is likely to be a problem, follow the recommendations on pages A3, A13.

WIRING CONNECTIONS

(See page A4)

7 m of twin core screened cable is fitted.

Red core: Output +ve (Signal HI)

Black core: Output -ve (Signal LO)

Connect the output +ve to the high side and the output -ve to the low side of an input channel or measuring device. The bubble level must be mounted facing upwards. A positive output indicates that the net radiation flux is downwards (incoming).

Connect the screen to a good earth or ground connection at the measuring instrument end (only). This will help reduce possible electronic interference in the cable. The screen is not connected to any metal parts of the NR2 itself.

Extra cable

If you need to extend the cable, you can join additional similar screened cable to it, up to a total length of about 50 m. The calibration of the NR2 will not be affected, but you must check that noise problems do not occur if the cable is situated in an electrically noisy environment. Make sure the cable joints are weatherproof.

CONNECTIONS TO DELTA-T LOGGERS

The NR2 gives a low level voltage signal which will range from between about +70 mV dc to -20 mV dc in typical outdoor conditions.

Single ended voltage measurement is recommended, using the 15-channel channel mode on the DL2(e) LAC1 input card. Please refer to your DL2(e) User Manual for complete information.

Connections

On the logger terminal connector for the required input channel:

- connect the signal HI wire to the "+" terminal
- connect the signal LO wire to the "-" terminal
- connect the "-" terminal to the analogue earth terminal on the screw connector block
- connect the cable screen to a digital earth (61 "-" or 62 "-") or a frame connection.

Configuring the Logger channel

Create a sensor code for the NR2 sensor, and configure the input channel for

- voltage measurement
- base units: mV
- engineering units: W.m⁻²

Logger Conversion Factor(s)

This is the mV per W.m⁻², which corresponds to the value of sensitivity shown on your NR2 calibration certificate.

The NR2 in general has somewhat different sensitivities for positive and negative signals. This presents no problems for sophisticated loggers such as the DL3000, but requires a special approach for simpler loggers such as the DL2(e).

Two methods can be used:

1. Single conversion factor

Use only the positive sensitivity for all readings. After the results have been collected, identify any negative readings, and apply a correction to them. The correction will be:
Corrected reading = Logged reading x negative sensitivity / positive sensitivity

2. Linearisation Table

Construct a linearisation table using the positive sensitivity for values above zero and the negative sensitivity for values below zero. An *example* is given below. You must use the values on your calibration certificate if you adopt this method.

| W.m ⁻² | mV | Sensitivity |
|-------------------|---------|---------------------------------|
| -200 | -17.120 | 0.0856 mV per W.m ⁻² |
| 0 | 0.000 | |
| 200 | 21.600 | 0.108 mV per W.m ⁻² |
| 400 | 43.200 | |
| 600 | 64.800 | |
| 800 | 86.400 | |

Sampling and data compression intervals

These can be specified in the logging configuration program.

Typical values could be sample at 1 minute intervals, and store the average every hour.

MAINTENANCE

Regular inspection

Ideally the NR2 should be inspected daily, or at frequent intervals, to ensure that the instrument is level and that the domes are undamaged and free of internal condensation.

Dome replacement

See page A8

Desiccant renewal

See page A9

Other attention

See pages A10-13

CALIBRATION AND ACCURACY

Specifications :See pages A1-3

Accuracy

The WMO (ref.1) recognises that in practice the precision of net radiation measurements is difficult to determine. Comparisons at different sites of different designs of net radiometer yield differences of 10% or more. No specific design of standard instrument is recommended by the WMO.

For consistency of results, we recommend either that you determine your own calibration method and use it, or where practical, return the instrument to Delta-T Devices regularly for recalibration.

Calibration Factors and sensitivities

The NR2 is unusual among net radiometer designs for providing different sensitivities for positive and negative net radiation flux (see page A2). The manufacturer has established this approach after much experimentation and testing.

Wind effect

Methods for correcting for the effects of ambient wind speed are presented in detail (see pages A5-8). Broadly speaking, correcting readings for windspeed will only be worthwhile in highest accuracy work. In everyday monitoring of net radiation, the improved accuracy obtained is likely to be swamped by errors from practical factors such as the presence of water on the domes.

NR2 Ventilator

For highest accuracy work a ventilator can be supplied. This has the advantages of stabilising the windspeed over the domes, and of greatly reducing spurious readings caused by the formation of dew, but it does require a continuous power supply of about 4 W. Please ask Delta-T for more information.

*EXAMPLE - for illustration only
Do not use these values!
Use the values on the certificate
supplied with the NR2*

DELTA-T DEVICES

NET RADIOMETER **Type NR2**

CALIBRATION CERTIFICATE

Serial Number:NR2-001.....

Date:..1 September 1996.....

Positive outputs (zero wind):

Calibration Factor:...9.30..... W.m⁻²/mV

Sensitivity:.....0.108..... mV/(W.m⁻²)

Negative outputs (zero wind):

Calibration Factor:.....11.68..... W.m⁻²/mV

Sensitivity:.....0.0856..... mV/(W.m⁻²)

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GUARANTEE, REPAIRS AND SPARES

Our Conditions of Sale ref: COND/91/11 set out Delta-T's legal obligations on these matters. For your information the following paragraphs summarise Delta-T's position but reference should always be made to our Conditions of Sale which prevail over the following explanation.

Instruments supplied by Delta-T are guaranteed for one year against defects in manufacture or materials used. The guarantee does not cover damage through misuse or inexpert servicing, or other circumstances beyond our control.

For the UK this means that no charges are made for labour, materials or return carriage for guarantee repairs.

For other countries, the guarantee covers free exchange of faulty parts during the guarantee period.

Alternatively, if the equipment is returned to us for guarantee repair, we make no charge for labour or materials but we do charge for carriage and UK customs clearance.

We strongly prefer to have such repairs discussed with us first, and if we agree that the equipment does need to be returned, we may at our discretion waive these charges.

SERVICE AND SPARES

We recognise that some users of our instruments may not have easy access to technically specialised backup.

Spare parts for our own repairable instruments can be supplied from our works. These can normally be despatched within 1 working day of receiving an order.

Spare parts and accessories for sensors not manufactured by Delta T, but supplied by us individually or as part of the weather station or other system, may be obtained from the original manufacturer. We will endeavour to obtain parts if requested, but a certain amount of additional delay is inevitable.

Should it prove necessary, instruments may be returned to our works for servicing. We normally expect to complete repairs of our own instruments within 2 days of receiving the equipment. Other manufacturers' sensors supplied by us and returned for servicing will take longer. They will have to be returned to the original manufacturer for servicing, and may be subject to additional delays of two to four weeks.

Users in countries that have a Delta-T Agent or Technical Representative should contact them in the first instance.

REFERENCES

Reference 1:

WMO No.8

'Guide to Meteorological Instruments and Methods of Observation', Fifth edition, 1983, of the World Meteorological Organization (WMO), Geneva, Switzerland.

APPENDIX

The following pages are supplied by the manufacturer.

DELTA-T DEVICES

NET RADIOMETER **Type NR2**

CALIBRATION CERTIFICATE

Serial Number:.....

Date:.....

Positive outputs (zero wind):

Calibration Factor:..... $\text{W} \cdot \text{m}^{-2}/\text{mV}$

Sensitivity:..... $\text{mV}/(\text{W} \cdot \text{m}^{-2})$

Negative outputs (zero wind):

Calibration Factor:..... $\text{W} \cdot \text{m}^{-2}/\text{mV}$

Sensitivity:..... $\text{mV}/(\text{W} \cdot \text{m}^{-2})$

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