

## Product certificate

 Pages: 4  
 Release date: 15 MAR, 2019

Product code **IR20-T2**  
 Product identification **serial number 4063**  
 Product type pyrometer  
 Measurand longwave radiation

### Calibration result

Sensitivity  **$S_0 = 11.60 \times 10^{-6} \text{ V}/(\text{W}/\text{m}^2)$**   
 Calibration uncertainty  **$\pm 0.52 \times 10^{-6} \text{ V}/(\text{W}/\text{m}^2)$**

the number following the  $\pm$  symbol is the expanded uncertainty with a coverage factor  $k = 2$ , and defines an interval estimated to have a level of confidence of 95 percent

Temperature coefficients  
 **$a = -16.1630 \times 10^{-6} \text{ }^\circ\text{C}^{-2}$**   
 **$b = 25.4523 \times 10^{-4} \text{ }^\circ\text{C}^{-1}$**   
 **$c = 0.9556$**

Measurement function  $E = U/(S_0 \cdot (a \cdot T^2 + b \cdot T + c)) + \sigma \cdot (T + 273.15)^4$   
 with E irradiance in  $[\text{W}/\text{m}^2]$ , U voltage output in [V],  $\sigma$  the Stefan-Boltzmann constant in  $[\text{W}/\text{m}^2/\text{K}^4]$ , T the instrument body temperature in  $[\text{ }^\circ\text{C}]$

### Product specifications

1: resistance **10.1  $\Omega$**   
 2: insulation resistance  **$> 100 \times 10^6 \Omega$**   
 3: cut-on wavelength (5 % transmission point)\*  **$4.5 \times 10^{-6} \text{ m}$**   
 4: spectral range (50 % transmission points)\*  **$4.7 \text{ to } 40.0 \times 10^{-6} \text{ m}$**

\*values valid for this instrument, complete transmission curve available on request via info@hukseflux.com

**Table 0.1 connections**

PIN	WIRE	
2	Red	10 k $\Omega$ thermistor [+]
3	Pink	10 k $\Omega$ thermistor [+]
6	Blue	10 k $\Omega$ thermistor [-]
8	Grey	10 k $\Omega$ thermistor [-]
1	Brown	heater
4	Yellow	heater
9	Black	ground
7	White	signal [+]
5	Green	signal [-]

The 10 k $\Omega$  thermistor is a single four-wire thermistor measuring instrument body temperature.

Calibration procedure according to Hukseflux IR20C. Traceability of calibration is to the WISG (World Infrared Standard Group) operated at the Infrared Radiometry Section of the World Radiation Center in Davos, Switzerland.

Please consult the user manual for information on measurement uncertainty during actual use and for product set up, operation and maintenance instructions.

**Person authorising acceptance and release of product:**  
 H.E. Brouwer

**Date:**  
 15 MAR, 2019



## Calibration certificate

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Product code	<b>IR20-T2</b>
Product identification	<b>serial number 4063</b>
Product type	pyrgeometer
Measurand	longwave radiation

### Calibration result

Sensitivity	<b><math>S_0 = 11.60 \times 10^{-6} \text{ V}/(\text{W}/\text{m}^2)</math></b>
Calibration uncertainty	<b><math>\pm 0.52 \times 10^{-6} \text{ V}/(\text{W}/\text{m}^2)</math></b>

the number following the  $\pm$  symbol is the expanded uncertainty with a coverage factor  $k = 2$ , and defines an interval estimated to have a level of confidence of 95 percent

Reference conditions	horizontal mounting, downward longwave irradiance, clear sky nights, 20 °C
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### Measurement process

Metrological characteristic	$S_0$ in $[\text{V}/(\text{W}/\text{m}^2)]$ ; sensitivity to downward longwave irradiance, with 180° field of view angle, valid for reference conditions
Calibration method	outdoor comparison to a reference pyrgeometer
Measurement function	$E = U/(S_0 \cdot (a \cdot T^2 + b \cdot T + c)) + \sigma \cdot (T + 273.15)^4$ with $E$ irradiance in $[\text{W}/\text{m}^2]$ , $U$ voltage output in $[\text{V}]$ , $\sigma$ the Stefan-Boltzmann constant in $[\text{W}/\text{m}^2/\text{K}^4]$ , $T$ the instrument body temperature in $[\text{°C}]$ and $a$ , $b$ , $c$ temperature coefficients <sup>1</sup>
Measurement equipment	Hukseflux Outdoor Test Facility
Calibration conditions	4 clear sky night(s) between 07 MAR, 2019 and 12 MAR, 2019. Temperature between 2.8 °C and 8.7 °C. Net radiation between -94.2 $\text{W}/\text{m}^2$ and -70.0 $\text{W}/\text{m}^2$

### Metrological traceability

Calibration traceability	to WISG (World Infrared Standard Group)
Working standard	pyrgeometer type IR20, serial number 4038
Calibration institute	PMOD World Radiation Center, Davos, Switzerland
Standard sensitivity <sup>2</sup>	$C = 7.90 \times 10^{-6} \text{ V}/(\text{W}/\text{m}^2)$

### Evaluation of the uncertainty of the calibration result

Uncertainty calculation	the calibration uncertainty calculated as the square root of the sum of the squares of the calibration uncertainty of the working standard, the uncertainty of the method and the uncertainty due to deviations from the reference conditions is $\pm 4.5 \%$ .
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### Person performing calibration:

M. Rietveld

### Date:

12 MAR, 2019

<sup>1</sup>  $a$ ,  $b$  and  $c$  are determined in the Hukseflux Temperature Response Characterisation, see separate page

<sup>2</sup>  $C$  was derived using pyrgeometer coefficients  $k_1 = -0.10$  and  $k_2 = 1.0048$



# Temperature response

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 Product type pyrgeometer  
 Measurand longwave radiation

**Characterisation result**

Temperature coefficients **a = -16.1630 x 10<sup>-6</sup> °C<sup>-2</sup>**  
**b = 25.4523 x 10<sup>-4</sup> °C<sup>-1</sup>**  
**c = 0.9556**

**Measurement process**

Characterised parameter dependence of sensitivity to temperature  
 Measurement function  $S(T) = S_0 \cdot (a \cdot T^2 + b \cdot T + c)$   
 with S(T) sensitivity in [V/(W/m<sup>2</sup>)] at an instrument body temperature T, S<sub>0</sub> sensitivity in [V/(W/m<sup>2</sup>)] at 20 °C instrument body temperature, T the instrument body temperature in [°C]  
 Measurement equipment Hukseflux Temperature Response Characterisation

**Table 0.2** temperature dependence test result

<b>TEMPERATURE DEPENDENCE TEST</b>									
T [°C]	-30	-20	-10	0	10	20	30	40	50
$\frac{S(T) - S_0}{S_0}$	-13.5 %	-10.2 %	-7.2 %	-4.4 %	-2.1 %	+0.0 %	+1.7 %	+3.2 %	+4.2 %

**Person performing characterisation:**  
 R. van den Dool

**Date:**  
 04 MAR, 2019